NATURAL CAPITAL AND ECOSYSTEM ASSESSMENT

ENGLAND ECOSYSTEM SURVEY
SOIL CLASSIFICATION SURVEY MANUAL

Version 1.2

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Editor: Jakub Olewski

Authors: Gabriella Abbott-Gribben, Olwen Belgrove, Vilma Cortes, Hannah Howells, Charlotte Long, Jakub Olewski, Sonja Schmidt, Matthew Shepherd

Reviewed by: David Martin

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1 Introduction

1.1 About this manual

This manual comprises of four sections:

- Introduction
- Preparation for the survey
- Field work
- Packaging and postage of samples

The introduction gives an overview of the purpose of the soil monitoring, survey design at the plot level, and health and safety. The sections that follow the introduction are written as instructions to follow in the order that they are given. Please read them in full when reading for the first time. Ask questions through your survey coordinator if anything is not clear or you have any comments. Additional information is provided in appendices.

1.2 The soil monitoring part of the England Ecosystem Survey

The soil monitoring programme is part of the England Ecosystem Survey (EES) developed by Natural England. The aim is to gather nationally representative data about soils in England. The survey will support the reporting on the state of England's soils and allows for monitoring changes over time. This data will be co-located with field observations for vegetation, habitats, and landscapes which also will be collected as a part of EES. Data will be gathered within main units called 'monads' (1km^2 squares).

The soil classification survey will be a one-off survey that will take place during the first monitoring cycle of the England Ecosystem Survey (EES). The purpose of this work is to obtain detailed soil profile description and soil type classification for each soil monitoring plot.

The field data collected will also enable Natural England to assign an Agricultural Land Classification (ALC) grade to each soil monitoring plot.

1.3 Types of soil survey in the England Ecosystem Survey

There will be two types of soil survey:

- soil sampling and assessment survey
- soil classification survey.

Guidance for the soil classification survey is presented in this manual.

The soil sampling and assessment surveys will be conducted in spring and autumn of 2023. The vegetation, landscape, and other environmental assets will be surveyed separately during summer.

The purpose of the soil classification survey is to provide essential background information about the soil type present in each soil plot. This will be made based on soil profile description carried out using methodology described in Hodgson (2022). Knowledge of the soil type is needed for grouping of similar soils for analysis of results and reporting. The soil classification surveys will not be repeated in subsequent survey cycles.

1.4 Survey design within the monad and the soil plot

Each monad is surveyed in pre-selected locations within potentially suitable land. The sample unit for the soil survey is a soil plot. The soil plot is a square measuring 16m by 16m. There are two to six soil plots in each monad. Not all of them may be suitable for soil surveys for a range of reasons.

In the centre of each soil plot there is a 2m by 2m vegetation plot. The soil sampling points are distributed around the vegetation plot. In the sampling and assessment survey the sampling points are 1m^2 areas of disturbance where different soil samples are taken. Potential sampling points are placed 2m apart. Four sampling points are sampled every five years (Figure 1). They provide a set of composite and individual samples that represent the plot. They are sent for a number of physicochemical and biological analyses.

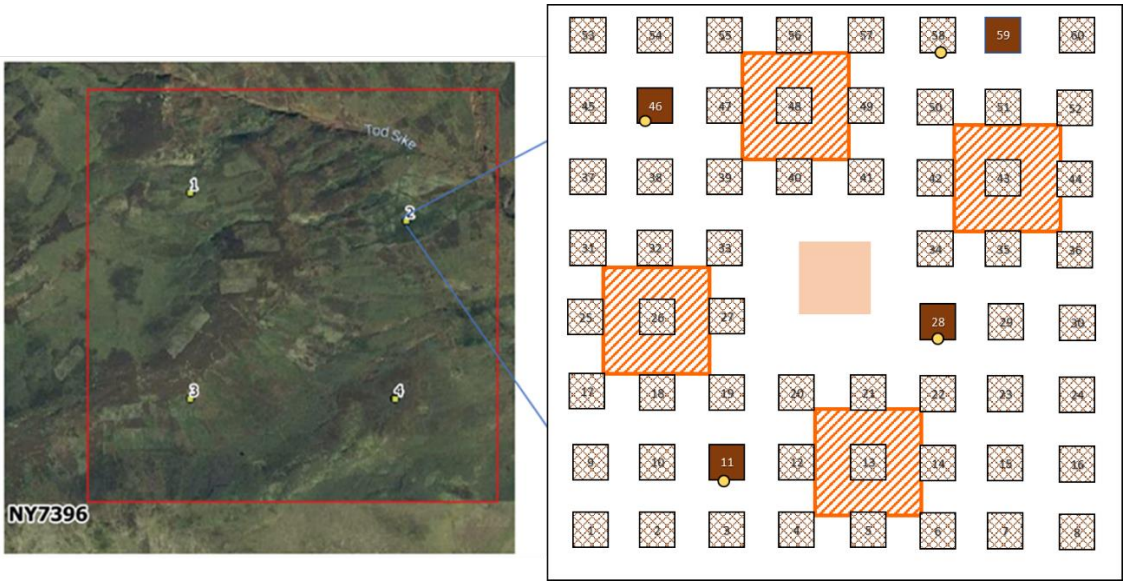

Figure 1: Example of a monad (1km by 1km, left) and a 16m by 16m soil plot, with four soil sampling points (brown squares), a vegetation plot (2m by 2m, light orange square) in its centre and the four possible 3m by 3m locations for the soil classification survey (squares with orange hatch) with centre point.

For the soil classification survey, four predetermined locations (centred on sampling points 13, 26, 43 and 48) within the 16m by 16m soil plot are provided (Figure 1). Each of them is a 3m by 3m square. The most representative location for the soil profile description is chosen by the surveyor. Soil profile description is carried out

from a pit excavated using a spade to a minimum of 60cm, or to an impenetrable surface (e.g. rock), and soil auger core from the base of the pit to 120cm, if coring to that depth is possible.

The vegetation plot in the centre and 1.5m buffer zone around it, as well as the four soil sampling points used in the sampling and assessment survey remain undisturbed by the soil classification survey. The co-location of soil sampling points and vegetation plot provides valuable information about the relationship between the plants and the soil.

1.5 Health and safety

Surveying involves navigating over open countryside carrying heavy equipment. It may also take place during periods of poor weather conditions and poor visibility. You must be mindful of any medical or other conditions that may impact on you or others during the surveys.

As a contracted surveyor you and your organisation must have robust health and safety procedures. These include use of site-specific risk assessments and up-to-date biosecurity measures. You must have also completed mandatory training, including:

- manual handling (internally within your organisation)
- detection of underground utilities and use of radio detection equipment
- unexploded ordnance (UXO) awareness
- EES soil classification survey induction delivered by Natural England.

You must follow the control measures set out in your risk assessment. Carry a copy (electronic or paper) of the risk assessment with you when carrying out the survey.

1.6 Biosecurity procedures

The EES soil survey is considered a high-risk activity because of the many different sites visited and likelihood of spread of harmful species between them. This could happen due to transfer of soil, plant material, and other debris. You must always clean sampling tools between the plots and undertake other procedures to avoid cross contamination that could affect the results of analysis.

Biosecurity procedures are described in detail in section 3.10.

The biosecurity disinfectant for the tools, equipment and clothing that have contact with soil is Safe4 disinfectant cleaner at a 1:50 dilution. The Safe4 concentrate used to make up the solution is corrosive and can damage eyes. You must ensure that you have appropriate COSHH risk assessments prepared and that you adhere to them. You must use appropriate PPE, storage and handling methods for the chemicals used. Basic clean-up equipment has been provided (see equipment list in Appendix 1).

There may be sites where disease orders require you to use a different concentration of the working solution or a different disinfectant instead of Safe4. It is your responsibility to follow local APHA and landowner's requirements.

1.7 Dynamic risk assessment

If there is a hazard which was not assessed as a risk, you must do a dynamic risk assessment and decide whether and how to continue the work.

Everyone who works on this survey has both the authority and responsibility to stop any task that could expose themselves or someone else to injury or harm.

1.8 Accidents and near misses

If you experience an accident or a near miss, you must report it as required by your organisation. You must also report it to Fera, who will report to Natural England.

2 Preparation for the survey

The main steps of the preparation before the survey are described in the following sub-sections. Please follow the steps in the given order and do not skip any of the steps unless you have already confirmed they are not relevant or have been addressed some other way.

2.1 Coordination and planning of survey work

The soil classification surveys are taking place before or after other surveys. The sampling and assessment surveys are carried out from March 2023 to May 2023, and then will begin again in September 2023. The vegetation and landscape surveys take place between May 2023 and August 2023. Fera needs to be told which monads you are planning to survey to keep the survey tracker up to date.

In brief, this is essential to ensure that you are aware of whether other teams have recently contacted the landowner or land manager, and whether the other teams have surveyed or are planning to survey the same monad soon. You will need to tailor what you will say to and what questions you will need to ask when arranging access to land. This is also needed to find out whether the default plot or an alternative option has been surveyed. The survey needs to take place in the same plot options as those surveyed before. Details of what is required of you as the surveyor and where to find this information are provided below.

1. As soon as you plan that you would like to carry out a survey, fill in the Excel sheet ‘Soil classification tracker’ (which was sent to you by Martin Worsley) and update it weekly.

2. Return the updated Excel sheet ‘Soil classification tracker’ every week either on Friday PM or Monday AM to Martin Worsley (martin.worsley@fera.co.uk) and Melissa Davie (melissa.davie@fera.co.uk).

3. Review of the Surveyor Information Pack and the Surveyors’ Report. Download the files you may need in the field from SharePoint so that you can refer to them offline (EES External Surveyors Site - Surveyor information packs - All Documents (sharepoint.com)).

4. Review information about designations (e.g. is the site a SSSI), risks to historic artefacts (archaeology) and habitat regulations assessment (HRA). Take a note of mitigation required and restrictions.

5. Check site location, potential access routes, hazards (e.g. steep slopes). Review properties of expected soil types using the NATMAP vector layer available for the monad area in the Surveyor Planning Map and in Field Maps app.

6. Review the UXO report to see if survey involves a known historical or current military firing range or if it was likely to have been a military target; check what mitigation is required.

7. Review the utilities reports for each plot and note which plots have known utilities mapped nearby and what are they.

2.2 Arranging access and obtaining additional information

1. Review information in the Surveyor's Report which will contain the following information: land parcels, owner details, site access contact(s), where we have permission to access.

2. The Surveyor Planning Map (arcgis.com) shows the parcels to which the information contained in the Surveyor's Report applies to (Figure 2).

Figure 2: Example of a monad with plots and 1ha squares shown, and land parcel information available in the Surveyor Planning Map.

3. Check if the contact has been made by other surveyors (soil sampling and assessment survey, vegetation and landscape survey), and also if any of these surveys have already taken place. The information about completed and planned

surveys for different monads will be made available in the survey coordination spreadsheet here: https://defra.sharepoint.com/sites/WorkDelivery3549/Survey%20Coordination/Forms/AllItems.aspx
The coordination spreadsheet has not been set up at the time of writing, please check with Fera's survey coordinator if there are other surveys planned for the monad you are intending to survey.

4. If the monad has been surveyed before, but the information is not yet available in the Surveyors' Report, please contact the surveyors who have carried out the survey to obtain information about the access, parking, restrictions etc. for the site. If the spreadsheet shows that the survey has been planned, please contact the surveyors who are planning the survey to coordinate the surveys and contacting site access contacts.

5. The site contacts may be landowners, tenants, land managers, and land agents. There may be many different people to contact, and you may not get through to them on your first attempt.

6. Make contact to arrange site access at least a week prior to the start of the survey, earlier if possible. You must have access arranged at **least 48 hours** in advance. If you were not able to arrange access, you cannot sample at that location even though permission had been given.

7. When contacting your site contacts:

    - Explain to them that this work is being carried out by or on behalf of Natural England, as part of the England Ecosystem Survey.
    - Confirm that the landowner has already given a written permission for the survey to take place.
    - Refer to the initial access letter and landowners' Frequently Asked Questions (FAQ) documents to answer any questions landowners and tenants may have (these can be found in the Surveyor Library on SharePoint.)
    - Explain you will come back to them if you cannot answer any queries immediately, follow these up with colleagues and provide an answer as soon as possible via an agreed channel, e.g. phone call or email.

8. Ask the essential questions listed below and record the answers given (unless already known from previous surveys and the situation would not change since):

    - Have those who work the land (farmers, land managers, game keepers etc.) have been made aware of your planned survey? You may need to contact them separately if not confirmed by the site contact.
    - Are there any special arrangements for access: locked gates that need to be unlocked for you, places where (not) to park etc.?

- Are there any areas that should be avoided, for example because of dangerous ground features or unpredictable livestock?
- Have fertilisers, manures, sewage sludge, other organic wastes, other agrochemicals recently been applied? If yes, ask for the type of product(s) and date of application. Using information obtained decide whether it is safe for you to carry out the survey at the planned time or whether it needs to be postponed.
- Are there underground utilities other than those known from the utilities report present within or near the alternative plot options grid for the given plot?
- Is there anything else you need to know beforehand; any additional precautions to be followed, e.g. additional biosecurity measures.
- If you suspect the land may be flooded or covered in snow, check this too as such conditions make the site non-surveyable. You will need to postpone the survey if such conditions occur.

9. Please mention to the site contacts that they are likely to be contacted again for the soil sampling and assessment survey (if not carried out already), and vegetation survey later in the year.

10. Record the information that you obtain in the Surveyor's Correspondence Form (one form for each landowner contacted). The form can be found in the Surveyor Library on SharePoint, or in Appendix 2. Please send filled forms as attachments to: englandecosystemsurvey@naturalengland.org.uk

11. The information contained in Surveyor's Correspondence will be collated and added to the land access database, from which updated Surveyors' Reports will be generated and made available for future surveys on SharePoint.

12. You must comply with all conditions and restrictions, e.g. Covid-19 control measures.

13. Landowners, tenants, managers, do not need to be present for the survey but can meet you if they so wish.

2.3 Finding out whether default or one of alternative plot options has been surveyed

1. Check if the site has been surveyed before or if the survey on it has already been planned by consulting the survey coordination spreadsheet available at: https://defra.sharepoint.com/sites/WorkDelivery3549/Survey%20Coordination/Forms/AllItems.aspx (not set up at the time of writing, please check with Fera's survey coordinator if there are other surveys planned for the monad you are intending to survey).

2. Review the Surveyor Planning Map (arcgis.com) , which will show you for which plots field records have been submitted.

When a soil plot has been surveyed before the soil classification survey takes place and the forms have been submitted, the soil sampling points be will be highlighted with yellow dots in the Surveyor Planning Map (arcgis.com) and in the Field Maps app (Figure 3).

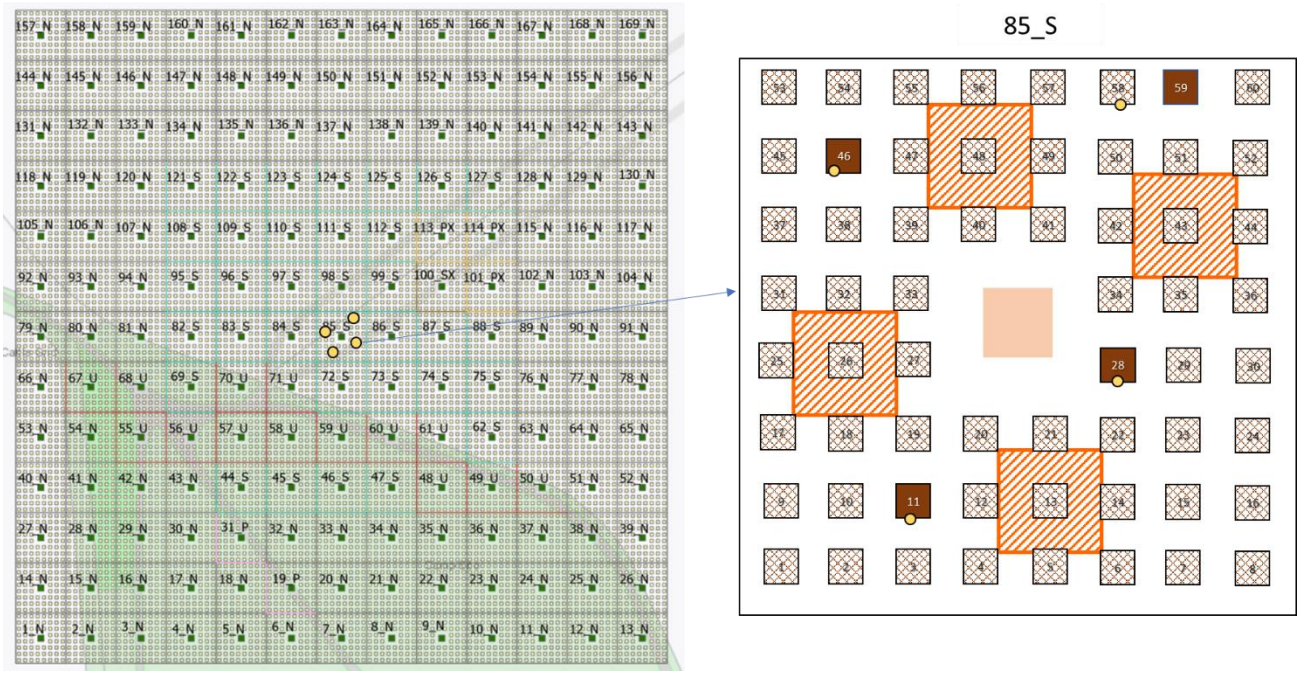

Figure 3: **Left:** grid of alternative plot options for one of the plots within a monad with four soil sampling points completed for plot option 85 (highlighted with yellow dots). **Right:** Surveyed plot with four sampling and assessment survey sampling points completed (yellow dots), also showing default sampling and assessment survey sampling points in brown; soil classification survey 3m by 3m sampling points shown as squares with orange hatch.

For plots that have been surveyed before, the plot option in which the soil classification survey is to be conducted will be the one with yellow dots in it.

This information will not be available if the other surveys are taking place at the same time or if the data has not been uploaded yet. In such cases direct contact with the other surveyors must be made to confirm plot options to be surveyed.

2.4 Review of hazards and risk mitigation measures required

1. Make a note of the nearest emergency department (A&E dept), including name, distance from, route to.

2. Make a note of the grid references or What3Words of plot locations (it is also useful to have What3Words app downloaded onto your devices https://what3words.com/products/what3words-app).

3. Plan route to site and note any potential hazards including livestock, farm buildings, watercourses, mineshafts, spoil heaps, boggy areas, cliffs.
4. Check what biosecurity measures will be required, e.g. when crossing land holding boundaries.
5. Check current restrictions due to disease outbreaks: link to APHA's interactive map.
6. Check for any issues flagged up in the Surveyors' Report.
7. Check local mobile coverage: Mobile Phone Coverage 2023 - UK Mobile Phone Network Signal Coverage Comparison. Compare 5G, 4G and 3G on Vodafone, EE, O2, 3, Tesco, Virgin and more. (ukmobilecoverage.co.uk).
8. Include any additional hazards and how to control them in the site-specific risk assessment.
9. Make colleagues and buddy aware of any medical conditions or allergies, bring any necessary medication such as insulin, epi-pens.
10. Check the weather forecast and postpone survey if necessary.
11. Do a personal risk assessment if you have any relevant medical conditions or are pregnant.
12. Check what additional mitigation is required if accessing protected sites.

2.4.1 Mitigation for protected sites

If you follow the general avoidance measures and methodology below, the proposed operations are unlikely to damage any of the flora, fauna, geological features or physiographical features that make it a Site of Special Scientific Interest (SSSI). This means no individual or collective assent is required from Natural England. Supporting documentation is provided in the Surveyor Library on SharePoint.

Care must be taken to avoid damage to any SSSI, on any Special Protection Area (SPA), Special Area of Conservation (SAC), or Ramsar site that may be selected for soil sampling during the survey.

To mitigate potentially adverse effects of the surveys you must:

- Check for designated features on the Designated Sites View of Natural England.
- Review the Habitats Regulations Assessment (HRA) rapid screening documents for the sites you are going to in: Surveyors Library – Designated Site Process.

- Review comments from Natural England's local area teams provided in the access notes in the Surveyor's Report.
- Identify vehicular access and parking ideally off site or restricted to surfaced tracks and hard standing areas within the SSSI. All other access to be on foot.
- Remove all materials and equipment used in the survey, including any food remains.
- Keep damage to the vegetation and soil to a minimum and restrict trampling. Do not cut or remove vegetation to facilitate access.
- Take great care to avoid disturbance to wildlife, including ground nesting birds, by being vigilant, avoiding areas around any breeding sites and moving away quickly if causing disturbance.
- Take care so that no organisms are released on site, including plant seed and micro-organisms carried from other sites on boots, clothing, bags and equipment.
- Follow the general biosecurity measures and any site-specific measures provided in the Surveyor's Report and by the access permissions contact for the site.

Similarly, it is considered that the proposed operations are unlikely to have a significant effect, either alone or in-combination, on any Special Protection Area (SPA), Special Area of Conservation (SAC), or Ramsar site that may be selected for survey and therefore require no strategic or site-based appropriate assessment by Natural England as the competent authority.

The rapid HRA screening tool that is designed to record the screening of lower risk projects will be used to record the judgement that no likely significant impacts are foreseen from the EES on SAC's/SPA's or Ramsar sites. This preliminary screening will be carried out by Natural England in advance of the survey.

Following liaison between the survey co-ordinators, the 'Protected Sites and Nature Recovery' team and local area teams, any issues or constraints will be flagged up in the Surveyors' Report, that will be made available to you before the survey.

2.5 Preparation of equipment and consumables

List of equipment expected to be needed in the surveys is provided in Appendix 1.

1. Bring an OS map for remote sites to be able to navigate back to the vehicle in case of electronic device failure.
2. Make sure the mobile phone, GNSS receiver (the Geode) and iPad are fully charged (when charging Geode always use the charger it was supplied with).
3. Check that you have Spot-X tracker and spare lithium batteries.

4. Prepare appropriate clothing for the time of the year and location.
5. Periodically check contents of the first aid kit, replenish stock of items if used recently, replace out of date items with new ones.
6. Perform vehicle checks: e.g. condition of tyres and pressure, engine oil, screenwash, fuel levels.
7. Plan how you will carry the equipment depending on the access and what you require to do the survey in expected environment.
8. Prepare disinfectant required for the site. Use Safe4 disinfectant at 1:50 dilution, if no specific requirements are given by the survey coordinator or the site contact. Follow COSHH risk assessments and wear appropriate PPE when using chemicals.
9. Fill up the water container and check stock of paper towels.
10. Download the offline area for the monad in the Field Maps app shortly before you go out to ensure you have the most up-to-date version.
11. Check for updates to Survey123 form when online and before you go on site.

3 Field work

3.1 Summary workflow

3.1.1 On site before start of soil classification survey

1. Turn on GNSS receiver upon arrival (see Appendix 3 for instructions).
2. Locate suitable vegetation and soil plot. Find alternative option if needed.
3. Take picture of the entire soil plot (16m by 16m).
4. Choose suitable soil profile location within the plot.

3.1.2 At soil profile location within the soil plot

1. Record date, time, monad, plot, sampling point number, and coordinates of the south-west corner of the sampling point (1m by 1m area in the centre of the 3m by 3m soil pit area) in the Survey123 app.
2. Take picture of 3m by 3m square of where soil pit will be dug.
3. Dig soil pit to 60cm depth and extend to 120 cm using the auger (unless bedrock is present at shallower depth.
4. Take photograph of the soil profile in the pit and auger core.
5. Describe soil profile according to the *Soil Survey Field Handbook* (Hodgson, 2022) using the Survey123 data collection form.
6. Take soil sample from each horizon and bag them separately in pre-labelled bags.
7. Close soil pit.
8. Take picture of 3m by 3m soil pit after it has been closed.

3.1.3 After finishing work at the soil plot

1. Clean tools as required to prevent sample cross-contamination and to maintain biosecurity.
2. Carry out the end of the day clean-up procedure.
3. Add any new information about access and hazards present on site to the Surveyor's Correspondence Form (Appendix 2) and email it to: englandecosystemsurvey@naturalengland.org.uk

3.2 Locating the plots

3.2.1 General information about navigation and locating plots

EES uses high accuracy GNSS (Global Navigation Satellite System) receivers and field data collection apps on an iPad to navigate and locate the sampling plots and points. The GNSS receiver that is used in the surveys is Geode GNS3M with additional positioning correction subscriptions. Guidance for use of the receiver and the apps is provided in Appendix 3. Please familiarise yourself with use of the receiver and the apps before the surveys.

Figure 4: Locating the SW corner of location for soil classification pit using the GNSS receiver and an iPad mounted on a survey pole.

It is important to keep disturbance of areas to a minimum. Walking across the soil plot should be minimised to only what is necessary to the location for the soil profile. The central 2m by 2m vegetation square is excluded from the soil survey and must not be walked across.

Switch on the GNSS receiver as soon as arriving on site and use it for general navigation. This allows for the convergence of Atlas corrections to take place and be maintained between reaching the plot. This takes between 15 and 40 minutes and the receiver must be on and upright all the time to enable this and to maintain high accuracy positioning thereafter.

Use the GNSS receiver mounted on the survey pole. The survey pole is to be extended to its full length (2m) to ensure best reception of satellite signal (for full app and receiver use instructions please refer to Appendix 3).

If the position in Field Maps is not received from the GNSS receiver or it is not working, the locating of sampling points cannot proceed, and the survey cannot proceed. This is because the accuracy of the iPad integrated provider is not good enough to avoid sampling within the vegetation plot or on soil sampling and assessment survey points. If this occurs report the problem to survey coordinator.

3.3 Assessing suitability of the plots

3.3.1 Desk study completed by Natural England

Natural England identified potentially suitable 16m by 16m soil plot locations in a pre-survey desk study by looking at the following:

- Land where soil cannot be sampled due to designations, such as scheduled monuments.
- Land where sampling would be unsafe, such as landfills, quarries.
- Presence of known underground and overhead utilities (does not replace the need to follow the HSE guidance HSG47).
- Unexploded ordnance (UXO) hazard level.
- Presence of significant non-uniformities within the plot, such as trees, tracks, paths, different habitats, different soil types (see criteria for assessment of plot suitability in the field, section 3.3.2).

The desk study did not include assessment of suitability for the vegetation surveys.

The desk study assessment of plot suitability does not guarantee that the default plot is safe and suitable for the survey. You must confirm the suitability of the plot according to the procedure described in section 3.3.5 before you start the survey.

There are between two and six plots in each monad. The map in the field data collection app shows grids of alternative plot options within a monad for each plot. Therefore, there are between two and six alternative plot options grids in each monad. Each plot is numbered (1-169) and has a suffix indicating results of the desk study assessment carried out by Natural England, for example 61_SX. Each grid is centred on a default plot location: **the central plot option of the grid, no. 85 (Figure 5).**

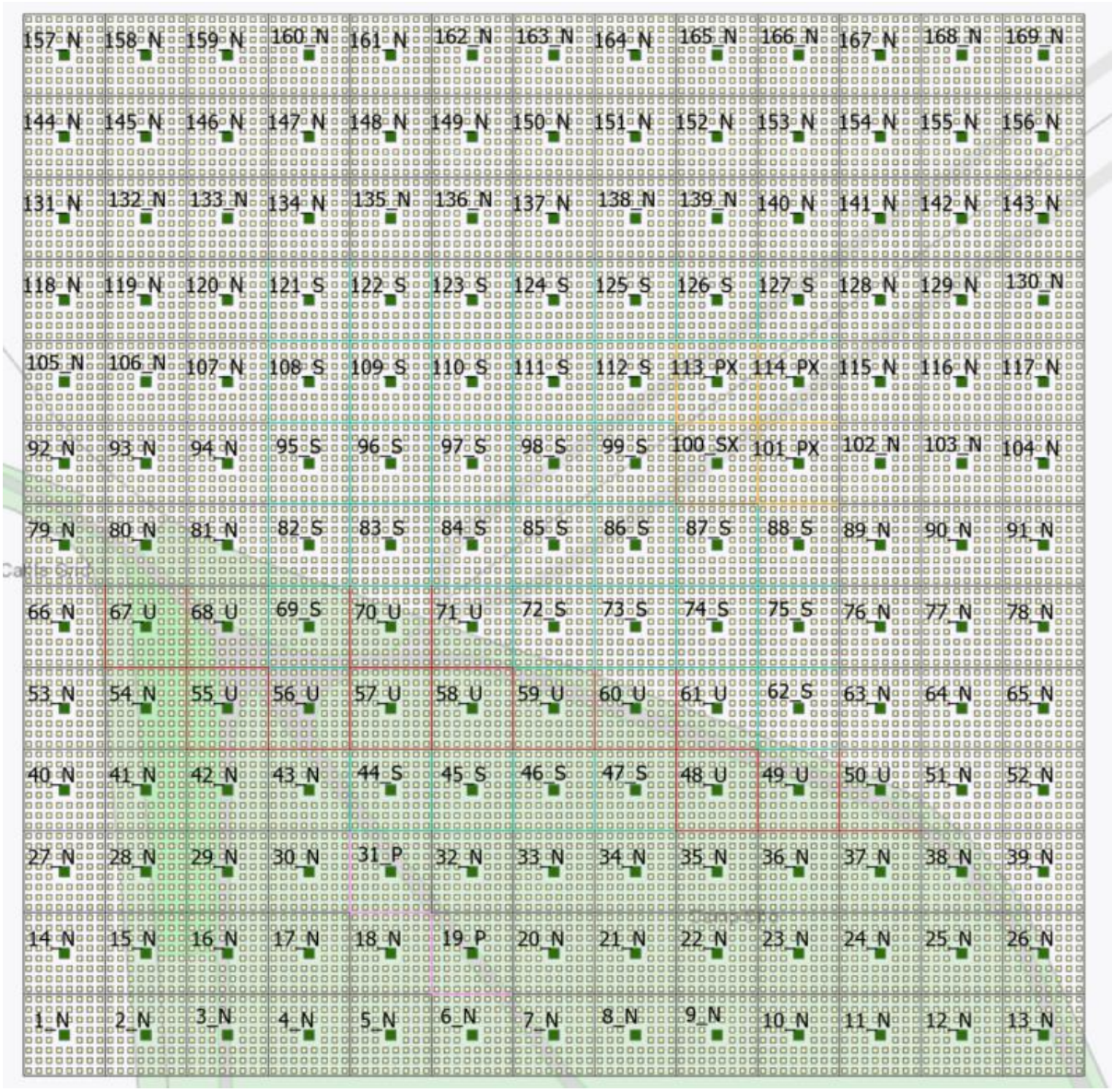

Figure 5: Example of grid of alternative plot locations numbered from 1-169.

The suitability category suffixes shown in Figure 5 are defined as:

S – plot deemed as suitable for the soil survey, carry out field checks on field-identifiable features to verify.

P – plot deemed potentially suitable for the soil survey, outside of hard constraints, but for which review of aerial imagery and other data was inconclusive. If considering such plot option for survey, carry out field checks on field-identifiable features to verify.

U – plot deemed unsuitable for the soil survey, either due to hard constraints or non-homogeneity. Must not be surveyed.

N – suitability not assessed, the plot was not assessed as enough suitable plots close to default location were found during the desk study. Automated intersection

with hard-constraint layers did not show the plot to be unsuitable. If considering such plot option for survey, carry out field checks on field-identifiable features to verify.

X – additional suffix indicating UXO risk higher than low. Soil surveys must not be carried out without non-intrusive UXO survey and explosive ordnance clearance (EOC) engineer's supervision – checking of sampling points by the engineer is required before sampling is undertaken. The process for arranging this is as follows:

1. Inform survey coordinator about the survey date (minimum two weeks in advance).
2. Survey coordinator will pass this information to Natural England.
3. Natural England will instruct the EOC engineer to provide the non-intrusive UXO survey and supervision during the soil survey.
4. Survey coordinator will provide you with the engineer's contact details so that you can arrange to meet them on site.
5. You are responsible for contacting the engineer immediately should there be changes to survey schedule.

3.3.2 Assessing suitability of survey plots on site

Every soil survey plot must have a suitable vegetation plot in its centre. The soil plot is not surveyed if the vegetation plot is unsuitable. There are defined locations where vegetation plots can be surveyed without having soil plots associated with them. In such a case an additional vegetation plot with suitable soil plot around needs to be identified.

If the soil classification survey takes place before the soil sampling and assessment survey and vegetation survey, you first need to assess the vegetation plot for its suitability. Default locations of vegetation plots are selected at random and not assessed before the survey for their suitability. This means it is possible for the default vegetation plots to be in unsuitable areas, such as on roads, small water bodies, access tracks, and others.

If the vegetation survey or the soil sampling and assessment survey have already taken place, you need to carry out the soil classification survey in the location identified as suitable for the soil survey by the surveyors that have been previously on site (soil plot highlighted in Field Maps and Surveyor Planning Map (arcgis.com) with yellow dots or as plot number given directly by the other surveyors).

It is rare that you will have to abandon a soil plot because you identified it as unsuitable after the vegetation survey was carried out. This is because suitability for the soil survey is checked during the desk study and during the vegetation survey. However, you still need to do the safety checks, because on-site checks for underground utilities are not carried out by the vegetation surveyors.

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3.3.3 Criteria for suitability of a vegetation plot

A 2m by 2m vegetation plot is unsuitable if it is in a:

- woodland or a linear feature, such as a hedgerow or riparian vegetation
- river or lake, coastal lagoon, marine habitat
- on a sealed surface, constructed or unvegetated track or path, in a built-up area.

It is also unsuitable if it is in a curtilage (an area of land attached to a building, forming one enclosure with it, and with a use linked to the building e.g., garden).

Should the plot be located on a vegetated track or path and the vegetation is representative of the surrounding habitat, it can be a representative vegetation plot.

3.3.4 Criteria for suitability of a soil plot

A soil plot is unsuitable if:

- The vegetation plot in its centre is unsuitable.
- The plot is crossed by underground utilities or overhead power lines.
- There is no or very limited soil is present on a large part of the plot that would make soil sampling very difficult such as exposed rock, scree slopes.
- A significant part of the plot has got a different macro or microtopography such as vertical exposures, e.g. half ridge and furrow and half not.
- There are significant differences in slope or aspect in parts of the plot giving rise to differing soil characteristics such as part of the plot is on a slope and part is level.
    - Exception: spatial variation at a plot scale characteristic of the surrounding area such as eroded revegetated blanket bog.
- There is significantly different land use or land management in parts of the plot such as grassland and arable within soils plot. A plot is also unsuitable if crossed by a field boundary, even if management on both sides of the boundary appears to be the same.
- The plot is an unusual landform otherwise not present in the surrounding area, such as a single mound or hollow.
- Part of the plot is subject to localised erosion, compaction or superficial damage which otherwise is not a regular, unavoidable feature of a larger area such as erosion rills, vehicle tracking, scrapes, gullies.

- Part of the plot is noticeably wetter or drier.
- There are man-made structures in the plot, such as:
    - a path
    - track
    - materials storage (manure, soil, hay)
    - soil stripping
    - electricity pylon
    - drainage ditch (except frequent moorland grips)
    - path of animal crossing through the field
    - feeding stations where animals gather etc.
- Part of the plot appears to be influenced by localised pollution or nutrient enrichment.
- The plot includes two different habitats, stands etc, unless it is a typical feature of the surrounding area, a pattern occurring at a plot scale which would be impractical to avoid.
- There are indications of different soil types present.
- It is in a woodland.
- Single tree(s) are present in the plot or at plot boundary.

Soil plot is also unsuitable if large shrubs are present in the plot. Small shrubs, such as heather that are in keeping with the surrounding habitats and would not interfere with sampling are permitted.

Soil plot is also unsuitable if large animal burrows are present (rabbit warrens, badger setts etc.), but it is suitable if only the occasional burrows such as, mole hills, are present.

To avoid badger setts, look around the plot and nearby for signs of badger activity. Follow guidance given in Appendix 4 for signs of badgers. Choose a plot option buffered by at least one more plot from a plot where badgers sett is suspected.

A soil plot that is currently unsuitable may become suitable later in the same survey campaign if:

- Plot is flooded.
- Potentially dangerous animals, such as bulls, cows with young calves, are present within the plot (enquire with farmer/landowner).
- Fertilisers, manures, waste materials or pesticides have been applied that would make surveying unsafe.

3.3.5 Assessing plot suitability – soil plot and vegetation plot not surveyed before

The procedure for assessing plot suitability when soil classification surveys take place before the soil sampling and assessment surveys, and vegetation and landscape surveys is as follows:

1. Navigate to the edge of the vegetation plot in the default plot location (plot no. 85). Do not walk on the vegetation plot.
2. Assess suitability of the vegetation plot according to the criteria given in 3.3.3.
3. If the vegetation plot is unsuitable, do not proceed with assessment of the soil plot but:
    a. Assess alternative options for the vegetation plot in the order of: W, N, E, S (plots no. 84, 98, 86, 72). Choose the first suitable option and proceed with no. 4 below.
    b. If none of the options is suitable, assess the closest in-between options in this order: SW, NW, NE, SE (plots no. 71, 97, 99, 73).
    c. If none of the above are suitable, continue assessment of further alternative plot options one grid segment further from the default plot in clockwise order starting from plot no. 59, 58, 57, 70 and so on.
4. Once a suitable vegetation plot is identified, mark it with flags. Assess suitability of the soil plot by looking around and applying criteria given in section 3.3.4 above.
5. If the soil plot appears suitable after this quick check, walk outside it along its perimeter, keep assessing its suitability, and mark the corners with the flags.
6. Check the suitability of the soil plot again, now looking at the marked extent of the soil plot.
7. If the soil plot is suitable, take a photograph of it in the app. The photograph is to be taken from the north, looking south, when standing on the northern side of the plot, outside of it. Frame the photo so that entire plot is visible and takes the entire width of the frame, but with corner flags still visible. Locate the plot in the bottom part of the frame so that part of the surrounding area is also captured.
8. Proceed with locating, choosing, and checking soil profile location as described in section 3.4 below.
9. If only vegetation plot is suitable, go to no. 1 above in this list to search for a suitable vegetation plot with a suitable soil plot around it.

3.3.6 Assessing plot suitability – vegetation plot surveyed before

1. Check which plot option have been surveyed in each plot as described in section 2.3 above.

2. Go to soil plot that was identified as suitable by the vegetation surveyors, walk around it (outside) to confirm its suitability and mark its corners with flags.

3. In a rare situation that the soil plot is found to be unsuitable, do not proceed with the soil classification survey in this plot. Provide feedback to survey coordinator.

4. If the soil plot is suitable, proceed with choosing suitable soil profile location within the soil plot as described in section 3.4 below.

3.3.7 Assessing plot suitability – soil plot and vegetation plot surveyed before

1. Check which plot option have been surveyed in each plot by reviewing the Surveyor Planning map and alternative plot options grid in Field Maps after downloading the offline areas for your plots.

2. Proceed with locating and checking suitable soil profile location within the plot as described in section 3.4 below.

3.4 Locating the soil profile within the soil plot

1. Looking at the soil plot with marked corners and the corners of the vegetation plot, find approximately where the sampling points 13, 26, 43 or 48 are. Assess these locations visually. Use flags if needed.
2. When approaching the location for the soil profile avoid trampling on the vegetation plot and the four soil sampling points allocated for the EES soil sampling and assessment survey 2023.
3. Choose one suitable soil profile location out of the four using the following criteria:
    a. Soil profile must not be upslope from the vegetation plot.
    b. For plots with unavoidable heterogeneity, the soil profile should be in a point that represents the greatest area of the soil plot (provided that criteria 3.a above has been fulfilled).
4. Navigate to the south-west corner of the 3m by 3m soil profile disturbance area in the chosen sampling point and mark it with a flag.
    a. When setting out the point with the survey pole, use circular spirit level on the pole to ensure it is in a vertical position when checking the position on the map in the app.
    b. Mark the four corners of the 3m by 3m squares in the chosen location using the GNSS receiver. If receiver accuracy is less than 0.5m, a tape measure (or pacing) from the south-west corner can be used instead.
5. Leave the GNSS receiver on and standing upright to maintain high accuracy position fix (push the survey pole into soft ground or lean the pole against a backpack).
6. Check for underground services using a Cable Avoidance Tool (CAT) and a signal generator (Genny) in each of the points. Follow the guidance given in the Health & Safety Executive's Booklet HS(G)47,"Avoiding Danger from Underground Services".

7. The check can be done by one person walking around the plot with signal generator c. 20 metres away or more from the person with the scanner in the sampling point.
8. If there is an indication of underground utilities crossing or being near any of the sampling points, then the whole plot is unsuitable. The action to take depends on whether the vegetation survey already took place within the plot:
    a. For sites where soil classification survey takes place before the soil sampling and assessment and vegetation surveys, establish the direction of the utility and find an alternative plot at least one plot away from the utility in a perpendicular direction.
    b. For sites where the soil plot was identified as suitable during earlier vegetation surveys, do not seek alternative suitable soil plots in this location, do not proceed with the soil classification survey in this plot. Provide feedback to survey coordinator.
9. If the location of the soil profile is suitable, proceed with the survey.

3.5 Labelling of sample bags

Bags need to be labelled in advance of the fieldwork. Files with labels and label sheets for printing will be provided by the survey coordinator.

Manual bag labelling method is to be used before the sample labels are made available. Take spare bags and marker pens into the field in case a bag needs replacing. Use permanent marker pen and label the bags with:

- monad id
- plot number
- horizon number
- depth range from which sample was taken
- date.

Use ‘x’ used as a separator, for example:

TG2200 x 1 x H1 x 0-20

20/03/23

When writing using provided markers, ensure the letters are legible and resistant to removal by writing slowly on clean and dry surface to allow thick coverage of the ink.

Figure 6: Sample bag labelled using a marker pen (top folded a few times, to be stapled).

3.6 Field description of soil profiles and sampling

This description of the soil profile will allow for grouping of similar soils for reporting, to increase the power of statistical analysis across EES, and will provide information on the soil's morphology, its environment and evolution.

The soil pit excavation and coring should be carried out in a way that minimises disturbance and allows for bringing back the surface as close to original condition as practicable. When excavating place topsoil separately from subsoil. If possible, excavate topsoil as intact blocks with turf which can be placed back after replacing subsoil (Figure 7). Place soil from digging on tarpaulin sheet(s) as it makes it easier to fill hole after soil description has been finished. The use of tarpaulins is mandatory on protected sites to minimise disturbance to sensitive vegetation. Use of tarpaulins on other sites is at discretion of the surveyor.

Figure 7: Turf blocks placed to the side for ease of replacement later

The description of the soil profile is to be conducted on soil pits of suitable width (typically 60cm or more) dug to 60cm depth or bedrock, whichever is shallower. Where bedrock has not been reached the pit is to be extended using 70mm Edelman auger to 120cm, or bedrock, whichever is shallower.

Figure 8: Soil profile pit (photograph recorded in the app).

Figure 9: Coring to sample lower part of the profile.

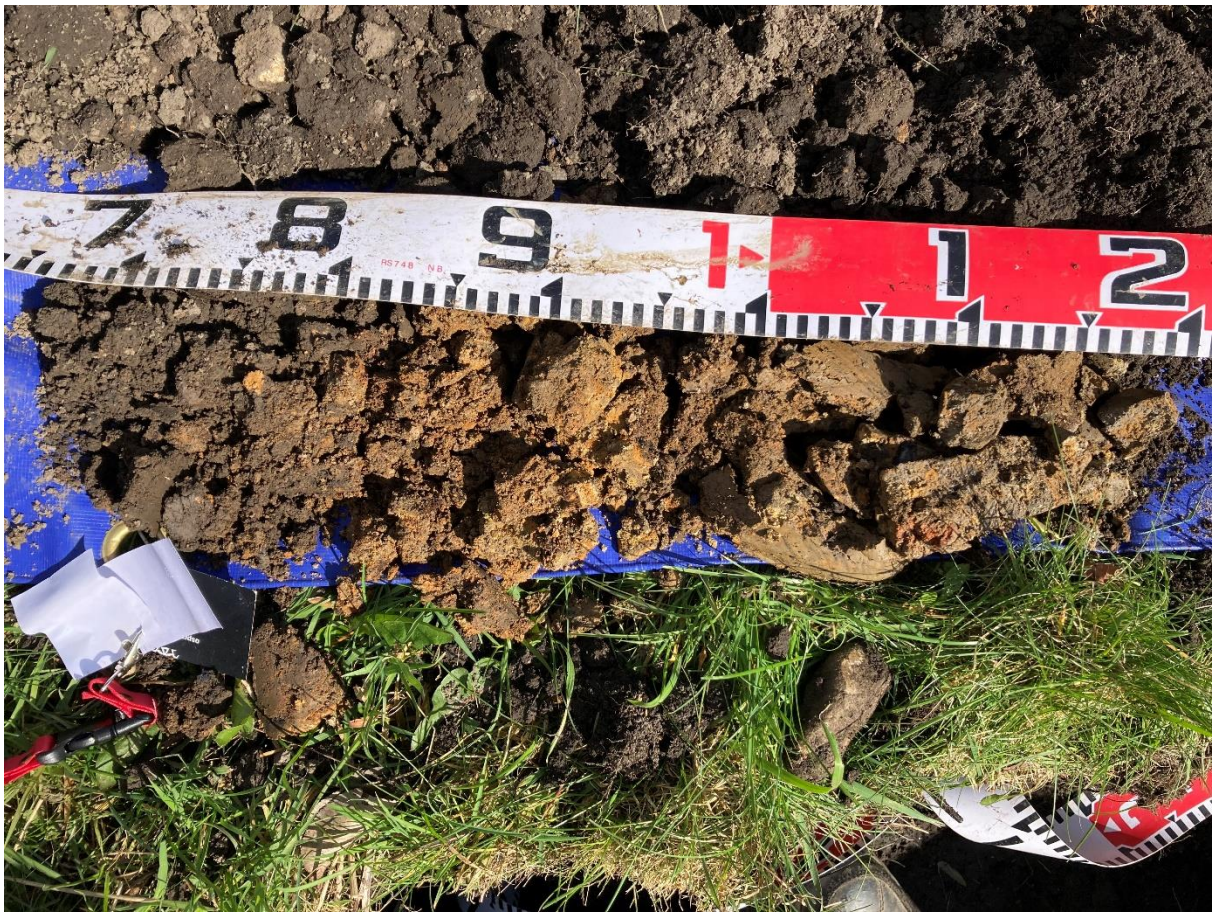

Figure 10: Soil core representing lower part of the profile (photograph recorded in the app).

The reporting of soil profile description should follow international standards. General, site, soil surface, and soil profile description is to be according to the fourth edition of the *Soil Survey Field Handbook* (Hodgson, 2022)[1].

1. Record the observations in standardised form in the Survey123 app. The following observations will be required at each soil plot:
    a. Location and site description
    b. Description of soil surface
    c. Profile description
    d. Soil classification.
2. Soil degradation class is to be assessed for the soil plot using the descriptions given in Figure 2 in Palmer and Smith (2013), (Appendix 5).
3. If more than 2cm thick organic horizon is present, record its depth as peat depth in the 'Peat depth' section at the end of the Survey123 form.
4. The method of measuring peat depth using a probe is described in Appendix 6, using this method will ensure that results are compatible with those used in the England Peat Map project.
5. For undrained peat soils with high water table taking cores using a Russian corer (provided) will be required.
6. For peat, where appropriate, describe the degree of decomposition using the von Post scale, set out in Table 1 on page 24 of the field handbook, (Hodgson, 2022). Additional guidance for recognising different soil textures and peat, like that used in the England Peat Map Project[2] is provided in Appendix 7.
7. In locations where digging of pits is not permitted (e.g. due to high risk of disturbance to archaeology), profile description is to be taken in its entirety from an auger core.
8. Take samples according to the method described on page 98 of the handbook (Hodgson, 2022) '*Collection of Disturbed Samples for Particle-size, Chemical and Mineralogical Analyses'* (note the need to split homogenous horizons if thicker than stated in the handbook). The samples shall be c. 0.5 litre, of volume estimated in a compacted state, (weight of c. 0.8kg for a moist soil). For samples

[1] Available from LandIS https://www.landis.org.uk/publications.cfm

[2] England Peat Map is a Natural England's Project which main aim is to provide up to date map of peat and its condition in England. The data collected in the EES soil surveys will be used by the project to verify accuracy of their mapping prepared using digital soil mapping methods.

taken using augers, split the samples lengthwise if reduction in volume is required.

9. When closing the sample bags please fold the top at least three times before stapling. Please check the label is readable before posting the samples.

10. Classification of the soil subgroup to be according to *Soil Classification for England and Wales (Higher Categories)* (Avery,1980).

11. Classification of the soil series to be according to *Criteria for Differentiating Soil Series* (Clayden and Hollis, 1984).

3.7 Taking high quality photographs

The photographs taken during the survey create a visual record of the survey. They may be used in the future to:

- Obtain additional data
- Maintain survey standards
- Inform later surveys
- Prove that the soil was reinstated correctly.

It is therefore important that the photographs are taken in a standardised way and are of high quality. The general tips provided below will help with this.

Do:

- ✓ Ensure photo is correctly exposed by locking the focus and exposure on the object (tap on the object).
- ✓ Ensure nothing is covering the lens and that it is clean and dry.
- ✓ Frame the photographed feature in full, in the centre, and filling the frame.
- ✓ Take soil profile photos (in pit and of auger core) with iPad parallel to the photographed surface not at an angle; to achieve this it may be helpful to orientate iPad with camera at the bottom.
- ✓ Use iPad camera app to lock focus and exposure on the photographed feature.
- ✓ Your best to ensure there is no glare on the lens; if possible, use your arm to block glare from the sun.

Don't:

- ⊗ Have people in the frame.
- ⊗ Have shadows blocking details of the photo (if possible).

- ⊗ Leave equipment in the plot during the photo (except tape measures, plot marking flags, and colour correction cards).
- ⊗ Take photos directly from Survey123 (the embedded camera app has got limited functionality, it does not allow for adjusting exposure to the object of interest).
- ⊗ Use zoom or use ultra-wide (0.5x) camera lens, unless (1x) does not allow for capturing the full object and you cannot move further.

3.8 Returning soil surface to acceptable condition after sampling

You must return the soil profile and soil surface close to the condition it was in before sampling took place. Make sure the surface is even and without holes to prevent injury to animals.

1. Backfill the soil classification pit keeping the original order of soil layers.
2. Tamp down each layer as you are backfilling the pit.
3. Place turf and disturbed turf on top.
4. Tread on the soil to even out the surface.
5. If sampling at a location with moss, replace the moss lifted before sampling.
6. Close the auger hole by placing the remaining soil back in it and tamping down the opening with a heel of a boot.
7. Take a photo of the surface after sampling, in the same way the ‘before’ photo was taken.

Figure 11: Example of a photo of the sampling point before the survey

3.9 Finalising Survey123 app data collection form

When edits to the survey form are no longer required, finalise the survey form by pressing the tick at the bottom right-hand corner of the screen to submit the form. A pop up will appear. While you are in the field with no access to Wi-Fi select the 'Save in Outbox' option. Later, when you are connected to Wi-Fi go to your Outbox from the home screen where you would usually choose to collect data. In the Outbox press the 'Send' icon in the bottom right of the screen to send all the surveys. Please do this at the end of every day.

3.10 Clean-up and biosecurity measures

When continuing work in the same landholding, before moving to the next plot mechanically remove excess soil from the tools, boots and other equipment. Before starting sampling in a new plot 'prime' the trowel with the soil from the plot to remove remains of the soil from previous plot.

To prevent spread of animal and plant diseases, when moving between different landholdings, the tools, soiled boots and clothing need to be disinfected. The process should be carried out after finishing work in a plot, before moving to the next one, e.g. at the landholding boundary:

1. Remove bulk of soil residue from the tools.

2. Use water sprayer and a brush to remove soil residue.
3. Clean the brush and gloves with water.
4. Place all rinsed tools on clean large plastic bag or clean tarpaulin.
5. Spray the brush and gloves with disinfectant (wear safety glasses).
6. Clean and disinfect working surfaces of the gloves.
7. Clean the boots, knee pads, and the tarpaulin by removing soil with tools and water, then apply the disinfectant.

At the end of the day, at the vehicle, clean and disinfect the tools before placing them in the boot to prevent contamination of the storage space with the soil. If placing soiled tools and clothing in the car, keep them separate from where clean items are kept.

4 Packaging and postage of samples

Unless instructed otherwise, you must post samples once a week.

1. Store the collected samples in a cool and dark place away from sources of heat.
2. When packaging the samples please follow the Animal and Plant Health Agency (APHA) guidance for moving soil: “You must make sure any specified material you are moving under your authorisation is stored in 3 layers of packaging. At least 1 of the layers must be escape-proof and shatter-proof.” This means that you need to place all the individual bags in one more collective bag before placing the samples in the box. This way there will be three layers: the box, the outer large bag and the individual bags. More info at: https://www.gov.uk/guidance/moving-prohibited-plants-plant-pests-pathogens-and-soil
3. Include in the box a note with the list of samples, stating that these are EES soil classification survey samples, the analysis code: Q46344, and the client code: M739. One page paper sheet to be printed for this purpose will be provided.
4. Post with Royal Mail to NRM Laboratories in provided postage paid boxes.

4.1 References

Hodgson J.M. (ed.) (2022) *Soil Survey Field Handbook. Soil Survey Technical Monograph No. 5*, Cranfield.

Avery, B.W. (1980) *Soil Classification for England and Wales (Higher Categories). Soil Survey Technical Monograph No. 14*. Harpenden.

Clayden, B. and Hollis, J.M. (1984) *Criteria for Differentiating Soil Series. Soil Survey Technical Monograph No. 17*. Harpenden

Palmer, R.C. and Smith, R.P. (2013) *Soil structural degradation in SW England and its impact on surface-water runoff generation.* Soil Use and Management, 29: 567-575. https://doi.org/10.1111/sum.12068