What Is A Catchment?

The amount of water carried by a stream, the shape of the channel, the chemical composition of its water, and its ability to support life are determined by its catchment and what is happening there. A stream is only as healthy as its surrounding catchment.

This section will help you to look beyond the stream, and learn about the land that surrounds it.

Everybody lives in a catchment.

A **catchment** is a basin shaped area of land, bounded by natural features such as hills or mountains from which surface and sub surface water flows into streams, rivers and wetlands. Water flows into, and collects in, the lowest areas in the landscape. The system of streams which transport water, sediment and other material from a catchment is called a **drainage network.**

A catchment catches water which falls to earth as precipitation (rainfall), and the drainage network channels the water from throughout the catchment to a common outlet. The outlet of a catchment is the mouth of the main stream or river. The mouth may be where it flows into another river or stream, or the place where it empties into a lake, estuary, wetland or ocean.

Catchments vary in size from large ones such as the Waikato, which begins in Tongariro National Park, includes most of Waikato Region (see map on the next page) and extends to the ocean just south of Auckland, to the myriad of small catchments that drain Mt Taranaki.

Tributaries are small feeder streams that empty into larger streams or rivers. The catchments of tributaries are referred to as sub-catchments. Large catchments are often made up of a number of smaller sub-catchments. For example, the catchment of the Buller River contains eleven major sub-catchments.

Whatever happens in each of the smaller streams affects the overall wellbeing of the main waterway.

What does your catchment look like?

It is quite a simple task to trace your catchment boundaries and drainage network from a topographical ('topo') map onto tracing paper, and to examine the pattern of streams and rivers that cover the reaches of your catchment.

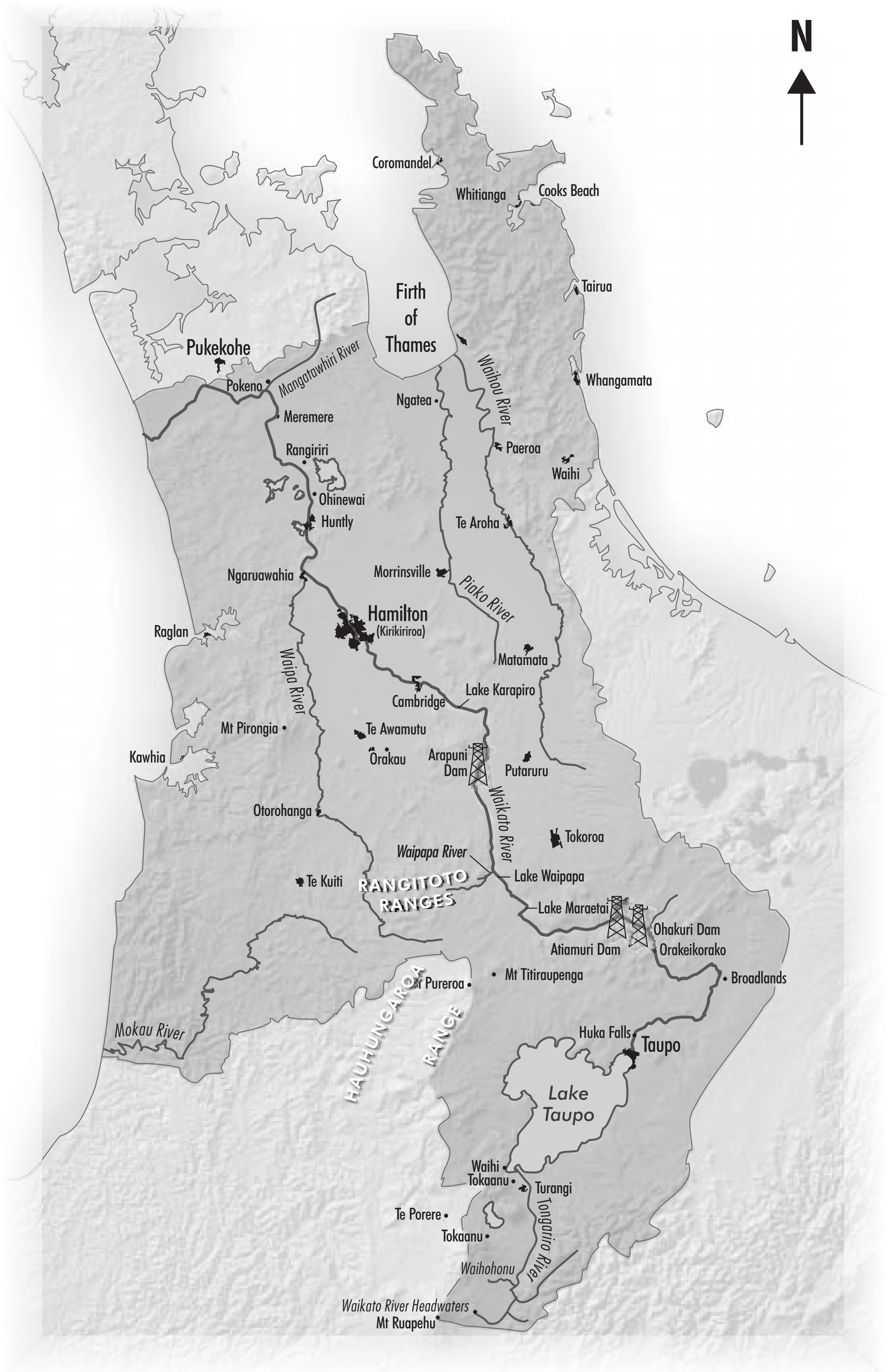
No catchment is exactly like another. Each has a different size, shape, drainage pattern and features that are determined by natural processes, particularly geology and climate.

The geology of your catchment will influence many of its characteristics, from the stability of the streambanks and streambed to the natural pH of the water.

Climatic processes and flowing water erode and shape the land. As rocks are broken down into smaller pieces they can be transported in the flow. Fine materials are transported as sediment throughout the catchment. Weathered rock and organic matter make up the soils that blanket the landscape.

Soils have different textures, mineral content, structure and drainage properties. The nature of the soils in your catchment will have a key role in deciding how much water runs off the land and how likely the land is to erode.

Waikato, Waipa, Waihou and Piako Rivers in the Waikato Region



From Raging Torrent To Languid, Murky Flow

Despite there being many differences between catchments, there are some general trends common to most. Follow this journey through an 'average' catchment and compare it to the one you live in. Take into account changes that take place along the way when you evaluate the results of your tests and surveys.

Upper Catchment - The Headwaters

Streams begin their journey to the sea in the upper reaches of the catchment. Some may appear briefly, flowing only during periods of intense rainfall. Some are intermittent, flowing during the wet seasons of the year. Others are more permanent, having year-round flow.

If the stream is steep it will be fast-flowing and energetic. This means that it has the energy to carry large amounts and large-sized pieces of rock and gravel which have been eroded from stream beds and banks.

Streams tend to be narrower here and riparian vegetation almost completely covers the stream with its canopy. Very little sun reaches these streams, so the water temperature remains cool throughout the year.

Low light levels restrict algal growth, and upstream plant eaters (herbivores) rely mostly on food material from outside the stream, leaves, fruits, seeds, twigs and bark. This coarse material is made finer by physical abrasion and microbial activity.

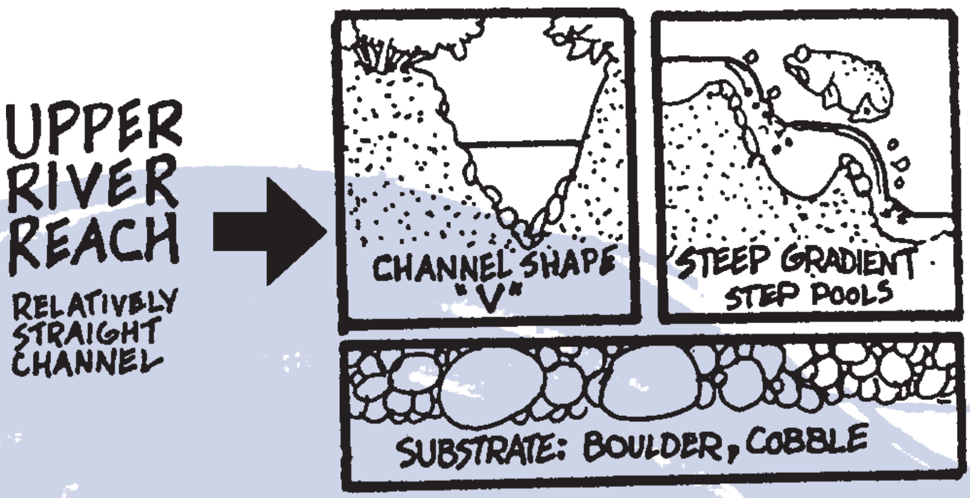
Some more processing is done by macroinvertebrate 'shredders', but there are not many in New Zealand streams. Collector-browsers tend to dominate in these sections (see Glossary). Coarse organic debris, especially larger woody debris, also provides habitat for stream life.

In headwater streams that are not shaded by streambank vegetation, attached algae and rooted aquatic plants produce most of the available food.

Headwater streams in unforested areas tend to show greater seasonal and daily changes in water temperature. In these streams, sunlight and air temperature have greater effects on water temperature.

Rocks, pebbles and bedrock are characteristic of fast-flowing headwater streams, and these substrates are usually well sorted. Rocks, pebbles and the mosses etc growing on provide many habitats for aquatic macroinvertebrates.

The headwaters of a river system can be very important to the health of the entire river.



Courtesy Adopt-A-Stream Foundation

Macroinvertebrates and fish species are provided with lots of varied habitat, making these areas important for restocking depleted downstream sites. These areas also provide much of the food carried downstream.

Dams and weirs restrict the distribution of food and the movement of aquatic animals.

Middle Catchment

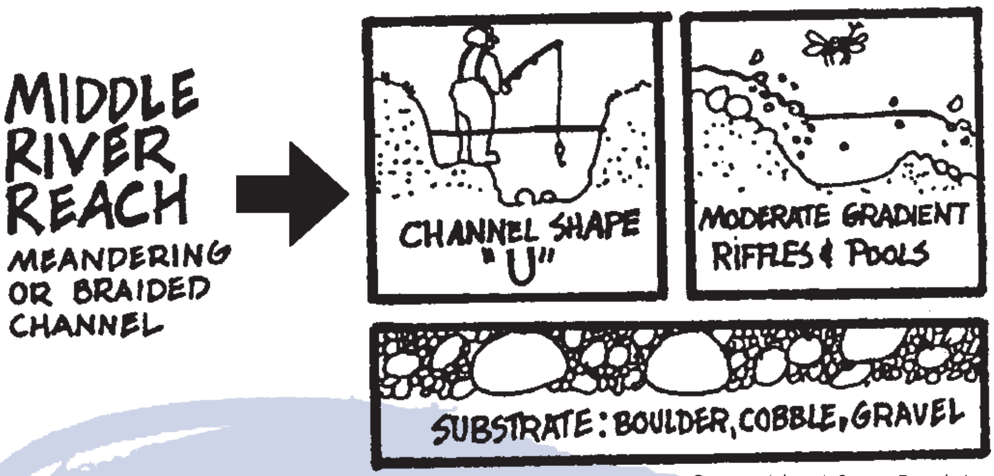
In the middle reaches of the catchment some tributaries have entered the stream and added to the flow. The land is generally flatter, and the flow of the stream is slower. There are frequent shallow areas of faster moving water called riffles, where rocks break the surface and deeper areas of water called pools. The bottom substrate is composed of mostly gravel and cobble.

The channel has widened into a 'U' shape and you can usually detect a flood plain - a flat area beside the streambank. The stream regularly overflows onto this area, slows, and dumps its load of sediment.

The stream often flows across the flood plain in curves or meanders. Usually there is a combination of erosion on the outside edge of bends, where the water flow is more rapid, and sediment in areas where the water flow is slower.

In these middle reaches the canopy no longer reaches across the stream to shade the entire water surface. Here the sun is able to warm the water, raising water temperature over the day. Slower flows, together with murkier water in these reaches may increase the heat. Seasonal changes in water temperature are usually greatest in this section.

Organic debris still falls into the stream from the riparian zone but the amount of light increases algae become an important part of the food base. As the nature of the food base changes there is a shift in the kind of life. Grazer and collector macroinvertebrates dominate this section of the stream.



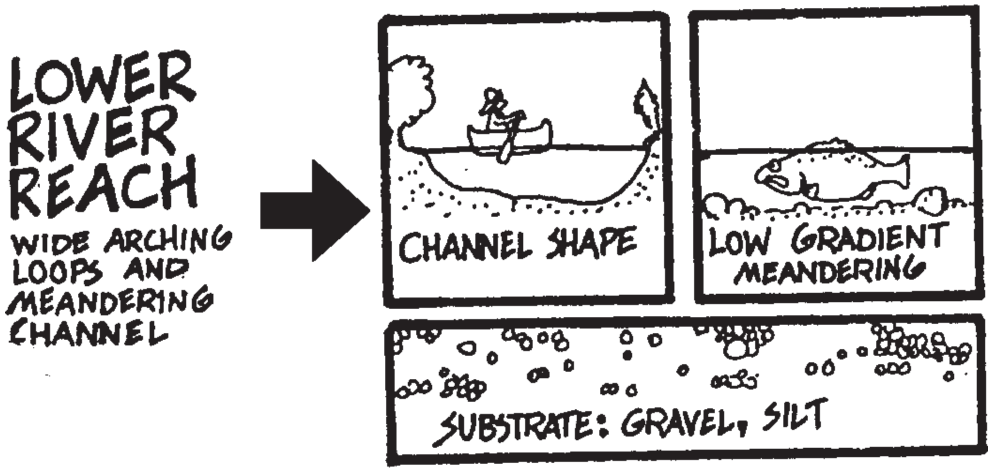
Courtesy Adopt-A-Stream Foundation

Lower Catchment

Moving downstream towards the stream's mouth, more tributaries have entered and added more flow. The wider, deeper channel meanders through a flat flood plain and broad valley. The stream travels very slowly and deposits the large quantities of sediment it has been carrying from further upstream.

Although the water is unshaded, the murky water limits sunlight penetration, but some attached algae may grow in the shallows if stones or other suitable substrate are available. Fine particles replace organic debris and algae as the food source.

The community of small aquatic organisms is changed again. Collector-filterer macroinvertebrates are more common 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.



Courtesy Adopt-A-Stream Foundation

In slower stream reaches, there is less spread of atmospheric oxygen into the surface water. This causes even lower dissolved oxygen levels in the streambed sediments. The breakdown of organic matter often decreases the dissolved oxygen level in the sediments even more. Organisms that tolerate lower oxygen levels and that prefer slower flowing water are more common in this section of the stream.

At its mouth, the stream or river empties into another body of water and carries its remaining load of sediment, debris and other substances. Lakes and estuaries gather these, which can damage them. Estuaries are particularly sensitive environments and their role as a nursery for fish is easily disturbed.

General trends you may see when monitoring a stream at different points in the catchment are detailed in Table 5.

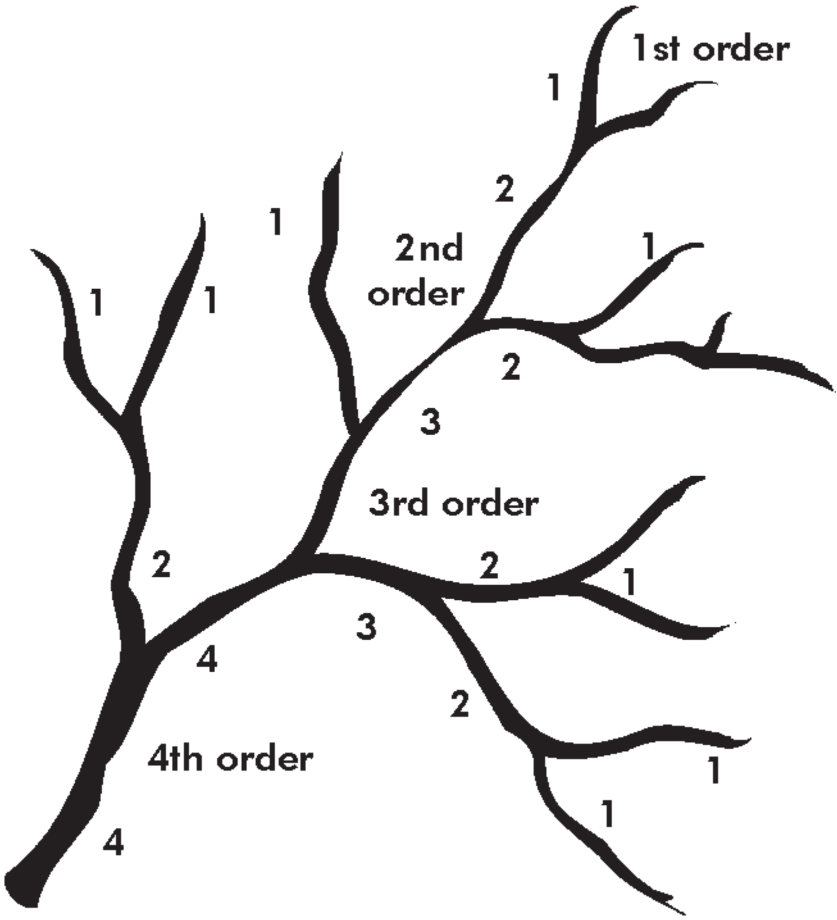
Table 5   Downstream changes in streams

Factor	Change From Upstream To Downstream	Explanation
Stream Velocity	Decrease.	Reduced gradient of the stream and greater depth.
Temperature	Increase.	Increased exposure to sunlight (less shade and an increase in the length of sunlight time), lower altitude and energy absorbed by suspended particles (turbid streams).
Water Clarity	Decrease.	Accumulation of sediment from runoff and erosion.
Nitrogen and Phosphorus	Increase.	Increased discharge into the stream, particularly from soil water. Increase may be hidden because aquatic plants use it. More agricultural activity on lowlands.
Conductivity	Increase.	As above.
Dissolved Oxygen	Decrease.	Decrease in tumbling and mixing (aeration), slower flow velocity, higher water temperature. Abundant aquatic plant growths result in greater daily variation.
Biological Oxygen Demand (BOD)	Increase	Increased amount of organic matter, uses oxygen as it decays.
pH	Decrease.	CO_2 levels increase as a result of photosynthesis by aquatic plants. Daily change particularly evident in the middle reaches of the stream.
Faecal Coliforms	Increase.	Accumulated contamination along length of stream from stock wastes.
Macroinvertebrate Community	Shift in composition	Shift from collector-browsers to grazers and collector-filterers. Less 'sensitive' species present as substrate and oxygen levels become less suitable.
Habitat	Fewer riffles and less variety in pool depth and size.	Reduced gradient of the stream.
Substrate	Smaller particle sizes, poorly sorted.	Reduced gradient (lower flow velocities and therefore less kinetic energy).

Stream Order

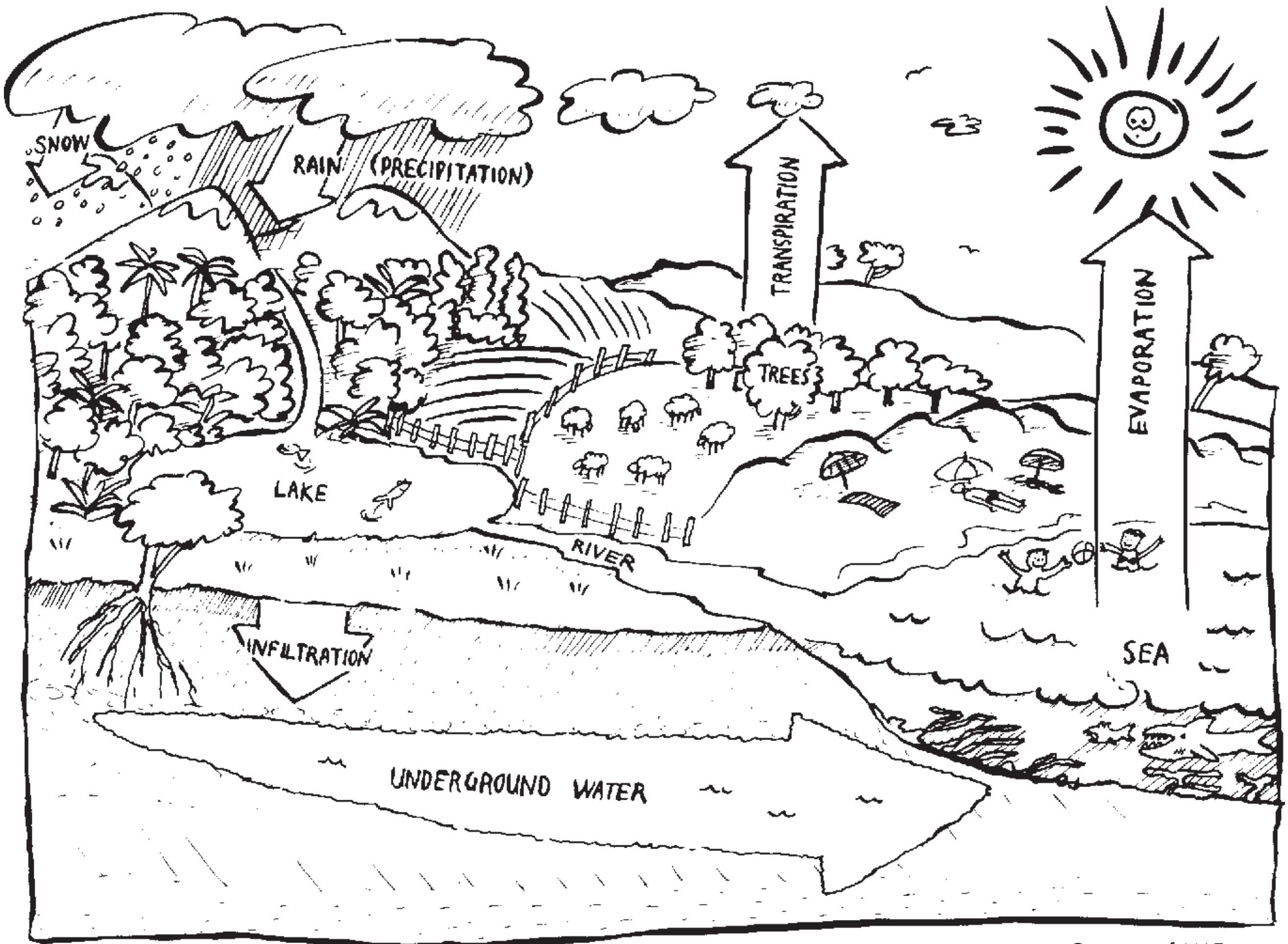
Streams are often classified by size. Within any catchment the smallest streams that have year round flow and no tributaries are called **first order** streams. When two first order streams meet they form a **second order** stream. A **third order** stream is formed when two second order streams join, and so on.

Stream order only changes when two streams with the same classification meet. For example, when a first order stream meets a second order stream the resulting stream remains a second order stream.



The Water Cycle And Our Use Of Catchments

Catchments are part of a gigantic water circulation network. Powered by the sun, the water cycle moves water between the earth's surface and atmosphere in a continual circuit. It may seem that this powerful natural process is entirely independent of human activity, that it is indestructible and capable of continually replenishing and purifying our water.



Courtesy of MAF

However, two critical aspects about the cycle are often overlooked: the tiny amount of the water that is usable (within streams, rivers and lakes), and the rate at which water travels around the cycle.

> *"Of all the water on Earth, 97.2 percent is sea water. Of the remaining (fresh) water, 2.24 percent is trapped in ice caps. Groundwater accounts for 0.61 percent and lakes for just 0.009 percent. The atmosphere holds about 0.001 percent. All this means that the amount of water flowing water in streams and river at any one time is an almost negligible 0.0001 percent.'*
>
> Allan (1995)

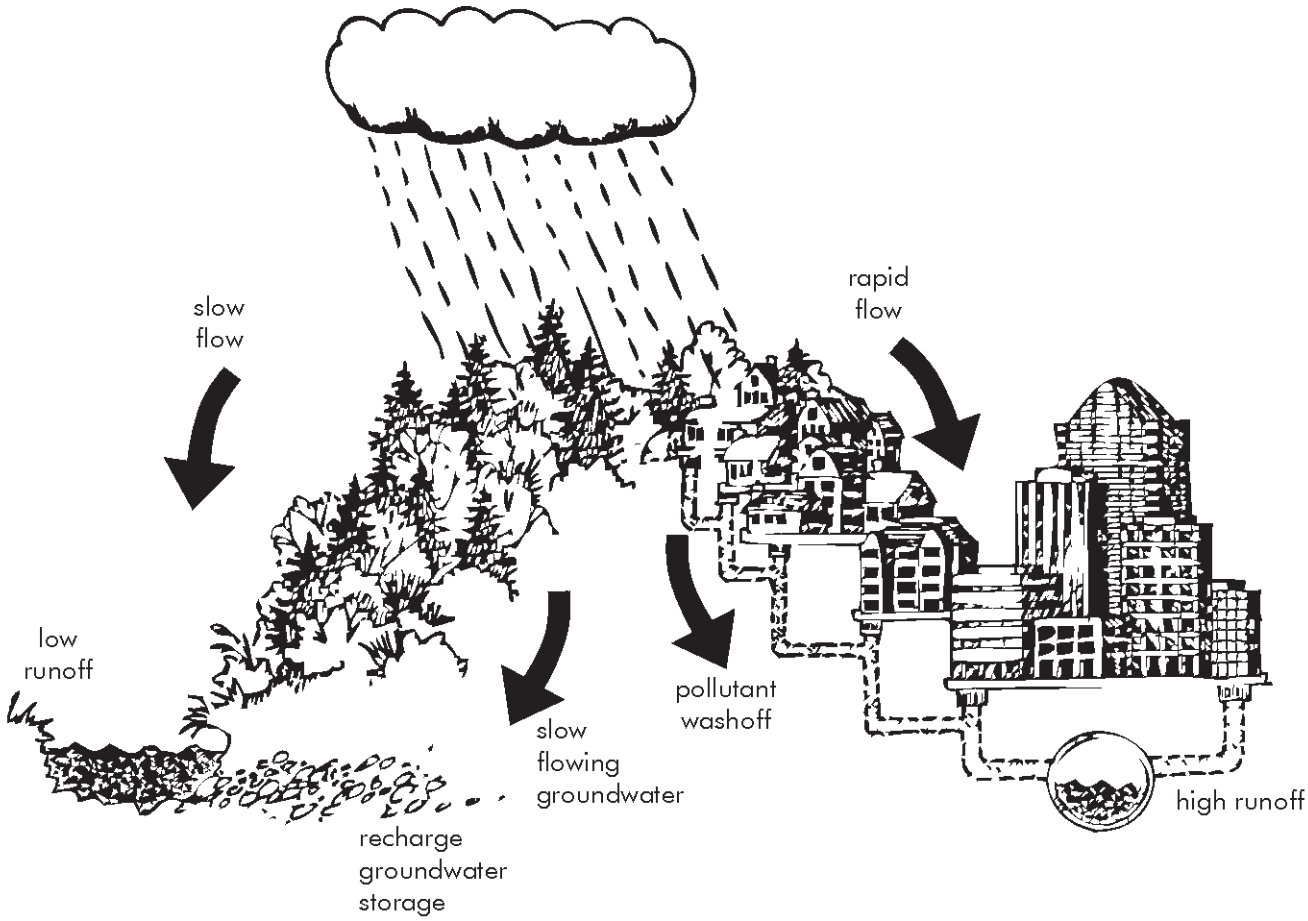
The rate of movement of water through the cycle can be altered dramatically through changes we make to the land surface. Vegetation and wetlands act like sponges to slow and absorb water during wet times of the year.

When we replace vegetation and wetlands with impervious surfaces (roading, paving, parking areas, rooftops, etc.), less water infiltrates into the ground and more water flows directly into streams through drainage ditches and stormwater drainage pipes. The increased runoff may cause a variety of problems, including flooding, streambank erosion, sedimentation and pollution.

The problems created by paved surfaces are made worse at dry times of the year. Because infiltration is slowed, there is less build up of groundwater. The 'sponge' becomes dry. Without the return of groundwater, many streams simply dry up during periods of low rainfall. By reducing the amount of water a catchment can hold, you end up having too much when it rains and not enough when it doesn't.

The balance of the cycle may be further disrupted when we take water for domestic, agricultural or energy needs. Dams, taking water from streams and rivers and pumping groundwater from wells all affect the amount, and quality, of water within our waterways.

While human uses of land and water have changed the quantity and timing of water cycling through catchments, they have also affected the quality of water resources. Table 1 in the 'Getting Started' section (Deciding Which Parameters To Monitor) outlines some of these possible changes, and common causes.



Natural Environment **Urbanised Environment**

Understanding Your Catchment

Learning about a stream and its catchment can be quite an adventure.

As you investigate your catchment you will discover information about its natural and cultural resources, history, its use (and abuse) by people and wildlife, and about the health of its waters. Getting to know your catchment is an important first step in your Stream Sense programme. Investigating it will enhance your sense of connection to the catchment and its watercourses.

Everything that happens in the catchment affects the stream in some way. A catchment inventory will give you some clues as to what's happening on the land that surrounds and drains into your stream and how the various activities might be affecting it. It will help you better design your stream monitoring objectives.

Investigating your catchment is in three parts:

1. First, identify the boundaries of your catchment and make a working (base) map.

2. Then gather all the available information you can about your catchment.

3. Next, get out and conduct a field assessment of your catchment.

If you choose to work on a larger stream or river system you may want to focus on the sub-catchment that is in your 'neighbourhood'. You may be able to combine your research and findings with other groups working upstream and downstream to create a more comprehensive picture of the total catchment.

Catchment Maps

There are many choices of maps that might be useful to you. The most important tool to start with is the topographical map. Topo maps can be used to determine catchment boundaries. The most detailed topo maps from Terralink have a scale 1:50,000 (2 centimetres on the map equals one kilometre on the ground).

Terralink topo maps convey some basic information on land surface features, such as elevation, location of water features, transport routes, vegetation, and some land uses. Topo map code numbers and grid references are commonly used in reports to describe locations within the catchment.

Some councils are able to create sub-catchment maps from their GIS (Geographical Information System) computer database. On top of topographical information many GIS systems can superimpose requested data - different land uses; industrial, urban and commercial areas; stormwater drainage systems; sewerage systems and sewerage treatment plants; roads, railways and power lines; parks, playing fields and golf courses; rubbish dumps. The available information depends on what is contained in the GIS database and can never be totally up to date.

Aerial photographs are often very useful for determining the type and extent of agricultural activities. By comparing aerial photos of different dates, you can see land use changes that occurred between photographs. Aerial photos taken of your stream or river's outlet to the sea following a storm can be very revealing. Landsat images may show more broad-scale features of catchments and the wider landscape.

Other types of maps may be helpful with your catchment inventory. The Department of Conservation (DoC) has maps that show areas of special ecological value and the distribution of flora and fauna. Some local councils have maps that show similar features, such as 'significant ecological sites', 'significant natural areas', and reserves.

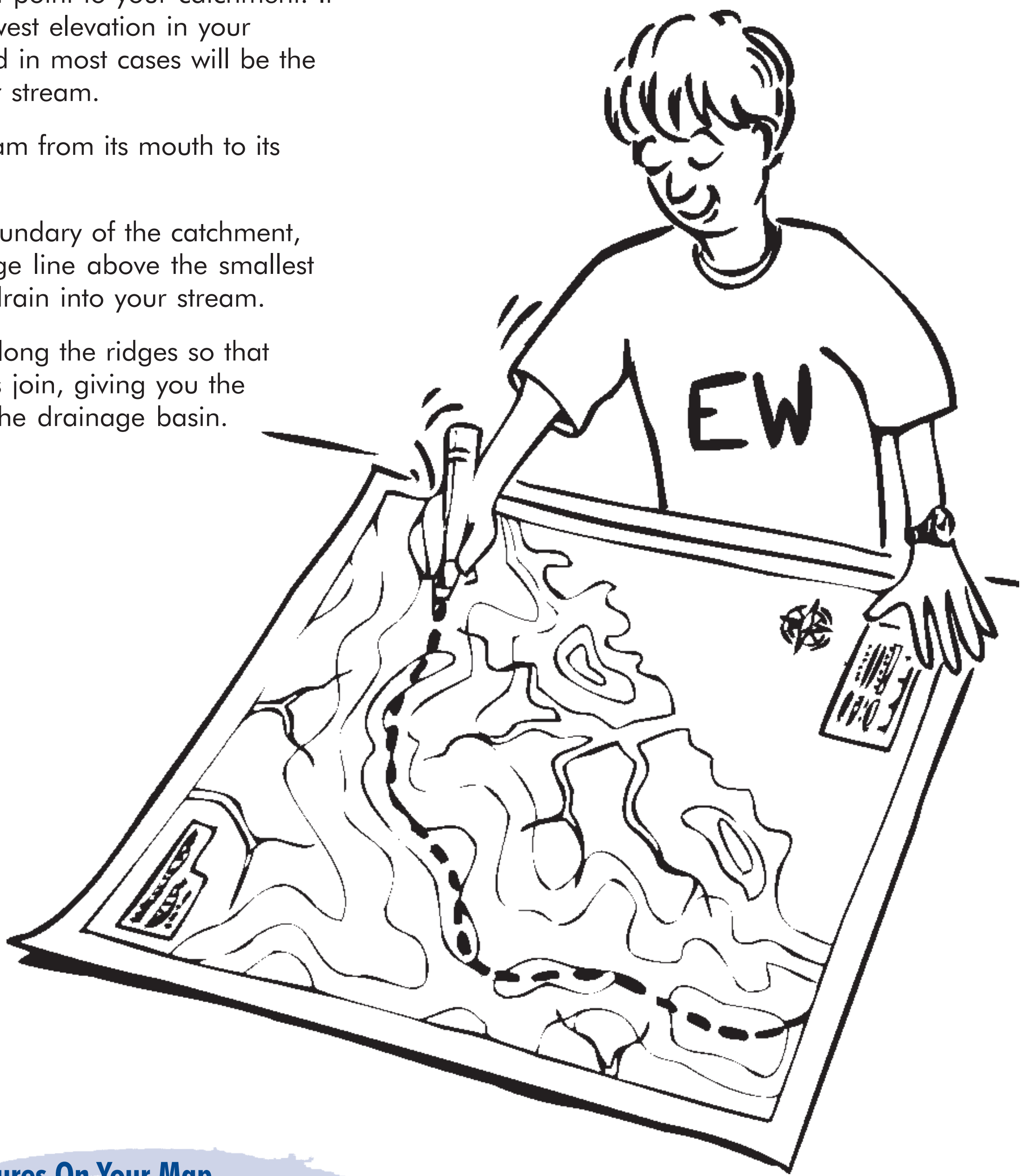
Property titles may be useful if you want to determine the boundaries of properties.

Creating Your Own Catchment Map

The following exercise will help you become familiar with your catchment and its boundaries. You may need to cut and paste several topographic maps together if the stream system you are studying has an extensive catchment.

Determining The Boundaries Of Your Catchment

1. Find the outlet point to your catchment. It will be the lowest elevation in your catchment and in most cases will be the mouth of your stream.
2. Trace the stream from its mouth to its tributaries.
3. To find the boundary of the catchment, locate the ridge line above the smallest streams that drain into your stream.
4. Draw a line along the ridges so that the ridge lines join, giving you the boundary of the drainage basin.



Courtesy
Streamwatch

Highlighting Features On Your Map

Highlight your stream and its tributaries. You will be able to see the pattern of the stream network. Count the number of tributaries and classify the various streams into their orders.

You can work out the length of your stream by laying a piece of wet string along its length. Use the scale on the map to calculate the length of the stream/s (remember to make scale adjustments if you change the size of the map when you photocopy).

Show the position and size of other surface water features, such as lakes and wetlands.

Also trace roads and tracks, the outline of settlements/towns/cities and district boundaries.

Draw the area occupied by each land use on your base map. Create a key, such as a specific symbol or colour, to identify each land use on the map and name them.

Pinpoint other features of significance on your map such as dams, areas of ecological significance and historical sites. Be sure to include recent changes that have taken place in your catchment, such as new housing developments.

The catchment inventory sheet contains an extensive list of features that you could research and add to your map. By building up this detailed picture of your catchment through your own observations, local knowledge and collaboration with government agencies and special interest groups, you will have a clearer understanding of the pressures and influences on your watercourse and the threats to its health. This will enable your group to select the most appropriate and useful site(s) to monitor depending upon your interests and purpose.

It is a good idea to make some photocopies of this catchment map. These copies will be working maps: you can label or mark the copies with different features, land uses and structures or make clear overlays to layer onto a base map. You should take one of the copies into the field to check some of the map's features and include a copy of your map in your field trip report.

Write a summary of the disturbances to the watercourse, riparian zone, flood plain and wider catchment since settlement. List the current potential and actual pollution sources on a catchment basis and in particular upstream of your site.

Clues may include dead upright trees in the water, unhealthy looking aquatic plants (pale green or covered in a brown furry coating), bare banks, eroding banks, stock access to the water, increased sedimentation, drains and effluent pipes, unpleasant odours, unusual water colour or clarity, black smelly ('rotten egg' gas) sediment, surface scum or film, white sewage fungus, plenty of algae - either surface algal blooms or stream bottom filamentous algae. As you can see, some very unpleasant things can happen to water.

Your land use catchment map can become a very valuable resource for your local council, government agencies and community groups, as well as your group. It can become an historical base map upon which future changes can be plotted or overlaid.

Catchment Inventory Assessment Sheet

RECORD SHEET

Discovering information about your catchment - the stream, the land surrounding it and the activities that may affect it.

Catchment Location

Catchment name ______________________ Topo map number/s ______________________

Begins in ______________________ Flows through ______________________

Ends in ______________________ *(name town, district, region, etc.)*

Drains into ______________________ *(name of body of water e.g. lake or river)*

Catchment area__________km^2 Approx. length km ______________ Width km__________

Highest point______________________ Lowest point ______________________

Climate

Average annual precipitation ________mm Most precipitation occurs (months)____________

Flood frequency (month/s, year/s) ____________ Location within the catchment______________

Water shortage/drought frequency (month/s, year/s) ______________________

Coldest month of year____________ Warmest month____________ Yearly temp. range____________

Geology/Topography

Describe briefly the geological history that shaped your catchment______________________

____

Describe the physical characteristics of different reaches of your catchment: ______________________

____

	Upper Reaches	Middle Reaches	Lower Reaches
Valley shape ('V', 'U' or wide flat ◡ shape.)			
Gradient (steep, medium, gentle)			
Channel sinuosity (straight, meandering)			
Bottom substrate (cobble, gravel, etc)			

Predominant rock types present: igneous ☐ metamorphic ☐ sedimentary ☐

Name of most common type of rock ______________________

R E C O R D   S H E E T

Water Sources

Headwaters originate from:

snow/glacier ☐ wetlands ☐ lake ☐ groundwater/spring ☐ rain (overland flow) ☐

Length of stream ________km Name of tributaries ____________________

Order of your stream at the outlet point of your catchment (1 to 4) ____________________

Names of lakes ____________________

Number of wetlands ____________________ Name/s of large wetlands (if any) ____________________

Areas underlain by aquifers (if any) ____________________

Soils

Predominant soil types ____________________

Areas with soil unsuitable for farming or development ____________________

Reason/s ____________________

Areas with soil erosion/stability problems ____________________

Vegetation

List the native and introduced plant species that dominate the different plant communities of your catchment:

	Native	Introduced (Exotic)
Upland		
Lowland		
Riparian		
Other		

Percentage of your catchment now covered with native vegetation________ %

Reasons for the loss of native vegetation____________________

____

____

Time period over which the loss occurred____________________

Endangered or threatened plant species ____________________

____

Fish

Native species (circle if endangered or threatened) ______________________________

____

Abundance ______________________________

Introduced species (circle if presence threatens native species) ______________________________

____

Abundance ______________________________

Types and location of barriers to fish migration ______________________________

____

Wildlife

Native species (circle if endangered or threatened) ______________________________

____

Introduced species (circle if they should be threatened!) ______________________________

____

Key wildlife habitat areas ______________________________

____

Location of 'Protected Natural Areas'[1] and/or 'Areas of Ecological Significance'[2] ______________________________

____

Significance of these areas ______________________________

____

[1] Contact the Department of Conservation. [2] Contact your local council.

Historical

The earliest human inhabitants were ______________________________ Date ______________

Reasons for settlement ______________________________

Describe the subsequent settlement of your catchment ______________________________

____

Significant cultural and historical features of your catchment ______________________________

____

Demographics

Population of your catchment ______________ Projected population in 10 years ______________

Population 10 years ago ______________ 50 years ago ______________ 100 years ago ______________

RECORD SHEET

R E C O R D S H E E T

Area most populated ______________________ Impact on waterways ______________

____

Area of land occupied by town/cities etc. ______________________________

What makes people want to live (or not) in your catchment ____________________

____

Potential for increased human settlement ______________________________

Land and Water Uses

Estimate the percentage of your catchment zoned for each land use and the activities that are permitted:

Rural residential	________ %	densities (average size of blocks) ________ ha.	
Urban/suburban residential	________ %	densities (houses per ha.) ________	
Commercial	________ %	☐ light commercial	☐ heavy commercial
Industrial	________ %	☐ light industry	☐ heavy industry
Agricultural	________ %	☐ grazing ☐ crops	☐ feedlots ☐ dairy
		☐ other (state) ________	
Forestry	________ %	☐ clear-cut ☐ selective	☐ farm forestry
Quarrying/mining	________ %	type of activity ________	
Parks/open spaces	________ %	☐ swimming ☐ boating	☐ fishing ☐ other ____
Other recreation	________ %	☐ golf course ☐ skiing	☐ other ________

Percent of the catchment that is: public land __________ % private land __________ %

Percent of the catchment covered with impervious surfaces: __________ %

Sources of domestic water supply for catchment residents ____________________

Location of sewage treatment plants (if any) ____________________________

Areas that rely on septic tanks ______________________________________

Altered hydrology (dams, diversions, culverts, drained wetlands etc.):

Type of alteration	Location	Purpose

Water quality

Water quality classification/s of your stream and tributaries ____________________

List pollutants of concern and their potential sources (state if diffuse or point source) __________

____