BARN HILL MEADOWS HABITATS AND SOIL ANALYSIS TECHNICAL NOTE

Drax Bioenergy with Carbon Capture and Storage

The Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations, 2009 – Regulation 5(2)(g)

Document Reference Number: 8.17

Applicant: Drax Power Limited

PINS Reference: EN010120

REVISION: 01

DATE: June 2023

DOCUMENT OWNER: WSP UK Limited

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PUBLIC

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1. INTRODUCTION

1.1. OVERVIEW

1.1.1. WSP UK Ltd (WSP) was commissioned by Drax Power Limited (the 'Applicant') to undertake further assessment in relation to air quality impacts on designated sites for the Drax Bioenergy Carbon Capture and Storage (BECCS) 'Proposed Scheme' (as it will be hereafter referred). The Proposed Scheme is a Nationally Significant Infrastructure Project (NSIP). A Development Consent Order (DCO) application was submitted to the Secretary of State (SoS) in May 2022 and accepted for examination in June 2022.

1.1.2. This assessment follows on from work undertaken as part of a Habitats Regulations Assessment (HRA) for the Proposed Scheme. Further details on the background and requirement for this further assessment are provided in **Section 2**, below.

1.1.3. This Technical Note reviews soil pH data for the Barn Hill Meadows Site of Special Scientific Interest (SSSI). This has been undertaken with specific reference to 'Unit 2' of the SSSI, which has been determined to experience the greatest air quality impacts in-combination of any of the four units comprising the SSSI. The impacts of the Proposed Scheme alone are nearly identical across all units of the SSSI and do not exceed 1% of the most stringent site-specific critical loads for acid deposition or nitrogen deposition. Impacts of the Proposed Scheme alone therefore do not lead to significant adverse effects and are not considered further.

1.1.4. The purpose of this review is to examine the pH data to determine the relative sensitivity of the grassland habitat present within Unit 2 of the SSSI to acid deposition. This information will be used to decide which Air Pollution Information System (APIS) 'critical load'[1] values to use in the assessment of possible air quality impacts on the SSSI. APIS offers a choice of two options: those applicable to 'acid grassland' or those applicable to 'calcareous grassland'.

1.2. PROPOSED SCHEME

1.2.1. The Proposed Scheme will involve the installation of Carbon Capture and Storage (CCS) technology to two existing power station units at Drax. When the CCS is fitted to the two units, this will change the thermal and chemical characteristics of the emissions from Drax's Main Stack. The two units that will have CCS fitted to them are also expected to run for an increased number of hours, with 8750 hrs of operation instead of the 4000 hrs of operation assumed for baseline 'without scheme' purposes.

1.2.2. As a consequence of the change in the exhaust emissions from the Proposed Scheme, increased rates of acid deposition and nitrogen deposition would occur within ~15 km of the Main Stack. Other pollutants also increase, but do not trigger

[1] Critical loads are defined as '*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge'* Source: [redacted]

potential for likely significant effects so are not discussed here. There are several sites of international and national importance within 15 km of the Main Stack that would be subject to these increased deposition/concentrations.

1.3. BACKGROUND

1.3.1. Air quality modelling has been undertaken for the Proposed Scheme. Part of the modelling has been used to assess the air quality impacts of the Proposed Scheme and the resulting effects on relevant European sites as part of the HRA (REP6-021). The assessment of air quality impacts on SSSI and other nationally designated sites has been presented in the Ecology chapter of the Environmental Statement for the Proposed Scheme (APP-044). APIS publishes habitat-specific critical loads for nitrogen and acid deposition. Comparing the air quality model output for the Proposed Scheme against the relevant critical loads supports assessment and understanding of potential air quality effects on designated sites.

1.3.2. Barn Hill Meadows SSSI is within 15 km of the Main Stack. The meadows comprise seven fields grouped into four 'units', each designated as part of the SSSI. Barn Hill Meadows is designated for its herb-rich, unimproved neutral grassland, which is a habitat uncommon in the intensively farmed landscape of Humberside and in lowland England in general.

1.3.3. The previous air quality assessment was made with regard to critical loads of relevant habitat types within a number of designated sites. Critical loads are typically assigned against EUNIS (European Union Nature Information System) habitat classes, although where no suitable EUNIS class exists they may be classified against the Annex I habitat type(s) for which a site has been designated. Different critical loads are available on the APIS website for the qualifying interest grassland habitats of Barn Hill Meadows SSSI, depending on whether the 'acid grassland' or 'calcareous grassland' habitat class is used. On a precautionary basis, the previous air quality modelling has been based on the acid grassland habitat class, as this is more sensitive to acidification effects than the calcareous grassland habitat class, as indicated by the site relevant critical loads provided on APIS (APIS, no date)[2].

1.3.4. Natural England provided the following comments at Deadline 4 (REP4-041):

"Natural England's advice is that, in relation to identified nature conservation issues within its remit, there is no fundamental reason of principle why the project should not be permitted. However, Natural England considers that the applicant has provided insufficient evidence and is not yet satisfied that the following issues have been resolved:

a. Nationally designated sites:

[2] APIS (no date). Site-relevant Critical Loads and Source Attribution. [redacted] [Accessed 19 May 2023].

i. Impacts of acid deposition on Barn Hill Meadows Site of Special Scientific Interest (SSSI)

Natural England note that, with the additional mitigation proposed, acid deposition at Barn Hill Meadows SSSI is now 0.9% of the critical load from the project alone. In-combination, with the additional mitigation, acid deposition at the site is modelled to be 1.5% of the critical load and the [Predicted Environmental Concentration] PEC exceeds 100% of the critical load."

"It appears that the Applicant has not provided further assessment of whether these exceedances in the [Process Contribution] PC/PEC in combination for Barn Hill Meadows SSSI are acceptable. Natural England therefore advise that further assessment of the results should be completed."

1.3.5. The part of the Barn Hill Meadows SSSI subject to the greatest air quality impacts is Unit 2 – Knedlington Cross-road Meadows. This Unit is 1.79 hectares in size and is located adjacent to the A63 road on the outskirts of the town of Howden.

1.4. PURPOSE OF THIS NOTE

1.4.1. The purpose of this Technical Note is to explore which critical load class is most appropriate to use for the assessment of acid deposition impacts on the Barn Hill Meadows SSSI: the 'acid grassland' critical load class or the 'calcareous grassland' critical load class. A summary of the acid deposition modelling for Barn Hill Meadows SSSI, using the confirmed critical load class, is also presented.

2. METHODOLOGY

2.1. APPROACH

2.1.1. A series of soil samples were collected from Unit 2 of Barn Hill Meadows SSSI on 10 May 2023. A total of nine sampling locations were used, comprising three rows of three, with samples taken from the upper 0.1m of soil. The collected samples were sent off for laboratory analysis to determine their pH values. The methodologies used and the results obtained are presented in full in Appendix A.

2.1.2. When reviewing the pH values provided by the analysis, consideration was given to the distance of the sample locations from the A63 and the potential contribution to acid deposition by emissions from road traffic.

2.1.3. There is no neutral grassland category in the APIS system. Thus, dispersion (air quality) modelling must be assessed against either acid grassland or calcareous grassland critical loads. The results of the analysis were used to determine (for the purpose of this assessment) which grassland habitat may most appropriately be considered to be present and, in turn, the habitat's sensitivity to acid deposition.

2.2. NOTES AND LIMITATIONS

2.2.1. WSP ecologists have not completed their own detailed botanical assessments of the Barn Hill Meadows SSSI. It is evident that the Natural England data contained within the SSSI citation was collected by a competent botanist and is therefore assumed that the most recent citation information is accurate, although this could not be directly verified. Natural England have also confirmed that the latest condition assessment for Unit 2 of Barn Hill Meadows SSSI found the site to be in favourable condition. This assessment was completed in 2012.

2.2.2. APIS provides limited guidance on how to define acid grassland and calcareous grassland so the National Vegetation Classification definitions of these grassland types (Rodwell, 2006)[3] have been used as proxies.

2.2.3. As mentioned above, there is no neutral grassland category in the APIS system. Thus, dispersion modelling must be assessed against either acid or calcareous grassland critical loads, in the absence of a potentially more appropriate critical load for neutral grassland being available.

3. RESULTS

3.1. ASSIGNMENT OF ACID DEPOSITION CRITICAL LOAD CLASS

3.1.1. Soil pH describes how acidic or alkaline the soil is, and the following pH ranges correspond to specific soil descriptions[4]:

Table 1 - pH ranges and description of soil provided by Plantlife

pH range	Description of Soil
< 5	Acid
5 – 5.4	Acid – Neutral
5.5 – 6.5	Neutral
> 6.5	Calcareous

3.1.2. **Table 2** summarises the pH values of each of the nine soil samples taken, as well as highlighting their approximate distance from the A63 road.

[3] Rodwell, J.S. (2006) National Vegetation Classification Users' Handbook. JNCC, Peterborough.

[4] [redacted]

Table 2 - pH Values of Soil Samples Taken

Sample number	pH	Approx. distance from the A63 (m)
1	5.8	103
2	5.7	99
3	5.8	48
4	5.4	52
5	6.8	10
6	6.8	15
7	6.5	18
8	6.2	63
9	5.9	113

3.1.3. The pH values of the soil samples ranged from 5.4 to 6.8. The samples were predominantly in the 'neutral' range (six of nine samples), with one 'acid-neutral' and two 'calcareous' samples.

3.1.4. A review of the pH values does not indicate any significant change in pH with increasing distance from the A63. This suggests a lack of influence from historic emissions from road traffic on acid deposition on the SSSI. This is reinforced by the two 'calcareous' samples being taken from two of the sample locations closest to the road, where any acid deposition from the road would typically be expected to be most significant.

3.1.5. The results of the soil sample analysis indicate that the habitat classification of neutral grassland remains accurate.

3.1.6. Given these findings it is considered that, on balance, the calcareous grassland habitat is the more appropriate proxy for calculating critical loads. This is because most samples analysed returned a neutral pH value, with two in the calcareous range and one of the nine samples exhibiting a pH that is classed as acidic-neutral.

3.2. UPDATED ACID DEPOSITION OUTPUTS

3.2.1. As set out in Section 3.1, the 'calcareous grassland' acid deposition critical load class has been determined to be the most appropriate for modelling acid deposition impacts on Barn Hill Meadows SSSI. The calcareous grassland acid deposition critical load class for Barn Hill Meadows SSSI has been obtained from APIS. A summary of the acid deposition results for Barn Hill Meadows SSSI, using the calcareous grassland acid deposition critical load class, is set out below in **Table 3.**

Table 3 - Updated Acid Deposition Impacts Against Revised Critical Load

	Proposed Scheme Alone		Proposed Scheme cumulatively with other plans and projects	
Critical Load used (keq/ha/yr)	**Max Process Contribution (PC) Impact (keq/ha/yr - unmitigated)**	**Max PC impact (% of critical load)**	**Max cumulative impact (keq/ha/yr - unmitigated)**	**Max cumulative impact (% of critical load)**
4.856	0.010	0.21%	0.014	0.29%

4. POTENTIAL FOR SIGNIFICANT EFFECTS

4.1.1. Following EA guidance (Environment Agency, 2021), if the change in Process Contribution (PC) associated with the With Proposed Scheme mid-merit (cumulative) scenario meets both of the following criteria, impacts are considered to be insignificant and further assessment is not required if:

a. The short-term PC is less than 10% of the short-term environmental standard for the ecological receptor; and
b. The long-term PC is less than 1% of the long-term environmental standard for the ecological receptor.

4.1.2. If the above criteria are not met, additional criteria are applied as follows:

a. If the short-term PC exceeds the above screening criteria, significant effects cannot be screened out and further assessment is needed; and
b. If the long-term PC is greater than 1% and the PEC is less than 70% of the long-term environmental standard, the emissions are insignificant, and no further assessment is required; or
c. If the PEC is greater than 70% of the long-term environmental standard, significant effects cannot be screened out and further assessment is needed.

4.1.3. With use of the calcareous grassland acid deposition critical load class, the Proposed Scheme alone leads to a maximum impact of up to 0.21% of critical load. The cumulative impact with other plans and projects is modelled to be up to 0.29% of critical load. In both instances this is less than 1% of the critical load, i.e. the long-term PC is less than 1% of the long-term environmental standard. Following the EA guidance referred to above at paragraph 4.1.1, the impacts of the Proposed Scheme, both alone and cumulatively, are considered to be insignificant as screening criteria are not exceeded.

5. CONCLUSION

5.1.1. The soil pH analysis shows that 66% of the soil samples are in the neutral range, which increases to 77% if the acid-neutral sample is also taken into consideration. Only one of the nine samples (acid-neutral) fell within the acidic range, with the remaining two being calcareous. These findings are consistent with the SSSI habitat classification of neutral grassland.

5.1.2. The results of the analysis suggest limited influence of road traffic emissions on acid deposition. This is because only one of the nine samples falls (partly) within the acidic range, and two of the three samples taken from closest to the A63 (where emissions effects would be expected to be most significant) were found to be calcareous in nature.

5.1.3. Given these findings, the Barn Hill Meadows SSSI clearly supports a neutral grassland, and it is considered that, on balance, the calcareous grassland habitat may be the more appropriate proxy for calculating critical loads, based on the results of the soil sample analysis. This is because most samples analysed returned a neutral pH value, with two in the calcareous range and one of the nine samples exhibiting a pH that is classed as acidic-neutral.

APPENDIX A – SOIL PH AND NUTRIENT TESTING

READING AGRICULTURAL CONSULTANTS

May 2023

WSP Ltd

Soil pH and Nutrient Testing

at

land at Barn Hill Meadow, Howden

Beechwood Court,
Long Toll, Woodcote,
RG8 0RR

[redacted]

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FIGURE RAC/9440/4 SAMPLING PLAN 8

1. Introduction

1.1. Reading Agricultural Consultants Ltd (RAC) is instructed by WSP Ltd on behalf of Drax Power Station to investigate the soil pH and major nutrients on land approximately 7km to the east of the power station at the junction of the A63 and B1228, to the immediate west of Howden.

1.2. The purpose of the survey is to support the ecological assessment in order to satisfy Natural England's request for additional information in relation to the assessment of cumulative acid deposition at Barn Hill Meadows Site of Special Scientific Interest.

2. Soil Survey Methods

2.1. The area surveyed is shown on Figure RAC/9440/4. At each point, composite topsoil samples were taken from points to the north, east, south and west and mixed with the sample from the identified point. The composite samples were sent to an accredited laboratory for analysis of soil pH and major nutrients.

2.2. Two soil profiles (at points 2 and 8) were also examined using an Edelman (Dutch) auger. The following characteristics were assessed for each soil horizon up to a maximum of 120cm depth:

- soil texture;
- stone content;
- colour (including localised mottling);
- consistency;
- structural condition;
- free carbonate; and
- depth.

3. Background Conditions

3.1. The survey area extends to approximately 1.5ha within three small grassland fields. The topography is flat at approximately 5m above Ordnance Datum (AOD).

Agro-climate

3.2. Agro-climatic data for the site have been interpolated from the Meteorological Office's standard 5km grid point dataset, and are given in Table 1. The climate is moderately warm and dry, resulting in moderately large moisture deficits. The number of Field Capacity Days (FCD) is lower than average for lowland England (150) and is favourable for providing opportunities for working the land.

Table 1: Local Agro-climatic Conditions

Parameter	Value
Altitude	5m
Average Annual Rainfall	584mm
Accumulated Temperatures >0°C	1,405 day°
Field Capacity Days	125 days
Average Moisture Deficit, wheat	110mm
Average Moisture Deficit, potatoes	103mm

Soil parent material and soil type

3.3. The underlying geology mapped by the British Geological Survey[1] is the Sherwood Sandstone Group, which comprises red, yellow and brown sandstone with subordinate red mudstone and siltstone.

3.4. In the north of the area, superficial deposits of Alluvium are mapped and consist of clay, silt, sand and gravel; with superficial deposits of the Breighton Sand Formation, consisting of sand, silt and gravel, mapped in the south.

3.5. The Soil Survey of England and Wales soil association mapping[2] (1:250,000 scale) shows the Newport 1 association at the site. This association comprises well drained, sandy or

[1] **British Geological Survey (2023).** *Geology of Britain viewer*, [redacted]

[2] **Soil Survey of England and Wales (1984).** *Soils of Northern England* (1:250,000), Sheet 1.

coarse loamy soils, some of which are affected by fluctuating groundwater, but which are typically controlled by drainage ditches to Wetness Class (WC) I[3].

4. Description of the Soils and Laboratory Results

4.1. The soil profiles have been described according to Hodgson[4] which is the recognised source for describing soil profiles and characteristics.

4.2. Profile 2 represents soils in the southern field (observation points 1-4) and consists of 34cm of dark greyish brown (10YR4/2 in the Munsell soil colour charts[5]), sandy clay loam topsoil. There is distinct ochreous mottling in the topsoil. The upper subsoil consists of brown (10YR5/3), distinctly mottled, sandy clay. The lower subsoil consists of slowly permeable, brown (10YR5/3) clay, with distinct ochreous and grey mottling. This profile shows evidence of gleying within 40cm, is slowly permeable within 61cm and is assessed as imperfectly drained in WCIII.

4.3. Profile 8 represents soils in the western and northern fields (observation points 5-9). It consists of 24cm of dark greyish brown (10YR4/2) medium clay loam topsoil, with prominent ochreous mottling in the topsoil. This lies over a greyish brown (10YR5/2) clay upper subsoil which is slowly permeable and prominently mottled. The lower subsoil is a brown (10YR5/3), distinctly mottled, slowly permeable clay mixed with very fine sand. This profile is gleyed within 40cm, slowly permeable within 42cm and assessed as poorly drained in WC IV.

4.4. The laboratory data from the composite samples are attached as Appendix 1 and summarised below in Table 2.

Table 2: Soil pH and Major Nutrients

Determinand	Southern field (1-4)	Western field (5-7)	Northern field (8-9)
Soil pH (mean)	5.6	6.7	6.1
Soil pH (range)	5.4 – 5.8	6.5 – 6.8	5.9 – 6.2
Phosphorus (P Index)	0 (range 0 – 0)	1 (range 0 – 3)	0 (range 0 – 0)
Potassium (K Index)	0 (range 0 – 0)	0 (range 0 – 1)	1 (range 1 – 1)
Magnesium (Mg Index)	2 (range 2 – 3)	5 (range 3 – 6)	6 (range 6 – 6)

[3] **Jarvis et al (1984).** *Soils and Their Use in Northern England*. Soil Survey of England and Wales Bulletin 10, Harpenden.
[4] **Hodgson, J. M. (Ed.) (1997).** *Soil survey field handbook.* Soil Survey Technical Monograph No. 5, Silsoe.
[5] **Munsell Color (2009).** *Munsell Soil Color Book*. Grand Rapids, MI, USA

4.5. The soils are all acid with an average (mean) pH of 6.1 within a range of 5.4 to 6.8. There is variability within the site, with the soils in the southern field being more acid (mean of 5.6) than those in the western (mean of 6.7) and in the northern field (mean of 6.1).

4.6. This is likely to be related primarily to soil type, with the soils in the southern field represented by point 2 and having a higher sand fraction in the topsoil and subsoil, with sandy clay loam topsoils over sandy clay subsoils, compared to medium clay loam topsoils over clay subsoils in the other two fields.

4.7. The principal distinction in nutrient levels within the site relates to magnesium levels, which are higher in the western and northern fields, as would be expected with clay soils.

4.8. There appears to be some (negative) correlation between soil pH and the distance from the A63 carriageway, with the sample points closest to the carriageway (5, 6 and 7 which are less than 20m from the carriageway) having a mean pH of 6.7; whilst those further distant (50-60m from the carriageway) have a mean pH of 5.8 and those furthest distant (100-110m) a mean pH of 5.7. However, soil texture and type is considered likely to be the principal determinant of soil pH (as also supported by the nutrient results).

Appendix 1: Laboratory results

ANALYSIS REPORT

Contact : READING AGRICULTURAL CONS
BEECHWOOD COURT
LONG TOLL
WOODCOTE
READING
RG8 0RR
Tel. : 01491 684233

H 95

Please quote the above code for all enquiries

Client : 9440

Distributor : 9440

Local Rep : CHARITY MOORE

Telephone : 07739 547039

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 69287/23

Date Received 15-May-23
Date Reported 16-May-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
369931/23	1	**9440 1** *No cropping details given*	**5.6**	**0**	**0**	**2**	**5.2**	**50**	**95**
369932/23	2	**9440 2** *No cropping details given*	**5.7**	**0**	**0**	**2**	**3.4**	**45**	**87**
369933/23	3	**9440 3** *No cropping details given*	**5.8**	**0**	**0**	**3**	**4.2**	**54**	**143**
369934/23	4	**9440 4** *No cropping details given*	**5.4**	**0**	**0**	**2**	**4.4**	**44**	**95**

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 Myles Nicholson On behalf of NRM Date 16/05/23

ANALYSIS REPORT

Contact : READING AGRICULTURAL CONS
BEECHWOOD COURT
LONG TOLL
WOODCOTE
READING
RG8 0RR
Tel. : 01491 684233

H 95

Please quote the above code for all enquiries

Client : 9440

Distributor : 9440

Local Rep : CHARITY MOORE

Telephone : 07739 547039

Sample Matrix : Agricultural Soil

Laboratory Reference
Card Number 69288/23

Date Received 15-May-23
Date Reported 16-May-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
369935/23	1	**9440 5** *No cropping details given*	**6.8**	**3**	**1**	**3**	**28.8**	**80**	**169**
369936/23	2	**9440 6** *No cropping details given*	**6.8**	**1**	**0**	**5**	**10.0**	**41**	**324**
369937/23	3	**9440 7** *No cropping details given*	**6.5**	**0**	**0**	**6**	**4.0**	**36**	**413**
369938/23	4	**9440 8** *No cropping details given*	**6.2**	**0**	**1**	**6**	**4.4**	**67**	**454**
369939/23	5	**9440 9** *No cropping details given*	**5.9**	**0**	**1**	**6**	**4.6**	**93**	**477**

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 *Myles Nicholson* On behalf of NRM Date *16/05/23*

N

1:2500

50m 0 50m 100m

KEY

Sampling area

+1 Sample location

Rev.	Comment	Date

Drawing title

SAMPLING PLAN

Contract

LAND AT DRAX POWER STATION,
NORTH YORKSHIRE

Reading Agricultural Consultants Ltd
Gate House
Beechwood Court
Long Toll
Woodcote
RG8 0RR
[redacted]

READING AGRICULTURAL CONSULTANTS

Ref.	Rev.
RAC/9440/4	
Drawn by: AGM	Checked by: AIF
Scales: 1:2,500@A4	Date: 05/2023