

# *Part III Solid Waste Engineering*

## **12 Evolution of Solid Waste Management**

### **12.1 Solid Waste—a Consequence of Life**

Problems with the disposal of wastes can be traced from the time when humans first began to congregate in tribes, villages, and communities and the accumulation of wastes became a consequence of life.

## 12.2 Waste Generation In a Technological Society

### Materials Flow and Waste Generation

### The Effects of Technological Advances

Of particular significance are the increasing use of plastics and the use of frozen foods, which reduce the quantities of food wastes in the home but increase the quantities at agricultural processing plants.

Thus, the engineers responsible for the design of solid waste facilities must be aware of trends, even though they cannot, of course, predict all the changes in technology that will affect the characteristics of solid wastes.

But important questions arise: Which elements of society generate the greatest quantities of solid waste and what is the nature of these wastes? How can the quantities be minimized? What is the role of resource recovery? Can disposal and recovery technology keep up with consumer product technology?

## 12.3 The Development of Solid Waste Management

Solid waste management may be defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes.

In its scope, solid waste management includes all administrative, financial, legal, planning, and engineering functions involved in solutions to all problems of solid wastes. The solutions may involve complex interdisciplinary relationships among such fields as political science, city and regional planning, geography, economics, public health, sociology, demography, communications, and conservation, as well as engineering and materials science.

# Functional Elements of a Waste Management System

The activities associated with the management of solid wastes, from the point of generation to final disposal have been grouped into the six functional elements: (1) waste generation; (2) waste handling and separation, storage, and processing at the source; (3) collection; (4) separation and processing and transformation of solid wastes; (5) transfer and transport; and (6) disposal.

**Waste Generation**

**Waste Handling and Separation, Storage,  
and Processing at the Source**

**Collection**

**Separation, Processing, and  
Transformation of Solid Waste.**

**Transfer and Transport**

**Disposal**

## **12.4 Integrated Solid Water Management**

**Hierarchy of Integrated Solid Waste management**

**Source Reduction**

**Recycling**

**Waste Transformation**

**Landfilling**

**Planning for Integrated Waste Management**

**Proper Mix of Alternatives and Technologies**

**Flexibility in Meeting Future Changes**

**Monitoring and Evaluation**

## **12.5 Operation of Solid Waste Management Systems**

**Management Issues**

**Setting Workable but Protective Regulatory Standards.**

**Improving Scientific Methods for Interpretation of Data**

**Identification of Hazardous and Toxic Consumer Products Requiring Special Waste Management Units**

**Paying for Improved Waste Management Units.**

**Designating Land Disposal Units at or near Large Urban Centers**

**Establishing and Maintaining More Qualified Managers to Develop and Operate Waste Management Units**

**Future Challenges and Opportunities**

**Changing Consumption Habits in Society**

**Reducing the Volume of Waste at the Source**

**Making Landfills Safer**

**Development of New Technologies**

# 13 Sources, Types, and Composition of Municipal Solid Wastes

## 13-1 Sources of Solid Wastes

- (1) residential,
- (2) commercial,
- (3) institutional,
- (4) construction and demolition,
- (5) municipal services,
- (6) treatment plant sites,
- (7) industrial,
- (8) agricultural.

## **13-2 Types of Solid Wastes**

**Residential and Commercial**

**Special Wastes**

**Hazardous Wastes**

**Construction and Demolition**

**Municipal Services**

**Treatment Plant Wastes and Other Residues**

**Industrial Solid Waste**

**Agricultural Wastes**

## 13.3 Composition of Solid Wastes

Composition of MSW

Distribution of Individual Waste Components

Effect of Waste Diversions on Components in Residential MSW

## 13-4 Determination of the Composition of MSW in the Field

### Residential MSW

### Commercial and Industrial MSW

The field procedure for component identification for commercial and non-process industrial solid wastes involves the analysis of representative waste samples taken directly from the source, not from a mixed waste load in a collection vehicle.

## **13-5 Types of Materials Recovered from MSW**

**Materials Commonly Separated from MSW**

**Specifications for Recovered Materials**

## **13-6 Future Changes in Waste Composition**

**Impacts of Waste Diversion Programs**

**Future Changes in Waste Components**

# 14 Physical, Chemical, and Biological Properties of Municipal Solid Waste

## 14- 1 Physical Properties of MSW

Specific Weight

Moisture Content

Particle Size and Size Distribution

Field Capacity

## 14- 2 Chemical properties of MSW

Proximate Analysis

Fusing Point of Ash

Ultimate Analysis of Solid Waste Components

Typical proximate analysis and data for materials found in residential, commercial, and industrial solid

Essential Nutrients and Other Elements

## **14- 3 Biological Properties of MSW**

**Biodegradability of Organic Waste Components**

**Production of Odors**

**Breeding of Flies**

## **14- 4 Physical, Chemical, and Biological Transformations of Solid Waste**

**Physical Transformations**

**Biological Transformations**

# 15 Disposal of Solid Wastes and Residual Matter

## 15-1 The Landfill Method of Solid Waste Disposal

The Landfilling Process

Preparation of the site for landfilling.

Reactions Occurring in Landfills.

Concerns with the Landfilling of Solid Wastes

## **15-2 Composition and Characteristics, Generation and Control of Landfill Gases**

**Composition and Characteristics of  
Landfill Gas**

**Generation of Landfill Gases**

**Management of Landfill Gas**

## **15-3 Composition, formation and control of leachate in landfills**

**Composition of Leachate**

**Water Balance and Leachate Generation  
In Landfills**

**Fate of Constituents in Leachate in  
Subsurface Migration**

**Control of Leachate in Landfills**

**Leachate Collection Systems**

**Leachate Management Options**

## **15-4 Environmental Quality Monitoring at Landfills**

**Vadose Zone Monitoring**

**Groundwater Monitoring**

**Landfill Air Quality Monitoring**