

Calculating Stormwater Runoff



Common Core Standards CCSS.MATH.CONTENT.5.OA.A. 2

Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.

CCSS.MATH.CONTENT.5.MD.C. 5.C

Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

CCSS.ELA-LITERACY.SL.5.1.C

Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

Next Generation Science Standards

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment

Maryland Environmental Literacy Standards

5.A.2 Analyze the effects of human activities that deliberately or inadvertently alter the equilibrium of natural processes
6.B.1 Recognize and describe that people in Maryland depend on, change, and are affected by the environment
7.B.1 Examine the influence of individual and group actions on the environment and explain how groups and individuals can work to promote and balance interests.

Objective: Students will be able to calculate the stormwater runoff from their schoolyard by finding areas, and volumes of pervious and impervious surfaces to solve the equation.

Time: 45 minutes

Materials:

- Calculating Stormwater worksheet
- Pencils
- Scale map of schoolyard
- Calculators (optional)

Procedure

Engage

1. ASK STUDENTS: to recall the definition of runoff from their previous SLURRP lesson (Runoff is rainwater and anything else that gets washed up with it (like litter, chemicals, animal wastes) on its way to a stormdrain.)
2. Have students share examples of runoff that they observed in their schoolyards.
3. Ask students if they think their schoolyard produces a lot of runoff or a little bit of runoff? Have students support their hypothesis by data from their schoolyard report card.

Explain

4. EXPLAIN that today we are going to calculate how much stormwater runoff our schoolyard sends to the stormdrains.
5. EXPLAIN that the amount of runoff is different for the different types of surfaces (pervious vs impervious)
6. ASK students why the amount of runoff is expected to be different for different types of surfaces. Students answers should expand on the definitions of pervious and impervious (pervious surfaces will have less runoff because these surfaces absorb water; impervious surfaces will have more runoff because they cannot absorb water)
7. Explain that to calculate stormwater runoff, they will have to find the area of surfaces in their schoolyard.
8. EXPLAIN that the goal of today is to calculate the volume of stormwater that is going through their schoolyard into a stormdrain every year

Explore

9. Provide students will a scale map of their schoolyard. Have students calculate the area (this can be approximate) for the different types of surfaces in Data Table 1

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10. Have students analyze the locations and determine the runoff coefficient for each location and record in Data Table 2.
11. Have students multiply the surface area x runoff coefficient x 3.5 ft (average rainfall/year) to find the volume of runoff
12. Students will convert total runoff to gallons by multiplying by 7.48 gal/ft³

Extend:

1. Extend the lesson by having students go outside to measure areas in the schoolyard rather than providing the map and dimensions.
2. Have students use their schoolyard redesigns to calculate how much runoff they will prevent if their new schoolyard designs are implemented.

Evaluate

1. ASK students how much runoff their schoolyard produces within 1 year?
2. ASK students to how this would impact the pollution levels around their communities.
3. ASK students if they were surprised by the amount of runoff. Why or why not?

Calculating Stormwater Runoff

Name: _____

Name: _____

Name: _____

Name: _____

Now that you have investigated your schoolyard and brainstormed improvements to reduce runoff pollution, we need to determine HOW MUCH runoff is occurring on your schoolyard. Knowing how much water runs off or through your property is critical to design and implementation of any stormwater reduction plan. In order to calculate the volume of stormwater runoff you will need a drawing of your property.

Here's the equation:

$$\text{Volume Runoff} = \text{Surface Area} \times \text{Runoff Coefficient} \times \text{Rainfall Depth}$$

Step 1: Calculate Surface Area (A):

- 1) Using your property map, find the length and width of the different surface types in your schoolyard. Record these measurements in Data Table 1
- 2) Using those dimensions, multiply the length and width of each location to find its surface area.
- 3) Record your answer in Data table 1

Example: Your school parking lot is 10 ft long and 50 ft wide.

$$10 \text{ ft} \times 50 \text{ ft} = 500 \text{ ft}^2$$

Data Table 1:

Location	Width (ft)	Length (ft)	Area (ft ²)
Parking lot			
Playground			
Building			
Open Space (pervious surfaces)			

Step 2: Determine runoff coefficient for each location.

- 1) Using the table provided, look up the runoff coefficient that most closely resembles your site
- 2) Record this number in Data Table 2 (on the next page)

Example: Parking lot is 100% impervious so the runoff coefficient is 0.98

Runoff Coefficients:

Land Use/ Cover	Coefficient
100% impervious (parking lots, rooftops, sidewalks)	0.98
Open space with 50% or less grass	0.86
Open space with 50-75% grass	0.79
Open space with 75% or more grass	0.74

Step 3: Do the Math

- 1) In Baltimore, the annual rainfall is about 3.5 feet.
- 2) For each location, multiply the surface area, runoff coefficient, and average annual rainfall
- 3) This will give you the runoff for that location

Example: For the parking lot:

$$\text{Volume Runoff} = 500 \text{ ft}^2 \times 0.98 \times 3.5 \text{ ft}$$

$$\text{Volume Runoff } 1,715 \text{ ft}^3$$

- 4) Add together the individual runoff amounts to get the total runoff for your school yard.

Data Table 2:

Location	Surface Area	Runoff Coefficient	Average Rainfall	Volume Runoff
Parking Lot				
Playground				
Building				
Open Space				
Total Runoff:				

Step 4: Convert to gallons

- 1) Most people have trouble thinking about water in cubic feet, so we will convert to gallons.
- 2) To convert to gallons, multiply the total runoff by 7.48 gal/ft³

Example: $1,715 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 12,828.2 \text{ gallons of runoff}$

Analysis Questions:

1. What type of land-use provided the most amount of runoff? Why?
2. Where you surprised by the amount of runoff your schoolyard produces? Why or why not?
3. What can you/your school do to help prevent runoff?