ACCUMULATION AND MOVEMENT OF GROUNDWATER

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ACWADAM

An aquifer is very much like an *underground watershed*

Aquifer catchments are areas from where aquifers receive recharge, *i.e. groundwater recharge areas or zones.*

Aquifer commands are areas where aquifers send groundwater, i.e. *groundwater discharge areas or zones.*

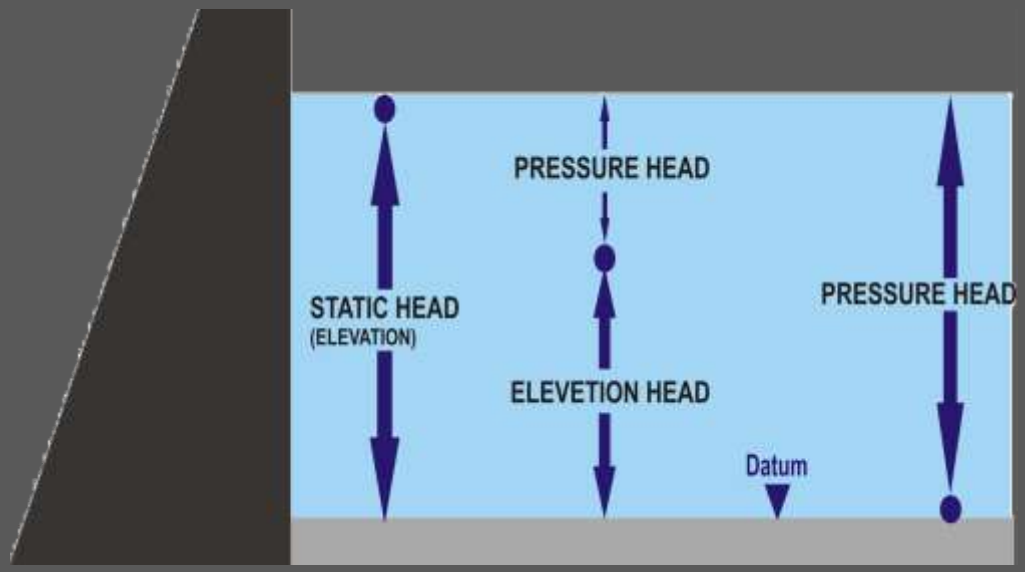
Aquifers are defined by:

- **Physical (impermeable / permeable boundaries)**
- **Hydraulic boundaries (constant / fluctuating water tables)**

The energy that drives groundwater movement is derived from the HEAD and/or PRESSURE of water…

This energy may be due to:

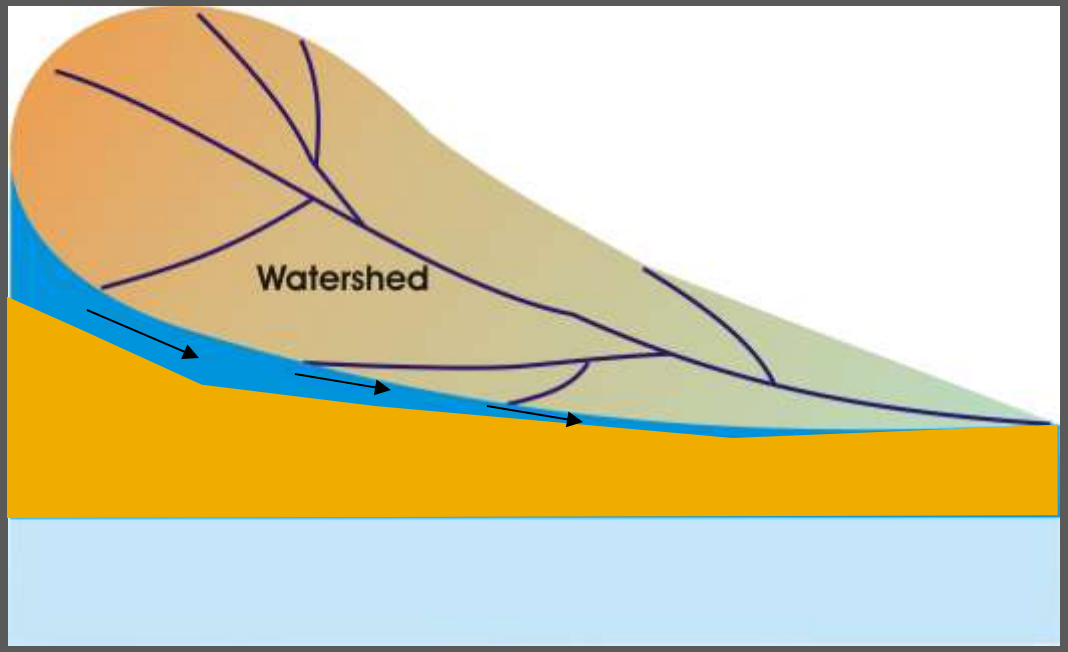
- The elevation (HEAD) of water at any given location
- The pressure of (overlying) water at another location
- A combination of the elevation and pressure components



After Price 1996

Differences in HEAD or PRESSURE make groundwater flow from one point to another

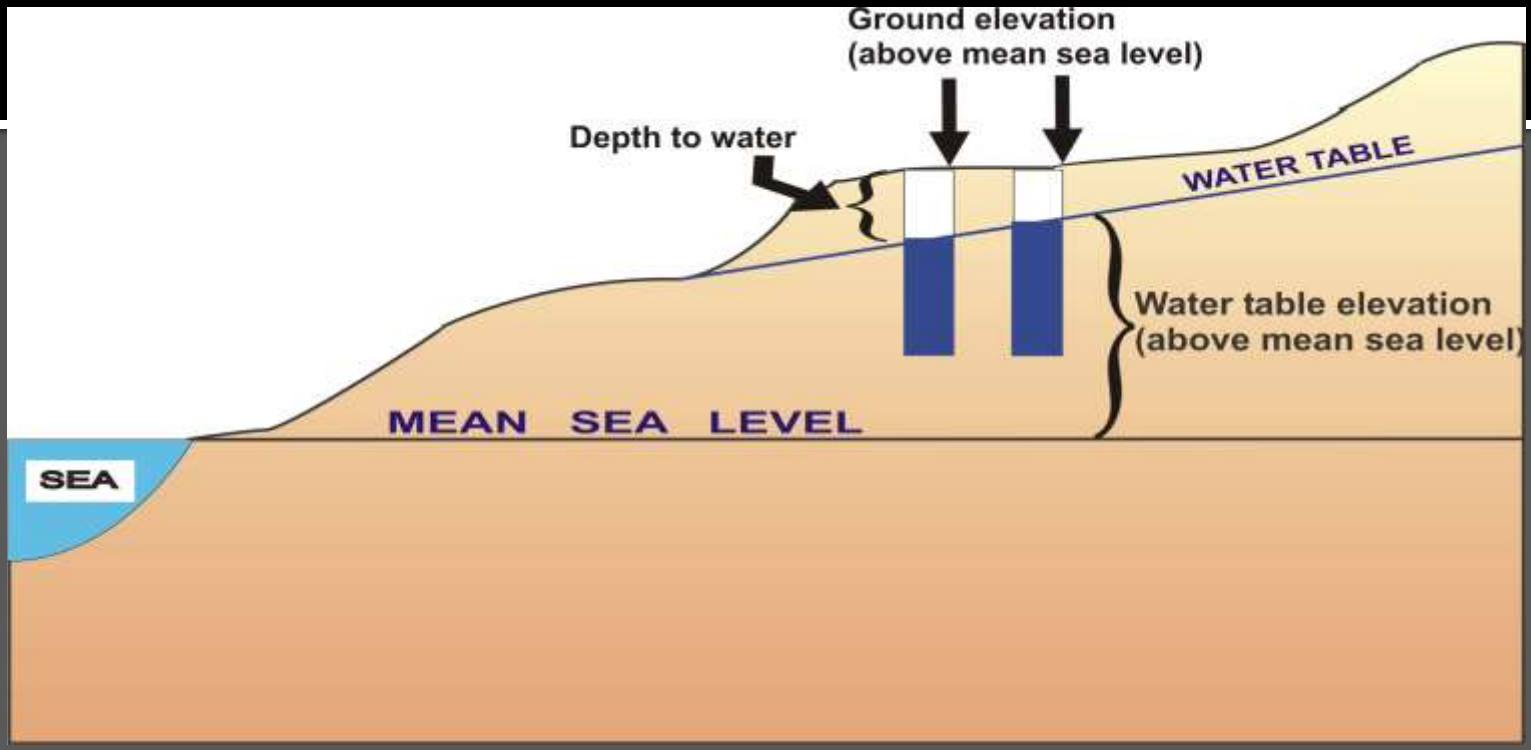
- Groundwater flows from portions where the water table elevation (or potentiometric surface) is higher to those where the water table elevation (potentiometric surface) is lower.
- Hence, understanding the movement of groundwater requires measurement of water levels.



Measuring the depth to water and elevation of the ground surface

- Fix a *measuring* point at any given place at the top of the well from where water levels will be measured.
- Estimate the elevation (from the mean sea level or from a temporary bench mark) of this point using a suitable survey method or a high resolution altimeter.
- Measure the vertical distance of the water level in the well from the measuring point – this is called the *depth to water*.
- Estimate the elevation of the water table in the well as follows…

Water levels w.r.t. a standard datum

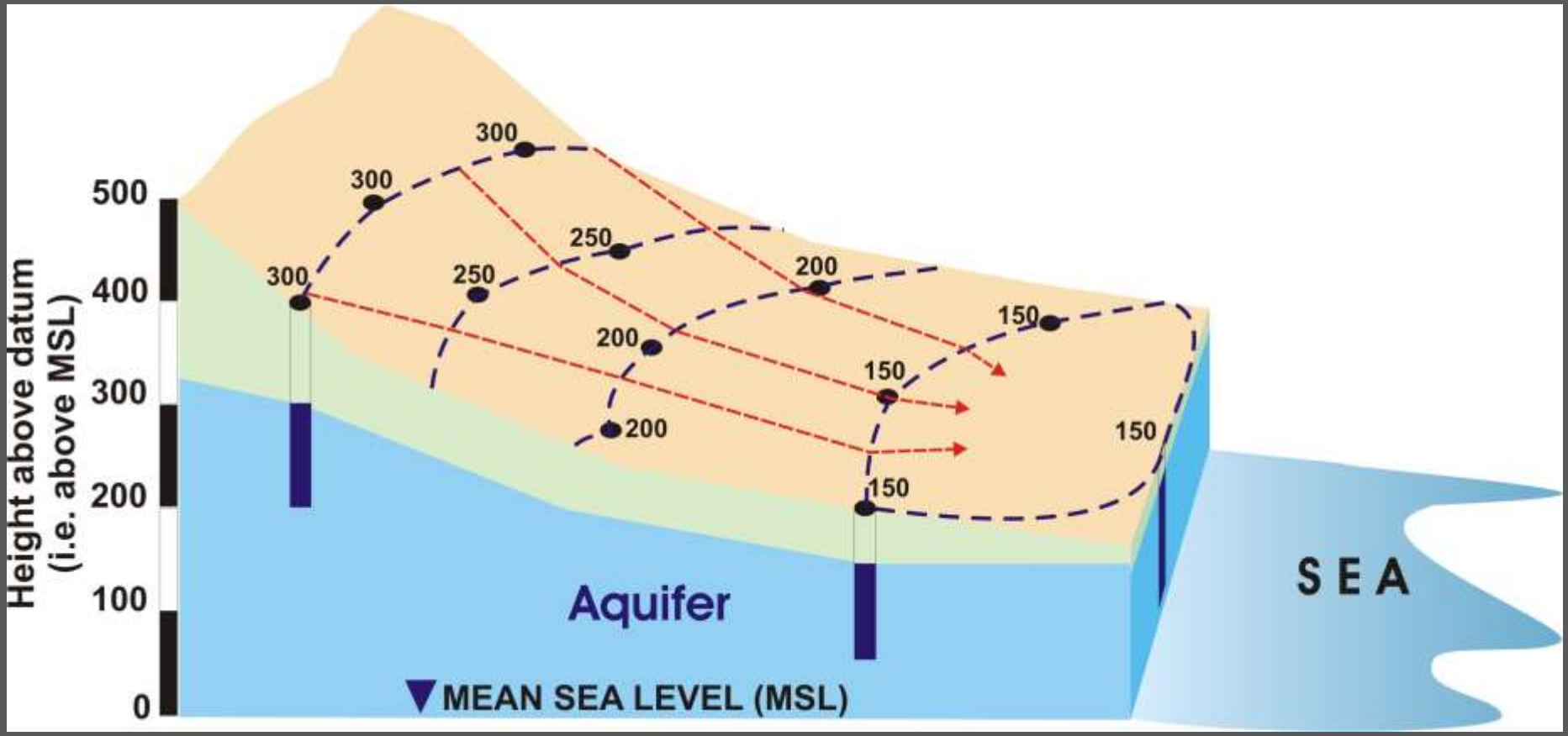


- The slope of the water table (water table gradient) helps understand the movement of groundwater
- Water levels in wells are measured as:
  - Depth to water below the ground surface
  - Water table elevation
- Water table elevation= Ground elevation – Depth to water

….Or measuring spring discharge

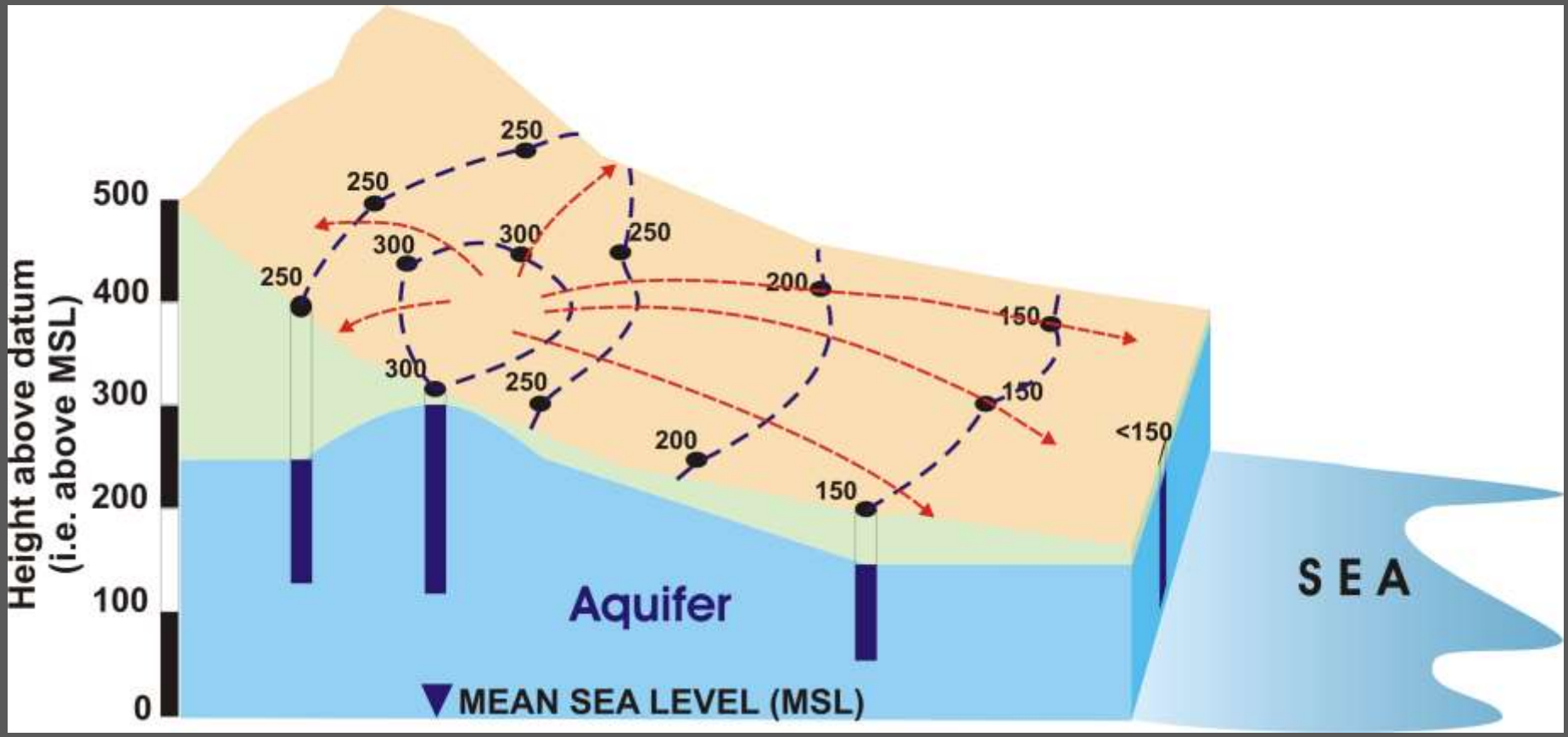
WATER TABLE CONTOURS

Slope of the WT generally follows the topography



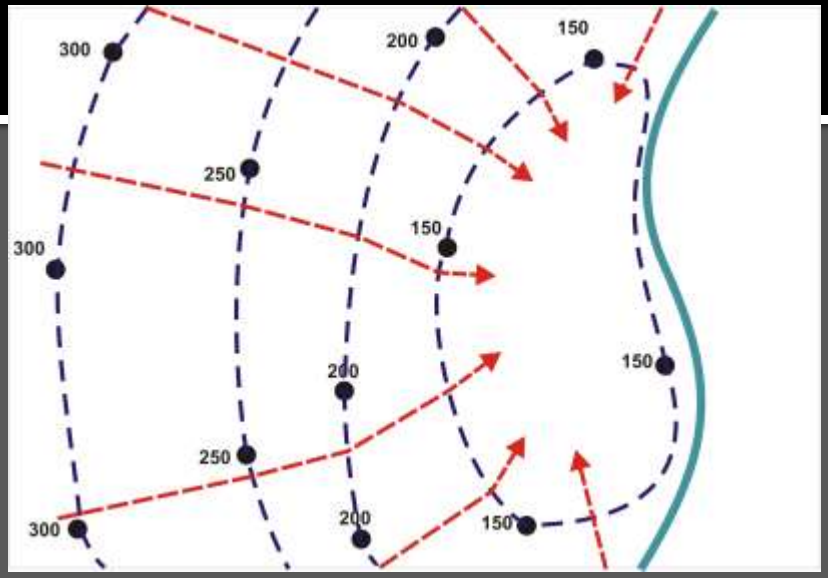
WATER TABLE CONTOURS

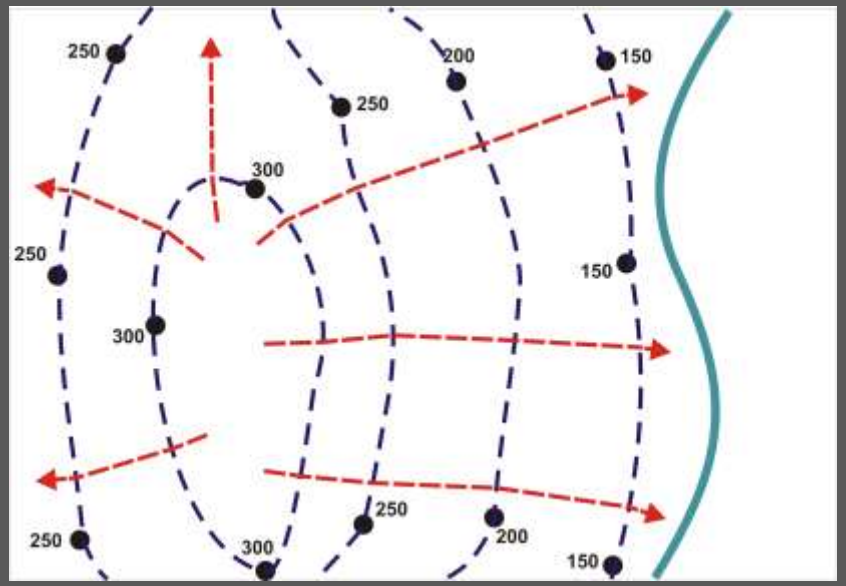
Slope of the WT independent of the topography



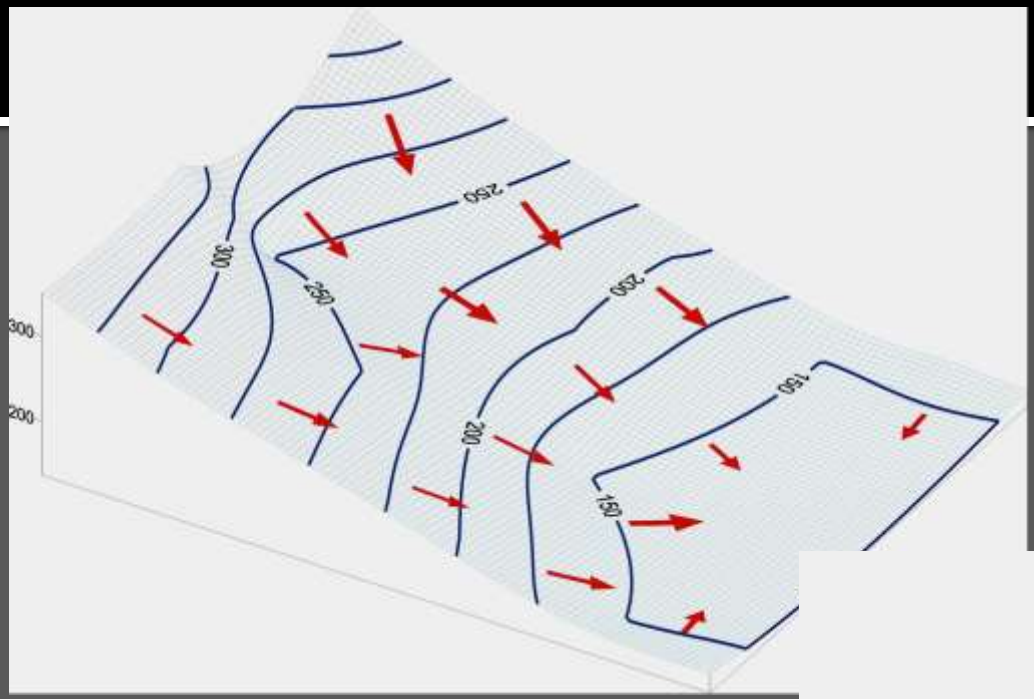
Water level information on a map

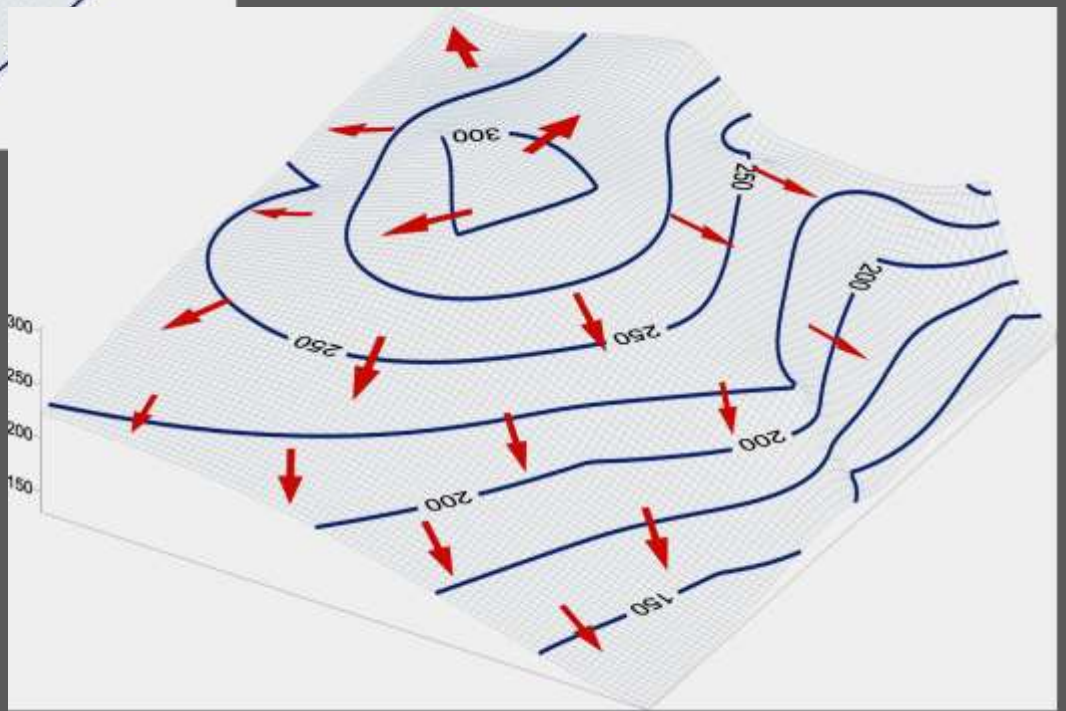
- Points (wells) of equal water level elevations are joined by lines called *water level contours.*
- Lines drawn perpendicular to the water level contours indicate the *groundwater flow direction and are called groundwater flow lines.*
- Water table contours and flow lines indicate *recharge and discharge areas.*





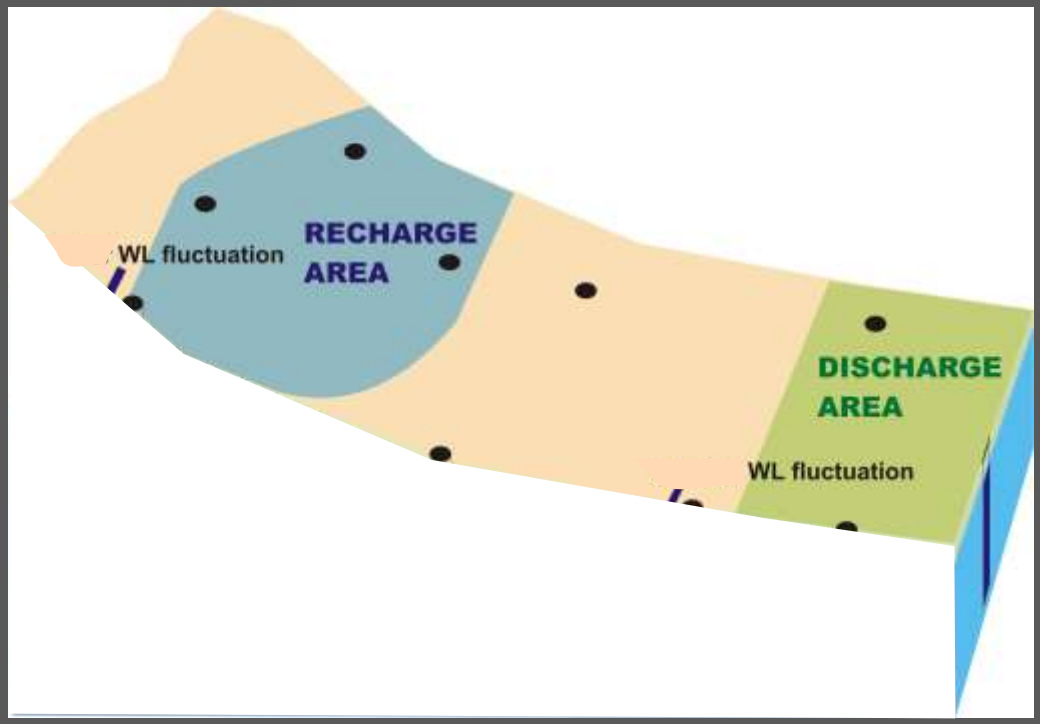
The water table surface





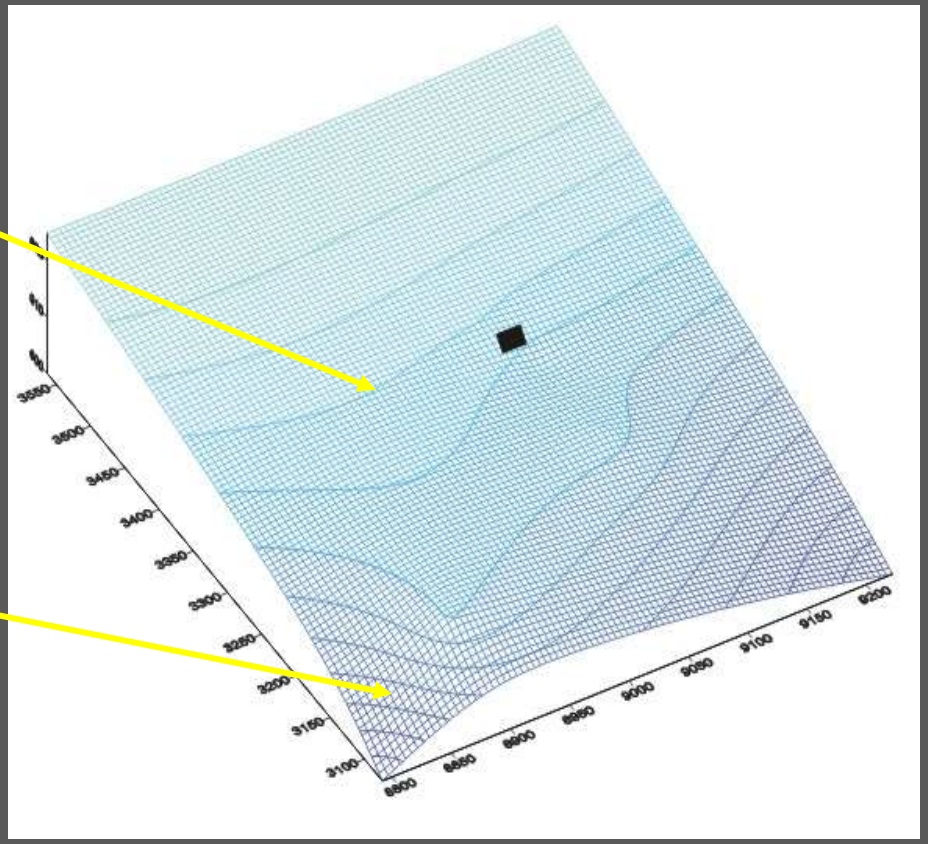
Recharge and discharge of groundwater

- RECHARGE AREAS:
  - Groundwater flow lines diverge (move away from each other).
  - The water level fluctuates relatively more in recharge areas
- DISCHARGE AREAS
  - Groundwater flow lines converge (come towards each other).
  - Water level fluctuation in discharge areas is relatively small.



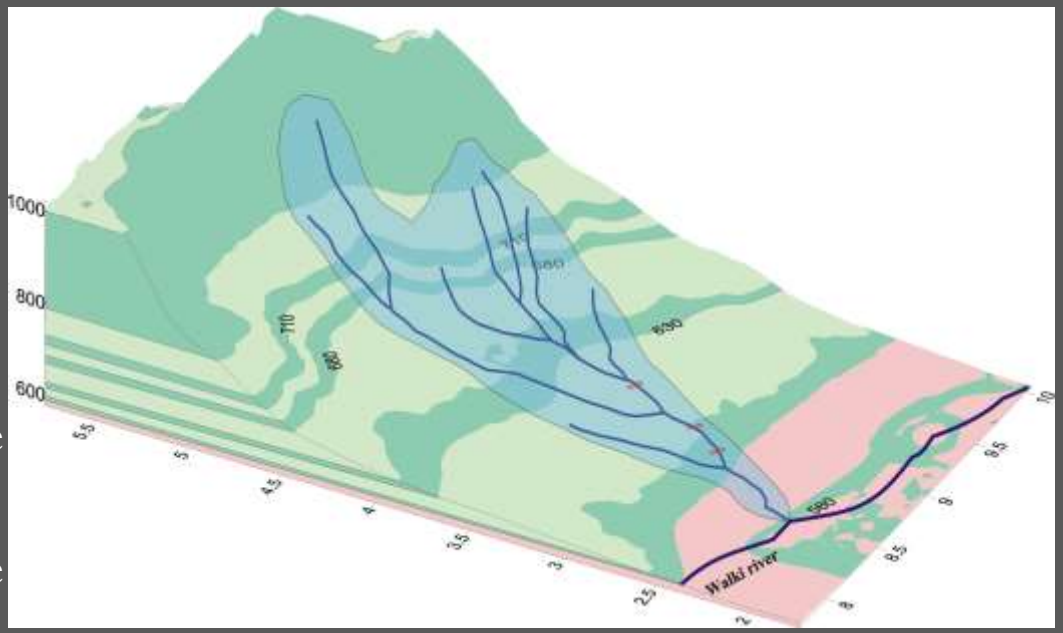
A water table contour map can be used to understand aquifer properties…

- Widely spaced WT contours indicate low hydraulic gradients and high Transmissivity.
- Close spaced WT contours indicate steep hydraulic gradients and low Transmissivity.

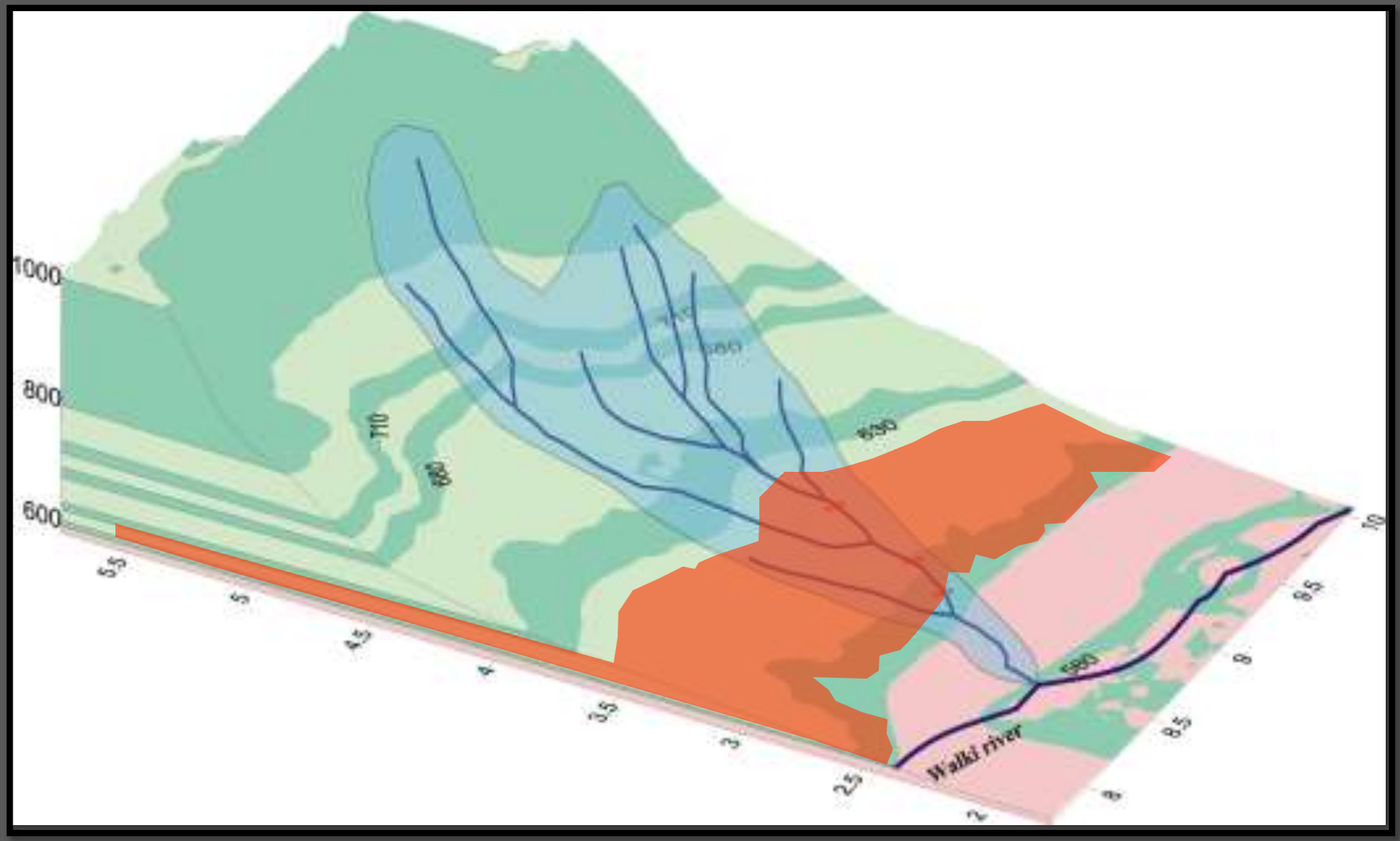


Water level data can be used to understand the relationship between WATERSHEDS & AQUIFERS

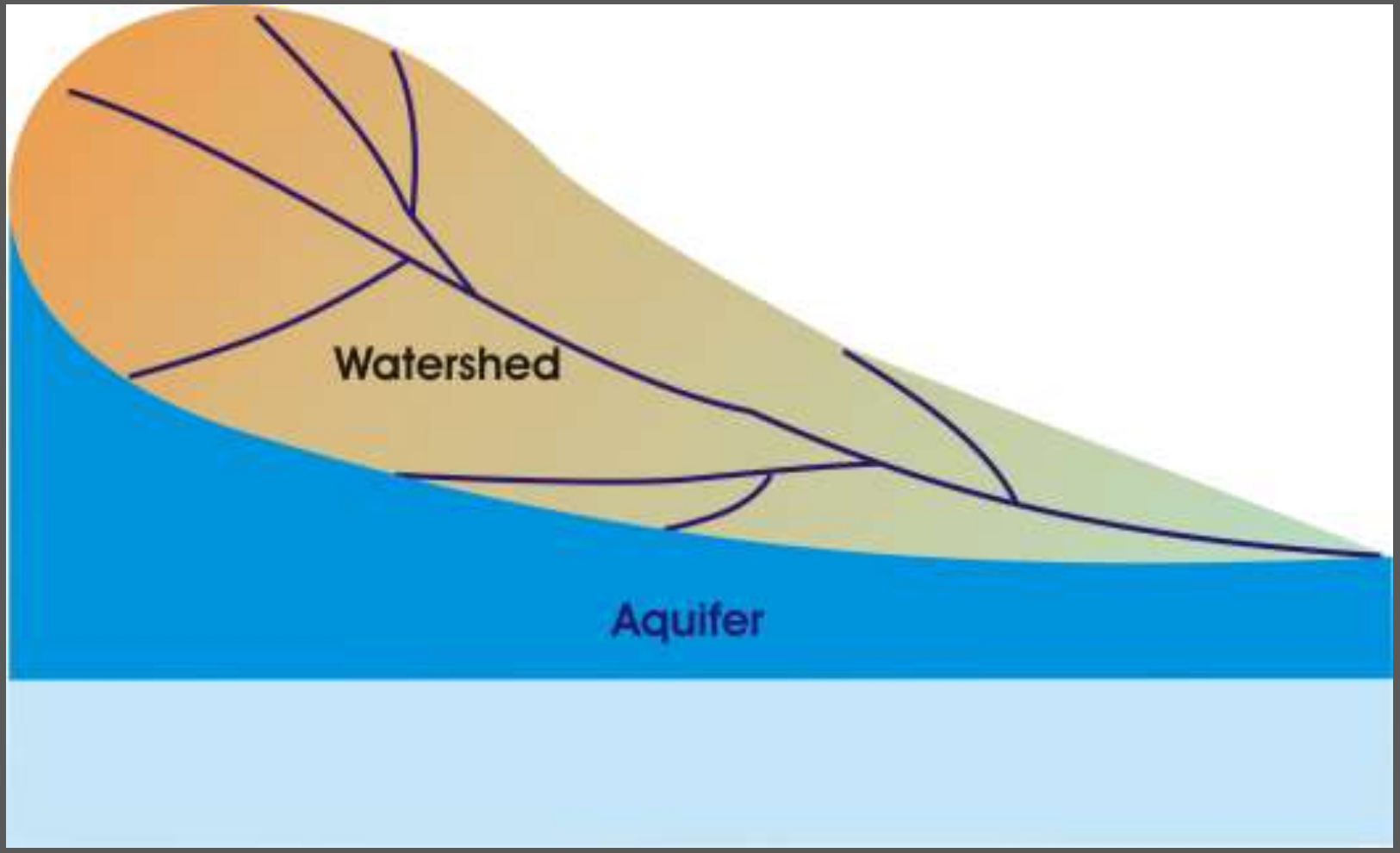
- One aquifer may underlie one or more watersheds
  - Watershed and aquifer boundaries may be common.
  - Aquifer boundaries may extend beyond the watershed boundaries – the aquifer extends below more than one watershed.
- One watershed may include more than one aquifers
  - All aquifers in the watershed may have boundaries within the limits of the watershed.
  - Some aquifers in the watershed may have boundaries within the watershed whereas others may have boundaries beyond the watershed.
  - All aquifers in the watershed have boundaries beyond the watershed.



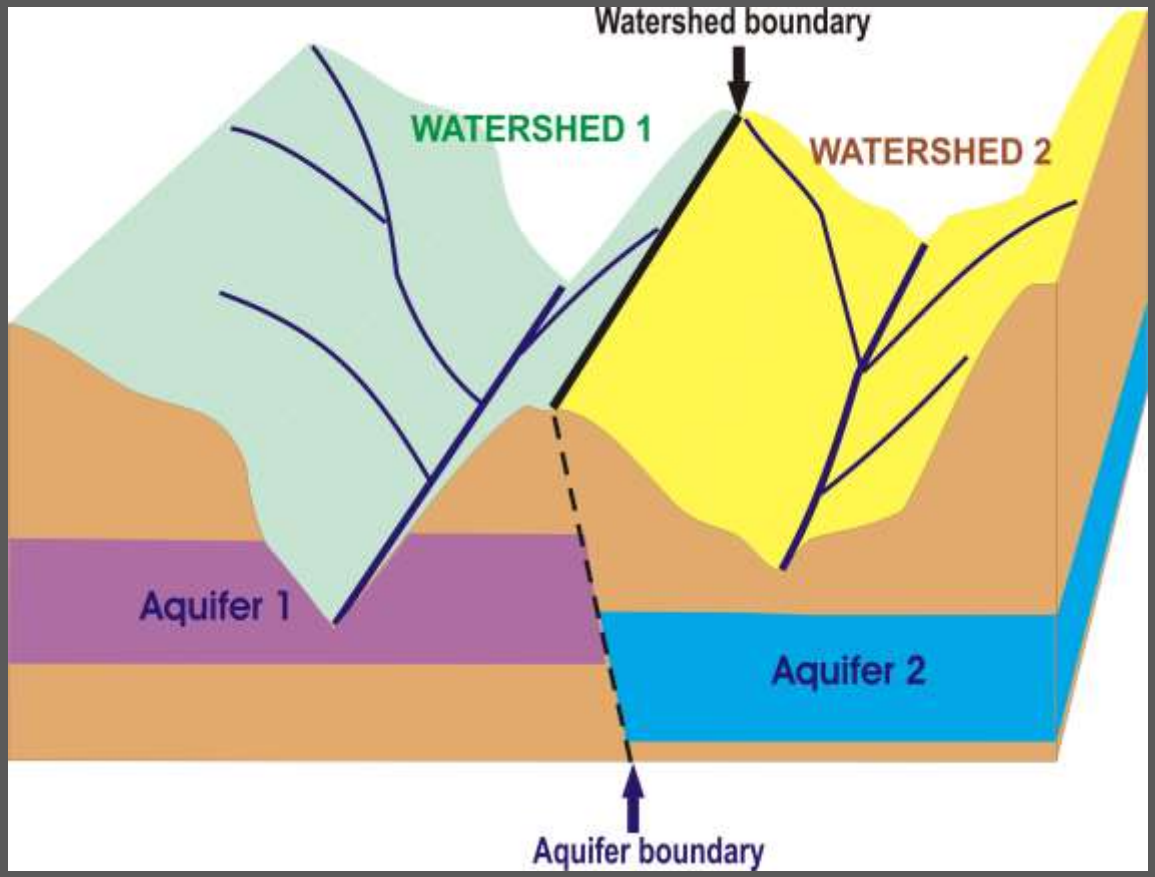
Watersheds and aquifers



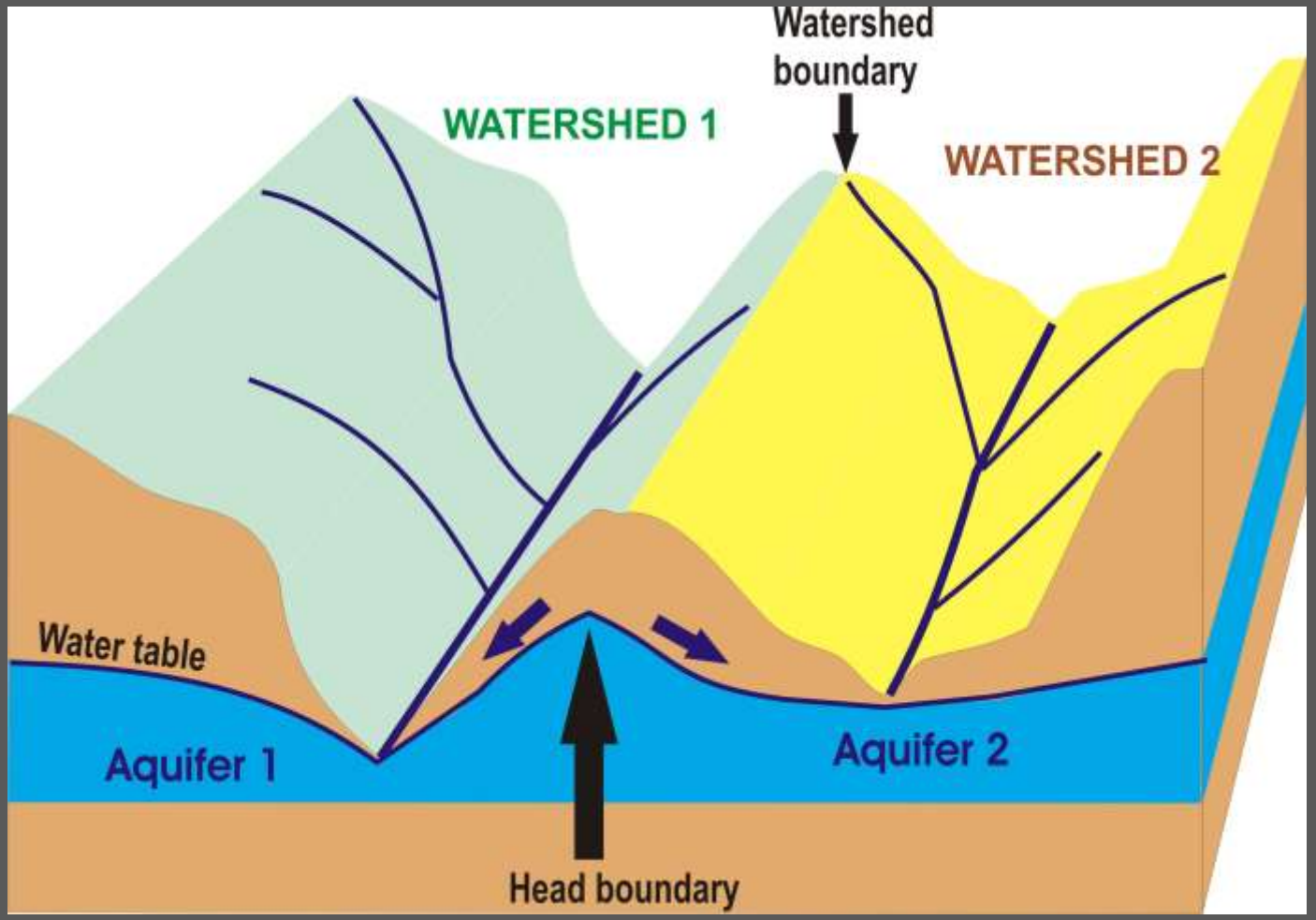
One watershed underlain by one aquifer



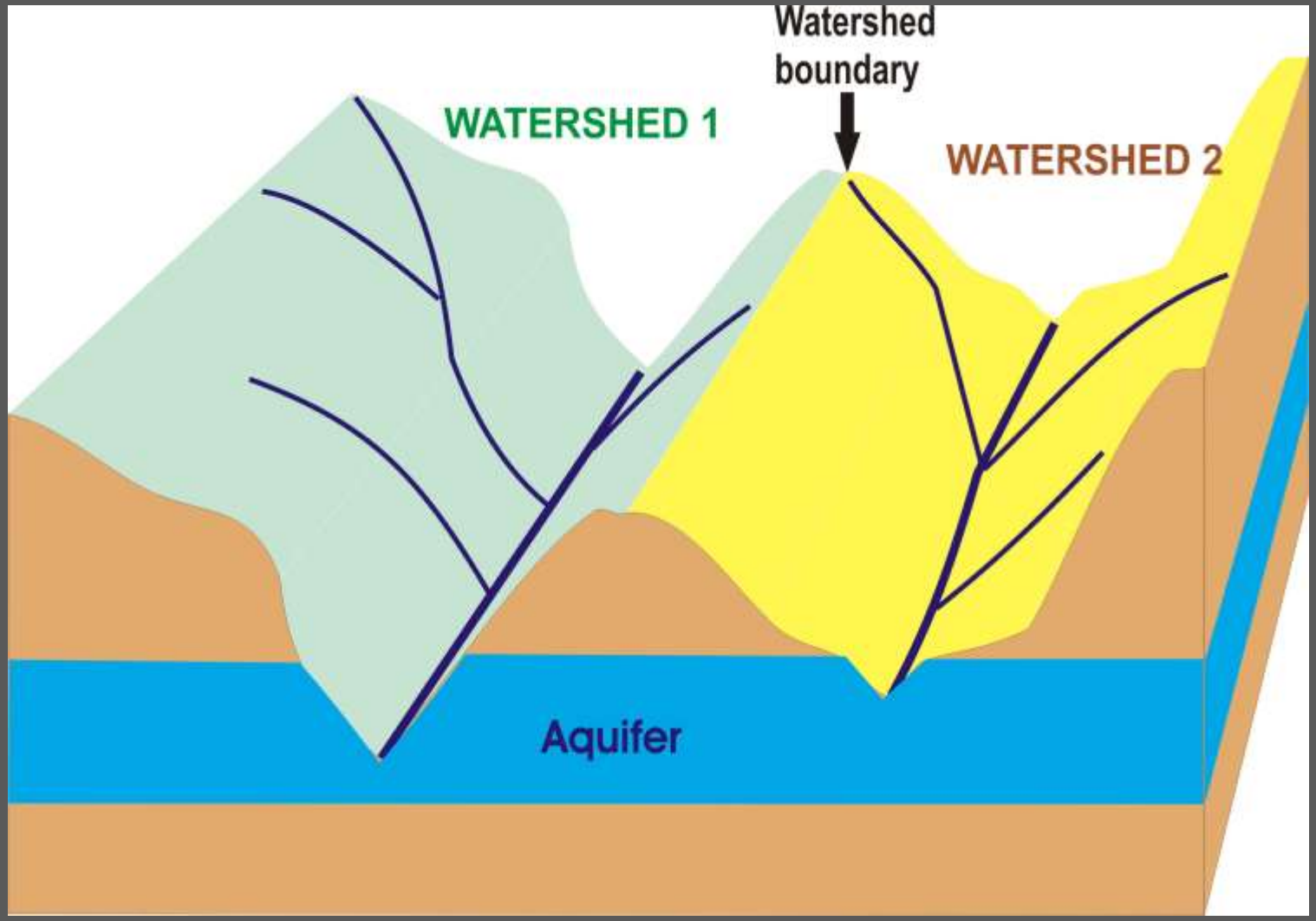
Watershed and aquifer boundaries are coherent due to physical boundaries



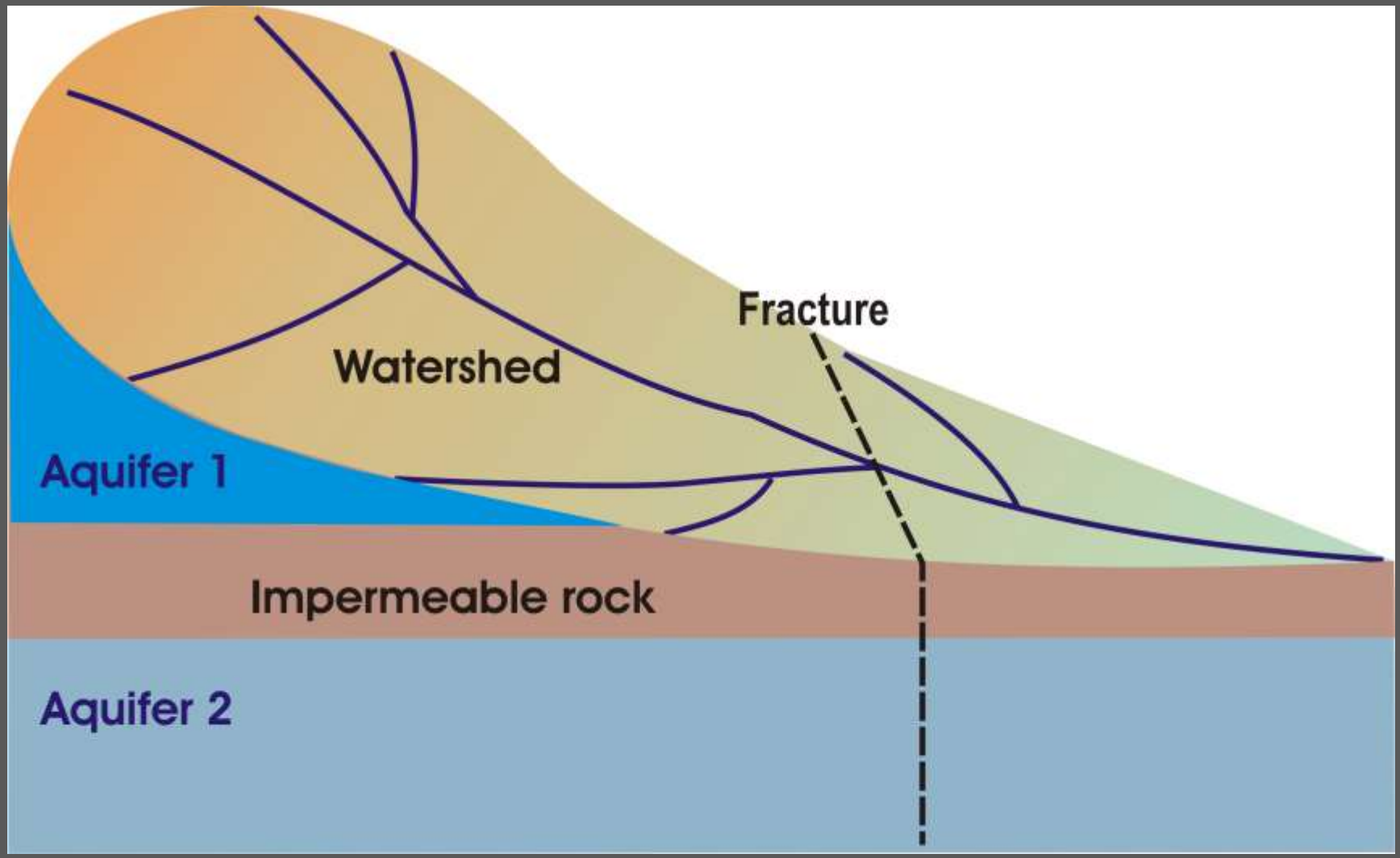
Watershed and aquifer boundaries are coherent due to the water table configuration



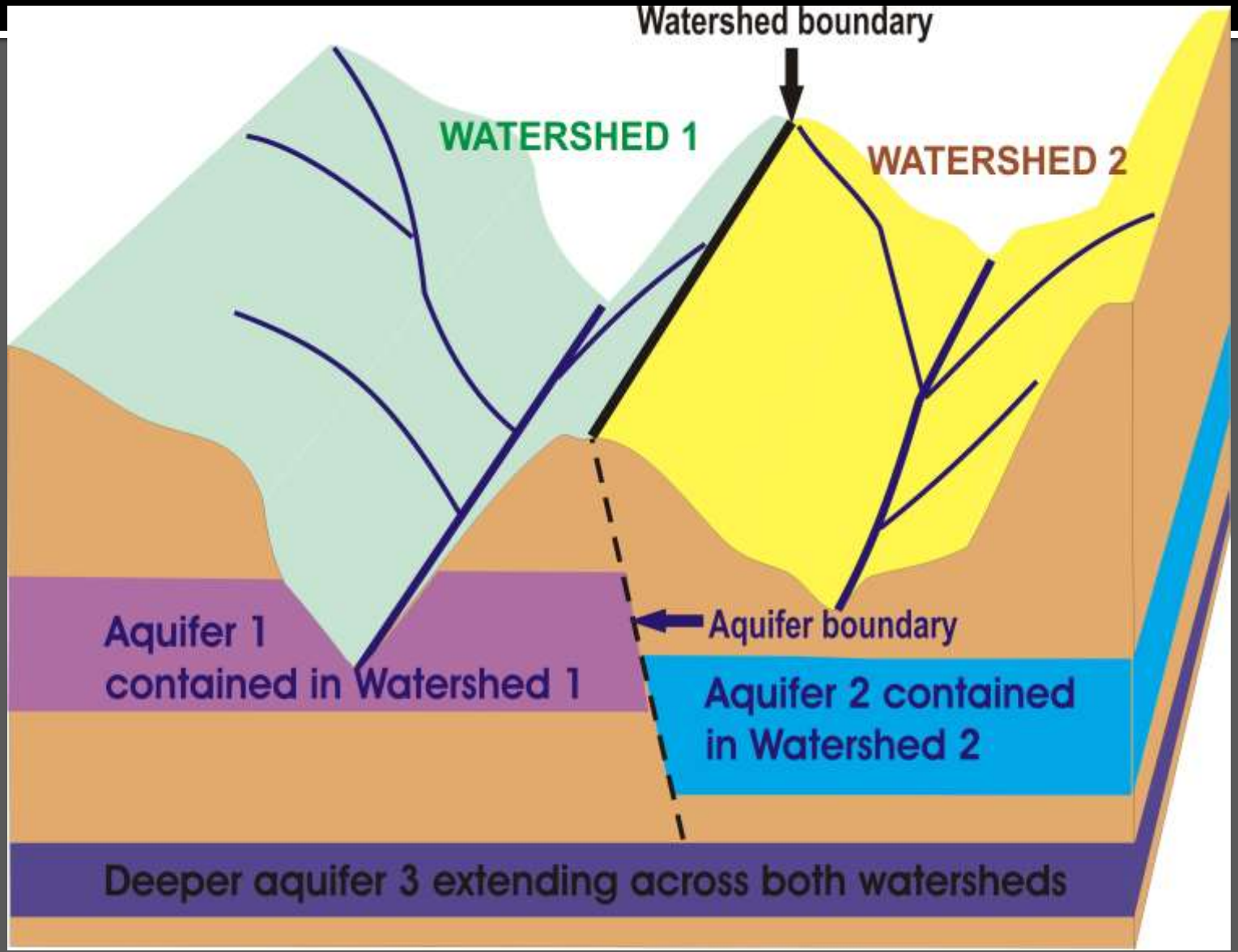
An aquifer extends below more than one watershed



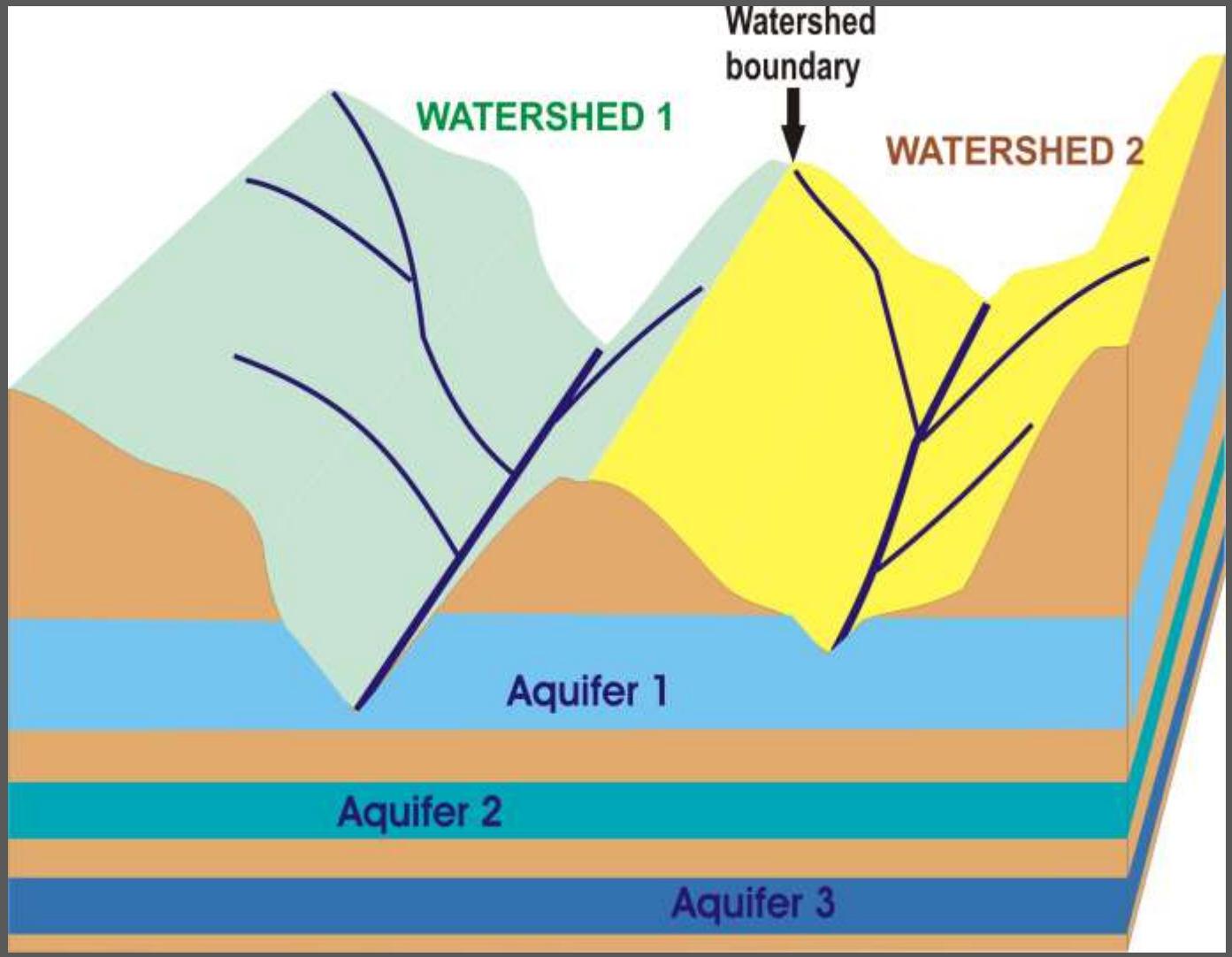
A watershed includes more than one aquifer – aquifer boundaries are within the watershed



Some aquifers have boundaries within the watershed, while others have boundaries extending beyond the watershed boundaries

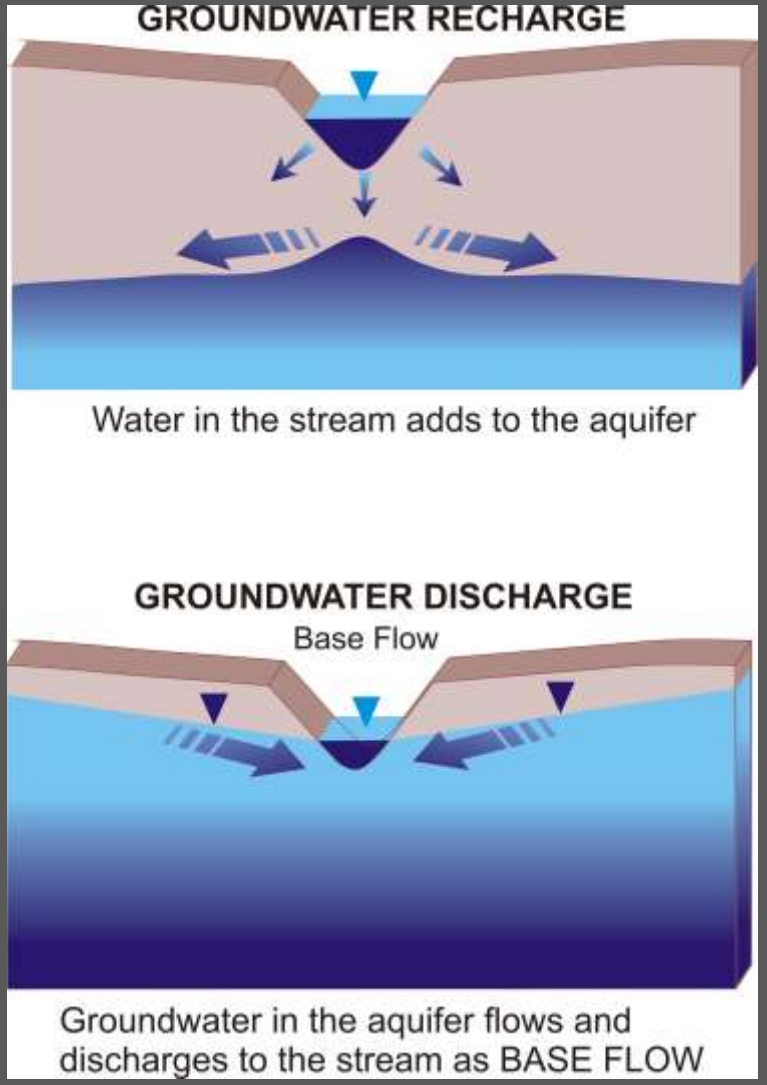


All aquifers in the watershed have boundaries beyond the watershed

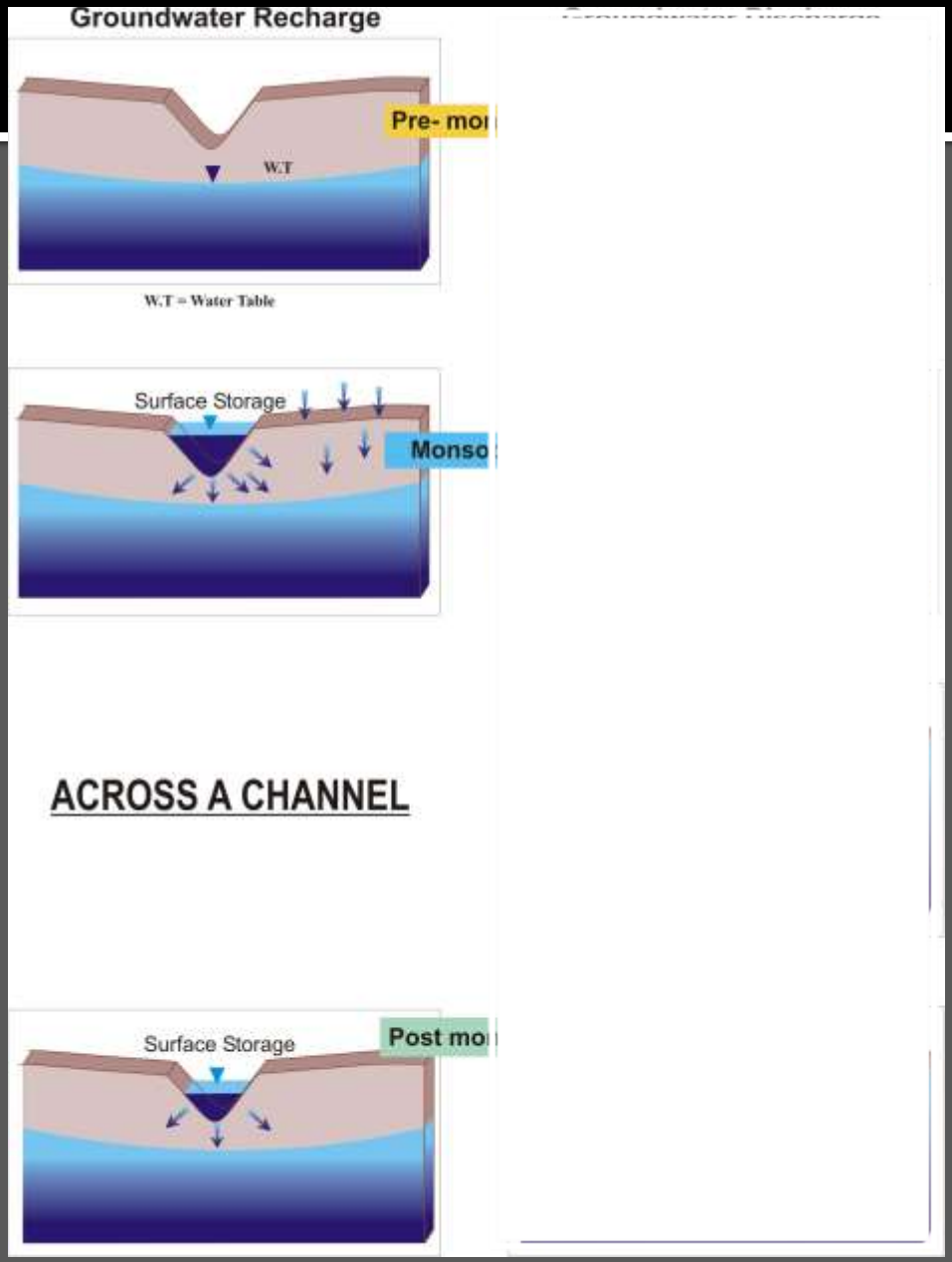


Water level data is also useful to understand surface flow in streams and rivers

- Influent streams
  - Streams losing water to adjacent aquifers
  - Groundwater flows out of streams and into aquifers
  - Such streams are natural *groundwater recharge areas*
- Effluent streams
  - Streams gaining water from adjacent aquifers
  - Groundwater flows towards streams
  - Such streams are natural *groundwater discharge areas*



Groundwater recharge & discharge near a stream



THANK YOU.