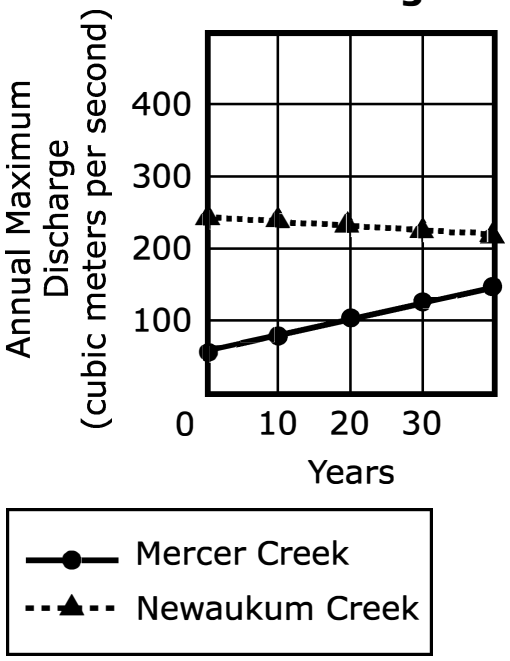
Stimulus 1

Scientists studying Mercer Creek and Newaukum Creek in the state of Washington noticed that there was a difference in the flood risks for the two creeks. They compared the flood risks, land surfaces, and human population trends in the regions around the two creeks. The scientists plan to use the results of the study to design a solution to control flood risk in the affected communities.

The scientists studied the annual maximum discharge for the two creeks. Discharge is the volume of water moving down a creek per unit of time. This measurement shows the size of the largest flood each year. Figure 1 shows the trends over time found in the annual maximum discharge study of the two creeks.

Figure 1. Annual Maximum Creek Discharge



Source: USGS, 2002

Stimulus 2

The scientists then compared the road densities of the regions around the two creeks. Road density is the number of kilometers of road per square kilometer of land. Table 1 compares the road densities of the two regions.

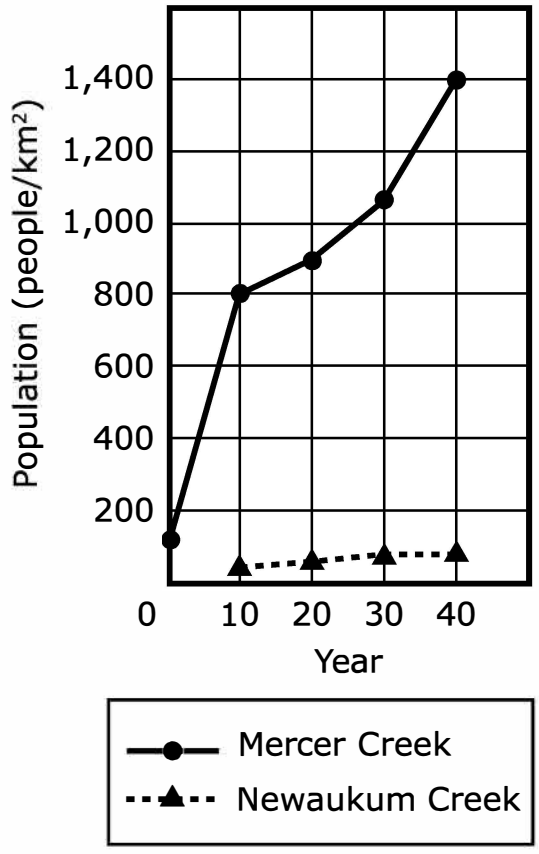
Table 1. Road Density Near the Creeks

Creek	Road Density (km/km^2)
Mercer Creek	9.1
Newaukum Creek	2.6

Source: USGS, 2002

Because human population affects the road density in a region, the scientists next considered the human population in the regions around the creeks. Figure 2 shows the trends in human population in the regions around the two creeks over time.

Figure 2. Population Density Near the Creeks

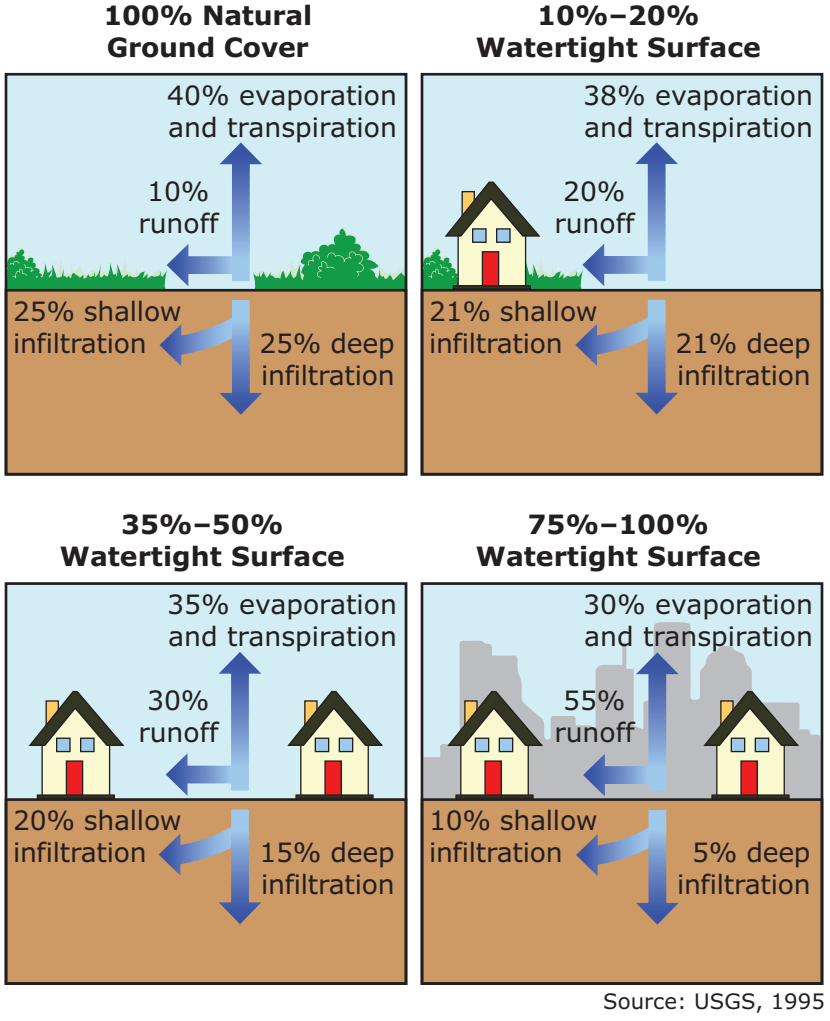


Source: USGS, 2002

Stimulus 3

Infiltration occurs when precipitation or surface runoff absorbs into the soil. The infiltration rate is the amount of water, in centimeters, that the surface absorbs per minute. The scientists created Figure 3 to show how land use affects the infiltration of rainwater from a storm. The percentages represent the proportion of rainwater that infiltrates the soil, enters the atmosphere, or becomes surface runoff. A watertight surface prevents water from being absorbed into the ground.

Figure 3. The Effects of Land Use on Rainwater Infiltration



Source: USGS, 1995

Stimulus 4

Finally, the scientists considered designing new road surfaces to reduce the flood risk around the creeks. Three different types of road surfaces and their infiltration rates are shown in Table 2.

Table 2. Infiltration Rate of Different Road Surfaces

Surface	Infiltration Rate (cm/min)
Porous asphalt	0.05
Dirt	0.14
Porous concrete	0.68

Source: American Society of Civil Engineers

Item 1

Which flood-risk forecast is **best** supported by the trends shown in Figure 1?

A. The flood risk will greatly decrease for both Mercer Creek and Newaukum Creek.

B. The flood risk will continue to increase for both Mercer Creek and Newaukum Creek.

C. The flood risk will greatly decrease for Mercer Creek and will stay about the same for Newaukum Creek.

D. The flood risk will continue to increase for Mercer Creek and will decrease slightly for Newaukum Creek.

Item 2

The students use Table 1 and Figure 2 to compare the trends in population and the trends in road development in the two regions. Which claim can the students correctly make?

- A. Both creek regions had stable populations, so the same amount of land was used to build roads in both creek regions.
- B. Both creek regions had population increases, so the same amount of land was used to build roads in both creek regions.
- C. Newaukum Creek had a more stable population, so more land was used to build roads in this region than in the Mercer Creek region.
- D. Mercer Creek had a larger population increase, so more land was used to build roads in this region than in the Newaukum Creek region.

Item 3

Use Table 1 and Figure 2 to predict the trends in human population and flood risk if road development increases in the Mercer Creek region.

Place a check mark in the circle to indicate your answer choice in each column.

	Human Population	**Flood Risk**
Will increase	○	○
Will decrease	○	○
Will stay the same	○	○

Rubric	
Score	Description
1	Human population: **Will increase** Flood risk: **Will increase**
0	The response is incorrect or irrelevant.

Item 4

Complete the argument about flood risk around the creeks.

Circle the correct answers from the lists to complete the sentences.

Based on Figure 3, as humans use more land resources for urban development, the amount of rainwater that infiltrates the soil

increases decreases stays the same	. This results in	an increase a decrease no change	in surface runoff.

Rubric	
Score	Description
2	Based on Figure 3, as humans use more land resources for urban development, the amount of rainwater that infiltrates the soil **decreases**. This results in **an increase** in surface runoff.
0	The response is incorrect or irrelevant.

Item 5

A student makes an argument that urbanization decreases the risk of floods that cause damage to land resources.

Based on the evidence in Figures 1, 2, and 3, determine whether the student's claim is supported.

Write the answers in the correct boxes. Not all answers will be used.

First Blank

- A. is supported
- B. is not supported

Second Blank

- C. an increasing annual maximum discharge
- D. more water infiltration at its surface

This claim [_____] by the evidence, because the evidence shows that the Mercer Creek region has [_____] compared with the Newaukum Creek region.

Rubric	
Score	Description
1	This claim **is not supported** by the evidence, because the evidence shows that the Mercer Creek region has **an increasing annual maximum discharge** compared with the Newaukum Creek region.
0	The response is incorrect or irrelevant.

Item 6

A major rainstorm occurred during late January in the regions of Mercer Creek and Newaukum Creek. The scientists monitored the water discharge for several days after the storm. They wanted to know why there were differences in the flooding trends between the two regions and how they could reduce the flooding risk.

- Explain how the trends in Figure 1 relate to the patterns of road density around the two creeks.
- Choose the road surface from Table 2 that will best control flooding, and explain why.
- Explain which creek region has a greater need to use this road surface.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

Scoring Rubric	
Score	**Description**
3	The student answers all 3 parts correctly.
2	The student answers any 2 parts correctly.
1	The student answers any 1 part correctly.
0	The response is blank, incorrect, or irrelevant.
	• Figure 1 shows that Mercer Creek annual maximum creek discharge has been rapidly increasing over the past 40 years. This is likely due to the increasing road density in the region related to the rapidly increasing population density. As road density increases, rainwater infiltration of the ground decreases, so more rainwater runoff quickly flows into the creek. Newaukum Creek annual maximum creek discharge has been slowly decreasing. The road density in that region is a lot lower by comparison due to the significantly lower population density. • Porous concrete will best control flooding because it has the highest infiltration rate. This means that it quickly absorbs water into its surface. • The Mercer Creek region has a much greater need for flood-control road surfaces than the Newaukum Creek region does. Mercer Creek has a greater road density, therefore the use of porous concrete for roads in this area would decrease the risk of flooding by allowing more water to be absorbed into the ground instead of running off into the creek and increasing creek discharge.