ATME College of Engineering

WATER CONSERVATION AND RAIN WATER HARVESTING (BCV654A)

Course Co-ordinator
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ATME College of Engineering

COURSE OBJECTIVES

- Appreciate basic concepts of Water and its importance.
- Learn elementary knowledge of ground water.
- Conceptually learn various theories related to Groundwater recharge.
- Study about Subsurface investigation of Ground water.

SYLLABUS

MODULE 1:

Water and its importance Monsoon- types and behavior in India, rainfall — characteristics and distribution, onset and withdrawal of effective rains, dry spells and wet spells, critical dry spells, water loss from the soil, measurement and factors, hydrological cycle, Importance and issues relating water status Scenario of water in Karnataka: sources, geographical distribution, quality. Water (hydrological) cycle, influence of human activity on the water cycle, Surface water resources.

MODULE 2:

Elementary knowledge of ground water: General aquifer. Water quality" and its impact on human beings. Water harvesting: need, principles of water harvesting, general water harvesting methods - rain water harvesting - methods, classes, benefits, approach, rooftop rainwater harvesting, subsurface barrier/dykes, farm ponding, etc mostly used in rural areas.

MODULE 3:

Groundwater recharge: Factors affecting groundwater recharge, Revival of traditional techniques for water harvesting. Calculation of available rain water for harvesting. Preparation of suitable technical drawing and design of rain water harvesting structure.

MODULE 4:

Elementary conservation of water: Importance, knowledge regarding conservation/saving of water in daily use, in agriculture, in industries. Water Conservation strategies- Limiting the consumption, Reuse and recycling, Elimination of losses, Pollution prevention.

MODULE 5:

Subsurface investigation of Ground water: General, geophysical methods and its importance. Present law regarding water management Water footprints- blue water footprint, green water footprint, grey water footprint. Sustainability assessment.

- **MODULE 2:**
- Elementary knowledge of ground water: General aquifer. Water quality" and its impact on human beings. Water harvesting: need, principles of water harvesting, general water harvesting methods - rain water harvesting - methods, classes, benefits, approach, rooftop rainwater harvesting, subsurface barrier/dykes, farm ponding, etc. mostly used in rural areas.

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- How aquifers work
- Water from precipitation seeps into the ground and fills the spaces between rock cracks and sediments.
- The water-filled spaces are connected, allowing water to flow through the rock.
- Wells can be drilled into aquifers to extract water.

An aquifer is a layer of underground rock or sediment that contains and releases water. Aquifers are a vital source of fresh water for human consumption and agriculture

Importance of aquifers

Aquifers are important for maintaining the level of groundwater, which is a vital resource for clean drinking water.

What is an aquifer?

FIGURE 1

An aquifer is *not* an underground river or lake.

Actually ...

An aquifer is a body of rock and sediment that's saturated—water is in it and around it. And water can move through it. It can be made of sand and gravel, sandstone, sandstone and carbonate, and other rocks. Each is made up of permeable material.

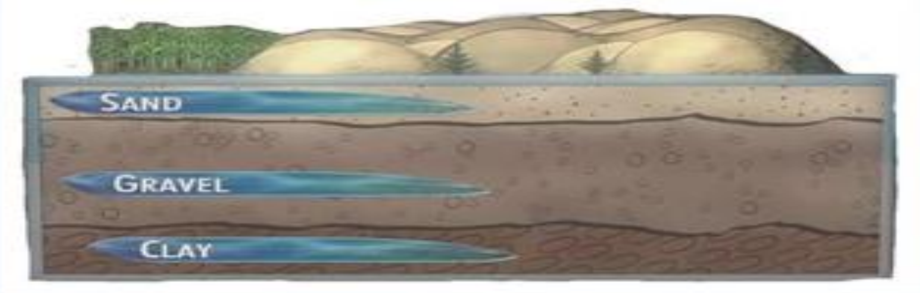

FIGURE 2

- An aquifer is made up of soils and rocks that have tiny spaces between the grains of soil or crystals of rock called porosity. This porous space is filled mostly with air above the water table and is filled with water below the water table.

- Aquifer management
- The study of water flow in aquifers is called hydrogeology.
- Aquifer systems need to be managed sustainably to meet increasing demands for water.
- If water is pumped from a well faster than it is replenished, the water table is lowered and the well may go dry.
- Examples of aquifers Sandstone aquifers, Carbonate-rock aquifers, Igneous and metamorphic-rock aquifers, and Unconsolidated and semiconsolidated sand and gravel aquifers.

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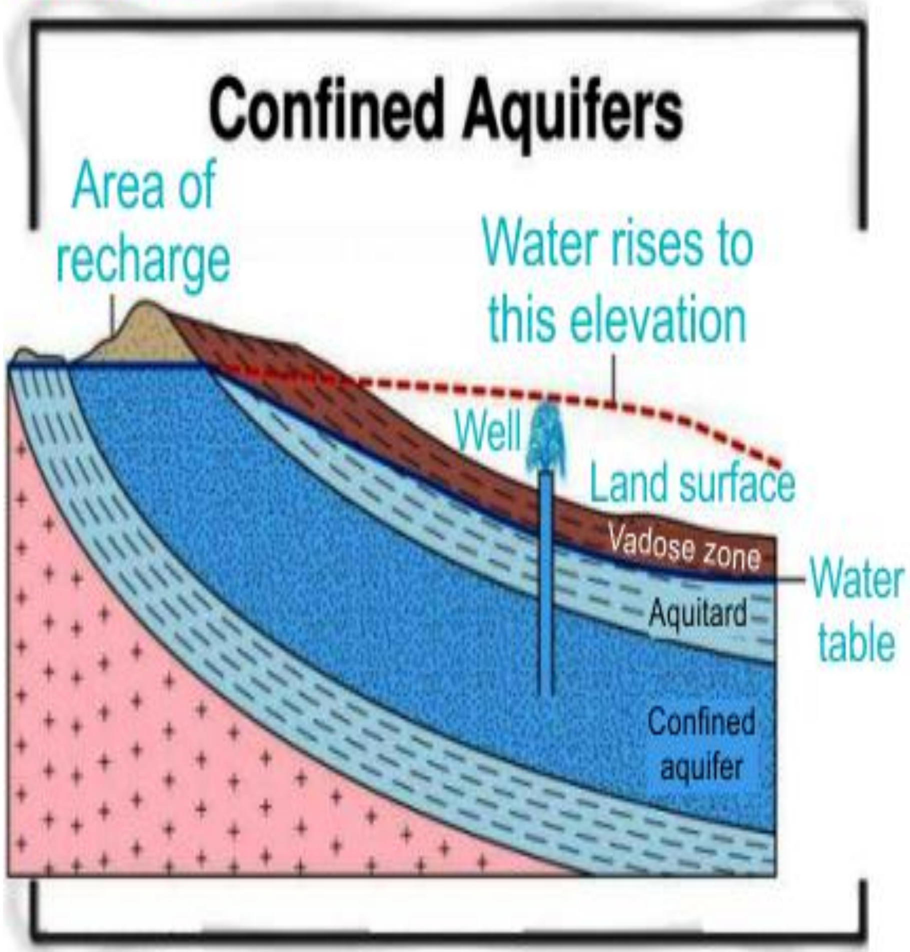


A confined aquifer is a water-saturated rock layer that is under pressure because of impermeable layers above and below it.

How it works

Confining layers: Thick deposits of clay or unfractured mudstone that prevent groundwater from moving in and out of the aquifer

Pressure: The confining layers cause the groundwater to be under pressure

Artesian wells: Wells that go through confining layers, allowing water to rise above the top of the aquifer

Artesian flow: When water flows out of an artesian well under natural pressure

Other features

Confined aquifers are usually deeper underground than unconfined aquifers

Confined aquifers are less likely to be impacted by surface activities, unless those activities are in the recharge area

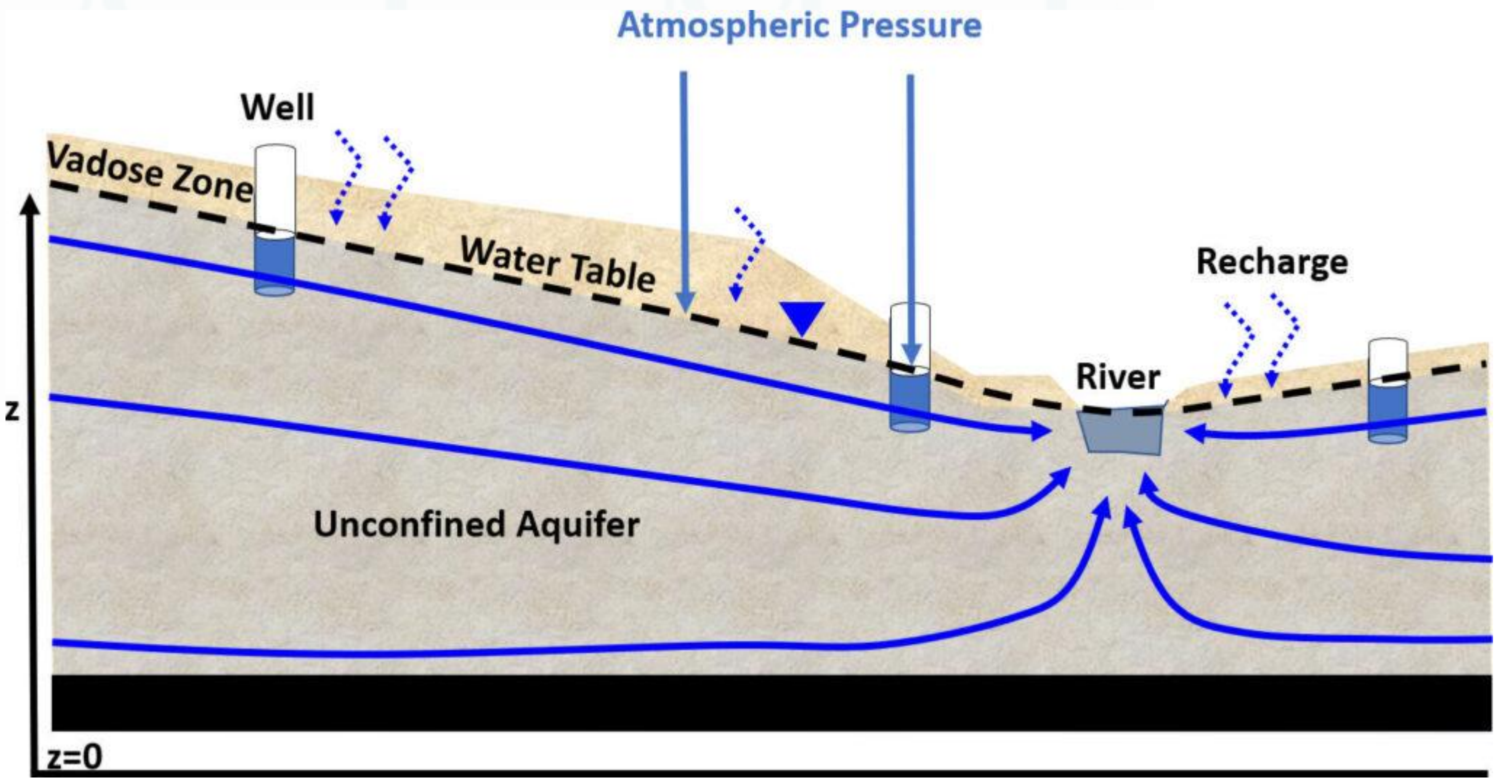
Confined aquifers can be recharged by rain or stream water that seeps into the rock at a distance

Groundwater in confined aquifers can be thousands of years old

Importance

Wells drilled into aquifers are one of the most important sources of fresh water on Earth.

- An unconfined aquifer is an aquifer where groundwater is in direct contact with the atmosphere. The upper surface of the groundwater in an unconfined aquifer is called the water table.



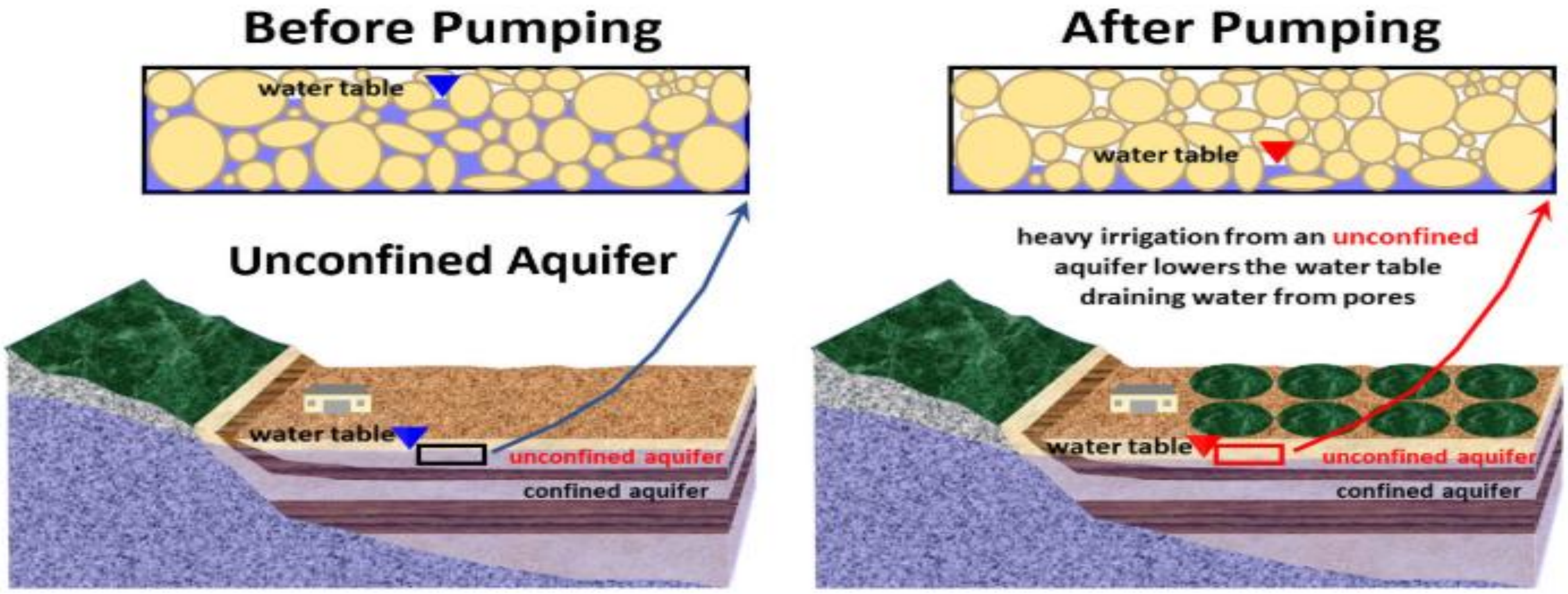


Figure 32 – Schematic showing the change in aquifer conditions before (left) and after (right) heavy pumping of an unconfined aquifer (pores drain) (Poeter et al., 2020, gw-project.org).

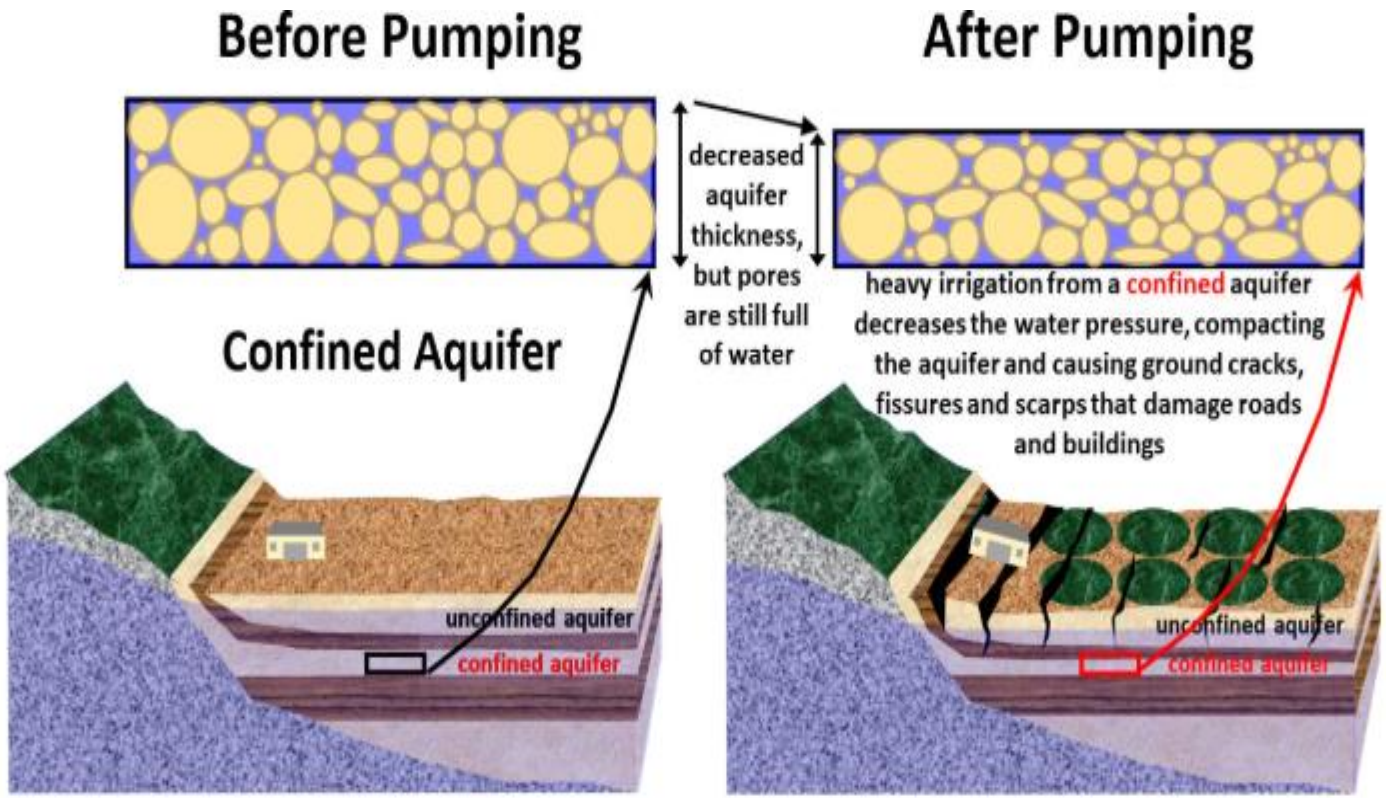
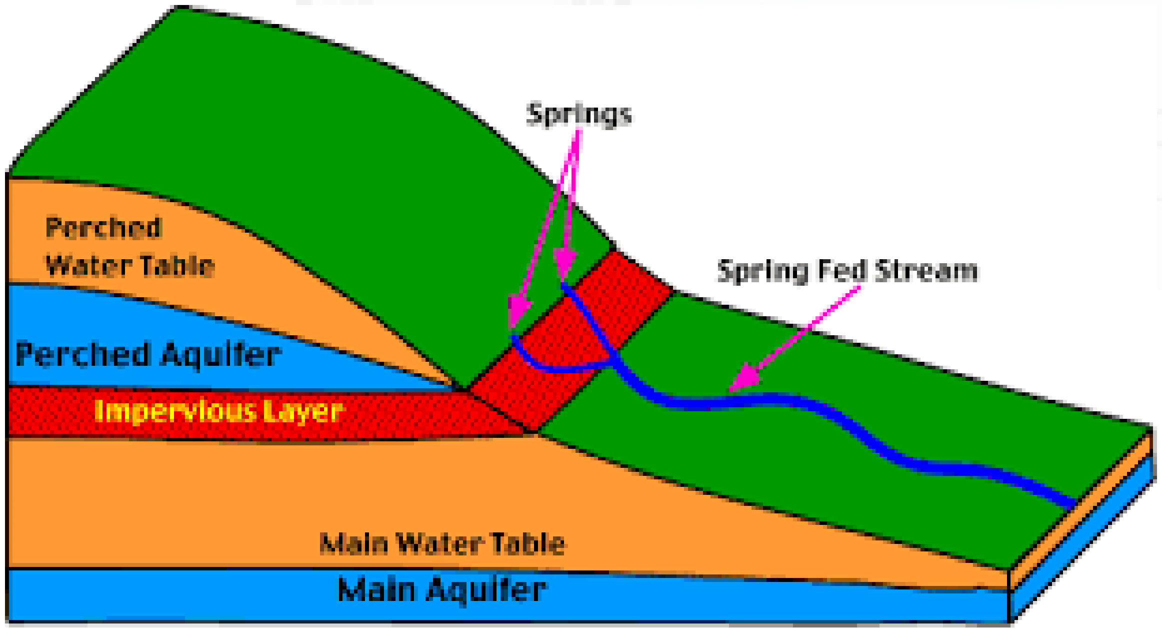


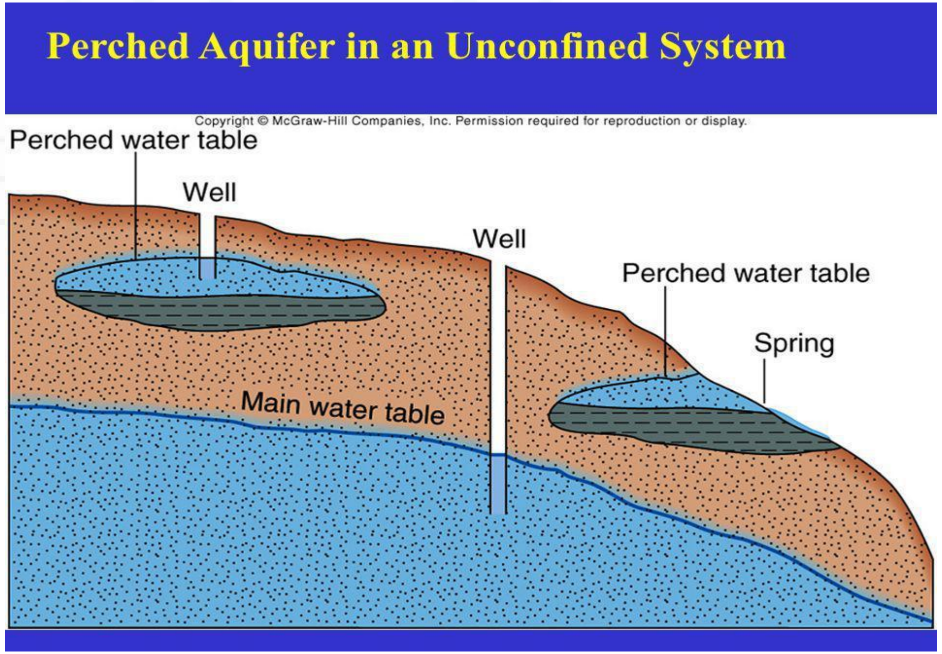
Figure 33 – Schematic showing the change in aquifer conditions before (left) and after (right) heavy pumping of a confined aquifer (pores depressurize and geologic layers compact) (Poeter et al., 2020, gw-project.org).

- How does an unconfined aquifer work?
- The water table is exposed to atmospheric pressure and can rise and fall.
- The water table depth varies due to factors like topography, geology, season, and tidal effects.
- Unconfined aquifers are usually recharged by rain or snow melt.
- Unconfined aquifers are more susceptible to contamination than confined aquifers.

Confined Aquifers	Unconfined Aquifers
• It is one kind of aquifer that is below the earth's surface (saturated with groundwater) • It can generally be found at a very deep level below the ground • Most of the time confined aquifers are not generally affected by drought • These types of aquifers form at a slower pace than unconfined ones	• It is one kind of an aquifer whose water table is generally at the level of atmospheric pressure • It is gnarly closer to the surface of the earth • Unconfined aquifers are significantly affected by drought • These types of aquifers form at a very fast speed

- **Perched Aquifer** – A smaller, localized water zone sitting above the main water table due to an impermeable layer





- Causes of water pollution
- Water pollution that impacts human health can be caused by both unnatural (man-made) and natural means.
- Man-made pollution is caused by:
- Sewage & waste disposal (including animal waste)
- Agricultural runoff
- Urban runoff
- Fuel & chemical spillages
- Plastic waste
- Radioactive waste

- Water pollution occurs when water becomes contaminated, usually by chemicals or microorganisms. Pollution can cause water to become toxic to humans, leading to infections and health problems.

Water is an essential resource for all life on Earth. If a water source becomes contaminated due to pollution, it can lead to health issues in humans, such as cancer or cardiovascular conditions. This article explores the causes of water pollution, how it can affect human health, and what people can do to help prevent it.

- **Sources of water pollution**
- Water is sometimes referred to as the universal solvent, as it dissolves more substances than any other liquid. However, this ability means that water is easily prone to pollution.
- **Sewage and wastewater**
- After being used, water becomes wastewater. Wastewater can be domestic, such as water from toilets, sinks, or showers, or from commercial, agricultural, or industrial use. Wastewater also refers to rainwater that washes oil, grease, road salt, debris, or chemicals from the ground into waterways.

- **Agriculture**
- Agriculture
- The agriculture industry is one of the biggest consumers of fresh water. In fact, around 70% of the world's freshwater use goes toward crop agricultural irrigation. In some countries, this figure is considerably higher. For example, in Pakistan, around 98% of freshwater goes toward agricultural use.
- One way that agriculture causes water pollution is through rainwater. When it rains, pollutants such as fertilizers, animal waste, and pesticides wash from farms into waterways, contaminating the water.
- Contaminates from agriculture usually contain high amounts of phosphorous and nitrogen, which encourage the growth of algal blooms. These blooms produce toxins that kill fish, seabirds, and marine mammals, as well as harming humans.

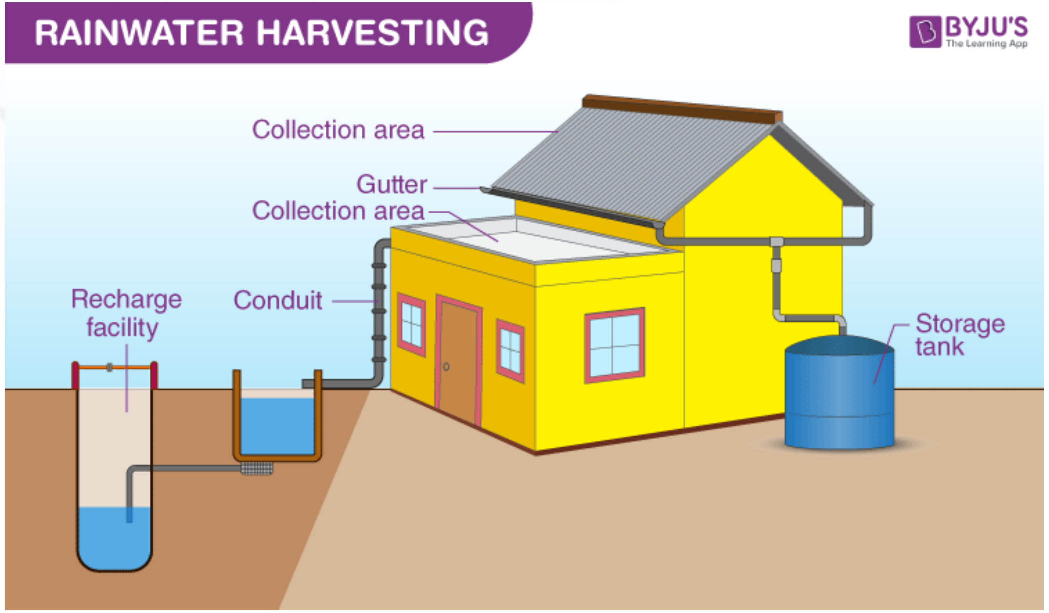
- **Plastics and garbage**
- We produce approximately 2.1 billion tons of waste each year. Of this annual waste, 10% comprises plastics. Due to the widespread use of plastics, experts estimate that there is 75 to 199 million tons of waste plastic in the world's oceans.
- Plastic and garbage can enter the water in many ways:
- debris falling off ships
- trash blowing into the ocean from landfills
- garbage swept into the sea via rivers from people discarding used items such as food packages
- people throwing their trash on to the beach

- **Oil**
- Oil pollution can occur when oil tankers spill their cargo. However, oil can also enter the sea via factories, farms, and cities, as well as via the shipping industry.
- **Radioactive waste**
- Radioactive waste can endure in the environment for thousands of years, making safe disposal difficult. If improperly disposed of, it can enter the water, making it hazardous to humans, marine life, and the environment.

- **Fracking**
- Fracking is the process of extracting oil or natural gas from rock. The technique uses large amounts of water and chemicals to crack the rock at high pressure. The fluid created by fracking contains contaminants that can pollute underground water supplies.
- **Climate change**
- Emerging studies suggest that rising sea levels due to climate change may negatively affect the quality and safety of drinking water.

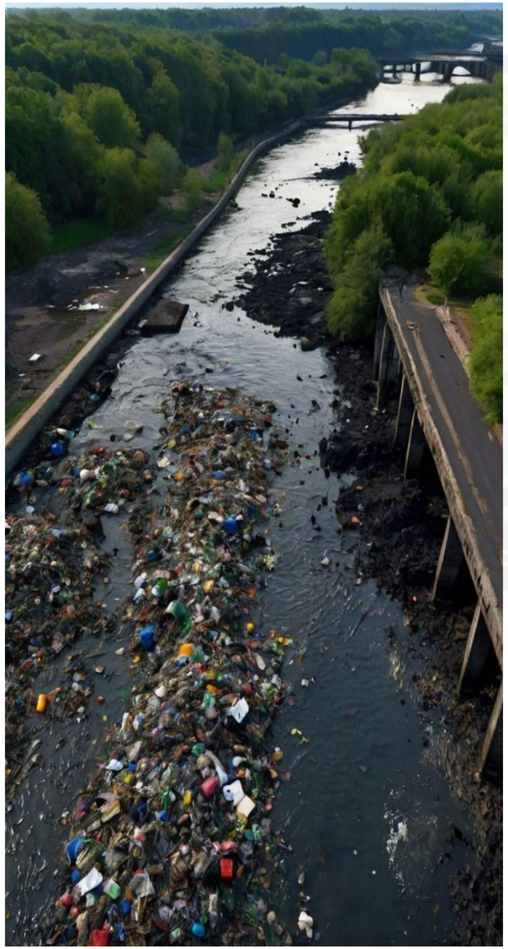
- **Ingesting microplastics**
- A person may ingest microplastics through drinking water or by eating contaminated seafood. One 2020 studyTrusted Source estimated that humans ingest between 0.1 and 5 grams of microplastics weekly.
- Studies show microplastics may cause oxidative stress, inflammatory reactions, and metabolic disorders in humans. However, further research is needed to confirm these effects.
- **Consuming water contaminated by sewage**
- The WHO notes that globally, around 1.7 billionTrusted Source people use drinking water sources with fecal contaminants. Contaminated water can harbor bacteria, such as those responsible for diarrhea, cholera, dysentery, typhoid, hepatitis A, and polio.
- According to the WHO, every year, approximately 1.4 million peopleTrusted Source die due to poor sanitation, poor hygiene, or unsafe drinking water each year.

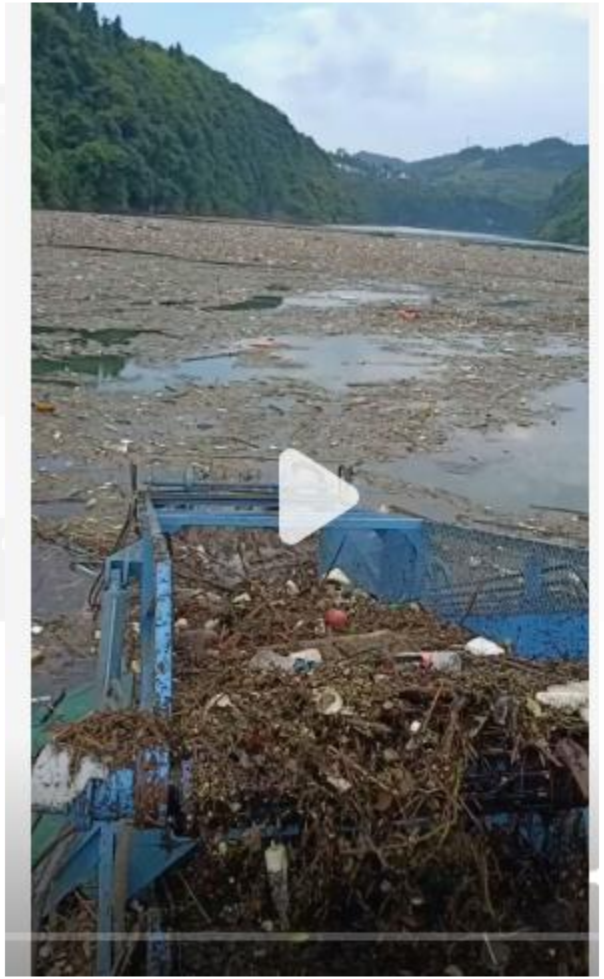
- Water harvesting
- Rainwater harvesting means capturing the rain where it falls or capturing the runoff and taking measures to store that water and keep it clean.
- Rainwater harvesting can be undertaken through a variety of ways:
  - capturing run-off from roof tops
  - capturing run-off from local catchments
  - capturing seasonal floodwater from local streams
  - conserving water through watershed management



Example of Small level Rain Water harvesting in villages in India

- **Effects of Pollution of Water**
- Diseases: In humans, drinking or consuming polluted water in any way has many disastrous effects on our health. It causes typhoid, cholera, hepatitis and various other diseases.
- Destruction of Ecosystems: Ecosystems are extremely dynamic and respond to even small changes in the environment. Water pollution can cause an entire ecosystem to collapse if left unchecked.
- Eutrophication: Chemicals in a water body, encourage the growth of algae. These algae form a layer on top of the pond or lake. Bacteria feed on this algae and this decreases the amount of oxygen in the water body, severely affecting the aquatic life there.
- Effects the food chain: Disruption in food chains happens when toxins and pollutants in the water are consumed by aquatic animals (fish, shellfish etc) which are then consumed by humans.



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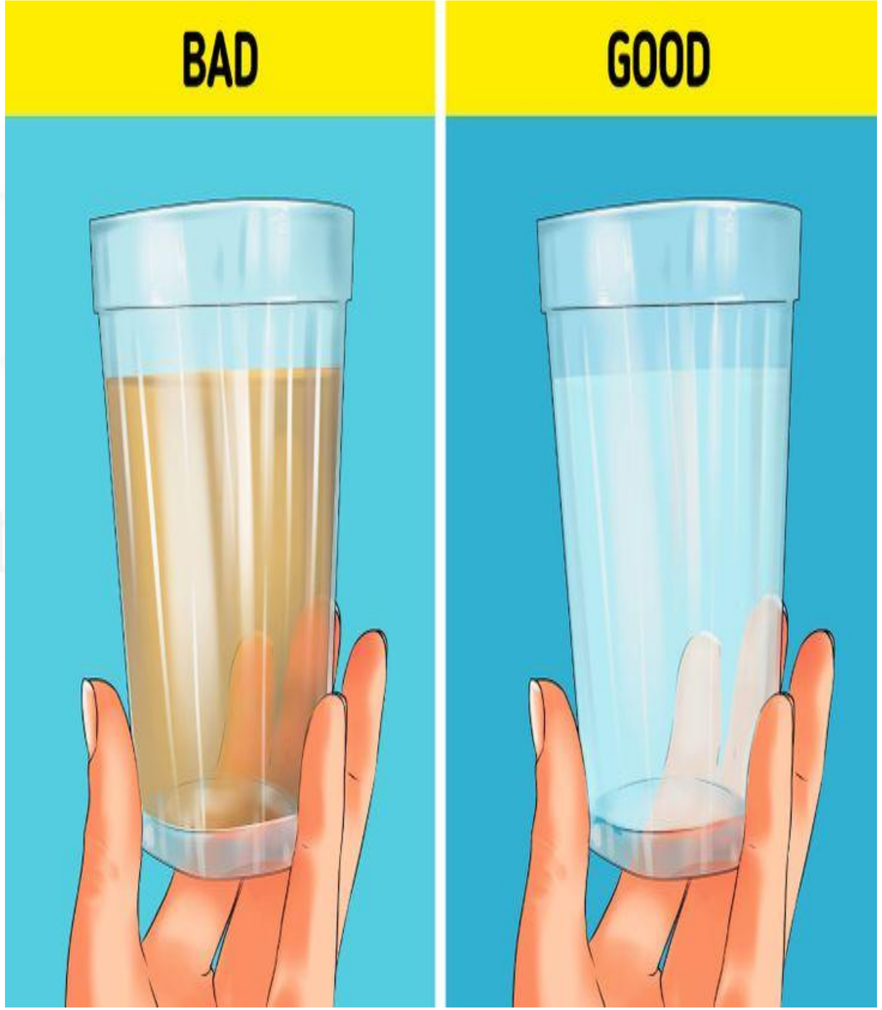
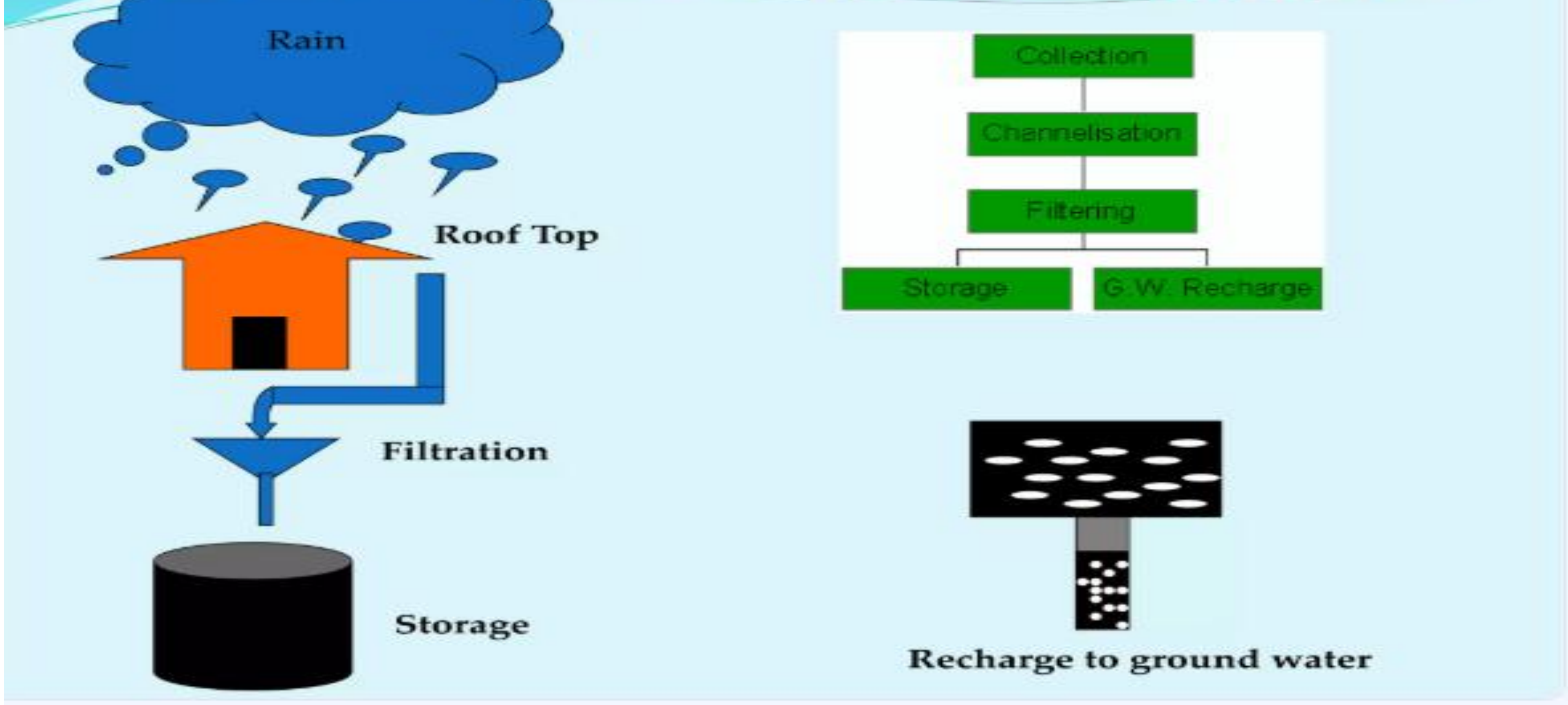
NetSol Water
Health Concerns Resulting from Contaminated Water


Image Source: arrythewaternc

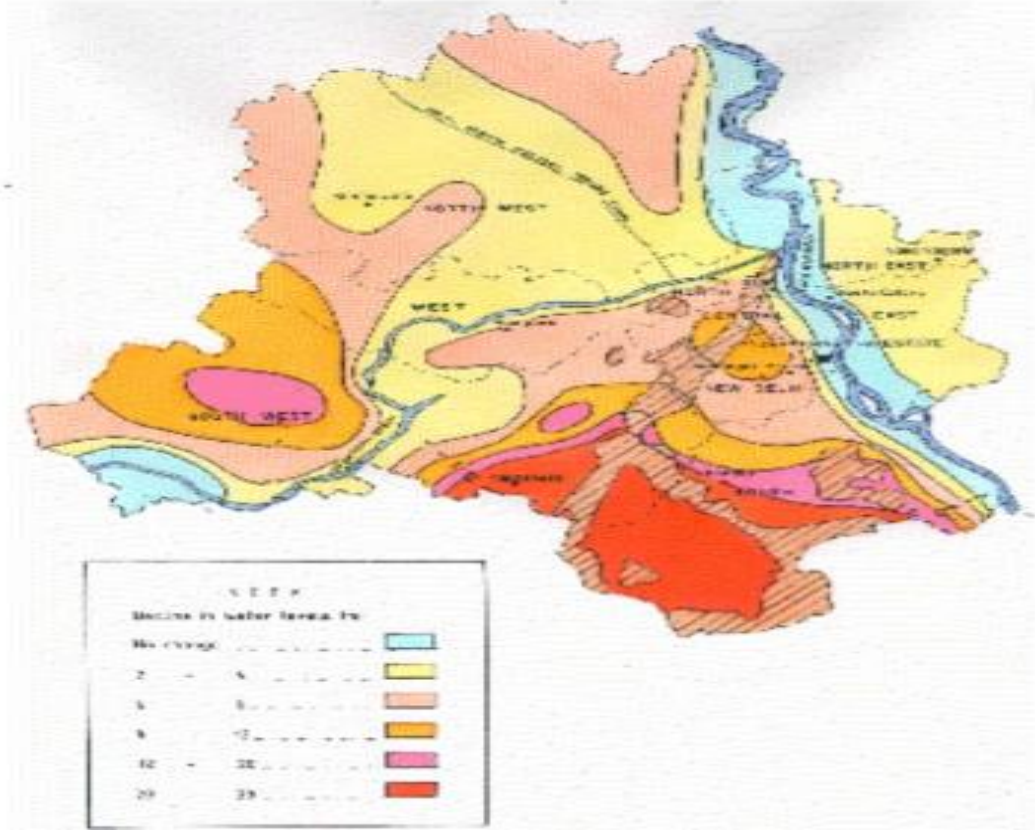

WATER POLLUTION
Reported by: Group I


BAD
GOOD

RAIN WATER HARVESTING



DECLINE IN GROUND WATER LEVELS



In Delhi the water level in 1960 was, by and large,within 4 to 5 m but by 2001 it has gone down by 2-6 m in alluvial areas, 8-20 in south west district and 8-30 in south district.

- **Water harvesting techniques: Why is it important?**
- To serve as domestic usage with appropriate filtration (drinking, watering garden).
- To act as unfiltered landscape irrigation, especially for dryland farming.
- To boost groundwater recharge, which will increase soil fertility even further.
- To lessen sewage treatment plant overloads, urban flooding, and stormwater discharges; keeps the clean, fresh surface water free of metals, pesticides, fertilisers, and other sediments.
- To lessen the influx of saltwater into coastal communities.
- Rainwater harvesting methods are affordable than other purifying or pumping methods, and ensure high-quality water.
- It reduces the demand for ground water. Having a rainwater harvesting system boosts the productivity of aquifer leading to increase in groundwater levels.

• Functions of rainwater harvesting

Harvesting rainwater has several functions:

- providing water to people and livestock
- providing water for food and cash crops
- increasing groundwater recharge
- reducing storm water discharges, urban floods and overloading of sewage treatment plants
- reducing seawater ingress in coastal areas

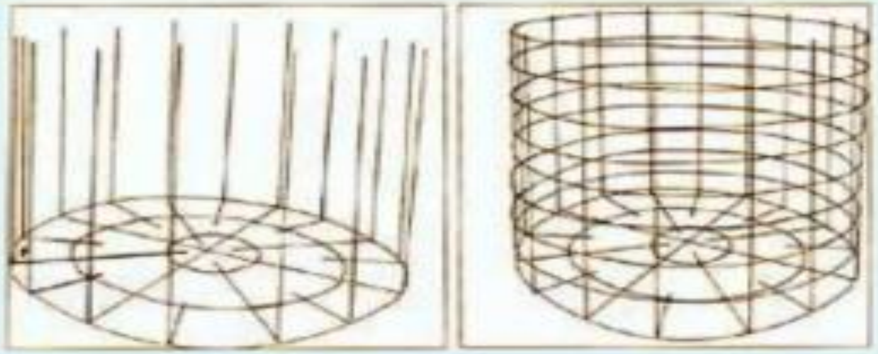
- **Rain water harvesting: Advantages**
- This an easily accessible renewable water resource.
- Rain water harvesting reduces urban flooding.
- Rain water harvesting will prevent soil erosion.
- Rain water harvesting is very cost effective way of saving water.
- This is not labour intensive.
- **Rain water harvesting: Disadvantages**
- The water that is received by rain water harvesting may not be suitable for drinking unless treated properly.
- It cannot be done in areas that have long dry spells.
- One has to maintain the storage facility properly or else it can result in contamination of water. These can also become breeding grounds for insects.
- While its not expensive, the initial set up may be high.
- The rainwater harvesting system yield depends on the rainfall received and varies from season to season.

Pot shaped container

Ferro Cement Jars

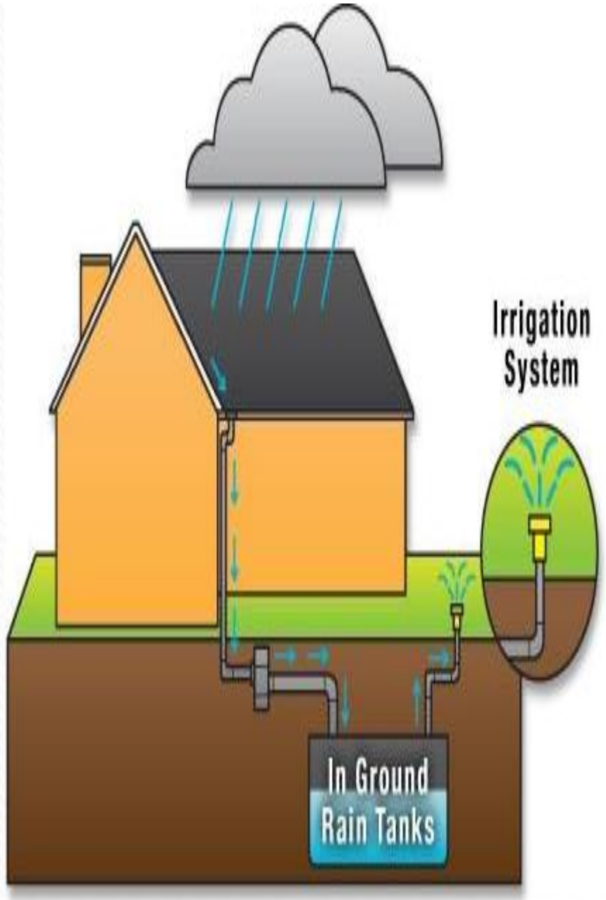
RCC Tank

Masonry Tank



FTSC Tank

- Roof water harvesting includes collection of the precipitation falling on to the roof or terrace of a building and storing it in a sump at ground level or directing the water to the ground directly after passing through filter media to recharge the ground water which is depleting day by day due to concretization.

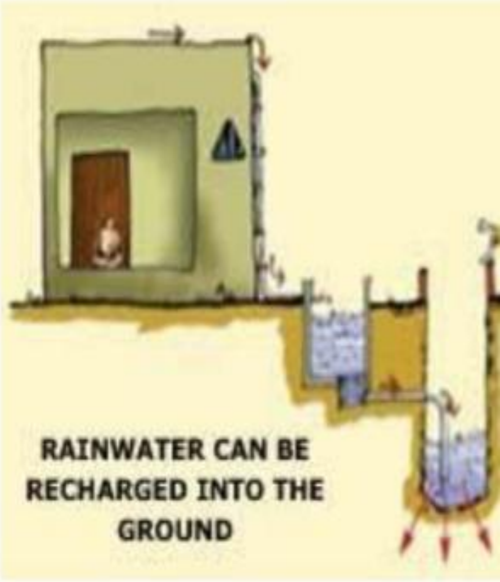


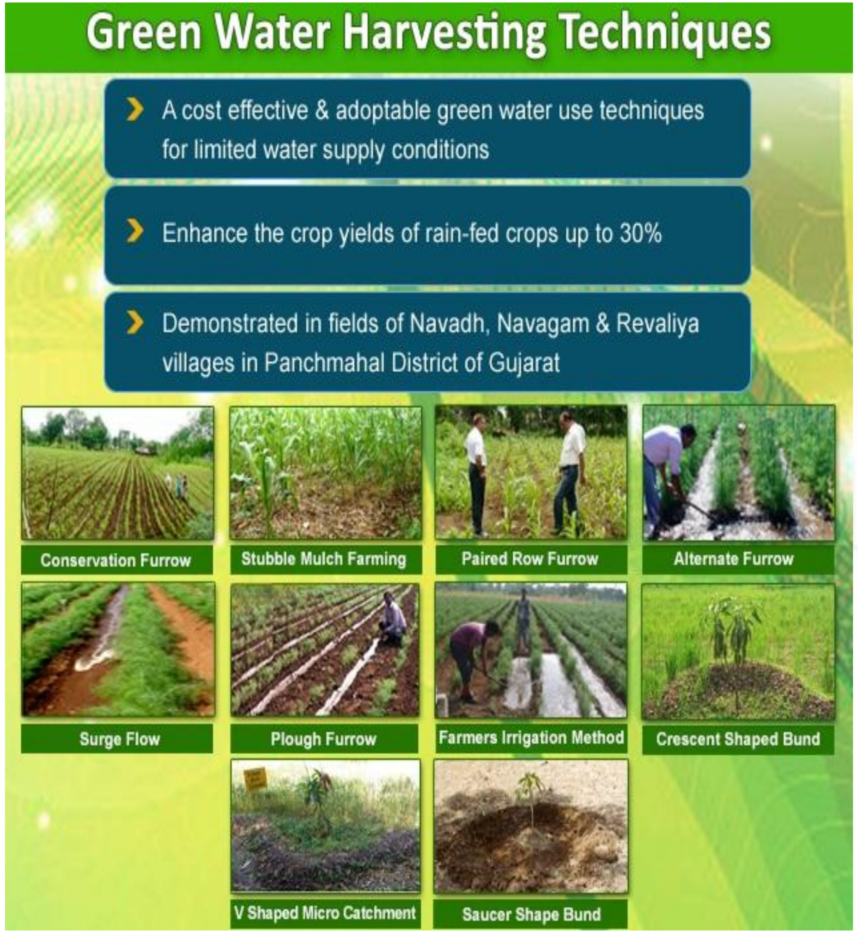
- In situ water harvesting is a special variety of rain water harvesting in which the rain incident on a plot of land is harvested there itself by storing it in a pit or trench. This method is useful in areas having heavy rainfall with quick runoff and no aquifers to recharge the rain water. In such a situation there is no need of the traditional approach of collecting from a donor catchment and storing in a recipient area.

- Rain water harvesting is collection of rain water through

(1) Storage for direct use

(2) Recharging of ground water.




Green Water Harvesting Techniques
A cost effective & adoptable green water use techniques for limited water supply conditions
Enhance the crop yields of rain-fed crops up to 30%
Demonstrated in fields of Navadh, Navagam & Revaliya villages in Panchmahal District of Gujarat
Conservation Furrow
Stubble Mulch Farming
Paired Row Furrow
Alternate Furrow
Surge Flow
Plough Furrow
Farmers Irrigation Method
Crescent Shaped Bund
V Shaped Micro Catchment
Saucer Shape Bund


Rainwater Harvesting
in India


1. STEPWELL


2. TAANKA


3. BAOLI


4. ERI


5. ZABO


6. KHADIN

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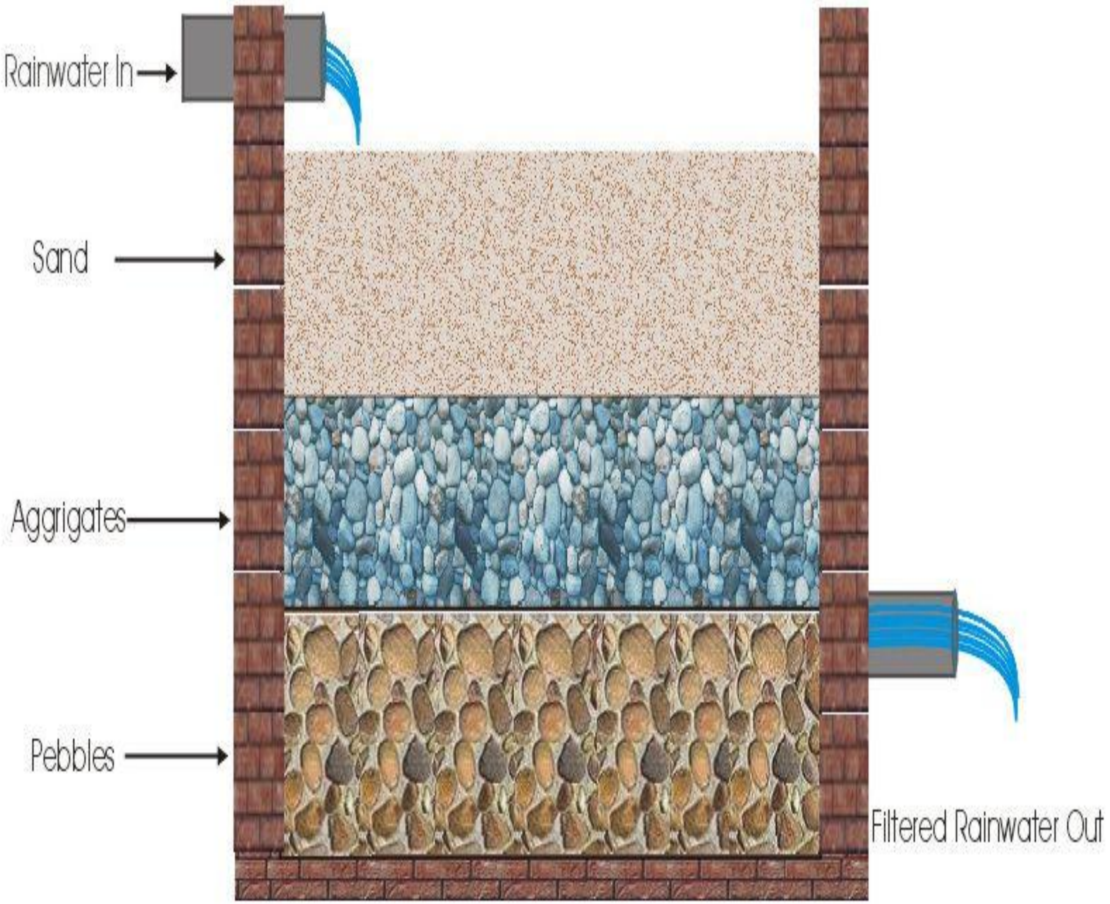
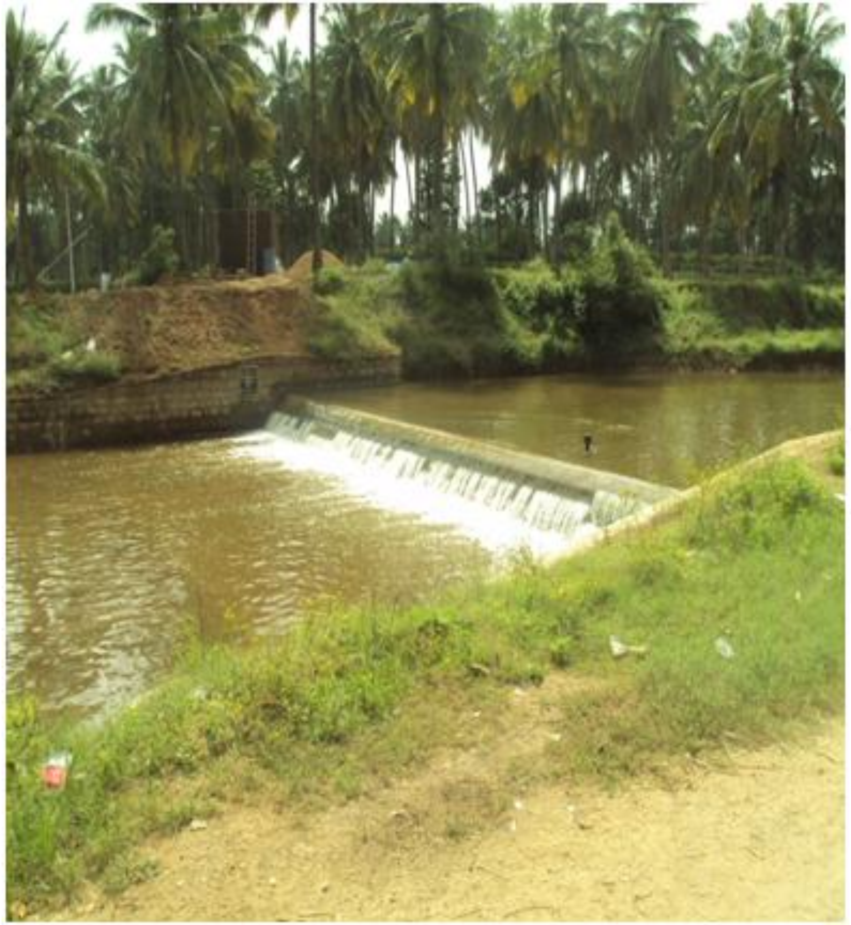
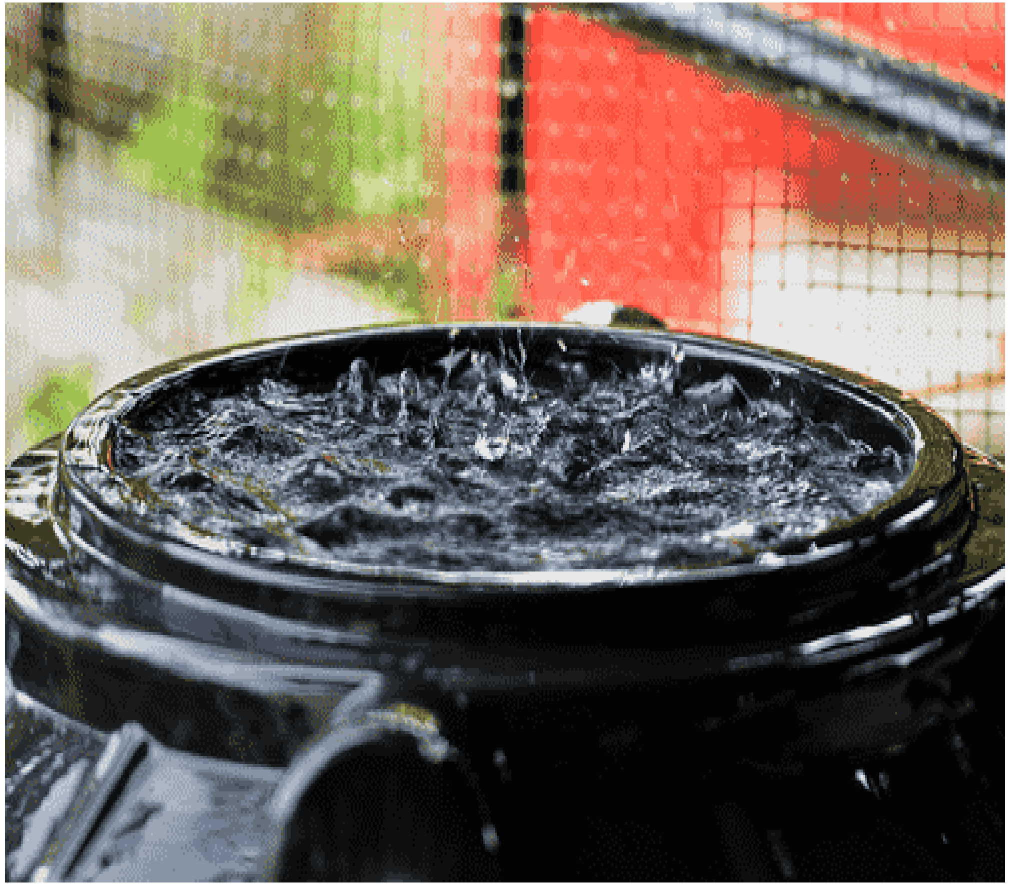
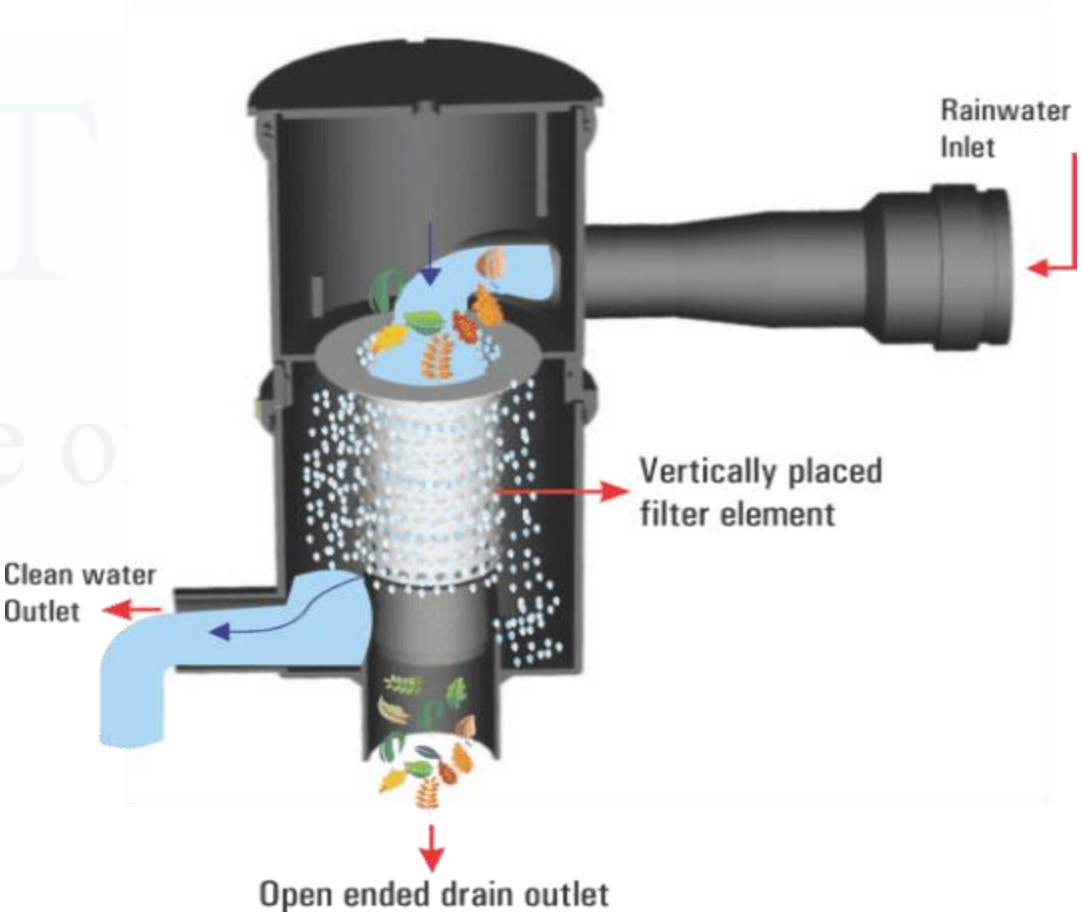

Rainwater In
Sand
Aggrigates
Pebbles
Filtered Rainwater Out


©Aquascape, Inc.






Rainwater
Inlet
Vertically placed
filter element
Clean water
Outlet
Open ended drain outlet

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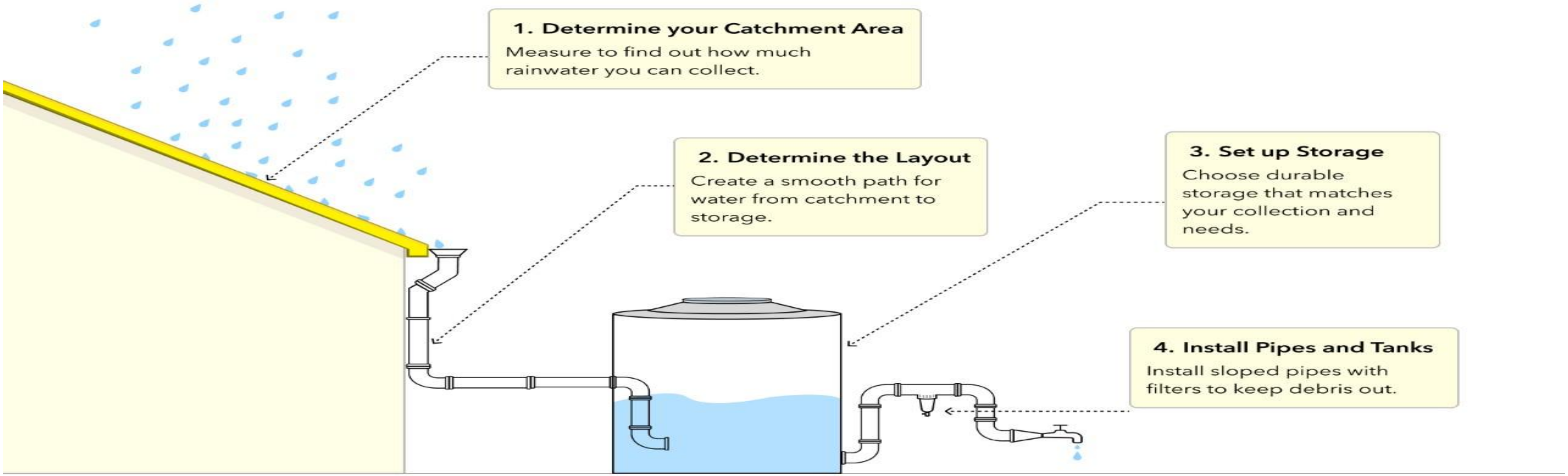
The Steps to An Efficient Rainwater Harvesting System

UltraTech Cement — The Engineer's Choice — INDIA'S NO.1 CEMENT



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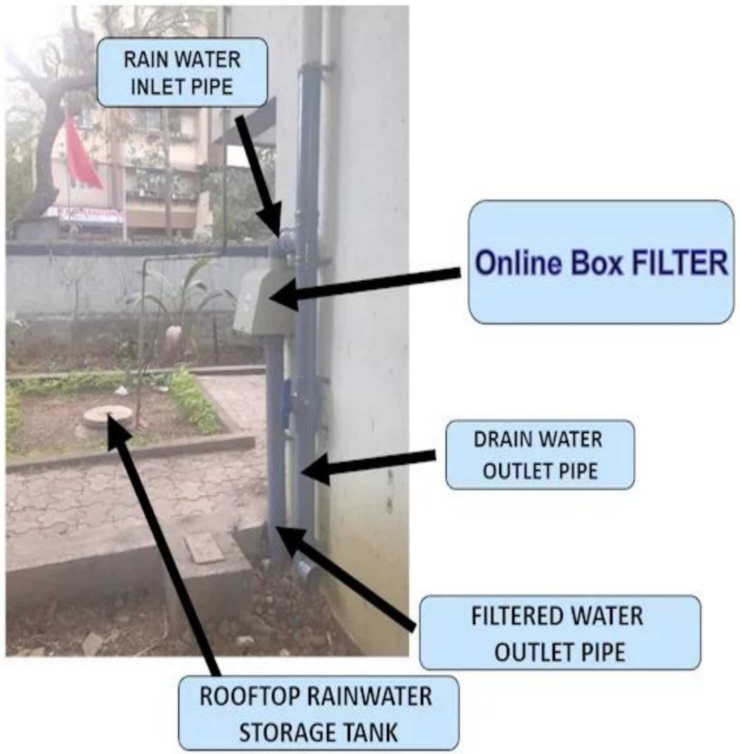
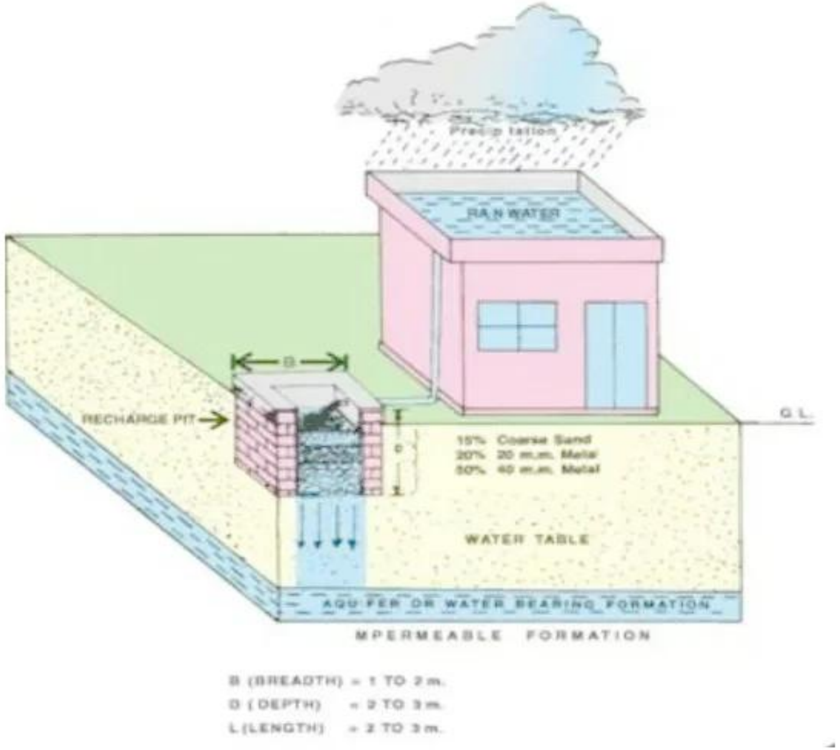
- **1. Storage of Rain water in collection tanks**
- In place where the rains occur throughout the year, rain water can be stored in tanks. However, at places where rains are for 2 to 3 months, huge volume of storage tanks would have to be provided. In such places, it will be more appropriate to use rain water to recharge ground water aquifers rather than to go for storage. If the strata is impermeable, then storing rain water in storage tanks for direct use is a better method. Before storing rainwater in storage tanks rainwater should pass through Apollo Rooftop Online Filter installed at Rooftop Downtake pipe.



Storage of Rooftop water in Storage tank after passing through Apollo Rooftop Online Filter installed at INDIAN WATER WORKS ASSOCIATION – MUMBAI HEAD QUARTERS

- Recharging ground water aquifers from roof top run off
- Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth



- Recharging ground water aquifers with runoff from ground areas
- The rain water that is collected from the open areas may be diverted by drain pipes to a recharge dug well / bore well. Apollo Vee Wire Filter Kit/ Rainwater Filter Kit is installed at the mouth of Borewell so that filtered water is recharged into Ground without contaminating Ground Water Table. The abandoned bore well/dug well can be used cost effectively for this purpose.

- **Roof Top Rainwater/Storm Runoff Harvesting** through in rural areas:
- **Gully Plug** – **Gully plugs** are built using local stones, clay, and bushes across small gullies and streams running downhill slopes.
  - They help capture drainage and create tiny catchments during the rainy season.
- **Contour Bund** – **Contour bunds** are effective for conserving soil moisture in a watershed.
  - They are constructed on sloping ground along the contour lines to impound monsoon runoff, intercepting water before it gains erosive velocity.
  - They are suitable for low rainfall areas.
- **Dugwell Recharge** – After cleaning and de-silting, existing and abandoned dug wells can be used as recharge structures.
- **Percolation Tank –** A percolation tank is an artificially created surface water body that submerges highly permeable land, allowing surface runoff to percolate and recharge groundwater storage.
  - It is best constructed on second—to third-order streams with highly fractured and weathered rocks.
- **Check Dam/Cement Plug/Nala Bund – Check dams** are built across small streams with gentle slopes.
  - They store water mostly within the stream course and are usually less than 2 meters high, allowing excess water to flow over the wall.
- **Recharge Shaft** – This technique recharges **unconfined aquifers** overlain by poorly permeable strata.
  - It helps recharge groundwater from village tanks during the rainy season while maintaining sufficient water in the tank for domestic use.

- Traditional methods of Rainwater Harvesting

1.Khadin(Rajasthan)

- A Khadin is an ingenious construction designed to harvest surface runoff water for agriculture. It is also called a dhora. The khadin system is based on the principle of harvesting rainwater on farmland and subsequent use of this water-saturated land for crop production.
- It is First designed by in western Rajasthan in the 15th century, its main feature is a very long (100-300 m) earthen embankment built across the lower hill slopes lying below gravelly uplands.

VARIOUS METHODS OF WATER HARVESTING

KUL

- *Kuls* are water channels found in precipitous mountain areas.
- These channels carry water from glaciers to villages in the Spiti valley of **Himachal Pradesh**.
- Where the terrain is muddy, the *kul* Is lined with rocks to keep it from becoming clogged.

NAULA

- Naula is a surface-water harvesting method typical to the hill areas of **Uttaranchal.**
- These are small wells or ponds in which water is collected by making a stone wall across a stream.

VIRDAS

- *Virdas* are shallow wells dug in low depressions called *jheels* (tanks).
- They are found all over the Banni grasslands, a part of the Great Rann of Kutch in **Gujarat.**

APTANI

- This is a wet rice cultivation cum fish farming system practiced in elevated regions of about 1600 m and gentle sloping valleys, having an average annual rainfall about 1700 mm and also rich water resources like springs and streams.

- ... s both ground and surface water for ...d by Apatani tribes of ziro in the ...t of Arunachal Pradesh.

dug in low depressions
ey are found all over the
f the Great Rann of Kut...

- ... valleys are terraced into plots separated by 0.6 meters high earthen dams supported by bamboo frames. All plots have inlet and outlet on opposite

- Kund (Rajasthan and Gujarat)
- A Kund is a saucer-shaped catchment area that gently slope towards the central circular underground well. Its main purpose is to harvest rainwater for drinking. Kunds dot the sandier tracts of western Rajasthan and Gujarat. Traditionally, these well-pits were covered in disinfectant lime and ash.
-

- Taanka (small tank) is a traditional rainwater harvesting technique indigenous to the Thar desert region of Rajasthan (Bikaner). A Taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows. Once the taanka is completely filled, the water stored in it can last throughout the dry season and is sufficient for a family of 5-6 members for drinking. In this way, the people of Bikaner were able to meet their water requirements.
-

- Jhalara
- Jhalaras are typically rectangular-shaped step wells with three or four tiered sides. The steps were constructed in stages.
- Jhalaras were man-made tanks found in Rajasthan and Gujarat that were built to conserve rainwater and ensure an easy and consistent supply of water for religious rites, royal ceremonies, and community use such as bathing and religious rites.

- Eri (Tamil Nadu)
- The Eri (tank) system of Tamil Nadu is one of the oldest water management systems in India. It played several important roles in maintaining ecological harmony as flood-control systems, preventing soil erosion and wastage of runoff during periods of heavy rainfall, and recharging the groundwater in the surrounding areas. Without Eris, paddy cultivation of Tamil Nadu would have been impossible. The Eri system is mostly present in all ancient temples of Tamil Nadu.

- Disadvantages of Traditional Rainwater Harvesting

- Digging deeper wells is not only expensive but can cause environmental damage, such as collapsing the soil where the water used to be. Rainfall is hard to predict, and throughout the year (depending on where you are), you may experience little or no rainfall. This means it's not recommended to rely solely on rainwater alone for all your water needs.

- Depending on the system's size and the methods used, installing a rainwater harvesting system is expensive and construction techniques and material cost also very expensive. Rainwater harvesting systems necessitate regular maintenance and upkeep because tanks, jhalara, and kunds are larger in area and size in traditional methods. Furthermore, they are vulnerable to rodents, algae growth, and insects.

- The barrels or tanks can only hold limited water. So, during a very heavy downpour or storm, and once the catchment is full, the system may not be able to hold all the rainwater. The excess rainwater overflows and then ends up going into drains and rivers anyway.

- Certain chemicals, insects, dirt, or animal droppings leach into the reserved water. If you use the harvested water to water your garden, these substances can harm the plants or your lawn. It is

- What are sub-surface dykes?
- Sub-surface dykes are essentially underground barriers built across streams or rivers to impede the natural flow of water. Unlike traditional dams or surface dykes, these structures are constructed below the ground level. The primary objective of sub-surface dykes is to store water upstream, which subsequently aids in groundwater recharge. This method is particularly effective in areas with wide valleys and shallow impermeable layers, making it a versatile solution for various geographical settings.

SUB-SURFACE DYKE BEFORE BACKFILLING

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- **How do sub-surface dykes work?**
- The working principle of sub-surface dykes is relatively straightforward yet highly effective. By creating an underground barrier, these dykes prevent water from flowing downstream. Instead, the water is retained upstream, allowing it to percolate through the soil layers and recharge the groundwater table. This process is beneficial in maintaining the water levels in wells and boreholes, ensuring a steady supply of water even during dry seasons.

Construction of sub-surface dykes

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- Construction of sub-surface dykes
- Building a sub-surface dyke involves several steps, each crucial for the structure’s effectiveness and longevity. Here’s a simplified breakdown:
- **Site selection:** The first step is to identify a suitable location. Ideal sites are those with wide valleys and shallow impermeable layers. Geological surveys and hydrological studies are often conducted to determine the best site.
- **Design and planning:** Once a site is selected, detailed designs and plans are prepared. This includes calculating the required depth and length of the dyke, considering the soil type, water flow, and other environmental factors.
- **Excavation:** The next step is to excavate the selected site to the required depth. This involves digging trenches that will house the dyke.
- **Construction:** The actual construction involves placing impermeable materials like clay, concrete, or plastic liners in the excavated trenches. These materials form the barrier that prevents water from flowing downstream.
- **Backfilling:** After the barrier is in place, the trenches are backfilled with soil. This helps to stabilize the structure and restore the natural landscape

- Benefits of sub-surface dykes

- Sub-surface dykes offer numerous benefits, making them a valuable tool in water management. Here are some key advantages:
- Groundwater recharge: By retaining water upstream, sub-surface dykes facilitate the percolation of water into the ground, effectively recharging the groundwater table.
- Reduced water loss: Unlike surface reservoirs, sub-surface dykes minimize water loss due to evaporation, ensuring more water is available for groundwater recharge.
- Environmental impact: These structures have a minimal impact on the environment since they are constructed underground. They do not disrupt the natural landscape or aquatic ecosystems.
- Cost-effective: Sub-surface dykes are relatively inexpensive to construct and maintain compared to large dams or surface dykes.
- Sustainable: By promoting groundwater recharge, these dykes contribute to the sustainable management of water resources, ensuring a reliable supply for future generations.

- **Case studies**

Let's look at some examples where sub-surface dykes have made a significant impact:

- **Karnataka:** In the drought-prone regions of Karnataka, sub-surface dykes have been constructed across several streams. These structures have significantly improved groundwater levels, providing much-needed relief to farmers and local communities.
- **Maharashtra:** Similar initiatives in Maharashtra have shown promising results. Sub-surface dykes in the state have helped in maintaining water levels in wells and boreholes, ensuring a steady water supply for agricultural activities.
- **Rajasthan:** In the arid regions of Rajasthan, sub-surface dykes have been instrumental in combating water scarcity. These structures have enabled the storage and efficient use of rainwater, benefiting both agriculture and domestic water supply

- Challenges and considerations
- While sub-surface dykes offer numerous benefits, there are also challenges and considerations to keep in mind:
- Site selection: Identifying the right location is crucial for the effectiveness of sub-surface dykes. Geological and hydrological studies are essential to ensure the selected site is suitable.
- Construction quality: The quality of construction materials and techniques can significantly impact the dyke’s performance. Proper planning and execution are vital to ensure the structure’s durability and effectiveness.
- Maintenance: Regular maintenance is necessary to ensure the dyke continues to function effectively. This includes monitoring water levels, inspecting the structure for any damage, and making necessary repairs.
- Community involvement: Engaging local communities in the planning, construction, and maintenance of sub-surface dykes can enhance their effectiveness and ensure long-term sustainability

What is meant by farm pond?

Farm pond. Farm Pond is a dug out structure with definite shape and size having proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. It is one of the most important rain water harvesting structures constructed at the lowest portion of the farm area.

Engineering Measures - Farm ponds

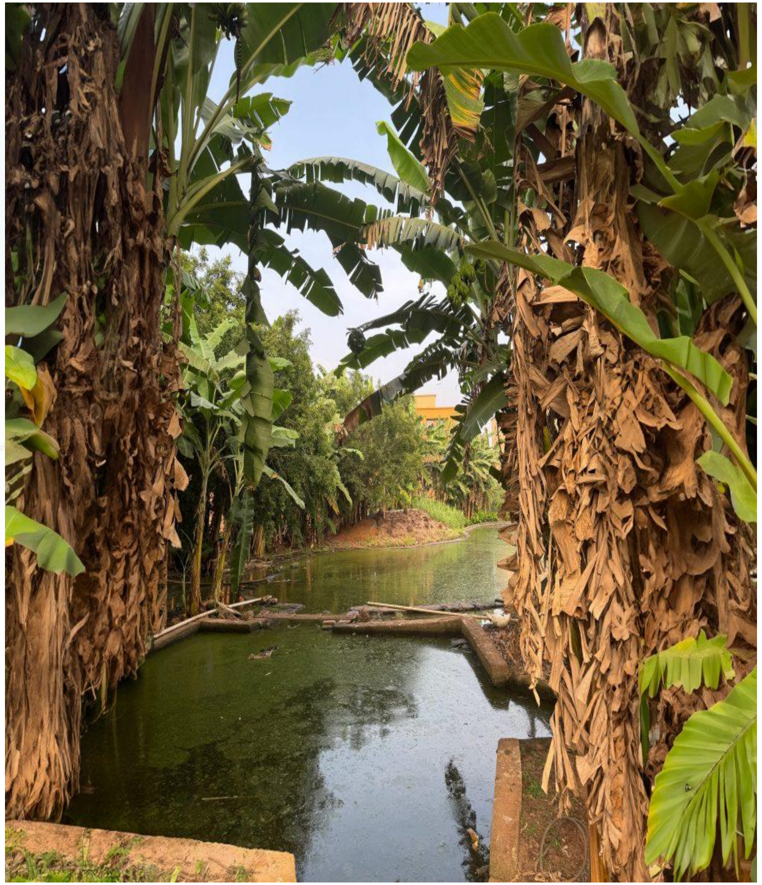

Farm ponds construction


Farm ponds in plain areas


Farm ponds in hilly areas

1	Bottom Area	20 m x 20 m
2	Top Area	35 m X 35 m
3	Depth	2.2 m
4	Cost of lining material (Rs)	85,000
5	Excavation (Rs)	20,000
6	Coir dust & spreading (Rs)	2,000
7	Spreading plastic lining and sheet welding (Rs) and with earth cover	27,000
8	Cost of inlet and outlet structures	66,000
9	Total cost (Rs)	2,00,000

- What is a water harvesting pond?
- Water harvesting ponds collect and store rainwater runoff from surrounding areas, preventing it from flowing away and allowing it to be stored for future use. By capturing rainwater, these ponds help reduce soil erosion and prevent surface runoff, thereby protecting the landscape and maintaining soil fertility.



- What are the different types of farm ponds?
- Farm ponds are classified into different types based on the water source and location. These include:
- Excavated ponds: Also known as dug out ponds, these are created by digging a hole in the ground.
- Surface ponds: These ponds are built on the surface of the ground.
- Spring or creek fed ponds: These ponds are fed by water from springs or creeks.
- Off stream storage ponds: These ponds are constructed across a stream or water course.
- Diversion ponds: These ponds are fed by water from another source, such as a spring, lake, or reservoir.
- Earthen ponds: These ponds are built by excavating a hole in the ground and constructing an artificial dam.
- Concrete ponds: These ponds are built by vibrating hollow blocks or reinforced concrete slabs.
- Tarpaulin ponds: These ponds are lined with geomembrane liners to reduce the risk of disease transmission and contamination.
- Farm ponds are built to help farmers with climate variability, water storage, crop failure, and non-remunerative prices.
- Tips for building farm ponds
- Consider the availability, quantity, and quality of water.
- Ensure the pond is properly sited and built.
- Construct the pond with an earthen dam, mechanical spillway, and emergency spillway.

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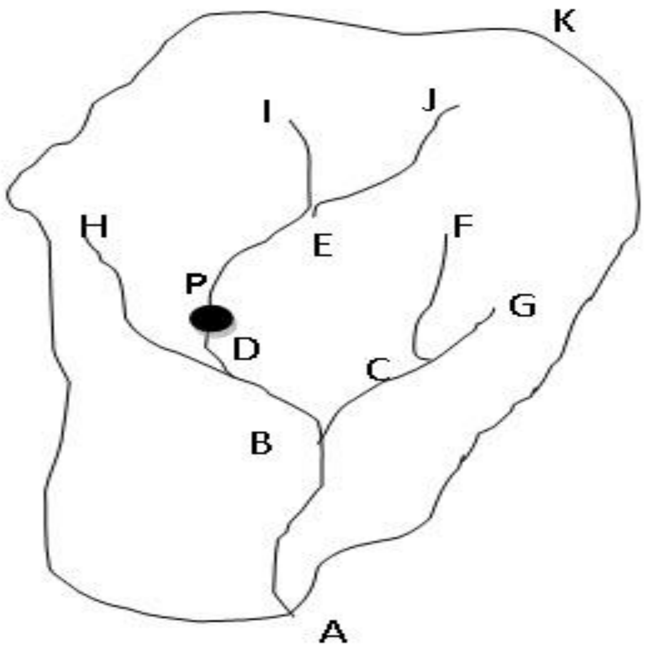
Example 27.1: Design of Embankment Type Farm Pond



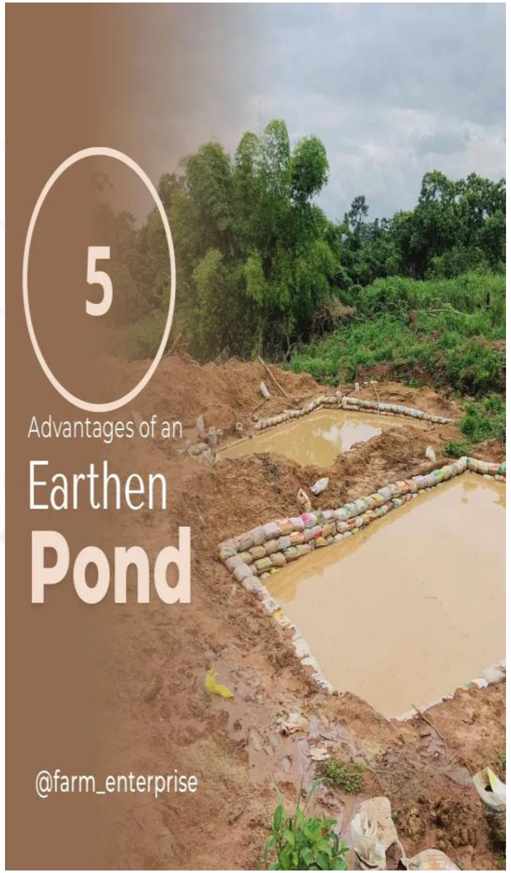
Let's assume to construct an embankment type pond in the watershed shown in Fig. 27.1 at location P. The detailed contours are presented in fig. 27.2. The embankment proposed to have maximum water level at 216 m. The dotted line represents the natural stream IE and JEP of this figure. Pond receives runoff during monsoon rain only. The catchment area is 65 ha. Following data are available.

1. Average annual monsoon rainfall: 750 mm
2. The site condition is such that the 20% of average annual monsoon rainfall is received by the pond as runoff.
3. Rainfall intensity for 25 years return period is 90 mm/hr and daily rainfall is 300 mm.
4. The average sedimentation @ 40t/ha/annum during first 5 years followed by 20, 10, 5 and 2 t/ha/annum in every succeeding 5 years.
5. The soil contains silt and clay with low compressibility.
6. Channel length is 1.2 km, and slope is 2%.

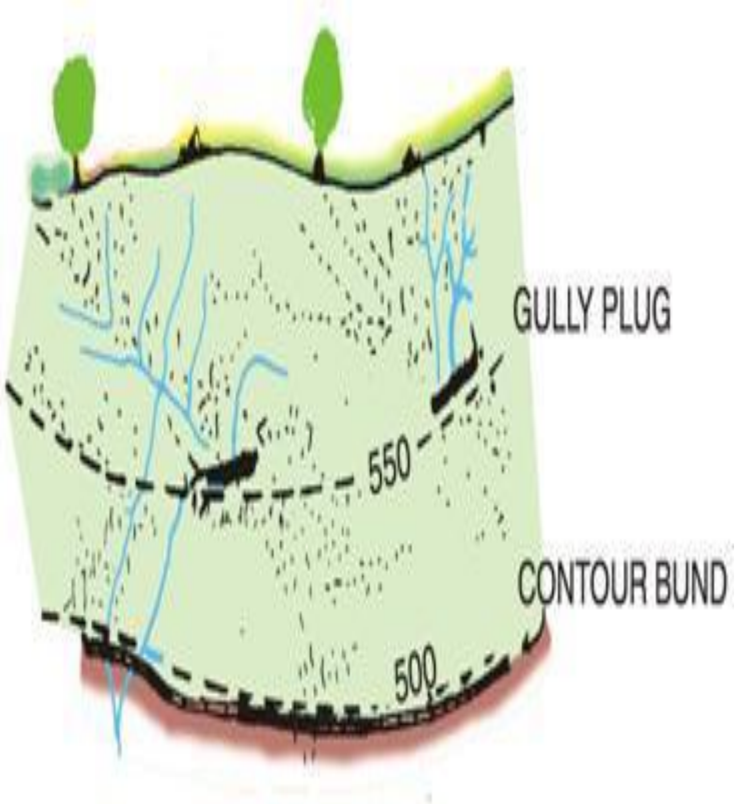
Fig. 27.1. Watershed Map.

- 1. Embankment type: Embankment type farm ponds are generally constructed across the stream or water course. Such ponds consist of an earthen embankment, which dimensions ar fixed on the basis of volume of water to be stored, mainly. These farm ponds are usually constructed in that area where land slope ranges from gentle to moderately steep; and also where stream valleys are sufficiently depressed to permit a maximum storage volume with least amount of earthwork.

- **Excavated or Dug Out Type:**
- Dug out type farm ponds are constructed by excavating the soil from the ground, relatively in flat areas. The depth of pond is decided on the basis of its desired capacity, which is obtained almost by excavation. The use of this type of pond is suitable, particularly where a small supply of water is required.
- Apart from above two types, the farm ponds are also of two more types, i.e. the spring or creck fed and off-stream storage pond, depending on the sources of water available for feeding them.



- Ground water recharge in Rural areas
- In rural areas, rain water harvesting is taken up considering watershed as a unit. Surface spreading techniques are common since space for such systems is available in plenty and quantity of recharged water is also large. Following techniques may be adopted to save water going waste through slopes, rivers, rivulets and nalas.
- Gully plug
- Gully plugs are built using local stones, clay and bushes across small gullies and streams running down the hill slopes carrying drainage to tiny catchments during rainy season.
- Gully Plugs help in conservation of soil and moisture.
- The sites for gully plugs may be chosen whenever there is a local break in slope to permit accumulation of adequate water behind the bunds.

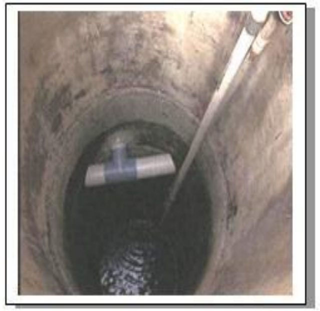


- Gabion structure
- This is a kind of check dam commonly constructed across small streams to conserve stream flows with practically no submergence beyond stream course.
- A small bund across the stream is made by putting locally available boulders in a mesh of steel wires and anchored to the stream banks.
- The height of such structures is around 0.5 m and is normally used in the streams with width of less than 10 m.
- The excess water over flows this structure storing some water to serve as source of recharge. The silt content of stream water in due course is deposited in the interstices of the boulders. With the growth of vegetation, the bund becomes quite impermeable and helps in retaining surface water run off for sufficient time after rains to recharge the ground water body.

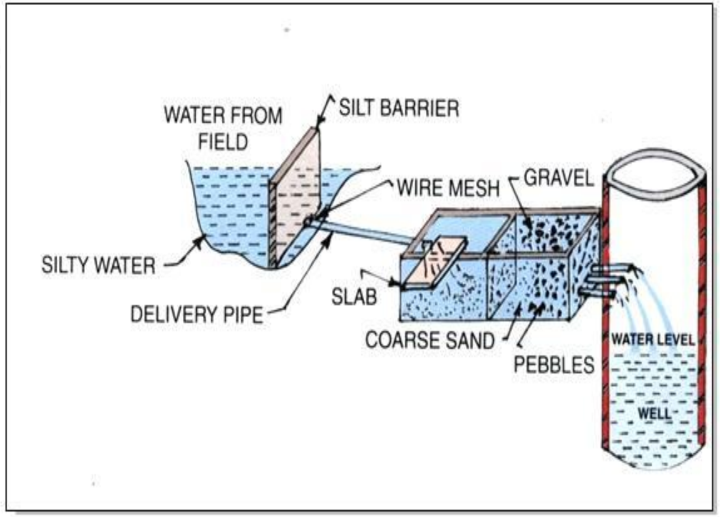
- Check dams / cement plugs / nala bunds
- Check dams are constructed across small streams having gentle slope. The site selected should have sufficient thickness of permeable bed or weathered formation to facilitate recharge of stored water within short span of time.
- The water stored in these structures is mostly confined to stream course and th height is normally less than 2 m and excess water is allowed to flow over the w In order to avoid scouring from excess run off, water cushions are provided at downstream side.
- To harness the maximum run off in the stream, series of such check dams can b constructed to have recharge on regional scale.
- Clay filled cement bags arranged as a wall are also being successfully used as a barrier across small nalas. At places, shallow trench is excavated across the nala and asbestos sheets are put on two sides. The space between the rows of asbe sheets across the nala is backfilled with clay. Thus a low cost check dam is creat On the upstream side clay filled cement bags can be stacked in a slope to provi stability to the structure.

- Dugwell recharge
- Existing and abandoned dug wells may be utilized as recharge structure after cleaning and desilting the same.
- The recharge water is guided through a pipe from desilting chamber to the bottom of well or below the water level to avoid scouring of bottom and entrapment of air bubbles in the aquifer.
- Recharge water should be silt free and for removing the silt contents, the runoff water should pass either through a desilting chamber or filter chamber.
- Periodic chlorination should be done for controlling the bacteriological contaminations.

Abandoned Dug Well



Abandoned Dug Well fitted with Rain Water Harvesting Mechanism



- Percolation tank
- Percolation tank is an artificially created surface water body, submerging in its reservoir a highly permeable land, so that surface runoff is made to percolate and recharge the ground water storage.
- Percolation tank should be constructed preferably on second to third order steams, located on highly fractured and weathered rocks, which have lateral continuity down stream.
- The recharge area down stream should have sufficient number of wells and cultivable land to benefit from the augmented ground water.
- The size of percolation tank should be governed by percolation capacity of strata in the tank bed. Normally percolation tanks are designed for storage capacity of 0.1 to 0.5 MCM. It is necessary to design the tank to provide a ponded water column generally between 3 & 4.5 m.
- The percolation tanks are mostly earthen dams with masonry structure only for spillway. The purpose of the percolation tanks is to recharge the ground water storage and hence seepage below the seat of the bed is permissible. For dams upto 4.5 m height, cut off trenches are not necessary and keying and benching between the dam seat and the natural ground is sufficien