	SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY **VIRUDHUNAGAR** **DEPARTMENT OF CIVIL ENGINEERING**	

QUESTION WITH ANSWERS

DEPT: CIVIL –IV **SEM:VII**

SUB.CODE/ NAME: EN6501 /Municipal Solid Waste Management.

UNIT 5 - Disposal.
PART - A (2 marks)

1.What is called municipal solid waste landfill (MFWLF)?

- definition: depositing waste on the ground and burying it with at least six inches of dirt.

- municipal solid waste landfill (MFWLF) —receives household wastes but can also receive non-hazardous sludge, industrial solid waste, construction and demolition debris.

2.Define LEACHATE.

LEACHATE = a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

3.What are the Landfill types?
a) **bioreactor landfills (bioreactors)**
—quickly transform / degrade organic waste
addition of liquid and sometimes air to enhance microbial processes||
b) **construction and demolition debris (C & D) landfills**
—only accepts concrete, asphalt, brick, wood, drywall, asphalt roofing shingles, metals, and some types of plastics
C&D landfills are subject to less stringent standards than municipal solid waste landfills due to the relatively inert nature of C&D debris materials||

3.What are the Advantages of landfills?
Advantages of landfills.
a) no burning needed
b) air pollution minimal
c) constant burying of the layers—vermin (rats, etc.) are kept to a minimum

4.What type of Problems with landfills in disposal.

- Landfills require space
- Produce methane gas (can be used for energy, or can cause climate change)
- Leachate must be collected and treated
- Potential for water pollution
- NOT a long-term remedy.

5.What is called Secure landfills.

Land filling of hazardous solid or containerized waste is regulated more stringently than land filling of municipal solid waste. Hazardous wastes must be deposited in so-called secure landfills, which provide at least 3 metres (10 feet) of separation between the bottom of the landfill and the underlying bedrock or groundwater table.

6.Write about leachate collection system.

A secure hazardous-waste landfill must have two impermeable liners and leachate collection systems. The double leachate collection system consists of a network of perforated pipes placed above each liner. The upper system prevents the accumulation of leachate trapped in the fill, and the lower serves as a backup.

Collected leachate is pumped to a treatment plant. In order to reduce the amount of leachate in the fill and minimize the potential for environmental damage, an impermeable cap or cover is placed over a finished landfill.

7.What is meant by Leachate recirculation?

Leachate recirculation: It is one of the simplest forms of treatment. Recirculation of leachate reduces the hazardous nature of leachate and helps wet the waste, increasing its potential for biological degradation.

8.What is meant by Natural liners?

Natural liners: These refer to compacted clay or shale, bitumen or soil sealants, etc., and are generally less permeable, resistant to chemical attack and have good sorption properties. They generally do not act as true containment barriers, because sometimes leachate migrates through them.

9. What is meant by Synthetic (geo-membrane) liners?

Synthetic (geo-membrane) liners: These are typically made up of high or medium density polyethylene and are generally less permeable, easy to install, relatively strong and have good deformation characteristics. They sometimes expand or shrink according to temperature and age.

10.What are the minimum requirements you need to consider for a sanitary landfill?

The four minimum requirements you need to consider for a sanitary landfill are:
(i) full or partial hydrological isolation;
(ii) formal engineering preparation;
(iii) permanent control;
(iv) planned waste emplacement and covering.

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UNIT 5 - Disposal.
Part B-(16 marks)

1.Explain the Remedial action for disposal of MSW.

Disposal of hazardous waste in unlined pits, ponds, or lagoons poses a threat to human health and environmental quality. Many such uncontrolled disposal sites were used in the past and have been abandoned.

Depending on a determination of the level of risk, it may be necessary to remediate those sites. In some cases, the risk may require emergency action. In other instances, engineering studies may be required to assess the situation thoroughly before remedial action is undertaken.

problems
a) ***leachate generation***
- leachate—*water tainted with pollutants*
- forms from percolation and dissolving chemicals
- *can have heavy metals, battery acid, cleaning fluid, pesticides, POPs…*

Gas released, as a result of degradation or volatilisation of waste components, causes odour, flammability, health problems and damage of the vegetation (due to oxygen depletion in the root zone). The measures to control this include liners, soil covers, passive venting or active extraction of gas for treatment before discharge into the atmosphere.

Polluted leachate appears shortly after disposal of the waste. This may cause groundwater pollution and pollution of streams through sub-surface migration. Liners, drainage collection, treatment of leachate, and groundwater and downstream water quality monitoring are necessary to control this problem.

b) ***methane production***

- buried wastes promotes *anaerobic* bacterial action
- **biogas** is produced (2/3 CH_4, the rest H_2 and CO_2)
  - biogas seeping underground can poison root systems of plants
  - biogas can seep upward into homes and may cause explosions
- **LFG** = **landfill gases**

c) ***incomplete decomposition***

- lack of moisture and exposure to the elements slow down decomposition of biodegradable materials buried in a landfill
- increased water increases decomposition BUT would increase the toxicity of the leachate

d) ***settling***

- settling and compacting of waste as it decomposes
- monitoring the area to maintain a level surface

e) *land values and land use*

improving landfills

a) **landfill siting –** an example process

characteristics of landfill siting: high ground, significant distance above the water table

- initial site inspection
- initial site report (ISR)
- pre-feasibility report
- feasibility report
- environmental analysis
- public hearings
- plan of operation report
- landfill construction documentation report
- negotiation
- arbitration, if needed

main parts of a landfill

- leachate collection system
- contoured floor
- layers of soil, sand/gravel, clay in a pyramidal shape
- layers of refuse buried

combustion **(burning) of waste**

1) advantages

a) reduction of the weight and volume of trash

b) reduction of toxic substances into two types of ash

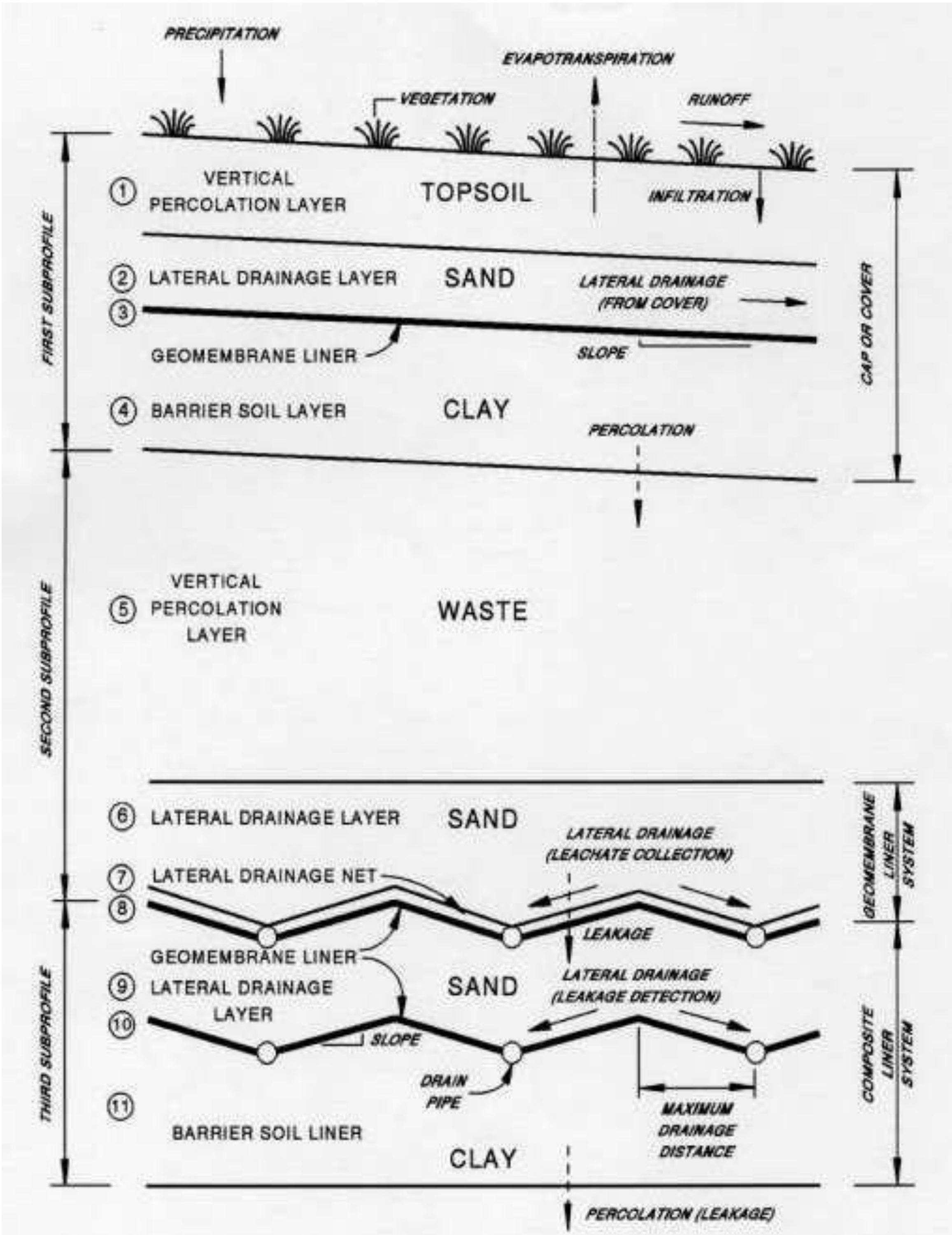
- *fly ash* (collected from fumes)
- *bottom ash* (collects at the bottom of the boiler)

c) trash picked up as usual, just to a different destination

d) electricity can be produced in **waste-to-energy (WTE)** facilities

- **resource recovery—**separating materials before and after combustion

2.Draw the Landfill design.



LANDFILL DESIGN

3.Explain the priniciple and layout of sanitary landfill.

SANITARY LANDFILL

The term landfill generally refers to an engineered deposit of wastes either in pits/trenches or on the surface. And, a sanitary landfill is essentially a landfill, where proper mechanisms are available to control the environmental risks associated with the disposal of wastes and to make available the land, subsequent to disposal, for other purposes.

However, you must note that a landfill need not necessarily be an engineered site, when the waste is largely inert at final disposal, as in rural areas, where wastes contain a large proportion of soil and dirt.

This practice is generally designated as non-engineered disposal method. When compared to uncontrolled dumping, engineered landfills are more likely to have pre-planned installations, environmental monitoring, and organised and trained workforce. Sanitary landfill implementation, therefore, requires careful site selection, preparation and management.

The four minimum requirements you need to consider for a sanitary landfill are:

(i) full or partial hydrological isolation;

(ii) formal engineering preparation;

(iii) permanent control;

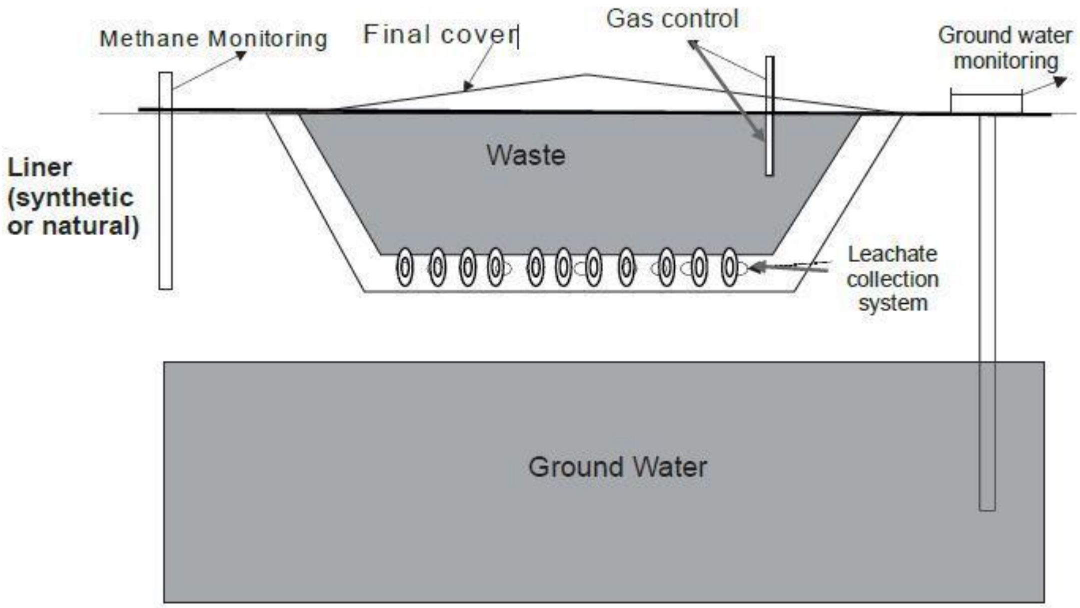
(iv) planned waste emplacement and covering.

Principle

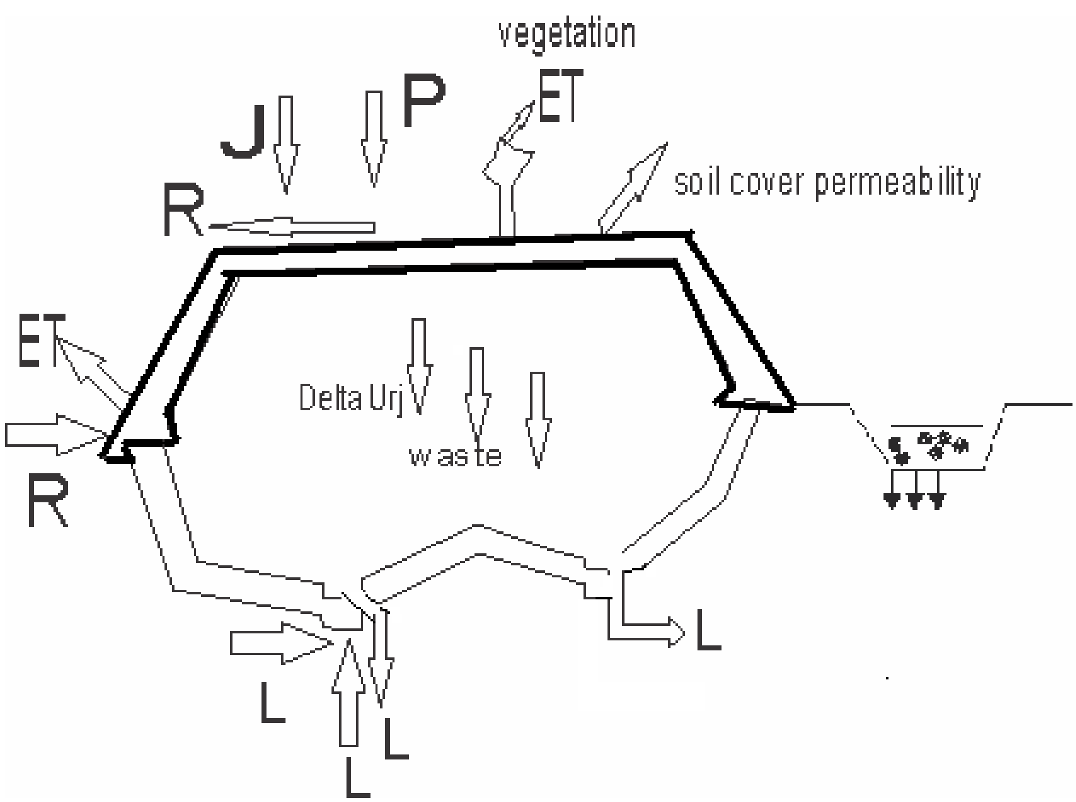
The purpose of land filling is to bury or alter the chemical composition of the wastes so that they do not pose any threat to the environment or public health. Landfills are not homogeneous and are usually made up of cells in which a discrete volume of waste is kept isolated from adjacent waste cells by a suitable barrier. The barriers between cells generally consist of a layer of natural soil (i.e., clay), which restricts downward or lateral escape of the waste constituents or leachate.

Land filling relies on containment rather than treatment (for control) of wastes. If properly executed, it is a safer and cheaper method than incineration . An environmentally sound sanitary landfill comprises appropriate liners for protection of the groundwater (from contaminated leachate), run-off controls, leachate collection and treatment, monitoring wells and appropriate final cover design (Phelps, 1995). Figure below gives a schematic layout of sanitary landfill along with its various components:

Schematic Layout of Sanitary Landfill



Design components in a subtitle D Landfill



4.Explain the life cycle of a landfill.

let us touch upon the phases in the life cycle of a landfill, and these are:

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.

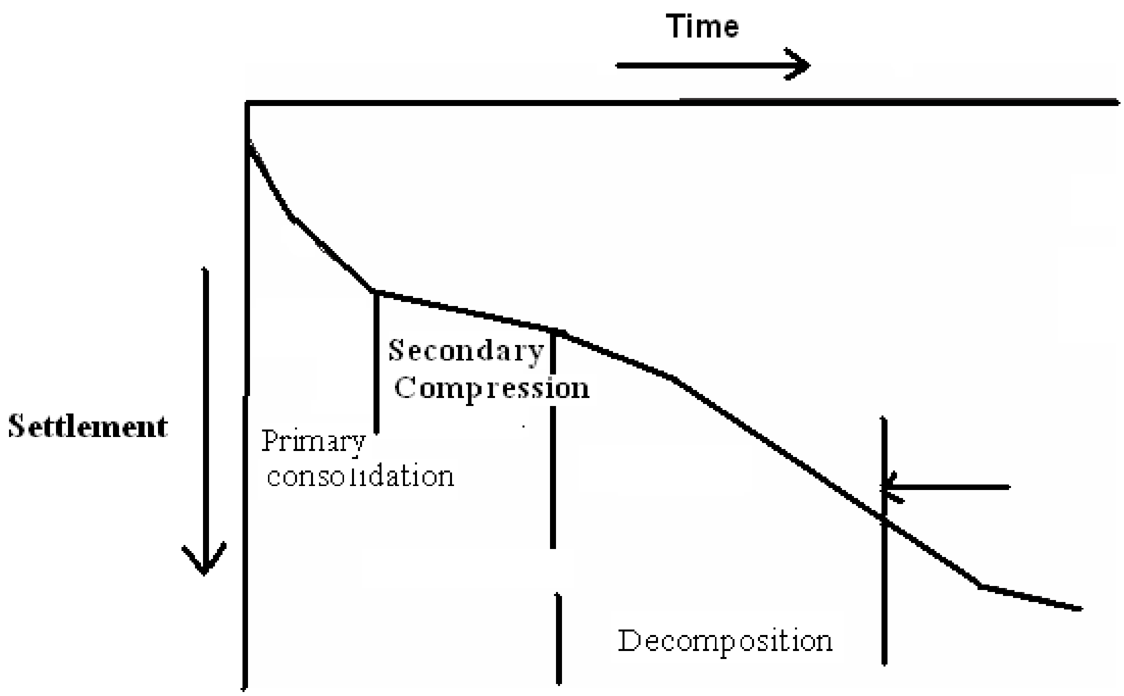
Completed phase (20 – 100 years): This phase involves the termination of the actual filling to the time when the environmental installations need no longer be operated. The emissions may have by then decreased to a level where they do not need any further treatment and can be discharged freely into the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

Final storage phase: In this phase, the landfill is integrated into the surroundings for other purposes, and no longer needs special attention.

Landfill processes
The feasibility of land disposal of solid wastes depends on factors such as the type, quantity and characteristics of wastes, the prevailing laws and regulations, and soil and site characteristics. Let us now explain some of these processes.

(i) **Site selection process and considerations:** This requires the development of a working plan – a plan, or a series of plans, outlining the development and descriptions of site location, operation, engineering and site restoration. Considerations for site include public opinion, traffic patterns and congestion, climate, zoning requirements, availability of cover material and liner as well, high trees or buffer in the site perimeter, historic buildings, and endangered species, wetlands, and site land environmental factors, speed limits, underpass limitations, load limits on roadways, bridge capacities, and proximity of major roadways, haul distance, hydrology and detours.

(ii) **Settling process:** The waste body of a landfill undergoes different stages of settling or deformation. Figure below illustrates these stages:



The three stages shown in the figure above are described below:
Primary consolidation: During this stage, a substantial amount of settling occurs. This settlement is caused by the weight of the waste layers. The movement of trucks, bulldozers or mechanical compactors will also enhance this process. After this primary consolidation, or short-term deformation stage, *aerobic degradation* processes occur.

Secondary compression: During this stage, the rate of settling is much lower than that in the primary consolidation stage, as the settling occurs through compression, which cannot be enhanced.

Decomposition: During the degradation processes, organic material is converted into gas and leachate. The settling rate during this stage increases compared to the secondary compression stage, and continues until all decomposable organic matter is degraded. The settling rate, however, gradually decreases with the passage of time.

To appropriately design protective liners, and gas and leachate collection systems, it is, therefore, necessary to have a proper knowledge of the settling process of wastes.

(iii) **Microbial degradation process:** The microbial degradation process is the most important biological process occurring in a landfill. These processes induce changes in the chemical and physical environment within the waste body, which determine the quality of leachate and both the quality and quantity of landfill gas (see Subsection 4.3.2). Assuming that landfills mostly receive organic wastes, microbial processes will dominate the stabilisation of the waste and therefore govern landfill gas generation and leachate composition. Soon after disposal, the predominant part of the wastes becomes *anaerobic*, and the bacteria will start degrading the solid organic carbon, eventually to

produce carbon dioxide and methane. The *anaerobic degradation* process undergoes the following stages:
Solid and complex dissolved organic compounds are hydrolysed and fermented by the fermenters primarily to volatile fatty acids, alcohols, hydrogen and carbon dioxide.

An acidogenic group of bacteria converts the products of the first stage to acetic acid, hydrogen and carbon dioxide.

Methanogenic bacteria convert acetic acid to methane and carbon dioxide and hydrogenophilic bacteria convert hydrogen and carbon dioxide to methane.

The biotic factors that affect methane formation in the landfill are pH, alkalinity, nutrients, temperature, oxygen and moisture content.

Enhancement of degradation

Enhancement of the degradation processes in landfills will result in a faster stabilisation of the waste in the landfill, which enhances gas production, and we can achieve this by:
Adding partly composted waste: As the readily degradable organic matter has already been decomposed aerobically, the rapid acid production phase is overcome, and the balance of acid and methane production bacteria can develop earlier and the consequent dilution effect lowers the organic acid concentration.

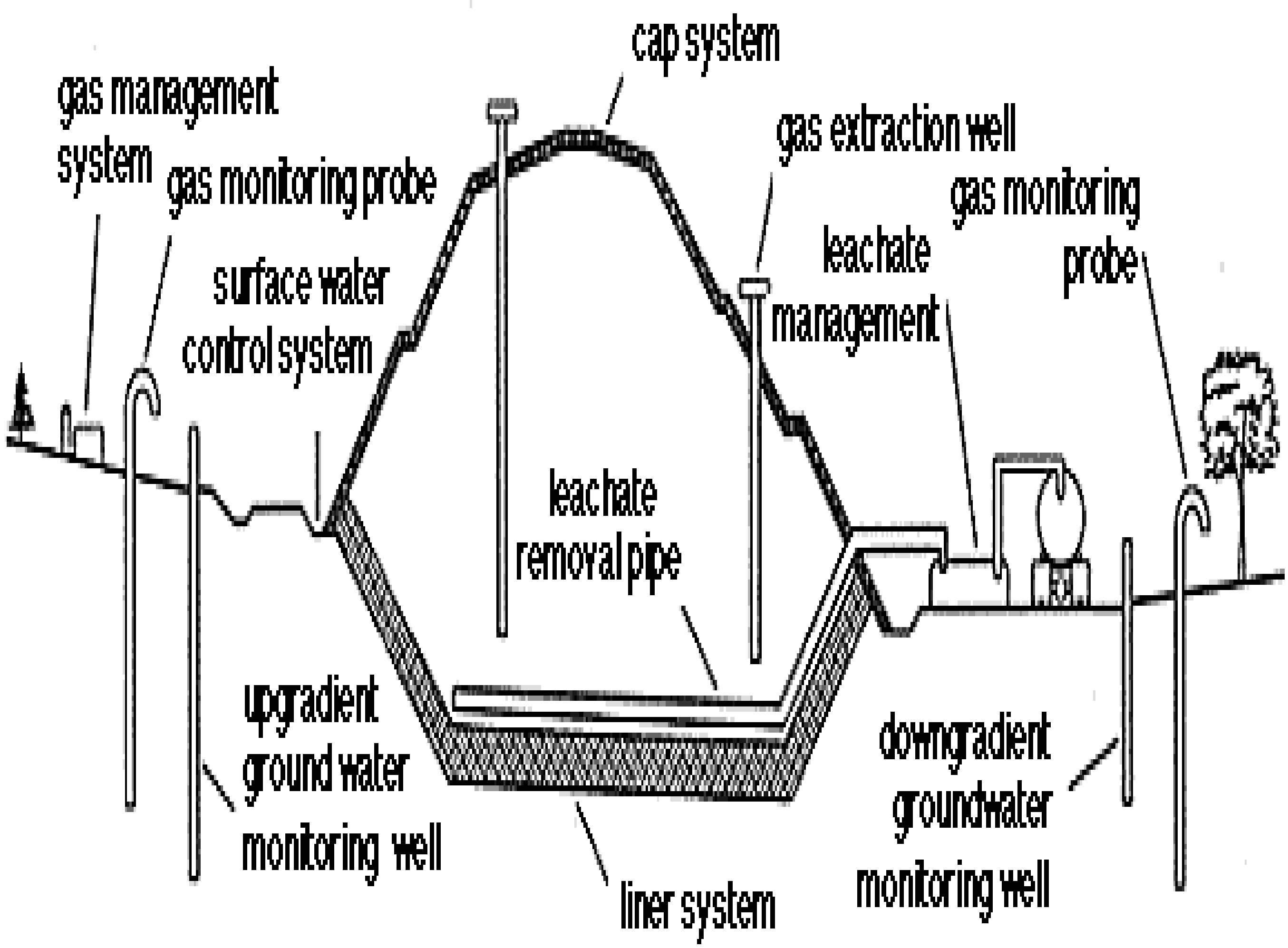
Recirculating leachate: This may have positive effects since a slow increase in moisture will cause a long period of gas production. During warmer periods, recirculated leachate will evaporate, resulting in lower amounts of excess leachate.

5.Explain the leachate collection and treatment.

LEACHATE FORMATION

Leachate can pollute both groundwater and surface water supplies. The degree of pollution will depend on local geology and hydrogeology, nature of waste and the proximity of susceptible receptors. Once groundwater is contaminated, it is very costly to clean it up. Landfills, therefore, undergo siting, design and construction procedures that control leachate migration.

Typical schematic of a state-of-the-art landfill



(credit: Paul C. Rizzo Associates)

Composition and properties

Leachate comprises soluble components of waste and its degradation products enter water, as it percolates through the landfill. The amount of leachate generated depends on:

- water availability;
- landfill surface condition;
- refuse state;
- condition of surrounding strata.

The major factor, i.e., water availability, is affected by precipitation, surface runoff, waste decomposition and liquid waste disposal. The water balance equation for landfill requires negative or zero (“Lo”) so that no excess leachate is produced. This is calculated using the following formula:

$Lo = I – E – aW$

$i.e.\ I – E < aW$

where, Lo = free leachate retained at site (equivalent to leachate production minus leachate leaving the site); I = total liquid input;
E = evapotranspiration losses; a = absorption capacity of waste; W
= weight of waste disposed.

Common toxic components in leachate are ammonia and heavy metals, which can be hazardous even at low levels, if they accumulate in the food chain. The presence of ammoniacal nitrogen means that leachate often has to be treated off-site before being discharged to a sewer, since there is no natural bio-chemical path for its removal (Ali, et al., 1995). Leachate composition varies with time and location. Table 4.2 shows a typical leachate properties and composition at various stages of waste decomposition.

Table.
Properties and Composition of Leachate at Various Stages of Decomposition (mg/l except pH)

Components	Fresh wastes	Aged wastes	Wastes with high moisture
pH	6.2	7.5	8.0
COD	23800	1160	1500
BOD	11900	260	500
TOC	8000	465	450
Volatile acid (as C)	5688	5	12
NH_3-N	790	370	1000
NO_3-N	3	1	1.0
Ortho-P	0.73	1.4	1.0
Cl	1315	2080	1390
Na	9601	300	1900
Mg	252	185	186
K	780	590	570
Ca	1820	250	158
Mn	27	2.1	0.05
Fe	540	23	2.0
Cu	0.12	0.03	-
Zn	21.5	0.4	0.5
Pb	0.40	0.14	-

Leachate migration
It is generally difficult to predict the movement of escaped leachate accurately. The main controlling factors are the surrounding geology and hydrogeology. Escape to surface water may be relatively easy to control, but if it escapes to groundwater sources, it can be very difficult both to control and clean up. The degree of groundwater contamination is affected by physical, chemical and biological actions. The relative importance of each process may change, however, if the leachate moves from the landfill to the sub-surface region.
Control
The best way to control leachate is through prevention, which should be integral to the site design. In most cases, it is necessary to control liquid access, collection and treatment, all of which can be done using the following landfill liners:

Natural liners: These refer to compacted clay or shale, bitumen or soil sealants, etc., and are generally less permeable, resistant to chemical attack and have good sorption properties. They generally do not act as true containment barriers, because sometimes leachate migrates through them.

Synthetic (geo-membrane) liners: These are typically made up of high or medium density polyethylene and are generally less permeable, easy to install, relatively strong and have good deformation characteristics. They sometimes expand or shrink according to temperature and age.

Note that natural and geo-membrane liners are often combined to enhance the overall efficiency of the containment system. Some of the leachate collection systems include impermeable liner, granular material, collection piping, leachate storage tank; leachate is trucked to a wastewater treatment facility.

Treatment

Concentrations of various substances occurring in leachate are too high to be discharged to surface water or into a sewer system. These concentrations, therefore, have to be reduced by removal, treatment or both. The various treatments of leachate include:

Leachate recirculation: It is one of the simplest forms of treatment. Recirculation of leachate reduces the hazardous nature of leachate and helps wet the waste, increasing its potential for biological degradation.

Biological treatment: This removes BOD, ammonia and suspended solids. Leachate from land filled waste can be readily degraded by biological means, due to high content of volatile fatty acids (VFAs). The common methods are aerated lagoons (i.e., special devices which enhance the aerobic processes of

degradation of organic substances over the entire depth of the tank) and activated sludge process, which differs from aerated lagoons in that discharged sludge is recirculated and is often used for BOD and ammonia removal. While under conditions of low COD, rotating biological contactors (i.e., biomass is brought into contact with
circular blades fixed to a common axle which is rotated) are very effective in removing ammonia. In an anaerobic treatment system, complex organic molecules are fermented in filter. The common types are anaerobic filters, anaerobic lagoon and digesters.

Physicochemical treatment: After biological degradation, effluents still contain significant concentrations of different substances. Physicochemical treatment processes could be installed to improve the leachate effluent quality. Some of these processes are flocculation-precipitation. (Note that addition of chemicals to the water attracts the metal by floc formation). Separation of the floc from water takes place by sedimentation, adsorption and reverse osmosis.

6. Explain the ENVIRONMENTAL EFFECTS OF LANDFILL.

ENVIRONMENTAL EFFECTS OF LANDFILL

The environmental effects of a landfill include wind-blown litter and dust, noise, obnoxious odour, vermin and insects attracted by the waste, surface runoff and inaesthetic conditions. Gas and leachate problems also arise during the operation phase and require significant environmental controls. In what follows, we will describe some of the major environmental effects below:

(i) Wind-blown litter and dust are continuous problems of the ongoing landfill operation and a nuisance to the neighbourhood. Covering the waste cells with soil and spraying water on dirt roads and waste in dry periods, in combination with fencing and movable screens, may minimise the problem of wind-blown litter and dust. However, note that the problem will remain at the tipping front of the landfill.

(ii) Movement of waste collection vehicles, emptying of wastes from them, compactors, earthmoving equipment, etc., produce noise. Improving the technical capability of the equipment, surrounding the fill area with soil embankments and plantations, limiting the working hours and appropriately training the workforce will help minimise noise pollution.

(iii) Birds (e.g., scavengers), vermin, insects and animals are attracted to the landfill for feeding and breeding. Since many of these may act as disease vectors, their presence is a potential health problem.

(iv) Surface run-off, which has been in contact with the land filled waste, may be a problem in areas of intense rainfall. If not controlled, heavily polluted run-off may enter directly into creeks and streams. Careful design and maintenance of surface drains and ditches, together with a final soil cover on completed landfill sections, can help eliminate this problem.

(v) An operating landfill, where equipment and waste are exposed, appears inaesthetic. This problem may be reduced by careful design of screening soil embankments, plantings, rapid covering and re-vegetation of filled sections.

(vi) Gas released, as a result of degradation or volatilisation of waste components, causes odour, flammability, health problems and damage of the vegetation (due to oxygen depletion in the root zone). The measures to control this include liners, soil covers, passive venting or active extraction of gas for treatment before discharge into the atmosphere.

(vii) Polluted leachate appears shortly after disposal of the waste. This may cause groundwater pollution and pollution of streams through sub-surface migration. Liners, drainage collection, treatment of leachate, and groundwater and downstream water quality monitoring are necessary to control this problem.