Engineering with Nature: Rainwater Project

(2-4 Weeks)

Authors

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SUBJECT/GRADE LEVEL

Subject Area(s): Environmental Science

Grade Level(s): 10-12

Materials

- Food grade barrel (If the barrel has previously been used, ensure that its contents were nontoxic) (Home Depot, July 19, 2022)
- Rain barrel spigot kit or boiler drain and matching fitting or lock nut
- Silicone caulk
- Aluminum, stainless steel or fiberglass window screen mesh or drain hair strainer
- 1/2-inch screws: brass, stainless steel or exterior grade
- Flexible downspout adapter or downspout diverter
- Gravel (optional)
- Landscape timbers (optional)
- Concrete blocks and/or pavers (optional)
- Water pump or siphon (optional)

Tools:

- Drill
- 3/4-inch drill bit or hole saw (Measure your spigot for exact size, then go about 1/8-inch smaller than the diameter of the threads)
- Driver bit for screws
- Jigsaw if barrel has non-removable lid
- Wrench or pliers for retaining nut, if needed
- Utility scissors to cut screen
- Caulk gun for silicone sealant

Some additional or alternate resources

- LEARNING TO LIVE WITH LESS WATER
- PROJECT CHOICE RESOURCE
- ALTERNATE OR EXTENSION MODULE OR RAIN FOREST WATER LESSON

STANDARDS

Next Generation Science Standards

- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS.Human Sustainability

LESSON OBJECTIVE(S)

Students will determine the advantages of combining green and gray infrastructure to repair/rebuild old infrastructure in sustainable, cost efficient ways by designing a rainwater collection apparatus (barrel) that combines green and gray infrastructure to use in gardening.

CENTRAL FOCUS

By the end of this unit the students will be able to:

a. Determine the difference between green and gray infrastructure
b. Determine the impact of using only gray infrastructure on the environment.
c. Determine the advantages of combining green and gray infrastructure to repair/rebuild old infrastructure in sustainable, cost efficient ways.
d. Design a rainwater collection apparatus (barrel) that combines green and gray infrastructure to use in gardening that will be sustainable and cost efficient.
e. Build and test a rainwater collection apparatus that combines green and gray infrastructure to use in gardening that will be both sustainable and cost efficient.

CAREER CONNECTION(S)

Mentor Background: Dr. Kyle McKay, Research Civil Engineer

Our team's work focuses broadly on trade-offs between human and ecological uses of water resources with applications in ecosystem restoration, flood management, and ecological modeling. The team is currently seeking to better understand natural infrastructure and the potential role of ecosystems in infrastructure portfolios, and we are partnering closely with the Network for Engineering with Nature .

STEM Careers: Aquaculturist, Farmer, Agriculture Engineer, Environmental Scientist, Environmental Engineer, Botanist, Hydrologist, Plant Scientist

ENGAGEMENT

Brief Description:

The teacher will invite a scientist to speak to the class about the impact climate change has on the environment. The speaker will address the impact of natural disasters on biodiversity.

Vocabulary: Circulation, Detention pond, Downspout, Erosion, Flow Path, Focal Point, Pervious surface, Ponding, Site Inventory, Retention pond

Question to engage students:

How can humans combine green and gray infrastructure to address the increase in drought conditions across the United States?

Procedures:

I. The teacher will determine students' preconceptions about climate change by:
   a) Asking them "What is climate change?"
   b) Is there evidence to prove there is climate change?
   c) How can humans address climate change without causing harm to the environment?

II. After addressing the preconceptions, factual knowledge will be provided from the invited speaker.
   a) The speaker will address the impact of climate change, if any, on the environment.
   b) The speaker will address the impact of natural disasters on biodiversity.

The teacher will direct the students back to the engaging question.
The teacher will use this picture to determine if students can infer what is green infrastructure and what is gray infrastructure.



(Rainwater Management)

EXPLORATION

Brief Description:

The students will research gray infrastructure and green infrastructure.
The students will research the advantages and disadvantages of rainwater usage.

Procedures:

1. The students will research to determine the difference between green infrastructure and gray infrastructure. The students will complete an oral KWL.
2. The students will research the advantages and disadvantages of the integration of green and gray infrastructure. The class will engage in a large group discussion of the pros and cons of the groups' projects.
3. **Alternate or extension:** research use "Learning to Live With Less Water" to research water challenges. Write a summary of the research and submit for grade. ARTICLE SUMMARY RUBRIC
4. The students will find at least three articles that chronicle the advantages and disadvantages of rainwater usage and view the attached video→ LIFE OF A DROP
5. The students will discuss specific ways the rainwater is utilized based upon cost to benefit ratios.
6. The students will evaluate the types of rainwater harvesting equipment.
7. The students will evaluate how the rainwater harvesting equipment functions in collecting the rainwater. A Rain Barrel System
8. **Alternative or extension:** the student groups may investigate how to build the best rain gauge. Water related projects RAIN GAUGE

To help students organize their research, they will use a T Chart Template: Free Download when finding the advantages and disadvantages. The students can use a chart to show the distinguishing features of the distinguishing features of the various types of rainwater collections systems.

EXPLANATION

Brief Description: The students will in small groups and as a large group discuss the information they have learned.

Procedures: The students may choose or be assigned a group to share out all the information they have gathered during their research. As a group the students will create a media presentation (PowerPoint, Google slides, brochure, newsletter, etc.) to share out the research that they have gathered to the class. The class (with input from the teacher) will discuss each group's information discussing the pros and cons then use the shared information to make their project idea decisions or recommendations. Presentation Rubric

ELABORATION

Brief Description: The students will in groups or as individuals build or propose a model for rainwater collection and defend their idea.
The students will as a class or classes implement or recommend the agreed upon design(s).

Procedures: The students will be assigned to work groups whose mission it is to take all the information they have learned and gotten from the experts who have spoken and come up with an "original" design to collect, use, monitor or track rainwater on their school campus. This part could be viewed as a competition, fair or panel presentation. The goal is for one no more than three design ideas be agreed upon for a class or classes to build or recommend.

Alternate activities: These would serve as a way to learn about rain water and resources if a class chooses not to build the rainwater system project.PROJECT CHOICE RESOURCE
Using the design(s) determined by the class or classes from the various models or design ideas. The class or classes will develop a template or actual system to collect and use rainwater from the designs proposed. The agreed upon design will be constructed or recommended for construction.
Alternative or extension: the student groups may build the best rain gauge as they determine it to be. RAIN GAUGE
Alternative or extension: The students will conduct a laboratory activity related to rain water, LIMESTONE LAB and a water transfer lab WATER TRANSFER LAB

EVALUATION

Brief Description: A combination of students, parents, administration, experts and community partners will evaluate the rainwater collection system or proposal for sustainability and viability, and cost effectiveness. .

Audience for presentation: Students, parents, administration, experts and community partners

Procedures: Led by the original expert speakers the constructed or recommended project. The class(es) will test their system or setup. Or they may provide data to support their recommendations of a system or a setup. Summary of article will be evaluated using the rubric. The lab exercises will be evaluated from their lab reports. Most of this unit can be done *virtually* with the exception of the building of the systems and the labs. These labs may be substituted for **virtual simulations. Fluid Simulation Lab Fluid Simulation Activity**

REFERENCES

- Green Infrastructure: How to Manage Water in a Sustainable Way | NRDC
- Green Infrastructure
- What is Green Infrastructure? | US EPA
- Why You Should Consider Green Stormwater Infrastructure for Your Community | US EPA
- The Many Benefits and Advantages of Rainwater Harvesting
- Rainwater Harvesting: Advantages, Disadvantages, Uses and Techniques - Conserve Energy Future

- Uses of Rainwater Harvesting | The Renewable Energy Hub
- Learn more about rainwater
- Life as a Drop
- A Rain Barrel System
- How to Build a Rain Gauge
- HOME DEPOT
- Rain Garden/Barrel
- EPA Lesson Plans-Rainwater