PART 2

INTERMEDIATE LAND NAVIGATION

USING THE MILITARY LENSATIC COMPASS

WARNING

This presentation is intended as a quick summary, and not a comprehensive resource. If you want to learn Land Navigation in detail, either buy a book; or get someone, who has the knowledge and skills, to teach you in person.

NOTE

To get the ideas across presented on these slides, many figures, pictures, and calculations may not be to scale and may be exaggerated for clarity.

Note:

Prior to being issued any training *equipment, you will be required to sign a "statement of liability" agreeing to pay for anything you damage or lose.

All items will be inspected and inventoried prior to your signature and at the end of the training day too.

If you do not intend to sign this statement, then you may be denied training.

* **You may use your own equipment.**

Any Questions?

BREAK TIME

. . . and now on with the . . .

LAND NAVIGATION WITH MAP AND LENSATIC COMPASS

LAND NAVIGATION

Why Learn **Land Navigation**? *Training and practicing land navigation on foot provides the following everyday navigation (how not to get lost) benefits;*

- *Tracking present location (Where am **I** ?)*
- *Determining Distance (How far is it and am **I** there yet ?)*
- *Sense of direction (Where do **I** want to go and where am **I** actually going ?)*
- *How to read a topographic map (Do **I** understand the map ?)*
- *Terrain and map association (What hill or river am **I** looking at ?)*
- *Spatial skills (Can **I** mentally visualize the landscape in 3D ?)*
- *Planning safe, practical routes (Take a long safe route or a short risky route ?)*
- *And more Navigational skills*

The best way to learn **LAND NAVIGATION** is to get "dirt time", that is, get out there with a map and compass!

Navigation is not about finding yourself after you are lost (although that's what happens sometimes); it's about keeping track of your position as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is ahead.

Navigation in the wilderness means knowing your starting point, your destination, and your route to get there.

These skills will allow you to venture farther off the beaten path than you ever thought before.

THIS PRESENTATION IS DIVIDED INTO FOUR PARTS

PART 1 **Basic Land Navigation**

- The Lensatic Compass
- The Topographic Map
- The Land and Map Association

PART 2 **Intermediate Land Navigation**

- Making Sense of Direction
- Tracking Present Location
- Determining Travel Distance

PART 3 **Advance Land Navigation**

- Planning to Navigate
- Navigation Methods to Stay On Course
- Additional Skills of Land Navigation

PART 4 **Expert Land Navigation**

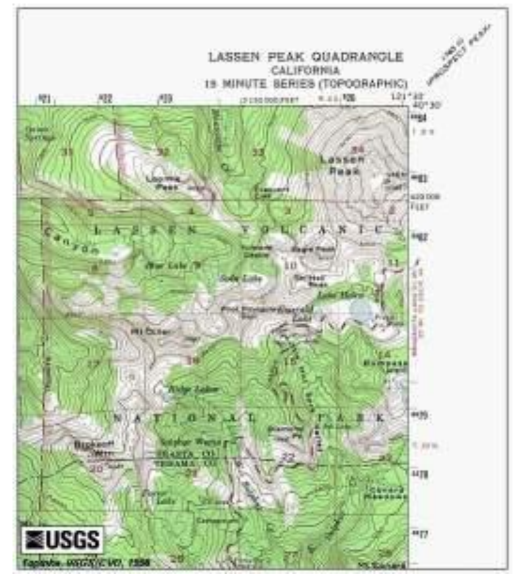
- Navigation in different types of Terrain
- Night Navigation
- Sustainment

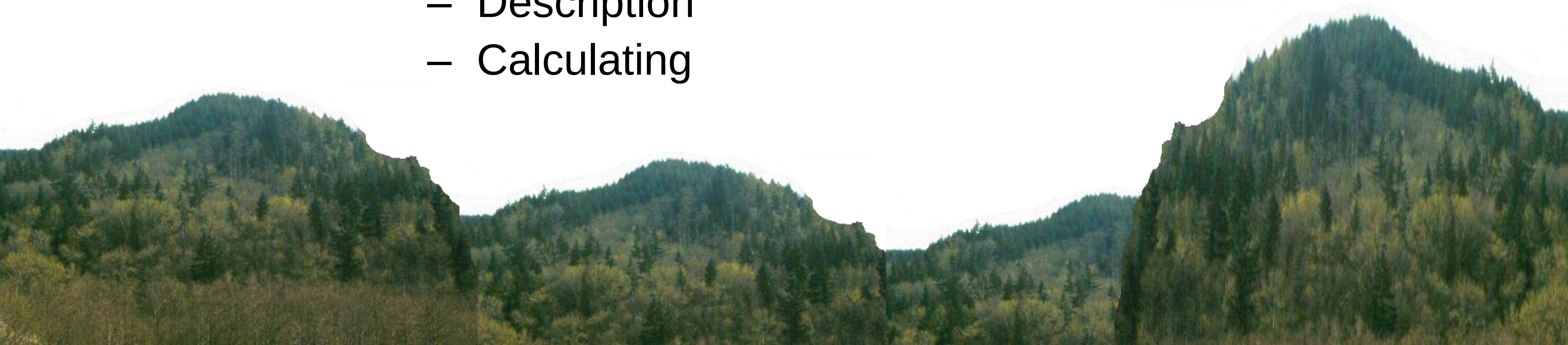
Any Questions?

PART 2

INTERMEDIATE LAND NAVIGATION

- **Making Sense of Direction**
  - Description
  - Current Azimuth
- **Tracking Present Location**
  - Description
  - Finding Your Location
- **Determining Travel Distance**
  - Description
  - Calculating





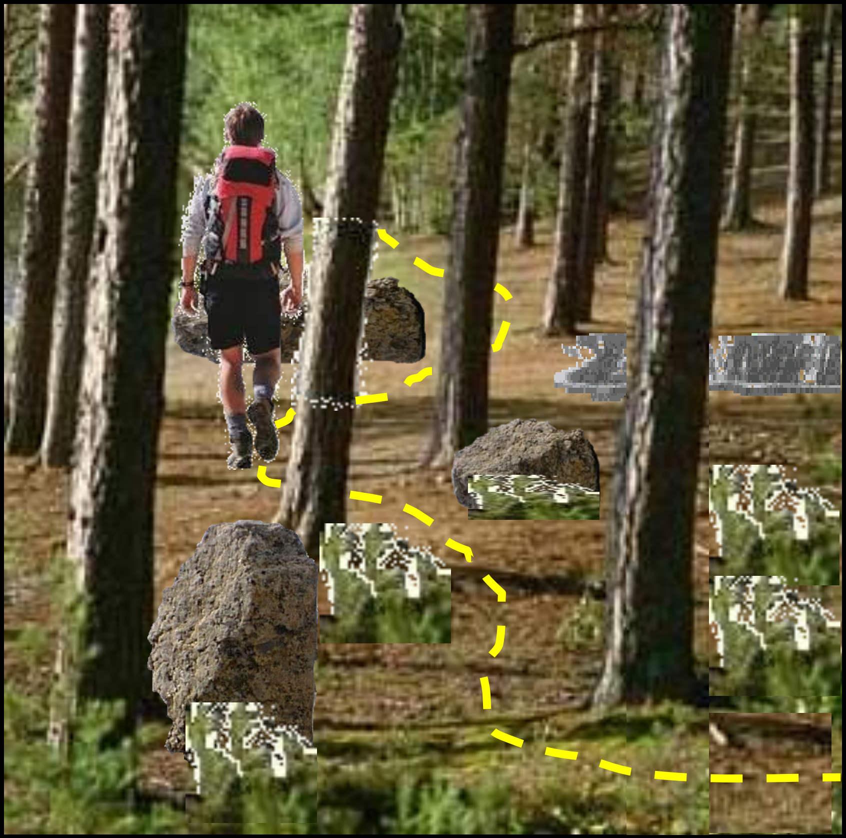
MAKING SENSE OF DIRECTION

DESCRIPTION

WHERE DO YOU WANT TO GO AND WHERE ARE YOU ACTUALLY GOING ?

A hiker's path isn't straight, small detours are made in following a general bearing – like around a big log in the way, a boulder, or avoiding a small water pond, etc. – since the land has so many irregularities.

The idea is to be conscious of the detours, keep them short, and try to zig as often as you zag. If you must make a sizeable detour, you are better off plotting a new travel bearing.



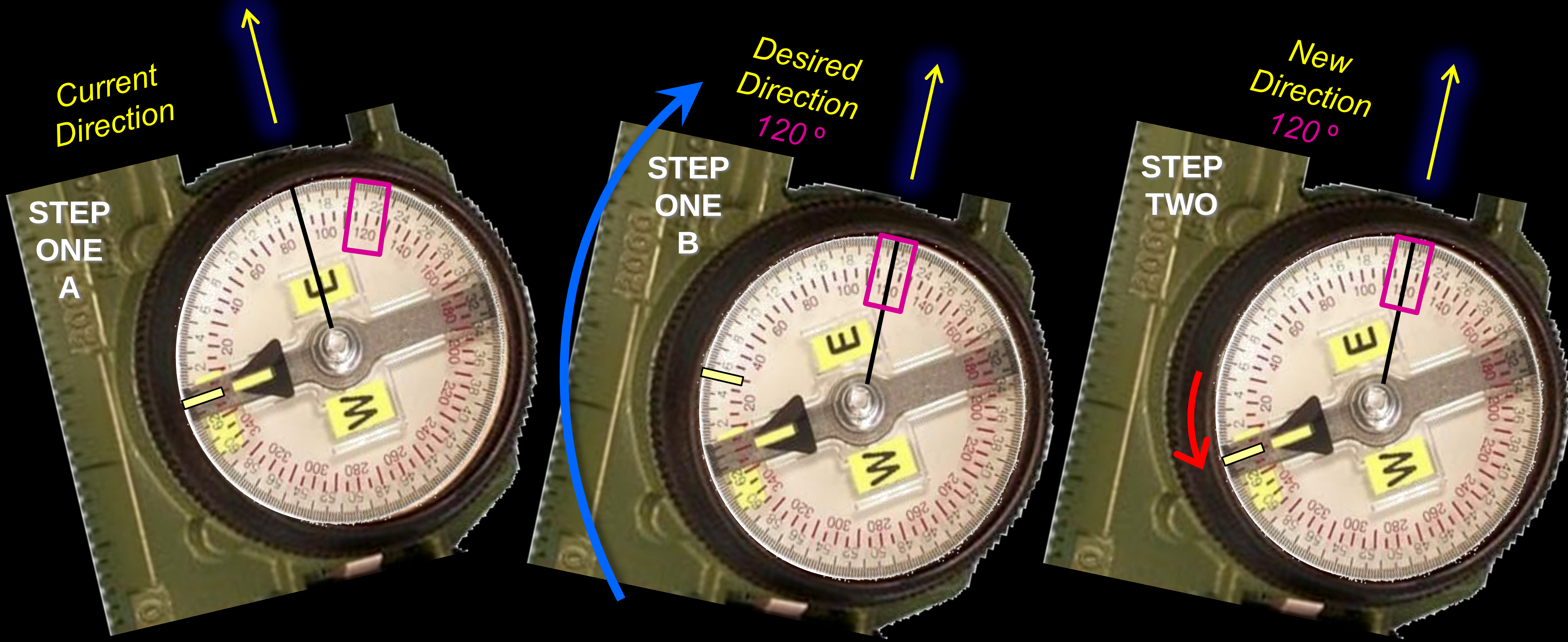
MAKING SENSE OF DIRECTION

TO SET A COURSE (Follow An Azimuth)

Three Methods

METHOD ONE

1. Select the desired azimuth you want to follow, example 120º azimuth. Then rotate the compass until the Black Index Line is positioned over the 120º azimuth.
2. Rotate bezel until Luminous Bezel Line is aligned with the North Arrow. Once bezel is set leave it there.
3. Follow set azimuth.



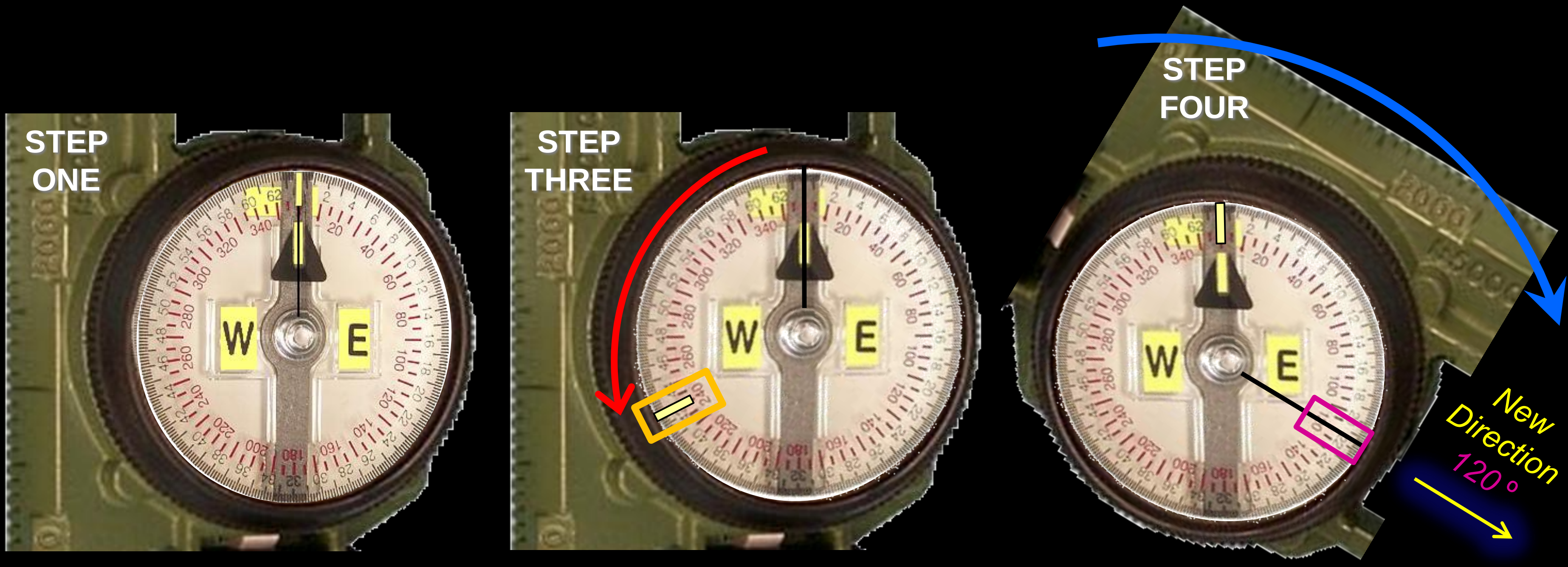
MAKING SENSE OF DIRECTION

TO SET A COURSE (Follow An Azimuth)

Three Methods

METHOD TWO

1. Align the North Arrow and Luminous Bezel Line with the Black Index Line.
2. Subtract the desired azimuth (example 120º) from 360º . 360º – 120º = 240º
3. Rotate bezel until Luminous Bezel Line is aligned with 240º. Once bezel is set leave it there.
4. Then rotate the compass until Luminous Bezel Line is aligned with the North Arrow. The Black Index Line will be aligned with 120º.



MAKING SENSE OF DIRECTION

TO SET A COURSE (Follow An Azimuth)

Three Methods

METHOD THREE

1. Align Luminous Bezel Line with the Black Index Line. It does not matter which direction compass is facing.
2. Divide desired azimuth (example 120º) by 3.   120º ÷ 3 = 40 clicks left

   * Above 180º is 360º- desired azimuth (example 285º) ; 360º – 285º = 75º÷ 3 = 25 clicks right

   * Desired AZIMUTHS below 180º go left, desired AZIMUTHS above 180º go right
3. Rotate bezel 40 clicks left. Once bezel is set leave it there.
4. Then rotate the compass until Luminous Bezel Line is aligned with the North Arrow. The Black Index Line will be aligned with 120º.

Any Questions?

MAKING SENSE OF DIRECTION

CURRENT BEARING

Where do you want to go and where are you actually going ? - COMPASS FOLLOWING

- Using the compass without a distant reference landmark is known as **compass following**.
  - It results in a lateral error (drift) as shown here.
- The compass provides only the forward part of navigation.
  - By itself it has no way of preventing lateral errors.

Intended line of travel BEARING 58º
Actual line of travel
Compass "read" here to stay on 58º

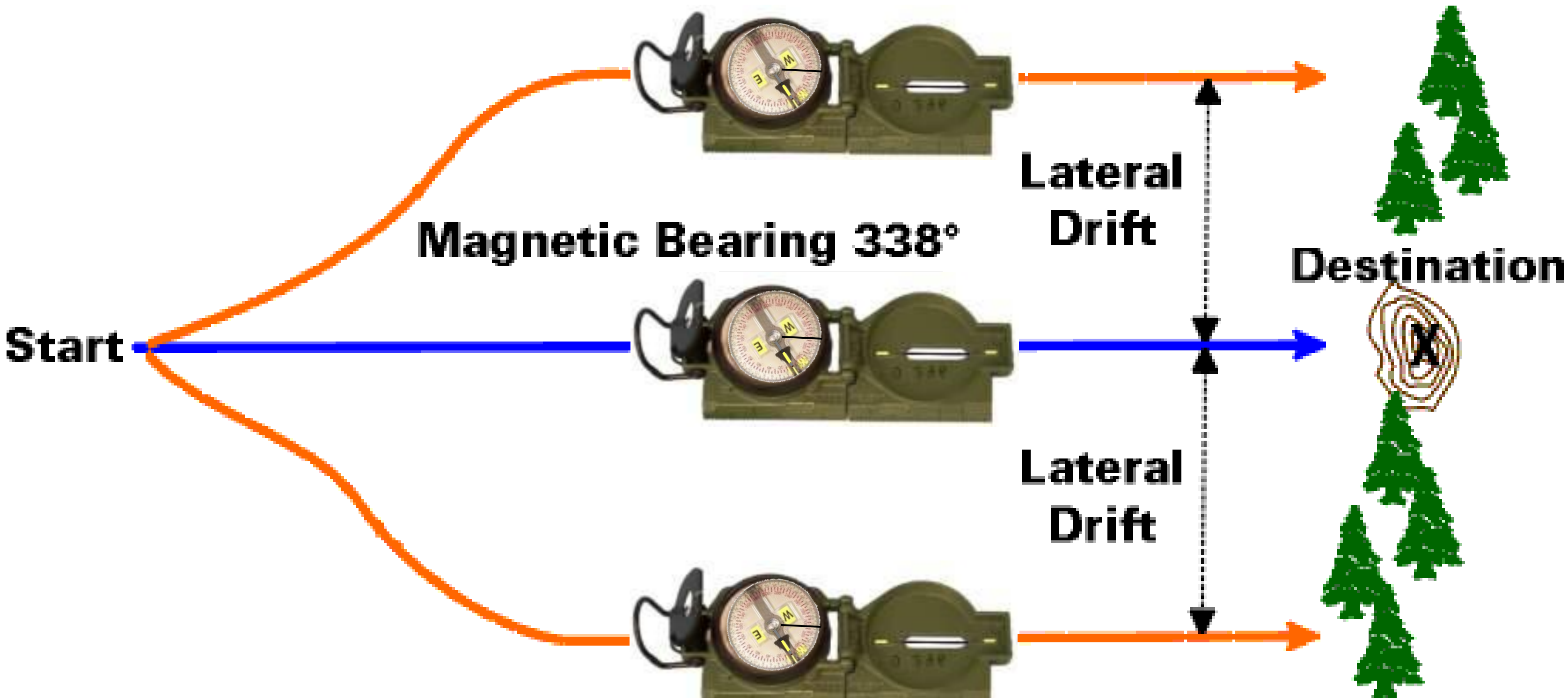
- This is where the use of landmarks fits in.
  - Known as **intermediate landmarks**.
    - ✓ Like trees, huge boulders, hill, saddle, or any landmarks that will be visible when traveling from **START** to "**A**" **intermediate landmark**, then to "**B**" **intermediate landmark**, then to "**C**" **intermediate landmark**, then to **GOAL**.
    - ✓ Intermediate landmarks should be short distances from landmark to landmark.

MAKING SENSE OF DIRECTION

CURRENT BEARING

COMPASS FOLLOWING (summarized)

- Is when you drift away from the given destination, but you remain on the same bearing.
- The compass alone, is not enough to eliminate lateral drift.
- Spot a landmark (tree, knoll) on the set bearing, walk to that landmark, then pick another. Continue until destination is reached.

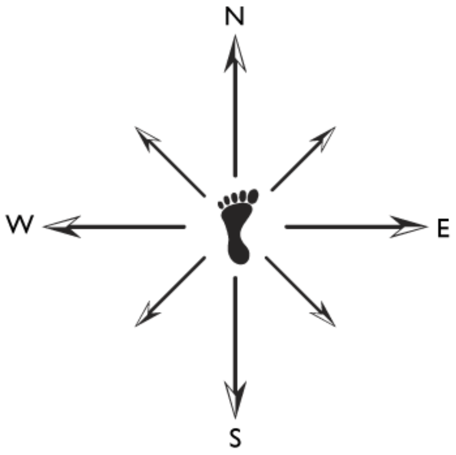


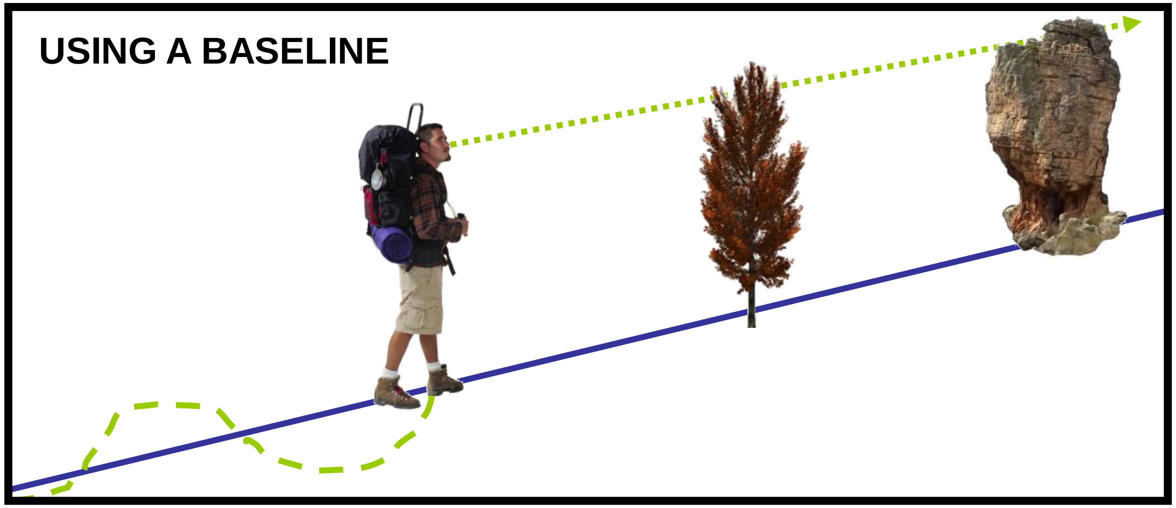
MAKING SENSE OF DIRECTION

CURRENT BEARING

GIVEN THE NECESSITY OF OCCASIONAL DETOURS, you can come close to your destination by . . .

- Make careful, accurate sightings on both destination and **intermediate landmarks**.
- Recheck bearings often, to avoid accumulation of small errors. (LATERAL DRIFT)
- Use bearings over short distances when possible.
- Continually relate your progress to the map.
- Aim for a line rather than a point ; for instance, a stream is easier to hit than a waterfall on that stream.
- Line up two distant objects on your bearing line that will always be in sight – example, a prominent tree and a huge crag (boulder). When you have to detour off course, quickly correct for error by moving until these two points are again aligned.





Any Questions?

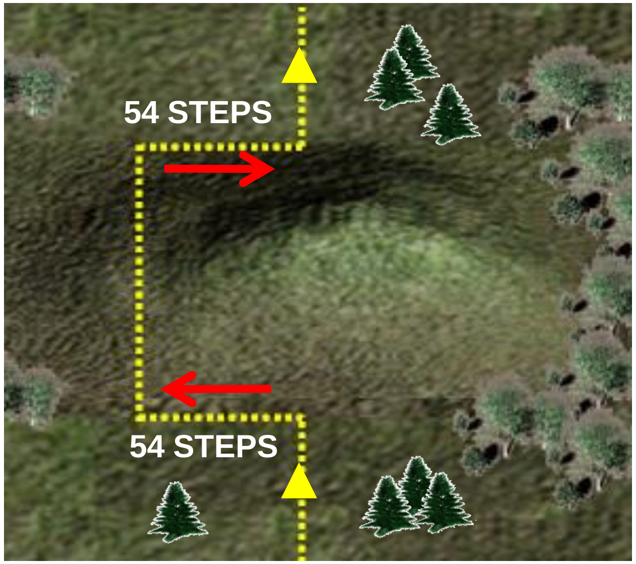
MAKING SENSE OF DIRECTION

CURRENT BEARING

OBSTACLES – getting around them

1. While on course you run into a lake.
2. On the other side you clearly see a lone tree directly on the same course bearing.
3. So you walk the lake shore until you get to the lone tree
4. and continue on your course bearing.

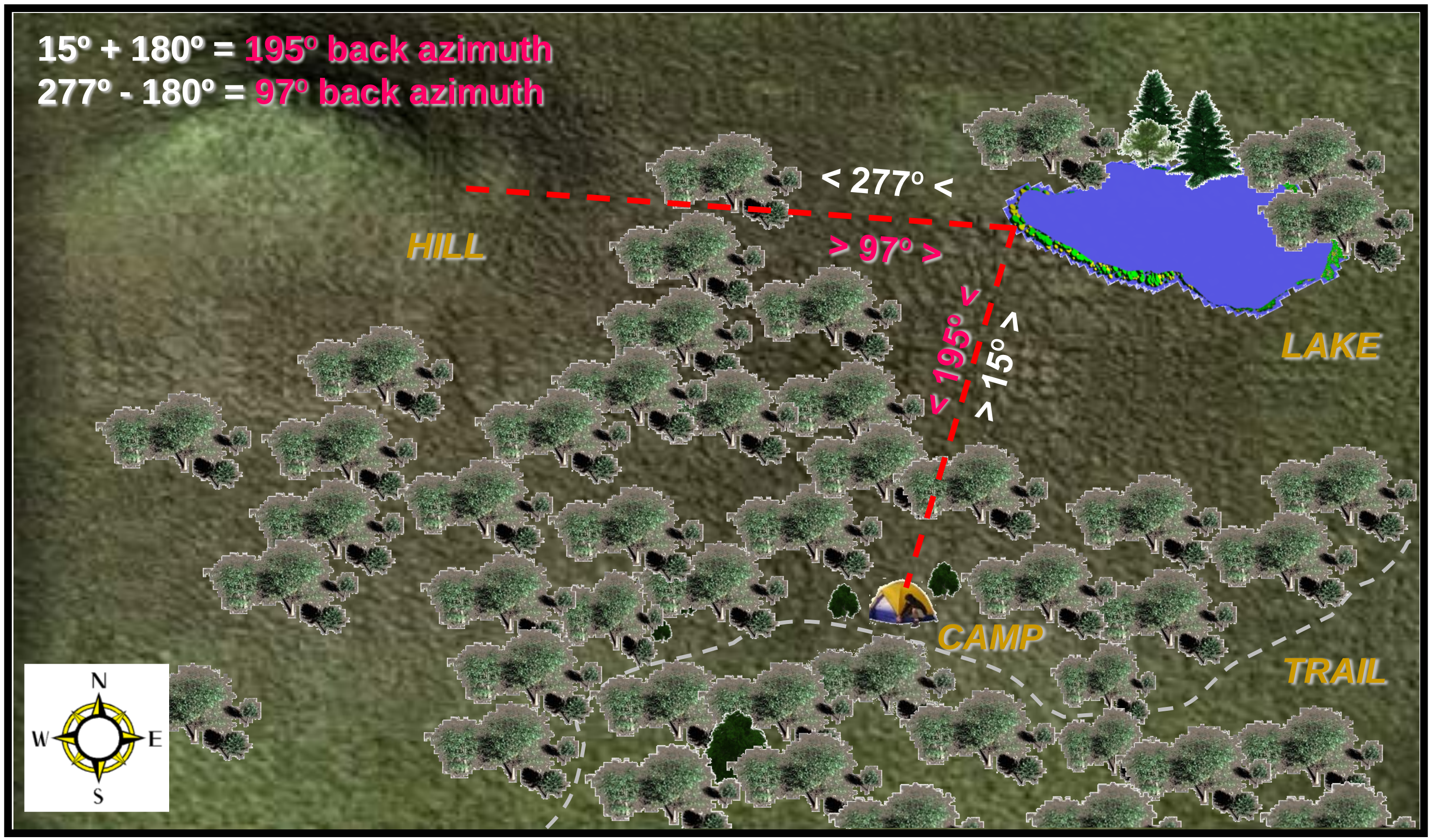
1. While on course you run into a hill.
2. You take a 90º left turn and pace count until you clear the hill.
3. Then turn right 90º and walk till you clear the hill again.
4. Then turn right 90º again and pace count the same amount as the first pace count.
5. At the end of the pace count, turn left 90º and continue on your course bearing.



MAKING SENSE OF DIRECTION
CURRENT BEARING
BACK AZIMUTH – return trip

- A **back azimuth** is the reverse direction of an azimuth. It is comparable to doing an "about face".
  - Azimuth <u>less</u> than 180º ADD 180º.
  - Azimuth <u>more</u> than 180º SUBTRACT 180º.

    NOTE: the back azimuth of 180º may be stated as either 0º or 360º



MAKING SENSE OF DIRECTION

CURRENT BEARING

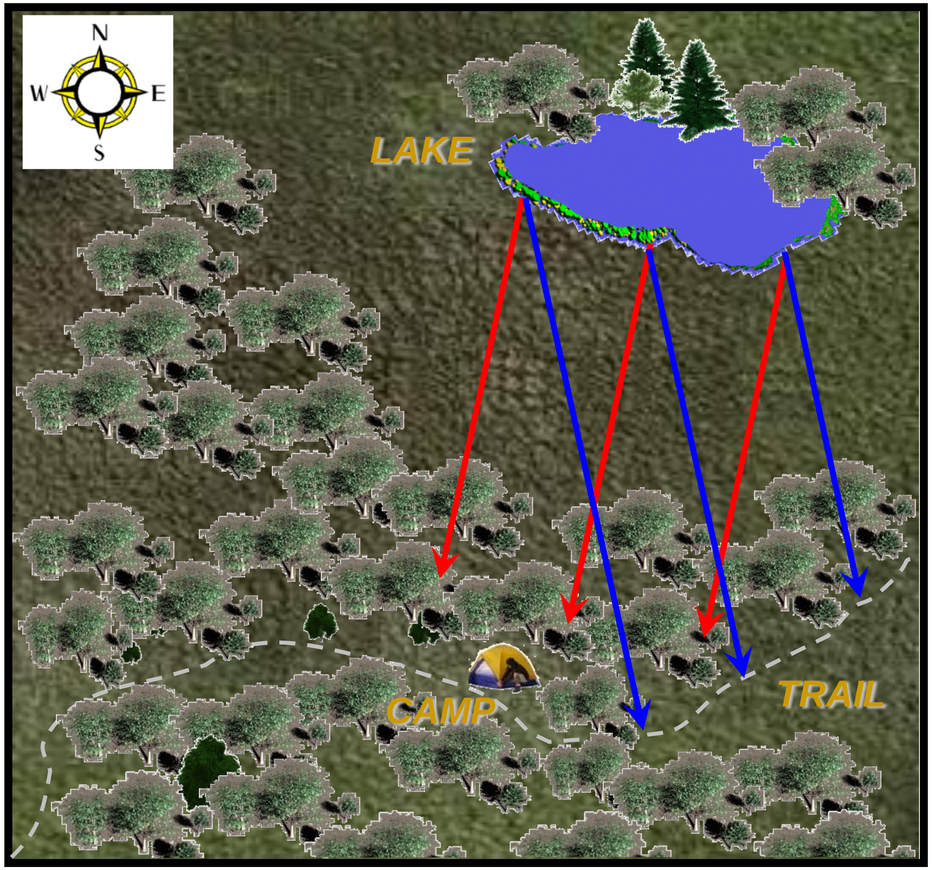
DELIBERATE OFFSET – aiming off

1. You are at the lake and want to head back to camp at a **195º bearing**.
   - But when you reach the trail, which way to go, which way to turn; left or right?
2. At the lake; deliberately offset to a **165º bearing** and follow the bearing to the trail.
   - When you reach the trail, all you have to do is turn right and go to the campsite.

NOTE

Deliberate Offset needs a LINE reference, like a

- Trail
- River
- Road
- Shoreline
- Etc.



Any Questions?

TRACKING PRESENT LOCATION

DESCRIPTION

Navigation is not about finding yourself after you are lost (although that's what happens sometimes); navigation is about keeping track of your *POSITION* as you move away from a known point. As you move you have to remain cognizant of the terrain you are leaving, of the terrain you are passing, and of the terrain that is ahead of you.

- Make it a habit of keeping your map and compass handy and refer to them every hour or so to locate your position (more often in low visibility). Keep track of your starting time, rest breaks and general hiking pace. This will also give you an idea of how far you have traveled.

- To find out where you are, you must relate your position to features you can see and identify on the map.

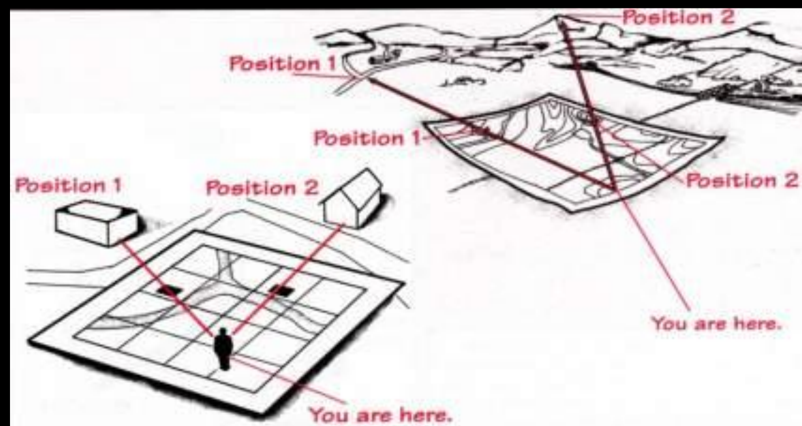
- There are several techniques to find your position on a map.
  - RESECTION - With map only (no compass).
  - MODIFIED RESECTION – With map or One compass bearing.
  - DISTANCE RESECTION – With compass.
  - INTERSECTION - Two compass bearings.
  - TRIANGULATION - Three compass bearings.
- Plotting Location to record your position.

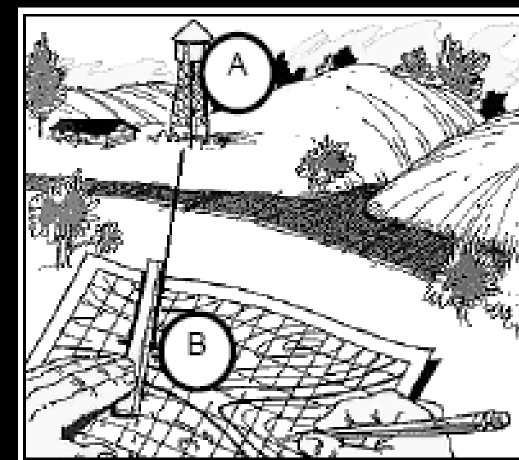
TRACKING PRESENT LOCATION

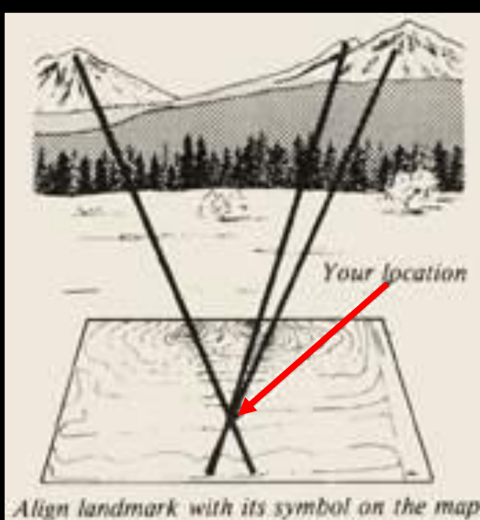
FINDING YOUR LOCATION – ***RESECTION*** (with map only)

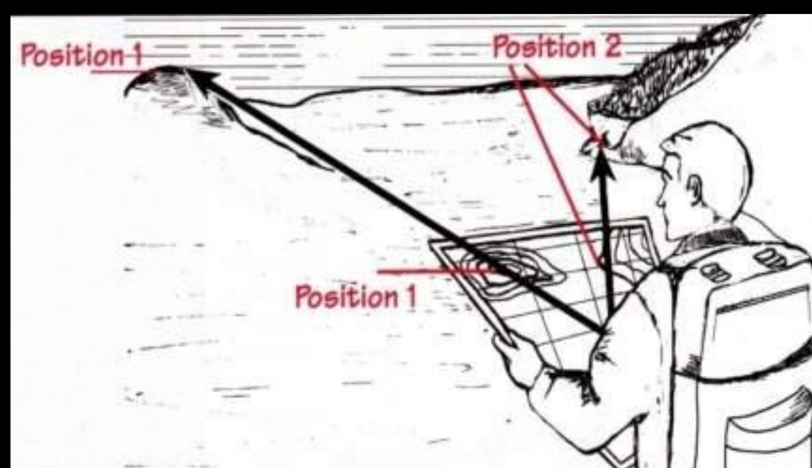
- RESECTON has only one prerequisite - there must be at least two, but preferably three, identifiable points on the landscape that also appear on the map.
- Orient the map with the landscape. And then using a straight edge object (example; ruler), lay flat on the map and align with the landmark, then draw a line. Repeat for the second landmark.
- Where lines intersect, you are there.
- You may also do this visually to estimate where you are.

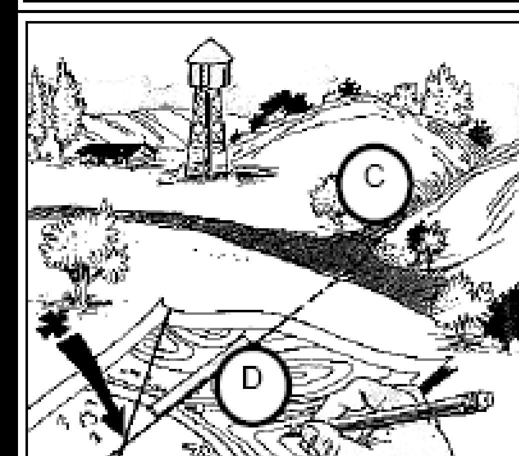
Examples 1, 2, 3, and 4







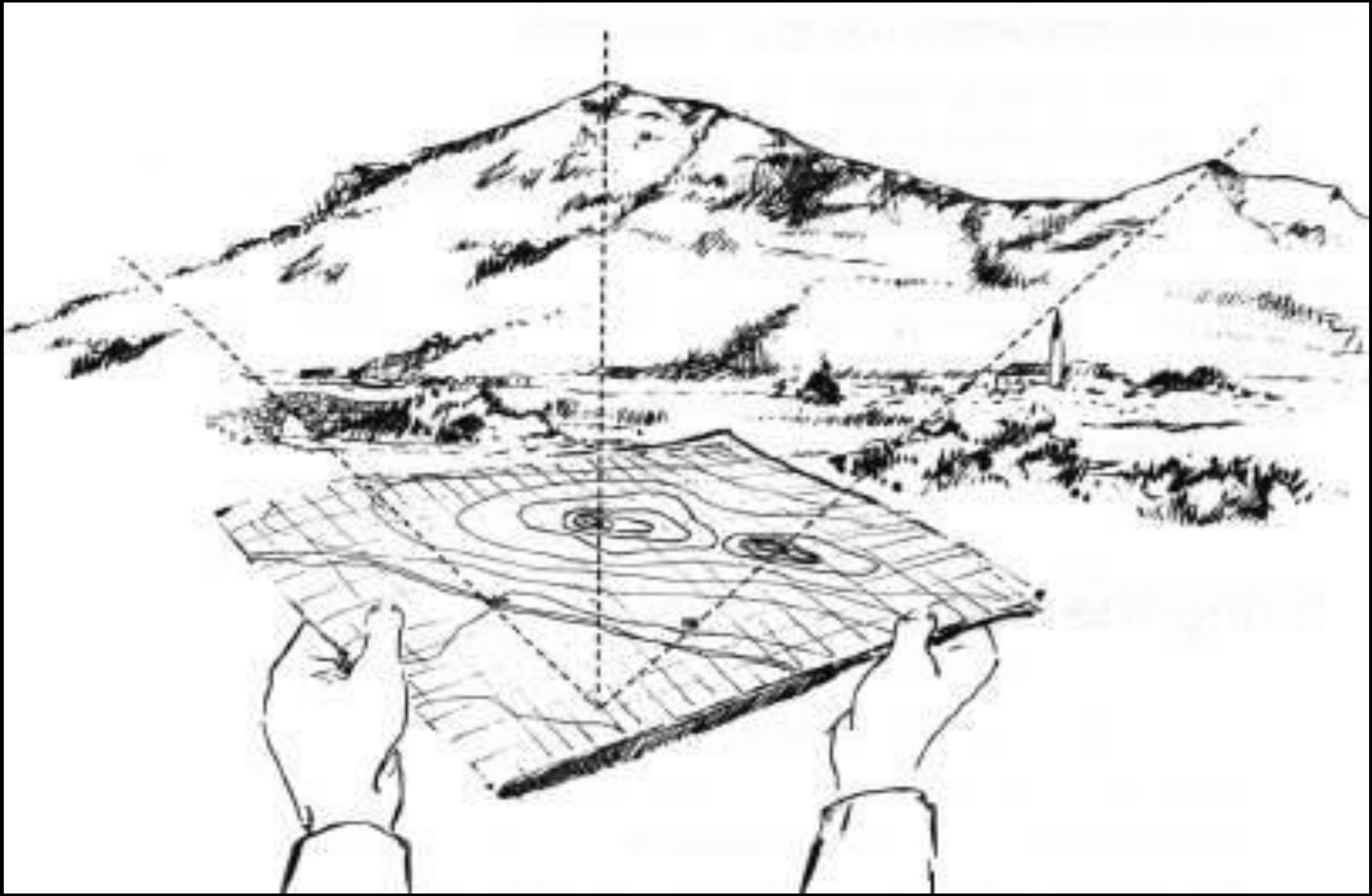




TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***RESECTION*** (with map only)

Example 5

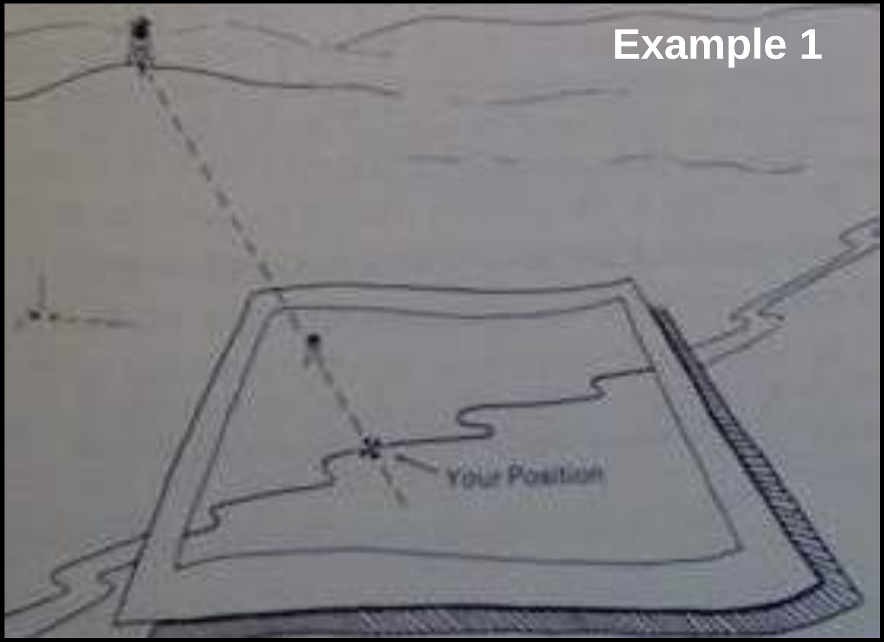


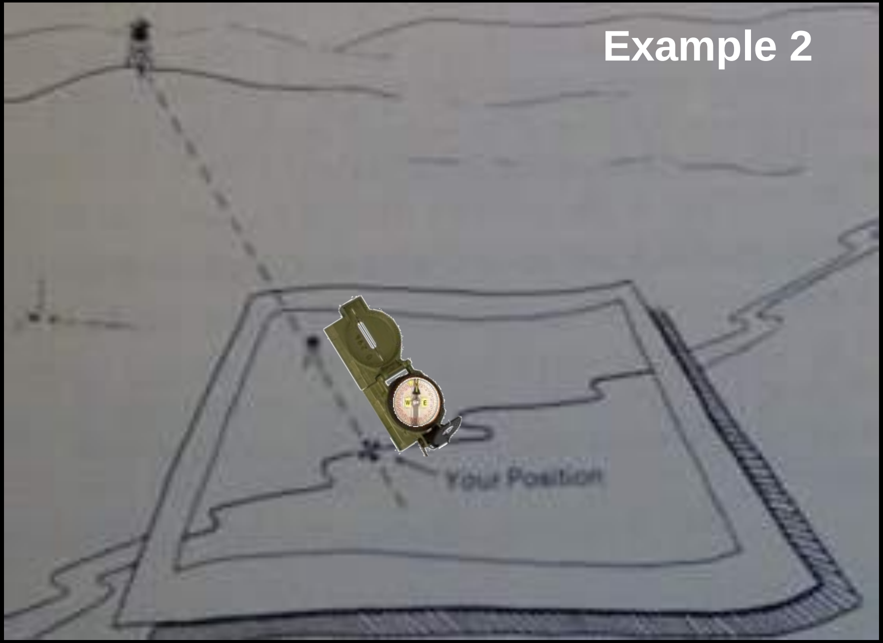
TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***MODIFIED RESECTION***

(with map or compass)

- MODIFIED RESECTON has one prerequisite – you must be on a linear feature (trail, road, river, ridge line, etc).
- **Orient** the map with the landscape (visually or with compass & map magnetic north).
  - And then use a straight edge object (ruler) and align with an identifiable landmark, then draw a line.
  - Or visualize the line on the map.
  - Or take a compass magnetic bearing to the landmark and lay compass on the map landmark and only rotate the compass to the bearing taken. (see INTERSECTION slides for more details)
- Where the line (or compass) crosses the linear feature (trail, road, river, ridge line), that is where you are.



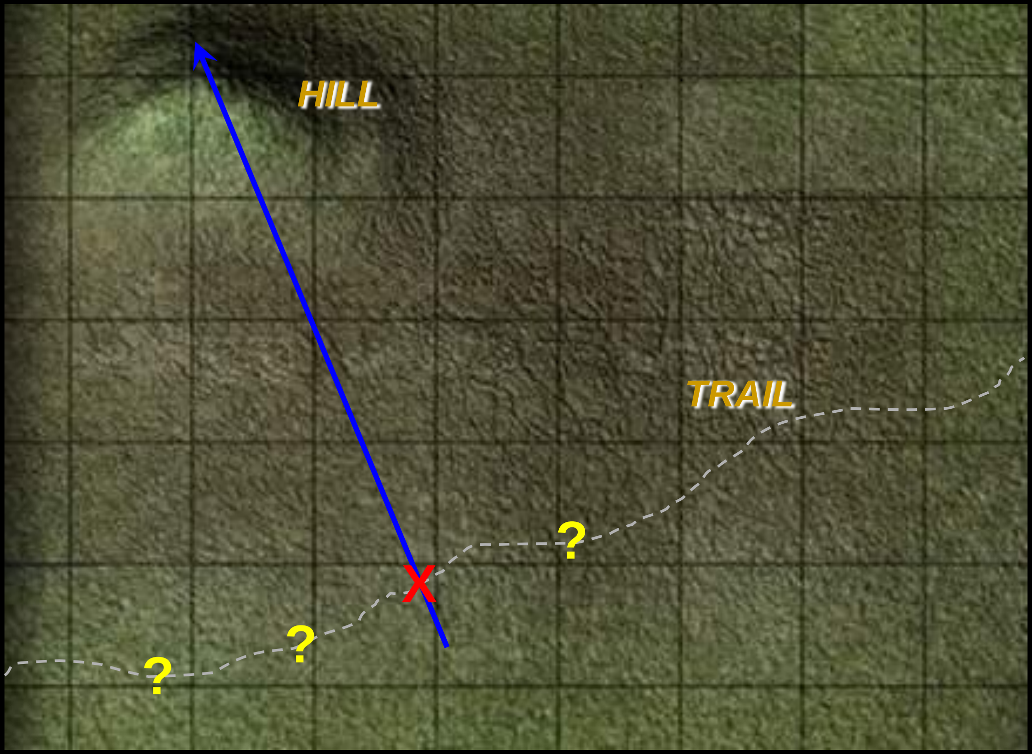


TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***MODIFIED RESECTION***

(with map or compass)

- Example 3 - Where are you on the trail in the field?
- Example 4 - Where are you on the ridge line?
- After orienting the map and taking a compass bearing or a visual lineup to a landmark, you find that you are at the "X" position.

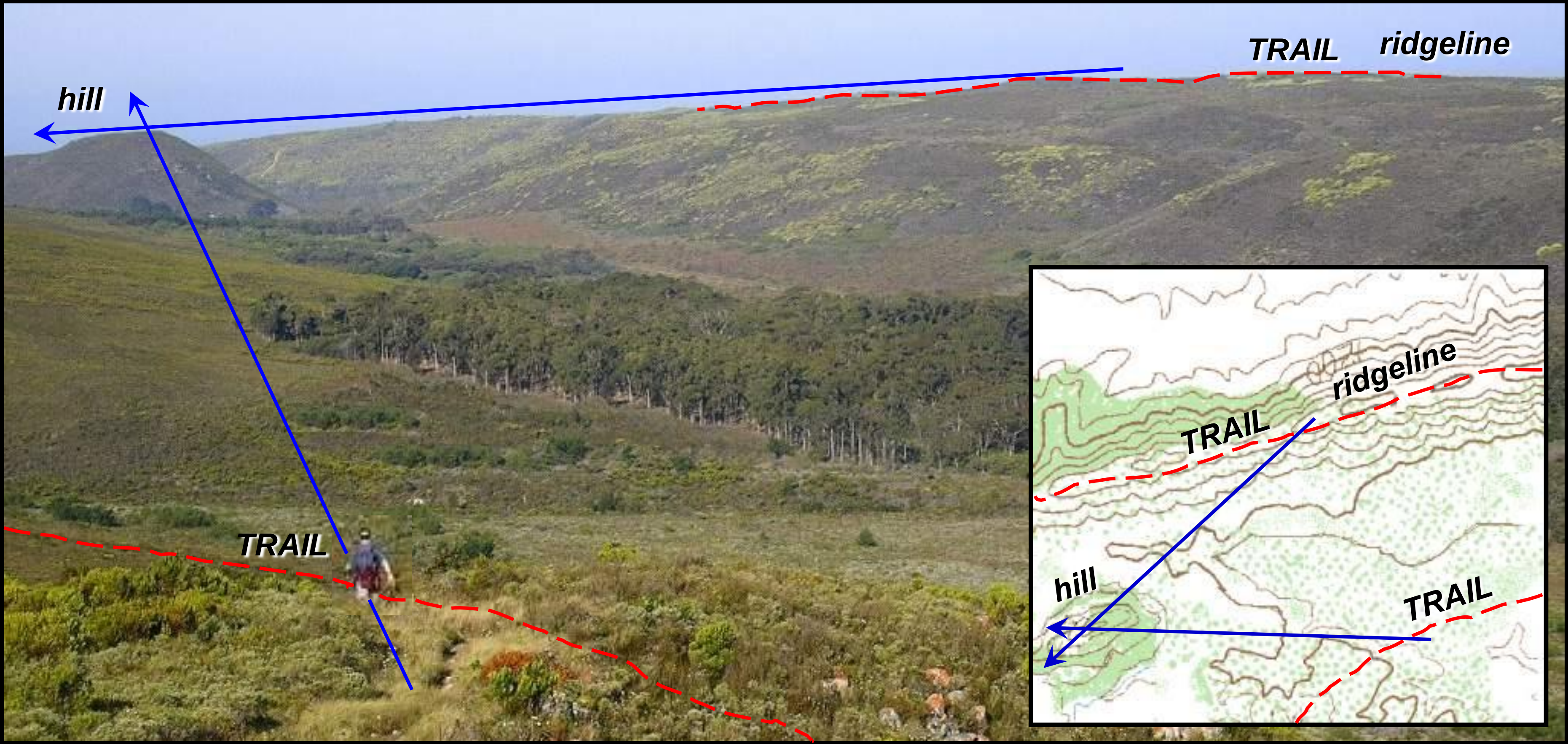


TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – *MODIFIED RESECTION*

(with map or compass)

- Example 5 - Where are you on the field trail?
- Example 6 - Where are you on the ridgeline trail?



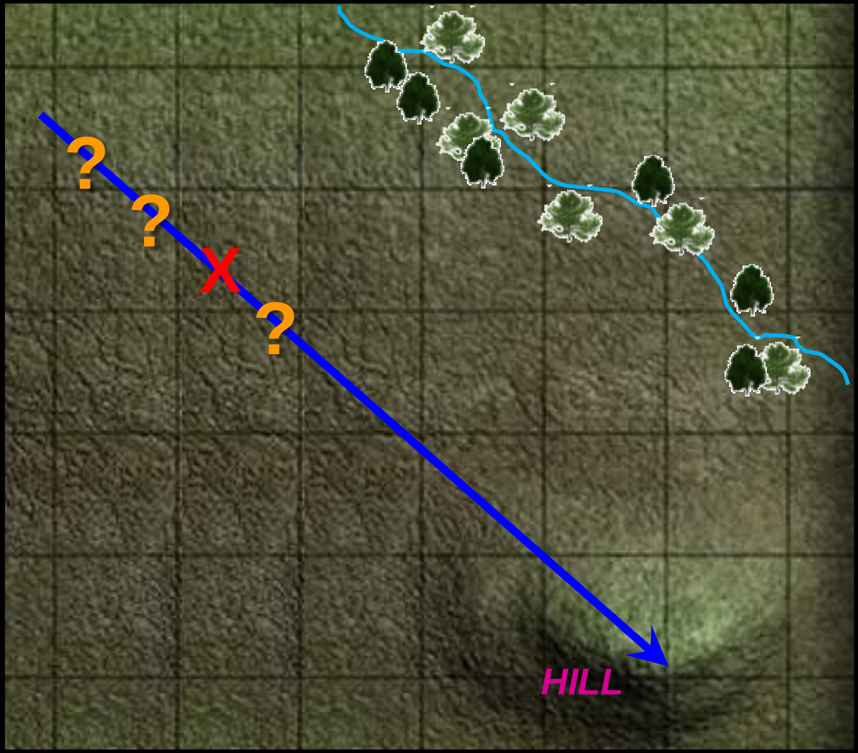
TRACKING PRESENT LOCATION

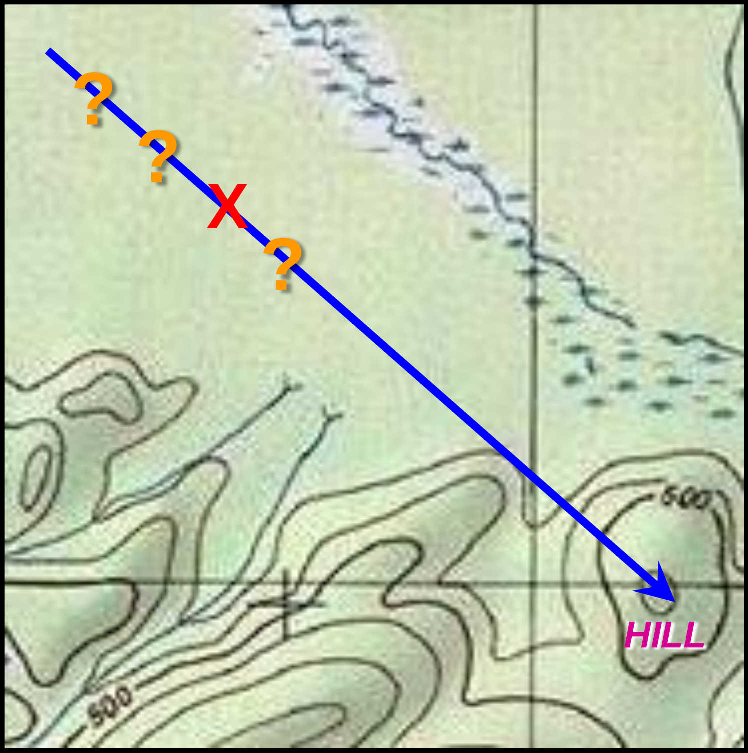
FINDING YOUR LOCATION – ***DISTANCE RESECTION***

(with compass)

- Example 1 - Where are you on the one azimuth line?
- After taking a compass bearing to a landmark (**HILL**), you can find yourself on the azimuth line by determining the distance to the landmark. With this technique you will know where you are on the one azimuth line (**X**).

* See PART 3 ADVANCED LAND NAVIGATION "DETERMING DISTANCE" for details on how to do it.





Any Questions?

TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***INTERSECTION*** (two compass bearings)

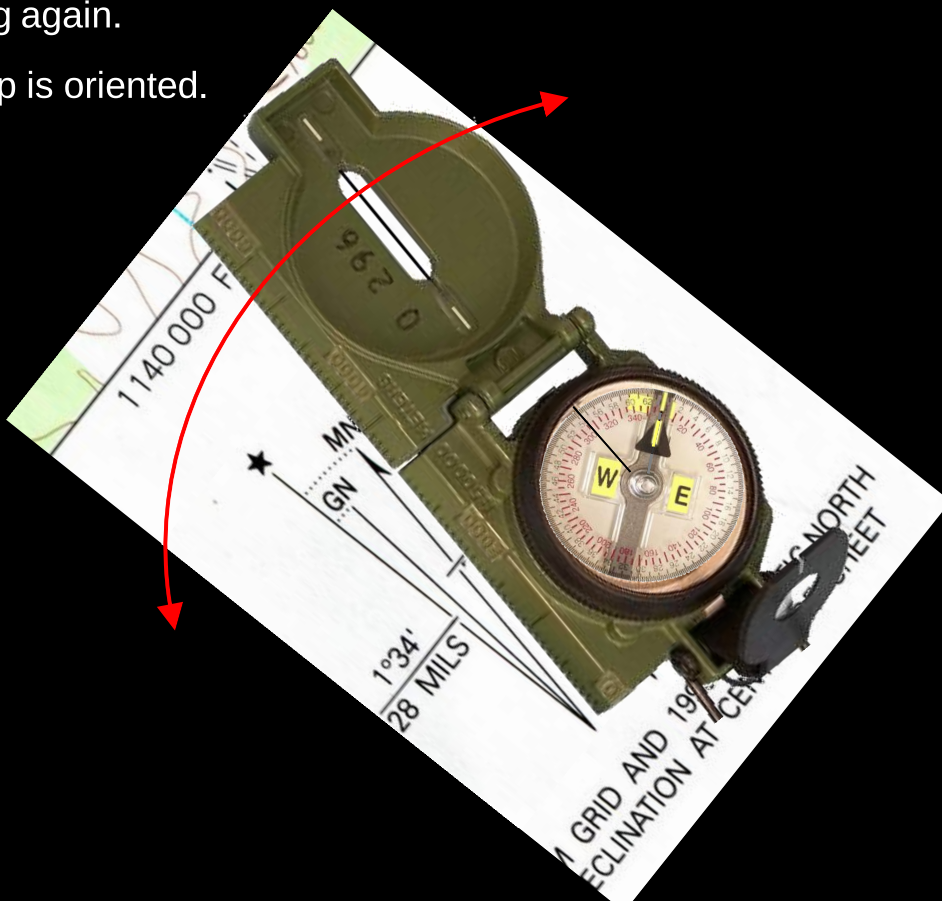
- INTERSECTON has only one prerequisite - there must be two identifiable points on the landscape that also appear on the map.
- Orient the map with MAGNETIC NORTH. And then take a lensatic compass bearing to the first landmark and lay compass on the map landmark and only rotate the compass to the bearing taken, draw a line.
- Then take a lensatic compass bearing to the second landmark and lay compass on the map landmark and only rotate the compass to the bearing taken, draw a line.
- Where lines cross each other, that is approximately where you are. (SEE NEXT SLIDES FOR DETAILS)

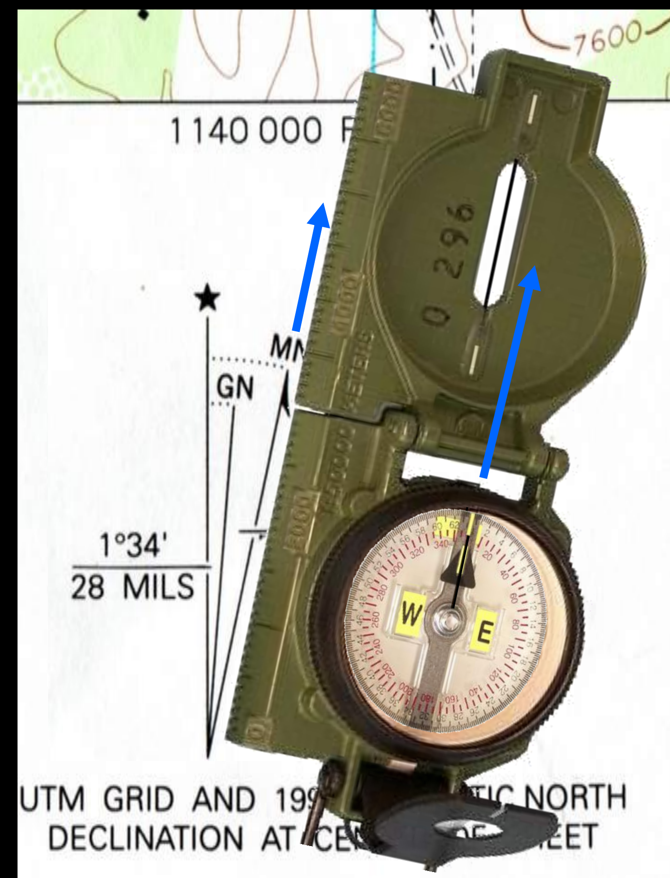
TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***INTERSECTION*** (two compass bearings)

STEP ONE. With compass & map:

1. Lay the map on a flat surface and lay the compass on the MN line on the map.
2. **Rotate** map and compass together until the compass bearing reads 0° degrees Magnetic North (compass and MN line on the map are **aligned** / **parallel**). Put rocks on each corner of the map to prevent it from moving again.
3. The map is oriented.





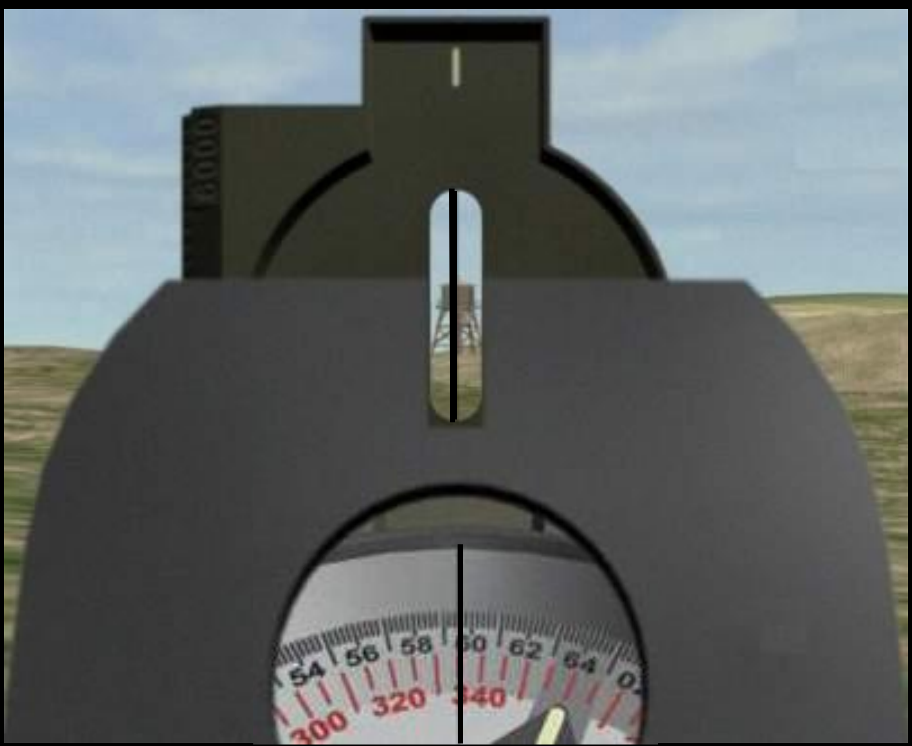
TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***INTERSECTION*** (two compass bearings)

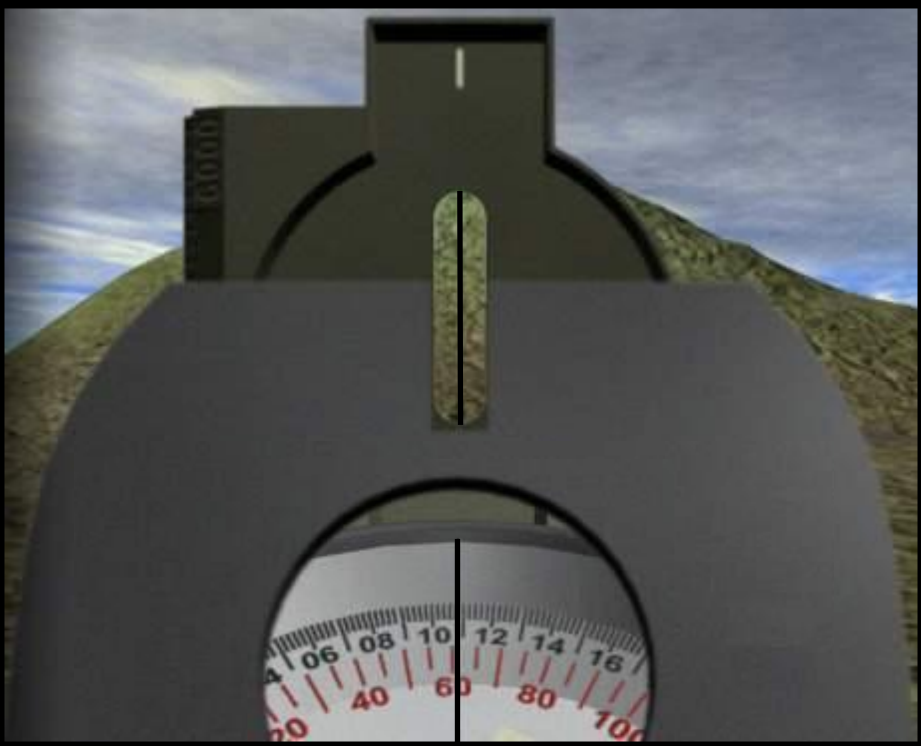
STEP TWO. With compass & map:

1. With lensatic compass take an azimuth (bearing) to both (two) landmarks.

TOWER AZIMUTH = 335°



HILL AZIMUTH = 60°

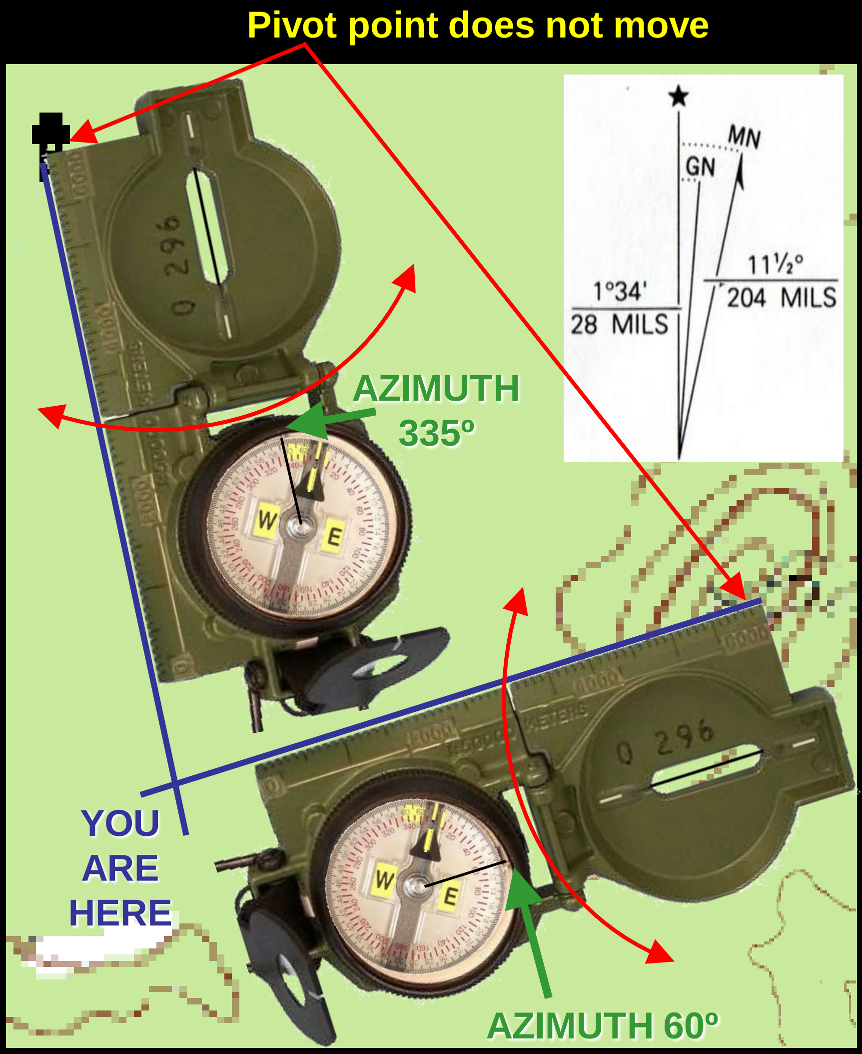


TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***INTERSECTION*** (two compass bearings)

STEP THREE. With compass & map:

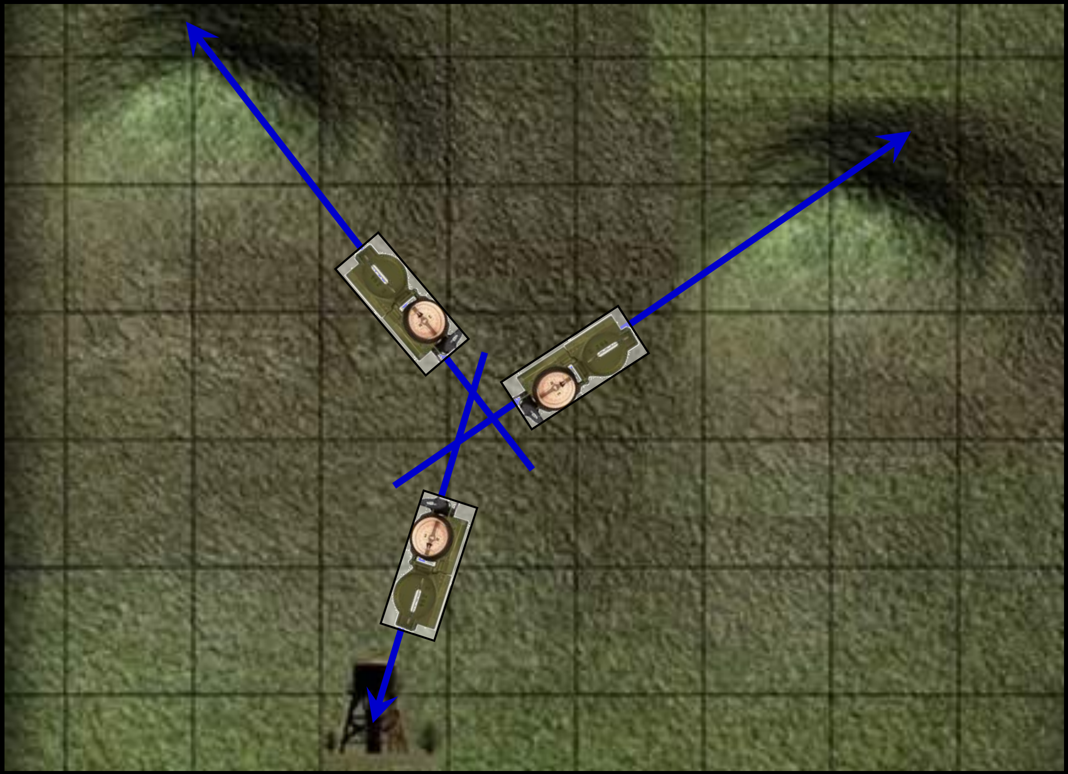
1. Lay compass front left corner on first map landmark.
2. **Rotate** compass until the **azimuth** taken to the landmark is on the **index line**.
1. **Draw a line**.
2. Repeat for second landmark.
3. Where the **lines cross** each other, that is approximately where you are.



TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***TRIANGULATION*** (three compass bearings)

- TRIANGULATION has only one prerequisite - there must be three identifiable points on the landscape that also appear on the map.
- Orient the map with MAGNETIC NORTH. And then take a lensatic compass bearing to the first landmark and lay compass on the map landmark and only rotate the compass to the bearing taken, draw a line. Repeat for the other landmarks. (same procedures as INTERSECTION)
- Where the triangle is, that is where you are. The more accurate you are with the compass bearings, the more accurate or smaller the triangle.



Any Questions?

TRACKING PRESENT LOCATION

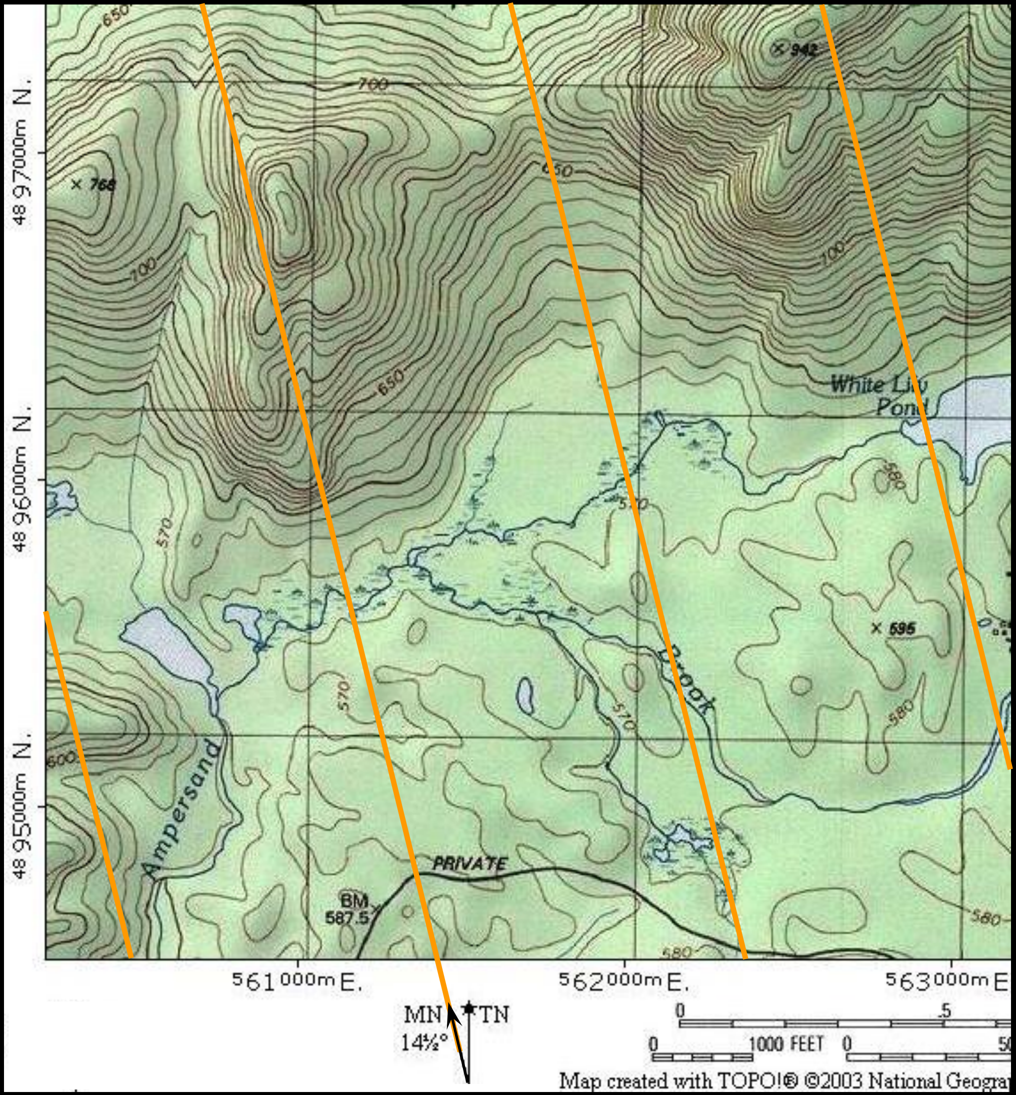
FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

MAKING YOUR MAP SPEAK "COMPASS LANGUAGE"

Instead of going to the trouble of converting map GN to compass MN or vice versa each time you take an azimuth direction from the map or compass, with the possibility of making errors, there is a much simpler way of compensating for G-M Angle conversions.

MN Lines drawn on the map allow you to orient a map so that the map landmarks are aligned with the actual ground landmarks they represent. You also can use the **MN Lines** to identify landmarks, find your own location, and follow compass bearings without orienting the map, and that can save you lots of time and trouble.



TRACKING PRESENT LOCATION

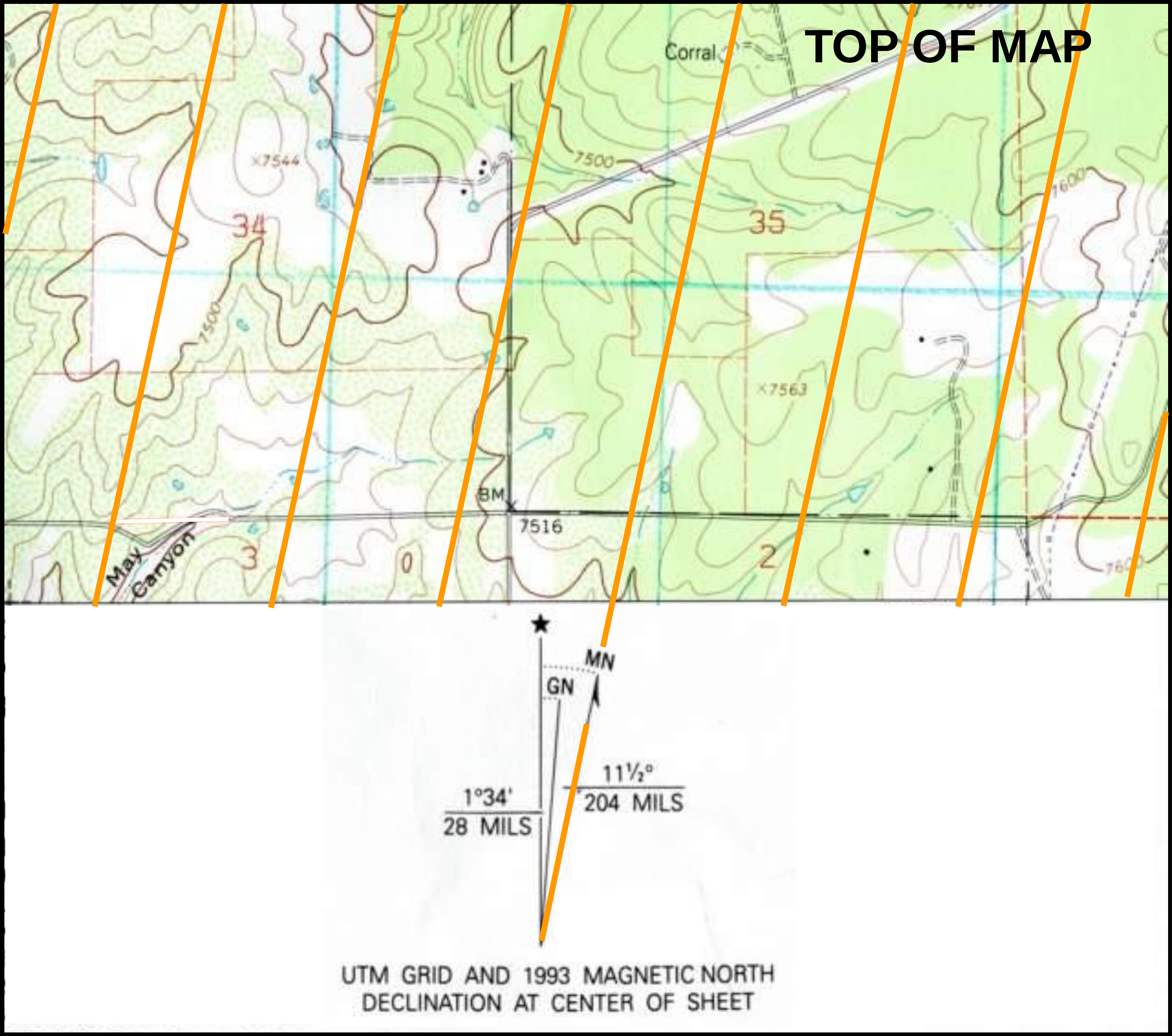
FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

STEP ONE. With compass & map:

1. With the **MN lines** drawn on the map, there is no need to orient the map to find your position.
   - *This will be explained in the following slides*.
2. With a ruler or flat edged object, draw **MN lines** on the map.
   - Do this before going into the wilderness.
   - Make the lines as light or heavy as you want.
   - Draw as many lines as you want.
   - Space out the lines as wide or close as you want.

Ensure the lines drawn are accurately parallel with the map MN line to eliminate errors when used with the compass



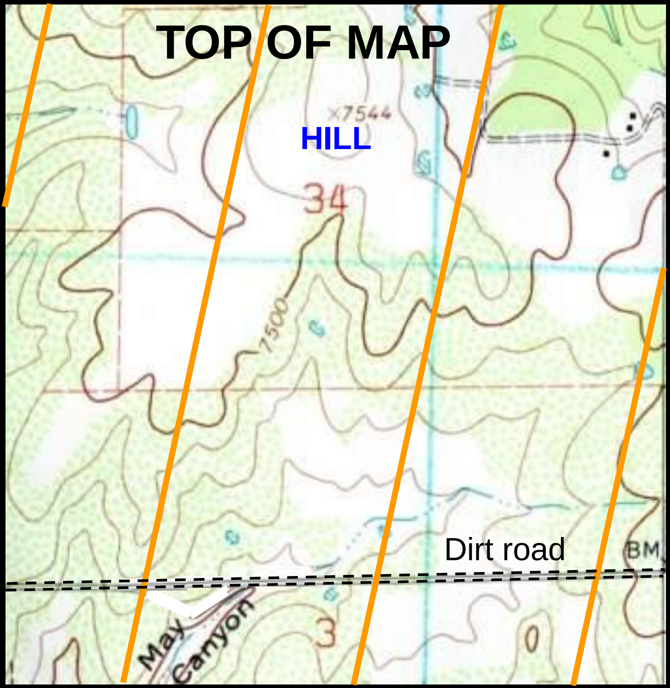
TRACKING PRESENT LOCATION

FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

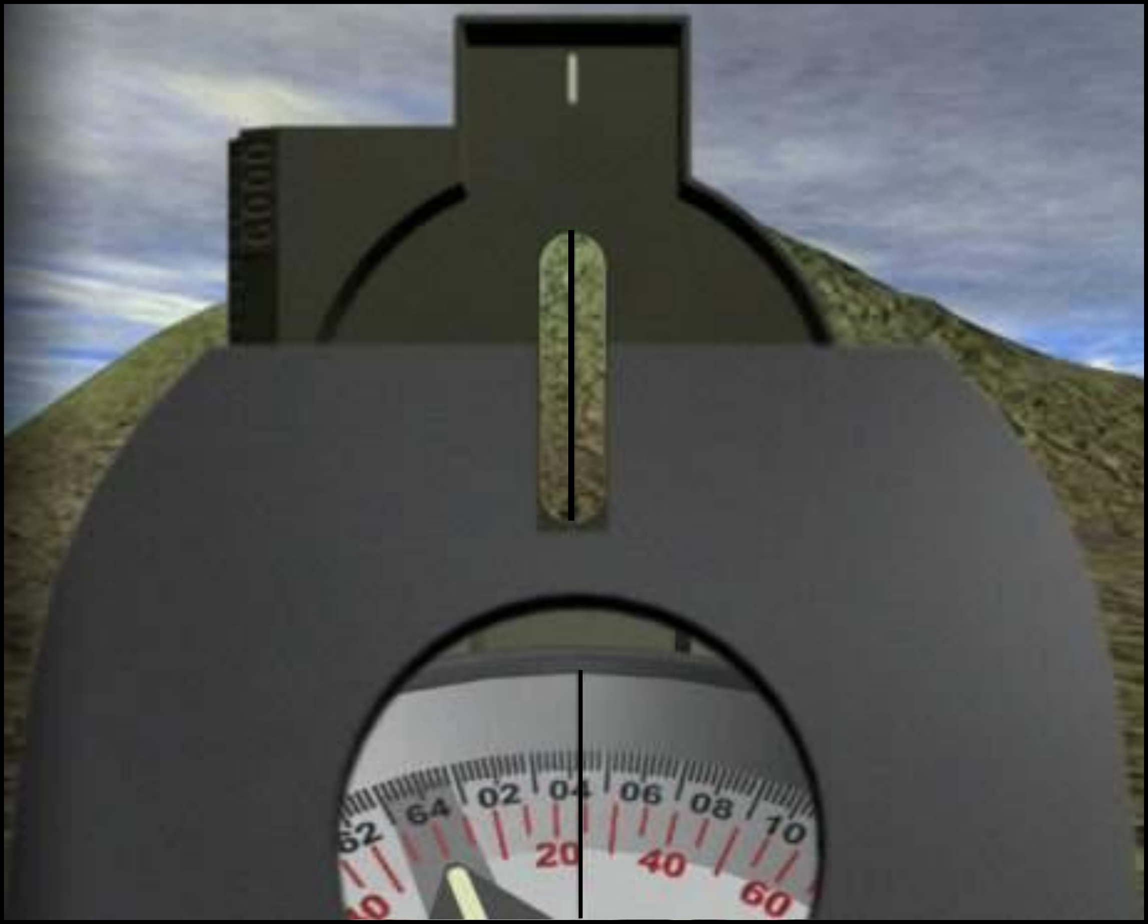
for Modified Resection, Intersection, Triangulation

STEP TWO. With compass & map:

1. Identify a landmark on the map.
2. Take an azimuth to the landmark.
   - Example – you want to know where you are on the dirt road, in relation to the distant **HILL**.



HILL AZIMUTH = 25°



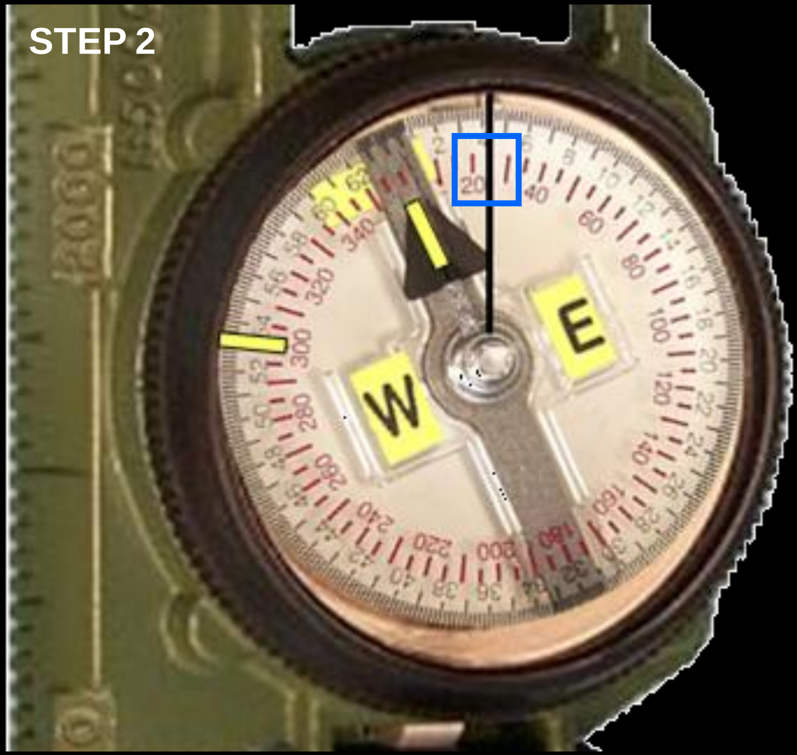
TRACKING PRESENT LOCATION

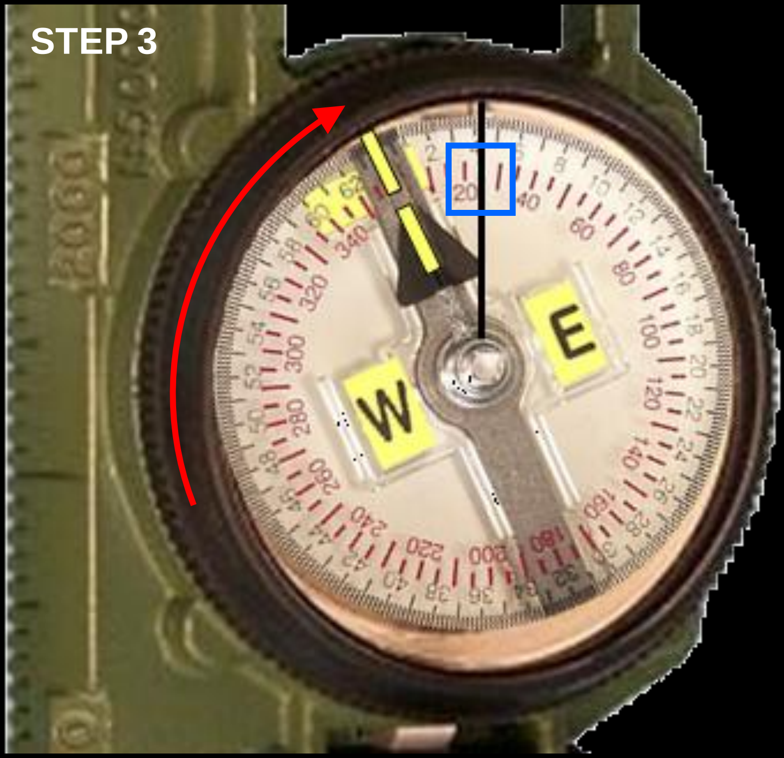
FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

STEP THREE. With compass & map:

1. Lower the compass till you can see the whole compass dial. Example, to your chest or waist.
2. Keeping the compass dial and index line set to the landmark azimuth (**HILL AZIMUTH 25º**).
3. **Rotate** bezel until **Luminous Bezel Line** is aligned with compass needle. Once bezel is set leave it there. (The Luminous Bezel Line now represents the North Needle Arrow).





TRACKING PRESENT LOCATION

FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

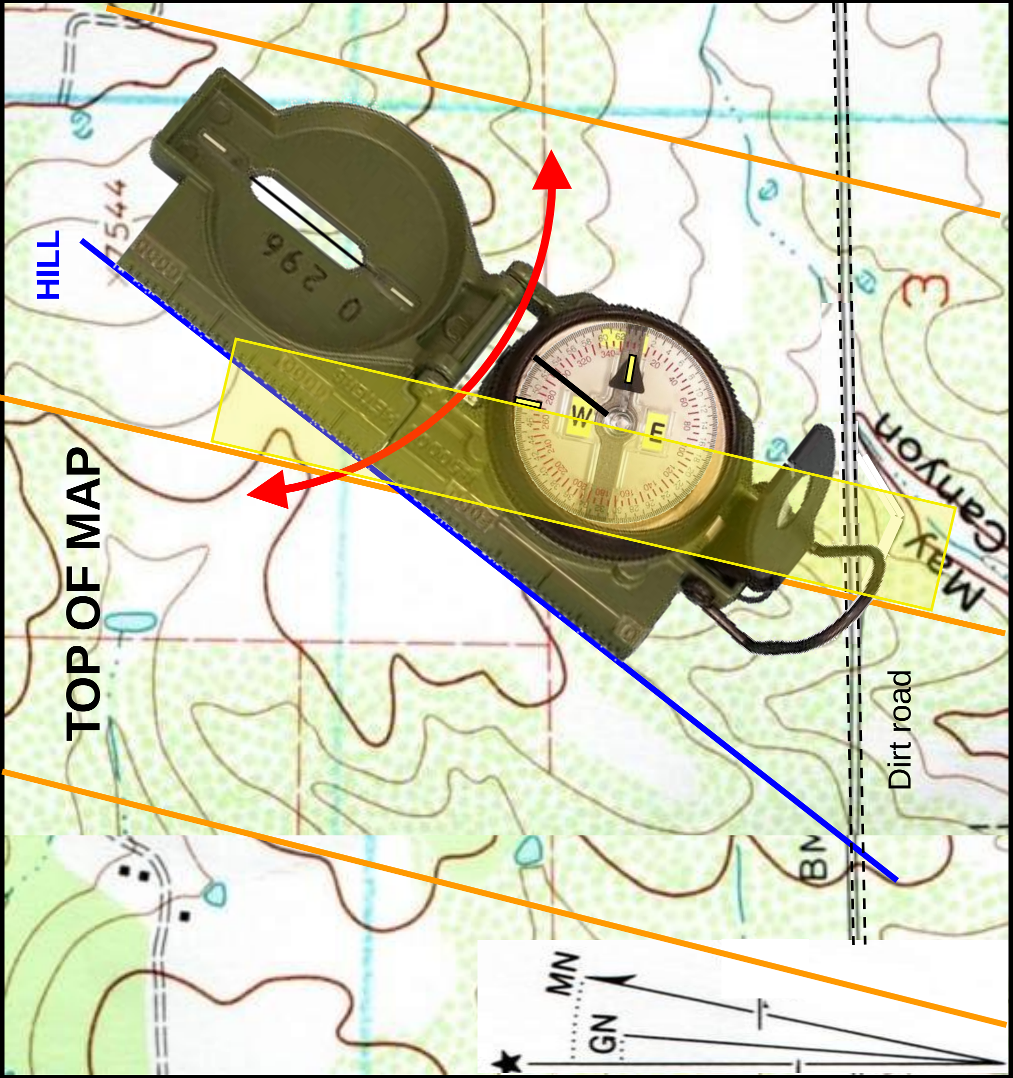
STEP FOUR. With compass & map:

1. Map does not have to be oriented. Why? Because you will be using the **MN Lines** and **Luminous Bezel Line** as references.
2. Open flat the compass and put the compass front left corner on the **HILL** landmark.
3. Then **Rotate** the whole compass until the **Luminous Bezel Line** (which represents the Magnetic North Needle in STEP THREE) is aligned / parallel with the **MN Lines**.
   - **The** luminous bezel line will always point to Magnetic North (Top of map).
   - **Ignore the compass dial needle.**

NOTE

a transparent square has been drawn to show that the **Luminous Bezel Line** and **MN Lines** are aligned / parallel.

4. **Draw a line** from the **HILL** to the dirt road. That is where you are.



TRACKING PRESENT LOCATION

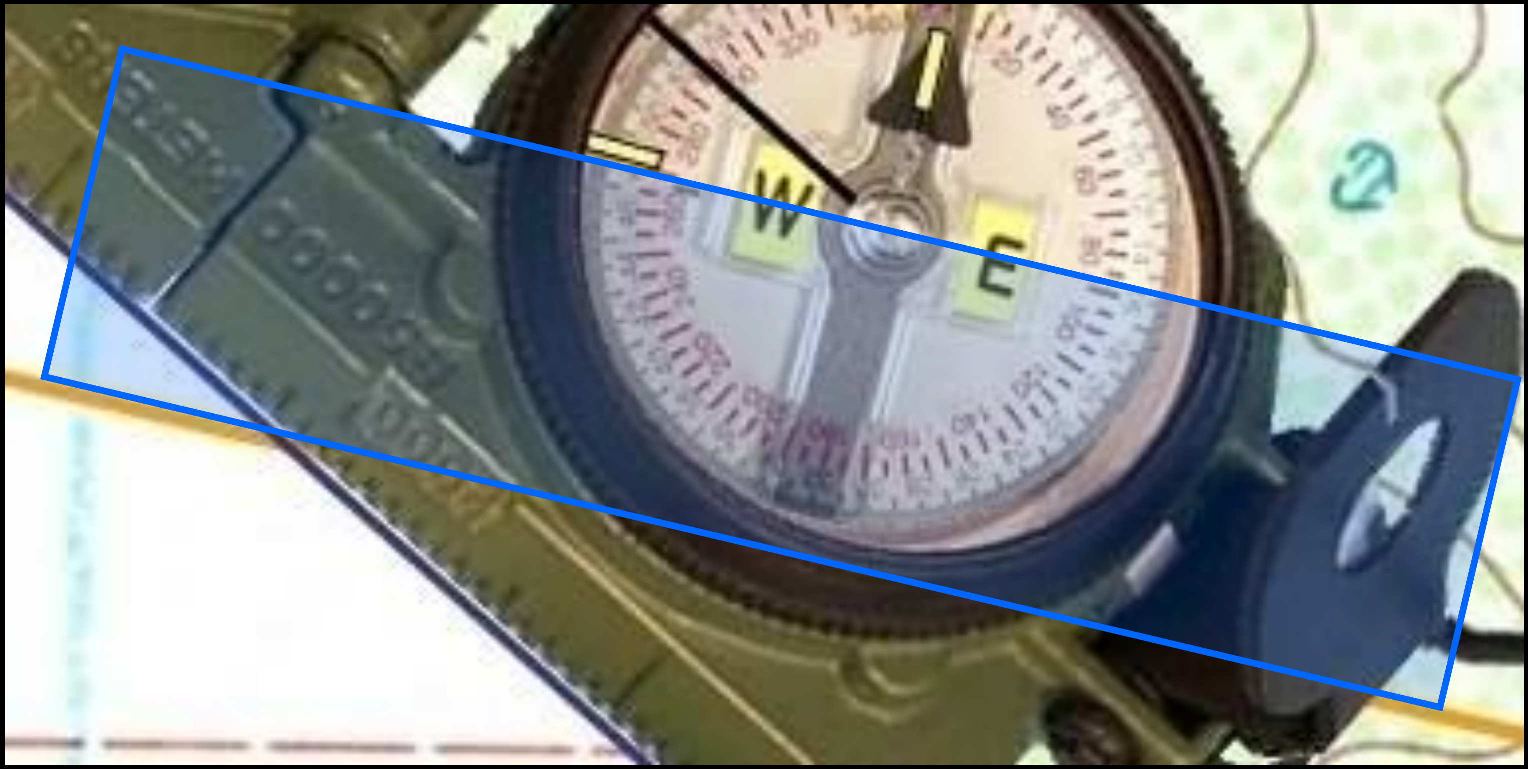
FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

Here is a *closer look* at **STEP FOUR**.

You can see that the **Luminous Bezel Line** and the **MN Lines** are **aligned** / **parallel**.

NOTE - Depending on how accurate you align the lines, your location can be off by as much as 200 yds. This method is only an estimation. If you want to be very accurate, orient the map to MN and align the Magnetic North Needle with the Luminous Bezel Line.



TRACKING PRESENT LOCATION

FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

To improve the accuracy of aligning the Luminous Bezel Line with the MN lines on the map.

1. Get a *superfine* permanent marker
2. Draw three lines parallel with the Luminous Bezel Line.
3. This will visually improve your accuracy of alignment.

However this will also add clutter to the face of the Lensatic Compass. This is a personal preference, if you want to add this to your compass face.

TRACKING PRESENT LOCATION

FINDING YOUR LOCATION - *ALTERNATE TECHNIQUE*

for Modified Resection, Intersection, Triangulation

Which one is easier to align?

You can clearly see the difference.

NOTE

However this will also add clutter to the face of the Lensatic Compass. This is a personal preference, if you want to add this to your compass face.

If you decide that you DO NOT want the lines on the face of the compass, you can remove them by getting an erasable marker and go over the permanent marker lines with it. This will moisten the lines so you can wipe them off with a towel. DO NOT use isopropyl alcohol or other liquids like nail polish remover – these liquids will discolor or fog up the compass face of the Lensatic Compass.

You can actually use the oils on the tips of your fingers to wipe of the lines; if you rub hard enough.

Any Questions?

TRACKING PRESENT LOCATION

FINDING YOUR LOCATION – ***ALTITUDE*** (altimeter)

An altimeter can help you determine your location by adding an elevation reading to other things you know. Think of this altitude as corresponding to a particular contour line on your map.

It can also tell you when you have reached a contour line on a map and guide you along that line, minimizing unnecessary uphill and downhill climbs.

This method works best if you are on a trail, ridgeline, or valley that contains a large section that is all uphill or all downhill. It can also be used in conjunction with the triangulation method to determine your position more accurately. First, be sure that you altimeter has been calibrated. Next, find the point on your map where the trail, ridgeline, or valley intersects the contour line that most closely corresponds to your altimeter reading.

Calibrating the altimeter:
The most accurate and ***first method*** is to set the altimeter at a location where the elevation is known, such as a trailhead. The ***second method*** is to adjust the altimeter to the current barometric pressure. This usually requires access to weather information on a radio designed to receive such broadcasts.

Your altimeter reads 5840 FEET
You are at contour line "X".

ANALOG

DIGITAL

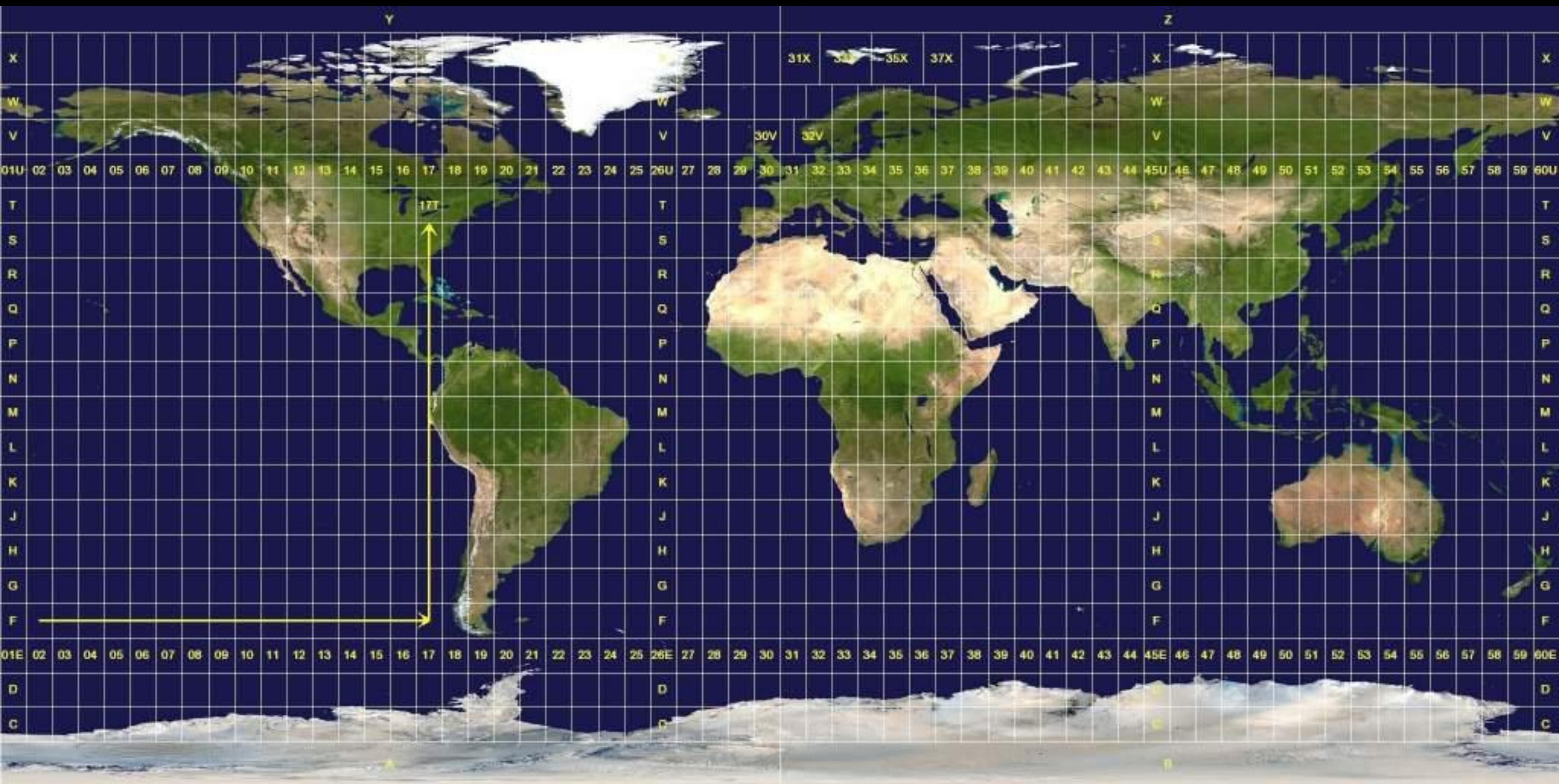
WATCH

Any Questions?

TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

Below is the Universal Transverse Mercator (UTM) grid.

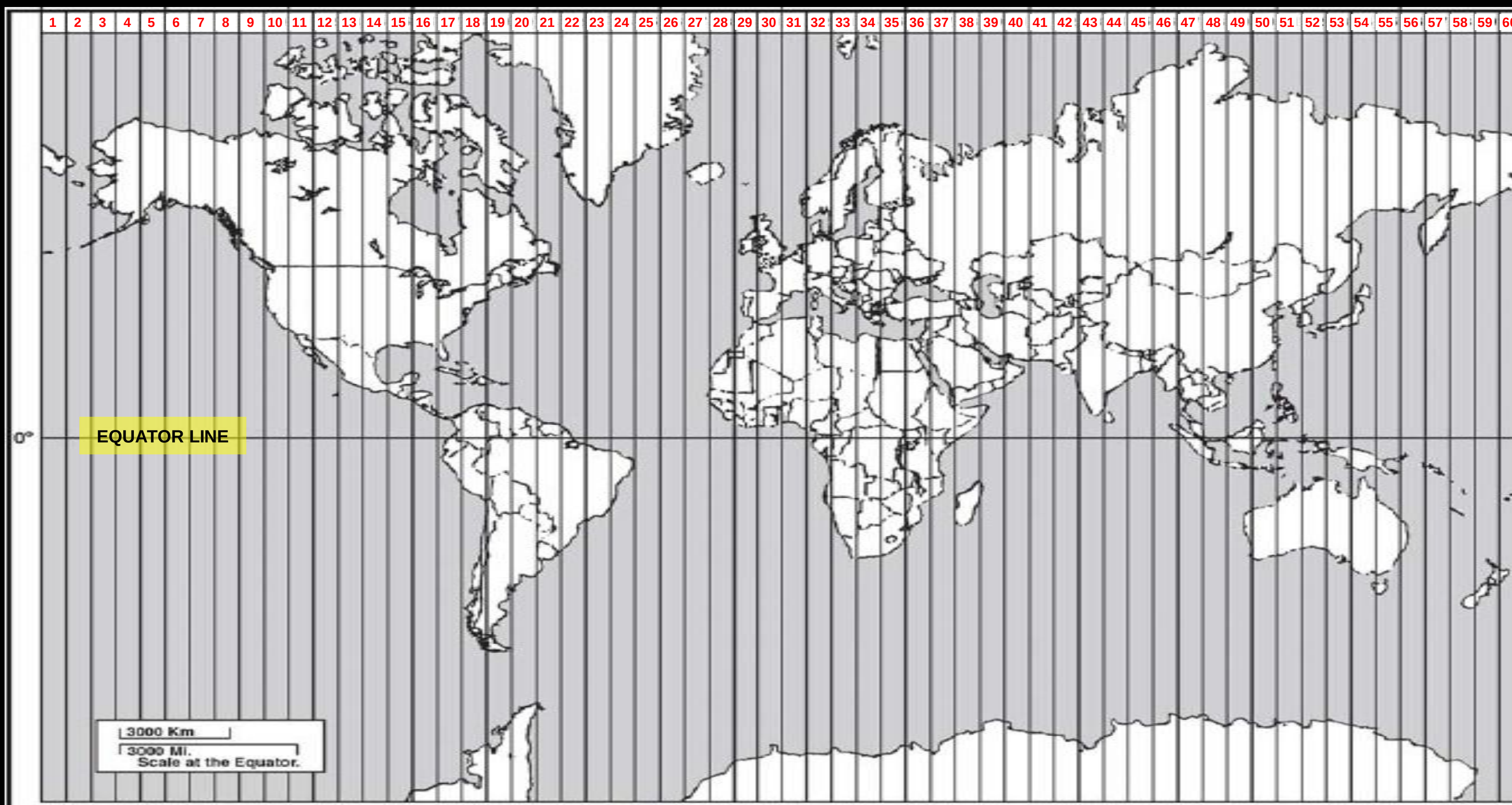


TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

HERE IS A BETTER WAY OF LOOKING AT THE UTM GRID LAYOUT

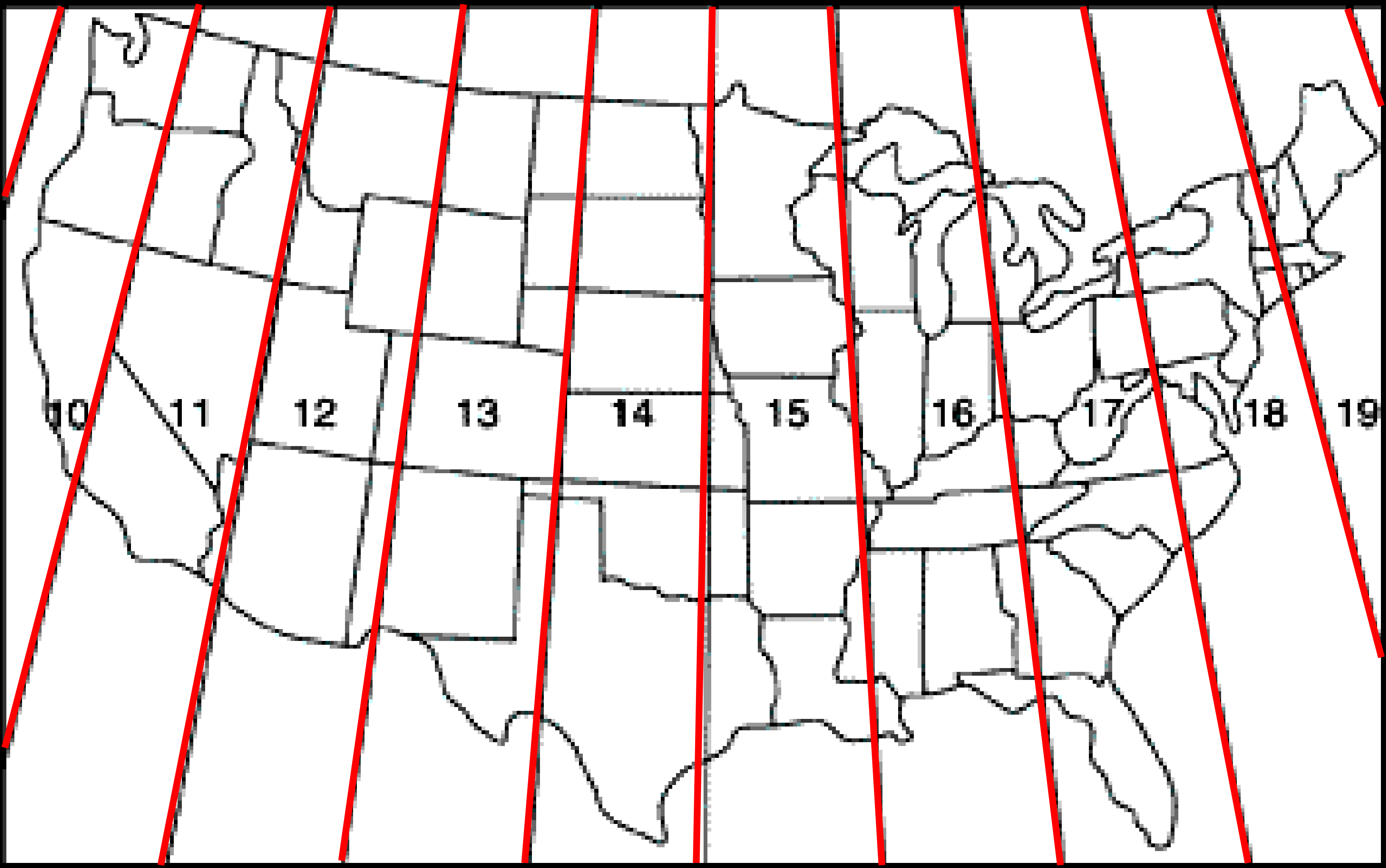
The world is divided into **60 zones**.
Here you can see **ZONES 1** thru **60** at the top of the world map.



TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

Close-up of UTM **ZONES**. Here we see **zones 10** thru **19**.



TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

On the bottom left corner of the map is the Universal Transverse Mercator information.

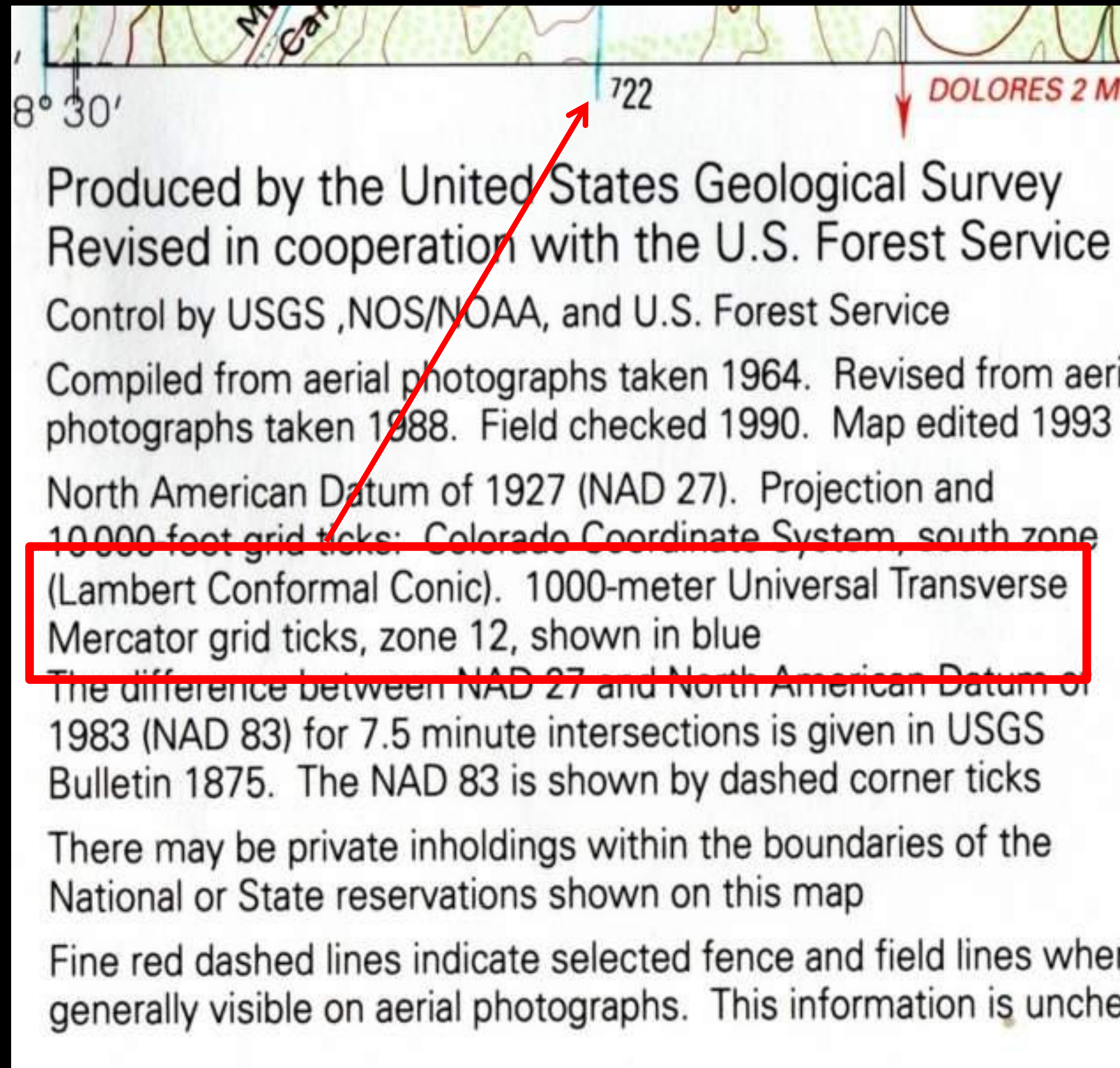
It will list the square area size covered and the **ZONE** the map represents.

The **ZONE** number is represented in the front of a UTM coordinate.

example

Z12 5**59**000m 42**81**000m

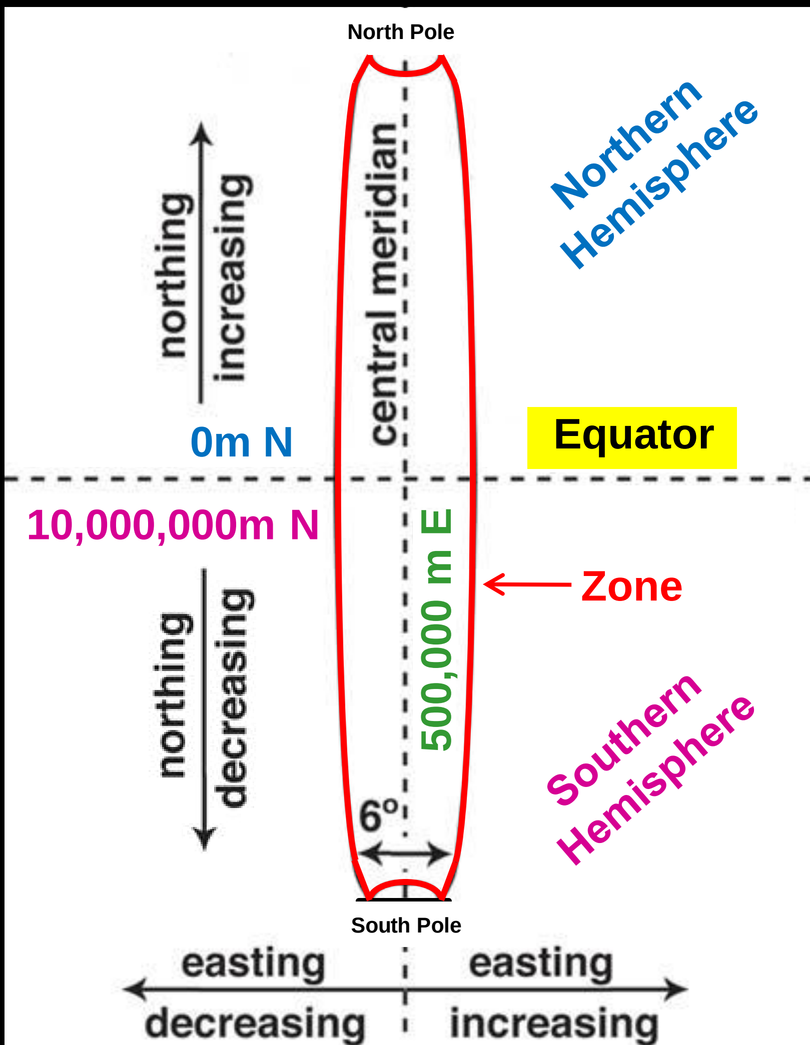
UTM Coordinates are explained in the next slides.



TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

UTM uses two coordinates – EASTING and NORTHING – to determine a location. Locations within a **ZONE** are measured in meters east and west from the central meridian (center of the **zone**), and north and south from the equator.



EASTING coordinate

The central meridian is an arbitrary line drawn down the center of each **zone**, and given a false easting value of **500,000 meters** so that only positive eastings are measured anywhere in the **zone**.

Eastings increase eastward and decrease westward from the central meridian.

NORTHING coordinate

Northing is the distance in meters north and south of the equator (measured along a line within the **zone**).

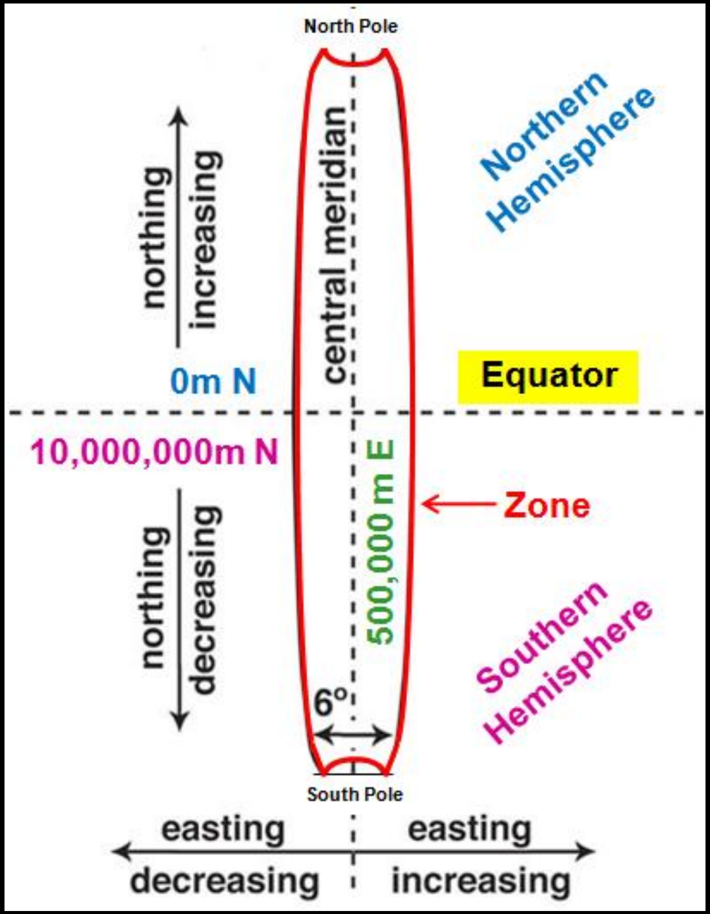
If the point lies north (**Northern Hemisphere**) of the equator, coordinates always increase from south to north (bottom of map to the top) of the equator, with the equator given a value of **0 meters in the Northern Hemisphere.**.

For locations south (**Southern Hemisphere**) of the equator, the equator is given a false value of **10,000,000 meters in the Southern Hemisphere** and values decrease from north to south (top of map to the bottom) of the equator.

TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

UTM Z19 0297480E 4834360N will be used for an example in a **Northern Hemisphere map** and a **Southern Hemisphere map**.



UTM Z19 0297480E 4834360N (**with a Northern Hemisphere map**)

1. Coordinate **0297480E** represents an east-west measurement and is the easting. This coordinate is located 202,520 meters west of **zone** central meridian line.

2. The 202,520 meters was calculated by observing that **297,480E** is smaller than **500,000mE**. Therefore, **500,000mE** – **0297480E** = **202,520**. The coordinate is 202 thousand, 520 meters west of **zone** central meridian line.

   NOTE:
   If the Easting number is greater than **500,000mE**, for example **574620E**. The coordinate is located 74,620 meters east of **zone** central meridian line. This number 74,620 meters was calculated by observing that **574620E** is bigger than **500,000mE**. **574620 E**– **500000mE** = 74,620. Therefore it is 74,620 meters east from the central meridian.

3. Coordinate **4834360N** represents a north-south measurement and is the northing. The location of this coordinate is 4,834,360 meters **North** of the equator in the **zone**, which starts at **0 meters**.

Z19 0297480E 4834360N (**with a Southern Hemisphere map**)

1. The coordinate **0297480E** is the same as above.

2. The coordinate **4834360N** represents a north-south measurement and is the northing. The location of this coordinate is 5,165,640 meters **South** of the equator in the **zone**. The number 5,165,640 was calculated by Subtracting **4,834,360** from **10,000,000 m N**.

TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

1. A UTM coordinate includes the zone, easting coordinate, and northing coordinate; this coordinate describes a specific location using meters. There are different ways that UTM coordinates are written, for example:

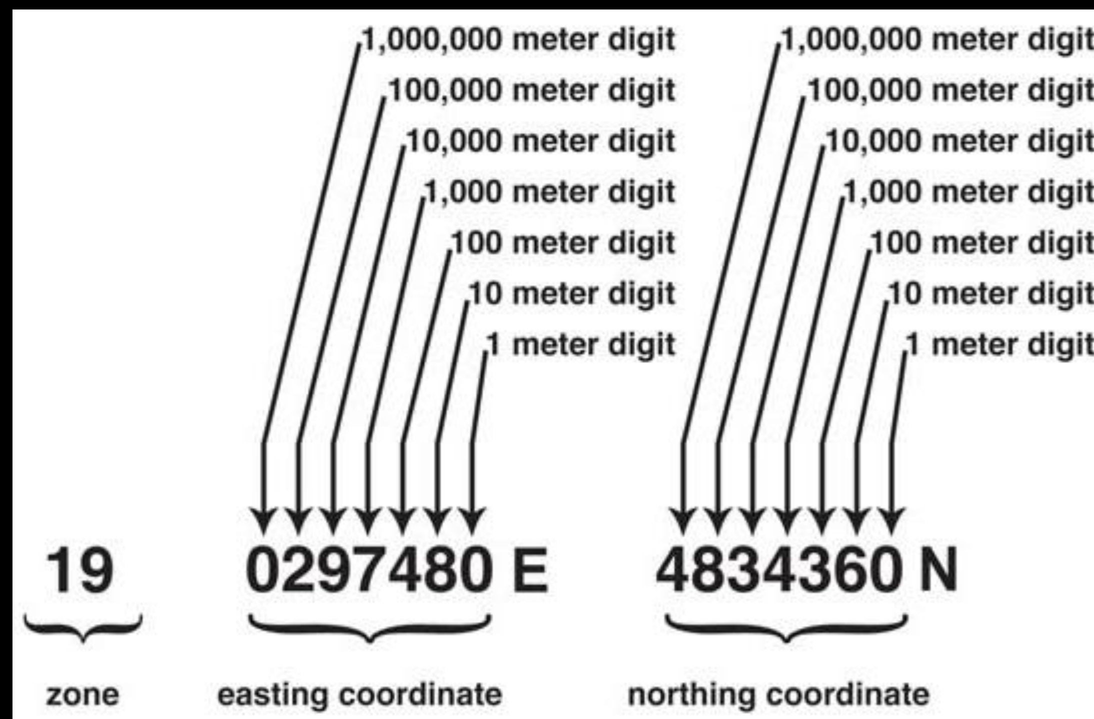
Z19 0297480E 4834360N
19 0297480E 4834360N
0297480mE 4834360mN (zone number is not used, because the hiking groups are all using the same maps and know
297480mE 4834360mN what zone they are in for communicating their location to each other via radios.)

2. Coordinates are also abbreviated to the extent of location accuracy desired; for example, UTM Z19 0297480E 4834360N :

19	297	4834	(1000 m by 1000 m square)
19	2974	48343	(100 m by 100 m square)
19	29748	483436	(10 m by 10 m square)
19	297480	4834360	(1 m by 1 m square)

NOTE:
The more digits you include, the closer you get to the exact location.

NOTE:
More detail given in the following slides.

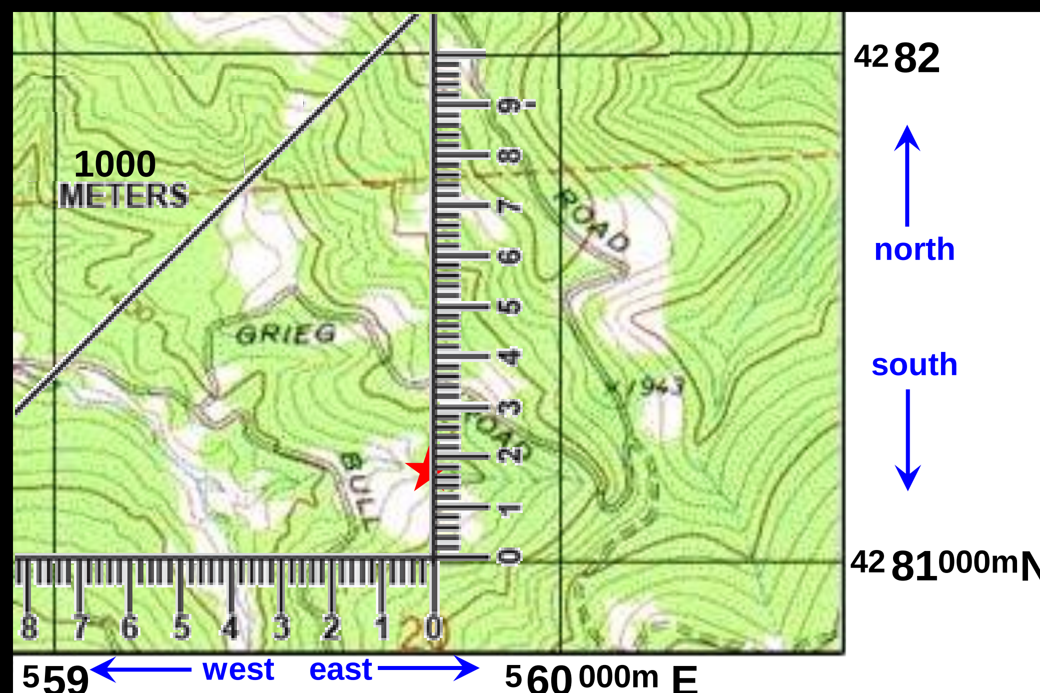


TRACKING PRESENT LOCATION

UTM GRID or GRID NORTH COORDINATES

- UTM refers to the system grid that divides the world into sixty zones, at 6º degree intervals.
- The UTM grid is based on the **METER SYSTEM**, and grid lines are always one kilometer apart (1,000 meters), making it much easier to estimate distance on a map.
- UTM numbers indicate east/west and north/south positions. The numbers along the left/right of margin are called Northing, numbers along the top/bottom are called Easting. Increasing numbers indicate you are traveling either north or east, decreasing numbers south or west.
- A full UTM tick number along the margin of the map is as follows: tick **4281000mN** and tick **4282000mN**, the principle (**large**) digits **81** and **82** indicates thousands of meters, and since a thousand meters equals one kilometer, the two ticks are one thousand meters or one kilometer apart (**82** – **81** = 1).
- The last three smaller numbers **000m** indicates hundreds of meters. If the ticks read **4281000mN** and **4281500mN** this would indicate the ticks were five hundred meters or ½ kilometer apart.
- GN refers to the UTM grid.
- The more digits you include, the closer you get to the exact location.

559000m 4281000m (4 digit) 1000m x 1000m area.
559700m 4281100m (6 digit) 100m x 100m area.
559750m 4281170m (8 digit) 10m x 10m area.
559753m 4281175m (10 digit) 1m x 1m area.

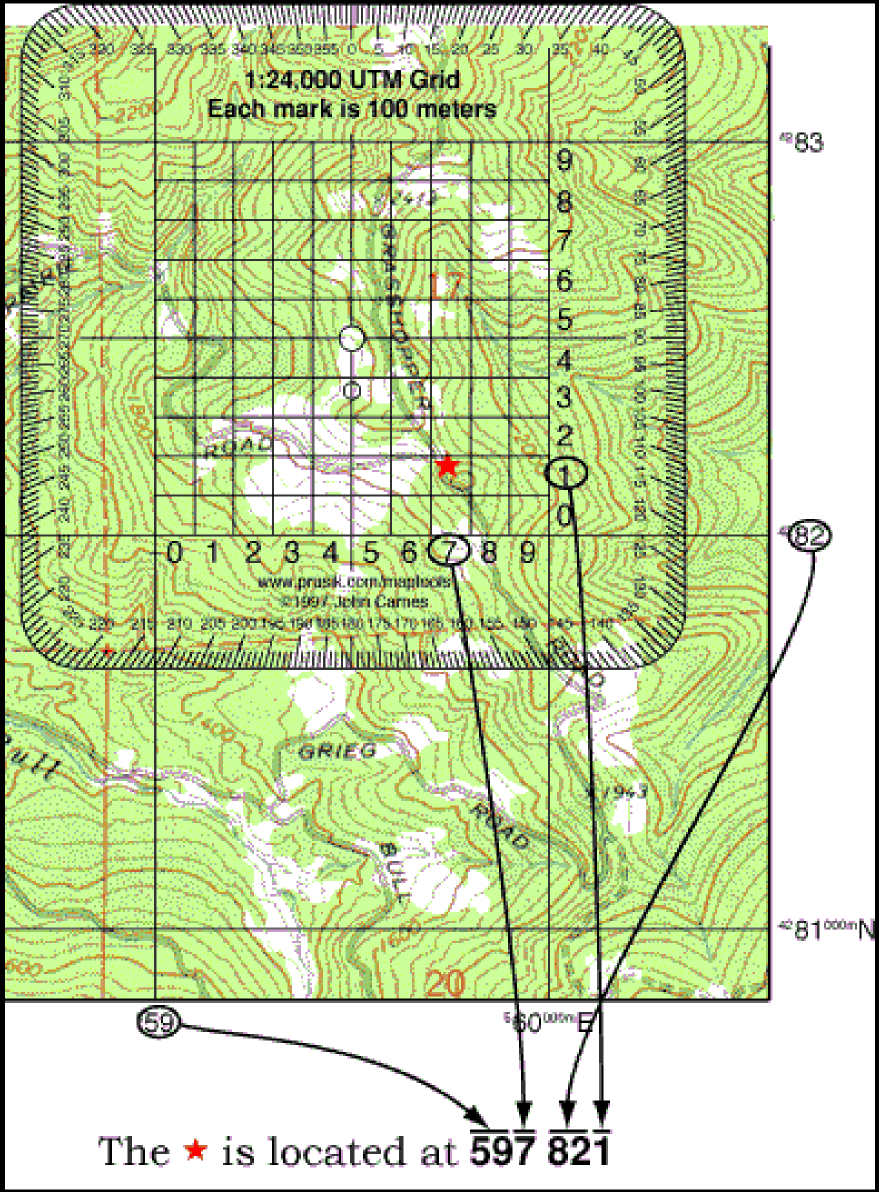


TRACKING PRESENT LOCATION

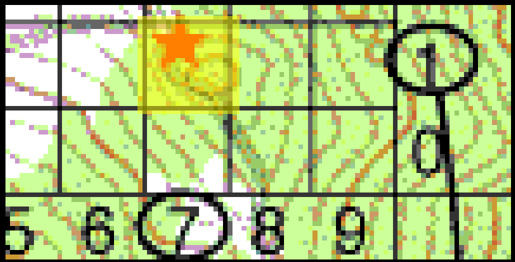
UTM GRID or GRID NORTH COORDINATES

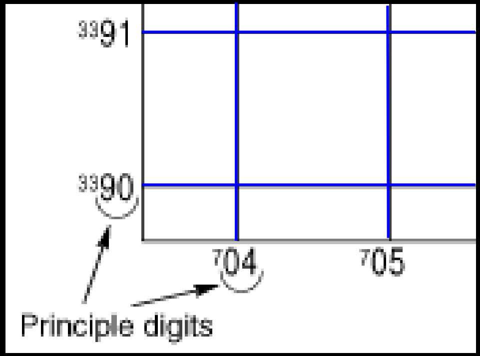
This is good to use when navigators have the same maps and need to communicate their location via walkie-talkies, when they are separated for any reason.

1. Note which 1000 meter grid square your position is in (read from the left bottom corner).
    - Example (★) is in 5**59**000 and 40**82**000.
2. Note that the Easting number (vertical grid line) is always read first, then the Northing (horizontal). Also note that two digits are large (principle digits) and the rest are small. This makes it easier to read.
3. Align the protractor within the grid square and see what small square your position (★) is in.
4. Then include vertical and horizontal square numbers to get 5**59**700 and 40**82**100 GRID COORDINATE.
    - You can read the six digits as **597 821**, 100 meter by 100 meter area (328FT x 328FT).



You are somewhere in this square area.





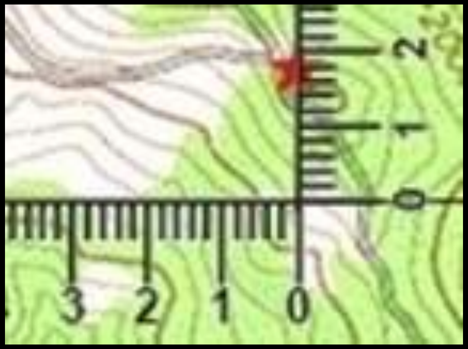
TRACKING PRESENT LOCATION

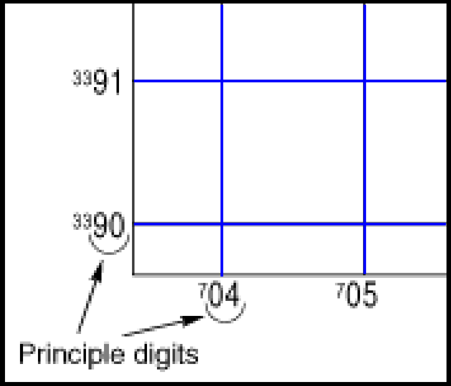
UTM GRID or GRID NORTH COORDINATES

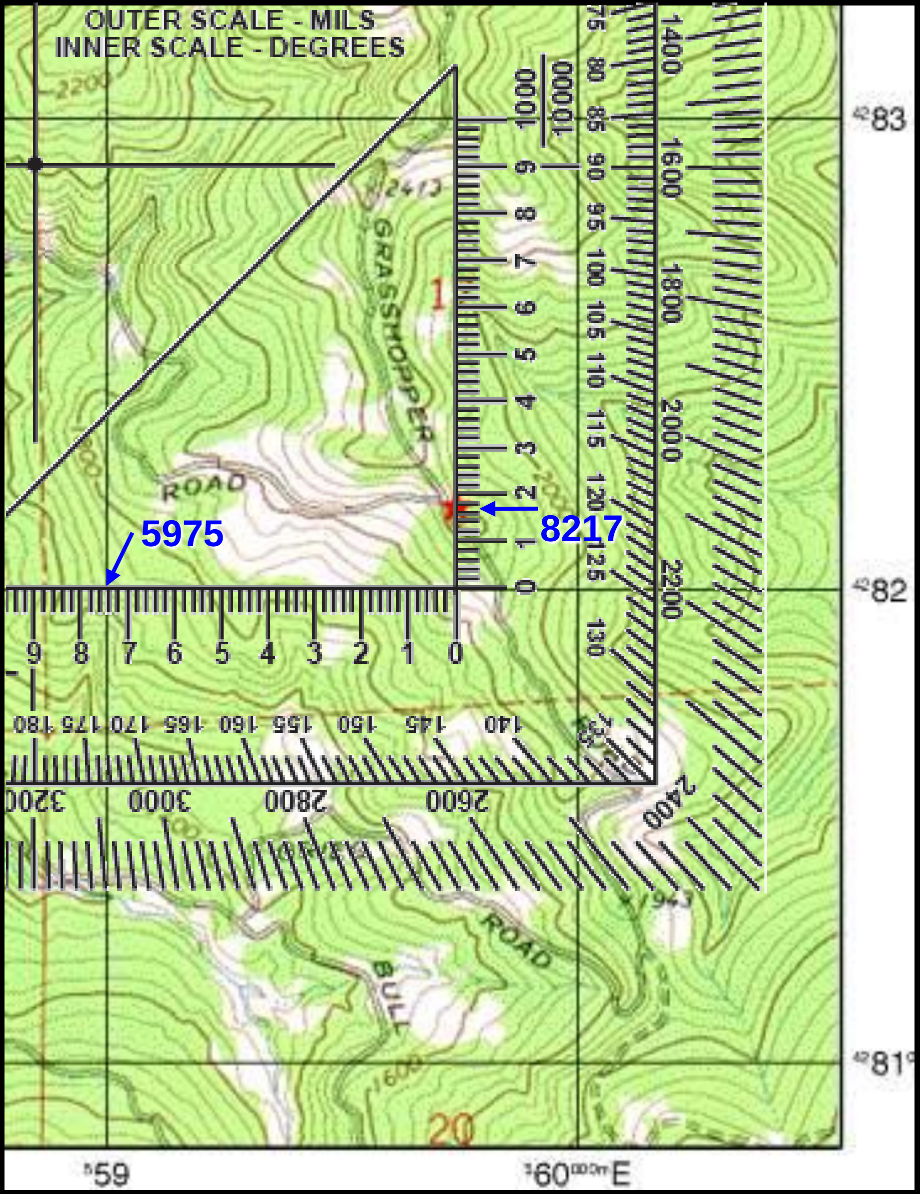
This protractor is more accurate in your location.

1. Note which 1000 meter grid square your position is in (read from the left bottom corner).
    - Example (★) is in 5**59**000 and 40**82**000.
2. Note that the Easting number (vertical grid line) is always read first, then Northing (horizontal). Also note that two digits are large (principle digits) and the rest are small. This makes it easier to read.
3. Align protractor horizontal scale with **82** horizontal grid line square and shift left or right till the vertical scale is aligned over your position (★).
4. Then include the vertical and horizontal tick numbers to get 5**59**750 and 40**82**170 GRID COORDINATE numbers.
    - You can read the eight digits as **5975 8217**, 10 meter by 10 meter area (33FT x 33FT).

You are exactly here.







TRACKING PRESENT LOCATION

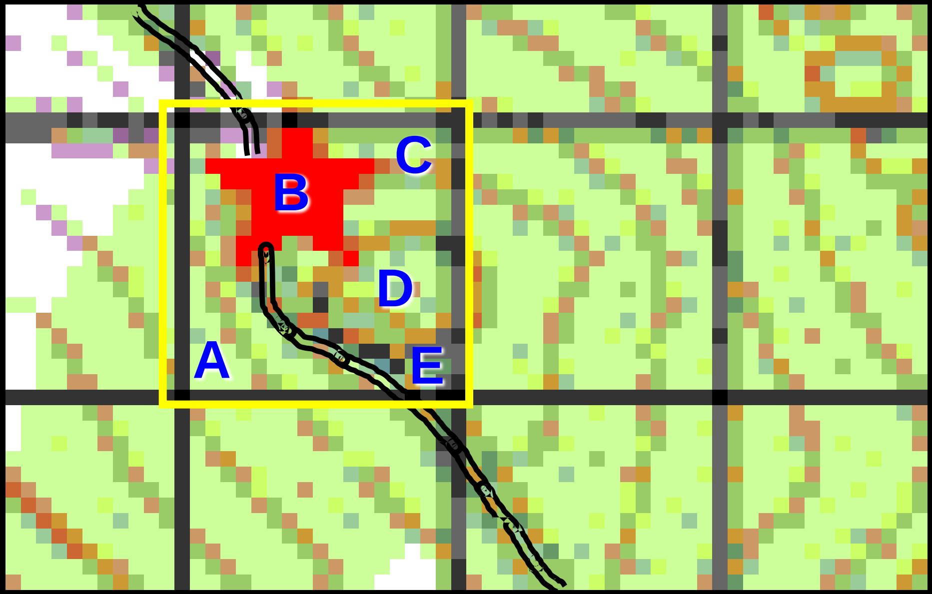
UTM GRID or GRID NORTH COORDINATES

On this type of protractor you have a general location where you are.

100m x 100m area / 10,000 sq meters
110y x 110y area / 12,100 sq yards

At which location are you?

A. South west side of road, west side of hill?
B. North east side of road, north west side of hill?
C. Due north side of hill?
D. On top of hill?
E. Due south side of hill?



On this type of protractor you have a more exact location where you are.

10m x 10m area / 100 sq meters
3.3y x 3.3y area / 11 sq yards

You know you are exactly at location **B**.

Any Questions?

DETERMINING TRAVEL DISTANCE

DESCRIPTION

Determining travel distance is the most common error encountered while moving. There may be circumstances where you are unable to determine travel distance using your map. It is therefore essential to learn methods by which you can accurately measure, pace, or estimate distances on the ground.

How far is that mountain? An ability to judge distances accurately is not a natural gift, but it is a skill worth developing. Judging distances accurately can help to identify features and avoid wrong assumptions that could lead to trouble; ("We should have reached camp by now… that's got to be Eagle Mountain, I think?")

- There are several techniques to **measure distance** on a map.
  - STRAIGHT LINE DISTANCE – measuring from point A to point B on a map (horizontal distance).
  - CURVATURE DISTANCE – measuring a trail or other curved line on a map (horizontal distance).
  - SLOPE DISTANCE – measuring the planned route terrain slope on a map (vertical distance).
- There are several techniques to **determine distance** on the ground.
  - SPEED – estimating your travel speed, how many miles per hour.
  - PACE COUNT – count the number of steps you have taken and translate to ground distance.
  - ESTIMATION – visualizing a set ground distance.
  - TIME – Make it a habit of keeping your map and compass handy and refer to them every hour or so to locate your position (more often in low visibility). Keep track of your starting time, rest breaks and hiking pace. This will also give you an idea of how far you have traveled over a period of time.

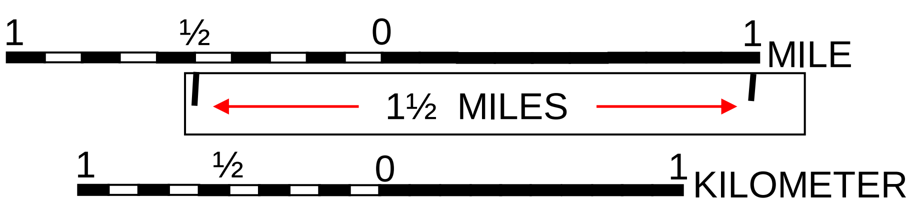
DETERMINING TRAVEL DISTANCE

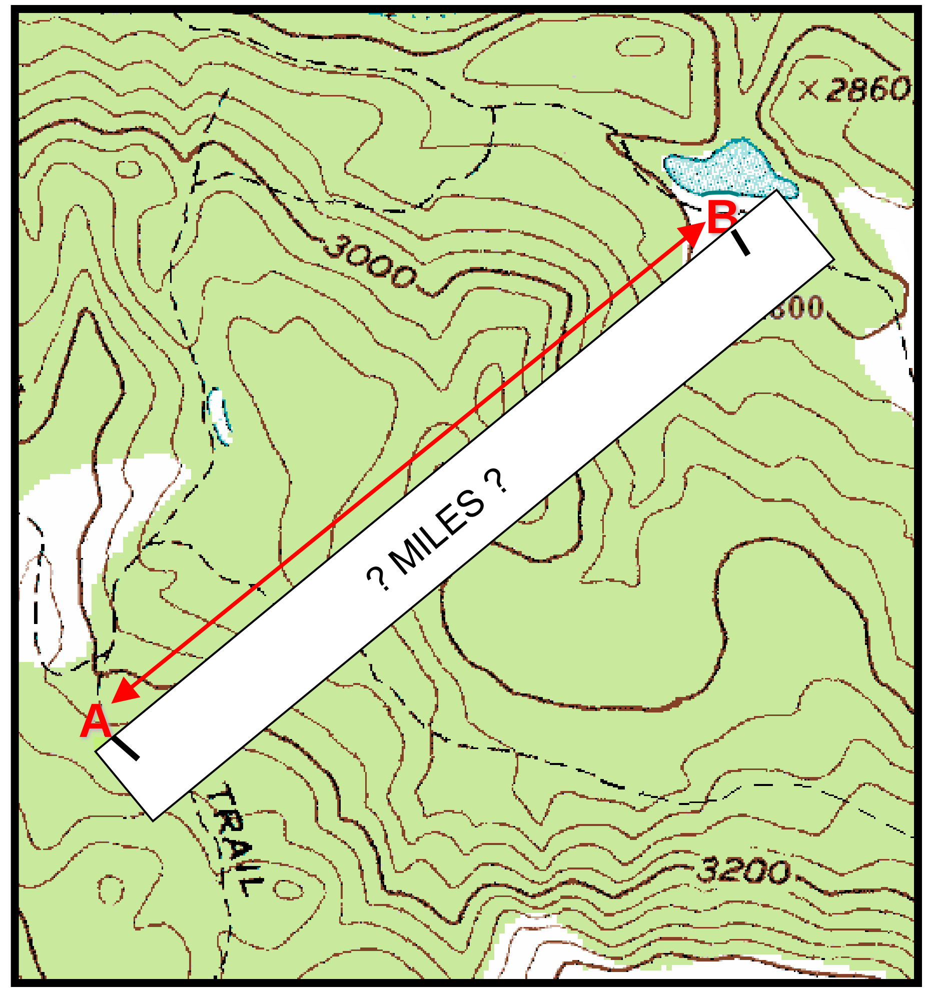
MEASURE STRAIGHT LINE DISTANCE

1. To determine straight-line distance between two points on a map, lay a straight-edged piece of paper on the map so that the edge of the paper touches both points and extends past them. Make a tick mark on the edge of the paper at each point.

2. To convert the map distance to ground distance, move the paper down to the graphic bar scale, and align the right tick mark with a printed number in the primary scale so that the left tick mark is in the extension scale.

3. Measure (add) the bar scale miles or kilometers.

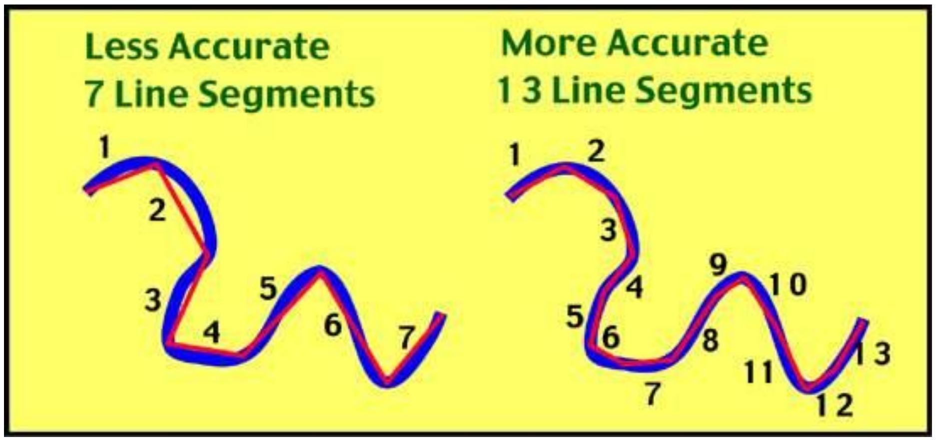




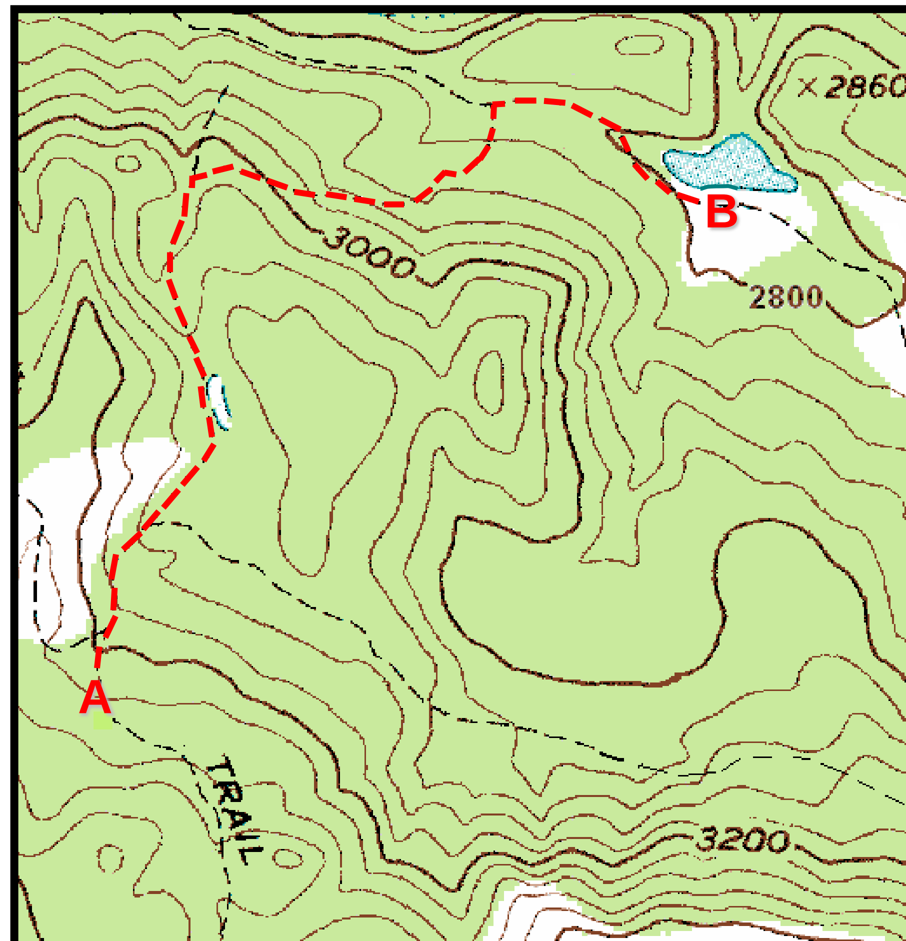
DETERMINING TRAVEL DISTANCE

MEASURE CURVATURE DISTANCE

Measuring distance along map features that are not straight is a little more difficult. One technique that can be employed for this task is to use a number of straight-line segments. The accuracy of this method is dependent on the number of straight-line segments used.



Another method for measuring curvature map distances is to use a device called a map wheel. This device uses a small rotating wheel that records the distance traveled. The distance is measured by placing the device wheel directly on the map and tracing the trail or planned route with the wheel, it measures either in centimeters or inches.

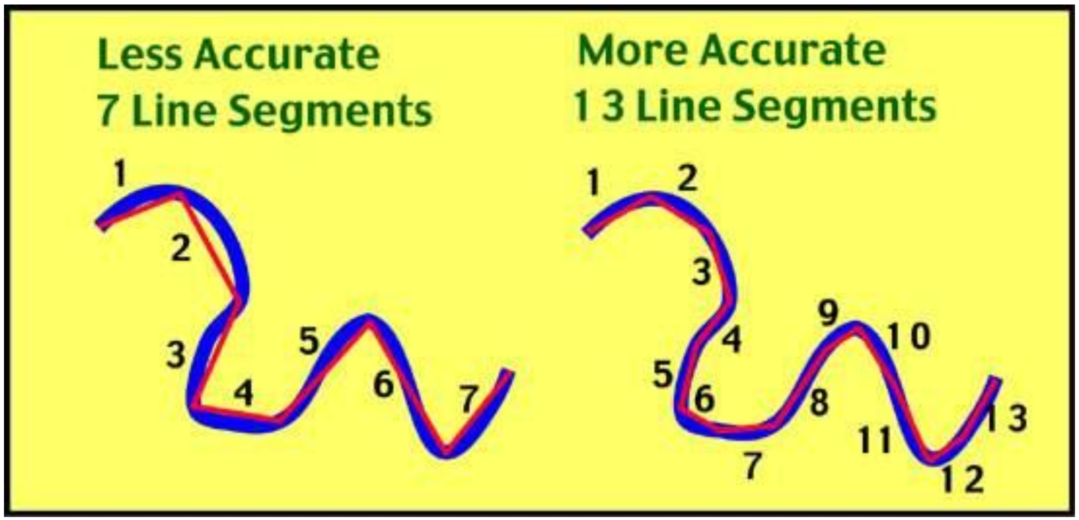


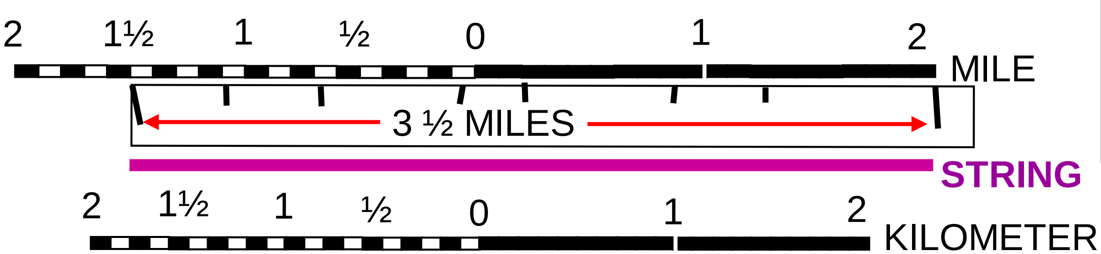
DETERMINING TRAVEL DISTANCE

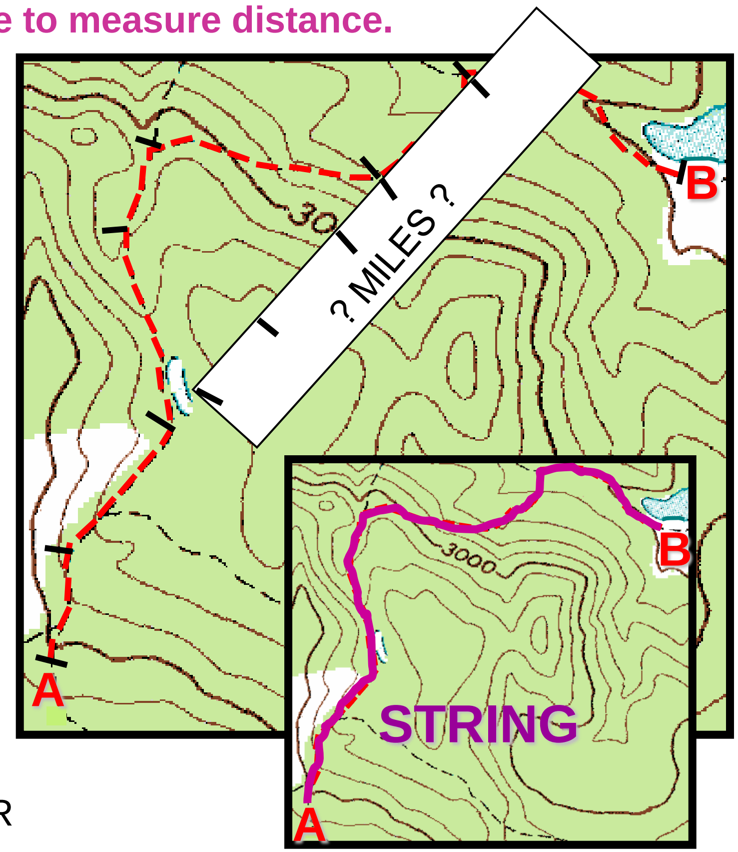
MEASURE CURVATURE DISTANCE

To measure distance along a road, stream, or other curved line, the straight edge of a piece of paper is used. Place a tick mark on the paper and map at the beginning point from which the curved line is to be measured. Align the edge of the paper along a straight portion and make a tick mark on both map and paper where the edge of the paper leaves the straight portion of the line being measured. Repeat for each straight segment of the road, stream, or other curved line. When completed, measure distance from first tick mark to last tick mark on map scale.

NOTE – you can also use a string laid out on the planned route to measure distance.







DETERMINING TRAVEL DISTANCE

MEASURE SLOPE DISTANCE (percentage or degree)

1. Determine elevation of point (**A**) (**3240 feet**) and (**B**) (**2800 feet**).
2. Vertical Distance (VD) is subtracting the lowest slope point (**B**) from the highest point (**A**), (**440 feet**) is VD.
3. Measure Horizontal Distance (HD) between points (**A**) and (**B**).
4. Compute the slope percentage by using the formula below. (HD) + (Slope%) = total distance

Example **5280ft (1mile) + 25% slope = 5280ft + 1320ft (25% of 5280) = 6600ft (1¼ mile)**

* * 25% slope (14º)= every 100ft traveled forward is 25ft traveled up (4ft forward is 1ft up) * *

NOTE*: *the higher the percentage % or degreeº, the steeper the slope and the longer the distance.

$$\text{Slope \% percent} = \frac{VD \times 100}{HD} = \text{\% percent}$$

$$\text{Slope degree}^{o} = \frac{VD \times 57.3}{HD} = \text{slope degree}^{o}$$

Slopes above 12% is a concern for a hiker.
Slopes above 25% and a hiker is climbing.

CURVATURE DISTANCE IS 3½ MILES = 18480 FEET

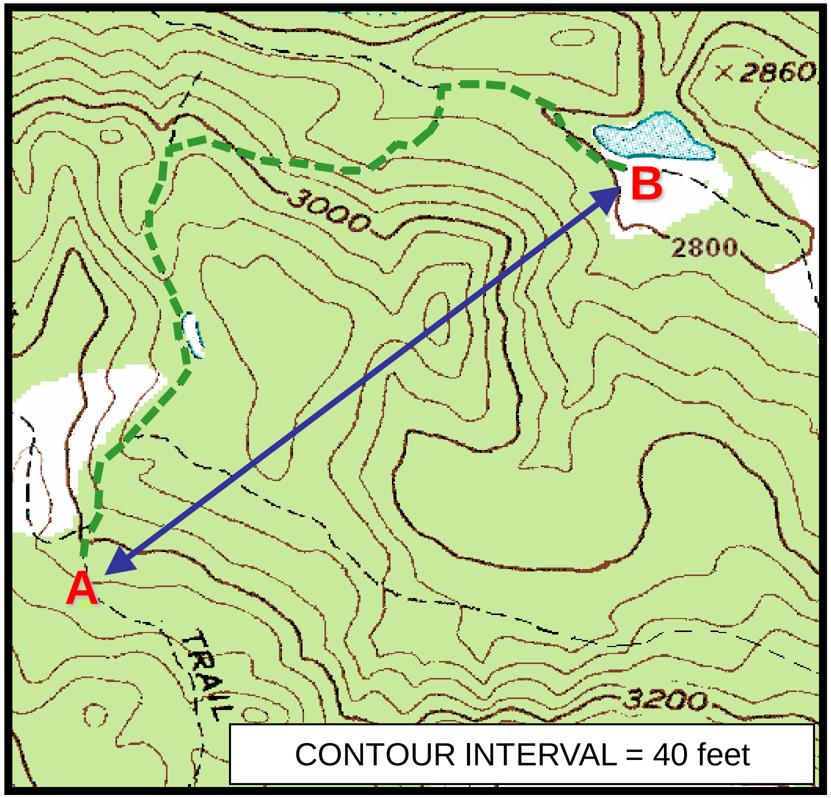
$$\text{Slope \%} = \frac{440\text{ ft} \times 100}{18480} = 2\ \%\ (+370\text{ ft})\ [1^{o}\text{ slope}]$$

Total distance 18480 + 370 =18850 feet

STRAIGHT LINE DISTANCE IS ¾ MILE = 3960 FEET

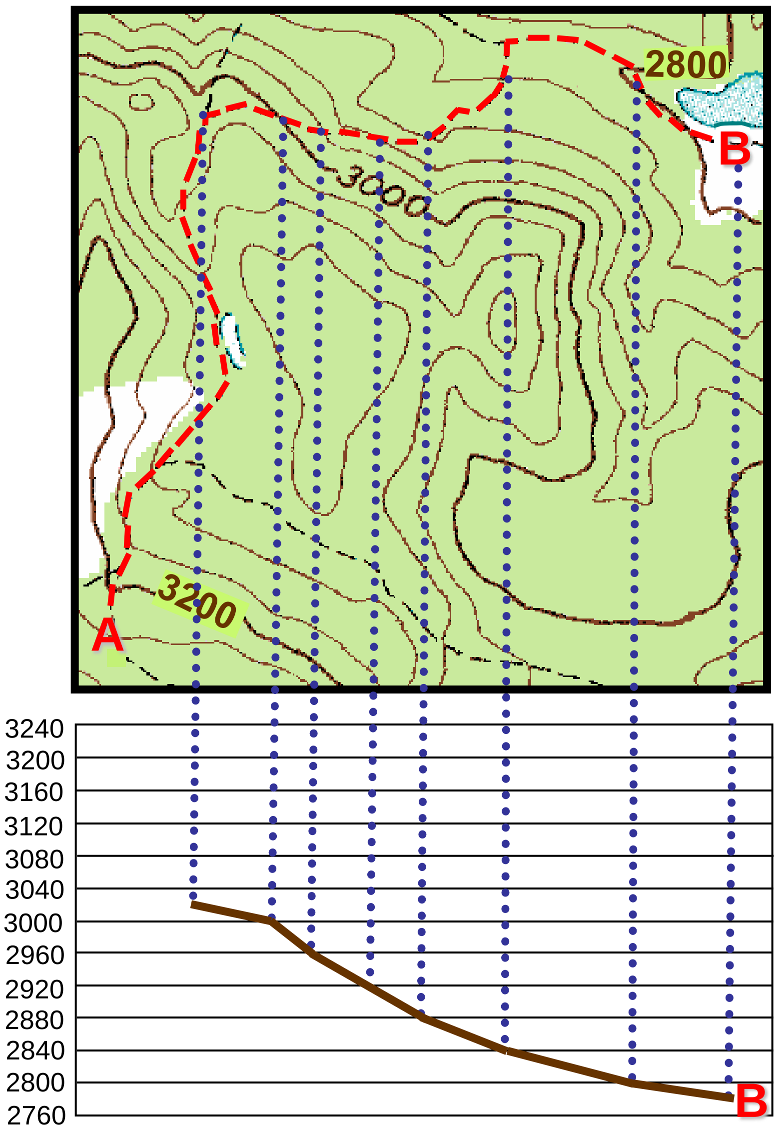
$$\text{Slope\%} = \frac{440\text{ ft} \times 100}{3960} = 12\ \%\ (+443\text{ ft})\ [6^{o}\text{ slope}]$$

Total distance 3960 + 443 = 4403 feet



DETERMINING TRAVEL DISTANCE

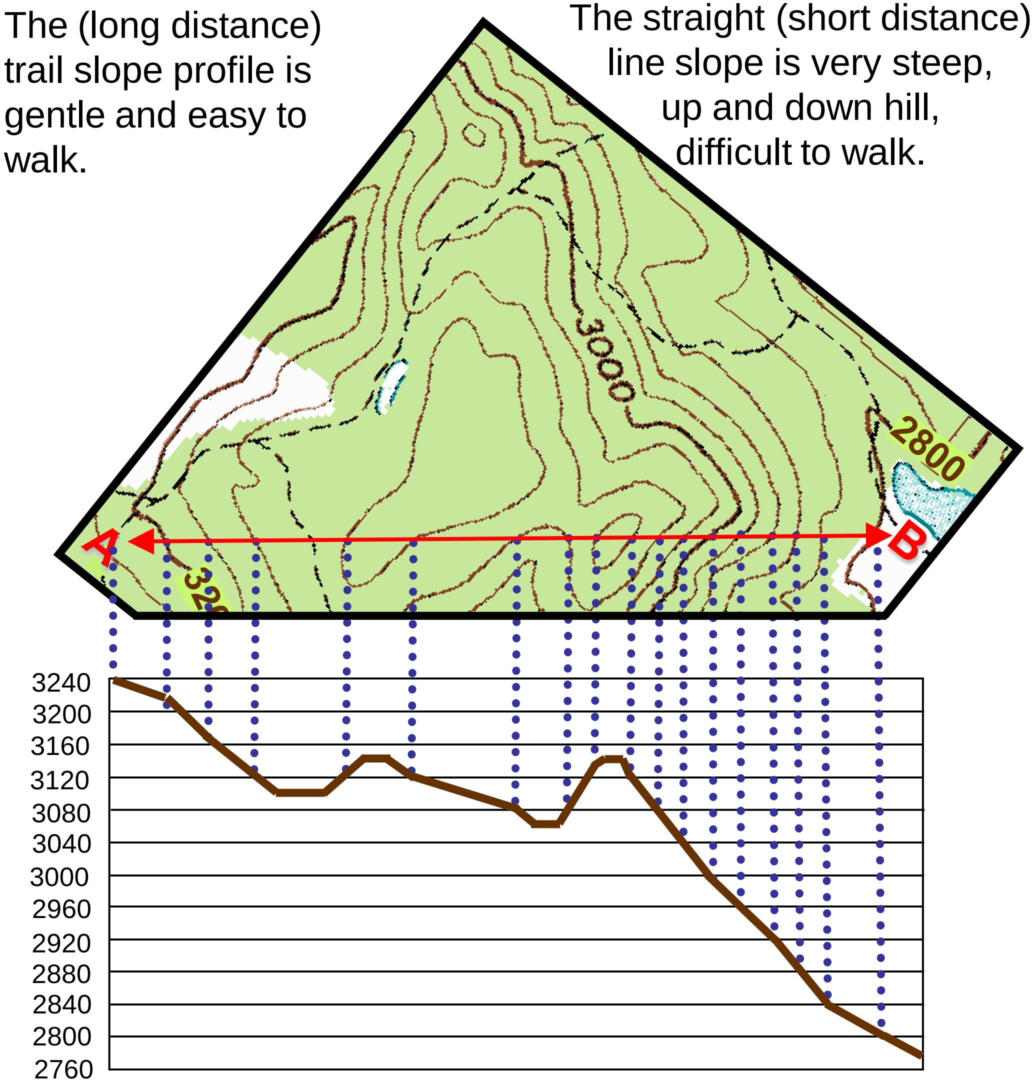
MEASURE SLOPE DISTANCE (slope profile)



Curvature Trail route vs. Straight Line route.

The (long distance) trail slope profile is gentle and easy to walk.

The straight (short distance) line slope is very steep, up and down hill, difficult to walk.

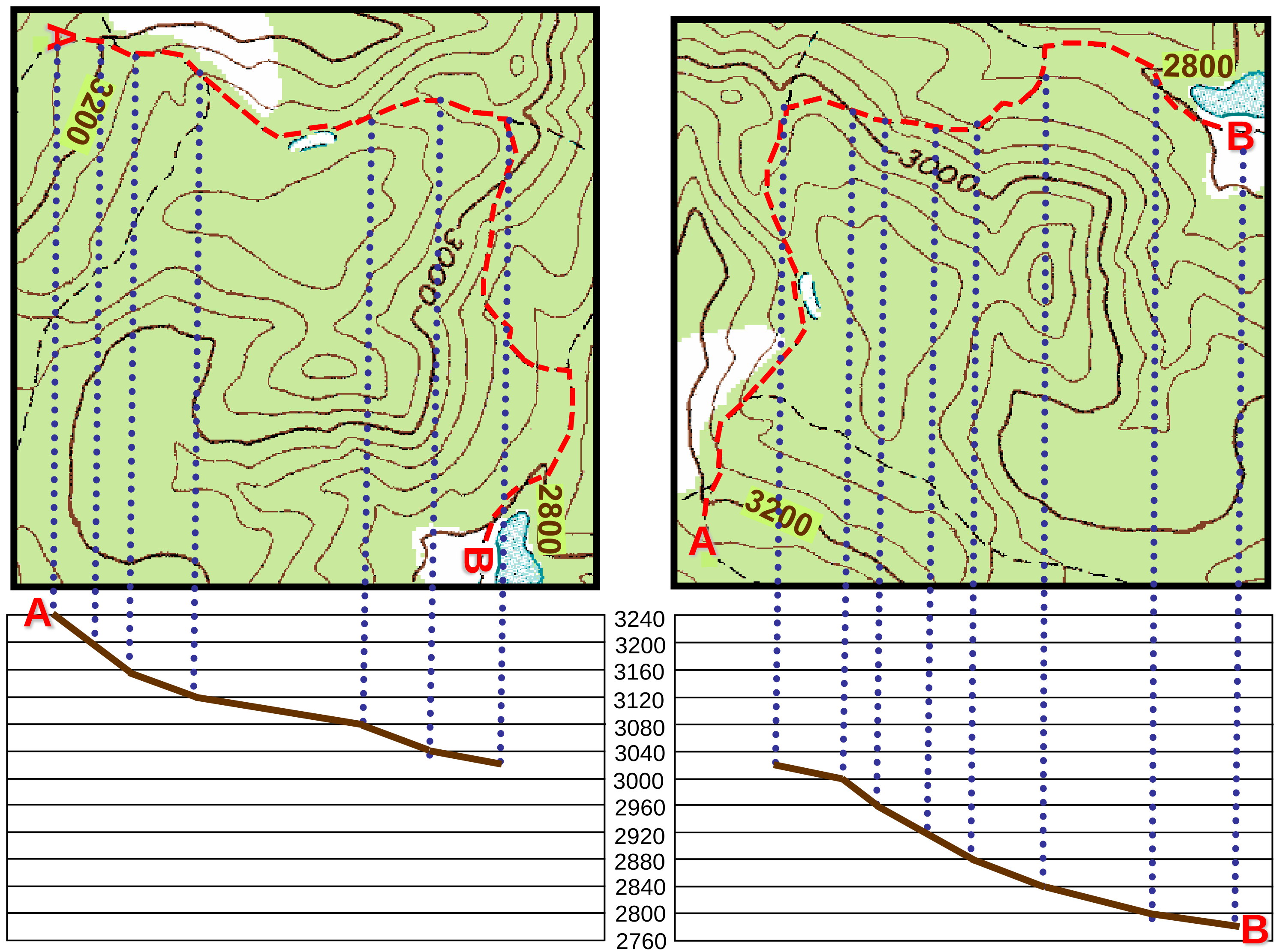


DETERMINING TRAVEL DISTANCE

SLOPE DISTANCE (slope profile)

Curvature Trail route and slope steepness.

Even though this route is longer, it is obvious that this is a gentle and easy route to walk.



Any Questions?

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY SPEED

- Estimating your rate of travel is essential when calculating the amount of time it will take to traverse a route. Especially when a group is hiking at the pace of the slowest group member.
- This data is needed when planning your own trip or a group trip.
- According to the U.S. Army, the following way is a good method to estimate hiking speed.

FEMALE		
TIME	STEPS	SPEED
10 SEC	20 - 21	3 MPH
10 SEC	27 - 28	4 MPH

MALE		
TIME	STEPS	SPEED
10 SEC	16- 17	3 MPH
10 SEC	20 - 21	4 MPH

You also need to factor in elevation gain and loss
ADD ONE HOUR FOR EVERY 1,000 FEET OF ELEVATION CHANGE

Example you hike 4 MPH, on a 4 mile route, with a 2,000 feet elevation gain, takes you 3 hours.

1hr (4miles / 4mph) **+ 2hrs** (1hr per 1,000ft [2,000ft]) **= 1 + 2 = 3 hours**

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY PACE COUNT

Why count paces?

While pace counting is an old distance determination technique that is seldom used by trail-bound hikers, it is an ***essential*** technique used by ***off-trail navigators*** (with other techniques) who travel cross-country through challenging wilderness. In certain situations, a map and compass alone just aren't enough.

More mistakes are made in orienteering by wrongly estimating distance than from any other reason. While most of us can quickly learn to travel in the right direction, few of us have any idea of how far we have traveled.

Think about it for a moment. Have you ever cut an azimuth through the bush and wondered if you had missed your target, or perhaps not gone far enough, when it did not materialize? Did you continue on another 10 minutes, then 20 minutes, hoping it would appear? Or did you backtrack? You could have eliminated much of the guesswork in this situation by using a technique known as “pace-counting."

Pace counting with ***Ranger Pacing Beads*** is well suited for the complicated navigational challenges faced by today's ***wilderness navigator***. For example, pace counting is essential for dead reckoning, where azimuth (or direction of travel) data is combined with pacing (or distance traveled) data. With this technique, one can establish his or her position in nondescript terrain, foul weather, or even in complete darkness.

The hardest thing to get a "feel" for is how to adjust your pace-count for weaving back and forth on a route covered with trees, shrubs, and boulders.

The "dead" in dead reckoning is derived from "ded.," an abbreviation of "deduced.“ It's navigation by logical deduction. It does not necessarily mean it's a deadly form of navigation.

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY **PACE COUNT**

- In thick jungle, where landmarks can not always be seen to track your position, **PACE COUNT** is the best way of measuring distance. It is the only method which lets a navigator know how far he has traveled. With this information, he can estimate where he is at any given time.
- To be accurate, the navigator must practice pacing over different types of terrain. First you have to do some calculations. Measure out exactly 100 meters on three types of ground. Flat **easy** terrain, **rougher** terrain with some slope and then **steep hill** terrain. Then on each measured course count your paces (every time your left foot touches the ground or every 2 steps = 1 pace). You will have 3 different pace counts for different types of terrain. If you wear a pack when in the woods then do your pace testing with the pack and boots on. Once finished MEMORIZE your pace count of all 3 types.
- When using a map and you have a destination that's 3 km's away you have an idea how many paces it will take you to travel that distance as an estimate.
- A navigator could make a PERSONAL PACE TABLE like one of these three examples:

TERRAIN	METERS	PACES
Swamp	100	85
Forest	100	70
Desert	100	115
Snow	100	115
Jungle	100	125
Prairie	100	65
Hills	100	95

TERRAIN	METERS	PACES
Sand	100	115
Gravel	100	100
Snow	100	120
Flat	100	65
Thick brush	100	80
Up hill	100	95
Down hill	100	90

Flat easy terrain	100 meters	65 paces
Rougher terrain with some slope	100 meters	75 paces
Steep hill terrain	100 meters	95 paces

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY PACE COUNT

RANGER PACECOUNTER TM

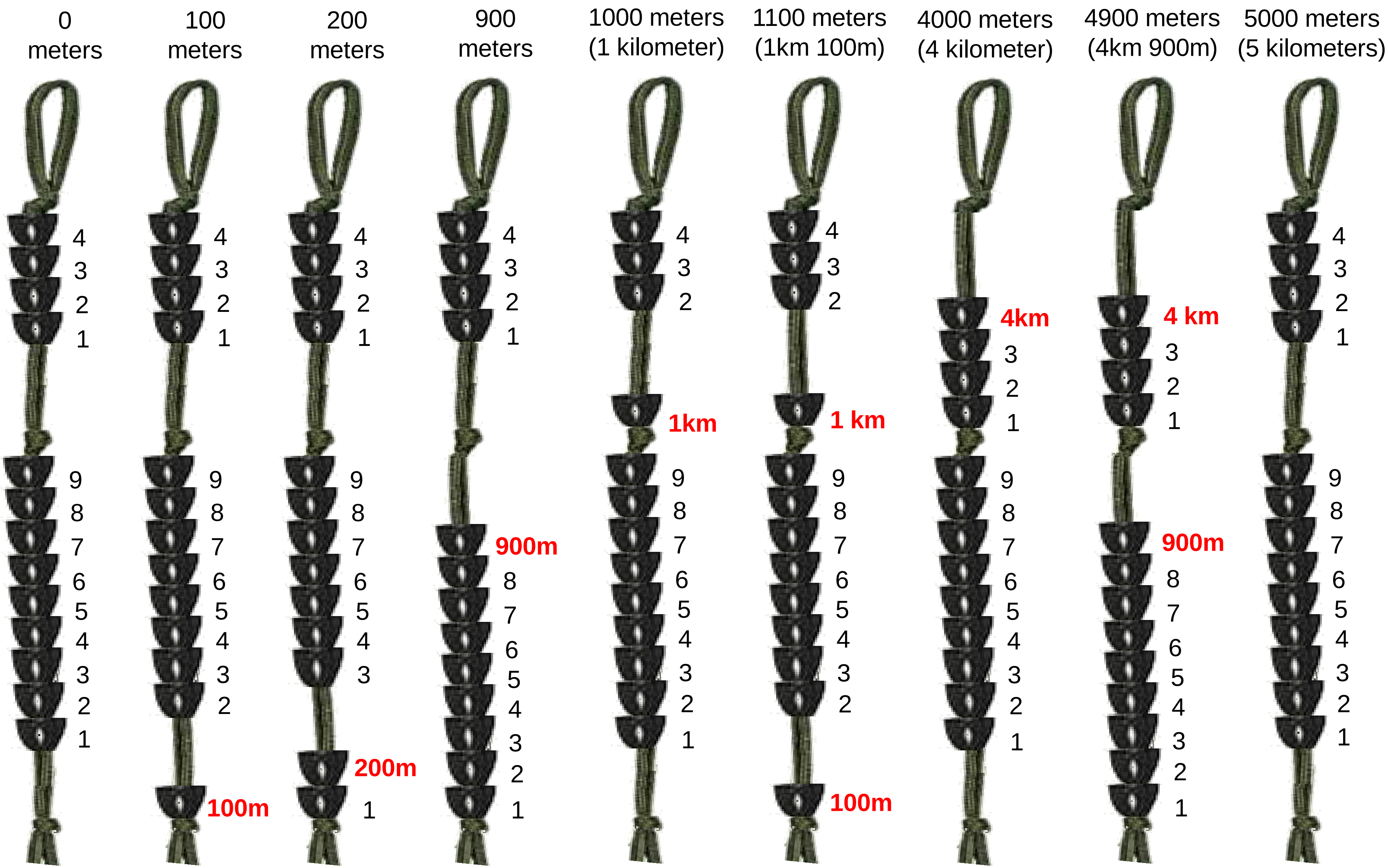
Attach the **RANGER PACECOUNTER**TM by passing the loop end through your top button hole or LCE and pulling the beaded end through the exposed loop. Pull both sets of beads as far up as possible. After pacing off 100 meters, for example 65 paces with your left foot, pull down the first bead from the line with nine. Continue this until all nine beads are down. After the next 100 meters pull down a bead from the line with four and reset the nine beads. This marks 1 kilometer. When all the beads are pulled down at (at 4900 meters) pace off another 100 meters, pull all the beads up to mark 5 kilometers, and start again. With practice you can be sure of your pace count day or night.

Tested and proven
at Fort Benning and Fort Bragg.

MADE IN USA

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY **PACE COUNT**



Any Questions?

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

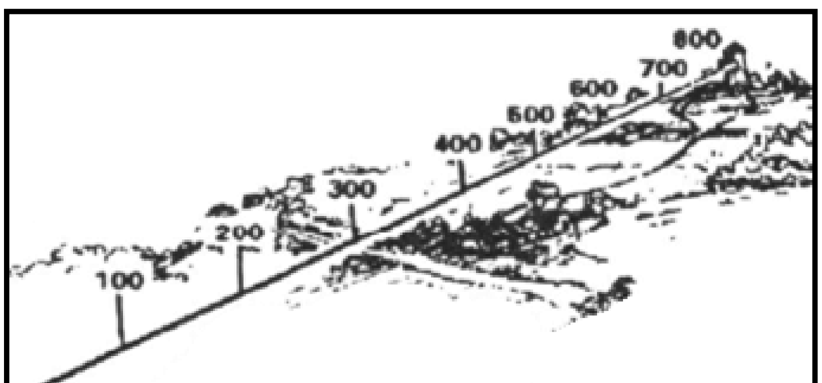
At times, because of land navigation situation, it may be necessary to estimate range. There are methods that may be used to estimate range or distance.

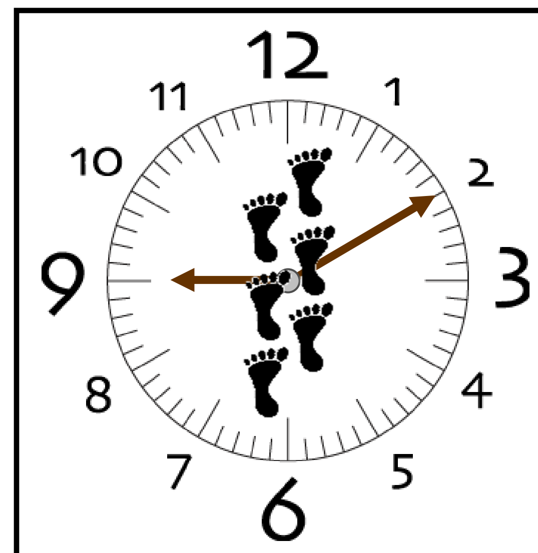
Proficiency of Methods. The methods discussed are used only to estimate range. Proficiency in these methods requires constant practice. The best training technique is to require the navigator to pace the range after he has estimated the distance. In this way, the navigator discovers the actual range for himself, which makes a greater impression than if he is simply told the correct range.

100-Meter Unit-of-Measure Method. The navigator visualizes a distance of 100 meters on the ground.

Rule-of-Thumb-Measure Method. The navigator uses his thumb, arm and eyes.

Time-Measure Method. Keep track of your starting time and hiking pace.





DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

100-Meter Unit-of-Measure Method. There are factors that affect range estimation.

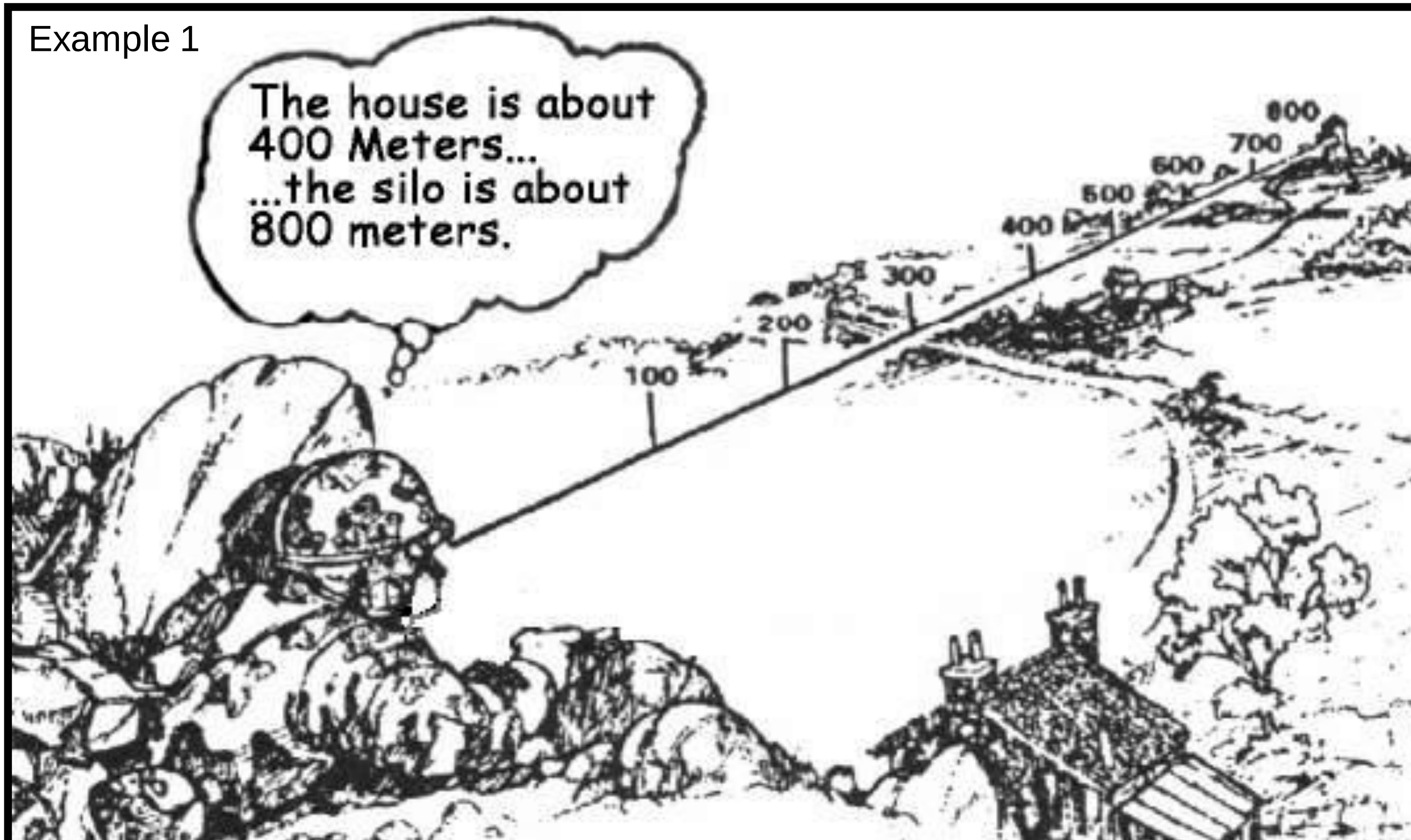
Factors Affecting Range Estimation	Factors Causing Under-estimation of Range	Factors Causing Over-estimation of Range
The clearness of outline and details of the object	When most of the object is visible and offers a clear outline	When only a small part of the object can be seen or the object is small in relation to its surroundings
Nature of terrain or position of the observer	When looking across a depression that is mostly hidden from view When looking downward from high ground When looking down a straight, open road or along a railroad When looking over uniform surfaces like water, snow, desert, grain fields In bright light or when the sun is shining from behind the observer	When looking across a depression that is totally visible When vision is confined, as in streets, draws, or forest trails When looking from low ground toward high ground When poor light, such as dawn and dusk; in rain, snow, fog; or when the sun is in the observer's eyes
Light and atmosphere	When the object is in sharp contrast with the background or is silhouetted because of its size, shape, or color When seen in clear air of high altitudes	When object blends into the background or terrain

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

100-Meter Unit-of-Measure Method. To use this method, the navigator must be able to visualize a distance of 100 meters on the ground. For ranges up to 500 meters, determine the number of 100-meter increments between the two objects he wishes to measure. Beyond 500 meters, the navigator must select a point halfway to the object and determine the number of 100-meter increments to the halfway point, then double it to find the range to the object.

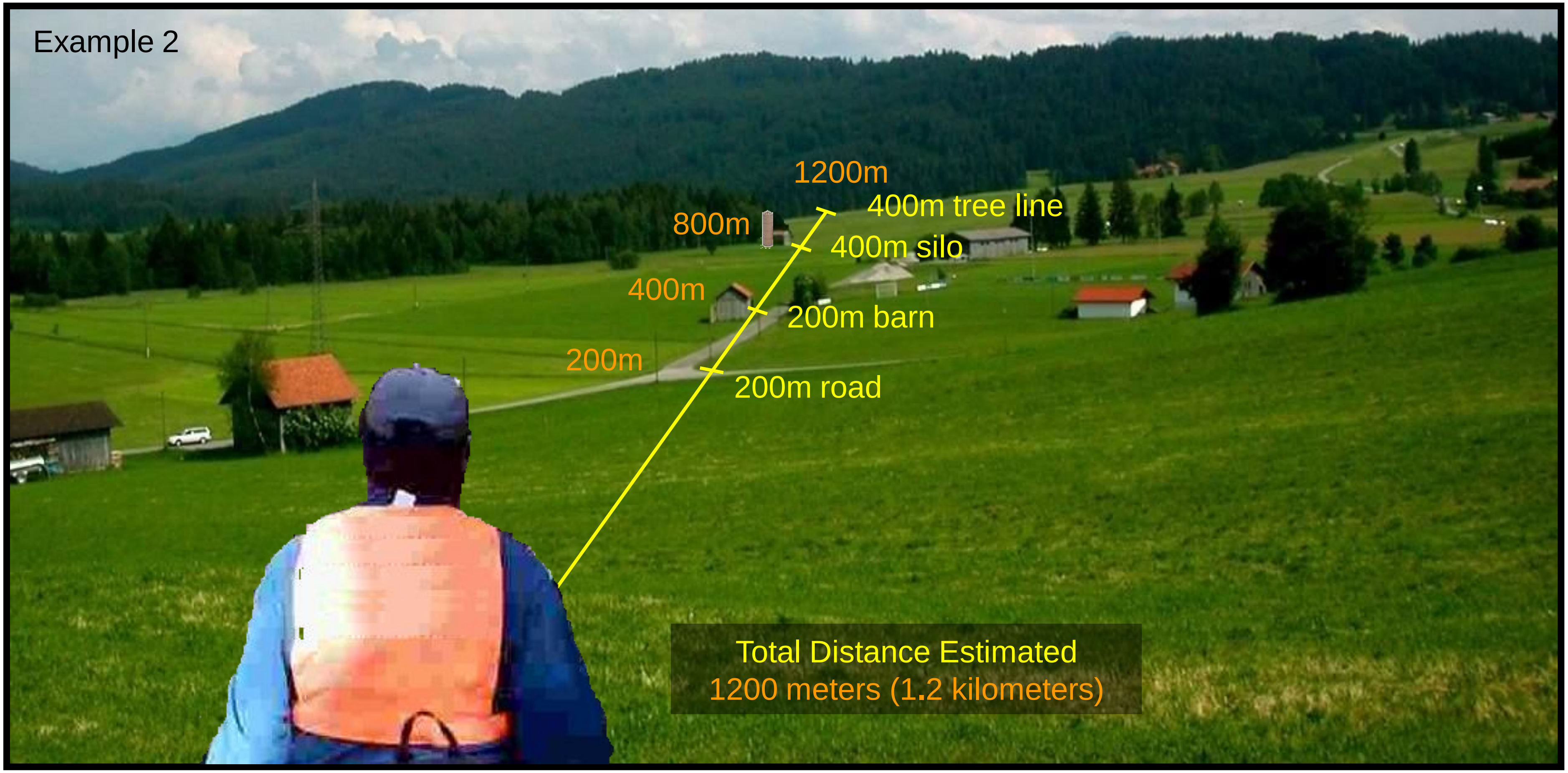
Example 1



DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

100-Meter Unit-of-Measure Method. **200 meters** to the road from the starting point (**200 meters**).
400 meters to the barn from the starting point, or **200 meters** from the road.
800 meters to the silo from the starting point, or **400 meters** from the barn.
1200 meters to the tree line from the starting point, or **400 meters** from the silo.



DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

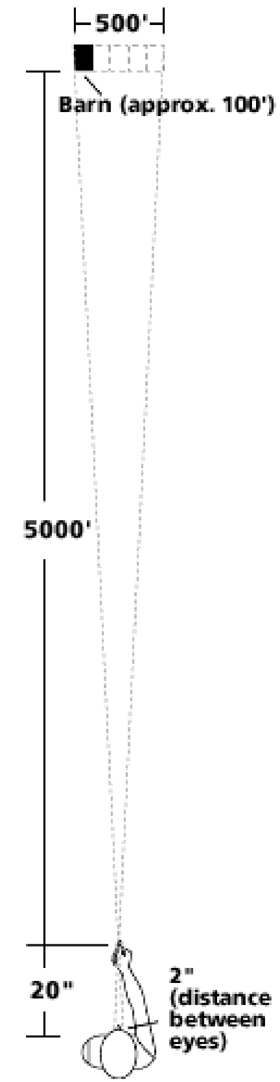
100-Meter Unit-of-Measure Method. **200 meters** to the dirt road from the starting point (**200 meters**).
600 meters to the first tree patch from the starting point, or **400 meters** from the dirt road.
1400 meters to the second tree patch from the starting point, or **800 meters** from the first tree patch.
2400 meters to the mid point from the starting point, or **1000 meters** from the second tree patch.
4400 meters to the hill top from the starting point, or **2000 meters** from the mid point.

Any Questions?

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

Rule-of-Thumb Method



YOUR ARM IS ten times longer than the distance between your eyes. With that fact, you can estimate the distance between you and any **object of approximate known size**.

Example, you're standing on the side of a hill, trying to decide how far it is to the top of a low hill on the other side of the valley. Just below the hilltop is a barn, about 100 feet wide on the side facing you.

1. Hold one arm straight out in front of you, elbow straight, thumb pointing up.
2. Close one eye, and align one edge of your thumb with one edge of the barn.
3. Without moving your head or arm, switch eyes, now sighting with the eye that was closed and closing the other.
4. Your thumb will appear to jump sideways as a result of the change in perspective.
5. How far did it move? (Sight the same edge of your thumb when you switch eyes).
   - Let's say it jumped about five times the width of the barn, or about 500 feet.
   - Now multiply that figure by the handy constant 10 (the ratio of the length of your arm to the distance between your eyes), and you get the distance between you and the barn -- 5,000 feet, or about one mile.

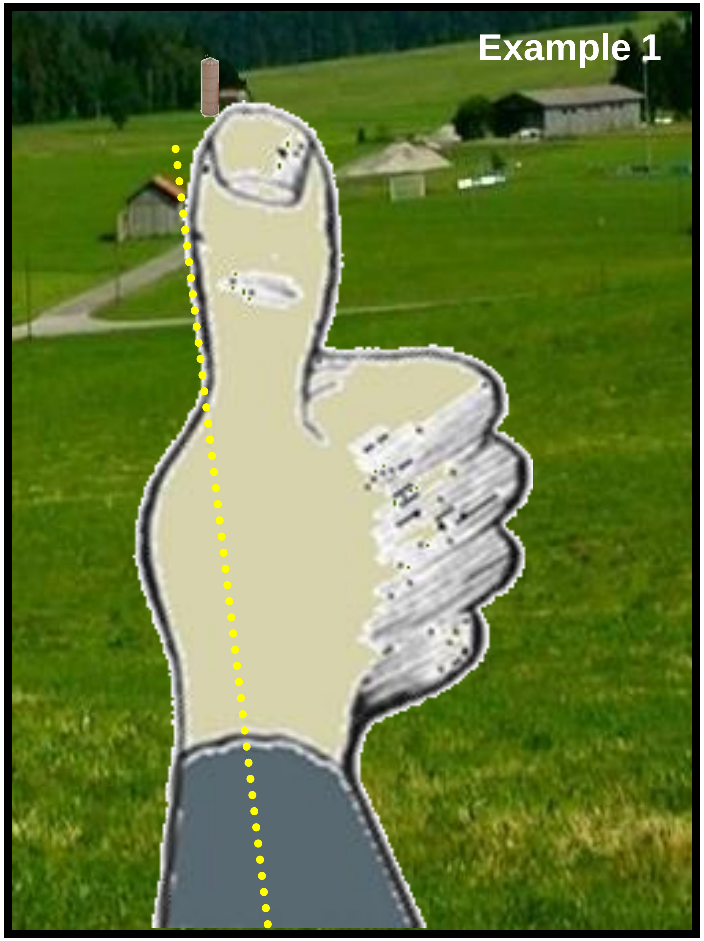
With practice, you can perform a quick thumb-jump estimate in just a few seconds, and the result will usually be more accurate than an out-and-out guess.

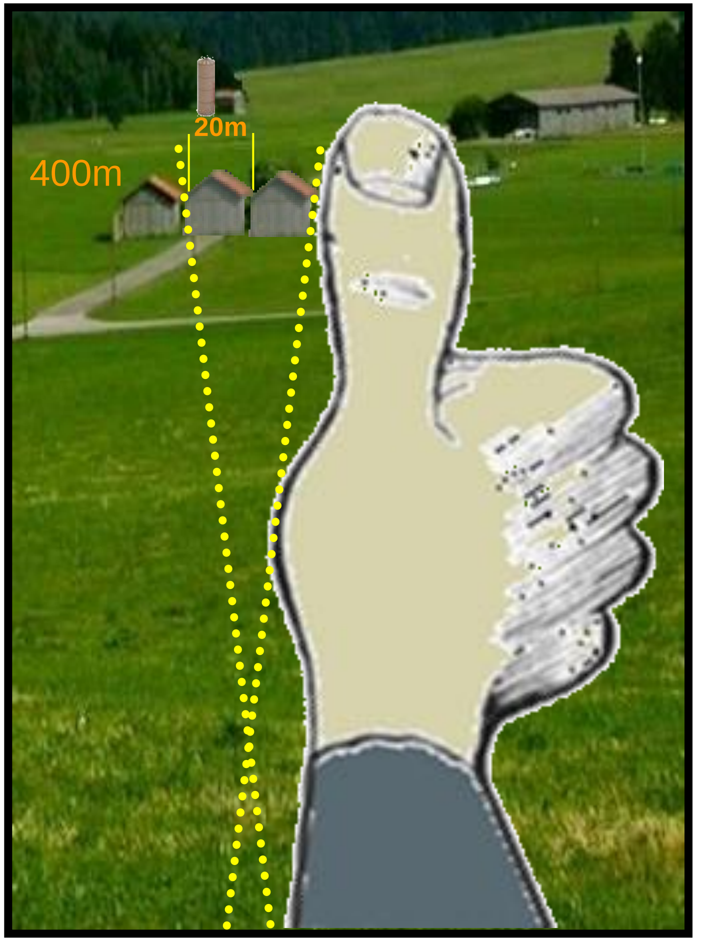
DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

Rule-of-Thumb Method

1. You estimate that the small barn is 20 meters wide.
2. You stretch your arm out, put your thumb up and close one eye.
3. You switch closed eye with open eye.
4. And find that your thumb moved the distance of two barn lengths.
5. 20 x 2 x 10 = 400m



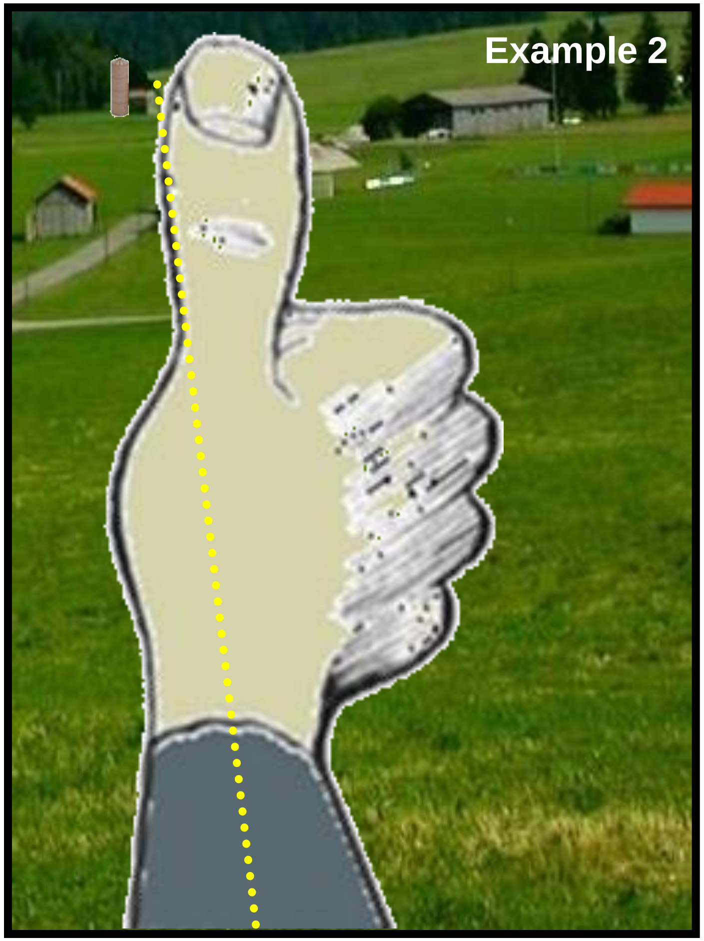


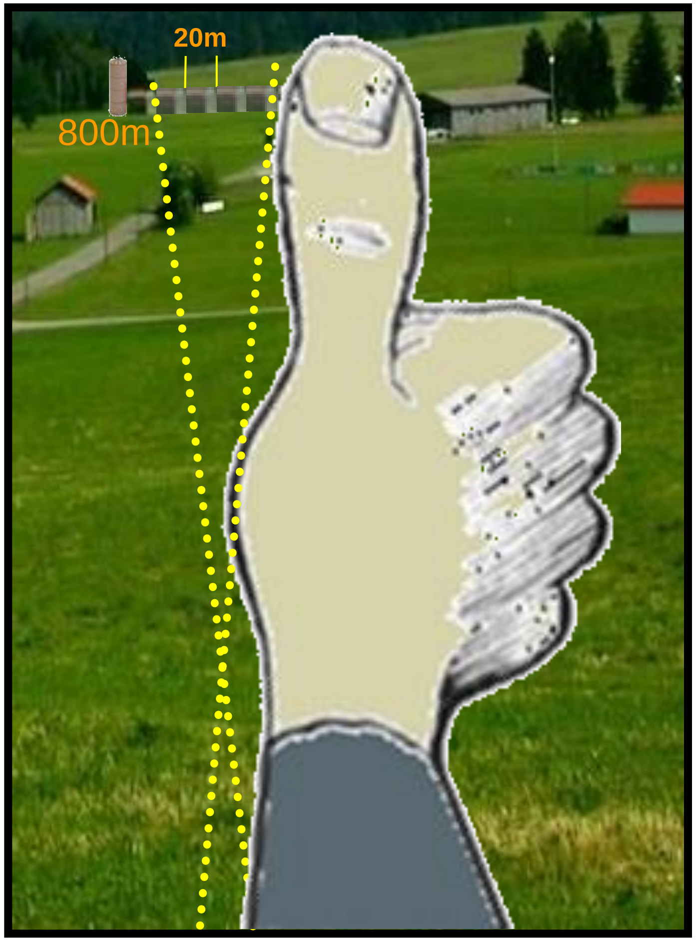
DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY **ESTIMATION**

Rule-of-Thumb Method

1. You estimate that the small barn in the far distance is 20 meters wide.
2. You stretch your arm out, put your thumb up and close one eye close.
3. You switch closed eye with open eye.
4. And find that your thumb moved the distance of four barn lengths.
5. 20 x 4 x 10 = 800m





DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY **ESTIMATION**

Time Method

- Make it a habit of keeping your map and compass handy and refer to them every hour or so to locate your position (more often in low visibility). Keep track of your starting time, rest breaks and hiking pace. This will also give you an idea of how far you have traveled over a period of time.
- This is based on knowing the speed at which you are walking and keeping a note of when you left your last known point. Walking speed varies and is dependent on a range of factors including fitness, weight of rucksack, length of journey, wind, conditions underfoot, slope angle.
- The simplest formula combines the horizontal distance with the height gained. Allow 5 km per hour on the flat plus 10 minutes for every 100 meters height gain. But remember that it doesn't allow for rests or stops. SEE TIMING CHART (next slide)
- Working out timing calculations mentally becomes straightforward with practice - Measure the distance and allow 1.2 minutes for every 100 meters, at a pace of 5kph (see chart next slide).
  - ❖ An easy way to work this out is to use the 12 times table and move the decimal point forward.

    TWO EXAMPLES –

    300 meters

    3 x 12 = 36 = 3.6 minutes = 3½ minutes (Round off to the nearest half minute)

    650 meters

    6 x 12 = 72 = 7.2 minutes = 7 minutes (Round off to the nearest half minute)
    Add ½ minute for the extra 50 meters = 7½ minutes

NOTE:
None of this is of any use if you don't have a watch. It is useful to have a stopwatch so you don't have to remember the time at the start of each leg.

DETERMINING TRAVEL DISTANCE

DETERMINE DISTANCE BY ESTIMATION

Time Method

Using a Timing Chart for the horizontal component makes the calculations easy. Although many people prefer to do it mentally.

For short navigation legs, break it down to 1.2 minutes per 100 meters horizontal distance and 1 minute for every 10 meters of ascent.

You can only travel at the speed of the **slowest person** and so you may need to use a slower formula such as 4 kph which is calculated at 1.5 minutes per 100 meters.

When going **gently downhill**, it is best to ignore the height loss and just use the horizontal component of the formula.

When **descending steep ground** which will slow your rate of travel a rough estimate can be used – allow 1 minute for every 30 meters of descent, although this is only an approximation.

Timing Chart	The timings have been rounded to the nearest ½ minute.			
Distance traveled in meters	Speed in kilometers per hour			
	5kph	4kph	3kph	2kph
1000 m	12 min	15 min	20 min	30 min
900 m	11 min	13½ min	18 min	27 min
800 m	9½ min	12 min	16 min	24 min
700 m	8½ min	10½ min	14 min	21 min
600 m	7 min	9 min	12 min	18 min
500 m	6 min	7½ min	10 min	15 min
400 m	5 min	6 min	8 min	12 min
300 m	3½ min	4½ min	6 min	9 min
200 m	2½ min	3 min	4 min	6 min
100 m	1min	1½ min	2 min	3 min
50 m	½ min	¾ min	1 min	1½ min
Remember to add 1 minute for every 10 meters of ascent.				

Any Questions?

Note:

Prior to being issued any training *equipment, you will be required to sign a “statement of liability” agreeing to pay for anything you damage or lose.

All items will be inspected and inventoried prior to your signature and at the end of the training day too.

If you do not intend to sign this statement, then you may be denied training.

* **You may use your own equipment.**

TESTING

Now it is time for the following . . .

- Written exam
- Hands-on / Outdoors exam

THE END OF
LAND NAVIGATION
PRESENTATION
PART 2