Waste Management

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Solid Waste

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What are Wastes?

Waste (also known as **rubbish**, **trash**, **refuse**, **garbage**, **junk**, **litter**, and **ort**) is unwanted or useless materials. In biology, waste is any of the many unwanted substances or toxins that are expelled from living organisms, metabolic waste; such as urea and sweat.

Basel Convention Definition of Wastes

"substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of the law"

Disposal means

"any operation which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses (Annex IVB of the Basel convention)"

Basel Convention

- The **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal**, usually known simply as **Basel Convention**, is an international treaty that was designed to reduce the movements of hazardous waste between nations, specially to prevent transfer of hazardous waste from developed to less developed countries (LDCs). It does not, however, address the movement of radioactive waste. The convention is also intended to minimize the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and other wastes they generate.
- **The Convention was opened for signature on 22nd March 1989, and entered into force on 5 May 1992.**

Kinds of Wastes

Solid wastes: wastes in solid forms, domestic, commercial and industrial wastes

Examples: *plastics, styrofoam containers, bottles,cans, papers, scrap iron, and other trash*

Liquid Wastes: wastes in liquid form

Examples: *domestic washings, chemicals, oils, waste water from ponds, manufacturing industries and other sources*

According to EPA regulations, SOLID WASTE is

- Any garbage or refuse (Municipal Solid Waste)
- Sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility
- Other discarded material
- Solid, liquid, semi-solid, or contained gaseous material from industrial, commercial, mining, and agricultural operations, and from community activities

http://www.epa.gov/epaoswer/osw/basifact.htm#solidwaste

Classification of Wastes according to their Properties

Bio-degradable

can be degraded (paper, wood, fruits and others)

Non-biodegradable

cannot be degraded (plastics, bottles, old machines,cans, styrofoam containers and others)

Classification of Wastes according to their Effects on Human Health and the Environment

- **Hazardous**

  Substances unsafe to use commercially, industrially, agriculturally, or economically and have any of the following properties- ignitability, corrosivity, reactivity & toxicity.

- **Non-hazardous**

  Substances safe to use commercially, industrially, agriculturally, or economically and do not have any of those properties mentioned above. These substances usually create disposal problems.

Classification of wastes according to their origin and type

- **Municipal Solid wastes:** Solid wastes that include household garbage, rubbish, construction & demolition debris, sanitation residues, packaging materials, trade refuges etc. are managed by any municipality.
- **Bio-medical wastes:** Solid or liquid wastes including containers, intermediate or end products generated during diagnosis, treatment & research activities of medical sciences.
- **Agricultural wastes:** Wastes generated from farming activities. These substances are mostly biodegradable.

- **Fishery wastes:** Wastes generated due to fishery activities. These are extensively found in coastal & estuarine areas.
- **Radioactive wastes:** Waste containing radioactive materials. Usually these are byproducts of nuclear processes. Sometimes industries that are not directly involved in nuclear activities, may also produce some radioactive wastes, e.g. radio-isotopes, chemical sludge etc.

- **E-wastes:** Electronic wastes generated from any modern establishments. They may be described as discarded electrical or electronic devices. Some electronic scrap components, such as CRTs, may contain contaminants such as Pb, Cd, Be or brominated flame retardants.
- **Industrial wastes:** Liquid and solid wastes that are generated by manufacturing & processing units of various industries like chemical, petroleum, coal, metal gas, sanitary & paper etc.

Hazardous Waste

Hazardous waste

- 1999: *Canadian Environmental Protection Act*:
  - **Flammable** = substances that easily catch fire
  - **Corrosive** = substances that corrode metals in storage tanks or equipment
  - **Reactive =** substances that are chemically unstable and readily react with other compounds, often explosively or by producing noxious fumes
  - **Toxic =** substances that harm human health when they are inhaled, are ingested, or contact human skin

Hazardous wastes have diverse sources

- **Households currently are the largest source of unregulated hazardous waste**
  - **Household hazardous waste (HHW)**
  - **Paints, batteries, oils, solvents, cleaning agents, pesticides**
- **Canadians improperly dispose of 27 000 tonnes of HHW each year**
  - **Average home has close to 45 kg of hazard wastes**
  - **Two classes are particularly hazardous**
    - **Organic compounds**
    - **Heavy metals**

Organic compounds and heavy metals can be hazardous

- **Organic compounds**
  - **are particularly hazardous because their toxicity persists over time and synthetic organic compounds resist decomposition**
    - **Keep buildings from decaying, kill pests, and keep stored goods intact**
    - **Their resistance to decay causes them to be persistent pollutants**
    - **They are toxic because they are readily absorbed through the skin**
    - **They can act as mutagens, carcinogens, teratogens, and endocrine disruptors**

What Harmful Chemicals Are in Your Home?

Cleaning

- Disinfectants
- Drain, toilet, and window cleaners
- Spot removers
- Septic tank, cleaners

Paint

- Latex and oil-based paints
- Paint thinners, solvents, and strippers
- Stains, varnishes, and lacquers
- Wood preservatives
- Artist paints and inks

General

- Dry cell batteries (mercury and cadmium)
- Glues and cements

Gardening

- Pesticides
- Weed killers
- Ant and rodent killers
- Flea powders

Automotive

- Gasoline
- Used motor oil
- Antifreeze
- Battery acid
- Solvents
- Brake and transmission fluid
- Rust inhibitor and rust remover

“E-waste” is a new and growing problem

- **Electronic waste (e-waste)** = waste involving electronic devices
  - Computers, printers, VCRs, fax machines, cell phones
  - Disposed of in landfills, but should be treated as hazardous waste (6% of a typical computer is composed of lead)
  - Some people and businesses are trying to use and reuse electronics to reduce waste
  - Serious concerns about health risks to workers

Several steps precede the disposal of hazardous waste

- For many years, hazardous waste was discarded without special treatment
  - Public did not know it was harmful to human health
  - Assumed the substances would disappear or be diluted in the environment
  - Since the 1980s, cities designate sites or special collection days to gather household hazardous waste

FIGURE 18.13
Many communities designate collection sites or collection days for household hazardous waste. Here, workers handle waste from an Earth Day collection event.

There are three disposal methods for hazardous waste

- Secure landfills
- Surface impoundments
- Deep-well injection
- These methods do nothing to lessen the hazards of the substances but do keep the waste isolated

MAGNITUDE OF PROBLEM: Indian scenario

- **Per capita waste generation increasing by 1.3% per annum**
- **With urban population increasing between 3 – 3.5% per annum**
- **Yearly increase in waste generation is around 5% annually**
- **India produces more than 42.0 million tons of municipal solid waste annually.**
- **Per capita generation of waste varies from 200 gm to 600 gm per capita / day. Average generation rate at 0.4 kg per capita per day in 0.1 million plus towns.**

IMPACTS OF WASTE IF NOT MANAGED WISELY

- **Affects our health**
- **Affects our socio-economic conditions**
- **Affects our coastal and marine environment**
- **Affects our climate**

IMPACTS OF WASTE…

- **GHGs are accumulating in Earth's atmosphere as a result of human activities, causing global mean surface air temperature and subsurface ocean temperature to rise.**

- **Rising global temperatures are expected to raise sea levels and change precipitation and other local climate conditions.**

- **Changing regional climates could alter forests, crop yields, and water supplies.**

- **This could also affect human health, animals, and many types of ecosystems.**

- **Deserts might expand into existing rangelands, and features of some of our national parks might be permanently altered.**

Impacts of waste....

- **Activities that have altered the chemical composition of the atmosphere:**

- **Buildup of GHGs primarily carbon dioxide (CO_2) methane (CH_4), and nitrous oxide (N_20).**

- **$C0_2$ is released to the atmosphere by the burning of fossil fuels, wood and wood products, and solid waste.**

- **CH_4 is emitted from the decomposition of organic wastes in landfills, the raising of livestock, and the production and transport of coal, natural gas, and oil.**

- **$N0_2$ is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. In 1977, the US emitted about one-fifth of total global GHGs.**

Effects of waste on animals and aquatics life

- Increase in mercury level in fish due to disposal of mercury in the rivers.
- Plastic found in oceans ingested by birds.
- Resulted in high algal population in rivers and sea.
- Degrades water and soil quality.

SOURCES OF HUMAN EXPOSURES

Exposures occurs through

- Ingestion of contaminated water or food
- Contact with disease vectors
- Inhalation
- Dermal

Impacts of waste on health

- Chemical poisoning through chemical inhalation
- Uncollected waste can obstruct the storm water runoff resulting in flood
- Low birth weight
- Cancer
- Congenital malformations
- Neurological disease
- Nausea and vomiting
- Increase in hospitalization of diabetic residents living near hazard waste sites.
- Mercury toxicity from eating fish with high levels of mercury.

Points of contact

- Soil adsorption, storage and biodegrading
- Plant uptake
- Ventilation
- Runoff
- Leaching
- Insects, birds, rats, flies and animals
- Direct dumping of untreated waste in seas, rivers and lakes results in the plants and animals that feed on it

Waste hierarchy

Waste hierarchy refers to 3 Rs
Reduce, Reuse, Recycle (I more R-Refuse)

Waste

- Minimizing solid waste

  - **Minimizing packaging**
  - **Recycleable**

    Paper, plastics, metals, glass, wood
  - **Reusable ?**

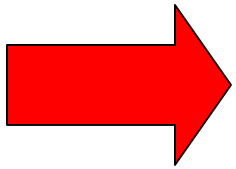
    Textiles, leather, rubber, metals, wood
  - **Compostable**

    Yard trimmings, food scraps (vegetable)

CATEGORIES OF WASTE DISPOSAL

1. **DILUTE AND DISPERSE**

(ATTENUATION)



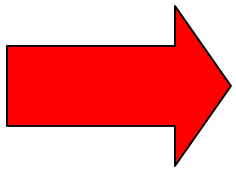
Throw it in the river / lake / sea

Burn it

Basically this involves spreading trash thinly over a large area to minimize its impact

Works for sewage, some waste chemicals, when land-disposal is not available

2. **CONCENTRATE AND CONTAIN (ISOLATION)**



Waste dumps, landfills

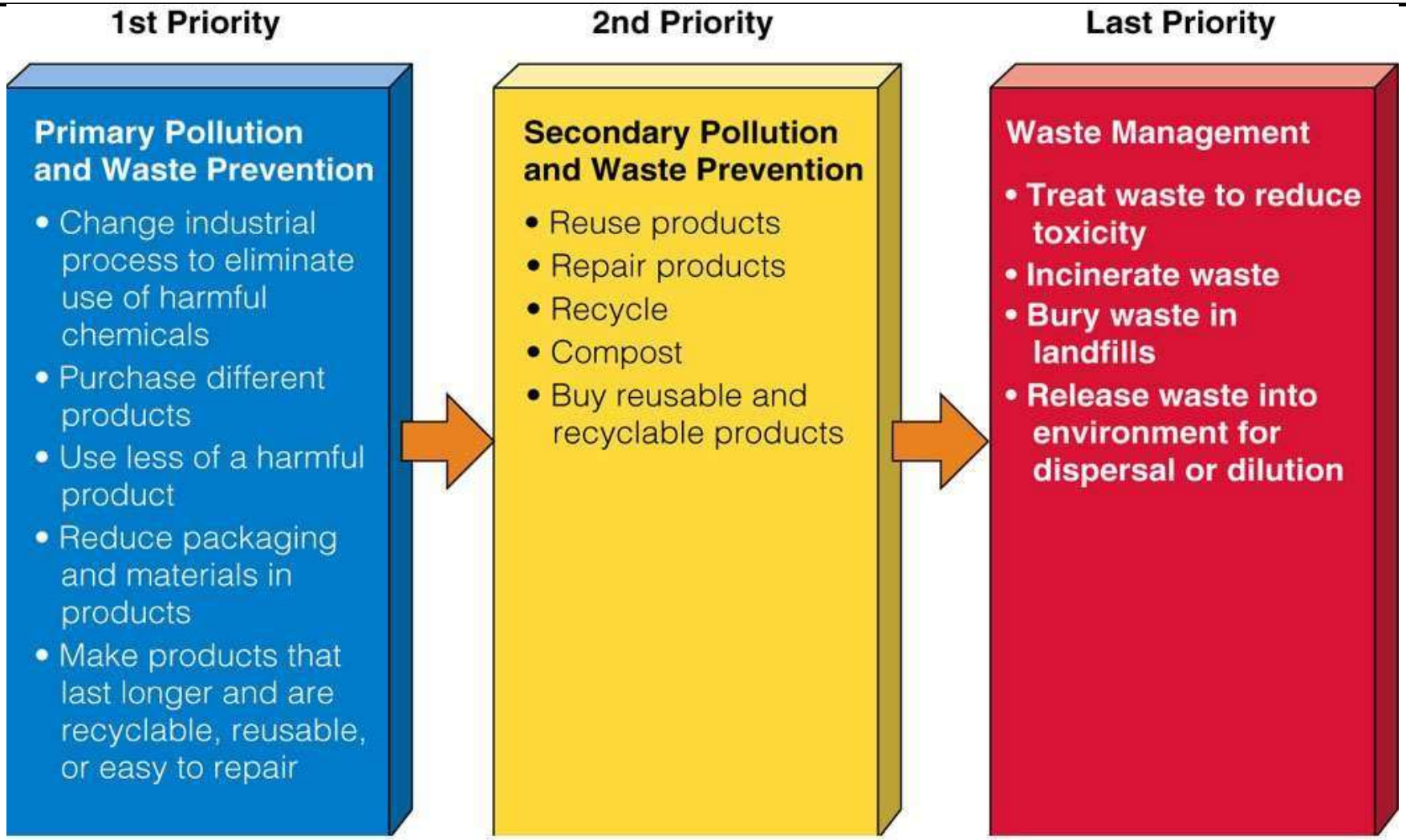
Historically, that's how most of the solid waste gets treated

Useful options

- Resource recovery
- Composting
- Vermicomposting

- Energy recovery
- Incineration
- Pyrolysis
- Gasification
- Bio-methanation or anaerobic digestion

Dealing with Material Use and Wastes



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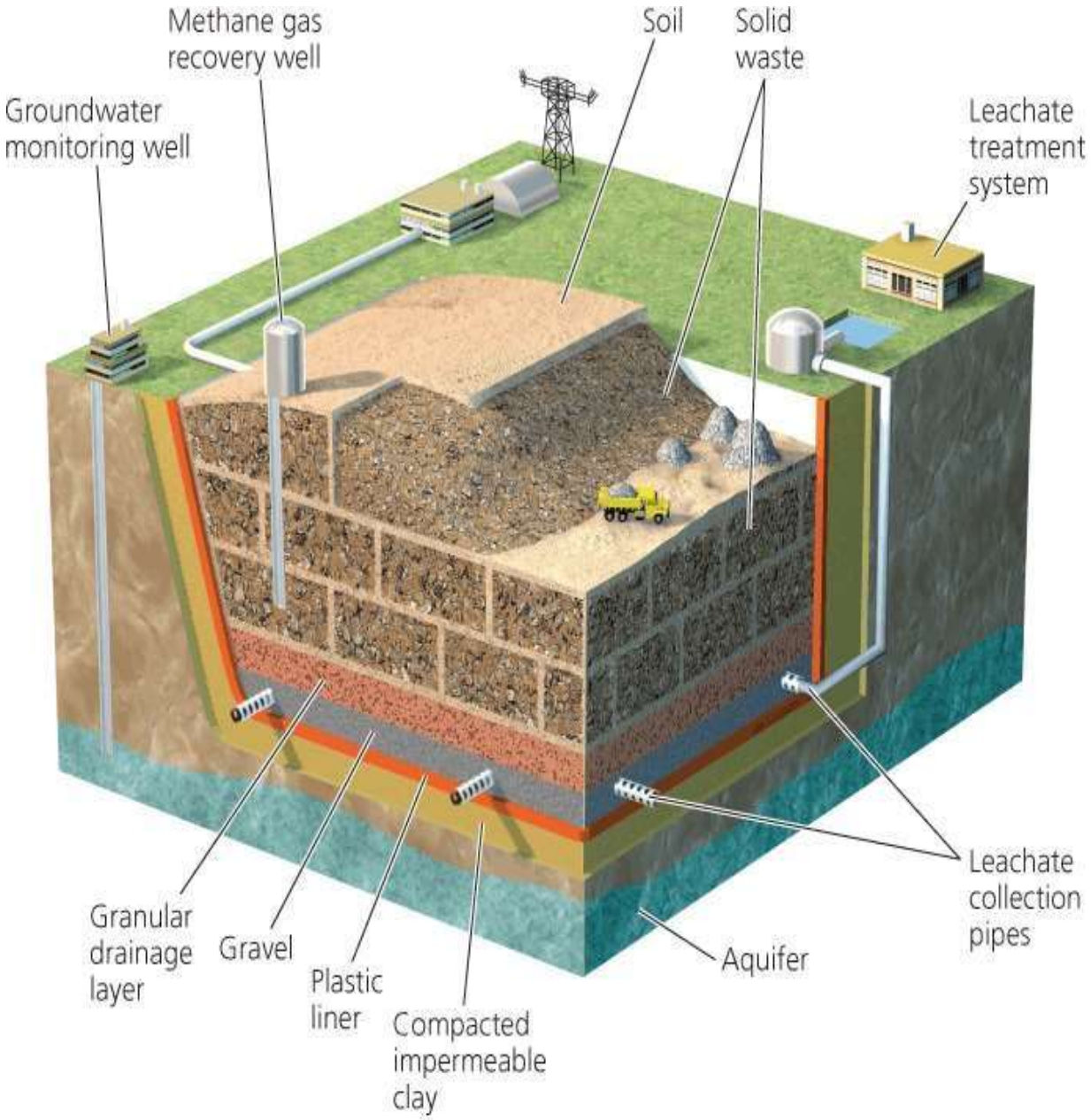

FIGURE 18.5

Sanitary landfills are engineered to prevent waste from contaminating soil and groundwater. Waste is laid in a large, lined depression, underlain by an impervious clay layer designed to prevent liquids from leaching out. Pipes of a leachate collection system draw out these liquids from the bottom of the landfill. Waste is layered along with soil until the depression is filled, and it continues to be built up until the landfill is capped. Landfill gas produced by anaerobic bacteria may be recovered, and waste managers monitor groundwater for contamination.

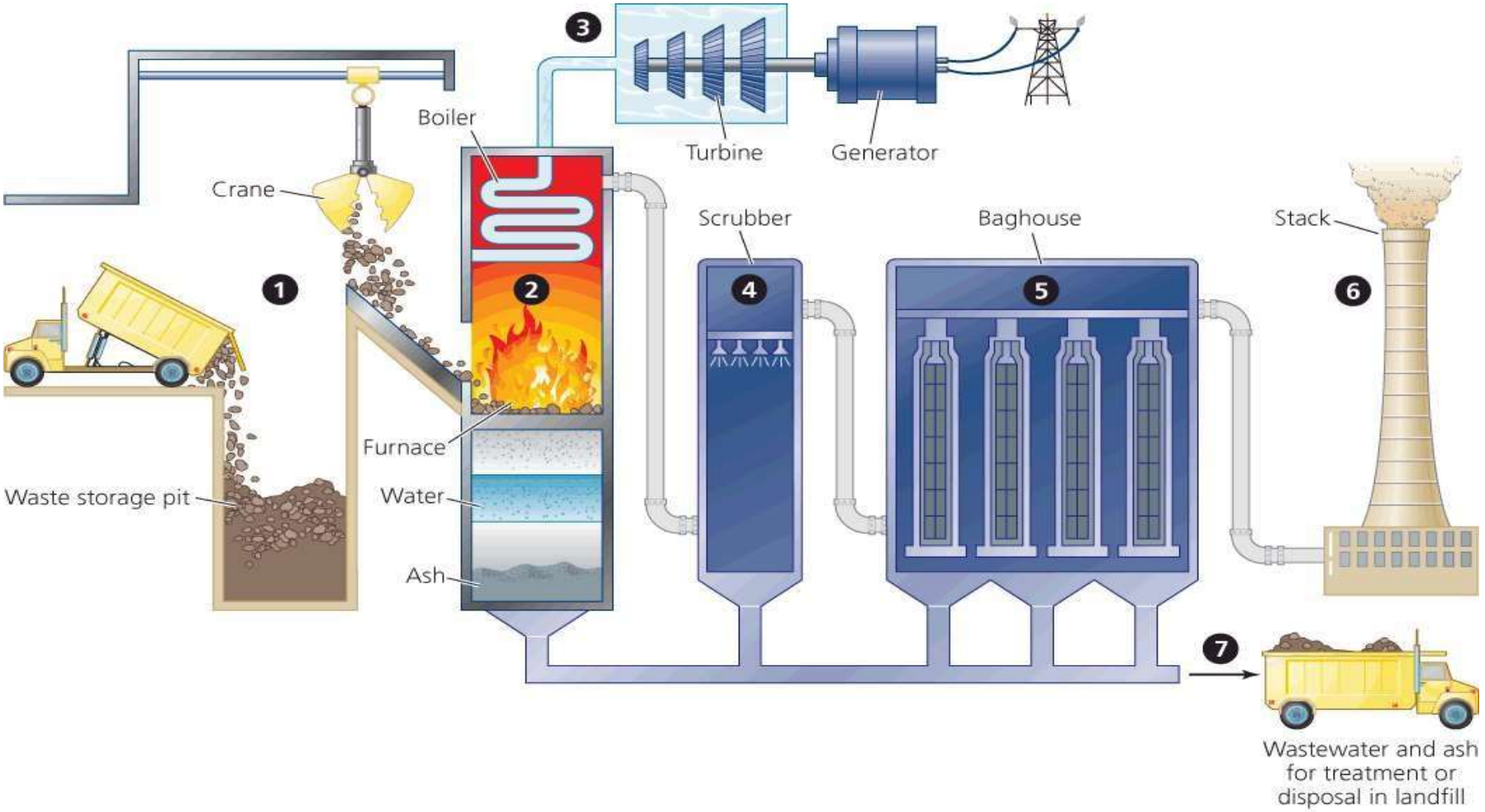

FIGURE 18.7 Incinerators reduce the volume of solid waste by burning it but may emit toxic compounds into the air. Many incinerators are waste-to-energy (WTE) facilities that use the heat of combustion to generate electricity. In a WTE facility, solid waste (1) is burned at extremely high temperatures (2), heating water, which turns to steam. The steam turns a turbine (3), which powers a generator to create electricity. In an incinerator outfitted with pollution-control technology, toxic gases produced by combustion are mitigated chemically by a scrubber (4), and airborne particulate matter is filtered physically in a baghouse (5) before air is emitted from the stack (6). Ash remaining from the combustion process is disposed of (7) in a landfill.

WHAT SHOULD BE DONE

- **Reduce Waste**
  - **Reduce office paper waste by implementing a formal policy to duplex all draft reports and by making training manuals and personnel information available electronically.**
  - **Improve product design to use less materials.**
  - **Redesign packaging to eliminate excess material while maintaining strength.**
  - **Work with customers to design and implement a packaging return program.**
  - **Switch to reusable transport containers.**
  - **Purchase products in bulk.**

WHAT SHOULD BE DONE

Reuse

- Reuse corrugated moving boxes internally.

-Reuse office furniture and supplies, such as interoffice envelopes, file folders, and paper.

-Use durable towels, tablecloths, napkins, dishes, cups, and glasses.

-Use incoming packaging materials for outgoing shipments.

-Encourage employees to reuse office materials rather than purchase new ones.

WHAT SHOULD BE DONE

Donate/Exchange

- old books
- old clothes
- old computers
- excess building materials
- old equipment to local organizations

WHAT SHOULD BE DONE

Employee Education

- **Develop an “office recycling procedures” packet.**

-**Send out recycling reminders to all employees including environmental articles.**

-**Train employees on recycling practices prior to implementing recycling programs.**

-**Conduct an ongoing training process as new technologies are introduced and new employees join the**

WHAT SHOULD BE DONE

Education

- education campaign on waste management that includes an extensive internal web site, quarterly newsletters, daily bulletins, promotional signs and helpful reference labels within the campus of an institution.

WHAT SHOULD BE DONE

Conduct outreach program adopting an ecologically sound waste management system which includes:

- **waste reduction**
- **segregation at source**
- **composting**
- **recycling and re-use**
- **more efficient collection**
- **more environmentally sound disposal**

Recycling consists of three steps

FIGURE 18.8
The familiar recycling symbol consists of three arrows to represent the three components of a sustainable recycling strategy: collection and processing of recyclable materials, use of the materials in making new products, and consumer purchase of these products.

Residents may be organized into small groups to carry out the following:

1. construction of backyard compost pit
2. construction of storage bins where recyclable and reusable materials are stored by each household
3. construction of storage centers where recyclable and reusable materials collected by the street sweepers are stored prior to selling to junk dealers
4. maintenance of cleanliness in yards and streets
5. greening of their respective areas
6. encouraging others to join

It is estimated that food wasted by the US and Europe could feed the world three times over. Food waste contributes to excess consumption of freshwater and fossil fuels which, along with methane and CO2 emissions from decomposing food, impacts global climate change. Every tonne of food waste prevented has the potential to save 4.2 tonnes of CO2 equivalent. If we all stop wasting food that could have been eaten, the CO2 impact would be the equivalent of taking one in four cars off the road.

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What Can You Do?

Solid Waste

- Follow the four R's of resource use: Refuse, Reduce, Reuse, and Recycle.
- Ask yourself whether you relly need a particular item.
- Rent, borrow, or barter goods and services when you can.
- Buy things that are reusable, recyclable, or compostable, and be sure to reuse, recycle, and compost them.
- Do not use throwaway paper and plastic plates, cups, and eating utensils, and other disposable items when reusable or refillable versions are available.
- Use e-mail in place of conventional paper mail.
- Read newspapers and magazines online.
- Buy products in concentrated form whenever possible.

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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 usefull 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, dishtowels, and handkerchiefs instead of throwaway paper ones.

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Dealing with Hazardous Wastes