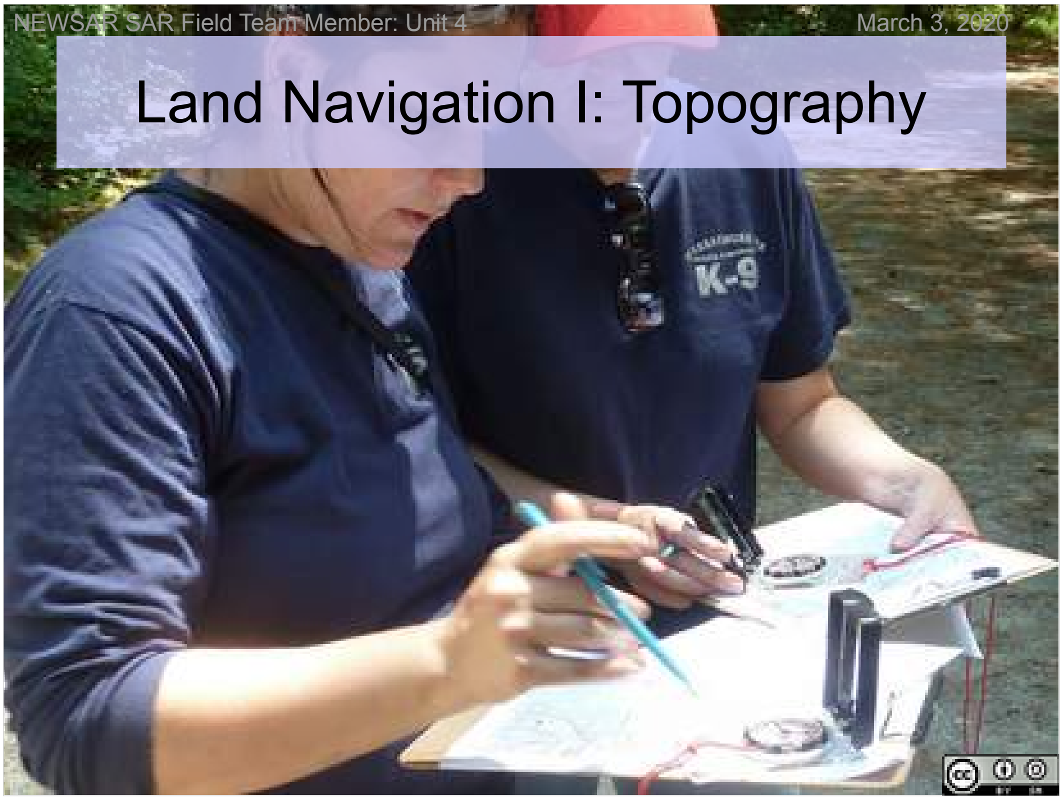

Unit 4, Land Navigation I: Topography
Date Last Updated March 3, 2020 [crosschecked]

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Map and Air Photo

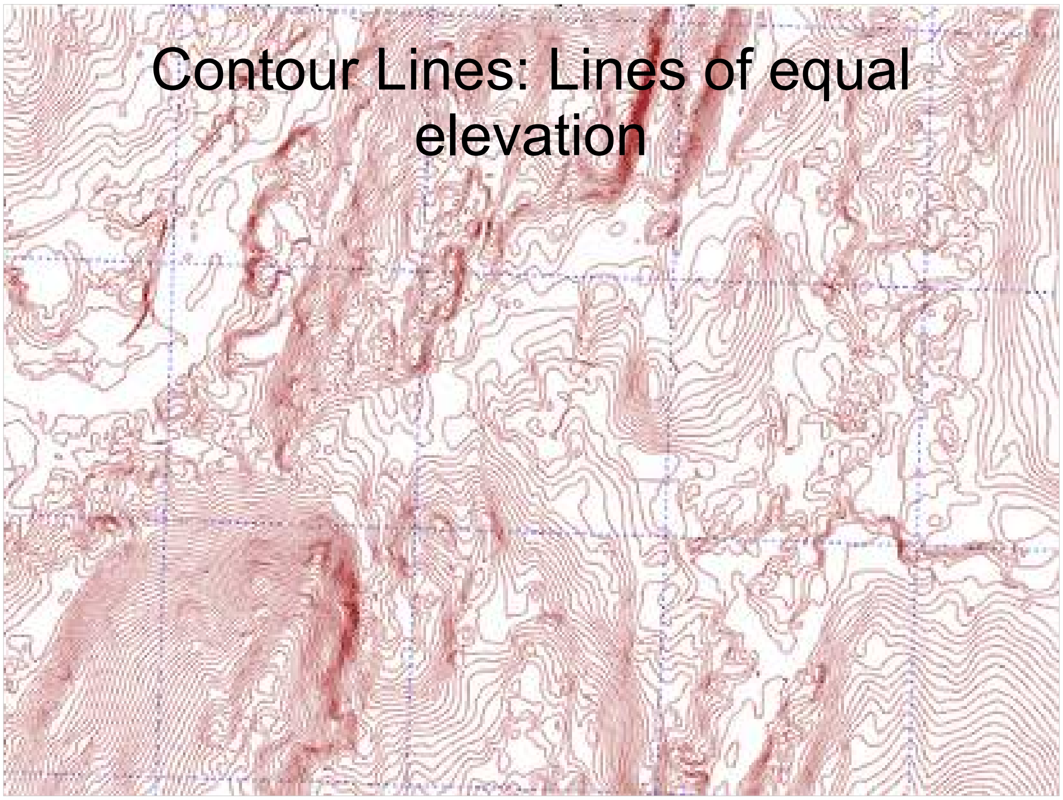
Teaching map reading used to be simple, all about learning to read topographic maps.

No longer true. There are all kinds of map and GIS products readily available in SAR – including air photos and satellite imagery.

Learning to work with all kinds of cartographic products is important, as is understanding what you can get from one sort that you can't get from another.

What can we see in the map?

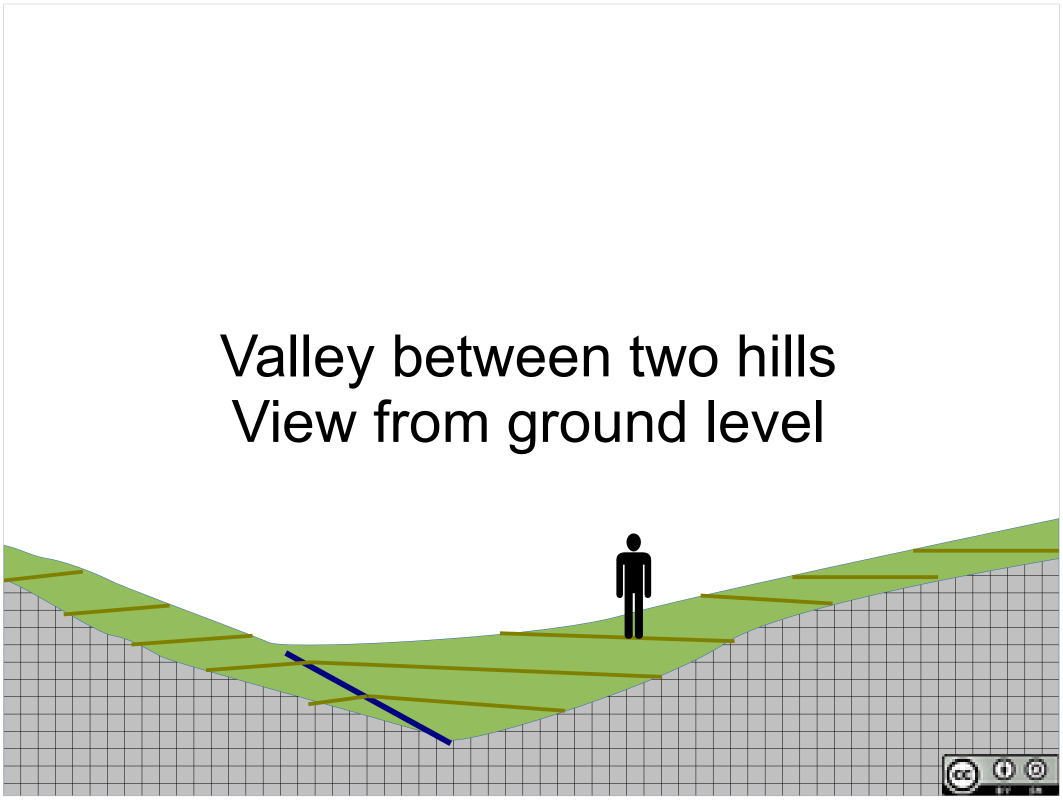
What can we see in the air photo?



Key thing that is on topographic maps is a representation of – the topography.

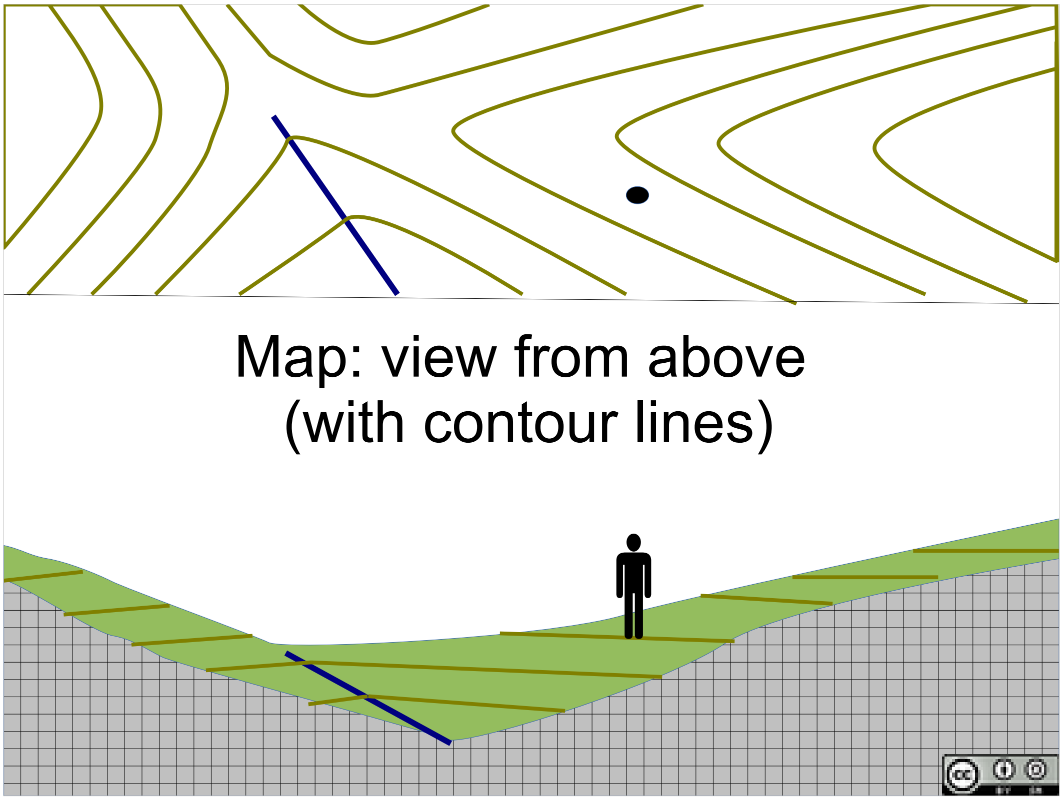
Represented with contour lines.

All the points on a contour line are at the same elevation.



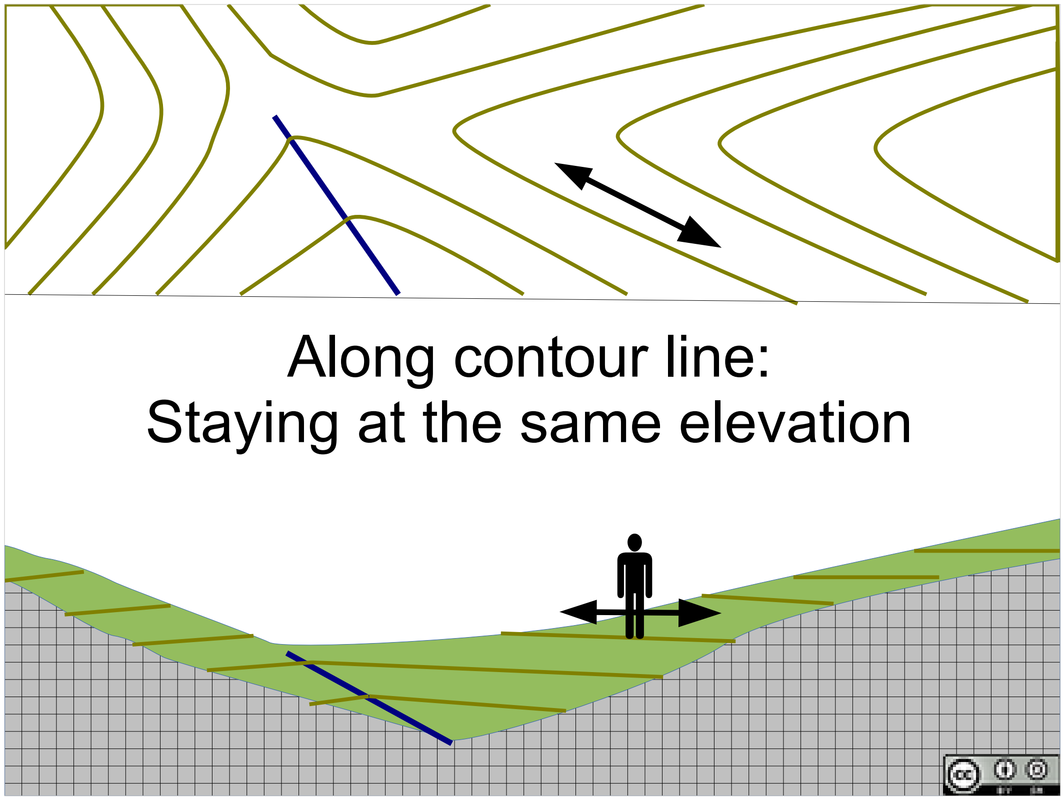
Let's visualize this.

Lets look from the side at a valley between two hills.

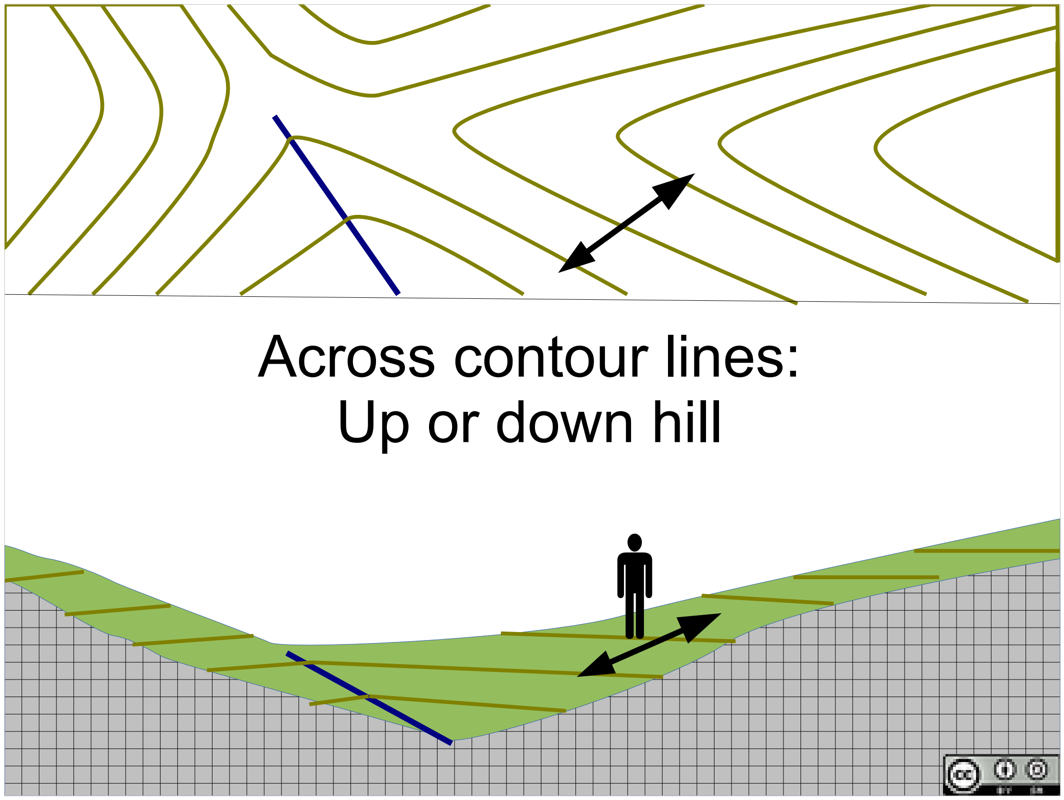


Now, lets look at it from above – in map view.

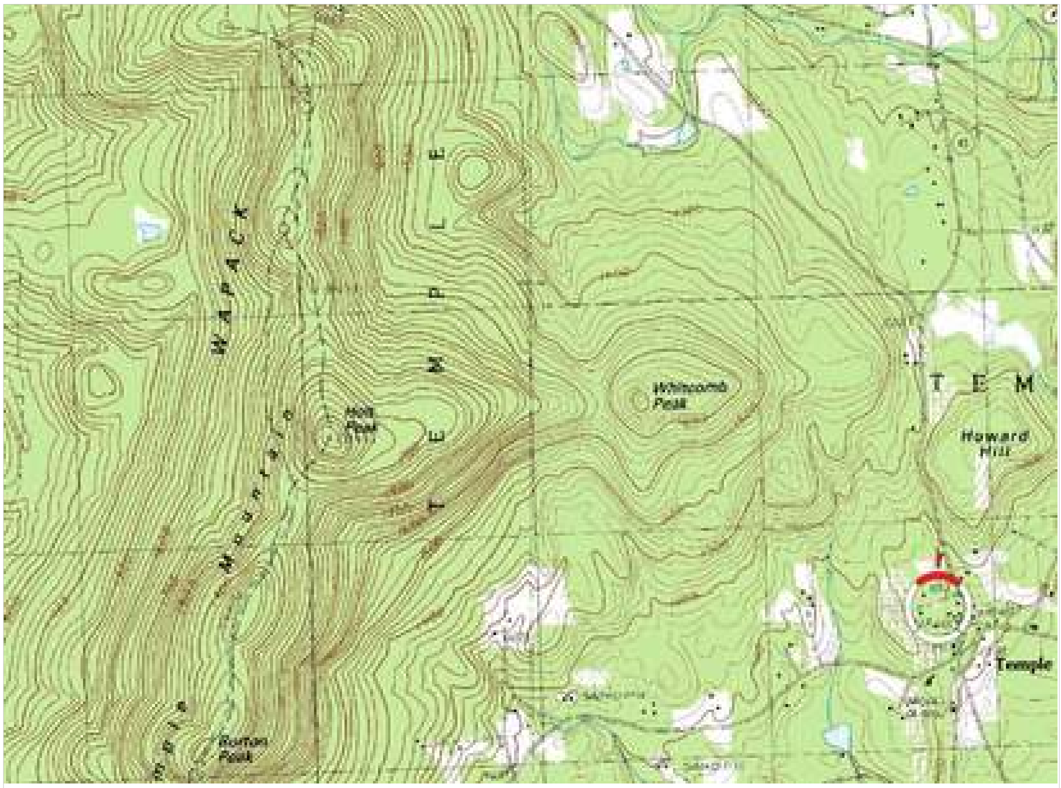
We can see the point where the person is, the stream, and the terrain (a saddle)



If the person walks back and forth on the hill staying at the same elevation they will be walking on a contour line.



If the person walks up or down hill, they will be crossing contour lines.

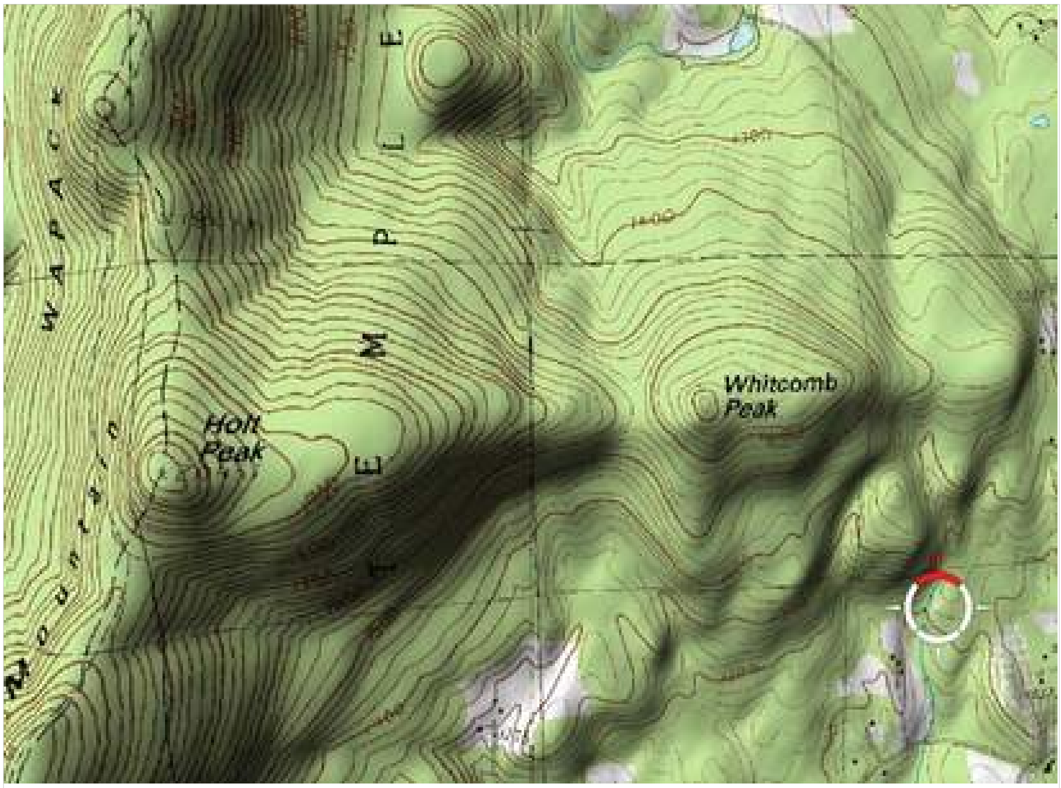


Topographic map

Where are the high points?

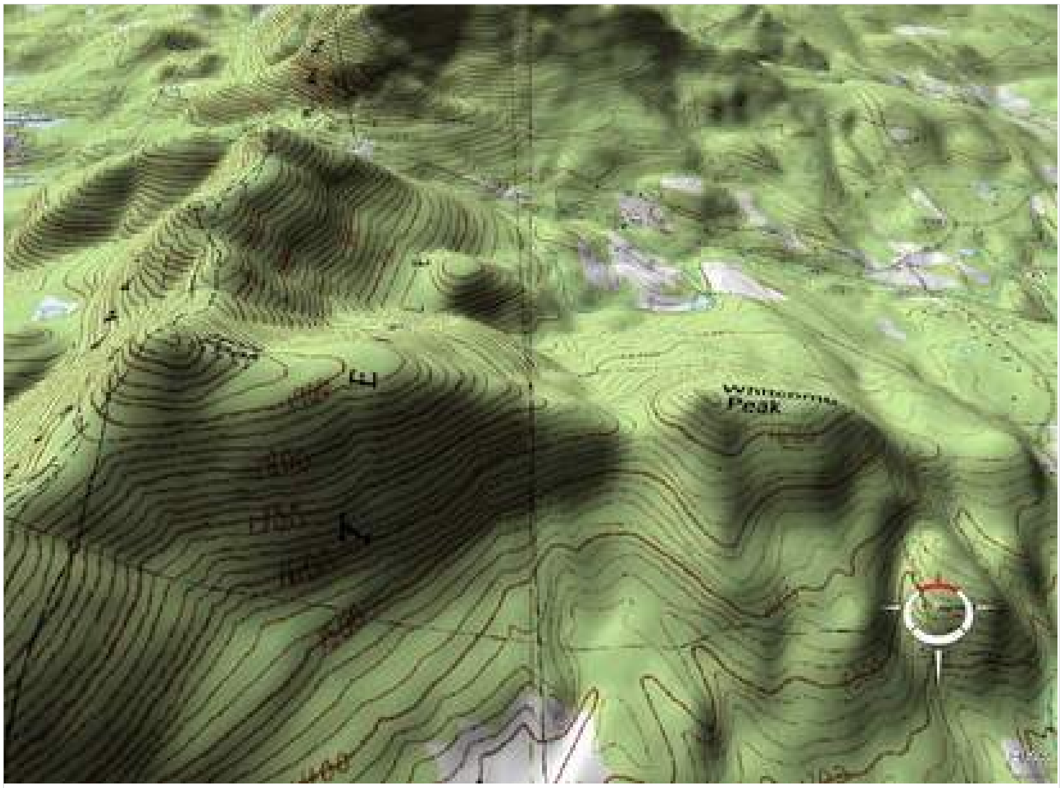
Where is it steep?

Where is it flat?



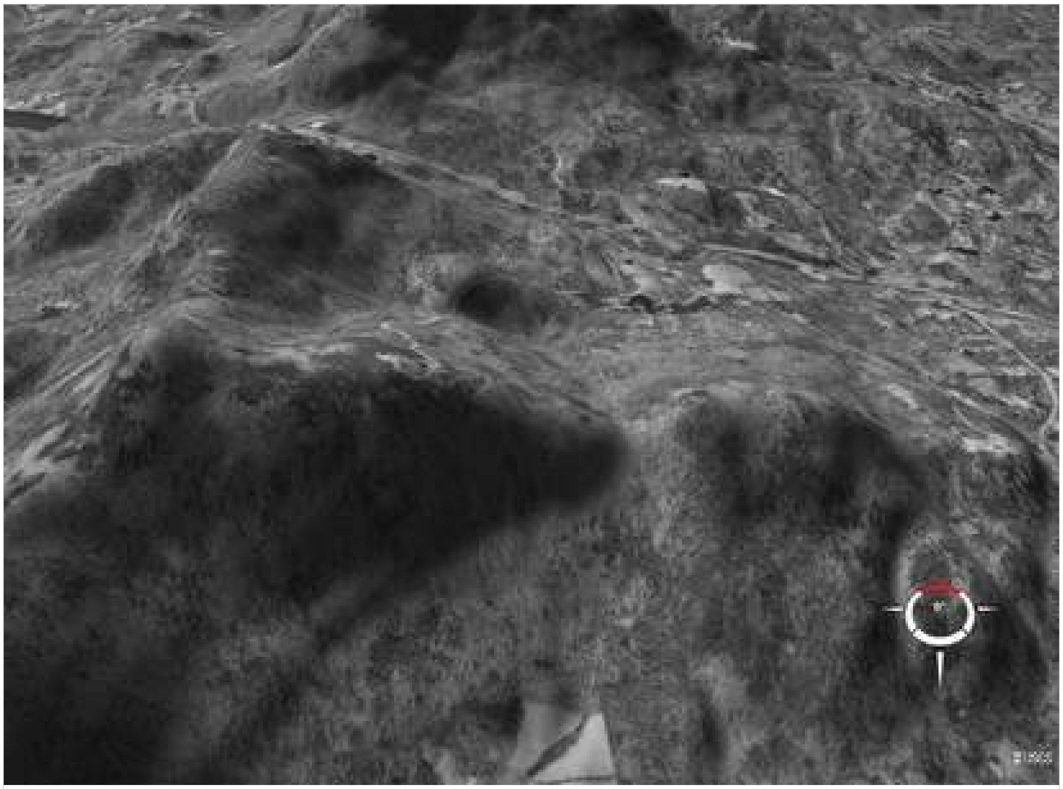
With shaded relief – easier to see the terrain.

Some maps add contour lines and shaded relief – much easier for most people to easily see the terrain.

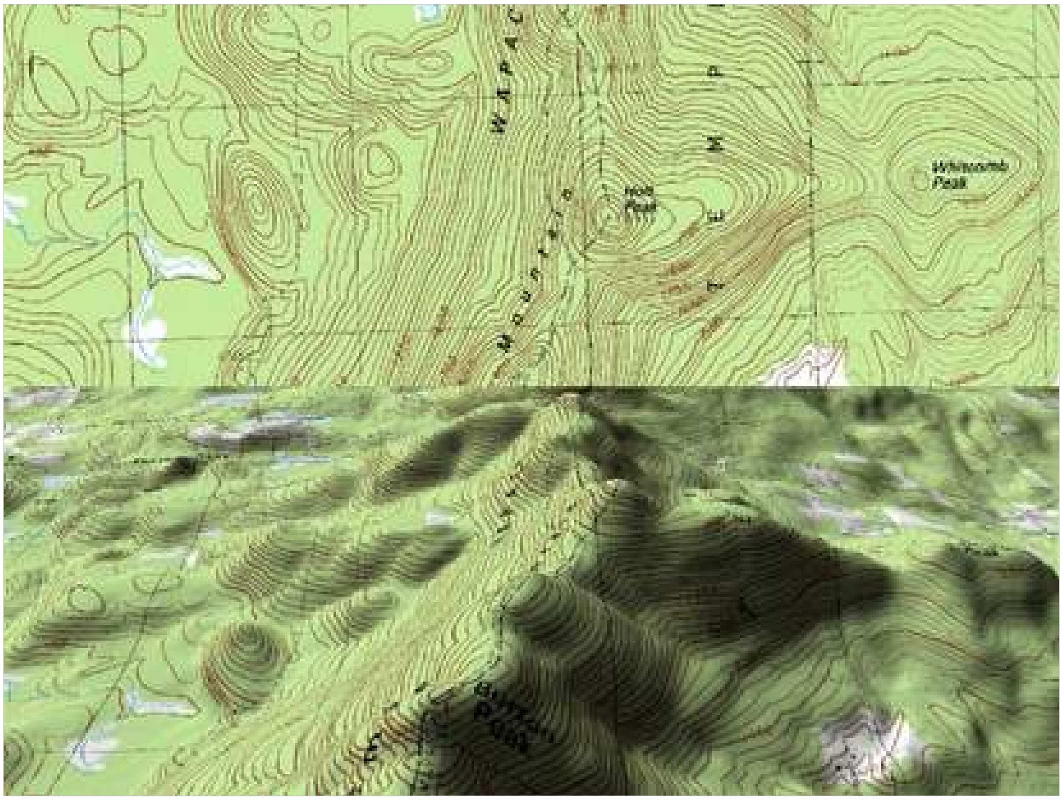


Not looking straight down anymore – tilted to a perspective view as looking out the side window of an airplane

(Visualization in NASA WorldWind, similar view available in Google Earth).

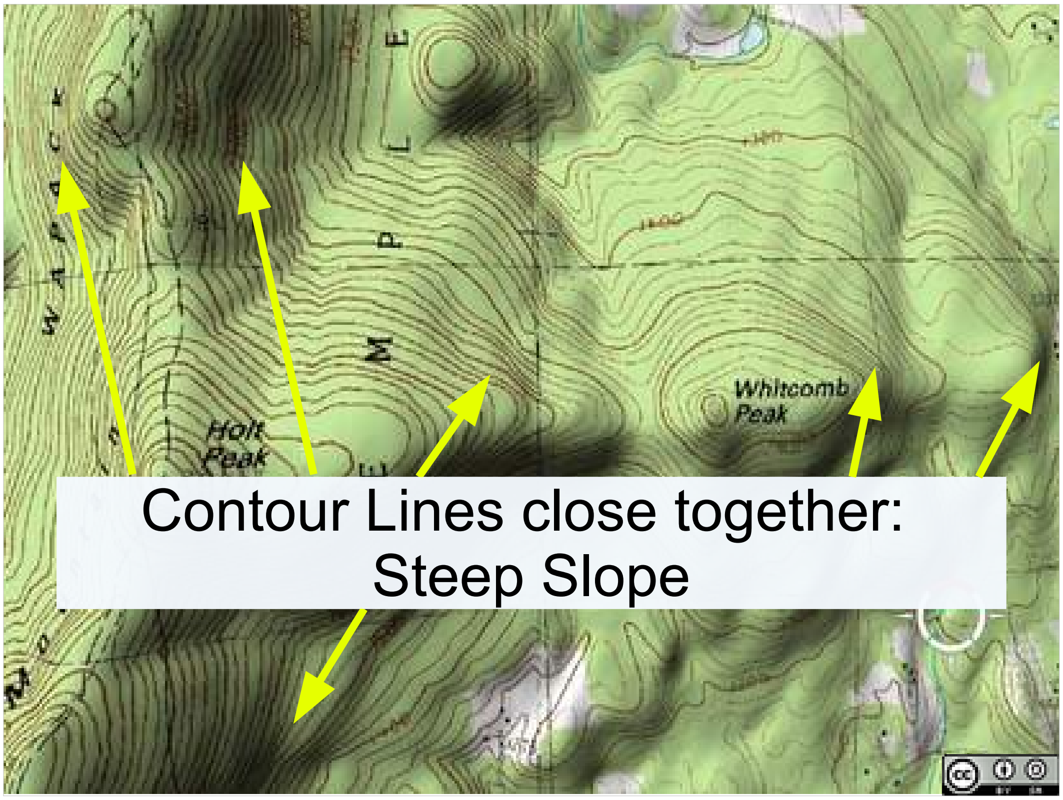


Air photo draped over the terrain. In perspective, with shaded relief.

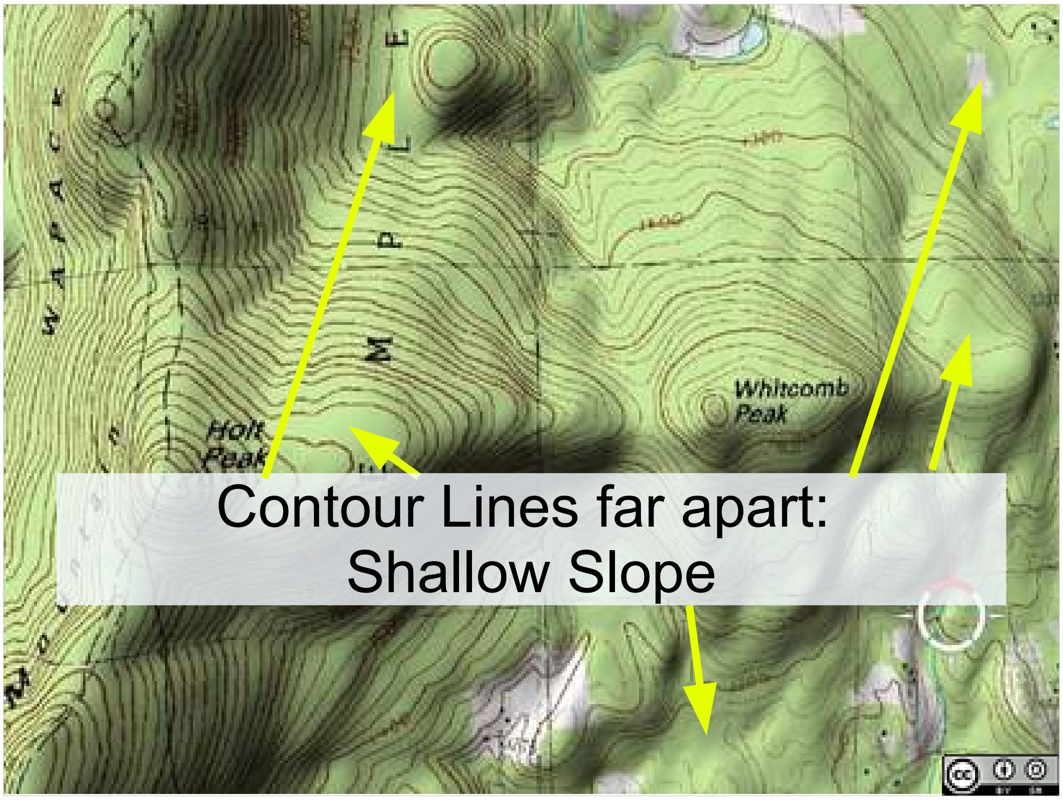


When you look at a topographic map you should be able to visualize what the terrain looks like: Where are the high points, where are the valleys, where is the terrain steep, where is it flat, where are the streams flowing....

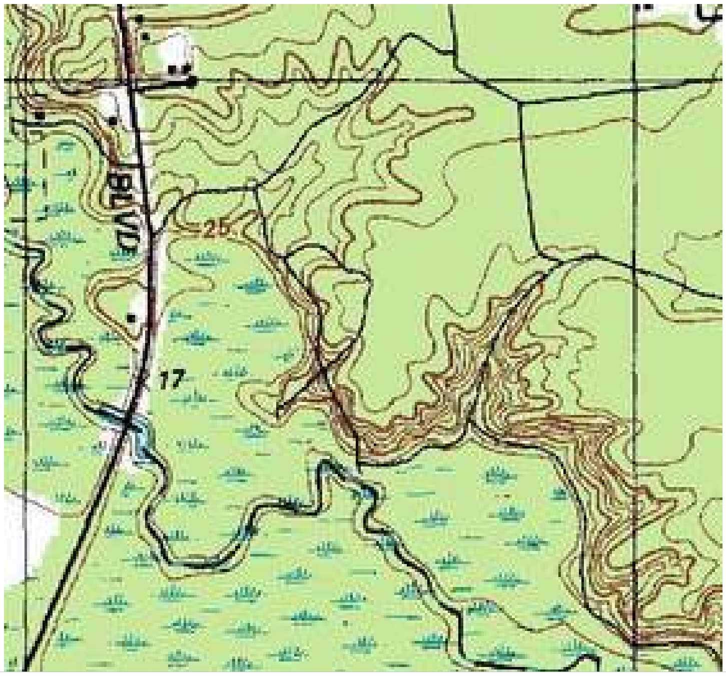
Comparison of topographic map, and perspective view of same area with shaded relief.



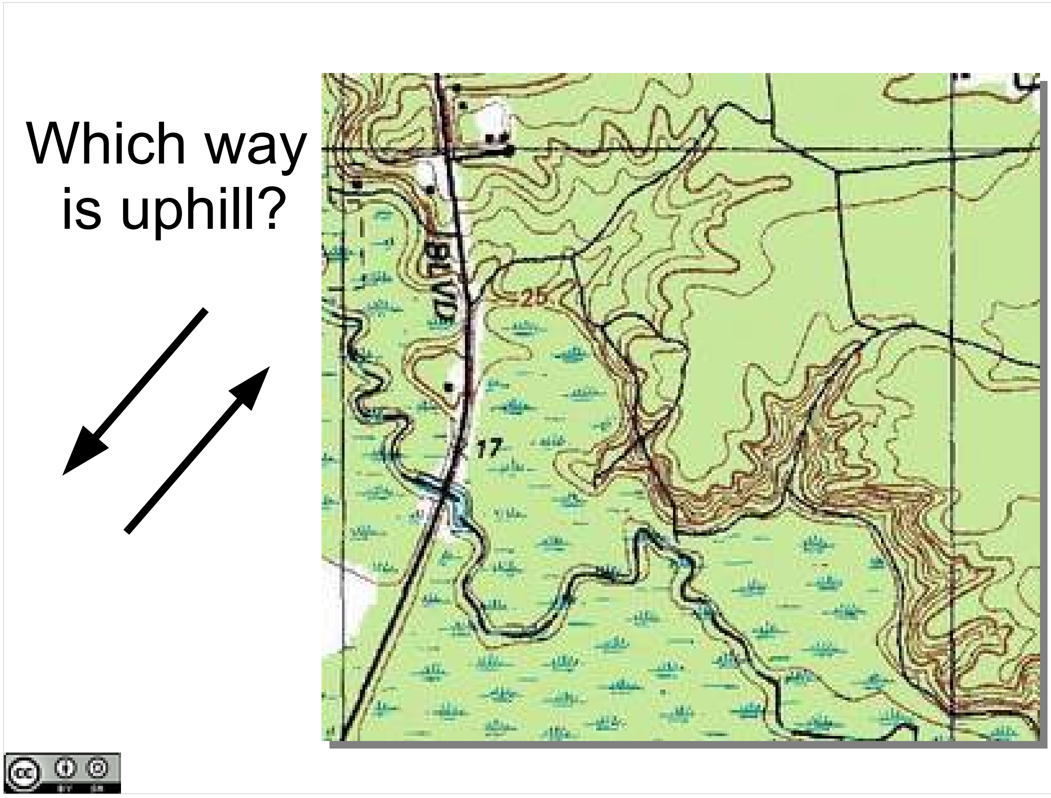
Some places are steep, some are flat.


Contour Lines far apart:
Shallow Slope
Holt Peak
Whitcomb Peak

Where are the steep slopes?



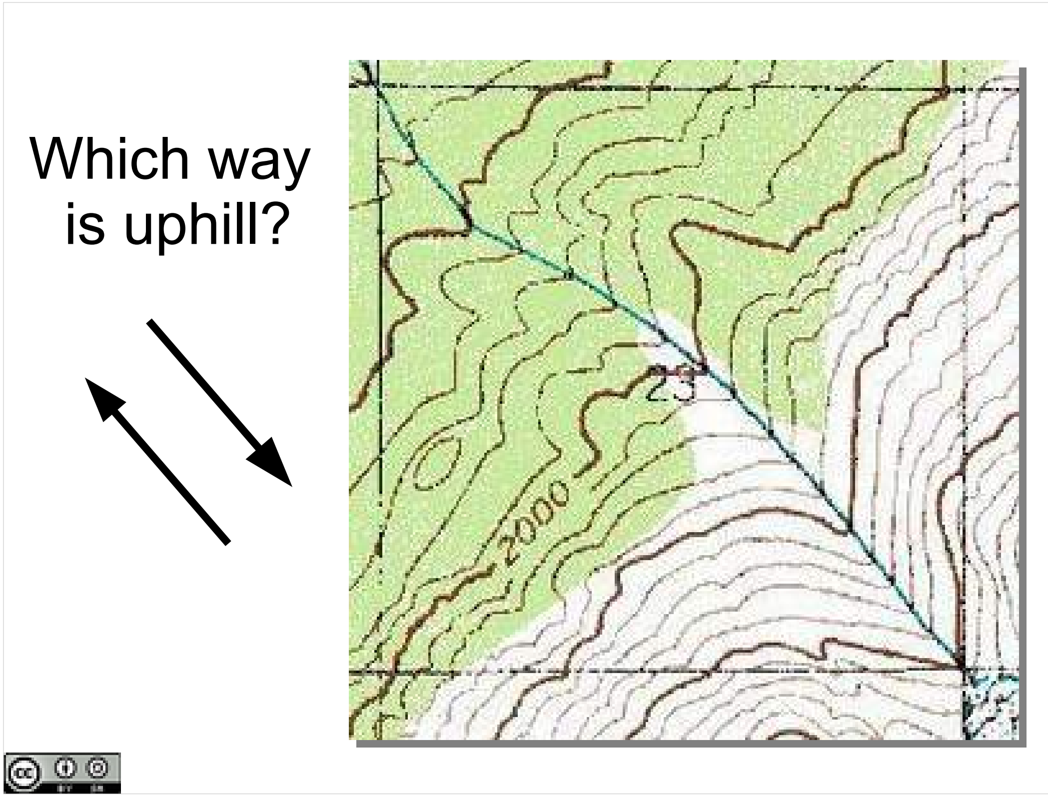
Tightly spaced contour lines between the level ground in the upper right and the swamp in the lower left.



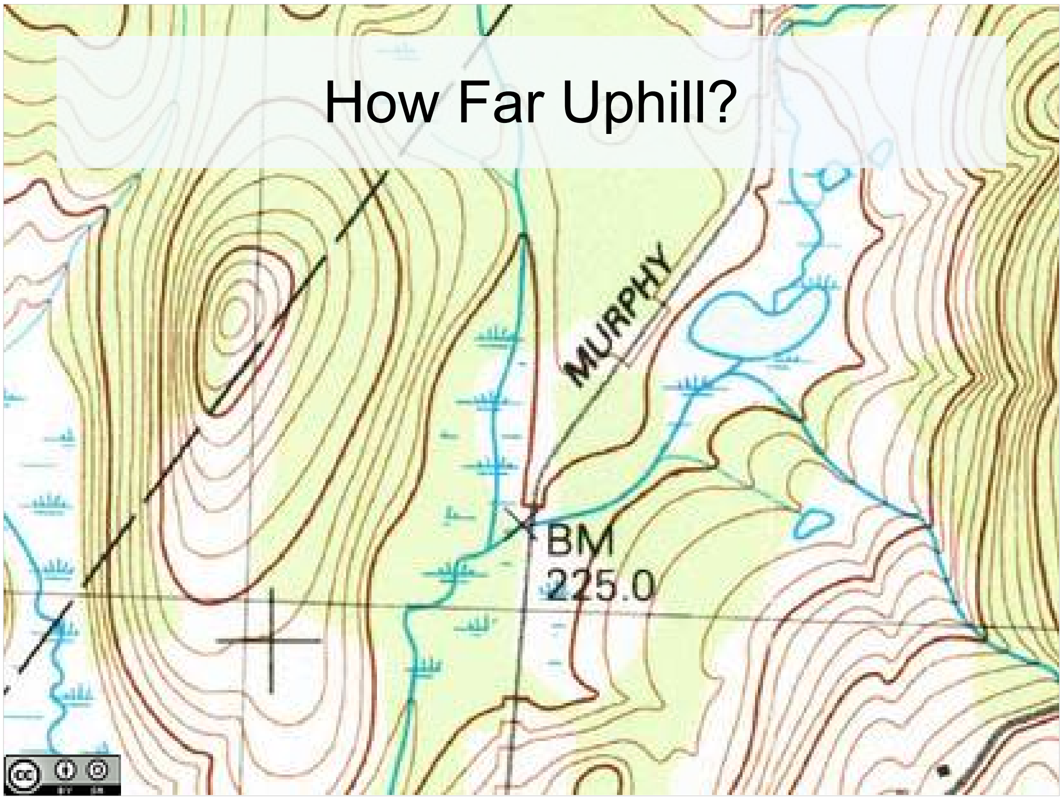
Do the streams drain out of the swamp to the north east (upper right is low ground), or into the swamp from the north east (upper right is high ground)?

Law of Vs – where a drainage crosses a contour line, the contour line makes a V with the point of the V pointing towards higher elevation.

High plateau to the upper right, with a steep break and drainages down into the swamp.

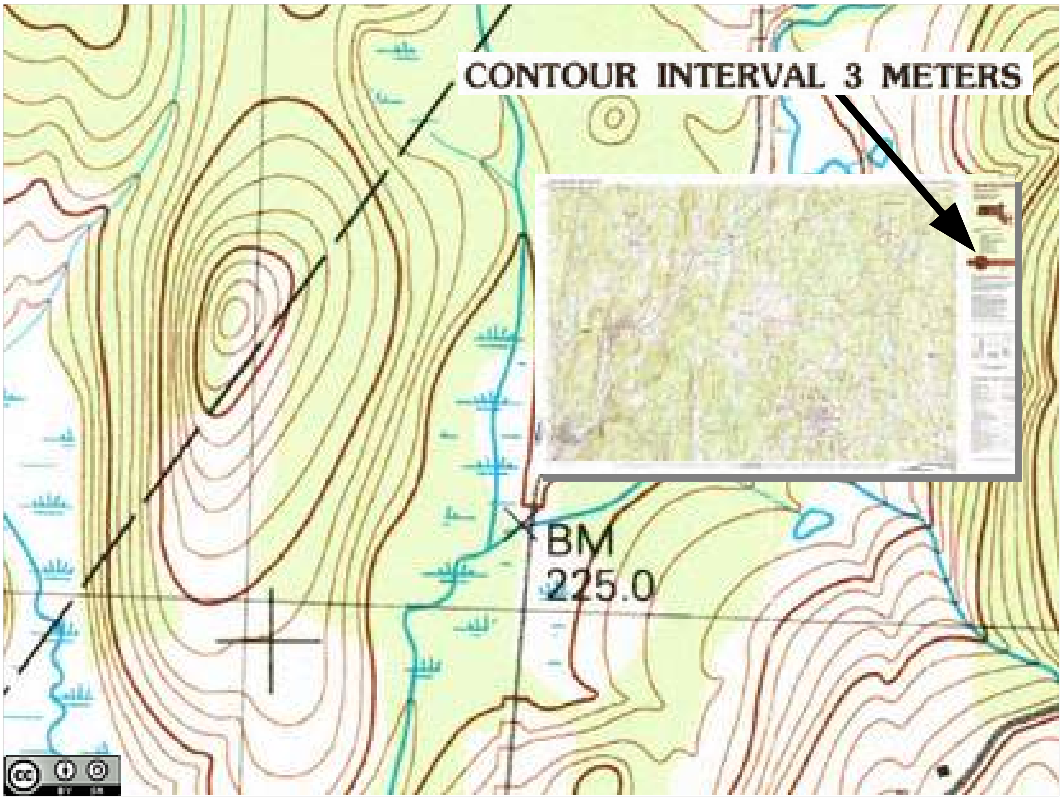


Vs point up hill. Uphill is above the tree line, and has a glacier at the top of the drainage (lower right corner).

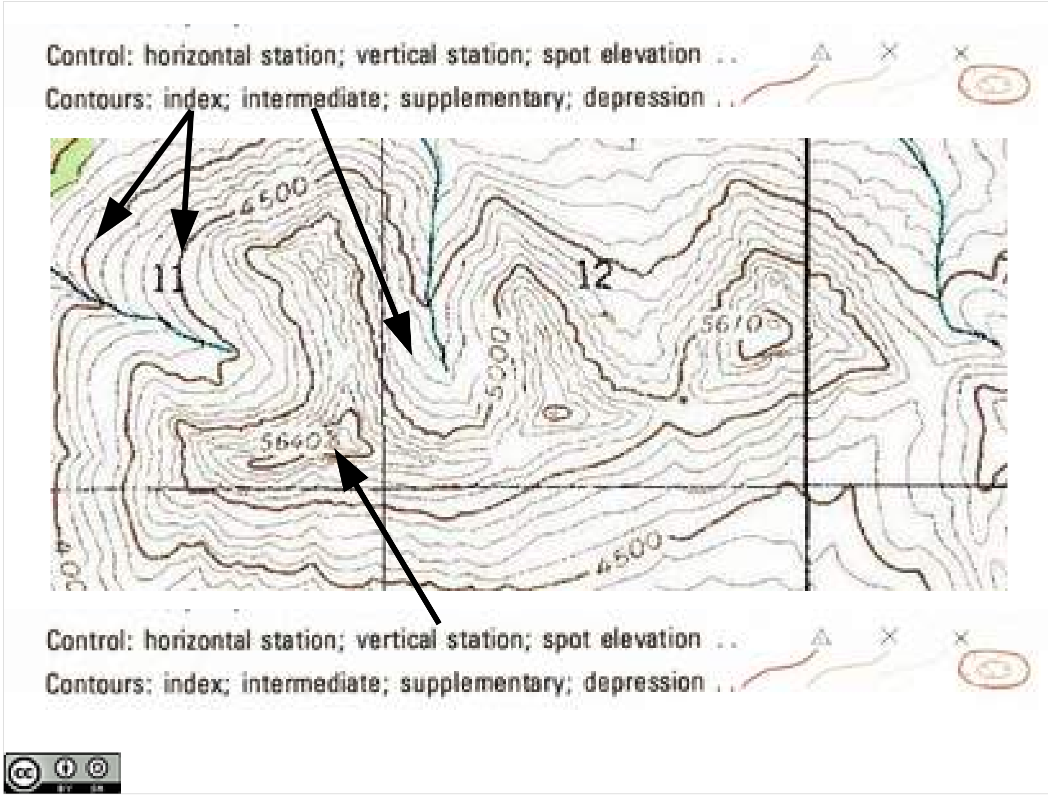


Contour lines also tell us how tall hills are.

(Here there's a benchmark at 225.0 [something], but no other indication of how much relief is present).



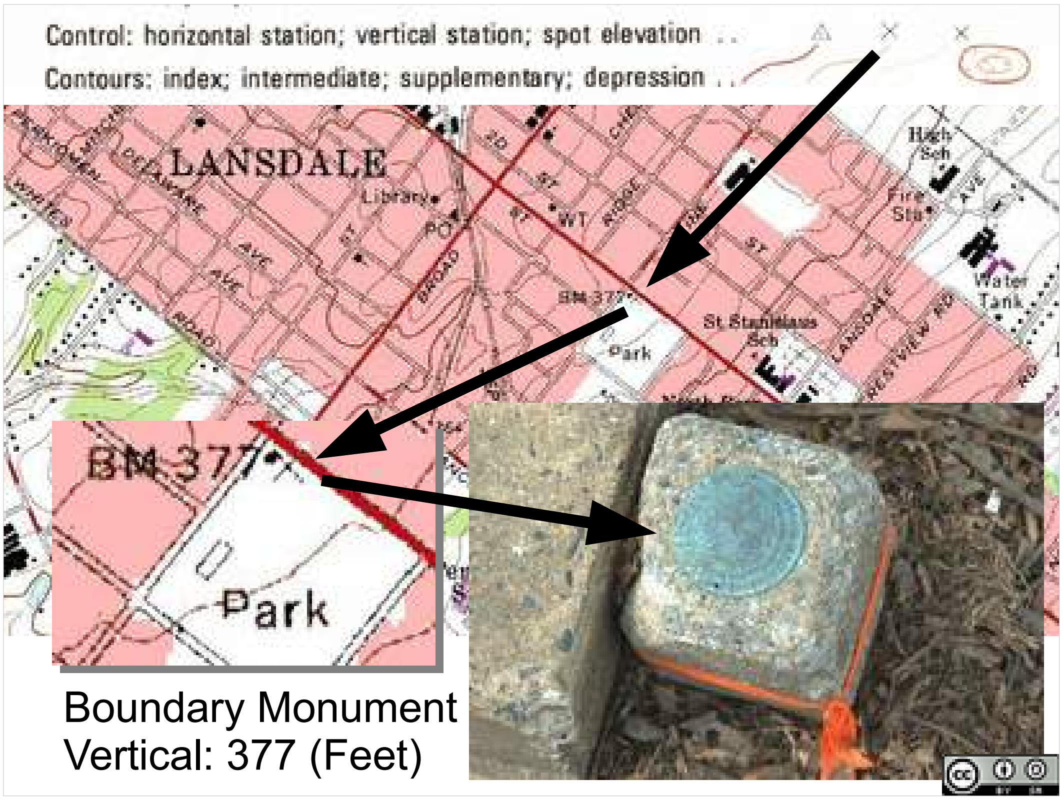
The metadata on the map border can tell us how far apart the contour lines are – what the contour interval is.



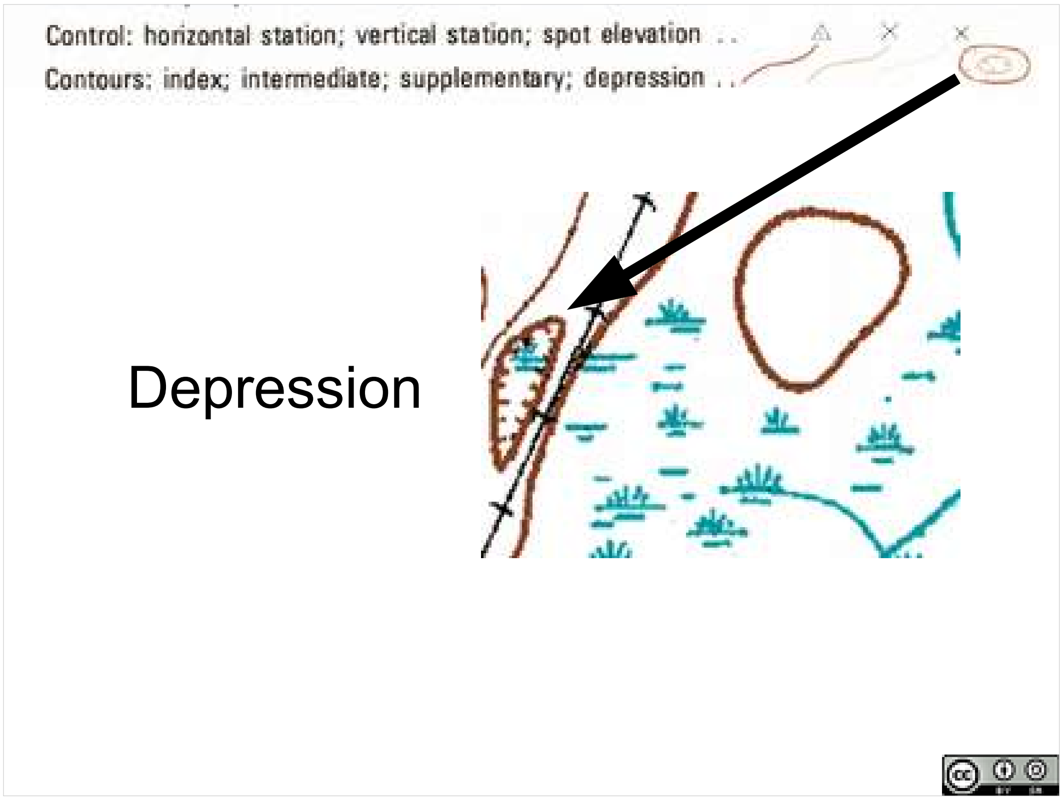
Contour lines are often of two line weights – thick lines with elevations on them (index contour lines), and thin lines without elevations (intermediate contour lines). The contour interval is the (vertical) distance between intermediate (thin) contour lines.

Points can also have elevations associated with them – spot elevations, and vertical survey stations.

[Very flat areas can get supplementary contour lines to show features that are smaller than the intermediate contour lines. Depressions get contour lines with tick marks pointing down (to tell them from peaks)]



Here is a vertical station, a boundary marker with a surveyed elevation of 377 feet. (Technically, this is a vertical control station, common parlance is “a benchmark”).

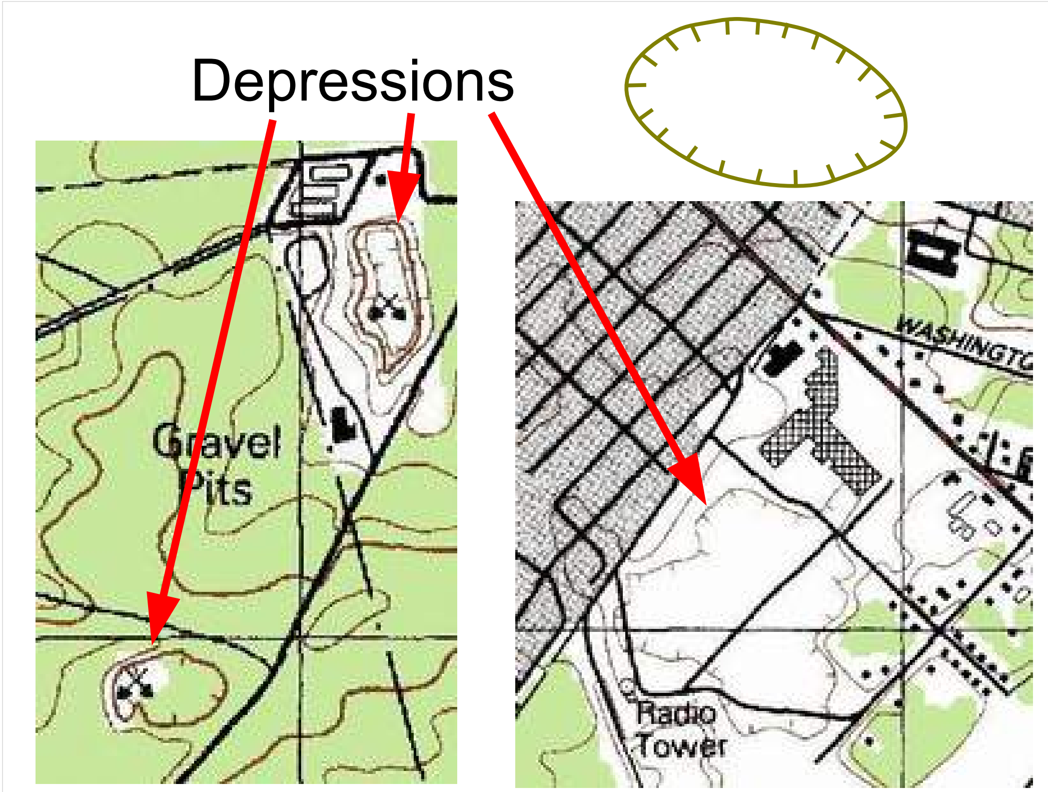


Depression: Tickmarks point down hill (to let you distinguish a depression from a small hill).

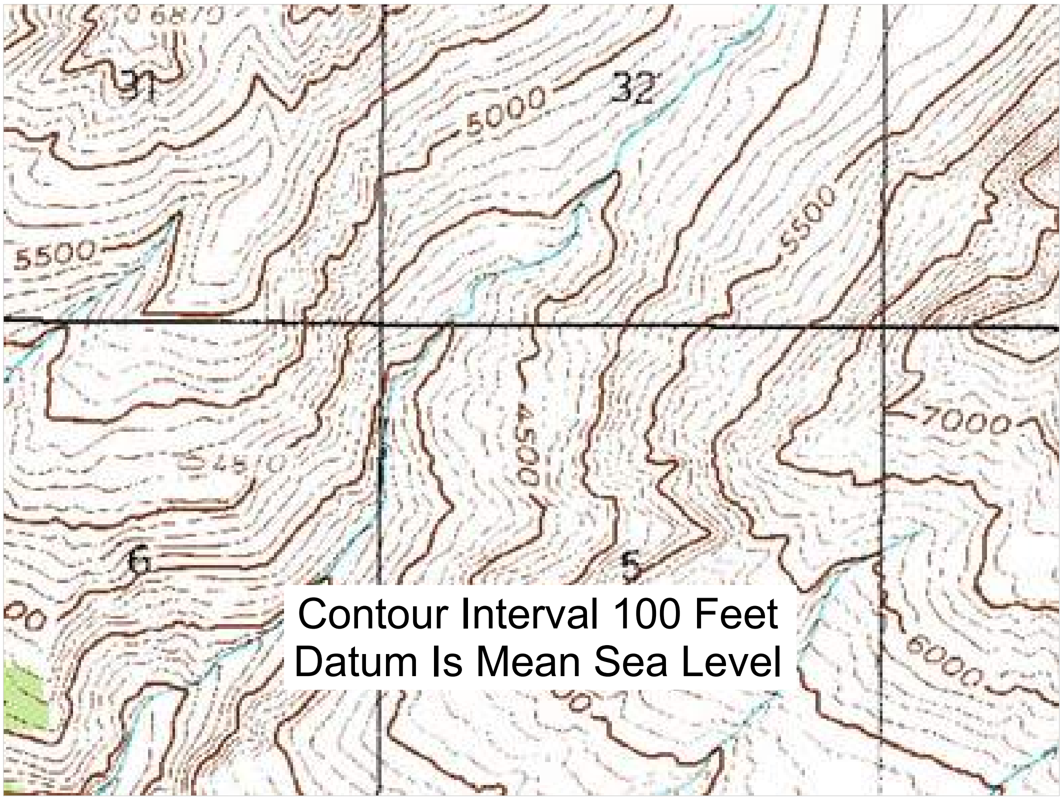
One contour line with tick marks – a depression shallower than the distance between two contour lines.

So what do we see here?

There's a swamp, with a hill in it, then a railroad line (the black line with the cross ticks) running down along the edge of the swamp. An embankment was built up for the railway line, and left part of the swamp cut off as the depression.



Here are a couple more examples of depressions on topographic maps.

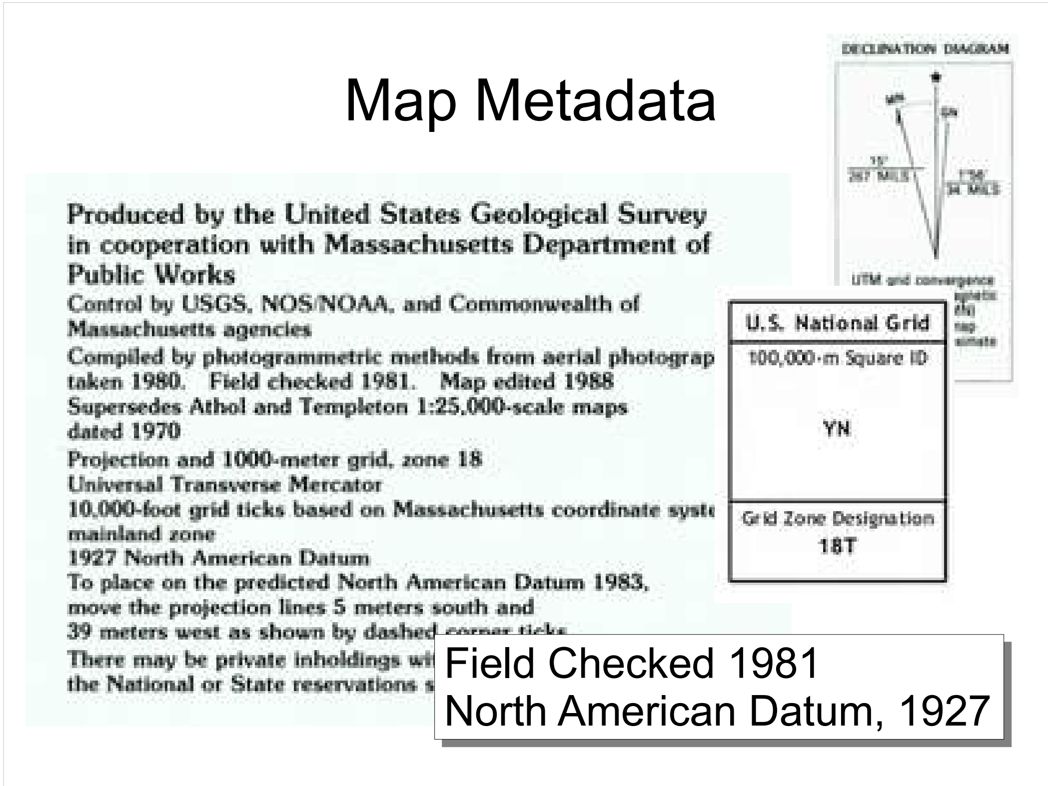


How steep is this?

How can we tell?

Side note: Usual indication of elevation is labeled index contour lines along with metadata on the map border indicating the contour interval, the units (feed in this case), and the vertical datum – what is the basis for 0 elevation.

Numbers on the map are seldom enough – you will likely need some other indication of whether they are in feet or meters.   Can be an issue with print on demand maps that may not include the contour interval.



Lots more information in the map border:

How old is the map?

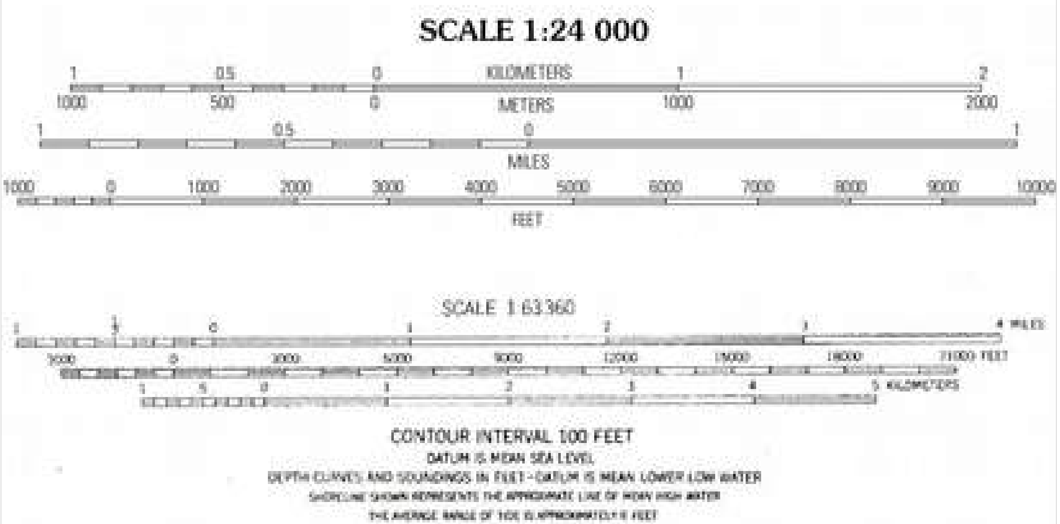
The datum (model of the shape of the Earth used in projecting the map onto a flat piece of paper). We'll come back to this.

What grid is printed on the map. We'll come back to this.

The vertical datum (0 for elevation, some meaning of sea level, quite important in coastal areas).

Which way is north (for different sorts of North). We'll come back to this.

Map Scales and Distance



Map metadata typically includes the scale of the map, and scale bars.

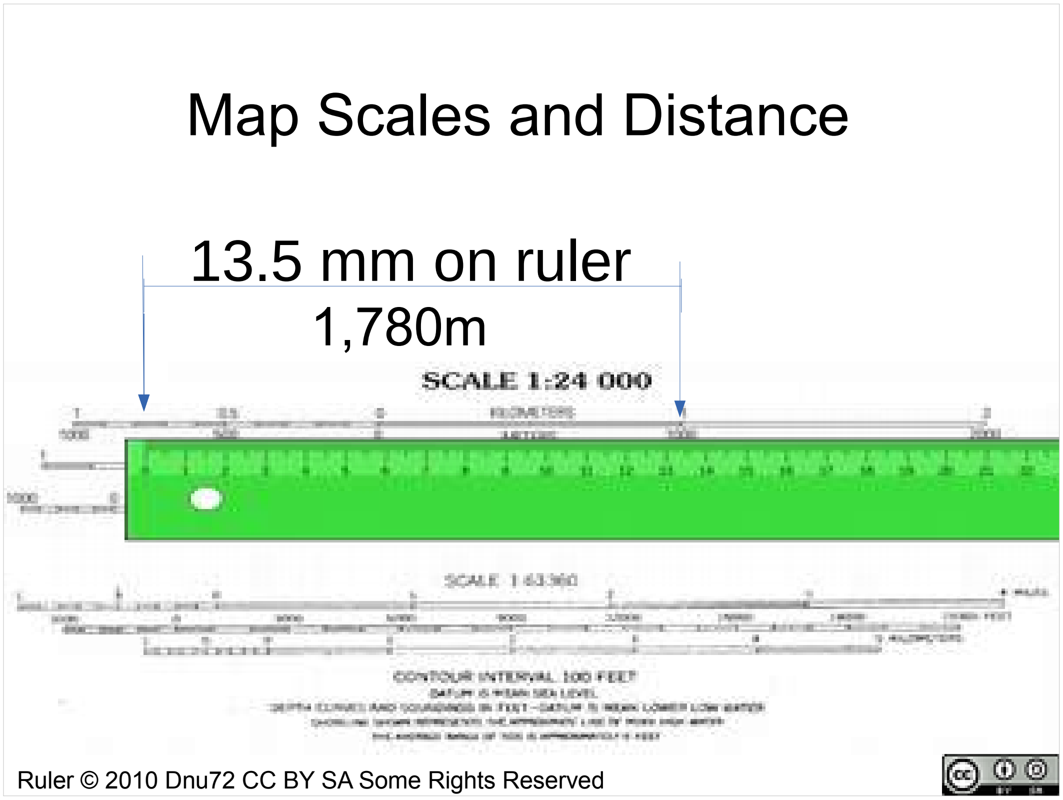
Use these to measure distance.

Scale of 1:24,000 means that 1 inch on the map is 24,000 inches on the ground.

Scale of 1:100,000 means that 1 inch on the map is lots more – 100,000 inches on the ground.

Larger number on the scale = less detail on the map.

Note that 0 on the scale bar usually isn't at the end of the scale bar.

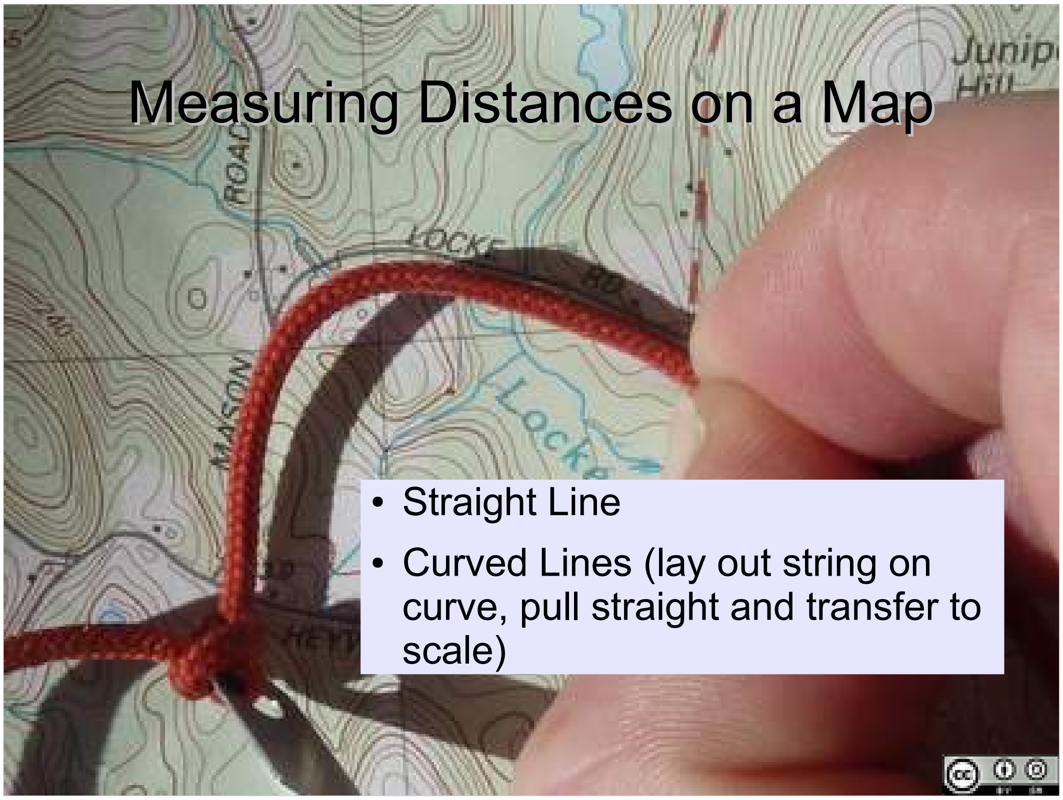


Don’t “do the math” even if you are a math whiz (under normal low stress circumstances.)

Use simple methods:
“two-finger” the distance between two points and hold it next to the RIGHT scale.

Direct measurement. Measure the distance on the map, then put this distance next to the scale bar. Line up measurement on ruler next to a big mark (e.g. 1 km here) so that 0 of ruler is below 0 in the finely divided marks on the scale bar, then read off and add up on scale (1km, plus 700m, plus about 80 meters).

Ruler is from Dnu72, Dáni para los amigos:
https://commons.wikimedia.org/wiki/File:Regla_01.svg



With a ruler or the edge of your compass, you can measure straight line distances on the map easily using the scale.

You can also measure distances along trails and curving routes on the ground. Lay the lanyard on your compass along the trail, then transfer to the scale bar and measure the length of the straightened out string.

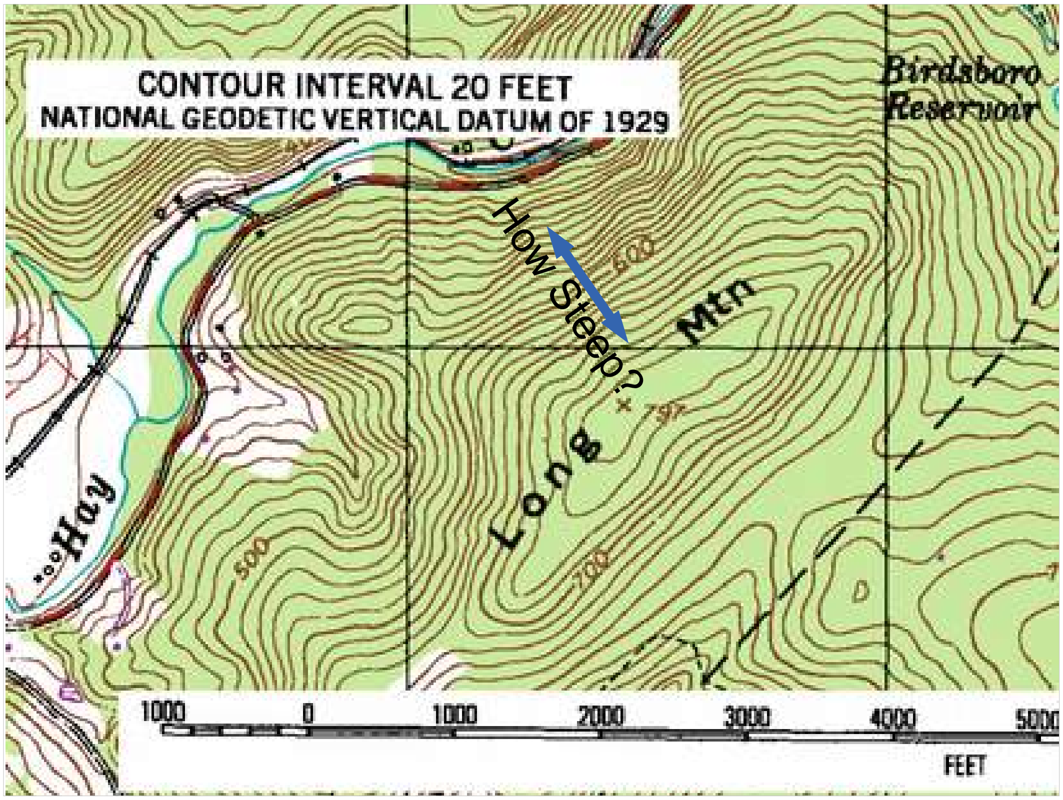
Practical Evolution 1 here. (Map for practical Evolution 1 is next slide)

Map for Practical Evolution 1 (and 2)

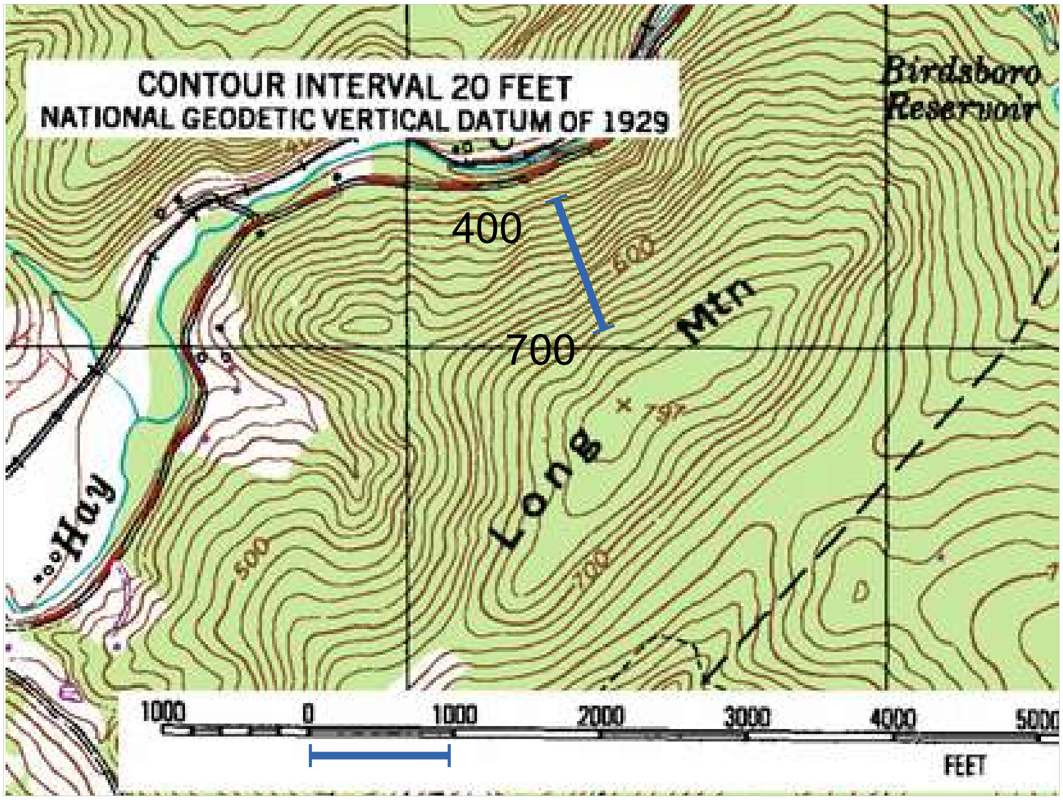
Point out scale bars, and that 0 point of scale is not at end.

Measure the straight line distance between two landmarks: (Measure the distance from the peak of Crow Hill to the Water Tank by the Fernald State School (~1350 meters)).

Measure the distance along a winding path (using the compass lanyard): (Measure the length of Norcross Hill Road (~2km)).

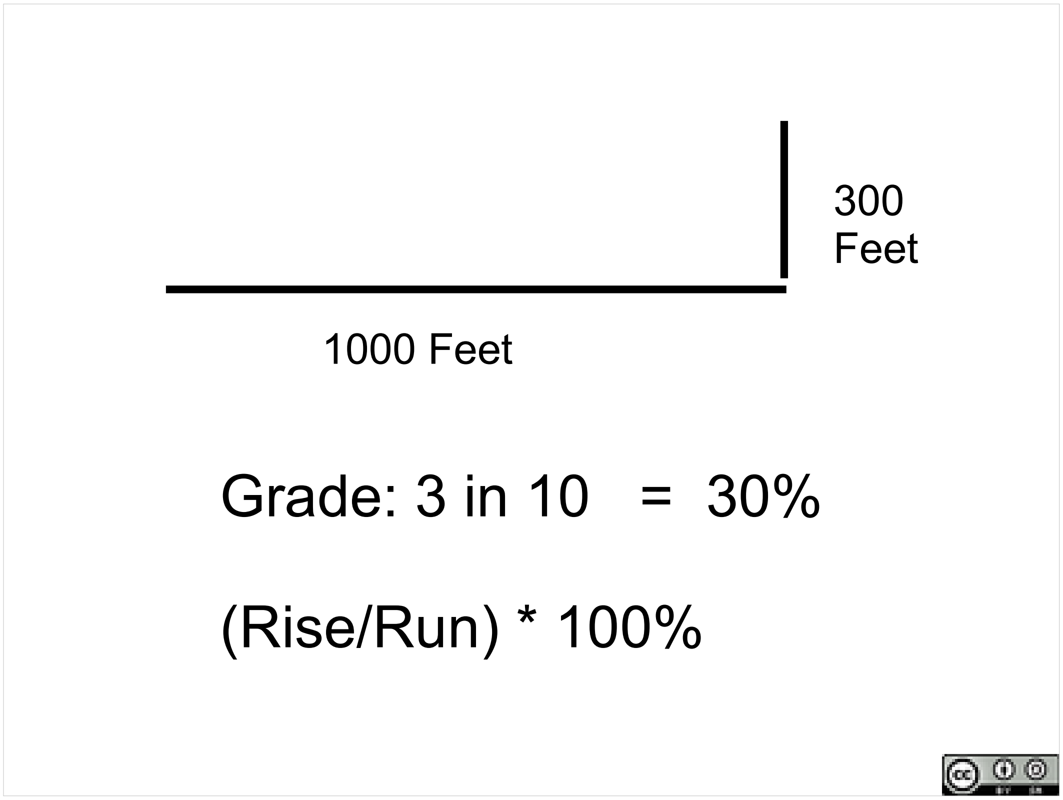


Contour intervals also let us find steep places and flat places – how steep is the NW face of Long Mountain?

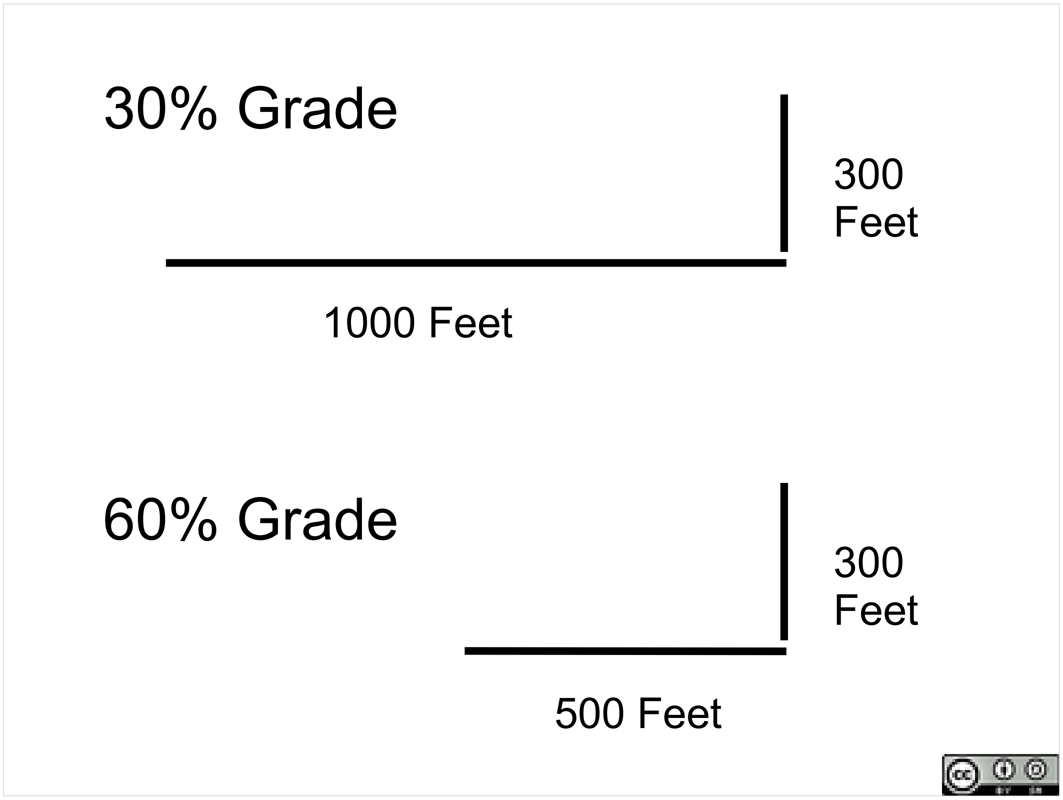


Vertical distance along the blue bar is 300 feet (400 foot contour line to 700 foot contour line)

Measure that horizontal distance on the scale – it is 1000 feet.

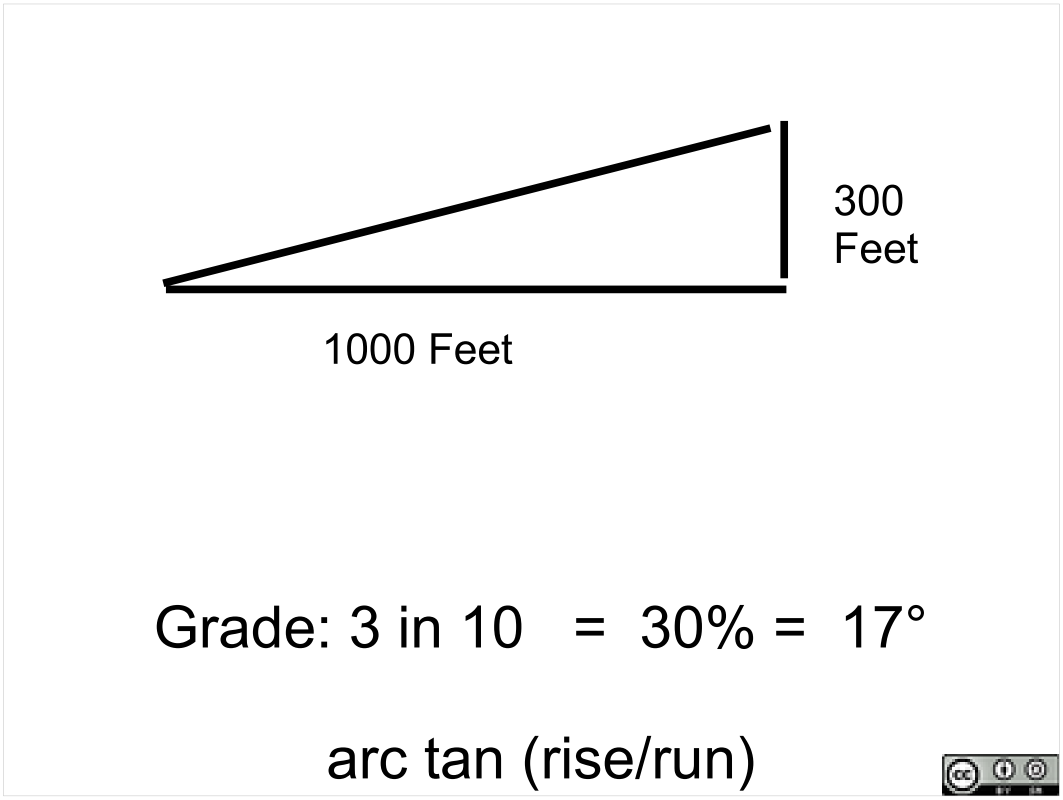


300 feet up a in a 1000 foot run, 3 in 10 grade, or 30% grade. Quite steep.



300 feet up in 1000 feet of run 30% grade

300 feet up in 500 feet of run, 60% grade



With a calculator we can work out the angle – arc tan of the grade, 17 degrees for a 30% grade.

Slopes

- High Angle
  - Weight is supported by a rope
- Low Angle
  - Weight is supported by the ground
  - Use rope for an assist
- Non-Technical
  - May use rope for an assist

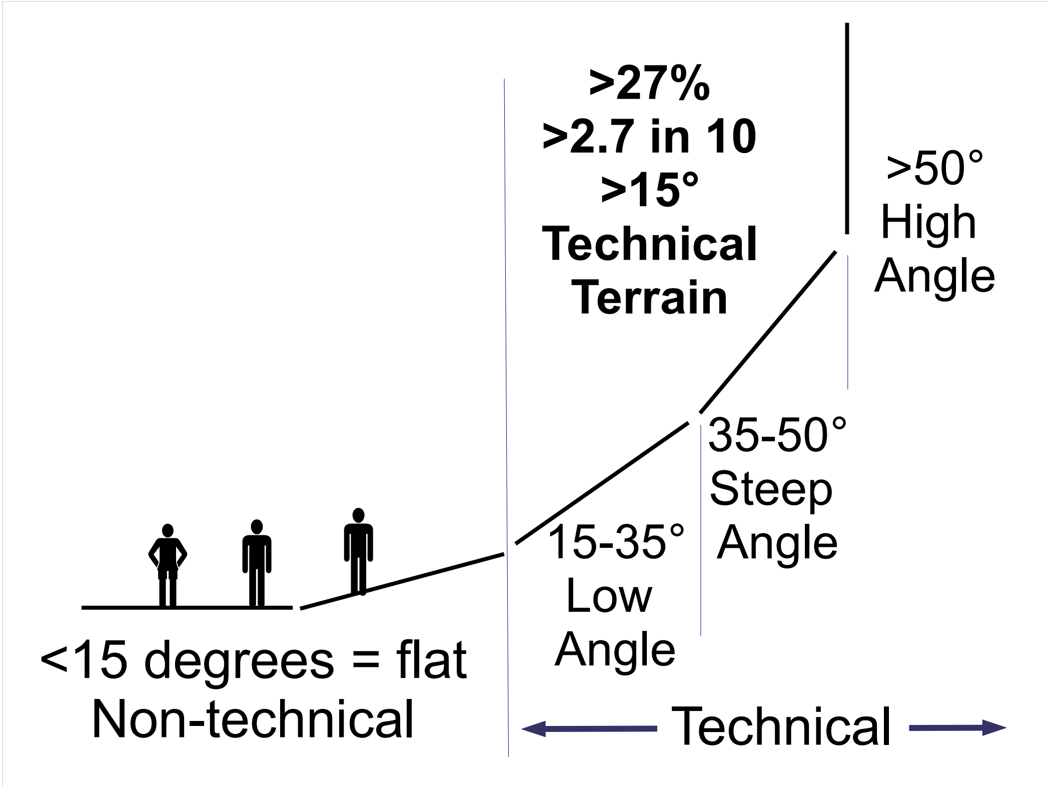
Top Image: Public Domain, Glacier National Park, NPS Image by: Jacob W. Frank, 2016/NPS.
Bottom image: © 2009 CC Attribution Share Alike Some rights reserved by AusAID: Department of Foreign Affairs and Trade. Members of the Namuka village (Fiji) disaster management committee in an exersise.

For technical rescue, we think of high angle terrain – where you are dangling off a rope, and low angle terrain, where the ground is supporting your weight (but you may still be using ropes, particularly in rough ground).

More that about 35-40 degrees is high angle.

35 degrees is about 70% grade.

If the rise is more than about 3/4 of the run, you are looking at high angle terrain.



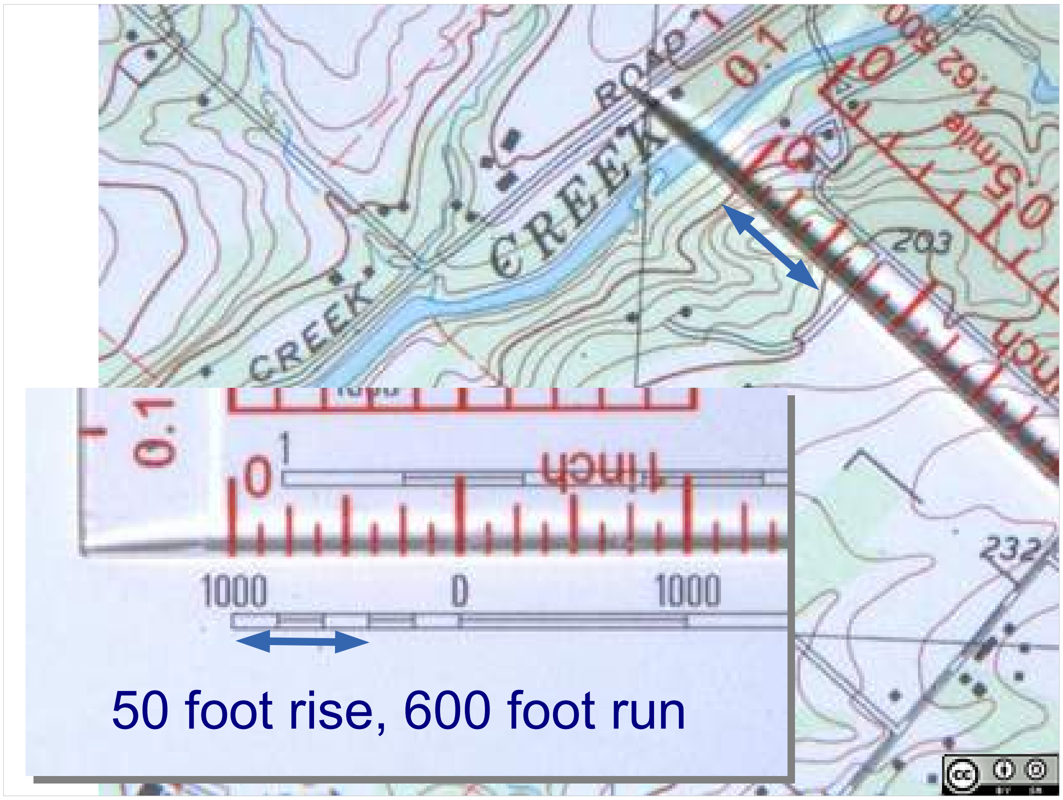
Definitions for high/low angle conditions vary:

NFPA: High Angle = Weight supported by rope system. Low Angle = Weight supported by ground.

Common (but slightly variable definition) we'll use here:
Flat ground: 0-15 degrees
Low angle: 15-35 degrees
Steep angle: 35-50 degrees (most dangerous)
High angle: 50-90 degrees

Quality of footing also factors in – poor footing, loose scree, etc, makes for more dangerous conditions.

Anything more that 15 degrees calls for support from technical rescue resources. 15 degrees is about 27% grade, or rise of 2.7 in run of 10.



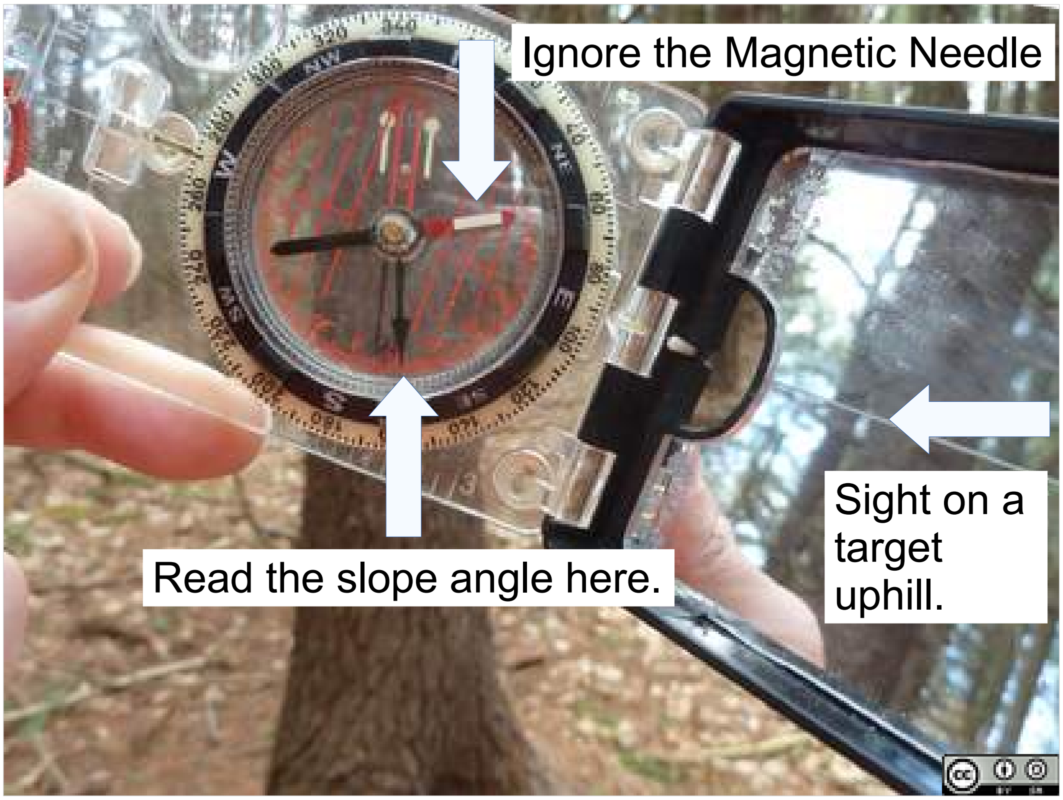
How steep is this?

Do you need technical rescue assets to work on this terrain?

Approximate
60/600 = .1
around 10% grade, not very steep.

More precicely
50/600 = .08
about 8% grade, about 5 degrees.

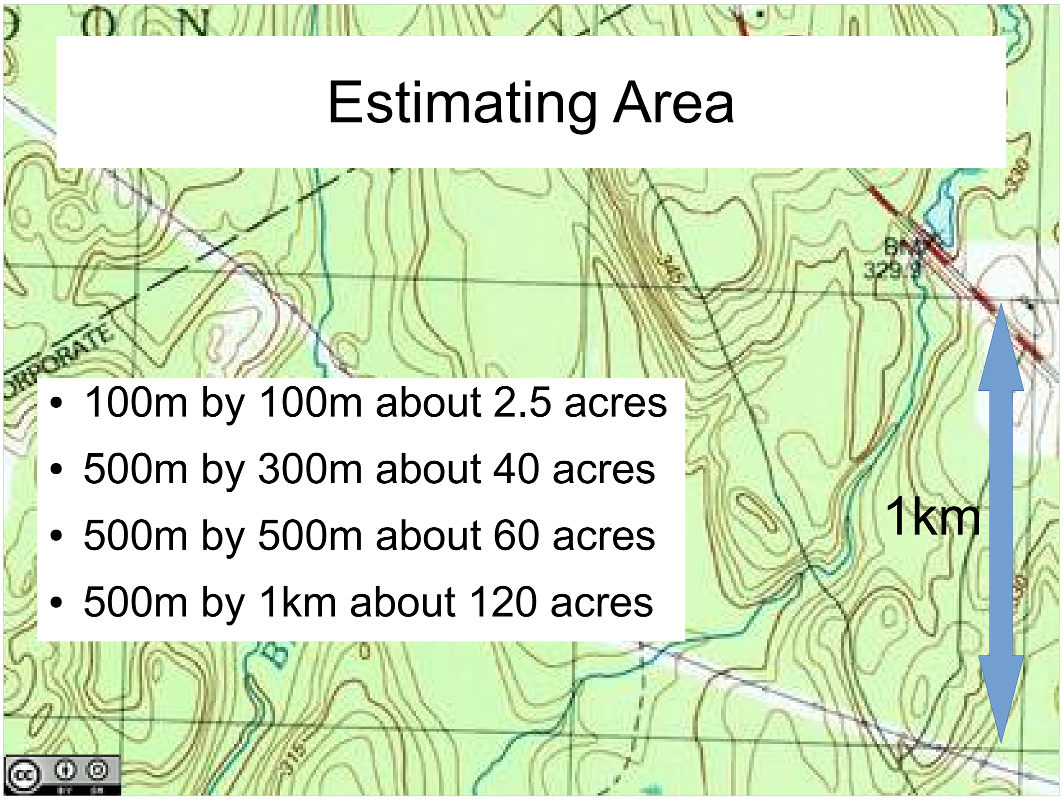
Less than 15 degrees or 27% grade, so probably can operate here without technical rescue assets.
But, note the contour lines aren't uniform, steeper in the bottom 100 feet, could be 30% grade there.



Some compasses have a free hanging needle that allows the compass to be used as an inclinometer – to measure a slope.

Ignore the magnetic needle. Sight on something uphill (or downhill), tilting the compass to line up the sights, and read off the angle from the free hanging needle on the inclinometer scale (which can also serve as the declination scale).

Practical Evolution 2 here, measure slope on map.



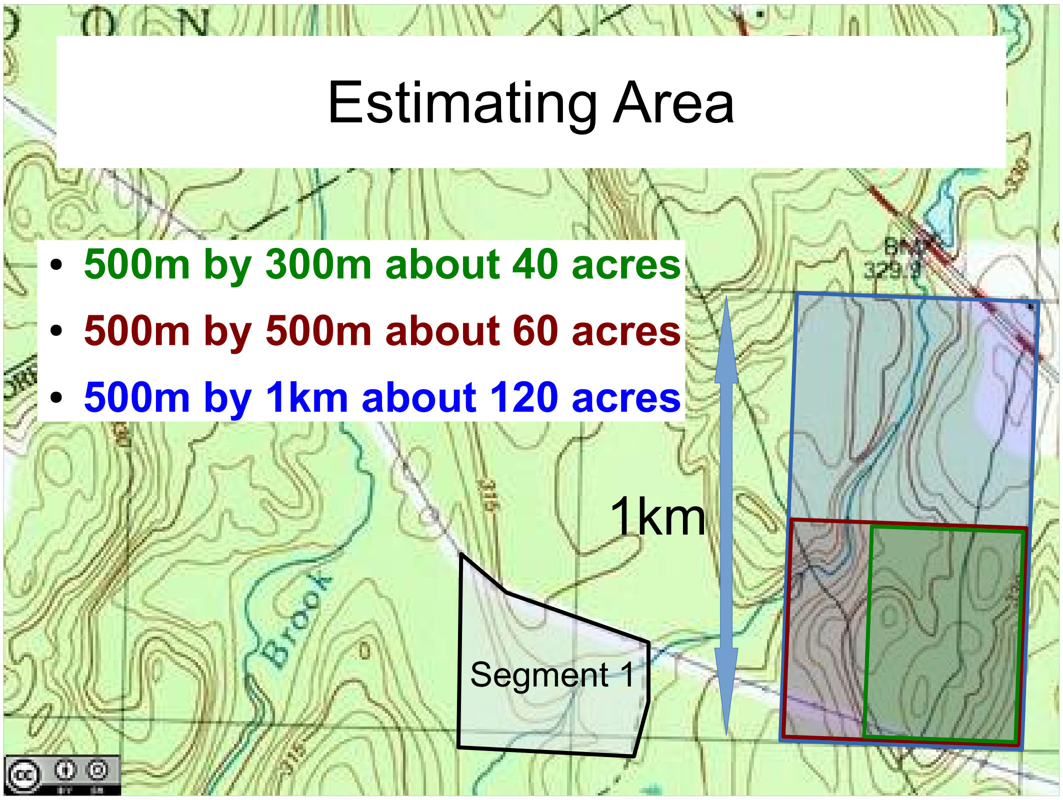
We often think of land area in terms of acres, and think about whether an area is a large area to search or not based on the number of acres.

But, our maps generally don't have acres drawn out on them.

They do tend to have grid lines drawn on them at 1 km intervals.

If we know how many acres are in a few subdivisions of a 1 km square, we can easily estimate the number of acres of some segment on the map.

Here's a few useful acreages



With a 1km grid on a map, it is easy to develop a a mental scale get a rough estimate of the size of typical segments.

About how large is segment 1?