Watershed Experience Trailer: Rainfall Simulation

Goal:

Observe, predict, and discuss amounts of run-off versus ground water across different surface types.

Objectives: The Student Will Understand:

- The effect of land cover and management on the path of rainwater.
- Water storage in the soil, ground water, and surface reservoirs.
- The effect that impervious areas have on water movement in a watershed.
- Water and land management options that decrease runoff and promote infiltration.

Materials:

- Rainfall simulator remote (button **#3**). *The same remote is used for the Enviroscape AND the Rainfall Simulation.*
- 8 labeled beakers (4 for Runoff, 4 for Infiltration)
- Towels to dry beakers before storing.

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Discussion:

We are going simulate rainfall on different types of ground surfaces. Who can tell me what simulate or simulation means? Excellent! To simulate or a simulation is a something that represents something from real life, like how many of you know or have played with a flight simulator. You get to act like you are flying a plane, but in reality you are playing a computer game.

Today we are going to look at four different types of ground surfaces, some more pervious than others and simulate rainfall on top of them. Who can raise their hand and tell me what pervious means? Great! Pervious ground refers to how much water is able to soak into the soil and ultimately into the groundwater system. You will predict (hypothesize) how much groundwater versus surface water will result from each surface type. Can anyone give me an example of a type of ground water? Right on! Aquifers are a great example of groundwater. Can anyone give me an example of surface water? Stormwater, river, lakes. Okay, you guys are ready to simulate rainfall!

A few rules to remember as we go:

Please be careful, we are in the field so watch your step
Keep your hands out of the exhibits and the water
Always respect your classmates and instructor, listen carefully and participate fully. We need your help to make this rainfall simulation a success!

Here We Go!

1. Have students gather around the simulator so that they all have a good visual perspective. It works best if they stay one step back so that the entire group can see.
2. Each student should have their journals open to the question and reflection page for the rain fall simulator
3. Before the simulation starts, ask students to share their visual observation about each surface container and where they might find each type of surface in their life.
    a. Bare Soil. This container is bare ground. It represents a pasture that is overgrazed, a plowed field with no cover crops, or an area under construction.
    b. Diverse Tallgrass Native Prairie: This container has several species of native Texas grassland species. Student might respond that it looks like a field or meadow, which is a great transition to guide their understanding towards the importance of plant diversity and adaptation that native Texas plants have to thrive and survive.
    c. Concrete Container: is a parking lot, road or driveway, or the roof of your house. This surface is Impervious, smooth and water cannot soak in.
    d. Mowed Lawn / Monoculture Container: This container has only one species of short grass. Depending on whether the students are urban or rural they might respond that it looks like their front lawn, a park, golf course, or pasture. This lack of diversity is called a monoculture.
4. Have students create hypothesis of whether each surface will have more groundwater and infiltration or surface run-off, and why.
5. Start the rainfall simulation (remote button **#3**), and run for about 15 seconds.

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6. Once all of the ground water and surface water has finished filtering into the beakers have the students assess whether their hypotheses were supported. You can provide the following explanations:

   a. Bare Soil: a lot of runoff with little ground water. Discussion points include that the soil is hard packed, there are not enough plants to help capture the water, and in the runoff a significant amount of top soil is also normally removed.

Discuss that the water wouldn't be or look clean like our simulation.
Discuss cover crops

ASK: When it rains, will the water runoff or will it soak into the ground? (Allow a chance for student responses.)

With no vegetation, the rain hardens bare soil and makes it impervious.

ASK: what is potentially in the runoff water?

Stormwater runoff carries pollutants and erodes soil away. Examples in trailer.

   b. Diverse Tallgrass Native Prairie: mostly groundwater/infiltration with some runoff. Discussion points include: native plants have vast deep root systems that are designed to distribute water downward, and helps to keep them anchored in the ground. The surface structure of the plant help slow down surface water movement and allow time for water to soak into the soil and to help prevent topsoil removal.

These tall grasses have been in this area of hundreds of years have adapted to the climate conditions of Texas.

ASK: what is potentially in the runoff water….

See appendix for diversity, pollinator, and ecosystem services information.

   c. Concrete Container: all run off and no infiltration. Areas with high amounts of impervious surfaces will experience significant flooding due to this.

ASK: What does impervious means? (Allow a chance for student responses.) Impervious means that it will not allow water or other fluids to pass through it.

Examples: sidewalks, roads, building foundations, or roofs.

ASK: what is potentially in the runoff water?

Stormwater runoff carries pollutants from roads or roofs. Ex. Of pollutants: Sediment, oils, trash, grass and leaves, etc. Stormwater is also about quantity, not just quality.

   d. Mowed Lawn / Monoculture Container: run off and groundwater will be similar levels, they will vary depending on the saturation level of the soil.

ASK: what is potentially in the runoff water…. Pesticides and fertilizers! You can also talk about the importance of xeriscaping for conservation of water since turf lawns are generally very 'thirsty'. Relate the to the homeowner Reclamation Practices in the Conservation exhibit.

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Assessment:

The types of land that did the best job in allowing water to soak into the ground was those that had grass on them. And more water soaking into the ground means more water in the aquifer!

If time allows, ask the following questions or discussions:

ASK: In the DFW Metroplex, where do we get a large supply of our water? *From reservoirs, aka lakes. Sometimes from aquifers or from the Trinity River.*
ASK: Does anyone have a well or know someone who does? How did it get there?

Rainwater has to soak into the ground and it's filtered by the soil, like a sponge.
Stormwater Runoff is the another kind of surface water. It goes directly into a ditch, storm drains, a river or stream, or it just sits in a puddle, instead of soaking into the ground.
Stormwater Runoff isn't filtered or cleaned by anyone, and it can get dirty as it travels through the watershed unless we have built

When it rains, water will do one of two things it will either run off or it will soak in and become groundwater.
Water soaking into the ground is the only way to recharge the aquifer, lake, or river. Infiltration and percolation.

ASK: Why do we care if water soaks into the ground? (Allow a chance for student responses.)
Water soaking into the ground is the only way to recharge the aquifer. It also slows and cleans stormwater.

If we REMEMBER the definition of "impervious" we said that it does not allow water to soak in. That is why the water ran off, went somewhere else.

ASK: Where did the water go when it rained on our turf grass?
(If done correctly, some water should have gone into the run off container. The majority of the water should have flowed into the groundwater container.)

ASK: It looks as though the majority of the water went into the ground. Is this good? Why or why not? (Allow a chance for student responses.)

a. Bare soil: What you see (in real life) in the run-off water is dirt. Because there was no grass protecting the soil, erosion took place. Erosion is water washing away soil or wind blowing it away. We are getting some ground water, however. This type of land is not good to have because of erosion.

b. Diverse Tallgrass Native Prairie: All of our water was soaked into the ground. Very little, if any, water ran off. These native grasses have a deep root system. More water is able to soak into the ground. This is the water that will recharge the aquifer. This is good. This is what we want, a lot of water soaking into the ground when it rains.
c. Concrete Container: Impervious surfaces

ASK: When it rains at your house or apartment, will the water runoff or will it soak into the ground?

TEKS

Science:

5th Grade:	5.2ABCDF	5.3A	5.4A	5.7B	5.9AC	
6th Grade:	6.1AB	6.2ABCD	6.4A	6.12E		
7th Grade:	7.1AB	7.2ABCDE	7.3A	7.4A	7.5B	7.10AB
8th Grade:	8.1AB	8.2ABCDE	8.3A	8.4A	8.11AB	
9thBiology:	B.1AB	B.2F	B.3A	B7.E	B.11BC	B.12BCF

Background Information: Water Cycle

United States Geological Services: The Water Cycle

Surface runoff is precipitation runoff over the landscape, aka stormwater runoff

In our section about water storage in the oceans we describe how the oceans act as a large storehouse of water that evaporates to become atmospheric moisture. The oceans are kept full by precipitation and also by runoff and discharge from rivers and the ground. Many people probably have an overly-simplified idea that precipitation falls on the land, flows overland (runoff), and runs into rivers, which then empty into the oceans. That is "overly simplified" because rivers also gain and lose water to the ground. Still, it is true that much of the water in rivers comes directly from runoff from the land surface, which is defined as surface runoff.

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When rain hits saturated or impervious ground it begins to flow overland downhill. It is easy to see if it flows down your driveway to the curb and into a storm sewer, but it is harder to notice it flowing overland in a natural setting. During a heavy rain you might notice small rivulets of water flowing downhill. Water will flow along channels as it moves into larger creeks, streams, and rivers. This enviroscape gives a graphic example of how surface runoff (here flowing off a road) enters our water supply. The runoff in this case is flowing over bare soil and is depositing sediment and pollutants into the river (not good for water quality). The runoff entering this creek is beginning its journey back to the ocean.

As with all aspects of the water cycle, the interaction between precipitation and surface runoff varies according to time and geography. Similar storms occurring in the Amazon jungle and in the desert Southwest of the United States will produce different surface-runoff effects. Surface runoff is affected by both meteorological factors and the physical geology and topography of the land. Only about a third of the precipitation that falls over land runs off into streams and rivers and is returned to the oceans. The other two-thirds is evaporated, transpired, or soaks (infiltrates) into groundwater. Surface runoff can also be diverted by humans for their own uses.

The small creek shown in the picture on the trailer will merge with another creek, eventually flowing into a larger river. Thus, this creek is a tributary to a river somewhere downstream, and the water in that river will eventually flow into an ocean. The concept is not that much different from the small capillaries in your body carrying blood to larger arteries, eventually finding its way to your heart, analagous to the ocean.

Factors affecting infiltration

Precipitation: The greatest factor controlling infiltration is the amount and characteristics (intensity, duration, etc.) of precipitation that falls as rain or snow. Precipitation that infiltrates into the ground often seeps into streambeds over an extended period of time, thus a stream will often continue to flow when it hasn't rained for a long time and where there is no direct runoff from recent precipitation.

Soil characteristics: Some soils, such as clays, absorb less water at a slower rate than sandy soils. Soils absorbing less water result in more runoff overland into streams.

Soil saturation: Like a wet sponge, soil already saturated from previous rainfall can't absorb much more ... thus more rainfall will become surface runoff.

Land cover: Some land covers have a great impact on infiltration and rainfall runoff. Vegetation can slow the movement of runoff, allowing more time for it to seep into the ground. Impervious surfaces, such as parking lots, roads, and developments, act as a "fast lane" for rainfall - right into storm drains that drain directly into streams. Agriculture and the tillage of land also changes the infiltration patterns of a landscape. Water that, in natural conditions, infiltrated directly into soil now runs off into streams.

Slope of the land: Water falling on steeply-sloped land runs off more quickly and infiltrates less than water falling on flat land.

Evapotranspiration: Some infiltration stays near the land surface, which is where plants put down their roots. Plants need this shallow groundwater to grow, and, by the process of evapotranspiration, water is moved back into the atmosphere.

Subsurface water

As precipitation infiltrates into the subsurface soil, it generally forms an unsaturated zone and a saturated zone. In the unsaturated zone, the voids— that is, the spaces between grains of gravel, sand, silt, clay, and cracks within rocks—contain both air and water. Although a lot of water can be present in the unsaturated zone, this water cannot be pumped by wells because it is held too tightly by capillary forces. The upper part of the unsaturated zone is the soil-water zone. The soil zone is crisscrossed by roots, openings left by decayed roots, and animal and worm burrows, which allow the precipitation to infiltrate into the soil zone. Water in the soil is used by plants in life functions and leaf transpiration, but it also can evaporate directly to the atmosphere. Below the unsaturated zone is a saturated zone where water completely fills the voids between rock and soil particles.

Background Information: Native Prairies and Communities

Texas Parks and Wildlife

Native grasslands and prairies, with their ecologically complex plant and animal communities, were important components on the landscape of early Texas. They were dominant features on the landscape in the Edwards Plateau, Cross-Timbers and Prairies, Coastal Plains, High Plains, and Lower Rolling Plains. They contributed significantly to forage production for livestock grazing and habitat for a wide variety of wildlife species. Most of the native prairies found in the Blackland Prairie and Coastal Prairie Regions of Texas have been depleted. Only isolated relic native prairies sites remain. Native prairies were also found within most of the other ecological regions of the state where adaptable soils site occurred. Soil that once supported these vast plant communities of native perennial grasses and forbs now maintain a thriving farming economy. Currently most of these lands are devoted to the production of wheat, milo, corn, cotton, hay, improved pastures, and an array of other cash crops to meet our demands for food and fiber.

Texas Parks and Wildlife Department recognizes the importance of native prairies and grasslands and their function as habitat for many wildlife species including native and migratory birds, small and large mammals, reptiles and amphibians, insects, and invertebrates.

Background Information: Native Prairies and Grasslands

Texas Native Prairies Association of Texas

The imperiled tallgrass prairies of Texas need our help now: out of the original 20 million acres of beautiful Texas tallgrass prairie, less than 1% now remains due to suburban sprawl, plowing for row-crop agriculture, and improper overgrazing during the last 150 years.

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Protecting water quality and quantity: Native grasslands protect the watersheds in which they occur, increase water infiltration and water yield, increase water supply by reducing erosion and reservoir sedimentation, and increase water quality due to the lack of fertilizer, pesticide, and herbicide use.

Protecting declining grassland birds, native pollinators, and other wildlife by protecting and restoring their habitat: In addition to the native plant communities of the tallgrass prairies, conservation of tallgrass prairie is needed as habitat for wildlife such as grassland birds and native pollinators. Grassland birds are experiencing the greatest declines of all bird groups, and to save the grassland birds we need to protect and restore their habitat: prairie.

Many tall grass prairie birds have declined drastically due to land conversion and fragmentation. The Blackland Prairies region is important stopover habitat for migrant songbirds and wintering raptors. In the Gulf Prairies and Marshes, Attwater's prairie chicken, whooping crane, aplomado falcon, white-tailed hawk, Gulf Coast hog-nosed and eastern spotted skunks are all in need of attention, as are many of bird species that depend on this important migratory stopover area.

The State Wildlife Action Plan lists 15 - 25 high priority grassland bird species, in addition to other high priority wildlife, in each of these prairie ecoregions of Texas.

Game wildlife species that depend on native prairies and grasslands as habitat will also benefit from prairie conservation. These species include Bobwhites (Colinus virginianus), Scaled quail (Callipepla squamata), Rio Grande turkeys (Meleagris gallapavo), Eastern Wild Turkey (Meliagris gallopavo sylvestris), and Mourning doves (Zenaida macroura).

Other prairie wildlife that will benefit from this program includes the threatened Texas horned lizard (Phrynosoma cornutum) and small mammals such as the Gulf Coast hog-nosed and eastern spotted skunks. Parkhill Prairie Crayfish (Procambarus steigmani), an endangered prairie species recently discovered, will also benefit.

To save the grassland birds and other prairie wildlife, we need to protect existing and restore additional grassland bird and other wildlife habitat: the tallgrass prairie.