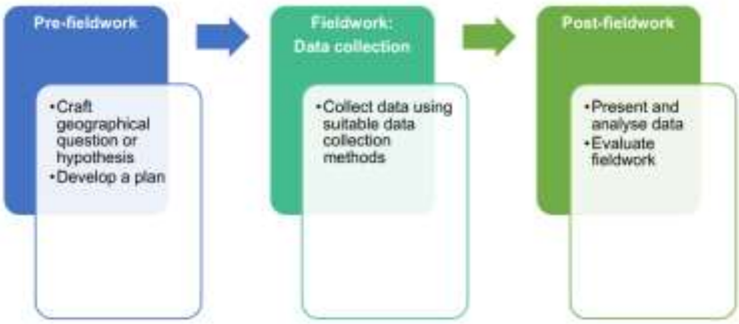
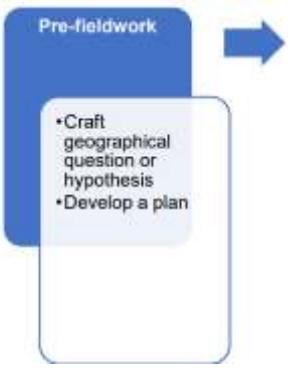
St Andrew's Junior College
H2 Geography
Cluster 4: Fieldwork



Topics in the syllabus: Fluvial flood risk and strategies to mitigate it (Cluster 2)
Area chosen: Bishan Ang Mo Kio Park (BAMK Park)

Craft Geographical Question or Hypothesis

Students should be able to craft geographical questions/hypotheses based on geographical issues or phenomenon that are:
- at a suitable scale
- researchable ***or*** measurable
- clearly defined



Hypothesis:
Places near the Kallang River in BAMK Park have higher flood risk than places far from the riverbank.

Geographical question:
Does places near the Kallang River in BAMK Park have higher flood risk than places far from the riverbank?

Develop a plan:
- establishes the primary and secondary data needed to examine the question/hypothesis posed
- identifies appropriate methods to determine sample size, select sample and collect data
- ensures accuracy and reliability of data collected
- addresses possible issues related to research ethics and the limitations imposed by resources
- minimises potential risks in undertaking fieldwork.

- How does flood risk differ with **distance** from the Kallang River in BAMK Park? (Swamp Tea Tree and Aramsa)
- How does flood risk differ with **land use** along the Kallang River in BAMK Park? (Students may opt to study Swamp Tea Tree and Aramsa/241 HDB)
- How does flood risk differ with **urban function** along the Kallang River in BAMK Park? (Aramsa and 241 HDB)

Flood Risk Index:

	Indicator	**Rating for Site A**	**Rating for Site B**
Severity of Impact **(1: Highly Severe; 5: Not Severe)**	Distance from river channel		
	Elevation above river channel		
	Land Use		
	Human Flow		
River Efficiency **(1: Low river efficiency; 5: High river efficiency)**	Hydraulic Radius		
Potential for OLF to Take Place **(1: High potential for OLF; 5: Low Potential for OLF)**	Ground Cover		
	Infiltration Rate		
Effectiveness of Mitigating Strategies **(1: Ineffective;** **5: effective)**	Hard Engineering Measures		
	Soft Engineering Measures		
	Average Rating:		

Data Collection Methods:

	Indicator	**Data Collection Method**
Severity of Impact **(1: Highly Severe; 5: Not Severe)**	Distance from river channel	Google Map
	Elevation above river channel	Google Map
	Land Use	Observation
	Human Flow	Pedestrian Count
River Efficiency **(1: Low river efficiency; High river efficiency)**	Hydraulic Radius	Measurement
Potential for OLF to Take Place **(1: High potential for OLF; 5: Low Potential for OLF)**	Ground Cover / Landuse pattern	Observation
	Infiltration Rate	Measurement
Effectiveness of Mitigating Strategies **(1: Ineffective; 5: effective)**	Hard Engineering Measures	Observation
	Soft Engineering Measures	Observation

To <u>measure</u> infiltration rate, follow the steps below:

a) Based on the considerations above, select two different areas at different distance from the Kallang River.

➢At different distance from the river: near and far

➢ Different land use: vegetated (permeable), impermeable surface

➢ Accessible

For example:

- Site A - Swamp Tea Tree (**near the river**, vegetated)
- Site B - Aramsa/241 HDB (**far from the river**, building)

b) Sink/hammer a bottomless round tube/container (15cm), about 3-5 cm, into the ground of one area you have selected.

c) Place a ruler vertically inside the tube/container to record fall in water level.

d) Fill the tube/container with water, perhaps to about 10 cm in height or even to the brim.

e) Measure and record the drop in the water level after 5 minutes.

f) Top up the water and record the drop in the water level after another 5 minutes.

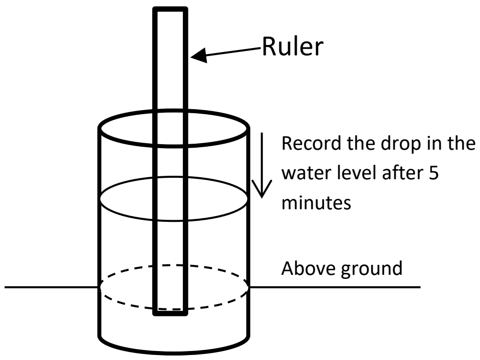
g) Repeat step f. Note that you should record the drop in water level for <u>at least 3 successive periods</u> of 5 minutes. It would be best to continue the experiment until infiltration appears to be at a constant rate (this would be the steady-state infiltration capacity of the soil).

h) Record your results in the tables that follow.

i) Repeat steps **b** to **h** for the ground of the other area (Sites B) you have selected.

<u>Example</u>

Suppose we fill the tube/container to the brim.
Drop in water level after 5 minutes = x cm
∴ Infiltration rate = x/*5* cm per min or x/*300* cm per s



You are required to pick two sites to measure infiltration rate:

- **Site A** - Swamp Tea Tree (near the river, vegetated)
- **Site B** - Aramsa/241 HDB (far from the river, building)

However, do take note of site chosen and <u>take pictures</u> of the site for reference.

Description of Selected Site A: ____

____

	Attempt 1	Attempt 2	Attempt 3	
Drop in water level after 5 minutes (cm)	2cm	1.8cm	1.6cm	Average Infiltration rate
Infiltration rate (cm/min)	2cm/5= 0.4cm/min	1.8cm/5= 0.36cm/min	1.6cm/5= 0.32cm/min	1.08cm/3= 0.36cm/min

Description of Selected Site B: ____

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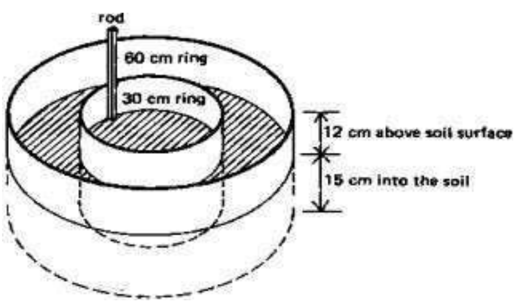
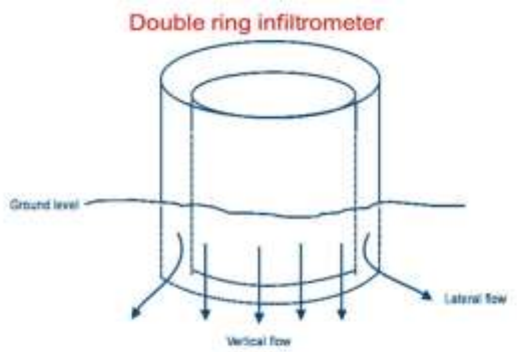
	Attempt 1	Attempt 2	Attempt 3	
Drop in water level after 5 minutes (cm)				Average Infiltration rate
Infiltration rate				

<u>To improve **accuracy** of measuring infiltration rate:</u>

Use a double ring infiltrometer – you can also measure infiltration rates using a double ring infiltrometer, which can yield reliable and accurate results. Drive the infiltrometer 15-20 cm into the soil. Be sure the rings are level. Cover the soil surface in the inner cylinder with a perforated metal plate, in order to dissipate the force of applied water and distribute water uniformly inside the ring. Add water in both rings. Measure the amount of water infiltrated after every fixed interval, such as 15 minutes, for at least three successive periods. Ensure that the water in both the inner and outer cylinders is topped up after each interval. Note that the measurement is to be taken in the inner cylinder; the outer cylinder is used only as a tool to ensure that water from the inner cylinder will flow downwards and not laterally.





Fluvial flood risk and strategies to mitigate it

To determine flood risk, we need to measure 1) river discharge and 2) river efficiency

1) Measuring River Discharge (i.e. cross sectional areas and velocity) of the channel

Many factors can influence flood risks. These include both natural (e.g. climate, geology, gradient) and anthropogenic factors (types of land use). Essentially, flood occurs when the channel exceeds its bankful discharge. Hence, it would be useful to measure the discharge of the river channel. **Discharge** refers to the **volume of water** that passes through a given cross section per unit time, usually measured in **cubic meters per second** (m/s).

Discharge (Q) = Cross Sectional Area (A) x Velocity (V).

Stage 2: Data Collection

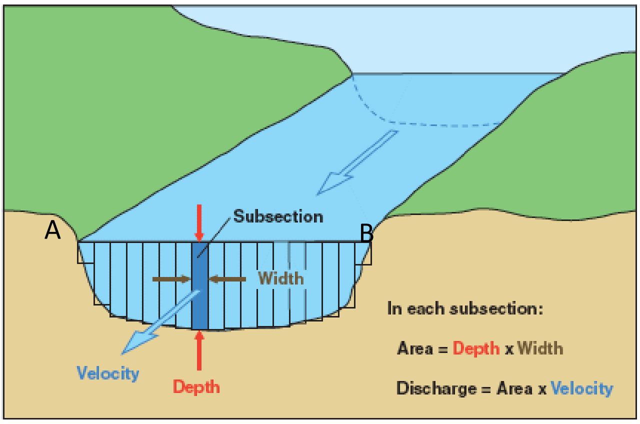
1.1 Measuring the cross sectional area of the channel.

Cross Sectional Area (A) = Width (W) x Depth (D)

Measuring the width (W) of the channel:

Follow the steps below:

a) Requires at least two persons.
b) Identify a section of the channel that you want to measure.
c) One person stands with the **measuring tape** on one bank of the channel, where the water touches the bank. The other person walk across the river pulling the measuring tape across the water surface to the other bank of the channel.
d) Record the length of the width in centimetres.



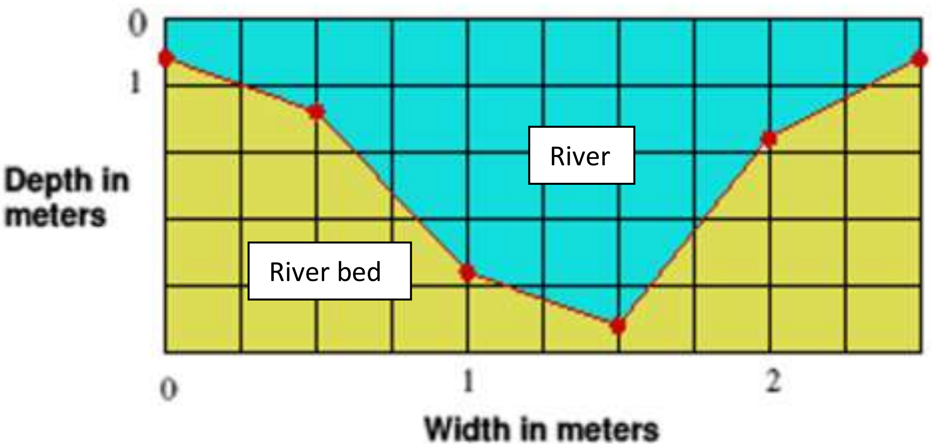
<u>Measuring the depth (D) of the channel</u>

Follow the steps below:

a) Requires at least 3 persons.
b) Depending on the width of the channel measured earlier, divide the width into at least 5 regular intervals. State the interval chosen: _________________.
c) Using a metre rule, dip the ruler in water at each regular interval $D_1 – D_6$.
d) Ensure that the base of the ruler, with the 0m mark, touches the channel bed.
e) Hold the ruler vertically and take the measurement where the surface water touches the ruler. The measurement is taken from 0m at the river bed upwards.
f) Repeat step c – e for the rest of the intervals. Record your readings in the table below.

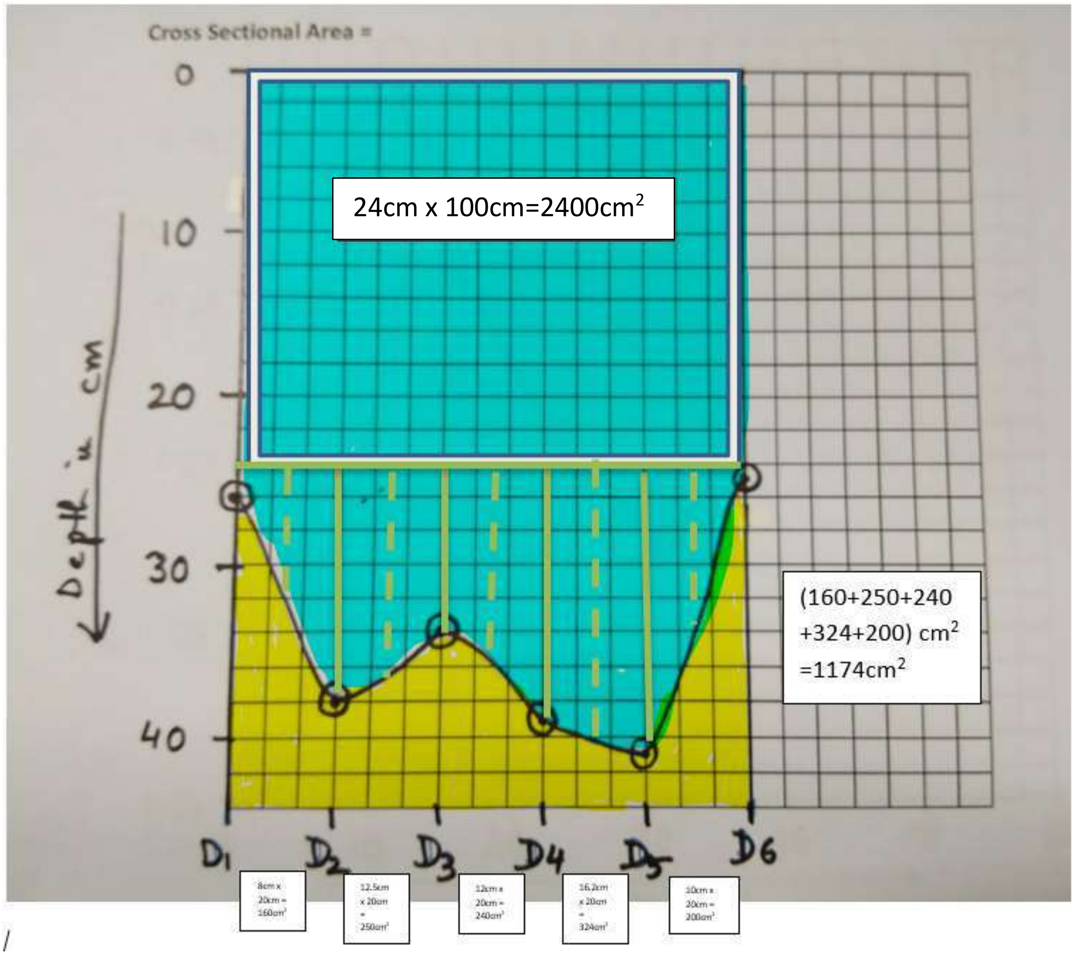
	Depth (cm) across the channel at few points
D_1 (At Bank A, 0m)	26cm
D_2	38cm
D_3	34cm
D_4	39cm
D_5	41cm
D_6 (At Bank B)	25cm

g) Using a graph paper and the data collected for width and depth, draw the cross section of the channel. The diagram below serves as an illustration.



After drawing your own channel cross section in the grid squares below, calculate the grid squares to determine the cross sectional area of the channel.

Cross Sectional Area =



	Average Depth (cm) across the channel at few points	Cross sectional area
$D_{1-}D_2$	**8cm**	**8cm X 20cm = 160cm^2**
D_2-D_3	**12.5cm**	
D_3-D_4	**12cm**	
D_4-D_5	**16.2**	
D_5-D_6	**10cm**	

Cross Sectional Area (A) = 2400 +1174cm^2

1.3 Measuring the river velocity

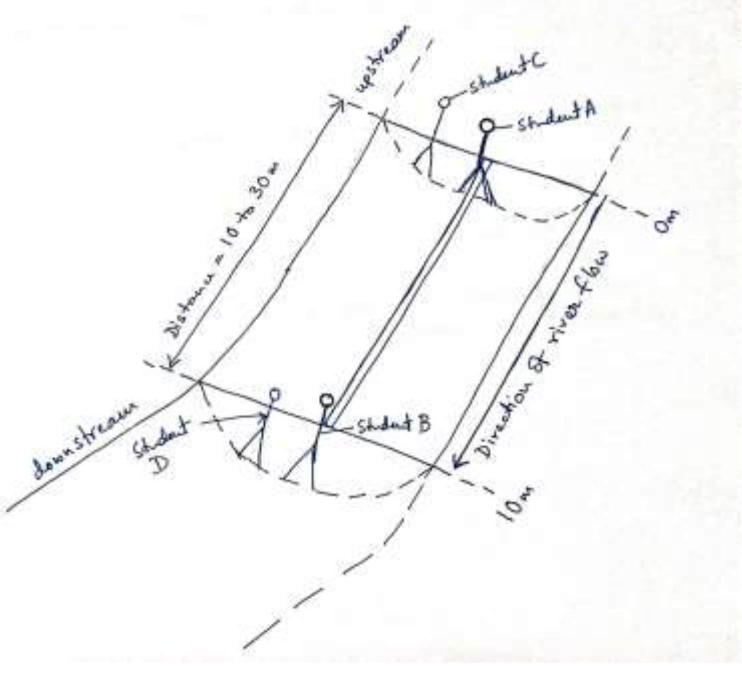
The exact method to calculate river velocity will depend upon the nature of the stream and your equipment.

Equipment needed:
Meter tape,
float (orange, pin pong ball, light stick, dry leaves),
wooden or steel meter ruler 1m

Float Method: In a comparatively clear stretch of river the simple float method will suffice. Students should choose a straight stretch of the river channel with the least obstructions, around 10-30m long.

Steps:

a) Requires at least 4 persons. Student A should stand with the 0m of the measuring tape in the middle of the river channel facing downstream. Student B stands 10m away downstream from student A in the middle of the channel and faces upstream. Student C stands next to Student A with the floating device. The best floating devices are those that float beneath the water surface and are thus unaffected by wind, for example oranges. Student D stands next to Student B with a stopwatch.
b) Student C releases the floating device into the water at 0m, where Student A is standing, and shouts "Start" so that Student D can start the stopwatch. As soon as the floating device reaches Student B, Student D stops the stopwatch and records the time taken.



c) Repeat step **b** and ensure that the timing of the floating device over the measured distance at the centre of the river is taken at least three times.

d) Calculate each velocity reading by dividing distance by time. Take the average of the 3 velocity readings.
e) Multiply the average velocity by 0.85, because the water on the surface flows faster than under it, and this conversion ensures an accurate velocity reading for the whole cross-section.

Velocity in the centre of the river							
Times of measurement	**Length of river segment (metres)**	**Start time**	**End time**	**Time difference (seconds)**	**Velocity (Distance/Time) (metres/sec)**	**Average Velocity (m/sec)**	**Average Velocity (x 0.85) (m/sec)** (for accuracy)
First attempt	10m	0sec	0.55sec	0.55sec	0.18m/sec	Add velocity of 3 attempts / 3	
Second attempt							
Third attempt							

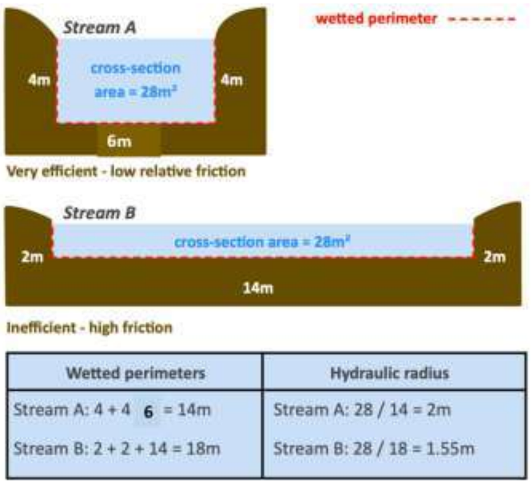
The disadvantage of this method is the fact that the float (even with the 0.85 constant) does not always flow at the same speed as the water. It can also get caught up in eddy flows and behind boulders and surface debris.

<u>To improve velocity measurement:</u>
<u>Use a flow vane</u> – you can also measure the velocity readings using a flow vane, which are designed to record velocity both at the surface and below the surface. This equipment is expensive.


2) Measuring River Efficiency by measuring Hydraulic Radius:

R = A/P (where, R=Hydraulic Radius; A=Cross sectional area; P=Wetted Perimeter)

Stream A: Greater Hydraulic Radius = Higher River Efficiency --> Lower Fluvial flood risk
Stream B: Lower Hydraulic radius = Lower River Efficiency --> Higher Fluvial flood risk



Data Recording Sheet (Hard Engineering Measures)

Negative Evaluation Factor	Score						Positive Evaluation Factor
	-3	-2	-1	1	2	3	
Below maximum flood height							Above maximum flood height
High construction costs							Low construction costs
Flimsy							Durable
Poor access to river							Good access to river
Ugly							Attractive

Data Recording Sheet (Soft Engineering Measures)

Negative Evaluation Factor	Score						Positive Evaluation Factor
	-3	-2	-1	1	2	3	
Obscure							Visible
Confusing language							Clear language
Inaccessible to diverse groups of park users							Accessible to diverse groups of park users
Non-compliance by park users							Compliance by park users
Ugly							Attractive

STAGE 3: Present and Analyse Data/Evaluate Fieldwork

Use line graph, bar graph, hydrograph etc.

How has the presence of obstruction in the river channel affect the measurement of river velocity?

The obstruction in the river channel will create a great deal of friction between the water molecules and the obstructions as the river flows past them. This resistance caused by friction reduces the river's velocity.

Explain how the use of ping pong ball as a float will affect the accuracy of measurement of river velocity.

The ping pong ball might not be able to withstand some rough treatment, especially in fast flowing and turbulent water. It might not be able to flow in the right direction when flowing in rivers with higher turbulent velocity.

Ideally, the float used must not catch the wind. Only the water should be able to move it. A ping pong ball can be blown by the wind and won't give reliable readings.

Using a flow vane – you can also measure the velocity readings using a flow vane, which are designed to record velocity both at the surface and below the surface. This equipment is expensive.

Cluster 4: Fieldwork

<u>H2 A Level Specimen Paper</u>

You and a group of classmates were tasked with undertaking a fieldwork exercise on two contrasting river channels to ascertain the flood risk in these locations associated with the nature of the channels at each site.

The group was divided up into teams of four to measure river velocity and wetted perimeter of each river. One site (River A) was along a river in an area of protected environment status. The other site (River B) was along a managed river channel. Discharge is calculated by multiplying the cross sectional area of the channel by the velocity of the water.

Your team took measurements on two consecutive Tuesdays in March and were given 4 hours, between 10 a.m. and 2 p.m., at each site to complete the river velocity and wetted perimeter measurements.

Teams were each given the following equipment to gather the primary data on river velocity:

- Oranges
- Tape measure
- Stop watch

The time taken for the floating object to cover a pre-determined distance defined by the position of 2 students standing by the side of the river was recorded. At River A, the group found that the floating object often became stuck in fallen trees or debris in the river. The data collected was recorded using a data collection sheet (see Resource 3).

To measure the river's wetted perimeter your team used the following equipment:

- Tape measure
- Meter rulers

Your team laid an unweighted tape measure along the river bed and took depth measurements at equal distances across the river. This data was used to plot the river's wetted perimeter and then the cross sectional areas of the two rivers were calculated.

Resource 1 shows land use in drainage basins associated with Rivers A and B. Resource 2 shows two photographs, one of a river in an area of protected environment status (River A) and one of a managed river channel (River B). Resource 3 shows the data collected by your team to calculate the velocity of Rivers A and B.

(a) With reference to Resource 1, suggest a suitable hypothesis for your group investigation. [1]

(b) Explain the strengths of your hypothesis. [5]

(c) Explain how your group would minimise the impacts of your investigation differently at the two rivers shown in Resource 2. [8]

(d) Suggest limitations of the data representation method shown in Resource 3 and sketch one line graph to represent the average velocity of Rivers A and B over time. [8]

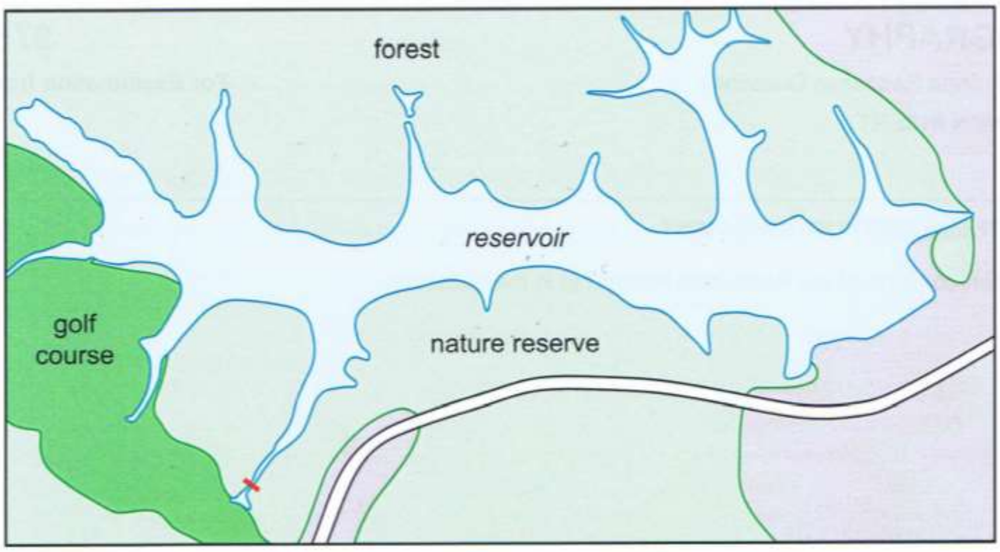
(e) Your group concluded that some of the discharge data collected may not be completely reliable and/or accurate.
Explain how the process of data collection could be improved. [8]

(f) Evaluate the usefulness of the river velocity data shown in Resource 3 in helping to ascertain the flood risk at each of the two rivers. [10]

Resource 1 for Question 1

Land use in drainage basins associated with River A and River B

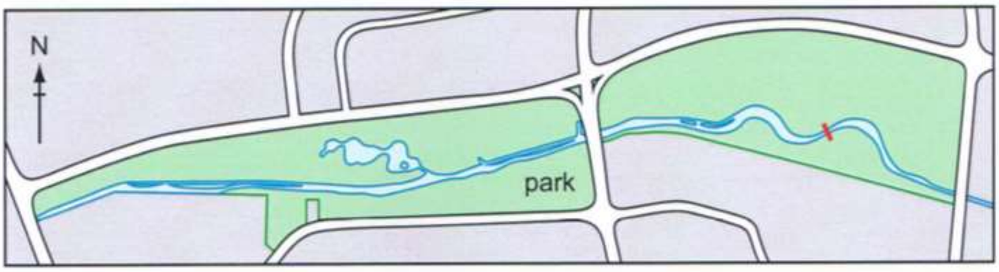
River A



Key

- site of river fieldwork
- built up area

River B



Key

- site of river fieldwork
- built up area

Resource 2 for Question 1

River A

River B

Resource 3 for Question 1

Data collected to calculate the velocity of Rivers A and B

River A | **River B**

Time	River A Velocity (m/s) 1	2	3	average	River B Velocity (m/s) 1	2	3	average
10:00	0.42	~~0.52~~ 0.48	0.46	0.45	0.36	0.40	0.45	0.40
11:00	0.50	0.50	0.48	0.49	0.52	0.58	0.56	0.55
12:00	0.56	0.58	0.55	0.56	0.62	0.63	0.66	0.67
13:00	~~0.51~~ 0.53	0.52	0.54	0.53	0.51	0.53	0.56	0.53
14:00	0.48	0.46	~~0.48~~ 0.45	0.46	0.48	0.49	0.50	0.49