Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1981 Volume V: The Human Environment Energy

The Hazardous Waste Dilemma

Curriculum Unit 81.05.05
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Introduction

Toxic chemicals seeping out of corroded drums. Lakes saturated with industrial waste. Stockyards of chemical wastes waiting to explode. The Love Canal tragedy. The New Jersey chemical dump fire. It does on. Carcinogens in the drinking water. Birth defects due to chemicals dumped illegally. Stories of hazardous wastes seem to dot the news each day. No wonder it has been dubbed the “Nightmare of the 80’s”. My unit will attempt to explain how we’ve gotten into this dilemma and what will be necessary to avoid total devastation in the future. The unit is intended for a fifth or sixth grade Science class as an overview of the problem with special attention paid to awareness of actions, alternatives and remedies.

The objectives of this unit are:

1. To describe the characteristics of a hazardous waste site.
2. To describe how hazardous wastes can cause health problems.
3. To identify present and proposed methods of dealing with hazardous wastes.
4. To create in children an awareness of the hazardous waste problem.
5. To identify the role of environmental groups, government and industry in dealing with hazardous wastes.

Rationale

We live in a media centered age. People are more aware of events, tragedies, sensational items and scandals than ever before. A topic that has been getting hotter in the news all the time, because of its possible drastic complications involving the public, the government and industry, is the hazardous waste problem. Because it is such a hot news item and because it does have implications for our students in the future, I have chosen the hazardous waste dilemma as my unit topic.

Some far reaching lessons can be learned from a unit on a current topic such as this. First of all the children will be able to follow stories of what is being done about hazardous wastes as they happen. They will get an idea of how the government works when faced with a pressing problem. They will see how community and environmental groups organize and attack problems that threaten the welfare of the public. The significance of such studies can only be enlightening. Students will become more aware of the news and what government decisions mean to them. More importantly, they may become more concerned with community problems and learn to exercise the proper means of protest afforded them by their local government. The result of such a study may be a more aware citizenry who will not allow problems to become as immense as the hazardous waste one has.

Information

1. *The Law of Conservation of Matter*

Discussion of wastes and environmental pollutants must include an understanding of the law of conservation of matter. It states that matter cannot be created nor destroyed but merely changed from one form to another. In simpler terms, everything we think we have thrown away is still here with us in one form or another. It is imperative that children are taught this law that everything must go somewhere. We live in a "throwaway" society, or so we are told. In reality nothing is ever really thrown away but changed to dust, soot, solid wastes or, in the case of industry, hazardous wastes.

2. *Why do we have Hazardous Wastes* ?

Hazardous wastes are with us because we have become a highly technological society. The plastics we consume with great regularity emit hazardous waste material as a natural by-product. Making an automobile or refrigerator results in hazardous wastes from acids used to clean steel and from cyanides used to harden steel. Wastes from the ink used to print this very page are probably hazardous because of the organic dyes it may contain. In essence, hazardous wastes are unavoidable. They have become a facet of our lives.

Industry creates the bulk of hazardous wastes material, but surely hospitals, the Department of Defense and others do their part. It would take some drastic changes in our American life style to do away with these industrial wastes—changes we are neither prepared to propose nor willing to carry out. These changes would dig deeper than just going back to bottled milk rather than the plastic containers we use now. These changes would be more sweeping than just doing away with all the plastic wraps for good old plain paper. These changes are unrealistic, inconceivable and never to be seen. We as Americans have grown to rely on the technology we have developed for our very existence. The state of Connecticut, in fact, without its factories

wouldn't be nearly as prosperous as it is now. So the hazardous wastes themselves seem to be here to stay. Our problem is what do we do with them?

3. *How are Wastes Hazardous* ?

Wastes become hazardous when they are haphazardly stored. The Environmental Protection Agency (EPA) estimates that from 7080% of waste disposal is held on the generator's property. Liquid wastes are stored in drums. Solid wastes are piled on the ground and wetted down to prevent dispersion in the wind. Others dump waste material in lagoons and small lakes or rivers.

The waste material that is improperly stored, transported or disposed of can enter the ecosystem in six basic ways:

1. Liquids that leak from disposal sites contaminate groundwater;
2. Runoff from disposal sites contaminates surface water;
3. Incineration, evaporation or wind erosion of wastes pollutes the air;
4. Poisonous wastes are absorbed or ingested by organisms that pass them on in the food chain;
5. Poisons spill in storage or transit, doing damage by direct contact;
6. Fires and explosions do direct damage.

Each of these ways can cause harmful, if not fatal, side effects on living things coming into contact with the poisonous material. Some chemicals emitted are known to cause cancer, birth defects and genetic damage in test animals. Arsenic, a pharmaceutical byproduct, can damage the brain and nervous system. Benzene, a chemical solvent, has been known to cause leukemia. Cadmium, a plasticizer, is known to damage kidneys and cause hypertension. The list goes on. Chromium, copper, lead, manganese, mercury, selenium, trichloroethylene; all have been linked to one or more serious human malconditions.

Wastes can be hazardous in any or all of these ways:

TOXIC—Poisonous, potentially harmful to humans causing the aforementioned maladies.

CORROSIVE—Can corrode storage containers; can damage human tissue if touched.

REACTIVE—Unstable; can react if exposed to heat, shock, air or water.

IGNITABLE—Can explode, catch fire or emit toxic fumes or gases.

The tragedy of Love Canal in Niagara Falls, New York epitomizes the destruction poorly managed hazardous wastes can wreak on a community. Chemicals leaking from corroded drums buried twenty years earlier have totally uprooted some 240 families. The frightening thing is there are more potential "Love Canals" festering in all parts of the country.

4. *The Alternatives*

Hazardous wastes, as I have previously mentioned are here to stay. It then becomes of major importance how we store or dispose of them. Alternatives are being explored but with the alternatives come “trade offs”. For example, should we pollute the oceans instead of streams, lagoons and rivers? The alternatives are interesting, expensive and in most cases controversial. Here are the latest ideas:

A landfill cell— This controversial but most conventional method is widely used. Land, about 150 meters long and wide is excavated and fitted with a liner of reinforced synthetics It is then covered with a meter of clay. Drums are placed in the excavated area divided by clay barriers into subcells. Incompatible wastes are kept separate. When totally filled the pit is capped with another synthetic liner and another layer of clay.

Incinerator ships— This proposal would take the smokestacks out of the cities and into the oceans. It would cut costs and reduce social pressure. Incineration on land costs $110 much abuse from neighbors. (Incineration is good—but not next door to me.) Incineration at sea costs $80 per ton and the contaminants are greatly diluted by the water. In fact many of the contaminants are natural to the oceans. People opposed to this method cite increased handling and transportation as a drawback because it raises the possibilities of spills while in transit or being loaded. Also environmentalists are opposed to any ill effect imposed on marine life.

Handling sludge— Sludge containing zinc, lead, PCB’s and other chemicals can be spread in areas with inedible plants and covered with topsoil. This is one of those “trade-offs” because other alternatives are not conducive to the safety of the public. (i.e. burial at sea, piled up on land, spread over cultivated areas.)

Deep-well injection— Liquid waste is injected into porous rock deep in the earth. Industry has employed this technique for years with mixed results. Opponents to this method argue that the liquids injected into poorly constructed wells can rise to contaminate subsurface waters. The EPA has since devised ways of measuring and predicting the viability of such deep wells and is monitoring all existing sites.

Cement kilns— These are being used as an alternative to incineration. Extremely high temperatures are used to decompose highly toxic substances such as PCB’s.

Treatment— This is a long term approach to the hazardous waste problem. Wastes are treated prior to disposal in an effort to detoxify the hazardous components. The process is not foolproof since the end product cannot be determined to be completely nonhazardous. This method can be amplified into a centralized treatment concept where industries with like hazardous wastes can bring the toxic liquids to for treatment. This would reduce costs for industry since ,they would share in the operation of such a plant rather than maintaining one of their own.

5. *The Role of Industry*

It was previously stated that industry must use some highly toxic chemicals in the production of essential products. An example of this is the common additive chromium. Chromium is used as a protective agent in the manufacturing of stainless steel cutlery. In fact it makes up about 12% of the final product. Chromium is highly resistant to heat and aids in keeping the cutlery tarnish free. However, in this process of chromium plating chromic acid mists rise from the plating tanks. Dermatitis can result from constant contact with this acidic mist. Skin that is irritated by chromic acid should be washed with warm water and soap. Clothing should be washed before reuse.

Since chromium is a powerful oxidizing agent, it can cause fires. Therefore, it should be stored in a cool place away from all fire hazards. Persons involved in the storage of chromium should wear protective clothing such as goggles, rubber gloves, rubber aprons, face shields and some type of head gear.

Strict adherence to safety regulations is the essential role of industry. Hazardous chemicals do not have to endanger the public. Proper storage and discriminate disposal will play a large part in the hazardous waste solution.

6. *The Role of Government*

A bill that addressed the question of liability in cases of hazardous waste abuse was signed into law by President Carter in December of 1980. The bill became known as “superfund” while being debated in the Congress. The end product hardly lives up to that name.

The original proposals tried to answer these questions concerning hazardous wastes:

—Who should pay for clean up of existing sites, industry or the government?

—Are responsible parties liable to fines?

—Where should the money to create a “superfund” come from?

—What relief for victims, if any, should be included?

The House of Representatives version of the bill called for a $1.2 billion fund, of which $900 million would be contributed by industry to clean up “top priority” sites. The companies would be held liable for future indiscretions. No relief for victims was included.

The more extravagant Senate version called for a $4 billion fund, of which $3.5 billion would be industry derived. This money would be used to clean up any existing site and pay for victim compensation. Also, health studies of areas possibly affected by existing sites would be undertaken. Liability for future indiscretions would be on the offenders.

The bill that President Carter signed was a watered down version of what environmentalists lobbied for. The “lame duck” Congress was running out of time and rather they “passed what they could now—come back next year for the rest.” PL96-510 provides $1.6 billion over the next five years to pay for response costs, remedial actions and damages to natural resources due to the release of hazardous substances. Eighty-seven percent money will be industry derived. “Superfund” does not address the problem of victim compensation.

7. *The Role of Citizen Groups*

The name “Love Canal” has become synonymous with hazardous wastes. It has become the rallying cry of groups concerned with a clean environment. Actually Love Canal, located in Niagara Falls, New York had an innocent if not ambitious beginning. It was originally dug in 1890 to serve as a power plant and supply route. When these plans fell through it became the local swimming hole in summer and ice skating pond in winter. Hooker Chemical Company bought the body of water for use as a dumping site for drums of chemical wastes. Years later the canal was filled in and a housing development was built. In 1976 tragedy struck. The buried drums had apparently corroded and hazardous chemicals began showing up in the drinking water. An entire community was uprooted.

Environmental groups around the country were alarmed. Future “Love Canals” would have to be prevented. Local citizen groups concerned with the horrors of Love Canal cropped up. A national association called “Hunt the Dump” was formed. Its purpose is to seek out hazardous waste sites and determine whether they are environmentally dangerous.

In Enfield, Connecticut a legal battle is taking place between a local citizens group, CASE, and a Texas firm whose intent it is to build a hazardous waste treatment site in their community. The CASE group was formed by community people who are out to make sure their health and safety is not being compromised to accommodate industry. Their battle has been fought on many fronts: organized rallies and protest marches for media attention, bumper sticker and lawn sign campaigns, legislation introduced into the state House of Representatives and in the courts where the decision will ultimately be made. To be sure, the disposal of hazardous wastes is a hot topic. It will be interesting to see what happens in Enfield. A precedent might be set for future clashes between citizens and industry.

Unit Outline

I. The Law of Conservation of Matter
   A. Experiments proving this law
II. Hazardous Wastes
   A. Characteristics of hazardous wastes
   B. Define the terms
      1. Toxic
      2. Corrosive
      3. Reactive
      4. Ignitable
   C. Discuss “Love Canal”
III. Alternatives
   A. Describe the present and future alternatives
      1. Land fill cell
      2. Incinerator Ships
      3. Handling sludge
      4. Deep-well Injection
      5. Cement Kilns
      6. Treatment
IV. The Role of Industry
   A. Describe uses of chromium (for ex.)
   B. Chronicle the Upjohn Plant chemical problem
   C. Newspaper articles
V. The Role of Government
   A. “Superfund”
   B. Present proposals
   C. Newspaper articles

VI. The Role of Citizen Groups
- A. How groups organize
- B. “Hunt the Dump” group
- C. Newspaper articles

VII. Culminating Activities
- A. Effects of water on Life Experiment
- B. Role Playing Activity
- C. Teacher made quiz on topics covered

Classroom Activities

Activity A— *The Law of Conservation of Matter*

In order to understand the hazardous waste problem the children must first comprehend that matter cannot be created or destroyed, only changed in form. Some simple experiments can be done to graphically illustrate this concept. I would suggest that these activities be done during one class period (perhaps simultaneously) to ensure total mastery.

1. Ice to water—allow an ice cube to change its form from a solid to a
2. Tearing paper—tear a large piece of construction into several strips.
3. Sugar into water—place sugar into water and stir until all particles have been seemingly absorbed.
4. Burning a candle—allow a candle to burn down considerably.

Point out in each case that the matter has not been destroyed but only changed in form. It may be necessary to explain that air has weight and occupies space (i.e. the burning candle experiment). If needed this concept can also be shown. All that is needed is two balloons, a ruler and a spool. Place an unblown balloon on each end of the ruler which is balancing on the spool. It should balance. Now blow up one balloon and place it on the ruler. The resulting dip illustrates that the balloon filled with air has more weight. Thus air is matter because it occupies space.

Activity B— *Effects of Water on Life*

A major point of this unit is the effect hazardous wastes have on life and the implications for health in the future. To illustrate how our drinking water is directly related to our health do the following experiment:

Buy five inexpensive fish from a pet store. Fill five bowls with water from different sources. For example, a bowl of school tap water, a bowl of water from the reservoir, a bowl of water from the Housatonic River, a bowl of water from a nearby stream and a bowl of water from a home tap. Place a fish in each bowl. Feed the fish the same amount of food each day. Make a chart to record how long each fish survives, their growth and

activity level. The purpose is to see how water with varying chemical consistencies affects life.

Activity C— *Role Playing*

Bring a sticky substance, such as fly paper or two-way tape, to your classroom. Tell your students that they must dispose of the sticky substance *in the classroom* . Divide the students into three groups—four children to represent industry, four children to represent the government and the rest to represent a citizens group. Each group is to form an opinion as to where the sticky substance should be disposed of. The group representing industry owns the substance and is planning to deposit community. The citizens group will react to the decision of industry as they see fit. Ultimately, the government group will decide the fate of the sticky substance and make up some rules to follow in future cases.

In this role playing activity the children should try to emulate the actions of the group they represent to the best of their ability based on the information disseminated in the unit. The teachers role is to monitor the groups to see that they are functioning in this manner.

When the role playing activity is done, and it might take 3 to 5 class periods to organize, discuss and perform, a classroom discussion should take place. Feelings about how groups function, what motivates them, how the children felt during the activity and questions about the final decision should be discussed. Analogies to real-life situations in dealing with the hazardous waste question can be made. Hopefully, this activity will leave the students with an awareness of the problems we are faced with now and the problems they will be faced with in the future.

Activity D— *Bulletin Board*

Since the hazardous waste problem is a current one, it is highly likely that much printed information will appear in newspapers and magazines on this subject during the course of your unit. Have your students be aware of these articles by clipping them and posting them to a board in your classroom. You can get even more sophisticated by dividing your bulletin board up into three sections—industry, government and citizenry. After going over each article with the students, have them decide under which category the clipping should be posted. In other words, decide who owns the problem described in the particular article. It should prove interesting after a period of time to see which group is written about most often. A discussion can take place as to why one group gets more press than the others and whether the press is positive or negative.

Pertinent Vocabulary

1. carcinogen—a substance or agent producing or inciting cancer.
2. corrosive—having the power to wear away gradually through chemical reactions.
3. ground water—water that lies buried from a few feet to a half mile or more beneath the land’s surface in stretches of permeable rock, sand and gravel known as aquifers.
4. ignitable—having the ability to catch fire or emit toxic gases or fumes.
5. landfill—an area where wastes have been placed for permanent disposal.
6. leachate—liquid that has percolated through hazardous wastes and contains components from the waste.
7. PCB’s—mixtures of many chemical compounds; widely used as a pesticide extender; found in the fatty tissues of humans.
8. reactive—unstable chemical that can explode if exposed to heat, shock, air or water.

9. toxic—poisonous, potentially harmful to human health.

STUDENTS ANNOTATED BOOK LIST

Gray, Charles A. *Explorations in Chemistry* New York: E.P. Dutton & Co., Inc. 1967. For the advanced, very interested student. Further more complex experiments on principles of matter.

Orlowsky, Wallace & Perera, Thomas Biddle. *Who River?* New York: Coward, McCann and Geohagen, Inc. 1970. Dramatic presentation of water pollution for young readers. Easy reading, many pictures.

Paradis, Adrian A. *Reclaiming the Earth* New York: David McKay and Co., Inc. 1971. Future career opportunities in the field of improving the environment are presented in a clear, concise and realistic manner. Above average reader.

Perry, John *Our Polluted World* New York: Franklin Watts, Inc. 1967. Informative book that asks the question how long can we dump wastes into the air and water and escape extinction? Above average reader.

Schneider, Herman. *How Scientists Find Out* New York: McGraw-Hill Book Co. 1976. Good book for students to further study of matter. Drawings and photographs accentuate the text.

Shuttlesworth, Dorothy E. *Clean Air—Sparkling Water* Garden City, NY: Doubleday & Co., Inc. 1968. Vivid pictures of pollution. Readable text. Good book for all students.

Stone, George K. *Science Projects You Can Do* Englewood Cliffs, NJ: Prentice-Hall, Inc. 1971. Easy to do demonstrations and projects for the interested learner. Can be used as reference book in a Science Fair.

Swezey, Kenneth M. *Science Shows You How* New York: McGraw Hill Book Co. 1964. Science experiments dealing with matter for the interested learner. Illustrated well but with old pictures.

TEACHERS ANNOTATED BIBLIOGRAPHY

Early, A. Blakeman. “A Brief and Appalling Look at Hazardous Wastes”, *SIERRA* (May/June 1980). Good resource. Chronicles activities of “Hunt the Dump” group. Filled with statistics.

Harmer, Ruth Mulvey. *Unfit for Human Consumption* Englewood Cliffs, N.J.: Prentice-Hall Inc. 1971.

Excellent book on pesticide use and how it affects our health.

Kiefer, Irene. “Hazardous Wastes,” *SCIQUEST* Vol. 52 #4 (April 1979).

Very informative article. “Love Canal” and other trouble spots are explored.

Lennett, David J. “Handling Hazardous Waste: An Unsolved Problem”, *ENVIRONMENT* Vol. 22 #8 (Oct. 1980).

Explanations of various new methods of dealing with wastes.

Maugh, Thomas H. “Burial is the Last Resort for Hazardous Wastes”, *SCIENCE* Vol. 204 #4 (June 22, 1979).

Describes a landfill cell in detail.

Pamphlets

“ Hunt the Dump”
Send to: Blake Early
Sierra Club
330 Pennsylvania Ave., S.E.
Washington, D.C.
“The Toxic Substances Dilemma: A Plan for Citizen’s Action”
Send to: The National Wildlife Federation
Dept. TD
1412 16th St., N.W.
Washington, D.C.
“Controlling Hazardous Wastes”
Send to: Publications
Center for Environmental Research Info.
US EPA

Cincinnati, OH 45268

Films

"Cry of the Marsh," Bill Snyder Films 1969 12 min. color The calm beauty of a marsh is invaded by human beings. Scenes depicting frightened animals scurrying about can be frightening to children. (High school—adult)

"The Second Genesis," UI Films 80 Temple St. 16 min. color Offers new ways of cleaning up the environment without abandoning established means of production. (7th Grade—high school)

"Communities Keep Clean," AV Dept. 11 min. color Close-ups of men and machines showing such activities as water purification and landfill projects. (Gr. 5—high school)

"River, Where Do You Come From?" AV Dept. 10 min. color The film follows the flow of a river—the section on water pollution is especially interesting. (Gr. 5—high school)

References

Abrams, Nancy E. and Primack, Joel R. "Helping the Public Decide," *Environment* Vol. 22 #3 (Apr. 1980).

Cottrell, A. H. *An Introduction to Metallurgy* , New York: St. Martin's Press 1967.

Early, A. Blakeman. A Brief and Appalling Look at Hazardous Wastes," *Sierra* (May/June 1980).

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Lewis, Jim. "The Chemical Condo," *Environmental Action* Vol. 12 #7 (Jan. 1981).

Lyman, Francesca. "Dredging for Dollars," *Environmental Action* Vol. 12 #8 (Feb. 1981).

Maugh, Thomas H. "Burial is the Last Resort for Hazardous Wastes, *Science* Vol. 204 #4399 (June 22, 1979).

Maugh, Thomas H. "Burning Questions About Toxic Wastes," *Science '80* (Nov./Dec. 1979).

Miller, G. Tyler, Jr. Living in the Environment—2nd Edition. Belmont, CA: Wadsworth Publishing Co. 1979.

Sax, N. Irving, Handbook of Dangerous Materials, New York: Rheinhold Publishing Corporation 1951.

Sister Sheila Marie, Energy, Matter and Living Things, New York: McGraw Hill Book Co. 1967.

"Toxic Wastes," *Time* (Sept. 22, 1980).

Ward, Barbara and Dubos, Rene, *Only One Earth* , New York: W. W. Norton and Co., Inc. 1972.