HYDROGRAPHIC SURVEY

What is Hydrographic Survey?

Branch of science that deals with the measurement of bodies of water.

It is the art of dilineating the submarine levels, contour and features of seas, gulfs , rivers and lakes.

It is the science of measurement and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration/offshore oil drilling and related activities.

History of Hydrographic Surveying

Although the history of hydrography is nearly as old as sailing, in the United States it officially began on February 10, 1807.

The first official hydrographic survey in the U.S. was conducted along the south shore of Long Island in 1834. Five years later, in 1839, the U.S. government produced its first nautical chart.

Early hydrographic surveys consisted of depths measured by sounding pole and hand lead line, with positions determined by three-point sextant fixes to mapped reference points.

The 1930s saw the development and implementation of single-beam echo sounders that used sound to measure the distance of the sea floor directly below a vessel.

In the 1950s, 1960s, and 1970s, a number of evolutionary concepts were advanced that fundamentally changed how we look at and map the seafloor.

Side scan sonar technology offered a qualitative means of obtaining the sonic equivalent of an aerial photograph and improved the ability to identify submerged wrecks and obstructions.

Multibeam swath systems made it possible to obtain quantitative depth information for 100 percent of the bottom in a survey area.

Objects of Hydrographic Surveying

1. Determination of bed depth, by soundings
2. Establishing MSL and observation of tides.
3. Making nautical charts for navigation and determination of rocks, sandbars, lights and buoys
4. Determination of shore lines
5. Making subaqueous investigations to secure information needed for the dersign, construction, development and improvement of port facilities and marine structures, offshore structures, sea defense works, etc.
6. Controlling and planning of engineering projects like harbors, dams, bridges, tunnels, reservoirs etc.
7. Determination of area subject to silt and scour and asertain the quantity of dredging material Determination of direction of current in connection with the location of sewer any pipe or channel that carry waste water out falls
8. Measurement of discharge of rivers/quantity of water and flow of water in connection of water schemes, power scheme and flood controls.
9. Identifying the location of lights rocks, sand bars, buoys (anything that floats on the surface of water)

SHORELINE SURVEY

Consist of-

1. Determination or delineation of shorelines
2. Location of shore details and prominent features to which soundings may be connected
1. Determination of low and high water lines for average spring tides.

Determination or delineation of shorelines is done by traversing along the shore and taking offset to the water edge.

For narrow river both banks may be located by running a single line of traverse on one bank.

For wide river traverse may be run along both the banks. Traverse should be connected at convenient intervals to checks the works.

Sometimes, a triangulation network is run along a wide river.

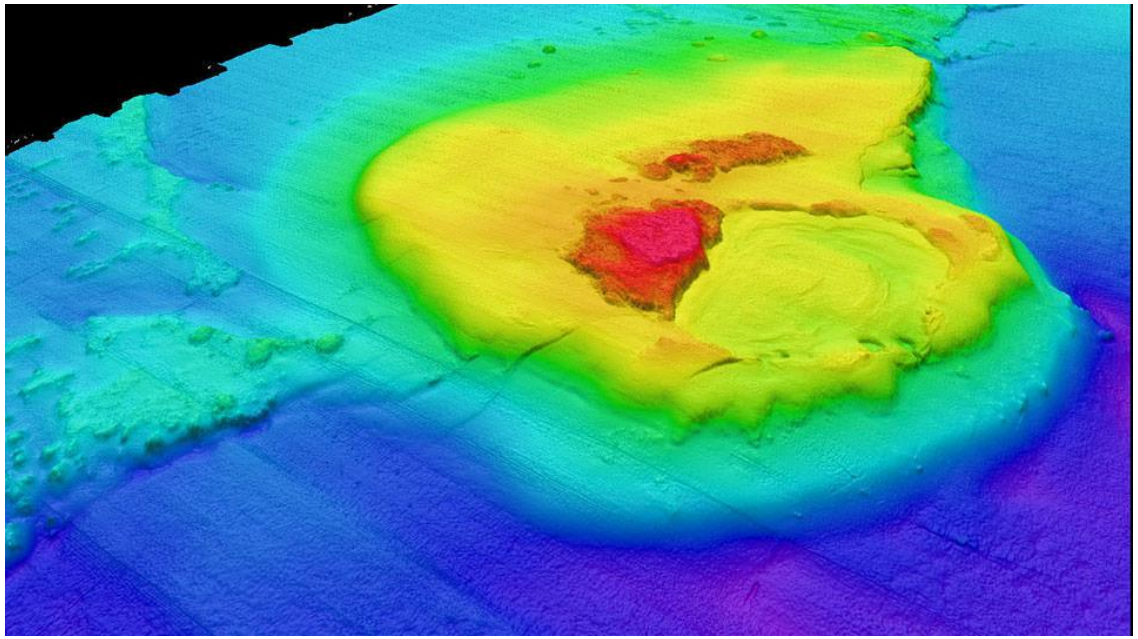
In sea shore survey, buoys anchored off the shore and light houses are used as reference points and are located by triangulation.

What is Bathymetry?

The term "bathymetry" originally referred to the ocean's depth relative to sea level, although it has come to mean “submarine topography,” or the depths and shapes of underwater terrain.

Bathymetry is the foundation of the science of hydrography which measures the physical features of a water body. Hydrography includes not only bathymetry, but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.

In the same way that topographic maps represent the three-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in sea-floor relief may be depicted by color and contour lines called depth contours or isobaths.



SOUNDING

Sounding is the measurement of the vertical depth below the water surface of the lake, river or sea

Soundings are required for:

- **Making nautical charts for navigation**
- **Measurement of areas subject to scour or silting and to ascertain the quantities of dredging materials**
- **Making subaquas investigation to secure information needed for the construction, development, improvement of port facilities.**

To take the sounding a vertical control and to locate sounding horizontal control is necessary

Horizontal Control

May consist of either triangulation or traverse. For large area a 2nd or 3rd order triangulation as main control. For smaller areas – transit-tape-traverse may be used.

For long narrow river – horizontal control is established by running a single traverse line on one shore. If width is more than 1km – traverse may run on both sides and may be connected at intervals.

Vertical Control

It is essential to know the Gauge reading i.e. the level of water which continuously goes on changing.

Tide gauges are used to establish the common datum before sounding is taken. Before sounding operation a vertical control must be established to connect these gauges with shore elevation and with each other.

Sounding Equipment

1. Sounding boat
2. Sounding Rods or poles
3. Lead lines or Sounding lines
4. Sounding machine
5. Fathometer

Sounding Boat

Should be sufficiently roomy and stable.

For quiet water flat bottom boat and for rough water round bottom.

Sould be built with a sounmding platform.

For strong current, a motor or stream launch may be used.

Sounding Rod

5 – 8 m long, suitable for shallow and quiet water

plate or shoe on end to prevent sinkage into soft bottom

Sounding Equipment

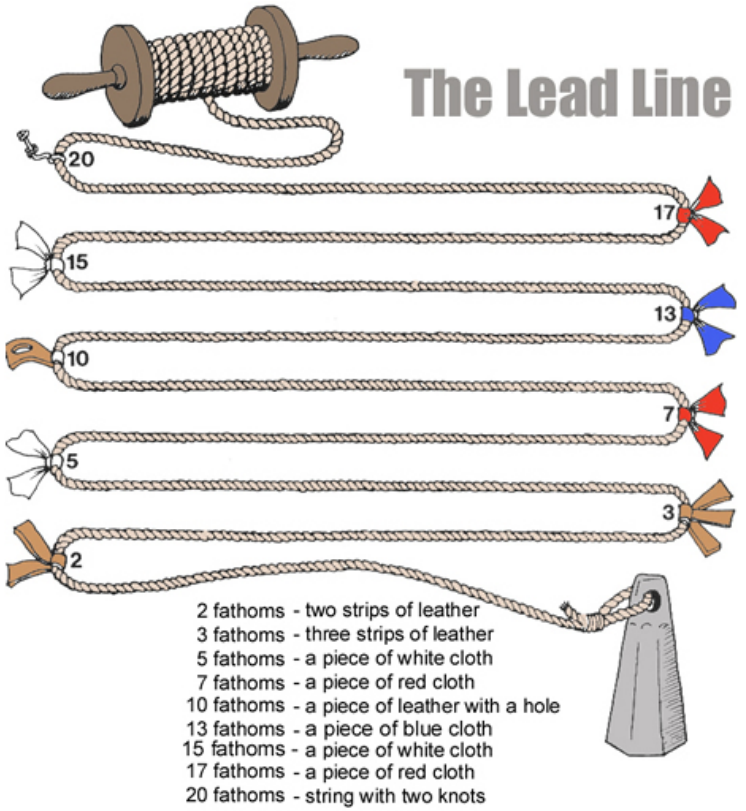
Lead Line

A length of rope or chord with attached lead of conical shape having 4-12 kg weight depending upon the depth of water and str of current.

Used for a depth of about 6m.

Rope or chord is graduated

For regular use a chain of brass, steel or iron is preferred



Sounding Machine

Require when much of sounding to be done.

Either hand driven or automatic.

Reading are indicated in two dials.

Lead is lowered by controlling the drum

The machine is mounted on sounding boat.

Sounding Equipment

Fathometer

An echo sounding instrument which uses sound waves to determine the depth.

Used for ocean sounding

Installed below the boat or ship.

Adjusted with the vel of sound for different types of water.

Indicate depth visually or graphically on a roll which continuously revolve and provide a virtual profiles of the lake or sea.

Main parts:

- **Transmitting and receiving oscillators**
- **Recorder unit**
- **Transmitter or power unit**

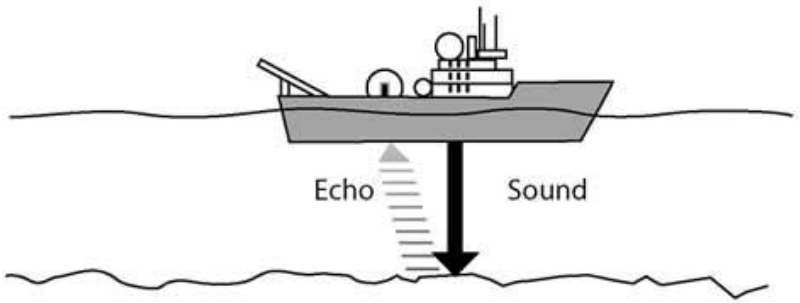
Sounding Equipment

Sonar Equipment (Sound Navigation and Ranging)

measure the range of an object by timing the two way journey of pulse of sound energy and converting the result to units of distance

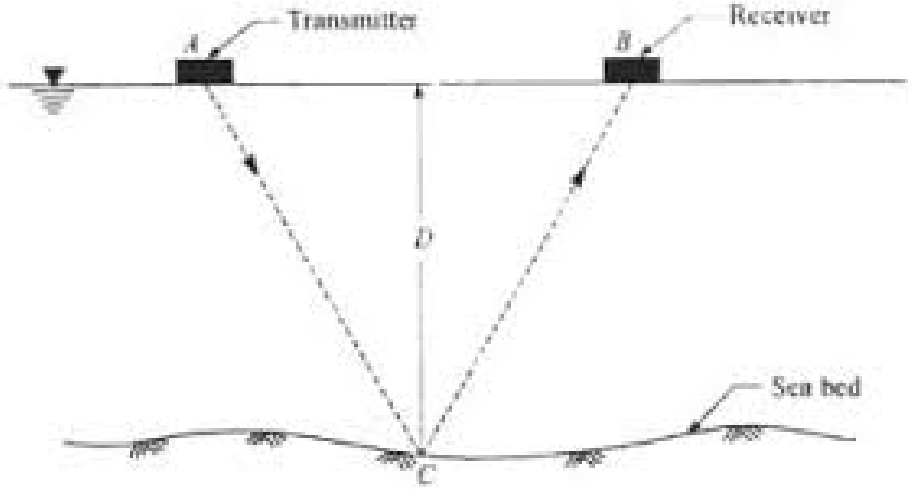
Echo Sounder

- sounding device utilizing a fixed beam with a vertical axis
- shape and width of the beam varies
- the shape of the beam is assumed to be a cone
- the frequency of the sound signal determines the beam width and the reflective and penetrative capabilities of the pulse



Principle of Echo-Sounding

It consists in recording the interval of time between the emission of sound impulse direct to the bottom of the sea and the reception of the wave or echo, reflected from the bottom.



If the sped of the sound in that water is v and the time interval between the transmiter na dreceiver is t, the depth h is given by $h = 0.5v \times t$

Advantages of echo sounding

- More accurate as truly vertical sounding is obtained.
- Can be used with strong current and unsuitable weather condition.
- More sensitive than lead line.
- Provides contineous record.
- Speed of soundiong and plotting increased.
- Error reduced
- Rock underlying softer material is recorded. (required for submarine boring)

Making the Sounding

For depth less than 25 m, sounding can be taken with the boat is in motion.

- By Rod
- By lead

  Leadsman stand on bow.

  Plunges /casts rod/lead forward.

  Reading taken when rod or lead vertical.

The water surface changes continuously, hence it is required to take the gauge reading at regular interval so that sounding can be reduced to fixed datum.

To correlate each sounding with gauge reading, it is essential to record the time at which each sounding is made.

Method of Locating Sounding

Soundings are located with reference to the shore traverse by observation made

- **Entirely from the boat**
- **Entirely from the shore**
- **Or from both boat and shore**

Method of locating Sounding

(a) By conning the survey vessel

- **By cross rope**
- **By range and time intervals**

(b) By observation with Sextant or Theodolite

By range and one angle from the shore
By range and one angle from the boat
By two angles from the shore
By two angles from the boat
By one angle from the shore one from the boat
By intersecting ranges
By tachometry

(c) By Theodolite angles and EDM distances from the shore

(d) By microwave systems.

Conning

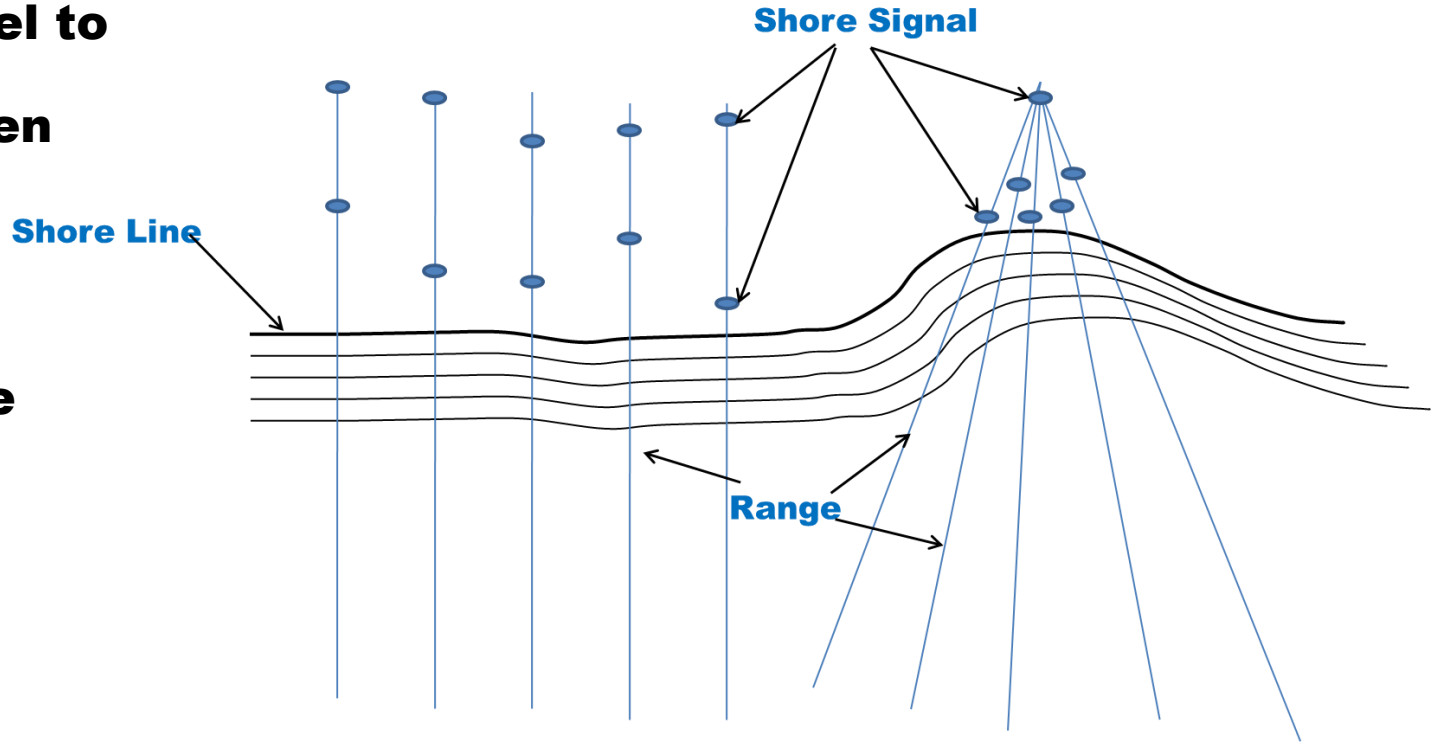
the process of keeping the survey vessel or boat on a known course.

Range

line on which soundings are taken
Perpendicular to shore line and parallel to each other
Or radiates from prominent points when shore line is irregular.

Shore Signal

to fix or mark the range,
consists of two points at considerable dist
Should be readily seen and easily distinguished

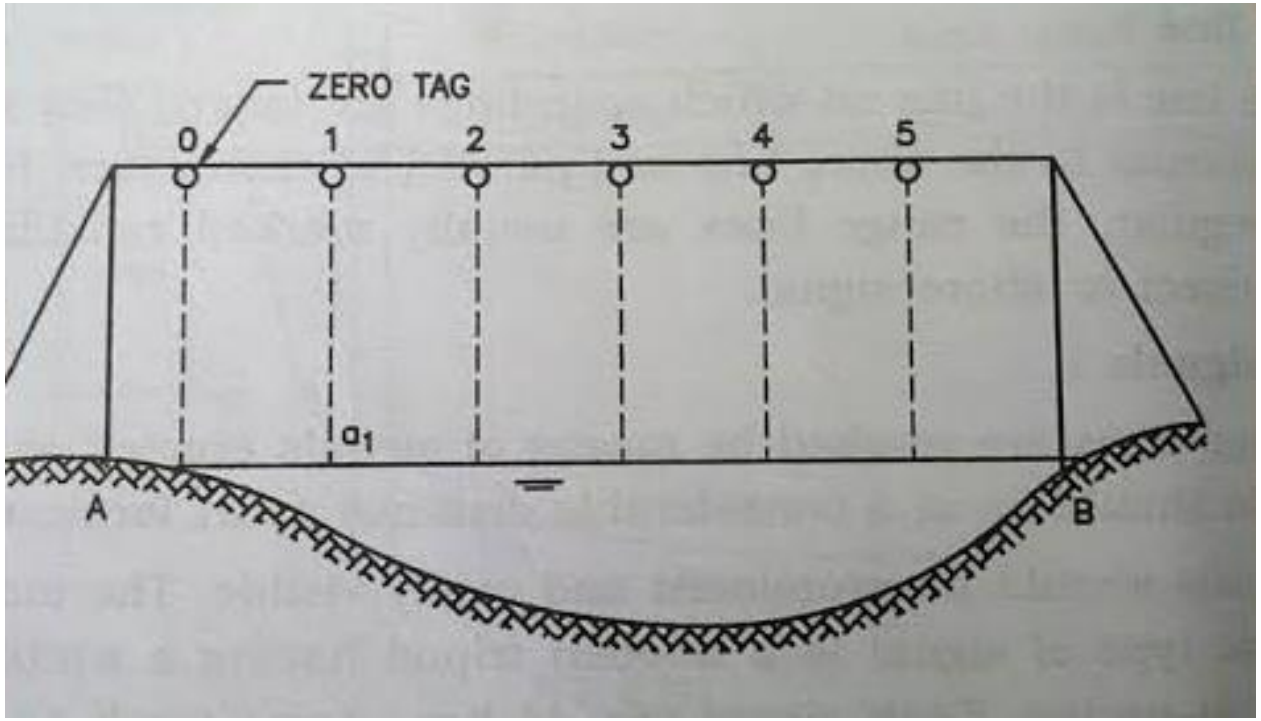


By conning the survey vessel

Location by Cross Rope

In this method, a wire or rope with markings at known distances is stretched across the channel. The starting point of rope at the shore is marked as reference point. Then using boat, the sounding at different distances of wire are determined by weighted pole.

Location by Range and Time Interval



By observation with Sextant or Theodolite

By range and one angle from the shore

By range and one angle from the boat

By two angles from the shore

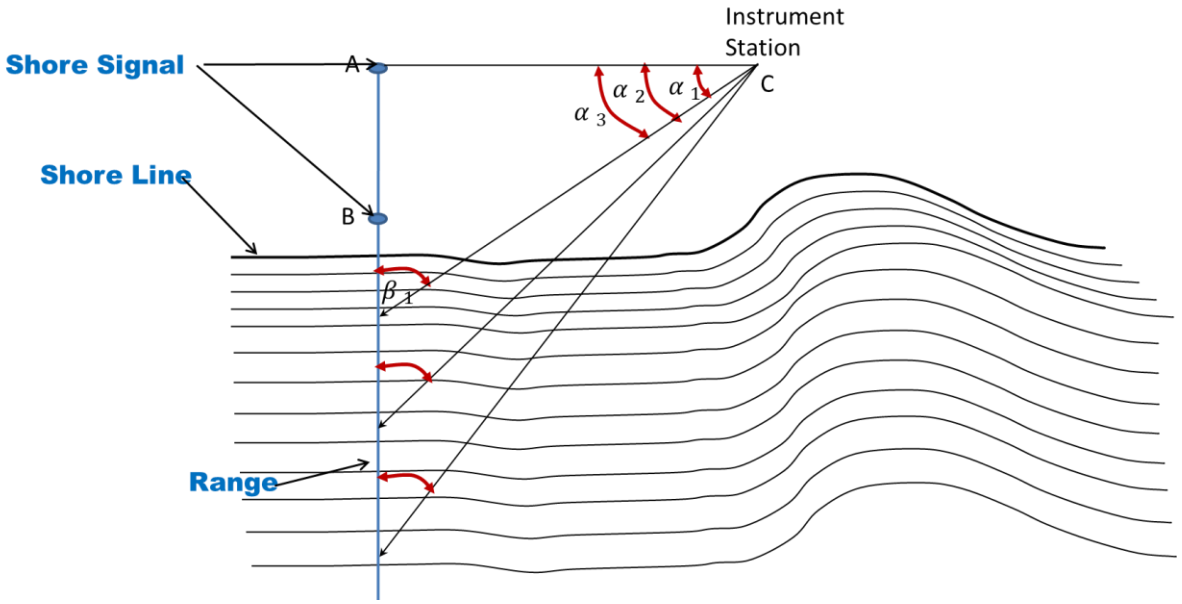
By two angles from the boat

By one angle from the shore one from the boat

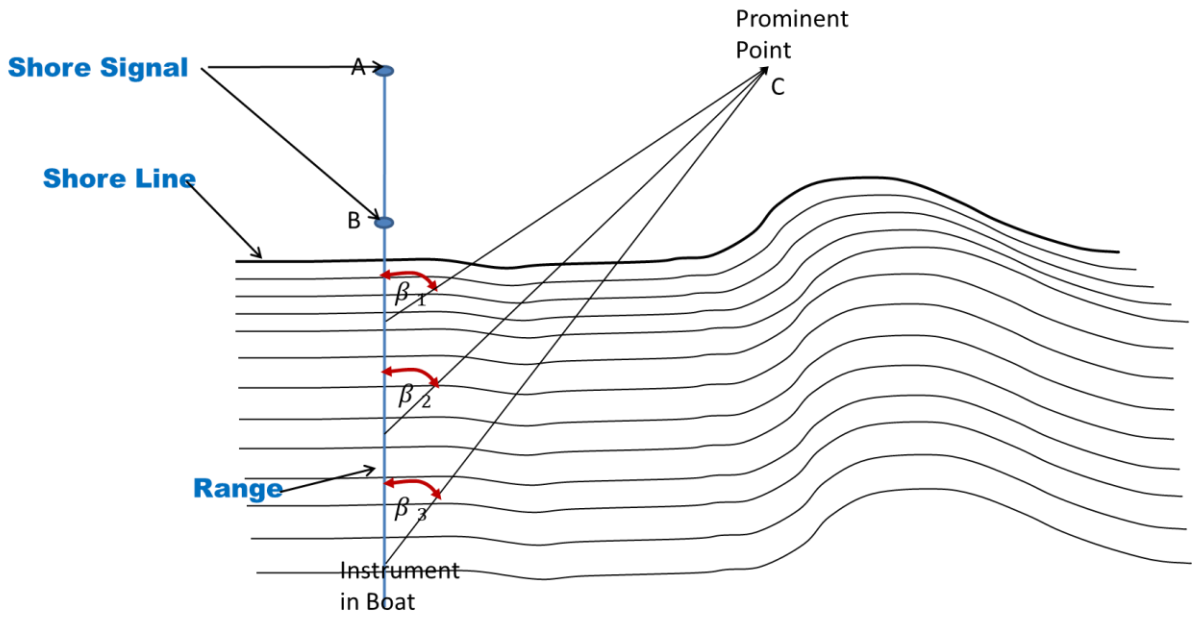
By intersecting ranges

By tachometry

By Range and one Angle from the Shore



By Range and one Angle from the Boat



Hydrographic Chart

An information medium and a tool for maritime traffic for the safety and ease of navigation

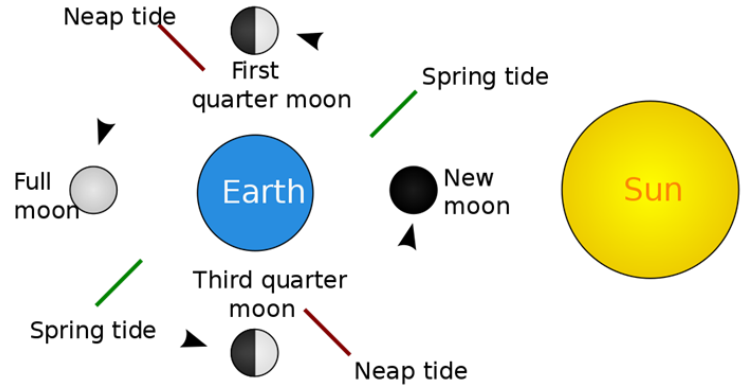
Contains information on

- **least water depths**
- **nature of ocean bottom**
- **sea and swell conditions**
- **surface navigational dangers**
- **other navigational significant data**

Related definitions

Tides

Caused by the combined gravitational effects of the sun and moon, with the moon having the major effect
Influenced by • terrestrial gravity • earth's rotation • land masses • weather systems



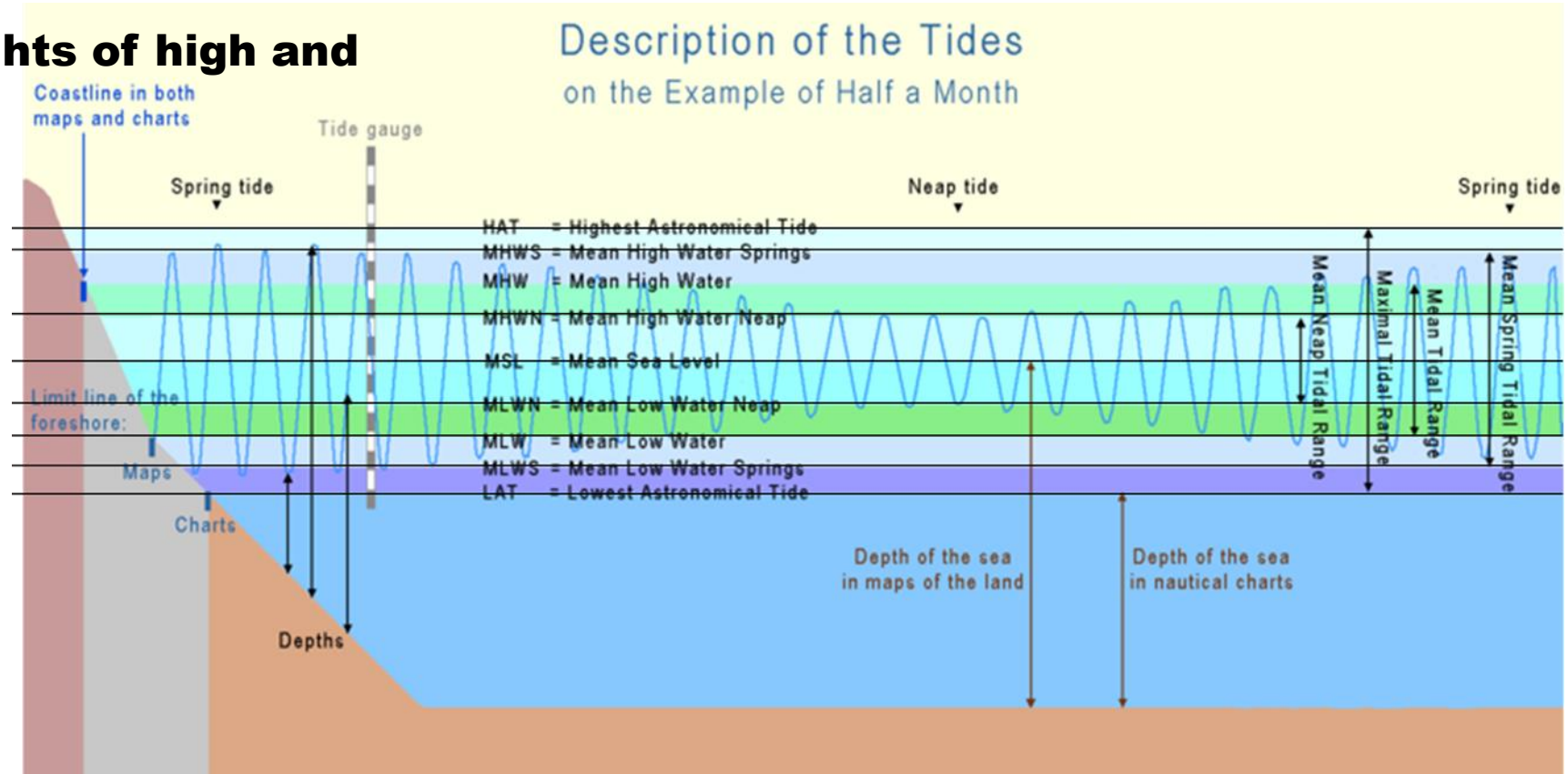
Mean Sea Level (MSL)

Mean Tide Level (MTL)

Average value of the heights of high and low water

Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS)

Average values derived from a sufficiently long series of high water springs and low water springs



Gauges

Tide Gauges

the height of high and low water, and its variations with time can be measured at site with the help of tide gauge.

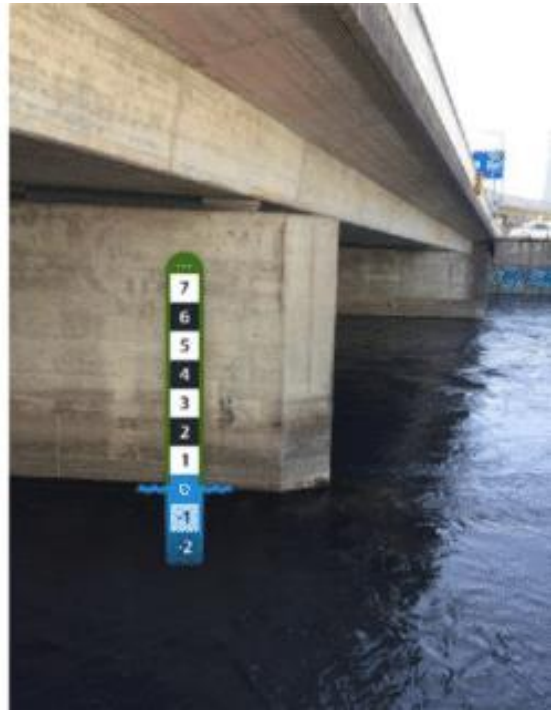
Types of Tide Gauges

a. Non registering type of tide guage
   i. Staff gauge
   ii. Float gauge
   iii. Weight gauge

b. Self Registering type of tide gauge

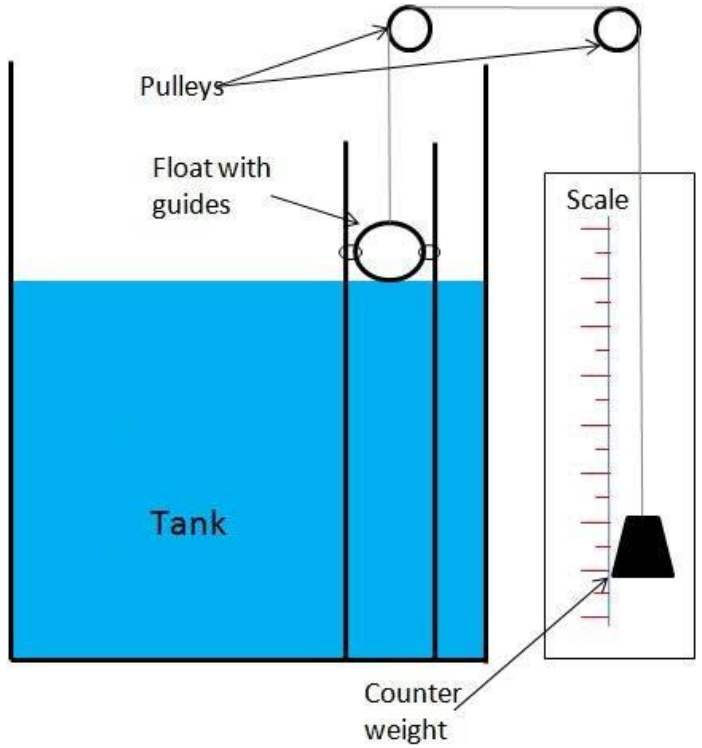
Staff Gauge: merely a vertical staff with a broader face than a levelling staff. This may be graduated every 5 or 10 centimetres, according to the accuracy required. The tide board is often difficult to read due to the surface chop or wave action



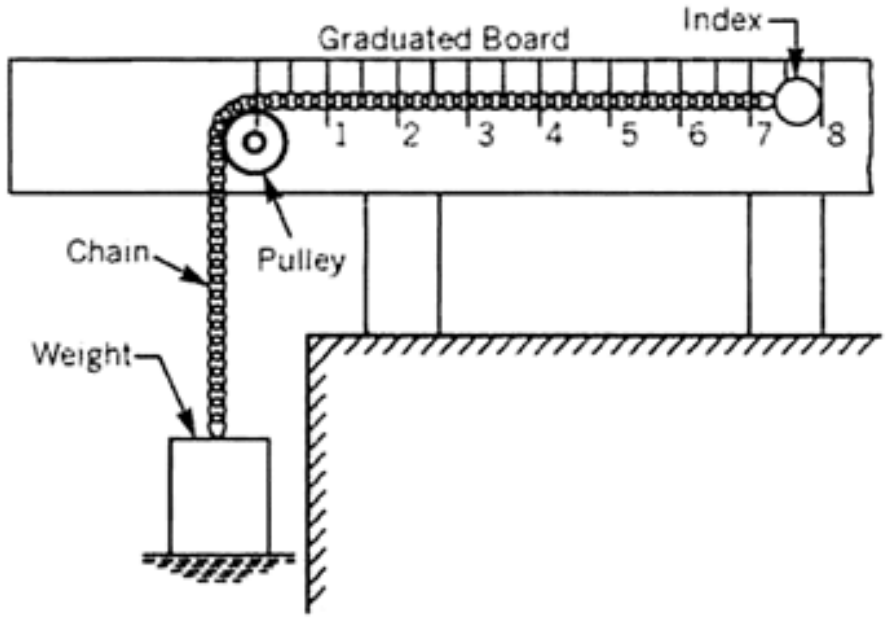


Float Gauge

A float is attached to the bottom of a staff. The staff is then held in a box which is fixed in a vertical position. Only the bottom of the box is open to the sea. The float rises and falls with the tide, the staff running up and down through guides on the inside of the box.

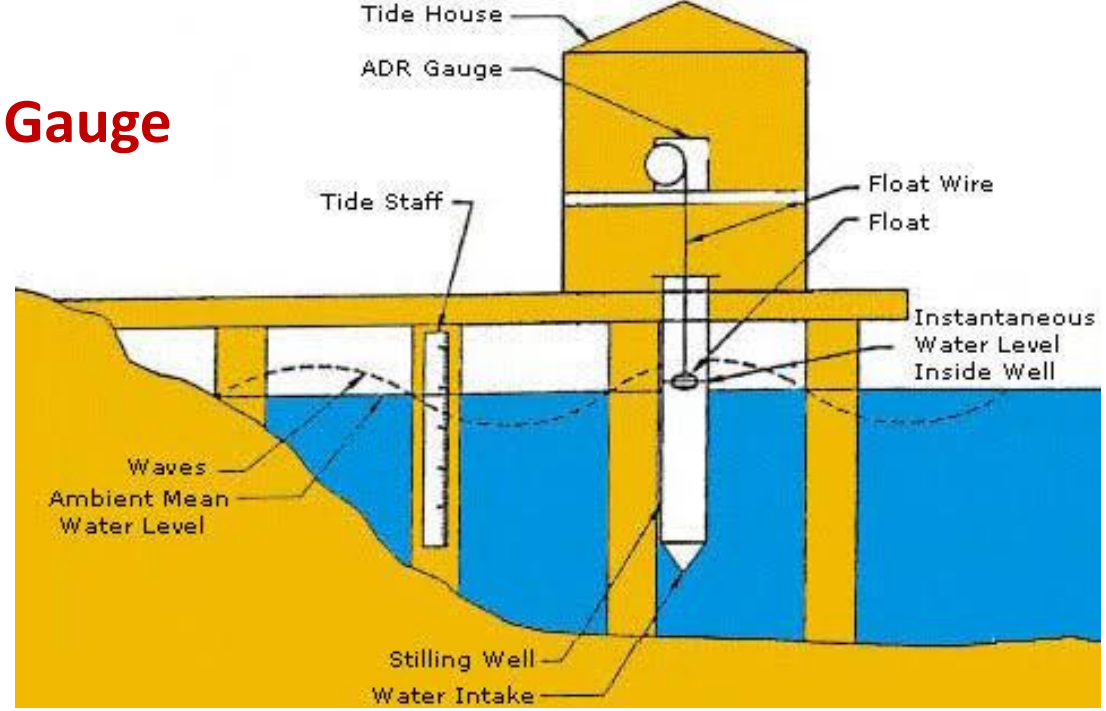


Weight Gauge



Self Registering or Automatic Tide Gauge

Normally established permanently at an official tide station.
The tidal fluctuations are recorded on a chart attached to a drum which revolves with time.
The gauge may need to be visited only once every seven days to change the paper chart and reset the drive mechanism, i.e. wind the clock



Water Pressure Tide Gauge

- **Operates on the changes of water pressure due to tide rising and falling**
- **Completely self contained instrument designed to measure and record tidal movements when mounted on an underwater offshore structure or on the sea bed**
- **Due account must be made for barometric pressure reading and the necessary corrections applied**

OBS (Optical Backscatter)

The OBS is an optical sensor for measuring turbidity and suspended solids concentrations by detecting infra-red light scattered from suspended matter.

The response of the OBS sensors strongly depends on the size, composition and shape of the suspended particles.

OBS response to clay of 2 um is 50 times greater than to sand of 100 um of the same concentration. Hence, each sensor has to be calibrated using sediment from the site of interest.

The measurement range for sand particles (in water free of silt and mud) is about 1 to 100 kg/m^3. The sampling frequency generally is 2 Hz

Discharge Measurement

Discharge is the volume of water moving down a stream or river per unit of time, commonly expressed in cubic feet per second or gallons per day.

In general, river discharge is computed by multiplying the area of water in a channel cross section by the average velocity of the water in that cross section:

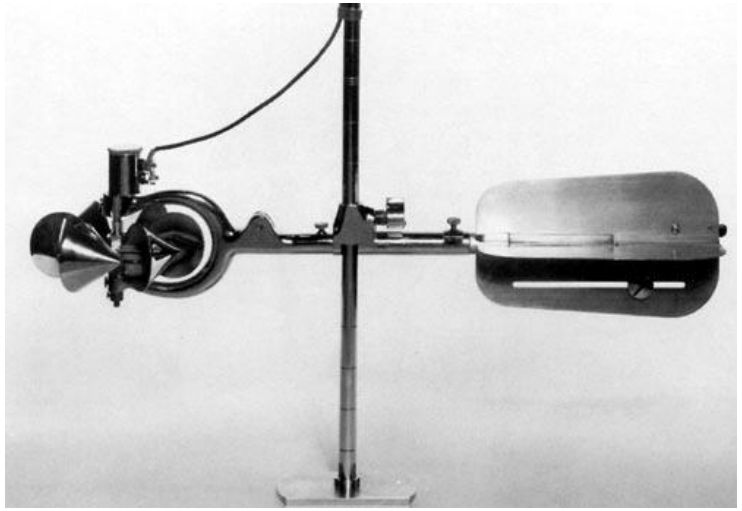
Discharge = area x velocity

Stream flow measurement Generally three methods are used for making stream flow measurements.

1. Current meter.
2. Dilution techniques.
3. Indirect methods.

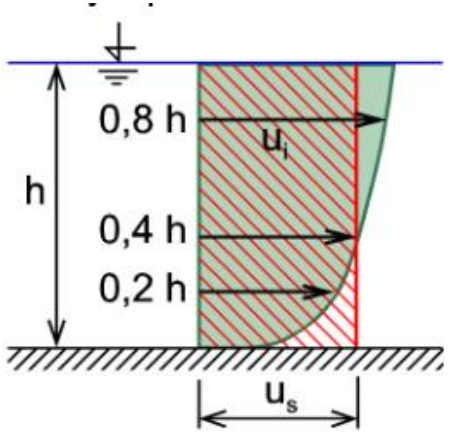
Discharge by Current Meter

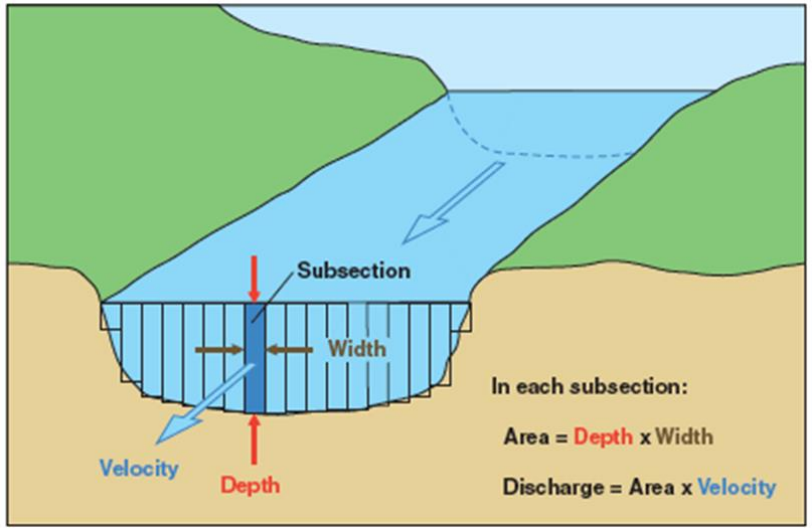
The most common method used by the USGS for measuring discharge is the mechanical current-meter method. In this method, the stream channel cross section is divided into numerous vertical subsections (diagram to the left). In each subsection, the area is obtained by measuring the width and depth of the subsection, and the water velocity is determined using a current meter (left-side picture below). The discharge in each subsection is computed by multiplying the subsection area by the measured velocity. The total discharge is then computed by summing the discharge of each subsection.



Different types of current meter are available for measuring velocity at points in a stream. The price current meter, consists of vertical axis rotor with six curve shaped cups (vanes) pointing in a horizontal plane. The current meter is calibrated by noting down revolutions per minute (rpm) for different known velocity and calibration curve is plotted velocity is measured at 0.2 to 0.8 of the flow depth.

Subsection width is generally measured using a cable, steel tape, or similar piece of equipment. Subsection depth is measured using a wading rod, if conditions permit, or by suspending a sounding weight from a calibrated cable and reel system off a bridge, cableway, or boat or through a hole drilled in ice.





Discharge by ADCP

Advanced technology to make discharge measurements by use of an Acoustic Doppler Current Profiler (ADCP).

The ADCP uses the Doppler Effect to determine water velocity by sending a sound pulse into the water and **measuring the change in frequency of that sound pulse reflected back to the ADCP by sediment or other particulates being transported in the water.**

The change in frequency, or Doppler Shift, that is measured by the ADCP is translated into water velocity. The sound is transmitted into the water from a transducer to the bottom of the river and receives return signals throughout the entire depth.

The **ADCP also uses acoustics to measure water depth** by measuring the travel time of a pulse of sound to reach the river bottom at back to the ADCP.

