United States
Environmental Protection
Agency

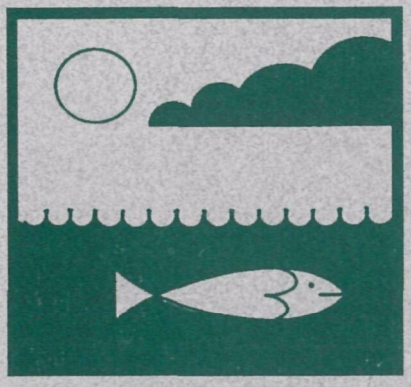
Region 7
Office of Public Affairs

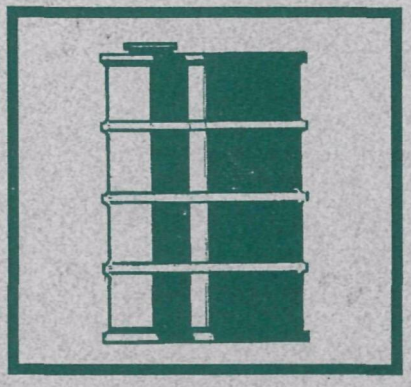
April 1990

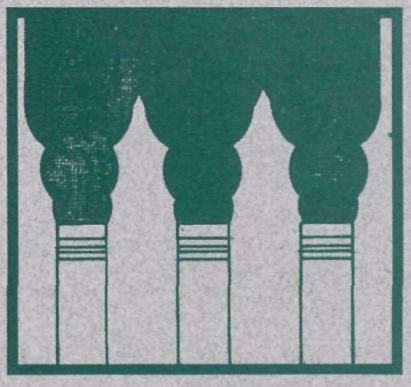
EPA

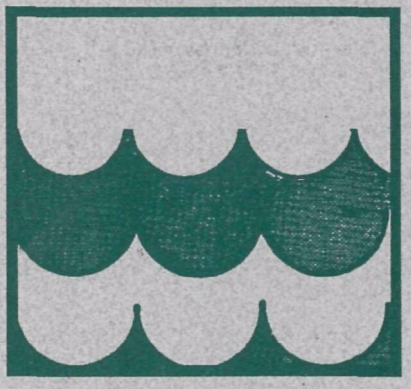
ENVIRONMENTAL CURRICULUM

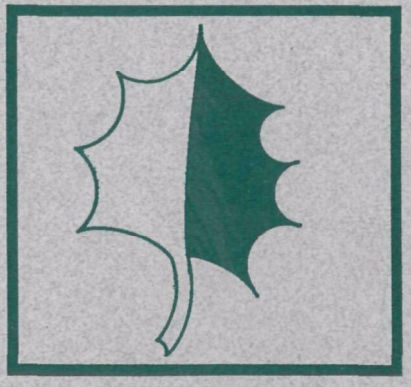
A FIVE-DAY PLAN

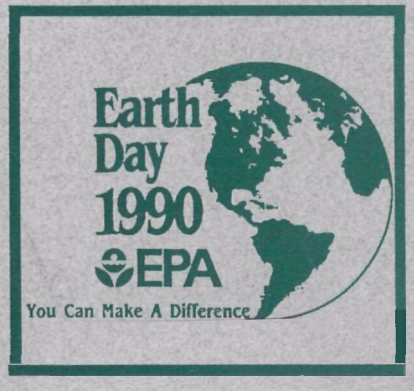












Dear Educator:

As we learn more about the Earth's environment, the lesson seems to center around the fact that all of nature is connected in a complex web of interdependence. John Muir, founder of the Sierra Club, expressed this concept a century ago. More recently, we were impressed by the smallness of our planet when we saw the first pictures taken from space. The visualization of the only known life supporting region in the universe, a very thin layer at the surface of a rather small astronomical body, has brought us to a sobering realization -- *The resources of the Earth are finite, and if we pollute its systems beyond their ability to recover, life on Earth could be seriously affected.*

The first Earth Day in 1970 was in response to mounting public concern over glaring problems affecting the environment. Cities were being choked with clouds of soot, lakes and rivers were clogged with raw sewage and industrial discharges, and automobile exhaust was laced with lead. Gains have been made in all these areas. After two decades of environmental protection, we have become a nation investing much time and effort in determining how to cope with all the waste generated by our modern industrial society. We spend roughly $85 billion per year - $340 per capita - on pollution controls, but we still haven't achieved our goals of clean air and water.

As Earth Day 1990 approaches, we are confronted with new problems. Global warming, stratospheric ozone depletion, acid rain, radon, deforestation, soil erosion, species extinction, and habitat destruction. These were not prime issues of the first celebration. Even the disposal of society's garbage and solid waste is proving to be a challenge.

Finding creative approaches to pollution prevention is a priority for EPA. A national commitment to pollution prevention and the importance of the individual to the solution are the themes of EPA's Earth Day 1990 celebration. President Bush said, "Through millions of individual decisions simple, everyday, personal choices - we are determining the fate of the Earth," he said. " We are all responsible for the environment and it's surprisingly easy to move from being a part of the problem to being part of the solution."

One of the keys to pollution prevention is education. Education can increase the public's understanding of the environment and encourage a national ethic of individual responsibility. Environmental Education, combined with market incentives, can influence the millions of choices we make as citizens and

consumers. When children are involved, we must remember not to frighten them or leave them without hope as we inform them about the conditions of our environment and encourage them to become pollution preventers.

William K. Reilly, EPA Administrator, recently wrote, "Pollution prevention must become a fundamental part of all our activities, all our initiatives, and all our economic growth. The biggest environmental gains we have made have been when industry phased out or found substitutes for problem substances. Banning the use of DDT and taking the lead out of gasoline are great examples of pollution prevention.

"During the 90s and beyond, our goal must be an efficient and sustainable society that will preserve our planet while providing the economic growth necessary to allow all peoples to benefit from the renewable worth the Earth provides."

We hope you will find this ***Environmental Curriculum: A Five Day Plan*** helpful in your teaching endeavors.

Rowena L. Michaels

Rowena L. Michaels, Director
Office of Public Affairs

How to Use This Curriculum

This curriculum is designed to be used during the week prior to Earth Day. However, it may be used at any time to address environmental awareness. The five days should be thought of as chapters. Each chapter has two major topics. Flexibility is the key design criteria and a short discussion of the topic of composting or a long-term project on the analysis of the classroom waste stream are both appropriate applications.

Each of the ten topics covered in the five days has the following subsections:

❑ **ENVIRO - MINTS** —Short, interesting, factual statements that indicate some of the issues surrounding the topics. They can be used as discussion starters or as background information for further study.

❑ **WHAT YOU CAN DO** — A brief list of individual actions that can help the problem identified by the topic. It can also be used as discussion material and may help students realize that actions can be taken to improve a situation.

❑ **FOCUS** — Questions that can be used to start class discussion and the activities that follow them.

❑ **BACKGROUND** — A short information section to provide answers to the questions raised and further explanation of the topic.

❑ **ACTIVITIES** — Many activities are provided for each topic, so choice is the key. They vary from a crossword puzzle in Day 5 to the efficiency of a bicycle in Day 2. There are far more than can be done in a day and they are adaptable to grade levels.

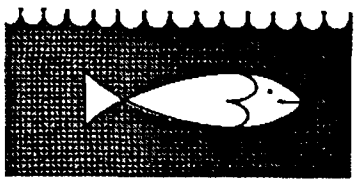
A useful extensive glossary of environmental terms is included after Day Five.

DAY 1 **Page**

Any views expressed in this material should not be construed as official U.S. Environmental Protection Agency policy.

DAY 1

ECOSYSTEMS



"When you dip your hand into nature you find that everything is connected to everything else."

John Muir
(Founder of Sierra Club)

Enviro-mints

❑ Ecosystems are made up of living organisms which interact with each other as well as with non-living substances, such as solar energy, wind, rainfall, and inorganic chemicals. An ecosystem can be a planet, a tropical rain forest, a lake, a desert, or even a small, grassy portion of a large field.

❑ The biosphere is the area of the planet which encompasses all living things. It includes ecosystems of air, water, soil and rock.

❑ Wetlands are the most productive wildlife habitat on an acre-by-acre basis and are being destroyed at a rate of 350,000 to 500,000 acres per year.

❑ Numerous types of fungus and bacteria (up to 10 million per gram of soil) have been found 850 feet below the surface.

❑ The biosphere is the life supporting layer at the surface of the Earth and is only about 10 miles thick.

❑ Tropical forests cover only 7% of the Earth's surface, but house between 50% and 80% of the planet species.

❑ Tropical forests are found in areas where the rainfall is 80 inches or more per year.

❑ Some 25% of the medicinal substances in use in the United States today contain ingredients originally derived from wild plants found in tropical forests.

❑ Numerous tropical rainforests are under attack by man and less than 5% receive any protection.

❑ By 1985, two-thirds of Central America's accessible rainforests had been cleared or heavily depleted for cattle farms.

❑ In 1989, an estimated 28 million acres of tropical rainforests were destroyed.

❑ Deforestation contributed to the recent droughts in Africa and the devastating mud slides in Rio de Janeiro.

What You Can Do

❑ Contact your local elected representatives and encourage them to support wetlands protection programs.

❑ Plant and maintain trees.

❑ Become aware of which species are endangered and what you can do to preserve them.

❑ Minimize driving by cutting out unnecessary trips and by car-pooling.

❑ Educate others on the need to preserve the world's rainforests.

Focus: Biosphere

1. What is the biosphere?
2. How large is the biosphere?
3. What can be done to protect the biosphere?

Background

The biosphere is a thin spherical shell at the Earth's surface that is habitable by living organisms on a continuous basis. The biosphere contains the lowest region of the Earth's atmosphere as well as the deepest ocean depths. It has a thickness of only about 10 miles (16 kilometers). This thin region contains the habitat of all known living organisms in the universe.

Activities

❑ As an illustration, bring an apple to class and show the student that the skin thickness on the apple is about the same size in relation to the radius of the apple as the thickness of the biosphere is to the radius of the Earth.

❑ As an illustration and math activity, have the students take a globe and measure its diameter and divide this by two to get its radius. Then, have them use a proportion to find the relative thickness of the biosphere in relation to the globe.

Have them use the proportion:

$$\frac{\text{Earth Biosphere Thickness - (10 mi.)}}{\text{Earth Radius (4,000 mi.)}} = \frac{\text{? Globe Biosphere Thickness}}{\text{? Globe Radius}}$$

(0.0025)(Globe Radius) = Globe Biosphere Thickness

If the globe has a radius of 6", then the globe biosphere would have a proportional thickness of:
(0.0025)(6 inches) = 0.015".

Take two plies of 20-pound paper and place it over a portion of the globe to show the students how thin the biosphere is. Twenty-pound paper is 10 mils thick which is 10 thousandths of an inch. Two plies would be .020" thick or thicker than the biosphere on the globe in the example.

❑ Use the following two questions and collection of facts to initiate a class discussion on deforestation and biodiversity.

Question 1:

Should people in developed countries care about survival of tropical species never seen outside a rainforest? If so, why?

Answer:

Variety is the spice of life. Variety is the stuff of life. Life needs diversity because of the interdependencies that link flora and fauna, and because variation within species allows them to adapt to environmental challenges. Extinction is irreversible. As lowly species (i.e., plants and insects) disappear unnoticed, they take with them hard-won lessons of survival encoded in their genes over millions of years.

Discussion

Humanity already benefits greatly from the genetic heritage of little-known species. Hidden anonymously in clumps of vegetation about to be bulldozed or burned might be plants with cures for still unconquered diseases.

Diversity is the raw material of Earth's wealth, but nature's true creativity lies in the relationships that link various creatures and given the complex working of an ecosystem, it is never clear which species, if any, are expendable. Different habitat areas of the earth are each part of an ecosystem, a fragile, often delicately balanced conglomeration of supports, checks, and balances that integrate life-forms into functioning communities.

Only 1.7 million of the estimated 5 to 30 million different life-forms on Earth have been cataloged. Hundreds of thousands of species may be extinct by the year 2000; the world has neither the scientists nor the time tc identify the yet uncounted. Systematists widely agree that whatever the absolute numbers, more than half of the species on the Earth live in moist tropical forests.

These ecosystems are found in warm areas where the rainfall is 200 centimeters or more per year, which allows broad-leaved evergreen trees to flourish. The trees typically sort into three or more horizontal layers, the canopy of the tallest being 30 meters (about 100 feet) or more above the ground. Together, the tree crowns of the several layers admit little sunlight to the forest floor, inhibiting the development of undergrowth and leaving large spaces through which it is relatively easy to walk.

The belief that a majority of the planet's species live in tropical rainforest habitat is not based on an exact and comprehensive census but on the fact that the two overwhelmingly species-rich groups, the arthropods (especially insects) and the flowering plants, are concentrated there.

Dividends From Diversity

❑ University of Pennsylvania biologist Daniel Janzen says that he knows of three plants with potential to treat AIDS. "One grows in an Australian rainforest, one in Panama, and one in Costa Rica."

❑ Venom of the Brazilian pit viper was used to develop a drug for high blood pressure.

❑ A biotechnical firm in the United States found that transplanting genes from tropical tomatoes increased the density of U.S. tomatoes 2%, promising catsup manufacturers extra profits.

❑ Scientists believe that arcelin, a natural protein in wild Mexican beans that repels insects, might protect some U.S. crops without poisoning soil and water.

❑ Future newspapers may be printed on paper from kenaf, an African plant that can produce five times as much pulp per acre than trees normally cut for newsprint.

Question 2:

Why are so many species and habitats threatened?

Answer:

Throughout the tropics, developing nations are struggling to feed their peoples and raise cash to make payments on international debts.

Discussion

Many countries are chopping down their forests for the sake of timber exports. The millions of tons of hardwoods that are harvested to provide doors, window frames, and furniture in Europe, North America, and Japan, come from tropical forests. In tropical forests, perhaps 10 percent of the trees are valuable timber species. The rest is left as the bulldozers drag the huge trunks of the selected few across the delicate forest soil, compacting it and damaging the roots as they crunch their way toward the timber collection yard.

Tropical forests worldwide are being cleared at a rate of 7,700 square miles every year, not to produce permanent farms, but to make a short-term profit before the land is ruined.

As a rule, the soil in tropical rainforests is useless without the tropical forests. Most of the nutrients are not in the soil, but above ground, locked up in the trees and plants. When anything dies, it is not absorbed into the soil, but rapidly converted into new plant growth. There simply isn't any fertile humus. And once the canopy of the trees is removed, the soil is exposed to torrential rainfall and the fierce heat of the sun, and erosion quickly sweeps it away.

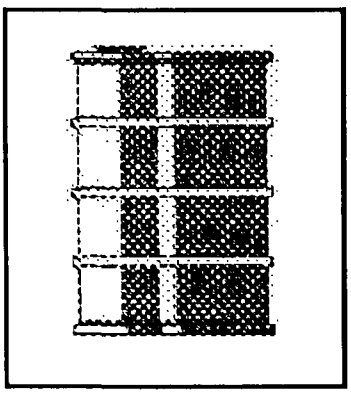
Old established farms on this so-called reclaimed land do not exist. For example, 25 million acres of Amazonian forest were converted to pasture (between 1966 and 1983). Yet, by 1986, nearly all the ranches that were cleared before 1978 had been abandoned because soil erosion and loss of productivity made them worthless.

The United Nations Environmental Program is drafting an international biodiversity-conservation treaty. Among other things, it could provide financial incentives to protect tropical forests, whose destruction threatens thousands of life forms with extinction.

Forests are vital to watersheds that absorb excess moisture and anchor topsoil. Deforestation contributed to the recent droughts in Africa and the devastating mud slides in Rio de Janeiro last year. Costa Rican topsoil eroded from bald hills has greatly shortened the life of an expensive hydroelectric dam. The surrounding watershed might have been protected for 20 years at a cost of only $5 million. Now, the government must reforest the watershed at ten times that price.

It has been suggested by climatologists that the loss of moisture from Africa's air as a result of the forest clearance in West Africa has contributed to the southward push of the Sahara Desert.

DAY 1
Part 2



Waste Stream Generation

Enviro-mints

❑ The United States has 6% of the world's population, but uses 40-50% of the world's nonrenewable resources.

❑ It is estimated that the amount of waste we generate in our lifetime is approximately 600 times our adult weight, or we produce approximately 4 1/2 pounds of trash per person per day. (Both estimates include industrial and commercial wastes.)

❑ Laid end-to-end, the 18 billion disposable diapers thrown away in the United States each year would reach back and forth to the moon seven times.

❑ From 1958-1971, packaging in the United States grew from 33 million to 66+ million tons.

What You Can Do

❑ Use mugs instead of paper cups, rags instead of paper towels, cloth instead of paper napkins.

❑ Double-side photocopies and use the reverse sides of paper.

❑ Buy products with the least amount of packaging.

❑ Study your community's waste disposal system. If recycling isn't a part of it, lobby to start a recycling program.

❑ Buy products that will last, and mend and repair rather than throw-away and replace.

❑ Recycle used motor oil, tires and batteries.

Focus: Eco-Fate

1. Where do the waste streams ultimately go from your home, school, and community?

2. What are the amounts and contents of each waste stream?

Background

The breakdown of typical American trash is:

Paper products:	41%
Yard waste:	18%
Metals:	9%
Glass:	8%
Food waste:	8%
Rubber, leather, textiles, wood:	8%
Plastic:	7%
Other:	1%

Activities

❑ Save all trash generated by an individual for one week, i.e., have each student maintain a collection bag. Have each sort, categorize and weigh the contents of his/her bag. Have students compare their trash. Are there major differences? How does each student's collection of trash compare to the "average" generation of 4 1/2 pounds of trash/day/individual? (Categorize the items under "essential to survival," "necessary to maintain present lifestyle," or "luxuries.")

❑ Sort your classroom's trash at the end of the day weigh it, itemize it, measure it, and draw it. Calculate the volume of trash your classroom will probably generate over a school year. How many classrooms would it fill?

❑ Take a walk and pick up small litter items around school. Categorize and discuss the contents of your findings.

❑ Examine the different types of materials discarded on a daily basis in your school lunchroom. Sort and weigh the materials based on their general composition. Discuss options on minimizing any of the streams.

❑ Invite the custodian to discuss waste management at your school. Have questions prepared in advance. Cover subjects such as volume of trash/day, problem areas, and hazardous waste issues.

❑ Design an ad campaign to discourage the littering of fast food packaging or the overuse of packaging. Draw posters for bulletin boards or prepare radio or TV commercials. Consider the following key characteristics of good consumer education programs:

a. Content.
b. Simplicity.
c. Convenience.
d. Quality.
e. Tone.
f. Timing.

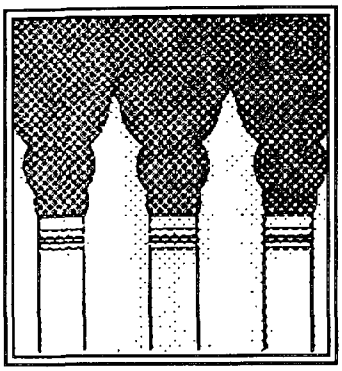
❑ Discuss the pros and cons of dealing with our waste (residential, industrial, medical, radioactive, agricultural) by the following:

a. Landfilling it.
b. Dumping it into a ravine or hole in the ground.
c. Burning it (incineration plant, fireplace, backyard).
d. Dumping it into the ocean, the desert, a neighboring state or country.
e. Incorporating it into building materials (e.g., insulation, paving and roofing materials, parking space dividers)
f. Composting it.
g. Recycling it.

Consider the expected impacts on air, land, water, and your health. How can the impacts be reduced? What guidelines need to be established for each disposal method? What are the costs associated with each method? What methods are being used or considered in your community? Should there be a preferred order of use of such methods?

DAY 2

GLOBAL ATMOSPHERIC CHANGE



"Hurt not the Earth neither the sea, nor the trees."

Revelation 7:3

Enviro-mints

❑ The greenhouse effect results from the entrapmen of solar heat by carbon dioxide. Without this effect, th earth would be a frozen planet like Mars, the averag temperature being 0 degrees Fahrenheit instead of 59 degrees Fahrenheit. However, through the burning of fossil fuels such as coal, oil and natural gas, we are increasing the amount of carbon dioxide in the atmosphere. On a global scale, this activity may, by early next century, have increased the average global temperature enough to shift agricultural production areas, raise sea levels to flood coastal cities, and disrupt national economies.

❑ Investigators concluded in 1987 that the ozone hole over Antarctica was the largest ever and was caused by chlorofluorocarbons (CFCs). Chlorofluorocarbons are compounds that consist of chlorine, fluorine and carbon. They are gaseous and have been used as coolants for refrigerators and air conditioners, propellants for aerosol sprays, agents for producing plastic foam and cleansers for electrical parts. Each chlorine atom in a CFC molecule can destroy as many as 10,000 ozone molecules.

❑ Recent evidence shows a global loss of ozone between 2% and 5% over the last 15 years.

❑ Our total mileage each year equals 2 million round trips to the moon.

❑ Each car contributes 5 tons of CO_2 to the atmosphere. That's 600 million tons of CO_2 from autos alone.

❑ More than half of the nation's air pollution comes from mobile sources (cars, trucks, boats, and planes).

❑ After 1974, U.S. consumption of aerosols dropped sharply due to public concern about ozone depletion.

❑ In 1978, EPA and other federal agencies banned the non-essential use of CFCs as propellants.

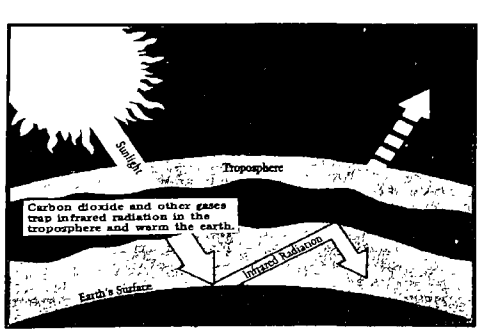
What You Can Do

- ❑ Avoid the use of aerosols with CFC propellants.
- ❑ Encourage car pooling, walking, use of public transportation, or biking, whenever possible.
- ❑ Avoid using car air conditioning whenever possible.
- ❑ Keep your engine tuned.

Background

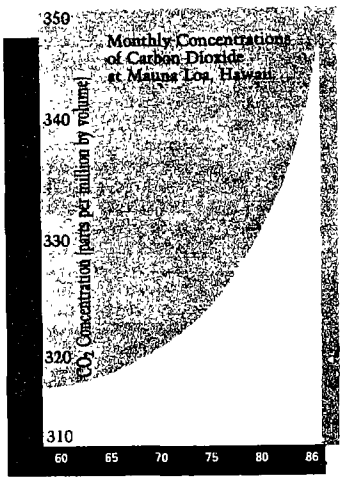
Certain types of air pollutants are producing long-term and perhaps irreversible changes to the global atmosphere. These changes seriously threaten human health and the environment. Industrial growth since the mid-nineteenth century has released large amounts of carbon dioxide. In the troposphere (the lower ten miles of atmosphere) high levels of carbon dioxide are producing an overall warming of the global temperatures. This "greenhouse" effect may cause irreversible changes to the climate. In the stratosphere (extending from the troposphere to about 30 miles above the earth's surface) chlorofluorocarbons (CFCs) and halons are breaking down the ozone layer which protects the earth from ultraviolet radiation. This increased radiation threatens to cause increases in skin cancer and other adverse effects. CFCs and halons can remain in the atmosphere from 75 to 100 years. Even if emissions were eliminated today, the concentrations of these gases would take many decades to return to pre-industrial levels. The global warming trend may take even longer to correct.

The Greenhouse Effect



The greenhouse effect is a natural phenomenon largely caused by carbon dioxide, which has an effect comparable to that of the glass in a greenhouse. Visible light passes through the atmosphere to the earth's surface. The earth radiates the heat as infrared rays; some heat escapes, but carbon dioxide and other gases in the troposphere trap the rest, warming the earth. Without the greenhouse effect, the Earth

Global Concentrations of Carbon Dioxide Have Risen 10 Percent Since 1958



Source: National Oceanic and Atmospheric Administration, 1985

would be a frozen planet like Mars; the average temperature of the earth would be 0° Fahrenheit, rather than the current 59° Fahrenheit.

By increasing the amount of carbon dioxide in the atmosphere through the burning of fossil fuels such as coal, oil, and natural gas, we have created a warming trend that may raise global temperatures between 20° F and 80° F by the year 2050. The clearing of rain forests also contributes carbon dioxide and other greenhouse gases to the atmosphere when wood is burned. Moreover, the clearing of large areas of rain forests means that less carbon dioxide is removed from the air by plants. Deforestation in Brazil, Africa, Indonesia, and the Philippines may be contributing to rising global temperatures.

Global warming may change weather patterns and regional climates. Many important agricultural areas of the United States, for example, could become arid and less productive. Natural ecosystems would also be affected. One major consequence of global warming is already being felt; rising sea levels, amplified by storms are increasing the erosion of many coastal areas. Sea levels are being raised not only by the melting of alpine glaciers and polar ice sheets, but also by the expansion of the oceans as they are heated. Sea level is expected to rise one foot in the next 30 to 40 years and 2 to 7 feet by the year 2100. Sea level rise of this magnitude would inundate 50 to 80 percent of U.S. coastal wetlands, erode all recreational beaches, and increase the salinity of estuaries and aquifers. In addition, coastal development would be damaged.

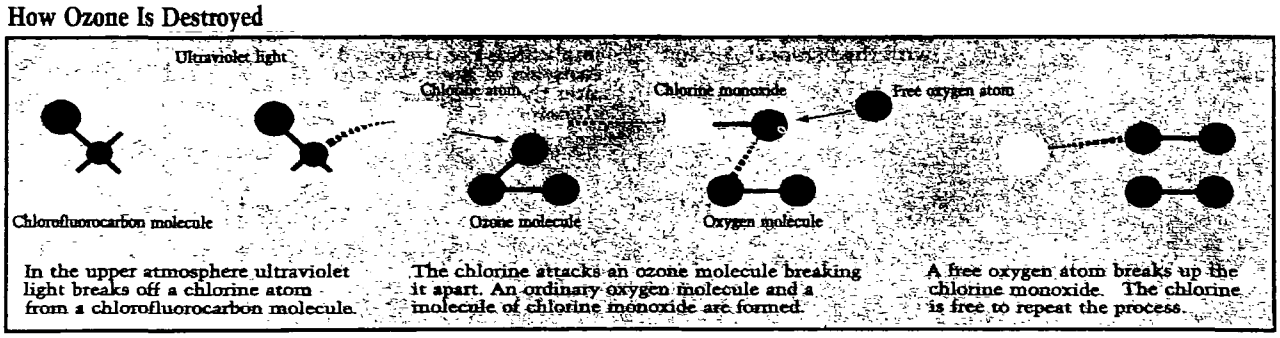
Ozone Depletion

Increasing concentrations of the synthetic chemicals known as CFCs and halons are breaking down the stratospheric ozone layer, allowing more of the sun's ultraviolet rays to penetrate to the Earth's surface. Ultraviolet rays can break apart important biological molecules, including DNA. Increased ultraviolet radiation can lead to greater incidence of skin cancer, cataracts, and immune deficiencies, as well as decreased crop yields and reduced populations of certain fish larvae, phytoplankton, and zooplankton that

are vital to the food chain. Increased ultraviolet radiation would also contribute to smog and reduce the useful life of outdoor paints and plastics. Stratospheric ozone also protects oxygen at lower altitudes from being broken up by ultraviolet light and keeps more of these harmful rays from penetrating to the earth's surface.

Chlorofluorocarbons are compounds that consist of chlorine, fluorine, and carbon. First introduced in the late 1920s, these gases have been used as coolants for refrigerators and air conditioners, propellants for aerosol sprays, agents for producing plastic foam, and cleansers for electrical parts. CFCs do not degrade easily in the troposphere. As a result, they rise into the stratosphere where they are broken down by ultraviolet light. The chlorine atoms react with ozone to convert it into two molecules of oxygen. More important, chlorine acts as a catalyst and is unchanged in the process. Consequently, each chlorine atom can destroy as many as 10,000 ozone molecules before it is returned to the troposphere.

How Ozone Is Destroyed



Halons are an industrially-produced group of chemicals that contain bromine, which acts in a manner similar to chlorine by catalytically destroying ozone. Halons are used primarily in fire extinguishing foam.

Laboratory tests have shown that nitrogen oxides also remove ozone from the stratosphere. Levels of nitrous oxide (N_2O) are rising from increased combustion of fossil fuels and use of nitrogen-rich fertilizers.

Ozone Hole Over Antarctica

In 1985, atmospheric scientists of the British Antarctic Survey published the unexpected finding that there is an ozone "hole" in the atmosphere over Antarctica. They found that springtime levels of ozone in the stratosphere over Halley Bay, Antarctica

had decreased by more than 40 percent between 1977 and 1984. Measurements taken from space by the Nimbus-7 satellite showed that the loss was occurring above an area greater than the size of the entire Antarctic continent. The British study provided the first evidence that the stratospheric layer of ozone surrounding the earth might be in greater jeopardy than previously thought.

In 1987, scientists from four continents met in Punta Arenas, Chile to conduct the most detailed study to date, the Airborne Antarctic Ozone Experiment. Data from high altitude airplanes, ground monitors, and satellites were used to gather detailed information about its size and chemistry. Investigators concluded not only that the ozone hole in 1987 was the largest ever, but that it is caused by chlorofluorocarbons (CFCs).

It is now clear that CFCs are responsible for reducing the amount of ozone in the atmosphere. Moreover, the CFCs that have already been released into the stratosphere will continue to break down ozone for decades to come.

Focus: Bicycle

Many people see the bicycle as an attractive form of transportation, since it does not rely on fossil fuels which can be destructive to the atmosphere.

1. What is the efficiency of the bicycle and how does it compare to the efficiency of other means of human transportation?

2. How can the bicycle contribute to the reduction of environmental pollution?

Discussion

Efficiency of the Bicycle

Bicycles have been around since at least the early 1800s, and in their current form with sprocket and chain drive since the late 1800s. In many societies, such as Asia and Africa, the bicycle is the most important form of transportation. One of the most

interesting facts about the bike is that it is the most energy efficient form of transportation. A person on a bicycle uses less energy to move a kilogram of body mass over a distance of one kilometer than any other machine or animal form of conveyance.

In terms of the environment the bicycle is non-polluting and can be beneficial to the health of the rider. The bike uses only human power thus consuming no gasoline, electricity, or nuclear power; has no exhaust and therefore no harmful pollutants; and does not require the land use or construction expense of large highways and parking facilities.

The efficiency of a machine is defined as the ratio of the work output by the machine to the work input to the machine. Work in science is defined as the force applied to move some object times the distance through which the object moves as a result of the applied force. The force and the distance in this calculation must be collinear. If a force of 50 newtons is applied to an object in a horizontal direction and the object moves through a horizontal distance of 10 meters, the work done on the object by the force would be:

(50 Newtons) X (10 meters) = 500 Newton meters = 500 Joules

The Joule is the unit of work in the MKS system. Thus the efficiency of a machine would be calculated using the equation:

Efficiency = Work Output ÷ Work Input
(1)

OR

Efficiency = (Force Output x Distance Output)/(Force Input x Distance Input)
(2)

assuming that the force and distance are collinear in each case. In the case of the bicycle, the useful work

output is the resulting energy of motion of the bicycle and rider as a system in locomotion, and the work input is the energy expended by the rider to achieve the resulting energy of motion. Energy of motion is called kinetic energy and is calculated using the equation:

Resulting Kinetic Energy = (1/2) (Mass of Bike and Rider)(Velocity)
(3)

A rough estimate of the input work, if it is assumed that the rider stands, pedals straight down, and uses his or her entire weight on each downward stroke in a stiff legged fashion, would be the change in potential energy of the rider over the vertical fall of the pedal. This approximation of the potential energy input would be calculated using the equations.

Potential Energy Input Per Pedal Stroke = (Weight of Rider)(Distance of Pedal Fall)
(4)

Work Input = (Input Per Stroke)(2 Pedal Falls Per Revolution)(Number of Revolutions)
(5)

Thus a very crude approximation of the rolling efficiency of the bicycle can be calculated using the relationship:

Efficiency = (Resulting Kinetic Energy)/(Potential Energy Input)
(6)

Another way to find the efficiency of a machine is to find the ratio of the Actual Mechanical Advantage (AMA) to the Ideal Mechanical Advantage (IMA).

EFFICIENCY = AMA / IMA
(7)

Where the AMA is the ratio of the output force of the machine to the input force to the machine, and the IMA is the ratio of the distance the input mechanism of the machine moves to the distance the output mechanism of the machine moves as the machine operates.

AMA = (Force Output)/(Force Input)
IMA = (Input Distance)/(Output Distance)
(8)

It should be remembered that the measurements that are made to calculate the efficiency using this equation are static and will not include losses due to frictional forces like rolling resistance and air resistance.

Activities

❑ The purpose of this activity is to measure the static efficiency of a bicycle and to gain experience with the concepts of Actual Mechanical Advantage, Ideal Mechanicals Advantage, and efficiency.

EQUIPMENT:

- Bicycle (any type)
- Spring scale (large range like fish or bathroom scale)
- Meter stick

PROCEDURE:

Attach spring scale between stationary object and seat post on bicycle so that it can measure impelling

force on the bike as a result of force applied to the pedal. If a bathroom scale is used it should be attached or held in place on the wall so that the front tire of the bicycle will push against it as a force is applied to the pedal. The reading taken here is the force output by the bike.

Adjust the bicycle so that the pedals are in a horizontal position which will give the maximum impelling force for a given force applied to the pedal. Measure the weight of the student that is going to stand on the pedal. This weight will be the Input Force.

Have the student stand on the pedal and measure the force the bike applies to the scale. This reading is the Output Force or the impelling force on the bicycle.

Calculate the Actual Mechanical Advantage using equation (8).

Take the bicycle and mark its original position on the floor. Take the pedal and move it through one complete revolution allowing the bicycle to move forward and mark the final position of the bicycle on the floor. Measure the distance the bicycle moved for one complete revolution of the pedal. This distance is the Output Distance of the bicycle.

Calculate the circumference of the circle through which the pedal moves. Use:

Circumference =
(pi)(Diameter of Circle)
(9)

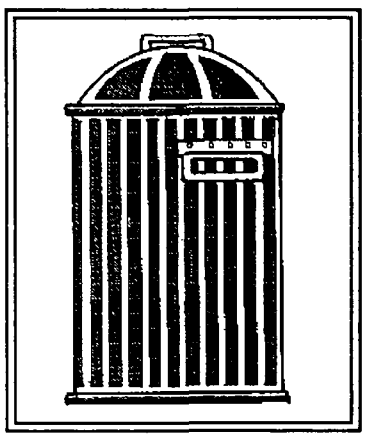
This circumference is the Input Distance.

Calculate the Ideal Mechanical Advantage using equation (8) and the Static Efficiency of the bicycle using equation (7).

(OPTIONAL) If your bicycle has multiple gears, try this in different gears and compare your results.

LANDFILLS

DAY 2
Part 2



Enviro-mints

❑ Landfills are difficult to site due to the "not in my backyard" syndrome, and the cost of conveniently located land is often very high.

❑ Landfills must be monitored for many years after closure for leakage to groundwater; this is an expensive maintenance requirement.

❑ Current landfill design actually inhibits the natural degradation of biodegradables due to the design requirements, which route rainfall away from the fill and inhibit oxygen inputs.

❑ There are 203 billion used tires stored in piles throughout the United States and 200 million more are added yearly.

What You Can Do

❑ Buy beverages in recyclable containers.

❑ Ask for recycled products at stores.

❑ Separate your recyclable garbage (newspaper, glass, paper, aluminum, and organic waste for composting) and only send nonreusable materials to the landfill.

❑ Find out where in the community you can recycle motor oil, tires, and batteries and take them there.

❑ Notify the Post Office that you do not wish to receive junk mail.

❑ Study your community's waste disposal system. Don't send hazardous substances to the landfill.

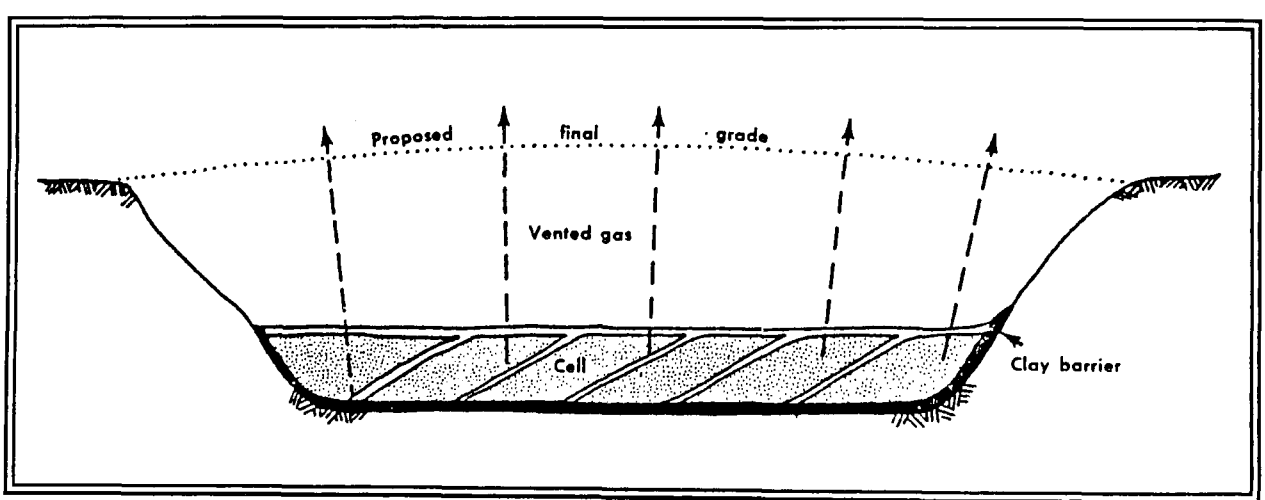
Focus: Disposal

1. What are some of the disadvantages to the use of landfills for waste disposal?

2. What are some common terms associated with landfills? Be able to draw a schematic of a modern sanitary landfill.

Background

Current landfill design actually inhibits the natural degradation of biodegradables due to the design requirements, which route rainfall away from the fill and inhibit oxygen inputs. Additionally, the diverse mixture of fill often causes degradables to be contaminated with products which are toxic or inhibiting to beneficial bacterial decomposition. Studies have shown that carrots, which have been landfilled for over ten years are still recognizable; newspapers have been preserved for even longer times.



Cross-section of a typical sanitary landfill.

INCREDIBLE EDIBLE CHEMICAL LANDFILL

Suggested Ingredients:

3 different flavors of jello
- pistachio pie filling
chocolate pudding
- butterscotch pudding
pineapple ice cream topping (chunky)
creme de menthe ice cream topping (syrup)
- licorice swizzles
root beer barrels
jelly/nougat candy
- iced blue lozenges

PROCEDURE:

1. Obtain a container to use as the mold, such as a large Tupperware container.

2. Pour in a layer of jello and allow it to set. Remember, the first layer poured will be the top of the landfill, but will have the rest of the layers on top of it in the bowl.

3. Add root beer barrels, licorice swizzles, or any other materials to the layer when it is partially jelled.

4. Pour successive layers and add barrels. Allow mold to set.

PRESENTATION:

After studying some of the issues involved in chemical waste in the United States today, it should be interesting to see what kinds of decisions we can make regarding disposal and treatment. I have constructed a model of a chemical landfill. Can you identify the liner? Notice the leachate seeping out. Let's see if we

can eliminate this waste before the end of the period. I will now remove the liner so you may inspect the contents. (Explain that all materials are edible and list ingredients to the class.) Our edible landfill will represent all the chemical waste in the USA today. Proper treatment of the waste will be represented by consumption of the jello mold. If each of us takes an equal share of the jello mold and consumes it, there will be none left at the end of the period. Whatever material remains will continue to be a problem for future generations.

Here are some examples of applications for real life, using the model:

Model	Real World
- Incredible Edible Landfill	- chemical waste
- mold	- liner
- root beer barrels	- barrels of toxic waste
- jello	- chemical sludge
- iced blue lozenges	- aromatic, organic wastes
- liquids formed	- leachate
- eating the jello	- proper treatment
- discarding the jello	- illegal treatment
- extra credit for eating	- incentive

Although the Incredible Edible Landfill is not aesthetic or appetizing, neither is the problem of chemical waste!

Adapted from:

The Incredible Edible Landfill by **Rich Wagner, Wissahickon Sr. High School, Ambler, PA**

CONSTRUCT A MINIATURE LANDFILL BEGINNING WITH THE FOLLOWING ITEMS:

❑ Litter items previously collected or pieces of fruit or vegetables, such as slices of tomato or an apple core;
❑ A small piece of plastic, such as a plastic fork, part of a broken toy, or polystyrene foam;

- ❑ Pieces of paper, cloth, and aluminum foil;
- ❑ A large container, such as a glass jar, or terrarium;
- ❑ Soil; and
- ❑ A large piece of immersible plastic.

Place 1/3 of the soil in the bottom of the container. Cover the soil with the plastic, folding up the edges a few inches all around. On top of the soil place the pieces of trash, plastic, cloth, and foil. Alternate more soil with the landfill items. Put the container in a warm place, and keep the soil damp. On a weekly basis, check on the condition of the items. Does the fruit or vegetable look different than it did when you buried it? Does the plastic look different? Some things persist for a long time. Which items do you think are more harmful to the environment? Why? When you disassemble the landfill, look for leachate.

LIST SOLID WASTE ITEMS WHICH ARE DEGRADABLE

Make charts which contrast degradation rates in a sanitary landfill with "natural" decomposition rates. One study which examined "old trash" at a sanitary landfill is entitled "Rubbish!", by William L. Rathje, The Atlantic Monthly, December 1989, pp. 99-109.

INTERVIEW YOUR LOCAL WATERSHED REPRESENTATIVE

Discover when the landfill serving your community is projected to be filled at current disposal rates. How old will you be?

CALL THE LOCAL SANITARY ENGINEERS

Find out how many truckloads of solid waste are emptied at the landfill every day, and how much weight/volume each truck holds. Ask if any solid waste is incinerated or otherwise disposed of in lieu of the landfill.

NAME YOUR SOLID WASTE

Generate a list of synonyms for garbage, e.g., throwaway, trash, waste. Define at what point one labels something garbage.

SAY WHAT'S IMPORTANT

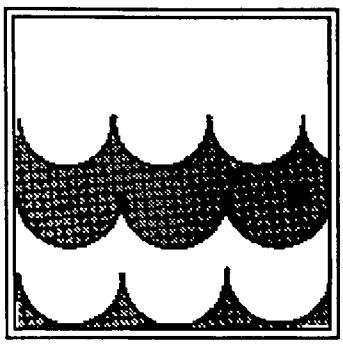
List on the board the things students think are important in siting a landfill in their area. Landfills must be sited according to local land-use plans and state environmental protection laws and rules. Add to the list the following considerations addressed in these laws and rules:

a. Leachate ("garbage soup" which drains from the bottom).
b. Groundwater and surface water protection.
c. Methane gas control.
d. Surface drainage control.
e. Floodplain and endangered species protection.
f. Access roads.
g. Visual screening of the site.
h. Fire prevention.
i. Litter control.
j. Vector and rodent control.
k. Site monitoring.

Divide students into groups and, using the same county and/or city maps, have each group try to determine the best landfill site. Ask them to list the reasons they chose that site. Was consideration given to the present location of your community-water supply, parks, prime farmland, schools, residences, and business district? Have each group present its conclusions to the class. Are there objections to the sites chosen?

DAY 3

WATER RESOURCES



"We have not inherited the Earth from our fathers, we are borrowing it from our children.

Old American Saying

Enviro-mints

❑ We each need about 1 quart of water per day to replace the water we lose naturally.

❑ Big animals, like horses, need about 15 gallons of water per day.

❑ Our bodies are about two-thirds water.

❑ It takes about 115 gallons of water to grow the wheat for a loaf of bread.

❑ It takes about 120 gallons of water to care for a chicken to lay one egg.

❑ It takes about 4,000 gallons of water to produce a pound of beef.

❑ Less than 1% of the water on Earth is in the form of usable freshwater in lakes, streams, and underground aquifers.

❑ A drinking water system for a medium-sized city adds up to construction costs of $100 million.

❑ A small municipal sewage treatment plant can cost between $15 and $20 million.

❑ In the United States, groundwater is used for agricultural purposes, like irrigation. Only 14% of United States groundwater is used for drinking, but in the Midwest groundwater is the most common source of drinking water.

❑ In rural areas, groundwater provides 95% of drinking water.

❑ 20% of water supply systems have detectable levels of volatile organic compounds (VOCs), although only 1% have levels of VOCs that exceed health standards.

❑ Americans use about 90 billion gallons of groundwater every day.

What You Can Do

❑ Don't run the tap continuously while brushing teeth, shaving, and doing dishes.

❑ Install a water saver shower head.

❑ Cut an inch or two off of the depth of your bath.

❑ Take shorter showers.

❑ Take three-step showers: (1) wet; (2) soap with water off; (3) rinse.

Focus: Water Conservation

1. How much water does your family use for bathing, showering, and flushing the toilet?

2. How can the amount of water used be lessened?

Background

When you conserve water you are also conserving energy. Energy is required to deliver the water to your residence and energy is used in the home to heat the water for cooking and cleaning. Thus conserving water helps to ease the impact on other environmental problems by preventing pollution and lessening the need to divert rivers and pump water from the ground.

One place in the home where simple steps can be taken to lessen the water budget for the family is the bathroom. It is estimated that 70% of the average household water use flows through the bathroom.

Activities

❑ **The Bathtub** - Measure your bathtub. (For this example, we will assume the tub to be rectangular with a flat bottom, although we know that is not really the case.) Now, find the area of the tub by multiplying the length by the width - your answer will be in square inches. Now, multiply that figure by the number of inches of water you put in the tub. That will give you the total number of cubic inches of water used in a bath. There are 231 cubic inches in a gallon.

For example, if your tub is 52 inches long and 18 inches wide, the area is 936 square inches. If you usually put about a foot of water (12 inches) in the tub, you use 11,232 cubic inches of water per bath, or 48.6

gallons. If you were to use 10 inches of water instead, you would save over eight gallons of water. And if you would only use 4 inches of water, you would save over 30 gallons of water.

How many baths are taken per week in your house? How much water does your family use bathing? How much can you save by using less water per bath?

❑ **The Shower** - Spend some time and determine the length of time the water is on when members of your family shower. From that, determine the average length of time spent in the shower.

Once you have found out how much time is spent in the shower you need to know how much water is used. One easy method is to take a one-gallon plastic milk jug and cut the top out of it large enough to get your shower head through it. Turn the shower on, adjust it to a normal flow, and time how long it takes to fill the jug. [You can find out where the full or one-gallon mark on the jug is by looking at a full milk jug.]

If the jug fills up in 20 seconds, your shower runs at the rate of three gallons of water per minute (20 seconds is 20/60 of a minute, or 1/3 min. - 3 x 1 = 3 gallons). If it takes 30 seconds, then your shower runs at the rate of 2 gallons per minute (30/60 = 1/2 min. 2 x 1 = 2 gallons).

When you find how many gallons per minute your shower uses, you can multiply the gallons per minute times the number of minutes to determine the gallons of water per shower.

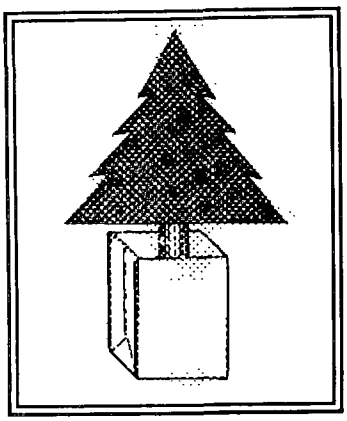
❑ **The Toilet** Measure the size of the storage tank in the back of the toilet, much the same as you did for your bath tub, and determine its capacity. Then, estimate the number of times that it is flushed each day to determine usage (put up tally sheets).

Determine how much water you will save per week. Determine how much water you will save per month. Determine how much water you will save per year.

If you were to combine the most conservative approaches on the above, how much water would you save altogether in a day, a week, a month, a year?

DAY 3
Part 2

SOURCE REDUCTION



"The goal of life is living in agreement with nature."

Zeno 335-263 B.C.

Enviro-mints

❑ By being a conscientious consumer, the amount of trash each person generates can be lessened.

❑ Every Sunday, the United States wastes nearly 90% of the recyclable newspapers. This wastes about 500,000 trees.

❑ The Center for the Biology of Natural Systems reported that 84% of the household trash stream is recyclable. The disposal rate for incineration is only 70%.

❑ Americans throw away more trash than any other nation. An average per capita comparison looks like:

U.S.	4 lbs./day
Japan	2.5 lbs./day
Norway	1.7 lbs./day

❑ Approximately 158 million tons of municipal solid waste were discarded in 1986.

What You Can Do

❑ Practice refusing unnecessary packaging at the lunchroom, the store, the fast food restaurant.

❑ In the classroom, practice conserving paper by using both sides, by using smaller sizes.

❑ Bring your own shopping bags to the store.

❑ Develop recommendations for reducing or eliminating the use of certain types of materials consumed on a daily basis in your school lunchroom.

Focus

What are ways you can help reduce waste?

Background

By being a conscientious consumer, the amount of trash each person generates can be lessened.

By letting manufacturers and retailers know that excessive packaging is not responsible packaging,

and by "voting with one's pocketbook" by not buying excessively packaged products, one can reduce some of one's own trash generation. Examples include:

Not placing all produce in individual plastic bags, when shopping;

Bringing one's own bags to the store;

Refusing bags for easily carried objects when purchased;

Using one bag instead of two;

Choosing comparable items based on packaging amounts, and on the recyclability of the containers (i.e., buying a liquid product in a glass bottle instead of a plastic bottle or soft drinks in cans instead of plastic bottles;

Reusing "disposable" items, especially plastics, many times before recycling/disposing;

Staying alert to other creative uses for previously discarded items.

Activities

❑ Explore and discuss solutions for reducing the amount and kinds of waste that we generate. Possibilities include: making different buying choices; reusing materials, banning or taxing certain disposables such as plastics, beverage containers, and hard-to-recycle products; promoting the use or disuse of certain packaging materials; increasing disposal fees for garbage; mounting a letter writing campaign to a particular business or industry that promotes or fails to promote pollution prevention actions; developing home or neighborhood recycling programs; writing the editor or congressman supporting a uniform refillable container law.

❑ Become an environmental reporter for a day or a week. Accompany your parents to a grocery store or visit a retail store of your choice. Report on the types of product packaging available, particularly those that you and your family purchase. Are the materials reusable, recyclable, made from recycled components and labeled as such, in large or small containers? From what are the packaging materials made? What does the store package your purchase in? Weigh or measure the volume of nonreusable packaging which enters your home over a week.

❑ Conduct your personal "pre-cycling" effort for one week. First, before you purchase or "consume" an item, trace the pathway of the item's container, package, or other aspects. Then, examine your consumer options, be selective toward packaging, avoid disposables, buy in bulk, reuse, repair, or recycle. Report to the class on the results of your efforts.

❑ Practice refusing unnecessary packaging at the lunchroom, the store, the fast food restaurant. Carrying a string bag or plastic bag with you when you shop will make it easier to refuse unnecessary bags.

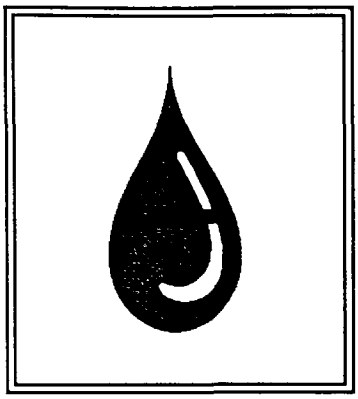
❑ For one week in the classroom, practice conserving paper by using both sides, by using smaller sizes. Every time a conservation step is taken, take the equivalent paper which would have been used and add it to a neat stack. How big is the stack at the end of the week? How many trees could you and your class save yearly by continuing this practice? (HINT: One ton of paper is equivalent to 17 trees.)

❑ Pick a landscaped area around your school or home. Ask the person in charge what pesticides are used on the area. Find out what chemicals are in the pesticides. Visit the landscaped area when it is raining. Find out where the water running off the area goes. Could the runoff contain traces of pesticides? Discuss strategies which could eliminate or lessen this problem.

❑ If you have a garden at home or school, try keeping it pest-free without pesticides. Wearing gloves, pick off with your hands larger pests like caterpillars and Japanese beetles. Hose the plants with water to wash off pests. Do not harm ladybugs, praying mantises, spiders, toads, and birds, which control insect pests.

DAY 4

Acid Rain



"Come forth into the light of things, let nature be your teacher."

William Wordsworth

Enviro-mints

❑ Acid rain (or snow) results from the interactions of sulfur dioxide and nitrogen oxides with sunlight and water vapor in the upper atmosphere to form acidic compounds that fall to the earth. Sulfur dioxide is emitted from coal-burning power plants. Nitrogen oxides are primarily emitted from motor vehicles and coal-burning power plants.

❑ Over 80% of sulfur dioxide emissions in the United States originate in the 31 states east of or bordering the Mississippi River.

❑ Acid deposition may increase the acidity of water and soil, reducing their abilities to sustain life.

❑ Estimated damage to building materials in 17 northeastern and midwestern states may be as high as $6 billion.

❑ Today, 2/3 of all United States SO2 emissions come from electric power plants, with coal-fired plants accounting for 95% of the total.

What You Can Do

❑ Cut down on your energy consumption by using it more efficiently.

❑ Buy a car that gets better gas mileage.

❑ Use public transportation.

❑ Urge public officials to promote public transportation, biking, walking and to develop the infrastructure to support them.

Focus: pH

1. What is acid rain and where does it come from?

2. What effects does acid rain have on the Earth's ecosystem?

Background

Acid deposition is a serious environmental concern in many parts of the country. The process of acid deposition begins with emissions of sulfur dioxide (primarily from coal-burning power plants) and nitrogen oxides (primarily from motor vehicles and coal-burning power plants.) These pollutants interact with sunlight and water vapor in the upper atmosphere to form acidic compounds. During a storm, these compounds fall to earth as acid rain or snow; the compounds also may join dust or other dry airborne particles and fall as "dry deposition."

Over 80% of sulfur dioxide emissions in the United States originate in the 31 states east of or bordering the Mississippi River. Most emissions come from the states in or adjacent to the Ohio River Valley. Prevailing winds transport emissions hundreds of miles to the northeast, across state and national borders. Acid rain is now recognized as a serious long-term air pollution problem for many industrialized nations.

The extent of damage caused by acid rain depends on the total acidity deposited in a particular area and the sensitivity of the area receiving it. Areas with acid-neutralizing compounds in the soil, for example, can experience years of acid deposition without problems. Such soils are common in much of the United States. But the thin soils of the mountainous and glaciated northeast have very little acid-buffering capacity, making them vulnerable to damage from acid rain. Surface waters, soils, and bedrock that have a relatively low buffering capacity are unable to neutralize the acid effectively. Under such conditions, the deposition may increase the acidity of water, reducing much or all of its ability to sustain aquatic life. Forests and agriculture may be vulnerable because acid deposition can leach nutrients from the ground, kill nitrogen-fixing microorganisms that nourish plants, and release toxic metals.

Activities

❑ Measuring pH Collect samples of tap water, drinking water, lake water and stream water in clean jars. Use indicator paper and the color scale to approximate the pH of each sample. Compare the pH of these samples to pH you measure from samples of lemon juice, vinegar, distilled water, baking soda solution, and diluted household ammonia.

From the above exercise, can you determine if the water in your local lakes and streams is threatened by acid rain? Call your local U.S. Department of Agriculture Soil Conservation Office and ask them for the acidity of the soil in your area. How does this compare to your pH readings? A rainwater pH below 5.6 is considered acid rain.

❑ Using regular pH paper readings (every few drops) determine how many drops of acidic solution (vinegar or lemon juice) it takes to bring the pH of the distilled water below 6. Then, determine how many additional drops it takes to bring the pH below 5. Ask the students how many additional drops it will take to bring the pH below 4. Stir well as you add the drops. Begin with plenty of space in the container above the water level for adding the vinegar or lemon juice. Explain to the student the ten-fold increase in acidity associated with a change in pH of 1.

❑ What is part per thousand/parts per million/parts per billion/parts per trillion?

In each of four 1,000 milliliter (ml) beakers place 999 ml of water. To the first beaker add 20 drops (1 ml) of a fluid you want to consider the contaminant (food coloring works nicely). This solution will have a concentration of about 1 part per thousand.

Next, take 20 drops of this solution and add it to the second beaker. The original concentration is now diluted 1,000 fold, and the concentration of the contaminant is now 1 part per million.

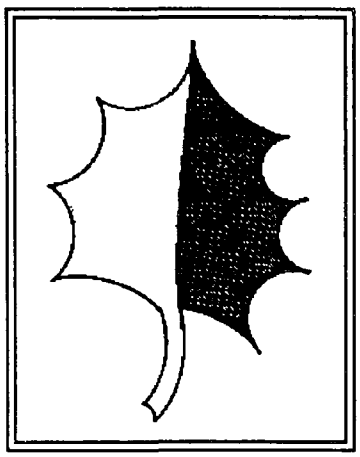
Adding 20 drops of this second solution to the third beaker results in a concentration of 1 part per billion. Repeating this procedure for the fourth beaker results in a 1 part per trillion concentration.

Have the students make observations of the successive dilutions as to whether the contaminant can be observed. Explain to the students that many pollutants are not considered safe to drink at concentrations as low as a few parts per billion, and that the goal for contaminants that have a cancer causing potential is zero concentration.

Repeat this exercise using a contaminant with an odor, like ammonia or vinegar. Ask the students if they can still smell the contaminant at low concentrations.

DAY 4
Part 2

COMPOSTING



Enviro-mints

❑ Compostables generally are non-animal source yard waste and kitchen wastes.

❑ On an individual family basis, composting can save on yard maintenance costs as well as provide savings in taxes and trash pickup costs.

❑ The essential components of a successful compost pile are: air supply, sufficient moisture, and a mixture of yard and kitchen wastes that provide the nutrients needed by the beneficial bacteria.

❑ Yard waste alone is poor in phosphorus, potassium, and trace minerals, while kitchen waste alone is poor in nitrogen. A combination is best.

❑ Americans landfill about 24 million tons of grass clippings and leaves annually.

What You Can Do

❑ Encourage city-wide composting.

❑ Start a compost pile at home or at school.

❑ Save kitchen scraps for composting.

Focus: Compost

1. What are some examples of compostables?

2. How much can composting reduce the amount of our household waste stream that must be landfilled?

3. What are the major requirements of a "healthy" compost pile?

Background

Compost is typically made from readily-available yard waste and kitchen wastes. On an individual family basis, composting can save on yard maintenance costs as well as provide savings in taxes and trash pickup costs.

The end product of composting is a very rich topsoil-like substance, high in minerals and organic matter. Natural fertilizers and other soil enhancers can be "manufactured" on the spot.

Creating a composting structure is very simple. An ideal, but not critical size, is 4' x 4' x 4'. Approximately one cubic yard of compost is needed to generate ideal decomposition temperatures (104-170 degrees F). Since air aids the bacteria in decomposing the waste a tightly-packed pile is to be avoided. Open wall supports, such as chicken wire or fencing facilitates air exchange.

Readily compostable wastes include all yard wastes (i.e., grass clippings, hedge/tree trimmings, weeds) with the exception of thick tree branches, trunks, and all food wastes with the exception of animal products (although egg shells are fine to include). It is best to exclude animal products, including bones, grease, meat wastes, manure, and dairy products, to avoid problems with vermin such as rats and mice. A "vegetarian" compost heap is very trouble-free.

A viable compost pile is started by mixing equal parts yard and kitchen wastes. First, layer the base with yard waste, e.g., thin sticks, leaves, and grass clippings; sprinkle with a thin layer of dirt to introduce the bacterial "workers" and add kitchen wastes, such as vegetable and fruit parings. Rotten produce is fine to add as well, since it is already beginning the decomposition process and has been inoculated with "willing workers." Cover this food waste layer with a few more leaves and clippings, and lightly sprinkle with water. Heaps should be kept lightly moistened, not saturated, in order to keep the bacteria slightly wet, but not separated from an air supply.

Continue the layering as wastes are generated, and occasionally turn the whole pile to better aerate the heap and to see the manufacturing of the top soil. Any part of the pile which is black, friable, and smells like soil is immediately usable as a soil additive. If the heap begins to smell rank, it is likely due to excess moisture and can be easily dried out by spreading the pile out in the sun for a few days or by turning it.

To avoid air flow problems due to compaction, the pile should not exceed about 4' in height. However, due to the on-going decomposition, the pile always will be shrinking, so that the maximum height actually takes quite a while to achieve.

In summary, the essential components of a successful compost pile are: air supply, sufficient moisture, and a mixture of yard and kitchen waste that provide the nutrients needed by the bacteria. Yard waste only is poor in phosphorus, potassium, and trace minerals, while kitchen waste alone is poor in nitrogen.

Activities

❑ Construct a small compost pile in a terrarium or old aquarium. Materials needed include the following:

A variety of organic waste materials sawdust, hair, wood, food, scraps, leaves, grass and ash; avoid the use of meat, fat, or oils, and manure;

Lawn fertilizer containing nitrogen, but not herbicides or insectide. A ratio of 25-30 parts carbon to 1 part nitrogen is ideal (this addition will speed up the process);

Soil: 1-2 dozen earthworms (also will speed up the process);

Use a small spade or large spoon for turning and aerating the pile.

Layer the pile as instructed above, adding the fertilizer to the layers of waste. Turn the pile weekly, taking the opportunity to remove certain waste items and noting their state of decomposition. Place removed waste items in small baggies (freeze, if possible) and compare the items over many weeks or months. Record what you smell and see when working with the compost pile. Record temperatures on the bottom, middle and top of the pile. Where is the pile warmest? Coolest? Why?

❑ Draw a schematic of a compost heap, including the layering and the air/water flows. List the requirements for "happy microbes" which do the work. Include a list of inputs (i.e., leaves, food waste) and outputs (i.e., soil enhancers, soil).

EARTH DAY

"The great end of life is not knowledge but action."

Thomas Henry Huxley

Environ-mints

❑ **By the late 1960s:**

- The air in many cities was considered unhealthy.
- Lake Erie was on its death bed.
- The Cuyahoga River erupted in flames.
- Pesticides like DDT were taking their toll on wildlife.
- Only 1% of the population thought that environmental protection was worthwhile.

❑ **Since 1970:**

- By 1971, 25% of the population thought that environmental protection was important.
- Today, closer to 2/3 of the population thinks that environmental protection standards "can't be too high."
- Lead levels in urban air dropped 87% between 1977 and 1986.
- Sulfur dioxide levels have been reduced 37% and particulates are lower by 23%.
- Lead use in gasoline has dropped 95%.

❑ One tree can filter up to 60 pounds of pollutants from the air each year.

❑ Every year, about 3,000 facilities manage 275 million metric tons of hazardous wastes in the United States.

❑ We are spending roughly $85 billion a year - $340 per capita - on pollution controls and still fall short of our goals of clean air and water.

What You Can Do

❑ Get involved in a local environmental group or bring the environment up as a topic for consideration in the organizations where you are already involved.

❑ Celebrate Earth Day 1990 on April 22 and all other days of the year.

❑ Take part in your community's recycling programs.

❑ Consume with preservation of the Earth in mind.

❑ Plant a tree.

❑ Conserve water and energy.

❑ Identify and handle household hazardous wastes responsibly.

Focus: Earth

1. What is Earth Day?

2. What were the main environmental issues facing us on the original Earth Day?

3. What progress have we made since the original Earth Day?

4. What environmental challenges do we face on Earth Day 1990?

5. Who are the people protecting the environment?

Background

Although concern for the environment can be traced to decades ago, general public awareness and large scale correction of pollution/environmental problems has greatly increased over the last few decades.

❑ In the late 1960s, only 1% of the public thought that protecting the environment was important.

❑ In mid-1971, similar White House polls showed that a quarter (one-fourth) of the public thought that protection of the environment was important.

Seventeen years later, in 1988:

❑ Fifty-eight percent of the public thinks the United States spends too little on the environment (6% think we spend too much).

❑ Fifty-nine percent of the public thinks there is too little environmental regulation (7% think there is too much).

❑ *The New York Times* / CBS poll, July 1988, reported that 65% of the American public believed that environmental protection standards "cannot be too high" and that environmental improvement should be made "regardless of costs." Twenty-two percent disagreed. (In 1981, the corresponding percentages were 45 and 42%, respectively.)

These various polls indicate that the general public has become more and more aware of the countless and related environmental issues. Although a number of events and activities of numerous organizations contributed to the increased environmental awareness, Earth Day, April 22, 1970, certainly needs to be given a great deal of credit for increasing the visibility of the environmental issues.

Earth Day April 22, 1970

Earth Day was the largest organized demonstration in human history. An estimated 25 million Americans took part to demonstrate their concern about water and air pollution and to encourage the little known concept of ecology. Demonstrations were held in large cities; thousands of schools and colleges held special "teach-ins" on the environment; the media brought environmental programs into virtually every home; and members of the United States Congress took the day off to participate in Earth Day programs in their districts.

What were Americans concerned about; what environmental issues did they (we) want to be addressed and solved? The air in many industrial cities was routinely blackened by industrial pollution. Lakes and streams suffered so heavily from pollution that aquatic life could no longer be supported. Pesticides, like DDT, threatened wildlife populations.

How Far Have We Come?

Since the original Earth Day, much progress has been achieved in addressing the environmental issues that

concerned us in the late 1960s/early 1970s. More and more people became actively involved in addressing the issues, correcting the problems and keeping the public informed.

❑ Two major laws were passed to address two of the biggest issues that concerned Americans on Earth Day the Clean Air Act and the Clean Water Act.

❑ The Environmental Protection Agency (EPA) was created in December 1970 to enforce these and other environmental laws.

❑ Such urban air pollutants as lead, sulfur dioxide, ozone (ground-level), and carbon monoxide have been significantly reduced in the last 10-15 years. Programs were established to reduce carbon monoxide emissions from mobile sources (cars), to reduce lead in gasoline, to use of pollution controls to reduce smokestack release of sulfur dioxide, and to reduce the release of chemicals (volatile organic compounds-VOCs) that lead to the formation of ozone. They have all resulted in improved air quality.

❑ Dramatic improvements have been made in treating the wastewater (bathroom, kitchen, washing machines) generated by residents and public/commercial establishments. Treatment plants have been constructed with a large amount of federal, state and local money. Numerous agencies have been involved in making sure the projects would treat the wastewater adequately before the water is released back into the nation's waters streams, rivers, lakes, and oceans. Thousands of companies have designed, constructed, and operated these treatment plants.

❑ Use of many pesticides has been canceled or restricted. The risks of tens of thousands of pesticide products are being reevaluated. Populations of bald eagles, peregrine falcons, and brown pelicans have increased as a result of EPA's ban on DDT.

❑ Many untreated hazardous wastes are now being banned from land disposal. Cleanup actions are underway at more than 1000 potentially hazardous sites.

Where Do We Go From Here?

Although much has been accomplished since the original Earth Day, continued attention must be given to maintaining the progress already achieved and to address environmental issues that have been publicly recognized relatively recently. Some of the environmental challenges that we face during the 20th anniversary of Earth Day - April 22, 1990, are:

Greenhouse gases heating up the atmosphere

Effects of the depletion of the ozone layer

Deforestation

Groundwater pollution

Nonpoint source pollution

Ever increasing solid waste quantities to manage

Continued management of hazardous waste sites

Protection of wetlands

Continued improvements to air and surface water quality

Over the last several years, a change has begun to take place in the way environmental issues are addressed. Around the time of the original Earth Day, the emphasis was on controlling pollution once created, or once it was released into the environment. Now, the emphasis in addressing environmental issues is on preventing the pollution from occurring. Pollution prevention is the theme recognized by the EPA for Earth Day 1990.

Activities

❑ Discuss with the class how far we have come since Earth Day 1970 and how far we still have to go.

❑ Include people who have professions associated with environmental protection in your career day.

❑ Visit a wastewater treatment plant, EPA, recycling center, water treatment plant. What environmental issues are they most concerned about? What can they do to help protect the environment? What do they plan to do on Earth Day 1990?

❑ Have students prepare a theme about protecting the environment and/or an environmental career.

Environment Crossword Puzzle

"Crossword" means that the words cross each other.

Some words go "across"

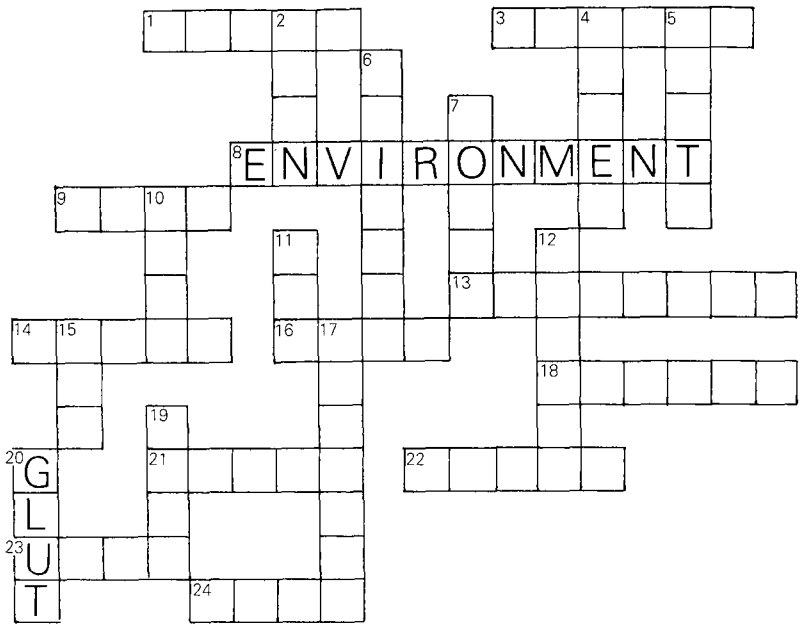
Some words go "down"

T
H
L I K E
S

What is the missing word in each sentence below?

Find the number of each word in the puzzle.

The FIRST letter of that word goes in the box with the number.



Across words

"Every litter bit _ _ 1 _ _."

Trash tossed away where it doesn't belong is called _ _ 3 _ _.

The _ _ _ _ 8 _ _ _ _ is what every living thing needs for life. (Already filled in)

_ _ 9 _ are good to use for cleaning. Save them.

_ _ _ 13 _ _ _ needs to help keep the environment clean.

Each living thing must have _ _ 14 _ _ to survive.

Dirty water from factories can kill _ 16 _.

People, animals, and _ _ 18 _ _ live on earth.

When you run the shower too long, you _ _21_ _ _ _22_ _.

When something like garbage or dirty water is not nice to look at, it is _ 23 _.

Emissions from _ 24 _ can make the air dirty.

Down words

When you leave a room, _ 2 _ _ _11_ the lights to save energy.

Paper is made from _ _ 4 _ _.

The air and water now on _ _ 5 _ _ have always been here; no new supplies come from space.

The environments of many wild _ _ _ 6 _ _ _ have been hurt by man.

Loud _ _ 7 _ _ bothers people and hurts their ears.

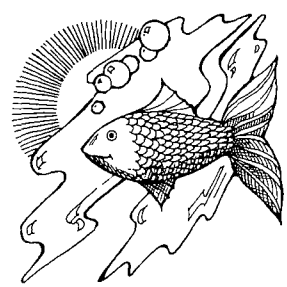
Don't throw away good, used items you no longer need. _ 10 _ them _ 19 _ so others can use them.

Too many _ _ 12 _ _ have hurt the environment.

Living things need fresh _15_ in the environment.

Many birds eat _ _ 17 _ _ _.

Save resources; don't be a _ 20 _. (Already filled in)



Solution to crossword puzzle on page **46.**

Word Search

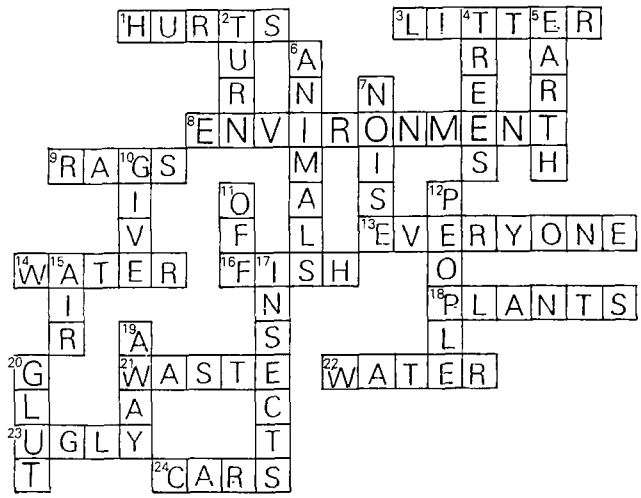
How many of the following words can you find in this puzzle? Each word may be spelled forwards, backwards, downwards, or diagonally. One word is spelled diagonally backwards. Answers to puzzle on last page.

environment
pollution
groundwater
runoff
recycle
smog
emissions
radon
lead
ozone
corrode
waste
hazardous
litter
incinerate
decompose
pesticide
water
toxic
dioxin
asbestos
discharge
standard
dump
chemicals
lab
air
earth
land
rain
dispose
health
acid
smoke
residue
risk

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

Solution on page **46.**

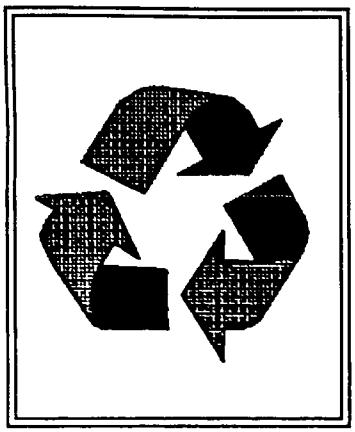
Answers to Crossword Puzzle and Word Search



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

DAY 5 Part 2

RECYCLING



Enviro-mints

❑ Recycling all the recyclables could eliminate from 58% to 65% of the solid waste stream. If all yard and food wastes were composted, from 84% to 91% of the total municipal solid waste stream could be eliminated.

❑ If an entire community recycled/composted just 75% of their typical trash contents, a landfill's life expectancy could quadruple.

❑ Aluminum requires significantly less energy (95%) to recycle than to mine and produce.

❑ 1 quart of oil can contaminate over a million gallons of groundwater; dirty oil can be easily cleaned up and reused.

❑ Until both the technology to reclaim/reprocess a material and a market for reclaiming that material exist, a material cannot be considered recyclable.

What You Can Do

❑ Contact industries that produce or use glass, aluminum, and other materials. Encourage their participation in the development of recyclable and recycled products.

❑ Promote oil management and recycling through your school's drivers education and auto shop classes.

Focus: Recycle

1. Why is it important to recycle?

2. What are the recyclable materials in your household trash?

Definitions:

Recyclable Products *Products capable of being recycled.*

Recycled Products - *Products made from reprocessed materials into the same or other products.*

❑ Recycling all the recyclables could eliminate from 58% (without plastics recycling) to 65% (with plastics recycling) of the solid waste stream.

❑ If all yard and food wastes were composted, from 84% to 91% of the total municipal solid waste stream could be eliminated.

❑ If an entire community recycled/composted just 75% of their typical trash contents, a landfill's life expectancy could quadruple.

❑ Recycling can benefit a community financially in another way. Glass, aluminum, other metals, high-quality white paper, newspaper, and, someday, plastics, have re-sale value as raw manufacturing stock. Therefore, in addition to landfill cost savings, income to the community can be generated.

❑ Until both the technology to reclaim and to reprocess a material and a market for reclaiming that material exist, a material cannot be considered recyclable.

Major Recyclable Categories:

- Glass
- Aluminum
- Other Metals: Iron, steel, tin
- Paper
- Plastics
- Compostables
- Used Motor Oil

Glass

❑ In 1985, beer and soda bottles comprised 60% of all discarded metal, glass and plastic containers.

❑ Glass must be sorted by color: amber, green, clear.

❑ Only 8.5% of discarded glass is now recovered.

❑ Recyclable products include all glass containers such as bottles and jars. One pound of discarded glass can be recycled into one pound of new glass without any loss of materials.

❑ Recycled glass products include new glass containers, fiberglass insulation, aggregate substitutes (fill), foam insulation, and "glassphalt," a paving material.

Aluminum

❑ Aluminum requires significantly less energy (95%) to recycle than to mine and produce.

❑ Today, 25% of discarded aluminum is recovered.

❑ Recyclable aluminum products include cans and a wide variety of other products, ranging from aluminum engine blocks to miscellaneous scrap.

❑ Recycled aluminum products include much more than just beverage cans. Virtually every product made from aluminum contains at least some recycled aluminum.

Other Metals

❑ Consider these recycling rates for containers:

	Aluminum Cans	Steel (Tin Cans)
Nationally	40%	5%
All states with bottle bills	70%	Not Affected
Oregon	95%	6%

Today, less than 4% of discarded ferrous metals is recovered.

❑ Recyclable ferrous metal products include a wide variety of scrap metal items, including steel cans, automobiles (bodies, engine blocks), and major appliances.

❑ Recycled ferrous metal products encompass the same wide range as do the recyclable products. For example, the steel from used appliances can be recycled into sheet steel, and engine blocks can be recast into any number of items, including new engines.

Paper

❑ Recycling paper saves trees; 2,000 pounds of paper equals 17 trees.

❑ If everyone in the United States recycled 1/10 of their newspapers each year, it would save 25 million trees.

❑ Today, on the average, about 22 percent of used paper is recovered.

❑ Recyclable paper products include newspaper, office paper, computer paper, magazines, and cardboard.

❑ Recycled paper products include gray cardboard, high-grade office paper, xerographic and laser printing paper, mixed paper, newsprint, photographic paper, corrugated cardboard, gypsum, wallboard liner, cellulose insulation, tissue products, and "agropaper," a soil mulch.

Plastics

❑ The use of plastic beverage containers in the United States has increased as follows:

1967 - 15.0 million
1982 - 8.5 billion
1985 - 12.5 billion
1990 - 20.0 billion

❑ Today, approximately 1% of discarded plastics is recovered.

❑ Plastics can be sorted by type, ground, and reprocessed to produce "new" plastic products.

❑ Recyclable plastics include discarded polyethylene terephthalate (PET) bottles, high-density polyethylene (HDPE) milk and juice jugs, and polyvinyl chloride (PVC).

❑ Recycled plastic products vary depending on the type of plastic that is recycled. PET bottles are recycled as: fiberfill for coats and sleeping bags, rigid plastic foam insulation, woven or spun geotextiles/ geofabrics (used in erosion control), continuous filament yarns, carpeting, garbage bags, and garbage cans. HDPE is made into: drain pipes, pallets, playground equipment, plastic lumber, plant pots, hoses, urethane foam insulation, and molded plastics (e.g., shower stalls). PVC is recycled to make: molded bathroom products, floor mats, automobile battery casings, and tire traction mats.

Compostables

❑ Yard wastes can be composted and sold as soil enhancers or mulch.

Motor Oil

❑ One quart of oil can contaminate over a million gallons of groundwater; dirty oil can be easily cleaned up and re-used.

❑ Waste oil can be re-refined for use as a lubricant. It may also be burned with adequate air pollution controls.

Activities

❑ **Make Recycled Paper**

Materials: newspaper, buckets or bowls, water, hand beater, pieces of screen or felt.

First Day

For each piece of paper desired, tear or cut up a half of a page of newspaper into small, 1/2 to 1 inch, pieces. Fill buckets or bowls with one part paper pieces and two parts water. Let the paper soak overnight. It will be soft and ready to be "pulped" the next morning. (Newspaper often requires more than one night of soaking . . . add cornstarch the day of activity - it smoothes it out a bit.)

Second Day

Use a hand beater to "pulp" the fibers in the paper. Beat the mixture until it looks like mush.

Take a handful of pulp and place it on a piece of screen or felt. Mold the pulp to the size of the sheet of paper you wish to make. Press the pulp with your hands or use a rolling pin to squeeze out the excess water. (Placing plastic over the pulp before rolling will prevent sticking.)

Let the paper dry one to two days. when it feels totally dry, remove it from the screen or felt, and you have recycled paper.

❑ Give each student a small piece of clay with which to make a bottle or other container. After students' bottles are made, collect them and discuss how more new bottles could be made. Solicit suggestions to use the same clay again, mixing it and repeating the activity. How would new bottles be made if the first bottles were discarded? If possible, use several different clay colors to demonstrate the importance of separating glass colors before recycling.

❑ Discuss the term "recycle." Reinforce the term recycle by listening for or finding the small word "cycle" in other words, and compare the term recycle to other cycles students may know— seasons, bicycle, etc.

❑ Role-play the recyclable beverage container cycle by assigning individuals to be consumers, grocery store workers, bottling company workers, truck drivers.

Discuss how returnable or recyclable bottles and cans go in a circle. Compare this to non-returnable, non-recyclable items. Try this both with a deposit on the containers and without.

❑ From previously gathered bags of "trash" separate reusable, recyclable, compostable and repairable items from those that are not. Discuss how removal of such items reduced the overall amount of "trash."

Have students create something useful and artistic with those recovered items (e.g., musical instruments, bird feeders, planters, doorstops, toys, crafts).

❑ Develop a class questionnaire to determine the attitudes of neighbors, friends, and family toward solid waste management and recycling participation. Solid waste is defined as the waste stream which is not disposed of via the sewer.

❑ Visit a local paper, aluminum, metals, or glass recycling business or composting facility in your community. Ask the business or facility manager about the success of its efforts, the pollution problems, the condition of available markets for recyclable products, transportation costs. Ask what "wish list" they have for the future.

❑ Contact local environmental groups active in support of recycling and source reduction. Invite someone from such a group to address your class and discuss the issues and problems.

❑ Promote oil management and recycling through your school's drivers education and auto shop classes by the following:

1. develop a school incentive program for recycling;

2. design posters and logos for display in school;

3. identify oil recycling outlets in your community; if none exists, encourage likely recyclers (e.g., auto parts stores, gasoline service stations, auto repair shops) to become outlets.

State used-oil recycling contacts are:

IOWA

Mr. Stu Schmitz, Department of Natural Resources, 900 East Grand, Des Moines, IA 50319, (515) 281-8499.

KANSAS

Mr. Richard Flanary, Department of Health and Environment, Bureau of Waste Management, Bldg. 730, Forbes Field, Topeka, KS 66620, (913) 296-1609.

MISSOURI

Mr. Bruce Martin, Department of Natural Resources, P. O. Box 176, Jefferson City, MO 65102, (314) 751-3176.

NEBRASKA

Mr. Dale Gubbels, Nebraska State Recycling Association, P. O. Box 80729, Lincoln, NE 68501, (402) 475-3637.

❑ Investigate the United States' nationwide efforts to recycle during World War II. What was recycled? Why was recycling during the war so successful? How was recycling promoted and encouraged? Why is it harder to get people to recycle today? Interview neighbors and relatives who were involved in the recycling efforts in the 1940s.

❑ Develop new ideas for dealing with the mounting waste stream of plastics. Address solutions that reduce our reliance on plastics and create recycling opportunities for plastics. Consider the following: Federal health laws prevent reprocessing plastic into food containers; there are more than 100 different kinds of plastics, some of which cannot be reprocessed together; contaminants can hinder reprocessing; and since plastic is lightweight but bulky, it often results in solid waste handling problems, including collection, sorting, and transporting.

❑ Examine the pros and cons of using returnable beverage containers. What states have "bottle bills?" Contact one or more of these states for information

about how the legislation was accomplished politically, how it has been implemented and what impacts it has had on recycling, litter, jobs, public opinion and energy use. Contact your state legislators, businesses, agencies and organizations and ask for their viewpoints and reasons for supporting or opposing beverage container deposit laws in your state. What do you think about a state or federal bottle bill?

❑ Discuss the problems that arise when the recycling loop is not complete, i.e., recyclable materials do not successfully return to the marketplace. Consumer demand for products and packaging that promote source reduction and recyclability depends on household consumer education, and marketplace initiatives, economic incentives or disincentive, and mandatory requirements and restrictions. Choose one of the four components of consumer demand and develop a tool (e.g., an advertisement, rebate, or discount, tax, package logo or label) to influence the behavior of a key group (e.g., household buyer, and industry or business, a community).

ENVIRONMENTAL I.Q. QUIZ*

More than one answer may be correct for some questions.

1. The loss of ozone in the earth's atmosphere is causing the atmosphere to become warmer. This warming trend occurs because the loss of ozone allows more ultraviolet light to enter the atmosphere, causing temperatures to rise and creating what is called: (pick the best answer)

   a. The Global Warming Trend
   b. The Glass Ceiling Effect
   c. The Air Bubble Encasement Theory
   d. The Greenhouse Effect
   e. The Thermal Blanket Effect

2. What two elements comprise most of our atmosphere?

   a. hydrogen b. oxygen c. nitrogen d. carbon

3. Which of the following can be recycled?

   a. glass b. aluminum c. plastic containers
   d. rubber e. frozen concentrated juice cans
   f. tuna cans

4. How many trees are saved by recycling one ton of paper?

   a. 11 b. 15 c. 17 d. 25 e. 33

5. In 1782, when the bald eagle became our national symbol, there were 25,000 to 75,000 eagles nesting in the lower 48 states. By the 1970's, the number had plummeted to about:

   a. 1,000 b. 3,000 c. 5,000 d. 7,000

6. What pesticide, which was banned in the U.S. in 1972, but is still used in third world countries, causes the egg shells of eagles and other birds to be affected?

   a. alcor b. DDT c. diazinon d. sevin

7. What chemicals emitted by industries, cause acid rain?

   a. sulfur dioxide b. ozone c. carbon monoxide
   d. dihydrogen oxide e. nitrogen oxide

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*Sponsored by the Federal Womens' Program, U.S. Army Corps of Engineers, Kansas City, MO; and Women in Science and Engineering, U.S. Environmental Protection Agency, Kansas City, KS

8. Efforts in water pollution control in the 1970's focused primarily on clean up of point sources such as pipes that discharge pollutants from cities and industries. As these point sources were cleaned up, it became apparent that pollution related to man's use of the land also greatly affected water quality. These diffuse sources of pollution are called:

   a. non-pipe sources
   b. pointless pollution sources
   c. chemical sources
   d. ecosystem sources
   e. nonpoint sources

9. Name the mammal that was virtually extinct in Missouri, but has been making a comeback due to wildlife trade with the state of Kentucky. (Hint: Missouri gives Kentucky 36 wild turkeys for every 20 of these mammals, which Kentucky purchases from a company in Louisiana).

   a. river otter b. bobcat c. black bear
   d. prairie chicken e. beaver

10. What chemical used to make apples grow bigger and firmer was found to be carcinogenic and taken off the market in 1989?

    a. chlordane b. sevin c. DDT d. alar

11. What are "prairie pigeons"?

    a. whooping cranes b. black-footed ferrets
    c. prairie dogs d. golden plovers

12. What was the "Duck Special"?

    a. a special fall, hunter's dinner served at the Elms in Excelsior Springs, Missouri
    b. an old-time Northern and Western Railway train for Iowa hunters
    c. an early airplane used to sight waterfowl in western Kansas
    d. a canal built from the Erie Canal to Lake Erie in New York to aid hunters in following migrating ducks

13. Name the only wetland area in Kansas or Missouri that has been designated as an area of "international" importance by world waterfowl conservationists.

    a. Squaw Creek National Wildlife Refuge in Missouri
    b. Swan Lake National Wildlife Refuge in Missouri
    c. Quivira Lake National Wildlife Refuge in Kansas
    d. Cheyenne Bottoms National Wildlife Refuge in Kansas
    e. Missouri's bootheel region

14. The "passive peril" refers to the risk of cancer from:

a. non-smokers being around smokers
b. breathing ozone
c. acid rain
d. breathing excess carbon monoxide from car exhaust

15. Shortly after President George Bush took office in 1988, he declared that he was pursuing a "no net loss" policy on this resource. This policy refers to which resource:

a. endangered species
b. wild and scenic rivers
c. wetlands
d. redwood forests

16. Which of the following species are on the National List of Endangered Species?

a. Bald eagle
b. Peregrine falcon
c. Whooping crane
d. California condor
e. Manatee
f. Brown Pelican
g. Jaguar
h. Kemp's ridley sea turtle
i. Gray wolf
j. Gray bat
k. Piping plover

17. What endangered plant, native to the tropical forests of Madagascar, produces a drug that improves the chances of survival from a form of leukemia?

a. teosinte (wild corn)
b. green pitcher plant
c. furbush lousewort
d. rosy periwinkle

18. Which of the following birds <u>cannot</u> be found in the wild in <u>either</u> Kansas <u>or</u> Missouri during some part of the year? (There are only <u>two</u>!)

a. Whooping Cranes
b. American Avocet
c. Wood Duck
d. Greater Yellowlegs
e. Snowy Egret
f. Red-winged Blackbirds
g. Killdeer
h. American Bittern
i. Great Blue Heron
j. American White Pelican
k. Emu
l. Eastern Meadowlark
m. Peregrine Falcon
n. Sandhill Crane
o. Great Horned Owl
p. Bald Eagle
q. California Condor
r. Green Heron
s. Wild Turkey
t. Marsh Hawk
u. Louisiana Heron
v. Eastern Bluebird
w. Indigo Bunting
x. Cliff Swallow
y. Whistling Swan
z. Bufflehead

19. What is the fastest living creature on earth? (Hint: This animal attains speeds of 200 miles per hour and is endangered!)

a. peregrine falcon
b. cheetah
c. bald eagle
d. ocelot
e. puma

20. When Mount St. Helens erupted on May 18, 1980, approximately 3 billion cubic yards of volcanic and landslide material were deposited in a 17-mile avalanche flow in the upper North Fork of the Toutle River, and another 50 million cubic yards filled the upper four miles of the South Fork of the Toutle. Between 150 to 200 million cubic yards filled the river channels down the 70-mile course of the Toutle and Cowlitz rivers and into the Columbia River. Because of the problems this sediment caused, the U.S. Army Corps of Engineers designed and began construction of a dam for the primary purpose of:

a. retaining water
b. retaining fish
c. retaining sediment
d. preventing future flooding

21. Who wrote the bestseller River of Grass which championed the saving of an important wetland in America?

a. Rachel Carson
b. Marjory Stoneman Douglas
c. Joy Adamson
d. Margaret Mead

22. About what wetland was the River of Grass written?

a. Everglades
b. Okeefenokee Swamp
c. Chinquoteague, Island Virginia
d. Delmarva Penninsula
e. Lake Ponchatrain, Louisiana

23. Which of the following is (are) not (a) pioneer(s) of the conservationist/environmental movement?:

a. Aldo Leopold
b. Rachel Carson
c. Marjory Stoneman Douglas
d. Caldwell Taylor
e. John Muir
f. John James Audubon
g. Thurgood Marshall

24. To a conservation activist, what does the acronym HHW stand for?

a. Household Hazardous Wastes
b. Human Health Warning
c. Health Hazard Warning
d. Hazardous Human Wastes

25. Earth Day was first celebrated on April 22nd of what year?

a. 1969
b. 1970
c. 1974
d. 1979

26. How many people participated in that first Earth Day observance?

a. 250,000 b. 500,000 c. 750,000 d. 1,000,000
e. 2,000,000 f. 5,000,000 g. 10,000,000 h. 20,000,000

27. Which of the following laws were passed or agencies created within two years of the first Earth Day celebration?

a. Clean Water Act b. Clean Air Act
c. Rivers and Harbors Act d. Environmental Education Act
e. Environmental Protection Agency f. Army Corps of Engineers

28. Which of the following were concerns which prompted the first Earth Day?

a. smog b. raw sewage c. acid rain
d. automobile emissions e. toxic waste f. global warming
g. habitat destruction h. ozone depletion
i. industrial air pollution

29. Nonpoint source pollution to water comes from:

a. soil erosion from agricultural fields
b. fertilizers such as phosphorus and nitrogen
c. pesticides
d. land disturbing activities related to building construction
e. stormwater runoff from streets
f. disposal of wastes
g. pipes discharging from cities
h. pipes discharging from industries

30. Concerns about continuing ozone depletion in the atmosphere have led automobile makers to specifically redesign what part of an automobile?

a. muffler b. engine c. exhaust system
d. carburetor e. air conditioner

31. According to the National Science Foundation in a 1989 study, what percentage of Earth's plants, animals, and microbes are in danger of extinction?

a. 2% b. 5% c. 10% d. 15%
e. 20% f. 25% g. 30% h. 35%

32. The 1990's have been designated as "Decade of the _____?"

a. River b. Environment c. Wetlands
d. Clean Air e. Endangered Species f. Ecosystem

33. What is the name of the world's largest wetland?

a. Antananarivo b. Niihau c. Kyushu
d. Amazonia e. Pantanal f. Komodo

34. Which of the following species of plants is <u>not</u> found in lakes or wetlands in Kansas or Missouri?

a. American lotus b. coontail c. arrowhead d. elodea
e. water hyacinth f. algae g. willow h. duckweed

35. Which of the following species has <u>not</u> been successfully restored in Missouri?

a. gray wolf b. ruffed grouse c. giant Canada goose
d. river otter e. wild turkey f. white-tailed deer

36. A watershed is:

a. A building to shelter a well
b. The land area from which water drains to a waterbody such as a lake, stream, or wetland
c. The land area that contributes pollutants from land runoff to a waterbody such as a lake, stream, or wetland
d. A hydrologic unit
e. A covered bridge over a river

37. Match the endangered species to a state in its regional habitat in the United States. Use only one state for a species. No state should be used more than one time.

a. Whooping Crane	1. Nebraska
b. Black Panther	2. Wyoming
c. Ocelot	3. Hawaii
d. Nene	4. Texas
e. Black-footed ferret	5. Florida

38. Match the endangered species with its historic range (where it was originally found).

a. Nene	1. West and Central Africa
b. Giant Panda	2. Africa
c. Brown bear	3. Eastern North America
d. Cheetah	4. Tibet (China)
e. African Elephant	5. Bolivia
f. Chimpanzee	6. Southeast & South Central Asia, Taiwan
g. Tiger	7. Hawaii
h. Eastern Cougar	8. Temperate & Tropical Asia
i. Clouded Leopard	9. Republic of China
j. Chinchilla	10. Africa to India

39. Match the species with the product that is made from it. Note: Some of the animal species listed are endangered because of over-hunting to obtain the product listed.

a. African elephant	1. fur
b. Rhinoceros	2. meat
c. Ocelots	3. skin
d. Sperm whale	4. dagger handles & fever reducing medicine
e. Ostrich	5. feathers
f. Green sea turtle	6. ivory
g. American alligator	7. Ambergris for perfumes

40. Animals have always been an important part of our lives. Some of our sayings compare people or things to animals. Match the beginning of the saying with the animal that completes it.

a. Sly as a _____.	1. Owl
b. Wise as an _____.	2. Turtle
c. Crazy as a _____.	3. Loon
d. An _____ never forgets.	4. Eagle
e. To soar like an _____.	5. Elephant
f. _____ in the belfry.	6. Fox
g. "The fog comes in on little _____ feet"	7. Bats
	8. Mule
h. Quiet as a _____.	9. Cat
i. Slow as a _____.	10. Mouse
j. Stubborn as a _____.	

Recorder's Name: _____

Teacher's Name: _____

Class Name/Hour/Period: _____

Students' Grade Level: _____

School: _____

Address: _____

Telephone: _____

ENVIRONMENTAL I.Q. QUIZ

Entry No._____

Answer Sheet

List your answer in the blank corresponding to the question number.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
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14. _____
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35. _____
36. _____

37. a _____
b _____
c _____
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e _____

38. a _____
b _____
c _____
d _____
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f _____
g _____
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i _____
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39. a _____
b _____
c _____
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40. a _____
b _____
c _____
d _____
e _____
f _____
g _____
h _____
i _____
j _____

Answers to Environmental I.Q. Quiz
April 1990

1. d
2. b, c
3. a, b, c, d, e, f
4. c
5. b
6. b
7. a, e
8. e
9. a
10. d
11. d
12. b
13. d
14. a
15. c
16. a, b, c, d, e, f, g, h, i, j, k
17. d
18. k, q
19. a
20. c
21. b
22. a
23. d, g
24. a
25. b
26. h
27. a, b, d, e
28. a, b, d, i
29. a, b, c, d, e, f
30. e
31. f
32. c
33. e
34. e
35. a
36. b, c, d

37.
a 1
b 5
c 4
d 3
e 2

38.
a 7
b 9
c 4
d 10
e 2
f 1
g 8
h 3
i 6
j 5

39.
a 6
b 4
c 1
d 7
e 5
f 2
g 3

40.
a 6
b 1
c 3
d 5
e 4
f 7
g 9
h 10
i 2
j 8

Glossary

ENVIRONMENTAL GLOSSARY

Absorption -
1. Adhesion of molecules of gas, liquid, or dissolved solids to a surface.
2. An advanced method of treating wastes in which activated carbon removes organic matter from wastewater.
3. The passage of one substance into or through another,e.g., an operation in which one or more soluble components of a gas mixture are dissolved in a liquid.

Accelerator - In radiation science, a device that speeds up charged particles such as electrons or protons.

Acid Rain / Deposition- A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either a wet or dry form. The wet forms, popularly called "acid rain," can fall as rain, snow, or fog. The dry forms are acidic gases or particulates.

Acute Toxicity - The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose. Also, any severe poisonous effect resulting from a single short-term exposure to a toxic substance (See: Chronic Toxicity, Toxicity).

Adaptation - Changes in an organism's structure that help it adjust to its surroundings.

Adulterants - Chemical impurities or substances that by law do not belong in a food or in a pesticide.

Advanced Waste Water Treatment - Any treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids (See: Primary, Secondary Treatment).

Aeration - A process which promotes biological degradation of organic waste. The process may be passive (as when waste is exposed to air) or active (as when a mixing or bubbling device introduces the air).

Aerobic - Life or processes that require, or are not destroyed by, the presence of oxygen (See: Anaerobic).

Aerosol - A suspension of liquid or solid particles in a gas.

Agricultural Pollution - The liquid and solid wastes from farming, including: runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; animal manure and carcasses; crop residues; and debris.

Air Contaminant - Any particulate matter, gas, or combination thereof, other than water vapor or natural air (See: Air Pollutant).

Air Mass - A widespread body of air that gains certain meteorological or polluted characteristics, e.g., a heat inversion or smogginess while set in one location. The characteristics can change as it moves away.

Air Pollution - The presence of contaminant or pollutant substances in the air that do not disperse properly and interfere with human health or welfare, or produce other harmful environmental effects.

Airborne Particulates - Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. The chemical composition of particulates varies widely, depending on location and time of year. Airborne particulates include windblown dust, emission from industrial processes, smoke from the burning of wood and coal, and the exhaust of motor vehicles.

Algae - Simple rootless plants that grow in sunlit waters in relative proportion to the amounts of nutrients available. They can affect water quality adversely by lowering the dissolved oxygen in the water. They are food for fish and small aquatic animals.

Algal Blooms - Sudden spurts of algal growth, which can affect water quality adversely and indicate potentially hazardous changes in local water chemistry.

Alpha Particle - A positively charged particle composed of two neutrons and two protons released by some atoms undergoing radioactive decay. The particle is identical to the nucleus of a helium atom.

Ambient Air - Any unconfined portion of the atmosphere: open air, surrounding air.

Anadromous - Fish that spend their adult life in the sea but swim upriver to fresh water spawning grounds to reproduce.

Anaerobic - A life or process that occurs in, or is not destroyed by, the absence of oxygen.

Analytes - The chemicals for which a sample is analyzed.

Antagonism - The interaction of two chemicals having an opposing, or neutralizing, effect on each other, or given some specific biological effect a chemical interaction that appears to have an opposing or neutralizing effect over what might otherwise be expected.

Antarctic "Ozone Hole" Refers to the seasonal depletion of ozone in a large area over Antarctica.

Antibodies - Proteins produced in the body by immune system cells in response to antigens, and capable of combining with antigens.

Antigen - A substance that causes production of antibodies when introduced into animal or human tissue.

Aquifer - An underground geological formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Asbestos - A mineral fiber that can pollute air or water and cause cancer or asbestosis when inhaled. EPA has banned or severely restricted its use in manufacturing and construction.

Asbestosis - A disease associated with chronic exposure to and inhalation of asbestos fibers. The disease makes breathing progressively more difficult and can lead to death.

Ash - The mineral content of a product remaining after complete combustion.

Atmosphere -
1. A standard unit of pressure representing the pressure exerted by a 29.92-inch column of mercury at sea level at 45 degrees latitude and equal to 1,000 grams per square centimeter.
2. The whole mass of air surrounding the earth, composed largely of oxygen and nitrogen.

Atomize - To divide a liquid into extremely minute particles, either by impact with a jet of stream or compressed air, or by passage through some mechanical device.

Attenuation - The process by which a compound is reduced in concentration over time, through adsorption, degradation, dilution, and/or transformation.

Attractant - A chemical or agent that lures insects or other pests by stimulating their sense of smell.

Attrition - Wearing or grinding down of a substance by friction. A contributing factor in air pollution, as with dust.

Autotrophic - An organism that produces food from inorganic substances.

Background Level - In air pollution control, the concentration of air pollutants in a definite area during a fixed time prior to the starting up or on the stoppage of a source of emission under control. In toxic substances, monitoring, the average presence in the environment, originally referring to a naturally occurring phenomena.

Bacteria - Microscopic living organism which can aid in pollution control by consuming or breaking down organic matter in sewage, or by similarly acting on oil spills or other water pollutants. Bacteria in soil, water or air can also cause human, animal and plant health problems. The singular form of bacteria is bacterium.

Band Application - In pesticides, the spreading of chemicals over, or next to, each row of plants in a field.

Basal Application - In pesticides, the application of a chemical on plant stems or tree trunks just above the soil line.

Benthic Organism (Benthos) - A form of aquatic plant or animal life that is found on or near the bottom of a stream, lake, or ocean.

Beryllium - An airborne metal that can be hazardous to human health when inhaled. It is discharged by machine shops, ceramic and propellant plants, and foundries.

Beta Particle - An elementary particle emitted by radioactive decay that may cause skin burns. It is halted by a thin sheet of paper.

Bioaccumulative - Substances that increase in concentration in living organisms (that are very slowly metabolized or excreted) as they breathe contaminated air, drink contaminated water, or eat contaminated food (See: Biological Magnification).

Bioassay - Using living organisms to measure the effect of substance, factor, or condition by comparing before and after data. Term is often used to mean cancer bioassays.

Biochemical Oxygen Demand (BOD) - A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.

Biodegradable- The ability to break down or decompose rapidly under natural conditions and processes.

Biological Control - In pest control, the use of animals and organisms that eat or otherwise kill or outcompete pests.

Biological Magnification - Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into a river or lake and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals, or humans. The substances become concentrated in tissues or internal organs as they move up the chain (See: Bioaccumulative).

Biological Oxidation - The way bacteria and microorganisms feed on and decompose complex organic materials. Used in self-purification of water bodies and in activated sludge wastewater treatment.

Biological Treatment - A treatment technology that uses bacteria to consume waste. This treatment breaks down organic materials.

Biomass - All of the living material in a given area; often refers to vegetation. Also called "biota."

Biomonitoring -
1. The use of living organisms to test the suitability of effluents for discharge into receiving waters and to test the quality of such waters downstream from the discharge.
2. Analysis of blood, urine, tissues, to measure chemical exposure in humans.

Biosphere - The portion of earth and its atmosphere that can support life.

Biotechnology - Techniques that use living organisms or parts of organisms to produce a variety of products (from medicines to industrial enzymes) to improve plants or animals or to develop microorganisms for specific uses such as removing toxics from bodies of water, or as pesticides.

Biotic Community - A naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustained and interdependent.

Black Lung - A disease of the lungs caused by habitual inhalation of coal dust.

Blackwater - Water that contains animal, human, or food wastes.

Bog - A type of wetland that accumulates appreciable peat deposits. Bogs depend primarily on precipitation for their water source and are usually acidic and rich in plant residue with a conspicuous mat of living green moss.

Boom -
1. A floating device used to contain oil on a body of water.
2. A piece of equipment used to apply pesticides from ground equipment such as a tractor or truck.

Botanical Pesticide - A pesticide whose active ingredient is a plant produced chemical such as nicotine or strychnine.

Bottle Bill - Proposed or enacted legislation which requires a returnable deposit on beer or soda containers and provides for retail store or other redemption centers. Such legislation is designed to discourage use of throwaway containers.

Brackish Water - A mixture of fresh and salt water.

Broadcast Application - In pesticides, the spreading of chemicals over an entire area.

Bubble - A system under which existing emissions sources can propose alternate means to comply with a set of emissions limitations. Under the bubble concept, sources can control more than required at one emission point where control costs are relatively low in return for a comparable relaxation of controls at a second emission point where costs are higher.

Buffer Strips - Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

By-product - Material, other than the principal product, that is generated as a consequence of an industrial process.

Cadmium (Cd) - A heavy metal element that accumulates in the environment.

Cap - A layer of clay, or other highly impermeable material, installed over the top of a closed landfill to prevent entry of rainwater and minimize production of leachate.

Carbon Dioxide (CO2) - A colorless, odorless, nonpoisonous gas, which results from fossil fuel combustion and is normally a part of the ambient air.

Carbon Monoxide (CO) - A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

Carrying Capacity -
1. In recreation management, the amount of use a recreation area can sustain without deteriorating its quality.
2. In wildlife management, the maximum number of animals an area can support during a given period of the year.

Catalytic Converter - An air pollution abatement device that removes pollutants from motor vehicle exhaust, either by oxidizing them into carbon dioxide and water or reducing them to nitrogen and oxygen.

Catanadramous - Fish that swim downstream to spawn.

Caustic Soda - Sodium hydroxide, a strong alkaline substance used as the cleaning agent in some detergents.

Cells -
1. In solid waste disposal, holes where waste is dumped, compacted, and covered with layers of dirt on a daily basis.
2. The smallest structural part of living matter capable of functioning as an independent unit.

Cesium (Cs) - A silver-white, soft ductile element of the alkali metal group that is the most electropositive element known. Used especially in photoelectric cells.

Channelization - Straightening and deepening streams so water will move faster. A flood-reduction or marsh-drainage tactic that can interfere with waste assimilation capacity and disturb fish and wildlife habitats.

Characteristic - Any one of the four categories used in defining hazardous waste: ignitability, corrosivity, reactivity, and toxicity.

Chemical Oxygen Demand (COD) - A measure of the oxygen required to oxidize all compounds in water, both organic and inorganic.

Chemical Treatment - Any one of a variety of technologies that use chemicals or a variety of chemical processes to treat waste.

Chemosterilant - A chemical that controls pests by preventing reproduction.

Chilling Effect - The lowering of the Earth's temperature because of increased particles in the air blocking the sun's rays (See: Greenhouse Effect).

Chlorinated Hydrocarbons - These include a class of persistent, broad-spectrum insecticides, that linger in the environment and accumulate in the food chain. Among them are DDT, aldrin, dieldrin, heptachlor, chlorodane, lindane, endrin, mirex, hexachloride, and toxaphene. Other examples include TCE, used as an industrial solvent.

Chlorinated Solvent - An organic solvent containing chlorine atoms, e.g., methylene chloride and 1,1,1,- trichloromethane, which are used in aerosol spray containers and in traffic paint.

Chlorination - The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds.

Chlorofluorocarbons (CFCs) - A family of inert, nontoxic and easily liquified chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

Chlorosis - Discoloration of normally green plant parts that can be caused by disease, lack of nutrients, or various air pollutants.

Chronic Toxicity - The capacity of a substance to cause long-term poisonous human health effects (See : Acute Toxicity).

Clarification - Clearing action that occurs during wastewater treatment when solids settle out. This is often aided by centrifugal action and chemically induced coagulation in wastewater.

Cloning - In biotechnology, obtaining a group of genetically identical cells from a single cell. This term has assumed a more general meaning that includes making copies of a gene.

Close-Loop Recycling - Reclaiming or reusing wastewater for nonpotable purposes in an enclosed process.

Coagulation - A clumping of particles in wastewater to settle out impurities. It is often induced by chemicals such as lime, alum, and iron salts.

Coastal Zone - Lands and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology, or, inversely, whose uses and ecology are affected by the sea.

Combustion - Burning, or rapid oxidation, accompanied by release of energy in the form of heat and light. A basic cause of air pollution.

Confined Aquifer - An aquifer in which groundwater is confined under pressure that is significantly greater than atmospheric pressure.

Conservation - Avoiding waste of, and renewing when possible, human and natural resources. The protection, improvement, and use of natural resources according to principles that will ensure their highest economic or social benefits.

Contact Pesticide - A chemical that kills pests when it touches them rather than by being eaten (stomach poison). Also, soil that contains the minute skeletons of certain algae that scratches and dehydrates waxy-coated insects.

Contaminant - Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil.

Coolant - A liquid or gas used to reduce the heat generated by power production in nuclear reactors, electric generators, various industrial and mechanical processes, and automobile engines.

Cooling Tower - A structure that helps remove heat from water used as a coolant, e.g., in electric power generating plants.

Corrosion - The dissolving and wearing away of metal caused by a chemical reaction such as between water and the pipes that the water contacts, chemicals touching a metal surface, or contact between two metals.

Cover - Vegetation or other materials providing protection as ground cover.

Cultural Eutrophication - Increasing rate at which water bodies "die" by pollution from human activities.

Curie - A quantitative measure of radioactivity equal to 3.7×10^{10} disintegrations per second.

DDT - The first chlorinated hydrocarbon insecticide (chemical name: Dichloro-Diphsdyl-Trichloromethane). It has a half-life of 15 years and can collect in fatty tissues of certain animals. EPA banned registration and interstate sale of DDT for virtually all but emergency uses in the United States in 1972 because of its persistence in the environment and accumulation in the food chain.

Dechlorination - Removal of chlorine from the substance by chemically replacing it with hydrogen or hydroxide ions in order to detoxify the substances involved.

Dissolved Oxygen (DO) - The oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic life and for the prevention of odors. Traditionally, the level of dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced waste treatment are generally designed to protect DO in waste-receiving waters.

Dissolved Solids - Disintegrated organic and inorganic matter contained in water. Excessive amounts make water unfit to drink or use in industrial processes.

Distillation - The act of purifying liquids through boiling, so that the stream condenses to a pure liquid and the pollutants remain in a concentrated residue.

DNA - Deoxyribonucleic acid, the molecule in which the genetic information for most living cells is encoded.

DNA Hybridization - Use of a segment of DNA, called a DNA probe, to identify its complementary DNA; used to detect specific genes. This process takes advantage of the ability of single strand of DNA to combine with a complimentary strand.

Dose - The amount of a substance penetrating the exchange boundaries of an organism after contact. Dose is calculated from the intake and absorption efficiency, and it usually is expressed as mass of a substance absorbed into the body per unit body weight per unit time, e.g., mg/kg-day. Also, in radiology, the quantity of energy or radiation absorbed.

Dredging - Removal of mud from the bottom of water bodies using a scooping machine. This disturbs the ecosystem and causes silting that can kill aquatic life. Dredging of contaminated muds can expose aquatic life to heavy metals and other toxics.

Dump - A site used to dispose of solid wastes without environmental controls.

Dust - Particles light enough to be suspended in air.

Dystrophic Lakes - Shallow bodies of water that contain much humus and or organic matter, that contain many plants but few fish and are highly acidic.

Ecology - The relationship of living things to one another and their environment, or the study of such relationships.

Ecosystem - The interacting system of a biological community and its nonliving environmental surroundings.

Effluent - Wastewater - treated or untreated - that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Electrodialysis - A process that uses electrical current applied to permeable membranes to remove minerals from water. Often used to desalinize salty or brackish water.

Emission - Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

Endangered Species - Animals, birds, fish, plants, or other living organisms threatened with extinction by man-made or natural changes in the environment. Requirements for declaring a species endangered are contained in the Endangered Species Act.

Enrichment - The addition of nutrients , e.g., nitrogen, phosphorus, carbon compounds, from sewage effluent or agricultural runoff to surface water. This process greatly increases the growth potential for algae and aquatic plants.

Environment - The sum of all external conditions affecting the life, development and survival of an organism.

EPA - The U. S. Environmental Protection Agency; established in 1970 by Presidential Executive Order, bringing together parts of various government agencies involved with the control of pollution.

Epidemiology - The study of diseases as they affect population, including the distribution of disease, or other health-related states and events in human populations, the factors, e.g., age, sex, occupation, economic status, that influence this distribution, and the application of this study to control health problems.

Erosion - The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber-cutting.

Estuary - Regions of interaction between and near shore ocean waters, where tidal action and river flow create a mixing of fresh and salt water. These areas may include bays, mouths of rivers, salt marshes, and lagoons. These brackish water ecosystems shelter and feed marine life, birds, and wildlife (See Wetlands).

Ethylene Dibromide (EDB) - A chemical used as an agricultural fumigant and in certain industrial processes. Extremely toxic and found to be a carcinogen in laboratory animals, EDB has been banned for most agricultural uses in the United States.

Eutrophic Lakes - Shallow, murky bodies of water that have excessive concentrations of plant nutrients causing excessive algal production (See: dystrophic lakes).

Eutrophication - The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication, the water body is choked by abundant plant life as the result of increased amounts of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration - The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

Exposure -
1. The amount of radiation or pollutant present in an environment which represents a potential health threat to the living organisms in that environment.
2. Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism, e.g., skin, lungs or gut, and available for absorption.

Extremely Hazardous Substances - Any of 406 chemicals identified and listed by EPA on the basis of toxicity. The list is subject to revision.

Fecal Coliform Bacteria - Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Feedlot - A relatively small, confined area for the controlled feeding of animals that tends to concentrate large amounts of animal wastes that cannot be absorbed by the soil and, hence, may be carried to nearby streams or lakes by rainfall runoff.

Fen - A type of wetland that accumulates peat deposits. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium. (See: Wetlands)

Fermentation - Chemical reactions accompanied by living microbes that are supplied with nutrients and other critical conditions such as heat, pressure, and light that are specific to the reaction at hand.

Fertilizer - Materials such as nitrogen and phosphorus that provide nutrients for plants. Commercially sold fertilizers may contain other chemicals or may be in the form of processed sewage sludge.

Flocculation - The process by which clumps of solids in water or sewage are made to increase in size by biological or chemical action so that they can be separated from the water.

Flume - A natural or man-made channel that diverts water.

Fluorides - Gaseous, solid, or dissolved compounds containing fluorine that result from industrial processes. Excessive amounts in food can lead to fluorosis.

Fluorocarbon (FCs) - Any of a number of organic compounds analogous to hydrocarbons in which one or more hydrogen atoms are replaced by fluorine. Once used in the United States as a propellant in aerosols, they are now primarily used in coolants and some industrial processes. FCs containing chlorine are called chlorofluorocarbons (CFCs). They are believed to be modifying the ozone layer in the stratosphere, thereby allowing more harmful solar radiation to reach the Earth's surface.

Fly Ash - Noncombustible residual particles from the combustion process, carried by flue gas.

Food Chain - A sequence of organisms, each of which uses the next, lower member of the sequence as a food source.

Formaldehyde - A colorless, pungent, irritating gas, CH20, used chiefly as a disinfectant and preservative and in synthesizing other compounds and resins.

Formulation - The substance or mixing of substances which is comprised of all active and inert ingredients in a pesticide.

Fresh Water - Water that generally contains less than 1,000 milligrams-per-liter of dissolved solids.

Fumigant - A pesticide that is vaporized to kill pests. Used in buildings and greenhouses.

Fungi - (Singular, Fungus) Molds, mildews, yeasts, mushrooms, and puffballs, a group of organisms that lack chlorophyll, i.e., are not photosynthetic, and which are usually nonmobile, filamentous, and multicellular. Some grow in the ground, others attach themselves to decaying trees and other plants, getting their nutrition from decomposing organic matter. Some cause disease, others stabilize sewage and break down solid wastes in composting.

Game Fish - Species like trout, salmon, or bass, caught for sport. Many of them show more sensitivity to environmental change than "rough" fish.

Gamma Radiation - Gamma rays are true rays of energy in contrast to alpha and beta radiation. The properties are similar to X-rays and other electromagnetic waves. They are the most penetrating waves of radiant nuclear energy but can be blocked by dense materials such as lead.

Gene - A length of DNA that directs the synthesis of a protein.

Genetic Engineering - A process of inserting new genetic information into existing cells in order to modify any organism for the purpose of changing one of its characteristics.

Germicide - Any compound that kills disease-causing microorganisms.

Gray Water - The term given to domestic wastewater composed of washwater from sinks, kitchen sinks, bathroom sinks and tubs, and laundry tubs.

Greenhouse Effect - The warming of the Earth's atmosphere caused by a build-up of carbon dioxide or other trace gases; it is believed by many scientists that this build-up allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

Gross Alpha Particle Activity - Total activity due to emission of alpha particles. Used as a screening measurement for radioactivity generally due to naturally-occurring radionuclides. Activity is commonly measured in picocuries.

Gross Beta Particle Activity - Total activity due to emission of beta particles. Used as the screening measurement for radioactivity from man-made radionuclides since the decay products of fission are beta particle and gamma ray emitters. Activity is commonly measured in picocuries.

Ground Cover - Plants grown to keep soil from eroding.

Ground Water - The supply of fresh water found beneath the Earth's surface, usually in aquifers, which is often used for supplying wells and springs. Because ground water is a major source of drinking water, there is growing concern over areas where leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating ground water.

Habitat - The place where a population, e. g., human, animal, plant, microorganism, lives and its surroundings, both living and nonliving.

Half-Life -
1. The time required for a pollutant to lose half its effect on the environment. For example, the half-life of DDT in the environment is 15 years, of radium, 1,580 years.
2. The time required for half of the atoms of a radioactive element to undergo decay.
3. The time required for the elimination of one-half a total dose from the body.

Halogen - Any of a group of five chemically-related nonmetallic elements that includes bromine, fluorine, chlorine, iodine, and astatine.

Halon - Bromine containing compounds with long atmospheric lifetimes whose breakdown in the stratosphere cause depletion of ozone. Halons are used in fire fighting.

Hard Water - Alkaline water containing dissolved salts that interfere with some industrial processes and prevent soap from lathering.

Hazardous Substance -
1. Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive.
2. Any substances designated by EPA to be reported if a designated quantity of the substance is spilled in the waters of the United States or if otherwise emitted to the environment.

Hazardous Waste - By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Heat Island Effect - A "dome" of elevated temperatures over an urban area caused by structural and pavement heat fluxes, and pollutant emissions from the area below the dome.

Heavy Metals - Metallic elements with high atomic weights, e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

Heptachlor - An insecticide that was banned on some food products in 1975 and all of them in 1978. It was allowed for use in seed treatment until 1983. More recently, it was found in milk and other dairy products in Arkansas and Missouri as a result of illegally feeding treated seed to dairy cattle.

Herbicide - A chemical pesticide designed to control or destroy plants, weeds or grasses.

Heterotrophic Organisms - Consumers such as humans and animals, and decomposers - chiefly bacteria and fungi that are dependent on organic matter for food.

Holding Pond - A pond or reservoir, usually made of earth, built to store polluted runoff.

Host -
1. In genetics, the organism, typically a bacterium, into which a gene from another organism in transplanted.
2. In medicine, an animal infected by or parasitized by another organism.

Humus - Decomposed organic material.

Hybrid - A cell or organism resulting from a cross between two unlike plant or animal cells or organisms.

Hybridoma - A hybrid cell that produces monoclonal antibodies in large quantities.

Hydrogen Sulfide (HS) - Gas emitted during organic decomposition. Also byproduct of oil refining and burning. It smells like rotten eggs and, in heavy concentration, can cause illness.

Hydrogeology - The geology of ground water, with particular emphasis on the chemistry and movement of water.

Hydrology - The science dealing with the properties, distribution, and circulation of water.

Ignitable - Capable of burning or causing a fire.

Immediately Dangerous to Life and Health (IDLH) - The maximum level to which a healthy individual can be exposed to a chemical for 30 minutes and escape without suffering irreversible health effects or impairing symptoms. Used as a "level of concern" (See: level of concern).

Impoundment - A body of water or sludge confined by a dam, dike, floodgate, or other barrier.

In Vitro -
1. "In glass:" a test-tube culture.
2. Any laboratory test using living cells taken from an organism.

In Vivo - In the living body of a plant or animal. In vivo tests are those laboratory experiments carried out on whole animals or human volunteers.

Incineration -
1. Burning of certain types of solid, liquid or gaseous materials.
2. A treatment technology involving destruction of waste by controlled burning at high temperatures, e.g., burning sludge to remove the water and reduce the remaining residues to a safe, nonburnable ash which can be disposed of safely on land, in some waters or in underground locations.

Indicator - In biology, an organism, species, or community whose characteristics show the presence of specific environmental conditions.

Insert Ingredient - Pesticide components such as solvents, carriers, and surfactants that are not active against target pests. Not all inert ingredients are innocuous.

Infiltration -
1. The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.
2. A land application technique where large volumes of waste water are applied to land, allowed to penetrate the surface and percolate through the underlying soil (See: Percolation).

Inflow - Entry of extraneous rain water into a sewer system from sources other than infiltration, such as basement drains, manholes, storm drains, and street washing.

Influent - Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

Injection Well - A well into which fluids are injected for purposes such as waste disposal, improving the recovery of crude oil, or solution mining.

Inoculum -
1. Bacterium placed in compost to start biological action.
2. A medium containing organisms which is introduced into cultures of living organisms.

Inorganic Chemicals - Chemical substances of mineral origin, not of basically carbon structure.

Insecticide - A pesticide compound specifically used to kill or control the growth of insects.

Inversion - An atmospheric condition caused by a layer of warm air preventing the rise of cooling air trapped beneath it. This prevents the rise of pollutants that might otherwise be dispersed and can cause an air pollution episode.

Ion - An electrically charged atom or group of atoms which can be drawn from waste water during the electrodialysis process.

Ion Exchange Treatment - A common water softening method often found on a large scale at water purification plants that remove some organics and radium by adding calcium oxide or calcium hydroxide to increase the pH to a level where the metals will precipitate out.

Ionizing Radiation - Radiation that can remove electrons from atoms, i,e, alpha, beta, and gamma radiation.

Irradiation - Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray, or ultraviolet) for medical purposes, the destruction of bacteria in milk or other foodstuffs, or for inducing polymerization of monomers or vulcanization of rubber.

Irrigation - Technique for applying water or wastewater to land areas to supply the water and nutrients needed for plants.

Isotope - A variation of an element that has the same atomic number but a different weight because of its neutrons. Various isotopes of the same element may have different radioactive behaviors.

Lagoon -
1. A shallow pond where sunlight, bacterial action, and oxygen work to purify wastewater; also used to store wastewaters or spent nuclear fuel rods.
2. Shallow body of water, often separated from the sea by coral reefs or sandbars.

Land Application - Discharge of wastewater onto the ground for treatment or reuse. (See: Irrigation)

Land Farming (of waste) - A disposal process in which hazardous waste deposited on or in the soil is naturally degraded by microbes.

Landfills -
1. Sanitary landfills are land disposal sites for nonhazardous solid wastes at which the waste is spread in layers, compacted to the smallest practical volume, and cover material applied at the end of each operating day.
2. Secure chemical landfills are disposal sites for hazardous waste. They are selected and designed to minimize the change of release of hazardous substances into the environment.

LC50/Lethal Concentration - Median level concentration, a standard measure of toxicity. It tells how much of a substance is needed to kill half of a group of experimental organisms at a specific time of observation (See: LD50).

LF D - The highest concentration of a toxic substance at which none of the test organisms die.

LD 50/ Lethal Dose - The dose of a toxicant that will kill 50 percent of the test organisms within a designated period of time. The lower the LD50, the more toxic the compound.

LD L0 - The lowest concentration and dosage of a toxic substance which kills test organisms.

Leachate - A liquid that results from water collecting contaminants as it trickles through wastes, agricultural pesticides or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, ground water, or soil.

Lead (Pb) - A heavy metal that is hazardous to health if breathed or swallowed. Its use in gasoline, paints, and plumbing compounds has been sharply restricted or eliminated by federal laws and regulations. (See: Heavy Metals)

Leaded Gasoline - Gasoline to which lead has been added to raise the octane level.

Level of Concern (LOC) - The concentration in air of an extremely hazardous substance above which there may be serious immediate health effects to anyone exposed to it for short periods of time.

Limnology - The study of the physical, chemical, meteorological, and biological aspects of fresh water.

Lower Explosive Limit (LEL) - The concentration of a compound in air below which a flame will not propagate if the mixture is ignited.

Lowest-Observed-Adverse-Effect Level (LOAEL) - In dose-response experiments, the experimental exposure level representing the lowest level tested at which adverse effects were demonstrated.

Marsh - A type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh or saltwater and tidal or nontidal. (See: Wetlands)

Maximum Contaminant Level (MCL) - The maximum permissible level of contaminant in water delivered to any user of a public water system. MCLs are enforceable standards.

Media - Specific environments—air, water, soil—which are the subject of regulatory concern and activities.

Mercury (Hg) - A heavy metal that can accumulate in the environment and is highly toxic if breathed or swallowed. (See: Heavy Metals)

Metabolite - Any substance produced in or by biological processes and derived from a pesticide.

Methane (CH 4) - A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds.

Microbes - Microscopic organisms such as algae, animals, viruses, bacteria, fungi, and protozoa, some of which cause diseases. (See: Microorganism)

Microorganism - Living organisms so small that individually they can usually only be seen through a microscope.

Mist - Liquid particle measuring 500 to 40 microns, that are formed by condensation of vapor. By comparison, "frog" particles are smaller than 40 microns.

Monoclonal Antibodies - (Also called MABs and MCAs) Molecules of living organisms that selectively find and attach to other molecules to which their structure conforms exactly. This could also apply to equivalent activity by chemical molecules.

Muck Soils - Earth made from decaying plant materials.

Mulch - A layer of material (wood chips, straw, leaves) placed around plants to hold moisture, prevent weed growth, protect the plants, and enrich the soil.

Mutagen - Any substance that can cause a change in genetic material.

Mutate - To bring about a change in the genetic constitution of a cell by altering its DNA. In turn, "mutagenesis" is any process by which cells are mutated.

Natural Gas - A natural fuel containing primarily methane and ethane that occurs in certain geologic formations.

Natural Selection - The process of survival of the fittest, by which organisms that adapt to their environment survive and those that do not disappear.

Necrosis - Death of plant or animal cells. In plants, necrosis can discolor areas on the plant or kill it entirely.

Nematocide - A chemical agent which is destructive to nematodes (round worms or threadworms).

Neutralization - Decreasing the acidity or alkalinity of a substance by adding to it alkaline or acidic materials respectively.

Nitrate - A compound containing nitrogen which can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and cows.

Nitric Oxide (NO) - A gas formed by combustion under high temperature and high pressure in an internal combustion engine. It changes into nitrogen dioxide in the ambient air and contributes to photochemical smog.

Nitrification - The process whereby ammonia in wastewater is oxidized to nitrite and then to nitrate by bacterial or chemical reactions.

Nitrilotriacetic Acid (NTA) - A compound being used to replace phosphates in detergents.

Nitrite -
1. An intermediate in the process of nitrification.
2. Nitrous oxide salts used in food preservation.

Nitrogen Dioxide (NO2) - The result of nitric oxide combining with oxygen in the atmosphere. A major component of photochemical smog.

Nitrogen Oxide (NOx) - Product of combustion from transportation and stationary sources and a major contributor to the formation of ozone in the troposphere and acid deposition.

No-Observed-Effect-Level - In dose-response experiments, the experimental exposure level representing the highest level tested at which no effects at all were demonstrated.

Non-ionizing Electromagnetic Radiation -
1. Radiation that does not change the structure of atoms but does heat tissue and may cause harmful biological effects.
2. Microwaves, radio waves, and low frequency electromagnetic fields from high voltage transmission lines.

Non-Observed-Adverse-Effect-Level (NOAEL) - In dose-response experiments, the experimental exposure level representing the highest level tested at which no adverse effects were demonstrated.

Non-Point Source - Pollution sources which are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by stormwater runoff. The commonly used categories for non-point sources are: agriculture, forestry, urban, mining, construction, dams and channels, land disposal, and salt water intrusion.

Nuclear Winter - Prediction by some scientists that smoke and debris rising from massive fires resulting from a nuclear war could enter the atmosphere and block out sunlight for weeks or months. The scientists making this prediction project a cooling of the Earth's surface, and changes in climate which could, for example, negatively effect world agriculture and weather patterns.

Nutrient - Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Oligotrophic Lakes - Deep clear lakes with low nutrient supplies. They contain little organic matter and have a high dissolved-oxygen level.

Opacity - The amount of light obscured by particulate pollution in the air; clear window glass has a zero opacity, a brick wall has 100 percent opacity. Opacity is used as an indicator of changes in performance of particulate matter pollution control systems.

Open Dump - An uncovered site used for disposal of waste without environmental controls . (See:Dump)

Organic -
1. referring to or derived from living organisms.
2. In chemistry, any compound containing carbon.

Organic Chemicals/Compounds - Animal or plant-produced substances containing mainly carbon, hydrogen, and oxygen.

Organic Matter - Carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

Organism - Any living thing.

Organophosphates - Pesticide chemicals that contain phosphorus; used to control insects. They are short-lived, but some can be toxic when first applied.

Organotins - Chemical compounds used in anti-foulant paints to protect the hulls of boats and ships, buoys, and dock pilings from marine organisms such as barnacles.

Osmosis - The tendency of a fluid to pass through a permeable membrane such as the wall of a living cell into a less concentrated solution so as to equalize the concentrations on both sides of the membrane.

Overburden - The rock and soil cleared away before mining.

Oxidation -
1. The addition of oxygen which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means.
2. Oxygen combining with other elements.
3. The process in chemistry whereby electrons are removed from a molecule.

Oxidation Pond - A man-made lake or body of water in which waste is consumed by bacteria. It is used most frequently with other waste-treatment processes. An oxidation pond is basically the same as a sewage lagoon.

Oxygenated Solvent - An organic solvent containing oxygen as part of the molecular structure. Alcohols and ketones are oxygenated compounds often used as paint solvents.

Ozone (03) - Found in two layers of the atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer beginning 7 to 10 miles above the earth's surface) ozone is a form of oxygen found naturally which provides a protective layer shielding the earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere (the layer extending up 7 to 10 miles from the earth's surface), ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system and is one of the most prevalent and widespread of all the criteria pollutants for which the Clean Air Act required EPA to set standards. Ozone in the troposphere is produced through complex chemical reactions of nitrogen oxides, which are among the primary pollutants emitted by combustion sources; hydrocarbons, released into the atmosphere through the combustion, handling and processing of petroleum products; and sunlight.

Ozone Depletion - Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to biological life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbons or halons) which break down when they reach the stratosphere and catalytically destroy ozone molecules.

Pandemic - Widespread throughout an area, nation or the world.

Paraquat - A standard herbicide used to kill various types of crops, including marijuana.

Particulate Loading - The mass of particulates per unit volume of air or water.

Particulates - Fine liquid or soil particles such as dust, smoke, mist, fumes, or smog, found in air or emissions.

Pathogens - Microorganisms that can cause disease in other organisms or in humans, animals and plants. They may be bacteria, viruses, or parasites and are found in sewage, in runoff from animal farms or rural areas populated with domestic and/or wild animals, and in water used for swimming. Fish and shellfish contaminated by pathogens, or the contaminated water itself, can cause serious illnesses.

PCBs - A group of toxic, persistent chemicals (polychlorinated biphenyls) used in transformers and capacitors for insulating purposes and in gas pipeline systems as a lubricant. Further sale of new use was banned by law in 1979.

Percolation - The movement of water downward and radially through the sub-surface soil layers, usually continuing downward to the ground water.

Permeability - The rate at which liquids pass through soil or other materials in a specified direction.

Persistence - Refers to the length of time a compound, once introduced into the environment, stays there. A compound may persist for less than a second or indefinitely.

Pest - An insect, rodent, nematode, fungus, weed or other form of terrestrial or aquatic plant or animal life or virus, bacterial or microorganism that is injurious to health or the environment.

Pesticide - Substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. Pesticides can accumulate in the food chain and/or contaminate the environment if misused.

Pesticide Tolerance - The amount of pesticide residue allowed by law to remain in or on the harvested crop. By using various safety factors, EPA sets these levels well below the point where the chemicals might be harmful to consumers.

pH - A measure of the acidity or alkalinity of a liquid or solid material.

Phenols - Organic compounds that are by-products of petroleum refining, tanning, and textile, dye, and resin manufacturing. Low concentrations cause taste and odor problems in water; higher concentrations can kill aquatic life and humans.

Pheromone - Hormonal chemical produced by female of a species to attract a mate.

Phosphorus (P) - An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies. Increased phosphorus levels result from discharge of phosphorus-containing materials into surface waters.

Photochemical Smog - Air pollution caused by chemical reactions.

Photosynthesis - The manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.

Phytoplankton - That portion of the plankton community comprised of tiny plants, e.g., algae, diatoms.

Phytotoxic - Something that harms plants.

Picocurie (pCi) - Measurement of radioactivity. A picocurie is one million millionth, or a trillionth of a curie, and represents about 2. 2 radioactive particle disintegrations per minute.

Picocuries Per Liter (pCi/L) - A unit of measure used for expressing levels of radon gas.
(See: Picocurie)

Plankton - Tiny plants and animals that live in water.

Plasmid - A circular piece of DNA that exists apart from the chromosome and replicates independently of it. Bacterial plasmids carry information that renders the bacteria resistant to antibiotics. Plasmids are often used in genetic engineering to carry desired genes into organisms.

Plastics - Non-metallic compounds that result from chemical reaction, and are molded or formed into rigid or pliable construction materials or fabrics.

Plume -
1. A visible or measurable discharge of a contaminant from a given point of origin. Can be visible or thermal in water, or visible in the air as, for example, a plume of smoke.
2. The area of measurable and potentially harmful radiation leaking from a damaged reactor.
3. The distance from a toxic release considered dangerous for those exposed to the leaking fumes.

Plutonium (Pu) - A radioactive metallic element similar chemically to uranium.

Point Source - A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Pollen -
1. A fine dust produced by plants.
2. The fertilizing element of flowering plants.
3. A natural or background air pollutant.

Pollution - Generally, the presence of matter or energy whose nature, location or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, and radiological integrity of water.

Polyelectrolytes - Synthetic chemicals that help solids to clump during sewage treatment.

Polymer - Basic molecular ingredients in plastic.

Polyvinyl Chloride (PVC) - A tough, environmentally indestructible plastic that releases hydrochloric acid when burned.

Population - A group of interbreeding organisms of the same kind occupying a particular space. Generally, the number of humans or other living creatures in a designated area.

Potable Water - Water that is safe for drinking and cooking.

PPM/PPB - Parts per million/parts per billion, a way of expressing tiny concentrations of pollutants in air, water, soil, human tissue, food, or other products.

Precipitation - Removal of solids from liquid waste so that the hazardous solid portion can be disposed of safely; removal of particles from airborne emissions.

Precursor - In photochemical terminology, a compound such as a volatile organic compound (VOC) that 'precedes' an oxidant. Precursors react in sunlight to form ozone or other photochemical oxidants.

Pretreatment - Processes used to reduce, eliminate, or alter the nature of wastewater pollutants from nondomestic sources before they are discharged into publicly owned treatment works.

Prevention - Measures taken to minimize the release of wastes to the environment.

Primary Drinking Water Regulation - Applies to public water systems and specifies a contaminant level, which, in the judgment of the EPA Administrator, will have no adverse effect on human health.

Primary Waste Treatment - First steps in wastewater treatment; screens and sedimentation tanks are used to remove most material that floats or will settle. Primary treatment results in the removal of about 30 percent of carbonaceous biochemical oxygen demand from domestic sewage.

Proteins - Complex nitrogenous organic compounds of high molecular weight that contain amino acids as their basic unit and are essential for growth and repair of animal tissue. Many proteins are enzymes.

Protoplast - A membrane bound cell from which the outer cell wall has been partially or completely removed. The term often is applied to plant cells.

Public Water System - A system that provides piped water for human consumption to at least 15 service connections or regularly serves 25 individuals.

Putrescible - Able to rot quickly enough to cause odors and attract flies.

Pyrolysis - Decomposition of a chemical by extreme heat.

Quantitation Limit - The lowest level at which a chemical may be accurately and reproducibly quantitated. Usually equal to the detection limit multiplied by a factor of 3 to 5, but varies between chemicals and between samples.

RAD (Radiation Absorbed Dose) - A unit of absorbed dose of radiation. One RAD of absorbed dose is equal to .01 joules per kilogram.

Radiation - Any form of energy propagated as rays, waves, or streams of energy particles. The term is frequently used in relation to the emission of rays from the nucleus of an atom.

Radiation Standards - Regulations that set maximum exposure limits for protection of the public from radioactive materials.

Radiobiology - The study of radiation effects on living things.

Radionuclide - Radioactive element characterized according to its atomic mass and atomic number which can be man-made or naturally occurring. Radioisotopes can have a long life as soil or water pollutants, and are believed to have potentially mutagenic effects on the human body.

Radius of Vulnerable Zone - The maximum distance from the point of release of a hazardous substance in which the airborne concentration could reach the level of concern under specified weather conditions.

Radon (Rn) - A colorless, naturally-occurring, radioactive, inert gaseous element formed by radioactive decay of radium atoms in soil or rocks.

Radon Decay Products - A term used to refer collectively to the immediate products of the radon decay chain. These include Po 218, Pb 214, Bi 214, and Po 214, which have an average combined half life of about 30 minutes.

Raw Sewage - Untreated wastewater.

Recharge Area - A land area in which water reaches to the zone of saturation from surface infiltration, e.g., an area where rainwater soaks through the earth to reach an aquifer.

Recombinant DNA (DNA) - The new DNA that is formed by combining pieces of DNA from different organisms or cells.

Recommended Maximum Contaminant Level (RMCL) - The maximum level of contaminant in drinking water at which no known or anticipated adverse affect on human health would occur, and which includes an adequate margin of safety. Recommended levels are nonenforceable health goals. (See: Maximum Contaminant Level)

Recycle/Reuse - The process of minimizing the generation of waste by recovering usable products that might otherwise become waste. Examples are the recycling of aluminum cans, wastepaper, and bottles.

Red Tide - A proliferation of a marine plankton that is toxic and often fatal to fish. This natural phenomenon may be stimulated by the addition of nutrients. A tide can be called red, green or brown, depending on the coloration of the plankton.

Reference Dose (RfD) - Toxicity value used most often in evaluating noncarcinogenic effects resulting from exposures at Superfund sites.

Registration - Formal listing with EPA of a new pesticide before it can be sold or distributed in intra- or interstate commerce. The product must be registered under the Federal Insecticide, Fungicide, and Rodenticide Act. EPA is responsible for registration (pre-market licensing) of pesticides on the basis of data demonstrating that they will not cause unreasonable adverse effects on human health or the environment when used according to approved label directions.

REM (Roentgen Equivalent Man) - The unit of dose equivalent from ionizing radiation to the human body, used to measure the amount of radiation to which a person or a part of a human has been exposed.

Reportable Quantity (RQ) - The quantity of a hazardous substance that triggers reports under Superfund. If a substance is released in amounts exceeding its RQ, the release must be reported to the National Response Center.

Resource - A person, thing, or action needed for living or to improve the quality of life.

Restriction Enzymes - Enzymes that recognize certain specific regions of a long DNA molecule and then cut the DNA into smaller pieces.

Ribonucleic Acid (RNA) - A molecule that carries the genetic message from DNA to a cell's protein producing mechanisms; similar to, but chemically different from, DNA.

Ringlemann Chart - A series of shaded illustrations used to measure the opacity of air pollution emissions. The chart ranges from light gray through black and is used to set and enforce emissions standards.

Riparian Habitat - Areas adjacent to rivers and streams that have a high density, diversity, and productivity of plant and animal species relative to nearby uplands.

River Basin - The land area drained by a river and its tributaries.

Rodenticide - A chemical or agent used to destroy rats or other rodent pests, or to prevent them from damaging food and crops.

Rubbish - Solid waste, excluding food waste and ashes, from homes, institutions, and work-places.

Run-Off - That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surfacewater. It can carry pollutants from the air and land into the receiving waters.

Salinity - The degree of salt in water.

Salt Water Intrusion - The invasion of fresh surface or ground water by salt water. If the salt water comes from the ocean, it may be called sea water intrusion.

Salts - Minerals that water picks up as it passes through the air, over and under the ground, and as it is used by households and industry.

Salvage - The utilization of waste materials.

Sanitary Sewer - Underground pipes that carry off only domestic or industrial waste, not storm water.

Reportable Quantity (RQ) - The quantity of a hazardous substance that triggers reports under CERCLA. If a substance is released in amounts exceeding its RQ, the release must be reported to the National Resource Center, the state, and community emergency coordinators for areas likely to be affected.

Sanitation - Control of physical factors in the human environment that could harm development, health or survival.

Saturated Zone - A subsurface area in which all pores and cracks are filled with water under pressure equal to or greater than that of the atmosphere.

Scrubber - An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Secondary Treatment - The second step in most publicly owned waste treatment systems in which bacteria consume the organic parts of the waste. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settled solids and about 90 percent of the oxygen demanding substances and suspended solids. Disinfection is the final stage of secondary treatment (See: Primary, Tertiary Treatment).

Sedimentation - Letting solids settle out of wastewater by gravity during wastewater treatment.

Sediments - Soil, sand, and minerals washed from land into water usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish-nesting areas and holes of water animals, and clouding the water so that needed sunlight might not reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to be washed off the land after rainfalls.

Semi-Confined Aquifer - An aquifer that is partially confined by a soil layer (or layers) of low permeability through which recharge and discharge can occur.

Senescence - Term for the aging process. Sometimes used to describe lakes or other bodies of water in advanced stages of eutrophication.

Septic Tank - An underground storage tank for wastes from homes having no sewage line to a treatment plant. The waste goes directly from the home to the tank, where the organic waste is decomposed by bacteria and the sludge settles to the bottom. The effluent flows out of the tank into the ground through drains; the sludge is pumped out periodically.

Sewage - The waste and wastewater produced by residential and commercial establishments and discarded into sewers.

Sewer - A channel or conduit that carries wastewater and stormwater runoff from the source of a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers are used for both purposes.

Silt - Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment.

Sludge - A semi-solid residue from any of a number of air or water treatment processes. Sludge can be a hazardous waste.

Slurry - A watery mixture of insoluble matter that results from some pollution control techniques.

Smelter - A facility that melts or fuses ore, often with an accompanying chemical change, to separate the metal. Emissions are known to cause pollution. Smelting is the process involved.

Smog - Air pollution associated with oxidants. (See: Photochemical Smog)

Smoke - Particles suspended in air after incomplete combustion of materials.

Soft Water - Any water that is not "hard," i.e., does not contain a significant amount of dissolved minerals such as salts containing calcium or magnesium.

Sole Source Aquifer - An aquifer that supplies 50 percent or more of the drinking water of an area.

Solid Waste - Nonliquid, nonsoluble materials ranging from municipal garbage to industrial wastes that contain complex, and sometimes hazardous, substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid waste also refers to liquids and gases in containers.

Solvent - Substance (usually liquid) capable of dissolving or dispersing one or more other substances.

Soot - Carbon dust formed by incomplete combustion.

Sorption - The action of soaking up or attracting substances. A process used in many pollution control systems.

Species - A reproductively isolated aggregate of interbreeding populations of organisms.

Spoil - Dirt or rock that has been removed from its original location, destroying the composition of the soil in the process, as with strip mining or dredging.

Stabilization - Conversion of the active organic matter in sludge into inert, harmless material.

Stable Air - A mass of air that is not moving normally, so that it holds rather than disperses pollutants.

Stack - A chimney or smokestack; a vertical pipe that discharges used air.

Stack Effect - Used air, as in a chimney, that moves upward because it is warmer than the surrounding atmosphere.

Stagnation - Lack of motion in a mass of air or water, which tends to hold pollutants.

Standards - Prescriptive norms which govern action and actual limits on the amount of pollutants or emissions produced. EPA, under most of its responsibilities, establishes minimum standards. States are allowed to be more strict.

Sterilization -
1. In pest control, the use of radiation and chemicals to damage body cells needed for reproduction.
2. The destruction of all living organisms in water or on the surface of various materials. In contrast, disinfection is the destruction of most living organisms in water or on surfaces.

Storage - Temporary holding of waste pending treatment or disposal. Storage methods include containers, tanks, waste piles, and surface impoundments.

Storm Sewer - A system of pipes (separate from sanitary sewers) that carry only water runoff from building and land surfaces.

Stratification - Separating into layers.

Stratosphere - The portion of the atmosphere that is 10 to 25 miles above the Earth's surface.

Strip-Cropping - Growing crops in a systematic arrangement of strips or bands which serve as barriers to wind and water erosion.

Strip-Mining - A process that uses machines to scrape soil or rock away from mineral deposits just under the Earth's surface.

Sulfur Dioxide (S02) - A heavy, pungent, colorless, gaseous air pollutant formed primarily by the combustion of fossil plants.

Surface Impoundment - Treatment, storage, or disposal of liquid hazardous wastes in ponds.

Surface Water - All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries) and all springs, wells or other collectors which are directly influenced by surface water.

Surfactant - A surface-active agent used in detergents to cause lathering.

Suspended Solids - Small particles of solid pollutants that float on the surface of or are suspended in sewage or other liquids. They resist removal by conventional means. (See: Total Suspended Solids)

Swamp - A type of wetland that is dominated by woody vegetation and does not accumulate appreciable peat deposits. Swamps may be fresh or salt water and tidal or nontidal. (See: Wetlands)

Synergism - The cooperative interaction of two or more chemicals or other phenomena producing a greater total effect than the sum of their individual effects.

Synthetic Organic Chemicals (SOCs) - Man-made organic chemicals. Some SOCs are volatile, others tend to stay dissolved in water rather than evaporate out of it.

Systemic Pesticide - A chemical that is taken up from the ground or absorbed through the surface and carried through the system of the organism being protected, making the organism toxic to pests.

Tailings - Residue of raw materials or waste separated out during the processing of crops or mineral ores.

Teratogen - Substance that causes malformation or serious deviation from normal development of embryos and fetuses.

Terracing - Diking, build along the contour of sloping agricultural land, that holds runoff and sediment to reduce erosion.

Tertiary Treatment - Advanced cleaning of wastewater that goes beyond the secondary or biological stage. It removes nutrients such as phosphorus and nitrogen and most suspended solids.

Thermal Pollution - Discharge of heated water from industrial processes that can affect the life processes of aquatic organisms.

Threshold Limit Value (TLV) - Represents the air concentrations of chemical substances to which it is believed that workers may be daily exposed without adverse effect.

Tidal Marsh - Low, flat marshlands traversed by channels and tidal hollows and subject to tidal inundation; normally, the only vegetation present are salt-tolerant bushes and grasses. (See: Wetlands)

Total Suspended Solids (TSS) - A measure of the suspended solids in wastewater, effluent, or water bodies, determined by using tests for "total suspended non-filterable solids". (See: Suspended Solids)

Toxic - Harmful to living organisms.

Toxic Cloud - Airborne mass of gases, vapors, fumes, or aerosols containing toxic materials.

Toxic Pollutants - Materials contaminating the environment that cause death, disease, birth defects in organisms that ingest or absorb them. The quantities and length of exposure necessary to cause these effects can vary widely.

Toxic Substance - A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Toxicant - A poisonous agent that kills or injures animal or plant life.

Toxicity - The degree of danger posed by a substance to animal or plant life. (See: Acute, Chronic Toxicity)

Toxicology - The science and study of poisons control.

Transpiration - The process by which water vapor is lost to the atmosphere from living plants. The term can also be applied to the quantity of water thus dissipated.

Trash-to-Energy Plan - A plan for putting waste back to work by burning trash to produce energy.

Trichloroethylene (TCE) - A stable, low boiling, colorless liquid, toxic by inhalation. TCE is used as a solvent, metal degreasing agent, and in other industrial applications.

Trihalomethane (THM) - One of a family of organic compounds, named as derivatives of methane. THMs are generally the by-product from chlorination of drinking water that contains an organic material.

Troposphere - The lower atmosphere, the portion of the atmosphere between seven and ten miles from the Earth's surface where clouds are formed.

Tundra - A type of ecosystem dominated by lichens, mosses, grasses, and woody plants. Tundra is found at high latitudes (arctic tundra) and high altitudes (alpine tundra). Arctic tundra is underlain by permafrost and is usually very wet. (See: Wetlands)

Ultraviolet Rays - Radiation from the sun that can be useful or potentially harmful. UV rays from one part of the spectrum enhance plant life and are useful in some medical and dental procedures; UV rays from other parts of the spectrum to which humans are exposed , e.g., while getting a suntan, can cause skin cancer or other tissue damage. The ozone layer in the atmosphere provides a protective shield -- limits the amount of ultraviolet rays that reach the Earth's surface.

Unsaturated Zone - The area above the water table where the soil pores are not fully saturated, although some water may be present.

Urban Runoff - Stormwater from city streets and adjacent domestic or commercial properties that may carry pollutants of various kinds into the sewer systems and/or receiving waters.

Vaporization - The change of a substance from a liquid to a gas.

Vector -
1. An organism, often an insect or rodent, that carries disease.
2. An object that is used to transport genes into a host cell (vector can be plasmids, viruses, or other bacteria). A gene is placed in the vector, the vector then "infects" the bacterium.

Vinyl Chloride - A chemical compound, used in producing some plastics, that is believed to be carcinogenic.

Virus - The smallest form of microorganisms capable of causing disease.

Volatile - Description of any substance that evaporates readily.

Volatile Organic Compound (VOC) - Any compound containing carbon and hydrogen or containing carbon and hydrogen in combination with any other element which has a vapor pressure of 1.5 pounds per square inch absolute (77.6 mm. Hq) or greater under actual storage conditions.

Waste -
1. Unwanted materials left over from a manufacturing process.
2. Refuse from places of human or animal habitation.

Wastewater - The spent or used water from individual homes, a community, a farm, or an industry that contains dissolved or suspended matter.

Water Pollution - The presence in water of enough harmful or objectionable material to damage the water's quality.

Water Quality Criteria - Specific levels of water quality which, if reached, are expected to render a body of water suitable for its designated use. The criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water Quality Standards - State-adopted and EPA-approved ambient standards for water bodies. The standards cover the use of the water body and the water quality criteria which must be met to protect the designated use or uses.

Water Solubility - The maximum concentration of a chemical compound which can result when it is dissolved in water. If a substance is water soluble, it can very readily disperse through the environment.

Water Table - The level of ground water.

Watershed - The land area that drains into a stream.

Well - A bored, drilled, or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground.

Wetlands - An area that is regularly saturated by surface or ground water and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include: swamps, bogs, fens, marshes, and estuaries.

Wildlife Refuge - An area as designated for the protection of wild animals, within which hunting and fishing are either prohibited or strictly controlled.

Working Level (WL) - A unit of measure for documenting exposure to radon decay products. One working level is equal to approximately 200 picocuries per liter.

Working Level Month (WLM) - A unit of measure used to determine cumulative exposure to radon.

Xenobiotic - Term for nonnaturally occurring man-made substances found in the environment, i.e., synthetic material solvents, plastics.

Zooplankton - Tiny aquatic animals eaten by fish.

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Notes

EPA Resources

U.S. Environmenttal Protection Agency
Region 7

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Region 7, U.S. Environmental Protection Agency (EPA), is responsible for environmental activities in Missouri, Kansas, Iowa and Nebraska. EPA was established as a regulatory agency under a Presidential Executive Order in 1970 to protect human health and the environment. The Agency enforces nine major environmental laws passed by Congress to protect air, water and soil from contamination. The Agency is also spearheading a global movement for joint cooperation between all nations to protect and preserve our earth's ecological systems.

EPA is keenly aware of the importance of our nation's youth in determining the futue of environmental progress and has developed a two-tier program to recognize those young people who have been involved in environmental projects. The annual President's Environmental Youth Awards Program (PEYA) is a non-competitive program for students K-12. The PEYA National Awards Competition is competitive and winners receive a free trip to Washington, D.C. to attend the awards ceremony.

Educational Resources

Services	K-6	Junior High	High School	College/ Civic
Speakers	❑	❑	❑	❑
Chipmunk Visits	❑			
Audiovisuals	❑	❑	❑	❑
Publications	❑	❑	❑	❑
Field Trip (tours)	❑	❑	❑	❑
Tech. Assist.		❑	❑	❑
Classes/Programs	❑	❑	❑	❑

Categories				
Air Pollution	❑	❑	❑	❑
Asbestos		❑	❑	❑
Hazardous Waste		❑	❑	❑
Pesticides	❑	❑	❑	❑
Radon		❑	❑	❑
Recycling	❑	❑	❑	❑
Solid Waste	❑	❑	❑	❑
Water Pollution	❑	❑	❑	❑
Wetlands	❑	❑	❑	❑