USEFUL DEFINITIONS & DARCY’S LAW

- **Soil Water** - water contained in soil pores
- **Pores** - empty/void space
- **Vadose Zone** - zone of unsaturated conditions
- **Water Table** - upper limit of the saturated zone
- **Aquifer** - saturated zone/contains water
- **Groundwater** - water contained in aquifer. Flows freely into a well
- **Unconfined aquifer** - no confining geologic structure on the aquifer (aquifer pressure about the same as the atmosphere)
- **Confined Aquifer** - confining geologic formation on top of aquifer. Aquifer pressure usually greater than atmospheric
- **Artesian aquifer** - confined aquifer where water is so pressurized that it reaches the surface without pumping
- **Perched Aquifer** - geologic formation (usually a clay lens) within vadose zone that intercepts water and creates a small, localized aquifer
- **Infiltration** - movement of water through vadose zone into saturated zone
- **Recharge** - water entering an aquifer from precipitation
- **Overland flow** - precipitation is faster than infiltration and excess water runs over surface of land
- **Residence Time** - time a water molecule remains in a given hydrologic compartment

**DARCY’S LAW:** \( Q = KIA \)

1. **HYDRAULIC CONDUCTIVITY**

- **symbol** - \( K \)
- **units** - length/time EX. (m/day)
- **Ability of a particular material to allow water to pass through it**
2. HYDRAULIC HEAD/FLUID POTENTIAL

- **symbol** - h
- **units** - length EX. (m)
- A measure of energy potential (essentially is a measure of elevational/gravitational potential energy)
- Is the driving force for groundwater flow
- WATER ALWAYS FLOWS FROM AREA OF HIGH HEAD TO AREA OF LOW HEAD (even if this means it may go "uphill"!)
- Measure head by sinking a well then measuring the level (elevation) to which the water rises in the well in relation to a reference point which is taken as zero meters (usually sea level)
- Hydraulic head determines the hydraulic gradient

3. HYDRAULIC GRADIENT

- **symbol** - I
- **units** - unitless (why? because length divided by length cancels out the units!)
- This is essentially the slope of the water table, and groundwater flow will be "down" this slope
- Sink two wells and measure head. Then find the difference between them and divide this by the flow length (distance between the two wells)
- EXAMPLE: head in well one = 100 feet. Head in well two= 10 feet. Distance between the two wells is 10 feet. So the hydraulic gradient is: 100 feet-10 feet/10 feet = 9

4. AREA OF FLOW

- **symbol** - A
- **units** - distance squared EX. (m²)
- Cross-sectional area of flow. (i.e. aquifer width x thickness)

5. DISCHARGE

- **symbol** - Q
- **units** - volume/time EX. (m³/day)
- Volume of water flowing through an aquifer per unit time
- FIND WITH DARCY'S LAW Q = KIA
6. **FLUX**

- **symbol** - \( v \)
- **units** - distance/time EX. (m/sec)
- \( v = \frac{Q}{A} = KI \)
- this is a velocity measure and gives the **IDEAL** velocity of groundwater (assumes that water molecules can flow in a straight line through the subsurface).
- this is ideal because it doesn't account for **tortuosity** of flow paths (this means that the water molecules actually follow a very windy path in and out of the pore spaces and so travel quite a bit slower in reality than the flux would indicate).

![Diagram of actual path of water molecule vs. groundwater flow direction](image)

**TORTUOSITY OF FLOW PATHS**
Black arrow indicates overall flow direction; red line indicates actual flow path; blue = pore space

\( v = \text{how fast} \); \( Q = \text{how much} \)

7. **POROSITY**

- **symbol** - \( n \)
- **units** - %
- percent of void space (empty space) in soil or rock. Represents the path water molecules can follow in the subsurface
- Primary porosity - intergranular
- Secondary porosity - fractures, faults etc.
8. Darcy Flux

- **Symbol**: \( v_x \)
- **Units**: distance/time EX. (m/sec)
- \( v_x = \frac{Q}{A n} = \frac{K I}{n} \)
- This is the actual velocity of groundwater and does account for tortuosity of flow paths by including porosity in its calculation.

Remember! Just because porosity \((n)\) is high doesn't mean hydraulic conductivity \((K)\) will be high! For example, clay has a high \(n\), but a low \(K\) (because it has very small pores).

Water table contour lines are similar to topographic lines. They essentially represent "elevations" in the subsurface. These elevations are called the hydraulic head. And, just like a ball rolling down a hill, water in the subsurface will go from an area of high head (elevation) to an area of low head (elevation).

- Water table contour lines can be used to tell which way groundwater will flow in a given region.
- Lots of wells are drilled and hydraulic head is measured in each one.
- Water table contours are drawn that join areas of equal head (these are called equipotential lines - it's like "connect-the-dots"!)
- Groundwater flow is always perpendicular to the water table contour lines (or flow lines).

Darcy's Law

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Q = K I A
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