

# LESSON 2: Away to the Landfill

## LESSON'S CONCEPTS

- Solid wastes are made from a variety of natural resources. Once these wastes are placed in a landfill, they are no longer available to be reused or recycled, and the natural resources used to make them are wasted.
- Landfills are the most common sites used for waste disposal.
- Landfills take up space and are located in areas that are, or once were, habitats for people, wildlife, and other living things.
- Modern landfills are designed to protect the environment.

## PURPOSE

Students learn how landfills are constructed to protect the environment. They will conclude that once objects are placed in a landfill, these objects can no longer be used; and, therefore, the natural resources used to make the objects are wasted.

## OVERVIEW

In this lesson students will:

- Construct in a bottle a model of a landfill.
- List what goes into a landfill and determine what happens to the natural resources used in objects that end up in a landfill.
- Demonstrate that waste takes up space in a landfill and that some waste can be diverted from a landfill by being reused or recycled.
- Classify items in their models of landfills according to what can be reduced, reused, or recycled.
- Observe over time the changes occurring in the waste in their models of landfills.
- Analyze school waste that has been placed in a landfill.
- Discuss alternatives to putting school waste in a landfill.

## CORRELATIONS TO CALIFORNIA'S CONTENT STANDARDS AND FRAMEWORKS AND TO BENCHMARKS FOR SCIENCE LITERACY

- Students construct a landfill model in a bottle to learn how landfills are constructed to protect the environment.

- "(People) need to exercise judgment, care, and planning in their use of natural resources . . . and in their practices of disposing of wastewater and materials." (*Science Framework*, page 125)
- "Public landfills must be planned responsibly . . ." (*Science Framework*, page 97)
- "To develop geographic literacy, students must: . . . Understand human and environmental interaction." (*History–Social Science Framework*, page 16)
- Students categorize classroom waste items into those that can be reduced, reused, or recycled.
  - "Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . Students will classify objects . . . based on appropriate criteria . . ." (*Science Content Standards, Grades K–12; Grade 5; Investigation and Experimentation, Standard 6a*)
  - "Discarded products contribute to the problem of waste disposal. Sometimes it is possible to use the materials in them to make new products, but materials differ widely in the ease with which they can be recycled." (*Benchmarks for Science Literacy*, page 189)
- Students describe what they see when they go on an imaginary tour of a landfill. They discuss the pros and cons of landfills.

- "Students listen critically and respond appropriately to oral communication. They speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation." (*English–Language Arts Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, page 26)

### SCIENTIFIC THINKING PROCESSES

observing, communicating, ordering, classifying

### TIME

45–60 minutes to prepare; 60 minutes to implement the lesson; plus time to examine the contents of the landfill in a bottle one month later

### VOCABULARY

landfill

## PREPARATION

1. Read the "Background Information for the Teacher" at the end of this lesson.
2. Contact the waste manager or local recycling coordinator (check the telephone directory, or call the California Integrated Waste Management Board's Office of Integrated Education at (916) 341-6769 to get the phone number for your city's or county's solid waste department, which is often part of the Department of Public Works in your community). Ask for information about the nearest landfill. If possible, have the coordinator send you photographs of, and other information concerning, the landfill. Also, ask whether the coordinator is willing to come to speak about solid waste to the class or to set up a field trip.
3. If possible, arrange to take students to visit a local landfill or take slides or make a video of the landfill to show to the class.
4. Obtain the video, *Kids Talking Trash*, available from the California Integrated Waste Management Board.
5. Ask students to bring in a two-liter beverage container and a plastic grocery bag.
6. If needed, precut the two-liter bottles to prepare them for students to use. See "Procedure," section "B."
7. Make transparencies of "Construction of a Landfill in a Bottle" (page 267); "Layers in a Landfill in a Bottle" (page 268); "Diagram of a Landfill" (page 269); and "Waste Stream from Schools" (page 270)

## MATERIALS

- \_\_\_ A trash can of clean classroom waste
- \_\_\_ Plastic tarp or cloth sheet on which to spread out the waste
- \_\_\_ Piece of butcher paper on which to make a chart
- \_\_\_ A photograph, book, or video (e.g., *Kids Talkin' Trash*) that shows a landfill
- \_\_\_ Two rinsed two-liter beverage containers and caps for each pair of students
- \_\_\_ One plastic grocery bag for each pair of students
- \_\_\_ A one-gallon bucket of garden soil (Do not use sterilized potting soil.)
- \_\_\_ A one-gallon bucket of gravel
- \_\_\_ Scissors, tape, two rubber bands, and utility knives
- \_\_\_ Assorted small pieces of clean nonhazardous waste between one-half and one-inch long (e.g., pieces of apple cores, banana peels, bread pieces, leaves, aluminum foil, bottle caps, rubber bands, pennies, pieces of cloth, plastic toy, newspaper, copy paper, and plastic scraps) (Use some materials from the classroom's trash can.)
- \_\_\_ Clay soil (if necessary, garden soil mixed with clay to give the soil a clay-like texture); approximately one half-cup per two-liter beverage container
- \_\_\_ A pair of plastic or garden gloves for each pair of students
- \_\_\_ Transparencies of "Construction of a Landfill in a Bottle," "Layers in a Landfill in a Bottle," "Diagram of a Landfill," and "Waste Stream from Schools"

## PRE-ACTIVITY QUESTIONS

- A. Spread the garbage from the classroom trash can on a plastic tarp or cloth sheet for students to see. Ask students:

- What should we do with this waste or trash? *Throw it in a garbage can. Throw it away.*
  - What happens to our trash when we throw it in a garbage can? *The garbage company picks it up.*
  - After the garbage company picks it up, where is it taken? *To dump; to a landfill.*
- B.** Make a chart labeled “What Goes in a Garbage Can?” on a piece of butcher paper. Ask students what goes in a garbage can, and list their responses on the chart. Keep this chart to use at the end of this lesson.

### What Goes in a Garbage Can?

- |                           |                   |
|---------------------------|-------------------|
| • Paper                   | • Grass clippings |
| • Food scraps             | • Leaves          |
| • Tin cans                | • Old clothes     |
| • Candy wrappers          | • Aluminum cans   |
| • Gum wrapper             | • Diapers         |
| • Plastic food containers | • Styrofoam       |
| • Milk jugs               | • Broken toys     |

Submitted by Janet Cohen’s sixth-grade class, Gold Trail Elementary School, Gold Trail Union School District.

- C.** Have students complete the following sentence in their journals: “I put my garbage in a garbage can; then it goes . . .” Prompt students with the following questions:
1. What happens to the garbage after it is placed in a garbage can?
  2. Who moves it?
  3. How does it get in the garbage truck?
  4. Where does the garbage truck take it?
  5. What happens to the garbage then?
- D.** Ask students to share their journal entries.
- Discuss where most garbage ends up. *In a landfill.*
  - Ask whether anyone has seen a landfill and encourage students to describe one.
  - Show photographs, read sections of a book, or show a video about landfills.
- E.** If possible, have the local waste manager or recycling coordinator come and speak to your class.

**Note:** Keep the waste from the classroom and use some of it in the models of landfills.

Picture intentionally deleted.

Students from Valley Oak Elementary School look at garbage from a garbage can.

## PROCEDURE

- A.** Tell students that they will be building landfill models in bottles to learn more about the construction requirements for landfills. Provide two 2-liter bottles for each pair of students.
- B.** The following are directions for preparing the bottle for the landfill model in a bottle. To help you prepare the bottles, see “Construction of a Landfill in a Bottle” in this lesson. Cut two 2-liter bottles, as shown in the diagram:
- Cut Bottle B 9 inches from the cap. For safety, make an incision with the utility knife and then let the students cut around the bottles with scissors (for younger children, the 2-liter bottles will need to be precut). If the edges are jagged, trim them with scissors and place masking tape over them.
  - The base of Bottle A will be the base of the landfill.

## Trash In the Garbage Can?

I put my trash in a garbage can, then it goes into a bigger garbage can. Then I put it outside. Then garbage people come in a giant trash truck and they pick up the trash. The trash goes to a giant landfill and gets dumped. Sometimes they take stuff out like toys and recycle them. By Brooke

Kevin  
... at the landfill the garbage gets covered by soil and sits there for however long it takes to disintegrate under ground. Some garbage doesn't disintegrate, and it stays there a long time.

Submitted by Ed Malaret, fifth-grade teacher, Marguerite Hahn Elementary School, Cotati-Rohnert Park Unified School District.

- Leave the screw top on Bottle B.
  - Turn the top portion of Bottle B upside down and place it on top of the base.
  - After filling the landfill, you will place the top of Bottle A on top of the inverted Bottle B to form the cap.
  - Recycle the bottom portion of Bottle B.
  - Place a cup of gravel in the bottle to represent an aquifer. An *aquifer* consists of rock, sand, or gravel which stores groundwater.
  - Place  $\frac{1}{2}$  cup of soil (about 2 inches) on top of the gravel in the bottle to represent the ground.
- C. Show the transparency "Layers in a Landfill in a Bottle." Tell students that all new landfills require clay soil, a heavy (60 mil HDPE) plastic liner, gravel, and soil to be placed on the ground before waste is added. Note that in most new landfills and those that are being expanded, a geotextile cushion is placed above the plastic liner and below the crushed rock or gravel to keep the rocks from piercing the liner. A geotextile cushion

is a soft, waterproof, approximately  $\frac{1}{4}$ -inch thick material that looks like outdoor carpet. Some of these cushions have a layer of rigid plastic netting sandwiched between soft material. Sometimes a geotextile cushion is placed on top of the crushed rock or gravel to keep the soil from mixing with the rock. In some landfills, a geotextile cushion is also placed below the plastic liner. In this lesson the geotextile cushions were omitted in the landfill in a bottle to make it easier for the students to build the model.

- Have students place the following materials in the order listed:
    - A layer of clay soil about 1 inch high on top of the existing soil
    - A plastic liner over the clay soil
    - A layer of gravel over the liner
    - A layer of soil over the gravel
  - Ask students why they were asked to place clay soil, a plastic liner, gravel, and soil in the bottle before they added the waste. *To keep the waste from contaminating the soil.*
  - If needed, explain to students that when it rains, the water can go right through the landfill and mix with the waste. Then this polluted water can percolate through the soil and pollute the groundwater. So before the waste is dumped in a new landfill, a layer of clay soil, a liner of plastic, gravel, and more soil must be added. The clay soil and liner help to keep the water that seeped through the waste from reaching the groundwater. Some cities and counties are also expanding their landfills. All of these expansions require a layer of clay soil, a plastic liner, gravel, and additional soil to be placed before any waste is added.
- D. Provide clean pieces of waste to students. Ask students to:
- Record in their journals the type of waste they plan to place in their landfill models.
  - Place the pieces of waste on top of the soil, piling the waste about two inches high.
  - Cover the garbage with  $\frac{1}{2}$ -inch layer of soil (see "Layers in the Landfill in a Bottle").

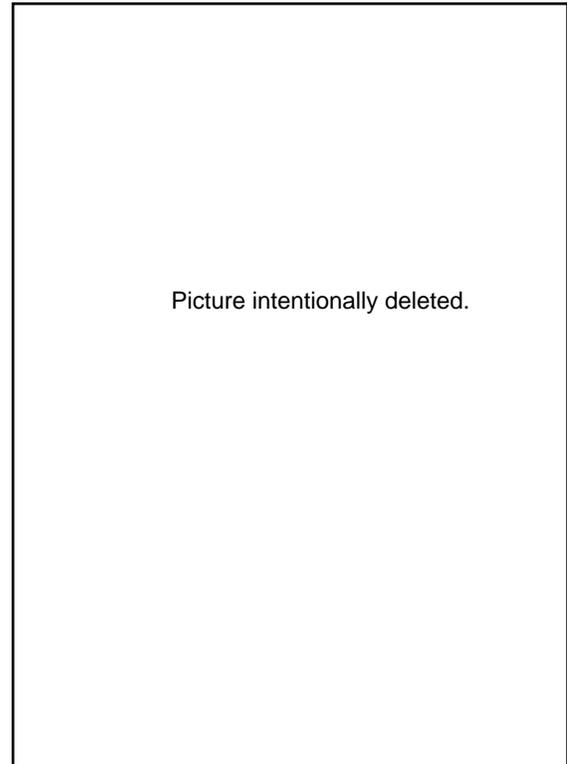
- Add a second layer of garbage and top it with a 1-inch layer of soil.
- E. Ask students why the garbage is covered with soil at the end of the day. *To keep garbage from being moved by the wind; to keep it from creating an odor; to keep animals away from it.*
- F. Ask students to predict how the garbage would change in four or more weeks.
- G. With the class, compile a list of items that were placed in the landfill. Have students identify natural resources from which each item was produced.
- H. Show the first part of the video *Kids Talking Trash*. Discuss what the video says about landfills.

**Homework Assignment:** Ask students to use descriptive words to name the landfill that they designed. They should also describe why they selected that name. (They should write more than “I liked the name.”)

- I. Ask students to share with the class the names they selected for their landfills.

## DISCUSSIONS/QUESTIONS

- A. Discuss with students:
- What is waste? *Anything that people don't want.*
  - Where do all the products we buy come from? *Natural resources.*
  - Where do all the products go when we no longer want them? *Mostly to landfills.*
  - When does an object become waste? *When it becomes spoiled, ruined, dirty, ugly, broken, old, no longer useful.* Make sure that students understand that once an object is thrown into a landfill, the object can no longer be used. The natural resources used to make the object end up in the landfill and are therefore wasted.
  - What is valuable? *Whatever you think is important.* When does a new thing lose its value? *When someone who has it doesn't want it anymore; when it breaks or becomes soiled; when it gets old.*
  - What can be done with things we no longer want, instead of throwing them into a trash can? *They can be given to someone else; reused; made into something else; recycled.*



Students from Nona Reimer's fifth-grade class at John Malcom Elementary School construct a model landfill in a bottle.

- Do you think landfills are a good idea? *Yes/No* If students say yes, ask them to explain. *We need landfills—a place where items that can't be reused or recycled can be thrown away.* If students say no, ask them what the alternative is. Where will people put their garbage? *They can recycle it or reuse it. They can try not to make garbage.* Can everything be either reused or recycled? *No.*
  - Would most people want a landfill built next door to their homes? Why or why not? Where do we find areas for landfills? *Usually in areas where people do not live.* What is usually present in these areas? *Plants, animals, ecosystems.*
  - Consider the distance that garbage trucks will need to travel to get to a landfill. What natural resources do trucks use to transport trash? *Fossil fuels.*
- B. Discuss as a class the pros and cons of placing waste in landfills.
- Some pros to putting waste in landfills are listed below:
    - Garbage needs to go somewhere, and a landfill can handle large

amounts of waste, keeping it away from where people live.

- Placing garbage in a landfill is an easy way to dispose of unwanted items.
- The garbage is better contained in a landfill.
- The landfill keeps other places waste-free.
- A landfill can be designed to protect the environment.
- Some cons to landfills are listed below:
  - A landfill takes up space where an ecosystem existed and makes it impossible for people and wildlife to use the land.
  - A landfill is ugly.
  - Heavy equipment working in a landfill create noise and dust.
  - A landfill might pollute groundwater.
  - Landfills can create unpleasant odors and attract insects and rodents.
  - Materials that end up in a landfill are usually no longer available for people to use.

**Note:** If some concepts about landfills are not familiar to your students, you may want to introduce them briefly at this point or cover them in other lessons.

## APPLICATION

- A. Project the transparency of a “Diagram of a Landfill.” Ask students to compare their landfills in bottles to the diagram of a landfill. Discuss what is similar and what is different.

**Note:** In the “Diagram of a Landfill,” a “geotextile cushion” is added between the crushed rock and the liner. This keeps the rocks from piercing the liner. Above the crushed rock, another geotextile cushion keeps the soil from mixing with the rock. In this lesson the geotextile cushions were omitted in the landfill in a bottle to make it easier for the students to build the model.

**Homework Assignment:** Ask students to select an object discarded in a trash can. Ask them to describe how the object was made, what natural resources were used to make the object, how this object was used, why it ended up in the trash, and what will happen to it now. They can write this from the object’s “point of view.”

- B. Ask students to share their homework assignments.
- C. Introduce students to the waste management hierarchy listed below. Explain to students that because of the energy savings and the amount of natural resources conserved, this hierarchy serves as a way of setting up priorities for dealing with waste.
1. Reducing and reusing
  2. Recycling and composting, including buying products made from recycled materials
  3. Environmentally safe transformation (waste to energy) and environmentally safe land disposal (landfilling)
- D. Ask students to focus on the chart, “What Goes in a Garbage Can?” developed at the beginning of this lesson. Ask students to tell you, as you circle items using different colored markers, which items on the chart could be reduced (i.e., used more sparingly in the first place), reused, or recycled. The chart can be used for reference, as a record of changes as the students learn more, and as an assessment tool.
- E. Project a transparency of “Waste Stream from Schools.” Ask students to look at the “Schools” column and to indicate what natural resources each came from. Then have them identify which could be reduced, reused, or recycled.

**Project Idea:** Have groups of students research the location of the landfill where their garbage goes and to identify any nearby streams or other bodies of water. Have them find the source of their community’s drinking water. If the landfill is not located in their community, have students find out the source of the drinking water of the community in which the landfill is located. Then discuss with students how the landfill might impact the community’s drinking water.

**Project Idea:** Have groups of students collect and analyze water samples of surface water surrounding a landfill. They should share their results with community members.

*At least four weeks later*

- A. Provide plastic or garden gloves to each pair of students and have them sort through their landfills. Discuss with students:
1. What was the condition of the items when they were removed from the

model landfills? Was anything rotting? Explain to students that garbage placed in landfills usually does not rot because there is not enough air and moisture to help things to decompose. (The topic of decomposition is addressed in the 4–6 Module, Unit 3.)

2. Was it easy to take the trash out of the students' landfills and to separate it? Would it be easy or difficult to try to separate the trash from a real landfill? What would be some problems? Explain to students that some communities have a materials recovery facility (MRF) where all types of garbage are separated before the non-recyclables are transported to a landfill. However, once the garbage has been covered with soil in a landfill, it is very difficult and would be very expensive to try to remove all the items that could be reused and recycled. Therefore, it is more efficient to separate the recyclable and usable materials before the trash is buried in the landfill.

**Note:** For more information and a lesson on MRFs, see the 4–6 Module, Unit 2, Lesson 8, and Appendix B–III.

3. What items in the models of landfills (including the containers themselves) should be reused, recycled, or put in a landfill after this lesson? For example, most communities recycle the

two-liter PETE bottles (polyethylene terephthalate); organic wastes, such as banana peels and leaves, can be composted/mulched; pennies can be reused; newspaper can be recycled/mulched; aluminum can be recycled; cloth can be reused or, if made from cotton, silk, wool, or other all-natural fiber, can be mulched or composted.

- B. Keep these models of landfills to use in the 4–6 Module, Unit 4, Lesson 2, when students will learn more about leachate and what household waste should not go into a garbage can and end up in a landfill.

### FIELD TRIP

Take students on a field trip to see their local landfill, transfer station, or MRF. If your community has a transfer station, explain to students its purpose. A transfer station is a place that is usually located closer to residential and commercial areas than a landfill. Waste is temporarily stored there and then loaded on large trucks and hauled to the landfill.

If a field trip is not possible, consider taking slides or making a video of the landfill and show these to the class; or invite the local waste manager or recycling coordinator to visit the class and bring slides or a video of the landfill.

When observing a landfill, students should realize that it would be quite difficult to separate trash once it is placed in the landfill.



A landfill in Sonoma County.



A landfill in Sonoma County. In the background the day's garbage is being covered with soil. In the foreground compost is available for sale.

## VARIATION

Have students weigh the garbage before they place it in their model landfills. Then once they have removed the garbage and separated it, have students calculate the total weight for items that could be reused, those that could be recycled, and those that need to be placed back in the landfill. This will indicate how much garbage, by weight, can be diverted. Trucks with garbage are weighed at the landfill and their drivers pay to dump their garbage, based on the weight of the garbage.

**Note:** In a landfill the volume of materials is more important than the weight, because it is the volume of garbage that takes up space. Have students figure out how they can measure the volume (i.e., how much space the garbage takes up) of their garbage.

## EXTENSIONS

- A. Ask students to make a map of current and former landfills in the community. Ask if they can think of reasons why landfills might be placed in certain areas (e.g., areas of low population, areas designated for industrial use) and what a landfill's impact might be on the surrounding community.
- B. Ask students to draw and label what they can do to keep more garbage out of the landfill.

## RESOURCES

### Videos

*Bill Nye the Science Guy: Garbage.* Elk Grove Village, Ill.: Disney Educational Products, 1995. (50 minutes)

In addition to other information about waste, Bill Nye shows that garbage usually does not decompose in a landfill.

*Garbage, Garbage, Garbage.* The Green Earth Club series. Produced by TV Ontario, 1992 (15 minutes). Chatsworth, Calif.: AIMS Media (distributor).

Shows a landfill site and explains what usually happens to garbage after it leaves our homes.

*It All Adds Up (Waste/Pollution).* The Outside Story with Slim Goodbody series. Produced by Agency for Instructional Technology (AIT) and the Slim Goodbody Company, 1991 (15 minutes).

Stresses the importance of dealing with waste responsibly and shows various ways in which humans dispose of waste. Encourages students to reduce, reuse, and recycle as much of the waste they create as possible.

*Kids Talkin' Trash.* San Leandro, Calif.: Alameda County Waste Management Authority, 1995 (14 minutes). Sacramento: California Integrated Waste Management Board (distributor).

Students learn how to make less garbage and protect the environment by practicing the four R's: reduce, reuse, recycle, and rot. Shows a landfill.

### Books

Amos, Janine. *Waste and Recycling.* Chatham, N.J.: Raintree, 1992.

Discusses what waste is and how it can be recycled.

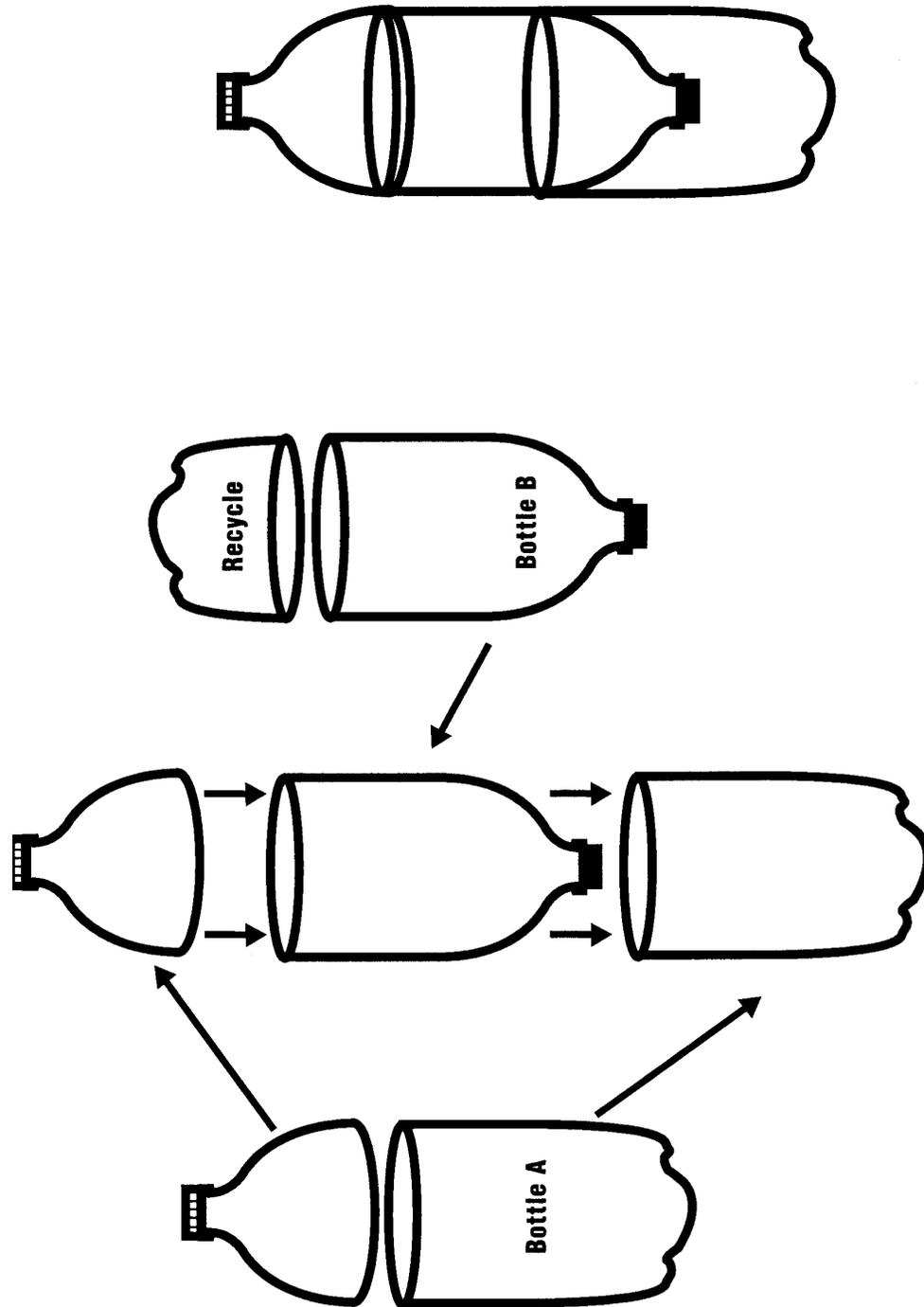
Bottle Biology Resources Network. "Compost Column." Madison: University of Wisconsin, March 1990.

### Website

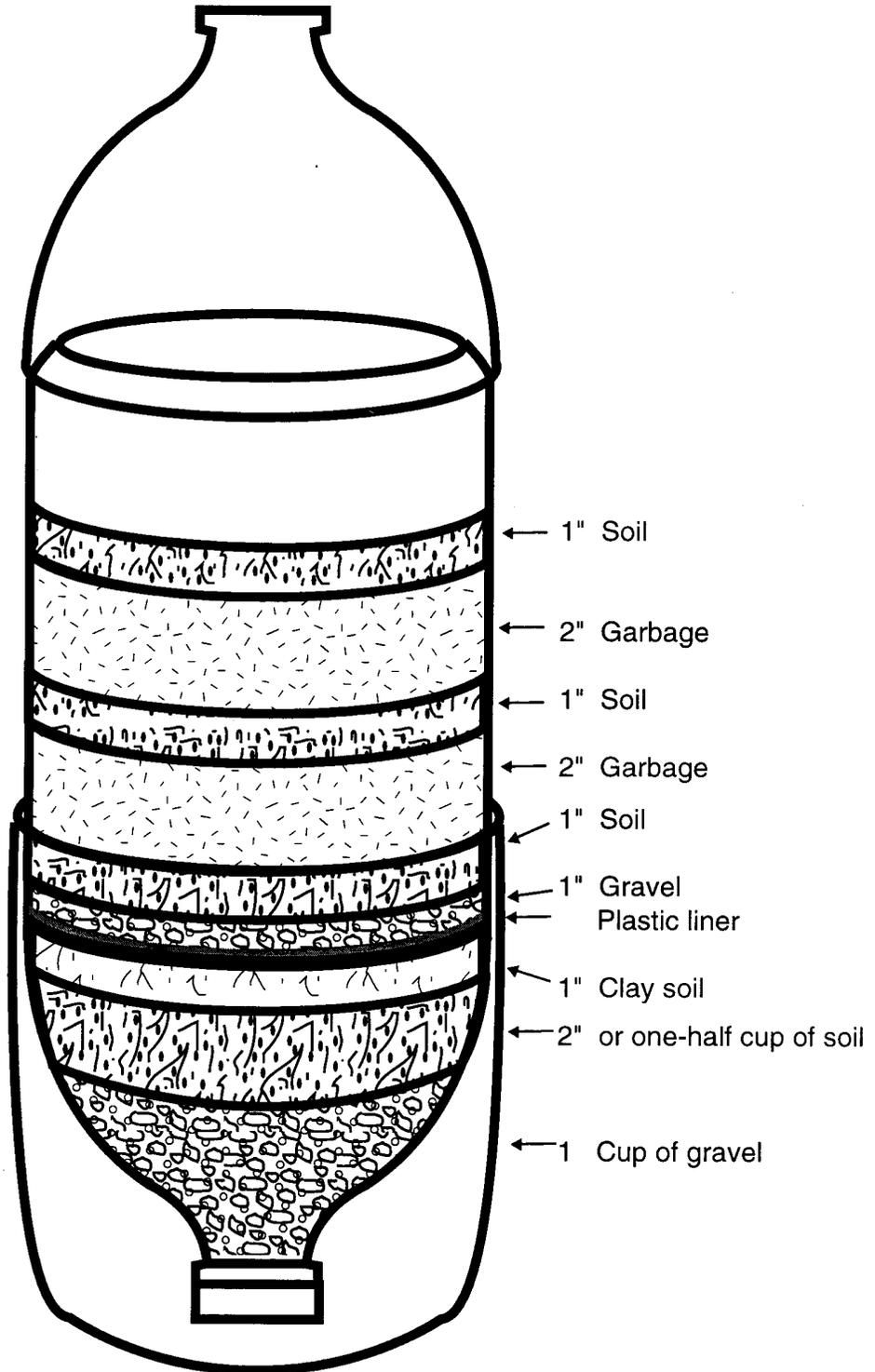
See "Appendix F-III, Landfill websites."

Transparency

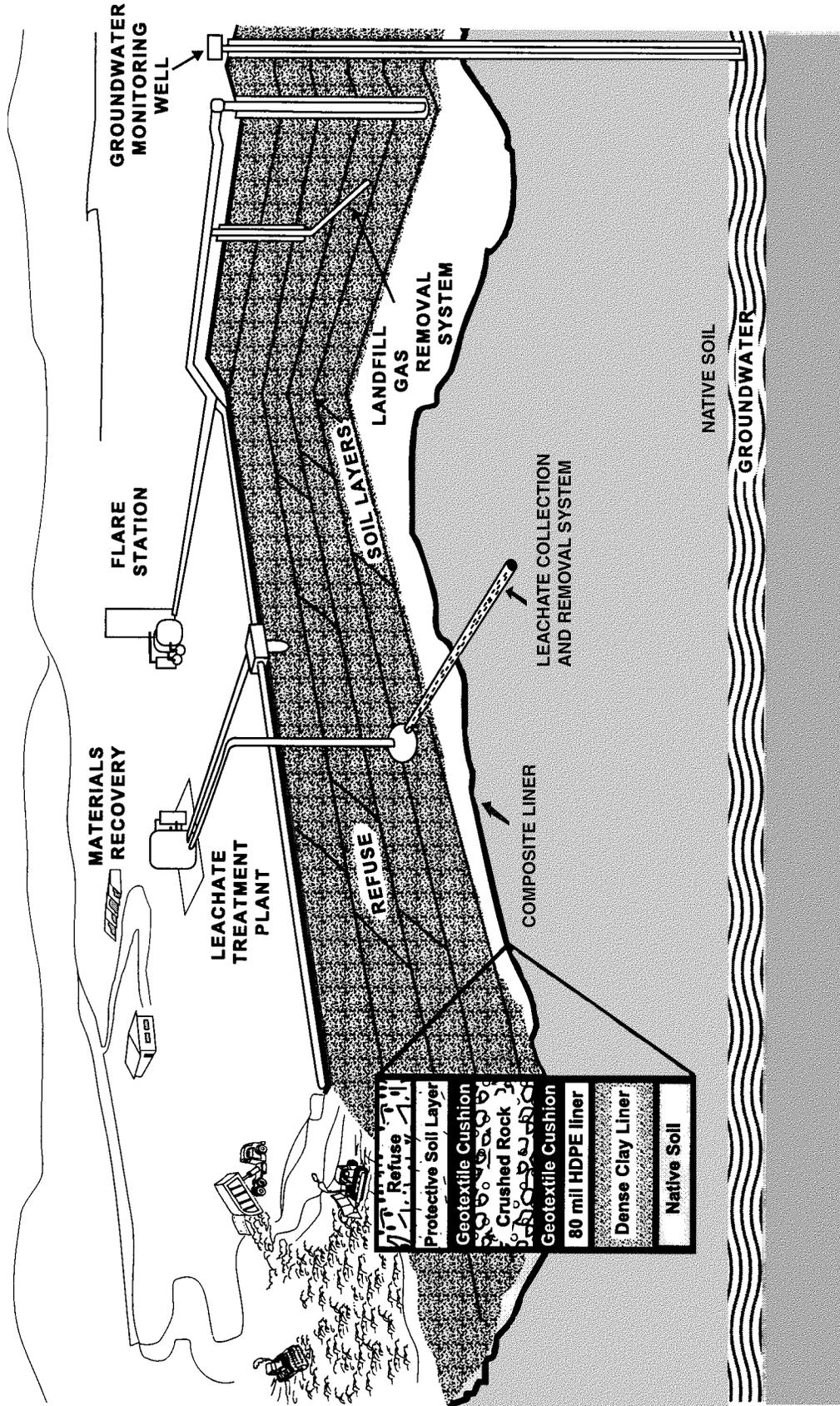
# CONSTRUCTION OF A LANDFILL IN A BOTTLE



# LAYERS IN A LANDFILL IN A BOTTLE



# DIAGRAM OF A LANDFILL



# WASTE STREAM FROM SCHOOLS<sup>1</sup>

Material	Schools' waste (percent by composition)	Major category of natural resources used to make this product.	Can this item be reduced, reused, recycled, composted?
<i>For example:</i>		<i>plants</i>	<i>reused</i>
<b>PAPER</b>	total: 53.9%		
Corrugated/Kraft	2.2%		
Newspaper	0.6%		
Office paper	1.9%		
Mixed paper	16.2%		
Other	33.0%		
<b>GLASS</b>	total: 1.1%		
Clear bottles/containers	1.0%		
<b>METAL</b>	total: 2.6%		
Ferrous metals	0.9%		
Nonferrous metals	0.3%		
Other	1.4%		
<b>PLASTIC</b>	total: 11.9%		
HDPE	0.6%		
PET	0.2%		
Film plastic	7.4%		
Other plastic	2.7%		
Other	1.0%		
<b>OTHER ORGANIC</b>	total: 26.8%		
Food	22.9%		
Yard/landscape	3.5%		
Other	0.4%		
<b>OTHER INORGANIC</b>	0.5%		
<b>HOUSEHOLD HAZARDOUS WASTE</b>	2.6%		
<b>MIXED RESIDUE</b>	0.5%		

<sup>1</sup>City of Los Angeles 1995 Waste Composition Sampling Table 4-9, "Disposal Composition for Education–Public Primary/Secondary Target."

# BACKGROUND INFORMATION FOR THE TEACHER

In 1997 Californians generated approximately 52.5 million tons of garbage. Only 32 percent of the discarded materials were recycled and composted.<sup>2</sup> The rest of the discarded materials were thrown “away.” But where is this “away”? For most people in California, “away” is the landfill where, in 1997, 68 percent of the waste (including some discarded materials that could have been reused or recycled) was dumped. But the discarded materials in a landfill do not go away. They occupy space in the landfill. Materials buried in a landfill decompose slowly, because the conditions are not ideal for rapid decomposition by decomposers, many of which need oxygen and moisture. (For more information about decomposers, see the 4–6 Module, Unit 3, Lesson 2.) Note that some decomposers, such as anaerobic (those that do not need oxygen) bacteria also decompose garbage in a landfill. Some drier parts of a landfill are “mummified” for awhile, but as time goes by moisture in the site moves around to different locations and decomposition takes place. What takes five or ten years in a wet landfill to decompose might take 30 to 50 years in a dry landfill site.<sup>3</sup>

A landfill is not the best place for garbage that can be reduced, reused, or recycled. Instead of reusing objects or using waste materials to make new products, some communities bury waste materials in landfills, and they are potentially lost to those communities forever. Furthermore, all of the natural resources and energy used to make the items that are now in a landfill are wasted and are no longer available to people and other living things. Unburying and separating items for reuse or recycling would be cost-prohibitive at this time.

In addition, large areas of land are used for landfills. These areas were once ecosystems, providing habitats for wildlife and plant life. Also, people could have used the areas for a variety of purposes, such as parks or home sites.

However, landfills are essential, because people need a place to put their garbage where it will

<sup>2</sup>“Estimated California Waste Tonnages and Diversion Rates.” Information sheet. Sacramento: California Integrated Waste Management Board, November, 1998.

<sup>3</sup>Written communication from Joe Haworth, Information Officer, County Sanitation Districts of Los Angeles County, October 22, 1998.

be contained and kept from contaminating the environment. Landfills are required by law to incorporate special design features to protect the environment. For example, the landfill operators must conduct methane monitoring to ensure that gases given off by the decaying garbage do not become a health risk or pollute the environment. The methane gas can be collected at a landfill and is often used as a source of energy.

Another landfill feature that helps to protect the environment is the use of an impervious clay layer and a synthetic plastic membrane at the landfill site. A geotextile cushion, crushed rock, another layer of cushion, and soil are placed on top on the plastic membrane before refuse is added. Sometimes a cushion is also placed below the plastic membrane. These features keep the potentially hazardous liquid, called leachate, which accumulates when rainwater leaches through the garbage, from contaminating groundwater.

Leachate can run off from the landfill and contaminate streams and other surface waters. If leachate from a landfill seeps down and reaches the water table, it can contaminate groundwater. With over half of all Americans dependent on groundwater for their drinking water, contaminated groundwater constitutes a significant problem. Therefore, landfill operators are required to install a leachate collection system to collect and remove the leachate that gathers at the base of the landfill. The groundwater and surrounding surface waters must be regularly monitored for contaminants from the landfill. (More information on leachate and its hazards to groundwater is provided in the “Background Information for the Teacher” in the 4–6 Module, Unit 4, Lesson 2. Also, see “Appendix B–IV, Landfill Issues.”)

Every day dump trucks deliver tons of garbage and discarded materials to landfills. Throughout the day the garbage is compacted with heavy machines. A layer of soil is placed over the garbage to keep it from creating foul odors and to keep animals, including insects, from getting into the garbage and spreading it around. Landfill operators will sometimes use a substitute cover if soil is hard to find. This substitute material may be ground or chipped old tires, green waste, or special woven tarps made from plastic.

Once landfill sites have reached capacity, they must be capped (closed with layers of clay and

soil) and monitored. Such sites are often landscaped and used for parks, golf courses, hiking and equestrian trails, and open spaces. Some problems have resulted from the buildup of explosive methane gas and the settling of buried trash. Engineers and scientists are working on ways to make these sites safe for people and wildlife.

The California Integrated Waste Management Board (CIWMB) is responsible for implementing the Integrated Waste Management Act (AB 939), which is a comprehensive set of laws, passed in 1989, designed to address California's solid waste problems and lessen the demand on natural resources. Students can help to reduce solid waste through reducing, reusing, recycling, and composting. For more information on waste management-related legislation, see "Appendix B-I, History of Waste Management."

The integrated waste management hierarchy promoted by the California Integrated Waste Management Board emphasizes the following priorities concerning products and packaging:

1. Reducing and reusing
2. Recycling and composting
3. Environmentally safe transformation (waste-to-energy) and environmentally safe land disposal (landfilling)

"Although there are not many waste-burning plants in California, there are two large waste-to-energy facilities in southern California. With the low price of electricity and the general opposition to burning things in California, there has been a deemphasis on waste-to-energy, but there are people whose communities use those plants—mainly the cities of Commerce and Long Beach."<sup>5</sup> For more information on waste-to-energy facilities, see "Appendix B-V, Incineration: Waste-to-Energy Facilities."

Understanding the role landfills play in managing our waste and their potential environmental impacts will enable us to use our natural resources in a more efficient manner.



The Ogden–Martin waste-to-energy facility receives four tons of garbage daily from the county of San Joaquin and the city of Modesto, which is deposited by 20-ton garbage trucks into the waste storage pit. The crane collects this garbage and feeds the two combustion units that generate 21.5 megawatts of electricity per hour. Photo courtesy of Ogden-Martin.