

Green Learning

Sixth Grade Teacher's Guide

Green Learning is an educational guide designed to help you meet SOL requirements while teaching important concepts about care of the environment to sixth grade students. As you read through the guide, you will see that it incorporates maps, articles, puzzles, and interactive class activities to teach concepts such as watershed education, pollution prevention, stormwater management, water conservation, resource management, and prevention of sanitary sewer overflows.

This teacher's guide includes suggested resources and additional educational activities, and identifies the SOLs met by each section of *Green Learning*.

Green Learning is provided for use by sixth grade students throughout Hampton Roads. It was created by askHRgreen.org, a public education and outreach program that encourages environmental stewardship among all residents here in southeastern Virginia. It is funded by the 16 cities and counties of Hampton Roads and administered through the Hampton Roads Planning District Commission (HRPDC). Members of askHRgreen.org include the cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg; the counties of Gloucester, Isle of Wight, James City, Southampton, Surry, and York; and the Hampton Roads Sanitation District (HRSD).

Green Learning and this teacher's guide are available online at askHRgreen.org/Green-Learning.

PAGE 2 – WHAT IS A WATERSHED?

SOLs: Science 6.7

Resources:

- Virginia Hydrologic Unit Explorer, Virginia Department of Conservation and Recreation: dswcapps.dcr.virginia.gov/htdocs/maps/HUExplorer.htm

- The Chesapeake Bay Watershed, Chesapeake Bay Program: chesapeakebay.net/discover/baywatershed

Activity:

Investigating Watersheds Using Fieldscope

This activity is from the Chesapeake Bay Program, gonzaga.org/NetCommunity/Document.Doc?id=2708.

The interactive map from National Geographic was designed to allow users to discover traits and features within their local Chesapeake Bay watershed. For schools not located within the

Chesapeake Bay watershed, it will be beneficial for the students to select an address within the watershed so that they may navigate around the map.

If your school is not within the Chesapeake Bay watershed, please visit the *Virginia Hydrologic Unit Explorer*, Virginia Department of Conservation and Recreation, dswcapps.dcr.virginia.gov/htdocs/maps/HUExplorer.htm. This map allows users to enter their address and identify their local watershed along with the rivers, streams, and lakes in the watershed.

Discussion:

Discuss the definition of a watershed: A watershed is an area of land that drains to a particular river, lake, bay, or other body of water. Watersheds are sometimes called “basins” or “drainage basins.”

Discuss with students that the United States Geological Survey created a system called the hydrologic unit code (HUC) to divide and categorize watersheds into smaller units. “Maps of these smaller regions within the watershed are helpful for scientists and land planners who need to study local environmental issues. ... Every school, house, and shopping mall in the watershed is part of a sub-region, sub-basin, and local watershed (National Geographic, Chesapeake Bay Field Scope).” The codes range from one digit (the largest level) to 12 digits (the finest sub-watershed level).

Discuss the factors that affect water quality in a watershed and how those factors can affect an ecosystem (factors are described on pages 3, 5, 7, 11-12, 16).

PAGE 3 – THE 411 ON TMDL

SOLs: Science 6.7

Resources:

- Total Maximum Daily Load, askHRgreen.org: askhrgreen.org/total-maximum-daily-load/
- Learn the Issues, Chesapeake Bay Program: chesapeakebay.net/issues
- The Chesapeake Bay, *The Washington Post*: washingtonpost.com/wp-srv/special/lifestyle/kidspost/chesapeake/index.html

Activity:

Bay in a Beaker: Mini-Bay Simulation

This activity demonstrates the affect fertilizer has on water quality.

Question for students: How does the amount of fertilizer and light affect the growth of algae in water?

Ask students to develop a hypothesis: If I increase the amount of fertilizer in water and decrease the amount of light, then the growth of algae will increase.

1. Fill four beakers or jars with 750 ml. of stream or pond water.
2. Weigh and then add 10 mg. of fertilizer to one beaker.

3. Weigh and add 25 mg. of fertilizer to the second beaker.
4. Add 10 mg. of fertilizer to a third beaker and completely cover it with aluminum foil (this is the control for the light).
5. Don't add anything to the fourth beaker (this is the control for the fertilizer).
6. Label and date each beaker.
7. Place all four beakers together on a sunny windowsill.
9. Record results.

Conclusion: Ask students to relate the water in the beakers to the water in our ponds, streams, and Chesapeake Bay. How could the abundance of algae affect submerged aquatic vegetation? How could it affect crabs, oysters, and fish? How do nutrients get into the Chesapeake Bay? Where do they come from? How can we reduce our inputs of nutrients to the Chesapeake Bay?

Discussion:

Discuss the vast land area the Chesapeake Bay Watershed covers and the diverse landscapes, animals, plants, and people in the watershed.

PAGE 4 – WATERSHED PUZZLER

SOLs: Science 6.7, English 6.4

Resources:

- Rivers and Streams, Chesapeake Bay

Program: chesapeakebay.net/issues/issue/rivers_and_streams

Activity:

Wetland in a Pan

This activity is from the Penn State College of Agricultural

Sciences: ecosystems.psu.edu/youth/sftrc/lesson-plans/water/6-8/wetland.

This activity covers three concepts:

- Wetlands act as a buffer zone between dry land and bodies of water.
- Destroying wetlands can cause serious flooding.
- Wetlands help trap excessive amounts of pollutants and silt.

Discussion:

Ask students to argue for and against commercially developing a parcel of land containing a large wetland area. Have students design and defend a land-use model that minimizes negative impacts.

PAGE 5 – STORMWATER POLLUTION

SOLs: Science 6.4, 6.5, 6.7, English 6.4

Resources:

- A Clean, Healthy Bay Starts at Home, askHRgreen.org: askhrgreen.org/a-clean-healthy-bay-starts-at-home/

- Learn the Issues, Chesapeake Bay Program: chesapeakebay.net/issues

Activity:

Schoolyard Cleanup

Hold a school yard cleanup with students. Engage staff and parents to build pride in the school. Visit askhrgreen.org/recycling-contacts/ to find contact information for your Clean Community Program Managers. Managers will be able to provide tips for organizing a cleanup.

Grade Your Schoolyard

With this activity students will walk around the schoolyard to evaluate and make recommendations about water conservation and protection. If you would like to contact your local stormwater department, please visit www.askhrgreen.org/stormwater-contact-information/.

1. Make a copy of *Grade Your Schoolyard*, (located at the end of this guide) for each student.
2. Review the questions with the students to make sure they understand what they are looking for.
3. Send students out in small groups to evaluate the schoolyard.
4. Gather students back in the classroom and ask a representative from each group to discuss their findings and recommendations. Encourage students to look at page 6 in the *Green Learning* guide for ideas.

How's My Waterway

The U.S. Environmental Protection Agency has launched a new app called "How's My Waterway" to help people find information on the condition of thousands of lakes, rivers, and streams across the United States. The website uses GPS technology or a user-entered zip code or city name to provide information about the quality of local water bodies. The release of the app and website helps mark the 40th anniversary of the Clean Water Act, which Congress enacted on Oct. 18, 1972, giving citizens a special role in caring for the nation's water resources. Forty years later, EPA is providing citizens with a technology-based tool to expand that stewardship.

This project can be extended to include use of the *Fieldscope* mapping tool (See page 2.) Visit gonzaga.org/NetCommunity/Document.Doc?id=2708.

1. As a class or in pairs, have students visit watersgeo.epa.gov/mywaterway/
2. Click on the "Choose a Location" icon.
3. Enter the zip code or city/state for the school's location.
4. Ask students to list the name of the waterway closest to the address they listed.
5. Students can click on the "Show Map" button to locate the waterway.
6. Ask students to list the pollution categories for that waterway. Students can click on the category to learn more about where the pollution comes from, what people can do to prevent pollution, and the effects of pollution.
7. Ask students if the waterway has a TMDL Cleanup Plan.

Discussion:

Talk with students about their responsibilities for keeping our local waterways clean. Discuss actions they can take at school and at home to keep pollution out of waterways.

PAGE 6 – SLOW THE FLOW

SOLs: Science 6.5, 6.7

Resources:

- Rain Barrel Basics, askHRgreen.org: <http://askhrgreen.org/rain-barrel-basics/>
- How to Make a Rain Barrel, askHRgreen.org: <http://www.askhrgreen.org/wp-content/uploads/2011/06/CBF-Rain-Barrel-Construction.pdf>

Activity:

Role of Plants in Water Filtration, EPA

http://water.epa.gov/learn/kids/drinkingwater/upload/2005_03_10_kids_activity_grades_4-8_plantsinwaterfiltration.pdf

Objective: To understand the role of plants in filtering the water moving through a watershed.

Discussion:

1. In what ways can plants and soil benefit drinking water quality?
 2. We saw plants and soil remove some types of impurities from water. How might the plants remove larger quantities?
 3. Can plants and soil remove any type of impurity from water?
 4. What other organisms in the soil-plant system might aid the uptake of water pollutants?
 5. What is the role of rainwater moving through contaminated soil?
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PAGE 7 – POINTING TO THE SOURCE OF POLLUTION

SOLs: Science 6.7

Resources:

- Understanding Point vs. Nonpoint Source Water Pollution, National FFA (Future Farmers of America) Organization, <https://www.ffa.org/documents/learn/MS.NR.3.4.pdf>

Activity:

Non-Point Solution,

EPA http://water.epa.gov/learn/kids/drinkingwater/upload/2005_03_10_kids_activity_grades_4-8_nonpoint_pollution.pdf

Objective: This activity is designed to demonstrate to students what an average storm drain collects during a rainfall event and how the water from storm drains can impact the water quality and aquatic environments of local streams, rivers, and bays.

Discussion:

1. What types of pollution are natural?
 2. What types of pollution are added by people living in the local communities?
 3. How can we remove the pollution from the water?
 4. What could be done to stop pollutants from entering storm drains?
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PAGE 8-9 – ALL ABOUT WATER

SOLs: Science 6.5, 6.7, English 6.4

Resources:

- WaterSense Fix a Leak Week Activity Sheets,
EPA: http://www.epa.gov/watersense/docs/falw2011_activitypage.pdf

- Water Treatment Process,
EPA: http://water.epa.gov/learn/kids/drinkingwater/watertreatmentplant_index.cfm

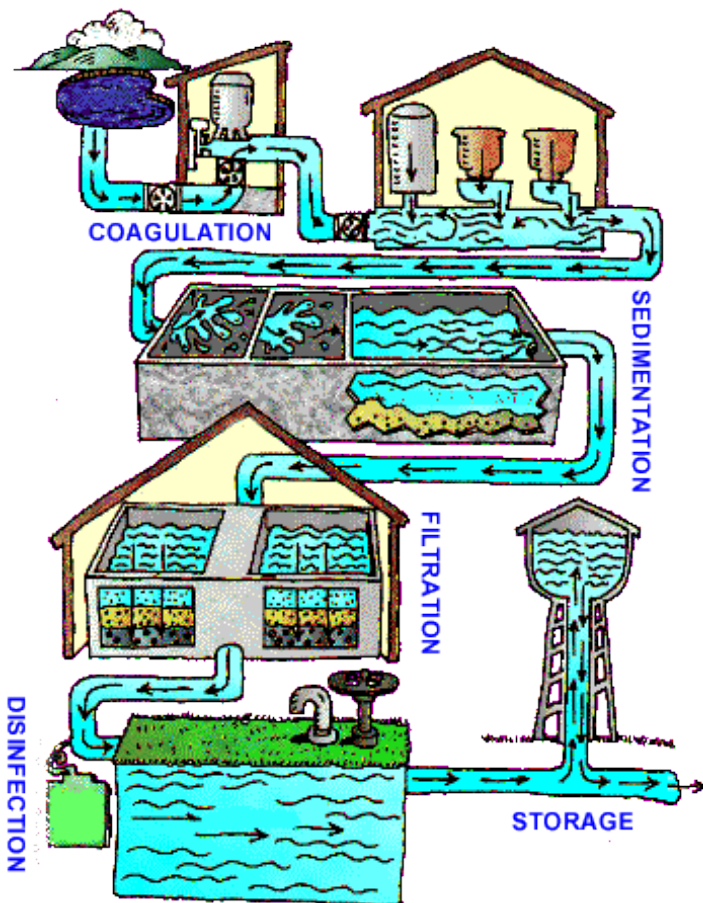
Activity 1:

The Water Treatment Process

Do you know what it takes to make the water you drink and use everyday clean?

Raw or untreated water is treated differently in different communities depending on the source and quality of the water which enters the plant. Groundwater is water located underground and typically requires less treatment than water from lakes, rivers, and streams.

View the diagram below (available online at the link above) and read about the water treatment process to solve the following word scramble activity.



Coagulation & Flocculation - Coagulation and flocculation are the processes that remove dirt and other particles suspended in water. Alum and other chemicals are added to water to form tiny sticky particles called "floc" which attract the dirt particles.

Solids Removal - The particles of floc and dirt eventually accumulate and become masses of sludge that are removed through sedimentation (where heavy particles settle to the bottom) or clarification.

Filtration - The water passes through filters, made of layers of materials such as sand and coal that help remove even smaller particles.

Disinfection - A small amount of chlorine or some other disinfectant is added to kill or inactivate harmful microorganisms that may remain in the water.

Storage - The water is sent to elevated or ground level storage tanks. From there the water is delivered on demand, into the water distribution system, consisting of many miles of pipes of various sizes that bring the water to your house or business.

the color shows up in the bowl, the toilet is leaking. Make sure to flush twice immediately after this test to avoid staining the tank or bowl.)

Detect leaky faucets. Students can create measuring cups in class to take home to test their faucets. (Measure out water in class, pour it into a paper cup and mark off 1, 2, 3, and 4 ounces on the outside with a marker.) At home, students place the empty measuring cup under the faucet and measure how much water leaks from the faucet in one minute. Figure out how much water you would lose if the faucet dripped for one hour (60 minutes), one day (1,440 minutes), and for one year (525,600 minutes).

Discussion:

1. Where does your drinking water come from and how does it get to your glass?
 2. Is your water provider privately or publicly owned?
 3. If publicly owned, how does providing water service fit within the limited powers of local government?
 4. Explain the role a water utility plays in providing for public health and safety?
 5. Does your water supplier face any special water supply issues?
 6. What the treatment process is used by your water utility and what chemicals do they use to make the water clean and safe?
 7. On average, how much water does the local utility provide in a single day? In one month? In one year?
 8. Why is it important to use water wisely, even when there isn't a water shortage? Why should you care about water conservation?
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PAGE 10-11 – GREEN LIVING STARTS HERE

SOLs:

Science 6.2, 6.5, 6.9

Resources:

- Your Home, askHRgreen.org: <http://askhrgreen.org/your-home/>
- Your Yard, askHRgreen.org: <http://askhrgreen.org/your-yard/>
- Energy Sourcebooks, TVAkids.com: <http://www.tvakids.com/teachers/sourcebooks.htm>

Activity:

A Day in the Life

Students should write a short story using as many tips as possible from the "Green Living Starts Here" home schematic found on pages 10-11 of *Green Learning*. Students should also incorporate at least three additional tips that were not included in the home schematic on pages 10-11 of *Green Learning*.

Discussion:

1. What is energy conservation and how can we achieve it in our home?
2. Does anyone know what insulation is and how and why it is used in our homes?

3. Are our homes completely airtight? When all the doors and windows are closed, can outside air still come in and can our inside air seep outside? What effect does this have on how much energy we use?

Additional Discussion:

Students should discuss this scenario: Jenny and her family are planning to take a family vacation in the summer. What are some things they can do in their home before leaving for vacation that could help save resources? While traveling, what are some tips they can implement to have a minimal impact on the environment?

PAGE 12-13 – DO THE MATH

SOLs: Science 6.5, 6.9, Math 6.2

Resources:

- Home Water Use Data, www.h2ouse.org/tour

- Smart Water Use: Indoor, askHRgreen.org, askhrgreen.org/smart-water-use-indoor/

- Smart Water Use: Outdoor, askHRgreen.org, askhrgreen.org/smart-water-use-outdoor/

Activity:

What's the Percentage?

For this exercise, students should refer to the water usage values they totaled on pages 12-13 of *Green Learning*. Using these values, calculate how much each activity (shower, bath, toilet, etc.) contributes to the total family use per day. Represent calculations as a fraction, decimal, and percentage.

Example:

Assume Total Family Use Per Day = 300 gallons

SHOWERS (5 gallons per minute) x 30 minutes per day = 150 gallons of the Total Water Use Per Day

150 gallons / 300 gallons = 0.5 or ½ or 50% of the family's total water usage

Discussion:

1. Compare water use activities. In what area of the house is the most/least water used? What is the biggest water waster?
 2. What are some ways to save water, and how much could be saved by modifying behaviors?
(see www.h2ouse.org/tour for average home water use data by fixture)
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PAGE 14 – MAKING THE RIGHT CHOICES

SOLs: Science 6.9, Math 6.1

Resources:

- Tap vs. Bottled Water, askHRgreen.org: askhrgreen.org/tap-vs-bottled-water/.

- Walk This Way: Making the right choices to reduce your water footprint, GOOD: [awesome.good.is/transparency/web/trans0309walkthisway.html](https://www.awesome.good.is/transparency/web/trans0309walkthisway.html).

Activity:

Persuasive Essay

We make hundreds of choices each day that affect our environment. Have students write a persuasive essay explaining why people should change their behaviors to incorporate practices from the *Green Learning* guide.

Discussion:

When explaining the *Making the Right Choices* activity, inform students that virtual water use means the amount of fresh water used to make something. Virtual water can also be referred to as a water footprint. The main idea of this activity is to teach students to think about the interrelationships of everyday commodities and water use.

PAGE 15 –WHERE DOES THE WATER GO?

SOLs: Science 6.5, 6.7, English 6.6

Resources:

- Discover the Role of Water in Our Lives, Project WET, discoverwater.org/.
- Storm Drain Medallion Program, askHRgreen.org: askhrgreen.org/storm-drain-medallion-program/.

Activity:

Map Your School Yard

Students will identify storm drains on school property and learn the purpose of storm drains. Students will learn that everything that enters a storm drain flows untreated to nearby waterways.

If your school is located within the Chesapeake Bay Watershed, you can direct students to the Chesapeake Bay FieldScope map at gonzaga.org/NetCommunity/Document.Doc?id=2708 to assist with this activity. Map directions and further activities can be found at gonzaga.org/NetCommunity/Document.Doc?id=2708.

1. Have the students sketch a map of the school yard. They should identify major landmarks like the school building, the parking lot, the playground, athletic fields, etc.
2. Show the students a local map and help them locate the approximate location of the school. Then identify several of the nearest bodies of water. Have the students add one or two bodies of water to their map, even if it is only an unidentified stream on the local map or a stormwater pond.
3. Bring the students outside with pencils and their maps. Explore the school yard looking for storm drains and best management practices. Have the students mark these features on their maps. If possible, point out the nearest body of water to which the stormwater likely flows. Discuss the role of gravity and elevation in draining water off the land.
4. After the students have found and mapped the storm drains, have them draw pipes, or arrows to the bodies of water on their maps. They should connect the storm drain to the most likely destination. A guess is

fine, as students only need to understand that storm drains flow to waterways by way of gravity and elevation.

Discussion:

1. What are the differences between storm drains and toilet drains? (Answer: Toilet drains connect to the sanitary sewer system, which is a closed system that flows to a wastewater treatment plant. Water in the sanitary sewer system is cleaned before being returned to the environment. Storm drains are generally open to the environment and flow directly to area waterways. The water that flows through the storm drain is not cleaned before it enters our waterways. Storm drains help reduce flooding. Toilet drains create a safe way to dispose of human waste.)
 2. Discuss the meaning of: "Clean Waterways Begin With You." What happens to fertilizer, litter, and pet waste left on the ground when it rains?
 3. What is the probability that the items listed below (or others that you can think of) might enter the storm drain from your school property? Use the terms "certain, likely, unlikely, impossible."
 - Car oil
 - Leaves and grass clippings
 - Soapy water from washing cars and buses
 - Toys left on the playground
 - Pet waste and wild animal waste
 4. Explain how each of the items in the previous question is harmful to the quality of our water.
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PAGE 16 – FAT-FREE DRAINS AS EASY AS 1, 2, 3

SOLs: Science 6.1, 6.5, 6.9

Discussion:

1. What foods contain fats, oils, and grease? Remind students that in addition to foods like bacon, hamburger, pizza, and French fries, foods such as salad dressing, batter, olive oil, ice cream, frosting, and sauces also contain FOG.
2. Discuss what they learned in the article. What happens when FOG goes down the drain? What effect does it have on our homes, our community, and our environment?
3. Is a sanitary sewer overflow due to FOG point or non-point source pollution? (*Using the description from the learning guide on page 7, a sanitary sewer overflow meets the definition of point source pollution; the source can be pointed at and controlled. However, with the thousands of miles of underground sanitary sewer pipes, it is often a challenge to identify and control this type of pollution.*)

Activity 1:

Don't Be a Pain in the Drain: Keep Out the FOG

The amount of grease generated from cooking one meal may seem insignificant, but this quick assignment illustrates how fat, oils and grease add up and create a problem.

What is the volume of grease in 1lb. of 80% lean ground beef? This is the amount of grease produced during one family dinner. You can also use this as an estimate for the amount of grease a family produces in one day. Even though we don't eat ground beef every day, lots of other foods have FOG in them.

Based on your measurements, how many gallons of FOG does a family produce in one month? In one year? What is produced by one family may not seem like much, but how much would all the students' families in your class produce?

Estimate the number of families in your school. How much FOG do the families in your school produce? What is the population of your city? If everyone poured a tablespoon of FOG down the drain every day for a year, how many gallons would go into our sewer system?

1 gallon = 16 cups = 256 Tablespoons

Items needed:

- 1 lb 80% ground beef, cooked with grease drained and set aside
- Heat safe container to collect drained grease
- Tablespoon measuring spoon or ¼ cup measuring cup

Steps:

1. Have teacher cook 1lb of 80% ground beef at home and drain the excess fat into a heat-safe container for the FOG lesson.
2. Bring the drained fat to class and have students measure the volume of grease using the measuring cup. One pound yields about 4 tablespoons or ¼ cup of liquid grease. Bringing the grease to class helps kids visualize and will help with their Greasy Pipe Project later in this activity.
Optional: If this is not feasible, start by having the class calculate the amount of fat from 80% lean ground beef (1 lb 80% ground beef = 0.8 lb meat and 0.2 lb fat) and adjust the calculations to use pounds instead of volume.
3. What is measured is the amount of fat from one family dinner. Based on the number of students in class, have them calculate the amount of fat from one week's worth of family dinners for the entire class. (*i.e.* 24 students = 24 meals)

The calculation can be continued to illustrate the amount of fat from a month or a year's worth of meals.

Example:

1 lb cooked ground beef = fat measurement from students or 1/4 cup of fat (or 0.2lb of fat)

24 students

1 meal per day per student

7 days a week

52 weeks a year

$(0.25 \text{ cups per meal}) * (24 \text{ meals per day}) * (7 \text{ days per week}) * (52 \text{ weeks per year}) = 2,184 \text{ cups of fat kept out of the sanitary sewer system per year (equivalent in volume to 1,456 cans of soda)}$

-OR-

$(0.2 \text{ lb per meal}) * (24 \text{ meals per day}) * (7 \text{ days per week}) * (52 \text{ weeks per year}) = 1747.2 \text{ lbs of fat kept out of the sanitary sewer system per year}$

You can see that the grease will quickly add up. How can you do your part to be a good citizen and keep grease out of the sanitary sewer system?

Activity 2:

Greasy Pipe Simulation

This activity illustrates the long-term effects on the typical sanitary sewer pipe of garbage disposal use and disposing of FOG down the drain.

Items needed:

- Empty cardboard tube (from paper towel or toilet paper roll)
- White glue
- Confetti (or scraps from hole punch)
- 1 tablespoon measuring spoon

The cardboard tube is used to simulate a sewer pipe; designate a "top of pipe" and "bottom of pipe." The glue will simulate the FOG and the confetti will simulate the food particles chopped up by the garbage disposal. Sanitary sewage flows along the bottom of the pipe; have the students pour 1 tablespoon of glue into the bottom of the pipe to simulate the fats, oils and grease washed down the drain and then follow it with 1 tablespoon of confetti, simulating the food particles from the disposal. Allow the cardboard pipe to rest overnight and repeat the steps for 1 week. At the end of the week evaluate the flow efficiency of the cardboard pipe. Has the inside diameter been reduced? Are there blockages along the bottom of the pipe that would impede the flow of sewage?

PAGE 17 – RESOURCE MANAGEMENT MATTERS & TO RECYCLE OR NOT TO RECYCLE?

SOLs: Science 6.2, 6.5, 6.9

Resources:

- Recycling at Home, askHRgreen.org: www.askhrgreen.org/recycling-at-home/
- Recycling, Keep America Beautiful: www.kab.org/site/PageServer?pagename=recycling
- What We Really Save by Recycling, Earth 911: www.earth911.com/news/2012/10/17/how-much-energy-water-saved-by-recycling/.

Activity:

Recycling Relay

Students will practice identifying what can and cannot be recycled. This activity is best suited for a gymnasium or outside.

1. Split the class into two teams. Each team will need one empty container marked for recycling and one empty container marked for trash. Each team also needs a container with a mix of recyclables and dry trash. Make sure there are enough items for each team member.
2. Form two lines with students. Place the containers with recyclables and dry trash in front of each line. Place each team's recycling and trash container 20 feet away.
3. On the teacher's start, the first student from each team takes one item from the combined container and runs down to place it in their team's correct container. (No verbal cues allowed). The student then comes back and tags the next player.

4. The game continues until all items have been sorted. The group with the lowest number of misplaced items wins.

Discussion:

Encourage students to cut out the "To Recycle, or Not to Recycle" section and hang it on their fridge at home.

Discuss with students how their personal choices have costs and benefits related to the generation of waste.

GARBAGE, GARBAGE, EVERYWHERE

SOLs:

(6.4 e) describe cause-effect relationships and their impact on plot

(6.4h) paraphrase and summarize the main points in the text

(6.9) analyze reports, media articles, and other narrative materials related to waste management and resource use to determine various perspectives concerning the costs/benefits in real-life situations

(6.9) describe the role of local and state conservation professionals in managing natural resources: waste management

(6.9) analyze resource-use options in everyday activities and determine how personal choices have costs and benefits related to the generation of waste

Resources/Materials:

Reading:

One copy Per Student

FYI How Landfills Work, Department of Health and Environmental Control (attached and available online at: www.scdhec.gov/environment/lwm/recycle/pubs/landfill_102.pdf)

Welcome to Your Hampton/NASA Steam Plant (article attached)

Writing Activity:

Blank Paper

Lined Paper

Pencils

Internet Activity:

Access to the Internet

Part 1 – Read: FYI How Landfills Work, Welcome to Your Hampton/NASA Steam Plant

Reading Suggestions

1. *Jigsaw:* Students work in small groups of five to read specific portions of the passages. They then share the information they learned with the group. Each student takes notes on what other students have shared. They use their notes to answer questions about the passages. The whole class then reviews the answers with the teacher to check for understanding. Remind students to save their notes to use during the writing activity.

2. Task Distribution

Student 1: How Landfills Work: Read the introduction, "From Your Home to the Landfill, and What Happens Every Day"

Student 2: How Landfills Work: Read "The Sum of Its Parts"

Student 3: How Landfills Work: Read "The Life Expectancy of a Landfill, When a Class 3 Landfill Closes"

Student 4: Welcome to Your Hampton/NASA Steam Plant: 1st Page

Student 5: Welcome to Your Hampton/NASA Steam Plant: 2nd Page

Additional Students: If a group has more than 5 students, two students can read the same section. This would be good for students who have difficulty reading at grade level.

Part 2 – Write: Comparison of Landfill disposal to Steam Plant Disposal

Students use the notes they took during the Jigsaw portion of the reading. The teacher could evaluate their note taking skills by not allowing them to refer to the original passages during the writing activity. If students are restricted to using their notes, it also becomes good practice for timed writing. Students can use a Venn Diagram to organize their thoughts before they write. Students should have at least 3 differences and 3 similarities in their writing passage.

Part 3 – Activity – Let's Get on the Web!!

Use a Website, Find Directions on the Internet

Instructions: See Attached

Tasks

1. Determine the cost of transporting your garbage to the landfill.
2. Determine how many times your own weight your annual trash is equivalent to.
3. Answer a question about Municipal Solid Waste.
4. Learn about Mount Trashmore Park in Virginia Beach.

Questions

1. What is the main idea of the introduction in How Landfills Work?
2. What does the crane operator do during the time the trash is in the refuse pit?
3. Why do trucks come from long distances to central landfills?
4. Give an example of a sentence from the passage that states a fact. Explain your choice. Do the same thing with a sentence that is an opinion.
5. How does having a Steam Plant nearby help the owners of a Landfill?
6. What was the author's purpose in writing Welcome to Your Hampton/NASA Steam Plant?

Sequence:

1. Put the following events in order.

_____ The crane deposits the refuse into the feed chute.

_____ The gases given off by the combustion process are piped to the Spray Dry Absorber.

_____ The steam is exported by pipes and valves to NASA for its use.

_____ The crane operator makes an inspection of the trash.

_____ "Fly ash" is carried away by conveyor.

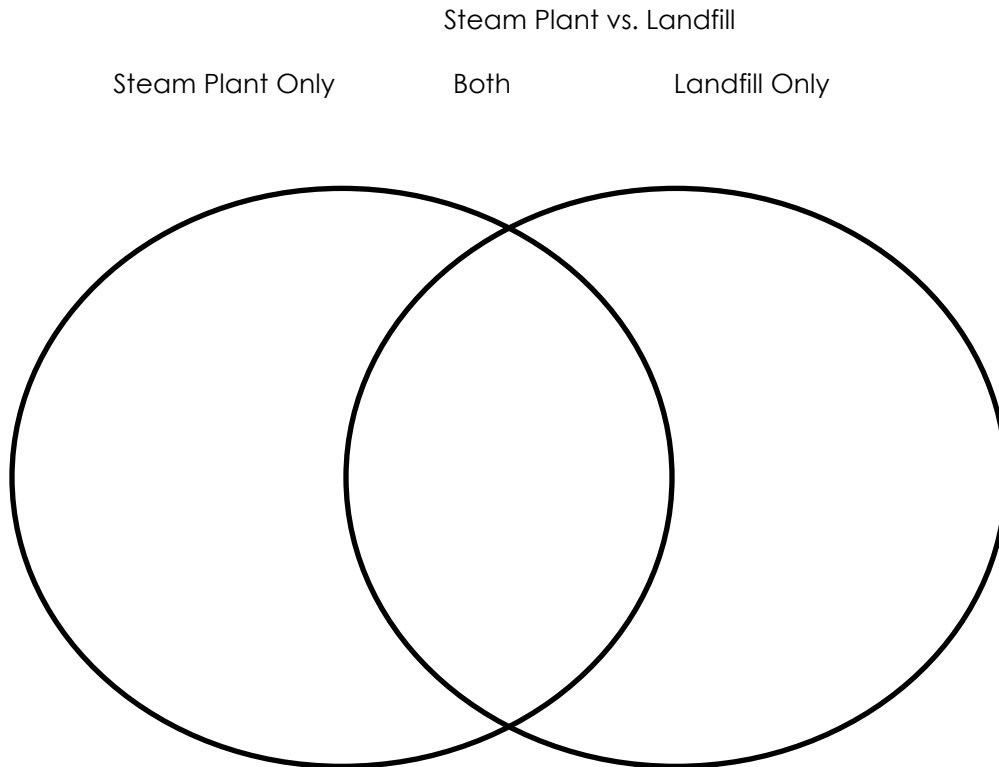
Compare/Contrast:

2. Use a Venn Diagram to compare the storm water drainage system to the leachate collection system.

Cause/Effect

3. How are the exhaust gases prepared to be released to the atmosphere?
4. *Identify the cause and effect in this sentence:* The life of a landfill depends on the size of the facility, the disposal rate and the compaction rate.

Venn Diagram



LET'S GET ON THE WEB!

Objective: Use a Website, Find Directions on the Internet

Part One: Internet Directions

Type in "Finding Directions" in the search tab. Several direction finders such as MapQuest or Yahoo Maps will come up. Students can use several different websites and compare how they like them. They should type in their home address as the starting point, then the address for the Bethel Landfill in Hampton. (100 North Park Lane, Hampton, Virginia 23666) This will give them the mileage from their home to the landfill. They will need that information to determine the cost of transporting garbage to the landfill using the Michigan Curriculum website.

Part Two: Using the Michigan Environmental Education Curriculum: Where does Our Garbage Go?

Website Address: <http://techalive.mtu.edu/meec/module15/title.htm>

Students can also just type in "Michigan Environmental Education Curriculum" into a search engine. Then click on the website. Click on "Michigan Tech, Tech Alive, Training Modules." Click on "Where Does Our Garbage Go?"

Tasks

1. Determine the cost of transporting your garbage to the landfill.
2. Determine how many times your own weight your annual trash is equivalent to.
3. Read the Landfill Gas to Energy section and write a short paragraph about the benefits of converting methane gas to electricity.
4. Try out a link to one of the games.

Part Three: Learn More About It

Garbage to Green: 10 Landfills Turned into Nature

Preserves <http://webecoist.momtastic.com/2009/05/10/garbage-to-green-10-landfills-turned-into-nature-preserves/>

Learn about 10 Landfills that have been turned into parks including our own Mount Trashmore Park in Virginia Beach! You may even want to visit the park with your family.

Grade Your Schoolyard

What is your school doing to protect and conserve our water? Use the following questions to find out. When you have finished, make suggestions for how your school could improve. What could you and your class do to help?

Runoff and Erosion

1. What type of surface do your school's downspouts pour into?
 - a. Patch of rocks, vegetation, or mulch – 10
 - b. Pavement or eroding ground – 5
 - c. Ground near waterway without buffer – 0
2. How much of your schoolyard is covered with an impervious surface?
 - a. Less than 10% – 10
 - b. 10-25% - 5
 - c. More than 25% - 0
3. Walkways where plants can't grow are covered with...
 - a. A pervious surface like wood chips – 10
 - b. An impervious surface – 5
 - c. Large bare patches and eroded areas – 0
4. Look for patches of bare soil and signs of erosion, like areas where rainwater has carved out ditches or soil has splashed onto windows or walls. The schoolyard has...
 - a. Very little erosion and bare patches – 10
 - b. Several areas showing erosion – 5
 - c. Large bare patches and eroded areas – 0

Vegetation

5. How much of the grounds are regularly mowed?
 - a. Less than 50% - 10
 - b. 50 - 80% - 5
 - c. Over 80% - 0
6. Land around where water drains and collects (like storm drains) is...
 - a. Covered with trees and shrubs – 10
 - b. Covered with un-mowed grass – 7
 - c. Covered with mowed grass/leaves – 3
 - d. Bare soil or pavement – 0
7. How is the grass fertilized?
 - a. Grass clippings are left on the ground – 10
 - b. Lawn fertilizer according to a soil test – 7
 - c. Lawn fertilizer according to instructions – 3
 - d. Lawn fertilizer randomly applied or unsure – 0

Education

8. How many storm drains are labeled to let people know they go straight to waterways?
 - a. All – 10
 - b. A few – 5
 - c. None – 0
9. How many ways are there to learn about water quality at your school? (posters, books, etc.)
 - a. 3 or more – 10
 - b. 1 or 2 - 5
 - c. None – 0
10. How much litter do you see in the school yard?
 - a. None – 10
 - b. Some – 5
 - c. A lot – 0

Transportation

11. How many people work at your school? How many cars are in the parking lot?
 - a. 50% fewer cars than people – 10
 - b. 25% fewer cars than people – 5
 - c. One car per person – 0
12. Are there bike racks at your school? Are they used?
 - a. Bike racks full of bikes – 10
 - b. Bike racks with a few bikes – 5
 - c. No bike racks – 0
13. Is there any sort of reward or encouragement for teachers or students to walk to school, ride their bikes, carpool or take public transportation?
 - a. Yes – 10
 - b. No – 0

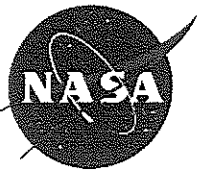
Total score _____ **(possible 140)**

0 – 80 Needs Improvement

80-120 Better than Average

120-140 Excellent

(Adopted from City of Norfolk Stormwater Division)



Welcome to your Hampton/NASA Steam Plant

Keeping Hampton Green...with Steam!



OUR MISSION

To provide municipal solid waste disposal for the City of Hampton and energy for NASA Langley Research Center in an environmentally safe and economical manner.



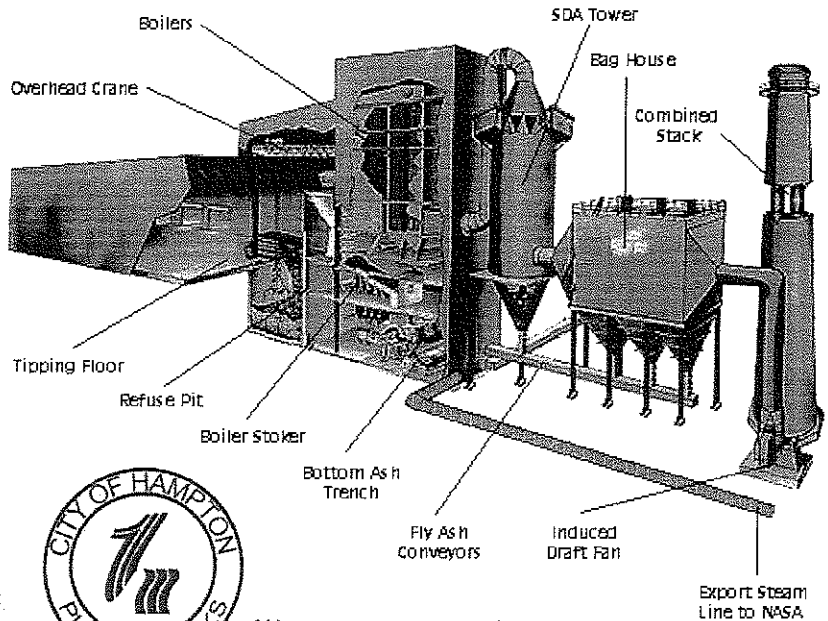
OUR HISTORY

Hold on, Herodotus—we've only been around since 1980. Still, we've managed to make our mark.

Completed under a unique partnership with the federal government, this award winning facility serves Hampton, Poquoson, five federal installations, law enforcement agencies, and the private sector.

We have hosted representatives from Brazil, Iceland, Japan, the Ukraine, and other countries interested in exploring waste to energy technology for their communities.

Fairly recently, we completed a \$9 million upgrade that that will extend the life of the plant and meet the new federal Clean Air Act regulations



Waste-to-Energy System

The Process

Every day municipal solid waste (MSW) trucks arrive on our enclosed tipping floor. They all dump into the refuse pit while the crane operator makes a preliminary inspection from his overhead vantage point. He moves the trash into neat pyramids, periodically feeds the boilers, and occasionally removes oversized or unburnable items.

The crane deposits the refuse into the feed chute where it falls to the stoker. The stoker is like a travelling floor that moves the trash through the boiler as it burns. At the end of the stoker, any remaining "bottom ash" is dropped into a water filled trench where it is quenched and carried out by conveyors. From there, it is screened for size while a magnet removes the ferrous metal for recycling.

The boiler is actually a group of drums (large tanks), headers (long small tanks), and hundreds of tubes hanging from supports 65 feet in the air. It transfers the heat of combustion to the 5,255 gallons of water in its tubes at the top and along the walls. Steam forms in the tubes and makes its way up to the steam drum. The 365 psi, 440° steam is then exported by pipes and valves to NASA for use.

The gases given off by the combustion process are piped to the Spray Dry Adsorber (SDA) Tower where a fine mist of lime slurry is sprayed to reduce any acid content and lower the temperature. The exhaust gases are then directed to the bag house where they are filtered by very fine mesh bags. The scrubbed and filtered exhaust is then drawn to the stack by the induced draft fans, carried 248 feet in the air, and released into the atmosphere. The particles that drop out of the exhaust stream in the SDA and bag house are called "fly ash" and are carried away by conveyor. This process continuously maintains strict environmental compliance using a sophisticated program and numerous monitors.

Fly ash and bottom ash combine and are again treated with lime. This is our residue ash and it can be used as sanitary top cover at the Bethel Landfill.

The Results

NASA receives affordable energy for its research while conserving fossil fuel at the same time. The City's refuse is fully processed in six days; minimizing growth time for pathogens and spores. Odors are effectively controlled by storing the refuse in an enclosed area with tipping floor ventilation being injected into the furnace to destroy organic vapors. MSW residue ash is rendered inert, generates no landfill gases, and takes up one-tenth the space of raw refuse; greatly extending the lifespan of our landfill.

A Win-Win Situation for Everyone!

Where We Fit in the Waste Stream

The EPA is committed to Waste-to-Energy as part of its goals:

Reduce: the United States is the single largest consumer on the planet. We are also one of the largest producers of waste. Think before you buy. Do your best to try to consume less and at the same time look for ways to waste less; e.g., packaging material, printing, junk mail, etc.

Reuse: are you sure you have to throw it away? Maybe there's still some life left in it after all, or if you're sure you can't use it, maybe some one else can. Ask, sell, or donate.

Recycle: curbside recycling diverts much of the usable waste, but depends on you to sift and sort before you throw. Take the time—it's worth it on so many levels.

Recover: this is us. As a major part of the City's integrated approach to managing solid waste, we directly recover the stored energy inherent in refuse. By burning it, we release that energy and convert it to usable steam. Our steam is used directly by NASA, but many other WTE Plants all over the world have been adapted to generate reliable base load electricity with high efficiency turbines.

Dispose: if there isn't any way to take care of it in the alternatives above (or after it has been processed through the Plant); then it can be taken to the landfill.

Number Crunching Step Up



Recycling and Waste to Energy are not mutually exclusive and can co-exist quite peacefully. You may have heard the phrase "Zero Waste," and while an admirable goal, it is not entirely practical. Let's take a look.

According to the EPA, each of us produces 4.4 pounds of trash a day. That comes to 1,606 lbs per year.

Out of the typical waste stream, 60-75% of the material is recyclable in some way. Since advocating recycling in 1970, we currently average between 28-33%, depending on location. Some communities in Canada have attained 50% and the EPA has set a goal of 40% for the US by 2011.

So, even by Canadian standards, we would still have to deal with 803 lbs of trash per person every year.

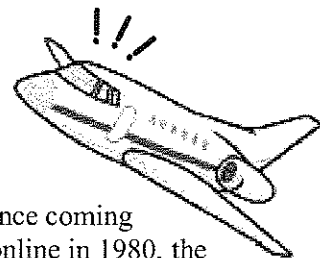
That's plenty left over for us to recover.

By the way, recycling also helps us here at the Plant. Incinerating batteries, for example, releases harmful gases, acids, and heavy metals. As you read, we treat our exhaust and ash, but just taking these ordinary objects out of the waste stream would save us thousands of dollars in treatment chemicals and be more environmentally healthy.



We recycled 900 tons of scrap metal in 2009.

That's enough material to build 607 VW Beetles or 707 Cooper Minis!



Since coming online in 1980, the HNRP has processed more than 2,235,357 tons of trash.

That's a big number—perhaps too big to imagine. Let's try to put it in some perspective.

If our landfill was only the size of a football field, that same amount of garbage would make a pile 5 miles tall.

I doubt the fighter pilots at Langley AFB or the jets flying in to Patrick Henry Field would appreciate that!

We've reduced that ridiculous tower of refuse to a responsible amount of residue that would fill the same field to only 1,447 feet.

Fortunately for us, and all those pilots, the great team at the Bethel Landfill spreads it out a little more evenly!

Did You Realize That...

If you threw any trash away in Hampton since 1980, you helped NASA: Explore Mars, test space shuttle aerodynamics in over 60,000 hours of wind tunnel runs, develop the record setting Mach 9.6 X-43A scramjet, construct the inflatable lunar habitat, conduct over 50 space-borne experiments in the Long Duration Exposure Facility (LDEF), design CALIPSO to study atmospheric aerosols that affect global climate change, reduce dangerous wake vortices in wing technology, and even perfect 14-time Olympic gold medalist Michael Phelps' hydrodynamic Speedos for Beijing.



Got Steam?

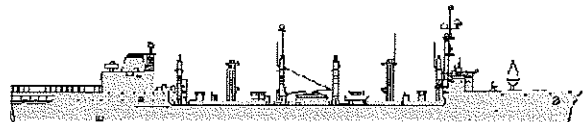
We've got plenty. In fact, we generated 484,800,883 pounds of steam in 2008 alone. If we used, say, a couple small Turbodyne turbine generators instead of sending our raw steam to NASA, we'd be capable of producing 16.2 million kilowatt hours of power annually—enough energy to conservatively supply 1,436 Hampton households.

Got Gas?

Well, keep it to yourself. Seriously though, if we didn't burn refuse to generate the steam NASA needs, they'd have to burn more traditional fuel to get it. Over the past ten years alone we've produced enough refuse generated steam to save the planet 29.9 MILLION gallons of fuel oil and natural gas.

That's more fuel than the 659 foot long, 40,100 ton US Navy replenishment oiler USS *Wabash* and three of her sisters could carry in cargo.

4 x



= 28.8 million gallons

Remember, for more info anytime, call:
311.1
JUST ONE CALL DOES IT ALL

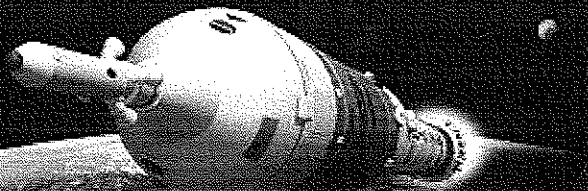
See for yourself:

To see how you can help recycle various batteries locally, go to <http://www.fbrc.org/consumer/> or visit <http://earth911.com/electronics/> to see how to recycle a wide variety of home electronics.

For more ideas on how to recycle, see <http://kids.niehs.nih.gov/recycle.htm>

Check out your carbon footprint at <http://michaelbluejay.com/electricity/carboncalculator.html>

See what NASA LaRC is up to at <http://www.nasa.gov/centers/langley/home/index.html>





How Landfills Work

It's not a dump – so don't call it that.

It's not just some hole in the ground either – it's much too expensive to build and operate to think of it that way. It's a Class 3 landfill that accepts municipal solid waste (MSW). It's the place your household garbage calls home.

So, just what is a Class 3 landfill? A Class 3 landfill is a scientifically engineered facility built into or on the ground that is designed to hold and isolate waste from the environment. Federal and state regulations strictly govern the location, design, operation and closure of Class 3 landfills in order to protect human health and the environment.

Class 3 landfills are the most common places for waste disposal and are an important part of an integrated waste management system. Today, about 73 percent of the MSW generated in South Carolina is disposed of in the state's 24 permitted Class 3 landfills. Nationwide, about 54 percent of the MSW generated is disposed of in landfills according to the U.S. Environmental Protection Agency (EPA).

From Your Home to the Landfill

You think garbage, you think garbage truck. Depending on the Class 3 landfill's size, as many as 200 trucks may come every day. The trucks come from all over, too. Why? Well, Class 3 landfills are difficult to locate as well as expensive to build and operate. Given that, there are fewer Class 3 landfills today than in the past, but they are larger and accept MSW from greater distances.

There are, of course, different types of garbage trucks that hold different amounts of waste. The truck that comes through your neighborhood can hold anywhere from 12 to 14 tons of waste. How much is that? Well, on average, this type of garbage truck can pick up waste from about 800-850 homes. When the truck is full, it heads to the landfill. At the landfill, the truck drives on to a scale and is weighed on its way in, on its way out, or both. The truck carefully drives to a specific area of the landfill and dumps or "tips" its load. Then it leaves and drives to another neighborhood to repeat the process.

What Happens Every Day

The daily operation at a Class 3 landfill includes dumping of waste into a specific area of the landfill – called a

working face – followed by compaction (crushing) of the waste and then covering of the waste with soil.

Waste is dumped into an open area of the landfill called a cell. Class 3 landfills almost always just have one cell open at a time to accept waste. At the same time, another cell is being built so it is ready when the current cell becomes full.

Space is money. Garbage is compacted or crushed to save space. You've seen the giant tractor with spiked wheels that goes back and forth over the garbage. Well, that's a compactor. It weighs 100,000 pounds. The compactor makes three to five passes over the garbage to crush as much garbage into the space as possible. On average, about 1,200 to 1,400 pounds of garbage can be compacted into one cubic yard of space.

At the end of the day, the working face of the cell is covered with a layer of soil or other cover material to minimize odor, pests and rodents as well as litter. This is called daily cover.

This three-step process is repeated over and over until the cell is filled.

The Sum of Its Parts

Here are some basic parts of a landfill.

1. The **bottom liner system** is designed to keep waste from coming in contact with the environment – particularly groundwater. From the bottom up, the system is: 1) 2 feet of clay 2) a plastic liner and 3) a protective layer 2 feet thick, usually comprised of sand.
2. **Cells** are specific areas where the waste is dumped and compacted (crushed).
3. The **storm water drainage system** collects rainwater that falls on the landfill. The system may include plastic drainage pipes that collect water and move it to a retention pond at the Class 3 landfill. This water has not come into contact with the garbage.
4. The **leachate collection system** collects liquids – called leachate – that are part of the MSW and any water (e.g., rainwater) that comes into contact with the garbage. This water works its way through the Class 3 landfill like water percolating through coffee grounds. As the water moves through the garbage, it picks up contaminants. It must be collected and treated.

5. The **methane collection system** collects methane gas that is created during the decomposition of the garbage. Bacteria break down the garbage. The by-product is landfill gas that is about 50 percent methane and 50 percent carbon dioxide with very small amounts of nitrogen and oxygen. Methane gas presents a hazard because it can explode and/or burn. Methane is actively collected in a series of pipes, then passively vented or burned through a flare. Currently seven Class 3 landfills in South Carolina (Anderson Regional Landfill, Lee County Landfill, Horry County Solid Waste Authority (SWA) Landfill, Palmetto Landfill, Three Rivers SWA Landfill, Greenwood County Landfill

and the Richland Landfill) burn methane to produce energy (methane produces about half the energy of natural gas).

6. The **final covering or cap** is placed on the Class 3 landfill when it is closed. The final cover has: 1) 18 inches of clay at the bottom; 2) a plastic liner in the middle; and 3) 2 feet of soil on top. The covering seals the waste from air and reduces the amount of water getting into the landfill. It also prevents pests (birds, rats, mice, flying insects and so on) from getting into the waste.

The Life Expectancy of a Landfill

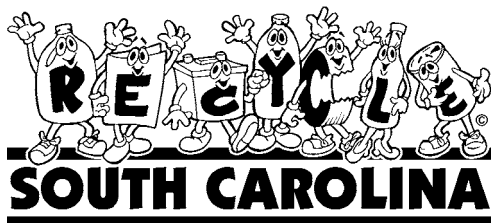
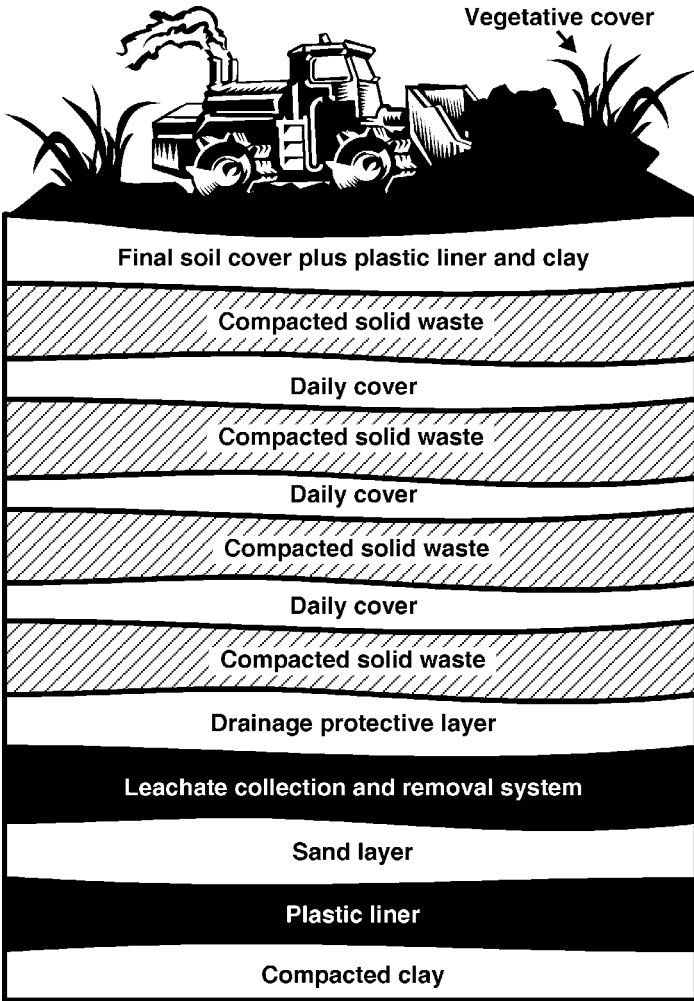
The life of a landfill depends on the size of the facility, the disposal rate and the compaction rate. All Class 3 landfills are permitted by the S.C. Department of Health and Environmental Control to accept a specific amount (tons) of waste each year – this amount cannot be exceeded. As mentioned earlier, Class 3 landfill operators strive for the maximum compaction rate possible in order to save space. Given these considerations, the average life expectancy could be anywhere from 30 to 50 years. Class 3 landfills must be monitored for 30 years after closure.

When a Class 3 Landfill Closes ...

When a Class 3 landfill is full, it is closed with a final cover that includes a clay layer, a plastic liner and a soil layer. Even though the facility is closed, the responsibility of the landfill operator does not end.

Class 3 landfill owners must set aside money (called financial assurance) to close the landfill and to provide post-closure care in the event of potential environmental issues. Operators must continue to pump the leachate, test the groundwater, inspect the cap, repair any erosion, fill low areas due to settlement, maintain vegetation and prevent trees from growing. Why no trees? Trees have roots and roots can tear the liner.

DISCLAIMER: The definitions in this fact sheet do not constitute DHEC's official use of terms for regulatory purposes. Specific legal definitions of some words may be found in various South Carolina laws and regulations.



Office of Solid Waste
Reduction & Recycling
1-800-768-7348 ● www.scdhec.gov/recycle

DHEC's Office of Solid Waste Reduction and Recycling FYIs provide general information on environmental topics. Readers are encouraged to reproduce this material. For more information about solid waste issues, please call **1-800-768-7348** or visit our Web site at www.scdhec.gov/recycle. Please send written correspondence to: DHEC's Office of Solid Waste Reduction and Recycling, 2600 Bull Street, Columbia, SC 29201.