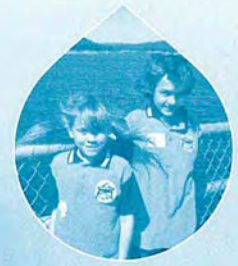
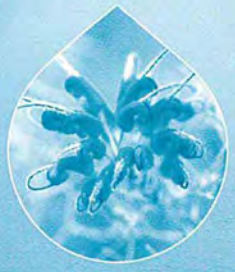
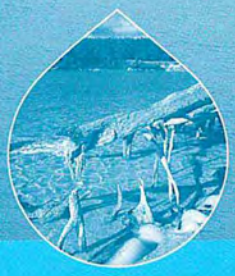
Catchment **Carers'** Trail

A Cleaner Glass of H_2O







Exploring the relationship between how we use our water catchments and the quality of the water we drink.

Activities for Middle Childhood to Early Adolescence

WATER CORPORATION

Department of Environment and Conservation

Our environment, our future

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Acknowledgments

Many people and agencies contributed to this resource. The Department of Environment and Conservation's EcoEducation section gratefully acknowledges their assistance and support.

EcoEducation acknowledges the support given by the Water Corporation, especially the WaterWise School's Program staff and to Water Corporation's Manager of the Mundaring Reservoir Protection Zone for their advice.

EcoEducation acknowledges the resources we have sourced from other agencies, both Western Australian and from other states. These are separately acknowledged where they are used and in the Resources Section.

Artwork has been used from the original Catchment Carers' Trail Booklet. Lorita Schmitz, former Leader with EcoEducation, supplied the original quality artwork.

Thanks also go to EcoEducation Leaders and office staff at Perth Hills National Parks Centre and our current manager, Elaine Horne, and previous manager, Liz Moore, who assisted with their knowledge and experience of our forest, water quality issues and experience in working with students in the field.

How to book an excursion

Perth Hills National Parks Centre
Phone: 9295 6149 or 9295 6300
Fax: 9295 3247
email:ecoeducation@dec.wa.gov.au

South West (Wellington Discovery Centre and Margaret River EcoDiscovery Centre)
Phone: 9725 4300
Fax: 9725 4351

Excursions run for four hours from 10am to 2pm, allowing time to travel from and back to school.

Contents

Overview of teacher and student book

Recommended for Years 4 to 8 – Student activities and notes

Main learning focus

To broaden teachers' and students' understanding that human activities in a catchment area affect the quality of water running into our dams and reservoirs, and that we can make a difference to water quality by the actions we choose.

Student will have the opportunity to:

- become aware of some of issues relating to water quality;
- understand what a catchment area is and how it relates to the water cycle;
- become aware of how the forest surrounding a reservoir (such as Lake C Y O'Connor) is critical to the quality of water in the weir;
- realise that quality of water depends on good forest and catchment management practices; and
- understand that the choices we make as individuals does make a difference to the environment and the community.

This booklet will assist you to:

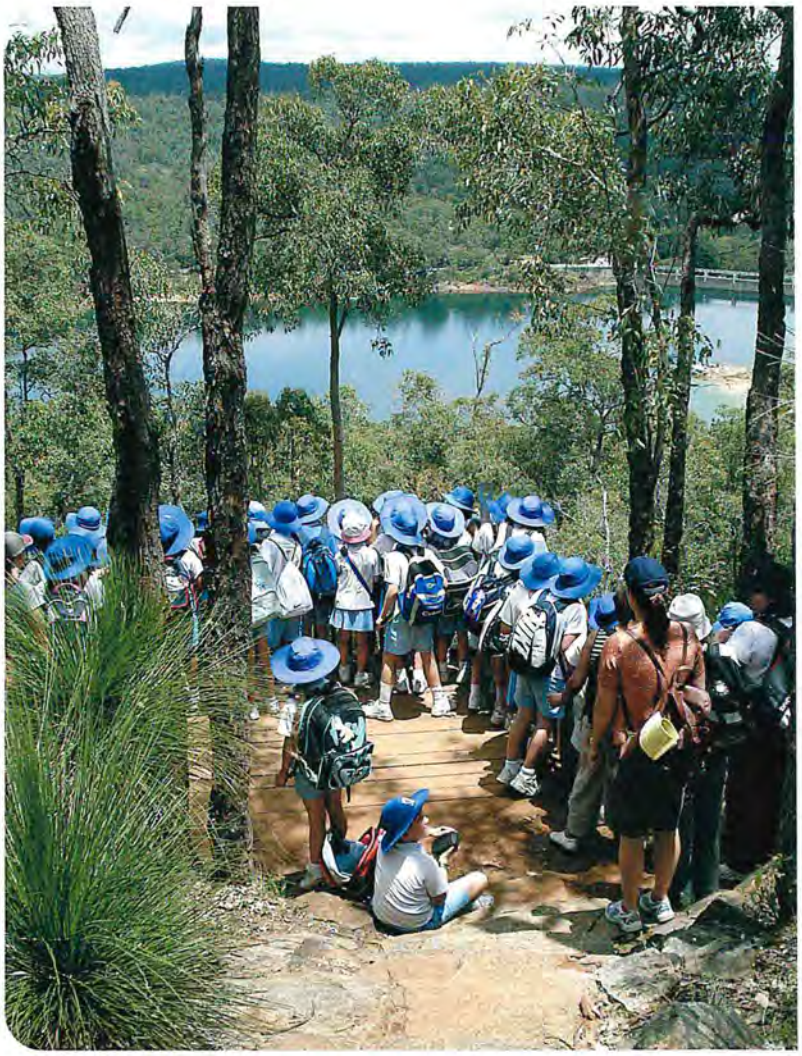
- be prepared for your activities during your excursion;
- have a broader understanding of water quality issues;
- plan relevant pre- and post-excursion activities; and
- make the most of your time when visiting EcoEducation Centres (such as Perth Hills National Parks Centre, Mundaring Weir) and surrounding areas.

Using at other locations?

This resource is be transferable to other locations in the south-west. The issues explored are generic to most catchment areas and their management. If you require assistance please contact the Perth Hills National Parks Centre EcoEducation Team Leader or the DEC Bunbury Project Officer.

Student activities in this booklet are clearly marked as pre-excursion or post-excursion in the relevant section. They may be photocopied for classroom activities.

These notes can be complemented by Water Corporation Resources and the other resources highlighted in Resources Section.



Curriculum planning for Catchment Carers' Trail – A Cleaner Glass of H_2O

EcoEducation integrated learning experiences through Science and Society and Environment with cross curricular links to English, underpinned by the cluster of values: Environmental Responsibility and Social and Civic Responsibility.

The shaded number of outcomes and values are those that are most supported by this resource. Educators can select the most appropriate depending on their students' approach.

Recommendation: Print onto A3 paper and enlarge to 141%.

Year level: _____ *Phase of Development:* _____ *Timeframe:* _____

Curriculum Framework Overarching Learning Outcomes

1 Students use language to understand, develop and communicate ideas and information and interact with others. **Catchment Carers Trail:** *Students discuss and complete pre- and post-excursion activities in their classes and collaborate in solving problems, undertake hands-on activities, role-play and provide solutions on the excursion trail.*	2 Students select, integrate and apply numerical and spatial concepts and techniques. **CCT:** *In pre- and post-excursion activities, students take measurements as part of the investigations and undertake map-reading exercises. Students assess the topography, special elements of vegetation, slope and other aspects of the environment, examine the catchment model and measure various aspects of the environment while undertaking the excursion.*	3 Students recognise when and what information is needed, locate and obtain it from a range of sources and evaluate, use and share it with others. **CCT:** *Within the pre- and post-excursion activities are opportunities to undertake individual or group research. On the CCT excursion, students will have help in identifying what information from the environment is useful and aspects that can be measured to provide data and evidence.*	4 Students select, use and adapt technologies. **CCT:** *In researching aspects of water catchment, students use equipment for particular purposes to take measurements and for observation.*	5 Students describe and reason about patterns, structures and relationships in order to understand, interpret, justify and make predictions. **CCT:** *Students explore and determine relationships within the catchment environment, structural aspects of the physical and biotic environments, patterns of water flow, land use and vegetation and make predictions and interpret causes and effects.*	6 Students visualise consequences, think laterally, recognise opportunity and potential and are prepared to test options. **CCT:** *Students search for and test evidence concerning water drainage, salinity, human impact, vegetation change, think about a range of causes, effects and consequences of these issues.*	7 Students understand and appreciate the physical, biological and technological world and have the knowledge and skills to make decisions in relation to it. **CCT:** *Students relate catchment, potable water collection and storage with topography, soil, vegetation and types, and use technology in measuring a range of aspects of these.*	8 Students understand their cultural, geographic and historical contexts and have the knowledge, skills and values necessary for active participation in life in Australia. **CCT:** *Students explore geographical aspects of the catchment, some historical needs for water and water distribution and the construction of the dam, and relating community issues and concerns within this catchment.*	9. Students interact with people and cultures other than their own and are equipped to contribute to the global community. **CCT:** *Through the exploration of catchments and the multiple issues, including human impacts, that are recognised and discussed, students can translate the methodologies and issues in interactions with others on a local or global scale.*	10. Students participate in creative activity of their own and understand and engage with the artistic, cultural and intellectual work of others. **CCT:** *Students relate to the intellectual work in discussions of the multiple issues involved in catchment management and construction of a dam.*	11. Students value and implement practices that promote personal growth and well being. **CCT:** *Students explore the consequences of their actions in terms of disease risk to vegetation, choices made in the past of vegetation types, causes of erosion and salinity and how these all impact on drinking water, which could affect our health. Also students on excursions are familiarised with personal safety issues in the natural environment and avoidance of risk to themselves and others.*	12 Students are self-motivated and confident in their approach to learning and are able to work individually and collaboratively. **CCT:** *Students work together on experiments, exercises, hands-on forest activities and discussions. They work individually and need to be self motivated and have self control on an excursion in a forest environment.*	13 Students recognise that everyone has the right to feel valued and be safe, and, in this regard, understand their rights and obligations and behave responsibly. **CCT:** *Students are exposed to strong messages relating to personal and others' safety and caring for organisms and places. Leaders on the excursion value the students' contributions and personal safety.*

Cluster of Values

1) A pursuit of knowledge and a commitment to achievement of potential.	2) Self-acceptance and self-respect.	3 Respect and concern for others and their rights	4 Social and civic responsibility.	5 Environmental responsibility.
1.1 The pursuit of personal excellence. 1.2 Domains of human experience. 1.3 Empowerment. 1.4 Knowledge.	2.4 Openness to learning. 2.5 Initiative and enterprise.	3.4 Open learning environment. 3.5 Individual differences.	4.2 Community. 4.4 Contribution. 4.5 Authority. 4.6 Reconciliation. 4.8 Responsibility and freedom. 4.9 Benefits of research.	5.1 Cultural heritage. 5.2 Conservation of the environment. 5.3 Sustainable development. 5.4 Diversity of species.

Concepts adapted from the WA syllabus

Concepts to be learnt as a result of the Catchment Carers' Trail resources

Adapted from the WA syllabus	Adapted from the scope and sequence statements
Borrowed and altered from the WA Science *Earth and Beyond* syllabus (Middle Childhood) and *Life and Living* (Middle Childhood)	* Changes occur in the physical environment as a result of humans (e.g. the impact of land clearing or degradation on salinity, erosion, water quality and habitats, the impact of fire in catchment areas).
	* Land care strategies should be considered before new human activities or in cases of degraded environments (e.g. Reservoir Protection Zone in reducing erosion and improving water quality, vegetation retention or increase in critical locations to reduce salinity).
	* When elements of an ecosystem disappear, or new elements are introduced, the whole ecosystem can be affected (e.g. pine forest replacing jarrah-marri forest, changes in surface layers such as leaf litter, reduction in habitat, increased water erosion, reduction in water quality as a result of reduction in vegetation).
Borrowed from the WA Society and Environment syllabus *Place and Space* (Middle Childhood)	* There are relationships within and between natural systems: dependence and interdependence (e.g. water cycle, food webs, ecosystems).
	* Undertake an investigation of an environmental issue in the local, national and/or global context (e.g. salinity).
	* Comparisons can be made between resource use and management (e.g. sustainability: ecosystem protection, drinkable water and reservoir protection zones).
	* The sustainability factors associated with production and consumption of a familiar resource (e.g. water resources: renewable/scarce; use of utilities in drinking water production; disposal/reuse and recycling of water and by-products; health issues for producers and consumers; how the resource is used).
	* Spatial patterns are shown using different sources (e.g. climatic and physical maps: topographic maps: contour, rivers; topographic model and its use)
	* Sustainable use of particular landscapes and the wider environment involves broad-based community cooperation* (Civics and Citizenship) (e.g. heritage values, biodiversity, Reservoir Protection Zone, conservation).
	* Geographic inquiry can be assisted through strategic questioning (e.g. visioning questions – What do we need to do to achieve a balance that will satisfy all groups that have strong views regarding water provision for consumers? Personal inventory questions – What is your view regarding water provision? Change questions – What do you need to do to clarify this situation and bring about a better solution?).
Borrowed from Science *Earth and Beyond* (Early Adolescence)	* Humans use a range of resources to provide for their way of life (e.g. use of water for drinking, gardens, swimming pools and washing and sewage).
	* Effect of resource use on the environment (e.g. habitat destruction, loss of topsoil, salinity and climate change).
	* trends in environmental change and populations and their effects on each other (e.g. rising salinity, desertification, loss of biodiversity and effects on each other and water supply).
	* matter is cycled through ecosystems (e.g. carbon, oxygen, water).

Curriculum Framework Society and Environment Learning Outcomes

Ideas for Investigations associated with Catchment Carers Trail

1 Investigation, Communication and Participation	2 Place and Space	3 Resources	4 Time, Continuity and Change	5 Natural and Social Systems	6 Active Citizenship
Students investigate the ways in which people interact with each other and with their environments in order to make informed decisions and implement relevant social action.	Students understand that the interaction that people have with places in which they live is shaped by the location, and patterns and processes associated with natural and built features.	Students understand that people attempt to meet their needs by making optimum use of limited resources in enterprising ways.	Students understand that people's actions and values are shaped by their understanding and interpretation of the past.	Students understand that systems provide order to the dynamic natural and social relationships occurring in the world.	Students demonstrate active citizenship through their behaviours and practices in the school environment, in accordance with the principles and values associated with the democratic process, social justice and ecological sustainability.
Investigation Example: Investigate the many uses of forested water catchments, and the ways these uses can impact on the natural environment and the production of clean water. Students could: • Brainstorm uses of forested catchments as a topic and devise focus questions to assist in investigating forest uses (Planning Investigations). • Locate and select forested catchment information using key words and subject terms (Conducting Investigations). • Sharing understandings of their forested catchment investigations through oral reports, graphs, models, written reports. Recounts, procedures and lists (Evaluating and Applying Findings).	**Investigation** Example: Investigate the way in which catchments (natural and artificial) are part of the environment we live in. Students could: • Describe catchment areas that they live in – both natural and artificial (Features of Places). • Describe how people adapt to natural forested catchment areas and utilise resources in these catchments (People and Places). • Describe how humans have modified natural forested catchment areas (People and Places). • Identify issues that arise from the modification and pollution of forested catchment areas (Care and Places).	**Investigation** Example: Investigate how State forest can be conserved for multipurpose use i.e. the provision of water, nature conservation, biodiversity, recreation as well as timber and mineral resources. Students could: • outline how State forest resources, particularly water, can be conserved for the future (use of Resources); and • describe how forests can be conserved through the use of innovative forest management practices e.g. Scientifically planned prescribed burning and logging practices, establishment of streamside reserves, control of dieback disease, legislation and control of mining practices (Management and Enterprise).	**Investigation** Example: Investigate the importance of water to regions throughout Western Australia (e.g. in the past, at present and for the future (Goldfields and Agricultural regions)). Students could: • select water-related information from a variety of sources (photos, internet, pamphlets, videos, local histories); • make a timeline tracing the development of the Goldfields and Agricultural Water Supply Scheme (Time and Change); and • identify events that led to the development of a suitable water supply for the Goldfields Region (Interpretations and Perspectives).	**Investigation** Example: Investigate how the pathways of water from rain clouds to a reserve in a forested catchment are part of the water cycle. Students could: • identify elements of the water cycle in forested catchments and the role they play within the environment (Natural Systems); • give reasons for regulations in forested catchments and around reservoirs (Political and Legal); and • explain that our right to enjoy recreation in forested catchments is dependent on their protection (Political and Legal Systems).	**Investigation** Example: Adopt correct behaviours in respect of the use of resources that are obtained from forested catchments at home, at school, in the community and when visiting forested catchments. Students could: • demonstrate that they have an understanding of the problems associated with excessive an careless consumption of forested catchment resources such as water, paper and timber; • take action at school to lesson their consumption of resources; and • take action at home and when visiting forested catchments to reduce their impact on that environment.

Curriculum Framework Science Learning Outcomes

Ideas for discussions, Investigations, assignments associated with Catchment Carers Trail.

1 Investigating	4 Acting Responsibly	5 Earth and Beyond	8 Life and Living
Students investigate to answer questions about the natural and technological world using reflection and analysis to prepare a plan; to collect, process and interpret data; to communicate conclusions; and to evaluate their plan, procedures and findings.	Students make decisions that include ethical consideration of the impact of the processes and likely products of science on people and the environment.	Students understand how the physical environment on Earth and its position in the universe impact on the way we live.	Students understand their own biology and that of other living things, and recognise the interdependence of life.
At the site, students could investigate: • the physical environment, such as the suitability of the soil or rock type for drainage and the proximity to water supplies; • the nature and slope of the surface; • the biological habitat in the area; and • whether these features will promote or reduce erosion and turbidity of water when it reaches the dam. Students can devise an hypothesis, such as rocky soil type, will erode less than silt. They can then plan an experiment to show that statement as correct or incorrect. They identify the independent variable (soil type) and the dependent variable (erosion or movement of soil). Then describe methodology. For example, water from a watering can sprayed on a slope of gravel (rocky soil) and sprayed on a slope (same angle) of silt. Observe the result. Record observations and write a conclusion. The conclusion should relate to the hypothesis. For example, the rocky soil eroded less than the silty soil. Then students should attempt an explanation based on science they already know. For example, rock particles are heavier than silt and are less likely to move is one explanation.	Students could: • investigate evidence of human impact on the environment and comment on consequences; • describe the impact they are having as a class in undertaking the excursion and ways to reduce their effect; and • discuss the RPZ and Leave No Trace principles as solutions in reducing human impact in an area.	Students could: • describe how sustainability of life is dependent on the quality and availability of water; • explain why rock is a better surface for dam catchments than silt or clay and describe the process of erosion and why that could be detrimental to dam catchments; • describe how mining sites could be rehabilitated to reduce water pollution problems from the site and reduction of vegetation diseases; • describe how fires in a water supply catchment could affect water quality; and • describe how salt builds up in a landscape and why it is a particular problem in water supply areas.	Students could: • use the ecosystem within the catchment being studied to describe the relationships between the organisms, such as fauna and vegetation, and the non-living parts of the environment such as the soil, water evaporation and water runoff; • describe how cells, seeds and tissues respond to salt. Why is salt a problem if there were high levels in water supplies? Does the World Health Organisation have a position on salinity in drinking water and what is it?; • explain why salinity reduces biodiversity; and • explain how jarrah dieback reduces biodiversity and affects water supply catchments. How does jarrah dieback kill trees? Research which other diseases may affect vegetation, which then may have detrimental affects on catchments.

Introduction

Many teachers would be familiar with EcoEducation's *Catchment Carers' Trail*, developed more than13 years ago by the former Senior EcoEducation Project Officer Liz Moore and her team. This new package, *Catchment Carers' Trail - A Cleaner Glass of H_20*, builds on the initial program.

Catchment Carers' Trail - A Cleaner Glass of H_2O focuses on water quality issues, protection and conservation of the water source, the importance of catchments and the personal choices students can make while in the natural environment to help improve water quality.

Catchment Carers' Trail - A Cleaner Glass of H_2O EcoEducation excursion is a conducted, four-hour, hands-on program that explores personal choices and water quality. From this, students realise that they can make a difference by their personal choices and by introducing this empowerment to their schools and local environment to make positive changes.

This booklet is designed for teachers and students and contains the background to the excursion as well as pre- and post-excursion activities, a glossary, and useful resources section. It is an integral part of the *Catchment Carers' Trail - A Cleaner Glass of H_2O* excursion.

This program also complements the Water Corporation's Waterwise Schools Program, so contact the Water Coorporation about their 'Water is Our Future' Teacher Resource Files for additional water-related curriculum activities.

As mentioned earlier, this package is intended to be used at a range of locations in the south-west. We have tried to keep specific data and specific locations out of the materials. Please, do not be afraid to cut, paste, delete and add to this package to suit your needs.

Key concepts

Water, a life-giving resource from forests

Water is one of the most important resources we obtain from forests. It is vital for all living things. Careful forest management is necessary to ensure that our present and future water needs can be met.

In 2009, 27 per cent of Perth's water needs are supplied by four large reservoirs in the jarrah forest – Canning Dam, Serpentine Dam, and the South and North Dandalup dams. A fifth dam, Lake C. Y. O'Connor provides some water to Perth, but the eastern hills, the Wheatbelt, and the Goldfields as far away as Kalgoorlie and Norseman, are its main recipients.

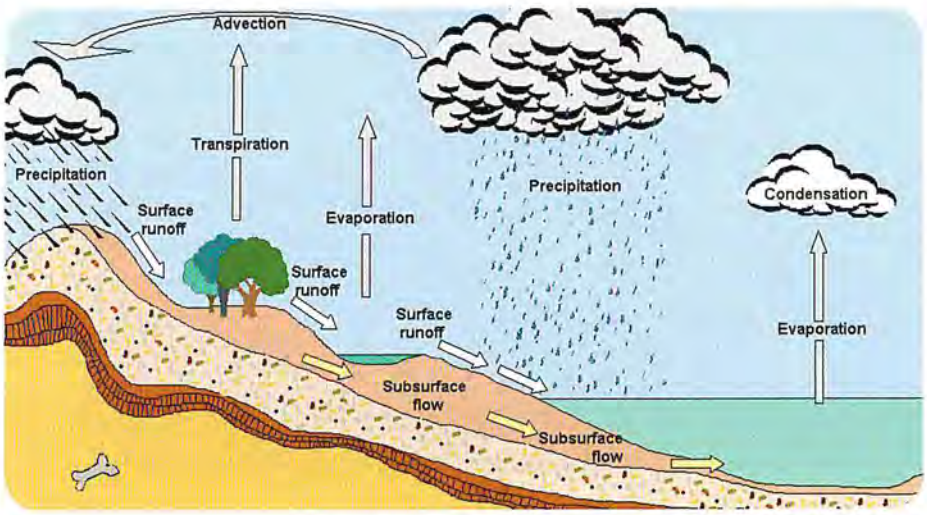
Where does the water come from?

The diagram below shows the water cycle. Some water cycle diagrams may or may not indicate the below ground part of the cycle, some show tree roots only, others aquifers, percolation or water table.

But what happens when human activity interferes with the cycle?

Human activities generally have a negative impact upon the cycle, reducing the quantity and quality of water, and altering the rate of movement of water moving through the cycle.

Moisture-bearing clouds from above the Indian Ocean are carried by winter winds and forced up and over the Darling Scarp, bringing rain to the coastal plain and the western edge of the scarp. Further east, rainfall declines. The rain falls into catchment areas, with the runoff feeding the dams in State forests and national parks.



Source – Gladstone Area Water Board (www.gawb.qld.gov.au)

For example, the Mundaring Weir catchment is the area of land which collects rainfall, and drains by way of surface and underground streams into the Helena and Darkin rivers and then into the reservoir. This area of 1,470 square kilometres extends from farmlands as far east as York, south to the Brookton Highway and north to the Great Eastern Highway.

Forty per cent of the water in the reservoir is pumped from the Lower Helena Dam downstream of the Mundaring Weir.

For school groups visiting other EcoEducation centres, specific details on the catchment story can be provided on request.

Do forests and their users affect water supplies?

Forests determine the quantity, rate and quality of water which flows into streams and then into dams. Although the forests around the Mundaring Weir are managed primarily as a water catchment they have a number of other values including for wildlife and nature conservation, timber production, mining, education, honey production, wildflower industry, tourism, recreation and research.

People and their vehicles in the catchment area may increase the risk of water pollution through soil erosion, vegetation loss from dieback disease, and wildfires. To prevent these there must be integrated catchment management, the coordinated planning, use and management of water, land, vegetation and other natural resources.

The Department of Environment and Conservation (DEC) therefore works closely with the Water Corporation, other agencies and the community, and actively promotes the concept that people within the catchment need to care for the catchment.

This program invites students to explore and investigate a number of issues affecting the harvesting, gathering and collecting of water to our storage facilities. This is not the full range of issues, but some that are considered to be of higher importance. Issues further down the supply chain of water to the community are not in the scope of the program.

Catchment **Carers'** Trail

A Cleaner Glass of H_2O

Pre-excursion activities

Exploring the relationship between how we use our water catchment and the quality of the water we drink.

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Creating your own water cycle

Concept/Issue – The water cycle connects with all parts of the environment.

Students: create a model that demonstrates the water cycle; and show the finite aspects of our global resources.

You will need

- 1.25 or two-litre clear plastic soft drink bottles
- potting mix or sandy soil
- seeds or small plants
- thin rod
- masking tape
- scissors or Stanley knife

What to do

1. Cut the container with scissors or Stanley knife about a quarter of the way up the bottle.
2. Place soil 2.5 to 5cm deep in the bottom of it and moisten with water.
3. Plant seeds or small live plants into the soil using the thin rod. Also put in stones, etc to make a natural effect.
4. Join the top and bottom sections with a strip of masking tape.
5. Tape on a lid and make the container airtight.
6. Put your bottle in a place where it will receive indirect sunlight and monitor over several weeks/months.

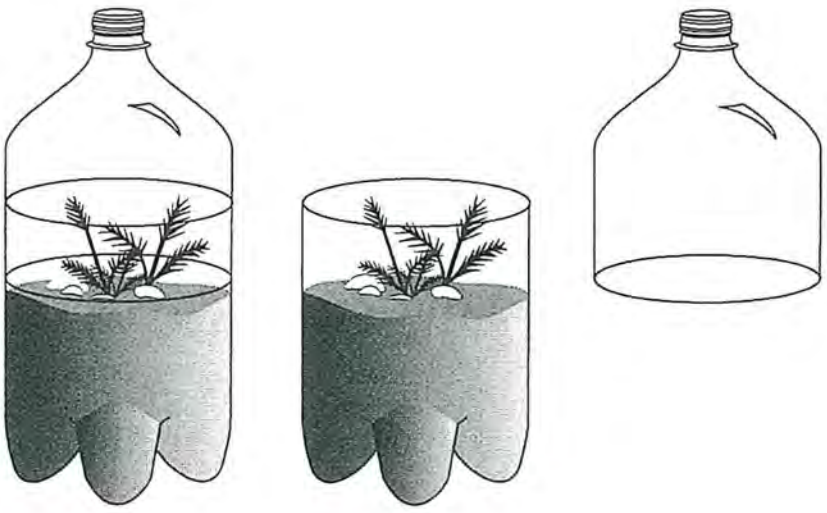
POE (Predict Observe Explain)

- What would happen if you placed several drops of oil on the soil on one side of the container?
- What would happen if you unscrewed the lid off the bottle?
- What would happen if you put the container in more sunlight?

Teachers' notes

- Some teachers may prefer to make the experiment a little more scientific by finding the mass of the bottle, soil and plants, the volume of water of the water etc and then measuring the combined mass at regular intervals to see if any changes take place.
- This model illustrates a closed system. All ecosystems on Earth are part of a global closed system.
- An aesthetic point: If students construct the model tastefully using a suitable container, colourful plants and eye-catching contents the finished product becomes a terrarium that would be suitable for a present.
- A short explanation of the water cycle is included in the key concepts page, also refer to useful resources page.

Activities adapted from Foster, D, Robb, J and Yorkston, T (1995) Waterwatch and Your Catchment. DPI, Queensland.



The schoolground – a catchment?

Issue – Everyone lives in a catchment.

Students: explore the boundaries of catchments within the school grounds.

Questions/actions

1. What happens to the water in your schoolyard when it rains?
2. Draw a map of the school grounds.
   a. Mark on the boundary and the buildings.
   b. Locate the high and low areas in your school ground and mark these areas on the map. Describe any differences between the high and low areas.
   c. Find areas that would act as miniature rivers in the event of heavy rain. Draw these onto your map of the school ground.
3. How does your school ground form a catchment?
   a. Mark onto your map any small catchments or sub-catchments within the larger school catchment.
   b. How do you think that slope affects the water as it flows?
   c. What will happen to an area of bare soil on a slope as water flows over it?
4. Are there areas of the school that drain into surrounding properties?
   a. What would happen if litter covered the school grounds before a storm? Where would it end up?
5. Are there other properties that drain into the school grounds?
   a. What would happen if just before a storm the landowner sprayed their lawns with weedkiller? Whose lawns could die and why?

Hint

By following a rolling ball you will get an idea of where the water will flow.

What do trees do?

Concept/Issue – Trees play an important role in taking up ground water.

Students: show how plants transport water; and
hypothesise what role this plays in a catchment area.

Part A - Sucked in and up

You will need

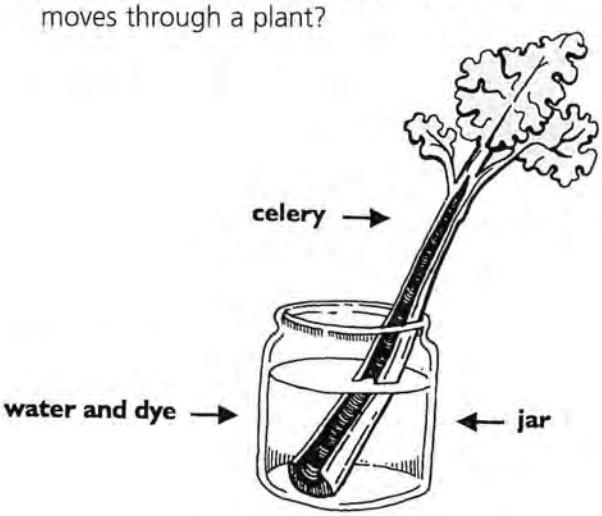
- a fresh celery stalk with leaves
- red or blue food dye
- container to hold water
- a sharp knife

What to do

1. Cut about 2cm off the bottom of the celery stalk.
2. Add the dye to the water until it is dark red or blue.
3. Place the celery in the jar and leave for 24 hours (see figure below).
4. After 24 hours, remove the celery and cut off the bottom 2cm.

Questions

1. What do you see?
2. Cut again 6cm higher. What do you see here?
3. Scrape the edge of the celery stalk. What has happened to the dye?
4. What does this tell you about how water moves through a plant?



Part B - Trees breathing?

You will need

- clear plastic bag (such as large freezer bag)
- twist tie or string

What to do

1. Find a tree with low branches, or a shrub.
2. Place a bag over a branch containing at least six leaves.
3. Close the opening by tying around the branch with twist tie or string (see figure below).
4. Leave for 24 hours.
5. Examine the bag without removing it.

Questions/actions

1. What do you see in the bag?
2. Note other observations (if any).
3. Explain your observations (think back to part A).
4. Where does the water come from? (see previous experiment)

Challenge questions

1. When trees are cleared and replaced with grasses or crops, would you expect more or less groundwater to be used? Explain your answer.
2. Trees have deep roots compared with grasses and crops. Do you think trees or crops would more easily survive a drought? Explain why.
3. If trees were cut down, what might happen to the watertable?
4. What other changes might occur in the catchment basin if many trees were cut down? Explain your answer.

Activities adapted from Foster, D, Robb, J and Yorkston, T (1995) Waterwatch and Your Catchment. DPI, Queensland.

How many? Ball game

Issue – Tree density effects runoff

Students: shows the effect decreasing the number of trees on a slope and the effect on runoff.

Trees have in important role in intercepting rainfall and reducing the amount of runoff that occurs. By intercepting rainfall more water has the chance of infiltrating, or soaking into, the ground.

You will need

- Lots of tennis or foam balls

Setting for activity

A gully or area with a slight gradient.

What to do

- Students are divided into two groups, one third in Group 'A', two thirds in Group 'B'.

Part A – Tree removal

- Group B stand on the slope, scattered randomly, like trees in a forest. They are the trees.
- Group A stands at the top with several balls for each student. The students are the rain clouds, the balls are the raindrops.
- The rain clouds gently throw the balls up into the air so they land among the trees. The trees have to catch as many balls as they can while standing still, they can not bend down and pick them up off the ground. The balls that are not caught are the runoff.
- Now take some of the trees away and perform the exercise again. What happened and why? There should be more runoff with fewer trees.
- Take even more trees away so that only a few students remain and perform the exercise again. What happened and why? There will be even more runoff and the trees won't be able to prevent the rain from hitting the ground.

Conclusion

The students will be able the see the 'raindrops' running down the slope without being intercepted by the trees. By removing trees they will be able to observe more runoff.

Part B – Stormy weather

- Repeat the set-up as above.
- This time the rain clouds gently throw all their balls up into the air at once so they land among the trees. The trees have to catch as many balls as they can while standing still, they can not bend down and pick them up off the ground. The balls that are not caught are the runoff.
- How was this different from Part A? Difference in runoff? Why?
- Now take some of the trees away and perform the exercise again. What happened and why? There will be even more runoff and the trees won't be able to prevent the rain from hitting the ground.

Conclusion

The students will be able the visually see that storms produce more runoff than normal rain. Removing trees only makes the situation worse.

Extension

Students have to redesign the student numbers to represent a rainforest or a desert. Allow students to explain why they made the changes and what they predict the result would be if the game was played.

Salinity – Situation critical

Concept/Issue - Salinity

Student: better understands one of the causes of salinity and the solution to the issue.

Salt in Lake C Y O'Connor

Read the article by Penny Hussey, 'Salt in Lake C Y O'Connor', then answer the following.

1. Water from Lake C Y O'Connor supplies water for what areas? _____

2. There are currently two main problems facing the weir. They are _____

3. In the past, salinity problems have been fixed twice before with what method? _____

4. What is the desirable level of salt in drinking water (include the units) ? _____

5. As the dam was being constructed, how many acres of trees were ringbarked, and what happened to the salinity level?

6. What is ringbarking? How does it affect the tree? (Answer is not in the article) _____

7. At Flynn's farm, a monoculture of trees was planted. During the next 30 years what happened? (Give as much detail as possible)

8. What is the lesson we should learn from this experience? _____

9. Recently about 3% of the Mundaring Weir catchment was cleared. Salinity has risen because of this.

   a) How do you think we can overcome the salinity problem? _____

   b) What 'rules' can we put in place to stop the problem reoccurring in the future? _____

REVEGETATION

SALT IN LAKE C.Y. O'CONNOR

Damming the Helena River and pumping water to the Goldfields is a major event in WA history. Currently this system supplies water not just to the Goldfields but to much of the central and eastern wheatbelt as well. However, the system is teetering in the balance – firstly there's not enough water being collected and secondly the salinity is increasing - again. In the life of the scheme, this is the third time the salinity has risen, each time for exactly the same reason – clearing in the catchment. Twice it has been 'fixed' by revegetation, but every 30-40 years people ignore past experience and clear some more.

The desirable salt level for drinking water is set at less than 500 mg/L Total Dissolved Solids (TDS). In Mundaring Reservoir (named Lake C.Y. O'Connor since the centenary of construction) it is fairly stable at 510 mg/L. Top-ups from a second dam downstream and from the aquifer at Gnangarra both freshen the water and help to keep up with demand. But why is the Helena above Mundaring Weir going salt – the catchment is still covered in native vegetation, isn't it? Well, 97% is forested, 3% is cleared. It is from that 3% that the problems arise – such a small area to give such a big problem.

The Helena was fresh (290-370 mg/L) when the dam construction started in the 1900s but, in an attempt to increase run-off, about 20,000 acres of nearby forest was ringbarked and by 1908 the salinity had risen alarmingly to 550 mg/L. Water engineers clearly demonstrated the link between clearing and salinity. Much of the cleared areas were replanted with pines, the rest left to regrow and gradually the salinity stabilised at a lower level. This was the first example in WA of a 'salinity recovery catchment'.

Alas, not all lessons learnt are remembered. In the 1940s, 50s and 60s, land releases and significant further clearing for agriculture within the catchment was permitted and pushed reservoir inflow salinity upwards for the second time. The WA Government's response in the 1970s was to build a second dam downstream (whose water comes mainly from Pickering Brook and the eastern side of Kalamunda) and to purchase private property in the catchment including the block known as Flynn's Farm.

Since purchase, trees in monoculture blocks for forestry have been planted over most of the cleared area of Flynn's Farm. In addition, 40 monitoring bores have been installed. Gradually, over 30 years, these trees have lowered the watertable and so disconnected surface runoff from sub-surface salinity. In essence, revegetation has returned the surface soil and surface runoff to below the critical 500 mg/L (aided, of course, by the decrease in rainfall since 1975).

Lesson learnt: tree planting in sufficient quantity in the correct location will, given time, lower the salinity such that the streams and surface soil are no longer saline.

But while this revegetation was quietly working away to solve this second instance of clearing-caused salinity, from 1970 on more land release, clearing and sand-mining was permitted north of Flynn's Farm, and streams draining this area have reached salinities of 2500 mg/L. This year, agreements with the Forest Products Commission have seen pines planted over a portion of this area, but will it be enough? Will we ever learn?

[Data in this article has been extracted from the 'Helena River Salinity Situation Statement', Smith *et al*, Department of Water, Perth 2007. Available in hard copy, CD or on DoW website.]

Penny Hussey

Did you know ...?

'No living mammals eat *Hakea*'. This is a quote from 'Australia's Mammal Extinctions: a 50,000 year history' by Chris Johnson, pub. 2006.

He goes on to develop the theme that the thorny defences of many species (not just hakeas) developed to deter the megaherbivores, such as the 'hippo-sized wombat' *Diprotodon*, that went extinct around 45-40 thousand years ago. Fascinating stuff!

Can I make a difference? - Part 1

Concept/Issue – Personal choices make a difference.

Student: investigate their own perceptions of water quality issues.

On the following page is a diagram that illustrates, side by side, good and poor catchments and what happens within them.

What is good and poor within the catchment?

1. Study the diagram for two minutes without writing anything.
2. You now have four minutes to highlight all the good and poor things that are happening that effect the water quality. Try circling an issue and number it, then in the space below explain what is positive or negative about this issue. Remember to focus only on water quality issues.

1) _____

_____

2) _____

_____

3) _____

_____

4) _____

_____

5) _____

_____

6) _____

_____

7) _____

_____

8) _____

_____

Available from Queensland Waterwatch Waterwatch,
http://www.qld.waterwatch.org.au/images/resources/poster_healthycatchment.jpg

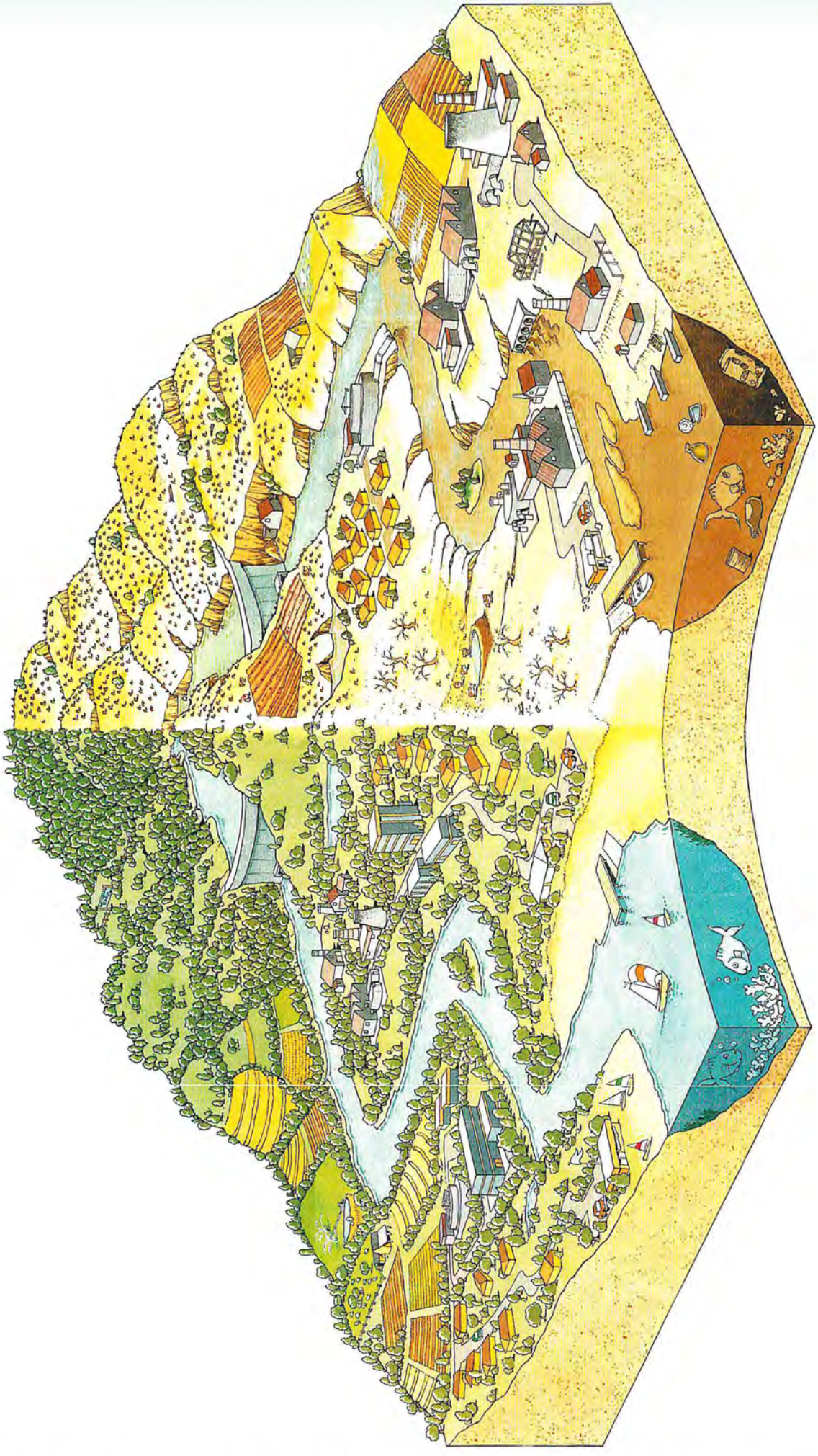


Image courtesy of Waterwatch Queensland, Department of Natural Resources and Water (www.qld.waterwatch.org.au).

Catchment **Carers'** Trail

A Cleaner Glass of H_2O

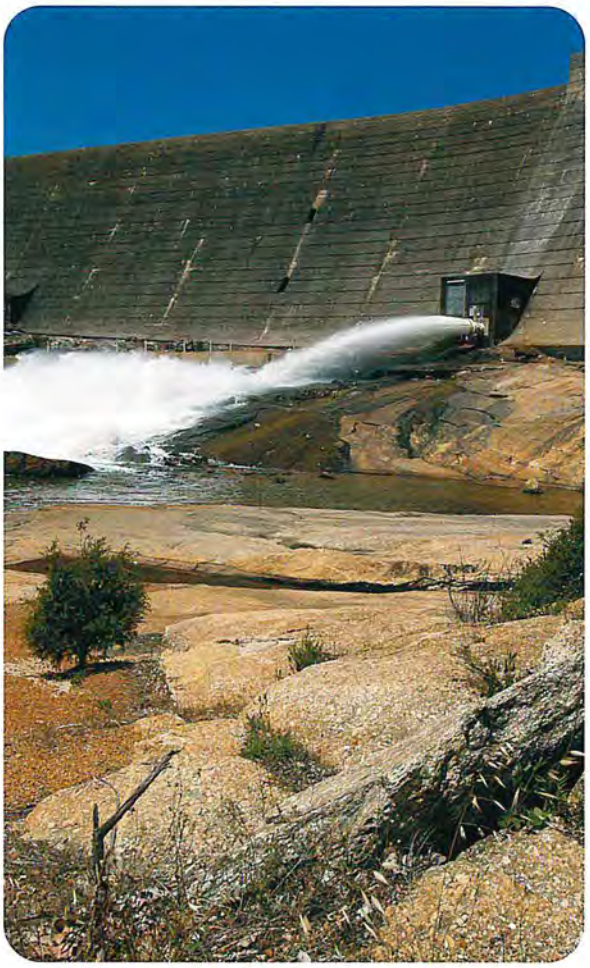
Excursion activities

Exploring the relationship between how we use our water catchment and the quality of the water we drink.

ecoeducation

Welcome to the Catchment Carers' Trail

The Catchment Carers' Trail starts at the Perth Hills National Parks Centre and meanders through to the Mundaring Weir. Along the way there are several vegetation changes and good views of Lake C Y O'Connor. The trail runs through the forest, along the side of a stream, past Lake C Y O'Connor to the C Y O'Connor memorial above the Mundaring Weir.



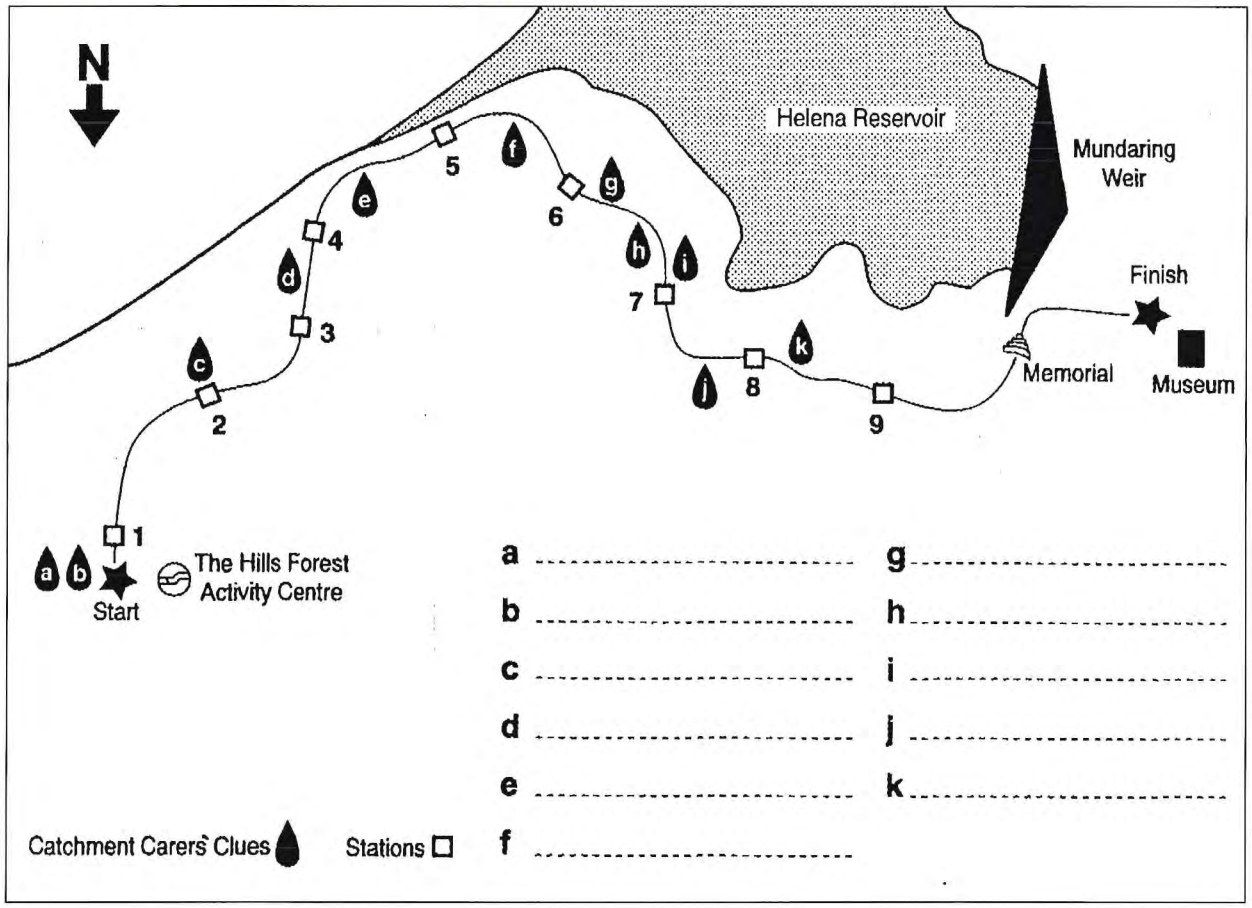
Along the trail there are 11 stations. These notes give background information for you and your students on water quality issues that are the basis of activities at each station.

When you arrive at the Perth Hills National Parks Centre for your excursion:

- You will be greeted by your EcoEducation Leader who will introduce you and your students to the centre and the day's program.
- Your EcoEducation Leader will introduce your students to the Catchment Carers' Conundrum (p 20). Along the trail there are clues to sharers of the jarrah forest resources. As students discover them, write the Carers' name on the line provided on the map shown on the same page.

Enjoy your day in the forest!

Trail map and conundrum



Now solve this conundrum:

I have listed every Carer
But there's one more left to see
Someone who uses water, and paper from the tree
I know – it must be _ _ !

.....

Cut here before copying for your students

Answers (Clues in italics) in order of appearance on the trail

A – *Teacher* = **Educator**;
B – *Leader* = **DEC Employee**
C – *Pine Tree* = **Forester/Logger**;
D – *Bush Walking Sign* = **Recreator/Bush Walker**
E – *Operation Fox Glove* = **Researcher**;
F – *Bird Nesting box* = **Conservationist**
G – *peep holes to quarry* = **Miner**;
H – *Beehive* = **Apiarist**
I – *Scenic Lookout Sign* = **Tourist**;
J – *Hakea tree* = **Wildflower grower/seed collector**
K – *Water Corporation Sign* = **Water Corporation Employee**

Station 1 Reservoir Protection Zone

Issue - To protect the reservoir from contamination, a protection area is needed.

Effect on water quality

By limiting the activity of people within the Reservoir Protection Zone (RPZ), the native forest can effectively play its role in filtering water of contaminants before it reaches the reservoir.

Overview of field work at station

Students investigate the role and location of the Mundaring Weir RPZ. The need for this zone is highlighted and what students can do when they are in RPZs and near water bodies in general.

Additional activities

Pre-visit activities

Think, pair, share about the effects of a range of activities on water quality and if there should be controls. For example, what is the effect of walking, motorbike riding, camping and horse riding on water bodies? Should these activities be kept a minimum distance away from water bodies? Why?

Post-visit activities

Investigate which dams and weirs are protected by RPZs in Western Australia's south-west.

Background notes

Importance of water quality

The quality of water being pumped from the Mundaring Weir, and other water-storage bodies needs to be of a high quality. Consequently, any human activities within the immediate catchment area that adversely impact on water quality need to be managed carefully. Recreational uses are controlled, mainly to reduce the chances of erosion.

What is an RPZ?

An RPZ is a specially designated part of the catchment that is managed to control the effects of human activity on water quality. An RPZ is normally an area of catchment within two kilometres of the high water mark.

Natural biological filters

Native forests have the capacity to filter out contaminants from surface water before they reach water bodies. Organic matter (leaves, twigs and living vegetation) traps soil particles and other suspended materials cleaning the surface water as it flows through. Good-quality native forests surrounding our water bodies are important for good quality water.

Increasing pressures

The need for RPZs has arisen from increased recreational use of areas surrounding water bodies. With increasing populations, greater access to the natural environment and increased popularity of some forms of recreation such as motorbike and quad bike riding and four-wheel driving, RPZ areas around water bodies are needed to protect the water we are going to drink.

Station 2 Dieback

Issue - Effect of an introduced organism (in this case a pathogen) in the natural environment.

Effect on water quality

Introduced organisms have the potential to disrupt the natural ecosystem, with a follow-on disruption to the water cycle in the catchment.

Overview of field work at station

Students investigate dieback and its effect on the jarrah-marri forest and discover how they can help control the spread of this introduced disease.

Background notes

DRA

Parts of the jarrah forest are at high risk of dieback disease – caused by the introduced pathogen, or water mould, *Phytophthora cinnamomi*. Some areas are declared as Disease Risk Areas (DRA) to reduce the spread of the pathogen.

Water mould

Dieback lives in the soil and attacks the roots of plants, starving them of water and nutrients until they die. In south-west Western Australia, it is estimated that of the 5,700 species of plants, as many as 2,300 are susceptible to dieback.

Infestation

Dieback spreads rapidly in water and moist soil, travelling from root to root. However, it can be more quickly and widely spread through infested soil being carried on vehicles, horses, motorbikes and shoes.

Risk of infestation is greatest during the wet season, but spores (reproductive bodies) can survive long periods of dry before becoming active after rain.

Prevention

As there is no known cure for dieback disease so it is crucial the spread of it is controlled.

Phosphite, a chemical, is used to help plants resist dieback. Phosphite can be injected into the stem or it can be sprayed on plants to control of the disease for a period of time.

Control

People moving through the forest should, and must, take personal measures to control the spread of dieback. A mild bleach solution or Methylated spirits can be sprayed onto your boots or tyres of vehicles and bikes, or on horses legs and other vehicles to kill the spores and reduce the spread of the disease.

Effect on the ecosystem

The loss of canopy cover and plants causes the understorey to become hotter and colder, as well as drier, reducing their rate of survival in changed these conditions. This then impacts on the animals that require plant resources for survival in a flow-on effect. The net effect is a loss of biodiversity and a change in the balance within the forest ecosystem. As well, with fewer plants, silty runoff to the weir could increase.

Additional activities

Pre-visit activities

Research on internet about dieback.

Post-visit activities

- Investigate how one type of recreational activity can spread dieback. Maybe choose trail or mountain bike riding, horse riding, bushwalking or four-wheel driving.
- Using this information, create a brochure or poster for the people who take part in this activity to inform them about how they can help reduce the spread of dieback.
- Write a short story about what would happen to the quality of water in the weir if dieback spread through the forest in this area. Mention the effects on animals, as well as water.
- Alcoa World Alumina Australia mines areas of jarrah forest that may contain dieback. Investigate and report on how Alcoa controls dieback and what else it is doing to help control the disease. A useful site to start your research is listed in the 'Useful Resources' section.

Station 3 History never repeats

Issue - When making management decisions, follow-on effects need to be considered.

The story of the effects of clearing native trees and planting pine forest in the catchment.

Effect on water quality

Choices we make today can have follow-on effects for many years. The effects your choices have on the environment in the longer term need to be considered when making choices today. A quick solution can have long-term negative effects on water quality.

Overview of field work at station

Students investigate how historical choices have led to our present forest and water catchment situation. Students are encouraged to think through problems over a long time scale, and consider how their choices may have long-term effects on the environment and water quality. Students compare the depth of leaf litter between the pine forest and native forest.

Additional activities

Pre-visit activities

- Research the history of your local dam or weir.

Post-visit activities

- Investigate and design alternative homes for animals of your area that are under threat from habitat loss.

Background notes

The decision

Many decisions that were made in the past still have an effect on us today – both positive and negative. The decision to build the Mundaring Weir has a positive effect on our life style, through the supply of clean water, and for industry, through the supply of water to the Goldfields and agricultural regions.

Problem with the decision

The decision to clear trees in the catchment area soon after completion has had a negative effect upon the flora and fauna, through loss of life or habitat, and increased the salinity of the waterways to an unacceptable level.

Problems with the solution

Control measures for the salinity problem – planting introduced pine trees – helped solve the salinity problem but didn't provide habitat or food for native animals. It also created an acidic soil under the pines inhibiting the spread of native plants.

Longer-term effects of the decision

These issues are still present more than 100 years after the clearing. Black-cockatoos need large hollows for nesting, however, with the rate of growth of jarrah and marri trees, it will probably be another hundred years, or much more, before these hollows return.

Learning from your mistakes

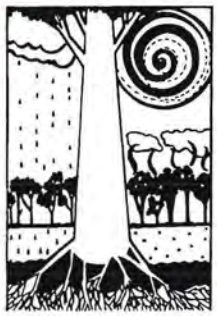
We need to learn from history and not repeat our mistakes. Regardless of how many dollars we can save now, we need to consider the long-term effects on our unique environment.

Station 4 Sucked in, up and out

Issue - Trees are important in the lowering of the water table to reduce salinity.

The problem of salinity

Effect on water quality



Trees are an important part of the forest and the water cycle. Trees help reduce the impact of raindrops on the soil surface. Trees also draw up large volumes of water which is used by the plant and for transpiration. This both contributes to the water cycle and assists in lowering the water table stopping salty water from rising towards the soil surface.

To obtain good quality runoff from the land we need a healthy forest to protect the soil, and lower the ground water.

Overview of field work at station

Students calculate the volume of water taken up by the jarrah trees surround the station. We then investigate the trees' role in helping to prevent salinity issues.

Background notes

Effect of trees

Deep rooted trees are a critical part of the water cycle in the forest. They are also important in reducing the impact of falling raindrops on the soil surface. Deep rooted plants take in water through roots deep in the ground. A 20-metre jarrah tree can draw up about 50 litres of water a day. This lowers the level of the water table.

Salt and plants

Dry salt in the ground has minimal effects on plants, salt dissolved in the water table but can be devastating to plants. The health of the forest plants requires the water table to be well below the soil surface and the salt content of the groundwater to be low.

Prevention easier than cure

Preventing salt rising to the soil surface is much easier than reversing salinity at the surface or in water bodies.

Runoff versus salinity

Some agencies advocate selective logging of catchment areas to increase runoff into water storage areas. However, there is a risk of creating a salinity problem. It is a careful juggle between increasing runoff and creating salinity. Every catchment is different and much research on an individual catchment basis is required to get the balance right.

Additional activities

Pre-visit activities

Revise the water cycle and how water moves through trees/plants.

Post-visit activities

Investigate the difference in water use by shallow-rooted plants, such as grass, and deep-rooted plants, such as trees. Relate this to rising salinity in the landscape.

Station 5 Fitting in – Where are you?

Issue - Catchment management is on a broad landscape basis.

The water cycle and the catchment

Effect on water quality

Catchments are large areas that need to be managed as a whole. The volume and intensity of rainfall have an affect on the volume and quality of runoff entering water storage areas. Vegetation management surrounding water bodies is also critical for water quality.

Overview of field work at station

Students examine a model of the Mundaring Weir catchment area and investigate features of a catchment area. Students also 'rain' and 'storm' over the catchment to understand how water moves through a catchment area.

Background notes

Complex and variable

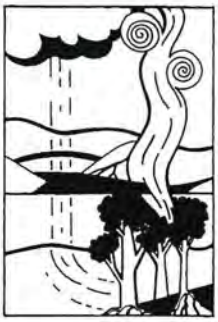
The flow of water through a catchment area is a complex concept with many variables. Use of this model helps students to begin to understand these concepts.

What is a catchment?

By using a 3D model, students get a better appreciation of a catchment area and its boundaries. Catchment areas have many topographical features in them that influence physical runoff. The model also highlights relationships across a large physical area, it can rain in one part of the catchment and cause stream level to rise in another area of catchment.

Where does the water go?

In a catchment, water can go into two systems; surface water or ground water. Surface water flows across the surface due to gravity, all the while slowly soaking in. When water moves to below the soil surface, it is ground water, which is more complex in its movement.



Surface water

Three main factors influence the volume of surface water produced. Rainfall intensity effects the ability of water to enter the soil. Soft rain allows water time to absorb. Heavy rain can limit the soil's ability to remove air so water can enter. The type of soil is also important – some soils are close to water repellent so you would expect more surface water. The existing volume of water in the ground is the third factor. Given a chance, dry soils have the capacity to soak up more water before runoff occurs, compared to wet soils. Factors are variable over time and location.

Ground water

Once water is absorbed into the ground it can follow many pathways. Some water is taken up by plants, some evaporates and some is absorbed by subterranean animals. If water filters down deep enough, it reaches the water table. This could take hours or weeks, depending on the soil type and depth of water table. From here, water will slowly flow to the lowest point, which may be a creek, reservoir, artesian basin or the sea. Some water could be trapped in isolated pockets due to the shape of the impervious layer below.

Additional activities

Pre-visit activities

Research the amount of rainfall over a period of time, either in your local area or at your local water storage facility.

Post-visit activities

Investigate how Western Australia's or Australia's climate has changed over millions of years. Try to explore how this has affected the flora and fauna. Or use this to introduce the concept of plate tectonics or Climate Change.

Station 6 Cover up to clean-up

Issue - Soil erosion can be reduced by the presence of ground cover plants and plant matter on the soil surface.

Soil erosion

Effect on water quality

Ground cover plants and plant matter on the soil surface reduces the impact of raindrops on the soil. This reduces the erosive potential of raindrops. By not disturbing the soil surface, loose soil particles are less likely to be washed away and runoff is likely to be cleaner. It also allows water more opportunity to be absorbed into the ground.

Overview of field work at station

Students perform an experiment to show the difference between the effect of water on bare soil and soil covered by low vegetation. Students then discuss the implication of their findings for the reservoir.

Additional activities

Pre-visit activities

Choose five different surfaces within the school grounds and rank them in order of potential for erosion, from easiest to hardest.

Post-visit activities

- Choose two different surfaces and record, by photographs diagrams or measurements, the effect of a single drop on the surface. Does height change the amount of erosion?
- Now repeat the experiment with a layer of vegetation over the surfaces.

Background notes

Mulching prevents erosion

Students know the importance of mulching gardens. This station is an extension (origin?) of this principle. Raindrops are powerful erosive agents and stopping their impact on bare soil has a major effect on the quality of water running off.

Where does eroded material go?

If organic material does not catch and filter out sediments, material can be spread over large distances, changing the environment. Eroded materials can be caught by vegetation further away and deposited. It can enter streams and cause turbidity, or eventually end up in reservoirs, turning them muddy, silting them up and killing off aquatic plants and animals.

Applying the principle

Once students understand how this principle conserves the environment, they can extend it to their actions. By going off tracks, people disturb and reduce the ground cover, leading to greater potential for soil erosion.

Station 7 Which way do you go?

Issue - The slope of a disturbed surface is a major factor that influences how easily the surface can be eroded.

Planning your movements

Effect on water quality

By creating tracks with as gentle a slope as is possible, you can reduce the potential for erosion. This can also be achieved by hardening surfaces, installing appropriate track drainage and revegetating damaged areas. All these steps can improve the quality of runoff water.

Overview of field work at station

Students investigate the relationship between the slope of a track and its ease of erosion. They then transfer this knowledge to their choice of routes. The steeper the track they walk on, the more chance of causing erosion. The concept of hardening a track, revegetating damaged areas, and track drainage can be introduced if appropriate.

Background notes

Planning

'Prevention is better than the cure' is an old saying that applies very well to erosion. Planning before roads, tracks and bush trails are constructed needs to consider how to move water away from disturbed surfaces.

Gentle slopes

Using gentle slopes is a good starting point, but is not the full solution. Even gentle slopes in heavy rain can create an unexpected amount of erosion. Short-cutting on the construction and maintenance of a walking track can change a good track into a problem area quickly. Short-cutting might save a minute or two, but creates problems that can take years to fix.

Personal choices

The decisions we make about walking in the forest can affect the water quality.

Additional activities

Pre-visit activities

Explore the school grounds and discover where erosion is occurring. Describe each area in written format and possibly include a diagram or photo. Pay attention to whether there are common features between all the sites.

Post-visit activities

For sites investigated in the pre-visit activities, develop a plan for how to solve the problem. Submit the plan to the School Principal and grounds-person to get approval to do the work.

Station 8 Mining

Issue - Modern society requires minerals but a balanced responsible approach is needed to obtain the resources we require.

Effect on water quality

Modern mines need to meet strict environmental protection standards. Thanks to these protection standards, the streams surrounding mines are in good quality.

Overview of field work at station

Students observe the quarry on the opposite side of the reservoir. Granite from this quarry was used to build the Mundaring Weir at the turn of the last century. Students pick up a small handful of soil and are asked to feel, observe and describe to a partner the colour, texture, grain size and shape, and the presence of plant and animal matter.

Additional activities

Pre-visit activities

Research where steel and aluminium come from. Get students to trace it back to the minerals and where they are found.

Post-visit activities

- Research how minerals are mined, including what are the steps involved?
- Develop a map of mine sites in the south-west and the minerals that are mined and their relationship to catchment areas.

Background notes

Reducing the impact

Modern mining practices are designed to minimise the mine's long-term effects on the environment, including water quality. Mining companies now have to build walls around the mine to capture runoff and so reduce the risk of erosion.

Dieback precautions

Dieback is most easily spread when the weather is warm and wet during this time the movement of traffic and heavy machinery in and out of the mine site is minimised, and vehicles are thoroughly sprayed with fungus-killing chemicals.

External monitoring

Water Corporation representatives inspect the mines and its operations to ensure these precautions are taken. DEC researchers are contracted to assist in rehabilitating mined areas back to healthy forests.

Station 9 Your actions?

Issue - We all need to be responsible for our choices.

Effect on water quality

By making choices based on how we affect water quality, it is possible to reduce our impact on catchment areas, and the environment as a whole.

Overview of field work at station

Students spend several minutes quietly reflecting on what they have experienced during the day. They then share what they have learnt.

Background notes

Stop and enjoy

Life, and this program, are very busy. We all need to take time out to reflect on what we have experienced. This stop gives students that chance. Many students have also never stopped and sat still, in total quiet, for any length of time.

Individual reflection

This station gives students the opportunity to individually develop their own reflections, rather than the usual group discussion and reflection process. For many students it is also during this time that they become more aware of what is really around them – the beauty of the natural environment.

Review the conundrum

Check back to the welcome and your work on the conundrum. Finish the answers and discuss with others in your class.

Additional activities

Pre-visit activities

A week before the excursion, ask students to share what choices they can make, and actions they can take, while in the natural environment to help to protect water quality.

Post-visit activities

Several weeks after the excursion, ask students to do a written reflection on what they recall from the excursion and how it has affected their lives. Or ask them the same question from the additional pre-visit activities above.

Station 10 Fire

Issue - Fire can adversely effect the quality of water in a reservoir.

Effect on water quality

Fires, especially wildfires, can reduce the quality of water in a reservoir due to ash, sediment and scorched leaves being blown into reservoirs. Contamination of the water body by these components needs to be minimised where possible.

Overview of field work at station

Students look for evidence of fire and discuss the meaning of a prescribed burn. Students observe the exposed trunk of a balga and count the fire rings. The relevance of the spacing between rings is discussed.

Background notes

What has fire to do with water quality and quantity? The answer: a great deal!

Wildfires

Wildfires are fires that burn very hot, are almost impossible to control and are dangerous to forests, towns, peoples' lives and farms. They occur in areas that have not been burnt for many years, and so have large amounts of leaves, twigs, bark and dead plants on the ground, known as ground fuel.

Effects of fires

After a wildfire, the landscape is black and charred. If the fire is followed by rainfall, surface runoff can carry ash into streams and then into reservoirs. If, during a wildfire, the wind blows towards a reservoir, scorched vegetation is blown into the water. If heavy rainfall occurs before the plants have had time to recover, the unprotected topsoil can be eroded into streams and dams. In these ways wildfires can result in considerable water pollution.

How many fires?

Every year, DEC responds to as many as 500 wildfires on the land it manages in the State's south-west. Many are started by arsonists, while others are started by accident or lightning.

Prescribed burns

To protect life, property and water quality in catchments, DEC works to minimise the threat of wildfire through its prescribed burning program. Planned (prescribed) fires are lit in forests around towns and farms to reduce the amount of fuel. This program does not prevent wildfires but can reduce their severity and extent.

Planning

Prescribed burns are planned carefully and are lit every five to 10 years in spring, early summer or late autumn when it is cool and relatively moist. Preventative measures are taken to stop scorched material blowing into the reservoir. For example, burns are carried out on days when the wind is blowing from main water bodies.

To consider

The effects of fire on the ecology of WA forests have been studied for more than 30 years and shown to be highly variable. Many plants can survive a fire, but a fire repeated every two or three years will cause the vegetation to change. Native animals are often able to survive fires, and research has shown that population levels of some birds and mammals return to pre-burn numbers within three to four years. Therefore, DEC maintains a period of at least four years between burns.

Why burn?

Prescribed burning is a forest management technique used for protecting a number of forest values. The result is a patchwork of regularly burned areas. The intensity of a wildfire can be reduced when it reaches a recently burned patch.

To prevent fires being started when conditions are extreme in summer, a total fire ban is imposed, which must be observed by all visitors to the forest.

Station 11 Who cares?

Issue - Several agencies share the responsibility of ensuring quality drinking water is available to all Western Australians.

Effect on water quality

Joint management of a catchment area is required to ensure supply of good quality water. Without cooperation, the system will not work.

Overview of field work at station

Students discover who is responsible for managing the catchment and water quality. There are two government organisations closely involved in managing the catchment area and the weir. This provides the necessary level of protection and management to ensure that water going into the weir is of good quality.

Additional activities

Pre-visit activities

Research the Water Corporation and Department of Environment and Conservation, and what they do.

Post-visit activities

Investigate where your water comes from.

Background notes

Who is responsible?

The supply of quality water to users is taken for granted by almost everyone, until the system breaks down. The Water Corporation has the lead role in ensuring water quality but this responsibility would be near impossible if the water going into water storage bodies, such as the Mundaring Weir, is of poor quality. So, joint management of surrounding areas within the catchment is vital and some areas are of particular concern are afforded Reservoir Protection Zone status for added protection.

Need for protection

Some people believe that these protective arrangements are unnecessary and just keep them 'locked out' of areas they think they should be allowed in. However, everyone requires access to good quality drinking water, not water that is a muddy colour or smells. So, to ensure everyone gets good quality water, some catchment areas need to have limited access. A few may be inconvenienced for the benefit of all.

Catchment **Carers'** Trail

A Cleaner Glass of H_2O

Post-excursion activities

Post-excursion activities have been grouped together based on the key concept the group of activities relate to.

ecoeducation

Post-excusion activites

Key concept 1 Salinity

Salinity is a major issue throughout south-west WA and many other areas of Australia and beyond.

Some of the key issues relating to salinity are:

- Salinity reduces ecological biodiversity.
- Alterations in vegetation and the water cycle can cause increased salt in the landscape, therefore in our drinking water.
- Organisms are affected by increased salt levels.
- Although a small amount of salt is needed by cells, increased salt affects cells detrimentally and therefore life processes.
- Salinity in the landscape can change over millions of years or in a generation of careless land use.

Salinity is both complex and variable. Salinity can become an issue when other issues develop, for example excessive clearing can provide the opportunity for saline ground water to rise and become noticeable.

As with many water quality issues, the question of balance is very important.

A salty birth

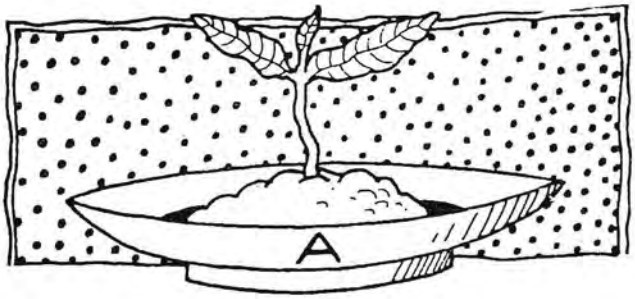
Concept/Issue – Salinity

Student: shows the effect of salt on seed germination.

Salt kills plants by reducing their ability to take up water so they end up dying of dehydration. This experiment shows the effect of salt on seed germination.

Materials

- seeds (alfalfa, wheat, mung or bean)
- five saucers
- cotton wool
- distilled water
- five salt solutions of the following concentrations in plastic 'squirt' bottles
  A - distilled water
  B - 2.5 grams salt per litre of distilled water (g/L)
  C - 5g/L
  D - 10g/L
  E - 15g/L



What to do

1. Place cotton wool in the base of each saucer.
2. Label saucers A to E.
3. Spread seeds (not too thickly) across the cotton wool in each dish.
4. Water each saucer with its matching solution. Dish A with solution A (distilled water), Dish B with solution B (2.5 g salt per litre) etc.
5. Place saucers in a safe place (they do not need to be in sunlight).
6. Check the saucers every day and add solution as necessary to keep the seeds moist.

Independent variable: Amount of salt in solution.

Dependent variable: The number of seeds that germinate.

Count the number of seeds that germinate over a period of two weeks. Record your observations in a table then on a graph. What conclusions can you draw about the effect of salt on germination?

Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

A taste of salt

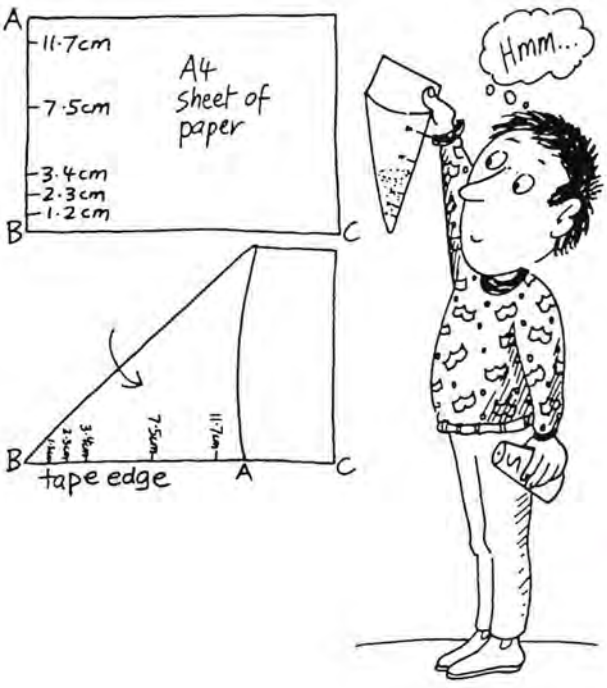
Concept/Issue – Salinity

Student: experiences the taste of different concentrations of salt.

It is okay for people to have salt on fish and chips or on the odd baked potato, but in soils it is a real problem. This is because salt kills plants by reducing their ability to take up water. And when salt gets into our water supply catchments we really start to notice the problem. In this activity you will taste water with different concentrations of salt.

Materials

- six litres of distilled water
- table salt
- five one-litre containers
- cotton wool buds (six per student)
- one sheet of A4 paper
- ruler and pencil
- adhesive tape

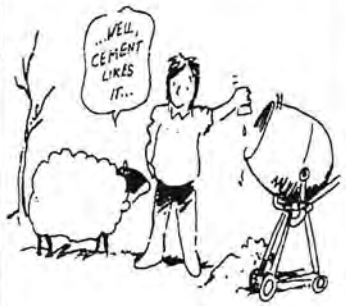


What to do

1. Prepare the paper cone for salt measurement:
   a) On an A4 sheet of paper label the corners
   A B and C as shown in the diagram.
   b) Use a ruler to measure the following graduations on the AB edge (corner B is zero).
   1.2cm = 0.15g – fresh water
   2.3cm = 1.00g – marginal water
   3.4 cm = 3.00g – brackish water
   7.5cm = 35.00g – sea water
   11.7cm = 130.00g – Barr Creek (a tributary of the Murray River)
   c) Turn the paper over and trace the graduations and mark on the grams again.
   d) Make up the cone by bringing the A corner to the B C edge and securing with adhesive tape. (Do not overlap the edges)
2. Use your paper cone to measure salt quantities for each solution. Pour in salt to required graduation holding cone up to light, to match with the line.
3. Prepare the six salt solutions by filling the one-litre containers with distilled water and adding the measured quantities of salt.

   Taste each of the solutions by dipping cotton buds and placing on your tongue.

Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

µS/cm	Use
0 - 800 	■ Good drinking water for humans (provided there is no organic pollution and not too much suspended clay material) ■ Generally good for irrigation, though above 300 µS/cm some care must be taken, particularly with overhead sprinklers which may cause leaf scorch on some salt-sensitive plants ■ Suitable for all livestock
800 - 2 500 	■ Can be consumed by humans, although most would prefer water in the lower half of this range if available ■ When used for irrigation, requires special management including suitable soils, good drainage and consideration of salt tolerance of plants ■ Suitable for all livestock
2 500 - 10 000 	■ Not recommended for human consumption, although water up to 3 000 µS/cm can be consumed ■ Not normally suitable for irrigation, although water up to 6 000 µS/cm can be used on very salt-tolerant crops with special management techniques. Over 6 000 µS/cm, occasional emergency irrigation may be possible with care. ■ When used for drinking water by poultry and pigs, the salinity should be limited to about 6 000 µS/cm. Most other livestock can use water up to 10 000 µS/cm.
Over 10 000 	■ Not suitable for human consumption or irrigation ■ Not suitable for poultry, pigs or any lactating animals, but beef cattle can use water to 17 000 µS/cm and adult sheep on dry feed can tolerate 23 000 µS/cm. However, it is possible that waters below these levels could contain unacceptable concentrations of particular ions. Detailed chemical analysis should therefore be considered before using high salinity water for stock. ■ Water up to 50 000 µS/cm (the salinity of the sea), can be used (i) to flush toilets provided corrosion in the cistern can be controlled and (ii) for making concrete, provided the reinforcement is well covered.

* *µS/cm is a measure of the ability of the soil to conduct electricity, or the salinity of soil.*

Adapted from Foster, D, Robb, J and Yorkston, T (1995) Waterwatch and Your Catchment. DPI, Queensland.

Travelling with salt

Concept/Issue – Salinity

Student: shows how salt can move through the environment.

When Europeans arrived in Australia they did not understand the Australian environment. They used farming methods that worked well in Europe but created disasters for Australian soils. The landscape, soils and climate are very different. The early settlers tried to make a living off the land the only way they knew - by clearing vegetation including deep-rooted native trees and grasses. These activities have caused our water tables to rise, bringing salt to the surface in lots of areas.

This experiment will show you how salt rises to the surface and take you one step closer to understanding salinity.

Materials

- tall drinking glass
- paper towel
- water
- salt

What to do

1. Near the top of the glass write 'surface' and on the bottom write 'ground water'.
2. Fill one third of the glass with water.
3. Dissolve two teaspoons of salt into the water.
4. Cut a paper towelling strip a bit longer than the length of the glass. Label the strip 'soil'.
5. Place the paper towel strip in the glass so that one end is dipped in the water and the other end is overlapping the top of the glass.
6. Observe what happens.
7. Tear off a small piece of the wet paper from the end of the strip and place it on your tongue. What can you taste?
8. Remove the paper from the water and place in a warm position. Observe the surface after the water has evaporated.

How does this help to explain how salt moves in a catchment?

Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

Post-excusion activites

Key concept 2 Erosion

Erosion is an issue facing much of Australia and beyond.

Some of the key issues relating to erosion are:

- Erosion is a natural process that can be caused by wind and water.
- Human activities may have caused the rate of erosion to increase.
- A wide range of organisms, both plant and animal, are affected by erosion.
- Control measures are complex and expensive to implement.
- Some changes in the landscape caused by erosion cannot be reversed due to their scale and the fragility of the landscape.

The land is always eroding away. However, it is the rate of erosion and the causes of erosion that humans have severely modified. Humans like to think the environment is pristine and untouched, but the abiotic and biotic factors within the environment all work at reshaping our landscape, usually on a long-term timeframe.

Making rain clouds

Concept/Issue – Raindrops on soil cause erosion

Student: discovers the effects of raindrops on soil.

In this activity you will make your own special 'rain cloud' that will help you discover the effects of rain on different types of land. You will need this cloud for other activities, so make sure it is labelled with your name.

Materials

- plastic drink bottle with a screw lid
- nails
- felt pen (oil based)
- water

What to do

1. Remove the cap and carefully make several holes in it, using a nail.
2. Turn the bottle upside down and use felt pens to draw a cloud shape.
3. Fill the bottle with water and replace the cap.
4. Go outside and test your cloud by turning it upside down and shaking it so that rain begins to fall.

Investigation and report

1. Find as many different types of bare soils as possible around the school grounds.
2. In pairs, investigate one soil type with your clouds and record the effect on the surface. If possible take photos or detailed field sketches of before and after the 'rain' event.
3. Report to the class through an oral presentation or a poster.

Research

- Find out about different cloud types. Try to identify these clouds in the sky.
- Which clouds are rain clouds?
- Find out how sailors and farmers can forecast the weather by reading the skies. Do you know of any other ways of predicting rain?

Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

The mighty raindrop

Concept/Issue – The erosive effect of raindrops

Student: shows the effect of raindrops on bare soil.

A scientist once worked out that more than one kilogram of soil could be blasted into the air from four square metres of bare soil during a violent rainstorm. The following experiment will show you how this can happen.

Materials

- three sheets of white paper
- one petri dish or a shallow small tin containing top soil
- one small jar containing water
- one eye dropper
- one spoon or icecream stick
- Condy's crystals
- one apron or old shirt to protect your clothes
- plasticine

What to do

1. Place the first sheet of paper on a flat surface. Put the container of soil in the centre of the sheet.

   Sprinkle a few grains of Condy's crystals over the top of the soil.

   Using the dropper, let several drops of water fall on to the soil from a height of about 25 centimetres.

   What happens? Do you get coloured splashes on the paper?

   Let the paper dry and label it *splash pattern – flat surface*

2. Repeat this test with the remaining two sheets. Put the second sheet on a gently sloping surface. You will need to support the paper using a board or book. Use the plasticine to hold the soil container in place. Label this sheet splash pattern – sloping surface.

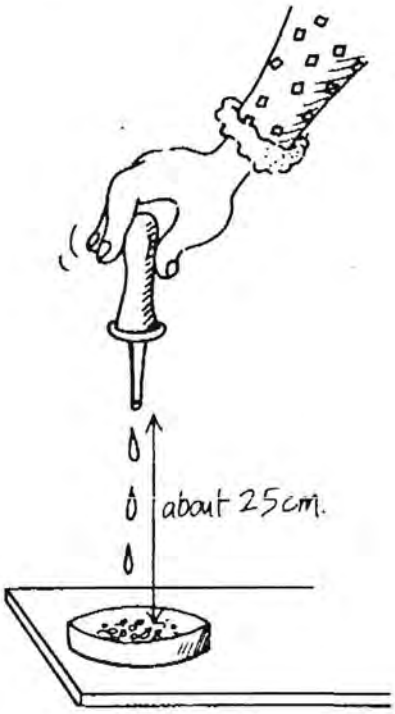
3. Put the third sheet on a steep slope. Label this one splash pattern – steep slope. Show the direction of the slope by drawing arrows.

   Are the splash patterns the same?

   Can falling raindrops move soil away?

   What is the name for this?

   What type of surface is it most likely to happen on?



Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

Water soaks

Concept/Issue – The porous nature of different surfaces

Student: investigates how porous different surfaces are and the effect on the amount runoff.

Students will be investigating which areas in your school grounds are good at soaking up water. A porous surface is able to take up water readily, like a sponge, while other surfaces do not take up water readily and are considered non-porous.

Method – Explore your school grounds for areas listed below. Use your rain cloud and observe what happens when raindrops hit the ground in these different spots.

Results

Area	Observation
Grassy slope	
Hard bare slope (where people walk)	
Moist leaf litter or other mulch	
Freshly turned soil (garden bed)	
Low growing plants (creepers or ground covers)	
Asphalt/concrete/bricks	
Other (describe)	

Which areas are best at soaking up water? _____

_____

Why? _____

In which areas does the water run off rapidly? _____

_____

Why? _____

Next time it rains, go outside with an umbrella and look at the same areas again.

Adapted from Vic Dept of Conservation and Natural Resources, Our Land: Landcare Activities for Upper Primary

Which way should I go?

Concept/Issue – Slope of land effects erosion.

Student: shows the effect of slope of the ground on erosion.

This activity is an advanced extension activity.

Aim

This activity has several aims, depending on how far you think your students are able to proceed. At a basic level, students learn to understand the features shown on the map – hills, valleys, creeks. For the more advanced, there is an activity to develop the skill of drawing a cross-sectional graphing, this graph is then used to decide on routes that reduce environmental impact.

Basic map reading activity

Background

Map reading

Being able to read a map is a valuable skill that can help you decide a safe route through the environment. It is also one of the tools used in deciding which way cultural (man-made) features are placed within the environment to reduce their impact.

Contour maps

In this activity, we will look at roads and trails, similar to in station 6 of the excursion. A section of a contour map is used, where contours join all points of equal height above sea level. As the numbers (height) of the contours increase you are going uphill, if they are falling, you are going downhill. The closer the contours the quicker the rise or fall. Widely spaced contours indicate flatter ground.

Labelling direction

North should always be at the top of the map, so east is on the right, south at the bottom and west on the left. Using this rule, you can navigate students around a map, using compass points as reference.

Activity

Using the section of map provided:

- Identify which directions the compass points lie. (Answer is in the background notes).
- Find a flat area on the map (hint: contour lines are further apart). (Answer: near the words 'Disease Risk Area')
- If you were walking from the hills below the word 'Area' to the creek to the east, would the walk be steep or flat? Explain why. (Answer: walk would be steep because the contours are closer together.)
- What is the difference in height between each contour line on this map? (Answer: 10 metres.)
- Between the words 'Slavery' and 'Lane', a track (marked by dashes) heads off towards the reservoir and joins another track solid orange line at point "AT 70 2". What is the difference in height between the start of the track and the end? (Answer: start height is 270 metres, finish height is 160 metres so there is a fall of 110 metres.)

Introduction

A friend has invited you on a walk, but they can't decide which walk would be better. Your friend recently broke her leg and can't walk up or down hills very easily as it causes too much pain, so you need to make the walk as easy as possible for her. Your friend wants you to decide which way to go!

Your friend and you can be dropped off on Slavery Road at the stop marked as "A". The choice you have is whether to walk north-east for about 1.5 km to point B, or to walk south-west for about 1.5 km to point C. You can be picked up at either B or C.

Method for deciding

How do you decide? There are two ways, just look at the map and guess, or work out the answer by a simple graphing exercise. Students should try both ways.

Guess method

Have a look at the map and guess which way you should go, A to B or A to C. Now describe in two to three sentences why you chose the track you chose.

Cross-section graph method (Advanced Extension)

This seems more complicated but is a more accurate method of deciding which way to go. So let's do it step by step.

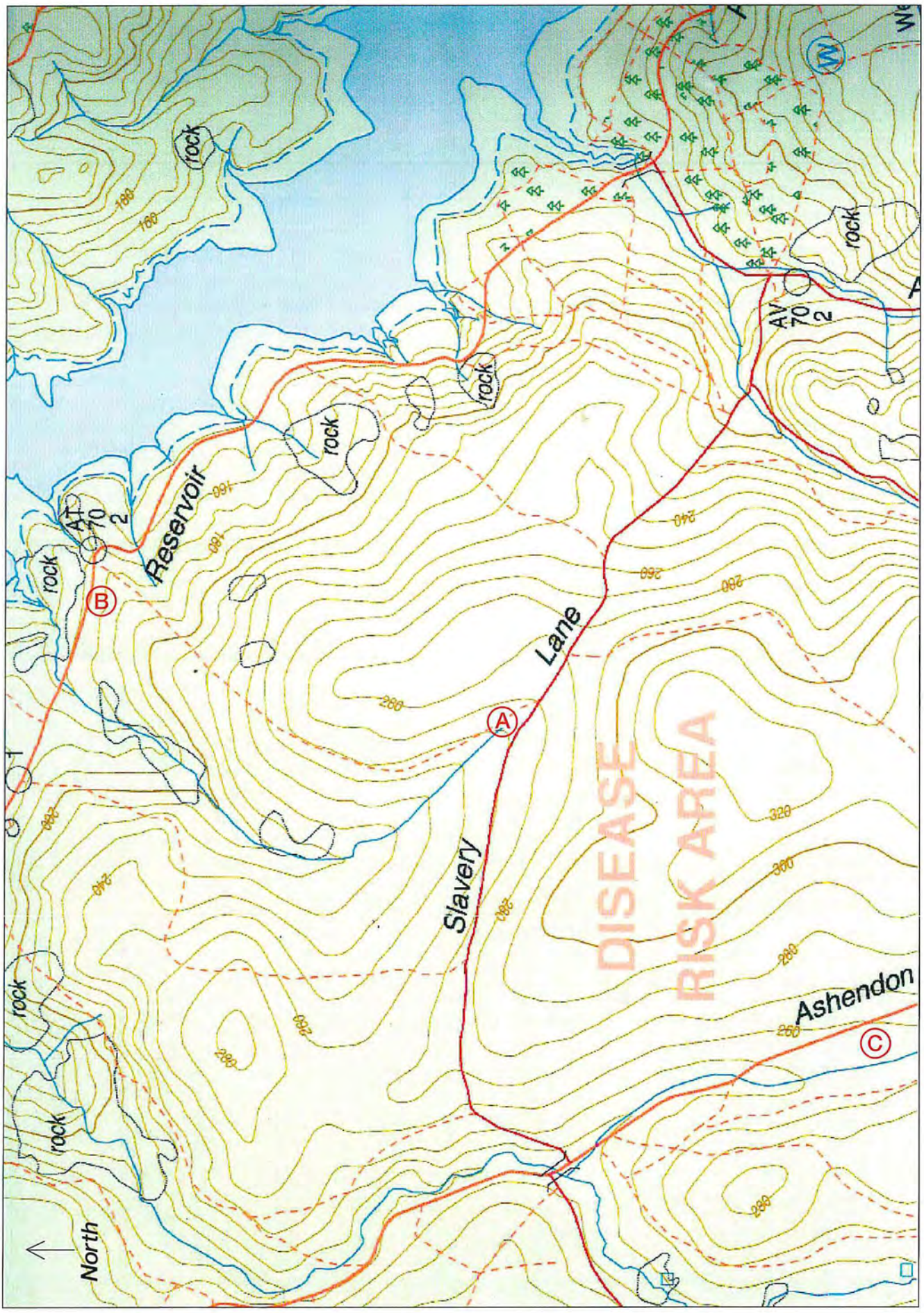
A 'cross-section' is a slice through a particular feature. So we will be doing two 'slices' – A to B then A to C. This description is for the cross-section line A to B.

1. Put the straight edge of a piece of scrap paper along your cross-section line. Mark the beginning and end of the cross-section, and write down the grid references.
2. Go along the cross-section line, making a mark every time a contour line goes under the paper. Add any height numbers you see. Also mark the position of any main features, e.g. the river or roads.
3. On graph paper, draw a frame for your cross-section. The length along the bottom should be the same as your cross-section line. The scale on the side axis should be in 10-metre intervals up to the maximum height in your cross-section. For this graph, five millimetres on the paper should denote 10-metre intervals.*
4. Put your piece of scrap paper along the bottom of the frame and mark on a dot for each contour line in the correct place. The distance along the bottom should be the same as on the scrap paper, and the distance up the side of the frame should correspond to the height of the contour line. If you don't have a number for a particular line, count up or down from one you do have. Look out for places where the same contour line crosses the paper more than once. Remember there is a gap of 10 metres between contour lines; 100-metre lines are shown in bold; and the tops of height numbers are towards the top of the slope.
5. Join the dots with a smooth line and check back to the map to make sure your cross-section looks reasonable. Draw arrows and label important features, e.g. the river or steep valley sides.

* Vertical exaggeration is caused by the vertical and horizontal scales being unequal. If the vertical scale is too large the graph looks very steep, you can 'flatten out' the graph to make the hills and valleys look more realistic by reducing the vertical scale.

Once you have the two cross-section graphs, A to B and A to C, decide which one has less hills and valleys. Which route is most suitable for you and your friend?

Which way should I go?



Post-excusion activites

Key concept 3 Water pollution

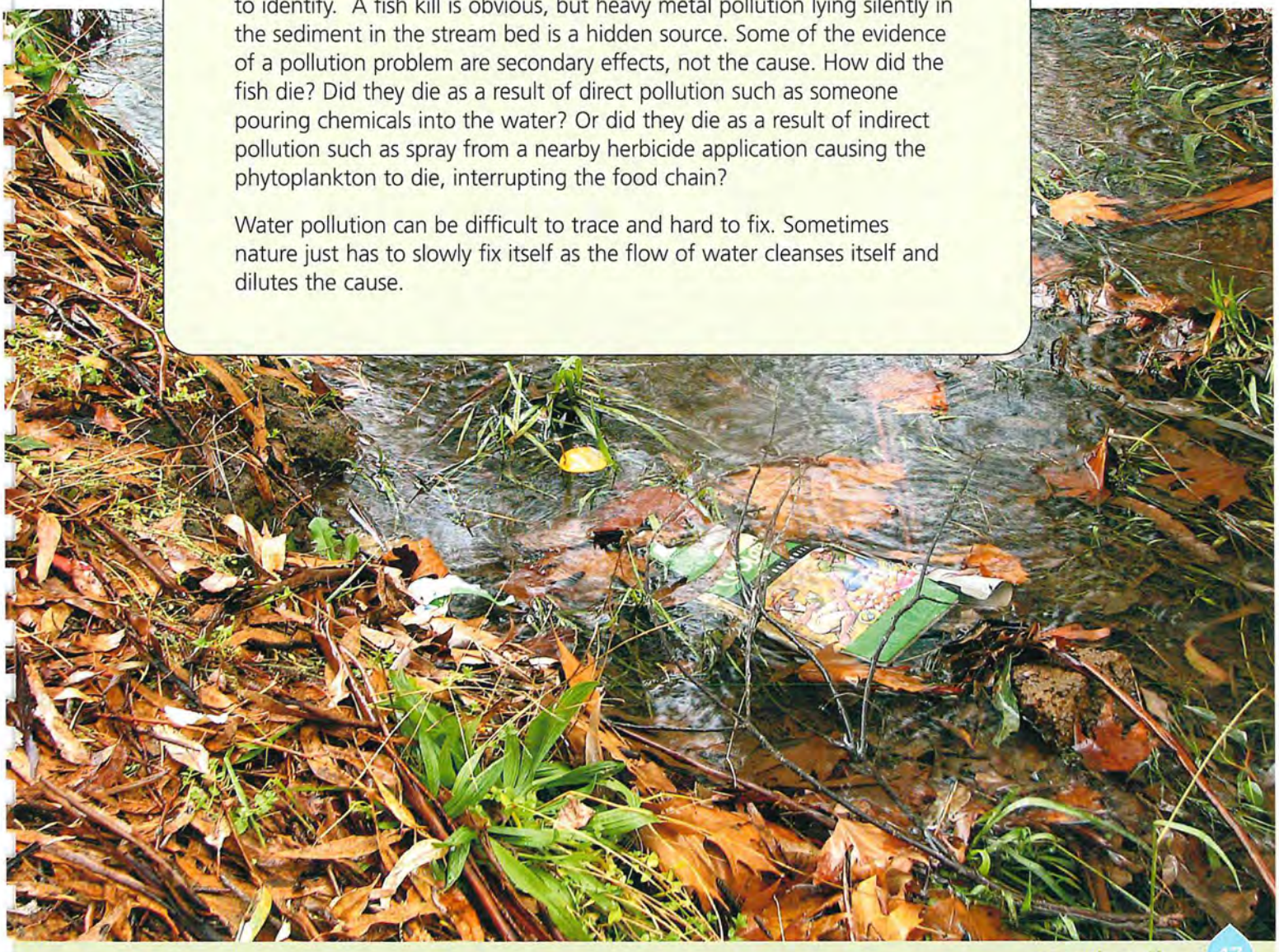
Pollution is a major worldwide issue and takes many forms. Water pollution is caused by many factors.

Some of the key issues relating to water pollution are:

- There are many causes of pollution, some obvious, some difficult to identify.
- Pollution reduces ecological biodiversity.
- Different pollutants affect different components of the aquatic ecosystem.
- Some pollutants bio-accumulate and only become obvious in the higher order consumers.
- Some sources of water pollution are from land-based sources.
- Managing the reservoir zone can reduce some pollutants ability to enter the aquatic environment.

In some cases water pollution is obvious and in some cases it is difficult to identify. A fish kill is obvious, but heavy metal pollution lying silently in the sediment in the stream bed is a hidden source. Some of the evidence of a pollution problem are secondary effects, not the cause. How did the fish die? Did they die as a result of direct pollution such as someone pouring chemicals into the water? Or did they die as a result of indirect pollution such as spray from a nearby herbicide application causing the phytoplankton to die, interrupting the food chain?

Water pollution can be difficult to trace and hard to fix. Sometimes nature just has to slowly fix itself as the flow of water cleanses itself and dilutes the cause.



The story of a river

Concept/Issue – Water pollution and its effect on water quality

Student: - explores the links between lifestyle and water pollution; and
- investigates decision-making processes.

In this activity you will make your own special 'rain cloud' that will help you discover the effects of rain on different types of land. You will need this cloud for other activities, so make sure it is labelled with your name.

Activity outline

This activity provides an excellent summary of the issues relating to water quality and river management. Students gain insights into the inter connections of a catchment and some of the causes of water pollution by observing the impact of pollution on a simulated catchment. You may wish to do some simple testing –salinity, turbidity or have students make observational recordings, describing what happened and the changes that resulted.

Students can work in pairs to rank the significance of different causes of water pollution based on their own experiences and knowledge of the various causes of water pollution. The class can discuss the impacts and the significance of each. You can then identify what issues may exist in your own catchment.

Materials

- one clear container such as a punch bowl or small fish tank with a four- to five-litre capacity filled with water
- catchment story labels
- 16 film vials (available from chemists and photo outlets)

Advanced preparation

- There are 16 land uses identified in the activity story. These can be adapted to suit the size of the group (e.g. each land use could be assigned to two people, some uses could be omitted or more than one allocated per participant to cater to the size of the group). Some land uses could be omitted if they are not relevant to your catchment.
- Prepare one labelled film vial for each participant. Fill with substances and quantities listed in the table on page 6?. Photocopy the 'labels' and cut and tape a label to each vial.

Activity instructions

Briefly introduce the concept of Australia being the driest inhabited continent in the world and discuss the preciousness of water and how many ecosystems are under threat of pollution. Everybody living in water catchment areas contribute directly or indirectly, significantly or not so significantly to the degradation of our waterways, often without realising the relationships and impacts that humans make.

Procedure

1. Place a clear jar (e.g. a punch bowl or small fish tank) containing four to five litres of water centrally in the room and explain it represents the 'river'.
2. Distribute the vials among the group. Remind students not to open them until their 'character' emerges in the story, which is when they are to empty their vial into the clear bowl of water – the 'river'.
3. Read the story in a dramatic way, stopping at the end of each section when a character/land use is mentioned. Remind participants to come forward and empty their cannister.

Note:

- The title of the river in the story has been left open so you can include the name of the local river which runs through your catchment, if you wish.
- *Each particular land use is written in bold in the story.*

The story of a river

This is the story of the travels of a very special river, our river, through its catchment. It begins in the higher parts of the catchment where the rain runs off the slopes and begins its long journey to the sea. In the valley below there is a **power station** which generates electricity for the region. It burns large quantities of coal and releases pollutant gases into the atmosphere.

These pollutants combine with moisture in the atmosphere to produce acid rain. Rainfall carries these acids back to the Earth's surface and can pollute the river. The water gathers momentum as it descends the slopes. The river continues its journey towards the sea through **farming country** where, recently, some crops were fertilised. Afterwards, the crops were watered and some of the fertiliser entered the river as runoff.

The neighbouring farm is a **piggery**. Some of the manure from the pig pens washes into a drainage pipe which empties into the river. On the other side of the river are **grazing lands**. There are very few trees remaining and, in some of the lower parts of the pasture, the water table has risen because the trees are not using the water any more. This water brings the salts in the soil up to the surface making the land unusable. It also means that runoff from the land is salty and this threatens the freshwater organisms and animals in the river. A grazing **herd of cattle** feed on the vegetation on the banks. When heavy rains arrive the banks collapse into the river.

The **coal mine**, which supplies raw mineral for the power station, pumps water out of the river to clean its equipment and flush out some of the waste. This includes various acids which all drain back into the river. Slowly, the river starts to wind its way through the outskirts of a major town. Here, there are a number of **hobby farms**. The houses here are not connected to a sewerage system but have their own septic tanks. Occasionally these tanks overflow and untreated sewage seeps directly into the river.

There are a number of people making use of the river around the bend. Someone is **fishing** on the banks. Unfortunately their line gets caught around a rock and is left in the water. Other people are **water skiing**. Their boat needs a service and its engine is leaking oil directly into the river. Another group of people is enjoying a picnic at a **park** overlooking the river. A gust of wind blows some of their rubbish off the table and down into the water.

Further downstream the river is being used for **tourism**. A charter boat is taking people on a scenic tour of the river. Drinks are available on board but not everyone uses the bins that are provided.

The river now starts to meander through the suburban part of town. A new **subdivision** is being developed. Many of the trees have been removed and the top layer of soil is eroded so, when it rains, silt enters the river. Most houses in the developed parts of the town have a **garden**. To keep garden pests away, gardeners use a range of pesticides. At the end of the day they turn on their sprinklers to water the plants. The pesticides wash off into the stormwater drains and enter the river.

People who have spent the day at work are now driving home. The **roads** are choked with traffic. Oil drips out of many cars and sometimes they brake in a hurry leaving traces of rubber on the road. Every time it rains, these pollutants are carried into the stormwater drains and straight into the river.

There is still some **industry** along the river here. Some factories use detergents to keep their production equipment clean. Sometimes, the dirty water is hosed out of the factory into the gutter where it washes into a storm water drain and flows straight into the river. If there are phosphates in the detergent, excess algae growth can occur in the river. When this algae dies and begins to rot, it uses up oxygen which animals in the water rely on. They may suffocate as a result.

Redevelopment is occurring on the opposite bank. Demolishers have discovered a few drums of something mysterious. They won't be able to sell these as scrap. Someone suggests emptying them into the river. Everyone agrees and the waste from the old **tannery** is released into the river, to the detriment of all the organisms and animals living in it.

With one final bend the river finally arrives at its mouth and flows into the sea. But look at what flows out with it!

What can we do with our river? A heavy rainstorm would help. The fresh supply of river water from rain can help flush out many pollutants. Indeed, rivers can be a major way of flushing and cleaning ecosystems. However this only moves the problem to a coastal area where other ecosystems will be affected. We must reduce the amount of pollution that is entering the river.

The story of a river

Questions

1. How did you feel about the change in the colour and look of the 'river' ? _____

2. How would you feel about drinking or swimming in this water? _____

3. Why was the water so different in appearance at the end of the story? _____

4. Do you think this is like the real situation is this how pollution might occur in our river? _____

5. List the ways that pollution in a catchment might affect you personally. How might this accumulated pollution affect the beach, coast, or ocean and, in turn, you? _____

6. Were any types of water pollution in the activity illegal? If so, why does this pollution still happen? If not, why aren't laws or penalties to protect waterways more effective? _____

7. What other kinds of measures could be used to prevent or reduce water pollution? _____

8. Where could this activity be used to raise peoples' awareness of water pollution? _____

9. Write your own story about the catchment in which you live, drawing on the different issues in your area.

Catchment story labels

Power Station	Herd of Cattle	Farming Country	Piggery
Grazing Land	Coal Mine	Hobby Farms	Fishing
Water Skiing	Park	Tourism	Subdivision
Gardens	Roads	Industry	Tannery

Land use	Substance	Quantity/condition
Power station	Vinegar (acid rain)	1/2 vial
Herd of cattle	Thick muddy water	1/2 vial
Baking powder (fertiliser)		1/2 teaspoon
Piggery	Thick muddy water	1/2 vial
Grazing land	Salty water	1/2 teaspoon salt in full canister of water
Coal mine	Vinegar (acid runoff)	1/2 vial
Hobby farms	Yellow water/toilet paper	Full canister water and a small piece of paper
Fishing	Tangle of line	
Water-skiing	Vegetable oil	1/2 teaspoon
Park	Styrofoam, plastic, etc	
Tourism	Paper, plastic, etc	
Subdivision	Soil	1/2 teaspoon
Gardens	Baking soda (pesticide)	1/2 teaspoon
Roads	Vinegar (acid runoff)	1/2 vial
Industry	Soap water (detergent)	1 drop detergent in full canister of water
Tannery	Food colouring (red) or beetroot juice	5 drops solution in full canister of water

Note: All of these substances are non-toxic.

Adapted from Who Polluted the Potomac? Alice Ferguson Foundation USA, and Queensland Waterwatch.

Post-excusion activites

Key concept 4 Personal choices

Throughout this whole package, the links between our personal choices and water quality have been highlighted. It is hoped that students are, by now, thinking about how they personally affect water quality.

Some of the key issues relating to personal choices are listed below.

- Every individual can make a difference.
- Small positive actions accumulate to help make positive changes.
- You do have a choice.
- Actions speak louder than words.
- Join with like-minded people to support each other in your actions.

Empowering students is a very positive aspect of teaching. Part of a teacher's legacy lies in the lives of students they have positively influenced, and how they go on to positively change others. Helping students to understand the link between their personal choices and water quality will help students become socially responsible citizens.

Finding a solution

The Catchment Carers' Conundrum introduced you to many of the people who share the catchment. Some of the carers may cause problems that will lower the quality of our reservoir water.

Suggest a solution to each of the following problems

Problem	Solution
1 Forest understorey plants throughout the forest are crushed by the many feet of visiting students and tourists.	
2 Forest trees and understorey plants are threatened by the spread of dieback disease.	
3 Dog owners allow their dogs to roam the reservoir shores and introduce harmful bacteria into the water.	
4 Ash and soil blow into the reservoir after a forest wildfire in summer.	
5 Topsoil from a gravel quarry site washes into the reservoir after rain.	
6 Salty stream water turns the reservoir water saline.	
7 A landowner wants to remove trees growing on the edge of a river flowing into the reservoir.	
8 A motor boat owner accidently pollutes the reservoir with oil.	
9 Topsoil erosion caused by road building turns the reservoir water muddy.	
10 Individual sharers of the forest use the forest as they please.	

Can I make a difference? - Part 2

Concept/Issue – Personal choices make a difference

Student: - investigates their changed perceptions of water quality issues.

This activity was offered as a pre-excursion activity. It is now repeated to try to gauge if students have a changed understanding of water quality issues. Please compare pre- and post-activities to see if a change has occurred, what has been understood and what might need reinforcing.

What is good and bad within the catchment?

1. Study the diagram for two minutes without writing anything.
2. You now have four minutes to highlight all the good and bad things that are occurring that effect the water quality. Try circling an issue and number it. Then, in the space below, explain what is positive or negative about this issue. Remember to focus only on water quality issues.

1) _____

_____

2) _____

_____

3) _____

_____

4) _____

_____

5) _____

_____

6) _____

_____

7) _____

_____

8) _____

_____

See diagram on page 16, Can I make a difference? - Part 1.

Available from Queensland Waterwatch Waterwatch,
http://www.qld.waterwatch.org.au/images/resources/poster_healthycatchment.jpg

Glossary

The following are key words when talking about water quality, the water cycle and catchment areas Not all words have been used in this booklet but are still important to understanding water

Catchment area All land that drains into a common drainage point. Can be small (a few hundred square metres) or large (thousands of square kilometres).

Erosion The removal of soil particles from the surface of the ground by water or wind. Can range from rill erosion (small channels a few millimetres wide) to gulley erosion (where the channels are metres wide and can be metres deep).

Water quality A measure of certain physical and chemical properties of water against national and international standards.

Dieback The common name for the disease caused by the introduced water mould Phytophthora cinnamomi. This disease can cause up to 40 per cent of the plants in the jarrah forest to die, including jarrah, bull banksia, snotty gobble, balga/grass tree and she oaks.

Turbidity A measure of the amount of suspended particles in the water. The more particles, the more dirty/muddy the water looks.

Soil salinity Is the measure of electrical conductivity of a soil and water sample and is expressed in microsiemens per centimetre at 250 (µS/cm). Relates to the amount of water soluble salts in the soil. These salts at high levels are harmful to plant growth and increases the chance of soil erosion.

Habitat The place where animals live, including places they eat, sleep and breed.

Threatened species A species of plant or animal that has suffered a decline in population numbers to the extent that if no action is taken to conserve the species it may become vulnerable, endangered or even extinct.

Introduced species A species of plant or animal that is not native to the area. Plants and animals from the eastern states fit this description and should be considered introduced, even though they are Australian.

Rehabilitation The process of repairing an area that is damaged in an attempt to return it to its original state.

Water cycle The movement of water from the atmosphere to the earth and back to the atmosphere through precipitation, runoff, infiltration, percolation, storage, evaporation and transpiration.

Surface water/runoff Water that flows across the surface of the ground and runs into a water body, such as a stream. Along the way, it may pick up and carry soil particles, vegetation and pollution.

Organic matter Any dead plant or animal material.

Vegetation Plants, including trees, shrubs, grasses, moss and bushes.

Canopy The upper layer of vegetation of a forest.

Ground cover Vegetation that grows low to the ground, covering the soil surface.

Short cutting Taking a different route through the bush off the designated path. Usually done near the bend in a walking track to save time and distance. In reality, short cutting saves little time nor distance and causes erosion and considerable damage to vegetation.

Evaporation The process by which water changes from a liquid to a gas.

Condensation The process by which water changes from a gas to a liquid.

Transpiration The process of evaporating water from stomata (tiny pores on the underside of leaves). The water was taken up by the plant from the soil.

Precipitation Technical name for rain. When water droplets come together in the sky until they are too heavy to be supported by the air and fall towards the ground.

Watertable The level of a body of ground water which has a pressure equal to that of atmospheric pressure, below this level the soil is completely saturated with water.

Porous Is a description of how well, or poorly, a surface absorbs and holds water.

Percolation The downward movement of water through soil and rocks.

Impervious Not allowing, or allowing with great difficulty, the penetration of water into or through a surface.

Infiltration The movement of water through the pores of soil or other porous medium.

Useful resources

Below is a list of useful sites about water and catchments

Water Corporation WA - http://www.watercorporation.com.au/

Queensland Waterwatch - http://www.qld.waterwatch.org.au/

WA Ribbons of Blue - http://www.ribbonsofblue.wa.gov.au/

Animated Water Cycle - http://www.watercorporation.com.au/education/water-cycle.htm

Overview of WA water topics - http://www.watercorporation.com.au/education/index_topics.cfm

Yarra Valley Water - http://www.yvw.com.au/waterschool/

Recommended:

Curriculum resources available from Water Corporation

'Water is Our Future' Teacher Resource File – Middle Childhood

The following topic booklets within the file contain activities related to caring for our catchments:

- Value of Water
- Water and Public Health
- Our Drinking Water Catchments
- Perth's Water Supply
- The Golden Pipeline

'Water is Our Future' Teacher Resource File – Early Adolescence

The following topic booklets within the file contain activities related to caring for our catchments:

- Water and the World
- Drainage Systems in the Community
- Climate Change and Future Water Supplies
- Country Water Supply in the South of Western Australia
- Sustainable Water Use Across Our State

A curriculum resource from the Department of Environment and Conservation.

DVD resources

- Catchment to Tap
- The Value of Water - A day in the Life of Western Australia

Contact the Education section of Water Corporation on 9420 3016 for further details.

Dieback resources -

Dieback Working Group - www.dwg.org.au

Alcoa World Alumina Australia has developed a disease-resistant strain of jarrah http://www.alcoa.com/australia/en/info_page/mining_dmanagement.asp

Ribbons of Blue – In and Out of the Classroom Teacher Resource File – Primary.

www.ribbonsofblue.wa.gov.au

This resource is divided into the following sections:

1. Background Information
2. Curriculum Planning Documents
3. Lesson Plans and Activities
   - Catchment
   - History
   - Landforms, Climate and Soil
   - Vegetation, Fauna and Macroinvertebrates
   - Land Use
   - Water Quality
   - Issues
4. Support for Teachers

The resource kit and advice is available from your local coordinator and the State Team Education Officer.

For more information on this and other resources, please contact:

EcoEducation
Department of Environment and Conservation
Phone: 9334 0481
Fax: 9334 0498
Email: customer.service@dec.wa.gov.au
Mailing address: Locked Bag 29, Bentley Delivery Centre, Bentley, WA 6983

2009169-0609-2000

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