The Solid Waste Management Resource Guide

for Massachusetts Schools

1996 Edition

Commonwealth of Massachusetts

Trudy Coxe, Secretary
Executive Office of Environmental Affairs

David B. Struhs, Commissioner
Department of Environmental Protection

Original Printed on Recycled Paper

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COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON MA 02108 (617) 292-5500

October, 1996

Dear Massachusetts Educator:

The Department of Environmental Protection is pleased to present the revised *Solid Waste Management Resource Guide for Massachusetts Schools, 1996 Edition*. This guide, first produced in 1990, has been invaluable in fostering an awareness and knowledge of solid waste among the students of the Commonwealth.

Massachusetts has set ambitious goals for waste reduction and recycling, to be achieved by the end of this decade. At the same time, the Commonwealth has also created new educational standards for both educators and students. These goals reflect the growing recognition that it is our responsibility to maintain a healthy environment for future generations as well as to provide the citizenry of Massachusetts with the skills and knowledge necessary to make decisions regarding environmental protection.

If we are to reach these goals, we must continue to invest in the education of the youngest members of our society, our children. We must continue to educate and inform the students of today about the environmental issues they will face in the future. This resource guide will assist educators in teaching students about the source reduction and solid waste management issues they face today and will confront tomorrow.

The Executive Office of Environmental Affairs and the Department of Environmental Protection are committed to increasing recycling education resources available to educators. We are confident that the Revised 1996 Solid Waste Management Resource Guide will continue to be a valuable tool in imparting awareness of solid waste management issues.

Sincerely,

David B. Struhs
Commissioner

Department of Environmental Protection

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WMX

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Dear Educator,

At Waste Management, Inc., we are dedicated to increasing recycling awareness and education throughout Massachusetts. We are honored to join the Massachusetts Department of Environmental Protection and the Massachusetts Audubon Society in sponsoring the *Solid Waste Management Resource Guide: 1996 Edition* for the schools in our state.

All of us at Waste Management, Inc., hope the guide will be a valuable tool in expanding statewide education initiatives. This public/private partnership allows us to teach today's youth the importance of protecting our natural resources.

Our company provides recycling services to cities, towns, and businesses throughout the commonwealth. Educating the next generation of leaders today on the importance of waste reduction and reuse is an important step in both increasing and maintaining recycling efforts statewide.

At a time when environmental issues are a concern to everyone, the 1996 *Solid Waste Management Resource Guide* serves as an effective tool to educate students of all ages. This curriculum teaches sound environmental practices through hands-on activities and projects. As a company dedicated to protecting and enhancing the environment, we are pleased to have a role in supporting this program.

We look forward to being a community partner for this worthwhile project.

Sincerely,

Jay Rooney
Northeast Group President

Using the Resource Guide

Building public awareness is a critical step toward ensuring that our solid waste is managed in environmentally responsible ways in the future. Teachers have a golden opportunity to reach our children and to help them understand the nature of waste, why it needs to be dealt with, and how it can be managed. The material in this guide is meant to provide teachers with supporting material and specific activities to use in teaching about solid waste issues and the individual's role in affecting them.

This Resource Guide was developed for grades K–12. It reflects the Commonwealth's forward-looking legislation and DEP's Solid Waste Master Plan 1995 update. The goals behind preparation of this material were to:

- Help students understand solid waste and resource management issues.
- Make students understand that their attitudes and actions affect these issues.
- Present the state's four-step integrated approach to solid waste management: reduce, recycle, incinerate, and landfill.

The material in this guide is divided into four sections: an overview of the materials that comprise the waste and recycling streams; a brief history of solid waste management in Massachusetts; profiles of the four disposal strategies being implemented by DEP; and appendices. Activities following each of the first three sections are divided into two age groups, K–6 and 7–12. We encourage you to browse through the activities for both age groups for ideas.

The activities are designed to increase the students' knowledge and awareness of solid waste issues, to enhance their skills through interdisciplinary studies, and to encourage active participation in understanding and addressing solid waste issues. You may wish to create solid waste units or use individual activities to supplement your regular curriculum.

The guide's updated appendices contain sources used in the development of this project, as well as an extensive list of organizations, publications, audio-visual materials, and other instructional tools that provide supporting information on solid waste issues.

This guide is not intended to function as a curriculum by itself. Rather, it should be viewed as a treasure chest of ideas and background information for you to use creatively and freely. Please feel free to photocopy materials from the guide and share them with your colleagues. Additional copies may be obtained by contacting the DEP at (617) 338-2255 from area code 617 and outside Massachusetts, and at 1-800-462-0444 from area codes 413 and 508.

Overview of Revisions to the 1996 Resource Guide

Dear Educator,

The original scope of the Resource Guide revisions was to update facts and figures only. The project revisions expanded to reflect the significant changes in the Commonwealthís *Solid Waste Master Plan: 1995 Update*. The layout of the guide is essentially the same as that of the 1990 edition, with some sections expanded. The major sources for the updated information were the *Massachusetts Solid Waste Master Plan: 1995 Update*, and the U.S. Environmental Protection Agencyís *Characterization of Municipal Solid Waste in the United States*, 1992 and 1994 editions. The Commonwealth has made significant strides toward the goals set out in its original 1990 Master Plan. The information in the guide reflects the stateís progress. Changes in the guide include:

1. Revision of the appendices:

    - All resources listed were verified by mail and phone.
    - The *Further Readings* Appendix was removed due to the outdated publications listed.
    - The *Entertainer* Appendix is now Appendix D, *Performers*, and has been significantly expanded.
    - The *Audio-Visual* and *Curricula* Appendices have been expanded and separated according to the following topics: composting, recycling, and household hazardous waste.
    - There are two new appendices: Appendix C-7, *Resource Guides*, and Appendix C-8, *Multi-Media Tools for Teaching About Waste Management*.
    - Appendix B-4, *Industry*, has been expanded significantly. Many of the materials are free; however, they are meant to represent the viewpoint of the industry providing them. This should be kept in mind when using the materials.

2. Revision of the guide’s background materials:

    - The “Household Hazardous Waste” section of “Problem Waste Facts” has been significantly expanded in the areas of hazardous product identification, safe management, and reduction.
    - The “Problem Waste Facts” section was expanded to include an extensive section on batteries.

- "Trash Facts" was changed to "Recycling Facts" where appropriate to reflect that recyclables in the waste stream are, in fact, valuable resources.

- The "Natural Resources" section was moved to the front of the guide to reflect the concept that waste is a resource.

- A discussion of aseptic packaging (e.g., drink boxes, juice boxes) has been added.

3. Revision of the activities:

   - Facts and figures in activities have been updated. No new activities were added.

   - The "School Recycling" section was removed. Instead, DEP has sponsored the development of a separate publication, *Manual for Implementing a School Recycling Program*. This manual is available from DEP's Division of Solid Waste Management.

The 1996 edition of the Resource Guide serves as a foundation for teaching about solid and hazardous waste, conservation of natural resources, and pollution prevention. There are a multitude of good, solid waste curricula, audio-visual materials, and instructional resources available to supplement the activities offered here. Check the appendices for an extensive listing of these resources. The effort invested in the guideís revisions is dedicated to the empowerment of the community to make informed, responsible environmental decisions.

Sincerely,

Lynn Rose
Program Director
Franklin County Solid Waste Management District

SECTION I

WHAT IS WASTE?

SOLID WASTE COMPOSITION

Is trash really waste?

Waste is often composed of products for which we no longer have a use. These products are made up of natural resources that can often be used repeatedly before being disposed of. Old products can be broken down, reprocessed, and used to replace virgin materials in the manufacturing process. Thus, waste can be a valuable resource. For our society to truly recapture the natural resources that are discarded as trash, we need to re-evaluate what we mean by "waste."

What is the definition of solid waste?

While it can be called garbage, trash, or refuse, solid waste takes many forms and comes from many sources. The Commonwealth of Massachusetts uses these definitions for waste:[i]

- Total Solid Waste: Unwanted or discarded material that requires disposal of some type. It can come in a solid, liquid, or contained gaseous form. This material comes from household, commercial, industrial, agricultural, mining, or municipal activities. Solid waste does not include materials such as hazardous waste or sewage.

- Municipal Solid Waste (MSW): The portion (about 73 percent) of the total solid waste stream that comes from residences, businesses, municipalities, and institutions (schools, hospitals, nursing homes, etc.). MSW does not include solid waste from manufacturing, mining, or agricultural operations.

In 1994, Massachusetts generated approximately 10 million tons of solid waste, of which more than 7 million tons were MSW. Solid waste (including recyclable and compostable material) from residences accounted for 41 percent of all MSW, while commercial waste (business and institutional wastes) accounted for the remaining 59 percent of the MSW.[ii] The remaining 3 million tons of solid waste were composed primarily of industrial wastes, biosolids (sludge) from wastewater and industrial processes, and construction and demolition debris. Figure 1-1 shows the composition of a typical American community's municipal solid waste stream by percentage of material.

How much solid waste do we generate?

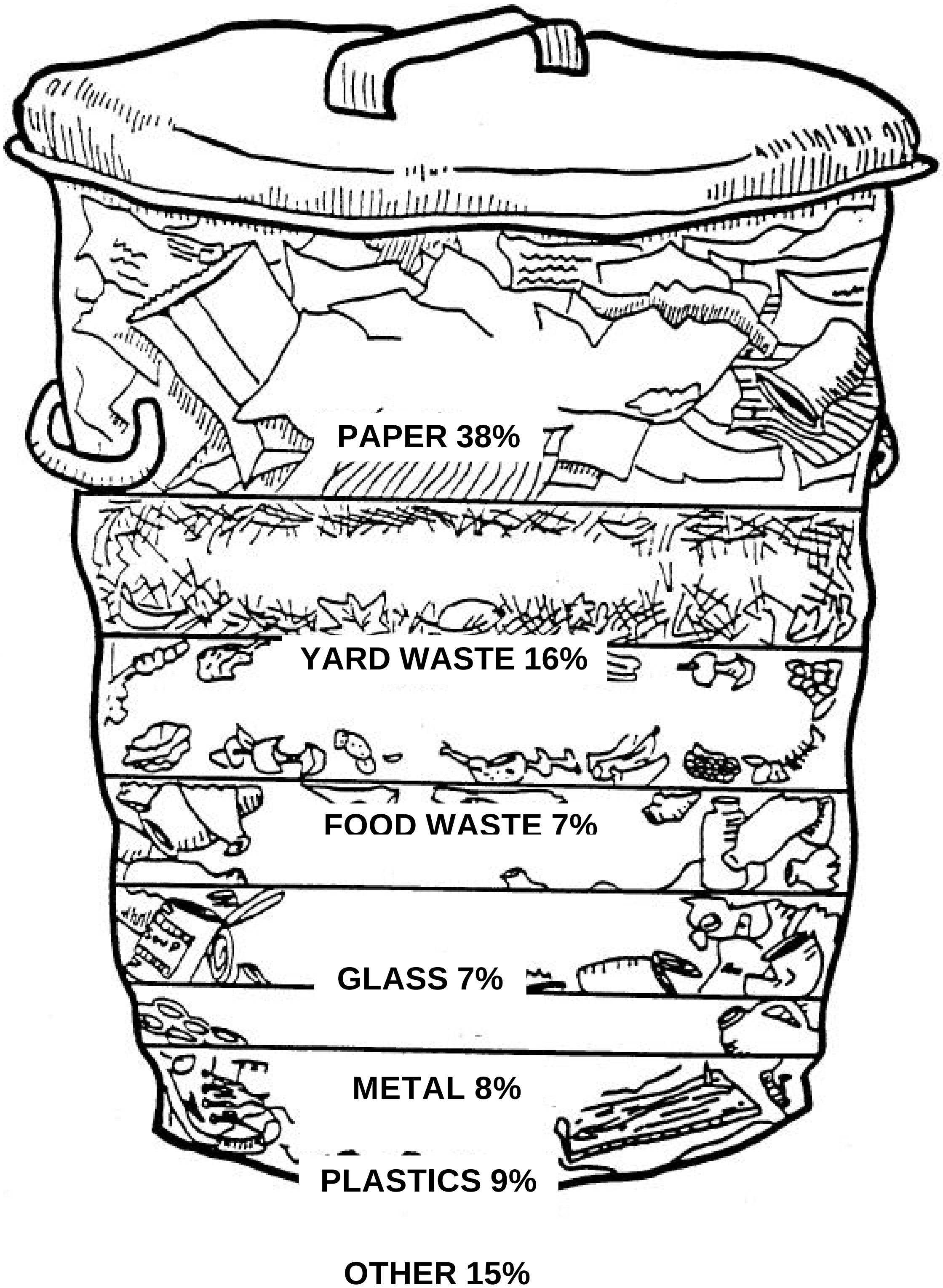
- Americans generate enough waste every year to fill a convoy of 10-ton garbage trucks 145,000 miles long, which would circle the equator six times.[iii]

- Americans throw away enough aluminum to rebuild the American air fleet 71 times, enough steel to reconstruct Manhattan, and enough paper and wood to heat 5 million homes for 200 years.

- National figures show that Americans generated over 207 million tons of solid waste in 1993, more than three-quarters of a ton per person.[iv] This amount equals approximately 4.4 pounds per person per day.

Where is solid waste generated?

Waste is generated at every step of a product's lifecycle, including mining, processing, manufacturing, packaging, use, and disposal. Thus, our purchase of consumer products creates waste that we don't see or deal with directly. Our consumer habits directly affect the amount of industrial and agricultural waste generated in this country and abroad.


PAPER 38%
YARD WASTE 16%
FOOD WASTE 7%
GLASS 7%
METAL 8%
PLASTICS 9%
OTHER 15%

Source: U.S. EPA, *Characterization of Municipal Solid Waste in the United States: 1994 Update*

Figure 1-1. Components of municipal solid waste in the United States, by weight

NATURAL RESOURCE FACTS

What are natural resources?

Natural resources are valuable, naturally-occurring materials on which we and other living organisms depend. Some examples of natural resources include air, water, soil, rock, minerals, plants, wildlife, metals, and fossil fuels. They can be mined from the ground, harvested from forests and fields, or removed from the atmosphere. Every product we use and produce is derived from one or more natural resources. As a result, our continued existence is directly related to the abundance, availability, and quality of these raw materials. It is also dependent on our ability to obtain them. A great deal of time and energy are spent locating raw materials and transforming them into products we need and use.

Although it is sometimes difficult to recognize the source of manufactured or processed items, everything can be traced back to the earth. A fast food hamburger, for example, is made from beef, which comes from a cow. The bun is made from grains which, like the grass that cows feed on, grow in soil and are nourished by minerals, water, and sunlight. The polystyrene container is made from fossil fuels extracted from the earth. In addition, a large quantity of energy, also derived from natural resources, is used to transform the raw materials into the hamburger. Producing just one burger requires many natural resources, often tapping sources worldwide. Because the earth is the ultimate source of everything we need and produce, we must take good care of it.

What are renewable and nonrenewable resources?

Natural resources can be divided into two major categories: renewable and nonrenewable.

Renewable resources are those that are replenishable on a short time scale. Because they are replenished naturally, supplies can be restored and maintained indefinitely, if properly managed. Some examples of renewable resources include trees, plants, wildlife, solar energy, and hydropower. Many useful materials and products such as food, clothing, medicine, paper, and lumber are derived from these resources. After the raw materials are harvested, more can be planted or grown and, over time, restored. For example, if we harvest trees to use in paper production, we can plant new seedlings that will grow to produce more wood.

Renewable resources can be replenished, but excessive and improper use can severely deplete and, ultimately, destroy them. In general, we have the ability to consume resources more quickly than they can regenerate. Sophisticated technology and equipment exacerbate this problem as they enable us to harvest resources at rates that greatly exceed their natural ability to replenish themselves, even with human assistance such as replanting. Harvest and regrowth should be carefully balanced to maintain sustainable supplies of renewable resources.

Nonrenewable resources are those resources that cannot be replenished in the short term. Some examples of nonrenewable resources include precious metals, minerals, and fossil fuels. These raw materials are used as fuel, as well as to produce plastics, synthetics, glass, steel, and other useful items that are now part of our daily lives. Limited supplies of these materials are found on the earth. Running out of raw materials that have become necessities could significantly alter the way we live and have far-reaching environmental ramifications. Like humans, some renewable resources, such as trees, depend on nonrenewable resources, including minerals, soil, water, and air. Consequently, nonrenewable resources must be carefully managed for the sake of all living beings.

How do consumer practices affect the supply of natural resources?

Natural resources are not equally distributed around the world. Thus, countries compete for rights and access to these valuable materials. As the world population and the complexity of most societies increase, the demands and pressures placed on natural resources also increase. In addition, an increase in toxic materials entering the environment and polluting the water, air, and soil greatly threatens the integrity of existing resource reserves.

Excessive human consumption and mismanagement are destroying supplies of both renewable and nonrenewable resources. Varying amounts of resources and energy are required to support different lifestyles. The United States and other industrialized nations require more energy and resources per capita than do most other countries. Only 6 percent of the world's population lives in the United States, yet we consume 33 percent of the world's energy. Much of this energy is used to meet industrial, residential, and transportation demands that are viewed by many as excessive and inefficient. As a result, natural gas and oil are disappearing rapidly. It has been estimated that the earth's fossil fuels will be depleted in the next 30 to 60 years, and that coal supplies will be exhausted by the year 2400. Unfortunately, fossil fuels are nonrenewable resources and no amount of money or power will be able to replenish them. Zinc, lead, copper, and other nonrenewable resources are also expected to be depleted within the next century.

Poor management and excessive consumption of a renewable resource not only threaten that resource, but all those who depend on it as well. For example, trees are being harvested from tropical rain forests much faster than they can possibly grow back. Although trees are considered to be renewable with proper management, most tropical rainforests and North American old growth forests that are clear-cut and burned will probably never return to their original state. Rapid deforestation destroys valuable plant species and eliminates habitat and food sources for many species of wildlife. A reduction in mature forest vegetation also means a decrease in its oxygen-producing capacity and in the amount of organic matter and essential nutrients that are returned to the soil. Less vegetation means fewer roots exist to hold the soil in place, thereby increasing soil erosion and decreasing soil fertility. These are some of the ways that poor resource management can have local as well as global ramifications.

Our convenience-oriented lifestyle not only consumes a great deal of natural resources, but it also wastes them. Many resources are converted to products with very short life spans. For example, oil—which is produced over millions of years—is used to create a plastic container that will warm a hamburger for 30 minutes before it is discarded and sent to a landfill to be buried. This use pattern severely restricts the benefits that can be gained from such a limited and versatile resource as petroleum.

How can we conserve natural resources?

There are several steps we can take to conserve resources and protect the environment. The first step is to become an educated and responsible shopper. We can reduce our resource consumption by purchasing fewer disposable products, especially those made from nonrenewable resources such as petroleum. In addition, purchasing products in reusable and recyclable containers can prevent the resources making up those containers from becoming trash. Instead of using virgin raw materials, recyclables can be used to make new products, often reducing the amount of energy needed and the pollution generated in production.

Reducing, reusing, and recycling decrease the demands on natural resources, as well as the rate at which they are consumed. Fewer resources are used, limited supplies are conserved, and regeneration of renewable resources is given time to occur. In addition, less waste is generated, thereby reducing the amount of trash that must be landfilled or incinerated. As the amount of trash buried or burned decreases, so does the potential for air and water pollution from the improper disposal of wastes.

Natural resources must be conserved and properly managed to prevent their depletion and contamination, and to ensure that people around the world have access to those materials necessary to maintain a decent standard of living. Choices we make in our personal lives can and do affect the environment. By reducing, reusing, and recycling, we can help conserve the earth's resources and the life they support for many generations to come.

RECYCLING FACTS

Paper

DID YOU KNOW THAT 38 percent (by weight) of all municipal solid waste is made from paper or paperboard? Some paper products that we discard regularly include newspaper, cereal boxes and other paperboard food containers, letters, magazines, tissues, toilet paper, and paper towels. Currently, the United States is the largest producer and consumer of paper and paper products in the world. In 1993, the United States generated 78 million tons of paper and paperboard waste.[v] Of this total, approximately 66 percent was not recycled or composted.[vi]

Where does all this paper come from?

Paper is produced from wood. About 35 percent of the world's annual wood harvest is used to produce paper and this share is expected to grow to 50 percent by the year 2000. It takes approximately 17 trees (roughly 3,700 pounds of wood) to make 1 ton (2,000 pounds) of paper. Fortunately, trees are a renewable resource; however, we are currently harvesting our trees faster than we are replacing them. Without proper management or sufficient natural regeneration, some species of trees (as well as the production of paper and other wood products) could be threatened.

How is paper made?

Paper is made in paper mills, which are usually located near the forests where the trees are harvested. Once the trees are cut down, they are debarked and chipped. These smaller pieces of wood are mixed with chemicals and processed in a large pressure cooker called a *digester*. This process helps to break the wood down into cellulose fibers. These fibers are rinsed to remove chemicals, unwanted wood contaminants, and dirt. The remaining wood-water mixture is called *slurry* and is fed onto screens that catch the fibers. The material on the screens is shaken to intermesh the fibers and drain any excess water. The resulting sheets of paper are passed through a series of rollers where they are pressed and dried. The final rolls of paper are produced by machines at rates as fast as 30 feet per second and can be as wide as 16 feet.

An increasing number of paper mills are using recycled paper as a feed stock to make new paper. Recycled paper contains cellulose fiber that can be reused (alone or combined with new fiber) to make many kinds of paper products including newsprint, stationery, towels, tissues, napkins, insulation, roofing paper, packaging, and paperboard. When it arrives at the paper mill, recycled waste paper is first processed in a pulper. Water is added to turn the paper into a soft, wet material called *pulp*. Chemicals may be added to remove inks and contaminants from the paper fibers. The pulp is sifted through screens (to remove staples, paper clips, etc.) and washed. Clean pulp is mixed with clean water until it becomes a thick, white substance. This is spread into thin layers on a screen, heated, dried, and smoothed on a series of rollers to form sheets of clean finished paper.[vii]

As paper recycling programs have become more common, the supply of recycled paper has increased and become more reliable. Many new paper mills that use recycled paper are being located near population centers to be near this new source of raw materials.

How does paper production affect our environment?

In addition to consuming resources, paper production can pollute our environment. Producing 1 ton of paper from trees may create as much as 84 pounds of air pollutants, 36 pounds of water pollutants, and 176 pounds of solid waste. This does not include the negative impacts resulting from the conventional disposal of used paper and paper products.

While the use of recycled paper to make more paper should be encouraged, the recycling process does create its own environmental hazards. The paper de-inking process, in which ink is removed from recycled paper, produces wastes that may contain lead. These wastes require careful management and disposal. As more printing companies switch to soy-based inks, the de-inking process should become less of an environmental concern.

Of major concern in the production of paper, either from trees or recycled paper, is the use of chemicals that produce cancer-causing wastes. Chlorine, which is commonly used to bleach, or whiten, paper fibers, causes the production of dioxin, a known carcinogen. New bleaching methods that reduce or eliminate the use of chlorine are being developed. Paper mills are slowly switching over to using oxygen, carbon dioxide, hydrogen peroxide, and ozone in place of chlorine.

What are the benefits of recycling paper?

Paper has become an integral part of our lives and plays an important role in many sectors of our society. It is a product that adds to our high standard of living and is essential in maintaining quality education, health and safety standards, and cost effective and efficient transportation of goods.

If we recycled half of the paper used in the world today, we would meet almost three-quarters of the demand for new paper and save millions of acres of forest at the same time. When left standing, forests help purify the air, provide essential wildlife habitat, and offer recreational opportunities to humans. Using waste paper instead of trees to manufacture new paper products also reduces water consumption by 60 percent and the generation of environmental pollutants by 70 percent. Recycling a ton of newsprint is equal to saving four 42-gallon barrels of oil! In addition, recycling paper products extends the life of landfills by conserving valuable space. Recycling 1 ton of waste paper saves an average of 3 cubic yards of landfill space.

How can we "close the loop?"

To "close the loop" is to purchase products that contain recycled materials. If demand for recycled-content goods is steady, manufacturers are more likely to invest in the machinery and processes needed to use recycled materials in their products. Manufacturers that are set up to use recycled materials as feedstock provide a steady market for recyclables that are collected by community recycling programs.

A Recycling Success Story in Massachusetts

Newspapers are the most commonly recycled household item in Massachusetts. The Commonwealth and the Massachusetts Newspaper Publishers Association signed an agreement in 1989 in which newspaper publishers voluntarily agreed to increase the recycled newsprint content used in Massachusetts newspapers to 13 percent by 1993, 23 percent by 1995, 31 percent by 1997, and 40 percent by 2000. This agreement promised a steady demand for old newspapers, and paper manufacturers became willing to invest millions of dollars in recycling technologies. This legislative initiative brought recycled newspaper supply and demand closer to equilibrium than they had been previously. By 1992, the average recycled content of Massachusetts newspapers had risen from 6.4 percent in 1991 to almost 15 percent.

Sources: Massachusetts DEP, *Master Plan: 1995 Update*; Florida, *4Rs Project*

Glass

DID YOU KNOW THAT 7 percent (by weight) of everything we threw away in 1993 was made from glass?[viii] Some examples of commonly used glass items are jars and bottles which contain food, beverages, toiletries, cleaners, and medicines. Other glass objects in the waste stream include window panes, light bulbs, and mirrors. It is estimated that each person in the United States uses almost 400 bottles and jars each year. Glass is popular because it is versatile, strong, and fairly easy to produce. It can be recycled an unlimited number of times. Refillable glass bottles were originally designed to endure 30 round trips from manufacturer to consumer. Because we often throw them away after using them only once or twice, the raw materials and energy invested in their production are wasted. The Massachusetts Bottle Bill, passed in 1983, has greatly increased the number of bottles recycled in the state, although many glass containers are exempt and are still discarded as garbage.

Where does glass come from?

Glass is produced from minerals. Silica, more commonly known as sand, is the primary ingredient used in its production. Silica is the most common substance in the earth's crust, and although it is a nonrenewable resource, there is quite a large supply of it. It takes 1,330 pounds of sand, 433 pounds of soda ash, 433 pounds of limestone, 151 pounds of feldspar, and 15.2 million BTUs (British Thermal Units) of energy to produce 1 ton of glass. The soda ash (sodium carbonate) lowers the melting point of silica and helps regulate the consistency of the mixture. Limestone (calcium carbonate) is added to stabilize the mixture and keep it from dissolving in water. Different colors of glass are produced by adding small amounts of other substances such as iron, copper, and cobalt. Green glass, for example, is made by adding iron.

How is glass made?

Glass is produced in factories where the raw materials are melted together and transformed into bottles, jars, and other products. There are 90 glass manufacturers in the United States that produce a total of approximately 80 million containers a day. The mixture of silica, soda ash, limestone, and feldspar is called a *batch* of glass. The batch is mechanically fed into large furnaces and heated to temperatures as high as 2,800 °F. When it is completely melted, the material is transferred to a glass forming machine where molten glass is dropped into molds for shaping. Compressed air is then forced into the center of the mold blowing the glass out against its walls, forming the desired shape. This formation process only takes approximately 13 seconds. Finally, the containers are placed on conveyor belts and are slowly passed through cooling tunnels to prevent shattering. Slow cooling, in addition to a protective coating, strengthens the glass and increases its durability. In about 1 hour, the bottles are cool enough to touch and can be labeled, filled and sent to market.

How are glass, energy, and the environment related?

The raw materials used to produce glass are plentiful and fairly accessible, but the process of transforming them into glass requires a lot of energy. It takes about 7,600 BTUs of energy to produce just 1 pound of glass. In addition, the manufacturing of 1 ton of glass can generate as much as 385 pounds of mining waste and 28 pounds of air pollutants.

What are the benefits from reusing and recycling glass?

Reusing glass at home conserves resources and energy. Industries also reuse glass by cleaning and refilling glass containers that are returned for the bottle deposit. The energy savings from this activity, though, are partially offset by the energy expended in the cleaning and transport of the used bottles.

Recycling glass can also save resources and energy and can reduce the amount of waste and pollution generated by glass production. To be fully useful to manufacturers, recycled glass must be separated by color—green, brown and clear. Ceramics and window glass, which have an entirely different composition from container glass, are considered contaminants to recycled container glass.

Recycled glass is crushed into cullet, small pieces less than one-half inch in size. Adding cullet to the batch saves energy because recycled glass has a lower melting point than do the virgin source materials. The temperature of the furnace can be lowered 10 degrees for every 10 percent cullet added. Because a new batch of glass may contain up to 83 percent cullet, using old bottles to make new ones can conserve a significant amount of energy (approximately 6 percent). Using 1 ton of recycled glass will also save 1.2 tons of raw materials and reduce mining wastes and other harmful by-products of glass production. It has been estimated that using 50 percent recycled glass in the manufacturing of new glass can reduce mining wastes by 79 percent, water consumption by 50 percent, and air emissions by 14 percent.

In addition to making new glass containers, recycled glass can also be used in fiberglass manufacturing and as a substitute for aggregate in road building. Finally, recycling glass saves landfill space. Instead of becoming trash and lying in landfills for thousands of years, bottles and jars can be used over and over again, and recycled indefinitely.

Sources: AVR, *Teacher's Resource Guide*; Bell and Swartz, *Oscar's Options*; Florida, *4Rs Project*

Metal

DID YOU KNOW THAT 8 percent of everything we threw away in 1993 was made from metal?[ix] Iron and aluminum are the metals most frequently used in the production of items we use daily, such as food and beverage containers, pie plates, frozen food trays, foil, car and aircraft parts, gutters, pipes, window frames, construction beams, and appliances. The chemical composition and structure of these metals result in products that are strong and durable, even when exposed to the elements. For example, an aluminum can left outside will take 500 years or longer to disintegrate to dust. Unfortunately, the very properties that make metal products so useful and versatile also contribute to problems associated with their disposal.

Where does metal come from?

Metals are elements or mixtures of elements that occur naturally in the earth. Abundance, accessibility, and the processing required to transform these natural substances into a usable form vary with the type of metal.

Aluminum

Aluminum is the third most common element and constitutes 8 percent of the earth's crust. Although it is quite common and can be found dispersed throughout most rocks and clays, it is never found naturally in its metallic state. The greatest concentration of aluminum is found in bauxite ore, which contains large amounts of alumina. Most of the world's bauxite reserves are in the subtropics where heat and water weather away other elements, leaving a high concentration of alumina. The United States imports 85 to 90 percent of its bauxite.

Surface mining of bauxite requires a large energy input and generates solid, waterborne, and hazardous wastes, as well as air pollution. After the bauxite ore is extracted from the ground, it is transported to refineries where the alumina is chemically separated from the ore. The aluminum is then extracted from the alumina through an energy-intensive process called *electrolysis*. Small amounts of other metals or alloys may be added to the aluminum to strengthen it. The melted aluminum is then cast into ingots and sent to manufacturing plants where it is remelted and formed into a variety of items. Aluminum is often used when a strong, durable, yet light-weight, material is needed.

Iron, Steel, and Tin

Iron is also a naturally occurring element. Steel is produced by adding carbon to iron. Different grades of steel are produced by adding various elements to this basic mixture. Tin is another metallic element. "Tin" cans are really steel cans with a thin coating of tin, which prevents the steel from rusting or corroding. Steel is very strong and is the most widely used metal today. The mining and processing of iron is quite costly, and energy intensive.

How can I tell the difference between the types of metals?

You can tell the difference between steel cans and aluminum cans with a magnet. Magnets will attract steel, but not aluminum. Bimetal cans are steel cans with an aluminum top and bottom. A magnet will attract these cans if pointed at the steel portion, but not if placed near one of the aluminum ends.

What are the benefits of recycling metal products?

Metal products are used extensively throughout the world. We have come to depend on them for transportation of people and goods, for sturdy building materials, and for packaging and storage of food and beverages. It is clear that as population increases and the standard of living rises worldwide, so too will the demand for metal products. Unfortunately, metals are nonrenewable resources and their extraction from the earth is expensive, energy intensive, and detrimental to the environment. Recycling metal and reusing it to make new cars, appliances, and window frames, for example, can offset the monetary and environmental costs of consuming metal products, while continuing to meet the increased demand.

Pure aluminum cans are 100 percent recyclable. Using them to produce new aluminum products can reduce energy consumption and air and water pollution by approximately 95 percent. Recycled aluminum is shredded, remelted and cast into ingots and mixed with virgin aluminum before being shaped. Once produced, aluminum cans may be recycled indefinitely.

Compared with manufacturing steel from virgin materials, recycling steel can reduce energy consumption by 74 percent, air pollution by 86 percent, water use by 40 percent, water pollutants by 76 percent, and mining wastes by 97 percent. For every ton of steel recycled, 2,500 pounds of iron ore, 1,000 pounds of coal, and 40 pounds of limestone are saved. The Steel Recycling Institute reports that each year in the United States, recycled steel saves enough energy to meet the electrical power needs of the city of Los Angeles for 8 years! Recycled steel is generally shredded or compacted, cleaned, and remelted. For each ton of scrap metal used in place of virgin materials, 1.5 tons of iron ore and one-third of a ton of coke/coal are saved.

Most residential recycling of ferrous metals—i.e., iron and steel products—focuses on the recovery of steel cans. Steel cans are composed of roughly 1 percent tin (used as a coating) and 99 percent steel. These cans are most often sent to a de-tinning factory where the chemical separation of tin from steel takes place. The two materials are then marketed to different manufacturers for use in new products. Increasingly, steel cans are being sent directly to steel mills where they are mixed with other raw materials to make new steel.

In addition to reducing pollutants and conserving resources and energy, recycling metal materials saves landfill space. Every pound of metal that you recycle means one less pound of metal for your community to dispose of by landfill or incinerator. Steel is 100 percent recyclable and can endure an infinite number of cycles through the recycling process.

The recycling of metals has increased dramatically in the past two decades. In 1970, only 3 percent of all metals in the United States were recycled. By 1990, 21 percent were being recycled.[x]

Sources: AVR, *Teacher's Resource Guide*; Bell and Swartz, *Oscar's Options*; Florida, *4Rs Project*

Plastic

DID YOU KNOW THAT plastics account for approximately 9 percent by weight[xi] of everything we threw away in 1993, and represent roughly twice that amount in volume?[xii] Since the end of World War II, plastics have become extremely popular in the United States. Plastics are used to produce many items we rely on daily, including milk and juice jugs, soda bottles, food wraps, garbage bags, and several types of packaging. In addition, plastics have contributed to many scientific breakthroughs and have played a major role in the development of important products such as contact lenses, artificial hearts, more fuel-efficient cars, and portable computers. Plastics are lightweight, durable, waterproof, versatile, relatively inexpensive to produce, and increase the mobility and shelf life of many products. These properties make plastics very desirable to both consumers and manufacturers, and as a result, they have been replacing traditional materials such as glass, aluminum, steel, and paper. Unfortunately, the very properties of strength and low weight that make plastics appealing also create complex problems during their production and disposal.

What is plastic made from?

Plastics are synthetic materials derived from petroleum and natural gas. Petroleum and natural gas also provide energy for residential and commercial needs, production processes, and transportation needs around the world. Availability of these scarce, nonrenewable resources is a critical issue underlying the continued use and disposal of plastics. At current consumption rates, world-wide reserves of accessible petroleum and natural gas are only expected to last for another 30 to 60 years.

How are plastics made?

Plastics consist of carbon combined variously with hydrogen, oxygen, nitrogen, chlorine, or fluorine. They are made by linking together small molecule groups called *monomers* into long-chain molecules called *polymers*. When this chemical rearranging occurs, a plastic resin is formed. While in liquid form, plastics can be molded and cast into many different shapes. Plastic resins are used to produce hundreds of different types of plastic, all of which fall into two basic categories, thermoset and thermoplastic.

Thermoset plastics harden permanently, making them difficult to recycle. Thermoset plastics are used to produce products that require a hard, durable, and permanent plastic such as, furniture, toys, tableware, and computer casings. These items constitute approximately 10 percent of plastics sold in the United States.[xiii]

Thermoplastics will also harden when cooled, but may be remelted and molded into new plastic products. This characteristic makes thermoplastics good candidates for recycling. Thermoplastic resins are commonly used for rigid containers such as soda, dairy, detergent, and cosmetic bottles, and other noncontainer products such as trash bags, toys, rope, utensils, flooring, Styrofoam, upholstery, and pipes. To recycle thermoplastic materials, scrap plastic must be reduced to granules, pellets, or powder, which are then marketed as feedstock to plastics molders.

Many thermoplastic products have a recycling code imprinted on their bottom panel. The code consists of a number, 1 through 7, inside of a recycling symbol (the chasing arrows). The Society for the Plastics Industry (SPI) developed this code so that plastics could be sorted by type at recycling facilities. Whether these numbered plastics are recyclable in a particular community depends on local collection capabilities and existing markets for recycled plastics.

The thermoplastic resin types most commonly used in the United States and most frequently seen in the waste stream are listed below, next to their SPI code:

1 PETE

2 HDPE

3 V

4 LDPE

5 PP

6 PS

Polyethylene Terephthalate (PET) has been used extensively since 1977 for soft drink bottles. It is also used in other packaging materials such as plastic jars, sheeting, and blister packs, as well as for certain appliance and auto parts.

High Density Polyethylene (HDPE) is used for the majority of rigid containers such as milk jugs, laundry detergent jugs, plastic tubs for butter and margarine, containers for ice cream, cosmetics, and medicine, and for heavy-duty trash bags.

Polyvinyl Chloride (PVC) is a versatile plastic because it is tough, yet can be modified by additives to be flexible. PVC is primarily used for durable construction products such as pipes, siding, cables, and gutters. Commonly known as “vinyl,” it also is used extensively for flooring, paneling, siding, luggage, footwear, upholstery, clothing, camping gear, and beach rafts. Roughly 25 percent of the PVC produced is used for disposable packaging.

Low Density Polyethylene (LDPE) is used extensively in packaging materials such as clear wrap, supermarket produce bags, bread bags, dry-cleaning bags, and for coating other containers such as milk and juice cartons.

Polypropylene (PP) is used for durable items including battery cases, furniture, fibers for rope and strapping, cellophane-like food wrappers, and in some of the layers of multi-layered plastic containers.

Polystyrene (PS) is best known in its foamed form, better known by Dow Chemical’s trademark, Styrofoam. It is used for products such as food trays, egg cartons, hot cups, and clamshell containers for take-out foods. Polystyrene is also used to produce plastic cutlery, disposable razors, prescription and vitamin bottles, mini-containers for cream, and packaged cookie trays.

Other includes plastics that are not one of the six previous types. Also in this category are products that consist of multiple plastic resins in layers, blends, or different parts. Mixing resins allows strength, flexibility, and other desired properties to be combined in one product. Squeezable ketchup bottles are an example of a multi-layered plastic container. Although these plastics help to increase product shelf life or protect the flavor and texture of food items, mixing of multiple plastic resins makes them more difficult to recycle.

What are the disadvantages to using plastics?

The production of plastics requires large quantities of crude oil and natural gas, and generates a significant amount of solid waste, as well as air and water pollutants. Each day, millions of plastic products are discarded, and the potential energy embodied in them is wasted. Disposal of plastics can generate air pollution when burned in combustion facilities. For example, burning PVC releases chlorine gas into the atmosphere, which can threaten human health. The burning process also creates hydrochloric acids that can corrode the inside of combustion chambers, resulting in an increase in atmospheric emissions.
In addition to the problems associated with the production and subsequent disposal of plastic waste, many plastic items are disposed of improperly and end up in oceans, waterways, and along roadways. This plastic litter threatens the health of many species of wildlife and often compromises the natural beauty of these areas. It is estimated that plastic garbage (e.g., six-pack rings, fishing lines and nets, plastic bags, utensils) commonly found in United States waters accounts for the death of thousands of marine mammals per year, including endangered species of turtles and whales.

Plastic products and packaging have become necessities in our convenience-oriented society. In Massachusetts, plastics accounted for approximately 528,000 tons of municipal solid waste in 1992.[xiv] Plastics do not rust, biodegrade, dissolve, or evaporate when exposed to the elements. Although most plastic products are used only briefly, they will remain in our environment for a very long time and will continue to create serious waste management and pollution concerns.

What are biodegradable and photodegradable plastics?

The litter and marine pollution problems associated with plastics have prompted keen interest in the development of degradable plastics that break down naturally and disappear over time. True biodegradable plastics that can be broken down into organic substances by bacteria and fungi are presently in the experimental stage, and are not yet available for general use.

Recently, several plastic products such as trash bags and disposable diapers have been advertised as being biodegradable. These plastics are oil-based and contain additives such as cornstarch. Bacteria readily feed on the starch in the blend and, although this action breaks up the plastic material into small fragments, these little pieces of the oil-based plastic remain in the environment.

Photodegradable plastics are blended with additives that degrade when exposed to the ultraviolet rays in sunlight. Direct exposure to sunlight for extended periods of time causes these materials to become brittle and the plastics break down into smaller pieces. These fragments of plastic also remain in the environment. Manufacturers are currently producing six-pack yolks from photodegradable plastics and are required to do so by law in over twelve states, including Massachusetts. Other commercial products made with photodegradable plastics include trash bags and agricultural mulches. While these items break down in the sunlight, they will have the longevity of other plastics if buried in landfills, as they will receive no exposure to the sun.

How are plastics recycled?

The ideal type of plastics recycling is a *primary* recycling process that creates a closed-loop system. An example of a primary process is the conversion of an old laundry detergent container into a new detergent container, again and again, indefinitely. There are some factors that limit the use of the primary recycling process for plastics. The cost to transport the high-volume, low-weight plastic containers to a manufacturer that can process the containers into more of the same kind is often prohibitive. There are also U.S. Food and Drug Administration regulations that limit the use of recycled plastic in food grade containers because recycled plastic containers cannot be sufficiently sterilized during the recycling process.

A *secondary* recycling process is one that converts a plastic product into a different product that is also recyclable. While this process does not eliminate the need to use virgin materials to make more of the first product, it does displace some virgin materials in the production of the second product.

A *tertiary* recycling process converts the recyclable plastic into an item that cannot be recycled again. The ideal goal in this process is to take items with short life spans, such as ketchup bottles, and convert them into an item with a long life span, such as plastic lumber.

Although there are more than seven kinds of thermoplastics, only a few types are commonly recycled. The most-recycled plastics are #1, PET, and #2, HDPE. They comprise 90 percent of the plastics used for bottle remanufacturing.[xv] Recycling these plastics involves shredding or grinding the containers, washing them, and removing contaminants. They are then melted down and formed into new products.

Manufacturing new plastic goods with recycled plastic feedstock requires less energy than using virgin raw materials for the process. Making containers from recycled PET requires only 12 percent of the energy needed when using virgin materials. Recycling 1 ton of HDPE conserves approximately 76 million BTUs. Recycled PET is commonly used as fiberfill in pillows, jackets, sleeping bags, and automobile seats. Other uses include insulation, shower stalls, floor tiles, automobile bumpers, taillight covers, and power tool housings.[xvi] Recycled

HDPE can be remolded into flower pots, trash cans, automotive mud flaps, kitchen drain boards, beverage bottle crates, and pallets.[xvii]

Polystyrene foam packaging is being recycled in a growing number of programs around the country. Various types of foam packaging waste are collected, flaked, remelted, and pelletized. Recycled polystyrene is mixed with virgin polystyrene to produce coat hangers, flower pots, wall and building insulation, and protective packaging.

The plastics industry has also developed technology and products that do not require the separation of resins for recycling. Mixed-resin plastics are used to make plastic lumber for boat docks, auto curb stops, park benches, horse stalls, picnic tables, railroad ties, marine pilings, piers, and fencing. Research into the separation of mixed plastics and its uses is continuing.

At this time, plastics recycling programs are expensive because of the high-volume/low-weight characteristics of plastic. One ton of plastics takes up six times the space of 1 ton of glass, for example. Crushing and densifying plastic containers reduces their volume, allowing greater shipping and storing efficiencies. These efficiencies can result in a more cost-effective collection program.

Sources: Massachusetts DEQE, *Plastics Recycling*; U.S. OTA, *Facing America's Trash*; AVR, *Teacher's Resource Guide*; Florida, *4Rs Project*

Aseptic Packaging and Milk Cartons

DID YOU KNOW THAT approximately 3 billion aseptic drink boxes are sold in the United States each year? Nationally, each household generates approximately 9 pounds of aseptic packaging and milk carton waste per year. Drink boxes have gained popularity because they are sterilized and they allow liquids to be stored without the need for refrigeration or preservatives. They also have a lower packaging-weight-to-product-weight ratio (4 percent) than do other containers, such as glass bottles (35 percent), plastic bottles (16 percent), or aluminum cans (5 percent). This attribute makes aseptic packaging attractive to those paying for product transportation by weight.

What is aseptic packaging made of?

Aseptic packaging consists of three different materials layered together. Paper makes up 70 percent, by weight, of each drink box. Polyethylene (24 percent) and aluminum (6 percent) make up the rest of the box. Each box has six layers of material: two innermost layers of polyethylene, followed by aluminum, polyethylene, paper, and a final layer of polyethylene. This combination of materials makes drink boxes waterproof and durable.

Is aseptic packaging recyclable?

Packaging that contains more than one type of material presents a recycling challenge. Because aseptic packaging is 70 to 80 percent paper, many paper companies use equipment that will separate the paper fiber from the polyethylene and aluminum. This process, called *hydrapulping*, blends the cartons with water in a big vat that acts like a blender. Cut up, empty containers are put in the vat and agitated in the water, which turns them into a soft, mushy pulp. This pulp is sifted and cleaned to separate the paper fiber from the aluminum and polyethylene. The paper fiber is used to make new paper products, such as paper towels, napkins, tissues, and writing paper. The aluminum and polyethylene are currently burned for energy or landfilled.

A new recycling technology that is being developed for aseptic containers is called *mixed plastics recycling*. In this process, the remaining polyethylene and aluminum from the hydrapulping process are combined with other kinds of plastics to form building materials, such as plastic lumber. Though technically possible, the commercial applications for this process are still being developed. In the future, this recycled plastic may be used as a substitute for traditional construction materials, such as wood, to make a variety of products, including highway markers, garden planters, and decking.

Source: Aseptic Packaging Council, *The Truth About Aseptic Packaging*

PROBLEM WASTE FACTS

Problem wastes are components of the waste stream that need to be managed differently from the way typical components of the residential and commercial waste stream are handled. These "difficult-to-manage" wastes place special demands on the waste management system. Problem wastes include construction and demolition debris, tires, sludge, waste oil, batteries, household hazardous wastes (HHW), and bulky items (furniture and appliances).

Batteries

DID YOU KNOW THAT Americans purchase nearly four billion batteries every year? These batteries power such items as radios, watches, flashlights, toys, laptop computers, cellular phones, and many other household appliances. Batteries play an important role in our daily lives. Increasing concern, however, has developed over the disposal of these batteries due to their heavy metal content.

What is a battery?

Batteries are electrochemical devices that convert chemical energy into electrical energy and provide power for many commonly used items. The basic battery cell consists of a negative electrode (anode), a positive electrode (cathode), and an electrolyte, which is a solution through which an electrical current can travel between the anode and the cathode. There are two types of batteries: primary cells and secondary cells.

- **Primary Cells** (nonrechargeable): A primary cell is not rechargeable and ceases to work when the active chemicals that produce the energy are depleted. They are not designed to be recharged and attempting to do so may cause them to explode. Most common household batteries are primary dry cells. Dry cell refers to the nonliquid electrolyte contained in the battery.

- **Secondary Cells** (rechargeable): Secondary cells, or wet cells, are rechargeable and can be used repeatedly. The chemical reaction that creates the electricity can be reversed, thereby allowing an electrical current to recharge the battery. The electrolyte in the wet cell is in the form of a liquid bath. A common example is a rechargeable household battery that is available with a special charging unit. A car battery is also a secondary cell.

Table 1-1 identifies different types of common household batteries and their chemical components.

Table 1-1. Most Common Types of Household Batteries

Battery Type	Common Sizes	1992 Percent Sales	Chemical Components	Principal Applications
Alkaline	D, C, AA, AAA, N, 9V, button	63%	Manganese dioxide, zinc, potassium hydroxide, cadmium, mercury[a]	Consumer appliances
Zinc-Carbon	D, C, AA, AAA, 9V	20%	Manganese dioxide, zinc, ammonium chloride, lead, cadmium, mercury[a]	Consumer appliances
Silver Oxide	Button	3%	Silver oxide, zinc, potassium hydroxide, mercury[a]	Watches, calculators, hearing aids, some cameras, small electrical devices
Mercuric Oxide	Button, some cylindrical	1%	Mercuric oxide, zinc, potassium hydroxide	Hearing aids, watches, calculators
Zinc-Air	Button	3%	Zinc, potassium hydroxide, mercury[a]	Hearing aids, electronic pagers
Lithium	Button, coin, and larger 3V, 6V, AA	0.2%	Manganese dioxide, lithium, organic solvents	Photographic applications, small electronic devices
Nickel-Cadmium (rechargeable)	D, C, AA, AAA, 9V, battery "packs"	9%	Nickel hydroxide, cadmium, potassium hydroxide	Power tools, computers, cellular phones, video cameras
Sealed	Rectangular	0.6%	Lead dioxide, lead,	Computers, cellular

Lead-Acid (rechargeable)	block, one round cell		sulfuric acid	phones, video cameras, garden tools

[a]Mercury being phased out by several battery manufacturers beginning in 1990.
Source: New York State Department of Environmental Conservation, *Report on Dry Cell Batteries in New York State*

Why are batteries a problem?

Lead-acid automotive batteries, nickel-cadmium rechargeable batteries, and button batteries are undesirable in the waste stream because they contain heavy metals that can harm the environment and threaten human health. Until recently, alkaline or zinc-carbon household batteries also had heavy metals in them. The principal routes of heavy metals from batteries into the environment are:

- Incineration of solid waste: When batteries are burned, heavy metals (particularly mercury) can enter the environment through air emissions if the air pollution technology is not designed or operated properly to capture the metals.[xviii] Air emissions include both fly ash in the smoke and vaporized materials. Proper air pollution control equipment can filter out the fly ash better than it can capture the vapors. Heavy metals concentrate in the bottom ash of the incinerator and can come in contact with humans or the environment during storage, transportation, and disposal of the ash. Lastly, these metals may render the ash hazardous, thereby increasing disposal costs for the material.

- MSW composting: When batteries end up in composting operations, heavy metals may become concentrated in the composted soils.

- Unlined landfills: When batteries are buried in unlined landfills, leachate (water percolating through the garbage) may carry the heavy metals out of the landfill and into the surrounding groundwater.

Most heavy metals are toxic to people and animals and can cause a variety of serious health disorders. Unlike most organic compounds (those containing carbon), heavy metals do not decay or break down in the environment. Because plants and animals cannot metabolize these substances, they experience a build-up of heavy metals in their tissues. As larger animals eat contaminated smaller animals or plants that have been contaminated, the heavy metals become more and more concentrated and continue to bioaccumulate as they make their way up the food chain. The toxic battery components of major concern are cadmium, lead, and mercury. Batteries have been the largest source of cadmium and mercury in MSW.

Current manufacturing technology has dramatically reduced the mercury content of household batteries. In past years, mercury content was roughly 1 percent of the battery's weight. The major American battery manufacturers are now producing "no-mercury-added" alkaline batteries that present less danger to the environment.[xix] Between 1990 and 1993, Eveready, Duracell, Panasonic/Kodak, and Rayovac all converted to a no-mercury-added design for their alkaline and zinc-carbon batteries. Government and industry are working to create the ideal battery that has no toxic components, is rechargeable, is recyclable, can be safely handled, and meets high performance standards.

There are also safety concerns related to batteries. Batteries need to be stored properly. Batteries should not be stored in tight containers or poorly ventilated areas in case of hydrogen gas or mercury vapor build-up. Batteries may leak and corrode metals or cause a skin burn on contact. Batteries should be stored in dry, vented containers that are clearly labeled. Such containers could be made of steel with a protective lining or heat resistant plastic or nylon.

Are batteries recyclable?

Metals can be extracted from batteries and recycled, but this technology is very expensive. Most of the research for battery reclamation is being done in Europe and Japan. Comparatively, the United States is doing less research, though programs to recycle button and nickel-cadmium rechargeable batteries have begun in some parts of the country.

Recycling batteries uses large amounts of energy and has very high capital and operating costs. The cost of battery recycling is determined by battery type, concentration of mercury, and the avoided costs of disposal. The cost of recycling could be reduced somewhat if batteries were more easily sorted by type. Sorting difficulties currently add to the cost of collecting the batteries.

Metals from batteries will become an increasingly attractive feedstock for the metals industry as battery manufacturers eliminate mercury from alkaline and zinc-carbon batteries.

How should we handle old batteries?

Because each type of battery poses a different kind of environmental concern, the issue of what to do with a dead battery can be confusing. Listed below are the types of batteries and how to dispose of them in Massachusetts:

- **Household batteries** (alkaline and zinc-carbon): Throw away with the regular household trash. While these batteries do contain some levels of toxic metals, most are low enough in mercury to be safely put into landfills or incinerators. Household batteries are not considered hazardous waste under the federal Resource Conservation and Recovery Act (RCRA) and thus they are not regulated as hazardous waste for collection, storage, and processing.

- **Button batteries**: Should be recycled through a recycling program. Due to their heavy metal content and the fact that they are salvageable at reasonable cost, button battery recycling programs are available throughout the state.

- **Rechargeable batteries** (nickel-cadmium): Federal law prohibits the land disposal of nickel-cadmium batteries. Should be recycled or taken to a hazardous waste collection. Although they are longer-lasting than single-use disposable batteries, the toxic metals they contain pose a significant environmental risk if they are discarded in landfills or incinerators. Remember that many small appliances have rechargeable batteries built in. Remove the battery for recycling or disposal through a household hazardous waste collection program before discarding the appliance.

- **Automotive batteries** (lead-acid): Recycle through a recycling program or bring them to auto garages or retail stores. You can trade your old battery in when you purchase a new one. Since 1992, lead-acid batteries have been restricted from Massachusetts landfills and incinerators. Nationally, nearly 90 percent of lead-acid batteries are recovered for recycling. [xx] These batteries are valued for their lead content, and the battery acid and plastic casing can be reused.

Sources: AVR, *Teacher's Resource Guide*; *Household Batteries;* Taylor et al., *Recycling in the 1980s*; New York DEC, *Report on Dry Cell Batteries*

Motor Oil

DID YOU KNOW THAT American car owners who change their own oil generate more than 200 million gallons of used motor oil each year? Unaware of the potential dangers associated with adding used oil to the environment, many people discard their waste oil wherever it is most convenient. It is estimated that through this "innocent" dumping, 180 million gallons of waste oil enter the environment each year.[xxi] In other words, do-it-yourself mechanics dump the equivalent of the Exxon Valdez oil spill every 3 weeks!

What is waste oil and why is it dangerous?

Waste oil is motor oil that has been used in cars, trucks, boats, trains, and other engines that need oil to function properly. Waste oil can contaminate water supplies, pose serious health threats, and cause extensive environmental problems. One gallon of used oil can contaminate and foul 1 million gallons of fresh water, which is equivalent to one year's supply of water for 50 people. One pint of used motor oil can produce an oil slick slightly larger than a football field and will kill floating aquatic organisms and algae that are food sources for fish. As fish eat these contaminated organisms, oil accumulates in their bodies. Oil also prevents the replenishment of dissolved oxygen in the water, further threatening the lives of fish and other aquatic creatures. Since contaminated organisms are eaten by fish, birds, and people, components of the waste oil move up through the food chain and can cause serious health disorders and genetic abnormalities. Human health is threatened if we drink oil-contaminated water, eat fish or animals that have ingested oil, or if our skin is directly exposed to it for long periods of time.

In addition, there are many additives and contaminants present in waste oil that make it toxic. For example, several substances are added to automotive oil to prevent rusting of engine parts and to enhance oil performance. The breakdown of these additives, plus contaminants from engine wear, and the infiltration of gasoline and combustion by-products, creates high levels of heavy metals such as lead, zinc, magnesium, and cadmium, as well as benzene and other potentially harmful substances. If not disposed of properly, these materials can contaminate water supplies, enter the food chain, and cause long-term ecological damage.

How does waste oil enter the environment?

Many consumers pour their used oil on the ground, down the sink, into storm drains, or discard it with the rest of their trash, which is landfilled or incinerated. A number of problems result from these disposal methods. When oil is dumped on the ground or buried, it can leach into groundwater and contaminate drinking water supplies. Oil poured into storm drainage systems meant to carry rainwater is transported directly into streams, lakes, and rivers. In a sanitary sewer system, wastewater proceeds to treatment plants. If waste oil contaminates this water, it can kill the bacteria that help break down sewage and purify the water. Not only does this diminish the effectiveness of the wastewater treatment, but water contaminated with oil is often discharged from these plants into rivers and coastal waters. It has been estimated that sewage treatment plants discharge twice as much oil into coastal waters as do oil tanker accidents—15 million gallons per year versus 7.5 million gallons per year. While it is quite difficult to prevent oil tanker accidents, we can effectively manage our waste oil to ensure that it does not haphazardly enter and pollute our waterways and the environment.

How can recycling waste oil save resources and protect the environment?

Improper disposal of used motor oil not only threatens human health, it also squanders a nonrenewable and scarce resource. Waste oil can be recycled by cleaning or refining it and can be used indefinitely as a lubricant. It only takes 1 gallon of used oil to produce 2-1/2 quarts of lubricating oil, while 42 gallons of crude oil are needed to produce the same amount of lubricating oil.

Waste oil can also be used as a fuel or fuel supplement. This is the primary means of recycling oil in Massachusetts since there are no refineries in the Northeast. Recycling the used motor oil dumped by do-it-yourself mechanics in one year would generate enough energy to power 360,000 homes for a year. Re-refining this same amount would produce 96 million quarts of lubricating oil.

How is used oil recycled in Massachusetts?

Massachusetts consumers have an alternative to dumping their waste oil. State law requires all motor oil retailers to accept for free up to 2 gallons of waste oil per day from every customer presenting a valid proof of purchase. The retailer is responsible for having this oil recycled in compliance with the Department of Environmental Protection’s (DEP’s) Hazardous Waste Regulations. The consumer is responsible for bringing waste oil to the store where it was purchased, in a clean, secure, and unbreakable container. It is important that oil is not mixed with gasoline, antifreeze, water, or any other substances because contamination will hinder the recycling process.

In addition to providing disposal opportunities under state law, the Commonwealth is making oil collection units available through grants to towns and cities. Some communities have already set up waste oil collection centers where residents can bring their used oil for recycling. With these choices available, it is now up to citizens to ensure that they dispose of waste oil in a safe and environmentally sound manner.

For further information on recycling oil in Massachusetts, call DEP’s Used Oil Hotline at (617) 556-1022.

Sources: AVR, *Teacher’s Resource Guide*; Massachusetts DEP, “How to Safely Handle . . .”

Construction and Demolition Debris

DID YOU KNOW THAT nearly 2 million tons of construction and demolition (C&D) debris were processed for reuse in Massachusetts in 1993?[xxii] C&D waste is generated from construction, renovation, repair, and demolition of houses, roads, bridges, and large building structures. C&D waste is made up of wood, steel, concrete, masonry, plaster, metal, and asphalt. C&D waste is significant because it contains hazardous materials such as asbestos, creosote, lead, arsenic, chromium, and formaldehyde resins, and because it makes up a large share of the solid waste stream.

In Massachusetts, C&D waste is handled in three basic ways. It is disposed of at landfills or combustion facilities, processed for reuse, or transported out of state for disposal or processing. The preferred alternative for C&D handling is processing for reuse. Reusing C&D waste saves landfill space and conserves virgin materials.

There are many beneficial uses for recycled C&D waste. Unpainted and untreated wood is chipped and used as a compost bulking agent, or for landscaping and erosion control. Chips from painted or preserved wood are sold for boiler fuel. Metal materials are removed from C&D waste and sold to scrap metal dealers. Asphalt waste is crushed and mixed with new asphalt. Concrete, brick, and asphalt, after crushing and screening, are used for road base and the production of new concrete.

Tires

DID YOU KNOW THAT Massachusetts has an estimated 10 to 12 million old tires stockpiled, primarily at privately owned tire disposal sites? Annual generation of scrap tires in Massachusetts is estimated at six million. Massachusetts faces the challenge of cleaning up existing piles and preventing future piles by enforcing regulations that prohibit stockpiling of tires. Additionally, the DEP supports legislative actions that promote the reuse and recycling of scrap tires.

Massachusetts is approaching tire management in several ways. DEP encourages tire recycling by excepting tires from restrictive disposal regulations. It also regulates the disposal of tires by requiring shredding prior to disposal at landfills or combustion facilities. DEP has just permitted several new facilities to manage tires. Massachusetts is one of seven northeast states working together on a regional EPA supported project to develop a coordinated approach to tire management. Finally, DEP is working with the Massachusetts Highway Department to increase the amount of tire rubber used in asphalt pavement.

Biosolids

DID YOU KNOW THAT Massachusetts produces approximately 90,000 dry tons per year of biosolids?[xxiii] Biosolids, or sludge, are the waste generated by wastewater treatment facilities. Sludge is disposed of by a variety of methods including sludge-only landfills and incinerators, co-disposal with MSW, and composting alone or with MSW.

The large quantity of sludge currently being disposed of at MSW landfills is the result of the successful advancement of the Commonwealth's water pollution control efforts. The anticipated closure of many Massachusetts landfills, however, will severely restrict this option. One method of disposal that the state encourages as a replacement to landfilling is co-composting of sludge with the organic portion of MSW.

Source: Massachusetts DEP, *Master Plan: 1995 Update*

Household Hazardous Products and Waste

DID YOU KNOW THAT each person in the United States uses almost 6 pounds of household hazardous products (HHP) in a year? HHP are those products used around the home which contain hazardous chemicals. These chemicals can be dangerous to human health and to the environment. The products are used to clean, polish, disinfect, and maintain our homes. We also use these products for our personal care, car maintenance, pest control, yard maintenance, and hobbies.

Household hazardous waste (HHW) is a household hazardous product that is no longer used. HHW can be products that are degraded, outdated, contaminated, overstocked or no longer used. The average American stores 3 to 10 gallons of HHW at any given time. Hazardous waste can be solid, semi-solid (or sludge), liquid, or gaseous. It requires special handling, storage, disposal, and, sometimes, transportation to protect people and the environment.

Some common types of HHP include:

- Cleaning supplies: e.g., cleansers, polishes, disinfectants.
- Maintenance supplies: e.g., oil-based paints, stains, glues.
- Automotive products: e.g., waste oil, antifreeze, batteries.
- Personal care products: e.g., hair dyes, nail polishes and polish removers, hair bleach.
- Hobby supplies: e.g., photography chemicals, leaded ceramic glazes, artist's paints.
- Pest control products: e.g., pesticides that include herbicides (kill weeds and plants), fungicides (kill fungi, mold, bacteria), insecticides (kill insects), mothballs (repel moths and insects), rodenticides (kill rats, mice, gophers), wood preservatives (repel pests), nematicides (fumigate soil), and molluscicide (kill snails and slugs).

is the definition of hazardous?

A product is hazardous if it has one of the following characteristics:

Toxic: A chemical capable of causing immediate or long-term illness, injury, or death through ingestion, inhalation, or absorption into the body. Potentially harmful to the health and/or the reproductive ability of humans and animals.

Combustible: Any liquid that gives off enough vapors to ignite at 100 °F or higher. This is called the *flash point*. Combustibles present a fire hazard, although they are a lower fire hazard than products labeled "flammable."

Flammable: Any solid, liquid, or gas that will burn below 140 °F by spontaneous combustion or by coming in contact with a burning material.

Reactive/Explosive: A substance with a tendency to undergo chemical changes and release energy and toxic fumes. A reaction can be triggered by a source of heat, water, air, shock, pressure, or other chemicals.

Corrosive: A substance that can chemically change and eat through metal, skin, and other materials. Corrosive substances are either acidic, with a pH less than or equal to 2, or caustic, with a pH greater than or equal to 12.5 (on a pH scale of 1 to 14).

How can exposure to HHP and HHW occur?

People are exposed to HHP and HHW through direct hazards and indirect hazards**.** A direct hazard is direct exposure to hazardous products or waste when not managed or disposed of properly. This exposure can be a one-time acute incident, or a chronic exposure over a long period of time.

Indirect hazards exist during the mining, production, transportation, and disposal of hazardous products. Occupational exposure to hazardous chemicals can pose a threat to a worker's health through acute or chronic exposure. Another indirect hazard is the improper disposal of HHW down the drain, where it moves to the home septic system or the sewage treatment plant. If it moves into groundwater it can contaminate drinking water supplies.

How do hazardous products and hazardous waste affect human health?

Exposure to and injuries from HHP and HHW may be local or systemic. A local injury results from direct contact of the hazardous chemical with tissue such as the skin, eyes, or lungs. A systemic injury happens when a chemical enters the body through inhalation, ingestion, absorption, or injection, and then enters the bloodstream. Once in the bloodstream, it may cause injury to specific tissues or organs. Not all toxic chemicals follow the same pathway into or through the body. Some chemicals, for example, primarily damage the central nervous system, while others may damage the liver.

Toxins can be described as *carcinogens, mutagens,* and *teratogens*. A carcinogen is any agent that produces and/or accelerates the development of malignant tumors or abnormal growth of cells. A mutagen is an agent that affects DNA so that it may produce cancer or a mutation in a future generation. A teratogen is an agent that interferes with normal development of a fetus.

The amount of damage chemicals can do to the body depends on their toxicity. Toxicity is [illegible]lity of a chemical to produce harm or injury to a living organism when the chemical [illegible]ched a sufficient concentration. The Threshold Limit Value (TLV) is the estimated

average safe concentration of a hazardous chemical that a human can tolerate on a repetitive basis, for an 8-hour period on a day to day basis.

How can one determine if a product is hazardous?

HHP can be identified by looking at the label on the product. The Hazardous Substances Act (the federal law that establishes labeling requirements for consumer products containing hazardous ingredients) requires the following labeling for products that have an acute (immediate) effect on people:

- Signal words such as:

  "danger": highly toxic, flammable, or corrosive
  "poison": highly toxic
  "warning": moderately toxic
  "caution": slightly toxic depending on the level of danger

  These words must appear on the front of the label. ("Nontoxic" is an advertising word and has no federal regulatory definition.)

- A description of the hazard, such as "vapor harmful" or "flammable." This must appear on the front of the label.

- A statement warning users how to avoid the hazard. e.g., "Use in a well ventilated room."

- A common or chemical name for the hazardous substance.

- If necessary, instructions for safe use and handling, including the proper usage amounts, safety equipment needed, and proper mixing procedures.

- First aid instructions.

- The name and location of the manufacturer, distributor, or repacker.

- The statement, "Keep Out of Reach of Children," or its equivalent.

What should you consider if you have to buy a household hazardous product?

Decide if you really need it

In many cases, a less toxic or nontoxic alternative is available. If there are no alternatives available, ask yourself if the risks involved are worth using the product. For information on alternatives, contact the Massachusetts DEP, (617) 292-5898, the Office of Technical Assistance for Toxics Reduction, (617) 727-3260, or your local Board of Health.

Read labels and compare products

Read labels and compare products to find the least toxic alternative. Check the warnings and hazards that are listed to find out the product's danger to you and the environment. Labels provide information on short-term health effects, but not long-term health effects or environmental impacts. You can contact the manufacturer for a Material Safety Data Sheet for more information on these. Also, remember that disposal information is specific to each town.

Buy only the quantity that you need

Although it is often less expensive to buy products in a larger quantity, products may deteriorate over time. The less HHP you buy, the less you have to store and dispose. Disposal of HHP is very expensive.

How can HHP be used safely?

When it is necessary to use HHP in the home, be sure to follow these instructions for their safe use:

- Always read and follow the directions on the label. It will tell you about safe use, storage, disposal, and emergency measures in case of an accident.

- Always use proper safety equipment such as rubber gloves, safety glasses, face mask, or respirator. Be sure the safety equipment is the right kind for the job. For example, a variety of face masks are designed for specific exposures such as dust or chemical fumes. Gloves are also designed for specific uses such as chemical contact. Make sure you size and fit your equipment well.

- Use products outside if possible. If you must use them inside, use in a well ventilated area. "Well ventilated" means that fumes are exhausted outside the building and not into other areas of the home. You still need to wear a respirator designed for the product you are using.

- Don't smoke near the HHP—fumes and vapors can ignite.

- Keep a fire extinguisher nearby and know how to use it.

- Never mix chemicals. It is possible to create an extremely hazardous chemical by mixing materials. Bleach and ammonia, for example, form a deadly gas.

- Do not wear soft contact lenses when using volatile solvents, as they can absorb the chemical. The contact lenses can hold the chemical against the eye and cause a reaction.

What should I do if I spill a hazardous material?

- Clean up spills immediately.
- Try to contain in a small area, do not let it flow.
- Place nonchemical-type clay cat litter or sawdust (for nonflammables) on the spill to absorb it. Put saturated material in a noncorrosive container with a lid for disposal.
- Wash work area and yourself after chemicals have been cleaned up. Discard contaminated cloth, mop, or broom in trash or at a HHW collection. Flammables should be put outside to dry, then stored for disposal in a metal or hard plastic container to prevent air infiltration.
- Clean-up after using HHP. Any cloths or sponges you use to clean with now are saturated with that product. Put them in a covered noncorrosive container for storage or disposal.

How should HHP and HHW be stored?

To protect your home and family, HHP and HHW should be properly stored for later use or disposal. The product label will provide some information on its storage.

- Hazardous materials should be stored on a high shelf or in a locked cabinet away from children, pets, food, and living areas. A detached building is the safest location, particularly for flammables. Metal cabinets help protect chemicals from sparks and fires. The storage area should stay above freezing and be cool, dry, and ventilated. These conditions help to reduce deterioration of products and corrosion of product packaging.
- Always store hazardous materials in a container labeled with permanent ink. The label should include hazards, warnings, ingredients, use, storage, disposal information, and the date of purchase.
- Never store hazardous materials in a container previously used for another purpose. Children who cannot read may mistake the container’s contents for a familiar product.
- Never leave hazardous materials out in the open and unattended.
- Do not mix or store products or wastes together.
- Tighten caps on containers to prevent vapors from escaping.
- Store incompatible chemicals apart from one another. For example, store reactives apart from each other and other chemicals.

How should HHW be disposed of safely?

The only reliably safe way to dispose of HHW is to store it until your community participates in a hazardous waste collection day. A licensed hauler will collect the material and take it to an environmentally safe hazardous waste disposal facility. Be sure that containers are labeled with information on purchase date, ingredients, hazards, warnings, handling, and disposal of the products.

Remember these Don'ts when disposing of HHW:

- Don't mix wastes.
- Don't change containers (without proper labeling). If a product is leaking, enclose the whole container in a new container with a lid.
- Don't pour down a drain, dry well, toilet, or on the ground.
- Don't put in regular trash.
- Don't bury or burn HHW.

What are the problems created by improper disposal of HHW?

Careless disposal of HHP or HHW can:

- Pollute drinking water supplies, ponds, harbors, and rivers.
- Injure trash collectors during curbside pick-up, when chemicals mix together and cause fires, acid burns, and/or release of toxic fumes.
- Allow evaporation of solvents from products such as paints, varnish strippers, and even fingernail polish, contributing to smog and other air pollution problems.
- Injure fire fighters battling fires involving large amounts of flammable substances (e.g., gasoline or paint thinner), explosives, or pesticides stored in homes and garages.
- Destroy important bacteria necessary to properly break down wastes in sewer and septic systems.[xxiv]

Sources: For a Cleaner Environment, Woburn, MA; Massachusetts DEP, "How to Safely Handle . . ."; MWRA, *A Healthy Environment*; AVR, *Teaching Toxics*

WHAT IS WASTE?

THEME:	Trash is composed of a variety of items.
GOAL:	Students will understand that trash is composed of basic materials.
METHOD:	Guessing game with discussion
SUBJECTS:	Language arts
SKILLS:	Comparing, observing
MATERIALS:	Garbage can filled with clean trash representing all types of household waste: newspaper, cardboard, notebook paper, brown paper bag, cereal box (boxboard), magazine, glass bottle, plastic soda or milk bottle, plastic-coated cardboard milk or juice carton, plastic wrap, plastic six-pack ring, aluminum can, aluminum foil or tray, wax paper, Styrofoam, disposable diaper, fabric pieces (natural and synthetic fibers), orange peel, chicken bone, leaves, twig, etc.; Ali Ka Zim rhyme on chart paper; wand
TIME:	45 minutes

GETTING STARTED

To get a sense of what the students think about trash, ask them what kinds of things they throw away. List their ideas on the board to later compare with what is in the sample trash can.

PROCEDURE

1. Invite students up one at a time to reach into the trash can while you recite the following rhyme and point to the words with your wand:

> Ali Ka Zim, Ali Ka Zam
> What is (student's name) going
> To pull out of the can?

2. Have each child describe what the item they are touching feels like, without actually saying what it is. Have the other children try to guess what the item is and what it is made of.

3. Ask the children how they think the item is spelled and write it on the board.

4. After going through the entire contents of the can, compare the list of items with the one the students first made. Point out that trash often contains items that we might not ordinarily consider to be garbage.

EXTENSIONS

1. Hand out the attached worksheet, "A Smorgasbord of Trash." Have the children draw or cut pictures out of magazines for each of these items to create a trash dictionary. Make a bulletin board display illustrating examples of the same words.

2. Make a checklist of typical items a family might throw away in a week. (This might be the same as the worksheet list, or a shorter version.) Have the children mark an "X" next to an item every time they throw one out. Compare the students' tallies at the end of the week. Have them circle the ones that could have been recycled or reused, rather than thrown out.

3. Learn the “I Love Trash” song from Sesame Street. (Available on videotape: *Sesame Street’s 25th Birthday: A Musical Celebration*. 1993. 60-minute VHS. Produced by Random House in cooperation with Children’s Television Workshop, New York, NY.)

4. Have students complete the attached “Search-a-Word” puzzle to find the 16 words having to do with solid waste.

5. Have each student pick an item from the sample trash can. Have them write its life story: How was it made or grown? How was it used by its owner(s)? How was it consumed? How did it end up in the trash? What will happen to it now? Have the children draw pictures to accompany the story and put them together to make a book.

Sources: Adapted from Bell and Swartz, *Oscar’s Options*; Wisconsin, *Recycling Study Guide*; Kristen Walser

A SMORGASBORD OF TRASH

Listed below are typical items found in many household trash cans. For each of these items, draw a picture or cut one out of a magazine and bind them together to make a trash dictionary.

paper plate

glass jar

aluminum can

plastic storage bag

corrugated packing box

Styrofoam cup

newspaper

plastic milk carton

cardboard cereal box

Styrofoam egg carton

plastic-coated cardboard milk carton

aluminum foil

orange peel or apple core

broken toy

grass clippings

brown paper bag

old rag

disposable diaper

plastic trash bag

junk mail

Styrofoam packing material

plastic margarine tub

dead leaves

cardboard egg carton

aseptic juice container

fast-food restaurant packaging

paper napkin

chicken bone

gum wrapper

SEARCH-A-WORD PUZZLE

The words listed below are hidden within the puzzle of letters. Some are spelled as you usually see them, but others are spelled backwards or on the diagonal. How many of them can you find?

RECYCLE	GLASS	LANDFILL	OIL
BOTTLE	TRASH	NEWSPAPER	CAN
PAPER	COMPOST	PLASTIC	REDUCE
METAL	BATTERY	ALUMINUM	ENVIRONMENT

M	R	E	C	Y	C	L	E	H	Q	X	P	M
B	L	O	I	R	Z	A	L	T	I	M	E	U
Y	L	T	T	E	O	R	N	C	R	T	U	N
P	L	L	S	T	K	S	E	J	A	S	W	I
C	I	R	A	T	Q	U	P	L	V	T	E	M
O	F	G	L	A	S	S	P	A	K	Y	C	U
M	D	I	P	B	F	G	Y	A	M	D	U	L
P	N	K	O	T	R	A	S	H	P	U	D	A
O	A	M	C	W	P	I	T	Z	R	E	E	B
S	L	U	N	E	W	S	P	A	P	E	R	V
T	L	I	N	W	P	O	O	T	S	X	Y	N
T	N	E	M	N	O	R	I	V	N	E	L	A
P	T	I	N	R	C	E	L	T	T	O	B	D

WHEN IS IT TRASH?

THEME:	When is an object considered to be trash?
GOAL:	Students will consider when an object becomes trash and why careful and proper disposal is important.
METHOD:	Discussion
SUBJECTS:	Language arts
SKILLS:	Comparing, drawing conclusions, making value judgments
MATERIALS:	None
TIME:	30 minutes

GETTING STARTED

Have the students start by reviewing the typical components of trash. (See Activity 1-1.)

PROCEDURE

1. Ask the children what makes an item a piece of trash. For example, once a container of milk is empty, once they are finished reading the newspaper, once they have raked all the leaves off their lawn—are all these now trash? Have each child name a piece of trash and why they think it is no longer useable. What qualities do trash items have in common?

2. Ask the students why it is necessary to take trash to a special place (landfill or incinerator). Why not just leave it in their backyard or by the side of the road? Make a list of the children's responses (e.g., it is ugly, attracts animals, could catch fire).

3. Are there items that might be dangerous even if they are buried in a landfill or burned? Discuss hazardous items such as gasoline, radioactive chemicals, and so on. Why are they harmful?

EXTENSIONS

1. Examine how other cultures use items that our society might consider to be trash.

TRASH CAN SCAN

THEME:	The waste stream is comprised of many different kinds of objects.
GOAL:	Students will understand what garbage consists of and that it can vary in composition over time or by location of collection.
METHOD:	Classify, weigh, and graphically represent the composition of the classroom's trash
SUBJECTS:	Language arts, math, computer science
SKILLS:	Analyzing, comparing
MATERIALS:	"Components of Municipal Solid Waste" handout; 3 days worth of classroom trash; scale capable of weighing in ounces or grams; rubber gloves; large tarp or plastic sheet; construction paper and/or graph paper; computer, if available; spreadsheet/graphing software
TIME:	1 hour per day for several days

GETTING STARTED

Ask students what kinds of things they throw away. What are they made of? Find out what materials they think make up most garbage.

PROCEDURE

1. Distribute the "Components of Municipal Solid Waste in the United States" handout. Discuss the different categories of trash (paper, plastic, metal, etc.), and list examples of items in each category. Students can create trash category posters or collages using these lists and drawings or pictures from magazines and newspapers.

2. Collect all trash discarded by the class for several days. Lay a sheet on the floor, dump the trash on it, and let the students sort it according to category—i.e., paper, plastic, metal. For items that can fit into more than one category, have them decide which material is predominant. If many materials are equally represented, you might want to create a mixed materials category. Working in groups, have the students weigh a category of trash and record their results on the blackboard.

3. Have the students create a bar chart bulletin board display that compares the various components of the classroom waste stream. Each material can be represented by a different colored construction paper bar. Determine the scale to be used (e.g., 2 vertical inches equals 1 ounce).

Alternately, the data from this exercise can be plotted on a computer if you have a graphics or spreadsheet program that can use the data.

4. Repeat this activity for three separate trials (e.g., 3 different days, weeks, or locations), each time separating and weighing the trash, recording the data, and constructing a bar chart. Students may also calculate the three-trial average. Have the class graph the results.

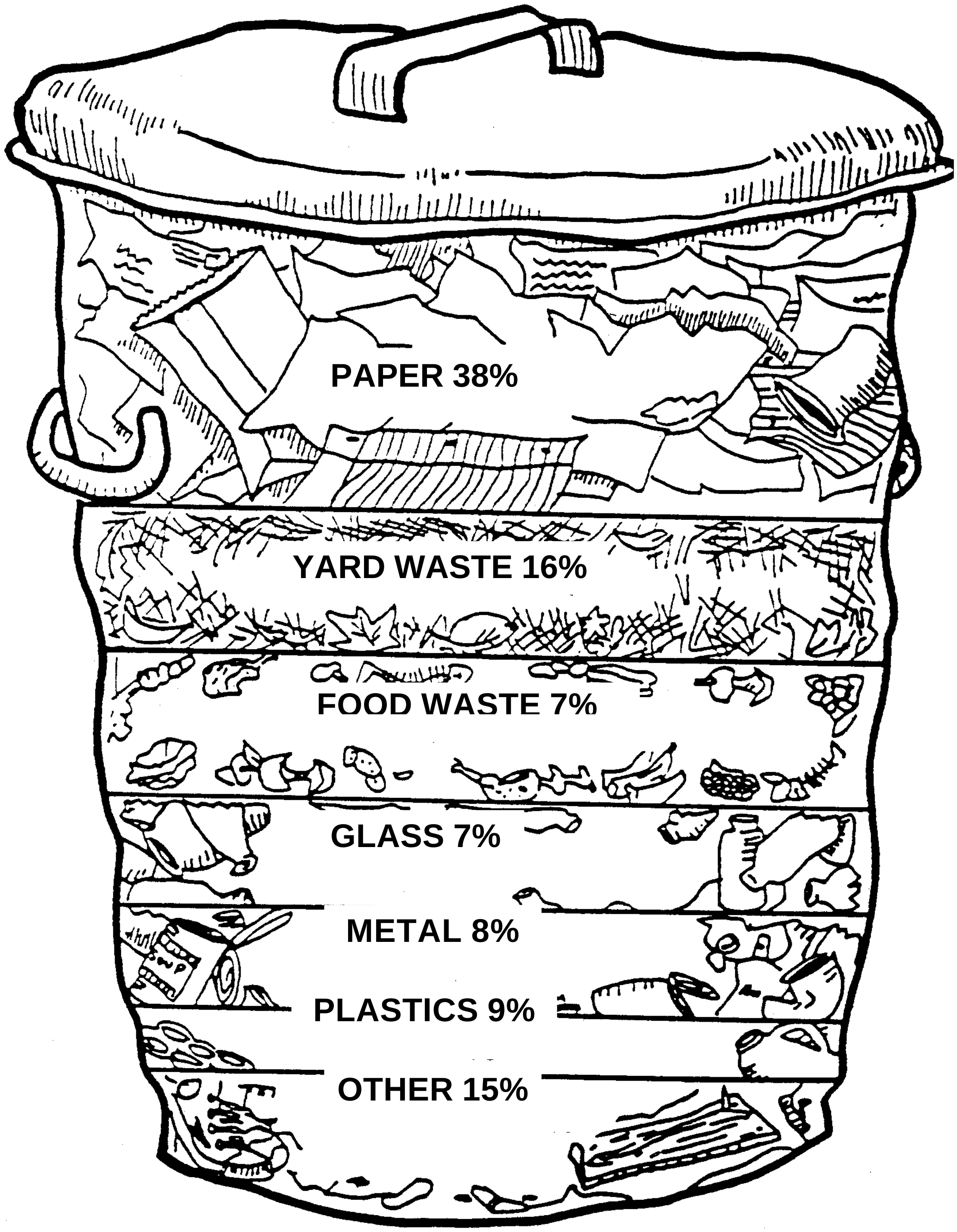
5. Compare your classroom results to the figures on the handout. What are the differences and similarities? Did the time of week when the trash was collected affect the results? How? Why?

EXTENSIONS

1. Discuss the difference between amount in weight and amount in volume. Would the category that is the heaviest also take up the most space in the trash can or at the landfill?

2. Have the different groups survey trash cans from other areas of the school (other classrooms, the library, the gym) or home, and compare the results with those obtained in your classroom. Does the composition of the waste stream vary at each location? If so, how and why? Discuss differences and similarities between the trash from different locations. Predict the results of this type of trash analysis for department stores, supermarkets, factories, and other institutions. What would be some of the differences and similarities in the composition and amount of their waste? Why?

Components of Municipal Solid Waste in the United States, By Weight



Source: U.S. EPA, *Characterization of Municipal Solid Waste in the United States: 1994 Update*

TYPES OF WASTE: PRODUCT PROFILES

THEME:	Trash can be divided into basic categories of materials (glass, metal, paper, plastic, etc.).
GOAL:	Students will identify the different categories of materials found in trash.
METHOD:	Classification of objects
SUBJECTS:	Science
SKILLS:	Comparing, classifying, interpreting
MATERIALS:	Trash items (cleaned and rinsed); several empty cardboard boxes labeled with different categories (paper, metal, etc.); labels for paper, plastic, glass, metal, rubber, textiles, organic, other; tape
TIME:	30 to 45 minutes

GETTING STARTED

Ask students to think about the composition of different items of trash. Have them name various categories of materials (plastic, food, etc.) and an example of each.

PROCEDURE

1. Line up a set of boxes on the front desk, one per category. Each box should have a label—metal, plastic, paper, etc.—with an accompanying sample or illustration. Give the class a brief explanation of each category and show them an example of each.

2. Divide the students into small groups. Give each group a set of trash items that includes at least one example from each material category, and a set of labels. Have the students sort and label the objects by material type. Some items may be made of more than one type of material and the students will need to decide which is the most predominant.

3. When the students have finished classifying their objects, ask each group to deposit them in the correct cardboard box in the front of the room. List the trash items by category on the board. Which category has the most items? Which has the fewest?

EXTENSIONS

1. Make a bulletin board display of a trash can. Cut out the shapes of different trash items and label them, using the same paper color for each category of material.

2. Set up a scavenger hunt in the classroom. Give each child or team of children a category of material. Tell them that within a certain time limit they have to find an object in the room that is made from that material and must label it by material type. Which category has the most items in it?

3. Set up the category boxes in one corner of the room. Have the students separate everything they throw away into the appropriate container. At the end of one week go through the boxes and look at the different types of items under each category. Could some items be classified under more than one category? Which category had the largest number of items? Which category of items took up the most space?

4. Divide the class into teams, each representing a different category of materials. Have each team develop a list of everyday items made from their material. For example, the plastics group might include dishes, hairbrush, toys, etc. Have each team keep a daily log of the items they use made out of their material. Compare the lists between teams and discuss how important each of these categories of materials is to our society.

Source: Kristen Walser

KNOW YOUR PROPERTIES

THEME:	Basic materials have different properties.
GOAL:	Students will understand the properties of basic materials.
METHOD:	Classification of objects
SUBJECTS:	Language arts, science
SKILLS:	Comparing, drawing conclusions, observing
MATERIALS:	Boxes of trash (cleaned, rinsed) separated by type of basic material (see Activity 1-4); chart paper
TIME:	45 minutes

GETTING STARTED

Ask the students what the properties or characteristics of basic materials are. How might these affect what the materials are used for and how they are disposed?

PROCEDURE

1. Line up the boxes of separated trash (paper, metal, etc.) and have the children sit in a semi-circle around them. On the chalkboard, draw two columns for each category of material. Take an object out of one of the boxes and pass it around. Ask the students to describe it: what it looks and feels like, and different uses for it. For example, glass might be described as hard, breakable, clear, smooth, colored, holds water, round, etc. Write the words on the board, in the first column for that category of material. In a second column list the opposite characteristics (e.g., soft, unbreakable, opaque, rough, clear, porous, square, etc.). Repeat for different items in each of the categories.

2. Break the students into pairs and assign each group one set of opposite characteristics. Give each pair a set of trash items to sort into one of two piles based on their given characteristic or its opposite (e.g., breakable and nonbreakable, rough and smooth, etc.).

3. Do any patterns emerge? Is all the glass in the “round” pile? Is most of the metal in the “shiny” pile? Why?

4. Draw conclusions about how the properties of objects affect how they are made and how they are used. For example, ask students why manufacturers don’t put soda in paper bags or print newspapers on metal.

EXTENSIONS

1. Make a list of the basic characteristics—breakable, smooth, porous, etc. Have students categorize other items found around the classroom by these characteristics. Do they fit the same patterns discovered above?

2. Put a variety of trash items in a large bag. Without looking at the item, have each student reach into the bag and use their sense of touch to determine if it is made out of glass, metal, plastic, etc. Have them tell the other students how they made their decision.

3. Make a bulletin board display of the new vocabulary words describing the properties of items, grouped by opposites. Have the students cut out magazine pictures that illustrate examples of each characteristic and its opposite. For example, under “round” they might display a picture of a bottle and a windowpane.

4. Introduce the concept of magnetism and what magnets can reveal about the basic properties of metals. Explain how magnets can be used to tell whether a can is made out of aluminum or steel. Using magnets, have

the students test out other metal objects in the classroom. How might magnetism be used to sort metals that are brought to the recycling station?

Source: Kristen Walser

SIZING UP WASTE: VOLUME vs. WEIGHT

THEME:	Composition of trash by volume and weight can be very different.
GOAL:	Students will learn the concepts of volume and weight and how different types of trash affect the quantity of solid waste produced.
METHOD:	Classification and weighing of items
SUBJECTS:	Math, computer science
SKILLS:	Comparing, counting, drawing conclusions, measuring
MATERIALS:	Can of trash collected in the classroom for one week OR sample can of trash items prepared in advance; scale; graph paper; computer, if available; spreadsheet software
TIME:	1 hour

GETTING STARTED

Ask the students if all the items they throw away are the same size and weight. Have them name some examples that are small, large (bulky), light, heavy, etc. Ask the students to predict which materials make up the greatest portion of waste by volume, by weight, and by number of items.

PROCEDURE

1. Using the trash collected in the classroom for a week or a sample trash can of items prepared in advance, have the students separate it into the different categories of materials—paper, plastic, glass, metal, etc.

2. Ask the students which category of items they think is the heaviest? Which takes up the most room? Which contains the greatest number of pieces? Have the students write down their answers in order of heaviest to lightest, bulkiest to most compact, and most to least numerous.

3. Weigh each category of items. For the paper category, material could be divided into newspaper, cardboard, writing paper, and other. Then place the objects in a clear container and determine their volume by measuring how much space they occupy (width, depth, and height). Finally, count the number of items. Make a chart on the board showing the weight and volume of each category. Do the heaviest items also take up the most room?

4. Discuss how weight and volume of trash are both important in its disposal. Bulky items may not weigh much, but may take up more space in the landfill or trash compactor. How might the volume change if glass, cans, or boxes are crushed? Does the weight change if the volume changes?

EXTENSIONS

1. Extend the exercise by asking what other sorts of items are thrown away that were not represented in the trash can: yard wastes, white goods (refrigerators, washing machines), etc. Where do they fit into the spectrum?
2. Make a bulletin board display using different colored blocks to represent each part of the waste stream. Make one trash can showing the trash content by weight, another showing trash content by volume, and a third showing trash content by number of items. For each category of waste, cut out a band of paper representing its percentage of the total, so that when stacked one above the other, the three trash cans are full. What are the implications of these differences in terms of waste disposal?

3. Have students repeat the exercise at home. Have each student label a set of paper bags with the different material categories (paper, plastic, glass, etc.). Ask the students to put everything they discard for one or two weeks into the appropriate bag. Compare the students' home results with one another and with those derived from the classroom trash. Which category of items differs the most in the comparison? Why?

BE A GARBAGE DETECTIVE

THEME:	Humans produce a lot of garbage but are often unaware of what happens to their waste.
GOAL:	Students will define waste and consider the implications of throwing something away.
METHOD:	Creating pictures as a basis for discussion and story telling
SUBJECTS:	Art, language arts, science
SKILLS:	Comparing, drawing, inferring, researching
MATERIALS:	Drawing paper; magazines
TIME:	1 to 2 hours

BACKGROUND

All living creatures produce some sort of waste, but their ways of disposing of it vary greatly. Humans are very wasteful compared with other creatures on earth. Often we are unconcerned with what happens to our waste and unaware of the impacts it can have on the environment. By looking at how animals and plants minimize the amount of waste they produce, as well as the ways in which they deal with their garbage, we can learn some important lessons about efficiency and waste disposal.

GETTING STARTED

Ask the students to think about their house and about the kinds and amount of garbage their families produce. What do they do with their garbage? What do they think happens to it?

PROCEDURE

1. Ask each student to draw two pictures: one of his/her house and the other of an animal's "house." Have the students share their pictures with the class and start a discussion on where garbage fits into each picture. What is garbage? Do animals create garbage? Who produces more garbage, people or animals? What are some differences and similarities between waste generated by people and animals? Why do people dispose of so much more than animals do? How do people get rid of their garbage? Where does it go? What could people do to be more like animals in the production and disposal of waste?

2. Have the class create a story about the pictures they have drawn. Write the story on the blackboard for the students to read and/or write down and attach to their pictures.

3. Have the students create a poster or collage by cutting out magazine pictures of items that are usually thrown away after one use. Discuss the items on the posters. How can we avoid throwing away so many of these things? Review the following questions: What is garbage? Where does it come from? Why do people create more waste than other animals? Is this a problem? What can we do about it?

EXTENSIONS

1. Have the students research an animal of their choice to learn about its habitat, way of living, the kinds and amount of waste it produces, and its methods of dealing with this waste. The children could write and illustrate stories based on what they have learned and present them to the class.

Source: Reprinted from Washington, *A-Way With Waste* with permission

ONE PERSON'S GARBAGE CAN IS ANOTHER'S GOLD MINE

THEME:	Some components of the waste stream are valuable resources; by reusing them we can help solve some of our solid waste disposal problems.
GOAL:	Students will re-examine waste as a resource by looking at other uses for it.
METHOD:	Reading and discussion
SUBJECTS:	Language arts, social studies
SKILLS:	Inferring, listening, predicting, reasoning
MATERIALS:	Excerpts from *Stuart Little* and *Charlotte's Web*; drawing and writing paper
TIME:	1 hour (longer if children write their own stories)

BACKGROUND

The terms "waste" and "resource" are relative and reflect our own needs and values rather than any objective quality of an object. How we feel about garbage has a lot to do with how we take care of it. Some items that we might ordinarily consider worthless (e.g., garbage), may prove to be very useful to another individual, family, company, or industry. By changing our perceptions of trash and discovering alternative uses for it, we can prevent valuable resources from being wasted and reduce the amount of solid waste that needs to be landfilled or incinerated.

GETTING STARTED

Ask students what they think of when they hear the word "garbage"? Have them describe their feelings.

PROCEDURE

1. The children will probably have a negative reaction to the previous question. Explain that the class is going to read about someone who feels the same way they do about trash. Stuart Little is a mouse who lives in the city and is always getting into trouble. This passage relates one of Stuart's misfortunes, when he accidentally gets caught in a garbage can. Read the following quote from *Stuart Little*:

The men threw the can with a loud bump into the truck, where another man grabbed it, turned it upside down, and shook everything out. Stuart landed on his head, buried two feet deep in wet slippery garbage. All around him was garbage, smelling strong.

Under him, over him, on all four sides of him—garbage. Just an enormous world of garbage and trash and smell. It was a messy spot to be in. He had egg on his trousers, butter on his cap, gravy on his shirt, orange pulp in his ear, and banana peel wrapped around his waist.

Still hanging onto his skates, Stuart tried to make his way up to the surface of the garbage, but the footing was bad. He climbed a pile of coffee grounds, but near the top the grounds gave way under him and he slid down and landed in a pool of leftover rice pudding. "I bet I'm going to be sick at my stomach before I get out of this," said Stuart.

2. Discuss how Stuart felt about garbage. Why didn't he like it? Explain to the class that what was unpleasant for Stuart might be a field day for someone else. Read the following quote from *Charlotte's Web*:

Lurvy dragged Wilbur's trough across the yard and kicked some dirt into the rat's nest, burying the broken egg and all Templeton's other possessions. Then he picked up the pail. Wilbur stood in the trough, drooling with hunger. Lurvy poured. The slops ran creamily down around the pig's eyes and ears. Wilbur *grunted. He gulped and sucked and gulped, making swishing and swooshing noises, anxious to get everything at once. It was a delicious meal—skim milk, wheat middlings, leftover pancakes, half a doughnut, the rind of a summer squash, two pieces of stale toast, a third of a gingersnap, a fish tail, one orange peel, several noodles from a noodle soup, the scum off of a cup of cocoa, an ancient jelly roll, a strip of paper from the lining of the garbage pail and a spoonful of raspberry jello.*

How did Wilbur feel about garbage? Point out that the garbage Wilbur ate was useful and not wasted. Our own garbage can also be a resource. Brainstorm some possible uses for our trash, including composting, feeding food waste to pet pigs or rabbits, building tree houses or scooters out of construction debris, fixing broken toys or using the old parts to make new ones, etc.

EXTENSIONS

1. Bring the children back to *Stuart Little* to find out what happens to him.

There was no way for him to get out of the truck, the sides were too high. He just had to wait. When the truck arrived at the East River, the driver drove out onto the pier, backed up to a garbage scow, and dumped his load. Stuart went crashing and slithering along with everything else and hit his head so hard that he fainted and lay quite still, as though dead. He lay that way for almost an hour, and when he recovered his senses, he looked about him and saw nothing but water.

The scow was being towed out to sea. "Well," thought Stuart, "this is about the worst thing that could happen to anybody. I guess this will be my last ride in this world." For he knew that the garbage would be towed twenty miles out and dumped in the Atlantic Ocean.

2. Discuss what happens not only to Stuart but to all garbage. Are they really going to dump it in the ocean? What effect will this have on the water and on the creatures living in it? Brainstorm positive alternatives that would treat garbage as a resource, as in *Charlotte's Web*. Mention that in addition to individuals using garbage as a resource, companies and industries can use it to manufacture useful products. For example, crushed glass can be used in street pavement to increase reflectivity.

3. Have students create their own adventure stories about an animal or another character and solid waste.

4. Create drawings, posters and/or a bulletin board display of the alternative uses for garbage that the class came up with during the discussion.

Sources: Reprinted from AVR, *Teacher's Resource Guide* with permission; excerpts reprinted from *Charlotte's Web* and *Stuart Little* by E.B. White with permission.

WASTE NOW...WORRY LATER

THEME:	Wasteful habits have negative impacts on the earth and its inhabitants.
GOAL:	Students will examine the concept and implications of waste.
METHOD:	Reading and discussion
SUBJECTS:	Language arts
SKILLS:	Drawing, inferring, interpreting, listening, writing
MATERIALS:	"Why People Have To Work," an African-American folk tale
TIME:	45 minutes

GETTING STARTED

Ask students what they think it means to be wasteful.

PROCEDURE

1. Consider using the medium of storytelling or reading aloud to present the attached folk tale, or have the students read it and/or act it out.

2. Discuss the story. What made the sky so mad? Why did the people waste the sky? What is something that we waste? Ask the students why they think we waste things. What can we do to avoid wasting important materials or resources?

EXTENSIONS

1. Have the students write down what they remember of the folk tale and illustrate their own version of the story.

2. Have the children write and illustrate their own stories about items that we waste and what might happen if we continue to do so.

Source: Kristen Walser

WHY PEOPLE HAVE TO WORK

The sky used to be very close to the ground. In fact, it wasn't any higher than a man's arm when he raised it above his head. Whenever anybody got hungry, all they had to do was to reach up and break off a piece of the sky and eat it. That way, no one ever had to work.

Well, it was a fine arrangement for a while, but sometimes people would break off more than they could eat, and what they couldn't eat they just threw on the ground. After all, the sky was so big there would always be enough for everybody to eat. What did it matter if they broke off more than they actually wanted?

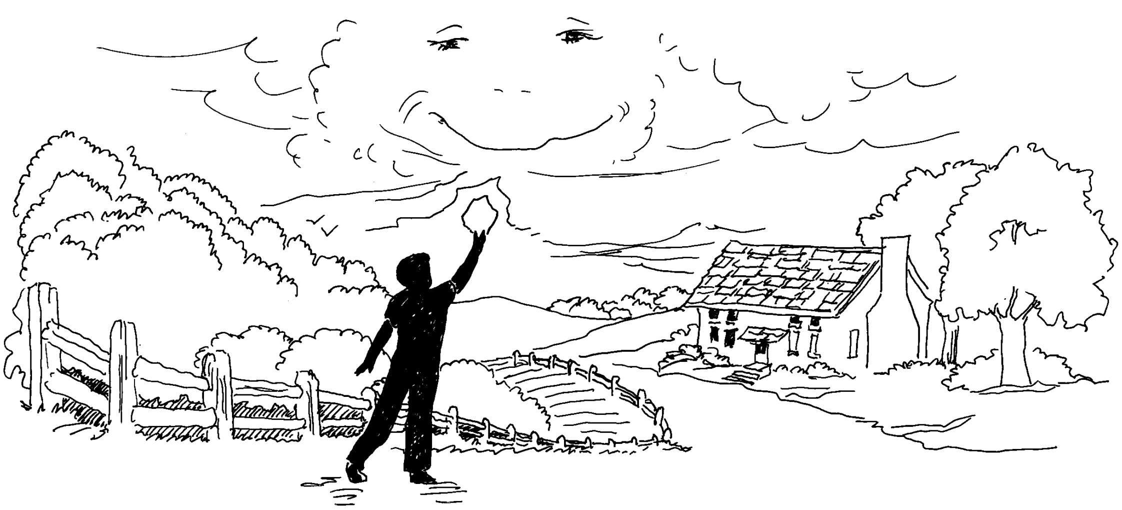
Maybe it didn't matter to them, but it mattered to the sky. In fact, it made the sky angry to see itself laying on the ground, half-eaten, like garbage. So one day the sky spoke out and said, "Now look-a-here! Can't have this! Uh-uh. Can't have you people just breaking off a piece of me every time your stomach growls and then taking a little bite and throwing the rest away. Now if y'all don't cut it out, I'm going to move so far away no one will ever touch me again. You understand?"

Well, people got the message. In fact, they were pretty scared, and for a while they made sure that no one ever broke off more sky than they could eat. But slowly they began to forget. One day, a man came by and broke off a chunk big enough to feed forty people for a month. He took a few little bites, looked around the edges, threw the rest over his shoulder, and walked on down the road just as happy and dumb as anything you've ever seen. Well, the sky didn't say a word, but with a great roar, the sky lifted itself up as high as it could, and that was pretty high.

When people realized what was happening, they began crying and pleading with the sky to come back. They promised that they would never do it again, but the sky acted like it didn't hear a word.

The next day, the people didn't have a thing to eat, and that's why people are working to this very day.

Source: Reprinted from Lester, *Black Folk Tales* with permission



THE RESOURCEFUL EARTH

THEME:	Everything comes from the earth.
GOAL:	Students will trace objects from their source and learn that everything we use is made from raw materials that come from the earth.
METHOD:	Skit of the manufacturing process
SUBJECTS:	Science, theater, performance skills
SKILLS:	Classifying, drawing conclusions, interpreting
MATERIALS:	Two cardboard boxes large enough for a child to fit through, with entry and exit doors cut out; string; garbage can filled with different items of clean trash; index cards labeled with headings: Minerals/Oil, Minerals/Rock, Plants, or Animals
TIME:	1 hour

BACKGROUND

Natural resources are the source of everything we make, use, and throw away. Some raw materials are used in their natural state (e.g., wood), while others are chemically altered. Many of these materials took millions of years to form. Current rates of human consumption and trash generation are starting to rapidly deplete many of the earth's natural resources.

Raw materials fall into two categories: renewable and nonrenewable. Renewable resources can be slowly replaced if they are managed wisely. Trees cut down to make paper or lumber can be replaced by new growth to ensure a continuous supply of wood. Other resources, however, are found in limited quantities; once the current supply is gone, no more is available. Once the earth's deposits of oil or copper run dry, no more can be grown. These are called nonrenewable resources.

GETTING STARTED

Repeat the Ali Ka Zim rhyme from Activity 1-1, "What is Waste?" while having each student pull an object out of the trash can. Ask the child into which category of basic materials the item fits (glass, plastic, paper, metal, etc.) and to name one characteristic of it.

Discuss the concepts of renewable and nonrenewable resources with the students. What are some examples of each?

PROCEDURE

1. Select an object from the trash can, e.g., a glass bottle. What is glass made from, and how? Explain that it is made of sand, soda ash, limestone, and feldspar, the purpose each of these components serves, and where they come from. Note that energy is used to melt the materials that are then blown or molded into different shapes. Repeat this exercise with examples from each of the basic categories.

2. Tell the children they are going to play a game called "Factory." Arrange the two large boxes side by side at the front of the room. Label one "Oven" and the other "Sawmill." Attach a string from the boxes to an electric pole drawn on the board to represent the use of energy in making goods. Explain that there is a separate factory for the wood because it is shaped by cutting rather than by melting. Select one student to be the factory operator and another to be a miner or logger. Hand the remaining students an index card representing one of the four resource groups: minerals/rock, minerals/oil, plants, or animals.

3. The game starts with the miner "digging out" a certain type of mineral or the logger "cutting down" a tree. The miner/logger brings the raw material to the factory (oven or sawmill) and tells the class which of the four resource groups it represents (based on the card given to each student). The child then goes through the Factory box. Upon emerging from the other side, the student should say what type of basic material the raw material was made into (glass, metal, paper, etc.) and name one use for the product it has become. Hand the child an example of the object they suggested or write it on a card for them to hold.

4. After all the children have gone through the factory, ask them where they can get more raw materials. What if there was no more oil for heating homes or trees for making paper? Discuss which of these raw materials are considered renewable and nonrenewable resources. Emphasize that in some cases (e.g., oil) it took millions of years to make the material and it cannot be quickly replaced.

5. Have each child try to think of another way to make the trash item they represent without using virgin materials. For example, they could take the container back to the store for refills, or take newspapers to be recycled. How could a bottle be made without using any new sand? Is there a connection between our shrinking supply of natural resources and the growing amount of waste?

EXTENSIONS

1. Have the children draw out the factory process, starting with the raw material and following what it is made into and what that is used for (e.g., sand > glass > bottle> milk container). This could also be taken another step by completing what happens to the container after it has been used.

2. Make a bulletin board listing the raw materials used to produce common products. Have the children cut out pictures of objects made from these to add to their trash dictionaries.

3. Take the factory exercise a step further by having the children take back the item they represent to the factory to be made into a different product. Have students suggest how items might be reused (e.g., newspaper used to manufacture cereal boxes).

4. Conduct a survey of items around the classroom and identify what kinds of raw materials were used to manufacture them. Which resource category and material type is represented the most?

5. Start a game of Twenty Questions based on raw materials and how they are used. Put trash objects or cards containing names of trash items into a bag. Let one student see a sample item or card. The class tries to guess what the object is by asking questions such as: Do I come from the earth? Am I made from a renewable or nonrenewable resource? Am I a container? Am I recyclable?

6. Make a Natural Resources Bulletin Board showing the four resource groups (see following example). Have students cut out magazine pictures of products made from each resource group.

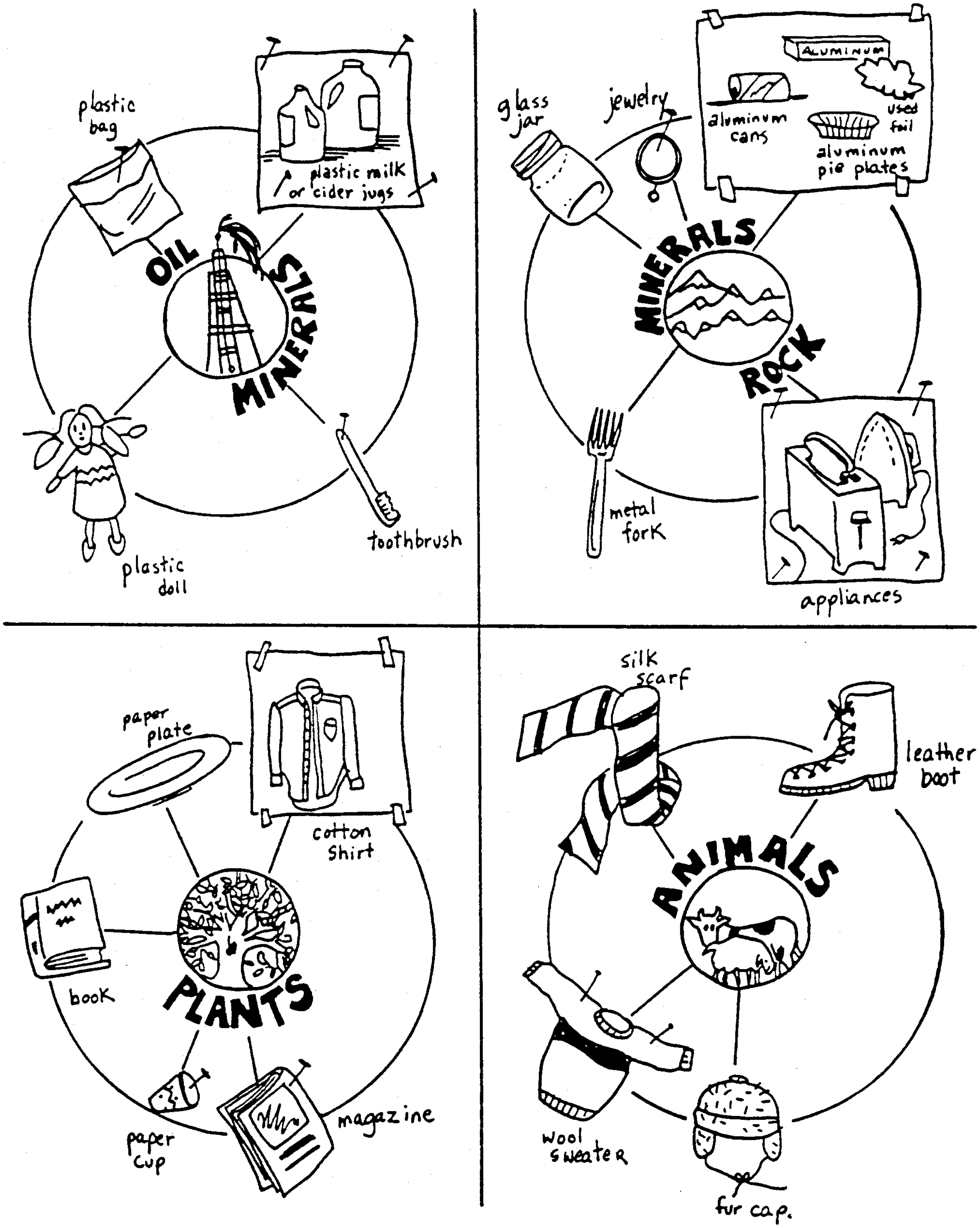
7. Assign each student a materials category (e.g., paper, metal, etc.) and have them write a short essay addressing questions such as: How has (paper) contributed to the development of our culture? How are (paper) products used? What is the effect of (paper) use on our natural resources?

8. Increase the level of detail for older students. For example, assign each the name of a specific mineral (e.g., bauxite, cassiterite), rather than the broad category of minerals/rocks. Have the students research where specific natural resources are plentiful and how they are used in the manufacture of products.

9. Distribute the worksheet, "What Are My Roots?" Explain to the students that, often, just looking at an item will not reveal much about the raw materials that were used to make it. For example, the soda can is made from aluminum which was manufactured from bauxite mined from the earth. Have the students work in teams to complete the worksheet or have them make posters tracing an item back to its raw materials.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Bell and Swartz, *Oscar's Options*; Kristen Walser

Natural Resource Bulletin Board



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WHAT ARE MY ROOTS?

Try to trace each of the steps that changed these items from raw materials into the product we use. For example, the milk you had with lunch came from cows, who ate grass and other grains, which grew from the earth.

MILK < COW < GRASS/GRAINS < EARTH

PLASTIC MILK CARTON

WOODEN TABLE

NEWSPAPER

GLASS BOTTLE

WOOL SWEATER

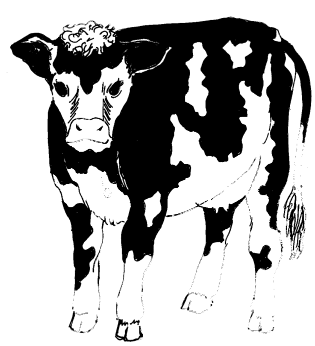
STEEL SHOVEL

STYROFOAM CUP

EGGS

LEATHER PURSE

COTTON THREAD



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CREATING CRAYONS

THEME:	It takes raw materials, energy, time, and money to manufacture products.
GOAL:	Students will examine how raw materials such as glass, metal, and plastic are transformed, often by heat, into other products.
METHOD:	Making crayons
SUBJECTS:	Language arts, science
SKILLS:	Comparing, interpreting, observing
MATERIALS:	Old crayons with the paper removed and broken into little pieces; oven; small aluminum pans; aluminum foil; timer
TIME:	40 minutes

GETTING STARTED

Ask students if they know how forks are made. Discuss the process of pouring molten plastic or steel into a mold.

PROCEDURE

1. Tell the students that they're going to be making crayons in much the same way that manufacturers produce forks, bottles, toys, or anything made out of metal, glass, or plastic. Explain that manufacturers start with a raw material, mix it with other raw materials, heat it, shape it, and then cool it.

2. Point out that the raw material used to make crayons is wax that has been mixed with coloring. Collect old and broken crayons, remove the paper, and distribute the pieces to the children.

3. Have the students create molds by wrapping aluminum foil around a small object like a thick magic marker and then carefully removing the marker. Fill the mold with broken crayon pieces.

4. Place molds in a pan and "cook" for approximately 10 minutes at 350 8F. If possible, show the students the crayons while they are still liquid. After cooling, remove melted crayon mixture from the molds. What happened to the crayons? What is the new product? What are the differences and similarities between the old and new products? How does this process compare to making crayons from virgin materials? Have the students write and draw about the process.

5. Show the students pictures of metal forges, clay kilns, and glassblowing or plastics factories. Explain that all of these processes use heat to transform raw materials into products that we commonly see and use. The energy for the heat comes from burning natural resources such as gas, wood, oil, or coal.

Source: Kristen Walser

RUNNING OUT OF RESOURCES?

THEME:	Some of our natural resources are renewable, others are not. Once nonrenewable resources are depleted, they cannot be replaced.
GOAL:	Students will distinguish between items made from renewable and nonrenewable resources.
METHOD:	Worksheet and discussion
SUBJECTS:	Science, social studies
SKILLS:	Analyzing, evaluating, identifying
MATERIALS:	"Running Out of Resources?" worksheet
TIME:	45 minutes

GETTING STARTED

What are natural resources? Will there always be enough to meet human needs? Which resources can be replaced? Which cannot?

PROCEDURE

1. Discuss the concepts of renewable and nonrenewable resources, providing students with examples of each.

2. Have the class complete the worksheet "Running Out of Resources?" and discuss the following:

    a. Which items on the worksheet do you use? Are they made from renewable or nonrenewable resources?

    b. List some other items that you have and use. What natural resources are they made from?

    c. What might you do to conserve both renewable and nonrenewable resources? What choices can you make about the items that you buy?

EXTENSIONS

1. Have students survey different items in the classroom and identify what natural resources were used to make them. Are they renewable or nonrenewable? Are more items made from renewable or nonrenewable resources? Can you think of an object made from a nonrenewable resource that could be replaced by one made from a renewable resource?

Sources: Adapted from Sonoma County Community Recycling, *Garbage Reincarnation*; Bell and Swartz, *Oscar's Options*

RUNNING OUT OF RESOURCES?

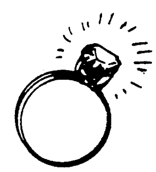
Worksheet

Some resources come from plants and animals, which grow and reproduce. These can slowly be replaced if we use these resources wisely and plan ahead for the future. If we cut down a tree to make lumber, paper, or cardboard, we can plant a new tree. Since more trees can be grown, trees are called a renewable resource. Crops, animals, and other things that can be replaced are renewable.

There are some resources, though, that cannot be replaced or replenished in our lifetimes. These resources are nonrenewable. We can't grow or make new copper or other precious metals. And when the last oil well runs dry, there will be no more oil for heat, for cars or for use in the many plastic products that are now part of our lives. In addition to minerals and fossil fuels, water and air are also nonrenewable.

DIRECTIONS: Identify the resource that is used to make each of the items listed below. For example, cardboard boxes are made from trees. In addition, think about whether that resource can grow or be replaced so that we will have more. Mark an "R" next to those items that come from a renewable resource. Place an "NR" next to those items that are made from resources that cannot be replaced. They are nonrenewable.

cardboard box	<u>TREE—R</u>	aluminum pan	__________
steel bucket	__________	drinking glass	__________
copper pipe	__________	steak	__________
book	__________	corn on the cob	__________
leather jacket	__________	wool sweater	__________
wooden desk	__________	tire	__________
cotton shirt	__________	diamond ring	__________
polyester shirt	__________	plastic wastebasket	__________



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RUNNING OUT OF RESOURCES?

Teacher's page

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cardboard box	**tree—R**	aluminum pan	**bauxite—N**
steel bucket	**iron—NR**	drinking glass	**sand/silica—NR**
copper pipe	**copper—NR**	steak	**animal—R**
book	**tree—R**	corn on the cob	**plant—R**
leather jacket	**animal—R**	wool sweater	**sheep—R**
wooden desk	**tree—R**	tire	**rubber tree—R**
cotton shirt	**plant—R**	diamond ring	**diamond, gold—NR**
polyester shirt	**oil—NR**	plastic wastebasket	**oil—NR**

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

TAKING CARE OF OUR LAND

THEME:	Our attitudes toward the natural environment affect how we use or misuse it.
GOAL:	Students will develop an appreciation of the Native American philosophy, characterized by a respect for the earth and a belief in the interconnectedness of all life.
METHOD:	Reading and discussion
SUBJECTS:	Art, language arts, social studies
SKILLS:	Comparing, evaluating, inferring
MATERIALS:	"Selling the Land" essay
TIME:	1 hour

BACKGROUND

Born in the vicinity of the city that now bears his name, Chief Seattle was the leader of the Dwamish and Suquamish Native American tribes. When the first white settlers came into the region, he greeted and befriended them. On January 22, 1855, Chief Seattle signed the Treaty of Point Ellington, thereby giving the land over to the settlers. His famous speech captures both the philosophy of Native Americans toward the land and his hope that its new stewards would treat it with reverence and respect.

GETTING STARTED

Do you ever think about your relationship with the natural world around you? Do you consider yourself superior to other living things? Why?

PROCEDURE

1. Read aloud the speech by Chief Seattle and discuss the following questions:

   a. How did Native Americans feel about the earth?

   b. Why does Chief Seattle feel that the land can never really be sold? Do you agree?

   c. What does he mean when he calls the murmuring water the voice of his "father's father" or the river his "brother?" What does this say about his relationship to nature? What importance does he place on it? How is it different from the way most of us think?

   d. What do you think of the last line? If Chief Seattle were alive today what would he think of the condition of the earth?

2. Have the children write or draw a short story illustrating how they would change the way we treat the earth. Ask what changes they would make to keep the water clean, the air pure, and plants and animals safe?

EXTENSIONS

1. Tell the students to imagine that they have just been notified that a place they find special is about to be significantly changed or taken away. Have each student write a speech that reveals his/her philosophy on the issues involved and how s/he feels about the event. Organize a class forum and have each student present his/her talk, followed by a group discussion on the issues raised.

SELLING THE LAND

How can you buy or sell the sky? The land? The idea is strange to us. If we do not own the freshness of the air and the sparkle of the water, how can you buy them?

Every part of this earth is sacred to my people. Every shining pine needle, every sandy shore, every mist in the dark woods, every humming insect. All are holy in the memory and experience of my people.

We know the sap which courses through the trees as we know the blood that courses through our veins. We are part of the earth and it is part of us. The perfumed flowers are our sisters. The bear, the deer, the great eagle, these are our brothers. The rocky crests, the juices in the meadow, the body heat of the pony, and man, all belong to the same family.

The shining water that moves in the streams and rivers is not just water, but the blood of our ancestors. If we sell you our land, you must remember that it is sacred. Each ghostly reflection in the clear waters of the lakes tells of events and memories in the life of my people. The water's murmur is the voice of my father's father.

The rivers are our brothers. They quench our thirst. They carry our canoes and feed our children. So you must give to the rivers the kindness you would give any brother.

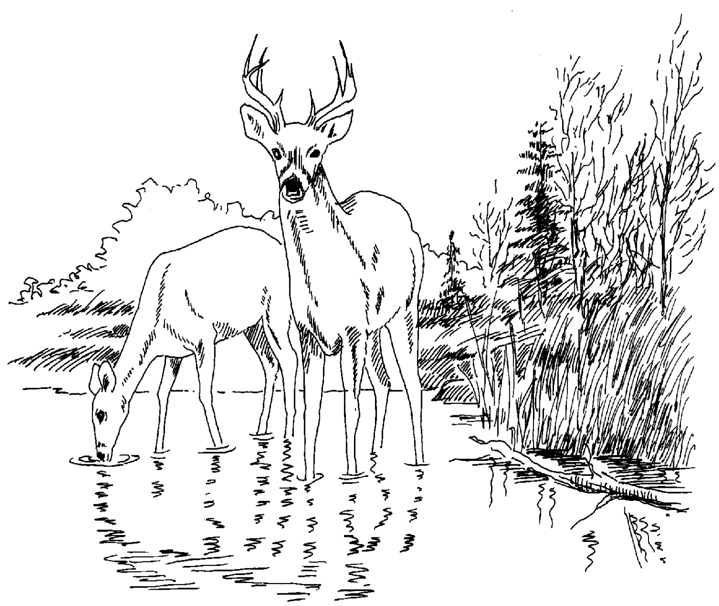
If we sell you our land, remember that the air is precious to us, that the air shares its spirit with all the life it supports. The wind that gave our grandfather his first breath also receives his last sigh. The wind also gives our children the spirit of life. So if we sell our land, you must keep it apart and sacred, as a place where man can go to taste the wind that is sweetened by the meadow flowers.

Will you teach your children what we have taught our children? That the earth is our mother? What befalls the earth befalls all the sons of the earth.

This we know: the earth does not belong to man, man belongs to the earth. All things are connected like the blood that unites us all. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web he does to himself.

One thing we know: our god is also your god. The earth is precious to him and to harm the earth is to heap contempt on its creator.

CHIEF SEATTLE



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LEARNING ABOUT LITTER

THEME:	Litter is a serious problem that we can all help solve.
GOAL:	Students will realize that their actions can help solve litter problems.
METHOD:	Litter walk and discussion
SUBJECTS:	Art, social studies
SKILLS:	Analyzing, examining, identifying
MATERIALS:	A rough scale map of the school grounds, divided into four or five areas; gloves; trash bags for collecting litter
TIME:	1 hour

GETTING STARTED

Do you see litter on your way to school or on the school ground? What kind? Why do you think people litter?

PROCEDURE

1. Divide the children into four or five groups and distribute trash bags and gloves. Send each group to a designated area of the school yard, as shown on the map. Have students collect the litter in their area (excluding broken glass or other dangerous items).

2. Have each group sort through their bag and identify the types of litter they collected and the number of pieces in each category.

3. Discuss the following questions after each group has recorded its data.

   a. What kinds of litter did you find in your area? How much was there? Did you expect to find more? Less?

   b. Where do you think it came from?

   c. Did some areas have more litter than others? Why?

   d. Were different kinds of litter found in different areas?

   e. What are some of the negative impacts of littering? (e.g., it's ugly, it pollutes the earth, it may be dangerous)

4. As a class, brainstorm ways to reduce litter in and around your school. Start a campaign to educate your school about litter. Have students design anti-litter posters, write and perform skits for other students, or campaign for more trash cans at school.

EXTENSIONS

1. Have students read (or read aloud to each other) *The Wartville Wizard* by Don Madden (New York: MacMillan Press. 1986.). This book tells the story of a man given the power to make litter fly back onto the person who threw it away.
Source: Kristen Walser

HAZARDS AT HOME

THEME:	Some products are hazardous and remain so even after they are put in the trash.
GOAL:	Students will learn that some products are poisonous and harmful to humans as well as to the environment.
METHOD:	Puppet show or teacher demonstration
SUBJECTS:	Science, theater
SKILLS:	Analyzing, communicating, value judgment
MATERIALS:	Two puppets; cardboard box approximately 1-1/2 foot square; pictures or empty containers of hazardous products: e.g., oven and drain cleaners, auto cleaners, paint thinner, varnish, used motor oil, gasoline
TIME:	30 minutes

GETTING STARTED

Introduce the concept of poisons. Ask the children if they know what it means if something is poisonous. Can they name some examples of poisons? Why might someone eat a poisonous product?

PROCEDURE

1. Explain to the students that some things used for cleaning, painting, killing unwanted bugs or plants, and maintaining cars can hurt them and other living creatures. Many can be harmful if eaten, inhaled, or touched.

2. Set up a stage on a front desk.

3. Introduce puppets Rebecca Rabbit and Rocky, and tell the children they have a story to share with them. If possible, have two different adults act the two parts.

* * * * *

(Play Begins)

Rebecca: Hi Rocky! How are you?

Rocky: Funny you should ask. I had to go the hospital last week. My stomach still doesn't feel very good.

Rebecca: Too much candy again, Rocky?

Rocky: Not exactly. I was having a good time playing house and ate something I found under the kitchen sink. It looked like something my Mom spreads on crackers at her parties. It made me very sick and I still have to eat special foods. At the hospital they told me that there are a lot of things in my house that are dangerous to eat, smell, and touch.

Rebecca: Really? (Rebecca looks in her cupboard—a cardboard box with a door—and pulls out containers or magazine pictures representing various household hazardous substances. For each item she asks the students what it is used for and whether or not it is hazardous. Rephrase the questions by interchanging the words hazardous, poisonous, toxic, harmful, could make you sick, etc.)

Rocky: (Looks over all the objects from Rebecca's cupboard.) There are a number of items that are toxic at my house, too.

Rebecca: Well, forget it! If these things can make me sick then I don't want them in my house. (Rebecca starts to throw the hazardous materials in the trash, but is stopped by Rocky)

Rocky: Don't throw them in the trash, Rebecca! These things are also dangerous there. If they get buried at the dump, rain water can run through them and carry the poisons into our drinking water, or an animal could eat them.

Rebecca: Okay. I'll pour them down the sink instead.

Rocky: Don't do that, Rebecca! If you pour them down the sink they will go to the treatment plant where they try to clean the water. But these poisons can't be cleaned very well so they'll end up in the river or the marsh.

Rebecca: The river? That could hurt a number of my friends who live there if they were to drink the water. Let's see, there are the Scales, a fish family, and the Quacks—you know that nice family of ducks and their cousins from Canada, the Honkers. (To the audience) Do you know anyone who drinks water from the river?

Okay, I won't pour them down the drain. I know what, I'll send them to the incinerator where they can be burned and get rid of them that way.

Rocky: Sorry Rebecca, but that is just as bad. The toxins will then end up in the air or in the ground when the ash remains are buried. Burning it doesn't make it less dangerous.

Rebecca: What can I do, Rocky?

Rocky: Have your parents save these items in a safe place until your town has a hazardous waste collection day. People will come and carefully collect the poisonous materials in special containers and take them away to places where they can be disposed of more safely. Some can be burned in special ovens, while others, like used motor oil, can be reprocessed into new oil, saving energy and reducing pollution.

Rebecca: That sure sounds better than putting these harmful things in the water.

Rocky: It sure is; but do you know the best thing you can do?

Rebecca: What?

Rocky: Find substitutes to use in place of these toxic materials. There are a number of things you can clean with that are not hazardous. I make up a mixture of soapy water to kill the bugs on plants, and I use baking soda and water to clean the oven. Then no one has to worry, not the Scales nor the Quacks, not you and not me!

Rebecca: Thanks for telling me what to do about toxins, Rocky. But next time you want to learn something, please ask somebody about it. Don't just eat anything you find around your house. Promise?

Rocky: I promise

Rebecca: I like you, Rocky

Rocky: I like you too, Rebecca

THE END

EXTENSIONS

1. Have the students create a symbol that can be placed on hazardous items and which communicates "stay away." Have students make their own copies to take home and use.

2. Send students home with the handouts "Poisons in the Home" and "Safer Alternatives to Toxic Products" (see Activity 1-16). Have students discuss with their families. Ask students to test one of the nontoxic alternatives at home and report back to the class on its efficacy.

3. Make a bulletin board display, having children cut out pictures of products they think might be hazardous and ones that are not. Have the children discuss why they think the item is or is not harmful.

4. Give students a list of items that are commonly found around the home and may be toxic. Many of them are used to make things cleaner or to make our lives easier. The list might include paint thinner, oven cleaner, bathroom scouring powder, bleach, weed or bug killer, nail polish, turpentine, etc. Have the students draw a picture of a house and label where these items might be found. Discuss what precautions should be taken with these items. Have the students write a class letter to their parents telling them what they have learned about household hazardous wastes and asking for their parents' help in identifying these materials at home.

Source: Kristen Walser

POISONS IN MY HOME?

Take a Closer Look

What Are Household Hazardous Materials?

Household hazardous materials are chemically-based products that can be dangerous to human health and the environment. They include (but are not limited to):

Cleaning Products:	ammonia, spray cleaners, rug cleaners, furniture and metal polishes, drain cleaners
Garden Supplies:	weed and insect killers, fertilizers, gasoline, charcoal lighter fluid
Auto Supplies:	antifreeze, motor oil, transmission fluids, cleaners, waxes, gasoline, batteries
Paint Supplies:	furniture refinishers, turpentine, oil-based paints, paint and varnish removers, caulking and sealing products, waxes and glues
Laundry Aids:	bleaches, starches, detergents, spot removers
Recreation Supplies:	swimming pool chemicals, photographic chemicals, craft and hobby supplies

ALTERNATIVE BINGO—THE SAFER WAY TO PLAY

THEME:	Many common household and garden products are toxic and can be replaced by safer alternatives.
GOAL:	Students will become familiar with less toxic substitutes for poisonous home and garden products.
METHOD:	Bingo game
SUBJECTS:	Language arts, health, science
SKILLS:	Inferring, problem solving
MATERIALS:	Bingo grid; master cards; "Safer Alternatives" handout; a container (e.g., empty can); ten markers per student (e.g., beans, pennies, paper clips)
TIME:	45 minutes

GETTING STARTED

Ask the students if they think there are any poisonous substances at their house. Do their parents use any toxic materials when they work around the house or in the garden? If so, could they use anything else to do the same job?

PROCEDURE

1. Discuss the meaning of toxic and poisonous with the children. Point out that many items we use are poisonous and could harm us and the environment. Give some examples such as drain cleaners, paint thinner, flea dip, and oven cleaners. Point out that these toxic materials are usually expensive and that cheaper and safer alternatives often work just as well.

2. Distribute the "Safer Alternatives" information sheet and go over it with the students. Ask them if they are surprised by anything they see on the list. Have they seen any of the items used in their homes? Can the children think of additional items to put on the list? Do they think that their families would be willing to try some of the suggested alternatives? Which ones? Why? Why not? Brainstorm ways in which safer alternatives could be made more convenient to use.

3. Distribute a Bingo grid to every student. Each student should fill in the grid by randomly writing one of the headings listed on the safer alternatives sheet in each box (e.g., aerosol sprays, ant control, drain openers). No phrase or heading should be used more than once. Give each student ten markers.

4. Cut up the master cards and place them in the container. Draw one master card from the container and call out the substance. Students place one marker over a toxic substance on their grid that can be replaced by the alternative called. For example, if the teacher calls out baking soda, the students may place a marker over oven cleaner, scouring powder, or deodorizer. Players may choose any one of these substances but may use only one marker per turn. Students should be encouraged to refer to the "Safer Alternatives" sheet for help. Marking four toxics in a row horizontally, vertically, diagonally, or in the four corners of the grid, wins the game. Students may exchange grids for additional games.

EXTENSIONS

1. Have the students create illustrations, jingles, or skits advertising or promoting a safer alternative.

2. Have the students compare the costs of toxic products with an appropriate safer substitute. This may be done in pairs at a local supermarket (make sure to get permission from the store manager), or at home with their

parents. Have the students record their findings on a chart and bring them to class for comparison and discussion.

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

ALTERNATIVE BINGO

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

ALTERNATIVE BINGO

MASTER CARDS

Cut each rectangle and place in a container:

LEMON JUICE AND VEGETABLE OIL	PAN WITH BEER
PUMP-STYLE SPRAY	MAYONNAISE AND SOFT CLOTH
OPEN WINDOWS FOR FRESH AIR	PLUNGER /PLUMBER'S SNAKE
HOT VINEGAR SET IN A DISH	SALT
BAKING SODA	WATER-BASED PAINT
FRESH CUT FLOWERS	OVERTURN CLAY POTS
DRIED FLOWERS WITH SPICES	COMPOST
GRATED LEMON RIND	SCREENS
STEEL WOOL	CREAM OF TARTAR
MECHANICAL MOUSE TRAPS	BIODEGRADABLE SOAP
SOAP AND WATER	VINEGAR AND SALT
EUCALYPTUS LEAVES	BREWERS YEAST

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

SAFER ALTERNATIVES TO TOXIC PRODUCTS

The following is a list of safer substitutes for some household toxics. These products can generally be purchased in any grocery store.

AEROSOL SPRAYS
- Use pump-type spray containers whenever possible to replace aerosols (e.g., hair sprays).
- Use fresh flowers or sachets of dried petals mixed with spices instead of room sprays.

ANT CONTROL
- Sprinkle cream of tarter in front of the ant's path. (Ants will not cross over it.) Cream of tarter is a substance used in baking.

BUG SPRAY
- Place screens on windows and doors.
- Brewer's yeast tablets taken daily give the skin a scent that mosquitoes seem to avoid.

CHEMICAL FERTILIZERS
- Compost

COPPER CLEANER
- Pour vinegar and salt over copper and rub.

DEODORIZERS and AIR FRESHENERS
- Open windows or use exhaust fans as a natural air freshener.
- A dish of hot vinegar can get rid of fish odors.
- Baking soda placed in the refrigerator reduces odors.
- Fresh cut flowers or dried flower petals and spices can add a nice scent to a room; boiling potpourri or cinnamon and cloves in water will also produce a nice scent.

DETERGENTS (LAUNDRY and DISHWASHING)
- Replace detergents with soaps that are relatively nontoxic and biodegradable.

DRAIN OPENERS
- Pour boiling water down the drain. Do this every week for preventive maintenance.
- Use a plumber's helper (plunger) or a plumber's snake.

FLEA REPELLENT
- Place eucalyptus seeds and leaves around the area where an animal sleeps.

FLOOR CLEANERS
- Use soap and water.
- Use baking soda and water.

FURNITURE POLISH
- Use a soft cloth and mayonnaise.
- Mix one part lemon juice and two parts vegetable oil.

GENERAL CLEANERS (ALL PURPOSE CLEANSERS)
- Use baking soda with a small amount of water.

GLASS AND WINDOW CLEANERS
- Use cornstarch and water.
- Mix a 1/2 cup of vinegar and 1 quart warm water; wipe with newspapers.
- Use lemon juice and dry with a soft cloth.

OVEN CLEANERS
- Place liners in oven to catch any drips during baking.
- Sprinkle salt on spills when they are warm and then scrub.
- Rub spills gently with steel wool.

PAINT
- Water-based paints are less toxic than oil-based paints, and require no solvent for clean-up.

RAT POISON
- Put a screen over drains.
- Use mechanical mouse and rat traps.

SCOURING POWDER
- Dip a damp cloth in baking soda and rub.
- Use steel wool.

SNAIL & SLUG BAIT
- Place a shallow pan with beer in the infested area.
- Overturn clay pots; snails take shelter in them during sunny days and thus can be collected and removed.

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

TONS OF TRASH

THEME:	Every person in Massachusetts generates trash and contributes to the solid waste stream.
GOAL:	Students will recognize that we all contribute to solid waste disposal problems and will visualize how much waste is produced by each person in Massachusetts.
SUBJECTS:	Math, science, social studies
SKILLS:	Calculating, inferring, measuring, predicting
MATERIALS:	A 7-pound bag of clean garbage (items that represent ordinary household trash); "How Much Trash Do You Figure?" worksheet
TIME:	One to two class periods

BACKGROUND

Each day, Massachusetts citizens fill trash cans with food scraps, bottles, paper, junk mail, disposable diapers, plastic milk jugs, and empty food containers. We pile worn out tires on the curb next to stacks of newspapers, and we tote broken furniture out of our homes to the transfer station. It's trash, and since we don't need it or use it anymore, we throw it away.

In 1994, Massachusetts generated approximately 10 million tons of solid waste. More than 7 million tons of this waste were from households, stores, schools, restaurants, and offices. This means that each person was responsible for approximately 1.2 tons of discarded waste in 1992, or roughly 7 pounds per person per day. The sheer amount of waste generated has increased dramatically due to technological advances, the production of less durable products, and an increase in disposable packaging. In Massachusetts, 2 million tons of packaging alone are discarded each year. The magnitude and increased complexity of our solid waste stream has had serious impacts on our waste disposal methods, costs, and technologies.

GETTING STARTED

Show the students the bag of trash and ask them how long they think it would take to produce that amount of garbage.

PROCEDURE

1. Lay an old sheet or cloth on the floor and empty the bag of trash onto it. Discuss what kinds of things are in the pile. What are some qualities that make us consider an item to be trash? Does this pile of garbage represent a lot of trash? Tell the class that roughly 7 pounds of garbage on the floor is equal to the amount of waste that is thrown out each day by the average person in Massachusetts. Ask the students how they feel about the fact that they are responsible for generating 7 pounds of trash per day, or almost 1 ton of garbage each year? Will this number ever change? How? Why? (Possibilities include: changes in population, lifestyle, environmental ethics, and legislation, for example.)

2. Have the students complete the worksheet "How Much Trash Do You Figure?" and discuss the following questions: Where does all the garbage go? What would we do with our garbage if there were no transfer stations, landfills, or curbside pick-up? How might this affect the amount of trash you and your family produce? What could you do to reduce the amount of garbage you produce?

EXTENSIONS

1. Have the students look through back issues of local or regional newspapers for articles on how the growing waste stream is affecting communities. The same thing can be done using magazines and newspapers that cover broader geographical areas. Have the class compare these findings to those in your region. Students could write a newspaper or magazine article summarizing the most common and/or most serious problems that they discovered. What are the future implications of these problems?

Source: Adapted from Wisconsin, *Recycling Study Guide*; data from Massachusetts DEP, *Master Plan: 1995 Update*

HOW MUCH TRASH DO YOU FIGURE?

1. If you generate 7 pounds of trash each day, how many pounds do you produce every:

week _________ month ________ year _________

2. Convert these numbers from pounds to tons. How many tons of trash do you produce every:

week_________ month ________ year _________

3. To visualize how much a ton weighs, use the following equivalent:

   a. The average weight of one horse is 950 pounds.

   b. Two horses weigh approximately 1,900 pounds, almost 1 ton.

   c. How many "horses worth" of trash do you make every:

week _________ month ________ year _________

4. How many people are there in your family? ________

If 7 pounds of trash are generated each day for every person, how many pounds/tons of trash does your family produce every:

pounds: week _________ month ________ year _________

tons: week _________ month ________ year _________

5. How many people are there in Massachusetts? ________

How many pounds and tons of trash are generated in the Commonwealth each:

pounds: day____ weeks ____ month____ year____

tons: day____ week ____ month____ year____

6. If every person in Massachusetts threw away one less pound of trash per day, by how much would our state's solid waste stream be reduced?________

Source: Wisconsin, *Recycling Study Guide*

THROWING IT ALL AWAY

THEME:	Our consumer-oriented society produces much waste.
GOAL:	Students will understand the sources, content, and magnitude of the solid waste we must dispose of.
METHOD:	Questionnaire and discussion
SUBJECTS:	Language arts, math, social studies
SKILLS:	Inferring, interpreting, predicting, problem solving, computer use
MATERIALS:	"Throwing It All Away" questionnaire
TIME:	One class period

GETTING STARTED

Ask the students what they know about the solid waste we produce. Does it create any problems?

PROCEDURE

1. As an introduction to the problems associated with solid waste disposal, distribute the "Throwing It All Away" questionnaire and allow time for completion. Students may also bring the questionnaire home and complete it with their families.

2. Discuss the questionnaire and encourage students to share their reactions to the answers. (See the questionnaire answer sheet for additional information pertaining to question.) Discuss the implications and problems associated with each of the questions, as well as possible solutions to some of these problems. What can we do to address these issues in our personal lives? As community members? As members of government, business, or industry?

EXTENSIONS

1. Have the students create their own questionnaire. Some of the same questions may be used but the survey should also include original questions that explore local solid waste issues. Have the students work together to come up with one set of questions for the class. Questionnaires can be filled out by other classes, the entire school, and/or by people in the community. Students can then tabulate the results to determine what people do and do not know about solid waste issues. (Various groups may respond differently, so students may wish to tabulate surveys separately.)

2. As a follow-up to the survey, have students create educational fact sheets that discuss the answers to the questions. Encouraging students to focus on providing information on those issues with which people are the least familiar. These information sheets can be computer generated or made into posters and illustrated. Once completed, students should distribute them and/or create a display in a public area of the school or town, such as the library or town hall. Again, depending on the results of the survey, different fact sheets may be necessary for different groups, especially if the survey population includes people of varying ages.

Source: Reprinted from AVR, *Teacher's Resource Guide* with permission

THROWING IT ALL AWAY

Questionnaire

Circle the answers that you think are correct.

1. How many pounds of residential trash does the average Massachusetts family of four produce each week?	25 550 72 1020
2. In the past 50 years, the amount of waste discarded per person in the United States has:	stayed the same decreased doubled increased ten times
3. How many millions of pounds of edible food do Americans throw away each day?	1 100 400 900
4. How many cars do Americans send to the junkyard each day?	250 1000 10,000 20,000
5. How many TVs do Americans throw out each year?	100,000 5.2 million 1 million 7.6 million
6. What percentage of packaging (boxes, bags and wrappers) is thrown out as soon as we open a product?	90% 75% 50% 10%
7. How much paper do Americans use each year?	1 million tons 1 million pounds 5 million tons 50 million tons
8. How many tons of municipal solid waste (from households, schools, stores, restaurants, and offices) were produced in Massachusetts in 1994?	500,000 1.5 million 4.5 million 7 million

Source: AVR, *Teacher's Resource Guide*; data from Massachusetts DEP, *Master Plan: 1995 Update*

THROWING IT ALL AWAY

Questionnaire Answer Sheet

1. The average Massachusetts family of four creates approximately 72 pounds of residential trash each week. Multiplied by 52 weeks, this equals 3,744 pounds, almost 2 tons, each year. To help envision this amount of waste, picture 4 horses (950 lb. each), 2 cows (1,800 lb. each), 2-1/2 pilot whales (1,500 lb. each), or 1/2 of a World War II German fighter plane (7,700 lb.). In addition, 100 lb. of solid waste per family of four per week are generated outside the home, by the commercial and institutional sector.

2. In the past 50 years, the amount of waste discarded per person in the United States has doubled. Increased packaging, a rise in the use of disposable products, developments in industry and production technology, an increase in personal wealth and purchasing power, and the switch to "planned obsolescence" as a design strategy all contribute to the increase in personal consumption and waste disposal.

3. Each day, Americans throw away 400 million pounds of edible food. In addition to our food waste, farmers in the United States produce a surplus of food that is not used and is often discarded. In contrast to the situation in the United States, millions of people are underfed and undernourished throughout the world. The United Nations estimates that 460 million people do not receive an adequate amount of the right kinds of food. The diet of these people is frequently lacking in:

   - Calories: Fewer than 2,200 calories per day is the norm in China, India, and much of Africa. The average United States citizen consumes more than 3,300 calories per person per day.

   - Protein: Average protein consumption in China, India, and much of Africa is less than 60 grams per day, compared with a 90 gram-per-day average in the United States.

   - Needed micronutrients: Very often a lack of variety in diet causes deficiencies in important nutrients, vitamins, and minerals.

   Even people who get enough calories per day could be suffering from malnutrition because of protein or nutrient deficiencies. This is a common occurrence right here in the United States. In many cases malnutrition exists not because we do not produce enough food, but because of an unequal distribution of what is grown. The most affluent one-third of the world's population eats well over one-half of the food produced.

4. We send 20,000 cars to the junkyard each day or 7 million cars (and 200 million tires) per year. Placed end to end, the cars discarded each year would reach two-thirds of the distance around the earth at the equator.

5. Some 7.6 million TVs are thrown away each year. Television sets last, on average, 10 to 15 years. The number of appliances and pieces of audio-visual equipment thrown out within only a few years of purchase reflects a fast turnover in technology as well as strong consumer desire for state-of-the-art equipment and new fashion. A planned obsolescence design strategy by producers, and the fact that it is often less expensive to buy something new than to repair something old also contribute to this high rate of appliance disposal.

6. Approximately 90 percent of packaging is thrown out right away. Packaging is increasingly made of plastic, which is noted for its nonbiodegradability and long life.

7. Americans use 50 million tons of paper each year. It takes 17 trees to produce 1 ton of paper, and 10,000 trees to print one edition of the Sunday *New York Times*. Newspapers are usually discarded within 24 hours of being purchased, and only one-fourth of the paper produced in the U.S. is recycled.

8. Approximately 7 million tons of municipal solid waste was produced in Massachusetts in 1994. An additional 2.7 million tons of waste, including industrial wastes, sludge from wastewater and industrial processes, demolition and construction debris, used appliances or white goods, tires, waste oil, and asbestos were generated that same year. These wastes require special handling and processing before and during disposal.

Source: Reprinted with permission from AVR, *Teacher's Resource Guide*; data from Massachusetts DEP, *Master Plan: 1995 Update*

PRODUCTION BY-PRODUCTS—GETTING TO THE SOURCE

THEME:	Everything we do generates some type of waste.
GOAL:	Students will learn that every process creates byproducts or waste.
METHOD:	Research and interviews
SUBJECTS:	Language arts, science, social studies
SKILLS:	Interviewing, problem solving, researching
MATERIALS:	None
TIME:	Several weeks

BACKGROUND

When we look at our trash it is fairly easy to determine how these items became trash. Our garbage generally contains materials we no longer want, those products we've used up, and the byproducts of things we do or make. Similarly, industry and business produce waste as they convert raw materials into products we can use. The nature and amount of waste generated by industry depends on the type of products being manufactured and the size of the company. Safe disposal of this waste is an issue which industries and businesses must continuously address.

GETTING STARTED

Ask the students to consider the types and amount of waste generated in the production and processing of items that are part of our daily lives.

PROCEDURE

1. Have the class generate a list of items produced in Massachusetts and another list of industries and businesses in the state. Some examples of items are cranberries, fisheries and fish processing, furniture, plastics, and computer and electronics equipment. Have the students speculate on the kinds of waste each one generates. How do manufacturers dispose of these various wastes? Are some wastes more difficult to get rid of than others? Which wastes are the most costly to dispose of?

2. Have each student research one of Massachusetts' products or industries. Students should contact manufacturers to find out: What is involved in the production process? What kind of waste, and how much, is generated? What does the company do with the waste? Are their waste disposal costs increasing, decreasing, or staying the same? What affects disposal costs? Are they planning to make any changes in their waste disposal methods? Do they currently use any recycled products? If not, have they ever considered it?

3. Students should write about what they've discovered and suggest changes that could benefit the manufacturer, consumers, and the environment. (Waste reduction and recycling programs are two possible options.) Students could send these suggestions to the manufacturer or try to meet with them in person, or write an article for the local paper.

EXTENSIONS

1. Have the students draw diagrams to illustrate the manufacturing process. These should include raw materials used, conversion or production processes involved, by-products generated and where they go, and the final manufactured product. This can be taken one step further to include the market and the consumer.

2. Have the class brainstorm possible uses for production wastes, as well as potential products that could be made out of them (e.g., fertilizer from fish remains).

Source: Adapted from AVR, *Teacher's Resource Guide*

THE LORAX

THEME:	The rapid use of resources could require changes in our present lifestyle.
GOAL:	Students will explore the differences between necessary and unnecessary products and the impacts of excessive materialism on the environment.
METHOD:	Reading and discussion
SUBJECTS:	English, social studies
SKILLS:	Analyzing, problem solving, researching
MATERIALS:	*The Lorax* by Dr. Seuss
TIME:	40 minutes

GETTING STARTED

What are the consequences of our throwaway habits? What do you really need to live?

PROCEDURE

1. Have students read *The Lorax*. Start a class discussion based on the following questions: How did each step of the Once-ler's developing business destroy a piece of the ecosystem? At what point did the ecosystem cease to function entirely? Why was the Super Axe Hacker invented? Why did the Once-ler ignore the Lorax's warnings? What happened to the Lorax? What management techniques could have been employed to help sustain the ecosystem and the business?

2. Have students research real life examples of the following items in the story: Swomee-Swans, Brown Bar-ba-loots, Humming Fish, Thneeds, Smogulous Smoke, Gluppity-Glupps and Once-lers (e.g., Truffula Trees could represent tropical rainforests). Make sure they include the issues and potential solutions to the problems addressed on global, national, local, and personal levels.

EXTENSIONS

1. Have the students write their own story about our wasteful habits, modeled after *The Lorax*.

2. Have the class perform the story of *The Lorax* as a play for younger children. Students should lead a discussion after the skit about what the story was trying to say, asking the children how they might change their habits to be less wasteful.

Source: Adapted from AVR, *Teacher's Resource Guide*

PLASTIC POLLUTION AND MARINE WILDLIFE

THEME:	Plastic litter in our oceans and beaches endangers the lives of seabirds, seals, marine turtles and other aquatic species.
GOAL:	Students will learn about the negative effects of plastic waste on marine wildlife.
METHOD:	Reading and discussion
SUBJECTS:	Biology, English, political science
SKILLS:	Analyzing, value judgment, research
MATERIALS:	“Plastics at Sea” article
TIME:	1 hour

BACKGROUND

When we picture litter we often think of it as something strewn on our roadsides and city streets. Yet, our oceans are becoming increasingly polluted with plastic debris that threaten many of the species that live in and around the sea. Some creatures mistake plastic bags for animals that they regularly feed on, such as jellyfish. Others become entangled in plastic six pack yokes and eventually choke to death. The harmful effects of plastic litter on marine life will increase if people do not take action to alleviate the situation.

GETTING STARTED

Ask the students what kind of litter they usually see at the beach. Where does it come from?

PROCEDURE

1. Have the students read the 1983 article, “Plastics at Sea,” and discuss the following:

    a. In what ways does plastic litter affect wildlife?

    b. Why is plastic litter even more of a problem than other kinds of trash?

    c. Where did all the plastic come from? Is it all discarded directly by people? Why do people litter?

    d. Do you litter?

    e. What are some ways that you can protect marine wildlife and help solve the problems associated with plastic litter?

2. Have the students research and update the information in the article. Specifically:

    a. What is the scope of the plastic pollution problem in the marine environment today?

    b. What is the status of the following legislation mentioned in the article?

        - Clean Water Act (Federal Water Pollution Control Act)
        - Ocean Dumping Act (Marine Protection, Research, and Sanctuaries Act)

        Have these laws been effective in addressing marine pollution?

Have any new American or international laws to protect the marine environment been passed since 1983?

c. What international conventions, if any, have there been since 1972 or 1973 to address the problems of ocean dumping and marine pollution?

3. As an alternative, have some students choose a species of marine wildlife that has been affected by plastic waste and research some of the following questions: How has plastic litter harmed this species? What is the primary source of the litter? What will happen if this problem continues? What must be done to eliminate the improper disposal of plastic waste? What can you do?

EXTENSIONS:

1. Have students write a letter to the local newspaper outlining what they have discovered and what people can do to alleviate the problem of plastic litter on our beaches and in our oceans.

2. Prepare a class display using short stories and poems written by students on the effects of plastic litter on the marine environment.

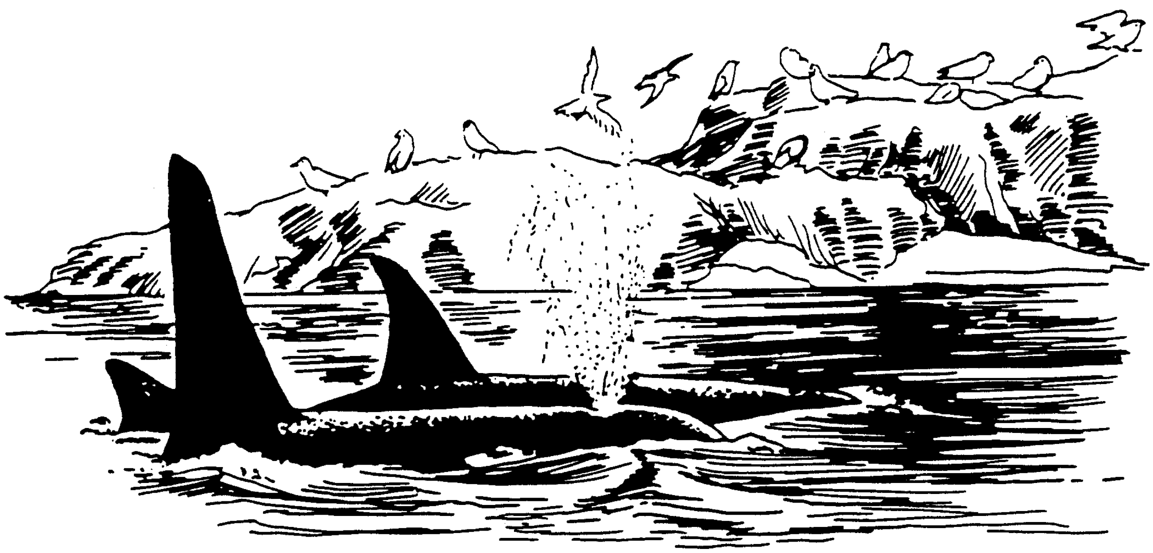
Source: Adapted from Washington, *A-Way With Waste*

PLASTICS AT SEA

Throughout the 1970s, a number of biologists studying the feeding habits of seabirds in different oceans of the world recounted the same story: the birds were eating plastic. Similar reports of plastic ingestion and of entanglement in plastic debris began to surface for other marine animals—fish off southern New England, turtles off Costa Rica and Japan, whales in the North Atlantic. At the same time, plastic particles turned up in surface plankton samples from both the Atlantic and Pacific oceans; plastic debris was retrieved by benthic trawls in the Bering Sea and Britain's Bristol Channel; and plastic pellets washed ashore in New Zealand in such large numbers that some beaches were literally covered with "plastic sand." By the close of the decade, marine scientists around the world had become aware of a new problem of increasing ecological concern—plastics at sea.

Two forms of plastic exist in the marine environment: "manufactured" and "raw." Manufactured plastic material along beaches and adrift at sea is primarily refuse from transport, fishing, and recreational vessels. In 1975, the National Academy of Sciences estimated that commercial fishing fleets alone dumped more than 52 million pounds of plastic packaging material into the sea and lost approximately 298 million pounds of plastic fishing gear, including nets, lines, and buoys.

Raw plastic materials—spherules, nibs, cylinders, beads, pills, and pellets—are the materials from which products are manufactured. These particles, about the size of the head of a wooden match, enter the ocean via inland waterways and outfall pipes from plants that manufacture plastic. They are also commonly lost from ships, particularly in the loading and unloading of freighters. Occasionally, large quantities are deliberately dumped into the sea.



Plastics turn up everywhere. Along portions of the industrialized coast of Great Britain, concentrations of raw particles have reached densities of about 2,000 pieces per square foot in benthic sediments. Near Auckland, New Zealand, 100,000 pieces of plastic were found every lineal feet of beach. Particles have also washed ashore on beaches in Texas, Washington, Portugal, Colombia, Lebanon, and at such remote sites as the Aleutian and Galapagos Islands.

Much of what we know about the distribution patterns and abundance of raw plastic in the world's oceans comes from plankton sampling of surface waters. Between 1972 and 1975, for example, the Marine Resources Monitoring, Assessment, and Prediction Program, a nationally coordinated program of the National Marine Fisheries Service, recorded plastic particles in plankton samples collected between Cape Cod and the Caribbean Sea. The majority of the particles were found to have entered the coast of southern New England, and the highest concentrations were usually in coastal waters. Raw plastic, however, was ubiquitous in the open ocean and especially common in the Sargasso Sea. This suggests that winds and currents are instrumental in redistributing and concentrating particles in certain oceanographic regions.

Inevitably, many animals foraging in the marine environment will encounter and occasionally ingest these widely distributed plastic materials. One of the first records of plastic ingestion appeared in 1962 for an adult Leach's storm petrel collected off Newfoundland. Four years later, researchers in the Hawaiian Islands found that the stomach contents of young Laysan albatrosses contained plastic, apparently fed them by their parents.

For the most part, these early reports were treated as curious anecdotes included in the studies of the feeding ecology of a few sea birds. During the 1970s and early 1980s, however, with the proliferation of such anecdotes, biologists are paying closer attention and were surprised to find how frequently plastic occurred in the stomach contents of certain procellariids from the North Pacific and the North Atlantic (short-tailed shearwaters, sooty shearwaters, and northern fulmars) and alcids from the North Pacific (parakeet auklets and horned puffins). Lower frequencies were reported for other Northern Hemisphere sea birds, including phalaropes, gulls, terns, and also other procellariids and alcids. The feeding habits of marine birds in southern oceans have not been studied as extensively, but plastic ingestion has been documented for several species of procellariids (petrels, shearwaters, and prions) in the South Atlantic, South Pacific, and subantarctic water. To date, approximately 15 percent of the world's 280 species of sea birds are known to have ingested plastic.

Sea birds choose a wide array of plastic objects while foraging: raw particles, fragments of processed products, detergent bottle caps, polyethylene bags, and toy soldiers, cars, and animals. Marine turtles on the other hand, consistently select one item—plastic bags. In the past few years, plastic bags have been found in the stomachs of four of the seven species of marine turtles: leatherbacks from New York, New Jersey, French Guiana, South Africa, and the coast of France; hawksbills on the Caribbean coast of Costa Rica; greens in the South China Sea and in Japanese, Australian, and Central American coastal waters; and olive ridleys in the Pacific coastal waters off Mexico. Evidence points to plastic ingestion in loggerheads as well, based on liver samples containing high concentrations of a plasticizer (a chemical compound added to plastic to give it elasticity). Polystyrene spherules have been found in the digestive tracts of one species of chaetognath (transparent, wormlike animals) and eight species of fish in southern New England waters. They have also turned up in sea snails and in several species of bottom-dwelling fishes in the Severn Estuary of southwestern Great Britain.

Marine mammals are not exempt from participation in the plastic feast. Stomachs of a number of beached pygmy sperm whales and rough-tooth dolphins, a Cuvier's beaked whale, and a West Indian manatee contained plastic sheeting or bags. In addition, Minke whales have been sighted eating plastic debris thrown from commercial fishing vessels. Curiously, plastic has not been found in any of the thousands of ribbon, bearded, harbor, spotted, ringed, or northern fur seal stomachs examined from Alaska.

The obvious question arising from these reports is, Why do marine animals eat plastic? In the most comprehensive study to date, Robert H. Day of the University of Alaska maintains that the ultimate reason for plastic ingestion by Alaskan seabirds lies in plastic's similarity—in color, size, and shape—to natural prey items. In parakeet auklets examined by Day, for example, 94 percent of all the ingested plastic particles were small, light brown, and bore a striking resemblance to the small crustaceans on which the birds typically feed. Marine turtles also mistake plastic objects for potential food items. Transparent polyethylene bags apparently evoke the same feeding response in sea turtles as do jellyfish and other medusoid coelenterates, the major food item of leatherbacks and subsidiary prey of greens, hawksbills, loggerheads, and ridleys.

Sea birds, marine turtles, and marine mammals all eat plastic. So what? Perhaps ingesting plastic is inconsequential to their health. After all, cows are known to retain nails, metal staples, and strands of barbed wire in their stomachs for more than a year with no ill effects. For marine animals, however, the evidence is growing that in some cases at least, ingested plastic causes intestinal blockage. George R. Hughes of the Natal Parks Board, South Africa, extracted a ball of plastic from the gut of an emaciated leatherback turtle; when unraveled, the plastic measured nine feet wide and twelve feet long. There is little doubt that the plastic presented an obstruction to normal digestion. Similarly, a mass mortality of green turtles off Costa Rica has been attributed to the large number of plastic banana bags eaten by the turtles.

The twenty dead red phalaropes discovered on a beach in southern California, all with plastic in their digestive tracts, present a less clear case. Did the birds suffer an adverse physiological response after eating plastic or were they already under stress because of a reduced food supply and eating the plastic in a last-ditch effort to prevent starvation? The same question applies to other instances of emaciated animals that have eaten plastic. At this time, we don't have an answer.

We do know that plastic is virtually indigestible and that individual pieces may persist and accumulate in the gut. Ingested plastic may reduce an animal's sensation of hunger and thus inhibit feeding activity. This, in turn, could result in low fat reserves and an inability to meet the increased energy demands of reproduction and migration. Plastic may also cause ulcerations in the stomach and intestinal linings, and it is suspected of causing damage to other anatomical structures. Finally, ingestion of plastic may contribute synthetic chemicals to body tissues. Some plasticizers, for example, may concentrate in fatty tissues, their toxic ingredients causing eggshell thinning, aberrant behavior, or tissue damage. When highly contaminated tissues are mobilized for energy, these toxins may be released in lethal doses.

Publication of data on plastic ingestion is in its infancy. As the problem gains notoriety, it will certainly be revealed to be even more widespread than is now recognized. There are already several known instances of secondary ingestion, in which plastic consumed by animals feeding at low trophic levels shows up in higher-level consumers. The remains of a broad-billed prion, together with the plastic pellets it had ingested, were found in the castings of a predatory South Polar skua in the South Atlantic; plastic pellets found in the Galapagos Islands were traced from transport vessels in Ecuadorean ports through a food chain involving fish, blue-footed boobies, and, finally, short-eared owls.

A more obvious effect of plastic pollution is the aesthetic one. Whether we venture deep into the woods, high atop a mountain, or out on the ocean to escape the trappings of civilization, our experience of the natural world is often marred by the discovery of human litter. Even more disturbing to the spirit is the sight of a young pelican dangling helplessly from its nest by a fishing line, a whale rising to the surface with its flukes enshrouded in netting, or a seal nursing wounds caused by a plastic band that has cut into its flesh. Unfortunately, such observations are becoming more and more common, another consequence of plastics at sea. During the last twenty years, fishing pressure has increased dramatically in all the world's oceans, and with it, the amount of fishing-related debris dumped into the sea. In addition, the kind of fishing equipment finding its way into the ocean has changed. Traditionally, fishing nets were made of hemp, cotton, or flax, which sank if not buoyed up. These materials disintegrated within a relatively short time and, because of the size of the fibers, were largely avoided by diving sea birds and marine mammals. With the advent of synthetic fibers after World War II, however, different kinds of nets came into use. These new nets were more buoyant and longer-lived than their predecessors, and some of them were nearly invisible under water.

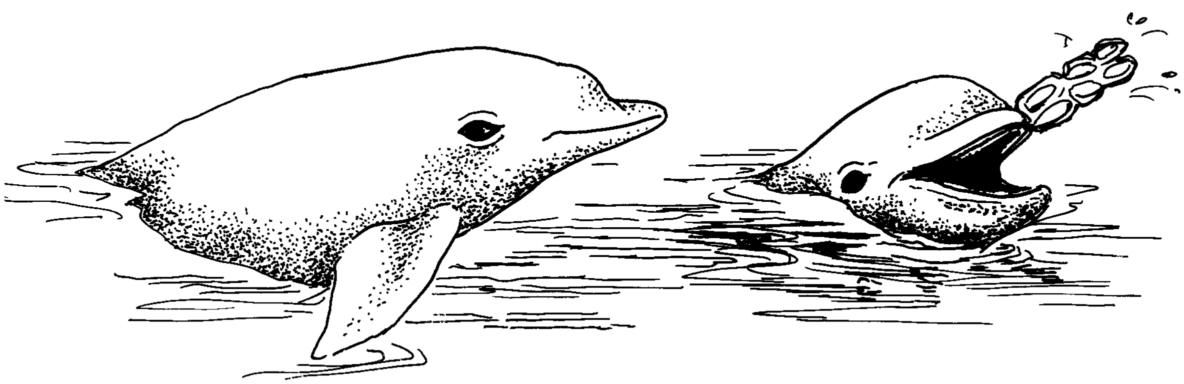
The result of these changes in net materials has been a tragic increase in mortality of air breathing animals. A few examples are sufficient to give an idea of the magnitude of the problem. During the heyday (1972–76) of the Danish salmon fishery in the North Atlantic, the incidental catch of thick-billed murres amounted to three-quarters of a million birds annually; in 1980, 2,000 sea turtles off the southeastern coast of the United States drowned when incidentally caught in shrimp trawl nets. Incidental catch refers to nontarget animals that are accidentally caught in an actively working net. Another kind of net-related mortality is known as entanglement and refers to any animal caught in a net that has been lost or discarded at sea. Some government officials estimate that about 50,000 northern fur seals currently die in the North Pacific each year as a result of entanglement in fishing gear. Unlike working nets, which fish for specific periods of time, these free-floating nets, often broken into fragments, fish indefinitely. When washed ashore, they may also threaten land birds and mammals; in the Aleutians Islands, for example, a reindeer became entangled in a Japanese gill net.

Plastic strapping bands—used to secure crates, bundles of netting, and other cargo—are another common form of ship-generated debris. Discarded bands are often found girdling marine mammals, which are particularly susceptible to entanglement because of their proclivity for examining floating objects. The instances of seal entanglement in plastic bands has increased so remarkably in the past two decades that fur seal harvesters in Alaska and South Africa now monitor the number of ringed animals.

Sea birds that frequent recreational waters or coastal dumps are also subject to ringing by the plastic yokes used in packaging six-packs of beer and soda pop. Gulls with rings caught around their necks are sometimes strangled when the free end of the yoke snags on protruding objects. Similarly, pelicans, which plunge into the water to feed, run the risk of diving into yokes. If the rings become firmly wedged around their bills, the birds may starve.

Not all encounters with plastic prove harmful to marine organisms. Some animals are incorporating the new materials into their lives. Algae, hydrozoans, bryozoans, polychaetes (marine worms), and small crustaceans attach to plastic floating at sea; bacteria proliferate in both raw and processed plastic refuse. Plastic provides these organisms with long-lived substrates for attachment and transport; in some cases, hitching a ride on floating pieces of plastic may alter an organism's normal distribution. Several species of tube-dwelling polychaetes construct their tubes of raw plastic particles present in benthic sediments. Other invertebrates, such as sand hoppers and periwinkles, find temporary homes in aggregates of plastic particles they encounter on beaches. Marine birds all over the world incorporate plastic litter into their nests, but in this case, the use of plastic may be harmful because chicks can become entangled in the debris and die.

Instances of marine animals adapting to this new element in their environment do not alter the predominantly negative effect of plastics at sea. The problem is global and will require international cooperation. Historically, the high seas have, in many respects, been considered an international no-man's land. Recently, however, perception of the ocean as a finite and shared resource has caused many nations to express concern for its well-being.



In 1970, the U.S. Congress passed the National Environmental Policy Act which, among other things, pledged to "encourage productive and enjoyable harmony between man and his environment." Subsequently, a number of laws on waste disposal were adopted, two of which affect pollution by plastics: The Federal Water Pollution Control Act (commonly known as the Clean Water Act) and the Marine Protection, Research, and Sanctuaries Act (the Ocean Dumping Act). The Clean Water Act does not specifically address the problem of persistent plastics but does require all significant polluters of U.S. waterways to obtain a federal permit, under which limits are set on, among other things, discharges of solid matter. The Ocean Dumping Act prohibits the deliberate dumping of significant amounts of persistent plastic materials at sea. Having these laws on the books, however, does not immediately solve the problem. Small-scale refuse disposal on the high seas is difficult to regulate; fishermen who claim to have unintentionally lost their nets at sea cannot be held responsible; and illegal large-scale dumping at sea is hard to detect. Granted, laws must be tightened, but enforcement is really the bigger problem.

On the international level, the problems of water pollution and litter in the oceans were highlighted at the United Nations Conference on the Human Environment held in Stockholm in 1972. The conference, with 110 nations represented, defined the need for international policy on marine pollution among coastal and maritime nations. Treaties to implement such a policy soon followed: the 1972 London Convention on the Prevention of Water Pollution by Dumping of Wastes and Other Matter (Ocean Dumping Convention), a part of which specifically prohibits marine dumping of persistent plastic material; and the 1973 London International Convention for the Prevention of Pollution from Ships (Marine Pollution Convention), which is broader in scope and regulates the control of oil pollution, packaged substances, sewage, and garbage. While neither of these treaties has been adopted by all nations, they represent a start toward global control of marine pollution.

In the meantime, the quantity of plastics in the world's oceans will undoubtedly continue to mount. Ironically, the very characteristics that make plastic appropriate for so many uses—its light weight, strength, and durability—lead to the majority of problems associated with its presence at sea. As organic material, plastic is theoretically subject to degradation by mechanical, oxidative, or microbial means. Owing to the strength of most plastics, however, mechanical degradation by wave action is generally restricted to the breaking of large pieces into smaller ones. Photooxidation and microbial action are limited by plastic's high molecular weight and its antioxidants, ultraviolet light stabilizers, and biocide additives, which effectively immunize it against degradation. The longevity of plastics in seawater is not known, but on the beach, particles may last from five to more than fifty years.

Given plastic's long life and projected annual increases in production, one thing is clear—the rate of plastic deposition in the marine environment will continue to be higher than the rate of disappearance. In a study of the accumulation of plastic on the beaches of Amchitka Island, Theodore R. Merrell, Jr., of the National Marine Fisheries Service recorded that 550 pounds of plastic litter were added to less than a mile of the beach in one year. He also found an increase of more than 250 percent in both the number and the weight of plastic items washed ashore over a 2-year period.

Outside the realm of laws and treaties, solutions to the problem can come from both inside and outside the plastic industry. The technology to manufacture biodegradable plastics is available. In fact, one of the beauties of plastic is that its properties can be altered and its life expectancy prescribed. Alaska has already taken steps toward reducing plastic litter by requiring that six-pack yokes be made of a self-destructing compound. Another, but perhaps less workable solution, given the logistics and expense involved and the degree of business and public cooperation required, lies in recyclable plastics. At the very least, all countries should require that the discharge of raw plastic materials from industrial plants be reduced by filtering outflow before it enters waterways. A recent decline in the uptake of plastic by marine organisms in southwestern England has been attributed, in part, to the efforts of one of the major contaminating plants to filter, collect, and reuse raw particles present in its effluent.

Consumers share with industry the responsibility to reduce the amount of plastic in the sea. Recreational boaters, beach-goers, and commercial fisherman all discard plastic refuse. Preferably, no trash plastic-bands, netting, or other debris should ever be tossed overboard or left on a beach. If six-pack yokes or strapping bands must be discarded at sea, the rings should be cut first so that they pose less of a threat to marine animals.

The first step in combating plastic pollution is to alert both industry and the general public to the gravity of the problem and the need to do something about it soon. Education alone cannot solve the problem but it is a beginning. Public awareness of a problem, combined with the resolve to correct it, can bring dramatic results.

Source: Reprinted from by Wehle and Coleman, "Plastics at Sea" with permission

THE RESOURCE PROTECTION GAME

THEME:	Human activity can affect our environment in a variety of ways.
GOAL:	Students will recognize the ecological impacts of different solid waste management practices on natural resources.
METHOD:	Resource Protection Game
SUBJECTS:	Science, social studies
SKILLS:	Analyzing, problem solving
MATERIALS:	“Resource Protection Game” handout; “Natural Resource Cards” handout
TIME:	45 minutes

GETTING STARTED

Ask the students in what ways their activities affect the environment.

PROCEDURE

1. As an introduction, review with the class the earth’s natural cycles and how human activities can affect these cycles and our natural resources.

2. Have students read through the list of sample situations. Discuss what effects these situations might have on our natural resources and some possible alternatives to each of these situations.

3. Divide the class into six groups. Distribute a natural resource card to each group and have a spokesperson from each group read its resource card to the rest of the class. The task of each group is to develop a strategy to protect that resource in each of the given situations.

4. Each group should answer the following questions in terms of their resource and each situation:

    a. How does this situation help your natural resource?

    b. How does it harm your natural resource?

    c. Is this situation good or bad? How might it be improved? What alternatives might you suggest?

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RESOURCE PROTECTION GAME

SITUATIONS:

1. A mandatory curbside recycling program has just begun in your town. Residents must separate their newspapers, aluminum, steel cans, and glass for recycling. It is now illegal to send bags of leaves and yard waste to the landfill.

2. A local cheese factory produces several hundred pounds of whey waste each week. The milk haulers dump the whey illegally in local swamps, streams, and on unused fields when they think no one is looking.

3. A local developer wants to build 360 new condominiums on the side of one of the highest peaks in the state.

4. After heavy rains, untreated sewage and rainwater contaminated with automobile oil flows into water bodies used by Massachusetts residents for recreation and as reservoirs.

5. A print shop generates 40 pounds of chemical waste each month, which does not have to be reported to the state or disposed of with other regulated hazardous wastes. The print shop owner waits until he can fill several 55-gallon drums and then dumps them at the local landfill.

6. A fishing party out on the Connecticut River discards beer bottles, plastic sandwich bags, orange peels, and other litter overboard before the end of the trip. A few plastic six-pack rings and fishing lines were thrown in as well.

7. The landfill in your city is scheduled to close in six months. The city has decided to build a new landfill on the other side of town.

8. A trash-to-energy incinerator plant is being built in a nearby town. This plant will supply your town with some of its electricity. Some of the ash produced will be deposited in your town's landfill and may be toxic.

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RESOURCE PROTECTION GAME

NATURAL RESOURCE CARDS

AIR

Clean air is essential to all living things. Any smoke or other chemicals that enter the air result in air pollution. Protect the air from all forms of air pollution.

WATER

Fresh water serves two important functions. Not only do many living things need to drink it to survive, but many also need it for their homes. Salt water also supports many forms of life. It is essential to protect both kinds of water.

SOIL/MINERALS

Soil contains minerals and nutrients needed by all living things. There is, however, a limited supply of these minerals on our earth. The soil and its minerals must be protected.

WILDLIFE, FISH, BIRDS, INSECTS

Fish and wildlife are essential members of the ecosystem. They also provide us with food and recreation, such as nature study and fishing. We and other living things are dependent upon them to live. We must protect them.

FORESTS AND PLANTS

Plants are an important natural resource. Not only are they beautiful, but they also help to purify our air through the oxygen they give off in photosynthesis. Plants are also a source of food and shelter for animals.

PEOPLE

Human beings are a natural resource. We are part of many food chains and affect the ecological balance of the earth. We are also consumers of natural resources and must conserve them for future generations who will inherit the earth from us.

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HOME SAFE HOME

THEME:	Many household substances can be dangerous and should be used with great caution.
GOAL:	Students will identify which household products are toxic and predict the results of improper use and storage.
METHOD:	Reading and discussion
SUBJECTS:	Health, language arts, science, social studies
SKILLS:	Inferring, predicting, problem solving
MATERIALS:	"Poisons in My Home?" handout (see Activity 1-5); "Unsafe Situations" worksheet; drawing materials
TIME:	1 hour

GETTING STARTED

Distribute the "Poisons in My Home?" handout and discuss it with the students. Do they have any of these kinds of products in their homes? Do they ever use them? If so, do they use any precautions (e.g., rubber gloves, face mask)? Where are these products kept? Did they ever consider how dangerous these products might be?

PROCEDURE

1. Distribute the "Unsafe Situations" worksheet and use it in one of the following ways. (Note the accompanying Teacher's Page).

   a. Have the students complete their predictions in writing. Discuss both their predictions and methods for rectifying the unsafe situations.

   b. Read aloud each of the Unsafe Situations scenarios and have the students brainstorm both problems and solutions.

   c. Have teams of students act out one of the scenarios and encourage classmates to suggest ways in which the situation might have been avoided.

2. After the students have completed the worksheet, discuss the results. Help them identify ways to minimize the chance of accidental poisoning (e.g., storing materials in original containers, keeping toxic materials on high shelves or in locked cabinets, using child proof caps). Discuss the best method for dealing with accidents involving hazardous household materials. If there is a local poison control center, inform students and discuss its purpose.

3. Distribute drawing materials. Have the students make a diagram of their home and label, by location, twenty items commonly found there which they believe may be toxic. Examples might include nail polish remover, furniture stripper, flea powder, spot remover, kerosene, toilet bowl cleaner, detergent, weed killer, motor oil, antifreeze, brake fluid, paint, deodorizers, oven cleaner, moth balls, bleach, scouring powder, bug spray, and charcoal lighter fluid. Brainstorm safer alternatives to these products.

EXTENSIONS

1. After the students have drawn and labeled their homes, have them trace the routes through which hazardous household substances could get into the environment. Possibilities include evaporation, leaching, seepage,

runoff, and dumping. Point out that hazardous household materials are not only dangerous to humans, but can also affect other living creatures and the environment.

2. Have the students survey their homes to see how many toxic items are actually used by their families.

3. Point out to students that industry and business also use toxic materials. Have students research a well-known toxic catastrophe such as Love Canal or the Exxon Valdez oil spill, or, more locally, the contamination of wells in Hatfield or Woburn. How and why did these incidents occur? What were the acute effects? What were the chronic effects? Could these incidents have been prevented? How? Have students write reports summarizing their findings and present the information to the class.

Source: Adapted from Bell and Swartz, *Oscar's Options*

UNSAFE SITUATIONS

PRODUCT: drain cleaner
SITUATION: When the doorbell rang, the bottle was left on the bathroom floor. A baby was playing nearby.

PREDICTION:

PRODUCT: lemon furniture oil
SITUATION: When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.

PREDICTION:

PRODUCT: antifreeze
SITUATION: After changing the antifreeze in a car, someone threw it into a ditch in front of the house.

PREDICTION:

PRODUCT: aerosol air fresheners/deodorizers
SITUATION: A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.

PREDICTION:

PRODUCT: chlorine bleach/ammonia
SITUATION: A bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.

PREDICTION:

PRODUCT: furniture stripper
SITUATION: Your neighbor decided to strip the paint off of an old chair. He is working in his workshop and turns on the fan.

PREDICTION:

PRODUCT: hair spray
SITUATION: Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.

PREDICTION:

PRODUCT: pesticides
SITUATION: To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.

PREDICTION:

PRODUCT: oven cleaner
SITUATION: Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.

PREDICTION:

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UNSAFE SITUATIONS

Teacher's Page

PRODUCT: drain cleaner
SITUATION: When the doorbell rang, the bottle was left on the bathroom floor. A baby was playing nearby.

PREDICTION: Child could drink it; product is corrosive to skin and eyes.

PRODUCT: lemon furniture oil
SITUATION: When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.

PREDICTION: Someone might drink it, thinking it was safe; color and scent make it attractive.

PRODUCT: antifreeze
SITUATION: After changing the antifreeze in a car, someone threw it into a ditch in front of the house.

PREDICTION: Pets have died from drinking puddles of antifreeze; they are attracted by its sweet taste; could leach into groundwater.

PRODUCT: aerosol air fresheners/deodorizers
SITUATION: A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.

PREDICTION: Fumes may adhere to food or make residents sick; can could explode due to heat.

PRODUCT: chlorine bleach/ammonia
SITUATION: A bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.

PREDICTION: Mixing chlorine bleach and ammonia releases a toxic gas; the fumes can result in eye, throat, nose irritations and breathing difficulty; products should never be mixed.

PRODUCT: furniture stripper
SITUATION: Your neighbor decided to strip the paint off of an old chair. He is working in his workshop and turns on the fan.

PREDICTION: Using a fan in closed quarters will only recirculate the bad air; such products need extreme caution and plenty of fresh air.

PRODUCT: hair spray
SITUATION: Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.

PREDICTION: Fumes from chemical sprays can irritate and damage skin, eyes, and lungs; they can also cause internal harm by entering bloodstream through the lungs; containers can explode from the heat.

PRODUCT: pesticides
SITUATION: To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.

PREDICTION: Chemicals can penetrate socks and be absorbed through the skin; health effects of pesticides, especially long-term effects, are not fully known.

PRODUCT: oven cleaner
SITUATION: Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.

PREDICTION: The chemicals could cause the skin to burn or develop a rash; skin and eye contact should be avoided.

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EVERYWHERE IS SOMEWHERE

THEME:	Toxic wastes have far-reaching effects on the environment.
GOAL:	Students will analyze our waste disposal practices and the serious environmental consequences that can result from them.
METHOD:	Reading and analyzing
SUBJECTS:	Science, English
SKILLS:	Analyzing, value judgments
MATERIALS:	"Everywhere is Somewhere" poem
TIME:	One class period

GETTING STARTED

What are some toxic materials that you use? After you use these materials, where do they go? How does this affect the environment?

PROCEDURE

1. Read the poem and discuss the following:

   a. When people discard hazardous materials, do you think they usually consider the environmental impacts?

   b. In light of the poem "Everywhere is Somewhere," what problems do you foresee in the future, especially if we don't change our toxic waste disposal methods?

   c. How can we educate the public about the implications of our throwaway habits? The poem was one effective way; can you think of others?

EXTENSIONS

1. Have the students read Rachel Carson's *Silent Spring* or Aldo Leopold's *A Sand County Almanac*. What message(s) are these authors trying to get across? In what ways do our actions affect the world around us?

2. Have the students write a poem similar to "Everywhere is Somewhere" which discusses the effects of hazardous waste on a living creature(s). The poems should address where the poisons come from, how they affect different organisms, and how they affect the ecosystem.

EVERYWHERE IS SOMEWHERE

by Betty Miles

When people spray poisons into the air
to kill plant eating insects,
the insects may die
but the poison does not go away.
It stays, unseen, in the air.
And it falls, perhaps years later,
on other plants and on the land.
When the rains come, some poisons
wash off the plants
and run off the land
into ponds and lakes and rivers.
The poison is always somewhere.
It gets into water plants
and small water animals
and into the fish that eat them.
Birds of the air catch the poisoned fish,
or eat the poisoned insects,
and poison gets into the birds.
The poisoned bird lays eggs with soft eggshells.
No baby birds will come out of these eggs.
Some kinds of birds will never fly through the air again.
They are gone forever,
because of poisons in the air.
In the air everywhere is somewhere.
Nowhere is away.

When you rinse garbage down the drain
of a sink,
or flush trash down the toilet,
it does not go away;
it goes somewhere.
Sewage and waste go into big pipes.
The pipes go into the river.
The river runs into a bigger river.
The big river flows to the sea.

Far, far away
in the middle of the ocean,
garbage and trash float on the sea water.
Pollution does not float away;
it floats somewhere.
And it will stay there,
floating and sinking under the sun,
for years and years.

When you rinse something down the drain,
it does not go away—
it goes somewhere.
In the water, everywhere is somewhere.

Source: Miles, *Save the Earth!*

TRACKING HAZARDOUS WASTES: WHERE DO THEY GO?

THEME:	Improper disposal of hazardous wastes is harmful to the environment.
GOAL:	Students will examine common disposal practices and gain an appreciation of better disposal options.
METHOD:	Role playing with discussion, research
SUBJECTS:	English, theater
SKILLS:	Analyzing, communicating, problem solving, making value judgments
MATERIALS:	"Where Does It Go?," "Where Should It Go?" handouts; Problem-solving exercise scenarios, cut into cards; Problem-solving exercise decision sheet
TIME:	1 to 2 hours; one follow-up class

GETTING STARTED

Ask the students what happens to household hazardous wastes if they are poured down the sink? Brought to the landfill? Burned in an incinerator? How are these practices harmful to the environment?

PROCEDURE

1. Distribute informational sheets, "Where Does It Go?" and "Where Should It Go?". Discuss the information with the class. Have the students make a diagram of their homes indicating all avenues for disposal of household hazardous materials and where the material goes. This should trace, for example, the route of material poured down the kitchen sink, from septic tank to leach field or, when pumped, to a treatment facility, and so on.

2. Have students research the proper local disposal options for the items listed on the "Where Should It Go?" worksheet. Share the results in a subsequent class.

3. Tell students they are going to role play the decision making process for dealing with some common household hazardous substances. Divide the class into three groups and assign each a different scenario. The three scenarios are:

SCENARIO #1: Hilda discovers a can of gasoline in her garage. What should she do with it? If she decides to dispose of it, what options does she have?

SCENARIO #2: A group of neighbors is setting up a community gardening project. They have purchased the plot of ground and are meeting now to make some decisions about policy. The first issue they decide is whether to use Slug Bait in their garden.

SCENARIO #3: Nine individuals who have operated independent cleaning services have decided to combine their talents to create the Zippy Cleaning Service. As a group they need to make some decisions about the products they will use and the policies they will follow.

4. Each student should get one card listing a possible reaction to the question raised in their scenario. They must represent that point of view in a group discussion on how the situation should be handled. Point out to the students that there is not necessarily one correct answer to these problems. These are current situations for which the state—and society at large—are trying to find solutions.

5. Allow 30 minutes for discussion, at which time each group should make a recommendation concerning their particular dilemma. Have an assigned scribe keep track of the discussion (on the Decision Sheet) to tell the class what factors were considered prior to achieving a consensus.

EXTENSIONS

1. After completing one set of scenarios, allow the groups to discuss the other scenarios. Compare the final recommendations and the decisions made to reach those conclusions. How did they differ?

2. Have the students write an essay on how they would respond to one of the three scenarios.

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WHERE DOES IT GO?

When you wash your clothes in sudsy detergent, where does it go? When you clean your sink with cleanser, where does it go? When you pour a waste into the street drain, where does it go? It doesn't disappear; it all goes somewhere. It all helps or hurts someone or something.

All the drains in your house lead from the bathroom, kitchen, and laundry room down to one large drain. The watery wastes pass into a septic tank, if you live in the country. A septic tank is a large underground concrete container. Wastewater spends two or three days there. Solids settle to the bottom of the tank. Liquids are piped into a drainfield which allows them to seep slowly into the soil. This solid sludge must be pumped out approximately every five years. It is then taken to a sewage treatment plant.

If you do not have a septic tank, then your wastewater is piped from your house to the sewage treatment plant. Underground pipes mix the liquids from homes, stores, and factories. At the sewage treatment plant, wastewater is treated with bacteria. This can remove only some of the harmful materials. Then the waste is diluted with water and discharged into nearby lakes or streams.

Pouring wastes into storm drains is illegal. That's because they lead directly to waterways. Many chemicals could harm the fish, or poison humans who eat the fish or drink the water.

Dumping wastes on the ground pollutes the soil. As the poison seeps into the soil, groundwater supplies may be ruined.

Burning toxic wastes is not a good idea, either. Harmful gases contaminate the air. Aerosol cans will explode.

There are only two good ways to deal with toxic materials. Use as little as possible. Then dispose of any wastes through a hazardous waste collection program.

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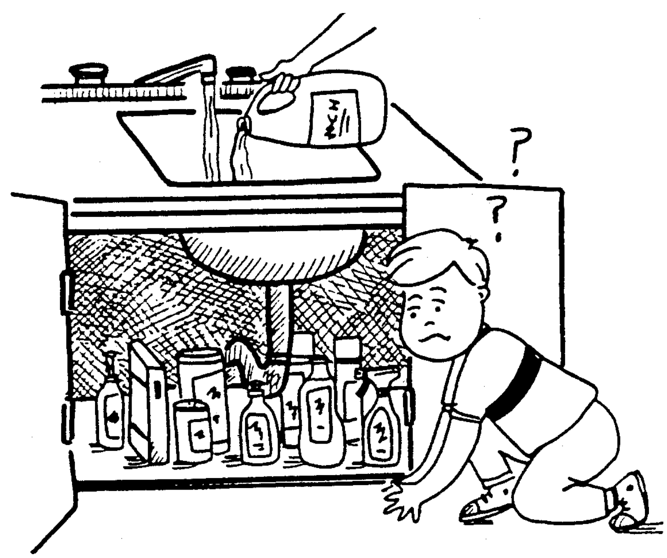

WHERE SHOULD IT GO?

Contact your local Board of Health or Department of Public Works to determine the proper way to dispose of the following items in your community:

HOUSEHOLD HAZARDOUS PRODUCT	HOW TO DISPOSE OF
powder cleaners	______________________
window cleaner	______________________
toilet cleaner	______________________
bleach	______________________
latex paint	______________________
pool cleaning agents	______________________
drain cleaner	______________________
silver polish	______________________
flea powder	______________________
kerosene	______________________
mothballs	______________________
spot removers	______________________
household insecticides	______________________
rat poison	______________________
paint stripper	______________________
rechargeable batteries	______________________
car batteries	______________________
motor oil	______________________
auto-antifreeze	______________________
button batteries	______________________

Source(s) of information: ____________

PROBLEM SOLVING EXERCISES

Scenario #1: Hilda's Can of Gasoline

Scenario #1

You are Hilda's neighbor, Nancy Nextdoor. You point out that gasoline evaporates. Maybe Hilda should just evaporate the gasoline. But, you know that the fumes are dangerous—poisonous, in fact. There are small children in the neighbor-hood. You also wonder if evaporation might cause some air pollution.

Scenario #1

You are Joe Cleandrain from the sewage treatment plant. You tell Hilda that it is against regulations to pout gasoline down sink, sewer, or storm drains.

Scenario #1

You are Peter Putrescible, a representative of the community landfill. You tell Hilda that the landfill will not accept flammable materials.

Scenario #1

You are Lt. Jane Jones of the local fire department. It is very dangerous to store gasoline, as it is a fire hazard.

Scenario #1

You are Pat, Hilda's neighbor. You know that gasoline is a solvent. How could Hilda use a solvent? You suggest that Hilda check with a recycling center that takes solvents. But, the only one you know of is 25 miles away—clear over on the other side of the county.

Scenario #1

You are Hilda. You discovered a can of gasoline in your garage while you were cleaning. You don't know exactly how long it has been there. Because you are worried that it may have water, oil, or rust in it, you have decided not to use it in your car.

Scenario #1

You are Hilda's brother-in-law, Fred. You tell Hilda that gasoline is an effective weed killer. Hilda has a large patch of poison ivy in the corner of her lot. Maybe she should throw the gasoline on the ground around the poison ivy.

Scenario #1

You are Chris, Hilda's son's high school buddy. You say that your dad has always poured his excess gas down the storm drain in front of the house. It is such a small quantity that it can't possibly hurt anything.

Scenario #1

You are Hilda's son, Ralph. Another friend of yours says that his dad is glad when he has excess gasoline around. He uses it to start the barbeque.

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PROBLEM SOLVING EXERCISES

Scenario #2: The Community Garden

Scenario #2

You are Bob Tool. You own the Valley Hardware and Garden Store. You know that Metaldehyde is the active ingredient in slug baits. It was first discovered in 1936 and has been around for a long time.

Scenario #2

You are Polly Puregard. You checked with the local "Grow 'Em" Community Garden people. They don't allow any chemicals in their community gardens. If this project allows chemicals, you don't want to participate.

Scenario #2

You are Rita Byeby. You recommend planting sacrificial rows of bok choy, lettuce, cabbage, or other vegetables, all around the perimeter of the garden. These vegetables will keep the slugs busy and they will never get into the "real" garden.

Scenario #2

You are Sally Street. You have used salt on the slugs in your own garden. Last year you used saucers of beer to get rid of them. Although it worked pretty well, the saucers had to be changed often and sometimes it seemed like too much work.

Scenario #2

You are Ned Punchly. You suggest that boards be laid around the individual beds. The slugs will crawl under them during the day and someone can then turn the boards over and collect or kill them. Or, maybe the group could elect a member to go out at night with a flashlight and collect them.

Scenario #2

You are Dudley Doread. You read the label from a slug bait container and know that it is toxic to pets. Some pets have been poisoned by accidentally eating it in the garden. You also discovered that you are supposed to keep it away from the edible parts of the vegetables. What does this mean?

Scenario #2

You are Sandy Beach. You read in a gardening magazine that kelp or seaweed laid around the edges of the garden would get rid of slugs. They crawl over the salty surface of the seaweed and the salt causes them to dry out and die.

Scenario #2

You are Susan Feathers. You recommend that the group build two fences; one right around the garden plot and another 2 or 3 feet away from the first. The group could then put ducks and geese in this enclosed area. They would eat the slugs before they could get into the garden.

Scenario #2

You are John Goodgardner. You have tried over the years to garden with a min-imum of chemical pesti-cides and fertilizers. But last year you lost most of your lettuce to the slugs and that was a real disappoint-ment. You also want the project to work and want everyone to feel com-fortable with the decisions that the group makes.

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PROBLEM SOLVING EXERCISES

Scenario #3: The Zippy Cleaning Service

Scenario #3

You are Annie Aerosol and are very concerned about aerosol cleaners. You know they are popular but not very cost efficient. Small droplets can land on other objects besides those being cleaned and some propellants can damage the ozone layer around the earth. Disposal of aerosol cans also creates problems because they may explode if they get too warm.

Scenario #3

You are Tom Smellnice and are concerned about disinfectants and deodorizers that end up down the drain or in the air after they are used. You realize that these products do not create a germ-free environment anyway. You also wonder about toilet bowl cleaners that are flushed into the sewer or septic tank. Does this create a problem?

Scenario #3

You are Jack Cleanwater and are concerned about the phosphates in detergents, as well as the cleaning agent TSP. You heard that phosphates can threaten the health of lakes, rivers, and streams by encouraging algae growth.

Scenario #3

You are Carl Caustic and are concerned about alkalies found in dishwashing and laundry detergents, and oven and drain cleaners. Swallowing such products can result in severe stomach pains and burns in the mouth and throat. Inhalation can cause severe coughing and burns to the throat and lungs. Skin and eye contact can also cause burns and possible damage to the cornea.

Scenario #3

You are Priscilla Polish and have been looking into the amount of hydrocarbons, petroleum distillates, and napthas in polishes and cleaners. You have found that they can cause skin rashes, as well as eye, nose, throat, and lung irritation. They are also hazardous when ingested. Repeated exposure can result in liver and kidney damage.

Scenario #3

You are Cloris Toxgas and are concerned with the human health hazards of chlorine. It is the basic ingredient of some bleaches and drain cleaners, and can cause burns and surface damage to eyes. If mixed with an acid or ammonia, a highly toxic gas is produced. Inhalation is especially dangerous to those with lung problems and can result in death.

Scenario #3

You are Lisa Lemon and have researched some alternatives to commercial furniture polishes and recommend the following substitutes:

1 teaspoon lemon oil
1 pint mineral oil

or equal parts of:

turpentine, boiled linseed oil, and vinegar, plus a few drops of lemon oil for fragrance.

Scenario #3

You are Granny Smith and have researched some alternatives to conventional cleaners. For example, several teaspoons of vinegar in water works well for cleaning glass and marble. Baking soda is recommended for items that are particularly greasy, such as coffee pots, chrome, and tile.

Scenario #3

You are Bob Bleach and have researched alternatives to commercial disinfectants. You have found that 1/4 cup bleach in 1 quart of water works well for cleaning many surfaces including counter tops, floors, toilet bowls, and bathtubs.

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PROBLEM SOLVING EXERCISES

Decision Sheet

Which scenario? ______________________________

Students in the group: ______________________________

After each person in the group contributes information and the entire problem unfolds, what do you see as the ISSUES in this exercise?

____

____

POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

____

____

____

____

What environmental or human health EFFECTS could result from this solution?

____

____

____

____

POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

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What environmental or human health EFFECTS could result from this solution?

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POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

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What environmental or human health EFFECTS could result from this solution?

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POSSIBLE SOLUTION:

What are some tradeoffs to this solution?

____
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____
____

What environmental or human health EFFECTS could result from this solution?

____
____
____
____

FINAL DECISION: ____

____

Was the entire group satisfied with the decision? If not, why not?________________

____

Note any COMMENTS and QUESTIONS that your group had during the decision making process. Discuss these with the rest of the class.

____

____

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HOUSEHOLD HAZARDOUS WASTE AUDIT

THEME:	The average household contains many products that could be designated as hazardous materials.
GOALS:	Students will identify hazardous household products, understand the health hazards associated with them, learn nontoxic alternatives to many commonly used household products, and become familiar with safe ways to recycle and dispose of household hazardous waste.
METHOD:	Household hazardous waste audit and preparing advertisement
SUBJECTS:	English, science, communications
SKILLS:	Analyzing, comparing, researching
MATERIALS:	Examples of toxic household products; household hazardous waste audit worksheets; Hazardous Waste Wheel [available from EHMI, 10 Newmarket Rd., Durham, NH 03824 (603) 868-1496]; Household Hazardous Waste Brochure [available from the Office of Technical Assistance for Toxics Reduction (OTA), Executive Office of Environmental Affairs, Room 2109, 100 Cambridge St., Boston, MA 02202 (617) 727-3260]
TIME:	45 minutes, plus several hours for audit

BACKGROUND INFORMATION

A hazardous material is a poison, corrosive agent, flammable substance, explosive, radioactive chemical, or any other material which can endanger human health or well-being if handled improperly. Many household products contain chemicals that, when improperly discarded, may contribute to the contamination of water supplies and other natural resources. To find out if a product is potentially hazardous, read the product label and look for words such as **WARNING, POISON, CAUTION, HARMFUL, CAUSTIC, FLAMMABLE, EXPLOSIVE, IRRITANT,** or **HAZARDOUS.**

GETTING STARTED

Ask the class to define household hazardous waste. Have the students bring in several examples or pictures of items that they think are or could be considered household hazardous waste.

PROCEDURE

1. Develop a class list of household hazardous wastes. Each student should contribute the names of ten items that they think are or could be called household hazardous wastes, and explain their rationale for choosing these items. Distribute list to all students.

2. Divide the class into small groups and assign each a set of items from the class household hazardous waste list. Using the Hazardous Waste Wheel (or "Safer Alternatives to Toxic Products" from Activity 1-16) and the OTA brochure, have each group determine:

   - If the product is potentially a hazardous waste
   - What toxic chemical(s) it contains and why they are harmful
   - Possible alternatives
   - Proper disposal methods

3. Distribute the Household Hazardous Waste Audit sheet for students to complete at home. After discussing the results, have each student choose one alternative product and use it in their house for one week. Each student should prepare a TV or radio commercial stating the advantages and disadvantages of the hazardous product and the alternative. Have the class evaluate the effectiveness of each of the commercials.

EXTENSIONS

1. Invite a speaker to talk to the class about household hazardous waste. Contact the Office of Technical Assistance for Toxics Reduction at the Executive Office of Environmental Affairs or a local environmental group for suggestions. Consult the Appendices in the back of the guide for additional speaker contacts.

2. Have students perform a school-wide hazardous waste audit similar to the one done at home. Determine alternatives and proper disposal methods for toxics that are found.

3. Have the class prepare a list of alternative household products to distribute to the entire school.

Sources: Amy Ballin and Tim Greiner

HOUSEHOLD HAZARDOUS WASTE AUDIT WORKSHEET

Directions:

You are from the Massachusetts State Office of Technical Assistance for Toxics Reduction. You have been asked to conduct an audit at the home of ___________________________ to locate potential household hazardous substances. You will complete the audit locating all hazardous materials and then make recommendations to the family of __________________ about ways to decrease their use of consumer products containing hazardous chemicals.

Number of persons living in the house: ______________________________

AUDIT FORM

Product	Hazardous Substance	Product Use	Product Location	Storage Problems	Container Condition
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

HOUSEHOLD HAZARDOUS RECOMMENDATIONS FOR THE FAMILY OF

____

Prepared by_____________________

Below is a list of the hazardous materials in your household. For each hazardous product listed, I have suggested a less hazardous alternative, a technique to reduce the hazardous product's use and, where appropriate, a proper disposal method.

Hazardous Product	Alternative Product	Reduction Technique	Disposal Method
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

SECTION II

SOLID WASTE MANAGEMENT IN MASSACHUSETTS

SOLID WASTE MANAGEMENT IN MASSACHUSETTS

The Past

How was garbage handled and disposed of in the past?

Trash disposal is an ancient problem that has typically been dealt with in the cheapest, quickest way available. From the 1700s until the mid-1950s, communities in the Commonwealth relied on open burning and dumping for solid waste disposal. Trash from Massachusetts was disposed of in unpopulated areas considered unfit for development, such as river banks, wetlands, floodplains, marshes, swamps, and bogs.[xxv]

By the mid-1800s, unsightly dumps were causing a number of health problems because they attracted rodents and other pests that transmit infectious diseases. As populations grew, so did refuse accumulation, and the question of what to do with household garbage intensified. By the late 1800s, communities began passing ordinances to clean up refuse areas.[xxvi]

At the turn of the century, most communities in the United States still dumped their waste in marshes and wetlands. These areas were considered unsuitable for development and could be purchased at very low prices by local haulers and municipal governments.[xxvii] The prevailing belief was that the soil would act as a natural filter and that, as the waste residues percolated through the ground, the dilution process would render them harmless. No one anticipated the consequences of groundwater contamination and the effects on public and private water supplies. Garbage dumps were frequently established in areas where supplies of fresh groundwater are recharged by rainfall, the very places where many municipalities were also locating drinking water pumps and wells.

In the 1930s, much waste was burned in open pits to reduce its volume before burial. Open pit burning caused its own problems, however. First, surrounding neighborhoods lived with continuously smoky air. Second, the fire department always seemed en route to put out landfill fires. In fact, landfill fires used to be so abundant that they were used by fire departments to train newly-enrolled firemen.[xxviii]

Communities responded by passing ordinances limiting open burning to specific areas. As the need for disposal grew and the availability of marginal land for disposal decreased, many cities built incinerators, which reduced the amount of land needed to bury garbage.[xxix]

What led to the regulation of solid waste facilities?

Public awareness of land-use issues and the importance of preservation grew dramatically during the 1960s and 1970s. Attention focused on wetlands, floodplains, and other water resources as scientists identified the role of these natural resources in maintaining our public and private water supplies. These were the very areas where household garbage and industrial waste were being dumped and buried. Most Commonwealth communities at the time still disposed of their waste in this manner. (See Section III for more information on landfills.)

Lobbying efforts by environmental groups such as the National Audubon Society and the Sierra Club led to legislative action, including passage of the National Solid Wastes Act in October 1965. This Act required all states to accept federal guidelines structuring regulations for solid waste management and disposal. Each state could add to these requirements as it saw fit.[xxx]

The establishment of the U.S. Environmental Protection Agency (EPA) in 1970 heralded further environmental and legislative reforms that reflected a growing public understanding of environmental issues. The EPA's mission was to administer and enforce anti-pollution laws directed toward air and water. The Clean Air Act of 1970 and the Clean Water Act of 1972 set standards and compliance procedures for industrial polluters and, for the first time, gave governments authority to levy fines against companies that failed to comply. Compliance with the new federal air emissions standards under the Clean Air Act required that all solid waste incinerators be retrofitted with costly pollution control devices. In Massachusetts all incinerators, except two, closed rather than take on the high cost of compliance.

National legislation passed in the last 20 years has given the federal government a greater role in waste management. Laws have been passed related to pesticide control, toxic substance control, air quality, water quality, low-level radioactive waste, and nuclear waste. The Resource Conservation and Recovery Act (RCRA) of 1976 created the first significant role for the federal government in waste management by launching a hazardous waste management program and addressing recycling and the conservation of energy and resources. The events at Love Canal, New York, in 1978, where houses were built on an abandoned hazardous waste site that leaked into nearby homes, created a fear of serious health effects that extended to all parts of the country. This new awareness of toxics and their effects led to the passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), known as "Superfund." This law established an elaborate system to study and clean up contaminated sites.

How did solid waste management become a public priority in Massachusetts?

In 1969, Massachusetts passed the Solid Waste Disposal Act, which surpassed the federal standards established by the 1965 National Solid Wastes Act. The Commonwealth's legislation established the authority of the Massachusetts Department of Public Health to write and enforce regulations governing the design and operation of sanitary landfills. This responsibility now belongs to the Department of Environmental Protection (DEP). The Act and the regulations:

- Outlawed open dumps.

- Required that sanitary landfills be sited, designed, operated, and closed in such a manner as to protect public health, safety, and the environment.

- Prohibited "the occurrence of conditions of air, land, and water pollution and assisted in the abatement of such conditions when and where such pollution occurs."[xxxi]

Approximately thirty municipalities closed their landfills in 1971, the first year that the Massachusetts landfill disposal regulations went into effect. The remaining municipalities either upgraded their landfills if they could afford to, or continued to operate them without meeting state regulations. In most cases, alternative options for disposal were not readily affordable.[xxxii] Between the years 1971 and 1985, many communities struggled with the closure of their landfills. Many simply stopped using the sites for dumping, but never formally closed them in accordance with regulations.

The Present

How is our solid waste handled in the 1990s?

In 1994, 28 percent of the Commonwealth's municipal solid waste was landfilled in one of its 91 active landfills.[xxxiii] Twenty-five of these landfills were constructed with liners to prevent contaminated water from exiting the landfill into surrounding soil. In 1994, 66 older, unprotected facilities were still active. At least 23 of these were expected to stop operation by December 1995.[xxxiv]

The other major solid waste disposal option in Massachusetts is to burn trash in combustion facilities. As of 1994, Massachusetts had nine trash-burning plants. One of these is an older municipal incinerator, two are refuse-derived fuel plants that shred the trash prior to burning it, and six are mass-burn plants (see Section III, ìCombustionî). Some of these facilities burn as little as 240 tons of trash per day, while the largest burns 2,700 tons of trash per day.[xxxv] These plants burned approximately 31 percent of all the household and commercial solid waste produced in Massachusetts in 1988, and 34 percent of that generated in 1994.

As recently as ten years ago, the cost of solid waste collection and disposal was minimal, ranging from $5 to $20 per ton, and was a relatively small percentage of overall municipal budgets. In Massachusetts today, garbage disposal costs range from $40 to $150 per ton. Transportation costs add $20 to $40 per ton. On average, the cost of waste disposal has become the third largest municipal expenditure after schools and roads. These climbing costs provide local governments with an incentive to look beyond landfills and incineration facilities for ways to manage their waste.

In 1994, an estimated 31 percent of the Commonwealth's municipal solid waste stream was recycled or composted. Nearly every Massachusetts community offers its residents the opportunity to recycle, and two-thirds of the stateís residents can recycle at the curb.

Section III provides details on the solid waste disposal methods discussed above.

What environmental safeguards exist for solid waste facilities?

Responding to public concern about potential threats to the environment and public health, state and federal officials have taken steps to strengthen environmental safeguards at all solid waste facilities, including landfills, combustion facilities, and recycling plants.

The DEP is the Commonwealth's lead agency for regulating solid waste facilities. DEP's Division of Solid Waste Management:

- Establishes standards that protect public health and the environment when siting, constructing, and operating solid waste facilities.

- Issues permits and regulates existing facilities to ensure they comply with these standards.
- Levies penalties for illegal dumping.
- Establishes and maintains the stateís solid waste management priorities and planning strategies.

State-of-the-art landfill technology now includes standards for construction, operation, and environmental monitoring. Landfill operators are required to install impermeable clay or synthetic liner systems, groundwater monitoring devices, and gas collection equipment.

Safeguards at combustion facilities have also been established, requiring all new plants to have state-of-the-art air pollution equipment installed in their smokestacks to control emissions.

What is the cost of building a landfill?

The cost of building a new landfill or expanding an old one has risen drastically in recent years. Depending on geologic and other conditions, construction costs may range from $250,000 to $400,000 per acre. In addition to the land and construction expenses, these costs include air pollution control equipment, collection, insurance, and transportation. The additional expense of closing a landfill can range from $125,000 to $140,000 per acre. In total, it can cost upwards of $500,000 per acre to develop, operate, and properly maintain a landfill site over its 20-year lifespan.

The Future

How do we plan to manage our waste in the future?

Answers to the question of how to best manage our waste are not simple. The Commonwealth is promoting an integrated solid waste management strategy that prioritizes reducing, reusing, and recycling waste before using combustion or landfilling as a management option. By placing source reduction, recycling, and composting at the top of the waste management hierarchy, the state and local municipalities will conserve resources and, possibly, money. Source reduction results in less waste to haul and dispose of, while recycling and composting can often cost less than combustion or landfilling. The waste management hierarchy is explained further in the following paragraphs.

Source Reduction

Source reduction means avoiding the generation of waste. When the amount and toxicity of waste are reduced, disposal costs are reduced and resources are conserved. Source reduction occurs when industry designs and sells products that are durable, use less packaging, and have minimum or no toxic ingredients. Consumers can also reduce their waste by avoiding disposable and over-packaged products, buying reusable products, and getting off of ìjunk mailî lists when possible. The Commonwealthís source reduction goal is 10 percent by the year 2000.[xxxvi]

Recycling and Composting

Recycling (including the composting of food and yard materials) and reusing of products prevents potentially useful materials from being buried or burned and extends the lifespan of landfills, thereby preserving valuable space. What was once treated as waste has become a major resource in the manufacture of new products. Using recycled materials in place of virgin materials also saves energy and natural resources. Composting food and yard trimmings produces organic material that can be used on gardens and farm fields. In 1994, the Commonwealth diverted 31 percent of its MSW through recycling and composting. Its goal is to divert 46 percent of the waste stream through recycling and composting by the year 2000.[xxxvii]

Combustion or Incineration

Combustion, or incineration, is designated for waste that cannot be reduced, composted, or recycled, but can be burned. Combustion facilities should be equipped with state-of-the-art pollution control and energy recovery equipment. Such facilities reduce the volume of nonrecyclable, nonrenewable waste, and convert the heating value of garbage to steam or electricity. The leftover ash is then disposed of in a monofill—a landfill that accepts only one kind of material. In 1994, the Commonwealth incinerated 48 percent of its municipal solid waste. Its goal is to reach and maintain a 50 percent incineration rate through the year 2000.

Landfills

Landfilling is the last resort as a waste disposal method. Landfills should be equipped with proper liners and leachate collection systems to protect the environment. DEP's goal is to create a system in which no waste is landfilled without first being processed and reduced in volume. The Commonwealth's goal is to reduce the amount of waste landfilled from 28 percent of all municipal solid waste in 1994, to 4 percent by the year 2000.

* * *

Communities that follow this hierarchy stand to reduce disposal costs while cutting down on air and water pollution. Recognizing that communities need assistance to comply with this waste management plan, DEP offers the following help to towns and cities:

- Technical assistance in all areas of solid waste management.
- Municipal grant programs for recycling and composting public education and equipment.

How might a community institute an integrated solid waste management system?

Take as an example the hypothetical town of Carneysville, which wants to comply with the goals of the state's 1995 Master Plan by establishing an integrated solid waste management system. Carneysville generates approximately 2,000 tons of municipal solid waste a year (30 percent is commercial and 70 percent is residential). The town is responsible for the collection and disposal of all 2,000 tons.

Following the list of preferred disposal options in the solid waste hierarchy, the town adopts an ambitious source reduction program to decrease its waste stream by 200 tons per year, or 10 percent.

The major business in the community, a shampoo manufacturer, is asked to consider using less packaging for its shampoo bottles and to identify pollution prevention opportunities in its manufacturing process. This will reduce the amount of waste consumers throw out and minimize the amount of discarded and toxic material resulting from the production process. The company also decides to initiate an office paper recycling program, and a ìbuy recycledî purchasing policy in their administrative offices.

Consumers (both in households and in businesses) are encouraged to shop selectively, avoiding disposable goods, toxic products, and excess packaging. The area supermarkets begin to sell shopping bags to encourage customers to purchase and use their own bags in the market. Some citizens write to the Direct Marketing Association in New York to request the removal of their names from junk mail lists. (Mail Preference Service, Direct Marketing Association, Inc., P.O. Box 9008, Farmingdale, NY 11735-9099)

Next, the town takes an inventory of what can be recycled in its community. They calculate that they can realistically recycle close to 30 percent of their waste stream, or 600 tons of paper, glass, metals, plastic, drink boxes, and leaf and yard waste a year. Carneysville joins forces with neighboring communities to form a regional recycling committee. A private contractor, attracted by the large projected volume of recyclable materials generated by the towns, constructs a regional processing center, a Materials Recycling Facility (MRF). The communities sign a contract to deliver their recyclable newspaper, glass, metal, and plastic to the facility for processing and subsequent sale.

Residents participate in the new recycling program by separating their paper, glass, metal, drink boxes, and plastic into specially marked containers. The remaining nonrecyclable trash is disposed of as usual in the trash bin.

The town also initiates a comprehensive leaf and yard waste composting program. During the fall and spring, the town provides curbside collection service. In addition, citizens can bring in their materials by car or truck. This organic yard waste is put in large piles. Through the composting process, microorganisms break down the materials into a nutrient-rich, soil-like substance called *humus*, which is used by the town for landscaping.

The town conducts two household hazardous waste collection days each year for materials that cannot be safely disposed of by conventional methods. These materials include drain and septic tank cleaners, nail polish, pesticides, medicines, and paint. The town initiates a toxics reduction campaign to educate consumers about the dangers of many household products and to offer consumers environmentally sound product alternatives.

Of the remaining 1,200 tons of refuse, the town estimates that 1,000 tons, or 50 percent of the total municipal solid waste generated, can be burned at a neighboring combustion facility. Carneysville negotiates a flexible contract with that facility that allows the town to adjust the tonnage it provides for burning based on its recycling rate.

The town is left with 200 tons of waste that cannot be reduced, recycled, or burned. In addition, there are approximately 100 tons of residual waste from the recycling facility and incinerator combined. Of these 300 tons of waste that are left, the incinerator ash will go to the nearby monofill that accepts only ash. The rest of the waste will go to the town landfill.

The result: The amount of waste being landfilled in Carneysville has been significantly reduced by establishing an integrated solid waste management program.

ENDNOTES

THEN AND NOW

THEME:	Our waste stream has changed over time, reflecting technological advances, increased wealth, and changes in social behavior.
GOAL:	Students will understand that changes in the composition of the waste stream depend on our habits and lifestyles.
METHOD:	Research and completion of worksheet
SUBJECTS:	Language arts, social studies
SKILLS:	Analyzing, comparing, researching
MATERIALS:	"Then and Now" worksheet
TIME:	1 hour, plus additional time for research

GETTING STARTED

Ask students how life today differs from life in the 1800s. How would these differences affect the kind and amount of waste produced?

PROCEDURE

1. Ask students to make a list of items they use every day (e.g., kitchen appliances, clothing, tools, machines, types of transportation, food).

2. As a class, go over the students' lists. Do any patterns emerge? What kinds of lifestyles require these products? What do these products tell you about our priorities?

3. Have each child pick one item from their list and research its equivalent from one or two hundred years ago. Have students complete the "Then and Now" worksheet and draw pictures or construct an artifact of their item for a class display.

4. Discuss the differences between the products used during each time period. Ask the class: What do the products tell you about the lifestyles and the way people spent (or spend) their time during each time period? Can you tell what was (or is) important to the people in each time period? How might these differences affect the generation and disposal of solid waste?

EXTENSIONS

1. Have the students, individually or in groups, invent an alternative to a modern convenience that uses few, if any, nonrenewable resources, is designed to last a long time, and will not adversely affect the environment when its useful life is over.

Source: Adapted from AVR, *Teacher's Resource Guide*

THEN AND NOW

Worksheet

NAME OF YOUR ITEM____

NAME OF ITS HISTORICAL EQUIVALENT____________________________

1. Answer the following questions for your item and its historical equivalent.

   a. Is it made from natural or synthetic components?
   NOW:

   THEN:

   b. Is it made from renewable or nonrenewable resources?
   NOW:

   THEN:

   c. Does it require energy from renewable or nonrenewable resources to operate?
   NOW:

   THEN:

   d. Does it last a long time or is it disposed of quickly?
   NOW:

   THEN:

   e. Is it hand crafted or mass produced?
   NOW:

   THEN:

   f. Is it something you could do without or something you consider necessary?
   NOW:

   THEN:

   g. Is it biodegradable or nonbiodegradable?
   NOW:

   THEN:

   h. Does it contain any hazardous materials?
   NOW:

THEN:

i. Is it necessary for survival or is it a convenience?
NOW:

THEN:

2. List some "luxuries" from the past that are considered necessities today.

3. What changes in lifestyle would result from the following:

   a. The loss of a nonrenewable resource

   b. A drastic increase in the price of a nonrenewable fuel

   c. Irreparable damage to a renewable resource (e.g., groundwater contamination, depletion of forest reserves, animal extinction)

Source: Reprinted with permission from AVR, *Teacher's Resource Guide*

UNDERSTANDING PACKAGING OVER TIME

THEME:	Our culture encourages the use of disposable products and packaging.
GOAL:	Students will learn that disposable products and excess packaging create more waste than reusable or recyclable products do.
METHOD:	Reading and comparing products and packaging
SUBJECTS:	Language arts, social studies
SKILLS:	Analyzing, comparing, critical thinking
MATERIALS:	*Ox Cart Man* by Donald Hall; other books depicting packaging and products from different cultures or time periods; one of the following books depicting products of today: The Wright Group Big Books (*To Market, To Market*; *What's for Lunch?*; *I Want Ice Cream*) or The Rigby Big Books (*Breakfast in Bed*; *Green Bananas*)
TIME:	1 week

GETTING STARTED

Ask the students what the function of packaging is. Did people living during the Colonial period need packaging? Did they use the same kind as we do?

PROCEDURE

1. Read aloud or have students read the *Ox Cart Man* and discuss the following questions: What is packaging? What is it used for? What did the family in the book use for carrying and holding food and other items? What products did they buy? What resources were used to make those products? What did they do when something was broken, used up, or worn out?

2. Have the class read one of the stories depicting home life today. Discuss the same or similar set of questions.

3. As a class, compare the two books. How does our lifestyle differ from that of Colonial Americans? How are they the same? What kinds of waste might Colonial Americans have had more of than modern Americans? What kinds of waste do we have more of? Why are so many of our products and packages designed for short-term use and quick disposal?

EXTENSIONS

1. Have the students interview a parent, grandparent, or another adult about what they used for products or packaging when they were children as compared to today.

2. Plan a "no-trash" lunch using old fashioned packaging such as baskets, tins, and cloth napkins. Compare packaging to what we typically use today.

Source: Kristen Walser

IF TOYS COULD TALK

THEME:	Over the past century the items we use have changed significantly, as have the nature and composition of our waste.
GOAL:	Students will understand how the products we use today differ from those used by our parents and grandparents.
METHOD:	Interviewing and discussion
SUBJECTS:	Language arts, social studies
SKILLS:	Analyzing, comparing, interviewing
MATERIALS:	Pictures or examples of antique toys and modern-day toys
TIME:	2 hours, plus additional time for interviews

BACKGROUND

Most products, including toys, have changed significantly over the years. At one time most toys were made from natural materials such as wood. Handmade country toys like whirligigs, bean shooters, yo-yos, and tops were very popular. Over time, commercially manufactured toys such as wooden Lincoln Logs and Tinker Toys became available. In the 1960s, plastic toys began to dominate the market, and the demand for hula hoops, frisbees, Lego, toy guns, and plastic models increased steadily. Today, battery-operated and electronic toys, along with video and computer games, are quite popular. Changes in the way toys are made, in what they can do, and in the materials used to produce them reflect changes in our society.

GETTING STARTED

Make a list of the students' favorite toys. What are most of the toys made of?

PROCEDURE

1. Ask the students if they have had a favorite toy that didn't last very long. What happened to it? What was it made of? Ask students to bring in toys that are broken or to be thrown away. What are they made of? How long did they last? Are there any patterns or similarities between the broken toys? Discuss how some of these toys could be redesigned to last longer. How might these toys be fixed or made into new toys?

2. Have the students interview an older person about toys that were available when they were children. Another option is to invite a senior citizen to class for a group interview or to take a field trip to a nursing home or senior citizen center. Have the class develop a list of questions that the students might ask the person they decide to interview. Questions could include:

- What was your favorite toy when you were little?
- How many toys did you have? What were they made of?
- Who made them? Where did you get them?
- How long did they last? Could they be fixed if they broke?
- Would it have been cheaper to fix an old toy or buy a new one? Why?
- Could you fix a broken toy at home, or did someone else have to fix it?

- If a broken toy could not be repaired, what did you do with it?
- How are the toys sold today different from those that you had?

3. Have the students answer their own questions. Discuss the differences between their answers and those of the people they interviewed. Ask the students to make some generalizations about their lives and those of their ancestors. What do these differences imply? How might these differences affect our natural resources?

EXTENSIONS

1. Take a field trip to a museum or a historical society to look at their old toy collection.

2. Find out how some old toys were made and make them in class. Students could also invent new toys made out of natural materials.

3. Have each student choose to research and write a report about toys that were popular in a different time period or culture (e.g., Native American toys, Egyptian toys).

Sources: Adapted from AVR, *Teacher's Resource Guide*; Wisconsin, *Recycling Study Guide*

DECADES OF DISPOSAL: THE GREAT DEBATE

THEME:	Trash disposal methods have changed over the past 250 years.
GOAL:	Students will evaluate how solid waste disposal methods have evolved to reflect new technology and changes in the types of waste being generated.
METHOD:	Research and debate
SUBJECT:	English, science, social studies
SKILLS:	Analyzing, public speaking, researching, role playing
MATERIALS:	None
TIME:	One class period, plus additional time for class debates

GETTING STARTED

As a class, develop a list of factors that might influence the kinds of trash disposal methods employed.

PROCEDURE

1. Have the students research population growth in Massachusetts since 1650. Discuss the relationship between increased human population and the amount of solid waste being produced. How might the amount and composition of solid waste be influenced by changes in lifestyle? What impacts have increased numbers of people and the amount and complexity of the waste stream had on the environment?

2. How have disposal methods changed over time? Why? (Some reasons include changes in waste stream composition, technological progress, and new knowledge regarding the environmental impacts of waste and particular disposal methods.) Point out that the way we dispose of our waste has evolved in response to changes in our society.

3. Divide the class into small teams. Assign each group a time period and have them research trash disposal method(s) used in Massachusetts during that era. Choose time periods that include or follow a major breakthrough in solid waste technology, a social or scientific discovery, or the passage of new legislation. Students should explore the impetus for the transition, disposal methods used before and after the change, and the pros, cons, and environmental impacts of these methods.

4. Have each group present a debate of the issues surrounding solid waste disposal from their era. The facts used in the debate should reflect the information and technology available at that time. Each student in the group should play a different role representing a character in their time period. For example, characters in a Colonial period debate might include a town father, a store keeper, a farmer, a doctor, and a person who lives in town. Characters involved in the era surrounding the passage of the Bottle Bill might include a supermarket manager, an environmentalist, a legislator (for and against the Bottle Bill), a state resident, a liquor store owner, etc.

5. Debates should be presented chronologically. At the end of each debate, initiate a short class discussion to summarize and record the key points. At the conclusion of all the debates, copy and distribute the lists of key points. Students will have created a Massachusetts Solid Waste Disposal history book.

EXTENSIONS

1. Have each group research a waste disposal method used today (source reduction, recycling, composting, combustion, landfills), and stage a class debate on the pros and cons surrounding each method. Explore the validity of each method for particular types of waste. Discuss the rationale behind the Department of Environmental Protection's prioritization of these methods. Introduce the concept of Integrated Solid Waste Management and discuss the importance of combining the various methods to suit the environmental and financial situations in the Commonwealth.

TRASH THROUGHOUT THE AGES

THEME:	The composition of our trash differs from that of our ancestors.
GOAL:	Students will gain an understanding of how our use of natural resources and generation of waste have changed over time.
METHOD:	Poster or essay with discussion
SUBJECTS:	Art, science, social studies
SKILLS:	Critical thinking, inferring, researching
MATERIALS:	Construction paper; pictures
TIME:	1 hour

BACKGROUND

Looking back into the lives of previous generations reveals many interesting facts about how their lives were different from those we live today. Not only did people make do without the many technological advances we now take for granted, but they generated less waste by reusing and recycling many items (even if they didn't call it by those names). Comparing our lifestyles and habits to those of past generations reveals much about how modern society lives and suggests ways we could reduce our use of natural resources and the amount of waste we generate.

GETTING STARTED

Have the students list some modern conveniences we have today (e.g., frozen foods, disposable diapers, etc.) and what their ancestors might have used instead.

PROCEDURE

1. Divide the class into small groups and assign each a different time period in American history (e.g., Pre-European or Arrival of the Pilgrims, Colonial Settlement, The California Gold Rush, World War II). Have each group research its time period and make a poster illustrating the kinds of trash items they would have generated then. Each group should explain its poster to the class. What kinds of things can you tell about a culture by examining its waste? What do the differences in trash indicate about the lifestyles of the people living then?

2. Make a time line and mount the posters at the appropriate period. Have students write an essay on how and why the materials Americans throw away have changed over time.

3. Ask the class what people did before the convenience products we use today (e.g., disposable diapers, scotch tape, microwave ovens, plastic wrap, plastic soda bottles) were available. Give each student a card with the name of an object we use today and have them come up with an alternative product used in a different time period but which does the same thing. How would the waste generated by the alternative differ from that generated by the product used today?

EXTENSIONS

1. Have the students interview their parents, grandparents, or other adults to find out how the products they used as children, and the type and amount of trash they generated, are different from today.

2. World War II was a period of full-fledged recycling in the United States. Have the students research what types of things were recycled and write an essay on how this affected the amount and type of waste being generated. Why have things changed?

3. Tell the students they are archaeologists from the Year 3000 and have discovered an old landfill from the Year 1990. What sorts of items would they find? What conclusions could they draw about our society from looking at its trash?

4. Have the students (individually or in groups) select a foreign country and research the amount and types of trash it generates. Have students report back to the class and discuss how American society and habits differ from those in other countries. What can different countries learn from one another?

Source: Adapted from AVR, *Teacher's Resource Guide*

SECTION III

SOLID WASTE DISPOSAL METHODS

SOLID WASTE DISPOSAL METHODS

Source Reduction

What is source reduction?

Source reduction refers to industry and consumer practices that reduce the quantity and toxicity of waste generated. While industry can reduce waste and pollution from production processes, consumers can purchase products that are durable, reusable, less toxic, less resource intensive, or have less of a negative impact on the environment during use.

Frequent stylistic and technological changes in our society have increased the amount of waste we produce. Products deliberately designed for single or very limited use before disposal contribute to our throw-away lifestyle. Reducing the amount of trash produced will require changes in the attitudes and behaviors of most citizens. Product manufacturers and consumers must assume joint responsibility for their waste generation and make changes in production design practices and in purchasing decisions.

In response to the high cost of solid waste disposal and the overuse of nonrenewable resources, government officials, industry representatives, and consumers are devising and implementing strategies to reduce packaging. The following strategies will help to achieve source reduction of packaging waste:

- Reducing the total volume of disposable packaging material generated for domestic, commercial, industrial, and government use.

- Reducing the negative impacts of packaging waste disposal by changing to less toxic and more environmentally benign packaging material.

Source reduction also involves efforts by industry to reduce the amount of environmentally harmful ingredients contained in household products. Solvents found in paints, paint strippers, nail polish remover, and some cleaners evaporate and can react with sunlight to create smog. Some state governments are considering restrictions on the content of solvents in consumer products as a means of fighting smog. Drain, toilet, tub, and tile cleaners, and other toxic chemical products flushed down the drain during normal use can harm septic systems, sewers, and sewage treatment systems. Chemicals discharged from these systems can contaminate sewage sludge, rivers, lakes, and oceans, harming wildlife and natural ecosystem functioning.

Educational programs to inform and motivate consumers are critical to the success of any source reduction program. We can make choices for the environment rather than for our personal convenience. It is not always easy to change our attitudes and behaviors, but the consumer choices we make today will have a direct effect on the quantity of waste we must dispose of tomorrow.

Manufacturers provide some of the information that consumers need to make responsible environmental choices right on product labels. This product information often includes percentage of pre- and post-consumer recycled content; the technical recyclability of a product (some items can technically be recycled, yet there may be no collection of this item in your area); and the proper use, storage, and disposal methods. Read and compare labels to select the least wasteful and the most environmentally safe products.

How can the average consumer practice source reduction?

The cumulative effects of individual actions can have a significant impact on the amount of waste we generate as a society. The following actions are ones that individual consumers can take in their everyday lives, and are ones that will help reduce the amount of waste generated in their own community and beyond.

Select Products Carefully

- Consider the environmental impact of each purchase you make. The product label often gives information about the productís ingredients, use, storage, and disposal. What is the product made of? Is it safe for the environment? Can it be reused or recycled? Is there a safer alternative product or type of packaging? Do you really need the product or its excess packaging?

- Be picky about packaging. At the store, reach for the product packaged in materials that you can recycle in your community. ‘Biodegradable’ plastic bags, now widely offered at supermarkets, merely break up into smaller pieces of plastic under special conditions and are not truly biodegradable.

- Avoid overpackaging. If the packaging isn’t necessary to protect the product, or if it’s simply eye-catching, buy the less packaged alternative. It will probably cost less too.

- Avoid disposables. Don’t buy products manufactured expressly for limited use, such as disposable razors and lighters, or plastic or paper plates. Do buy items designed for reuse: thermos jars, metal razors, cloth napkins, and sponges.

- Buy in bulk. Avoid overpackaging and save money too. Bring your own container with you to the store and buy non-food items in bulk rather than the pre-packaged items. Massachusetts prohibits the use of your own containers for purchasing food items in bulk. Store brands and generic goods often have less packaging than other brands.

Reduce Waste From Fast Food

If you are a regular take-out patron, bring your own thermos or cup for beverages. If you are buying one product from a fast food restaurant and do not need a bag, ask not to be given one.

State Your Views

Talk to the store manager about your product and packaging preferences. Suggest that your grocer sell strong shopping bags or string bags designed for reuse. Encourage in-store recycling programs. Educate fellow consumers. Patronize businesses that offer recyclable products, less packaging, and the opportunity to buy in bulk. Write or call your state and federal officials to lend your support to legislation that favors recycling and reduces unnecessary and nonrecyclable packaging.

Reuse And Repair Things

When you no longer need clothing or household items, consider giving them to charity or a consignment shop. Don’t discard items if they can be fixed. By patronizing neighborhood repair shops, you will help the local economy.

Compost Food And Yard Materials

Feed your garden and it will feed you. The Department of Environmental Protection’s Division of Solid Waste Management has a free brochure about backyard composting. Your local Department of Public Works has a video on grass clipping management entitled *Doním Trash Grass* and your local library has a video on how to compost, *Turning Spoils into Soils*. (Contact the DEP if you are unable to locate either video.)

Teach Children To Practice Waste Reduction

Children may be highly susceptible targets for the lure of overpackaged goods, but they are quick learners and we can teach them to do it right from the start.

Source: Adapted from City of Berkeley, *“PRECYCLE” Campaign*

Recycling

What is recycling?

Recycling is the conversion of discarded material into useful commodities or, put simply, turning trash into new products. Recycled material is reprocessed to be used in place of, or in addition, to virgin (new) materials in the manufacturing of new products. Materials that are commonly recycled include newspaper; office paper; corrugated cardboard; glass, metal and plastic containers; food wastes; and leaf and yard wastes. Less commonly recycled materials include batteries, aseptic packaging (drink boxes and gable top containers), and motor oil, for example.

Although recycling will not solve all of our solid waste problems, it is one means of handling significant portions of our waste stream with relatively little detriment to the environment.

How does recycling work?

Separation/Collection

Remanufacturing
Processing

The three arrows of the standard recycling logo represent the three components of the recycling process:

- **Separating** recyclable products from other trash and **collecting** it.

- **Processing** (e.g. cleaning, shredding) such products so that they can be substituted for virgin raw materials at manufacturing plants.

- **Remanufacturing** recyclable material into useful commodities, usually as part of other products (e.g., cardboard can be reused in packaging, or glass processed to make reflective paint or other glass).

Step One: Separation and Collection

Residential recycling programs are either run by the local government or contracted out to private companies or nonprofit organizations. Commercial businesses are usually responsible for setting up their own recycling collection programs. Generally, the most effective programs are those that operate like the current trash collection systems as much as possible. Residential and commercial programs are typically one—or a combination—of the following four basic types.

- **Household Separation/Curbside Collection**: This type of program is appropriate for communities that have curbside trash collection. Individual households are encouraged (or required by ordinance) to separate certain materials (such as bottles, cans, and newspapers) from the trash and put them at the curb for collection. Materials may be placed in special containers or bagged separately from ordinary trash.

- **Drop-off Centers**: These are designated collection centers where people bring recyclables. This is the most common form of recycling in rural areas.

- **Buy-Back Centers**: These centers pay consumers for bringing in recyclable materials such as deposit cans and bottles.

- **Commercial Collection**: Private haulers collect recyclables from businesses, offices, institutions, schools, and industries that, often, are not served by municipalities. Commercial customers often generate large quantities of one type of waste, such as cardboard or white paper.

Sample Massachusetts Municipal Recycling Program

The City of Somerville has a recycling program that combines several recycling methods. Somerville, with a population of more than 76,000 people and covering 4.1 square miles, has had a drop-off recycling program since 1989 and a city-wide curbside program since 1993. White paper recycling in municipal buildings has been ongoing since 1990. As of July 1994, the following materials were accepted curbside: clear and colored glass; steel cans; aluminum cans, foil, and trays; #1 (PETE) and #2 (HDPE) plastic bottles; milk and juice cartons; drink boxes; corrugated cardboard; telephone books; newspapers with all inserts; magazines; junk mail; and office paper.

In addition to the curbside program, Somerville offers used motor oil and tire recycling, household hazardous waste collections, and a drop-off recycling center which has been opened to businesses at no charge.

Step Two: Processing Recyclables

Recyclables are processed to prepare them for market. Processing occurs after the recyclables have been collected and taken to a sorting facility. Processing involves a variety of steps, usually beginning with sorting and segregation by material type or color, and removing contaminants (e.g., the metal rings on glass bottles). Materials may then be crushed, shredded, flattened, or baled depending on industry requirements and shipping considerations (called *market specifications*). Market specifications can include instructions on:

- How to prepare materials: e.g., bale them, crush them, provide them loose.

- How to sort materials: e.g., separate clear #2 HDPE milk jugs from the color HDPE household containers.

- What contaminants to remove: e.g., remove plastic bags from shipments of newsprint.

Each industry has its own specifications. Materials that do not meet market specifications for one reason or another are difficult to sell, and may end up in either the landfill or the incinerator. Usually the return or disposal of a rejected load must be paid for by the sender.

Because processing is a specialized activity, and because end-markets tend to be large industrial factories, recycling is often more cost-effective when processing occurs on a regional basis. Regional processing facilities can accommodate large quantities of material and can assure fairly standard quality of output. After materials have been processed, they are marketed and transported to their next destination.

There are three levels of recycling:

- **Primary**: A closed-loop system in which a product is recycled into the same type of product over and over. Examples include glass bottles that are remanufactured into glass bottles and steel cans that are remanufactured into steel cans.

- **Secondary**: This type of recycling involves remanufacturing a recycled item a few times into the same type of product until it can no longer be remanufactured into the same product. For example, every time paper is recycled, its fibers are shortened. After recycling paper several times, the fiber can no longer be used to make high-grade paper products, so it is used to make a "secondary" product, such as toilet paper, that cannot be recycled again.

- **Tertiary**: This type of recycling uses materials that can only be recycled once. Sometimes a product that has a short lifespan, such as a ketchup bottle, is remanufactured into a product with a longer lifespan, such as plastic lumber.

Step Three: Remanufacturing and Marketing—Closing the Loop

Recycling is not complete until the collected materials are remanufactured into desirable products and resold as new goods. Recycled materials removed from the municipal waste stream for remanufacturing are called *post-consumer* materials. Materials that are left over from the manufacturing process and product over-runs that are salvaged for reuse in the manufacturing process are called *pre-consumer* materials. These pre-consumer materials are also called *millbroke.*

Buyers of processed post-consumer materials are usually large industrial manufacturing firms that use the recycled materials as a substitute for virgin raw materials. Table 3-1 lists several examples of products that can be manufactured with recycled materials. Also listed are the natural resources those recycled materials displace.

Table 3-1. Common Products and Their Recycled-Material Feedstocks

END PRODUCT	VIRGIN RESOURCE FEEDSTOCK	RECYCLED MATERIAL FEEDSTOCK
Boxboard	Pulp from trees	Newspaper
Glass	Sand, soda ash, limestone	Glass
Aluminum	Bauxite ore	Aluminum
Steel	Iron ore, coal	Steel cans
Plastic	Resins from oil and natural gas	Plastic

Processing is the key to integrating recycled materials with virgin materials for remanufacture. End markets need uncontaminated, high quality materials that can compete with virgin materials. Recycled materials compete with well-established sources of virgin materials. That is why quality control in processing must be high. Marketing recycled materials requires identifying specific companies that can use the materials to make new products. Once these companies are found, the recycled materials are priced so that the buyer can afford to use them instead of the traditional supply of virgin raw materials.

How much does recycling cost?

One misconception about recycling is that it always generates revenue. This premise was based on the past when relatively small amounts of materials were being collected, primarily in volunteer drives. This type of recycling was not done for waste management purposes but to raise funds for community programs.

Today recycling is a means by which millions of tons of materials are managed. Extensive labor and equipment are required to collect, process, transport, and sell such large quantities of materials. While there will be revenues from the sale of some recycled materials, communities cannot, and should not, count on those revenues to entirely offset the costs of recycling.

While communities generally will not realize a net profit from recycling, they may realize savings in the overall cost of solid waste management if recycling is less expensive than combustion or landfilling. If a town can pay less per ton to recycle than to dispose of its waste via combustion or landfilling, the town can see a net savings per ton of material recycled. This savings is referred to as *avoided cost*.

How is the Commonwealth approaching regional recycling?

The Springfield Materials Recovery Facility

In January, 1990, the Commonwealth established a large-scale regional processing plant—a materials recycling facility (MRF) in Springfield, Massachusetts. The MRF accepts large quantities of recyclable materials and upgrades them into high quality feedstocks that provide economically-attractive alternatives to virgin industrial feedstocks.

The MRF is one of the largest projects of its kind in the country. It serves approximately 100 communities in the five western counties, or approximately 1,000,000 residents. DEP's recycling program in western Massachusetts involves a cooperative effort between the state and local municipalities. Communities bringing their recyclables to the state's 240-ton-per-day plant pay no tipping fee; they pay only to transport their recyclables to the facility.

A recent contract option allows towns to receive payment for their recyclables. (For more information call DEP at 617-292-5988.) In addition, the state provides many of these communities with household recycling containers, specialized recycling vehicles to perform curbside pickup, and/or large roll-off containers for collection of recyclables at drop-off recycling centers.

To participate in using the MRF, communities are required to pass mandatory recycling ordinances, collect recyclables from residences and deliver them to the MRF, and conduct ongoing public education activities. Communities may have a representative serve on the MRF Advisory Board with the DEP to oversee the MRF operations. The Advisory Board also assists towns in improving their recycling programs and increasing their recycling rate, and serves as a vehicle for communication between DEP and the towns on materials handled, operating policies, and education.

The MRF program is simple and is designed to be compatible with the trash disposal system residents currently use. Residents separate their recyclables and place them in the portable container provided by DEP. In communities where citizens have curbside collection, the recycling bin is set out for pickup on the designated collection day. In communities where residents must bring their trash to a landfill or transfer station, residents deposit recyclable materials in large containers at their recycling depot, usually nearby the landfill.

The MRF is operated by private recycling companies under long-term contracts with the state. The current private operator is responsible for processing the recyclables and marketing them.

The MRF provides the needed link between community collection of recyclable materials and use of recycled materials by manufacturers. It produces consistent quantities of high-quality materials for use in place of or in addition to virgin materials in manufacturing.

Other Regional Recycling Activities

In addition to western Massachusetts, several groups elsewhere in the state are exploring regional recycling strategies. Long-term possibilities being investigated include extensive cooperative market programs, regional drop-off stations, regional efforts to collect hazardous or difficult-to-manage wastes, and development of shared, multi-community MRFs.

What is the Commonwealth doing to increase recycling?

Identifying Barriers to Recycling

While recycling programs and markets have grown over the past few years, there are still barriers to increasing recycling that need to be overcome. DEP has identified the following barriers to recycling:

- **Recycling market uncertainty**: In recent years, recycling programs have grown faster than demand for recyclable material, causing the prices paid for recyclable materials to fluctuate.

- **Transportation costs**: Some municipalities must transport their recyclables over long distances to recycling facilities and industries. Many regions of the state have no means to consolidate their recyclables at transfer stations to make them cost-effective to collect and transport.

- **Insufficient public education**: Businesses and residents need to be educated about what materials are recyclable, and what recycled-content products are available for purchase.

- **Poor regional cooperation**: Cities and towns must work together to compensate for the lack of strong regional government in some parts of the state.

- **Waste disposal contracts that discourage recycling**: Many communities have signed long-term ìput-or-payî contracts with combustion facilities, which commit them to sending a minimum guaranteed amount of their waste for disposal. When these towns remove recyclables from their waste, they often reduce the amount of waste to a level below the minimum guaranteed tonnage. Communities may be fined for these tonnage shortfalls.

- **Remaining capacity at unlined landfills**: Although the state is closing all unlined landfills in the near future, the several unlined landfills still operating in the state provide disposal space that is cheap but, often, polluting. When these unlined landfills are shut down, new disposal facilities will be more expensive, providing municipalities with more of a financial incentive to recycle.

- **Not enough buying recycled**: State and local municipalities need to set an example for their communities by purchasing products made from recycled materials. This may involve rewriting purchasing policies or passing an ordinance to mandate this change.

Addressing Barriers to Recycling

To address many of these problems, the Commonwealth developed a Ten Point Recycling Plan to expand recycling and composting in Massachusetts. Funding for the strategies, priorities, and proposals outlined in the Plan comes from the Clean Environment Fund (money from unredeemed bottle deposits across the state). The Ten Point Recycling Plan is as follows:

Ten Point Recycling Plan

1. **Municipal Recycling and Composting Equipment Grants**: These grants help cities and towns acquire equipment and educational materials for the start-up or expansion of recycling and composting programs.

2. **Public Education Recycling Campaign**: Funds are given to cities and towns to educate businesses and residents about recycling and composting opportunities available to them.

3. **Household Hazardous Waste Program**: This program targets the most common hazardous products for which recycling options already exist. Funds are granted to communities to establish facilities for operating used paint and used oil recycling or swap programs.

4. **Recycled Products Procurement Program**: This program encourages government, businesses, and individuals, to ìbuy recycled.î Funds are used to increase state government purchases of recycled products. The state Department of Procurement and General Services is researching the availability of recycled products and educating buyers about establishing a purchasing program for recycled products.

5. **Municipal Transfer Station Grants**: These grants are given to cities and towns for the construction of waste and recycling collection facilities. Transfer stations enable towns to consolidate solid waste and recyclables for a more cost-effective transfer to processing facilities.

6. **Municipal Guaranteed Annual Tonnage Recycling Assistance**: This program directly addresses the problem of towns being penalized for reducing their waste below the minimum tonnage guarantee to combustion facilities under ìput-or-payî contracts.

7. **Recycling Research and Development**: Funds are provided for studies at the University of Massachusetts focusing on obstacles to increased plastics recycling.

8. **Higher Education Recycling Initiative**: Funds support solid waste research at several higher education institutions with environmental programs.

9. **Recycling Investment Loan Program**: This program stimulates the development and expansion of recycling and composting industries by providing technical and financial support.

10. **Springfield Materials Recovery Facility (SMRF) and the Cooperative Market**: The SMRF will provide a market ìsafety net," guaranteeing municipalities a market and a base price for collected recyclables. The MRF also serves to assure markets of a steady, reliable source of materials.

Commercial Incentives for Recycling

Commercial waste accounts for approximately half of the Commonwealthís solid waste stream. The DEP, working with trade associations, businesses, and nonprofit organizations around the state, helped establish WasteCap in 1994. WasteCap is a voluntary, statewide, nonprofit organization whose purpose is to educate and advise businesses and institutions on the benefits and processes of minimizing and recycling nonhazardous solid waste. The WasteCap program is modeled after similar programs in other New England states, where businesses take the lead in providing technical assistance to other businesses to minimize their wastes.

Composting

What is composting?

Composting is a natural process by which microorganisms break down organic materials such as kitchen, leaf, and yard materials into a soil-like substance called *humus*. Humus can be used to stabilize and enrich soil. In nature, this breaking down process can take a number of years, but under controlled conditions, with proper levels of moisture and air circulation, composting can take from as few as 2 weeks to 1 year.

The proper combination of temperature, oxygen, moisture, and organic materials produces the conditions needed for composting at a fast rate without offensive odors. The proper conditions allow a host of microorganisms to decompose the organic material. Bacteria and fungi are two types of microorganisms that are largely responsible for breaking down organic matter. During the eating and digesting process, these microorganisms break down organic matter into its basic elements—water, carbon dioxide, and humus. Other soil organisms, such as nematodes, mites, springtails, centipedes, and earthworms also contribute to the composting process by processing the organic matter as food.

What percent of the waste stream is compostable?

Approximately 65 to 70 percent of the municipal solid waste stream is composed of organic material such as food, paper, cardboard, wood products and by-products (paper sludge), and yard materials.[xxxviii] Leaf and yard materials (grass clippings, leaves, brush, and tree prunings) make up approximately 18 percent by weight of the household waste stream.[xxxix] They are more efficiently processed by composting than by landfilling or burning because of their bulk and high moisture content.[xl] Since yard materials consist of relatively clean, biodegradable materials, landfilling them simply wastes space and burning them wastes energy.

How does composting fit into the Commonwealthís plan for waste management?

Composting is a vital part of the Commonwealth's integrated solid waste management strategy. It offers significant environmental and economic benefits, including:

- A savings on waste transportation, management, and disposal costs because a heavy portion of the waste stream is pulled out at the source of generation.
- Reduced volume of waste to be incinerated or landfilled.
- Minimal negative environmental impacts.

- Production of beneficial material—humus—that improves the productive potential of soil.

What are the different types of composting systems?

Composting is a versatile process that can be done at sites of varying size, using a variety of materials, and with different levels of technology. Composting system types are as follows:

- **Home Composting**: A system in which residents compost food scraps and yard trimmings in their yard using a manufactured or home-made composting bin, or by making a free-standing pile. Households can reduce and convert their waste by as much as 50 percent by weight using this method.

- **Vermicomposting**: Another residential system that can also be done on a small or larger scale. Vermicomposting means composting with worms contained in an enclosed bin perforated for air circulation. Certain types of worms (red wrigglers) can eat and expel their own weight in organic material every day, so even a small worm bin can produce pounds of rich sweet-smelling compost. These worms cannot survive in freezing temperatures, so the bins must be maintained at temperatures between 40 °F and 80 °F.

- **Centralized Yard Composting**: A community program at a landfill, transfer station, or farm, where residents can drop off leaves and brush.

- **Municipal Solid Waste Composting**: A large-scale system run by public agencies or private businesses to manage MSW from homes and businesses. The organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant.

- **Co-Composting**: The simultaneous composting of two or more diverse organic waste streams. Co-composting systems are usually run by public agencies or private businesses to manage organic materials. As with MSW composting, the organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant. It is mixed with another organic component of the waste stream, such as paper or sewage sludge.

- **Institutional Composting**: A food scrap management system used by restaurants, markets, schools, institutions, and food processors. Food scraps are separated at the institution and composted either on-site at the institution or off-site at a farm or composting facility.

- **On-Farm Composting**: A farm-based composting system using farm equipment. The compostable materials can include farm materials such as yard trimmings and manure, or other items, such as paper products and wood scraps (shredded for bedding and composting). Farms can also accept food scraps from restaurants, institutions, food processors, and supermarkets. The organic waste from these sources may be composted or used as animal feed.

What are the state's future composting goals?

The least costly of all waste management technologies, composting may account for nearly half of the stateís municipal solid waste diversion by the year 2000. Organic materials including leaves, wood, food, paper, paperboard waste, and yard trimmings account for 67 percent of total MSW by weight.[xli] To achieve maximum diversion of these organic materials from the municipal solid waste stream, the Commonwealth employs the following hierarchy:

1. **Source Reduction**: Organic materials that have traditionally required collection and centralized processing can be composted at the source of generation such as homes and businesses. The state is working to promote home composting by providing towns with training and education materials for their residents. The state also subsidizes the cost of home composting bins made out of 50 to 100 percent recycled Massachusetts plastic and sold by towns to their residents. The DEP has also revised the Site Assignment Regulations for Solid Waste Facilities to exempt institutions and small businesses that generate and compost less than 2 tons per week of source-separated food scraps from solid waste facility permitting requirements. These simplified regulations also allow small operations such as farms to compost while complying with state regulations.

2. **Leaf And Yard Waste Composting**: Municipal leaf and yard waste composting programs have been established in 239 Massachusetts cities and towns, as of 1995.[xlii] Since April 1993, leaves, grass clippings, and brush (up to 1 inch in diameter), hedge clippings, and weeds have been restricted from disposal in Massachusetts landfills and incinerators.

3. **Municipal Solid Waste Composting**: Large-scale composting of either mixed solid waste or source separated degradable MSW has grown increasingly popular in the United States. The number of composting facilities in this country has doubled since 1991 to 21, most of which process and compost mixed municipal wastes. Since 1986, the Commonwealth has helped communities evaluate MSW composting options. Feasibility studies for Northampton, Franklin County, and the Southern Berkshires concluded that these projects are technically and economically feasible.

Combustion

What is a combustion facility?

Combustion facilities burn wastes to reduce their volume, thus conserving valuable landfill space. A 1,500-ton-per-day facility can typically achieve a reduction in waste of 75 percent by weight and 90 percent by volume.[xliii] Leftover ash is landfilled. The three technologies employed by the nine facilities in Massachusetts are mass-burn, refuse-derived fuel (RDF), and incineration. Mass-burn and RDF facilities are frequently referred to as waste-to-energy facilities because they convert heat from the combustion process into electricity.

There are six mass-burn facilities in Massachusetts. Mass-burn plants burn solid waste just as it is received at the facility. In this technology, the furnace is lined with a water-filled wall. The heat from the burning garbage turns the water into steam. The steam is then sent to a turbine generator where it is converted to electricity. The electricity is sold to a utility or neighboring commercial business to offset a portion of the cost of the combustion facility.

There are two RDF facilities in the state. The types of furnace and boiler used by these facilities to generate steam are different from those used in mass-burn operations. RDF facilities first separate out ferrous metals, such as steel and cast-iron, then shred the remaining trash into fairly small, uniform pieces. This trash is then burned. The separated metal is recycled. This pre-screening of the metals, combined with the shredding process, creates a more homogeneous and consistent fuel for burning.

There is one incinerator in Massachusetts. This type of combustion technology simply burns trash without producing electricity. Incinerators have been operating in Massachusetts since the late 1800s, while mass-burn and RDF facilities are more modern technologies and have been operating since 1975.

Combustion facilities burning MSW can produce a number of pollutants, along with two types of ash. Air pollutants that can be produced include carbon monoxide, sulfur dioxide, and fine particles containing heavy metal compounds (e.g., from lead and cadmium). The release of these pollutants is prevented in modern facilities by air pollution control devices, though these do not always operate at maximum efficacy. The two types of ash produced are bottom ash and fly ash. Bottom ash is the unburned and unburnable matter that remains on the bottom of the combustion chamber after the waste passes through. It can contain heavy metals and other hazardous components. Bottom ash comprises between 75 and 90 percent of all ash produced. Fly ash is a powdery material that leaves the combustion chamber with the flue gases. Fly ash, which tends to have higher concentrations of certain metals and certain organic materials, is captured by the air pollution control devices. These two types of ash need to be disposed of properly to prevent the harmful substances in the ash from entering groundwater.

New standards for burn facilities in Massachusetts require additional air pollution control equipment to remove ash particles and gaseous materials from the air exiting the smoke stack. Massachusetts also requires that toxic ash residue from the combustion process be disposed of in monofills, landfills reserved exclusively for ash disposal. Under the Commonwealth's rules and regulations, a combustion facility must have a contract with a monofill for 20 years before it can receive a license to operate. These monofills are equipped with liners and leachate collection systems.

The Commonwealthís goal is to prioritize combustion over landfilling as a disposal option for nonrecycled waste. If 46 percent of the state's waste is being recycled by the year 2000, the state hopes to burn 50 percent and landfill the remaining 4 percent. In 1994, 34 percent of Massachusetts' MSW was disposed of by combustion.[xliv]

What is the future role of this technology?

Over the past decade the public has expressed increased concern over air emissions and the disposal of toxic ash residues. While major air pollutants and particulates have been significantly reduced by scrubbers and other air pollution control devices, heavy metals, acid gases, and organic compounds such as dioxins and dibenzofurans are still emitted into the air.

Combustion ash contains heavy metal particulates such as cadmium and lead, which are trapped by the air pollution equipment when trash is burned. The better the air pollution control equipment, the greater the concentration of metals in the ash. Operational handling requirements are becoming increasingly vigorous to protect workers and to ensure that ash is not released into the environment during its transfer from burn facilities to ash monofills.

Industry is presently researching potential uses for the ash residue, including its addition to concrete products for embankments, road-paving materials, pre-cast blocks, and other construction projects, as well as use as a landfill cover. Before state regulators certify such uses, however, these products must undergo further testing.[xlv]

Recycling competes with combustion because the higher-BTU components of the waste stream are paper and plastic. Most types of paper and many plastics are recyclable. Recycling is considered the most desirable end use of a product, so it should be the first management technique considered. Many communities in Massachusetts have signed long-term put-or-pay contracts with incinerators to provide a guaranteed minimum tonnage of trash at designated intervals. If the communities fail to send this minimum tonnage, they are fined. This discourages communities from reducing their waste stream through recycling and source reduction. In 1994, the state made a commitment to help communities change these contracts.

Landfills

What is a landfill?

A landfill is a site that is excavated and constructed for the disposal of solid wastes. Older landfills were located on pieces of land that were considered unsuitable for development, such as wetlands and gravel pits. These early landfills had no environmental controls to prevent the movement of the waste into the environment. The soil was thought to act as a natural—and adequate—filter.

After garbage is dumped into a landfill, it is spread into thin layers, compacted to the smallest volume, and covered with at least 6 inches of soil. A daily cover of soil prevents blowing litter and helps to maintain sanitary conditions.

Solid waste placed in a landfill undergoes some changes, but not as many as were once thought to occur. Most household waste is "entombed" in plastic bags, then placed in a landfill where virtually all light and oxygen are eliminated once the daily cover of soil is applied. Recent landfill excavations by archeologist William Rathje have turned up newspapers, food scraps, and other items showing little evidence of decomposition, having been neatly preserved for decades.[xlvi]

Landfills are not inert, however. Some of the processes taking place inside the landfill are:

- Anaerobic (in the absence of oxygen) decay of organic material, which produces landfill gases, primarily methane.
- Movement of moisture from the surface of the landfill through to the bottom. This liquid, called *leachate*, picks up decaying and toxic components of landfilled waste as it moves downward through the landfill.
- Escape of gases from the refuse, and lateral movement of the gases through the soil.[xlvii]
- Chemical oxidation of materials.

These changes are determined by the composition of waste, the amount of water, air, and sunlight entering the landfill, and the degree of compaction of the trash.

The engineering goal of modern sanitary landfills is to prevent leachate from contaminating the groundwater and to prevent the movement of methane gas into the surrounding communities. This is accomplished by installing impermeable barriers to isolate the disposed waste, and leachate and methane collection systems to transport the leachate and methane to a treatment area. The impermeable liners may be constructed of a nonporous clay material, plastic, or a combination of these materials. Collection pipes lie on top of this barrier layer within a drainage layer to remove leachate. Landfill construction costs, including clay, plastic liner material, drainage material, and labor range from $250,000 to $400,000 per acre.

What are some of the negative environmental impacts of landfills?

Groundwater Contamination

The principal environmental concern raised by landfills is the contamination of groundwater. Groundwater is found beneath most land surfaces and accumulates after precipitation percolates down from the surface. Geologists call this percolating process *groundwater recharge*, and the places where it occurs *recharge areas*. Once groundwater reaches a saturated or impervious layer underground, it begins to move slowly by the force of gravity through interconnecting surfaces until it reaches a discharge area, where it seeps or flows out into a wetland, spring, river, or pond to become part of the surface water.[xlviii] Because these areas are valuable elements of our environment, it is imperative that our groundwater not become contaminated.

Leachate is a combination of liquid generated from the decomposition of solid waste, and precipitation that has fallen on the landfill. A large amount of leachate can be created by precipitation that filters through landfills. For example, a 5-acre landfill with an average infiltration rate of 21 inches of precipitation per year could generate over 2.75 million gallons of leachate annually.[xlix] If substances such as paint products, household cleaning supplies, pesticides, batteries, or motor oil are present in a landfill, their harmful ingredients may be dissolved or suspended in the leachate. Contaminated leachate can vary in make-up depending on the garbage content of any particular landfill.

The rate at which leachate travels along the surface, contaminating tributary ponds and streams, or percolates downward toward groundwater depends on the grade of the land and soil composition. On Cape Cod, for example, the typical hydrogeologic conditions consist of permeable soils and high water tables. These conditions virtually guarantee that wastes deposited on the land will end up in the groundwater.[l]

Biological and chemical reactions in a landfill influence the composition of leachate. Mounds of refuse offer dark, warm environments attractive to bacteria. When organic compounds are broken down by bacteria, many of the simpler compounds that are formed are acidic. When these substances dissolve in water that seeps through a landfill, they make the water acidic. This increases the water’s ability to slowly oxidize heavy metals such as iron, copper, and mercury, adding concentrations of metals to the leachate.

If substances such as pesticides, cleaning products, or paints are discarded in landfills, the degree of contamination of leachate can increase. Products such as these contain synthetic organic solvents that can pollute the environment and threaten human health. Examples of organic solvents include toluene, acetone, benzene, vinyl chloride, and carbon tetrachloride.

As a landfill ages, leachate production and composition change. In general, most components of leachate become more dilute over time. Organic decomposition products are at their highest concentration during the first 3 to 5 years of leachate production, and decrease thereafter. Synthetic and petroleum-based organic solvents tend not to break down in landfills, but continue to be released for long periods of time. Similarly, the concentration of metals in leachate does not seem to decrease over time. Levels of metals and nondegrading organic solvents may need to be monitored even long after a landfill has been capped and closed.[li]

Methane Generation

Gas forms in landfills as a result of the decomposition of organic material. Landfill gas contains methane gas, which is flammable and explosive and can have undesirable environmental impacts. Landfill gas can move through refuse and surrounding soils to migrate away from the landfill. It has accumulated in buildings by entering through cracks, construction joints, sub-surface utility service openings, and almost any other weak spot in basement walls or building floors. Homes and businesses have been evacuated when explosive levels of methane were detected. Controlling landfill gas is a high priority when managing landfills because of the danger of explosion and fire.[lii]

If there is concern about landfill gas migrating off the landfill site, probes are installed into the ground to monitor gas pressure, migration patterns, and methane concentrations. If engineering controls are necessary, systems such as passive vents or gas pumping systems are employed.

Passive systems rely on natural pressure and convection mechanisms to vent the landfill gas to the atmosphere. A gravel-filled trench excavated around the outside of the landfill intercepts gas that is moving through the soil and vents it through the gravel to the surface.

Active gas collection systems remove landfill gas from the landfill or surrounding soils by pumping it out of the ground. These systems may provide migration control or recover methane for energy recovery purposes. Landfills that employ active gas collection systems are usually quite large in size or generate large quantities of methane. The Fresh Kills Landfill in New York, the largest landfill in the world, also has the largest methane recovery system in the world.

What happens to inactive and abandoned landfills?

The majority of currently active unlined landfills in Massachusetts will close before the year 2000 either because they have reached their capacity to receive waste or because of environmental concerns. An amendment to the Massachusetts Solid Waste Act of 1993 replaces the strict closure deadlines for landfills with a public process meant to determine if the landfill poses an immediate threat to the environment or public health. Each existing landfill was assigned an estimated closure date based on site capacity and permitted tonnage or on operating permit expiration. In October 1993, owners of unlined landfills were asked by DEP to submit a notification of their intent to operate beyond December 1993. As part of this notification, the owners conveyed the date on which their facility would cease operation.

Closure dates were then established by assigning either the date indicated by the owner, or a date based on the facilityís classification as a threat to the environment and public health, whichever came first. Those facilities classified as a significant threat are assumed not to be operating beyond 1995. Those classified as potential, little or no threat, or insufficient data to classify are assumed to close before the milestone year of 2000, with the "potential threat" facilities closing first.

Once a landfill is filled to capacity, the entire area used for solid waste disposal must be closed or "capped" with an impervious layer of material. This minimizes the amount of precipitation seeping into the landfill and, therefore, reduces leachate production. As an integral part of constructing the cap, vents are inserted into the landfill to allow gas from interior regions of the landfill to escape. Groundwater wells are drilled around the site to monitor the production rate and toxicity of the leachate. Similar to construction costs for a state-of-the-art landfill, proper closure is an expensive procedure, ranging from $125,000 to $140,000 an acre.

The post-closure phase of landfill management extends for at least 15 years. Post-closure monitoring insures that the integrity of the landfill's final cover, liner(s), and groundwater or gas monitoring systems are maintained. Once landfill settling and environmental dangers have been addressed, the former landfill site might be reclaimed as a recreational area, such as a park or ball field.

What is the future of landfilling in the Commonwealth?

The Commonwealth has set a goal of diminishing the use of landfills from 42 percent in 1990 to 4 percent by the year 2000.[liii] Instead of being a primary solid waste disposal source, landfills will provide capacity for materials that cannot be reused, recycled, composted or burned.

WISE USE OF PAPER

THEME:	Many of our daily habits are wasteful regarding the use of paper.
GOAL:	Students will recognize how much paper is wasted and how it accumulates over time.
METHOD:	Collecting and weighing paper, graphing the results
SUBJECTS:	Math, social studies
SKILLS:	Analyzing, comparing, measuring
MATERIALS:	Waste paper; two cardboard boxes; scale
TIME:	2 weeks

GETTING STARTED

Ask the students how much paper they think they use. How much do they think they waste?

PROCEDURE

1. Each day have the students place in boxes all paper that would normally have been thrown away. In one box, place paper that has been completely used (i.e., written on both sides). In the other, pile paper that has been only partially used or not used at all.

2. At the end of the day select a student to weigh each stack of paper and have the class graph the results.

3. Follow this procedure every day for a week and discuss the following: Were you surprised at the amount of paper that was wasted? What is the effect of this waste on our natural resources and landfills? How can people change their habits so that there is less waste?

4. Repeat the same activity for a second week. How different were the results? List on the board the different ways the students tried to conserve paper. Are there other items that are sometimes thrown away before they are completely used?

EXTENSIONS

1. Using the results obtained above, have the class determine how much paper it would waste in a month. In a year? How much paper would the class save in a month or a year if it reduced its paper consumption by one-half? By one-quarter?

2. Working in small groups, have the class list the paper products they use at home or at school. In a parallel column, have them list products that could be used in their place (e.g., dishcloths instead of paper towels, handkerchiefs for paper tissues).

Source: Adapted from Washington, *A-Way With Waste*

TRASH TO TREASURE

THEME:	Reusing materials before they are thrown away can conserve landfill space and natural resources.
GOAL:	Students will realize they can reduce the trash load by redefining waste as a potential resource.
METHOD:	Creating a class treasure chest
SUBJECTS:	Art, language arts, social sciences
SKILLS:	Creating, observing, making value judgments
MATERIALS:	Trash can; old box; scraps of fabric, yarn, paper, ribbons, etc.; egg cartons; glue; scissors
TIME:	45 minutes

GETTING STARTED

Does everything that we throw away have to be trash?

PROCEDURE

1. Fill the trash can with the various scrap items and explain to the class that these are things that would normally have been thrown away, never to be used again.

2. Have the children come up one at a time and ask them to select several items out of the trash can. Have students use these materials to create whatever they want—a picture, a sculpture, jewelry.

3. With the leftover materials decorate the old box to make it look like a treasure chest and have the students come up and place their new "treasure" in the chest.

4. Point out that the garbage can is now empty. The students have both reduced the amount of garbage that has to be disposed of and reused it to make something new.

EXTENSIONS

1. Read aloud the poem "Johnny." Ask the class to think of other items at school or home that could be reused instead of being thrown away. Have the students create drawings to illustrate these objects and how they would be used in new ways.

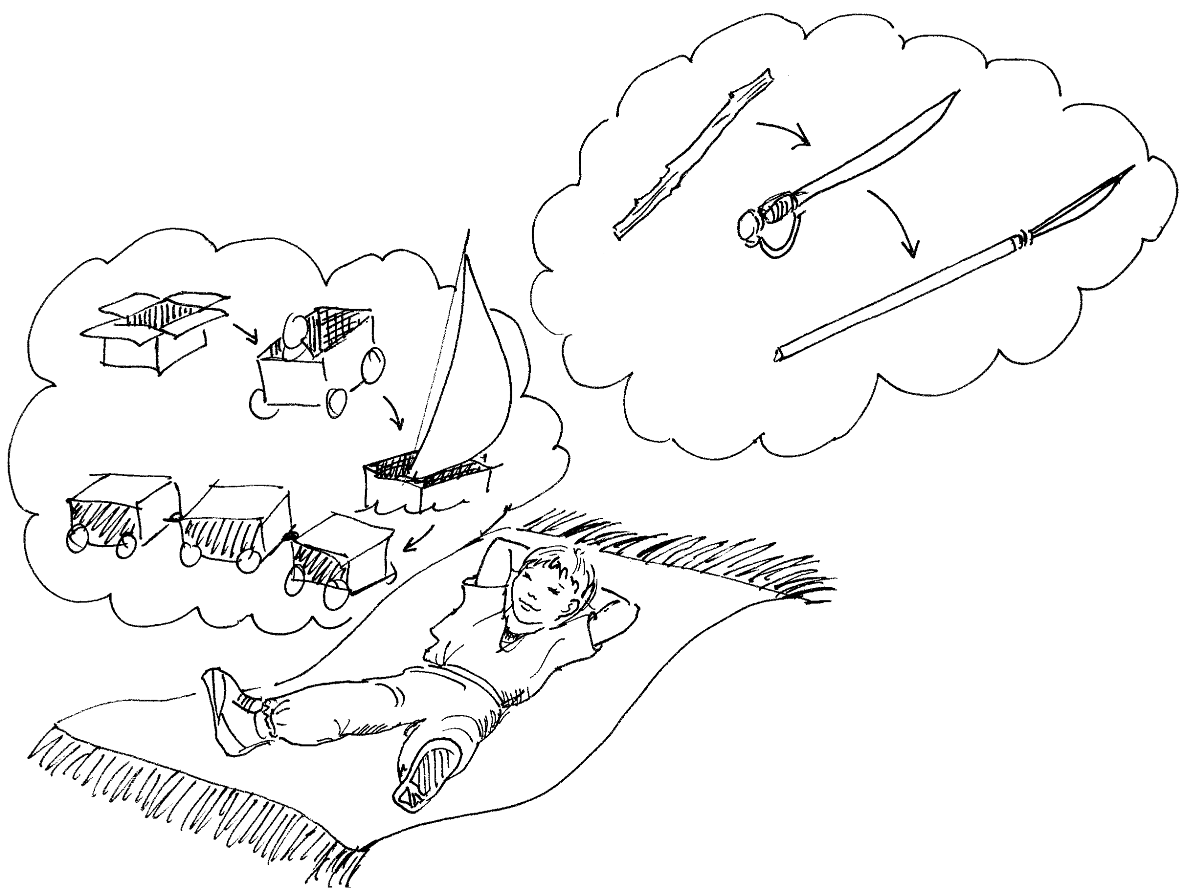
2. Have the students write a short story or poem about the item they just made. Where did it come from? What did it become? Is it trash or treasure?

Source: Adapted from AVR, *Teacher's Resource Guide*

JOHNNY

To Johnny a box
is a house
or a car
or a ship
or a train
or a horse.
A stick
is a sword
or a spear
or a cane,
and a magic carpet
is magic,
of course.

by Marci Ridlon



Source: Used with permission of the author

GIVING TREES A SECOND CHANCE

THEME:	Recycling is one way to keep from wasting natural resources.
GOAL:	Students will understand how both trees and recycled paper can be used to manufacture paper and other products.
METHOD:	Puppet show or teacher demonstration
SUBJECTS:	Performing arts, science
SKILLS:	Observing, listening, problem solving, reasoning
MATERIALS:	Animal puppet; human puppet; small tub roughly 2' x 1' x 1', labeled "Paper Mill"; bowl; egg beater; paper; crayons; examples of nonrecyclable paper items (e.g., wax paper, foil-coated gum wrappers); examples of items made of recycled paper (e.g., cardboard egg cartons, ticket stubs, toilet paper rolls, copy paper, corrugated cardboard); cardboard tree; saw; rolling pin; small pitcher
TIME:	45 minutes

GETTING STARTED

Ask the children to name different types of paper products and list them on the board. What is paper made from?

PROCEDURE

1. Explain to the class that new paper products are generally made from trees, but that, in some cases, paper manufacturers can use recycled paper instead of new wood to produce paper items. Although trees will continue to be harvested for paper goods, the number of trees that are cut can be reduced if paper recycling programs are instituted.

2. Set up stage on a front desk, along with the cardboard tree.

3. Introduce the puppets, Rebecca Rabbit and the Logger, and tell the children they have a story to share with them. If possible, have two different adults act out the two parts.

* * * * *

(Play Begins)

Rebecca: Hi! My name is Rebecca Rabbit. I live here in the forest. Well, it's my nap time, good night.

(Rabbit lies down under cardboard tree. Human puppet with saw enters and starts to cut down the tree. You make saw noises.)

Rebecca: Hey! Hey! What are you doing?

Logger: I've got to cut down this tree so they can make newspaper. (Turns to students.) Does anyone here have newspapers at their house? (Turns to Rabbit.) To put out the paper every day, I have to cut down trees and haul them away.

Rebecca: But you can't do that! A lot of animals need this tree! I use its leaves in my burrow to make it warm. (Turns to students.) Do you know any other animals that might use this tree?

(You will find out what they know and can add to it as needed. For example: birds, bugs, and squirrels live in them; beavers build their homes from them and eat the bark; many animals eat their fruit; animals use them to escape from predators)

Rebecca: (Turns to Logger.) See all the things we need this tree for? How can you take it?!

Logger: People want to read the newspaper every day, as well as books and magazines, so I cut down trees and haul them away. (Logger drags tree off desk)

Rebecca: I'm going to follow him. I want to see where he's taking my tree! (Put tub upside down on desk.) I think he brought it here. (Rebecca sticks her head into box and comes out again.) Yes—here it is. (Turns to students.) Can you see inside the mill? (Students say "NO.") Okay, I'll go inside and then tell you what is going on.

(Rebecca goes into box—which rattles and makes factory noises—then comes out).

Rebecca: It sure is loud in there! (Goes back in and comes out.) Now I can tell you how they make paper. First, they chop the tree into tiny pieces and put it in a huge bowl like this—(pretends to put sawdust into bowl)—except that their bowl is as big as this rug (or mention some other object that is about 8-foot square). Next, they pour water into it and stir it up just like this. (Rebecca pretends to pour in water from the pitcher and then uses eggbeater vigorously.)

Boy, am I tired! This takes a lot of energy! (Continues to use eggbeater.) I'm working hard. I'm using up a lot of my energy...Whew! Guess what it looks like now? It looks like hot cereal—Cream of Wheat! Have any of you ever eaten Cream of Wheat?

Now, is the paper you write on wet or dry? Dry? Well, the way they get the water out of this paper soup is with many huge rolling pins. I'm not kidding! They're as long as this room! Guess how many? Over one hundred huge rolling pins! (Put bowl on floor and demonstrate rolling pin on table.)

When they're done, the paper looks like this! (Hold up a piece of paper.) I think I'll draw a picture. (Rebecca scribbles.) I don't like this one, I think I'll throw it away. (Heads for trash can.) Wait a minute. I can't throw this away! This was my tree. It took all that hard work to make this paper. What can I do?

(If children mention recycling, ask them what that means. If they don't, Rebecca can ask them if they've ever heard the word recycling. Students may also mention ways to reuse the paper.)

Recycling means you take the used paper back to the factory and make new paper out of it. I think I'll go back to the factory and see how this is done. (Rebecca sticks her head under the box and pulls it out again.) It's almost the same as when they make new paper, but they don't have to cut down any trees. They use the old paper instead. (Rebecca shreds the paper into the bowl and uses the eggbeater on it, then pulls out another piece of paper, as good as new.)

The people at the factory told me to tell you to make sure you don't recycle Kleenex. And gum wrappers cannot be recycled because they clog up the beaters. No plastic or wax paper either, okay? These things get caught in the drain and could ruin the new paper.

Can you guess what else they were making out of old paper? (Pull out and label whatever examples you have.) Pretty neat, huh? Do you kids have a box in your classroom to collect used paper that can be sent back to be recycled? That's great, you're saving trees from being cut down. (OR, We'll have to get you one so you can save trees from being cut down.) Just remember, no food or tissues in there.

Do you have any questions for me before I go? You know what? After today, I think I'm going to change my name. I think I'm going to call myself RECYCLING RABBIT! Well, it's time to go. Bye!

(The children may want some personal contact with Rebecca after the show, so you may want to have her kiss or shake the hands of the students before she leaves.)

THE END

EXTENSIONS

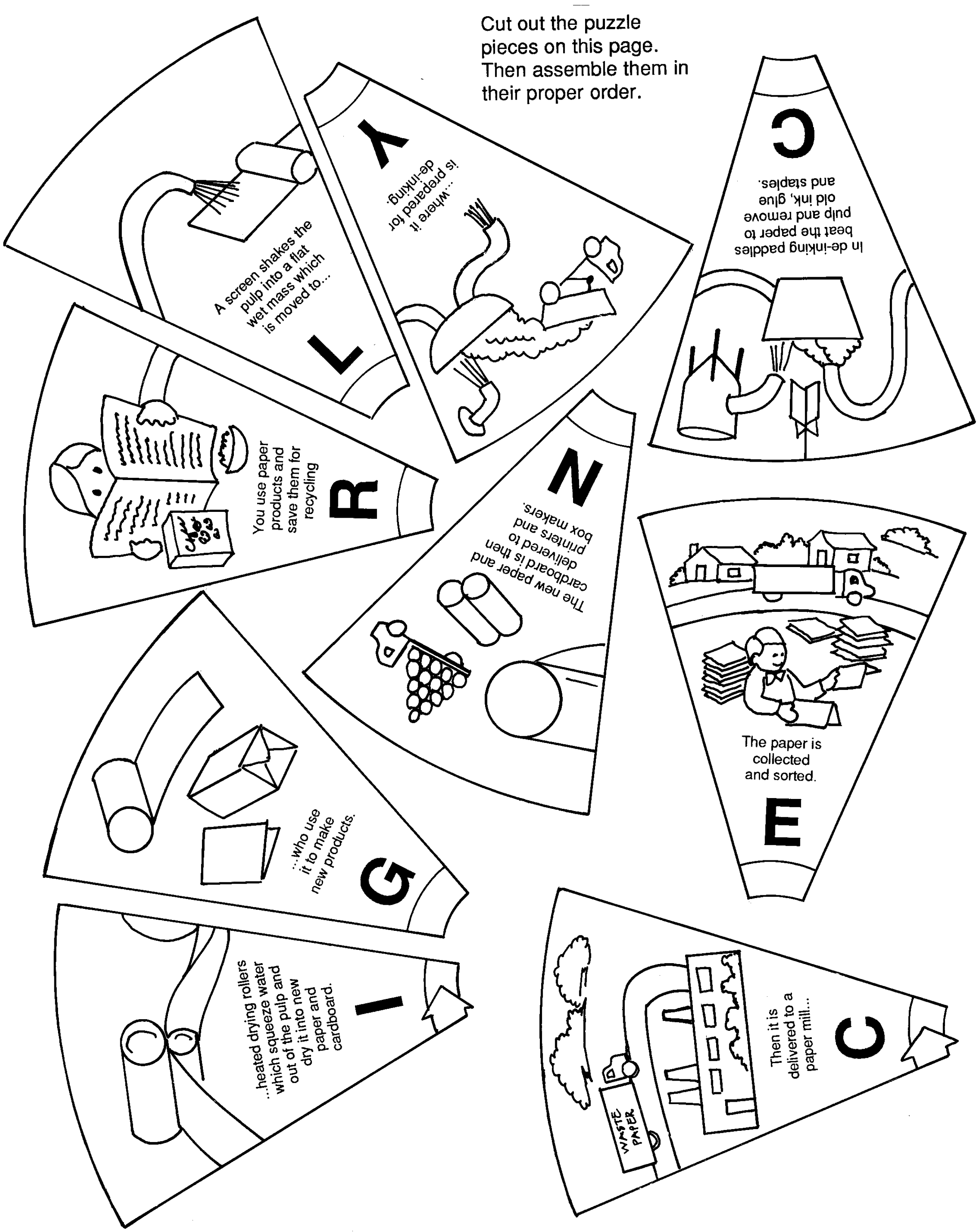
1. Have students make recycled paper. See Activity 3-5, “Papermaking”.

2. Distribute the attached handout, “How Paper is Recycled.” Have the children color the pieces and assemble them in their proper order. Make an enlargement of the pieces to post on the bulletin board.

Source: Kristen Walser

HOW PAPER IS RECYCLED

Cut out the puzzle pieces on this page. Then assemble them in their proper order.



Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

JOIN THE RECYCLING TEAM

THEME:	Recycling is a positive action everyone can take.
GOAL:	Students will understand that recycling is a team effort in which everyone can participate.
METHOD:	Reading and discussion
SUBJECTS:	Language arts, performing arts
SKILLS:	Listening
MATERIALS:	*The Little Red Hen*
TIME:	30 minutes

GETTING STARTED

Ask the students how many people are needed to recycle. Is it easier to recycle when people help one another?

PROCEDURE

1. Adapt the story of *The Little Red Hen* by changing the words. The story follows the original until the section where the hen finds the grains of wheat. Adapt the story to read:

One day when she was hoeing, she found some soda cans. "Who will help me put these soda cans in the recycling bin?" "Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

Each morning when she was cleaning around the house, she saved up all the glass bottles, metal cans, newspapers, and cardboard and put them aside. She stacked the paper and cardboard together and put the glass and cans in a large bin.

When the paper stacks became too high to reach, the Little Red Hen asked, "Who will help me put the newspapers and cardboard in bundles?" "Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

When the glass and metal bin was full and there were several bundles of paper and cardboard the Little Red Hen said, "Who will help me take the bin and bundles to the recycling center?"

"Not I," said the cat. "Not I," said the dog. "Not I," said the duck. "Then I will," said the hen, and she did.

So the Little Red Hen piled everything in her car and drove to the recycling center where she put everything in its place. With the money she got for the bottles, she bought a fresh loaf of bread.

The rest of the story can continue until the end, when all the animals help her collect, bundle, and deliver the recyclables to the center.

2. Have the children act out the story as a play.

Source: Kristen Walser

PAPERMAKING

THEME:	Some products can be recycled into new and useful items.
GOAL:	Students will learn how paper is recycled.
METHOD:	Making recycled paper
SUBJECTS:	Art, science
SKILLS:	Designing, experimenting, observing, predicting
MATERIALS:	Scrap paper (white copy paper, construction paper, etc.); decorative filler scraps (flowers, seeds, pine needles, yarn, thread, feathers, etc.); two wooden frames of the same size; nylon fly screening or the equivalent (cut to a size slightly larger than the frames); duct tape; staple gun; tin cans; absorbent rags or towels as large as the frames; one 24” x 16” plastic wash basin; blender; sponge
TIME:	2 hours

BACKGROUND

Paper makes up 41 percent of all household trash by weight; at least one-quarter of this is newspaper, which is discarded after only one day of use. Although wood is a renewable resource, our wasteful habits are using up forest resources faster than they are being replaced. Recycling paper can help conserve the energy and natural resources that are used to make paper.

Almost all paper is recyclable and much of the paper we use daily contains recycled fiber. People are the link in the paper recycling process. If more people recycled paper fewer trees would need to be harvested and less waste material would need to be burned or buried.

GETTING STARTED

Ask the students why we should recycle paper.

PROCEDURE

<u>NOTE</u>: Making paper can be messy because of the amount of water that is drained and pressed out of the material. Keep handy absorbent material such as sponges, sheets, or towels. Avoid using newspaper to soak up excess water; newsprint will turn everything gray.

Set up stations around the room to allow everyone in the class to participate at the same time. Each station should be equipped with one basin and mold and deckle (frame for making paper) for each four to five students.

1. Introduce the process of papermaking to the class. (See Section I, “How is paper made?”).

2. Have the students make their own paper, following the directions on the attached “Papermaking” sheet. Explain to the class that the machines used in the manufacture of recycled paper perform all the same tasks they will perform in this experiment. When they are through, compare the students’ recycled paper with other types of paper in the classroom and to commercially manufactured recycled paper. How do they differ in weight, color, texture, durability, and as a surface for writing?

3. Start a discussion about the reasons for recycling (e.g., conserving trees, habitat, energy, landfill space). Also introduce the related problems of water pollution, contaminants, and paper grades.

EXTENSIONS

1. Have children write short poems (e.g., Haiku) or stories about trees on their recycled paper. (NOTE: Test pens first to make sure they do not bleed.)

2. Have the class weigh all the waste paper it generates in a week. Have the students separate out the recyclable portion and weigh the remainder to see how much the class would save by recycling. Start a contest with another class or for the entire school to see which classroom can recycle the most.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Bell and Swartz, *Oscar's Options*

PAPERMAKING

1. Before making paper, construct a paper mold by building a wooden frame (suggested size: 6” x 9”) and stapling nylon fly screening to it. To help make the paper more even, assemble a second wooden frame (same size as the first), called a “deckle,” without the fly screening. If you cannot construct frames, cut out a piece of screening 6” x 9” and cover all the rough edges with duct tape.

2. Start by having students tear scrap paper into tiny pieces. Soak them in a dishpan of hot water for 30 minutes.

3. Fill the blender half-full of warm water and place a handful of soaked paper into it. (WARNING: Too much paper will burn out the blender’s motor.) Mix at medium speed until it has a watery-creamy consistency. This means that the paper fibers have broken down and are now considered pulp. Repeat with successive batches of soaked paper scraps.

4. OPTIONAL: To make colored paper, add food coloring, nontoxic fabric dye, or bits of grass, dried flowers, or orange peels directly to the pulp in the blender or to the mixture in Step #5.

5. Fill a dishpan with 4 to 6 inches of water and pour in the paper slurry from the blender. Mix by hand. The amount of pulp you add to the water in the basin will affect the thickness of the paper. (NOTE: For younger students, a thicker slurry and paper will ensure greater success.)

6. Put the deckle on top of the mold with screen. Using two hands, dip the mold into the dishpan, lifting up some of the pulp onto the screen, or use a tin can to pour liquid and pulp onto the screen. Gently rock the mold back and forth to get an even layer of fibers on the screen. Let water drain through the screen for several minutes. Put mold on a protected surface (plastic sheeting covered by a towel or rag) and carefully lift the deckle off the mold. In place on the screen is your newly formed piece of paper.

7. To remove the paper from the screen, lay a piece of light-colored construction paper on top of the newly formed piece of recycled paper and turn the screen over onto the towel on the table. From the back of the screen, sponge off any excess water. Gently lift off the screen and the recycled paper should remain on the piece of construction paper. Place another piece of construction paper on top of the recycled piece, to form a sandwich.

8. To dry the paper quickly, place this “sandwich” on a towel and iron it at a medium setting. Once dry, gently remove the new recycled paper from the two pieces of construction paper. It can also be dried by pressing it onto a pane of glass or setting it aside in a warm place for 1 to 2 hours.

9. CLEAN-UP: Pour the leftover pulp in a strainer. DO NOT pour pulp down the drain because it might block the drain. The strained pulp can be discarded or kept in a plastic bag in the freezer for the next papermaking exercise.

REUSE OR RECYCLE

THEME:	Many items we throw away can be reused or recycled.
GOAL:	Students will discover how and where they could recycle or reuse items they typically throw away.
METHOD:	Completing checklist and discussion
SUBJECTS:	Language arts, social studies, science
SKILLS:	Interpreting, predicting
MATERIALS:	“Reuse or Recycle: Discarded Materials Checklist” handout
TIME:	1 hour

GETTING STARTED

Can the items you throw away be used again?

PROCEDURE

1. Explain to the class the concepts of reusing, recycling, and composting, showing them examples of recycled products. Give each student a copy of the “Reuse or Recycle” checklist to complete during the next week. Alternatively, post the checklist on the board and have the class work through it as a group.

2. Have each student tally the results of his or her checklist. Make a class summary on the board and use it to have the students answer the discussion questions on the checklist.

EXTENSIONS

1. Have the students brainstorm the steps they might take to design and implement a reuse or recycling project for the class or for the entire school. (Contact DEP for a copy of the *Manual for Implementing a School Recycling Program*)

2. List different types of recyclables on the board. Discuss what happens to the items when they are recycled. Can these items be recycled locally?

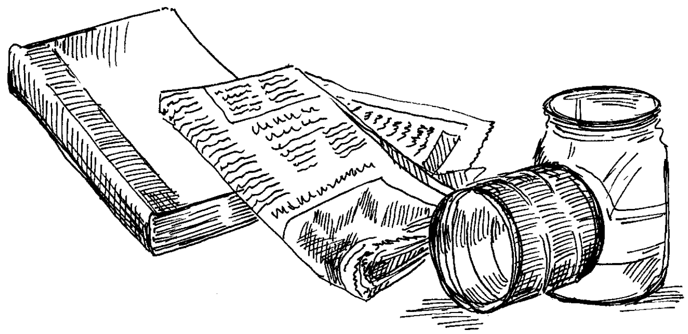
Source: Adapted from Wisconsin, *Recycling Study Guide*

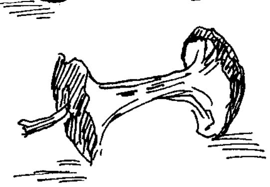
REUSE OR RECYCLE:

Discarded Materials Checklist

Place an X next to items you threw away this week. Then, circle the items you think could have been reused, recycled, or composted.

____ orange peel	____ paper bag	____ newspaper
____ broken toy	____ book	____ magazine
____ plastic bag	____ paper milk carton	____ other paper
____ grass clippings	____ paper napkin	____ aluminum can
____ plastic milk jug	____ apple core	____ old clothes
____ glass jar	____ tin can	____ gum wrapper
____ other		





Discussion Questions

1. What items did you circle?
2. How could you have reused items?
3. What could you have done with the recyclable items?
4. What could you have done with apple cores and orange peels?
5. Which items are difficult to reuse or recycle? Why?
6. Should society be making items that are not reusable or recyclable?
7. Should items which are wrapped in excessive or non-recyclable packaging cost more?
8. Did any of your classmates reuse, recycle, or compost any of the items you circled? How did they do this? Was reusing or recycling the materials easy or difficult?
9. What do you think happens to the items you didn't circle?

NATURE AT WORK

THEME:	Organic waste can be recycled (composted) and used to enrich soil.
GOAL:	Students will learn about recycling organic wastes through composting.
METHOD:	Building a model compost pile
SUBJECTS:	Science
SKILLS:	Classifying, inferring, observing, predicting
MATERIALS:	Aquarium; organic wastes: soil (NOT potting soil); thermometer; trowel or large spoon; 1 to 2 dozen red earthworms
TIME:	1 hour to assemble, up to 1 year for observation

BACKGROUND

Composting is the oldest form of recycling. It is based on the scientific principle that nothing ever really dies, but just changes shape and takes on new forms. When a leaf falls and begins to decompose, it is broken down by time, weather, insects, and worms into the original materials from which it was made. The same is true for waste we throw away every day, such as grass clippings, banana peels, egg shells, and apple cores. These materials can be set aside for use as fertilizers in gardens and farms.

Compost is formed through the action of certain microbes that proliferate when mixed organic refuse receives sufficient air and water. These bacteria, which generate a temperature of 150 degrees, literally cook the wastes. The finished product, called "compost" or "humus," is an excellent fertilizer and looks just like soil. It is high in carbon and nitrogen, which are important sources of food for plants and vegetables. In addition to being clean, safe, and thrifty, composting can significantly reduce the volume of solid waste generated by a household.

Oscar's Options

GETTING STARTED

Can food scraps, leaves, and grass clippings be recycled?

PROCEDURE

1. Have the students bring in a variety of organic wastes such as green grass clippings, sawdust, wood ash, leaves, and kitchen food scraps. (Avoid meat scraps, dairy products, fats, and oils, which inhibit decomposition, cause odors, and can attract pests.) Tear or chop the materials into small pieces, leaving a few larger pieces of each type of waste for comparing rates of decomposition. Ask the students if they think there will be a difference.

2. Begin to fill the aquarium, alternating layers of the materials as follows (amounts are approximate): 1 inch of soil; 2 inches of dry, carbon rich, organic waste (i.e., leaves); 1 inch of green grass clippings; and sprinkle of water. Repeat several times.

3. Cover the last layer with a half inch of soil and water the pile so it is moist, but not soggy—like a damp sponge.

4. Have the students add the earthworms and observe their behavior.

5. Place the compost pile where it will be at room temperature (but not in direct sunlight). Once a week, have a student test the temperature of the pile and vigorously mix the pile to aerate it. For consistency, take the

temperature at the same location, depth, and time each week. Make a temperature graph and have each student enter his or her reading.

6. As the class starts to see changes in the pile, discuss the process of composting. How does it reduce the amount of waste thrown out? What happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

EXTENSIONS

1. Have the children write and illustrate a story that explains what they have learned about composting. Where applicable, encourage them to construct a compost pile at home, where they can use the finished compost on the family garden or flower beds.

2. Have the class begin a school garden or "adopt" a particular flower bed. Have them add the compost they made and plant some flowers or vegetables.

Source: Adapted from Wisconsin, *Recycling Study Guide*

THE BURNING QUESTION

THEME:	Combustion as a waste management method has both benefits and drawbacks.
GOAL:	Students will evaluate the advantages and disadvantages of combustion.
METHOD:	Visiting a waste combustion facility
SUBJECTS:	English, science, social studies
SKILLS:	Comparing, observing, value judgment
MATERIALS:	None
TIME:	One class period, plus additional time for field trip

GETTING STARTED

Is burning a good way to get rid of trash?

PROCEDURE

1. Introduce the process of incineration and its advantages and drawbacks as a waste management tool. Note that burning can reduce the volume of trash by 80 to 90 percent. The concepts of volume and weight reduction might be addressed through comparison with a wood fire and the amount of material visible before it is ignited vs. what remains after the fire has burned out.

2. Invite the manager of an incinerator to class to describe how the process works, what sort of preparation is needed, what kind of special treatment is required for the ash residue, and so on.

3. Arrange a trip to visit a waste combustion facility. A list of facilities can be obtained from DEP's Division of Solid Waste Management. Prior to the trip, have the students prepare questions about combustion facilities. One approach is to divide students into small groups, with each group assigned a different aspect of the combustion process (e.g., air emissions, ash residues, siting issues). Each group would be responsible for getting information on its topic and presenting the results to the class.

4. Construct a wall chart comparing the advantages and disadvantages of combustion.

EXTENSIONS

1. Take a sample of trash and have the students sort out items that could be reused or recycled, removing them from the waste stream. Compare the amount left to be burned to the original sample. Discuss the implications of burning versus recycling.

2. If your community is serviced by an incinerator, have the students research how much of the town's solid waste is burned versus recycled. Have the class compare the economics of incineration with those of recycling and prepare a report on their findings.

Source: Adapted from AVR, *Teacher's Resource Guide*

BUILD A MINI-LANDFILL

THEME:	Landfilling is one method for disposing of solid waste in Massachusetts.
GOAL:	Students will understand how little decomposition occurs in landfills.
METHOD:	Constructing a small-scale replica of a landfill
SUBJECTS:	Science
SKILLS:	Observing, recording
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
TIME:	1 hour the first day, 10 to 15 minutes each day thereafter for 3 weeks

GETTING STARTED

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.

Source: Adapted from Bell and Swartz, *Oscar's Options* with permission

BUILD A MINI-LANDFILL

Worksheet

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

2. The items that decomposed the most are:

Week 1:

Week 2:

3. The following items decomposed a little:

Week 1:

Week 2:

4. These items did not change at all:

Week 1:

Week 2:

BUILD A MINI-LANDFILL

Worksheet (continued)

5. Why to you think some items are decomposing more quickly than others?

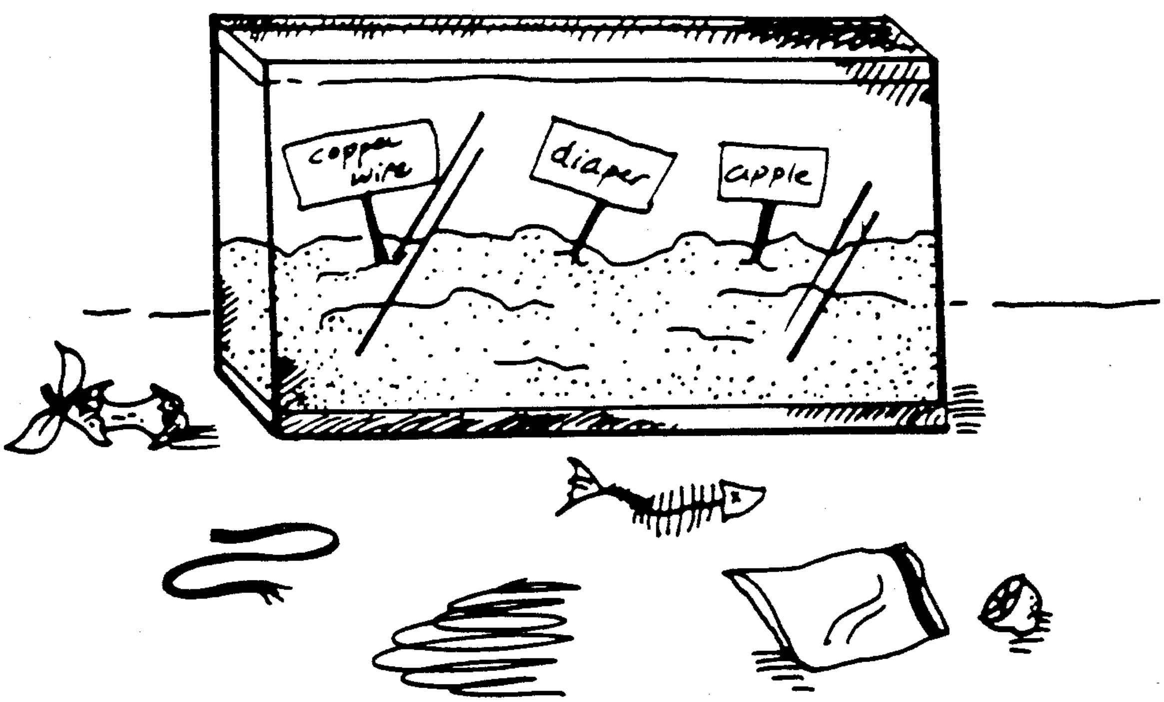
____
____

6. Note any significant changes that have occurred between observations:

____
____

7. What differences were there between the trash in the plastic bag and the trash that was placed directly in the soil?

____
____



WASTE DISPOSAL AT SCHOOL: WHERE DOES IT GO?

THEME:	There are limited options for the disposal of trash.
GOAL:	Students will understand where the trash from their school or community is taken, and what is involved in the disposal process.
METHOD:	Interviewing school custodian or trash hauler
SUBJECTS:	Art, language arts, science, social studies
SKILLS:	Experimenting, interviewing
MATERIALS:	Tape recorder, video camera (optional), a few samples of trash
TIME:	Two 15- to 30-minute periods

GETTING STARTED

Ask the students where their trash goes after being collected from school.

PROCEDURE

1. Invite the school custodian to the class and have the students interview him/her about trash removal. Prior to the interview, have the class write down questions they would like to ask. These might include:

   a. How often is the trash collected?

   b. How long does it take to collect it?

   c. Where is it taken? Where does it go from there? What happens to the trash?

   d. Is it ever used again for anything?

   e. What is most of the trash composed of?

   f. How much trash do we throw out each week?

   g. What does it cost to throw it out?

2. After the interview, have the students draw pictures that reflect the information they just learned. Ask them to write an accompanying paragraph further describing the interview, and post these as a bulletin board display. Send copies to the custodian as a thank you note.

EXTENSIONS

1. Arrange for students to meet the school's trash hauler when he or she comes to pick up the trash. When the truck comes, have children watch the trash removal process and ask the following questions:

   a. When do you start working in the morning and when do you finish at night?

   b. How many truckloads of trash do you collect each day?
   c. Why is your truck designed the way it is and how does it work?

   d. How many houses and businesses do you collect from?

e. How many miles do you drive each day?

f. Where do you take the trash?

g. What happens to it then?

h. Is it ever used again?

i. How long have you had your job? Have you noticed any changes in the amount or composition of trash since you started?

2. Take the class on a field trip to a landfill or combustion facility. A list of facilities can be obtained from DEP's Division of Solid Waste Management. Discuss the process, benefits, and potential problems associated with each method of disposal. For example, if the town sends its trash to a combustion facility, discuss whether or not all the trash disappears. If you visit a landfill, find out if it is running out of space. If so, what will the community then do with its trash?

3. Have the students create a mural about how trash is created, collected, and disposed.

Source: Adapted from AVR, *Teacher's Resource Guide*

TV TECHNIQUES: ADVERTISING FOR THE ENVIRONMENT

THEME:	Advertisers often overlook the environmental consequences of their product and its packaging.
GOAL:	Students will learn that commercials can be promotional and still consider the product's impact on the environment.
METHOD:	Revising television or radio ads
SUBJECTS:	English, science, social studies
SKILLS:	Analyzing, communicating, designing
MATERIALS:	A video camera to tape commercials (optional)
TIME:	Several class periods

BACKGROUND

Television and radio ads persuade us to purchase certain items for reasons other than product quality. Many of these products, although useful and desirable, can have far-reaching environmental impacts that are not normally considered by advertisers or purchasers.

GETTING STARTED

What techniques do advertisers use to sell their products? How effective are these techniques? Do certain commercials target specific audiences?

PROCEDURE

1. In preparation for making their own TV commercials, have students view one hour of TV, paying special attention to the content and duration of the ads. Ask them to list the various methods advertisers use in commercials (e.g., sex appeal, convenience, status symbol, flashy packaging, famous people). Assign each student a particular time to watch or listen to commercials. This will enable them to decide whether advertisers use specific techniques to reach particular audiences.

2. As a class, discuss the results. What techniques are used most often? Was product durability or effect on the environment ever mentioned? Are manufacturers concerned with overpackaging or reducing the amount of waste generated by their product?

3. Have each student select a commercial to revise. The new commercial should present the environmental consequences of making and using the product and should appeal to the consumer. Students may want to create a new package or alter the item to make it less wasteful. For example, an ad for soda could promote the fact that it uses reusable glass bottles instead of plastic and that the energy used to produce the containers was derived from burning trash rather than fossil fuels.

4. Have the students present their new commercials in front of the class and discuss why and how they changed the original ad. Encourage students to give each other feedback on the effectiveness of the new commercial.

EXTENSIONS

1. Have students write to the manufacturers of the products whose advertisements they changed, and explain how and why they changed the ad for their product.

Source: Adapted from Washington, *A-Way With Waste*

BACK TO BASICS

THEME:	The production and disposal of packaging affects our natural environment.
GOAL:	Students will explore the natural resources used to create different types of packaging.
METHOD:	Researching the manufacture and disposal of different types of packaging
SUBJECTS:	English, science, social studies
SKILLS:	Analyzing, drawing conclusions, reporting, researching
MATERIALS:	None
TIME:	Several class periods

GETTING STARTED

Begin a discussion by asking the students to list different types of packaging materials. What raw materials are used to make these?   How do they become the package that we buy at the store?

PROCEDURE

1. Divide the class into groups, with each one representing one of the following types of packaging: aluminum can, egg carton, plastic bags, cardboard box, soda bottle, steel can, and milk container.

2. Have each group research its packaging type, tracing the packaging's creation from raw materials through the final process. The students might also explore the cultural or historical basis for using this material for packaging and what was used in earlier generations. Each team should prepare an illustrated report to distribute to the rest of the class.

3. Select a representative from each group to present its report to the class. Discuss the advantages and disadvantages of each type of packaging. Which ones use the most energy and resources to manufacture? Which require the most energy and resources for disposal?   Which use the least? Which types of packaging have the greatest negative environmental impacts? What could we do to help minimize these impacts?

EXTENSIONS

1. Have the students write letters to product manufacturers with the results of their research and their suggestions for better product packaging.

Source: Adapted from AVR, *Teacher's Resource Guide*

A PICTURE IS WORTH A THOUSAND WORDS

THEME:	Art reflects the values of society.
GOAL:	Students will appreciate the ability to influence society through artistic media.
METHOD:	Creating artistic works (pictures, poems or short stories, photographs, songs, paintings, etc.)
SUBJECTS:	English, art, social studies
SKILLS:	Analyzing, creating, value judgment
MATERIALS:	Examples of artwork; craft supplies (paint, markers, glue, etc.)
TIME:	1 to 2 hours

BACKGROUND

Art often reflects what society values. Sometimes artistic expression can affect society by making it see its own flaws, including wasteful habits that are practiced at the cost of the environment.

GETTING STARTED

Ask the students to name their favorite form of art—music? Painting? Dance? Poetry? Photography? Have them consider: In what ways does art affect you? Reflect you?

PROCEDURE

1. Provide or have students bring in samples of art that reflect an appreciation of the natural environment (e.g., the paintings of Thomas Cole), portray American values (e.g., selections from the essays of H.D. Thoreau), or illustrate our wasteful habits.

2. Have the class discuss the various examples, addressing questions such as: What message was the artist trying to get across? How did he or she achieve this? How does his or her art affect you?

3. Ask each student to create a piece of artwork that reflects how they personally would like to change our throw-away society.

4. Organize an informal show for the students to present their projects to the rest of the class. Have each explain why they chose the artistic medium they did. Let other students guess and then discuss the message behind each piece.

EXTENSIONS

1. Hold an exhibit of all art projects, either at the school or in a local building such as the town hall or library. Have students write a brief paragraph to accompany their work.

THE SMART SHOPPER

THEME:	Each of us is responsible for the size and content of the waste stream.
GOAL:	Students will examine their own buying habits in terms of solid waste generation.
METHOD:	Examining and evaluating products
SUBJECTS:	English, home economics, social studies
SKILLS:	Communicating, interpreting, recording
MATERIALS:	Construction paper; markers
TIME:	15 minutes to discuss assignment; one class period to discuss results

GETTING STARTED

Ask the students what factors influence which products they decide to buy? Do they think about what happens to the solid waste stream when they throw away those items?

PROCEDURE

1. Have students ask their families the following questions about their shopping habits.

    a. Does the ability to recycle a product or its packaging play a part in determining what you buy?

    b. When shopping, do you think of how easy or difficult it will be to dispose of a product or its packaging?

    c. Which factors influence your decision to buy a product?

    ___ cost per pound
    ___ convenience in preparation or use
    ___ advertising
    ___ high nutritional value
    ___ lack of artificial coloring or preservatives
    ___ trying something new
    ___ familiarity with the brand
    ___ other

2. Have the class discuss the results of the survey. What are some of the most common reasons for buying a product? How often was recyclability or packaging taken into account?

3. As a class, come up with shopping strategies that might help to reduce the waste stream (e.g., using cloth shopping bags instead of choosing paper or plastic; choosing foods that are not excessively packaged or overprocessed). Have students make a "Smart Shoppers Sheet" to hang on their refrigerators at home.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Washington, *A-Way With Waste*

PACKAGING DESIGN FAIR

THEME:	Packaging is useful and necessary, but also contributes to our solid waste stream.
GOAL:	Students will explore the function of packaging and how to make packaging both effective and environmentally sound.
METHOD:	Designing the "perfect" packaging
SUBJECTS:	Home economics, social studies
SKILLS:	Analyzing, designing
MATERIALS:	Drawing materials; commercially packaged products; magazines
TIME:	Two class periods

BACKGROUND

Packaging has a number of functions and benefits, as well as some drawbacks.

Merits of packaging include:

- Preserves and protects the product.
- Provides instructions on product use.
- Advertises product, increasing sales and profits.
- Ensures public health and safety.

Drawbacks of packaging can include:

- Can be difficult to recycle in some communities.
- Wastes resources and energy if the packaging materials cannot be reused or recycled.
- Excessive packaging wastes natural resources and energy.

GETTING STARTED

Why is it important to change the way some products are packaged? Could packaging be designed to be less wasteful and still accomplish the same functions?

PROCEDURE

1. Have the students look through magazines and cut out pictures of packaged products. (Students could also bring in a commercially packaged product they are interested in studying.) Each student should choose one product for which they will design an alternative package.

2. Ask the students to look at their product and decide what the designer was trying to accomplish. Discuss the functions and drawbacks of the packaging. What is the packaging made from? What materials were used? Is any of the packaging designed with the environment in mind?

3. Have the students design a new environmentally-sound alternative to their chosen packaging. The designs should address waste reduction, reuse, and recycling, as well as public safety, product protection, shipping weight, cost of packaging material, advertising, and public demand. New design parameters should include some or all of the following: minimum resource extraction, minimum use of energy in processing, minimum transportation, selection of reusable or recyclable resources, design for reusability and recyclability, use of nonhazardous materials, and more. How do these new parameters conflict with, or limit, the old packaging?

4. Have the students list the materials they used in their alternative packaging and explain their choices. Each student should present their new design and explain the functions and environmental impact of the new packaging.

5. Display the students' new packaging designs (or actual items, if applicable). Each item should be accompanied by a paragraph explaining the new design, its impacts, and why it is better than the old one.

EXTENSIONS

1. Invite representatives from local environmental organizations, the local landfill, a recycling facility, or a newspaper to come and view the displays and discuss their organization's efforts to address this issue.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Washington, *A-Way With Waste*

GRAPHING PRICES FOR RECYCLABLES

THEME:	The markets for recycled materials change over time.
GOAL:	Students will see how fluctuating markets and prices affect recycling.
METHOD:	Researching and analyzing prices for recyclables
SUBJECTS:	Business, math
SKILLS:	Analyzing, interpreting, graphing
MATERIALS:	Graph paper; transparencies; *Recycling Services Directory* (available from DEP's Division of Solid Waste Management)
TIME:	Several months

BACKGROUND

For recycling to be worthwhile, collected materials must be remanufactured into desirable products and sold to consumers. This calls for industry to accept recycled goods in place of raw materials as its feedstock. A challenge that confronts recycling is the development of consistent end markets for materials separated from the waste stream.

GETTING STARTED

What prices are being paid for recycled materials? What factors influence these prices? How often do the prices change?

PROCEDURE

1. Discuss the concept of recycling. Illustrate the process with several examples of the "life histories" of recyclable items, from their natural resource base to their original use to how they are recycled and used a second time and third time, and so on.

2. Obtain DEP's *Recycling Services Directory*. Working in teams, have the students interview several recyclers, asking questions such as: What recyclables do you collect? How much do you collect of each type (weekly, monthly)? What price do you currently receive for each ton of material delivered to market? What factors influence the price you are paid for each item? Are there markets for other recyclables not now being collected? Have each team write up its interview in the format of a newspaper article.

3. Using the data obtained from different recyclers, have the students generate the following graphs:

   a. Amount of each material collected monthly per hauler

      - Glass (green, brown, clear, mixed)
      - Paper (e.g., newsprint, corrugated cardboard, mixed paper)
      - Metal (steel and aluminum cans)
      - Plastic (HDPE, PET, etc.)

   b. Fee ($/ton) charged by haulers to collect recyclables

   c. Cost ($/ton) to process recyclables

d. Price received per material when sold to manufacturers

Have the teams repeat this exercise for several months to examine price fluctuations. Which types of recyclables pay the most? Why might the prices vary from month to month?

EXTENSIONS

1. Have the teams research where the recycled items are picked up and where they are eventually taken. Compare the transportation costs with the value of the materials being recycled.

2. Have the students research the advantages and disadvantages of industry using recycled goods instead of virgin raw materials. They should examine issues such as: For what types of goods does this work the best? Is it more or less expensive to use recycled feedstock? Are these cost differences passed on to the consumer? Does industry have difficulties finding a consistent supply of recycled materials?

Source: Adapted from Washington, *A-Way With Waste*

MY TWENTY-FOOT SWATH

THEME:	Every person contributes to the solid waste stream and has a responsibility to help minimize it.
GOAL:	Students will develop a plan for decreasing pollution in the environment by setting realistic personal goals.
METHOD:	Reading essay and developing a personal action plan
SUBJECTS:	English, social studies
SKILLS:	Brainstorming, problem solving, making value judgments
MATERIALS:	*My Twenty-Foot Swath* article
TIME:	One class period, plus several weeks to keep journal

GETTING STARTED

Ask the students whether personal or global problems such as poverty or environmental pollution ever become so overwhelming that people are immobilized or driven to some action that actually aggravates the problem. Discuss some examples.

PROCEDURE

1. Have the students read the essay, *My Twenty-Foot Swath*. Each student should think of three questions or issues this piece raises, and write them on separate slips of paper. Pool the questions together in a box and have each student select one at random to answer, either in writing or orally in front of the class.

2. Have students relate similar personal experiences to the one described by Lundberg. As a class, brainstorm different ways to expand positive action from a personal level to the world community.

3. Have each student select a problem that makes them feel helpless, outline a positive action plan, and keep a daily journal documenting their experiences and feelings.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Washington, *A-Way With Waste*

MY TWENTY-FOOT SWATH

by Kenneth V. Lundberg

"I worried so much about world hunger today, that I went home and ate five cookies." Did personal or global problems ever become so overwhelming that you were immobilized. or driven to some action that actually aggravated the problem? Have you experienced such fru

the problems of poverty, environmental pollution, or human suffering at you were powerless to do anything about their alleviation? This is d. Here's how I dealt with this feeling. I park my car away from my cise and parking space, as everyone else competes for spots next noon strolls take me on a stretch of lawn between the tennis courts ar ally used softball diamond. The lawn is twenty feet wide, more or l ittered. Tennis players discard tennis ball containers (and their fl elaces and old candy bar wrappers. Soccer game spectators leave behind beer bottles and junk food cellophane.

In my early days it disgusted me, and my thoughts centered on ways of correcting the situation by writing letters to the campus newspaper (no doubt totally ignored); campaigning for anti-litter regulations (who would enforce them?); organizing a "Zap-Day" cleanup (leaving 364 days of littering). All my noble efforts would have demonstrated my indignation, raised my blood pressure, and attracted attention, but they would not have changed the appearance and/or condition of the area. So, I decided to take ownership. I would be the solution. I did not tell anyone of this; it was probably against some rule or another. I decided that I would be responsible for the environmental quality of this twenty-foot swath. I did not care what other parts of the campus were like. They were someone else's problem. But each day, going from and to my car, I picked up litter.

At first, it was as much as I could conveniently carry. Then I made a game of it, limiting my picking to ten times each way. It was an exciting day when I realized I was picking faster than "they" were littering. Finally, the great day arrived when I looked back on my twenty feet of lawn—now perfectly clean.

Where did I put the litter? At first, I brought it into a waste basket in the building, or took it to the car to bring home. Then a curious thing happened. One day, large orange barrels appeared at each end of my swath. Someone in maintenance had become my silent conspirator—periodically emptying and replacing the barrels. He, too, knew the wisdom of keeping a low profile about it all.

I've done this for several years now. Has the general campus appearance changed? Not much! Have litterers stopped littering? No! Then if nothing has changed, why bother?

Here lies the secret. Something has changed. My twenty-foot swath and me! That minute walk is a high spot of the day. Instead of fussing and stewing and storing up negative thoughts, I begin and end my workday in a positive mood. My perspective is brighter, I can enjoy my immediate surroundings—and myself—as I pass through a very special time space. "It" is better because of me. I am better because of "it." "We" enjoy the relationship. Maybe, even, "it" looks forward with anticipation to my coming.

My learning—and the twenty-foot swath—does not stop at the building door. There's an important principle that follows wherever I go. I cannot solve man's inhumanity to man but I can affirm, with a smile and a word of appreciation, those who feel burdened by the need to work at lowly jobs. I cannot right the imbalances of centuries of discrimination, but I can "lift up" someone who feels the weight of a poor self-image. I can treat women as equals without solving the problems of sex discrimination. I can seek out the social and economic litter in my own "twenty-foot swath" without demanding of myself that I "clean up the world."

I now practice a discipline of leaving each time-space capsule of my life a little better than when I entered it. Each personal contact, each event, each room I enter

becomes a small challenge.
I want to leave it improved, but more important,
I am responsible to myself to be improved; and thereby,
maybe—just maybe—my having been there will make
life better for someone else.

I am becoming more and more disenchanted and suspicious of revolutionaries, crusaders, militants, and do-gooders. Many, if not most, seem to be more concerned about being right than being loving or effectual. The zealot, no matter how well-intentioned, often leaves a trail of wounded people while in pursuit of the cause.

Is this all too myopic—shutting one's eyes to the greater concerns? It does not need to be! I now have a twenty-foot swath. Next year it may be forty, or sixty, or eighty feet wide. Ten talents were not required of him who had been given only one. Too many people stumble by taking on causes too great for their level of discernment and discipline. They need to begin to catch the vision of the important promise, that the meek shall inherit the earth, not the indignant or frustrated.

Source: Reprinted from *Covenant Companion* with permission

DESIGNING A COLLECTION SYSTEM

THEME:	An efficient system for handling recyclables will enhance the success of any recycling program.
GOAL:	Students will understand some of the design considerations for establishing a recycling facility.
METHOD:	Studying and designing a recycling facility
SUBJECTS:	Art, government, industrial arts, social studies, planning
SKILLS:	Designing, inferring, interpreting, observing
MATERIALS:	Graph and drawing paper; colored markers; ruler; population figures; local maps; "Municipal Recycling Programs" profiles
TIME:	1 week

GETTING STARTED

What kind of recycling program would be best meet the needs of your school or town?

PROCEDURE

1. Discuss with the class the different types of programs for collecting and processing recyclables: household separation/curbside collection, drop-off centers, buy-back centers, and commercial collection. (Note: Refer to Section III, "Recycling," for definitions of these programs.)

2. Have the students collect information on local waste and recycling practices to determine the needs for a town or school recycling program. They should consider the amount of waste and recyclables being generated, potential markets for recyclables, program funding sources, storage space, transportation costs, maintenance and management costs, and community support, among other things.

3. Have the students review the "Municipal Recycling Programs" profiles for background information about successful programs in other towns.

4. Invite a local recycler, town or state official, or local planning or health board member to talk to the class and/or have the class visit a recycling facility.

5. Using the information gained, have the class decide on what type of program (buy-back, curbside, drop-off) would be best for the town (or school). Once this is determined, have them design a program for collection, storage, transportation, processing, and marketing of the recyclable(s).

EXTENSIONS

1. Have the students prepare their plans and information to present to school or town officials, or local planning groups.

2. Have the class research or visit recycling facilities in other communities. Have them interview a program representative asking questions such as: How did the program get started? What does it cost to operate and maintain? What is the level of community participation? What types of problems have been encountered? Using this information, have the students compare different programs and the advantages and disadvantages of each.

3. Have the students compare the cost effectiveness of the different types of recycling programs (e.g., curbside collection, buy-back, drop-off centers).

Source: Adapted from AVR, *Teacher's Resource Guide*

MASSACHUSETTS MUNICIPAL RECYCLING PROGRAMS

Revised 1994

Bedford, Massachusetts

Bedford is a suburban community northwest of Boston with a population of 12,000 and a substantial industrial base (mostly light industry and electronics). It generates approximately 6,000 tons per year (tpy) of residential waste. The town currently contracts with Browning-Ferris Industries (BFI) for complete curbside collection of recyclables. Commingled containers consisting of clear, green, and brown glass; steel cans; aluminum cans; and #1 and #2 plastics (PETE & HDPE) containers are collected on an alternating weekly basis with mixed paper. Mixed paper consists of newspaper, magazines, junk mail, cardboard, and all types of office paper. The town has had a voluntary curbside collection program since the 1970s; however, the town approved a mandatory curbside collection beginning in 1991. The annual cost of the program is $120,000.

Approximately 1,500 tons of material (25 percent of the waste stream) are collected annually through this program. Mixed paper accounts for 900 tpy, while commingled containers account for another 300 tpy. In addition, a fall mandatory leaf collection program collects 300 tpy of leaves for composting purposes. Participation rates regularly approach 90 percent. White goods including washing machines, dryers, stoves, hot water heaters, refrigerators, air conditioners, dishwashers, and other appliances are collected curbside the last Friday of every month. Not included in the tonnage figures are the approximately 1,000 tons of road sweepings and catch basin cleanings that are annually processed with leaf mulch into soil products for use on town projects.

At first glance, the $80 per ton cost of recycling would appear to be a savings compared with the combined tipping fee and hauling cost of $164 per ton of refuse. Bedfordís contract with the operator of the North Andover incinerator, however, is a ìput or payî contract. As a result, recycling actually costs the town $169 per ton. This translates to an added program cost of $7,500 per year. As long as this town’s incinerator contract is in effect (until 2005), this situation will exist, making recycling a more expensive option than incineration.

Source: Richard Warrington, Director of Public Works, Town of Bedford

Amesbury/Newburyport

Recycling began in Newburyport in December 1990 as a drop-off program. The municipal program was staffed by the volunteer organization Citizens for the Environment, who operated on two Saturdays a month. The program went curbside in November 1993 when the City was awarded a grant from the Department of Environmental Protection for a collection vehicle and recycling bins. The Town of Amesbury joined the program and the two communities formed a regional recycling program.

The two communities awarded the curbside collection contract to Kaufman Machine and Equipment Company, and Newburyport provided a lot to use as a recycling transfer station. The City of Newburyport also staffs a drop-off station at the same location which is open to residents of both communities. The drop-off program is separate from the curbside contract.

The curbside recycling program currently provides collection for all residents and businesses that have municipal curbside trash collection. Almost 2,700 tons of recyclables were collected in 1994. This represents 15 percent of the municipal solid waste stream. Approximately 11,000 stops are eligible under the contract for collection, with participation estimated to be at about 70 percent. The collection schedule alternates weekly between the communities with both vehicles operating in one community at the same time. Recycling is collected on the same day as trash.

The materials currently collected under the curbside contract include newspaper; aluminum, steel, and glass food and beverage containers; and #2 clear ìnarrow neckî plastic containers. Materials, which can be mixed in the bin, are separated into compartments on the trucks as they are collected. At the transfer station, separated materials are lightly processed for shipment.

The drop-off facility accepts all materials collected curbside with the addition of corrugated cardboard, #1 narrow neck plastic containers, most #2 colored narrow neck containers, and phone books, magazines, etc. White goods may also be delivered during drop-off hours. In addition, each community maintains separate drop-off compost sites.

Somerville

Somerville has a population of 76,210 and covers 4.1 square miles. The city is bordered by Boston, Cambridge, Medford, and Arlington.

Somerville has had a drop-off recycling program since 1989, a pilot curbside program since 1991 (covering about half the city), and city-wide curbside recycling since 1993. White paper recycling in municipal buildings has been ongoing since 1990.

The following materials are currently accepted through the curbside collection program: clear and colored glass; steel cans; aluminum cans, foil, and trays; #1 and #2 plastic bottles; coated paper milk and juice cartons; drink boxes; corrugated cardboard; telephone books; newspapers with all inserts; magazines; junk mail; and office paper.

In addition to the curbside program, the City of Somerville offers used motor oil and tire recycling, household hazardous waste collections, and a drop-off recycling center which has been opened to businesses at no charge.

Source: Somerville Conservation Commission Recycling Committee

KEEPING TRACK OF PAPER, COMPUTER STYLE

THEME:	Computers are a valuable tool for collating and recording information about resource use.
GOAL:	Students will use a computer spreadsheet to record waste paper generation in the school.
METHOD:	Creating a computerized monitoring program
SUBJECTS:	Math
SKILLS:	Interpreting data, problem solving, computer use
MATERIALS:	Computer; spreadsheet software
TIME:	1 hour to start, 30 minutes per week thereafter

GETTING STARTED

How might a computer be used to track important information about the quantity of material recycled at your school?

PROCEDURE

1. Have the students set up a paper recycling program at your school (Contact DEP for a copy of the *Manual for Implementing a School Recycling Program*). Alternately, have them collect and record the weight of paper products discarded by your school in a given number of weeks.

2. Working individually or in teams, have the students set up a spreadsheet that records and stores information about the amount of paper collected each week. The spreadsheet should include:

   a. The total number of students in the school

   b. The average weight of paper thrown away per student each week

   c. A running total and average of the above information

3. Using the figures below (provided by the Scott Paper Company), have the students determine how many trees—in the form of paper—are being consumed by the school each week:

In the South and East Coast regions of the U.S., an "average" tree used to make pulp for printing and writing paper would probably weigh about 500 pounds. This 500-pound tree, after processing through the paper-making system, would make approximately 100 to 150 pounds of paper.

4. Have the students use the following figures to determine the amount of energy used to generate the paper being thrown away each week.

In a typical pulp and paper mill, it takes approximately 27 million BTUs of energy to make 1 ton of paper. Another way of looking at this would be to say that 1 gallon of "oil equivalent" would make approximately 11 pounds of paper.

Source: Reprinted with permission from Washington, *A-Way With Waste*

PAPER RECYCLING AND ITS BY-PRODUCTS

THEME:	Recycling conserves resources, saves money, and reduces waste, but it does not eliminate all pollution.
GOAL:	Students will understand some of the technical problems encountered in the production of recycled paper.
METHOD:	Making recycled paper and testing the water for pollutants
SUBJECTS:	Chemistry, earth science
SKILLS:	Experimenting, interpreting, measuring, predicting
MATERIALS:	Several sheets (at least 9” x 12”) of different types of paper (newsprint, colored newsprint, white office paper, construction paper, envelopes, etc.); nylon stocking, cheesecloth, or Millipore filter; pH testing kit; a small scale; “Recycled Paper and its By-Products” worksheet (See Activity 3-5, “Papermaking,” for additional papermaking materials)
TIME:	One class to make the paper, one class to test the water for contaminants

BACKGROUND

Although recycling paper saves natural resources and energy, pollution still occurs in the production of recycled paper. To be recycled, waste paper must be de-inked and have contaminants removed. Black printing inks used in newspapers are composed of about 30 percent pigment (usually carbon black) and about 70 percent petroleum-refined oil. Colored pigments in magazines—and increasingly in newspapers—contain heavy metals. New low-rub inks and laser printing cause additional problems because they are difficult to remove from paper. The papermaking process requires large amounts of water, all of which must be cleaned of contaminants. The remaining paper sludge also must be disposed of properly because petroleum distillates and heavy metals can remain present in this material. Both the contaminated water and sludge must be treated in a wastewater treatment plant before being released into the environment.

GETTING STARTED

Does recycling eliminate all the pollution associated with manufacturing products?

PROCEDURE

1. Divide the students into small groups. Using the procedure in the papermaking activity, have each group make recycled paper out of a different type of waste paper.

2. Students should collect the water that drains through the screen while the paper is being pressed and check it for pollutants by testing the pH and noting color and sediment. Have each group strain the collected water and sludge through cheesecloth, nylon stocking, or a Millipore filter, and examine what contaminants remain behind.

3. Have the students collect a sample of water after straining, and note its pH, color, and sediment. Set samples aside (do not disturb). Repeat pH, color, and sediment tests and observations after 1, 4, and 24 hours.

4. Have each group complete the “Recycled Paper and Its By-Products” worksheet and discuss the results as a class. (See Teacher’s Page for answers to these questions.)

5. Have the students measure and compare the volumes and weights of both the scrap paper before it is torn up and placed in solution, and the new recycled paper that is produced from it. The recycled paper should be dried

before weighing and measuring. Does the recycled paper weigh as much as the original paper? Why is there a difference? Students should also compare the length of fibers and appearance of both types of paper.

EXTENSIONS

1. Visit a paper mill.

2. Research the pollution control methods used in paper mills.

Sources: Adapted from AVR, *Teacher's Resource Guide*; Paul Emond

PAPER RECYCLING AND ITS BY-PRODUCTS

Worksheet

1. What materials are in the sediment and sludge generated from making paper?

2. What is causing the discoloration of the water?

3. Is the strained water less polluted than the unstrained water?

4. Should the remaining paper sludge be treated as solid waste or as hazardous waste?

5. How can we reduce the amount of pollution generated by the papermaking process?

PAPER RECYCLING AND ITS BY-PRODUCTS

Teacherís Page

1. What materials are in the sediment and sludge generated from making paper?

   The sludge contains primarily wood fibers (paper) that were too small to be recovered in the papermaking process. Any materials that were in the paper before recycling (including petroleum distillates and heavy metals), will be in the new recycled newspaper, the sludge or the water discharged after processing.

2. What is causing the discoloration of the water?

   Some of the inks, fibers, and other materials in the paper being processed get suspended or dissolved in the process water, causing discoloration.

3. Is the strained water less polluted than the unstrained water?

   The strained or filtered water is less polluted than the unstrained water because some suspended materials have been removed. A finer filter will remove more suspended solids, resulting in less polluted water.

4. Should the remaining paper sludge be treated as solid waste or as hazardous waste?

   It depends on the concentrations of chemicals in the final sludge. If the original paper before recycling contained a minimal amount of hazardous materials (e.g., heavy metals, petroleum, etc.), the final sludge will also be low in these materials. The sludge, therefore, would contain mostly wood fibers and be considered a solid waste and not a hazardous waste.

5. How can we reduce the amount of pollution generated by the papermaking process?

   In this context, pollution problems can be reduced by:

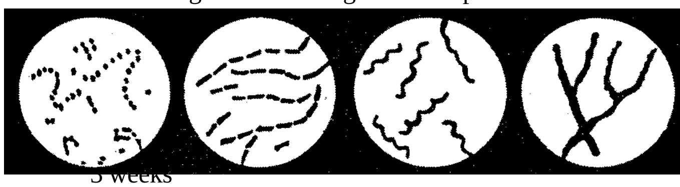
   a. Source Reduction: Hazardous materials used in the original paper manufacturing process should be removed.

   b. Waste Minimization: Additional pollution control methods can be employed to remove and concentrate the hazardous materials in the sludge.

   c. Beneficial Reuse: The sludge waste can be reused by composting it for use as a low-grade fertilizer.

MICROORGANISMS: BACTERIAL RECYCLERS

THEME: Microorganisms are essential to the recycling of organic matter.
GOAL: Students will relate the importance of healthy microorganisms to composting.
METHOD: Observing and sketching slide samples under the microscope
SUBJECTS:
SKILLS:
MATERIALS: t or methylene blue; matter (food waste, leaves,



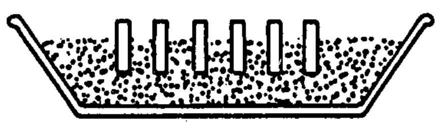
TIME: 3 weeks

GETTING STARTED

What types of organisms are responsible for the composting process?

PROCEDURE

1. Divide the students into small teams. Have each group fill one tray with dry soil and a second tray with soil plus 5 to 10 percent organic matter, well mixed. Insert six slides vertically into each tray as shown in Figure 1.



2. Six slides in each container will permit observation of each sample at the end of one, two, and three weeks. Adjust the moisture content of the soil to about 20 percent water by adding a volume of water corresponding to about 1/5 of the volume of soil. Keep moisture content as constant as possible by adding water as needed.

3. After one week, have students examine two slides from each container according to the following procedure. Dig soil away from one side of the slide, then tilt the same slide toward the hole and lift it out.

4. The slide will now have a film of soil and microorganisms on one side. Have the students clean the other side with a cloth and label the slide with a wax pencil. Repeat for a second slide.

5. The preparation on the slide is "fixed" by passing the slide over a flame—one or two passes should be sufficient. Stain one slide dark, using gentian violet or methylene blue. Stain the other slide light, using erythrosine or eosine.

6. Have each team examine their slides for bacteria with the low and high powers of a microscope. If present, spirilla will probably not be seen unless the field is darker. Have the students sketch what they see and compare them to the diagrams in Figure 2 to identify the morphological class of the bacteria. Are there differences in the number and types of microorganisms in each of the samples?

Figure 2: Common Morphological Classes of Bacteria

7. At the end of the second week, repeat the procedure with another pair of slides from each sample. Have the students determine if the number and types of bacteria in the samples have changed significantly. What might account for any observed changes?

8. At the end of the third week, repeat the procedure and make further comparisons. Have each team relate its observations and conclusions to composting.

Source: Reprinted from Bell and Swartz, *Oscar's Options* with permission

HOW TO MAKE COMPOST—VARIATIONS ON A THEME

THEME:	Composting reduces the amount of organic material requiring landfilling or incineration; produces a valuable soil supplement; and provides an opportunity to observe nature at work.
GOAL:	Students will learn how to construct a good compost pile as well as how different factors affect the composting process.
METHOD:	Comparing one correctly-made compost pile with other piles in which key components are varied
SUBJECTS:	Biology, ecology, horticulture, math, chemistry
SKILLS:	Analysis, experimentation, prediction, observation
MATERIALS:	Organic materials including at least one type of high-carbon material (e.g., brown leaves, straw, sawdust, cardboard, paper) and at least one type of high-nitrogen material (e.g., grass clippings, fruit and vegetable scraps, weeds, seaweed); 1–6 compost bin(s)*; six shovelfuls of finished compost or outdoor soil for each compost bin (smaller containers will require less soil); two or three paper cups containing finished compost; compost thermometer; gloves, rakes, and shovels; "Necessary Components of a Compost Pile," "Variations on a Theme—How Not to Compost," "Home Composting," and "Composting is Easy" handouts/worksheets
TIME:	Two 1-hour sessions for set-ups, several months for observations

*Many communities sell low-cost compost bins through the DEP's recycling grant program; some donate compost bins to schools. A garbage can with holes drilled in the sides and bottom may be used as a compost bin, also. Smaller containers such as 5-gallon buckets may be used for the variation piles in this activity.

BACKGROUND

There are four key ingredients to the composting process. If any one of them is left out, composting may create odors or may not occur at all. This activity teaches students how to compost successfully, and to try variations that leave out key ingredients, thus illustrating the importance of each.

GETTING STARTED

What are the essential ingredients for successful composting?

PROCEDURE

1. To illustrate the nature of the decomposition process, pass around the paper cups containing finished compost for students to observe, touch and smell. Ask students to guess what the original ingredients were. Their answers will indicate how much they already know about composting and provide a good introduction to the topic of how to make compost.

2. Review with students the “Necessary Components of a Compost Pile,” “Home Composting,” and “Composting is Easy!” handouts. As a group, make a compost pile based on the information given, using an aerobic compost bin. This will be your control pile (one session).

3. Working in teams, build additional compost piles based on the variations described in the “Variations On A Theme” worksheet (one session).

4. Have each group prepare a log book and record the daily temperature of its pile and the control pile for 2 months. Have students record other observations, such as organisms seen, odors detected, moisture content, color, and amount of decomposition that has occurred.

5. Discuss the results, addressing the questions on the “Variations” worksheet as well as: How is composting related to the concept of recycling? Can composting make a difference in the amount of waste needing disposal? Why don’t more people compost? What would make it easier for people to compost?

EXTENSIONS

1. Have the students design compost bins that satisfy the requirements of the decomposer organisms and the needs of people who might use the bins. This could be a group or individual project. Select the best bin, have the class build it and use it.

2. Grow seedlings using the finished compost. Make different blends with potting soil, using pure potting soil as a control.

3. Have each student research one decomposer organism in depth, then make a 5-minute presentation to the rest of the class.

4. Using the C:N ratio for leaves (80:1) and grass clippings (20:1), have students calculate how many parts leaves to grass clippings would result in a C:N ration of 30:1.

Source: Massachusetts DEP

NECESSARY COMPONENTS OF A COMPOST PILE

Composting is not difficult—most of the work is done by organisms that live in the soil and on the surface of organic material. The smallest and most numerous of these decomposers are naturally-occurring bacteria. They are assisted by molds, fungi, mites, beetles, centipedes, millipedes and, perhaps most popular among gardeners, earthworms. All of these creatures play important roles in the food web of the compost heap. If your compost pile is in contact with the soil, these organisms will migrate up into the organic material. If your compost pile is contained and has a floor, place 2 inches of nonsterile soil in the bottom of the container before adding organic material.

Successful composting is simply a matter of providing the conditions in which the decomposer organisms will flourish. Like you, they need food, air, water, and a habitable temperature. If you keep these requirements in mind, you will compost successfully.

Food

What you add to your compost pile will provide the food for the decomposers. All organic material contains carbon and nitrogen in varying amounts. The microorganisms need carbon for energy and nitrogen to reproduce, and they are most productive when the ratio of carbon to nitrogen is approximately 30 to 1 (30:1). To achieve a good carbon-to-nitrogen ratio, keep in mind that dry, woody materials, such as dried leaves, straw, and cornstalks (“browns”), are high in carbon, and should be layered with damp, green materials, such as weeds, grass clippings, or vegetable scraps (“greens”), which are high in nitrogen. High-carbon materials may be successfully composted alone, but high-nitrogen materials composted alone will result in a gooey, odorous mess. Maximize surface area by shredding or chopping the material.

OK To Put in Compost Pile		**Keep Out of Compost Pile**
Brown	**Green**	
Fall leaves Straw Brown hay Paper Coffee filters Sawdust Wood chips Wood ash (thin layers)	Grass clippings Weeds (without seeds) Fruit and vegetables scraps Manure (not dog or cat) Coffee grounds, tea bags Egg shells Bread and grains (if bin is rodent resistant) Seaweed	Meat, bones, fat, grease Peanut butter, oils Dairy products Cooked foods with butter or sauce Dog and cat manure Branches Diseased plants Weeds gone to seed Weeds that spread by roots and runners

Air

If your compost pile is too wet or too compact, anaerobic organisms will take over, creating odors of ammonia or rotten eggs. To keep your compost pile from developing unpleasant smells, oxygen must be available so that aerobic organisms will thrive. Oxygen is supplied to the inside of the pile by turning it regularly, and air passages can be built into the pile by using coarse material on the bottom.

Moisture

Decomposer organisms require a moist environment. The composting material should contain about 50 percent moisture, which should make it feel as damp as a wrung out sponge, but not dripping wet. If material is not damp, the composting process will stop. If material is too wet, air spaces will be filled with water, resulting in anaerobic conditions and odors.

Habitable temperatures

As the organisms go to work, they produce heat, which causes the temperature in the pile to rise. This creates a good environment for other heat-loving organisms to multiply, increasing the population of decomposers. To maintain its heat throughout the year, the compost pile must have sufficient mass. One cubic yard (27 cubic feet) is the minimum volume needed to maintain the heat of composting through the winter. If you don't have enough material to make a pile that large, the pile will freeze in the winter but the organisms will revive when warm weather returns and the composting process will resume.

Refer to the following chart if you should have problems with your compost pile.

COMPOSTING TROUBLE-SHOOTING CHART

Symptoms	Problems	Solutions
Pile not decomposing	Too dry	Moisten till damp
Pile smells rotten and/or attracts flies	Too wet Wrong materials in pile	Mix in dry, woody materials Remove meat, bones, etc.
Rodents or other animals attracted to pile	Food scraps in open bin and/or not buried	Use rodent-resistant bin

	Wrong materials in pile	Bury food scraps at least 8” deep Remove meat, bones, etc.

VARIATIONS ON A THEME—HOW *NOT* TO MAKE COMPOST

Worksheet

Make five compost piles that, all other conditions being the same, vary in one of the ways described below (see the "Home Composting" handout for information on the standard way of setting up the piles). Variations 1 and 4 will not produce odors. Variations 2, 3 and 5 are likely to produce odors. You can experiment with variations 2, 3, and 5 without creating nuisance conditions by making miniature piles. Use 5-gallon buckets or similar containers instead of full-size compost bins.

Variation 1. Not Enough Moisture

Make the compost pile with dry ingredients only. Do not add moisture. Use a bin with solid cover to keep rainwater out, or cover the bin with plastic.

Variation 2. Too Much Moisture

Make the compost pile, soaking the materials with water as they are placed in the bin. Water should drip from the material when it is picked up. Add water every day for one week.

This variation may produce strong odors, depending on how much moisture is retained in the pile. Make observations after one week, then mix enough dry, brown leaves into the pile so that it is moist, not dripping. If the pile is generating odors, cover with 2 inches of soil and let sit for one month without turning.

Variation 3. Too Much Nitrogen, Not Enough Carbon (C:N Ratio Too Low)

Make the compost pile using only high-nitrogen materials. Use anything from the "greens" list. Continue this variation for one week only.

This variation may produce strong odors, depending on the size of the pile. After one week, mix twice the volume of brown leaves into the pile of high-nitrogen material. Cover with 2 inches of soil. Let sit for one month without turning.

Variation 4. Too Much Carbon, Not Enough Nitrogen (C:N Ratio Too High)

Make the compost pile using only high-carbon materials. Use anything from the "browns" list. This variation will not create unpleasant odors.

Variation 5. Not Enough Air

Make the compost pile in an airtight container, such as a garbage can with a tight-fitting lid, or a smaller container. Do not open the lid for one week.

This variation may produce odors, depending on the material used, the size and the airtightness of the container. After one week, mix twice the volume of brown leaves into the container. If the pile generates odors, cover with 2 inches of soil. Let sit for one week without turning. Move material into an aerobic bin (or drill holes in the garbage can every 2 inches) and continue composting.

Questions:

1. Why didn't anything happen to the dry pile?

2. Why did the wet pile start to smell?

3. Why does an excess of high-nitrogen materials in a compost pile result in odors?

4. Why doesn't an excess of high-carbon materials in a compost pile result in odors? Why does it take longer to decompose?

5. Why does a lack of oxygen result in odors?

VARIATIONS ON A THEME—HOW *NOT* TO MAKE COMPOST

Teacher's Page

Questions:

1. Why didn't anything happen to the dry pile?

Without adequate moisture, the decomposer organisms cannot thrive.

2. Why did the wet pile start to smell?

Water fills air spaces, aerobic organisms die. Anaerobic organisms take over, releasing odorous gases (hydrogen sulfide, ammonia).

3. Why does an excess of high nitrogen materials in a compost pile result in odors?

Too much nitrogen can cause the desirable aerobic organisms to multiply very quickly, use up all the available oxygen, and die off. Anaerobic organisms then take over, releasing odorous gases. Also, excess nitrogen will be converted to ammonia.

4. Why doesn't an excess of high carbon materials in a compost pile result in odors? Why does it take longer to decompose?

An excess of carbon necessarily implies a shortage of nitrogen. This condition limits the rate of microbial reproduction and the circumstances that lead to odors, as described in Answer 3. A lower rate of microbial growth results in slower composting.

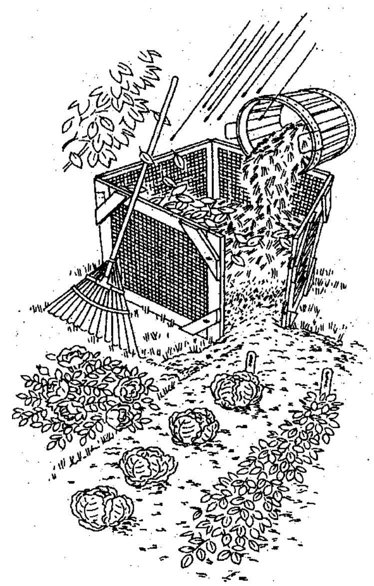
5. Why does a lack of oxygen result in odors?

A lack of oxygen results in odors because such an environment encourages the growth of anaerobic organisms, which release odorous gases, such as hydrogen sulfide.

HOME COMPOSTING

Turn spoils into soil . . .

A guide for composting yard and food waste



What is Composting?

Composting is a controlled process of decomposition of organic material. Naturally-occurring soil organisms recycle nitrogen, potash, phosphorus, and other plant nutrients as they convert the material into humus.

Benefits of Composting

Composting is a convenient, beneficial and inexpensive way to handle your organic waste and help the environment. Composting:

- Reduces the volume of garbage requiring disposal;
- Saves money for you and your community in reduced soil purchases and reduced local disposal costs; and
- Enriches the soil. Using compost adds essential nutrients, improves soil structure, which allows better root growth, and increases moisture and nutrient retention in the soil. Plants love compost!

What You Should Compost

Yard wastes such as leaves, grass clippings and weeds make excellent compost. Fruit and vegetable scraps, plus food wastes such as coffee grounds, tea bags, and eggs shells, can be composted. To keep animals and odors out of your pile, do not add meat, bones, fatty food wastes (such as cheese, grease and oils), dog and cat litter, and diseased plants. Do not add invasive weeds and weeds that have gone to seed to the pile.

HOME COMPOSTING

(continued)

Elements of a Good Compost Pile

With these principles in mind, you can convert your organic wastes into resources by turning your spoils to soil.

The Biodegraders

Nature has provided an army of workers who specialize in decomposing organic material. These "critters"—bacteria, fungi, molds, earthworms, insects and other soil organisms—eat all types of organic material and in the process convert nutrients into a form plants can utilize. Without those compost critters, we would be surrounded by mountains of leaves and the soil would be barren. The process of composting is simply a matter of providing the soil organisms with food, water and oxygen. They do the rest.

Organic Material

Organic material contains varying amounts of carbon and nitrogen which nourish the organisms naturally present in your compost pile. (Billions of bacteria inhabit the surface of every leaf and blade of grass in your yard.) The critters need both carbon and nitrogen. An easy way to provide both of these is to remember that brown, woody materials, such as autumn leaves, are high in carbon while green, moist materials, such as grass clippings, are high in nitrogen (refer to the table on the back of this brochure).

Alternating layers of brown and green materials will yield finished compost in three to eight months. Leaves alone break down in six to 15 months. Grass clippings or food scraps composted alone result in unpleasant odors because they contain more nitrogen than the compost organisms can use. Layer leaves or straw with green material, or let it dry until it turns brown before composting it alone.

Air

The compost critters need oxygen, just as we do. Lack of oxygen will slow down the composting process and cause odors. Turn your pile, fluff it with a hoe or compost turning tool, or build air passages into the pile with cornstalks to provide oxygen to the organisms.

Moisture

Compost organisms need a moist environment. The pile should be as damp as a wrung-out sponge, but not dripping wet. Make sure leaves are damp when you add them to the compost pile because they will not break down if they are dry. Since moisture evaporates as the pile heats up (a sign of active composting), let rain and snow replace it, or add water during dry spells. A cover helps retain moisture in hot weather.

HOME COMPOSTING

(continued)

How to Use Compost

When the composted materials look like rich, brown soil, it is ready to use. Apply one-half to three inches of finished compost and mix it in with the top four inches of soil about one month before planting. Compost can be applied as a top dressing in the garden throughout the summer. Compost is excellent for reseeding lawns, and it can be spread one-quarter inch deep over the entire lawn to rejuvenate the turf. To make potting soil, mix equal parts compost, sand and loam. You may put the compost through a sieve to remove large particles—these can go back into the pile.

Mulching

Grass clippings, leaves and woody yard wastes can be used as mulch in gardens and around shrubs to keep the soil moist, control weed growth and add nutrients. Woody materials should be chipped or shredded. Use a mulch of pine needles around acid-loving plants. Leaves will work first as mulch, then as a soil enricher as they decompose. Grass clippings should be dried before using as mulch. Do not mulch with grass clippings which have been treated with herbicides; composting them first, however, will break down the herbicides.

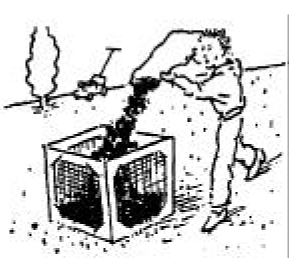
Composting Without a Yard

Composting can be done indoors using an earthworm farm. Not only can you recycle your food scraps, you can also have a steady supply of fishing bait! For more information call DEP's Solid Waste Management Program.

Compost Bins

Holding Bins

These portable containers are the simplest way to comp ost. Turning is optional.

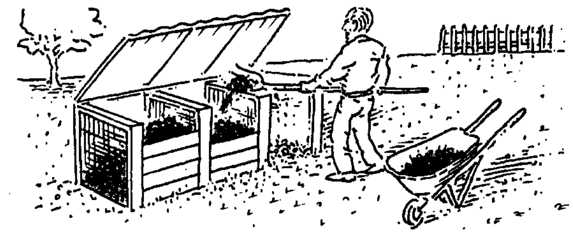


HOME COMPOSTING

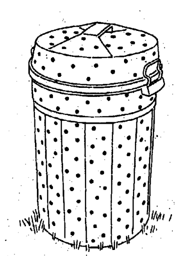
(continued)

Turning Bins

A series of three or more bins allows you to make compost in a short time by turning the materials on a regular schedule.

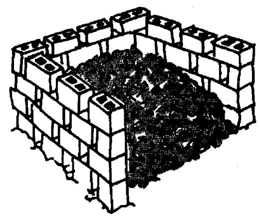


Barrel Bin

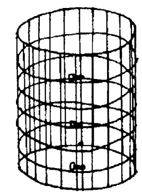


These bins can easily be from plastic garbage cans.

Block Bin

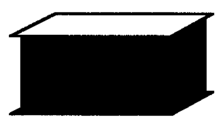


Wire Bin



Block bins and wire bins can also be made for made composting.

Earthworm Bin



How To Make a Compost Pile

There are as many different ways to make compost as there are people who do it. The following guidelines will get you started, but soon your own experience will help you tailor a method that best fits your needs.

1. Build or purchase a compost bin. Check to see if your community has a composting bin distribution program, or order from a garden catalogue, nursery or hardware store. Enclosed compost piles keep out pests, hold heat and moisture in, and have a neat appearance. Or, bins can be simply made of wire, wood, pallets, concrete blocks, even garbage cans with drainage holes drilled in them. In urban areas, rodent-resistant compost bins—having a secure cover and floor and openings no wider than one-half inch—must be used.

HOME COMPOSTING

(continued)

2. Set up the bin in a convenient, shady area with good drainage. A pile that is about three feet square and three feet high will help maintain the heat generated by the composting organisms throughout the winter. Although a smaller pile may not retain heat, it will compost.

3. Start the pile with a layer of coarse material such as corn stalks to build in air passages. Add alternating layers of "brown" and "green" materials with a shovelful of soil on top of each layer. Shredding leaves or running over them with a lawn mower will shorten the composting time. Be sure to bury food scraps in the center of the pile.

4. Add water as you build the pile if the materials are dry.

5. As time goes on, keep oxygen available to the compost critters by fluffing the pile with a hoe or compost turning tool each time you add material. A complete turning of the pile—so the top becomes the bottom—in spring and fall should result in finished compost within a year. More frequent turning will shorten the composting time.

High Nitrogen "Green" Ingredients	**High Carbon "Brown" Ingredients**
• Alfalfa Hay/Meal • Grass Clippings • Blood Meal • Manure (cow, horse, chicken, rabbit) • Food Wastes (fruit & vegetables, coffee grounds, tea bags, egg shells) • Seaweed	• Autumn Leaves • Cornstalks • Straw • Pine Needles • Paper/Cardboard • Wood chips • Saw Dust

Where to Get More Information

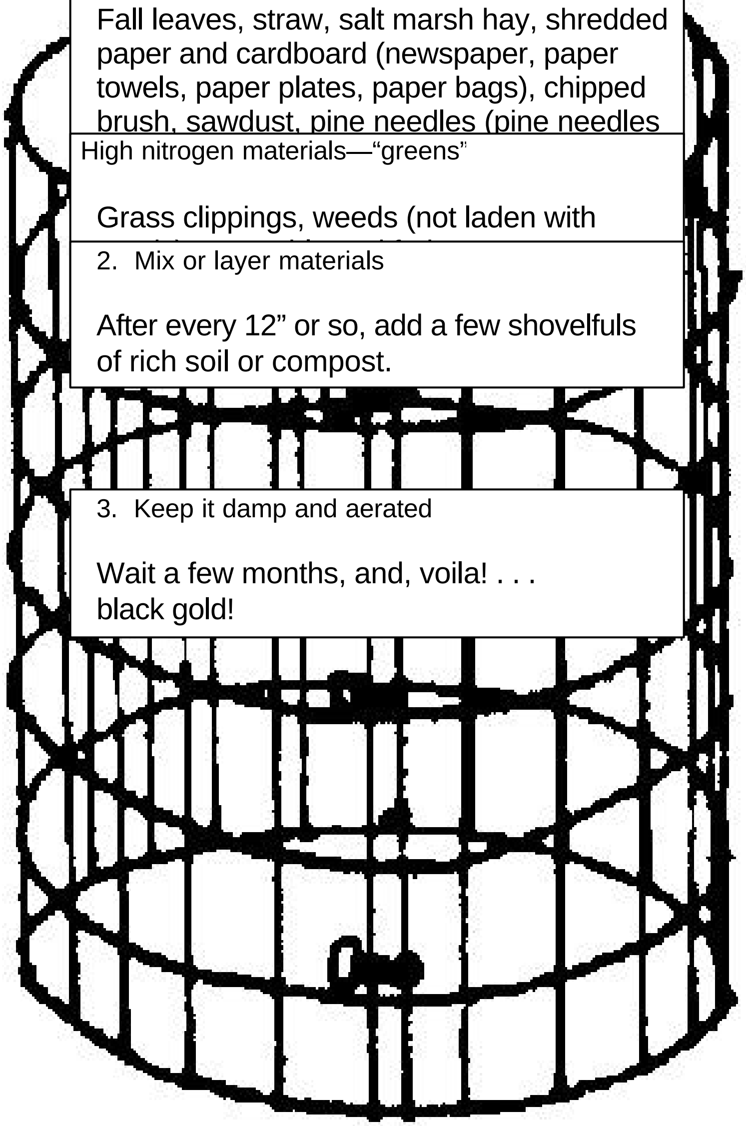
In cooperation with the Massachusetts DEP, the State of Connecticut has produced a video entitled *Turning Your Spoils to Soils*, which is available in most local libraries in Massachusetts. DEP's Solid Waste Management Program also provides technical assistance and reference materials on composting, and can be reached at (617) 292-5834.

Source: Massachusetts DEP; graphics courtesy of the Massachusetts Audubon Society and Seattle Solid Waste Utility

Composting is easy!
Just follow these simple steps

To make compost:

1. Add:



High carbon materials—"browns"

Fall leaves, straw, salt marsh hay, shredded paper and cardboard (newspaper, paper towels, paper plates, paper bags), chipped brush, sawdust, pine needles (pine needles

High nitrogen materials—"greens"

Grass clippings, weeds (not laden with

2. Mix or layer materials

After every 12" or so, add a few shovelfuls of rich soil or compost.

3. Keep it damp and aerated

Wait a few months, and, voila! . . . black gold!

For best results, and to keep out odors and pests:

DO NOT ADD

- Meat
- Bones
- Fat
- Grease
- Oils
- Peanut Butter
- Dairy products (cheese, butter, milk, eggs)
- Cooked foods with sauces or butter
- Dog and cat manure
- Diseased plants
- Weeds gone to seed
- Weeds that spread by roots and runners (vines)

Source: Massachusetts DEP

NOT IN MY BACKYARD

THEME:	Building new waste disposal facilities usually raises strong public opposition.
GOAL:	Students will examine the social, economic, and environmental issues raised during the proposal for building a combustion facility in their community.
METHOD:	Mock town meeting
SUBJECTS:	Economics, science, social studies
SKILLS:	Analyzing, communicating, problem solving
MATERIALS:	Journal articles (see list under Procedure section)
TIME:	Two periods, plus preparation time

BACKGROUND

When new waste disposal facilities need to be built, the prevailing public sentiment has been "Not-In-My-Backyard" or NIMBY. When surveyed, most Americans consistently rank solid waste management as among the top local priorities. Even though this is true, strong public opposition remains to placing facilities in one's own community. Opposition to combustion facilities and landfills rests on widespread concern about the environmental impact of the facility. The fear of groundwater contamination is the primary worry about siting landfills, while air emissions and problems with ash disposal are seen as the threats from combustion facilities. Increased public acceptance of waste facilities will depend on the industry's ability to alleviate environmental anxieties through education.

Edward Byers, "Now Entering the Age of NIMBY?"
Waste Age Magazine, January 1990

GETTING STARTED

Present the following scenario to students: Your town has a solid waste disposal problem and is considering construction of a combustion facility to alleviate the situation. Is this a wise decision? What would be the advantages and disadvantages to your community?

PROCEDURE

1. Explain to the students that there will be a public hearing held by town officials to consider whether a combustion facility should be built in the community. Testimony from different groups will be heard at the meeting.

2. Divide the class into four groups:

- Town government officials (e.g., Selectmen or Town Council)
- Citizens group (including environmental groups)
- Project developer (including chemists and environmental engineers)
- Board of Health official or Town Planner

Groups should research the issue and prepare to represent that viewpoint at the mock town meeting. Assign one spokesperson from each of the last three groups to present his or her group's position. Each local government official or town council member will be allowed to ask questions of the groups following the presentation.

3. Obtain and distribute the following articles to help students formulate their position for the hearing.

- "Now Entering the Age of NIMBY?" by Edward Byers, *Waste Age*, January 1990, pp. 36–38.

- "YIMBYism is Coming, But..." by Marvin G. Katz, *Waste Age*, January 1990, pp. 40–41.

- "A Micro Study of NIMBYism" by A.L. Rydant, *Waste Age*, January 1990, pp. 44–45, 48, 50, 52.

- "Funding Sites for Waste-to-Energy" by Frank Cross, Phil O'Leary and Patrick Walsh, Lesson 6, University of Wisconsin/*Waste Age* Course, pp. 29-33.

Waste Age Magazine, 1730 Rhode Island Ave., NW, Suite 1000, Washington, DC 20036

4. When the groups are ready to make their presentations, assemble the entire class. Seat town council members to face the audience. Each group spokesperson should present a position statement, followed by an opportunity for questions and discussion. At the end of the meeting the council votes on the proposal to site the facility.

EXTENSIONS

1. Use this same format for siting a landfill in a community.

Source: Adapted from Bell and Swartz, *Oscar's Options*

BURY THAT TRASH

THEME:	Most solid waste is disposed of in landfills.
GOAL:	Students will understand how a landfill is operated, managed, and regulated.
METHOD:	Visiting a landfill and/or interviewing a landfill expert
SUBJECTS:	Language arts, math, science, social studies
SKILLS:	Estimating, interviewing, observing, recording
MATERIALS:	“Bury That Trash” questionnaire
TIME:	1 hour, excluding time for field trip

GETTING STARTED

What happens to waste when it goes to a landfill? How are landfills operated?

PROCEDURE

1. Contact a municipal or commercial landfill and obtain permission for your class to visit. Arrange for the site manager or landfill personnel to guide your class around the site and to answer questions. A list of landfill disposal sites in Massachusetts can be obtained from DEP’s Division of Solid Waste Management.

2. If you are unable to take a trip, invite a solid waste management representative to your class as a guest speaker. Possibilities include a waste disposal site operator, a private waste hauler, a Board of Health officer, a public works official, a state DEP official, or a regional solid waste planner or manager.

3. Prior to the field trip or speaking engagement, have the students develop a list of questions such as those listed on the “Bury That Trash” questionnaire, and investigate possible answers. Send the questions to the guide or guest speaker in advance so they can prepare responses.

4. Based on the interviews, have the class determine the costs involved in collecting and disposing of waste.

5. Present the following problem to the class and discuss the implications of the results.

A new landfill is being sited in your town. You are the local landfill expert and have been asked to answer some questions about the project. Assume the following:

- Each resident produces 1.1 pounds of trash per day or 405 pounds per year.
- 800 pounds of trash = 1 cubic yard of landfill space
- 1 acre of landfill space, 10 feet deep = 16,133 cubic yards capacity

a. Determine the amount of space in both cubic yards and acres that will be needed to serve your community for 20 years, 50 years, 70 years.

b. Your town is seriously considering a 50-acre site for its new landfill. They have asked you to determine how long it will last, assuming the amount of trash generated per person and population of your town remain constant over time.

c. How would population growth affect the life of the new landfill?

6. Have the students write essays that address some or all the questions discussed with the landfill expert. Encourage students to include their personal views and thoughts on some of the issues associated with landfills.

7. As a class, discuss some of the questions and issues that came up in the essays. Additional discussion questions include: Are landfills the best way to dispose of trash? What are the merits and potential problems associated with landfills? Would you mind living near one? How do modern sanitary landfills differ from open dumps? How might we reduce our need for landfill space?

EXTENSIONS

1. Design a use for your landfill when it closes.

Sources: Adapted from Wisconsin, *Recycling Study Guide*; AVR, *Teacher's Resource Guide*

BURY THAT TRASH

Questionnaire

1. Where is the garbage from your home and school taken?

2. How does it get there?

3. Why was the landfill located on this site? What factors must be considered when a site is selected?

4. What tests were done at the site before it was opened? What were the results?

5. What laws govern solid waste disposal in your community?

6. Is the landfill an engineered or unengineered site?

7. Who owns the landfill? When did it open? What was the cost of constructing it?

8. Who does the site serve? Who can bring wastes to the landfill?

9. What is the tipping fee for using the landfill?

BURY THAT TRASH

Questionnaire (continued)

10. How much does it cost to take care of trash once itís in the landfill?

11. How much solid waste is disposed of at this facility daily? Weekly? Yearly?

12. Who monitors what is dumped at the site? Are any of the materials hazardous?

13. What happens to the trash once itís been dumped at the landfill? How is the site managed for control of erosion, surface runoff, leachate, and blowing trash?

14. Are any groundwater, soil, or methane tests performed regularly at the site?

15. How many years is the landfill expected to last? How much time does the community have to find a new site or an alternative means of disposal?

SOIL MAKES A DIFFERENCE

THEME:	Leachate from landfills can threaten ground and surface water supplies.
GOAL:	Students will learn that the underground movement of leachate is influenced by soil type.
METHOD:	Comparing the waterholding capacity of various soils
SUBJECTS:	Geology, science
SKILLS:	Observing, recording
MATERIALS:	Plastic containers with covers (e.g., empty juice or milk jugs); pebbles, gravel, coarse sand, fine sand, topsoil, clay, or other types of soil; a watch or clock with a second hand; water; bowls; measuring cup; powdered paint; "Landfill Soil" worksheet
TIME:	1 hour

BACKGROUND

The geology and soil underlying and surrounding a landfill influences the direction and rate of leachate flow and whether it will threaten water supplies. The ability of a material such as soil to transmit water is called permeability. Leachate tends to move quickly through highly permeable soils such as sand or gravelly loam, while impermeable clays present an obstacle to quick drainage. This is one avenue for leachate to contaminate groundwater supplies.

For additional information on groundwater, obtain Groundwater Informational Flyer #8 from the Massachusetts Audubon Society.

GETTING STARTED

Ask the students whether the type of soil or bedrock beneath a landfill influences the flow of leachate. How does it influence the contamination of nearby water supplies?

PROCEDURE

1. Divide the students into small teams to set up the experiment. To prepare containers, perforate the cap of each plastic jug and cut off the bottom end. Replace the cap, turn the container upside down, and fill it about two-thirds full with one kind of soil. Repeat with different types of soil, labeling each jug as to soil type. In addition, the instructor should prepare a separate container in which several tablespoons of powdered paint have been buried in a well in the soil. Cover the paint completely so that the students do not know the paint is there.

2. Have each team select one container and remove the cap before placing the mouth end in a bowl. Noting the time, pour in one pint of water. Each team should record the time at which water starts dripping into the bowl and the time at which it stops. Have each team measure the amount of water that came through and record next to the time calculations for later analysis. Was the amount of water that dripped through more or less than was initially added? What might this say about the soil?

3. Have teams repeat the experiment with each type of soil. Students should compare the data from all their trials and write a brief description of each type of soil and its properties.

4. Repeat the experiment a third time with the soil containing the paint. What color was the water that drained out? Discuss with the students that there are many chemicals, like the paint, that are buried in landfills and not detectable to the eye. When water passes through a landfill it can pick up traces of chemicals, heavy metals, bacteria, and various products of decomposition. The type of soil surrounding the landfill determines the rate

and direction of leachate flow. Discuss this process with the class addressing questions such as: Which type of soil is most suitable for a landfill site? Why? What kinds of problems could result from underground movement of leachate? How might these be solved?

EXTENSIONS

1. Have the students research techniques that have been developed to inhibit leachate formation, as well as those designed to reduce the potential for groundwater contamination. Possible topics include impermeable landfill liners, leachate collection systems, and capping of closed landfills. Have students present their findings to the class as the basis for a discussion on the effectiveness of these techniques or other relevant issues they have discovered.

Sources: AVR, *Teacher's Resource Guide*; Bell and Swartz, *Oscar's Options*

LANDFILL SOIL

Worksheet

SOIL TYPE	TIME ELAPSED BEFORE PERCOLATION	TIME ELAPSED UNTIL PERCOLATION IS COMPLETED	AMOUNT OF WATER RELEASED FROM SOIL	CONCLUSIONS

Source: Reprinted from Bell and Swartz, *Oscarís Options* with permission

COMMUNITY WASTE PLAN

THEME:	Communities have different disposal options available to them for managing solid waste.
GOAL:	Students will gain an understanding of different waste management methods, and of the costs, benefits, and drawbacks associated with each option.
METHOD:	Researching waste processing methods
SUBJECTS:	English, math, science, social studies
SKILLS:	Analyzing, communicating, problem solving
MATERIALS:	"Community Waste Plan" worksheet
TIME:	One class period, plus additional time for research

GETTING STARTED

Ask the students which solid waste management method(s) are available in their municipality. Which are the best suited for their community's needs?

PROCEDURE

1. The Commonwealth of Massachusetts prescribes the following waste management hierarchy:

- Reducing the amount of waste produced.
- Reusing, recycling, or composting certain components of the waste stream.
- Incinerating the balance of the waste stream that cannot be reduced or recycled, but can be safely burned.
- Landfilling only that waste which cannot be reduced, recycled, or burned.

Divide the students into groups and have each team research one of these four waste management methods: Source Reduction and Reuse; Recycling and Composting; Combustion; and Landfilling. Encourage them to contact and obtain information from municipal and state officials, local recyclers, solid waste management planners, and environmental groups.

2. Have the students consider the questions on the "Community Waste Plan" worksheet.

3. Have each group select a spokesperson to present its findings to the class. Analysis and discussion should include benefits and drawbacks for each waste management method.

EXTENSIONS

1. Visit a resource recovery/combustion facility, recycling facility, or landfill, or invite a representative from one of these facilities to come and speak to the class.

COMMUNITY WASTE PLAN

Worksheet

Questions to consider:

1. What is your community's current waste composition?
2. How is your community's waste currently handled?
3. What percentage of the waste stream can this process handle?
4. What is the cost per ton of processing the waste by this method?
5. What is the expense of constructing this facility or starting this program and how can it be financed? What are the estimated costs of program maintenance?
6. What, if any, are the environmental or public health problems associated with the method? Do the benefits of the method outweigh the problems associated with it?
7. What are the experiences of other communities that are using this method?
8. How many years into the future are you planning to use this method? (Be sure to consider population growth, long-term economic trends, and potential environmental impacts.)
9. Is the method convenient and will the public endorse its use and actively participate in the program?

SOURCE REDUCTION

RECYCLING AND COMPOSTING

COMBUSTION

LANDFILLING

NATURE AT WORK

THEME: Organic waste can be recycled (composted) and used to enrich soil.
GOAL: Students will learn about recycling organic wastes through composting.
METHOD: Building a model compost pile
SUBJECTS: Science
SKILLS: Classifying, inferring, observing, predicting
MATERIALS: Aquarium; organic wastes: soil (NOT potting soil); thermometer; trowel or large spoon; 1 to 2 dozen red earthworms
TIME: 1 hour to assemble, up to 1 year for observation

BACKGROUND

Composting is the oldest form of recycling. It is based on the scientific principle that nothing ever really dies, but just changes shape and takes on new forms. When a leaf falls and begins to decompose, it is broken down by time, weather, insects, and worms into the original materials from which it was made. The same is true for waste we throw away every day, such as grass clippings, banana peels, egg shells, and apple cores. These materials can be set aside for use as fertilizers in gardens and farms.

Compost is formed through the action of certain microbes that proliferate when mixed organic refuse receives sufficient air and water. These bacteria, which generate a temperature of 150 degrees, literally cook the wastes. The finished product, called "compost" or "humus," is an excellent fertilizer and looks just like soil. It is high in carbon and nitrogen, which are important sources of food for plants and vegetables. In addition to being clean, safe, and thrifty, composting can significantly reduce the volume of solid waste generated by a household.

Oscar's Options

GETTING STARTED

Can food scraps, leaves, and grass clippings be recycled?

PROCEDURE

1. Have the students bring in a variety of organic wastes such as green grass clippings, sawdust, wood ash, leaves, and kitchen food scraps. (Avoid meat scraps, dairy products, fats, and oils, which inhibit decomposition, cause odors, and can attract pests.) Tear or chop the materials into small pieces, leaving a few larger pieces of each type of waste for comparing rates of decomposition. Ask the students if they think there will be a difference.

2. Begin to fill the aquarium, alternating layers of the materials as follows (amounts are approximate): 1 inch of soil; 2 inches of dry, carbon rich, organic waste (i.e., leaves); 1 inch of green grass clippings; and sprinkle of water. Repeat several times.

3. Cover the last layer with a half inch of soil and water the pile so it is moist, but not soggy-like a damp sponge.

4. Have the students add the earthworms and observe their behavior.

5. Place the compost pile where it will be at room temperature (but not in direct sunlight). Once a week, have a student test the temperature of the pile and vigorously mix the pile to aerate it. For consistency, take the temperature at the same location, depth, and time each week. Make a temperature graph and have each student enter his or her reading.

6. As the class starts to see changes in the pile, discuss the process of composting. How does it reduce the amount of waste thrown out? What happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

EXTENSIONS

1. Have the children write and illustrate a story that explains what they have learned about composting. Where applicable, encourage them to construct a compost pile at home, where they can use the finished compost on the family garden or flower beds.

2. Have the class begin a school garden or "adopt" a particular flower bed. Have them add the compost they made and plant some flowers or vegetables.

Source: Adapted from Wisconsin, Recycling Study Guide

MICROORGANISMS: BACTERIAL RECYCLERS

THEME: Microorganisms are essential to the recycling of organic matter.
GOAL: Students will relate the importance of healthy microorganisms to composting.
METHOD: Observing and sketching slide samples under the microscope
SUBJECTS: Biology
SKILLS: Comparing, observing
MATERIALS: Trays or pans; soil; glass slides; water; containers; violet or methylene blue; erythrosine or eosine; microscopes; wax pencil; organic matter (food waste, leaves, yard trimmings); a flame source
TIME: 3 weeks

GETTING STARTED

What types of organisms are responsible for the composting process?

PROCEDURE

1. Divide the students into small teams. Have each group fill one tray with dry soil and a second tray with soil plus 5 to 10 percent organic matter, well mixed. Insert six slides vertically into each tray as shown in Figure 1.

Figure 1: Slide Placement in Tray

2. Six slides in each container will permit observation of each sample at the end of one, two, and three weeks. Adjust the moisture content of the soil to about 20 percent water by adding a volume of water corresponding to about 1/5 of the volume of soil. Keep moisture content as constant as possible by adding water as needed.

3. After one week, have students examine two slides from each container according to the following procedure. Dig soil away from one side of the slide, then tilt the same slide toward the hole and lift it out.

4. The slide will now have a film of soil and microorganisms on one side. Have the students clean the other side with a cloth and label the slide with a wax pencil. Repeat for a second slide.

5. The preparation on the slide is "fixed" by passing the slide over a flame-one or two passes should be sufficient. Stain one slide dark, using gentian violet or methylene blue. Stain the other slide light, using erythrosine or eosine.

6. Have each team examine their slides for bacteria with the low and high powers of a microscope. If present, spirilla will probably not be seen unless the field is darker. Have the students sketch what they see and compare them to the diagrams in Figure 2 to identify the morphological class of the bacteria. Are there differences in the number and types of microorganisms in each of the samples?

Figure 2: Common Morphological Classes of Bacteria

7. At the end of the second week, repeat the procedure with another pair of slides from each sample. Have the students determine if the number and types of bacteria in the samples have changed significantly. What might account for any observed changes?

8. At the end of the third week, repeat the procedure and make further comparisons. Have each team relate its observations and conclusions to composting.

Source: Reprinted from Bell and Swartz, Oscar's Options with permission

MAKING GOOD COMPOST

THEME: Composting can reduce the volume of household solid waste requiring disposal by other means.
GOAL: Students will examine different factors that affect the quality of compost and learn how to construct a good compost pile.
METHOD: Constructing and comparing different compost treatments
SUBJECTS: Biology, horticulture
SKILLS: Analyzing, experimenting, predicting
MATERIALS: Organic waste; soil; five 30-gallon buckets; thermometer; "Backyard Composting," "Necessary Components of a Compost Pile," and "Making Good Compost" handouts
TIME: 1 hour for set-up, several months for observation

GETTING STARTED

What are the essential ingredients for successful compost?

PROCEDURE

1. Prior to starting this experiment, have the class review DEP's "Backyard Composting" and the handout, "Necessary Components of a Compost Pile." Using the "Backyard Composting" handout, choose the method that fits your time and budget limitations. Keep compost piles about 1 cubic yard in size, or, if necessary, use five 30-gallon buckets with holes drilled in the sides.

2. Working in small teams, have the students start six compost piles, each reflecting one of the six characteristics listed on the "Making Good Compost" worksheet. Maintain each pile by following the steps listed below its particular characteristic. Organic wastes can include grass clippings, leaves, manure, weeds, hay, sawdust, household kitchen wastes (excluding bones, meat, or grease that could cause odors or attract pests).

3. Have each group prepare a log book and record the daily temperature of its pile and make other observations for a period of several weeks or months.

4. Discuss the results, addressing questions such as: Which experimental compost was most successful? How is composting related to the concept of recycling? How can composting reduce waste? Where does composting occur naturally?

EXTENSIONS

1. Have the students research different natural cycles (e.g., the nitrogen cycle, the carbon cycle), how they work and how they relate to composting. Have students prepare a handout explaining and illustrating the cycle they researched. Group students by the type of cycle they examined and have each team prepare a bulletin board display explaining in text and graphics how the cycle works and its importance to composting and other solid waste disposal methods.

2. Have students test the effects of the different compost treatments on plant growth.

Sources: Adapted from AVR, Teacher's Resource Guide; Washington, A-Way With Waste

BACKYARD COMPOSTING

BACKYARD COMPOSTING

BACKYARD COMPOSTING

COMPOSTING LEAF AND YARD WASTE

NECESSARY COMPONENTS OF A COMPOST PILE

SOIL: Contains microorganisms that help decomposition.

ORGANIC
WASTE: Includes leaves, food scraps, and grass clippings. Materials should be varied, including materials with both carbon and nitrogen. By alternating layers of high carbon and high nitrogen materials, you can create good environmental conditions for decomposition to occur.

NITROGEN: Many of the organisms responsible for decomposition need nitrogen. Nitrogen is found naturally in many organic materials, such as manure and green grass clippings, as well as many fertilizers.

WORMS: Worms eat the materials, helping to break them down. The worms' tunneling aerates the pile, facilitating decomposition. Their castings ("droppings") enrich the soil. Worms eventually die and become part of the compost.

WATER: Necessary for normal functioning of life. Too much water in a compost pile can make it soggy, taking up air space, and reducing oxygen. This condition slows down decomposition.

AIR: Adequate levels of aeration allow microorganisms to thrive. The biological activity of fungi, bacteria, small insects, and other organisms results in decomposition.

TIME: Decomposition takes time. To speed up decomposition, aerate your pile every few days. Otherwise, just leave it and wait.

HEAT: Heat is produced by the biological activity that occurs during decomposition. Heats help sanitize the compost by killing certain organisms, e.g., weed seeds, pathogens, harmful insect larvae, etc.

MASS: To generate enough heat for optimal decomposition, the pile must contain at least 1 cubic meter of organic material. Given this, the temperatures generated in a small compost pile will be different from those generated in a larger compost pile.

MAKING GOOD COMPOST

Worksheet

A. Low In Nitrogen
   1. No organic waste that is high in nitrogen.
   2. Keep moist, but don't soak with water.
   3. Turn regularly, every three or four days, then once a week.
   4. Include a mixture of ingredients such as food scraps, clippings, leaves, weeds, etc.
   5. Add critters to the pile. ("Critters" include earthworms, beetles, centipedes, millipedes.)

B. Not Enough Moisture
   1. Include manure and ingredients that are high in nitrogen.
   2. Turn the pile regularly.
   3. Have a good mixture of ingredients.
   4. Do not add water or moist ingredients.
   5. Add critters to the pile.

C. No Air Circulation
   1. Include materials with high nitrogen.
   2. Keep the pile moist.
   3. Do not turn the pile.
   4. Create a balanced mixture of materials.
   5. Add critters to the pile.

D. Too Much Of A Single Ingredient
   1. Include nitrogen material.
   2. Keep the pile moist.
   3. Add only bone meal or manure.
   4. Turn regularly.
   5. Add critters to the pile.

E. No Little Critters

1. Use potting soil that is sterilized.
2. Turn the pile regularly.
3. Keep the pile moist.
4. Create a good mix of ingredients.
5. DON'T put in any critters.

F. Good Compost Pile

1. Include nitrogenous material (manure and blood meal are good sources).
2. Keep the pile moist.
3. Turn the pile regularly.
4. Include a good mix of ingredients which are layered.
5. Add critters to the pile (add earthworms after the temperature has dropped).

Activity 3-7: Composting/Grades K-6

Composting/Grades K-6: Activity 3-7

Activity 3-21: Composting/Grades 7-12

Composting/Grades 7-12: Activity 3-21

Activity 3-22: Composting/Grades 7-12

Composting/Grades 7-12: Activity 3-22

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4. Discuss the results, addressing questions such as: Which experimental compost was most successful? How is composting related to the concept of recycling? How can composting reduce waste? Where does composting occur naturally?

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BACKYARD COMPOSTING

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WATER: Necessary for normal functioning of life. Too much water in a compost pile can make it soggy, taking up air space, and reducing oxygen. This condition slows down decomposition.

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MAKING GOOD COMPOST

Worksheet

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5. Add critters to the pile. ("Critters" include earthworms, beetles, centipedes, millipedes.)

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1. Include nitrogen material.
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3. Add only bone meal or manure.
4. Turn regularly.
5. Add critters to the pile.

E. No Little Critters
1. Use potting soil that is sterilized.
2. Turn the pile regularly.
3. Keep the pile moist.
4. Create a good mix of ingredients.

5. DON'T put in any critters.

F. Good Compost Pile

1. Include nitrogenous material (manure and blood meal are good sources).
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Activity 3-7: Composting/Grades K-6

Composting/Grades K-6: Activity 3-7

Activity 3-21: Composting/Grades 7-12

Composting/Grades 7-12: Activity 3-21

Activity 3-22: Composting/Grades 7-12

Composting/Grades 7-12: Activity 3-22

Composting

What is composting?

Composting is a natural process in which microorganisms break down organic materials such as kitchen, leaf, and yard materials into a soil-like substance called humus. Humus can be used to stabilize and enrich soil. In nature, this breaking down process can take a number of years, but under controlled conditions, with proper levels of moisture and air circulation, composting can take from as few as 2 weeks to 1 year.

The proper combination of temperature, oxygen, moisture, and organic materials produces the conditions needed for composting at a fast rate without offensive odors. The proper conditions allow a host of microorganisms to decompose the organic material. Bacteria and fungi are two types of microorganisms that are largely responsible for breaking down organic matter. During the eating and digesting process, these microorganisms break down organic matter into its basic elements-water, carbon dioxide, and humus. Other soil organisms, such as nematodes, mites, springtails, centipedes, and earthworms also contribute to the composting process by processing the organic matter as food.

What percent of the waste stream is compostable?

Approximately 65 to 70 percent of the municipal solid waste stream is composed of organic material such as food, paper, cardboard, wood products and by-products (paper sludge), and yard materials.i Leaf and yard materials (grass clippings, leaves, brush, and tree prunings) make up 18 percent by weight of the household waste stream.ii They are more efficiently processed by composting than by landfilling or burning because of their bulk and high moisture content.iii Since yard materials consist of relatively clean, biodegradable materials, landfilling them simply wastes space and burning them wastes energy.

How does composting fit into the Commonwealth's plan for waste management?

Composting is a vital part of the Commonwealth's integrated solid waste management strategy. It offers significant environmental and economic benefits, including:

¥ A savings on waste transportation, management, and disposal costs because a heavy portion of the waste stream is pulled out at the source of generation.

¥ Reduced volume of waste to be incinerated or landfilled.

¥ Minimal negative environmental impacts.

¥ Production of beneficial material-humus-that improves the productive potential of soil.

What are the different types of composting systems?

Composting is a versatile process that can be done at sites of varying size, using a variety of materials, and with different levels of technology. Composting system types are as follows:

¥ Backyard Composting: A system in which residents compost food scraps and yard trimmings in their yard using a manufactured or home-made composting bin, or by making a free-standing pile. Households can reduce and convert their waste by as much as 29 percent by weight using this method.

¥ Vermicomposting: Another residential system that can also be done on a small or larger scale. Vermicomposting means composting with worms contained in an enclosed bin perforated for air circulation. Certain types of worms (red wrigglers) can eat and expel their own weight in organic material every day, so even a small worm bin can produce pounds of rich sweet-smelling compost. These worms cannot survive in freezing temperatures, so the bins must be maintained inside.

¥ Centralized Yard Composting: A community program at a landfill, transfer station, or farm, where residents can drop off leaves and brush.

¥ Municipal Solid Waste Composting: A large-scale system run by public agencies or private businesses to manage MSW from homes and businesses. The organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant.

¥ Co-Composting: The simultaneous composting of two or more diverse organic waste streams. Co-composting systems are usually run by public agencies or private businesses to manage organic materials. As with MSW composting, the organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant. It is mixed with another organic component of the waste stream, such as paper or sewage sludge.

¥ Institutional Composting: A food scrap management system used by restaurants, markets, schools, institutions, and food processors. Food scraps are separated at the institution and composted either on-site at the institution or off-site at a farm or composting facility.

¥ On-Farm Composting: A farm-based composting system using farm equipment. The compostable materials can include farm materials such as yard trimmings and manure, or other items, such as paper products and wood scraps (shredded for bedding and composting). Farms can also accept food scraps from restaurants, institutions, food processors, and supermarkets. The organic waste from these sources may be composted or used as animal feed.

What are the state's future composting goals?

The least costly of all waste management technologies, composting may account for nearly half of the state's municipal solid waste diversion by the year 2000. Organic materials including leaves, wood, food, paper, paperboard waste, and yard trimmings account for 67 percent of total MSW by weight.iv To achieve maximum diversion of these organic materials from the municipal solid waste stream, the Commonwealth employs the following hierarchy:

1. Source Reduction: Organic materials that have traditionally required collection and centralized processing can be composted at the source of generation such as homes and businesses. The state is working to promote home composting by providing towns with training and education materials for their residents. The state also subsidizes the cost of home composting bins made out of 50 to 100 percent recycled Massachusetts plastic and sold by towns to their residents. The DEP has also revised the Site Assignment Regulations for Solid Waste Facilities to exempt institutions and small businesses that generate and compost source-separated food scraps from solid waste facility permitting requirements. These simplified regulations also allow small operations such as farms to compost while complying with state regulations.

2. Leaf And Yard Waste Composting: Municipal leaf and yard waste composting programs have been established in 239 Massachusetts cities and towns, as of 1995.v Since April 1993, leaves, grass clippings, and brush (up to 1 inch in diameter), hedge clippings, and weeds have been restricted from disposal in Massachusetts landfills and incinerators.

3. Municipal Solid Waste Composting: Large-scale composting of either mixed solid waste or source separated degradable MSW has grown increasingly popular in the United States. The number of composting facilities in the state has doubled since 1991 to 21, most of which process and compost mixed municipal wastes. Since 1986, the Commonwealth has helped communities evaluate MSW composting options. Feasibility

studies for Northampton, Franklin County, and the Southern Berkshires concluded that these projects are technically and economically feasible.

1. U.S. EPA, Characterization: 1994 Update.
2. Ibid.
iii. U.S. EPA, Yard Waste Composting, p.1.
4. U.S. EPA, Characterization: 1994 Update.
v Massachusetts DEP, Master Plan: 1995 Update.

Composting

Composting

Composting

What is composting?

Composting is a natural process in which microorganisms break down organic materials such as kitchen, leaf, and yard materials into a soil-like substance called humus. Humus can be used to stabilize and enrich soil. In nature, this breaking down process can take a number of years, but under controlled conditions, with proper levels of moisture and air circulation, composting can take from as few as 2 weeks to 1 year.

The proper combination of temperature, oxygen, moisture, and organic materials produces the conditions needed for composting at a fast rate without offensive odors. The proper conditions allow a host of microorganisms to decompose the organic material. Bacteria and fungi are two types of microorganisms that are largely responsible for breaking down organic matter. During the eating and digesting process, these microorganisms break down organic matter into its basic elements-water, carbon dioxide, and humus. Other soil organisms, such as nematodes, mites, springtails, centipedes, and earthworms also contribute to the composting process by processing the organic matter as food.

What percent of the waste stream is compostable?

Approximately 65 to 70 percent of the municipal solid waste stream is composed of organic material such as food, paper, cardboard, wood products and by-products (paper sludge), and yard materials.i Leaf and yard materials (grass clippings, leaves, brush, and tree prunings) make up 18 percent by weight of the household waste stream.ii They are more efficiently processed by composting than by landfilling or burning because of their bulk and high moisture content.iii Since yard materials consist of relatively clean, biodegradable materials, landfilling them simply wastes space and burning them wastes energy.

How does composting fit into the Commonwealth's plan for waste management?

Composting is a vital part of the Commonwealth's integrated solid waste management strategy. It offers significant environmental and economic benefits, including:

¥ A savings on waste transportation, management, and disposal costs because a heavy portion of the waste stream is pulled out at the source of generation.

¥ Reduced volume of waste to be incinerated or landfilled.

¥ Minimal negative environmental impacts.

¥ Production of beneficial material-humus-that improves the productive potential of soil.

What are the different types of composting systems?

Composting is a versatile process that can be done at sites of varying size, using a variety of materials, and with different levels of technology. Composting system types are as follows:

¥ Backyard Composting: A system in which residents compost food scraps and yard trimmings in their yard using a manufactured or home-made composting bin, or by making a free-standing pile. Households can reduce and convert their waste by as much as 29 percent by weight using this method.

¥ Vermicomposting: Another residential system that can also be done on a small or larger scale. Vermicomposting means composting with worms contained in an enclosed bin perforated for air circulation. Certain types of worms (red wrigglers) can eat and expel their own weight in organic material every day, so even a small worm bin can produce pounds of rich sweet-smelling compost. These worms cannot survive in freezing temperatures, so the bins must be maintained inside.

¥ Centralized Yard Composting: A community program at a landfill, transfer station, or farm, where residents can drop off leaves and brush.

¥ Municipal Solid Waste Composting: A large-scale system run by public agencies or private businesses to manage MSW from homes and businesses. The organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant.

¥ Co-Composting: The simultaneous composting of two or more diverse organic waste streams. Co-composting systems are usually run by public agencies or private businesses to manage organic materials. As with MSW composting, the organic portion of the waste stream is separated from recyclables and noncompostables, is picked up by waste haulers, and is taken to a large-scale composting plant. It is mixed with another organic component of the waste stream, such as paper or sewage sludge.

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1. U.S. EPA, Characterization: 1994 Update.
2. Ibid.
iii. U.S. EPA, Yard Waste Composting, p.1.
4. U.S. EPA, Characterization: 1994 Update.
v Massachusetts DEP, Master Plan: 1995 Update.
Composting

Composting

ENDNOTES

APPENDIX A

MASSACHUSETTS RESOURCES

Appendix A-1

Regional Planning Agencies

Organization: Berkshire County Regional Planning Commission
Address: 10 Fenn Street, Pittsfield, MA 01201
Phone: (413) 442-1521

Organization: Cape Cod Planning and Economic Development Commission
Address: First District Court House, Barnstable, MA 02630
Phone: (508) 362-2511

Organization: Central Massachusetts Regional Planning District Commission
Address: 340 Main Street, Suite 747, Worcester, MA 01608
Phone: (508) 756-7717

Organization: Franklin County Commission
Address: District Courthouse, 425 Main Street, Greenfield, MA 01301
Phone: (413) 774-3167

Organization: Martha's Vineyard Commission
Address: P.O. Box 1447, Oak Bluffs, MA 02557
Phone: (508) 683-3453

Organization: Massachusetts Regional Planning Agencies
Address: c/o Metropolitan Area Planning Council, 110 Tremont Street, Boston, MA 02108
Phone: (617) 523-2454
Purpose: An association of planning agencies that promote orderly growth. Agencies study area resources and needs, including solid waste disposal and pollution.

Organization: Merrimack Valley Planning Commission
Address: 350 Main Street, Haverhill, MA 01830
Phone: (508) 374-0519

Organization: Metropolitan Area Planning Council
Address: 110 Tremont Street, Boston, MA 01208
Phone: (617) 451-2770

Organization: Montachusett Regional Planning Commission
Address: R1427 Water Street, Fitchburg, MA 01420
Phone: (508) 345-7376

Organization: Nantucket Planning and Economic Development Commission
Address: 4 North Waste Street, Nantucket, MA 02554
Phone: (508) 228-7233

Organization: Northern Middlesex Area Commission
Address: 32 Market Street, 2nd Floor, Lowell, MA 01852
Phone: (508) 454-8021

Organization: Old Colony Planning Council
Address: 47 West Elm Street, Brockton, MA 02401
Phone: (508) 583-1833

Organization: Pioneer Valley Planning Commission
Address: 26 Central Street, West Springfield, MA 01089
Phone: (413) 781-6045

Organization: Southern Regional Planning and Economic Development District
Address: 88 Broadway, Taunton, MA 02780
Phone: (508) 824-1376

Appendix A-2

Regional Recycling Associations

Organization: Anawan Region Solid Waste Committee
Contact: Michael Van Splinter
Address: 155 Gilbert Street, Mansfield, MA 02048
Phone: (508) 339-9865

Organization: Cape Cod Commission
Contact: David Hall, Waste Management Coordinator
Address: 3225 Main Street, Barnstable, MA 02630
Phone: (508) 362-3828

Organization: Central Massachusetts Resource Recovery Committee
Worcester Department of Public Works
Contact: Bob Fiori
Address: 20 East Worcester Street, Worcester, MA 01604
Phone: (508) 799-1430

Organization: Coalition for North Central Waste Management
Contact: Don Leistikow
Address: 28 Maple Street, Ayer, MA 01432
Phone: (508) 772-3490

Organization: Eastern Massachusetts Recycling Association
Contact: Don Marshall
Address: P.O. Box 12, Bedford, MA 01730
Phone: (617) 275-0637

Organization: Millis Consortium
Contact: Robin Chapell
Address: Town Hall, 135 School Street, Walpole, MA 02081
Phone: (508) 660-7320

Organization: North Central Consortium
Board of Health
Contact: Edward Wirtanen
Address: City Hall, Room 29, Gardner, MA 01440
Phone: (508) 630-4013

Organization:	Northeast Regional Recycling Committee
Contact:	Karen Sheridan
Address:	10 Sheffield Road, Boxford, MA 01921
Phone:	(508) 887-5519

Organization:	North Shore Regional Recycling Committee
Contact:	Rebecca Curran
Address:	7 Widger Road, Marblehead, MA 01944
Phone:	(617) 659-4909

Organization:	South Central Recycling Association of Massachusetts
Contact:	John Alphin
Address:	27 Ashley Road, North Brookfield, MA 01535
Phone:	(508) 867-9491

Organization:	South Shore Regional Refuse Disposal Board Marshfield Department of Public Works
Contact:	Ken Pelletier
Address:	870 Moraine Street, Marshfield, MA 02050
Phone:	(617) 834-5559

Organization:	Western and Central Massachusetts Materials Recovery Facility
Contact:	Steve Ellis
Address:	436 Dwight Street, Springfield, MA 01103
Phone:	(413) 784-1100 x239

Appendix A-3

Regional Solid Waste Districts

Organization: Carver-Marion-Wareham Regional Refuse District
Address: Town Hall, 2 Spring Street, Marion MA 02738
Phone: (508) 748-3550

Organization: Eastern Hampshire Refuse District
Address: c/o Amherst Town Hall, Amherst, MA 01002
Phone: (413) 256-4050

Organization: Franklin County Solid Waste Management District
Address: 50 Miles Street, First Floor, Greenfield, MA 01301
Phone: (413) 772-2438

Organization: Greater New Bedford Regional Refuse Management District
Address: Dartmouth Town Hall, Room 214, 400 Slocum Road, North Dartmouth, MA 02747
Phone: (508) 993-2804

Organization: Hilltown Resource Management Cooperative
Address: P.O. Box 630, Williamsburg, MA 01096
Phone: (413) 268-3845

Organization: Marthaís Vineyard Regional Refuse Disposal District
Address: P.O. Box 2067, Edgartown, MA 02539
Phone: (508) 627-4501

Organization: Northern Berkshire Solid Waste Management District
Address: 18 East Street, Adams, MA 01220
Phone: (413) 743-8208

Organization: Southern Berkshire Solid Waste Management District
Address: P.O. Box 235, Sheffield, MA 01257
Phone: (413) 229-3353

Appendix A-4

Massachusetts State Agencies

Organization:	Massachusetts Cooperative Extension
Address:	102 Stockbridge Hall, University of Massachusetts, Amherst, MA 01003
Phone:	(413) 545-4800
Purpose:	Serves as the outreach arm of University of Massachusetts and the U.S. Department of Agriculture. Provides educational and technical assistance to agricultural businesses.

Organization:	Massachusetts Department of Environmental Management
Address:	100 Cambridge Street, Boston, MA 02202
Phone:	(617) 727-3159
Purpose:	Develops and implements policies to protect and manage the Commonwealthís land.

Organization:	Massachusetts Department of Environmental Protection Division of Hazardous Waste
Address:	One Winter Street, 5th Floor, Boston, MA 02108
Phone:	(617) 292-5851
Purpose:	Enforces a hazardous waste regulatory program that encourages sound management and safe treatment of hazardous waste. Responds to releases of hazardous materials to the environment.

Organization:	Massachusetts Department of Environmental Protection Division of Solid Waste Management
Address:	One Winter Street, 4th Floor, Boston, MA 02108
Phone:	(617) 292-5961
Purpose:	Regulates and enforces proper disposal of solid waste at municipal and commercial landfills and transfer stations. Develops and implements new alternative waste management programs that emphasize recycling, composting, source reduction, and toxics reduction.

Organization:	Massachusetts Department of Food and Agriculture
Address:	100 Cambridge Street, Boston, MA 02202
Phone:	(617) 727-3000
Purpose:	Supports agriculture and composting.

Organization:	Massachusetts Division of Fisheries, Wildlife and Environmental Law Enforcement
Address:	100 Cambridge Street, Boston, MA 02202
Phone:	(617) 727-1614
Purpose:	Responsible for the protection and management of all inland fish, wildlife and plants. Maintains biodiversity through a land acquisition program.

Organization:	Massachusetts Division of Law Enforcement Hazardous Waste Unit
Address:	One Ashburton Place, Attorney Generalís Office, Boston, MA 02133
Phone:	(617) 727-2200
Purpose:	Enforces environmental laws, including those relating to hazardous waste.

Organization:	Massachusetts Executive Office of Environmental Affairs Office of Technical Assistance for Toxics Reduction
Address:	100 Cambridge Street, Room 2109, Boston, MA 02202
Phone:	(617) 727-3260 x696
Purpose:	Non-regulatory agency designated by the Toxics Use Reduction Act (TURA) to provide confidential education and technical assistance on pollution prevention and hazardous waste management, disposal, and reduction for industry and business.

Organization:	Massachusetts Water Resources Authority
Address:	100 First Avenue, Charlestown Navy Yard, Boston, MA 02129
Phone:	(617) 242-6000
Purpose:	A regional environmental management agency that delivers water, parks, recreational services, and police protection to residents in Metropolitan Boston area.

Organization:	Metropolitan District Commission
Address:	26 Somerset Street, Boston, MA 02108
Phone:	(617) 727-5215

Organization:	University of Massachusetts College of Food and Natural Resources
Address:	Stockbridge Hall, Amherst, MA 01003
Phone:	(413) 545-2766
Purpose:	To educate students through the Stockbridge School of Agriculture, Massachusetts Cooperative Extension Service, Shade Tree Laboratory, Suburban Experiment Station and Cranberry Station.

Appendix A-5

Massachusetts Environmental Groups

Organization:	Center for Ecological Technology (CET)
Addresses:	112 Elm Street, Pittsfield, MA 01201 26 Market Street, Northampton, MA 01060
Phone:	(413) 445-4556, (413) 586-7350
Purpose:	Independent nonprofit organization providing western Massachusetts with services and information on energy conservation and solid waste management. Provides teacher training and resources.

Organization:	Clean Water Action
Address:	186 South Street, Boston, MA 02111
Phone:	(617) 423-4661
Purpose:	Administers the Environmental Shoppers Campaign, which encourages shoppers and supermarkets to join in efforts to reduce packaging, promote recycling, and halt pesticide contamination of food. Provides education on household hazardous waste.

Organization:	Earthworm, Inc.
Address:	35 Medford Street, Somerville, MA 02143
Phone:	(617) 628-1844
Purpose:	Nonprofit, collectively-managed recycling organization providing collection (paper only), referral, and educational services to its clients and to the greater Metropolitan Boston community.

Organization:	E-Call, The Ecology Hotline
Address:	Boston, MA
Phone:	(800) 800-6881, (617) REC-YCLE
Purpose:	Hotline service that provides updates on the latest recycling information for every municipality in Massachusetts.

Organization:	Environmental Lobby of Massachusetts
Address:	3 Joy Street, Boston, MA 02108
Phone:	(617) 742-2253
Purpose:	Privately funded, nonprofit, exclusively devoted to promoting sound environmental laws in Massachusetts through lobbyists at the State House and statewide grassroots support.

Organization:	Fundamental Action to Conserve Energy (FACE)
Address:	75 Day Street, Fitchburg, MA 01420
Phone:	(508) 345-5385
Purpose:	Provides conservation materials and information on energy and recycling issues to the north central region of Massachusetts. Provides teacher training and community household hazardous waste education.

Organization: Greenpeace/New England
Address: 139 Main Street, Cambridge, MA 02142
Phone: (617) 542-7052
Purpose: International organization dedicated to preserving the earth and its resources. Information available regarding hazardous and solid wastes.

Organization: Harvard Environmental Law Society
Address: Auston 20, Harvard Law School, Cambridge, MA 02138
Phone: (617) 495-3125
Purpose: Law students research current environmental issues for the public.

Organization: League of Women Voters of Massachusetts
Address: 8 Winter Street, Boston, MA 02108
Phone: (617) 357-8380
Purpose: Promotes the informed and active participation of citizens in government.

Organization: Massachusetts Association of Conservation Commissions (MACC)
Address: Lincoln-Filene Center, Tufts University, Medford, MA 02155
Phone: (617) 381-3457
Purpose: A private nonprofit service corporation whose members are the municipal Conservation Commissions of Massachusetts. MACC assists the Commissions in improving the quality of environmental decision making in their communities through workshops, lobbying, and publications.

Organization: Massachusetts Association of Conservation Districts (MACD)
Address: 20 Maple Street, Randolph, MA 02368
Phone: (617) 693-1162
Purpose: MACD is the association of the Commonwealthís 16 local conservation districts, organized to coordinate federal, state, and local programs and initiatives for the conservation of soil, water, and related resources.

Organization: Massachusetts Audubon Society (MAS)
Address: South Great Road, Lincoln, MA 01773
Phone: (617) 259-9500
Purpose: The oldest state Audubon Society, MAS owns and protects over 14,000 acres of sanctuary land, with 17 staffed nature centers and an active membership of 36,000 households. Through conservation, education, research, and advocacy, its overall goal is to preserve a quality environment that supports both people and wildlife. Has a library with waste management curricula.

Organization: Massachusetts Environmental Education Society (MEES)
Address: Thornten W. Burgess Society, 6 Discovery Hill Road, East Sandwich, MA 02537
Purpose: A professional organization dedicated to the promotion and improvement of environmental education in Massachusetts.

Organization: Massachusetts Public Interest Research Group (MASSPIRG)

Address: 29 Temple Place, Boston, MA 02108
Phone: (617) 292-4800
Purpose: Nonprofit, nonpartisan research and advocacy organization focusing on state-level consumer and environmental issues. Laws on reduction in product packaging.

Organization: Masscosh
Phone: (617) 277-0097
Purpose: Occupational hazards.

Organization: MASSRECYCLE: The Massachusetts Recycling Coalition
Address: 25 West Street, 2nd floor, Boston, MA 02111
Phone: (617) 338-0244
Purpose: Nonprofit statewide recycling coalition dedicated to bringing together individuals, local and state governments, industry, and environmental groups for the purpose of promoting and facilitating waste reduction, reuse, and recycling. A member-operated organization, MASSRECYCLE serves as an informational clearinghouse and an educational resource for members who are working to reduce waste in their homes, communities, businesses, and in government.

Organization: Mass Trash Action Coalition
Address: c/o Clean Water Action, 186 South Street, Boston, MA 02111
Phone: (617) 423-4661
Purpose: Consumer advocacy organization focusing on solid waste issues.

Organization: Sierra Club, New England Chapter
Address: 3 Joy Street, Boston, MA 02108
Phone: (617) 236-7715
Purpose: Provides public education on environmental concerns and lobbying for enactment and enforcement of protective legislation. Contact Boston office for list of Sierra Club groups throughout the state.

Organization: WasteCap of Massachusetts
Address: 222 Berkeley Street, 13th Floor, P.O. Box 763, Boston, MA 02117
Phone: (617) 236-7715
Purpose: Links businesses with other business to provide free assistance with recycling system set-up.

Organization: Waste Watch Center
Address: 16 Haverhill Street, Andover, MA 01810
Phone: (508) 470-3044, FAX (508) 470-3384
Purpose: Education, technical assistance, and publications on hazardous materials management and reduction. Conference proceedings on the National Household Hazardous Waste Conference.

Appendix A-6

Environmental Education Centers

Organization:	The Boston Public Schools Recycle Center
Address:	P.O. Box 1003, Boston, MA 02205
Phone:	(617) 282-2812
Purpose:	The center offers high quality by-products donated by a network of industries free to teachers for classroom projects and provides teacher in-service training, discovery workshops for children, and direct technical assistance for educators. The Center also runs projects in Worcester and Lawrence. Contact the center if you would like to start a center in your area.

Organization:	Buck Hill Conservation Education Center
Address:	RR #1, Box 265, McCormick Road, Spencer, MA 01562
Phone:	(617) 885-2595
Purpose:	Dedicated to the teaching of good conservation practices for land, water, and forest management. Oversees a 10-acre pond with self-interpretive trail and an environmental library.

Organization:	Cape Cod Museum of Natural History
Address:	Drawer R, Route 6A, Brewster, MA 02631
Phone:	(508) 896-3867
Purpose:	Nonprofit corporation dedicated to increasing the awareness and appreciation of the Capeís unique natural environment by residents and visitors, and to conserving the regionís natural resources. Offers exhibits, workshops, and other educational programs.

Organization:	Center for Environmental Management, Tufts University
Address:	Curtis Hall, 474 Boston Avenue, Medford, MA 02155
Phone:	(617) 381-3486
Purpose:	Established in 1984 to conduct research on health effects and technology, to analyze policy and to develop educational programs in the fields of hazardous and solid wastes and toxic substances.

Organization:	Habitat Institute for the Environment
Address:	10 Juniper Road, Belmont, MA 02178
Phone:	(617) 489-5050
Purpose:	Nonprofit organization that manages a 30-acre sanctuary. Offers environmental education programs for adults and children, using the land as a teaching resource. Runs outreach programs for schools.

Organization: Hitchcock Center for the Environment
Address: 525 South Pleasant Street, Amherst, MA 01002
Phone: (413) 256-6006
Purpose: The goal of the Hitchcock Center is to foster greater awareness and understanding of the environment and to develop ìenvironmentally iterateî citizens. Offers programs for the public and local schools, art exhibits, several camps, and a resource center for teachers and naturalists.

Organization: Horizons for Youth
Address: 121 Lakeview Street, Sharon, MA 02067
Phone: (617) 828-7550
Purpose: Offers school programs that provide comprehensive 1-day field trips or 2- to 5-day residential programs for elementary through high school students. Students can study the natural environment through structured exploration of woods, fields, lakes, and wetlands.

Organization: Massachusetts Audubon Societyís Wildlife Sanctuaries and Nature Centers
Address: South Great Road, Lincoln, MA 01773
Phone: (617) 259-9500
Purpose: Contact state headquarters for a list of the 17 staffed centers throughout the state.

Organization: Regional Environmental Council
Address: P.O. Box 255, Worcester, MA 01613
Phone: (508) 831-5551
Purpose: Nonprofit, volunteer group concerned with restoration, protection, and conservation of natural resources. Provides some waste management education to the Worcester-area schools.

Organization: South Shore Natural Science Center
Address: P.O. Box 429, Jacobs Lane, Norwell, MA 02061
Phone: (617) 659-2559
Purpose: Private, nonprofit center for focusing on environmental education and the natural and cultural history of the region. Offers interpretive walks and activities, pre-school and summer day camps, workshops, and exhibits.

Organization: Thompson Island Education Center, Inc.
Address: Thompson Island, P.O. Box 127, Boston, MA 02127
Phone: (617) 328-3900
Purpose: The Center promotes individual initiative, responsibility, teamwork, and urban survival skills, while teaching students about their communityís environment. Provides educational services to schools and organizations that offer experience-based programs.

APPENDIX B

NATIONAL RESOURCES

Appendix B-1

Federal Agencies

Organization: Governmental Advisory Associates, Inc.
Address: 177 East 87th Street, Room 404, New York, NY 10028
Phone: (212 410-4165

Organization: Governmental Refuse Collection and Disposal Association
Address: 8750 Georgia Avenue, Suite 123, P.O. Box 7219, Silver Springs, MD 20910
Phone: (301) 585-2898

Organization: National Association of Counties
Address: 440 First Street, NW, Washington, DC 20001

Organization: National Association of Towns and Townships
Address: 1522 K Street, NW, Suite 730, Washington, DC 20005
Phone: (202) 737-5200, FAX (202) 289-7996

Organization: National League of Cities
Address: 1301 Pennsylvania Avenue, NW, Washington, DC 20004

Organization: U.S. Conference of Mayors
Address: 1620 I Street NW, 4th Floor, Washington, DC 20006
Phone: (202) 293-7330
Resources: National Office Paper Recycling Project. Publication on paper grades, office paper recycling and purchasing of recycled paper.

Organization: U.S. Consumer Product Safety Commission
Phone: (800) 638-2772
Purpose: Product safety information

Organization: U.S. Environmental Protection Agency
Address: Office of Solid Waste (OS-305), U.S. EPA, 401 M Street SW, Washington, DC 20460
Phone: RCRA Information Center (202) 475-9327, or Hotline (800) 424-9346

Organization: U.S. Environmental Protection Agency, Solid Waste Division, Region 1
Address: JFK Federal Building (HER-CAN6), Boston, MA 02203
Phone: (617) 573-5720
Purpose: Handles solid waste issues for the federal government in all 6 New England states.

Appendix B-2

Regional Government-Related Agencies

Organization:	Coalition of Northeastern Governors, Policy Research Center, Inc.
Address:	Hall of States, 400 North Capital Street, Suite 382, Washington, DC 20001
Purpose:	The Centerís mandate is to study regional issues, particularly those related to economic and environmental conditions and resources of the Northeast, and to encourage innovative solutions to problems facing the region.

Organization:	New England Waste Management Officials Association (NEWMOA)
Address:	85 Merrimac Street, Boston, MA 02114
Phone:	(617) 367-8558
Purpose:	A nonprofit, interstate government organization formed by the directors of state hazardous and solid waste programs in New England. Purpose is to provide a forum for the discussion of common issues and problems in the areas of solid and hazardous waste management, provide coordination and information-sharing between groups addressing these issues, and promote public awareness.

Organization:	Northeast Recycling Council
Address:	270 Broadway, New York, NY
Phone:	(212) 693-0400
Purpose:	The Council encourages recycling among states, exchanges information, and takes positions on waste reduction, reuse, and recycling.

Appendix B-3

National and Regional Environmental Organizations

Organization: Citizens Clearinghouse for Hazardous Wastes
Address: P.O. Box 926, Arlington, VA 22216
Phone: (703) 276-7070
Resources: Has networking information for people working on recycling legislation at the local level.

Organization: Coalition for Recyclable Waste
Address: P.O. Box 1091, Absecon, NJ 08201
Phone: (619) 576-1996
Purpose: Targets products that arenít recyclable, stages protests, and advises industries on alternatives.

Organization: Environmental Action
Address: 1525 New Hampshire Avenue, NW, Washington, DC 20036
Phone: (202) 745-4870
Purpose: Supports grassroots efforts on environmental safety and waste reduction; as well as recycling, degradable plastics, and packaging.
Resources: Extensive information on plastics, tires, and toxics. Free listing of recycling contacts and publications.

Organization: Environmental Action Coalition
Address: 625 Broadway (Bleeker/Houston), New York, NY 10012
Phone: (212) 677-1601
Purpose: Provides environmental education, training, and technical assistance.
Resources: Resources available on recycling and combustion issues.

Organization: Environmental Defense Fund
Address: 257 Park Avenue South, New York, NY 10010
Phone: (212) 505-2100
Purpose: Founded in 1967, EDF was one of the first environmental groups to use litigation to change environmental policy. The organization strives to propose viable solutions that balance both the protection of the environment and the economics of a given capital project.
Resources: Resources available on recycling and combustion issues.

Organization: INFORM
Address: 381 Park Avenue South, New York, NY 10016
Phone: (212) 689-4040
Purpose: A nonprofit research center that works to protect the environment by examining and addressing business practices that have a negative effect on natural resources. Involved in issues surrounding source reduction and waste stream composition.
Resources: Offers information on resource recovery and waste management.

Organization:	Institute for Local Self-Reliance
Address:	2425 18th Street, NW, Washington, DC 20009
Phone:	(202) 232-4108
Purpose:	Helps cities and community developers make new products from recycled materials.

Organization:	League of Women Voters
Address:	1730 M Street, NW, Washington, DC 20036
Phone:	(202) 429-1965
Resources:	Publications include information on household hazardous waste, source separation, resource recovery, and waste reduction.

Organization:	National Consumersí League
Address:	815 15th Street, NW, Washington, DC 20005

Organization:	National Recycling Coalition
Address:	1101 30th Street, NW, Suite 304, Washington, DC 20077
Phone:	(202) 625-6406
Purpose:	A national coalition that brings together business and community interests to promote nationwide plans for recycling, source reduction, composting, market development, and buy recycled programs.
Resources:	Publishes a newsletter *NRC Connection* and other documents with information on national markets, recycling, reuse, and reduction.

Organization:	National Solid Waste Institute
Address:	10928 North 56 Street, Tampa, FL 33617
Phone:	(813) 985-3208

Organization:	National Solid Wastes Management Institute
Address:	1730 Rhode Island Avenue, NW, Suite 1000, Washington, DC 20036

Organization:	The National Toxics Campaign (NTC)
Address:	29 Temple Place, 5th Floor, Boston, MA 02111
Phone:	(617) 482-1477
Purpose:	NTC is a coalition of citizens, scientists, consumer groups, and environmentalists formed to develop and implement solutions to the toxics crisis.
Resources:	Publications available on recycling.

Organization:	National Wildlife Federation
Address:	1412 16th Street, NW, Washington, DC 20036
Phone:	(202) 797-6800
Purpose:	Conservation organization working to restore and conserve the nationís natural resources.
Resources:	Information and activities on environmental issues for grades 4–12.

Organization:	The New Alchemy Institute
Address:	237 Hatchville Road, East Falmouth, MA 02536
Phone:	(508) 564-6301
Purpose:	Massachusetts Environmental Education Centers.
Resources:	Offers information on composting.

Organization:	Northeast Industrial Waste Exchange
Address:	Syracuse, NY
Phone:	(315) 422-6572
Purpose:	Matches waste generators with waste users in Northeast through a ìListings Catalogueî and an ìOnline Catalogue.”
Resources:	Listings catalogue and online catalogue.

Organization:	Northeast Resource Recovery Association
Address:	Concord, NH
Phone:	(603) 224-6996
Purpose:	Cooperative marketing of recyclables. Hosts annual conference.
Resources:	Provides market information, education, and technical assistance on recycling.

Organization:	Solid Waste Association of North America
Address:	8750 Georgia Avenue, #140, Silver Springs, MD 20910

Organization:	Worldwatch Institute
Address:	1776 Massachusetts Avenue, NW, Washington, DC 20036
Phone:	(202) 452-1999
Purpose:	Nonprofit, independent organization for research and analysis of hazardous and solid waste management issues.
Resources:	Publications available regarding global resource issues.

Appendix B-4

Industry Associations

Organization: Air and Waste Management Association
Address: P.O. Box 2861, Pittsburgh, PA 15320
Phone: (412) 232-3444

Organization: Aluminum Association
Address: 900 19th Street, NW, Washington, DC 20006
Phone: (202) 862-5100, (202) 862-5163, FAX (202) 862-5164
Purpose: Trade association of the aluminum industry
Resources:
- *Publications and Audiovisuals Guide*. 1994.
- *Guidelines for Aluminum Scrap Quality*. 1993. $30.00.
- *Aluminum Recycling: Americaís Environmental Success Story*. 1992. Free.
- *Aluminum Recycling Casebook*. 1994. $10.00.
- *Aluminum Recycling: Your Next Assignment*. 18-minute video. To borrow, call (800) 243-6877; $10.00 to buy.
- *Call Me Can*. Story of a talking aluminum can explaining the benefits of recycling. Grades K–6. 18-minute video.

Organization: Aluminum Company of America
Address: 5516 Lonas Road, Central Park W., #2, Knoxville, TN 37909
Phone: (615) 594-4700, FAX (615) 594-4747

Organization: Aluminum Foil Container Manufacturers' Association
Address: P.O. Box 1177, Lake Geneva, WI 53147
Phone: (414) 248-9208

Organization: Aluminum Recycling Association
Address: 1000 16th Street, NW, Suite 400, Washington, DC 20036
Phone: (202) 785-0951
Purpose: Provides public information and publications on aluminum recycling.

Organization: American Coal Ash Association, Inc.
Address: 1913 I Street, NW, Sixth Floor, Washington, DC 20006
Phone: (202) 659-2303, FAX (202) 223-4989
Resources: Publication list. Categories include: Asphalt Pavement, Base Subsurface, Block, Brick, Concrete, Filler, Filler Layer, Flow Fill/CSLM, Grouts, Landfill Cover/Liner, Lightweight Aggregate, Roofing Granulate, Soil Amendment, Soil Modification, Structural Fill, Wallboard, and Waste Stabilization/Solidification.

Organization: American Forest and Paper Association
Address: 1111 19th Street, NW, Suite 800, Washington, DC 20036
Phone: (800) 878-8878
Purpose: An industry group committed to 50% paper recovery by the year 2000.
Resources: *Recovered Paper Statistical Highlights*. 1993.

Organization: American Forest and Paper Institute
Address: 1250 Connecticut Avenue, NW, South 361, Washington, DC 20036
Phone: (202) 463-2420
Purpose: Trade organization representing pulp, paper, and paperboard industries.
Resources: Pamphlets and audiovisuals on paper recycling, de-inking, the recycled content initiative, and chlorine bleaching. Publications include:

- *Index: Sources of Information About the Forest Products and Paper Industry*
- *How Paper Recycling Works*. Video. Free.
- *Paper Bag Recycling: Protecting Tomorrowís Environment Today*. Video. Free.
- *Annual Statistical Summary Recovered Paper Utilization*. $60.00.

Organization: American Institute of Chemical Engineers (Center for Waste)
Address: 345 E 47th Street, New York, NY 10017
Phone: (212) 705-7338

Organization: American Iron and Steel Institute
Address: 1101 17th Street, NW, 13th Floor, Washington, DC 20036
Phone: (202) 452-7100
Resources: Information on steel, not on recycling.

Organization: American Petroleum Institute
Address: 1220 L Street, NW, Washington, DC 20005
Phone: (202) 682-8000
Purpose: Trade association of oil industries.
Resources: Information on recycling used motor oil.

Organization: American Plastics Council
Address: 1275 K Street, Washington, DC
Phone: (800) 2-HELP-90
Purpose: Focuses on disposal alternatives for plastics.
Resources: Provides markets information, videos, research reports, and other educational materials.

Organization: Amoco Foam Products Company
Address: P.O. Box 566728, Atlanta, GA 30356-6013
Phone: (800) 323-4732, (800) 637-3873, FAX (404) 882-4831
Resources: Teacherís Recycling Kit. Includes 5 lessons and 6 worksheets on recyclingís origins, benefits, and processes. Emphasis on foam disposables.

Organization:	Anheuser-Busch Companies, Inc.
Address:	Government and External Affairs, One Busch Plaza, St. Louis, MO 63118-1852
Resources:	Publications on litter reduction and recycling programs.

Organization:	Association of Petroleum Re-Refiners
Address:	P.O. Box 605, Buffalo, NY 14205
Phone:	(716) 855-2757, FAX (716) 855-0339

Organization:	Association of State and Territorial Waste Management Officials (ASTWMO)
Address:	444 North Capitol Street, NW, Washington, DC 20001
Phone:	(202) 624-5820

Organization:	Battery Council International
Address:	401 N. Michigan Avenue, Chicago, IL 60611
Phone:	(312) 644-6610, FAX (312) 321-6869

Organization:	Can Manufacturers Institute
Address:	1625 Massachusetts Avenue, NW, Suite 500, Washington, DC 20036
Phone:	(202) 232-4677, FAX (202) 232-5756
Purpose:	The trade association of the can industry and its suppliers.
Resources:	School ìcan roundupî contest includes prizes and program information on community, school, and business can fundraising programs; 30 tips for teachers on aluminum; and fact sheets on aluminum can recycling.

Organization:	Center for Plastics Recycling Research
Address:	Rutgers University, Building 4109, Livingston Campus, New Brunswick, NJ 08903
Phone:	(980) 932-3632/4402, FAX (980) 932-5636
Resources:	• Bibliography of Resource Material. Includes sections: Books/Publications, Recycling/Environmental Journals, Environmental Organizations and Agencies, and References for Recycled Products. • Information sheet on plastics recycling. 1990. • *Plastics Recycling: From Vision to Reality*. 8-page summary. • *Market Research on Plastics Recycling, Tech. Report #31*. 8-page summary. 1989. • *Plastics Recycling: An Overview*. Includes plastics in a multi-material collection/sortation program for non-rural, single-family homes. 5-page summary. • *Recycling Mixed Plastics: Whoís Doing It; What Products are They Making?* 7-page summary.

Organization: Composting Council
Address: 114 South Pott Street, Alexandria, VA 22314
Phone: (703) 739-2410, (800) 457-4474, FAX (703) 739-2407
Purpose: To achieve maximum conservation, composting, and utilization of organic materials in an environmentally sustainable manner.
Resources: Publications and videos on topics ranging from proceedings of their symposia and conferences to compost literature reviews; MSW and backyard compost information; facility planning, etc. Information may be suitable for HS research projects.

Organization: Consumer Aerosol Products Council
Address: 1201 Connecticut Avenue, NW, Washington, DC 20036
Phone: (202) 833-9471, FAX (202) 835-8879

Organization: Container Recycling Institute
Address: Washington, DC
Phone: (202) 797-6839
Resources: Provides recycling information on all types of beverage containers, and technical assistance on ways to reduce container and packaging waste.

Organization: Council for Solid Waste Solutions
Address: 1275 K Street, NW, Suite 400, Washington, DC 20005
Phone: (202) 371-5319

Organization: Council for Textile Recycling
Address: 7910 Woodmont Avenue, Suite 1212, Bethesda, MD 20814
Phone: (301) 656-1077, FAX (301) 656-1079

Organization: Council on Packaging in the Environment (COPE)
Address: 1001 Connecticut Avenue, NW, Suite 401, Washington, DC 20036
Phone: (202) 331-0099, FAX (202) 466-5447
Purpose: Focus on solid waste disposal issues.
Resources: Four-page fact sheets on packaging, source reduction, recycling, case studies in integrated waste management. Grade 4 and above. $1.50 each.

Organization: Degradable Plastics Council
Address: 1000 Executive Parkway, Suite 105, St. Louis, MO 63141
Phone: (314) 576-5207
Resources: *The Right To Know: Chemical Manufacturing and Waste Disposal*. 16 mm. 28 minutes. 1982.

Organization: Environmental Institute
Address: Institute for International Research, 331 Madison Avenue, 6th floor, New York, NY 10017
Phone: (212) 883-1770

Organization: Flexible Packaging Association
Address: 1090 Vermont Avenue, NW, Washington, DC 20005-4960
Phone: (800) 331-5652
Resources:
- *Less Waste in the First Place*. 6 lessons on packaging, flexible packaging and source reduction. 42 pages. Grades 4–10. 1991.
- Source reduction booklet
- *Five Major Myths About Garbage, and Why Theyíre Wrong*. (article)
- *Recycling at the Crossroads*. January 1993. (article)

Information on flexible packaging.

Organization: Food Service and Packaging Institute
Address: 1901 N. Moore Street, Suite 1111, Arlington, VA 22209
Phone: (703) 527-7505, FAX (703) 527-7512
Purpose: Industry trade organization that is 61 years old. Members are producers of disposable food services.
Resources: Video exploring food service disposables and the environment. Middle school and above, science, social studies. Free to educators. 1991.

Organization: Food Service Coalition for a Better Environment
Address: 304 W. Liberty Street, Suite 201, Louisville, KY 40202
Phone: (502) 583-3783

Organization: Glass Packaging Institute
Address: 1627 K Street, NW, Suite 800, Washington, DC 20006
Phone: (202) 887-4850
Resources: Offers materials that teach about the benefits of recycling glass containers.
- *The Importance of Quality in Recycling Glass Bottles and Jars*. 9-minute VHS video with brochure.
- *Recycling: The Need Is Clear.* 12-minute video. Describes glass recycling programs nationwide.

Organization: Golden Aluminum Company
Address: Marketing, 1600 Jackson Street, Golden, CO 80401
Phone: (303) 277-7500, FAX (303) 277-7584

Organization: Governmental Advisory Associates, Inc.
Address: 177 East 87th Street, Room 404, NY 10128
Phone: (212) 410-4165

Organization: Governmental Refuse Collection and Disposal Association
Address: 8750 Georgia Avenue, Suite 123, P.O. Box 7219, Silver Springs, MD 20910
Phone: (301) 585-2898

Organization: Institute of Scrap Recycling Industries
Address: 1627 K Street, NW, Suite 700, Washington, DC 20006
Phone: (202) 466-4050, FAX (202) 466-9109
Purpose: Represents scrap processors and brokers for metals, paper, plastics and textiles.
Resources: Publications on metal, paper, glass, textiles and plastics.

Organization: Integrated Waste Services Association
Address: 1133 21st Street, NW, Suite 205, Washington, DC 20036
Phone: (202) 467-6240

Organization: Keep America Beautiful, Inc.
Address: Mill River Plaza, 9 West Broad Street, Stamford, CT 06902
Phone: (203) 323-8987, FAX (203) 323-9199
Purpose: Nonprofit dedicated to improving waste handling practices. The Land Stewardship Program involves volunteers in cleaning and maintaining public lands.
Resources: See Appendices C-1 and C-2.

Organization: Laidlaw Environmental Services, Inc.
Address: Attn. Jan E. Carelli, 221 Sutton Street, North Andover, MA 01845
Phone: (508) 683-1002
Resources: *An Environmental Education Program for Kindergarten Through Adult*. Earth Academy program supplements environmental curricula and provides presenterís notes for teachers. Combines a live speaker presentation by a Laidlaw staff person (or teacher) with video, printed posters, brochures, coloring/activity booklets, classroom and home-project activities, study questions, reading lists, and evaluation forms.

Organization: Mid-America Glass Recycling Program
Address: 824 N. Mission, Sapulpa, OK 74066
Phone: (918) 227-3889, FAX (918) 227-3958

Organization: Mid-Atlantic Glass Recycling Program
Address: P.O. Box 1088, Carlisle, PA 17013

Organization: National Agricultural Chemical Association
Address: Madison Building, 1155 15th Street, NW, Washington, DC 20005
Phone: (202) 296-1585, FAX (202) 463-0474

Organization: National Association of Container Distributors
Address: c/o Consolidated Bottle Company, 111 Manred Street, Point Clair, Quebec, Canada H9R4Y4
Phone: (514) 694-2860

Organization:	National Association of Diaper Services
Address:	2017 Walnut Street, Philadelphia, PA 19103
Phone:	(215) 569-3650

Organization:	National Association of Solvent Recyclers
Address:	1875 Connecticut Avenue, Suite 1200, Washington, DC 20009
Phone:	(202) 989-8150, FAX (202) 989-8061

Organization:	National Center for Resource Recovery, Inc.
Address:	1211 Connecticut Avenue, NW, Washington, DC 20036
Resources:	Publications on waste management and resource recovery.

Organization:	National Consumers' League
Address:	815 15th Street, NW, Washington, DC 20005
Phone:	(202) 639-8140, FAX (202) 737-2164

Organization:	National Electric Manufacturers Association
Address:	Washington, DC
Phone:	(202) 457-8400
Resources:	Information on source reduction and recycling of batteries.

Organization:	National Food Processors Association
Address:	1401 New York Avenue, NW, Washington, DC 20005

Organization:	National Oil Recyclers Association
Address:	12429 Cedar Road, Suite 26, Cleveland, OH 44106-3172
Phone:	(216) 791-7316, FAX (216) 791-6047
Purpose:	Member organization for groups that process, transport, recycle, and market used motor oil. They organize conferences, lobby, and maintain an information center.
Resources:	Research, reports, legislation, how-to recycle, etc. Posters, charts, and written materials for elementary through high school students.

Organization:	National Polystyrene Recycling Company
Address:	25 Tri-State International, Suite 100, Lincolnshire, IL 60069
Phone:	(708) 945-1991, FAX (708) 945-2147

Organization:	National Restaurant Association
Address:	1200 17th Street, NW, Washington, DC 20036
Phone:	(202) 331-5900

Organization: National Soft Drink Association
Address: Solid Waste Management Department, 1101 16th Street, NW, Washington, DC 20036
Phone: (202) 463-6768
Purpose: Trade association of the soft drink industry.
Resources: *National Directory of Solid Waste Curricula/Education Resources*. Section I: A state-by-state listing of resources. Section II: Additional environmental curricula. Section III: Additional recycling education materials. 1994. 30 pages. Free.

Organization: National Solid Waste Institute
Address: 10928 North 56th Street, Tampa, FL 33617
Phone: (813) 985-3208

Organization: National Solid Waste Management Association
Address: 1730 Rhode Island Avenue, NW, Suite 1000, Washington, DC 20036
Phone: (202) 659-4613, FAX (202) 775-5917
Purpose: Serves as a lobbying, educational, and research forum for its 2,700 member firms which represent every aspect of the solid and hazardous waste management industry.

Organization: National Tire Dealers and Retreaders Association
Address: 1250 I Street, NW, Suite 400, Washington, DC 20005
Phone: (202) 789-2300, FAX (202) 682-3999

Organization: National Wood Energy Association
Address: 777 N. Capital Street, Suite 805, Washington, DC 20002
Phone: (202) 408-0664

Organization: National Wooden Pallet and Container Association
Address: 1625 Massachusetts Avenue, NW, Washington, DC 20036
Phone: (202) 667-3670

Organization: Newspaper Association of America
Address: 11600 Sunrise Valley Drive, Reston, VA 22091
Phone: (703) 648-1000, FAX (703) 620-4557

Organization: Paperboard Packaging Council
Address: 1101 Vermont Avenue, NW, Suite 411, Washington, DC 20005
Phone: (202) 289-4100

Organization: Partnership for Plastics Progress
Address: 1275 K Street, NW, Suite 400, Washington, DC 20005
Phone: (202) 371-5319, FAX (202) 371-5679
Resources: *How to Implement a Successful Polystyrene Recycling Program.* 12-page manual.

Organization: Plastic Bag Information Clearinghouse
Address: 1817 E. Carson Street, Pittsburgh, PA 15203
Phone: (800) 438-5856

Organization: Plastic Bottle Information Bureau
Address: 1275 K Street, NW, Suite 400, Washington DC 20005
Phone: (202) 371-5244, FAX (202) 408-0736

Organization: Plastic Bottle Institute
Address: 1275 K Street, NW, Suite 500, Washington, DC 20005
Phone: (202) 371-5200

Organization: Plastics Recycling Foundation
Address: P.O. Box 189, Kennett Square, PA 19348
Phone: (215) 444-0659

Organization: Polystyrene Packaging Council, Inc.
Address: 1025 Connecticut Avenue, NW, Suite 515, Washington DC 20036
Phone: (202) 822-6424, FAX (202) 331-0250
Purpose: Association of foam packaging recyclers.
Resources:

- *Fast Facts about Polystyrene*. Brochure.
- *Polystyrene Fact Sheet*. Describes polystyrene uses and benefits, recycling, expansion agents, and production.
- *The Plastics and the Environment Sourcebook*. May 1993. 31-page booklet.
- *How to Implement and Administer a Successful Polystyrene Recycling Program.* 12-page booklet.
- *Convenience Recycled*. Describes polystyrene recycling, the ìpaper or plasticî issue, and plastics in the waste stream. 15-minute video. Grades 6–12. All materials free to educational groups.

Organization: Proler International Corporation
Address: 7501 Wallisville Road, P.O. Box 286, Houston, TX 77001
Phone: (713) 675-2281, FAX (713) 675-5970, recycling information (800) 347-2281

Organization: Recycled Paperboard Technical Association
Address: 350 S. Kalamazoo, MI 49007
Phone: (616) 344-0394

Organization: Rubber Manufacturers Association
Address: 1400 K Street, NW, Washington, DC 20005
Phone: (202) 682-1338

Organization: Scrap Tire Management Council
Address: 1400 K Street, NW, Suite 900, Washington, DC 20005
Phone: (202) 408-7781, FAX (202) 682-4854

Organization: Society of the Plastics Industry
Address: 1275 K Street, NW, Suite 400, Washington, DC 20005
Phone: (800) 2-HELP-90, (202) 371-5200
Purpose: Represents plastics firms and offers information on plastics recycling.
Resources:
- *The Resource Revolution*. Futuristic depiction of plastics recycling and the role of recycling in dealing with the garbage crisis. 12-minute video. Grades 7–12. Free.
- *Working Together for a Healthier Planet*. Takes a look at the mounting garbage problem and examines some misconceptions (especially about plastics) and some solutions. 15-minute video.
- *Plastics in Our World* curriculum. Guide for K–6.
- *Plastics in Our World* curriculum. Guide for 7–12.

Organization: Solid Waste Association of North America
Address: P.O. Box 7219, Silver Springs, MD 20910
Phone: (310) 585-2898, FAX (310) 589-7068, recycling information (800) 677-9424
Resources: Policy and educational publications and resources on entire range of waste issues.

Organization: Southern Aerosol Technical Association
Address: 1091 Lake Drive, Marietta, GA 30066

Organization: Steel Recycling Institute
Address: Foster Plaza 10, 680 Anderson Drive, Pittsburgh, PA 15220
Phone: (800) 876-SCRI, (412) 922-2772
Massachusetts office: (508) 266-1847
Resources: Information on tin can recycling, and materials recovery from municipal waste and steel producing companies.
Cycles for Science. 1995. Curriculum supplements on earth science chemistry, physics, biology, and community volunteer projects. Has videos and other educational materials.

Organization: Textile Fibers and By-Products Association
Address: P.O. Box 11065, Charlotte, NC 28220

Organization: Tire Retread Information Bureau
Address: 900 Weldon Grove, Pacific Grove, CA 93950
Phone: (408) 372-1917

Organization: Vinyl Institute
Address: 155 Route 46 West, Wayne Interchange Plaza II, Wayne, NJ 07470
Phone: (201) 890-9299

APPENDIX C

INSTRUCTIONAL RESOURCES

Appendix C-1

Recycling Curricula

Organization: Alameda County Office of Education
Contact: Regina in Media Sales
Address: 313 West Winton Avenue, Hayward, CA 94544-1198
Phone: (510) 670-4186
Resource: *California State Environmental Education Guide*
Description: General environmental orientation, activity based, designed to take students from awareness to action. Has "Help For Beginning Teachers," which provides information on managing groups outdoors or in a lab situation, learning style considerations, and ways to plan your unit. 1988. Award winning.
Cost: $17.95
Grades: K–6

Organization: Association of Oregon Recyclers
Contact: Staff
Address: 1615 NW 23rd Ave., Suite One, Portland, OR 97210
Resource: *Reduce, Reuse, Recycle*
Grades: K–12

Organization: Association of Vermont Recyclers (AVR)
Contact: Staff
Address: P.O. Box 1244, Montpelier, VT 05601
Phone: (802) 229-1833
Resource: *Association of Vermont Recyclers Teachers' Resource Guide*
Description: Guide designed to help teachers integrate solid waste and recycling education into their existing schedules and required courses. Divided into grade level sections. Large information and resource sections. 1989.
Cost: $45.00. 20% off with member discount.
Grades: K–12

Organization: Browning-Ferris Industries
Contact: Tish Penn
Address: P.O. Box 3151, Houston, TX 77253
Phone: (800) BFI-8100
Resource: *Mobius Curriculum: Understanding the Waste Cycle*
Description: This curriculum focuses on the "3Rs" through the subjects of science, mathematics, and social studies. It can be used as part of a teaching plan or taught as a separate course. The worksheet packet at the back of the book offers a collection of exercises with varying degrees of difficulty for extra credit or extension activities. 121 pages plus handouts. 1992.
Cost: Free to teachers.
Grades: 4–6

Organization:	Community Recycling Center
Contact:	Judy Godwin
Address:	720 North Market Street, Champaign, IL 61820
Phone:	(217) 351-4495
Resource:	*Recycling: A Solution to Pollution*
Description:	A recycling and reuse student activity guide. Revised 1993.
Cost:	$25.00
Grades:	K–6

Organization:	Earth Generation
Address:	P.O. Box 2005, Midland, MI 48641
Phone:	(517) 631-4010
Resource:	*The Earth Generation* curriculum
Grades:	Middle and junior high school science students

Organization:	Education Development Specialists
Contact:	Ann Crafton
Address:	5505 East Carson Street, Suite 250, Lakewood, CA 90713-3093
Phone:	(310) 420-6814
Resource:	*Think Earth!*
Description:	Three units that are interrelated and sequential, including a 27-minute video and individual grade packets containing teacher guidelines, blackline masters, and posters. 1993.
Cost:	Call for cost information.
Grades:	4–6

Organization:	Environmental Action Coalition
Contact:	Blair Baker
Address:	625 Broadway, NY, NY 10025
Phone:	(212) 667-1601
Resource:	*Don't Waste Waste!*
Description:	Not available until revised.
Cost:	$.50 each

Organization:	ERIC/CSMEE
Contact:	Staff
Address:	1929 Kenny Road, Columbus, OH 43210-1080
Phone:	(614) 292-6717
Resource:	*Recycling: Activities for the Classroom*
Description:	Contains activities designed to help teachers involve students in examining the nature and importance of recycling. For each activity, purpose, grade level, subject matter area, and recycling concept are given. 1978. 147 pages. Item No. 034E.
Cost:	$8.50

Resource: *Solid Waste Activity Packet for Teachers*
Description: A compilation of materials adapted from other states on solid waste management education. Divided into seven sections: Introductory Materials, Reducing, Reusing, Recycling, Landfilling, Incineration, and Teacher Resources. 1990. 100 pages.
Cost: Call for ordering information.
Grades: 4–6

Organization: ERIC Document Reproduction Services
Address: 7420 Fullerton Road, Suite 110, Springfield, VA 22153-2852
Resource: *Oscar's Options* (and copies of other waste management curricula)
Description: *Oscar's Options* is no longer available in its original form. It is now available as a reproduction.
Cost: $40.00
Grades: 4–8

Organization: Exegetics Interpretative and Educational Services
Contact: Staff
Address: P.O. Box 191895, Sacramento, CA 95819-7795
Phone: (916) 381-7795
Resource: *Waste Is a Terrible Thing To Waste*
Description: A collection of classroom activities ranging from simple worksheets to difficult socio-dramas. Student-directed inquiry provides opportunity for higher-level thinking and interesting learning experiences. 1991. 118 pages.
Cost: $35.00 plus tax
Grades: K–6

Organization: Florida Department of Education
Contact: Melayne Ford, Education Materials
Address: Collins Building, Room B-1, Tallahassee, FL 32399-0400
Phone: (904) 488-7108
Resource: *4 Rs Project: a Solid Waste Management Curriculum for Florida Schools*
Description: A curriculum designed for infusion into math, social studies, language arts, science, and other disciplines. Chosen as the best K–12 solid waste curriculum nationally by the Solid Waste Association of North America in 1991.
Cost: Prepay $3.50
Grades: 4–12

Organization: Florida Department of Education, Office of Environmental Education
Contact: Robert Raze
Address: Turlington Education Center, 325 West Gaines Street, Room 224-C, Tallahassee, FL 32399-0400
Phone: (904) 487-7900
Resource: *Garbology*
Description: A set of student instructional materials containing reuse options for paper, plastic, metal, and glass in the classroom, lab, and field.

Organization:	Governor's Recycling Program, Office of State Planning
Contact:	Staff
Address:	2 1/2 Beacon Street, Concord, NH 03301
Phone:	(603) 271-1098
Resource:	*Trash Today, Treasure Tomorrow*
Description:	A collection of activities adapted from existing sources. Emphasizes the need for students and their families to create market demand for recycled goods. Excellent crafts projects with quilts, reusable grocery bags, etc.
Cost:	$12.50
Grades:	Kindergarten Readiness, 1–2, 3–4, 5–6.

Organization:	Group for Recycling in Pennsylvania
Contact:	Staff
Address:	P.O. Box 4806, Pittsburgh, PA 15206
Resource:	*The Importance of Being a Garbologist*
Grades:	3–6

Organization:	City and County of Honolulu, Recycling Office, Division of Refuse Collection and Disposal
Contact:	Suzanne L. Varady
Address:	650 South King Street, 6th Floor, Honolulu, HI 96813
Phone:	(808) 527-5335
Resource:	*Recycle Hawaii*
Description:	A collection of lessons generated by teachers and taken from existing curricula. Divided into six units: "What's in the Can, Man?," "How Can We Stop Throwing Away So Much Trash?," "Once is Not Enough," "Composting," and "Landfills," and "Incinerators." 166 pages. 1990.
Cost:	Free. Must pay postage
Grades:	9–12

Organization:	The Institute for Environmental Education
Contact:	Mary Chadbourne
Address:	18554 Haskins Road, Chagrin Falls, OH 44023-1823
Phone:	(216) 543-7303
Resource:	*Closing the Loop*
Description:	A collection of activities grouped under three thematic sections: "Everything Ends Up Somewhere," "We Have Options and We Make Choices," and "Everything is Connected." Activities are intended to be hands-on, problem centered, practical, and adaptable across grade levels and subjects. 1991.
Cost:	$32.00 for K–12; $28.00 for K–8 only; $26.00 for 9–12 only
Grades:	K–12

Organization:	Keep America Beautiful
Contact:	Denise Harkin
Address:	9 West Broad Street, Mill River Plaza, Stamford, CT 06902
Phone:	(203) 323-8987

Resource: *Waste in Place*
Description: Curriculum supplement for teachers. 35 lesson plans on responsible waste handling. Promotes critical thinking and decision making skills. Revised 1994.
Cost: $40.00
Grades: K–6

Resource: *Waste: A Hidden Resource*
Description: Provides an overview of solid and hazardous waste that encourages students' investigation and decision making. 35 freestanding lessons can be taught sequentially or individually.
Cost: $40.00
Grades: 7–12

Resource: *Plastics Recycling by Numbers*
Description: Covers the uses of plastics, the plastic container coding system, and how to separate plastics for recycling.
Cost: $.50
Grades: 3–4

Resource: *Mister Rogers' Activity Book for Young Children*
Description: Teaches lessons on reuse and recycling. See Appendix C-2 for information on the accompanying video.
Cost: $1.50
Grades: K–6

Organization: Michigan United Conservation Clubs
Contact: Staff
Address: P.O. Box 30235, Lansing, MI 48909
Phone: (517) 371-1041
Resource: *WISE: Waste Information Series for Education*
Description: Curriculum integrates pollution prevention with solid waste education for classrooms. Includes lesson plans, techniques, overheads, computer games and student readers. Also includes great stories about kids making a difference! 350 pages.
Cost: $35.00, includes shipping
Grades: K–12

Organization: New Jersey Department of Environmental Protection, Division of Solid Waste Management, Office of Communications
Contact: Shirley Allen
Address: 840 Bear Tavern Road, CN 414, Trenton, NJ 08625-0414
Phone: (609) 530-8593
Resource: *Here Today, Here Tomorrow Revisited*
Description: A teacherís guide to solid waste management that includes activities on source reduction, recycling, resource recovery, and landfilling. Also included are a glossary of solid waste management terms and a listing of resources and references. Revised 1994.
Cost: Free
Grades: 4–8

Organization: Ohio Academy of Sciences
Contact: Staff
Address: 1500 West 3rd Avenue, Suite 223, Columbus, OH 43212-2817
Phone: (614) 488-2228
Resource: *Ohio Science Workbook: Litter Prevention and Recycling*
Cost: Free. One per request.

Organization: Ohio Department of Natural Resources, Office of Litter Prevention and Recycling
Contact: Heidi Hetzel-Evans, Public Inquiries
Address: 1889 Fountain Square, Building F-2, Columbus, OH 43224-9988
Phone: (614) 265-6333
Resource: *Super Saver Investigators*
Description: Environmental studies activity guidebook containing over 65 hands-on learning activities regarding solid waste, recycling, and natural resources.
Cost: $25.00. Make check out to ODNR.
Grades: K–3

Organization: Oregon Department of Environmental Quality, Public Affairs
Contact: Joan Grimm
Address: 811 SW 6th, Portland, OR 97204-1390
Phone: (503) 229-6709

Resource: *Re-Thinking Recycling: An Oregon Waste Reduction Curriculum*
Description: Teacher Resource Guide. An interdisciplinary approach to solid waste information. Includes facts, activities (e.g. waste audit, classroom resource center), resources, and an overview of the material. Revised 1993.
Cost: $8.00
Grades: K–12

Resource: *Classroom Activity Packets*
Description: Packets include 12 lessons, overheads, and worksheet masters.
Cost: $5.00
Grades: K–2, 3–5, 6–8, 9–12

Resource: *Handbook on Oregon Schools' Formula for Success in Waste Reduction*
Description: A how-to handbook to help schools reduce, reuse and recycle.
Cost: $5.00
Grades: Entire school

Organization: Pennsylvania Glass Recycling Corporation
Contact: Staff
Address: 509 North Second Street, Harrisburg, PA 17101
Phone: (717) 234-8091
Resource: *The Great Glass Caper*
Description: Education kit on recycling with mini-film strip, poster, mimeograph activity, and teacher's guide.
Cost: Free
Grades: 4–6

Organization: San Diego County Division of Solid Waste
Contact: Carol Gann
Address: 5555 Overland Avenue, Mall Stop 0383, San Diego, CA 92123
Phone: (619) 974-2648
Resource: *RAYS: Recycle And You Save*
Description: A collection of activities correlated to the California State Frameworks for science, social science, mathematics, language arts, and health. Designed to be easily integrated into daily teaching plans. 71 pages, plus appendices. 1991.
Cost: $15.00
Grades: K–2, 3–4, and 5–6

Organization: SEPUP (Science Education for Public Understanding Program)
Contact: Staff
Address: Lawrence Hall of Science, University of California, Berkeley, 1 Centennial Drive, Berkeley, CA 94720
Phone: (510) 642-8718
Resource: *The Waste Hierarchy: Where is "Away?"*
Description: A diverse educational program highlighting chemicals and their uses in the context of societal issues. Students will learn to apply the waste management hierarchy to develop an integrated waste management plan that will extend the life of their landfill. 1993. 154 pages.
Cost: $225.00. Includes materials for 160 students
Grades: 7–9

Organization: Sonoma County Community Recycling
Contact: Staff
Address: P.O. Box 1375, Santa Rosa, CA 95402
Phone: (707) 584-8666
Resource: *Garbage Reincarnation: Interdisciplinary Approach to Materials Conservation and Recycling*
Description: Classroom manual that teaches recycling, solid waste, and conservation principles through classroom and community activities. 1986. Printed on 100% recycled paper.
Cost: $8.95
Grades: 4–6

Organization: U.S. Environmental Protection Agency, RCRA Information Center
Contact: Staff
Address: 401 M Street SW, Washington, DC 20460
Phone: (800) 424-9346
Resource: *Let's Reduce and Recycle: A Curriculum for Solid Waste Awareness* (EPA/530-SW-90-005)
Description: Tool for educators to stimulate discussion about and heighten awareness of solid waste issues. Includes resource list for related publications.
Cost: Free
Grades: K–12

Organization: Vermont Institute of Natural Science
Contact: Staff
Address: P.O. Box 86, Woodstock, VT 05091
Phone: (802) 457-2779
Resource: *Waste Away*
Description: A curriculum designed to educate students who will, in turn, educate their schoolmates, families, and community about solid waste issues. 1989. 120 pages.
Cost: $18.95 plus $3.00 shipping/handling
Grades: Upper elementary and junior high

Organization: WasteWorld
Contact: Ann Harris
Address: 244 Boulevard of the Allies, 2nd Floor, Pittsburgh, PA 15222
Phone: (412) 338-8600
Resource: *WasteWorld*
Description: Guide designed to teach students about the critical environmental, economic, and energy-related issues associated with municipal solid waste management. The program focuses on recycling, waste-to-energy, and landfilling. It does not discuss source reduction as a waste management strategy. Contains computer disks and slides for Macintosh computers.
Grades: Middle school

Organization: Wisconsin Department of Natural Resources Publications
Contact: Joel Stone
Address: 2421 Darwin Road, Madison WI 53704
Phone: (608) 264-6029

Resource: *Recycling Study Guide*
Cost: $.50
Grades: K–5

Resource: *K–3 Supplement to the Recycling Study Guide*
Cost: $.40
Grades: K–5

Resource: *The Fourth "R"*
Cost: $.40
Grades: K–5

Resource: *Nature's Recyclers Activity Guide*
Cost: $.50
Grades: K–5

Resource:	*Nature's Recyclers Coloring Book*
Cost:	$.15
Grades:	K–5

Appendix C-2

Recycling Audio-Visual Materials

Organization: ACI Media, Inc.
Contact: Staff
Address: New York City, NY
Resource: *Let's Help Recycle*
Description: Students talk to their city council about how they're recycling and doing source reduction. 11-minute video. 1973.
Grades: K–3

Organization: AIMS Media
Address: 9719 DeSoto Avenue, Chatsworth, CA 91311-4409
Phone: (800) 367-2467, (818) 773-4300, FAX (818) 341-6700

Resource: *Let's All Recycle*
Description: Woody Woodpecker introduces children to recycling and environmental preservation. Lessons on the earth's limited resources and the value of conserving energy. Program accompanied by a fact and activities booklet. 8-minute video.
Cost: $150.00 purchase; $50.00 rental
Grades: Primary–intermediate

Resource: *Protecting Our Environment* Series: *Reduce*
Description: Concrete suggestions for reducing the amount of debris that we throw away. Explains how overpackaged and disposable items create garbage and waste precious resources and energy. 14 minutes.
Cost: 16 mm: $395.00 purchase; video: $295.00 purchase, $50.00 rental
Grades: Intermediate–high school

Resource: *Protecting Our Environment* Series: *Reuse*
Description: Program explains how everything from kitchen scraps to automobile parts can be reconditioned and reused. 13 minutes.
Cost: 16 mm: $395.00 purchase; video: $295.00 purchase, $50.00 rental
Grades: Intermediate–high school

Resource: *Protecting Our Environment* Series: *Recycle*
Description: Program explains the recycling process and shows that the list of recyclable items is a long one indeed. 16 minutes.
Cost: 16 mm: $395.00 purchase; video: $295.00 purchase, $50.00 rental
Grades: Intermediate–high school

Resource: *Garbage, Garbage, Garbage*
Description: A visit to a landfill shows what happens to garbage after it leaves the curb. Two student projects include replacing Styrofoam packaging with popcorn, and planting a vegetable garden. 15-minute video.
Cost: $195.00 purchase; $75.00 rental
Grades: Intermediate

Resource: *A Recycling Update*

Description: Program explores the way used bottles and cans are processed into new materials. 15-minute video.
Cost: $195.00 purchase; $75.00 rental
Grades: Intermediate

Resource: *How Paper Is Made*
Description: Program tours a modern paper manufacturing plant. Each step is illustrated and compared to the pre-industrial era. Today paper is made mostly with recycled paper and wood, instead of fabrics, as in the past. Provides statistics on paper manufacturing, consumption, conservation, and recycling. 14-minute video.
Cost: $275.00; $75.00 rental
Grades: Intermediate–high school

Resource: *A User's Guide to Planet Earth: The American Environment Test*
Description: Celebrity hosts question viewers on their environmental awareness while showing breathtaking shots of the environment. Teaches about reducing and recycling waste, preserving forests, pollution, and conservation. 30-minute video.
Cost: $195.00 purchase; $75.00 rental
Grades: Intermediate–adult

Organization: The Aluminum Association
Contact: Staff
Address: 900 19th Street, NW, Washington, DC 20006
Phone: (202) 862-5163

Resource: *Aluminum: An Element of Change*
Description: Sound cycles. 21-minute video. 1978.
Cost: Free loan

Resource: *Aluminum Recycling: Your Next Assignment*
Description: VHS
Cost: Free loan

Organization: Animedia, Inc.
Contact: Staff
Address: Los Angeles, CA
Resource: *Help Woodsy Spread The Word*
Description: Helps children recognize pollution problems and their solutions. 18-minute video with music.
Grades: K–6

Organization: Bullfrog Films
Contact: Staff
Address: Oley, PA 19547
Phone: (800) 543-FROG

Resource:	*Recycling: Waste Into Wealth*
Description:	Explains how to prepare recyclable materials, curbside collection, drop-off centers, processing of recyclable materials, etc. Study guide and resource guide accompany the film. 29-minute 1/2ì VHS. 1984.
Cost:	$175.00 purchase, $50.00 rental
Grades:	5–adult

Resource:	*Toxic Chemicals: Information Is the Best Defense*
Description:	Produced by the California League of Women Voters. Part I: *Who Needs to Know?*, Part II: *Developing a Community Right-To-Know Law* (on 1 cassette), the community toxic chemical ordinance to preserve public health and prepare for emergencies. 52-minute VHS. 1985.
Cost:	$175.00 purchase, $55.00 rental
Grades:	9–adult

Resource:	*Waste*
Description:	Connects consumer habits, from the individual to the multi-national, with the waste problem. Views common and uncommon examples of the generation, disposal and reuse of a variety of wastes including toxics, municipal sewage, space waste. 29-minute VHS. 1985.
Cost:	$150.00 purchase, $50.00 rental
Grades:	7–adult

Resource:	*Going Green: How to Reduce Your Garbage*
Description:	Provides a step-by-step guide to reducing a household's impact on the environment. Also discusses recycling, alternatives to chemicals, composting, bulk buying. 22-minute VHS. 1992.
Cost:	$175.00 purchase, $40.00 rental
Grades:	5–adult

Resource:	*Owl* TV Series IV
Description:	International environmental series for children. Includes recycling, composting, avoiding waste, water quality, and endangered species. 290 minutes: 10 1/2-hour shows, VHS. 1990.
Cost:	$780.00
Grades:	2–7

Resource:	*Owl* TV Series VI
Description:	International environmental series for children. This issue includes a session on making paper from recycled scraps. 290 minutes: 10 1/2-hour shows, VHS. 1992.
Cost:	$780.00
Grades:	2–7

Resource:	*Recycling is Fun!*
Description:	Three kids explore the 3Rs by going to a landfill, recycling center, and a supermarket. 12 minutes. 1991.
Cost:	16 mm: $315.00; VHS: $195.00 purchase, $25.00 rental
Grades:	K–4

Resource:	*The White Hole*
Description:	An animated, fanciful story commenting on our throw-away society. 10 minutes. 1990.
Cost:	16 mm: $250.00; VHS: $175.00 purchase, $25.00 rental
Grades:	5–adult

Organization:	Cornell University Resource Center
Contact:	Rich Grey or Liz Powers

Address: 7-8 Cornell Business and Technology Park, Ithaca, NY 14850
Phone: (607) 255-2091, FAX (607) 255-9946

Resource: *Do You Know Where Your Garbage Is?*
Description: Discusses options for garbage that's not reducible, reusable, or recyclable. Explores controversial issues of composting, incineration, and landfilling. 12-minute animated video.
Cost: $49.00 purchase; $18.00 rental
Grades: All ages but especially elementary school age

Resource: *Recycling In Your School Makes Good Sense*
Description: Shows how to start an office paper recycling program in schools. Students increase their awareness of recycling, interact with people in the community, learn to plan, and bring recycling information home. 40 slides with cassette and script. 7 minutes. 1990.
Cost: $42.00 purchase; $18.00 rental
Grades: 6–12

Resource: *Woodsy's Wastewise*
Description: Script with activities on solid waste disposal. Discusses problems of landfills versus composting and recycling. 46 slides, tape and cassette. 1986.
Cost: $39.00 purchase; $18.00 rental
Grades: 2–6

Resource: *Woodsy's Resource Gold Mine*
Description: Script with activities portraying trash as a resource. Discusses solid waste management and energy conservation. Provides suggestions on how children can reduce, reuse, and recycle. 52 slides and tape. 1989.
Cost: $46.00 purchase; $18.00 rental

Organization: Do Dream Music
Contact: Betty Truszkowski
Address: P.O. Box 5623, Takoma Park, MD 20913
Phone: (800) 4-BILLY-B
Resource: *Recycle Mania*
Description: Audio cassette tape of musician and performer Billy B. It is a high energy show for the whole family.
Cost: $7.00
Grades: All ages

Organization: ecol-o-kids
Address: 3146 Shadow Lane, Topeka, KS 66604
Phone: (800) 433-7202

Resource: *Dirty Rotten Truth*
Description: Produced by the childrenís educational program ì3-2-1 Contact.î Discovering the truth about garbage and recycling. Comes with free 30-minute teacherís guide.
Cost: $19.95
Grades: Ages 6–16

Resource: *Get Busy: How Kids Can Save the Planet*
Description: Learn about environmental problems. Meet kids who have made a difference and find out what you can do to help. 30-minute video.
Cost: $19.95
Grades: Ages 6–16

Organization: Environmental Action Coalition
Contact: Blair Baker
Address: 625 Broadway, New York, NY 10025
Phone: (212) 667-1601

Resource: *The Garbage Monster*
Description: Alien visitor finds planet Earth overcome by the garbage monster. Children solve problems through recycling. Slides with script.
Cost: $35.00
Grades: K–5

Resource: *Pay Attention to Waste Prevention*
Description: Conceived of and filmed by middle school students on Waste Prevention Project. 18-minute video. 1992/93.
Cost: $45.00
Grades: 6–8

Organization: Environmental and Occupational Health Science Institute, Public Education and Risk Communication Division
Contact: Ricki Kashdan
Address: UMDNJ, Robert Wood Johnson Medical School, Trailer #2, 675 Hoes Lane, Piscataway, NJ 08854-5635
Phone: (201) 463-4500
Resource: *Alum Man The Can*
Description: Animated video, VHS.
Cost: 1/2" VHS: $25.00; 3/4" VHS: $35.00
Grades: K–3

Organization: Keep America Beautiful
Contact: Denise Harkin
Address: 9 West Broad Street, Mill River Plaza, Stamford, CT 06902
Phone: (203) 323-8987

Resource: *Overview: Solid Waste Disposal Alternatives*
Description: Reviews options for managing waste. 33-minute video.
Cost: $19.95
Grades: 7–12

Resource: *Mister Rogers Recycling Video*
Description: Produced by the PBS series ìMister Rogers' Neighborhood" for children. 30-minute video.
Cost: $19.95
Grades: K–6

Resource: *How Did This Get Here?*
Description: How to educate the public about litter and the adverse impacts that result when people mishandle waste. Identifies seven sources of litter and strategies to prevent it. 10-minute video.
Cost: $8.00
Grades: 7–12

Resource: *Environmental Court*
Description: Explains how an Environmental Court works. 1994.
Cost: $8.00

Resource: *Beyond the Bins—Sustaining a Recycling Program in Your Community*
Description: Video.
Cost: $7.50

Resource: *Recycling Realities: A National Town Meeting*
Description: Video conference addressing the perceptions versus realities of recycling and other option for community waste management. 120-minute video.
Cost: $20.00

Organization: KQED/The Rotten Truth
Contact: Staff
Address: KQED/The Rotten Truth, 5959 Triumph Street, Commerce, CA 90040
Phone: (800) 441-3000
Resource: *The Rotten Truth*
Description: Excellent presentation by children of information on waste disposal. Produced by the children's educational program "3-2-1 Contact." Video.
Cost: $14.95 + $3.00 postage and handling
Grades: Relevant to both children and adults

Organization: Minnesota Office of Waste Management, Waste Education Clearinghouse
Contact: Minerva Birkeland
Address: 1350 Energy Lane, Suite 201, St. Paul, Minnesota 55108
Phone: (612) 649-5482

Resource: *Protecting Our Environment: Recycle*
Description: Explains the process of recycling and lists recyclable items. Several items are shown as they are broken down, recycled, and manufactured into new products. 16-minute video.
Cost: Free on a 2-week loan basis
Grades: 4–7

Resource: *The Recycling Raccoon's Amazing Adventure*
Description: Uses a puppet and human actors to call attention to curbside recycling, proper disposal of yard waste, and techniques for environmentally sensitive shopping. 24-minute video.
Cost: Free on a 2-week loan basis

Resource: *Earth to Kids*
Description: Shows children how to evaluate products for their environmental impact. Activity booklet is included. 10-minute video.
Cost: Free on a 2-week loan basis

Resource: *In Partnership with the Earth*
Description: Discusses the importance of pollution prevention and recycling. Narrated by EPA administrator William Reilly and John Denver. 60-minute video.
Cost: Free on a 2-week loan basis

Organization: Modern Talking Picture Service, Inc.
Contact: Patti Larkin
Address: 5000 Park Street North, St. Petersburg, FL 33709
Phone: (813) 541-7571
Resource: *Call Me Can*
Description: The story of recycling is told through a talking can. The characters explain the many benefits of recycling and the importance of a clean environment. 18-minute video.

Cost: Free 5-day loan

Organization: Oregon Department of Environmental Quality, Public Affairs
Contact: Joan Grimm
Address: 811 SW 6th, Portland, Oregon 97204-1390
Phone: (503) 229-6823

Resource: *Time's A-wasting: Garbage and Recycling in Oregon*
Description: Solid waste management practices in Oregon. Also a segment on how a family makes purchasing decisions based on the reduce, reuse, recycle approach. 20-minute video. 1993.
Cost: $6.00
Grades: 4–12

Resource: *Recycle Lifecycle: Paper; Recycle Lifecycle: Steel cans; Recycle Lifecycle: Glass containers*
Description: Shows the journey that recyclables take from curbside pickup through the remanufacturing process. Video.
Cost: $6.00
Grades: K–12

Organization: Plastics Recycling Foundation
Contact: Staff
Address: 1275 K Street NW, Washington, DC 20005
Phone: (202) 371-5200
Resource: *Plastics Recycling Pilot Plant: A Video Tour*
Description: Tour of Rutgers University's Center for Plastics Recycling Research. 6-minute video.
Cost: $10.00 purchase; free loan

Organization: Syracuse University Film Rental Center
Contact: Staff
Address: 1455 East Colvin Street, Syracuse, NY 13244-5150

Resource: *Garbage*
Description: Illustrates disposal systems struggling to keep up with an ever increasing flow of garbage generated by our affluent society. 11-minute color 16 mm film.
Cost: $12.00 rental

Resource: *The Garbage Explosion*
Description: Investigates nature, volume, and composition of solid waste, and long-range solutions. 16-minute color 16 mm film.
Cost: $12.00 rental

Resource: *Recycling In Action*
Description: Establishes the need for recycling and then makes a general introduction to community-type volunteer reclamation centers; shows preparation of recyclables for market. (#2-10563). 14-minute color 16 mm film. 1973.
Cost: $12.00 rental

Organization: The Video Project
Contact: Kate Day
Address: 5332 College Avenue, Suite 101, Oakland, CA 94618
Phone: (800) 4-PLANET, (510) 655-9050, FAX (510) 655-9115

Resource: *Our Fragile Earth* Series: *Recycling*
Description: Program for young people on wastefulness and recycling. Focuses on student groups that have set up recycling programs in schools and communities. Also ties their work into a paper recycling plant. Stresses reducing waste and buying recycled products. 16-minute video, VHS.
Cost: Institutions: $65.00 purchase, $30.00 rental. Individuals and low-income: $35.00 purchase, $20.00 rental
Grades: Ages 13 and up

Resource: *Solid Solutions: Rural America Confronts the Waste Crisis*
Description: Presents a positive look at how 4 rural southern communities are creatively coping with waste crises. Includes 32-page booklet. 30-minute video. 1994.
Cost: Institutions: $79.00 purchase, $35.00 rental. Individuals and low-income: $35.00 purchase, $25.00 rental
Grades: Adult

Resource: *Fueling the Future Part III: No Deposit, No Return*
Description: Investigates how America's throw-away society creates an enormous energy cost and how we can get to the root of the problem. 58-minute video.
Cost: Institutions: $85.00 purchase, $45.00 rental. Individuals and low-income: $45.00 purchase, $25.00 rental
Grades: High school–adult

Resource: *Tinka's Planet*
Description: The story of a young girl who learns about recycling, starts recycling, and then convinces her friends and some reluctant adults to follow suit. 12-minute video.
Cost: Institutions: $55.00 purchase, $30.00 rental. Individuals and low-income: $24.95 purchase
Grades: 1–6

Organization: Walt Disney Productions
Contact: Staff
Address: Burbank, CA
Resource: *In The Bag*
Description: Humphrey the Bear and his problems cleaning up litter. Video.

Organization: Waste and Toxics Progress Report
Contact: Louris Jackson
Address: Agency Building #4, 5th Floor, Albany, NY 12248
Phone: (518) 455-3711

Resource: *The 3Rs*
Description: Childrenís film on recycling. 22-minute video. 1990.
Cost: $10.00

Resource: *The Mountain in the City: New York Material Use and Disposal Crisis*
Description: Guest appearance by Pete Seeger and narrated by James Whitmore. 52-minute VHS. 1986.
Cost: $20.00
Grades: High school to adult

Organization: Wisconsin Department of Natural Resources
Contact: Bureau of Solid Waste Management

Address:	P.O. Box 7921, Madison, WI 53707
Resource:	*Resource Guide for Audio Visual-Aids on Recycling*

Organization:	Wisconsin Department of Natural Resources
Contact:	Third Eye Films—producer and distributor
Resource:	*Energy Where You Least Expect It*
Description:	Large and small waste-to-energy projects including incineration, methane recovery, refuse-derived fuels, recycling. Includes financing, plant efficiency, air pollution, and energy distribution. 28-minute color video. 1982.

Appendix C-3

Composting Curricula

Organization:	Alameda County Home Composting Education Program
Address:	7977 Capwell Drive
Phone:	(510) 635-6275
Resource:	*Compost! A Teacherís Guide to Activities and Resources in the East Bay*
Description:	A compilation of compost activities. 38 pages.
Grades:	2–12

Organization:	Cornell Program in Environmental Sciences for Educators and Youth
Contact:	Nancy Trautmann
Address:	425 Hollister Hall, Cornell University, Ithaca, NY 14853
Phone:	(607) 255-2814
Resource:	*Composting In The Classroom*
Description:	A high school teachers guide for indoor composting activities. October, 1994.
Grades:	9–12

Organization:	Cornell University Resource Center
Address:	7 Business and Technology Park, Ithaca, NY 14850
Phone:	(607) 255-2091
Resource:	*Composting: Waste to Resources*
Description:	4-H Leaderís/Teacherís Guide. 36-page curriculum with activity sheets. 1990.
Resource:	*How Does Composting Work?; Life Cycle of the Compost Pile*
Description:	Posters
Cost:	Call for price

Organization:	Flower Press
Address:	10332 Shaver Road, Kalamazoo, MI 49002
Phone:	(616) 327-0108
Resource:	*Worms Eat My Garbage*
Description:	How to set up a worm composting bin.
Cost:	$9.95 plus $2.50 shipping and handling
Grades:	K–12
Resource:	*Worms Eat Our Garbage: Classroom Activities For a Better Environment*
Description:	Activities and experiments specifically focused on learning about worms and worm composing.
Cost:	$21.95 plus $3.00 shipping and handling
Grades:	K–8

Organization: Food Works
Address: 64 Main Street, Montpelier, VT 05602
Phone: (802) 223-1515
Resource: *The Wonderful World of Wigglers*
Description: Activities on vermicomposting and worms.
Cost: $114.95 plus $3.00 shipping and handling
Grades: K–12

Organization: Gardenerís Supply
Address: Department PR9R, 128 Intervale Road, Burlington, VT 05401
Phone: (802) 863-1700 or (800) 955-3370
Resource: *Kids and Composting*
Description: A family activity guide
Cost: Free

Organization: Governorís Recycling Program
Address: 2 1/2 Beacon Street, Concord, NH 03301
Phone: (603) 271-1098
Resource: *Worms in the Classroom*
Description: School curriculum ideas manual that was included with a K–8 New Hampshire grant-funded worm composting kit.
Grades: K–8

Organization: J. S. Press, Inc.
Address: Box 351, Emmaus, PA 18049
Resource: *The Decomposer Food Web*
Description: 70 slides plus script focusing on the biology of the compost pile. 1980.

Organization: Kendall/Hunt Publishing Company
Contact: Staff
Address: 4050 Westmark Drive, P.O. Box 1840, Dubuque, IA 52004-1840
Phone: (800) 228-0810, FAX (800) 346-2377
Resource: *Bottle Biology* by Paul H. Williams of University Wisconsin-Madison
Description: Classroom experiments and life science explorations using recycled #1 PET bottles. Activities include the Ecocolumn, Decomposition Chamber, Fermentation Chamber, Predator Prey, etc. Revised 1993.
Cost: $15.95 plus $3.00 shipping and handling for first copy; $.50 for each additional copy
Grades: K–12

Organization: Klutz Press
Contact: For RETAIL: contact Customer Service, mail order. For WHOLESALE: contact Customer Service, wholesale.
Address: 2121 Staunton Court, Palo Alto, CA 94306
Phone: (415) 857-0888
Resource: *Kids Gardening*
Description: recently updated
Cost: $12.95
Grades: > 3

Organization: Marin County Hazardous and Solid Waste Management Authority; Office of Waste Management
Address: 10 N. San Pedro Road, Suite 1022, San Rafael, CA 94903-4155
Phone: (415) 499-6647
Resource: *Composting Across the Curriculum*
Description: Provides teachers with the technical information and activities on compost, solid waste, and nutrient cycling to start compost and vermicompost projects. Enables teacher to integrate composting into other topic areas.
Cost: $8.50
Grades: K–12

Organization: Modern Talking Picture Service
Address: 500 Part Street North, St. Petersburg, FL 33709-9905
Resource: *Decision Earth*
Description: An environmental education unit designed to teach students about making informed consumer product choices.
Grades: 7–9

Organization: Municipal Waste Reduction Branch
Address: 3rd Floor, 777 Broughton Street, Victoria, British Columbia V8V1X4
Phone: (604) 387-0709
Resource: *Eco Education Program Curricula: Compost Module*
Description: This compost module has hands-on activities, extension ideas, and instructions for backyard and worm compost systems. 36 pages.
Grades: K–7

Appendix C-4

Composting Audio-Visual Materials

Organization:	Bullfrog Films
Contact:	Staff
Address:	Oley, PA 19547
Phone:	(800) 543-FROG
Resource:	*Organic Gardening: Composting*
Description:	The basics of composting. 10 minutes. 1971.
Cost:	16 mm: $225.00; video: $60.00 purchase, $20.00 rental
Grades:	3–adult

Organization:	Department of Floriculture and Ornamental Horticulture, Cornell University
Contact:	R. Kozlowski
Address:	15-F Plant Sciences Building, Ithaca, NY 14853
Resource:	*Home Composting*
Description:	Script and 49 slides focusing on the basics of composting. Takes approximately 20 minutes to present. 1989.
Cost:	$35.00. Make check out to Cornell University.

Organization:	Flower Press
Address:	10332 Shaver Road, Kalamazoo, MI 49002
Phone:	(616) 327-0108
Resource:	*Wormania*
Description:	Close-up scenes of live earthworms. Educational songs. Appearances by Billy B Band and Mary Appelhof. 48-page teaching guide. 26-minute video. 1995.
Cost:	$34.90 plus $3.50 shipping and handling
Grades:	8 and up

Organization:	Massachusetts Department of Environmental Protection; Division of Solid Waste Management, Composting Program
Address:	One Winter Street, 4th Floor, Boston, MA 02108
Phone:	(617) 292-5834
Resource:	*Home Composting: Turning Your Spoils to Soil*
Description:	Developed by Connecticut DEP. Provides a complete overview of how to set-up a compost pile in your yard. 17-minute video.
Cost:	Available at libraries throughout Massachusetts and may be copied for educational purposes. If you belong to an organization that could circulate the video, contact the Massachusetts DEP for a free copy. If you would like to purchase your own, contact the Connecticut DEP at (860) 424-3365. It costs $10.00.
Grades:	K–adult

Resource: *Donít Trash Grass*
Description: How to reduce grass clippings, manage your lawn to minimize the use of fertilizers and pesticides, and encourage healthy grass. 12-minute video.
Grades: Middle to high school and adult

Organization: Recycling Council of Ontario
Address: 489 College Street, Suite 504, Toronto, Ontario M6G 1A5
Phone: (416) 960-1025
Resource: *The Magic of Composting*
Description Humorous story features the Compost Fairy who persuades a reluctant Yuppie about the benefits of composting, and shows him the basics of how to do it. Contains a brief section on composting in an apartment complex with worms. 13-minute video.
Cost: $20.00. Make check or money order out to the Recycling Council of Ontario.

Appendix C-5

Household Hazardous Waste Curricula and Resources

Organization: Alameda County Office of Education
Contact: Regina, in Media Sales
Address: 313 West Winton Avenue, Hayward, CA 94554-1198
Phone: (510) 670-4168
Resource: *Toxics Taking Charge*
Description: Supplement to the California *State Environmental Education Guide*. Includes 9 classroom activities and an action project. Focuses on making responsible choices in the home.
Grades: 4–6

Organization: Association of Vermont Recyclers
Contact: Ivy Zeller
Address: P.O. Box 1244, Montpelier, VT 05601
Phone: (802) 229-1833

Resource: *Teaching Toxics: Creating Solutions to Household Pollution*
Description: Teacher's resource guide providing background information, interdisciplinary activities, and resource listings. Includes experiments, puppet shows, movement exercises, and guided imageries.
Cost: $20.00 member; $25.00 nonmember
Grades: K–12

Resource: *Hazardous Materials Management: A Manual for Schools*
Description: A layperson's guide to responsibly managing hazardous materials in school science labs, art classes, vocational programs, and janitorial areas. Includes strategies for toxics use reduction, safe use and storage, and environmentally safe disposal.
Cost: $20.00 member; $25.00 nonmember
Grades: Middle and high schools

Organization: California Department of Toxic Substances Control, Public Information and Education
Contact: Public Education Coordinator
Address: 400 P Street, P.O. Box 806, Sacramento, CA 95812-0806
Phone: (916) 322-0476

Resource: *The No Waste Anthology: A Teacherís Guide to Environmental Activities*
Description: Discusses general waste issues, natural resources, and the effects of water and air pollution. Includes a large section on household hazardous waste.

Resource: *The Hazard House Workbook: Teacherís Manual* and computer software
Description: A workbook to help students, teachers, and parents learn about the hazardous products and hazardous waste in their homes.
Cost: Free
Grades: K–12 and adult

Organization: ERIC Clearinghouse for Science, Mathematics, and Environmental Education (CSMEE)
Contact: Joe E. Heimlich
Address: 1929 Kenny Road, Columbus, OH 43210-1080
Phone: (614) 292-6717

Resources: ERIC houses a massive data base and library on science and environmental education. You can find reprints of some out-of-print materials. They also produce their own materials. They can be contacted by phone, through the mail, and on the internet to get a listing of their resources.

Resource: *Activities for Teaching about Hazardous Materials in the Home*
Description: Compilation of activities from several sources. 149 pages. 1989.
Cost: $10.50

Resource: *Teaching About Hazardous and Toxic Materials*
Description: Compilation of activities from several sources. 257 pages. 1985.
Cost: $16.90

Organization: J. Weston Walch, Publisher
Address: 321 Valley Street, P.O. Box 658, Portland, ME 04104-0658
Resource: *40 Low-Waste Low-Risk Chemistry Labs*
Description: Student book and teacher book. Written by David Dougan to help schools teach chemistry safely with a minimum of hazardous materials.
Cost: Student book: $9.95; teacher book: $11.95, plus postage and handling

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Organization: Massachusetts Water Resources Authority
Address: 100 First Avenue, Charlestown, MA 02129
Phone: (617) 242-7110

Resource: *Down the Drain*
Description: Explains how the things that we flush down the drain are taken to the waste waster treatment plant where they are processed and released back into Boston Harbor. It makes the direct link between what we do in our homes and the natural environment around us. It teaches how waste water treatment plants work, the dangers of household hazardous waste to humans and the environment, and how to reduce our use of hazardous products. Some good diagrams.
Cost: Free
Grade: Middle to high school, can be adapted to younger

Resource: *Water Wisdom*
Description: Lessons on water conservation and pollution issues.
Cost: Free
Grades: High school

Organization: Metro Hazardous Waste
Contact: Ann Moser
Address: 130 Nickerson Street, Suite 100, Seattle, WA 98109
Phone: (206) 689-3051
Resource: *Hazards on the Homefront*
Description: Compilation of activities about household hazardous waste that cross subject areas. Activities show impact of hazardous waste on water, air, and solid waste. Bibliography. 1995.
Cost: Call for pricing
Grades: 4–12

Organization: Ontario Federation of Naturalists
Contact: Nancy Makowski
Address: 355 Lesmill Road, Don Mills, Ontario M3B 2W8
Phone: (416) 444-8419
Resource: *Hazardous Waste Education Kit*
Description: Resource kit with information pamphlets and lesson plans. Eight teaching units, resource handbooks, worksheets, posters, games.
Cost: $30.00 + $4.00 shipping and handling
Grades: High school; also adaptable for 7–9

Organization: SEPUP (Science Education for Public Understanding Program)
Contact: Staff
Address: Lawrence Hall of Science, UC Berkeley, 1 Centennial Drive, Berkeley, CA 94720
Phone: (510) 642-8718

Resource: *CHEM: Chemicals, Health, Environment, and Me*
Description: Ten chemistry-based units utilizing commonly available household and classroom supplies, with the emphasis on direct experience by the learner. Includes teachers' guide with blackline masters, and a complete materials and equipment kit. 129 pages. 1993.
Cost: $125.00 (Materials for 160 students)
Grades: 5–6

Resource: *Chemical Education for Public Understanding Project*
Description: Activity-oriented science modules
Grades: 7–12

Organization: Solid Waste Services of the Municipality of Anchorage
Contact: Bill Kryger
Address: P.O. Box 196550, Anchorage, AK 99519-6650
Phone: (907) 561-1906
Resource: *Household Toxics*
Description: A science-based curriculum written for Anchorage. Intended to educate students on the everyday use of hazardous products in the home and the consequences of improper disposal. Lessons general enough to be applicable anywhere. 1989.
Cost: $25.00 plus shipping.
Grades: 5–6

Organization: U.S. Product Safety Commission

Contact: Ken Giles
Address: 5401 Westward Avenue, Bethesda, MD
Phone: (301) 492-6580
Resource: *School Science Laboratories: A Guide to Some Hazardous Waste Substances*
Description: Identifies hazardous substances and provides an inventory, lists of explosives, carcinogens, etc.
Cost: Free

Organization: Town of Yorktown
Contact: Linda Cooper
Address: Town Hall, 363 Underhill Avenue, P.O. Box 703, Yorktown, NY 10598
Phone: (914) 962-5722
Resource: *Household Hazardous Waste: How It Fits Into Your Curriculum*
Description: An anthology aimed at middle and high school students. Divided into eight sections: “Groundwater,” “Household Hazardous Waste,” “At School,” “At Home,” “At Work,” “Health Effects/Alternatives,” “Ecology,” and “Stewardship.” 378 pages. 1992.
Cost: Call for cost information
Grades: 6–12

Appendix C-6

Household Hazardous Waste
Audio-Visual Materials

Organization:	AIMS Media
Address:	9719 DeSoto Avenue, Chatsworth, CA 91311-4409
Phone:	(800) 367-2467, (818) 773-4300, FAX (818) 341-6700
Resource:	*Down the Drain*
Description:	Program looks at toxic cleaning materials that we wash down our drains, and the complex process that water goes through to become drinkable. 15-minute video.
Cost:	$195.00 purchase; $75.00 rental
Grades:	Intermediate

Organization:	Association of Vermont Recyclers
Contact:	Ivy Zeller
Address:	P.O. Box 1244, Montpelier, VT 05601
Phone:	(802) 229-1833
Description:	The rapping, rhythmic, and educational AVR Assembly Program on HHW and Recycling. It is a homemade video. 35 minutes.
Cost:	$25.00 purchase; $15.00 rental

Organization:	Bullfrog Films
Contact:	Staff
Address:	Oley, PA 19547
Phone:	(800) 543-FROG
Resource:	*Toxic Chemicals: Information Is the Best Defense*
Description:	Produced by the California League of Women Voters. Part I: *Who Needs to Know?* Part II: *Developing a Community Right-To-Know Law* (on 1 cassette), the community toxic chemical ordinance to preserve public health and prepare for emergencies. 52-minute video. VHS. 1985.
Cost:	$175.00 purchase; $55.00 rental
Grades:	9–adult
Resource:	*Toxic Waste*
Description:	Students learn about chemistry; the food chain; custom plastics; science's responsibility to educate the public; waste treatment and disposal, "cradle-to-grave" disposal; and government, industry and public control of hazardous waste. 29-minute video. 1984
Cost:	16 mm (disc): $350.00 purchase; VHS: $350.00 purchase, $75.00 rental
Grades:	7–12

Organization: Environmental Hazard Management Institute (EHMI)
Contact: Amy Cabannis
Address: 10 Newmarket Road, P.O. Box 932, Durham, NH 03824
Phone: (800) 446-5256, (603) 868-1486
Resource: *Project ACE: Automobile Care for the Environment*
Description: Designed to educate 10th and 11th graders attending driver education classes about the environmental and health risks from improper use and management of used and leftover automobile products. Includes a video, *Lean, Green, Drivin' Machine*, student activities, certification awards, and program evaluations.
Cost: $96.00 plus $8.95 shipping and handling
Grades: 11–12

Organization: The Environmental Health Coalition
Address: 1844 Third Avenue, San Diego, CA 92101
Phone: (619) 235-0281

Resource: *Outta Sight, Outta Mind*
Description: Focuses on health effects of household hazardous materials and pollution due to improper disposal. A boy and his grandfather visit a polluted lake closed to fishing and discuss what's toxic, how toxins enter the body, safer substitutes, and recycling waste oil. Also covers safe use, storage, and disposal of household hazardous materials. 11-minute video. 1981.
Grades: Ages 8–12

Resource: *Safer Pest Control for Amateur Exterminators*
Description: How to control insects without pesticides. Demonstration of methods to control five common indoor pests. Organic gardening experts explain keys to preventing insects and weeds in the garden. 30-minute video. 1988.
Grades: Ages 8–12

Resource: *Safe Substitutes*
Description: This slide show presents practical information on safer home management through use of safer cleaning and pest control products. 120 slides/carousel/audio tape. 15-minute video.
Grades: Ages 8–12

Resource: *Toxics in the Home*
Description: Presents the use, storage, and disposal dilemmas related to household toxic materials. Health and hazardous materials professionals identify problems and suggest solutions. Common household products are featured and their hazards examined. 29-minute video. 1985.
Grades: Ages 8–12

Organization: League of Women Voters of Massachusetts
Address: 8 Winter Street, Boston, MA 02108
Phone: (617) 357-8380

Resource: *Beginning at Home: Tackling Household Hazardous Waste*
Description: VHS, Beta, or 3/4" Cable. 18 minutes. 1986.
Cost: $75.00 purchase ($30.00, nonprofits); $25.00 rental ($10.00, nonprofits)
6 weeks notice for rental. Make checks payable to Scarfman Fund, LWVM.

Resource: *Household Hazardous Waste: Everyone's Problem*
Description: VHS, Beta, or 3/4" Cable. 19 minutes.
Cost: $100.00 purchase ($65.00, nonprofits); $25.00 ($15.00, nonprofits)

6 weeks notice for rental. 10-day rental. Make checks payable to Scarfman Fund, LWVM.

Organization:	The Video Project
Contact:	Kate Day
Address:	5332 College Avenue, Suite 101, Oakland, CA 94618
Phone:	(800)-4-PLANET, (510) 655-9050, FAX (510) 655-9115
Resource:	*Cleaning Up Toxics at Home*
Description:	Provides information to help students learn about hazards and what they can do to protect their families and homes. Experts describe the dangers of many household chemical products, discuss safe use and disposal of them, as well as safer alternatives. Highlights community HHW programs for oil, paints and pesticides. 25-minute video. 1990.
Cost:	Institutions: $59.95 purchase, $35.00 rental; Individuals and low-income: $29.95 purchase, $20.00 rental
Grades:	Ages 14–adult

Appendix C-7

Resource Guides

Organization: California Department of Education
Contact: Staff
Address: Publication Sales, P.O. Box 271, Sacramento, CA 95812-0271
Phone: (916) 445-1260
Resource: *Science and Environmental Education Resource Guide*
Description: Directory of national science and environmental resources.
Cost: $3.00

Organization: California Department of Toxic Substances Control
Contact: Melinda Fox
Address: P.O. Box 806, Sacramento, CA 95812-0806
Phone: (916) 322-0476
Resource: *Tools For The Environmental Teacher*
Description: Annotated bibliography of educational materials about household hazardous wastes and related topics. The resources listed discuss household products, water systems and contamination, hazardous waste recycling, pollution prevention, health, etc. Some references are already out of date.
Cost: Free
Grades: K–12

Organization: California Integrated Waste Management Board
Address: 8800 Cal Center Drive, Sacramento, CA 95826
Phone: (916) 255-2296
Resource: *Environmental Education Compendium for Integrated Waste Management*
Description: A compendium for waste management educational materials. Developed to specifically assist educators in locating solid waste materials that are appropriate for use in their classroom. Describes and rates most current curricula.
Cost: Free
Grades: K–12

Organization: The Commonwealth of Massachusetts, Higher Education Coordinating Council
Address: Room 1401, McCormack Building, One Ashburton Place, Boston, MA 02108-1696
Phone: (617) 727-7785
Resource: *Massachusetts Resources in Math and Science*
Description: Describes projects funded under the federal Dwight D. Eisenhower Mathematics and Science Education Act. The goal of the funds are to strengthen the skills of math and science teachers and students, and to increase the access of underserved minority groups and gifted students to science and math education. 1993/94.
Cost: Free

Organization: Federal Reserve Bank of Boston
Resource: *Educatorís Resource Guide*
Description: Provides summaries of educational services provided by educational agencies, professional associations, corporations, and cultural, civic and academic programs. Also includes funding information. 1991/92.
Cost: Free

Organization: The Five College/Public School Partnership
Address: Five College Center, P.O. Box 740, Amherst, MA 01004
Phone: (413) 256-8316

Resource: *Spreading the Word*
Description: A guide to organizations whose conferences and newsletters can help schools, colleges, and cultural institutions. August 1993.

Resource: *Whatís Out There*
Description: A directory of science, technology, and mathematics resources for teachers and administrators. August 1993.

Organization: Minnesota Pollution Control Agency, Public Information Office
Contact: Barb Hannegan
Address: 520 Lafayette Road, St. Paul, MN 55155
Phone: (612) 296-6619
Resource: *Teacher's Guide: Educational Material in Resource Recovery*
Description: A bibliography of curricula, audio-visuals, and childrenís books. Primary subject matter is resource recovery. Curricula areas in resource recovery range from industrial arts and home economics to educational guides for educable mentally handicapped.
Cost: Free
Grades: K–12

Organization: National Soft Drink Association (NSDA)
Contact: Staff
Address: 1101 16th Street, NW, Washington, DC 20036
Phone: (202) 463-6700
Resource: *National Directory of Solid Waste Curricula/Education Resources*
Description: Directory providing current information on state-by-state programs, privately-sponsored curriculums, and additional recycling education materials used in America's schools.
Cost: Free
Grades: K–12

Organization: The Rainbow Collection
Contact: Bob and Debra Neary
Address: 83 Rolling Hill Lane, Southington, CT 06489
Phone: (860) 621-7946

Resource: *The Rainbow Collection Catalog: Nature-Oriented Teaching Materials*
Description: A unique collection of nature-oriented materials for teachers in many fields, including nature centers, science programs, day-care centers, libraries, etc.

Cost: Free
Grades: Pre-school, K–2

Organization: United States Environmental Protection Agency, Communication and Public Affairs
Contact: Staff
Address: A-107, 401 M Street, SW, Washington, DC 20460
Phone: (202) 260-4484

Resource: *Environmental Health Risk Education For Youth: A Resource Manual*
Description: Manual intended for school administrators, teachers, curriculum developers, students, parents, government officials, and others interested in environmental health risk education. It describes programs, curricula, classroom materials, and other resources that provide students with the knowledge and critical thinking skills needed to evaluate environmental health risk information.
Cost: Free
Grades: K–12

Resource: *Environmental Education Materials for Teachers and Young People*
Description: Annotated compendium of educational materials on environmental issues. The entries are diverse with materials ranging from workbooks to curriculum plans, to posters and pamphlets, to film and computer software.
Cost: Free
Grades: K–12

Appendix C-8

Multi-Media Tools for Teaching About Waste Management

Organization: Association of Vermont Recyclers (AVR)
Contact: Ivy Zeller
Address: P.O. Box 1244, Montpelier, VT 05601
Phone: (802) 229-1833
Resource: *Traveling Resource Center*
Description: Two colorful kits containing a set of 2' x 3', illustrated information panels and a set of books, videos, and reference materials. Supplements *AVR Resource Guide for Solid Waste and Recycling Education*.
Cost: Rental: $60.00 for 1 week, $40.00 each added week, plus shipping and handling
Grades: Elementary and secondary.

Organization: Channing L. Bete Co., Inc.
Contact: Staff
Address: 200 State Road, South Deerfield, MA 01373-0200
Phone: (800) 628-7733

Resource: *Put Waste in Its Place*
Description: Guide to household solid waste management. Includes information about composting, recycling, and burning.
Cost: $1.00 (price is reduced if more than 24 copies ordered)

Resource: *Breaking The Waste Habit*
Description: Guide to waste reduction. Overview on how to create less waste. Tips on buying, usage, and disposal of goods.
Cost: $1.00 (price is reduced if more than 24 copies ordered)

Resource: *What You Should Know About Recycling*
Description: Depicts materials that can be recycled, describes different recycling programs, and shows readers how to ensure successful recycling.
Cost: $1.00 (price is reduced if more than 24 copies ordered)

Resource: *About Managing Yard Waste*
Description: Explains concept and benefits of yard waste management. Includes information about backyard and community composting efforts.
Cost: $1.00 (price is reduced if more than 24 copies ordered)

Resource: *Letís Learn About Recycling*
Description: Information and activities book with games and puzzles designed to teach children the importance of recycling. Points out many recyclable items and encourages family participation in source reduction.
Cost: $1.50 (price is reduced if more than 24 copies ordered)
Grades: 4–6

Resource: *Letís Recycle*
Description: Coloring and activities book contains friendly characters and games that teach youngsters why recycling is important, and how they can join in their family's recycling efforts.
Cost: $1.50 (price is reduced if more than 24 copies ordered)
Grades: 1–3

Organization: Commedia, Inc.
Contact: Deborah Rodney
Address: 2324 SW Dolph Court, Portland, OR 97319
Phone: (503) 282-2627

Resource: *Superdude Fights for Clean Rivers*
Description: This is a play about keeping hazardous waste out of our water. It is appropriate for pollution fighters of all ages. Script is designed to be easily produced by both professional actors and students.
Cost: $2.50 per script, $10.00 royalty per performance; $20.00 for a cassette tape of performance-quality music
Grades: K–12 and adults

Resource: *Chicken Little Calling!*
Description: A recycling play including information about the 3 Rs.
Cost: $2.50 per script, $10.00 royalty per performance; $20.00 for a cassette tape of performance-quality music
Grades: K–5

Organization: Cornell University Resource Center
Contact: Richard Gray or Liz Powers
Address: 7-8 Business and Technology Park, Ithaca, NY 14850
Phone: (607) 255-2090

Resource: *Trash Goes to School*
Description: IBM 5 1/4" discs in WordPerfect 5.0. Provides more than 60 activities on waste reduction, recycling, composting, incineration, landfilling, and the environment. 1991.
Cost: $35.00
Grades: K–3, 4–6, 7–8, 9–12

Resource: *Recycling: Mining Resources From Trash*
Description: 5-poster package illustrates what materials are recyclable, and what new products can result from recycling.
Cost: $8.00

Organization: ecol-o-kids
Address: 3146 Shadow Lane, Topeka, KS 66604
Phone: (800) 423-7202

Resource: Recycling workbook and poster set
Description: A complete teaching unit with four 17” x 22” color posters illustrating ìWhat People Throw Away,î ìTrash Becomes New Products,î ìTodayís Trash—Tomorrowís Problems,î and ìLife Span of Wastes.î Also includes 16-page teacherís guide with 12 reproducible pages.
Cost: $8.95
Grades: Ages 8–14

Organization: Environmental Hazards Management Institute (EHMI)
Contact: Amy Cabannis
Address: P.O. Box 932, Durham, NH 03824
Phone: (603) 868-1496, (800) 446-5256

Resource: *Trash to Treasure Land: A Coloring and Activity Book*
Description: Takes children to a magic land where they learn the value of our natural resources and ways to reduce, reuse, and recycle. 1993.
Cost: $.75 each; volume price break
Grades: Elementary

Resource: *Recycling Wheel*
Description: Provides options for reducing, reusing, and recycling 17 materials.
Cost: $2.47 each; volume price break
Grades: All ages

Resource: *Household Hazardous Waste Wheel*
Description: Has information on proper handling and disposal of 32 potentially hazardous household products. It also provides alternatives for less toxic products.
Cost: $2.47 each; volume price break
Grades: Teenage–adult

Resource: *Kids Wheel on Household Hazardous Products*
Description: Provides information on hazardous product identification, safety, and less toxic alternatives.
Cost: $1.60 each; volume price break
Grades: 9–13 years old

Resource: *Daily Recycler Wheel*
Description: Quick reference tool on reducing, reusing, and recycling.
Cost: $1.60 each; volume price break
Grades: Teenage–adult

Resource: *Auto Recycler Wheel*
Description: A do-it yourselfers’ guide to management of used and leftover automotive products.
Cost: $1.60 each; volume price break
Grades: Teenage–adult

Resource: *Home Inventory of Hazardous Household Products*
Description: An interactive educational tool for identifying and labeling hazardous household products. Stickers and slide chart are included.
Cost: $2.47 each; volume price break
Grades: Teenage–adult

Resource: *The Environmental Education Partnership* and *the EHMI Earth Express*
Description: The Partnership links sponsoring organizations with schools in an environmental education program. It provides sponsors' and educators' guides to program implementation, an educational clearinghouse, a toll-free advisory hotline, and more. The Partnership also provides the *EHMI Earth Express*, a bimonthly tabloid publication on environmental issues that contains activities and teacher masters, reports, etc.
Cost: $100.00 for 1–24 copies, distributed 4 times during the academic year
Grades: K–12

Resource: *Recycling Bookcovers*
Description: Activities, games and coloring.
Cost: $.45 (minimum order: 1,000)
Grades: K–12

Resource: *Recycling Posters*
Description: Activities, games, and coloring.
Cost: $.40 (minimum order: 1,000)
Grades: K–12

Organization: Governor's Recycling Program
Address: 2 1/2 Beacon Street, Concord, NH 03301
Phone: (603) 271-1098
Resource: *Trash Today, Treasure Tomorrow*
Description: A recycling education kit from which teachers can develop classroom programs.
Cost: $12.50
Grades: K–6

Organization: Michigan Department of Natural Resources, Waste Management Division, Resource Recovery Section
Contact: Staff
Address: P.O. Box 30241, Lansing, MI 48909
Phone: (517) 335-4090

Resource: *Fun with Recycling*
Description: Children's puzzles and information
Cost: Free
Grades: Elementary

Resource: *Clipart: Recycling and Composting*
Description: Slogans and pictures
Cost: Free

Resource: *Clipart: Buy Recycled*
Description: Slogans and pictures
Cost: Free

Organization: Minnesota Office of Waste Management
Contact: Minerva Birkeland
Address: 1350 Energy Lane, Suite 201, St. Paul, MN 55108
Phone: (612) 649-5482
Resource: Sample brochures
Description: Examples of brochures for waste reduction, recycling, and composting education programs.
Cost: Free

Resource: *Waste Audit*
Description: Examples and work sheets for doing an inventory of waste generation.
Cost: Free

Organization: Minnesota Pollution Control Agency
Contact: Barb Hannegan
Address: 520 Lafayette Road, North St. Paul, MN 55155
Phone: (612) 296-6619

Resource:
- *Waste Education Clearinghouse*
- *EPA Earth Trek*
- *Explore Your Environment*
- *EPA Earth Notes for Educators*
- *Household Hazardous Waste (17 Fact Sheets)*
- *Reduce Your Household Hazardous Waste*
- *Checklist for Household Chemicals*
- *Toxic Chemicals: What They Are and How They Affect You*
- *Recycling School Wastes, Recycle (Grades K–6)*
- *Recycle (Grades 7–12)*
- *Teacherís Guide: Educational Materials in Resource Recovery*

Cost: Free
Grades: K–12

Organization: Oregon Department of Environmental Quality, Public Affairs
Contact: Joan Grimm
Address: 811 SW 6th, Portland, OR 97204-1390
Phone: (503) 229-6709
Resource: *Oregon Recycles* Clipart
Cost: $3.00

Organization: The Rainbow Collection
Contact: Bob and Debra Neary
Address: 83 Rolling Hill Lane, Southington, CT 06489
Phone: (203) 621-7946

Resource: *Trash Oh!*
Description: Environmental travel game for drives or field trips. Players must try to spot actual pollution and litter while on a motor trip and identify them on their game sheets. Each game sheet can mailed to a Congressman or Senator to show how much litter there is in certain areas, underscoring the need for action on environmental issues. Contains 24 game sheets with directions for 6 game variations. Made from recycled paper and cardboard.
Cost: $4.00 ($3.00 each when 6 or more are ordered)
Grades: Ages 5 and up

Resource: *Trash Oh! Bingo*
Description: Educational game based on the familiar Bingo format. Familiar litter and trash objects are presented and their impact on the environment is explained. The cards also suggest ways in which children can help the environment.
Cost: $7.00
Grades: Ages 5 and up.

Resource: *Clean Up Littertown*
Description: A 47” x 34” washable cloth playmat that represents a town filled with places from which to collect litter. Comes with two 4-inch-long wooden trucks that can be filled with litter cards, representing trash items. The game uses environmental awareness to promote vocabulary development, memory, communication, and social skills. Made of biodegradable materials.
Cost: $17.50
Grades: Ages 3–9

Organization: U.S. Environmental Protection Agency, Office of Solid Waste
Contact: Staff
Address: 401 M Street, SW, Washington, DC 20460
Phone: Resource Conservation and Recovery Act (RCRA) Hotline (800) 424-9346

Resource: *School Recycling Programs: A Handbook for Educators*. EPA/530-SW-90-023.
Description: Illustrated booklet describes school recycling program options, along with step-by-step instructions on how to set one up. Instructions for applying for Presidentís Environmental Youth Award included.
Cost: Free

Resource: *Adventures of the Garbage Gremlin: Recycle* and *Combat a Life of Grime*. EPA/530-SW-90-024.
Description: Contains information about recycling for elementary and middle school students. This appealing comic book features the Garbage Gremlin, a character that is constantly outwitted by students who practice recycling.
Cost: Free

Resource: *Ride the Wave of the Future: Recycle Today*. EPA/530-SW-90-010.
Description: Colorful poster of surfer riding glass, paper, and can recyclables. Part of EPAís educational ìStamp out the Garbage Gremlinî series. Folds for easy mailing.
Cost: Free

Organization: Waste and Toxics Progress Report
Contact: Louris Jackson
Address: Agency Building #4, 5th Floor, Albany, NY 12248
Phone: (518) 455-3711
Resource: *Strategy for a NY Statewide Solid Waste Education and Communication Program*
Description: A report from the seventh annual Conference on Solid Waste Management and Materials Policy Education Participants from 1/92.
Cost: Free

Appendix C-9

Periodicals

Publication: *All About Recycling*
Cost: Free with $30.00 membership

Organization: Pennsylvania Resources Council
Address: P.O. Box 88, Media, PA 19063
Phone: (215) 565-9131

Publication: *Biocycle*
Topics: Monthly magazine covering waste reduction and recycling.
Cost: $55.00 per year

Organization: JG Press, Inc.
Address: P.O. Box 351, Emmaus, PA 18049
Phone: (215) 967-4135

Publication: *Fibre Markets News*
Topics: Paper recycling market information.
Cost: $110.00 per year for 24 issues

Organization: G.E.I. Inc. Publishers
Address: 4012 Bridge Avenue, Cleveland, OH 44113
Phone: (800) 456-0707

Publication: *Green Alternatives* Magazine
Topics: Provides product hazard information and nontoxic product alternatives.
Cost: bi-monthly

Organization: Greenkeeping, Inc.
Address: 38 Montgomery Street, Rhinebeck, NY 12572
Phone: (914) 876-6525

Publication: *Materials Recycling Markets*
Topics: Monthly newsletter covers northeastern U.S. and Canadian recycling markets.
Cost: $75.00 per year

Address: P.O. Box 577, Ogdensburg, NY 13669
Phone: (800) 267-0707

Publication:	*P3*
Topics:	The earth-based magazine for kids.
Cost:	$14.00 per year
Address:	P.O. Box 52, Montgomery, VT 05470
Phone:	(802) 326-4669

Publication:	*The Paper Stock Report*
Organization:	McEntree Media Corp.
Address:	13727 Holland Road, Cleveland, OH 44142-3920
Phone:	(216) 923-8042

Publication:	*Phoenix Quarterly*
Topics:	Easy-reading magazine that covers recycling of metals, paper, and plastic.
Cost:	$16.00 per year
Organization:	Institute of Scrap Recycling Industries
Address:	1627 K Street, NW, Suite 700, Washington, DC 20006
Phone:	(202) 466-4050

Publication:	*Recycled Paper News*
Topics:	"Independent coverage of recycled paper is sues."
Cost:	$195.00 per year
Organization:	RP Publications
Address:	6732 Huntsman Boulevard, Springfield, VA 22152
Phone:	(703) 642-1120 x116

Publication:	*Recycling Today*
Topics:	Information on recycling programs and trends.
Cost:	$32.00 per year
Organization:	Gie, Inc.
Address:	P.O. Box 5817, Cleveland, OH 44101-9867
Phone:	(216) 961-4130, (800) 456-0707

Publication:	*Recycling World*
Topics:	Tips on precycling, and reports on community recycling.
Cost:	Send $.45 and a SASE
Organization:	Environmental Defense Fund
Address:	257 Park Avenue South, New York, NY 10010
Phone:	(212) 505-2100

Publication:	*Resource Recycling*
Topics:	Monthly industry publication. *Resource Recycling* is called the ultimate source on recycling.
Cost:	$42.00–$85.00 per year, depending on subscriber's affiliation
Organization:	Resource Recycling
Address:	P.O. Box 10540, Portland, OR 97210
Phone:	(503) 227-1319

Publication:	*The Sometimes Monthly Recycling Rag*
Topics:	Covers local, state, and national recycling issues.
Cost:	Free
Organization:	Garbage Reincarnation, Inc.
Address:	P.O. Box 1375, Santa Rosa, CA 95402
Phone:	(707) 584-8666

Publication:	*Warmer Bulletin*
Topics:	Great quarterly that covers world recycling issues, especially in Europe.
Cost:	Free
Organization:	World Resources Foundation
Address:	83 Mount Ephraim, Turnbridge Wells, Kent TN4 8BS, ENGLAND

Publication:	*Waste Age*
Topics:	Covers solid waste issues and recycling.
Cost:	$45.00 per year
Organization:	National Solid Waste Management Association
Address:	1730 Rhode Island Avenue NW, Suite 1000, Washington, DC 20036
Phone:	(202) 861-0708

Publication:	*Waste Age's Recycling Times*
Topics:	The journal of recycling markets.
Cost:	$99.00 per year for 26 issues
Organization:	Environmental Industry Association
Address:	P.O. Box 420186, Palm Coast, FL 32142-0186
Phone:	(800) 829-5443, (202) 659-4613

Publication:	*Waste Dynamics of the Northeast*
Topics:	"... the link connecting those responsible for municipal and commercial waste with those whose business is waste management."
Cost:	$42.00 for 1 year; $62.00 for 2 years
Address:	150 Dow Street, Manchester, NH 03101
Phone:	(603) 624-1442

Publication: *Waste Watch*
Topics: Provides legislative updates.
Cost: Free with $20.00 membership

Organization: Californians Against Waste
Address: 909 12th Street, Suite 201, Sacramento, CA 95814
Phone: (916) 443-5422

Publication: *Wastelines*
Topics: Provides updates on recycling legislation around the country.
Cost: $10.00 per year

Organization: Environmental Action Foundation
Address: 1525 New Hampshire Avenue, NW, Washington, DC 20036
Phone: (202) 745-4870

Publication: *World Watch: Magazine of Environmental Solutions*
Topics: Tracks indicators of Earthís well-being. Monitors environmental trends and the connections between the world economic system and environmental systems. Provides a global perspective on a wide range of environmental issues.

Organization: World Watch Institute
Address: P.O. Box 6991, Syracuse, NY 13217-9942
Phone: (202) 452-1999 (Washington)

APPENDIX D

PERFORMERS

Appendix D

Performers

Artist/Group: Peter and Mary Alice Amidon
Address: 6 Willow Street, Brattleboro, VT 05301
Phone: (802) 257-1006
Description: Concert of songs and stories with a focus on the environment.

Artist/Group: Arts on Earth
Address: 38 Stowe Road, Grafton, MA 01519
Phone: Carolyn: (508) 839-3588, Robin: (508) 839-4437
Description: Visual artists and educators with a rich background in Theater Arts and a deep commitment to the environment. Also provides student and teacher workshops.
Grades: 2–6

Artist/Group: Bash the Trash Experimental Orchestra
Contact: John Bertles
Address: 11 Wilson Place, Hastings-On-Hudson, NY 10706
Phone: (914) 478-1103
Description: Bash the Trash is a dedicated group of musicians and educators who use the central theme of building instruments out of junk to illuminate a wide range of subjects. Also provides workshops.
Grades: All ages

Artist/Group: Bygone Tales
Contact: Donna Dufresne
Address: 54 Tull Lane, Pomfret Center, CT 06259
Phone: (203) 974-3098
Description: Storytelling and dramatic performances for integrated learning about the environment.

Artist/Group: Tom Callinan and Ann Shapiro
Contact: Crackerbarrel Entertainment
Address: 168 Shore Road, Clinton, CT 06413
Phone: (203) 669-6581
Description: ìLetís Clean Up Our Act,î ìCleaning Up The Earth,î ìSolid Waste Songs,î etc. An environmental hootenanny—participatory songs using a variety of instruments.

Artist/Group: Compost Magic
Contact: Fred Glover
Address: 28 Whiting St., N. Attleboro, MA 02760
Phone: (508) 699-2904
Description: Presentation about how to make and use compost. Uses magic, balloon sculpturing, and a video showing how compost improves the growth of plants.

Artist/Group:	Earth Echoes
Contact:	Susan Tobin
Address:	12 Winch Park Road, Framingham, MA 01701
Phone:	(508) 778-0194
Description:	A 10-year veteran storyteller, Susan tells environmental stories and folk tales for all ages emphasizing ìearth ethicsî and peopleís relationship to the planet.

Artist/Group:	Earthsong
Contact:	Julia or Carol at Joyful Noise Productions
Address:	Box 295, Norwich, VT 05055
Phone:	(802) 649-3840
Description:	Women ecotroubadors provide dynamic participatory workshops, concerts, and residencies for students, educators, and families.
Grades:	All ages

Artist/Group:	Earthtunes
Contact:	Barbara Herson
Address:	16 Linden Terrace, Newton, MA 02158
Phone:	(617) 964-7463
Description:	Earthtunes is an engaging blend of music, puppets, and participation. Provides student/teacher workshops.
Grades:	All ages

Artist/Group:	Diane Edgecomb
Address:	P.O. Box 422, Hyde Park, MA 02136
Phone:	(617) 455-1926
Description:	Well known nature storyteller specializing in Native American tales and stories about recycling, pollution, water conservation, and rain forest and wildlife protection.
Grades:	K–6 and family audiences

Artist/Group:	Dan Einbender
Address:	1091 Albany Post Road, Gardiner, NY 12525
Description:	Dan sings with The Sloop Singers. He enjoys his work educating children and adults about the environment. Provides residencies, workshops, and concerts.
Grades:	All ages

Artist/Group:	Barbara Fletcher
Address:	89 Beals Street, Brookline, MA 02146
Phone:	(617) 277-3019
Description:	Barbaraís an artist whose unusual 3-D creations of lifelike animals made from recycled paper make for an inspiring hands-on ìcast party.î Provides workshops.
Grades:	All ages

Artist/Group:	Wendy Frank and Human Nature
Address:	308 Commonwealth Avenue, Concord, MA 01742
Phone:	(508) 371-2221
Description:	Human Nature explores recycling, ecology, conservation, and other topics, using guitars, banjo, flute, songs, puppets, and improvisation.
Grades:	PreK–5

Artist/Group:	Garden Planet Project
Contact:	Peter Racy
Address:	204 Pond Road, Natick, MA 01760
Phone:	(508) 653-6347
Description:	Garden Planet features Brazilian music and musicians who mix upbeat environmental songs in their benefit concerts.

Artist/Group:	Jack Golden
Address:	528 Leyden Road, Greenfield, MA 01301
Phone:	(413) 774-5483
Description:	Dr. T (who has a ìPh.D.î in Garbology) has a one-person, 40-minute show for schools and fairs.
Grades:	All ages

Artist/Group:	Grumbling Gryphons
Address:	R.R. Box 46, Crean Hill Road, West Cornwall, CT 06796
Phone:	(203) 672-0286
Description:	A traveling childrenís theater troupe that specifically addresses current marine environmental issues using the provocative and entertaining medium of theater.
Grades:	All ages

Artist/Group:	Paul Kaplan
Address:	203 Heatherstone Road, Amherst, MA 01002
Phone:	(413) 253-4984, (212) 873-1811
Description:	Folk singer whose focus is on sea songs and environmental songs.
Grades:	All ages

Artist/Group:	The Kidsí Earth Chorus Workshops
Contact:	Dr. Jill Stein and Ken Selcer
Address:	50 Saville Street, Cambridge, MA 02138
Phone:	(617) 497-1537
Description:	The Kidsí Earth Chorus sings songs about the Earth and the ìBig Family on it.î The chorus has children ages 4–13.
Grades:	K–6

Artist/Group:	Living Planet Magpie
Address:	P.O. Box 5467, Takoma Park, MD 20913-0467
Description:	Living Planet performs environmental songs to celebrate Mother Earth and her children. Themes include Whales to Wolves, Magpies to Macaws, Oceans, Tundra, and Rainforests.
Grades:	All ages

Artist/Group:	Bill Oliver
Contact:	Live Oak Recordings
Address:	515 E. 40th Street, Austin, TX 78751
Phone:	(512) 454-5008, (512) 469-3176
Description:	Bill is the composer of the popular song ìHabitat.î He sings songs about sea turtles, acid rain, and more. He is sometimes accompanied by his ìOtter Space Band.î
Grades:	K–12

Artist/Group:	Sarah Pirtle
Contact:	The Discovery Centre
Address:	63 Main Street, Shelburne Falls, MA 01370
Phone:	(413) 625-2355
Description:	Sarah trains students and teachers in ecology awareness using the expressive arts. She has won national recognition on her three recordings.
Grades:	PreK–8

Artist/Group:	John Porcino
Address:	120 Pulpit Hill Road, #10, Amherst, MA 01002
Phone:	(413) 549-5448
Description:	A combination of stories and songs to encourage children to make positive changes in the environment.
Grades:	All ages

Artist/Group:	Recyclus
Contact:	Marc Breslav
Address:	11 Peekskill Road, Cold Springs, NY 10516
Phone:	(914) 265-2624
Description:	Featured on CBS, in The *New York Times*, and elsewhere, Recyclus, the nationís ìRecycling and Waste Reduction Superhero,î conducts educational assembly programs at schools and other locations nationwide.
Grades:	K–6

Artist/Group:	Pat Scanlon
Address:	34 Washington Avenue, Andover, MA 01810
Phone:	(508) 474-9195
Description:	Clamshell organizer Pat Scanlonís music reflects his concern for the environment.

Artist/Group:	Evi Seidman
Contact:	Standup Environmentalist
Address:	6 Hornbeck Lane, Accord, NY 12404
Phone:	(914) 687-0845
Description:	Evi raises environmental awareness through performance art, comedy sketches, rap, poetry, and satire.
Grades:	7–12

Artist/Group:	Don Sinetti
Address:	54 Ellsworth Drive, Bloomfield, CT 06002
Phone:	(203) 242-1135
Description:	A presentation of traditional, contemporary, and original music illustrates our relationship to whales and how that affects our natural world.
Grades:	All ages

Artist/Group:	Small Change
Contact:	Original Theatre
Address:	212 Third Avenue North, Suite 205, Minneapolis, MN 55401
Phone:	(612) 341-0882, (612) 341-2277
Description:	Theatrical presentation about solid waste, composting, recycling, and related subjects. Group will tour on behalf of your local city or municipal recycling program.

Artist/Group:	John Tierney
Address:	169 Browning Street, Green Hill Beach, Wakefield, RI 02879
Phone:	(401) 789-1749
Description:	Environmental education, tree impersonations, sign language stories, animal puppet theatre with special guest ìBurt the Raccoon.î
Grades:	K–6

Artist/Group:	Roger Tincknell/Earth Rhythms
Address:	P.O. Box 332, Montague, MA 01351
Phone:	(413) 367-9715
Description:	Participatory musical program using facts, music and stories to help children find multi-cultural solutions to environmental problems.

Artist/Group:	Too Much Trash
Contact:	Lida Marchisio
Address:	7 Kevin Drive, East Windsor, CT 06088
Phone:	(203) 627-8330
Description:	Participatory storytelling about the environment using creative movement and drama.

Artist/Group:	Tim Van Egmond
Address:	414 Chestnut Hill Road, Montague, MA 01351
Phone:	(413) 367-9304
Description:	ìHearing Natureís Voice.î Stories and songs of our relationship with Mother Earth.

Artist/Group:	Dennis Waring, Ph.D.
Address:	P.O. Box 465, Middletown, CT
Phone:	(203) 347-5354
Description:	Program on making music with found and thrown away items. The development of instruments is the running theme of his program.
Grades:	K-6

Artist/Group:	Timothy Wenk
Address:	P.O. Box 500, Stockbridge, MA 02162
Phone:	(413) 243-0629
Description:	Timothyís *Magic of Recycling* show educates and entertains about recycling issues.

Artist/Group:	Wolfsong
Address:	7 Cataract Place, Vergennes, VT 05491
Phone:	(802) 877-3087
Description:	Storyteller whose Native American stories about earth awareness open doors for discussions about respect for the circle of life.

Artist/Group:	Yoruba
Contact:	Ralph Williams
Address:	11385 Old Town Road, Bridgeport, CT 06606
Phone:	(203) 371-1181
Description:	Jazz percussionist and ìjunk sculptorî who makes art from found objects. Artist in Residence at Stratford Dump. Provides residencies and workshops.
Grades:	All ages

Glossary

aerobic: able to live and grow in the presence of free oxygen; aerobic bacterial decomposition results in the conversion of organic wastes to compost

anaerobic: able to live and grow only in the absence of free oxygen; anaerobic decomposition of organic wastes by bacteria results in the production and release of methane gas

aluminum: a light silvery-white metal made from bauxite ore that can be easily bent or crushed, but is highly resistant to oxidation (rust)

aquifer: an underground geologic formation in which the cracks in rock, sand, soil, or gravel are filled with water

bacteria: single-celled living organisms; some types can cause disease and others break down solid waste

bioaccumulation: concentration of chemicals in the fatty tissues of living organisms; concentration may move up the food chain over time

biodegradable: able to be broken down naturally by microorganisms into simple, naturally-occurring compounds such as carbon dioxide and water; includes most organic wastes such as food and paper

BTU: British Thermal Unit, or a unit of heat required to raise the temperature of one pound of water one degree Fahrenheit; For example, it takes 70 BTUs to heat a cup of water from room temperature (72 8F) to boiling (212 °F).

carbon dioxide (CO_2): a common gas formed by respiration, combustion, and decomposition; comprises 0.03 percent of air

combustion: burning of waste materials, fuels, etc.

compost: decayed organic waste which has changed into humus

composting: the conversion of organic materials to humus by microorganisms; an effective solid waste management method for reducing the volume of the organic portion of waste, including lawn clippings, leaves, kitchen scraps, and manure

conservation: the planned management and wise use of natural resources to minimize their loss, exploitation, neglect, and waste

consumer: a person who buys goods or services

contaminants: compounds that pollute, making the original substance impure or unusable

decompose: to break down into constituent parts or basic elements; decomposition of organic waste materials by bacteria is an essential life process because it makes essential nutrients available for use by plants and animals

demolition debris: waste materials produced during construction or remodeling; includes items such as used lumber, masonry, sheetrock, shingles, insulation, etc.
ecology: the scientific study of the relations of living things to one another and to their environment

ecosystem: a system made up of a community of living things and the physical and chemical environment in which they interact

environment: all the conditions, circumstances, and influences surrounding and affecting the development or existence of living things

fly ash: small particles of ash and soot which are collected by pollution control devices during the incineration of solid wastes

food chain: a succession of organisms in a feeding chain in which food energy is transferred from one organism to another as each consumes a lower member of the chain and is, in turn, preyed upon by a higher member

garbage: spoiled or waste food that is thrown away; generally defined as wet food waste and excludes dry material (trash); This term is often used interchangeably with the word “trash.”

glass: a transparent, inorganic, non-porous, impermeable material produced by melting silica sand with limestone, with the addition of soda ash for strength and chemical durability

groundwater: water beneath the earth’s surface that moves between soil particles and rock; supplies wells and springs

habitat: place where a plant or animal normally lives; part of an ecosystem

hazardous waste: waste that results in special problems to living creatures or the environment because it has one or more of the following characteristics: (a) poisonous, (b) explosive, (c) corrosive to flesh or metal, (d) readily burnable, with or without a flame, (e) transmits disease, or (f) radioactive. Some wastes cause only one problem; others combine several of the above

household hazardous waste: substances used in the home that have some or all of the characteristics of hazardous wastes; should not be disposed of in the same manner as other solid waste

humus: organic material consisting of decayed vegetative matter; provides nutrients for plants and increases the ability of soil to retain water

incinerate: to burn waste to ashes, reducing the volume of trash to be landfilled

incinerator: a plant designed to reduce the volume of waste by burning

inorganic: not made from plant, animal, or carbon compounds; most inorganic compounds (e.g., glass or metal) are derived from mineral resources

landfill: a large outdoor site for the controlled burial of solid waste by spreading it in layers and covering it with soil. New regulations for landfills call for special engineering techniques to reduce hazards to public health and safety.

leachate: liquid that has percolated through a landfill and/or been generated by the decomposition of solid waste; contains dissolved or suspended materials in it such as decomposed waste or bacteria; must be collected and treated to avoid contamination of surface water or groundwater supplies

lime: a mineral or industrial form of calcium carbonate used in the production of glass, in pollution control devices in incinerators, and to control acidity in composts

litter: waste materials discarded in an inappropriate place; Littering is against the law in Massachusetts.

manufacture: to make products from raw materials, especially on a large scale with machines

materials recycling facility (MRF): a facility where recyclables are sorted and processed for sale; The state's first MRF, serving the four western counties, opened in Springfield in January 1990.

methane (CH_4): an odorless, colorless, but highly explosive (flammable) gas which is a by-product of solid waste decomposition; also a commercial fuel, natural gas

microorganisms: microscopic living organisms involved in the sewage treatment process and in the composting of many other wastes

natural resources: valuable, naturally-occurring items such as plants, animals, minerals, water, and air which are used by people to help make things such as energy, food, clothes, buildings, etc.

nitrogen cycle: the continuous cyclic progression of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, assimilated and metabolized by bacteria and plants, and returned to the atmosphere following decomposition

nonrenewable resources: natural resources that are considered finite in amount because of their scarcity, the length of time required to form them, or their rapid depletion; examples include petroleum, coal, natural gas, and copper

organic: derived from living organisms and containing carbon compounds; organic chemicals, those containing carbon, are also synthesized by humans

oxidation: chemical combination with oxygen; e.g., the rusting of iron

pH: a numerical measure, ranging from 1 to 14, of the acidity of a substance; very low pH values (1–3) indicate high acidity (vinegar pH=3); high values (12–14) indicate an extremely basic or alkaline substance (lye pH=10); pH of 7 is neutral

packaging: the wrappings, container, or sealing used to protect, identify, and advertise a product

pesticide: any substance designed to kill living organisms, including insects (insecticides), plants (herbicides), fungi (fungicides), rats and mice (rodenticides), and bacteria (germicides)

plastic: any one of many human-made materials consisting of carbon in combination with hydrogen, oxygen, nitrogen, and other organic and inorganic elements which are produced by polymerization, and which can be molded, extruded, or cast into various shapes and films

pollution: harmful substances deposited in the air, water, or on land, leading to contamination of the environment
polyethylene: a common plastic used to make plastic bags (low-density polyethylene) and milk bottles (high-density polyethylene)

pulp: a soft, moist, sticky mass of fibers made up of wood, straw, etc., and used to make paper and paperboard

recycling: using something over again; the collection and reprocessing of a manufactured material or waste product for reuse either in the same form or in the manufacture of the same or a different item

recycling center: a site where manufactured materials are collected and sold for reprocessing

refuse: a general term for solid waste materials or trash

renewable resource: a natural resource derived from an endless or cyclical source (e.g., sun, wind, wood, fish); with proper management and wise use, replacement of these resources by natural or human-assisted systems can be approximately equal to their consumption

resource: a supply of something that can be used or drawn upon; something that can be used to make something else—e.g., wood into paper, bauxite ore into aluminum, old bottles into new ones, sand into glass

resource recovery: use of technology to burn mixed solid waste and produce energy; may involve mechanical separation of recyclables before or after burning

reuse: to extend the life of an item by repairing or modifying it, or by creating new uses for it

sanitary landfill: see **landfill**

septic tank: a tank into which sewage is discharged and decomposed by bacteria

sewage: mostly liquid waste, including human waste, which is transported away by sewers and purified in a sewage treatment plant

sludge: the muddy sediment left after sewage has been processed

solid waste: all solid and semi-solid wastes, including garbage, rubbish, ashes, industrial wastes, demolition and construction debris, and household discards (appliances, furniture, equipment)

solid waste management: the controlling, handling, and disposal of all solid waste; one goal is to reduce waste to a minimum

source reduction: behavior to deliberately minimize the amount of waste generated by an activity or use of a product; the primary focus of the Massachusetts Solid Waste Management Action Plan developed by DEP

Styrofoam: a rigid polystyrene plastic that uses petroleum as a resource base.

tipping fee: charge to deposit waste in a landfill or to dump recyclables at a recycling facility

transfer station: an intermediate location used to collect and consolidate solid waste or recyclables, which are then taken elsewhere (for example, a distant landfill or market)
trash: material considered worthless, unnecessary, or offensive that has been discarded; generally defined as dry waste material, excluding food waste (garbage) and ash; This term is often used interchangeably with the word, “garbage.”

waste: anything that is discarded or not considered useful

wastewater: water that has been used in the home, business, or manufacturing process, and which requires treatment and purification before it can be used again

white goods: household appliances, including ovens refrigerators, freezers, water heaters, washers, dryers, etc.

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ENDNOTES

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