Lesson 1: No Place to Run

Lesson Overview:

Purposes: To help students understand:
1) why storm water runoff can be a problem and
2) how rain gardens can be used to help manage storm water.

Background:
Urban areas in America are experiencing unprecedented growth. And with growth comes the need for storm water management. As more and more land is developed, there is no place for water to soak in so larger volumes of runoff are traveling through storm drains untreated to streams instead. Given this challenge, Storm Water Managers are "thinking out of the box" and using more low cost "green" alternatives to manage storm water like rain gardens and rain barrels. **Rain gardens** are shallow depressions that are designed to intercept and capture surface water runoff or water from downspouts. They resemble perennial garden beds. Runoff trapped in the rain garden is absorbed by the soil where pollutants are removed before the water is taken up by plants and released back into the atmosphere. Rain gardens can be an attractive focal point in the landscape and serve as wildlife habitat. **Rain barrels** are containers used to intercept rainfall from runoff and/or downspouts and store it for other uses like watering lawns and gardens. Rain barrels and rain gardens can also be used in combination. For example, downspouts can be diverted to rain barrels and the water from the rain barrel can be used to water the rain garden. Rain gardens can serve as an exciting outdoor learning laboratory where students use their skills and knowledge to solve a real-world problem – storm water management. In addition to monitoring how effective the rain garden is in capturing and purifying runoff, they can be used for years to come for students to study soils, porosity, water quality, plants, wildlife, ecosystems, and succession.

To understand how rain gardens work, it is necessary to become familiar with the way **water "cycles"** in natural environments. Rain falls onto the lands surface where it soaks into the ground and becomes part of groundwater, or it runs off into a stream, pond, lake, wetlands or ocean. Plants slow the velocity of the rain and help the soil absorb the water. The water that we can see is called **surface water**. Water that flows over the surface of land is called **runoff.** Most runoff comes from rain and snow. The spaces between soil and rocks that store water underground are called **aquifers** and they store **groundwater**. The top surface of ground water is called the **water table**. The height of streams, ponds, lakes, wetlands, and oceans is the top of the water table. Ground water flows slowly downhill through soil where many of the impurities are filtered out until it percolates into streams, ponds, lakes, and even the ocean. The process of precipitation soaking into the ground and becoming part of the aquifer is called **groundwater recharge**. Groundwater is the **base flow** that keeps water bodies filled with water during dry periods. During wet periods, base flow and surface water runoff combine to fill water bodies and the water level in the stream is higher. Depending on the amount of rain, the stream can escape its channel and overflow onto the floodplain; this is called **flooding**.

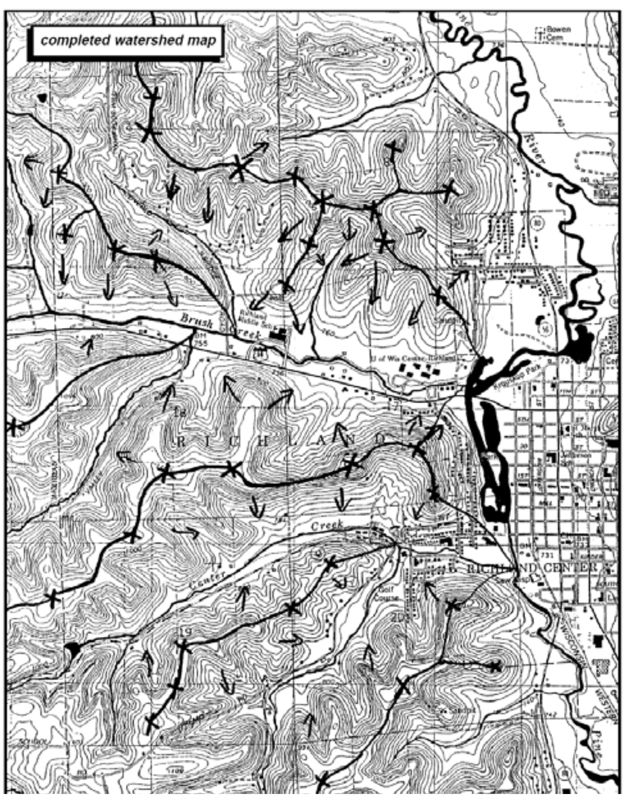
Gravity causes water to run from the highest point to the lowest point. The shape and composition of the earth determines how and where water will flow. Some of the earth's surface is more **porous or pervious** than others. For example, black top, pavement, and buildings are not porous or **impervious** so water runs off these surfaces. Other surfaces like grass, woodlands, croplands, forests, and wetlands are more porous or **pervious** and allow different amounts of water to soak into them. The slope of the earth surface also affects how much water can be absorbed. In general, the more gentle the slope, the greater the chance water will soak into pervious surfaces. As the slope increases, more and more water will runoff the land before soaking in. Weather also plays a factor. For example, the heavier the rain, the more water will run off the land rather than soaking in. Whether or not the ground is still saturated from a previous rain also affects porosity. As more and more land is developed, there are less porous areas for precipitation to soak into.

It is possible to actually predict how much water will run off land after a rain event. A calculation can be performed using watershed size (drainage area), soil porosity, runoff coefficients for different land uses, and rainfall. Topographic maps are used to measure drainage areas and local weather information can be used to determine rainfall. The drainage area and amount of rainfall in inches can be used to determine the volume of water that contributes runoff to a particular water body.

Special maps called **topographic maps** are used to represent the earths' 3-dimensional shape in 2-dimensions. A topographic quadrangle map is one 7.5 x 7.5 minute rectangle of the earth's surface that has been created from aerial photographs to show features on the earth's surface. **Cartographers** or map makers divide the earth into squares by horizontal and vertical lines. The vertical lines or **Meridians of Longitude** are north-south lines connecting the poles and the horizontal lines are **Parallels of Latitude** are east-west lines parallel to the equator. Meridians and Parallels are circles that have 360 degrees, 60 minutes per degree, and 60 seconds per minute. There are 3,600 seconds per degree. Locations on the earth are expressed as degrees, minutes and seconds. For example, 39° 8' 8.5" is equal to 39 degrees, 8 minutes, 8.5 seconds latitude. To describe a location on the earth the longitude and latitude coordinates are needed. For example, Avey's Run at Cincinnati Nature Center is 39° 7' 56.3" latitude and 84° 15' 21.9" longitude.

Contour lines represent the lands elevation about sea level. Contour lines run parallel and the connect points at the same elevation. The interval or distance between 2 topographic lines is usually 10 or 20 feet. Every fifth brown parallel line is a heavier brown line with a number in it; this is the elevation above sea level. Topographic maps use colors to represent different features. Contour lines are brown. Woodland and wetlands are green. Black features are building and roads. Pink features are urban areas. Yellow areas are mines and the red areas are landfills. Purple features are items that have been added to the map since the last edition of the maps and have not been verified.

Topographic maps can be used to determine the direction water is flowing. The land area that contributes runoff to a specific point or place is called a **watershed.** The watershed for a school yard is the land area that contributes water to the lowest point on the school grounds. The watershed of the Little Miami River is the land area (including tributaries) that drains to where the Little Miami River meets the Ohio River. Watersheds can vary in size depending on the reference point. For example, the watershed of the Little Miami River is much larger than the watershed of one of the tributary streams like O'Bannon Creek that feeds into it. A watershed is also a geographic community that includes all living and non-living things such as humans, animals, plants, soil, rocks,



Source: Give Water A Hand

Lesson Descriptions:

Option 1: Upper Elementary (Grades 3-5):

Objectives: Students will:

1) Distinguish a pervious from impervious surfaces;
2) Trace the path of water from precipitation to runoff and storage; and
3) Construct a model to demonstrate how changes in percent impervious surfaces help manage storm water runoff.

Topics Covered: Water Cycle, Pervious and Impervious Surfaces, Weather, Precipitation, Flooding, Groundwater Recharge, Land Use, and Water Pollution

Activity Time: 1 class period

State Standards: (See Appendices – Rain Garden Lesson Guide Correlations by Grade)

Materials:

Sidewalk chalk or ball of string and tent stakes
9 x 13 x 2 inch container with a hole drilled in either one corner or the middle of one side at the top edge of the container
Modeling Clay (4 or 5 pound block) or other modeling clay
Dental floss for cutting clay layers from block
Rolling pins or 16 oz food cans (full cans)
Sponges or other porous material like pillow foam
Plastic spoon
Scissors or X-acto knife
Plastic table knives
Small garden watering can
Source of Water
Plastic cup to catch water from hole in plastic container
2 cup measuring cup or beaker
Set of crayons
Notebook paper
Pencils
Sand

Follow Up:
Same as Hands On

Extension:
Plastic straws
Food coloring
Powered drink mixes

Introduction

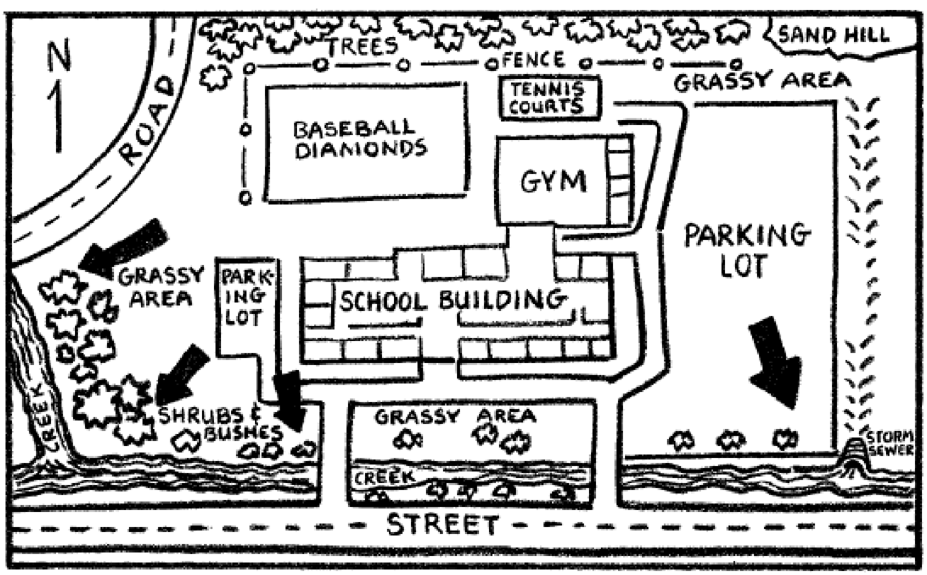
Begin inquiry with a discussion of "where does water go when it rains?" Discuss how water runs off the land. Answers will vary, but should include that rain soaks into the ground, runs over the land to a water body, runs down the roads into storm drains, etc. What happens to the water that falls on a home or the school? If the students were a water drop that landed at the school, where would they go? Would they soak into the ground? If so, the ground is porous or pervious to water. Would they soak in if they landed on the parking lot? If they cannot soak in the ground is impervious. Where would they go if they could not soak into the ground? They move downhill by gravity to a place where they can soak in. Discuss how gutters capture the water and direct it to the street where it flows into storm drains that run into the river. What happens when we have a particularly heavy rain? Discuss how some streams and rivers overflow or **flood**. Think about reasons that water flows over the ground instead of soaking into the ground. Discuss how some surfaces are **pervious** and some are **impervious.** Mention that even some pervious surfaces can become impervious under certain conditions like when the ground becomes saturated with rain and cannot absorb more water. Think of ways to get more water to soak into the ground. How they would make it easier for water to soak in or make the lands surface more pervious. Think about the school site. Are there ways to make it easier for water to soak into the ground on the school site? Discuss what a rain garden is and how it is used to capture and store water. Emphasize that a **rain garden** is a bowl-shaped garden placed down hill from where most runoff flows that is used to capture and store water. Plants help get the water to soak into the ground by breaking up the soil with their roots or they absorb the water and transpire it back into the atmosphere. The class is going to re-create their school site as a model to show how rain gardens work. The problem is: "What location on the school grounds is the most effective site for a rain garden?" Students are going to figure out where to put a rain garden to capture the most runoff and what size it should be to get the most water to soak into the ground.

Advanced Preparation:

1) Mark off the watershed area with sidewalk chalk or use stakes and string so the area is ready for the students to sketch.
2) Decide in advance how you want to orient your pan depending on the school site and have the hole drilled as close as you can to the top lip of the pan either in the middle or corner of the pan.
3) If you are using a block of clay, use dental floss to cut the layers and put plastic wrap between them so they are ready to pass out.

Hands On:

1) Divide the students into teams of 4-students and give each team a piece of paper, clip board, a set of crayons, two lids or containers with a hole drilled in center or corner of one the sides, a sheet of modeling clay, rolling pin or food can, clean dry sand, sponges or foam pieces, scissors, a plastic knife, an X-acto knife (optional), and a cup to catch the water.
2) Have teams:
   a) Cut a piece of paper the about ½ smaller than the size of their lid or container
   b) Make a layer of dry sand in each of the lid or container about 1 inch deep so that it is deeper than the sponges you are using.
   c) Place a sheet of plastic wrap on the table, put the clay layer on it, and use a rolling pin to make a layer of clay about ¼ inch thick to just a little bigger than the size of their paper. Tell students that the clay layer represents the impervious surface created when they built the school and made the parking lot, play ground, and driveways.
3) Place a sheet of paper on the clip board and have the students take it and their crayons outside to make a drawing of the school site.



Source: Give Water A Hand

4) Observe the area and note where the water will go when it rains. Ask where a good location would be to put a rain garden? The chalk or string represents the boundaries of the watershed. Students are going to draw the boundary first, and then sketch in all of the other elements like side walks, buildings, parking lot, and other features. Label each part of the drawing with a "P" is they think the area is porous or pervious. Label each part of the drawing with a "NP" or nonporous if it is an impervious surface like a parking lot. Look to see where water would flow on the site and to draw arrows indicating the direction of flow. Think about where they would place a rain garden but do not sketch it on the drawing. When the students have finished, return to the classroom.

5) Lay their drawing on top on the clay and use a rolling pin to merge the paper with the clay. For more accuracy, orient their drawing so the downhill side is next to the side with the drain hole.
6) Cut the clay piece the drawing so it is the size of the paper with a plastic knife or X-acto knife. Locate any areas in the drawing where the land is pervious (labeled "P") and use scissors or an X-acto knife to cut it out (clay and paper layers). The sand should be exposed. Remove the clay pieces, peel away the paper, and save this clay for another purpose.
7) Carefully lay the clay layer onto the sand and use fingers to push the outside edges so they merge with the container so water cannot run into the sand around the outside edges.
8) In order for water to flow towards the hole, tilt the model by placing the "hole" side on the edge of table and the opposite side on a higher surface such as a book about ½ inch thick. Have one of the students hold a container under the hole to catch the runoff.
9) The activity works best if the teacher is the "water keeper." Measure 1/2 cup of water and pour it into their sprinkling can. Gently pour the water onto the entire school site model using the sprinkling can. When all of the water has run off into the container, have a student pour the water into the measuring cup and record how much water ran off the model.
10) Using the data collected, write a description of the results and make an inference to the reason for the results.
11) Pose the following questions: Where would the best location for a rain garden on the model? Think about the school site. What would be the best shape? How large will the rain garden need to be in order to capture the most runoff? Now have the students think about where they might put a rain garden, what shape it should be, and how big it should be to capture the most amount of the runoff.
12) Gently remove the clay layer from the first lid or container and move it to the second dry container. Use fingers to push the outside edges so they merge with the container. Set the wet sand container aside.
13) Cut up a dry sponge in the shape they want the rain garden to be. Examine the sponge before the experiment. Use a spoon to excavate the sand from the selected location and place the sponge in area where the rain garden is planned. Make sure the sponge is level with the sand layer.
14) Repeat the experiment using ½ cup of water and recording how much water poured out.
15) Discuss what happened? Did the "rain garden" reduce the runoff amount?
16) Remove the sponge and examine it after the experiment? Ask them to explain what happened to the sponge and relate that to what happens in a rain garden.

Follow-ups:

1) Combine all the student data into one classroom table. Display the models on one table so everyone can look at them.
2) Lead a discussion. Did adding the rain garden significantly reduce the amount of water running off the property? Which teams model reduced the runoff the most and why? If given a chance to repeat the experiment, would they put their garden in a different place and why? How did the size of the garden affect how much water was removed?

Extensions:

1) Repeat the experiment using the saturated model and see how much of water was retained. Essentially this is what is happening in the spring after snow melts or when we have back-to-back storms. Discuss how you would use this information to design your rain garden. Explain that you might make the garden (sponge) bigger or you might install a drain (straw) so the garden drains to a storm drain and does not flood. Or use a different volume of water to simulate what happens in different size rain events such as 1/4 inch (1/8 cup), 1/2 inch (1/4 cups), 1 inch (1/2 cup) 2 inches (1 cup), and more.
2) Demonstrate what happens when water runs off the roof using your container. Using a bendable straw, put a straw through the clay layer of the model bend it so it is running parallel under the clay. This is the gutter. Attach the bendable straw to another straw and use masking tape to seal them. The straw running beneath the clay is the storm drain. Connect more straws until the line runs directly to the hole. Push the straw through the hole in the lid or container. The hole coming out the lid or container is the storm drain that would exit to the stream. Ask students if they ever saw a big concrete pipe that empties into a stream. Have they observed the storm drain outlet after a rain? What happens? Storm water running off impervious surfaces is traveling untreated to streams. Pour 1/2 cups of water into the container and let it run off. Note that over 98% of the roof runoff went into the container or would runoff into a storm drain. Some rain gardens are designed to capture roof runoff. The gutter is disconnected and redirected so the runoff flows into the rain garden. To demonstrate this, remove the straw from the hole and direct the straw into the rain garden (sponge) and pour water into it. Roof runoff can be captured roof in a rain barrel and directed into a rain garden or used for watering lawns and gardens. Show students pictures of rain garden where the gutter is directed into the garden and homes where rain barrels are attached to the downspouts and/or directed into rain gardens.
3) Use food coloring or drink mixes to simulate pollution that may be occurring on the school parking lot before you site your rain garden. Use green to represent fertilizers and food waste, yellow to represent animal wastes, red to represent oil and gasoline from cars, and coco powder to simulate erosion. Dilute food coloring by adding 1 drop food coloring to every 10 mL of water. Put the food coloring or drink mixes in areas where it might be on their school grounds. Water the model and look what happened to the water. Add in the rain garden and repeat. The sponge (rain garden) will remove a lot of the coloring from the water when the model is rained on again.
4) If you are planting a rain garden on the school site, show students where you plan to install it and compare the location with the one professionals chose. Why did the professional select the spot they chose?

Option 2: Middle School

Objectives: Students will:

1) Use topographic maps to trace the flow of surface water runoff on their school grounds and construct a model of their school site showing how surface water runoff could be trapped in a rain garden and used to recharge underground aquifers.
2) Distinguish a pervious from impervious surfaces;
3) Trace the path of water from precipitation to runoff and storage; and
4) Construct a model to demonstrate how changes in percent impervious surfaces help manage storm water runoff.

Topics Covered: Pervious and Impervious Surfaces, Weather, Precipitation, Flooding, Groundwater Recharge, Erosion, Topographic Maps, Land Use, and Water Pollution

Activity Time: 1-2 class periods

State Standards: (See Appendices – Rain Garden Lesson Guide Correlations by Grade)

Materials:

7.5 minute topographic map of school
Blown up section from topographic map of school grounds
Colored pencils or markers
Masking tape
Plain or graph paper
Pencils with eraser
Clip board
Hose
Bucket
Water source

Follow Up:

Hose
Bucket
Water source
Plain or graph paper
Pencils with eraser
Clip board

Extension:

2 foot x 6 inch boards
Clay or play dough
Half Gallon or Quart water pitcher
Water Source
Plain paper
Pencil with eraser
Clip board
2 gallon bucket
8 quart square container
Other containers (optional)

Introduction:

Begin the same way as the ***No Place to Run*** Grades 3-5 Option Introduction with a discussion of "where does water go when it rains?" Students are going to figure out where on their school yard might be a good location to capture the most water in a rain garden. Students are going to use a topographic map to help them figure out what land area drains to their schoolyard so they can site the rain garden.

Introduce students to topographic maps. Show them a 7.5 minute quadrangle topographic map. This map represents one square of the earth surface. Note that topographic maps are not actually squares or rectangles because of the shape of the earth. Show students a topographic map and then project a topographic map onto a screen for the whole class to view (optional). Look at the lines on the maps. Ask what they think the lines represent? (contour lines, elevations). The brown lines are called contour lines and they show elevations. Look at the map scale to see what the distance is between contour lines? The distance varies but is usually 10 or 20 feet depending on the map. Look for the numbers embedded in the brown lines. This number is the elevation of the land above sea level. Every 5^{th} line has a number in it. The map also includes other features like woodlands and wetlands and these features are green. The black features are building and roads. The pink features are urban areas. The yellow areas are mines and the red areas are landfills. And the purple features are items that have been added to the map since the last edition of the maps and have not been verified. They are going to do an activity to determine the watershed boundary of their school yard and use this to site a rain garden on the property.

Hands On:

1) Divide the class into teams of 4 students and give each team a copy of a section of topographic map that includes their schoolyard and a set of colored pencils or markers. Have students:
   a) find their school on the map and to draw a red circle around it; and
   b) locate streams, rivers, lakes, marshes, and ditches closest to the school site and mark them in blue. Mark the direction of flow with an arrow. Remember water flows down hill. Contour lines going down hill look like “V’s” are usually water channels. Contour lines going uphill that look like “M” are hills.
2) Have students complete the **Topographic Map Orientation Activity.** (See Appendices)
3) Students are going to draw a watershed boundary for the rain garden proposed at their school site. Pass out a copy of a 400% topographic map magnification of just their school site. Find the highest and lowest points on the map using the numbers in the contour intervals and mark them with black “X’s.” Where is the school in relation to the high and low points?
   a) Look uphill from the school and mark all of the hilltops with a black “X.” Use arrows to show which direction the water flows. Where does the water flow in relation to your school? Where does it flow in relation to water bodies around your school?
   b) Where would be the best place on the school ground to put a rain garden? Put and “R” in the proposed rain garden spot and then draw the watershed boundary for the area. Find the highest ground around the school and follow the hilltops and ridges connecting the “X’s” until you finally connect the line to the proposed rain garden site. The outline should look somewhat like a balloon with the knot representing your proposed rain garden site.
   c) Tape their map up on the wall so everyone can look at the drawings. Which rain garden site has the largest watershed (biggest balloon)? Or the smallest?
   d) In general the rain garden will be anywhere from one third to one fifth of the size of the watershed depending on soil types and infiltration rates that they will study later. Given this new information, which location would work the best? Have them develop a list of factors that would affect their decision of what would make the best rain garden site. For example, manageable size; foot, car, and bus traffic patterns; existing landscaping; safety issues; visibility; and proximity to discharge point like storm drain or water body.
4) Take the students outside with their watershed maps showing the proposed locations and have them use their list of factors to pick a good spot for a rain garden. Have each team pick a location and tell the other students why they chose this location. See if the students can come to a consensus. The process they are using is similar to that of the superintendent, principal, teachers, and watershed professionals who make these types of decisions.

Follow-up: Explore where water actually runs to on their school site. Make their own crude map of the school site showing the highest and lowest points. Using buckets of colored water, travel to the highest points on the school ground and pour out the water. Watch to see where the colored water runs to. Mark it on their crude maps. Repeat this procedure as they travel downhill marking their findings on the crude map. Pass out the topographic maps they marked up during the Hands On portion of this activity and have students compare what they found out as they traveled around the site with the arrows placed on the topographic maps. Is the water going where they thought it would? Why or why not? Then check the date on the topographic map. When was it made? Could there be elevation changes on your school site that are not marked on the map? Discuss how maps are a tool to be used in combination with actual site visits or ‘*ground truthing’*. Mention that topographic maps are updated every 10-20 years on average.

Extension: Create a watershed model of the proposed Rain Garden site at your school following the directions in the High School Option of the ***No Place to Run*** lesson Hands On 4.

Option 3: High School

Objectives: Students will:

1) Distinguish a pervious from impervious surfaces;
2) Use a topographic map to draw the watershed that contributes runoff to their school site, trace the flow of precipitation over the school grounds, calculate slope, and develop a model showing options for capturing and storing rain water on the school grounds including rain gardens and rain barrels;
3) Construct a model to sell rain garden project to school administrators and parents;
4) Determine what it would cost to implement a rain garden project and summarize in a proposal; and
5) Use model to demonstrate how rain garden work.

Topics Covered: Pervious and Impervious Surfaces, Weather, Precipitation, Flooding, Groundwater Recharge, Erosion, Topographic Maps, Land Use, and Water Pollution

Activity Time: 1-3 class periods

State Standards: (See Appendices – Rain Garden Lesson Guide Correlations by Grade)

Materials:

7.5 minute topographic map of school
Topographic Map Activity Directions
Pencil with eraser
Clip board
Clear acetate sheet with Dot Grid printed onto it
Dry erase markers
7.5 minute topographic map of school
Access to copier
Scissors
Cardboard, foam core boards, or foam craft sheets
Colored paper or foam craft sheets
Glue or spray adhesive
Colored markers

Follow Up:
None

Extension:
Pottery clay, Paper Mache, or soil from school yard
Clear plastic wrap or clear acrylic paint or varnish
Permanent markers
Source of water
Sprinkling can
Watershed Boundary Map from Hands On activity
Colored markers
Model from Follow Up
Felt
Sponges
Eye Dropper
Water Source
Drink Mix
Food Coloring
Oil

Introduction:

Begin inquiry with a discussion of “where does water go when it rains?” Then lead a discussion about how water runs off the land. Answers will vary but should include that rain soaks into the ground, runs over the land to a water body, runs down the roads into storm drains, etc. What happens to the water that falls on their homes or the school? Discuss how gutters capture the water and direct it to the street where it flows into storm drains that run into the river. What happens when we have a particularly heavy rain? Why do some streams flood and rivers overflow or flood? Think about reasons that water flows over the ground instead of soaking into the ground. Talk about how some surfaces are pervious and some are not (impervious). Mention that even some pervious surfaces can become impervious under certain conditions like when the ground becomes saturated with rain and cannot absorb more water.

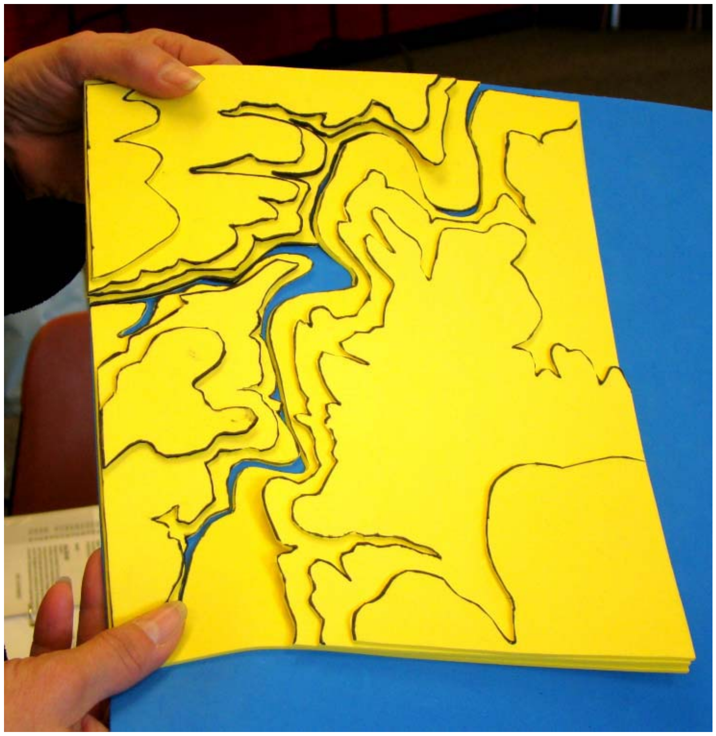
Introduce the students to topographic maps. Show them a 7.5 minute quadrangle topographic map. This map represents one square of the earth surface. The earth is divided into squares by horizontal and vertical lines. The vertical lines are *Meridians of longitude* are north-south lines connecting the poles and the horizontal lines *are Parallels of latitude* are east-west lines parallel to the equator. Meridians and Parallels are circles that have 360 degrees, 60 minutes per degree, and 60 seconds per minute. There are 3,600 seconds per degree. A topographic map is one 15 x 15 minute square of the earth that has been created from aerial photographs to show 3-dimensional features of the earth’s surface. Locations on the earth are expressed as degrees, minutes and seconds. For example, 39° 8' 8.5" is equal to 39 degrees, 8 minutes, 8.5 seconds Latitude. To describe your location on the earth you need the longitude and latitude coordinates. For example, Avey's Run at Cincinnati Nature Centers is 39° 7' 56.3" Latitude and 84° 15' 21.9"longitude.

If you wish to use free online maps for this activity, visit: http://terraserver-usa.com/ or http://mapserver.mytopo.com/homepage/index.cfm?CFID=3692819&CFTOKEN=19169154.

Hands On:

1) Divide the class up into teams and give each team a topographic map of their school. Have students:
   a) Locate the school on the map.
   b) Determine the longitude and latitude coordinates of their schools front door (optional) on the topographic map. Note the vertical line on the left of the map is marked for latitude and the horizontal line at the top of the map is marked for longitude. Use a straight edge to find the horizontal and vertical coordinates When students have figured this out, visit the front door and use a hand held GPS to determine the coordinates. Compare them with the coordinates the students determined using the topographic map. With the coordinates from the GPS Unit Were they close? Why or why not?
   c) Review the features of topographic maps including contour lines and the color coding. See background section for more information. Have them complete Topographic map Orientation Activity from Middle School Option (optional).
2) Select a location on the school site they think would be the best place to put a rain garden using directions in the ***No Place to Run*** Middle School Option Hands-On Section Step 3.
   a) Draw the watershed boundary for that site.
   b) Use a dot grid to determine the size of the watershed area for that rain garden and write this number on their maps. The directions for using the Dot Grid are on the handout. (See Appendices for **Dot Grid Master**.) If the topographic map was blown up 400%, be sure to blow up the Dot Grid Master 400% when you make the transparencies for the activity.
3) Complete ***No Place to Run*** Middle School Option Hands-On Section Step 4. Evaluate each rain garden location and select one location. What factors did their place the most weight on and why?
4) Assume students need to "sell" the idea of a rain garden to their school administration (principal, superintendent, school board) and the community. To do this, create a 3-dimensional model like architects and landscape designers use to sell their ideas. Use the watershed boundary map created in step 2 of this activity and their preferred alternatives of where to locate a rain garden using information from step 3 of this activity. This model will show where a rain garden could go. It could also be used in a presentation along with a written proposal to fund a rain garden project at their school (optional).
   a) To create the watershed model, blow up the topographic map section of a copier to 400% larger or more than its original size. Be sure to keep scale in mind. For example, if original topographic maps is 1 inch = 24,000 feet. In the blown up version, 1 inch = 240 feet. Using this information, make your rain garden to scale. For example, a 400 foot x 400 foot garden would be 1 ¾ inch by 1 3/4 inch.
   b) Use a material like card board, foam core, or foam sheets to make the layers. Use push pins to secure the map to the material you chose.
      i) Place the photocopy of the topographic map on top of the foam core, cardboard, or foam sheet.
      ii) The model is created starting with a flat base. Each layer is an elevation on the topographic map and you start with the lowest elevation and add each new elevation as a separate layer. For example 820 feet might be the lowest layer and then add on 830, 840, 850, and so on until the model is complete,
      iii) Carefully cut along the dark contour line with the number in it representing the **lowest** elevation. Label the center of the construction paper with a "1." This is the first level of the model which you will build. Set aside the layer.
      iv) Now you are ready for the next elevation. Place the photocopy of the landform on top of another sheet of foam board, cardboard, or foam sheets (the color you use does not matter) and carefully cut around the next dark contour line with the number in it. Label the center of layer with a "2". This is the second level of your model.
      v) Repeat this procedure until you have cut out all of the contour lines. Don't forget to label the layer with the appropriate number.
      vi) Now you are ready to build your 3-D model.
      vii) Take layer number 2 and glue the spacers to the bottom of the layer (optional). The spacers represent the increase in elevation between each contour line (contour interval).
      viii) Glue layer 2 onto the top of the first layer.
      ix) Repeat Step 6 and 7 with the rest of your layers until you have built your model.

c) Make 3-dimentional models of the schools other features like buildings, trees, bushes, flag poles, cars in the parking lot etc. and glue them to the landscape.
d) Use colored markers to draw in the flat features like parking lot lines, road, grass, etc.
e) Cut out a separate piece that shows the proposed rain garden location and glue it to the model. Color the rain garden using permanent markers to show colorful plants.
f) Be sure to label the final model with names of the school site, buildings, roads, other features, and rain garden.
g) Place the model in a prominent location where it can be viewed by faculty, staff and students. Have the students devise a way to get feedback on their model and proposed plan.



Follow Ups:

1) Find out what it would cost to create a rain garden and write a written proposal to create a rain garden on their school site.
2) Make a presentation to school officials and/or the PTA about their idea.

Extensions:

1) Using the basic watershed cardboard or foam core model created in the ***No Place to Run*** High School Option Hands On section, and cover it with clay (or dirt from the school ground) and apply it to the bare model so the surface looks like the actual topography of the school yard. Locate the proposed rain garden location using the map and create the garden. Use a serrated knife to excavate and make your flat-bottom bowl shape. Remember that the garden needs to be oriented perpendicular to the water source. Use additional clay to form the berm around the garden to trap the water. Then make models of the buildings, roads, etc. with paper and permanent markers. Use small pieces of paper to label all the features including the rain garden. Place the model over a towel (or take the model outside on the grass) to capture any water that runoff off and use a sprinkling can to simulate rain and rain on the model. Students will see how rainwater runs from the highest points toward the lowest. Generally a body of water, such as a lake or river and in this case rain garden is formed at the lowest point. Observe where water went on their model? Was this a good location for the rain garden? What modifications would they make? Tell them in an actual garden, the water would soak in!
2) Demonstrate how many inches of rain your rain garden could hold by modifying the lands surfaces to represent pervious and impervious surfaces. Take the watershed boundary map of the site the student's selected and then give a copy to each team and some colored markers. Have students that they evaluate the

watershed in terms of pervious and impervious surfaces and use the colored markers and a key to label their maps according to how pervious the land is. For example, bare ground has a different porosity than a grass area. Go outside and label their maps coloring in the sections according the land use. Given what they know now, have they selected the best location for their rain garden? Why or why not? Using this information, modify the watershed model. Leave the impervious areas as modeling clay and add felt to cover grass areas. Cut away the clay and sink in small sponges for trees and make landscape beds out of sponges the approximate size of the bed using the map scale as a reference. Then put a sponge inside the rain garden. Using an eye dropper, rain on the landscape in varying amounts representing rainfall events. Depending on the size of your model, select an appropriate amount of water for rainfall amounts. For example, 1 tablespoon = 1 inch and 2 tablespoons equals 2 inches. How well did the rain garden perform?

3) Extend the demonstration to show students how pollution created by common substances such as automotive fluids, garden fertilizers and pet wastes can be carried by rainwater into the lake or river. Dry off the model with a towel and then sprinkle food coloring or drink mix onto the model in locations where you might find it. For example, use red food coloring or drink mix to simulate automotive fluids, green to simulate fertilizers, brown or yellow to simulate pet wastes. Then rain on the model again. Where did they go? Into the Rain Garden? Tell them that one of the functions of a rain garden is to filter out pollutants so they do not travel through storm drains untreated into rivers, lakes, and streams.