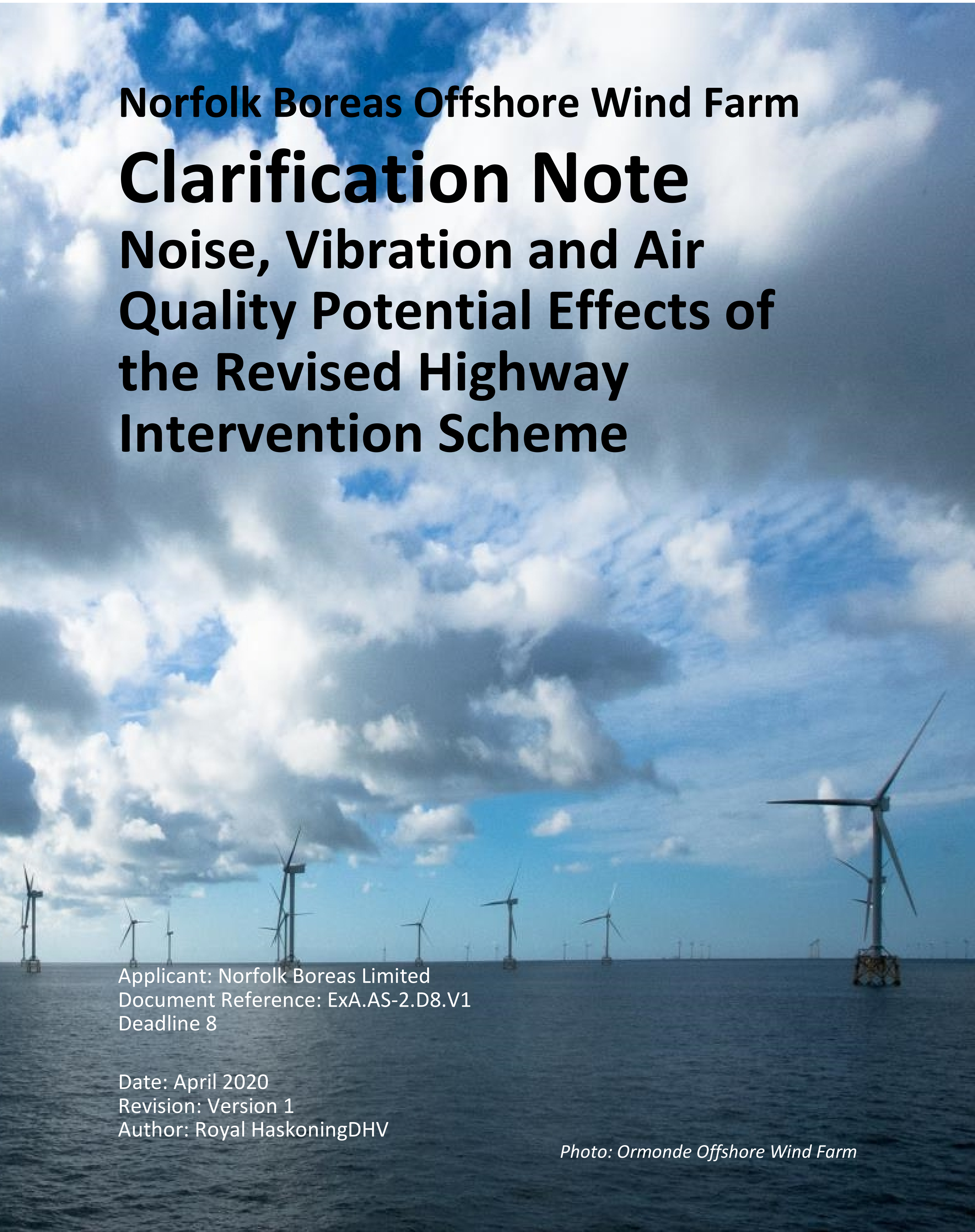
Norfolk Boreas Offshore Wind Farm

Clarification Note

Noise, Vibration and Air Quality Potential Effects of the Revised Highway Intervention Scheme



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Glossary of Acronyms

AAWT	Annual Average Weekday Traffic
BNL	Basic Noise Level
BS	British Standard
CRTN	Calculation of Road Traffic Noise
DMRB	Design Manual for Roads and Bridges
ETG	Expert Topic Group
eVDV	Estimated Vibration Does Value
HIS	Highway Intervention Scheme
HP3	Hornsea Project Three
NCC	Norfolk County Council
NPSE	Noise Policy Statement for England
OCoCP	Outline Code of Construction Practice
OTMP	Outline Traffic Management Plan
PPV	Peak Particle Velocity
TMP	Traffic Management Plan
TRL	Transport Research Laboratory
VDV	Vibration Dose Value
WCS	Worst Case Scenario

Glossary of Terminology

Air quality Objectives	A series of objectives set by the UK Government's Expert Panel on Air Quality to be achieved either without exception or with a permitted number of exceedances within a specific timescale.
dB(A)	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
dB(Z) (or previously L_{leq})	Decibels measured on a sound level meter incorporating a flat frequency weighting (Z weighting) across the frequency range.
$L_{A10,T}$	The A weighted noise level exceeded for 10% of the specified measurement period (T). L_{A10} is the index generally adopted to assess traffic noise.
$L_{A90,\ T}$	The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 2014 it is used to define the 'background' noise level.
$L_{Aeq,T}$	The equivalent continuous sound level – the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). $L_{Aeq,\ T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter.
L_{Amax}	The maximum A-weighted sound pressure level recorded during a measurement.
Onshore infrastructure	The combined name for all onshore infrastructure associated with the project from landfall to grid connection.
Onshore project area	All onshore electrical infrastructure (landfall; onshore cable route, accesses, trenchless crossing technique (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modification).
The Applicant	Norfolk Boreas Limited.
The project	Norfolk Boreas Offshore Wind Farm, including the onshore and offshore infrastructure.

1 Introduction

1. This Norfolk Boreas clarification note provides further information on the potential noise, vibration and air quality effects of road traffic as a result of the Cawston Revised Highway Intervention Scheme (HIS), which is part of a package of mitigation measures that would serve to reduce traffic impacts through Cawston (Link 34, B1145). The revised HIS was detailed in the Outline Traffic Management Plan (OTMP) submitted at Deadline 5 [REP5-025].

2. The revised HIS was developed following consultation with Norfolk County Council (NCC) to address the recommendations of the initial Road Safety Audit (RSA) and the concerns raised by NCC. The revisions to the HIS are summarised as follows:

   - Removal of footway widening;
   - Details of parking restrictions;
   - Details of 20mph zone signing;
   - Improvements to Cawston C of E Primary School pedestrian crossing;
   - Bus stop locations;
   - High Street carriageway alignment adjacent to Chapel Street;
   - Removal of mandatory priority traffic management; and
   - Clarification of road surfacing.

3. The revised HIS was subject to a further RSA (see Revised Cawston HIS Road Safety Audit Decision Log [REP5-055] for full details). The Applicant has addressed all the recommendations made in the RSA in the revised HIS drawings submitted at Deadline 5 in the Outline Traffic Management Plan Appendices [REP5-027]. The Applicant understands from NCC that no further amendments are required to the HIS and as there are no remaining technical objections the intention is to 'sign-off' the road safety audit thereby approving the scheme.

4. Concerns have been raised by Broadland District Council and Cawston Parish Council on potential noise, vibration and air quality effects associated with the traffic flows along the B1145 (Link 34) during the implementation of the HIS. To address these concerns the Applicant has undertaken an assessment of potential noise, vibration and air quality effects to identified receptors in the vicinity of the B1145 during the implementation of the revised HIS. Each topic is discussed in turn in the following sections of this note.

2 Noise Assessment of Revised Highway Intervention Scheme

2.1 Introduction

5. This section considers the potential for road traffic noise impacts in the vicinity of Cawston, resulting from construction traffic travelling along Link 34 for Norfolk Boreas alone and considers the cumulative effects of traffic flows associated with Hornsea Project Three (HP3). Specifically, the effects of mitigation measures devised as part of the revised HIS on Link 34 through Cawston, as outlined in Section 1.

6. The noise impact assessment methodology for road traffic impacts was previously agreed with stakeholders during Expert Topic Groups (ETGs) and detailed as part of the Evidence Plan Process (EPP). Since the submission of the Norfolk Boreas Offshore Wind Farm Chapter 25 Noise and Vibration Environmental Statement (ES) [APP-238], the guidance for assessing construction phase road traffic impacts has been revised. The ES submission presented the assessment based on Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Chapter 3.

7. The DMRB was revised in November 2019 and issued as LA111 Noise and Vibration Revision 0 (formerly HD 213/11, IAN 185/15). The LA111 provides guidance on the environmental assessment of noise impacts from road schemes. The DMRB contains advice and information on transport-related noise and vibration, which is relevant to construction traffic impacts affecting sensitive receptors adjacent to road networks. It also provides guideline significance criteria for assessing traffic related noise impacts.

2.2 Road Traffic Noise Assessment Methodology

8. This noise assessment was undertaken using the methodology outlined in the Norfolk Boreas Offshore Wind Farm Chapter 25 Noise and Vibration ES [APP-238] submission but using the updated 2019 DMRB guidance.

9. ES Chapter 24 Traffic and Transport [APP-237] outlined the concept of a Traffic Management Plan (TMP (DCO Requirement 21)). The version of the Outline Traffic Management Plan (OTMP) (REP5-026) submitted as part of Deadline 5 details the revised Highway Intervention Scheme (HIS) measures and this has been used to inform this assessment.

2.2.1 Norfolk Boreas Scenarios and Traffic Data

10. Traffic flow data was provided by Royal HaskoningDHV's transport specialist for the B1145, Cawston. Since the ES assessment updated baseline data is available following a survey undertaken by Hornsea Project 3 (HP3) in 2019. The updated HP3 2019 baseline flows have been used to derive the baseline plus growth flows to inform the assessment, replacing the 2017 baseline flows used within the ES.

11. Traffic data for the Cawston HIS (road Link 34) noise assessment was provided as 18hr Annual Average Weekday Traffic (AAWT) (as required by the CRTN methodology) for the construction scenarios detailed in **Table 2.1**. The Scenario 1 assessments do not include cumulative construction traffic associated with HP3 as it is expected that there would be no overlap between the projects.

Table 2.1 Noise and vibration assessment scenarios

Norfolk Boreas HIS Scenario	Traffic data*	Year
Scenario 1	Baseline traffic flows + construction traffic associated with Norfolk Boreas alone	2026/2027
Scenario 2	Baseline traffic flows + construction traffic associated with Norfolk Boreas alone and cumulative with HP3	2023/2024

12. **Table 2.2** details the road link in the Cawston HIS study area.

Table 2.2 Assessment link classification and survey detail

Link No.	Road	Survey type	Posted Speed Limit (km/h)
34	B1145 - Cawston (Between Long Lane and B1149)	ATC9	37.3*

*Speed taken from HP3 traffic data survey 2019

2.2.2 DMRB Guidance Comparison

13. The 2019 DMRB guidance was compared with the assessment methodology for the road traffic noise and vibration assessment outlined in Section 25.4.1.1.2 Road traffic noise and vibration emissions assessment, detailed in [APP-238]. Differences to the assessment methodology are presented here.

14. In the Norfolk Boreas ES Chapter 25, construction phase road link dBA changes were assessed using the impact magnitude criteria in **Table 2.3**. The thresholds for differentiating the criteria are taken from recommendations outlined in the 2011 DMRB (Volume 11, Section 3, Chapter 3, Table 3.1) which are specific to short-term impacts (such as the construction phase traffic) and are an indication of the relative change in ambient noise as a result of the project. Section 3.40 of the 2011 DMRB guidance states "*Table 3.1 should be used in the assessment of noise impact associated with construction traffic on the local road network and from temporary diversion routes resulting from construction*".

Table 2.3 Significance criteria for relative change due to road traffic (short term) (2011 DMRB guidance)

Change in noise level ($L_{A10\ (18\ hour)}$ dB)	Impact magnitude
0.0	No change
0.1 – 0.9	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
5.0+	Major

15. For comparison, the revised 2019 DMRB guidance thresholds for differentiating the criteria specific to construction (short-term) impacts are shown in **Table 2.4**, which is derived from the revised magnitude impact criteria detailed in Table 3.17 of the 2019 DMRB guidance (LA 111 Noise and Vibration, Revision 0, 2019).

Table 2.4 Magnitude of effect at receptors (revised 2019 DMRB guidance)

Magnitude of effect	Increase in Basic Noise Level of closest public road for construction traffic (dB)
Major	Greater than or equal to 5.0
Moderate	Greater than or equal to 3.0 and less than 5.0
Minor	Greater than or equal to 1.0 and less than 3.0
Negligible	Less than 1.0

16. Key differences (other than the title of the table taken directly from LA111) are the number of categories for magnitude of impacts and a rounding of the threshold values i.e. Minor is now represented by a 1.0 to 3.0dB change in the Basic Noise Level (BNL); previously 1.0 to 2.9dB. Negligible in the 2019 guidance refers to a change in the BNL of <1.0dB. The effect of removing the No Impact category from the 2019 DMRB magnitude of impact matrix (detailed in **Table 2.4**) means that a change in $L_{A10,18hr}$ noise level of <1dB is categorised as Negligible.

2.2.3 Road Traffic Noise Assessment Methodology

17. Following the methodology contained in DMRB LA111 Noise and Vibration (formerly HD 213/11, IAN 185/15), an initial screening assessment was undertaken to assess whether there would be any significant changes in traffic volume and composition on Link 34 as a result of the worst case for the construction of Norfolk Boreas alone (Scenario 1 and Scenario 2) and cumulatively with HP3 for Scenario 2 for the relevant construction phase years (Scenario 1 2026 and 2027 and Scenario 2 2023 and 2024).

2.2.4 Magnitude

18. An assessment was then undertaken following the Basic Noise Level calculation procedure within CRTN (and detailed in LA111) to predict a relative $L_{10,18hr}$ dBA change for each link. The calculation also incorporates a correction for mean traffic speed and the percentage of heavy vehicles.

19. The revised HIS limits the speed of vehicles to 20mph (32.2km/h) along Link 34 and has been considered within the assessment.

20. The Basic Noise Level was calculated using the formulae detailed in CRTN and a correction applied for composition and speed:

- Basic noise level $L_{10(18hour)}$ = 29.1 + 10 Log10Q dB(A) (Q = Total Flow/18hr day)
- Correction for %HGVs (p) and Mean Traffic Speed (V) = 33 Log10 (V + 40 + 500/V) +10 Log10 (1 + 5p/V) – 68.8 dB(A)

21. No correction for distance propagation or a noise level at a specific receptor was calculated as there are no expected significant changes in alignment; therefore, traffic would be travelling along the link in the same way for the 'with' and 'without' scenarios.

22. Paragraph 12 of The Calculation of Road Traffic Noise (CRTN) states:

"The basic noise level at a reference distance of 10 m away from the nearside carriageway edge is obtained from the traffic flow, the speed of the traffic, the composition of the traffic, the gradient of the road and the road surface. On any given road the traffic flow, mean speed and composition are interdependent; for example, increasing the traffic flow may cause a reduction in the mean speed so that the net increase in noise level may be comparatively small. Similar effects are observed with changes in composition.

The choice of reference point or distance is arbitrary and other reference distances could be used by changing the numerical values of constants appearing in certain of the predictions."

23. Additionally, no correction was applied for the gradient or road surface type as these parameters were assumed to stay as per the existing baseline 'without development', and only Total Traffic Flows, Percentage HGVs as indicated in the 18hr AAWT traffic data would vary due to the additional scheme related traffic using the network.

24. A worked example is provided in **Table 2.5**.

Table 2.5 Calculation of road traffic noise worked example

		2018 Base + Growth		2023 Base + Growth + Development Construction Traffic	
		Input	Correction	Input	Correction
BASIC NOISE LEVEL					
18hr AAWT traffic flow	=	3158	64.1 dBA	3378	64.4 dBA
% HGVs	=	1.0		2.6	
Traffic speed km/h	=	69.7	-0.3 dBA	69.7	0.2 dBA
Correction for traffic speed	=	0.0		0.0	
Corrected traffic speed	=	69.7	0.0 dBA	69.7	0.0 dBA
Total Basic Noise Level	=		63.8 dBA[1]		64.6 dBA[2]
Difference (dBA)	=	+0.8 dBA			

25. The magnitude of any predicted change in noise level was then assessed in accordance with the criteria contained in the 2019 DMRB (**Table 2.4**).

2.2.5 Sensitivity

26. As per the ES Chapter 25, the Cawston road traffic Link 34 receptor classification is medium sensitivity for the residential receptors in the vicinity of this road link.

2.2.6 Impact Significance

27. Following the identification of receptor sensitivity and magnitude of the effect, it is possible to determine the significance of the impact. The impact significance matrix is detailed in **Table 2.6**. The impact magnitude is compared with the sensitivity of the receptor to derive the impact significance. Only Moderate or Major impacts are considered significant in EIA terms.

Table 2.6 Impact significance matrix

		Negative magnitude				
		High/ Major	Medium/ Moderate	Low/ Minor	Negligible	No Impact
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Negligible*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*

2.3 Noise Assessment

28. A road traffic noise assessment was undertaken following the methodology contained in DMRB (LA111, 2019) to assess whether there would be any significant changes in traffic volumes and composition on Link 34 as a result of the worst case scenarios (WCS) for the construction of Norfolk Boreas alone (Scenario 1 and Scenario 2) and cumulatively with HP3 for Scenario 2. The magnitude of any predicted change in noise level was then assessed in accordance with the criteria contained in the 2019 DMRB (**Table 2.4**) and significance assessed with the impact matrix at **Table 2.6**.

2.3.1 Norfolk Boreas Scenario 2 alone and with HP3

29. For Scenario 2, traffic impacts were assessed for the construction phase years of 2023 and 2024 (as per the programme details in Chapter 24 Traffic and Transport [APP-237]), taking base flows, annual growth, Norfolk Boreas project-generated construction traffic and HP3 generated construction traffic into consideration.

30. **Table 2.7** presents the Scenario 2 traffic (using 2019 18hr AAWT base flows) along Link 34 and the screening assessment for each relevant assessment year.

31. **Table 2.7** details the percentage change in 18hr AAWT Total Flows and considers the change in composition for number of HGVs (% change) for:

- Baseline plus Growth versus the Baseline plus Growth plus Development Construction Traffic (NBS2) for 2023 and 2024
- Baseline plus Growth versus the Baseline plus Growth plus Development Construction Traffic (NBS2) plus Cumulative (HP3) for 2023 and 2024.

Table 2.7 Link 34 Screening Scenario 2 – Norfolk Boreas HIS

	(18hr AAWT)[A]		(18hr AAWT)[B]		% Change	
	Total Flow	HGVs	Total Flow	HGVs	Total Flow	HGVs
2023 Baseline + Growth **versus** 2023 Baseline + Growth + Development Construction Traffic	3,491	313	3,767	424	7.9	35.7
2023 Baseline + Growth **versus** 2023 Baseline + Growth + Development Construction Traffic + HP3 Cumulative	3,491	313	4,137	551	18.5	76.3
2024 Baseline + Growth **versus** 2024 Baseline + Growth + Development Construction Traffic	3,567	320	3,843	431	7.7	35.0
2024 Baseline + Growth **versus** 2024 Baseline + Growth + Development Construction Traffic + HP3 Cumulative	3,567	320	4,213	558	18.1	74.7

Note: A = Baseline+Growth 18hr AAWT flows, B=Baseline+Growth+Development 18hr AAWT flows

32. **Table 2.8** shows the predicted relative dBA change (following the Basic Noise Level calculation procedure) for the assessment of Scenario 2 construction traffic along Link 34 (using 2019 18hr AAWT base flows) based on the $L_{A10,18h}$ criteria for traffic in accordance with CRTN methodology with the corresponding 2019 DMRB derived impact magnitude using the criteria in **Table 2.4**. The impact significance is determined through the assessment matrix provided in **Table 2.6**.

Table 2.8 Scenario 2 – Norfolk Boreas HIS impacts

	Predicted Basic Noise Level $L_{10,18hr}$ dBA	Predicted Basic Noise Level $L_{10,18hr}$ dBA	dBA Change $L_{10,18hr}$	Speed (km/h)	Impact magnitude	Impact significance
2023 Baseline + Growth **versus** 2023 Baseline + Growth + Development Construction Traffic	63.6	64.6	+1.0	32.2	Minor	**Minor Adverse**
2023 Baseline + Growth) **versus** 2023 Baseline + Growth + Development Construction Traffic+HP3 Cumulative)	63.6	65.5	+1.9	32.2	Minor	**Minor Adverse**
2024 Baseline + Growth **versus** 2024 Baseline + Growth + Development Construction Traffic	63.7	64.7	+1.0	32.2	Minor	**Minor Adverse**
2024 Baseline + Growth **versus** 2024 Baseline + Growth +	63.7	65.5	+1.8	32.2	Minor	**Minor Adverse**

	Predicted Basic Noise Level $L_{10,18hr}$ dBA	Predicted Basic Noise Level $L_{10,18hr}$ dBA	dBA Change $L_{10, 18hr}$	Speed (km/h)	Impact magnitude	Impact significance
Development Construction Traffic+HP3 Cumulative						

33. **Table 2.8** shows the predicted impact significance for Scenario 2 with the HIS, alone and cumulatively with HP3, along link 34. The highest impact magnitude is Minor (using the 2019 DMRB criteria in **Table 2.4**) on a medium sensitivity receptor. Using the matrix detailed in **Table 2.6** this results in an impact significance of **Minor adverse**. This is not considered significant in EIA terms.

2.3.2 Norfolk Boreas Scenario 1

34. For Scenario 1 traffic impacts were assessed for the construction phase years of 2026 and 2027 (as per the programme details in Chapter 24 Traffic and Transport [APP-237]), taking base flows, annual growth and Norfolk Boreas project-generated construction traffic into consideration.

35. **Table 2.9** presents the Scenario 1 alone (using 2019 18hr AAWT base flows) along Link 34 and the screening assessment for each relevant assessment year.

36. **Table 2.9** details the percentage change in 18hr AAWT Total Flows and considers the change in composition for number of HGVs (% change) for the Baseline plus Growth versus the Baseline plus Growth plus Development Construction Traffic (NBS1) for 2026 and 2027.

Table 2.9 Link 34 Screening Scenario 1 – Norfolk Boreas HIS

Scenario	(18hr AAWT)[A]		(18hr AAWT)[B]		% Change	
	Total Flow	HGVs	Total Flow	HGVs	Total Flow	HGVs
2026 Baseline + Growth **versus** 2026 Baseline + Growth + Development Construction Traffic	3,688	330	3,818	391	3.5	18.5
2027 Baseline + Growth **versus** 2026 Baseline + Growth + Development Construction Traffic	3,736	335	3,866	396	3.5	18.2

Note: A = Baseline+Growth 18hr AAWT flows, B= Baseline+Growth+Development 18hr AAWT flows

37. **Table 2.10** shows the predicted relative dBA change (following the Basic Noise Level calculation procedure) for the assessment of Scenario 1 construction traffic along Link 34 (using 2019 18hr AAWT base flows) based on the $L_{A10,18h}$ criteria for traffic in

accordance with CRTN methodology with the corresponding 2019 DMRB derived impact magnitude using the criteria in **Table 2.4**.

Table 2.10 Scenario 1 – Norfolk Boreas HIS impacts

Scenario	Predicted Basic Noise Level L10,18hr dBA	Predicted Basic Noise Level L10,18hr dBA	dBA Change L10, 18hr	Speed (km/h)	Impact magnitude	Impact significance
2026 Baseline + Growth) **versus** 2023 Baseline + Growth + Development Construction Traffic	63.9	64.4	+0.5	32.2	Negligible	**Minor Adverse**
2027 Baseline + Growth) **versus** 2023 Baseline + Growth + Development Construction Traffic	63.9	64.4	+0.5	32.2	Negligible	**Minor Adverse**

38. **Table 2.10** shows the predicted impact significance for Scenario 1 with the HIS along Link 34. The highest impact magnitude is Negligible (using the 2019 DMRB criteria in **Table 2.4**) on a medium sensitivity receptor. Using the matrix detailed in **Table 2.6** this results in an impact significance of **Minor Adverse.** This is not considered significant in EIA terms.

2.4 Noise Assessment Summary

39. A revised HIS along Link 34 in Cawston is proposed during the construction phasing for Norfolk Boreas.

40. Traffic data, including speed, was provided for Link 34 in the form of 18hr AAWT with speed data and percentage HGVs for Scenario 1 and Scenario 2. For each scenario, the traffic data considered various traffic years based on each proposed project start date and sequencing. For this assessment, Norfolk Boreas baseline traffic flows were updated, based on the 18hr AAWT traffic flows provided from the 2019 survey, along with revised speed flows for Link 34 (proposed as part of the revised HIS). Construction phase traffic along Link 34 was assessed for Scenario 1 and Scenario 2 alone and Scenario 2 was also assessed cumulatively with HP3 for each project year.

41. In accordance with the DMRB criteria detailed in **Table 2.4**, it is anticipated that for Scenario 2 project generated construction traffic alone or cumulatively with HP3, with the implementation of the revised HIS, along Link 34 at Cawston will result in change of minor magnitude (no greater than +1.9db). A change of minor magnitude on a medium sensitivity (residential) receptor results in a **Minor adverse** impact, and therefore will not have a significant effect.

42. In accordance with the DMRB criteria detailed in **Table 2.4**, it is anticipated that for Scenario 1 project generated construction traffic with the implementation of the revised HIS along Link 34 at Cawston will have a negligible magnitude of change (no greater than +0.5db). A negligible magnitude of change on medium sensitivity (residential) receptor results in a **Minor adverse** impact and therefore will not have a significant effect.

3 Vibration Assessment of Highway Intervention Scheme

3.1 Introduction

43. This vibration assessment was undertaken using the methodology outlined in the submission at Section 25.4.1.2 of ES Chapter 25 Noise and Vibration [APP-238].

44. This section refers to the vibration implications of the revised HIS on receptors in the vicinity of Link 34, Cawston. Relevant tables from the ES chapter in [APP-238] are reproduced here to facilitate ease of interpretation.

3.2 Vibration Assessment Methodology

3.2.1 Vibration Impacts on Humans – Vibration Dose Value (VDV)

45. BS 6472-1:2008 ("Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting") contains a methodology for assessing the human response to vibration in terms of either the Vibration Dose Value (VDV), or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as Peak Particle Velocity (PPV). The VDV is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings.

46. The prediction of the effect of additional HGV movements can be calculated using the following equation:

$$_{e}VDV_{Total} = (N)^{0.25} \times V$$

47. In the equation 'N' represents the number of HGV movements (existing and proposed for the scheme) and 'V' is the vibration dose value per HGV movement.

48. The VDV is determined over a 16-hour daytime period or 8-hour night-time period and the thresholds for probability of adverse comment are reproduced from BS6472-1 as **Table 3.1.**

Table 3.1 VDV ranges which might result in various probabilities of adverse comment within residential buildings

Place and Time	Low probability of adverse comment ($m.s^{-1.75}$)[1]	Adverse comment possible ($m.s^{-1.75}$)	Adverse comment probable ($m.s^{-1.75}$)[2]
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: [1]Below these ranges adverse comment is not expected. [2]Above these ranges adverse comment is very likely

3.2.2 Vibration Impacts on Buildings

49. The response of a building to ground-borne vibration is affected by the type of foundation, ground conditions, the building construction and condition. For construction vibration, the vibration level and effects detailed in **Table 3.2** are based on criteria in BS5228-2:2009+A1:2014 ("*Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*"). Limits for transient vibration, above which cosmetic damage could occur, are given numerically in terms of PPV.

Table 3.2 Transient vibration guide values for cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	$50mms^{-1}$ at 4Hz and above	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	$15mms^{-1}$ at 4Hz increasing to $20mms^{-1}$ at 15Hz	$20mms^{-1}$ at 15Hz increasing to $50mms^{-1}$ at 40Hz and above

50. **Table 3.3** details the VDV impact magnitude matrix for humans.

Table 3.3 Construction vibration – VDV impact magnitude

Daytime Vibration limit VDV ($m.s^{-1.75}$)	Interpreted significance to humans	Impact magnitude
<0.2	Less than a low probability of adverse comment	Negligible – Adverse
≥0.2 to <0.4	Low probability of adverse comment	Minor – Adverse

Daytime Vibration limit VDV (m.s$^{-1.75}$)	Interpreted significance to humans	Impact magnitude
≥0.4 to <0.8	Adverse comment possible	Moderate – Adverse
≥0.8 to <1.6	Adverse comment probable	Major – Adverse

51. For construction vibration from sources other than blasting, the vibration level and effects presented in **Table 3.4** were adopted based on Table 3.31 of LA111 DMRB, 2019. These levels and effects are based on human perception of vibration in residential environments.

Table 3.4 Construction vibration – PPV impact magnitude

Vibration limit PPV (mm/s)	Interpreted significance to humans	Impact magnitude
<0.3	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction	Negligible - Adverse
0.3 to 1.0	Vibration might just be perceptible in residential environments	Minor – Adverse
1.0 to ≤10.0	It is likely that vibration at this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents	Moderate – Adverse
≥10.0	Vibration is likely to be intolerable for any more than a brief exposure to this level	Major – Adverse

3.3 Vibration Assessment

3.3.1 Vibration Survey

52. A noise and vibration assessment for Cawston Village was undertaken by Hornsea Project Three (HP3) (see Applicant's Comment on Responses to ExA Written Questions Appendix 2 [REP3-006]). Consideration was also given to the cumulative impacts from the Norfolk Vanguard Scheme.

53. The findings from the HP3 report [REP3-006] were reviewed and considered in the Applicant's Comments on Responses to the ExA's Further Written Questions at WQ14.0.6 [REP3-003] and were deemed appropriate for Norfolk Boreas.

54. In order to establish the prevailing acoustic environment through Cawston a baseline vibration survey was undertaken. Vibration measurements were undertaken by the HP3 consultants at four receptors along Link 34 between 11th and 13th February 2019. The locations of these receptors are presented in Figure 3.1 of the HP3 report [REP3-006]. These were:

- The Old Forge;
- 20 High Street;
- 27 High Street; and
- Whitehouse Farm.

55. These locations are considered to be representative of the High Street corridor where the sound values are expected to be at their highest and include the Grade II Listed Whitehouse Farm. The final monitoring locations were agreed with the Environmental Health Officer at Broadland District Council by HP3.

56. The measurement duration of the HP3 survey is considered sufficient as is the geographical spread along Link 34 to determine typical and representative vibration data to be gathered for VDV and PPV indices.

57. This approach represents a reasonable worse case (conservative approach), it is location specific and has determined the impacts based on measured noise and vibration levels from HGV passbys at each of the four locations surveyed.

58. It is normal practice to measure at a selection of receptor locations which are deemed representative of groups of receptors. Therefore, it would be reasonable to extrapolate these assessed vibration levels to other nearby receptors along the same road link (Link 34).

3.3.2 Vibration Assessment – Human Receptors

59. Predicted construction traffic vibration effects were calculated based on the measured baseline vibration levels (contained in the HP3 report [REP3-006]) experienced from existing vehicles. The current vibration effects are a function of the existing road surface and existing traffic. The vibration effects associated with the introduction of construction vehicles can be extrapolated based on the expected sizes and speeds of those vehicles in relation to the existing vehicle types.

60. A review of the measured VDV data presented in Table 3.8 to 3.11 of the HP3 report [REP3-006] for the four receptor locations within Cawston was undertaken. The eVDV was then calculated using the highest measured value at each property (measured during the HP3 2019 survey) and the worst case cumulative HGV traffic flows (as used for the noise assessment, see section 2.2.1).The calculated levels at each of the four receptor locations are detailed in **Table 3.5**.

Table 3.5 Construction vibration – Predicted eVDV based on HIS Cumulative Flows

Location and Measured Maximum VDV	X axis (m.s^1.75)	Y axis (m.s^1.75)	Z axis (m.s^1.75)	V	N	Predicted Daytime Vibration eVDV Total
Old Forge	0.005	0.006	0.022	0.023	646	0.12
20 High Street	0.006	0.006	0.012	0.015	646	0.076
27 High Street	0.004	0.004	0.01	0.011	646	0.055
Whitehouse Farm	0.005	0.005	0.019	0.020	646	0.10

61. The highest eVDV was predicted at the Old Forge as 0.12 $eVDV_{Total}$. Using the assessment criteria in **Table 3.3** this indicates a "*Less than low probability of adverse comment*" and therefore results in a negligible impact magnitude at a medium sensitivity receptor (residential). Using the matrix detailed in **Table 2.6** this results in a **Minor adverse** impact significance. This is not considered significant in EIA terms.

3.3.3 Vibration Assessment – Buildings (including Listed Buildings)

62. The highest measured PPV levels recorded during the HP3 survey [REP3-006] were used to establish potential structural impacts on residential and listed buildings along Link 34. The highest measured PPV value at each property is detailed in **Table 3.6**.

Table 3.6 Measured Maximum PPV from HGV movements at each receptor

Location	Date	Time	Measured Maximum PPV (mm/s)
Old Forge	12/02/19	15:49	0.803
20 High Street	11/02/19	16:11	0.723
27 High Street	11/02/19	14:14	0.402
Whitehouse Farm	12/02/19	11:09	0.482

63. The highest measured values were compared with the relevant PPV thresholds (reproduced from guidance in BS5228-2:2009+A1:2014) detailed in **Table 3.2** and used to derive a PPV impact magnitude as detailed in **Table 3.4**.

64. The highest PPV along Link 34 was measured at 0.803 mm/s at Old Forge. This is significantly below the thresholds presented in **Table 3.2** (based on criteria within BS5228-2:2009+A1:2014) and represents a minor impact magnitude using the criteria in **Table 3.4.** A minor magnitude at a medium sensitivity receptor, using the matrix detailed in **Table 2.6,** results in a **Minor adverse** impact significance, which is not significant in EIA terms.

65. There will be an increase in the number of HGVs, both with Norfolk Boreas alone, and cumulatively with HP3.

66. The Norfolk Boreas Scheme will use HGVs conforming to the existing maximum 44 tonne restriction for Link 34. Therefore, the measured vibration levels at each of the four properties obtained during the HP3 survey are deemed representative of the range of PPV levels from typical HGV movements, likely to be experienced during the Norfolk Boreas and HP3 projects.

67. The speed of passing HGVs and all vehicles will reduce as part of the revised HIS measures, from 23.2mph (measured during the 2019 baseline survey) to a proposed 20mph restriction. The routing and proximity to residential dwellings and listed buildings in Cawston of the project's HGVs will not change. Therefore, it is reasonable to consider the measured PPV levels are representative of future HGV pass-bys of the dwellings and listed buildings.

68. Additionally, the vibrational transfer to the buildings would remain constant (based on no proposed changes in vehicle weight, routing or closer proximity to the buildings); though the number of events would increase due to the additional vehicular movements along Link 34.

69. This approach demonstrates a reasonable worst case, both for the Norfolk Boreas scheme alone, and cumulatively with HP3 traffic movements.

3.4 Vibration Assessment Summary

70. Predicted vibration impacts on humans (VDV) are below the threshold level "*Less than low probability of adverse comment*" using the criteria detailed in **Table 3.1**. Using the criteria in **Table 3.3** this results in a negligible adverse magnitude on a medium sensitivity receptor, resulting in a **minor adverse** impact significance for vibration impacts on human receptors as a consequence of implementing the revised HIS. This is not considered significant in EIA terms.

71. Predicted vibration impacts (PPV) on buildings (including those designated as listed buildings) are significantly below the threshold level for cosmetic damage detailed in **Table 3.2** when using the highest measured level at each of the four receptor locations (representative of listed and residential dwellings along Link 34).

72. Although it is noted the frequency of vibrational transfer events from HGV movements along Link 34 to each building during the scheme mobilisation hours (09:00 to 15:00 and 16:00 to 18:00) will occur more often, the predicted impacts are of minor magnitude on a medium sensitivity receptor which results in a **minor adverse** impact significance. This is not considered significant in EIA terms.

4 Air Quality Assessment of the Highway Intervention Scheme

4.1 Introduction

73. The air quality assessment was undertaken using the same methodology as detailed in ES Chapter 26, Air Quality [APP-239] Section 26.1.1.2 for construction vehicle exhaust emissions (please refer to the ES for full details).

74. Air quality modelling was also carried out to consider the potential impact of the revised HIS on residential properties along the B1145 (Link 34) in Cawston, as described in Section 1, and based upon the same traffic datasets as the noise assessment. This was undertaken to assess if the revised HIS would lead to any significant impacts at the identified receptors in the vicinity of the B1145.

4.2 Air Quality Assessment Methodology

4.2.1 Norfolk Boreas Scenarios and Traffic Data

75. The air quality assessment was undertaken using the same parameters as the assessments undertaken for ES Chapter 26, Air Quality [APP-239]. Traffic flow data was provided for the B1145, Cawston, by Royal HaskoningDHV's transport consultant. Two different sets of baseline traffic flow data were provided; those collected for the Norfolk Boreas project (2017), and those collected for HP3 (2019). The HP3 2019 traffic flows were higher than those collected for Norfolk Boreas (2017), and recorded speeds were lower, as noted in **Table 4.1.** The effect of both of these differences (in the HP3 2019 data) would result in a worst-case for air quality as they would give rise to higher vehicle emissions. As such, the assessment of the revised HIS was carried out using the 2019 baseline traffic flow data, as summarised in **Table 4.1**. The Scenario 1 assessments do not include construction traffic associated with HP3 as it is expected that there would be no overlap between the projects.

Table 4.1 Air Quality Modelling scenarios

Norfolk Boreas Scenario	Traffic data*	Year	ID
Scenario 1	2019 baseline traffic flows + construction traffic associated with Norfolk Boreas	2027	Scenario 1_HP3 data
Scenario 2	2019 baseline traffic flows + construction traffic associated with Norfolk Boreas and HP3	2024	Scenario 2_HP3 data
*Note: Base HP3 HGV flows (from 2019 survey) were higher than the Norfolk Boreas (and Vanguard) base HGV flows (from 2017 survey) (i.e. ES data), as ES data did not include the TB2 vehicle class (ARX+ vehicle classification) within the HGV flows, as previous research has indicated that this class can greatly over estimate the amount of HGVs and is based on axle lengths, thus as a worst case ES data only included vehicle classes above TB2 as HGVs.			

4.2.2 Implications on Air Quality of the Revised HIS

76. The main implications of the revised HIS, with regards to air quality impacts, were that:

- A 20 mph zone would be employed through Cawston;
- A marked parking area (for a minimum of 9 vehicles (cars) on the north side of Cawston High Street would be provided, which would create a section of road that only allows one vehicle to pass at a time; and
- The potential for a two-way articulated HGV or large tipper HGV conflict areas would be created, which would result in vehicles idling in sections of the road before / after the HGV conflict areas along the B1145.

77. The frequency and duration over which vehicles may be idling either side of the HGV conflict areas cannot be estimated. As such, a conservative approach was taken to representing these queueing areas within the dispersion model to ensure that potential impacts were sufficiently captured.

78. It was therefore assumed that, during working hours when HGV deliveries would occur, the HGV conflict areas would give rise to idling vehicles.

79. All sections of road identified as potentially having HGV conflict areas and / or queues of idling vehicles were modelled at 5 kph (the lowest speed that can be modelled in ADMS-Roads), from the hours of 07:00-08:00, 09:00-15:00 and 16:00 to 18:00 Monday to Friday, and from 07:00-18:00 Saturday, as per the HIS. These areas are as shown by the red lines in **Figure 4.1**.

80. The model therefore assumed that vehicles would be travelling at this speed continually during these hours; this is conservative as vehicles would only be required to wait when two HGVs would approach each other at the same time, for a short duration.

81. There would be an area designated for on-road parking, as shown by the green line in **Figure 4.1**. Although there would be parked vehicles on one carriageway along this stretch of road (i.e. the northern carriageway), traffic could freely pass along the southern carriageway at the speed limit (20mph). Any on-coming traffic would then be required to wait at either end, in the areas marked red in **Figure 4.1**. The areas shown by the green line were therefore modelled at low speed, as described above. The roads outside the 20 mph zone, shown by the blue lines in **Figure 4.1**, were modelled at the average speeds recorded during the HP3 traffic survey[1].

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[1] Speeds from the HP3 traffic survey in 2019 were lower than the speeds recorded in the Norfolk Boreas / Vanguard traffic survey in 2017, as HP3 ATCs were undertaken within more built up areas of Cawston while Norfolk Boreas counts were undertaken further to the west, within a rural 60 mph speed limit.

82. Outside of working hours, it was assumed that all traffic would travel at the HIS speed limit (20mph).

83. A summary of the vehicle speeds included within the model for the different times of day, based on the links shown in **Figure 4.1**, is provided in **Table 4.2.**

Table 4.2 Vehicle Speeds Assigned in the Model

Road Link	Speed (kph)		
	Without HIS*	During Working Hours	Outside Working Hours
Blue	37/42	48	32
Red	37/42	5	32
Green	37/42	32	32

* as recorded during the traffic survey

Figure 4.1: Speeds on Link 34 (B1145) as represented in the dispersion model

4.2.3 Receptors

84. The assessment undertaken for the ES [APP-239] included receptors along the B1145 through Cawston (R17 and R18); these were included within this assessment.

85. Additional receptors were added on the B1145 (Cawston New Receptor (CNR) 1 – 7), to consider impacts at locations adjacent to potentially idling vehicles along the B1145 as a result of the revised HIS. Details of the new receptor locations are in **Table 4.3**, and all receptor locations are shown in **Figure 4.2**.

Table 4.3 New receptor locations

ID	Location	X	Y
CNR1	25 High St., Cawston	613423	323934
CNR2	Across from 15 High St., Cawston	613576	323867
CNR3	1 Aylsham Rd.	613464	323907
CNR4	1 High St., Cawston	613514	323912
CNR5	10 High St., Cawston	613566	323890
CNR6	24 High St., Cawston	613542	323892
CNR7	The Old Forge, Booton Rd./Cawston Junction	613484	323918

Figure 4.2: Receptors (original ES (R17, R18) and new (CNR1-7)) included in the air quality assessment

4.2.4 Sensitivity

86. The sensitivity of a human receptor is not considered in the assessment of air quality impacts; the Air Quality Objectives in **Table 4.4**, which are health-based, only apply at locations where there is relevant public exposure as detailed in **Table 4.4.**

Table 4.4 Example of where the Air Quality Objectives should/should not apply

Averaging period	Objective should apply at:	Objectives should generally not apply at:
Annual Mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-Hour Mean and 8-Hour Mean	All locations where the annual mean objective would apply, together with hotels and gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-Hour Mean	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer	Kerbside sites where the public would not be expected to have regular access.

87. Sensitive receptor locations that experience pollutant concentrations close to, or in exceedance of the objectives experience a larger impact magnitude with a smaller change in pollutant concentrations, as detailed below.

4.2.5 Magnitude and Significance

88. Guidance is provided by the IAQM and EPUK (IAQM and EPUK, 2017) on determining the magnitude and significance of a project's impact on local air quality. The guidance was developed specifically for use in planning and assessing air quality impacts associated with mixed-use and residential developments. However, due to the nature of the project, the criteria detailed below were utilised in the assessment to provide consideration of the impacts associated with the project.

89. The impact descriptors that take account of the magnitude of changes in pollutant concentrations, and the concentration in relation to the Air Quality Objectives, are detailed in **Table 4.5**.

Table 4.5 Impact descriptors for individual receptors

Long term average concentrations at receptor in assessment year	% change in concentrations relative to the air quality objective			
	1	2 - 5	6 – 10	>10
75% or less of objective	Negligible	Negligible	Slight	Moderate
76 – 94% of objective	Negligible	Slight	Moderate	Moderate
95 – 102% of objective	Slight	Moderate	Moderate	Substantial
103 -109% of objective	Moderate	Moderate	Substantial	Substantial
110% of more of objective	Moderate	Substantial	Substantial	Substantial

Note: Figures are to be rounded up to the nearest round number. Any value less than 1% after rounding (effectively less than 0.5%) will be described as “Negligible”.

90. Further to the determination of the impact at individual receptors, the guidance recommends that assessment is made of the overall significance of the impact from a development on local air quality. The overall significance will need to take into account the following factors:

- The existing and future air quality in the absence of the project;
- The extent of current and future population exposure to the impacts; and
- The influence and validity of any assumptions adopted when undertaking the prediction of impacts.

91. The guidance also states that a judgement of the significance should be made by a competent professional who is suitably qualified. This air quality assessment and determination of the significance of the project on local air quality was undertaken by members of the IAQM.

4.3 Air Quality Assessment Results

92. The impact assessment was undertaken as described in the ES chapter [APP-239], using Institute of Air Quality Management (IAQM) and Environmental Protection UK (EPUK) guidance (IAQM and EPUK, 2017). The ‘Without Development’ scenario relates to the future baseline for the relevant assessment year without either Norfolk Boreas or HP3 traffic included. The results of the assessment for each modelled scenario are shown in **Table 4.6** and **Table 4.7**.

Table 4.6 Results for Norfolk Boreas Scenario 1 as a result of the revised HIS

Receptor ID	Norfolk Boreas Scenario 1 (2027)				
	Without Development Concentration (µg.m⁻³)	With Norfolk Boreas and the HIS Concentration (µg.m⁻³)	Change (µg.m⁻³)	Change as % of Objective	Impact Descriptor
Annual Mean NO_2 Concentrations					
R17	11.28	12.71	1.43	4%	Negligible
R18	9.78	10.68	0.90	2%	Negligible
CNR1	10.13	10.46	0.33	1%	Negligible
CNR2	12.70	14.99	2.29	6%	Slight adverse
CNR3	13.84	17.07	3.23	8%	Slight adverse
CNR4	10.51	11.85	1.34	3%	Negligible
CNR5	12.38	12.96	0.58	1%	Negligible
CNR6	13.15	15.95	2.80	7%	Slight adverse
CNR7	10.52	11.84	1.32	3%	Negligible
Annual Mean PM_{10} Concentrations					
R17	15.21	15.21	0.00	0%	Negligible
R18	15.11	15.11	0.00	0%	Negligible
CNR1	15.13	15.13	0.00	0%	Negligible
CNR2	15.30	15.30	0.01	0%	Negligible
CNR3	15.37	15.38	0.01	0%	Negligible
CNR4	15.15	15.16	0.00	0%	Negligible
CNR5	15.28	15.27	0.00	0%	Negligible
CNR6	15.33	15.34	0.01	0%	Negligible
CNR7	15.16	15.16	0.01	0%	Negligible
Annual Mean $PM_{2.5}$ Concentrations					
R17	10.12	10.12	0.01	0%	Negligible
R18	10.05	10.06	0.00	0%	Negligible
CNR1	10.07	10.07	0.00	0%	Negligible
CNR2	10.17	10.18	0.01	0%	Negligible
CNR3	10.22	10.24	0.01	0%	Negligible
CNR4	10.08	10.09	0.01	0%	Negligible
CNR5	10.16	10.16	0.00	0%	Negligible
CNR6	10.19	10.21	0.01	0%	Negligible
CNR7	10.08	10.09	0.01	0%	Negligible

Table 4.7 Results for Norfolk Boreas Scenario 2 and HP3 as a result of the revised HIS

Receptor ID	Norfolk Boreas Scenario 2 (2024)				
	Without Development Concentration (µg.m-3)	With Norfolk Boreas, HP3 and the HIS Concentration (µg.m-3)	Change (µg.m-3)	Change as % of Objective	Impact Descriptor
Annual Mean NO_2 Concentrations					
R17	11.16	13.89	2.73	7%	Slight adverse
R18	9.72	11.35	1.63	4%	Negligible
CNR1	10.06	10.98	0.92	2%	Negligible
CNR2	12.51	16.77	4.26	11%	Moderate Adverse
CNR3	13.61	19.41	5.80	15%	Moderate Adverse
CNR4	10.42	12.84	2.42	6%	Slight adverse
CNR5	12.21	14.03	1.82	5%	Negligible
CNR6	12.95	18.00	5.05	13%	Moderate Adverse
CNR7	10.43	12.82	2.39	6%	Slight adverse
Annual Mean PM_{10} Concentrations					
R17	15.20	15.25	0.05	0%	Negligible
R18	15.10	15.13	0.03	0%	Negligible
CNR1	15.13	15.15	0.03	0%	Negligible
CNR2	15.29	15.36	0.08	0%	Negligible
CNR3	15.36	15.46	0.10	0%	Negligible
CNR4	15.15	15.19	0.04	0%	Negligible
CNR5	15.27	15.33	0.06	0%	Negligible
CNR6	15.31	15.40	0.09	0%	Negligible
CNR7	15.15	15.19	0.04	0%	Negligible
Annual Mean $PM_{2.5}$ Concentrations					
R17	10.11	10.15	0.04	0%	Negligible
R18	10.05	10.07	0.02	0%	Negligible
CNR1	10.07	10.09	0.02	0%	Negligible
CNR2	10.17	10.22	0.06	0%	Negligible
CNR3	10.21	10.29	0.07	0%	Negligible
CNR4	10.08	10.11	0.03	0%	Negligible
CNR5	10.15	10.20	0.04	0%	Negligible
CNR6	10.18	10.25	0.06	0%	Negligible
CNR7	10.08	10.11	0.03	0%	Negligible

93. As shown in **Table 4.6** and **Table 4.7** in both scenarios, pollutant concentrations **were well below the respective annual mean air quality Objectives (40µg.m-3 for NO_2 and PM_{10}, 25µg.m-3 for $PM_{2.5}$) at all receptors**.

94. For both scenarios the long term average concentrations (annual mean concentrations presented in **Table 4.6** and **Table 4.7**) at all receptors were all less than 75% of the objective (40µg.m-3 for NO_2 and PM_{10}, 25µg.m-3 for $PM_{2.5}$). In accordance with the IAQM and EPUK guidance (IAQN and EPUK, 2017) and Table 4.5, for Scenario 1 the change in annual mean NO_2 concentrations were between 1% and 7% of the objective; this corresponded to a 'negligible' to 'slight adverse' magnitude. For Scenario 2 cumulatively with HP3 the change in annual mean NO_2 concentrations were between 2% to 7% of the objective at six of the receptor locations; this corresponded to a 'negligible' to 'slight adverse' magnitude. At three receptor locations the change in annual mean NO_2 concentrations were between 11% and 15% of the objective; this corresponded to a 'moderate adverse' magnitude.

95. In both scenarios, the impacts of highest magnitude were predicted to be experienced at receptors within the HGV conflict areas (CNR2, CNR3, CNR6), which were very conservatively modelled at a speed of 5 kph for the duration of the working day. Furthermore, as explained in the ES chapter, the assessment assumed no improvement in vehicle emissions between 2019 and 2024 or 2027. This is also considered to be extremely conservative, as the vehicle fleet would be expected to comprise a larger number of vehicles of a higher Euro standard during the years of construction when compared to 2019 baseline levels.

96. As stated in Section 4.2.5, the conclusion of the significance of air quality effects is made in accordance with IAQM and EPUK guidance (IAQM and EPUK, 2017) using professional judgement, taking into account the number of receptors affected, the total concentrations and potential for exceedances of the Objectives. Given the highly conservative nature of the assessment, and that predicted concentrations are 'well below' the air quality Objectives for all pollutants in all scenarios, impacts are considered to be **not significant**.

4.4 Air Quality Assessment Summary

97. In both scenarios, pollutant concentrations were well below the respective annual mean air quality Objectives (40µg.m^{-3} for NO_2 and PM_{10}, 25µg.m^{-3} for $PM_{2.5}$) at all receptors.

98. Due to the approach to assessment outlined in Section 4.2.2, these results are also noted to be extremely conservative as vehicles would not be continuously idling through Cawston during working hours.

99. As such, although the revised HIS would give rise to additional emissions and associated pollutant concentrations at receptors, the impacts have not been assessed as significant. Therefore, the implementation of the HIS would not lead to the exceedance of the air quality Objectives, or significant EIA effects, at receptors in the vicinity of the B1145.

5 Conclusions

100. This clarification note has detailed the potential noise, vibration and air quality effects associated with the implementation of the revised HIS for Norfolk Boreas upon the identified receptors in the vicinity of the B1145.

101. The findings of the road traffic noise assessment concluded that for Norfolk Boreas alone and cumulatively with HP3 impacts will be no greater than **minor adverse**, and therefore will have no significant effect upon the receptors in the vicinity of Link 34.

102. The vibration assessment concluded that the predicted vibration impacts on humans (VDV) are currently below the threshold level "*Less than Low probability of adverse comment*". The predicted vibration impacts on human receptors as a consequence of implementing the HIS are **minor adverse**, which is not significant in EIA terms.

103. Predicted vibration impacts (PPV) on buildings (including those designated as listed buildings) are below the threshold level for cosmetic damage at each of the four receptor locations (representative of listed and residential dwellings along link 34). Although it is noted the frequency of vibrational transfer events from HGV movements along Link 34 to each building during the scheme mobilisation hours will increase , the predicted impacts are **minor adverse**, which is not significant in EIA terms.

104. The air quality assessment for both scenarios (as detailed in Section 4.2.1) concluded that the pollutant concentrations were **well below the respective annual mean air quality Objectives (40µg.m^{-3} for NO_2 and PM_{10}, 25µg.m^{-3} for $PM_{2.5}$)** at all receptors identified. Therefore, impacts were assessed as **not significant**.

6 References

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