Disposal of Solid Wastes and Residual Matter
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The safe and reliable long term disposal of solid waste residues is an important component of integrated waste management.

Solid waste residues:

Solid waste residues are waste components that are not recycled, that remain after processing at a materials recovery facility or that remain after the recovery of conversion products and or energy.

Landfills have been the most economical and environmentally acceptable method for the disposal of solid wastes.

Landfill management incorporates the planning, design, operation, closure and post closure control of landfills.
Disposal of Solid Wastes and Residual Matter (Cont.)

- Definition of landfilling
- Define some term that are commonly used when discussing the landfilling of solid waste
- Landfill classification, types and methods
- Overview of landfill planning, design and operation
- Describe the life of landfill
- Landfill layout and design
- Landfill operations and management
- The reaction occurring in landfills
- The management of landfill gases
- The management of leachate
- Environmental monitoring
- Landfill closure and post closure care
- To identify environmental concerns associated with landfills
- To review briefly some federal and state regulations governing the disposal of solid waste in landfills
Landfills:

Landfills are the physical facilities used for the disposal of residual solid waste in the surface soils of the earth.

OR

Engineered method of disposing of solid waste on land in a manner that protects the environment

OR

Spread refuse in thin layer, compact it, cover with compacted soil (geonet) at end of day

OR

Landfilling is the placement of wastes into the land under **controlled** conditions to minimize their migration or effect on the
Sanitary landfills (Solid waste management units): It is used for the disposal of MSW.

Sanitary landfills are considered to be land disposal facilities that receive solid wastes from residential, commercial and industrial sources.
Secured landfills: It is used for the disposal of hazardous wastes.

Hazardous Waste Landfill (secured landfills)

Acceptable wastes: Solid wastes generated by residential, commercial, industrial and agricultural sources may be disposed in a sanitary landfill of modern design without necessarily directly or indirectly endangering the well being of the public and the quality of the environment. Such wastes are referred to as "acceptable wastes".

In contrast, many types of industrial process wastes (as opposed to the wastes generated in the offices of industrial facilities) should not be disposed in sanitary landfills but should be handled in specially designed landfills. These wastes are referred to as “unacceptable wastes”.

Wastes that are unacceptable should receive special evaluation to assess the particular risks associated with their disposal.

Note: Dewatered solids (i.e., sludges or, synonymously, biosolids) from municipal wastewater treatment plants and water supply treatment plants (excepting raw sludge) can be regarded as being acceptable wastes.

Special wastes There are several types of wastes that are commonly termed "special wastes":

Medical (infectious) wastes and various types of sludges
Landfilling:

- It is the process by which residual solid waste is placed in a landfill.
- Landfilling includes monitoring of the incoming waste stream, placement and compaction of the waste and installation of landfill environmental monitoring and control facilities.

Disposal of Solid Wastes and Residual Matter (Cont.)
Cell:

- Cell is used to describe the volume of material placed in landfill during one operating period, usually one day.

- A cell includes the solid waste deposited and the daily cover material surrounding it.

- Daily cover consists of 6 to 12 in of native soil or of native soil or alternative materials such as compost, foundry sand, or auto shredder fluff that are applied to the working faces of the landfill at the end of each operating period.

- The purpose of daily cover are to control the blowing of waste materials, to prevent rats, flies and other disease vectors form entering or exiting the landfill; and to control the entry of water into landfill during operation.

A completely covered compacted solid waste unit is called a cell. A cell's width depends on the number of vehicles unloading solid waste at given time.
Lift:

- A lift is a complete layer of cells over the active area of the landfill.

- Landfills are comprised of a series of lifts.

  OR

- A series of adjoining cells, all the same height, makes up a lift.

- The completed fill consists of several vertical lifts which may extend 50 or 100 feet above the original ground surface.
Bench:

- A bench (or terrace) is commonly used where the height of the landfill will exceed 50 to 75 ft.

- Benches are used to maintain the slope stability of the landfill, for the placement of surface water drainage channels, and for the location of landfill gas recovery piping.

- The final lift includes the landfill cover layer.

- The final cover layer is applied to the entire landfill surface after all landfilling operations are complete.

- The final cover usually consists of multiple layers of soil and/or geomembrane materials designed to enhance surface drainage, intercept percolating water and support surface vegetation.
Leachate:

- The liquid that collects at the bottom of a landfill is known as Leachate.

- In deep landfills: Leachate is collected at intermediate points.

- Leachate is a result of the percolation of precipitation, uncontrolled runoff, and irrigation water into the landfill.

- Leachate can also include the water initially contained in the waste as well as infiltration ground water.

- Leachate contains a variety of chemicals constituents derived form the solubilization of the materials deposited in the landfill and from the products of the chemical and biochemical reaction occurring within the landfill.
Landfill gas:

- Landfill gas is the mixture of gases found within a landfill.

- The bulk of landfill gas consists of methane and carbon dioxide, the principal product of the anaerobic decomposition of the biodegradable organic fraction of the MSW in the landfill.

- Other components of landfill gas include atmosphere nitrogen and oxygen, ammonia and trace organic compounds.
Landfill liners:

- Landfill liners are materials (both natural and manufactured) that are used to line the bottom area and below grade sides of a landfill.
- Liners usually consist of layer of compacted clay and/or geomembrane material designed to prevent migration of landfill Leachate and landfill gas.

The final landfill cover layer is applied over the entire landfill surface after all landfilling operations are complete.

Landfill covers consist of successive layers of compacted clay and/or geosynthetic material designed to prevent the migration of landfill gas and to limit the entry of surface water into the landfill.
Landfill control facilities include liners, landfill Leachate collection and extraction systems, landfill gas collection and extraction systems and daily and final cover layers.

Environmental monitoring involves the activities, associated with collection and analysis of water and air samples, that are used to monitor the movement of landfill gases and Leachate at the landfill site.

Landfill closure: It is the term used to describe the steps that must be taken to close and secure a landfill site once the filing operation has been completed.

Post closure: Post closure care refers to the activities associated with the long-term monitoring and maintenance of the complete landfill (typically 30 to 50 years).

Remediation: It refers to those actions necessary to stop and clean up unplanned contaminant releases to the environment.
Planning phase: This typically involves preliminary hydro-geological and geo-technical site investigations as a basis for actual design.

Construction phase: This involves earthworks, road and facility construction and preparation (liners and drains) of the fill area.

Operation phase (5 – 20 years): This phase has a high intensity of traffic, work at the front of the fill, operation of environmental installations and completion of finished sections.

Completed phase (20 – 100 years): This phase involves the termination of the actual filling to the time when the environmental installations need no longer be operated. The emissions may have by then decreased to a level where they do not need any further treatment and can be discharged freely into the surroundings.

Final storage phase: In this phase, the landfill is integrated into the surroundings for other purposes and no longer needs special attention.
Cutaway views of a sanitary landfill: (a) after geo-membrane liner has been installed over compacted clay layer and before drainage and soil protective layers have been installed; (b) after two lifts of solid waste have been completed; and (c) completed landfill with final cover installed.
Development and operations phases
When a new landfill is developed, operated and eventually closed, it progresses through five, through five distinct phases which are:

- Site selection
- Detailed plan design
- Construction and operation
- Landfill closure; and
- Monitoring and long-term care.
Landfill Sitting Considerations
One of the most difficult tasks faced by public agencies and private waste management firms in implementing an integrated waste management program is the sitting of new landfills.

Factors that must be considered in evaluating potential sites for the long-term disposal of solid waste include:
- Haul distance
- Location restrictions
- Available land area
- Site access
- Soil conditions and topography
- Climatological conditions
- Surface-water hydrology
- Geologic and hydrogeologic conditions
- Existing land use patterns
- Local environmental conditions
- Potential ultimate uses for the completed site
Overlay maps of various site criteria used in the screening of potential landfill sites
Final selection of a disposal site usually is based on the
  • Results of a detailed site survey,
  • Results of engineering design and cost studies,
  • The conducting of one or more environmental impact assessments, and
  • The outcome of public hearings.

**Landfill siting consideration:**

**1) Haul distance:**

The length of haul can significantly affect the overall design and operation of the waste management system.

Minimum haul distances are desirable.
(2) Location Restriction:

Secured or Engineered Landfills shall not be located within a certain distance of the following.

1) Lake or Pond: No landfill within 200 m of any lake or pond.

2) River: No landfill within 100 m of a river or stream.

3) Flood Plain: No landfill within 100 year flood plain.

4) High way: No landfill within 500 m of any state or national highway.

1) Habitation: No landfill within 500 m of any notified habitated area.

2) Public Parks: No landfill within 500 m of a public park.

3) Critical Habitat Areas: No landfill within critical habitat areas including reserved forests with endangered species.
8) Wetlands: No landfill within wetlands

9) Airports: No landfill to be constructed with in a zone around airports as notified by the regulatory authority or the aviation authority (They do not pose a bird hazard to aircraft).

10) Water Supply Well: No landfill with in 500 m of any water supply well.

11) Coastal Regulation Zone: No landfill in CRZ.

12) Ground Water Table Level: No landfill shall be located in areas where the ground water table will be less than 2 m below the base of the landfill.

Landfill located within the 100 year floodplain will have to designed so as not to restrict flood flow, reduce the temporary waste storage capacity of the floodplain or results in washout of solid waste which would pose a hazard to human heath and the environment.
(3) Available Land Area

In selecting potential land disposal sites, it is important to ensure that sufficient land area is available.

There are no fixed rules concerning the area requirement.

It is desired to have sufficient area including an adequate buffer zone, to operate for at least five years at a given site.

(4) Site Access

As the number of operating landfills continues to decrease, new landfills that are being sited are increasing in size.
(5) Soil conditions and Topography

Because it is necessary to cover the solid wastes placed in the landfill each day and to provide a final cover layer after the landfilling operation is completed, data must be obtained on the amounts and characteristics of the soils in the area.

If the soil under the proposed landfill area is to be used for cover material, data must be developed on its geologic and hydrogeologic characteristics.

If cover material is to be obtained from a borrow pit, test borings will be needed to characterize the material.

The local topography must be considered because it will affect the type of landfill operation to be used, the equipment requirements and the extent of work necessary to make the suitable site usable.

If suitable cover material is limited or an effort is being made to extend the useful life of the landfill, it may be necessary to consider the use of compost or other materials for intermediate cover.
(6) Climatologic conditions

The local whether conditions must be considered in the evaluation of potential sites.

In many locations, winter conditions will affect access to the site.

Wet whether may necessitate the use of separate landfill areas.

Wind strength and wind patterns must also be considered carefully.

To avoid blowing or flying debris, windbreaks must be established. The specific form of wind break depends on local conditions.
(7) **Surface water hydrology**

The local surface water hydrology of the area is important in establishing the existing natural drainage and runoff characteristics that must be considered.

Flood Plain: No landfill with in 100 year flood plain.

Mitigation measures must be developed to divert surface runoff from the landfill site, planners must take great care in defining existing and intermediate flow channels and the area and characteristics of the contributing water shed.

(8) **Geologic and Hydro geologic conditions**

Geologic and Hydro geologic conditions are important factors in establishing the environmental suitability of the area for a landfill site.
Data on these factors are required to access the pollution potential of the proposed site and to establish what must be done to the site to ensure that the movement of leachate or gases from the landfill will not impair the quality of local ground water or contaminate other subsurface or bedrock aquifers.

(9) Local Environmental Conditions

They must be operated carefully if they are to be environmentally acceptable with respect to traffic, noise. Odor, dust, airborne debris, visual impact, vector control, hazard to health and property values.

To minimize the impact of land filling operations, landfills are now sited in more remote locations where adequate buffer zones surrounding the landfill can be maintained.

(10) **Ultimate use of completed landfills:** Once it is completed, it is available for use of other purposes.
Federal and state regulations for landfills

- The principle federal requirements for municipal solid waste landfills are contained in subtitle D of the Resource Conservation and Recovery Act (RCRA) and in EPA regulations on criteria for classification of solid waste disposal facilities and practices (40 CFR 258).
- The final version of Part 258 criteria for municipal solid waste landfills (MSWLFs) was signed on September 11, 1991.
- The subparts of part 258 deal with the following issues:
  - Subpart A General
  - Subpart B Location restriction
  - Subpart C Operating criteria
  - Subpart D Design criteria
  - Subpart E Ground water monitoring and corrective action
  - Subpart F Closure and Post closure care
  - Subpart G Financial assurance criteria

The clean air act also contains provision dealing with gas emission from landfills.
In addition to the federal regulations, many states have adopted regulations governing the design, operation, closure and long-term maintenance of landfills.
Landfill classification, types and methods

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<td>II</td>
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<tr>
<td>III</td>
<td>Municipal solid waste (MSW)</td>
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Types of landfills

Landfills can be classified as
1. Conventional landfills for commingled MSW
2. Landfills for milled solid wastes
3. Monofills for designated or specialized wastes
Landfill Types

(1) Moisture
   - Dry LF - keep waste dry to limit biological activity
   - Wet LF - leachate recirculation used to moisten waste, bioreactor

(2) Use
   - Municipal (sanitary)
   - Hazardous
   - Controlled LF - co-disposal

(3) Configuration
   - Above ground LF - catch pan design - 3:1 or 4:1 slope
   - Under ground LF - valley or depression used

(4) Special LF
   - Conventional
   - LF for milled (shredded) SW (35% greater in place density, daily cover not required)
   - "Mono-fill" LF - specialized cells - asbestos, incinerator ash, anaerobic decomp of yard waste