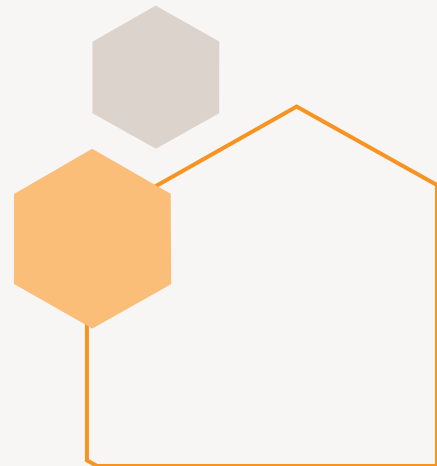


Engineering and Construction Surveying

ACBA4020

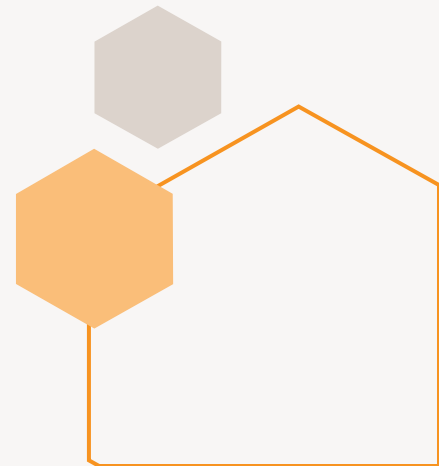


Understanding Plans



Understanding Plans

Item	Symbol	Alternatives
Fence		
Tree		
Gate		
Embankment/ Cutting		
Hedge		
Spot height	x 25.79 BM	+25.79 示
Gully, manhole	G MH	
Paving		
Grass		
Steps, ramp		





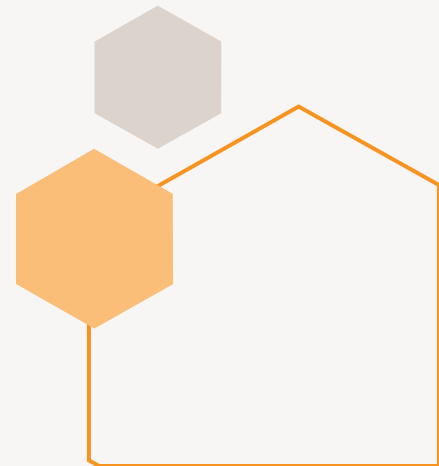
Understanding Scale

- Scale usually refers to the adjustment of size, which is either the reduction or magnification of real-life objects while maintaining their proportions.
- When a drawing is described as 'to scale,' it means that each element in that drawing is in the same proportion, related to the real or proposed thing – it is smaller or indeed larger by a particular percentage.
- If something is 'drawn to scale' we expect that it has been drawn, or printed, to a common scale that is used as standard in the construction industry



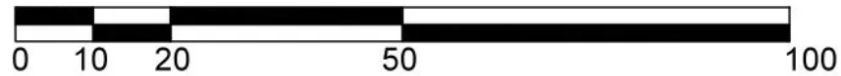
Understanding Scale

- Scales are expressed in ratios. In the real world, one metre is equal to one metre. This is considered a 1:1 scale. A drawing at a scale of 1:10 means that the object is 10 times smaller than in real life scale, 1:1. You could also say, 1 unit in the drawing is equal to 10 units in real life.
- As the numbers in the scale get bigger, i.e. 1:50 – 1:200, the elements in the drawing get smaller. This is because in a drawing at 1:50 there is 1 unit for every 50 units in real life. A drawing of 1:200 is representing 200 units for every one unit – and therefore is showing the elements smaller than the 1:50 drawing.



Understanding Scale

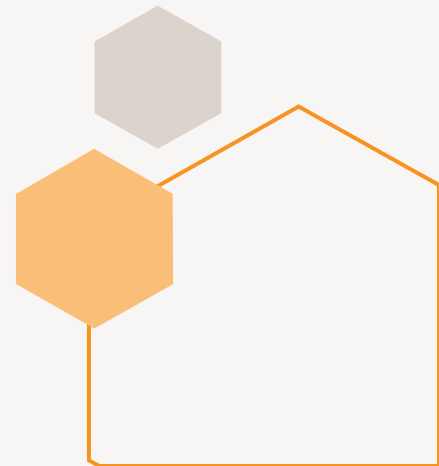
- The scale bar is a key component of scale drawings as it helps provide an understanding of distances depicted on the drawing.



SCALE BAR 1:500

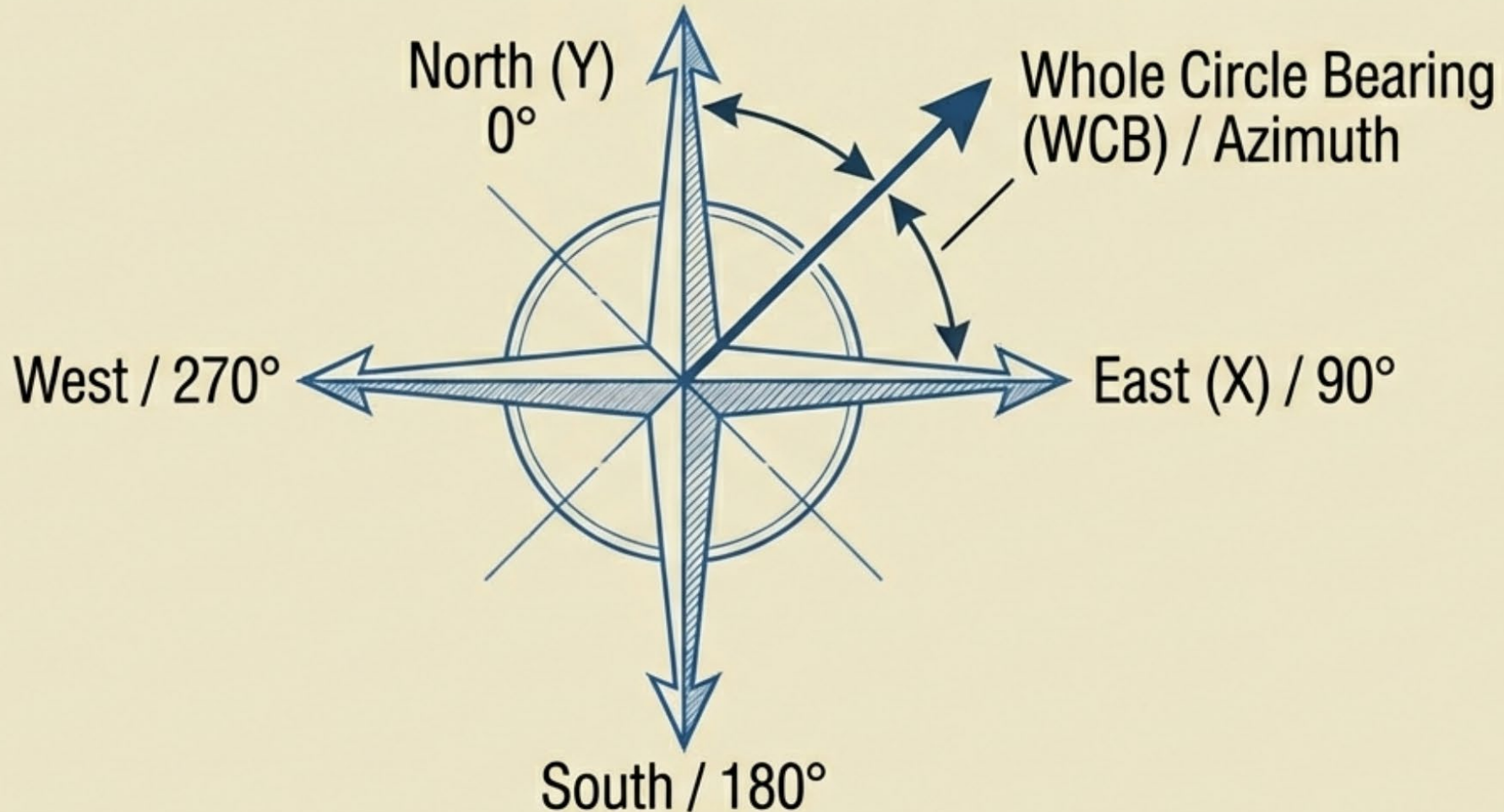


SCALE BAR 1:250



THE GEOMETRY OF POSITIONING

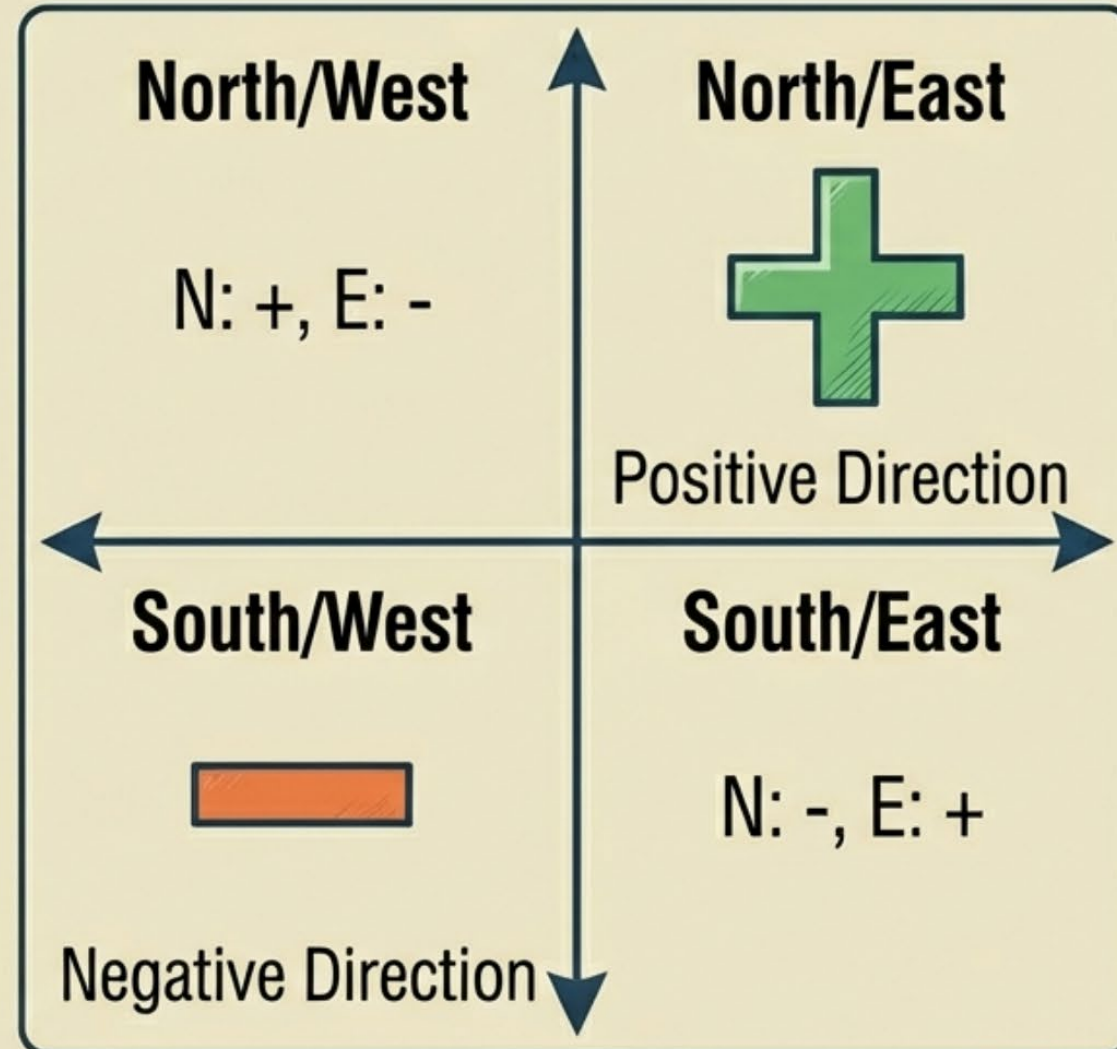
All coordinate systems are relative to an **origin point (0,0)** and orientated to the North (Y axis) and East (X axis).



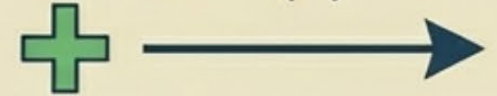
Grid Orientation: North is 0 degrees, East is 90, South is 180, West is 270.

UNDERSTANDING PARTIAL EASTINGS AND NORTHINGS

Partial Eastings and Northings represent the vector distance due North and due East from a point, relative to the origin.



Movement towards
North or East
= Positive (+)



Movement towards
South or West
= Negative (-)



Surveying Example

A surveyor sets out from a **control station A** and walks **due East for 30 m**, then **due North for 40 m** to reach station **B**.

The surveyor then returns directly to **station A** along the shortest possible route.

- a) Calculate the **distance** of the direct route from B to A.
- b) Calculate the **bearing** of the direct route from B to A.

Question 2

A surveyor leaves **benchmark A** and walks **due South** for **60 m**, then **due East** for **25 m** to reach point **B**. The surveyor then returns directly to benchmark **A** by the shortest route.

- a) Calculate the **distance** of the direct route from B to A.
- b) Calculate the **bearing** of the direct route from B to A.

Question 3

A surveyor sets out from **control point P** and measures **80 m due West**, then **30 m due North** to reach point **Q**.

The surveyor then observes point **P** directly from **Q**.

- a) Calculate the **distance** from Q to P.
- b) Calculate the **bearing** from Q to P.

Question 1

A surveyor measures a traverse leg from **station A** on a bearing of **045°** for a distance of **100 m**.

Calculate the **change in Easting (ΔE)** and **change in Northing (ΔN)**.

Question 2

A boundary line runs from **point B** on a bearing of **210°** for a distance of **65 m**.

Calculate the **change in Easting** and **change in Northing**.

Question 3

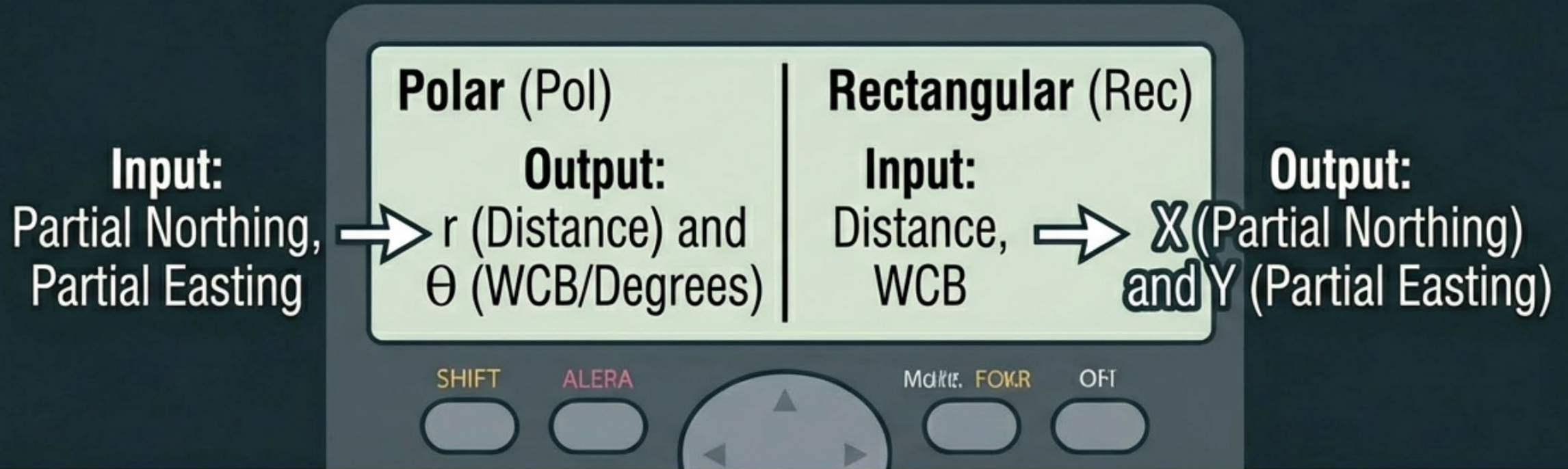
A surveyor sets out from **control point E** with coordinates:

$$E = (E\ 2500.000, N\ 1750.000)$$

The surveyor travels on a bearing of 300° for a distance of **120 m**.

Calculate the **coordinates of point F**.

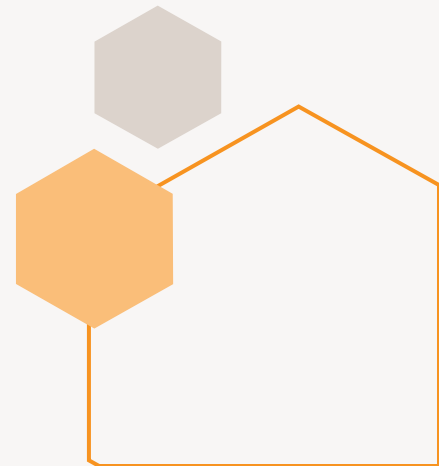
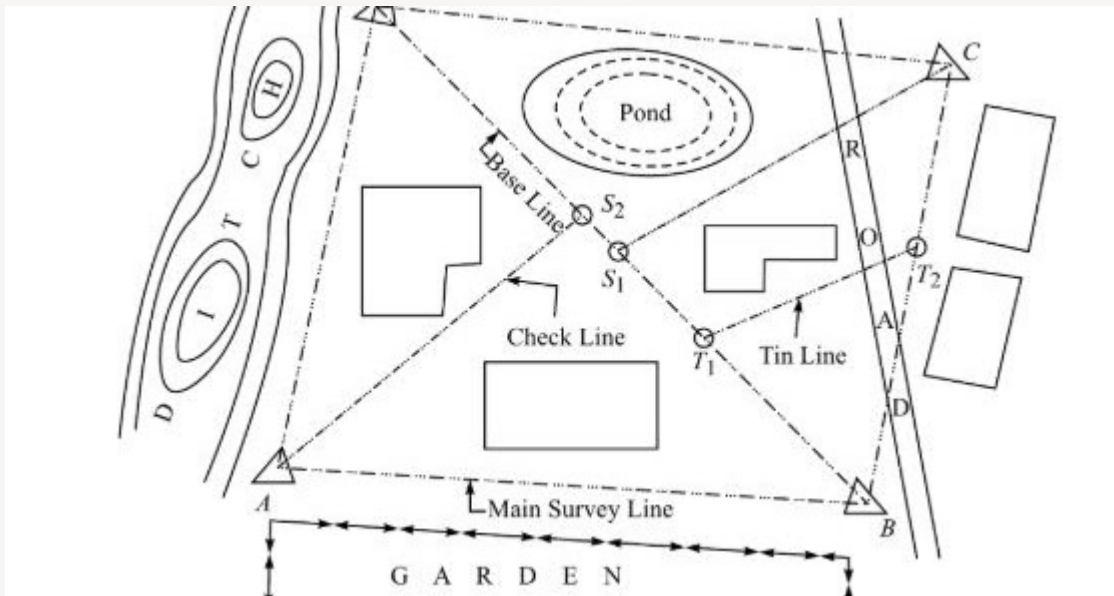
Modern scientific calculators offer Polar and Rectangular functions to speed up coordinate geometry.



Note: Once partials are calculated, simply add them to the known station coordinates to fix the new position (check signs for +/- direction).

Linear Surveys

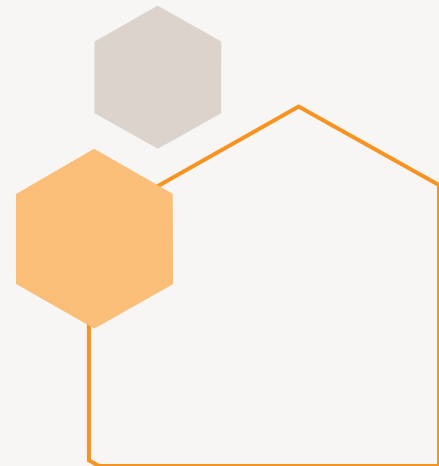
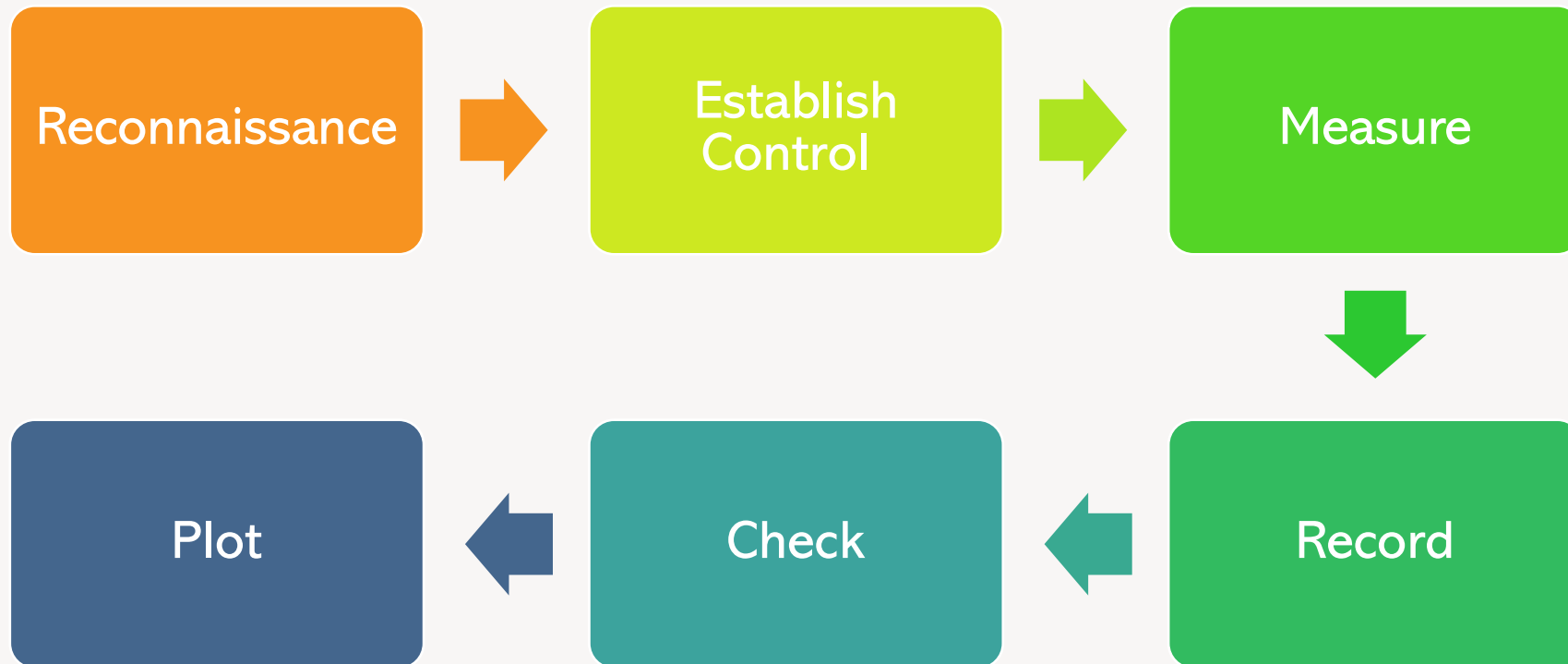
Linear surveying focuses primarily on measuring distances between points or features.



Linear Surveys

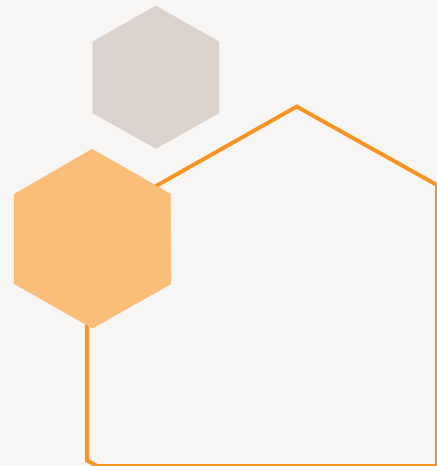


Basic Survey Process



Reconnaissance

- On arrival at the site, the survey team's first task is to make a reconnaissance survey.



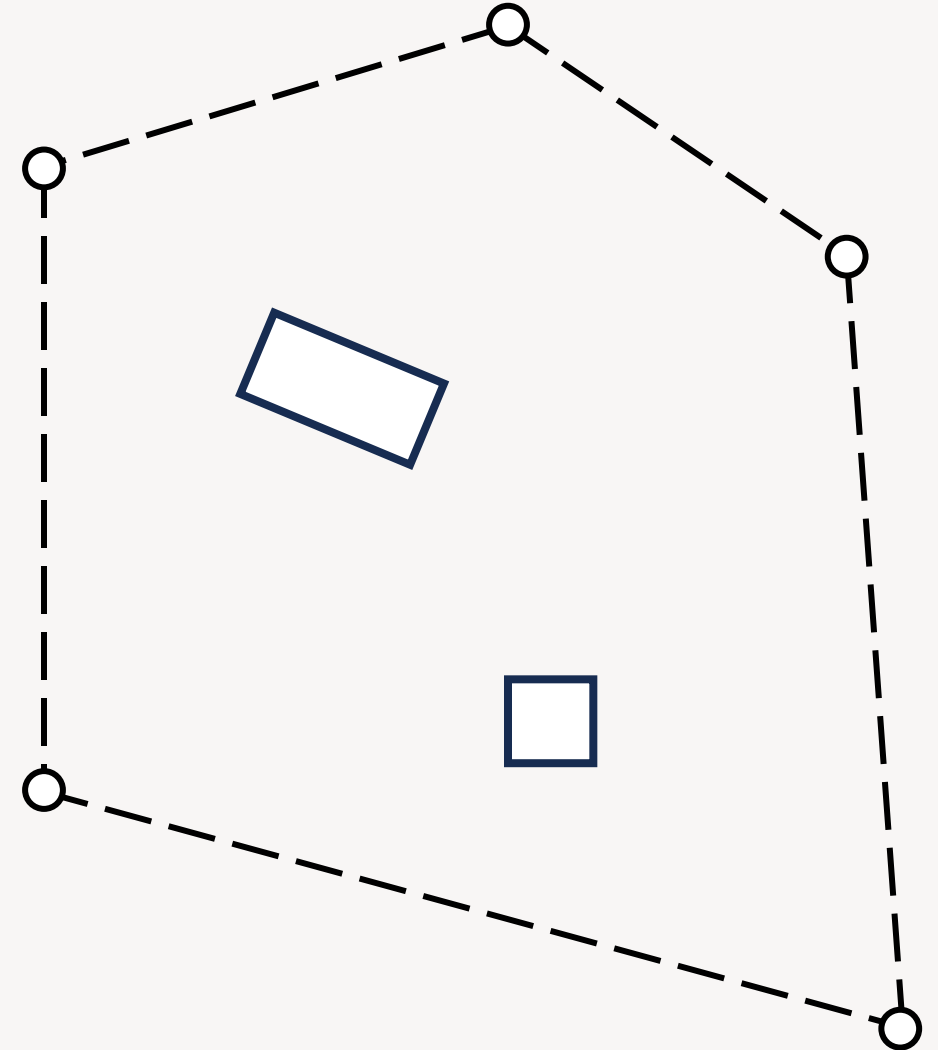
Whole to Part

- Surveyors must establish a framework of control points over the entire survey area first, before measuring smaller, detailed sections.



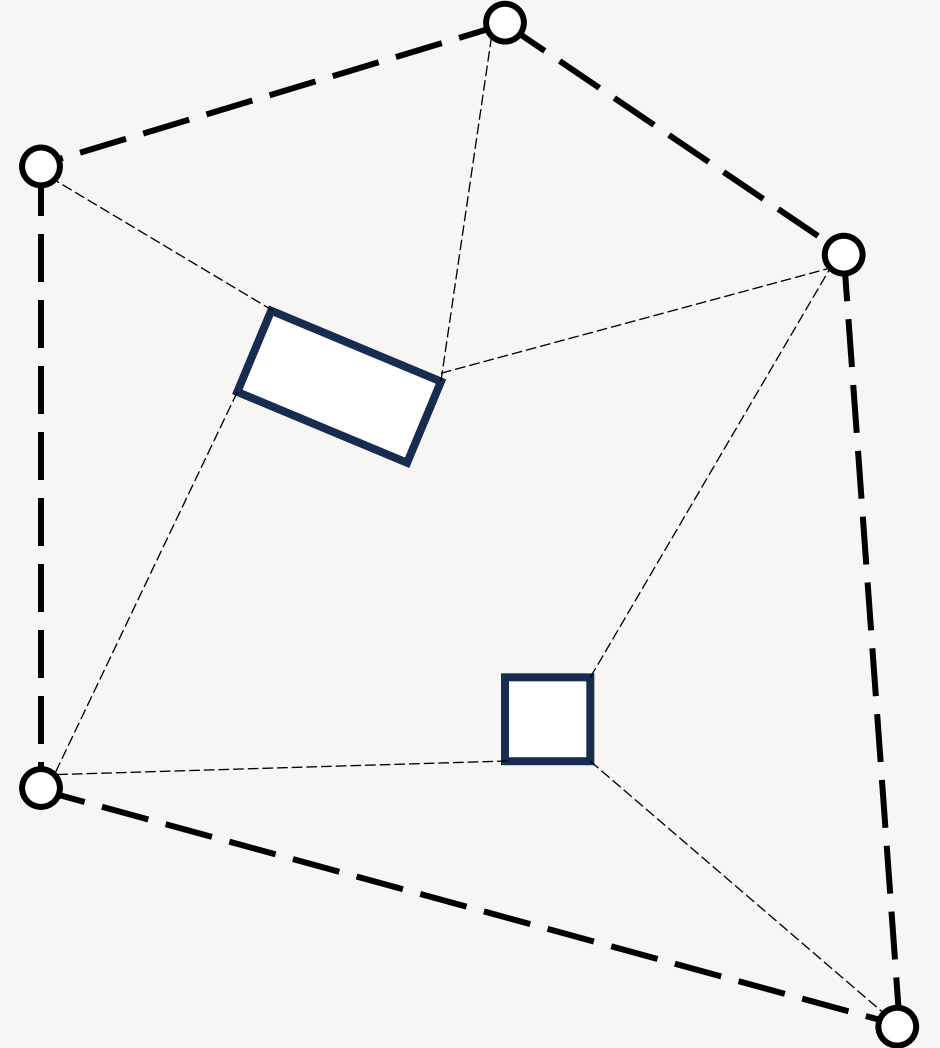
Whole to Part

- Establish main control points (like triangulation stations or traverse points).
- These points are measured very accurately.
- They form a strong reference network over the whole area.



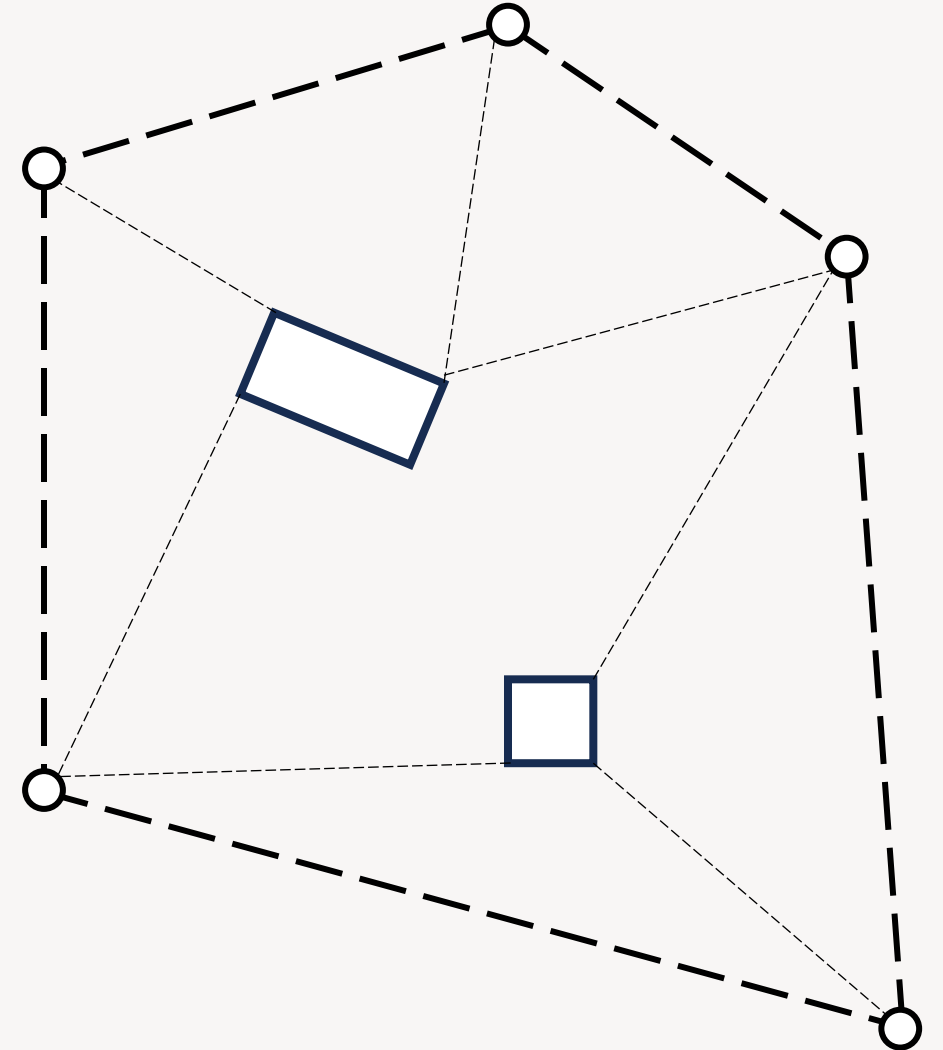
Whole to Part

- Smaller features (roads, buildings, boundaries, details) are measured.
- These are tied to the already-fixed control points.



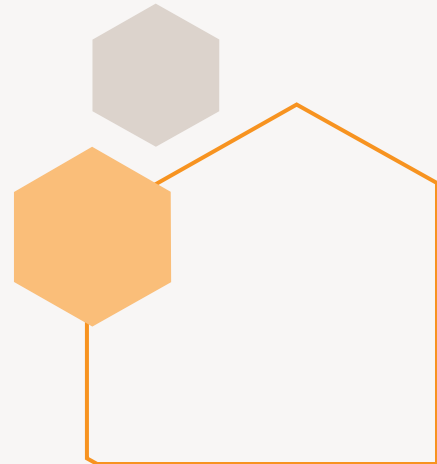
Whole to Part

- The goal is to minimise the accumulation of errors.
- If you work part to whole, small errors compound to large discrepancies.



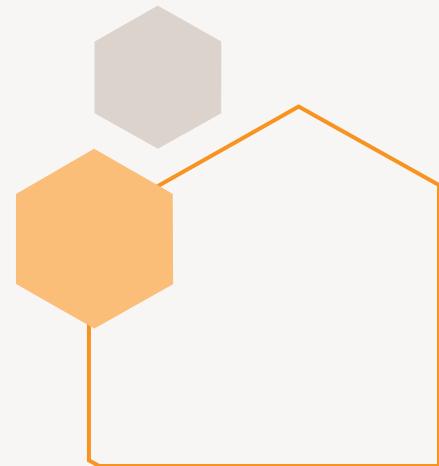
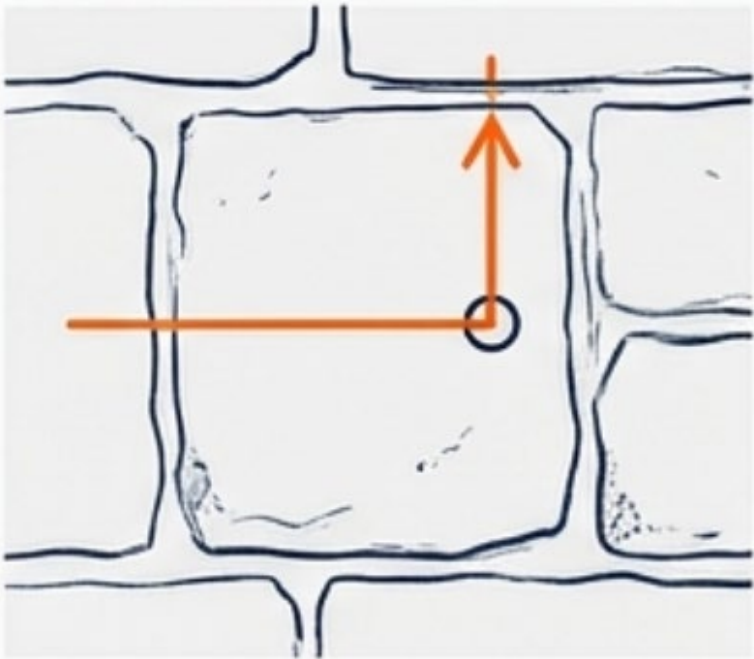
Establishing Control

Benchmarks in surveying are fixed points used to determine elevations, classified by permanence and purpose



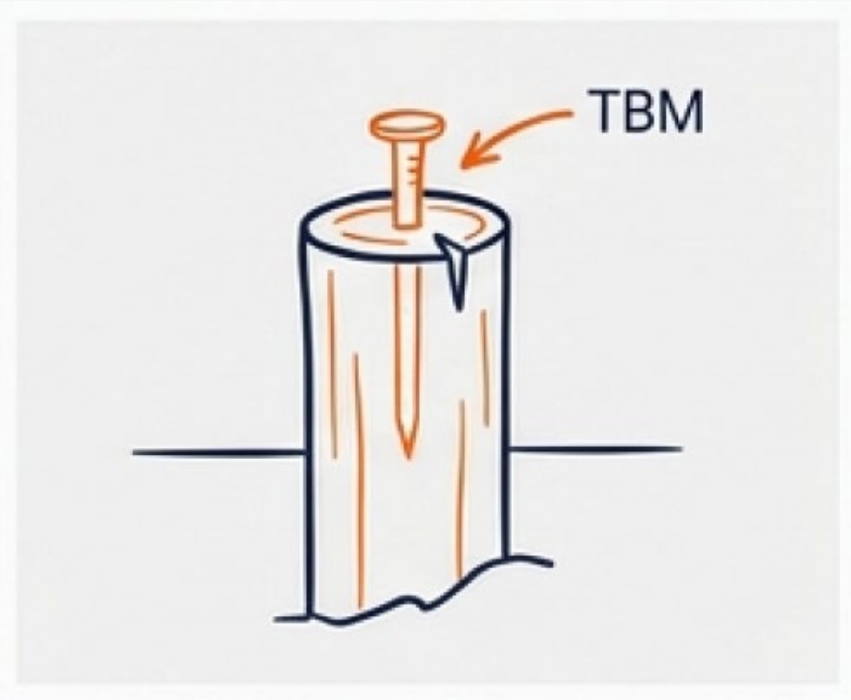
Arbitrary Benchmarks

Reference points with an assumed elevation used for localised, small-scale construction projects when high precision to national datum is unnecessary.



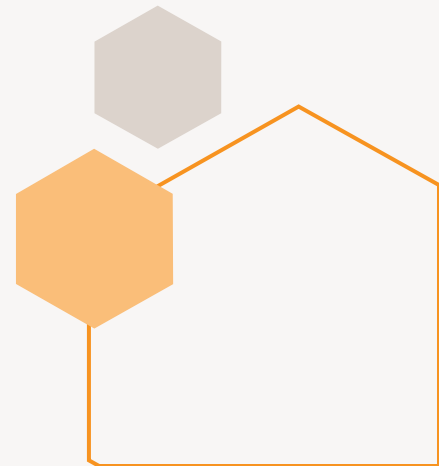
Temporary Benchmarks

Acts as a reference point for levelling and alignment, commonly set up when the main benchmark is too far from the work site.



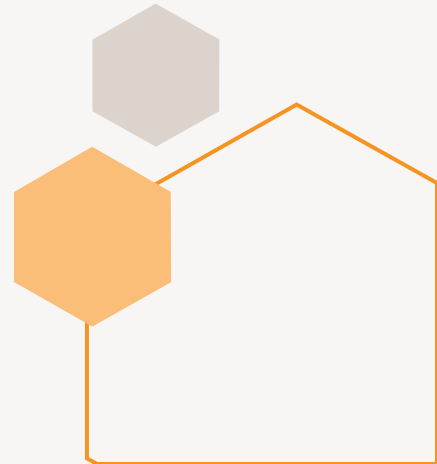
Control Locations

- Referencing Stations



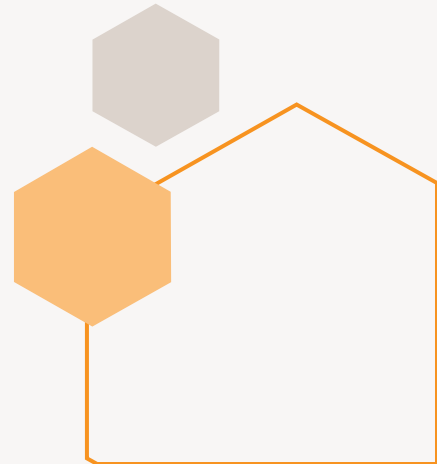
Control Locations

- Referencing Stations
- Obstructions

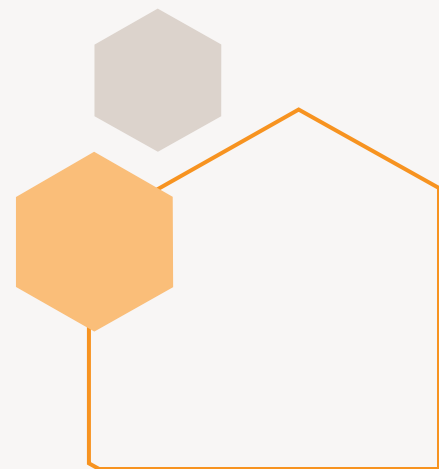


Control Locations

- Referencing Stations
- Obstructions
- Visibility



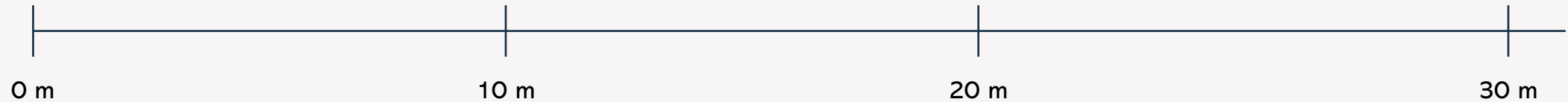
Measure



Chainage

Chainage describes the distance along a baseline from a defined starting point.

Example: a feature 17.4 m from the origin has a chainage of 17.4 m.

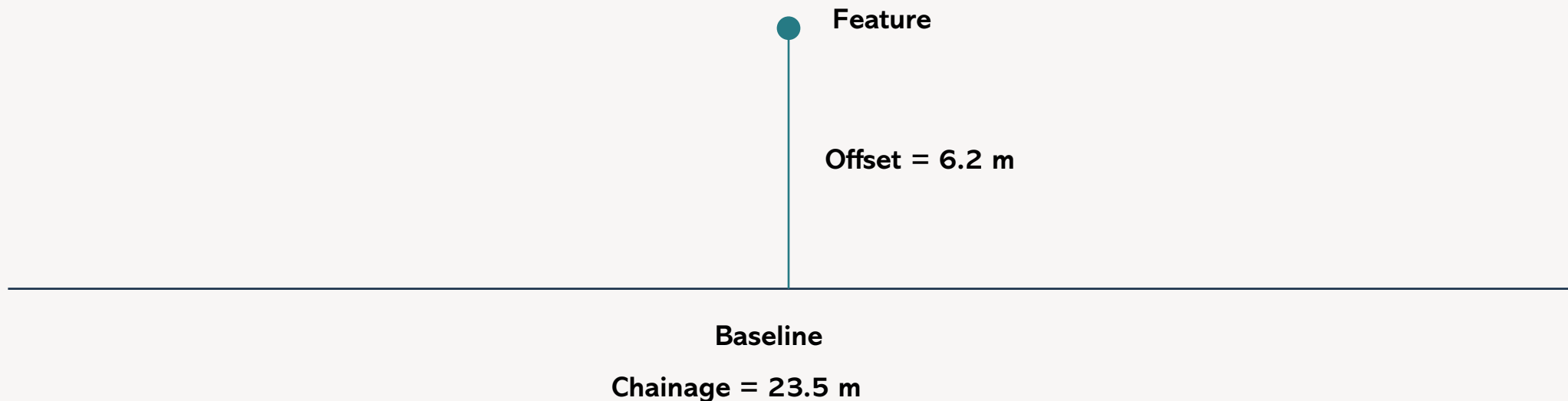


Offsets

An offset is the distance from the baseline to a feature.

Normally, the offset is measured perpendicular to the baseline.

Chainage + offset provides a simple way to locate a feature.

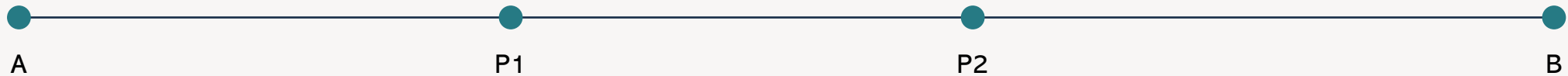


Ranging

Ranging establishes intermediate points along a straight survey line.

Intermediate points must remain on the intended line.

If points are poorly aligned, the measured distance may not represent the required straight-line distance.



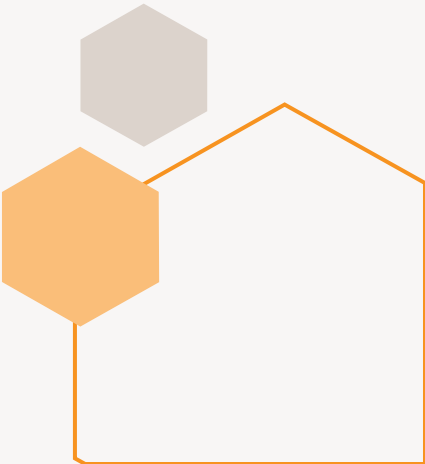
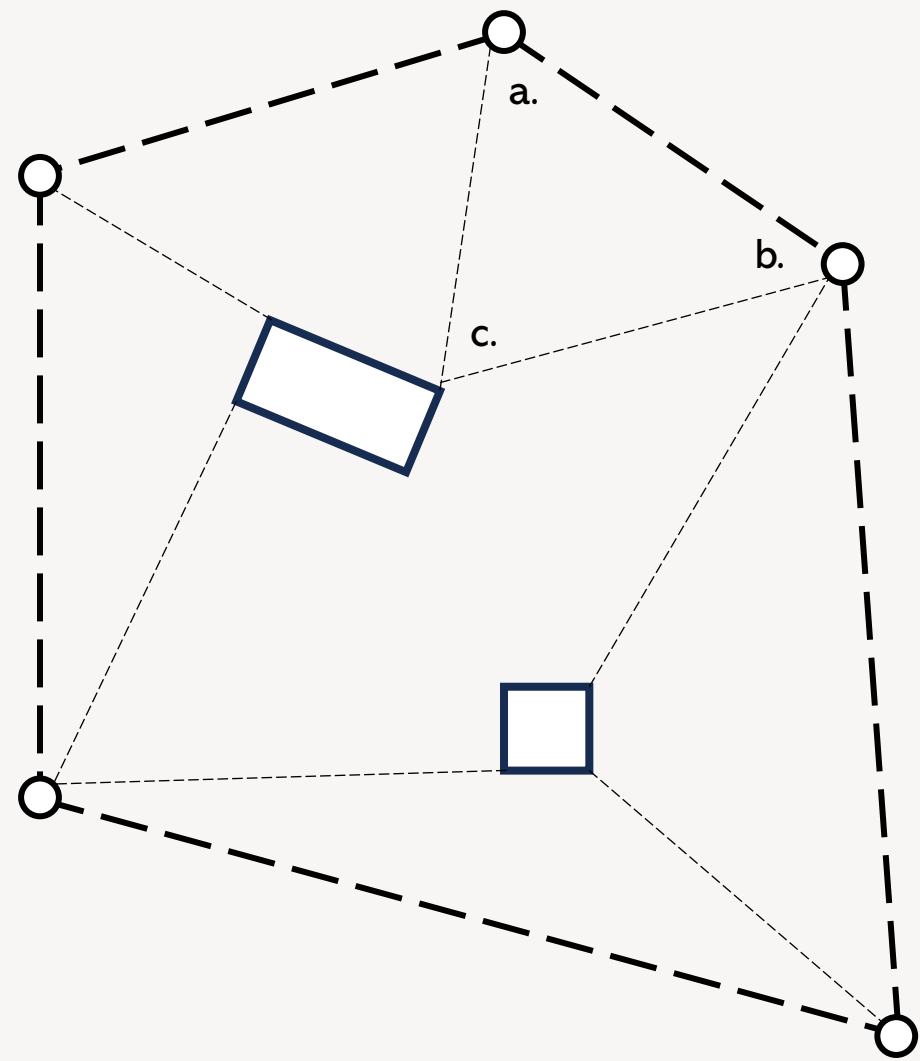
Slope Distance Vs Horizontal Distance

On sloping ground, a tape may measure the slope distance.

If the required quantity is horizontal distance, the slope must be accounted for.

Using Pythagoras: $D = \sqrt{L^2 - h^2}$

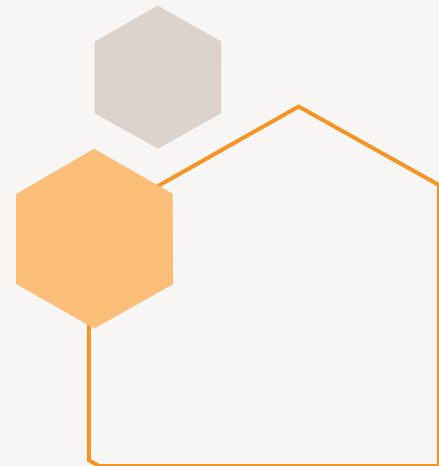
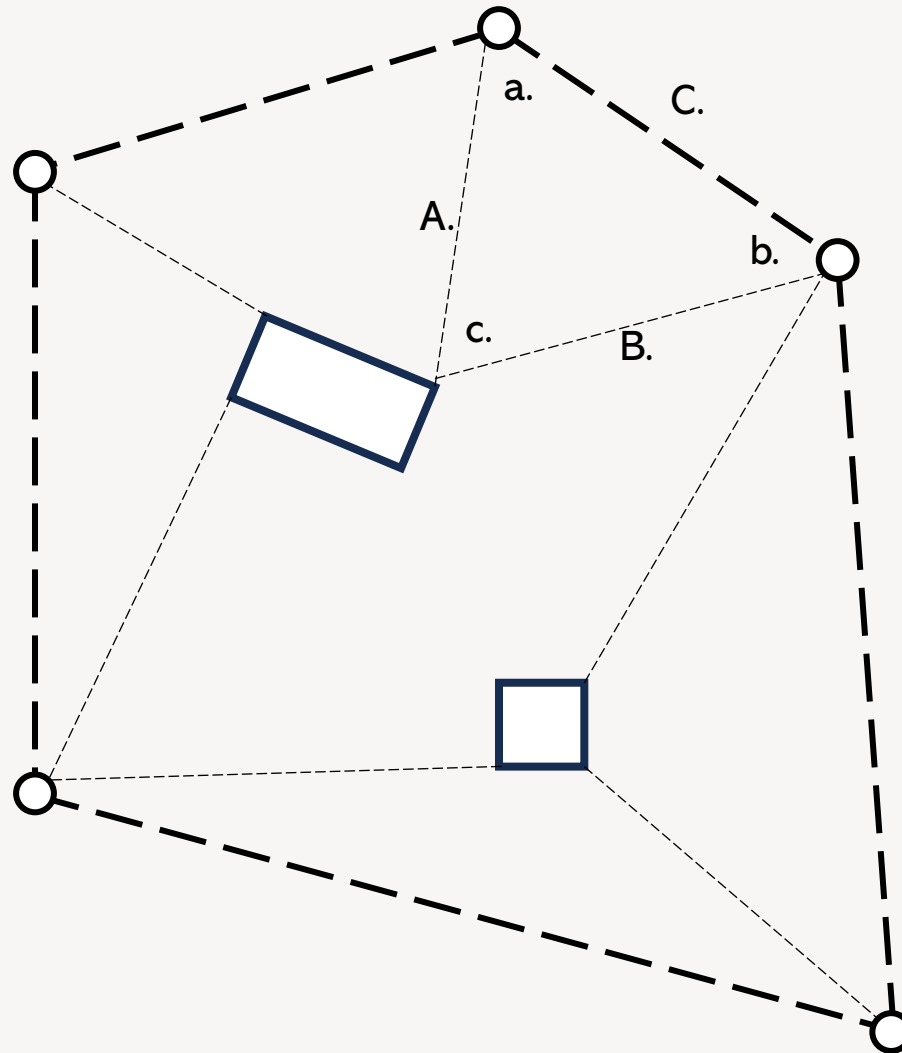
Triangulation



Triangulation

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

$$C^2 = A^2 + B^2 - 2AB \cos c$$



Example question – Triangulation

Two survey stations **A** and **B** are located **500 m apart** on level ground.

A surveyor wants to determine the position of a radio mast at point **C**.

From station A, the angle between the baseline **AB** and the line to the mast is measured as:

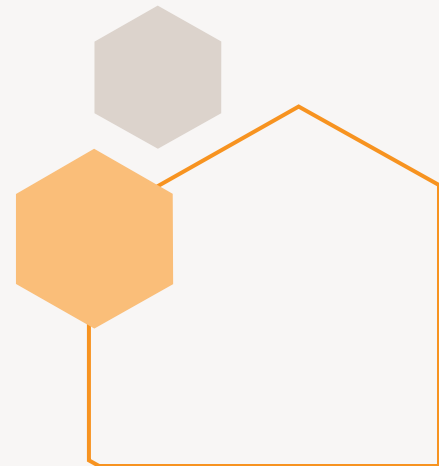
$$A = 70^\circ$$

From station B, the angle between the baseline **BA** and the line to the mast is:

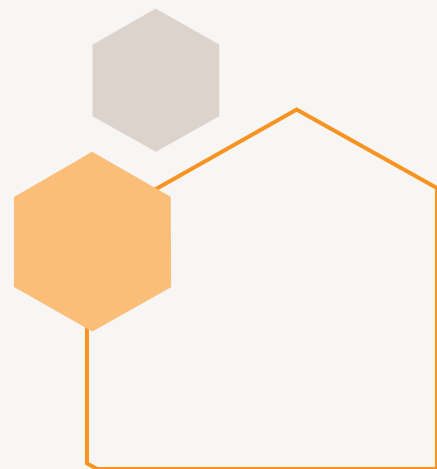
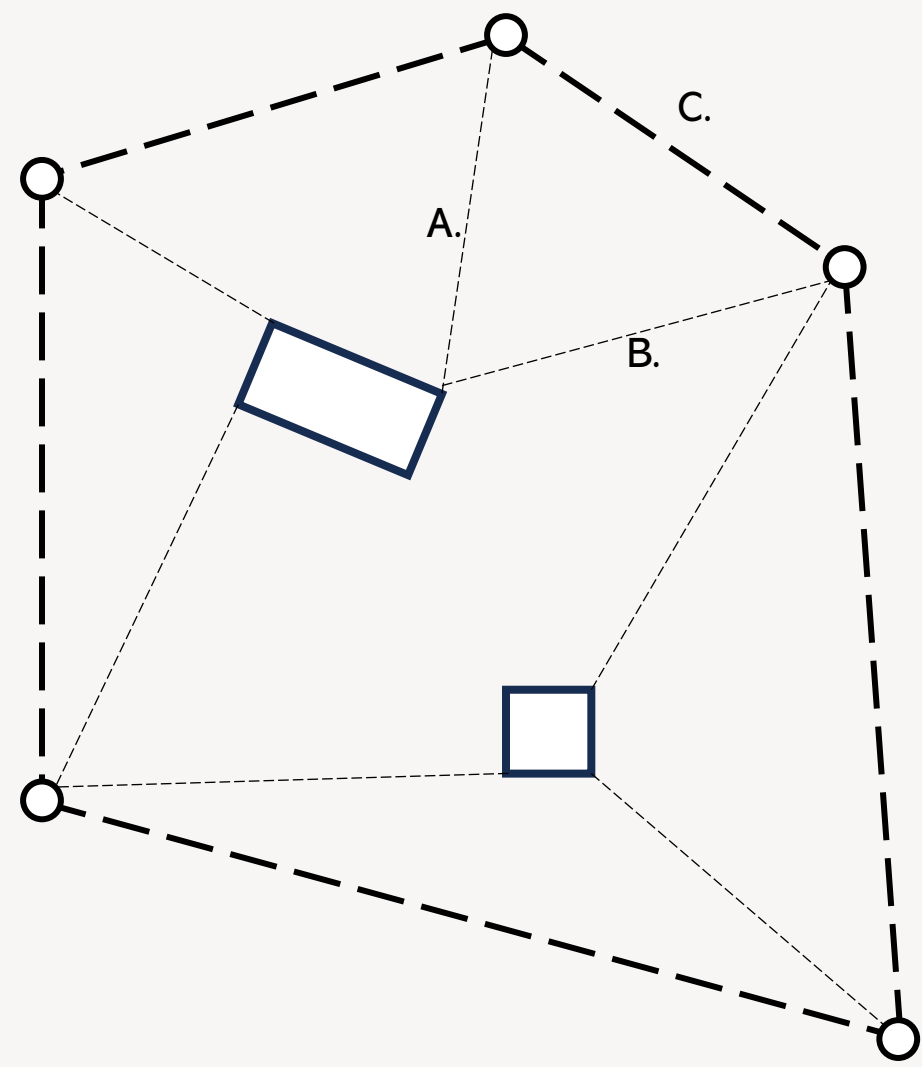
$$B = 65^\circ$$

Calculate:

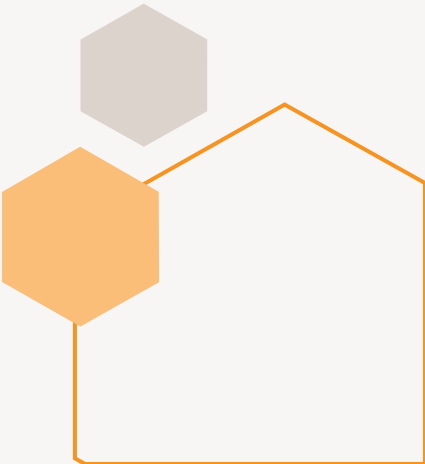
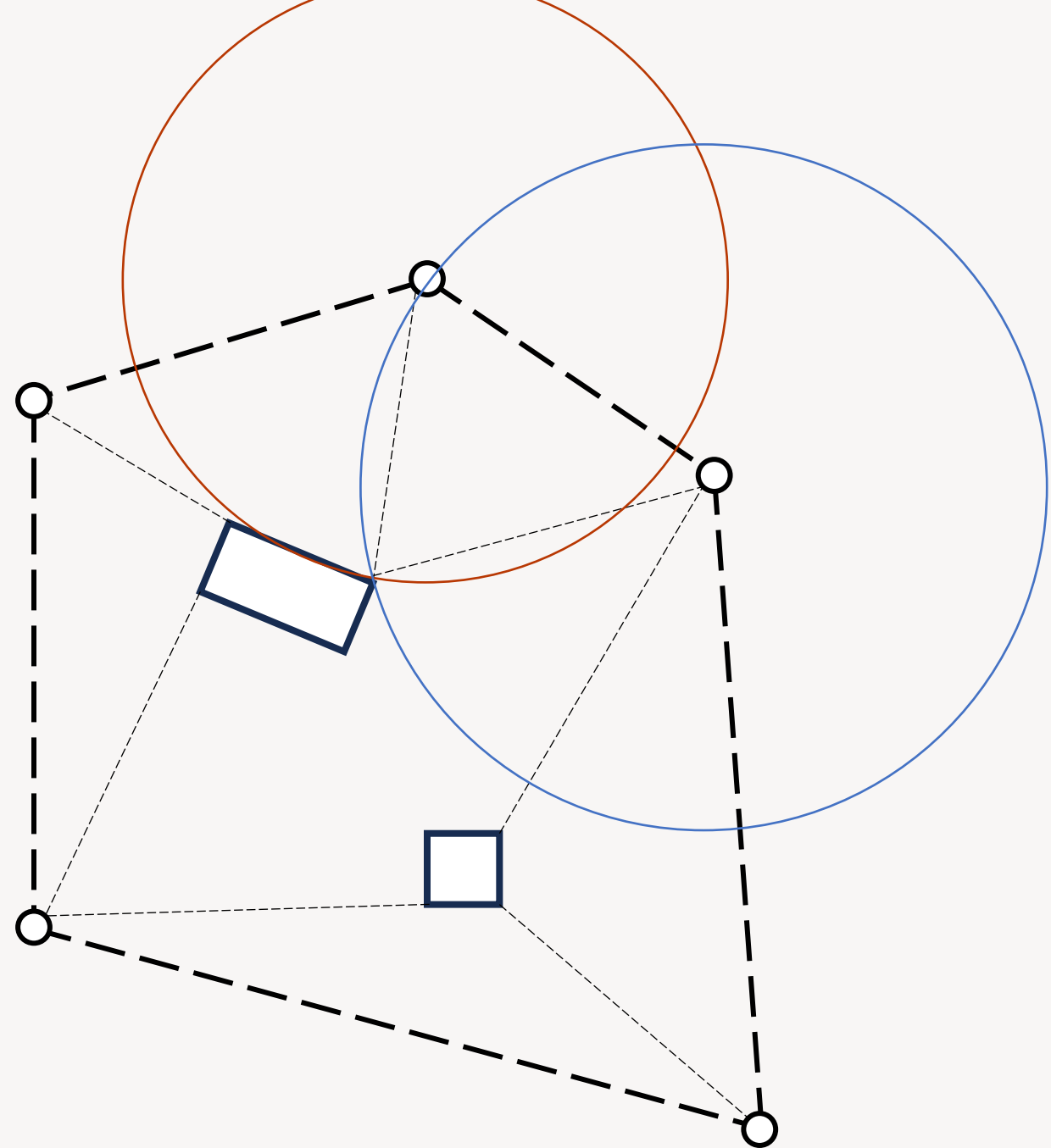
1. The angle at the mast, C .
2. The distance from station A to the mast, AC .
3. The distance from station B to the mast, BC .



Trilateration

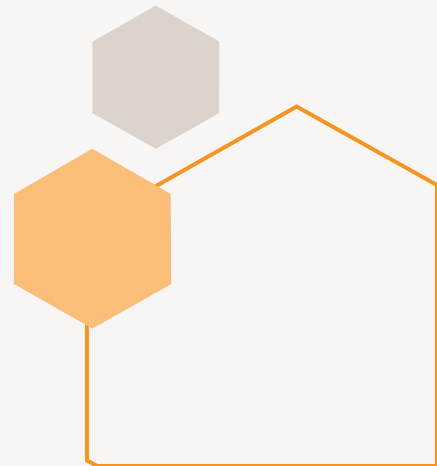


Trilateration



Formation of Triangles

- The triangles into which the area is broken should be well conditioned, i.e. they should have no angle less than 30° nor greater than 120° .
- The ideal figure is an equilateral triangle.



Using a Tape Measure

Alignment — keep the tape on the intended survey line.

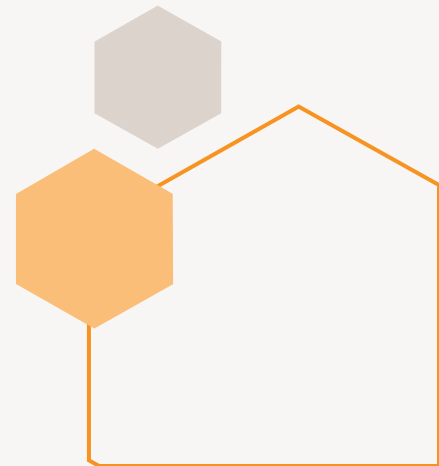
Tension — apply consistent tension.

Straightness — avoid bends and unnecessary deviations.

Level — ensure the tape is horizontal when required or correct for slope.

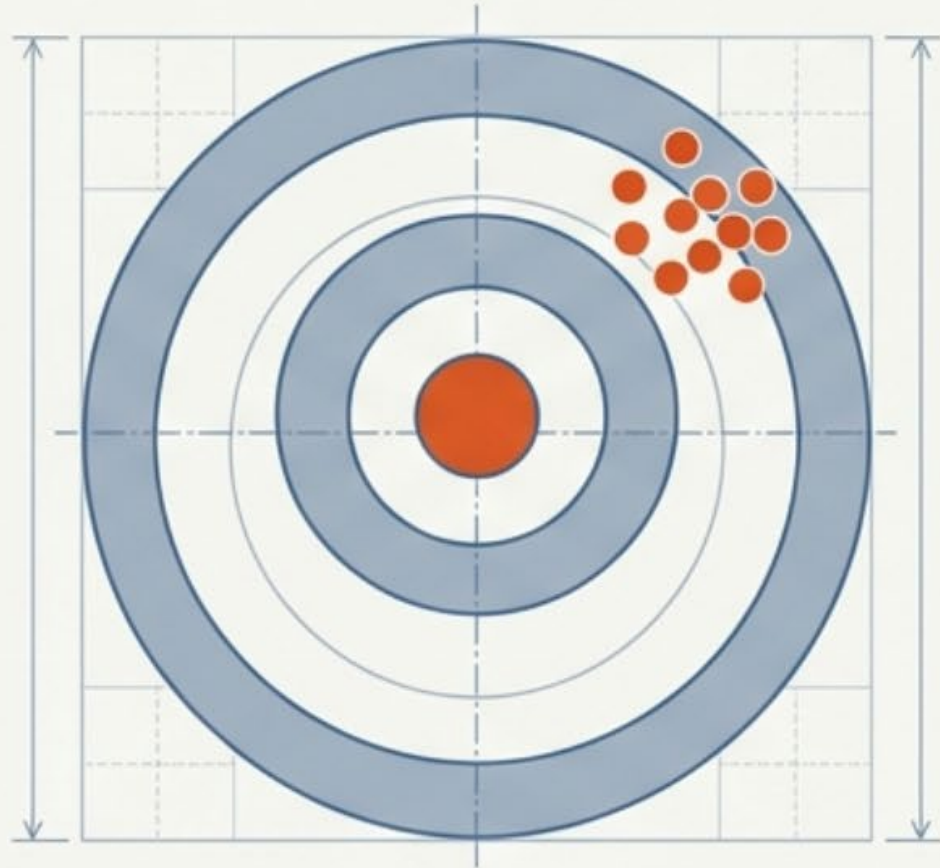
Reading — read carefully.

Recording — write the value and units immediately.



Data Quality: Accuracy vs. Precision

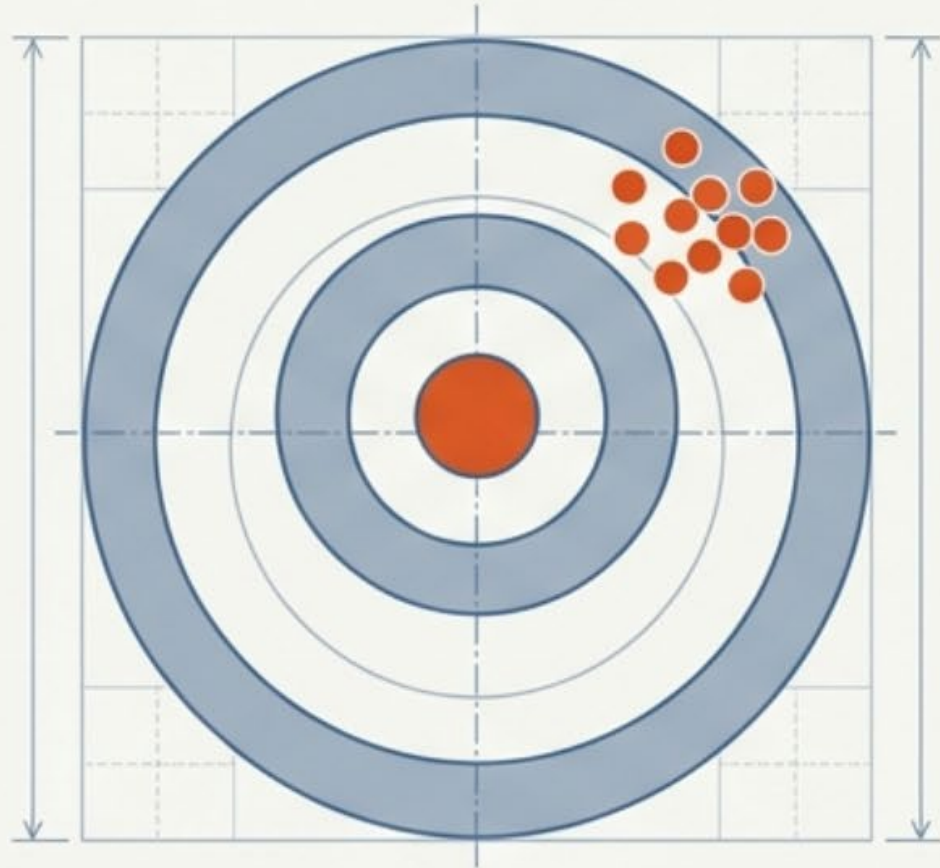
High Precision, Low Accuracy



Precision = Repeatability
(Minimizing variation)

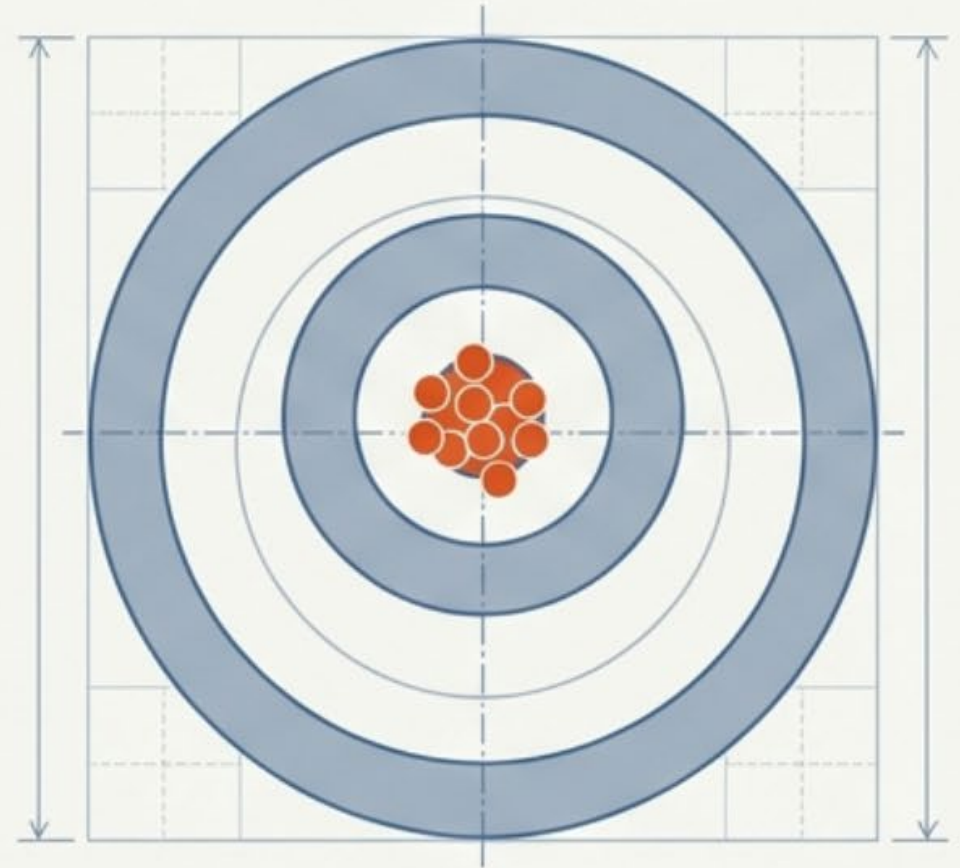
Data Quality: Accuracy vs. Precision

High Precision, Low Accuracy



Precision = Repeatability
(Minimizing variation)

High Accuracy, High Precision



Accuracy = Closeness to truth
(Minimizing error)

Record

- Record measurements systematically in a field book or digital data collector.
- Include date, location, surveyor, equipment and site conditions.
- Record chainages, offsets, feature descriptions and observations.
- Use sketches and notes where they help interpretation.



Example field data

Point	Chainage (m)	Offset (m)	Feature
A	0.00	0.00	Start
B	8.50	3.20	Tree
C	14.70	2.80	Fence
D	23.40	5.10	Manhole

Check



Why do we need checks?

Surveying is a measurement process — measurements can contain error.

Repeat measurements can reveal inconsistencies.

Independent checks can identify recording or alignment mistakes.

Checks should be appropriate to the required accuracy of the survey.

Never assume a measurement is correct simply because it has been written down.

Plot

1. Establish the drawing scale.
2. Draw the baseline.
3. Locate each chainage along the baseline.
4. Construct the perpendicular offset.
5. Plot the feature.
6. Label and dimension the drawing.
7. Check the plotted information against the field data

