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WATER WE GOING TO DO?

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Water We Going to Do

Grade Level: 6-7 and applicable to HS environmental science

Purpose/Overview:
In this lesson, students will explore how water behaves on various substrates (ground surfaces), what occurs during a flood, and the causes of flash floods. This lesson concludes with students designing and testing various floodplain models intended to mitigate the effects of flash floods.

Acknowledgement: This lesson was written by Quentin Biddy and Brandi Williams at the K20 Center through a partnership with the Oklahoma Floodplain Management Association division of the Oklahoma Water Resource Board. A link to this lesson on the K20 Center's LEARN lesson repository can be found here: https://learn.k20center.ou.edu/lesson/0f22aab19f1881985cc638b033029e85

National Geography Standards from *Geography for Life* Geographic Elements & Standards:

Geography Standard 4: The physical and human characteristics of places.
- **2.** Physical and human characteristics of places change.
  - **B**. Explain the ways that human processes change places.

Geography Standard 14: How human actions modify the physical environment
- **3.** The physical environment can both accommodate and be endangered by human activities.
  A. Analyze the positive and negative consequences of humans changing the physical environment, as exemplified by being able to analyze the proportion of built area to vegetation land cover around a community and identify possible consequences in changes to that proportion.

Oklahoma Academic Standards for the Social Studies:

OAS 2012	OAS 2019
Grades 6&7, Content Standard 1.2 Integrate visual information, draw conclusions, and make predictions from geographic data and analyze spatial distribution and patterns by interpreting that data as displayed on globes, graphs, charts, satellite and other forms of visual imagery including data from bar and line graphs, pie charts, thematic maps, population pyramids, climographs, cartograms, contour/relief maps, GIS systems, and diagrams.	**6.1.3** Integrate visual information, draw conclusions, and make predictions from geographic data and analyze spatial distribution and patterns by interpreting that data as displayed on geographic tools. **7.1.5** Integrate visual information, draw conclusions and make predictions from geographic data and analyze spatial distribution and patterns by interpreting that data as displayed on geographic tools.
Grade 6, Content Standard 5.3 Evaluate the effects of human modification of and adaptation to the natural environment.	**6.4.2** Evaluate the effects of human modification on the natural environment through transformation caused by subsistence and

	commercial agriculture, industry, demand for energy, and urbanization.
Grade 7, Content Standard 2.5 Explain and summarize how and why regions change over time through physical and human processes which operate to modify Earth's surface.	**7.5.1** Define the concept of region and explain how and why regions change over time through physical and human processes which operate to modify the Earth's surface.

Geographic Themes:
Human-Environmental Interaction.

Objectives:

1. After the lesson, students will be able to describe the consequences of land use changes due to urbanization as it relates to runoff.
2. After the lesson, students will be able to analyze a physical model of a landform and demarcate the boundaries of a watershed.
3. After the lesson, students will be able to distinguish between pervious and impervious substrates, providing examples of each.
4. After the lesson, students will be able to predict land use trends in urban areas and describe two major impacts of those changes.

Materials:

- Flash Flood Warning Clip(s) https://www.youtube.com/watch?v=7V-2Ny6NGYI
- Flash Flood Video Clips - Could Use Clips such as the following or search Oklahoma Flash Flood https://www.youtube.com/watch?v=jPozQhNV8fE
- https://www.youtube.com/watch?v=-NQWDmDBKWc
- https://www.youtube.com/watch?v=4QsPW-hWzC0
- http://www.youtube.com/watch?v=mSAXAoR1gck
- http://www.youtube.com/watch?v=r6Xub0R-If8
- http://www.ksdk.com/news/world/article/383635/28/Caught-on-camera-Storm-chaserdrives-into-creek Modeling Clay
- Aerial photographs of watersheds over different time periods
- Sample photos included others can be found by searching and/or the links below:
- http://www.historicaerials.com
- http://www.google.com/earth/index.html
- http://www.kingcounty.gov/environment/data-and-trends/natural-resourcemaps/aerials.aspx Transparent grid paper (you can photocopy graph paper onto transparencies)
- Dry erase markers
- Water
- Food Coloring
- Eyedropper
- Wax paper
- Blue string
- Red string

- Scissors
- Rectangular plastic food storage container with hole on short end for drainage
- Wooden blocks
- Watering can
- 100 mL graduated cylinder
- Sponges
- Flooring tiles
- Plastic cups
- Hydrology Student Handout (Included)
- Poster or Butcher paper
- Markers, crayons, or colored pencils
- Rubric (Included)

Time Frame: 3 class periods

LESSON PROCEDURES

1. ENGAGE

Begin by playing the flash flood warning for the students. (https://www.youtube.com/watch?v=7V-2Ny6NGYI)

You can also show students local news clips with footage from local flash flooding events. Ex.

- https://www.youtube.com/watch?v=jPozQhNV8fE
- https://www.youtube.com/watch?v=-NQWDmDBKWc
- https://www.youtube.com/watch?v=4QsPW-hWzC0
- http://www.youtube.com/watch?v=mSAXAoR1gck
- http://www.youtube.com/watch?v=r6Xub0R-If8
- http://www.ksdk.com/news/world/article/383635/28/Caught-on-camera-Storm-chaser-drives-into-creek

Provide the students with the KWL chart (See K20 Tools Sheet). Have the students fill out the first two columns of the chart with information that they currently know (K) and information they would like to know (W) concerning floods and floodplains.

K(now)	W(hat I want to know)	L(earned)
Floods happened when it rains a lot. Water doesn't soak into concrete or asphalt. Flash floods can wash away soil and trees and can be dangerous to people and cars.	How can we control flooding? Are there ways to keep people from getting hurt in a flood?	

Sample KWL Chart

2. EXPLORE

Option: You may want to contact Oklahoma Floodplains Management Association can be contacted at (918)-396-1900 or pshn10@live.com to schedule a visit, and they would bring a large-scale functional flood plains hydrology model as an alternative to this exploration.

TEACHER'S NOTE

Students will be conducting two different investigations during this portion. You can debrief and discuss the result with students after each section or wait until all the investigations have been completed. Divide students into groups of 4-5 for the investigations.

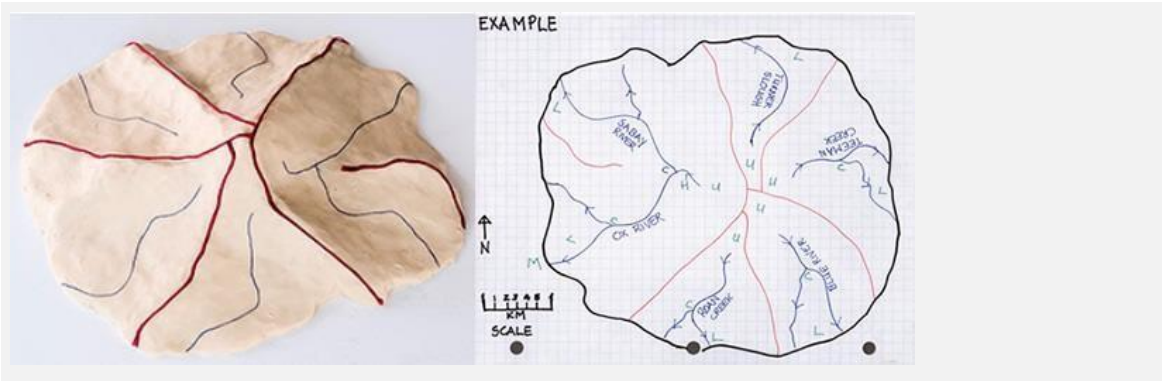
Investigation #1

Begin by providing each student group a ball of modeling clay atop a sheet of wax paper or paper plate. Direct the students to create an island using the modeling clay. The island should not be flat - it should have hills or peaks and valleys.

Provide each student group with an eyedropper and a container of water. Direct the students to drop water on different locations on their island and observe the path of the water as it runs off of the island. (Note: If the water pools in one location, direct students to add more water to the pool until it runs off.)

Next, give each group of students a spool of blue string and a pair of scissors. The blue string will represent the island's streams. Direct students to push the blue string into the clay at the locations where the water runs off the island. Finally, direct each group of students to outline the boundaries of the watershed areas with the green or red string.

Have students do a walkabout/gallery walk. Ask students to walk around the room and make observations of the other groups' watershed model noting similarities and differences.



Sample Clay Watershed Model

Investigation #2

Give each group of students a copy of the Hydrology Data sheet to record their data (attached to end of lesson).

Provide each student group with a rectangular food storage container ("drainage" container), a watering can, a 100 mL graduated cylinder, a plastic cup, a sponge, and flooring tiles.

Direct students to prop up the short end of the container (the end without the hole) using wooden blocks.

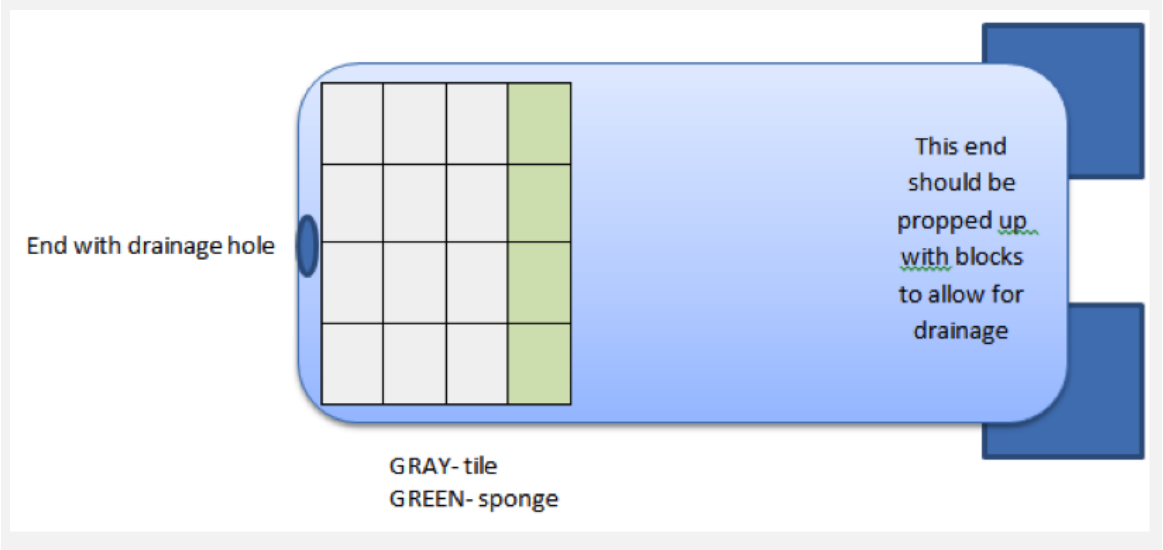
Instruct students to place several tiles in the bottom ¼ of the drainage container, and then pour 100 mL of water into the watering can while holding the can over the elevated end of the drainage container.

Have a second student should collect the drained water in a cup, while a third student times the water collection.

Have students collect the water for 30 seconds and capture the remaining water in a separate container, then discard it. Direct the students to record the amount of water collected on a data table.

Direct students to repeat the investigation using sponges instead of tiles.

Finally, direct students to repeat the investigation at least three times using both tiles and sponges, varying the ratio of tiles to sponges with each trial. For instance, have students could test a ratio of 75% tile to 25% sponge, or 50% tile to 50% sponge. A sample picture of a 75% tile to 25% sponge set up is shown below.



Top view of Floodplain Model Surface Set-up (75%tile/25%sponge)

3. EXPLAIN

Direct students to graph the data collected during investigation #2 using the included data table.

At this point you may need to define pervious and impervious for the class.

- **Pervious** - allowing water to pass through; permeable.
- **Impervious** - not allowing fluid to pass through; impermeable.

Lead a discussion with students in which they analyze the impact of different substrates on water runoff, relate that to the effect of real-world land surface substrates on water runoff, and explain how flash floods occur and can be prevented. Sample questions and responses include:

How do the different substrates affect water run off? (Probe to have them cite evidence from their experiment.)

> **SAMPLE STUDENT RESPONSE**
>
> *Impervious substrates absorb less water than pervious substrates; as a result, impervious substrates result in more water run off.*

Which real-world land surfaces would result in greater run off? Which would result in less runoff? (Probe to have them cite evidence from their experiment.)

> **SAMPLE STUDENT RESPONSE**
>
> *Pervious surfaces such as soil and vegetation would absorb more water and decrease runoff; impervious surfaces such as concrete would absorb less water and result in greater runoff.*

How do surfaces that are already saturated affect runoff? (Probe to have them cite evidence from their experiment.)

> **SAMPLE STUDENT RESPONSE**
>
> *Saturated surfaces are impervious to additional water, and result in greater runoff, and possibly flash flooding.*

How do surfaces that are extremely dry affect runoff? (Probe to have them cite evidence from their experiment.)

> **SAMPLE STUDENT RESPONSE**
>
> *Extremely dry surfaces are impervious, and unable to absorb water. For this reason, heavy rainfall following a drought may result in flash flooding.*

How do surface types contribute to, or mitigate, flash flooding? (Probe to have them cite evidence from their experiment.)

> **SAMPLE STUDENT RESPONSE**
>
> *Flash floods result when the amount of water that is added to a land area is greater than what can be absorbed. Pervious surfaces such as soil and vegetation decrease the severity of flooding by absorbing water, while impervious surfaces such as concrete are unable to absorb water, resulting in the increased likelihood of flooding.*

4. EXTEND

> **TEACHER'S NOTE**
>
> *During this investigation students will be analyzing a series of aerial maps of the same watershed taken over an extended period of time. They will be calculating how land usage has changed over time.*

Provide each group with a transparency and three different colors of dry erase markers.

Give each group an aerial photo map of one of the regions (maps can be local maps or you can use maps from the following websites:

- http://www.historicaerials.com
- http://www.google.com/earth/index.html

- http://www.kingcounty.gov/environment/data-and-trends/natural-resource-maps/aerials.aspx

Ask the students to look at the picture, give the students time to study it, then ask them what they see when looking at the photo.

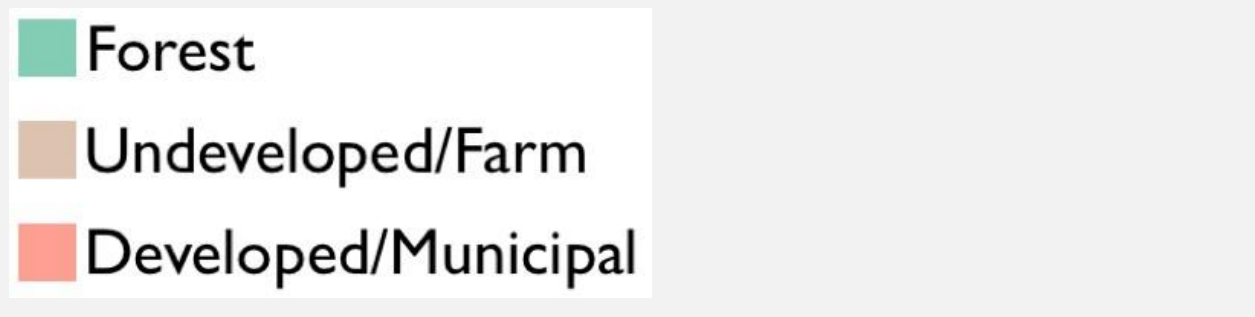
SAMPLE STUDENT RESPONSE

I see fields and trees. I see roads, buildings, etc

After the students have shared with the class, have their group create 3-4 categories to classify the land use. Ex. Wild, Agriculture/Farming, City/Municipal, Forest, etc..

Give each category a color (Ex. - Agriculture = red, Municipal = Blue, Forest = Green)

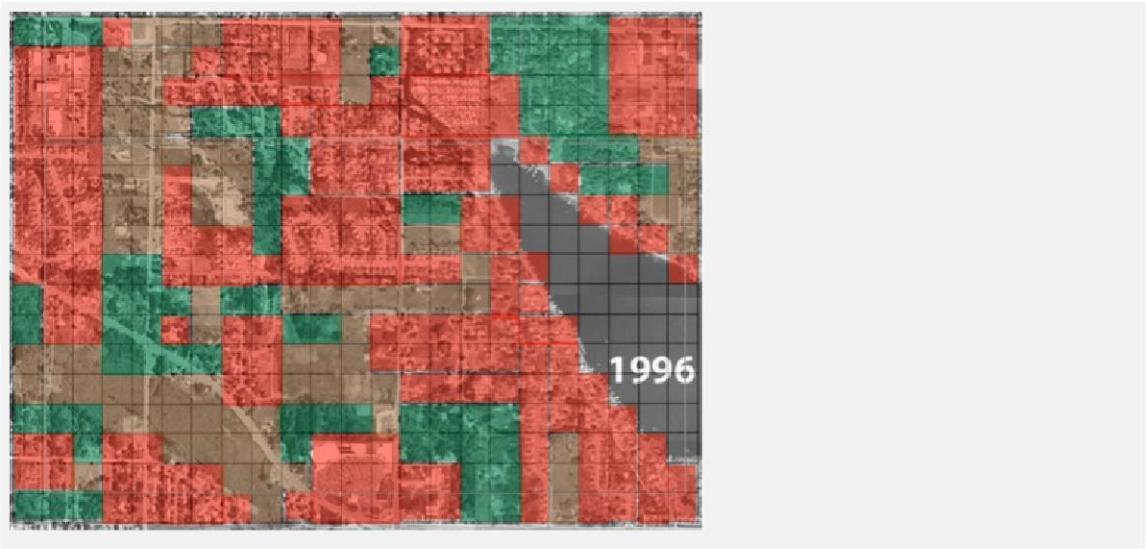
Instruct students to place the grid transparency over the map and to color in the squares according to the land use. Have the students do this for the other maps as well so they can compare how the land use has changed over time. See examples on next page:



Map Key

1936 Aerial Map

1970 Aerial Map



1996 Aerial Map

• Have students calculate the ratio of land usage for each time period.

EX: 1936

1. Forest 100/391=26%
2. Undeveloped/Farm 278/391=71%
3. Developed/Municipal 13/391=3%

Discuss the results with the students. Use the following questions to guide the discussion:

When looking at the watershed over time what observations can you make?

SAMPLE STUDENT RESPONSE

The amount of forest decreased. The cities grew. The undeveloped land decreased. More land was converted to developed land.

What type of land would you consider as "livable space"? Ask them to explain why they decided this.

SAMPLE STUDENT RESPONSE

The developed land . The land with houses and buildings .

What type of surfaces would be included in a developed "livable space"?

SAMPLE STUDENT RESPONSE

Concrete, brick, wood, asphalt, grass....

Have each group write a GIST statement responding to the following prompt: Based on how land use has changed how would this change in land use and surface type effect the frequency of flash flood events?

SAMPLE STUDENT RESPONSE

Developed land has increased causing more impervious surfaces to increase, which will result in drastic increases of flash flood events.

5. EVALUATE

Provide each group with a copy of the rubric that will be used to grade their project.

Provide each group of students with a large piece of butcher paper or poster paper.

Explain that their community model can resemble your local community (students can use what they know as a starting point for their model); however the goal is to reduce or mitigate the effects of flash flooding.

Direct students to create a community watershed model. Inform the students that their goal is to create a model of community development that reduces and/or mitigates the risk of flooding.

Each community model must include the following:

- A business district o Residential neighborhoods
- Roads and highways
- Public services (hospital, library, post office, police, fire)
- Parks and Recreation

Instruct students to label all components of the model, including drainage ditches or retention ponds if included in the model.

Ask students to create a 3-5 minute video or slideshow with audio that communicates to the general public in an informative, memorable, and creative way, lessons learned and reasoning used to maximize livable space in your community model and minimize the resulting runoff caused by development. The phrase "Turn Around, Don't Drown" must be used at least once for text and once as audio to emphasize understanding of flood safety and the dangers associated with floodwaters. A rubric for evaluating the presentations and model is included.

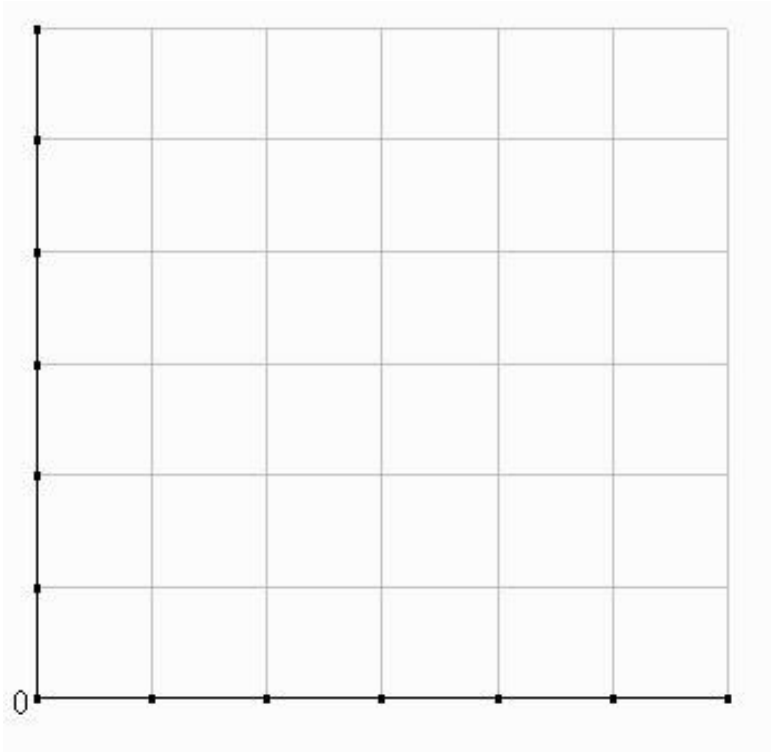
Ask students to complete an exit ticket out the door by writing a summary statement that answers the essential question: What can scientists do to understand the factors involved in flash floods and how can the effects from flash floods be mitigated.

Assessment Options:

1. The coded maps students make can be used as an assessment.
2. The research project with the rubric can be used as an assessment.
3. There is a six-question multiple-choice test that accompanies this lesson on page 12.

Flood Plains Hydrology Data Sheet

# OF TILE SQUARES	# OF SPONGE SQUARES	RATIO OF TILES TO SPONGE SQUARES	TOTAL % OF NONPOROUS SURFACE	AMOUNT OF RAINFALL RUNOFF (mL)
			100	
			0	



PRESENTATION/MODEL RUBRIC

	3	2	1
Student used video, PowerPoint, Prezi, or other program for presentation	Video, PowerPoint, Prezi, or other program was used	Used, but not useful or appealing.	Video or PowerPoint was not used
Presentation included audio	Presentation included audio	Audio is done poorly or is unintelligible.	Presentation did not include audio
Presentation includes the phrase "Turn Around Don't Drown" at least once	Phrase is included	Phrase is used but not included.	Phrase is not included
Presentation is easily understandable by the general public	Presentation is easily understandable by the general public	Presentation contains a few instances that would not be clear to the general public	Presentation contains several instances that would not be clear to the general public
Presentation is informative	Presentation provides relevant and useful information	Presentation provides some relevant and useful information	Presentation provides no relevant or useful information
Presentation is creative	Presentation demonstrates creativity from beginning to end	Presentation demonstrates some instances of creativity	Presentation demonstrates no instances of creativity
Presentation describes lessons learned during the unit	Presentation fully describes lessons learned	Presentation describes some, but not all, lessons learned	Presentation does not explain any lessons learned
Presentation includes description of ways to maximize livable space while minimizing runoff	Presentation includes description of ways to maximize livable space while minimizing runoff	Presentation includes description of ways to maximize livable space while minimizing runoff, but the suggestions are not supported by the lessons learned throughout the unit	Presentation does not include description of ways to maximize livable space while minimizing runoff
Presentation describes the model community and all of the components included.	Through description of model community including all components and how they work together to reduce the risk of flooding.	Description of model community including most of the components and some explanation about how they work to reduce the risk of flooding.	Little to no description of model community and/or connections to reducing the risk of flooding.

Presentation includes reasoning for the design of the model community	Accurate reasoning is provided	Reasoning is provided, but is flawed	No reasoning provided

Water We Going to Do

1. Which substrate/land surface would you expect to have more moisture? a. Sandy soil
   b. Clay soil
   c. Rocky soil
   d. Cement

2. Which of the following helps most to reduce runoff?
   a. Urban Development
   b. Agriculture
   c. Timber production
   d. Vegetation

3. How does climate affect a watershed?
   a. It determines the amount of water input and output in a watershed.
   b. It determines if the watershed will absorb water or not.
   c. It determines how fast water will be moved through a watershed.
   d. It does not affect watersheds.

4. Use Figure 7 to answer question 4.

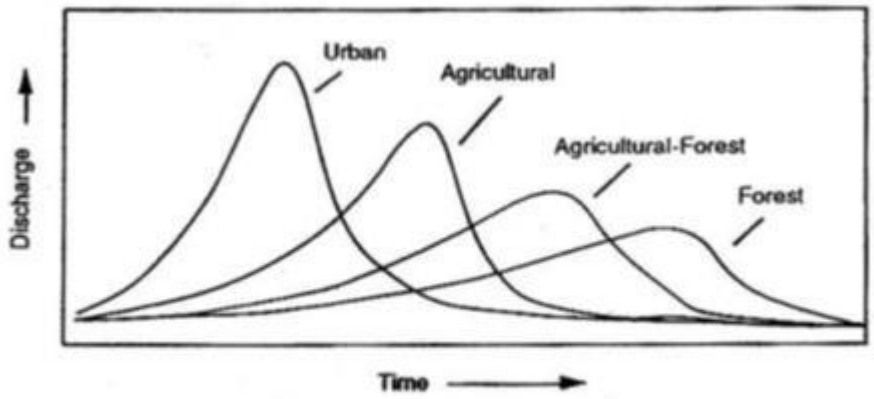


Figure 7. Stormwater discharges from various land covers.

Given the same amount of rainfall over the same amount of time, which area would you expect to have the highest chance of flash flooding?

a. Urban
b. Agricultural
c. Agricultural-Forest
d. Forest

5. How are the boundaries of a watershed determined?
   a. State and county lines.
   b. The elevation of the surrounding area
   c. The size of the largest river in the watershed.
   d. Migration patterns of geese.

6. A hydrologist (water scientist) is measuring the water runoff in various storm drains. After a downpour, which storm drain will contain the most water from runoff?
   a. The drain attached to a garden on the rooftop of the city building.
   b. The drain on a street in an urban area with a lot of concrete.
   c. The drain on the edge of a golf course.
   d. The drain on the edge of a squishy, muddy field.

Water We Going to Do--Answers

1. Which substrate/land surface would you expect to have more moisture? **a. Sandy soil**
   b. Clay soil **Correct Answer: A**
   c. Rocky soil
   d. Cement

2. Which of the following helps most to reduce runoff?
   a. Urban Development
   b. Agriculture
   Correct Answer: D
   c. Timber production
   d. **Vegetation**

3. How does climate affect a watershed?
   a. It determines the amount of water input in a watershed.
   b. It determines if the watershed will absorb water or not.
   c. It determines how fast water will be moved through a watershed.
   d. It does not affect watersheds.

Correct Answer: A

4. Use Figure 7 to answer question 4.

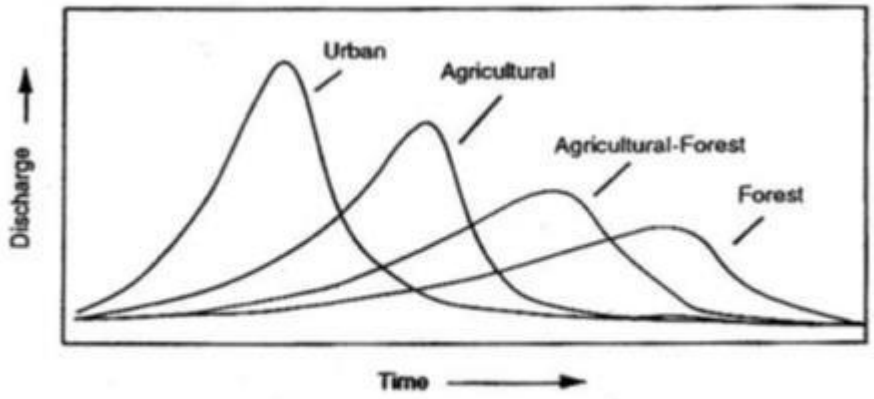


Figure 7. Stormwater discharges from various land covers.

Given the same amount of rainfall over the same amount of time, which area would you expect to have the highest chance of flash flooding?

a. Agricultural

b. Urban **Correct Answer: B**

c. Agricultural-Forest

d. Forest

5. How are the boundaries of a watershed determined?

a. State and county lines.

b. T**he elevation of the surrounding area**

Correct Answer: B

c. The size of the largest river in the watershed.

d. Migration patterns of geese.

6. A hydrologist (water scientist) is measuring the water runoff in various storm drains. After a downpour, which storm drain will contain the most water from runoff?

a. The drain attached to a garden on the rooftop of the city building.

b. The drain on the edge of a squishy, muddy field.

c. **The drain on a street in an urban area with a lot of concrete.**

d. The drain on the edge of a golf course.

Correct Answer: C