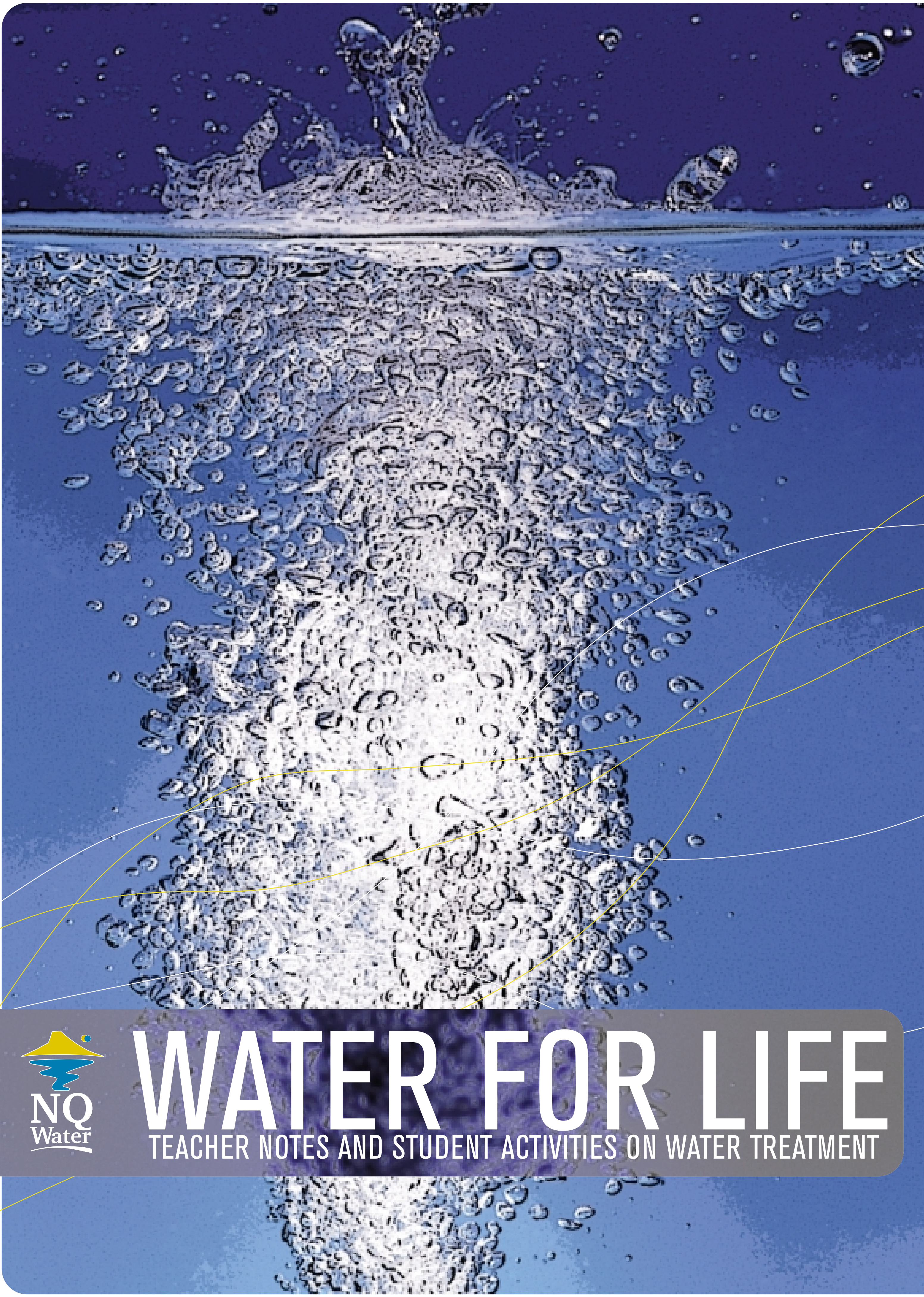

NQ Water

WATER FOR LIFE

TEACHER NOTES AND STUDENT ACTIVITIES ON WATER TREATMENT

YEARS 5 - 10 TEACHER AND STUDENT RESOURCES

This booklet has been prepared by Angela Colliver, and edited by Simon Towle for NQ Water, Townsville.

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INTRODUCTION

WHY TEACH ABOUT WATER AND ITS JOURNEY THROUGH LOCAL WATER AND WASTEWATER TREATMENT PLANTS?

Water is a powerful vehicle for exploring ideas and issues in science, technology, society and environment. The knowledge, skills, values and actions linked to water and water treatment are diverse and significant and provide numerous opportunities for first-hand experience and integration with many curriculum areas.

Water is a 'real life' topic to which children can easily relate. Without water, there can be no life as we know it. Without adequate treatment, our water would be undrinkable.

We tend to think about water only during times of drought or when some negative aspect of water quality hits the headlines, yet water is integral and essential to every aspect of our daily lives.

For most people, our familiarity with water from the tap is matched by a lack of awareness of where water comes from, where wastewater goes, and of the infrastructure needed to maintain them.

Water seems to 'appear' and 'disappear' as if by magic at the turn of a tap, the pull of a plug or the touch of a button. Its means of transportation and treatment are often a mystery.

THE INFORMATION AND ACTIVITIES OUTLINED IN THIS RESOURCE WILL ASSIST TEACHERS TO:

- Investigate water as a vital resource;
- Broaden teachers' and students' understanding of water;
- Guide students through a water treatment plant;
- Plan relevant pre- and post-visit activities to a water treatment plant; and
- Investigate water and wastewater treatment options.

Teacher notes and student activities on water treatment are clearly marked and may be photocopied for classroom use. The pre-visit activities are designed to stimulate students to ask questions during their visit. Several post-visit activities are also provided.

Please treat these resources as maps to guide you and your students' journey through the topic of water treatment.

SYNOPSIS, OBJECTIVES

SYNOPSIS

In this resource, students investigate the concept of water as a vital resource: its past, present and future, and the storage, treatment and distribution processes used in North Queensland.

Students consider ways in which a continuous supply of good water is ensured, and some of the problems and issues of distribution and quality. Students will learn about conserving and protecting their local water supply more effectively.

OBJECTIVES

To encourage an informed understanding of the importance of water in our daily lives, and to explain the various treatment and distribution processes used in the Douglas Water Treatment Plant.

This resource will assist teachers to:
- Guide students through stations along the water treatment trail;
- Plan relevant pre- and post-visit activities;
- Make the best use of time when visiting a Water Treatment Plant; and,
- To encourage an understanding of wastewater treatment processes.

KEY CONCEPTS

The key concepts provide important planning considerations for teachers, including:
- Water as a life-giving resource;
- People need a reliable supply of good quality water;
- Water is supplied to people in many different ways;
- Many people are only beginning to receive a satisfactory supply of good quality water;
- Why water needs to be treated and how this is done; and that
- Each of us has a responsibility to ensure the on-going supply of good quality water.

WELCOME TO… WATER FOR LIFE

Water for Life will introduce you to water and the operation of the Douglas Water Treatment Plant. Most of the water delivered to schools and other properties in Townsville and Thuringowa comes from the Douglas Water Treatment Plant where it is treated and disinfected before being supplied to you.

The resource examines how the water was used by Aboriginal people, and by early European settlers in North Queensland. Catchment management, riparian environments, water quality, use and consumption, are also considered. These matters could usefully be explored before your visit.

During your visit to the Douglas Water Filtration Plant, you will see the process of water treatment stage by stage. The following notes provide information on topics and activities for students at each stage or station in the process.

On arrival at the Douglas Water Treatment Plant, a guide from Citiwater, which operates this facility and associated infrastructure on behalf of NQ Water, will meet you. The guide will explain the operations of the plant and its role in providing a water supply to local house, schools and businesses.

PLEASE REMEMBER THAT THE WATER TREATMENT PLANT IS A LARGE PROCESSING FACILITY. STUDENTS MUST ALWAYS STAY WITH THEIR GROUP AND OBEY ALL SAFETY INSTRUCTIONS GIVEN BY DOUGLAS WATER TREATMENT PLANT PERSONNEL AND ACCOMPANYING TEACHERS.

We trust you enjoy your visit!

SCHOOL VISITS

It is essential to contact Citiwater or the Douglas Waster Treatment Plant in advance of your visit to ensure that:
- Several groups do not visit at the same time;
- Activities are coordinated and relevant to students' learning;
- Accurate statistics on school use and demand can be gathered to further develop activities and resources for students and teachers; and
- Teachers are confident about the location and activities.

FURTHER INFORMATION AND CONTACT

For more information about visits to the Douglas Water Treatment Plant, contact:

CITIWATER
PO Box 1268
Townsville QLD 4810
Phone/fax: (07) 4727 8950 or (07) 4727 8927
Email: citiwater@townsville.qld.gov.au

EDUCATION PROGRAM

ABOUT THE EDUCATION PROGRAM

A range of two-hour packages is available at the Douglas Water Treatment Plant.

Most programs begin with an introduction to the plant by Douglas Water Treatment Plant staff, who also help teachers to guide and support student activities during the visit.

Supervision of the students is the responsibility of the teacher. We recommend bringing additional adult support to assist with supervision as required.

Most programs incorporate practical activities at the Water Treatment Plant and including those in this resource.

Information sheets are provided to focus students' attention during the visit. They are designed to help students make observations, engage in practical activities, and participate in discussions with small groups and the whole class.

Make the most of your visit. Ask questions and swap ideas. Students who are well prepared will benefit most from their visit to the Water Treatment Plant visit. We recommend teachers use Sections 2 and 3 of this resource to assist in pre-visit preparation.

DOUGLAS WATER TREATMENT PLANT, TOWNSVILLE

ESSENTIAL INFO

ESSENTIAL INFORMATION FOR VISITORS

TRANSPORT

There is vehicle access to the Douglas Water Treatment Plant complex for safe loading and unloading of passengers.

TOILETS

Toilets are located in the Douglas Water Treatment Plant complex. Please make use of these before your program begins.

WHAT TO BRING

Clip boards for working on. Wear loose, comfortable clothing and strong, comfortable shoes. As this is a large complex in which chemicals and machinery are used, please do not wear open sandals or thongs.

WHERE TO MEET

Groups should arrive and wait outside the main entrance. Please allow access for other visitors.

DOUGLAS WATER TREATMENT PLANT RULES

- Walk and talk quietly to be considerate to other visitors.
- Students require clipboards. Leaning activity sheets against walls may scratch or damage them.
- Ask lots of questions!

ADVICE TO TEACHERS

Your students are your responsibility. Please ensure that students are adequately supervised and aware of Douglas Water Treatment Plant rules.

We encourage an inquiry-based approach to your program. We hope you will assist in practical and observational activities, and make valuable input into group discussion. In short – we'd like you get at least as much out of the visit as your students do!

CANCELLATION POLICY

Programs are heavily booked. If you need to cancel, please telephone the Citiwater Garbutt office on (07) 4727 8950 at least one week before the day on which you would have visited, to give other schools time to organise a visit.

RISK MANAGEMENT POLICY

Citiwater have Risk Management policy that is available upon request. Citiwater have identified, reduced or eliminated risks to its customers, property, interests and employees. Formal management and operational practices are established to ensure exposures to risk are controlled through appropriate risk management strategies.

PART 1

EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

1.1 THE WATER CYCLE

Where was your water last night? Last month? Last year? Ten thousand years ago? Where is it headed as it swishes across the sink and vanishes down the plughole? What happens to water when you wash clothes, water the garden, or take a bath?

As more people reach for the tap, these become critical questions. Growing populations require more food, houses, shopping centres, roads, cars - all of which increase demands for clean, fresh water.

(**Source**: Water: Precious Resource. National Geographic Society, Washington D.C. November 1993)

SOME FACTS ABOUT WATER

About 80 per cent of the world is covered by water or ice but only 1 per cent is suitable for human use (97 per cent is salt water in the oceans and 2 per cent is held in polar ice caps of Antarctica and the Arctic).

Surprisingly, the world's driest continent is Antarctica, which is so high, so cold and so dry that humidity averages just seven per cent – less than the Sahara Desert. There is almost no rain or snow because there is little evaporation. Water vapour freezes out of the atmosphere.

Australia is the world's driest inhabited continent. Of the inhabited continents, Australia has the lowest average rainfall and the lowest water runoff.

The human body is 50-65 per cent water (measured as body weight) and loses an average 3-3.5 litres of water per day. This may increase with exercise, air temperature and humidity.

An average person can survive for nearly two months without food, but less than a week without drinking water.

(**Source**: WaterWise Queensland)

NATURAL CYCLES

Every day Earth recycles: rivers and changing sea levels destroy land, and geological processes such as volcanism create new land. Living things die and new life is born. These are examples natural cycles that maintain planet Earth in what scientists describe as 'a state of dynamic equilibrium,' in which everything is continually changing, while deceptively appearing to stay much the same. Among the many natural cycles, the carbon, oxygen and water cycles, powered by solar energy from the sun, are the most critical, because without them, life as we know it on Earth could not exist.

There will never be any more fresh water on Earth than there is now. None is being created, and water cannot escape from the Earth. The water we use is recycled repeatedly.

The water cycle is the simplest natural cycle on Earth. Solar energy draws water from the ocean, lakes and rivers. Millions of litres of water rise invisibly into the atmosphere as water vapour. This process is called evaporation.

Water vapour forms over the oceans through evaporation and is blown onto the land by winds. There it meets the mountains, rises, cools, and forms clouds of tiny water droplets in a process known as condensation. The droplets fall to earth as rain, snow or ice (hail). The water runs into streams and rivers, and eventually flows into lakes or the sea, evaporation takes place, and the cycle begins anew.

PRE-VISIT ACTIVITIES

These activities lead students through an inquiry process, to question, hypothesise and research why water is a vital resource for them.

WONDERFUL WATER

Read The Wonder Thing to the class. Before starting, ask students to predict what The Wonder Thing might be. Stop reading before the final page and ask students to reconsider their predictions. Note any changes.

Reference: Hatthorn, L. and G. Gouldthorpe, P., (1995), The Wonder Thing. Viking.

ASK STUDENTS TO COMPLETE THE FOLLOWING STATEMENT:

"I know water is vital to people and the environment because …"

Ask them to offer as many ideas as they can to demonstrate their knowledge and understanding about the importance of water as a resource.

COLLAGE

In small groups, ask students to brainstorm ideas for as many uses of water as they can. They should record these on labels, and place them on a collage of photographs, pictures, illustrations and newspaper articles related to water and water use. Students should include examples of water use by both Nature and people.

HOMEWORK TASK

Students record use of water by family members. They can record their family's water use with or without formal units. For example, they might measure the number of litres used to wash the dishes or have a shower. Alternatively, they might prepare a graph or some other visual representation, such as photographs, of their findings.

PART 1
EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

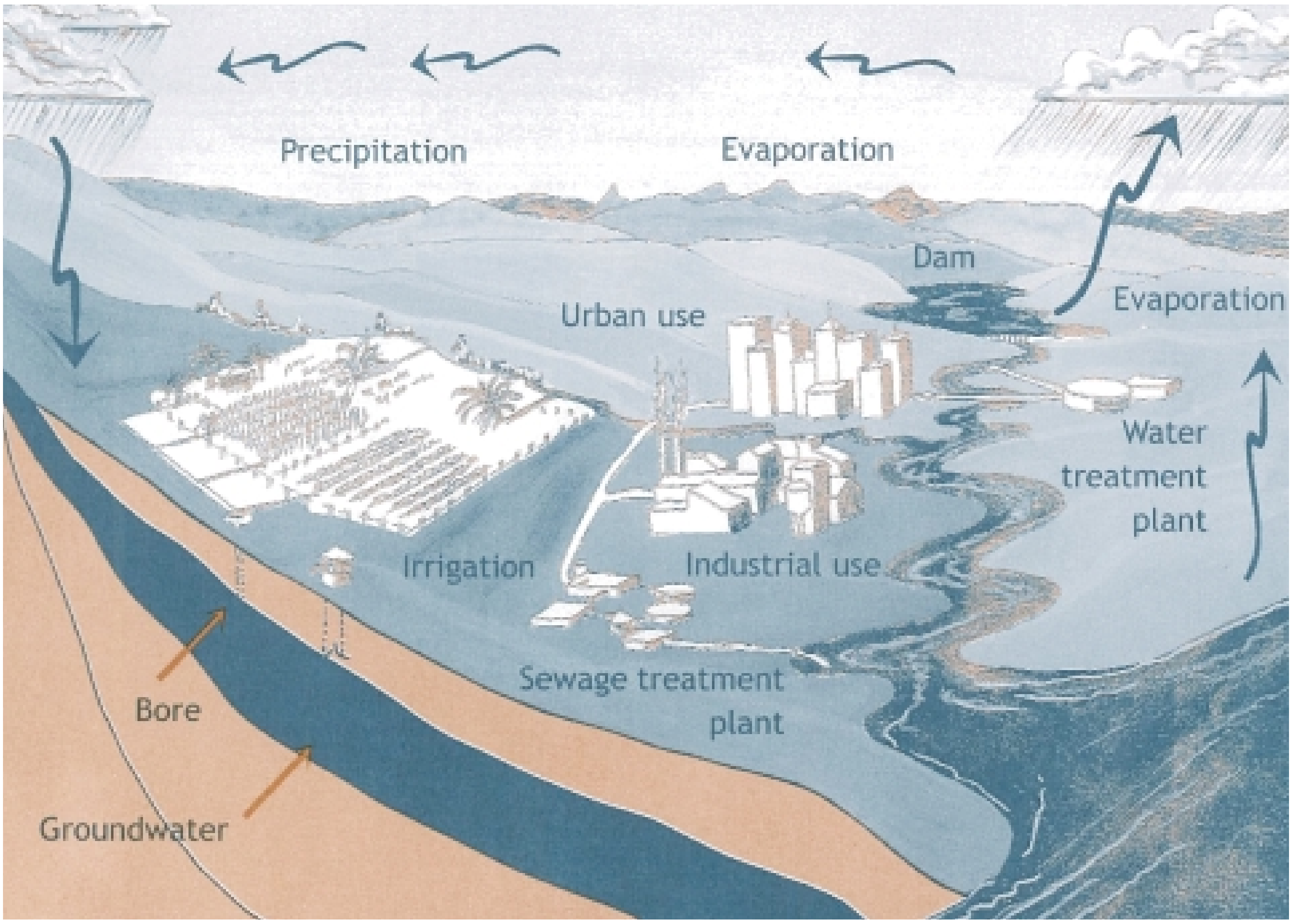


DIAGRAM OF WATER CYCLE (**Source**: We all use Water. AWA: 2002)

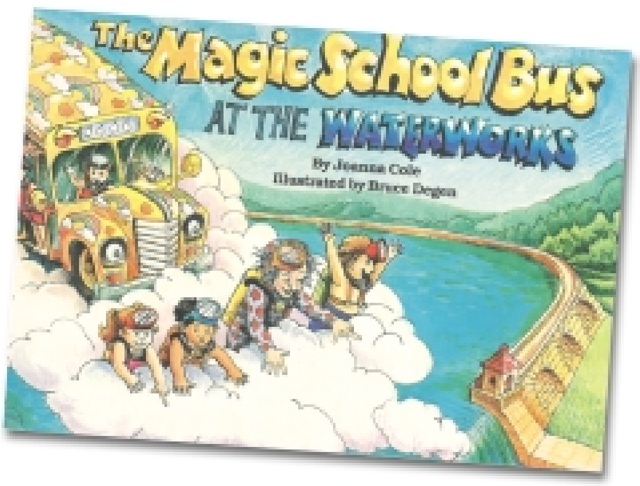
WHERE DOES OUR WATER COME FROM?

As a class, discuss the water cycle and how it works, using a big book such as *Waterways, Connections* or *The Magic School Bus at the Waterworks* to promote discussion.

Introduce and explain the terms:

- Water cycle;
- Evaporation;
- Condensation; and
- Precipitation.

Reference: Murdoch, K. and Ray, S. (1994) *Waterways, Connections*, Macmillan.
Cole, J. (1995) *The Magic School Bus at the Waterworks*, Scholastics Inc., New York.



Provide each student with a sheet with the question "Where do we get our water?" circled in the centre of the page. Students then:

- Write or draw places;
- State whether or not the water resources are clean and safe, or polluted;
- Indicate ways we use this water.

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EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

1.2 THE ROSS RIVER DAM AND CATCHMENT

The Ross River Dam is NQ Water's largest water storage facility, and is the source of water for most of Townsville and Thuringowa. Behind the dam is an artificial lake, built to control flooding and provide drinking water.

The Ross River Dam is about 20 kilometres upstream from the Townsville city centre, and is by far the largest fresh water body within the Townsville/Thuringowa area. It was built during the 1970s and 1980s, and is estimated to have a current storage capacity of about 210 000 Megalitres. (1 Megalitre = 1 million litres). The embankment of the Dam is more than 8km long and is made of earth fill and earth/rock to form an embankment up to 35 metres high. The dam spillway is concrete, and has the longest wall of its type in Australia and the southern hemisphere.

The Dam is used primarily to supply water, which is cleaned and disinfected at the Douglas Water Treatment Plant before being piped to Townsville and Thuringowa houses, schools and businesses. The Dam supplies the Douglas Water Treatment Plant with 150 Megalitres of raw (untreated) water per day. The Ross River Dam and its catchment are important to the region, with dual roles of water supply and flood mitigation. The Dam is also of major ecological importance, and NQ Water is exploring opportunities for increased community and recreational use.

ROSS RIVER DAM & SPILLWAY

Although it's man-made, Ross River Dam is an important wetland for wildlife, particularly during periods of drought when other wetlands in the Townsville district retreat or dry up. Migratory birds visit the Ross River Dam every year from as far away as the Arctic. Over 200 bird species have been recorded on and around the Dam. A diverse variety of other wildlife, including mammals, reptiles and fish also live there. Competition from other land uses has resulted in some of these animals becoming rare or threatened in the Townsville District. As a result, the critical habitat values of the Dam are carefully managed to maintain species biodiversity.

The Ross River Dam catchment occupies an inland area of considerable environmental significance. It is approximately 750km2 in size, and located within both Townsville and Thuringowa City boundaries. The catchment is bounded by Hervey Range to the west and Mount Elliot to the east, and extends as far as Mount Stuart to the north and the Dalrymple Shire boundary to the south.

The catchment encompasses several freshwater, non-tidal creeks, most of which feed into the Ross River or Dam. Most are located in the Hervey Range area south west of the Dam and include the Ross River, and the Central, Six Mile and Landsdowne Creeks. Several smaller streams flow from Mount Elliot and Mount Stuart. The catchment also contains a number of wetlands, both natural and human-made.

Several waterways within and adjacent to the catchment have important environmental qualities, and are used in various ways by the wider community – the Ross River, for example, is used for swimming and recreation, and its estuaries for commercial and recreational fishing.

The Ross River Dam catchment is close to:

- National Parks (Bowling Green Bay National Park);
- Conservation Parks (Townsville Town Common); and
- Ramsar declared wetlands (the coastal area between Alligator Creek and Cape Bowling Green).

This adds to the environmental significance of the area, and with growing community concerns about ecological sustainability, eco-tourism and nature conservation have become increasingly important throughout the region.

SUMMARY

The Ross River Dam and catchment has a vital role, providing:

- Water for Townsville and Thuringowa;
- Flood protection to downstream areas, especially Townsville and Thuringowa;
- Recreational and aesthetic opportunities for the community;
- Support for local industries such as sand extraction; and
- Support for local flora and fauna, wetlands, and migratory birds.

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EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

ROSS RIVER DAM CATCHMENT AREA

PRE-VISIT ACTIVITIES

WHY IS THE ROSS RIVER DAM IMPORTANT?

Students sit in a circle. Ask students what they know about the Ross River Dam. Students take turns to share information and ideas. Their thoughts are recorded on cards, which are sorted into three categories - Positive, Negative or Interesting - things about the Ross River Dam.

WHERE TO FROM HERE?

Ask students what they think are the most important things we need to know to ensure the Ross River Dam and catchment continues to supply clean, safe water now and into the future. Use their responses to determine focus questions for the class.

INITIATE AN ENQUIRY

In groups or pairs, students decide what they wish to investigate. For example, they might ask the following questions:

- Who uses water supplies from this source?
- What is the water most commonly used for?
- Is the supply reliable or not?
- How is the water made clean and safe?

Students consider how they might report the information found, e.g. written report, oral report, artistic impression, visual display, or debate.

As a group, discuss the Ross River Dam's importance to people. Consider landscapes, ecology, economics, politics and the Townsville and Thuringowa regions. Discuss which aspects are the most or least important. Discuss difficulties in trying to set such priorities. For example:

- How important is the Ross River Dam and catchment?
- To whom is it important?
- How can we decide which is the most/least important aspect of the Dam and catchment?
- Why do we think this?
- What do others think?
- Do these views conflict? Why?

Identify any issues that might affect the catchment, such as dams, irrigation, surrounding land use, pollution, or recreation.

Students might identify a local area that they would like to change or restore e.g. by planting native trees or native drought-resistant grasses. Identify the elements in such a change process. For example:

- Who makes decisions about how the catchment is used?
- Who do we need to approach to obtain permission to undertake the project?
- What might the cost of such ideas be?
- How might a proposal for change be presented?
- What/who might benefit from local action to restore, revitalise, revegetate and repair the catchment.

Support students in discussing and implementing an action plan for environmental or social action.

1.3 ABORIGINAL USE OF WATER

Aboriginal people have had an association with the Ross River Catchment for at least 30,000 years and possibly as long as 50,000 years. The waterways have been a source of fresh drinking water and food. Freshwater played an important role in Aboriginal life and influenced the seasonal movements of Aboriginal groups.

Historical accounts reveal that campsites were usually located near water and groups would congregate at certain times of the year when seasonal food sources were plentiful.

FOOD FROM THE RIVER ENVIRONMENT

"… the Australian Aborigine from at least thirty-two thousand years ago until the beginning of this century lived along the rivers, harvesting the resource of that environment in a way which did not destroy it…Aborigines had formed equilibrium with the river, which persisted for tens of thousands of years…They developed a mystical relationship with their lands along the river which made them part of the land, the water and the other creatures who shared the area with them."

Source: Davis (1978) p 21

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EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

The river and catchment are rich with food such as fish, shellfish, crustaceans, frogs, water birds and edible plants. Resources from the land include mammals, reptiles, birds and plants. The Aboriginal people fished, hunted, and gathered plants from both areas.

Nets were used to catch fish. Small nets were made from stringy bark (eucalypt) fibre and the larger ones, up to 100m long by 2m wide, were made from fibre created by chewing bulrush roots.

Freshwater mussels and crustaceans were also collected for food. Water birds and their eggs were taken during the nesting season. Others were hunted with sticks or boomerangs. Plants provided a valuable source of food, of which the most important were those with edible roots such as bulrush, water ribbons (Triglochin spp.) and club-rushes.

These plants are available all year-round and provide a good source of carbohydrates. Flour was made from the seeds of native grasses and nardoo, a water plant.

RAW MATERIALS FROM THE WATERWAYS

The waterways provided raw materials for making many useful objects. As we have seen, bulrush roots were chewed into fibre to make string and nets. Reeds, rushes and sedges were used to make mats, bags, baskets and other containers, together with necklaces, arm and forehead bands.

Reeds were used for spear shafts and canoes were made from sheets of bark cut from gum trees (often called canoe or scarred trees). The ends of the bark sheet were tied together, or closed up with mud. Canoes varied in size and carried between one and ten people for fishing or transport.

Sheets of bark were used for a variety of purposes, such as in building huts, or making shields and bowls. Some river stones were hard enough to be used as stone tools, mortars and grinding stones.

CAMP SITES ON THE WATERWAYS

Archaeological studies have shown that apart from camping and food gathering, the river was important for other activities, including burial, art and ceremonies. Some campsites utilised rock shelters and cliff overhangs along the river. Sheltered areas such as these offered protection from the cold, wind and rain. Rock art and ceremonial sites are often found in sheltered locations. They contain valuable information about Aboriginal life on the rivers.

CONSERVATION OF ABORIGINAL SITES

Many Aboriginal sites along waterways have been identified and are protected by legislation. Despite this, their survival is threatened by human and natural impacts such as water erosion, livestock grazing, salinity, rabbits, farming practices, quarrying, clearing of trees, fire, development of various types and vandalism. Representative samples and unique sites along the rivers must be protected and conserved. They are both a tangible reminder of Aboriginal heritage and continue to have immense cultural significance for Aboriginal people today.

PRE-VISIT ACTIVITIES

Read some traditional stories to highlight the importance of the land and river to the Aboriginal people. Discuss how the Aboriginal people's relationship to the river carries responsibilities for its survival and continuity.

Reference: *Stories of the Dreaming* http://www.dreamtime.net.au

Find out about local traditional stories related to the Ross River Catchment. Invite Aboriginal parents or local identities to the classroom.

- Relate the ways Aboriginal people accessed their water and food supplies
- Talk about ways Aboriginal people used water, plants and animals.

Create a mural showing life in the Catchment before European contact, highlighting water, plants, animals, soil and people, and the interactions between them.

Create a timeline for the Catchment to show changes over time.

1.4 EUROPEAN SETTLEMENT AND WATER SUPPLIES

Townsville was founded in 1846. The first Europeans travelled the length of the Ross River about this time. The rivers and creeks in the area were said to be full of crocodiles.

It is thought that Townsville's first reticulated water supply came from wells near Mundingburra. Records indicate that a bore was sunk at Hubert Wells in 1889, followed by others south of the Jubilee Bowling Club in what is now Anderson Park, known as Shire Wells. Steam pumps pumped water to nine-inch diameter cast iron pumps, which reticulated water to what is now the Hermit Park area.

Construction on Gleeson's Weir, the first on the Ross River, began in 1908. The weir, took 12 years to build. It rose about three metres above the riverbed and stored about 90 million gallons (x million litres) of water. However water was not pumped directly from the weir until 1923.

The Townsville Council enlarged the water system in 1918, having assumed responsibility for the area between Ross River and what

PART 1

EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

was then the southern boundary of the city. Lowth's Well, Aplin's Well and Power Well were also well known.

The Council installed an electricity scheme in 1922 and built a powerhouse on the site of Hubert Wells. Electricity enabled many small pumping stations to be installed on the riverbank in places where reasonable supplies of water could be obtained. Good domestic supplies were available from an area bounded by the Ross River, the Vale Arms Hotel, the old Gasworks on Thompson Street and the bridge near Bowen Road.

The Department of Irrigation and Water Supply investigated further sources of water in 1923 at the request of the Council. Much new information was collected about the Ross River as a major source of Townsville's water supply, although no firm recommendations were made.

Gradual steps were taken to improve the water supply over succeeding years. Aplin's Weir was built in 1928, followed by the Black School Weir in 1934.

Little rain fell in the 1930s and the ensuing drought forced authorities to investigate other sources of supply. The Council carried a resolution in 1935 that 'no further expenditure be incurred in the development of the Ross River Water Supply Scheme,' opting instead for the Crystal Creek Gravitation Scheme as Townsville's future water supply.

However, in the absence of actual surveys, stream gauges or any other supporting scientific data, these schemes were abandoned. Recognising the importance of reliable scientific information in making potentially expensive decisions on water supply, the Council began the systematic collection rainfall and stream data, which has continued ever since.

The storage capacities of weirs were increased in the 1940s and a second weir was built at Aplin's Weir in 1943, which was one of the main sources of stored water in Ross River at the time.

During the World War Two from 1939 to 1945, large numbers of troops were stationed in Townsville and water supply became critical. The Crystal Creek Scheme became a reality in 1954 and five years later Paluma Dam was completed.

The Council reviewed the future of Townsville's water supply schemes in 1960 and the Ross River Weir System and Paluma Dams were further developed.

References:

- Fairweather, I. (1966) History of Townsville's Water Supply Augmentation*
- Mayston, H.R. (1973) Townsville's Water Supply*

* Reports by City Engineers about water supply in Townsville.

PRE-VISIT ACTIVITIES

1. Research the ways that Europeans and Asian settlers in Townsville and Thuringowa changed the landscape as water became available. Design 'before and after' views or timelines to represent these changes.
2. Talk to elderly local residents about changes to the river and to the local area during their lifetimes. Write and publish these oral histories.
3. Create a role-play to show how catchments were changed to meet the needs of European and Asian settlers.

LAKE PALUMA

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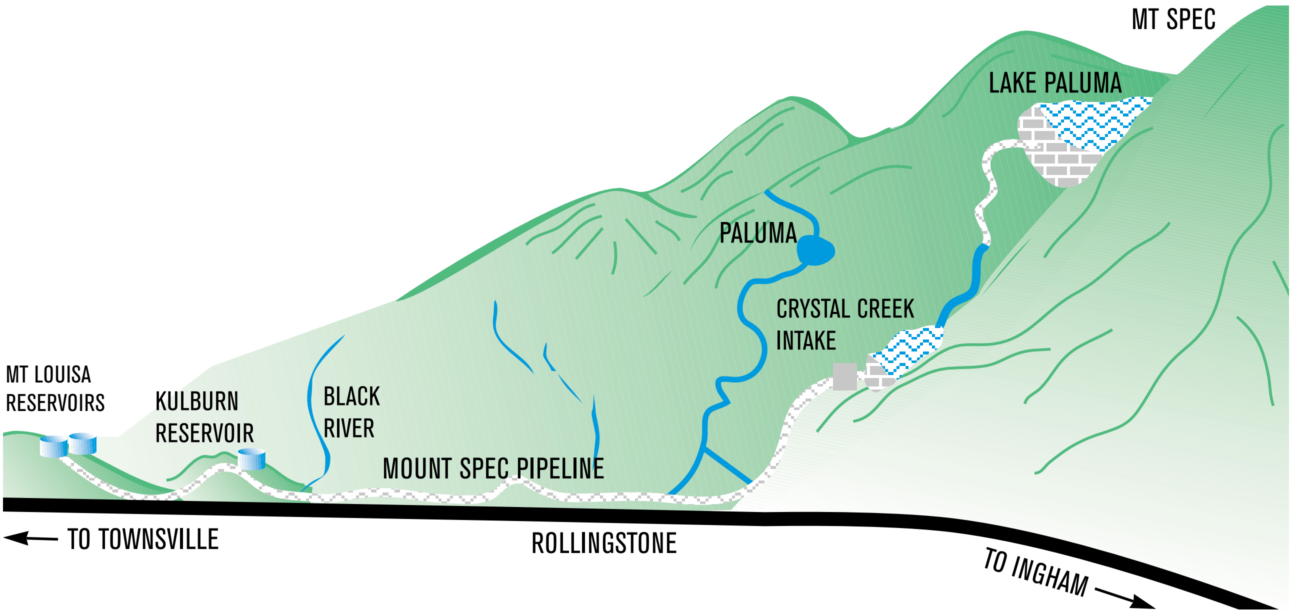
EVERY DROP COUNTS – WATER IS A VITAL RESOURCE



1.5 ACCESS TO GOOD QUALITY DRINKING WATER

Access to good quality water is essential to human health. The World Health Organisation estimates that nearly a quarter of the world's six billion people currently lack access to good quality water for drinking, personal hygiene, domestic use or sanitation. As the global population increases, and scientists predict that climate change is making many countries drier, access to fresh water has become one of the most critical unresolved issues of the 21st Century.

WHAT IS GOOD QUALITY WATER?

Good quality water can include water for the environment, for stock, human consumption, cropping and treated surface water, as well as untreated and uncontaminated water from springs and wells. Ross River Dam provides water for many of these uses.
We each use about 200 litres of good quality water every day to maintain our metabolism, and for hygiene and domestic purposes. The Douglas Water Treatment Plant provides this water for our use in Townsville and Thuringowa.

Drinking water is defined as water intended primarily for human consumption but which has other domestic uses. It may be consumed directly from the tap, indirectly in beverages or foods prepared with water, or for bathing and showering.

Reference: NHMRC/ARMCANZ (1996) Australian Drinking Water Guidelines.

Drinking water should be safe to use and aesthetically pleasing. Ideally, it should be clear, colourless and well-aerated with no unpalatable taste or odour and it should contain no suspended matter, harmful chemical substances or pathogenic micro-organisms. From a public health perspective, microbiological, physical, chemical and radiological factors determine whether our water is safe to drink.

Of these, microbiological quality is usually the most important. The most common and widespread health risk associated with drinking water is contamination by human and animal excreta and with micro-organisms contained in faeces.

Without good quality water, people cannot lead healthy, productive lives. Worldwide, an estimated 900 million people suffer, and two million die, from water-related gastric illnesses each year. Millions more are affected by other water-related diseases, such as bilharzia, cholera, elephantiasis and hookworm.

Pathogenic (disease-causing) organisms of concern include bacteria, viruses and protozoa and the diseases they cause vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhoea, dysentery, hepatitis, cholera or typhoid fever.

For additional information on the importance of good quality water visit the World Bank website at www.worldbank.org/depweb/english/modules/environm/water/index.htm

Access to a good water supply and sanitation generally improve people's health and quality of life. Good quality water is also critical to ecosystems and economies. Lack of water directly affects long-term prospects for sustainable development.

Competing demands for water are cutting into the global supply of good quality water. Many rivers and catchments are polluted by industrial, agricultural and human waste, while other sources, including groundwater, are drying up because people are using water faster than nature can replenish it.

Obtaining water is generally more difficult and often more expensive for the poorest people. In rural areas of some nations, women and children spend up to six to eight hours each day carting water from rivers or wells to their homes or fields. In cities, the poor often do not have water piped to their homes and have to buy it or get it from other sources. For example, the sources of water in a town in Mozambique are given below:

House connection/yard tap	36%
Stand post	9%
Yard well	5%
Shallow well	11%
Private borehole with electric pumps	9%
Neighbour's house or yard tap	30%

Only about a third of the people living in this town have clean water piped to their homes or yards. The rest must depend on other sources that may be expensive, unreliable or some distance from their homes.

How does this compare with water sources in your town or suburb?

Industrial countries also are increasingly concerned about water quality and availability. Although these nations have wealthier economies and greater capacity to collect, clean and deliver water to their population, per capita consumption is often high and they spend large amounts cleaning up water polluted by industrial waste, energy production, agriculture and households.

Ensuring that people have an adequate supply of good quality water involves a complex mixture of social, economic and environmental issues. Around the world, people have begun to acknowledge that water is an economic good of great value, and not a free limitless resource to be taken fore granted.

PRE-VISIT ACTIVITIES

HOW DO PEOPLE GET AND USE THEIR WATER?

Introduce students to the following people and their situations:

- Rebecca has a strawberry farm near Black River;
- Fred is a househusband in Annandale;
- Gary grows beef near Herveys Range;
- Lindy has a hydroponics farm in Kelso;
- Toula and Yibo grow avocados and mangos in Gulliver;
- Billie has an aquaculture farm in Bluewater;
- John is a volunteer fire fighter in Kirwan; and
- Barry works at the Yabulu Nickel Refinery in Yabulu.

As a class, identify these places on a map and discuss the water requirements for each person's activity, together with the climate and natural water supplies that might be available in each area. Students can suggest how each person obtains their water. Ask students to research and share information about water supply and use in different parts of Townsville and Thuringowa.

Methods might include:

- Excursions to nearby water filtration plants
- Writing to NQ Water or Thuringowa Water as a class group
- Viewing water companies Internet sites
- Writing to local councils in Townsville and Thuringowa.

EFFECTS WHEEL

Students select a person in the activity above and ask the following questions:

'What would happen if the natural water supply dried up and there was no rain?'

And/or

'What would happen if the Douglas Water Treatment Plant stopped operating?'

Students draw an effects wheel to show effects upon people, their livelihoods and the natural and built environments. Also ask:

'Where could the people get another supply of water?'

1.6 WATER CONSUMPTION AND USE

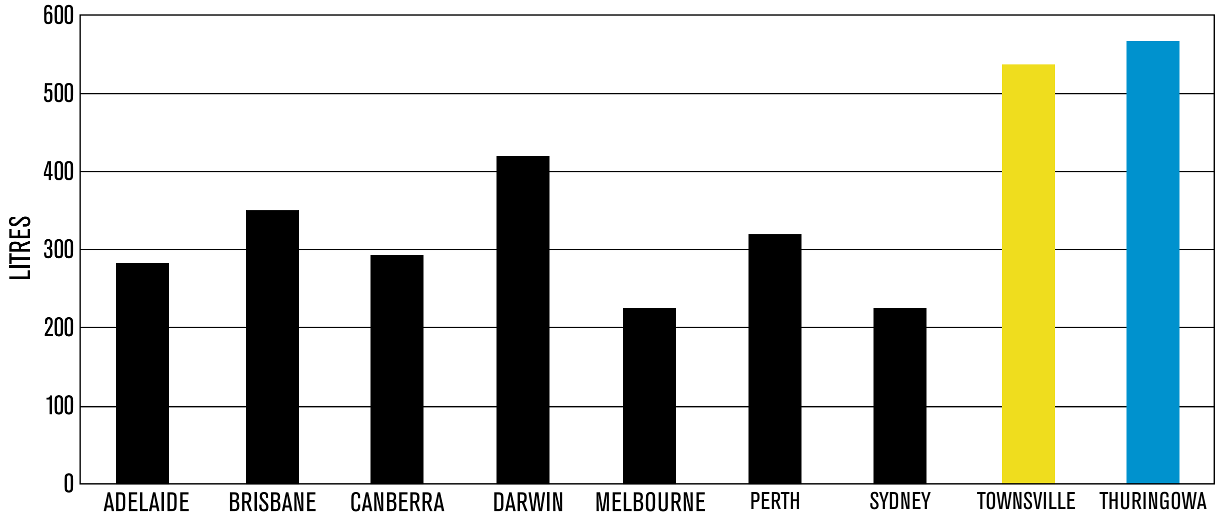
'Just about anything we do or touch involves water either directly or indirectly - switching on a light, reading a newspaper, driving a car, or eating a hamburger.' (Ask students to discuss this statement)

Per capita water consumption in Australia is high by world standards despite the relative scarcity of the resource. Total per capita water consumption in the Townsville and Thuringowa areas averages 538 litres per day, the second highest nationally.

Reference: ARMCANZ (1998), Average annual household water consumption in Australian capital cities, 1993-94, State of the Environment Report for South Australia

HOW MUCH WATER DO YOU USE?

The table below gives an indication of how much water is used in general household activities (**Source**: Waterwise Queensland).



AVERAGE DAILY RESIDENTIAL CONSUMPTION (**Source**: WSSA. Facts)

ACTIVITY	AMOUNT OF WATER (LITRES)
Per shower	40-250
Per bath	50-150
Per toilet flush	12
Per dishwasher load	20-50
Per washing machine load	40-265
Tap running while brushing teeth	5
Drinking, cooking, cleaning per day	8
Hand basin per use	5
Garden sprinkler per hour	1000
Drip irrigation per dripper per hour	4
Car washing with hose (12 minutes)	200
Hosing driveway (5 minutes)	75
Dripping tap per day (1 drip per second)	30

Note: figures are averages and will vary depending on personal habits and design of household appliances

PRE-VISIT ACTIVITIES

Discuss the many ways we use water. Use the chart above to help calculate how much water is used everyday. Ask students to:

- Monitor how much water they use in a day at home and school;
- Monitor how much water is used in their household in 24 hours;
- Look at the way it is used;
- Consider whether it is used wisely or whether it is wasted;
- Investigate how the household/school could change its water usage. Discuss why it should do so;
- Find out how much their local community uses in 24 hours (contact the local water authority);
- Investigate from where it comes and where it goes;
- Discover which industry or organization in Townsville/Thuringowa uses the most water. Consider whether the water could be better used, and how? and
- Investigate why other areas of Australia might use more or less water than Townsville/Thuringowa.

STUDENTS CAN ALSO:

- Find out what about grey water – what it is and how it could be used at home, school, and in the community.
- Investigate whether your local council permits the use of grey water at home, school, or in the community.
- Consider the advantages and disadvantages of using grey water. Are there health risks/advantages?
- Research how residences, companies and others use grey water.

1.7 WATER QUALITY AND TREATMENT

Many parts of Australia rely on water supplies that contain high levels of insoluble impurities such as clay, microbes and colloidal colour bodies. Water may also contain dissolved impurities such as salt, hardness, nitrates, chemical compounds that change its colour, and sulphur compounds that give it an unpleasant flavour or taste. Many supplies do not meet the minimum standards for safe drinking water set by the World Health Organisation.

It would be extremely expensive to treat all sub-standard water supplies, so it is vital to preserve the good quality of our water and catchment areas.

Citiwater Townsville operates the Douglas Water Treatment Plant on behalf of NQ Water. Citiwater adopts a 'best practice' approach to the management of its operations and the Douglas Water Treatment Plant. The plant complies with the International Quality Standards ISO

9002 and with the International Environmental Standards ISO 14001, developed by the International Standards Organisation (ISO).

PRE-VISIT ACTIVITIES

HOW DO WE ENSURE A CONTINUOUS SUPPLY OF CLEAN, SAFE WATER?

Present one of the following scenarios to the class:

- You turn on a tap. The water is brown. Is it safe to drink? How do you know?
- You are camping in the bush by a river. You need water to drink. You are not sure that the water is suitable for drinking. What do you do?
- There are lots of silt and impurities in the river from which you wish to drink. How can you improve the situation?
- The local community is concerned about the quality of their water. What could they do about it?

Students discuss these scenarios and present their solutions to the class. Record suggested solutions. Consider alternatives. Discuss how practical these solutions might be, together with people's rights and responsibilities. Ask:

- Does it matter if the solution is very expensive?
- Would you pay more to have a permanent and clean, safe water supplies?

1.8 CATCHMENT ISSUES

A catchment is any area of land on which water drains to its lowest level. A catchment can range from a small creek to a major river system.

During this visit your students will be investigating the catchment of the Ross River. The entire Ross River catchment covers an area of 1707km^2. Grazing is the dominant land use occupying 1481km^2. State forest and timber reserves occupy 48km^2 and protected areas cover 245km^2. Other land uses at a much smaller scale include horticulture and sugarcane (both less than 10km^2). Sediment export is classified as low risk, whilst total nitrogen and phosphorus exports are classified as medium risk in the Ross River catchment.

Issues in the catchment:

- Grazing lands are in reasonably good condition, with some gully and sheet erosion;
- Many native grasses are still present;
- Significant alteration of the river has occurred through extractions of sand and gravel to supply construction sites in Townsville and for water storage;
- Presence of heavy industry;
- Fish migration patterns have been disrupted by structures such as weirs and dams; and
- Significant area of the catchment has been cleared for grazing.

PRE-VISIT ACTIVITIES

CATCHMENTS

The quality of the water draining a catchment is determined by a variety of factors, the most important being land use in the catchment.

During your visit to the Douglas Water Treatment Plant, identify the land uses in the catchment. Reflect on those you may have passed as you travelled to the Water Treatment Plant. Consider the land uses below:

TYPE OF LAND USE PRESENT (P) OR COMMENTS ABSENT (A)

Grazing - beef cattle
Grazing - horses
Grazing - other
Fruit orchards
Market gardening/vegetables
Forests - plantations
Woodlots
Native vegetation
National Parks
Quarries
Mines
Towns/urban areas
Dams
Industrial sites
Other - (specify)

Add other uses identified by the class. Identify whether particular uses are common or only occasional. Determine whether any of these land uses might pollute the water that runs into the Ross River. Why?

List the types of land degradation that may affect the catchment, or that you may have observed on your way to the treatment plant, such as soil erosion, salinisation, air pollution, stormwater, industrial waste, unhealthy trees, weeds or pest animals, or degraded stream banks. Identify the causes of these problems and suggest possible solutions to improve water quality and the health of the river.

Students might work in small groups to prepare this material. A written report titled 'A healthy catchment - our water supply' taking the form of a poster or report might be prepared and presented to the class.

Discuss the difference between a healthy and an unhealthy catchment.

Issues affecting catchment land management

SOIL EROSION

Ask the class to consider the following questions:

- How does soil erosion in the Ross River catchment affect water quality?
- How has soil erosion occurred? What land uses are likely to result in soil erosion?
- What can be done to protect soil from erosion?

As a class consider the following questions:

- Describe the land (more than one term may apply)
  - Flat;
  - gentle slope;
  - steep slope;
  - river valley;
  - hilly

- Describe the land use
  - Houses;
  - Farms;
  - Dams;
  - Factories;
  - Fences;
  - Grazing animals;
  - Orchards;
  - Vineyards;
  - Roads;
  - Railways;
  - Field crops;
  - Quarries; and
  - Mines.
- Describe the soil
  - Dry, moist, wet
  - Colour - red, yellow, brown, white, grey, black
  - Texture - sandy, silty, clay, rocky
  - Erosion - none, sheet erosion, tunnel erosion, gully erosion
  - Vegetation cover - native vegetation, planted trees and shrubs, pasture grasses, crops

- What land uses are appropriate to protect the quality of the water in the catchment? For what should the land not be used?

SITE EVALUATION

Choose a site within the catchment and evaluate the condition of the land. Add other headings to the list as you undertake an investigation.

1.9 RIPARIAN ISSUES

WHAT IS RIPARIAN LAND?

Riparian land is any land, which adjoins or directly influences a body of water, such as a stream, river or lake. It includes the land immediately next to small creeks and rivers, including the riverbank itself. It may also include drainage lines or gullies which run with surface water during the wetter parts of the year, and wetlands on river floodplains which interact with the river in times of flood or high water levels.

Riparian land is often highly productive. As a result, it is often cleared and used for intensive cropping, grazing or irrigation. In its natural state, riparian land plays an important role in the lifecycle of many native animals and plants.

By its very nature, riparian land is fragile. Its productivity also makes it vulnerable to overuse and to practices which may cause it to deteriorate, causing additional environmental problems. Good management of riparian lands is an essential part of the sustainable management of a property or catchment.

Riparian lands need to be carefully managed to decrease erosion, improve water quality, the health of ecosystems and to retain nutrients in the soil.

Reference: Land and Water Resources Research and Development Corporation (1996) Managing Riparian Land, Canberra.

PRE-VISIT ACTIVITIES

STREAM AND RIVER ASSESSMENT

Water quality and riparian habitat are affected by the condition of our waterways. This activity will enable students to assess the health of a section of their local waterway or one of its tributaries. Use the following questions to frame this activity.

1. Name of the waterway:
2. Date of the assessment:
3. Is it part of a larger river system? If so, what river does it flow into?
4. Width of the watercourse:
5. Look at the water. Is it flowing?
6. Observe its colour. Is the water: - very clear (can see the bottom)?
   - cloudy/murky (can't see very far through the water)
   - very unclear (muddy, brown colour)

PART 1

EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

SITE:

DATE:

	EXCELLENT	GOOD	FAIR	POOR	VERY POOR
GRASS COVER					
HEALTH OF TREES					
TREE COVER					
HUMUS CONTENT OF SOIL					

IS THERE EVIDENCE OF:	YES	NO
Crop cultivation		
Cattle grazing		
Other animals grazing		
Water supply		
Sheet erosion		
Gully erosion		
Wind erosion		
Contouring/terracing		
Windbreaks		
Woodlots		
Remnant trees/vegetation		
Weeds		

Make notes about what you observe. From your notes and the table, comment on the condition of the site you have investigated. How could its condition be improved?

PART 1
EVERY DROP COUNTS – WATER IS A VITAL RESOURCE

THE HEALTH OF RIPARIAN STRIPS

Using string or a tape measure, establish a transect (a straight line) running about 15 metres at right angles up the bank from the edge of the waterway. One end should be in or near the water. Establish a similar transect on each side of the waterway. This is often referred to as 'the riparian strip.' Assess its condition by walking along the transect recording what you see on either side of the line. Use the following table to rank your findings (excellent, good, fair, poor, very poor).

Note: *The True Left (i.e. Left Hand Bank) of a waterway is to your left as you face downstream in the direction in which the water is flowing.*

Water treatment is the process of cleaning water and making it safe for people to drink. Water can absorb all kinds of contaminants and, as we have discussed, natural water is not always clean and safe for people to drink.

Water treatment plants clean and maintain the quality of drinking water by taking it through the following processes:

- Aeration;
- Coagulation;
- Flocculation;
- Sedimentation;
- Filtration;
- Disinfection; and
- Fluoridation.

To set the stage for your visit to the Water Treatment Plant ask the following questions:

- How many of you used water in some way today?
- How did you use water?
- Where does your water come from?
- How can you be sure your water is safe to drink?

Discuss the role of the water treatment plant. Discuss the process that takes place during each step. For primary students, read J. Cole's *The Magic School Bus at the Waterworks*. Use the diagram of the water treatment plant and the following definitions given to explain each step to older students.

ISSUE	LEFT HAND BANK	RIGHT HAND BANK
Condition of native vegetation		
Evidence of grazing		
Presence of introduced trees		
Presence of grasses/pasture		
Presence of cultivated land		
Presence of weeds		
Presence of stream bank erosion		
Evidence of stream bed erosion		

What is the condition of this part of the waterway? How could you improve the riparian strip?

PART 2
WHAT HAPPENS AT A WATER TREATMENT PLANT

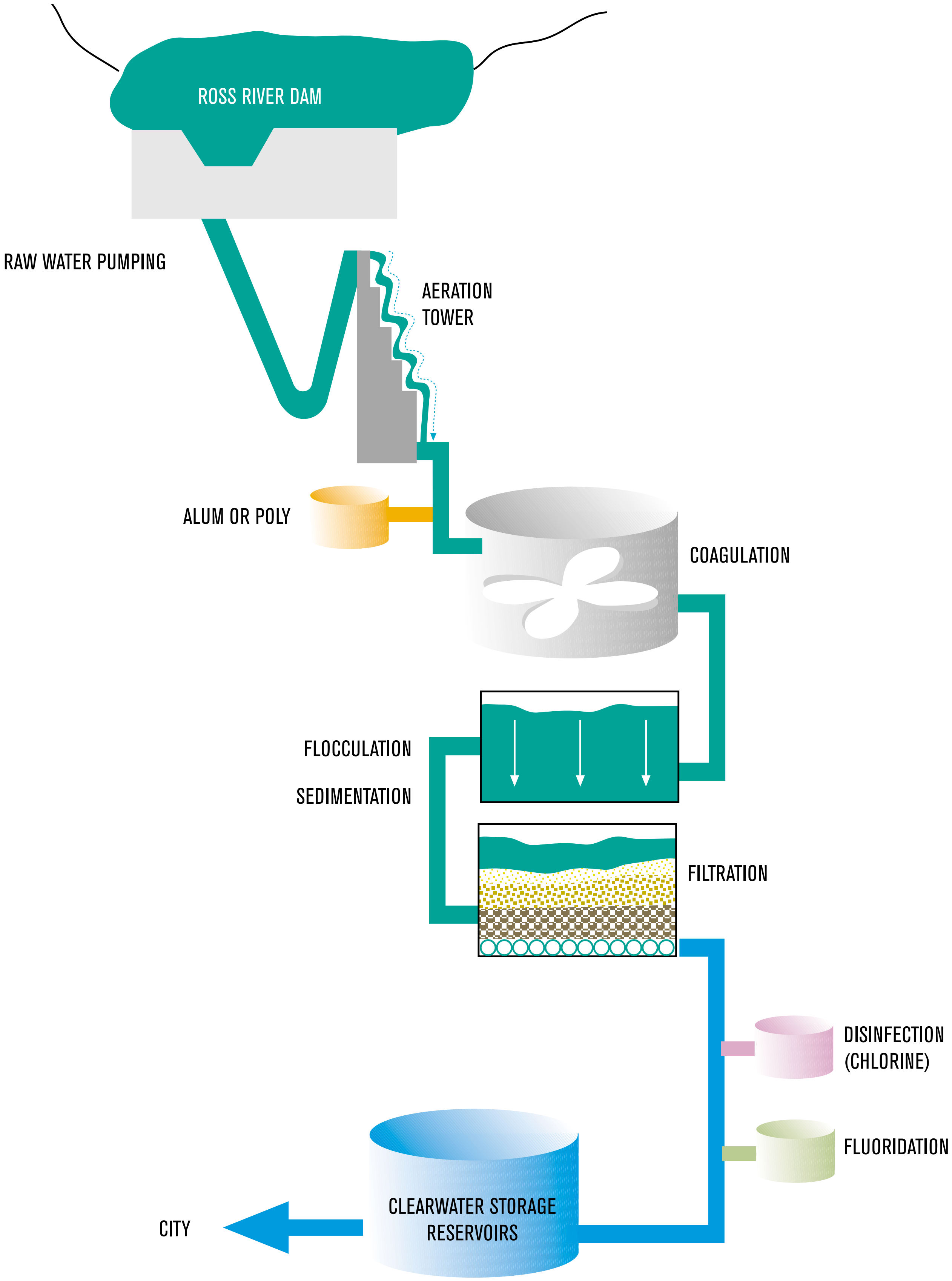


DIAGRAM OF WATER TREATMENT PROCESS

PART 2

WHAT HAPPENS AT A WATER TREATMENT PLANT

Aeration: Thorough mixing via vertical turbine mixers or towers.
Coagulation: Adding chemicals to destabilise harmful particles and to form pin-size floc.
Flocculation: Gentle stirring to cause floc to aggregate into clumps
Sedimentation: Letting the clumps settle out (they are heavier than water so they sink to the bottom).
Filtration: Pouring the water through a filtering system that has many layers of materials that trap particles that did not settle out (including things too small to see).
Disinfection: Adding chlorine to kill germs that might make people sick (similar to swimming pool methods).
Fluoridation: The process of adding fluoride to reduce the incidence of dental decay.

PRE-VISIT ACTIVITY

Review the diagram of the water treatment plant. Discuss it with the students, checking for understanding. Allow for questions from students.

In groups simulate discussion on the water treatment process. For example:

GROUP 1

Prepare some dirty water; add approximately 600 ml of clay to 4 litres of water. Pour 1.5 litres of “dirty water” into a 2-litre bottle (use a funnel). Ask students to describe the water.

GROUP 2

Add 2 ml of alum solution, place the cap on the 2-litre bottle and gently shake for 30 seconds. Continue the rapid mixing process by pouring the water back and forth ten times between two bottles. Ask the students what part of the treatment process has been demonstrated *(coagulation and rapid mixing)*. Encourage the students to describe any changes they observe in the water.

GROUP 3

Take the bottle of coagulated and rapid mixed water and let it stand. At intervals of 1 minute, gently swirl the contents for a period of 10 minutes. Then gently swirl the contents every 2 minutes for another 10 minutes. Observe what happens to the size of the particles during the 20 minutes of this process *(flocculation)*.

GROUP 4

Encourage students to allow the "flocculated" water to stand undisturbed for 40 minutes. Ask students to observe the water at 5-minute intervals and record their observations as to changes in the appearance of the water. Ask students what step of the treatment process this represents *(sedimentation)*.

GROUP 5

Ask students to construct a filter using four 2 litre plastic bottles. One should be full of water.
To prepare the filter:
1. Cut one 2-litre bottle in half;
2. Cut the bottom from another bottle and;
3. Cut the top from a third bottle;
4. Using the bottle with its bottom cut off, turn it upside down and loosely put a cotton wool plug in its neck;
5. Pour fine sand over the cotton wool plug;
6. ‘Clean’ the filter by slowly pouring 4-8 litres of water through it. (This could be done while the water is settling for 40 minutes with the earlier group).
7. Using the water that has settled, and without disturbing the sediments, pour the top two-thirds through the filter.

Ask students what step is being simulated *(filtration)*.

8. Quickly rest the model filter in the bottle cut in half to collect the filtered water.
9. Wait until more than half of the water has been collected and add 40 ml of chlorine bleach to the filtered water to represent the chlorination process *(disinfection)*.

Talk with the students about the filtration process; the amount of water recovered; the amount lost in the treatment process and revisit the sections on treated water and untreated water. Make comparisons. Ask the students whether treatment has changed the appearance and smell of the water.

Finally, explain that this is a simulation of the process that a water treatment plant uses and therefore this water may not be safe to drink.

NOW FOR THE REAL THING

The ten stations outlined below will enable students to gain an appreciation of the water treatment processes carried out at the Water Treatment Plant.

STATION 1: RAW WATER PUMPING

This is the first of 10 stations at the Douglas Water Treatment Plant.

The raw water for the Douglas Water Treatment Plant comes from the Ross River Dam. It can be gravity fed or pumped through a pipeline directly from the dam to the water treatment plant. The flow rate varies between 0 and 1300 litres per second under the influence of gravity, or up to a maximum of 2800 litres per second when boosted by four additional pumps. The Process Controllers can change the flow rate (see Station 10) as the pumps have variable speed motors.

PART 2
WHAT HAPPENS AT A WATER TREATMENT PLANT

In an average season, the Ross River Dam supplies 70-80 per cent of Townsville and Thuringowa's total irrigation, stock, domestic and industrial water supply. In a dry season, this can increase to 90 per cent. The raw water from the Ross River Dam contains a quantity of large objects including logs, sticks and weeds. Screens are placed on the intake pipes from the Dam to prevent these large objects from entering the system. A variety of suspended materials including soil particles and algae is also found in the raw water. Consequently the water must be treated to make it safe to drink.

STATION 2: AERATION AND COAGULATION

All raw water is pumped into aeration tanks before going on to the water treatment plant. Aerators 'tumble' the water in the tanks allowing it to oxygenate. This helps the processes of coagulation and flocculation that follow next. Aeration also oxidises any iron or manganese in the water and helps remove odours.

The next stage is coagulation. This is a chemical process where the raw water (which contains colloidal clay particles, algal, bacterial and colour compounds) is dosed with a coagulant. As its name suggests, the coagulant makes the suspended particles and other compounds in the water bond together. In other words, it takes very tiny particles and changes them chemically so they stick together. This allows them to form lumps or 'flocs,' which settle out so they can be removed subsequently by sedimentation or filtration.

Coagulant chemicals used in the water filtration plants include Aluminium Sulphate (alum) and polymers known as Cationic and Anionic Polymers.

The dose rate of these three coagulants depends on the quality of the raw water. The worse the raw water, the more coagulant is needed. The dose range for alum is 10– 80 mg/L, Cationic Polymer is 3 mg/L, and 0.2mg/L for the non-ionic polymer.

Once the coagulant chemicals have been added, the raw water must immediately be mixed rapidly for a short period in the flash mixer to ensure the chemicals come into contact with all the particles and compounds in the raw water.

STATION 3: FLOCCULATION

Once the water has been dosed with coagulants and are flash mixed, the tiny particles need time to 'clump' together. This is achieved by gentle mixing in flocculation tanks. It is important to ensure that the particles settle well in the next phase of the water treatment process. The water in the tanks is mixed using slow-moving inline mixers combined with the energy of the water flowing into the system.

The treated water stays in the flocculation tanks for about 10 minutes when the plant is at maximum flow If you look carefully, you will see that the floc particles are larger at the outlet of the flocculation tanks than at the inlet.

A polymeric flocculant aid, polyacrylamide, is added to the flocculation tanks to assist flocculation and also to enhance the operation of the sand or coal filters later in the process.

Flocculant aid dose rates are from 0.1 to 0.5 mg/L, depending on the quality of the raw water.

STATION 4: SEDIMENTATION

From the flocculation tanks, the water and suspended floc particles flow downwards and settle out at the bottom of more tanks known as clarifiers. Weirs on the surface remove the settled water uniformly to ensure that any sediment stays in the clarifiers.

The water stays in the clarifier for three hours, before flowing through the system to the weir where it passes to a next stage.

The settled water, which is now much clearer than the raw untreated water (it has a turbidity of less than one NTU), passes on to the filters.

About 90% of the floc particles formed by coagulation and flocculation settle on the floor of the clarifiers. The floors are conical and sludge is removed by the continual operation of a scraper which spans the bottom of the tank and is pulled along the floor by motors. Although they operate automatically, the speed and rate at which the clarifiers are discharged can be changed by the Process Controllers to suit different plant flows and raw water qualities.

PART 2
WHAT HAPPENS AT A WATER TREATMENT PLANT

STATION 5: FILTRATION
The water passes from the clarifiers to a sand filtration process. The sand filters are pressure filters that are sealed. The height of the water creates pressure and forces the water through a filter. The filters are made up of a 700mm layer of sand (grain size about 0.5mm) and five layers of graded gravel 75-100mm thick. The water percolates through the sand, which traps any floc that has escaped the clarifiers. The filtered water then passes into the main collection pipe to the next stage of the process: disinfection, fluoridation, and pH correction.

STATION 6: DISINFECTION, FLUORIDATION, LIME DOSING AND STORAGE
After the water has been filtered, the water is much improved aesthetically and has a turbidity of less than 0.5 NTU and colour less than 2 HU. However, it may still contain bacteria and other minute organisms (such as viruses, parasites, amoeba) that have the potential to cause illness.

To protect public health, the filtered water is disinfected after filtration by adding liquid chlorine (Sodium Hypochlorite). At low dose rates, up to 5 mg/L, liquid chlorine has no impact on humans but is toxic to micro-organisms.

Fluoride is also added to the filtered water. Fluoridation of Townsville and Thuringowa's water supply began in 1967. The benefits of fluoridation have been recognised since the 1930s as an effective way to reduce the incidence of dental decay, particularly in young children.

Hydrated lime is added to the water to increase the Calcium Carbonate content of the water. Townsville's water is reasonably soft and therefore can be corrosive to pipes and the cement lining of pipes throughout the distribution system. By increasing the Calcium Carbonate concentration of the water its corrosive nature is inhibited.

The filtered water is stored in clear water storage tanks allowing the dosed chemicals time to react with the water. The tanks serve as storage tanks for the pumping stations that deliver water to storage reservoirs. Two pumping stations supply water to the Douglas and Mt Louisa reservoirs before the water is distributed to towns and properties in the Townsville and Thuringowa council areas.

STATION 7: BACKWASHING
Periodically, the filters in the treatment plant become overloaded with particles and have to be cleaned so that water can continue to flow through the system. A process known as filter backwashing is automatically initiated at this time. Backwashing uses waster flowing upwards (i.e. in the reverse direction) to clean the filter by removing particles collected on each grain during filtration.

The filter is also blasted with compressed air (known as air scouring) to help clean it. Backwashing takes less than 6 minutes.

STATION 8: SLUDGE REMOVAL
In the process of removing the colour and turbidity from the raw water, large amounts of suspended solids are produced, both from backwashing, and from alum slurry from the clarifiers. This material is collected in two reclamation ponds. These ponds have mechanical mixers to ensure the suspended solids do not settle out. They are pumped up to small clarifiers where the suspended solids form into sludge. The clear water is recycled back into the raw water main for re-treatment. The thickened sludge is pumped into a centrifuge that spins out the water at high speed and dries the sludge to approximately 20% of its bulk. The resulting sludge is spread out to dry fully before being trucked to land fill.

STATION 9: CHEMICAL DOSING
It is vital to be able to accurately control and measure the chemicals that are added during the water treatment process. The process requires special equipment such as positive displacement metering pumps and magnetic flow meters. Metering pumps with variable stroke length are used to change the chemical dose rate and a variable frequency drive regulates the flow of chemical solution to match the flow of water through the treatment plant. In this way, the concentration of chemical in the treated water can be kept constant.

Chemical dosing systems also have calibration cylinders so the Process Controllers can check the accuracy of dosing pumps and flow meters. There are normally two systems for each chemical, so if one fails, a standby system is ready to take over.

Chemicals are delivered to the water treatment plant by road transport. Some chemicals are delivered in liquid form as solutions (alum, Sodium Hypochlorite, Cationic Polymer) and are stored directly in tanks and dosed as solutions. Other chemicals are delivered as a powder (lime, polyacrylamide, fluoride) and have to be mixed with water and are dosed as slurries or solutions.

Many of these chemicals are hazardous, and emergency showers and eyewashes are provided in case operators are sprayed or doused accidentally. Rigorous training in the handling of these chemicals is part of the duties of the Process Controllers.

Each chemical storage tank is equipped with level sensors and the Process Controllers can monitor the amount of chemical through the plant's control system.

STATION 10: CONTROL SYSTEM
The plant is fully automated and computer controlled by a Supervisory Control and Data Acquisition (SCADA) System. This

allows the daily flow rate, tank levels, chemical dose rates and other plant operating criteria to be set as required. The plant is controlled by one of two programmable logic controllers (PLCs), one operating and one on standby to take over if the other fails, which are accessed by the Process Controllers through each Control Room desktop computer. The plant can also be controlled remotely using the Process Controllers' laptop computers via a modem and telephone line.

The plant computers contain mimic screens with flow sheets showing how the process works. The computers tell the Process Controllers which valves or items of equipment are on or off, chemical dose rates, tank levels and plant flows, and any faults in plant operation. Plant and equipment can be started or stopped from the computer system. The computers also contain trend screens which are graphs of plant operating parameters (for example, water flow, tank levels, chemical dose rates) over a relevant time period, such as the last 24 or 48 hours.

All plants are designed to operate automatically and unattended. An automatic dialler is used to telephone the on-duty Process Controller in the event of a fault or plant breakdown.

Four Process Controllers look after the Douglas Water Treatment Plant.

POST-VISIT ACTIVITIES

The following 'challenges' are open-ended practical or research activities, designed to encourage students to use and build on understandings gained during the visit.

Each challenge might be photocopied onto card and laminated for use by students.

MOVING WATER (LINK TO STATION 1: RAW WATER PUMPING)

Devise a way of moving water from one container to another
Your challenge is to make a simple model to move water. To do this you can use tubing, containers, tube connectors and water. If you have another idea, discuss it with your teacher.

In planning how to make your model you will need to do some research. Some ideas to consider as you plan your work include:

- How do water treatment plants move water from a source to a holding tank?
- How is water moved to a water tower?

You may also have to consider the materials available to use. Write a record of your work including information about planning and conducting your investigation and evaluating your findings.

PART 2
WHAT HAPPENS AT A WATER TREATMENT PLANT

GET RID OF THAT SMELL (LINK TO STATION 2: COAGULATION)

Find a way of removing smells from water

Your challenge is to design and build a system to remove smells from water. You will need:

- Filtering materials;
- Two containers or pots;
- A funnel;
- Pipette;
- Beaker;
- Scented water; and
- Activated carbon.

1. Reflect on the processes used at your local water treatment plant to remove smells from water.
2. Make a list of materials you could use to simulate a smell in water and devise a process which removes the smell.
3. As a group, discuss ideas for your system. Draw up your selected idea and explain how it will work. Build your model and run scented water through it.
4. Evaluate whether your system works efficiently or whether any modifications or changes are required.

SETTLE DOWN QUICKLY (LINK TO STATION 2 AND 3: COAGULATION AND FLOCCULATION)

Find a way of making murky water settle down quickly

Your challenge is to plan a simple investigation and simulate the process of coagulation (the process by which dirt and other suspended particles are chemically "stuck together" so they can be removed from the water). You will need:

- 2 small pots
- 1 stirrer
- 1 pipette
- Clay powder
- Aluminium Sulphate (alum) (found in the spices section of a supermarket)
- Water

1. Use one pot containing 100 ml of water and a teaspoon of clay as your control.
2. Repeat amounts in the second pot adding 4 ml (in 2 amounts of 2 ml) of Aluminium Sulphate (alum).
3. Stir, let settle and make comparisons.
4. Record observations and comment on the difference the alum has made.
5. Write a record of your work including information about planning and conducting the investigation and then processing data and evaluating your findings.

WILL IT SINK, SETTLE OR DISAPPEAR? (LINK TO STATION 4: SEDIMENTATION)

Find out whether a range of clumps settle out

Your challenge is to select a range of materials and then think of an interesting investigation you can do to learn whether the materials settle out like the suspended floc particles do in the sedimentation process. You should talk about your ideas with your teacher, set up your experiment and start recording your observations.

Consider the materials you may need:

- Gravel;
- Salt;
- Sand;
- Flour; or
- Soil .

1. Make predictions about what you think will happen when they are mixed with water.
2. Devise a way to test fairly whether your predictions are correct.
3. Write a record of your work including information about your planning, predictions and conducting your investigation (include a diagram).
4. Record your observations, findings and evaluations.

CLEAR AS WATER (LINK TO STATION 5 AND 6: FILTRATION AND DISINFECTION)

Find a way to clean up water

Your challenge is to design and construct a simple water filtration system that has layers of material. You will need:

- 2- litre plastic bottles;
- Yoghurt or margarine containers;
- Tubing and filtering materials eg cotton wool, fine sand, charcoal, coarse sand, fine gravel, coarse gravel and water.

As an alternative, design and make a sand filter similar to those used in swimming pools or fish tanks.

1. Start with a bottle of fresh rainwater.
2. Find out what contaminates this water as it makes its way to your town or city.
3. Add these contaminants to your water.
4. Research what materials are commonly used in commercially made water filters. Make a list of materials you could use to filter your murky water.
5. Draw two neat sketches of the two different filters you could make.
6. Select your best idea and complete a labelled drawing of it.

OR

Make your filter and write an explanation of how it works. Write a short piece titled: *'A day in the life of a water filtration system.'*

Evaluate:
- Does the filter work?
- Is the water safe to drink?
- Is it suitable for the garden?
- What can we do to reduce the amount of contaminants entering the water filtration plant?

REMOVING SLUDGE (LINK TO STATION 8: SLUDGE REMOVAL)

Find out how sludge can be removed from water

Your challenge is to design a sludge removal system similar to that found in a water treatment plant.

You will need:
- A 2-litre clear plastic soft drink bottle;
- A mixture of dirty water containing soil sediments to represent the sludge; and
- Two corks or stoppers.

1. You will need to devise a way of separating the soil sediment from the water.
2. You will need to consider your prior knowledge of gravitational forces and what you have learned from your visit to the local water treatment plant.
3. Discuss ideas for your 'Sludge Remover'.
4. Draw a neat sketch of your model, complete with labels highlighting how it works.
5. Make your model and write an explanation of how it works, using diagrams to illustrate both before and after sludge removal.

DISTRIBUTING WATER (LINK TO STATION 6: STORAGE AND DISTRIBUTION)

Find out what happens when water is moved from one point to another

Your challenge is to build a model of a community water supply system from the source to the user.

1. Reflect on information obtained at the local water treatment plant and from your teacher.
2. Investigate where your water comes from and draw your selected version of this source.
3. Construct a water treatment plant with storage tanks, houses and other buildings to represent your town and design a system of pipes to supply the water.
4. Write a report about the water system.
5. Include details of what you have learnt, how you have worked as an individual or with your partners, the quality of your research and finished model, and if you enjoyed the task.

Optional: You may also show another set of "pipes" going to a wastewater treatment plant and returning to the source.

PROMOTE A LOCAL WATER TREATMENT PLANT AND THE BENEFITS IT PROVIDES

Your challenge is to support the Board of NQ Water.

Scenario: It appoints you as Sales and Marketing Director to produce a T-shirt for sale to visitors. Your T-shirt requires a unique design - one that is attractive and in keeping with the water treatment plant. It should promote a clean water message. You are required to present an actual T-shirt with your design for the Board's approval.

Task: to promote a T-shirt on which is a design and information, which will appeal to the public, convey some information and satisfy the Board of NQ Water.

Requirements: The following aspects need to be taken into account when creating your design:
- The name of NQ Water must appear as part of your design; and
- Any symbol, logo and design should cover an area of no less than 900 cm^2 (30cm x 30cm).

- Investigate how best you can produce your chosen image.
- Give some thought to the age level of wearers of your T-shirt. Are you designing for a certain age group or community water consumer?
- Remember to seek permission to use the NQ Water logo.
- Keep records during the task. Comments could be made on:
  - The suitability of materials/fabrics
  - Easy and difficult tasks
  - Help needed, eg, why and what?

GROUP PRESENTATIONS

Devise a way to showcase the understandings you have gained about where your water comes from, how and why it is treated and how it is distributed to others.

CONSIDER THE FOLLOWING OPTIONS:
- An oral presentation;
- A brochure, pamphlet or booklet;
- A web page;
- A multi-media; or
- PowerPoint presentation

PART 3
WASTEWATER

It is easy for people to take fore granted uninterrupted access to safe, clean drinking water and reliable wastewater treatment. We turn on the tap and water appears. We flush the toilet and our waste disappears. As if by magic – out of sight and out of mind. But it's not that simple.

You now know what happens to untreated water before it reaches your homes to make it safe for you and your family to use. But have you ever wondered how the water is handled after you've used it to ensure that you and our environment are protected?

Reference: Ontario Clean Water Agency (2000) Water and Wastewater Treatment

3.1 WHAT IS WASTEWATER?

Wastewater comprises used water from domestic toilets (generally called sewage), kitchens, bathrooms and laundries (often called grey water). Used water from manufacturing and processing plants is also part of wastewater. Wastewater is 99.97% liquid and the balance is a small amount of solid or dissolved matter.

Wastewater should not be confused with stormwater which is run-off resulting from rainfall collected off roofs, guttering and sealed surfaces such as roads, which eventually flows into collector drains or watercourses. In our urban areas, the wastewater and stormwater collection systems are quite separate, but in some countries they are combined. Each is designed to do a specific task and to cope with different volumes of waste.

ACTIVITIES

- Ask students to predict what makes up wastewater.
- Ask students how water gets 'dirty.'
- How is it cleaned?
- Talk with the class about their challenge of finding out how wastewater is cleaned.
- Challenge students to define wastewater.
- Ask students to stop and think about what happens when they pull the plug in the bathroom, laundry or kitchen sink, have a shower or flush the toilet.
- Where does all the water and waste go?
- Consider the question "Where does our water go once we have used it?" Use a "think-pair-share" strategy and then collate ideas.
- Make comparisons between wastewater and stormwater that are carried away from our homes and suburbs by separate systems of pipes.

Challenge students to make some wastewater. They will need:

- Containers or glass jars;
- Water;
- Cooking oil;
- Soil;
- Detergent;
- Plastic
- Paper food scraps;
- Cotton buds;
- Sugar.

Ask students to record the procedure they used. Discuss with students whether this water could be used again and whether it needs to be treated to make it suitable for reuse.

Discuss what happens to rain water. For example 'it flows over or under paths, drips, pours, runs, washes away, it goes through downpipes, into gutters and drains away.' Explore whether and how students think this water can be reused.

Observe what happens to wastewater at home. Survey what goes down the kitchen sink. Design a survey sheet. Undertake survey overnight and discuss the survey results on return to class. Talk about things that should not have gone down the kitchen sink, and consider what is safe to put down the kitchen sink.

Write an account, 'What went down my kitchen sink last night.' Ensure the concluding statement addresses the cause/effect of putting inappropriate materials down the sink.

- Discuss the health implications of putting inappropriate wastes down the kitchen sink, and the importance of disposing of household wastes in the appropriate manner.
- Devise simple rules that could be put in place for the disposal of ingredients down the sink.
- Brainstorm and discuss items that shouldn't be put down the toilet.
- Design posters educating people about what shouldn't be put down the kitchen sink or toilet.
- Observe (over a week) what happens to wastewater in the home.
- Design a chart to list what goes into the wastewater system and include ways to prevent harmful items entering it.
- For each of the areas identify items that are safe to dispose of into the system.
- For unsafe items, identify how they should be disposed of properly.
- Find out to which treatment plant the wastewater from your school would go.
- Estimate the number of toilets, drinking fountains and sinks from which wastewater enters into the wastewater system from your school.
- Discuss in groups, how wastewater from the school could be disposed of if there were not a wastewater disposal system.
- Investigate ways of reducing the amount of wastewater going into the wastewater system.

PART 3
WASTEWATER

Note: The amount of domestic wastewater entering the system everyday is about 200 litres per person.

Work out how many of the following containers would represent 200 litres of wastewater. How many:
• 2 litre plastic cordial containers;
• 9 litre plastic buckets; or
• 600 millilitre milk cartons?

3.2 WASTEWATER IN TOWNSVILLE

Citiwater collects and treats wastewater in Townsville. There are two major wastewater treatment plants (WWTP) in the Townsville area:

• Cleveland Bay Wastewater Purification Plant; and
• Mt St John Wastewater Treatment Plant.

The Cleveland Bay Wastewater Treatment Plant started operations in August 1988. Processes for the treatment of wastewater at the plant include:
• Screening;
• Aerated grit removal;
• Activated sludge treatment;
• Clarification;
• Dissolved air flotation;
• Sludge thickening;
• Anaerobic sludge digestion;
• Sludge lagoon drying; and
• Disposal.

The plant receives and treats 22 ML (Megalitres) of raw sewerage every day.

The Mt St John wastewater treatment Plant is one of Townsville's major wastewater treatment plants. It started operations in 1972 and has been continually upgraded ever since to meet the demands of an ever- increasing population.

The Mt St John wastewater Treatment Plant consists of:
• A primary screen;
• Aerated grit tank;
• Primary clarifiers;
• Bio-filters;
• Secondary clarifiers;
• Sludge digestion tanks;
• Sludge drying beds; and
• UV disinfection.
Sewage at this plant goes to primary and secondary levels of treatment.

The plant receives between 11 and 13 ML of raw sewage every day. Some treated effluent is reused to irrigate the plant's grounds, the RAAF Base, Rowes Bay Golf Course and the Pallarenda foreshore.

These resources discuss how wastewater is collected, treated and used.

ACTIVITIES

Explore facts about wastewater in Townsville. Visit the Townsville City Council website. See http://www.townsville.qld.gov.au and research how council collects, treats and reuses wastewater.

Prepare either a multi-media presentation, a report or brochure which conveys detailed information about the Council's collection and treatment of wastewater in Townsville, and its commitment to maximising the productive use of treated wastewater wherever this is economically and environmentally sustainable.

3.3 COLLECTING WASTEWATER

Try to imagine a world below your feet: A vast underground network of drains and sewage pipes going in all directions, linking houses, offices, entertainment places and factories, working silently and unseen 24 hours a day, seven days a week, 365 days a year.

This is the wastewater collection system. This dark world of pipes is largely taken fore granted, but we all rely upon it for the city to function. If it didn't work, we would all know about it pretty quickly!

The wastewater system operates largely by gravity flow, but it also includes pumping stations. In the city centre and the suburbs, the wastewater pipes are from one to six metres below the ground surface. The pipes are generally circular, with diameters ranging from 150 mm to 2.6 m, depending on the volume of wastewater to be transported. The pipes can be made from vitrified clay (pottery pipes) or more commonly today, they are reinforced concrete or plastic.

ACTIVITIES

Revisit *Ninja Turtles* and *Abe's Odyssey* in PlayStation video games. Talk about where these characters came from and the world they inhabit.
Locate and map drains and access holes in roads in your neighbourhood. Suggest what they might be used for.

Make a model representing Townsville's wastewater collection system.
Devise a way of moving water by gravity flow. To do this you might use tubing, containers, tube connectors and "dirty water". If students have alternative ideas discuss these with peers and

teachers. In the planning stage research how wastewater systems operate largely by gravity flow and pumping stations. Consider how wastewater systems move water from homes and businesses to wastewater treatment plants. Write a record of the investigation processes and outcomes. Make the model and appraise its effectiveness.

Explain to the class that:
The wastewater generated by the community in Townsville is collected by sewers for treatment and disposal. This **wastewater system** collects and transports wastewater to a treatment plant.

Household wastewater flows from the house (using gravity) into pipes which are usually at the front or rear of the property. These pipes in turn run into a network of larger pipes or main sewers. From the main sewers the wastewater gravitates or is pumped to a treatment plant for treatment and disposal.

Ask students:
- What additional things you would like to know about the wastewater system?
- What could you do to find out more?
- What are some of the things that concern you about the wastewater system? (e.g. environmental issues, disposal issues, age of the sewer network).
- What could people do to help solve these problems?
- Students draw, write about, and prepare information to demonstrate their views.
- Discuss in groups how wastewater from your school could be disposed of if there were not a wastewater disposal system.

Pose the question: Can wastewater be used to irrigate parks and gardens?

Design a flow chart of the wastewater system.

Find out what happens when wastewater goes into the wastewater collection system.

- Build a model of the wastewater system from the source to the wastewater treatment plant.
- Reflect on where wastewater comes from and make models of your selected version of these sources.
- Design a system of pipes to collect the wastewater and construct a wastewater treatment plant.
- Write a report about the wastewater system in Townsville or a suburban area.
- Include details of what has been learned, processes used to make the model, how you have worked individually or as a member of a team, the quality of your research and finish model, and what you learnt from the task.

3.4 WHY DO WE TREAT WASTEWATER?

Until relatively recent times, sewage and other wastewater was disposed of without being treated, and in many parts of the world, this still happens. Untreated waste was generally discharged to water, to the sea, a river or a lake. The result was polluted water and many serious outbreaks of water-borne diseases such as cholera. The waste was frequently discharged into the same body of water that the community used for drinking, cooking and washing.

Wastewater can be a source of disease-causing organisms, toxic compounds and nutrients, which in excessive amounts can cause environmental pollution. **Toxins** are compounds that are poisonous or harmful to living things (including humans) that are often difficult to remove from the environment once they are released. They include herbicides, pesticides, heavy metals (such as copper, zinc, chromium and mercury) and some household chemicals.

The elimination of pollutants must occur at source: at home or at work. We all contribute to wastewater pollution in our daily activities, but we can minimise our impact by not disposing of potential pollutants to the wastewater system. The key to reducing household pollution is simply to cut down or eliminate your use of chemical products.

Many household products contain toxins, for example shampoo, toothpaste, detergents, disinfectants, chlorine bleaches, hair dyes and tints, toilet 'blues,' general cleaners, mouthwash, floor cleaners, shaving cream, ointments, anti-dandruff shampoo, and so on - the list is almost endless.

This is important because wastewater treatment relies in large part on microscopic bacteria and other living organisms to assist in breaking down and purifying the waste. Wastewater treatment is a living process. Modern chemicals can kill these organisms. Entire wastewater treatment systems can be 'knocked out' by people disposing of chemicals in the wrong way. In addition, many modern compounds are extremely persistent – which means that they stay in the environment for a long time without breaking down, and can continue to cause damage for many years.

There are many alternative compounds to modern chemicals that can be used, that do not have harmful environmental impacts. Many of them have been around a very long time and would have been used by your great grand parents who did not have access to today's chemical compounds. For example, use pure, unscented soaps, white vinegar, lemon juice, bicarbonate of soda and eucalyptus oil as cleaning agents. There are many books and websites promoting natural alternatives.

Pollution can also arise from the dumping of products such as paints, sump oil, swimming pool chemicals, pesticides, mineral turpentine, kerosene, acids and garden chemicals, into the wastewater system. It has been estimated that almost 1.5 kg per person of household chemicals is disposed of annually in the wastewater stream in Sydney. That's a lot of pollutants that must be removed before we can safely reuse the treated wastewater or **biosolids**.

ACTIVITIES

Discuss why it is important that we treat and dispose of wastewater correctly.

Research how people in earlier times disposed of their wastewater.

As a class, discuss why we need to treat wastewater and build on the discussion by conducting an experiment.

Using an ice cream container two-thirds full of water, ask students to place different ingredients into the water, such as matchsticks, dirt, cooking oil, food scraps, paper, plastics, detergent, toothpaste, soap. Ask students to predict what they think might happen and observe results. Record the findings.

Talk with students about the problems that occur when such ingredients go into water.

Talk with students about what might happen if all the wastewater from homes and industries were disposed of directly into our rivers, oceans or groundwater without being treated.

Note: If water wasn't treated before being disposed of, our water resources would become polluted. Wastewater contains solid materials of human and animal origin as well as some potentially harmful bacteria and viruses. With population growth, the environment and its rivers, streams, and oceans would be unable to cope with the volume of untreated wastewater.

Reflect on the past. Ask students to imagine what North Queensland's beaches, rivers and creeks might have been like a 150 years ago when sewage and wastewater was disposed of without being treated. Use this scenario to develop a consequence wheel to uncover the many consequences that might result from discharging untreated wastewater into the environment. Identify first, second and third order consequences.

Investigate why we need to treat wastewater. Simulate wastewater using a large container two thirds full of water. Add cooking oil, detergent, torn paper, cotton buds, soil, sugar and food scraps. Stir or shake gently. Discuss your observations.

Ask students what they think are the most important things people need to know to avoid wastewater pollution in our daily activities.

In groups, students discuss and record why they think it is important to know how to minimise our contributions to wastewater pollution in our daily activities, now and in the future.

Encourage students to collect information and prepare a poster, brochure or web page to demonstrate ways in which people can avoid wastewater pollution.

Discuss how the human body functions in a similar way to the operation of the wastewater system. Discuss ways in which we need to look after our body. Liken this to maintaining the wastewater system.

Note: Pipes in the wastewater system can be compared to arteries in the human body. Just as a high fat diet causes blockages in the blood supply, too much fatty material poured down the drain causes the same build up and restricts water flow in sewage pipes.

Explain to the students that it could cost a house owner anywhere between $100 and $200 to have a routine blockage fixed.

Reflect on the following scenario:

- A wastewater pipe from your house, 100 millimetres in diameter, becomes blocked after someone has accidentally dropped a can into the toilet and flushed it. Discuss the following questions:
    - What do you think could happen?
    - What would happen if it blocked the wastewater system?
    - How would it be fixed and how much might it cost?

Draw a consequence wheel and consider the consequences of larger sewer pipes being blocked.

Students write or draw anything that comes to mind when they hear the phrase *Wastewater Treatment Plants*.

Identify an example of one of Townsville's Wastewater Treatment Plants; define and list the characteristics of this treatment plant.

Visit the Council website and download information about our Wastewater Treatment Plants. See http://www.townsville.qld.gov.au and search 'wastewater treatment.'

Contact Citiwater to arrange a tour of your local Wastewater Treatment Plant and request their brochures about wastewater treatment.

Assign students a task as newspaper reporters. They are asked to write a report on "Where does our wastewater go?" In carrying out this investigation ask students to examine where wastewater from their homes, local businesses and industries goes.

PART 3
WASTEWATER

3.5 WASTEWATER TREATMENT

The processes used to treat wastewater at Townsville's Wastewater Treatment Plants are fundamentally similar but there are some differences in procedure between the plants. The discussion below gives a general description of the treatment process that has four main stages, namely:

- Preliminary treatment;
- Primary treatment;
- Secondary treatment; and
- Disinfection.

Let's consider what these stages involve:

PRELIMINARY TREATMENT

The main objective of this stage is to remove large solid materials and grit from the wastewater, which could interfere with the treatment process, causing blockages or damage to the operating plant. The phases in this stage include:

Screening: removes coarse materials which could damage or block pumps or other equipment.

Grit removal: eliminates inorganic material such as sand and silt which could cause abrasions to plant and equipment.

Pre-aeration: minimises odour problems and increases the efficiency of the sedimentation stage. All screenings and grit are disposed of off-site to an approved landfill site.

PRIMARY TREATMENT

Primary treatment is a sedimentation process. It may, or may not, involve chemical assistance. Following preliminary treatment, wastewater is piped to large sedimentation tanks where solid particles are removed from suspension by gravity settling. The settled raw or primary sludge is pumped into an anaerobic digester while the wastewater, now termed primary effluent, passes to the secondary treatment stage. Primary treatment removes up to 40% of the organic pollutants and 60% of the suspended solids.

SECONDARY TREATMENT

This stage removes dissolved and suspended organic material using aerobic biological oxidation and sedimentation. The biological process breaks down dissolved and suspended solids with active micro-organisms, such as bacteria, protozoa, fungi and algae. Wastewater is a rich source of food for micro-organisms. Aerobic micro-organisms (that is, those that require oxygen to live) are able to break down the organic matter in wastewater quickly and efficiently; so various technologies have been developed to optimise conditions for these microbes to work.

Two main secondary processes are used in our wastewater treatment plants: bio-filters (also known as trickling filters) and activated sludge. All metropolitan plants use the activated sludge process while some country plants use bio-filters. Activated sludge plants are more expensive to build and operate but are capable of removing more nutrients from the wastewater.

The activated sludge process takes place in aeration tanks. Air is blown into the tanks to provide oxygen and mixing, which enables the micro-organisms to remove organic pollutants and nutrients from the wastewater. With the airflow supplying the necessary oxygen, these microbes digest the organic matter in the wastewater. The carbohydrates in the waste matter are converted to biomass, carbon dioxide and water, and the nitrogenous matter from ammonia and proteins is converted to nitrates.

Sludge produced during this stage is termed activated sludge. From the aeration tanks the mixed liquor passes into secondary clarifiers where the sludge settles to the bottom from where it is continuously returned to the aeration tanks. This treatment stage removes more than 90% of the organic matter and suspended solids remaining after the primary treatment.

DISINFECTION

The treated wastewater is disinfected prior to leaving the treatment plant to be discharged. Chlorine was most often used for this purpose (chlorination) but as it is toxic to aquatic life, modern plants that produce high quality, clear effluent can use ultra violet (UV) irradiation in the disinfection process. Disinfection must eliminate all disease-causing organisms that may represent a risk in the proposed reuse.

After disinfection the flow is discharged to the sea, a waterway, an evaporative lagoon, or is reused. High quality recycled water is used within the plant for flushing equipment, to irrigate grassed areas or on garden beds. Treated wastewater from several wastewater treatment plants is now being piped to nearby green areas as a water saving initiative.

ACTIVITIES

In small groups, brainstorm and record everything known about wastewater treatment plants. A reporter from each group shares this information with entire class.

Discuss what a wastewater treatment plant is all about. Predict how it might work, what you might see and find there.

Build on understandings and in groups simulate the wastewater treatment process.
Assign process names and provide each group with a process card describing what happens within their process component.

PART 3
WASTEWATER

Note: These can be developed from the teacher notes.

Assign a small group of students to be 'wastewater.' You might tape paper scraps onto them. Invite the wastewater students to undergo 'cleaning.' Each group representing a treatment process describes their cleaning activity and removes paper scraps from the 'wastewater.' Continue until all 'wastewater' students are 'clean water.'

Arrange a visit by an officer from the local wastewater treatment plant to talk about the wastewater treatment process or visit a wastewater treatment plant to experience how wastewater is treated.

Create a large sample of wastewater. Place cooking oil, detergent, some soil, food scraps, sugar, small pieces of torn paper, plastic, and matchsticks in water. Devise a way to simulate the process that takes place during each step of the wastewater treatment process.

Students can be challenged to design and produce a process to:
• Screen coarse materials;
• Eliminate sand or grit;
• Remove odours;
• Separate solids and liquid that may be settled by gravity settling;
• Remove sludge;
• Disinfect; and
• Distribute treated wastewater to users.

and/or

Use a similar wastewater recipe, and leave to stand overnight. Consider what would have to be done to it before it could be released into the environment. Consider how to dispose of the 'waste' materials separated from the liquid. Challenge students to devise a way to clean the wastewater using similar processes to screening, grit removal, aeration and both primary and secondary treatment processes.

Support students in planning and producing a flow chart to explain the processes of wastewater treatment. Ask students to include:
• A title and subtitles;
• Labels;
• Pictures or diagrams;
• Arrows; and
• Sections that show the stages within the processes of wastewater treatment, including sources of wastewater; stages within preliminary treatment; stages within secondary treatment and disposal of treated wastewater.

In addition, ask students to include a brief explanation what happens at each stage of wastewater treatment including:
• Sources of wastewater;
• Stages within preliminary treatment;
• Stages within primary treatment;
• Stages within secondary treatment; and
• Disposal (or use) of treated wastewater.

ADVANCED TREATMENTS
Effluent can be further treated to produce water of even higher quality when the water is to be:
• Discharged to a natural watercourse;
• Used for industrial purposes;
• Used for irrigation of crops that are eaten raw;
• Used for recharging of groundwater supplies; and
• Used to augment drinking water supplies.

The type of treatment used will depend on the intended use of the water. It can be a waste of resources, such as energy, to process wastewater to a standard that is higher than necessary for its intended use. However, the quality of effluent water must be sufficient to protect human health and the natural environment. Advanced treatment methods may include further disinfection, chemical coagulation or filtration. Artificial wetland systems can be used to further purify water. Wetlands are also used to clean stormwater prior to storage, reuse or discharge.

ANAEROBIC DIGESTION
The sludge from the primary sedimentation tanks, and excess activated sludge from the clarifiers, is pumped to sludge digestion tanks (also known as heated anaerobic digesters). These are anaerobic digesters where the micro-organisms work in the absence of oxygen. Bacteria are used to break down the organic matter to produce carbon dioxide, methane and a stabilised organic and inorganic residue, known as digested (sewage) sludge or biosolids.

The methane produced is used as a fuel for the gas-fired boilers, which maintain the temperature of the digestion tanks at around 35o C, and in engines and turbines to provide power for plant operation. Digested sludge is further stabilised and air-dried in lagoons. The dried sludge (generally known as 'biosolids') is stockpiled on site for several years to reduce pathogens that may affect human health. It is used, in accordance with strict guidelines, for a range of purposes.

BIOSOLIDS
Biosolids, the organic solid residues produced by the wastewater treatment process, are useful crop fertilisers and soil conditioners.

Biosolids contain approximately 1% each of nitrogen and phosphorous, 30-40% organic material, and various micro-elements, such as copper, zinc, nickel and lead. They have a pH of about 7.2, which means they are nearly neutral – neither acidic nor alkaline. The product is air dried, relatively odourless, and friable, which makes it easy for spreading. Research shows that an application of biosolids of 10 tonnes per hectare will increase soil organic matter by about 0.5 tonnes per hectare.

Biosolids are already producing significant benefits as fertiliser and as a soil improver for farmers in other states. Its use in agriculture has increased rapidly in New South Wales over the past decade. In 1996-97 nearly 96,000 tonnes or 70% of the total production from the Sydney metropolitan area, was used for growing crops and pastures.

ACTIVITIES

Group of students can determine their own area of inquiry based on wastewater treatment technologies that emerge from classroom discussions. Encourage students to clarify the question they are intending to investigate by individual or group formulation of possible inquiries.

Valuable information can be collected via a variety of means, and students could be encouraged to:

- Conduct interviews with staff from wastewater treatment plants and industries who are involved in treating wastewater for reuse opportunities; and
- Take notes from published information.

Invite a guest speaker from the Environment Protection Authority or local council to explain the damage that can be done to the environment by the release of wastewater and the purpose and significance of advanced treatments.

Write reports about the processes of treating pollutants and the effect pollutants can have when released into the environment.

CONTACTS

WATER TREATMENT PLANT CONTACTS

Douglas Water Treatment Plant
Phone: (07) 4727 8999 or (07) 4727 8950
Fax: (07) 4727 8927
Email: citiwater@townsville.qld.gov.au

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GLOSSARY

Activated sludge: Treatment process in which wastewater to be treated is mixed with previously grown micro-organisms and aerated.

Aeration: Mixing or agitation of wastewater, allowing for the mixture of air (oxygen) with the wastewater.

Algae: Type of simple aquatic plants.

Algal bloom: An extensive growth of algae in a body of water (river, lake, dam), usually as a result of high nutrient levels in the water.

Arable: Land that is or could be cultivated for crop production.

Biosolids: The organic solid residues produced by the wastewater treatment process.

Catchment: The area of land from which surface and groundwater drains into a river or other watercourses.

Chlorination: The application of chlorine to water generally for the purpose of disinfection.

Coagulate: To thicken into a semi-thicken mass.

Coliform: Group of bacteria coming from animal intestines; used as an indicator of the bacteriological quality of water.

Colloidal matter: Very fine particles, which do not readily settle (or precipitate) but remain in suspension in a liquid.

Cyanobacteria: Blue green algae.

Degradation: Any decline in quality of natural resources commonly used by humans. Pollution which enters a watercourse via numerous entry points or arises from a large number of dispersed sources.

Disinfection: The destruction or inactivation of water-borne bacteria and viruses with a disinfectant such as chlorine.

Drainage: Systems of drains, natural or artificial, which intercept and remove excess surface and/or sub-surface water. The water is generally collected in a drainage disposal basin and the water allowed to evaporate.

EC: Abbreviation for 'electrical conductivity'. Commonly used to indicate the salinity of water.

ESD: Abbreviation for 'environmentally sound development.' Is development that meets the needs of the present generation development but does not compromise the ability of future generations to meet their own needs.

Ecosystem: A community of plants and animals, considered as a total unity with its physical environment.

Effluent: The cleaned wastewater, that is, the final liquid by-product of the wastewater treatment process, flowing out of a treatment plant or lagoon.

Erosion: The wearing away of rocks and soil by an agent, eg wind and water.

Evaporation: Water evaporated from the Earth's waterways, lakes and the ocean and rises invisibly into the air as water vapour.

Flocculate: To form masses or aggregates of particles.

Freshwater: Water that has very low levels of salt.

Gigalitre (GL): One thousand million litres.

Greywater: Kitchen, laundry or bathroom wastewater, also known as sullage.

Groundwater: Water that has soaked into the ground and permeates rock and soil layers.

Grit removal: Eliminates inorganic material such as sand and silt that could cause abrasions to plant and equipment.

Irrigation: The watering of crops and pastures in dry areas or during dry seasons.

Land capability: The ability of the land to sustain particular uses without suffering permanent damage or a reduction in future productivity.

Lagooning: Storage in treatment ponds (lagoons) for purification of primary or secondary treated effluent or wastewater.

Megalitre (ML): One million litres.

Non-potable water: Water not suitable for human consumption, drinking or cooking.

Particulate matter: Particles or very small pieces of solid matter.

Pesticide residue: Refers to a pesticide, which remains in the soil, water or food, after application.

pH: Measure of the degree of acidity or alkalinity, expressed on a scale of 1 to 14. A pH of 7.0 denotes neutrality; higher values indicate alkalinity and lower values acidity.

GLOSSARY

Point source pollution: Pollution that is discharged at a discrete, identifiable location and can be readily measured -c.f. diffuse source pollution.

Potable water: Water of a quality suitable for drinking or cooking.

Primary treatment: The first stage of the wastewater treatment process which uses physical methods to remove pollutants in the water.

Pre-aeration: Minimises odour problems and increases the efficiency of the sedimentation stage.

Primary treatment: Primary treatment is a sedimentation process that may or may not involve chemical assistance.

Recharge: Water entering the soil and reaching the groundwater table. The systematic delivery of a water supply to consumers by a network of pipelines.

Reclaimed water: Water which has been derived from sewerage systems and treated to a standard which is satisfactory for its intended use.

Riparian vegetation: The vegetation of the floodplain of a creek or river.

Runoff: That part of rainfall that flows off the land surface into the drainage system.

Sand filter: A sand filter is a bed of fine sand over which wastewater is distributed and under which treated water is collected.

Salinisation: The accumulation of salts at the soil surface or in the root zone of plants, usually due to capillary rise of saline water from a shallow watertable.

Salinity: The amount of sodium chloride or dissolved salts in a unit of water.

Salinity, dryland: When saline groundwater rises too close to the land surface, often resulting in deposition of salt on the surface. Interception of highly saline groundwater and its disposal to evaporation basins.

Screening: Removes coarse materials that could damage or block pumps or other equipment.

Secondary treatment: The second stage of the wastewater treatment process, often using biological methods to remove organic pollutants from water.

Sediment: Solid material settled from suspension in water.

Sewage: Wastewater from domestic sources. May also be used to describe municipal wastewater, which includes industrial or trade wastewater.

Stormwater: Rain water that has run off roads, roofs, paved areas etc, and is conveyed to watercourses and the ocean.

Stream/watercourse: A small body of water that flows over the land surface in a channel. A large body of water is termed a river.

Suspended solids: Larger, often organic material, suspended in wastewater that may be removed by filtration.

Transpiration: Water is released into the air by plants by a process known as transpiration.

Turbidity: The cloudy condition (opaqueness) in water caused by suspended solids and soil sediment.

Wastewater: Wastewater comprises of used water from domestic toilets, sinks, bathrooms and washing machines. Also refers to water from industrial sources.

Water Cycle: The circulation of water on Earth as it evaporates from lakes and the ocean, condenses into clouds and precipitates as rain, hail or snow.

Watertable: A surface defined by the level to which water naturally rises in an open well or bore hole.

Watercourse: A stable water disposal area used to discharge surplus water runoff and allowing it to flow to a lower level.

Water way: As above.

Weed: A plant species growing where it is not wanted by humans.

Wetland: An area of the floodplain which retains water when the river returns to normal flow levels.