STRUCTURE AND OPERATION OF LAND FILL

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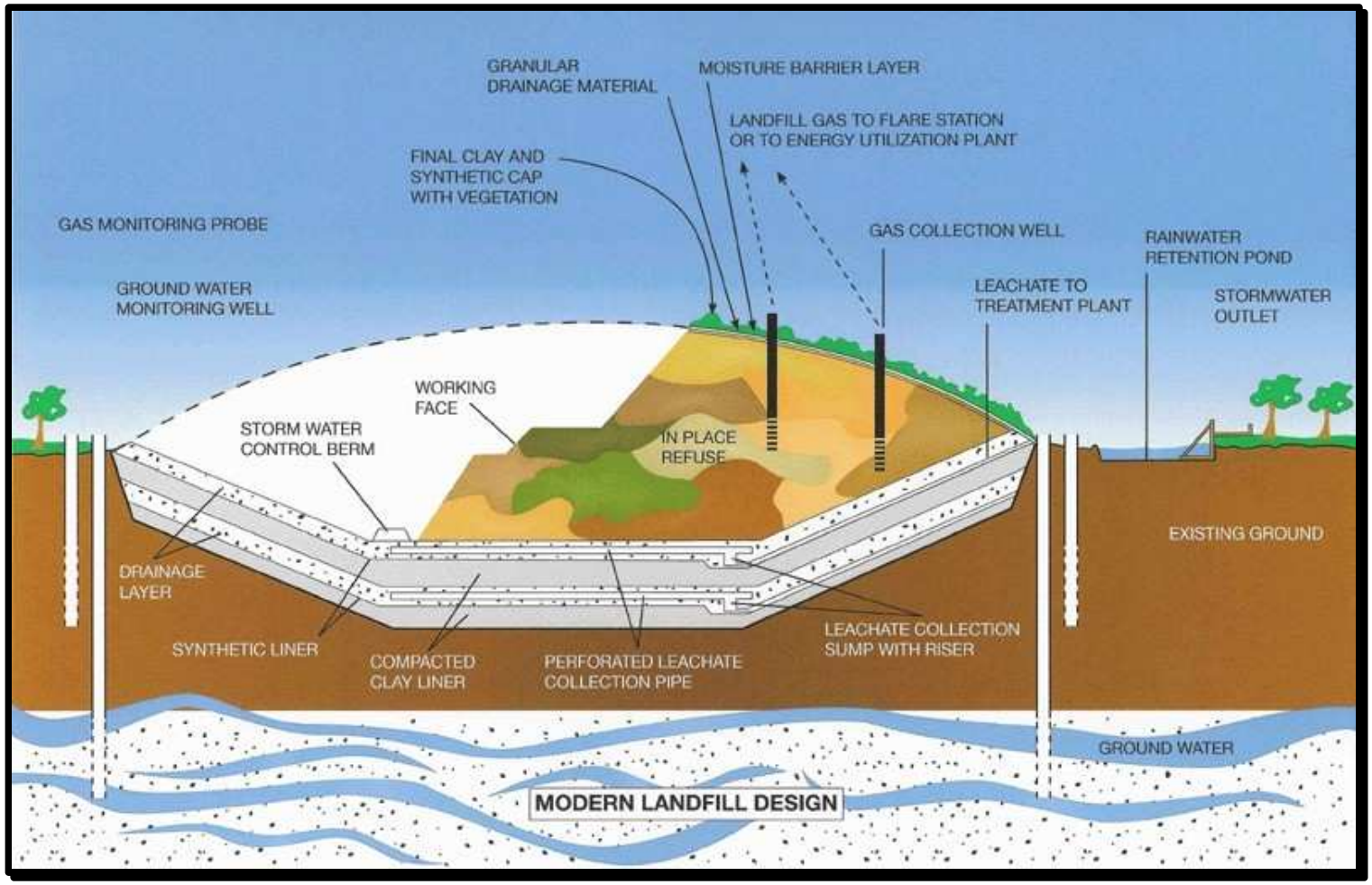
What is Landfill?

- A landfill is an engineered method for land disposal of solid and hazardous waste.
- Land filling is the term used to describe the process by which solid waste is placed in the landfill.
- Landfills for individual waste constituents such as combustion ash, asbestos and other similar wastes are known as mono fills.
- Landfills for the disposal of hazardous wastes are called secure landfills.



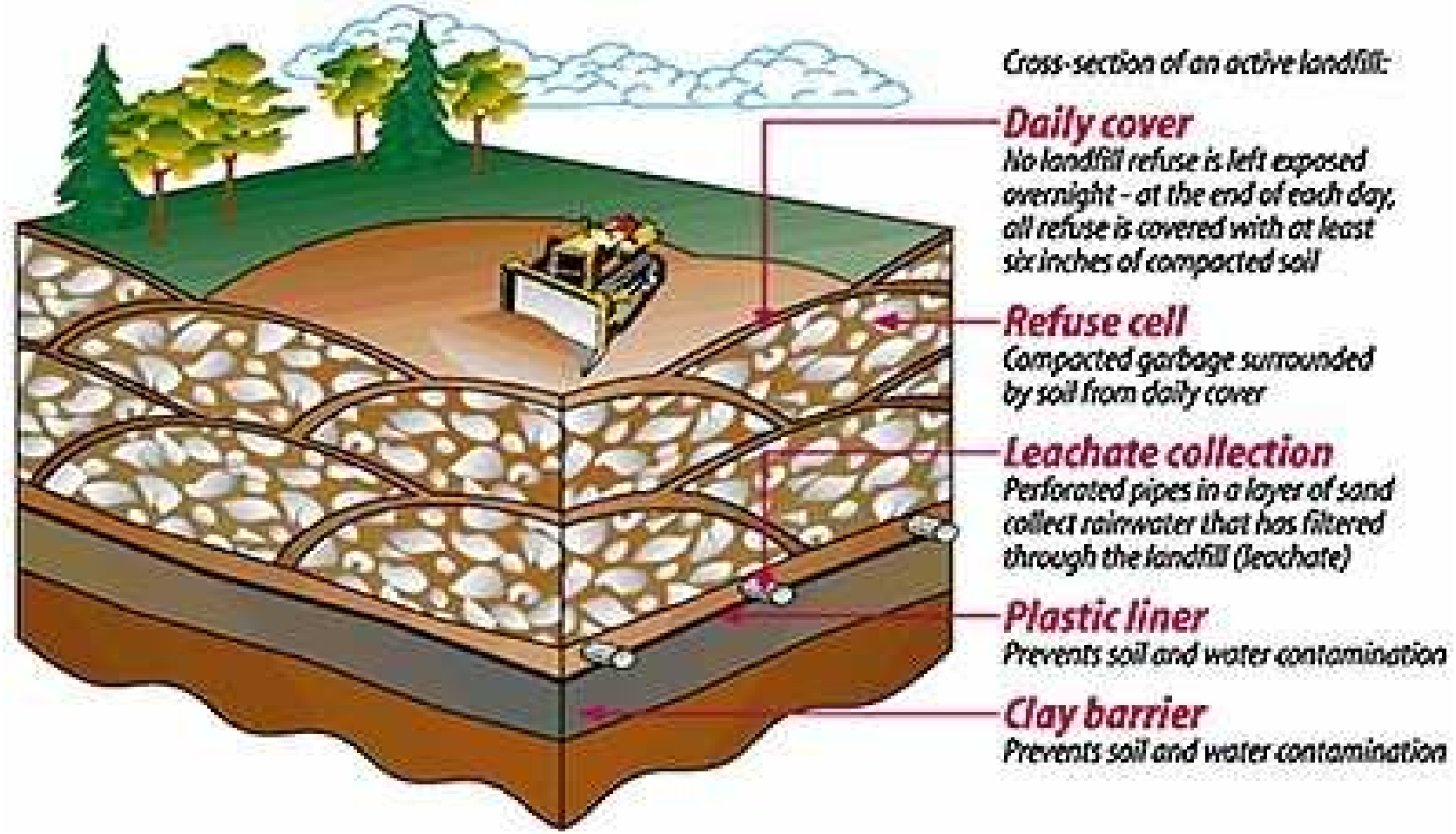
Landfill need not be an engineered site when the waste is mostly inert at final disposal. **In rural area** waste contain large proportion of soil and dirt. The practice of disposal of such waste is called as **non–engineered disposal method**.

Principle

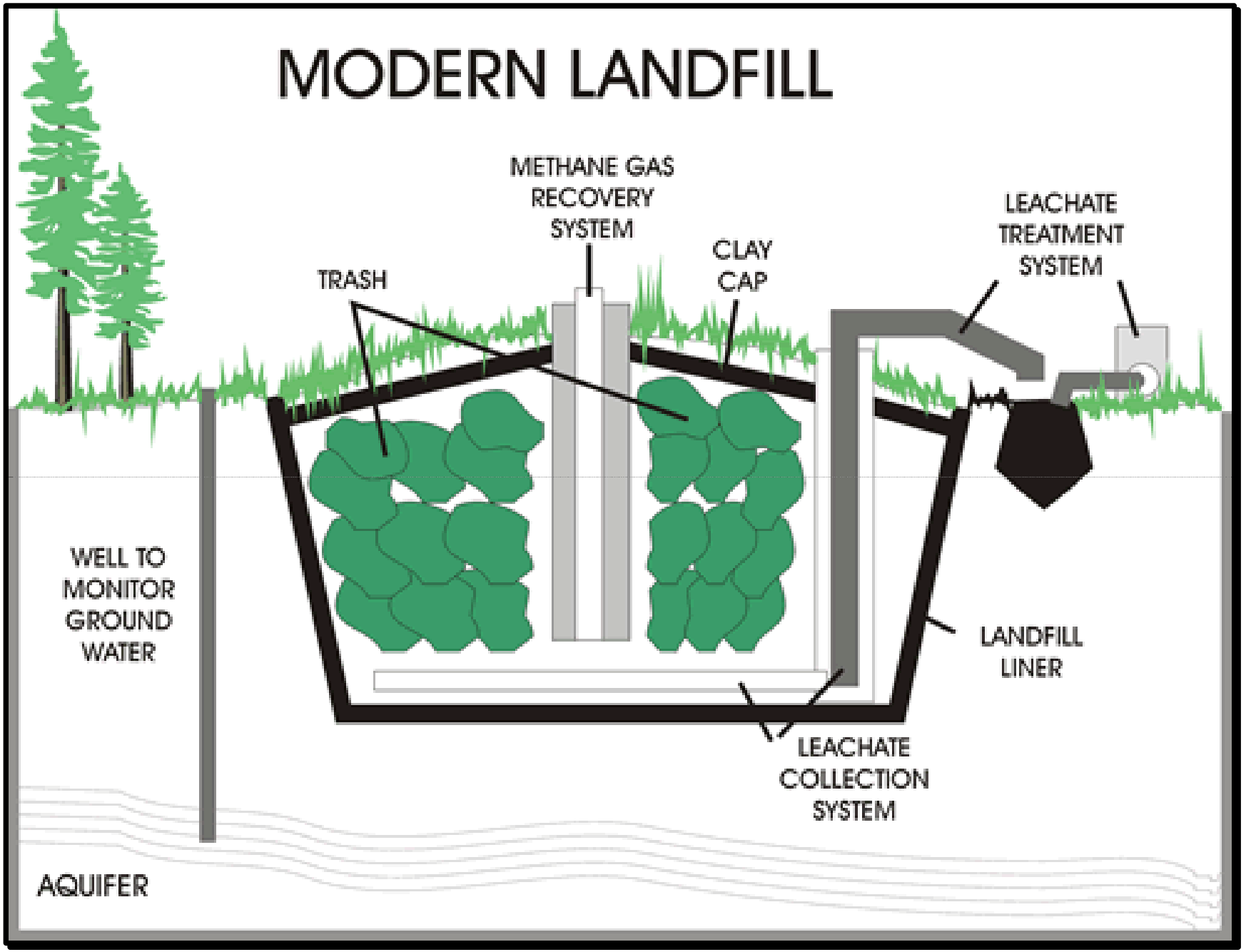
- The purpose of landfilling is to bury/ alter the chemical composition of the waste so that they do not pose any threat to environment/public health.

- Landfills are usually made up of cells in which a discrete volume of waste is kept isolated from adjacent waste cells by a suitable barrier.

- The term **cell** is used to describe the volume of material placed in a landfill during one operating period.



Landfill Design


MODERN LANDFILL
METHANE GAS RECOVERY SYSTEM
TRASH
CLAY CAP
LEACHATE TREATMENT SYSTEM
WELL TO MONITOR GROUND WATER
LANDFILL LINER
LEACHATE COLLECTION SYSTEM
AQUIFER

Characteristics of Landfill

1.solid waste is placed in a suitably selected and prepared (lined) landfill site in a carefully prescribed manner.

2.the waste material is spread out and compacted with appropriate heavy machinery.

3. The waste is covered each day with a layer of compacted soil.

4.Most important feature of modern sanitary landfill design is the technology used to prevent GW pollution.

5. It relies on containment rather than treatment.

Requirements For a Landfill

There are four minimum requirements

1) Full/ partial hydrological isolation .
2) Formal engineering preparation
3) Permanent control
4) Planned waste placement and covering

Important aspects of landfill process

The feasibility of land disposal of solid waste depends on factors

- Type of solid waste
- Quantity of waste
- Characteristics of waste
- Laws and regulations
- Soil and site characteristics

Total capacity and design life of a new landfill depend on Size

- Topography of the site
- Rate of refuse generation
- The degree of refuse compaction

The amount of daily soil cover adds 20% of overall fill volume, it must be considered for evaluation of capacity of landfill.

Site selection process

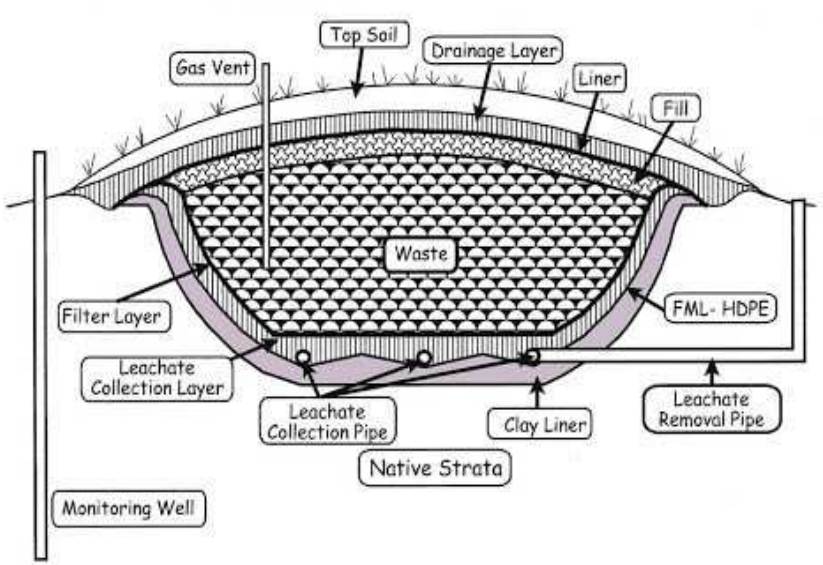
The suitability of a landfill site is determined by

- Its size/area/volume
- Techniqual and environmental factors
- Climate and hydrological conditions.
- It requires a development of a working plan, description of site location, operation, engineering work and site restoration.
- People are reluctant to allow construction of new landfill, thus siting approval authority is important.

Landfill Component

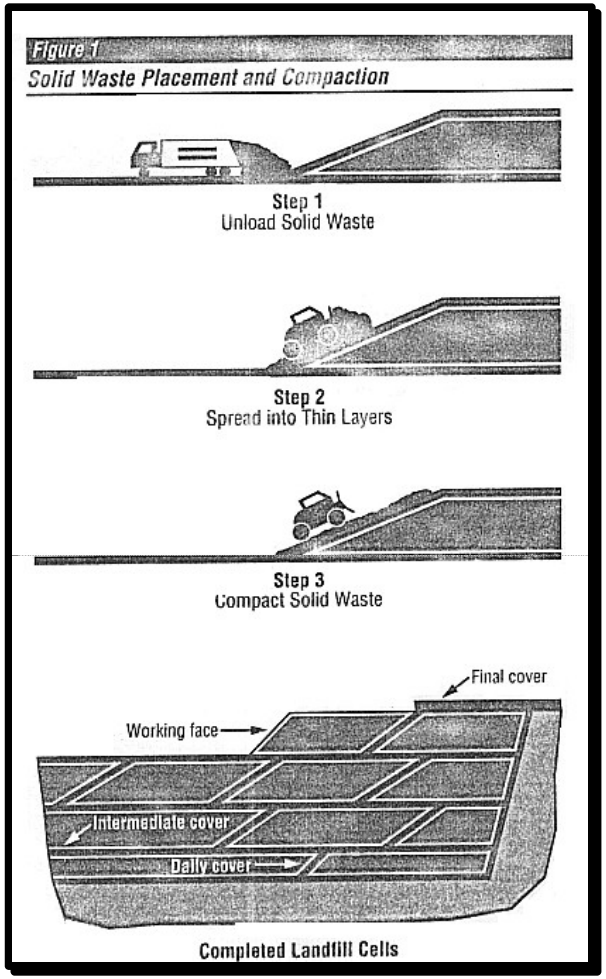
An environmental sound landfill comprises

- An appropriate liners for protection of GW
- Runoff controls
- Leachate collection and treatment system
- Monitoring wells
- Appropriate final cover design



Why cell is necessary in Landfill?

- A cell includes the SW deposited and the daily covered material surrounding it.
- Daily cover usually consists of 6-12 in. of native soil or alternative material such as compost, sand, auto shredder fluff.
- The barriers between the cells (soil, compost etc.) restricts downward/ lateral escape of the waste constituents.

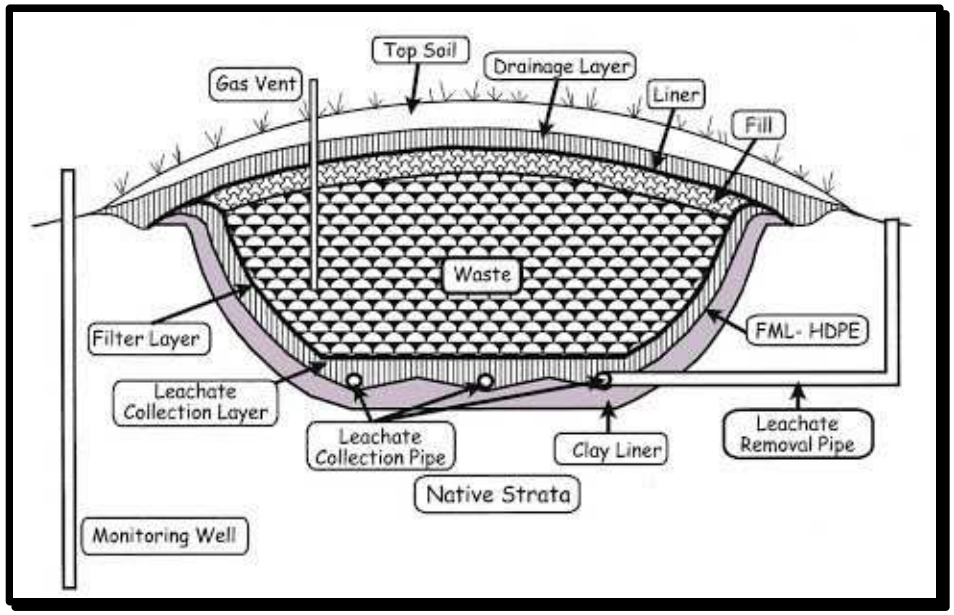


Landfill Cells

Landfill – Design and Operation

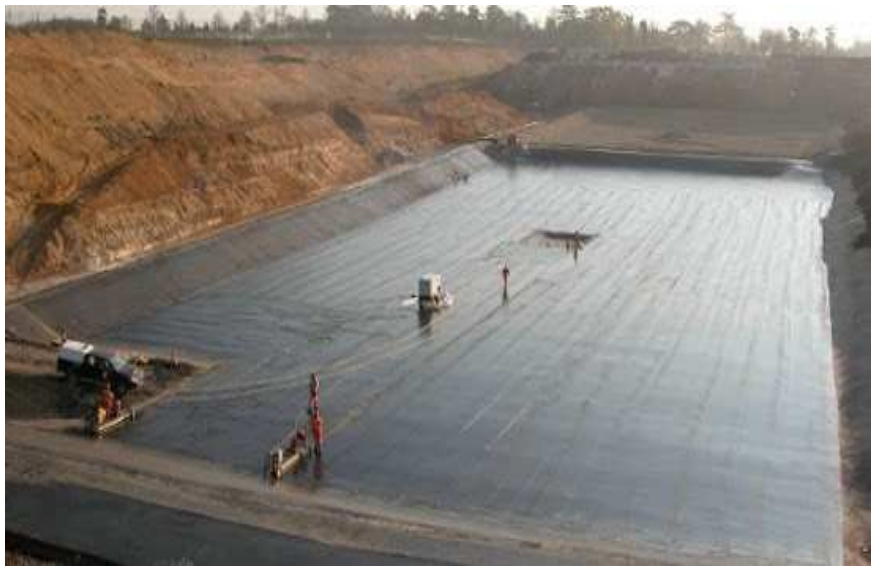
1) Planning phase – involves

Preliminary hydro-geological and geo-technical site investigations as a basis for actual design.



2) Construction phase – involves

Earthwork, road and facility construction and preparation (liners, drains) of the fill area.



3) Operation Phase (5-20 years)

- Involves work at the front of the fill area
- Operation of env installations
- Completion of finished sections
- Has a high traffic intensity

4) Completed phase (20- 100 years)

It involves termination of actual filling to the time when envt. Installations need no longer to be operated.

The emissions may have decreased to a level where they do not need any further treatment and can be discharged freely into the surroundings.

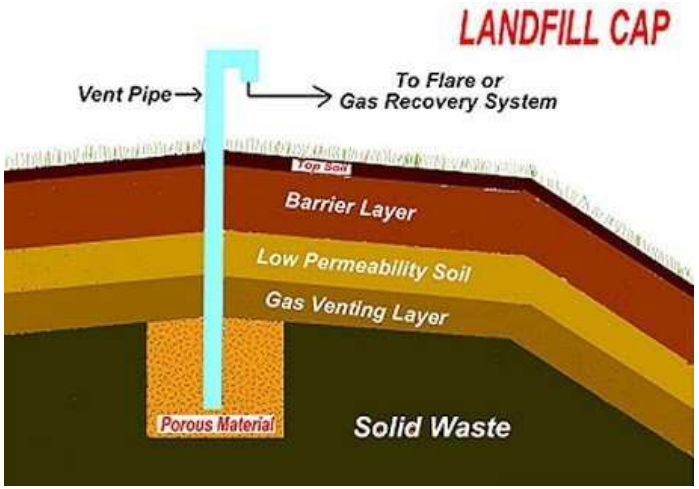
5) Final storage phase

In this phase the landfill is integrated into the surroundings for the further purpose, no longer needs special attention.

Final Cover or cap Specifications

Once the landfill reaches design height, a final cap is placed to

- Minimize infiltration of rainwater
- Minimize dispersal of waste
- Accommodate settling
- Facilitate long term maintenance of the landfill.



The final cover shall have a barrier soil layer.

- On the top of barrier soil layer, there shall be drainage layer of 15 cm.
- On the top of the drainage there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

Final cap Specification

A cap consists of from top to bottom

- Vegetation and supporting soil (6 in)
- Filter and drainage layer – protective material (18-36 in) drainage material (12 in)
- A hydraulic barrier– clay layer (24 in), LDPE barrier
- Foundation for hydraulic barrier– gravel layer (6 inch) sand bedding for LDPE (4 inch)

Specification For Landfilling Operation

- Waste subjected to landfilling shall be compacted in thin layers by compactors to achieve high density of the waste.
- Prior to the commencement of monsoon season, an immediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration.
- Proper drainage shall be constructed to divert runoff away from the active cell of the landfill.
- When the total depth of landfill exceeds 9 m(30 ft) from base an intermediate cover to be used at mid depth. It is typically 2 ft of clay soil and 6” of topsoil over the area.
- New phases are started on the top of lower phase.

Landfill Settling Process

It consists of three stages

1.Primary consolidation – Substantial amount of settling occurs at this stage.

- It is caused by weight of the waste layers, truck movements, bulldozers , mechanical compactors.
- After this stage aerobic degradation of waste occurs.

2. Secondary compression

- Rate of settling is much lower than first stage.
- Settling occurs through compression.

3.Decomposition- It is the degradation process. Organic material is converted to gas and leachate.

- Settling rate increases as compare to secondary stage, but with the passage of time it gradually decreases.
- It continues till the organic matter is degraded.

Microbial Degradation Process

- Biological process is most important aspect in landfilling which determines the quantity and quality of leachate and gas.
- After the disposal, large part of waste becomes anaerobic(du to absence of oxygen.
- Microbial activity degrade the solid organic carbon and produces methane and carbon dioxide.
- In an anaerobic process solid and dissolved organic compounds are hydrolyzed and fermented to volatile fatty acids, alcohols, hydrogen and carbon dioxide.
- The methanogenic bacteria convert acetic acid to methane and carbon dioxide.
- Hydrogenophilic bacteria convert hydrogen and carbon dioxide to methane.

Decomposition pathways for common organic waste material

Proteins	carbohydrates	lipids
↓	↓	↓
Amino acids	simple sugar	long chain of volatile fatty acids
↓	↓	↓
Hydrogen/ carbon dioxide	Acetate	Short chain of volatile fatty acids
↓	↓	↓
Methane	Methane + CO_2	← Acetate

Composition Of Landfill Gas

Gases	% dry volume basis
Methane	45-60
Carbon dioxide	40-60
Nitrogen	2-5
Ammonia	0.1- 1
Oxygen	0.1- 1
Hydrogen	0-0.2
Carbon monoxide	0-0.2

Factors Affecting The Landfill Gas And Leachate Generation

1. **Nature of waste** – amount of gas depends on the content of biodegradable matter in the waste.
2. **Moisture content** – microorganisms require minimum 12% moisture for growth, thus it is important factor in determining gas production.
3. **pH** – methanogens grow only at low pH around neutrality. % of gas depends on pH.
4. **Particle size and density –** particle size affects density achieved by compaction that affects surface area and hence volume. This affects the moisture absorption and thus the biological degradation.
5. **Temperature** – Increase in temperature tends to increase in gas production. It affects microbial activity.

Methods of Landfilling

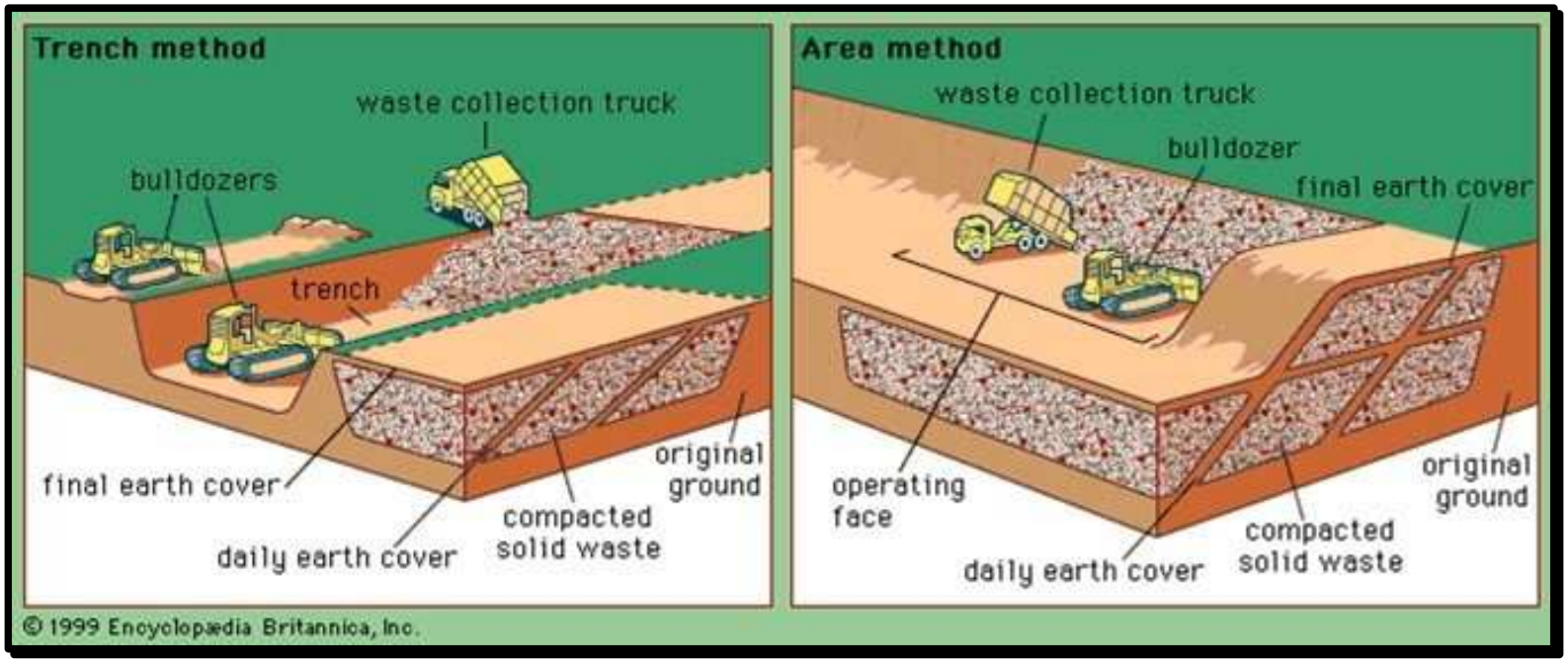
The principle methods used for landfilling are

1. Excavated cell/ Trench method- Ideally suited to areas where an adequate depth of cover material is available at the site and water table is not near the surface.

- SW are placed in cells/ trenches excavated in the soil.
- Soil excavated from the site is used for daily and final cover.
- Excavated cells are lined with synthetic membrane liners/ low permeability clay/combination of two to limit the movement of landfill gas and leachate.

2. Area method- Used when terrain is unsuitable for excavation of cells/ trenches and GW table is high.

- Site preparation includes installation of liners and leachate management system.
- Cover material must be obtained from adjacent land/ burrow, pit areas.
- Since there is limited material for covering, compost, foundry sand has been utilized as intermediate cover material.
- Temporary cover material of soil and geosynthetic blankets placed temporarily over completed cell and removed before next lift is began.
- Leachate generation may occur and may be difficult to control.



Methods of Landfilling

3. Canyon/depression method

- Technique involves placement and compaction of SW in canyon/ depression.

- It differs with geometry of site, characteristics of available cover material, hydrology, geology of the site.

- Control of surface drainage is often a critical factor in this method.

- Filling starts at the headed of canyon and ends at mouth, to prevent accumulation of water behind the landfill.

Advantages of Landfilling

- In addition to provide an option for waste management, it also serves to improve/ reclaim poor quality land.
- It raises the ground elevation/surface grade of the site. Completed landfills have been converted to municipal parks, playgrounds, golf courses, community land use projects.
- It is the most economical alternative for SW disposal which accounts for its frequent application.
- Other disposal methods are not entirely safe and efficient throughout the year.
- Incineration is a costly process, residue requires ultimate disposal on land.
- Composting is a seasonal option.
- It is not possible to reclaim and recycle all SW material.
- Thus landfilling is the most convenient option.

Disadvantages

- Difficult to find suitable site within economically feasible distance.
- It is not possible to build a completely safe and secure SW landfill.
- Some of the pollutants may escape in the env in the form of leachate.
- Potential harm to public health due to air, soil, water and noise pollution
- Damage to local ecosystem.
- Public oppose

Public, environmental and health Concerns

- It is important to minimize contamination from landfill to the surrounding environment.
- Hydrology (GW flow) and geology (Rock type, soil permeability) of the site has a direct influence on the possibility of water pollution (GW pollution).
- Landfill should not be located in low lying wetland areas i.e. near marshes, swamps, as the waste should not come in contact with surface/ GW.
- It should not be located in flood plains of streams/ rivers. There should be minimum distance of 60m from any lake/pond.
- Vertical separation of 1.5 m between base of landfill and seasonally high GW table elevation.
- It should not be located in unstable areas or if it is present it must be designed to resist forces caused by seismic activity.

THANKYOU