



# YALE NATIONAL INITIATIVE

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Curriculum Units by Fellows of the National Initiative  
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## **Reduce, Reuse, Recycle, Oh My!**

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by Huwerl Thornton, Jr.

### **Introduction**

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I teach 3<sup>rd</sup> grade at Wexler-Grant Community School in New Haven, Connecticut. We are a school that begins with headstart and ends with 8<sup>th</sup> grade. We have an interesting history. We were two separate schools at one time: Helene W. Grant School and Isadore Wexler School. We merged during the 2002-2003 school year. Our population of students is approximately 90% African-American and the remaining 10% is made up of White, Hispanic, and Indian. We are a community school which means that our building is open to the neighborhood in a variety of ways. We open the gym to the youth so that they can play basketball, the cafeteria is used for African drumming, Tai Chi, Pilates, and more. Our auditorium is used to put on plays and other types of performances as well as graduations for other high schools. Other types of meetings, seminars, conferences, and workshops take place in our building for various organizations within the community throughout the year. We have a family resource room that provides services for parents, grandparents, and students. We try to truly embrace and embody the concept of community, which is included in our name.

### **Rationale**

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The actions and attitudes of my children helped to drive me toward this seminar. The rising cost of oil was the proverbial nail in the coffin in helping me decide to choose the seminar: Energy, Climate, and Environment. I am amazed at the amount of paper and pencils that are wasted every day in my school. If a child makes a mistake on their paper, they want a new paper. If their paper gets wrinkled, they want to throw it away and get a new paper. The boys in my class are constantly balling up papers, new and old, to make jump shots in the wastebasket. At the end of the day, my two trashcans are overflowing with paper and other trash. Our children today are growing up in a disposable society and have no idea about where some things come from and that those things could potentially run out. We use paper and foam plates, plastic cups, plastic cutlery, and paper napkins. Even our electronics have become disposable. There are disposable cameras, disposable video cameras, and organic transistors and semi-conductors that will be in use in credit cards and packaging by the year 2015 as reported by NanoMarkets in 2007. We have become a throw-away society. How did this happen? The fact that we as a society have no qualms about throwing trash away without a second thought of

its effect on the planet. This is the core of the problem. My students have become the embodiment of this problem. They don't even know where the trash goes when they throw it away nor do they care. It is important to raise the consciousness of the newest generation about the deforestation and clear cutting of the land not only here in the United States, but all over the world. Global warming is very real and it will have a major impact on the lives of my students, especially when they become adults.

The rising cost of oil has also become a concern of my mine for my students. Fossil fuels are a limited resource and I worry that by the time my students reach my age, fossil fuels will become very rare or non-existent. Thus the cost of gasoline or home heating oil will be exorbitant. My fear is that our government tends to be reactive. I want to teach my students be proactive. It would not surprise me if our government waits until most or all of the fossil fuels have been used up and then decide to look for alternative resources. By then it will be too late and there could be major upheaval in our country. Connecticut is a state that has public transportation, but it is basically limited to busses and van pools. It is very difficult to get around without a car. The cost of oil became so high in 2008 that many people had difficulty heating their homes. I believe that our children deserve better!

I would like this unit to focus on teaching my students the three R's: Reduce, Reuse, and Recycle. I want my students to know about the importance of trees and their relationship with the paper industry and the planet. My students will create a PowerPoint presentation that showcases what is happening to the landfills in our country as well as the waste management techniques in other parts of the world. It is important that they also have ideas and strategies that can be implemented to rectify the problem.

I would also like to implement a more hands on approach to this unit. I want my students to look at the various types of waste management in this country. I would like for them to take a stance as to which practice they think is better for our country and our environment. I want them to explore what ideas they may have as to how to deal with waste. It is extremely important for them to take a look at their own lives and see where they can make changes to reduce the amount of trash that they throw away, reuse items so that they are not thrown away, and recycle those things that can be recycled. My students need to know how trash affects global warming and how practicing the three R's can combat it.

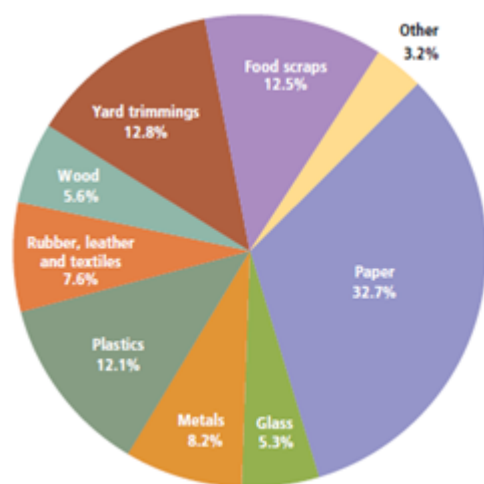
## So What's the Big Deal?

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Many people wonder what is the big deal? We buy an item, use that item, and when we are done and that item has out used its usefulness, we throw it away. We never put much thought into where that item goes once it has left our home. The average person probably does not know where their trash goes and the effect that trash has on the environment. Adults would probably say that it goes to a landfill. Children would probably say that the trash just goes away on the garbage truck. However it is important to know that our trash is composed of many different types of materials. A person may be surprised if they could analyze the contents of what is in a typical bag of trash that is taken from someone's home. Typically there is food of all types from banana peels, apple cores, bones, coffee grounds and a myriad of other items directly related to food. This in and of itself is not too bad. But what about the styrofoam plate, plastic silverware and plastic cups used for a meal that are disposed of in the trash? These are items that do not decompose as easily and readily as food products. Now, let's throw in paper of all types, copy paper, newspaper, packaging of a product, batteries, broken toys, burned out light bulbs and a wide variety of other items. All of these items are

sent away in the trash without a care or worry of the disposer. Mother Nature is beginning to make people take notice.

The United States Environmental Protection Agency (EPA) has collected data for more than 30 years about the generation of waste and the disposal of that waste. In 2007, the United States generated 254 million tons of waste. <sup>1</sup> The amount of waste per person that is generated is approximately 4.62 pounds per day. <sup>2</sup> This is an increase from 3.66 pounds per person in 1980. In almost 30 years, the amount of waste per person has increased by one pound. This is amazing that the average person is throwing away about 5 pounds of trash a day. In the course of one year, the average person is throwing away approximately 1,686 pounds! The Earth is saying, "No More!" The EPA did a breakdown of the 254 million tons of waste that were thrown away by the U.S. in 2007. The EPA reported that 32.7% of all waste was paper, 12.8% were yard trimmings, 12.5% were food scraps, 12.1% were plastics, 8.2% were metals, 7.6% were rubber, leather and textiles, 5.6% were wood, 5.3% were glass, and 3.2% was other. <sup>3</sup> A graphical representation better illustrates this. This graph comes courtesy of the Environmental Protection Agency's (EPA) Guide for Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007.



So what does this mean to the average person? Why is this important? In the past 47 years, the amount of waste that each person generates has increased from 2.7 pounds per day to 4.62 per day. <sup>4</sup> If this trend continues, there will be serious issues to contend with in the next 50 years as our population continues to rise. The best way to tackle this problem is to try to prevent the waste from being generated in the first place. It is essential to look at how we can reduce the amount of waste we generate, reuse items so that they are not discarded in the trash, and recycle objects that have been discarded.

## Where Does the Trash Go?

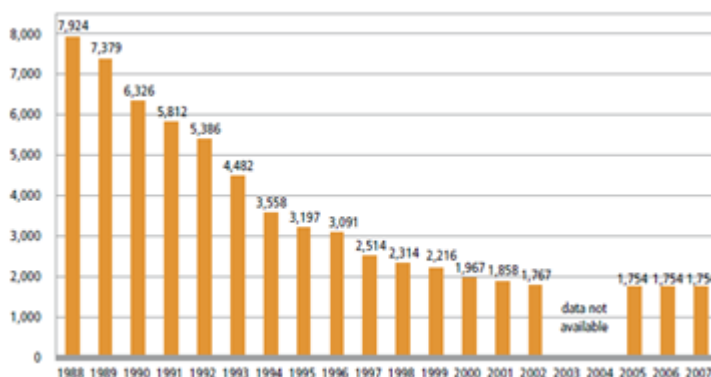
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When the trash is put on the garbage truck and taken out of the community, where does it go? There are two main areas that trash is brought to be disposed of, landfills and incinerators also called combustion facilities. A landfill is typically a hole in the ground where trash is brought and buried. Historically, it was called a midden. A landfill is one of the oldest forms of waste treatment. It is also one of the most common forms of waste treatment still in use today. Landfills have evolved over the years. They had to. In many cases, as items began

to decompose the toxicity levels began to rise. Rain water would mix in and create a substance called leachate. Leachate has been known to migrate from the landfill and contaminate wells, lakes, rivers, as well neighboring soil. Current landfills are chosen carefully based on proximity to the street, and the type of land it will be treated on. The landfill site has to pass very strict legal, environmental, and engineering tests. This process can take some time. It can easily take five years before a landfill is ready to use and the cost can be anywhere from \$ 2 to \$ 4 million dollars.

The modern landfill is no longer just a hole in the ground to dump trash in. A newer landfill is able to use the properties of a landfill to the advantage of the people. New landfills have four basic components. First, all modern landfills must be set in geologic location that has clay deposits and other natural land features that will help in preventing contamination from the landfill to the natural environment around it. Second, the bottom and sides of a modern landfill must have a liner that is made of clay or plastic. The purpose of the liner is to prevent leachate from escaping and contaminating the natural environment around it. The third thing a modern landfill must have is a leachate collection system. Leachate is collected by a series of drains that are networked throughout the landfill, and the leachate is pumped to the surface and sent to a wastewater treatment plant for treatment. The fourth and final element essential for modern landfills is a cover. The cover is usually several sloped layers of clay, soil, or membrane liner. This is to keep rain from entering the landfill and forming new leachate. A topsoil often overlays the landfill so that vegetation can root and stabilize the underlying layers of the cover. The cover has to be maintained. If it is not maintained, the leachate can build up to a point that it overflows the landfill and contaminates the surrounding environment. Covers are vulnerable to the natural environment around them. They can erode, vegetation grows on them thus bringing in burrowing soil-dwelling mammals, as well as reptiles, insects, and worms. Sunlight can even be a problem for covers, they are susceptible to cave-ins and even rubber tires which somehow tend to float upward in a landfill causing a possible breach. Modern landfills may also have additional components to them. They may have a well to monitor the methane gas that is created from the decomposing waste. Other landfills have a way to harness the methane gas where it can be used as a fuel for vehicles or power plants. This is very important for our planet. Methane gas is a gas that tributes to the greenhouse effect. The greenhouse effect is causing our planet to heat up at an unnatural rate.

Landfills are the most common way to dispose of waste in this country. Surprisingly, the number of landfills have decreased in the United States. In 1988, there were 7,924 across the country, by 2007 there were only 1,754. <sup>5</sup> The bar graph below illustrates the decline. This graph comes courtesy of the EPA's Guide for Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007.



Although the number of landfills in the United States has declined, the size of the average landfill has increased. Zerowasteamerica.org has described a landfill as a big bathtub. The liner works to hold everything in but sometimes there are problems. The state of the art liners are made of a tough polyethylene plastic

(HDPE) that is only 1/10 of an inch thick and whether it is clay or plastic can become brittle and crack due to the common household chemicals that can degrade it such as mothballs, margarine, vinegar, ethyl alcohol, shoe polish, and even peppermint oil. When cracks form in the liner, leachate and other contaminants can leak into the ground and surface water. Studies have shown that a ten acre landfill that has a leaking liner can have a leak rate somewhere between 0.2 and 10 gallons per day. <sup>6</sup> Another potential problem is that the landfill can fill up with leachate and overflow, polluting and contaminating the surrounding area. This can happen when the pipes that carry the leachate to the wastewater system get clogged, deteriorate, or are crushed from the weight of the waste.

In 1989 Dr. William Rathje, a professor at the University of Arizona, did a very surprising study. He wanted to find out what was in America's landfills, so he formed a group called the Garbage Project. What the group found astonished him! Items that were thought to degrade quickly were found in the landfill in relatively good shape. The Garbage Project found newspapers from 1952 that could still be read perfectly, grass clippings that were still green, hot dogs that looked good enough to eat, a banana that was still yellow, and an ear of corn that had the husks and all, mixed in with material that was dated from 1971. Newspaper in a laboratory degrades very quickly. Sometimes it degrades within a day. The items that Dr. Rathje expected to find like plastic, foam packaging, and disposable diapers were there, but they were in much smaller amounts than the experts had predicted.

Another place trash goes is to an incinerator or combustion facility. An alternative to landfills, incinerators are more expensive but tend to be a safer method of waste disposal. An incinerator is simply a type of furnace that is used for burning waste. Modern incinerators are built and designed to destroy at least 99.9% of the organic waste material that they handle. <sup>7</sup> There are a number of thermal processes that recover energy from solid waste. Some companies will burn in-plant wastes in conventional incinerators so that they can produce steam. Most of the incinerators used in this country incorporate the recovery of an energy product, usually steam or electricity. There is a benefit to doing this, the energy that is produced reduces the amount of energy needed from other sources. The sale of the energy generated helps to offset the cost of operating the facility. Early on, the sole purpose of incinerators was to reduce the sheer volume of waste. It was not until the 1980's that the recovery of energy became more prevalent. The total number of incinerators in the United States that recovered energy from combustion was 87 in 2007, that's down from 102 in 2000. <sup>8</sup> These facilities in 2007 were processing 94,721 tons per day (tpd). <sup>9</sup> The EPA reports that the Northeast region had the most facilities that recovered energy from combustion. The following table from the EPA's Municipal Solid Waste In The United States: 2007 Facts and Figures Guide, shows how the municipal waste-to-energy facilities are distributed throughout the country:

Region	Number Operational	Design Capacity (tpd)
Northeast	40	46,537
South	23	31,131
Midwest	16	10,912
West	8	6,141
U.S. Total	87	94,721

There is a stark contrast between the Northeast and the West. There is a small, but growing number of facilities that are separating specific waste, particularly rubber tires which have been used as fuel in cement kilns, utility boilers, pulp and paper mills, industrial boilers, and dedicated scrap tire-to-energy facilities. <sup>10</sup> There is also combustion of wood wastes and some paper and plastic wastes. These are usually incinerated in

boilers that already burn some other type of solid fuel. The EPA in its 2007 report estimated that about 3.1 million tons of waste was incinerated in this manner with tires contributing the majority of the total. <sup>11</sup>

When waste comes in it must be sorted for not all materials can be incinerated. A process of chemical decomposition, called pyrolysis, produces a variety of gases and inert ash. If the wrong material is incinerated, it could release toxic fumes and ash that could harm the workers and the environment. In the past, waste that has been burned in incinerators has poisoned the air, soil, and water. For this reason, many communities object to being near incinerators for fear of possible toxic emissions.

A third way of disposing waste is to compost. Composting is a biological process that occurs when tiny microscopic organisms break down organic waste which is plant and animal based waste. <sup>12</sup> The microscopic organisms recycle the organic waste and turn it into a new rich, healthy, and fertile soil that can be used for a garden. The combination of the oxygen, heat and moisture helps to break down the organic waste. The second largest portion of American trash is yard trimmings. Composting is a specialized type of recycling that recycles yard waste as well as kitchen waste. Some cities have a separate compost area where they will take yard waste. The great thing about composting is that it can be done at home or at school. Composting at home can save time, energy and money needed for transporting yard and home waste from a home to a landfill or recycle center.

There is another seldom used method for waste disposal. The hazardous waste is pumped into deep wells in the earth. There is very strong opposition to this method. There have been explosions and even earthquakes that have resulted from this technique of injecting waste deep into the earth.

## Ancient Recyclers

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With our growing and rising mounds of trash that our country is producing, the alarms about what to do are rising. However, the idea of recycling is not a new concept. The California Environmental Protection Agency created a very well written document called The Illustrated History of Recycling in 1997. It does a very nice job of giving the history of recycling which I shall share in my unit. When nomadic people began to settle down in 10,000 B.C., there became the issue of what to do with the waste? No longer could they just drop their waste as they traveled. Thus began the challenge of what to do with the trash? In 1,600 B.C., religious, utilitarian, and social conventions played a major role in establishing sanitary practices. As an example, Jewish code of sanitary law obligated individuals to be responsible for removal of their own waste. In 500 B.C., Athens organized the first municipal dump in the western world. The local law dictated that all waste must be disposed of at least one mile from the city walls.

In 1301, Japan is the first country on record for using waste paper for making new paper. All of the documents and paper were recycled and repulped into new paper. It was then sold in paper shops. In addition to the rat fleas, garbage tossed onto the unpaved streets and vacant spaces allowed the Black Death epidemic to kill hundreds of thousands of men, women, and children in 1348. The recycled paper manufacturing process was introduced in 1690. The Rittenhouse Mill near Philadelphia began to make paper from the fiber that came from recycled cotton and linen rags.

During the American Revolution in 1776, all types of material from cloth to metal to paper was recycled and



reused to fight the British. In 1801, the first mill that produced paper from material other than cotton and linen rags, was built in London England. In the 1840's, men with backpacks and horsedrawn carriages would travel from town to town in an attempt to collect and recycle anything that had a resale value. These men were usually poor immigrants who had just come to this country. Some of them are the direct descendants to some of today's most successful scrap-recycling business families. In 1849 the U.S. canning business began to take off as the gold rush and the Civil War required food that could be preserved and transported over long distances. In 1849, the U.S. canning business produced 5 million cans. Five years later in 1854, U.S. canners were producing 30 million cans. The Salvation Army was created in 1865 in London, England. They begin by collecting, sorting, and recycling unwanted goods. The Salvation Army comes to the United States in the 1890's and they bring their recycling ideals with them. Curbside recycling begins in Baltimore, Maryland in 1874. That same year, a new device called "the destructor" was invented in Nottingham, England. This device provided the first systematic incineration of municipal waste. In 1895, New York City appoints Colonel George E. Waring as street-cleaning commissioner. Waring created the first practical comprehensive system of waste management in the United States. His system required households to sort organic wastes, paper, ashes, and street sweepings into separate containers for collection. Waring's system even helped New York make a profit by reselling the recovered materials that were separated. New York City in 1897 creates a materials recovery facility where trash is separated into various grades of paper, metals, and carpet. Burlap bags, twine, rubber, and even horsehair are also sorted for recycling or reuse. <sup>13</sup>

The first aluminum can recycling plants to open in the United States opened in Chicago and Cleveland in 1904. World War I saw shortages of raw materials from 1916 to 1918. The federal government created the Waste Reclamation Service. Their motto was, "Don't Waste Waste - Save It." The Waste Reclamation Service advertised extensively to encourage the public to save old rags and wastepaper. The agency was the first to advocate scientific methods of managing the United States' water, timber, land and minerals in an attempt to protect resources for future generations. For the first time in our nation's history, thousands of tons of old books, newspapers, and business papers are recycled by paper mills. The 1920's saw the introduction of landfills. This becomes a popular disposal method by reclaiming wetlands with layers of garbage, ash and dirt. From 1939 to 1945, World War II had the attention of the world. Once again, like in World War I, recycling became a major cause to rally behind. Americans begin to donate everything from doorknobs to girdles to help in the war effort. One magazine went so far as to say that salvaging the metal straps from corsets alone saved enough metal to build two warships.

In 1955, the August 1<sup>st</sup> issue of Life magazine shows the country a lavish two-page spread of a family titled, "Disposable Living." The article talks about using disposable plates and silverware and celebrated their ability to cut down on household chores." A photo of the family shows them cheerfully throwing dozens of their disposables into the air. This had a profound effect on the American consumer. They began to look for single use items as a necessity of a modern life. Ease of use and convenience became two of the most desirable qualities American consumers looked for when making purchases. This had an extremely negative side-effect. American parks, forests and highways became littered with trash. In 1959, the American Society of Civil Engineers published a guide to landfilling. This guide called for compacting trash and covering it daily with a layer of soil to guard and protect against rodents. Later landfills will call for much stricter standards. New landfills must have a liner on the bottom and liquid collection systems that will pump out water as well as collect methane gas which is produced as waste decomposes. The Solid Waste Disposal Act is passed by Congress in 1965. This is the first significant recognition of waste as a national issue. The primary focus of the act is to start up a national research and development program and to help state and local governments with their disposal programs.

1970 could be considered a landmark year for the start of the modern day era of environmental concern. 1970 marks the "beginnings" of the modern day push for recycling in this country. April 22, 1970 marked the first "Earth Day" celebration in the United States. It was created by Wisconsin Senator Gaylord Nelson. The first Earth day had approximately 20 million Americans celebrating at festivals and fairs all throughout the United States. Recycling is one of the focuses, and it begins to evolve into a mainstream movement throughout this country. The United States Environmental Protection Agency was created in 1970 as a government response to the public's growing environmental concerns, as well as the Office of Solid Waste began to examine problems caused by the generation and disposal of waste.

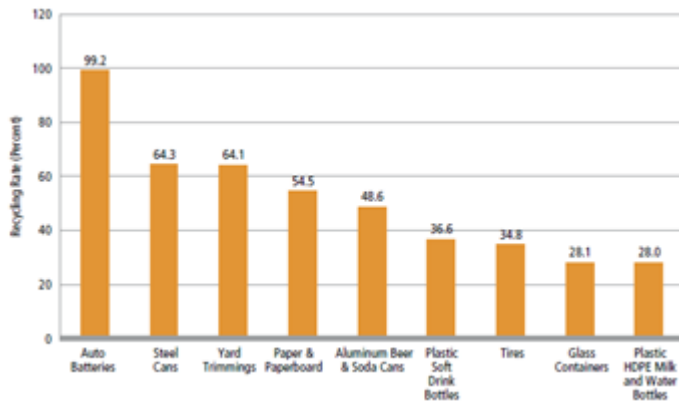
The California EPA guide continues on to 1995 with other various facts and tidbits about the history of recycling in this country. It is curious to see that at various times this country has rallied behind a cause and recycled all sorts of materials. At times, we as a country often still have the attitude of the family in the Life magazine article. We look for ease of use and convenience in so many areas of our lives. Can you imagine china plates, metal silverware, glass cups, and cloth napkins at a 4<sup>th</sup> of July cookout? The host would probably have a heart attack just thinking about the clean-up afterwards! The flip side of that scenario is, think about how many bags of trash there would be if all the materials were reusable. To make this kind of change in thought process, it must be done with the children. They have to see using reusable items as the "norm" and disposable items used for that rare occasion.

## Is There Hope for the Future?

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Though this unit may read like a lot of gloom and doom, there have been positive changes in the attitudes and thinking of Americans in this country. The EPA reports that out of the 254 million tons of trash that was generated in the United States, 85 million tons of that waste was recycled and composted. This results in a 33.4% recycling rate and on average United States citizens recycled and composted 1.5 pounds of the 4.6 pounds that individuals waste per day. <sup>14</sup> The EPA reported that in 2007, Americans recovered 63 million tons (excluding composting) through recycling and this is 1.9 million more tons than in 2006. <sup>15</sup> Composting recovered almost 22 million tons of waste and Americans combusted 32 million tons for energy recovery which is about 13 percent. <sup>16</sup> When subtracting out what was recycled and composted, as well as what was combusted with energy recovery, Americans discarded just over 3 pounds per person per day. Although the amount of solid waste generated per person increased from 3.6 pounds to 4.62 pounds, the recycling rate has also increased. In 1980, less than 10 percent of the waste generated was recycled. In 2007, that has increased to over 33 percent. <sup>17</sup> In 2007, paper and paperboard recovery rose to over 54 percent which translates into 45 million tons, and 64 percent of yard trimmings were recovered. Metals were recycled at a rate of almost 35 percent and by recycling 7 million tons of metals, which includes aluminum, steel, and mixed metals, greenhouse gas emissions totaling close to 25 million metric tons of carbon dioxide equivalent were eliminated. <sup>18</sup> The EPA calculates that this is equivalent to removing more than 4.5 million cars from the road for one year. The bar graph below shows the different items and the amounts at which they were recycled. This graph comes courtesy of the EPA's Guide for Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007.





The item that was recycled the most was car batteries. It is important to help the American consumer to realize that house batteries need to be recycled at the same rate. Too often batteries are used to power various electronics at home and they are discarded into the trash. Those batteries can contain dangerous chemicals that cannot be incinerated and should not be placed in a landfill. The batteries will leak and contribute to the leachate of a landfill.

The evidence from the EPA shows that people are recycling more but there is still room for improvement. It is important for people to begin to reduce their amount of personal waste. Although this unit is about the three R's, I would like the unit to focus on reducing and reusing. It is vitally important to raise the consciousness of students to recognize the amount of trash that they are throwing away, as well as their family members.

It is really important to look to nature to provide the model as to how we should manage waste. Michael Pollan wrote a letter to President-Elect Obama in the October 12, 2008 issue of the New York Times. In the letter he talks about the importance of food and he urges President Obama to really look at how food is processed in the United States as well as its effect on global warming. In his letter, Pollan talks about the evolution of farms and how cows were taken off of farms and brought to feedlots. He talks about how moving the cows from farm to feedlot made absolutely no sense. The cows on the farm would graze in a pasture and their waste was considered a precious source of fertility. Pollan tells how Wendell Berry realizes that removing the cows from the farms also removed the fertility that the crops deplete. Now the farmer has two problems, soil that is not fertile and pollution on the feedlot due to the cows waste. The farmer resorts to using a fertilizer made from fossil fuels which can lead to contamination of groundwater and rivers and streams and no options for the waste at the feedlot. Nature had solved that problem naturally. The cows eat the grass, their waste becomes fertilizer for the soil. The soil becomes rich with nutrients and crops flourish! By trying to do things better than nature intended, we often make more of a mess that no one wants to deal with or clean up!

Companies are starting to realize that recycling can help them save and/or make money. Constellation Energy Group which is a subsidiary of Baltimore Gas and Electric Company has recycled 71 percent of the total waste it generated since 1993.<sup>19</sup> Portland General Electric in Oregon has recycled almost 100,000 tons of metal and nearly 2,000 tons of paper since 1991.<sup>20</sup> Constellation avoided nearly 160,000 metric tons of CO<sub>2</sub> equivalent through recycling and the company saved approximately \$ 5 million in avoided disposal costs and they saved more than \$ 8 million by avoiding purchases as a result of the reuse program.<sup>21</sup> Portland General Electric estimates that they avoided 68,000 metric tons of CO<sub>2</sub> equivalent. In 1999, Portland General Electric reduced 11,836 metric tons of CO<sub>2</sub> equivalent and avoided more than \$ 100,000 in disposal costs due to recycling of metal and paper.<sup>22</sup> This is extremely important information in the cause to get companies to switch over to alternate methods that are healthier for the planet. Those are just two examples and there are hundreds more

that going green can create jobs and save money!

It often surprises me that people can just speak without really thinking about what they say. It surprises me more when they are people who are speaking to people en masse by being on the radio or television. One oil company executive on a morning talk news show said that we will never run out of oil. He said that the Stone Age never ran out of stones and we are in the petroleum age and we will never run out of oil. I also heard a D.J. on the radio wondering what was the big deal about the planet getting a little bit hotter. He wouldn't mind if it was a couple of degrees warmer. Both of these men were irresponsible in their comments. Evidence clearly shows that our oil supply is dwindling. The reality of global warming could have devastating effects on the world economy. As ice caps melt and the ocean level rises, prime waterfront real estate will be lost all around the world. It is important for our students to be armed with the facts and the reality of what is going on in the world. The knowledge that my students will receive from this unit will arm them with skills and knowledge to make informed decisions about how they deal with waste, as well as how they can affect change within their own families.

The internet has become a powerful tool for teachers in that there are wonderful lessons that other teachers have used and have willingly shared. It has become an invaluable resource for teachers. The following lessons have been found and adapted to fit the needs of my class.

## Lesson 1

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How Long Does Trash Last?

This lesson has been adapted from Education World® at Education-World.com. It was written by Gary Hopkins.

Brief Description

Student will learn how long trash lasts in landfills in this activity.

Objectives

Students will work together in groups of 4 to formulate their best estimate of how long some trash items might last in a landfill.

Students will learn about environmental consequences of not recycling.

Keywords

Trash, recycle, biodegrade, longevity, garbage, landfill

Materials Needed

aluminum can (soda pop can)

banana

cigarette butt

cotton rag

glass bottle

leather boot

paper bag

plastic 6-pack rings

plastic jug

rubber sole of the leather boot (above)

Styrofoam cup

tin can (soup or vegetable can)

wool sock

Before the Lesson

Display for students the materials you have collected (see Materials section above). Provide a chart on which you have written the names of those materials.

Draw students' attention to the items you have gathered. You might ask, What do all the items have in common? If your students are too young to figure out the answer to the question, you can share with them that each of the items will likely end up in a landfill one day.

Next, ask What will happen to these items when they end up in the landfill? How long do you think they will last there? Do they disappear/disintegrate/degrade immediately? Or will they continue to take up space in the landfill? Let students freely discuss those questions.

Draw students' attention to the list on the board or chart. Ask students to copy the list. Then ask them to think on their own about how long each of the items on the list might last when buried in a landfill.

Recreate the list by writing each item in order according to how long they think it might last in a landfill. Students should start their lists with the item they think will degrade fastest and end with the one that will last the longest.

Next, arrange students into small groups. (Groups of 4 to 5 students will work best.) Let students share their lists and discuss what they believe to be the correct sequence. Ask each group to come to a consensus about the correct order of the items.

Now it is time for the groups to share their lists. Call on one group to share their answers first. Have them tell you the sequence they decided on. As they call out "sheet of paper — number 1," write a number 1 on the chart next to the words sheet of paper. Do the same for the other groups. When that activity is completed, draw students' attention to the discrepancies on the chart. For example, Why did some people include the

sheet of paper before the banana? At the conclusion of the discussion, reveal to students the best guesstimates of scientists, who say the following is the correct sequence:

banana

paper bag

cotton rag

wool sock

cigarette butt

leather boot

rubber sole of the boot

tin can (soup or vegetable can)

aluminum can (soda pop can)

plastic 6-pack rings

plastic jug

Styrofoam cup

glass bottle

Point out to students that conditions could result in some items degrading more or less quickly than the list indicates.

Now, turn the assignment back to students. Now that they know the correct order, ask them to brainstorm in their groups how long (how many weeks, months, or years) each item will last. Repeat the procedure above as groups discuss, then share, their best guesses about how long items will last. Then share scientists' approximations listed below:

banana — 3 to 4 weeks

paper bag — 1 month

cotton rag — 5 months

wool sock — 1 year

cigarette butt — 2 to 5 years

leather boot — 40 to 50 years

rubber sole (of the boot) — 50 to 80 years

tin can (soup or vegetable can) — 80 to 100 years

aluminum can (soda pop can) — 200 to 500 years

plastic 6-pack rings — 450 years

plastic jug — 1 million years

Styrofoam cup — unknown? forever?

glass bottle — unknown? forever?

Note: The data above was gathered from sources such as the Bureau of Land Management and the Oregon Department of Environmental

Quality.

After you have provided students with data about the longevity of the displayed items, discuss the following questions: What does the data tell you about landfills? Do items continue to degrade and make room for new garbage? Or will those landfills eventually fill up? Do those trash life spans say anything to you about the importance of recycling? Why or why not?

Extension Activities

Have students use a graph-making software program to create graphs that illustrate the lifespan of trash items discussed in the activity. If students do not have access to such a program, introduce them to the free and easy-to-use online Create a Graph tool.

Have students create posters to encourage recycling the items listed on the chart. Display those posters where students in the school will see them or in prominent public places, such as the library or a grocery store.

Assessment

Have students write a paragraph explaining what they learned about landfills or recycling from the activity.

## Lesson 2

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This lesson comes from Brain Pop Jr. website [www.brainpopjr.com](http://www.brainpopjr.com). They have a very good section that teaches about reducing, reusing, and recycling.

Trash for a Day

Objective:

Students will see how much trash that they generate in one day.

## Materials Needed:

2 plastic shopping bags per student or 1 large zip top bag per student, rubber gloves, a scale

## Procedure:

Have each student keep all their trash for a day. Whenever they want to throw something out, they should place it in a bag. Have them continue with their day, but still carry their garbage around. This is a great way to show students how much waste they produce in a day. You can add a math connection by weighing each bag at the end of the day and comparing weights. You may want them to use clear zip-top bags so students can see the garbage and discuss what could have been reused, recycled, or reduced.

## Extensions

To extend this activity even further, students can bring their bags home and continue to collect all of the trash that they throw away to truly represent one days worth of trash. This is where they would use 2 plastic shopping bags doubled up. Discussions would have to be had in regards as what to do about food scraps. The bags should be brought in the next day and analyze the contents similar to the earlier exercise. Use the rubber gloves when analyzing the contents.

Have the students do the activity again but challenge them to cut their waste in half.

## Lesson 3

This lesson comes from the Massachusetts Department of Environmental Protection. The lesson was written by Carole Bell and Martha Schwartz.

### Build a Mini-Landfill

Objective: Students will understand how little decomposition occurs in landfills.

Materials: Two identical samples of food scraps, newspaper, cardboard, glass, cloth, aluminum foil, plastics, copper wire, etc.; several small plastic bags; a small aquarium or clear plastic box; clear plastic bags to line the tank or box; soil (not potting soil); masking tape; index cards or small cardboard squares; water; magnifying glass; "Build a Mini-Landfill" worksheet (See Appendix B)

Time: 1 hour the first day, 10 to 15 minutes each day thereafter for 3 weeks

### Before the Lesson

What kind of decomposition happens to food in landfills? How do other types of material decompose in landfills?

### Procedure

1. Explain to the students the purpose of a landfill and how they are constructed.
2. Have the students, individually or in small groups, construct their own mini-landfill. Line a small aquarium or clear plastic box with a plastic bag and fill it half full of earth.
3. Have each student prepare two identical groups of trash. Place the trash from the first group in one of the small plastic bags and seal it, simulating what they do with their household waste. Do not place the



second batch of trash in a bag. Bury the two groups of trash in adjacent rows, marking the location of each item with a cardboard label.

4. On the worksheet, each student or group should note the items placed in the landfill, along with the date. Have them add water to moisten the soil and place the mini-landfill in a sunny spot. The landfills should be watered regularly, keeping the soil moist but not wet, to simulate rain.
5. After 7 to 10 days, have the students carefully remove some of the waste items from each of the rows of trash and examine them. (A magnifying glass may be helpful at this point.) Students should complete the questions for Week One on the "Mini-Landfill" worksheet.
6. Wait another 7 to 10 days and repeat the procedure for the remaining trash in each row. Have the students complete the questions for Week Two on the worksheet.
7. Use the students' observations to discuss the results, comparing the condition of waste in the plastic bag with that which was buried directly in the soil. Address questions such as: Which items in the landfill decomposed the most? Were the decomposed items natural or manmade? Did the type of decomposition in the bag differ from the type that occurred in the soil? What characteristics are shared by the items that decomposed the quickest? Some items showed no signs of decomposition: Will they remain unchanged for a long time? Why?

#### Extensions

1. Have students replace the items removed in step 6 and cover the box or aquarium. Let it sit for at least 2 months to allow for leachate formation. (Leachate will collect in the bottom of the liner plastic bag.) Have students empty the contents of the landfill to determine which items decomposed and which did not. Also have them collect a sample of the leachate and test its acidity. (Note, the mini-landfill does not contain the kind of toxic materials that exist in real landfills. These toxics would have an effect on the acidity of the leachate, were they present.)
2. Have the students research why leachate needs to be controlled at landfills, addressing what kinds of materials are commonly found in leachate and whether or not they are harmful.
3. Items such as disposal diapers and plastic trash bags are being advertised as biodegradable. Discuss with the class the meaning of biodegradable and whether these products are indeed biodegradable and why.

## Appendix A

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This unit fits in very well with the New Haven science curriculum. Content standard 3.4 for the 3<sup>rd</sup> grade states earth materials provide resources for all living things, but these resources are limited and should be conserved. The Expected Performance for 3<sup>rd</sup> grade is describe how earth materials can be conserved by reducing the quantities used, and by reusing and recycling materials rather than discarding them. This unit will teach about conservation and the importance of reducing, reusing and recycling.

## Appendix B

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### Build A Mini-Landfill Worksheet

List the items placed in the landfill and the date you buried them:

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The items that decomposed the most are:

Week 1:

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Week 2:

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The following items decomposed a little:

Week 1:

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Week 2:

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These items did not change at all:

Week 1:

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Week 2:

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## Student Resources

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There are a wealth of children's books that tackle the subject of the three R's: Reduce, Reuse, Recycle. Here are a just a few books that tackle this global issue.

*The Three R's: Reduce, Reuse, Recycle (What Do You Know About? Books)* by Nuria Roca and illustrated by Rosa M. Curto. A good book that teaches about the three R's and teaches children about what they can do to reduce pollution.

*Where Does the Garbage Go?* by Paul Showers and illustrated by Randy Chewning. An excellent book that answers the question, where does our garbage go? This book is tailored for grades 1-4.

*The Adventures of a Plastic Bottle: A Story About Recycling* by Alison Inches and illustrated by Pete Whitehead. A wonderful book about recycling written in diary form from the point of view of a plastic bottle. The journey goes from the refinery plant to the recycling plant where the bottle ends up as a fleece jacket.

*I Can Save the Earth!: One Little Monster Learns to Reduce, Reuse, and Recycle* by Alison Inches and illustrated by Viviana Garofoli. An entertaining yet informative book about Max the Little Monster who is an environmental nightmare. Kids can learn as Max learns about ways he can become more environmentally aware.

## Teacher Resources

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Here are a few books that can provide additional background information in regards to waste and ways that we can reduce the amount we produce.

*Reduce, Reuse, Recycle: An Easy Household Guide* by Nicky Scott. A good practical book that informs the reader about what they can do with old cell phones and medicines. It has a listing from A-Z of household items and how they can be recycled.

*Composting: An Easy Household Guide* by Nicky Scott. A great book that teaches about composting whether you live in a house or an apartment. Excellent for those teachers who would like to create a compost at their school.

*Don't Throw It Out: Recycle, Renew and Reuse to Make Things Last* by Lori Baird. A terrific book that gives other uses for household items rather than throwing them away.

*Rubbish!: Reuse Your Refuse* by Kate Shoup. A cool craft book that allows the reader to make more than 30 projects from items that would normally be thrown away like bottle cap magnets, credit card bracelets and board game clocks.

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## Endnotes

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<sup>1</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 1

<sup>2</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 2

<sup>3</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 4

<sup>4</sup> US EPA "Municipal Solid Waste In The United States: 2007 Facts and Figures," 143

<sup>5</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 10

<sup>6</sup> <http://www.iun.edu/~environw/landfills.html>

<sup>7</sup> <http://www.umich.edu/~gs265/society/wastedisposal.htm>

<sup>8</sup> US EPA "Municipal Solid Waste In The United States: 2007 Facts and Figures," 150

<sup>9</sup> US EPA "Municipal Solid Waste In The United States: 2007 Facts and Figures," 150

<sup>10</sup> US EPA "Municipal Solid Waste In The United States: 2007 Facts and Figures," 151

<sup>11</sup> US EPA "Municipal Solid Waste In The United States: 2007 Facts and Figures," 151

<sup>12</sup> <http://techalive.mtu.edu/meec/module15/Composting.htm>

<sup>13</sup> California EPA "The Illustrated History of Recycling," 6

<sup>14</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 1

<sup>15</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 2

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<sup>18</sup> US EPA "Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2007," 2

<sup>19</sup> US EPA "Success Story-Getting on the Books with Waste Reduction," 1

<sup>20</sup> US EPA "Success Story-Getting on the Books with Waste Reduction," 1

<sup>21</sup> US EPA "Success Story-Getting on the Books with Waste Reduction," 2

<sup>22</sup> US EPA "Success Story-Getting on the Books with Waste Reduction," 2

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