SAN MATEO COUNTY Sustainability Department

Building a Landfill - 5E Teacher Guide

GRADE BAND: 6-8

LAST UPDATED JULY 2020

This lesson was adapted from: Wake County Environmental Services, Solid Waste Management Division, Raleigh, NC

Standards and Topic Connections:

One Planet Topic	Standards: Next Generation Science	Environmental Principles and Concepts (EP&Cs)
Consumption and Waste	**Performance Expectations (PE) and Disciplinary Core Ideas (DCI)**	**Principle IV**
	MS-ESS3-4 Earth and Human Activity: **Construct an argument supported by evidence** for how increases in human populations and per-capita consumption of natural resources impact Earth's MS-ESS3.C: Human Impacts on Earth Systems: **Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species**. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	 The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Purpose / Learning Objectives:

- Every student will be able to demonstrate understanding of the landfill layers concept by building a landfill model.

Driving / Essential Question(s):

- Why does every landfill need layers to function?
- How does each layer in a landfill help the landfill do its job?

Lesson Terms / Academic Vocabulary:

Waste	Waste is defined as any item which is discarded after its primary use, or is deemed worthless, defective or of no use.
Garbage	Garbage is defined as waste that is sent to a landfill and items that never break down or will be used again.
Compost	Compost is defined as waste that is made of organic material that can be added to soil to help plants

	grow. Examples: Yard trimmings and food scraps.
Recycle	Recycle is defined as waste items that can be melted down and reformed into new items of the same material. Examples: Plastic items and metal items.
Rot	Rot is defined as the process in which organic waste items (compost) are breaking down into the basic nutrients soil needs to make plants grow.
Environment	The air, water, soil, minerals, organisms, and all other factors surrounding an organism.
Raw Materials	Raw materials are defined as the basic materials that are used to produce goods, finished products, energy, or intermediate products that are needed for finished products. Examples:
Natural Resources	Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain. Examples of natural resources: water, air, coal, oil, natural gas, phosphorus, iron, other minerals.
Renewable Resource	A renewable resource is a natural resource which will replenish to replace the depleted portion by consumption or usage. Examples: forests of trees grow back over time but cannot always keep up with the level of consumption by the human race.
Non-renewable Resource	A non-renewable resource is a natural resource that does not replenish to replace the depleted portion after consumption or usage.
Groundwater	Water that is running beneath the earth's surface that feeds wells and springs
Compacted Clay	A thick layer of clay that acts as a barrier to prevent liquids in the landfill from coming in contact with the groundwater. Clay is a soil type that is resistant to water moving through it.
Liner	A thick layer of plastic that serves as a barrier to keep trash and liquids from coming in contact with soil and groundwater below.
Leachate Collection Pipes	Leachate is any liquid produced as trash settles. It must be collected through pipes in this layer of the landfill and is sent to be treated to remove any hazardous chemicals
Geo-textile Mat	This layer consists of a mixture of gravel and other synthetic/fabric like materials that help drain liquids from the landfill.
Drainage	Drainage described the natural or manmade removal of a surface's water.
Soil	Soil is the ground that has the nutrients that living things need to survive, especially plants. Soil is a mixture of minerals, water, air and organic matter.
Garbage	Any waste item that cannot be reused, recycled or breaks down over time into natural materials through compost/rot.
Vegetation	Another term to describe plants such as grasses that are planted on top of a landfill. The vegetation you usually see as a landfill has to have shallow roots, resulting in many types of grasses being planted and not many trees or larger plants that need deep roots to survive.

Materials / Technology:

Please **repurpose or reuse** the materials you would normally sort into the recycling bin for this activity

- Clean, empty 2-liter bottles (one per student)
- Blue and brown colored scraps of material
- Cardboard
- Plastic grocery bags

- Packaging peanuts
- Construction paper
- Straws

Agenda / Activities:

5E Model - *Engage, Explore, Explain, Extend/Elaborate, Evaluate*	
(15 min)	**Engage:** The purpose of this section is generate ideas about what students already know about landfills
Directions for Activity:	1.) Ask students: Where do things that are sorted in the garbage bin go after it leaves their house? a.) Trucks take it to the landfill 2.) Ask students: How does a landfill work? a.) A landfill has layers that help keep the items we place in the landfill in the landfill instead of flowing down into the ground. 3.) Ask students: Did you know every landfill has layers? Ask them to share in small groups what other things they know have layers. a.) Answers will vary 4.) Have students share out what other things have layers and how do the layers help that item do its job? a.) Layers in a cake allow for more flavor to be in each bite b.) Paper towels have layers to absorb wet messes better c.) Onions have layers to hide emotions 5.) Ask students why it is important to build landfills a special way a.) To keep the environment safe b.) To keep the trash contained in an area c.) To make it easy for trucks to dump trash at the landfill
(50 min)	**Explore/Explain:** Introduce the activity for today's lesson and create clear expectations for the students on how to complete the activity at home or in a virtual classroom.
Directions for Activity:	**1.** Arrange students into groups of four or five (or use this as an activity for an individual to do on their own) 2. Tell students they will be constructing a landfill in a bottle 3. Distribute materials to each group 4. Distribute "Follow-Along Worksheet" to each group 5. Students should read what the job of each layer is, find the material used to represent it, then place that layer into their 2-liter bottle landfill 6. Repeat this process until the landfill is completely assembled
(30 min)	**Extend/Elaborate:** Students can now show you what they learned from this activity.

	1. Ask students if they can identify a layer they think is particularly important to the landfill's job. Students can share out in small groups, written format as a reflection assignment or raise their hand to share in a classroom. 2. Based on the answers you get for this question, you may need to clarify the function of each layer and introduce landfill terms to the class to explain their ideas.
(20-30 min)	**Evaluate**: Students display their landfill and make a poster to educate
	1. Have students take their landfills home and display them somewhere that their families can see. 2. Instruct students to create an "answer key" or educational tool of sorts to have displayed near their landfill to help others understand the display. a. In the display it should include in the students' own words what each layer does to help the landfill function. 3. Students can send a picture or create a short video showing their display/art exhibit to show the teacher that they did the activity and what they learned from making the educational tool to explain what was made.

Furthering the Lesson:

Edible Landfill Activity:
This can be made in a large baking or serving dish for your family! Make individual servings in small cups can make a large amount of waste so we'd like to keep that waste low during this lesson extension. If you use ice cream, have students examine the bottom of the container to see if the "liner" is functioning properly. If so, the cookies will remain dry.

Groundwater	Blue tablecloth
Clay	Sandwich cookie half with filling
Liner	Fruit leather
Leachate Pipes	Licorice pieces
Drainage Layer and GeoText. Mat	Graham crackers
Soil	Sandwich cookie half with filling
Garbage	Candy pieces or ice cream
Vegetation	Cool whip or green sprinkles

ZERO WASTE EDUCATION – OOS SCHOOLS PROGRAM

Build a Landfill

SAN MATEO COUNTY Sustainability Department

Background: Humans have always had to think about what to do or where to put the waste we create. What happens when we can't reuse, recycle or compost our waste? In the early 1900s, people would burn their trash at home or dump it in open areas around their towns. By the 1960s, cities decided that one way to deal with these informal "open dumps" was to create "sanitary landfills." Why did engineers think that it was important to build landfills in a special way? New landfill standards aimed to protect groundwater, reduce runoff pollution and permanently contain the waste created by town and city residents.

Lesson: In this lesson, you will build a model landfill. You will then use it to demonstrate your understanding of the landfill layers concept used by landfill engineers around the United States.

1. Before you begin, read the following table of considerations that engineers must examine when constructing a landfill and each consideration's definition or purpose. Answer the prompts to the right.

Consideration	What it is/does.	**Answer or Predict:**
Groundwater	Freshwater running beneath the earth's surface that feeds wells and springs.	**How might landfills contaminate groundwater?**
Soil Type	There are 3 main soil types: sand, silt and clay. Each soil type has different qualities that allow life to thrive or struggle. Clay soil is important for landfill engineers because it is resistant to water moving through it.	**Why do you think soil type is an important consideration when engineering a landfill?**
Liners	Liners are made of thick, impermeable plastic.	**Make a prediction on how you think liners are used in a landfill.**
Leachate	Leachate is the liquid that settles at the bottom of a landfill. This liquid comes from a combination of the liquids in the garbage itself and rainwater that comes into contact with the garbage in the landfill	**Make a prediction on how leachate must be removed and treated so that it does not contaminate groundwater.**
Garbage	In a municipal landfill, garbage is any waste that comes from households and businesses. It should not include hazardous waste such as batteries, hazardous liquids or medical waste.	**Garbage is bulky and has a lot of air space in between all the different items. Make a prediction on how landfill operators remove all the extra air space in a garbage heap.**
Vegetation	Plants placed on top of a closed landfill heap.	**Why are grasses favored over trees as landfill vegetation?**

2. Gather as many of the following materials as you can:

- A clean, empty 2-liter bottle
- Craft foam sheets. If you don't have these, you can substitute cardboard.
- 1 or 2 plastic straws
- 1 plastic bag, to cut up and make layers from
- Small garbage items (This is a model, so you will have to break your garbage material down into small pieces.)
- About a cup of small rocks, washed and rinsed clean
- Food coloring or a tea bag (to color water)

When gathering supplies, reuse or find recyclable materials from your home. Get creative and write your own key for the items you find in your home to represent each layer:

Clay	
Liner	
Leachate Pipes	
Soil	
Vegetation	

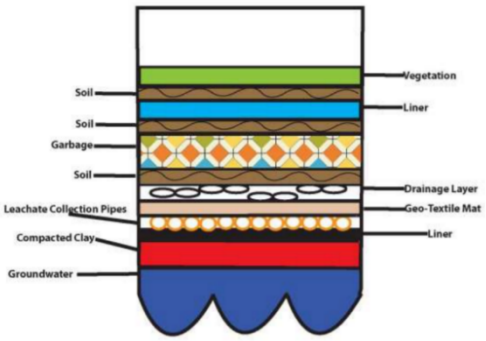
3. Now you will build a model landfill. Your goal will be to protect the groundwater underneath all the landfill layers. Here are some preliminary steps, but mainly you will use your materials and ingenuity!

A. Carefully cut the top of your two liter bottle off so it looks like the shape below.

B. Add about ¼ cup of water to the bottom of the bottle. This will be your groundwater. Place rocks in your groundwater to make it easier to build on.

C. Now you will begin to add layers corresponding to the different materials that are needed to construct a landfill. You'll notice that your first challenge is to keep your first layer from touching the groundwater.

D. Your next challenge is to use as many of the landfill elements as possible and to keep your groundwater clean. On a separate piece of paper, make sure to draw and label your finished landfill. Example:



E. Once your layers are complete, your last step will be to simulate rain by spraying or sprinkling about a ¼ - ½ cup of stained or colored water onto the top of your landfill model. Record your observations.

Image Source: Wake County Environmental Services

Finish your landfill investigation by answering the following questions:

1. Were you able to keep your groundwater clean? If yes, what strategies do you think helped your groundwater stay clean? If no, describe what you think happened.

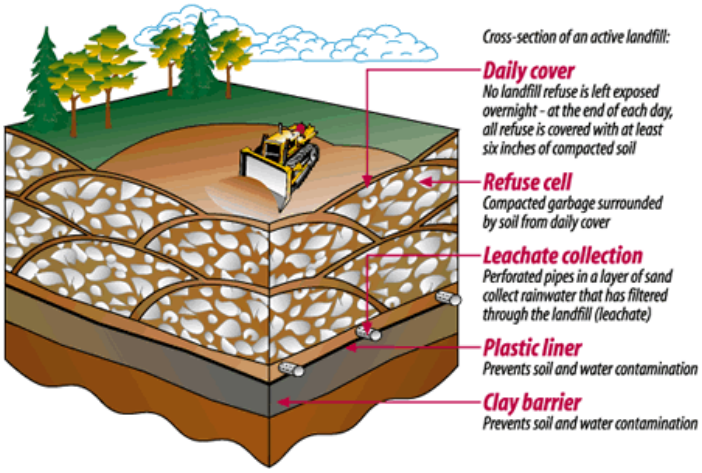


Image Source: teachengineering.com

2. Why are soil types an important consideration when constructing landfills? How does clay soil affect the movement of water in a landfill? Besides soil, what other factors are affecting the movement of water in a landfill?

3. What other daily and yearly considerations do landfill operators have to be prepared for when operating a landfill?

4. In the real world, what do you think happens to all the layers in a landfill over time? If we could slice through a landfill like a cake and look at the layers, would the layers look the same in 50 years? 100 years? 500 years?

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Example “Repurposed Materials Only” Landfill