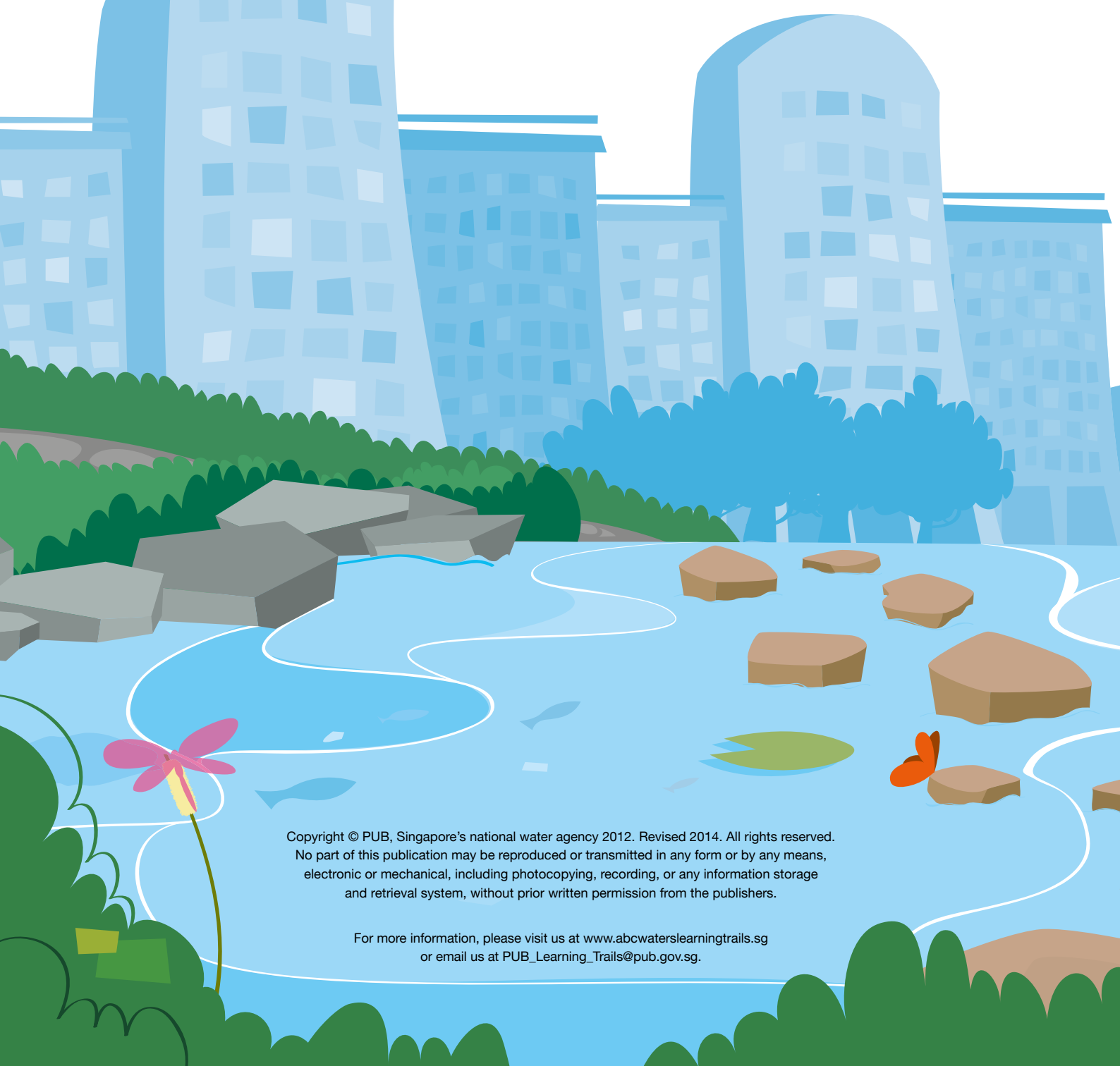
PUB ACTIVE, BEAUTIFUL, CLEAN WATERS

SECONDARY

Learning Trail

Kallang River @Bishan - Ang Mo Kio Park

TRAINER'S GUIDE



For more information, please visit us at www.abcwaterslearningtrails.sg
or email us at PUB_Learning_Trails@pub.gov.sg.

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Objectives of the Active, Beautiful, Clean (ABC) Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park

This place-based inquiry experience allows students to:

1. Learn about the Singapore Water Story and appreciate Singapore's unique challenges and success.

2. Realise that we must be guardians of our waters by keeping our waterways clean and practising good water habits to ensure water sustainability.

3. Understand PUB's ABC Waters Programme which will transform Singapore's pervasive network of drains, canals and reservoirs into beautiful and clean streams, rivers and lakes. By integrating the streams, rivers and lakes with the parks and gardens, new community spaces can be created. These will be bustling with life and activities, and transform Singapore into a City of Gardens and Water, a vision outlined by Singapore's Prime Minister Lee Hsien Loong.

4. Find out how we can harness technology to transform and improve our environment.

5. Evoke the sense that our water quality is affected by the physical environment and human activities. A healthy ecosystem supports rich biodiversity.

6. Be aware that our drains and canals are all inter-connected with two-thirds of Singapore being water catchment. In a catchment area, litter that is being thrown on the ground can be washed by rainwater runoff into our waterways, polluting them and eventually our reservoirs.

7. Promote stewardship for our strategic water resource and the need for everyone to play a part to keep our waterways and reservoirs active, beautiful and clean.

Details of the ABC Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park

Level: Secondary students (13-16 years old)
Programme Duration: 2.5 - 3 hours
Ratio of Facilitator to Students: 1 : 10 - 20 students
Recommended maximum group size: 40 students
Before the Trip:

- Give students a copy of the preparation brief (Annex 5) so that they can prepare the items needed. Print these only if necessary.
- Conduct a reconnaissance of Kallang River @ Bishan-Ang Mo Kio Park and familiarise yourself with the area and stations.
- Complete the Risk Assessment Management (RAM) form required by Ministry of Education. Suggested information is given in Annex 6.
- Conduct a pre-trail activity using the Extension Activity (Refer to Page 40) in class to spark students' interest in finding out more about water.

Educational Approaches

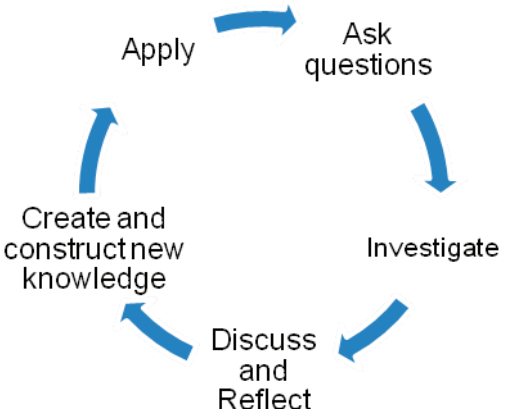
This trail uses inquire-based and experiential learning.

What is Inquiry-Based Learning?
The inquiry-based approach focuses on student constructed learning, as opposed to teacher or guide-transmitted information.

This process aims to enhance learning through:
1. Increased student involvement
2. Multiple ways of knowing

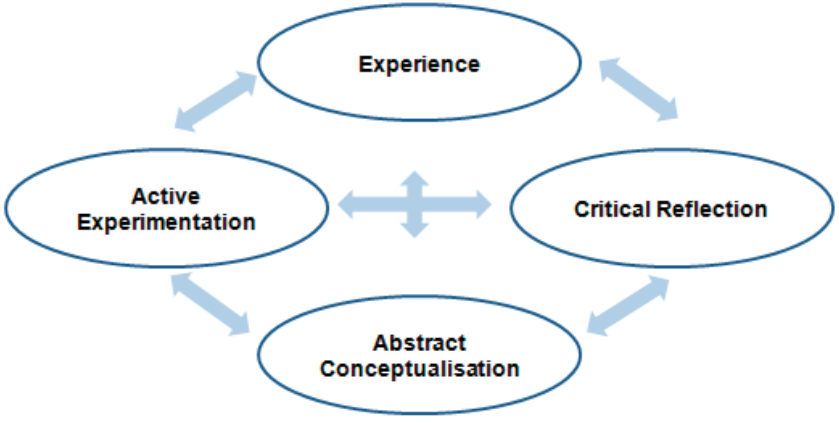
This is achieved by:

- Starting with an open-ended question or demonstration.
- Gather responses and subsequent questions from students with little comment or direction.
- Requiring students to collaborate on designing experiments or methods of inquiry.



What is Experiential Learning?

Experiential learning is the process of making meaning from direct experience.



Integrated Learning
Using the systems (a macro concept) approach, students learn how everything interacts with each other to constitute a meaningful whole.

What is a System?
A system is a collection of things and processes that interact with each other and together to constitute a meaningful whole. Examples from the realm of science include atoms, chemical reaction systems, organisms, ecosystems, solar systems and galaxies; non-science examples include sewer systems, political systems, banking systems, transportation systems, and so on.

All systems share certain properties. These include:

- Systems have identifiable elements.
- Systems have definable boundaries.
- Most systems receive input in the form of material or information from outside their boundaries and generate output to the world outside.
- The combination of internal interactions among a system's elements and their response to the external environment determines the overall nature and behaviour of the system.

Kallang River, its source and end-point can be considered as the **boundary** of the river / park system. The **elements** are the river, its source, its catchment area, water, rain, plants and animals in the river and parks nearby, the gases and nutrients that dissolve in the water, organisms along the river bank, and human activities in the river. The elements **interact** with each other actively. For example, water enters the body of fish and enables the fish to survive. The fish in turn produces carbon dioxide during respiration, which is used by plants for photosynthesis. **Input** of the river includes water from Lower Peirce Reservoir and the catchment areas, as well as rain water. **Output** of the river includes water flowing to Marina Reservoir, evaporation of water from the river surface, before being stored at other water bodies, treated and distributed to homes and industries.

Before the Trip

- Brief students on the field trip and what to bring and wear. Refer to Annex 5.
- To prepare students, show students the Pack List (Annex 5). Assign students to carry/be in charge of equipment/materials.
- Conduct a reconnaissance of Kallang River @ Bishan-Ang Mo Kio Park and familiarise yourself with the area and stations.
- Fill in the Risk Assessment Management (RAM) form required by Ministry of Education (MOE). Suggested information is given in Annex 6.
- Inform the relevant authorities – PUB and NParks and make a booking for your school visit.

Wet Weather Procedure

On the day of the field trip:

- Check the weather forecast and lightning status 1 to 2 hours before the Learning Trail begins:
  - Visit the National Environment Agency website www.weather.gov.sg.
  - Dial the lightning advisory number at 6282-6821
- If there is a heavy downpour or the Lightning Category 1 is still not cleared:
  - Do not start the trail
  - Remain at the sheltered area and conduct the extension learning activities and other indoor activities.
- If lightning or heavy rain persists, stop the programme and plan for another make-up session if possible.
- Should a storm be expected during the Learning Trail, bring students back to the sheltered area as soon as possible. If it is impossible to reach the sheltered area in time, students should wait under shelters along the trail and move back to indoor area as soon as they can. Conduct the extension activity at the sheltered area.

Summary of the ABC Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park

Station	Duration	Location	Main Points	Subject Links (See Annex 7 for details)	Page No.	Materials
	20min	Sheltered area at Riverside Gallery (Riverside Plains) / Info Kiosk (Pond Gardens)	**Introduction** • Aims of the ABC Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park • Understanding of water sustainability • Our Water Story and the Four National Taps • Importance of our First National Tap – Local Catchment Water • Safety briefing	**Geography** – managing water resources **National Education**	1-3	Student booklets
1	10min	Bridge near the playground (Riverside Plains) / Bridge behind Info Kiosk (Pond Gardens)	**The Water Cycle and Journey of Water and What's Around Here** • Water Cycle and Journey of Water at Kallang River @ Bishan-Ang Mo Kio Park • Features around the park	**Geography** – managing water resources, map reading	4-6	Student booklets

Station	Duration	Location	Main Points	Subject Links (See Annex 7 for details)	Page No.	Materials
2	10min	Sheltered area near fast-food restaurant (Riverside Plains) / Sheltered area opposite a school (Pond Gardens)	**Past and Present: The River that Flows and Human Impact on River and Environment** • History of Kallang River @ Bishan-Ang Mo Kio Park • Understand how human activities can impact our environment and waters	**History** of Singapore **Character Education –** civic consciousness	7-9	Student booklets
3	10min	Safety node after fast-food restaurant (Riverside Plains) / Safety node near playground (Pond Gardens)	**Enjoy the River Responsibly** • Understand the safety features at the park and practise good water safety habits.	**Character Education –** civic consciousness	10	Student booklets

Station	Duration	Location	Main Points	Subject Links (See Annex 7 for details)	Page No.	Materials
4	30min	Stepping stones in the river before sculpture (Riverside Plains) / Along the river banks near Lotus Garden (Pond Gardens)	**Water Watch - What's the Water Quality Like?** • Learn the link between water quality and water sustainability • Test parameters for water quality • Evaluate water quality in the river • Note limitations of this water testing activity	**Science** – process skills, scientific method **Geography** – managing water resources	11-13	Student booklets, pail, water test kit
5	40min	Test bed opposite sculpture (Riverside Plains) / Cleansing biotope (Pond Gardens)	**Naturalisation of Kallang River and Sustainable ABC Waters Design Features** • Understand the ABC Waters concept • Understand the transformation of Kallang River @ Bishan-Ang Mo Kio Park • Learn about soil bioengineering techniques applied for slope stabilisation and erosion control • Discover the benefits of the cleansing biotope	**Science –** use of technology to solve problems **Geography** – managing water resources **National Education**	14-16	Student booklets

Station	Duration	Location	Main Points	Subject Links (See Annex 7 for details)	Page No.	Materials
6	30min	Riverside Gallery, in front of the sheltered area (Riverside Plains) / Along the river banks near Info Kiosk (Pond Gardens)	**Get Close to Biodiversity** • Spot, identify and record plants and animals in the river, along the river bank and around the park • Understand that different animals and plants thrive in different types of habitats and everything collectively forms the macro-system (inter-dependency on one another) • Heighten students' understanding of species biodiversity in the area	**Science –** biodiversity of plants and animals (classification), habitats, population, communities **Geography and Science –** protecting and conserving the environment at different levels (individual, national, international) **Character Education –** civic consciousness	17-19	Student booklets (A) Fishing nets, white tray, magnifying glass, plastic pipette (B & C) Binoculars Nature and biodiversity books or reference materials

Station	Duration	Location	Main Points	Subject Links (See Annex 7 for details)	Page No.	Materials
-	20min	Sheltered area near Riverside Gallery (Riverside Plains) / Info Kiosk (Pond Gardens)	**Debrief and Reflections** • Run through the main objectives from the trail • Reflection questions • Highlight to students that they have a part to play in keeping our waters clean, appreciating every drop of water and using the place responsibly.	**Geography and Science –** protecting and conserving the environment at different levels (individual, national, international) **Character Education –** civic consciousness	20	Student booklets
Total Duration: 2.5 - 3 hours						
EXTENSION ACTIVITY						
-	1.5hr	As preferred	**Activity 1: Problem-Based Learning** **Activity 2: What do you know about water?** **Activity 3: Your Water Footprint**	**Geography** – managing the changing environment (water resources)	21 22 23	

Lesson Plan for ABC Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park

Introduction

Duration: 20min
Location: Sheltered area at Riverside Gallery (Riverside Plains) / Info Kiosk (Pond Gardens)
Learning Points:

- Aims of the ABC Waters Learning Trail at Kallang River @ Bishan-Ang Mo Kio Park
- Understanding of water sustainability
- Our Water Story and the Four National Taps
- Importance of our First National Tap – Local Catchment Water
- Safety briefing

Trainer's Notes / Activities	Time	Page/ Materials
1. **Welcome** students to Kallang River @ Bishan-Ang Mo Kio Park and count students. Distribute the Learning Trail booklets and ask them to write their names.		Pen/Pencil
2. Introduce and explain the **aim of the ABC Waters Programme.** • Transform these utilitarian drains, canals and reservoirs into active, beautiful and clean streams, rivers and lakes. • Create a seamless blue-green network which is well integrated with the adjacent land developments, thereby creating new community spaces and encouraging new lifestyle activities to flourish in and around the waters. • In line with Singapore's vision outlined by PM Lee Hsien Loong to turn Singapore into a vibrant City of Gardens and Water.	5min	Pg 1

Trainer's Notes / Activities	Time	Page/ Materials
3. Explain the **aims of the trail** as indicated on Page 1 of this Trainer's Guide and the themes that they will learn (Page 2 of Student Booklet)**.** Share about **Singapore's Four National Taps** – Local Catchment Water, Imported Water, NEWater and Desalinated Water. Ask if students have visited the NEWater Visitor Centre and Marina Barrage.		Pg 2 Pg 3
4. Highlight how the **Four National Taps** contribute towards the water sustainability ensuring that water is available now as well as for future generations. Suggested questions: • Which of the Four National Taps does Kallang River @ Bishan-Ang Mo Kio Park belong to? (Local Catchment Water which consists of rainwater collected via drains, canals, rivers, stormwater ponds and reservoirs.) • What is the relevance of land area within each catchment? (Land area defines the space from which we can collect rainwater from and the space for water storage.) • With two-thirds of Singapore's land area being used as water catchment, more of us will soon discover ourselves staying nearby or within water catchment areas. o Need to emphasise what it means to live in a catchment. Rainwater falling in catchment areas is channelled to waterways, which eventually carries the water to reservoirs for storage, before it is treated and supplied to homes. o Need to emphasise that litter thrown on a ground in the catchment area will be washed by rain into the drains, canals and rivers, and end up in the reservoirs. • Ask students for reasons on Singapore's move to explore water	10min	Pg 3

Trainer's Notes / Activities	Time	Page/ Materials
technologies, creating the 3rd and 4th National Taps like NEWater and Desalinated Water. Some suggestions: ○ Lack of natural aquifers and groundwater and limited land to collect and store rain water. NEWater, or reclaimed used water, enables us to use every drop of fresh water more than once, thus multiplying our potential water supply. ○ NEWater and desalinated water are not dependent on rainfall. They serve to meet future challenges like extended drought spells, given extreme weather changes today.		
5. **Conduct a safety briefing**: Student should: • Inform you or the teacher if they do not feel well, have a cut, are stung or are bitten. • Be alert and look out for potentially dangerous animals like scorpions or bees along the trail. Move away immediately if they encounter these animals. • Stay hydrated by drinking water along the way. • Always move in pairs or a group. Do not work or wander off on your own. • Do not enter the river if you hear the warning sirens and announcements. • Listen to instructions from the guide should the weather change. The learning trail will be stopped if there is an impending thunderstorm (lightning category 1 warning). The group will return to the sheltered area to wait out the storm. • Preparation: Give students few minutes to apply mosquito repellent and	5min	

Trainer's Notes / Activities	Time	Page/ Materials
sun block, go to the washroom or buy a drink. **6. Start the Learning Trail.** **Let students navigate their way or bring them to Station 1.**		

Station 1: The Water Cycle, the Journey of Water and What's Around Here

Duration: 10min
Location: Bridge near the playground (Riverside Plains) / Bridge behind Info Kiosk (Pond Gardens)
Learning Points:

- Water Cycle and the Journey of Water at Kallang River @ Bishan-Ang Mo Kio Park
- Features around the park

Trainer's Notes / Activities	Time	Page/ Materials
1. Water Cycle and Journey of Water • Ask students to point to the direction where Kallang River originates and where it ends up. (Origin: Lower Peirce Reservoir. End point: Marina Reservoir.) • Briefly discuss the water supply network for areas surrounding Kallang River. • Reiterate the importance of keeping our waterways clean as all our drains and canals are inter-linked. The responsibility of keeping our waterways clean lies with all of us. Any litter that is thrown on a ground within a catchment area such as Kallang River @ Bishan-Ang Mo Kio Park will be washed by the rain into the drains, canals and rivers and end up in our reservoirs.	5min	Pg 4
2. Introduce features at the park and navigation. • Get students to spot some of the features that they can see along the trail. Trainer can help by pointing out these features. • Share with students that these features are built for the community to enjoy and to bring them closer to water. • Let students self-orientate to the next station according to the landmarks around.	5min	Pg 5-6

Trainer's Notes / Activities	Time	Page/ Materials
• Point out a soil bioengineering technique that can be seen clearly at this station, the Gabions. Revisit them at Station 5. 3. **Ask students to move to the next station.**		

Station 2: Past and Present – The River that Flows and Human Impact on River and the Environment

Duration: 10min
Location: Sheltered area near fast-food restaurant (Riverside Plains) / Sheltered area opposite a school (Pond Gardens)
Learning Points:

- History of Kallang River @ Bishan-Ang Mo Kio Park
- Understand how human activities can impact our environment and waters

Trainer's Notes / Activities	Time	Page/ Materials
1. History of Kallang River @ Bishan-Ang Mo Kio Park. • Discuss the history of Kallang River using the timeline on Page 7. • Highlight about the major clean-up campaign that affected over 26,000 residents. 2012 marked the 25th year anniversary of the clean-up. • Ask students what they know about Bishan. (Bishan derived its name from the large Cantonese burial ground, commonly known as *Peck San Theng*, which means "pavilions on the green". The burial ground was established by Chinese immigrants.) • Gather students to try the puzzle on Page 8.	5min	Pg 7-8
2. Discuss some **human activities** that students see and their **impacts on biodiversity, safety and water quality**. • Example: Discuss the potential impact of having the fast-food restaurant in the park, near the water. Some possible answers: ○ Littering in the water: It causes water pollution and spread germs or harmful diseases. ○ Feeding of animals: It may cause overpopulation of certain	5min	Pg 9

Trainer's Notes / Activities	Time	Page/ Materials
animals which may in turn threaten other species living on land or in the water. Animals may also become dependent on humans, and will not know how to look for food on their own. Feeding of fishes also adds nutrient loading (pollutants) into the water. This may lead to algae blooms at Marina Reservoir. Uneaten food / excess food also cause pollution. ○ Fishing: Fishing rods and drop lines with hooks can cause injury to park users. Fishing with "scoop" nets is allowed as long as the fishes are returned to the river to minimise disruption to the ecosystem. 3. **Ask students to move to the next station.**		

Station 3: Enjoy the River Responsibly

Duration: 10min
Location: Safety node after fast-food restaurant (Riverside Plains) / Safety node near playground (Pond Gardens)
Learning Points:

- Understand the safety features at the park and practice good water safety habits

Trainer's Notes / Activities	Time	Page/ Materials
1. Explain the **importance of adhering to the safety measures**, especially in times of heavy rain or emergencies. • Highlight the river as a floodplain whereby water flow is normally confined to a narrow stream in the middle during dry weather flow. The banks will be used to contain rainwater as water level rises when it rains. ○ What is the function of the safety node? (When heavy rain is forecast or when water level rises, the safety nodes will be activated. Park users will see red and yellow flashing lights, hear warning announcements and sirens.) ○ When does the warning siren go off? (The warning siren goes off when the water level rises and when a heavy rain warning is received.) ○ What should you do when the warning siren goes off? **(**Listen to the announcements and move out of the river, beyond the red markers.) • **Draw students' attention to other safety features – the red markers, safety lines and life buoys along the river.** ○ Red markers are placed along the river. When water level rises, move away from the river, beyond the markers.	10min	Pg 10

Trainer's Notes / Activities	Time	Page/ Materials
○ Safety lines are placed across the river. These lines will float with the water level and serve as an additional precautionary measure. ○ Life buoys are placed along the river to serve as another precautionary measure in case of an emergency. 2. **Ask students to move to the next station.**		

Station 4: Water Watch – What's the Water Quality Like?

Duration: 30min
Location: Stepping stones in the river before sculpture (Riverside Plains) / Along the river banks near the Lotus Garden (Pond Gardens)
Learning Points:

- Learn the link between water quality and water sustainability
- Test parameters for water quality and evaluate
- Note limitations of this water testing activity

Trainer's Notes / Activities	Time	Page/ Materials
1. Bring students to the **water collection point** to observe the water: • What is water quality? (Water quality refers to the physical, chemical and biological properties of water.) • What do they think the water quality is like - good or poor? (Answers vary.) • Why does the water in the river need to be of good quality? (It is a source for our water supply, to support aquatic life.) 2. Use a pail to scoop some water. Pour the water into one water kit and then lead the students back to find a place to sit down to do the water test. 3. Ask students to turn to the page 11 of their booklet. 4. Explain why we carry out this water testing – to see what the water quality in the river is like. It needs to be good as it is for our water supply and sustains aquatic life. The water testing activity during this trail is not an extensive one, but we will have a quick indication of water quality for that day and hour.	5min	Pg 11-13

Trainer's Notes / Activities	Time	Page/ Materials
5. **Conduct a demonstration** on how to use the water kits. You may also use the data loggers brought by the school. Introduce the World Water Monitoring test kit. Pour water from the pail into an emptied water kit to the fill-line. Highlight that for accuracy, the water needs to be filled exactly to this level. Run through the water parameters progressively, as in pages 11 to 13, explaining each parameter as you go (what each parameter is and some implications of the readings). Demonstrate how the Dissolved Oxygen (D.O.) and pH tests should be conducted. 6. After your demonstration, assign the teams and distribute the test kits to each team. 7. Collect more water from the river in a pail to distribute to the students. Ensure that no student is allowed to collect water directly from the river and that no equipment falls into the water. Give teams 5-10 minutes to complete their tests and record their answers in the "observation" boxes in their booklets. They should not fill in the "analysis" boxes yet. You will analyse the results of all the teams after they have obtained their results. 8. After teams have obtained their readings, gather everyone for debrief. Ask them to give you their D.O and pH bottles. Place these together and start debrief. 9. Discuss the readings obtained and **evaluate the state of the water**. Expected results: • **Location of Water Quality Study** – important because the results obtained give an idea of the water quality for that particular area	15min 10min	Materials: Pail, data logger with temperature, pH and dissolved oxygen sensors, or World Water Monitoring Day test kit containing tests for dissolved oxygen, pH, turbidity and to print the turbidity disc in Annex 1.

Trainer's Notes / Activities	Time	Page/ Materials
only. It may not be the same for other parts of the river. ○ Encourage students to compile their findings and consider doing a long term study of how the water quality changes over time. They can come back to the exact location over a certain time period to compare results. • **Weather Conditions** – weather conditions can affect the readings. The water is cooler when it rains, or when it is cloudy. This affects temperature and dissolved oxygen. Rain can also affect the turbidity of the water. • **Debris and Smell** – there should not be any smell. There may be debris washed down from upstream after a rain. ○ Explain that it is important not to throw rubbish anywhere within a catchment area. Throwing litter within a catchment area will pollute the waterways and eventually the reservoir. • **Turbidity** – this should be as clear as possible. The usual reading is the lightest or second lightest number. ○ Reiterate that turbidity is caused by small particles suspended in the water. It affects the light penetration in the water. The clearer the water, the higher the light penetration – allowing more aquatic plants/algae to grow in the water. • **Colour** – the water should be slightly green or yellow in colour (due to the presence of some algae, which is normal). ○ Some algae is good as this can add to the level of dissolved oxygen in the water.		

Trainer's Notes / Activities	Time	Page/ Materials

• **Temperature** – expected results is between 28 – 30°C.
  ○ Ask students why the water temperature is lower than the air temperature. (Water takes a longer time to heat up and cool down.)
  ○ Ask students what factors can affect water temperature. (Weather conditions, rain).
  ○ Reiterate that temperature can affect the amount of dissolved gases, like dissolved oxygen. (Higher temperature, lower the amount of dissolved oxygen)
 	
• **Dissolved Oxygen** – this should be at least 4ppm (parts per million), below which the water will be too low poor to support aquatic life.
  ○ Ask students what affects the amount of dissolved oxygen in the water. (Organic materials that are present in the water will be decomposed by bacteria, using up oxygen in the process. Windy conditions will allow more oxygen to be mixed into the water.)
 	
• **pH** – pH of 6 – 9. pH scale ranges from 0 to 14 with pH 0 being very acidic, pH 7 being neutral and pH14 being very alkaline. Most aquatic organisms survive well in a pH range that is near neutral.
  ○ Ask students what causes the water in the river to be acidic. (Decomposing of leaves which releases tannic acid causing the water to be acidic and brownish.)
 	
10. **Summary**. Ask students to answer the 3 questions at the bottom of page 13:
• Conclusion: Overall quality of water. (Expected answer: generally		

Trainer's Notes / Activities	Time	Page/ Materials
good) • Can you drink from the river? Why? (No. There are other parameters we have not tested to know if the water is safe for drinking (e.g. bacteria count, algae count etc.) Water collected has to undergo water treatment before it is potable (drinkable).) • Where does the water in Kallang River come from? How does this affect the water quality in the river? (It comes from the rain, drains from the surrounding housing areas also known as urban catchments and Lower Peirce Reservoir. Pollutants in the rain such as particles or other gases could affect the pH or turbidity of the water. If people throw rubbish and chemicals into the drains, all these will also flow into Marina Reservoir.) ○ Reiterate the importance of throwing rubbish responsibly into bins, not polluting drains with chemicals and not feeding fish in waterways or reservoirs. Also, do not release animals into our waterways. Do not discharge the used water from washing of your cars into the drains. They should be discharged into the sewers (used water network). 11. **Limitations** of this water testing activity. • Only one measurement is taken at one location, at a certain time and water was only collected from the river surface. A better testing method requires many measurements at several locations, at several times throughout the day and at different water depths. • Limited number of water parameters is tested. Additional parameters could be exclusion of bacterial count, heavy metal		

Trainer's Notes / Activities	Time	Page/ Materials
testing, etc. • There are limitations in the accuracy of the water testing kit. **12. Ask students to move to the next station.**		

Station 5: Naturalisation of Kallang River and Sustainable ABC Waters Design Features

Duration: 40min
Location: Test bed opposite sculpture (Riverside Plains) / Cleansing biotope (Pond Gardens)
Learning Points:

- Understand the ABC Waters concept
- Understand the transformation of Kallang River @ Bishan-Ang Mo Kio Park
- Learn about soil bioengineering techniques applied for slope stabilisation and erosion control
- Discover the benefits of the cleansing biotope

Trainer's Notes / Activities	Time	Page/ Materials
1. Explain the **ABC Waters Concept**. • It integrates the blue (waterbodies), with the green (environment) and the orange (community). At the ABC Waters sites, these aspects have been incorporated in the facilities found there.	5min	Pg 14
2. How is the river transformed? The river is designed on a flood plain concept whereby water is confined to a narrow stream in the middle of the river on a normal dry weather days. The slopes of the river, constructed using soil bioengineering techniques are gently sloped. Park users are able to get close to the river and enjoy observing a wide range of flora and fauna during dry weather. When it rains, the park land that is next to the river doubles up as a conveyance channel, carrying the flow downstream. This enables multiple land uses within the park and creates more spaces for the community.	5min	Pg 14
3. Soil Bioengineering Techniques	15min	Pg 15

Trainer's Notes / Activities	Time	Page/ Materials

• Ask students to guess the purpose of the test bed.
  ○ It is used to gather data to determine the appropriate types of plantings and soil bioengineering methods to stabilise and protect the river banks from erosion in Singapore's climate. Measuring 60m by 10m test bed, there are approximately 10 soil bioengineering techniques tested.
 	
• What are **soil bioengineering techniques**?
  ○ A combination of vegetation, natural materials such as rocks, and civil engineering techniques that are applied to transform a concrete canal into a natural river.
  ○ These techniques help stabilise the river banks, protect them from erosion and form natural habitats that encourage certain wildlife species to settle and reproduce.
 	
• What are the **benefits** of soil bioengineering techniques?
  ○ Technical
  – Natural / sustainable method of construction as the natural materials are self-regenerating.
  – Low maintenance requirements.
  – Stabilises the slopes and protects the soil surface from erosion.
  – Together with the meandering river, it slows down the flow of water, facilitates settlement and deposition of sand and silt, thus protecting the quality of water bodies downstream.
  ○ Ecological
  – Fully naturalised banks that support biodiversity and enhance aesthetics of the environment.
  – Increasing soil integrity through root networks.
 	
• Different soil bioengineering techniques are selected based on their		

Trainer's Notes / Activities	Time	Page/ Materials
resistance to shear stress, the slope gradient and aesthetic and functional aspects e.g. maintenance, installation process (whether it is labour-intensive). • Highlight three soil bioengineering techniques that students can easily locate: Brush mattress with live fascines, gabions and geotextile wrapped soil-lifts. • Make reference to what students observed at Station 1 earlier. 4. Understand the **functions of the cleansing biotope**. Carry out the card game in Annex 2a and 2b to explain the water treatment process carried out by the cleansing biotope. Arrange the card strips (Annex 2a) to reflect the correct order of the process using the photo aid (Annex 2b) to help visualise the process. The cleansing biotope comprises four terraces of cleansing biotopes which will filter the incoming water from the river and rainwater runoff from the park in sequence. The treated water is then channelled to the ponds in the park and also serves as water supply for the water playground. The water will eventually cascade back into the river. 5. **Ask students to move to the next station.**	15min	Pg 16

Station 6: Get Close to Biodiversity

Duration: 30min
Location: Riverside Gallery, in front of the sheltered area (Riverside Plains) / Along the river banks near Info Kiosk (Pond Gardens)
Learning Points:

- Spot, identify and record plants and animals found in the river, along the river bank and around the park
- Understand that different animals and plants thrive in different types of habitats and learn how everything collectively forms the macro-system (inter-dependency on one another)
- Heighten students' understanding of species biodiversity in the area

Trainer's Notes / Activities	Time	Page/ Materials
1. Before the students set off to do their own exploration and study of various species, trainer must explain the objectives, tasks and safety rules clearly to them. **Task** Students are to observe the flora and fauna and record these down in the space provided in the booklet. They are encouraged to take photos of the different species for further study or research. **Safety Rules** Students must be properly attired and wear proper shoes especially if they are entering the river. Students must not bring any animals or plants home.	5min	Pg 17-19 Materials: Guidebooks for identification of plants and animals.
2. Trainer will then proceed to divide the students into 3 groups to look and study species in different zones, namely, in the river, along the river bank and around the park. An assistant facilitator to each group should be allocated to each group if possible.	15min	

Trainer's Notes / Activities	Time	Page/ Materials
a) In the river Use small nets to catch and identify the fish and plants in the water. Release the fish and plants after students have identified them. If students cannot identify them, get them to describe the physical features: size, colour markings, shape, etc. and check with the guidebooks for identification of these plants and animals. To study the organisms on the river bed: ○ Fill the white tray with water from the river. ○ Scoop the sediments from the river bed using the net and put them into the white tray. ○ Allow the sediments to settle and observe the organisms. Use the rubber pipette to move the sediments around and the magnifying glass for a closer view of the organism, if necessary. ○ Identify and count the number of organisms and record it in the booklet.		Pg 17 Fishing net, white tray, magnifying glass, plastic pipette.
b) Along the river bank Identify the plants and animals found along the river bank and check with the guidebooks if they need help identifying the plants and animals. If students are not able to identify them, get them to describe the plant or animal that they see and record it in their booklet.		Pg 18 Binoculars.
c) Around the park Observe the plants and animals found in this area. Identify them and record into the table below. In the event that you cannot identify the organism, write a brief description of it in the space		Pg 19 Binoculars.

Trainer's Notes / Activities	Time	Page/ Materials
provided on Page 19 and share this with the class or encourage students to do research. 3. Students to assemble after the task. Trainer should give time for students to settle down, hydrate themselves and finish up their recording of species in the table. 4. Ask students to share their findings and conduct a very short debrief at the end of the activity. Refer to Annex 3 for more information on the plants and animals. 5. **Return to the sheltered area near Riverside Gallery for Debrief and Reflections.**	10min	

Debrief and Reflections

Duration: 20min
Location: Sheltered area near Riverside Gallery (Riverside Plains) / Info Kiosk (Pond Gardens)

Trainer's Notes / Activities	Time	Page/ Materials
1. Give students some time to reflect on their learning using questions in the Learning Trail booklet before discussing their responses.	5min	Pg 20
2. Run through the objectives of the Learning Trail by recounting the activities and learning points. **Pg 2-3:** Significance of Kallang River @ Bishan-Ang Mo Kio Park as a water catchment and understand the concept of a water catchment area. **Pg 4:** The journey of water from Kallang River where clean water eventually goes to residential homes. **Pg 5-6:** Knowing what is around the park and encouraging the use of the facility. **Pg 7-8:** Understanding the history of Kallang River and its transformation process, as well as its significance as part of Singapore's socio-economic development. **Pg 9-10:** Awareness of safety features and possible impacts from human activities on the water. Realisation of the importance of practising personal responsibility while enjoying our waters. **Pg 11-13:** Water quality of Kallang River @ Bishan-Ang Mo Kio Park. **Pg 14-16:** Understanding of the ABC Waters design features which include sustainable soil bioengineering techniques used for slope stabilisation and erosion control; as well as functions of the cleansing biotope in water treatment. **Pg 17-19:** Identification of the flora and fauna at Kallang River @ Bishan-	5min	Pg 3-19

Trainer's Notes / Activities	Time	Page/ Materials
Ang Mo Kio Park and their inter-dependence for survival. 3. Let students attempt the reflection questions before discussing their answers. • It is the responsibility of all of us to be involved in sustaining our water supply by practising good water conservation habits and preventing water pollution. • What can you personally do to help ensure water sustainability in Singapore? o Keep our water catchment areas clean by not littering. o Keep our waterways clean by not disposing of any waste, solid or liquid into our waterways. o Explain to people the consequence of their actions on the water if you encounter them. o Report to NParks or PUB if you encounter such undesirable activities. o Be aware of the safety features and help to keep the park safe for everyone to use. • Discuss what you will personally do to keep Kallang River @ Bishan-Ang Mo Kio Park, active, beautiful, clean and safe for everyone. Some suggested answers: o I will educate my family to visit the park and use the place responsibly. o I will encourage my friends to use the place as an educational platform for their projects. • Kallang River has gone through a significant transformation from a concrete canal into a meandering river. Do you agree that it is important	5min	Pg 20

Trainer's Notes / Activities	Time	Page/ Materials
for Singapore to constantly look at technology-driven methods to make a difference to our environment? Why? (It is important that Singapore looks into technology to curb the negative impacts of human involvement.)		
4. **Concluding Points.** Conclude by helping students achieve a conceptual understanding of the Learning Trail, the ABC Waters Programme and the use of this precious resource – water. • Link back to biodiversity and interdependence in the ecosystem. ○ The source and end-point of Kallang River can be considered the **boundary** of the river / park system. ○ The **elements** are the river, its source, its catchment area, water, rain, plants and animals in the river and parks nearby, the gases and nutrients that dissolve in the water, organisms along the river bank, and human activities in the river. ○ The elements **interact** with each other actively. For example, water enters the body of fish and enables the fish to survive. The fish in turn produces carbon dioxide during respiration, which is used by plants for photosynthesis. ○ **Input** of the river includes water from Lower Peirce Reservoir and the catchment areas, as well as rain water. ○ **Output** of the river includes water flowing to Marina Reservoir, evaporation of water from the river surface, before being stored at other water bodies, treated and distributed to homes and industries. • Human utilisation / intervention of our environment is essential for the survival of our nation. Precautionary and mitigating measures must be put into actions to minimise the extent of damages and loss of biodiversity.	5min	Pg 20

Trainer's Notes / Activities	Time	Page/ Materials

• Through the ABC Waters Learning Trail, we:
  ○ Understand the ABC Waters Programme better.
  ○ Have learnt more about Our Water Story.
  ○ Understand the journey of water and the history of Kallang River, one of the significant waterways in Singapore.
  ○ Have a better knowledge of water treatment processes that provide our city with clean water.
  ○ Have a better appreciation of our waterways and recognise the need to keep them clean.
  ○ Have a clear understanding of the role of the river in flood control, the soil bioengineering techniques that are implemented to create a naturalised river, and the benefits of the cleansing biotope.
  ○ Respect our environment, the animals and the plants that have made this place their home.		

Extension Activity

Duration: 1.5hr
Location: In the park or in a school computer lab (as a pre or post-field trip activity)

Trainer's Notes / Activities	Page/ Materials
1. Activity 1: Problem-Based Learning • Divide the class into groups with 5 students in each group. • Let each group work on the problem question presented for 45 minutes. Gather the class and let them make their presentations in the form of a skit / presentation. • Give your comments after each presentation and summarise the points raised after all the teams have presented. • Accept a variety of plausible answers: • Climate change, river becomes totally dry, or flooded. • Pollution due to human activities, industrial discharge and river becomes toxic to life. • Overpopulation, leading to an overcrowded park, and how that poses a danger to runners and cyclists. • Certain plants grow too rapidly and overpopulate the place. • Too many people take their dogs to the park and this makes other people uncomfortable. • Choose one of these threats and think of four alternative solutions. • Students generate possible alternative solutions to one stated problem / threat. • Choose a few criteria to evaluate these four alternative solutions such as cost effectiveness and extensiveness of damage to the environment. • Students should state the criteria used and show how they arrive at their best solution using these criteria. • Students can also develop and present their proposed plan to their class, based on their best alternative solution to address to the potential threats / problems.	Pg 21

Trainer's Notes / Activities	Page/ Materials
2. Activity 2: What do you know about water? • Students should do the True or False Activity – Why is water important to living things? Refer to Annex 4 for answers. • Teachers are to discuss the answers with students, and interested students can read "A" level textbooks or university textbooks for more information.	Pg 22
3. Activity 3: Your Water Footprint • Discuss the definition of water footprint with students especially the hidden water consumption behind our everyday items. For most of us in Singapore, we take water for granted and sometimes waste it through careless usage and ignorance of our water footprint. • Students are to do the water checklist and share their checklist with a classmate. • Ask students to think possible ways to save water and share this with their friends. • Share interesting facts about our water footprint for everyday products like rice, meat, and T-shirts with students. • Summarise and reinforce the importance of our water footprint.	Pg 23

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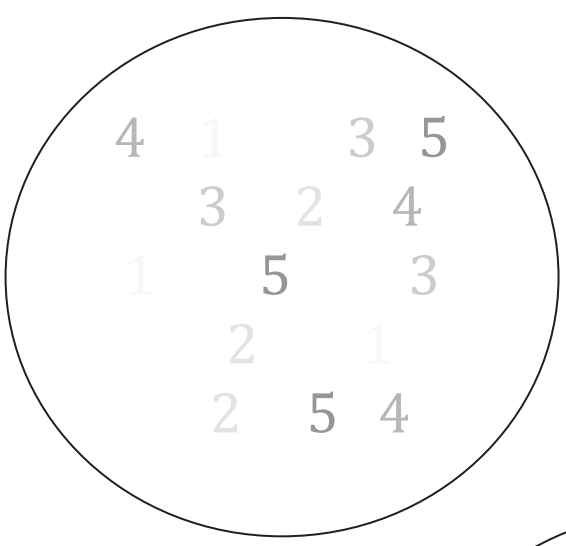
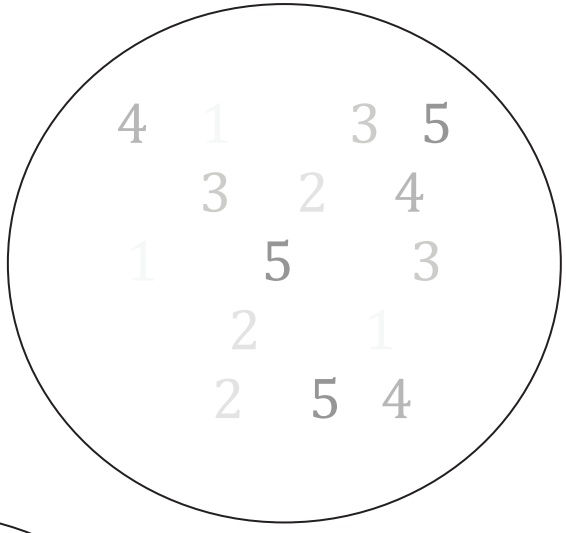
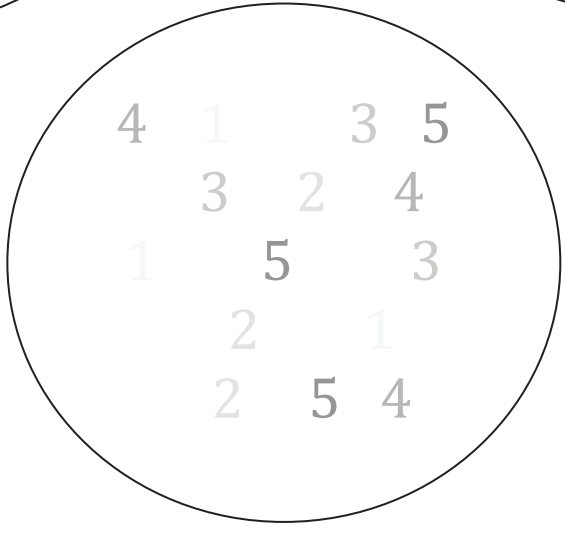
Annexes

Annex 1: Turbidity Disc







Annex 2a: Cleansing Biotope Card Game (Card Strips)

Rain Water	Water from River
Water from Pond	Water from Cleansing Biotope
Control Room	Control Room
Treated Water for Playground	Overflow Cascade

Annex 2b: Cleansing Biotope Card Game (Photo Aids)

Water Playground

River

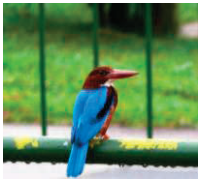
Annex 3: Information on Biodiversity at Kallang River @ Bishan-Ang Mo Kio Park

(A) In the River

Pondskater	Larvae of Midges
	
• Thin insects which are usually dark brown or grey in colour, with round eyes that protrude from the side of their heads. • Their legs are very sensitive and usually covered in fine and water-repellent hairs that can easily sense vibrations and ripples on surface of the water. • Pond skaters are very agile insects that can jump to avoid predators. • Often found hibernating together in sheltered places.	• Small in size, ranging in size from 1/16 to ½ inch long. • Sometimes called “bloodworms” because of their bright red colour although they are not worms. • Can be found in lakes, ponds, and slow-moving streams. • Feed on the dead organic material found at the bottom of ponds. • Able to tolerate very low oxygen levels and thrive in water that is rich in nutrients. They are often found in very large numbers in the sludge at the bottom of stagnant ponds.

Guppy	Apple Snail	Dragonfly Nymph
		
• Able to live for long periods on just algae, micro-organisms that grow on plants and objects in the water. • Also feed on insect and insect larvae. However, they have small stomachs and can only consume a small amount of food at each feeding. • Native to Antigua, Brazil, the Netherlands, Antilles, Venezuela, but have been introduced to many countries. • Thrive in water with an average pH of 6.8.	• One of the most common freshwater snails found in the tropics. • Can be found in a wide range of ecosystems, from swamps, ditches and ponds to lakes and rivers. • However, the majority of the species prefer standing water above streaming water. Only a few have adapted to rivers with strong currents. • Adapted to habitats with low-oxygenated water due to lung/gill combination. • Considered pests due to high reproduction rate, causing overpopulation. • Eggs are laid one by one and attached to each other in a solid clutch.	• Prominent inhabitants of lakes and ponds. • Large and often occur in great numbers. • Do not bite or sting and are thus harmless to Man. • Usually found near slow-moving or still freshwater (lakes or ponds). This secures an environment for them to develop into adult dragonflies. • Only come to the surface when they are ready to emerge as adults. • Feed on other animals (e.g. water boatman, pond snail eggs, water fleas etc.) • Possess a special hooked “mask” which can be shot forward to catch their prey.

(B) Along the River Bank

Dragonfly	Kingfisher	Cattail
		
• Characterised by large eyes, two pairs of strong transparent wings and an elongated body. • Dragonflies are similar to damselflies but the adult dragonfly's wings are held away from, and perpendicular to, the body when at rest. • Dragonflies possess six legs (like any other insect), but most of them use their legs to catch prey in flight. • Dragonflies are some of the fastest insects in the world.	• Brightly coloured birds and most species can be found in Australia. • Have large heads, long, sharp, pointed bills, short legs, and stubby tails. • Consume a wide range of prey as well as fish, usually caught by swooping down from a perch. • Often associated with rivers and lakes but over half of the world's species are found in forests and forested streams.	• Can grow up to 3 metres above slow-flowing water or at the reservoir edges. • The leaves are long and thin. • The flowers look like sausages-on-a-stick. Male flowers are found at the top and are covered with yellowish pollen when it is young. The female flowers, on the other hand, are located at the bottom and will turn into a fat brown "sausage" when they ripen eventually. • The fruits are the brown "sausages", which contain seeds with fluffy "parachutes". • Dense thickets of cattails provide shelter and nesting sites for many animals, both above water (birds) and underwater (fishes). Many birds use cattails as nesting material; the leaves are used to form the structure and the fluffy seeds to make a warm, soft lining.

(C) Around the Park

Parrot's Beak	Sealing Wax Palm	Common Flying Dragon
		
• A native tropical flower. • One of the most beautiful and exotic plants in Singapore. • An evergreen perennial that sports blooms in shades of orange, red and yellow. • Commonly grown for ornamental purposes due to beautiful colours. • Tends to thrive in the warmer months and is relatively easy to plant. • Prefers locations that receive a fair amount of sunlight but is also partly shady. It is drought-tolerant so it can still grow well during the drier months.	• A native palm in this part of the world. • A very popular palm. It has probably earned itself the status of "national palm". • Its seeds germinate slowly, sometimes taking up to one year although fresh seeds germinate more quickly. The young plants stay small (a few inches) for perhaps 3 years then begins to grow to reach about 6m eventually. • It is commonly found in the lowland coastal swamps. Because of this, this palm requires a lot of water to grow. It can be grown in outdoor areas that are partially shaded or fully bright.	• Member of the gliding lizards Draco. • It can spread out folds of skin attached to its movable ribs to form "wings" that it uses to glide from tree to tree over distance upwards of 8m. • Unable to sustain powered flight and is only capable of gliding. • Wings are brightly coloured with orange, red, and blue spots and stripes which provide camouflage when folded. • Feeds on ants and termites.

Annex 4: Answers for Extension Activity 2 – What do you know about water?

Question	Answer	Explanation
Water is lost during transpiration by moving from the roots to the top of the trees through the transpiration pull.	True	-
In Singapore, the average water consumption is 152 litres of water per person per day.	True	-
Water is a solvent for the transport of substances in the body.	True	-
Water does not move into the body of freshwater fish as the scaled on its body are impervious to water.	False	As the body of the freshwater fish is more concentrated than freshwater, water move into its body through osmosis and large amounts of water have to be excreted through its urine.
Certain small animals can exploit surface tension of water to move over water surfaces.	True	For e.g. Raft Spider
As water has a high heat capacity, the temperature of an aquatic environment will fluctuate less compared to that of land.	True	-
We will lost more water through sweat on a cold day.	False	There is less sweating on a cold day.
Water is needed for many chemical reactions in the body.	True	-
We can live for 10 days without water.	False	We can only live for up to about 5 days without water.

Annex 5: Preparation Brief for the ABC Waters Learning Trail

Suggested What-to-bring List for Students (Print only if you have to)

1. A fieldtrip bag (small bag for items below)
2. Water bottle
3. Insect repellent
4. Raincoat or umbrella (in case of rain)
5. Ziploc bag for waterproofing valuables (e.g. camera, hand phone)
6. A pen, or pencil and eraser
7. Cap
8. Plastic bag for wet shoes

Do not bring:
Digital hand held gaming devices, text books, sports equipment for the fieldtrip.

Optional

- Snacks
- Digital camera or camera hand phone

Suggested Attire for Students

- T-shirt
- Shorts, or track pants (lighter colours preferable)
- Covered shoes (no slippers)

Annex 6: Suggested Information for Risk Assessment Management (RAM) Form

Risk Assessment Management System
'W Checklist'

PROGRAMME DETAILS			
Activity:	ABC Waters Learning Trail	**Venue:**	Kallang River @ Bishan-Ang Mo Kio Park
Outgoing		**Returning**	
Date:	To be filled by teacher	**Date:**	To be filled by teacher
Estimated Time of Departure:	To be filled by teacher	**Estimated Time of Arrival:**	To be filled by teacher
Person-in-charge:	To be filled by teacher	**Assistant(s):**	To be filled by teacher

LOCAL VENDOR CONTACT DETAILS (IF ANY)			
Company name & full address:	Facilitator's Name Singapore Environment Council 1 Kay Siang Road #04-02 Singapore 248922		
Office number:		**Mobile number:**	HP of facilitator
Contact person:	Facilitator's name		

OVERSEAS VENDOR CONTACT DETAILS (IF ANY)			
Company name & full address:	NA		
Office number:	NA	**Mobile number:**	NA
Contact person:	NA		

WHY
State learning objectives: This programme aims to: 1. Foster a sense of national identity and emotional rootedness to Singapore 2. Learn about the Singapore Water Story, appreciating Singapore's unique challenges and successes 3. Understand one of PUB's long term initiatives – the ABC Waters Programme, which will transform Singapore's pervasive network of drains, canals and reservoirs into beautiful and clean streams, rivers and lakes 4. Better understand ecological and water topics in the Science syllabus 5. Promote stewardship for our strategic water resource and the need for everyone to play a part to keep our waterways and reservoirs active, beautiful and clean
Does the activity meet learning objectives? (Yes / No)

Note: *Please attach the programme / itinerary.*

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
WHAT (GENERAL)									
1.	**Equipment**								
	a) Appropriate equipment is available.								
	b) Appropriate equipment is serviceable.								
	c) Others :								
2.	**Transport**								
	a) Transportation service is reliable (e.g. driver, vehicle).						To be filled by teacher		
	b) Chartered vehicle is appropriate (e.g. using a 4WD for off-road terrain).						To be filled by teacher		
	c) Others :								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
3.	**Food**								
	a) Food is provided by licensed caterer / restaurants.								
	b) Nutrition is appropriate.								
	c) Special dietary needs are met.								
	d) If self-catering, additional hygiene measures are in place.								
	e) Water is potable.								
	f) Others :								
WHEN (TIMING)									
4.	**Programme**								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	a) Duration of activity is appropriate (e.g. start/stop/rest time).	Participants tired out from the activity	Dehydration/ Physical exhaustion	2	1	2	- The trail will last for 2 hours in the outdoors, with activity stops at the stations.		
	b) Timing of activity is appropriate (e.g. 5km run conducted before 10.30am or after 3.30pm).	Possible heat injuries due to weather	Dehydration/ Physical exhaustion	2	1	2	- Activities at stations will be conducted in shady areas or under available shelter. - Students will not be under the sun for a prolong period of time. - Students will be reminded to hydrate frequently.		
	c) Possible delay in activity (e.g. day hike extended into night).	NA							
	d) Others :								
WHO (PEOPLE)									
5.	**Teachers and Adult Supervisors**								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	a) Teacher(s)/ adult supervisor(s) are competent to supervise activity and manage participants (e.g. teacher/adult supervisor: participant ratio met for specific activity, female adult supervisor present for overnight activity involving female participants).	Participants fall sick and need attention/ evacuation	Not enough teachers/ adult supervisors	2	1	2	- Facilitators are experienced in supervising/managing students - Program ratio will be 1 facilitator to 20 maximum students.		
	b) Personnel is certified and competent to conduct activity.	Participants risk possible danger when outdoors	Participants may injure themselves	2	1	2	- Facilitators are experienced in conducting activities for students in indoor and outdoor settings.		
	c) Certified First Aider or	Injured students do	Minor injuries could manifest	3	1	3	- Facilitators are first-aid certified. (please verify)		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	paramedic is on site.	not get the proper first aid.	to major injuries if not treated well.				- Should there be any student who is injured, he/she will be accompanied by a teacher/parent volunteer to the nearest shelter to be attended to by the main facilitator.		
	d) Personnel is competent to co-ordinate/execute emergency evacuation plan (e.g. search and rescue).	Students with serious injuries cannot get to the hospital in time.	Injuries could be life threatening.	4	1	4	- Should there be a medical emergency involving the injured student, the main facilitator will call for an ambulance and the teacher/parent volunteer will accompany him/her to the hospital.		
	e) Others :								
6.	**Participants**								
	a) Participants understand the objectives of the activity.						- A briefing will be given at the start of the Learning Trail.		
	b) Participants are competent for the activity (e.g. pre-activity								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	training).								
	c) Participants are aware of and adhere to safety requirements of activity.						- A SAFETY briefing will be given at the start of the programme. Facilitators will reiterate safety points during the programme, when necessary. - Students will be briefed to react if they encounter potentially dangerous animals e.g. snake, monkeys, etc. - Students will be briefed not to enter water bodies; not cause anyone to fall into the water bodies. - Water collection for testing will not be carried out by students, but only by facilitators or teachers.		
	d) Special needs of the participants are met.								
	e) Medical declaration and information of participants are recorded and disseminated to						- Teacher/s to inform facilitators about any special cases – students with medical conditions.		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	relevant personnel.								
	f) Others:								
WHERE (LOCATION)									
7.	**Venue**								
	a) Accommodation is adequate (e.g. number of rooms).								
	b) Fire safety and evacuation route is communicated to all.								
	c) Area map is available for use during activity.	Students find themselves lost.	Injuries may ensue.	1	1	1	- Map of location is included in the student booklets. These are carried by both facilitators and students during the programme. - Students should be with the facilitators at all times.		
	d) Reconnaissance	Dangerous hazards	Injuries may ensue due to	1	1	1	- Facilitators would have conducted a		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	of area is conducted.	appear in between time of recon and actual day	unforeseen hazards.				reconnaissance of the location before the date of the learning trail.		
	e) In-country authorities and facilities (e.g. police, national park rangers and hospital) are accessible and/or contactable for assistance and support in the event of an emergency.								
	f) Water conditions (e.g. tides, currents, flash floods) and traffic (e.g. ships, power boats).								
	g) Others :								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
WEATHER									
8.	**Inclement Weather**								
	a) Weather forecast and warning (e.g. lightning, hot and cold spells, haze, floods)	Sudden down-pour	Participants get drenched which will cause participants to fall ill eventually.	1	1	1	- Facilitators to check NEA Rain animation and PSI level at these timings: o 2 hours before LT o 1 hour before LT o During LT if needed		
		Lightning	Participants strike by lightning	4	2	8	- Before students board bus for the location: In the case of **impending thunderstorm, heavy rain or levels of PSI above 100**, it is advised to delay the departure for the location, until Lightning Category 1 is lifted. - If there is **Lightning category 1 or PSI level of equal or greater than 100 during the Learning Trail,** all activities will be stopped and students will be led to take shelter.		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
							- If the conditions persist, the programme will be aborted and students brought back to school.		
	b) Others :								

Annex 7: Subject Links

	Theme	PUB's Educational Objectives	School Curricula
1	History of Kallang River @ Bishan-Ang Mo Kio Park	Setting up of water supply for Singapore – the four National Taps **WATER FOR ALL**	**History** • Growth and development of Singapore – setting up water supply in Singapore • National building from 1965 – 1971 **Geography** • Managing the changing environments – water resources, map reading (Environments through maps and photographs)
2	Water properties – link with flora and fauna and biodiversity	Understanding the need for clean water (not taken for granted) **VALUE**	**Science** • Process skills – measurement • Solutions (chemicals/minerals) and suspensions (turbidity) **Geography** • Inter-relationships of components of the environment • Managing the changing environments – water resources

3	Importance of water	**WATER FOR ALL**	**Science** • Properties of water • Important role of water to keep living things alive **Geography** • Managing the changing environments – water resources

4	Water supply and treatment	Water technology
		Local catchment water – the first of our 4 National Taps
		
		WATER FOR ALL
			Science
			• Basis of Biology and Chemistry
			
			Geography
			• Managing the changing environments
			  ○ Water resources
			  ○ Rising demand for water and responses
			  ○ Supply of water
			  ○ Catchment areas
			  ○ Technology

5	Biodiversity at Kallang River @ Bishan-Ang Mo Kio Park	Water supports life **CONSERVE** and **VALUE**	**Science** • Diversity of plants and animals (classification) • Habitats, populations, community • Relationship within community – food chains and webs (energy transfer in the ecosystem)

6	Sustainable ABC Waters design features and other bioengineering features	**VALUE** and **ENJOY**	**Science** • Using science and technology to solve problems **Geography** • Protecting and conserving the environment at different levels (individual, national and international) • Physical and human environments • Components of the physical environment • Inter-relationships of components of the physical environment

Annex 8: Suggested Packing List (of Resources) for Trainers

1. First Aid Kit
2. Insect repellent
3. Small pails (for collection of water)
4. Water Monitoring Kits with pH strips, turbidity discs, thermometer and dissolved oxygen tablets, glass vial and pH vial
5. Plastic bag to collect used pH strips and water which has been tested
6. Guide books on Singapore's plants, trees and freshwater animals
7. White tray
8. Fishing net (small and medium sized)
9. Hand lens (magnifying glass)
10. Plastic pipettes

Optional:

11. Camera

Acknowledgements

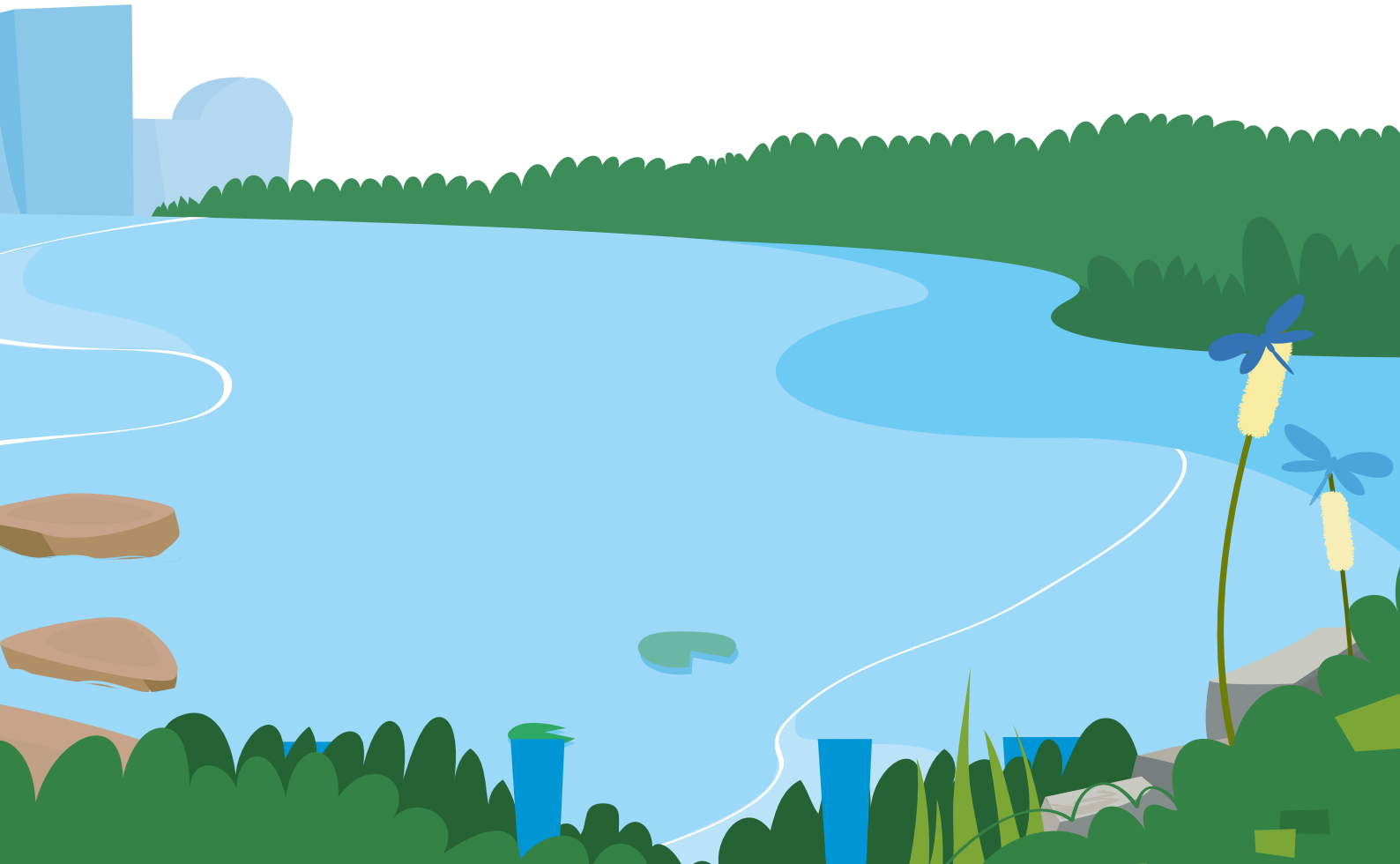
Raffles Institution

National Parks Board*

National Education Branch,

Ministry of Education

*Pictures courtesy of Flora & Fauna Web
http://florafaunaweb.nparks.gov.sg



PUB, Singapore's national water agency

PUB is the national water agency that manages Singapore's water supply, water catchment and used water network in an integrated way. PUB won the 2007 Stockholm Industry Water Award and was named Water Agency of the Year at the Global Water Awards 2006.

About PUB's tagline: Water for All: Conserve, Value, Enjoy

PUB has ensured a diversified and sustainable supply of water for Singapore with the Four National Taps (local catchment water, imported water, NEWater, desalinated water).

To provide water for all, PUB calls on all Singaporeans to play our part to conserve water, keep our water catchments and waterways clean and build a relationship with water so we can enjoy our water resources. We can then have enough water for all uses – for industry, for living, for life.

PUB SINGAPORE'S NATIONAL WATER AGENCY

www.pub.gov.sg