N.T. WATERWATCH
EDUCATION KIT

Part 1
The Water Cycle and Water Properties

NT WATERWATCH EDUCATION KIT

PART 1:
THE WATER CYCLE AND WATER PROPERTIES

WATERWATCH Northern Territory

WATERWATCH Australia
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Helping Communities Helping Australia
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PART 1: The Water Cycle and Water Properties

Introduction

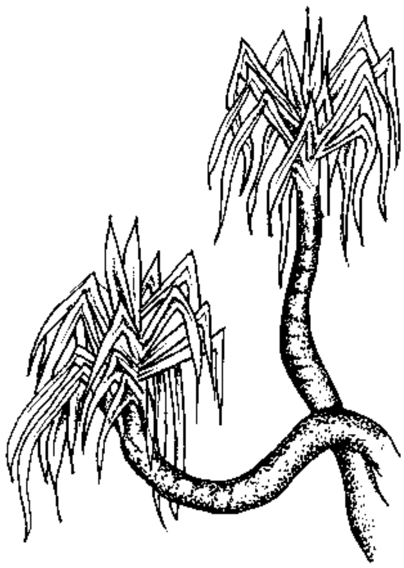
The aim of this section is to explore our environment through land divisions called catchments and to consider why it is appropriate to do so. Water is the primary determinant of catchment boundaries. The second part of the section aims to introduce the basics about water and its capabilities within an environmental context. The activities are designed to be participatory and/or may involve demonstration activities to capture the curiosity of students.

Rationale

A basic understanding of the water cycle and the properties of water is critical when working towards protection and sustainable utilisation of water.

By appreciating the water cycle it becomes easier for students to understand the complex ways in which various land uses can affect our catchments.

Similarly the concepts learnt about the properties of water will form a good grounding for understandings needed in later sections. For example in order to understand how water can get polluted you need to understand that water has the potential to dissolve things and hold them in suspension, similarly it helps to understand how the kinetic energy of flowing water has the power to erode landforms.



Where does Water come from?

97% of the Earth's water is too salty for consumption and use by humans. Similarly the majority of the remaining 3% is freshwater and can't be used as it is locked in glaciers, and icebergs. Accessible freshwater comes from streams, lakes and underground sources (Segar 1998). These sources represent less than half of 1% of all water on Earth. Figure 1 illustrates the difference in availability of salt to fresh water and sources of freshwater.

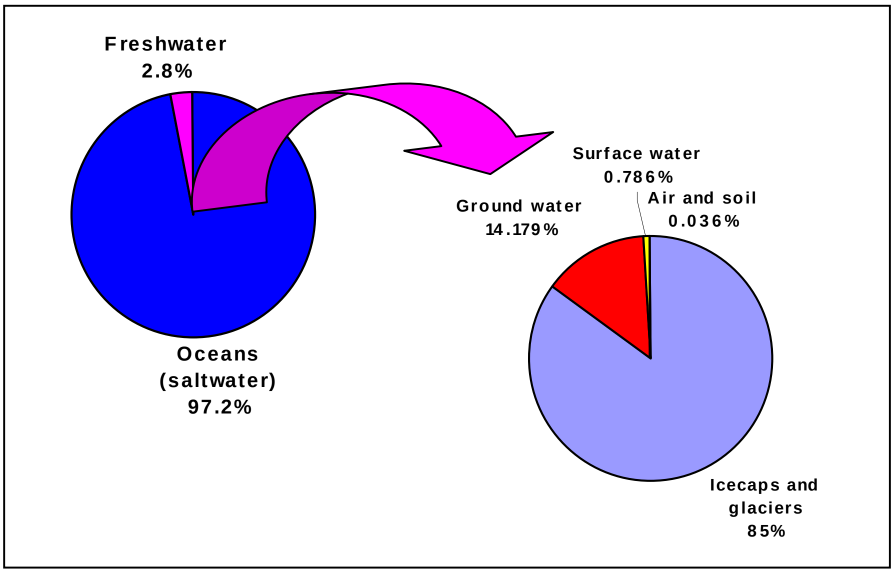


Figure 1 Earth's total water supply

See Activity 1 (p 23)

What is the Water Cycle?

Fresh water is replenished through a continuous cycle involving the evaporation of surface waters, oceans and other moisture. Energy from the sun heats the water, causing it to evaporate and rise as water vapour into the atmosphere. As the water vapour rises it cools and condenses to form clouds. The water cycle is a closed cycle, as there are no new inputs of water from external sources (Australian Water Association {AWA} 2002).

The Earth's rotation and the different rates at which air masses are heated and cooled create the winds that transport the condensed water vapour. When conditions are favourable, the condensed water vapour will be released as precipitation (rain, snow etc.) which returns to the Earth's surface so the cycle can begin again (PAWA 1996).

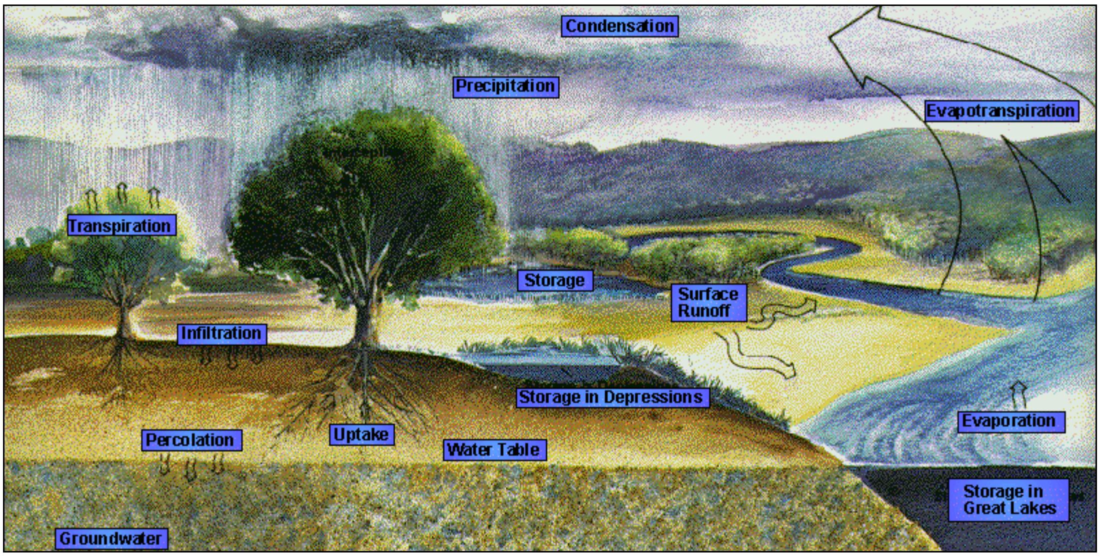


Figure 2 The water cycle (http://www.iwr.msu.edu/edmodule/water/cycle.htm)

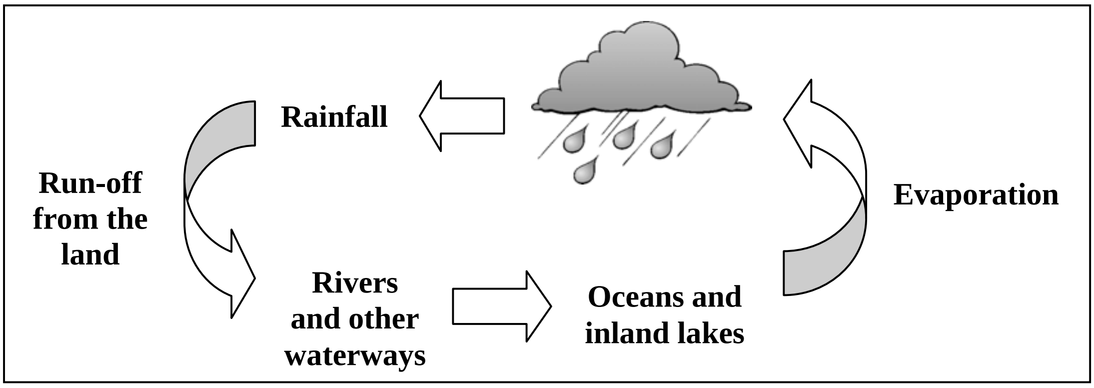


Figure 3 Schematic summary of the water cycle

See Activities 2 to 7 (p 25-33)

How does rain form?

Evaporation

Each year enough water is evaporated from oceans, lakes, rivers, soil and plants to entirely cover the Earth in water 1 metre deep (Segar 1988). Water rises in an endless cycle from oceans and land to the atmosphere and back again. It does so as an invisible water vapour. The change in state from a liquid to vapour (evaporation) requires heat energy from the sun (AWA 2002).

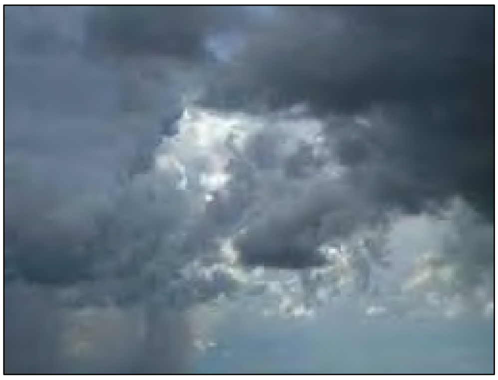
Plate 1 Dry floodplain mud

Transpiration

Plants also add water vapour to the atmosphere through transpiration. Water taken up by plant roots is lost by evaporation through microscopic pores in plant leaves as a result of solar radiation. The process of transpiration is well illustrated in wilting plants, which wilt when transpired water is not replenished by water uptake from the soil (Knox 1994).

Plate 2 Raindrop in *Nelumbo* lily leaf

Precipitation



As water vapour cools, it begins to condense into clouds. This process is called condensation. The water vapour forms droplets which fall back to Earth as rain, hail, sleet or snow (AWA 2002).

Plate 3 Monsoonal storm clouds

See Activities 8 to 12 (p 34-38)

Where does the rain go?

Between the cyclic phases of rainfall and evaporation rainfall may take several different paths. The rain may become run-off, which feeds streams, rivers and other surface water resources, it may infiltrate the cracks, pores and crevices of underground rocks to become groundwater resources or it may be taken up for use by humans, plants and animals (AWA 2002).

The travel path of water depends largely on the type of surface it lands on. On surfaces with plants such as shrubs and grasses, rain drops soak rapidly into the soil, providing water to the roots of plants. As water travels through the soil, it follows gravity, flowing to the lowest point, eventually reaching creeks, rivers and lakes. Some of the water will reach underground aquifers which hold so much of Earth's precious water (AWA 2002).

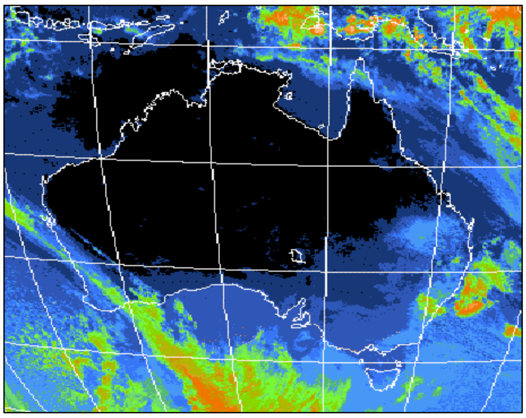
Plate 4 Rapid Creek

On surfaces from which vegetation is cleared, raindrops cannot readily infiltrate the soil. Instead rain flows along the surface, collecting in low depressions, from where it travels rapidly to the nearest water body carrying eroded soil particles. Increased run-off results in less water being able to reach the roots of plants, increased erosion and subsequent sedimentation of waterways (AWA 2002).

Plate 5 Sedimentation, resulting from increased run-off

Stormwater is run-off which collects in the roadside gutters and flows through a series of pipes until it reaches a stream, lake or the sea. Often stormwater can be polluted, because it can pick up wastes as it flows across the ground into the gutters. Mapping stormwater may assist in determining pollution sources and therefore can assist pollution prevention strategies.

See Activities 13 to 18 (p 39-44)



Rainfall patterns determine the amount of water in a catchment at any one time. Furthermore water is integral to the humidity of the atmosphere and the formation of clouds.

Figure 4 Weather map of Australia, 17 June 2002 (Bureau of Meteorology 2002)

Figure 5 illustrates the extensive variation in rainfall which is experienced between Darwin, which is situated on the north-western coast of the NT and Alice Springs, which is located in the arid centre of Australia. Rainfall dramatically influences the water cycle and associated surface and groundwater catchments.

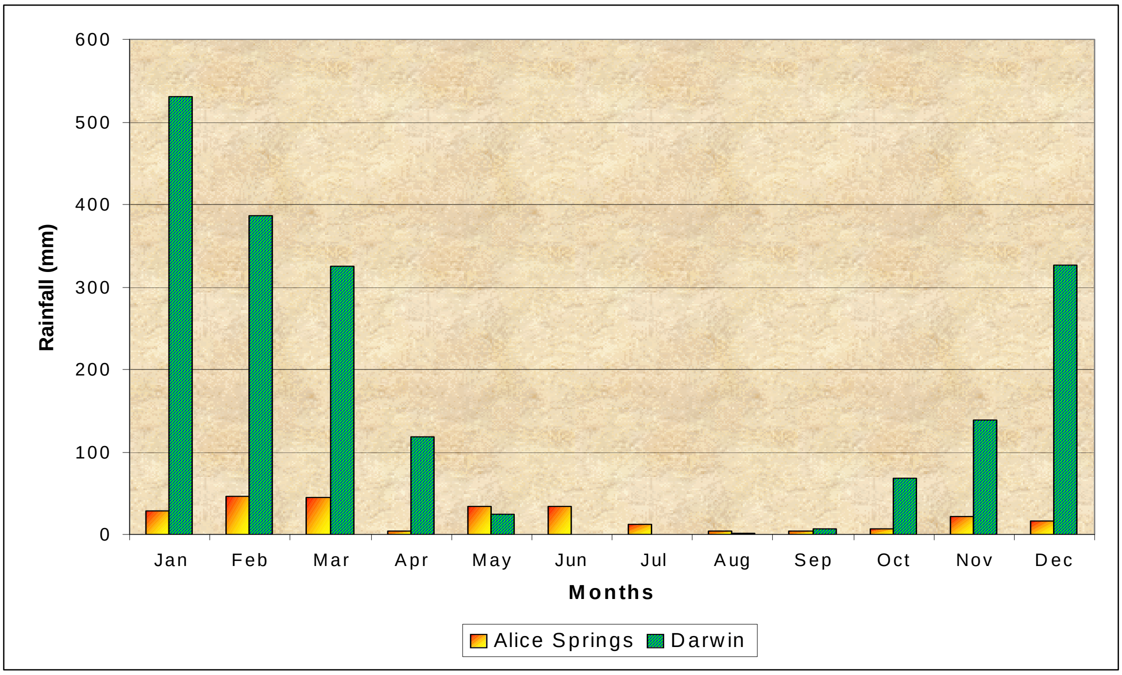


Figure 5 Average monthly rainfall in Darwin and Alice Springs 1990-2000 (Bureau of Meteorology 2001)

See Activity 19 (p 45)

The Top End

The Top End of the NT has a humid, tropical climate with distinct dry and wet seasons. The wet season (December-March) is regulated by moist, warm equatorial, maritime air masses that can bring vast quantities of rain and high humidity. In contrast, the dry season (June-September) is regulated by dry continental air masses. Transitional seasons are identified between these two periods.

Plate 6 Flora River Katherine

Seasons in the Top End cause large variations in surface flow. While many streams record little or no flow during the Dry season, flows up to ten times the monthly average may be recorded during the Wet season. The Top End has many beautiful and varied aquatic habitats. Examples include billabongs, floodplains, springs, paperbark swamps and estuaries. For more information see Part 3: Aquatic Ecosystems and Habitats.

Arid Regions

Surface waters in the arid zone are minimal as a result of much lower annual rainfall. Aquatic ecosystems are dry for the vast majority of the time, examples of such ecosystems include clay pans, salt pans, rivers and flood outs. The terrestrial and aquatic flora and fauna of the region have developed many interesting adaptations to the harsh, arid environment. For more information see Part 3: Aquatic Ecosystems and Habitats.

Plate 7 Bluebush Swamp, Central Australia

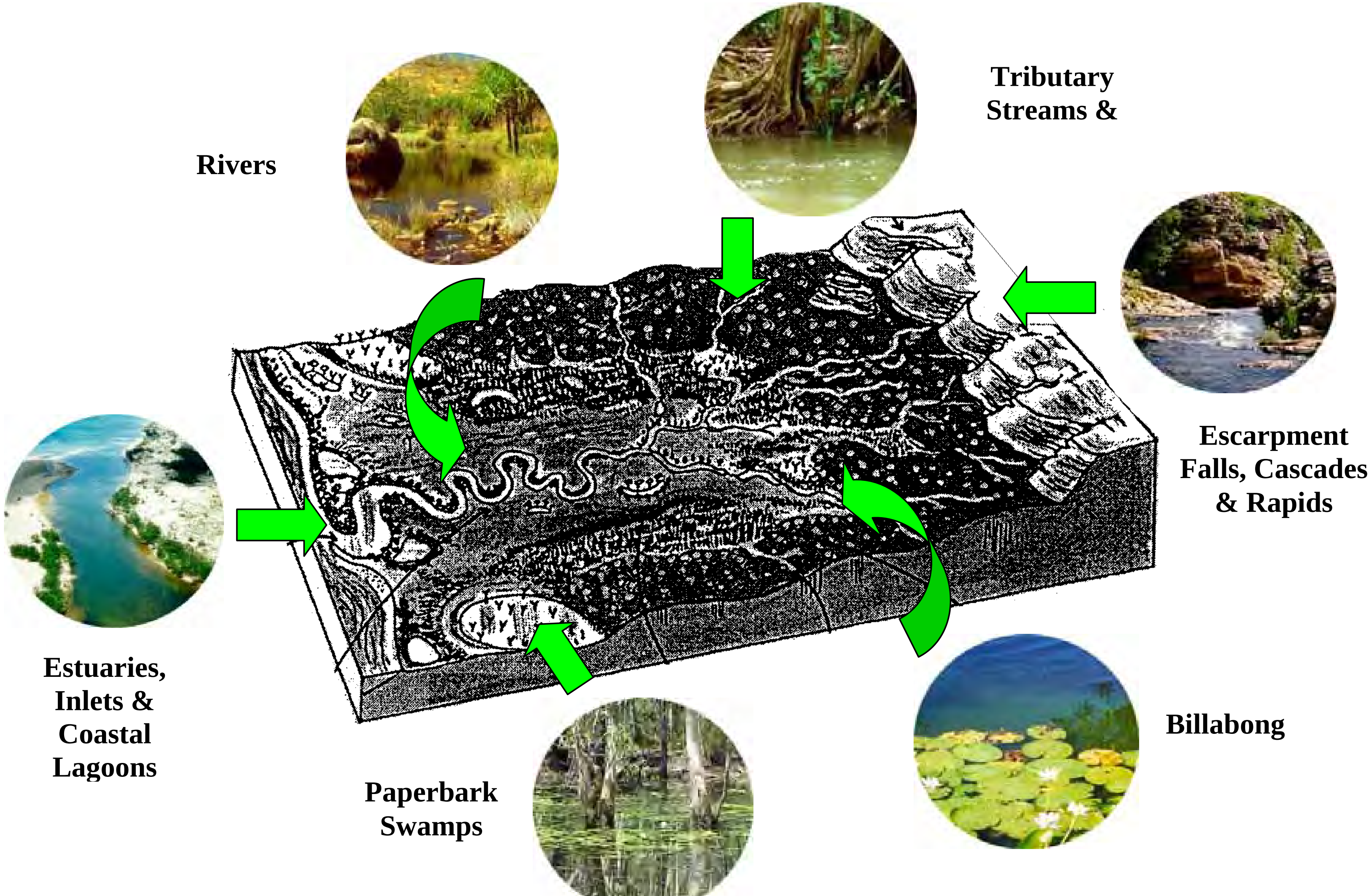


Figure 6 Block diagram of Top End water systems **(Adapted from NTDE 1993)**

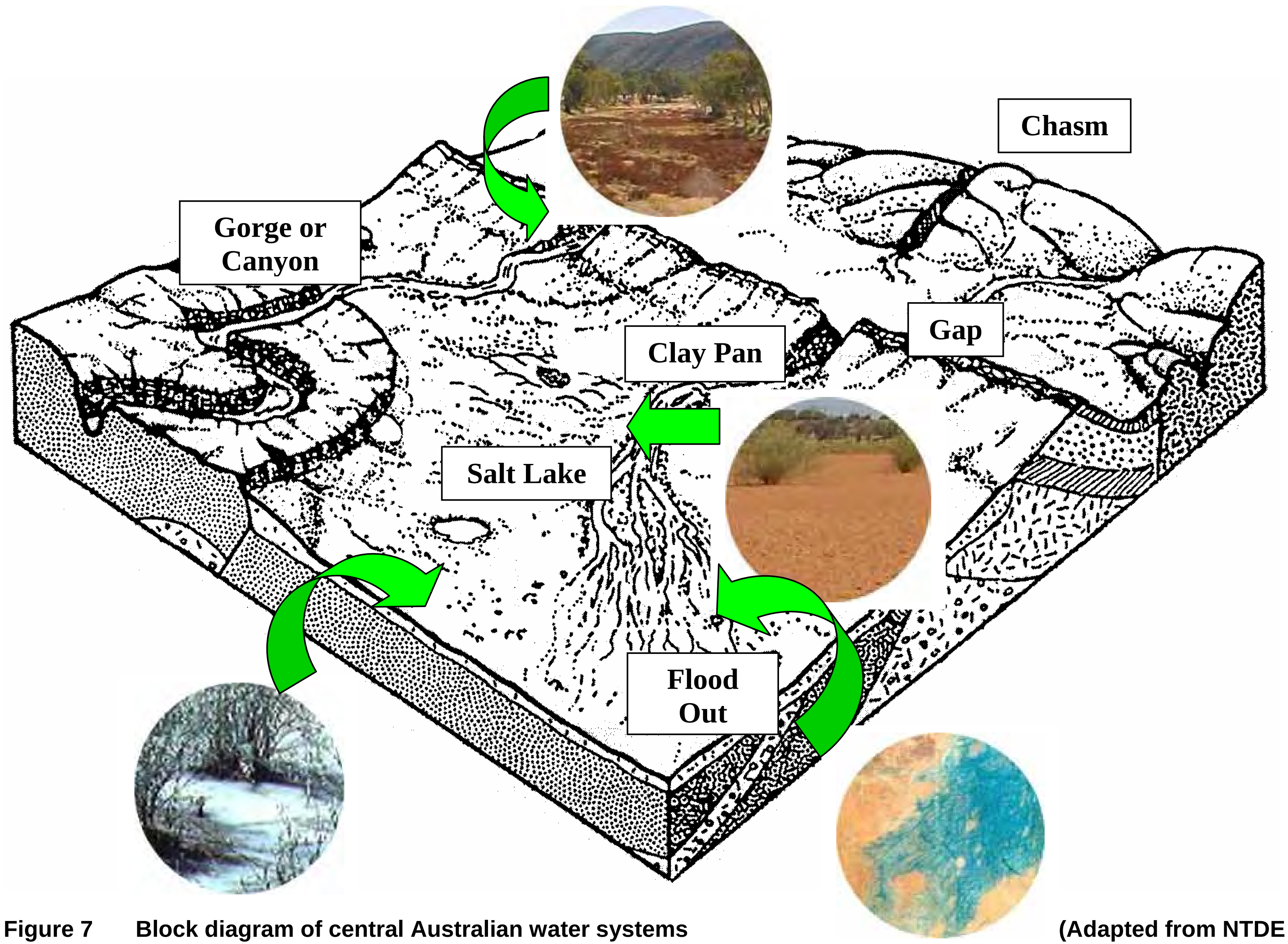


Figure 7 Block diagram of central Australian water systems **(Adapted from NTDE 1993)**

What is a Catchment?

A catchment is an area of land bounded by natural features such as hills, ridges or rises from which water drains to a collection point such as an estuary, river, waterhole or wetland. Some water continues to be drained into groundwater reservoirs which themselves can contribute to surface water flows. Therefore the boundaries between surface water catchments and groundwater catchments can merge together in some instances. Boundaries of catchments in the low lying areas may be very dynamic depending on the intensity of storms, the degree of flooding and on flood plains the change in sedimentation patterns (AWA 2002).

See Activities 20 and 21 (p 46-48)

Groundwater Catchments

Groundwater is water that has infiltrated the Earth's surface into the, often tiny, spaces which exist between soil and rock particles. Groundwater catchments largely follow similar boundaries to surface water catchments. The water underground flows from high points to low points (DWR 2000).

Groundwater flow determines water availability to humans, who use bores and wells to extract groundwater sourced from underground sources of groundwater known as aquifers. The soil type, geological layers, rainfall regimes and rates of human extraction affect groundwater availability and flow (DWR 2000).

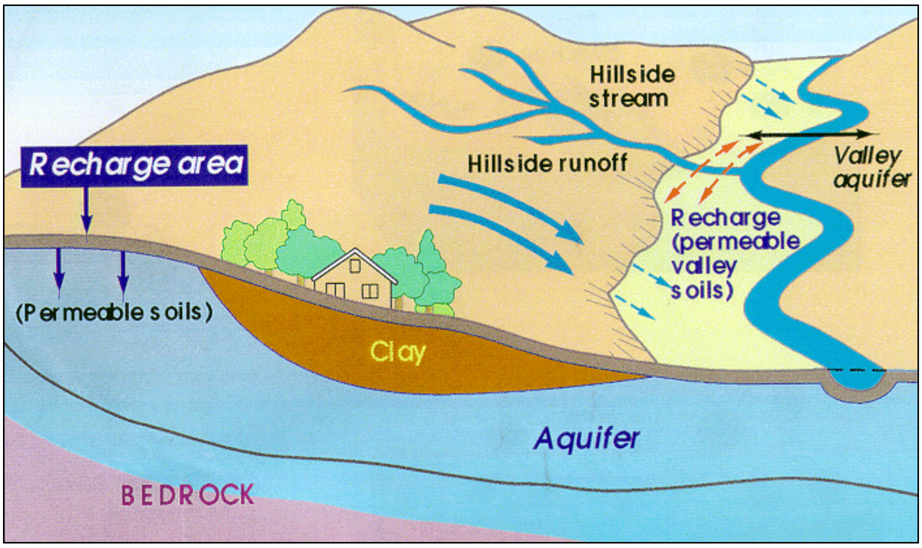


Figure 8 Groundwater Flow (Source: DWR 2002)

Aquifers

An aquifer is groundwater that is stored in the myriad of minute openings that exist along cracks in rocks or between grains of sand and silt. Aquifers come in all sizes. They may be small, only a few hectares in area, or very large, underlying thousands of square kilometres. Aquifers may be only a few metres thick, or could measure hundreds of metres from top to bottom. There are three common types of aquifer, these being confined, unconfined and perched (DIPE 2002).

Confined Aquifers

Confined aquifers usually have a confining bed, formed of materials such as impervious rock, as their upper and lower boundary (DIPE 2002).

Unconfined Aquifers

Unconfined aquifers have a confined lower boundary but the upper boundary is the water table being recharged from surface water infiltration (DIPE 2002).

Perched Aquifers

Perched aquifers are those that have a confining bed as the lower boundary and are therefore limited in size. It is located above the watertable within the unsaturated zone (PAWA 1996).

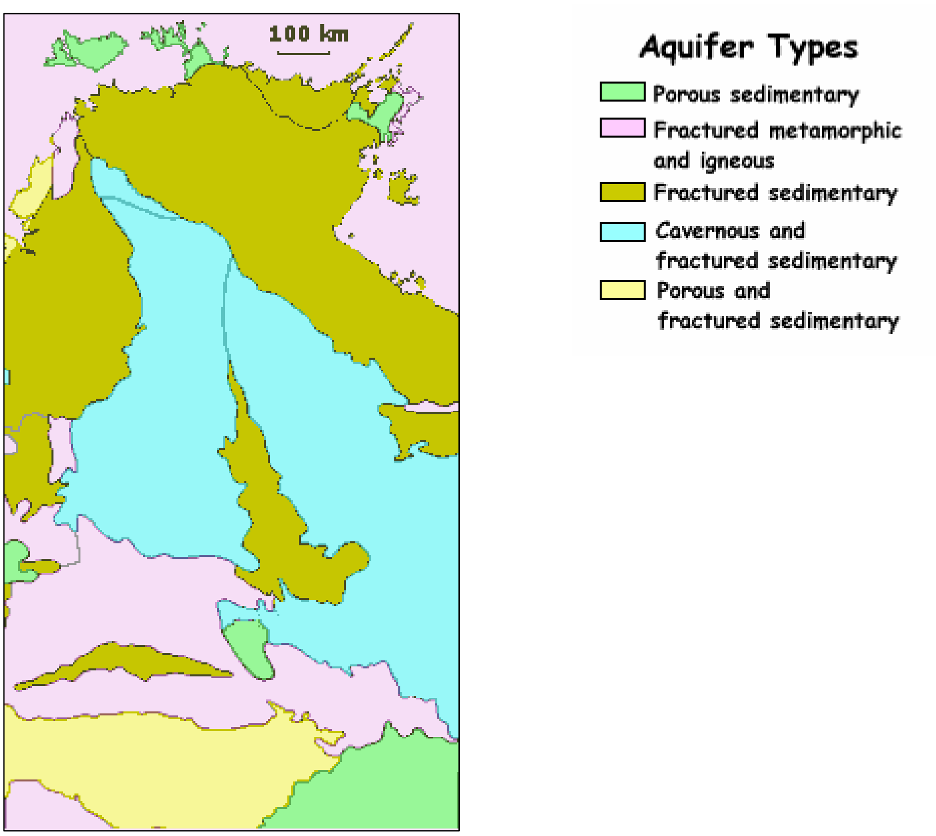


Figure 9 Aquifers in the NT

Aquifer type is determined by geological structure. Fractured rocks, such as granite and siltstone, are non-porous, but have become fractured as a result of stresses within the ground. Porous rocks, including limestone and dolomite, contain cavities or large pore spaces that have formed as a result of groundwater movement (Department for Water Resources 2000).

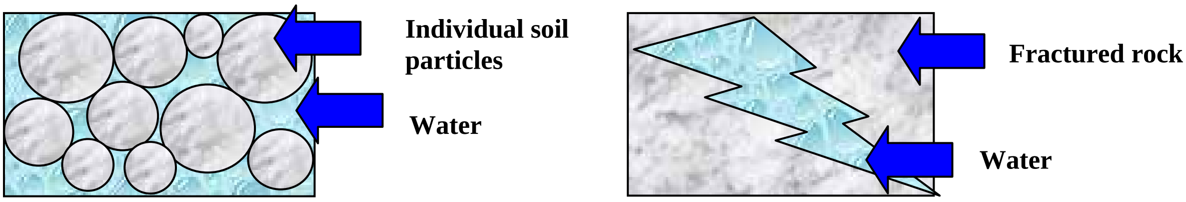


Figure 10 Magnified illustration of water in porous (left) and fractured (right) geological structures

For more information visit the following web sites:

- http://www.lpe.nt.gov.au/ADVIS/WATER/ground/nav_basics.htm
- http://www.cwmb.sa.gov.au/kwc/interactive/groundwater/index.htm

Plate 8 Groundwater seepage at Berry Springs

See Activities 22 to 34 (p 49-69)

Surface Water Catchments

Catchments exist on variety of scales. Larger regional or river catchments are made up of many smaller sub-catchments. The Katherine River catchment is an example of a sub-catchment of the larger Daly River regional catchment.

Your suburban area or neighbourhood forms part of a local catchment for a stream, wetland or groundwater area. Your school can also be viewed as part of a catchment, as it is an area that drains water towards a low point.

The NT has many varied and beautiful wetlands, which can be broken down into three main categories, these being permanent, ephemeral and man made.

Plate 9 **Koolpin Gorge** (*Jarrangbammi*)

Permanent

Permanent surface waters are present throughout the year. These are usually large rivers, lakes or swamps. At times when there is little or no rain, the water level is still maintained by groundwater contributions.

Ephemeral

Ephemeral water bodies are those that only hold water for part of the year. These are usually small creeks, lagoons, rock pools or low lying areas in the arid zone.

Man-Made

Surface water can also be held in man-made structures ranging from lakes, dams and water tanks to artificial swamps, sewerage treatment ponds, artificial waterways or lagoons.

See Activity 35 to 37 (p 70-74)

Natural Catchment Variation

The following notes outline some of the important natural changes that occur as it flows from the headwaters to a lake, wetland or the sea. Once we understand natural changes, we can then better identify human caused changes to the waterway (Waterwatch Aust. 2000).

Upper Catchment

The headwaters of a river system are very important to the health of the entire river. This is the source of sediment for the whole catchment. Fast-flowing water has the energy to erode the bed and bank, and carry large amounts of rock and gravel downstream. The type of material on the stream bottom is determined in part by the speed of the current and bedrock. Boulders and bedrock are generally resistant to erosion and are characteristic of fast-flowing streams in the upper catchment (Waterwatch Aust. 2000).

Vegetation has a great influence on the ecology and physical environment of small streams in the upper catchment, as overhanging tree branches often shade headwaters in forested areas. These environments show only small daily or seasonal variation in water temperature. In contrast, headwaters in non-forested areas and streams fed largely by run-off from the land tend to show greater variation in water temperature (Waterwatch Aust. 2000).

Overhanging vegetation in forested areas provides much of the food required by stream organisms in the form of leaves, fruits, seeds, twigs and bark. In headwater streams that are not shaded by stream-bank vegetation, attached algae and rooted aquatic plants produce most of the available food. Both shredder and collector macroinvertebrates are common in upper catchment regions (Waterwatch Aust. 2000).

Middle Catchment

In the middle part of the catchment, sediment is transferred from the upper to the lower catchment. The river typically meanders through flood plains and terraces of deposited sediment. During large floods, water spills out over banks onto the flood plain and deposits a layer of sediment. The meander slowly moves down the valley over time and occasionally may form an oxbow lake or billabong which may become an isolated permanent or ephemeral wetland. Occasional floods are important for maintaining the health of wetlands (Waterwatch Aust. 2000).

Often, in these middle reaches, the stream bank and its trees no longer shade all of the water surface. Here the sun is able to warm the water through the day particularly where the current slows to form pools. Water temperature tends to drop at night as the accumulated heat is given off to the cold air. Daily and seasonal changes in water temperature tend to be greatest here (Waterwatch Aust. 2000).

Attached algae become more abundant, grazer (plant eating) and collector macro-invertebrates dominate this section of the stream. Organisms like mayfly nymphs shear off pieces of algae growing on rocks. Collectors feed upon fine material transported from upstream and from local vegetation (Waterwatch Aust. 2000).

Lower Catchment

Close to the sea or end point the deeper and more turbid river travels slowly and deposits the large quantities of sediment it has been carrying from further upstream (Waterwatch Aust. 2000).

Vegetation has little effect on the physical shape of the channel. Aquatic plants with roots may grow in the turbid water along the shoreline and algae may grow in the shallows attached to stones or other objects. Common in this stretch of the stream are collector macroinvertebrates which filter out minute food particles suspended in the water and gather fine particles that have settled to the river bottom (Waterwatch Aust. 2000).

Dissolved oxygen levels are often reduced in the lower catchment. In slow moving areas the stream bottom becomes silty from a continuous supply of fine sediment from upstream. There is less mixing between the water and atmospheric oxygen with the result that oxygen levels are not replenished quickly in sediments. The breakdown of organic matter by bacteria further decreases dissolved oxygen levels in sediments. Organisms that tolerate lower oxygen levels are more common in this section of the river (Waterwatch Aust. 2000).

Plate 10 Sandy Island, Victoria River

Table 1 Typical changes from upper to lower catchment (Behar 1997 cited in Waterwatch Aust. 2000).

	Upper catchment	Middle catchment	Lower catchment
Physical characteristics			
Altitude	High	Decreasing	Low
Slope	Steep	Generally decreasing	Flat
Velocity	Fast	Generally decreasing	Slow
Depth	Shallow	Deeper	Deepest
Width	Narrow width	Generally increasing	Wide
Bottom	Rocky stream-bed	All types	Gravel, sand, silt or mud
Sediment transport	Erosion	Erosion = deposition	Deposition on flood plain
Turbidity	Clear water	Generally increasing	More turbid
Percentage shading	High	Generally decreasing	Low
Temperature	Cold	Increasing	Warmer, possible stratification
Dissolved oxygen	High	Generally decreasing	Lower
Nutrients	Low	Generally increasing	Higher
Vegetation			
Instream plants	Minor	Attached algae and large rooted plants	Free floating algae and large plants at margins of river
Riparian vegetation	Vegetation buffers stream from overland runoff	Vegetation reduces flow velocity and stabilises bed and banks	Vegetation influences bank stability, encourages levee deposition and slows floods
Food source for macroinvertebrates	Mainly coarse pieces of streamside vegetation	Increasing proportion of fine particles	Mainly fine particles
Macroinvertebrates			
Feeding types	Shredders and collectors dominate	Grazers and collectors dominate	Filtering collectors dominate
Body shapes	Adapted to fast moving water eg: streamlined	Wide variety of body shapes	Adapted to slow moving water eg: burrowers
Abundance	Low	Generally higher	Generally lower
Diversity	Low	Generally higher	Generally lower

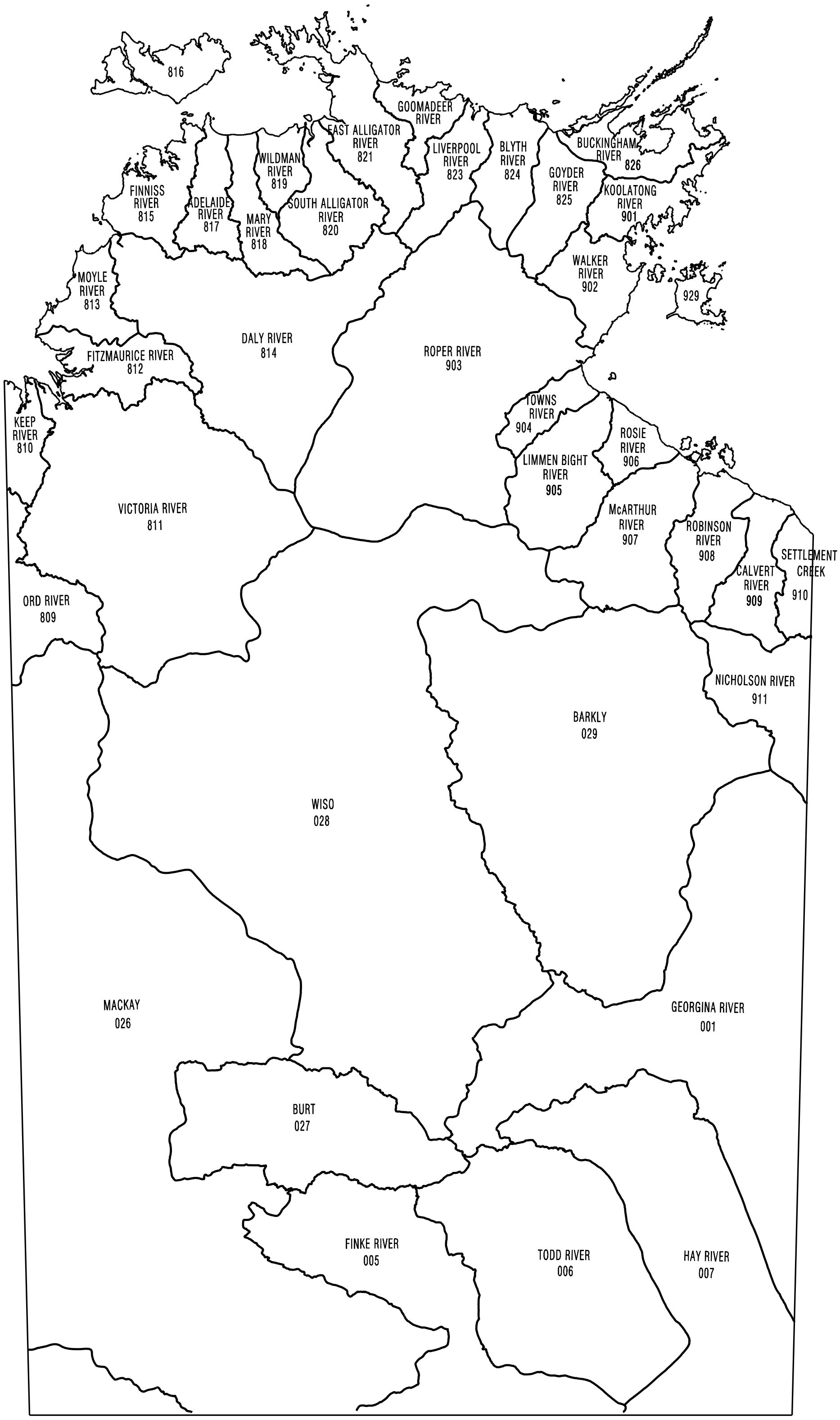
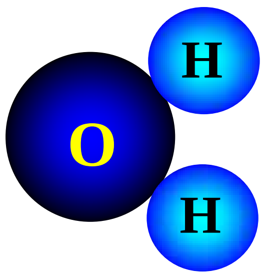


Figure 11 NT surface water catchments

The Properties of Water

The complex chemical properties of water are responsible for many of the unique features of water which make it so important for all life on Earth. The properties of water can be better understood by looking at the structure of the water molecule and by gaining an understanding of atoms, molecules and ions (Segar 1998).

- An **atom** is the smallest part of a chemical element (Segar 1998).
- **Chemical elements** are substances which cannot be made into simpler materials by chemical or physical changes. There are 111 known elements, examples include gold, iron, hydrogen and oxygen (Clesceri *et al.* 1998).
- **Molecules** are stable associations of two or more atoms, which have been combined by chemical forces. Examples of molecules include salt, sugar and water (Segar 1998).
- **Ions** are electrically charged particles. Elements in solution are generally ionised, for example the element chlorine exists as negatively charged Cl^- ions in solution. Many ions are compound such as nitrate (NO_3^{2-}) and phosphate (PO_4^{3-}) (Segar 1998).



The chemical symbol for water is H_2O. This symbol tells that each water molecule consists of two hydrogen atoms (H_2) and one oxygen atom (O) (Segar 1998).

Figure 12 Diagrammatic representation of the water molecule

Changing state

Water can exist in three states, these being solid, liquid and gas. Water freezes at 0 degrees Celsius (°C) to form ice. Between 0°C and 100 °C water exists as a liquid. At temperatures above 100 °C, water's boiling point, liquid water molecules begin to evaporate to form a gas (Segar 1998).

Ice

The fixed rigid shape of ice is determined by attractive forces between molecules, despite the constant vibrating of individual molecules (Segar 1998).

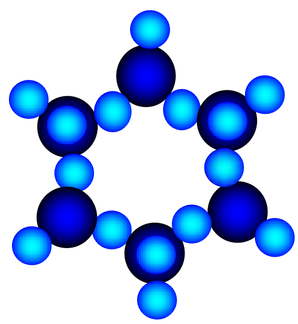


Figure 13 H_2O molecules fixed in position to create solid ice

Liquid

Liquid is created from a solid state by adding heat. The heat added to ice increases the vibration of the individual molecules. Each molecule has enough energy to vibrate, rotate and move around other molecules. In its liquid form water molecules move around to create the effect of flow (Segar 1998).

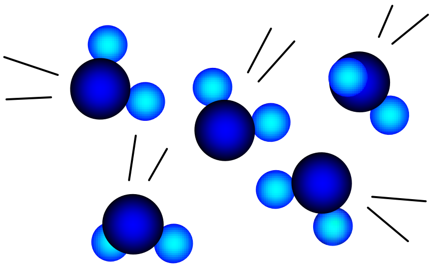


Figure 14 Liquid water molecules

Gas (water vapour)

If heat continues to be added to water eventually the individual molecules find enough energy to completely escape the attractive forces of their neighbouring molecules. The gas molecule can move away on its own accord (Segar 1998).

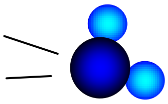


Figure 15 Gaseous water molecules are no longer bound to other molecules by attractive forces

Cooling of course has the opposite effect to heating. Reductions in temperature can cause water vapour to condense into a liquid, further temperatures drops (below 0°C) can cause liquid water to freeze and return to solid form (Segar 1998).

The Earth's water cycle, explained in Section 1, is dependent upon on water's ability to change state within the normal range of temperatures found in the Earth's climatic conditions. Without water's ability to evaporate, the transfer of water from plants, soil and the ocean could not occur and clouds could not continue to form. Similarly, without water's ability to transform from a vapour to liquid, rainfall could not occur. Water's ability to expand and contract in the form of ice and liquid has implications for weathering and erosion of the earth's crust – the process by which the formation of soil starts. Frost melting in the mornings in the desert is an important water source for organisms living in the desert environment and forms a component of the water cycle.

See Activities 38 and 39 (p 75-76)

Evaporation

Some liquids, including water, can change from a liquid to a gas at temperatures below their boiling point by a process called evaporation. Thankfully puddles of rainwater don't need to be heated to 100 °C before they evaporate and rejoin the water cycle! Evaporation occurs when molecules temporarily gain enough energy to escape from their liquid state, for example through collisions with other water molecules (Segar 1998).

See Activities 40 and 41 (p 77-78)

Dissolving Capabilities

Water can dissolve more substances and greater quantities of these substances than any other liquid. Water's dissolving capabilities are very important both within the environment and within living organisms (Segar 1998).

Water is the most abundant molecule found in living organisms, which contain 70-90% of water by weight. The water within living things acts as a medium in which molecules can interact. These interactions are essential for the removal of wastes and for the passage of nutrients and oxygen to and from cells (Knox *et al*. 1994). Water in the environment also acts as a medium for the transfer of wastes and nutrients. For example plants are dependent on water for the uptake of nutrients from the soil (Knox *et al*. 1994).

Osmosis

Osmosis is the movement of water from a region of high concentration of ions to an area of low concentration through a semi-permeable membrane (Knox *et al*. 1994).

For most aquatic organisms, if the water in which they live becomes concentrated (for example too salty) to a point where the water has a greater concentration of ions than inside their cells, water will be lost from the cells to the outside environment via osmosis. The animal and plant cells will shrink as it loses water and eventually collapses and dies (Knox *et al*. 1994).

See Activities 42 to 44 (p 79-81)

Positive and Negative Charges

Water can hold many ions in solution which enables the conduction of an electric current. This is essential for the uptake of water and nutrients by plants and biological processes.

The ability of water to conduct electricity is directly related to the concentration of ions in solution. The more ions there are, the better a solution will conduct electricity. Electrical conductivity can alter with temperature and with the different ions present (Segar 1998).

Total Dissolved Solids (TDS) is scientific measure of all ions in a sample, including some that are not charged.

Temperature

Water retains or exchanges heat more slowly than most other substances. This means that the water temperature within an aquatic habitat will remain relatively stable. This characteristic of water is very important for biota, as all organisms have preferred temperature ranges, within which they can optimally grow and reproduce. Water's insulative properties are also an important feature of the water cycle, which is reliant on the heating and cooling of the Earth's oceans (Segar 1998).

Surface Tension

Water bodies form a 'skin' made up of water molecules sticking together through cohesion, surface tension is created as a result. Water has the highest surface tension of any molecule except mercury (Knox *et al.* 1994). This surface tension allows water to support objects heavier than itself. Many aquatic insects use this surface skin as their habitat, as they feed from its surface or hang from it in the water.

Plate 11 Water boatman relying on the surface tension of water to float

Segar (1998) describes how a trampoline can be used to describe surface tension. Just as with surface tension a trampoline surface becomes depressed and stretched when somebody lands on it, however the trampoline's 'surface tension' causes it to snap back to it's shape and launch the trampoline into the air.

See Activities 45 and 46 (p 82-83)

Kinetic Energy

Kinetic energy is the energy of an object created by motion. Kinetic energy increases with the speed and/or mass of the object (Segar 1998).

Flowing water is a powerful force. The energy produced by flowing water can potentially wear away or dissolve whatever is exposed to it. Flowing water and the movement of objects transported by water can dramatically alter landscapes and in doing so can create and destroy macro (large) and microscopic habitats.

Animals and plants in and near water adapt to and depend upon the natural seasonal flow patterns for growth and reproduction. Stream velocity, volume and flooding frequency can determine the types of animals and plants that live in a water body. While some types of flora and fauna need fast flowing well-oxygenated riffles others prefer quiet pools. Changes in flow regime can significantly affect animal and plant biodiversity.

See Activities 47-51 (p 84-90)

Water Distribution Demonstration

B3

(Adapted from the ABC's of Groundwater folder, CRC for Groundwater SA 2000)

Activity 1

Curriculum Links:
Science Concepts and Context / Natural and Processed Materials CC 3.1

Focus Questions:

- **Where does the water we use in the catchment come from?**
- **How do we use water in the catchment?**

Aim:

To learn about the distribution and sources of Earth's water.

Main Ideas:

- Humans need freshwater to live, however, about 97 percent of the Earth's water is too salty to use. The remaining 3 percent is freshwater, but most of it is in polar icecaps, remote glaciers, and icebergs and is not easily accessible.
- Accessible freshwater, therefore, comes from streams, lakes and underground sources. These sources represent less than one-half of 1 percent of all water on Earth.

Earth's Total Water Supply (%)		**Earth's Total Freshwater Supply (%)**	
Oceans (salt water)	97.2	Icecaps /glaciers	2.38
Freshwater	2.8	Ground water	.397
		Surface water	.022
		Air and Soil	.001
TOTAL	**100**	**TOTAL**	**2.8**

Need:

2 x 1L graduated cylinders (or other suitable clear containers), 4 x 100 ml graduated cylinders, one medicine dropper and food colouring.

Consider:

Fill one of the large graduated cylinders with coloured water to the 1 000 ml line. Tell the students that this represents the Earth's entire supply of water. Pour 28 ml of the total water into a second 1000 ml graduated cylinder. The 28 ml of water represents the Earth's total freshwater supply. The remaining 972 ml of water is salt water that occurs primarily in oceans.

Divide the 28ml of freshwater by pouring into smaller containers; 23 ml for icecaps and glaciers, 4 ml for ground water, 2 drops for surface water, and 1 drop for the water in the atmosphere and soil.

List the percentages of Earth's water on the board or overhead projector. Refer to these numbers as you continue.

Analysis:

As the students examine and compare the different volumes of water in the graduated cylinders, ask the following questions:

Which of the four freshwater graduated cylinders represents the most freshwater on Earth?

Is this a source of freshwater commonly used by humans for drinking, watering the lawn, cleaning, etc.?

Approximately what percentage of the Earth's freshwater is groundwater?

Where is most of Earth's water found?

Can cities such as Darwin or Sydney, which are near oceans, use the water from the oceans for households and industry?

Can the salts be removed from water?

Why isn't this commonly done?

Extension:

Look at the issue of water as a finite resource by researching case studies from around the world.

The book ‘Water: the drop of life ‘ is based on the television series of the same name. It provides many varied and interesting case studies which highlight the need to preserve and effectively manage our water supplies.

Swanson, P. (2001) Water the Drop of Life. Creative Publishing international, Minnetonka.

Search the Internet by using the key words: Water, Water quality, Catchments, Water resources, Drought and Water supply.

Debate the statement “Future wars will be fought over water”.

Components of the Water Cycle B1- B3

Activity 2

> ***Curriculum Links:***
>
> **Science** Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1
>
> **Indigenous Languages and Culture** Natural Environment

Focus Question:

- **What is the water cycle?**

Aim:

To introduce students to the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- Water is cycled on Earth in gaseous, liquid and solid forms.
- Rain is formed through the processes of evaporation, transpiration and precipitation.

Need:

Pencils or paint, paper or card, pin-up board.

Consider:

Divide the class into groups and ask them to illustrate the following water cycle components.

Evaporation: (represented by the ocean or a large lake with a line for the water surface, fish swimming beneath it, and wiggly arrows pointing upwards from the water surface);

The sun: (represented by a large glowing ball);

Condensation: (represented by white clouds with wiggly lines pointing at their underside);

Precipitation: (represented by grey clouds with rainfall beneath them); and

Transpiration: (represented by a twig of vegetation with leaves and wiggly lines pointing upwards and away from the leaves).

Keep these pictures and pin them up on a board for later use in Activity 2.

School of the Air classes may like to do these and keep them for later sessions when school comes together.

Investigate:

What Indigenous Language exists in your region for these terms? What Indigenous art has been done to demonstrate these terms?

Reflection:

Do we take our water for granted?

Dramatising the Water Cycle

B3

(Source: Activity adapted from Saltwatch Victoria / Qld Waterwatch Education Kit)

Activity 3

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Indigenous Languages and Culture Natural Environment

Focus Question:

- **What is the water cycle?**

Aim:

To generate an understanding of the processes within the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- Water is cycled on Earth in gaseous, liquid and solid forms.
- Rain is formed through the processes of evaporation, transpiration and precipitation.

Need:

Paint/pencils and paper, clear bottles (with lids) filled with water, labels: evaporation, condensation, precipitation, runoff, transpiration, groundwater, infiltration.

Consider:

Ask the class to illustrate the following (to add to the pictures in Activity 1: P1A – previous page).

Infiltration and percolation: (represented by a brown line on a slope for the ground surface with green vegetation above it and another blue line below the brown line but roughly following the same slope, draw the blue line as an arrow pointing down the slope).

Run off: (represented by brown land showing a slope, with green vegetation above and a blue arrow above this pointing downhill).

Dramatisation

Arrange the classroom to provide five separate areas. Each representing part of the water cycle. These areas are:

1. A lake whose boundaries should be outlined using chalk or other suitable means.
2. Clouds which should be based on an elevated position, ie: up on chairs.
3. An area of native bush.
4. A creek/river.
5. A groundwater reservoir, students sit under blankets or desks to represent being underground

Students play the following roles:

Water carriers take water from the lake and deliver it to the clouds, demonstrating the process of evaporation.

Clouds take delivery of the water from the ***Water carriers***, demonstrating the process of condensation.

Precipitation will be demonstrated as the ***Clouds*** become ***Water drops***, students leaving the raised area to deliver water to the ***Rivers***, ***Trees*** and ***Groundwater Recipients***.

Preparation

Allocate roles to all students.

Place all water containers in the lake.

Run through the following sequence, discussing each process with students

Sequence

A: Water carriers each collect a water container from the lake and travels to the cloud area. Discuss what is happening to the water? Present the label ‘evaporation’.

B: The clouds receive the water containers from the water carriers who then return to the lake areas. Discuss how cold is it up in the clouds? What effect does the cold have on the water held by the clouds? Present the label ‘condensation’. Ask the clouds what they are going to do with the water they are holding?

C: Clouds can then become water drops and leave the elevated platform. Discuss what is happening to the water? Where is the water going? What do we call this water? Present the label Precipitation.

D: The water drops deliver the water containers to the trees, river and groundwater and then return to the clouds. The trees, river and groundwater people keep the water at this stage. After three cycles, the lake area should become depleted of water containers while the trees, river and groundwater are becoming overloaded. Discuss what should the river be doing with the water? Introduce the terms run-off and infiltration.

E: The water drops then deliver some water containers to the groundwater receivers. Some water containers can be stored and some passed along to the lake.

F: Continue the activity for two more cycles with the river passing some of the water containers on to the lake. The trees will now be overloaded with water containers. Discuss how trees use water? Do trees store all of their water? Do trees lose some of their water? Introduce the term transpiration, giving the appropriate label.

G: Run through the cycle with the trees given some water containers back to the clouds.

Analysis:

Why is the water cycle called a ‘cycle’ (think about the movement of water containers).

Investigate:

What Indigenous Language exists in your region for these terms? What Indigenous art has been done to demonstrate these terms?

Reflection:

How effective was the dramatic exercise at explaining science? Is it possible to achieve both art and science at one time?

Interactive Internet: Water Cycle Activities

B1-B3

Activity 4

> ***Curriculum Links:***
>
> **Science** Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **What is the water cycle?**

Aim:

To learn more about the water cycle using the Internet as a learning tool.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- Water is cycled on Earth in gaseous, liquid and solid forms.
- Rain is formed through the processes of evaporation, transpiration and precipitation.

Need:

Access to Internet.

Consider:

Go to the web sites:

http://www.yvw.com.au/newed/juniors.html

http://www.lpe.nt.gov.au/advis/WATER/ground/basics.htm;

http://www.cwmb.sa.gov.au/kwc/interactive/groundwater/index.htm.

Analysis:

Undertake activities.

Reflection:

How well does the Internet assist in communicating science?

Did you learn new scientific concepts from these sites or did they assist your understanding of concepts you already knew?

Reviewing Water Cycle Terminology B1- B3

Activity 5

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **What is the water cycle?**

Aim:

To revise the terminology relating to the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- The water is cycled on Earth in gaseous, liquid or solid form.
- Rain is formed through the processes of evaporation, transpiration and precipitation.

Need:

Figures 16 and 17 (overleaf).

Consider:

Hand out copies of the page overleaf. Ask all students to fold the paper in half.

Discuss all aspects of Figure 16 with students.

Analysis:

Ask students to fill in the missing words in Figure 17.

Reflection:

Does the water cycle change in various locations across the world?

Student Sheet 1.1: The Water Cycle

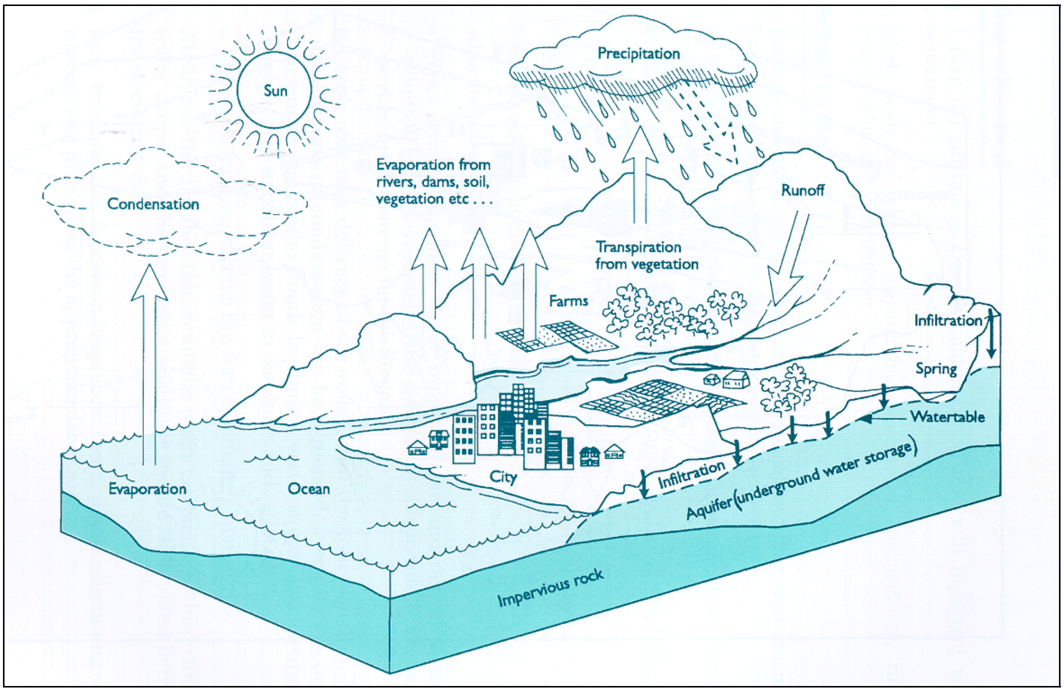


Figure 16 The Water Cycle (labels)

Fold Here – Don't Cheat!

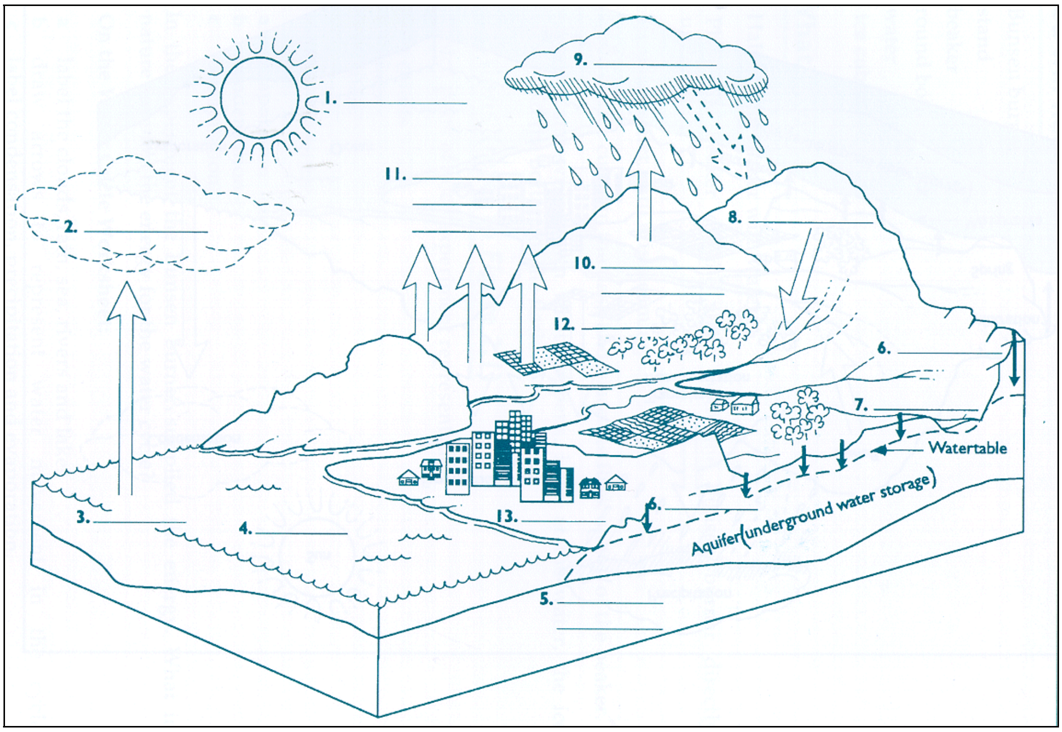


Figure 17 The Water Cycle (no labels)

Water Cycle Terminology

B1- B3

Activity 6

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Indigenous Languages and Culture Natural Environment

Focus Question:

- **What is the water cycle?**

Aim:

To learn how terminology relating to the water cycle varies between cultures, but the underlying concepts remain the same.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- The water is cycled on Earth in gaseous, liquid or solid form.
- Rain is formed through the processes of evaporation, transpiration and precipitation.

Consider:

Water cycle terminology could be translated into local indigenous terms by consulting local elders. For example the following terms came from Yolngu Matha in East Arnhem.

English	Yolngu Matha
sun	walu
steam	ngawulul
sweating plants	worr'yun nguli-dharpa
rain	waltjan or malwurrk or dharyun
forming of clouds	bunbuma
raining	djiltjilyun

Investigate:

What is the language most commonly spoken by indigenous communities in your local area? As a class invite a Traditional Owner to discuss some of the terms for the water cycle in their language.

Reflection:

What importance do Traditional Owners place on the passing on of knowledge related to the water cycle?

How are indigenous people reliant on the water cycle?

Reviewing the Water Cycle

B1- B3

Activity 7

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **What is the water cycle?**

Aim:

To improve student understanding of the path of water through the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs. Water is cycled on Earth in gaseous, liquid or solid form.
- Rain is formed through the processes of evaporation, transpiration and precipitation.
- Rainfall may become surface water, groundwater or evaporate/transpire from the atmosphere, plants or animals.

Need:

Student Sheet 1.2.

Consider:

Review water cycle terms and processes (See Student Sheet 1.2.

Analysis:

Ask students to write a report or story with pictures of what happens to a drop of water as it goes around the water cycle.

Reflection:

What would happen if it stopped raining in any one particular region for years

Student Sheet 1.2
Reviewing the Water Cycle

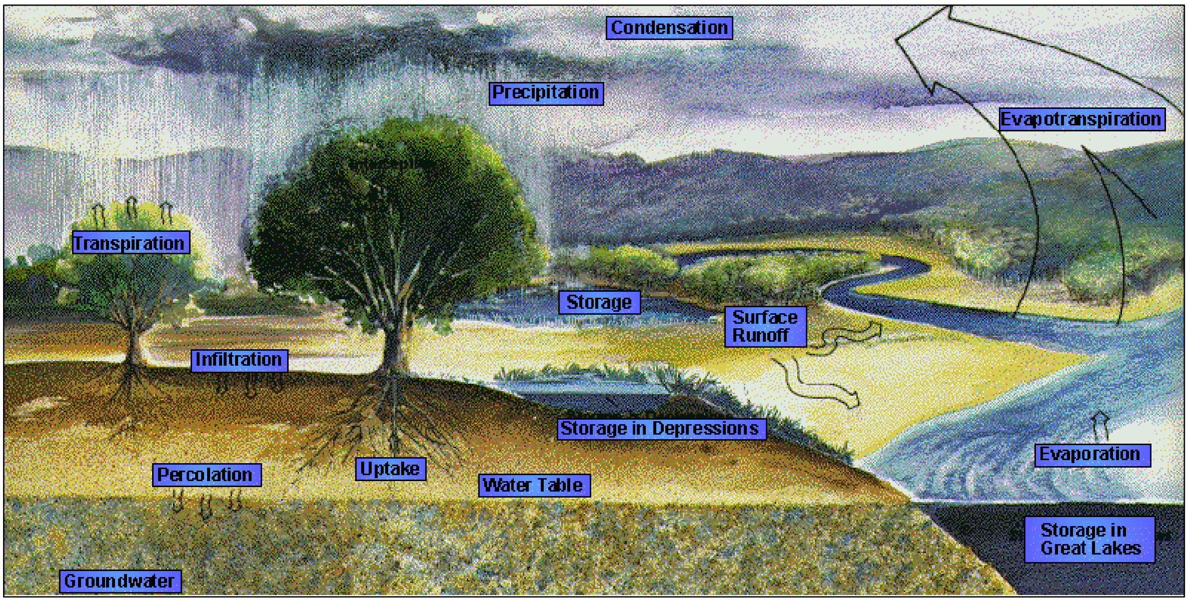


Figure 18: The water cycle *(*http://www.iwr.msu.edu/edmodule/water/cycle.htm*)*

Define the following:

Condensation

Precipitation

Evapotranspiration

Storage

Surface runoff

Transpiration

infiltration

Percolation

Uptake

Groundwater

Storage in depressions

Water table

Evaporation

Experiencing Evaporation

B1- B3

Activity 8

Curriculum Links:

Science Concepts and Contexts / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **What is evaporation?**

Main Idea:

- Water rises in an endless cycle from oceans and land to the atmosphere and back again. It does so as an invisible water vapour, which then condenses in the clouds to form rain.

Aim:

To demonstrate how water evaporates and why the process of evaporation is so important in terms of the water cycle.

Need:

Access to water, sheets of paper, two shallow dishes – one with a cover on it.

Consider 1:

Students experience evaporation by putting water on their face, then flapping paper to simulate wind. What happens?

Place the two shallow dishes filled with water into the sun, one covered and the other not. Students predict what happens, observe what actually happens.

Analysis 1:

Use drama to explain what happened to the water molecules in the evaporation process:

- Together as water (hold hands and flow).
- As the water heats up from the sun the individual molecules begin to separate. They are so light, warm and small they float up into the sky (evaporate).
- In the sky its cooler, so molecules come together to keep warm (don't hold hands yet), forming clouds (condensation).
- When there are two, they get heavy and join to make water/rain (precipitation).

Consider 2:

Review the water cycle and global weather patterns:
http://www.bom.gov.au/announcements/media_releases/990507.shtml
http://www.bom.gov.au/climate/glossary/elnino/elnino.shtml

Analysis 2:

Discuss the basics of global water evaporation and rainfall patterns. Discuss the weather your region is currently experiencing (seasonally and in the longer term)?

Reflection:

Does evaporation and the formation of rain have to occur in the same catchment in order for the waterways to flow in that catchment?

How would the change in the catchment's rain patterns change the cycling of water within the catchment – seasonally or long term?

Purple Celery? Movement of Water in Plants

B1- B3

(Source: Adapted from Queensland Waterwatch Education Kit)

Activity 9

> ***Curriculum Links:***
>
> **Science** Concepts and Contexts / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1 / Life and Living CC 1.2, CC 2.2, CC 3.2

Focus Questions:

- **How do plants contribute to the water cycle**

Aims:

1. To demonstrate how plants transport water.
2. Students to hypothesise what role plants uptake of water plays in a catchment area.

Main Ideas:

- Rain is formed through three processes, these being evaporation, precipitation and transpiration. Transpiration is dependent on plants.
- Water taken up by plant roots is lost by evaporation through microscopic pores in plant leaves as a result of solar radiation.

Need:

Fresh celery stalk with leaves, red or blue food dye, containers to hold water, a sharp knife.

Consider:

The teacher demonstrates transpiration:

Cut about 2 cm off the bottom of the celery;

Add dye to the water until it is dark red (or blue);

Place the celery in the jar and leave for 24 hours; and

After 24 hours remove the celery and cut off the bottom 2 cm.

Analysis:

Teacher asks the students:

What do you see?

Cut again another 6cm higher. What do you see here?

What does this tell you about how water moves through a plant? Scrape the edge of the celery stalk. What has happened to the dye?

How do plants contribute to the question: ‘Where does rain go?’

Reflection:

How does transpiration contribute to the water cycle? What would happen if the catchment was cleared of trees and other plants?

Demonstrating Transpiration: Bag a Branch

B1- B3

(Adapted from Queensland Waterwatch Education Kit)

Activity 10

Curriculum Links:

Science Concepts and Contexts / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1 / Life and Living CC1.2, CC 2.2, CC 3.2

Focus Questions:

- **How do plants contribute to the water cycle?**

Aim:

To demonstrate how plants transport water and to hypothesise about the role this plays in the water cycle.

Main Ideas:

- Rain is formed through three processes, these being evaporation, precipitation and transpiration. Transpiration is dependent on plants.
- Water taken up by plant roots is lost by evaporation through microscopic pores in plant leaves as a result of solar radiation.

Need:

Plastic bags, a twist tie or string and proximity to living plants.

Consider:

Find a tree with low branches or a shrub. Place your bag over a branch containing at least six leaves. Close the opening by tying around the branch with string. Leave for 24 hours.

Examine the bag without removing it. Once the bag has been examined remove it from the tree.

Analysis:

Students consider the following:

What do you see in the bag?

Explain the observations.

How do plants contribute to the water cycle?

When trees are cleared and replaced with grasses or crops, would you expect more or less ground water to be used? Explain your answer.

Trees have deep roots compared with grasses and crops. Do you think trees or crops would more easily survive a drought? Explain why.

Reflection:

If trees where cut down what might happen to the water table? What other changes might occur in the catchment if many trees were cut down? Explain your answer.

Demonstrating Transpiration: Creating a Terrarium

B1- B3

(Source: Adapted from Queensland Waterwatch Education Kit)

Activity 11

Curriculum Links:

Science Concepts and Contexts / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1 / Life and Living CC1.2, CC 2.2, CC 3.2

Focus Questions:

- ***What is the water cycle?***

Aims:

1. To demonstrate how plants transport water.
2. To hypothesise about the role this plays in the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs. Rain is formed through three processes, these being evaporation, precipitation and transpiration. Transpiration is dependent on plants.
- Water taken up by plant roots is lost, by evaporation, through microscopic pores in plant leaves as a result of solar radiation.

Need:

2 litre clear plastic soft drink container with lid, soil, seeds or small plants, a thin rod, masking tape and scissors.

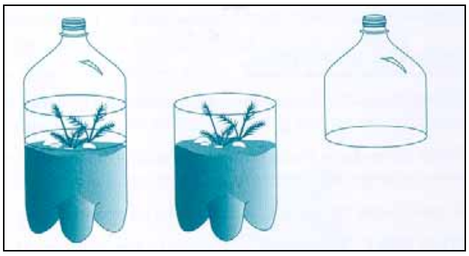
Consider:

Cut the container with scissors or stanley knife about a quarter of the way up from the bottom.

Take the bottom of the container and add moist soil (3-5cm deep) on the bottom of it.

Plant seeds or small live plants into the soil using a thin rod. Also put in stones etc to create a natural effect.

Rejoin the top and bottom sections of the container and seal with a strip of masking tape. Ensure the bottle has a lid, as it is essential the terrarium is airtight.



(Source: Waterwatch QLD 1995)

Place your bottle in a place where it will receive indirect sunlight and monitor over several weeks/ months.

Analysis:

Some teachers may prefer to make the experiment a little more scientific. Determine the mass of the bottle, soil, and plants, the volume of the water etc. Then measure the combined mass at regular intervals to see if any changes take place!

Note: Photosynthesis will allow energy to be converted to organic matter.

Reflection:

How do plants contribute to the question: Where does rain go?

Creating Rain - Evaporation and Precipitation

B1- B3

(Adapted from Queensland Waterwatch Education Kit)

Activity 12

Curriculum Links:

Science Concepts and Contexts / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **How does rain form?**

Aim:

To model the processes involved in the water cycle thereby increasing understanding of the water cycle.

Main Ideas:

- The water cycle is a closed cycle with no new inputs.
- Water is cycled on Earth in gaseous, liquid and solid forms.
- Rain is formed through the process of evaporation, transpiration and precipitation.

Need:

Bunsen burner, stand, beaker, round bottom flask, water, ice cubes.

Consider:

The teacher demonstrates the formation of rain in a beaker.

Half fill the beaker with water**.**

Place the beaker on the stand with the Bunsen burner directly underneath.

Heat the water until it is steaming.

Place the ice cubes in the flask and place the flask on top of the beaker.

Observe and write down what happens. Look at the water, the ice cubes and the bottom of the flask.

Analysis:

Ask students to draw a labelled diagram which illustrates the outcome of the experiment.

The diagrams should then be used to determine which parts of your experiment represented clouds, sun, rain and lakes?

Reflection:

Not all precipitation runs off the soil surface into rivers, dams or lakes. What else happens to rain?

Where Does the Water Flow?

B1- B3

Activity 13

Curriculum Links:

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **Where does the rain go?**

Aim:

To investigate rainwater flow

Main Ideas:

- Water runs from high points in the landscape to low points.
- When it rains some water soaks into the soil, where it may become groundwater or be taken up by plant roots.
- When soil becomes saturated the water cannot infiltrate the soil. Instead the water will remain on the soil surface, flowing from high to low points.
- Water on the soil surface is more likely to evaporate.

Need:

Large ball, proximity to some degree of slope.

Consider:

While outside, ask the children to observe where they might think water would flow to in the school yard, use a ball to demonstrate slope. You may like to first demonstrate that water flows downhill by using a hose and a slippery dip.

Investigate:

Identify at least two low points and two high points in the school yard. Discuss where the water would flow from and to.

Analysis:

Encourage the class to discuss the cause/effect of slope on the movement of the ball /water.

Reflection:

What effect does slope have on where water runs from and to?

Consider the relationship between slope and land surfaces to surface water sources and storm water drainage.

Rain and Soil Experiment

B1- B3

Activity 14

Curriculum Links:
Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **Where does the rain go?**

Aim:

Students investigate what happens to rainfall through sand and water play

Main Idea:

- When it rains some water soaks into the soil, where it may become groundwater or be taken up by plant roots.
- When soil becomes saturated the water cannot infiltrate the soil. Instead the water will remain on the soil surface, flowing from high to low points.
- Water on the soil surface is more likely to evaporate.

Need:

Sand, bucket and hose.

Consider:

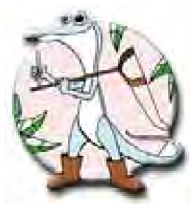
Use a sandpit with dry sand and some buckets of water/hose to demonstrate that when it rains, the water first sinks in, then starts to form run off once the soil becomes saturated. Over time, some water will evaporate – this may be demonstrated by going back to review the sand pit's soil moisture.

Analysis:

Students may like to make simple records of the experiment: what they did, what was the outcome.

Reflection:

How does this relate to the real world?



Investigating rates of runoff

B1- B3

Activity 15

Curriculum Links:

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **What is stormwater and how does it affect the water cycle?**

Aim:

To introduce students to the concept of permeability and its relationship to runoff rates and the water cycle.

Main Ideas:

- Permeable surfaces and substances allow water to penetrate their structure.
- Impervious surfaces and substances do not allow water to penetrate their structure.
- On vegetated surfaces, rain soaks into the soil underneath, providing essential water to the roots of plants.
- On surfaces devoid of vegetation, rain flows along the surface of the soil, collecting in low depressions. Very little water reaches the roots of plants.
- On surfaces covered with synthetic materials such as roads and footpaths, the water collects and flows into gutters and storm drains and then into our waterways.

Need:

Hose and water, access to hard surfaces and permeable surfaces or materials.

Consider:

Give students a list of things from which they determine whether they are pervious or impervious. You may include sponge, cloth, native areas of vegetation, lawn, hard compacted soil, cement, tiles, corrugated iron, stone, ocean, asphalt, bark chips, mulch, plastic or natural waterways.

Analysis:

Set up experiments with samples and a hose. Determine which factors causes the water to run off fastest.

Suggested Activities:

Ask the students to look for these different surfaces, where they occur in the environment and what direction the water is flowing in (if at all).

Record observations in a journal. After one week ask the children to relay their findings to the rest of the class.

Reflection:

Why is it important to have permeable surfaces when it rains?

Local Stormwater Investigation

B3-B5

Activity 16

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env 1.2, Env 2.2, Env 3.2

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **What is stormwater, and how does it influence the water cycle?**

Aim:

To introduce students to stormwater and its role in the water cycle.

Main Ideas:

- Stormwater is runoff from rainfall that has collected off ground and hard surfaces such as roads, pavements, roofed areas, car parks and airports.
- These surfaces speed up the water flow across the land, increasing the amount of water entering rivers and ocean.

Need:

Guest speaker.

WATERWATCH
Northern Territory
A Federal - Territory Partnership

Consider:

Ask the students to brainstorm what they know about stormwater and write up in a retrieval chart.

Ask a local Council member or Waterwatch Regional Coordinator to visit the class and discuss stormwater, different types of drains, why they exist and where the water travels to via these drains.

Analysis:

Investigate local drains in the local area – estimate what percentage of the drains you came across were cement, bare Earth, grassed or rock surfaced.

Where did the drains drain to?

Return to the retrieval chart and add to the class knowledge about stormwater drains.

Reflection:

How would surface water have been altered once storm water drains were installed? What role has urban development played in the establishment of stormwater drain systems?

How do hard surfaced drains influence stormwater quality and alter natural water flows in the catchment?

EXCURSION

Mapping Stormwater

B1- B3

Activity 17

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env 1.2, Env 2.2, Env 3.2

Science Working Scientifically **/** Investigating WS 1.2, WS 2.2, WS 3.2 / Evaluating WS 1.3, WS 2.3, WS 3.3 / Acting Responsibly WS 1.4, WS 2.4, WS 3.4

Focus Question:

- **What is stormwater and what role does it play in the water cycle?**

Aims:

1. To assist students to visualise a plan view of stormwater flows; and
2. Students will be able to use a street directory.

Main Idea:

- Mapping stormwater assists in determining where pollution may enter the stormwater system and therefore where to start in preventing the pollution.

Need:

Street directory/local map.

Consider:

Students make observations of where stormwater drains are in their local area, eg: to/from school, other places in their suburb/town. Copy notes of these onto a photocopy of a street directory or local map to mark where the stormwater drains and other hard surfaces occur and the direction of flow.

Analysis:

These findings can be brought together as a class to create a sub region/sub catchment stormwater drainage map that can be used in later exercises of the education kit.

Reflection:

If this water is going 'down the drain', where does it end up? Does it go to the sewerage ponds or the rivers and oceans?

Would the quality of the water going down these drains be the same as the quality of the rainfall?

If the water is going down the drain does this mean there is less water for the groundwater and vegetation?

EXCURSION

Stormwater Stencilling

B1- B3

Activity 18

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env 1.2, Env 2.2, Env 3.2

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3 / Acting Responsibly WS 1.4, WS 2.4, WS 3.4

Focus Question:

- **What is stormwater and how does it influence the water cycle?**

Aim:

Students become aware of the community and Government roles in protecting stormwater from pollution.

Main Ideas:

- It is important that stormwater remain unpolluted.
- Community action can assist in protecting stormwater.

Need:

WATERWATCH Northern Territory
A Federal - Territory Partnership

Street directory, local map and Internet access.

Consider:

With the assistance of the regional Waterwatch Coordinator, and permission from local authorities, undertake a stormwater stencilling program of your local stormwater drains. The stencils should make the public aware that the water in these drains ends up in the local river or estuary.

Analysis:

What programs have been established in the NT and throughout Australia to protect the quality of stormwater in our urban environments?

What role do the community play in these programs?

Are these programs appropriate in terms of dealing with the issues of stormwater pollution?

Students investigate the above questions via the Internet and by interviewing Waterwatch staff. This may be done individually or in small groups. Groups may be divided into NT, State and National Levels of Government.

Reflection:

What might happen if stormwater becomes blocked with rubbish or if rubbish was flushed into the sea?

EXCURSION

Landscape and Climatic Influences on the Water Cycle

B3

Activity 19

Curriculum Links:

Science Concepts and Contexts / Natural and Processed Materials CC 3.1

Focus Questions:

- **How do landscapes and climate influence the water cycle?**

Aim:

To compare different regions of the NT and corresponding variations in the water cycle.

Main Idea:

- How humans source their water will largely be determined by the climate and associated water sources available.

Need/Consider:

Look at the following figures in this booklet

- Figure 5 (p 6) Average monthly rainfall in Darwin and Alice Springs 1990-2000
- Figures 6/7 (p 8/9) Block diagram of Top End and central Australian water systems.

Access to the Internet, specifically the Bureau of Meteorology website, http://www.bom.gov.au

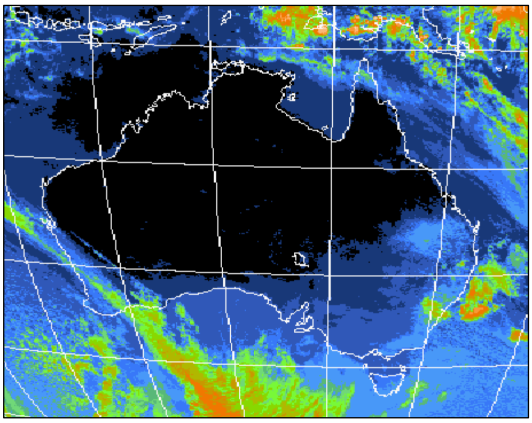
*Figures 1 and 2: Comparisons between groundwater, stream water and evapotranspiration in Darwin and Alice Springs **in Part 4** of this kit can also be used.

Investigate:

Connections between geographical formations, climatic zones, annual rainfall, vegetation and available water.

Analysis:

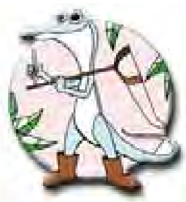
Discuss the variation in climate which exists between of the Top End of the NT and the arid centre of Australia.



Weather map of Australia, 17 June 2002 (Source: Bureau of Meteorology 2002)

Discuss why there are significant differences in the amount of surface and ground water available to humans in these two very different regions.

How can plants influence ground and surface water availability?



Miniature Catchments

B1- B3

Activity 20

Curriculum Links:

SOSE Environments / Place, Landforms and Features
Env 1.1, Env 2.1, Env 3.1

Focus Question:

- **What is a catchment?**

Aim:

To introduce the concept of a catchment.

Main Ideas:

- Often boundaries are physically marked by fences or painted lines. Catchment boundaries might not be physically marked, instead they are determined by natural features in the landscape.
- Features such as hills, ridges or rises drain water to a lower collection point such as an estuary, river, waterhole or wetland.

Need:

Water and sandpit.

Consider 1:

Ask the students to observe what happens when they place their hands cupped beneath the water flow of a sprinkler or slow tap.

Analysis 1:

Explain that the area within their hands could represent a catchment area. The rim of their hands represents a catchment boundary.

If different size hands were used to collect water, how would this change the outcome of this activity?

Consider 2:

Allow the students to have free play with the sandpit and water to observe how the two mediums interact. Ask the following questions:

- What happens to the water when it is first added to the sand?
- What happens if you dig into the sand where the water has been added?
- Why does water pool in the lower areas?

Construct catchment features in the sandpit such as hills, rivers, swamps, and add objects that represent buildings, roads, bridges, cars, trees and impermeable layers using plastic.

How do the different features influence where the water flows?

Reflection:

What features can you observe in your local catchment that influence where water flows?

Catchments in the school grounds

B3

(Activity Source "Waterwatch and Your Catchment" Qld Education Kit)

Activity 21

Curriculum Links:

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **What is a catchment?**

Aim:

To reinforce understanding of the features constitute a catchment.

Main Idea:

- A catchment is an area of land bounded by natural features such as hills, ridges or rises from which water drains to a collection point such as an estuary, river, waterhole or wetland.

Need:

Sprinkler and hose; balls, pens and paper. Student Sheet 1.3: What is a Catchment? (overleaf).

Consider:

Review the role of slope in determining catchment boundaries, by demonstrating slopes within the schoolyard using water and balls

Students then explore further and note their findings on sketches of the schoolyard. Combine all class notes to form a water flow diagram for the school grounds.

Analysis:

Where does the water come from? Where does it go? See Student Sheet overleaf.

Extension:

With the assistance of the Regional Waterwatch Coordinator you can track stormwater drain flow by looking at charted stormwater drain maps or if these do not exist by using dyes to track flow from one area to another.

Excursion:

Devise an excursion to review the local area's waterways and catchment boundaries. Where does water start to run off? Where does it travel to? How does it get there?

.

EXCURSION

Student Sheet 1.3
What is a Catchment?

1. Draw a map of the school grounds on the back of this piece of paper. Indicate:

a) The boundary;

b) The buildings; and

c) high and low areas in the school grounds.

2. Find areas which would act as a miniature river following heavy rain. Draw these onto your map of the school grounds.

3. How does your school ground form a subcatchment?

____

4. Mark onto your map any small catchments or 'sub-catchments' within the larger school catchment.

5. How do you think that slope affects the water as it flows?

____

6. What will happen to areas of bare soil on a slope as water flows over it?

____

Demonstrating Groundwater

B1- B3

Activity 22

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1

Focus Questions:

- **What is groundwater?**

Aim:

To use a groundwater model to investigate how water is held in the soil.

Main Ideas:

- Groundwater is water that has infiltrated into the spaces within the soil and rock.
- Groundwater is an important source of water for humans, especially in regions where surface water is not readily accessible.

Need:

A clear plastic container, a measuring jug, rocks, stones, sand and water.

Consider:

Place rocks in plastic container, then add smaller stones, then add sand until the container is 'full'.

Analysis:

Ask the students: If the container is full yes/no?

Gradually add water to the container, carefully measuring the quantity added.

Ask the students: If the container was full then how can it take the water as well? Explain that water is held in similar tiny spaces between soil particles underground.

The experiment may be taken a step further by asking the children to change the ratio of large and small rocks used and to remeasure the water held in the container as it is consumed.

Reflection:

What would happen to the water if the spaces between the soil particles were to become waterlogged?

What might happen to rainfall if the landscape where uniformly impervious?

Note: The Department of Infrastructure, Planning and Environment (DIPE) have more complex models that may be requested by your school with DIPE staff to assist in its demonstration.

Groundwater Sources in our Environment

B3-B5

Activity 23

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Focus Question:

- **How do humans source their water?**

Aims:

1. To gain an understanding of groundwater as a major component of the water cycle.
2. To demonstrate the importance of groundwater as a water source for human use and consumption.

Main Ideas:

- There are two types of stored water which humans successfully extract potable (drinkable) water for domestic, industrial, irrigation and other uses.

    1. Groundwater: Humans use wells and bores to extract the water that flows underground known as groundwater.
    2. Surface Water: Humans pump water from dams, creeks, rivers and reservoirs which are all surface water collections.

Need:

2 litre soft drink bottle, sand, film canister with some holes made around its bottom edges like a plant pot, bendy straw, cup, coffee, foam or block of wood to tilt the bottle on an angle and stop it sliding flat again, access to water.

Resources:

Department of Infrastructure, Planning and Environment groundwater models
Telephone: (08) 8999 3678.

Consider:

Use/create a model to examine groundwater and bores:

In this model the bottle represents an unconfined aquifer, the canister film tube a well, the straw is a pump for groundwater extraction/bore, the coffee is pollution and the notch is a spring. The cup of water is the rainfall and run off acting to recharge the groundwater.

Cut the drink bottle in half longitudinally with a small V notch just before the neck.

Fill the half bottle with sand and tilt it neck down on the foam or wood block on an angle.

Add some water at the bottom end of the bottle with a cup of water.

Dig into the sand to see if water fills the void.

Add some more water as before, this time place the camera film tube without its lid and with some holes in its base into the sand watch as the water fills into this 'well'.

As more water is added it travels and starts to poor out of the neck end of the bottle where the V notch is – this represents a spring.

Use a bendy straw to siphon water from the 'well' by placing the short end in and bending it downwards out of the bottle, watch as the water travels like a pump out of the 'well'.

Continue to add water to the model, then dig a hole in the sand ‘up stream’ of the ‘well’.

Add a spoonful of coffee into the hole just dug. As the water is added, watch how the coffee enters the well, this represents a source of groundwater pollution, eg: from a dump that travels through the groundwater and enters the well.

Analysis:

Ask students to draw the model they have created, labelling appropriate features. The relevance of these features should then be written on a separate piece of paper.

Investigate:

What local knowledge is passed down from generation to generation in Indigenous communities about sources of groundwater and their protection – invite a guest to discuss.

Reflection:

Why does society need to be careful about how we store and dispose of wastes?

Estimate what percentage of the NT population depends on groundwater for their or their businesses survival.

Extension:

How it is possible for pollution from the surface to affect groundwater quality?

Create a Groundwater Model

B3-B5

(Source: Dept of Water Resources SA 2000)

Activity 24

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Focus Question:

- **What is groundwater?**

Aim:

Students use a groundwater model to investigate how water is held in the soil

Main Ideas:

- Groundwater is water that has infiltrated into the spaces within the soil and rock.
- Groundwater is an important source of water for humans, especially in regions where surface water is not readily accessible.

Need:

Clay, gravel, plastic zip lock bag filled with water, a layer of soil, a small plastic colander sealed with plastic on its inside, model trees, straw.

Consider:

Using a clear container, create 'the ground' area. From the bottom up, place the following materials in layers.

1) clay
2) gravel
3) the plastic zip lock bag with water in it
4) a layer of soil
5) the colander lined with plastic in its inside, filled with water to be sunk into the soil so that the top is at surface level to simulate a lake.
6) models of grass and trees.
7) add the straw sinking it almost into the bottom of the gravel layer to represent a bore hole.

Pour a small amount of water onto the soil part of the model.

Analysis:

Ask the students where they think the water might have gone?

Name four different forms of water storage in the model.

Reflection:

Why does the model have trees to simulate vegetation?

Soil as a Filter

B3

Activity 25

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1

SOSE Environments / Place, Landforms and Features Env 3.1

Focus Questions:

- **How does soil affect water quality?**

Aim:

To review the concept of groundwater and relate it to human use and consumption of groundwater.

Main Ideas:

- Groundwater is water that has infiltrated the Earth's surface into the, often tiny, spaces which exist between soil and rock particles.
- Groundwater is frequently accessed by people for domestic and commercial purposes
- Soil particles can act as a filter to improve groundwater quality.

Need:

Three 2 litre soft drink bottles, some gravel, some clay and some sand, stocking and water.

Consider 1:

Look at the groundwater map on the web site: http://www.lpe.nt.gov.au/advis/WATER/ground/resources.htm

What do the different colours on the map mean? Why do the colours start and stop where they do?

Consider 2:

(Department of Water Resources SA 2000).

Cut the soft drink bottles in half and discard the bottom part.

Secure the stocking material over the top of the bottle (lids off).

Place the bottle halves upside down, so that the stocking capped end is facing downwards.

Fill one half bottle with the gravel, the next with the sand and the next with the clay (leave some space at the top of each).

Place under each of these a clear container to catch water.

A sample of water is then added to each of the half bottles (ask students to predict what might happen before pouring the water in).

Time how long the same amount of water takes to permeate through the containers.

Does each sample of 'filtered' water have the same clarity?

Analysis:

Describe what happened. Were the predictions correct? Which sample was the most / least permeable? How might this experiment relate to the groundwater maps on the web site?

Use Student Sheet 1.4 (below).

Student Sheet 1.4
Soil as a filter

Determine:

(1) The length of time it takes for the water to pass through each material.

(2) The volume of water that can be collected after the water has passed through.

Did the water flow through all the materials at the same rate?

Did similar amounts of water pass through all the materials? If not, what happened to it?

Make bar graphs using the information gained from the tests. (use graph paper/computer)

Discuss the results.

If an accidental oil spill occurred in an area of sandy soil, would there be a potential for groundwater contamination?

If the same spill occurred in an area of clay soils would you expect to see any difference?

If groundwater is moving at a rate of 15cm per year, how many years might it be until it reaches a location of 1.5km away?

Digging for Groundwater

B1- B3

Activity 26

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC1.1, CC 2.1, CC 3.1

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1

Indigenous Languages and Culture Natural Environment

Focus Questions:

- **What is groundwater?**
- **What happens to groundwater?**

Aim:

To investigate how water can be sourced from the ground.

Main Ideas:

- Gravity acts on groundwater in a similar way to surface water. The water underground flows from high points to low points depending on the nature of the substrate and points of extraction.
- Indigenous cultures learnt about groundwater and access points through the generations of information exchange.

Need:

Sandpit and bucket of water.

Consider:

In a sand pit of dry sand, poor in a bucket of water and watch the water sink in to the sand.

Where does it go?

Dig into the sand where the water was poured into the sand and watch the water flow into the hole just dug.

Analysis:

Why does the water come back into the space of the hole? (The release of resistance which the sand was placing on the water has been removed allowing the water to flow to the areas of least resistance. The base of the sand pit acts as an impervious layer stopping the water from disappearing completely into the Earth's subsoil.)

Try doing this in other locations, eg: at the beach in the wet sand or along the banks of the Todd River where groundwater feeds the River Todd. Ask your local indigenous community for ideal locations to demonstrate this.

Encourage students to record their actions and findings and discuss as a class. How is gravity related to sourcing groundwater?

Reflection:

Could we successfully dig for water without the benefit of gravity?

Note: Areas in the Top End are potential hazards for leptospirosis, please take precautions when digging in soil. Contact Territory Health Services for further advice.

Local Groundwater Investigation B3-B5

Activity 27

Curriculum Links:
Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1
SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1
Indigenous Languages and Culture Natural Environment

Focus Questions:

- **What happens to groundwater,**
- **Where does groundwater travel?**

Aim:

To encourage students to consider where groundwater exists in their local environment and where it goes.

Main Idea:

- Groundwater is water that has infiltrated into the spaces within the soil and rock.

Need:

WATERWATCH Northern Territory A Federal - Territory Partnership

The Internet. The assistance of a Waterwatch Coordinator.

Consider:

Go to the web sites:

- **http://www.lpe.nt.gov.au/advis/WATER/ground/basics.htm; and**
- **http://www.cwmb.sa.gov.au/kwc/interactive/groundwater/index.htm**

Investigate:

As a class or individually, investigate your local area for the presence of groundwater.

Ask the Waterwatch Regional Coordinator if they are monitoring any groundwater sources? They may advise on a location to visit.

Ask your local Indigenous community to identify local sources of groundwater and any dreamings associated with these sources.

Analysis:

Record your findings and discuss direction of flow, where does the ground water end up?

Discuss the findings as a class.

Resources:

DIPE staff telephone: (08) 8999 3678.

Reflection:

What is the relationship between surface, groundwater and the ocean?

Groundwater Terminology

B3-B5

Activity 28

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Indigenous Languages and Culture Natural Environment

Focus Question:

What is groundwater?

Aim:

To introduce students to groundwater terminology

Main Idea:

Groundwater is water that has infiltrated into the spaces within the soil and rock.

Need:

Access to Internet.

Consider:

Go to the web sites:

- **http://www.lpe.nt.gov.au/advis/WATER/ground/basics.htm; and**
- **http://www.cwmb.sa.gov.au/kwc/interactive/groundwater/index.htm**

Analysis:

As a class create a groundwater dictionary as a poster on the wall. (This can be added to over a number of weeks.)

Reflection:

Why is it important that everyone has the same understanding of a technical term? When might this be important?

Investigate:

Advanced groundwater terminology: aquifuge, aquitard, artesion, discharge, recharge, porosity, saturation or other terms you come across.

Work together as a class to make a crossword using these terms and to develop questions/clues.

Groundwater Sources

B3-B5

(Source: "Plugged In and Turned On", PAWA 1996)

Activity 29

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Indigenous Languages and Culture Natural Environment

Focus Question:

- **What are the different groundwater sources?**

Aim:

Students will be able to distinguish between the different types of groundwater sources.

Main Ideas:

Three different aquifer types exist:

- **Confined** aquifers usually have a confining bed as their upper and lower boundary.
- **Unconfined** aquifers have a confined lower boundary but the upper boundary is the water table being recharged from surface water infiltration.
- **Perched** aquifers are those that have a confining bed as the lower boundary and it is limited in size.

Need:

Access to Internet.

Consider:

Go to the web sites:

- **http://www.lpe.nt.gov.au/advis/WATER/ground/basics.htm; and**
- **http://www.cwmb.sa.gov.au/kwc/interactive/groundwater/index.htm**

Analysis:

Ask students:

Draw diagrams, posters or design models to demonstrate the types of groundwater.

Using the web site, investigate which type of groundwater is the most common in the NT.

Investigate:

Do local indigenous people use groundwater?

Reflection:

Why do you think it might be important to know what type of aquifer is providing your water supply?

Factors Influencing Groundwater B3-B5

Activity 30

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Focus Question:

- **What factors influence groundwater?**

Aim:

To make links between environmental conditions and groundwater.

Main Idea:

- Soil type, geological layers, rainfall regimes and discharge rates all affect groundwater flow.

Need:

Clear plastic disposable containers, eg: soft drink bottles, various soil types and rocks of various sizes, water, measure jug, scissors and a straw.

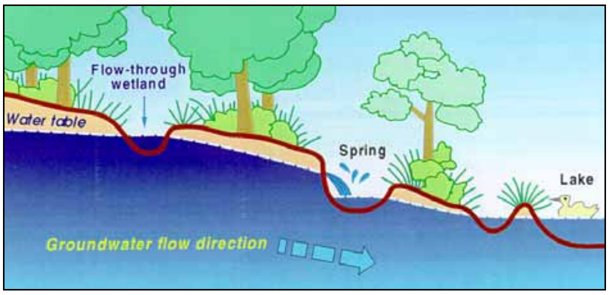
Consider:

To compare the water holding capacity of various soils, fill four containers with different soil types. Compare volumes of water which can be added.

Observe the time it takes for the water to infiltrate the different substrates.

Place a straw into the container after having added the water, to represent a plant sucking up the water into its roots. What happens, does the water start to come up the straw?

Cut a hole in the side of the container and place a small tube/straw into the hole to represent tapping into and pumping the groundwater, by being at the side not the top it will receive faster flow as it would if it was being pumped or if there was a natural reason for its discharge such as a spring.



(Source: Dept of Water Resources 2000)

Analysis:

Explain how groundwater may be influenced by the variables below:

1. Soil type – eg: variations in the size of spaces between particles. Consider clay in relation to gritty sand?
2. Geological layers – confined or unconfined storage.
3. Rainfall for recharge – seasonality and rainfall intensity.
4. Human extraction (pumping) of water for human/stock use.

Reflection:

How well does the model help to explain groundwater and factors influencing it? What type of aquifer is represented by the models?

Groundwater Warning

B3-B5

Activity 31

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1 / Environmental Awareness and Care Env 3.2, Env 4.2, Env 5.2

Focus Question:

- **How has human use of catchment's affected on catchment health?**

Aims:

1. To review the potential for exploitation of groundwater supplies in the NT.
2. To gain an understanding about water as a finite resource.

Main Ideas:

- Groundwater resources are an important water resource for communities in the NT.
- Careful management and planning is required to conserve and protect these resources from pollution or overuse.

Need:

Case study: Doctors Gully (overleaf).

Consider:

Read the case study by Erin White: Doctors Gully.

Analysis:

Students create three main messages from the Doctors Gully Case Study.

Students list some factors involved in aquifer recharge.

Students list some factors involved in pollution or overexploitation of groundwater.

Consider:

Students research NT legislation which has been put into place to prevent the over exploitation and pollution of groundwater resources (See Part 6).

What is happening nationally to assess human impacts on (surface and groundwater)?

Reflection:

Create an awareness program about the need to protect groundwater supplies, as a finite resource, and what society can do to prevent pollution or overuse of groundwater resources.

DOCTORS GULLY

Groundwater Flow

Figure 9: Photo of the creek in Doctors Gully

The water infiltrates the top layer through to the perched watertable. The water then, under the influence of gravity, flows towards the ocean. This water is discharged in the form of a spring at the base of the escarpment. Figure 8 is a photo of the historic walk with escarpment in the background. The constant flow of the spring has formed a small creek flowing through the gully. Figure 9 is a photo of this creek flowing through the gully.

Figure 8: Photo of escarpment in Doctors Gully

DOCTORS GULLY

Today

Today pollution is a serious threat to Groundwater systems, and Doctors Gully is no exception. There are two types of pollution, Point Source Pollution and Dispersed Pollution. Point source pollution in Doctors Gully is evident through pipes and drains. Figure 10 displays the closest sources of pollution to Doctors Gully in the form of drains. The catchment area is quite large with the pipe disposing the waste water into the creek at Doctors Gully. Disposal of household pollutants (washing detergent etc) all can enter the drainpipes and effect the native plants and animals that survive there.

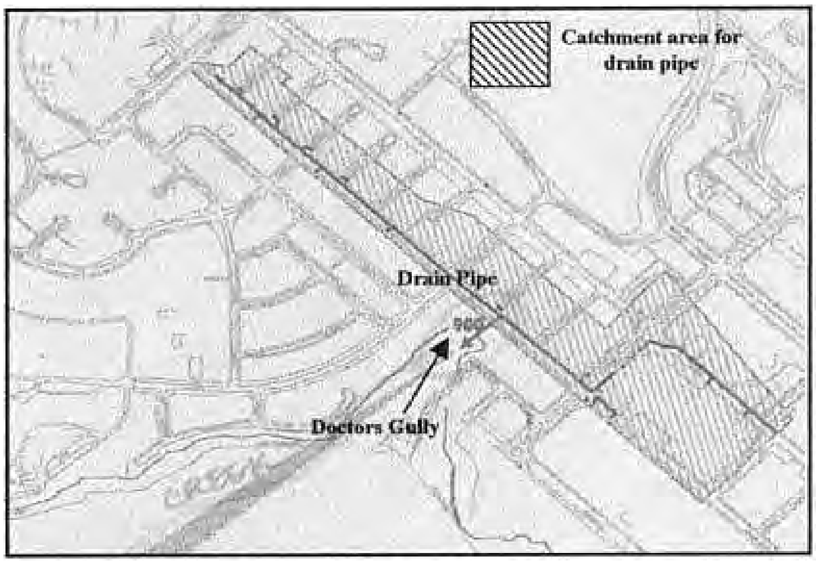


Figure 10: Catchment Area for the drainpipe located in the gully

The stream discharges straight into Darwin harbour very close to where they conduct a local Fish feeding venture. The pollutants contaminating the groundwater could have devastating effects on this tourism venture, let alone the natural aquatic life of Darwin Harbour. Because groundwater is part of the hydrological cycle pollutants can continue to travel through the cycle effecting anything or anyone in its way.

Changes

Below is an Aerial photo of Doctors Gully taken in 1945. The different land uses over 50 years has had an effect on not only the water quality but also the vegetation density.

1945 **1999**

Peel's Well

Figure 6 is a photo of the relic of Peels Well. Just a small cement structure today it provided many people with vital freshwater. . In October 1969 the groundwater level was recorded at 2.1m. And even after the removal of 2000-2500 Litres the level only fell to 1.5m.

Figure 6: Relic of Peel's Well

Aquifer

Doctors Gully is part of a perched aquifer. There is an impermeable layer of siltstone that acts as a confining layer for the groundwater. This formation has been geologically "squashed" and the layers are now vertical, which makes water penetration near impossible. The escarpment is made up of a claystone which has reasonably high porosity and permeability. Precipitation therefore infiltrates the claystone until it hits the siltstone. On top of this layer of siltstone there is a small band of gravel that allows free movement, under gravity, of water to flow towards the gully's creek. Figure 7 depicts the geology of Doctors Gully.

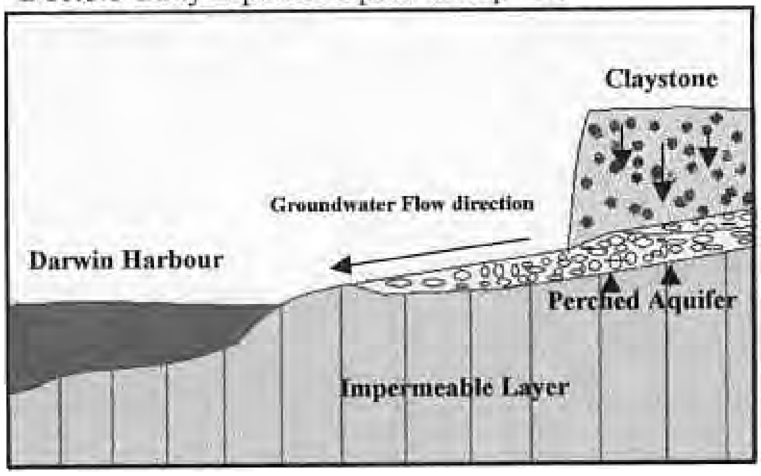


Figure 7: Geology of Doctors Gully

In 1873, the water was highly regarded for its quality and became the base ingredient used by a softdrink factory and brewery. However in 1874 due to illness upon the proprietor the operations ceased.

Hospital

Figure 3 features a hospital reserve just above the gully. In 1874 the hospital was opened due to the increasing number of outbreaks of malaria within the settlement. The hospital was built on top of the north western cliff enclosing the gully. In 1913 A. Holmes describes the hospital in 1911 "... The drains were incomplete and ineffective, often offensive... urinal and earth closets situated on verandahs... a Chinese gardener used the night soil as fertiliser in the adjacent gully and sold the vegetables back to the hospital...(Dermoudy,1995)".

Figure 3: Market Garden and Hospital Reserve

Chinese

During the early 1900's there was a strong Chinese presence in Darwin and there was construction of a number of Chinese temples. Figure 2 is a photograph of a Haka Temple built on the foreshore of Doctors Gully. The gully was handed over to the control of the Town Council for public purposes on 31/1/1921, as was the whole of the Esplanade. This marks the end of the Market Garden era.

Figure 4: The Haka Temple

RAAF

In the 1930's Doctors Gully was used by fishermen and small trading vessels, which were able to enter the small creek that led to the well. The next phase in history came about with the threat of war with Japan. In 1939 the RAAF formed a flying Boat Squadron and based it out of Doctors Gully. There was a construction of a ramp and some buildings in 1941 as well as jetties and slipways for workboats and a refuelling tripod. Aircraft and personnel did not however become permanent residents of Doctors gully until 1944. The bombing of Darwin illustrated the vulnerability to aerial attacks of the fuel tanks at Stokes Hill. The government then decided to build underground oil tanks in the escarpment surrounding the city. They also constructed 5 aboveground oil tanks at the edges of town, two of which were located in Doctors Gully.

Fish Feeding

Figure 5: Fish Feeding at Doctors Gully

After the war the government decided to hire a caretaker of Gully in order to prevent vandalism within the area. Carl Atkinson took over the caretaker's position in 1946. In 1962 Atkinson started to attract mullet to the surface on high tides by feeding them bread. He also experimented with meet and found that Carnivores could be attracted as well. He soon had Batfish, Bream, Milkfish and catfish feeding every high tide. In 1964 he convinced the government to declare a suitable area as a Fish Reserve. In 1979 he decided to retire to New South Wales and left the venture to Marshall and Cherry perron to take over. The Perrons have developed the area and employ 10 staff and have over 500 visitors a day (statistics from 1995).

Location

Doctors Gully is located in the heart of Darwin. The groundwater that discharges in this gully flows directly into Darwin Harbour (See Figure 1).

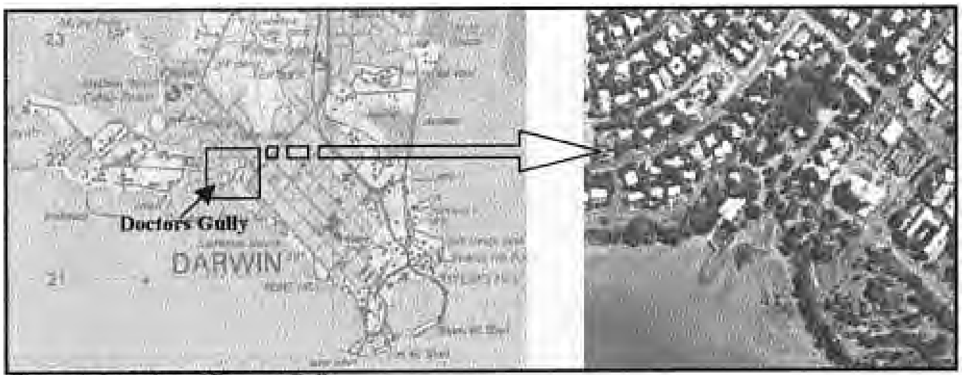


Figure 1: Location of Doctors Gully

History

Figure 2: Doctor Robert Peel

In February 1869 Dr Robert Peel (See Figure 2) and a team of well diggers went ashore at Doctors Gully in search of a good supply of potable water. Runoff water would have been reasonably abundant at this time of year however there was a need to find a suitable supply of water that would not run dry during the dry season months. Peels successful well digging coupled with a good wet season runoff suggested that the gully be made the major watering point for the camp and stock. Peels Well was an important source of water for visiting shops for many years. Initially water was carried by the ships' boat to the camp below Fort Hill but eventually was hauled by wagon.

Market Garden

Apart from finding a good supply of freshwater the next necessity was a garden to supply fresh vegetables and fruit for the camp. Seeds and plants were quickly planted in the rich floodplain of Doctors Gully and watered from its abundant well and adjacent creek. Many vegetables flourished including cress, radishes, melons potatoes and also sugarcane and bananas. A vegetable Garden reserve and adjacent water reserve was then established in 1872 (See figure 3). For many years the Gully provided ample fresh water for a very successful Market Garden.

Groundwater Dependant Aquatic Ecosystems

B3-B5

Activity 32

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Focus Question:

- **What are some types of aquatic habitats within the NT?**

Aim:

To investigate local aquatic environments for interactions with groundwater.

Main Idea:

- Groundwater is water that has infiltrated the Earth's surface into the, often tiny, spaces which exist between soil and rock particles.
- Some plants are directly dependent on sourcing groundwater for their survival.

Need/Consider:

Student Sheet 1.6 (overleaf).

Analysis:

Students investigate their region for natural springs and other aquatic habitats that are fed by groundwater. Investigate seasonal fluctuations in recharge.

Investigate the uniqueness, distribution and land use of these habitats in the NT. Ask the students to make judgements about the degree of risk that these are under and what protection may be required. Is the recharge to the groundwater sufficient to maintain the ecosystem while water extraction/diversion continues at the current rate?

Reflection:

How important do you think it is to ensure there is a balance between human use of groundwater and conservation of ground water for the survival of other groundwater dependant species

Student Sheet 1.6
Groundwater Ecosystems

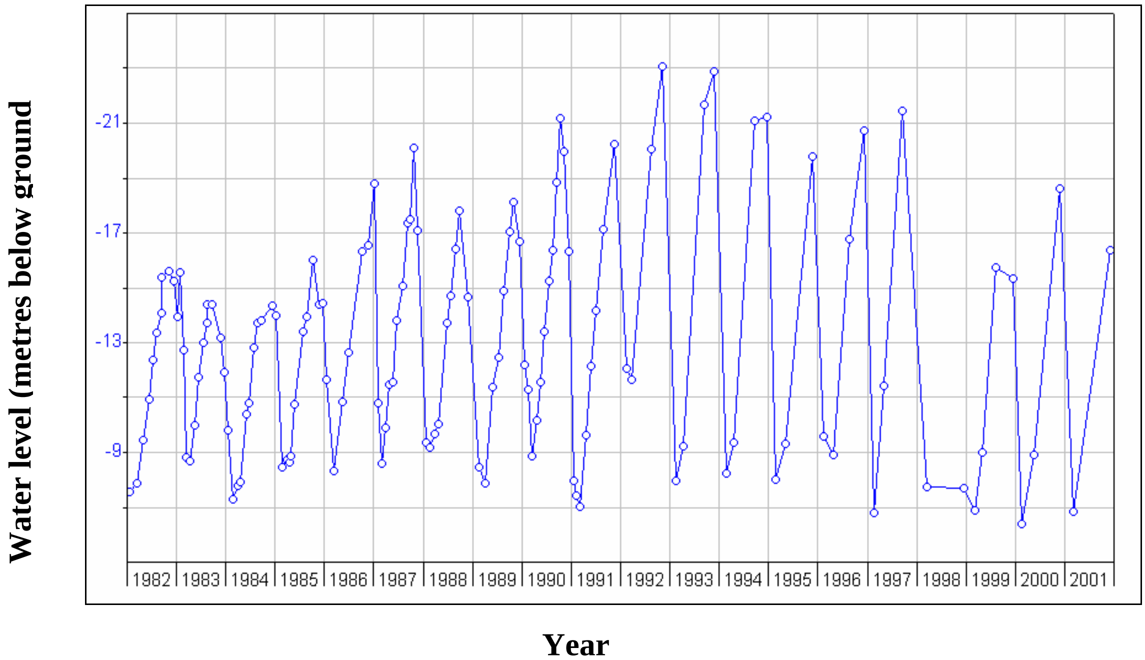
Groundwater dependent ecosystems are under increasing pressure from human activity. Bores used for domestic and commercial purposes can potentially significantly lower the amount of water available and pressure in an aquifer. Unsustainable depletion can cause natural springs to dry up. Over the last 100 years many springs within Australia have dried up, destroying various species even before they could be discovered (DWR 2000).

Many native vegetation, animal and bird species are totally or partially dependent on groundwater for their survival. This is particularly true in arid regions of Australia where surface water can be hard to come by. If the groundwater becomes depleted, polluted or saline then vegetation will die, adversely affecting other flora and fauna species (DWR 2000).

Groundwater and surface water catchments are strongly interconnected, making groundwater an important factor in supporting aquatic ecosystems associated with surface water. Recent scientific research has shown that aquifers themselves contain many forms of life and biological processes, some of which are new to scientists (DWR 2000).

Watertable aquifers found in the Top End are readily rechargeable each wet season. Confined aquifers, such as those which supply Tennant Creek and Alice Springs, are very slowly recharged from distant places and are considered to be 'fossil' waters.

The graph below demonstrates the recharge rate of a bore in the McMinns Lagoon area near Darwin between 1982 and 2001. Even in dry years when the bore was significantly depleted (eg: in both 1992 and 1993 water levels dropped to approximately 21 m below ground level) the bore water levels annually recover to in the vicinity of 9 m below ground level.



Clearly groundwater is a very important component in the environment and any plans to extract groundwater should take into account any detrimental effects on dependent ecosystems.

Accessing Groundwater

B3-B5

Activity 33

Curriculum Links:

SOSE Environments / Place, Landforms and Features
Env 3.1, Env 4.1, Env 5.1

Focus Question:

- **How do we use water in the catchment?**

Aim:

To gain an insight into the factors involved in accessing and maintaining groundwater suitable for human use.

Main Ideas:

- Unless the groundwater has the opportunity to come to the surface, groundwater must be accessed by the establishment of a bore.
- Legislation exists that requires a permit to establish a bore, and a licence to pump groundwater.
- The chemical nature of groundwater and its flow potential will determine the capacity for use.

Need:

Consult your local water resources person from DIPE or Power Water and gain permission to visit a local bore, to inspect, see how it operates and discuss how it is maintained and for what it is used.

Consider:

As a class, determine what knowledge students have already about groundwater. Does anyone use groundwater directly in their community or on their property?

Analysis:

Students determine:

What is another name for a 'bore'?

How can bores be of use when monitoring groundwater?

What are some factors to be considered when locating a bore?

How is the bore's column maintained and how does the well stop leakage to/from its column?

Why are 'headworks' important?

Why might a mild chloride solution be required to maintain the well?

What are some of the mineral salts found naturally in groundwater?

Investigate legislation associated with the establishment of a new bore.

Reflection:

How might the NT's population have been distributed if bore technology was *not* available? This could be represented on a map of the NT.

Groundwater in the NT

B3-B5

Activity 34

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **How do we use water in the catchment?**

Aim:

To investigate water availability in the NT and locally.

Main Ideas:

- The low and sporadic rainfall in NT can result in unreliable and poor quality surface water. Most developments and population centres in the NT are dependent on groundwater resources.
- Groundwater is stored in aquifers. Aquifers form when the pores or joints in the under ground rock beds are large enough to allow the continued flow of water under the pressure of gravity.
- Watertable aquifers found in the Top End are readily rechargeable each wet season. Confined aquifers, such as those which supply Tennant Creek and Alice Springs, are very slowly recharged from distant places and are considered to be 'fossil' waters.

Need:

Water Consumption Water Wise Education Kit. Water Notes: The Alice Springs Town Basin Area.

Internet access:

http://www.lpe.nt.gov.au/advis/water/facts/alice.htm

Consider 1:

Look at the groundwater web site – map of the NT groundwater resources.

Analysis 1:

Examine the key on the map and identify the quality of groundwater available to each population centre.

Record information on individual student maps.

Jointly construct a statement that describes and explains the nature and quality of groundwater found in the humid and arid zones.

Consider 2:

Using local services such as a bore driller gain access to a source of groundwater. The bore driller may be willing to discuss the process of drilling for groundwater and operation of equipment.

Analysis 2:

Students write a report about the trip which includes the following information:

town water supply;

amount of water used - compare wet/dry season usage - why are they different?

current or potential problems of your local water supply and quality.

EXCURSION

Encourage use of diagrams, maps, flow charts and other relevant visual representations.

Students to:

1. Look at town bores, private bores etc and what they are used for and what changes to water quality is made before human consumption.
2. Undertake a water use survey: how much water does your family use? Combine survey results, and estimate total residential use. Compare this to similar information from PAWA.
3. Write an argumentative essay showing reasons for and against current water usage levels by the community.

Reflection:

Participate in a class discussion about the possible limitations imposed by water resources on the growth of population and industries in the Top End and Central Australia. How might these limitations be overcome?

Extension: (Central Australia)

Undertake a study of Alice Springs water use – Roe Creek bore field.

Types of Surface Water

B1- B3

Activity 35

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1

Indigenous Languages and Culture Natural Environment

Focus Question:

- **What are the different types of surface water?**

Aim:

Students will be able to recognise that there are different forms of surface water, man-made, natural, permanent and ephemeral.

Main Ideas:

- Surface water is freshwater that is visible above ground in waterholes, rivers wetlands, lakes, dams etc.
- Surface water may be man-made, natural, permanent and ephemeral.

Need:

The following figures in this booklet

- Figure 6: Block diagrams of Top End water systems (p 8).
- Figure 7: Block diagrams of Central Australian water systems (p 9).

Consider:

Teacher interprets and discusses Figures.

Analysis:

How do we use surface water bodies? For example, discuss how rivers and lakes are used for fishing and canoeing, rock pools for swimming, lagoons for bird watching and streams and springs for drinking water.

What are some of the examples of surface water near your school? Are these water bodies permanent, ephemeral, man-made or natural? Tabulate the examples provided into a matrix: top headings: man-made/natural and side headings: permanent/ephemeral.

Invite a traditional owner to speak to the class about their perspective of the different types of surface water bodies in the local region.

Draw some pictures of surface water being used in different ways –pin them all up as a class – classify them into the following groups: Essential Use, Non Essential Use.

Reflection:

Band 1: If all the surface water was to dry up, what activities and uses of water could we no longer do? Which of these would effect your survival?

Band 3: What impact might global warming have on the location and frequency of ephemeral wetlands? What role does groundwater play in the supply of water to surface water bodies during periods of no rainfall?

Developing a Catchment Field Guide and Website

B3-B5

Activity 36

> ***Curriculum Links:***
>
> **SOSE** Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3
>
> **Indigenous Languages and Culture** Natural Environment

Focus Question:

- **What are catchments?**

Aims:

1. To learn about the components of the local catchment through the development of community reference materials.
2. To integrate information technology and indigenous knowledge into learning processes.

Main Idea:

- Community involvement in monitoring and education is very important in broad scale natural resource management.

Need:

WATERWATCH
Northern Territory
A Federal - Territory Partnership

Digital camera (if available), computer access, flora/fauna keys, record sheets local experts.

Invite local experts to participate, such as an Traditional Owner, Botanist, Entomologist or Taxonomist.

Consider:

Pre-visit the chosen sites to plan the excursion, consult with the local Landcare or Waterwatch coordinator.

When at the site, ask students to quietly observe and listen for 5-10 minutes, sketch and photograph features of the site: eg: riffle, edge, drainage lines and vegetation. Observe seasonal changes, weed presence and native flora/fauna.

Download photos and develop a website.

Analysis:

From this preliminary visit, did the site(s) seem to be in a healthy condition?

Extension:

Revisit site to document seasonal changes.

This activity could be done in conjunction with macro-invertebrate or land use surveys.

Reflection:

How might the site look at different times of the year, could this influence your initial view of how healthy the site(s) look?

EXCURSION

Local Catchment Investigation B1- B5

Activity 37

Curriculum Links:
SOSE Environments / Natural Systems Env 1.3, Env 2.3, Env 3.3, Env 4.3, Env 5.3

Focus Question:

- **What are the various components of waterways?**

Aims:

1. To develop observation and analytical skills
2. To gain an understanding of how natural systems can become impacted by human activities.

Main Idea:

- A habitat is a place that provides food, water and shelter for plants and/or animals that are occupying and using the space and resources.
- An aquatic habitat is one that an animal or plant uses to live or reproduce in, where water is the medium in/on which the organism lives. The water may be permanent or seasonal, fresh or saline water.

Need:

Transport, clip boards, pencils, observation table (overleaf), paper, sketch pad and bags to collect items. Student Sheet 1.7 (below).

Natural resource assessment officers may be invited to provide information on the waterway.

Ask the regional Waterwatch Coordinator for advice of a safe, accessible, healthy site near you.

Consider:

Take an excursion to visit a healthy waterway or water body near your school.

Ask the children to use each of their senses to observe the flora, fauna, soil, water, rocks, weather and human presence. Use the Student Sheet to prompt these observations.

Analysis:

On site:

Discuss whether as a class you consider the site to be healthy or unhealthy?

How have human alterations to the environment altered natural features and flows?

Identify the major features within the waterway and how they are dependent on each other.

Back in the classroom:

Students illustrate and research there favourite feature. A presentation by the student should trigger the memories of other students who may have observed the same feature.

Encourage students to practice the use of observation skills and apply them where-ever they travel to observe how healthy the environment is.

EXCURSION

Extension:

Make the excursion a day long one and ask the student to compare sites from the upper, middle and lower catchments and/or sites known to be healthy verses unhealthy.

Record observations in a variety of forms:

1 Recording on the day:

Individual student diaries - Designed to be used on the day, ie not too demanding, guided headings and presented in a format which is useable in the field.

Photographs – Different types of cameras provide visual records of a site which can be presented in various ways. Examples include digital camera and cameras with normal or slide film. Students may choose to bring their own cameras.

Videos - A parent or trained student with a video recorder can provide a valuable record for later presentations and site, catchment and activity analysis. Guest speakers on the day can be video taped for later reviewing.

Cassette - An audio recording of catchment sounds can be useful. Bush sounds, waterfalls, traffic, construction sites can all be useful for later.

2. Recording when you get back:

Class Big Book

Students can write a ‘Big Book’ which they could use to tell lower years levels about their trip.

Drama – Freeze Frames/Play

Like the game ‘statues’, students freeze in an action. This could be done to illustrate the favourite parts of the Crawl.

A full play, in costume, could be written for future presentations.

Student Sheet 1.7
Local Catchment Investigation

Name:

Date:

Location:

Describe	Prompt	Description
Weather	Temperature, humidity, wind, cloud, sun, rain, air pollution/smell, season?	
Geology / rocks	Rock colour, visible/minute grain sizes, hard or crumbly rock surface, smooth tumbled surface or sharp.	
Soil	Grain size, colour, changes through the bank depth.	
Water (physical observations)	Smell, life in it, colour, surface scum, clarity, depth, flow speed, direction of flow, shaded or in the sun.	
Fauna	Tracks, scats, sightings, burrows, behaviour. Is there any evidence of feral animals? Eg: pig rooting.	
Flora	Types, flowering/fruiting/setting seed, age structure of species, aquatic: floating or submerged; terrestrial: bank or top of bank and beyond, algae, leaf, flower or fruit smell, presence of weeds.	
Human presence	Water pumping devises, vehicle/foot tracks, bridges, drains, signage, fences, water control weirs, boat ramps, etc.	

Do you consider the waterway to be healthy or unhealthy. Explain why

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Melting Ice

B1- B3

Activity 38

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Focus Question:

- **Why is water's ability to change its state from liquid to solid important?**

Aim:

To recognise the importance of water's ability to change state from a liquid to a solid.

Main Ideas:

- Water's ability to change state from a gas to a liquid to a solid is essential in terms of the water cycle and seasonal changes.

Need:

Ice, container to catch the water as it melts.

Consider:

Watch an ice cube melt. (You can speed this up using the hot ground or make it more fun using tasty ice blocks).

Analysis:

Relate to the clouds and the fact that the atmospheric temperatures, even in the tropics, can drop below 0°C causing water in the atmosphere to freeze. Aircraft must have anti freezing devices to prevent ice weighing down the aircraft and causing it to crash!

This ice can be already formed in the very high cirrus clouds or it may form from super cool water droplets in the atmosphere that turn to ice on the planes wings as the very cold metal plane wings enter this zone. Therefore water's ability to ice up is part of the water cycle even in the tropics!

Reflection 1:

What part of the water cycle would fail to occur without the water's ability to convert to ice?

Students write their own interpretation for presentation to the class OR as a class discuss the potential outcome of such a consequence.

Reflection 2:

For southern NT, what would happen to the animals that live underwater if the whole water body was to freeze over during the Winter?

Students write their own interpretation for presentation to the class OR discuss the potential outcome of such a consequence as a class.

Water Crystals in the Desert

B3-B5

Activity 39

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is water's ability to change state from solid (ice) to liquid important?**

Aim:

To appreciate the importance of water's ability to change state from solid to liquid.

Main Idea:

- Water's ability to change state from a gas to a liquid to a solid is essential in terms of the water cycle, seasonal changes and access to water for plant and animal survival.

Need:

Library and Internet.

Consider:

Discuss what frost is. Has anyone seen it before? Can they describe it to the other class members?

Frost is limited to cooler climates including central Australia.

Frost melting in the mornings in the desert may be an important water source for organisms living in the desert environment and again forms a component of the water cycle.

Investigate:

Investigate organisms in your region that may be dependent on these small important sources of water. Choosing an animal, write a brief report on your findings to present to class.

This is applicable to both Central Australia and the Top End dry season.

Reflection 1:

What would happen to animals in the desert if the small areas of water available were to ice over in the night and not thaw again? Students write their own interpretation for presentation to the class OR as a class discuss the potential outcome of such a consequence.

Reflection 2:

What parts of the water cycle would fail to occur without the water's ability to melt? Students write their own interpretation for presentation to the class OR as a class discuss the potential outcome of such a consequence

Evaporation in a Bucket

B3-B5

Activity 40

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is water's ability to change state from liquid to gas (evaporate) important?**

Aims:

1. To identify and recognise situation where evaporation is occurring; and
2. To encourage students to appreciate the importance of water's ability to evaporate within the Earth's temperature range.

Main Idea

- Water's ability to change state from a gas to a liquid to a solid is essential in terms of the water cycle and seasonal changes.

Need:

Container such as a bucket of water, ruler, record sheets, water proof marker pen, graph and paper.

Consider:

Place a bucket of water with a known quantity of water outside in the sun.

Mark the top water level with a pen. Compare water levels on a daily basis using a ruler inside the bucket and record measurements until all the water has evaporated.

Measure the atmospheric temperature where the beaker is situated each day.

Graph water levels against time and temperature.

Determine the quantity of water lost.

Analysis:

Why and how did the water level drop? Where did the water go? What factors may have influenced the rate of evaporation?

What were some of the difficulties experienced? What conclusions can be drawn from the results?

Reflection:

What would happen to the water cycle if water did not evaporate to become a gas? Students write their own interpretation for presentation to the class OR as a class discuss the potential outcome of such a consequence.

Extension:

Mathematic principles may be applied to calculate an estimation of evaporative water loss over time. This information may then be used to estimate how long it would take a larger water body of known or hypothetical dimensions to dry out in similar climatic/weather conditions?

Monitoring Evaporation from a Waterhole

B3-B5

Activity 41

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is water's ability to evaporate important?**

Aims:

1. To plan an experimental design and provide an opportunity to communicate scientifically.
2. To identify and recognise situations where evaporation is occurring;

Main Ideas:

- Water's ability to change state from a gas to a liquid to a solid is essential for the water cycle and seasonal changes
- Some liquids, including water, can change from a liquid to a gas at temperatures below their boiling point by a process called evaporation.
- Evaporation occurs when water molecules temporarily gain enough energy to escape their liquid state at temperatures lower than 100°C.

Need:

Camera, transport, long ruler, photo point reference pole, record sheets, rain gauge.

Consider:

Consider viewing the video, *The Call of Kakadu* (available at ABC shops), which includes a seasonal time lapse at a lagoon.

Planning:

Encourage students to think through how they might best record the rate of recession of water from a waterhole/lagoon through the production of an experimental design.

Analysis:

Locate a suitable local lagoon or waterhole which significantly recedes between big rain events/Wet seasons. Undertake activities incorporating the student's experimental design OR do the following steps:

Visit the water body over a number of months. Set up a rain gauge at the site and check it as regularly as possible.

Set up a photo point pole at the edge of the water body in a direction that has the water body in good view.

Take a photo in the same spot every 2 weeks over the Dry season. While at the site, record the following onto a card for the site: the water depth whilst the reference pole is under water, the date and time, rainfall (if any).

Process and mount the time lapse series of photos as a display along with the information on the record cards.

Ask the students to suggest where they think the water from the waterhole/lagoon has gone.

Evaluate the experimental design. Did the experiment achieve its aims?

Extension:

Link the results of this experiment to seasonal influence on environmental flows. What impact did the evaporation of water have on the vegetation and habitat present?

Dissolved Substances

B1- B3

Activity 42

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1

Science Working Scientifically / Investigating WS1.2, WS 2.2, WS 3.2 / Evaluating WS 1.3, WS 2.3, WS 3.3

SOSE Environments / Environmental Awareness and Care Env 1.2, Env 2.2, Env 3.2

Focus Question:

- **Why is water's ability to dissolve solids important?**

Aim:

To learn that water's ability to dissolve solids can be beneficial but also detrimental to living things.

Main Ideas:

- Water within living things acts as a medium for removing wastes from their bodies, and allows other biochemical reactions to occur.
- Water in the environment acts as a medium for the transfer of wastes or for other chemical reactions to occur.

Need:

Lemon juice, powdered milk, detergent, food colouring, salt, milo, some organic matter, clear plastic containers of water.

Consider:

Ask the students to hypothesise what will happen to the characteristics of the water when each ingredient is added.

As a class, add listed ingredients to a separate container of water and mix

In an extra container add all ingredients to demonstrate the accumulative effect of pollutants.

Analysis:

As a class discuss how in this experiment:

milo and water are similar to suspended solids;

detergent represents detergents;

powdered milk represents sources of nutrients, eg: fertilisers; rotting plant material or rotting aquatic fauna;

lemon juice represents acidic industrial discharges;

flour represent sdry cement; and

salt represents tidal influence or salt water intrusion etc.

Students record the outcomes of adding various things to the water using the scientific method.

Reflection:

What inputs (dissolved /undissolved) are derived from natural processes? Create a list or create diagrams for those things that are derived from natural processes.

Discuss and debate these questions as a class. How can water's property of dissolving substances be harmful to the environment? When are these substances products of urban development?

Salinity and Total Dissolved Solids B3-B5

Activity 43

Curriculum Links:

Science Concepts and Context / Natural and Processed Materials CC 3.1, CC 4.1, CC 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is water's ability to hold charged particles important?**

Aims:

1. To develop an understanding of how salinisation of freshwater sources can be detrimental to health and the environment.
2. To develop an understanding of how water's salinity can be measured to determine its useability (potability).

Main Ideas:

- Water can hold particles that have a 'charge', which enables the conduction of an electric current. This is essential for the uptake of water and nutrients by plants and biological processes.
- The scientific name for salt is sodium chloride. The chemical symbol for salt is NaCl. When salt dissolves in water the two ions dissociate to become Na^+ and Cl^-.

Need:

Various water samples, mineral water and sports drinks, total dissolved solids probe and conductivity meter and graph paper (or substitute with tap water samples and various amounts of salt added).

Consider:

Imagine if we could not get access to fresh water and the only drinks available were very salty ones, how healthy would we be, how long could our bodies cope with this?

Analysis:

Taste the tap water and mineral water/sports drinks to identify which is the most salty.

Using a TDS (Total Dissolved Solid) hand meter from a *Waterwatch* test kit, test the TDS of various samples. Substitute ground water or salt lake samples for inland regions.

Extension:

You may like to use these solutions on a set of test plants (same species and stage of development) to see what effect the different salinities have on the plants' growth.

Reflection 1:

What would happen if plants were unable to get nutrients from the soil because of a lack of water to transport them into the plant?

If a freshwater water body were to become increasingly saline, what might happen to the frogs, fish birds etc?

How does a total dissolved solids (TDS) meter work? Does the ability of water to conduct an electric current come in to play in the mechanism?

Osmosis at Work

B3-B5

(From The Catchment Education Resource Book – DNRE Vic 1998)

Activity 44

Curriculum Links:

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Focus Questions:

- **What factors can affect the health of aquatic ecosystems?**

Aim:

To understand the concept of osmosis and how it contributes to the processes of photosynthesis and respiration.

Main Ideas:

- Saltwater intrusion occurs where freshwater environments become saline through the incursion of tidal waters.
- Over 240 km^2 of freshwater wetlands in the Mary River catchment have been destroyed by the intrusion of saltwater within the last 50 years.
- Osmosis is the movement of water from a region of high concentration to an area of low concentration through a semi-permeable membrane.

Need:

Per group: 3 small carrots, 3 beakers, distilled water, tap or river water, hyperosmotic solution (made by adding 1 tablespoon of salt to a beaker of water).

Consider:

Some animals and plants are able to tolerate saline water better than others. For example, the brine shrimp of central Australia are able to regulate internal osmotic pressures so that their cells do not collapse in the salty water in which they live.

For most aquatic organisms, if the water in which they live becomes saline to the point where the water has a greater concentration of ions than inside their cells, water will be lost from the cells to the outside environment via osmosis. The cell shrinks as it loses water and eventually collapses and dies.

Conduct an experiment to compare what happens to a carrot is placed in different solutions. Fill separate beakers with distilled water, tap or river water, and hyperosmotic water. Place one carrot in each of the three beakers and observe and record the results after 24 hours.

Analysis:

Explain the results in terms of osmosis. How do the cells of the carrot react when placed in these different solutions?

Discuss how salinity might negatively impact on previously freshwater wetlands.

Reflection:

Not all species are affected by rise in salinity, some have learnt to adapt to seasonal fluctuations. Which aquatic habitats are likely to be most susceptible to changes in water salinity? Research some examples of salt tolerant plants and animals.

Measuring Water Temperature

B1- B3

Activity 45

Curriculum Links: **Science** Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1   **Science** Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2 / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

Why is water's ability to insulate important?

Aims:

1. To discover water's ability to insulate.
2. To apply scientific method.

Main Idea:

Water retains or exchanges heat more slowly than other substances. This property of water is important for aquatic life and for the water cycle.

Need:

4 buckets of water, thermometers, an air conditioner and graph paper.

Consider:

Place two containers of water in the open sun. One should be full up to the top and another only a quarter full.

Place another identical container and volume inside the classroom near an air conditioning vent.

Analysis:

Students will then measure the air temperature at each site, the temperature of the bucket water and record the time of day.

Repeat the measures at different times of day and record the results in a table similar to the one below.

This could be done over several days with the data collected being graphed.

This experiment demonstrates that water temperature varies less than the atmospheric temperature, however variation is dependent on volume.

Extension:

Your class may like to ask your local Regional Waterwatch Coordinator for some local data or your class may like to be involved in testing some local water bodies themselves.

For more senior students, the hypothesis, experimental design results and conclusions could be devised by them under the guidance of the teacher.

Reflection:

What would happen to the animals that live underwater if the whole water body rapidly heated up in the day and rapidly cooled in the night? Students consider this independently and then discuss as a class.

How would the Earth's climate be different if the Earth's oceans rapidly heated and cooled? (See Part 4: Uses of Catchments - Global warming). Discuss and debate as a class.

Date	**Inside bucket (full)**	**Inside bucket (25% full)**	**Outside bucket (full)**	**Outside bucket (25% full)**	**Temp (°C)**
Morning					
Noon					
Evening					

Counting and Acting Surface Tension

B1- B3

Activity 46

Curriculum Links:
Science Concepts and Context / Natural and Processed Materials CC 1.1, CC 2.1, CC 3.1
Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2 / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

- **Why is surface tension important in aquatic habitats?**

Aim:

To apply the concept of surface tension.

Main Idea:

- Water bodies form an ' elastic skin' made up of water molecules sticking together through cohesion. This is known as surface tension. This surface tension allows water to support objects on its surface. Many aquatic insects use this surface skin as their habitat, as they feed from its surface or hang from it in the water.

Need:

A dropper, glass of water and five cent coin.

Consider:

Count the number of drops it takes to cover the five cent coin and form a blob of water before it breaks the surface tension and slips off the coin. Note the 'skin' as it forms into a spherical shape.

Now ask the students to all stand up and hold hands in a circle. Ask them to pretend to be a water droplet. Then holding on tightly, ask them to slowly come together and meet in the middle of the circle with there heads bent over until there heads meet, then ask them to sit down, still holding hands. This is to demonstrate via drama, the water drops (each student) cohering to each other to form the 'skin'.

Further demonstrate this skin by looking at the meniscus of water in the glass and drop some pepper onto its surface, see how it floats on the 'skin'. Explain that this pepper may represent small particles of food that insects feed on and that some small insects are able to float on the surface like the pepper.

Reflection:

If small insects were not able to live on the surface of water bodies, how would this effect the food chain of the water body? Class draws on previous experiences to draw/create a generalised food chain of a water body. Then take away/cross out the aquatic insects that use the surface tension to consider what impact this might have eg: on other insects, birds, fish, aquatic plants.

Extension

Observe how the surface tension of water is affected by the addition of a few drops of detergent to glass of water and pepper. Consider what impacts detergent may have on natural water systems.

Digging for Flow

B1- B3

Activity 47

Curriculum Links:

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1

Science Working Scientifically / Investigating WS1.2, WS 2.2, WS 3.2 / Evaluating WS 1.3, WS 2.3, WS 3.3

Focus Question:

Why is kinetic energy of water important to biota?

Aim:

To understand how water erodes soil and rocks.

Main Idea:

Flowing water is a powerful force. Energy provides the force and motion enabling the water to have erosive capability. This affects the types of habitats created and the diversity of living things at a site.

Need:

Water and sand.

Consider:

Students dig a hole in the sand either:

- at the beach near the water; or
- in the kindy/school sandpit with a hose running gently into it.

Analysis:

Watch the waves back fill the hole with more sand or get a bucket of water and gradually ‘wash’ it into the hole from one side. Watch how much sand goes into the hole and watch the erosion form as a result.

The force of flowing water can move solid material like sand / soil / stores and that these solid materials build up to fill spaces.

Draw a simple diagram series of what happened in the experiment above.

Reflection 1:

Ask the students to consider whether they have seen areas of rivers where water’s actions have dug out the sides of its banks? When is this most likely to occur?

Reflection 2:

What might happen to a river system or wetland that suddenly receives substantial reductions in water volume for a prolonged period of time? What would happen to the flow of a river in the lower catchment if a dam was built in the top half of the catchment? How could this effect aquatic habitats in the lower catchment?

You will need to choose a particular water body and its flora and fauna to answer this specifically, however there are some generalisations that can be made here.

Erosion Study

B1-B5

Activity 48

Curriculum Links:

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1, Env 4.1, Env 5.1

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 1.3, WS 2.3, WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is the kinetic energy of water important?**

Aim:

To identify examples of water actions that shape the landscape.

Main Ideas:

- Erosion is the wearing away of the Earth's surface.
- Flowing water is a powerful force. Energy provides the force and motion enabling the water to have erosive capability, which directly influences variations in aquatic habitats.

Need:

sketch paper and pencils; camera and photo point marker; and transport.

Consider:

Locate an appropriate study site, you may like to contact your regional Waterwatch Coordinator.

WATERWATCH Northern Territory
A Federal - Territory Partnership

Analysis:

Look for signs of how water flow has affected the physical shape and size of a waterway.

Photograph and sketch results. If possible observe the site before, during and after peak flow periods.

Reflection:

How might the erosive potential of water influence the types of habitats present in an aquatic environment?

Is this influence good or bad?

Water and Erosion

B1-B5

(Adapted from Water Wise NT)

Activity 49

Curriculum Links:

SOSE Environments / Place, Landforms and Features Env 1.1, Env 2.1, Env 3.1, Env 4.1, Env 5.1

Science Working Scientifically / Investigating WS 1.2, WS 2.2, WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 1.3, WS 2.3, WS 3.3, WS 4.3, WS 5.3

Focus Question:

- **Why is the kinetic energy of water important?**

Aim:

To assess the weathering qualities of water.

Main Ideas:

- Erosion is the wearing away of the Earth's surface.
- Energy provides the force and motion enabling the water to have erosive capability, which directly influences variations in aquatic habitats.

Need:

Hose, access to water, stones/dirt, a bottle of mineral water (with its label).

Consider 1:

Use a hose on high pressure to squirt water at grassed, hard and soft (bare) ground in the school yard. Note what happens.

Analysis 1:

Discuss what these surfaces may represent in a natural ecosystem. Discuss the periods of time over which different types of erosion may occur.

Consider 2:

Take a look at the contents list on a mineral water bottle. Where might these minerals have originated and how did they get into the water in the bottle?

Analysis 2:

Explain how erosion of rocks can affect the water mineral content.

Reflection:

How would the landscape look if rain and water flow did not shape the landscape?

What are some unnatural factors that can exacerbate erosion of waterways? For example feral animals and human activity.

Resources:

www.netc.net.au/enviro/fguide/soil1.html
www.epa.nsw.gov.au/soe/97/ch2/7_3.htm

Extension:

Take sample rubbings of water-worn surfaces (Ellery Rock Hole or elsewhere) using a pencil and some plain paper.

Kimberley : Land of the Wandjina

B3-B5

Activity 50

Curriculum Links:

SOSE Environments / Place, Landforms and Features Env 3.1, Env 4.1, Env 5.1

Science Working Scientifically / Investigating WS 3.2, WS 4.2, WS 5.2 / Evaluating WS 3.3, WS 4.3, WS 5.3

Indigenous Languages and Culture Natural Environment

Focus Question:

- **Why is the kinetic energy of water important to the biota?**

Aim:

To identify examples of water's actions that shape the landscape.

Main Idea:

- Flowing water is a powerful force. Energy provides the force and motion enabling the water to have erosive capability. The kinetic energy of water can affect the types of habitats created and the diversity of living things.

Need:

Kimberley: Land of the Wandjina video (available from the ABC shop for ~$25).
TV/video player.

This video looks at the water's role within Kimberley region this region including waters role as a creator of landscape. This includes Traditional Owner interpretations.

Consider:

Students create a retrieval chart of what they know about water shaping the landscape.

Students should take notes as they watch the video with specific reference to water's role in shaping the landscape .

Reflection:

How are the landscapes of Western Australia's Kimberleys similar to those in the Top End and Katherine regions of the NT? Class discuss their travels/holidays they may have been on where they have visited similar environments. The teacher may bring in some relevant text with photos to demonstrate similarities.

Take Home Messages

B3

Activity 51

Curriculum Links:
SOSE Environments / Environmental Awareness and Care Env 3.2,

Aim:

To share knowledge with family and friends, which emphasises the importance of looking after our planet's water resources.

Main Idea:

- Interesting facts about the Water Cycle can be shared by all.

Need:

Pens, scissors and card, magnets or double sided sticky tape/blue tack.

Students to take home some basic watery facts to share with their family and friends to emphasise the importance of looking after our planet's water resources.

What to Do:

Students may use the samples below or they may want to make up their own 'learnings'

Cut the following cards out and use them at home on the fridge or loo door for 1 week then pass them onto a friend or family who has not seen the card before or keep the card as part of a collection for further reference and revision at a later date.

Did you know?

The Earth's water cycle depends on water's ability to change state between a gas, liquid and solid within the normal range of temperatures found in the Earth's climatic conditions.

Did you know?

Plants play a vital role in the water cycle. Plants take up water from the soil, the re-release the water to the atmosphere via tiny opening in their leaves.
This process is called *transpiration*.

Did you know?

Most of the freshwater on Earth (85%) is actually 'locked up' in icecaps and glaciers

Did you know?

The water we use today is the same water that was available on Earth 3 Billion years ago, long before the dinosaurs were alive!

It is the only water that will be available in the future.

Did you know?

Water can dissolve more substances and greater quantities of these substances than any other liquid

Did you know?

Water acts as an insulator (in a similar way to an esky), so that changes in atmospheric temperatures do not dramatically affect the temperature of wetlands and waterways.

Did you know?

Flowing water is a powerful force.
The energy produced by flowing water can potentially wear away or dissolve whatever is exposed to it.

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