Community/Land Manager Waterwatch Guide

A guide for community monitoring of water quality and waterway health

waterwatch NEW SOUTH WALES
Communities Caring for Catchments

NSW GOVERNMENT Environment, Climate Change & Water

Australian Government

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The *Community/Land Manager Waterwatch Guide* and *Waterwatch Field Manual* are for use by the Waterwatch network, to support Waterwatch in New South Wales.

For more information about Waterwatch, check out the website:

www.waterwatch.nsw.gov.au

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How to use this guide

This *Community/Land Manager Waterwatch Guide* and the accompanying *Waterwatch Field Manual* have been designed as complementary resources for Waterwatch groups. Together they provide a complete guide to designing and implementing a community–based monitoring program.

This guide and the field manual both promote a strategic approach to Waterwatch monitoring that supports local and regional natural resource management and improved awareness and understanding of water quality and catchment health. The documents use a flexible approach, so that groups can select the resources that will assist them to achieve the objectives of their individual monitoring plan.

This guide also includes two sections specifically designed to meet the needs of landholders who wish to implement the Waterwatch program on their properties.

The methods and procedures described in the guide combine best practice and scientific rigour with straight-forward instructions, to guarantee the delivery of high quality data to the Waterwatch database. Such data becomes a valuable tool for natural resource managers to use in catchment planning.

The guide is divided into numbered sections:

Section 1: Introducing Waterwatch and maintaining healthy waterways
Section 2: Formulating a Waterwatch Plan
Section 3: Templates and checklists
Section 4: Waterwatch OH&S policy
Section 5: Background to the water quality tests
Section 6: Background to the habitat assessments
Section 7: Land managers' guide to water quality monitoring
Section 8: Management actions to improve water quality on farms
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This guide is to be used in conjunction with the *Waterwatch Field Manual* and contains cross-references to that document.

Congratulations on your involvement in Waterwatch!

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SECTION 1

Introducing Waterwatch and maintaining healthy waterways

Waterwatch is primarily concerned with the health of water catchments and the waterways they feed into. In this section you will be introduced to Waterwatch and its role in involving the community, including volunteer groups and landholders, in monitoring and maintaining healthy waterways.

1.1 Welcome to Waterwatch!

Waterwatch helps the community understand water quality issues and how to manage them within catchments, to create healthy waterways and promote the sustainable use of this precious and limited resource.

WATERWATCH VISION:

Current and future generations empowered and actively involved in the sustainable use and management of catchments.

In Australia, climate change, drought and the pressure of population have all contributed to increasing pressure on our water resources. When waterways are degraded by natural or human factors, it not only reduces freshwater supplies, but it also affects aquatic ecosystems.

Waterwatch uses action learning methods and by adopting an investigative approach, community groups, land managers and students can become involved in natural resource management within their local environment. Waterwatch engages communities by:

- raising awareness
- capacity building
- collection of quality assured community data
- participation in collaborative action
- building networks and partnerships.

Raising awareness

Waterwatch provides a range of programs, activities and events to raise awareness of water quality and sustainability issues. By promoting sustainable rivers and healthy catchments, Waterwatch aligns with key sustainability principles.

Capacity building

Waterwatch develops knowledge, skills and understanding of natural resource management issues by involvement in the care and management of local environments. This participatory approach to teaching and learning promotes quality teaching within schools and community involvement in local issues.

Collection of quality assured community data

Waterwatch provides a framework to support groups to develop and implement a monitoring plan that leads to the collection of quality assured community data. The data confidence standards of Waterwatch mean that the data can then be used for local natural resource planning and decision-making for on-ground action. Water quality data is stored on the NSW Waterwatch online database.

www.waterwatch.nsw.gov.au

Participation in collaborative action

Waterwatch facilitates the involvement of the community in actions to improve and/or restore the condition of their local creek, river, wetland or groundwater. Partnerships between community groups, schools, Catchment Management Authorities, local government agencies, catchment groups and businesses result in productive and sustainable joint projects. Collaborative projects to improve catchment health move Waterwatch from monitoring to action.

Building networks and partnerships

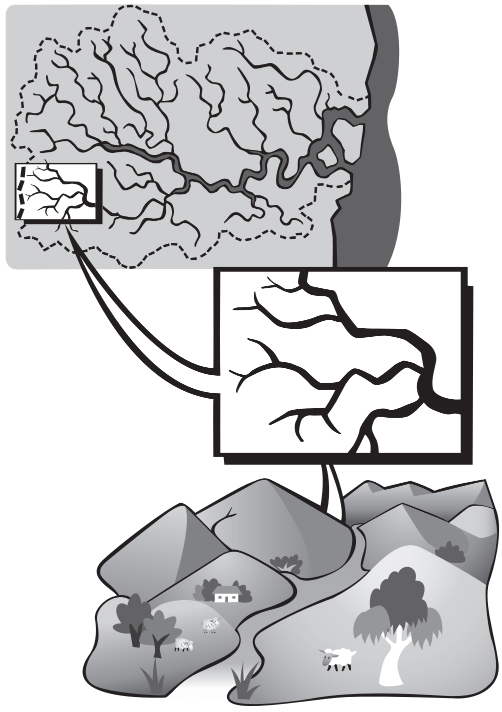
Integrated catchment management involves community groups, schools, the business sector and local and state government agencies working together to manage our precious natural resources. Waterwatch encourages and reinforces the value of community consultation and provides links to strong networks of environmental management and education. Waterwatch networks and partnerships enrich and strengthen the program throughout New South Wales while having the flexibility to meet local and regional needs.

1.2 Getting to know your place in the catchment

A catchment is an area of land catching rainfall that flows into a creek, river, wetland or ocean. It is essential to know where you are located within your catchment as activities upstream, downstream and in your local area, will impact on water quality and catchment health.

What is a catchment?

A **catchment** is an area of land catching rainfall that flows into a creek, river, wetland or the ocean. Hills or ridges separate each catchment and direct the flow of water into different waterways. Within catchments, there are natural features such as native vegetation, water, rocks and soils. However, catchments are also the places where people live, work and play. **Human use in catchments** can have an impact on water quality. This will affect the availability of water for a variety of uses.



Catchments occur at a variety of scales from very large catchments such as the Murray–Darling Basin to local creeks and streams that may only flow occasionally. The interconnectedness of catchments means that changes in water quality in small local catchments will impact on larger creeks and rivers downstream.

Waterwatch works with communities to monitor and develop actions to improve local catchments. As small catchments make up as much as 75% of the total stream network within any given catchment, local actions can make a significant contribution to water quality and catchment health, even when the creek may run only occasionally.

Catchments require management to be sustainable for future generations. Sustainable management will maintain and improve the quality of natural resources within a catchment and meet the needs of the community, ecosystems and the environment. In New South Wales, Catchment Management Authorities have been set up to work with the community, state government agencies, industry and individuals to identify and manage key natural resource management issues within the various catchments in their region.

Catchment Management Authorities (CMAs) are regional bodies that have developed Catchment Action Plans to manage key natural resource management (NRM) issues within their regions. It is important to identify the CMA region in which you live and link your Waterwatch monitoring actions to the priorities within the region's Catchment Action Plan.

NSW CMAs operate in the following regions:

Border Rivers/Gwydir; Central West; Hawkesbury–Nepean; Hunter–Central Rivers; Lachlan; Lower Murray–Darling; Murray; Murrumbidgee; Namoi; Northern Rivers; Southern Rivers; Sydney Metro; Western.

> *i* **For more information see www.cma.nsw.gov.au**

Parts of a catchment

Upper catchment

In the upper reaches of the catchment, such as mountain regions or foothills, rivers are usually fast flowing. This means they have the energy to carry large pieces of rock and gravel eroded from stream beds and banks. Vegetation along the banks (riparian) provides a buffer from overland flow, reducing the input of sediment and nutrients.

The upper parts of a river system are very important to the health of the entire river because this is the source of much of the food carried downstream. Dams and weirs impede the distribution of food and seeds and the migration of aquatic animals, as well as altering flow rates and flood frequencies.

Overhanging vegetation provides much of the food (in the form of leaves, fruits, seeds, twigs and bark) required by stream organisms such as macroinvertebrate 'shredders', which convert coarse material to finer fragments. These macroinvertebrates (water bugs) are adapted to fast moving water, e.g. by having streamlined bodies.

Middle catchment

In the middle part of the catchment, the river meanders through flood plains. During large floods, water spills out over banks onto the flood plain and deposits a layer of sediment. Occasional floods are important for maintaining the health of wetlands.

Often in these middle reaches, the stream bank and its trees no longer shade all the water surface. Here the sun is able to warm the water through the day, particularly where the current slows to form pools. Water temperature tends to drop at night as the accumulated heat is given off to the cold air. Daily and seasonal changes in water temperature tend to be greatest here.

Attached algae become more abundant and grazer (plant eating) and collector macroinvertebrates dominate this section of the stream. Organisms like mayfly nymphs shear off pieces of algae growing on rocks. Collectors feed upon fine material (shredder faeces and small plant fragments) transported from upstream and from local vegetation.

Lower catchment

As a river gets very close to the sea or other large bodies of water, it travels very slowly and deposits the large quantities of sediment it has been carrying from further upstream. Collector macroinvertebrates predominate in this stretch of the stream, filtering out accumulated minute particles suspended in the water and gathering fine particles that have settled to the river bottom. Organisms that are tolerant to lower oxygen levels and slow moving water are more common in this part of the catchment. In the lower catchment riparian vegetation influences bank stability and slows flood flows.

Estuary/marine

An estuary can be described as a semi-enclosed body of water occurring where fresh water joins and mixes with salt water from the ocean with tidal influences. Estuaries are some of the most productive ecosystems and a valuable asset of the coastal environment. They also play an important role in providing food and shelter for a wide range of aquatic organisms such as crustaceans and molluscs. Estuarine habitats include saltmarshes, mangroves, seagrasses, reedbeds, shallow sand and mud flats, rocky shores and reefs, and deeper zones of fine sediments.

Marine ecosystems are those that occur in sea water.

Typical characteristics of different parts of a catchment

Upper, middle and lower catchments each have their own typical landscape features and as the water travels downstream, it shows some predictable changes in factors such as turbidity, temperature and nutrient levels.

Typical landscape and water characteristics for different parts of a catchment

Characteristic	Upper catchment	Middle catchment	Lower catchment
Altitude	High	Decreasing	Low
Slope	Steep	Generally decreasing	Flat
Velocity	Fast	Generally decreasing	Slow
Depth	Shallow	Deeper	Deepest
Width	Narrow	Generally increasing	Wide
Bottom	Rocky stream bed	All types	Gravel, sand, silt or mud
Sediment transport	Erosion	Erosion and/or deposition	Deposition on flood plain
Turbidity	Clear water	Generally increasing	More turbid
Percentage shading	High	Generally decreasing	Low
Temperature	Cold	Increasing	Warmer, possible stratification (layering)
Dissolved oxygen	High	Generally decreasing	Lower
Nutrients	Low	Generally increasing	Higher

Recognisable trends also exist along the length of a catchment in the types of vegetation found in the waterway and along its banks, and the effect the presence of this vegetation has on the flow of water. The size of food particles available for macroinvertebrates (water bugs) also changes.

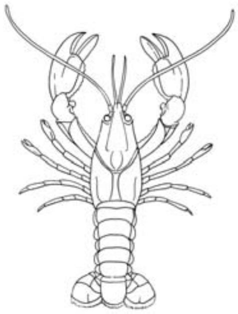
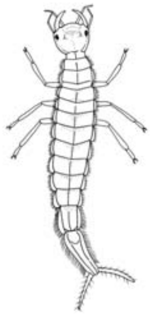
Typical vegetation for different parts of a catchment

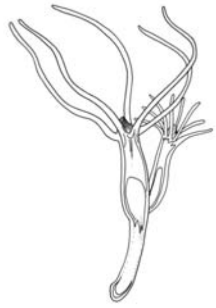
Vegetation type	Upper catchment	Middle catchment	Lower catchment
In-stream plants	Minor	Attached algae and large rooted plants	Free floating algae and large plants at margins of river
Riparian (stream bank) vegetation	Vegetation buffers stream from overland runoff	Vegetation reduces flow velocity and stabilises bed and banks	Vegetation influences bank stability only, encourages levee deposition and slows flood flows
Food source for macroinvertebrates	Mainly coarse pieces of streamside vegetation (dead leaves)	Increasing proportion of fine particles	Mainly fine particles

Features of water bugs, such as their mode of feeding and body shape, as well as their abundance and level of diversity, also show changes along the length of a typical catchment.

Typical macroinvertebrate composition for different parts of a catchment

Feature	Upper catchment	Middle catchment	Lower catchment
Feeding mode	Shredders and collectors dominate	Grazers and collectors dominate	Filtering collectors dominate
Body shape	Adapted to fast moving water, e.g. streamlined	Wide variety of body shapes	Adapted to slow moving water, e.g. burrowers
Abundance	High-moderate	Generally higher	Generally lower
Diversity	High-moderate	Generally higher	Generally lower

Healthy catchments and rivers

A healthy catchment is one that is sustainable and able to meet the needs of the community, ecosystems and the environment.

The health of a waterway can be measured by characteristics such as:

- water quality measured by physical, chemical and biological parameters
- healthy ecosystems with a high biodiversity. This includes both aquatic and terrestrial ecosystems, especially along riverbanks
- the resilience or capacity of the ecosystem to maintain its structure and function in the presence of stress. This may be caused by natural factors such as floods or human-induced change.

Land use is a key factor determining the health of waterways. Human activity can impact on river health by influencing the interactions between natural resources (land, water, vegetation and soils) and between aquatic and terrestrial ecosystems. The following table provides an outline of different land-use types within catchments and the tests that could be used to provide an indication of their impact on water quality and ecosystem health.

Site features and land use	Comments	Water quality tests
Wetlands	Complex natural ecosystems that can act as natural filters.	Macroinvertebrates pH Salinity (EC) Turbidity Phosphates Faecal coliform
Estuaries	Water quality is affected by tides. Human activity can impact on an estuary via activity within the marine environment and adjacent land.	Benthic invertebrates Dissolved oxygen Turbidity pH Phosphates Salinity (EC) Habitat assessments
Natural ecosystems	High quality diverse and sensitive ecosystems that will be highly impacted by human activity. This may affect water quality and ecosystems.	Macroinvertebrates Dissolved oxygen Turbidity pH Phosphates Salinity (EC) Habitat assessments
Forestry and logging operations	Building roads, clearing forests and logging can result in soil erosion and sediments washing into waterways. Removal of trees allows more light to penetrate to water, encouraging plant growth.	Compare data with that for natural ecosystems to determine the impact of operations Macroinvertebrates Dissolved oxygen Turbidity pH Phosphates Salinity (EC) Habitat assessments

Site features and land use	Comments	Water quality tests
Agricultural land uses – general crops and pastures	Removal of groundcover can cause erosion and rising water tables. Runoff can pollute water with nutrients, sediments and pesticides. Poor irrigation and land use can lead to salinity problems.	Macroinvertebrates Algae Stream cover Dissolved oxygen Turbidity pH Phosphates Salinity (EC) Habitat assessments
Agricultural – intensive livestock	Feedlots and dairies can pollute surface and groundwater with manure, nutrients and bacteria.	Faecal coliform Phosphates Algae
Urban	Runoff from urban areas and stormwater can contaminate water with oils, nutrients, toxic chemicals, litter, soil, sewage and other organic matter.	Macroinvertebrates Dissolved oxygen Turbidity pH Phosphates Salinity (EC) Heavy metals Habitat assessments
Golf courses and playing fields	Runoff may carry nutrients and pesticides.	Phosphates Stream cover Algae Macroinvertebrates
Construction sites	Poorly managed construction sites can result in sediment and chemical pollution of nearby waterways.	pH Salinity (EC) Turbidity
Septic and sewerage systems	Leaks, overflows and poorly functioning sewerage and septic systems can have a severe impact on water quality and public health problems.	Phosphates Faecal coliform Macroinvertebrates Heavy metals
Mining operations	Sediments, tailings, dust and chemical waste can have a severe impact on water quality. These impacts can be present long after mining operations have ceased.	Turbidity Salinity (EC) pH Dissolved oxygen Macroinvertebrates Heavy metals

It is essential to know where you are located within your catchment. Activities upstream, downstream and in your local area will impact on water quality and catchment health. River health reflects catchment health. Even the management of small waterways in catchments is important because they generally make up three-quarters of the total stream water.

1.3 Human impacts on waterways, including climate change

Human activity has modified the natural environment and this has led to many environmental problems or issues. Some of the most significant of these issues are increased soil and river salinity, land degradation, water pollution, loss of biodiversity and climate change. Management of these issues while maintaining the productivity and sustainability of the natural environment is a key challenge for the future.

Climate change

Climate change is one of the most significant human impacts on the environment. Higher air and sea temperatures, sea level rises, more extreme storms, more drought, less rainfall with most of it falling in storm events, and more flooding, are all predictions for how climate change will affect New South Wales.

Climate change will also impact on water quality. As temperatures rise, water becomes less able to hold dissolved oxygen. Reduced rainfall, particularly during the hotter months, will reduce vegetation cover over the landscape. Increased frequency of higher intensity storm events will produce greater sediment and nutrient loads. As a result, water quality and the overall health of river systems are likely to decline.

Waterwatch groups can help to track the effect of climate change by monitoring water and air temperature, plus turbidity, dissolved oxygen and nutrients, particularly following storm events.

Climate change will impact on both aquatic and terrestrial ecosystems. Waterwatch groups can monitor these changes through the ongoing sampling of macroinvertebrates and riparian condition.

SECTION 2

Formulating a Waterwatch Plan

Planning is important for the ongoing success of the Waterwatch program. This section outlines the steps you will need to take to develop a successful Waterwatch Plan, also known as a monitoring plan. Templates are provided for a Community/Land Manager Waterwatch Plan and Waterwatch Agreement.

Included in this section: *Page*

2.1 What is Waterwatch?

Waterwatch is an ongoing monitoring program that involves the community and schools in monitoring a local waterway. The program is designed to be flexible, to meet different outcomes, including school curriculum outcomes and community needs.

Monitoring is the regular observation and measurement of natural resource conditions over time, usually to detect change.

Waterwatch focuses on building skills within the community so the program can be run on an ongoing basis. Participants develop ownership of their site by monitoring water quality and ecosystems and by implementing actions to protect the environmental values at their site.

Waterwatch procedures, equipment and methods have been developed to ensure that the data collected by your group is quality assured and can be used for planning purposes by other organisations such as Catchment Management Authorities, local government and water authorities.

Why involve the community in monitoring?

Community monitoring is increasingly valued by natural resource managers and planners for the following reasons:

- Small waterways make up three-quarters of the total stream network within any given catchment and they can be monitored most effectively by local communities, including land managers.
- Local knowledge can be utilised that may not be available through scientific monitoring programs. This may include local data and information, including observations and stories about change over time.
- Data can be used to assess the effectiveness of local environmental management projects or as a tool for planning at the farm, sub-catchment or catchment scale.
- Community monitoring of natural resource condition increases awareness and ownership of local environmental management issues and the actions needed to address them.
- Community monitoring can empower communities by providing a framework for involvement in natural resource management decision-making. This may lead to better management outcomes.

2.2 Developing a monitoring plan

An effective Waterwatch program involves designing and developing a monitoring program that meets the needs of the group while collecting quality assured community data. The following questions will allow you to develop a monitoring plan that meets the needs of the group while collecting quality assured community data:

- Why are you monitoring?
- Where will you monitor?
- What are the Occupational Health and Safety (OH&S) risks?
- How often will you monitor?
- What will you monitor?
- What equipment will you use?
- What training will be required?
- How will you ensure the quality of your data?
- What will you do with the data collected?

The answers to these questions should be recorded in the Waterwatch Plan. Each of these questions will now be dealt with in more detail.

Why are you monitoring?

Waterwatch engages communities in natural resource management through community water quality monitoring. This may include the following outcomes:

- **Data collection** – Waterwatch uses best practice in community monitoring and groups use a range of skills and equipment to investigate an issue, collect data and record results. By storing information on the NSW Waterwatch online database, natural resource managers can use the data for planning and managing waterways at the local and regional scale.
- **Monitoring projects** – Waterwatch may provide the tools and resources to assist individuals and community groups to monitor projects. These may range from the protection and management of wetlands, rivers and estuaries to the monitoring of water tables and groundwater as part of a salinity project.
- **Catchment planning** – Waterwatch can provide baseline data for natural resource management agencies and organisations when formulating management actions. At the farm scale, landholder planning will be enhanced by mapping water resources and managing waterways and water sources on the farm.
- **Education and capacity building** – Waterwatch can help develop a community understanding of catchment issues and processes that will lead to improved water quality and catchment health through provision of information, education and skills.

> *i* **The monitoring objectives checklist in Section 3.1 can help you analyse your reasons for monitoring and decide what kind of monitoring will achieve your goals.**

Can you develop partnerships in the delivery of Waterwatch?

Consider the following possibilities for partnerships:

- Your local Catchment Management Authority may assist with your testing. They are interested in protecting and managing natural resources within a regional context.
- Local councils may have a project for your group and provide support.
- Environmental, Landcare, Bushcare and other community groups may be working on a local project. They may incorporate Waterwatch in their monitoring program.
- Local water authorities may be able to provide some support and technical advice.

Where will you monitor?

The site you choose for monitoring should provide ease of access and local interest. Groups can develop an understanding of their site over time and watch for future changes.

What makes a suitable site?

- an open flat area where the group can work
- easy and safe access to water
- shallow water for bug surveys
- accessible all year round
- samples taken will be representative of the water body
- at least 100 metres downstream of any drain
- above tidal influence (unless estuarine water quality is being tested)
- upstream of where the creek enters another water body, if applicable
- stable site that will not wash away during floods.

> *i* **To help you choose a suitable site, a site selection checklist is provided in Section 3.2.**

Once sites have been identified, they will need to be named and located. The Waterwatch Plan provides details of how to name sites. The location of sites needs to be very accurate for plotting on the Waterwatch website. Further details of how to do this follow.

Locating Waterwatch sites for the online database

To enter data on the statewide database, your Waterwatch sites need to be plotted onto the maps used in conjunction with the database. It is advisable to have your sites entered on the database as soon as possible. Sites are located on the online Waterwatch map by means of latitude and longitude. You can determine the latitude and longitude using one of the following methods:

GPS coordinates

A global positioning system (GPS) is a satellite-based navigation system that can record site location with a high level of accuracy. GPS systems usually record locations in latitude and longitude.

Latitude and longitude using the internet

A **geographic coordinate system** is a reference system that uses a three-dimensional spherical surface to determine locations on the earth using longitude and latitude coordinates.

The **datum** recorded by the geographic coordinate system comes from either the Australian Map Grid (AMG) or Map Grid of Australia (MGA), depending on the map you are using. You will find the mapping system in the margin of the map.

The mapping facility on the Waterwatch online database will generate latitude and longitude for sites.

If you are using GPS coordinates to locate sites, please check to make sure that the values are within the valid values ranges below:

Latitude		Longitude	
Min	**Max**	**Min**	**Max**
–28.16623	–37.56440	141.00946	153.63000

Topographic map references

Grid references from a topographic map can be used to locate sites. This is called a **projected coordinate system**. The map margin will provide information about the map zone and the datum used for the map. This information is required to locate sites using grid references. GDA 94 is the Australian coordinate system used during and after 1994, replacing AGD 66 (pre-1994 maps).

You will be able to generate site locations from the Waterwatch online database. The site locations will be stored as GDA 94 but the database can convert AGD 66 to GDA 94 as long as the correct datum is selected when locating sites.

If you are locating sites using a topographic map, you will need to determine the Eastings and Northings from the map. Eastings should be a 6 digit number and Northings a 7 digit number. When these coordinates are combined a site location based on a grid reference is provided.

Note: You will also need to record the map zone and datum from the map margin to locate your site.

Reading the Easting

Eastings consist of 6 numbers, the first 3 taken from across the top of the map:

- the single digit number in smaller type which is in front of some of the nearby grid references
- the 2 digit number above the grid line immediately to the left (west) of your site's location
- a number from 0 to 9 to approximate the distance across the grid square that your location lies. This number is 0 for locations right on a line.

Add two zeros to this number, bringing the total number of digits to 6.

Reading the Northing

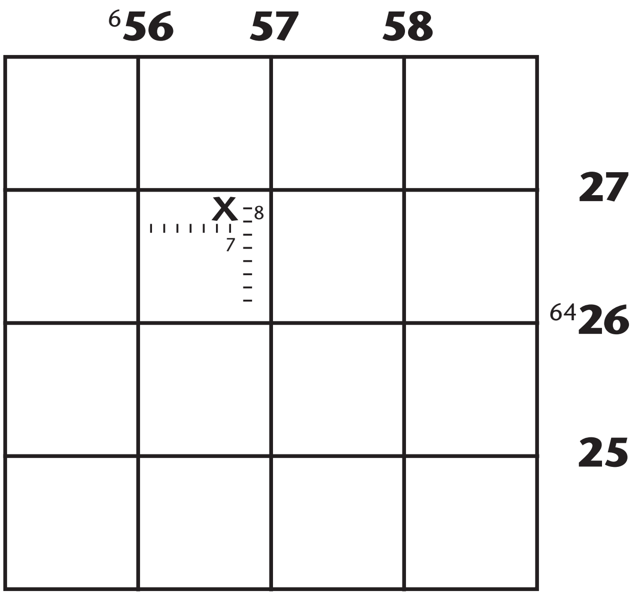
Northings consist of 7 numbers, the first 5 taken from the sides of the map:

- the 2 digit number in smaller type which is in front of some of the nearby grid references
- the 2 digit number beside the grid line immediately below (south of) your site's location
- a number from 0 to 9 to approximate the distance above the grid line that your location lies. This number is 0 for locations right on a line.

Add two zeros to this number, bringing the total number of digits to 7.

The diagram below illustrates how the grid reference for the site located at the cross would be determined. Easting = 6 56 7; Northing = 64 26 8

The grid reference for the site after adding two zeros for Eastings and two zeros for Northings is 6567006426800.



Once you have collected all the information from your topographic map, please check that your information is consistent with the valid values for grid references as follows:

ZONE	Easting		Northing	
	Min	Max	Min	Max
54	499000	793000	6060000	6793000
55	207000	794000	5844000	6837000
56	206000	844000	5844000	6887000

Once you have determined the grid reference for your site, enter this information into your Waterwatch Plan and the Waterwatch Coordinator can use a mapping tool to convert your grid reference to latitude and longitude.

What are the Occupational Health and Safety (OH&S) risks?

Waterwatch groups have a number of identified Occupational Health and Safety (OH&S) risks. NSW Waterwatch is committed to reducing risks to participants in community monitoring and has developed a comprehensive OH&S policy.

> *i* **Section 4 outlines the OH&S policy for the Waterwatch program and Section 3.5 has a template for an OH&S Risk Management Plan.**

In summary, the OH&S risks for anyone taking part in Waterwatch activities include site risks and chemical safety risks (if chemicals are used as part of the monitoring plan).

Waterwatch aims to avoid and/or minimise risks to participants by providing:

- an OH&S Risk Management Plan template to be completed prior to and during monitoring
- detailed instructions about storing and using the chemicals used in Waterwatch tests
- chemical safety sheets for all relevant tests (see *Waterwatch Field Manual).*

> *i* **It is essential that Waterwatch groups understand and implement the OH&S policy provided in Section 4.**

How often will you monitor?

Waterwatch is an ongoing monitoring program and you will need to consider how the monitoring you do fits into the aims of the wider program. Consider how you might develop a program that includes:

- regular monitoring throughout the year
- monitoring after significant rainfall or a pollution event
- monitoring associated with local projects and issues.

The frequency of the testing you do may be increased by regularly collecting water from your site(s) and taking it to a more convenient place to test.

What type of monitoring is right for your group?

Baseline studies are monitoring programs used to define the present state or condition of a waterway. This type of monitoring forms the basis of any monitoring plan and is conducted at the start of a monitoring program.

Snapshot monitoring may occur on a single day across a sub-catchment or catchment. This provides spatial information about the natural resource condition being monitored at a given point in time.

Ongoing monitoring is conducted on a regular basis and is useful in showing trends or changes over time. Monthly monitoring is recommended as a minimum for community groups and land managers.

Impact monitoring investigates whether an impact causes change, e.g. a sewage treatment plant may affect nutrient levels.

Event-based monitoring is done after significant events, such as rainfall, to work out what has changed during and after the event. It is important that this type of monitoring include frequent monitoring after the event, as the impacts may persist for only a few days. Event monitoring can include parameters such as electrical conductivity, pH, temperature and dissolved oxygen.

> *i* **The monitoring objectives checklist in Section 3.1 can help you determine the best type of monitoring to achieve the goals of your particular group.**

What will you monitor?

A waterway is a system of interrelated physical, chemical and biological characteristics. Indicators are key measures that best summarise information about the condition, trends and changes in the health of waterways and the environment. They are made up of parameters that can be measured by observation or field sampling.

Indicators can:

- detect early signs of changes (trends) in the catchment
- indicate whether the environment is as healthy as we would like
- indicate whether we have achieved our objectives
- suggest why problems have occurred.

Water quality and river health parameters

Water quality can be monitored by measuring physical, chemical and biological parameters. These are called quantitative assessments. Other assessments may provide information about factors that are more difficult to measure. These include observations and experiences that contribute to changes in environments over time. These assessments are called qualitative assessments and may be encompassed in case studies.

Quantitative assessment

Quantitative assessment involves collecting data to measure the physical, chemical and biological water quality and river health parameters.

Biological	**Chemical**	**Physical**
Macroinvertebrates Habitat assessments Riparian (riverbank) assessments Macrophytes (aquatic plants) survey Microbiological Faecal coliforms/*E. coli*	Available phosphate Dissolved oxygen	pH Electrical conductivity Temperature Turbidity Flow Bank assessments

Qualitative assessment

Community insights and knowledge about local environments will provide valuable information about social networks and the effectiveness of natural resource management projects for improved management outcomes.

Monitoring for planning and land-use change

Both quantitative and qualitative monitoring can assist to plan and promote land-use change at a variety of scales. Below are some examples of how monitoring promotes a greater understanding of catchment issues and community-driven land-use change.

Monitoring on-ground works

On-ground works projects to improve natural resource condition will require monitoring to assess their effectiveness. Baseline monitoring is important to assess the natural resource condition prior to any works starting. During and after the works the type and frequency of monitoring will be determined by the nature of the project, but may include ongoing monitoring and event monitoring that will provide an overall picture of the impact of management actions over time.

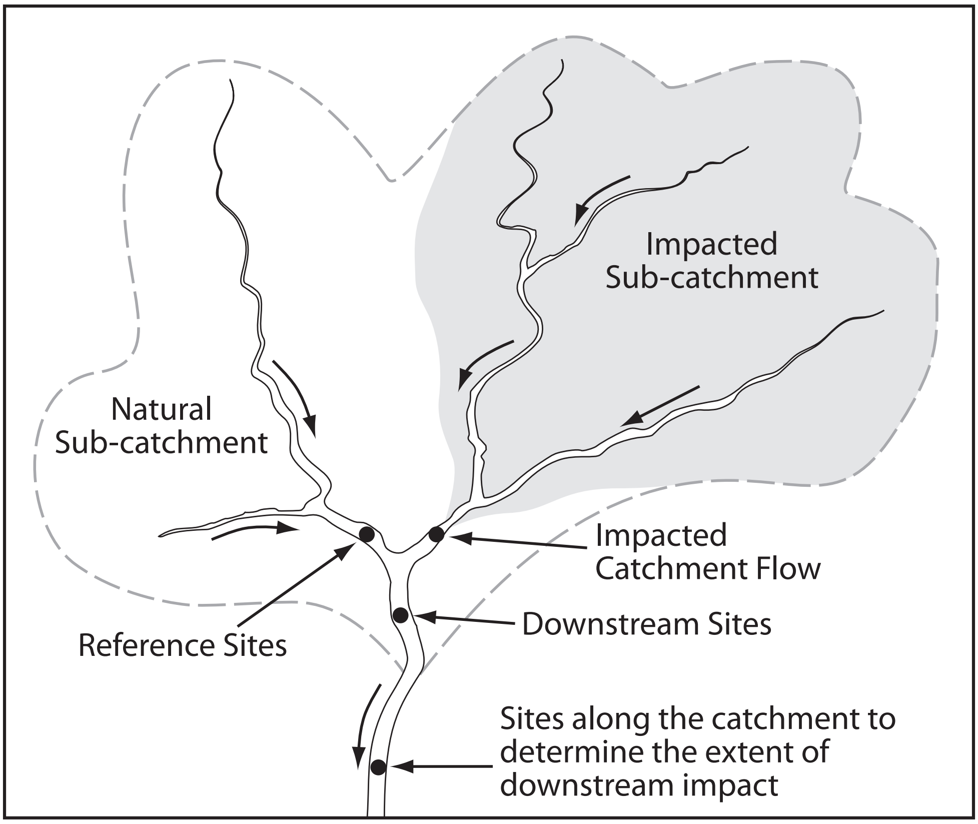
Comparing catchment and sub-catchment impacts

To monitor the impacts of a specific activity at the catchment or sub-catchment scale, a monitoring program can be designed to compare the impacted catchment with an unimpacted catchment.

Impact monitoring should include:

- sites in the unimpacted sub-catchment for comparison
- sites in the impacted sub-catchment
- sites downstream of the impacted sub-catchment to determine its effect on the main flow and the extent of the impact along the catchment.

Impacted catchment



Property planning

Baseline assessments at the property scale of water sources, water quality and the quality of in-stream and riparian habitats will assist landholders to manage water quality and ecosystem health as significant natural resources within the context of their property.

A **map layer** for a property plan that identifies all water sources, including creeks, springs, dams and groundwater, and their quality, will assist to protect and manage water resources on the farm. This may help identify key areas for management such as tree planting and regeneration to protect watercourses from erosion and runoff from agricultural land.

Planning at the property scale that identifies the water quality of different water sources and their potential for agricultural use can help landholders manage water in a more sustainable way. This in turn may lead to long-term enhancement of water quality and riverine ecosystems while providing strategies for reducing the risks imposed by drought on the farm. Baseline assessments for property planning will be most effective when followed up by an ongoing monitoring program to show trends and change over time.

> *i* **Section 7 contains a detailed guide to water quality monitoring for landholders.**

What type of monitoring will meet the needs of your group?

The type of monitoring you choose will depend on the goals and objectives of your group and may include one or more of the following indicators and parameters.

Indicator	Parameters that can be measured
Stream physical condition indicates the extent of change in the stream from the natural physical state	Stream bed composition, bank stability, amount of woody debris, habitat assessments, turbidity
Catchment stress indicates the effects of human activity and how it may change over time	Phosphates, salinity, pH, turbidity, temperature, human use and intensity of use, riparian vegetation assessment
Ecosystem integrity indicates the amount of change in the aquatic ecosystem from the natural condition prior to the influence of humans	Variety of in-stream habitats, macroinvertebrates, area of wetlands, quality of riparian vegetation, dissolved oxygen percentage saturation
Public health indicates risk to human health in situations of primary and secondary contact, resulting from contamination of waterways	Faecal coliform/*E. coli* testing to identify exposure to disease-causing bacteria
Chemical impact focuses on the amount of change from the natural chemical state of the water, which affects aquatic life and human use	Dissolved oxygen, available phosphate, macroinvertebrates
Land management at the property scale	Phosphates, salinity, pH, turbidity, temperature, human use and intensity of use, riparian vegetation assessment and macroinvertebrate sampling

Adapted from *Waterwatch Tasmania Manual*, 2003

What equipment will you use?

Waterwatch uses standardised equipment that has been selected to ensure high levels of data confidence, including:

- precision and accuracy of results
- consistency of methods
- ease of use
- robustness.

The type of equipment needed will depend on the parameters being tested and may include water quality testing equipment, as well as equipment for biological sampling of macroinvertebrates and/or riparian vegetation assessment.

It is important that only NSW Waterwatch accredited equipment is used to collect water quality data.

> **i** **A checklist of equipment required for on-site testing is provided in Section 3.6. A full list of Waterwatch accredited equipment and how to use it is provided in the *Waterwatch Field Manual*.**

What training will be required?

Once your group develops a Waterwatch Plan, the group is registered with NSW Waterwatch and training is provided by a Waterwatch Coordinator. Once trained, others can be trained within the group by a 'train the trainer' model. Only participants trained in Waterwatch methods, equipment use and OH&S should conduct the monitoring. Your local Waterwatch Coordinator will notify you if any training procedures change.

The annual quality assurance (QA) program conducted by NSW Waterwatch allows you to check the accuracy of your testing methods in comparison with Waterwatch standards. The information collected identifies issues with training, equipment and methods that can be improved.

> **i** **Section 3.3 is a skills checklist and Section 3.4 is a training log, to help you determine and manage your group's training needs.**

How will you ensure the quality of your data?

It is important that the data collected by your group meets the aims of the group and contributes to the Waterwatch knowledge base. To ensure high quality results, Waterwatch incorporates quality assurance (QA) and quality control (QC).

QA involves the management of planning, data collection, quality control and reporting, to ensure data is of high quality and meets defined standards. This includes procedures for setting and maintaining training standards, calibrating equipment and reporting results.

QC involves the specific steps taken to measure and control the quality of data and to reduce the risk of errors. Examples of QC procedures include taking measurements from more than one sample at the same site and comparing the results.

Waterwatch includes QA/QC in all aspects of the program from the design of the monitoring plan to the frequency of testing, training and the recording and validation of results. Waterwatch data confidence plans will include the following QC and QA checks.

Monitoring plan	• community monitoring plans designed to produce the data required for the project • plan takes into consideration where and when to test, the types of tests and the frequency of monitoring
Training and support	• training is essential to ensure that water quality tests are performed accurately • Waterwatch coordinators provide training to groups • other group members are trained by the 'train the trainer' model • annual QA events check the skills of the group and identify additional training needs
Group data management – recording your results	• Waterwatch provides field recording sheets to ensure all the information required is recorded at the site – never record results on bits of paper • Waterwatch data is stored on the online database – groups are trained to upload and download their data
Regional data management – uploading the data	Waterwatch coordinators assist your group to manage data by: • plotting your sites on the online Waterwatch database • verifying data uploaded to the Waterwatch database • liaising with groups about their results
Standardised equipment	• only approved Waterwatch equipment can be used by your group • equipment used for NSW Waterwatch is selected for its precision, accuracy, robustness and ease of use, allowing your group to produce good quality data with equipment that is easy to use and will not break under normal field conditions
Standardised methods	• procedures, calibration, sampling measurement, QC mechanisms and record keeping are standardised to make sure results are comparable between sites – your group will produce the most accurate results by following the prescribed procedures
QA events	• a statewide QA event is held each year to identify issues related to procedures and sampling equipment, as well as identify community training needs – all groups are encouraged to participate in this event
NSW Waterwatch online database	• upload data as soon as possible after testing to the Waterwatch online database at www.waterwatch.nsw.gov.au

What will you do with the data collected?

The data collected by your group will be useful to other groups and organisations. Uploading your data to the Waterwatch online database makes it accessible for all kinds of uses, including catchment planning. It is important to upload your results to the database as soon as possible after testing.

Analysis and interpretation of data involves organising the data to show findings and develop conclusions, and making recommendations and planning actions.

Conclusions are an explanation of why your data looks the way it does and what factors have influenced the results.

Recommendations describe what action should be taken and/or what further information should be gathered.

Analysis of your data should be made with reference to the *ANZECC Guidelines* provided for your site location within the catchment and in consultation with your Waterwatch Coordinator.

2.3 Community/Land Manager Waterwatch Plan (template)

waterwatch NEW SOUTH WALES
Communities Caring for Catchments

Community/Land Manager Waterwatch Plan

Contact name: ....

Address: ....

Telephone: .... Fax: ....

Email: ....

Date: ....

WATERWATCH VISION:
Current and future generations empowered and actively involved in the sustainable use and management of catchments.

The purpose of this agreement is to:

- identify the purpose of your monitoring plan
- record the equipment, sites and methods to be used
- outline management issues related to your monitoring
- record your responsibilities in implementing Waterwatch.

1. Waterwatch goal

Our Waterwatch activities will be aimed at achieving: ....

....

....

....

2. Who will be involved in Waterwatch?

....

....

....

3. Level of participation

Tick the following Waterwatch activities in which your group will participate:

Waterwatch activity		**Yes**	**No**
Spring / autumn water bug survey		☐	☐
Water quality monitoring		☐	☐
Parameters: (please circle)	Turbidity / Temperature / pH / TDS or EC / Available phosphate / Dissolved oxygen / Water bugs		
Testing frequency:			

Tick the boxes that apply to the aims of your monitoring plan:

- ☐ providing information about natural resource condition at the site
- ☐ enhancing knowledge and understanding of natural resource management and catchment issues
- ☐ monitoring of on-ground works projects
- ☐ identifying pollution events
- ☐ other (please specify)..

4. Waterwatch kits

To ensure the quality of the data entered onto the Waterwatch website, only equipment and methods endorsed by the NSW Waterwatch Best Practices Committee can be used for Waterwatch testing.

Equipment sponsorships

Equipment may be provided by a sponsor, such as your local council or Catchment Management Authority, or through other grants and sponsorships, etc.

Name of sponsor (if applicable) ....

NOTE: Equipment provided by a sponsor remains the property of the sponsor unless stated below.

Additional requirements by sponsor:

Waterwatch kit contents

Tick the appropriate box

☐ Waterwatch kit

☐ Macroinvertebrate kit

Test	Tick	Equipment	Tick
Temperature	☐	Thermometer	☐
pH	☐	pH strips	☐
Electrical conductivity	☐	ECScan low	☐
		ECScan high	☐
		ECScan dual range	☐
Total dissolved solids	☐	TDScan	☐
Turbidity	☐	Turbidity tube	☐
Available phosphate	☐	DC1200	☐
		Smart Colorimeter	☐
		Smart 2 Colorimeter	☐
Dissolved oxygen	☐	Colorimeter	☐
		Titration	☐
Faecal coliforms/*E. coli*	☐	Faecal coliforms filtration equipment	☐
		E. coli – glass Schott bottles, pipettes	☐
		Incubator	☐
Macroinvertebrates	☐	Macroinvertebrate kit	☐

5. Recording data on the online database

Choose a username and password in consultation with your Waterwatch Coordinator, to be used to enter or review your data in the 'Enter Your Data' section of the NSW Waterwatch website.

Username: ....

Password: ....

NSW Waterwatch web address: www.waterwatch.nsw.gov.au

6. Identifying water bodies and naming the site

Complete the information below for **each** site. It is highly recommended that sites are located by latitude and longitude using a GPS unit or the mapping facility on the Waterwatch website.

Type of water body

Circle the most relevant description

Lowland stream (below 150 metres asl)	**Coastal stream** (below 150 metres asl)	**Upland stream** (greater than 150 metres asl)	**Standing water** (e.g. lakes, dams)	**Groundwater:** bore piezometer spring

Note: Altitude is measured as distance above sea level (asl)

Naming the site

Name of catchment				
Name of sub-catchment (if applicable)				
Name of water body				
Locality (town)				
Specific site location				
Location (grid numbers or GPS coordinates)				
Site code (if required, will be provided by Waterwatch Coordinator)				
Type of water	**Tick the types of water found at your site**			
Surface water	☐ Fresh		☐ Estuary	
Standing water	☐ Dam	☐ Lake	☐ Wetland	☐ Other (specify) ....
Groundwater	☐ Bore	☐ Piezometer	☐ Spring	☐ Other (specify) ....

Site name registered on the NSW Waterwatch website:

....

Note: Additional tables can be photocopied and completed if there is more than one site.

7. Waterwatch management

Contact information

Role	Name and position	Contact details
Group coordinator		Phone:
		Fax:
		Mobile:
		Email:
2nd contact		Phone:
		Fax:
		Mobile:
		Email:
Support stakeholder (sponsor, if applicable)		Phone:
		Fax:
		Mobile:
		Email:
Waterwatch Coordinator		Phone:
		Fax:
		Mobile:
		Email:

Incident management

In case of a pollution incident, the group coordinator .... will contact their Waterwatch Coordinator by telephone to report the incident as soon as possible.

Training and safety

Training and retraining will be provided in all aspects of implementing the program. Anyone using the kit must be familiar with safety procedures and first aid.

Our group will strive towards best practice to ensure that results can be used by organisations such as Catchment Management Authorities and local government. This will involve:

- ☐ Waterwatch methods, equipment and testing procedures in accordance with the Waterwatch manual
- ☐ safety procedures and first aid awareness
- ☐ OH&S risk assessment and risk management
- ☐ quality assurance, including:
  - calibration of equipment
  - maintenance of kit and equipment
  - participation in yearly QA events.

Insurance

All Waterwatch groups must have their own insurance policy to cover any injury, loss or damage for their members and any other persons or property while participating in Waterwatch.

8. Telling the world

Waterwatch is about learning and communication. Our Waterwatch group will share our results and achievements with others through:

- ☐ water quality data entered on the NSW Waterwatch online database
- ☐ communication with our local Waterwatch Coordinator
- ☐ regular reports, displays or presentations to sponsors such as:
  - the Catchment Management Authority
  - local councils
  - other (specify) ....

2.4 Community/Land Manager Waterwatch Agreement (template)

waterwatch NEW SOUTH WALES
Communities Caring for Catchments

Community/Land Manager Waterwatch Agreement

.... (group name)

agrees to:
- develop a monitoring plan that identifies the purpose of monitoring
- monitor at least 12 times per year
- monitor at least one site that will be identified on the Waterwatch online database
- use only NSW Waterwatch equipment and Waterwatch methods to obtain results
- update equipment/methods in line with any reviews by Waterwatch
- ensure that all equipment is kept in good condition and that meters are calibrated to produce accurate results
- participate in training and refresher sessions
- participate in quality assurance (QA) testing as arranged by Waterwatch
- communicate and share results with sponsors
- enter water quality test results onto the Waterwatch website after testing
- contact the local Waterwatch Coordinator in the event of a pollution incident
- contact the local Waterwatch Coordinator and sponsor if we no longer wish to participate in Waterwatch testing
- review our Waterwatch Plan with the local Waterwatch Coordinator as appropriate
- participate in activities organised by the Waterwatch network in our area, e.g. water bug surveys, snapshot monitoring events, QA.

Additional sponsor requirements

Signed:

Group Coordinator/Landholder .... Date: ....

Waterwatch Coordinator .... Date: ....

Other Stakeholder/Sponsor .... Date: ....

Disclaimer

The Department of Environment, Climate Change and Water advises that those who participate in Waterwatch do so at their own risk. No responsibility or liability is accepted for any injury, loss or damage, however caused, arising from any participant’s involvement in the organisation, conduct or participation in Waterwatch.

SECTION 3

Templates and checklists

This section provides a number of useful checklists for making your preparations for participation in the Waterwatch program easier. Templates are also provided for a Waterwatch group training log and OH&S Risk Management Plan.

Included in this section: *Page*

3.1 Monitoring objectives checklist

Use this table to identify the types of monitoring that will achieve your goals.

Incorporate your monitoring objectives into your Waterwatch Plan.

Outcomes		**Monitoring objectives**	**Types of monitoring**
Capacity building		• Increase community education and awareness • Increased community skills • Planning at the property scale	All types of monitoring
Natural resource condition	**Water quality**	• Assess current condition of waterway	Snapshot assessment
		• Establish baseline values for the waterway • Monitor trends through time – both natural and human-driven variation over time • Detect any pollution events or pest species outbreaks • Develop local water quality guidelines	Baseline condition and trend (ongoing) monitoring
		• Estimate the effect of an event such as rainfall on water quality – may include sediment, nutrient and salt inputs (loads) during high flow events	Event monitoring – may include a number of samples during and after the event
		• Assess impact of a land use or pollution source	Impact assessment
		• Assess effectiveness of a management action	Restoration assessment
		• Investigate causes of a particular water quality or river health issue	Investigative studies using a variety of assessments
	Aquatic ecosystems	• Aquatic biodiversity • Ecosystem health	• Water bug surveys • Frog/waterbird survey • In-stream habitat assessment
	Riparian vegetation	• Assess riparian condition • Identify priority sites for investment/management • Assess impacts of management changes • Assess impacts of on-ground works	Riparian condition assessments

3.2 General tips and checklist for selecting a site

Is the site suitable for field testing?

- ☐ an open flat area to lay out testing equipment
- ☐ shade trees
- ☐ easy and safe access to flowing water
- ☐ shallow water for biological surveys
- ☐ accessible all year round
- ☐ at least 100 metres downstream of any drain
- ☐ above tidal influence (unless estuarine water is targeted)
- ☐ upstream of where the creek enters another waterway, if applicable.

Is the site representative of the stream?

- ☐ has typical features of waterways in the area
- ☐ includes a variety of habitats
- ☐ contains areas of different land-use types that are representative of the area.

Reference sites for baseline monitoring

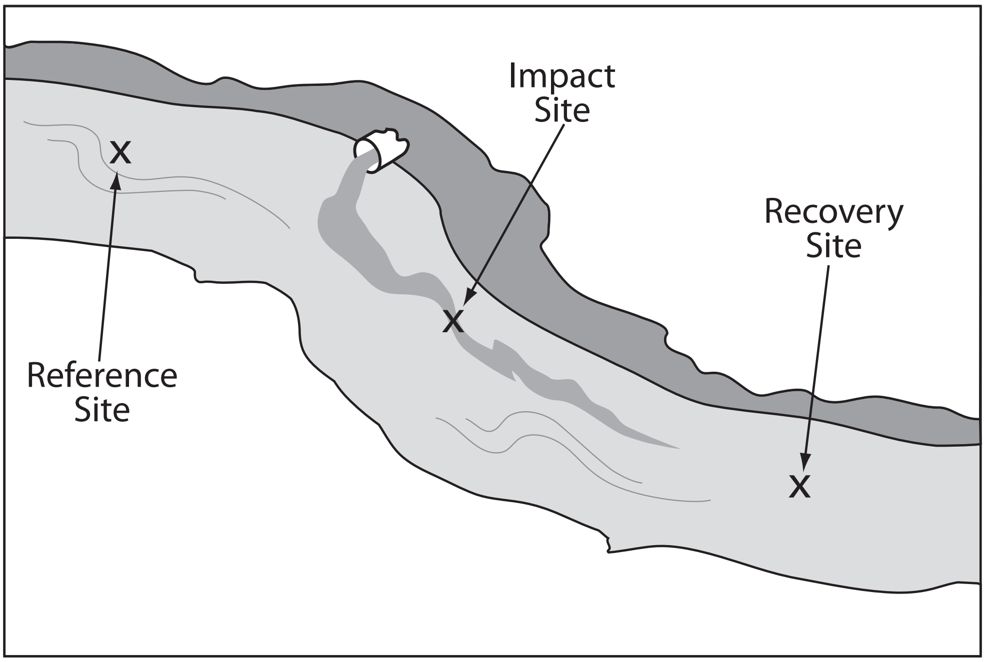
Sites should represent the typical conditions in the catchment:

- ☐ have similar shape and geology to the sites selected for comparison purposes
- ☐ be at least 50 metres upstream and 300 metres downstream of dams, pumps and other diversions of flow
- ☐ be upstream from identified pollution sources.

Point source pollution

To monitor the effect of pollutants entering from a single source, such as stormwater drains, livestock feedlot runoff points, factories, mining operations, septic tank systems and sewage treatment plants:

- ☐ sample 50 metres upstream of the pollution source (reference site)
- ☐ sample 50 metres downstream from discharge points (impact site)
- ☐ sample additional sites downstream to determine how far the pollution extends (recovery sites).



Diffuse source pollution

To monitor the contribution of pollutants to streams across a wide area, e.g. farmland, golf courses, residential areas, industrial areas:

- ☐ sample well upstream as close as possible to natural conditions
- ☐ sample within the affected area
- ☐ sample just downstream of the affected area
- ☐ sample more sites downstream to determine the extent of the impact.

Macroinvertebrate sampling

Sites for macroinvertebrate collection should be:

- ☐ shallow 'riffle' areas less than knee deep
- ☐ variety of habitats
- ☐ fringing vegetation in the riparian zone
- ☐ slow moving water.

Adapted from *Waterwatch Tasmania Manual 2003*

3.3 Monitoring skills checklist

Training is important to ensure that the group has the skills to gather quality assured (QA) data. Training will include all aspects of monitoring, including the management of data.

For the checklist below, tick the boxes to identify key areas of competency and the gaps where training is required.

Contact Waterwatch if you require training or retraining in any of the key areas identified below.

Yes	No	Key competencies
☐	☐	**Monitoring plan** Use the basic questions to design a monitoring plan. This will establish what aspects will be monitored and the level of training required.
☐	☐	**Sampling techniques** Training will include: sampling techniques, sample bottle cleaning, correct sampling procedures for different parameters, e.g. macroinvertebrate edge sampling, preservation of chemicals and other sampling techniques.
☐	☐	**Physical, chemical and biological parameters** Training involves the procedures and methods for all parameters being tested by monitoring groups. Training includes why testing is occurring at the site, what is being measured, QA/QC, field methods, identification of macroinvertebrates, habitat surveys, factors influencing the parameters and safety aspects. As the group's skills develop or as the monitoring plan changes, retraining may be required.
☐	☐	**Use and care of field equipment** Hands-on training for the correct use of field equipment, including equipment calibration, equipment care and troubleshooting.
☐	☐	**Recording of data** Standard data sheets are provided to ensure all information is recorded and in a format for entry on the Waterwatch online database. This will include training in how to record data and the correct reporting units.
☐	☐	**Data management** Your group will be trained to upload data to the Waterwatch online database. Groups that do not have access to the internet can seek the assistance of the Waterwatch Coordinator.
☐	☐	**Data analysis and interpretation** Your Waterwatch Coordinator will discuss how to analyse the data and interpret the results against known standards, such as the *ANZECC Guidelines* 2000 for your site location within the catchment.
☐	☐	**Sharing the results** Your monitoring group can use the data to enhance community education, awareness and community engagement. This may involve sharing your results with other organisations, such as CMAs, local government and others, to identify actions to improve catchment health. Your group will require skills in writing reports and articles for the media.

3.4 Waterwatch group training log

Keep a record of training provided to your group in this training log.

Group name: ....

Contact name: ....

Address: ....

Phone: ....

Fax: ....

Email: ....

Date	**Name of trainer**	**Names of trainees**	**Parameters** (please tick)
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition

Date	**Name of trainer**	**Names of trainees**	**Parameters** (please tick)
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition
			☐ Physical tests – turbidity, temperature, pH, EC ☐ Chemical tests – phosphates, DO ☐ Biological – faecal coliforms/*E. coli* ☐ Macroinvertebrates ☐ Riparian condition

3.5 OH&S Risk Management Plan for Waterwatch training and monitoring activities at a waterway (template)

Please note: Site hazards change over time at the same site. Complete a risk assessment and priority **each time** a Waterwatch monitoring activity occurs at a site.

Group name: .... **Location:** .... **Date of monitoring:**	**Group coordinator:** .... **Contact numbers:** .... **Special needs:**		
Hazard/risk identification Preliminary site inspection and assessment completed Date:	**Assessed risk level** (see matrix, next page)	**Risk management plan – Management/control measures**	**Who?**
General: all emergencies		Mobile phone and first aid kit carried in support vehicle. Staff responsibilities agreed and emergency numbers known to all; vehicle access to site, base staff know of whereabouts and expected time of return.	
Environmental hazards: weather • cold weather • heat, UV rays • extreme weather events, e.g. wind, storms, flash flooding		• Checking, warning, avoidance. Protection and shelter. • **Cold weather** – take warm clothing. • **Sun** – appropriate clothing, hat, sunscreen and water bottle. • **Extreme weather** – alternative sheltered location, checking, warning.	
Environmental hazards: insect/plant/animal • snakes • mosquitoes and insect pests • trees and branches in windy conditions		• Warnings issued. Check sites. Avoid high risk sites. • Insect repellent, sunscreen and water at each site. • Checking trees, warnings and alternative venue.	
Site surface and dangerous objects • needles, broken glass • rough or uneven terrain – slipping, tripping, grazes and sprains • barbed wire and electric fences/wires		• Site check, explicit instructions prior to activities, sharps container. • Wear enclosed, sturdy footwear. • Liaison with landholder prior to training. • Carry poles horizontally.	

Hazard/risk identification Preliminary site inspection and assessment completed Date:	**Assessed risk level** (see matrix, next page)	**Risk management plan – Management/control measures**	**Who?**
People • existing medical conditions • allergic reactions		Pass on information regarding existing and potential conditions.	
Water testing activities (cross out if it does not apply) • use of chemicals • use of equipment • carrying equipment, e.g. poles		• Explicit instructions regarding use of chemicals. • Supervision of participants. • Safety equipment – rubber gloves and safety glasses. • Carry poles horizontally.	
Proximity to water • drowning • health issues – dirty water, mud and sediment		• Supervision, no swimming, work with a buddy. • Wash hands thoroughly after contact with water. Gloves on request.	

Risk assessment matrix	**How likely is it to be serious?**				**Consultation prior to monitoring**: Date: Consulted with (signature)
How serious could the injury be?	**Very likely**	**Likely**	**Unlikely**	**Very unlikely**	
Death or permanent disability	1	1	2	3	**Persons exposed to risk**: Attach list of participants and special needs (e.g. wheelchair access)
Long-term illness or serious injury	1	2	3	4	
Medical attention and several days off	2	3	4	5	**Comments:**
First aid needed	3	4	5	6	

3.6 Waterwatch field equipment checklist

Items	Date: ………	Date: ………	Date: ………	Date: ………	Date: ………	Date: ………	Date: ………	Date: ………
Basic equipment								
Risk assessment sheet								
First aid kit								
Sunscreen								
Mosquito repellent								
Spray bottle (bleach and water)								
Folding table/chairs								
Mobile phone								
Emergency telephone number								
Clothing								
Hats								
Enclosed footwear								
Water (drinking and washing)								
Recording equipment								
Camera								
Pens/pencils								
Marker pens								
Results sheets								
Clipboards								

Items	**Date:**	**Date:**	**Date:**	**Date:**	**Date:**	**Date:**	**Date:**	**Date:** ....
Field equipment								
Waterwatch kit								
Waterwatch Field Manual								
WW procedure sheets (laminated)								
Sampling pole								
Accessories box								
Waste container								
Small rubbish bag								
Paper towels								
Lint-free cloth								
Available phosphate filters								
Available phosphate syringe								
Safety glasses								
Latex gloves								
Spare syringes								
Wash bottle								
Specimen containers								
Materials								
Deionised water								
Spare chemicals								
Calibration solution								

Before you leave the site, check the following:
- Is all the equipment cleaned?
- Is there any rubbish left behind?
- Has the stock in the kit been checked?
- Is any equipment broken or lost and so needs to be replaced?

SECTION 4

Waterwatch OH&S policy

Waterwatch groups have a number of identified OH&S risks. NSW Waterwatch is committed to reducing risks involved in community monitoring. This section contains important information to assist community group coordinators and monitors to reduce risks.

Included in this section: *Page*

4.1 Responsibilities and management of OH&S issues

The following table outlines the responsibilities and risk management procedures related to Waterwatch.

Responsibilities	Risk management
1. OH&S responsibilities of NSW Waterwatch and host agencies	• Providing training to groups in OH&S relevant to the Waterwatch group.
2. Identify hazards	• Waterwatch protocols regarding water testing risks – site and chemical usage. • Monitoring risk assessment pro forma included. • Discussions with groups to identify specific learning needs and actions to minimise risk – access to site for disabled participants – recorded on log.
3. Assessing risks	• Identify hazard (risk assessment) • Using the risk score assessment matrix, determine the priority action.
4. Develop and Implement actions	• From the risk score assessment matrix, calculate a risk score. • Identify the actions necessary to eliminate or control the risk. • Complete the risk assessments and store in a safe office space.
5. OH&S requirements	• The Waterwatch field manual contains the personal protective equipment (PPE) and other OH&S recommendations for the program • Within the manual, participant OH&S requirements are identified. • Training is provided on how to incorporate OH&S into water testing activities to ensure safety when using chemicals.
6. Monitor OH&S arrangements	• Incident reporting sheets completed. • From incidents reported, the hazard assessments are reviewed and updated. • A record of the latest version is dated and included on the assessment sheets.

4.2 Risk assessment

A risk assessment is required **each** time monitoring takes place.
The purpose of a risk assessment is to:

- identify potential hazards that participants may be exposed to
- assess the level of risk associated with the hazard
- implement and enforce corrective measures to eliminate/control or reduce the level of risk of hazards according to the hierarchy of controls (write a work method statement where necessary)
- review risk assessment and evaluation of the effectiveness of the corrective measures.

Participants should be aware of the following risks:

What can harm you – potential hazards	What can happen – outcomes/consequences
• UV radiation (sunlight)	• Sunburn
• Walking on uneven ground	• Slip, trip fall
• Unstable riverbanks/steep banks	• Slip, trip fall
• Water hazards	• Drowning, water contamination and impact on hygiene
• Vegetation – long grass, weeds	• Rashes/cuts
• Fencing – barbed wire, star pickets, electric fences	• Injury related to hazard: cuts and scratches
• Hazardous objects/syringes	• Needle stick injury
• Hot/cold weather	• Exposure to the elements
• Outdoor environment – snakes, insects, spiders, water	• Bites and stings; falling in/drowning
• Carrying equipment – long poles	• Electrocution from power lines/electric fences
• Travel, transport, public places	• Accidents travelling to site; strangers in public places such as toilets

4.3 Risk management

It is the responsibility of the group coordinator to ensure the following action is taken:

- A risk assessment is completed **each time** the site is visited using the pro forma provided, as conditions may change over time.
- A volunteer list is compiled for each field event.
- The group coordinator will mark off and confirm a list of participants who are actually present before and after the event.
- Volunteers are to be warned of the risks at the site and safety procedures explained to the trainees as a group. This warning will cover the following issues.

Water hazards

- Use the buddy system when collecting water samples.
- Develop procedures for emergency events such as flash flooding and/or sudden stormwater discharges.
- Beware of water quality contamination and ensure personal hygiene and protection.
- Handle water samples as little as possible.
- When sampling in high risk areas (e.g. stormwater drains), wear latex gloves.

Mosquitoes

- Mosquito repellent should be made available when Waterwatch testing occurs.

Sun sense

- Sunscreen is to be made available when Waterwatch testing occurs.
- Hats are to be worn at field locations.

Syringes

- Dispose of syringes safely in a sharps container or move to another location and notify council staff if in a public place.

Wildlife hazards (snakes, spiders, etc.)

- Be aware of potential hazards which may arise depending on the site.

Clothing and footwear

- Volunteers will **only** be trained if wearing enclosed footwear and the appropriate clothing.

First aid

- First aid kits will be fully stocked and taken on all field trips.
- Clean water will be available for dealing with spills or chemical contact.
- A mobile phone will be available on all field trips.

4.4 Waterwatch kits

New kits should contain:

- appropriate material safety data sheets (MSDS)
- safety instructions for the use of the kit.

Waterwatch kits used by high schools and community groups contain dangerous chemicals:

- sulfuric acid
- sodium hydroxide
- sodium azide
- sodium thiosulfate
- ammonium molybdate
- other hazardous chemicals.

If a spill or skin contact occurs use lots of water and remove contaminated clothing.

Notify coordinators immediately of any such incident.

Use of kits

Waterwatch kits require the use of personal protective equipment (PPE), such as gloves and safety goggles.

This kit must only be used by trained personnel and safety signage is to be displayed in storage areas:

> **The Waterwatch kit contains hazardous chemicals.**
> **Please ensure you are fully trained and have the necessary OH&S documentation and appropriate MSDS.**
> **Copies of relevant MSDS are provided in the *Waterwatch Field Manual*.**

4.5 Chemical storage and use

Participants should be aware of the following potential risks:

What can harm you – potential hazards	What can happen – outcomes/consequences
Use of chemicals • Use of acids/chemicals • Explosion caused by chemical reaction	• Skin burns from spillage or explosion • Can destroy clothing
Storage of chemicals • Chemical storage near food, in light, or in unsecured locations • Lack of signage	• Contaminate food • Fall into the hands of children • Burns, improper disposal, contamination
Environmental hazards Participants have a responsibility to ensure that chemicals are disposed of safely (into sewer or septic system)	• Chemicals can contaminate the environment

Awareness of chemicals and storage

- Ensure MSDS documentation is available for the kit used by your group.
- Signage for the kit and the storage area should indicate that Waterwatch kits contain hazardous chemicals and should be appropriately stored.
- Make sure all people using kits are fully trained.

Testing procedures

- Gloves and goggles are to be worn at all times when handling chemicals and equipment.
- Read the health and safety sections of the *Waterwatch Field Manual*.
- Follow the testing procedures in the field manual closely.

Disposal of waste – all waste should be collected in separate solid and liquid waste containers. Solid waste is to be disposed of into a garbage bin and liquid waste into the sewerage system.

Supply of water – is needed for rinsing equipment and for use in the event of a spill. Use only deionised water to rinse testing equipment.

Storage of kits and chemicals

Kits

- OH&S kit labels are required.
- Kits should be stored in a cool place.
- Store kits flat with top side up.
- If chemicals are stored in the kit the storage information below also applies.

Chemicals and MSDS documentation

- An inventory is required of all chemicals stored in the storeroom or cupboard.
- All chemicals are to be kept in the lockable cupboard if refrigeration is not required.
- Store chemicals away from food.
- Check the dates on chemicals and dispose of out-of-date chemicals safely.
- MSDS documentation to be kept in the cupboard and displayed in the storeroom.

> *i* **If MSDS sheets are lost, new sheets can be obtained from the Vendart website: www.vendart.com**

Reducing environmental hazards of chemical use

- Carry a liquid and a solid waste container.
- Dispose of waste safely, away from the site.
- Dispose of liquid waste into the sewerage system.
- Dispose of solid wastes into a garbage bin (do not recycle).
- Never dispose of chemicals into the environment.

Signage

Ensure your Waterwatch kit is clearly marked for authorised used only:

waterwatch NEW SOUTH WALES
Communities Caring for Catchments

This is a Waterwatch kit

To be used by
authorised personnel ONLY

> *i* **Groups will be provided with updates of OH&S requirements and chemical handling and testing procedures as these occur.**

SECTION 5

Background to the water quality tests

There are a number of water quality parameters that can provide information about the health of your waterway. Understanding these parameters and how they affect aquatic ecosystems is important if monitoring is to lead to actions to protect aquatic ecosystems.

This section provides detailed background information on all the tests performed as part of the Waterwatch program – what they measure and why they are important in the context of healthy waterways.

Included in this section: *Page*

> *i* **The *Waterwatch Field Manual* contains detailed procedure sheets for all the water quality tests described in this section.**

5.1 Water quality testing

Why test water quality?

Water quality is the 'suitability' of water for particular purposes.

Human activities can have a major effect on water quality.

There are two aspects to think about when testing water quality: the usefulness of water for human use, and the impact that changes in water quality have on plants and animals living in the river environment.

When the quality of the water declines, it is said to be polluted.

Pollution can occur directly, such as by wastewater disposal or urban stormwater. This is called point source pollution. Pollution can also occur indirectly from runoff from agricultural land or by the removal of native vegetation leading to increased erosion.

Water quality tests will give an indication of the health of the waterway. It is important to know what the problem is in order to fix it up!

By testing water over a period of time the changes in water quality can be noted. It is important to record changes in water quality so something can be done to reduce the problem.

Waterwatch provides the tools and methods that allow community members to conduct investigations at their local creek or river and to report any changes.

Monitoring water quality promotes an interest in and awareness of environmental issues, while collecting quality assured community data.

Water quality in catchments

Issue	Caused by	Consequences
Nutrients and eutrophication	Nutrients in runoff Treated sewage discharge Fertilisers Low stream flow	Algal blooms – death of aquatic organisms Eutrophication Low oxygen
Turbidity	Erosion Sediment runoff Chemicals and organic matter	Poor water clarity Death of aquatic organisms (including fish) Channel obstructions
Salinity	Land clearing Increased application of water Overuse of water Reduced stream flow Underlying geology	Reduced agricultural output Damage to infrastructure Poor drinking water Death of aquatic organisms Reduced biodiversity
Faecal coliforms	Sewer overflows and leakage Stormwater runoff	Unsuitability for recreation Unsuitability for drinking
Acid sulfate soils	Poor construction practices in low-lying coastal areas Wetting and drying of inland wetlands	Death of aquatic organisms Damage to infrastructure
Thermal pollution	Discharges from dams and other large water storages Industrial discharges Concrete channels	Death of aquatic organisms Reduced biodiversity

Source: *NSW State of the Environment Report 2006*, Department of Environment, Climate Change and Water

The tests

The tests conducted as part of the Waterwatch program include:

- temperature
- electrical conductivity (salinity)
- pH
- turbidity
- rate of flow
- available phosphate
- dissolved oxygen
- faecal coliforms or *E. coli*.

These tests have been selected because:

- they can be conducted in the field
- the results will be very accurate as long as the procedures are accurately followed
- they inform us about important catchment issues
- they develop an understanding of water quality and how the interaction of land and water affects water quality results.

5.2 Temperature

What is temperature?

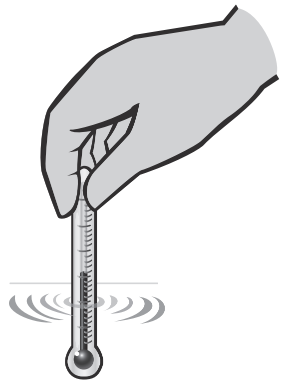
Temperature is a measure of heat and cold. Temperature is measured in degrees Celsius (°C).

Why is it important?

The main effect of water temperature on the environment is related to oxygen in the water. The amount of oxygen that water can hold decreases as the temperature of the water increases. So if water gets too hot there is less available oxygen for living things.

Temperature also affects the metabolic rate of aquatic animals, rates of development, breeding cycles, mobility, migration patterns and the sensitivity of organisms to toxins, parasites and disease. Life cycles of many organisms are related to temperature. Organisms can tolerate slow changes in temperature, but thermal stress can occur where the temperature changes more than 1 or 2°C in 24 hours.

Things which affect water temperature



Temperature is directly affected by:
- depth of water
- flow rate
- season
- time of day.

Other influences on temperature include:
- air temperature
- altitude – high altitudes are colder
- the amount of sunlight and shade
- surrounding vegetation – provides shade and traps sediment
- turbidity – high turbidity warms the water and smothers aquatic plants
- stormwater and urban runoff from hard surfaces such as streets and footpaths
- cold water releases from dams.

Protecting waterways

Cool to moderate water temperatures increase oxygen levels, which promotes healthy ecosystems. Protecting the plants that grow on the stream banks (riparian plants), or replanting where they have been removed, will help our waterways to stay cool and healthy.

The lowering of water temperature through cold water releases from dams can delay summer peak temperatures by up to 10 weeks, the rapid temperature rise in spring is eliminated, and the annual range of maximum and minimum temperatures is much smaller. This has very big impacts on breeding patterns for fish and other animals living in water. Keeping the right temperature balance means maintaining natural patterns of water flow and vegetation as much as possible.

5.3 pH

What is pH?

pH is a measure of the acidity or alkalinity of a substance. The pH scale ranges from 0 to 14, where 7 is classed as neutral, 0 to less than 7 is acidic and greater than 7 to 14 is alkaline or basic. Rainwater usually has a pH value between 5.5 and 6.0. Natural sea water has a pH of 8.2. A pH range of 6.5 to 8.2 is best for most fish and other aquatic organisms.

pH

← **Neutral** →

0	Acid	7	Alkaline	14

<6.5 poor 6.5–8 healthy >8 poor

Note: Sudden changes in pH are undesirable and may cause a loss of native plants and animals.

Why is it important?

The best pH level for most organisms in Australian waterways is pH 6.5 to pH 8.2. Changes in pH outside this normal range can cause a reduction in species diversity, with many of the more sensitive species disappearing.

Things which affect pH

Natural factors – pH will vary depending on the geology of the area. Water flowing through limestone country will be alkaline but in basalt and sandstone country the water will be slightly acidic. Water from a forested catchment will be slightly acidic after draining through the leaf litter.

Human activity – Industrial runoff and sewage may affect the pH of water. Chemicals on road surfaces washing into the water after rain can affect pH. The application of lime to agricultural land may raise the pH if washed into waterways, while fertilisers may lower it.

Daily changes – pH will rise (become more alkaline) during the day due to plant photosynthesis. During the night, pH may fall.

Chemical changes in the water – When carbon dioxide is removed from the water pH increases, and when carbon dioxide is added, pH decreases. pH can also change if polluting chemicals are added to the water.

How acid affects waterways

Water with a pH of less than 5.5 may cause the release of heavy metals trapped in sediments. Fish and other aquatic species may suffer skin irritations, tumours, ulcers and impaired gill functioning. People may get irritated skin or eyes in affected water.

How alkalinity affects waterways

If the water is too alkaline, fish and other aquatic species may suffer skin irritations, tumours, ulcers and impaired gill functioning. People may suffer skin or eye irritations in affected water.

pH of some common substances

The approximate pH reading for each of these substances is:

Acid	Neutral	Basic or alkaline
Hydrochloric acid 0		Blood 7.4
Vinegar 2.2		Baking soda 8.3
Orange juice 4.4		Ammonia 11
Rainwater 5.8		Lime (calcium hydroxide) 12.4
Milk 6.6		Bleach 12.9

5.4 Electrical conductivity (salinity)

What is salinity?

Salinity is the presence of salt in the landscape, in soil or rocks, or dissolved in water or groundwater. The most common salts include not only sodium chloride (table salt), but also the chlorides of calcium, magnesium, potassium and the bicarbonates and sulfates of these.

Why is it important?

Salt is present naturally in our land and water, but human changes due to land use have mobilised natural salt, concentrating it in certain areas of land and water, where it causes major economic and environmental problems.

Salinity is measured by electrical conductivity (EC). Salts conduct electricity, so electrical conductivity can be used to estimate the amount of salt in a water sample or soil/water solution. EC readings increase as salinity levels increase. EC is recorded in microsiemens per centimetre (μS/cm) or millisiemens per centimetre (mS/cm).

Causes and consequences of increased salinity

Increases in salt in the landscape can be caused by:

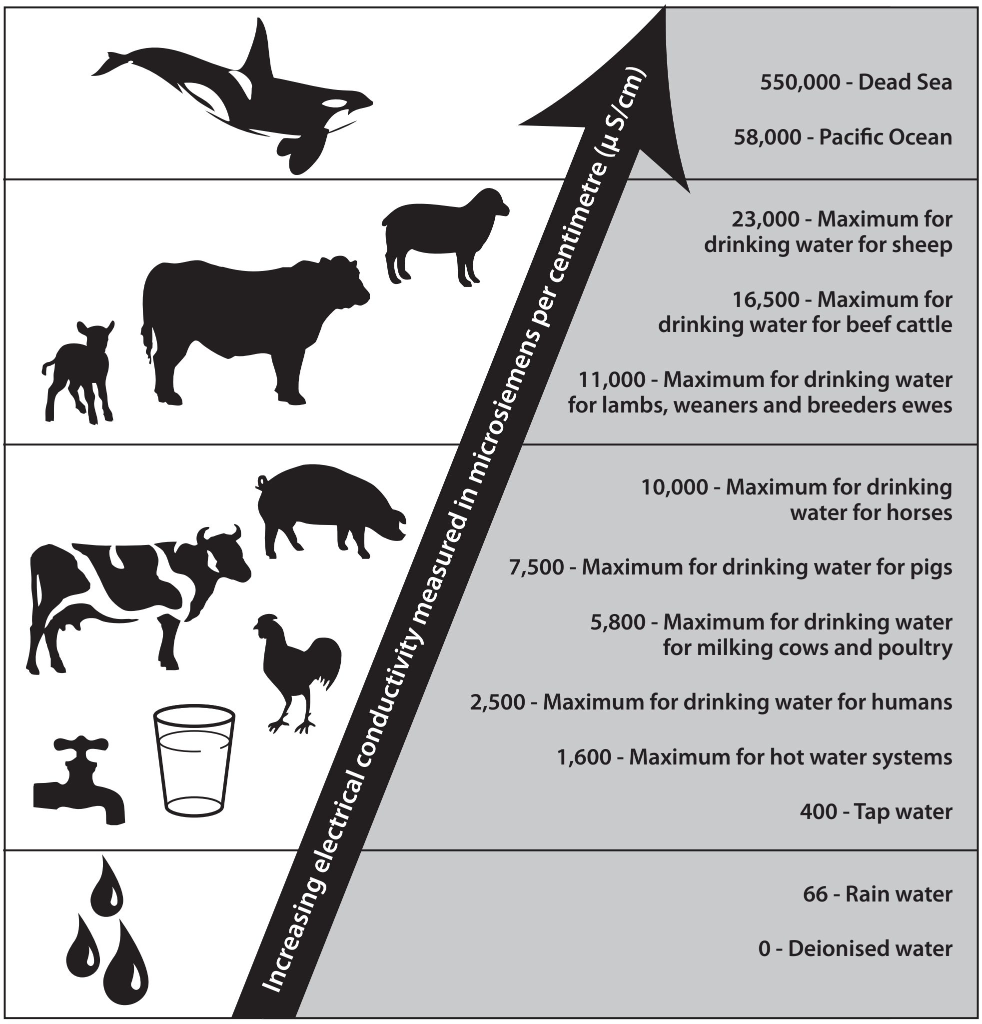
- erosion of rocks containing salts
- salty groundwater storage (aquifers)
- cyclic salt – salt deposited over millions of years from the atmosphere, including salt from soil particles
- rainfall
- runoff from urban and agricultural land
- discharges from industrial areas and sewage treatment plants (STPs).

Salts can be stored in soil or water. Human activities that change the natural balance can move more salts into waterways. This can be caused by:

- removing perennial native plants (trees, shrubs and grasses)
- poor irrigation practices that use too much water
- saline groundwater seepage into creeks and rivers
- industrial and sewage effluent
- agricultural runoff
- urban development in saline areas.

Increased salinity can have a range of environmental consequences:

- salt scalds, causing areas that are bare or have only salt-tolerant species
- inability to use saline waters for irrigation, drinking, industry, etc.
- dieback of trees and other vegetation
- changes to the number and diversity of living things in waterways
- damage to roads, building foundations and other infrastructure
- high water treatment costs.



Source: *Ribbons of blue: in and out of the classroom*, WA Dept of Education and Training.

5.5 Turbidity

What is turbidity?

Turbidity is the cloudiness or muddiness of water. Particles of clay, silt, sand, algae, plankton and other substances increase turbidity.

'Blackwater' is discolouration due to natural dyes in wetland/aquatic plants or caused by leaf litter as it breaks down. Blackwater also increases turbidity.

Why is it important?

Increased turbidity can affect:
- how much light can penetrate the water, reducing plant growth and oxygen production
- breeding and survival of fish and other aquatic animals
- water temperature, because sediments absorb more sunlight, raising the temperature
- oxygen levels, which decrease as water temperature rises
- visual clarity of water.

Causes and consequences of increased turbidity

Some waterways are naturally turbid, e.g. in clay soil areas; however, many human activities increase turbidity to unnatural levels:
- agriculture
- animals accessing waterways, particularly livestock
- removal of vegetation along stream banks, leading to erosion
- stormwater and other urban runoff
- sewage treatment plants (STPs)
- building sites not using sediment and erosion control
- land-use changes in catchments
- industrial discharges.

When the turbidity of waterways increases beyond natural levels, the consequences may include:
- reduced light penetration leading to reduced growth of aquatic plants
- clogged fish gills
- suffocation of aquatic plants
- siltation of stream beds leading to the loss of breeding habitat
- death of water bugs or disruption to breeding cycles
- increased temperature and reduced oxygen
- reduced long-term biodiversity.

i **Bug fact: Many water bugs are filter feeders. This means they filter food particles out of the water with special feeding mechanisms. When these are blocked by sediment, the numbers of these species will decline. For example, water boatmen have siphon mouthparts (sucking tubes) that clog up in turbid water, affecting the behaviour of the boatmen. If turbid water is replaced with fresh, clear water, the boatmen resume their normal behaviour.**

5.6 Rate of flow

What is the rate of flow?

Flow is the volume of water passing a particular point in a stream at any given time. Flow rates affect water temperature, dissolved oxygen, turbidity, salinity and the concentrations of pollution levels.

Why is it important?

Stream flow will vary due to the natural variability of rainfall. However, more permanent changes have occurred due to human modifications to the water cycle, such as the construction of dams, weirs and other channel obstructions. These obstructions even out the natural high and low flows to which many ecosystems have adapted, especially wetlands.

The best water quality usually occurs under conditions where there is sufficient flow to ensure:
- good oxygenation of the water
- dilution and flushing of pollutants
- limits to the build-up of algae.

High flows after heavy rain can also cause problems such as erosion and turbidity, especially in heavily developed areas with hard surfaces.

Consequences of changes in rates of flow

Low flows

Low flow rates can lead to:
- low oxygen levels
- reduced flushing of pollutants that build up over time
- increased salinity
- larger temperature variations, placing stress on aquatic life
- increased algal growth.

High flows

High flows due to heavy rainfall or releases of water from dams can result in:
- increased sediment load
- increased turbidity
- increased nutrients
- reduced salt concentrations
- increased salt loads.

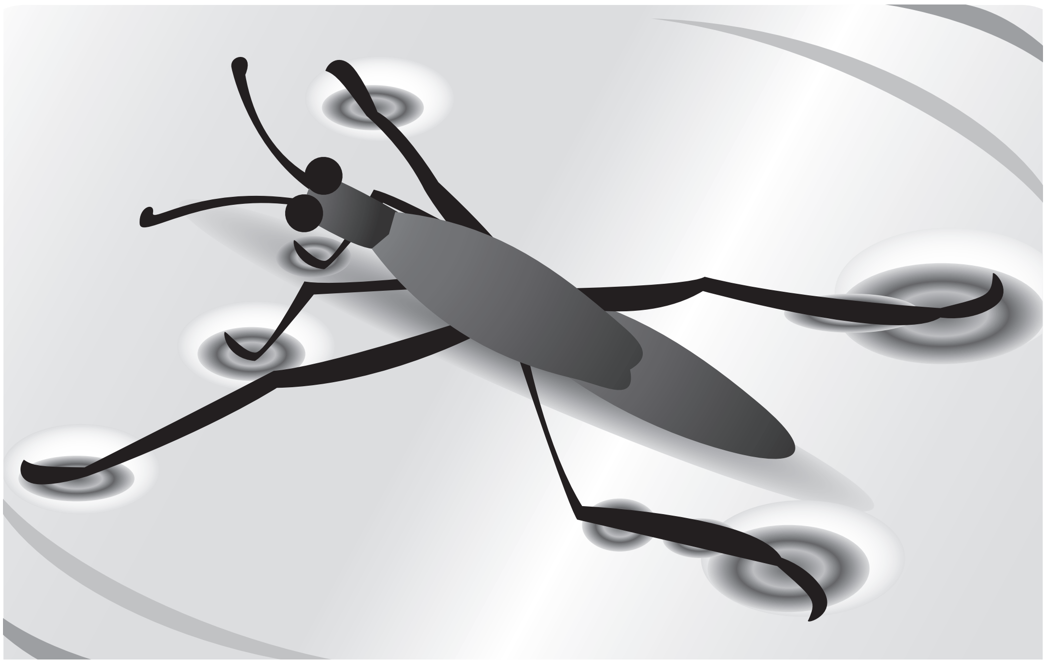
Flows in estuaries

In estuaries tidal movements almost totally dominate flow patterns, except in periods of flooding. This affects the movement of litter and sediment, and the movement of discharges from stormwater pipes and sewerage systems. It is usually the practice to monitor water quality on the ebb tide (going out).

Consequences for macroinvertebrates

The diversity and types of macroinvertebrates will vary with flow. Some are tolerant of low oxygen levels and prefer still pools, e.g. bloodworms, yabbies. However, many bugs are adapted to resist currents. Many have streamlined bodies and can swim fast or grip with claws, e.g. damselfly nymphs, dragonfly nymphs, beetles, mayfly nymphs, stonefly nymphs, snails and water boatmen.

Other water bugs have no mechanism to resist currents and may be washed away during high flows, e.g. mosquito larvae, water scorpions, lesser water striders. Water striders are able to hop upstream on the water's surface during periods of high flow because of pads on the ends of their legs.



5.7 Available phosphate

What is phosphate?

Phosphorus (P) is a nutrient essential to the growth of plants and animals.

Waterwatch measures available phosphate (PO_4).

Total phosphate is a measurement of all forms of phosphate compounds in a sample: orthophosphate (or available phosphate), condensed phosphates and organically bound phosphates.

Available phosphate is a measurement of the phosphate compounds that are soluble in water and therefore available to be absorbed by plants.

Why test phosphate?

The concentrations of phosphorus in Australian soils and water are naturally low. Native vegetation (both aquatic and terrestrial) has adapted to these low levels. In contrast, many introduced plants and weeds are adapted to the higher phosphorus levels of the Northern Hemisphere.

Phosphorus is derived from the weathering of rocks and the decomposition of organic material. It occurs as phosphate compounds. These compounds limit and control the rate and the abundance of plant growth.

Consequences of high phosphate levels are:
- an overabundance of algae and aquatic weeds, e.g. blue-green algal blooms
- waterways choked with vegetation resulting in reduced penetration of light
- increased biological oxygen demand
- reduced dissolved oxygen which can lead to fish kills
- reduced animal and plant diversity (exotic species are favoured, to the detriment of native species)
- eutrophication.

Sources of phosphate compounds in a waterway may be:
- sediment from erosion
- manure from feedlots, dairies and pet droppings
- sewage
- phosphate-based detergents
- decaying plant material
- fertilisers, e.g. superphosphate
- industrial waste.

Phosphate and algal blooms

Favourable conditions for algal blooms occur when there are high levels of nutrients including phosphate. Blue-green algal blooms lead to a decrease in dissolved oxygen at night, increases in pH and turbidity, the production of toxins and unpleasant odours, and the reduction in biodiversity. The toxins can cause the death of stock and are dangerous to humans.

When an algal bloom dies off and decays, dissolved oxygen in the water is consumed by decomposers. This sudden loss of oxygen in the water can cause a fish kill.

5.8 Dissolved oxygen

What is dissolved oxygen?

Dissolved oxygen (DO) is the volume of oxygen that is contained in water.

Why is it important?

Dissolved oxygen is vital for the survival of fish, aquatic invertebrates and amphibians. Dissolved oxygen levels in waterways depend on the physical, chemical and biochemical activities that are occurring in the water body.

Oxygen enters the water:

- as a waste product from the photosynthesis of aquatic plants and algae
- via the transfer of oxygen across the water surface
- through wave action, waterfalls and riffles.

Oxygen is lost from water when:

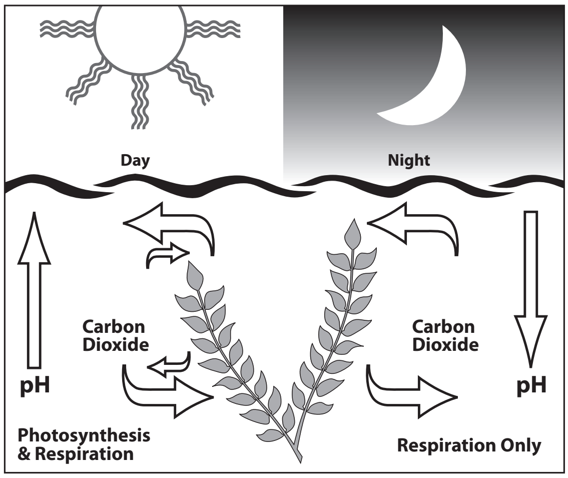
- water temperature rises
- salinity increases
- plants and animals increase respiration
- micro-organisms are feeding on decaying organic matter (e.g. sewage, leaf litter).

Prolonged exposure to low dissolved oxygen levels (<5 – 6 mg/L) may not directly kill an organism but will increase its susceptibility to other environmental stresses.

Exposure to very low dissolved oxygen levels (<2 mg/L) will kill aquatic life and only the air-breathing organisms will remain.

If still water undergoes less internal mixing, the upper layer of oxygen-rich water tends to stay at the surface, resulting in lower dissolved oxygen levels throughout the rest of the water levels.

Aquatic Plant Photosynthesis & Respiration



Source: *The Pond Water Kit*, LaMotte Company.

Daily variations in oxygen

- DO levels are highest in the afternoon as plants photosynthesise during the day.
- DO levels are lowest just before dawn as oxygen is used for respiration by aquatic plants and animals through the night.

5.9 Faecal coliforms and E. coli

What are faecal coliforms, including E. coli?

Faecal coliforms are bacteria that are found in the intestinal tract of warm-blooded animals. *E. coli* is the primary bacterium and this makes it a good indicator of faecal contamination.

E. coli is the abbreviated name of the bacterium *Escherichia* (genus) *coli* (species) and is in the family Enterobacteriaceae.

The relationship between *E. coli* and other thermo-tolerant coliforms is shown in the diagram below.

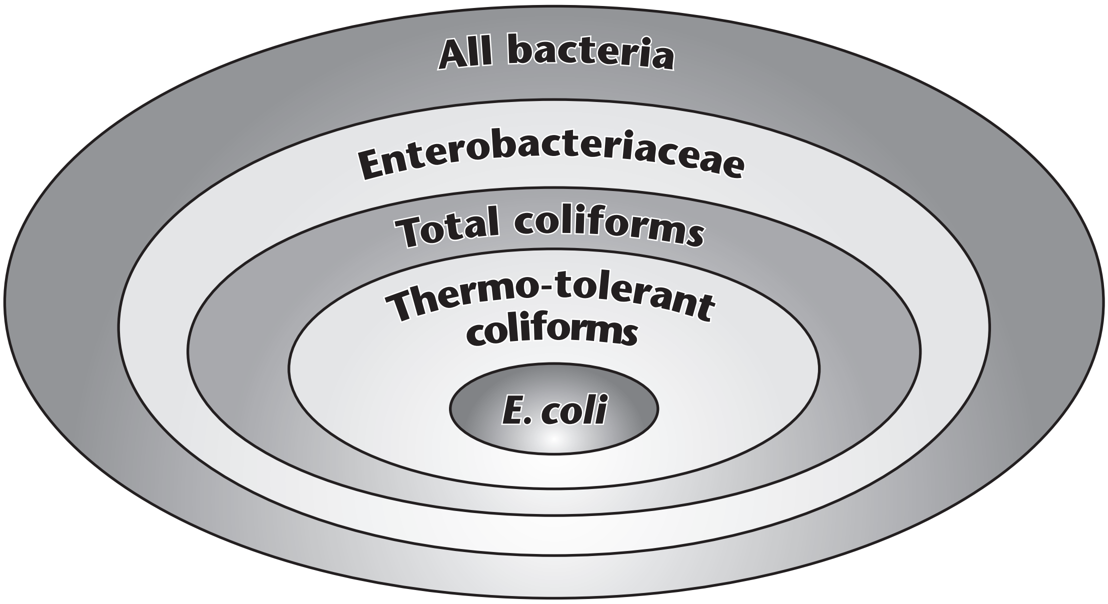


Diagram courtesy of Waterwatch Tasmania

Why test faecal bacteria?

Faecal coliforms are used as an indicator in assessing the level of risk to human health.

The presence of faecal coliforms and *E. coli* in freshwater environments may be due to wastewater contamination, runoff from agriculture, waterbird and livestock defecation and stormwater contamination.

How do faecal coliforms enter streams?

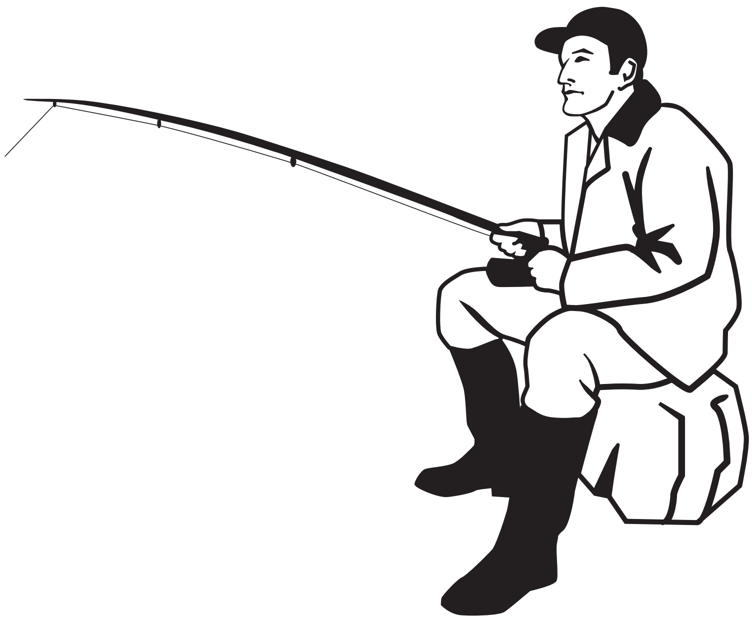
Faecal coliforms, including *E. coli*, can enter streams via:

- sewer and septic systems
- feedlot and dairy runoff, i.e. from intensive farming
- runoff from broad acre farming
- stormwater carrying dog and cat droppings
- waterfowl and livestock defecating directly into the water.

Faecal coliform limits for primary and secondary contact

Primary contact refers to activities where you are completely immersed in water – swimming, diving or surfing. The level of faecal coliforms should not exceed 150 faecal coliforms per 100 mL.

Secondary contact refers to activities where you come into contact with water but are not completely immersed in it – boating and fishing. The level of faecal coliforms should not exceed 1000 faecal coliforms per 100 mL.



> *i* **No contact should be made with water containing more than 1000 faecal coliforms per 100 mL, as serious illness may result.**

SECTION 6

Background to the habitat assessments

A habitat is a place that provides food and shelter for living things. There are many different habitats on land and in water, and each has its own collection of plant and animal species. At a waterway, the two main habitats are the riparian zone and the aquatic zone. Each of these is made up of a variety of smaller habitats.

This section provides background material for the habitat assessment activities included in the Waterwatch Field Manual.

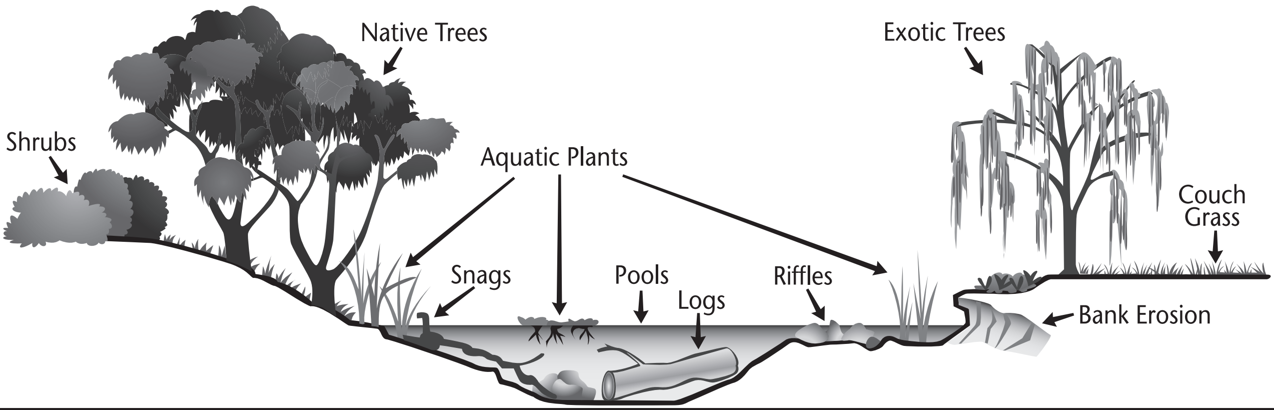
i **The *Waterwatch Field Manual* contains lots of additional information for conducting the habitat assessments described in this section, as well as recording sheets for use in the field.**

6.1 What is a habitat?

A habitat is a place that provides food and shelter for living things.
At waterways there are two main habitats:

- the riparian zone
- the aquatic zone.

The aquatic and riparian zones are interlinked and are important because they protect the health of the waterway. Changes in one zone will impact on the other. Erosion or revegetation of the banks directly impacts on water quality and aquatic habitats. Erosion causes sedimentation which smothers aquatic plants, the channel bed and fish breeding sites. Revegetation using native plants reduces erosion and provides a greater range of food sources for aquatic animals.



VERGE	BANK	IN-STREAM	BANK	VERGE
Riparian Zone		Aquatic Zone		Riparian Zone

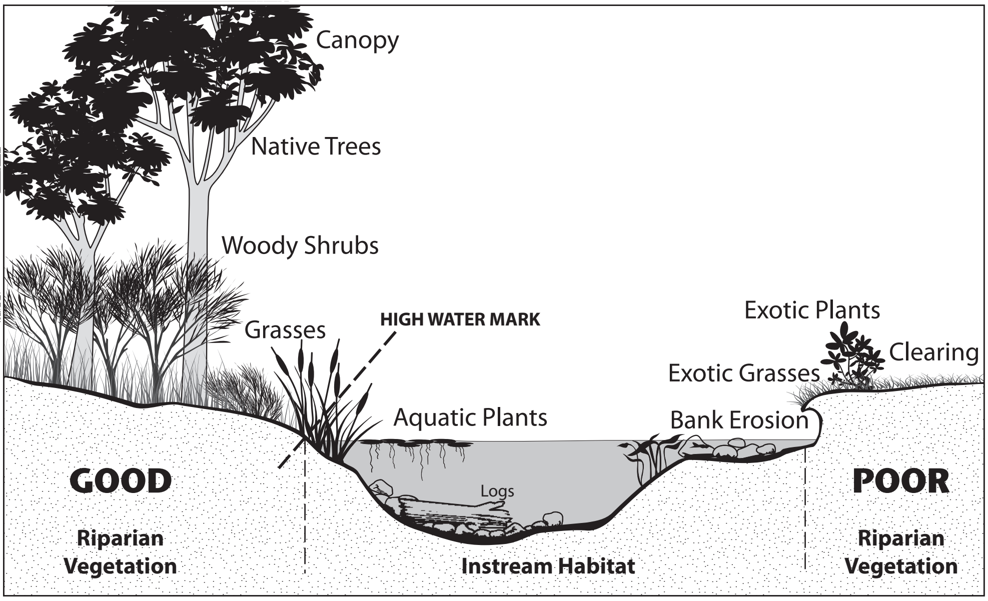
6.2 The riparian zone

The riparian zone extends along the banks of a river, creek or wetland. This area is next to, and influenced by, the water body. It includes aquatic and semi-aquatic plants, as well as tree and shrub vegetation.

The riparian zone habitat is an important link between the aquatic environment and the adjoining land. It provides food and shelter for aquatic, semi-aquatic and land animals such as lizards, snakes, bats, frogs and birds. When riparian vegetation is lost, many animals can no longer survive due to loss of habitat.

Riparian vegetation is also important to protect the waterway from erosion and prevent pollutants entering the stream. A lack of plants along the banks may cause poor water quality by increasing turbidity, which will affect aquatic life.

Typical riparian zone



Aliens at the site

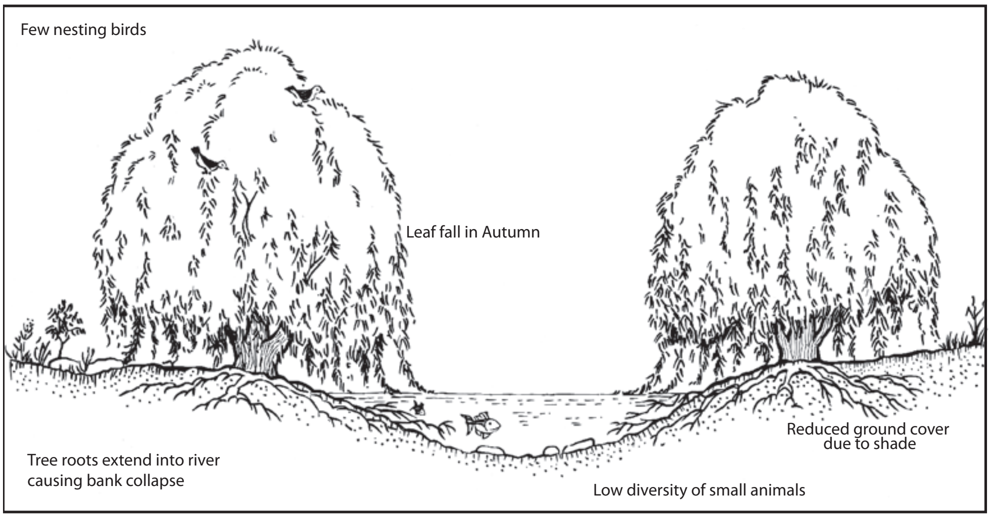
Weeds are alien plants that have been introduced to the area from another place. They can include:

- trees such as willows
- vines and bushes such as blackberries and lantana
- pasture weeds such as Paterson's curse
- aquatic plants such as alligator weed and salvinia.

Many weeds have been introduced to Australia. Few insects or birds live under or in exotic (weed) species. These species can also pollute the waterways. Examples of this include the leaves of weeping willows, which clog waterways, and camphor laurel leaves, which can be toxic to native fish.

Because introduced species sometimes don't have any natural predators or diseases in Australia, they can easily spread out of control.

Effects of willow trees on waterways



6.3 The aquatic zone

In-stream habitats are provided by the shape of the stream channel and by logs, branches, aquatic vegetation, stones and rocks within the channel.

The features of habitats in the aquatic zone can be described as follows:

- **riffles** – shallow areas where the water rushes over rocks.
- **pools** – deeper areas of still water which provide important habitats for larger fish and aquatic species
- **runs** – links between pools and riffles, with deep flowing water and little or no turbulence
- **snags** – fallen branches and washed-in shrubs.
- **logs and rocks**.

Fish and other aquatic organisms need snags, rocks and logs to shelter from predators and the current and to reproduce. Protruding snags provide safe perching and roosting sites for birds. Aquatic plants provide food and dissolved oxygen for aquatic species.

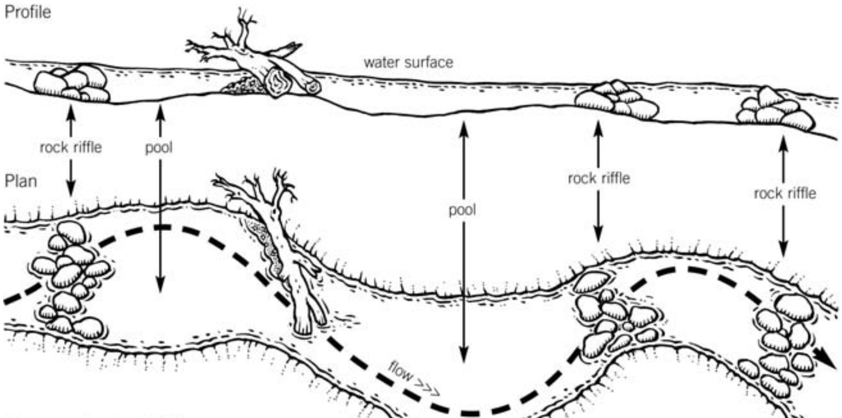
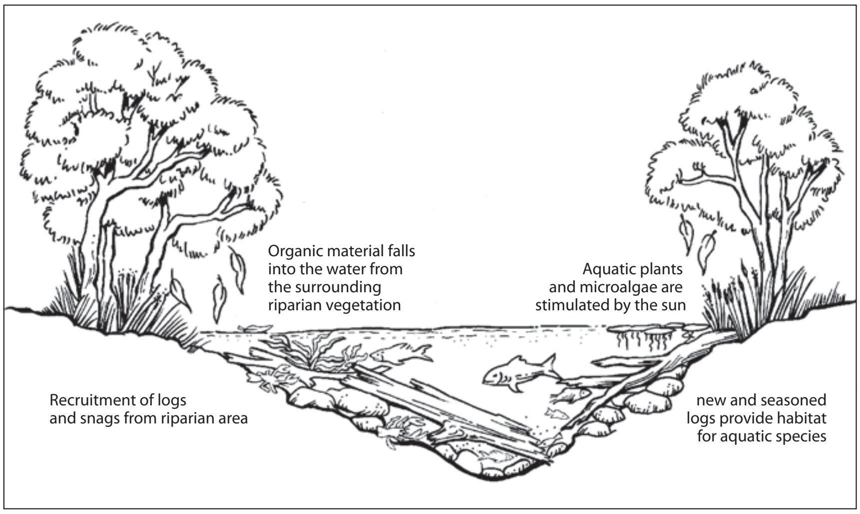


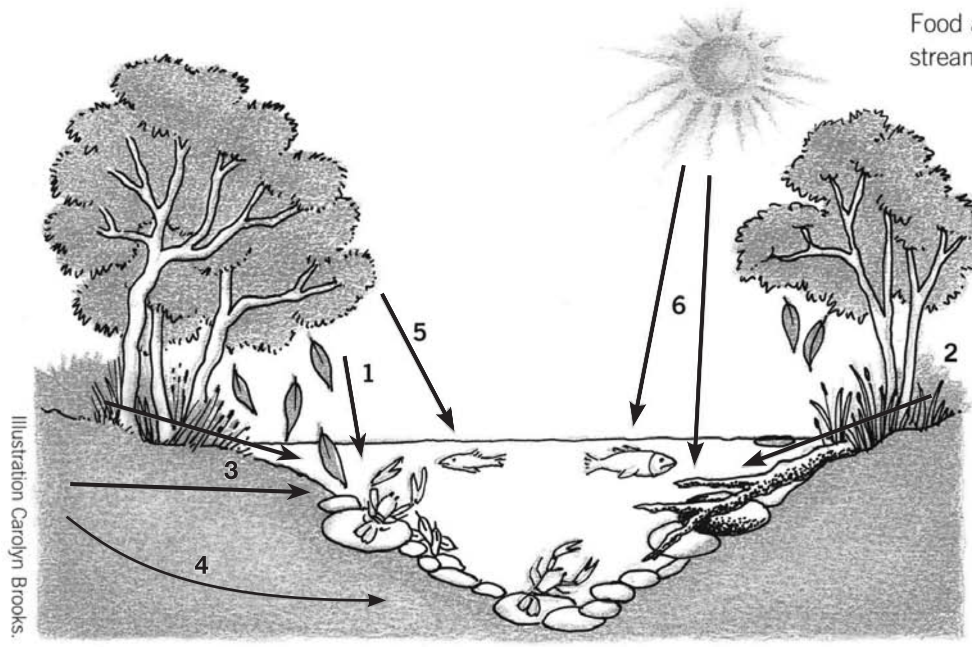
Diagram of pool and riffle sequence.
Illustration Paul Lennon.

The health of habitats in the aquatic zone is closely linked to the nature of the surrounding riparian zone. Plants along the stream support a range of aquatic plant and animal species. Logs and branches provide a habitat for fish and water bugs. Organic matter assists plant growth while insects falling from branches may provide food for some aquatic species.



6.4 In-stream food webs

Native riparian vegetation provides the leaves, fruits and insects that support in-stream food webs. Tree roots in the water and undercut banks provide important habitat, access to food sources, and protection from predators. Woody material, such as branches and whole trunks that fall in from riparian land, are important for in-stream bacteria, fungi and some specialised animals which, in turn, are an essential food source for other in-stream life.



Food and energy inputs to the stream from the riparian zone.

1. leaf litter from riparian vegetation
2. logs and branches
3. leaves, fruits and other organic matter washed in from surrounding catchment
4. dissolved organic matter in groundwater flows
5. insects falling from riparian vegetation
6. aquatic plants and microalgae stimulated by sunlight

6.5 Wetlands

Wetlands are areas featuring permanent or temporary shallow open water. They include billabongs, marshes, swamps, lakes, mud flats and mangrove forests. A wetland is virtually any land which is regularly or occasionally covered with water that is still or flowing, fresh, brackish or salt, including areas of sea water which do not exceed a depth of six metres at low tide.

Wetlands usually occur next to creeks and rivers, or near the coast, but they can exist even in arid desert areas. They can range in size from a small swamp to a vast shallow lake.

There are many types of wetlands. Wetlands that contain water all year round are called permanent wetlands, and those that only fill seasonally are called temporary wetlands. Another type, ephemeral wetlands, only occasionally contain water after heavy rains, or during floods. This may occur very infrequently, perhaps once every ten or more years. Wetlands may form in coastal areas in low-lying ground between sand dunes (swales) when groundwater levels rise. In some natural wetlands the plant and animal communities have adapted to a cycle of drought and flood.

There is a natural succession of plants as the environment changes. Flooding is often a trigger for many animals such as fish and birds to breed, and for the growth and flowering of many plants. The quality of water in wetlands will vary depending upon their location. The salinity (how salty or fresh the water is) determines the types of plants and animals present. Water quality parameters such as electrical conductivity and turbidity naturally increase during the summer as the water level in the wetland falls.

Why are wetlands important?

Wetlands are amongst the world's most diverse and productive environments, providing essential habitats for many species of plants and animals.

Wetlands are valuable because they:

- are breeding grounds for many animals, especially fish and waterbirds
- are vital habitats for the survival of many species, some of which are in danger of extinction, e.g. western swamp tortoise, orange-bellied parrot, white-bellied frog, honey blue-eye fish and rare plants
- support wildlife which can help control insect pests on farms
- are natural firebreaks
- are important drought refuges for wildlife
- provide places for a range of recreational activities such as swimming and fishing
- help to purify water by acting as 'kidneys' along waterways, filtering sediments, nutrients and other pollutants from the water.

Natural processes in a wetland help to improve the quality of water fed to it from a stream. Water which moves down creeks and rivers can pick up silt and contaminants, particularly stormwater runoff from city and suburban areas. When this water enters a wetland it slows down and its contents settle. Pollutants are naturally filtered and much of the washed-down material can be used as nutrients by wetlands plants, which in turn nourish birds, fish and other animals. Bacteria and viruses carried in the water are killed by exposure to bright sunlight as the water is spread over a large surface area. Some are also eaten by microscopic water life. This filtered water can now gently flow out of the wetland into a river system or out to sea. It is cleaner and healthier, protecting the health of plants, fish and other animals it meets downstream.

SECTION 7

Land managers' guide to water quality monitoring

This section has been specifically designed to meet the needs of land managers who wish to implement the Waterwatch program on their properties. Information is provided about managing and monitoring water sources on farms, as well as factors which can impact the quality of water sources.

This section should be used in conjunction with other relevant sections of this guide, especially Section 2. Reference to the Waterwatch Field Manual *is also essential.*

7.1 Managing farm water

Water is an essential farm resource and both its quantity and quality can be affected by farming practices. Waterwatch can assist land managers to monitor the water resources on their farms and assess progress towards natural resource management outcomes that enhance water quality and ecosystem health.

There are two aspects of water that are important: quantity and quality.

Water quantity

The amount of water available may provide the key limiting factor for different types of farm production. Effective management of water quantity is important for dealing with drought conditions and for the protection of the environmental values of the farm, such as habitat and wildlife.

Water quality

While the quantity of water on your farm is important, so too is water quality. Clean water is essential for stock, household and other farm uses. Poor quality water can cause algal blooms on farm dams and lower farm productivity. Water with high levels of salinity is unsuitable for some uses and may require dilution if used for irrigation. In animal production systems, animal performance is enhanced by high quality drinking water. It is essential to assess the water quality of all farm water supplies and identify management actions that may enhance water quality. The benefits of this will go beyond farm production to improve conditions for wildlife and enhance water quality within the catchment.

> *i* **'According to a national survey of 1500 wool growers, seventy percent have properties which adjoin at least one waterway. Of those with waterways, 55% have adopted practices to maintain and improve water quality.**
>
> **Healthy rivers, creeks and streams are the arteries of the Australian environment – they provide the water to sustain many different plant and animal communities and they are the lifeblood of our agricultural enterprises. Without healthy water bodies, Australia does not have a sustainable future.'**
>
> **Land, Water and Wool, *Improving water quality to benefit production*, 2007.**

The quality of water in creeks, streams, rivers and estuaries reflects the type of land use and management throughout the catchment. Water quality can be affected by:

- sediment from eroding stream banks, stock tracks, or from adjacent paddocks
- nutrients from natural sources, manure or fertiliser, either attached to soil particles or in soluble form
- pesticides from intensive land uses or from treated animals
- animal wastes, particularly dung washed from the riparian zone and possibly nitrate from urine
- dead stock in unfenced waterways
- salt from areas where rising groundwater is bringing salt to the surface.

Changes in water quality on the farm can have downstream water quality and environmental impacts. Key water quality issues include:

Turbidity – Increased muddiness of water can be caused by the erosion of riverbanks and stock access to waterways. This is a problem for aquatic life, but it can also be a problem for farm use. Soil particles and organic matter in the water can adsorb or neutralise the active ingredients in some pesticides. Spray nozzles are also prone to blockages when dirty water is used. Turbid water can also adversely affect stock health.

Nutrients – High levels of nutrients such as phosphates can lower water quality and create problems such as blue-green algal blooms that can be toxic to stock. This may be caused by stock access to waterways, riverbank erosion or runoff of agricultural fertilisers from adjacent land. Where stock have access to creeks and dams, compaction may accelerate runoff from agricultural land and transport phosphates and sediment to the waterway.

Salinity – High levels of salinity can affect the use of water for home and stock use. Recommended drinking water levels of salt should not exceed 800 µ/cm, and salinity exceeding 1500 µ/cm may affect aquatic life. Water with less than 3000 mg/L total salts (550 µS/m) can be used continuously by all livestock. Tolerance levels to saline water is set out in the table below.

Use	EC (µS/cm)	
Desired limit for human consumption	800	
Lucerne yield reduced by 10%	2200	
Absolute limit for human consumption	2500	
Upper limit for irrigation	2500	
Limit for mixing herbicide sprays	4690	
Stock water for:	Healthy growth	Max. limit
• Poultry	3200	5800
• Pigs	3200	6600
• Dairy cattle	4800	10 000
• Horses	6400	11 600
• Beef cattle	6400	16 600
• Adult sheep on dry feed	9600	23 000

The salinity of a water source may change over time and fluctuate with the seasons, so long-term trend monitoring and seasonal monitoring are also required. The salinity of dams, soaks and tanks may increase during the summer due to higher levels of evaporation. Stream salinity fluctuates seasonally due to river flow and rainfall. It is important to collect rainfall data as well as salinity data to find the relationship between rainfall and salinity at sites on your farm. The long-term changes in water salinity are complex and reflect a range of conditions at each site. By monitoring salinity over time, it is possible to identify the salinity processes and manage salinity as it affects the sites on your property.

Hardness – This is a measure of the dissolved calcium and magnesium salts, and is also expressed as mg/L $CaCO_3$ equivalent.

Hard water causes the formation of scums and makes it difficult to lather soap. It also causes encrustations on watering systems, metal pipes and irrigation fittings, and can reduce soil structure. Hard water can make some chemicals precipitate. It can also cause problems with wetting agents. Water with less than 100 mg/L $CaCO_3$ is generally regarded as suitable for most uses. A hardness level of 300 mg/L is the maximum limit for sprays and dips and may have an adverse effect on soil structure.

pH – Water for domestic and stock use should be in the pH range of 6.5 to 8.5. If the pH is highly acidic (less than 5.5), acidosis and reduced feed intake may occur. Highly alkaline water (over 9) may cause digestive upsets and diarrhoea and lower feed conversion efficiency.

The generally accepted pH for irrigation water is between 5.5 and 8.5, but some problems can occur within this range. For example, alkaline water may contain high concentrations of bicarbonates (generally in water of pH 8 and above) and carbonates (generally pH 9 and above). High bicarbonate and carbonate levels in water can cause soil sodicity, resulting in a loss of calcium and magnesium from the soil. In extreme cases this will affect plant growth. Some trace elements, like copper and zinc, will also be less available to the plant in this situation. Water with pH higher than pH 8.5, when used in spray mixes, can lessen the effectiveness of some pesticides.

Acidic water can have a detrimental effect on plant growth, causing nutritional problems in particular, while strongly acidic water (below pH 4) can contribute to soil acidification. Water with pH lower than 6.0 can affect the stability of some agricultural chemicals.

Monitoring of pH should occur on a seasonal basis and when new supplies are made available to stock. The testing of pH should be done in conjunction with salinity (EC) testing.

Dissolved oxygen (DO) – Low levels of dissolved oxygen can affect aquatic life, including the survival of fish and other aquatic species in farm dams and waterways. Still water in dams or non-flowing watercourses is most likely to be affected by low levels of oxygen.

In standing water on the farm, there is the risk of high nutrient levels during summer when evaporation rates are high. This may cause an excess of algal growth, causing a supersaturation (>100%) of dissolved oxygen, which is detrimental to water quality.

Dissolved oxygen varies throughout the day. DO levels are highest in the afternoon as plants photosynthesise during the day, and lowest just before dawn as oxygen is used for respiration by aquatic plants and animals through the night.

Faecal coliforms – These are naturally occurring bacteria found in the intestines of all warm blooded animals (including humans) and birds. Faecal coliforms (including *E. coli*) are used as an indicator for assessing risk to human health. Although faecal coliforms themselves are not pathogenic (disease causing), their presence is an indication that pathogenic bacteria and viruses may also be present.

Agricultural practices can add faecal coliforms to water via:

- feedlot and dairy runoff, i.e. from intensive farming
- runoff from broad acre farming
- effluent use on farms
- leaking septic or sewerage systems
- livestock defecating directly into the water.

7.2 Assessing current water management practices

An assessment of your current water management practices will provide an indication of those areas where you are currently managing your environmental impacts adequately and highlight areas that may need improvement (i.e. targets for action). An 'action required' ranking would identify an area of your farming operation that has a high risk of causing an impact on your farm and surrounding environment. In many cases you may have management approaches in place that are better than the 'best' outlined in this table.

Read each of the alternatives below and rate your current management. If there are significant differences between sites, complete the assessment for each water source.

Features	1. Best	2. Moderate	3. Action required	My rating
Planning	Water use planned and assessed. Property plan being implemented.	Property plan being developed.	No property plan.	
Monitoring	Ongoing monitoring of surface and groundwater and riparian areas. Results applied to land management decisions.	Baseline monitoring of some parameters – surface and groundwater and riparian areas.	No assessments conducted. No knowledge or incomplete knowledge of water quality of all farm water sources and/or riparian areas.	
Stock watering points	Off-stream watering system provides clean uncontaminated water on demand; watering points sited to optimise feed utilisation.	Stream used to water stock, but at constructed watering points only. Stock cannot walk along the stream or channel.	Stock have full access to creeks and streams. Potential for stock losses from bogging.	
Stock access to streams	Riparian areas fenced to control stock access, prevent losses and make mustering easier.	Riparian areas partially fenced or restricted to control the duration of stock access.	No fencing or other means of controlling stock access to riparian areas and the stream.	
Grazing management in riparian areas	Grazing of riparian areas managed for optimum pasture composition, feed production and feed utilisation, and to minimise parasite loads; ideally no grazing in zone.	Rotational grazing used in riparian areas based on assessment of feed available.	Riparian areas set-stocked or grazed heavily.	
Riparian management	Riparian areas managed for multiple uses – stream health, shade, shelter and habitat. Problem areas identified. Focus is on enhancement/ regeneration of riparian zone with native species.	Management plan for riparian zone under development.	No management of riparian zone.	

Adapted from Department of Primary Industries, *Environmental Management Self Assessment Guide.*

7.3 Developing a water monitoring program for your farm

Once you have completed a broad assessment of your current water management practices, as outlined in Section 7.2, you will probably already have some ideas for improvements you can make on your farm. Before beginning any management actions however, you should take the time to examine and test the water resources on your property and develop a detailed water monitoring program. Doing this preliminary work will ensure that any management actions you decide to take will be the most useful and effective ones for your particular situation.

Follow these steps to develop a water monitoring program for your farm:

1. Do a stockstake of all your farm's water resources.

2. Test the quality of each water resource.

3. Analyse the results of your water quality tests.

4. Set up an ongoing water monitoring plan.

5. Identify and implement management actions.

These steps will now be outlined in detail.

STEP 1: Do a stocktake of all your farm's water resources

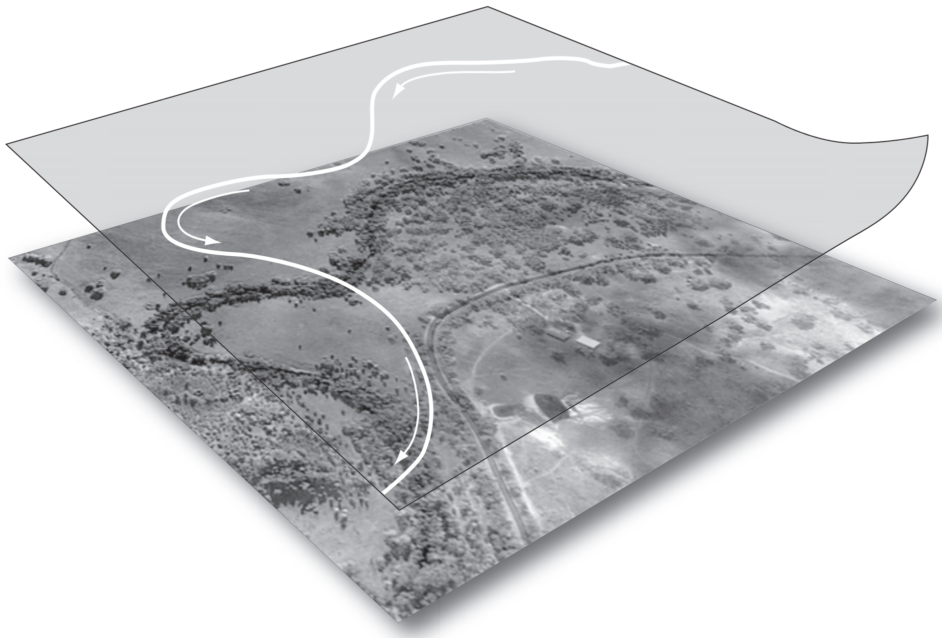
An aerial or satellite photograph is a basic tool for collecting relevant information about all the water sources on your farm. Once you have a photo like this, preferably at least A3 size, you can use a plastic overlay to record the position of all relevant water features such as watercourses, windmills, bores, springs and dams. Symbols are used to represent different water sources – refer to the legend on the picture opposite. Putting water resources on a separate overlay gives you the space to show both surface and groundwater sources. Choose a point on the base photograph and mark it with a cross – each time you make an overlay trace this cross onto it to help you align it next time.

Identify and mark all surface water and groundwater sites on your map overlay. These may include:

- surface water – creeks and rivers
- groundwater – bores and piezometers
- drainage lines
- storages – dams and lakes
- seasonally wet areas – waterlogged areas, discharge sites and wetlands.

The illustration below shows a sample photograph with water features marked on an overlay. Symbols have been used to indicate different water resources and the direction of water flow has been marked with arrows. You will continue to add details to your water overlay as you learn more about your water resources.

Property map with water overlay



Legend

Direction of Flow

Site assessment of farm surface water

For each water source on the farm, whether wetland, dam or creek, assess the management of **each** site for multiple uses (water quality, shade, shelter and habitat) by ticking the descriptions that apply at that site. Unticked questions may provide an indication of the management actions required to protect and enhance the environmental values of each site.

As you identify water sources on your farm, also note anything that may affect water quality. Examples include evidence of salinity, waterlogged areas, eroded gullies or algae on farm dams. Mark these onto the water overlay of your property map.

Date: ....

Site name 1: .... Site name 2: ....

Site name 3: .... Site name 4: ....

Assessment questions (Tick the boxes for each 'yes' answer for each site assessed) Answers **not** ticked may be areas for management action.	**Sites**			
	1	**2**	**3**	**4**
	Yes	**Yes**	**Yes**	**Yes**
All surface water sources				
Is all or part of the site fenced to control stock access?	☐	☐	☐	☐
Are watering points provided for stock away from the site?	☐	☐	☐	☐
Is there a diverse range of trees and shrubs present upslope of the dam or wetland or along a creek?	☐	☐	☐	☐
Is there a buffer zone between agricultural land (grazing and cropping) and creeks, dams and wetlands?	☐	☐	☐	☐
Are there any standing trees (dead or alive) with hollows near or within the dam or wetland or along a creek?	☐	☐	☐	☐
Is the site linked to remnant vegetation by corridors without gaps of more than 50 metres?	☐	☐	☐	☐
Is the site free of fertiliser, herbicide or chemical overspray or runoff?	☐	☐	☐	☐
Are weeds uncommon, sparsely scattered or absent from the site?	☐	☐	☐	☐
Are there any native fish present in the dam, creek or wetland?	☐	☐	☐	☐
Are introduced species (carp or mosquito fish) absent from the dam, creek or wetland?	☐	☐	☐	☐
Do foliage trees hang over the creek, dam or wetland?	☐	☐	☐	☐
Are bare areas and stock tracks near water uncommon?	☐	☐	☐	☐
Is the creek, dam or wetland free from regular algal blooms?	☐	☐	☐	☐
Are 'sensitive' macro invertebrates in the dam, creek or wetland? (e.g. caddisfly and mayfly nymphs)	☐	☐	☐	☐

Assessment questions (Tick the boxes for each 'yes' answer for each site assessed) Answers **not** ticked may be areas for management action.	**Sites**			
	1	**2**	**3**	**4**
	Yes	**Yes**	**Yes**	**Yes**
Creeks				
Are the banks of the creek free from erosion?	☐	☐	☐	☐
Is more than 50% of the creek corridor vegetated with a diverse range of native species?	☐	☐	☐	☐
Are there wider patches of vegetation along the creek corridor? (e.g. 25–50 metres wide)?	☐	☐	☐	☐
Dams				
Is there any earthen or floating island within the dam?	☐	☐	☐	☐
Does the dam have an irregular margin?	☐	☐	☐	☐
Does 50% of the dam have a gentle slope?	☐	☐	☐	☐
Is 50% of the dam less than 800 mm deep when the dam is full?	☐	☐	☐	☐
Are there hollow logs, rocks and litter around the dam?	☐	☐	☐	☐
Is there any regeneration of reeds and rushes upslope of the dam?	☐	☐	☐	☐
Wetlands				
Is there any regeneration of reeds and rushes upslope of the wetland?	☐	☐	☐	☐
Is the wetland free of irrigation tailwater?	☐	☐	☐	☐
Is the wetland free of fire during bird breeding seasons?	☐	☐	☐	☐
Are patches of wetland vegetation left unburnt as wildlife breeding habitat?	☐	☐	☐	☐
If the wetland has original vegetation, has the water regime remained largely unmodified?	☐	☐	☐	☐
Does the water level of the wetland fluctuate regularly (seasonally)?	☐	☐	☐	☐
Total number of yes answers				

Guide to wet area condition rating

Farm dam Number of yes answers	**Farm creek** Number of yes answers	**Farm wetland** Number of yes answers	**Condition rating*** *These provide a guide only	**Management actions** (A management plan should be developed for all actions; monitoring is needed to measure change over time.)
14+	15+	15+	Healthy	Maintain current management; identify specific issues for improvement.
11–13	12–14	12–14	Good	Assess management based on your results and target management issues identified.
8–10	9–11	9–11	Fair	A significant level of management needed to improve farm water sources.
0–7	0–8	0–8	Poor	Urgent action required to identify and prioritise management actions.

Condition rating and key management actions at each site:

Site 1	**Site 2**	**Site 3**	**Site 4**
Condition rating	**Condition rating**	**Condition rating**	**Condition rating**
Management actions	**Management actions**	**Management actions**	**Management actions**
1.	1.	1.	1.
2.	2.	2.	2.
3.	3.	3.	3.

Source: Adapted from ‘Save the Bush Toolkit’ in *Physical Property Planning,* NSW Department of Primary Industries, 1999

STEP 2:
Test the quality of each water resource

Now that you have identified all the water sources on your property and done basic site assessments at each, you are ready to test the quality of all surface water and groundwater. Your first round of testing will provide baseline data on current water quality and watertable depths against which future water quality data can be compared.

For each water source, select key sites that will provide a representative sample for the particular source. Also choose sites where water quality may be impacted by farm production. It is useful to take a photo at each site to provide a visual record of changes over time.

> *i* **Refer to Section 3.2 for tips on site selection.**

Once water quality testing sites have been identified they should be located on the Waterwatch online database, as the same location should be tested each time. The online database helps to manage the data collected as part of the farm monitoring plan and provides information for catchment planning.

> *i* **Refer to Section 2.4 for instructions about locating sites for the Waterwatch online database.**

Important tests for surface water are phosphates, turbidity, pH, temperature, EC (salinity), dissolved oxygen and rate of flow in streams. For groundwater you need only measure parameters that are relevant, e.g. EC and pH. You should also measure and record water levels in existing bores and wells.

> *i* **The *Waterwatch Field Manual* contains detailed instructions for conducting water quality tests.**

Additional monitoring

Macroinvertebrate and habitat assessments

Assessment of the health of waterways on your farm may also include macroinvertebrate sampling and/or in-stream habitat and riparian assessments. Refer to the *Waterwatch Field Manual* for details of how to conduct these assessments.

Monitoring groundwater

Groundwater can provide a useful source of farm water and good supplementary water in times of drought. However, its quality should be assessed and watertable depths monitored for change over time.

Groundwater often has a higher EC (salinity) than surface water. The measurement of EC from these sources will provide an indication of the usefulness of groundwater as a water source for irrigation and stock. Further tests may be required to determine other limiting factors to plant growth, such as pH.

Watertables

Monitoring watertables over a period of time will assist land management:

- If your bore, piezometer or test well shows that watertables are rising, it may indicate that too much water is being added due to irrigation, poor drainage or overwatering.
- If watertables are rising, crops and pastures are not using enough of the water in the soil and it is seeping through to the groundwater.

Assessing watertable depths

Watertable depth	Salinity risk	Assessment
Less than 1 metre	High	Very hazardous – watertables are close to the surface and are probably affecting plant growth and soil structure
1–2 metres	Medium	Danger – capillary rise will bring some salts to the root zone during the year. Plant growth may be affected. Preventing further rise is essential.
2–3 metres	Low	Potential problems, as capillary rise may bring some salts close to the surface.
Deeper than 3 metres	Low	Problems not significant, but monitoring is needed to record changes in the watertable over time.

The baseline information you obtain from your first round of water quality tests will be useful, but ongoing monitoring is essential for detecting and understanding changes in water quality due to natural climate cycles and in response to farm management actions. Step 4 outlines how you can set up an ongoing monitoring plan.

STEP 3:
Analyse the results of your water quality tests

The *Waterwatch Field Manual* contains detailed information about interpreting the results of water quality tests. Comparison of your results with the *ANZECC guidelines* will also provide an indication of the water quality in relation to health of the ecosystems on your farm – refer to the field manual for further information.

The following table contains basic information about what your results may mean; however, a detailed interpretation should also be done using the information provided in the field manual.

Water quality parameter	Possible cause	Impact	Monitoring
Turbidity	Erosion, poor groundcover/soil compaction due to stock or machinery, removal of vegetation from riverbanks, agricultural activity to the top of the stream bank	Affects aquatic plants and animals Carrier of phosphates and pesticides Smothers plants Blocks spray nozzles	Ongoing monitoring of turbidity and nutrients Event monitoring after rain of water quality and macroinvertebrates Percentage groundcover (using quadrats) Gully widening and deepening
Phosphates	Fertiliser runoff Stock access to waterway and dams, agricultural activity to the top of the stream bank (no buffer strip)	Increased growth of aquatic weeds Increased algal growth (affects dissolved oxygen levels)	Monitor nutrients after fertiliser application and after rain Monitor in conjunction with other parameters such as dissolved oxygen
Salinity (EC)	Reduced flow or low water levels in dams due to evaporation Runoff from agricultural land Upstream sources Groundwater contribution Salts stored in the soil may be mobilised	Loss of vegetation cover (scalds) Loss of productivity Limits use for irrigation High levels may affect stock	Event monitoring after rain and seasonal farm activities Monitoring of watertable depths and EC Monitoring groundcover and indicator species using quadrats/transects
pH	Usually reflects the geology of the area but may be affected by runoff of soil conditioners such as lime (alkaline) and fertilisers (acidic) In coastal areas runoff from acid sulphate soils may be an issue	High levels of alkalinity can affect crop production systems by lowering the availability of some trace elements to plants. Acidic water can contribute to soil acidification Highly alkaline water can affect stock while acidic water can cause acidosis and reduced feed intake High and low pH can reduce the effectiveness of some farm chemicals	Baseline monitoring and ongoing monitoring Monitor stock water from new sources Event monitoring after rain – especially if soil treatments have been used
Faecal coliforms/*E. Coli*	Cattle crossing waterways Effluent runoff	Harmful to human health	Ongoing monitoring in areas identified as high potential impact Monitoring related to seasonal conditions and farm activities

STEP 4:
Set up an ongoing water monitoring program

An ongoing monitoring program will record change over time and provide feedback on the effectiveness of any management actions. This will assist in the review and adaptive management of the farm's water resources.

Your monitoring program may also include event monitoring, such as measuring nutrients in water sources after fertiliser applications or turbidity after rain. It is important to note that water quality should be monitored on an ongoing basis as the quality and availability of water will vary according to seasonal influences and land management practices on the farm.

Section 2 of this guide provides detailed information about formulating a Waterwatch Plan. It goes through the key questions you should ask yourself about why, when, how and what you will monitor, and how you can ensure you collect high quality data. Some of the information is directed at community volunteer groups and may not be relevant to your situation; however, you will get the most out of it if you read all parts of the section and take what is most useful for your situation.

Section 2.12 provides a template for a Land Manager Waterwatch Plan. Using the template to formulate your individual Waterwatch Plan will ensure that all important considerations are covered. The Waterwatch Agreement in Section 2.13 represents a formal commitment to follow the requirements for participation in the Waterwatch program – this is necessary to ensure that data collected meets the high standards of the program and all Waterwatch equipment is used correctly and properly maintained. Both the Waterwatch Plan and Waterwatch Agreement need to be discussed with, and signed off by, your local Waterwatch Coordinator.

Monitoring the appearance of sites over time

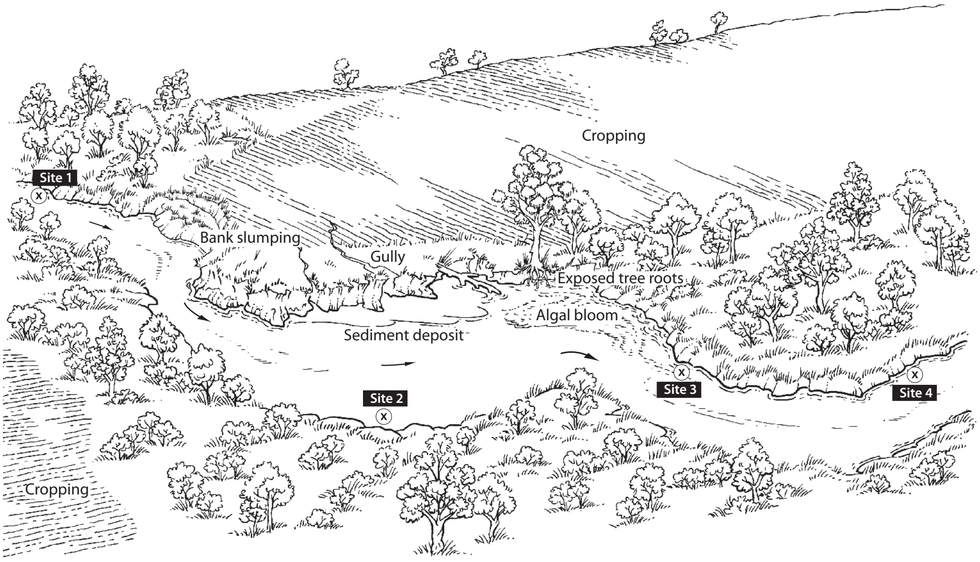
In addition to water quality testing, it is useful to record the appearance of sites each time you visit them to test. To ensure you will be able to compare a series of photos of a site, establish a photopoint. It may be a natural feature such as a large tree or you may use a star picket or peg to mark the photopoint for ongoing reference. From each photopoint, take at least two photos in different directions, using a distant feature to centre each one. You will use the same photopoint and reference features each time you visit the site. The idea is to build up a series of images which will enable you to see changes in your testing site over time, perhaps revealing negative trends needing your attention or positive changes resulting from successful management actions you have put in place.

You may find it useful to glue photos onto A4 sheets and place these in a display book – ensure you label each photo clearly with the site name and date taken, and group photos of the same site together for easy comparison.

Monitoring the impact of agricultural production on local waterways

The impact of farm production on water quality within the catchment can be monitored by land managers as part of the farm monitoring plan. This can be achieved by including upstream and downstream sites as part of the farm monitoring plan. The upstream site can be regarded as the reference site and all other monitoring sites downstream can be compared to this site to determine the impact of farmland use on water quality within the catchment. Although only one monitoring site is essential downstream, the selection of more than one site will provide information about the source and extent of the impact of farm production on water quality.

Site placement for assessing the impact of land use on river health



Source: Department of Natural Resources and Water, 2007.

Riparian assessments and macroinvertebrate sampling at water quality testing sites provide additional information about the effectiveness of the riparian zone to reduce sediment and nutrient transfer to waterways and the impact of farm production on aquatic ecosystems. This will provide information for future management actions.

STEP 5: Identify and implement management actions

You can use the information obtained from analysing your water quality testing results to identify, prioritise and implement management actions to improve water quality on your farm. Refer to Section 8 for detailed information about useful management actions that can be undertaken on farms.

SECTION 8

Management actions to improve water quality on farms

Management strategies aim to ensure that water quality meets farm production needs and ensures catchment health outcomes. Managing water on the farm requires an understanding of the factors affecting water quality.

This section follows on from Section 7 and presupposes that baseline water quality testing has been undertaken and an ongoing monitoring program is in place.

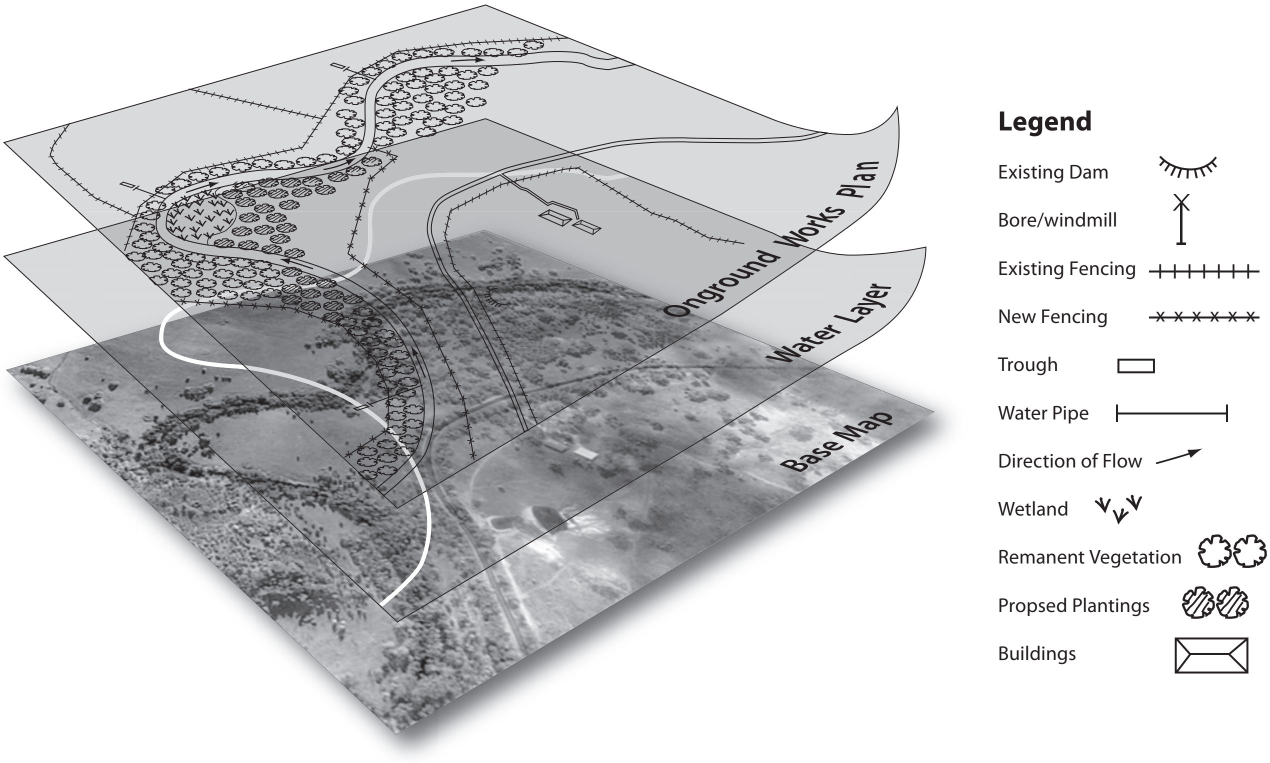
Included in this section: *Page*

8.1 Planning your management actions

Many land management decisions will directly and indirectly impact on water quality and should be considered in conjunction with the management of all other physical resources on the farm, including soil, land and native vegetation. Solutions to water quality issues may include in-stream structural works, bank stabilisation works, regeneration of riparian vegetation or putting buffer strips between farming activities and the watercourse.

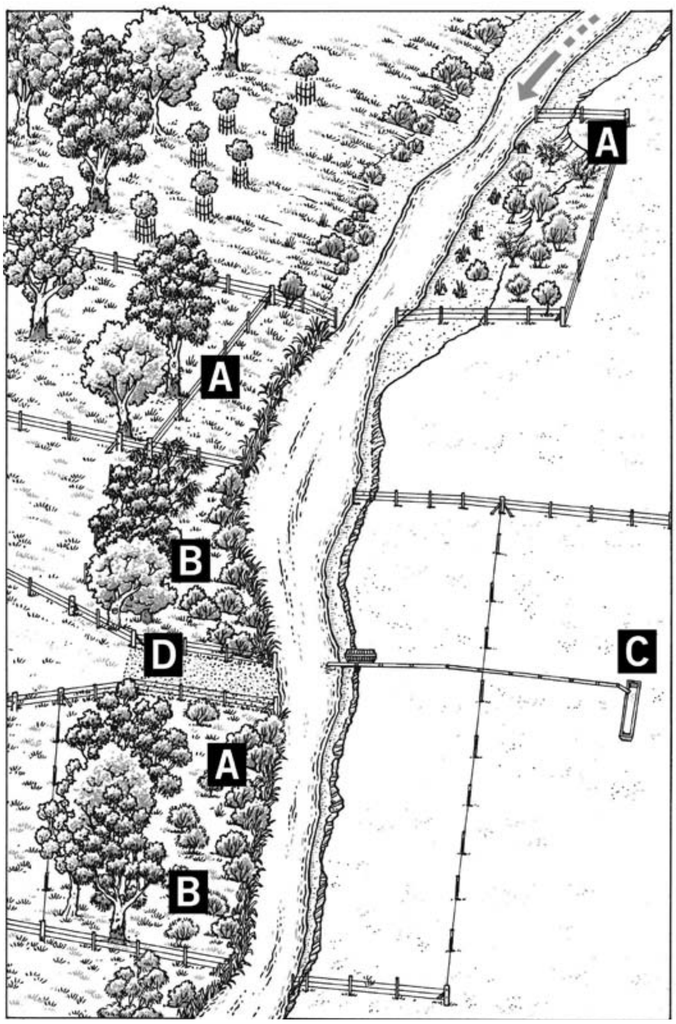
You will find it useful to show all your planned management actions on a separate overlay on your property map. This layer may be added to over time as projects are completed and new management actions are incorporated.

Property map with water and management action overlays



8.2 On-ground works projects

On-ground works projects will often be most effective when a staged approach is adopted within targeted areas. This is illustrated in the diagram below.



The diagram shows how land managers can gradually restore parts of their riparian land. In some parts of the stream, stock have been excluded so that natural regeneration can occur (A). In other parts revegetation has been more actively pursued to protect against bank erosion (B). Off-stream watering has been used on one side of the stream (C), while on the other side a gravelled stock drinking point restricts access to a small but stable part of the stream bank, where damage can be controlled (D).

A gradual restoration strategy that can be implemented in small units is an effective way to introduce changes to the management of riparian areas without becoming discouraged by the size of the overall task. Significant improvement is possible with a planned approach and an ongoing commitment.

Source: Land, Water and Wool, *Managing rivers, creeks and streams,* 2006

> *i* **Tip: You can also use maps or satellite images from mapping websites to create your property map or sketch map.**
> **Your local CMA or council may also be able to assist, using their GIS systems.**

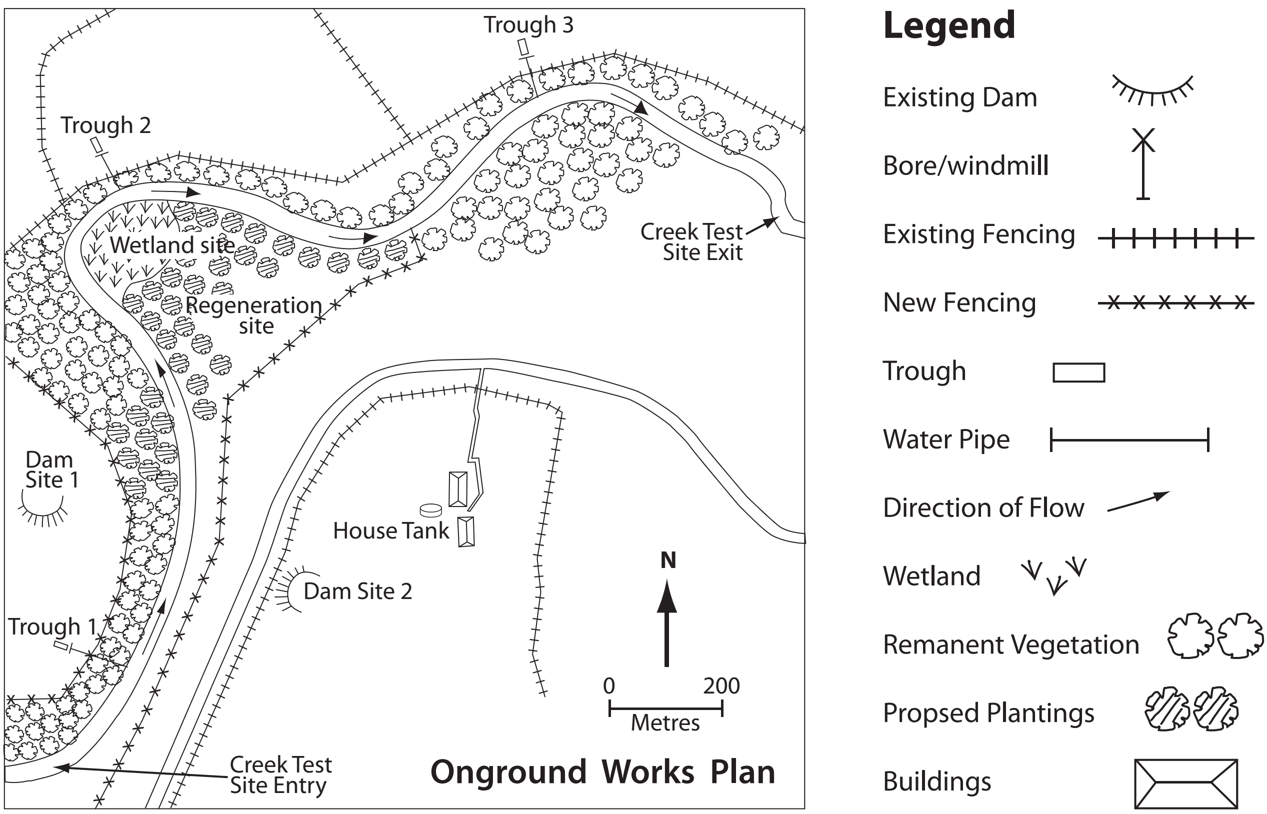
Sketch map of an on-ground works project

Once you have undertaken the initial mapping and assessments for your property plan, an enlarged bird's eye view map can provide the detail needed to implement a targeted project or seek NRM (natural resource management) funding.

The bird's eye view map should include:

- direction – North South East West
- scale – approximate only
- frame
- physical features – creek, remnant vegetation, landforms
- existing infrastructure – fences, buildings, dams
- new infrastructure – fencing, troughs, dams, tree plantings.

Bird's eye view map showing water test sites and rehabilitation area



Monitoring the impact of an on-ground works project

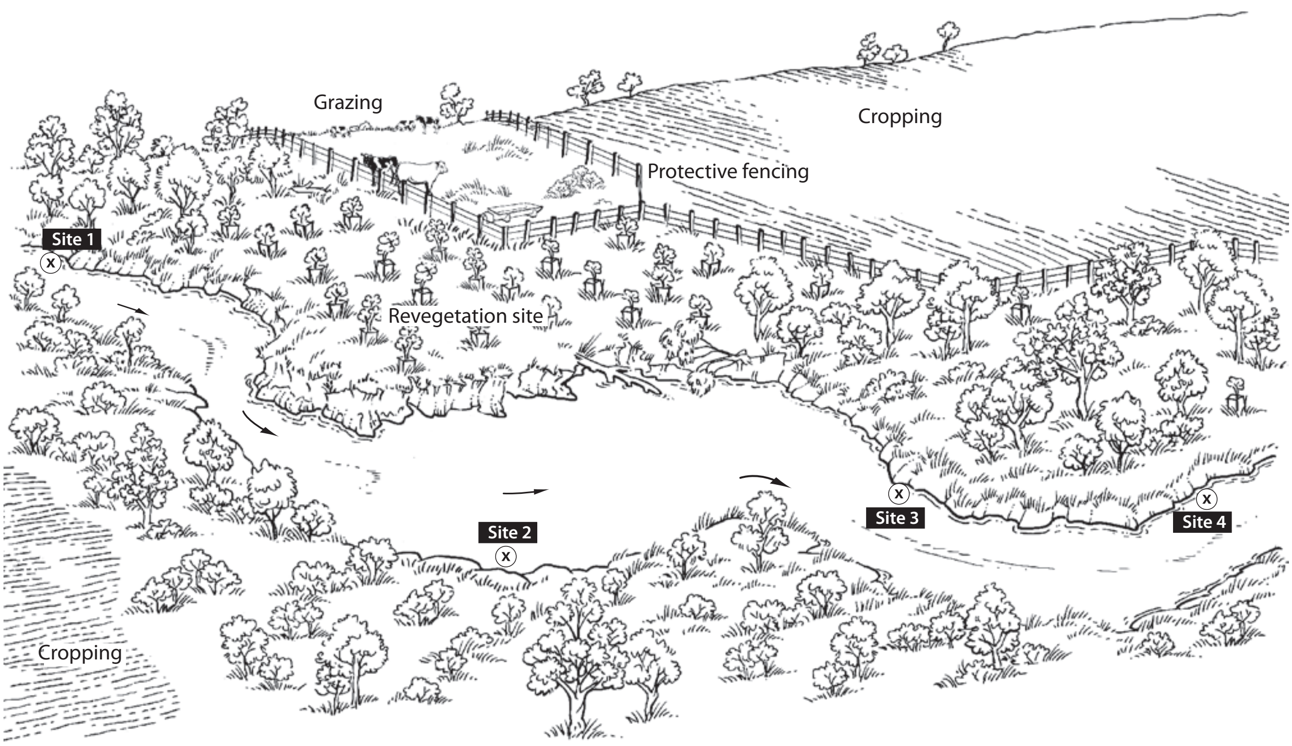
It is important to incorporate baseline and ongoing monitoring as part of an on-ground works project. This will assist you to evaluate the effectiveness of the project and allow management to be reviewed and improved over time.

It is anticipated that on-ground works projects will make a positive contribution to water quality and catchment health. Monitoring sites should be situated within the area connected to the management actions. This will enable comparisons to be made between restoration sites and other sites where no actions have taken place. The placement of monitoring sites downstream can also provide information about the spatial extent of the changes due to the on-ground works project.

In the example below, by monitoring above and below the revegetation site, the impact of this project can be assessed over time. The spatial extent can be determined by monitoring a number of sites below the riparian restoration area.

It is suggested that in conjunction with water quality monitoring, a riparian assessment should be conducted to monitor changes in the riparian condition over time. This may include plant regeneration and structure as well as tree size and growth rates. This will provide useful information about the effectiveness of the project in enhancing water quality and the riparian corridor that protects the waterway.

The design of the monitoring program will include site selection, the frequency of monitoring and the parameters to be monitored.



8.3 Assessing the condition of riparian land

Adapted from the Sydney Catchment Authority 'Grant Evaluation and Monitoring' (GEM) tool, this assessment is designed to monitor changes in riparian vegetation due to investment in on-ground works. The assessment can be uploaded to the Waterwatch online database and will provide information about riparian areas that can be related to water quality testing and macroinvertebrate sampling at Waterwatch sites.

> *i* **Section 9 of the *Waterwatch Field Manual* contains detailed instructions for setting up and conducting a riparian condition assessment, including field recording sheets.**

Riparian vegetation provides a surrogate measure for water quality when 'water quality' refers more broadly to 'river health'. This assessment provides a tool to assess changes in the riparian condition that impact on water quality, biodiversity and river health outcomes. A high level of risk means that the condition of the riparian attribute may be detrimental to river health. A low level of human disturbance or a well-managed site may have a very low level of risk to these outcomes.

Management of riparian areas aims to reduce the level of risk by improving the condition of the riparian attribute directly or indirectly. It can be used to target management or to monitor changes due to previous management actions.

Very high	High	Moderate	Low	Very low

← **Risk level** →

Outcomes and criteria for riparian condition assessment

The attributes used to measure changes in riparian condition include groundcover, stock access, native vegetation, erosion and exotic species/weeds, and can be summarised in the table below:

Outcomes	Criteria	Measures
Biodiversity and habitat	Riparian habitat/connections	Riparian width Longitudinal continuity
	Native plant cover	Native canopy cover Native understorey cover Native groundcover cover Organic matter (litter)
	Regeneration	Variation in stem width Presence of native seedlings
	Exotic species/weeds	Extent of infestation
Water quality	Filter for runoff	Groundcover Stream order Adjacent land use Stock access
	Filter for subsurface flow	Root density Stream order Adjacent land use
Bank stabilisation/gullying	Plant roots	Root density on banks Groundcover (grass)
	Erosion	Bank slope Bank slumping/exposed tree roots/gullies/tunnels Streambed lowering High volume water transfers Stock pressure/tracking
In-stream habitat	Organic matter to stream	Overhanging native vegetation
	Recruitment of logs/snags	Logs/snags/branches
	Habitat stability	Sediment deposition within the stream bed

Background to the riparian condition assessment

Riparian biodiversity and habitat

Native vegetation cover, structure and continuity provide terrestrial plant and animal habitats and protect biodiversity. They act as a refuge and provide connectivity within the landscape. Riparian areas that are >30 metres wide with few gaps and a high percentage of native canopy, understorey and groundcover plants will provide a very low risk to biodiversity outcomes.

Regeneration of native species

Long-term survival of native plant communities will occur when there is a range of ages and stem sizes of the canopy species. The presence of only mature stems may indicate that the plant community is at risk, with no seedlings to replace ageing canopy trees. This measure is incorporated within the assessment as it would provide a risk to biodiversity outcomes.

Exotic species/weeds

Riparian and in-stream vegetation provide food and shelter for both aquatic and terrestrial species. Exotic plants/weeds are often a poor substitute for native riparian species. For example, native fish and other aquatic life require the continual leaf fall provided by native plants. Introduced deciduous plants such as willows lose their leaves in autumn, and the sudden arrival of so much organic material in the stream causes a reduction in dissolved oxygen levels while the leaves are decomposing. This creates a risk to aquatic ecosystems.

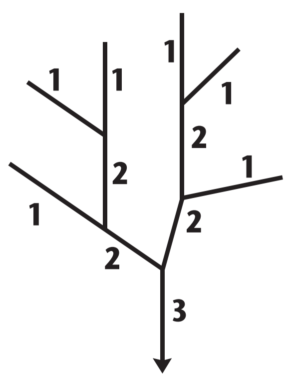
In-stream habitat

Riparian vegetation provides organic matter in the form of leaf litter, plant debris and insects for fish, birds and other wildlife. Stable in-stream habitats will support a diversity of aquatic life. The contribution of riparian areas to in-stream ecosystems includes the following:

- **Branches and logs** within the stream channel provide habitat and refuge for fish and small invertebrates. Without the recruitment of logs and snags to the stream, the variety and abundance of cover will decrease and the diversity of aquatic ecosystems will also decline. This is considered a risk to aquatic ecosystems in this assessment.
- **Overhanging vegetation and tree roots** provide shade and shelter for fish and other aquatic life, and also act to regulate conditions within the stream. This is important because wide fluctuations in water temperature can be detrimental to the growth or breeding of many native plants and animals.

Stream order

This assessment uses stream order to provide an indication of the size and position of the stream in the landscape. Generally, small non-perennial streams are classified as 1st or 2nd order streams while larger perennial streams are 3rd order or above.

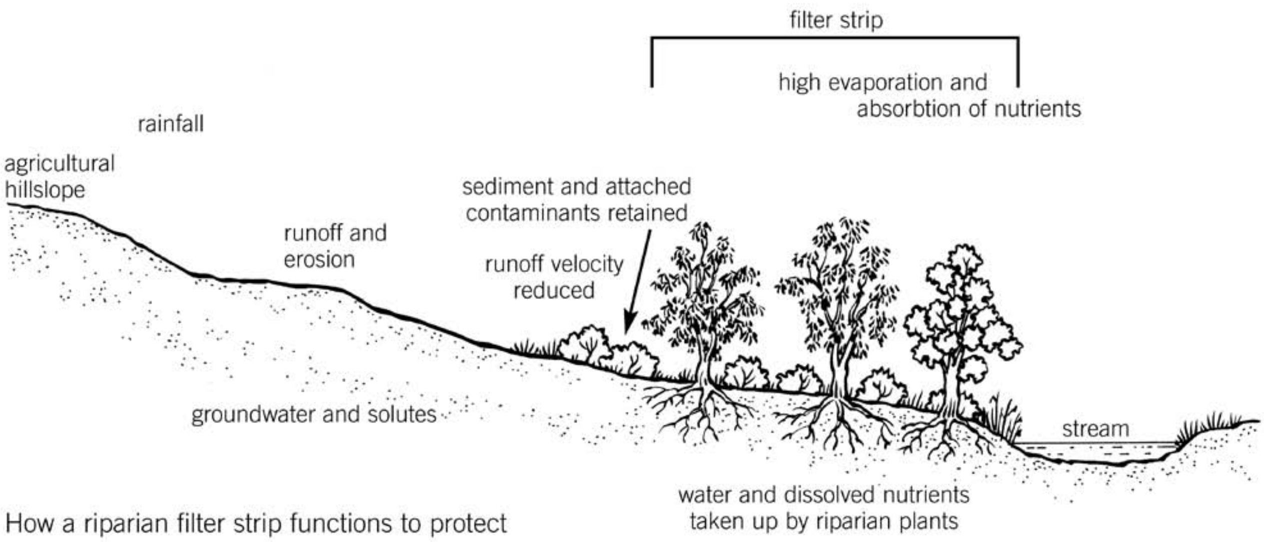


Stream size and location within the landscape can have a significant effect on the functioning of aquatic ecosystems. For example, streams transport organic matter from the upper catchment (1st and 2nd order streams) downstream, where it provides food for aquatic species. Stock may also have a greater impact on small streams where low banks and shallow water allow stock access at many points along the banks. This can affect water quality lower in the catchment.

Water quality

Riparian vegetation provides a buffer between land-use impacts and the waterway, filtering sediments, nutrients and other pollutants from runoff before they enter the stream. Buffer strips help to maintain or improve water quality and reduce the amount of nutrients in the stream that can lead to excessive growth of aquatic plants and algae. Grassy riparian zones trap more than half the sediments washed off nearby farming and grazing land.

In this assessment, the percentage cover of native riparian vegetation including groundcover, provides an indication of the level of risk to water quality. In many rural and urban areas where riparian vegetation has been cleared, the risk to water quality is increased.



How a riparian filter strip functions to protect the stream from contaminants. Illustration Paul Lennon.

Source: Land, Water and Wool, *Managing rivers, creeks and streams,* 2006

Stock access to streams

Stock can have a detrimental effect on streams by removing or degrading riparian vegetation which helps to stabilise stream banks. Stock trampling and the creation of tracks on stream banks can concentrate runoff and increase the risk to water quality by increasing the transfer of sediments and nutrients to the waterway. Stock watering within the channel can add nutrients and bacteria from urine and manure.

This assessment identifies stock access as a risk to water quality and bank stability. The restriction of stock by fencing riparian areas can have an immediate and positive effect on water quality and bank stabilisation.

Bank stability

Waterways naturally erode but land use can increase the rate of erosion and impact on river health. This may be caused by increased stock access or runoff from adjacent land, the removal of riparian vegetation and gravel extraction, poorly designed bridges and culverts or straightening the stream channel.

The erosion of riverbanks is now considered to be a significant issue as riverbanks store high levels of nutrients that can be added to waterways via erosion and bank slumping. A bank stability assessment should identify riverbank form and the susceptibility to bank instability. This will identify the need for future actions to stabilise the riverbanks.

The deep roots of shrubs and trees on stream banks can help to dry bank soils more quickly, preventing saturation of the banks during high rainfall and reducing cracking and bank collapse.

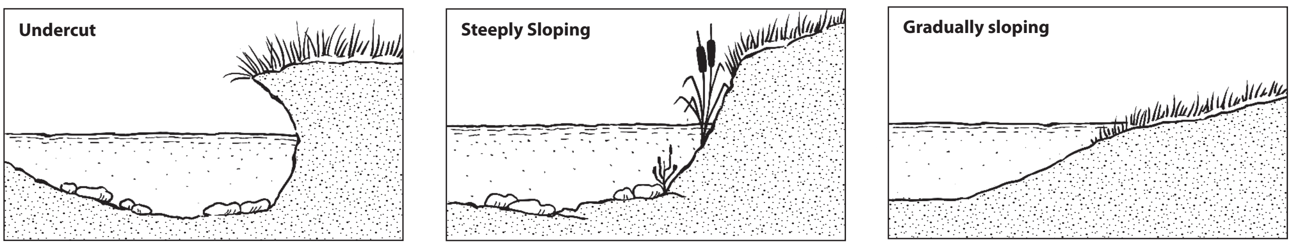
Riparian vegetation stabilises and protects stream banks from erosion by binding the soil particles together and absorbing the force of flowing water.

Banks vary in steepness and stability, such as:

- **Vertical or undercut** – a bank that rises vertically or overhangs the stream, generally gives good cover for macroinvertebrates and fish and is resistant to erosion. The banks may be composed of solid rock or very fine sediment which is more resistant to erosion.
- **Steeply sloping** – a bank that slopes at a more than 30 degree angle. This type of bank is very vulnerable to erosion if composed of sand or gravel.
- **Gradual sloping** – a bank that has a slope of 30 degrees or less. Although this type of stream bank is highly resistant to erosion, it does not give much streamside cover.

Artificial changes to banks include the use of wood, concrete or rock, e.g. retaining walls. If the stream has been lined with concrete banks, it will be more stable but will have little or no vegetation cover and few of the habitats needed by macroinvertebrates to live. Concrete banks may also cause erosion upstream or downstream due to changed water velocity.

Shape of stream banks

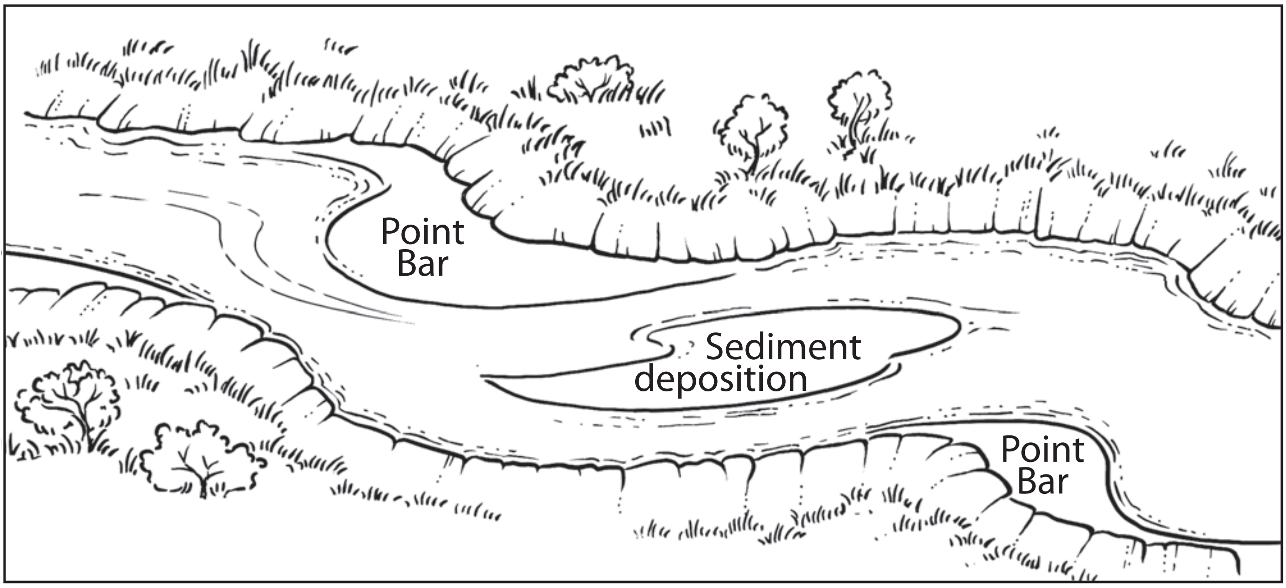


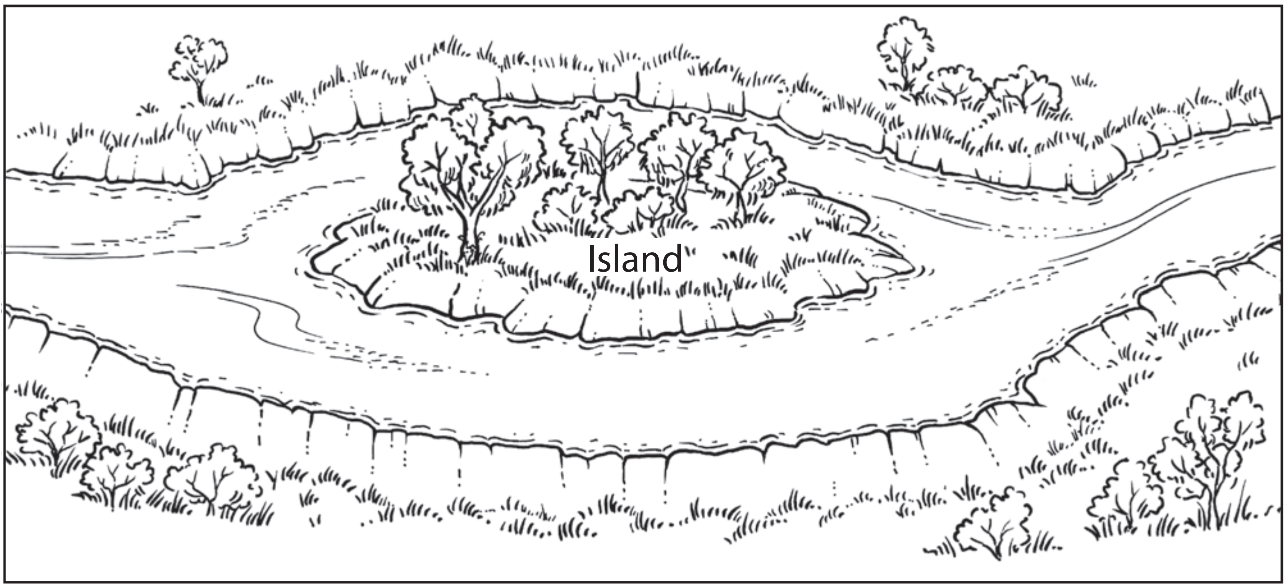
Source: Waterwatch Tasmania 2003.

Sediment deposition

Mobile sediment deposition from upstream sources or from banks can smother stones and cobbles and other in-stream habitats. This reduces habitat diversity and biodiversity at the site.

Sediment deposition may result in the accumulation of sediment in pools and on the stream bed, causing the formation of islands and point bars. Deposition is evident in areas that are obstructed by natural or human-made debris and in areas where the stream flow decreases, such as on bends. High levels of sediment deposition indicate an unstable and continually changing environment that becomes unsuitable for many organisms.



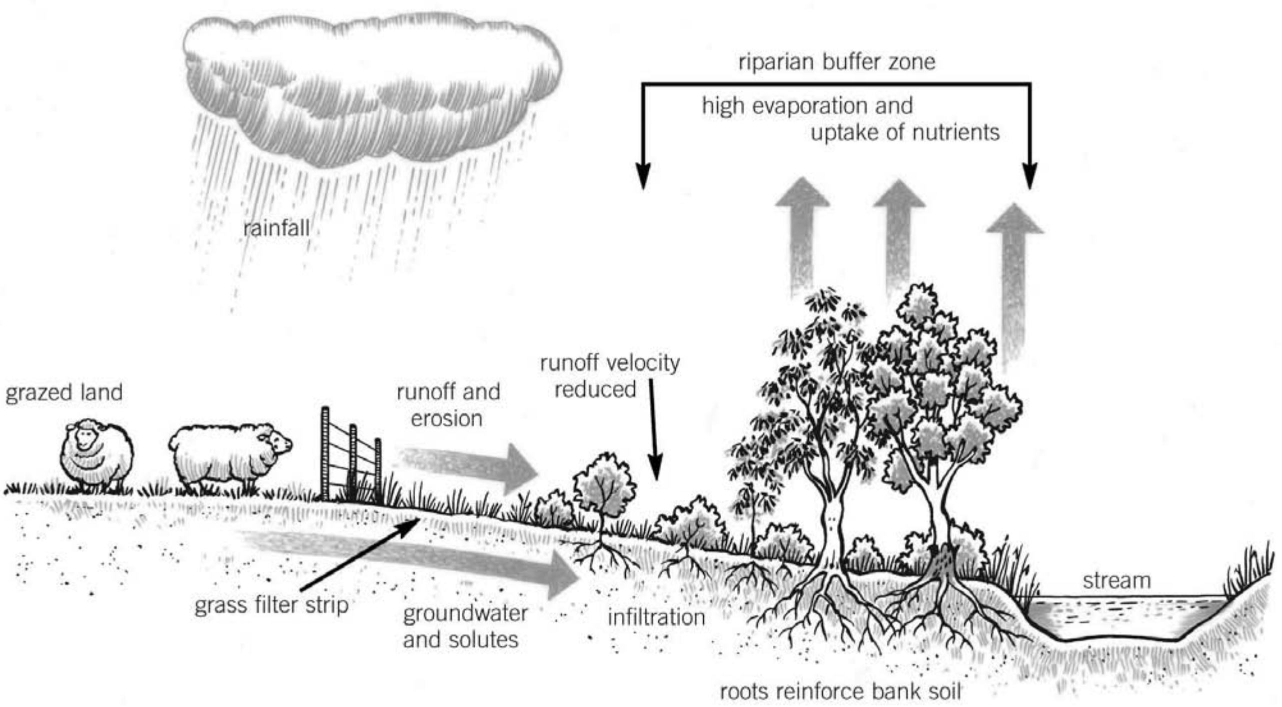


8.4 Managing riparian land

Riparian areas provide feed and water for livestock, fish, native animals, feral animals, grasses, trees, shrubs, as well as acting as nutrient filters and providing habitat, shade and shelter for animals and plants.

The maintenance of a good groundcover on all sloping land helps to prevent or slow contaminants from entering streams and creeks. This can be achieved by riparian filter strips that trap nutrients within and among vegetation. Grassy riparian zones trap more than half of the sediments washed off nearby farmed and/or grazed areas. Plants and microbes in the riparian zone use these sediments, providing the dual advantage of increased pasture growth and improved water quality. Monitoring nutrients and turbidity within the stream, as well as aquatic plants and macroinvertebrates, will provide a measure of the effectiveness of these measures in managing water quality.

Processes that occur in the riparian zone to assist streambank stabilisation. Illustration Paul Lennon.



Source: Land, Water and Wool, *Managing rivers, creeks and streams,* 2006

Management of grazing

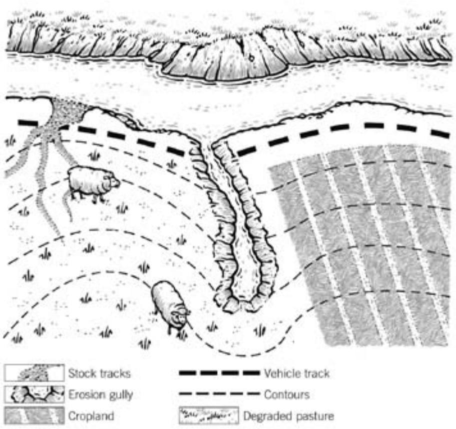
To prevent or reduce animal wastes (and parasites and disease organisms) entering creeks, it is essential to manage stock access to waterways and the immediate riparian area. This may include fencing out stock or managing the timing and duration of stock access to riparian areas to ensure they are not overgrazed. It may also include off-stream watering systems to ensure the best quality water for stock use.

Principles of grazing riparian zones

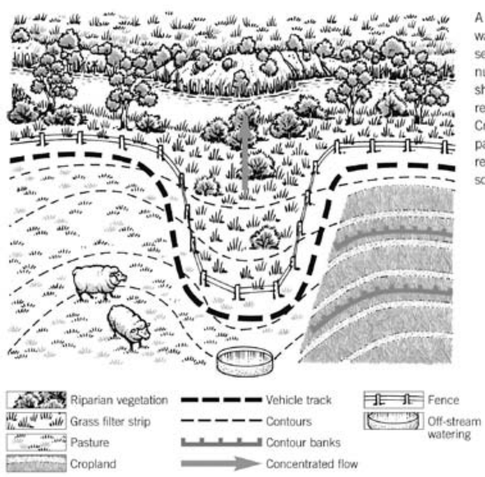
Managed grazing can benefit the riparian zone and water quality as long as sound principles of grazing management are adopted:

- Fence riparian zones to help you manage them independently of other paddocks on the farm.
- Graze your riparian paddock for a short time. Shorter grazing periods stop livestock from browsing on the trees and shrubs in the riparian paddock. The longer stock are in a paddock, the more chance they will graze young trees or ringbark older ones. This will reduce the benefits of the riparian zone to water quality.
- Do not 'crash graze'. To keep plants healthy, enough leaf needs to be retained on desirable plants (the perennials) to help them recover from grazing. Crash grazing removes too much plant material **and** lowers livestock performance. It will reduce groundcover and the ability of the riparian zone to act as a filter strip.
- Manage the rest period. Let livestock graze the riparian paddock only when the plants they like have recovered from the last grazing. This means longer rests (up to four months) in winter and shorter rests (usually no less than three weeks) in spring in wheat/sheep areas. Plant leaves should be upright and leafy and not creeping along the ground.
- Try **not** to use your stock to target weeds. Weeds will probably grow faster than the desirable plants. The more desirable plants need to become even healthier than the weeds. To achieve this, grazing the desirable plants should not occur until they have recovered.
- Litter is not just wasted grass! Leaf litter left behind and trampled by stock makes great mulch and feeds soil microbes. Leaf litter holds water, keeps the soil temperature more constant, makes a perfect seed bed for perennial plants, and is home to soil bugs and microbes. Bugs and microbes store and/or eat dung and litter, stopping it from fouling the waterway. Move stock out of your riparian paddock long before they bare the ground. Leaving litter on the ground will help you to maintain 100% ground cover 100% of the time.
- Encourage a wide range of plant species, particularly natives. Trees and shrubs protect riverbanks during floods. Grasses and forbs with fibrous roots hold the finer particles in place and stabilise the banks. Animals and microbes that feed on a range of species can balance their diet and are healthier as a result.

These principles apply equally to the surrounding paddocks. Don't forget to manage outside your riparian paddock: it will make your riparian paddock even healthier and easier to manage if it is part of a healthy, well-managed farm.



A degraded stream and riparian land. Significant sediment and nutrient is derived from degraded pasture, poor crop layout, unlimited stock access and gully erosion.
Illustrations Paul Lennon.



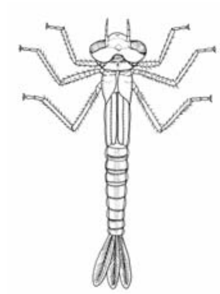
A riparian filter strip protects water quality by trapping sediment, absorbing nutrients and providing shade over the stream to reduce water temperatures. Crop layout and a vigorous pasture with good cover reduce the potential for soil erosion.

Source: Land, Water and Wool, *Managing rivers, creeks and streams,* 2006

8.5 Background to the water bug (macroinvertebrate) survey

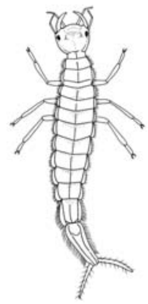
What are water bugs (macroinvertebrates)?

Water bugs or aquatic macroinvertebrates are small creatures that have no backbone and can be seen with the unaided eye. They live all or part of their life in water, providing a food source for larger animals such as fish, frogs and birds. Macroinvertebrates include snails, beetles, dragonflies, yabbies and worms.



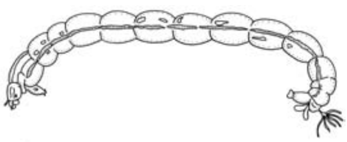
> *i* **Macro = visible to the unaided or naked eye**
> **Invertebrate = animal without a backbone**

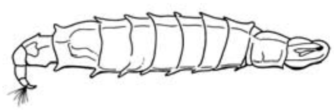
Macroinvertebrates and waterway health

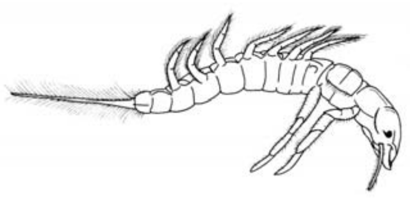


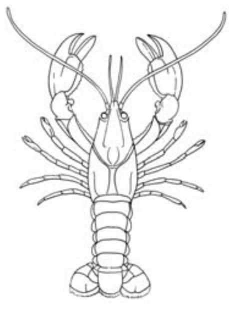
Water bugs provide an indication of the health of our waterways and are used to assess river health for the following reasons:

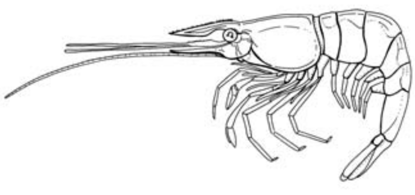
- Macroinvertebrates are found in almost every water body, even those that are dry from time to time.
- They are easy to catch with simple hand nets and are relatively easy to identify.
- They have different tolerances to pollution.
- The sedentary nature of some macroinvertebrates means they provide an indication of past conditions as well as present conditions.
- Macroinvertebrates are a major component of biological diversity. About 99% of animal species are invertebrates. Understanding the effects of human activity on aquatic macroinvertebrates helps in finding ways to conserve them.
- A healthy macroinvertebrate community is important to the normal functioning of a water body. Macroinvertebrates occupy a central position in the food webs of rivers and streams.











What does macroinvertebrate sampling provide?

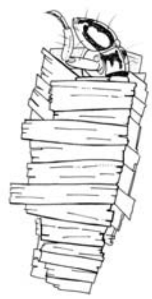
Sampling reveals information about the abundance, diversity and composition of water bugs. This in turn gives an indication of the health of the waterway.

Abundance

Abundance refers to the **number of animals present**. Excessive numbers of macroinvertebrates, particularly gastropod snails, tend to be found in water artificially enriched with nutrients. Small numbers may indicate erosion, toxic pollution or scouring by floodwaters.

Diversity

Diversity refers to the **number of different types of animal present**. Healthy streams usually have a greater diversity than degraded streams, although the diversity in headwaters may be naturally low due to a lack of food variety. Communities with many different species appear to be more stable and healthy than less diverse ones.

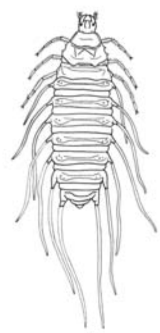


Composition

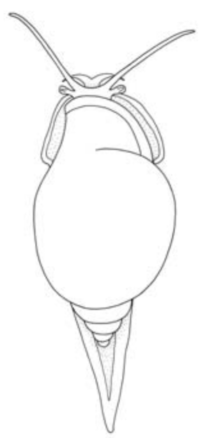
Composition of the community refers to the **proportion of different types of animals living together**. A sample from a healthy stream tends to contain a good number of mayfly, stonefly and caddisfly nymphs. However, if the sample contains a lot of worms and midge larvae (chironomids), the stream is probably degraded.

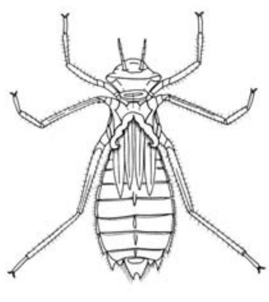
Pollution tolerance

Pollution tolerance refers to the **ability of macroinvertebrates to withstand pollution** from a range of sources, such as stormwater runoff, sewage, industrial effluent or heated water. This is reflected in the macroinvertebrate's SIGNAL 2 score – a simple scoring system for macroinvertebrate (water bug) samples.



> *i* **Section 10 in the *Waterwatch Field Manual* contains detailed information about doing a macroinvertebrate survey and using the results as an additional indicator of water quality.**





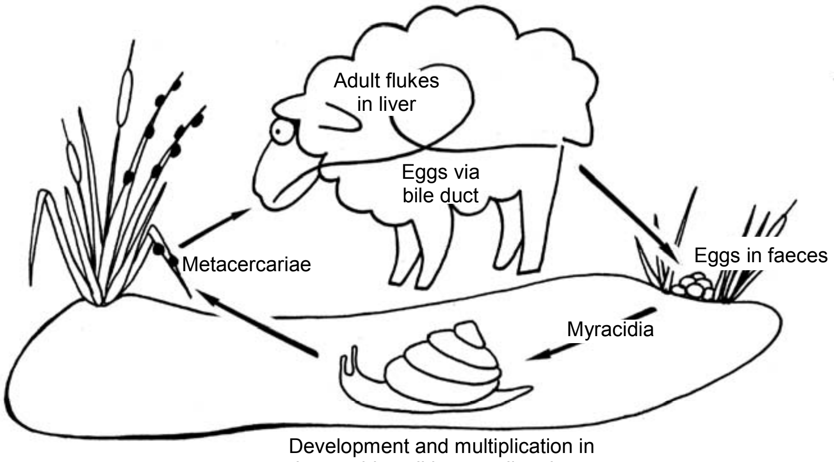
8.6 Managing wet areas – monitoring snails to control liver fluke

Macroinvertebrates provide an indication of the health of waterways and farm wetlands. Managing wet areas on farms is important to reduce the risk of liver fluke, which is transferred via certain species of aquatic snails.

The liver fluke cycle

Snails act as a host in the transfer of liver fluke. When favourable circumstances exist – water and moist conditions – the eggs hatch into larvae (miracidia) which invade the intermediate host snail. To survive and reach the host snail, the larvae need temperatures above 5°C with the optimum temperature being 15°C to 24°C.

After five to eight weeks and several larval stages, tadpole-like larvae emerge from the snail. These larvae form cysts on plants and are eaten by cattle and sheep. The larvae then migrate to the animal's liver before entering the bile ducts. Without the snails, the fluke cannot infect sheep or other hosts.



Where is liver fluke found in NSW?

Liver fluke is widespread across eastern New South Wales, where average rainfall is about 600 mm or more a year, especially on the tablelands and slopes and on the north and south coasts. It is also found in irrigation areas further west, where the annual rainfall is only 400 mm, but is supplemented by regular irrigation.

What areas of the farm may have snails?

Liver fluke snails may be native or introduced species. They live in the mud or on plants in shallow water at the edges of lakes, ponds, streams, drainage ditches, seepage areas, irrigation channels and poorly drained drainage channels. They feed on aquatic plant growth and algae. Different species of snail prefer different habitats and this may provide an indication of the type of snail. Snails are small and sometimes difficult to find.

Why monitor snails?

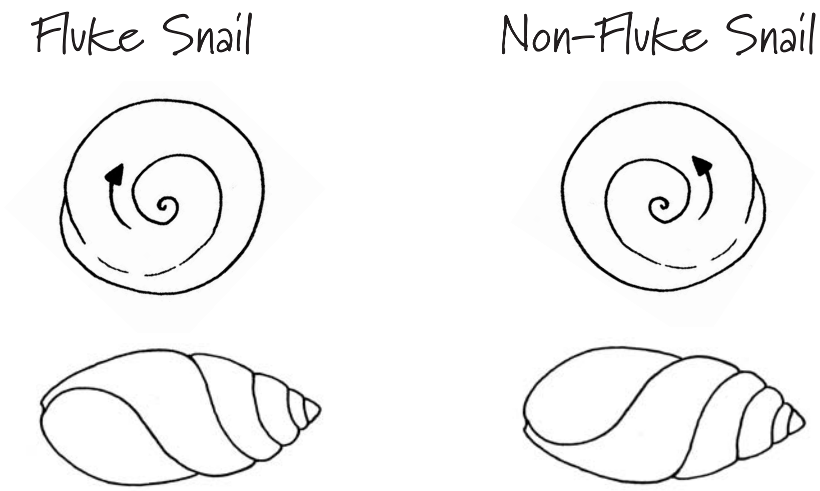
Monitoring provides an indication of the distribution of fluke-carrying snails on your property. This permits better management and control.

Monitoring also identifies the type of fluke-carrying snail. There is a native species that is a carrier of liver fluke, but introduced snails are also known to be fluke carriers. The monitoring of these species is important to determine the distribution and spread of these exotic species.

How to monitor and identify snails

Sampling wet areas for snails using dip nets will help identify the presence of liver fluke snails. Refer to Section 10 in the *Waterwatch Field Manual* for sampling techniques.

Not all aquatic snails are hosts for liver fluke. Fluke snails differ in the opening position and direction of their whorls. The most important host snail is the native species of freshwater snail, *Lymnaea tomentosa*. Introduced snails are also carriers of liver fluke and include *Lymnaea columella* (from North America) and *Lymnaea viridis* (from the Pacific area). Liver fluke infection only occurs where these snails are found.



Summary of features

Features	Fluke-carrying snail species		
	Lymnaea tomentosa	*Lymnaea viridis*	*Lymnaea columella*
Native or introduced	Native	Introduced (Pacific Islands)	Introduced (North America)
Whorls	3–4 whorls	4–5 whorls	2–3 whorls
Direction of spiral	Clockwise	Clockwise	Clockwise
Length of shell (adult) (mm)	4–12	4–12	8–20
Shell features	Short spiral/dark brown/ yellow colour		Elongated shell with grid-like striations
Operculum	Absent	Absent	Absent
Tentacles	Flat, triangular	Flat, triangular	Flat, triangular
Snail foot	Grey to yellowish		Dark grey/black
Preferred habitat	Trickling creeks flowing from hillside springs and soaks (black bogs), only rarely found in dams, water troughs or large creeks	Deeper creeks and channels, as well as in areas preferred by *Lymnaea tomentosa*	Slow waters, especially at the margins of lakes, ponds and swamps, on floating or emergent vegetation
Distribution in NSW	Eastern NSW on tablelands, western slopes and coast, as well as in irrigation areas	Coastal NSW and some tablelands area	Introduced by aquariums – has the potential to spread

Reference: Department of Primary Industries, *Prime Facts*, 476, June 2007.

Managing liver fluke snails

Snails are best managed by limiting grazing of snail infected areas. By fencing off swampy areas, by piping water to troughs and limiting grazing when the risk is highest (February to June), access to water containing fluke-carrying snails is restricted. Identify potential wet areas on the water layer of the farm plan map and include fencing for the management of liver fluke with other on-ground works projects to manage water on the farm.

SECTION 9

Glossary

Accuracy	how close the sampling result is to the true value – can be assessed by analysis of prepared standards from different sources – is most affected by the equipment and the procedures used
Acid	a substance that releases a positive hydrogen ion in solution – acidic solutions have a pH of less than 7
Acid sulfate soils	soils containing iron sulfides, found in low-lying waterlogged areas, generally less than 5 metres above sea level – when exposed to air, as can occur when drained, these sulfides oxidise to produce sulfuric acid, hence the name acid sulfate soils
Acid wash	a weak solution of hydrochloric acid used to wash colorimeter bottles
Action plan	a plan that identifies a goal and the steps required to reach this goal or objective
Aerial photograph	a photograph of the land taken from the air
Aerobic	organisms and processes that require oxygen
Algal blooms	extensive growth of algae in a body of water, which occurs due to climatic conditions or as a result of excess nutrients in the water
Alkalinity	the presence of bicarbonates, carbonates and occasionally borates, silicates and phosphates – a solution with a pH below about 5 contains no alkalinity
Anaerobic	living or occurring without oxygen
Anoxic	conditions where there is no oxygen
ANZECC Guidelines	Australian and New Zealand Environment Conservation Council guidelines for fresh and marine water quality
Aquatic	something that lives in water
Aquatic ecosystems	groups of plants and animals that live in water
Arable	land suitable for the production of crops
Assemblage	a number of species that live together in one area or habitat
Autoclave	an apparatus used to sterilise objects by means of steam under pressure
Available phosphate	a measure of the phosphate compounds that are soluble in water and therefore available to be absorbed by plants
Bank	sloping ground beside a river, stream or lake
Bank vegetation	plants that live on the sloping ground beside a river
Base flow	water that has infiltrated the soil and meets groundwater which seeps into a creek

Baseline monitoring	collecting data against which other data can be compared
Basin	the total area of land drained by a river and its tributaries
Belt transect	a transect where a quadrat frame lies against a transect line at regular intervals – permits a closer look at species composition within a quadrat
Benthic invertebrates	invertebrates that live in the bottom layer of a waterway
Best Management Practices (BMPs)	a monitoring activity that follows practices and procedures to ensure the best results relative to the constraints of the monitoring program
Biochemical oxygen demand	the amount of dissolved oxygen required for aerobic organisms to break down organic matter in a volume of water – an estimate of organic load in water samples
Biodegradable	compounds and materials capable of being decomposed by micro-organisms
Biodiversity	the variety of all plants, animals and micro-organisms in an ecosystem, biome, or the entire Earth
Biomass	the total mass of living material existing at a given time in a specified area – measured as live or dry weight per unit area
Biota	living plant and animal life
Bird's eye view map	a sketch map drawn as if features were viewed from above
Brackish	water that is slightly salty
Buffer zone	an area of plant groundcover that minimises runoff and erosion
Calibrate	to check and set the accuracy of an instrument such as an EC meter
Calibration standard	solutions of known concentration used to calibrate a meter before running a test
Capacity building	the process of building awareness, skills, knowledge, motivation, commitment and confidence
Carnivore	an animal that feeds on other animals
Catchment	a natural drainage basin where all runoff water flows to a low point
Catchment Management Authorities	NSW Government organisations established to set local priorities in natural resource management by the development of catchment action plans
Catchment stress	a measurement of how much a stream or waterway has changed from its natural physical state
Chemical impact	the effect of the chemical composition of water on human use and ecosystem functioning
Clarity (water)	the clearness of water
Climate change	the changes occurring in weather, temperature and rainfall at a site over a long period of time
Coastal stream	a stream that flows directly from its source to the ocean

Colorimeter	a piece of equipment used to measure water quality by comparing the colour change between an untreated and chemically treated sample, for a particular parameter, by shining light through it
Colorimeter tubes	the glass bottles containing sample water and/or chemicals inserted into a colorimeter
Community	an assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another
Community monitoring	information collected by the community about the health of their local ecosystem – may include both quantitative and qualitative assessments
Consistency	the ability to repeat a procedure many times and obtain the same result
Corrode	to wear away or destroy gradually, such as the impact of salt on objects
Data	numerical value or facts of any kind
Data confidence	the reliability of data as demonstrated by testing quality control samples – quality control results that fall within the designated tolerable error range for a parameter indicate that the monitoring data collected by a group can be treated with a high level of confidence
Data confidence program	the total integrated program for assuring the reliability and accuracy of monitoring data – includes quality control procedures
Decomposition	the breakdown of organic materials by micro-organisms
Deionised water	water that has had all the ions (atoms and molecules) other than hydrogen and oxygen removed
Detection limit	the lowest concentration that your equipment will report on accurately
Detritus	small pieces of dead and decomposing plants and animals
Dilute	to make less concentrated
Dilution factor	the amount by which a sample is diluted – the number of parts of deionised water plus the number of parts of sample water
Discharge area	an area where groundwater reaches the soil surface
Dissolved oxygen	the volume of oxygen that is contained in water
Dissolved oxygen % saturation	the relationship between the amount of oxygen in the water relative to the temperature of the water
Distilled water	pure water, free from dissolved salts
Dual range EC meter	an EC meter that can measure both high levels (mS/cm) and low levels (µS/cm) of electrical conductivity
E. coli	a species of bacteria in the faecal coliform group found in the intestines of animals and humans in large numbers – its presence in water indicates fresh faecal contamination
EC	abbreviation of electrical conductivity

EC meter	a meter that measures salinity by passing an electrical current through the water sample
Ecosystem	a community of living organisms and their non-living (abiotic) environment, functioning as one system, e.g. a river
Ecosystem condition	the current or desired status of health of an ecosystem, as affected by human disturbance
Ecosystem integrity	the health or condition of an ecosystem
Effluent	liquid flowing out
Electrical conductivity	the ability of a water or soil solution to conduct an electric current
Electrode of EC meter	the conductor through which an electric current enters or leaves an electrolytic cell, electric arc, electric valve or tube
Emergent plants	water plants that have their leaves above the water level
Environment	the sum total of all influences acting on an organism
Ephemeral stream	a stream that flows only for a short time
Estuaries	coastal bodies of water, typically at the mouth of a river, which are open to the sea, allowing fresh water from inland to mix with salt water from the sea
Eutrophication	the enrichment of a water body by inorganic plant nutrients – may occur naturally or may be accelerated by human activities (e.g. fertilisers or sewage disposal) – can lead to algal blooms
Evaporation	the change of state from a liquid to a gas
Event-based monitoring	monitoring that takes place after a certain event, which may be natural, such as rainfall, or a human activity
Exotic species	introduced, non-native species
Faecal coliform	naturally occurring bacteria found in the intestines of all warm blooded animals (including humans) and birds
Fauna	the animal life inhabiting a particular area or environment
Feedlot	an intensive method of raising animals in a confined area
Fertiliser	any substance, natural or manufactured, which is added to the soil to supply nutrients for plant growth
Field replicate samples	a duplicate sample that is collected at the same time and place – used to measure precision of sampling and analysis
Filamentous	the plant body of some types of algae, made up of thread-like rows of similar cells
Filter feeder	any marine or freshwater animal that feeds on microscopic organisms by using a filtering mechanism to trap particles out of water
Fish kill	the sudden death of fish, usually due to the introduction of pollution and/or the severe reduction in dissolved oxygen concentrations in the water body

Floating plants	plants that grow on the water's surface
Flocculation	a process whereby small particles in a liquid stick together to form clusters
Flood plain	the flat part of the valley bordering a river resulting from the deposition of silt during times of flood
Fluvial	belonging to or produced by a river
Food chain	a chain of organisms through which energy is transferred – each organism feeds on and obtains energy from the organism preceding it and in turn is eaten by and provides energy for the one following it (e.g. plant eaten by herbivore, then herbivore eaten by carnivore)
GPS	global positioning system that can be used to identify site location in latitude and longitude
Grazer/scraper	an animal that consumes algae and other material on the surface of submerged plants
Groundwater	water found and stored beneath the surface of the land
Gullying	a type of soil erosion caused by water continuously cutting channels on hillsides
Habitat	a place which provides suitable shelter and food for an organism
Headwaters	the upper tributaries of a river
Heavy metals	elements that can contaminate water and sediment, causing damage to some forms of life
Herbivore	an animal that feeds solely on plant matter
High range EC meter	an EC meter that can measure high levels of electrical conductivity (mS/cm)
Hydrology	an applied science concerned with the water cycle, which includes precipitation, runoff or infiltration, storage and evaporation
Impact monitoring	monitoring specifically to measure the result of an activity
Impact site	a site located immediately downstream of a pollution source
Impervious surface	a surface that does not allow water to soak in or infiltrate, e.g. asphalt
Incubator	an apparatus in which bacteria, etc. are grown at a suitable temperature
Indicators	key measures that summarise the condition, trends and changes in the health of a waterway and the environment
Indigenous	originating in a particular region or country
Invertebrate	an organism that has no backbone
Irrigation	the artificial addition of water to crops to supplement rainfall
Lagoon	a small pond-like body of water
Larva (larvae)	second developmental stage of an insect which proceeds from egg to larva to pupa to adult

Latitude	the angular distance north and south from the equator of a point on the Earth's surface
Limiting factor	a factor such as temperature, light, water or a chemical that limits the existence, growth, abundance, distribution or presence of an organism
Line drawing	a sketch of the features of the land at a particular location
Line transect	a line made with a tape measure or other object, used to record the number of species touching the tape at regular intervals as an estimate of abundance
Load	the volume or mass of a substance transported in a river, derived by multiplying the concentration by the flow rate over a specific period of time
Logarithmic scale	a scale of measurement in which an increase of one unit represents a tenfold increase – the scale on a turbidity tube is a logarithmic scale
Longitude	the angular distance east and west of Greenwich of a point on the Earth's surface
Longitudinal assessment	an assessment along a length or reach (of a stream)
Low range EC meter	an EC meter that measures low levels of salinity (µS/cm)
Lower catchment	the part of a river where the landscape is flat and the river travels slowly and deposits large amounts of sediment
Lowland stream	a stream located less than 150 metres above sea level
Macroinvertebrate	an animal without a backbone which is large enough to be seen with the unaided eye
Macrophyte	a large aquatic plant (e.g. rushes) that can be seen with the unaided eye
Marine	relates to the ocean
Marsh	land which is waterlogged
Material safety data sheets	information sheets about the risks involved in the use of specified chemicals
Meanders	bends in the course of a river which curve from side to side in wide loops
Meniscus	the curved upper surface of a liquid standing in a tube which is produced by surface tension
Metabolic rate	the rate at which an organism uses energy to sustain essential life processes such as respiration, growth and other activity
mFC broth	selective liquid medium which contains nutrients for the growth of faecal coliforms
Micro-organism	a single-celled organism that is invisible or barely visible to the unaided eye (e.g. bacteria, fungi)
Microsiemens per centimetre (µS/cm)	a measurement of salinity
Middle catchment	section of the stream where the river meanders through flood plains and occasional flooding is important for maintaining the health of wetlands
Milligrams per litre (mg/L)	a measurement that equates to 1 part per million

Millisiemens per centimetre (mS/cm)	a measure of salinity – 1 mS/cm x 1000 = 1 µS/cm
ML	abbreviation of megalitre – one million litres – one Olympic-sized swimming pool of water
mL	abbreviation of millilitre – one-thousandth of a litre
Modified Winkler titration method	the method used to determine the amount of oxygen in a water sample in mg/L
Monitoring	the regular observation and measurement of natural resource condition over time, usually to detect change
Monitoring frequency	how often monitoring takes place
Monitoring objectives	the reasons why monitoring takes place
MSDS	material safety data sheets (MSDS) are designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance – they include information such as physical data, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment and spill/leak procedures
Mystery sample	solutions provided where the concentrations of particular indicators are unknown
Natural resource condition	the health or condition of a natural resource measured against acceptable guidelines
Nephelometric turbidity units (NTU)	the unit of measurement for turbidity
Nutrients	any substance used or required by an organism for food
Nymph	the young, immature stage of certain insects, usually similar to the adult form
Occupational health and safety (OH&S)	a workplace policy designed to minimise and avoid risks – Waterwatch incorporates OH&S procedures such as the use of personal protective clothing and equipment, and site risk assessments prior to volunteer monitoring
Omnivore	an animal that eats both plant and animal matter
Organic	derived from or showing properties of a living organism
Organism	a living animal or plant
Osmosis	the force with which a solvent moves from a solution of lower solute concentration to a solution of higher solute concentration
Outfall	the site of a discharge of liquid from a pipe (e.g. the point at which a sewer discharges to a treatment works)
Overclearing	the removal of plant cover which results in accelerated erosion by wind and water
Overgrazing	continued grazing of grass or pasture at a level that leads to land degradation
Oxygenation	the process of adding dissolved oxygen to a solution

Parameter	a measurable or quantifiable characteristic or feature
Pasture	land that is covered in grass or herbage
Peptone water	a buffer solution used in the faecal coliform test
Perennial stream	a stream that flows most of the time
Permeability	the ease with which water moves through soil or rock
Pesticide	a substance or mixture of substances used to kill unwanted species of plants or animals
pH	a value that represents the acidity or alkalinity of an aqueous solution – defined as the negative logarithm of the hydrogen ion concentration of the solution
Phosphate (PO_4)	a molecule consisting of phosphorus bonded with oxygen, considered a source of nutrients
Phosphorus	a nutrient essential to the growth of plants and animals
Photopoints	identified locations at a site where photos can be taken to show change over time
Photosynthesis	the conversion of carbon dioxide to carbohydrates in the presence of chlorophyll, using light energy
Physio-chemical	refers to the physical (e.g. temperature, electrical conductivity) and chemical (e.g. concentrations of nitrate, mercury) characteristics of water
Phytoplankton	microscopic floating plants, mainly algae, that live suspended in water bodies
Pipettes	small droppers that deliver a measured quantity of a chemical or substance
Plankton	plants (phytoplankton) and animals (zooplankton), usually microscopic, floating in aquatic systems
Point source pollution	a source of pollution that can be pinpointed to a particular source or pipe
Pollution	the introduction of unwanted components into water, air or soil, usually as a result of human activity (e.g. hot water in rivers, sewage in the sea, oil on land)
Pool	a still, deep place in a stream, separated by shallow gravelled areas on straight sections between meanders
Potable	water suitable for drinking
Precipitate	to separate out (a dissolved substance) in solid form from a solution, by means of a reagent
Precision	how well you are able to repeat a measurement result obtained from a specific sample – can be measured by repeated analyses of the same sample, as human error in sampling and analytical technique is a major cause of imprecision
Primary contact	activities involving direct contact with water, bodily immersion/submersion (e.g. swimming)
Pristine	an environment that remains untouched and undeveloped
Profuse	in great amount, abundant

Protocol	defined procedure
Pupa (pupae)	developmental stage of an insect between larva and adult
Quadrats	a square used to measure species abundance and diversity within a particular location – may be used in conjunction with transects
Qualitative assessments	assessments based on human observations, insight or knowledge about local environments
Quality assurance	the degree of reliability of data based on the quality controls in place
Quality controls	the routine application of and procedures for measuring the standard of performance of sampling and testing
Quantitative assessments	the measurement of physical, chemical and biological parameters that provide numerical data about the health of a waterway
Raid biological assessment	a form of biological assessment, best developed using stream macroinvertebrate communities, that uses standardised, cost-effective protocols to provide rapid sample processing, data analysis, reporting and management response
Rate of flow	the speed at which water moves in a river or stream
Reach	a length of stream that is examined for its features
Reagent	a substance which, because of the reactions it causes, is used for chemical analysis
Reagent dropper	a dropper that delivers a measured quantity of a reagent for analysis
Recharge area	a place where surface water infiltrates the soil and groundwater system
Recovery site	a site located downstream of a suspected pollution source which is monitored to see how far the pollution impact extends
Reference site	a site used for comparison
Regulated river	a river where the flow is regulated by structures such as dams and weirs
Representative (data)	the extent to which collected data actually represents the conditions you are monitoring – most affected by site location
Resilience	the ability of water or an ecosystem to recover from disturbance
Resolution	the smallest change in a parameter that your method will discern with confidence
Respiration	the intake of oxygen and the release of carbon dioxide (in aerobic organisms)
Riffles	shallow water flowing quickly over rocks
Riparian zone	the zone alongside a riverbank and extending out to 30 metres, including the bank and verge vegetation
Risk assessment	an assessment of the risks of an activity with a view to minimising or avoiding them
River health	a measurement of the functioning and resilience under stress of an ecosystem – can be measured by parameters such as water quality

Runoff	water that flows across the land surface and does not flow into the ground
Salinisation	excessive amounts of soluble mineral salts in the soil, making the land unsuitable for agriculture
Salinity	the presence of soluble salts in or on soils or in water
Salts	compounds that dissolve in water and can conduct an electrical current (e.g. sodium, potassium, calcium)
Saturation	a point at which a solution contains enough of a dissolved solid, liquid or gas so that no more will dissolve into the solution at a given temperature and pressure
Scalding	bare patches lacking vegetation – can be the result of erosion or salinity
Scat	an animal dropping
Scavenger	an animal that feeds mainly on other dead animals or on the products of larger animals
Secondary contact	activities involving some direct contact with the water but where ingestion is unlikely (e.g. boating)
Sediment	unconsolidated mineral and organic particulate material that settles to the bottom of an aquatic environment
Seepage	the process by which water percolates downwards through the soil
Sewage	waste matter which passes through sewers
Sewerage	the pipes and fittings carrying sewage
Siemen	a unit measuring electrical conductivity
SIGNAL 2	SIGNAL stands for Stream Invertebrate Grade Number – Average Level – a simple scoring system for macroinvertebrate (water bug) samples from Australian rivers
Silt	a fine deposit of mud or clay in a water body
Site	a monitoring location
Snag	woody debris found within the river channel
Snapshot monitoring	monitoring that takes place at a certain time in many places to allow comparison between sites
Soluble	dissolves in solution, usually water
Standard calibration solution	the usual solution supplied by a laboratory to calibrate equipment such as an EC meter in different ranges
Standing water	water that does not flow, such as water in wetlands, dams, weirs
Stormwater	rainwater which runs off the land, frequently carrying various forms of pollution such as rubbish, animal droppings and dissolved chemicals – is carried in stormwater channels and discharged directly into creeks, rivers, the harbour and the ocean

Stream order	determined using the Strahler system, which starts with a 1st order stream at the top of the stream network, which is usually a small non-perennial stream. Larger perennial streams usually have a stream order of ≥3
Stream reach	a length of stream that is examined for its features
Submerged plants	water plants that grow underwater
TDS meter	an instrument that measures total dissolved salts in water
Temperature	a measure of how hot or cold the water is in degrees Celsius
Terrestrial	land-based
Thermal pollution	when the temperature of a water body is significantly warmer or cooler than the normal environmental conditions, temperature is considered to be a pollutant
Thermometer	an instrument used to measure temperature
Throughflow	water that has been absorbed into topsoil and then moves downhill into a water body
Titration	the addition of a measured quantity of one solution to an unknown solution concentration until a reaction takes place – allows the calculation of the concentration of the unknown solution – dissolved oxygen can be calculated by titration
Tolerance	the ability to survive and grow in the presence of a normally toxic substance (e.g. heavy metals)
Tolerant water bug	an aquatic macroinvertebrate that can be found in either clean or dirty water as it has the ability to withstand adverse environmental conditions such as water pollution
Topographic map	a map showing landform as contour lines, and other natural and human features
Total dissolved solids	a measure of the inorganic salts (and organic compounds) dissolved in water
Total phosphate	a measure of all forms of phosphate compounds in a sample – orthophosphate, condensed phosphates and organically bound phosphates
Toxic	harmful, destructive or deadly to organisms
Toxin	a poisonous product generated by an organism
Transect	a line between two points that allows changes to be observed along it
Transpiration	the evaporation of water from plant leaves and stems
Tributary	a small stream or river flowing into a larger one
Trigger values	the concentrations (or loads) of key indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur
Turbidity	a measure of the cloudiness or muddiness of water
Turbidity tube	a tube used to measure the level of turbidity in nephelometric turbidity units
Unregulated river	a river where the flow is not impeded by human-made structures such as dams

Upland stream	a stream more than 150 metres above sea level
Upper catchment	the source of a river
Vegetation	the plant cover of an area
Vegetation cover	the total imaginary shadow cast by the vegetation – a visual guide is used to assist with these estimates
Verge vegetation	the vegetation on an area up to 30 metres wide adjacent to a stream, including trees, shrubs and grasses
Water quality guidelines	a recommended value or range for a parameter (e.g. pH, turbidity, dissolved oxygen) – water quality guidelines can be adapted to different uses (e.g. environmental, recreation, drinking)
Water quality stressor	a change in a water quality parameter that puts stress on an ecosystem
Water velocity	the speed at which water moves in a river or stream
Watercourse	a channel having defined beds and banks where water flows on a permanent or semi-permanent basis
Watertable	the upper surface of the zone of groundwater saturation
Waterwatch	a community program that provides a framework for involvement in water quality monitoring
Waterwatch Plan	a strategy that sets out the purpose, frequency and sites for monitoring, and the equipment and interpretation of information collected as part of the plan
Weed	a plant that is not endemic to the local area and is unwanted there
Wetlands	a general term applied to open water habitats and seasonally or permanently waterlogged land areas (e.g. rivers, marshes and estuaries)
Woody debris	dead branches or roots of living trees that have fallen into a stream
Zone of saturation	the underground area above an impermeable layer where water fills all open spaces between rock, sand and soil particles

SECTION 10

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Note: Links to other useful publications and websites can be found on the Waterwatch website: www.waterwatch.nsw.gov.au

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