UNIT 3

Transportation Engineering Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

IMPORTANCE OF TRANSPORTATION IN NATION'S ECONOMIC DEVELOPMENT

i. Transportation is the means to carry people and goods from one place to another. This has become very important in each stage of human civilization.

ii. Transportation has contributed much to the development of economic, social, political and cultural fields and uplifting their condition. Speedy industrialization is impossible without development of transportation.

iii. Transportation helps in mass production. Whether it is to purchase and bring raw materials or it is to distribute finished goods, one or the other means of transport is necessary. This expands old markets and creates new ones. As a result, demands for goods increases and production should also be increased.

iv. If the development of transportation was not made, Market would be limited in local areas and production would be limited to meet local needs only. As a result, economy of each country would remain in undeveloped condition.

v. Transportation is a basic infrastructure, and its development is an indicator of the country's development.

vi. Transportation ensures extending of trade and network.

vii. The improvement and reforms in the transport sector enhance the dynamicity of freight and passengers in a region.

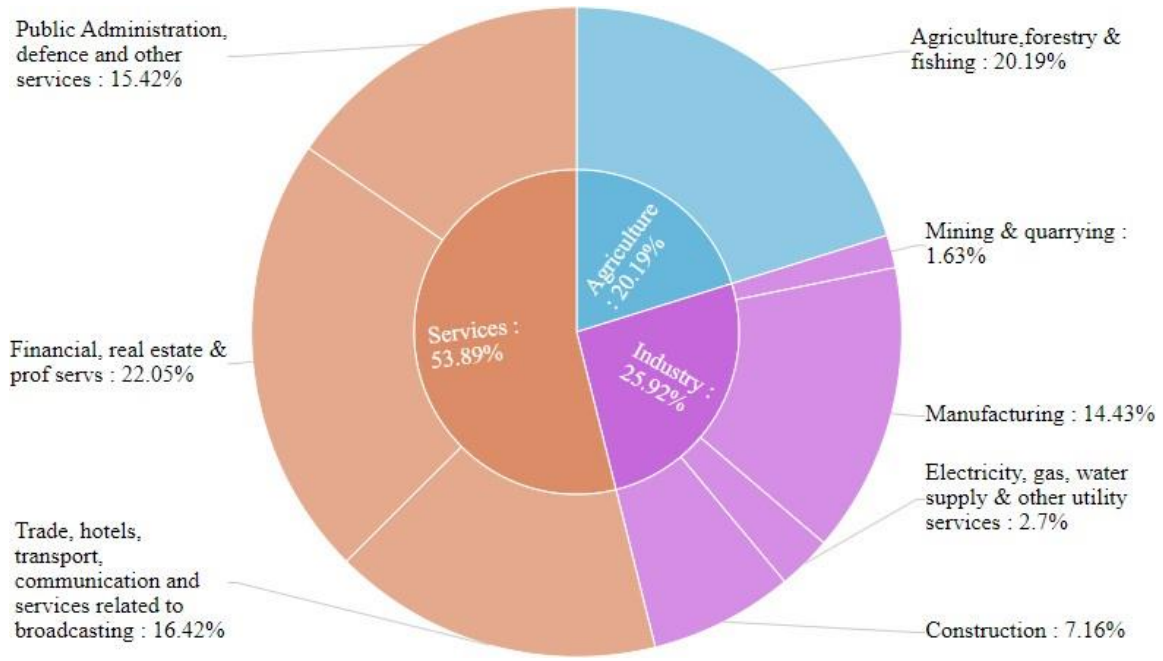
viii. With efficient roads and means of transport in place, industries and markets also develop.

ix. Economic growth gets a boost.

x. It increases job opportunities and decreases regional imbalances.

xi. Good transportation facilities in rural areas enhance the quality of life of people as they can easily access health and medical facilities.

xii. Lastly, it offers a lot of tourism and business opportunities to the government.



In many developed economies, **transportation accounts for between 6% and 12% of the GDP**

India's transportation sector is large and diverse, serving 1.1 billion people. It accounts for **6.4% of India's Gross Domestic Product (GDP).**

The transportation sector includes:

a. India's five means of transport are: Roads, Railways, Pipelines, Waterways, Airways.

b. 87% of passenger traffic

c. 60% of freight traffic movement

d. India has the second-largest road network in the world, spanning over 63,31,757 kilometers.

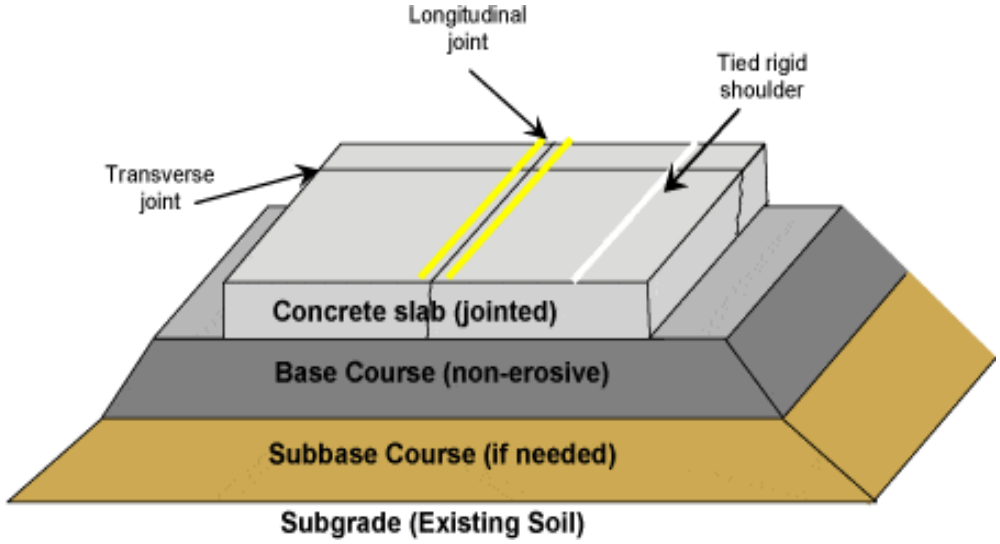
TYPES OF HIGHWAY PAVEMENTS

Road construction involves two primary types of pavement: rigid pavement and flexible pavement. Rigid pavement is constructed with a single layer, while flexible pavement consists of multiple layers.

1. Rigid Pavement
2. Flexible Pavement

1. RIGID PAVEMENT

It is a type of concrete pavement that is designed to provide durability, has a long lifespan, and has the ability to withstand heavy loads. It is commonly used for high-traffic roads, airports, and industrial areas, where the pavement needs to be able to handle a lot of wear and tear. The construction of rigid pavement typically involves pouring concrete slabs on top of a subgrade and base layer. The slabs are usually reinforced with steel or other materials to improve their strength and joints are used to allow for expansion and contraction due to changes in temperature. Joints can also help prevent cracking and other types of damage.



2. FLEXIBLE PAVEMENT

Flexible pavement can be defined as the one consisting of a mixture of asphaltic or bituminous material and aggregates placed on a bed of compacted granular material of appropriate quality in layers over the subgrade.

DIFFERENCES BETWEEN RIGID PAVEMENT AND FLEXIBLE PAVEMENT

S.No	Flexible Pavement	Rigid Pavement
1.	It transfers the wheel load to Subgrade by grain -to-grain mechanism.	It transfers the wheel load to Subgrade by Slab action.
2.	The initial Construction Cost is low.	The initial Construction cost is high.
3.	It doesn't require joints.	It require joints.
4.	Durability is low.	Durability is high.
5.	It doesn't distribute load uniformly.so good subgrade is required.	It distributes wheel load uniformly. So, there is no requirement for a good subgrade.
6.	There is no effect of temperature variation on stress variation.	Temperature variation effects the stress variation.
7.	The lifespan of Flexible pavement is approximately 10to 15 years .	The lifespan of rigid pavement is approximately 20 to 30 years .
8.	Repair work is simple.	Repair work is complex.
9.	The maintenance cost is high.	The maintenance cost is low.
10.	It doesn't require curing.	It requires curing.
11.	Poor night visibility due to the use of asphalt.	Good night visibility due to the use of Concrete.
12.	No glare due to sunlight.	High glare due to sunlight.
13.	Esay to locate and perform underground works like repairing or finding pipes.	Hard to perform underground works.
14.	Its thickness is more.	Its thickness is less.
15.	The bearing capacity of the subgrade influences design.	The bearing capacity of the subgrade doesn't influence its design.

HARBOUR

1. A harbour is basically an area filled with water sheltered by natural barriers like land and rocks or artificial barriers like breakwaters sometimes surrounded by tetrapod's, that can provide a ship with safe anchorage and allow the transfer of goods and/or passengers between the ship and the shore.

2. Natural harbours are usually surrounded by land, and this creates a protective bay making it a good anchorage point for ships.. Apart from coastlines around the world, natural harbours may also be found along lake sides, lagoons etc.

3. Since natural harbours were not always exactly where he wanted it, man began creating artificial harbours to develop and improve trade. artificial harbours can be created anywhere along the seaboard linking to industrial zones on land.

4. Some of the hallmarks of artificial harbours are breakwaters, concrete walls (sea walls), and other forms of barriers designed to protect the harbour from storms and reduce the tidal range.

5. But of course, it's not that easy just to create a harbour.. A harbour needs to be deep enough to allow ships to enter and exit without touching the bottom of the seabed while also providing enough space for the ships to turn and pass each other.

6. The bigger the capacity of the ships calling at the harbour, the deeper the harbour needs to be.

7. The act of keeping the shipping channels deep, wide and free of silt is known as dredging and is considered one of the main activities in maintaining a harbour.

8. Man used these natural harbours to enable trade between countries.. Although the formation may be natural, a lot of these natural harbours have been improvised upon, to be able to handle commercial activities.

9. A harbour has the following constituent parts:

    (a) An entrance channel, 100-300 m wide
    (b) A turning basin, dia 400-600 m
    (c) A breakwater, which protects the from waves
    (d) Docks, where ships berth

TUNNEL

A tunnel is an underground passageway that's dug through soil, earth, or rock. Tunnels are enclosed except for the entrance and exit, which are usually at each end.

Tunnels are typically much longer than they are wide. They're designed to withstand earth forces applied from all sides.

Tunnels can be used for a variety of purposes, including:

a. Highways

b. Railroads

c. Urban rapid transit systems

d. Urban water supply and distribution

e. Sewage collection and disposal

f. Hydroelectric power generation

g. Flood control

h. Mining

AIRPORTS

An airport is a place where airplanes can land and take off. They are also called air terminals, aerodromes, or airfields.

Airports typically have:

a. Runways: A long strip of level ground where planes can land and take off

b. Terminals: Buildings where passengers wait for their planes or luggage

c. Boarding gates: Where passengers board planes

d. Control towers: Utility buildings that maintain the airport

e. Hangars: Utility buildings

f. Maintenance facilities: For aircraft

g. Airports are divided into land-side and air-side areas.

Airports are classified as:

i. Primary: Have more than 10,000 passengers each year

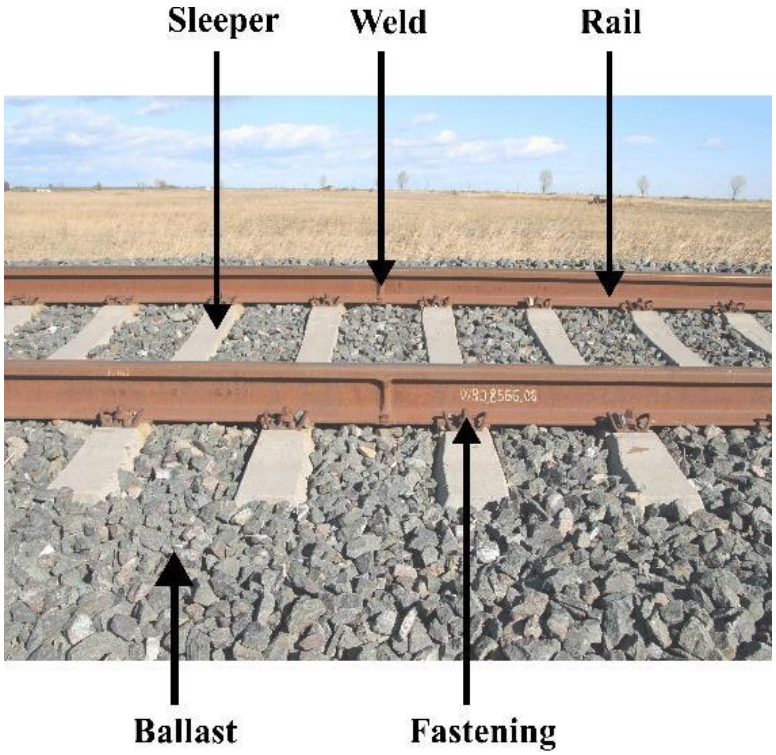
ii. Non-primary: Have only 10,000 passengers each year

iii. Cargo: Deal only with cargo

iv. International: Include customs and an international terminal

RAILWAY ENGINEERING

a. Railway engineering is a specialized branch of civil engineering that deals with the design, construction, and operation of all types of rail transport systems.
b. Railways are incredibly complex and expensive systems which are exclusively designed for the efficient passage of trains to transport people, freight, and equipment.
c. The components of a permanent way, also known as a railway track which Includes
d. Formation
e. Rails.
f. Sleepers.
g. Ballast.



FORMATION

The surface prepared to receive the ballast, sleepers, rails, etc.. for constructing the railway track is called formation or sub grade.

The formation has the following functions:

i. It provides a smooth and uniform bed on which the track is laid.

ii. It bears the entire load transmitted from the moving loads to it through the ballast.

iii. It provides drainage facilities.

iv. It provides stability to the track.

BALLAST

Ballast is a layer of broken stone, gravel, or any other suitable material placed under and around the sleepers for distributing the load from the sleepers to the formation.

Functions of Ballast

i. It provides a suitable foundation for the sleepers.

ii. It transfer and distributes loads from the sleepers to a larger area of formation.

iii. it provides effective drainage to the track.

iv. It helps in protecting the top surface of the formation.

SLEEPERS

Sleeper is transverse support for a railway to give stiffness to it.

Functions of Sleepers

i. Holds the rails to correct gauge.

ii. Give a firm and even support to the rails.

iii. Distributes the axle load over a sufficiently large area of ballast.

iv. To act as elastic medium between the rails and ballast to absorb vibration.

v. To maintain the alignment of the track.

vi. To provide insulation for electrified track.

RAILS

Rail is an iron beam.

Functions Of Rails

i. Its main function is to provide a most economical, smooth and level surface for the smooth passage of heavily loaded vehicles at great speed.

ii. The two rails of the track also serve as a lateral guide for the running of the wheels.

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting- Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Introduction to Water Resources and Environmental Engineering

Water resources are vital for sustaining life and various human activities. Environmental engineering involves managing these resources effectively to minimize environmental impact.

Importance of Water Sources:

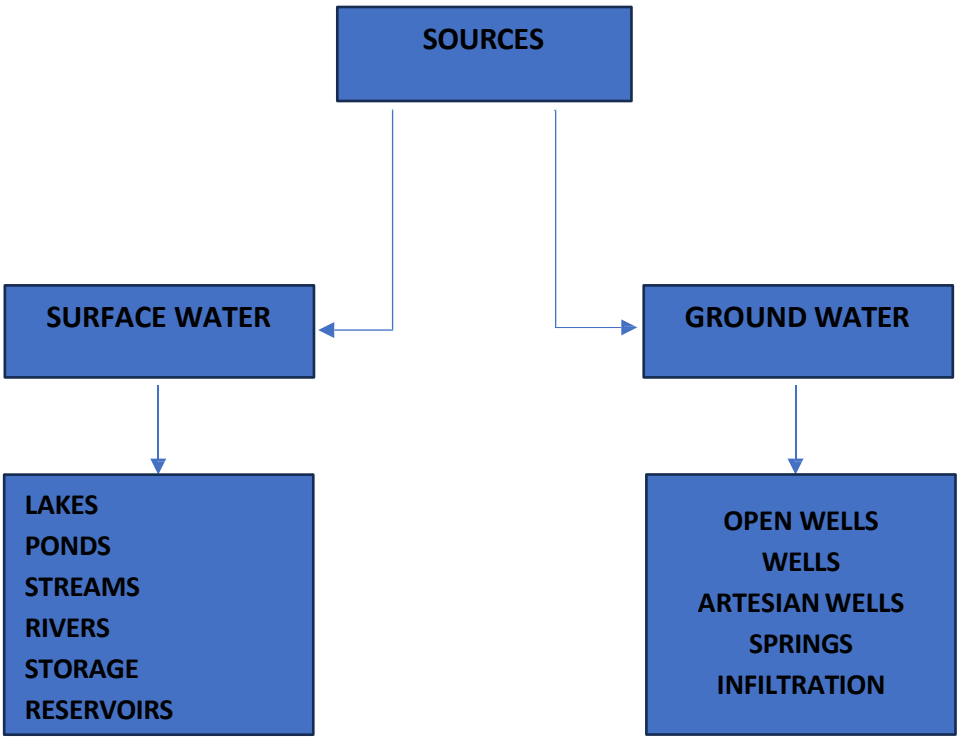
Water sources, comprising surface water bodies, groundwater reserves, rainwater, and desalination processes, form the cornerstone of global sustenance. Understanding these sources is paramount for their sustainable management and utilization.

Significance of Water Quality:

Sources, quality, and engineering specifications lies at the heart of environmental sustainability. A comprehensive understanding of these elements is crucial for creating a resilient and sustainable future.

The quality of available water directly influences public health, ecological balance, and industrial activities. Maintaining high water quality standards is imperative for safeguarding environmental integrity and human well-being.Water, a diverse resource, manifests in various forms and origins, each playing a vital role in meeting global needs. Understanding these sources is pivotal for sustainable water management.

SOURCES OF WATER



1. SURFACE WATER

Surface water refers to all the water on the Earth's surface, including natural water bodies such as rivers, lakes, ponds, and streams, as well as artificial water features like reservoirs, canals, and wetlands. It is the water that is readily visible and accessible on the planet's surface and is distinguished from groundwater, which is found beneath the Earth's surface within porous rock layers or aquifers.

Surface water plays a critical role in various ecological, economic, and societal functions. It is a source of freshwater for human consumption, irrigation, and industrial use. Additionally, surface water bodies often serve as habitats for diverse aquatic ecosystems, support wildlife, and offer recreational opportunities. They also play a role in regulating the Earth's climate by influencing weather patterns and storing heat.

a. **Lakes:** Lakes are generally larger bodies of standing water, ranging from small ponds to massive bodies like the Great Lakes in North America. They can be freshwater or saline and are essential for drinking water, recreation, and ecosystems.

b. **Ponds:** Ponds are smaller, shallow bodies of standing water, often formed naturally or artificially. They are common in parks and gardens.

c. **Rivers and Streams:** These are flowing bodies of water that can vary in size from small creeks to large, navigable rivers. They often serve as vital transportation routes and sources of freshwater.

d. **Reservoirs:** These are artificial bodies of water created by damming rivers. They serve various purposes, including water storage for drinking, irrigation, and hydroelectric power generation.

2. GROUNDWATER

Groundwater refers to the water that is located beneath the Earth's surface in the saturated zone of soil and rock. It occupies the spaces between particles in the subsurface, typically within layers of soil, sand, gravel, and permeable rock formations known as aquifers. Groundwater is a critical component of the Earth's hydrological cycle and is a significant source of freshwater.

a. **OPEN WELL:**

Open wells often referred to as a traditional or dug well, is a type of water well that is manually excavated or dug into the ground to access groundwater. Open wells have been used for centuries as a means of obtaining water for various purposes, including drinking, irrigation, and domestic use.

b. **TUBE WELL:**

A tube well is a type of water well that is typically constructed by drilling a deep hole or borehole into the ground to access underground water sources. These wells are named after the cylindrical tubing or casing that is usually installed in the hole to prevent it from collapsing and to facilitate the extraction of water.

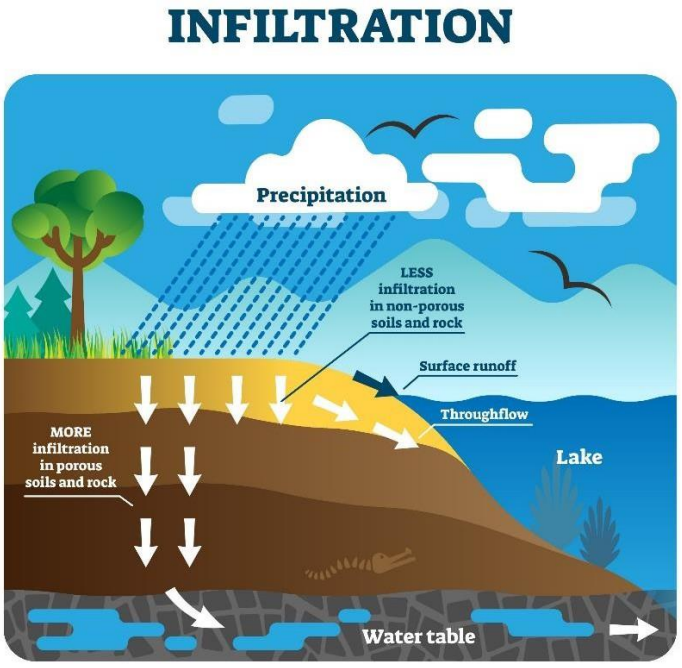
c. **ARTESIAN WELLS:** An artesian well is a type of well that derives its water from a confined aquifer, which is an underground layer of water-bearing rock or sediment that is trapped between impermeable layers, such as clay or shale. Artesian wells are

unique because the water in the aquifer is under pressure due to the geological formations surrounding it. This natural pressure allows the water to rise to the surface without the need for mechanical pumps.

d. **SPRING:** A spring is a natural source of water that flows or seeps out of the ground to the surface. Springs are typically found in areas where underground water, known as groundwater, emerges due to geological formations or hydrological processes.

e. **INFILTRATION:**

Infiltration is a process in hydrology and geology where water from precipitation, irrigation, or other sources penetrates or enters the soil surface and moves into the ground. It is a crucial component of the Earth's water cycle and plays a significant role in groundwater recharge, which ultimately replenishes underground aquifers. Infiltration occurs when the rate of water entering the soil exceeds the rate at which it is removed by surface runoff or evaporation.



QUALITY OF WATER

The quality of water refers to its chemical, physical, biological tests that determine its suitability for various uses and its safety for human and environmental health. Water quality can be assessed based on several parameters, and it is essential to maintain high-quality water for drinking, irrigation, industrial processes, aquatic ecosystems, and recreational activities.

QUALITY OF WATER

a. The quality of water is crucial for sustaining life and ensuring public health. Several factors determine water quality:

b. Chemical Composition: It includes the presence of contaminants like heavy metals (lead, mercury), pesticides, industrial chemicals, and minerals like arsenic or fluoride.

c. Biological Contaminants: Bacteria, viruses, and parasites can cause waterborne diseases like cholera, typhoid, or dysentery.

d. Physical Properties: Temperature, turbidity (cloudiness), odor, and taste affect the acceptability of water for consumption.

e. pH Level: The measure of acidity or alkalinity. Extreme pH levels can indicate contamination or potential issues with water treatment.

f. Dissolved Oxygen: Essential for aquatic life; low levels can indicate pollution or insufficient aeration.

g. Nutrient Levels: High levels of nutrients like nitrogen and phosphorus can lead to eutrophication, harming aquatic ecosystems.

Water quality is regulated and monitored by various agencies globally to ensure standards are met for human consumption, agriculture, industry, and environmental preservation. Treatment processes like filtration, chlorination, and other advanced methods are used to improve water quality and make it safe for consumption and other purposes.

WHO Standards for Drinking waterWHO Standards for Drinking water

S.No	Characteristics	Normally acceptable value	Max. Permissible limit
1	**Temperature**	10º C -15ºC	--
2	**Turbidity**	2.5	10
3	**Colour**	5.0	25
4	**Taste and odour**	Unobjectionable	
5	**pH**	7.0 to 8.5	6.5 to 9.2
6	**Total dissolved Solids(mg/L)**	500	1500
7	**Total Hardness**	200	600
8	**Chlorides(mg/L)**	200	1000
9	**Sulphates**	200	400
10	**Nitrates**	45	45
11	**Flourides(mg/L)**	1.0	1.5
12	**Calcium**	75	200
13	**Magnesium**	30-120	150
14	**Iron**	0.1	1.0
15	**Manganese**	0.05	0.5
16	**Phenolic**	0.001	0.002
17	**Arsenic**	0.05	0.05
18	**Chromium**	0.05	0.05
19	**Cynamides**	0.05	0.05
20	**Coliform count per 100ml**	zero	

INTRODUCTION TO HYDROLOGY

Hydrology is the scientific study of water, including its distribution, movement, properties, and the interaction between water and the environment. It encompasses the study of water in various forms, such as precipitation, surface water in rivers and lakes, groundwater, and even water in the atmosphere.

Hydrologists analyze and predict how water moves through and interacts with the Earth's natural systems, which is crucial for managing water resources, understanding floods and droughts, and ensuring the sustainable use of water for various purposes.

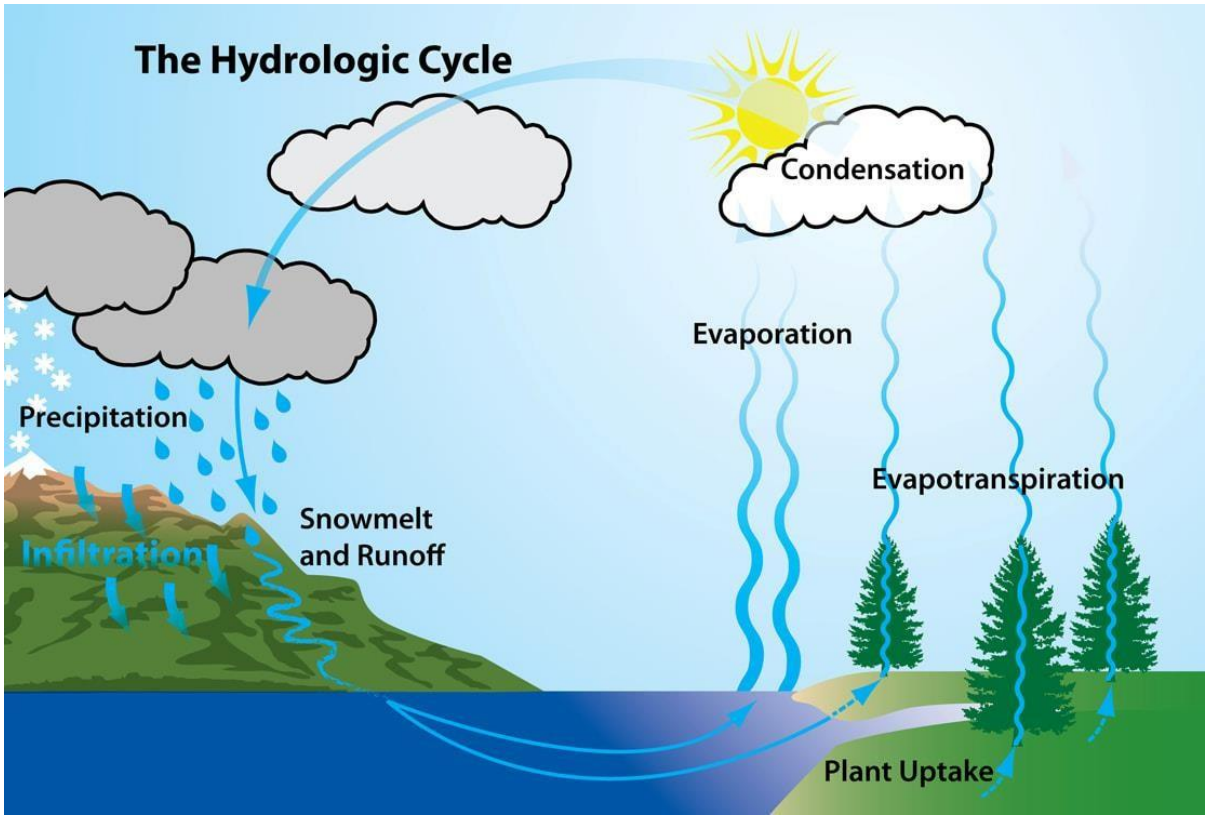


FIG: WATER CYCLE

Hydrology involves the study of water movement, distribution, and its interaction with the environment. Understanding the water cycle is crucial for managing water resources.

The water cycle involves a series of interconnected processes:

Evaporation: Water transforms from liquid to vapor from oceans, rivers, and other water bodies.

Precipitation: Condensed vapor forms clouds and falls as rain, snow, sleet, or hail.

Infiltration: Water seeps into the ground, replenishing groundwater sources.

Runoff: Excess water flows overland into rivers, lakes, or oceans.

Significance in Managing Water Resources:

Understanding the water cycle is crucial for managing water resources effectively. It aids in predicting water availability, addressing scarcity, and implementing sustainable water management practice.

IMPORTANCE OF WATER MANAGEMENT:

a. **Sustainable Resource Utilization:**Effective water resource management ensures sustainable utilization, balancing human needs with environmental conservation. It promotes efficient use and preservation for future generations.
b. **Ecosystem Health:**Proper water management maintains the health of aquatic ecosystems. Balancing water distribution supports biodiversity, preserving habitats, and sustaining natural processes.
c. **Economic and Societal Impact:**Water scarcity affects industries, agriculture, and communities. Efficient management practices prevent shortages, ensuring stability, economic growth, and social well-being.
d. **Climate Resilience:**Effective management strategies enhance climate resilience. Understanding water cycles aids in adapting to climate change impacts, such as droughts or floods.

RAINWATER HARVESTING

Rainwater harvesting is the process of collecting and storing rainwater that falls on rooftops and other surfaces for later use. It's like saving rainwater in a container to be used for watering plants, flushing toilets, or other non-drinking purposes, reducing the need for using tap water and helping conserve water resources.

Methods and Benefits: Techniques for collecting and storing rainwater for various uses. Rainwater harvesting reduces demand on conventional water sources and promotes sustainability.

Techniques for Rainwater Collection:

Rainwater harvesting encompasses diverse techniques, including rooftop collection systems, rain barrels, and cisterns. These methods efficiently capture and store rainwater for various purposes.

Reduced Demand on Conventional Water Sources:

By utilizing harvested rainwater, there's a decreased reliance on traditional water sources like municipal supplies or groundwater. This reduction supports sustainable water usage practices.

Promotion of Sustainability:

Rainwater harvesting contributes to sustainability by conserving water, reducing runoff, and alleviating pressure on water supplies, fostering environmental responsibility.

ADVANTAGES OF RAIN WATER HARVESTING

i. To conserve & augment the storage of ground water
ii. To reduce water table depletion
iii. To improve the quality of ground water
iv. To arrest sea water intrusion in coastal areas
v. To avoid flood & water stagnation in urban areas

WATER STORAGE AND CONVEYANCE STRUCTURES

Water storage and conveyance structures are essential components of water resource management systems that help capture, store, transport, and distribute water for various purposes, including drinking water supply, irrigation, industrial processes, and hydropower generation. These structures play a crucial role in ensuring a sustainable

and reliable water supply to meet the demands of growing populations and diverse industries.

DAMS

a. Dams are structures built across rivers or streams to impound water and create reservoirs. They serve multiple functions, including flood control, water storage, and hydropower generation. Dams can be made of various materials, including concrete, earth, or rock-fill.
b. Dams play a crucial role in water resources management by offering a range of benefits:
c. Water Storage: Dams store water during wet periods for use during dry spells, ensuring a continuous water supply for various needs like agriculture, industry, and domestic consumption.
d. Flood Control: They regulate river flow, reducing downstream flooding during heavy rainfall or snowmelt by storing excess water and releasing it gradually.
e. Hydropower Generation: Dams harness the potential energy of stored water to generate electricity, providing a renewable energy source.
f. Irrigation: Water stored in dams is often used for irrigation, improving agricultural productivity in regions prone to water scarcity.

Various types of dams categorized based on their structure:

a. Embankment Dams (Earth Dams): Constructed using compacted earth or rock fill. Embankment dams utilize natural materials and are typically wider at the base, tapering towards the top. They're versatile and suitable for various terrains.
b. Concrete Dams: Built using concrete, these dams are durable and often used for larger structures. Concrete dams can be gravity dams (hold back water through sheer weight) or arch dams (curved structure utilizing arch action to resist water pressure).
c. Arch Dams: Curved-shaped dams utilizing arch action to bear the water load. Arch dams curve upstream, transferring water pressure into the abutments or sides of the valley. They are ideal for narrow gorges or valleys.

d. **Gravity Dams:** Dams that rely on their weight to resist the horizontal pressure of water. Gravity dams are typically made of concrete or stone masonry and work effectively in wide valleys or areas with stable foundations.
e. **Buttress Dams:** Utilize a series of supports or buttresses to distribute water pressure. Buttress dams have a flat upstream side supported by buttresses or supports on the downstream side, suitable for locations with softer foundations. Each type of dam has its unique construction and characteristics, catering to different topographies and water management needs. The choice of dam type depends on factors such as geological conditions, available materials, and the intended purpose of the dam.

RESERVOIR

Reservoirs are large artificial lakes created by damming rivers or streams. They store water for various purposes, such as drinking water supply, irrigation, flood control, and recreational activities. Reservoirs can have a significant impact on ecosystems and may require careful management.

Classifications of reservoirs based on their function or purpose provide a comprehensive overview of their roles in water management:

a. **Storage Reservoirs:**Primarily designed to store water for various uses. They store water during periods of excess supply (rainy seasons) for utilization during dry periods, ensuring a consistent water supply throughout the year.
b. **Flood Control Reservoirs:** Specifically designed to mitigate flooding downstream. These reservoirs control excessive water flow during heavy rainfall or snowmelt, storing and releasing water gradually to manage downstream flooding.
c. **Multipurpose Reservoirs:** Serve multiple functions, combining storage with other uses. These reservoirs are versatile, designed to store water for various purposes like irrigation, drinking water supply, hydropower generation, and flood control simultaneously.

d. **Distribution Reservoirs:** Act as intermediate storage for water distribution networks. They store and regulate the flow of water within distribution systems, ensuring a steady and even supply to meet local demands.

e. **Balancing Reservoirs:**

Maintain system stability and balance water flow. These reservoirs help regulate and stabilize water flow in interconnected systems, managing variations in demand and supply to ensure system efficiency.