

# RECYCLE RIGHT INTRODUCTION

## Elementary School Programs Fourth and Fifth Grade (4-5)

Research proves there is a direct link between knowledge and active involvement. From gathering stones, shells, or pinecones, and shuffling through piles of autumn leaves to studying ecosystems, to seeing how technology has changed over time, learning about the environment is a life-long process. It advances skills and habits that people can use throughout their lives to understand and act on environmental issues. It promotes critical and creative thinking skills that are key to finding solutions.

### The Importance of Why We All Need to Recycle Right.

Recycling is an essential part of environmental protection. Forty years ago, the recycling challenge was about getting people and businesses at the grassroots level to embrace a new way of discarding waste. We started bundling newspapers, sorting out plastics and glass, and resisting the old habit of throwing everything in the garbage. Having won the public's support of recycling, we must now rethink recycling. With changing material streams, collections and processing systems, recycling has become more complex. The right materials really do matter. It is estimated that the rate of contamination of materials that are recycled is approximately 16%, indicating the need to educate everyone about what materials can be recycled. To meet the challenge of the Recycle Right program, everyone must understand why and how to recycle.

### Education is the Key to Recycle Right.

With the support of you and your students, we can close this gap between public support for recycling and the number of people who make recycling a habit and follow the recycling rules. The past has proven that through education, students are true ambassadors of carrying this message forward. The lessons that follow are designed to ensure that students not only have the basic knowledge about the need to reduce, reuse, recycle and rethink our garbage, but also to promote a change in their behaviors so that their knowledge is turned into action.

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## WHY RECYCLE?

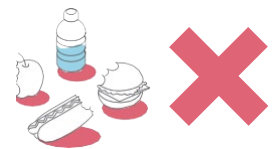
**Plastic bottles**  
can turn into clothing

**Aluminum Cans**  
can turn into new ones  
in 60 days.

**Today's news**  
can become a new  
cereal box



Recycle clean bottles, cans,  
paper, and cardboard.



Keep food and  
liquid out of your  
recycling.



No loose plastic bags  
and no bagged recyclables.



# CURRICULUM MATERIALS AND LESSONS

This curriculum offers teachers a resource where they can access highly effective content and related support materials. These resources and materials are STEM based and align with the Next Generation Science Standards.<sup>1</sup> Recycling is important for environmental protection. The goal is to help students develop an understanding of why they should make recycling a habit and how to recycle correctly. In this way, they will play an important role in furthering the recycling message in their homes, schools and communities. The lessons are designed to answer:

- What are the benefits of recycling?
- What should we recycle?
- What shouldn't we recycle?
- What are the challenges inherent in recycling efforts?
- What has been, and can be, the impact of recycling on our communities and natural resources?
- What is my part in becoming an environmentally responsible individual?
- How do I recycle forward?

Each lesson includes background information, the basic content to be delivered, a suggested lesson plan, a list of extension activities for going beyond the scope of the lessons provided, and the correlation between the lessons and the Next Generation Science Standards.<sup>1</sup> There are multiple opportunities to monitor learning and adjust teaching throughout each lesson. In addition to closure activities, these will provide opportunities for assessment of student learning. A suggested teacher dialogue is included with each lesson in order to reduce teacher preparation time and to help facilitate delivery of the lesson. As in all lessons presented by teachers, their own creativity, expertise, and adaptations to the levels of their students will make learning even more successful.

Although these can be considered stand-alone lessons, they are equally beneficial when integrated into other subject areas. For example, if a teacher's lesson is on persuasive writing, the need for a community to increase and improve recycling would be an excellent topic, and an opportunity for students to reinforce their learning about recycling. Research has shown it takes seven "touches" before someone will internalize and act on a call to action. We hope you see this curriculum as an ongoing opportunity for your students to learn and be inspired to become good stewards of the environment.

<sup>1</sup> "The Next Generation Science Standards (NGSS) is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of, and do not endorse, this product."

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# RECYCLE RIGHT GRADES 4-5

## The Anatomy of a Landfill Lesson

### Time Frame:

This lesson has been developed to span a time period of approximately 45 minutes. However, it can be adapted to fit your classroom needs based upon attention span and levels of students. It can also be adapted and used with learning centers and in reading and math lessons.

### Teacher Introduction

The goal of The Anatomy of a Landfill is to help students develop an understanding of municipal solid waste management, its importance to the environment, and the role it plays in their communities. It will introduce students to the science, technology, engineering, and math employed in an integrated solid waste system. Often students do not think about, or know, where their waste goes once it is picked up at the curb. In order for students to fully appreciate the need to recycle, and recycle the right way, they need to realize that the volume of waste they produce as individuals and we, as a society, must be managed via an integrated waste system.

The non-recycled garbage must go somewhere. The federal government now defines the classification and disposal method for different types of waste and dictates how these are transported for disposal. In some communities, the garbage is taken to a waste-to-energy facility, which burns the material and produces electricity. However, in most of the United States, we send the non-recyclable waste to a landfill. The reality is, the more garbage that is diverted from landfills, the longer the landfills will last. Therefore, recycling is central to the life of a landfill and will be reinforced again and again.

### Lesson Objectives

1. Students will be able to communicate solutions that will reduce the impact of humans on the land, water, air and other living things in the local environment.
2. Students will be able to explain the components of an integrated solid waste system and necessary waste management practices within that integrated system.
3. Students will be able to categorize types of waste and their treatment.

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4. Students will be able to list three characteristics of the engineering, design and operation of a landfill that ensure environmental protection.
5. Students will demonstrate awareness that managing waste is a local and environmental responsibility, and be able to articulate the contribution they can make to advance the Recycle Right message.

### **Essential Learnings**

1. Landfills, along with source reduction, recycling, composting, and waste-to-energy facilities, play an essential role in an integrated solid waste system.
2. A landfill is a highly engineered disposal option that ensures environmental protection through such features as:
  - a. documenting and videotaping of all trucks entering the landfill, and weighing when entering and exiting the landfill,
  - b. cell construction using a highly engineered liner system, c. compacting of all garbage,
  - d. daily cover, and
  - e. treating leachate (wastewater) and employing methane gas recovery systems.
3. An integrated solid waste system should always be committed to “collect and protect” through its structure and operations.
4. Increasing recycling and following the recycling rules play a significant role in both our economy and our environment.

### **Anticipatory Set**

*“In previous lessons we learned about recycling and the importance to the environment of recycling often and recycling the right way. We also learned that each person produces about four and a half pounds of garbage each day. Think about that and compute how many pounds and ounces that would be each day just for our class.”*

- Provide time for students to calculate and get responses.

*“Now think about how many students are in our school (there are about XX students in our school), and determine how many pounds and ounces that would be each day, just for our school!”*

- Provide time for students to calculate and get responses.

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*“That is just for one day, and just for our school. Imagine the entire school for a week, for a month, for a year! Now think about our community. At four and a half pounds per person per day every day of the year, I think you can see that perhaps we have to look very carefully at the amount of garbage we throw away, the kinds of garbage we throw away, and how it is handled. If not, the future of our environment may very well be in jeopardy!”*

### **Purpose for the Lesson**

*“Why are we looking at the challenges of waste disposal today? Well, clearly from your calculations, we throw out a lot of garbage every day. And that garbage has to go somewhere. The question is, where does it go, how does it get disposed of, and what is the impact on our environment?”*

*So you see, today’s lesson is more than just information for you to learn. It is also a call for you to turn that knowledge into action and do something to help ensure that our environment is protected.”*

### **Learning Activities**

*“Today we are going to discuss waste disposal within the framework of an integrated solid waste management system. What do you think that means? Think about each of the three concepts – integrated, solid waste management, and system. If you can define each of those concepts then you’ll have a pretty good idea of what the phrase means. Turn to the person next to you and exchange ideas.”*

- After a few minutes of exchange, re-focus students and elicit ideas, eventually coming up with the idea that it is a way of addressing how we deal with the garbage we throw out in a systematic, organized, and environmentally responsible way.
- Share with the class the Waste Management handout entitled **“Follow the Waste Stream,”** that highlights the life cycle of the garbage that we generate.

*“You can see on this chart, three of the options for the garbage after collection at the curb: 1- to be recycled, 2- to be disposed at a Waste-to- Energy Facility, or 3- to be put it in a landfill.” (Please note, there is also composting but that is not being covered in this lesson.)*

*“While we are talking about landfills, I also want you to be aware of two words and how they relate to everything we talk about. Those two words are Collect and Protect. Why do you think these two words are so important that I am highlighting them here?”*

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- Elicit answers, centering on the idea that as garbage is collected it is essential that we are informed about which materials are acceptable in our curbside mixed recycling program in order to make sure we maximize recycling, and minimize what is sent to the landfill (collect). Environmental protection is the foundation for the plan.

*“So, two things to continue to focus on throughout our discussion are to Collect and Protect.”*

*“So let’s start by following a truck from the time it picks up your garbage at the curb, until it empties its load and leaves the landfill. While we are following this truck, I want you to be aware of, and remember, at least three things that are done at the landfill to protect our environment.”*

*“Every truck that comes to the landfill provides necessary paperwork, is videotaped, and weighed both on entry and on exit. Why? To maintain a record of every truck and its weight by the ton. This also provides information for billing purposes. How does this involve collect and protect?”*

- Elicit answers.

*“The paperwork, videotaping, and weighing all are done to collect information about the garbage to be dumped, while at the same time making sure that the garbage in the truck meets waste acceptance rules (protect). Let’s assume that our truck entering the landfill weighs 66,000 pounds. When it is weighed on the way out, it weighs 12 tons. Why is the weight different? That’s correct, it weighs less because it dumped its load of garbage. How many tons of garbage did that truck dump in the landfill?”*

*“The truck continues on to where it will dump the garbage. It is directed to a specific area called a cell. These cells are constructed with a liner system and engineered in a way so that any water that passes through the garbage (leachate/wastewater) can be collected and treated. That is important to protect the groundwater and the environment. We will not be studying the liner system in depth, but I am passing out a graphic entitled “Typical Anatomy of a Landfill” (or show on smart board) that shows you how many protective layers there are to ensure the garbage never comes into contact with the ground below.”*

- Hand out **“Typical Anatomy of a Landfill.”**

*“Once again, this is to both collect and protect - How?” (Answer - Collect: The wastewater is collected and directed to a treatment plant. Protect: the liner system ensures safety and protects the groundwater.)*

*“Once the garbage is dumped, a landfill compactor (a heavy machine with spiked wheels that can weigh from 50 tons to more than 120 tons) drives over it again and again. Why is this done?” (Answer - To reduce the amount of space that the garbage takes up in the landfill, enabling as much garbage as possible to be dumped there.)*

*“How does the compactor collect and protect the environment?” (Answer: It allows us to collect more garbage to place in the landfill and protects by maximizing valuable space in the landfill.)*

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“At the end of each day, the area where garbage is dumped that day is covered with soil or a similar material. This keeps the garbage from blowing away, minimizes odors and provides protection from animals and birds. When the landfill reaches its allowable, engineered height, it is capped and grasses are planted. Methane, the gas produced as the garbage breaks down or decomposes, is collected and recycled into energy. Once again, how does that collect and protect?” (Answer – Collect: The methane gas is collected and recycled into energy, helping to reduce the depletion of fossil fuels and dependency on foreign oil. Protect: Covering the garbage that was dumped each day controls litter and the final capping protects the environment because it keeps rainwater out of the landfill, prevents erosion, and the landfill can now be a future park or have another use.)

“Finally, we have repeatedly said that if we follow the recycling rules it will help our environment, our natural resources will last longer, and we will save valuable space in our landfills. But what happens when recyclable materials are placed into the landfill instead

of being recycled? In order to demonstrate just how important recycling is to protecting our environment, I want you to look at the Garbage Decomposition Rates Chart I am now handing out. You will see that I have listed 12 items that are typically thrown out in our homes. Let’s talk about this term decomposition. I’ll bet all of you have seen decomposition in action. Have you ever forgotten a snack and left it in your backpack, or some leftover food that was pushed to the back of the refrigerator at home? What happens to it?”

- Call on several students.

“It may be moldy or slimy because it is decomposing. Decomposition is nature’s way of recycling. Here is what I want you to do. In pairs, (use a technique that you would use to do this such as the person next to you, behind you, etc.) I want you to predict how long you think it will take for each item to decompose or break down if it is placed in a landfill. At this point, just give your best guess.”

- Provide about 4-5 minutes for students to record their estimates.

“Now, I want you to indicate in the column on the right whether that item can be recycled or not. You can just put a Y in the column if it can be recycled and an N if it cannot be recycled. If it can be recycled, be ready to give me a rule about how it should be recycled the right way.”

- Upon completion, hand out the completed chart with all of the answers on it and discuss with the class, particularly emphasizing the length of time it takes for a recyclable item to decompose in the landfill. Have students offer their ideas on how we can reduce the number of recyclables that are placed in the landfill.

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**Closure:**

*“We have talked about a lot of very important information today regarding an integrated solid waste management plan, the design of a landfill that protects the environment, and the decomposition rates of many items that we throw into the trash in our schools and our homes. I want you to think back to our lesson and be prepared to share with someone near you the following: Two ways that the design of a landfill protects our environment, and secondly, based upon our lesson today, why are recycling often and following the recycling rules so vital to a successful integrated solid waste management plan for our communities.”*

- Possible responses to landfill question: Liner system, capping system, weighing and videotaping of trucks entering the landfill, compacting the garbage after it is dumped. Possible responses to the recycling question: Placing recyclable items in a landfill instead of recycling them takes up very valuable landfill space, decomposes at a very slow rate (if ever), impacts on the continued depletion of natural resources, and increases costs associated with waste disposal

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# RECYCLE RIGHT GRADES 4-5

## The Anatomy of a Landfill Extension Activities

### STEM Search in the Landfill

An excellent way to help students see the many applications of science, technology, engineering, and mathematics in today's world is through an examination of the design, construction, operations, and environmental controls at a landfill. To do this, students can

be placed into groups with the directive to examine the handouts that have previously been distributed, as well as the knowledge they have obtained from the Anatomy of a Landfill Lesson. Now, they will attempt to identify as many applications of science, technology, engineering, and mathematics as they can. Indicate that even though some of the more technical processes have not been discussed, perhaps they can predict how each of these subject areas is employed at the landfill.

Allow students to brainstorm their ideas and then discuss with the entire class. In order to provide some basis for this discussion with the students after they have brainstormed their ideas in groups, the following information is being provided as the basis for the class discussion.

- Analysis and treatment of the leachate (science).
- Mathematics, technology, and engineering are used in design and construction and to calculate how much leachate is collected and methane gas generated.
- Engineering, science and technology are evident at the wastewater treatment plant, from design to the biological treatment process.
- Compactors and other heavy equipment have Global Positioning Systems and on board computers (technology). This is important to maximize space in the landfill, determine fuel cost (math) and monitor where the garbage is disposed of each day.
- The design includes stormwater management to protect wildlife (science), ongoing monitoring and testing (science and technology) and calculations of how fast water from storms flows (mathematics), and a protective professional design (engineering) to meet those calculations.
- All aspects of STEM are important to make sure landfill gas systems are functioning and maintained. It is important to know what is in the gas and how the gas can be best used (science and applied research). Technology is an important component of monitoring and testing the gas and its flow. Mathematics is important for calculating the heating value per cubic foot and the flow rate per minute. Engineering applies in the design of gas collection systems, the power plants that can use the gas, and to make sure it functions properly.

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## A Model of Environmental Interdependency

"I'd like you to think about an integrated solid waste management system as a giant web that cannot have any weak links. Let's see how it works using this ball of yarn. We will be passing it around until everyone holds a piece of it."

- Have the students stand in a circle. Holding on to the end of the yarn, begin gently tossing the remainder of the ball to one student in the class. Have that student hold on to the yarn and toss the remaining ball to another student, who then tosses it to another student, until everyone in the class has a hold on to a piece of the yarn and they are all interconnected in a web.
- Ask one student to gently pull on their part of the yarn. Ask the students what the consequences are of this action to the other people connected to the "web." Throw a ball (like a tennis ball) into the web (it should fall through). Ask the students if there is anything they can do to ensure the ball does not fall through the web. They may suggest moving closer together, or tightening the yarn, or increasing the amount of yarn in the web. Have them make any adaptations they think would improve the strength of the web so that the ball will not fall through.
- Once the ball remains suspended in the web, ask two students to let go of their hold on the yarn. What is the result?

"I want you to think of the web you just designed as an integrated solid waste management plan, that is, waste reduction, recycling, composting and disposal. We do not want to "drop the ball" for our plan. We will be dividing into groups and each will be assigned a part of the plan for an environmental challenge."

- Divide the class into three groups, provide them with their group's challenge cards (attached) and explain that they have about 10 minutes to brainstorm and come up with solutions to the question assigned to their group. Within each group should be designated a facilitator, a timekeeper, a recorder, and a reporter.
  - a. **Group A:** Reflect on the experiment: How does the string represent the community? The environment? Ask students to list some potential impacts on others and the environment if one person or community does not dispose of their waste properly. What is the effect on water, air, land and wildlife? On natural resources? What can you do in your home to be sure the garbage is disposed of properly?
  - b. **Group B:** Reflect on the experiment: How are recyclables reflected in the experiment and where do you think recyclables go? What is most important to remember about recycling? What actions can they take in their community to promote those rules?
  - c. **Group C:** Reflect on the experiment: What waste can be found in nature? What happens to nature's garbage? Name some examples of recycling in nature. How does our recycling impact on nature?

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- Have groups report out on the issues they discussed. Minimally ensure that the following is addressed by the groups:
  - a. An integrated solid waste management plan must be comprehensive. If it does not address reduction, recycling and waste disposal, there will be “holes” (like the tennis ball falling through) in the plan that allow things to pass through and contaminate the recyclables or result in resources going to the landfill instead of being recycled.
  - b. If one person or one organization (for example the school, community, or a business) does not recycle, it breaks the web. Their actions can contribute to depleting natural resources, contaminating the recycling process, and using up valuable space in the landfill.
  - c. Some of nature’s garbage decomposes and these are examples of reusing and recycling. Animals use resources for habitat, shelter, camouflage, protection, tools and nutrients. As examples, birds’ nests, beaver dams, and woodpecker nests are reused, and the earth recycles water with rain, snow, etc.
  - d. Each of us must be committed to supporting an integrated solid waste management plan by doing everything we can to communicate the value and need to recycle often and follow the recycling rules.

“You can now see that each of us has a responsibility in managing our waste. Of highest importance is to recycle often and follow the recycling rules. But it has also become clear that a landfill is a needed disposal option for the un-recycled garbage.”

### **Recycle Right Newspaper Front Page**

Divide the class into groups of five. Ask the students to reflect on the information presented on recycling and the importance of an integrated solid waste management system in their community. Using a piece of poster board, have them design a front page of the newspaper with what they learned including persuasive Recycle Right messages and the importance of environmental protection.

### **Create Your Own Edible Landfill** (attached)

*The Create Your Own Edible Landfill graphic* that follows demonstrates how each layer in a landfill can be replicated using food. This is a dynamic, educational, and fun way to learn more about the structure of a landfill and for students to understand how the different layers contribute to environmental protection. An emphasis should be placed on the explanation of each layer and what it contributes to the structure, as outlined in the graphic. Students can be assigned to bring in the different “layers” of food or the teacher can obtain them personally. One caution is that students with allergies should be addressed in the selection of the types of food to be used in the construction, and parents should be informed in advance in case of any food allergies.

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# CHALLENGE CARDS

## GROUP A CHALLENGE CARD

Reflect on the experiment: How does the string represent the community? The environment?

List some potential impacts on others and the environment if one person or community does not dispose of their waste properly. What is the effect on water, air, land and wildlife? On natural resources?

What can you do in your home to be sure the garbage is disposed of properly?

## GROUP B CHALLENGE CARD

Reflect on the experiment: How are recyclables reflected in the experiment and where do you think recyclables go?

What is most important to remember about recycling, following the recycling rules, and the impact that can make?

What actions can you take in your community to promote those rules?

## GROUP C CHALLENGE CARD

Reflect on the experiment: What waste can be found in nature?

What happens to nature's garbage? Name some examples of recycling in nature.

How does our recycling impact on nature?

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# CREATE YOUR OWN EDIBLE LANDFILL

Begin from the 'bottom up' and learn about this integral process of keeping our environment clean and green!



1. GRAHAM CRACKERS spread a layer on the bottom of your container. Represents the clay liner that prevents liquids ( or leachate) from seeping through to the groundwater.
2. FRUIT ROLL UP add a layer on top of the graham crackers. Represents the plastic liner that creates a barrier and prevents any liquid or trash from seeping out of the landfill and into the environment.
3. RED LICORICE sprinkle on top of the fruit roll ups to represent the leachate collection system
4. VANILLA WAFERS cover the licorice with a layer to represent the sand and gravel that collects the leachate and allows it to drain through the leachate collection system.
5. VANILLA PUDDING spread a thin layer and then top off with a few
6. M&Ms
7. RAISINS or
8. CHOCOLATE CHIPS to represent the first layer of solid waste in your landfill.
9. CHOCOLATE PUDDING spread a thin layer to represent the soil that is used to cover the waste added to the landfill each day.
10. GLACK LICORICE insert vertically into the layers of the pudding (solid waste and soil) to represent the methane gas collection tubes that will remove the leachate from your landfill for transportation to a management facility for proper disposal.
11. GREEN COCONUT sprinkle on top to represent the grass that will grow on top of your landfill.
12. GUMMI WORMS an added touch to represent the critters who will visit your landfill.
13. EXCAVATE eat your ummy edible landfill.

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# RECYCLE RIGHT GRADES 4-5

## The Anatomy of a Landfill Teacher Preparation

1. Review landfill materials: Essential Landfill Information, Follow the Waste Stream, and Typical Anatomy of a Landfill (attached)
2. Prepare copies of the materials listed.

### Materials Needed

(Please note: consider laminating copies for shared or future use or display using available technology)

1. Waste Management poster entitled, **Follow the Waste Stream** (attached)
2. **Typical Anatomy of a Landfill** (attached)
3. **Garbage Decomposition Rates** – both a blank chart and a completed chart (attached)
4. **Recycle Right Recycling Rules** (attached)

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# TEACHER VOCABULARY FOR THE LESSON

Vocabulary for students should be adapted based upon grade level.

## **Contaminate**

To make something dirty or unusable (a list of items that will contaminate the recycling process and should not be recycled is attached in the handout entitled "Recycling Rules.")

## **Decomposition**

Decomposition is a form of recycling that occurs when organic materials break down.

Decomposition is nature's recycling system. Necessary for decomposition are air, heat, moisture, and FBI (fungus, bacteria, invertebrates). Composting is an example of decomposition.

## **Dispose**

Get rid of garbage; to throw away.

## **Groundwater**

Water that passes through the soil to underground reservoirs called aquifers. It is the source of water in springs and wells.

## **Groundwater Monitoring Wells**

Groundwater monitoring wells are used at landfills to enhance environmental protection. Samples are collected routinely and analyzed by state approved and qualified independent laboratories. The lab results are evaluated and then sent to local or state regulatory agencies for review.

## **Integrated Solid Waste Management**

A plan for disposing of garbage that uses several complementary components including source reduction, recycling, composting, waste-to-energy and landfill.

## **Landfill**

An engineered facility for disposing of solid waste, designed to reduce it to the smallest practical volume and be protective of the environment.

## **Landfill Liner System**

Natural and synthetic components associated with constructing the landfill containment system for protection of the environment.

## **Leachate**

Wastewater at a landfill from precipitation that passes through the garbage that is collected and treated to clean water standards.

## **Methane**

Gas produced as the garbage decomposes. This gas is collected through a system that includes gas wells, collection pipes and a compressor to create a vacuum. The energy from landfill gas helps reduce fossil fuels and lessens dependency on foreign oil.

## **Waste-to-Energy**

Disposal method for garbage brought to a facility where it is burned and converted into clean energy.

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## ESSENTIAL LANDFILL INFORMATION

After garbage is collected, it goes to the landfill for disposal. The truck enters the landfill where it is weighed, videotaped and necessary paperwork presented to a scalemaster. Landfills have strict regulations on the garbage allowed for disposal. The truck will be weighed again as it leaves the landfill to determine the amount of garbage disposed of and calculate the cost for billing.

The truck is directed to a designated disposal area, or cell, where it will dispose of the waste. The cell engineering, design and construction ensure groundwater protection and that the landfill is safe and secure. The pitch is like a bathtub with a low spot for draining liquids. Construction includes a multi-layered liner system and leachate (wastewater produced when rainwater filters through the waste) collection system.

Landfill compactors drive over the trash to pack it tightly into the cell. At the end of each day, six inches of soil, or approved material, covers the exposed trash. This keeps the garbage from blowing away, minimizes odors, and provides protection from animals and birds.

In the landfill, the waste decomposes in a natural, biological process, similar to that in a compost pile. As waste decomposes, it produces methane gas and is collected through a system that includes gas wells, collection pipes and a compressor to create a vacuum. Landfill gas is recycled as an energy source. Landfill gas has a number of energy applications. The most common use is production of electricity for sale to a local utility. Other options include using it directly as boiler fuel, producing compressed natural gas for vehicle fuel, to create steam for industrial processes, and upgrading it to pipeline-quality gas. Landfill gas is a valuable resource that helps conserve our energy reserves. Energy from landfills helps reduce the depletion of fossil fuels and lessens the dependency on foreign oil. This is a benefit to both the community and the environment.

When cells reach final elevation, a composite cap system is installed, at least two feet of compacted soil applied and vegetation planted. The landfill operator then implements a closure plan that includes maintenance of the landfill, groundwater monitoring, collecting and monitoring methane gas, and maintaining the final cover. After closure, landfills can continue to serve communities as parks or other open spaces.

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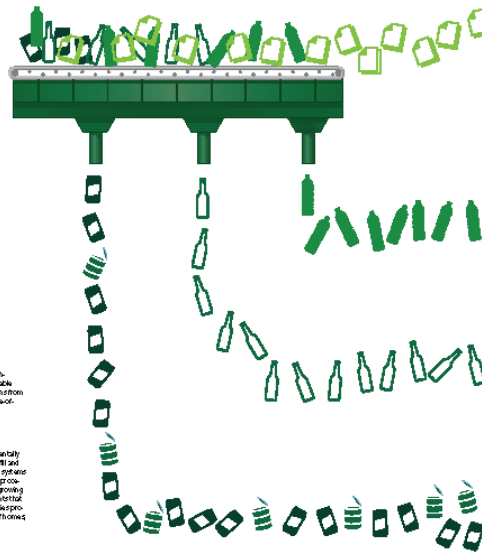
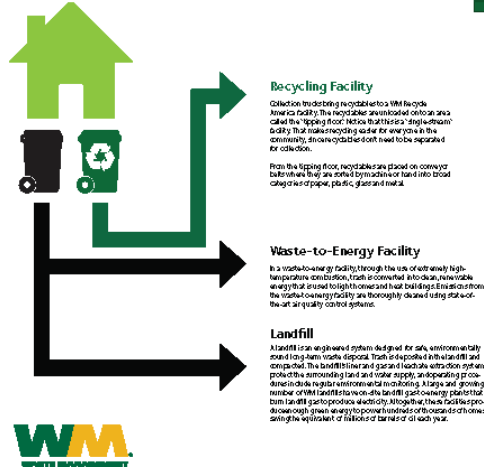
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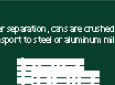




# MATERIAL RECOVERY FACILITY GRAPHIC

## Follow the Waste Stream

The "waste stream" is a term to describe the entire life cycle of the garbage we produce – from putting out the trash and recycling for pickup to landfilling, energy production and the reuse of recycled materials. Let's follow the journey...



<p><b>Paper</b></p> <p>Paper recyclables are separated into 4 categories:</p> <ul style="list-style-type: none"> <li>• Commercial boxes</li> <li>• Old Newspaper (ONP)</li> <li>• Mixed paper</li> <li>• Office mix</li> </ul>	<p>Paper recyclables are baled and sold primarily to paper mills.</p> 	<p>Old newspaper is de-linked by washing and rinsing it in large vats of water. This process also separates the short fibers from the long fibers.</p> 	<p>Some mills are able to use 100% recycled paper, while in others, recycled paper (long fibers) is combined with wood scraps from lumber mills. This is mixed to a pulp and poured onto large rollers and drained. The sheet is knead and fed through heated rollers, then finished and rolled. The rolls are sent to printing plants.</p> 	Recycled Paper
<p><b>Plastic</b></p> <p>Mixed plastic containers are sorted by type and color. Air is blown into the mix to separate heavier and lighter plastic. In some facilities, plastic containers are optically scanned for separation into types, such as PET, HDPE, etc.</p> 	<p>Textile, plastic, bottle, carpet and other manufacturers use these commodities.</p> 	<p>Baled, recycled plastics are sent to a plastics manufacturing plant. The plastics are ground up, washed, melted and formed into plastic pellets. The pellets are used to make containers, bottles, paint, clothing, furniture and many other consumer goods.</p> 	<p>Recycled plastic</p> 	Recycled Plastic
<p><b>Glass</b></p> <p>Glass recyclables are crushed to form cullet, which is then cleaned of debris and contaminants. Depending on the facility, glass may be sorted by color before or after crushing, or it may be shipped to end users without sorting.</p> 	<p>Cullet is loaded into trucks for transport to a variety of customers. Its used in a number of applications, including new containers for consumer products, road bedding, sandblasting, counter tops, and other uses.</p> 	<p>For use in making new glass containers, the cleaned cullet is mixed with sand, soda ash, feldspar and limestone at a glass plant. It is fed into a furnace and melted at temperatures reaching 2,700° Fahrenheit. Using recycled glass in this way reduces emissions and energy usage, extends the life of plant equipment, and conserves raw materials.</p> 	<p>Recycled Glass</p> 	Recycled Glass
<p><b>Metal</b></p> <p>Magnets are used to separate the steel from the rest of the recycling stream. Steel attracted to the magnet is removed to storage bin for baling.</p> <p>Aluminum remains on the sort belt and is mechanically separated by an eddy current.</p> 	<p>After separation, cans are crushed and baled for transport to steel or aluminum mills.</p> 	<p>Metal cans are crushed and poured into right molds or rolled into sheets. This steel is used by distributors to make new aluminum products.</p> 	<p>The steel is heated in large vats and poured onto sheets. The steel is coated with tin and shaped into cans.</p> <p>The sheets are shaped into cans, siding, storm window frames and other products.</p> 	Recycled Metal

## Closing the Loop

Recycled containers and products are purchased by manufacturers, who use them to produce or package their products that are shipped to retailers.



Consumers buy the products from a wide variety of retail stores. As we use the products, we create waste that begins the cycle over again.

## Choose Wisely!

There is currently no economical technology for separating waste from recyclable materials. The success of recycling depends on you! Place recyclables in the proper recycling container.

**THINK GREEN!**

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# TYPICAL ANATOMY OF A LANDFILL

**1 COVER VEGETATION**  
As portions of the landfill are completed, native grasses and shrubs are planted and the areas are maintained as open spaces. The vegetation is visually pleasing and prevents erosion of the underlying soils.

**2 Top Soil**  
Helps to support and maintain the growth of vegetation by retaining moisture and providing nutrients.

**3 PROTECTIVE COVER SOIL**  
Protects the landfill cap system and provides additional moisture retention to help support the cover vegetation.

## Composite Cap System

**4 Drainage Layer**  
A layer of sand or gravel or a thick plastic mesh called a geonet drains excess precipitation from the protective cover soil to enhance stability and help prevent infiltration of water through the landfill cap system. A geotextile fabric, similar in appearance to felt, may be located on top of the drainage layer to provide separation of solid particles from liquid. This prevents clogging of the drainage layer.

**5 Geomembrane**  
A thick plastic layer forms a cap that prevents excess precipitation from entering the landfill and forming leachate. This layer also helps to prevent the escape of landfill gas, thereby reducing odors.

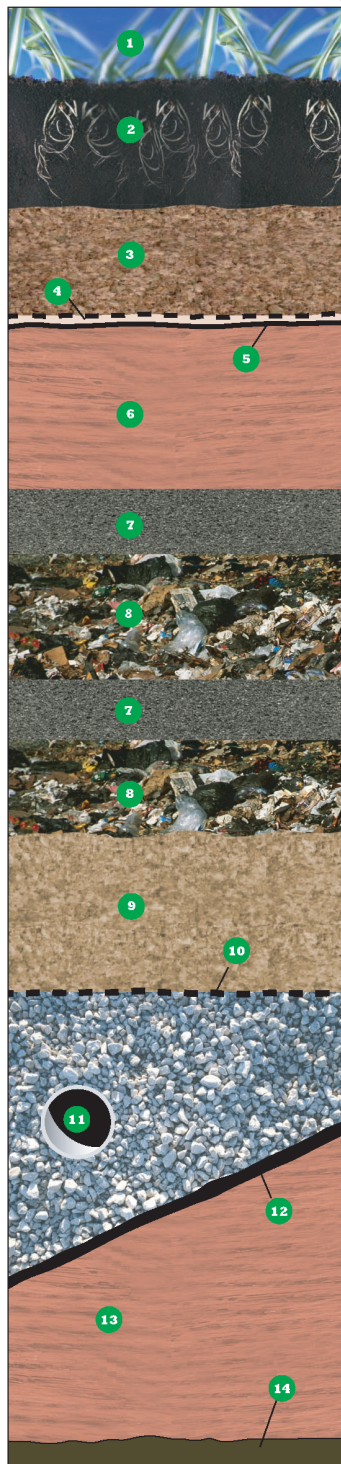
**6 Compacted Clay**  
Is placed over the waste to form a cap when the landfill reaches the permitted height. This layer prevents excess precipitation from entering the landfill and forming leachate and helps to prevent the escape of landfill gas, thereby reducing odors.

## Working Landfill

**7 Daily Cover**  
At the end of each working period, waste is covered with six to twelve inches of soil or other approved material. Daily cover reduces odors, keeps litter from scattering and helps deter scavengers.

**8 Waste**  
As waste arrives, it is compacted in layers within a small area to reduce the volume consumed within the landfill. This practice also helps to reduce odors, keeps litter from scattering and deters scavengers.

**Please Note:** This illustration depicts a cross section of the standard environmental protection technologies of modern landfills. While the technologies used in most landfills are similar, the exact sequence and type of materials may differ from site to site depending on design, location, climate and underlying geology.



(Not to scale)

## Leachate Collection System

Leachate is a liquid that has filtered through the landfill. It consists primarily of precipitation with a small amount coming from the natural decomposition of the waste. The leachate collection system collects the leachate so that it can be removed from the landfill and properly treated or disposed of. The leachate collection system has the following components:

### 9 Leachate Collection Layer

A layer of sand or gravel or a thick plastic mesh called a geonet collects leachate and allows it to drain by gravity to the leachate collection pipe system.

### 10 Filter Geotextile

A geotextile fabric, similar in appearance to felt, may be located on top of the leachate collection pipe system to provide separation of solid particles from liquid. This prevents clogging of the pipe system.

### 11 Leachate Collection Pipe System

Perforated pipes, surrounded by a bed of gravel, transport collected leachate to specially designed low points called sumps. Pumps, located within the sumps, automatically remove the leachate from the landfill and transport it to the leachate management facilities for treatment or another proper method of disposal.

## Composite Liner System

### 12 Geomembrane

A thick plastic layer forms a liner that prevents leachate from leaving the landfill and entering the environment. This geomembrane is typically constructed of a special type of plastic called high-density polyethylene or HDPE. HDPE is tough, impermeable and extremely resistant to attack by the compounds that might be in the leachate. This layer also helps to prevent the escape of landfill gas.

### 13 Compacted Clay

Is located directly below the geomembrane and forms an additional barrier to prevent leachate from leaving the landfill and entering the environment. This layer also helps to prevent the escape of landfill gas.

### 14 Prepared Subgrade

The native soils beneath the landfill are prepared as needed prior to beginning landfill construction.

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# GARBAGE DECOMPOSITION RATES

## Handout

HOUSEHOLD ITEM	YOUR BEST GUESS	SCIENTISTS' APPROXIMATIONS	RECYCLABLE ? YES OR NO
Plastic Bottle			
Leather Shoe			
Banana Peel			
Glass Bottle			
Tin Can (soup or vegetable)			
Wool Sock			
Cigarette Butt			
Cotton Rag			
Plastic 6-pack rings			
Aluminum Can (soda)			
Newspaper			
Paper Bag			

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# GARBAGE DECOMPOSITION RATES

## Answer Key

HOUSEHOLD ITEM	YOUR BEST GUESS	SCIENTISTS' APPROXIMATIONS	RECYCLABLE ? YES OR NO
Plastic Bottle		450 Years	YES
Leather Shoe		40-50 Years	NO
Banana Peel		3-4 Weeks	NO
Glass Bottle		1 Million Years (Forever?)	YES
Tin Can (soup or vegetable)		80-100 Years	YES
Wool Sock		1 Year	NO
Cigarette Butt		2-5 Years	NO
Cotton Rag		5 Months	NO
Plastic 6-pack rings		450 Years	YES
Aluminum Can (soda)		200-500 Years	YES
Newspaper		6 Weeks	YES
Paper Bag		1 Month	YES

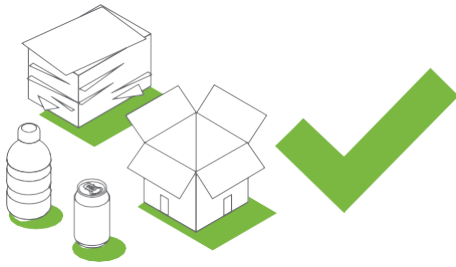
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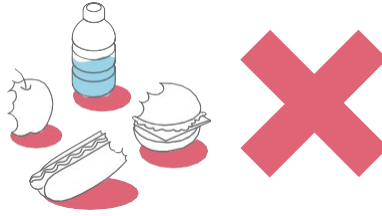


# RECYCLING RULES

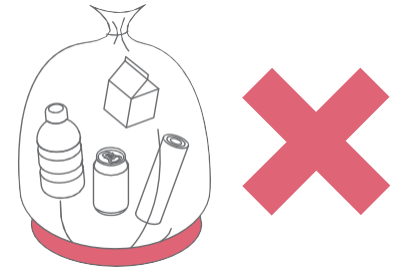
Certain offenders can slow down the recycling process or even ruin the load.



Recycle clean bottles, cans, paper, and cardboard.



Keep food and liquid out of your recycling.



No loose plastic bags and no bagged recyclables.

Visit [wm.com/recycleright](http://wm.com/recycleright) to join the cause and become a Recycling Ambassador.

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## Examples of Items That Contaminate the Recycling Process:

- Paper
- Towels
- Straws
- Items with Food or Liquid
- Chip Bags
- Juice Pouches
- Foam Cups
- Candy
- Wrappers

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# RELATIONSHIP TO NEXT GENERATION SCIENCE STANDARDS FOR GRADES 4-5

STANDARD	RELATIONSHIP
4-ESS3-1	Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. Over time, peoples' needs and wants change, as do their demands for new and improved technologies. Knowledge of relevant scientific concepts and research findings are important in engineering.
4.ESS3.A	Energy and fuels that humans use are derived from natural resources and their use affects the environment in multiple ways. Some resources are renewable and others are not.
3.MD.B.3	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.
4-ETS1-A	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution.
4-PS3-4	Apply scientific ideas to design, test and refine a device that converts energy from one form to another. Engineers improve existing technologies or develop new ones. Most scientists and engineers work in teams.
4.OA.A.1	Interpret a multiplication equation as a comparison. Represent verbal statements of multiplicative comparisons as multiplication equations.
4.OA.A.3	Solve multi-step word problems posed with whole numbers and having whole number answers using the four operations, including problems in which remainders must be interpreted.
4.MD.A.1	Know relative sizes of measurement units within a system of units.
4.MD.A.2	Use the four operations to solve word problems involving distances, intervals of time, liquid, volumes, masses of objects, and money, including problems, involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit.
5.NF.B.7	Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by fractions.

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# RELATIONSHIP TO NEXT GENERATION SCIENCE STANDARDS FOR GRADES 4-5

STANDARD	RELATIONSHIP
5.MD.A.1	Convert among different-sized standard measurement units within a given measurement system and use these conversions in solving multi-step word problems.
5.ESS3-1	Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and the environment.
5-PS1-3	Make observations and measurements to identify materials based on their properties.
5-LS2-1	Develop a model to describe phenomena.

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