NTC

YOUR WATER, YOUR FUTURE!

A HANDBOOK FOR STUDENTS AND PARENTS

This handbook has useful information for young adults about:

- The value of water
- The science of water treatment
- How geography impacts water
- The Jugiong Water Treatment Plant
- The future tech of water treatment

Goldenfields Water

YOUR WATER, YOUR FUTURE!

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Introduction

Your Water, Your Future is a fun and fast paced educational program about our most precious resource: ***Water***. The program explores the **science** and **geography** behind how we get the water we use, what lies ahead for the future of our water, advances in technology and career pathways.

We all know how important water is, not just for ourselves, but for the plants and animals with whom we share the environment. Equally important is the fascinating journey our water takes to be processed and how we are dealing with this finite resource.

Your Water, Your Future includes this Student Handbook alongside an exciting Livestream Event and an interactive e-learning pack with digital games, videos and resources for in-school and at-home.

Students, in this handbook you will find some great information that will reinforce everything you saw in the Livestream Event, as well as extra resources and fun activities to dive into.

Parents, check out our special section on career pathways, and explore together the section that takes you for a look inside the **Jugiong Water Treatment Plant**, operated by your local water supplier, Goldenfields Water!

THE VALUE OF WATER IN AUSTRALIA

Drinking water (potable water) is one of Earth's most precious resources. You might think that water is everywhere, and it is, but only a small percentage of it can be used for human consumption.

The majority of Earth's water is **salt water**, and not safe for human consumption. Around 97% of all water on Earth is salty, and only the remaining 3% is **fresh water**. But isn't that still a lot of water? Unfortunately, most of that fresh water isn't accessible to humans. 69% is frozen in ice caps, and 30% is stuck deep underground. So of all the water on Earth, approximately 1% is actually available to us to drink.

So our fresh water resources need to be conserved and managed carefully on a global level, but it's even more important in Australia. Here's why:

- Australia is the driest inhabited continent in the world, the driest continent of all being Antarctica (frozen water doesn't count as potable!)

- Nearly 20 per cent of Australia's land mass is classified as desert
- We have very hot temperatures meaning a lot of fresh water gets evaporated before we can use it
- We have low average annual rainfall
- We only get to use 6% of Australia's rainfall, the other 94% evaporates, drains into **groundwater** or is transpired by plants

Speaking of rainfall - as well as being low, rainfall across the country is ALSO highly variable, meaning it can be wildly unpredictable (**Variability**: the degree to which rainfall amounts vary across an area or through time).

Australia has always been the land of 'droughts and flooding rains' - a phrase coined by Aussie poet Dorothea Mackellar in her famous poem 'My Country'. It's normal to endure a multi-year drought, before experiencing major floods. You may think flooding is a good thing because it means more water, but flooding can create soil erosion and cause contamination of drinking water. Any extreme weather caused by growing climate change isn't good for our potable water supply.

We've also got a growing population, meaning the use of our available fresh water is increasing - not just for consumption, but for food production and industrial use. So we have an ever increasing demand on our available water supply.

Where does our fresh water come from?

- Rivers
- Lakes
- Creeks
- Dams
- Underground/Groundwater

If you live in an Australian city, there's a good chance that your water comes from **surface water** such as streams, rivers and reservoirs filled by rainfall and runoff.

In a lot of areas in Australia, groundwater is the primary source of water - sustaining whole towns, farms, mines and irrigation networks.

Groundwater is almost everywhere beneath our feet, with systems ranging from a few square kilometres to a couple of million square kilometres, such as the **Great Artesian Basin**.

It's stored in rocks within pores or fractures, in much the same way as a sponge holds water. The material that holds and transmits the water is known as an **aquifer**, and it can only be reached by specialised drilling machinery.

Once fresh water is collected and treated, the majority of it (about 70%) is used for agriculture, especially irrigation, to grow food and other products consumed in Australia and exported. Another 22% goes to industry, and households use about 8% (which is a lot!)

Every day the average Australian household uses about 400 litres of water. Over the course of a year this adds up - 146,000 litres to be precise (that could fill almost 50 fire engines!). In some countries with limited access to fresh water, families survive on less than 20 litres of water a day.

It can feel like a huge task to think about future proofing our water supply, but we can start by using small but mighty water saving measures in our homes, schools, and businesses.

Not only will decreasing water use save on our water bill, it's also good for the environment. It consumes a lot of resources and energy to deliver water from its source to people's homes and businesses. Reducing water waste can limit the waste of other resources too.

So it benefits not only the individual, but the community and environment as a whole.

How many water saving ideas can you do?

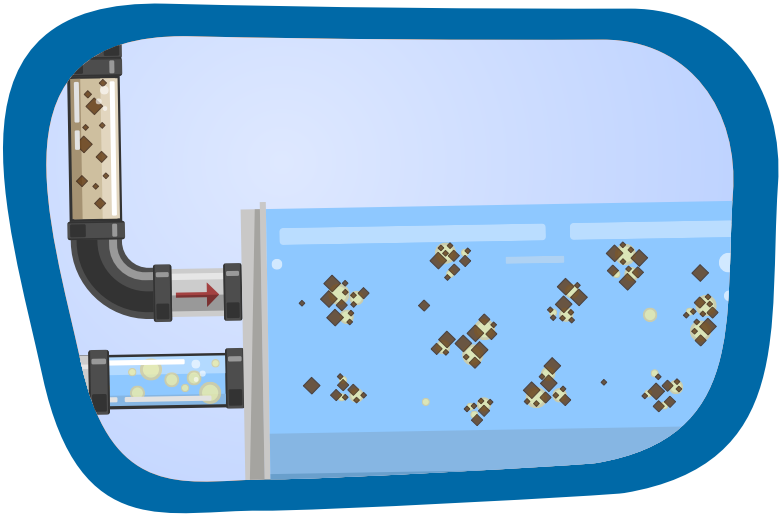
- ☐ Fix any leaks
- ☐ Use water-saving shower heads
- ☐ Limit shower times to four minutes
- ☐ Only run full loads for washing clothes and dishes
- ☐ Water your garden in the evening (to reduce evaporation)
- ☐ Use mulch on garden beds
- ☐ Keep pools covered
- ☐ Use native or waterwise plants (they require less watering!)

THE SCIENCE OF WATER TREATMENT

The water treatment process looks very similar all over the world. First, raw (meaning untreated water, straight from nature) water is pumped to the treatment plant from places like dams or rivers.

Initially, large screens stop any debris like rubbish, branches and other large plant matter from getting caught in the treatment process.

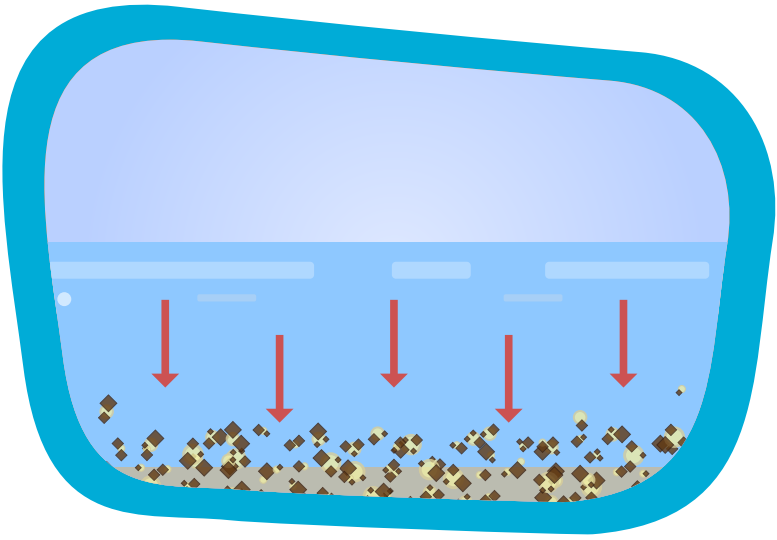
The water is then pumped to the treatment plant via a series of pipes. Then it's a 4-stage treatment process to bring it to a state where it's safe to drink and can be distributed to our taps.



Stage 1: Coagulation

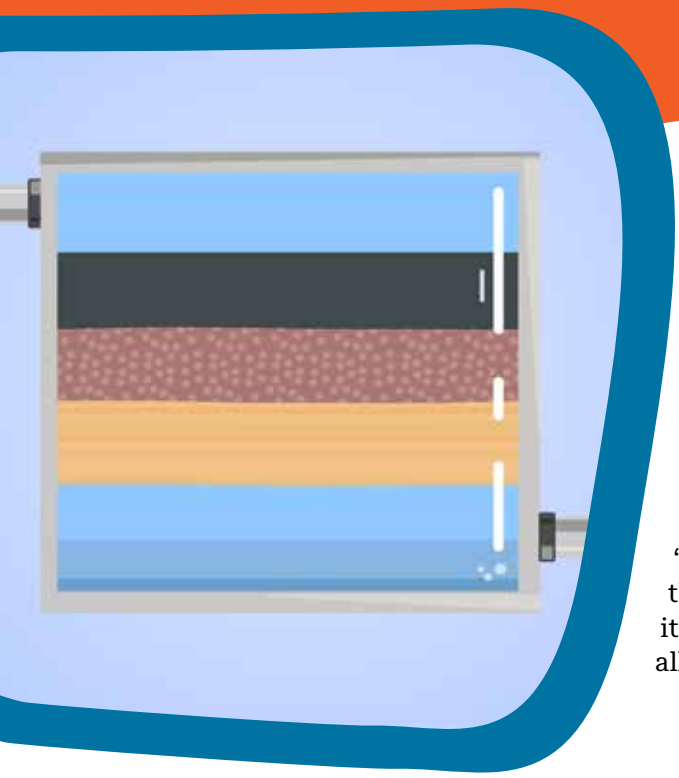
A chemical (coagulant) is added to the water that traps all of the impurities (small particles and organic matter) and makes them clump together.

The clumps are called ‘flocs’, and a two part mixing process is used to bring the flocs together. First ‘rapid mixing’ to increase contact with the coagulant, then ‘gentle mixing’ to allow the flocs to clump together so they are easier to remove later.



Stage 2: Sedimentation

The water is left to sit in sedimentation tanks for several hours. Because the flocs are more dense than the water, they simply sink down, forming a ‘sludge’ on the bottom. The water, now containing only a small amount of very fine floc particles, continues on to the filters. The sludge is removed for further treatment and disposal; it can also be re-used for soil conditioning.



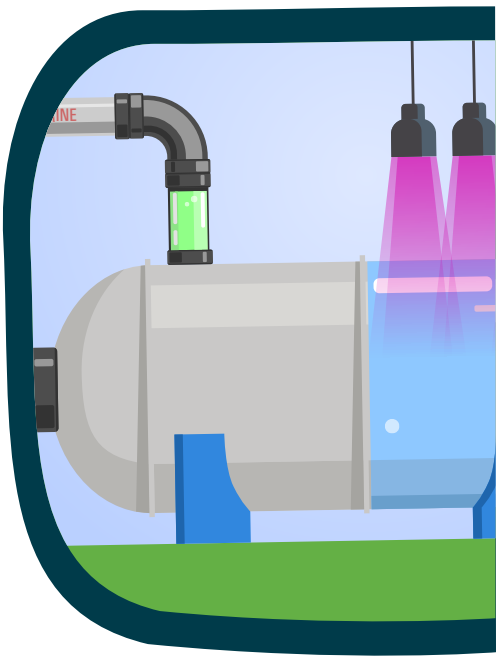
Stage 3: Filtration

Any remaining solids are then removed from the water by passing through one of many large filtration tanks. Inside are compact layers of gravel, sand and anthracite (a mineral sometimes referred to as 'hard coal'). The water goes through each level of grit as it gets finer and finer to get all the tiny impurities out.

Stage 4: Disinfection

The final step is the addition of a small amount of disinfectant to inactivate any micro-organisms that may be present. The most common types of chemical disinfectant used are chlorine and chlorine compounds. Only a tiny amount is used, so it's perfectly safe for human consumption. Another method is to blast the water with ultraviolet (UV) light.

Fluoride (a naturally occurring mineral) is also added to the clean water at this point, to help reduce tooth decay.



The water is now clean and safe to drink! It moves into large storage tanks before being distributed into the community. The water continues to be tested even after leaving the treatment plant, and water testers often visit different towns and communities to ensure that it's safe to drink.

Complete the Word Find below to identify the scientific process involved in Water Treatment!

Coagulation

Flocs

Sedimentation

Sludge

Filtration

Sand

Anthracite

Disinfection

Chlorine

E	A	X	S	Y	C	D	P	O	Z	C	N	A
I	X	A	F	A	C	J	W	U	O	E	O	N
S	C	O	L	F	N	E	U	A	H	N	I	T
C	D	N	O	E	G	D	G	T	Y	I	T	H
R	N	C	A	D	Y	U	Z	X	T	R	A	R
K	Y	R	U	S	L	G	I	A	X	O	T	A
F	L	L	S	A	O	O	R	M	J	L	N	C
X	S	N	T	E	O	A	D	T	Q	H	E	I
S	C	I	W	I	W	P	G	K	E	C	M	T
W	O	V	S	L	G	C	P	A	G	V	I	E
N	O	I	T	C	E	F	N	I	S	I	D	O
D	J	Q	H	H	V	R	W	S	R	N	E	L
F	I	L	T	R	A	T	I	O	N	I	S	Y

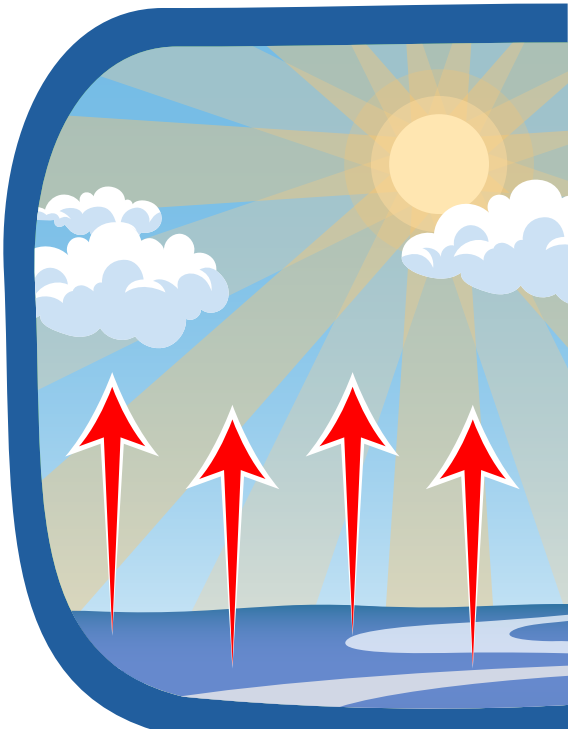
HOW GEOGRAPHY IMPACTS WATER TREATMENT

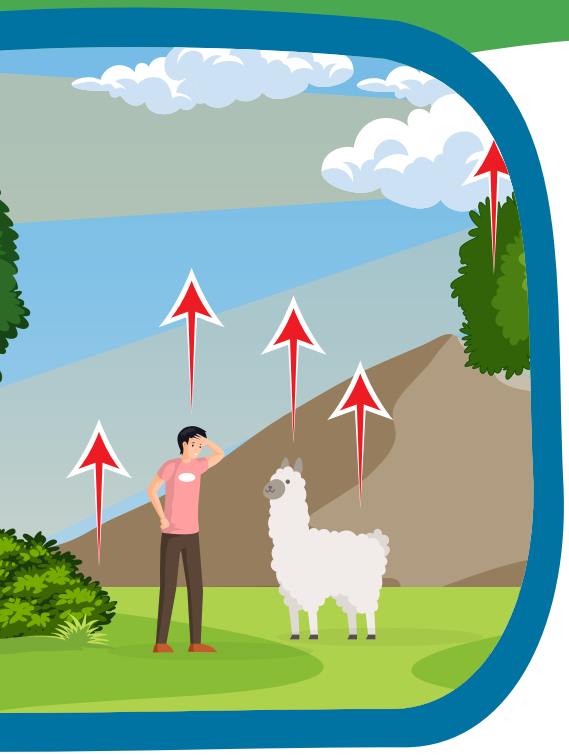
The water on Earth is constantly moving and changing form. The amount of freshwater on the planet is fixed, but is always transforming and shifting places. In fact, all the water on planet Earth is constantly being recycled; its actually been used many, many times before. The water you drink today could have once been a dinosaur's sweat, or a puddle in medieval times.

This constant shifting and changing is called the **Natural Water Cycle**.

Evaporation

Water in oceans, rivers and lakes is heated by the sun. It then transforms into a gaseous form called 'water vapour' which allows it to rise into the air.



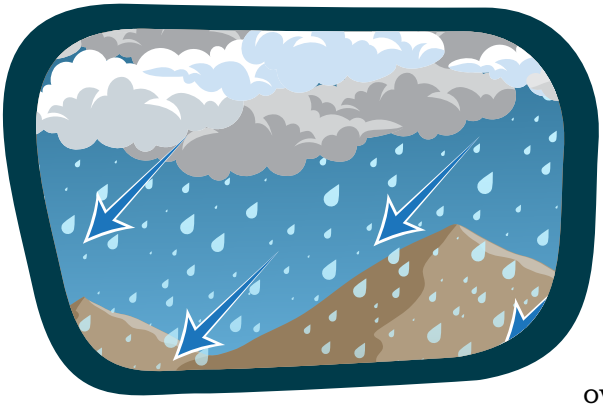


Transpiration:

Plants, animals and people also produce water vapour when heated - this accounts for more than 10% of the Earth's moisture!

Condensation:

All that water vapour in the air is then cooled as it rises, returning to a liquid form. This forms tiny water droplets which are responsible for the formation of clouds.



Precipitation:

Those water droplets then return to the Earth in the form of rain, snow or hail. They eventually find themselves back in the ocean, rivers, and lakes that they came from, or are soaked into the ground. Starting the cycle all over again!

What are the threats to the water cycle?

Pollution and Land Management: The way we use the land within a water catchment area affects the quality and amount of water in a river or reservoir. So we need to protect the water by avoiding contamination with agricultural, industrial or human waste.

Climate change: As the planet continues to warm, rainfall intensity will increase but so will dryness in some areas. Slowing climate change by reducing our use of fossil fuels will help ensure consistent and reliable freshwater supply.

The Geography of Australia: The fact that our land is mostly flat (our highest mountain is only 2,228 m) means we have less rainfall. Why? As rain-carrying winds cross land, they rise when encountering a mountain. As the air rises, it cools. Cooler air condenses more easily, forming droplets (or if even colder, crystals). Because our mountains are low, the air doesn't rise, or cool, as much, hence less rainfall.

Partnering with the Environment

We build systems and networks across our country to manage, preserve and protect the water to ensure we have enough for everyone in the present and future.

For example:

We build **reservoirs and dams** to catch and store the water so we always have enough.

We build **water treatment plants** to ensure the water is clean and safe to drink.

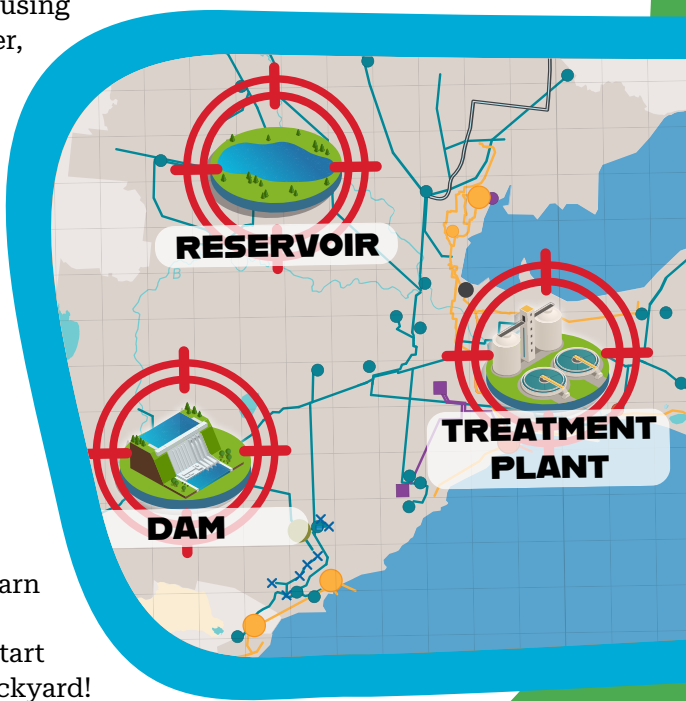
We build pipes and **distribution networks** to deliver the water to wherever it's needed.

All of the above systems endeavour to work with and protect the environment from which the water comes.

Can we do more?

In our towns and cities, rainwater falls on hard surfaces like roads and buildings rather than soaking into the ground or being absorbed by plants as it would in the natural environment. Any water that isn't absorbed is called stormwater runoff and flows into drains and onwards into our waterways, picking up waste and contaminants along the way. This can be a huge problem when rivers and lakes are contaminated, but there are ways to redesign the flow of urban rainwater to make better use of it so excess runoff doesn't reach our waterways.

This integrated approach to water management is called **Water Sensitive Urban Design (WSUD)**. It involves incorporating the water cycle into the architecture of cities and towns using good planning, and new innovative technologies. It's about working with the natural water cycle, not against it, using all elements like wastewater, rainfall, and runoff to add to the environment and character of a place.



Australia is a few steps behind on the global stage when it comes to WSUD. There is much more we could be doing to integrate the water cycle into our towns and cities. Check with your local council to see how they are implementing WSUD, speak to your local water treatment plant to learn what they do, get active in your community, or even start innovating in your own backyard! (See 'The Future Tech of Water Treatment' in this handbook for some examples.)

THE JUGIONG WATER TREATMENT PLANT

Since 1997, Goldenfields Water has been responsible for providing water supply services to communities within the South West Slopes and Riverina regions of NSW.

With 46,000 customers, Goldenfields Water supplies quality drinking water across an area of 22,526 square kilometres, which includes the local government areas of Bland, Coolamon, Junee and Temora Shires. It also includes parts of Cootamundra-Gundagai Regional Council, Hilltops Council and Narrandera Shire.

One of Goldenfields Water's largest treatment systems is the Jugiong Water Treatment Plant. The plant treats between 12 to 18 megalitres of water every day, providing quality drinking water to approximately 18,000 people from towns and farms such as Young, Harden, Jugiong and Cootamundra, just to name a few.

That's roughly 5 Olympic swimming pools every single day!

In addition to the Jugiong Water Treatment Plant, Goldenfields Water owns and operates 4 other water treatment systems which are located at different towns within their supply area. These 4 systems are different to Jugiong in that they are groundwater sources and come from bores, which need to be accessed by a drill.

The Jugiong Water Treatment plant uses surface water. Different types of surface water can include rivers, streams, creeks, lakes and reservoirs.

The water that is treated there is sourced from the Murrumbidgee River which is located just at the foot of the treatment plant.

The Murrumbidgee River is home to a diverse range of plant and animal life and is generally contaminated with particulate matter (dust, dirt and sand that are invisible to the human eye), as well as harmful microorganisms, or pathogens, that may cause disease.

So before it reaches your taps, a lot must happen to the water before it is safe enough to drink!

Goldenfields Water uses a conventional treatment plant, which involves the processes of flocculation, sedimentation, filtration and disinfection to ensure all bacteria, viruses and other harmful particles have been removed before it can be consumed by the public.

THE FUTURE TECH OF WATER TREATMENT

Australia is the driest inhabited continent on the planet. To ensure everyone across the entire country has enough water both now and in the future we need to factor in:

A growing population

Our population is expected to grow another 10 million by 2050.

Changes in climate

Extreme weather and climate events means more droughts (less water) and flooding (which can create soil erosion and contamination of drinking water).

We have to learn to do more with less water because Australia is getting hotter and, in southern Australia, drier.

This means we need to get smarter with how we use our water, and rely more heavily on water technology, in order to future proof our water supply.

Here are some examples:

Purified Recycled Water for Drinking (PRWD):

This is the use of purified wastewater (or storm water) to replenish struggling water supplies. The water is thoroughly treated and meets rigorous health and safety standards before being used.

This is taking some time to catch on in Australia – people feel uncomfortable with it (although Perth has been pumping treated, recycled water into its underground potable storages for years) but other countries are already doing it eg: Singapore, South Africa and the USA, and many more are starting.

Desalination:

Essentially taking the salt out of water to make it more drinkable, using water we wouldn't normally use (sea water).

There are already over 15, 000 desal plants globally, using one of two methods - Distillation (a simple process of boiling salty water and condensing the steam) and Membrane Processes (the use of a semi permeable membrane that separates the salt from the water).

Although it's a great way of creating a more reliable water supply not dependent on rain, there are some environmental and cost drawbacks, especially if desalination plants aren't powered by green energy.

'Water banking' a.k.a Managed Aquifer Recharge (MAR):

Use of aquifers (large natural underground reservoirs) to store water when it is abundant until required for use.

About 90% of Australia's rainfall gets evaporated into the atmosphere before making it into lakes and rivers, so storing water underground prevents evaporation and provides additional storage capacity.

Hydropanels:

A technology which uses solar power and air to create clean drinking water.

They look like solar panels, but inside are fans that draw air through a water-absorbing material, trapping water vapour from the air.

The water vapour is extracted and condenses into liquid that is collected in a reservoir.

In Murrurundi, New South Wales, an array of ten hydro panels extract enough moisture from the air to supply a school with 1,500 litres of drinking water a month.

Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design is the use of stormwater management practices to protect, restore, or mimic the natural water cycle. This reduces the resources required to treat and transport water, limits water pollution, decreases flood risk, and gives greater security of water supply. Examples include:

Permeable pavements - Porous surfaces can be used instead of standard asphalt and paving, so rainfall can find its way back into the ground, rather than filling the sewers. This could also help reduce pollution and flooding.

Bioretention - If we can treat rainwater before it reaches our waterways, they have less chance of becoming polluted. Bioretention involves using several different WSUD technologies together as part of a 'treatment train'. This might look like: water being captured by a bioretention garden, filtering through the soil and plants, draining into a series of pipes, then finally being directed into the stormwater system, natural waterways, or a detention basin.

Rainwater harvesting - In commercial areas, large unused rooftop spaces could be transformed into rainwater harvesting areas. This water could then be used to flush toilets, clean cars, or any other industrial water needs. Installing rooftop gardens and planting more street trees could also help reduce runoff.

SOURCE https://www.permeablesurfaces.com.au/information-centre/what-is-water-sensitive-urban-design
PHOTO CREDIT: https://www.flickr.com/photos/melbournewater/12646218153/in/photostream

Careers in the Water Tech Industry

Electrician/Mechanic

Mechanics and electricians preserve and create the machinery necessary to treat water and recover resources. They are responsible for wiring, installing, maintaining and controlling mechanical and electrical equipment.

Starting salary from $60,000

Laboratory Technician

Laboratory technicians analyse and test water to assess how well treatment processes are working. They examine water and biosolids and conduct necessary quality testing to ensure the water meets a high standard to protect public health.

Starting salary from $68,000

Engineer

Engineers design the processes that make water treatment and resource recovery possible.

They are a broad category of workers who design and implement the industrial processes that provide clean, safe water to sustain life and our economy.

Starting salary from $90,000

Water Treatment Plant Operator

Water treatment plant and system operators run the equipment, control the processes, and monitor the plants that treat water to make it safe to drink. Wastewater treatment plant and system operators remove pollutants from raw water, as well as domestic and industrial wastewater.

Starting salary from $60,000

Hydrologist

Hydrologists study everything about water, including its properties, distribution and movement through the atmosphere. They look for ways to minimise erosion and environmental pollution, and use technology to forecast future water supplies, floods, the spread of pollution and other events.

Starting salary from $90,000

To apply to undertake work experience, please email:

jobs@gwcc.nsw.gov.au

Aquifer	Layers and areas of rocks below ground where all the cracks, crevices, and spaces between rock particles are full of water.
Condensation	When water vapour cools and turns back into a liquid.
Desalination	The removal of salt from sea water for drinking.
Fresh water	Water that is not salty and suitable for consumption if clean or treated.
Groundwater	Water that has seeped into the ground and accumulated within cracks or pores in the rocks (aquifers).
Potable Water	Water which is considered safe and fit for human consumption, culinary and domestic purposes.
Salt Water	Or saline water; water that contains a high concentration of dissolved salts.
Surface Water	Any body of water above ground, including streams, rivers, lakes, wetlands, reservoirs, and creeks.
Water cycle	A series of physical processes that continuously moves water from the surface of the Earth into the atmosphere and back down again.

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www.gwcc.nsw.gov.au

Work Experience
www.gwcc.nsw.gov.au/Community/Education/Work-experience

World Water Day
www.worldwaterday.org

NSW Health: Drinking Water
www.health.nsw.gov.au/environment/water

Australian Water Association
www.awa.asn.au

NSW Education Department

WATER INDUSTRY OPERATIONS VET COURSE
www.boardofstudies.nsw.edu.au/voc_ed

CERTIFICATE III IN WATER INDUSTRY TREATMENT
www.tafensw.edu.au (and search for: Water Industry)

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