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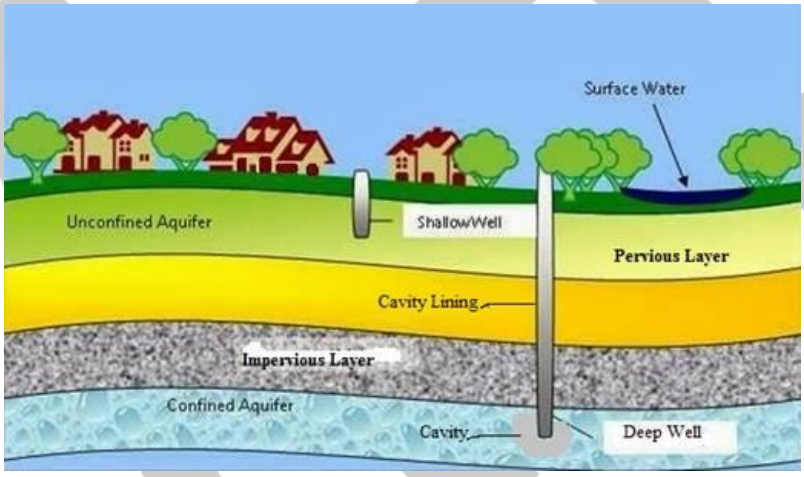
Lecture (10)

Types of water wells

Water wells can be divided according to the depth into two parts:

1. *Shallow wells*: are wells that reach depths to 35 m and receive water from the deposits of groundwater permeability, or their water may feed on surface water leaking through the soil.
2. *Deep wells*: are more than 35 meters deep and receive their water from deep aquifers.

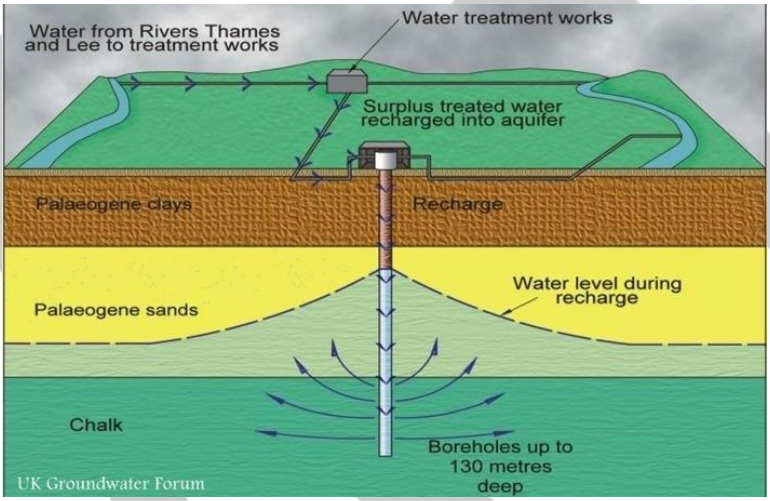


Water wells are classified according to the purpose of drilling to:

1. *Exploration wells*: dug for underground water investigation.
2. *Production wells*: dug for the utilization of groundwater.

3. *Observation wells*: are drilled to monitor water level fluctuations and are used to monitor water quality.

4. *Artificial injection wells* (*recharge wells*): are dug for groundwater recharge, industrially.



5. *Sewage and drainage wells*: dug to dispose of sewage water, industrial waste, and saltwater from agricultural fields.

Water wells can be divided according to the drilling method into:

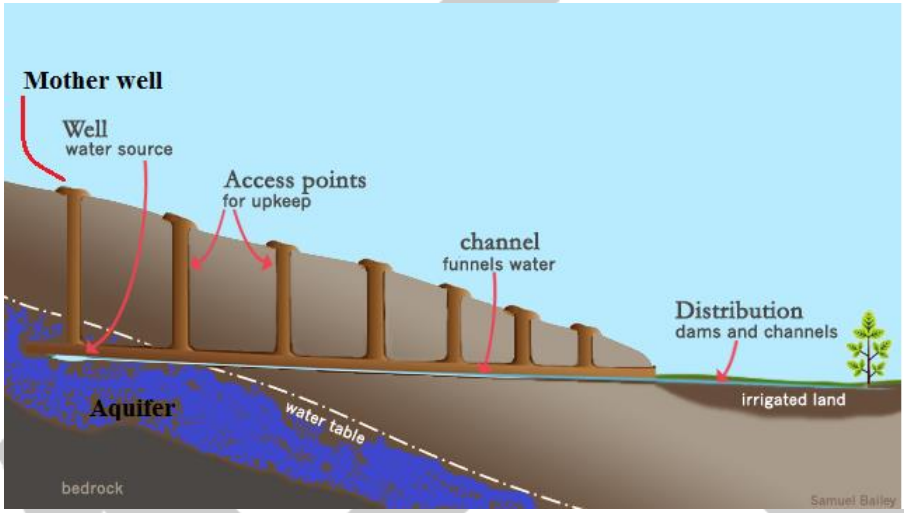
1. *Dug wells*: They are hand-dug well to a little depth; its water is used for household purposes. They are covered by wood and rock and are often used concrete in packaging. The depth varies depending on the depth of the water level and ranges between 5 -15 m, its diameter ranges between 1-5. Its mouth must be closed to protect from pollution, a concrete fence at least 30 cm high around the well mouth is recommended to cover it.

View into a hand-dug well cased with concrete rings

A dug well in a village in Kerala, India.

2. *Driven Wells*: These wells consist of a series of long pipes connected, and pushed into the ground by repeated blows to arrive at down water level. The diameters of these wells range from about 0.6 - 10 cm and are as deep as 16 m, the water is extracted from them by pumps of the absorbent or aspirating type. its water is used for household purposes and exploratory purposes in the investigation of groundwater.

3. *Tunnel wells*: A system consisting of one or more wells called the mother's well, usually drilled along the outer limits of valleys or basins. The depth of the mother wells from several meters to 300 m. To get water without using pumps, a tunnel is dug away from the well at the end of the ramp. Tunnels are drilled vertically and at certain distances for aeration.



4. *Boreholes*: Tube wells drilled in the ground and pass through the aquifer and aquifuge. They can be a casing with silent pipes opposite aquifuge and with perforated pipes or filters opposite the aquifer. And are drilled in the form of vertical or oblique wells. The depths of these wells range from several meters to more than 3000 meters, and variable diameters according to their depths, shall be suitable for pump size.

Methods of drilling deep wells

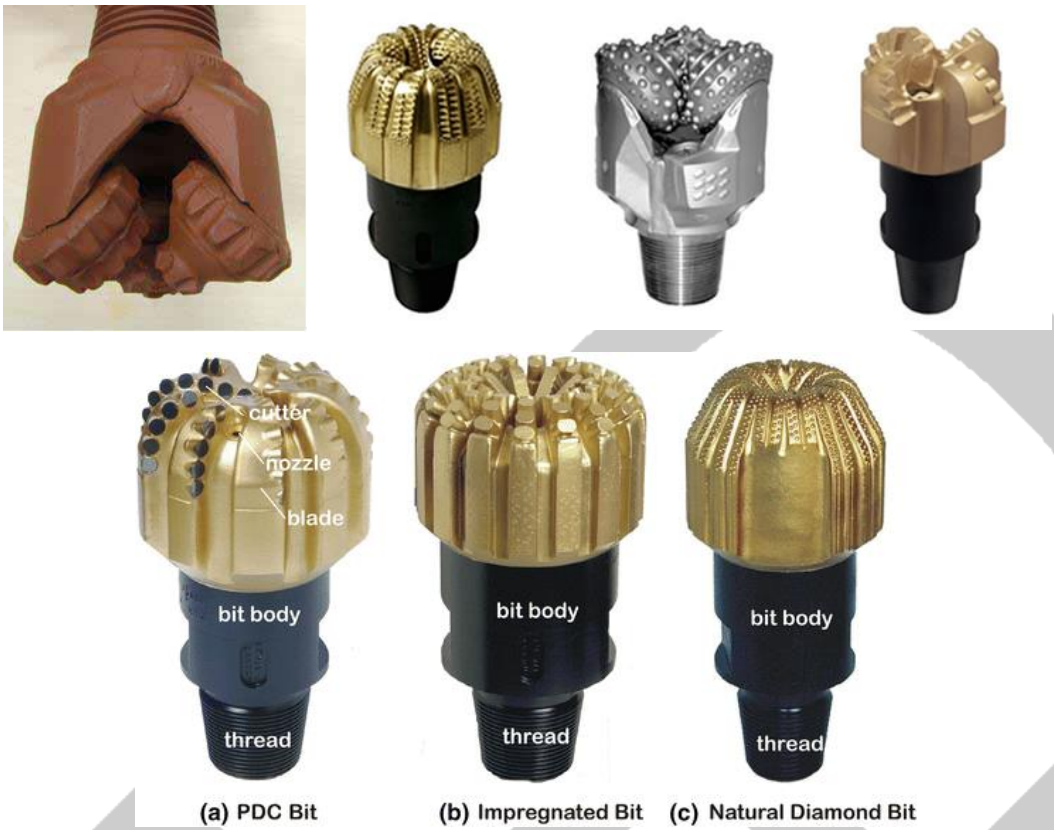
There are several different types of drilling methods, the most common methods used are:

Rotary Drilling:

Rotary drilling is the most popular well drilling method. The principle of rotary drilling is based upon a rotating drill stem made of lengths of drill pipe about 15 feet long .

A bit is attached to a heavy stabilizer at the end of the column of the drill pipe. The drill stem is hollow and has a drilling fluid of either mud or air circulating down the drill stem out through the nozzles in the bit and up along the outside of the drill stem.

Several types of bits are available to the rotary driller. The bit most generally used is the tri-cone roller bit. The type and number of cutting teeth on the bit cones vary depending upon the type of formations to be penetrated.



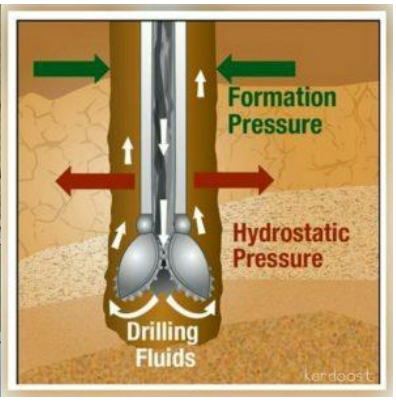
The rotating action of the bit breaks up the material and the drilling fluid carries the cuttings to the surface where they settle out in a mud tank. Mud rotary utilizes a drilling fluid of bentonite clay and water. The mud serves several purposes :

(1) remove cuttings from the drill hole ,

(2) prevent the collapse of the drill hole and reduce water loss to the formations by forming a filter cake on the borehole wall,

(3) suspend cuttings when drilling is stopped,

(4) cool and clean the drill stem and bit.



Reverse-circulation is another form of rotary drilling. It differs from conventional hydraulic rotary in that the drilling fluid travels in the opposite direction.

Cable Tool Drilling:

Cable tool drilling, also known as percussion drilling. The percussion method involves rising and dropping a large chisel-shaped tool weighing several tones repeatedly in the same hole.

During the drilling process, raising and dropping of the bit loosens up sand or clay and breaks up rock into "cuttings" and these cuttings accumulate at the bottom of the hole as a watery mixture (in the form a slurry) and are removed by a simple bailer made of hollow pipe fitted with a non-return valve at the base. This is also known as a sand pump. The process will then be repeated as many times as is needed until an adequate water-bearing formation is found.

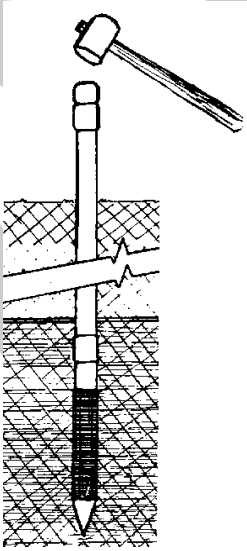
Figure --: Sand pump in operation. Sand bought up from the well is falling from the hole in the bailer and gathering in a pile.

The advantage of the cable tool is less costly and simpler to operate than a rotary drill rig and is suitable for most geologic conditions. However, the disadvantages of the cable tool method are its slow rate of progress. For this reason, it is limited to depths of about 50 meters. It is a slow method because of the need to case the hole in unconsolidated material to prevent collapses.

Hand Driving:

Driven wells are common in many areas, especially around lakes where groundwater may be close to the surface. Simple installation methods and the low cost of materials. However, since the well point and casing are driven into the ground, soil conditions are a major factor in the suitability of the site. The site must be generally sandy and free of boulders or bedrock to be suitable for a driven well. Hard clay, silt, and very fine sand are generally difficult to drive through.

A drive cap is placed on the top of the casing and a heavyweight is used to strike the top of the drive cap, driving the point into the ground, When the drive cap is driven close to the ground and driving cannot be continued, another length of casing is added and driving is resumed. Special drive couplings are used to join sections of casing.



The major disadvantages of driven wells are as follows:

(1) they are generally shallow, therefore more vulnerable to the surface or near-surface contamination ;

(2) the screens tend to encrust with carbonates at a faster rate due to their small diameter; and

(3) their yield is limited (< 10 gallons per minute [gpm]), since they can be pumped only with a shallow well jet pump or hand pump.

Well cementing

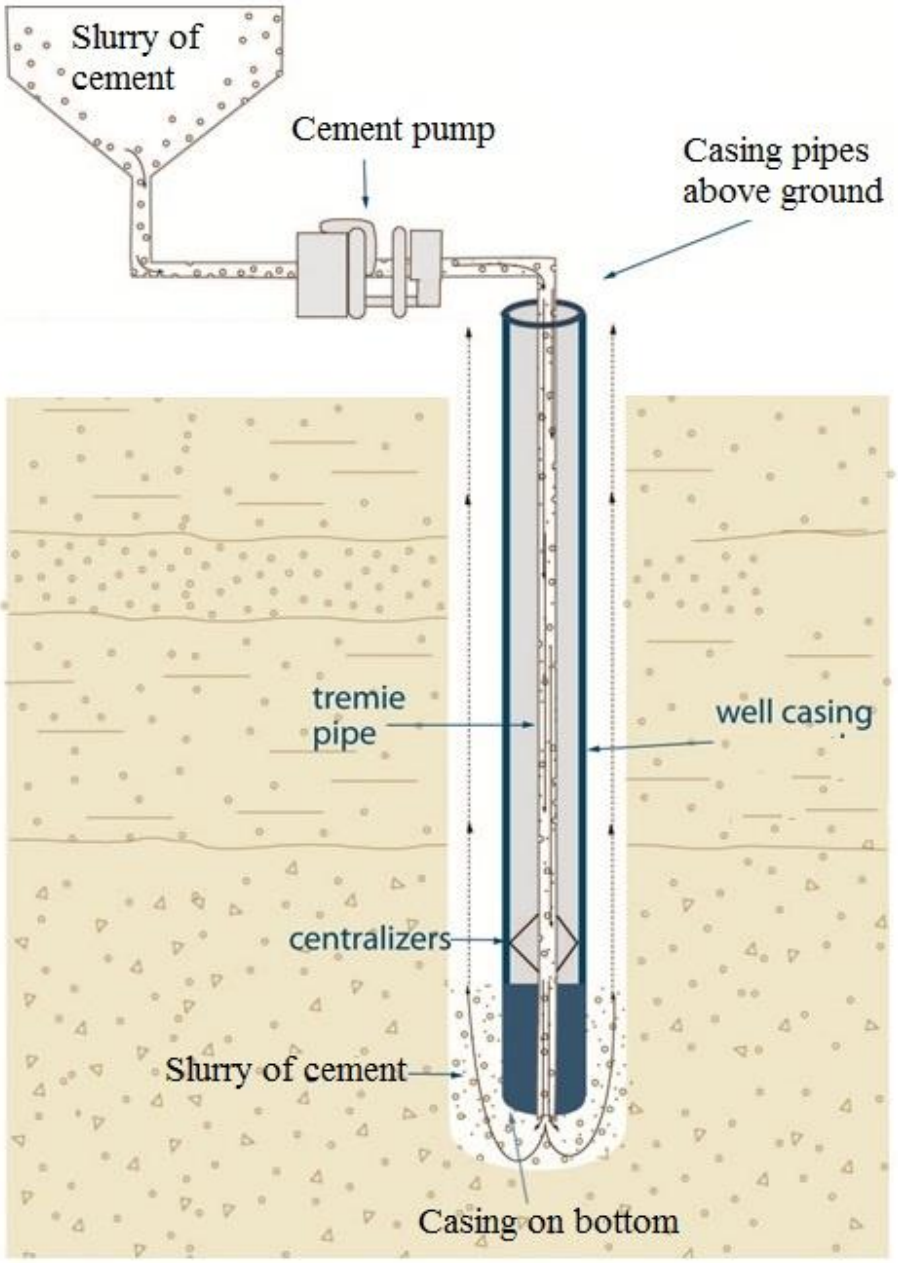
Well cementing is the process of introducing cement to the annular space between the well-bore and casing.

Of the advantages of the cement process, it protects the water level from pollution, cement is used to prevent fluid migration between subsurface formations, cement is used to hold casing in place, prevent the collapse of the clastic and unstable layers around the well, protecting the casing from corrosion.

A slurry of cement used in well cementing usually consists of a mixture of about 45 - 55 liters of water per 100 kg of cement. Bentonite can be added to avoid the hardening of the slurry of cement quickly, which must be continuously mixed.

Casing pipes should be extended above ground to prevent surface water from flowing down and polluting groundwater.

Tremie pipe



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