Ammonia Assessment

Blackmoss Farm, Chipping

Client: Stanworth Agricultural Ltd

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1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by Stanworth Agricultural Ltd to undertake an Ammonia Assessment in support of an agricultural development on land at Blackmoss Farm, Chipping.

1.1.2 The proposals have the potential to cause changes in pollution levels at sensitive ecological locations as a result of ammonia (NH_3) emissions associated with the project. An Ammonia Assessment was therefore undertaken in order to consider potential effects.

1.2 Site Location and Context

1.2.1 Blackmoss Farm is located off Gib Hey Lane, Chipping, at approximate National Grid Reference (NGR): 360152, 440399.

1.2.2 The project comprises the construction of a new livestock building for a maximum of 308 dairy cows on a slurry based system, as well as two new covered slurry tanks. Housing of 105 young stock will also be provided within an existing cattle shed, with a calving shed also providing capacity for the same amount of cattle.

1.2.3 Reference should be made to Figure 1 for a site layout plan.

1.2.4 It should be noted that it is not proposed to utilise the calving shed. However, stocking of the building was considered throughout the assessment to provide a robust analysis of potential emissions and provide flexibility for future operations.

1.2.5 The proposals have the potential to cause changes in pollution levels at sensitive ecological locations as a result of NH_3 emissions associated with the project. An Ammonia Assessment was therefore undertaken in order to consider potential effects. The methodology and findings are presented in the following report.

2.0 METHODOLOGY

2.1 Introduction

2.1.1 The methodology utilised for the Ammonia Assessment is summarised in the following Sections.

2.2 Guidance

2.2.1 The following guidance was utilised throughout the assessment:

- Air quality risk assessment interim guidance, Natural England (NE), 2022;
- Intensive farming risk assessment for your environmental permit, Environment Agency (EA), 2018;
- Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations, NE, 2018; and,
- Habitats regulations assessments: protecting a European site, Department for Environment, Food and Rural Affairs (DEFRA), NE, Welsh Government and Natural Resources Wales, 2021.

2.3 Assessment Stages

2.3.1 The assessment was undertaken in accordance with the stages outlined within the Habitat Regulations Assessment (HRA) guidance[1] produced by DEFRA. This is summarised as follows, though it should be noted that completion of all elements is not always necessary, depending on the findings of each stage:

- Stage 1 - Screening: Plans or projects with no likely significant effect on an ecological designation can be 'screened out' of the need for further assessment;
- Stage 2 - Appropriate Assessment: Detailed assessment to consider the likely significant effects of the proposal in more detail and identify ways to avoid or minimise any effects; and,

[1] Habitats regulations assessments: protecting a European site, DEFRA, NE, Welsh Government and Natural Resources Wales, 2021.

- Stage 3 - Derogation: To assess the likely significant effects of the proposal in more detail and identify ways to avoid or minimise any effects.

2.3.2 The methodology adopted for each stage is summarised in the following Sections.

2.3.3 It should be noted that although the HRA methodology only applies to European sites, the approach has also been adopted when considering effects on Sites of Special Scientific Interest (SSSIs) in lieu of alternative guidance.

Stage 1: Screening

2.3.4 Stage 1: Screening utilised the following steps, as derived from NE guidance[2] [3] and information provided within recent consultation responses from NE on similar projects:

- Step 1: Does the proposal give rise to emissions which are likely to reach an international or national site? If there are no designations within the vicinity of the project, then a screening conclusion of no likely significant effect can be reached with regard to air quality;
- Step 2: Are the qualifying features of the designation sensitive to air pollution? If there are no sensitive qualifying features, then a screening conclusion of no likely significant effect on the site can be reached with regard to air quality;
- Step 3: Could the sensitive qualifying features of the site be exposed to emissions? If the qualifying features could not be exposed to emissions, then a screening conclusion of no likely significant effect on the site can be reached with regard to air quality;
- Step 4: Application of the following screening thresholds to determine potential risk of effects alone and in-combination with emissions from other plans and projects:
  - 4a) Alone: Risk of significant effect if a predicted PC is 1% of the critical load or level or greater as a result of the proposal in isolation; and,
  - 4b) In-combination: Risk of significant effect if a predicted PC is 1% of the critical load or level or greater as a result of the proposal in-combination with other relevant plans or projects.

[2] Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations, NE, 2018.

[3] Air quality risk assessment interim guidance, NE, 2022.

> If the above criteria are not exceeded, then a screening conclusion of no likely significant effect on the site can be reached with regard to air quality.

2.3.5 If the above steps indicate a screening conclusion of no likely significant effects on the relevant designations can be reached with regard to air quality, then the assessment can be concluded. If potential effects cannot be screened out, then the assessment should proceed to Stage 2: Appropriate Assessment.

Stage 2: Appropriate Assessment

2.3.6 Having identified a risk of a significant effect from a plan or project either alone or in-combination, the purpose of Stage 2: Appropriate Assessment is to more precisely assess the likely effects and to inform a conclusion as to whether an adverse effect on site integrity can be ruled out. It should be noted that the assessment should be 'appropriate' in terms of its scope, content, length and complexity to the plan or project under assessment. This was reiterated by the Supreme Court[4], which clarified:

> "Appropriate' is not a technical term. It indicates no more than that the assessment should be appropriate to the task in hand: that task being to satisfy the authority that the project will not adversely affect the integrity of the site concerned."

2.3.7 It should not be assumed that an Appropriate Assessment will necessarily involve detailed and complex monitoring or modelling work. Whilst this may be necessary in fully understanding what will happen to a site if the plan or project goes ahead, it is equally possible that a fairly concise and straightforward assessment might be entirely 'appropriate'.

2.3.8 A number of factors are identified in the NE guidance[5] for further consideration during an Appropriate Assessment. These are summarised as follows:

[4] Champion v North Norfolk DC, UK Supreme Court, 2015.

[5] Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations, NE, 2018.

- Consider whether the sensitive qualifying features of the site would be exposed to emissions;
- Consider the European Site's Conservation Objectives;
- Consider background pollution;
- Consider the designated site in its national context;
- Consider the best available evidence on small incremental impacts from nitrogen deposition;
- Consider the spatial scale and duration of the predicted impact and the ecological functionality of the affected area;
- Consider site survey information;
- Consider national, regional and local initiatives or measures which can be relied upon to reduce background levels at the site;
- Consider measures to avoid or reduce the harmful effects of the plan or project on site integrity; and,
- Consider any likely in-combination effects with other live plans and projects from other sectors.

2.3.9 It should be noted that in accordance with the above definition of an Appropriate Assessment, not all factors may be relevant to a specific plan or project and only those which aid in forming a conclusion as to whether an adverse effect on site integrity can be ruled out need to be considered.

3.0 STAGE 1: SCREENING

3.1 Introduction

3.1.1 A Stage1: Screening Assessment of potential effects on sensitive ecological designations as result of emissions from the project was undertaken in accordance with the stages outlined in Section 2.3. The results are provided in the following Sections.

3.2 Step 1

3.2.1 Step 1 requires identification of any ecological designations within the vicinity of the site that may be affected by emissions from the project. The consultation response prepared by NE on 5th July 2023[6] indicated the following ecological designations should be considered in the assessment:

- Bowland Fells SSSI; and,
- Bowland Fells Special Protection Area (SPA).

3.2.2 Review of the MAGIC website[7] also indicated the following designations within the vicinity of the site:

- Hodder River Section SSSI;
- Red Scar and Tun Brook Woods; and,
- Rough Hey Wood SSSI.

3.2.3 As shown above, a number of designations were identified that may be affected by emissions associated with the project. As such, the assessment proceeded to Step 2.

[6] 440193, NE, 2023.

[7] https://magic.defra.gov.uk/MagicMap.aspx.

3.3 Step 2

3.3.1 In order to identify whether the designations are sensitive to air pollution, the critical loads and levels for the qualifying features were obtained from the Air Pollution Information System (APIS) website[8]. These are summarised in the following Tables.

3.3.2 The nitrogen critical loads for Bowland Fells SPA are presented in Table 1.

Table 1 Nitrogen Critical Loads - Bowland Fells SPA

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Circus cyaneus	Yes	Northern wet heath: U? Callunadominated wet heath (upland)	5	15
Falco columbarius	Yes	Northern wet heath: U? Callunadominated wet heath (upland)	5	15
Larus fuscus (Western Europe/Mediterranean/Western Africa)	No	Species' broad habitat not sensitive to eutrophication	-	-

3.3.3 The nitrogen critical loads for Bowland Fells SSSI are presented in Table 2.

Table 2 Nitrogen Critical Loads - Bowland Fells SSSI

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Calluna Vulgaris - Deschampsia Flexuosa Heath	Yes	Dry heaths	5	15
Calluna Vulgaris - Erica Cinerea Heath	Yes	Dry heaths	5	15
Calluna Vulgaris - Eriophorum Vaginatum Blanket Mire	Yes	Raised and blanket bogs	5	10

[8] APIS, www.apis.ac.uk.

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Calluna Vulgaris - Vaccinium Myrtillus - Sphagnum Capillifolium Heath	Yes	Dry heaths	5	15
Calluna Vulgaris - Vaccinium Myrtillus Heath	Yes	Dry heaths	5	15
Carex Dioica - Pinguicula Vulgaris Mire	Yes	Rich fens	15	25
Carex Echinata - Sphagnum Recurvum (Fallax) /Auriculatum (Denticulatum) Mire	Yes	Valley mires, poor fens and transition mires	5	15
Erica Tetralix - Sphagnum Compactum Wet Heath	Yes	Northern wet heath: `L? Erica tetralixdominated wet heath (lowland)	5	15
Erica Tetralix - Sphagnum Papillosum Raised And Blanket Mire	Yes	Raised and blanket bogs	5	10
Eriophorum Angustifolium Bog Pool Community	Yes	Raised and blanket bogs	5	10
Eriophorum Vaginatum Blanket And Raised Mire	Yes	Raised and blanket bogs	5	10
Juncus Effusus / Acutiflorus - Galium Palustre Rush Pasture	Yes	Moist or wet mesotrophic to eutrophic hay meadow	15	25
Molinia Caerulea - Potentilla Erecta Mire	Yes	Moist or wet mesotrophic to eutrophic hay meadow	15	25
Philonotis Fontana - Saxifraga Stellaris Spring	Yes	Valley mires, poor fens and transition mires	5	15
Quercus Petraea - Betula Pubescens - Dicranum Majus Woodland	Yes	Acidophilous Quercus forest	10	15
Quercus Spp.-Betula Spp.-Deschampsia Flexuosa Woodland	Yes	Acidophilous Quercus forest	10	15
Ranunculus Omiophyllus - Montia Fontana Rill	Yes	Valley mires, poor fens and transition mires	5	15

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Scirpus Cespitosus - Erica Tetralix Wet Heath	Yes	Northern wet heath: `L? Erica tetralixdominated wet heath (lowland)	5	15
Sphagnum Cuspidatum/recurvum (Fallax) Bog Pool Community	Yes	Raised and blanket bogs	5	10
Vaccinium Myrtillus - Deschampsia Flexuosa Heath	Yes	Dry heaths	5	15
Vascular plant assemblage	Yes	No comparable habitat with established critical load estimate available	-	-
Circus cyaneus	Yes	Rich fens	15	25
Circus cyaneus	Yes	Northern wet heath: U? Callunadominated wet heath (upland)	5	15
Circus cyaneus	Yes	Atlantic upper-mid & mid-low salt marshes	10	20
Falco columbarius	Yes	Northern wet heath: U? Callunadominated wet heath (upland)	5	15
Larus fuscus	No	Species' broad habitat not sensitive to eutrophication	-	-
Upland moorland and grassland with water bodies	Not assessed for this feature	No critical load has not assigned for this feature, please seek site specific advice	-	-

3.3.4 The nitrogen critical loads for Red Scar and Tun Brook Woods SSSI are presented in Table 3.

Table 3 Nitrogen Critical Loads - Red Scar and Tun Brook Woods SSSI

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Alnus glutinosa - Carex paniculata Woodland	Yes	Broadleaved deciduous woodland	10	20

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Alnus glutinosa - Fraxinus excelsior - Lysimachia nemorum Woodland	No	Designated feature/feature habitat not sensitive to eutrophication	-	-
Fraxinus Excelsior - Sorbus Aucuparia - Mercurialis Perennis Woodland	Yes	Carpinus and Quercus mesic deciduous forest	15	20
Quercus Robur - Pteridium Aquilinum - Rubus Fruticosus Woodland	Yes	Carpinus and Quercus mesic deciduous forest	15	20
Satyrium w-album	Not assessed for this feature	No critical load has not assigned for this feature	-	-

3.3.5 The nitrogen critical loads for Rough Hey Wood SSSI are presented in Table 4.

Table 4 Nitrogen Critical Loads - Rough Hey Wood SSSI

Feature Name	Is the Feature Sensitive to Nitrogen?	Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
Ardea cinerea	Not assessed for this feature	No critical load has not assigned for this feature	-	-

3.3.6 The acid critical loads for Bowland Fells SPA are presented in Table 5.

Table 5 Acid Critical Loads - Bowland Fells SPA

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Circus cyaneus	Yes	Dwarf shrub heath	0.642	0.180	0.822
Falco columbarius	Yes	Dwarf shrub heath	0.642	0.180	0.822

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Elymus Farctus Ssp. Boreali-Atlanticus Foredune Community	Not assessed for this feature	No critical load has not assigned for this feature, please seek site specific advice	-		
Festuca Rubra - Galium Verum Fixed Dune Grassland	Not assessed for this feature	No critical load has not assigned for this feature, please seek site specific advice	-	-	-
Phleum Arenarium - Arenaria Serpyllifolia Dune Annual Community	Not assessed for this feature	No critical load has not assigned for this feature, please seek site specific advice	-	-	-
Vascular plant assemblage	Yes	No Comparable Acidity Class	-	-	-

3.3.7 The acid critical loads for Bowland Fells SSSI are presented in Table 6.

Table 6 Acid Critical Loads - Bowland Fells SSSI

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Calluna Vulgaris - Deschampsia Flexuosa Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Calluna Vulgaris - Erica Cinerea Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Calluna Vulgaris - Eriophorum Vaginatum Blanket Mire	Yes	Bogs	0.321	0.334	0.655
Calluna Vulgaris - Vaccinium Myrtillus - Sphagnum Capillifolium Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Calluna Vulgaris - Vaccinium Myrtillus Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Carex Echinata - Sphagnum Recurvum (Fallax) /Auriculatum (Denticulatum) Mire	Yes	Bogs	0.321	0.334	0.655
Erica Tetralix - Sphagnum Compactum Wet Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Erica Tetralix - Sphagnum Papillosum Raised And Blanket Mire	Yes	Bogs	0.321	0.334	0.655
Eriophorum Angustifolium Bog Pool Community	Yes	Bogs	0.321	0.334	0.655
Eriophorum Vaginatum Blanket And Raised Mire	Yes	Bogs	0.321	0.334	0.655
Quercus Petraea - Betula Pubescens - Dicranum Majus Woodland	Yes	Unmanaged Broadleafed/Coniferous Woodland	0.285	0.496	0.781
Quercus Spp.-Betula Spp.-Deschampsia Flexuosa Woodland	Yes	Unmanaged Broadleafed/Coniferous Woodland	0.285	0.496	0.781
Scirpus Cespitosus - Erica Tetralix Wet Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Sphagnum Cuspidatum/recurvum (Fallax) Bog Pool Community	Yes	Bogs	0.321	0.334	0.655
Vaccinium Myrtillus - Deschampsia Flexuosa Heath	Yes	Dwarf shrub heath	0.642	0.180	0.822
Vascular plant assemblage	Yes	No Comparable Acidity Class	-	-	-
Circus cyaneus	Yes	Dwarf shrub heath	0.642	0.180	0.822
Falco columbarius	Yes	Dwarf shrub heath	0.642	0.180	0.822

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Upland moorland and grassland with water bodies	Not assessed for this feature	No critical load has not assigned for this feature, please seek site specific advice	-	-	-

3.3.8 The acid critical loads for Red Scar and Tun Brook Woods SSSI are presented in Table 7.

Table 7 Acid Critical Loads - Red Scar and Tun Brook Woods SSSI

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Fraxinus Excelsior - Sorbus Aucuparia - Mercurialis Perennis Woodland	Yes	Unmanaged Broadleafed/Coniferous Woodland	0.142	1.446	1.707
Quercus Robur - Pteridium Aquilinum - Rubus Fruticosus Woodland	Yes	Unmanaged Broadleafed/Coniferous Woodland	0.142	1.446	1.707
Satyrium w-album	Not assessed for this feature	No critical load has not assigned for this feature	-		
Maculinea arion	Not assessed for this feature	No critical load has not assigned for this feature	-	-	-

3.3.9 The acid critical loads for Rough Hey Wood SSSI are presented in Table 8.

Table 8 Acid Critical Loads - Rough Hey Wood SSSI

Feature Name	Is the Feature Sensitive to Acidity?	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
			CLMinN	CLMaxS	CLMaxN
Ardea cinerea	Not assessed for this feature	No critical load has not assigned for this feature	-	-	-

3.3.10 The annual mean NH_3 critical levels for Bowland Fells SPA are presented in Table 9.

Table 9 Critical Levels for NH_3 - Bowland Fells SPA

Feature Name	Are Bryophytes Integral for this Habitat?	Are Lichens Integral for this Habitat?	Annual Mean NH_3 Critical Level (µg/m³)
Circus cyaneus	-	-	3
Falco columbarius	-	-	3
Larus fuscus (Western Europe/Mediterranean/Western Africa)	-	-	-

3.3.11 The annual mean NH_3 critical levels for Bowland Fells SSSI are presented in Table 10.

Table 10 Critical Levels for NH_3 - Bowland Fells SSSI

Feature Name	Are Bryophytes Integral for this Habitat?	Are Lichens Integral for this Habitat?	Annual Mean NH_3 Critical Level (µg/m³)
Calluna Vulgaris - Deschampsia Flexuosa Heath	Yes	Yes	1
Calluna Vulgaris - Erica Cinerea Heath	Yes	Yes	1
Calluna Vulgaris - Eriophorum Vaginatum Blanket Mire	Yes	Yes	1
Calluna Vulgaris - Vaccinium Myrtillus - Sphagnum Capillifolium Heath	Yes	No	1
Calluna Vulgaris - Vaccinium Myrtillus Heath	Yes	Yes	1
Carex Dioica - Pinguicula Vulgaris Mire	Yes	No	1
Carex Echinata - Sphagnum Recurvum (Fallax) /Auriculatum (Denticulatum) Mire	Yes	No	1
Erica Tetralix - Sphagnum Compactum Wet Heath	Yes	Yes	1
Erica Tetralix - Sphagnum Papillosum Raised And Blanket Mire	Yes	Yes	1
Eriophorum Angustifolium Bog Pool Community	Yes	No	1

Feature Name	Are Bryophytes Integral for this Habitat?	Are Lichens Integral for this Habitat?	Annual Mean NH_3 Critical Level (µg/m³)
Eriophorum Vaginatum Blanket And Raised Mire	Yes	Yes	1
Juncus Effusus / Acutiflorus - Galium Palustre Rush Pasture	No	No	3
Molinia Caerulea - Potentilla Erecta Mire	Yes	No	1
Philonotis Fontana - Saxifraga Stellaris Spring	Yes	No	1
Quercus Petraea - Betula Pubescens - Dicranum Majus Woodland	Yes	Yes	1
Quercus Spp.-Betula Spp.-Deschampsia Flexuosa Woodland	Yes	Yes	1
Ranunculus Omiophyllus - Montia Fontana Rill	Yes	No	1
Scirpus Cespitosus - Erica Tetralix Wet Heath	Yes	Yes	1
Sphagnum Cuspidatum/recurvum (Fallax) Bog Pool Community	Yes	No	1
Vaccinium Myrtillus - Deschampsia Flexuosa Heath	Yes	No	1
Vascular plant assemblage	-	-	-
Circus cyaneus	-	-	-
Circus cyaneus	-	-	-
Circus cyaneus	-	-	-
Falco columbarius	-	-	-
Larus fuscus	-	-	-
Upland moorland and grassland with water bodies	-	-	-

3.3.12 The annual mean NH_3 critical levels for Red Scar and Tun Brook Woods SSSI are presented in Table 11.

Table 11 Critical Levels for NH_3 - Red Scar and Tun Brook Woods SSSI

Feature Name	Are Bryophytes Integral for this Habitat?	Are Lichens Integral for this Habitat?	Annual Mean NH_3 Critical Level (µg/m³)
Alnus glutinosa - Carex paniculata Woodland	Yes	Yes	1 or 3
Alnus glutinosa - Fraxinus excelsior - Lysimachia nemorum Woodland	Yes	Yes	1 or 3
Fraxinus Excelsior - Sorbus Aucuparia - Mercurialis Perennis Woodland	Yes	Yes	1 or 3
Quercus Robur - Pteridium Aquilinum - Rubus Fruticosus Woodland	Yes	Yes	1 or 3
Satyrium w-album	-	-	-

3.3.13 The annual mean NH_3 critical levels for Rough Hey Wood SSSI are presented in Table 12.

Table 12 Critical Levels for NH_3 - Rough Hey Wood SSSI

Feature Name	Are Bryophytes Integral for this Habitat?	Are Lichens Integral for this Habitat?	Annual Mean NH_3 Critical Level (µg/m³)
Ardea cinerea	-	-	-

3.3.14 A review of the relevant data indicated the following:

- Critical loads for nitrogen deposition have been defined for qualifying features in all designations, with the exception of Hodder River Section SSSI and Rough Hey Wood SSSI:
- Critical loads for acid deposition have been defined for qualifying features in all designations, with the exception of Hodder River Section SSSI and Rough Hey Wood SSSI; and,
- Critical levels for NH_3 concentrations have been defined for qualifying features in all designations, with the exception of Hodder River Section SSSI and Rough Hey Wood SSSI.

3.3.15 As outlined above, nitrogen and acid deposition critical loads and NH_3 critical levels have not been defined for the qualifying features of Hodder River Section SSSI and Rough Hey Wood SSSI. As such, the designations are not considered sensitive to changes in pollutant

levels. A screening conclusion of no likely significant effect on these sites as a result of the project alone and in-combination can therefore be reached with regard to air quality impacts.

3.3.16 Critical levels and loads have been defined for qualifying features present in the remaining designations. As such, these are considered sensitive to air pollution and the assessment proceeded to Step 3.

3.4 Step 3

3.4.1 The identified ecological sites contain features sensitive to changes in atmospheric pollution levels. For the purpose of Stage 1: Screening and in order to provide a worst-case assessment, it was assumed that the most sensitive feature of each designation is located at the boundary closest to the project as this is the area where impacts are most likely. Discrete receptors were subsequently defined to represent these locations. These are shown in Table 13.

Table 13 Discrete Receptor Locations

Receptor		NGR (m)	
		X	Y
E1	Bowland Fells SPA, Bowland Fells SSSI	354662.9	446628.3
E2	Bowland Fells SPA, Bowland Fells SSSI	355943.7	447121.9
E3	Bowland Fells SPA, Bowland Fells SSSI	357171.2	447388.8
E4	Bowland Fells SPA, Bowland Fells SSSI	359666.1	444466.9
E5	Bowland Fells SPA, Bowland Fells SSSI	361253.8	445587.6
E6	Bowland Fells SPA, Bowland Fells SSSI	362307.8	446281.4
E7	Bowland Fells SPA, Bowland Fells SSSI	363255.1	447028.5
E8	Red Scar and Tun Brook Woods SSSI	359059.6	434156.9
E9	Red Scar and Tun Brook Woods SSSI	358417.1	432166.2
E10	Red Scar and Tun Brook Woods SSSI	357822.4	431319.6

3.4.2 The relevant features and nitrogen deposition critical loads for the identified receptors are presented Table 14.

Table 14 Features and Critical Loads for Nitrogen Deposition

Ecological Receptor		Feature	Relevant Nitrogen Critical Load Class	Critical Load (kgN/ha/yr)	
				Low	High
E1 - E7	Bowland Fells SPA, Bowland Fells SSSI	Calluna Vulgaris - Deschampsia Flexuosa Heath	Dry heaths	5	15
E8 - E10	Red Scar and Tun Brook Woods SSSI	Alnus glutinosa - Carex paniculata Woodland	Broadleaved deciduous woodland	10	20

3.4.3 The relevant features and acid deposition critical loads for the identified receptors are presented in Table 15.

Table 15 Features and Critical Loads for Acid Deposition

Ecological Receptor		Feature	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
				CLMinN	CLMaxS	CLMaxN
E1 - E7	Bowland Fells SPA, Bowland Fells SSSI	Calluna Vulgaris - Deschampsia Flexuosa Heath	Dwarf shrub heath	0.642	0.180	0.822
E8 - E10	Red Scar and Tun Brook Woods SSSI	Fraxinus Excelsior - Sorbus Aucuparia - Mercurialis Perennis Woodland	Unmanaged Broadleafed/ Coniferous Woodland	0.142	1.446	1.707

3.4.4 The relevant features and critical levels for NH_3 for the identified receptors are summarised in Table 16.

Table 16 Features and Critical Levels for NH_3

Ecological Receptor		Feature	Critical Level for NH_3 ($\mu g/m^3$)
E1 - E7	Bowland Fells SPA, Bowland Fells SSSI	Calluna Vulgaris - Deschampsia Flexuosa Heath	1
E8 - E10	Red Scar and Tun Brook Woods	Alnus glutinosa - Carex paniculata Woodland	1

3.4.5 A review of the relevant data indicated the qualifying features within the identified designations could be exposed to emissions as a worst-case. As such, a screening conclusion of no likely significant effects on the sites could not be reached with regard to air quality and the assessment proceeded to Step 4.

3.5 Step 4a

3.5.1 Dispersion modelling was undertaken in order to quantify the predicted PC as a result of the project alone as a proportion of the relevant critical load or level at each receptor with subsequent comparison against the screening threshold. Reference should be made to Appendix 1 for the dispersion modelling inputs.

3.5.2 Predicted annual nitrogen deposition rates are summarised in Table 17.

Table 17 Predicted Annual Nitrogen Deposition - Project Alone

Receptor		Predicted Annual Nitrogen Deposition PC (kgN/ha/yr)	PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.007	0.13
E2	Bowland Fells SPA, Bowland Fells SSSI	0.007	0.13
E3	Bowland Fells SPA, Bowland Fells SSSI	0.007	0.14
E4	Bowland Fells SPA, Bowland Fells SSSI	0.017	0.35
E5	Bowland Fells SPA, Bowland Fells SSSI	0.010	0.19
E6	Bowland Fells SPA, Bowland Fells SSSI	0.005	0.11
E7	Bowland Fells SPA, Bowland Fells SSSI	0.004	0.08
E8	Red Scar and Tun Brook Woods SSSI	0.013	0.13
E9	Red Scar and Tun Brook Woods SSSI	0.007	0.07
E10	Red Scar and Tun Brook Woods SSSI	0.006	0.06

3.5.3 As shown in Table 17, the predicted PC was below 1% of the critical load at all receptors. As such, a screening conclusion of no likely significant effect as a result of the project alone can be reached with regard to nitrogen deposition on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and,
- Red Scar and Tun Brook Woods SSSI.

3.5.4 Predicted annual acid deposition rates are summarised in Table 18.

Table 18 Predicted Annual Acid Deposition - Project Alone

Receptor		Predicted Annual Acid Deposition PC (keq/ha/yr)	PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.0005	0.06
E2	Bowland Fells SPA, Bowland Fells SSSI	0.0005	0.06
E3	Bowland Fells SPA, Bowland Fells SSSI	0.0005	0.06
E4	Bowland Fells SPA, Bowland Fells SSSI	0.0012	0.15
E5	Bowland Fells SPA, Bowland Fells SSSI	0.0007	0.08
E6	Bowland Fells SPA, Bowland Fells SSSI	0.0004	0.05
E7	Bowland Fells SPA, Bowland Fells SSSI	0.0003	0.03
E8	Red Scar and Tun Brook Woods SSSI	0.0009	0.05
E9	Red Scar and Tun Brook Woods SSSI	0.0005	0.03
E10	Red Scar and Tun Brook Woods SSSI	0.0005	0.03

3.5.5 As shown in Table 18, the predicted PC was below 1% of the critical load at all receptors. As such, a screening conclusion of no likely significant effect as a result of the project alone can be reached with regard to acid deposition on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and,
- Red Scar and Tun Brook Woods SSSI.

3.5.6 Predicted annual mean NH_3 concentrations are summarised in Table 19.

Table 19 Predicted Annual Mean NH_3 Concentrations - Project Alone

Receptor		Predicted Annual Mean NH_3 PC Concentration ($\mu g/m^3$)	PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.0013	0.13
E2	Bowland Fells SPA, Bowland Fells SSSI	0.0013	0.13
E3	Bowland Fells SPA, Bowland Fells SSSI	0.0014	0.14
E4	Bowland Fells SPA, Bowland Fells SSSI	0.0033	0.33
E5	Bowland Fells SPA, Bowland Fells SSSI	0.0018	0.18
E6	Bowland Fells SPA, Bowland Fells SSSI	0.0010	0.10
E7	Bowland Fells SPA, Bowland Fells SSSI	0.0008	0.08
E8	Red Scar and Tun Brook Woods SSSI	0.0016	0.16
E9	Red Scar and Tun Brook Woods SSSI	0.0010	0.10
E10	Red Scar and Tun Brook Woods SSSI	0.0008	0.08

3.5.7 As shown in Table 19, the predicted PC was below 1% of the relevant critical level at all receptor positions. As such, a screening conclusion of no likely significant effect as a result of the project alone can be reached with regard to annual mean NH_3 concentrations on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and,
- Red Scar and Tun Brook Woods SSSI.

3.6 Step 4b

3.6.1 Step 4b requires consideration of potential effects in-combination with other plans or projects. A review of the following information sources was therefore undertaken in order to identify any schemes that may act in-combination, as required by NE guidance[9]:

[9] Natural England's approach to advising competent authorities on the assessment of road traffic emissions under the Habitats Regulations, NE, 2018.

- Planning Portals to locate applications awaiting permissions;
- Environmental Permits Register of Applications and Register of Issued Permits; and,
- Local Plans (including brownfield registers with permission in principle) and any allocations not yet permitted.

3.6.2 A review of planning applications submitted since 2020 was undertaken to identify the following projects within 10km of the site:

- Any agricultural proposals; and,
- Any industrial proposals with associated NH_3 emissions.

3.6.3 A review of the Environmental Permit register[10] was also undertaken in order to identify the following projects within 10km of the site which had received an Environmental Permit or Variation since 2020:

- Any intensive agricultural proposals; and,
- Any industrial proposals with associated NH_3 emissions;

3.6.4 Additionally, review of the site allocations in the relevant Local Plan was undertaken in order to identify any further proposals potentially coming forward within the relevant plan period.

3.6.5 It should be noted that a review period of 2020 onwards was selected to correlate with the latest background pollution data information available from APIS.

3.6.6 A review of the above identified the following proposal for consideration in the assessment:

- Ribble Valley Borough Council reference: 3/2020/0589 - Construction of a steel portal framed building for housing and feeding of cattle;
- Ribble Valley Borough Council reference: 3/2023/0021 - Proposed engineering works to form an earth-banked, clay-lined slurry lagoon;
- Preston City Council reference: 06/2021/1509 - Agricultural livestock building (part retrospective);

[10] https://environment.data.gov.uk/public-register/view/index.

- Preston City Council reference: 06/2022/0441- Agricultural livestock building (part retrospective);
- Wyre Borough Council reference: 20/00996/FULMAJ - Proposed erection of an agricultural livestock building (cattle housing) & access track (phase 1-4);
- Wyre Borough Council reference: 21/00976/FUL - Erection of one new agricultural livestock building;
- Wyre Borough Council reference: 22/00316/FULMAJ slurry tank - Erection of a cylindrical concrete slurry store (re-submission of application 21/01026/FULMAJ); and,
- South Ribble Borough Council reference: 07/2023/00044/FUL - Earth bank slurry lagoon and associated works.

3.6.7 Dispersion modelling of the above sources was undertaken in order to derive in-combination PCs. These values were subsequently compared against the relevant screening threshold.

3.6.8 Predicted annual nitrogen deposition rates are summarised in Table 20.

Table 20 Predicted Annual Mean Nitrogen Deposition - Project In-Combination

Receptor		Predicted Annual Nitrogen Deposition In-Combination PC (kgN/ha/yr)	In-Combination PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.009	0.18
E2	Bowland Fells SPA, Bowland Fells SSSI	0.008	0.17
E3	Bowland Fells SPA, Bowland Fells SSSI	0.009	0.18
E4	Bowland Fells SPA, Bowland Fells SSSI	0.020	0.40
E5	Bowland Fells SPA, Bowland Fells SSSI	0.012	0.24
E6	Bowland Fells SPA, Bowland Fells SSSI	0.007	0.15
E7	Bowland Fells SPA, Bowland Fells SSSI	0.006	0.11
E8	Red Scar and Tun Brook Woods SSSI	0.026	0.26
E9	Red Scar and Tun Brook Woods SSSI	0.035	0.35
E10	Red Scar and Tun Brook Woods SSSI	0.028	0.28

3.6.9 As shown in Table 20, the predicted in-combination PC was below 1% of the critical load at all receptors. As such, a screening conclusion of no likely significant effect as a result of the project in-combination can be reached with regard to nitrogen deposition on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and
- Red Scar and Tun Brook Woods SSSI.

3.6.10 Predicted annual acid deposition rates are summarised Table 21.

Table 21 Predicted Annual Acid Deposition - Project In-Combination

Receptor		Predicted Annual Acid Deposition In-Combination PC (keq/ha/yr)	In-Combination PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.0006	0.08
E2	Bowland Fells SPA, Bowland Fells SSSI	0.0006	0.07
E3	Bowland Fells SPA, Bowland Fells SSSI	0.0006	0.08
E4	Bowland Fells SPA, Bowland Fells SSSI	0.0014	0.17
E5	Bowland Fells SPA, Bowland Fells SSSI	0.0008	0.10
E6	Bowland Fells SPA, Bowland Fells SSSI	0.0005	0.06
E7	Bowland Fells SPA, Bowland Fells SSSI	0.0004	0.05
E8	Red Scar and Tun Brook Woods SSSI	0.0019	0.11
E9	Red Scar and Tun Brook Woods SSSI	0.0025	0.14
E10	Red Scar and Tun Brook Woods SSSI	0.0020	0.12

3.6.11 As shown in Table 21, the predicted in-combination PC was below 1% of the critical load at all receptors. As such, a screening conclusion of no likely significant effect as a result of the project in-combination can be reached with regard to acid deposition on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and,

- Red Scar and Tun Brook Woods SSSI.

3.6.12 Predicted annual mean NH_3 concentrations are summarised Table 22.

Table 22 Predicted Annual Mean NH_3 Concentrations - Project In-Combination

Receptor		Predicted Annual Mean NH_3 In-Combination PC Concentration ($\mu g/m^3$)	In-Combination PC as Prop. of CL (%)
E1	Bowland Fells SPA, Bowland Fells SSSI	0.0017	0.17
E2	Bowland Fells SPA, Bowland Fells SSSI	0.0016	0.16
E3	Bowland Fells SPA, Bowland Fells SSSI	0.0017	0.17
E4	Bowland Fells SPA, Bowland Fells SSSI	0.0039	0.39
E5	Bowland Fells SPA, Bowland Fells SSSI	0.0023	0.23
E6	Bowland Fells SPA, Bowland Fells SSSI	0.0014	0.14
E7	Bowland Fells SPA, Bowland Fells SSSI	0.0011	0.11
E8	Red Scar and Tun Brook Woods SSSI	0.0034	0.34
E9	Red Scar and Tun Brook Woods SSSI	0.0044	0.44
E10	Red Scar and Tun Brook Woods SSSI	0.0036	0.36

3.6.13 As shown in Table 22, the predicted in-combination PC was below 1% of the relevant critical level at all receptor positions. As such, a screening conclusion of no likely significant effect as a result of the project in-combination can be reached with regard to annual mean NH_3 concentrations on the following designations:

- Bowland Fells SPA;
- Bowland Fells SSSI; and,
- Red Scar and Tun Brook Woods SSSI.

3.7 Summary

3.7.1 The results of Stage 1: Screening can be summarised as follows:

- Five ecological designations were identified that may be affected by emissions from the project;
- Of the identified designations, three have features that are considered sensitive to changes in air quality. As such, these were progressed to Step 3 of the assessment;
- The remaining two designations, Hodder River Section SSSI and Rough Hey Wood SSSI, are not considered sensitive to changes in atmospheric pollutant levels. A screening conclusion of no likely significant effect on these sites as a result of the project alone and in-combination was therefore reached with regard to air quality impacts; and,
- Dispersion modelling was undertaken to determine PCs as a result of the project alone and in-combination at discrete receptor positions in the remaining designations. The results indicated that a screening conclusion of no likely significant effect could be reached with regard to nitrogen and acid deposition and annual mean NH_3 concentrations on Bowland Fells SPA, Bowland Fells SSSI and Red Scar and Tun Brook Woods SSSI.

3.7.2 As shown above, a screening conclusion of no likely significant effect as a result of the project could be reached for all designations. As such, a Stage 2: Appropriate Assessment was not required.

4.0 CONCLUSION

4.1.1 Redmore Environmental Ltd was commissioned by Stanworth Agricultural Ltd to undertake an Ammonia Assessment in support of an agricultural development on land at Blackmoss Farm, Chipping.

4.1.2 The proposals have the potential to cause changes in pollution levels at sensitive ecological locations as a result of NH_3 emissions associated with the project. An Ammonia Assessment was therefore undertaken in order to determine baseline conditions and assess potential effects.

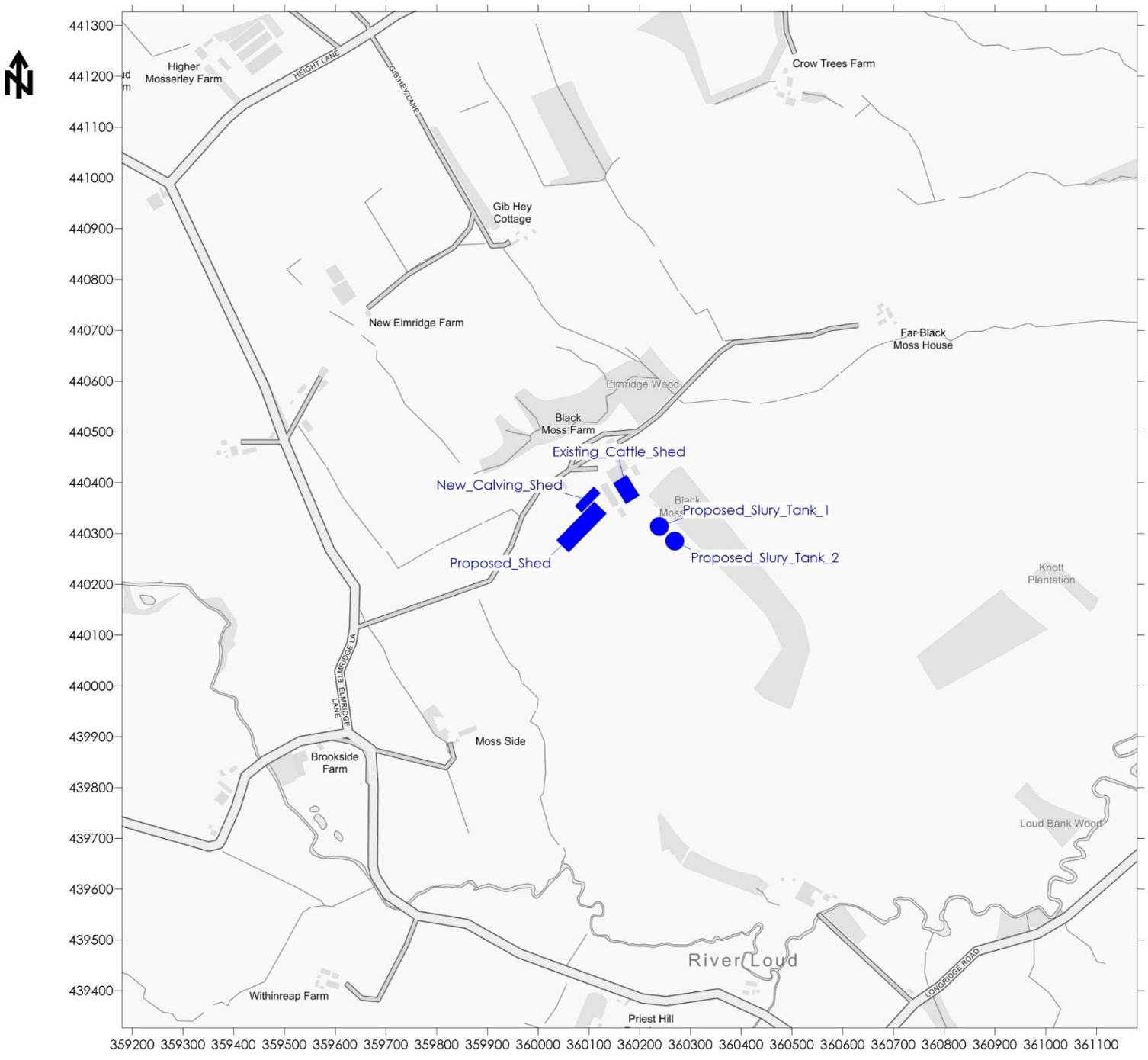
4.1.3 A staged assessment was undertaken with reference to relevant NE guidance. This considered emissions from the project alone and in-combination with other plans and projects.

4.1.4 The results of the assessment indicated a screening conclusion of no likely significant effect as a result of the project in relation to nitrogen and acid deposition and annual mean NH_3 concentrations both alone and in-combination could be reached for Bowland Fells SPA, Bowland Fells SSSI, Red Scar and Tun Brook Woods SSSI, Hodder River Section SSSI and Rough Hey Wood SSSI. As such, a Stage 2: Appropriate Assessment was not required.

5.0 ABBREVIATIONS

APIS	Air Pollution Information System
CERC	Cambridge Environmental Research Consultants
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
HRA	Habitats Regulations Assessment
NE	Natural England
NGR	National Grid Reference
NH_3	Ammonia
PC	Predicted contribution
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest

Figures



Legend

Emission Source

Title
Figure 1 - Proposed Site Layout

Project
Ammonia Assessment
Blackmoss Farm, Chipping

Project Reference
6499

Client
Stanworth Agricultural Ltd

Contains Ordnance Survey Data
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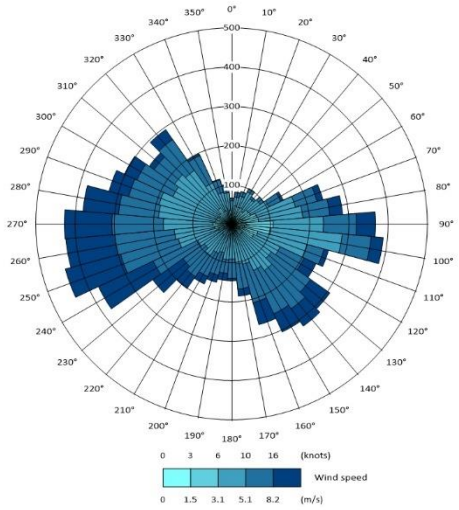
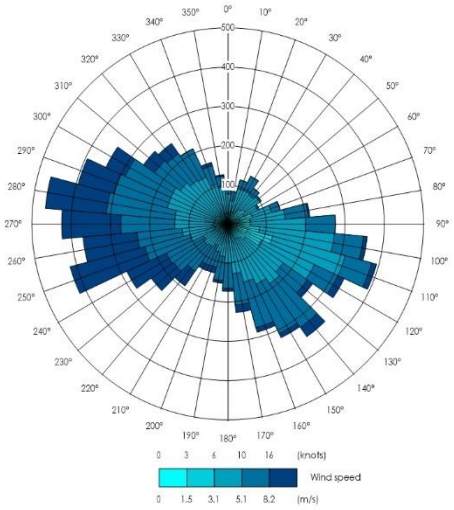
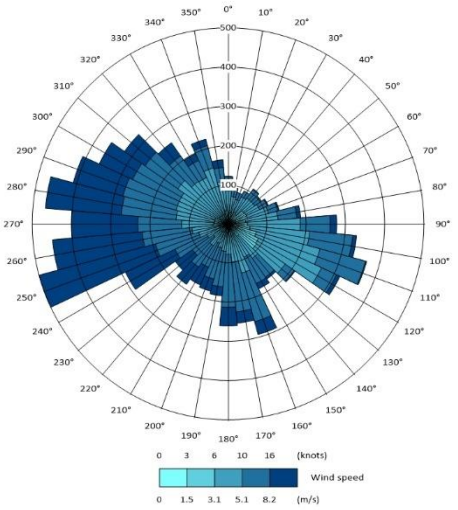


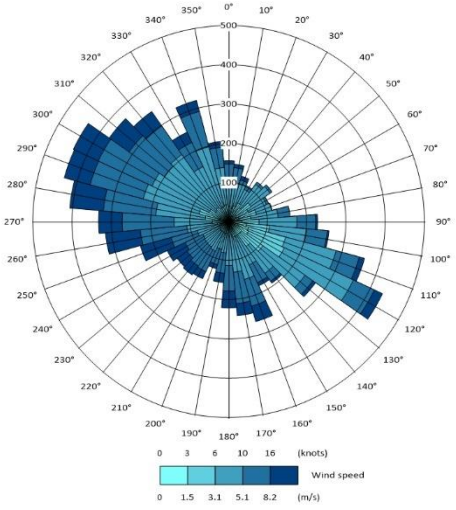
2018 Meteorological Data



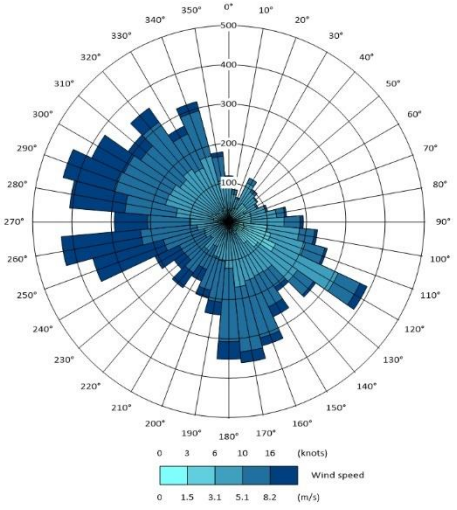
2019 Meteorological Data



2020 Meteorological Data



2021 Meteorological Data



2022 Meteorological Data

Title
Figure 2 - Wind Roses of 2018 to 2022 Blackpool Airport Meteorological Data

Project
Ammonia Assessment
Blackmoss Farm, Chipping

Project Reference
6499

Client
Stanworth Agricultural Ltd

Redmore environmental
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Appendix 1 - Assessment Input Data

Dispersion Model

Dispersion modelling was undertaken using ADMS-6. ADMS-6 is developed by Cambridge Environmental Research Consultants (CERC) and is routinely used throughout the world for the prediction of pollutant dispersion from agricultural sources. Modelling predictions from this software package are accepted within the UK by the EA and DEFRA.

Modelling Scenarios

Potential impacts have been defined by predicting nitrogen and acid deposition rates and NH_3 concentrations using dispersion modelling for the following scenarios:

- Project alone - Pollutant levels as a result of emissions from the proposed and existing livestock sheds and slurry tanks; and,
- Project in-combination - Pollutant levels as a result of emissions from the proposed and existing livestock sheds and slurry tanks, as well as other relevant plans and projects within the vicinity of the site.

Process Conditions and Emissions - Project Alone

Livestock Sheds

Releases from the existing and proposed livestock sheds were calculated by multiplying the relevant emission rates provided within the DEFRA document 'Inventory of Ammonia Emissions from UK Agriculture'[11] by the number of housed cattle. The results are summarised in Table A1.1.

Table A1.1 Project Alone NH_3 Emission Rate - Livestock Sheds

Parameter	Unit	Proposed Shed	Existing Shed	Existing Calving Shed
Housing system	-	Slurry based system	Slurry based system	Slurry based system
Number of cattle	-	308	105	105
NH_3-N emission rate	kg/head/annum	9.7	9.7	9.7

[11] Inventory of Ammonia Emissions from UK Agriculture, DEFRA, 2020.

Parameter	Unit	Proposed Shed	Existing Shed	Existing Calving Shed
NH_3 emission rate	kg/annum	2,987.60	1,018.50	1,018.50
NH_3 emission rate	g/s	0.0947	0.0323	0.0323

The data shown in Table A1.1 was utilised with additional information provided by the Applicant to define emissions within the model. A summary of the inputs is provided in Table A1.2.

Table A1.2 Project Alone Model Inputs - Livestock Sheds

Parameter	Unit	Proposed Shed	Existing Shed	Existing Calving Shed
Source type	-	Volume	Volume	Volume
Source length	m	106.6	52.80	30.5
Source width	m	33.5	18.20	47.4
Source depth	m	7.0	7.1	8.0
Source area	m^2	3565.20	968.75	1457.5
Source volume	m^3	24,956	6,878	11,660
Emission temperature	°C	Ambient	Ambient	Ambient
Total NH_3 emission rate	g/s	0.0947	0.0323	0.0185
Volume specific NH_3 emission rate	$g/m^3/s$	0.00000380	0.00000470	0.00000277

Slurry Tanks

An emission rate for use in the assessment was obtained from the DEFRA document 'Inventory of Ammonia Emissions from UK Agriculture'[12]. The relevant model input data for the proposed slurry tankx is summarised in Table A1.3.

[12] Inventory of Ammonia Emissions from UK Agriculture, DEFRA, 2020.

Table A1.3 Project Alone Model Inputs - Slurry Tanks

Parameter	Unit	Slurry Tank 1	Slurry Tank 2
Source type	-	Area	Area
Source area	m^2	1,023.2	1,023.2
Source temperature	°C	Ambient	Ambient
NH_3-N emission rate	$g/m^2/day$	4.2	4.2
NH_3 emission rate	$g/m^2/day$	0.84	0.84
NH_3 emission rate	$g/m^2/s$	0.000010	0.000010

Reference should be made to Figure 1 for a map of the emission source locations.

Process Conditions and Emissions - Project In-Combination

Releases from the identified in-combination projects were derived from information provided in the relevant planning applications and library emission rates from DEFRA or Natural Resources Wales. Model inputs for livestock sheds are summarised in Table A1.4.

Table A1.4 Project In-Combination NH_3 Emission Rates - Livestock Sheds

Parameter	Unit	3/2020/0589	06/2022/0441	20/00996/FULM	21/00976/FUL	06/2021/1509
Livestock type	-	Dairy cattle	Young calves	Dairy cattle	Young calves	Ewes
Number of livestock	-	30	100	100	50	80
NH_3 emission rate	g/s	0.0092	0.0029	0.0308	0.0014	0.00004
Source volume	m^3	7,680	6,903	8,319	6,903	8,319
Volume specific NH_3 emission rate	$g/m^3/s$	0.000001202	0.000000413	0.000003698	0.000004456	0.000000005

Model inputs for slurry storage are summarised in Table A1.5.

Table A1.5 Project In-Combination Model Inputs - Slurry Storage

Parameter	Unit	3/2023/0021	22/00316/FULMAJ	07/2023/00044/FUL
Source area	m^2	1,444.0	1,256.6	875.0
NH_3 emission rate	$g/m^2/day$	4.2	4.2	4.2
Factored NH_3 emission rate[(a)]	$g/m^2/day$	1.68	1.68	4.2
NH_3 emission rate	$g/m^2/s$	0.000019	0.000019	0.000049

NOTE: (a) Factored based on information from DEFRA to reflect store covering arrangements.

Terrain Data

Ordnance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC[13].

Meteorological Data

Meteorological data used in the assessment was taken from Blackpool Airport meteorological station over the period 1st January 2018 to 31st December 2022 (inclusive). Blackpool Airport meteorological station is located at NGR: 332308, 430915, which is approximately 29.7km south-west of the farm.

All meteorological files used in the assessment were provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 2 for wind roses of utilised meteorological records.

Roughness Length

The surface roughness (z_0) is a modelling parameter applied to allow consideration of surface height roughness elements. A z_0 of 0.2m was used to describe the modelling extents. This is considered appropriate for the morphology of the area and is suggested within ADMS-5 as being suitable for 'agricultural areas (min)'.

13 Note 105: Setting up Terrain Data for Input to CERC Models, CERC, 2016.

A z_0 of 0.1m was used to describe the modelling extents. This is considered appropriate for the morphology of the area and is suggested within ADMS-5 as being suitable for 'root crops'.

Monin-Obukhov Length

The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 1m was used to describe the modelling extents. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for a 'rural area'.

A minimum Monin-Obukhov length of 30m was used to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'mixed urban/ industrial'.

Deposition

Nitrogen deposition rates were calculated using the conversion factors provided within EA document 'Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06'[14]. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used for the determination of nitrogen deposition are presented within Table A1.6.

Table A1.6 Conversion Factors to Determine Dry Deposition Flux for Nitrogen Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to kg/ha/yr of pollutant species)
	Grassland	Forest	
NH_3	0.020	0.030	260

The relevant deposition velocity for each ecological receptor was selected from Table A1.6 based on the vegetation type of the qualifying feature.

[14] Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06, EA, 2014.

Predicted ground level NH_3 concentrations were converted to kilo-equivalent ion depositions (keq/ha/yr) for comparison with the critical load for acid deposition at each of the identified ecological receptors. The conversion to units of equivalents, a measure of the potential acidifying effect of a species, was undertaken using the standard conversion factors shown in Table A1.7.

Table A1.7 Conversion Factors to Determine Dry Deposition Flux for Acid Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m²/s to keq/ha/yr of pollutant species)
	Grassland	Forest	
NH_3	0.02	0.03	18.5

The following formula was used to calculate predicted PCs as a proportion of the critical load function:

PC as %CL function = ((PC of N deposition)/CLmaxN) x 100

The above formula was obtained from the APIS website[15].

Scientific literature suggests that the dry deposition velocity of NH_3 is concentration dependent and is significantly reduced at high concentrations, i.e. from 0.02m/s to 0.03m/s at ambient concentration down to approximately 0.003m/s at a long-term average over 80µg/m^3 [16] [17]. When the concentration dependence of the deposition velocity is considered, the reported cumulative depletion ratio (the ratio of NH_3 deposited to the total emitted) was about 10% at 500m to 1,000m downwind[18] [19].

15 http://www.apis.ac.uk/.

16 Walker J, Spence P, Kimbrough S and Robarge W, 2008. Inferential model estimates of ammonia dry deposition in the vicinity of a swine production facility. Atmospheric Environment 42, 3407-3418.

17 Cape JN, Jones MR, Leith ID, Sheppard LJ, van Dijk N, Sutton MA, Fowler D, Estimate of annual NH3 dry deposition to a fumigated ombrotrophic bog using concentration-dependant deposition velocities. Atmospheric Environment 42 (2008) 6637-6646.

18 Walker J, Spence P, Kimbrough S and Robarge W, 2008. Inferential model estimates of ammonia dry deposition in the vicinity of a swine production facility. Atmospheric Environment 42, 3407-3418.

19 Cape JN, Jones MR, Leith ID, Sheppard LJ, van Dijk N, Sutton MA, Fowler D, Estimate of annual NH3 dry deposition to a fumigated ombrotrophic bog using concentration-dependant deposition velocities. Atmospheric Environment 42 (2008) 6637-6646.

In order to represent the above within the model, the variable concentration dependent deposition velocity function within ADMS-5 was engaged, as outlined within EA guidance[20]. This utilised predicted annual mean NH_3 concentrations to determine location specific deposition velocities throughout the assessment extents for inclusion within the final model.

[20] Guidance on Modelling the Concentration and Deposition of Ammonia Emitted from Intensive Farming, EA, 2010.