Pacific H2O Lab: Procedures for Teachers (Key)

Important notes:

- This lab relies on students using this app to "choose their own adventure". As a result, each group's decision-making will be slightly different. Note: the app is best displayed on a laptop or tablet, phone screens are too small.

- Since each group's lab is unique, they will conduct a unique set of assays and treatments.

- Assay and treatment procedures are outlined in this document. Students need to make sure they are following the correct lab safety procedures. **Teachers can print out one copy for each lab group or post the document on a class website.**

- Finally, students should be regularly recording their decision-making in their lab notebook documents.

Lab Safety:

- **Chlorination tablets are toxic to aquatic life and must be disposed of in a Class 9 waste bin. This means that final, treated samples of coastal aquifer and river water need to go into Class 9.**

- **Rainwater catchment samples include copper nitrate. Any material that touches copper nitrate should be disposed of in a Class 5 waste bin. This includes the ion-exchange resin and any water used to rinse/clean glassware. The Class 5 bin can be a 2L plastic container or an ice cream container.**

- **Hazard and risk assessment can be found at the end of this document.**

Assay Procedure: JBL ProScan Water Test Strips (video)

1. Download the JBL ProScan app on a device equipped with a camera.
2. Select 'Water' and allow access to device camera.
3. Check you have a water analysis test strip, the reference colour card and the contaminated water sample (in a 100mL beaker) ready.
4. On the app, press start. A 60-second timer will commence. Submerge a water analysis test strip in the contaminated water sample for 2-3 seconds. Ensure all squares on the strip are in contact with the sample.
5. After 2-3 seconds, remove the strip. Shake off any excess solution and place in the centre of the reference colour card.
6. Wait for the remainder of the timer to allow the colours in the strip to develop.
7. Once the timer is finished, the camera will open on the application. Align your camera with the colour card + your strip. The application will automatically take a snapshot of the colours and produce an output screen as shown above (right).
8. Record the Nitrate (NO_3), pH and Chlorine values with their units.

****Students testing the river water might encounter pieces of fertiliser blocking the coloured squares. A tissue or paper towel can be used to gently remove/wipe the fertiliser off the strip. Be careful not to wipe into other coloured squares as this may hinder the analysis.**

Ensure when students are aligning the cameras with the colour card + test strip, that the environment is well-lit with minimal shadowing. A white background provides the best contrast for the app.

	Coastal Aquifer	*River Water*	*Rainwater Catchment*	*Tap Water*
NO_2 (mg/L)	0.25	0.25	0.25	0.25
NO_3 (mg/L)	18	25	18	<10
pH	6.8	6.8	<6	6.4
Cl^- (mg/L)	0.8	0	0	0

Assay Procedure: Rapid Panel Test Strips

1. Check you have a drinking water test strip and the contaminated water sample (in a 100mL beaker) ready.
2. Dip the drinking water test strip into the beaker for 2 seconds.
3. Take out the strip and place on the bench.
4. All parameters (excluding Nitrate and Nitrite) can be immediately compared to the reference colours on the drinking water strips container.

5. After 1 minute, Nitrate and Nitrite squares can be compared to the reference colours on the drinking water strips container.

Assay Procedure: Salinity Test Strips (video)

1. Check you have a saline test strip, the contaminated water sample, and a small vial or container (approx 20mL).
2. Pour at least 10mL of the contaminated water sample into the small vial. The volume should be around 2cm in height.
3. Place a saline test strip into the vial and let sit.
4. When the yellow band at the top of the strip has turned black (3-12 minutes), remove the test strip and place on the bench.
5. Compare to the reference chart provided with the saline test strips and determine the concentration of salt in the sample.

****The coastal aquifer solution should show a yellow peak. The other two samples should not have a peak.**

Assay Procedure: pH Paper (video)

1. Tear 1-2cm of pH paper from the pH paper roll and place on a clean surface.
2. Add a single drop of the contaminated water onto the pH paper using a pipette, stirring rod, or end of a spatula.
3. Compare the colour change on the pH paper with the key on the pH paper roll.

Assay Procedure: Turbidity Test (Qualitative)

1. Evaluate the transparency of your water sample:
    a. On a scale of 0 = transparent and 10 = opaque, what do you rate your water sample?
2. Evaluate whether there are particles present in your sample (indicating risk of microorganisms, algae, and bacteria):
    a. Are there particles present in your water sample? Yes or no
3. Record the answers to these questions in your lab notebook.

****River water sample should be opaque (5-8) and have particles. The other samples should be transparent without particles.**

Assay Procedure: API Freshwater Testing Kit (video)

pH Test

1. Using a plastic disposable pipette, collect 5mL of contaminated water in the glass vial provided in API test kit. The line on the vial indicates 5mL.
2. Add 3 drops of the API pH Test Kit (6-7.6) into the vial.
3. Cap the vial with the plastic cap provided. Invert the vial several times to mix.
4. Compare the colour of the solution with the provided pH Colour Chart.
5. **Waste information: Dispose the contents of the vial down the drain with plenty of water. Rinse vial and cap with distilled water for reuse.**

High Range pH Test

1. Using a plastic disposable pipette, collect 5mL of contaminated water in the glass vial provided in API test kit. The line on the vial indicates 5mL.
2. Add 5 drops API High Range pH Test [7.4-8.8] into the vial.
3. Cap the vial with the plastic cap provided. Invert the vial several times to mix.
4. Compare the colour of the solution with the provided High Range pH Colour Chart.
5. **Waste information: Dispose the contents of the vial down the drain with plenty of water. Rinse vial and cap with distilled water for reuse.**

Ammonia Test

1. Using a plastic disposable pipette, collect 5mL of contaminated water in the glass vial provided in API test kit. The line on the vial indicates 5mL.
2. Add 8 drops of API Ammonia Test Solution Bottle #1 into the vial.
3. Add 8 drops of API Ammonia Test Solution Bottle #2 into the vial.
4. Cap the vial with the plastic cap provided. Shake vigorously for 5 seconds.
5. Wait for 5 minutes for the colour to appear.
6. Compare the colour of the solution to the Ammonia Colour Chart.
7. **Waste information: Dispose the contents of the vial into a beaker, rinsing with distilled water. Dispose contents of the beaker into Mixed waste. Rinse vial and cap with distilled water for reuse.**

Nitrite Test

1. Using a plastic disposable pipette, collect 5mL of contaminated water in the glass vial provided in API test kit. The line on the vial indicates 5mL.
2. Add 5 drops of API Nitrate Test Kit into the vial.

3. Cap the vial with the plastic cap provided. Shake for 5 seconds.
4. Wait for 5 minutes for the colour to appear.
5. Compare the colour of the solution to the Nitrite Colour Chart.
6. **Waste information: Dispose the contents of the vial into a beaker, rinsing with distilled water. Dispose contents of the beaker into Class 8 waste. Rinse vial and cap with distilled water for reuse.**

Treatment Procedure: Boiling

1. Make sure your water sample is in heat-safe glassware (such as a beaker).
2. Place the glassware + water sample on top of a hot plate.
3. Raise the temperature of the hot plate to a safe level so that the water begins to boil.
4. The water should be boiling (bubbling) for 20 minutes.
5. Turn off the hot plate and allow the water sample to cool.

Treatment Procedure: Chlorination

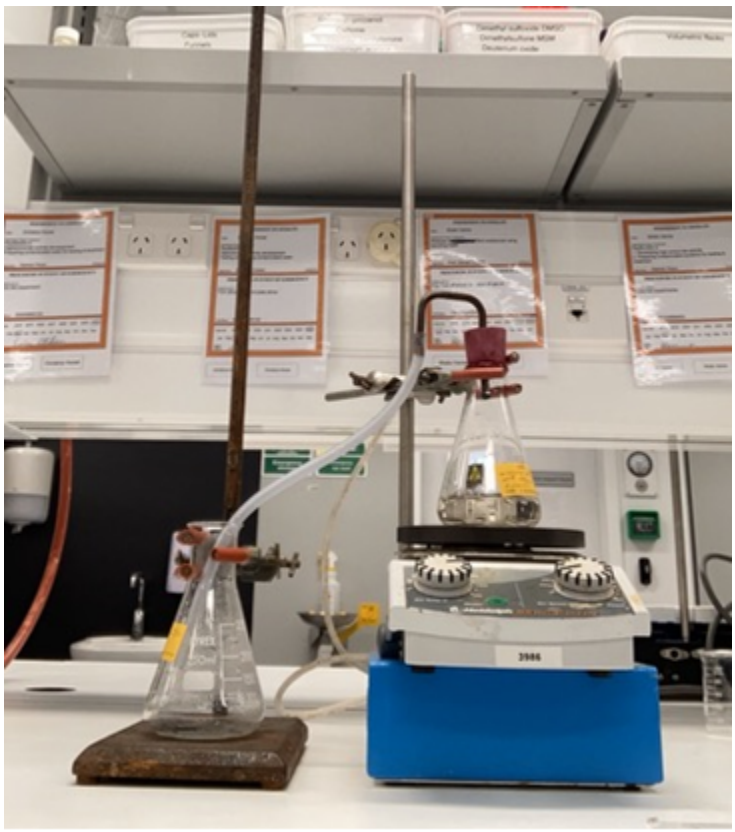
1. Ask your teacher for a weighing balance.
2. Your group will need to add 1/10 of a chlorination tablet to your sample to treat it for bacteria.
3. Weigh the amount of one tablet and divide it by 10.
4. Obtain the weight of 1/10 of a tablet in powder form.
5. Add the powder to your water sample.
6. After waiting a few minutes, the resulting water sample will be free from disease-causing pathogens.
7. **Note: after chlorinating the water, it should eventually be disposed in Class 9 waste (toxic to aquatic life). Reiterate this point to students when they are ready to dispose of their water sample at the end of the lab.**

Treatment Procedure: Distillation

→ Distillation involves heating water to its boiling point, leading to vapor formation. The vapor is then cooled and condensed back to liquid, eliminating many contaminants with boiling points higher than water.

1. Ask your teacher for a conical flask, collection vessel, plastic tubing, rubber bung, hot plate, clamps, and ice bath.
2. Set up distillation apparatus as per diagram. Ensure conical flask and collection vessel are secure with clamps. Ensure plastic tubing is long enough to reach the collection vessel, which should be placed inside the ice bath. If plastic tubing is unstable, use an additional clamp to hold in place.
2. Remove rubber bung and add your water sample.
3. Turn on the hot plate and gently heat to 100C. Once steam or water vapour begins to rise, the distillation has begun. Ensure that your water sample does not boil rapidly.
4. Monitor the volume of your water sample in the conical flask. The distillation is complete when little to no water remains.
5. When little water remains, turn off the hot plate.
6. Wait for the system to cool to room temperature.
7. Measure the volume of water collected in the collection vessel.
8. Disassemble the system. Rinse conical flask, collection vessel, plastic tubing, and rubber bung.

****When university students tested this method, the process was rather slow (1 hour) without the ice bath. They recommend using an ice bath to speed up the process. Below is a photo of their setup.**



Treatment Procedure: Filtration

1. Decide with your group if you will be using a paper filter or a fine filter.
2. Ask your teacher for a filter, a funnel, and an empty beaker.
3. Fold the filter paper in half two times and create a cone shape that fits into the funnel.
4. Hold the funnel and filter paper over the empty beaker so that the resulting liquid can be captured.
5. While holding the funnel and filter paper, carefully and slowly pour your water sample through the filter paper and funnel.
6. After the entire sample has passed through the filter paper, properly dispose of the filter paper and wash the used funnel.
7. Keep the new beaker with the treated water sample and clean the previous beaker.

Treatment Procedure: Flocculation

→ Flocculation involves adding a chemical called a coagulant to water which causes particles to clump together, forming larger particles. These larger particles are called flocs, which eventually settle to the bottom of the container and can be easily filtered out.

1. Ask your teacher for vinegar and a graduated cylinder.
2. Add 10mL of vinegar to your sample. Stir gently and cover.
3. Let sit overnight. The sample will coagulate and form flocs, which you can filter the next day.
4. The sample will coagulate and form flocs. **Perform a filtration** to remove the flocs from the treated water.
5. **Waste information: Same as filtration.**

****When university students tested this method, they found that flocculation only treated for turbidity. Students can perform a post-treatment nitrates assay and determine what additional nitrate-removing treatments must be performed.**

Treatment Procedure: Ion-Exchange

→ Ion-exchange is a process where wastewater flows through a resin bed.

- Ionic functional groups in the resin attract ions in the water and displace them with another ion (typically, sodium). This effectively removes unwanted contaminants from the wastewater.

1. Plug the neck of the funnel with cotton wool to ensure no ion-exchange resin will go through the funnel.
2. Add the ion-exchange resin into the funnel above the cotton wool. Depending on the size of the funnel, add enough resin to create a layer that is 3-4cm in height.
3. Place funnel equipped with resin and cotton wool into a collection flask.
4. Slowly pour your contaminated water into the funnel, careful not to overflow.
5. Evaluate the liquid that has passed through the funnel for presence of copper or nitrates.
6. **Waste information: If the resin was used to remove copper, dispose of the used resin as hazardous material in a Class 5 bin. The Class 5 bin can be a 2L plastic container or an ice cream container.**

****When university students tested this method, they found that ion-exchange effectively removed copper from the rainwater sample and nitrates from the river water sample.**

Treatment Procedure: pH Increaser or pH Decreaser

1. Ask your teacher for pH increaser or decreaser, pipette, and pH paper.
2. Tear approximately 4-5cm of pH paper from the roll and place on a clean surface (bench, paper towel, watch glass).
3. Add pH increaser or decreaser 20 drops at a time with a pipette. Check the pH of the solution often using the pH paper.
4. Compare the colouring on the pH paper to the key on the pH paper roll.
5. Stop adding the pH increaser or decreaser once your pH is at 7.

****When university students tested this method, they used 130 drops of pH increaser to get the rainwater solution to a pH of 7.**

Hazard & Risk Assessment

Hazard	**Control Summary**	**Consequence**	**Likelihood**	**Residual Consequence**	**Residual Likelihood**	**Residual Risk Level**
Cuts from broken glassware	Exercise caution using glassware. Check glassware for defects or cracks before using. Distillation set up has been designed to reduce the number of glass components.	Minor	Likely	Minor	Possible	Minor
Burns from hot plate or hot apparatus	Exercise awareness of the hot objects. Ensure users are trained on operation. Do not exceed intended temperatures for experiment (max 100C) Consider insulating mat beneath hot plate. Create a sign telling users and people in lab that equipment is hot.	Moderate	Good Possibility	Minor	Possible	Minor
Rubber bung flying out of distillation set up	Ensure rubber bung fits correctly in the opening of the conical flask. Consider the use of a clamp to hold rubber bung in place. Ensure the distillation does not exceed 100C. If the solution is boiling too rapidly, slow the rate of distillation by decreasing the heating temperature.	Minor	Possible	Minor	Highly Unlikely	Minor
Chemical spill on user or surfaces	Wear appropriate PPE (lab coat, gloves, safety glasses). Safe handling of chemicals - secondary containments, carrying baskets. Knowing where nearest eye wash stations and emergency showers are located. Knowing how to use spill kits.	Moderate	Possible	Minor	Possible	Minor