

APP/L2250/V/10/2131934 & APP/L2250/V/10/2131936

SECTION 77 TOWN AND COUNTRY PLANNING ACT 1990 – REFERENCE OF APPLICATIONS TO THE SECRETARY OF STATE FOR COMMUNITIES AND LOCAL GOVERNMENT

TOWN AND COUNTRY PLANNING (INQUIRIES PROCEDURE) (ENGLAND) RULES 2000

**REBUTTAL
PROOF OF EVIDENCE OF
DR. BETHAN TUCKETT-JONES PhD CEnv MIAQM
AIR QUALITY**

In respect of:

Planning Application Reference: Y06/1647/SH (New Terminal Building)

Planning Application Reference: Y06/1648/SH (Runway Extension)

relating to land at London Ashford Airport, Lydd, Romney Marsh, Kent, TN29 9QL



This Proof of Evidence is presented in the following documents:

LAA/8/A Proof of Evidence

LAA/8/B Summary

LAA/8/C Appendices

LAA/8/D **Rebuttal**

CONTENTS

	Page
1 INTRODUCTION	1
1.1 SCOPE OF REBUTTAL	1
2 REBUTTAL RESPONSES	2
2.1 PROOF OF EVIDENCE OF JO DEAR [NE/3] NATURAL ENGLAND	2
2.2 KENT WILDLIFE TRUST (EVIDENCE OF RICHARD MOYES, KWT/3)	15
2.3 CAMPAIGN TO PROTECT RURAL ENGLAND	19
3 CONCLUSIONS	21
3.1 SUMMARY	21

1 INTRODUCTION

1.1 Scope of Rebuttal

1.1.1 My name is Bethan Tuckett-Jones. I have set out my qualifications and experience in my original proof of evidence.

1.1.2 My evidence covers air quality matters in connection with the construction and operation of the proposed runway extension and terminal building for the Airport (the Applications). The proposed developments and the Airport Site are described in the Airport's Statement of Case [CD1.55].

1.1.3 This rebuttal proof of evidence provides a response to certain points raised in relation to air quality in the Proofs of Evidence of Natural England (Jo Dear, NE/3/A), Kent Wildlife Trust (Richard Moyse, KWT/3/B) and the Campaign to Protect Rural England (CPRE/04A-C).

1.1.4 This is not intended to be an exhaustive rebuttal and this document only deals with certain points where it is considered appropriate or helpful to respond in writing at this stage. Where a specific point has not been dealt with, this does not mean that these points are accepted and these other points may be addressed at the Inquiry.

2 REBUTTAL RESPONSES

2.1 Proof of Evidence of Jo Dear [NE/3] Natural England

Introduction

2.1.1 Natural England were consulted on the Applications and initially expressed the view that the proposals were likely to have significant effects on the interest features of the designated sites due to a deterioration in air quality.

2.1.2 However, by letter dated 11th February 2011, Natural England have confirmed that they accept “*that nitrogen deposition arising as a result of the proposals is unlikely to affect the integrity of the SAC in relation to the important vegetation communities occurring as part of the vegetated shingle in the SAC*” and “*is not likely significantly to damage the same in the SSSI*”. Furthermore, they have stated that, subject to the conclusion of discussions between the air quality experts, they expect that any *potential* effects on the vegetated shingle within the conservation sites could be addressed by way of condition.

2.1.3 Notwithstanding this position, I note that in her evidence Jo Dear continues to express concern relating to air quality matters and makes particular reference to the conclusions of the independent analysis of the Applicant’s assessment of nitrogen deposition undertaken by Atkins on behalf of Natural England [Appendix 10, NE/3/C]. Given the statement by Natural England, it is apparent that these concerns are not in fact directed at the principle of the development and the grant of planning permission, but given that they are still expressed in the written proof of evidence I address them below for the sake of completeness.

Evidence of Jo Dear NE3/A

2.1.4 Jo Dear asserts in her proof of evidence that “*The operation of the expanded Airport has the potential to significantly affect the vegetated shingle communities in the SAC and SSSI via increases in local nitrogen emissions*” [Para 287, NE/3/A].

- 2.1.5 However Natural England's official position following review of the available evidence is that the proposals are **unlikely** to affect the integrity of the SAC or to significantly damage the important vegetation communities within the SSSI. The assertion made by Ms Dear as to 'potential effects' appears to be dependent on a presumption of the operation of the Airport **not** remaining within the parameters of the basis on which it has been assessed rather than on a particular concern regarding proposed Airport activities in connection with the proposed development.
- 2.1.6 The Airport growth scenarios and proposed future Airport operations have been set out in detail in the Proofs of Evidence of Mrs Louise Congdon [LAA/4] and Mr Tim Maskens [LAA/3]. The scenarios assessed in the air quality modelling, of both the Applicant's and Natural England's consultants (Atkins), are entirely consistent with the parameters set out in these Proofs. These are the likely operating parameters and it is not necessary or appropriate to address other scenarios in respect of the Applications.
- 2.1.7 Jo Dear also asserts that whilst her expert colleagues at Natural England have judged that the critical load for the Dungeness SAC and SSSI should be 10kgN/ha/yr, there is the potential that, if this site were to be studied specifically to derive a site-specific critical load, it might be found to be more in the range of between 8 and 15 kgN/ha/yr. She further notes that the Applicant has not presented any evidence to date which may resolve this important issue [Para 277, NE/3/A].
- 2.1.8 It is not clear why Ms Dear makes this assertion given that the relevant experts within Natural England have advised that the critical load for Dungeness should be 10kgN/ha/yr and consider this is the standard against which to assess the potential impacts of the Airport on nitrogen deposition, as indeed has been done.
- 2.1.9 My evidence deals with the modelling and assessment of the potential air quality impacts of the Applications against accepted standards, and I have already explained that I have referred to the expertise of others in the setting of an appropriate critical load for the lichen communities at Dungeness.

Notwithstanding this, given what is claimed in respect of the linkage of changes in the lichen communities to air quality impacts, I reproduce in Appendix 1 to this rebuttal a further report, commissioned by the Applicant, on “Nitrogen deposition and its impact on lichen biota at Dungeness”. This report has been prepared by Dr Holger Thüs and Pat Wolseley of the Natural History Museum. Dr Thüs is curator of the lichen collections in the Botany Department at the Museum.

2.1.10 Dr Thüs has analysed the nitrogen content of a variety of lichen species from 15 sites at Dungeness (pursuant to a licence which was obtained from Natural England), both on and off the Airport, to establish whether the current levels of nitrogen deposition are above or below levels which have been shown to affect reindeer lichens or epiphytic species directly, or which induce habitat loss due to changes in the vegetation structure and competition by species. The main indicator species was *Cladonia portentosa*, which was also the species analysed by Remke *et al* (2009) at locations surrounding the Baltic Sea. This latter study was the driver for the recent update to the critical load for stable dune grasslands from 10 - 20 kgN/ha/yr to 8 - 15 kgN/ha/yr referenced by Jo Dear.

2.1.11 Within the *Cladonia portentosa*, the nitrogen content varied from 0.55%N (dry weight) to 0.94%N. At the more northerly sites (D1-D2, D10-D15), the mean concentration was 0.76%N; at the more southerly sites (D3 – D9), the mean concentration was 0.67%N. These existing concentrations are well below the content of 1.3%N suggested as being directly damaging to lichen in a study by Søchting (1995) but higher than the concentrations reported by Remke at which a shift from lichen-rich short vegetation to species-poor vegetation dominated by tall graminoids has been observed around the Baltic. The increase in nitrogen content at the more northerly sample sites is consistent with an increase in nitrogen deposition northwards over the Dungeness peninsula in the mapped data generated by the Centre for Ecology and Hydrology (CEH) and provided by the Air Pollution Information Service (APIS, www.apis.ac.uk).

- 2.1.12 In the report prepared by Dr. B Ferry on behalf of Kent Wildlife Trust [Appendix 9 to NE/3/A], the lichen heath at Dungeness is shown to be well developed, and stable in terms of both spatial extent and species composition over the last 20 years. With reference to this survey and the results of the Remke study, Dr Thüs has concluded that
- “Our measurements of nitrogen contents in long-established and stable lichen heath at Dungeness suggest that a much higher nitrogen deposition can be tolerated at Dungeness compared to other types of acid lowland heath as long as the pH remains low and accumulation of soil is limited”.* [para 4.1, Appendix 1]
- 2.1.13 Therefore taking into account the further analysis and conclusions of Dr. Thüs and the site-specific nature of his study, it is clear that there is no evidence to support Jo Dear’s assertion that the critical load for Dungeness can be inferred from the data collected by Remke on stable dune grasslands. Stable dune grasslands are simply not an appropriate proxy habitat for the assessment of vegetated shingle.
- 2.1.14 Jo Dear also states that she believes that there is a reasonably foreseeable risk that the increase in aircraft and vehicular emissions of nitrogen oxides will contribute to eutrophication which will adversely affect semi-natural ecosystems [Para 251, NE/3/A].
- 2.1.15 In response to this suggestion, I again refer to Natural England’s stated position which sets out that it has concluded that the proposals are **unlikely** to affect the integrity of the SAC or to significantly damage the important vegetation communities within the SSSI. I also refer to the results of the dispersion modelling of the Applicant’s and Natural England’s consultants, both of which demonstrate that no exceedences of the critical load for the vegetated shingle habitat are predicted in the future over the SAC whether or not the airport expansion proceeds. In the absence of exceedence of the critical load for the habitat, and with future deposition levels predicted to be lower than in the recent past whether or not the Airport expansion proceeds, it cannot reasonably be suggested or claimed that there is a foreseeable risk of

a contribution to eutrophication from the development since (amongst other things) no over-fertilisation is predicted to result from either existing or future sources of nitrogen compounds.

- 2.1.16 Jo Dear has also claimed that *“lichen vegetation tends to respond very sensitively to elevated levels of atmospheric nitrogen. This is especially well-documented in epiphytic lichens...”*. Furthermore, she then asserts in the same paragraph that *“As Dr Ferry and I observed when we visited the lichens within the environs of the Airport, these sorts of epiphytic lichen are present and also appear to be in decline”*. [Para 248, NE/3/A]. I note that in his report, Dr Ferry states that *“the communities of epiphytic lichens growing on blackthorn which were surveyed in 2010 already show change (including the loss of Usnea sp.) which is likely to be due to existing N levels”* [para 4.1.9, Appendix 9 to NE/3/A].
- 2.1.17 My evidence deals specifically with the assessment of the potential air quality impacts of the Applications, and I have referred to the relevant expertise of others in relation to a discussion of the details of the lichen communities at Dungeness and I refer again to the report of Dr. Thüs (Appendix 1).
- 2.1.18 At the northern fringe of the vegetated shingle, including the vicinity of the Airport, the epiphytic lichen flora is so far reduced that no species, other than widespread lichens with a moderate to high tolerance to elevated nitrogen levels, are present. The decline in those epiphytic lichens which are regarded as being sensitive to elevated concentrations of sulphur dioxide and nitrogen compounds was documented by Laundon in 1989, when it was noticed that several species on blackthorn which were recorded in the 19th century were not recorded in any survey in the 20th century. This decline continued after 1989, with a further decrease in species numbers being report by Dr. Ferry (2010).
- 2.1.19 Historically higher levels of both sulphur dioxide and nitrogen compounds in ambient air are likely to have contributed to the reduction in sensitive lichens. However, on the basis of past surveys and currently declining deposition

levels, it is simply not possible to conclude that **existing** levels of nitrogen deposition are responsible for the decline in the lichen.

- 2.1.20 Furthermore, in paragraph 4.7 of his report, Dr. Thüs notes that examples of the more sensitive species of epiphytic lichen are still present in the interior of extensive willow and blackthorn thickets near Dungeness Power Station (survey site D9), including *Usnea* sp. which has disappeared from the thickets surveyed by Dr. Ferry. It is important to note that these communities lie approximately 4km south-east of the Airport runway and are, therefore, too distant to be affected by the Applications in any event.
- 2.1.21 Closer to the Airport, Dr. Thüs notes that in Dr Ferry's report there is a significant difference between the blackthorn thickets at Dungeness which are located close to an arable field [thickets 146 – 159] and those at other sites more distant from arable fields [thickets 293 – 301] [para 4.8, Appendix 1]. However, as documented in Dr Thüs's survey, the nitrogen content of the lichen *Evernia prunastri* on the blackthorn at the site near the arable fields is in fact no higher than in samples from shingle in the centre of the Dungeness vegetated shingle. Furthermore, as can be seen from Dr. Ferry's report, another species of lichen, *Lecanora polytropa*, that is generally more frequent on rock surfaces is found only on the blackthorn in the vicinity of the arable fields [thickets 146 – 159].
- 2.1.22 Taken together, these observations contradict Dr Ferry's and Jo Dear's assertions that existing nitrogen levels are the likely cause of the change in the epiphytic lichens. Rather, such changes are consistent with a significant input of nutrient rich (but not necessarily nitrogen-rich) and alkaline particles to the lichen, and dust impregnation, with arable land in the vicinity of the Airport being the main potential emission source.
- 2.1.23 Finally I note that, as reported by Dr. Thüs [para 4.10, Appendix 1], Kirschbaum & Hanewald (2009) have studied epiphytic lichen in the direct vicinity of the airport of Frankfurt/Main (FRA, 51 million passengers in 2009, www.ausbau.fraport.com) and concluded that no impact of the airport emissions could be detected in the lichen communities.

Bethan Tuckett-Jones

- 2.1.24 In summary, therefore, historically higher levels of deposition of both sulphur dioxide and nitrogen compounds have contributed to a decline in sensitive lichen species in the vicinity of the Airport. However, given the slow growing nature of lichen and declining deposition levels, it is not possible to conclude that existing deposition levels are contributing to an ongoing decline.
- 2.1.25 The remaining sensitive communities at Dungeness will be unaffected by the Applications. In any event, the scale of the impact of the Applications is so small that it would not have any material impact, let alone any significant impact, on any potential recovery of the sensitive lichen communities in the vicinity of the Airport if, as predicted, background deposition levels continue to decline.
- 2.1.26 Jo Dear also asserts that the *“Applicant’s assessment has also been found to use a greater reduction in background nitrogen deposition in future years than original stated”* and that the *“Applicant’s consultants have... recognised the limitations of their original work and have agreed to further work in conjunction with our consultants”* [paras 255 – 256, NE/3/A]. _I do not agree with either of these statements.
- 2.1.27 In my December 2009 assessment of nitrogen deposition impacts [CD1.45], as stated in the December 2009 report, I took the site specific background deposition levels for Dungeness SAC from the Air Pollution Information Service (APIS) for the years 2003-2005 and 2010 and used a 2% reduction per annum to project the 2010 values forwards in time. Current practice in estimating future deposition levels is most commonly based on the guidance in the Highways Agency’s Design Manual for Roads and Bridges [CD8.5], which advises that deposition levels should be reduced by 2%, on a straightline basis, from the year 2000. In my December 2009 assessment, in the absence of site-specific data for 2000, I took the 2% reduction per annum to be calculated from the 2003-2005 data. The resulting rate of decrease in deposition per year post 2010 was in fact less than would have been inferred from a continuation of the trend in the APIS site specific data between 2003-2005 and 2010 and could, therefore, be considered to be conservative i.e. tending to over-predict future deposition levels. The reduction in background

deposition levels agreed in the Statement of Common Ground with Natural England, which calculates the 2% reduction per annum from the 2010 deposition levels, is more conservative still.

- 2.1.28 To suggest that I have acknowledged limitations in my original work in agreeing the Statement of Common Ground with Natural England is misleading and wrong. I have merely acknowledged that it is possible to make alternative assumptions relating to the future projection of nitrogen deposition levels and that the modelling employed by me used many worst case assumptions.
- 2.1.29 The use of agreed alternative assumptions relating to future deposition levels has had no impact on the conclusions of the December 2009 report, namely that the impacts of the expansion of the Airport on air quality will be negligible. The agreed reduction in nitrogen deposition over time in the Statement of Common Ground is more conservative than the original assumption made for the December 2009 report but remains consistent with my assertion that the results of the dispersion modelling are conservative and that actual impacts are likely to be lower than predicted.
- 2.1.30 Therefore, contrary to the assertion in Jo Dear's Proof, the reappraisal of the model assumptions that was undertaken during discussions with Natural England's consultants have not served to emphasise any limitations in the December 2009 assessment, but merely confirm that the assessment was robust in terms of its conclusions.
- 2.1.31 Jo Dear also claims that "*uncertainty remains in the conclusion of no adverse effect reached by the Applicant*" and that "*it cannot be said that no reasonable scientific doubt remains as to the absence of such effects*" [para 292 – 293, NE/3/A].
- 2.1.32 I strongly disagree. In fact the position is that there are in fact no significant effects which have been identified which would make it necessary to consider the issue of adverse effects on the integrity of the SAC. But in addition there is no reasonable scientific doubt as to the absence of effects on the integrity of the Dungeness SAC following expansion of the Airport.

- 2.1.33 As set out in Section 5.5 of my Proof of Evidence, my assessment concluded that, in the Dungeness SAC, the expansion of the Airport to cater for 500,000ppa would result in a maximum increase of 0.2kgN/ha/yr in relation to future baseline scenarios with no development of the Airport. This equates to just 2% of the critical load for vegetated shingle of 10kgN/ha/yr. The area of the SAC over which deposition increases by more than 1% of the critical load is less than 1% of the area of the SAC. Any effects of the expansion of the Airport will be insignificant, but in addition any effect on the designated site would be negligible and therefore could not affect the integrity of the designated site in any event. I also note that this was the conclusion reached in the assessment carried out by Shepway District Council
- 2.1.34 Experts within Natural England have concluded that, taking into account the most recent data available, the appropriate critical load for Dungeness was 10kgN/ha/yr. Moreover, the study by Dr. Thüs of the Natural History Museum has clearly demonstrated that there is no reason to suggest that the critical load for vegetated shingle should be lower than 10kgN/ha/yr (Appendix 1). Furthermore, Natural England's air quality consultants, Atkins, agreed appropriate baseline and future baseline nitrogen depositions and, in the conclusions to their modelling report have stated that "*There are a number of worst case assumptions or methodologies included in the assessment of the airport proposals, such that the final results are on a precautionary basis*" and that "*In the SAC, the proposals would not result in an exceedence of the critical load under any scenario*".
- 2.1.35 Taking into consideration these observations and, as set out in paragraph 2.1.2 above, Natural England's stated position in relation to nitrogen deposition impacts, I find it surprising that Jo Dear continues to express concern about the potential effects of nitrogen deposition from the operation of the expanded Airport on the vegetation communities on the shingle as this is at odds with the evidence and Natural England's stated position.
- 2.1.36 Notwithstanding this, I note that Jo Dear herself considers that a conclusion of no adverse effect on site integrity can be reached with the agreement of planning conditions. The Applicants are committed to working with Natural

England to agree suitable conditions and Section 106 provisions anyway (regardless of the points I have made above). At the time of writing, discussions are ongoing with Natural England's consultants, Atkins.

Atkins Summary of Finding (Appendix 10 to NE/3)

- 2.1.37 Atkins suggested that the minimum Monin-Obukhov length used in the Applicant's modelling of the Airport is inappropriate, and that no-predetermined minimum Monin-Obukhov length scale should be applied for the modelling of impacts over the SAC [Section 3.4.1]
- 2.1.38 The Monin-Obukhov length is a parameter, with the dimension of length, that gives a relation between parameters characterising dynamic, thermal, and buoyant processes in the atmospheric boundary layer. It is of the order of one to tens of meters.
- 2.1.39 In stable atmospheric conditions, which typically occur during clear nights with low wind speeds, the length scale is a small positive number. Under these conditions, it can be equated to the height within the atmospheric boundary layer at which there is a balance between the effects of the generation of turbulence resulting from air flowing over a 'rough' surface and the turbulence-suppressing effects of the cooling of the atmosphere by contact with a cold surface. At heights in the boundary layer greater than the Monin-Obukhov length scale, turbulence in the atmosphere is very weak and the dispersion of pollutants is suppressed.
- 2.1.40 The ADMS 4 User Guide (a sister program to the ADMS Airports model, with the same meteorological data processor) states that in rural areas, in very stable conditions, the value of the Monin-Obukhov length would typically be 2 to 20m. Setting a minimum Monin-Obukhov length effectively limits the formation of very stable conditions and the conditions under which, for ground level pollutant releases, maximum pollutant concentrations occur. It is typically used to allow for the effect of heat production in towns and cities, but could equally be applied where for other reasons very stable conditions are considered unlikely. The value selected in the Applicant's modelling is 10m, which is representative of small towns with a population less than 50,000.

Bethan Tuckett-Jones

2.1.41 Atkins re-ran the Applicant's modelling using no predetermined Monin-Obukhov length, which effectively sets a 1m minimum length scale, and found that reducing the specified minimum length scale increased the maximum predicted nitrogen deposition over the SAC in relation to the data presented by the Applicant. However, as set out below, there are a number of reasons why such modelling is fundamentally too conservative for the Airport including (in particular)

- The limitations on nighttime flying that would exist.
- The limited potential for the formation of stable conditions in the relatively windy conditions of the Dungeness peninsula
- The limited potential for the formation of very stable conditions due to the low potential for the pooling of cool, dense, air.

2.1.42 Stable conditions occur most frequently during the night time but, under the Applications, limits will be placed on flying hours such that aircraft movements will be limited to the hours between 0700 and 2300. This operational limit has not been taken into account explicitly in the dispersion modelling of either Atkins or the Applicants i.e. emissions from aircraft and airport activities are assumed to occur continuously throughout the day and night. As a result, it is reasonable to conclude that pollutant concentrations predicted will be conservative since the percentage of stable, and hence poor dispersion, conditions during which emissions will be released from the Airport is over-estimated.

2.1.43 In the Applicant's modelling, the minimum Monin-Obukhov length scale is applied for 2852 hours of the year. Of the occasions during which the minimum Monin-Obukhov length scale is applied, 54% occur during the period 23:00 to 07:00 when no flights will take place and a further 29% occur during the daytime but during the winter season when airport activity will be at a minimum. Taking these observations into account, I concluded that very stable conditions would, in reality, have minimal effect on the maximum ground level concentrations.

- 2.1.44 Furthermore, the statistics presented in the previous paragraph are based on modelling undertaken using meteorological data for Herstmonceaux. As an inland site, not at significant elevation, the mean windspeed at Herstmonceaux will be lower than that experienced at the Airport and the occasions on which the wind speed is sufficiently low to result in very stable conditions will be more limited at the Airport than at Herstmonceaux. For example, the wind speed database for the United Kingdom provided by Department of Energy and Climate Change (www.decc.gov.uk/en/windspeed/default.aspx) shows mean wind speeds of 5.3m/s at Lydd and 4.9m/s at Herstmonceaux, where both values are taken as an average over 5km x 5km, centred at the airport and monitoring station respectively.
- 2.1.45 Lastly, given the approximately level terrain at the site (excluding small scale variations), there is little potential for the drainage of cold, dense, air into pockets in the manner that would occur, for example, in sheltered valleys and lead to the formation of very stable conditions and low Monin-Obukhov length scale.
- 2.1.46 Taking all of these observations in account, it is considered that setting no minimum Monin-Obukhov length scale in the modelling is inappropriate and unjustified, and that Atkins's modelling on this basis will significantly and artificially overestimate the impacts of very stable conditions on the dispersion of the Airport's emissions such that the results of the Applicant's modelling better represent the true turbulence climate into which emissions from the Airport are dispersed.
- 2.1.47 I consider the model results presented in my proof to be robust and already conservative, and Atkins modelling to be unrealistic and overly-conservative.
- 2.1.48 Atkins also assert that the dispersion model results indicate that the expansion of the airport, and the resulting increase in traffic on the Airport access road, could worsen exceedences of the critical load of 10kgN/ha/yr in the SSSI in the vicinity of the junction between the Airport access road and Romney Road.

2.1.49 The table below shows the modelled total nitrogen deposition at the point of maximum impact in the SSSI at the junction to the Airport access road. In fact deposition levels exceed the critical load in the 2014 future year scenario, with or without the expansion of the Airport.

Table 1. Maximum nitrogen deposition within the SSSI near the airport the access road.

Year and Scenario	Nitrogen Deposition kgN/ha/yr
2005 Baseline	13.3
2010 Baseline ¹	11.4
2012 Future Baseline	10.7
2014 Future Baseline	10.2
2014 With Airport Expansion to 500K	10.4

1: Interpolated from 2005 baseline and 2012 future baseline concentrations, because scenario not modelled explicitly

2.1.50 However, the deposition in all future years remains well below the level of deposition in the 2005 baseline year and also below levels in 2010, even with the expansion of the Airport.

2.1.51 Furthermore, as explained in my Proof of Evidence, these scenarios in fact relate to an unrealistic, near instantaneous, growth in airport passenger numbers following construction of the runway and terminal building. Under realistic growth scenarios, as described by Louise Congdon in her Proof of Evidence [LAA/4], the rate of growth in traffic using the airport access road would inevitably be significantly slower than assumed above and deposition levels are therefore likely to fall below 10kgN/ha/yr between 2016 and 2018 in the future whether or not the expansion of the Airport proceeds.

2.1.52 Vegetated shingle currently exists in the vicinity of the access road. Since current deposition levels are likely to exceed 10kgN/ha/yr, this suggests that a critical load of 10kgN/ha/yr is in fact conservative for Dungeness and affords a high degree of protection to the shingle habitat.

2.1.53 Notwithstanding all of this and without prejudice to what the evidence in fact demonstrates, the Applicant is currently in negotiations with Natural England to secure what Natural England would consider to be appropriate mitigation and to monitor impacts under S106 provisions and planning conditions. Pollutant concentrations and vegetation surveys will be undertaken in the SSSI at locations to be decided in consultation with Natural England. It is intended that the S106 provisions will make reference to an air quality management strategy which will aim to minimise the impacts of vehicles accessing the airport through travel planning and the use of low emissions vehicles.

2.2 **Kent Wildlife Trust (Evidence of Richard Moyes, KWT/3)**

Potential Impacts on Invertebrates

- 2.2.1 Kent Wildlife Trust state that they continue to have concerns regarding the potential air quality impacts of the Airport expansion, stating in particular that
- i. Critical loads apply only to habitats and not to the species using those habitats [para 13.2.1, KWT/3/A]
 - ii. For rare and threatened species found at Dungeness, there is no information which indicates the level of nitrogen deposition below which plant-predator interactions are unaffected [para 13.2.2, KWT/3/A]
 - iii. Lichen-dominated plant communities have shown changes at levels of nitrogen deposition considerably below that predicted for Dungeness [para 13.2.3, KWT/3/A]
 - iv. Operation of the Airport will still be responsible for an elevated level of nitrogen deposition on a site which supports species known to be extremely sensitive to this nutrient [para 13.2.4, KWT/3/A]

- 2.2.2 My evidence relates to the assessment of the potential air quality impacts of the Applications, and I therefore defer to the expertise of others giving evidence for the Applicant regarding invertebrate communities at Dungeness outside the scope of my evidence. But I deal with Mr Moyes's claims on the limitations of critical loads and appropriate assessment levels for Dungeness, and deal with potential air quality impacts on plant-predator interactions.
- 2.2.3 In paragraph 13.2.1 of his evidence, Richard Moyes includes a caveat to the critical loads provided by the Centre for Ecology and Hydrology (CEH) which states that critical load values will not **necessarily** protect all habitats/species within each ecosystem, since data are not available for all habitats/species (my emphasis). However, as highlighted in the evidence of Natural England [paragraph 248, NE/3/A], lichens have in fact been shown to be the components of ecological systems most sensitive to the effects of air pollution, not least because, in the absence of a root system, they are adapted for efficient, direct uptake of atmospherically deposited nutrients over their surface.
- 2.2.4 Therefore, in relation to the assessment of impacts on the vegetated shingle, I strongly disagree with Mr. Moyes that the critical load is not protective of the ecosystem in its entirety. I have assessed the potential impacts of the Applications in relation to the critical load for the most sensitive species within the habitat and have, therefore, used an assessment level which will be protective of the ecosystem in its entirety.
- 2.2.5 In asserting that lichen-dominated plant communities have shown changes at levels of nitrogen deposition considerably below that predicted for Dungeness, Mr Moyes refers to the report of Dr. Bryan Ferry [Appendix 21 to KWT/3] which itself makes reference to the study of Remke *et al* (2009), and also the decline of the epiphytic lichen at Dungeness.
- 2.2.6 I have provided responses to both of these assertions in paragraphs 2.1.8 – 2.1.13 and 2.2.17 – 2.1.25 above and I do not repeat the detail here. In summary, the study of the nitrogen content of lichen within Dungeness

undertaken by Dr. Thüs, Curator of Lichen at the Natural History Museum, has demonstrated that:

- i. The data of Remke *et al* (2009) relating to stable dune grasslands surrounding the Baltic are not applicable to the study of the vegetated shingle at Dungeness, since the latter can clearly accommodate a significantly higher nitrogen loading without showing evidence of long term decline or composition change
- ii. Whilst historical levels of nitrogen (and sulphur) deposition have contributed to a decline in sensitive epiphytic lichen at the Airport, observed differences within the existing epiphytic lichen communities near the Airport are inconsistent with differences in nitrogen deposition but are consistent with a significant input of alkaline and nutrient rich (but not necessarily nitrogen-rich) particles to the lichen, and also dust impregnation. Arable land in the vicinity of the Airport is the main potential emission source for the dust and particles.

2.2.7 Therefore, it is not correct to infer that current levels of nitrogen deposition are above those which are damaging the vegetated shingle at Dungeness. Reference to damage at similar levels of nitrogen deposition in different ecosystems is irrelevant to the Applications for the reasons I have explained.

2.2.8 In relation to potential impacts on herbivorous invertebrates, there is no direct information which indicates the level of nitrogen deposition below which plant-predator interactions are unaffected at Dungeness. However, this is not necessary and does not justify the claim that plant-predator interactions are likely to be affected by the operations of the Airport.

2.2.9 Throop and Ler dau, 2004 (Appendix 12 to KWT/3) identify that the most likely mechanisms by which nitrogen deposition could affect interactions between plants and insects are a result of shifts in the quality and availability of host plant tissue. Direct effects on the insects themselves are not considered significant.

Bethan Tuckett-Jones

- 2.2.10 At Dungeness, as stated earlier in this rebuttal and in my proof, the overall conclusion of both my assessment of potential impacts of the Airport and that of Natural England is that the expansion of the Airport is unlikely to affect the integrity of the SAC or to significantly damage the important vegetation communities within the SSSI. I refer to the detailed evidence in this regard, and I therefore conclude that the invertebrate communities will not be affected by any material reduction in the availability of host plant tissue, whether or not the expansion of the Airport proceeds, since the habitat itself is not at risk.
- 2.2.11 In relation to impacts resulting from shifts in the quality of the host plant tissue, Mr Moyes himself acknowledges that studies generally show a positive impact of nitrogen deposition on insects [para 10.13], as embodied by the following statements Throop and Lerdaу (Appendix 12 to KWT/3/A, Abstract):
- “In general, N deposition has positive effects on individual insect performance, probably due to deposition-induced improvements in host plant chemistry”*
- “The evidence to date suggests that N deposition may also have a positive effect on insect populations”.*
- 2.2.12 Taking these statements into account, it is therefore somewhat surprising that Mr Moyes continues to assert any potential negative impact of the expansion of the Airport.
- 2.2.13 I note that Throop and Lerdaу further suggest that there appears to be an optimal nitrogen concentration in host foliage for most insects, and decreased performance is likely when the nitrogen content of tissue exceeds this level. The data provided by CEH and APIS indicate that the level of nitrogen deposition at Dungeness has fallen in the recent past, with the site-specific deposition for Dungeness having been 11.5 kgN/ha/yr in 2003-2005, falling to 9.8 kgN/ha/yr in 2010. Therefore, following the suggestion of Throop and Lerdaу in the previous paragraph, it is reasonable to conclude that the existing invertebrate communities at Dungeness are tolerant of a nitrogen content within their host plant communities which results from a level of nitrogen deposition that is significantly higher than current levels.

Bethan Tuckett-Jones

- 2.2.14 The magnitude of the decrease in deposition over the past few years is significantly greater than the predicted maximum impact of the Airport expansion over the SAC or the SSSI, which implies that it is highly unlikely that nitrogen deposition over the designated sites will in fact ever exceed levels seen in the recent past, whether or not the future expansion of the airport proceeds.
- 2.2.15 Therefore, it is highly unlikely that the nitrogen content of the invertebrate host plants will ever exceed historic levels, which I have already concluded to be levels to which they are tolerant. Therefore, taking Throop and Lerdaу's conclusions into account, I conclude that it is highly unlikely that any invertebrates would undergo a reduction in performance as a result of an increase in the nitrogen content of their host plant communities above their optimal level.
- 2.2.16 In summary, therefore I strongly disagree with Richard Moyes's assertion that potential impacts on plant-predator impacts are potentially significant.

2.3 Campaign to Protect Rural England

Reference to Air Quality Impacts on Health and Managed Land

- 2.3.1 In her proof on quality of life [CPRE/04/A], Cllr Valerie Loseby suggests that elderly residents in the district with pre-existing respiratory conditions will be particularly vulnerable to the effects of air pollution from increased airport activity. Similarly, in his proof of evidence [paras 2.7-2.8, CPRE/04/B], Cllr Roger Joynes makes reference to air quality impacts on vulnerable residents, and also to potential impacts on managed habitats such as gardens, grazing land and golf courses. Mr Paul Black [CPRE/04/C] makes passing reference to potential air quality impacts of the Applications on the school at Greatstone.
- 2.3.2 Firstly, I respond to the assertion of potential impacts on managed land such as gardens, grazing land and golf courses. In contrast to the natural shingle habitats in the area, managed land habitats are characterised by substantial additions of nutrients from the management activities themselves e.g. addition

of fertilizers, and, therefore, they are not vulnerable to additional nutrient inputs from the atmospheric nitrogen.

2.3.3 In relation to human health effects, Cllrs Loseby and Joynes and Mr Black are failing to distinguish between hazard and risk. There is indeed a general hazard relating to exposure to high levels of air pollution anywhere, particularly in vulnerable members of society. However, the risk of effects on health being experienced by local residents is necessarily related to the issue of the level of exposure to emissions from the Airport. Given the distance of residential receptors from the Airport itself, the impacts of the Airport activities on residential properties will be negligible and, taking into consideration existing background pollutant levels, concentrations will be well below the standards set out in the UK's Air Quality Strategy for the protection of human health. As to impacts on residential properties on the approach roads to the Airport, namely the A259 and Romney Road, even at roadside locations, pollutant concentrations are predicted to remain well within the UK's air quality standard, whether or not the expansion of the Airport proceeds.

2.3.4 Therefore, I disagree with the representatives of CPRE, and conclude that there will not be any material, let alone significant, impacts on the health of local residents as a result of the effects of air pollution following the expansion of the Airport.

3 CONCLUSIONS

3.1 Summary

3.1.1 In this Rebuttal Proof of Evidence, I have considered evidence submitted by Natural England, Kent Wildlife Trust and the Campaign to Protect Rural England and have provided a written response where considered appropriate. However I reiterate that this does not imply that other points raised by these parties and others are accepted; these will be dealt with, as necessary or appropriate, at the Inquiry itself.

3.1.2 My assessment of the air quality impacts of the Airport has been robust and that there are no likely significant effects of the Applications in relation to air quality. Furthermore and in any event, I consider that I have been able to demonstrate beyond reasonable scientific doubt that the Applications will not affect the designated nature conservation sites in Dungeness.

3.1.3 In preparing my responses, I have been assisted by the further work undertaken by Dr. Holger Thüs of the Natural History Museum (Appendix 1). The results of his study have provided conclusive evidence that the conclusions of Eva Remke (2009) and her proposed critical loads for stable dunes are not generally applicable to the vegetated shingle at Dungeness. In recognising the importance of Dr. Thüs's report, I consider it appropriate that I reproduce his conclusions here:

Taking into account

- (i) *the lack of evidence of adverse air pollution effects from the airport on the lichen heath on site at present,*
- (ii) *the slow-growing nature of the mature lichen heath communities,*
- (iii) *the general good health of those communities,*
- (iv) *evidence to suggest that nitrogen oxides concentrations and deposition levels were higher in the past than now, and*

(v) *the scale of the predicted increases in pollution and deposition levels,*

it seems logical to conclude that the impacts of the proposed extension and use of the runway on the integrity of the designated sites via air pollution effects will be imperceptible.

3.1.4 Furthermore, Dr. Thüs is clear in his conclusions that the impact of surrounding land uses (rather than the Airport) plays a significant part in determining the quality of lichen heath and epiphytic lichen in the vicinity of the Airport and he sets out his priority actions to further enhance the conditions for lichen vegetation at Dungeness:

We suggest that an enhancement of the quality of the lichen heath and epiphytic communities surrounding the airport is achievable by reducing the areas with open arable land in the vicinity of the SSSI by conversion to non fertilised and extensively managed meadows. Thereby the drift of agrochemicals and soil particles by air and water during occasional flooding of the lower grounds on and around the airport can be reduced. A strict ban of pesticides (especially fungicides) will further enhance the conditions for the lichen vegetation.

3.1.5 These and other mitigation options are the subject of ongoing discussions between Natural England and the Applicant.

APPENDIX 1

NITROGEN DEPOSITION AND ITS IMPACT ON LICHEN BIOTA AT DUNGENESS

Dr. Holger Thüs and Pat Wolseley

The Natural History Museum

Nitrogen deposition and its impact on lichen biota at Dungeness



**Carried out on behalf of London Ashford Airport Ltd.
by Dr Holger Thüs & Pat Wolseley
The Natural History Museum**

March 2011

1 Introduction

1.1. The open shingle ridges and blackthorn shrubs in the Dungeness SSSI are the habitat for nationally and internationally rare or threatened lichen species and lichen-dominated vegetation types (James et al. 1977, Laundon 1989, Ferry & Waters 1985, Ferry et al. 1990, Ferry & Lodge 1991, Doody 2005, Ferry 2010). Its extensive area makes the vegetated shingle at Dungeness one of the most important sites of its kind at a global level.

1.2. The species which constitute the lichen heath on shingle are generally poor competitors and rely on open shingle with a low cover of higher plants or mosses or on shrubs with a moderately acidic bark (Ferry 2010) and specific climatic conditions (Laundon 1989).

1.3. In the past acidic pollutants have played a major role as a threat to many lichen species in England, but these pollutants have fallen to levels which are unlikely to have a directly harmful affect on the lichen flora of the Dungeness SSSI today. On the contrary some species which require a moderate acidity might disappear today due to the reduction of (mainly) sulphur dioxide emissions. Most of the rare species at Dungeness rely on a moderately acidic environment, but an excess of acidity is damaging to them.

1.4. Despite the reduction in acidic emissions in large parts of Central and Western Europe, lichen-rich heath has continued to decline in many areas. Evidence has been produced that in the case of lichen heath on sand dunes, this decline is linked to an increase in the cover of tall grasses and a high nitrogen input from anthropogenic sources. A case study on dunes on the Baltic coasts has led to the proposal of a critical load of 4-6 kg N ha⁻¹yr⁻¹ (Remke et al. 2009), while for other types of acidic heath the current recommendation is 10-20 kg ha⁻¹yr⁻¹ (Economic and Social Council 2010).

1.5. It is common knowledge that the lichen heath that has developed on the shingle at Dungeness is unique in its extent and a careful approach is required when comparing it to other habitat types and estimating a critical load for this specific habitat and site. Monitoring of nitrogen deposition with NO_x-tubes and ammonia-samplers does not

include the input from soil particles or the results of nitrogen fixation by bacteria within the lichen heath. Furthermore the results reflect only the deposition during the period of their exposure. When exposed for short periods there is a serious risk that short but intensive deposition effects (eg. during or after the application of fertilizer on arable land) are missed. For this reason we have complemented the observations by Ferry (2010) with results from additional site visits and measured nitrogen content of selected lichen species in order to gain an insight into the spatial distribution of nitrogen deposition in different habitat types and lichen species.

2 Material and Methods

2.1. The lichen *Cladonia portentosa* in lichen heath and other lichen species growing on both soil and the bark of trees have been shown to be accurate monitors of the accumulated N-deposition, integrating various kinds of nitrogen sources (Søchting 1995, Hyvärinen & Crittenden 1998, Remke et al. 2009). Lichens have little control over their physical N-uptake and much of the nitrogen compounds are accumulated in the lichen thallus. A recent study has shown that the nitrogen deposition can be assessed over a time period of c. 3-6 years with the uppermost 2 cm of cushions of the lichen *Cladonia portentosa* (Remke et al. 2009).

2.2. By analysing the nitrogen content of lichens collected from various sites at Dungeness we want to address the question of whether the current levels of N-deposition are above or below levels which have been shown to affect reindeer lichens or epiphytic species directly, or which induce habitat loss due to changes in the vegetation structure and competition by species which respond positively to nutrient enrichment (table of sampling sites in Appendix 1 and map in Appendix 2).

2.3. Following the established methodology described in Remke et al. (2009) and Søchting (1995) we have sampled small lichen fragments at 15 sites at Dungeness (Table 1). At each site sub-samples from various individuals were pooled in order to achieve a sufficiently large quantity for analysis.

2.4. Our main indicator species was the reindeer lichen *Cladonia portentosa* for which data collected with a similar methodology from various European countries are

available for comparison (Søchting 1995, Remke et al. 2009). This species however did occur in the pioneer vegetation at the west end of the runway only in small quantities which prohibited a more extensive sampling for the nitrogen content analysis and this terrestrial lichen is not suitable for the monitoring of the N-deposition on the bark of blackthorn. In both habitats another lichen, *Evernia prunastri*, occurred in large quantities and was used as an alternative bio-indicator using the same methodology as for *C. portentosa*. Close to the arable fields in the north-west and north of the runway, where both *C. portentosa* and *Evernia prunastri* were missing, *Cladonia rangiformis* was chosen as the indicator lichen. *Hypogymnia phyodes* is regarded as a better accumulator of dry deposition of nitrogen compounds compared to *C. portentosa*, due to its lower thallus pH (Søchting 1995) and a sample of this species was taken from a large population close to the nuclear power plant.

2.5. None of the species sampled were rare or threatened lichens and the sampling did not have any significant effect on the integrity of the lichen vegetation at the sampling sites. Consent for the sampling was given by Natural England.

2.6. Samples for measuring the nitrogen content of selected indicator species were taken on the 26.11., 07.12., and 10.12.2010 at nine sites surrounding Lydd Airport and six additional sites between Greatstone-on-Sea and the sea shore east of the nuclear power plant (Figure 1). The samples were dried and cleaned from any detritus or animals directly after collection and subsequently analysed by the Centre of Ecology and Hydrology Lancaster with the Elementar Vario EL elemental analyser.

3 Results

3.1. All lichen species of the lichen heath communities on the shingle of the airport and in the direct vicinity of the airport are present and their spatial distribution has remained stable over the past decades (Ferry 2010).

3.2. The only species of the lichen heath which has not been recorded recently is *Cladonia mitis* which has not been seen after 1989. This species has never been found in the direct vicinity of the airport and the area affected by the planned increase in

flight numbers does not extend to areas where this species had occurred in the past (Laundon 1989).

3.3. The lichen vegetation on blackthorn instead has changed and the once characteristic species *Usnea subfloridana* has not been found recently (Ferry 2010). Twenty years ago a rich population of *Usnea subfloridana* on blackthorn was reported from large areas at Dungeness (Ferry & Lodge 1991). During our visits in November and December 2010 we noticed that lichens of the genus *Usnea* have now largely disappeared not only in the vicinity of the airport but also in most of the area between Lydd Airport, Greatstone-on-Sea and the nuclear power plant. We found instead a small specimen of the genus *Usnea* on flintstone pebbles only a few metres from the runway (50°57.06'N, 0°56,21'E,) and on blackthorn shrubs further to the SW (50°55'15.54"N, 0°57'58.68"E). These specimens (Appendix 2: figs. 3, 4) were small and could not be identified in the field to species level. Their small size may indicate that they are likely to be new colonizers and not survivors of the previously reported population. The site close to the runway is in an area which is characterised by recent disturbances (Ferry 2010) and the early stage of succession might have favoured the establishment and endurance of the *Usnea* spp. on this spot, which is likely to become out-competed when the succession to either *Cladonia*-rich lichen heath or vegetation dominated by flowering plants continues.

3.4. An ongoing decline of the lichen flora of the blackthorn compared to a rather stable species pool and extent of the lichen heath has been reported from Dungeness already 20 years ago when Laundon (1989) noticed that several species on blackthorn, which are regarded as being sensitive to both elevated sulphur dioxide concentration and nitrogen compounds, were last recorded in the 19th century but not found in the 20th century. The accelerated decrease in species numbers reported by Ferry (2010) highlights even further the difference between the change in epiphytic lichen communities and the lichen heath on the Dungeness shingle.

3.5. Nitrogen contents of *Cladonia portentosa* samples collected at Dungeness ranged between 0.55 % and 0.94% of their dry weight (Appendix 1). The median of all samples (n=14) was 0.89% across all samples from Dungeness, 0.85% (n=10) for all samples at the northern fringe of the open shingle, including Lydd-airport, and 0.69%

(n=8) for samples from more distant localities between Greatstone-on-Sea and the nuclear power plant.

3.6. Some of the lowest nitrogen contents (0.58% in *Cladonia portentosa* and 0.7-0.78% in *Evernia prunastri*) were found in the samples which were collected west of the end of the runway (Site D10), while the highest nitrogen contents were found at the eastern-end of the same runway which is surrounded to the north by slightly elevated slopes which are topped by arable land (Sites D14, D15). From this pattern it becomes clear that currently the nitrogen content of the lichens cannot be related to emission of nitrogen compounds from aircraft but must be dominated by other factors such as the proximity to arable land and potentially the exposure to inundation which may be connected with the deposition of nutrient-rich sediments on the lower grounds on the airport and its surroundings.

3.7. The nitrogen content of *Hypogymnia physodes* in the centre of the vegetated shingle is almost twice as high as in *Cladonia portentosa* and still higher than in *Evernia prunastri* (Appendix 1). Experiments have shown that *Hypogymnia physodes* specifically accumulates dry deposition (of mainly ammonia) (Søchting 1995, Franzen-Reuter 2004) while *Evernia prunastri* is less discriminating between different nitrogen sources (Franzen-Reuter 2004) and the content of *Cladonia portentosa* shows a high correlation to wet deposition of nitrogen (Remke et al. 2009).

3.8. At Dungeness we find well developed lichen heath which has shown no signs of change in spatial extension or species composition over the last 20 years (Ferry 2010), even at localities in the direct vicinity of the runway where the nitrogen content reaches 0.92%. These figures are above the nitrogen contents measured by Remke in *Cladonia portentosa* from Baltic sand dunes (0.33-0.56%) but still below the levels of 1.3% which were regarded as lethal by Søchting (1995). In our plots at Dungeness all lichens did not show any signs of reduced vitality, including those with the local maximal nitrogen content of 0.92% at site D15. Whilst the height of the lichen heath directly beneath the wind-exposed runway is lower compared to sites with shelter from nearby bushes and shrubs, no damage to the fungal or algal component was observed.

3.9. Close to arable land in the south of the runway we observed patches of bleached lichen colonies (*Evernia prunastri*) although nitrogen levels were low and even extreme nitrogen deposition on willows, covered in bird droppings have not produced similar damage. An analysis of the nitrogen content of bleached and unbleached *Evernia* samples from nearby sampling sites did not show any significant differences, therefore the effects of fertilizers or excessive nitrogen input from combustion products from aircraft can be ruled out. Impacts other than elevated levels of nitrogen input must therefore be considered as risk factors for some of the lichens in this part of the study area. A drift of pesticides or alkaline dust from burning organic matter in the vicinity of the site may explain the observed damages (Fig. 2). It is remarkable though that only *Evernia prunastri* showed this bleaching, no other species was affected. Further research is required to confirm the causes of the observed damage, though damage from aviation activity can be ruled out.

4 Discussion

4.1. It is clear that the lichen-rich shingle heath at Dungeness is a unique community. For the assessment of a critical load for nitrogen input it is best categorised as “acid lowland heath” although it is not identical with this community (Ferry 2010, paragraph 2.1). Based on this agreed common ground we conclude that the recommendations for critical loads of nitrogen compounds for dry coastal dunes (Remke 2009) cannot be applied to the lichen-rich shingle heath at Dungeness, because they refer to a different habitat type. Effects of elevated nitrogen input on sand dune systems on the coast of the Baltic Sea have been due to an increase in the grass cover of *Carex arenaria*, a species which does not play a role in the succession of the vegetation at Dungeness (Ferry et al. 1990, Ferry 2010). Our measurements of nitrogen contents in long-established and stable lichen heath at Dungeness suggest that a much higher nitrogen deposition can be tolerated at Dungeness compared to other types of “acid lowland heath” as long as the pH remains low and accumulation of soil is limited.

4.2. Long established and virtually unchanged lichen communities within the Dungeness SAC and SSSI still exist, despite evidence to suggest that nitrogen

deposition levels have exceeded for some time, 10kgN/ha/yr by some considerable margin (www.apis.ac.uk).

4.3. The report by Dr Brian Ferry (2010) for Kent Wildlife Trust states under paragraph 4.1.9 that “The communities of epiphytic lichens growing on blackthorn which were surveyed in 2010 already show change (including the loss of *Usnea* spp.) which is likely to be due to existing N levels. However for the lichen-rich shingle heath no change is reported from the area near the airport (statement in paragraph 2.4 compared with data from Ferry et al. 1990). On our visit on the 10.12.2010 we have recorded a specimen of *Usnea* growing directly on a flintstone pebble between the SE end of the runway and an arable field (50°56'59.4"N/0°55'50.21"E). The measurement of nitrogen content of *Cladonia portentosa* and *Evernia prunastri* at this site clearly indicates that although the emission of nitrogen compounds must be higher compared to samples further away from the runway, the nitrogen content remained in fact one of the lowest recorded for Dungeness.

4.4. The lichen communities on the vegetated shingle at Dungeness do not respond to deposited nitrogen compounds in the same manner as lichen communities on naturally acid bark in the same area. The reference to studies on critical levels of nitrogen compounds for epiphytic lichens (Ferry 2010 paragraphs 3.8, 3.9, 3.10) is therefore not relevant for the lichen-rich shingle heath at Dungeness.

4.5. At most sites at Dungeness those parts of the lichen vegetation which are growing directly on the open shingle are still dominated by species which are typical of acidic and nutrient-poor substrata (Ferry 2010, Table 1). Observations during our own visits revealed that nitrophytic species (eg. *Xanthoria parietina*, *Physcia ascendens*) do occur in high numbers on localised patches NE of the runway on disturbed open shingle in the vicinity of an arable field, with a high density of rabbit holes and droppings. This vegetation type also occurs on an equally disturbed area of the now disused runway east of the airfield. Here the shingle is mixed with alkaline fragments and dust from the former runway. Its location in a depression suggests that it receives additional nutrient-rich sediments from nearby areas. The result of the nitrogen measurements of lichen thalli however does not show a distribution which would correspond to a dominating impact from nearby arable land, but instead reflect small scale variation in soil development and the degree to which the vegetated shingle is

inundated during periods of high water. The tolerance to elevated nitrogen levels is far greater at Dungeness than in other habitats where *Cladonia* dominated lichen heath is a permanent feature, and indicates that factors other than nitrogen impact are currently shaping the extension and species composition of lichen heath at Dungeness.

4.6. The highest nitrogen deposition was found on old willows which were partly covered in faeces from resting birds. Thalli of *Evernia prunastri* were partly covered in free living algae due to the high nutrient availability but still did not show any signs of direct damages resulting from the high nitrogen supply. It is clear that a high bird population can locally cause a shift in the epiphytic vegetation towards nitrogen-tolerant communities.

4.7. In contrast to earlier reports the lichen vegetation growing on the bark of shrubs and trees is dominated today by indicators of a high deposition of nitrogen compounds and base-rich bark (Ferry 2010, Table 2). Further observations by us on 07.12.2010 and 10.12.2010 on the airport and on additional sites up to the nuclear power plant have shown the only exceptions are the interior of extensive willow and blackthorn thickets further east of the airfield (50°55'15.54"N/0°57'58.68"E), where more sensitive species, including the now declining *Usnea* sp., were observed.

4.8. In Ferry's report (2010) table 2 indicates a significant difference between the blackthorn thickets 146-159 (between sites D12 and D13 in our study), which are located close to an arable field when compared with other sites of blackthorn thickets (293-301, site D11 in our study). In the table the genus *Xanthoria* has been mentioned but no specification of the species has been provided. On our field visit we have noticed a strong dominance of *Xanthoria polycarpa* in blackthorn thickets nr. 146-159, while in the other blackthorn thickets *Xanthoria parietina* is dominant. Table 2 in Ferry (2010) also shows the only places with *Lecanora polytropa* are the same blackthorn thickets 146-159 close to the arable field. The species *Lecanora polytropa* is generally more frequent on rock surfaces and its presence on blackthorn indicates a significant dust impregnation at this site which is likely to have its origin in the neighbouring arable field. Nitrogen content of *Evernia prunastri* on the blackthorn at this site however is not higher than in samples from shingle in the centre of the Dungeness vegetated shingle (Appendix 1) and the deposition of other nutrients such

as phosphorus, and the physical consequences of dust cover or pH-shifts induced by the dust impregnation must be considered as potential reasons for the distinctive difference between the epiphytic lichen flora at the margins of the SSSI when compared with more central parts of the vegetated shingle.

4.9. The information from Table 2 in Ferry (2010) and our own observations indicate that a significant input of nutrient-rich (but not necessarily nitrogen-rich) and alkaline particles is currently influencing the lichen flora on the airport, with arable land in the vicinity as the main potential source for this type of air pollution. A constant input of more alkaline soil particles from the nearby arable land will eventually also alter the lichen-rich shingle heath. Therefore we regard this source as one the main threats to the local lichen diversity and the integrity of the lichen-dominated vegetation.

4.10. The concentrations of nitrogen oxides in the study area have fallen over the last five years while concentrations of ammonia remained at a high level. Some of the correlations between measured NO_x and the lichen vegetation surrounding roads with heavy traffic have been shown to be a side effect of the introduction of catalytic technology in vehicles (Cape et al. 2004, Frahm 2008, Frahm et al. 2009). In contrast the emission of ammonia from aircrafts is negligible and the additional NO_x -emission from the extension of the airfield has to be seen in the context of a background pollution which continues to decrease. Recent studies of Kirschbaum et al. (2009) have ruled out any significant influence of the airport of Frankfurt/M. on epiphytic lichen communities on studied plots in its vicinity.

4.11. At Dungeness, even with the proposed expansion of the number of movements of aircrafts on the airport, the total NO_x -impact on the sites will be lower in the future when compared to the years 1990 and 1991, the years when the last baseline studies on the composition of the lichen flora were carried out (Ferry et al. 1990, Ferry & Lodge 1991).

4.12. The recent survey by Ferry (2010) and our additional observations suggest that the largest current and future threat to the lichen communities in the vicinity of the airport is the import of less acidic or nutrient-rich soil particles, fertilizer and pesticides which might drift into the lichen-rich habitats. A conversion of adjacent arable land in non-fertilised grassland and a ban on the use of pesticides on these

areas is likely to increase the chances for survival of the lichen-rich shingle heath and a restoration of the epiphytic vegetation on the nearby blackthorn.

4.13. The lichen colonies on the raised parts of vegetated shingle in the vicinity of the airport and on the airfield itself are generally in good condition and apparently have not undergone any significant changes, despite the drop in the deposition of acidic compounds (namely sulphur dioxide) over the last two decades. Communities of primary conservation interest, the *Cladonia*-heath, appear to be long-established and their species composition is largely similar to areas with long-documented lichen heath further E on central parts of Denge Beach with the main difference being the absence of additional species such as *Cladonia gracilis* which reflects the natural proximity to alluvial soils and past disturbances (Ferry 2010, Paragraph 2.3 and table 1). Our own site visits on 07th and 10th of December 2010 confirm that species which are typical for high levels of nitrogen compounds, osmotic stress or alkaline pH are largely absent from the lichen heath on these reference sites closer to the Nuclear Power Plant as well as from most of the sites on the airport, except particular patches of clearly limited extent.

4.14. At our site D10 at the SW-end of the current runway we have found a lichen vegetation which has a different species composition compared to the typical *Cladonia* heath (vegetation types A2 and A2S in the local classification by Ferry et al. 1990 and Ferry 2010), probably due to past disturbance, with a lower percentage of *Cladonia* mats but locally high coverage of the species *Evernia prunastri* and *Hypogymnia physodes*, and notably one thallus of an unidentified species of the genus *Usnea*. Species of this genus are generally regarded as typical for acidic and nutrient-poor substrata. The presence of *Usnea* on the surface of a flintstone pebble on a site where the nearest blackthorns (shrubs nrs 293-301 in Ferry 1991, equals site D11 in our study) have lost all their previous *Usnea* populations (Ferry 2010, paragraph 2.9.) provides evidence that a similar nitrogen input on the surface of blackthorn twigs has a different effect on the associated lichen flora when compared with the terricolous communities on the Dungeness shingle.

4.15. In the absence of major local sources of pollution on the airport site, small scale variations in the condition of the lichens seen on the site cannot be linked to variations in air pollution levels, except for the transport of fertilizers, pesticides and nutrient-

rich soil particles from the surrounding arable land. We have observed on the 10th of December 2010 large patches of *Evernia prunastri* and *Cladonia rangiformis* where the thalli appeared bleached and at least the algal component of the lichen was obviously seriously damaged. Such patches were only found in the direct vicinity of the arable land surrounding the airport and nowhere near the runway or in the areas eastwards in the direction of the nuclear power plant.

5 Conclusions

5.1. Taking into account (i) the lack of evidence of adverse air pollution effects from the airport on the lichen heath on site at present, (ii) the slow-growing nature of the mature lichen heath communities, (iii) the general good health of those communities, (iv) evidence to suggest that nitrogen oxides concentrations and deposition levels were higher in the past than now, and (v) the scale of the predicted increases in pollution and deposition levels, we conclude that the impacts of the proposed extension and use of the runway on the integrity of the designated sites via air pollution effects would be imperceptible.

5.2. We suggest that an enhancement of the quality of the lichen heath and epiphytic communities surrounding the airport is achievable by reducing the areas with open arable land in the vicinity of the SSSI and SAC by conversion to non-fertilised runway grassland. Thereby the drift of agrochemicals and soil particles by air and water during occasional flooding of the lower grounds on and around the airport can be reduced. A strict ban of pesticides (especially fungicides) will further enhance the conditions for the lichen vegetation.

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Appendix 1

Nitrogen content of lichens at Dungeness.

Site	Longitude/Latitude	<i>Cladonia portentosa</i> On shingle	<i>Cladonia rangiformis</i> On shingle	<i>Hypogymnia physodes</i> On shingle	<i>Evernia prunastri</i> On shingle	<i>Evernia prunastri</i> On blackthorn	<i>Evernia prunastri</i> On willow
D1	50° 57.456'N 0° 57.318'E						1.78-2.44 (n=2)
D2	50° 57.120'N 0° 57.543'E	0.60-0.94 (n=3)					
D3a	50° 56.370'N 0° 58.164'E	0.65-0.75 (n=2)					
D3b	50° 56.289'N 0° 58.111'E	0.76 (n=1)					
D4	50° 56.069'N 0° 58.198'E	0.62-0.67 (n=2)					
D5	50° 55.761'N 0° 57.868'E	0.58-0.74 (n=2)		1.07-1.26 (n=2)	0.71-0.87 (n=2)		
D6	50° 55.184'N 0° 57.589'E	0.55-0.81 (n=2)					
D7	50° 55.038'N 0° 56.848'E	0.64-0.7 (n=2)			0.81-0.97 (n=3)		
D8a	50° 54.794'N 0° 56.520'E	0.74 (n=1)			0.79-0.93 (n=2)		
D8b	50° 54.802'N 0° 56.523'E	0.77 (n=1)					
D9a	50° 55.243'N 0° 57.964'E						1.64 (n=1)
D9b	50° 55.259'N 0° 57.978'E						1.07-1.28 (n=2)
D9c	50° 55.280'N 0° 57.972'E	0.55-0.6 (n=2)					
D10	50° 56.990'N 0° 55.960'E	0.58 (n=1)			0.70-0.78 (n=3)		
D11	50° 57.063'N 0° 56.212'E	0.67-0.89 (n=2)			1.02-1.06 (n=2)	0.71 (n=1)	
D12	50° 57.417'N 0° 56.671'E						1.51-1.93 (n=2)
D13	50° 57.537'N 0° 56.716'E				1.0 (n=1)		
D14a	50° 57.607'N 0° 56.404'E		0.88-0.89 (n=2)				
D14b	50° 57.565'N 0° 56.408'E		0.88-1.04 (n=2)				
D15	50° 57.546'N 0° 56.468'E	0.85-0.92 (n=2)	0.84-0.86 (n=2)				

Lichen nitrogen contents in % of dry weight, number of samples in brackets.

Appendix 2

Sampling sites and images of characteristic lichens at Dungeness



Fig. 1. Map of sampling sites for nitrogen content measurements of lichens at Dungeness. For details and coordinates see appendix 1.



Fig. 2. *Rinodina aspersa* is frequent in most areas with open shingle at Dungeness but very rare in the UK elsewhere. It is a poor competitor and disappears when the shading from other plants or lichens becomes too high.



Fig. 3. *Usnea* sp. (green lichen stretching from centre to the right), *Evernia prunastri* (whitish lichen in centre) and *Melanelixia subaurifera* (brown lichen attached to the surface of pebble) on flintstone. Sampling point D10, close to the N edge of the SSSI. While acidophytic lichens on bark in this area have strongly declined, no change was found for the lichens on exposed shingle at the same sites.



Fig.4. *Usnea* sp. on bark of willow, sampling point D9b, in central part of the SSSI. While still present on flintstone, epiphytic *Usnea* populations on the bark of willows are now missing from the north-eastern edge of the Dungeness SSSI close to agricultural land.



Fig. 5. *Xanthoria parietina* (yellow) in acidophytic lichen heath community – the disturbance indicator *Xanthoria* is restricted to a single piece of bone buried in the ground, but absent from the (acidic) flintstone which still has its natural acidity. Sampling site D7, close to the Nuclear Power Plant.



Fig. 6. *Xanthoria parietina* and *Physcia adscendens* on the surface of a flintstone from disused runway after removal of tarmac. Notice attached piece of mortar on flintstone surface (centre of image). This causes an elevated pH and creates a suitable habitat for *Xanthoria* which - without disturbance - would be largely absent from the Dungeness shingle at the northern edge of the SSSI.