NCEA
Natural Capital and Ecosystem Assessment

England Peat Map
Soil Field Survey Protocol

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Natural England Research Report NERR149 Annex 1

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Contents

1. Introduction

The following survey protocol was provided to field surveyors for the England Peat Map project. The surveys captured data from across England, recording information such as peat presence, depth, soil texture, and organic content from sites selected according to a comprehensive sampling strategy.

The soil survey was undertaken on any soil type and used a 6 x 4.5 metre quadrat layout. In some cases, soil samples were taken offsite for organic content analysis. It was not intended for the soil survey to be repeated, although some plots were revisited for quality control purposes.

2. Preparation

2.1 Desk preparation

2.1.1 Soils

There are two separate types of soil survey: **Clusters** and **Transects**. Clusters are groups of quadrats whilst transects are a mixture of quadrats and peat depth measurements along a line. At each quadrat location a soil core is taken up to 1 metre down and examined, a soil sample may be taken for analysis, and peat depth measurements taken. Coordinates will be provided for all quadrats and peat measurement points. Prior to survey it is strongly recommended that aerial photography and/or satellite imagery is consulted to ensure a site is suitable for survey.

Load the quadrats into the field app or GIS (Geographic Information System) and print a map with the quadrats overlayed. This should be printed or displayed so that the edges of the 6 x 4.5 m soil quadrats are clearly visible and shown both over an OS 1:10,000 scale map and a recent aerial photograph.

2.1.2 Designated sites/sensitive features

Prior to a survey being undertaken, checks need to be made to ensure that there are no sensitive features on site which might be damaged by the survey being conducted. Where appropriate, consent/assent/advice should be secured prior to a survey taking place e.g. SSSI consent.

2.1.3 Landowner permission

Prior to a survey taking place, permission must be obtained from the landowner using the approved access permission letter, FAQs and privacy notice. A suitable time and date for the survey to take place also needs to be agreed with the landowner in advance.

2.2 Equipment

Table 2 Equipment List

Item	Soil Survey Quantity
Tape measure 20 metres (minimum)	1
Tape measure 5 metres (minimum)	1
GPS (sub metre accuracy)	1
Map or app with quadrats identified (alternative depending on method)	1
Field survey forms or app	1
Lensatic Compass & Ordnance Survey Map	1
Open Faced (Edelman) Soil Auger (5 cm diameter)	1
Split Soil Corer (5 cm diameter & 40 cm depth) including handle, extension rod, and 22mm spanners	1
Dead blow hammer (2000 g)	1
Set of peat probes (see notes below)	1
Kitchen knife e.g. Serrated Paring Knife with Safety Sheath, 19.5 cm	1
Camera - (good quality smartphone/tablet camera or other camera with a standard wide angle lens (approx. 28 mm SLR equivalent)	1
Locator flags/canes	5
Gloves (if required by surveyor)	1

Our preferred tool for measuring peat depth is the Hisco Utility Probe which can be obtained either direct from Hisco or via UK based distributors such as Van Walt (www.vanwalt.com/equipment/peat-probes/) and NHBS (www.nhbs.com/peat-probe). Whilst the Hisco probe does not have a threaded tip, which is advantageous in identifying the presence of soft (non-peat) sediments, it does perform well across a range of peat types and is commercially available.

Alternatives to the Hisco probes can be used provided they meet the following criteria, the type of probe used is recorded and the specification of the probe is provided:

- The probe should be rigid, lightweight and inflexible, which you can easily add extensions to and preferably it has a threaded cone shaped tip.
    - Rigid/inflexible probes are preferred as they are more likely to follow a true path straight downwards and not be diverted off to one side if you encounter an obstruction e.g. a piece of timber buried in the peat.
    - Slightly narrower probes are better for pushing through dried out agricultural peat which can be quite hard, whereas wider diameter probes perform better in wetter peat where it can be harder to tell where the peat/mineral soil interface is.
    - Smooth sided probes are preferred over textured probes as they are easier to push through the peat making it easier to feel the resistance caused by the probe entering a mineral soil.

Further guidance on how to take a peat depth measurement can be found in the EPM Peat Probe Guidance.

2.3 Health & Safety

2.3.1 Requirements

The survey organisation is required to have:

- Health and safety procedures with a commitment to high standards of health and safety
- A method for ensuring safe systems of work in the form of suitable and sufficient written risk assessments and associated method statements
- Adequate training and where appropriate, qualifications
- Evidence of proven track record of high health and safety standards
- Resources available to implement effective health and safety systems relevant to the contract
- Resources available to implement effective health and safety systems

2.3.2 Lone working

Where it is reasonable and sensible to do so, lone working should be avoided. Where lone working does take place, a risk assessment should be carried out to determine if additional measures are required. Consideration should be given to the task being carried out/if the individual has specific health requirements/ circumstances are outside the norm. Additional measures should be proportionate to the risk.

2.3.3 Lowland raised mire/fen sites

Due to the risks associated with working on lowland raised mire/fen sites, surveyors are required to work in pairs (but still with their lone worker procedure/buddy running in the background). At least one of the surveyors should have experience of working in similar terrain and be capable of identifying safe routes and safe survey areas well away from open water or unconsolidated ground (i.e. saturated Sphagnum bogs) when working on these sites. It is recommended that surveyors use sticks or walking poles to assess the firmness of the ground when on these sites, and that they carry (and practice using) throwlines to help with an emergency rescue. Where practical, it is recommended that at least one of the surveyors has formal first aid training.

2.3.4 Open water/Sphagnum pools

Due to the risks associated with deep water surveyors are required to avoid areas of either open or Sphagnum covered deep water and select an alternative survey point.

2.3.5 Over head power lines

The surveyors should not conduct peat depth measurements within a horizontal distance of at least 10 metres from an overhead power line. These distances should be measured from the line of the nearest conductor to the work, projected vertically downwards onto the floor, and perpendicular to the route of the line.

2.3.6 Unexploded ordnance

The survey organisation is required to conduct a preliminary unexploded ordnance risk assessment to determine the potential level of risk across all the survey locations. The assessment needs to include all factors which have contributed towards the assessment. It also needs to include recommendations for further action. If required a detailed risk assessment should be produced, and all actions implemented.

The survey organisation is also required to provide its staff/sub-contractors with suitable training on unexploded ordnance and have clear procedures in place on what to do if unexploded ordnance is discovered while conducting the survey.

2.3.7 Underground services

It is the responsibility of the survey organisation to conduct enquiries about the presence of any underground services within or near to each survey point. A risk assessment and method statement, covering the risk of underground services and what mitigating controls are being implemented, is required. If the risk is too high, an alternative survey point should be selected.

If cables/services are damaged all work must stop immediately, and the utility owner should be contacted as soon as possible.

2.4 Biosecurity & invasive non-native species

All surveyors are required to follow the biosecurity procedures detailed in ‘Biosecurity Guidance. A good practice guide to minimising the risk of moving non-native species, pests and diseases’, Natural England, 2017 (Unpublished).

The surveyors are required to record and submit online incidental sightings of Invasive Non-Native Species either through a webpage or using an appropriate smartphone app e.g. iRecord.

3. Field protocol

3.1 Soils

3.1.1 Soils cluster & transects

3.1.1.1 Clusters

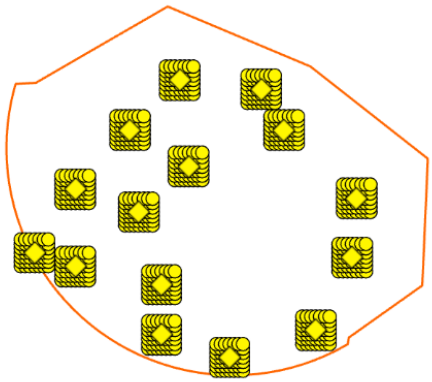

Figure 1. Cluster (orange line) containing several quadrats (yellow diamonds) and potential alternative quadrat locations (yellow circles)

A cluster is a 1 km^2 area containing 10-15 soil survey quadrats of which at least 8 need to be surveyed (Figure 1). Prior to survey the quadrats which are surveyed should be selected using a random method to avoid bias. Surveying the quadrats in numerical order e.g. EPM.3.c63.Q1-Q8 would be an acceptable random method as they have been randomly numbered.

Some clusters contain a small number of “Offset” quadrats. Where possible at least 1 Offset quadrat should be included in the 8 quadrats which are surveyed.

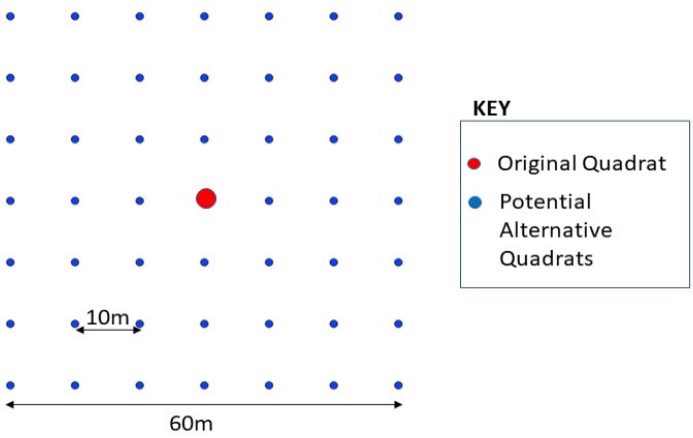

Figure 2. Preferred central quadrat (red circle) and alternative quadrat locations (blue circles) if required

In the field using GPS and map or app, locate the centre of the pre-assigned quadrat (Figure 2 red circle). Dangerous areas (e.g. deep-water areas/Sphagnum pools & man-made surfaces) or buildings/hard standing should not be surveyed; please re-site the quadrat to an alternate location. Alternative quadrat locations are limited to the nodes of a 10-metre grid centred on the original central quadrat up to a maximum of 30 metres offset from the central point (Figure 2 blue circles). The alternative quadrat which is closest to the original, and the easiest to access should be selected.

For the layout of each quadrat please follow section 3.1.4 Soil Quadrat Layout.

3.1.1.2 Transects

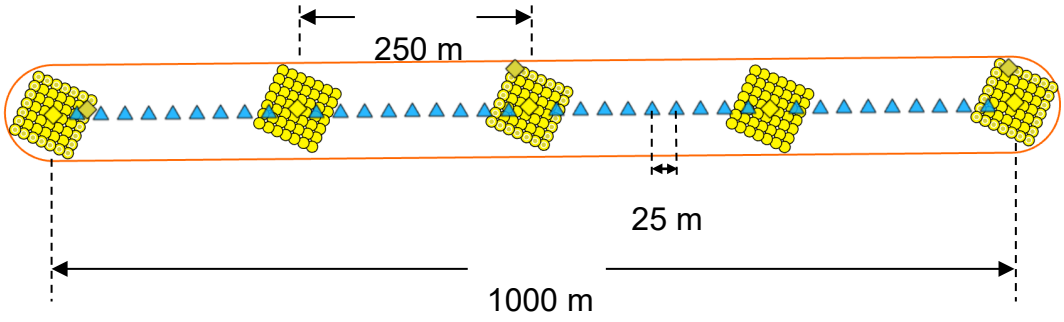

Figure 3. Soil Transect layout: Diamonds = quadrat locations; Circles = alternative quadrat locations; Triangles = peat depth points.

A Transect is a 1 km long linear survey containing 8 soil survey quadrats and 36 peaty soil depth measurements (Figure 3). All 8 quadrats need to be surveyed along with the peaty soil depth measurements. Peaty soil depth measurements should be obtained even if peaty soil is absent and recorded as 0. **NB** If a depth location is inaccessible, it does not need to be surveyed. There are 5 **central** or **core** quadrat locations (Figure 3: light yellow diamond), and 3 **offset** quadrats located at the outside edge of the alternative locations for core quadrats 1, 3 and 5 (Figure 3: dark yellow diamond).

Transects are generally located across areas where there is likely to be a change in peat depth and are generally orientated along the gradient of change (to the best of our knowledge). Coordinates will be provided for all quadrats and peat measurement points along a transect.

Using GPS and map or app, locate the pre-assigned quadrat that marks the start or end of the transect. Dangerous areas (e.g. deep water areas/Sphagnum pools & man-made surfaces) or buildings/hard standing should not be surveyed; please re-site the quadrat to an alternate location.

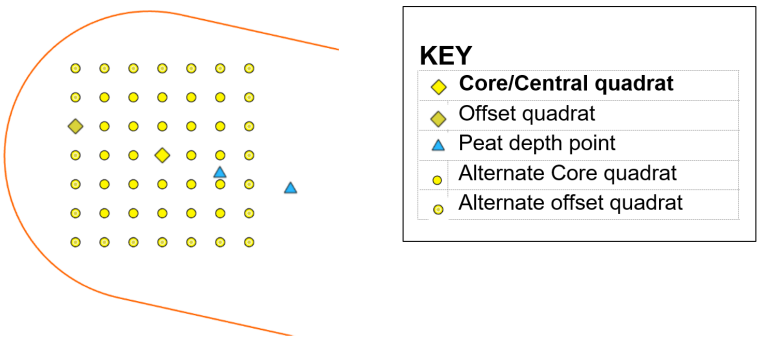

Figure 4. Transect Alternative Quadrat Locations

Alternative quadrat locations for central/core quadrats are limited to the nodes of a 10 metre grid centred on the central/core quadrat up to a maximum of 30 metres offset from the central point (Figure 4). For offset quadrats, only the outside edge of this grid should be used for alternatives. The alternative quadrat which is closest to the original should be selected, and the easiest to access should be selected. Also please record the reason(s) for rejecting a quadrat. For the layout of each core and offset quadrat please follow section 3.1.3 Soil Quadrat Layout.

3.1.2 Record survey information

Record the following:

Table 3 Survey information (per quadrat)

Variable	Method/comments
Cluster/Transect/Peat Depth Reference	Record the Cluster/Transect/Peat Depth reference e.g. EPM.7.C10.q1:core.
Reason if quadrat/peat depth moved	Record reason if quadrat/peat depth moved
Date	Record date of survey
Surveyor ID	The app uses your AGOL (ArcGIS Online) username as ID. In the event of the app being unavailable please record your AGOL username or initials if username not known. Do not share IDs between surveyors. Ensure each surveyor uses their own unique ID.
Peat Probe Type	Type of peat probe: select from peat probe, avalanche probe, cable rod, stick, other
Peat Depth Resolution	Resolution in cm at which depth was measured, e.g. nearest 5 cm, 1 cm etc.

3.1.3 Soils quadrat layout

Both Clusters and Transects contain soil quadrats. The soil quadrat consists of 5 soil sampling points: a central soil sampling point and 4 additional sampling points radiating out from the centre orientated along cardinal directions. Mark out the soil quadrat as follows:

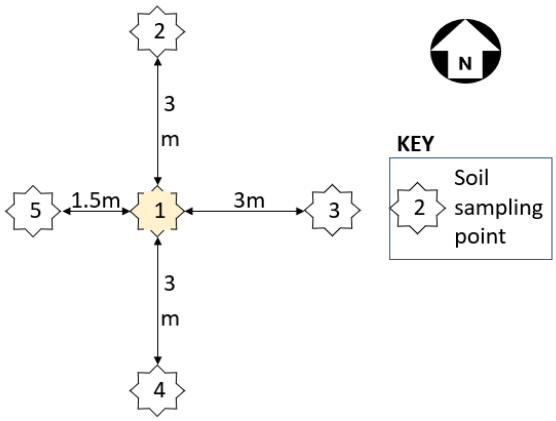

Figure 5. Soil quadrat layout

1. Use a locator flag or ranging pole to mark the first (central) soil sampling point
2. Using the tape measure and sighting with the compass mark out the remaining soil sampling points (Figure 5).
    - Sampling Point 2: 3 metres 0º N of point 1
    - Sampling Point 3: 3 metres 90º E of point 1
    - Sampling Point 4: 3 metres 180º S of point 1
    - Sampling Point 5: **1.5** metres 270º W of point 1

3.1.4 Record position

Once identified, record the GPS position of soil sampling point 1 OR a transect peat depth point.

Table 4 Position variables to record and methods to use

Variable	Method/comments
GPS position	**Optional**: If the GPS is not connected to the app or if a better resolution location is available (e.g. from another device) record the actual 12 figure grid reference at soil sampling point 1 OR at a transect peat depth point.
GPS accuracy	Record the precision in metres of the GPS signal at the time of the reading.
GPS unit	Record the make and model of the GPS unit used.

3.1.5 Organic soil presence, depth and characterisation

Carry out the survey activities described in Table 4.

Table 5 Variables to be recorded from within the soil quadrat

Variable	Method/comments
Intentionally blank	At Sampling Point 1 Only:
Take a soil core to determine the presence of organic soil	**Adjacent to** point 1 use the Edleman (open-faced auger) to check for the presence of organic soil at the surface. 1. Carefully push the vegetation to one side to minimise the amount of vegetation captured in the soil corer. If necessary, cut back the living vegetation. 2. Use the Edleman soil corer to obtain a soil core. 3. Examine the soil texture to check for organic soil (See "Detailed Hand Texturing Method and Use of Soil Maps" Document) If organic soil is present at the surface Or you are unsure about the soil texture, then you will need to take a second soil core next to the original using the 40 cm long 5 cm diameter split soil corer. The original soil core needs returning to the hole it came out of. 4. Prior to inserting the split soil corer, using the circumference of the corer as a guide, use a serrated knife to cut into the soil through any roots at the sampling point to ease the passage of the corer and minimise compression of the soil sample. 5. Insert the split corer into the ground to obtain a 40 cm long soil core. 6. If you cannot obtain a soil core from point 1 e.g. the split core comes back empty, please select one of the four other points. 7. Please record the location which the soil core was obtained from (1,2,3,4 or 5). 8. Lay the soil core out on the ground. 9. If buried peat is expected use the Edleman soil corer to continue taking a soil core down to a depth of 100 cm. If organic soil is absent at the surface use the Edleman (open-faced auger) to continue taking a soil core down to a depth of 40 cm (100 cm if buried peat is expected) using the following instructions: 10. Use the Edleman soil corer to progressively obtain a soil core. 11. Please record the location which the soil core was obtained from (1,2,3,4 or 5). 12. Lay the soil core out on the ground. Once a soil core has been obtained carry out the steps below: Photo, Layer Depth, Texture, Sample. Once soil analysis is complete, please backfill the hole in the order that the soil was removed.

Variable	Method/comments
Intentionally blank	When using the Split Soil Corer cut the soil core longitudinally in half, leaving half of the soil core in the corer, and place the other half of the core adjacent to the soil corer.
Photo	Take a photo(s) of the soil core (if using the split corer ensure the flat face of both halves is visible), alongside a tape measure with the tape starting at the end of the soil core that was closest to the surface. A maximum depth of 50 cm of soil should be visible in each photo. Care should be taken to ensure that the photos are not out of focus or blurry. The photos need to be labelled with the quadrat identifier followed by SC1 for the top 0-50 cm of soil closest to the surface, and SC2 for 50-100 cm e.g. “EPM.7.12 SC2” would be a photo of the top 50-100 cm of soil taken from quadrat EPM 7.12. Labelling can either be carried out digitally or by preparing an A4 sheet with the quadrat identifier in advance and holding it in the field of view of the photo.
Layer Depth	Record the distance from the soil surface down to the base of each soil horizon/layer in centimetres. Please do not include loose litter layer as a soil horizon.
Intentionally blank	Examine the soil core & carry out the following (NB when using the split soil corer use the half of the soil core that was removed from the corer):
Texture	Examine the colour and structure of each soil horizon/layer, and if required, carry out a hand texturing assessment. To do this, wet the soil and gradually knead thoroughly between finger and thumb until crumbs are broken down. Enough moisture is needed to hold the soil together and for the soil to exhibit its maximum stickiness but not as much so as to create a film of water on the surface of the soil or turn the soil into semi-liquid paste (if you have added too much water, add some more soil until the water film disappears). Assess the soil texture to determine if the soil is Organic, Humose or Mineral using the descriptions below and the guidance in the “Detailed Hand Texturing Method and Use of Soil Maps” Document
Organic (>20% OM) Horizon(s)/Layer(s) Texture	Record the texture of the organic horizon using the following categories: • Peat (>50% OM): humified, well-decomposed peat is usually black, with granular structure or is amorphous (structureless) and of noticeably low density when dry; note that in blanket and raised bogs the surface layer will typically be very fibrous, spongy and can be very dark brown rather than black, unless dried out through drainage. • Loamy or sandy peat (35-50% OM): black, binds to form a ball which breaks readily when pressed between the fingers, often presence of sand grains can be felt; granular or without distinct structure (amorphous).

Variable	Method/comments
	• Peaty loam or peaty sand (20-35% OM): very dark grey or black, properties of mineral components (see below) become noticeable but are not dominant, soil is soft when moist and easily workable in hand. Where clayey mineral deposits are present the soil is sticky and plastic (the ball can be formed into a thread), like clay, but softer and not as difficult to work as mineral clays.
Humose (8-20% OM) Horizon(s)/Layer(s) Texture	Humose/Organo-mineral soil (8-20% OM): very dark brown, dark greyish-brown colours, properties of mineral components are clearly dominant (silt feels silky, and slippery like butter, and is not sticky and like flour when dry; clay is very sticky and plastic and initially difficult to work if dry; if sand is present, the soil feels gritty and sand grains can be seen using a hand lens or even with a naked eye) even though the soil is almost black it does not tend to stain fingers, as the organic matter tends to be bound to mineral particles.
Mineral (<8% OM) Horizon(s)/Layer(s) Texture	Mineral soil: Measure the soil texture by hand and categorise into: Sand, Loamy Sand, Sandy Loam, Sandy Silt Loam, Silt Loam, Clay Loam, Sandy Clay Loam, Silty Clay Loam, Clay, Sandy Clay, Silty Clay using the flow chart in the Natural England Technical Information Note TIN037.
Intentionally blank	If an Organic horizon/layer has been identified OR a Humose layer OR if there is uncertainty in a layer's soil texture carry out the following steps on each layer:
Sample	For each unique organic soil texture class (Peat; Loamy or sandy peat; Peaty loam or peaty sand; Humose) present within the soil core a soil sample needs to be taken (i.e. if there are 2 soil layers both of which have the same soil texture e.g. Peat, only 1 sample should be taken from the layer closest to the surface)**:** If the horizon/layer is ≥ 5 cm long/100 cm^3: use the serrated knife to obtain a sample of approximately 100 cm^3 (5 cm long in the split soil corer) of the organic horizon/layer. Place the soil in a suitable sample bag and send it to a laboratory for loss on ignition analysis, labelling it with the plot identifier, horizon number, surveyor id and date. Samples will need to be kept cool during transport. Where possible the time between sample collection and processing at the laboratory should be kept to a minimum. If the horizon/layer is < 5 cm/100 cm^3: Record that a sample was not taken.
Intentionally blank	At a Peat Depth Point
Organic Soil depth in cm (at five locations per quadrat)	If mineral/humose soil has been found in the soil core, check all 5 depth points using the procedure below to make sure mineral soil can be found throughout the quadrat. Care needs to be taken to not confuse soft or recently disturbed mineral soil with organic soil. Peaty soil will offer significantly less resistance compared to the mineral soil. If no peaty soil is present at a depth point, please

Variable	Method/comments
	record zero in the survey form. If peaty soil is found, please use the procedure detailed below. If organic (peaty) soil has been found at the surface in the soil core or if there is uncertainty in a layer's soil texture, use the soil rods to measure the thickness of the organic horizon at all 5 depth points: Push the tip of the probe into the soil, attaching further extensions as required, until you feel resistance increasing markedly over a short depth interval, which can be associated with texture change (e.g. sand grains rubbing against the probe can be felt or heard; stoneless clay gives a much more gradual increase in resistance with no grinding and the probe can still be pushed into it; or the probe getting stopped abruptly (peat on rock)). Note that completely resistant, hollow-sounding material may be woody material which can sometimes be penetrated with further pressure or by probing again close-by. Once you've reached the bottom of the organic layer use a retractable tape measure to measure from the ground upwards to the nearest joint or to the end of the probe. This is the above ground value. Next, carefully remove the probe from the ground. Use known lengths of the probes/joints to calculate the length of the probe to the joint you measured the above ground value to. Subtract the above ground value from that length to obtain the depth of the organic layer. Record the depth at that point. If no peaty soil is present at a depth point, please record zero in the survey form. If Buried Peat is found at the bottom of the soil core, then at the location of the soil core use the soil rods to measure the thickness of the organic horizon beneath the ground. You will need to use the soil rods or soil auger to measure from the surface down to the start of the organic layer and subtract that from your final measurement to determine the thickness of the organic horizon. Please record the depth and location in the Notes field at the end of the survey form.
Bottom reached	Was the peat probe long enough to reach the bottom?
Presence of drainage feature within 5 metres (at five locations per quadrat)	Observe whether there are any natural or artificial drainage features such as gullies, grips or drains within a 5-metre radius of each point.
Intentionally blank	End If

4. Quality control

4.1 Purpose/Objective

The objective of the quality control process is to:

- Identify errors in the survey data.
- Ensure surveyors are following the agreed processes and procedures.
- Ensure remedial measures are put in place to reduce potential errors e.g. additional training.
- Improve survey accuracy using post survey data correction procedures.

4.2 Procedure

4.2.1 Survey point selection

To minimise survey error a second “blind” survey needs to be conducted on a subset of the points surveyed. At least 10% of each surveyor’s work needs to be “blind” surveyed. The first “blind” survey needs to be conducted as soon as possible after a surveyor has started surveying to ensure early identification of errors. Subsequent “blind” surveys need to be randomly selected from the pool of surveys that a surveyor has completed.

4.2.2 Field survey procedure

- Position of the original survey needs to be re-established using sub-metre accurate GPS.
- The original survey needs to be repeated without reference to the survey data apart from GPS location.
    - Soil Survey: A soil sample only needs to be obtained where an Organic horizon/layer has been identified as part of the QA survey or if there is uncertainty in a layer’s soil texture organic content **AND** no soil sample was originally obtained.
- Once complete, using a second device, compare the survey with the original.
- Where you consider there is significant deviation between the original and the new survey, record notes as to possible reasons why e.g. field has just been ploughed.

4.2.3 Post survey procedure

To ensure prompt and effective surveyor feedback the following post survey procedure needs to be followed: Upon receipt of the original and “blind” survey all survey fields need to be compared with each other and discrepancies highlighted. Any significant discrepancies need to be promptly investigated to understand the root cause. They need to be recorded along with any remedial action that needs to be taken, and clearly communicated to all involved. Any required remedial measure(s) need to be promptly implemented to prevent the discrepancy from reoccurring.

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