Lesson 9

Land Use

How is run-off affected when land is developed?
How can run-off be calculated?
What is the impact of land development on the watershed?

GOAL To understand that a small alteration in the land can greatly affect the flow of water.

OBJECTIVES Students will:

- ✓ calculate cubic feet of run-off on a 100 acre parcel of land
- ✓ compare pre and post development scenarios
- ✓ realize the impact of development on the watershed

MATERIALS **calculators**

CORE CURRICULUM CONTENT STANDARDS

- **Math 1(1,2), 2(1), 4(1), 10(1)**
- **Science 1(6), 7(5), 8(2-4), 14(1, 8)**
- **Social Studies 9(1-3), 10(1,3), 11(1) 12(3,5)**

VOCABULARY **hydrologist, curve numbers**

PROCEDURES

1. Begin by explaining to students that runoff increases as land development increases. Hydrologists use curve numbers to calculate the expected amount of runoff from land uses. Values are assigned to curve numbers based on soil type and their permeability. The lower the number, the more water can infiltrate, and the less water runs off. A parking lot will have a higher curve number than a field.
2. Explain that they were asked to calculate the amount of runoff for a potential development area. The information will be used to plan and incorporate more pervious surfaces in the development.
3. For the activity, have students use the following data:

pre-development land use	curve #	area (acres)
forest	55	30
pasture	79	40
organic farm	81	30

post – development land use	curve #	area (acres)
roads	98	3
homes	75	27
pasture	79	40
organic farm	81	30

1. Write the data on the board and have students identify the area of development (30 acres of forest was developed into 3 acres of roads and 27 acres of homes).
2. Have students calculate an average curve number for the whole area of the land. Multiply the curve # x area for each land use in the pre-development scenario. Refer to pre-development land use chart.
   a. 55 x 30 = 1650
      79 x 40 = 3160
      81 x 30 = 2430
   b. The sum of the number equals 7240. To calculate the weighted average curve number, divide 7240/100 acres = 72.4
3. Next, have students find the amount of run-off, using the curve number graph. Rainfall is on the x-axis and run-off is on the y-axis. Assume the average rainfall is 5 inches. Find 5 inches on the x-axis and follow up the graph until the curve number (72.4) is intersected. Follow horizontally across to the y-axis to find the inches of runoff. In this scenario, the answer is 2.2 inches.
4. To calculate the total runoff for the 100 acre parcel, multiply the inches of the run-off by the total area. Have students convert inches to feet and acres to square feet to compute a cubic foot value.

   a. 2.2 inches x 1 foot = 0.183 feet of runoff
      12 inches

   b. 100 acres x 43560 square feet = 4,356,000 square feet of runoff
      1 acre

   c. 0.183 feet x 4,356,000 square feet = 798,000 cubic feet of runoff

   d. To convert to gallons:

   To convert to gallons:

   798,000 cubic feet x 7.48 gallons = 5,969,040 gallons of runoff
   1 cubic foot

5. To calculate the runoff for the post-development scenario, repeat procedure 4, using the post-development data.

   a. 98 x 3 = 294
      75 x 27 = 2025
      79 x 40 = 3160
      81 x 30 = 2430

   b. The sum of the number equals 7909. To calculate weighted average curve number equals 7909 divided by 100 acres equals 79.
   c. Using the graph, 5 inches of rainfall with a curve number of 79 corresponds to 2.8 inches of runoff.

6. To compute total runoff:

   a. 2.8 inches x 1 foot = 0.233 feet of runoff
      12 inches

   b. 100 acres x 43560 square feet = 4,356,000 square feet
      1 acre

   c. 0.233 feet x 4,356,000 square feet = 1,016,400

7. To convert this figure to gallons:

   1,016,400 cubic feet x 7.48 gallons = 7,602,672 gallons of run-off
   1 cubic foot

8. Discuss the difference in volume of runoff between the pre- and post- development calculations. Remind the students that only 30 acres was developed.

9. Have students discuss ways to add more pervious surfaces to reduce runoff.

EXTENSIONS

1. Have students calculate estimated runoff in their backyard. Visit the Shodor Educational website to estimate runoff based on soil condition. Soil condition, hydrologic condition and storm information will have to be researched.
   http://www.shodor.org/cgi-bin/envsci/runoff/runoffstateunits.cgi

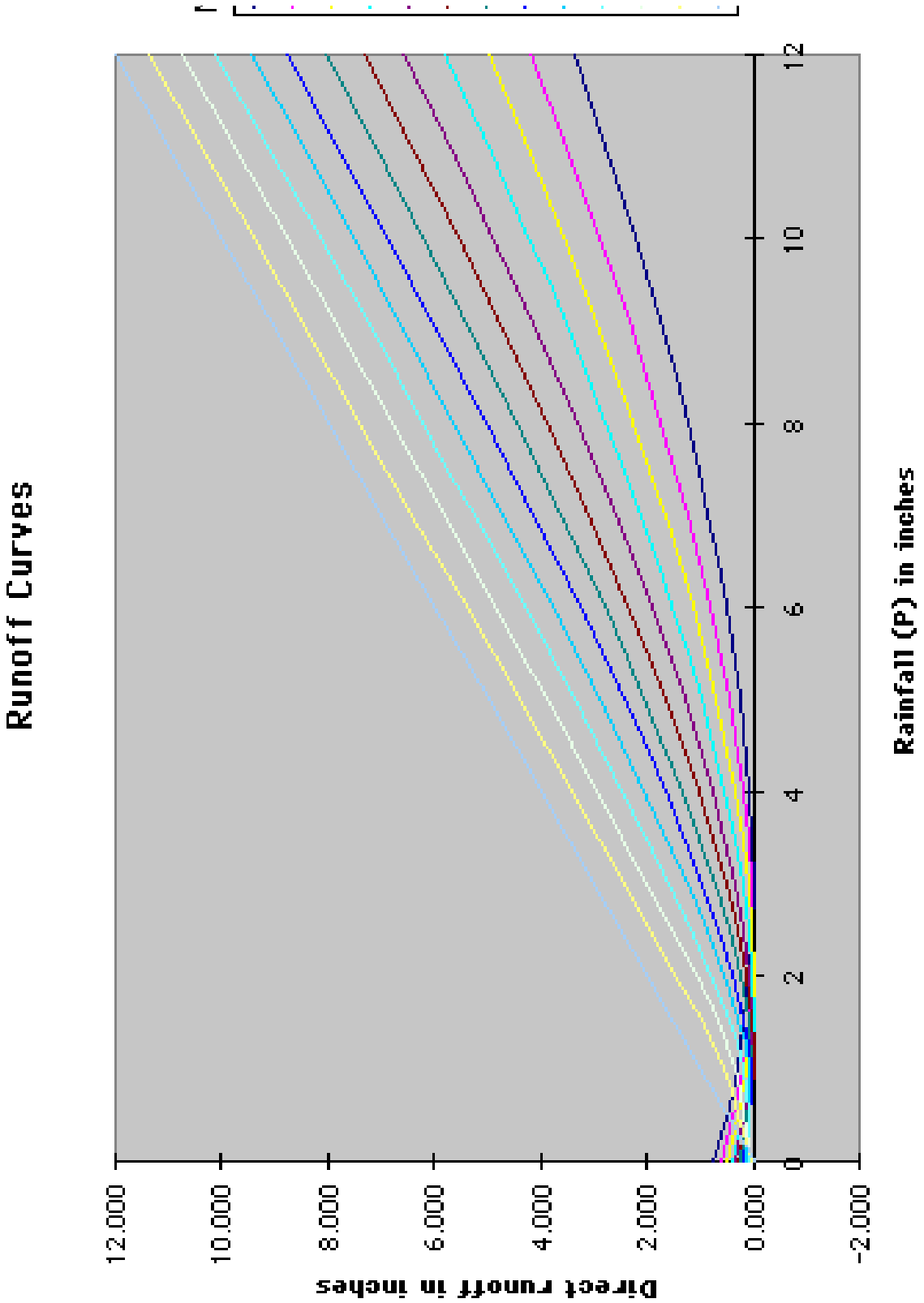
RESOURCES

Bechdol, Michael, Cheo, Martha S., O'Neal, Vicky, Slater, Meredith, The Pawcatuck Watershed Education Program; 1993, The Southern Rhode Island Conservation District and The University of Rhode Island Department of Natural Resources Science, Hope Valley, RI.

Shodor Education Foundation, Inc.; The Science of Surface Water Runoff; 1998;
http://www.shodor.org/master/environmental/water/runoff/index.html

GLOSSARY

curve numbers - numbers on a line representing data on a graph
hydrologist - a scientist who studies the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere


Runoff Curves
Rainfall (P) in inches
0
2
4
6
8
10
12
Direct runoff in inches
12.000
10.000
8.000
6.000
4.000
2.000
0.000
-2.000