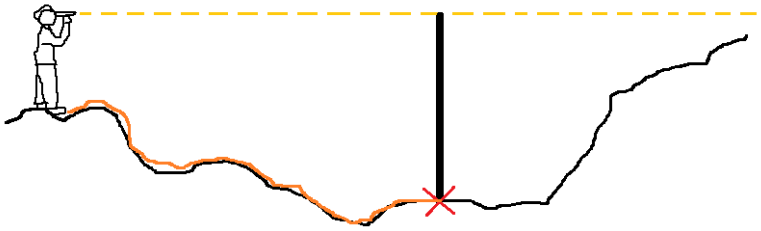
Crash course in basic surveying for Lab 2

The purpose of a survey is to take a topographic feature and turn it into a graphical representation of that feature, with elevation and distance points. There are three main components to a field survey: The rod, level, and tape. There are 2-3 main people involved in the survey: The rodman (or woman), leveler, and recorder. The rodman or leveler can double as the recorder.

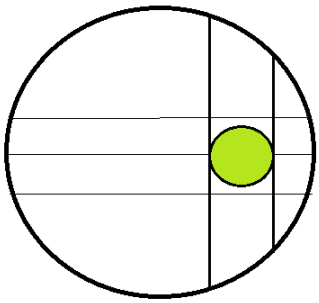
The fundamental idea behind the simple survey technique we are using is to create a plane of equal elevation with the level, and measure both how far below that plane the actual topography is using the rod, and where that point is located along the tape. In the illustration below, the position of point X is known based on the distance from the station (person), determined from a tape (orange line), and distance down from the elevation plane determined by sighting a level line (dashed yellow line) to the rod (thick black line).



Now to go through each of the three components:

The rod (see picture at right): The **stadia rod** is simply a large ruler, based on the metric system. It has multiple (4) levels that can be extended as needed, though the rod is more stable with fewer levels extended. Stadia rods are broken down into meters (with alternating yellow and white background), then decimeters (large numbers on left), then centimeters, then half centimeters. Along the side of each rod is the height in centimeters, though if you cannot read the numbers (which is often the case), you can count the filled blocks (again, see picture at right, which is the same design of stadia rod that we will be using).

The level: There are several types of levels used in surveying. For our purposes, we will be using simple **hand levels**, which are simple to use but have minimal zoom. If you take the ESS 6-wk field camp, you will use autolevels, which have greater zoom and are more delicate, but are also more accurate.



Hand levels have about 10x zoom and are held in your hand (hence the name). You put your eye on one end, aiming the other end at the rod. Black bump goes up (you won't have enough light to see the other way). The eyepiece can be adjusted to focus. Viewing through the hand level (see illustrated simplification at right), there are three lines visible (stadia lines), and a level bubble. Of the stadia lines, the middle one represents the level plane you are creating, and is the one you want to read off of. The upper and lower stadia lines are used to gauge stadia distance, which is a method of reading distance off of the rod and level alone (based on parallax). We won't need to do this in lab, but for future reference, if you take the readings at the upper and lower stadia lines, subtract them, and multiply by 100, that is the distance in meters between the level and the stadia rod. The bubble needs to be lined up with the middle stadia line in order to be level.

When using a hand level, the height of the level plane created by the hand level depends on your person as well, since you are essentially acting as a tripod for the level. Because of this, try to maintain an equal height position – one that is comfortable and stable, as you don't want to slouch halfway through a survey and suddenly lose your reference plane.

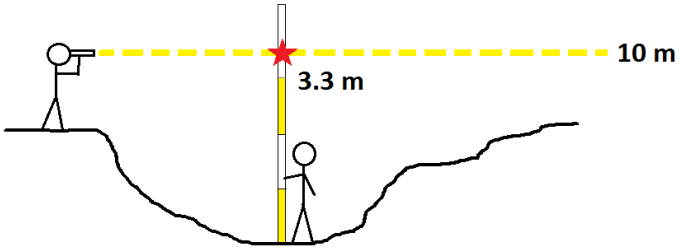
The tape: This one is pretty simple. Using a meter tape, measure the distance between the level and the measurement location (where the rod is). The distance normally needs to be a horizontal measurement, but for our purposes, it is accurate enough to drape the tape along the ground and record the tape distance where the level is, and where each reading is.

How do we get actual elevations from all this? First, we need to define some terminology.

Height of Instrument (HI): The elevation of the leveling instrument eyepiece, as well as the height of the equal elevation plane created by the level. Once this height is found, the elevation of other points can be determined. HI is the eye height of the person sighting through the hand level. For the convenience of avoiding negative elevations, it is advisable to add a fixed elevation (or the known elevation of the initial instrument location) to the HI to define the elevation at the start of a survey.

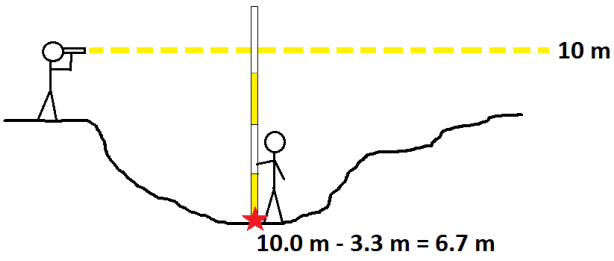
The eye height of the leveler forms the height of instrument – in this case set to an arbitrary 10 m to avoid negatives.

Foresight (FS): This is a measurement to a location of unknown elevation. Think of it as looking *for*ward in your survey. It is the reading on the stadia rod at that unknown elevation point.



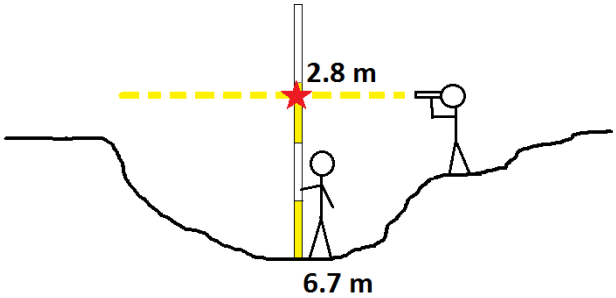
The foresight reading is taken off the stadia rod, using middle stadia hair.

Elevation (E): This definition may seem obvious, but it bears clarification that elevation refers to the elevation of the ground at the point you measure in the reference frame of your survey. It can be found by subtracting the foresight from the height of instrument (E = HI – FS).



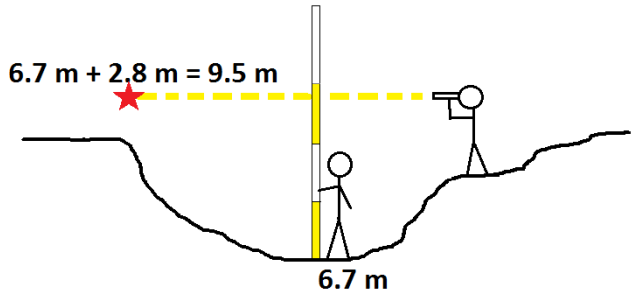
Using the height of instrument and foresight, the ground elevation is calculated.

Turning point (TP): Surveys often extend farther than you can see, or topography can drop in elevation so much that the stadia rod is too short, even when fully extended. This will be the case on the hillslope we survey. In this case, the level needs to be repositioned in what is called a turning point. When you realize the level needs to be moved, first take a foresight to a point, giving you the elevation of that point. Then, keeping the rod at that point, move the observation station (i.e., the person with the hand level) to a new station location (essentially pivoting, or *turning*, around a point). Once set up, backsight to where the rod is. This will give you a new height of instrument, and you can resume your survey.



The station is moved and a backsight taken to the pivot point.

Backsight (BS): Sometimes you don't know the elevation of your instrument. This is where a backsight comes in. It is a reading *back* to a known location, and is the stadia rod reading at that known elevation. To find the height of instrument, use the equation: HI = E + BS, where E refers to the elevation of the backsight point.



Using the backsight and elevation of the point, the new height of instrument is calculated.

Distance: The tape will be strung taut against the ground and the reading at the level and at the backsight are used to get the distance between the two.

To make your survey easier to read, organize your notebook in a logical manner. Below is the organization that is most common, and will be used in this class as well as field camp. The plus and minus next to backsight and foresight are to help you remember the equations for finding elevation.

Station	Backsight (+)	Height of Instrument	Foresight (-)	Elevation	Distance	Notes
Record notes on station (i.e. where the hand level person is standing) location information: start, end, landmarks, etc.	Record measurements taken where the stadia rod is at a known location (previously sighted location)	Elevation of the level. Calculate by adding the backsight measurement to the last known elevation. Equal to elevation of hand level person + eye height.	Record measurements taken where stadia rod is at an unknown location	Elevation of point where stadia rod is placed. Calculate by subtracting foresight from the current height of instrument	Record distance along survey line	Record notes relevant to the survey goals

Calculate the elevation in the field using a handheld calculator or cell phone. It is very important to do this, as well as (if possible) quickly and roughly plotting out the survey, so mistakes can be caught early on and fixed while in the field.

In brief, this is essentially what you do during a survey (see also the illustrations above): Set up the instrument/level in a stable location, determining its elevation through a benchmark (or in our case, setting it to be 10 m arbitrarily). String a tape along the distance of the transect, making sure it is not caught on any vegetation or rocks. The leveler will stay at the level's location while the rodman moves down the transect. The rodman sets the rod down along the transect, keeping the rod upright and vertical and facing the level. The recorder records the distance between the rod and level. The leveler, keeping the handlevel level, reads the rod at the middle stadia hair, and the recorder notes this. The rodman then moves down the transect and the process is repeated. The recorder should note any important features such as slope breaks at each elevation point, as well as calculate the elevation of each point as it is surveyed.