SOIL RESOURCES AND MANAGEMENT
POSTCOMBE AND LEWKNOR SOLAR FARM

Report 2250/1

13th November 2023

Land Research ASSOCIATES
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Report 2250/1

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1.0 Introduction

1.1 This report provides information on soil management of land near Lewknor Oxfordshire, proposed as the site of a solar installation. The report is based on a previous detailed soils and Agricultural Land Classification survey undertaken in August 2022 by Soil Environment Services Limited (document reference SES/S2/L/#3). Additional information regarding soil nutrient concentrations was obtained by site sampling in October 2023.

SITE ENVIRONMENT

1.2 The total site area comprises approximately 77 ha of land, comprising large arable fields either side of the M40. The land has been investigated to determine soil types, to inform a site-specific soil management plan for solar park construction.

1.3 This management plan details measures and working practices to prevent damage to soil resources which may cause adverse effects during and after the lifetime of a solar installation. The report covers:

- Soil resource types
- Machinery access timings (safe working conditions)
- Soil handling methods and work practices
- Remedial measures

2.0 Soils

2.1 A detailed soils investigation was carried out (by Soil Environment Services Limited) in December 2021 and July 2022. It was based on observations at intersects of a 100 m grid, giving a survey density of one observation per hectare. During the survey, soils were examined by augerings and hand-dug pits.

2.2 The survey found the soils to vary in depth, drainage and composition, as described below. The distribution of soil types is shown by Map 2 in an appendix to the report.

SHALLOW HEAVY SOILS OVER CHALK

2.3 Much of the land in the north and west has silty clay loam topsoils, either directly over chalk or with a thin subsoil above the rock. As is normal with soils over chalk, these soils are freely-draining and not often subject to waterlogging. However, the high clay content means care needs to be taken when moving soil or trafficking in wet conditions.

2.4 Given the shallow nature of these soils, installation of buried infrastructure is likely to involve bedrock excavation. Care should be taken to separate this material from overlying soil resources during stripping, stockpiling and replacement.

DEEPER HEAVY SOILS OVER CHALK

2.5 In the east similar soils occur, but with a greater depth of subsoil, typically extending to 50-60 cm depth over chalk bedrock. These soils are also freely-draining with heavy topsoils.

HEAVY WET SOILS

2.6 These soils occur over limited areas in the south-west and south-east. The underlying clay is poorly structured, causing water to pond above at certain times of year (mainly during the period from late autumn to mid-spring). The combination of high clay content and periodic wet conditions means that the timing of machinery operations needs to be carefully planned to avoid soil compaction and structural damage when wet (see paragraph 4.6).

LABORATORY TOPSOIL ANALYSIS

2.7 The topsoils have uniformly high nutrient concentrations (see Table 2.1) which is typical of intensively managed arable land. These levels are unlikely to decrease significantly under the current management regime. This means that any habitat creation schemes under solar use would need to factor in management techniques to reduce nutrient concentrations (and the dominance of productive grasses and

agricultural weeds).

2.8 Topsoil organic matter concentrations are moderate for a soil with high clay content, normal for a soil under arable cultivation. Organic matter concentrations of the surface layer would be expected to increase under permanent grass cover associated with solar use, with potential long-term benefits for soil structure and biological health.

Table 2.1: topsoil nutrient testing (October 2023)

Sample ID*	pH	Loss on ignition %	P	K	Mg
			MAFF indices		
A	8.2	6.4	3	3	2
B	8.2	6.2	3	3	2
C	8.2	6.6	3	5	2
D	8.3	6.5	4	4	2
E	8.0	6.1	4	3	2
F	8.1	6.5	4	3	2
G	8.2	6.0	3	3	2

*see Map 1

3.0 Timing of construction land access

3.1. The local area has moderate annual rainfall (*c.* 700 mm) and this means that the soils are naturally wet for a period of the year, typically around five months, from late autumn until mid-spring. Given the topsoils have a relatively high clay content, there is a risk of surface compaction damage if heavy construction machinery access is inappropriately timed. The programme of works should take into account these restrictions to ground works and heavy machinery traffic, and schedule activities according to the likely suitability of ground conditions. In particular it should be used to limit excavation and heavy traffic during unsuitable periods:

- Soil stripping/trenching should not take place before April or after the end of November. It is recommended that land not be accessed with heavy machinery for a minimum of twenty four hours following significant rainfall at other times, and best avoided for two days as far as possible[1]
- Although the programme of works will reflect the restrictions in access caused by wet ground conditions outlined above, some light works may be necessary outside of the safe working periods in order to meet project scheduling and other environmental restrictions. In order to ensure that these necessary works do not cause significant soil damage, the nature of permissible works should be restricted to the activities described in Table 3.1

Table 3.1: Winter activities

Activity	Mitigation
Delivery of components	Only to work on and from previously installed access tracks and hard standings.

3.2. Serious compaction damage is not anticipated as a result of these activities. Should minor damage occur, review and remediation should be conducted as stated in Section 5 of this report.

[1] For the purposes of this management plan, significant rainfall is defined as more than 10 mm within a 24 hour period. This figure should be treated as a guide rather than prescriptive.

4.0 General soil management principles

4.1 The main potential impacts of solar installation on long-term agricultural potential include:

- Loss of land to permanent construction features which cannot be removed.
- Compaction damage caused by inappropriate construction methods and timing

4.2 All operations are to be undertaken strictly in accordance with the methodology described within this document and the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, DEFRA (2009).

4.3 Soil quality can be impaired by incorrect handling, separation, storage and replacement. Particular problems arise from:

- Handling soils at inappropriate moisture content
- Inappropriate use of machinery
- Incorrect topsoil stripping depth resulting in dilution with underlying subsoil
- Poor storage separation resulting in mixing
- Excess stockpile height leading to compaction damage, runoff and erosion

4.4 The ease of soil handling is affected by soil type. Heavy soils such as those at this site are difficult to handle when wet without causing structural damage.

SOIL STRIPPING

4.5 All soil handling to be limited to dry conditions between April and November.

4.6 Whether soils are at an appropriate moisture content for handling to be checked by a simple 'plasticity test': this involves testing whether a 3 mm thick thread can be rolled in the palm of the hand. If it cannot, the material is suitable for handling.

4.7 Stripping should only take place using an excavator as described by Sheet 1 in the MAFF Good Practice Guide for Handling Soils[2].

4.8 Topsoil and subsoil resources should be stripped and stored separately in low bunds (less than 4 m in height), avoiding over-compaction.

[2] MAFF Good Practice Guide for Handling Soils, (www.defra.gov.uk/farm/environment/land-use/soilguid/)

4.9 Topsoil should be stripped carefully to avoid dilution with subsoil, the average topsoil depth at the site is 250 mm. In most places there is a distinct colour difference between topsoil and subsoil that should aid accurate stripping.

4.10 The following stages should be followed to ensure that suitable conditions exist and that damage to soils is minimised:

- **Machinery operation:** a tracked hydraulic excavator should be used to load topsoil and subsoil. The soils should be stripped, stockpiled, removed from storage (Sheet 3 in the MAFF Good Practice Guide) and replaced by tracked hydraulic excavator using the loose tipping technique (Sheet 4 in MAFF Good Practice Guide), with only gentle firming by tracked vehicles. Stockpiles should be less than 4 m in height
- **Rainfall during operations:** during rainfall and soon after it ceases there will always be surplus of water in the surface layers of soil. If earthmoving continues the surface layer could become compacted, ruts could be formed and any further rain will lie on the surface and tend to drain away far more slowly than previously. Conditions will then tend to deteriorate further during earthmoving with consequential damage to soils. Consequently, soil stripping should be suspended during heavy rainfall. After rainfall, the wetness of the soil should be checked (by the earthworks contractor) before recommencing mechanised soil handling.

CONSTRUCTION TRAFFIC MANAGEMENT

4.11 All plant movement/work should be undertaken from access tracks or temporary matting to prevent soil compaction.

5.0 Specific construction activities

SOLAR ARRAY CONSTRUCTION

Roadway/access track construction

5.1. Topsoil should be stripped from track construction areas using the excavator/dumper truck method which avoids traffic on stripped surfaces (as described in the Construction Code of Practice for the Sustainable use of Soils on Construction Sites) to a standard depth of 250 mm in accordance with the average findings of the soils and land quality report.

5.2. Long-term storage bunds should be sown to a grassland seed mix and kept weed free by cutting, to ensure topsoil is maintained in good condition for restoration.

5.3. Temporary access tracks should be surfaced with imported aggregate, underlain by geotextile matting to ensure the aggregate can be fully removed during decommissioning.

Preparation of hard standings for construction compound

5.4. Topsoil should be stripped from the temporary parking/offloading area using the excavator/dump truck method (as described in the Construction Code of Practice for the Sustainable use of Soils on Construction Sites) to a standard depth of 250 mm. Stripped topsoil should be placed in a temporary stockpile bund 3 m high for reuse.

5.5. The area should be surfaced with imported aggregate, underlain by geotextile matting to ensure the aggregate can be fully removed during decommissioning.

Seeding to grass

5.6. This would typically be undertaken prior to panel installation, ideally in the prior autumn to allow for establishment.

Installation of concrete plinths to support substations

5.7. Topsoil should be stripped and stockpiled from areas under the plinths.

Installation of buried cables (usually limited)

5.8. Cables installed at depth would not interfere with farm operations and could be left in situ. The vast majority of cabling should be above-ground.

Erection of piling/posts for panel frames

5.9. This would typically be undertaken with light piling plant.

Delivery and emplacement of pre-fabricated panels and substations

5.10. This equipment should be delivered via roadways and matting to be unloaded ready for installation.

Erection of security fencing and other security equipment

5.11. Fence post piling and security monitoring equipment to be installed using standard light plant equipment.

SITE DECOMMISSIONING

Panel dismantling

5.12. Components (solar panels, supports, string inverters and solar tables) should be dismantled by hand and collected by tractor and, to be removed from site and recycled.

Panel support removal

5.13. Steel piles may be removed using a light piling rig operating in reverse. The rig should operate from access tracks or matting, avoiding operating on the soil surface. Materials ot be collected by tractor and trailer to be removed from site and recycled.

Electrical infrastructure

5.14. Buried cables should be removed. Overlying topsoil and subsoil should be stripped and placed separately in temporary stockpiles. Stockpiled subsoil should be placed on geotextile matting. Trenching operations should be undertaken during dry weather between April and November to avoid soil structural damage. All materials should be collected by tractor and trailer to be removed from site and recycled.

5.15. Collection and removal of heavy components will mainly be limited to the use of roadways and access tracks. Where delivery requires access to other areas, low pressure matting should be employed.

Energy storage/substation compound removal

5.16. The future of the electrical compound (including the substation) should be discussed with the distribution network operator and agreed with the landowner and LPA prior to commencement of decommissioning.

Removal of substations/inverter pads

5.17. Collection and removal of heavy components will mainly be limited to the use of roadways and access tracks. Where delivery requires access to other areas, low pressure matting should be employed.

Removal of access tracks

5.18. Aggregate and matting should be stripped by an excavator/dumper operating on the track surface to avoid any soil compaction. All materials should be removed from site and recycled.

6.0 Remediative measures

INTRODUCTION

6.1. Remediation should not be necessary if the management plan detail is adhered to. However, should surface water problems be identified by operators in the seasons following cable installation, it is important that the causes are correctly identified.

SOIL COMPACTION

6.2. Compaction damage following soil reinstatement may be evidenced by standing water at the land surface, or by poor grass growth, resulting either from soil waterlogging or drought stress due to inhibited rooting depth.

6.3. Existence of over-compacted layers should be initially assessed by inspection of shallow pits. This is particularly important in establishing cause with reference to damage to drainage systems as described below.

6.4. Topsoil compaction can be removed relatively easily by cultivation (ploughing) and reseeding. This should be done under dry conditions in spring or early autumn.

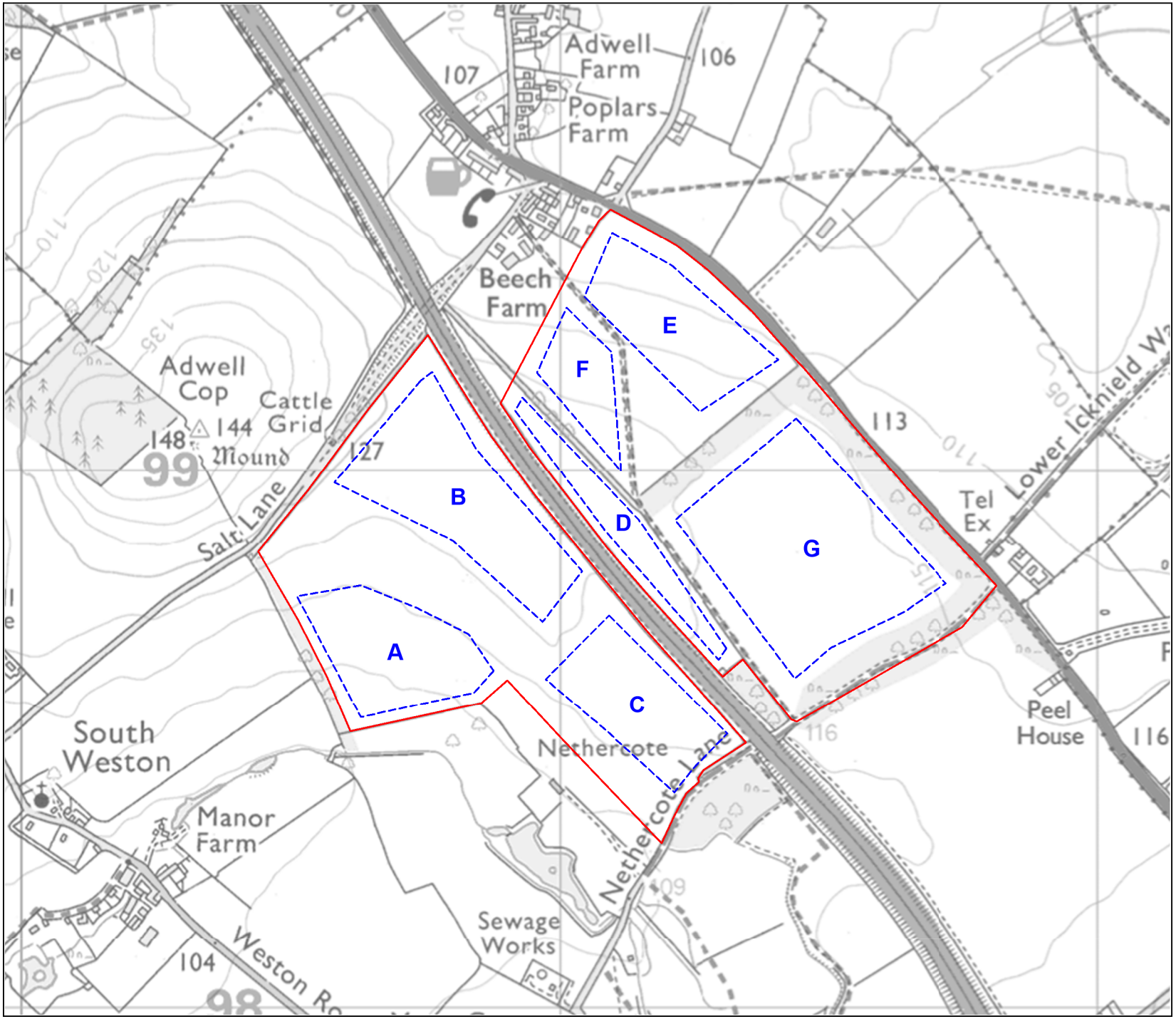
6.5. Where compacted subsoil layers are observed, they should be loosened/ripped using commercial subsoiling equipment. Grassland subsoilers (which minimise vegetation disturbance) are also commercially available.

APPENDIX

SAMPLING MAP

SOIL TYPES MAP

LABORATORY TESTING



KEY

Sample areas

Survey boundary

Site:

Postcombe and Lewknor Solar Farm

Map title:

MAP 1
Nutrient sample areas

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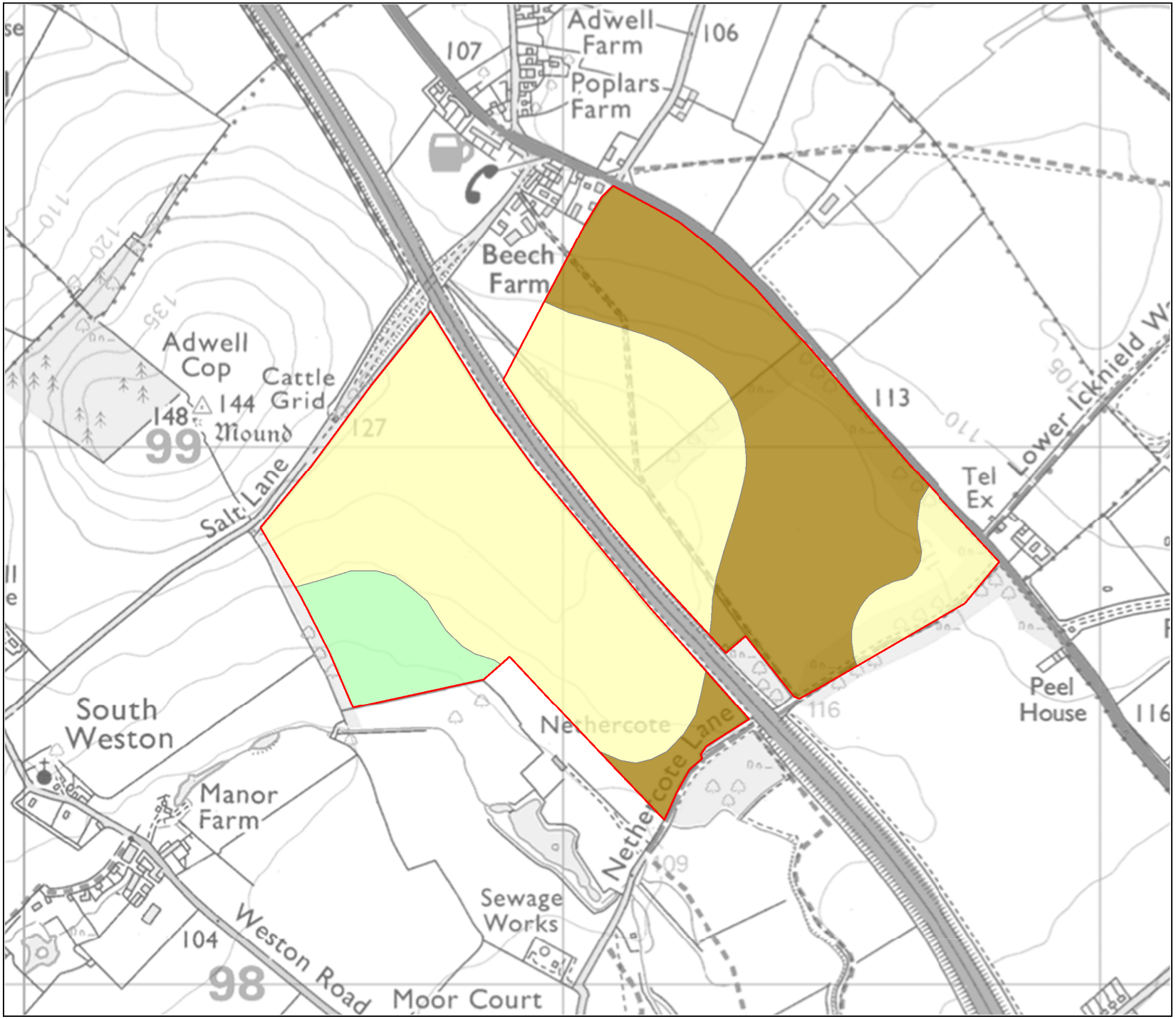
www.lra.co.uk

Date: 13/11/2023

Scale: 1:10,000



KEY

- Shallow heavy soils over chalk
- Deeper heavy soils over chalk
- Heavy wet soils
- Survey boundary

Site:

Postcombe and Lewknor Solar Farm

Map title:

Map 2
Soil types

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Date: 13/11/2023

Scale: 1:10,000

ANALYSIS REPORT

Contact : MR MIKE PALMER
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Please quote the above code for all enquiries

Client : LEWKNOR

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 14123/23

Date Received 03-Nov-23
Date Reported 07-Nov-23

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
59573/23	1	**A** *No cropping details given*	**8.2**	**3**	**3**	**2**	**32.6**	**262**	**92**
59574/23	2	**B** *No cropping details given*	**8.2**	**3**	**3**	**2**	**34.2**	**255**	**70**
59575/23	3	**C** *No cropping details given*	**8.2**	**3**	**5**	**2**	**41.8**	**635**	**66**
59576/23	4	**D** *No cropping details given*	**8.3**	**4**	**4**	**2**	**63.2**	**515**	**88**
59577/23	5	**E** *No cropping details given*	**8.0**	**4**	**3**	**2**	**53.8**	**348**	**75**
59578/23	6	**F** *No cropping details given*	**8.1**	**4**	**3**	**2**	**55.0**	**377**	**78**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the AHDB Fertiliser Recommendations RB209 9th Edition.

Released by *Sandy Cameron* On behalf of NRM Date *07/11/23*

ANALYSIS REPORT

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Client : LEWKNOR

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 14123/23

Date Received 03-Nov-23
Date Reported 07-Nov-23

SOIL ANALYSIS REPORT

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	Soil pH	P	K	Mg	P	K	Mg
59579/23	7	**G** *No cropping details given*	**8.2**	**3**	**3**	**2**	**38.2**	**287**	**73**

If general fertiliser and lime recommendations have been requested, these are given on the following sheets.
The analytical methods used are as described in DEFRA Reference Book 427
The index values are determined from the AHDB Fertiliser Recommendations RB209 9th Edition.

Released by *Sandy Cameron* On behalf of NRM Date *07/11/23*

ANALYSIS REPORT

DATE **7th November 2023**

SAMPLES FROM **LEWKNOR**

Report Reference: 14123/23

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Lab Ref.	Field Details		Soil Organic Matter [LOI%] Result
	No.	Field Name or Reference	
59573	1	A	6.4
59574	2	B	6.2
59575	3	C	6.6
59576	4	D	6.5
59577	5	E	6.1
59578	6	F	6.5
59579	7	G	6.0

Your Organic Matter Results Interpretation

Land use	Rainfall	Soil type	Very Low	Low	Target	High
Arable	Low <650mm	Light	<=1.0	1.1-2.1	2.2-3.2	>=3.3
		Medium	<=1.7	1.8-3.3	3.4-5.0	>=5.1
		Heavy	<=2.2	2.3-4.4	4.5-6.5	>=6.6
	Moderate 650-800mm	Light	<=1.0	1.1-3.0	3.1-4.5	>=4.6
		Medium	<=1.9	2.0-4.0	4.1-6.0	>=6.1
		Heavy	<= 2.7	2.8-5.2	5.3-7.6	>=7.7
	High 800-1100mm	Light	<=1.3	1.4-3.7	3.8-6.1	>=6.2
		Medium	<=2.5	2.6-5.0	5.1-7.5	>=7.6
		Heavy	<=3.6	3.7-6.2	6.3-8.8	>=8.9
Grassland (Lowland)	All	Light	<=2.1	2.2-4.9	5.0-7.9	8.0-14.9
		Medium	<=3.4	3.5-6.4	6.5-9.3	9.3-19.9
		Heavy	<=4.6	4.7-7.6	7.7-10.5	10.6-19.9