

## CHAPTER 15 WASTE DISPOSAL

### Important Concepts

1. The two major solid waste sources are the agricultural and the mineral industries. Non-mining industries produce the largest volume of toxic wastes.
2. Methods of municipal solid waste disposal include open dumps, sanitary landfills, incineration, and ocean dumping. Despite the aesthetic problems, and the health and fire hazards associated with open dumps, about one-half of solid wastes are disposed of this way. Sanitary landfills, in which the waste is covered with a layer of earth at least once a day, overcome many of the problems of open dumps; however, improperly designed sanitary landfills can pollute ground water. They also require a sizeable commitment of land. Incineration reduces waste volume but can contribute to air pollution and produce toxic residues that require special disposal. Ocean dumping has the serious drawback of polluting the marine environment.
3. Methods of reducing waste volume include incineration, compaction, composting of organic matter, recycling, and the establishment of waste exchanges (one industry's waste may be another's raw material). Recycling can extend the lives of valuable resources and reduce waste volume; however, not all materials are easily recycled, and recycling may conflict with other waste-disposal objectives.
4. The main categories of liquid wastes are sewage and toxic, liquid industrial wastes.
5. Methods of disposing of toxic liquid wastes include secure landfills, deep-well disposal, incineration, chemical neutralization, and waste exchanges. Secure landfills and deep-well injection can handle large volumes of liquid wastes; however, secure landfills have the same potential drawbacks as sanitary landfills, and deep-well disposal is limited by subsurface geology and concerns over leakage and the triggering of earthquakes in faulted rocks. The remaining methods are designed to deal with low-volume, specialized wastes.
6. Methods of sewage treatment include septic systems and municipal sewage systems. Septic systems are limited to individual or family use and require settling tanks and leaching fields. Most of the U.S. population is served by municipal sewer systems. The sludge produced as a by-product of sewage treatment presents a significant solid-waste disposal problem.
7. Radioactive wastes are subdivided into low-level radioactive wastes and high-level radioactive wastes. Low-level wastes require no special disposal precautions. High-level wastes pose severe radiation hazards and require extraordinary disposal precautions. Strategies proposed for the disposal of high-level wastes include space disposal, ice sheet disposal, burial in subduction zones, seabed disposal, and bedrock cavern disposal. All of these methods have flaws, and as of yet no permanent high-level radioactive waste disposal sites have been established, either in the United States or elsewhere in the world. The Yucca Mountain area of Nevada is being investigated by the Department of Energy as a possible site for building a permanent repository for high-level nuclear wastes generated in the United States.

## Key Terms

absorption field  
half-life  
high-level waste  
leachate  
leaching field

low-level waste  
multiple barrier concept  
sanitary landfill  
secure landfill  
source separation

## Multiple Choice

1. The largest volume of toxic wastes is generated by
  - a. agriculture.
  - b. municipalities.
  - c. industry.
  - d. research laboratories.
2. Which of the following materials makes up the largest percentage of municipal wastes?
  - a. paper
  - b. glass
  - c. garden debris
  - d. plastics
3. A disadvantage in using old landfill sites for cropland or pastureland is
  - a. the absence of many important micronutrients needed for proper plant growth.
  - b. low soil pH conditions that result in poor plant growth.
  - c. the development of highly porous soils that drain away water too rapidly.
  - d. the possible incorporation of toxic chemicals into plant tissues.
4. An advantage of incineration waste disposal is the
  - a. reduction of waste volume.
  - b. destruction of toxic chemical elements.
  - c. dilution of harmful substances in the ash residue.
  - d. release of carbon dioxide into the atmosphere.
5. All of the following are methods of reducing waste volume except
  - a. compaction.
  - b. composting.
  - c. recycling.
  - d. ocean dumping.
6. The number of hazardous-waste sites estimated to exist in the United States is about
  - a. 2000.
  - b. 5600.
  - c. 17,000.
  - d. 30,000.

7. Superfund monies are intended to pay for
  - a. recycling pilot projects.
  - b. emergency cleanup of abandoned toxic waste sites.
  - c. the relocation of persons living near hazardous toxic waste sites.
  - d. research into the problem of disposing of toxic wastes.
  
8. The required size of a septic system leaching field is determined by the number of persons served and by
  - a. the volume of liquid waste generated.
  - b. soil permeability.
  - c. the depth to the water table.
  - d. the rate of waste decomposition by soil organisms.
  
9. Radioactive particles never release
  - a. alpha particles.
  - b. beta particles.
  - c. cosmic rays.
  - d. gamma rays.
  
10. A sample of a certain radioisotope has a mass of 100 grams. If the radioisotope has a half-life of 10 years, how much of the original radioisotope would be present after 30 years?
  - a. 50 grams
  - b. 30 grams
  - c. 25 grams
  - d. 12.5 grams
  
11. An example of a radioisotope that is also a toxic chemical poison is
  - a. iodine-131.
  - b. iron-59.
  - c. plutonium-239.
  - d. strontium-90.
  
12. The radiation source responsible for the highest percentage of average radiation exposure for persons in the United States is
  - a. nuclear power plants.
  - b. cosmic rays.
  - c. rocks and soil.
  - d. medical X rays.
  
13. All of the following are strategies for disposing of high-level radioactive wastes except
  - a. disposal in sanitary landfills.
  - b. space disposal.
  - c. ice sheet disposal.
  - d. seabed disposal.
  
14. All of the following properties of the proposed Yucca Mountain (Nevada) high-level radioactive waste site contributed to its selection except
  - a. tuff host rock.
  - b. low population density.
  - c. low regional water table.
  - d. absence of faults.

15. Worldwide, the number of permanent high-level radioactive waste disposal sites is
- 0.
  - 6.
  - 15.
  - 32.

### Fill In the Blanks

1. A \_\_\_\_\_ is a disposal site for solid or contained liquid waste in which the wastes are covered by a layer of earth at least once a day.
2. \_\_\_\_\_ is water containing dissolved chemicals that has escaped from a waste-disposal site.
3. \_\_\_\_\_ are sediments dredged from waterways and reservoirs, usually to improve navigation or enlarge capacity.
4. \_\_\_\_\_ is the sorting of waste material by type before collection.
5. A \_\_\_\_\_ is a sanitary landfill designed for toxic waste disposal.
6. An \_\_\_\_\_ field is a network of porous pipes and surrounding soil designed to process the effluent from a septic system.
7. \_\_\_\_\_ treatment of municipal sewage consists of removing solids and floating grease and scum; \_\_\_\_\_ treatment of the remaining liquid is mainly biological.
8. The \_\_\_\_\_ of a radioisotope is the period of time required for one-half of an original sample of the material to decay.
9. \_\_\_\_\_ radioactive wastes are sufficiently low in radioactivity that they do not require special disposal precautions, whereas \_\_\_\_\_ radioactive wastes are sufficiently radioactive to require extraordinary disposal precautions.
10. A procedure that isolates solid, high-level radioactive wastes by surrounding the waste with several different types of materials to create multiple obstructions to waste leakage or invasion by ground water is called the \_\_\_\_\_ concept.

### True or False

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- \_\_\_\_ 1. An estimated four billion tons of solid waste are produced in the United States each year.
- \_\_\_\_ 2. More than 50% of the solid wastes produced in the United States are linked to the mineral industry.

- \_\_\_\_\_ 3. Sanitary landfills are ideally placed over permeable rock or soil so that leachate will not collect on the land surface.
- \_\_\_\_\_ 4. In 1990, the United States incinerated about 51% of its municipal refuse.
- \_\_\_\_\_ 5. In 1990, the United States recycled about 45% of the wastes it generated.
- \_\_\_\_\_ 6. The rate of liquid waste disposal by injection into a deep well is limited by the depth of the well.
- \_\_\_\_\_ 7. More than 75% of the U.S. population disposes of sewage by the use of sewer systems.
- \_\_\_\_\_ 8. It is impossible to dispose of a given quantity of radioactive material by accelerating its rate of radioactive decay.
- \_\_\_\_\_ 9. The radioactive isotopes that pose the greatest radiation hazards are those that have long half-lives.
- \_\_\_\_\_ 10. To date, there are no permanent high-level radioactive waste sites in the United States.

## **Review Questions**

1. What are the essential elements in the design of a sanitary landfill? What are the potential problems associated with landfills, and how should they be addressed?
2. Do you consider incineration a desirable way to dispose of solid municipal waste? Justify your answer, pointing out the advantages and limitations of this method of waste disposal.
3. Describe how the design of a secure landfill (for the disposal of hazardous liquid wastes) provides multiple barriers for the containment of the waste. Is deep-well disposal a better method?
4. Why is high-level radioactive waste considered so dangerous? What are the requirements that a permanent repository for high-level radioactive wastes must satisfy?
5. How should the sludge produced by municipal sewage treatment plants be handled?

## **Surfing the Net**

A comprehensive treatment of industrial and special waste, municipal solid waste, and hazardous waste (U.S. EPA Office of the Solid Waste):

<<http://www.epa.gov/OSWRCRA>>

Information on hazardous waste and the Resource Conservation Recovery Act (Solstice):

<<http://solstice.crest.org/environment/gotwh/general/hazwaste-RCRA/index.html>>

Information on innovative treatment technologies (U.S. EPA Technology Innovation Office):  
<<http://www.clu-in.com/>>

Nuclear Waste Bulletin containing information on waste-management policies and programs of various countries (International Atomic Energy Commission):  
<<http://www.iaea.org/worldatom/Press/Events/RadWaste/nearadwastedoc.pdf>>

## CHAPTER 15 ANSWER KEY

### Multiple Choice

- |                    |      |       |       |
|--------------------|------|-------|-------|
| 1. c               | 5. d | 9. c  | 13. a |
| 2. a (figure 15.3) | 6. d | 10. d | 14. d |
| 3. d               | 7. b | 11. c | 15. a |
| 4. a               | 8. b | 12. d |       |

### Fill In the Blanks

- |                      |                          |
|----------------------|--------------------------|
| 1. sanitary landfill | 6. absorption            |
| 2. Leachate          | 7. Primary, secondary    |
| 3. Dredge spoils     | 8. half-life             |
| 4. Source separation | 9. Low-level, high-level |
| 5. secure landfill   | 10. multiple barrier     |

### True or False

1. True
2. False. More than 50% of the solid wastes produced in the United States are linked to agricultural activities.
3. False. Sanitary landfills are ideally placed over rock or soil of low permeability.
4. False. Only 6% of municipal refuse was incinerated in 1990.
5. False. The United States recycled about 17% of the wastes it generated in 1990.
6. False. The rate of liquid waste disposal by deep-well injection is limited by the permeability of the rocks of the disposal stratum.
7. True
8. True
9. True
10. True