



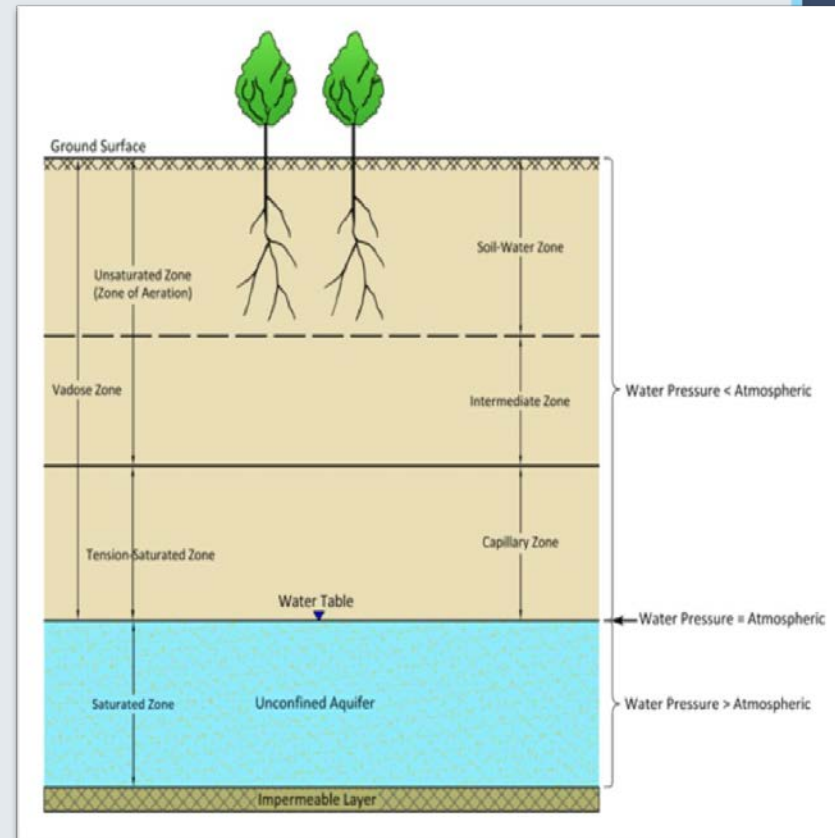
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# Introduction to Groundwater

What is Groundwater?

Groundwater is broadly defined as the water present in the zone of saturation below the ground.





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- ▶ The zone of saturation is technically called **‘aquifer’**.
- ▶ On the other hand, water stored in ponds, lakes, rivers, streams, seas/oceans and other surface reservoirs is called surface water.



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# TYPES OF GEOLOGICAL FORMATION

- **Aquifer:** A geologic formation, or a part of formation, or group of formations that yield significant quantity of water is defined as aquifer and examples of aquifer are sand, gravels etc.
- **Aquiclude** is defined as a geologic formation that can store significant amount of water but does not have the capability to transmit a significant amount of water and examples of aquiclude are clay etc.





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- ▶ **Aquitard** is defined as a geologic formation that can store some water as well as can transmit water at a relatively low rate compared to aquifers. Sandy clay is an ideal example of aquitard.
- ▶ **Aquifuge** is defined as a geologic formation that can neither store nor transmit water. Solid granite is an ideal example of aquifuge.



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# Types of aquifer

Aquifer can be basically classified into three types:

- (i) Unconfined aquifer,**
- (ii) Confined aquifer, and**
- (iii) Leaky aquifer.**

Sometimes, fourth type of the aquifer is known as '**Perched aquifer**'.



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# 1. Confined aquifer

It is Confined under pressure greater than the atmospheric pressure by over lying impervious (**aquiclude**) or semi-pervious strata (**aquitard**).

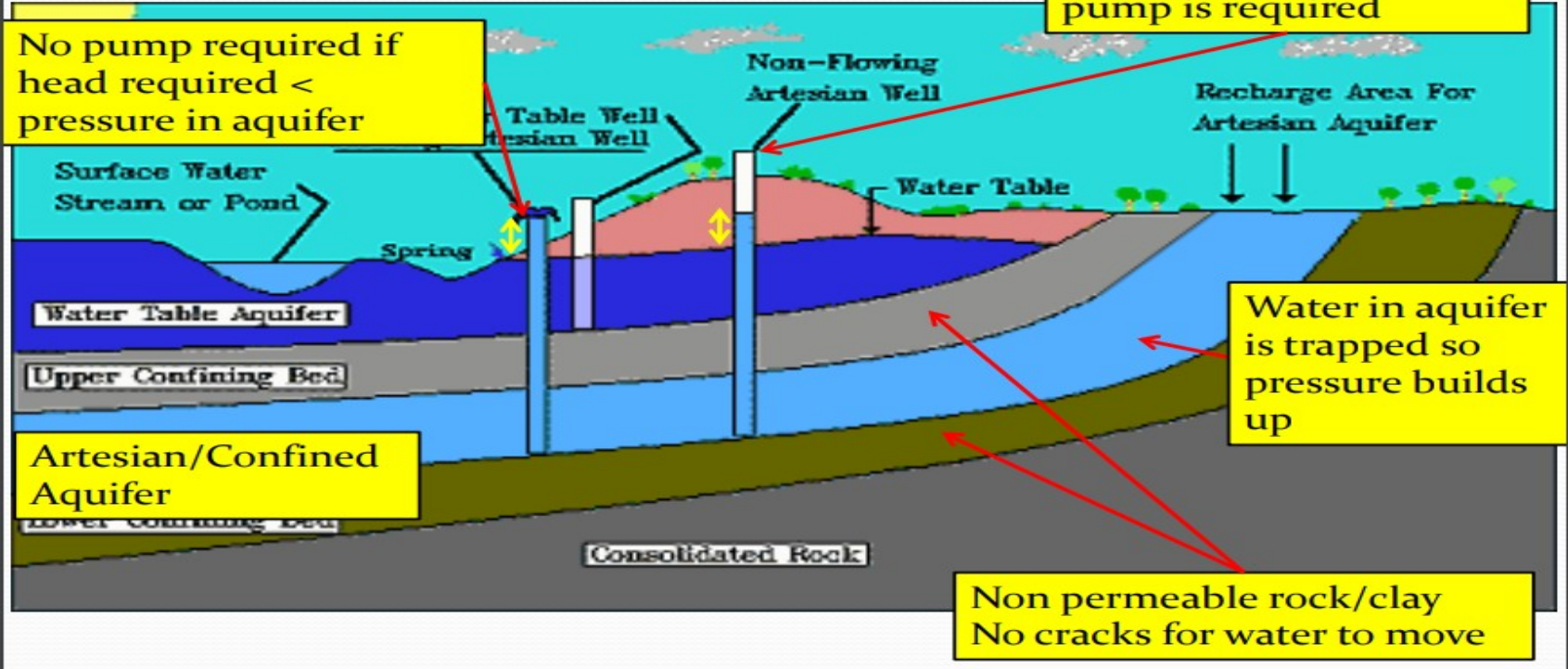
- ▶ When the water level in the well penetrating the confine aquifer rises above the ground, called **flowing well** otherwise, **artisian well**.
- ▶ The imaginary surface to which water rises in wells tapping an artesian aquifer is known as **Piezometric surface** .



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# Confined / Artesian Aquifer



No pump required if head required < pressure in aquifer

If head required > pressure in aquifer then pump is required

Water in aquifer is trapped so pressure builds up

Non permeable rock/clay  
No cracks for water to move

Surface Water  
Stream or Pond

Water Table Aquifer

Upper Confining Bed

Artesian/Confined  
Aquifer

Lower Confining Bed

Consolidated Rock

Table Well  
Artesian Well

Non-Flowing  
Artesian Well

Recharge Area For  
Artesian Aquifer

Water Table

Spring



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## 2. Unconfined aquifer

- ▶ It is a permeable bed saturated with water table serves as the upper surface of the zone of saturation, it is other wise be called as **water table aquifers**.
- ▶ Water which is present in an unconfined aquifer is called as **unconfined or phreatic water**.
- ▶ The upper surface is under atmospheric pressure and the is called **water table**.
- ▶ Water table undulates in form of depending upon the recharge and discharge, pumpage of wells and permeability.





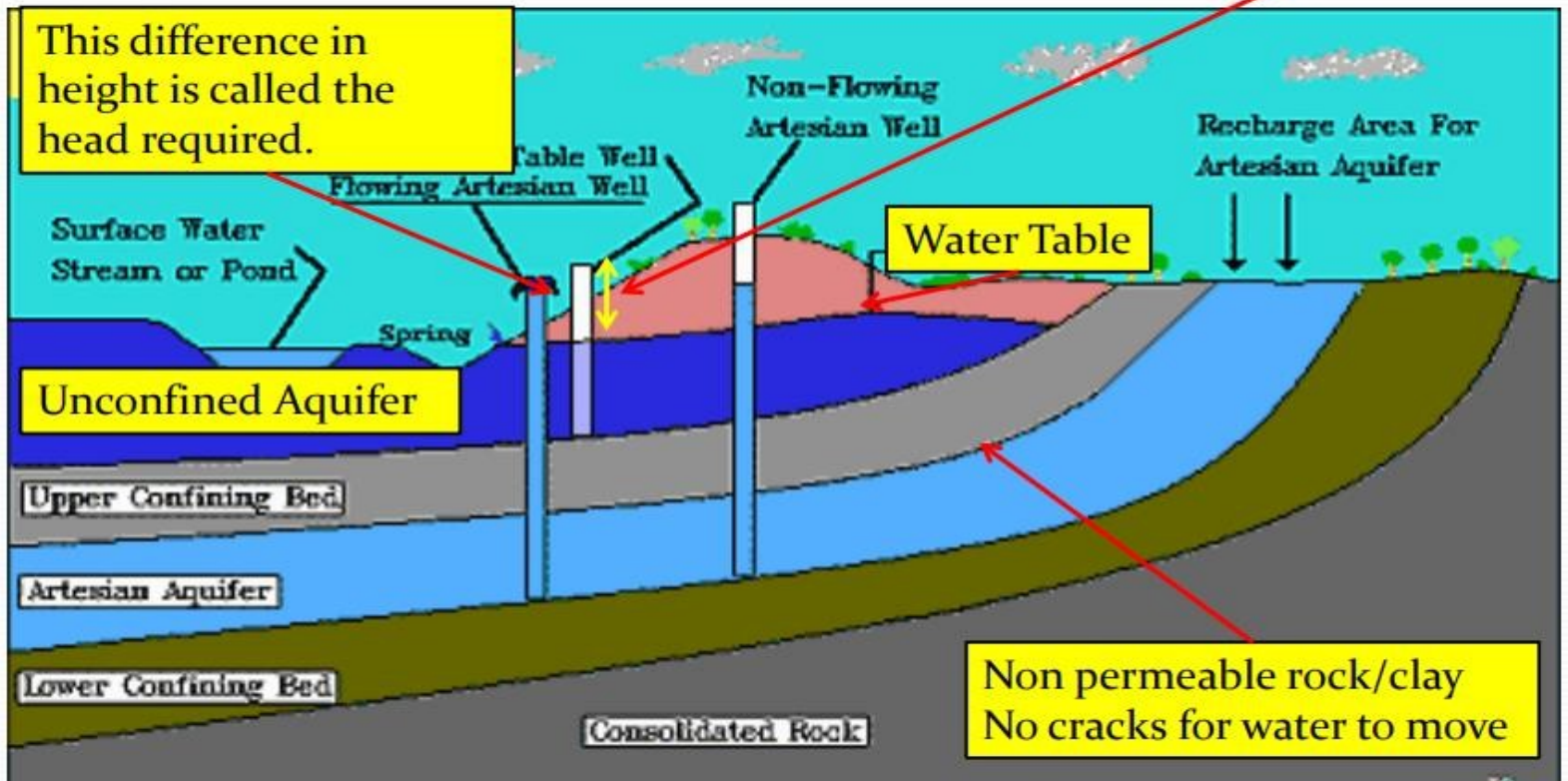
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# Unconfined Aquifer

A pump is required to overcome this head

This difference in height is called the head required.



Unconfined Aquifer

Upper Confining Bed

Artesian Aquifer

Lower Confining Bed

Consolidated Rock

Non-Flowing  
Artesian Well

Recharge Area For  
Artesian Aquifer

Water Table

Non permeable rock/clay  
No cracks for water to move

Surface Water  
Stream or Pond

Spring

Table Well  
Flowing Artesian Well



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## 3. Perched aquifer

- ▶ Perched aquifers, are special kinds of phreatic aquifers occurring whenever an impervious (or semi-pervious) layer of limited extent is located between the water table of a phreatic aquifer and the ground surface, thereby making a groundwater body, separated from the main groundwater body, to be formed.
- ▶ It is a special type of **unconfined aquifer**.



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# 4. Leaky aquifer

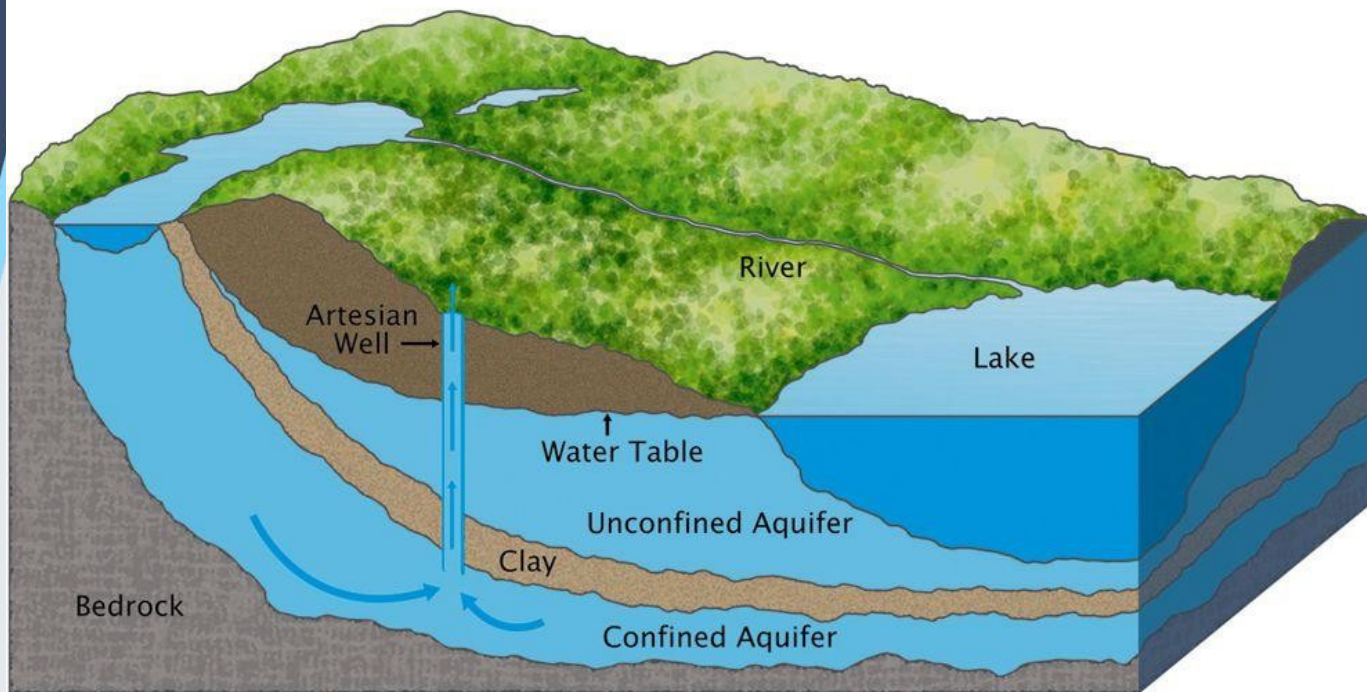
- ▶ If an aquifer (confined aquifer or unconfined aquifer) loses or gains water through adjacent semi-permeable layers, it is called a 'leaky aquifer'.
- ▶ Therefore, the terms 'leaky confined aquifer' and 'leaky unconfined aquifer' are widely used depending on whether the leaky aquifer is confined or unconfined.



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# Aquifer

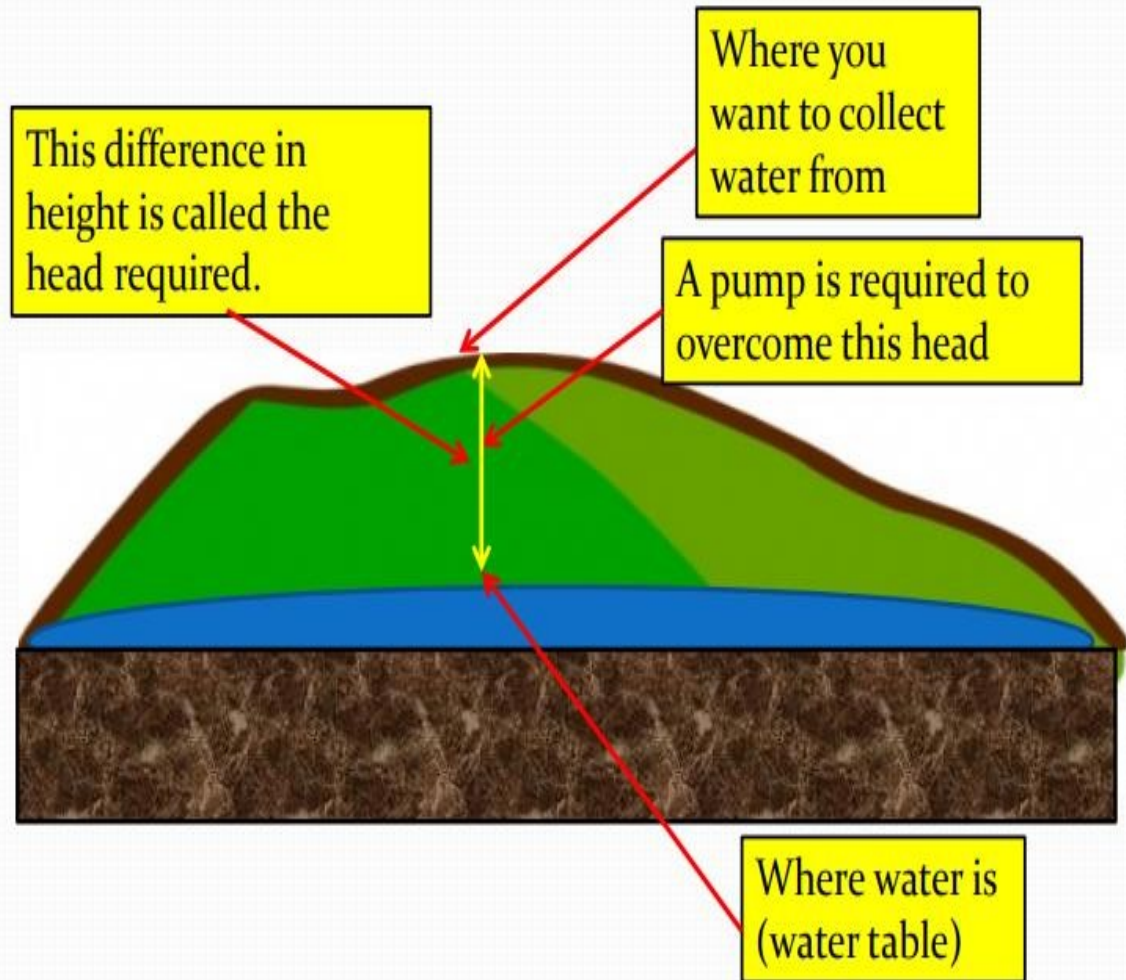




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# Head





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# Well Yield

- ▶ Important to know the yield of the well so we know what pump to use.
- ▶ Prevent drawing down the well too much or affecting other wells.
- ▶ A pumping test is done to estimate the yield of the borewell.
- ▶ The Yield of an aquifer depends on the
  - ▶ 1. Amount of water available
  - ▶ 2. Rate at which it can be extracted
- ▶ Depends on soil type or amount of cracks in the rock.
- ▶ A pumping test is done to estimate the yield of the borewell



# Pumping Test

Pump well for 8 to 48 hours.

Rate of water pumped  
= volume/time

Distance to new water level/time

Stand to support pipe

Borehole casing

Tests the balance between the max volume of water pumped out and recharge

Normally carried out by specialist contractors

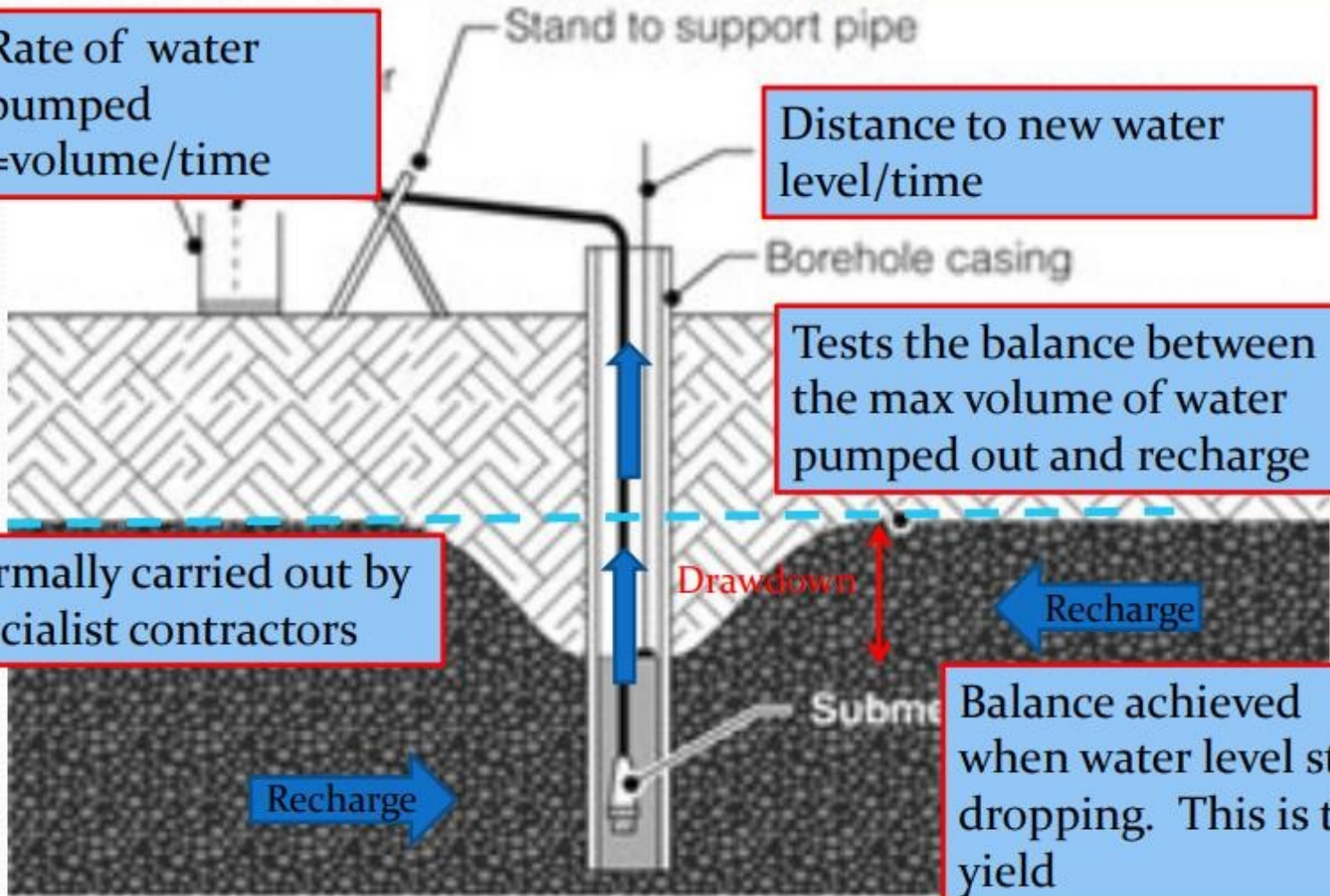
Drawdown

Recharge

Recharge

Subme

Balance achieved when water level stops dropping. This is the yield





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# ASSIGNMENT-1

- ▶ Describe about the distribution of the world's surface water and groundwater with suitable graphs and diagrams.
- ▶ What are the advantages of groundwater.
- ▶ Give a brief idea on the problems associated with groundwater withdrawal.