



# **SOLAR ENERGY UK GUIDANCE A Standardised Approach to Monitoring Biodiversity on Solar Farms**

**(2<sup>ND</sup> EDITION)**

**In collaboration with:**



## Summary

The second edition of the Standardised Approach to Ecological Monitoring on Solar Farms builds on the original 2022 framework, refining methods and guidance in response to practitioner feedback, findings from UK-wide monitoring between 2022 and 2024, and the rapid growth of the solar industry. Since the first edition, development has accelerated alongside new requirements such as mandatory Biodiversity Net Gain (BNG) monitoring and increased interest in natural capital benefits. The 2<sup>nd</sup> edition ensures that the methodologies align with BNG as well as new industry standard guidelines. This updated framework strengthens data consistency and comparability while providing clearer guidance on integrating monitoring into planning, management, and reporting, ensuring it remains relevant in a changing policy and environmental landscape.

## Ecological monitoring of solar farms

Monitoring ecology on solar farms is important as it helps us to identify their ecological state, assess change, identify land management issues and ensure planning obligations are met. Monitoring also allows the collection of valuable data that can be used to explore how solar farms might impact the local environment and biodiversity over time. This will become increasingly important as the construction of larger and more numerous solar farms are accelerated to meet energy requirements and climate change commitments, and as mechanisms for offering monetary rewards for ecological enhancements continue to evolve.

Approaches to ecological monitoring can vary, making it difficult to pool data and gain a greater understanding of solar farm impacts at the national level and the implications of different land management options. To address this, Solar Energy UK, Clarkson & Woods, Wychwood Biodiversity and Lancaster University have developed a standardised approach to monitoring ecology that will ensure similar data are being collected across solar farms and it will allow the amalgamation of information into a single database<sup>1</sup>. Solar Energy UK are using this database to investigate ecological trends on solar farms across the UK and the findings are published in an annual UK-wide Solar Habitat report<sup>1</sup>. The findings are providing the industry with important information on the biodiversity and environmental impacts of solar farms, as well as an evidence base to inform land management practice.

## A standardised approach

The monitoring approach is detailed in the table within this document and is divided into “Key Components” and “Additional Components”. “Key Components” should be measured on every monitoring visit and are designed to give a detailed snapshot of the site, with a focus on grassland botany (the most extensive habitat on a solar farm) as well as information useful for the ongoing management of the site.

<sup>1</sup> To include data in the national dataset, asset owners must be willing to share data collected at their sites with Solar Energy UK.



The “Additional Components” measured will vary depending on planning requirements and particular interests of asset owners/managers. These will be site-specific, and some components may be more applicable to certain sites than others; ecologists will be able to make suitable suggestions for further survey work. The approach has been based on published guidelines where possible, as well as a published peer-reviewed paper on a standardised sampling methodology for solar farms<sup>ii</sup>.

The estimated time required to undertake a survey have been included alongside each component, along with recommended seasonal timings. This will help determine whether surveys can be undertaken in a single day or if several days (or repeat visits) are required.

### Further considerations

It should be noted that this methodology will need to be scaled up for larger sites. A site-specific approach should be taken in these cases, though the framework set out in this document can be used as a basis for decision-making. With larger sites, it may be appropriate to set up a steering group that can guide monitoring or required changes to the Management Plan.

Additionally, monitoring is now a requirement as part of Biodiversity Net Gain (BNG) assessments in England and therefore post-construction monitoring will become standard on solar farms. This methodology can complement BNG monitoring and indeed the botanical approach is suitable to underpin a UKHab assessment. The methodology also provides broader information which compliments BNG monitoring such as data on fauna and soil.

Monitoring should be considered early in the planning process and a monitoring schedule along with the methodology should be submitted to the Local Planning Authority; this is best built in as part of a Management Plan for the site. This methodology can also be applied prior to construction taking place in order to obtain a baseline on which to base future monitoring and track changes in habitat.

It is beneficial (especially on large or complex sites) to create a Landscaping and Biodiversity Cost Schedule which includes rough fees for the habitat creation and management, as well as monitoring, as set out in the Management Plan. This ensures that prescriptions set out in the Management Plan are affordable but also ensures that future asset owners are aware of these costs and are therefore built into budgets. Please refer to the published Natural Capital Best Practice Guidance<sup>iii</sup> for more information and a downloadable example Cost Schedule.



## Data collection and analysis

A standardised survey form has been prepared in an excel format (available on the Solar Energy UK website), which can be used to collect data in the field or should be used to submit data in a standardised way if an alternative means was used to collect data in the field. We would also recommend mapping is undertaken either digitally, or on paper, as this is helpful to locate habitats, quadrats, fixed point photographs, habitat boxes and any specific issues that require attention (such as the location of invasive plants or concentrations of injurious weeds).

Where asset owners are willing for anonymised data to be submitted to Solar Energy UK for inclusion in the annual report, submit the data in the data collection excel sheet available on the Solar Energy UK website to the following email address: [monitoring@solarenergyuk.org](mailto:monitoring@solarenergyuk.org)



## Key Components – to be measured on every site

Component, Time Required on Site/Timing Requirements	Description	Further Considerations	Suitably Qualified Person	References (as applicable) – see links in Endnotes
<b>Site Information</b>  Time required: can take time to obtain this information – suggest early engagement with client To be updated during every visit as required	To be completed by the asset owner or Operation & Management company. Information should include: <ul style="list-style-type: none"> <li>• Date of grid connection</li> <li>• Energy capacity (MW)</li> <li>• Technology type (fixed tilt/tracker, bifacial/monofacial)</li> <li>• Distance between panels, width under panels, height of lower panel edge, height of upper panel edge</li> <li>• Previous land use</li> <li>• Red line boundary for planning</li> <li>• Lease boundary (if different to above)</li> <li>• If seeding has been undertaken (location, seed mix, timing)</li> <li>• Current grassland management within site and any areas outside of the fencing (grazed/cut and timings) and details of any agreed future changes</li> <li>• Stocking density (if grazed)</li> <li>• Herbicide use (spatial extent, timing, chemical used)</li> <li>• Details on the management of hedgerows</li> <li>• Details on any biodiversity areas and their management</li> <li>• Details of any habitat features installed (e.g. bird and bat boxes, hibernacula)</li> </ul>	This information should be collected at an early stage in the project as it can take some time to collect the data from relevant bodies.	Asset owner or Operation & Management company.	See Appendix B for solar farm terminology.
<b>Standard Survey Information</b>  Time required: minimal To be recorded during every visit	<ul style="list-style-type: none"> <li>• Name of surveyor</li> <li>• Location</li> <li>• Date</li> <li>• Weather (temp, wind – Beaufort scale, rain, cloud – Okta scale)</li> <li>• Time at start/end of survey (i.e. time spent on site)</li> </ul>		Ecologist (surveyor)	
<b>Site Management</b>  Time required: minimal To be updated during every visit	Different aspects of site management are recorded depending on their focus on biodiversity.	It is important to obtain management information from the asset owner or O&M company. In some cases, full management information cannot be obtained, especially for historical seeding.		



		In some cases, management approaches can be ascertained in the field.		
<p><b>UKHab Survey And Standard Botanical Quadrats</b></p> <p><b>Time required: dependent on size of site Should be repeated every 5 years</b></p>	<p>Mapping of all habitats within the redline boundary using the UKHab categories.</p> <p>1x1m quadrats at fixed locations:</p> <ul style="list-style-type: none"> <li>• 5 quadrats recorded directly under panels</li> <li>• 5 quadrats recorded in the open, between the strings of panels</li> <li>• 5 quadrats recorded in the edge of the site or within easements, where the solar panels are not affecting the grassland – the edge (inside the fencing)</li> </ul> <p>There are also additional optional locations, where habitat may be managed in a different way:</p> <ul style="list-style-type: none"> <li>• (optional) 5 quadrats recorded in field margin (between security fencing and field boundaries)</li> <li>• (optional) 5 quadrats recorded in enhanced area where there are specific areas managed to increase botanical diversity</li> </ul> <p>The % cover of all species within the quadrat will be recorded. Other information to record includes: height of sward in cm and % cover of bare ground, dead vegetation (rooted), arisings (cut vegetation lying on ground) and standing water (where applicable).</p>	<p>Depending on data required, high level UKHab categories may be utilised (e.g. Hedgerow).</p> <p>Where sites are bigger, the approach to botanical survey would need to be scaled up. The number and location of quadrats will be dependent on size, the different types of habitats present and monitoring requirements set out in a Monitoring Plan.</p> <p>More quadrats may need to be recorded where there are distinctly different habitats present within a solar farm. Quadrat locations should be selected randomly (either prior to accessing the site or whilst on site). Fixed quadrat locations should be accompanied with a grid reference and description.</p> <p>The quadrat location type should clearly be recorded (i.e. beneath, between, edge etc.).</p> <p>All habitat areas where quadrat sets have been taken will need their exact locations to be precisely mapped to calculate nectar production potential (below).</p> <p><b>Best carried out April to August inclusive</b></p>	<p>Ecologist. Ideally FISC Level 4<sup>iv</sup> or above.</p>	<p>Based on UKHab<sup>v</sup> and NVC survey methodology<sup>vi</sup>.</p> <p>See Appendix B for solar farm terminology.</p>



<p><b>Nectar Production Potential</b></p> <p>Minimal time required and desk based (calculated post survey) Should be repeated with every botanical survey</p>	<p>The botanical data from each area within the site can be extrapolated and then nectar production (from published research) applied to the flowering plants within the data. This gives a figure for the total potential nectar production for the entire solar farm. This figure has been shown to be directly correlated with the abundance and diversity of butterflies and bumblebees.</p>	<p>A calculation tool has been developed to aid with this.</p>	<p>Ecologist (some botanical knowledge is useful)</p>	<p>Based on UKCEH data<sup>vii</sup> Calculation tool, available on the SEUK website, can be utilised.</p>
<p><b>Basic Soil Survey</b></p> <p>Time required: 1hr to collect samples from one single field Should be repeated every 5 years</p>	<p>Basic soil properties (pH, phosphorus, potassium, total nitrogen, soil type, soil organic matter, soil organic carbon, hand texture). The methodology for soil collection should be checked with the laboratory, but will likely follow the standard collection method for agricultural analysis. Soil can be collected on site and sent to a laboratory at minimal cost or equipment purchased to enable in-house analyses. Soil analyses can also help to inform seeding of a site and indicate why seeding may have failed.</p>	<p>The survey approach will depend on the information required. One approach may be to take samples separately from under and between the panels in order to ascertain differences in soil properties; the location of the soil samples should be made clear (e.g. "under", "edge" or "between") and which field/s have been sampled. Every field could be sampled to get more accurate results, or just fields where habitat is visibly different. Where only a small area is surveyed (such as between panels in a single field), it should be made clear that this represents just a part of the overall site and that soil properties will be different in other areas (such as beneath panels). In addition, samples can be taken from a field outside the array which is managed in the same way that the array was prior to construction, as a control. A Risk Assessment will be required to dig to a depth of 7.5cm and any underground wiring should be considered. Can be carried out at any time of the year</p>	<p>Can be carried out by anyone</p>	<p>Soil sampling guidelines<sup>vii</sup></p>



<b>Fixed Point Photographs</b>  <b>Minimal time required</b> <b>To be recorded during every visit</b>	A number of fixed point photographs can be a simple way to visually assess change.	The number taken will depend on the variability of habitats and size of the site, but we suggest around 10. Fixed point photograph locations should be accompanied with a grid reference, map and description.	Can be carried out by anyone	Based on UKCEH data <sup>vii</sup> Calculation tool, available on the SEUK website, can be utilised.
<b>Ad-hoc Sightings</b>  <b>Minimal time required</b> <b>To be recorded during every visit</b>	Observations of species are recorded during the time spent on site; this may include sightings of hares and other mammals, birds by song or sight, patches of wildflowers, badger latrines, owl pellets as well as invertebrates (a tally should be kept for butterflies and bumblebees).	Although not directly comparable, ad hoc sightings can give a qualitative picture of a site. Best carried out April to August inclusive	Ecologist (surveyor) although useful information can be obtained from others that visit the site on a regular basis	

### Additional Components – will be site/budget dependent

Component, Time Required on Site/Timing Requirements	Description	Further Considerations	Suitably Qualified Person	References (as applicable) – see links in Endnotes
<b>Control Site Data</b>  <b>Time required: As per relevant survey description</b>	The monitoring methodology can be carried out prior to construction commencing in order to obtain an accurate baseline. Where no baseline data is available, a control site is a useful way to compare data to what the pre-construction situation may have been. A field should be selected within the landowner's ownership, which is under the same management as the solar farm was pre-construction (arable or pasture for example). The field should be selected to be of similar size and similar adjacent habitats. Control surveys may include an additional 5 botanical quadrats for comparison, soil survey or any of the relevant additional components listed below.	As per relevant survey description	As per relevant survey description	As per relevant survey description
<b>Wild Power Solar Biodiversity Scorecard</b>  <b>Time required: approx. 3-4 hrs</b>	The Wild Power Scorecard integrates habitat extent and condition, connectivity, biodiversity, ecosystem services, societal engagement and management actions to provide a holistic view of a site's contribution to biodiversity.	Can be carried out at any time of the year	Ecologist	Wildpower Solar Biodiversity Scorecard <sup>ix</sup> .



Should be updated every 3–5 years (or when management changes are made)	The Scorecard is the basis for the Wild Power Certification scheme for solar sites.			
<p>Biodiversity Net Gain (BNG) Assessment</p> <p>Time required: approx. 1–2hr per 15–20 ha per survey (although site dependent)</p> <p>Should be updated every 3–5 years (or when management changes are made) or as specified by BNG planning requirements</p>	<p>The Statutory Biodiversity Net Gain Metric is a quantitative tool which puts a numerical value on habitats and can be used to assess a baseline situation or compare a baseline to proposed changes. Although it is mandatory in England only, it can be a useful tool to benchmark sites and so can be useful outside of its legal requirement.</p> <p>A BNG assessment would encompass the preparation of GIS maps showing UKHab habitats (baseline and proposed, if required). Condition Assessment sheets are used to record the condition of each habitat and these, as well as the mapped areas are fed into the Metric to give an overall numerical value for the site.</p>	BNG monitoring will be a requirement for many sites, where BNG calculations were mandatory (or a Local Planning Authority requisite) at the planning stage.	Suitably competent ecologist described in BNG British Standard BS8683:2020 as a 'person who can demonstrate they have acquired through training, qualifications or experience, or a combination of these, the knowledge and skills enabling that person to perform a specified task'.	Biodiversity Metric, condition assessments and associated guidance <sup>2</sup>
<p>Detailed Soil Analyses</p> <p>Time required: variable depending on test</p> <p>Should be repeated every 5 years</p>	Other aspects of soil structure, micro/macro biota and health can be measured.	<p>Additional analysis may be carried out on the same sample collected for the basic soil survey within Key Components.</p> <p>Separate soil samples can be taken in different locations (e.g. to compare under panels soil with between panels) or could be paired with the quadrat locations.</p> <p>Can be carried out at any time of the year</p>	Can be carried out by anyone	See Appendix C for more information
<p>On and Offsite Water Survey</p> <p>Time required: approx. 15 mins per water feature</p> <p>Should be repeated every time on site given variability in measures</p>	Monitoring of basic water parameters in water features on site, such as ditches, streams or ponds, and any features off site that could be impacted by the solar farm. Use a handheld water quality meter to measure multiple parameters including temperature, dissolved oxygen, turbidity and conductivity.	Ensure the meter is calibrated. There is also potential to take samples and send for analyses for other parameters, such as nitrogen and phosphorous.	Preferably carried out by an Ecologist, but may be undertaken by others	



<p><b>Butterfly Survey</b></p> <p><b>Time required:</b> approx. 2-3hrs Should be repeated every 2-5 years</p>	<p>A minimum of 10 pre-selected 100m transect routes throughout the site. The habitat/location should be recorded (between panels, hedgerow edge, woodland edge etc).</p> <p>All butterflies within 2m of the transect should be recorded.</p>	<p>The survey is weather dependent and needs to be carried out during warm, dry, still weather (weather conditions should be recorded). A minimum of 2 visits in July and August (with at least 10 days between visits). Preferably, 2 further visits in May, June, July or August (again, with a minimum of 10 days between visits).</p> <p>Surveys should commence at roughly the same time of day on each visit.</p> <p>Weather conditions should be dry. With low wind speed, temperature &gt;13°C (or &gt;17°C if overcast).</p> <p>Carried out from May to August (with at least 2 visits in July and August) between 10:45 and 15:45.</p>	<p>Ecologist with suitable ID skills.</p>	<p>Survey methodology follows Wider Countryside Butterfly Survey (WCBS)<sup>ii</sup></p>
<p><b>Bumblebee Survey</b></p> <p><b>Time required:</b> approx. 2-3hrs Should be repeated every 2-5 years</p>	<p>Bumblebee observations can be added to the above survey in order to collect wider information on pollinators using the site.</p>	<p>As above.</p> <p>Bumblebee species and caste (queen, worker, male) should be recorded, where possible.</p>	<p>Ecologist with suitable ID skills.</p> <p>Given the complexities of identifying bumblebees to species and caste, it may be that purely abundance is recorded with identification to species where possible.</p>	<p>Survey methodology follows Bumblebee Conservation Trust BeeWalk<sup>iii</sup></p>
<p><b>Pollinator Survey – Flower-Insect Timed Count</b></p> <p><b>10 minutes per quadrat</b> Should be repeated every 1-5 years</p>	<p>Can be tied in with the above surveys. A 50x50cm quadrat targeted on specific flowering plants is used and for a duration of 10minutes, all insects that land on the flowers are counted.</p> <p>At least 10 recorded across the site (again, could be split into “between” and “enhanced” areas).</p>	<p>The survey is weather dependant and needs to be carried out with &lt;50% cloud cover and minimum temperature of 13°C (or where cloud cover is greater, a minimum temperature of 15°C)</p> <p>Can be carried out between April and September inclusive</p>	<p>Designed to be carried out by anyone, but Ecologist is preferable.</p>	<p>UK Pollinator Monitoring Scheme<sup>iii</sup></p>



<p><b>Breeding Bird Survey</b></p> <p>Time required: approx. 1-2hr per 15-20 ha per survey (although site dependent) Should be repeated every 2-5 years</p>	<p>Between 4-6 visits to the site conducted April to June and following the bird survey guidelines. The number of surveys will depend on the level of detail required.</p>	<p>The survey should avoid heavy rain or strong wind. Specialist bird ID skills are required in order to identify birds by sight and sound.</p> <p>Can be carried out March to early July inclusive (and from half an hour before sunrise to 11am).</p>	<p>Suitably experienced Ecologist. Should be at least Level 3 on the Ornithological Survey Skills Pyramid (preferably a Level 5)<sup>xiv</sup>.</p>	<p>Bird Survey &amp; Assessment Steering Group. (2021). Bird Survey Guidelines for assessing ecological impacts, v.0.1.0<sup>xv</sup></p>
<p><b>Wintering Bird Survey</b></p> <p>Time required: approx. 1hr per 15-20 ha per survey (although site dependent) Should be repeated every 2-5 years</p>	<p>Between 4-6 visits to the site conducted November to February to assess how birds utilise the solar farm and its boundaries over winter.</p>	<p>The survey should avoid heavy rain or strong wind. Specialist bird ID skills are required in order to identify birds by sight and sound.</p> <p>Can be carried out November to February inclusive</p>	<p>Suitably experienced Ecologist. Should be at least Level 3 on the Ornithological Survey Skills Pyramid (preferably a Level 5).</p>	<p>Bird Survey &amp; Assessment Steering Group. (2021). Bird Survey Guidelines for assessing ecological impacts, v.0.1.0<sup>xvi</sup></p>
<p><b>Wintering Bird Survey</b></p> <p>Time required: approx. 1hr per 15-20 ha per survey (although site dependent) Should be repeated every 2-5 years</p>	<p>Other surveys may be included within the monitoring where there are known records, habitat is managed with a focus on that species or due to local conservation priorities/planning obligations. This may include:</p> <ul style="list-style-type: none"> <li>• eDNA surveys</li> <li>• Nocturnal/dusk bird surveys</li> <li>• Reptile surveys</li> <li>• Bat surveys (activity surveys or checks of roosts)</li> <li>• Amphibian surveys (including great crested newt)</li> <li>• Dormouse surveys</li> <li>• Harvest mouse surveys</li> <li>• Hedgehog surveys</li> <li>• Badger surveys</li> <li>• Otter/water vole surveys</li> <li>• Invertebrates</li> <li>• Earthworms</li> <li>• Surveys to assess grazing productivity such as above ground biomass or forage quality (above ground biomass calculation)</li> </ul> <p>Survey methodologies are available for many of the species-specific surveys listed above and should be referred to as required. This list is by no means comprehensive.</p>			



## Appendix A: Management Assessment

Habitat Area	Management Description (multiple options may be selected)
Grassland within security fencing	Grassland managed through hay cut (after late July) with no cutting for at least 2 months over the summer – Arisings removed after cutting
	Grassland managed through hay cut (after late July) with no cutting for at least 2 months over the summer – Arisings left on site
	Grassland conservation grazed (sheep removed for at least 2 months over summer)
	Grassland managed at fairly low intensity resulting in variable sward height
	Grassland cut/grazed short and uniform
	No herbicide use
	Spot spraying only (usually under panels or at fencing)
	Blanket spraying (either under all panels or whole site)
Grassland outside of security fencing but within lease boundary	Biodiverse area more than 12m wide outside of security fencing (area which has been seeded or is being successfully conservation managed)
	Biodiverse field margins (2-12m)
	Tussocky grassland areas
Hedgerows (multiple options may be selected where hedgerows are managed differently across the site)	Hedgerows managed for wildlife (bushy, cut every 2 years or less, at least 2m tall and wide, good margins)
	Hedgerows tall but apparently unmanaged
	Hedgerows over managed, cut annually



New planted habitats (multiple options may be selected)	Hedgerows
	Trees/orchard
	Pond
	Other (please specify)

### Please also give an overall score for the site as a whole:

**1** – Optimal management for wildlife with conservation cutting/grazing<sup>2</sup> applied and no herbicide use. Arisings are removed from the site. Diversity of habitats (e.g. meadows, tussocky grassland, woodland planting, hedgerow planting).

**2** – Conservation cutting/grazing applied with arisings left on the site or low intensity management resulting in a variable sward<sup>3</sup>. Diversity of habitats (e.g. meadows, tussocky grassland). Herbicides may be used, but spot treatment only.

**3** – Site cut or grazed throughout the season leading to short sward in the summer months. However, some other habitats present such as tussocky margins. Use of herbicides apparent (i.e. blanket spraying beneath panels).

**4** – Site cut or grazed throughout the season leading to short sward in the summer months. Few other habitats present. Use of herbicides apparent (i.e. blanket spraying of fields or beneath panels).<sup>4</sup>

**5** – Site unmanaged or “Other”

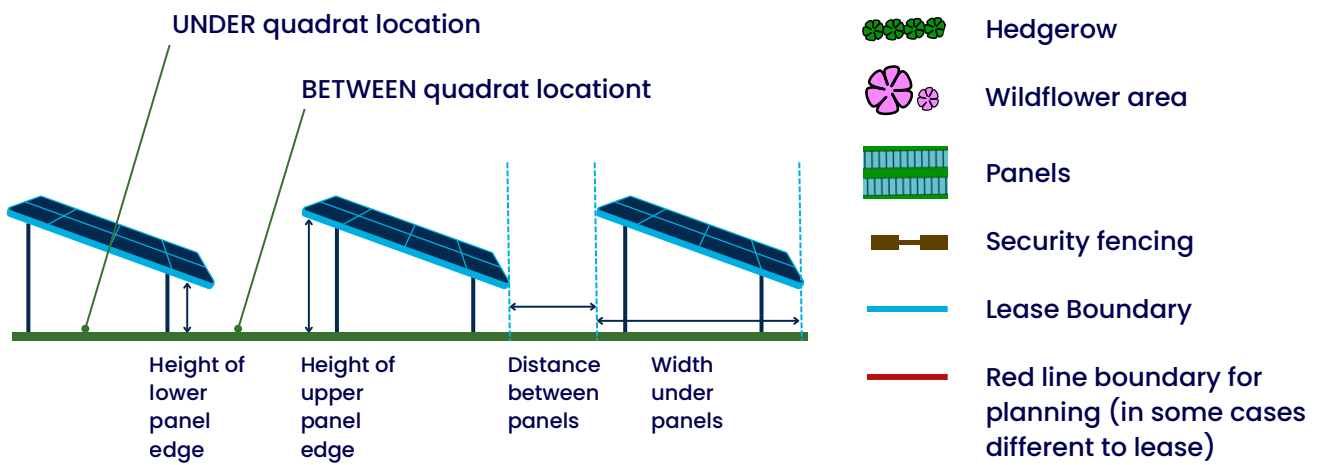
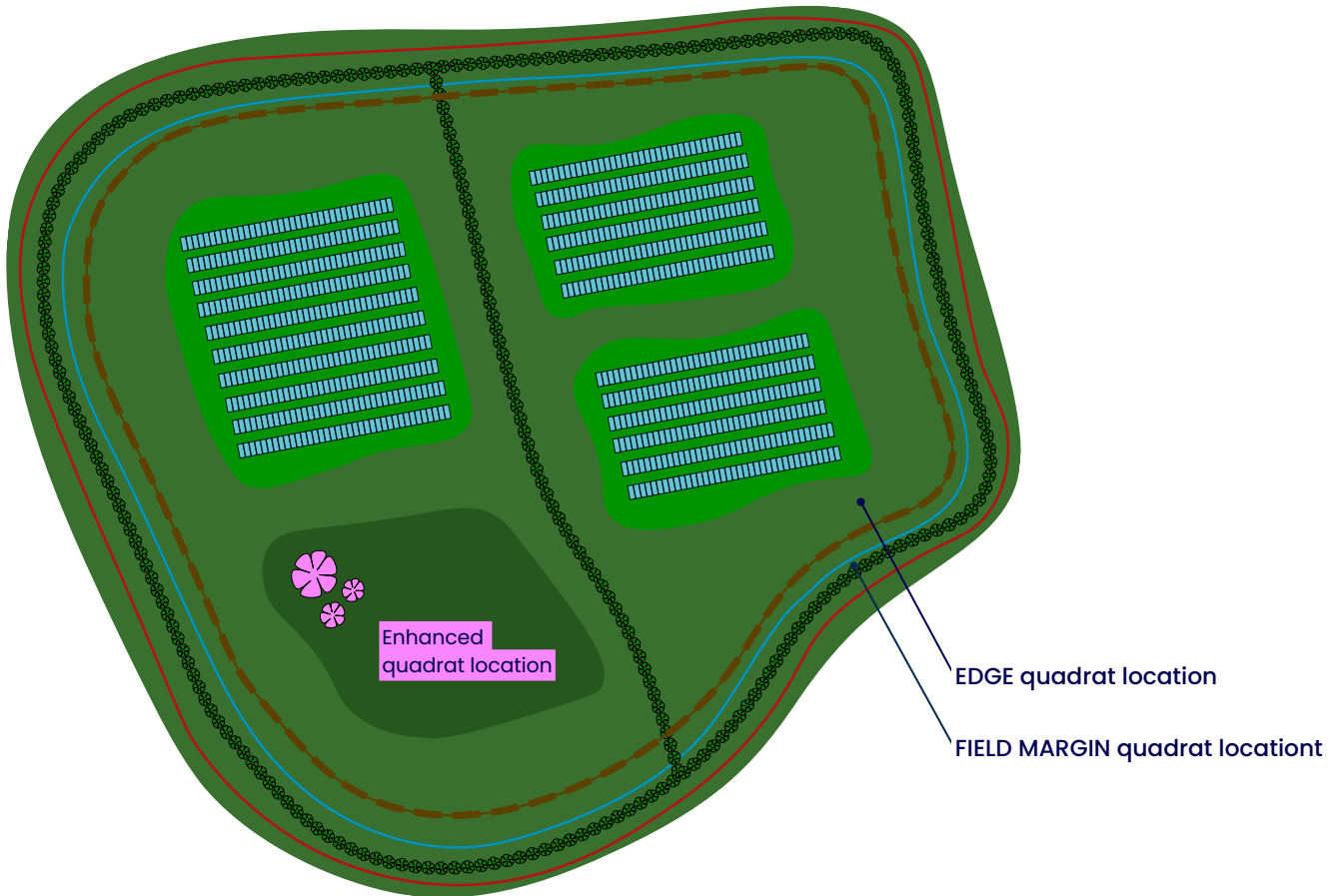
<sup>2</sup> Conservation grazing is defined as a regime where livestock are removed for at least 8 weeks between April and July or where livestock units are low enough to leave a varied and tall sward with flowering plants present (usually in the region of 2.5 sheep/ha/yr). Conservation cutting relates to a hay cut (where cutting takes place in July or later), with no cutting between April and July.

<sup>3</sup> A sward of varying heights, rather than a uniform structure

<sup>4</sup> Where management is unknown, it is often possible to look at evidence to indicate the likely category. This may include the height of grassland, diversity of broadleaved plants, presence of dead material (grass clippings or areas of dead weeds), presence of sheep dung etc.



## Appendix B: Management Assessment





## Appendix C: Management Assessment

Measurement	Description	Comments
Basic Soil Survey – Key Component of Monitoring		
<b>pH</b>	Useful to inform future seeding/planting (i.e., what plant types can establish and persist); amenable to management if desirable	Commercially available laboratory service
<b>Soil Type</b>	Relative proportions of sand/silt/clay (i.e., texture) can be useful to inform management or seeding/planting	Commercially available laboratory service
<b>Phosphorus (mg/kg) and Defra P Index</b>	Useful to inform future seeding/planting or assess why seeding has failed. Phosphorus is a key limiting nutrient to plant growth and its concentration in soils has implications for the establishment of diverse grasslands (i.e., by affecting the competitive ability of plant species) and the eutrophication of water bodies (i.e., via nutrient leaching from soils to water)	Commercially available laboratory service  Can be compared to Magnificent Meadow guidance <sup>xvii</sup>
<b>Potassium (mg/kg) and Defra K Index</b>	Useful to inform future seeding/planting or assess why seeding has failed	Commercially available laboratory service  Can be compared to Magnificent Meadow guidance
<b>Plant-available nitrogen</b>	Soil nitrogen in plant-available forms (e.g., nitrate, nitrite or ammonia) can exit the soil very quickly as gaseous emissions or leaching, but can also persist under certain conditions (e.g., those found under solar panels with decreased solar radiation and plant productivity). Soil plant-available N is normally highly responsive to soil amendments (e.g., nutrient addition) and its analysis is therefore just a snapshot of a very noisy variable	May be a requirement for Biodiversity Net Gain Habitat Management and Monitoring Plan.  Commercially available laboratory service
<b>Soil organic matter (SOM; %)</b>	Overall measure of soil health and can be used to estimate organic carbon (SOM/1.95). Organic matter can be very variable within a site and so only very long-term monitoring will pick up changes in this component.	Commercially available laboratory service  Conversion reference <a href="https://bsssjournals.onlinelibrary.wiley.com/doi/10.1111/ejss.12558">https://bsssjournals.onlinelibrary.wiley.com/doi/10.1111/ejss.12558</a>
<b>Soil organic carbon (SOC; %)</b>	Key component of natural capital for supporting ecosystem services e.g., nutrient cycling, soil formation and primary production.	Commercially available laboratory service
Advanced Soil Survey – Additional Component of Monitoring		
<b>CEH Soil Survey</b>	Includes the following components: <ul style="list-style-type: none"> <li>Bulk Density</li> </ul>	<a href="https://www.ceh.ac.uk/our-science/projects/cs-soils">https://www.ceh.ac.uk/our-science/projects/cs-soils</a>



	<ul style="list-style-type: none"> <li>• Organic carbon</li> <li>• pH</li> <li>• Total Nitrogen and C:N ratio</li> <li>• Mineralizable N</li> <li>• Olsen P</li> <li>• Soil metal concentrations</li> <li>• Soil invertebrates</li> </ul>	
<b>Carbon/nitrogen ratio</b>	Useful to determine the balance between carbon and nitrogen, which is crucial for nutrient availability to plants. Higher ratios are typically associated with more soil fungi and slower decomposition of OM, whilst lower ratios tend to support more soil bacteria and faster nutrient mineralisation to plants	Commercially available laboratory service
<b>Magnesium (mg/kg)</b>	Useful to inform grazing	Commercially available laboratory service
<b>Soil bulk density (g/cm<sup>3</sup>)</b>	Measure of soil compaction caused by construction and farming activities and general indicator of soil health with implications for plant growth	Commercially available laboratory service (however, a known volume of soil needs to be collected, e.g., using a soil corer of a known volume)
<b>Soil infiltration capacity</b>	A measure of compaction and soil health	Measured in the field through timing water infiltration into the soil
<b>Soil moisture (%)</b>	Affects carbon inputs to soil. Impacts soil microbial community e.g. through changes to microbial community composition and activity, with potential implications for processes such as decomposition	Commercially available laboratory service
<b>Measurements of soil organisms</b>	<p>Soil biological indicators are often the fastest to respond to changes in land use/management. These organisms can also affect ecosystem processes and services (e.g. decomposition, carbon sequestration, nutrient cycling). Measures may include:</p> <ul style="list-style-type: none"> <li>• eDNA of soil micro-organisms</li> <li>• Soil microbial biomass</li> <li>• Total Bacteria (bacteria dominated soils may result in faster CO<sub>2</sub> emission)</li> <li>• Total Fungi (fungi dominated soils can have higher stability and organic carbon)</li> <li>• Active Bacteria</li> <li>• Active Fungi</li> <li>• Protozoa</li> <li>• Nematodes</li> </ul>	Specialist laboratories offer these services



## References

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