



Chapter 22

Solid and Hazardous Waste



“It’s A Small World After All”

Outline

Wasting Resources

Solid waste is another kind of resource; the United States is not utilizing this resource well. The affluence of the United States is reflected in the fact that less than 4.6% of the world’s population produces 33% of the world’s solid waste.

- A. Solid waste is unwanted/discarded material that is not liquid/gaseous.
 - 1. For the most part, goods and services produce this waste indirectly.
 - 2. Municipal solid waste (garbage/trash) comes mostly from homes and workplaces.
- B. Solid waste is a sign of a society’s waste of its resources: aluminum, tires, disposable diapers, e-waste, plastic bottles, edible food, etc. Electronic waste (e-waste) is the fastest growing type of solid waste.

Integrated Waste Management

- A. One method to reduce waste and pollution is to implement waste management. This high-waste approach accepts waste production as a result of economic growth.
 - 1. It attempts to reduce environmental harm.
 - 2. It transfers the waste from one part of the environment to another.
- B. One method is waste reduction. This low-waste approach sees solid waste as a potential resource, which should be reused, recycled, or composted.
 - 1. It discourages waste production in the first place.
 - 2. It encourages waste reduction and prevention.
 - 3. Waste reduction saves matter and energy resources, reduces pollution, helps protect biodiversity, and saves money.
 - 4. Waste reduction is based on the five Rs:
 - a. Refuse
 - b. Reduce
 - c. Reuse
 - d. Repurpose
 - e. Recycle
- C. To cut waste production and promote sustainability, we must reduce consumption and redesign our products. These are the eight priorities based on the five Rs.
 - 1. Consume less.
 - 2. Redesign manufacturing processes and products to use less material and energy.
 - 3. Redesign manufacturing processes to produce less waste and pollution.
 - 4. Develop products which are easily repaired, reused, remanufactured, composted, or recycled.
 - 5. Shift from selling goods to selling or leasing the services they provide.
 - 6. Eliminate or reduce unnecessary packaging.
 - 7. Fee-per-bag system of waste collection
 - 8. Cradle to grave responsibility

Reuse

Reusing products helps reduce resource use, waste and pollution; it also saves money.

- A. Developing countries reuse their products; but there is a health hazard for the poor.
- B. U. S. e-waste goes to developing countries where workers are exposed to toxic metals, dioxins, etc.
- C. Large city dumps expose scavengers to toxins and infectious diseases.
- D. Refillable containers create jobs, costs less for the product, and lessen waste.
- E. Shopping bags, food containers, pallets, and tools can be reused/borrowed.

Recycling

Recycling collects waste materials, turns them into useful products, and sells the new products.

- A. Recycling is one of two types--it involves reprocessing discarded solid materials into new, useful products; secondary recycling involves converting materials into different products.

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- B. Five types of materials can be recycled: paper products, glass, aluminum, steel, and some plastics.
- C. Recycling saves money and creates jobs, more than burning or land filling wastes.
- D. Pre-consumer/internal waste is generated from a manufacturing process that is recycled. Post-consumer/external waste is generated by consumer use of products.
- E. Composting biodegradable organic wastes is a great way to mimic nature.
- F. Solid waste recycling can be done in a materials-recovery facility (MRF). Machines shred and separate the mixed waste and sell raw materials to manufacturers. The wastes are recycled and/or burned to produce energy; but such plants are expensive. They, also, must process a large input of garbage.
- G. Source Separation recycling relies on households and businesses to separate their trash; these are collected and sold to other dealers.
 - 1. This produces less air and water pollution.
 - 2. This method has less startup costs and operating costs.
 - 3. It saves more energy and provides more jobs than MRFs.
 - 4. Pay-as-you-throw (PAUT) waste collection systems charge for the mixed waste that is picked up but not for the recycled, separated materials.
- H. Plastic recycling is not feasible because of these problems.
 - 1. Plastics are difficult to isolate in different materials.
 - 2. Not much individual plastic resin is recoverable per product.
 - 3. Recycled resin is much more expensive than virgin plastic resin.
- I. A new polymer, polyactide (ACT), made by Cargill and Dow is being used to produce plastic containers, which can be composted for a soil conditioner.
- J. The economics of recycling depends on the cost one counts.
 - 1. The economic, environmental, and health benefits far outweigh the costs of recycling.
 - 2. But some materials cost more than it is worth.
- K. Factors, which hinder reuse and recycling, are:
 - 1. The cost of a product does not include harmful environmental health costs in its life cycle.
 - 2. Resource-extracting industries receive government tax breaks and subsidies while recycle and reuse industries do not.
 - 3. Landfill charges are low in the U.S.
 - 4. The demand and price for recycled materials fluctuates so there is less interest in committing to this method.
- L. There are tradeoffs in recycling--both advantages and disadvantages to recycling solid waste.

Burning and Burying Solid Waste

- A. Municipal solid waste is burned in waste-to-energy incinerators, which produces steam for heating or producing electricity.
- B. The advantages and disadvantages of burning solid waste are: (given in Figure 24-13)
 - 1. High operating costs
 - 2. Air pollution concerns
 - 3. Citizen opposition to the process
- C. Most solid waste is buried in landfills, which will leak toxic liquids into the soil and water.
 - 1. Open dumps in the ground hold garbage; sometimes it is covered with dirt.
 - 2. Sanitary landfills spread the solid waste out in thin layers, compact it, and cover it daily with clay/plastic foam. Modern landfills line the bottom with an impermeable liner, which collects leachate; rainwater is contaminated as it percolates through the solid waste. The leachate is collected, stored in tanks and then sent to a sewage treatment plant. But all landfills will eventually leak contaminants.
- D. There is a difficult dilemma in dealing with the more than 800 million used tires that have accumulated in large dumps and vacant lots and the approximately 273 million more tires discarded each year
 - 1. Tires and negative health and environmental effects
 - 2. There are several methods being used to reuse and recycle used tires.

Hazardous Waste

Hazardous waste is discarded solid or liquid material that may explode and/or release toxic fumes.

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The two largest classes of hazardous wastes are organic compounds (such as pesticides, PCBs and dioxins) and toxic heavy metals (such as lead, mercury and arsenic)

- A. The Resource Conservation and Recovery Act (RCRA) regulates about 5% of the U.S. hazardous waste.
- B. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund program) was passed in 1980.
 - 1. The law identifies hazardous waste sites
 - 2. The law provides for clean-up of these sites on a priority basis.
 - 3. The worst sites go on a National Priorities List (NPL) and are scheduled for total cleanup.
 - 4. There are, also, laws that provide for cleaning up brown fields, abandoned sites contaminated with hazardous wastes like factories, gas stations, junkyards, etc.
- C. Chemical and biological methods can be used to reduce the toxicity of hazardous wastes or to remove them.
 - 1. Treatment facilities can detoxify hazardous and toxic wastes.
 - 2. One biological treatment, bioremediation, uses bacteria and enzymes to help destroy hazardous or toxic substances. They are converted to harmless compounds in the process.
 - 3. Phytoremediation uses natural or genetically engineered plants to absorb, filter and remove contaminants from polluted water and soil. The advantages and disadvantages of phytoremediation are: (Figure 22-17)
- D. Hazardous waste regulation in the United States.
 - 1. Both the Resource Conservation and Recovery Act and the Superfund Act were supported to deal with hazardous wastes.
 - 2. Brownfields are contaminated industrial/commercial sites.

Dealing With Hazardous Waste

- A. An Integrated Management of Hazardous Waste involves producing less and then recycling, reusing, detoxifying, burnings and buying what is produced
- B. Physical, chemical, and biological methods and incineration and the plasma torch can be used to remove hazardous wastes or reduce their toxicity
- C. Deep-well disposal pumps liquid hazardous waste into dry, porous geologic formations far beneath water sources. Many scientists believe current regulations for deep-well disposal are inadequate.
- D. Surface impoundments are depressions excavated into the earth, like ponds, pits or lagoons, which are used to store liquid hazardous wastes. With evaporation, the wastes settle and become more concentrated. EPA studies found this method inadequate.
- E. In secure hazardous waste landfills, liquid and solid hazardous waste are stored in drums or other containers and buried. Carefully designed aboveground buildings can be used to store hazardous waste; the waste is contained in the upper floor; on the lower floor, leaks can, then, be easily identified.
- F. All of these methods have disadvantages and advantages and their ability to protect groundwater is probably limited.

Toxic Lead and Mercury

- A. Lead is a toxic metal and poses environmental threats in many countries, especially to the nervous systems of children.
 - 1. Lead poisoning can produce palsy, partial paralysis, blindness, mental retardation, hyperactivity, hearing damage, and behavioral disorders. Such poisoning is a risk in many places of the world.
 - 2. Methods to protect children from lead poisoning include: (figure 24-25).
- B. Mercury is released through burning coal and incineration of wastes.
 - 1. Mercury can be found in high levels in some types of fish.
 - 2. In the US up to 300,00 babies born each year are in risk of cerebral palsy, delayed onset of walking and talking, learning disabilities, loss of memory, and impaired coordination due to exposure to methylmercury while still in the womb.
 - 3. Methods of preventing mercury poisoning include: (figure 24-27).

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Achieving a Low-Waste Society

Environmental injustice has been practiced by placing hazardous treatment plants, incinerators, and landfills in communities populated by minority populations in the United States.

- A. Opposition to such has grown so that local, grass-root groups have successfully opposed the construction of such facilities. Health risks for people living near these facilities are much higher than for the general population.
- B. Environmental Justice means that every person is entitled to protection from environmental hazards regardless of race, gender, age, national origin income, social class or any other factors
- C. In 2000, a global treaty to control twelve persistent organic pollutants (POPs) was developed. To be made effective, fifty countries must ratify the treaty.
 - 1. POPs are toxic chemicals stored in the fatty tissue of humans and other organisms.
 - 2. Twelve chemicals, the dirty dozen, need to be phased out, detoxified and/or isolated.
- D. There are four principles for transitioning to a low-waste society:
 - 1. Everything is connected.
 - 2. There is no place to send wastes “away.”
 - 3. Diluting waste is not the solution to pollution.
 - 4. The best solution is to prevent waste and pollution and, then, reuse/recycle the materials that we use.
 - 5. It is necessary to detoxify the US economy.

Summary

- 1. Solid waste is any unwanted or discarded material that is not a liquid or a gas. Thirty-three percent of the world’s solid waste is produced by one country – the United States – which represents 4.6% of the world’s population.
- 2. Waste management, waste reduction, reduced usage and pollution prevention can all be used to reduce, reuse, or recycle solid waste.
- 3. The advantages of burning waste include reduction of trash volume, minimizing the need for landfills, and lowering water pollution. The disadvantages include high cost, air pollution, producing toxic ash, and encouraging waste production. The advantages of burying wastes include safety, wastes can be retrieved, ease of application, and low cost. Disadvantages include leaks and spills, existing fractures or earthquakes can cause waste escape, and encouraging waste production.
- 4. Hazardous waste is any discarded solid or liquid material that is toxic, ignitable, corrosive, or reactive enough to explode or release toxic fumes. We can use a pollution prevention or waste reduction approach to reduce production and manage existing hazardous waste mostly by burning or burying it.
- 5. Physical methods such as filtering and distilling, chemical reactions, bioremediation, phytoremediation, and plasma torches can all be used to detoxify hazardous waste.
- 6. Advantages of burning hazardous waste include reduction of waste volume, minimizing the need for storage space and lowering water pollution. The disadvantages include air pollutants such as toxic dioxins and production of toxic ash that must be stored. Advantages of burying hazardous waste include safety, wastes can be retrieved, ease of application, and low cost. Disadvantages include leaks and spills, existing fractures or earthquakes can cause waste escape, and encouraging waste production.
- 7. We can prevent lead poisoning through reduces use of lead gasoline and waste incineration, testing blood by age 1, and by banning lead solder, glazing, and candles containing lead. Mercury pollution can be prevented by reducing waste incineration, removing mercury from coal, using natural gas in the place of coal, and phasing out use of mercury in all products unless they are recycled. Dioxin pollution can be prevented by reducing waste incineration, banning the use of chlorine for bleaching paper, eliminating chlorinated hydrocarbon compounds burned in iron ore sintering plants and cement kilns, and testing of livestock forage and feed.

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8. The United States regulates hazardous waste through the 1976 *Resource Conservation and Recovery Act* that was amended in 1984.
9. Transition to a more sustainable low-waste society involves preventing the building of new incinerators, landfills, and treatment plants, as well as a focus on pollution prevention and the use of the precautionary principle.

Objectives

1. State the percentage of the world's solid wastes that is produced by the United States. State the percentage of solid waste produced in the United States that is municipal solid waste. Define *hazardous waste*. State the percentage of hazardous waste that is not regulated. List seven substances that are "linguistically detoxified."
2. Compare waste management and pollution prevention approaches to solid and hazardous waste. List the hierarchy of goals for a low-waste approach. Evaluate which approach makes the most sense to you. Give reasons for your choice. List seven ways to reduce waste and pollution. List four goals of an ecoindustrial revolution.
3. List reuse strategies for refillable containers, grocery bags, and tires. Compare the costs and benefits of disposable vs. cloth diapers. Define *compost*. Analyze the impact that widespread use of composting would have in the United States.
4. Describe each of the elements and priorities in an Integrated Waste Management system.
5. Discuss the variety of environmental management methods to deal with solid waste and describe the attributes and drawbacks of each of these methods.
6. Summarize Denmark's experience with detoxification of hazardous waste. Assess the pros and cons of incineration of hazardous and solid wastes. Compare U.S. incinerators with the Japanese fluidized-bed incinerators.
7. Describe a modern sanitary landfill. Summarize the benefits and drawbacks of burying solid wastes in sanitary landfills. Summarize the benefits and drawbacks of deep-well disposal of hazardous wastes. Summarize the status of export of wastes. Summarize the causes, effects, and ways to deal with lead, dioxins, and chlorine.
8. Name and briefly describe two U.S. hazardous-waste laws. Describe how Superfund has been subverted and how its enforcement can be improved.
9. Summarize the goals of the ecojustice movement. Visualize a low-waste society. Describe the pieces that will form the framework and fill in this picture.

Key Terms (**Terms are listed in the same font style as they appear in the text.**)

<i>Basal Convention</i> (p. 544) biological methods (p. 537) <i>bioplastic</i> (p. 528) <i>bioremediation</i> (p. 537) <i>brownfields</i> (p. 535) chemical methods (p. 536) <i>composting</i> (p. 527) <i>Comprehensive Environmental Response, Compensation, and Liability Act</i> (p. 535)	<i>cradle-to-grave responsibility</i> (p. 534) <i>cyclodextrin</i> (p. 536) <i>deep-well disposal</i> (p. 539) <i>dioxins</i> (p. 522) <i>dirty dozen</i> (p. 545) <i>electronic waste</i> (p. 522) environmental justice (p. 543) <i>environmental justice movement</i> (p. 544) <i>fee-per-bag</i> (p. 524, 529)
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<i>garbage</i> (p. 520) hazardous (toxic) waste (p. 520) hazardous waste (p. 533) <i>high-waste approach</i> (p. 523) <i>industrial solid waste</i> (p. 520) integrated waste management (p. 523) <i>low-waste approach</i> (p. 523) <i>materials-recovery facilities (MRFs)</i> (527) municipal solid waste (p. 520) <i>National Priorities List (NPL)</i> (p. 535) <i>nonomagnets</i> (p. 536) open dumps (p. 531) <i>pay-as-you-throw (PAUT)</i> (p. 527) <i>persistent organic pollutants (POPs)</i> (p. 544) physical methods (p. 536) phytodegradation (p. 537) phytoextraction (p. 537) <i>phytoremediation</i> (p. 537) phytostabilization (p. 537) <i>plasma torch</i> (p. 538) <i>pollution prevention</i> (p. 536) <i>post-consumer wastes</i> (p. 527) <i>precautionary principle</i> (p. 545) <i>preconsumer waste</i> (p. 527)	<i>primary (closed-loop) recycling</i> (p. 527) recycle (p. 524) reduce (p. 524) refuse (p. 524) repurpose (p. 524) reuse (p. 524) <i>recycling</i> (p. 526) Resource Conservation and Recovery Act (RCRA) (p. 534) rhizofiltration (p. 537) <i>resource containers</i> (p. 523) sanitary landfills (p. 531) <i>secondary recycling (downcycling)</i> (p. 527) <i>secure hazardous-waste landfills</i> (p. 540) solid waste (p. 520) <i>source separation</i> (p. 527) <i>Superfund</i> program (p. 535) <i>surface impoundments</i> (p. 539) <i>throughput</i> (p. 527) <i>trash</i> (p. 520) <i>waste management</i> (p. 523) <i>waste reduction</i> (p. 523) <i>waste-to-energy incinerators</i> (p. 530)
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