BASICS OF CIVIL ENGINEERING & MECHANICS
UNIT-2-2

Course code:CV14/CV24

Credits:3:0:0

Topics Covered

Environment- Traditional and Futuristic Systems

The surroundings or conditions in which a person, animal, or plant lives or operates.

Sanitary engineering, also known as public health engineering or wastewater engineering, is the application of engineering methods to improve sanitation of human communities, primarily by providing the removal and disposal of human waste, and in addition to the supply of safe potable water.

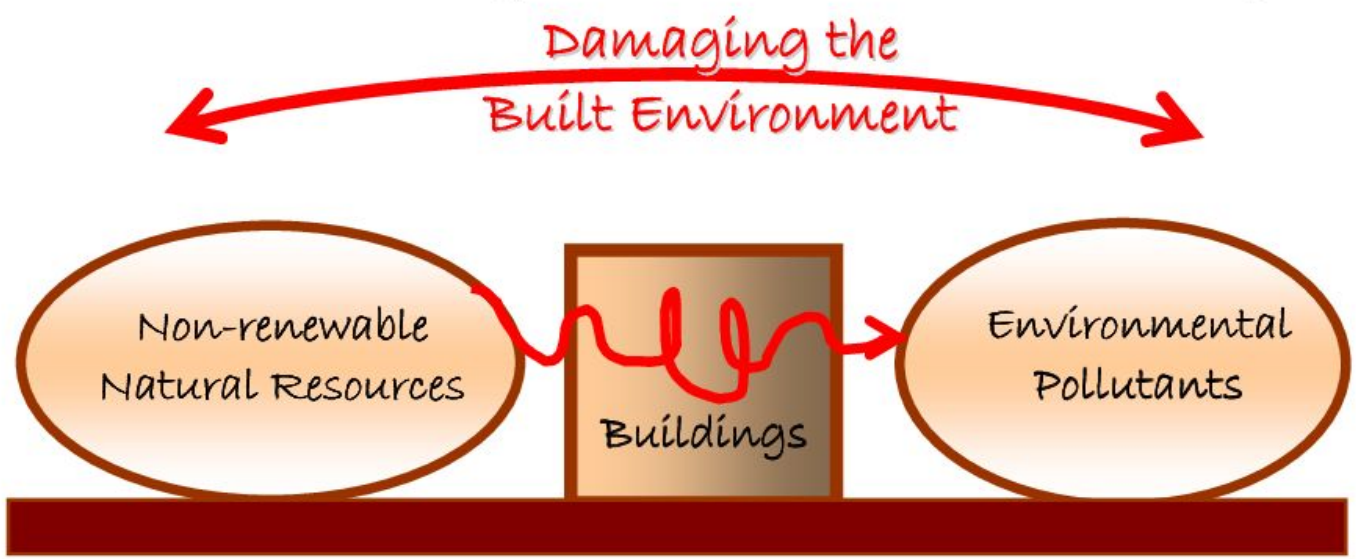
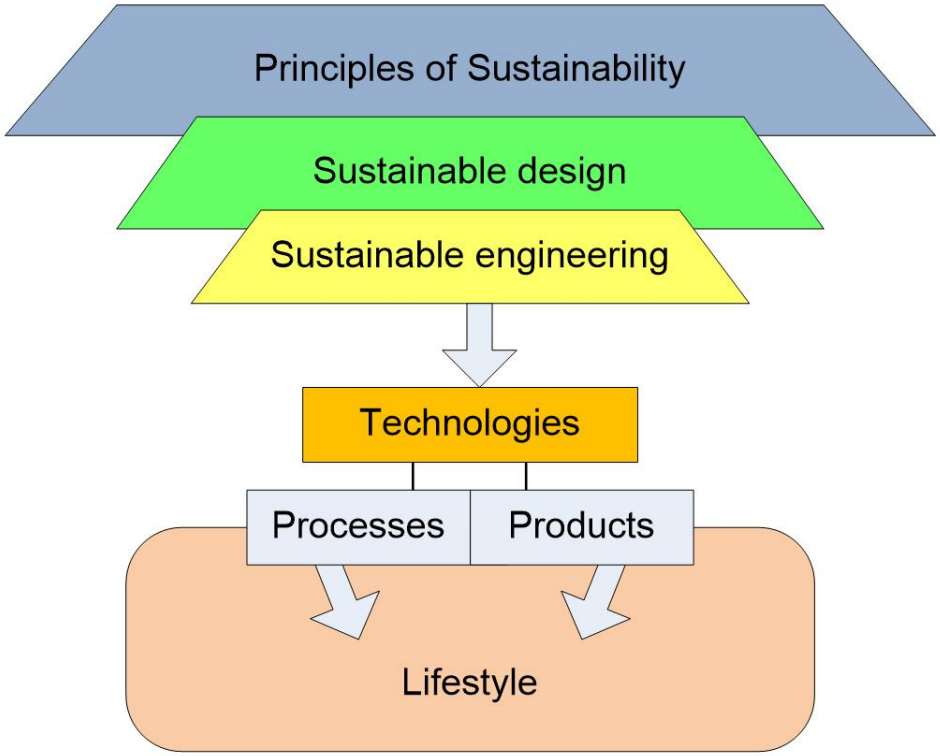


Figure 1: Analytical Sketch on Architectural Products (Building in Use)

ENVIRONMENT-TRADITIONAL USAGE



PRINCIPLES OF SUSTAINABLE ENGINEERING

RAMAIAH Institute of Technology

DEPARTMENT OF CIVIL ENGINEERING

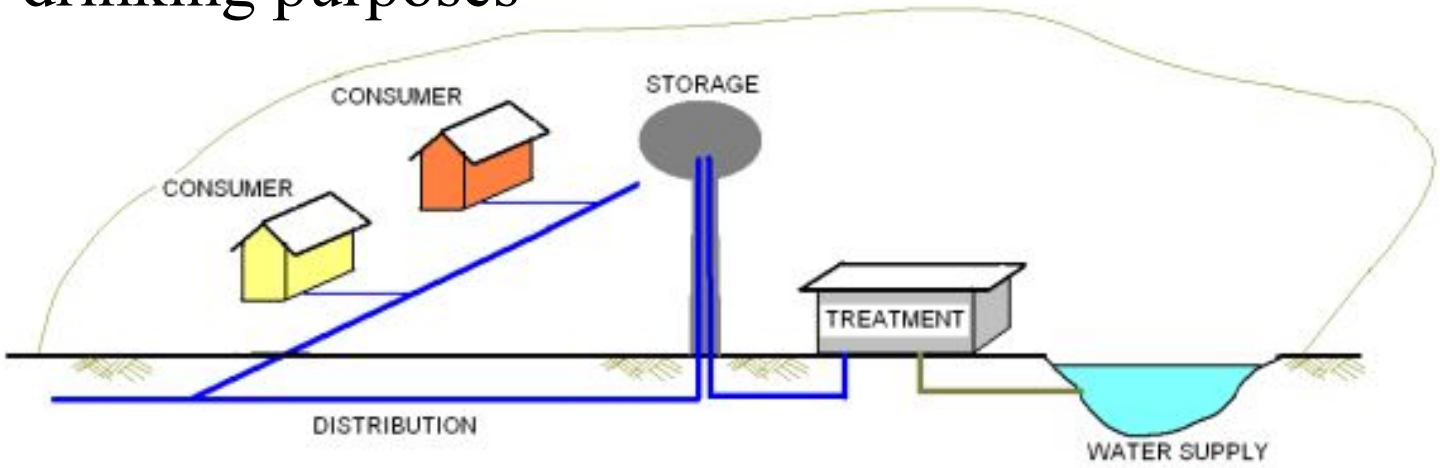
Course: Basics of Civil Engineering & Mechanics
Credits: 3:0:0

WATER SUPPLY AND SANITARY ENGINEERING

Distribution of water source

- Water is spread on two third of the earth but most of the water is not useful for direct human consumption. It is available as ice on the poles and the glaciers with a percentage of 2.14.
- The largest store is ocean with useless saline, brackish water (total dissolved solids more than 50000 ppm) having 97.24 per cent of total water. The total available fresh water (that can be used for irrigation and drinking) is 0.62 per cent.
- This fresh water is distributed in surface sources (rivers, lakes etc), ground water (shallow and deep), soil moisture and vapors in atmosphere.

- The surface water is only 1.5% of the total fresh water and most of the fresh water is the ground water. So the surface water is something around 0.01% of the total water. Because of its easy availability the surface water had been the main source of water for irrigation and drinking purposes



Distribution of water source

The various sources of water, which can be harnessed economically, can be divided into the following two categories:-

(A) Surface sources such as

(i) Ponds and lakes

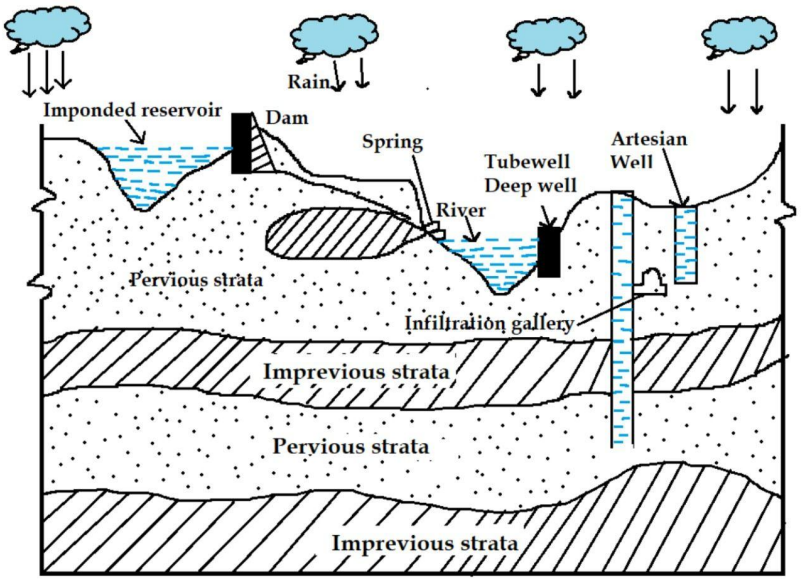
(ii) Streams and rivers

(iii) Storage resources (dams)

(B) Subsurface or underground

(i) Springs

(ii) Wells (open and tube-wells)



Various Sources of Water

Water Resources

- Quality of water is the most important aspect. There are international and national standards for the quality of water to be supplied for human consumption. The state governments may have a slight relaxation in the standards depending upon the local conditions but in general they are the same throughout the country.



Quality of Water

- The main aim of the public health engineering departments or the environmental engineering departments as they are called these days is to supply safe and palatable (good in taste) water to the consumers. Water should also be free from any odor. The temperature of water should be reasonably good. It should neither be corrosive nor scale forming and should be free from minerals that can produce undesirable physiological effects. For achieving this ideal condition the minimum standards of quality are to be established.
- As per the Manual on Water Supply and Treatment published by the Government of India, the main objective is to make water absolutely free from risks of transmitting disease, means safety is compulsory where as the other qualities are to be maintained within a specified range.

The following table shows the physical and chemical standards of water as per the manual.

Sl No	Charecteristics	*Acceptable	**Cause for rejection
1	Turbidity (units on J.T.U. Scale)	2.5	10
2	Colour (Units on platinum Cobalt Scale)	5.0	25
3	Taste and Odour	Unobjectionable	Unobjectionable
4	pH	7.0 to 8.5	6.5 to 9.2
5	Total dissolved solids(mg/l)	500	1500
6	Total hardness (mg/l)(as CaCO3)	200	600
7	Chlorides as Cl (mg/l)	200	1000
8	Sulphates (as SO4) (mg/l)	200	400
9	Fluorides (as F) (mg/l)	1.0	1.5
10	Nitrates (as NO3) (mg/l)	45	45

The following table shows the physical and chemical standards of water as per the manual.

Sl No	Charecteristics	*Acceptable	**Cause for rejection
11	Calcium (as Ca) (mg/l)	75	200
12	Magnesium (as Mg) (mg/l)	30	150
13	13 Iron (as Fe) (mg/l)	0.1	1.0
14	Manganese as Mn (mg/l)	0.05	0.5
15	Copper (as Cu) (mg/l)	0.05	1.5
16	Zinc as Zn (mg/l)	5	15
17	Phenolic Componds (as Phenol) mg/l	0.001	0.002
18	Anionic detergents (as MBAS) (mg/l)	0.2	1.0
19	Mineral Oil (mg/l)	0.01	0.3

TREATMENT OF WATER

The available raw water has to be treated to make it fit, i.e. potable, means safe for human consumption. It should satisfy the physical, chemical and bacteriological standards as specified above. The various methods of purification of water are

(i) Screening

(ii) Plain sedimentation

(iii) Sedimentation aided with coagulation

(iv) Filtration

(v) Disinfection

(vi) Aeration

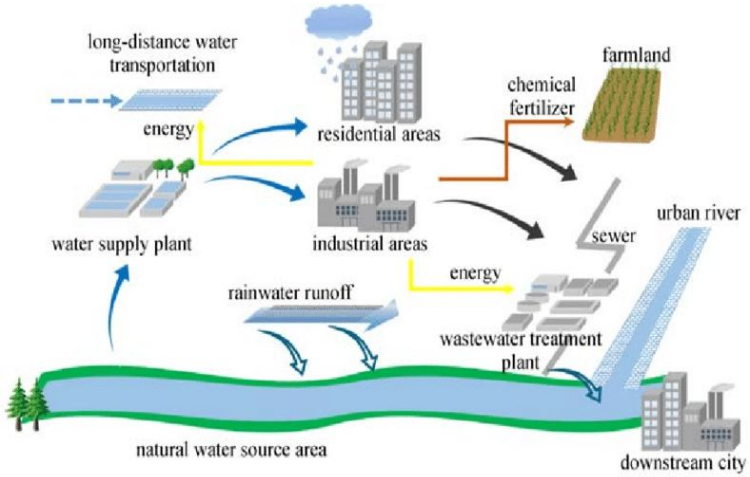
(vii) Softening

(viii)Miscellaneous treatments like defluoridation, recarbonation desalination etc.

WASTE WATER MANAGEMENT

As per the Manual on Sewerage and Sewage treatment the Government of India publication, in India, wastewater disposal systems are usually managed by local bodies. This service facility falls under the water supply and sanitation sector. The development of the sector is assisted at Government of India level, State Government level and local body level. There are five basic important aspects of the wastewater management namely,

(i) General Administration
(ii) Personnel Administration
(iii) Inventory Control
(iv) Financial Control
(v) Public Relation



The wastewater management system in general should aim at the following achievement.

(a) Proper collection of wastewater discharged by the community.

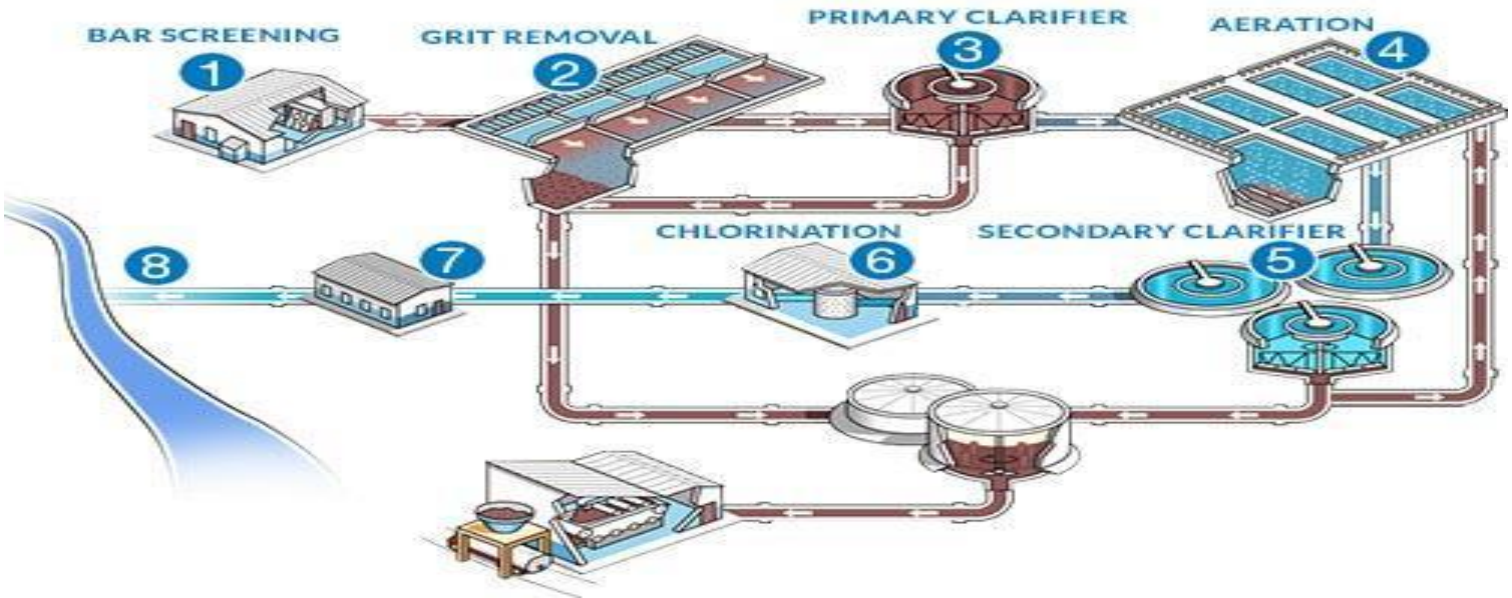
(b) Adequate treatment of wastewater to achieve the desired effluent standards.

(c) Safe and efficient operations and as far as possible self supporting.

(d) Sound financial management.

Waste Water Management

- The aim of wastewater management is the protection of environment from the ill effects of the wastewater. As stated earlier the wastewater management has the main components as collection, conveyance, treatment and disposal of wastewater.



Treatment of Wastewater

- The objective of sewage treatment is to make the sewage harmless before it is disposed.
- The disposal means final laying of sewage on the land or leaving it on land to flow and mix in some body of water like the river or a pond.
- The sewage has many characteristics like temperature, hydrogen ion concentration (pH), color and odor, solids, nitrogen, phosphorous, chlorides, bio-chemical oxygen demand (BOD), chemical oxygen demand (COD), and toxic metals etc. Though all of them are important for determination of disposal criteria, BOD is the most important one.

The following table shows the application of physical unit operations in wastewater treatment

Sl. No	Operation	Application
1	Screening	Removal of floating matter
2	Comminution	Grinding and shredding of big objects
3	Equalization	Equalization of flow and BOD loading
4	Mixing	Mixing of chemical and gases in wastewater and keeping solids in suspension

The following table shows the application of physical unit operations in wastewater treatment

Sl. No	Operation	Application
5	Flocculation	Enlarging small particles
6	Sedimentation	Removal of settle able solids
7	Floatation	Thickening of biological sludge
8	Filtration	Removal of fine material after biological or chemical treatment
9	Micro screening	Removal of algae from stabilization ponds, oxidation ponds effluent

The following table shows the application of chemical unit processes in wastewater treatment.

Sl. No	Process	Application
1	Chemical precipitation	Removal of phosphorus and enhancement of suspended solids removal in sedimentation
2	Gas transfer	Addition and removal of gases
3	Adsorption	Removal of organics
4	Disinfection	Killing of disease causing organisms
5	Dechlorination	Removal of chlorine residuals
6	Miscellaneous	Specific wastewater treatments

Biological unit processes are those processes in which the removal of objectionable matter is done by biological activity. In this process the objectives are to coagulate and remove the dissolved or non settleable colloidal solids.

Biological processes are differentiated by the oxygen dependence of the microorganisms responsible for the wastewater treatment as follows:

(a) Aerobic processes: The processes occur in presence of oxygen by the aerobic bacteria. The aerobic processes include the following,

(i) Trickling filter (attached growth process)

(ii) Activated sludge process with its modifications (suspended growth process)

(iii) Aerobic stabilization ponds (oxidation ponds)

(iv) Aerated lagoons

(b) Anaerobic processes: The anaerobic processes occur in absence of oxygen by the anaerobic bacteria. The anaerobic processes include the following:

(i) Anaerobic sludge digestion

(ii) Anaerobic contact process

(iii) Anaerobic filters

(iv) Anaerobic lagoons or ponds

(v) Septic tanks and Imhoff tanks

(c) Facultative Process: The facultative bacteria can act in presence as well as in absence of oxygen.

Hazardous Waste Treatment

- Hazardous waste can be treated by chemical, thermal, biological, and physical methods.
- Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization.
- Among thermal methods is high-temperature incineration, which not only can detoxify certain organic wastes but also can destroy them. Special types of thermal equipment are used for burning waste in either solid, liquid, or sludge form. These include the fluidized-bed incinerator, multiple-hearth furnace, rotary kiln, and liquid-injection incinerator. One problem posed by hazardous-waste incineration is the potential for air pollution.

Hazardous Waste Treatment

Incineration plant in Brescia, Italy.

Hazardous Waste Treatment

- Biological treatment of certain organic wastes, such as those from the petroleum industry, is also an option. One method used to treat hazardous waste biologically is called land farming. In this technique the waste is carefully mixed with surface soil on a suitable tract of land. Microbes that can metabolize the waste may be added, along with nutrients. In some cases a genetically engineered species of bacteria is used. Food or forage crops are not grown on the same site. Microbes can also be used for stabilizing hazardous wastes on previously contaminated sites; in that case the process is called bioremediation.

Hazardous Waste Treatment

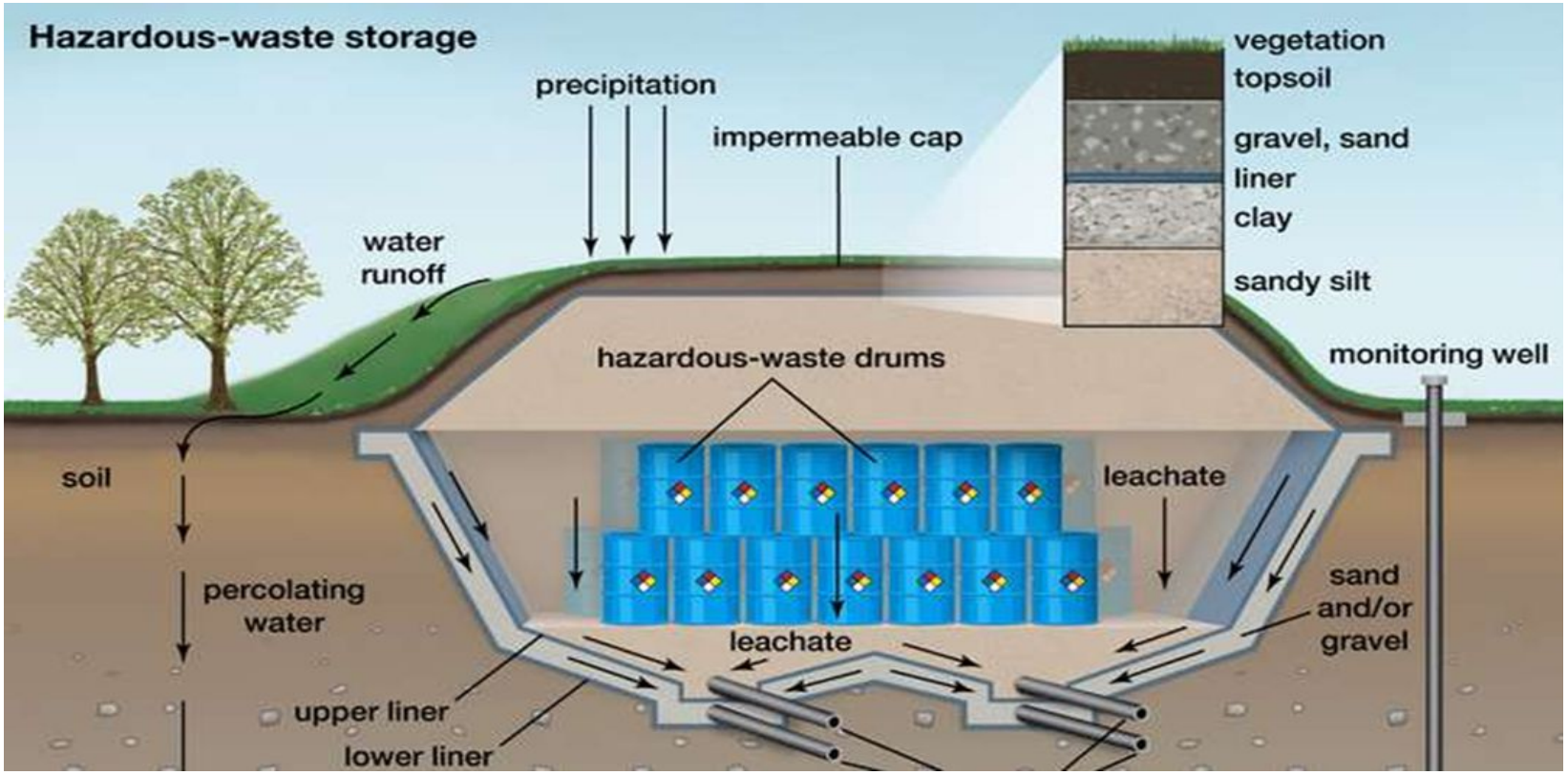
- The chemical, thermal, and biological treatment methods outlined above change the molecular form of the waste material. Physical treatment, on the other hand, concentrates, solidifies, or reduces the volume of the waste. Physical processes include evaporation, sedimentation, flotation, and filtration. Yet another process is solidification, which is achieved by encapsulating the waste in concrete, asphalt, or plastic. Encapsulation produces a solid mass of material that is resistant to leaching. Waste can also be mixed with lime, fly ash, and water to form a solid, cement like product.

Surface storage and land disposal

Hazardous wastes that are not destroyed by incineration or other chemical processes need to be disposed of properly. For most such wastes, land disposal is the ultimate destination, although it is not an attractive practice, because of the inherent environmental risks involved. Two basic methods of land disposal include land filling and underground injection.

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 meters (10 feet) of separation between the bottom of the landfill and the underlying bedrock or groundwater table. A secure hazardous-waste landfill must have two impermeable liners and leach ate collection systems.



Hazardous-waste landfill

Schematic diagram of a secure hazardous-waste landfill with a double leachate collection system. *Encyclopædia Britannica, Inc.*

Remedial action

- One option for remediation is to completely remove all the waste material from the site and transport it to another location for treatment and proper disposal. This so-called off-site solution is usually the most expensive option. An alternative is on-site remediation, which reduces the production of leachate and lessens the chance of groundwater contamination. On-site remediation may include temporary removal of the hazardous waste, construction of a secure landfill on the same site, and proper replacement of the waste. It may also include treatment of any contaminated soil or groundwater. Treated soil may be replaced on-site and treated groundwater returned to the aquifer by deep-well injection.

Remedial action

- A less costly alternative is full containment of the waste. This is done by placing an impermeable cover over the hazardous-waste site and by blocking the lateral flow of groundwater with subsurface cutoff walls. It is possible to use cutoff walls for this purpose when there is a natural layer of impervious soil or rock below the site. The walls are constructed around the perimeter of the site, deep enough to penetrate to the impervious layer. They can be excavated as trenches around the site without moving or disturbing the waste material. The trenches are filled with a bentonite clay slurry to prevent their collapse during construction, and they are backfilled with a mixture of soil and cement that solidifies to form an impermeable barrier. Cutoff walls thus serve as vertical barriers to the flow of water, and the impervious layer serves as a barrier at the bottom.

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