



# HOW TO DRAW ARCHAEOLOGICAL EARTHWORKS

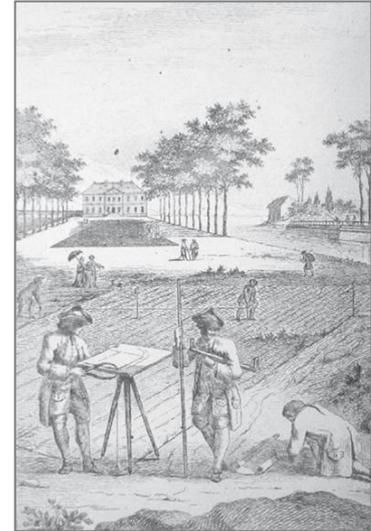
## INTRODUCTION

Surveying the earthworks of a historic monument is one of the oldest archaeological techniques. It was used by early archaeologists (called antiquarians) in the 17th and 18th centuries and is still used by archaeologists today. It is a really useful tool for mapping and understanding visible archaeological remains.

This session looks at three different methods of archaeological surveying:

1. Graphical (also called tape and offset) survey
2. Plane table survey
3. GPS survey

Archaeologists often still use the same techniques and equipment to record sites that the antiquarians used in the 18th century. However, over the past 40 years electronic recording methods have been introduced, which allow archaeological sites to be recorded very accurately and very quickly.



Technology doesn't always work, however, and it is really important for novice archaeological surveyors to learn how to take hand-measurements of the ground surface and learn how to draw archaeological plans. This also helps you to develop observational and analytical skills and improve how you see and understand archaeological remains.

There are other advantages to hand-measured surveys - the basic tools are cheap in comparison with electronic survey equipment, there is no risk that the batteries will run out and it is often easier to carry the equipment around.



Before you start your survey you need to do a bit of preparation.

- You will need to decide how detailed your survey is going to be and what area you are going to cover. This will help you decide what technique to use, what equipment and help you will need, what scale you will do your drawing at and how long it will take.
- You also need to think about who owns the site you want to survey and whether you have permission to access it, is there anything that might put you in danger when you do the survey (cliffs, falling masonry, animals). Some sites also have legal protection and you might need special permission to carry out the work.



## TASK

Survey part of a historic earthwork using the different survey techniques described in Activities 1-3.

## SETTING UP YOUR DRAWING

**Choosing a scale:** The scale at which you draw your plan will depend on the size of your site, the amount of detail you want to include and the size of your drawing board. Drawing things at scale instead of using photographs is important because it creates an accurate plan of the earthwork and makes it easier for archaeologists to compare one earthwork to another.

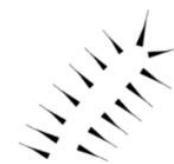
Earthwork plans are usually drawn at 1:100. This means that every 1cm on your plan will represent 100cm (1m) of your earthwork. If you want to draw something in more detail you might want to pick a larger scale such as 1:20 but if your site is really big, you may need to use a smaller scale such as 1:1000. Use the table below to decide which scale will be the most appropriate one to use.

Scale	Measurements on drawing	Measurements on ground
1:10	1cm	10cm
1:20	1cm	20cm
1:50	1cm	50cm
1:100	1cm	100cm (1m)
1:200	1cm	200cm (2m)
1:500	1cm	500cm (5m)
1:1000	1cm	1000cm (10m)

**How to draw earthworks:** You will record points along the top and the bottom of the slope of your earthwork and then depict the slope using 'hachures'. Hachures are short parallel lines with a thicker 'head' and thinner 'tail' used to show the direction and steepness of a slope (see picture).

- Draw a little triangle at the top of the slope and give it a tail running down to the bottom.
- The closer you draw the hachures, the steeper the slope; the further apart they are, the shallower the slope.

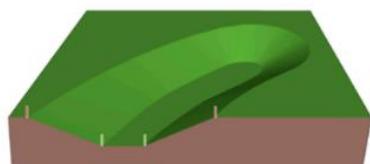
steep slope bank



shallow slope bank



ditch



field drawing

finished hachures



## ACTIVITY 1: GRAPHICAL (OR TAPE AND OFFSET) SURVEY

Graphical survey, or tape and offset survey, is a simple method which involves measuring distances from points along an earthwork to a straight line (called a baseline). It requires only the most basic equipment.

Ideally, 2-3 people are needed to record a site using the 'Tape and Offset' method. One person holds the tape over the points to be plotted, the second reads off the measurements at the right-angle crossing of the two tapes, and the third notes the points on the drawing. Take turns and try all three roles.

**You will need:**

2x 30m measuring tapes	Magnetic compass
2x survey pins or plastic survey pegs	Pencil (4H if using drawing film)
Bulldog clips or cloths pegs	Eraser and pencil sharpener
A3 or A2 size drawing board	Ruler (a scale rule is useful)
Masking tape (to attach paper to board)	Graph paper or drawing film

**Setting up your baseline:** Your first task is to set up a baseline with one of the 30m tapes. This is the line from which all your measurements will be recorded. Think carefully where you are going to place it. It is important that the start and end points of the line extend past the earthwork you are going to record. It is also easier if the baseline runs parallel to some of the earthworks you want to survey.

- Layout one of the 30m tapes in a straight line and fix it to the ground at either end using the survey pins/pegs and the bulldog clips or clothes pegs.
- Make sure that one end of the tape starts exactly at zero. Also make sure the tape is nice and tight. If it's blowing around you may need to weigh it down to keep it in a straight line.

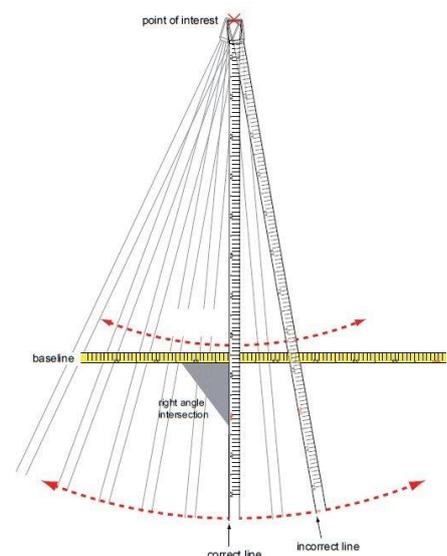
**Preparing and labelling your plan:** Once you have chosen your scale and set up your baseline, use a ruler to draw your baseline on your drawing film so that all the earthworks around it will fit onto your plan.

- It is helpful to mark the scaled distances of 0m, 5m, 10m and so on along your baseline. If you are planning at 1:100 you will mark these at 0cm, 5cm, 10cm and so on.

It is also important to label your plan so that people know what you are drawing. In one corner note the scale and, using a magnetic compass, add the direction north. You should also note the date, where you are and who drew the plan. You are now ready to start recording!

**Recording:** We will be recording the earthworks using 'offsets'. An offset is a measurement taken at a right-angle from the baseline tape to the point you want to record.

- Start at the 0m end of your baseline tape. One person take the second 30m tape by the end marked 0m and hold it over the first point you want to record. Second person, stretch the tape towards the baseline to create your offset. You need to take TWO measurements, one from each tape.
- Make sure the tape is taut and reasonably flat. Swing it in an arc across the baseline until it forms a right-angle. NOTE: the right-angle will be the shortest point on the second tape as it crosses the baseline tape (see picture).
- Read out the number along the baseline where the second tape crosses, then read out the distance along the second tape.
- Mark the point on the plan, measuring along the baseline first. Then measure the distance from the second tape and mark the spot with a small x. You have now recorded your first point. Repeat the process with the next point of interest. As you mark on more points you can begin to 'join the dots'. Once you have finished recording all your points add hachure lines to show the direction and steepness of the earthwork's slope.





## ACTIVITY 2: PLANE TABLE SURVEY

The plane table is one of the oldest surveying instruments and, though no longer in general use (it has been replaced by electronic forms of survey like GPS), is still useful for archaeological surveying. The name refers to the flat drawing board mounted on a tripod which is used in conjunction with a sight rule (more commonly known as an alidade).

Ideally, you will need 2-4 participants. Decide who is in charge of the project. One person using the alidade, one person holding the ranging pole and two people taking the tape measurement.

<b>You will need:</b>	1 x plane table	2x survey pins or plastic survey pegs
	1x tripod	Magnetic compass
	1x line level	Graph paper or drawing film
	1x plumb-bob	Masking tape (to attach paper to table)
	1x alidade	Pencil (4H if using drawing film)
	1-2x 2m ranging pole	Eraser and pencil sharpener
	1x 30m tape	Ruler (a scale rule is useful)

**Setting up your equipment:** Take all your equipment to roughly the centre of the area you wish to survey, so that all features can be recorded within a 30m radius of the table. If the area to be surveyed exceeds this, you may require more than one sheet of paper.

- Set up the tripod, extending the legs to a height at which you can survey standing up without bending over excessively.
- Secure the sheet of paper to the top of the table. Set up the table on the tripod and ensure it is level by placing the line-level on the table and checking it at various diagonals.
- Put a cross in the centre of the paper to mark the position of the table in the field. Use the compass to draw a north arrow, and write the location (site name, grid reference, parish), group name, participants' names and the date in a corner of the map. Put a scale on the map (usually 1:500, but you may want a smaller scale for surveys of smaller areas).
- Hang a plumb-bob from the centre of the tripod and mark the spot on the ground immediately below with a survey peg. Attach the zero end of the 30m tape to the peg.



**Recording:** Send two people with the other end of the tape and a ranging pole to the first point you wish to mark. Hold the ranging pole perfectly vertical and pull the tape tight and as horizontal as possible.

- Place the alidade next to the cross on the paper.
- Line up the alidade with the ranging pole using the foresight and the backsight.
- Once aligned, draw a faint line from the cross roughly to where you think the point you wish to mark lies. You are now ready to mark your first measurement.
- Ask the person with the tape what measurement they have, i.e. how far the ranging pole is away from the plane table. Using your ruler, mark on your first point with a dot.
- Repeat this for each point. When recording a continuous feature, such as a ditch, take measurements at about every 1m, or 2m, depending on how uniform the feature is.
- Once you have completed your survey (or have finished work for the day), GPS in the location(s) of the plane table and mark the co-ordinates on the map. Use these co-ordinates and the compass arrow to plot the location of your map on an Ordnance Survey map or Google Maps. In the absence of a GPS, measure the position of the plane table from two fixed points such as a road or corner of a building.



## ACTIVITY 3: GPS (NETWORK RTK) SURVEY

Today, archaeologists frequently use GPS to record earthworks instead of taking hand-measurements.

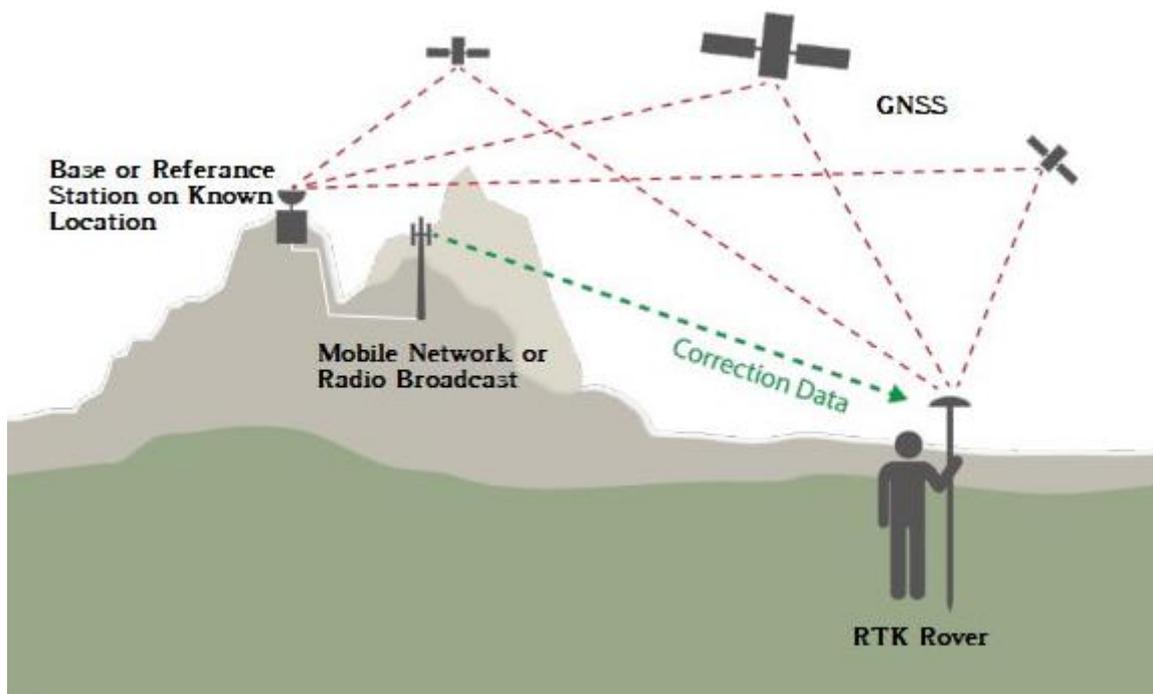
- GPS stands for Global Positioning System which is a global navigation satellite system (GNSS) which provides the real-time location of a GPS receiver anywhere on or near earth! It may sound familiar as it is now used in most mobile phones and in SatNav systems in cars.

For archaeologists it is invaluable because it provides a very fast and very accurate method for surveying large sites.

It does have its limitations, however. Most GPS systems are only accurate to around 3m and the equipment needed to get sub-centimetre accuracy can be very expensive. GPS also only works if it has an unobstructed line of sight to multiple satellites (so can't be used in wooded areas for instance).

The GPS equipment we are using today is called a Network Real-Time Kinematic (or RTK) system.

- The archaeological surveyor carries the 'Rover' which is a GPS receiver (at the top of the pole) synced to a tablet computer.
- It receives a signal from satellites in the sky and from a 'Base Station', which is a fixed point with a known coordinate.
- It measures the time it takes for the signal wave to travel between the different points. From this, it can calculate its distance and position in relation to the base station.
- There are three 'Base Stations' around Burrough Hill, one at Lincoln, one at Peterborough and one at Keyworth (Notts).



**Task 1 (10-15min):** The GPS has been pre-loaded with a plan of the hillfort showing a simple version of the main earthworks and some of the areas which have been excavated.

- Use the GPS to locate one of the roundhouses. Get YAC members to use the GPS to position themselves around the edge of the roundhouse so they can get a sense of how big it was.

**Task 2 (15-20min):** Part of the earthwork survey for the outer bank and ditch hasn't been finished.

- Use the GPS to survey and record the missing bits.



## USEFUL LINKS

Historic England have produced a number of useful Good Practice Guides for archaeological surveying.

- *Understanding the Archaeology of Landscapes*  
<https://historicengland.org.uk/images-books/publications/understanding-archaeology-of-landscapes/heag142-understanding-archaeology-of-landscapes>
- *Graphical and Plane Table Survey of Archaeological Earthworks*  
<https://historicengland.org.uk/images-books/publications/graphical-and-plane-table-survey-archaeological-earthworks/heag256-graphical-plane-table-survey-archaeological-earthworks/>
- *Traversing the Past: The Total Station Theodolite in Archaeological Landscape Survey*  
<https://historicengland.org.uk/images-books/publications/traversingthepast/heag062-traversing-the-past>
- *Where on Earth Are We? The Role of Global Navigation Satellite Systems (GNSS) in Archaeological Field Survey*  
<https://historicengland.org.uk/images-books/publications/where-on-earth-gnss-archaeological-field-survey/heag047-where-on-earth-are-we>

## SESSION PLAN

**Activity:** 2hrs + setup and registration time

Activity:	Time needed (e.g. 15min):	Timing (e.g. 10.00-10.15am)
Set-up	30min	10.00-10.30
Welcome & registration	15min	10.15-10.30
Meeting starts	-	10.30
Introduction	5min	10.30-10.35
<ul style="list-style-type: none"> <li>• Explain how the hillfort was planned in the past by antiquaries and how archaeologists would plan it today</li> <li>• Illustrate with print outs of past drawings made by antiquaries, archaeologists, Ordnance Survey, LiDAR etc.</li> </ul>		
Activities (delete or add as needed)		
Activity 1 - GPS	30min + 5min changeover	10.35-11.10
Activity 2 – Plane table	30min+ 5min changeover	11.10-11.45
Activity 3 – Tape & offset	30min + 5min changeover	11.45-12.20
Conclusion	5min	12.20-12.25
<ul style="list-style-type: none"> <li>• Quick wrap up of techniques used. Find out what members thought of the techniques. Discuss about pros and cons of each method.</li> </ul>		
Final notices	5min	12.25-12.30
Session ends	-	12.30