Wonder Project

Water Challenge

Challenge Guide

engineering new zealand te ao rangahau

SUPPORTED BY Beca Fulton Hogan GHD Foundation

Contents

Using the challenge guide

The challenge guide provides all the information you need to run the challenge successfully. Use it alongside the online modules in the student Learning Hub.

It's not important that you pānui this entire document – we know it's pretty huge! We recommend you understand the challenge overview, but otherwise please feel free to simply focus on the parts that are helpful to you. Karawhiua!

Kupu Māori glossary

We use kupu Māori throughout this document because it's a small but important way of encouraging others to do the same, to help keep the language alive.

Auahatanga	Creativity
Ākonga	Student
Awa	River
Hapori	Community
Ika	Fish
Kaiako	Teacher
Kaitiakitanga	Guardianship
Karawhiua	Give it heaps!
Kete	Basket
Kōrero	Speak/talk/conversation
Kupu	Word
Mahi	Work
Manawanui	Perseverance, commitment
Mātauranga Māori	Māori knowledge
Maunga	Mountain
Mauri	Lifeforce
Moana	Ocean
Motu	Island/country
Ngā momo wai	Water types
Pānui	Read
Papatūānuku	The Earth Mother
Pātai	Question
Ranginui	The Sky Father
Rōpū	Team/group
Roto	Lake
Tāngata whenua	People of the land
Taonga	Treasure/ anything highly prized
Te Hurihanga Wai	The water cycle
Wai	Water
Whakarongo	Listen
Whakataukī	Māori proverb
Whanaungatanga	Connection, relationships
Whenua	Land

STEM skills

Some of the STEM skills ākonga will use throughout the challenge are:

STEM skill	Description
Teamwork	Working with others to achieve an end goal – recognising each other's expertise and strengths, being flexible, and making sure each rōpū member has a job.
Whanaungatanga (connection, relationships)	Fostering belonging and togetherness by forming connections, strengthening relationships and embracing differences.
Communication	Passing on information effectively, whakarongo when others are sharing ideas, understanding instructions, and asking pātai. Bringing different knowledge and experience to the table to improve results.
Open mindedness	Being willing to whakarongo, considering and accepting different ideas, and being open to new experiences and learning about the world around you.
Auahatanga (creativity)	Respecting past knowledge while using inventiveness, creativity and outside the box thinking to collectively find solutions to issues ahead.
Problem solving	Thinking innovatively, being resilient, never giving up and trying lots of ideas to find the best solution.
Manawanui (perseverance, commitment)	Persevering when things don't go as planned, learning from mistakes made, and committing to solving the problem – no matter the journey.
Analysis	Being observant, collecting and interpreting data, detecting patterns, brainstorming ideas, and making decisions based on the results.

Challenge overview

Module	Activity sequence			
Module 1: Protect **85 minutes** **Purpose:** Understand the challenge, the pātai (question) you'll be solving, and explore the STEM design process, why water is a taonga, and the mauri compass.	**The world of wai** • Watch: Water Challenge welcome video • Understand the challenge pātai (question) ākonga will solve – I wonder how water reaches us?	**Let's dive in!** • Listen to the Ambassador's career story • Unpack your water kit • Start sourcing challenge materials	**STEM design process** • Learn the process ākonga will follow to create their wai networks – the STEM design process • Display the STEM design process poster • Unpack the first step of the STEM design process – ask • Complete "Activity 1.1: Ask" and set challenge goals	**The mauri of wai** • Learn that water has its own mauri (lifeforce) and should be considered a taonga (treasure) • Complete "Activity 1.2: The Mauri Compass" and assess the mauri of natural wai sources • Complete "Activity 1.3: Braided river" and create a class artwork to showcase the connection between people, land and water
Module 2: Collect **70 minutes** **Purpose:** Learn Te Hurihanga Wai and the water cycle. Then, unpack water's journey through our wai network, and plan a network prototype.	**The water cycle | Te Hurihanga Wai** • Watch: A Māori Creation Story video • Learn Te Hurihanga Wai and the water cycle • Display Te Hurihanga Wai poster • Complete "Activity 2.1: Te Hurihanga Wai" and cement water cycle learning	**The journey of wai** • Watch: The journey of wai video • Learn the four stages of water's journey through our wai network: collect, clean, connect, care	**Your wai network** • Assign challenge scenarios • Continue the STEM design process with steps 2 and 3 – imagine and plan • Complete "Activity 2.2: Wai network plan" and imagine and plan solutions to the challenge scenario	**Collect** • Complete "Activity 2.3: Collect" and create a rain gauge • Complete "Activity 2.4: Data dive" and compare rain gauge data to historic precipitation data to gain climate change insights
Module 3: Clean **90 minutes** **Purpose:** Learn ngā momo wai (types of water). Then, explore how to treat wai paru (dirty water) and create a water treatment plant.	**Ngā momo wai | Water types** • Learn ngā momo wai, the types of water recognised in Mātauranga Māori • Display ngā momo wai poster	**Clean** • Watch: Clean video • Complete "Activity 3.1: Wai paru investigation" and explore how to treat physical and chemical changes in wai • Continue the STEM design process with steps 4 and 5 – create and test • Complete "Activity 3.2: Clean" and create and test a water treatment plant		

Module	Activity sequence			
Module 4: Connect **90 minutes** **Purpose:** Learn how gravity impacts the flow of water. Then, use this knowledge to create and test a pipe prototype.	**Connect** • Watch: The power of gravity video • Complete optional activity: Siphon science	**Your pipe prototype!** • Watch: Create video • Revisit step 4 of the STEM design process – create • Complete "Activity 4.1: Create" and create a pipe prototype	**First flow** • Revisit step 5 of the STEM design process – test • Complete "Activity 4.2: First flow" and test your pipe prototype	
Module 5: Improve **90 minutes** **Purpose:** Improve pipe prototypes using challenge knowledge and Manning's equation. Then, connect them to the treatment plant and solve your challenge scenario.	**Manning's equation** • Watch: Manning's equation video • Learn the four key factors that influence how water flows through pipes • Continue the STEM design process with step 6 – improve • Complete "Activity 5.1: Improve" and use challenge knowledge to improve your pipe prototype	**Joining the journey** • Complete "Activity 5.2: Join the journey" and connect your treatment plant to your pipe prototype. Then, test its performance against your challenge scenario and collect data on the results		
Module 6: Care **80 minutes** **Purpose:** Plan how to care for wai that reaches us. Then, connect two wai networks to hydrate the entire hapori (community), and solve the challenge pātai.	**Care** • Learn why it's important to care for wai once it reaches us and some ways to practise sustainability	**Let's hydrate our hapori!** • Complete "Activity 6.1: Hydrate our hapori" and connect your wai network with another to hydrate the entire hapori	**I wonder how water reaches us?** • Form conclusion on the challenge pātai – I wonder how water reaches us? • Recite karakia • Celebrate and reflect on learning	

Curriculum links

Achievement objectives

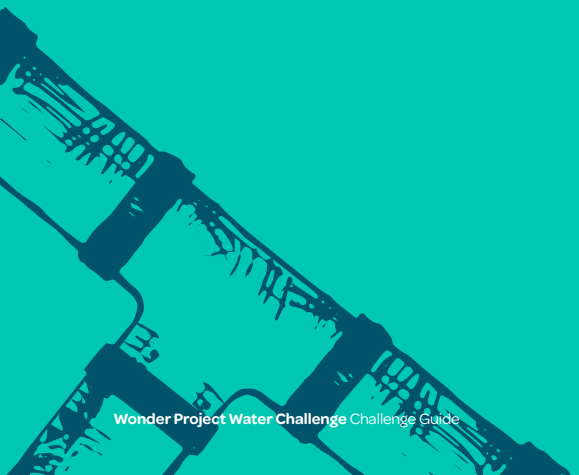
Kaiako can make wider curriculum links to other achievement objectives depending on ākonga level and individual learning programmes.

Strand	Ākonga will	Curriculum level/phase	Year level
Science: Planet Earth and Beyond Earth systems	Develop an understanding that water, air, rocks and soil, and life forms make up our planet and recognise that these are also Earth's resources.	Level 4	7–8
Science: Planet Earth and Beyond Interacting systems	Investigate the water cycle and its effect on climate, landforms, and life.	Level 4	7–8
Technology: Technological Knowledge Technological modelling	Understand how different forms of functional modelling are used to explore possibilities and to justify decision making and how prototyping can be used to justify refinement of technological outcomes.	Level 4	7–8
Technology: Nature of Technology Characteristics of technology	Understand how technological development expands human possibilities and how technology draws on knowledge from a wide range of disciplines.	Level 4	7–8
Mathematics: Mathematics and statistics Statistical investigation	Plan and conduct investigations using the statistical enquiry cycle: Gathering, sorting, and displaying multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends.	Phase 3	7–8

Your resources

To complete the Water Challenge, you'll be using the items in your water kit, alongside some items you'll need to source as a school.

Wonder Project kits are designed to be reused. Please keep it on hand for next year, or pass on to another kaiako so we can reach as many schools as possible.



Water kit items

Items:

Loose items

- Activated carbon
- Baking soda
- 4 x measuring jugs
- 8 x imagine card sets
- Green crepe paper
- Light blue crepe paper
- Dark blue crepe paper

Wai investigation box

- Salt
- Food colouring
- 6 x silicone straws
- 8 x measuring scoops
- 2 x cotton ball packs
- Lemon juice
- Filter paper
- 4 x pH strip packs

Connect box (1 of 2)

- 8 x nozzles
- 8 x nozzle connectors
- 24 x clear joiner pipes
- 8 x large elbow connectors
- 8 x taps
- Cable ties

Connect box (2 of 2)

- 8 x hydrate your hapori sets:
  - 6 x clear, large diameter pipes (long)
  - 3 x clear, large diameter pipes (short)
  - 6 x teal, small diameter pipes (long)
  - 3 x teal, small diameter pipes (short)
  - 9 x elbow connectors
  - 9 x straight connectors
  - 2 x t-bar connectors

Need help sourcing something? We're here to help with a library of resources you can borrow. Get in touch with what you need at **hello@wonderproject.nz**

Schools to supply

Required

- Technology for the ambassador's PowerPoint presentation
- Ākonga devices for research and challenge surveys

Wai paru experiments

- Clear glass (4 per rōpū)
- Dry, natural debris (dirt, bark, grass, leaves)

Wai network creation

- Clear, recycled 1.5/2L bottle (2 per rōpū)
- Resources to support wai network stability (eg, boxes, tape, bulldog clips)
- Containers that can hold 500ml of water (2 per rōpū)

Classroom resources

- Pens and pencils
- Decorations, coloured paper
- Tape (masking or washi tape)
- Scissors
- Gluesticks
- Calculators
- Ruler
- Timer

Optional:

- Torches for wai turbidity (1 per rōpū)

Lesson plans

Module 1:
Protect

85 minutes (approximate)

Purpose

Understand the challenge, the pātai (question) you'll be solving, and explore the STEM design process, why water is a taonga (treasure), and the mauri compass.

Resources

From your wai kit:

- Green crepe paper
- Light blue crepe paper
- Dark blue crepe paper

School to supply:

- Technology for the ambassador's PowerPoint presentation
- Ākonga devices for research
- Classroom resources including pens, coloured pencils, gluesticks, etc

Print or share online:

- Activity 1.1: Ask (1 per rōpū)
- Activity 1.2: The Mauri Compass (1 per rōpū)
- Activity 1.3: Braided river (1 per rōpū)
- Poster: STEM Design Process (A3, 1 per class)
- Braided river template (A4, 1–2 per class)
- Braided river title banner (A4, 1 per class)

Module outcomes

- Learn the challenge pātai/question they'll be solving – I wonder how water reaches us?
- Understand STEM skills and how they relate to water
- Form a rōpū and understand the importance of roles and responsibilities
- Learn the process they'll use to complete the challenge – STEM design process
- Follow the first step of the STEM design process to set challenge goals
- Understand how wai is a taonga, and how to practice kaitiakitanga
- Learn about the Mauri Compass and natural sources of wai

Preparation

Pre-module checklist

Kaiako

- ◯ Completed teacher training
- ◯ Pānui Module 1 of the Student Hub
- ◯ Checked your water kit is ready to flow
- ◯ Pānui the health and safety guidance
- ◯ Completed the teacher pre challenge survey
- ◯ Asked ākonga to complete the student pre challenge survey
- ◯ Asked ākonga to take home the caregiver information sheet
- ◯ Joined Wonder Project Facebook group

Ambassadors

- ◯ Completed ambassador training
- ◯ Pānui Module 1 of the Student Hub
- ◯ Ordered free Wonder Project t-shirt to wear on visits
- ◯ Pānui the health and safety guidance
- ◯ Prepared your career presentation
- ◯ Joined Wonder Project Facebook group

Module 1 lesson plan

Use this plan to support you as you work through Module 1 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
	Pre challenge surveys		
	Student and teacher pre challenge surveys	All kaiako and ākonga should complete their pre challenge survey before the challenge. They are an important tool for us to improve the programme each year and continue our funding to keep the Wonder Project free for schools.	
Block A 40 minutes	**The world of wai**		
	Module 1 whakataukī	Ko te wai te ora ngā mea katoa – *water is the life giver of all things.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	Video: Welcome to the Water Challenge	Watch video that introduces the Water Challenge – to design and build a wai network that supplies the hapori with water. Understand the challenge pātai (question) ākonga will solve – I wonder how water reaches us?	Support ākonga to understand how STEM relates to water and how exciting it can be. **Ask pātai:** *Why is it important for our hapori to have a reliable source of wai?*
	Let's dive in		
	Meet your support crew	Establish the kaiako and ambassador as the support crew. Then, the ambassador will share their career story. If you don't have an ambassador, watch Charlotte Arcus' career story video, our Wonder Project virtual ambassador.	Introduce yourself to the class and share your career story presentation (5 mins). Use the tips provided in the Wonder Project video telling your story.
	Unpack your water kit	Get ākonga to help unpack the kit.	Explain how each item might be used.
	STEM design process		
	STEM design process	Learn the STEM design process that ākonga will use to create their wai networks. Print and display the STEM design process poster.	**Ask pātai:** *What is important about each step of the STEM design process? How do they relate to one another? Why might it be helpful to go back and forth between each step?*

Timing	Activity	Teaching sequence	Ambassador role
Block A 40 minutes	**STEM design process (cont)**		
	Ask 	Explore the first step of the STEM design process 'ask'. Understand that STEM superstars start projects by asking pātai to help them define the problem they're trying to solve.	Discuss how you have asked pātai at the start of a project to help with the problem-solving process, and why it's important.
	Activity 1.1: Ask 	Get ākonga into their challenge rōpū of 3–4. Then, complete activity that encourages them to think about their goals for the challenge, pātai they need answered to help achieve their goals, and potential problems they might need to overcome.	Discuss why goal setting is an important part of STEM roles. After the activity, ask each crew to share one of their pātai and why they chose it.
Block B 45 minutes	**The mauri of wai**		
	The mauri of wai 	Establish how wai should be viewed and treated throughout the challenge – as a precious taonga (treasure) with its own mauri (life force) to be cared for and respected. Then, have a class discussion on why it's important to protect the mauri of wai. **Pātai to consider:** *How would it impact you/the whenua (land) if wai wasn't cared for? Can you think of a time where you've felt connected to wai?*	Support the kōrero by discussing how interconnected tāngata (people) and the whenua (land) are with wai. Eg, our bodies are around 60% water, the whenua relies on healthy and abundant wai to grow plant-life, etc.
	Kaitiakitanga | guardianship 	Have a kōrero on kaitiakitanga (guardianship or protection). **Pātai to consider:** *Why do you think it's important to practise kaitiakitanga for wai? How could future generations benefit from kaitiakitanga?*	Ask ākonga to think about what practising kaitiakitanga for wai in the Water Challenge might look like.
	The Mauri Compass		
	The Mauri Compass 	Discover the Mauri Compass – a tool designed to assess and restore the mauri (lifeforce) of waterways using factors relating to tāngata (people), wai (water), and whenua (land). **Pātai to consider:** *What factors relating to the tāngata/whenua/wai could help us assess the mauri of wai? How could our five senses give us signs and clues about the mauri of wai?*	Give examples of ways the Mauri Compass can help detect pollutants. Eg, an awa might look healthy, but the plant-life around it is dying, there are no fish inside it etc.
	Natural sources of wai 	Have a class discussion on natural sources of wai. **Pātai to consider:** *What are some natural sources of wai? How could you assess their mauri?*	Introduce ākonga to lesser known wai sources like groundwater (wai beneath the Earth's surface).

Timing	Activity	Teaching sequence	Ambassador role
Block B 45 minutes	**The Mauri Compass (cont)**		
	Activity 1.2: **The Mauri Compass** 	Complete activity by assessing the mauri of three different images of natural wai sources using the Mauri Compass.	Support ākonga to complete the activity. **Ask pātai:** *What clues does each image give you about the mauri of wai?*
	Activity 1.3: Braided river 	Create a class artwork linking tāngata (people), whenua (land), and wai (water) together as a braided river.	Circulate each rōpū, offering support where needed.
Remember: Ask ākonga to start collecting 1.5/2L bottles to collect wai.			

Module 2:
Collect

70 minutes (approximate)

Purpose

Learn Te Hurihanga Wai and the water cycle. Then, unpack water's journey through our wai network, and plan a network prototype.

Resources

From your wai kit:

- Imagine cards

School to supply:

- Clear, recycled 1.5/2L bottle
- Tape (masking or washi tape)
- Ākonga devices
- Classroom resources including scissors, pen, ruler etc.

Print or share online:

- Activity 2.1: Te Hurihanga Wai (1 per class/rōpū)
- Activity 2.2: Wai network plan (1 per rōpū)
- Activity 2.3: Collect (1 per rōpū)
- Activity 2.4: Data dive (1 per rōpū)
- Poster: Te Hurihanga Wai | The water cycle (A3, 1 per class)

Module outcomes

- Learn Te Hurihanga Wai and the water cycle in relation to Ranginui and Papatūānuku
- Learn the four stages of the journey of wai through our wai network and explore stage one – collect
- Follow the second and third steps of the STEM design process to imagine and plan a wai network
- Collect rainwater, recording data on the results
- Investigate historic precipitation data – comparing it to collected precipitation data to identify climate-related trends

Preparation

Pre-module checklist

- ◯ Collected your resources
- ◯ Pānui Module 2 of the Student Hub

Module 2 lesson plan

Use this plan to support you as you work through Module 2 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 40 minutes	**Module 2 whakataukī**	Toitū te marae a Tāne-Mahuta, Toitū te marae a Tangaroa, Toitū te tangata – *if the land is well and the sea is well, the people will thrive.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	The water cycle | Te Hurihanga Wai		
	Video: A Māori Creation Story in Sand – Ranginui and Papatūānuku	Watch video that tells the story of Ranginui and Papatūānuku.	**Ask pātai:** *How do you see the water cycle/te Hurihanga Wai represented in this video? How does wai help Ranginui and Papatūānuku stay connected?*
	The natural water cycle	Introduce ākonga to the water cycle, and how water is recycled through a series of processes so it doesn't run out. Print and display Te Hurihanga Wai/Water Cycle poster. **Pātai to consider:** *How does the water cycle relate to Ranginui and Papatūānuku? Why is it important that wai is recycled?*	Lead kōrero on each stage of the water cycle and how they connect to each other. **Ask pātai:** *Where have you seen precipitation/ collection/evaporation/condensation in your life?*
	Activity 2.1: Te Hurihanga Wai	Complete activity that reinforces the different stages of the water cycle.	Participate in the game.
	The journey of wai		
	Video: The journey of wai	Watch video that covers the four stages of Aotearoa New Zealand's wai network – collect, clean, connect and care.	**Ask pātai:** *How do you think STEM professionals have helped to get water to your taps?*

Timing	Activity	Teaching sequence	Ambassador role
Block A 40 minutes	**Your wai network**		
	Challenge scenario	Assign challenge scenarios evenly across rōpū (eg 4 rōpū per challenge scenario). As a class, discuss the different challenge scenarios.	Help the kaiako assign challenge scenarios. Support ākonga to understand the percentages of wai they'll need to supply to their hapori connection points. **Ask pātai:** *How could you solve your challenge scenario?*
	STEM design process – imagine and plan	Explore the second and third steps of the STEM design process, 'imagine' and 'plan'. Understand that after defining the problem they're trying to solve, STEM superstars imagine and plan some solutions to the problem.	Discuss how you have imagined and planned some solutions to a problem in your mahi.
	Activity 2.2: Wai network plan	Complete activity in rōpū by imagining solutions to their challenge scenario using the imagine cards. Then, draw their chosen solution on the activity sheet.	Circulate each rōpū and support them to imagine and plan their wai networks. **Ask pātai:** *Why have you chosen to add this feature? How will this network design solve your challenge scenario?*
Block B 30 minutes	**Collect**		
	Activity 2.3: Collect	Complete activity by creating rain gauges in rōpū to collect wai for their network, and measure precipitation data in their hapori.	Encourage ākonga to think of the purpose of a rain gauge. Eg, measure precipitation, predict floods, climate research, environmental monitoring. Then support ākonga to create their rain gauges.
	Climate comparison		
	Wai data	Explain how data is a helpful tool to solve STEM problems.	Give an example of a time you've used data in your mahi to inform decision making.
	Activity 2.4: Data dive	Complete activity by organising and analysing precipitation data – comparing it against historic online precipitation data to draw conclusions. Have a class discussion about the findings. **Pātai to consider:** *Did you have more or less rainfall than this time 10 years ago? What information can this give us about our climate?*	Support ākonga to make sense of their data. Eg, showing patterns, trends, and variations. **Ask pātai:** *What could your precipitation data tell you?*

Remember: Ask ākonga to start collecting clear glasses to investigate wai paru, and materials to create and test their water treatment plant. You'll need natural debris (dirt, bark, grass, leaves), 1 x clear recycled 1.5/2L bottle per rōpū, and a torch (optional).

Module 3:
Clean

90 minutes (approximate)

Purpose

Learn ngā momo wai (types of water). Then, explore how to treat wai paru (dirty water) and create a water treatment plant.

Resources

From your wai kit:

- Salt
- Lemon juice
- Baking soda
- pH strips
- Cotton balls
- Filter paper
- Activated charcoal (rinsed)
- Measuring scoops
- Measuring jug

Print or share online:

- Activity 3.1: Wai paru investigation (1 per rōpū)
- Activity 3.2: Clean (1 per rōpū)
- Poster: Ngā momo wai | Types of water (A3, 1 per class)

School to supply:

- Clear glasses, jars or cups
- Clear, recycled 1.5/2L bottles
- Dry, natural debris (dirt, bark, grass, leaves)
- Resources to stabilise your treatment plant (boxes or a stand)
- Classroom resources including scissors, rulers and pens
- Torch (optional)

Module outcomes

- Learn the different types of wai recognised in te ao Māori (ngā momo wai)
- Explore the second stage of wai through our wai network – clean
- Investigate physical and chemical changes in wai
- Learn how to measure pH and turbidity in wai and neutralise its pH
- Follow the fourth and fifth steps of STEM design process to create and test a water treatment plant

Preparation

Pre-module checklist

- ◯ Collected your resources
- ◯ Rinsed the activated charcoal to remove any dust/residue
- ◯ Pānui Module 3 of the Student Hub

Module 3 lesson plan

Use this plan to support you as you work through Module 3 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 45 minutes	**Module 3 whakataukī**	I orea te tuatara ka patu ki waho – *a problem is solved by continuing to find solutions.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	Ngā momo wai | Water types		
	Ngā momo wai | Water types	Explore the different momo wai (water types) recognised in te ao Māori, their values and uses. Appreciate the amount of wai-māori (freshwater) on Earth (3%) and how much is available to take care of the hapori (1%). Print and display the ngā momo wai poster.	**Ask pātai:** *What percentage of all of the wai-Māori/freshwater on Earth do you think is accessible? Why do you think it's important to take care of wai when there's only 1% of accessible wai-māori on Earth.*
	Wai paru | Dirty water	Establish wai paru (dirty water) as any water type that has become dirty through things like pollution. **Pātai to consider:** *How can we tell when wai has become wai paru?* *How could you use the Mauri Compass to detect wai paru?* *Is it always easy to tell when wai is paru? Why/why not?*	Offer examples of how wai can become wai paru. Eg, • Agriculture • Industrial waste • Sewage
	Clean		
	Video: Clean	Watch video that introduces the clean stage of Aotearoa New Zealand's wai network, and how STEM superstars test and treat chemical and physical changes in water, including: • pH: how acidic or basic water is • Turbidity: the clarity of water or how well a light beam can travel through it	Discuss how pH and turbidity work, bringing work examples/tools if relevant.
	Activity 3.1: Wai paru investigation	Complete activity to investigate chemical and physical changes in water and how to treat them.	Support ākonga to complete the activity. Offer examples of pollutants that you can't always detect with your five senses, eg chemical fertilisers, microorganisms.

Timing	Activity	Teaching sequence	Ambassador role
Block B 45 minutes	**STEM design process – create and test** 	Explore the fourth and fifth steps of the STEM design process, 'create' and 'test'. Understand that after STEM superstars have imagined and planned a solution to their problem, they create and test it.	Offer an example of when you've created and tested something at mahi. 
	Activity 3.2: Clean 	Complete activity by creating and testing a water treatment plant for their wai network. Collect test data, using results to improve its performance.	Support ākonga to create their water treatment plant and test wai for pH and turbidity.

Remember: Start collecting resources to create your pipe prototype including containers that can hold 500ml of wai and boxes/containers to support the structure.

Module 4:
Connect

90 minutes (approximate)

Purpose

Learn how gravity impacts the flow of water. Then, use this knowledge to create and test a pipe prototype.

Resources

From your wai kit:

- Nozzles
- Nozzle connectors
- Clear joiner pipes
- Large elbow connectors
- Taps
- "Hydrate your hapori" pipes and connectors set
- Water reservoir from the clean activity
- Measuring jugs (1 per rōpū)
- Silicone straws (optional)
- Food colouring (optional)

School to supply:

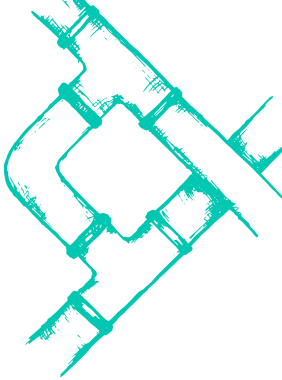
- Containers that hold at least 500ml of wai
- Resources to support wai network stability (boxes, tape, bulldog clips)
- Classroom resources including scissors and pens

Print or share online:

- Optional activity: Siphon science (1 per rōpū/class)
- Activity 4.1: Create (1 per rōpū)
- Activity 4.2: First flow (1 per rōpū)

Module outcomes

- Explore the third stage of wai through our wai network – connect
- Learn about gravity and its effect on water flow
- Revisit the fourth and fifth steps of the STEM design process to create and test a pipe prototype
- Evaluate and test pipe prototype fitness of purpose and wai output
- Analyse and draw conclusions from pipe prototype performance data



Preparation

Pre-module checklist

- ◯ Collected your resources
- ◯ Pānui Module 4 of the Student Hub

Module 4 lesson plan

Use this plan to support you as you work through Module 4 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 30 minutes	**Module 4 whakataukī**	Ka mate kāinga tahi, ka ora kāinga rua – *there is more than one way to achieve an objective.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	Connect		
	Connect	Introduce the connect stage of Aotearoa New Zealand's wai network, where wai is connected to hapori across the motu through pipes.	Explain the importance of STEM superstars in keeping our pipe network up and running.
	Video: Power of gravity	Watch video that covers gravity: a force that pulls objects towards each other. And, how it affects the flow of wai in our wai network. Have a class discussion on how our wai network is mostly gravity fed, and how ākonga could apply this to their networks.	Lead a kōrero on gravity. Give examples of gravity in action, eg, • An object falling to the ground if you drop it • Water resting at the bottom of a glass instead of hovering to the top • Water flowing down a pipe **Ask pātai:** *How will you consider gravity and flow in your pipe prototype?*
	Optional activity: Siphon science	Complete optional activity to explore how gravity and pressure affect the flow of wai in pipes by creating a siphon. Understand that siphons are a demonstration of how wai can flow uphill without pumps.	Lead a kōrero on the activity. **Ask pātai:** *What did you observe? How did wai flow through the siphon? What does this mean?*
Block B 60 minutes	**Your pipe prototype**		
	STEM design process – create	Revisit the third step of the STEM design process 'create'. Outline what a prototype is: a simple model that helps you test out an idea.	Explain a time that you might have created a prototype, or similar, to test some solutions to a problem.
	Video: Create	Watch instructional video that outlines how to put together the pipe prototype.	

Timing	Activity	Teaching sequence	Ambassador role
Block B 60 minutes	**Your pipe prototype (cont)**		
	Activity 4.1: Create 	Complete activity to create a pipe prototype using knowledge on gravity and flow, and their challenge scenario and wai network plan.	Support ākonga to build their pipe prototypes. Discuss how geometry and measurement can help construction and improve design.
	First flow		
	STEM design process – test 	Revisit the fifth step of the STEM design process, 'test'. Reiterate the importance of testing to collect data and improve performance.	Explain the importance of iterating and improving as a STEM professional. 
	Activity 4.2: First flow 	Complete activity by adding wai to pipe prototypes and collecting performance data. Analyse performance data to gather insights on how to improve pipe prototypes.	Encourage ākonga to embrace the STEM skill of manawanui if their pipe prototypes aren't working efficiently and support them to find potential improvements. 
Remember: Ask ākonga to start collecting resources to improve their pipe prototype.			

Module 5:
Improve

90 minutes (approximate)

Purpose

Improve pipe prototypes using challenge knowledge and Manning's equation. Then, connect them to the treatment plant and solve your challenge scenario.

Resources

From your wai kit:

- Pipe prototypes
- All extra pipes and connectors
- Water treatment plants
- All extra water treatment plant resources (charcoal, baking soda)
- Lemon juice
- pH strips
- Measuring jugs
- Measuring scoops

School to supply:

- Containers that hold at least 500ml of wai
- Dry, natural debris (dirt, bark, grass, leaves)
- Resources to support wai network stability (boxes, tape, bulldog clips)
- Timer
- Classroom resources including scissors and pens
- Torch (optional)

Print or share online:

- Activity 5.1: Improve (1 per rōpū)
- Activity 5.2: Join the journey (1 per rōpū)

Module outcomes

- Learn about Manning's equation and the factors that influence wai flow in pipes
- Follow the STEM design process to improve pipe prototypes
- Set and reflect on a conjecture on how improvements will impact pipe performance
- Join the water treatment plant and pipe prototype to complete the wai network
- Evaluate and test wai network fitness of purpose and wai output
- Analyse and draw conclusions from wai network performance data

Preparation

Pre-module checklist

- ◯ Collected your resources
- ◯ Rinsed the activated charcoal to remove any dust/residue
- ◯ Pānui Module 5 of the Student Hub

Module 5 lesson plan

Use this plan to support you as you work through Module 5 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 45 minutes	**Module 5 whakataukī**	Kāhore taku toa i te toa takitahi, he toa takitini – *we cannot succeed without the support of those around us.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	Manning's equation		
	Video: Manning's equation	Watch video that introduces Manning's equation – used by STEM superstars to help predict how wai will flow in a pipe.	Lead a class kōrero on Manning's equation, guiding thinking on what might influence the flow of wai. Demonstrate using pipes from the water kit and other cylinders you can find eg, paper towel roll. **Ask pātai:** *How do you think wai would flow in this object? Why?*
	STEM design process – improve	Explore the sixth step of the STEM design process – 'improve'. Reiterate the importance of using knowledge and data to improve mahi.	Explain the importance of iterating and improving as a STEM professional.
	Activity 5.1: Improve	Complete this activity to reflect on learnings and data from the challenge, then consider and carry out improvements to pipe prototypes.	Help ākonga understand their data and Manning's equation. **Ask pātai:** *Why do you think your pipe prototype performed this way?* *Can you find any patterns between prototype performance and design?*
Block B 45 minutes	**Joining the journey**		
	Activity 5.2: Join the journey	Complete this activity by reconnecting the treatment plant to the improved pipe prototypes, then adding wai paru and collecting performance data. Then, analyse the data to see if the pipe prototypes are solving the challenge scenario, or if there are any ways they can be improved.	Support ākonga to analyse their performance data and determine ways to improve their pipe prototypes, if necessary.

Module 6:
Care

80 minutes (approximate)

Purpose

Plan how to care for wai that reaches us. Then, connect two wai networks to hydrate the entire hapori (community), and solve the challenge pātai.

Resources

From your wai kit:

- Wai networks
- Extra pipes and connectors from the "hydrate your hapori" set
- Measuring jugs

School to supply:

- Containers that hold at least 1000ml of wai
- Resources to support wai network stability (boxes, tape, bulldog clips)
- Classroom resources including scissors and pens

Print or share online:

- Activity 6.1: Hydrate our hapori (1 per rōpū)
- Activity 6.2: Water Challenge competition (1 per class)

Module outcomes

- Recognise the importance of caring for wai and practising sustainability
- Connect wai network with another to explore resilience in pipe networks
- Test connected wai networks, collecting performance data
- Analyse and draw conclusions from wai network performance data
- Form a conclusion on the challenge question/pātai

Preparation

Pre-module checklist

- ◯ Collected your resources
- ◯ Pānui Module 6 of the Student Hub

Post-module checklist

Complete/share post-challenge surveys

- ◯ Teacher survey
- ◯ Student survey
- ◯ Ambassador survey

Module 6 lesson plan

Use this plan to support you as you work through Module 6 of the student online Learning Hub.

Key:	Refers to key concept	More information in the activity notes	Ambassador role can be done online
Explicit teaching:	Teaching and modelling	Development of skills (guided practise)	Application of skills

Timing	Activity	Teaching sequence	Ambassador role
Block A 20 minutes	**Module 6 whakataukī**	Inā kei te mōhio koe ko wai koe, i anga mai koe i hea, kei te mōhio koe kei te anga atu koe ki hea – *if you know who you are and where you are from, then you will know where you are going.* Ask one ākonga to read the whakataukī aloud. Have a kōrero on how it might relate to the module ahead.	Share what the whakataukī means for you.
	Care		
	Care	Introduce the care stage of Aotearoa New Zealand's wai network, where wai cares for the hapori and whenua, and we care for wai.	**Ask pātai:** *Why is the care part of the journey of wai important? How do you care for wai?*
	Ranginui and Papatūānuku	Revisit knowledge on Ranginui and Papatūānuku and explain how wai is returned to Ranginui after it has cared for our hapori.	**Ask pātai:** *Do you remember which water cycle processes return wai to Ranginui (the Sky Father)?* • Evaporation • Transpiration
	Spring into sustainability	Explore ways ākonga can practise gratitude and sustainability with wai at home. **Pātai to consider:** *How will you be more sustainable with wai at home?*	Explain ways you practise gratitude/sustainability with wai at mahi or home.
Block B 60 minutes	**Let's hydrate our hapori!**		
	Activity 6.1: Hydrate our hapori	Complete activity by connecting two wai networks with different challenge scenarios to hydrate the entire hapori. After the activity, review data collected, do a final analysis, and then, form a conclusion on the challenge pātai.	Explain how our hapori are connected to lots of different wai collection points in real-life wai networks. And, how this makes our network more resilient. Then, support ākonga to connect their wai networks together.
	Karakia	Recite a karakia as a class to encourage reflection, celebration, and gratitude at the culmination of the Water Challenge.	Join or lead the karakia.
	Whānau showcase	Invite whānau to visit the classroom so ākonga can show off their wai networks. You could also film the wai networks and share with whānau virtually.	Help set up the wai networks to demonstrate their performance.

Timing	Activity	Teaching sequence	Ambassador role
	Post challenge surveys		
	Student, teacher and ambassador post challenge survey	All kaiako, ākonga and ambassadors should complete their post challenge survey after they complete the challenge. They're an important tool for us to improve the programme each year and continue our funding to keep the Wonder Project free for schools. We supply kaiako with the survey data from their school to show the impact the Water Challenge has had on ākonga perceptions towards STEM, and how much they've learned.	
	I wonder how to tell our story		
	Activity 6.2: Water Challenge competition	Plan and create a creative video or poster that captures the Water Challenge experience to be in to win a prize.	

Activity notes

Activity 1.2:
The Mauri Compass

Here you'll find support notes and answers for relevant activities. If there's anything else you need help with, please get in touch at hello@wonderproject.nz

Example answers:

Factor	Pātai	Image 1 score (1 – 5)	Image 2 score (1 – 5)	Image 3 score (1 – 5)
Tāngata People	Are people protecting and harvesting kai in and around the waterbody?	1	4	5
	Do people have a strong connection to the waterbody?	1	4	5
Wai Water	Are there lots of different kai in and around the water that look healthy enough to eat? (eg, plants, fish, animals)	2	3	5
	Do the areas around the waterbody look healthy?	2	3	5
Whenua Land	Does the land around the waterbody have lots of different natural life?	2	3	5
	Does the water look germ and chemical-free?	2	4	5
	Total score:	**10/30**	**21/30**	**30/30**

Analysis

Image three had the strongest mauri because:

- It received the highest score.
- People are harvesting kai directly from the wai which suggests a strong connection.
- There is lots of kai available which means the wai is healthy enough for the kai to live in.
- The plant life is diverse which means the wai is providing enough nourishment for the whenua (land) to thrive.
- The wai appears to be germ and chemical free, and not murky.

Activity 1.3:
Braided river

Braided river assembly example

Troubleshooting

- The template prints in order of how it should be displayed.
- Make sure that the crepe paper is joined tightly together at each end of each braided river. This will ensure that the awa will flow seamlessly when the art is put together.

Activity 2.4:
Data dive

Ākonga should complete the activity whether or not they experienced precipitation in Activity 2.3

If you experienced precipitation:

Analyse: Climate comparison

Climate data tool

- Start by finding the historic precipitation data for your hapori:
  - After opening the climate data tool link, click on your region under the 'States/Regions' heading.
  - Scroll to the bottom of the region webpage to find your suburb/town/area.
  - Scroll down until you find the 'historical data' table.
  - Using the drop-down boxes, change the date and month to be 10 years prior. Then click 'go'.
  - You'll find the precipitation data in the 'precipitation' row.

Draw a conclusion:

Rōpū should think about what information their data gives them about how our climate might have changed over time. For example:

Less precipitation than 10 years ago	More precipitation than 10 years ago
• Our hapori is in a dry area and doesn't experience much rain. • When the Earth is warmer, evaporation increases. • This dries out the wai in the realm of Papatūānuku, which means we have less wai available to nourish our whenua and hapori.	• Our hapori is in a wet area and frequently experiences rainfall and storms. • When the Earth is warmer, evaporation increases. • This increases condensation over our hapori, which increases precipitation and storms. • This means our hapori is at risk of flooding or extreme weather events.

If you didn't experience precipitation:

To ensure rōpū get the intended learning and experience out of this activity, they can compare two online data sets using the climate data tool.

Climate data tool

- Follow the same steps as above to navigate to the historic weather data for their hapori.
- Using the drop-down menus, select the most recent year and month.
- Scroll down to find the 'Daily observations' table.

Then, following the same steps in the activity sheet, rōpū should:

- Organise the daily precipitation data into a graph, table or drawing.
- Analyse the data by comparing the average precipitation from your chosen month/year online, to the equivalent data from 10 years prior.
- Draw a conclusion with these results.

Activity 3.1:
Wai paru investigation

Turbidity and flocculation

Expected results

Step 1: Turbidity	Wai should be turbid once natural debris is added.
Step 2: Flocculation	After 2 minutes: Wai looks clearer, debris starts to sink to the bottom of the cup. After 20 minutes: Debris should collect at the bottom of the cup, leaving clear wai at the top.

pH

Possible results

Tests	Wai glass 1: Lemon	Wai glass 2: Salt	Wai glass 3: Natural debris	Wai glass 4: Neutral water
Test 1: Observation	Wai appears slightly turbid and smells of lemon. This means it's paru.	Wai does not appear paru as the salt has dissolved and it smells normal.	Wai appears turbid. This means it's paru.	Wai does not appear paru.
Test 2: pH	4	7	6	7
Test 3: Neutralisation	Acid/base added: baking soda pH: 7	Acid/base added: none pH: 7	Acid/base added: baking soda pH: 7	Acid/base added: none pH: 7

Neutralising wai:

We recommend ākonga experiment with neutralisation ratios to help them understand the pH scale. For this experiment, they should only need to neutralise wai glass 1 and 3:

- **Wai glass 1:** 2 teaspoons of lemon juice should be neutralised with ½ teaspoon of baking soda.
- **Wai glass 3:** Neutralisation of this wai will depend on what debris you've added. We recommend starting small with 1/8 teaspoon of baking soda.

Activity 3.2:
Clean

Troubleshooting

If treatment plants aren't working after completing the activity, think about the following:

- Is the filter paper covering all the holes in the bottom of the treatment plant?
- Have you rinsed your activated charcoal?
- Could you add more or less baking soda/lemon juice to achieve a neutral pH?

Ākonga are welcome to attempt adding other materials to filter wai including sand, pebbles, etc. However, it's hard to stabilise a heavy treatment plant.

Optional activity:
Siphon science

Possible answers

How did wai flow through your siphon?

Water from the full container was pulled up the siphon, and into the less full container.

How did gravity and pressure impact the flow of wai?

- **Gravity:** When the siphon tube is full of water, gravity pulls the water down the lower end of the tube.
- **Pressure:** This pull creates low pressure in the higher part of the tube. This pressure sucks more water up from the full container, down into the less full container.
- **Flow:** Water will flow until the full container empties, the end of the tube rises above the water, or air enters the tube.

How could you apply this to your wai network?

We can increase the slope of pipes that lead to the hospital connection point that requires more wai. The force of gravity will be stronger on this water, so it will flow faster to this connection point.

Your pipe prototype

Activities 4.1, 4.2, 5.1, 5.2

Prototype creation

As ākonga progress through the challenge, they'll gain more information on how to create a successful pipe prototype. Here are some of the things they should consider.

Things to consider	Module covered	Impact
Protecting the mauri of wai	Module 1	• When the mauri of wai isn't protected, it's lost to leaks. It can also become polluted.
Gravity	Module 4	• Pipes with a bigger slope will increase the flow of wai. • A more gradual slope will decrease the flow of wai. • A flat or upwards slope can stop the flow of wai.
Pipe length	Module 4	• Shorter pipes will mean the wai gets to its destination faster. • Longer pipes will slow the flow of wai to its destination.
Pipe internal diameter	Module 5	• A smaller internal diameter will decrease flow rate. • A larger internal diameter will increase flow rate.
Number of connectors	Module 5	• Adding more connectors increases pipe roughness which could trap wai or slow its flow.

Other tips include:

- You shouldn't need any glue to stick your pipes together – if there's a loose connection, try pushing the pipes further into the connectors.
- Keep the network stable by propping the treatment plant up with boxes, cable ties, or bulldog clips.

Achieving your challenge scenario

- There are many ways ākonga could assemble their pipes to achieve their challenge scenario. Below you'll find an example of pipe prototype arrangements that work. Ākonga should iterate and improve their prototype throughout the challenge to achieve the correct wai ratio.

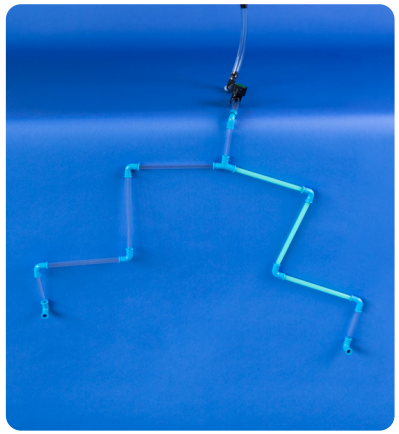
Your pipe prototype

Activities 4.1, 4.2, 5.1, 5.2

Challenge scenario 1: Firefighters suit up

From the t-bar connector:

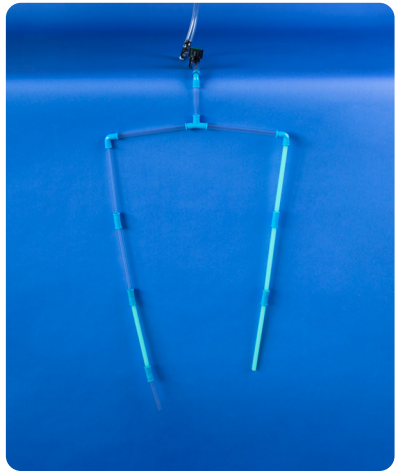
Whare (houses): 80% (400ml)	Fire station: 20% (100ml)
• 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (short) • 1 x elbow connector	• 1 x teal, small diameter pipe (long) • 1 x elbow connector • 1 x teal, small diameter pipe (long) • 1 x elbow connector • 1 x teal, small diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (short) • 1 x elbow connector



Challenge scenario 2: Hydrating for health

From the t-bar connector:

Hospital: 60% (300ml)	School: 40% (200ml)
• 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (long) • 1 x straight connector • 1 x clear, large diameter pipe (long) • 1 x straight connector • 1 x teal, small diameter pipe (long) • 1 x straight connector • 1 x clear, large diameter pipe (short)	• 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x teal, small diameter pipe (long) • 1 x straight connector • 1 x teal, small diameter pipe (long) • 1 x straight connector • 1 x teal, small diameter pipe (long)



Your pipe prototype

Activities 4.1, 4.2, 5.1, 5.2

Testing

Troubleshooting

Problem	Possible reason	Solution
Water isn't flowing	Air bubbles in pipes.	Identify where the water is trapped and remove the connector from that area. Allow all of the water to flow out of the network before reconnecting.
	Treatment plant debris has become lodged in the pipes.	Remove section of pipe prototype where the debris is lodged. Make sure the filter paper covers all holes in the treatment plant and that you're only using small chunks of debris.
	Tap is turned off.	Make sure the tap is switched on when you're ready for the water to flow.
Water is only flowing to one hapori connection point	Pipes aren't straight at the beginning of the network.	Make sure the pipes connected to the t-bar at the beginning of the network are as straight as possible. Keep them straight using tape, bulldog clips or cable ties.
	Too many pipes used on one side.	Ākonga may need to adjust their pipe layout if one side of their network isn't receiving wai.
Water is leaking	Loose connectors.	Make sure pipes are pushed fully into connectors. Make sure the reservoir (bottle) is twisted tightly into the nozzle. If still having trouble, apply some thread seal tape over the leaks.

Activity 6.1:
Hydrate our hapori

Possible method:

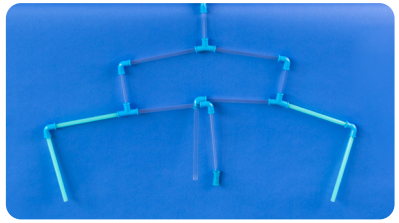
This is just one method that works. We encourage ākonga to think creatively about how to join their prototypes.

Step 1 Separate your pipe prototype and the start of the network by disconnecting the first t-bar connector.

Step 2 Choose one network starter to work with. It should end in a short clear pipe.
To this pipe, add the following resources:

T-bar connector

Pipe prototype 1	Pipe prototype 2
• 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (short)	• 1 x clear, large diameter pipe (long) • 1 x elbow connector • 1 x clear, large diameter pipe (short)



Troubleshooting:

If ākonga pipe prototypes achieved their challenge scenario, the combined prototypes should work. Make sure:

- Both pipe prototypes are connected to the start of the network with the same resources.
- Pipes at the beginning of the network are as straight as possible.

Challenge conclusion

Example answer

I wonder how water reaches us?

- There are many different journeys wai can take to reach our hapori.
- Some hapori have access to natural sources of wai, like awa. Wai reaches these natural sources thanks to Te Hurihanga Wai and the natural water cycle. In the water cycle wai is recycled through a series of processes across the atmosphere, and the Earth:
  - Wai reaches awa thanks to precipitation, or the tears of Ranginui.
- Clean wai from natural sources is not accessible to all hapori. So, to support wai to reach everyone while respecting natural wai sources, STEM superstars created Aotearoa New Zealand's wai network.
- Aotearoa New Zealand's wai network helps wai reach us in four stages:
  - Collect: wai is collected from a natural or manufactured source.
  - Clean: wai is piped to a treatment plant where STEM superstars test and treat it for things like pH and turbidity. This helps to make sure it's not wai paru, protect its mauri, and remove pollutants if required.
  - Connect: wai is piped to our hapori through a series of pipes. These are gravity-fed which means water flows through them thanks to the power of gravity. STEM superstars consider the factors of Manning's Equation to understand how wai flows through pipes. These are:
    - Flow rate
    - Cross-sectional area
    - How rough the pipe material is
    - Hydraulic radius
  - Care: wai cares for the hapori, and we care for the wai before it's returned to Ranginui.
- Throughout each stage of water's journey, it's important that we protect its mauri (lifeforce). This will ensure future generations can all benefit from clean, healthy wai.