There Is NO “away”

The Law of Conservation of Matter and Solid Waste Pollution

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Table of Contents

Goals and Objectives

Our world population is exploding. This increase in population and living standards is putting a strain on our planet natural resources. According to the Environmental Protection Agency, we generated approximately 254 million tons of MSW in 2007. MSW (municipal solid waste), also known as trash or garbage—consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, and batteries.

In this unit students relate the law of conservation of matter to the fact that you can never throw something "away." A week prior to beginning this unit I display a beautiful scenic poster in the front of the classroom; every day there after I tape trash on top of the poster. By the end of the week they can no longer see the ecosystem all they see is trash. This then serves as the beginning of a class discussion on trash and the United States overconsumption of goods and services. Then I show them the 20-minute clip, The Story of Stuff, which emphasizes how consumers contribute to environmental and social issues.

Throughout the various activities in this unit students become aware of the importance of living more sustainably and that the key to our future is pollution prevention. Students watch the film, Trashed: The Story of Garbage the American Style an investigation on the garbage industry. This film illustrates the effects of American waste on natural resources.

Other activities that I include in this unit on waste are the internet activity Recycle City. This is provided by the EPA and it is a simulation that allows students to see the effects of waste on a community. To end this unit and begin my water pollution unit, they conduct an investigation on the effects of biodegradable waste on dissolved oxygen.

At the end of this unit students should be aware of their environmental impact based on their need for resources that can't be thrown "away".

Sunshine State Standards

Grades 9 -12 Science Standards

SC.912.L.17.8: Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.

SC.912.L.17.13: Discuss the need for adequate monitoring of environmental parameters when making policy decisions.

SC.912.L.17.14: Assess the need for adequate waste management strategies.

SC.912.L.17.15: Discuss the effects of technology on environmental quality.

SC.912.L.17.16: Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

SC.912.L.17.17: Assess the effectiveness of innovative methods of protecting the environment.

SC.912.L.17.18: Describe how human population size and resource use relate to environmental quality.

SC.912.L.17.20: Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

Grade 8 Science Standards

SC.8.L.18.4: Cite evidence that living systems follow the Laws of Conservation of Mass and Energy.

Grade 7 Science Standards

SC.7.L.17.3: Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

Course Outline/Overview

There Is NO “Away:” The Law of Conservation of Matter and Solid Waste Pollution! unit is designed so teachers can either implement the entire program or use select lessons from this IMPACT II resource packet. From this unit, students will learn about all aspects of trash including where it comes from and how to prevent accumulating it in the first place. One of the more important lesson students take away from this unit is an understanding of the environmental impact that is caused from overconsumption of resources in the United States.

The unit is comprised of a variety of activities including one in which students view a mini-clip and examine the impact of the production and consumption of our resources. Students also conduct an experiment on the effect biodegradable waste has on oxygen availability.

This unit incorporates various forms of technology into lessons that are all student-centered. The key for students to become more environmentally conscious is for them to realize their own environmental impact or “footprint”.

Background Information

Law of Conservation of Matter: (everything must go somewhere)

We talk about consuming, or using up material resources, but actually we don't consume any matter. We only borrow some of the earth's resources for a while taking them from the earth, carrying them to another part of the globe, processing them, using them, and then discarding, reusing, or recycling them. In the process of using matter we may change it to another form, but in every case we neither create nor destroy any measurable amount of matter. This results from the law of conservation of matter: In any physical or chemical change, matter is neither created nor destroyed but merely changed from one form to another. When you throw away something, remember there is no "away." *Everything we think we have thrown away is still here with us in one form or another.*

How does this affect environmental science? Although we can certainly make the environment cleaner, the law of conservation of matter says we will always be faced with pollution of some sort. This means that we must trade-off one form of pollution for another. This trade-off involves making controversial scientific, political, economic, and ethical judgments about what is a dangerous pollution level, to what degree a pollutant must be controlled, and what amount of money we are willing to pay to reduce the amount of a pollutant to a harmless level.

What is waste?

A natural part of the life cycle, waste occurs when any organism returns substances to the environment. Living things take in raw materials and excrete wastes that are recycled by other living organ-isms. However, humans produce an additional flow of material residues that would overload the capacity of natural recy-cling processes, so these wastes must be managed in order to reduce their effect on our aesthetics, health, or the environment.

Solid and fluid, hazardous and non-toxic wastes are generated in our households, offices, schools, hospi-tals, and industries. No society is

immune from day-to-day issues associated with waste disposal. How waste is handled often depends on its source and characteristics, as well as any local, state, and federal regulations that govern its management. Practices generally differ for residences and industries, in urban and rural areas, and for developed and developing countries.

Municipal Solid Waste (MSW)

Waste collected from residences, commercial buildings, institutions such as hospitals and schools, and light indus-trial operations is most often categorized as municipal solid waste. MSW consists primarily of paper, containers and packaging, food wastes, yard trimmings, and other inorganic wastes. Municipal solid waste can also include industrial sludge, classified as hazardous or non-hazardous, resulting from a wide array of mining, construction, and manufacturing processes.

In 2006, Americans generated more than 250 million tons of trash. Nearly 33 percent, 82 million tons of materials, was recycled; the energy equivalent of more than 10 billion gallons of gasoline. More than 30 million tons (12.5 percent) were combusted through an energy recovery process, and approximately 138 million tons (55 percent) of materials were discarded in landfills. Municipal waste, when properly managed, does not pose an immediate threat to human health or the environment.

Hazardous Waste

Waste material that is flammable, corrosive, reactive, or toxic – which can be in the form of a solid, liquid, or gas – is defined as hazardous waste. Although the term often evokes an image of items marked with skull and crossbones, many hazardous wastes include products used every day, including paint, used oil from cars, batteries, shoe polish, and even laundry detergent. In addition, many of the items that we rely upon generate hazardous waste during the process of their production.

The U.S. Environmental Protection Agency (EPA) reported that 279 million tons of hazardous wastes were generated in 1996; ninety-six percent of which was industrial process water by-product waste. In 1997

the EPA made a rule change that separated industrial wastewater from hazardous waste reporting. This change can clearly be seen in current reporting numbers; in 2005 the EPA reported hazardous waste generation of just under 38.5 million tons.

Businesses that generate hazardous wastes are required by legislation to manage them from generation to disposal. The waste is often treated to change its biological, chemical, or physical characteristics in order to make it less hazardous or to reduce its overall volume. Some hazardous materials can be recycled if it is environmentally safe to do so, although it can be expensive. Any leftover waste is then safely disposed of to further neutralize any adverse affects to human health or the environment. Today, many industries are attempting to reduce their generation of hazardous waste by modifying their manufacturing processes or by replacing hazardous materials with less hazardous or non-hazardous substitutes.

E-Waste

A new and growing segment of our waste stream is termed ‘e-waste.' Although not clearly defined, e-waste applies to much of the electronic equipment used by businesses and individual consumers that are nearing the end of their usefulness. This includes, but is not limited to, computers, fax machines, copiers, and televisions.

A factor that complicates disposal of these items is that certain components contain hazardous materials. The cathode ray tubes in computer monitors and televisions are an example. As such, many old electronics sit idle due to the uncertainty of how to manage them.

Yet, many of these products can be reused, refurbished, or recycled. There are a number of options to reuse equipment that can still function – from selling it to someone who can use it or giving it as a charitable donation. Many non-working items can be refurbished in order to recover them into working condition. Finally, any components that cannot be repaired can often be recycled.

Although there no federal regulation for e-waste, some states have taken various approaches toward its management. Many states, including Massachusetts , Florida , and New York , have streamlined their regulations to increase the level of recycling. On the other hand, in 1993 California passed the Electronic Waste Recycling Act; yet, they also regulate cathode ray tubes as hazardous waste, banning them from regular trash disposal.

Engage Activity

Directions:

- A week prior to the unit place a poster illustrating a natural landscape in a visible location.
- Everyday add pieces of garbage (water bottle, paper, candy wrappers, plastic plates, etc) to the top of the posters. Students may ask you what are you doing but do not tell them until you are ready to begin the unit.
- On the first day of the unit, the poster's landscape should be covered with trash.
- This activity will get students to begin thinking of the impact of garbage on natural habitats.

Class Discussion

Warm-Up:

Ask students to make a list of everything they can remember throwing away during the past 24 hours. After giving them time to write, invite students to come to the board and write down one thing they threw away. Once they have made this class list, look at it together.

Ask: How much of this stuff is necessary? (You may get into a discussion over what is considered "necessary" and why.) Which of the things on this list might you dispose of differently?

As a class, brainstorm some alternatives to throwing away the "trash" they've listed. Examples might include bringing coffee from home in a reusable container or recycling a Starbucks cup.

Ask: Why is important to think about what we use and what we throw away, and to come up with alternatives?

Have the students consider the following statement: There is no such thing as “waste” it is impossible to throw away anything. What do you think is meant by saying that things can’t be thrown away?

As a class review The Law of Conservation of Matter; “matter cannot be created or destroyed.” Ask: How does this law relate to the statement made above by the chemist?

(All substances that we consider waste are made up of molecules and atoms that do not disappear just because we dispose of them. Things we label as waste and throw away because we have no use for them can be put out of sight and out of mind—but not out of existence. In a chemical reaction, atoms may end up as part of either the desired product or undesired byproducts.)

Activity:

Hand out "*Studying 'Stuff'".*

Ask students: What do you expect from a video you watch in a science or history class? Who might narrate it? What kind of images might you see? What might its general purpose be? Tell them that today they'll be watching a video about the effects of human consumption called "The Story of Stuff," created by a woman named Annie Leonard. Before watching, review the questions on the handout so students will be primed to react to them during and after viewing. Ask them to begin by recording the expectations they just listed. Tell them to continue to take notes on the handout as they watch.

Together, watch the video "The Story of Stuff," or assign it for homework.

After they watch the film, ask students to take a few minutes to finish recording their responses and reactions on the handout. Then, bring the

class together for discussion. Begin by reviewing the handout by having students share their responses and reactions to each prompt. Probe their thinking further by asking the following questions:

- What do we know about Annie Leonard from the video?
- Should we trust her? How do we know she is telling us the truth?
- Did you detect any bias? What do you think Ms. Leonard's personal views are? How can you tell?
- What images stayed in your mind? Why? What effect do the images have on you as a viewer?
- Where did you sense that Ms. Leonard used hyperbole to make a point?
- Why might she purposefully use hyperbole to provoke a response?
- Are you shocked? How does this video make you feel?
- What did you learn? Did the film change your mind about anything, or make you reflect on anything in your own life?

Tell students that this video has been used widely in U.S. classrooms to supplement curriculum on climate change and environmental issues since Leonard posted it on the Internet in 2007. Ask: Why do you think it has become popular?

Name: _____ Date: _____

Studying "Stuff": A Guide to Critical Viewing

The New York Times LEARNING NETWORK | www.nytimes.com/learning

Directions: Respond to the questions on this handout before, during and after viewing the film "The Story of Stuff."

Before Viewing

1. What do you expect from this video? Why?

First Impressions

2. Describe Ms. Leonard.

3. Describe her tone of voice and manner.

4. What kind of graphics does the video include?

During Viewing

5. As you watch, record statements Ms. Leonard makes that strike you as provocative.

6. What questions does the video raise for you? (In parentheses after your questions, note where you might look for answers.)

7. What, if anything, seems to be missing here?

After Viewing

8. Write down any lines and images that were particularly memorable for you.

9. How did the video make you feel?

10. How does your experience viewing the film relate to your initial expectations?

11. Did the film change your mind about anything? Did you learn anything that you previously did not know?

Internet Activity

Welcome to Recycle City! There's lots to do here - people and places to visit and plenty of ways to explore how the city's residents recycle, reduce, and reuse waste.

To get started, just click on any section of Recycle City that you want to tour, or click on the Dumptown Game. You can create your own Recycle City scavenger hunt or go to the Activities area and see other ways you can explore Recycle City.

When you leave this place, you'll know much more about what you can do to help protect the environment. If you need to print a section of Recycle City, you can save paper by using the printer-friendly version.

In October of 2003, we made some updates to Recycle City, thanks to feedback from recyclers around the world! Check out what's new in Recycle City!

Have fun!

Directions:

- Have students in groups of 2-3 access the recycle city website and play the dumptown game.
- As they explore the site they are to complete their assigned questions. Teachers should divide the 19 questions evenly among the groups.
- After all groups have completed their assignment each group will read their question and discuss answers with the entire class.

Name: _____ Date: _____

Recycle City WebQuest

1. Imagine you manage your own supermarket. What are some things you can do to reduce the amount of waste caused by the products you sell?

2. Then, visit Maria's Market in Recycle City and see if she has any other ideas you can use.

3. Name three ways that each of these items can be reused, instead of throwing them away. (You can use the whole thing or only part of it.)
    - Cardboard box
    - Plastic milk carton
    - Glass jar
    - Wooden board
    - Plastic bag
    - Newspaper
4. Can you find other ways these items are put to use in Recycle City?

5. Find the place in Recycle City where you can get information on what to do with leftover cleaning products. Is there a place to take those kinds of items in your town? Where is it?

6. Visit some houses in Recycle City and look for examples of household hazardous waste. How many are there? What are some safer, natural alternatives that could take the place of some of these things?

7. Visit any Recycle City location you like. Before you go inside, try to figure out what you would do to reduce waste and energy use there. Then, click on the site. Did you miss anything? Did we?

8. Cruise around Recycle City and find all the tips you can use to reduce pollution and waste that come from cars.

9. Gas stations aren't just places to fill up the tank. Can you find six things that Shaq at the Recycle City gas station does to help the environment?

10. Can you find out which recyclable item makes up the largest percentage of our trash?

11. Identify three recycling activities that Recycle City students use to help raise money for class projects.

12. Mayor Turner has been elected to state government, and you are selected to replace her as the new mayor of Recycle City. What kinds of things can you do to help citizens reduce, reuse, and recycle?

13. Find at least seven different ways to reduce or reuse paper.

14. Find at least three places in Recycle City where books are resold or reused.

15. Harlin Hazzard of the Recycle City Hazardous Waste Center wants to hire you as his assistant manager. Before you can accept, you must name the four characteristics that make hazardous waste hazardous.

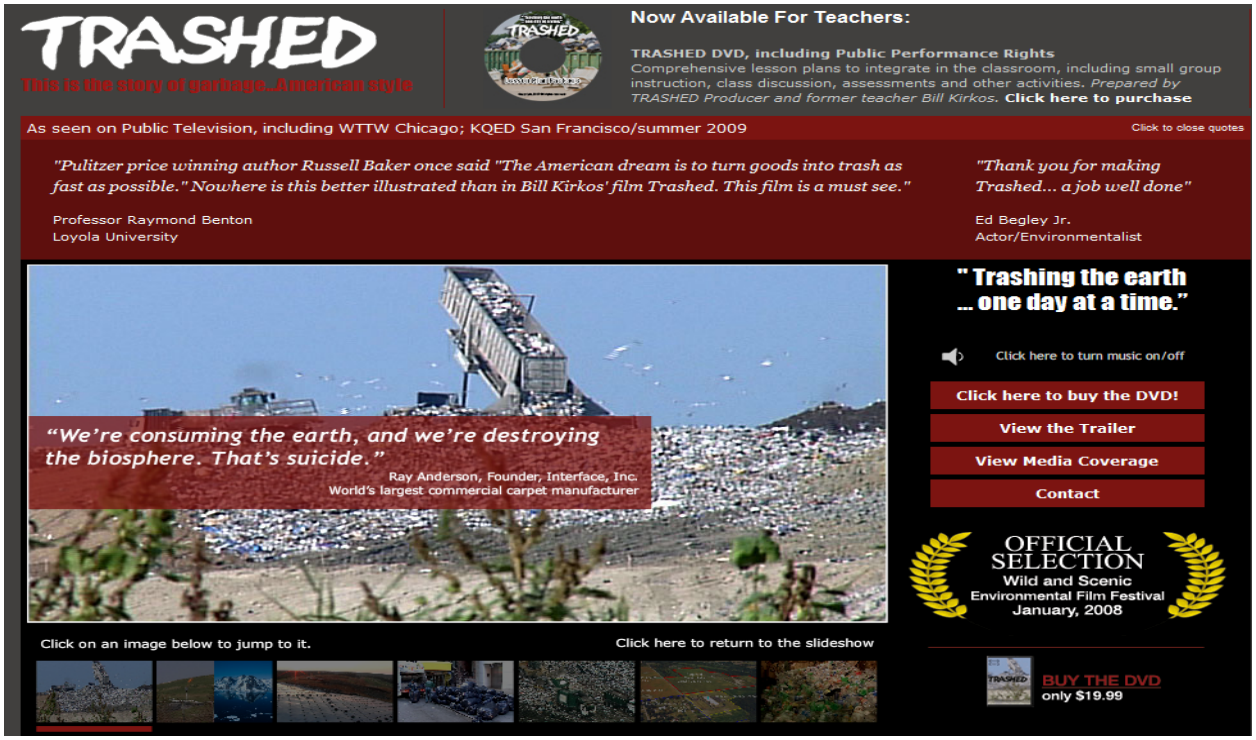
16. Before he gives you a higher salary, Harlin wants to know what can be done to reduce the amount of hazardous waste going into the hazardous waste landfill. Can you tell him?

17. Make a list of things around your house that you could donate to a charity or a community warehouse instead of throwing them out.

18. What are some ways you or your family could cut down on the amount of junk mail you receive at home?

19. How many places in Recycle City can you find used tires? Look carefully.

Film



Synopsis:

"Trashed" is a provocative investigation of one of the fastest growing industries in North America. The garbage business. The film examines a fundamental element of modern American culture…the disposal of what our society defines as "waste." It is an issue influenced by every American, most of whom never consider the consequences. Nor, it seems, the implications to our biosphere. At times humorous, but deeply poignant, "Trashed" examines the American waste stream fast approaching a half billion tons annually.

What are the effects all this waste will have on already strained natural resources? Why is so much of it produced? While every American creates almost 5 pounds of it every day, who is affected most? And who wants America to make more?

The film analyzes the causes and effects of the seemingly innocuous act of "taking out the garbage" while showcasing the individuals, activists,corporate and advocacy groups working to affect change and reform the current model. "Trashed" is an informative and thought-provoking film everyone interested in the future of sustainability should see.

Lab

Effects of Biodegradable Wastes on Dissolved Oxygen

Objectives:
To understand the relationship between biodegradable waste and dissolved oxygen in water.

Pre-Lab Activities:
You must complete the following in order to understand the basic concepts investigated in this lab.
1. What are microorganisms or microbes? List two examples.
2. What are biodegradable wastes? List two examples.
3. Describe the general process of photosynthesis.
4. Describe the general process of cellular respiration.

Read through and discuss the methods with your partners.
5. How will you know when the dissolved oxygen in the water sample is consumed?
6. When do you start timing?
7. After reading and discussing your answers to the background questions and the methods with your group, write a hypothesis about the relationship between the amount of organic matter, the amount of bacteria and the oxygen levels in a water sample.

Materials:
- 3 test tubes of equal size (with caps)
- test tube rack (see-through)
- pipettes (3 per group)
- yeast mixture (2 mL dry yeast and 20 mL water)
- milk
- methylene blue (dropper bottle)

Methods:
1. Label the three test tubes #1, #2, and #3. Place them in the test tube rack.
2. Using your pipette, add the amount of materials to each test tube as shown in the chart below:

TEST TUBE #	# DROPS MILK	# DROPS H_2O
1	37	0
2	15	22
3	3	34

3. Be sure that the height of the liquid in each of the three test tubes is exactly the same. You can adjust the height by adding drops of either milk or water to the tubes.
4. Add 3 drops of methylene blue to each test tube. Be sure to introduce the drops in the same fashion to each tube, with the dropper bottle as vertical as possible.
5. Mix the methylene blue with the milk/water mixture by screwing the cap onto the test tube and inverting each test tube 4 times.
6. For the next part of the lab, one of you will need to carefully time the experiment. As you mix each test tube with the yeast, you will need to begin timing **as soon as you put in the first drop of yeast mixture.**
7. Add 20 drops of the yeast mixture to test tube #1. Mix thoroughly by inverting 4 times and record the exact time that you add the yeast to the tube.
8. Now do the same for test tubes #2 and #3. Timing is critical. Begin timing each test tube as soon as you add the yeast. Record your time information on the data table below.
9. When the color has changed from blue to white in each test tube, record the exact time at which the change is complete. The surface of each test tube will remain blue? Why?

TEST TUBE #	MIXING START TIME (A)	TIME OF COLOR CHANGE TO WHITE (B)	TOTAL TIME FOR COLOR CHANGE (B-A)
1			
2			
3			

Note: It can take as long as 15 minutes for the color change, but the average time is 4 to 5 minutes.

Analysis:

1. Name the gas “inhaled” by microorganisms.
2. Name the gas “exhaled” by microorganisms.
3. Where do microorganisms living in water get the oxygen they need to live?
4. Where do green plants living in water get the carbon dioxide they need to live?

5. Shake one of the test tubes that turned white. What happens to the color? Why does the color change?
6. Air is added naturally to rivers when water goes through rapids and over falls. How does shaking the test tube prove that air is added to water when it tumbles over rocks?
7. Why is the oxygen in this experiment “used up?”
8. Name the part of the experiment that represents microorganisms.
9. Name the part of the experiment that represents waste.
10. In which test tube did you have the most waste? The least waste?
11. Which test tube contained the most oxygen? Which test tube contained the least oxygen?
12. Graph your results here using a line graph. Remember to correctly label the graph and provide a title.
13. What does the line you plotted tell you about the relationship between the amount of waste and oxygen in a body of water?
14. Does the data collected support your hypothesis? Why or why not?
15. If large amounts of waste were dumped in a river, what would be the effects of the dissolved oxygen in the water?
16. Write a short paragraph explaining the relationship between oxygen levels, bacteria and the breakdown of organic matter. What can you conclude about the dissolved oxygen levels and the amount of bacteria found in a water sample

Resource List

Set: Environmental Landscape Poster, Solid Waste (Paper, Bottles, Cardboard, Cans),

Class Discussion(Mini-Clip): Computer, Internet Access, Projector, The Story of Stuff Animation 25 minutes (http://www.storyofstuff.com/), Handout "Studying 'Stuff"'

Internet Activity: Computers, Internet Access, Environmental Protection Agency's Recycle City (http://www.epa.gov/recyclecity/), Handout "Recycle City WebQuest"

Film: DVD player, TV, CD-ROM: Trashed The Story of Garbage the American Style (http://www.trashedmovie.com/)

Lab: *Biodegradable Materials and Dissolved Oxyge*n (test tubes of equal size with caps, test tube rack, pipettes, yeast mixture, milk, methylene blue)

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Class Discussion: http://www.nytimes.com/learning/teachers/lessons/20090515friday.html

Mini-Clip: http://www.storyofstuff.com/

Internet Activity: http://www.epa.gov/recyclecity/mainmap.htm http://www.lessonplanspage.com/more/recyclecitywebquest.htm

Film: http://www.trashedmovie.com/

Lab: http://sftrc.cas.psu.edu/LessonPlans/Water/PDFs/SimulatingLab.pdf