Darcy's Law:

\[ \frac{Q}{A} = -K_s \frac{\Delta H}{L} \]

Key:
- \( Q \) = quantity of water flowing per unit time \( \{m^3/s\} \)
- \( A \) = cross sectional area perpendicular to flow \( \{m^2\} \)
- \( K_s \) = saturated hydraulic conductivity \( \{m/s\} \)
- \( \Delta H \) = change in water potential between two water heads \( \{m\} \)
- \( H = h + z \) (the sum of the water potential force due to the pressure potential \( [h] \) and gravitational potential \( [z] \) respectively)
- \( L \) = distance over which flow occurs \( \{m\} \)

*Hydraulic conductivity* is a measure of the permeability (infiltrate and percolate throughout) of a soil to water. Determined by the permeability of the substrate, the viscosity and density of the water.  
- The hydraulic conductivity increases or decreases by a factor of four proportionally to the radius of the pores.
- Large pores have a higher hydraulic conductivity under saturated conditions but capillary force is lower.
- The rise in a soil with large pores will occur more quickly, but will ultimately be lower than a soil with smaller pores.

**Saturated Soils:**

Water will flow through pores due to capillary forces and gravity. In unsaturated soils capillary force will be stronger than gravitational forces so water will move radially through the soil. When the soil is saturated gravitational forces will exceed capillary forces and move the water downward.

Movement through stratified soils:

*Movement will always be impeded upon reaching a different texture*

- **Coarse to fine:** Hydraulic conductivity decreases across the barrier so the coarse texture will become saturated before moving down to the finer texture.
- **Fine to coarse:** The matric potential of the fine soil is greater than the potential of the coarse soil so the fine soil pores will become saturated before moving down the profile.

*Mulching:* A layer of coarse soil will also reduce the rise of water up a profile, this reducing water loss through evapotranspiration (more water will be lost through evapotranspiration in a humid region than an arid one).

**Unsaturated Soils:**
Darcy's law is an important step in understanding the movement of fluids through unsaturated soils (Buckingham equation).

Differences in matric potential direct water movement over gravitational potential.
- Water movement occurs through capillary action (created by the adhesion of water molecules in films around soil particles, and polymerization of water due to cohesion).
- Hydraulic conductivity will be higher for soils with smaller pores in unsaturated conditions.
- The direction of water movement goes from areas of high matric potential to low matric potential (relative size of water films around soil particles).

Water retention is the property of a soil to hold on to water, due to intermolecular forces and capillary forces (adhesion and cohesion) that lower the water potential within the matrix, increases as soil moisture decreases.