

# Build a Model Landfill

## *Science + Engineering*

Work as an engineer in this two-part activity to build and observe model landfills you will make using plastic bottles. You will understand the processes of landfills as a waste-disposal method, as well as how methane can be captured from organic waste and used as a source of renewable energy.

### **Science & Engineering Connection:**

As organic waste (for example, food and food scraps) in landfills decays, it emits the gas methane, which is harmful to the Earth's atmosphere. Engineers can design and build facilities to capture the methane, then purify it into renewable natural gas (RNG) so it can be used as a clean, renewable energy and fuel in place of natural gas.

### **Learning Objectives:**

After this two-part activity, you will be able to:

- Build a model of a landfill.
- Make predictions and observations of a model landfill over a four-day period.
- Describe the role of engineers in landfill management.

### ***Educational Standards:***

International Technology and Engineering Educators Association - Technology:

- Explain why responsible use of technology requires sustainable management of resources (Grades 3 - 5).

Next Generation Science Standards:

- Develop a model to describe the movement of matter among plants, animals, decomposers and the environment (Grades 3-5).

### **Materials - Activity Part 1:**

- 2-liter plastic beverage bottle
- 1 standard party balloon
- ½ cup raw ground beef
- 2 lettuce leaves, torn into small pieces
- 2 tbsp. sand, such as playground or landscaping sand
- 2 tbsp. water
- Small length of string of any type, to tie around bottle opening
- 3-4 inches of duct tape, to secure balloon around bottle opening

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## Materials - Activity Part 2:

- 2-liter plastic beverage bottle
- 1 tennis ball-sized mound of modeling clay (enough to line the inside of the top half of the 2-liter bottle)
- 3 cups of soil
- $\frac{3}{4}$  cup water
- $\frac{1}{2}$  sheet of paper, torn into small pieces
- 2 lettuce leaves, torn into small pieces
- 1 apple, cut into small pieces
- 2-3 plastic food containers (like yogurt), cut into small pieces about  $\frac{1}{2}$  inch square
- 2 pairs of rubber or latex gloves
- 2 spoons or popsicle sticks
- Measuring cups: 1,  $\frac{1}{2}$  and  $\frac{1}{4}$  cups
- 4 inches of masking tape, for labeling

## Introduction - About Landfills:

Our garbage eventually ends up in a landfill—basically, a huge, layered pile of waste. Modern-day landfills are generally lined with clay or plastic to prevent the leakage of toxic substances into the groundwater and soil. One way engineers work with solid waste is to improve the effectiveness of landfill liners.

As organic waste decays in landfills it emits methane gas, which is harmful to the Earth's atmosphere. Modern landfills can be designed in a way to capture and collect the methane gas that is produced. Often, elaborate pipe systems are designed by engineers and installed between the garbage layers. When methane is captured before it escapes into the atmosphere, it can be processed into renewable natural gas (RNG), a clean form of energy that can be used as energy in homes and offices, and as a fuel for vehicles. Engineers are exploring better ways to collect the methane and more efficient ways to use it to produce energy (for homes, industry, etc.). In this experiment, we'll act as if we are engineers and build model landfills. We will add garbage to our landfill models and observe what happens as they are affected by rain, sun and the passage of time.

## Activity - Part 1:

### Before starting:

- Wash each bottle and leave it to air dry, saving the caps. You will use them again in Part 2 of the activity. Cut each 2-liter bottle in half horizontally (keep the top section slightly larger). Twist the caps on securely (even over-tighten them if possible).
- Pick a location to keep the model landfills during the observation period. Choose a place that receives sunlight, but where the odor will not be bothersome.
- Mix the food (lettuce and apples), the paper, and the plastic together into a "garbage" sample.



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## Activity - Part 1 (cont'd):

1. Place about 10 g of raw ground beef and the 2 lettuce leaves (torn into small pieces) into a cut-off plastic 2-liter bottle. Note: Be sure to wear your gloves and wash your hands when this part is over!
2. Carefully pour the sand into the bottle so that it covers the lettuce and meat. (Do not shake the bottle!)
3. Slowly pour the water into the bottle. Make sure the water runs down the side of the bottle instead of directly onto the sand/lettuce/meat layers.
4. Stretch the neck of the balloon tightly over the mouth of the bottle and secure it with the string and duct tape. (It will need to stay secure for 2-3 days.)
5. Make predictions about what you think will happen in the experiment. Write down your predictions.
6. Put the bottle in a warm location where you can observe it for 3 days. Remember that an observation is anything that stands out as important.
7. Discuss/ think about your observations. (Possible observations: The material at the bottom of the bottle has begun to decay; methane gas forms during decomposition; the methane gas inflated the balloon.)



Figure 1:  
Model landfill



Figure 2:  
Model landfill with balloon

## Activity - Part 2:

1. Gather your soil, approximately  $\frac{1}{2}$  cup of the "garbage" sample from Part 1 of the activity, water, 2-liter bottles, clay, gloves and masking tape.
2. Write your name on the masking tape and place it on the top portion (the neck end of the bottle) of the 2-liter bottle.
3. Put on your latex/rubber gloves.
4. Line the inside of the top portion of the 2-liter bottle with clay, as in Figure 3. (Think about how this is similar to the clay and plastic liners used in modern landfills to prevent toxins from leaching into the ground water.)
5. Place the top portion of the 2-liter bottle upside down in the cut off bottom half of the bottle. (The bottom serves as a stand that will help keep the model upright.)
6. Place about 2 cups of the soil inside the clay-lined "landfill."
7. Spread the "garbage" sample on top of the soil (see Figure 4).
8. Sprinkle the remaining soil on top of the "garbage."
9. Sprinkle  $\frac{3}{4}$  cup water over your landfill. (The water simulates rain.)
10. Draw a picture of your landfill - be sure to include, and label, the plastic liner, clay liner, soil and garbage.



Figure 3:  
Clay-lined model landfill



Figure 4:  
Model landfill with garbage

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## Activity - Part 2 (cont'd):

1. Write down your predictions about what you think will happen with your landfill over the next 4 days.
2. Place your landfill in a location where it will get some sunlight yet where the odor will not be bothersome.
3. On day two, observe your landfills and write down observations. Think about what leaching is (in this case, a process where waste leaks into the soil/water as a result of rain or other moisture) and look for evidence of it in your.
4. Repeat the observation process on days 3 and 4. On day 3, sprinkle another  $\frac{3}{4}$  cup water over your landfill.
5. On day 5, you will do your final steps and observations.
6. Put on your rubber/latex gloves, then carefully remove the cap from the bottle and let the water drain into the bottom half of the 2-liter bottle. Write down your observations.
7. Use a spoon or popsicle stick to gently scrape back the top layer of dirt. What do you notice about the garbage in your landfill? Write down your observations.
8. Finally, describe what this experiment taught you about landfills. Were any of your predictions correct?

## Safety Notes:

- Be sure to always wear gloves when handling the materials in this activity and don't touch any of the organic and waste with your bare hands because of bacterial growth.
- Be sure to open the balloon from Part 1 of the activity in a well-ventilated place before disposing of it.

*This activity was originally designed by the College of Engineering at the University of Colorado Boulder.*