

Solid and Hazardous Waste

Chapter 21

21-1 What Are Solid Waste and Hazardous Waste, and Why Are They Problems?

▪ **Concept 21-1** *Solid waste represents pollution and unnecessary waste of resources, and hazardous waste contributes to pollution, natural capital degradation, health problems, and premature deaths.*

We Throw Away Huge Amounts of Useful Things and Hazardous Materials (1)

▪ **Solid waste**

- Industrial solid
- Municipal solid waste (MSW)
- Hazardous, toxic, waste

▪ Hazardous wastes

- Organic compounds
- Toxic heavy metals
- Radioactive waste

We Throw Away Huge Amounts of Useful Things and Hazardous Materials (2)

- 80–90% of hazardous wastes produced by developed countries
- Why reduce solid wastes?
 - ¾ of the materials are an unnecessary waste of the earth's resources
 - Huge amounts of air pollution, greenhouse gases, and water pollution

What Harmful Chemicals Are in Your Home?

What Harmful Chemicals Are in Your Home?

Cleaning <ul style="list-style-type: none">■ Disinfectants■ Drain, toilet, and window cleaners■ Spot removers■ Septic tank cleaners		Gardening <ul style="list-style-type: none">■ Pesticides■ Weed killers■ Ant and rodent killers■ Flea powders
Paint Products <ul style="list-style-type: none">■ Paints, stains, varnishes, and lacquers■ Paint thinners, solvents, and strippers■ Wood preservatives■ Artist paints and inks		Automotive <ul style="list-style-type: none">■ Gasoline■ Used motor oil■ Antifreeze■ Battery acid■ Brake and transmission fluid
General <ul style="list-style-type: none">■ Dry-cell batteries (mercury and cadmium)■ Glues and cements		

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Natural Capital Degradation: Solid Wastes Polluting a River in Indonesia



Solid Waste in the United States

- Leader in solid waste problem
 - What is thrown away?
- Leader in trash production, by weight, per person
- Recycling is helping

Hundreds of Millions of Discarded Tires in a Dump in Colorado, U.S.

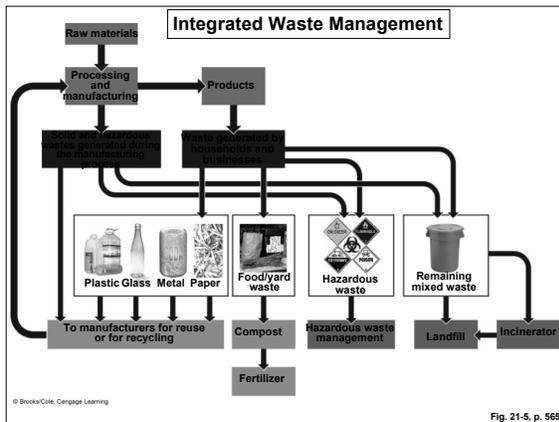


21-2 How Should We Deal with Solid Waste?

- **Concept 21-2** A sustainable approach to solid waste is first to reduce it, then to reuse or recycle it, and finally to safely dispose of what is left.

We Can Burn or Bury Solid Waste or Produce Less of It

- Waste Management
- Waste Reduction
- Integrated waste management
 - Uses a variety of strategies (Fig. 21-5)



Priorities for Dealing With Solid Waste



We Can Cut Solid Wastes by Reducing, Reusing, and Recycling (1)

- Waste reduction is based on
 - Reduce
 - Reuse
 - Recycle
- Seven strategies:
 - (1) Redesign manufacturing processes and products to use less material and energy
 - (2) Redesign manufacturing processes to produce less waste and pollution

We Can Cut Solid Wastes by Reducing, Reusing, and Recycling (2)

- Seven strategies cont...
 - (3) Develop products that are easy to repair, reuse, remanufacture, compost, or recycle
 - (4) Eliminate or reduce unnecessary packaging
 - (5) Use fee-per-bag waste collection systems
 - (6) Establish cradle-to grave responsibility
 - (7) Restructure urban transportation systems

WHAT CAN YOU DO?
Solid Waste

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Fig. 21-7, p. 566

21-3 Why Is Reusing and Recycling Materials So Important?

- **Concept 21-3** Reusing items decreases the use of matter and energy resources and reduces pollution and natural capital degradation; recycling does so to a lesser degree.

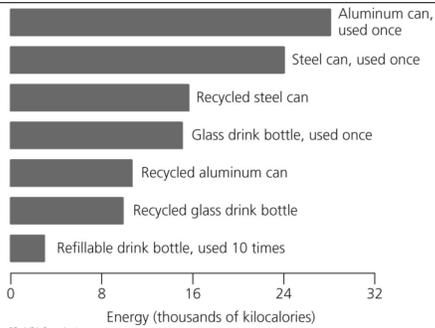
Reuse: Important Way to Reduce Solid Waste, Pollution and to Save Money

- Reuse: clean and use materials over and over
- Downside of reuse in developing countries
- Salvaging automobiles parts
- Rechargeable batteries

Case Study: Use of Refillable Containers

- Reuse and recycle
 - Refillable glass beverage bottles
 - Refillable soft drink bottles made of polyethylene terephthalate (PET) plastic
- Paper, plastic, or reusable cloth bags
 - Pros
 - Cons

Energy Consumption Involved with Using Different Types of 350 ml Containers



What Can You Do? Reuse

WHAT CAN YOU DO?

Reuse

- Buy beverages in refillable glass containers instead of cans or throwaway bottles
- Use reusable plastic or metal lunchboxes
- Carry sandwiches and store food in the refrigerator in reusable containers instead of wrapping them in aluminum foil or plastic wrap
- Use rechargeable batteries and recycle them when their useful life is over
- Carry groceries and other items in a reusable basket, a canvas or string bag, or a small cart
- Use reusable sponges and washable cloth napkins, dish towels, and handkerchiefs instead of throwaway paper ones
- Buy used furniture, computers, cars, and other items instead of buying new
- Give away or sell items you no longer use

There Are Two Types of Recycling

- **Primary, closed-loop recycling**
- **Secondary recycling**

- Types of wastes that can be recycled
 - Preconsumer: internal waste
 - Postconsumer: external waste
- Do items actually get recycled?
- What are the numbers?
- Will the consumer buy recycled goods?

We Can Mix or Separate Household Solid Wastes for Recycling

- **Materials-recovery facilities (MRFs)**

- **Source separation**
 - Pay-as-you-throw
 - Fee-per-bag

- Which program is more cost effective?

- Which is friendlier to the environment?

We Can Copy Nature and Recycle Biodegradable Solid Wastes

- **Composting**
 - Individual
 - Municipal

- Benefits

- Successful program in Edmonton, Alberta, Canada

Backyard Composter Drum: Bacteria Convert Kitchen Waste into Compost



Case Study: Recycling Paper

- Production of paper versus recycled paper
 - Energy use
 - Water use
 - Pollution

- Countries that are recycling

- Replacement of chlorine-based bleaching chemicals with H_2O_2 or O_2

Case Study: Recycling Plastics

- Plastics: composed of resins
- Most containers discarded: 4% recycled
- Litter: beaches, water
 - Significance?
- Low plastic recycling rate
 - Hard to isolate one type of plastic
 - Low yields of plastic
 - Cheaper to make it new

Discarded Solid Waste Litters Beaches



Science Focus: Bioplastics

- Plastics from soybeans: not a new concept
- Key to bioplastics: catalysts
- Sources
 - Corn
 - Soy
 - Sugarcane
 - Switchgrass
 - Chicken feathers
 - Some garbage
 - CO₂ from coal-burning plant emissions
- Benefits: lighter, stronger, cheaper, and biodegradable

Recycling Has Advantages and Disadvantages

- Advantages (Fig. 21-12)
- Disadvantages (Fig. 21_12)

TRADE-OFFS

Recycling Advantages and Disadvantages

Advantages <ul style="list-style-type: none">Reduces air and water pollutionSaves energyReduces mineral demandReduces greenhouse gas emissionsReduces solid waste production and disposalHelps protect biodiversityCan save landfill spaceImportant part of economy		Disadvantages <ul style="list-style-type: none">Can cost more than burying in areas with ample landfill spaceMay lose money for items such as glass and some plasticsReduces profits for landfill and incinerator ownersSource separation is inconvenient for some people
		

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Fig. 21-12, p. 573

We Can Encourage Reuse and Recycling

- What hinders reuse and recycling?

- Encourage reuse and recycling
 - Government
 - Increase subsidies and tax breaks for using such products
 - Decrease subsidies and tax breaks for making items from virgin resources
 - Fee-per-bag collection
 - New laws
 - Citizen pressure

21-4 The Advantages and Disadvantages of Burning or Burying Solid Waste

- *Concept 21-4 Technologies for burning and burying solid wastes are well developed, but burning contributes to pollution and greenhouse gas emissions, and buried wastes eventually contribute to pollution and land degradation.*

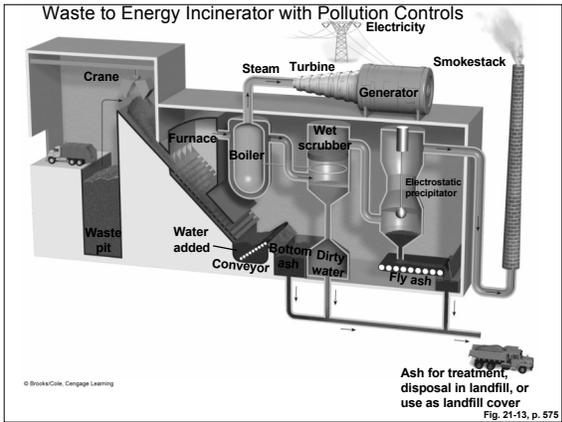
Burning Solid Waste Has Advantages and Disadvantages

- **Waste-to-energy incinerators (Fig. 21-13)**

- 600 Globally
 - Most in Great Britain

- Advantages

- Disadvantages



Trade-Offs: Incineration, Advantages and Disadvantages

TRADE-OFFS

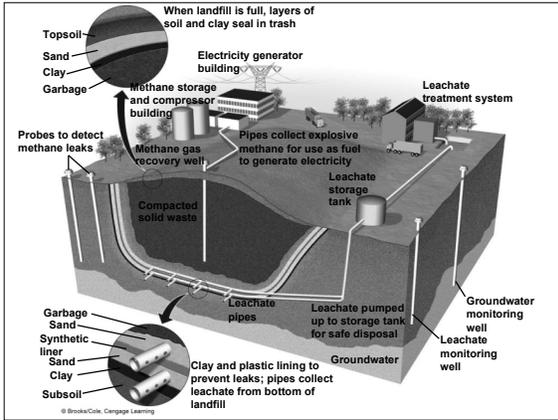
Incineration

<p>Advantages</p> <ul style="list-style-type: none"> Reduces trash volume Less need for landfills Low water pollution Concentrates hazardous substances into ash for burial Sale of energy reduces cost Modern controls reduce air pollution Some facilities recover and sell metals 	<p>Disadvantages</p> <ul style="list-style-type: none"> Expensive to build Costs more than short-distance hauling to landfills Difficult to site because of citizen opposition Some air pollution and CO₂ emissions Older or poorly managed facilities can release large amounts of air pollution Output approach that encourages waste production Can compete with recycling for burnable materials such as newspaper
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Burying Solid Waste Has Advantages and Disadvantages

- Open dumps
- Sanitary landfills



TRADE-OFFS

Sanitary Landfills

<p>Advantages</p> <ul style="list-style-type: none"> No open burning Little odor Low groundwater pollution if sited properly Can be built quickly Low operating costs Can handle large amounts of waste Filled land can be used for other purposes No shortage of landfill space in many areas 	 	<p>Disadvantages</p> <ul style="list-style-type: none"> Noise and traffic Dust Air pollution from toxic gases and trucks Releases greenhouse gases (methane and CO₂) unless they are collected Slow decomposition of wastes Output approach that encourages waste production Eventually leaks and can contaminate groundwater
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© Brooks/Cole, Cengage Learning Fig. 21-16, p. 576

21-5 How Should We Deal with Hazardous Waste?

- **Concept 21-5** *A sustainable approach to hazardous waste is first to produce less of it, then to reuse or recycle it, then to convert it to less hazardous materials, and finally, to safely store what is left.*

We Can Use Integrated Management of Hazardous Waste

- **Integrated management of hazardous wastes**
 - Produce less
 - Convert to less hazardous substances
 - Rest in long-term safe storage
- Increased use for postconsumer hazardous waste

Integrated Hazardous Waste Management

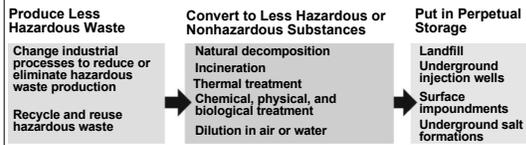


Fig. 21-17, p. 577

We Can Detoxify Hazardous Wastes

- Collect and then detoxify
 - Physical methods
 - Chemical methods
 - Use nanomagnets
 - Bioremediation
 - Phytoremediation
- Incineration
- Using a **plasma arc torch**

We Can Store Some Forms of Hazardous Waste

- Burial on land or long-term storage
- Deep-well disposal
- Surface impoundments
- Secure hazardous landfills

TRADE-OFFS

Deep-Well Disposal

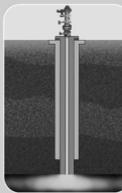
Advantages

Safe method if sites are chosen carefully

Wastes can often be retrieved if problems develop

Easy to do

Low cost



Disadvantages

Leaks or spills at surface

Leaks from corrosion of well casing

Existing fractures or earthquakes can allow wastes to escape into groundwater

Output approach that encourages waste production

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Fig. 21-21, p. 580

Surface Impoundment in Niagara Falls, New York, U.S.



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Surface Impoundments

Advantages

Low construction costs

Low operating costs

Can be built quickly

Wastes can often be retrieved if necessary

Can store wastes indefinitely with secure double liners



Disadvantages

Groundwater contamination from leaking liners (or no lining)

Air pollution from volatile organic compounds

Overflow from flooding

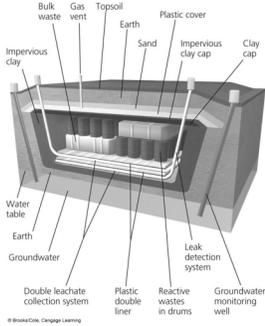
Disruption and leakage from earthquakes

Output approach that encourages waste production

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Fig. 21-23, p. 581

Solutions: Secure Hazardous Waste Landfill



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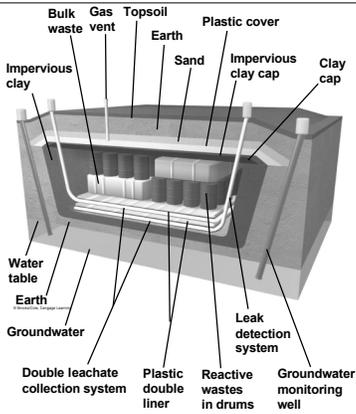


Fig. 21-24, p. 582

What Can You Do? Hazardous Waste

WHAT CAN YOU DO?

Hazardous Waste

- Avoid using pesticides and other hazardous chemicals, or use them in the smallest amounts possible
- Use less harmful substances instead of commercial chemicals for most household cleaners. For example, use vinegar to polish metals, clean surfaces, and remove stains and mildew; baking soda to clean household utensils and to deodorize and remove stains; and borax to remove stains and mildew.
- Do not dispose of pesticides, paints, solvents, oil, antifreeze, or other hazardous chemicals by flushing them down the toilet, pouring them down the drain, burying them, throwing them into the garbage, or dumping them down storm drains. Instead, use hazardous waste disposal services available in many cities.

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Case Study: Hazardous Waste Regulation in the United States

- 1976: Resource Conservation and Recovery Act (RCRA)
- 1980: Comprehensive Environmental, Compensation, and Liability Act (CERCLA), or **Superfund**
 - Pace of cleanup has slowed
 - Superfund is broke
- Laws encouraging the cleanup of brownfields

Leaking Barrels of Toxic Waste at a Superfund Site in the United States



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21-6 How Can We Make the Transition to a More Sustainable Low-Waste Society?

- **Concept 21-6** *Shifting to a low-waste society requires individuals and businesses to reduce resource use and to reuse and recycle wastes at local, national, and global levels.*

Grassroots Action Has Led to Better Solid and Hazardous Waste Management

- "Not in my backyard"
- Produce less waste
 - "Not in anyone's backyard"
 - "Not on planet Earth"

Providing Environmental Justice for Everyone Is an Important Goal

- **Environmental Justice**
- Which communities in the U.S. have the largest share of hazardous waste dumps?

Countries Have Developed International Treaties to Reduce Hazardous Waste (1)

- 1989 Basel Convention
 - 1995: Amended
 - 2008: Ratified by 192 countries, but not
 - The United States
 - Afghanistan
 - Haiti

Countries Have Developed International Treaties to Reduce Hazardous Waste (2)

- 2000: Delegates from 122 countries completed a global treaty
 - Control 12 persistent organic pollutants
- 2000: Swedish Parliament Law
 - By 2020 ban all chemicals that are persistent and can accumulate in living tissue

We Can Make the Transition to Low-Waste Societies

- Norway, Austria, and the Netherlands
 - Committed to reduce resource waste by 75%
- East Hampton, NY, U.S.
 - Reduced solid waste by 85%
- Follow guidelines to prevent pollution and reduce waste
