Rainwater Harvesting

Lesson 2: What is Rainwater Harvesting?

INTRODUCTION

This lesson will introduce students to the basic structures used in rainwater harvesting. They will understand how rainwater harvesting functions as a system to collect, convey, store, and infiltrate stormwater. They will plan and carry out an investigation and analyze the difference between permeable and impermeable surfaces using a physical model. They will use their model to learn about Best Management Practices (BMPs) for rain and stormwater. Finally, students will learn that water can be redirected for beneficial use by using a simple system.

Teaching Strategies

Thinking questions are posed throughout this unit presentation to help students think metacognitively and to make **D**istinctions, identify **S**ystems, recognize **R**elationships, and look from different **P**erspectives. This is called Systems Thinking through DSRP.

Mental Models or "mental maps" are used throughout this unit to illustrate the Systems Thinking process. Mental maps are more than a concept map. In addition to mapping out ideas, mental maps help illustrate relationships and include perspectives. They are a simple way to model systems, visualize concepts, define relationships, and organize content to achieve a deeper level of understanding for both simple and complex subject matter.

NOTE: Keep copies of mental maps and charts from every lesson as they may be referred to throughout the unit.

OBJECTIVES

- **DISTINGUISH:** Students will **ask questions and define problems** to distinguish how a passive rainwater harvesting system functions as well as why and how it can be utilized.
- **BUILD THE SYSTEM:** Identify the physical parts of a passive rainwater harvesting system and learn the four basic processes involved in harvesting rain: Collection, Conveyance, Infiltration, and Storage.
- **RELATE:** Identify the relationships between permeable and impermeable surfaces.
- **TAKE A PERSPECTIVE:** From a **cause-and-effect** perspective, relate the parts of rainwater harvesting to one another.

MATERIALS & EQUIPMENT

- Storm Water Activity Instructions
- Storm Water Best Management Practice Cards
- Stormwater Worksheet

For each cooperative group you will need:

- 12 sponges (made of 6 standard kitchen sponges cut in half)
- 2 plastic bags filled with 4 half-sponges each
- 2 plastic bags filled with 2 half-sponges each
- 100 ml graduated cylinders
- Cup to store water

The Rainwater Harvesting Unit is adapted with permission from the Arizona Project WET, Rainwater Harvesting Aqua STEM Program.

- 1 Aluminum tray 9 x 13 with a red stripe (cut a ½-inch diameter hole where the short side meets the bottom in one end)
- 1 Aluminum tray 9 x 13 with a black stripe

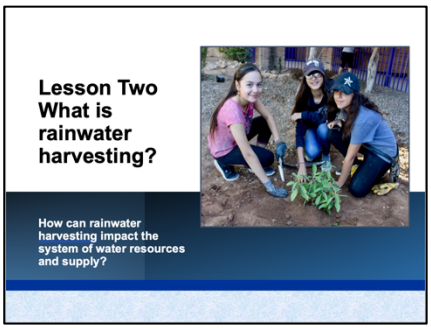
ADDITIONAL RESOURCES

Storm Water, p. 395 in *Project WET Curriculum and Activity Guide 2.0*

LESSON SUMMARY

In this lesson, students will begin to learn about rainwater harvesting and think about why it may be helpful in managing runoff on their school campus.

PRESENTATION GUIDE

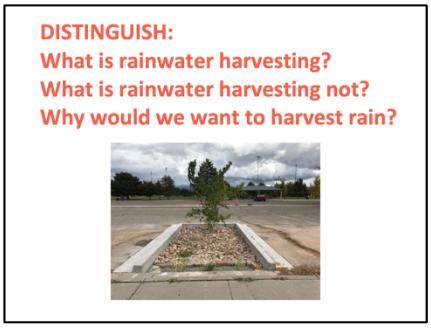


Connect to the Unit

In Lesson 1, students learned the differences between weather, climate, and climate change. They developed and used a simple model to record weather data over several years to simulate climate, then compared class climate averages to individual yearly data to identify trends or anomalies. Students also investigated the effects of excessive heat in urban areas and discovered how passive rainwater harvesting—combined with planting native plants and shade trees—can help reduce the urban heat island effect. They learned that these strategies not only cool the environment but also improve soil health by increasing groundwater retention and help conserve water by supplementing the potable water supply.

Launch the lesson

This lesson introduces students to the idea of rainwater harvesting by using basic DSRP questions used to deepen thinking on any topic. Begin a *"Rainwater Harvesting"* mental map.



DISTINGUISH

• What is rainwater harvesting?

Write student ideas under the question. They may suggest ideas such as collecting rainwater, storing water, allowing water to soak into the ground to help plants, or moving water to where it's needed. If needed, break down the term to guide their thinking. For example: What does it mean to **harvest** something? (e.g., gathering or collecting)

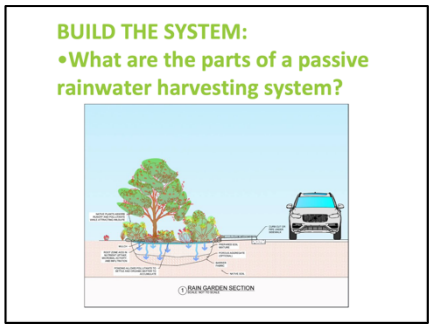
• What is rainwater harvesting not?

Again, record student ideas. Their ideas may include just collecting water alone or collecting water from any other source except precipitation runoff.

- **Why would we want to harvest rain?**

Discuss why it might be beneficial to harvest rain in our area. How can we increase shade in a sustainable manner? How can we save water and improve soil health through green stormwater infrastructure?

Ask students if they can define what a system is. A system is a set of connected parts that work together to make a complex whole. Lead students through a "roof to soil" discussion of where water might flow during a rainstorm. Where might they be able to capture flowing water?

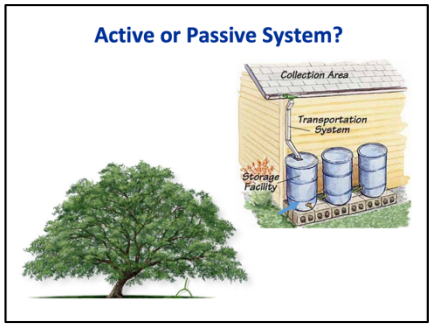


BUILD THE SYSTEM

- **What are the parts of a passive rainwater harvesting system?**

Write student ideas under the question. At this point they will be listing words like those in parentheses below. We will revisit these later in the unit to group them in these four categories:

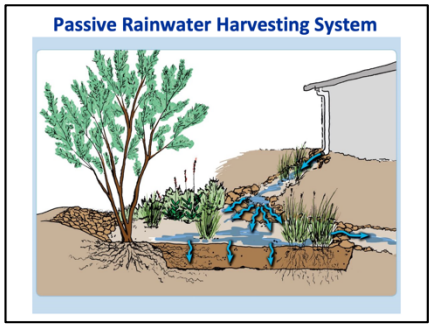
- Collection areas (roof, street, parking lot, patio, etc.);
- Conveyance equipment (gutters, downspout, piping, curb cuts, swales);
- Infiltration areas (basin, berms, overflow);
- Storage (plants: grasses, shrubs, trees, tanks, or directly into the groundwater system).



Explain to students that there are two main types of rainwater harvesting systems: "**Active**" and "**Passive**".

Ask students, "What type of system do you think is shown in this image?" Encourage them to explain their reasoning. Follow up with: "What structures do you see, and what are their functions?" Go through each component shown in the slide, making sure students understand how each part contributes to the system. Clarify the difference:

An **active rainwater harvesting system** requires a person, switch, or valve to actively turn it on or off. It often requires energy to move water from a storage container to where it's needed. For example, getting water to a tree might involve a pump or manually opening a spigot if it's gravity-fed. That's why it's called an "Active" system.

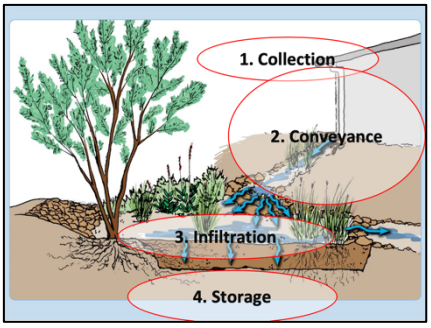


A **passive rainwater harvesting system** works on its own without needing switches, valves, or people to operate it. These systems use gravity and natural landscape features to slow down, spread out, and soak in water. The more passive the system, the less energy it uses.

In this image, the landscape has been contoured to create a basin or depression for water to soak into the ground as a form of infiltration for plants to store water. These features are called "earthworks," and they help increase infiltration and boost soil moisture. Native plants are

especially suited to this kind of system because they are adapted to local conditions and can access the stored water effectively.

Tell students that in this unit, we are going to focus on passive rainwater harvesting systems.



BUILD THE SYSTEM

• What are the four main processes involved in rainwater harvesting?

Have students group the parts of rainwater harvesting that they identified earlier into categories. They should begin to identify these four main categories:

- Impermeable or less permeable Collection surfaces (roof, street, parking lot, patio, etc.);
- Conveyance equipment (gutters, downspout, piping, curb cuts, swales);
- Infiltration areas (basin, infiltration berm, overflow);
- Storage (plants: grasses, shrubs, trees, or tanks).

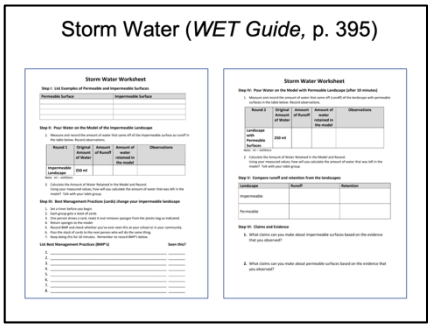
They may not yet think of the storage in the ground as part of the system yet, but we'll come back to it.

DISTINGUISH

Students are likely to be familiar with stormwater but may not know that water managers consider it a valuable source of water for reuse. In the next exercise, they will learn about Best Management Practices (BMPs) to prevent stormwater from flowing down our streets and into storm drains and arroyos, and to instead put it to use.

The ***Storm Water*** lesson in the Project WET Curriculum Guide 2.0 will demonstrate and quantify the effect different surfaces have on the flow of water. Following the Storm Water Activity instructions, *distribute the materials and demonstrate how to set it up.*

Have the students look at their model. If the sponges represent the natural land, ask them what they think the plastic bags represent?



Be sure they notice where the storm drain is located inside the top pan. The top pan will be nested into the second pan with one side propped onto the edge of the second pan so that it slopes down inside the pan. The storm drain should be on the lowest side.

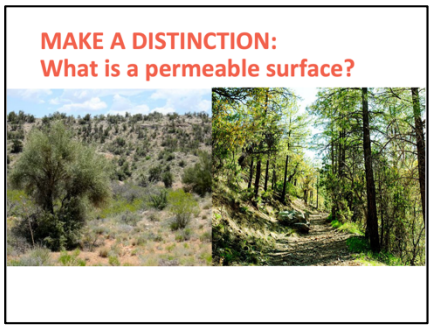
Ask the students, "Do the sponges in the bag represent an impermeable surface or permeable surface?" Have them write examples of both in Step I of the Storm Water Worksheet and explore more in the investigation.

The goal of this experiment is to discover and explore ways to manage rainwater by experimenting with runoff.

Have the students work through the worksheet. First, have them pour 250 mL of water on the top portion of the tray. Let the pan drain and collect into the second tray for one minute and then measure and record the amount (Step II). This is runoff.

Some ways of managing stormwater are better than others. During the next part of this activity, they will learn about Best Management Practices (BMPs) for managing stormwater. Each student group gets a stack of cards which describe different BMPs. Each card will describe the practice and then tell them to remove a certain number of sponges from the bag and place it back in the tray. Once a plastic bag is empty, they can take it out of the tray.

Start all the student groups at the same time and ask students to take turns drawing a card randomly from the stack and reading the card. Have them discuss the card and record the BMP type in the appropriate section of their worksheet (Step III). Then, have them follow the directions for removing sponges. Do NOT let them move on to Step IV until the timer goes off after 10 minutes.



Then, have students move on to Step IV: pour 250 mL of water on the top portion of the tray. Let the pan drain and collect into the second tray for one minute and then measure and record amount. Have students subtract that amount from the amount they poured on the model (250 mL) to calculate the amount of water retained in the model.

In Step V, have students compare the runoff and retention for the permeable and impermeable surfaces. Discuss their data.

DISTINGUISH

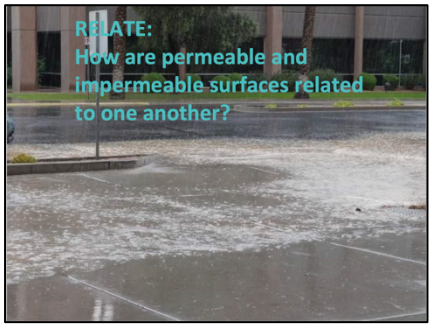
• What is a permeable surface?

Have students go back to their list of permeable surfaces on the data collection sheet. Ask them if there are other permeable landscapes they can add to their list. Were any mentioned in the BMP exercise?

DISTINGUISH

• What is an impermeable surface?

Have students add to their lists of impermeable surfaces on the data collection sheet. Ask them if there are other impermeable landscapes they can add to their list. For example, what impermeable surface might be a good one to harvest rain from? (roof) Why the roof?



RELATE

• How are permeable and impermeable surfaces related to one another?

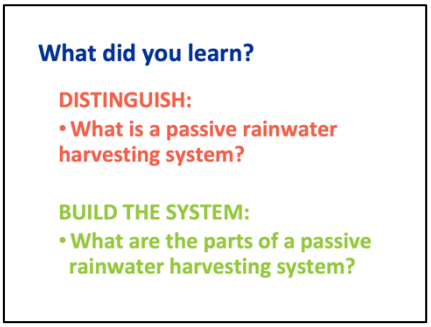
Connect their observations back to the ***Stormwater*** experiment and the

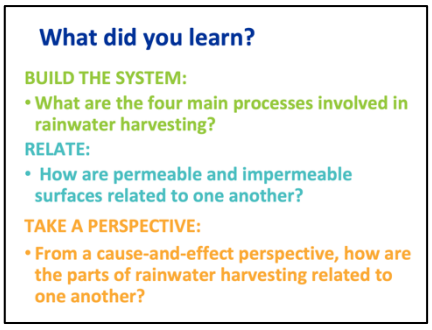
BMPs. What did they learn from the experiment? What might be some better ways to handle this excess of water?

Engage the students in a discussion of how water moves through our city. Why does water pool in some areas? Where does it end up? (low lying areas, water flows to it by gravity) Ask them if this is a good thing or a bad thing? (it could be both) Have they seen this happen in their neighborhood or at the school? Are there places in your school or community where it floods?

Discuss where this water goes after it "disappears." What do they think happens to it? (e.g., it could evaporate, go into a storm drain or arroyo, or infiltrate through cracks in pavement)

Ask students to explain where water flows during a storm on their school grounds. Encourage them to think about: Where does water collect? Where is water conveyed? Where can water infiltrate? Where is water stored? What does their schoolyard watershed look like?





Conclusion

Discuss with students or have them write in their science notebooks answers to these questions:

DISTINGUISH

• What is a "passive" rainwater harvesting system?

BUILD THE SYSTEM

• What are the parts of a passive rainwater harvesting system?

BUILD THE SYSTEM

• What are the four main processes involved in rainwater harvesting?

RELATE

• How are permeable and impermeable surfaces related to one another?

TAKE A PERSPECTIVE

• From a cause-and-effect perspective, how are the parts of rainwater harvesting related to one another?