Ground Improvement

By

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Methods of soil improvement

- Removal and replacement
- Dewatering
- Grouting
- In-situ densification
- Stabilization using admixtures
- Reinforcement
- Geosynthesis

Removal and replacement

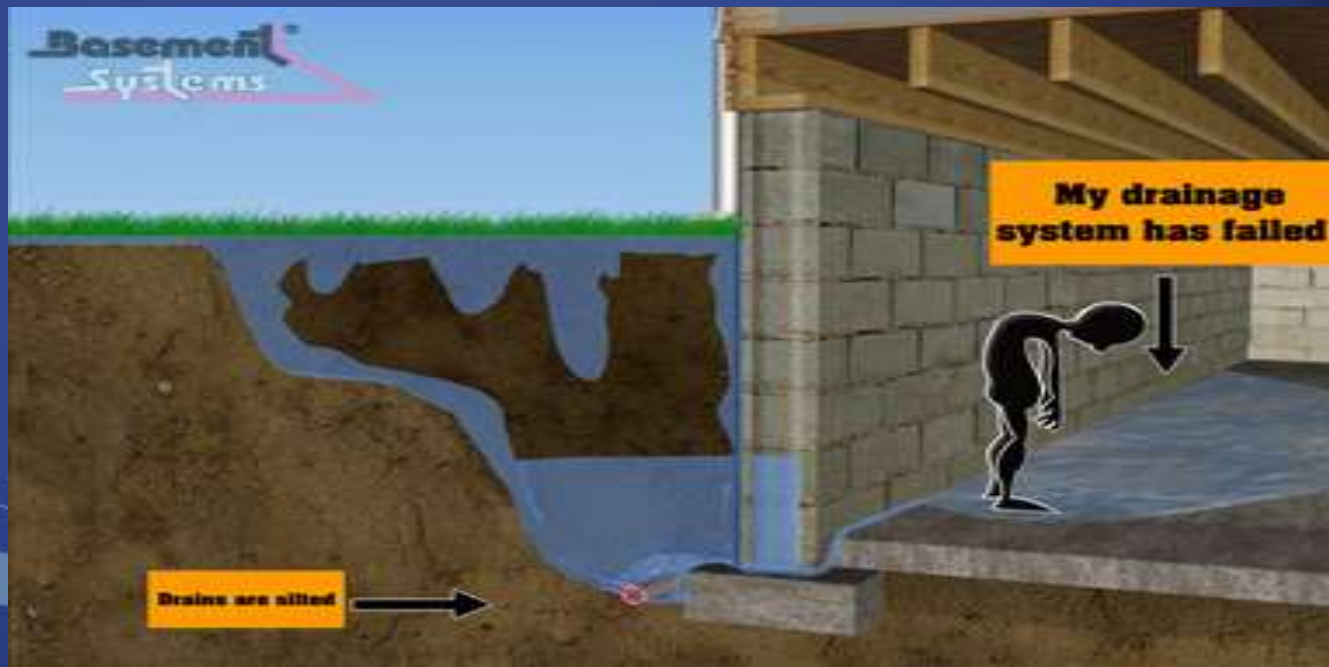
- One of oldest and simplest methods is simply to remove and replace the soil
- Soils that will have to be replaced include contaminated soils or organic soils
- Method is usually practical only above the groundwater table

UNIT – I

DEWATERING

What Happens When there is no Effective Drainage…….

- Reduction in bearing capacity
- High settlement of foundations
- Instability/ damage of structures



Dewatering

Dewatering is a technique in which Ground Water contained with in the site is extracted by different methods ensuring stable foundation.

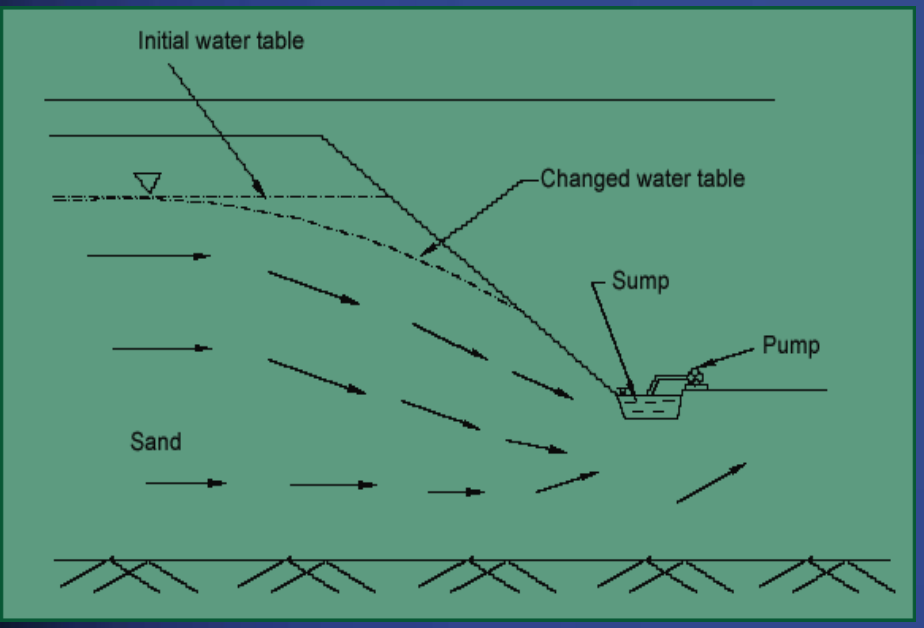
Dewatering Techniques:

- Sumps and interceptor ditches
- Well points
- Foundation and Blanket Drains
- Electro-Osmosis

Open sumps/Ditches

- This is the simplest form of dewatering used in shallow excavations in coarse grained soils.
- Shallow pits, called sumps are dug along the periphery of the area-drainage ditches.
- The water from the slopes or sides flows under gravity and is collected in sumps from which it is pumped out

Open sumps/Ditches



Well points

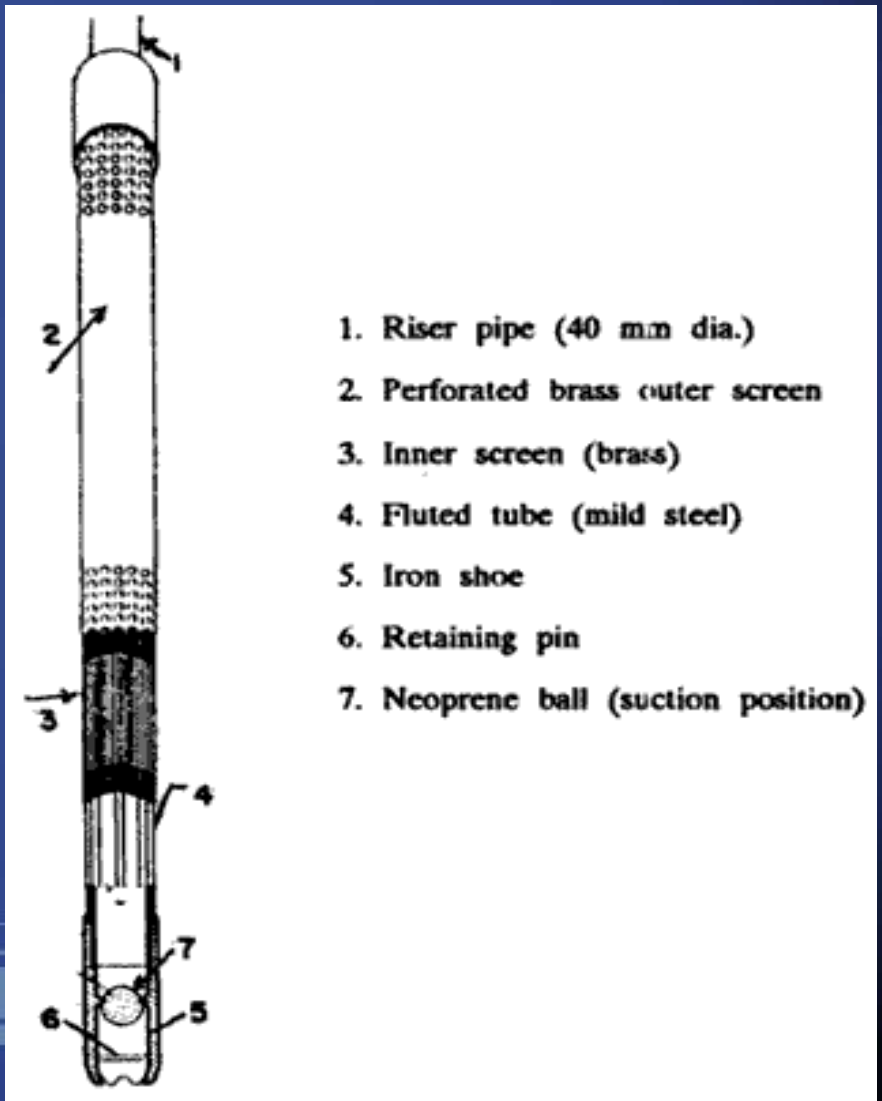
- Well points are small-diameter (about 30-50 mm) tubes with slots near the bottom that are inserted into the ground from which water is drawn by a vacuum generated by a dewatering pump.
- Well points are typically installed at close centers in a line along or around the edge of an excavation.
- As a vacuum is limited to bar, the height to which water can be drawn is limited to about 6 meters (in practice).
- Well points can be installed in stages, with the first reducing the water level by up to five meters, and a second stage, installed at a lower level, lowering it further.

Well points

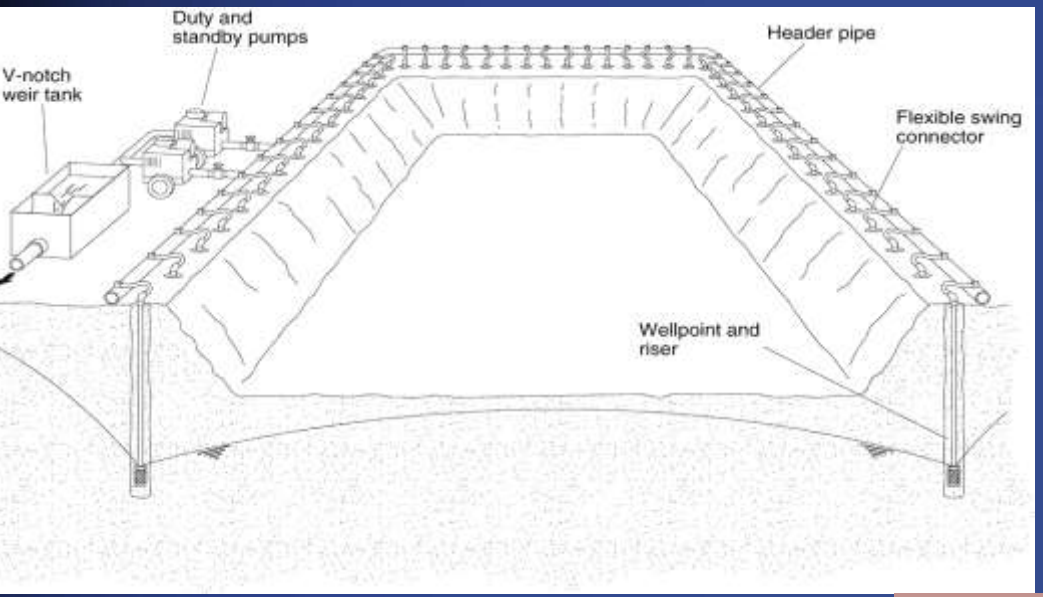
- The water trickling between the deep wells may be collected by a single row of well point at the toe. This method ensures a much thicker width free from seepage forces.
- Well point spears are generally used to draw out groundwater in sandy soil conditions and are not as effective in clay or rock conditions. Open pumps are sometimes employed instead of spears if the ground conditions contain significant clay or rock content.

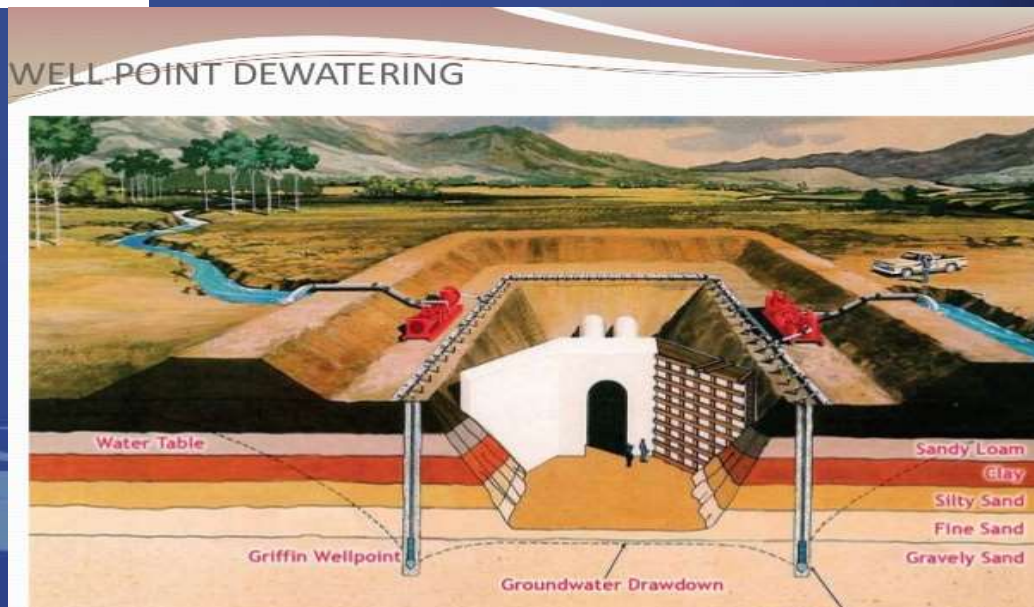
Well points

- Single Stage
  Well Points
- Multi Stage
  Well Points



Single Stage Well points

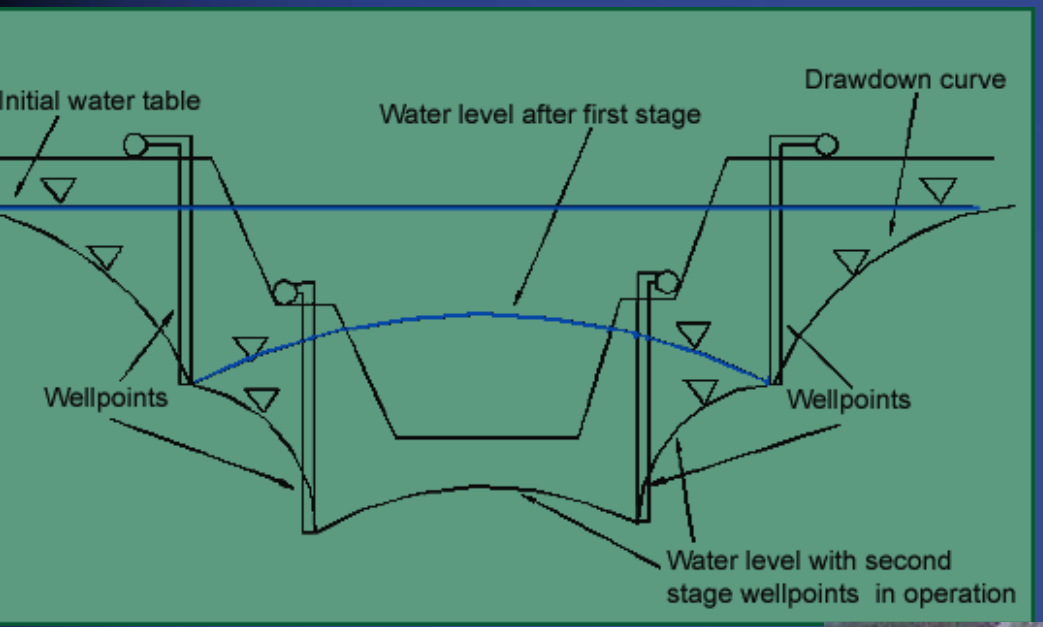




Multi Stage Well points

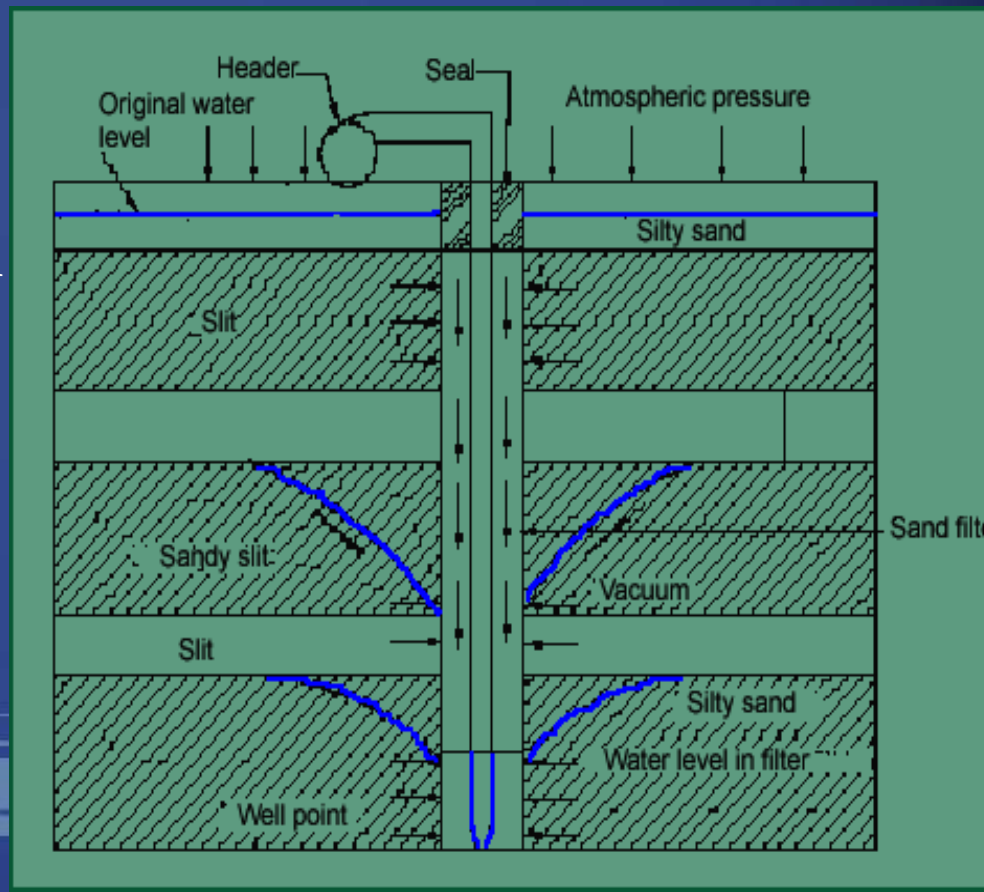
- Well-point system is suitable for depths up to 6 m if the pump is installed at ground level. Soils have to be coarser. If the sand content of soil is more than 20 per cent, the well-point system can work in it.
- For excavations deeper than 6 m, multi-staged dewatering equipment can be used. In this case, each stage has its own pump.
- Number of stages can vary but more than three stages of well points don’t seem practical. More the number of stages, more is the excavation width required.
- Sometimes, a single-stage well-point system is attached with jet-eductor pump - this system allows dewatering up to 25 to 30 m depth. This is preferable over a multi-stage well-point system.

Multi Stage Well points



Vacuum Well Points

- For fine grained soils of relatively low permeability in the range of 0.1-10*10^{-3} mm/s.
- The top few portion of the hole is sealed with impervious soil/ suitable material.
- The method is most suitable for stratified soils or layered soils.



Deep Well Points

- A deep well typically consists of a boreholes fitted with a slotted liner and an electric submersible pump.
- As water is pumped from a deep well, a hydraulic gradient is formed and water flows into the well forming a cone of depression around the well in which there is little or no water remaining in the pore spaces of the surrounding soil.
- Deep wells work best in soils with a permeability of $k = 10^{-3}$ m/s to 10^{-5} m/s; the amount of drawdown that a well can achieve is limited only by the size of the pump

Deep Well Points

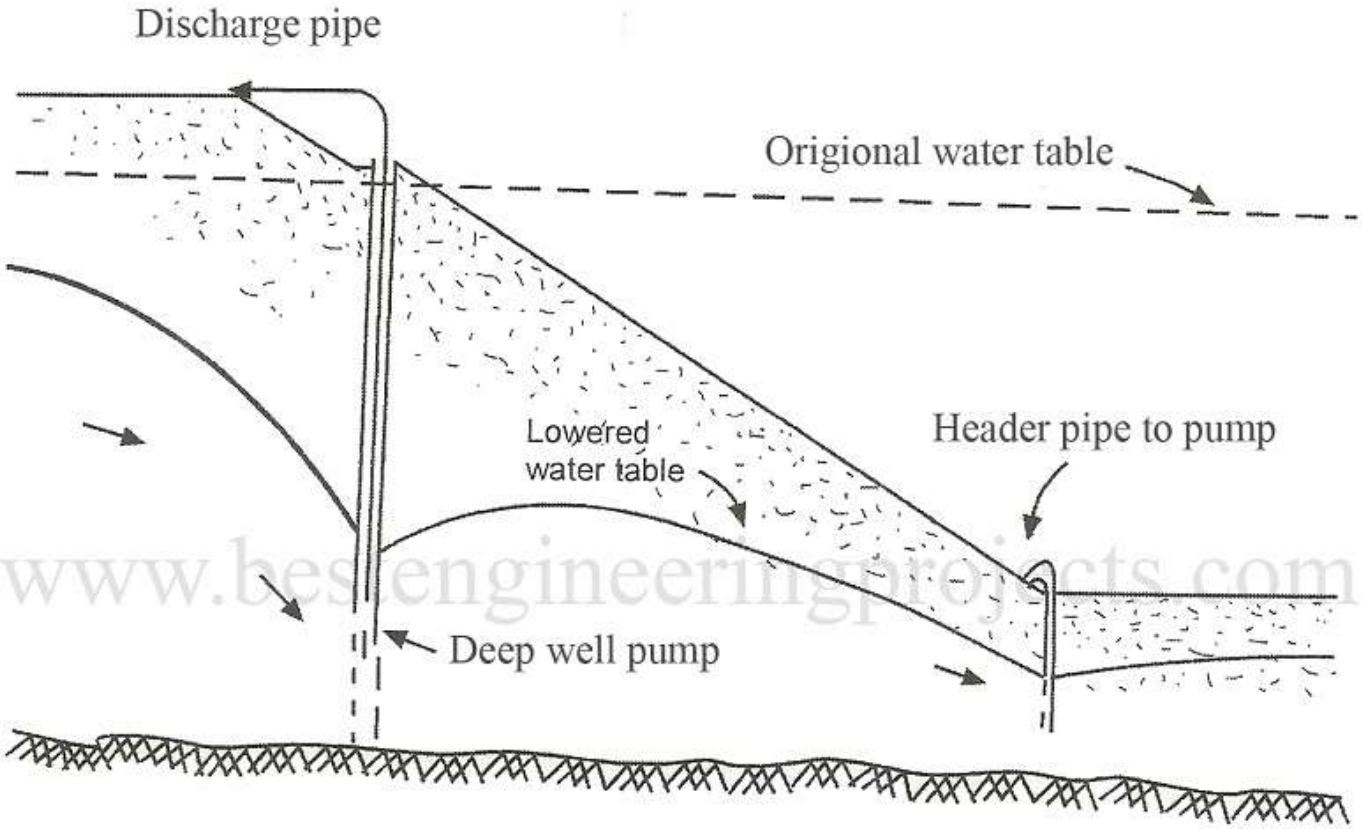
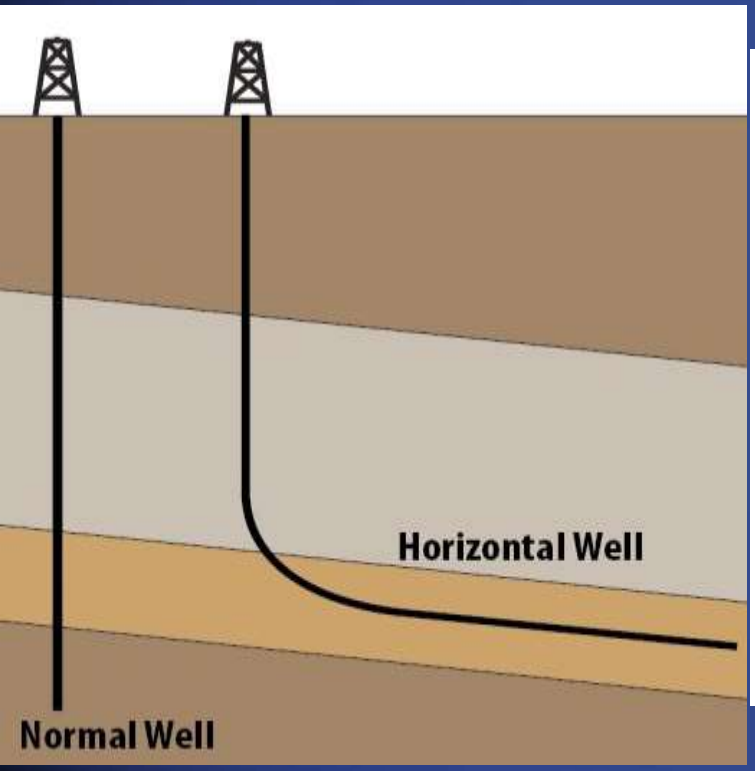


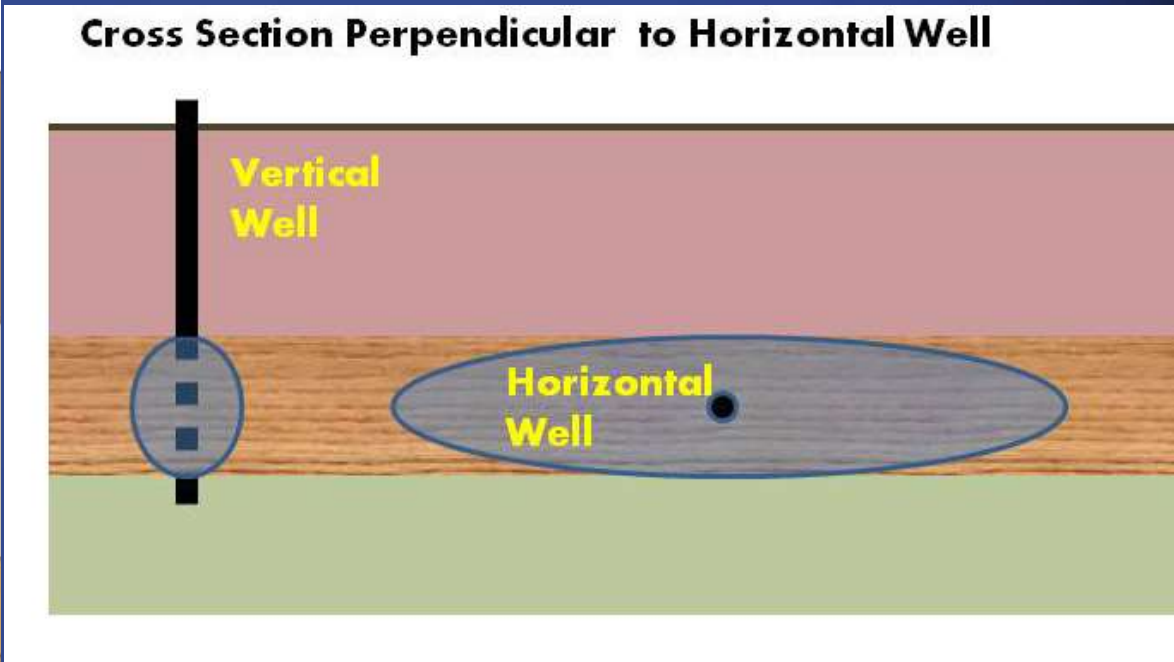
Fig 1 Deep Well Pump

Horizontal Wells

- The installation of horizontal dewatering systems is relatively easy. A trencher installs an unperforated pipe followed by a synthetic or organic wrapped perforated pipe.
- The drain length is determined by the drain diameter, soil conditions and the water table. In general drain lengths of 50 meters is common.
- After the water table has been lowered, the intended construction can start.
- After the construction is finished the pumps are stopped, and the water table will rise again.
- Installation depths up to 6 meters are common.

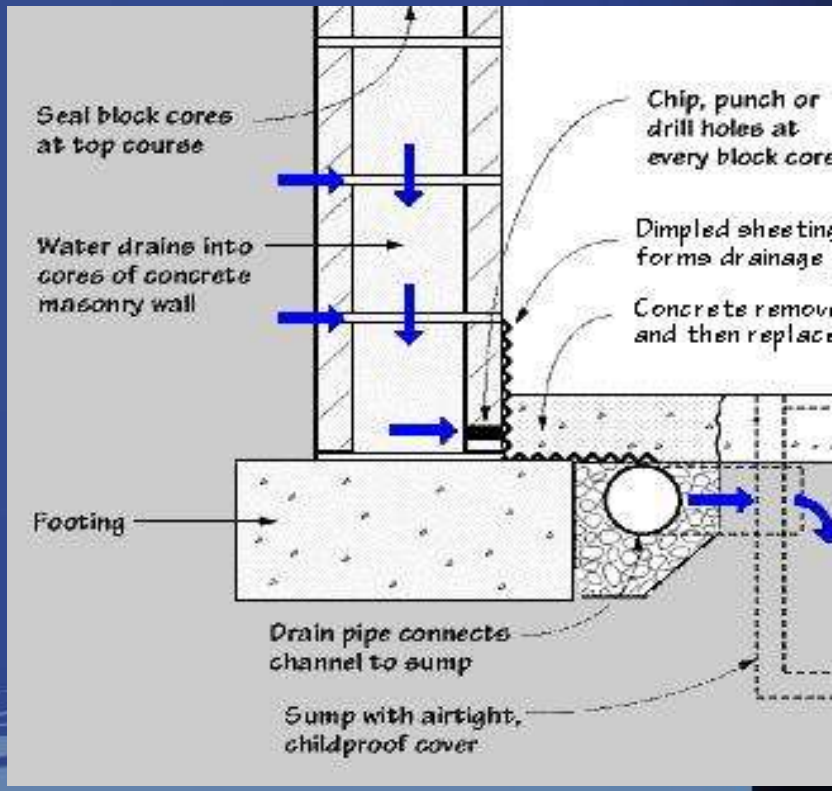
Horizontal Wells





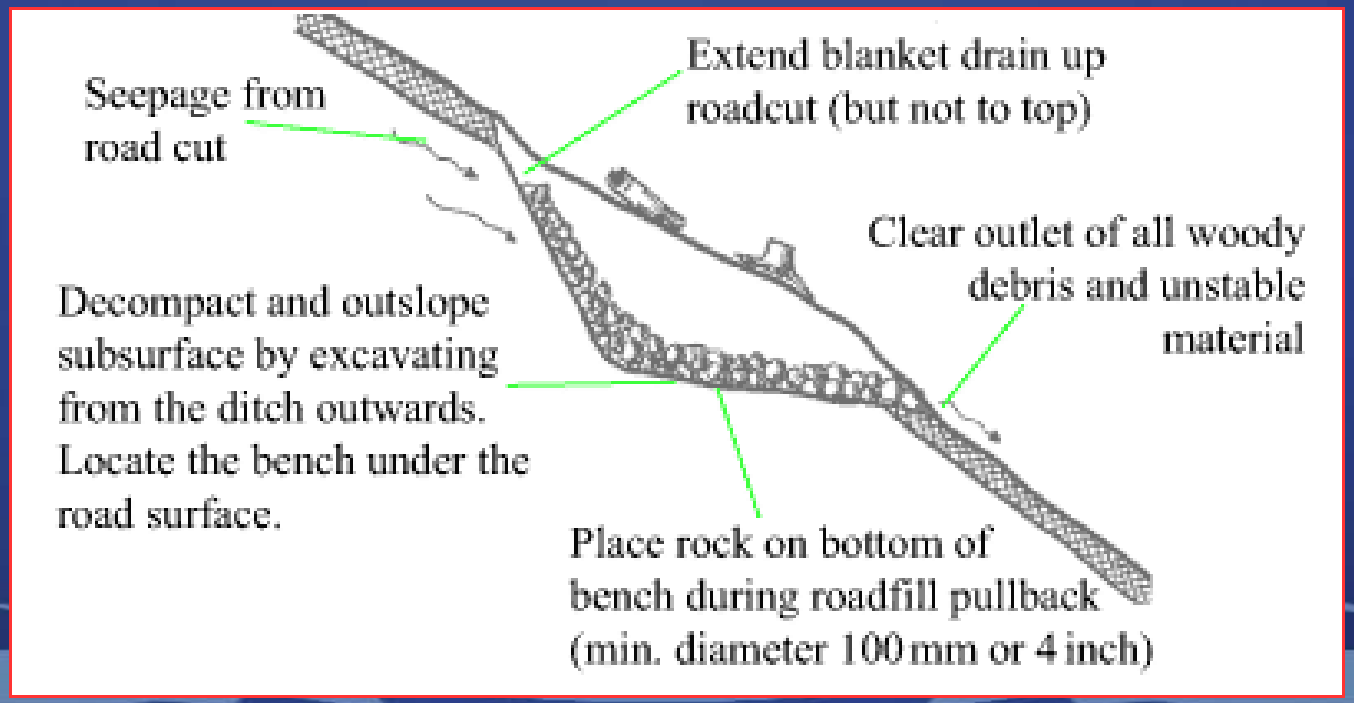
Foundation Drains

- **A footing drain,** that is an exterior foundation drainage system placed outside the foundation wall near the wall footing.



Blanket Drains

- A blanket drain is a drainage structure used to accommodate seepage zones on the road cut. The objective is to disperse low-velocity flows over the hill slope rather than concentrating them in cross-ditches.



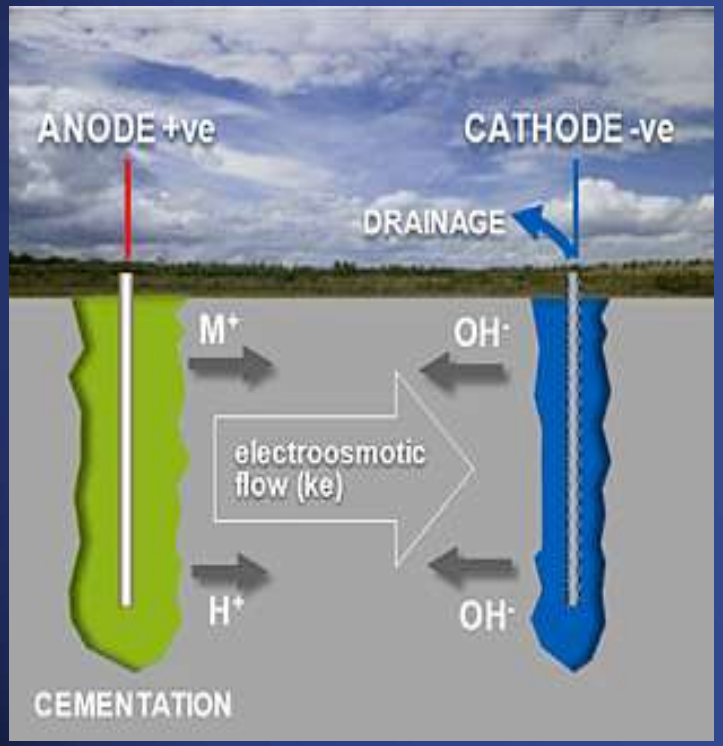
Electro-Osmosis

- This method is used for fine grained cohesive soils (such as clay), which can be drained or stabilized using electric current.
- If direct current is passed between two electrodes driven into natural soil mass, the soil water will travel from the positive electrode (anode) to the negative electrode (cathode).
- The cathode is made in the form of well point or metal tube for pumping out the seeping form of well point or a metal tube for pumping out the seeping water.

Electro-Osmosis

- A steel rod, a pipe or steel piling of excavation can serve as the cathode.
- The arrangement of electrodes is done in such a way that the natural direction of flow of water is reversed away from the excavation, thereby increasing the strength of the soil and stability of the slope.
- The potentials generally used in the process are from 40 to 180 volts, with electrode spacing of 4 to 5 meters.

Electro-Osmosis



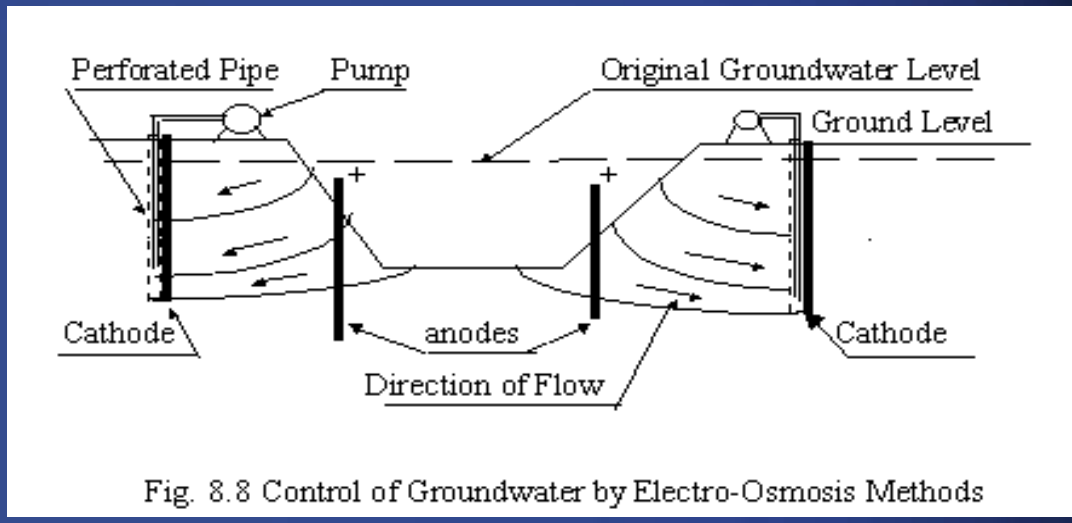


Fig. 8.8 Control of Groundwater by Electro-Osmosis Methods