

MODULE 2

Water Quality and Its Impact on Human Beings

Definition of Water Quality

Water quality refers to the physical, chemical, biological, and aesthetic characteristics of water. It is assessed based on its suitability for specific uses such as drinking, irrigation, and recreational activities. Key parameters used to assess water quality include:

- **pH level:** A measure of the acidity or alkalinity of water.
- **Dissolved Oxygen (DO):** The amount of oxygen dissolved in water, which is crucial for aquatic life.
- **Turbidity:** The cloudiness of water caused by suspended particles.
- **Chemical pollutants:** Contaminants such as heavy metals, pesticides, and fertilizers.
- **Microbial contamination:** The presence of harmful pathogens like bacteria, viruses, and protozoa.

Importance of Water Quality

Water is essential for all life forms and is used for a variety of human activities, including:

- **Drinking:** Clean drinking water is crucial for human health and well-being.
- **Agriculture:** Irrigation water quality affects crop growth and food safety.
- **Sanitation:** Clean water is necessary for hygienic practices, reducing the spread of diseases.
- **Industry:** Many industrial processes depend on water with specific qualities.

Sources of Water Pollution

Water can be contaminated by various sources, leading to poor water quality:

- **Point-source pollution:** Discharges from identifiable sources like factories, sewage treatment plants, and landfills.
- **Non-point source pollution:** Diffuse contamination from agricultural runoff, urban runoff, and atmospheric deposition.
- **Natural sources:** Geothermal springs, erosion, and natural disasters like floods can also impact water quality.

Types of Water Pollutants

Water pollution can be categorized into several types:

Chemical pollutants:

- **Heavy metals** (e.g., lead, mercury, arsenic) can cause serious health issues such as kidney damage, neurological disorders, and cancer.
- **Nutrients** (e.g., nitrogen, phosphorus from fertilizers) can lead to eutrophication, reducing oxygen in water and causing fish kills.
- **Pesticides and herbicides** can harm aquatic ecosystems and enter the human food chain through contaminated water and crops.

Biological pollutants:

- Pathogens such as **bacteria** (e.g., E. coli), **viruses**, and **parasites** (e.g., Giardia) can cause waterborne diseases, including cholera, dysentery, and typhoid fever.

Physical pollutants:

- **Turbidity and sedimentation** can obstruct light penetration in water bodies, disrupting aquatic life.
- **Microplastics** and other debris can pollute water, impacting both human health and marine ecosystems.

Health Impacts of Poor Water Quality

Poor water quality can lead to a range of health problems, including:

- **Waterborne diseases:** Contaminated drinking water can transmit diseases such as cholera, dysentery, giardiasis, and typhoid fever.
- **Chronic illnesses:** Long-term exposure to pollutants like heavy metals (e.g., lead, mercury) can cause developmental and neurological disorders, kidney damage, and cancer.
- **Nutrient-related problems:** High levels of nitrates in drinking water can lead to methemoglobinemia ("blue baby syndrome"), particularly in infants, which impairs oxygen delivery in the bloodstream.
- **Toxic exposure:** Pesticides and industrial chemicals can have long-lasting effects on human health, affecting reproductive, nervous, and immune systems.

Water Quality and Ecosystem Health

The health of aquatic ecosystems is directly linked to water quality:

- **Biodiversity loss:** Polluted water can cause the loss of aquatic species, disrupt food chains, and damage habitats.
- **Eutrophication:** Excessive nutrients can lead to algae blooms, depleting oxygen levels and creating "dead zones" where most marine life cannot survive.
- **Disruption of ecosystem services:** Healthy water ecosystems provide

numerous services, including water purification, flood regulation, and carbon sequestration, all of which are impaired by pollution.

Solutions and Mitigation Measures

Improving water quality involves a range of strategies, including:

- **Wastewater treatment:** Proper treatment of industrial, agricultural, and domestic wastewater is crucial for removing harmful contaminants.
- **Pollution control regulations:** Governments and agencies must enforce standards to limit pollution from industries, agriculture, and urban runoff.
- **Sustainable water management:** Implementing practices like rainwater harvesting, water recycling, and efficient irrigation to reduce the burden on freshwater sources.
- **Public awareness:** Educating communities about the importance of clean water, proper sanitation, and pollution prevention can help mitigate water quality problems.

Conclusion

Water quality is an essential factor in ensuring public health, ecosystem sustainability, and economic development. It is crucial to manage and protect water resources effectively, implement pollution control measures, and raise awareness about the importance of clean water for human and environmental health.

Effect of Water Pollution on Human Life

Every year, millions of people contract water-borne diseases due to the intake of contaminated water, or by consuming vegetables and fruits grown in water of a bad quality. There are many harmful effects of water pollution on human health in India, including negative effects of water pollution on the human body as well as marine life. The impact of water pollution on human health in India is manifold and can affect children as well as adults.

Neurological Problems (Liver and Kidney Failure)

Drinking water that has been polluted with chemical contaminants has been linked to kidney and liver problems. Chemical contaminants like Methyl tert-butyl ether (MTBE) and chlorinated solvents have been linked to organ damage. Polluted water is known to have caused liver inflammation, renal failure, and the formation of kidney stones. Furthermore, the chemicals may aggravate other disorders that require the proper function of these organs. Some neurological issues, such as Attention Deficit Hyperactivity Disorder (ADHD), have been associated with drinking water that has been contaminated with chemical contaminants over time.

Arsenicosis

Arsenicosis is a disease induced by long-term exposure to chemically contaminated drinking water containing trace quantities of arsenic. Arsenic poisoning is a long-term process. Exposure to this chemical can lead to cancers of the skin, bladder, lungs, and kidneys. Millions of people worldwide are affected by such problems because they drink arsenic-contaminated water.

Lead Poisoning

Lead poisoning can occur when water is contaminated with lead, either through old pipes or by the discharge of dangerous chemicals into water systems. It is one of the diseases caused by water pollution that might turn fatal. Children are at higher risk because excessive levels of metal in their bodies produce a variety of health concerns, including anaemia, high blood pressure, and reproductive system disorders.

Intestinal Worms

Intestinal worms are parasitic worms that are spread by drinking contaminated water or eating food that has been washed in infected water. Hookworms, roundworms, whipworms, and helminths are examples of intestinal worms. These worms cause stunted growth, anaemia, and malnutrition, particularly in children. Intestinal worms afflict roughly 10% of the population, mostly children.

Schistosomiasis

Parasitic worms cause schistosomiasis to develop in the water. As a result, whenever worms are present in a body of water, they can pass through the skin of people who may be swimming, wading, or washing themselves in polluted water. They can cause infections and harm to the intestines, bladder, and liver after entering the body. Schistosomiasis worms and eggs can be found in some freshwater snails.

Diarrhoea

Diarrhoea is a condition in which the bowel movements are frequent and watery. It causes food poisoning or intestinal infection due to ingesting polluted water containing microorganisms from animal or human faeces. It is one of the most prevalent diseases caused by water pollution and is produced by water-borne bacteria, viruses, and protozoans in most cases. Diarrhoea causes dehydration, electrolyte loss, and can turn fatal for babies and small children.

Conclusion

We have read about the harmful effects of water pollution and the impact of water pollution on human health in India. Water pollution is one of the country's major health concerns, and is caused mainly by the purposeful or unintentional release of pollutants into the water. Our communities, economy, and, most importantly, our

health depends on clean water. More than 60% of the human body is made up of water. Therefore, we require clean water to survive. Unfortunately, much of the world's water is polluted, and it is one of the world's most significant challenges we face today. Water contamination has various causes, and we need to take several steps to safeguard this valuable resource.

Water Harvesting: Need, Principles, and Harvesting Methods

Need for Water Harvesting

Water harvesting refers to the collection and storage of rainwater for future use. The need for water harvesting arises due to several factors, including:

1. **Water Scarcity:** Many regions across the world face water shortages due to inadequate rainfall, over-extraction of groundwater, and increasing population.
2. **Climate Change:** Changing weather patterns can lead to irregular rainfall, making it difficult to predict water availability.
3. **Groundwater Depletion:** Overuse of groundwater for agriculture, industry, and domestic purposes is leading to its depletion, making water harvesting a crucial alternative.
4. **Agriculture:** Effective water management is crucial for farming, especially in areas dependent on rainfall for irrigation.
5. **Improved Water Quality:** Rainwater is often cleaner than surface or groundwater sources, reducing the need for extensive purification.
6. **Sustainability:** Reduces reliance on conventional water sources, ensuring long-term water availability.

Principles of Water Harvesting

1. **Collection:** Water harvesting begins with the collection of rainwater. This is typically done through the collection of runoff water from rooftops, catchment areas, or water bodies.
2. **Storage:** Once collected, rainwater must be stored for future use. This is often done in storage tanks, ponds, or underground reservoirs, depending on the local climate and space availability.
3. **Distribution:** Proper infrastructure must be in place to distribute the stored water to the areas where it will be used (e.g., agricultural fields, household uses, etc.).
4. **Filtration and Purification:** Rainwater may need to be filtered to remove debris and impurities before it is used for drinking, irrigation, or industrial purposes.
5. **Sustainability and Efficiency:** The system must be designed to maximize the collection of rainwater during wet periods and minimize losses through evaporation or inefficient storage practices.

Harvesting Methods

There are various methods of water harvesting, depending on the area's climate, topography, and available resources. Some of the most common methods include:

1. Rainwater Harvesting (Rooftop and Surface Runoff)

- **Rooftop Harvesting:** This is the most common method used in urban areas where rooftops serve as catchment areas. Water from the roof is collected using gutters and downspouts and directed into storage tanks.
- **Surface Runoff Harvesting:** In rural or agricultural areas, rainwater is collected from surfaces like fields, roads, and open spaces. This runoff is captured in ponds or reservoirs for later use.

2. Check Dams

- Small dams built across seasonal rivers or streams to slow down and capture rainwater, increasing groundwater recharge and ensuring water availability during dry periods.

3. Pits and Ponds

- **Recharge Pits:** Small pits are dug to store water, allowing it to percolate into the ground and recharge groundwater aquifers.
- **Ponds:** Constructed to store large volumes of rainwater, which can be used for irrigation, livestock, and even for drinking in some cases.

4. Earthen and Cement Tanks

- Water is stored in specially constructed tanks made from earthen materials or cement. These tanks can vary in size and are commonly used for storing water in rural areas for household and agricultural purposes.

5. Percolation Tanks

- Large, shallow tanks or basins designed to allow rainwater to percolate into the soil, promoting groundwater recharge and enhancing local water supplies.

6. Contouring Techniques (Terracing and Rainwater Trenches)

- In hilly or sloped areas, contour trenches, terraces, or bunds are constructed along the land contours to slow down the flow of rainwater and prevent erosion. These structures allow water to be absorbed into the soil.

7. Borewell Recharge

- In areas with deep groundwater, rainwater can be directed into borewells to recharge the aquifer. This method is particularly useful in regions with falling groundwater levels.

8. Water Harvesting from Roads and Streets

- In urban areas, water runoff from roads and streets is captured using specially designed drainage systems, directed to underground tanks or reservoirs for storage and future use.

Conclusion

Water harvesting is essential for addressing the global challenges of water scarcity, especially in areas where natural water resources are insufficient or unreliable. The adoption of various water harvesting techniques helps ensure sustainable water management, contributes to groundwater recharge, and provides clean water for drinking and agricultural uses. By implementing the right methods based on regional needs and conditions, we can significantly enhance water availability for future generations.

RAIN WATER HARVESTING

Rainwater Harvesting (RWH) is the practice of collecting, storing, and using rainwater for various purposes like irrigation, drinking, and sanitation. This method is gaining popularity due to its environmental benefits and utility in water-scarce areas. There are different methods, classes, benefits, and approaches involved in rainwater harvesting.

Methods of Rainwater Harvesting

a. Rooftop Rainwater Harvesting (RRWH):

- This is the most common method, where rainwater is collected from rooftops and diverted through gutters, pipes, and filters to a storage system.
- The stored water can be used for irrigation, drinking (after proper treatment), or for non-potable uses like flushing toilets.

b. Surface Runoff Harvesting:

- Water from roads, pavements, and other surfaces is collected by channels or drains and stored in reservoirs or tanks.
- This method is mainly used for large-scale harvesting, such as in urban areas.

c. Subsurface Water Harvesting (Check Dams, Percolation Pits, etc.):

- Water is stored underground, either by creating artificial ponds or by using percolation pits or check dams to allow rainwater to seep into the ground.
- This method helps recharge groundwater levels.

d. Farm-based Rainwater Harvesting:

- Farmers use various techniques to capture rainwater in ponds, tanks, or natural depressions in the landscape to enhance soil moisture.
- Techniques like contour bunding, check dams, and water harvesting pits are used in agricultural areas.

Classes of Rainwater Harvesting

Rainwater harvesting can be categorized based on scale and usage:

a. Domestic Scale:

- Small-scale systems used in households for purposes like drinking, cooking,

cleaning, or irrigation.

- Typically involves rooftop collection and storage in tanks or barrels.

b. Community Scale:

- Large-scale systems that provide water to multiple homes, schools, or community centers.
- Involves bigger reservoirs and more complex filtration and distribution systems.

c. Agricultural Scale:

- Large-scale systems used to store rainwater for irrigation purposes, especially in arid or semi-arid regions.
- Can include surface water collection systems like check dams, ponds, and farm ponds.

d. Industrial Scale:

- Large industries collect rainwater for cooling, processing, and cleaning purposes.
- Generally involves larger storage tanks and more advanced filtration techniques.

Benefits of Rainwater Harvesting

a. Conservation of Water:

- Reduces dependence on groundwater and municipal water supplies, ensuring a sustainable water source.
- Helps in preserving fresh water sources, which are depleting due to overuse.

b. Cost Savings:

- Reduces water bills for households and industries by supplementing or replacing the need for externally supplied water.
- Low maintenance costs in the long run after initial setup.

c. Reduces Soil Erosion:

- Capturing rainwater reduces surface runoff, which otherwise contributes to soil erosion and loss of fertile topsoil.

d. Groundwater Recharge:

- Rainwater harvesting methods like percolation pits and check dams help recharge local aquifers, increasing groundwater levels and improving water availability.

e. Flood Control:

- By capturing excess rainwater, rainwater harvesting systems reduce surface runoff and help in mitigating urban flooding.

f. Reduces Energy Consumption:

- Less reliance on water pumps and other water supply systems that consume a lot of energy.

g. Environmental Benefits:

- Reduces pollution by reducing the runoff that carries pollutants into water bodies.
- Promotes sustainability by encouraging the use of renewable water sources.

Approach to Rainwater Harvesting

a. Site Evaluation:

- Before installation, a thorough evaluation of the site's rainfall patterns, water demand, and topography is crucial.
- Identifying the catchment area (roof area for rooftop systems or land area for surface runoff harvesting) and potential storage systems is the first step.

b. Design of the System:

- The design of the system includes choosing the appropriate type of storage tanks, pipes, filters, and the method for water distribution.
- For potable water, advanced filtration and purification systems are required, while for non-potable uses, simpler systems may suffice.

c. Implementation:

- Install the collection systems (gutters, downspouts, filters), storage tanks, and any necessary treatment infrastructure.
- Ensure proper maintenance routines are established to keep the system free from debris, bacteria, and contamination.

d. Maintenance:

- Regular cleaning of gutters, filters, and storage tanks is necessary to ensure that the water remains clean.
- Check for leaks or cracks in pipes and tanks to prevent water loss.

e. Education and Awareness:

- Raising awareness about the importance of rainwater harvesting among local communities and encouraging widespread adoption.
- Governments and local authorities often provide training, subsidies, or incentives for adopting rainwater harvesting methods.

Conclusion:

Rainwater harvesting is an effective and sustainable way to manage water resources. By adopting different methods, ranging from rooftop systems to larger community and agricultural approaches, it helps address water scarcity, reduces costs, and protects the environment. Proper design, implementation, and maintenance are key to making these systems successful and beneficial in the long term.

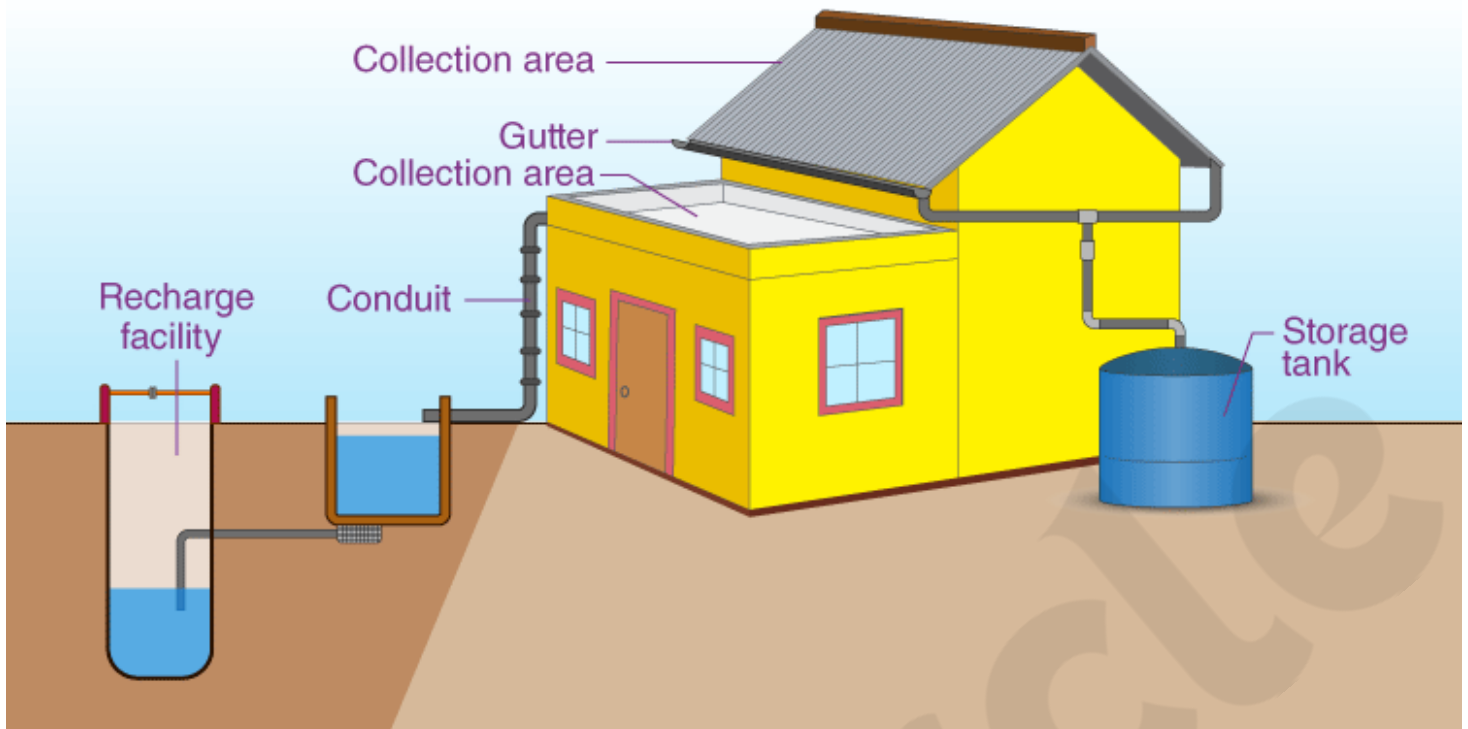
ROOFTOP RAINWATER HARVESTING

Rooftop rainwater harvesting is a sustainable and efficient method of collecting and storing rainwater from rooftops for various uses, such as irrigation, cleaning, and

even potable water with proper treatment. The process involves capturing rainwater runoff from the roof, filtering it to remove debris and contaminants, and then storing it in tanks or reservoirs for future use. Here's how the process works in more detail:

Components of a Rooftop Rainwater Harvesting System:

1. **Catchment Area (Roof):** The roof serves as the primary surface where rainwater is collected. The type of roofing material (e.g., metal, concrete, tile) can influence water quality, so it's essential to choose a material that won't introduce harmful substances into the water.
2. **Gutters and Downspouts:** Gutters are installed along the edges of the roof to channel rainwater to downspouts. These should be regularly cleaned to prevent blockages and ensure effective water collection.
3. **First-Flush Diverter:** A first-flush diverter is a system that helps eliminate the initial flow of rainwater, which may contain dust, debris, or contaminants from the roof. This ensures that only cleaner rainwater is directed into the storage system.
4. **Filtration System:** Filters can be installed to remove any remaining debris and particles from the rainwater before it enters the storage tank. Common types of filters include mesh screens or sand filters.
5. **Storage Tanks:** Rainwater is stored in tanks, which can vary in size and material (e.g., plastic, concrete, or metal). The storage capacity should be designed based on the local rainfall patterns and the intended use of the water.
6. **Pump and Distribution System:** If the harvested rainwater is to be used for irrigation or other applications, a pump system may be required to distribute the water. For potable water, additional treatment systems such as UV sterilizers or filters might be necessary.



Benefits of Rooftop Rainwater Harvesting:

1. **Conservation of Freshwater:** It reduces dependency on municipal water systems, conserving freshwater resources, especially in areas with water scarcity.
2. **Cost-Effective:** Once the system is installed, it can significantly reduce water bills, especially for non-potable uses like gardening or cleaning.
3. **Flood Mitigation:** By capturing rainwater, it reduces runoff and helps prevent flooding in urban areas, which can overwhelm drainage systems.
4. **Sustainability:** Rainwater harvesting promotes eco-friendly practices and can contribute to sustainable living in urban or rural settings.
5. **Water Quality Control:** Properly filtered rainwater is often of high quality, and in some cases, it can be made potable with the right treatment.

Considerations:

- **Water Quality:** Proper filtration and maintenance are essential to ensure the water remains safe for its intended use.
- **System Size:** The system should be designed to match the local rainfall and water consumption needs.
- **Maintenance:** Regular cleaning of gutters, filters, and storage tanks is important to avoid contamination and ensure efficient operation.

By implementing rooftop rainwater harvesting systems, both households and communities can contribute to water conservation efforts while reducing the environmental impact of water extraction and usage.

SUBSURFACE BARRIER / DYKE

A **subsurface barrier** or **dyke** refers to a structure that is built below the surface of the ground to control the flow of groundwater, prevent the migration of contaminants, or isolate specific areas for environmental management or protection.

Key Characteristics of Subsurface Barriers / Dykes:

1. Purpose:

- **Water Control:** Prevent the movement of groundwater or surface water into or out of a specified area. This can be used to control flooding, protect infrastructure, or manage water resources.
- **Pollution Containment:** Often used in environmental remediation to isolate contaminated groundwater or prevent pollutants from spreading to clean areas.
- **Structural Integrity:** Used in construction and civil engineering to support foundations or protect areas from the penetration of water or other materials.

2. Construction Materials:

- Can be made from a variety of materials, such as **concrete**, **steel**, or **geosynthetic materials**.
- In some cases, natural barriers like **clay** or **rock** formations are used to create the necessary impermeability.

3. Types:

- **Vertical Barriers:** Typically walls or panels constructed down into the ground, acting as a barrier to water or contaminant movement.
- **Horizontal Barriers:** These may be used at a shallower depth and often take the form of a layer of impermeable material to restrict water flow horizontally.

4. Applications:

- **Flood Protection:** Used to stop rising groundwater or surface water from flooding an area, particularly in areas prone to coastal or river flooding.
- **Waste Management:** In landfills or hazardous waste sites, subsurface barriers prevent contamination from leaching into surrounding soil or groundwater.
- **Mining:** Used to control the migration of contaminants from abandoned mines or mining operations.

5. Design and Installation:

- The design of a subsurface barrier typically depends on the **hydraulic conductivity** of the soil, the depth at which the barrier needs to be installed, and the type of fluid (e.g., water, contaminants) it is meant to block.
- Installation often involves **drilling**, **excavation**, or **injection** techniques,

depending on the material used and the desired depth of the barrier.

Summary:

Subsurface barriers or dykes are important tools for controlling groundwater movement, protecting against water-related damage, and preventing contamination in various environmental and civil engineering projects.

Farm Ponding

Farm ponds are man-made bodies of water designed for a variety of purposes, including irrigation, livestock watering, aquaculture, and recreation. Proper design and maintenance are essential to ensure their effectiveness and longevity.

1. Purpose of Farm Ponds

- **Water Storage:** Harvesting rainwater for irrigation during dry spells.
- **Livestock Watering:** A reliable water source for farm animals.
- **Aquaculture:** Fish farming or other aquatic species for food production.
- **Recreation:** Swimming, fishing, and other leisure activities.
- **Erosion Control:** Ponds can help reduce soil erosion by controlling runoff.

2. Site Selection

- **Topography:** Choose a low-lying area that naturally collects water. Ponds work best in areas with gentle slopes (less than 10%).
- **Soil Type:** Clay-rich soils are ideal for pond construction as they hold water better than sandy soils. If the soil is sandy, it may need to be lined or sealed.
- **Water Source:** Identify a reliable source of water (rainfall, spring, or stream).
- **Avoid Flood Zones:** Avoid areas prone to flooding or those in close proximity to large water bodies.

3. Design Considerations

- **Shape & Size:** Ponds should have an irregular shape to reduce wave erosion and increase surface area. Typical pond depth should range between 4-10 feet, with the deepest parts near the center.
- **Shoreline Slope:** The sides should slope gently (3:1 ratio) to prevent erosion.
- **Inlet & Outlet:** A reliable inlet (e.g., a pipe or ditch) and outlet system (e.g., spillway) must be designed to control water flow and prevent overflow.
- **Emergency Spillway:** To handle excess water during storms and prevent damage to the dam.
- **Water Aeration:** To ensure healthy water quality and prevent stagnation, especially in aquaculture.

4. Construction Process

- **Excavation:** The area for the pond is excavated to create the desired shape and depth.
- **Dam Construction:** If the pond needs to be created by damming a water

source, the dam must be made from compacted soil or other materials to prevent leaks.

- **Lining:** In some cases, ponds may need lining with clay, bentonite, or synthetic materials to reduce seepage, especially if the soil is porous.
- **Vegetation:** Planting grass or other vegetation along the edges helps control erosion and provides wildlife habitat.

5. Water Quality Management

- **Control Algae Growth:** Use aeration, water circulation, or chemical treatments (if necessary) to control algae blooms.
- **Monitor pH & Nutrients:** Regular testing to ensure water quality, especially for aquaculture ponds.
- **Sediment Control:** Implementing proper erosion control techniques to prevent sedimentation and silt buildup, which can reduce pond capacity and water quality.
- **Maintain Depth:** Periodic dredging may be required to remove accumulated silt.

6. Maintenance Tips

- **Inspect Regularly:** Check for signs of leaks, erosion, or structural weaknesses.
- **Clean the Spillway:** Ensure the outlet is clear to prevent water backup and damage.
- **Vegetation Control:** Trim overgrown plants around the pond to prevent obstructing water flow and ensure aeration.
- **Re-stock Fish (if applicable):** For aquaculture, restocking fish populations or monitoring species health is essential.

7. Legal and Environmental Considerations

- **Permits:** Check local regulations regarding the construction of farm ponds, especially if you plan to modify a natural watercourse.
- **Impact on Ecosystems:** Ensure that the pond does not negatively affect local wildlife, water flow, or surrounding ecosystems.
- **Water Rights:** Make sure you have the legal right to use water from streams or other natural sources for ponding.

8. Types of Farm Ponds

- **Dry Ponds (Retaining Basins):** These ponds are designed to temporarily hold water during heavy rains, allowing it to be slowly released, preventing erosion and flooding.
- **Wet Ponds:** Designed to hold water permanently or seasonally.
- **Fish Ponds:** Specifically constructed for fish farming, requiring specific water quality management for species survival.

9. Costs and Considerations

- **Initial Construction:** Building a farm pond can be a significant investment depending on size, location, and design complexity.
- **Ongoing Maintenance:** Costs include dredging, vegetation control, and water

quality management.

By carefully selecting a site, designing the pond for efficiency, and maintaining it properly, a farm pond can be a valuable resource for both agricultural and recreational use.