

Solid Waste Treatment

THE NATIONAL URBAN LEAGUE claims that 95 percent of our solid waste is disposed of in landfills that are almost full. In addition, 50 percent of landfills are desperately in need of repairs to prevent leaks. Clearly, the efficient management of solid wastes is or should be a high priority.



Objective:



Describe solid waste treatment practices.

Key Terms:



biomass	incinerating	municipal solid waste (MSW)
compost	industrial waste	non-methane organic compounds
composting	landfill	recycling
construction and demolition (C&D) waste	landfill gas	sludge
decomposers	landfilling	special waste
disinfecting	leachate	sterilizing
	long-term storage	
	medical waste	

Managing Solid Waste

All processes that occur produce some kind of waste. As a result, various methods exist to deal with that waste.

FORMS OF SOLID WASTE

Solid waste is any discarded material. It can be solid, liquid, semi-solid, or containerized gaseous material. Solid waste comes in different forms, including municipal solid waste, industrial waste, construction and demolition waste, special waste, medical waste, and sludge.

Municipal Solid Waste

Municipal solid waste (MSW) is waste consisting of paper, wood, metals, glass, plastic, organic materials, and contaminated soil. Americans generated about 250 million tons of municipal solid waste last year. Organic materials were the largest portion. Paper and paperboard accounted for 29 percent. Yard trimmings and food scraps made up another 27 percent. Plastics comprised 12 percent; metals accounted for 9 percent; and 8 percent consisted of rubber, leather, and textiles. Six percent of MSW was wood, and 5 percent was glass. Approximately 3 percent were other wastes.

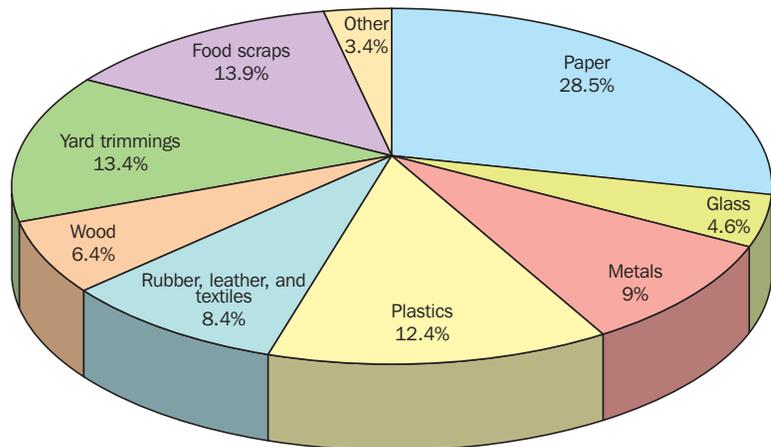


FIGURE 1. Total MSW generation was 250 million tons (before recycling).

Industrial Waste

Industrial waste is waste generated by industrial or commercial operations. It makes up a significant portion of solid waste and is usually collected by the private sector. Industries include those involved in organic chemicals, inorganic chemicals, primary iron and steel, plastics and resin manufacturing, stone, clay, glass and concrete, pulp and paper, and food and kindred products.

Construction and Demolition Waste

Construction and demolition (C&D) waste is waste generated during the construction, renovation, and demolition of buildings, roads, and bridges. Concrete, wood, asphalt, gypsum, metals, bricks, glass, plastics, trees, rocks, and earth are generally bulky. Reducing and recycling C&D materials conserves landfill space, reduces the environmental impact of producing new materials, creates jobs, and often reduces overall building project expenses through avoided purchase/disposal costs.

Special Waste

Some solid waste is classified as special waste. When the classification was decided upon, this waste type was believed to pose less risk to humans and the



FIGURE 2. Construction and demolition waste is a sizable portion of the total solid waste generated.

environment than the waste identified as hazardous waste. **Special waste** is waste that includes cement kiln dust; mining waste; oil and gas drilling muds and oil production brines; phosphate rock mining, beneficiation (mining processes in which ore is crushed and separated into valuable substances or waste), and processing waste; uranium waste; and utility waste (i.e., fossil fuel combustion waste). Typically, these wastes are generated in large volumes.

Medical Waste

Medical waste is all waste materials generated at hospitals, clinics, physicians' offices, dental practices, blood banks, veterinary hospitals/clinics, medical research facilities, and laboratories. Medical waste includes, but is not limited to, blood-soaked bandages; culture dishes and other glassware; discarded surgical gloves; discarded surgical instruments; discarded needles used to give shots or draw blood; cultures, stocks, and swabs used to inoculate cultures; removed body organs; and discarded lancets.

Sludge

Sludge is a material containing liquids and solids that is most often a product of liquid waste-treatment operations. Sludge can contain pathogenic organisms; heavy metals (e.g., cadmium and mercury), or toxins.

SOLID WASTE TREATMENTS

It is important that waste be managed in an efficient and sanitary way to protect human health and the environment. A determining factor in how solid waste is treated is if it is hazardous or nonhazardous. Generally, the major methods of treating wastes are recycling, incinerating, landfilling, composting, sterilizing, disinfecting, and long-term storage. Nonhazardous solid wastes are usually recycled, incinerated, taken to a landfill, or composted.

Recycling

Recycling is reusing a product or using waste materials to make a new product. In recycling, products are broken down, reprocessed, and returned to active use instead of being discarded. Recycling is a key component of waste management and is vital to the conservation of natural resources.

Incinerating

Incinerating is a method of waste treatment that involves the burning of organic substances within the waste. Incineration converts the waste into ash, flue gas, and heat. Ash consists mostly of inorganic materials and can be disposed of in landfills. Flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. Some incinerator systems are designed so the created heat can be used to generate electric power.

Landfilling

Landfilling is the disposal of waste materials by burial. It is the oldest form of waste treatment. Three goals of landfilling are to confine the landfill to as small an area as possible, compact the waste to reduce the volume, and cover the waste with a layer of soil daily.

Composting

Composting is a waste management technique in which organic matter is decomposed through the action of microbes and detritivores (e.g., earthworms). The composting process yields compost that can be used as soil amendment to enrich or improve soil consistency.

Sterilizing

Sterilizing is destroying microorganisms by chemical or physical means (e.g., heat).

Disinfecting

Disinfecting is applying substances to non-living objects to destroy microorganisms living on the objects. Not all microorganisms are killed by disinfection. It is, therefore, less effective than sterilization.

Long-Term Storage

Long-term storage is the most common method of handling radioactive waste. It most often involves geologic disposal. The basic concept is to locate a large, stable geologic formation to excavate a tunnel or drill a shaft 500 to 1,000 meters below the surface of Earth. Rooms or vaults are excavated for the placement of high-level radioactive waste. The goal is to permanently isolate nuclear waste from the living environment.

BASIC SANITARY LANDFILLS

A **landfill** is a carefully designed structure built into or on top of the ground in which trash is contained within a liner. Each day, garbage is added to the landfill, covered with soil, and



FURTHER EXPLORATION...

ONLINE CONNECTION:

The *Wall Street Journal* ran an article “Grappling with a Garbage Glut” that brings to light the costs of treating solid waste. The essay is based on the book *Garbology: Our Dirty Love Affair with Trash* by Edward Humes.

Read the article online:

<http://online.wsj.com/article/SB10001424052702304444604577337702024537204.html>

What is your opinion on the issues presented in the article?

packed down. The main goal when designing a landfill is to contain the trash while limiting exposure to air, surface water, and groundwater.

The major elements of a well-designed landfill are a bottom liner, cells containing the garbage, a storm-water drainage system, and a leachate collection system. **Leachate** is water contaminated by contact with wastes. There may be a methane collection system and a cap. Each element is necessary to prevent pollution.

Liners

Modern landfills use one of three types of liners to keep waste from polluting groundwater: clay, plastic, and composites. None of these materials is foolproof.

- ◆ Clay is a natural material, but it tends to fracture and crack. Additionally, a variety of chemicals can break down clay, resulting in leaks. Usually, a 2- to 5-foot layer of clay is required for a landfill liner. To create the liner, 6 to 8 inches of clay are laid down and compressed with a heavy roller. This process is repeated until the clay liner is 2 to 5 feet thick.
- ◆ According to the Environmental Research Foundation, the best liners are made of tough plastic called high-density polyethylene (HDPE). However, a variety of household chemicals, oils, vinegars, and alcohols will cause HDPE to degrade and crack.
- ◆ The composite liner is a combination of clay and HDPE. This type of liner is called a flexible-membrane liner (FML).

Leachate

Even a composite liner will have some leaks, so landfills are designed with equipment for collecting the liquid before it can contaminate groundwater. This is called a leachate collection system. The landfill is designed with a sloped bottom, and pipes are laid along the bottom to collect the leachate. The contaminated water is collected and pumped to a wastewater treatment facility for cleaning. Leachate collection systems can fail if the pipes become clogged or are crushed underneath tons of garbage.

Landfill Gas

Waste deposited in landfills is a potential source of air pollutants called landfill gas. **Landfill gas** is a combination of methane (40 to 60 percent) and carbon dioxide. Landfill gas is produced within one year of opening a landfill and continues to be produced for up to 50 years.

About 1 percent of landfill gas contains non-methane organic compounds (NMOC). **Non-methane organic compounds** are volatile air pollutants that vaporize and enter the atmosphere.

One of the major concerns with landfill gas is the possibility of explosion. Explosions are most likely to occur when too much air is introduced into the landfill or when the gas moves through the earth or the groundwater. Explosions caused by landfill gas have killed and injured

people, resulting in changes to the design and management of landfills. For instance, pipes are installed to channel the gas so it can be burned.

- ◆ Landfill gas contains about half the energy of natural gas. However, it can be burned to produce electricity, as a heat source for industrial processes, or to be processed into a higher-energy gas for power generation.
- ◆ Landfill gas is considered a renewable resource in the category of biomass. **Biomass** is living and recently living biological material that can be used as fuel or for industrial production. Some buildings, including schools, have been built near landfills to take advantage of the landfill gas as a fuel source.
- ◆ Using landfill gas as an energy source is not without its controversy. According to EPA estimates, burning landfill gas produces more pollutants than burning natural gas. The Energy Justice Network suggests that the toxic contaminants in landfill gas be filtered before the gas is burned.

SOLID WASTE INCINERATION

One effective way of treating solid waste is waste incineration or the controlled burning of domestic and industrial waste materials. During incineration, waste materials become ash, flue gas, and heat. Other than reducing the volume of waste, heat from the process can be used to convert water into steam to fuel heating systems or to generate electricity. Incineration facilities can remove materials for recycling. Incinerators are fitted with pollution-control technologies to significantly reduce the gases emitted into the air, including scrubbers that use a liquid spray to neutralize acid gases and filters that remove tiny ash particles.

Benefits

Incineration has some benefits over other types of waste treatment. Burning waste at extremely high temperatures destroys chemical compounds and disease-causing bacteria. Regular testing ensures that residual ash is non-hazardous before it is placed in a landfill. About 10 percent of the total ash formed in the combustion process is used for beneficial use, such as daily cover in landfills and road construction. Incineration greatly reduces the amount of waste going to landfills, a particularly important aspect because landfill space is limited.



FIGURE 3. Heat from the incineration can be used to convert water into steam to fuel heating systems or to generate electricity.

Negative Effects

Waste incineration can have some negative effects on human health and the environment. Production of ashes, flue gases, and other releases of incineration can harm humans and the environment. During incineration, waste materials are reduced to ash that consists of toxic substances (e.g., dioxins and heavy metals). These substances are difficult to destroy.

COMPOSTING

Composting is collecting organic waste (e.g., food scraps and yard wastes) and storing it under conditions designed to promote biological decomposition through the action of decomposers. **Decomposers** are microorganisms (e.g., bacteria and fungi) that break down organic material for energy and body-building materials. The composting process yields **compost**, which is an organic material that can be used as a natural fertilizer and soil amendment to enrich or improve soil consistency. Mature compost is a stable material that is dark brown or black and has a soil-like, earthy smell. Composting can be used on a large scale by waste disposal systems or on a small scale by people at their homes.

Yard trimmings and food residuals together constitute 27 percent of the U.S. municipal solid waste stream. Composting turns these wastes into environmentally beneficial compost and reduces the amount of waste sent to landfills. An estimated 57.5 percent of yard trimmings were recovered for composting in 2010, a dramatic increase from the 12 percent recovery rate in 1990. In contrast to yard trimmings recovery, only 2.8 percent of food waste was composted in 2010. The cost-prohibitive nature of residential food waste separation and collection is the primary deterrent to expanding food waste recovery efforts. However, in some areas, composting operations are working with high-volume commercial and institutional food producers to recover their food byproducts, saving these firms significant disposal costs.

Compost is created by combining organic wastes in proper ratios into piles, rows, or vessels; adding bulking agents such as wood chips to accelerate the breakdown of the organic materials; and allowing the finished material to fully stabilize and mature through a curing process.

Items That Can Be Used to Make Compost

- ◆ Manure
- ◆ Cardboard rolls
- ◆ Clean paper
- ◆ Coffee grounds and filters
- ◆ Cotton rags
- ◆ Dryer and vacuum cleaner lint

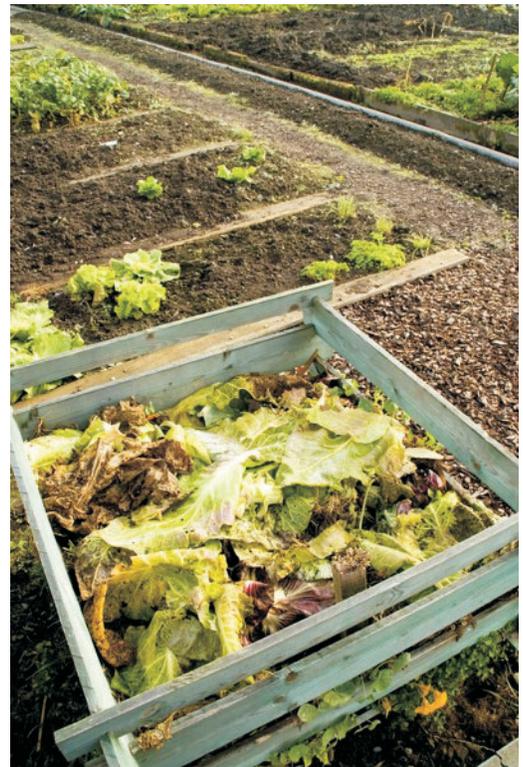


FIGURE 4. Composting turns organic wastes into environmentally beneficial compost and reduces the amount of waste sent to landfills.

- ◆ Eggshells
- ◆ Fireplace ashes
- ◆ Fruits and vegetables
- ◆ Grass clippings
- ◆ Hair and fur
- ◆ Hay and straw
- ◆ Houseplants
- ◆ Leaves
- ◆ Nut shells
- ◆ Sawdust
- ◆ Shredded newspaper
- ◆ Tea bags
- ◆ Wood chips
- ◆ Wool rags
- ◆ Yard trimmings

Items to Be Avoided When Making Compost

- ◆ Black walnut tree leaves, buds, fruit, and twigs contain a natural herbicide called juglone that is toxic to many plants.
- ◆ Coal or charcoal ash might contain substances harmful to plants.
- ◆ Dairy products (e.g., butter, milk, sour cream, yogurt) and eggs create odor problems and attract pests (e.g., rodents and flies).
- ◆ Diseased plants might survive and transfer the disease to other plants.
- ◆ Fats, grease, lard, and oils create odor problems and attract pests.
- ◆ Meat or fish bones and scraps create odor problems and attract pests.
- ◆ Pet wastes (e.g., dog or cat feces) might contain parasites, bacteria, germs, pathogens, and viruses harmful to humans.
- ◆ Yard trimmings treated with chemical pesticides might kill decomposers.

Summary:



Solid waste is any discarded material. Solid waste includes municipal solid waste, industrial waste, construction and demolition waste, special waste, medical waste, and sludge.

The major methods of treating wastes are recycling, incinerating, landfilling, composting, sterilizing, disinfecting, and long-term storage. Nonhazardous solid wastes are usually recycled, incinerated, taken to a landfill, or composted.

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Checking Your Knowledge:



1. What are the types of solid waste?
2. What methods are used to treat solid waste?
3. How are landfills designed?
4. What are benefits and negative impacts of incineration?
5. What should and should not be composted?

Expanding Your Knowledge:



Collect and weigh the solid waste generated by your household for one week. Carefully categorize the waste (i.e., glass, plastic, and paper), and keep a detailed record. At the end of the week, review your figures. How much solid waste was generated? What can your family do to reduce the amount of solid waste produced?

Web Links:



Municipal Waste

<http://www.epa.gov/osw/nonhaz/municipal/index.htm>

Landfills

<http://science.howstuffworks.com/environmental/green-science/landfill.htm>

Landfill Information

<http://www.enviroliteracy.org/article.php/63.php>

Agricultural Career Profiles

<http://www.mycart.com/career-profiles>