CE 374 K – Hydrology

Hydrologic Measurement

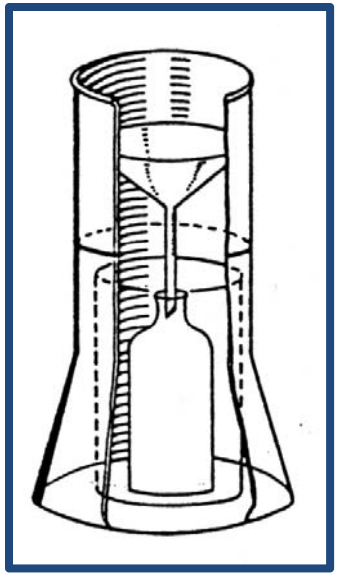
Daene C. McKinney

Climate Station

- Temperature (wet- and dry-bulb) - thermometer
- Humidity – Hygromoter
- Evaporation pan
- Anemometer
- Radiometer

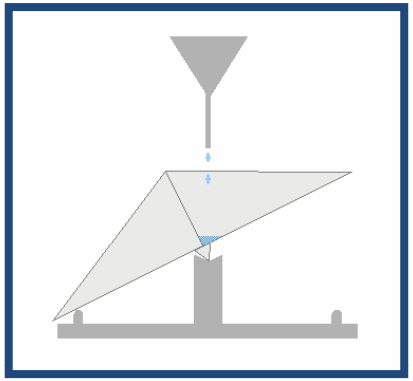
Non-Recording Raingauges

- Non-recording and recording rain gauges
  - A non-recording rain gauge is typically a catchment device calibrated to provide visual observation of rainfall amounts.
  - Recording gauges are equipped with paper charts and/or data logger equipment.
- Measure with calibrated flask or dipstick
- Flask usually tapered to allow accuracy if little rain



Digital Recording Raingauges

- Tipping Bucket Rain Gauge
  - Two containers on balance beam form a “tipping bucket”
  - Rain fills one container until it threshold weight reached
  - Bucket then tips over, emptying collected water into total container and continues to collect rainfall in other container
  - Magnet generates electric pulse which is recorded

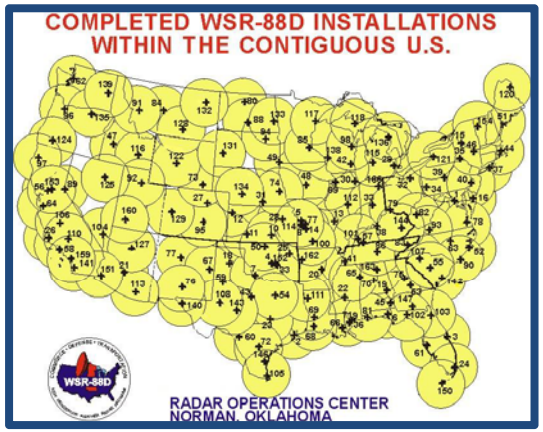


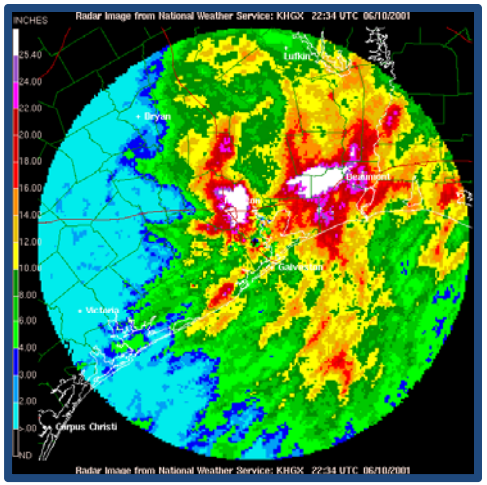
Digital Recording Raingauges

- Optical Rain Gauge (ORG)
  - The ORG is mounted on a small pole
  - The ORG sends a beam of light (which you cannot see) from one of its ends to a detector at the other end.
  - When raindrops fall, they break the beam. The rain rate is measured by the ORG by measuring how often the beam is broken.
  - The rain rate can be used to calculate the total amount of rain that has fallen in any given period
  - ORG measures the rate of rainfall in millimeters per hour (mm/hr).

RADAR Measurements

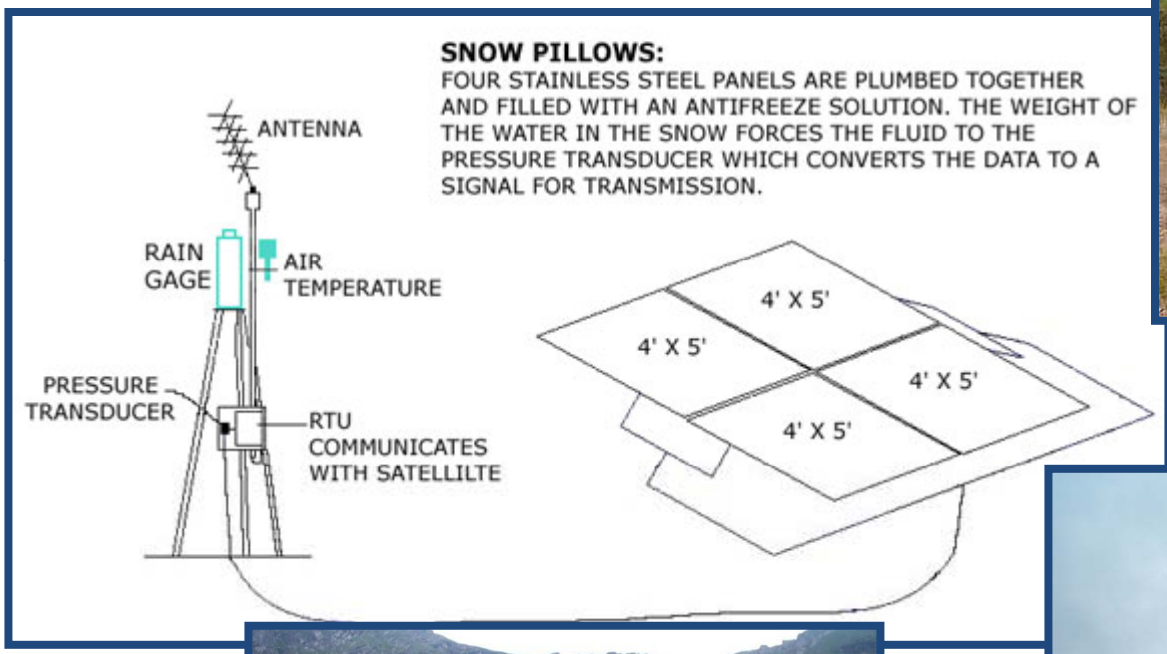
- Raindrops in the atmosphere and the characteristics of the reflected signal(Z) can be related to rainfall rates (R).
- Most common is Marshall-Palmer relationship
- Radar is far from an absolutely accurate measurement method
- Provides detailed information on the *time* and *spac*e distribution of rain and can be particularly valuable for heavy rainfall.





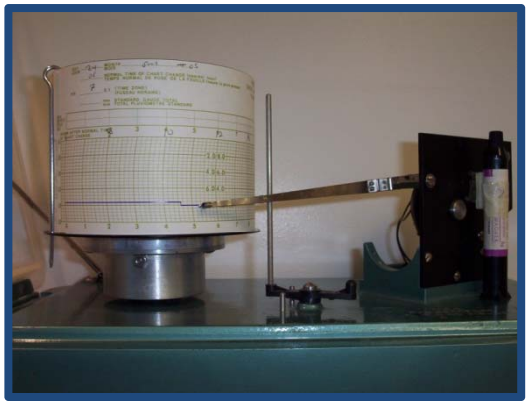
Snow Gauges

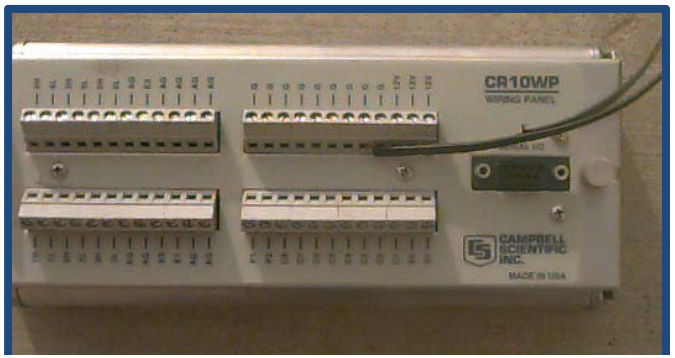
- Snow Pillows



Recording of Data

- Data Loggers
  - A data logger is a computer that records and stores data from sensors both analog (voltage) and digital(counts).
  - The data logger can also be used as a controller to turn on and off electrical
  - The data logger requires a program to tell it what to do.
    - Preloaded computer chip that already has the program in it
    - or create the program
  - Data can then be accessed by a computer to monitor current conditions or download stored data.





Streamflow

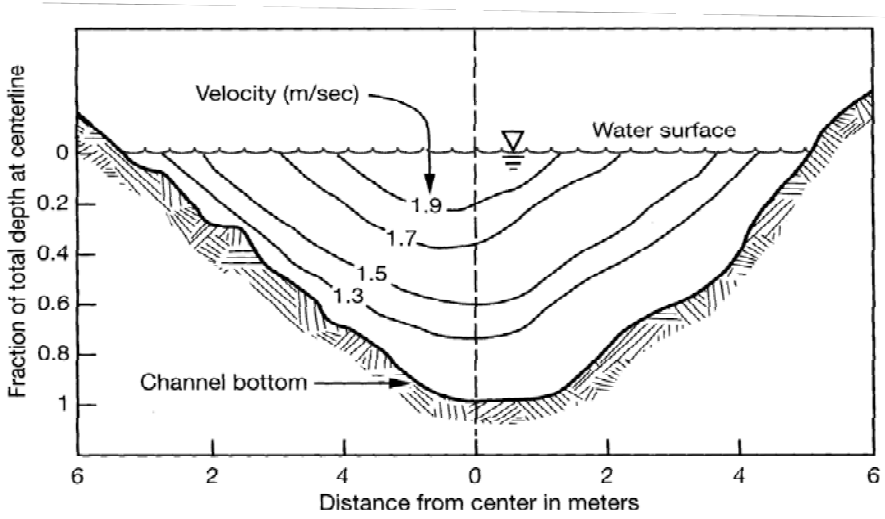
- The flow of water in an open channel (or discharge) is defined as the volume of water passing a specified point in a given interval of time
  - expressed in units of volume per time
- Common units
  - litres per second ($l.s^{-1}$),
  - cubic meters per second ($m^3.s^{-1}$).
- Various methods of determination
  - flow is often estimated by determining the velocity at which water flows through a given cross-sectional area.
  - flow may be routed through a measurement device and measured directly
  - may be determined indirectly through use of appropriate measurements and mathematical models

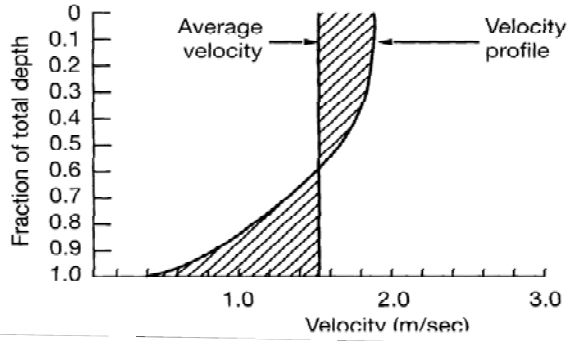
Streamflow

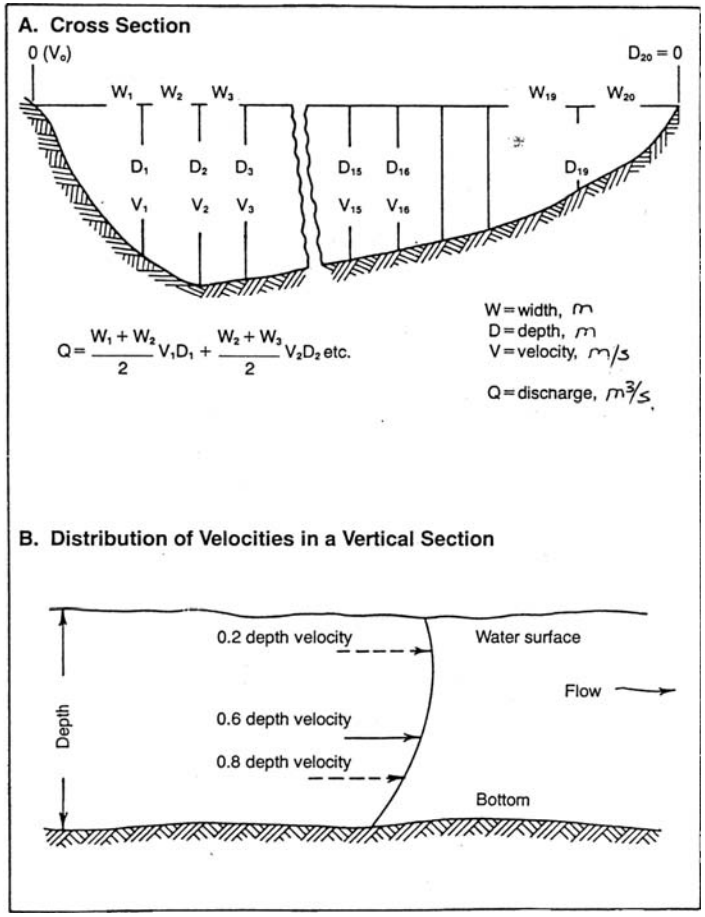
Velocity-Area Method

- Estimate flow volume by determining the velocity at which water flows through a given cross-sectional area.
    - Flow = velocity X cross-sectional area or
    - Q = VA
- Need estimates of channel:
  - cross-sectional area
  - "average" current velocity
- Final flow estimate accomplished by subdividing the cross-section of the channel, determining the "average" flow for each subdivision, and summing the subdivision flows into a total flow for the channel.

STREAM GAUGING



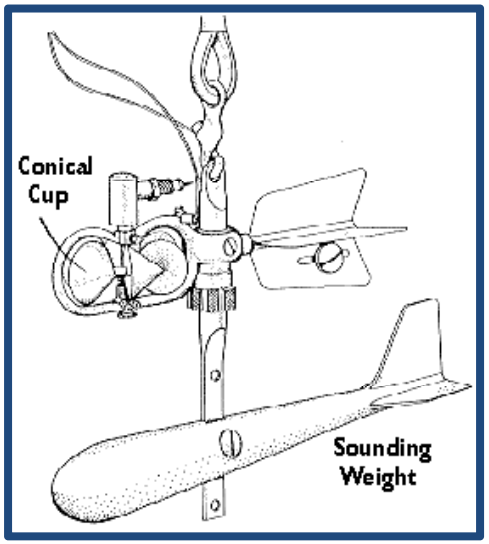




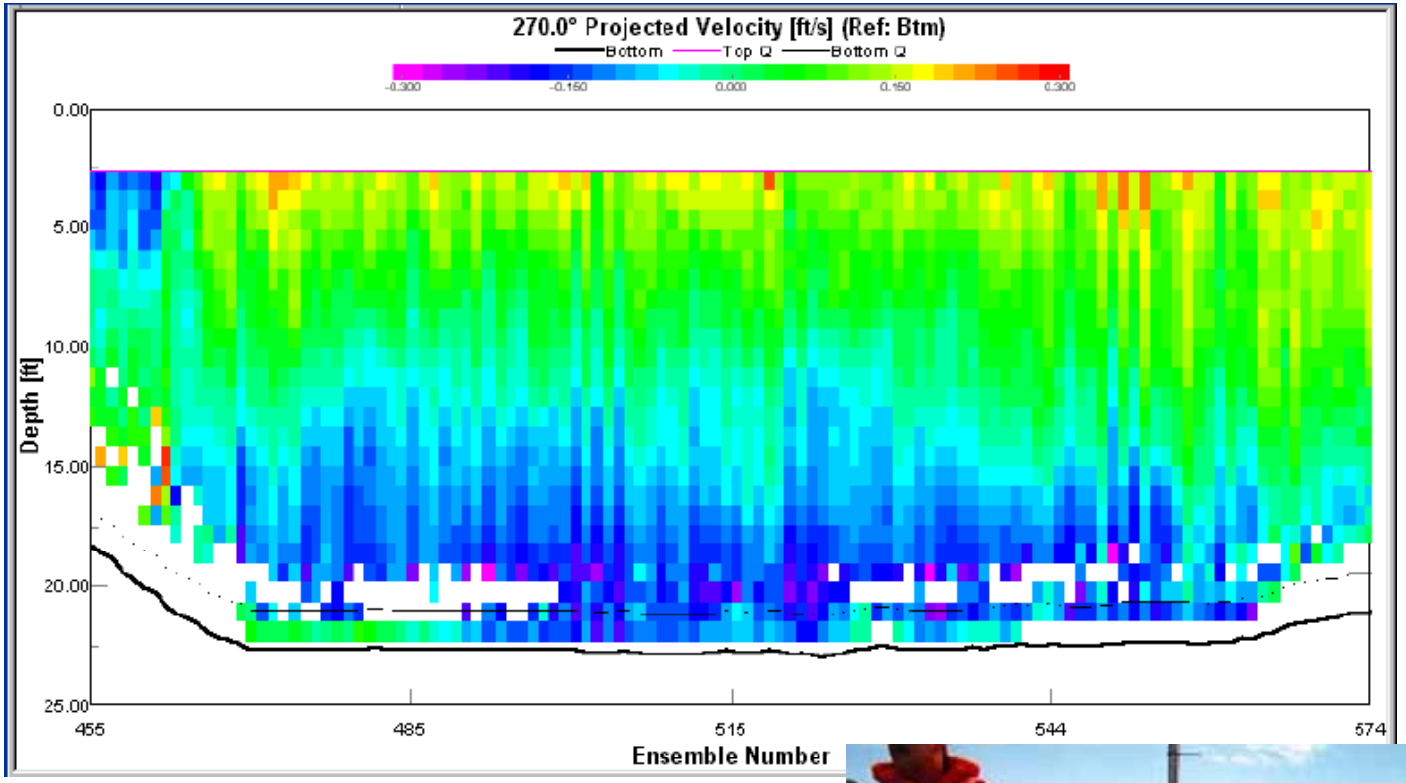
Notice average velocity is at approximately 0.6 of the total depth or 0.4 from the bottom.

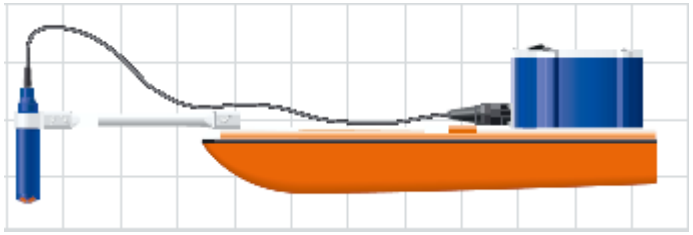
Streamflow Measurement

- Current meters used to measure velocity
- Current meters
    - shaft rotating vertically or horizontally
    - tail vanes - keep it in stream
    - weight - keep cable vertical



Acoustic Doppler Current Profiler

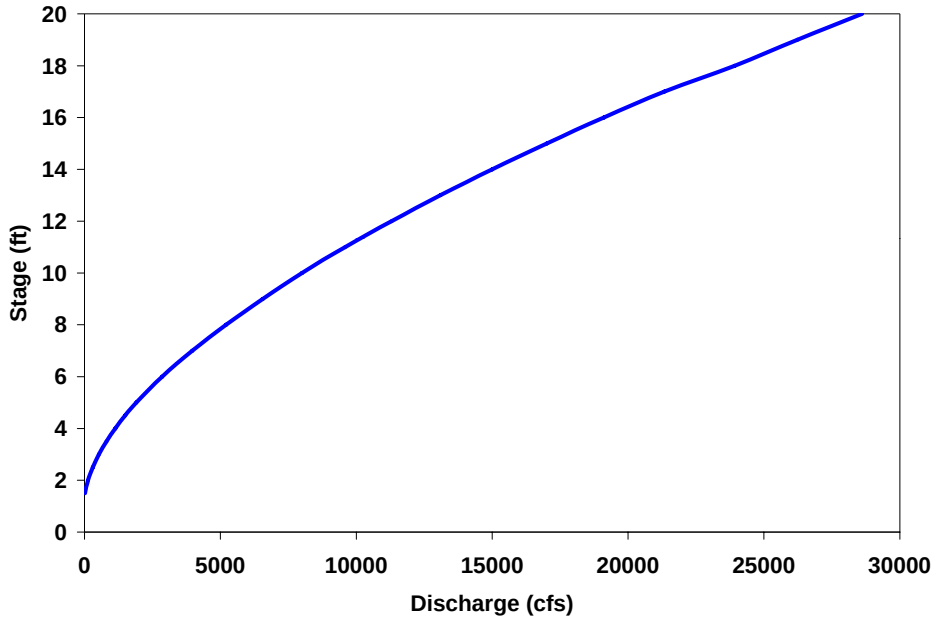




Streamflow

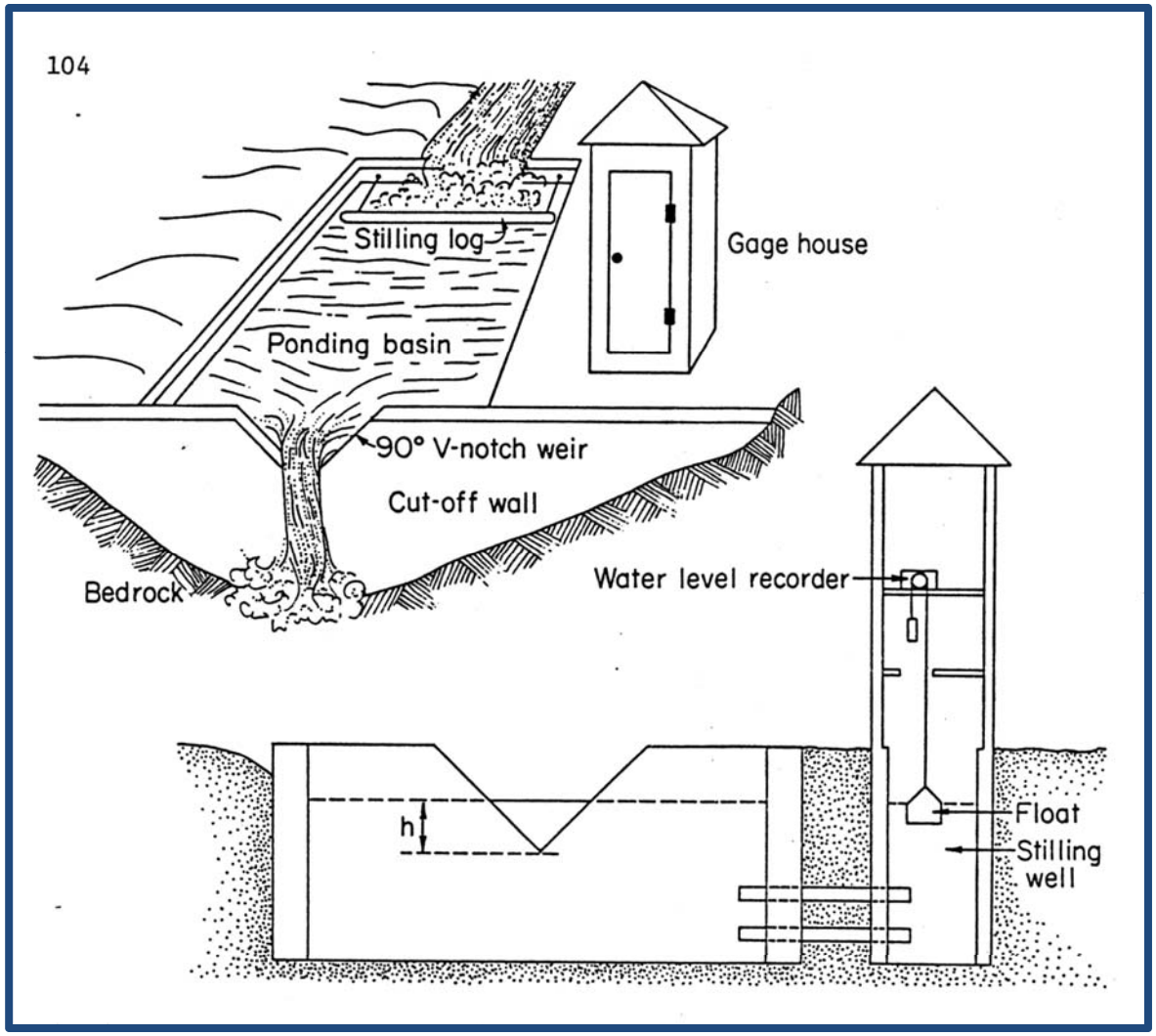
Determination of:

- Depth or height of the water surface (known as stage)
- Derivation of a relationship between stage and volume of discharge allows determination of a “rating curve”
- specific to the section of river
  - i.e. “rated section”
- Rating curves establish a relationship between depth (stage) and the amount of flow in a channel.



Streamflow

- *Measurement of Stage*
  - Graduated staff gauge
    - side of bridge etc.
  - Automatic water level recorders
    - logged automatically by logger, or
    - chart produced and digitised



Weirs and Flumes

- Commonly used on small streams and rivers
- Rigid, stable structures with closely defined cross-sectional area.

Stage Height

- Most common method of measuring the stage of a river is through the use of a stilling well.
- Stilling wells are located on the bank of a stream or on a bridge pier and are topped by a shelter that holds recorders and other instruments associated with the station.
- The well is connected to the stream by several intakes such that when the water level changes in the stream, the level simultaneously changes in the well
- Thus, the water surface in the well is maintained at the same level (stage) as the water surface in the stream.