EKFB Working in partnership with HS2

High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley

Nash Lee Noise Demonstration Report

1MC06-CEK-TP-REP-CS03_CL06-000002

Rev	Date	Author	Checked by	Approved by	Revision Details	EK Reviewer
C01	21/12/2021	Jens Erik Blumensaadt Jensen	Colin Cobbing	Mark Alcock	Internal Review	Mark Roberts

Stakeholder review required (SRR)	Purpose of SRR
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☐ LUL	☐ No Objection
☐ NRL	☐ Consent
☐ TFL	
☐ Utilities Company	
☐ Other (please specify)	

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Glossary of Terms

Term	Description
AFARP	As far as is reasonably practicable
AONB	Area of Outstanding Natural Beauty
AP	Additional Provisions
ARFC	All reasonably foreseeable circumstances
AVDC	Aylesbury Vale District Council
BC	Buckinghamshire Council
BS	British Standard
CDC	Chiltern District Council
CBA	Cost Benefit Analysis
CoCP	Code of Construction Practice
CRTN	Calculation of Road Traffic Noise
dB	Decibel
dB(A)	'A' Weighted Decibel.
EIA	Environmental Impact Assessment
EMRs	Environmental Minimum Requirements

ES	Environmental Statement
LOAEL	Lowest Observed Adverse Effect Level
LPA	Local Planning Authority
LpAeq	'A' Weighted Equivalent Continuous Sound Level
LpAmax	Maximum 'A' Weighted Sound Pressure Level
NDR	Noise Demonstration Report
Nominated undertaker	The body or bodies appointed to implement the powers of the hybrid Bill to construct and maintain the railway
PMA	Project Master Alignment
SADC	Stratford on Avon District Council
SES	Supplementary Environmental Statement
SOAEL	Significant Observed Adverse Effect Level
the Act	The High-Speed Rail (London – West Midlands) Act 2017
TNPM	Train Noise Prediction Model
TSI	Technical Specifications for Interoperability
ToR	Top of Rail
U&As	Undertakings and Assurances

EXECUTIVE SUMMARY

The purpose of this report is to provide Buckinghamshire Council (BC) (formerly Aylesbury Vale District Council) with supporting information to assist with the determination of the application made under Schedule 17 of the Act (AVDC Package 4 Nash Lee).

This report demonstrates how all reasonable steps have been taken for the combined airborne sound from altered roads and operational railways, predicted in all reasonably foreseeable circumstances, not to exceed the lowest observed adverse effect levels. The mitigation has been assessed as far as is reasonably practicable at this stage in the design process.

The Plans and Specifications submissions under Schedule 17 to the High-Speed Rail (London – West Midlands) Act 2017 is for works covering several assets including the proposed noise barriers.
Several mitigation options have been evaluated against a range of criteria including the acoustic effects; landscape and visual effects; engineering practicability, stakeholder engagement and value for money. The proposed designs represent the optimal solutions having regard to all the relevant factors.

The proposed mitigation designs have been selected on the basis that they reduce noise as far as reasonably practicable and represents the optimum balance between acoustic effects, other environmental considerations and costs.

For **Wendover Green Tunnel North Portal to Wendover North Cutting** the assessment shows that, on balance, the overall change in the acoustic performance is neutral compared to that reported in the ES (as amended). The visual impacts associated with the proposed earthworks mitigation design is a notable landscape and visual benefit. Particularly at a location which is within the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range elevated views from the realigned PRoW which traverses over the tunnel in proximity to the north portal.

For **Wendover North Cutting – Up-Side** the assessment shows that , on balance, the overall change in the acoustic performance is neutral compared to that reported in the ES (as amended). The visual impacts associated with the proposed earthworks mitigation design will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties.

For **Wendover North Cutting – Down-Side** the assessment shows, on balance, there is a material benefit and that the likely significant effect reported in the ES (as amended) will be avoided. The visual impacts associated with the proposed earthworks mitigation design will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties.

1 Introduction

1.1 Background and Aim

The purpose of this report is to provide Buckinghamshire Council (BC) (formerly Aylesbury Vale District Council) with supporting noise assessment information to assist with the determination of the application for Plans and Specifications submitted under Schedule 17 of the High-Speed Rail (London – West Midlands) Act 2017, for the AVDC Package 4 Nash Lee.

Although this report relates to the applications made under Schedule 17 of the Act, it is necessary to consider operational noise over a larger area outside each application site to properly understand the overall effect of noise. Therefore, a broader geographical area is considered for the purposes of the noise assessment, referred from hereon as the study area.

This Noise Demonstration Report is compiled in accordance with the High Speed Two (HS2) Phase 1 Planning Memorandum and Planning Forum Note 14: Operational Noise from the Railway and Altered Roads (PFN 14).

The information in this NDR shows, as far as is reasonably practicable at the current stage in the design process, how the proposed noise mitigation performs and the expected conditions. This information will provide reassurance in advance of the request for approval under paragraph 9 of the same document that the mitigation is appropriate. To determine optimal mitigation measures a number of options have been assessed. The noise mitigation options are presented in Section 3.3.

1.2 Structure of Report

This report comprises the following sections:

- Policy, Requirements and Standards
- Description of the Works
- Methodology
- Options appraisal
- Assumptions
- Results of the assessment of the proposed noise mitigation
- Conclusions

1.3 Site Location

The Nash Lee application area is shown on the Nash Lee Site Location Plan ((Drawing No. 1MC06-CEK-TP-REP-CS03_CL06-000002)) as presented in Appendix A as shown on Image 1.

The application site boundary is located to the north of Bacombe Lane, to the east of Risborough Road and to the west of the A413 Wendover Road, Wendover. It is located between the settlements of Nash Lee and Wendover. Wendover is the nearest largest settlement. The application broadly follows the alignment of the London to Aylesbury Railway Line.

The Development Plan for the site comprises the adopted Aylesbury Vale District Local Plan (AVDC LP 2004), the Proposed Submission Vale of Aylesbury Local Plan (VALP 2018), the adopted Wycombe District Local Plan (WDLP 2019) and the adopted Wycombe Delivery and Site Allocations Plan (WDDSA 2013). These documents identify the entire site as falling outside of a defined settlement boundary and within the open countryside. The WDDSA identifies land inside the site boundary as part of the Chilterns Area of Outstanding Natural Beauty (AONB) and also the London Area Greenbelt

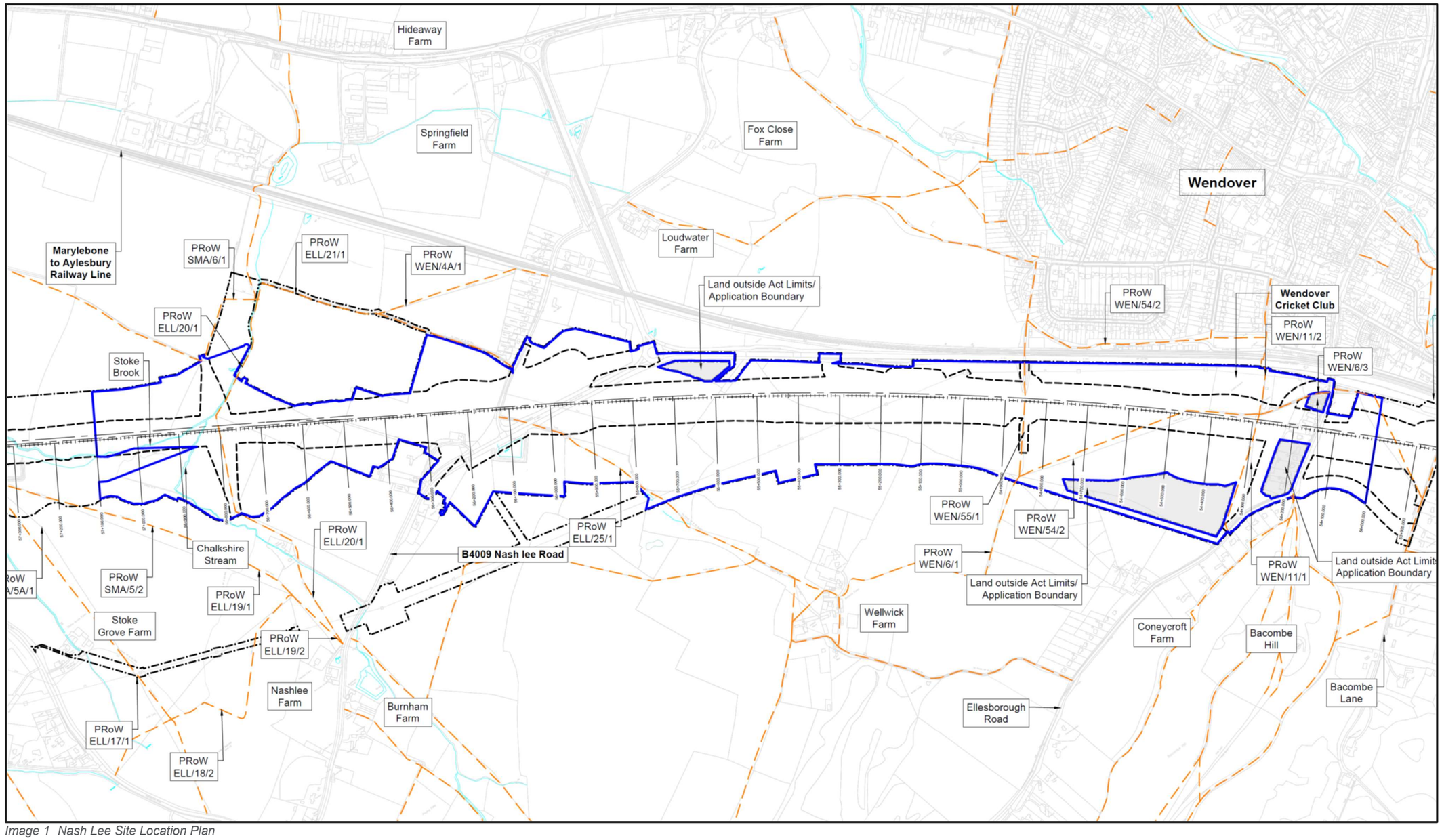

Image 1 Nash Lee Site Location Plan

The noise sensitive receptor locations are presented on Image 2 below.

The nearest residential properties are located on the southern and western edge of Wendover, particularly those on the north eastern side of Nash Lee Lane. There are also several scattered residential properties and farmsteads that surround the site, and clusters of properties along the roads that lead into Wendover from the surrounding area.

The Receptor Identity (ID) Numbers correspond directly with those used in the HS2 Phase 1 ES study, to allow for direct comparison. This is the case for receptor identities that represent individual receptor locations as well as groups of receptors.

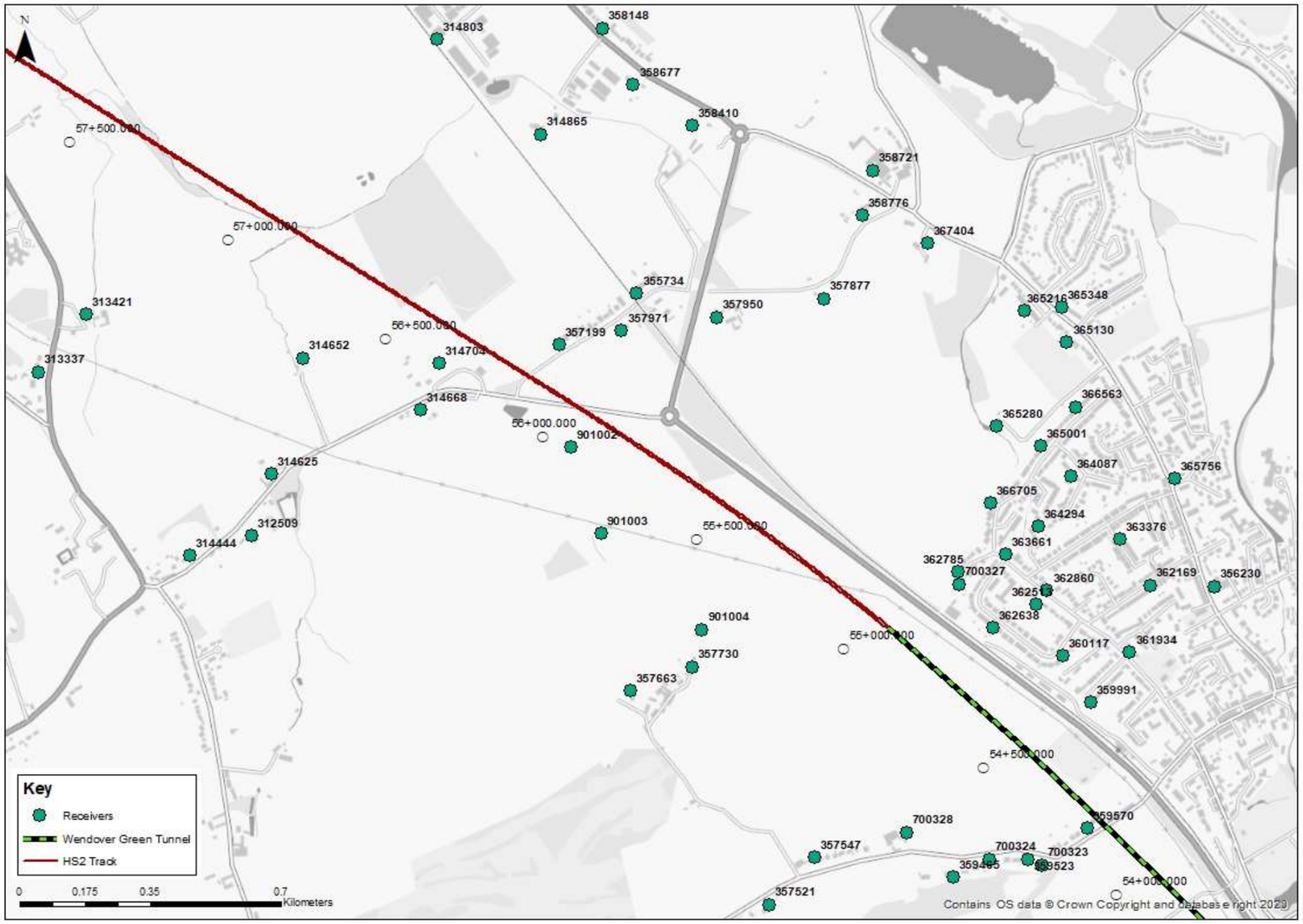

Image 2 Receptor Locations for Nash Lee

2 Policy, Requirements and Standards

The High-Speed Rail (London – West Midlands) Act 2017, referred to from this point forward as "*the Act*", provides powers for the construction and operation of Phase 1 of High Speed Two, for which HS2 Ltd is the nominated undertaker. The Secretary of State has also published Environmental Minimum Requirements (EMRs), which set out the environmental and sustainability commitments that will be observed in the construction of the Proposed Scheme.

Section 20 to *the Act* grants deemed planning permission for the works authorised by it, subject to the conditions set out in Schedule 17. Schedule 17 includes conditions requiring various matters to be approved by the relevant Local Planning Authority(ies) (LPA).

Schedule 17 of *the Act* sets out the specific grounds on which the LPA may impose conditions on approvals or refuse requests for approval. With respect to noise one of the specific grounds the LPA may refuse to approve plans or specifications is if "*the design or external appearance of the building works ought to be modified to preserve the local environment or local amenity and is reasonably capable of being so modified*".

Paragraph 7.5.2 of the Planning Memorandum states that when submitting designs for approval under Schedule 17 the nominated undertaker:

"shall, where reasonably necessary for the proper consideration of the design proposed, provide an indication or outline of the appropriate mitigation measures (if any) which it intends to submit subsequently under paragraphs 9 or 12 of the Planning Conditions Schedule. Where works for approval will have a mitigating effect in relation to the operational noise from the railway or new roads, the nominated undertaker will provide information to show, so far as is reasonably practicable at that stage in the design process, how the noise mitigation performs and the expected conditions. While not material to approvals under paragraph 2 or 3 this information will provide re-assurance in advance of the request for approval under paragraph 9 that the mitigation is appropriate and will present an opportunity to raise concerns."

This report provides information how the noise mitigation, proposed at this stage of the design development, performs and the expected conditions.

When seeking 'Bringing Into Use' approvals in relation to the relevant scheduled works under Schedule 17(9), an update to this report will be provided to the Local Planning Authority in order to assist it in determining whether there are any reasonably practicable measures which need to be taken for the purposes of mitigating the effect of the work or its operation on the local environment or local amenity.

The following section provides a summary of the EMRs and relevant information papers that have been produced to explain the commitments made in *the Act* and the Undertakings and Assurances (U&As) given by the Secretary of State, and how they will be applied to the design and construction of HS2 Phase 1.

2.1 Environmental Minimum Requirements (EMRs)

The EMRs set out environmental and sustainability commitments that will be observed during the construction and operation of the Proposed Scheme. The EMRs include the Code of Construction Practice (CoCP) and a series of other supporting documents.

The EMR general principles state:

The controls contained in the EMRs, along with powers contained in the Act and the Undertakings given by the Secretary of State, will ensure that impacts which have been assessed in the ES will not be exceeded, unless any new impact or impacts in excess of those assessed in the ES:

- *results from a change in circumstances which was not likely at the time of the ES[1]; or*
- *would not be likely to be environmentally significant[2]; or*
- *results from a change or extension to the project, where that change or extension does not itself require environmental impact assessment (EIA) under either (i) article 4(1) of and paragraph 24 of Annex 1 to the EIA Directive3; or (ii) article 4(2) of and paragraph 13 of Annex 2 to the EIA Directive[4]; or*
- *would be considered as part of a separate consent process (and therefore further EIA if required).*

In the circumstances described in the first bullet point above, if the significant adverse impacts identified in the ES are likely to be exceeded, HS2 and their contractors will take all reasonable steps to minimise or eliminate those additional impacts. If despite these reasonable steps, significant adverse impacts remain HS2 and their contractors will report them.

2.2 HS2 Information Paper E20: Control of Airborne Noise from Altered Roads and the Operational Railway

HS2 Information Paper E20 outlines the measures that are required to be put in place to control operational airborne noise. It sets out various objectives to minimise operational noise effects as summarised below.

- HS2 and their contractors will take all reasonable steps to design and construct the scheme so that the combined airborne noise predicted, in all reasonably foreseeable circumstances (ARFC), does not exceed LOAEL as set out in Appendix C. Where it is not reasonably practicable to achieve this objective, HS2 and their contractors will reduce airborne noise “As Far As Reasonably Practicable” (AFARP).
- Noise insulation will be offered with the aim that operational airborne noise from the scheme does not give rise to significant adverse effects on health and quality of life that would otherwise be expected when airborne noise exceeds the significant observed adverse effect levels (SOAEL) (Appendix B).

[1] *In addition, Supplementary Environmental Statements and Additional Provision Environmental Statements were published and tabled by the Promoter in July 2015, September 2015, October 2015 and December 2015.*
[2] *i.e. a situation that could not reasonably have been anticipated at the time of the Environmental Statement. This covers all effects (both positive and adverse) where those effects are simply of no environmental significance.*
[3] *2011 consolidated EIA Directive (2011/92/EU).*
[4] *Broadly, this would not allow those changes or extensions to the project (once it has received Royal Assent) which would give rise to adverse environmental effects within the EIA.*

3 Scheduled Works

3.1 Application Design

The works submitted for approval comprise of a 3.1km section of the HS2 route between Wendover and Nash Lee in a southeast to north west direction.

The works for approval comprise of all the bridges and associated earthworks that fall within this package. These comprise of Wendover Green Tunnel (Part of); Wendover North Cutting and Stoke Mandeville South Embankment (Part of). The 'other parts' of Wendover Green Tunnel and Stoke Mandeville South Embankment fall within AVDC Package 3 Small Dean and AVDC Package 5 Stoke Mandeville. These will be the subject of separate Schedule 17 applications.

Other works that require approval include earthworks associated with Wendover Green Tunnel and diversion of Nash Lee Road including a bridge over HS2; Nash Lee Culvert; 3 No. Access Tracks; 5 No. drainage ponds; drainage ditches; location of the Vehicle Restraint Barriers and the location of the permanent (security) fencing and gates.

Wendover Green Tunnel
The HS2 line will pass through the Wendover Green Tunnel. The Northern Tunnel Portal is within the site and is located approximately 320m to the south west of built development at the edge of Wendover.

Wendover North Cutting
Wendover North Cutting within the site will be approximately 1.85km in length. The cutting be up to 12m below existing ground level. The width of the cutting is up to approximately 80m. The inward slope of the cutting will be 1 in 2, 1 in 3 and 1 in 4 shown in image 3 and cross sections 2 of 4 and 3 of 4 (drawing 1MC06-CEK-TP-DSE-CS03_CL06-000004 and 1MC06-CEK-TP-DSE-CS03_CL06-000005).

Stoke Mandeville South Embankment
Stoke Mandeville South Embankment will be 1.53km in length, of which approximately 0,55km of this embankment falls within the application area. The embankment will be up to 4m above existing ground level. The width of the embankment will be up to approximately 90m within the site. The engineered profile of the embankment has an inward slope of 1 in 4.

On the western side of the HS2 line, over the full length of the embankment, a landscape mitigation earthwork is proposed that will screen HS2 from views to the west. This earthwork will be up to 7m in height above existing ground level and 4m above HS2 track level. The inward and outward slopes will be 1 in 4.

3.2 Scheme Design Updates

Design updates associated with the wider HS2 project are set out below; where appropriate and necessary to the Schedule 17 application these updates have been considered and implemented within the noise modelling:

- Track spacing at the tunnel portal has been reduced slightly from 7.29m in the ES to 6.99m in the design, bringing the earthworks at the portal slightly closer to the source.

- The track alignment incorporates the global reduction of track centres from 5m to 4.7m for the entire Phase 1 scheme.
- The HS2 face of the noise barrier options has been offset 4.6m from the HS2 trace which compares to the standard 5.7m offset used by HS2 at the time of the HS2 Phase 1 ES. By positioning the barriers closer to the tracks, their effectiveness has been improved.
- The earthworks cross sections for Wendover Green Tunnel North Portal are shown on Drawing 1MC06-CEK-TP-DSE-CS03_CL06-000004 and Image 3 below. Image 3 shows the cross section at Ch 55+400 with the cutting 10m deep to the east (slope 1:2) with additional landscaping earthworks at the top of the cutting with a 1:4 slope
- Wendover North Cutting (055-L1) has changed from 1V:4H at ERD to 1V:2H and 1V:3.5H at Scheme Design, representing a steepening of the cutting slopes. This will reduce the width of the cutting and reduce the volume of material excavated, as well as improving acoustic performance.
- New earthworks have been locally added between 55+000 to 56+200 on the eastern side of the route to provide visual screening and therefore land drainage ditches have been provided to provide a cut-off drain so water cannot encroach on the cutting slopes. See image 3.

The track support system has been revised to track slab for the HS2 main lines compared to a ballasted system adopted in the Phase 1 ES. The changes in noise source level implemented in the design considerations, from those used in the Phase 1 ES, are presented in Appendix D. The revised noise source terms include the removal of TSI compliant trains.

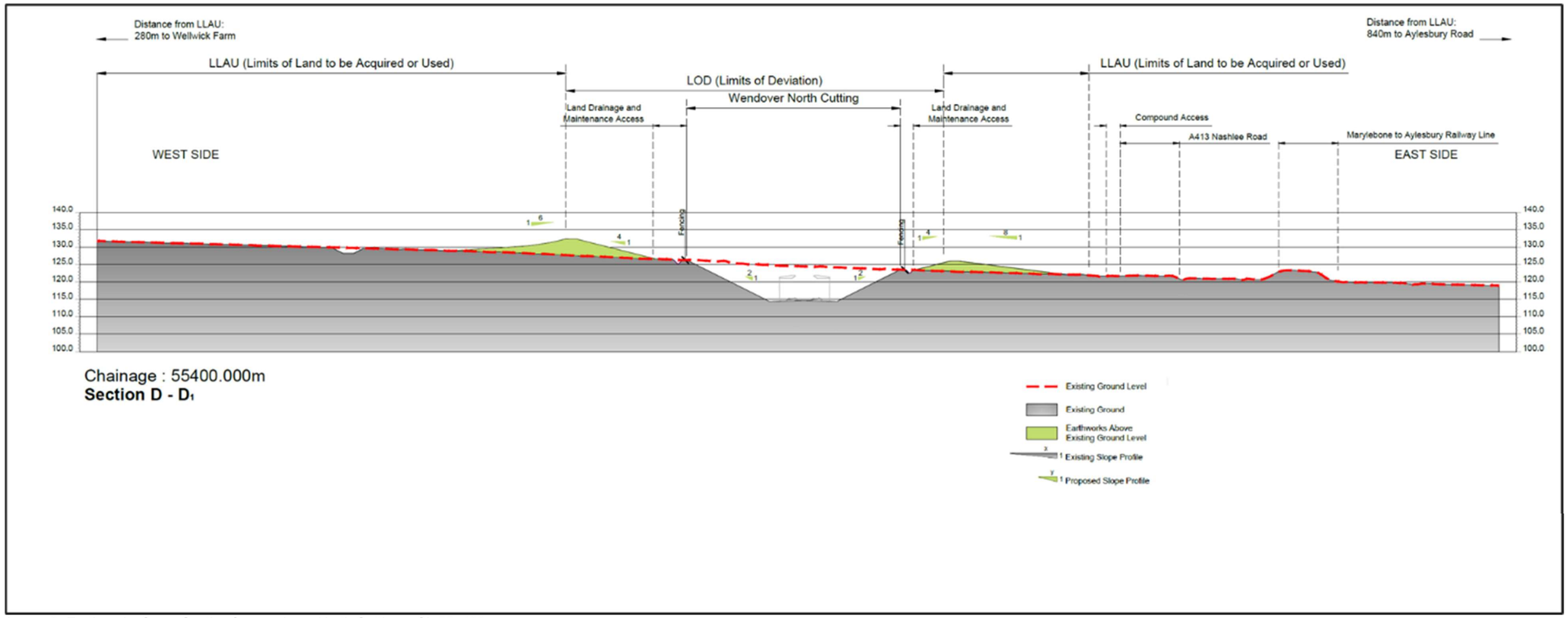

Image 3 Earthworks Cross Section for wendover North Cutting – Ch 55+400

4 Options appraisal

This report demonstrates how all reasonable steps have been taken within the design for the combined airborne sound from altered roads and operational railways, predicted in all reasonably foreseeable circumstances, to not to exceed the LOAEL. Where it has not been reasonably practicable to achieve this objective through the design, the report shows how airborne sound has been reduced 'As Far As Reasonably Practicable' (AFARP).

The change in acoustic performance, visual impact and value for money are compared to the ES Design (as amended through the SES 4). Stakeholder engagement has also been considered to ensure the AFARP criteria are met.

There has been extensive engagement with BC and the Wendover HS2 Mitigation Action Group on matters relating to noise mitigation.

Wendover HS2 Mitigation Action Group (Wendover HS2) - Summary

Petitioners from Wendover and Halton Parish Council and the Wendover Society presented tunnel proposals to the Select Committee as an alternative to the green tunnel proposed by HS2. These proposals included, amongst other things, a 500m northern extension to the Wendover Green Tunnel. The Select Committee did not accept these proposed alternatives but asked HS2 to develop an enhanced noise mitigation package.

As part of the proposals for further noise mitigation in this area, HS2 proposed an additional noise fence barrier located from the northern portal of the green tunnel extending to the access track leading to the portal buildings, approximately 300m in length, along the eastern side of the railway. A noise fence barrier of 6m above rail level, set back from the railway, was assessed, and reported in the ES (as amended) (see Image 5 part of the SES drawing).

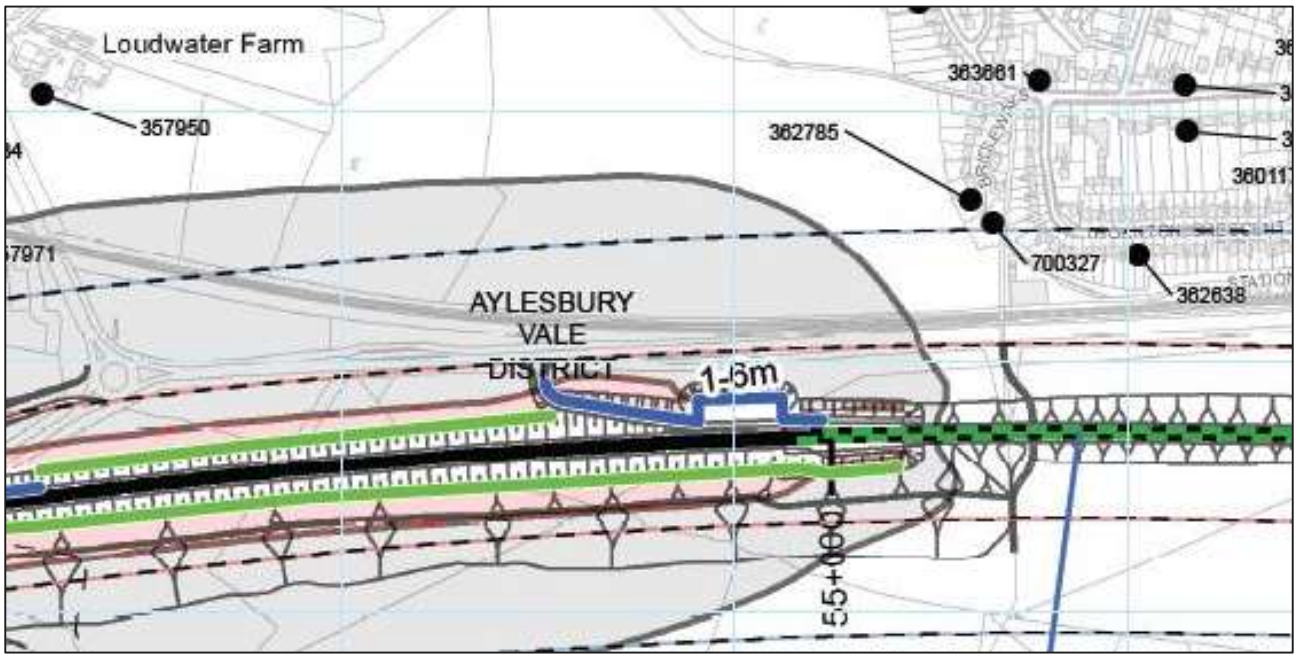

Image 4 Hybrid bill

On 17, 20 and 27 November 2020, Wendover HS2, EKFB and HS2 Ltd held engagement sessions on a number of noise issues. During these sessions HS2 provided an overview of 'as far as reasonably practicable' and explained how its contractors are implementing criteria outlined in Planning Forum Note 14 when optimising their mitigation designs. A further meeting on 15 April 2021 was held to discuss the HS2 design approval process including Schedule 17 applications and Noise Demonstration Reports.

During this phase of engagement, Wendover HS2 set out two mitigation proposals which they requested were included for consideration. The first was a redesign of the Wendover North cutting to incorporate a 10m retained wall. The second was a proposal for arched barriers to be included at Small Dean embankment and viaduct. A further iteration of the retained cutting proposal has since been presented to BC on the 17 September 2021 and to EKFB on 17 September 2021 for consideration (see Image 6 below).

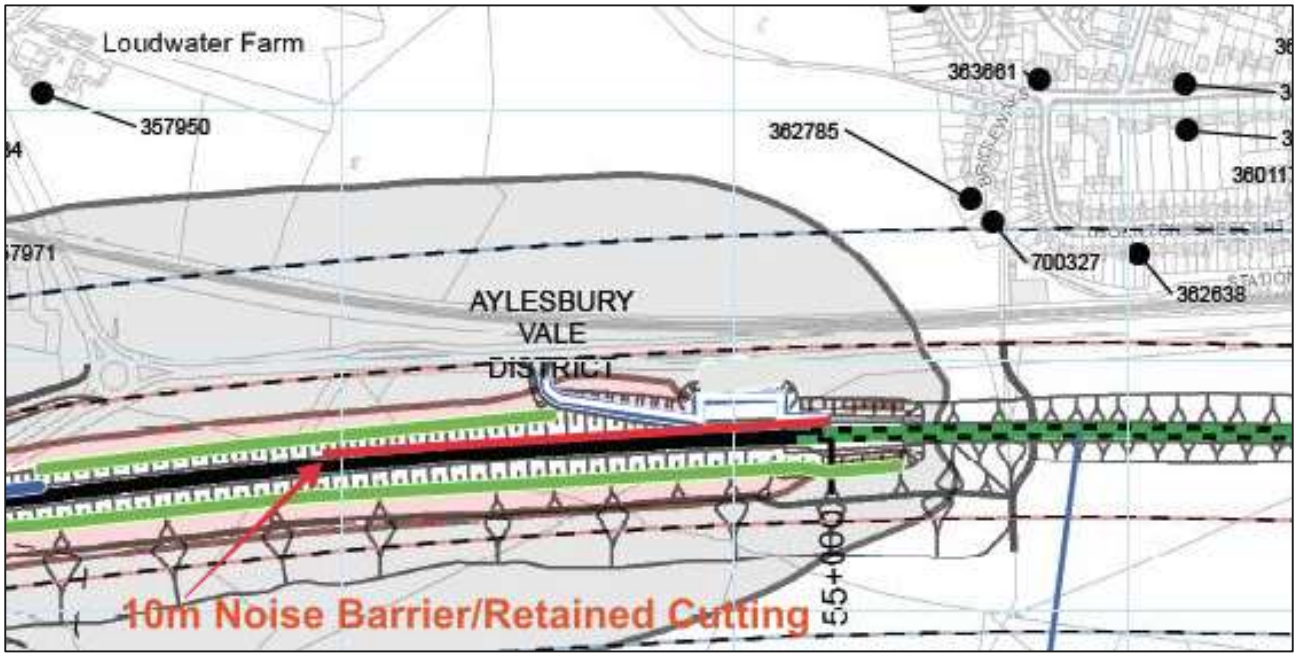

Image 5 Wendover HS2 Proposed design – 10m Noise Barrier length 220m and 280m Retained Cutting

The Wendover HS2 group has expressed significant concern about L_{Amax} levels from HS2 trains at night. To address this concern an additional analysis of L_{Amax} levels from recent noise monitoring data in the vicinity of the Wendover North cutting is provided in Appendix E of this report for information. To properly understand the effects of event noise levels at night both the magnitude of the event noise level, the number of events and the context in which the event levels from HS2 trains will occur must be considered.

The HS2 L_{Amax} LOAEL value of 60dB is defined using WHO recommendations for the onset of effects on sleep. At these levels of exposure however there is a very gradual increase in the probability of sleep disturbance and there needs to be a significant increase in the magnitude of event noise levels before there is a notable increase in the probability of any disturbance. This explains why there is a 20dB difference in the HS2 L_{Amax} LOAEL and SOAEL values.

The predicted L_{Amax} presented in Section 7 of this report show that where the LOAEL values are exceeded, they will only be marginally exceeded. At these levels there will be very little or no difference in the

propensity of the HS2 trains to cause disturbance. For example, the difference in the propensity for events of with L_{Amax} levels of 60 and 63 dB will be indetectable.

As shown in Appendix E, the area covered by this noise demonstration report is already exposed to levels of transportation noise where the L_{Amax} LOAEL value is regularly exceeded. It is therefore likely with the proposed mitigation in place any effects on sleep during the night will continue to be dominated by existing exposure to road and rail noise events.

4.1 Wendover Green Tunnel North Portal to Wendover North Cutting

The mitigation options considered are as follows:

- **No noise barrier** Option as a baseline including the scheme design noise bund designs.
- **Mitigation Design Option 1:** 4m absorptive noise barrier, lineside with offset of 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 2** 5m absorptive noise barrier, lineside with offset of 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 3:** 6m absorptive noise barrier, lineside with offset of 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 4:** 10m absorptive noise barrier with offset of 4.6m from outside rail and length of 220m and a 10m retained cutting 280m in length, including the scheme design earthworks noise bund designs. Option 4 is being considered as a mitigation option proposed by the Wendover HS2 Mitigation Action Group.

Table 1 below presents a summary of the outcome of the overall appraisal. The proposed design is highlighted in green.

Case	Description	Acoustic	Visual	Value for money	Engineering Constraints	Consultation
ES Noise Barriers [**Comparison Design]**	Mitigation provided by earthworks and a varied height barrier of between 1 and 6m ES mitigation (AP5 and provision) – performance presented in 'Do Something ES	-	-	-		
Baseline Option - Baseline design with mitigation in the form of earthworks	*Mitigation in the form of earthworks design*	N	✔	B	N	✔
Option 1 – Lineside Noise Barrier 4m above ToR on east side.	*Barrier 4m Absorptive noise barrier 4m above ToR on east side.*	N	X	W	N	✔
Option 2 – Lineside Noise Barrier 5m above ToR on east side.	*Absorptive noise barrier 5m above ToR on east side.*	N	X	W	N	✔
Option 3 – Lineside Noise Barrier 6m above ToR on east side.	*Absorptive noise barrier 6m above ToR on east side.*	N	X	W	N	✔
Option 4 – Lineside Noise Barrier 10m above ToR on east side. 220m of 10m Noise barrier and a 10m retained cutting 280m in length	*Absorptive noise barrier 10m above ToR length 220m and 10m retained cutting length 280m on east side.*	N	XX	W	XX	✔✔
✖✖ Materially worse *(Using EIA methodologies)*						
✖ Worse						
Neutral, N/A – no change or not applicable						
✔ Beneficial						
✔✔ Materially beneficial *(Using EIA methodologies)*						
Value for money compared to the ES: B – Better, W – Worse, N - Neutral						

Table 1 – Summary appraisal table, proposed mitigation scenarios, operational airborne noise for Wendover Green Tunnel North Portal to Wendover North Cutting

In summary;

- **Baseline Option:** mitigation in the form of the earthworks shows the following impacts:

	Baseline option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	228		306	
No. above SOAEL L_{Amax}	0		0	

Table 2 – Baseline Option and ES for Wendover Green Tunnel North Portal to Wendover North Cutting: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

The earthworks design has been optimised to improve the level of noise mitigation compared to the 1 to 6m noise barrier described in the supplementary ES.

The **Baseline Option** (earthworks design with no barriers) All the reported L_{Aeq} levels during the day and night continue to remain below the LOAEL values at all the receptor location. There is therefore no adverse impact when assessed against using the EIA methodology. This option results in a small reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period (228 impacts above LOAEL compared to 306). This reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period would be expected to provide little or no benefit.

Overall, the change in acoustic performance of this mitigation option compared to the ES (as amended) is neutral.

From a visual perspective mitigation in the **Baseline Option** in form of earthworks compared to the ES varied height barrier of between 1 and 6m positioned at the toe of the cutting to the back of the Tunnel Portal service building and access road would have a notable landscape and visual benefit. Particularly at a location which is within the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range elevated views from the realigned PRoW which traverses over the tunnel in proximity to the north portal.

The **Baseline Option** does not present any complex engineering constraints and is considered neutral.

The Baseline Option compared to the ES for the varied height barrier of between 1 and 6m is considered better regarding value for money as the barrier removed from the design is a saving.

- **Mitigation Design Option 1:** 4m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 1		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	145		306	
No. above SOAEL L_{Amax}	0		0	

Table 3 – Baseline Option and ES for Wendover Green Tunnel North Portal to Wendover North Cutting: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

As well as the enhancements to the earthworks design, this option considers a 4m lineside noise barrier which is potentially better than the1 to 6m noise barrier described in the supplementary ES (as amended) because it is located closer to the track. This option also overcomes the engineering constraints associated with the supplementary ES barrier scheme because the noise barrier is lineside at same hight and in at straight line, whereas the supplementary ES barrier is in varying hight and not in a straight line.

All the reported L_{Aeq} levels during the day and night continue to remain below the LOAEL values at all the receptor location. There is therefore no adverse impact when assessed against using the EIA methodology. This option results in a small reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances pf the L_{Amax} LOAEL values for the night-time period (145 impacts above LOAEL compared to 306). This reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 4m above TOR lineside noise barrier mitigation in the **Mitigation Design Option 1** compared to the ES assessed varied height barrier of between 1 and 6m positioned at the toe of the cutting to the back of the Tunnel Portal service building and access road would have a landscape and visual disbenefit, particularly at a location which is within the Chilterns AONB. The mass and appearance of the structure would be visible in some elevated views from the realigned PRoW which traverses over the tunnel in proximity to the north portal. It is anticipated that the barrier would not be visible from the wider elevated views at Bacombe Hill and Coombe Hill and from the adjacent A413. Over time planting on the landscape earthworks adjacent to Wendover Cutting would help to contain the structure, but it will continue to be visible from the PRoW above the tunnel portal. The structure, albeit contained by earthworks and planting, would be an additional permanent linear structure which would be incongruous with its rural setting. The structure would

create an intrusive hard element in views from the train, blocking views to the cutting slope and the planting above.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 1** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 1 is compared to the **Baseline Option** discounted on the basis that the slight acoustic benefits, if any, are far outweighed by the visual disbenefits and costs.

- **Mitigation Design Option 2:** 5m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 2		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	91		306	
No. above SOAEL L_{Amax}	0		0	

Table 4 – Baseline Option and ES for Wendover Green Tunnel North Portal to Wendover North Cutting: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

As well as the enhancements to the earthworks design, this option considers a 5m high lineside noise barrier which is potentially better than the1 to 6m noise barrier described in the supplementary ES because it is located closer to the track.

All the reported L_{Aeq} levels during the day and night continue to remain below the LOAEL values at all the receptor location. There is therefore no adverse impact when assessed against using the EIA methodology. This option results in a small reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period (91 impacts above LOAEL compared to 306). This reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 5m above TOR lineside noise barrier mitigation in the **Mitigation Design Option 2** compared to the ES assessed varied height barrier of between 1 and 6m positioned at the toe of the cutting to the back of the Tunnel Portal service building and access road would have a noticeable landscape and visual disbenefit, particularly at a location which is within the Chilterns AONB. The mass and appearance of the structure would be visible in some elevated views from the realigned PRoW which traverses over the tunnel in proximity to the north portal. It is anticipated that the barrier would not be visible from the wider elevated views at Bacombe Hill and Coombe Hill and from the adjacent A413. Over time planting on the landscape earthworks adjacent to Wendover Cutting would help to contain the structure, but it will continue to be visible form the PRoW above the tunnel portal. The structure, albeit contained by earthworks and planting, would be an additional permanent structure which would be incongruous with its rural setting. The structure would create an intrusive hard element in views from the train, blocking views to the cutting slope and the planting above.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 2** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 2 is compared to the **Baseline Option** discounted on the basis that the slight acoustic benefits, if any, are far outweighed by the visual disbenefits and costs.

- **Mitigation Design Option 3:** 6m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 3		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	72		306	
No. above SOAEL L_{Amax}	0		0	

Table 5 – Baseline Option and ES for Wendover Green Tunnel North Portal to Wendover North Cutting: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

As well as the enhancements to the earthworks design, this option considers a 6m high lineside noise barrier which is potentially better than the1 to 6m noise barrier described in the supplementary ES because it is located closer to the track.

All the reported L_{Aeq} levels during the day and night continue to remain below the LOAEL values at all the receptor location. There is therefore no adverse impact when assessed against using the EIA methodology. This option results in a small reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period (72 impacts above LOAEL compared to 306). This reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 6m above TOR lineside noise barrier mitigation in the **Mitigation Design Option 3** compared to the ES assessed varied height barrier of between 1 and 6m positioned at the toe of the cutting to the back of the Tunnel Portal service building and access road would have a noticeable landscape and visual disbenefit, particularly at a location which is within the Chilterns AONB. The mass and appearance of the structure would be visible in some elevated views in the environs of Bacombe Hill and the realigned PRoW which traverses over the tunnel in proximity to the north portal. It is anticipated that the barrier would not be visible from the adjacent A413. Overtime planting on the landscape earthworks adjacent to Wendover Cutting would help to conceal the structure in more distant views, but it will continue to be visible form the PRoW above the tunnel portal. The structure, albeit contained by earthworks and planting, would be an additional permanent structure which would be incongruous with its rural setting. The structure would create an intrusive hard element in views from the train, blocking views to the cutting slope and the planting above.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 3** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 3 is compared to the **Baseline Option** discounted on the basis that the slight acoustic benefits, if any, are far outweighed by the visual disbenefits and costs.

- **Mitigation Design Option 4:** 10m absorptive noise barrier, lineside with offset of 4.6m from outside rail, length 220m and a 10m Retained cutting length 280m including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 4		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	0		306	
No. above SOAEL L_{Amax}	0		0	

Table 6 – Baseline Option and ES for Wendover Green Tunnel North Portal to Wendover North Cutting: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

As well as the enhancements to the earthworks design, this option considers a 10m high lineside noise barrier which is potentially better than the1 to 6m noise barrier described in the supplementary ES because it is located closer to the track.

All the reported L_{Aeq} levels during the day and night continue to remain below the LOAEL values at all the receptor location. There is therefore no adverse impact when assessed against using the EIA methodology. This option results in a small reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period (0 impacts above LOAEL compared to 306). This reduction in the number of exceedances of the L_{Amax} LOAEL values for the night-time period would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 10m above TOR lineside noise barrier part 10m retaining wall mitigation in the **Mitigation Design Option 4** compared to the ES assessed varied height barrier of between 1 and 6m positioned at the toe of the cutting to the back of the Tunnel Portal service building and access road would have a significant landscape and visual disbenefit. Particularly at a location which is within the Chilterns AONB. Although the retained section would reduce the width of the cutting, the mass and appearance of two parallel retaining walls would be a significant piece of additional linear infrastructure which would be visible in some elevated views in the environs of Bacombe Hill, in more close-up views from the A413 and the realigned PRoW which traverses over the tunnel in proximity to the north portal. Although overtime planting on the landscape earthworks adjacent to Wendover Cutting would help to conceal the structure in more distant views and from the A413 it will continue to be visible form the PRoW above the tunnel portal. The structure, albeit contained by earthworks and planting, would be an additional permanent large-scale structure which would appear incongruous and out of scale with the adjacent tunnel portal and service buildings and likely to be harmful to the special qualities of the Chilterns AONB. The structure would create an

intrusive hard element in views from both sides of the train, blocking views to the cutting slope and the planting above.

Image 6 10m Noise barrier and retained cutting at Wendover Green Tunnel

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 4** presents complex engineering constraints and is considered materially worse. The increase in static and dynamic loads associated with a 10m stand-alone barrier would result in a significant increase in the dimensions of the noise barriers, piles and pile-caps for a stand-alone noise barrier compared to a 6m high noise barrier. For example, the dimensions of the piles are estimated to increase from 0.75m to 1.2-1.25m in diameter with a significant increase in length. Access for emergencies and for maintenance activities would need to be achieved either through a port in the barrier or a free access between a parallel 10m noise barrier and a shortening of the 10m noise barrier. The retained wall is also representing a significant challenge regarding ground anchoring and stability that will affect its dimensions. Such a retained structure would require support (props) from a parallel adjacent wall on the downside of the trace in order obtain sufficient stability.

Given the slight acoustic benefits as compared to the low cost to benefit ratio and the significant visual disbenefit, **Mitigation Design Option 4** is not a feasible mitigation option.

The **Baseline Option** (mitigation in the form of earthworks) is selected as the appropriate mitigation design as this represents an optimal solution from an acoustic, visual, economical and engineering perspective.

From here on this option is referred to as the **Proposed Design**.

4.2 Wendover North Cutting

4.2.1 Wendover North Cutting – Up-Side (East)

The mitigation option considered are as follows:

- **Baseline Option:** Baseline with mitigation in the form of earthworks;
- **Mitigation Design Option 1:** 2m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 2:** 3m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 3:** 4m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs

Table 7 below presents a summary of the outcome of the overall appraisal. The proposed design is highlighted in green.

Case	Description	Acoustic	Visual	Value for money	Engineering Constraints	Consultation
ES Noise Barriers [**Comparison Design]**	Mitigation provided by earthworks and 3m noise barrier on the top of the cutting ES mitigation (AP5) – performance presented in 'Do Something ES	-	-	-		
Baseline Option - Baseline design with mitigation in the form of earthworks	*Mitigation in the form of earthworks design*	N	✔	N	N	✔
Option 1 – Lineside Noise Barrier 2m above ToR on east side.	*Barrier 2m absorptive above ToR east (up-side)*	N	✔	N	N	✔
Option 2 - Lineside Noise Barrier 3m above ToR on east side	*Barrier 3m absorptive above ToR east (up-side)*	N	✔	N	N	✔
Option 3 - Lineside Noise Barrier 4m above ToR on east side	*Barrier 4m absorptive above ToR east (up-side)*	N	✔	N	N	✔
✖ ✖ Materially worse *(Using EIA methodologies)*						
✖ Worse						
- Neutral, N/A – no change or not applicable						
✔ Beneficial						
✔ ✔ Materially beneficial *(Using EIA methodologies)*						
Value for money compared to the ES: B – Better, W – Worse, N - Neutral						

Table 7 – Summary appraisal table, proposed mitigation scenarios, operational airborne noise for Wendover North Cutting – Up-Side

In summary;

- **Baseline Option:** mitigation in the form of the earthworks shows the following impacts:

	Baseline Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	7	7	7	7
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	13	20	20	21
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	42		45	
No. above SOAEL L_{Amax}	0		0	

Table 8 – Baseline Option and ES for Wendover North Cutting – Up-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a small reduction in noise levels compared to those reported in the ES, which results in a small reduction in the number of exceedances against the LOAEL values. This reduction in the number of exceedances of the L_{Amax} LOAEL values would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective mitigation in the **Baseline Option** in form of earthworks compared to the ES assessed 3m barrier positioned at the crest of the cutting slope will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. For the **Baseline Option** (earthworks design with no barriers) visual impact is considered a clearly evident benefit.

The **Baseline Option** does not present any complex engineering constraints and is considered neutral.

- **Mitigation Design Option 1:** 2m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 1		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	7	7	7	7
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	13	20	20	21
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	42		45	
No. above SOAEL L_{Amax}	0		0	

Table 9 – Baseline Option and ES for Wendover North Cutting – Up-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a small reduction in noise levels compared to those reported in the ES, which results in a small reduction in the number of exceedances against the LOAEL values. This reduction in the number of exceedances LOAEL values would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 2m noise barrier at the toe of the embankment length 560m in the **Mitigation Design Option 1** compared to the ES assessed 3m barrier positioned at the crest of the cutting slope will have a clearly notable landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a linear feature in the landscape, albeit contained within the cutting earthworks and glimpsed on the approaches to the Nash Lee overbridge. The barrier would form an intrusive feature in views from the train, partially blocking out the adjacent earthworks slope. For the **Mitigation Design Option 1** the visual impact is considered a clearly notable benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 1** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 1 is compared to the **Baseline Option** discounted on the basis of despite of slightly better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs is higher.

- **Mitigation Design Option 2:** 3m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 2		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	7	7	7	7
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	13	13	20	21
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	42		45	
No. above SOAEL L_{Amax}	0		0	

Table 10 – Baseline Option and ES for Wendover North Cutting – Up-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a small reduction in noise levels compared to those reported in the ES, which results in a small reduction in the number of exceedances against the LOAEL values. This reduction in the number of exceedances LOAEL values provides little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 3m noise barrier at the toe of the embankment length 560m in the **Mitigation Design Option 2** compared to the ES assessed 3m barrier positioned at the crest of the cutting slope will have a notable landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a linear feature in the landscape, albeit contained within the cutting earthworks and glimpsed on the approaches to the Nash Lee overbridge. The barrier would form a highly intrusive feature in views from the train, blocking out the adjacent earthworks slope. For the **Mitigation Design Option 2** the visual impact is considered a notable benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 2** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 2 is compared to the **Baseline Option** discounted on the basis of inspite of slightly better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs is higher.

- **Mitigation Design Option 3:** 4m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 3		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	7	7	7	7
Minor impact	0	0	0	0
No. above LOAEL L_{Aeq}	13	13	20	21
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	42		45	
No. above SOAEL L_{Amax}	0		0	

Table 11 – Baseline Option and ES for Wendover North Cutting – Up-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a small reduction in noise levels compared to those reported in the ES, which results in a small reduction in the number of exceedances against the LOAEL values. This reduction in the number of exceedances LOAEL values would be expected to provide little or no benefit.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), is neutral.

From a visual perspective the 4m noise barrier at the toe of the embankment length 560m in the **Mitigation Design Option 3** compared to the ES assessed 3m barrier positioned at the crest of the cutting slope will have a landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a linear feature in the landscape, albeit contained within the cutting earthworks and glimpsed on the approaches to the Nash Lee overbridge. The barrier would form a highly intrusive feature in views from the train, blocking out the adjacent earthworks slope. For the **Mitigation Design Option 3** the visual impact is considered a benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 3** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 3 is compared to the **Baseline Option** discounted on the basis of inspite of slightly better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs.

The **Baseline Option** (mitigation in the form of earthworks) is selected as the appropriate mitigation design as this represents an optimal solution from an acoustic, visual, economical and engineering perspective.

From hereon this option is referred to as the **Proposed Design**.

4.2.2 Wendover North Cutting – Down-Side (West)

The mitigation option considered are as follows:

- **Baseline Option:** Baseline with mitigation in the form of earthworks;
- **Mitigation Design Option 1:** 2m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 2:** 3m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs,
- **Mitigation Design Option 3:** 4m absorptive noise barrier, lineside with offset at 4.6m from outside rail, including the scheme design earthworks noise bund designs

Table 12 below presents a summary of the outcome of the overall appraisal. The proposed design is highlighted in green.

Case	Description	Acoustic	Visual	Value for money	Engineering Constraints	Consultation
ES Noise Barriers [**Comparison Design]**	Mitigation provided by earthworks and 3m noise barrier on the top of the cutting ES mitigation (AP5) – performance presented in 'Do Something ES	-	-	-		
Baseline Option - Baseline design with mitigation in the form of earthworks	*Mitigation in the form of earthworks design*	✔✔	✔	N	N	✔
Option 1 – Lineside Noise Barrier 2m above ToR on west side.	*Barrier 2m absorptive above ToR west (downside)*	✔✔	✔	N	N	✔
Option 2 - Lineside Noise Barrier 3m above ToR on west side	*Barrier 3m absorptive above ToR west (downside)*	✔✔	✔	N	N	✔
Option 3 - Lineside Noise Barrier 4m above ToR on west side	*Barrier 4m absorptive above ToR west (downside)*	✔✔	✔	N	N	✔

✖✖ Materially worse *(Using EIA methodologies)*

✖ Worse

- Neutral, N/A – no change or not applicable

✔ Beneficial

✔✔ Materially beneficial *(Using EIA methodologies)*

Value for money compared to the ES: B – Better, W – Worse, N - Neutral:

Table 12 – Summary appraisal table, proposed mitigation scenarios, operational airborne noise for Wendover North Cutting – Down-Side

In summary;

- **Baseline Option:** mitigation in the form of the earthworks shows the following impacts:

	Baseline Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	5
Minor impact	7	7	7	3
No. above LOAEL L_{Aeq}	8	14	22	22
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	41		57	
No. above SOAEL L_{Amax}	0		0	

Table 13 – Baseline Option and ES for Wendover North Cutting – Down-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances against the LOAEL values. This reduction in noise levels provides a benefit in accordance with the EIA methodology, resulting in the removal of 5 moderate impacts and the avoidance of a likely significant effect.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), represents a material benefit.

From a visual perspective mitigation in the **Baseline Option** in form of earthworks compared to the ES assessed 2m barrier positioned at the crest of the cutting slope will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. The **Baseline Option** (earthworks design with no barriers) visual impact is considered a clearly evident benefit.

The **Baseline Option** does not present any complex engineering constraints and is considered neutral.

- **Mitigation Design Option 1:** 4m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 1		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	5
Minor impact	5	5	7	3
No. above LOAEL L_{Aeq}	8	8	22	22
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	41		57	
No. above SOAEL L_{Amax}	0		0	

Table 14 – Baseline Option and ES for Wendover North Cutting – Down-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances against the LOAEL values. This reduction in noise levels provides a benefit in accordance with the EIA methodology, resulting in the removal of 5 moderate impacts and the avoidance of a likely significant effect.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), represents a material benefit.

From a visual perspective mitigation in the **Mitigation Design Option 1** in form of a 2m noise barrier above TOR at the toe of the embankment length 210m compared to the ES assessed 2m barrier positioned at the crest of the cutting slope will have a clearly notable landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a minor linear feature in the landscape, albeit contained within the cutting earthworks and briefly glimpsed on the approaches to the Nash Lee overbridge. The barrier would form an intrusive feature, albeit limited in length, and in very brief views from the train, partially blocking the adjacent earthworks slope. The **Mitigation Design Option 1** visual impact is considered a clearly notable benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 1** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 1 is compared to the **Baseline Option** discounted on the basis of despite of better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs is higher.

- **Mitigation Design Option 2:** 3m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 2		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	5
Minor impact	5	5	7	3
No. above LOAEL L_{Aeq}	8	8	22	22
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	41		57	
No. above SOAEL L_{Amax}	0		0	

Table 15 – Baseline Option and ES for Wendover North Cutting – Down-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances against the LOAEL values. This reduction in noise levels provides a benefit in accordance with the EIA methodology, resulting in the removal of 5 moderate impacts and the avoidance of a likely significant effect.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), represents a material benefit.

From a visual perspective mitigation in the **Mitigation Design Option 2** in form of a 3m noise barrier above TOR at the toe of the embankment compared to the ES assessed 3m barrier positioned at the crest of the cutting slope will have a notable landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a minor linear feature in the landscape, albeit contained within the cutting earthworks and briefly glimpsed on the approaches to the Nash Lee overbridge. The barrier would form a highly intrusive feature, albeit limited in length, and in very brief views from the train, blocking out the adjacent earthworks slope. The **Mitigation Design Option 2** visual impact and considered a notable benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 2** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 2 is compared to the **Baseline Option** discounted on the basis of despite of better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs is higher.

- **Mitigation Design Option 3:** 4m absorptive noise barrier, lineside with offset of 4.6m from outside rail including the scheme design earthworks noise bund designs:

	Noise Barrier Design Option 3		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	5
Minor impact	5	5	7	3
No. above LOAEL L_{Aeq}	8	8	22	22
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	41		57	
No. above SOAEL L_{Amax}	0		0	

Table 16 – Baseline Option and ES for Wendover North Cutting – Down-Side: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

This option results in a reduction in noise levels compared to those reported in the ES, which results in a reduction in the number of exceedances against the LOAEL values. This reduction in noise levels provides a benefit in accordance with the EIA methodology, resulting in the removal of 5 moderate impacts and the avoidance of a likely significant effect.

Overall, the change in acoustic performance resulting from this mitigation option, when compared to the ES (as amended), represents a material benefit.

From a visual perspective mitigation in the **Mitigation Design Option 3** in form of a 4m noise barrier above TOR at the toe of the embankment length 210m compared to the ES assessed 4m barrier positioned at the crest of the cutting slope will have a landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier at the cutting crest and repositioning at the toe would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties. However, the barrier will still continue to form a minor linear feature in the landscape, albeit contained within the cutting earthworks and briefly glimpsed on the approaches to the Nash Lee overbridge. The barrier would form a highly intrusive feature, albeit limited in length, and in very brief views from the train, blocking out the adjacent earthworks slope. The **Mitigation Design Option 3** visual impact is considered a benefit.

The cost of the noise barrier represents very poor value for money when compared to the scale of the noise benefit.

The **Mitigation Design Option 3** does not present any complex engineering constraints and is considered neutral.

Mitigation Design Option 3 is compared to the **Baseline Option** discounted on the basis of despite of better acoustic benefits, the visual benefits are not as good as in the **Baseline Option** and costs is higher.

The **Baseline Option** (mitigation in the form of earthworks) is selected as the appropriate mitigation design as this represents an optimal solution from an acoustic, visual, economical and engineering perspective.

From hereon this option is referred to as the **Proposed Design**.

5 Methodology

5.1 Airborne noise from operational railways

Airborne noise from the operational railway has been assessed according to the required HS2 methodology which requires predictions of noise emission from five discrete sources at different heights above the rail to represent the source of noise associated with High-Speed Rail. The total noise emission from the train is calculated from the summation of the contributions of each of these distinct elements of the train, individually corrected for propagation to the assessment location.

The methodology includes corrections to account for future rolling stock being quieter than TSI-compliant trains and the representation of an individual track to better allow for divergence of the up and down tracks.

Appendix D sets out in detail the technical methodology for the prediction of airborne noise from operational trains.

5.2 Assessment of Impacts

In accordance with Information Papers E20 and E21 and the Phase 1 ES methodology, the impact of each Design Option is considered and assessed against the following criteria:

- The number of residential properties with impacts predicted to exceed LOAEL;
- The number of residential properties with impacts predicted to exceed SOAEL;
- The number of residential properties with predicted noise impacts;
- The number of properties predicted to be eligible for noise insulation; and
- Effects on non-residential properties in accordance with the EIA methodology.

6 Assumptions

The study is based upon the available information at this stage of the design. For the operational railway the assumed train service patterns, track form, rolling stock parameters and noise sources, and planned operational train speeds are as provided by HS2 and are presented within Appendix E.

6.1 Uncertainties and Limitations

The Train Noise Prediction Method (TNPM) used within the assessment was originally validated against a large number of high-speed train noise measurements covering a broad range of scenarios, including propagation over flat ground up to distances of 800m from the railway, effects of screening (including reflective and absorptive barriers) and varying angles of view. The overall regression analyses gave a standard error, for the goodness of fit between predicated and measured levels, of approximately 3dB(A) for SEL and L_{pAFmax}. This means that the difference between predicted and measured sound levels is typically within a margin of error of ±3dB(A). Consistent with the hybrid Bill Scheme the mean levels predicted with the TNPM are presented in this report.

Any source of noise that could occur, or any mitigation that is installed or constructed to control noise and/or vibration; but is not subject to an acoustic specification / standard requires an assumption. Such assumptions are defined when taking into consideration the likely application of existing technology with reference to the probability of the noise and/or vibration occurring. This includes reference to sensitivity tests and regression analysis between predicted and measured levels such as those presented in Appendix SV-001-000: Annex D2 of the HS2 Phase 1 ES and set out in the methodology section of this report. Assumptions in all reasonably foreseeable circumstances are taken on a reasonable worst case. As such, under the majority of operating conditions, lower noise levels than those predicted in this assessment would be expected.

7 Results of the noise assessment for the proposed design

This section presents the results of the noise assessment for the proposed design in more detail.

7.1 Wendover Green Tunnel North Portal to Wendover North Cutting

The noise predictions at each receptor for the Phase 1 ES Design, and the **Proposed Design** (noise mitigation in the form of earthworks) are presented in Table 17 and summarised in Table 18.

Table 17 presents a comparison of the rail noise predictions as the mitigation design focuses on mitigation of the rail noise contribution at receptor locations. The cumulative noise including the Opening year baseline +15 Year Traffic L_{Aeq},dB (future baseline + rail noise +road traffic noise) is presented in Appendix F.

Receptor locations are shaded in red where a LOAEL value is predicted to be exceeded.

ID	Area Represented	No of Impacts Represented	ES Scheme		Proposed Design	
			Day	**Night**	**Day**	**Night**
365001	Lionel Avenue, Wendover	24	39	30	38	28
365130	Aylesbury Road, Wendover	15	36	28	35	25
365216	Aylesbury Road, Wendover	10	37	28	36	26
365280	Aylesbury Road, Wendover	1	40	31	39	30
365348	Aylesbury Road, Wendover	37	35	26	34	25
366563	Lionel Avenue, Wendover	38	37	28	36	26
362513	Dobbins Lane, Wendover	22	39	30	38	28
362638	Thornton Crescent, Wendover	49	39	30	39	30
362785	Bridleways, Wendover	22	45	36	45	35
362860	Dobbins Lane, Wendover	83	38	29	37	28
363661	Dobbins Lane, Wendover	19	42	33	41	31
364087	Orchard Close, Wendover	37	37	28	36	27
364294	The Cedars, Wendover	53	39	30	38	29
366705	Lionel Avenue, Wendover	32	42	33	41	32
700327	Bridleways, Wendover	1	45	36	45	35

Table 17 – Operational airborne noise, Proposed Design compared to HS2 Phase 1 ES Design for Wendover Green Tunnel North Portal to Wendover North Cutting

The predicted noise levels above LOAEL (L_{Aeq} daytime and night-time) for the **Proposed Design** (mitigation in the form of earthworks) have been compared against the Phase 1 ES and are summarised in Table 18.

	Observed Adverse Effect Level	Total Day	Total Night
Proposed Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	0	0
ES		0	0

Table 18 – Number of dwellings exceeding LOAEL in the Design and ES (L_{Aeq}) – Wendover Green Tunnel North Portal to Wendover North Cutting

The information presented within Table 17 and Table 18 shows that there is no change in the exceedances above LOAEL for rail noise only, for the **Proposed Design** compared to the Phase 1 ES.

Table 19 presents the assessment of the noise change resulting from the predicted railway noise levels when assessed against the baseline noise levels. This shows that the **Proposed Design** results in no change in the number of impacts compared to those reported in the Phase 1 ES.

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
Proposed Design (noise mitigation in the form of earthworks)	0	0	0	0	0	0
ES	0	0	0	0	0	0

Table 19 – Number of receptors identifying impacts in the Design and ES (L_{Aeq}) – Wendover Green Tunnel North Portal to Wendover North Cutting

The L_{max} levels for the **Proposed Design** have been compared against the Phase 1 ES and are presented in Table 20 and summarised in Table 21 below.

Locations where noise level rail noise levels are predicted to exceed the daytime LOAEL of 57.5dB (free field) are highlighted in red.

ID	Area Represented	No of Impacts Represented	Lmax Proposed Design	Lmax ES Design
365001	Lionel Avenue, Wendover	24	55	55/58
365130	Aylesbury Road, Wendover	15	51	51/54
365216	Aylesbury Road, Wendover	10	52	51/54
365280	Aylesbury Road, Wendover	1	56	56/59
365348	Aylesbury Road, Wendover	37	50	50/52
366563	Lionel Avenue, Wendover	38	53	53/56
362513	Dobbins Lane, Wendover	22	58	58/61
362638	Thornton Crescent, Wendover	49	62	61/64
362785	Bridleways, Wendover	22	63	64/66
362860	Dobbins Lane, Wendover	83	58	58/61
363661	Dobbins Lane, Wendover	19	59	60/63
364087	Orchard Close, Wendover	37	54	55/57
364294	The Cedars, Wendover	53	57	57/60
366705	Lionel Avenue, Wendover	32	59	59/62
700327	Bridleways, Wendover	1	64	64/67

Table 20 – Operational L_{Amax} noise levels compared against ES receptors – Wendover Green Tunnel North Portal to Wendover North Cutting

Barrier Design Option	Observed Adverse Effect Level	Total Night
Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	228
ES		306

Table 21 – Number of dwellings exceeding LOAEL in the Proposed Design and ES for L_{Amax} – Wendover Green Tunnel North Portal to Wendover North Cutting

Generally, the assessment shows small decreases in levels, attributable to changes in the design and the removal of the TSI trains from the fleet. The assessment of the **Proposed Design** predicts a decrease in L_{Amax} exceedances (228) above the LOAEL as reported in the HS2 Phase 1 ES (306).

The decrease in the number of exceedances of the L_{Amax} LOAEL values for the night-time period provides little or no benefit, especially when the predicted L_{Amax} levels are considered in context of the prevailing ambient L_{Amax} noise levels. Analysis of the baseline noise levels in this area shows that the L_{Amax} LOAEL values are already exceeded during the night and by significantly greater margins compared to the predicted railway noise levels. This is as expected given the proximity of these receptors to the A413 and the existing railway line. Further information on night-time ambient noise levels is presented in Appendix E.

Overall, the change in acoustic performance compared to the ES (as amended) is neutral.

7.2 Wendover North Cutting

7.2.1 Wendover North Cutting – Up-Side (East)

The noise predictions at each receptor for the Phase 1 ES Design, and the **Proposed Design** (noise mitigation in the form of earthworks) are presented in Table 22 and summarised in Table 23.

Table 22 presents a comparison of the rail noise predictions as the mitigation design focuses on mitigation of the rail noise contribution at receptor locations. The cumulative noise including the Opening year baseline +15 Year Traffic L_{Aeq},dB (future baseline + rail noise +road traffic noise) is presented in Appendix F.

Receptor locations are shaded in red where a LOAEL value is predicted to be exceeded.

ID	Area Represented	No of Impacts Represented	ES Scheme		Proposed Design	
			Day	**Night**	**Day**	**Night**
314803	Triangle Business Park, Rabans Lane Industrial (office)	19	52	43	50	41
358148	Wendover Road, Weston Turville	18	46	37	44	34
358410	Wendover Road Stoke Mandeville	2	45	36	43	33
358677	Wendover Road Stoke Mandeville	3	46	37	44	34
358721	Aylesbury Road Wendover	7	40	32	38	29
358776	Nash Lee End, Wendover	1	41	33	39	30
367404	Aylesbury Road Wendover	2	39	30	38	28
314865	Wendover Road, Stoke Mandeville	1	49	41	48	39
355734	Nash Lee Road Wendover	7	50	41	50	40
357199	Nash Lee Lane, Wendover	7	60	51	60	51
357950	Nash Lee End, Wendover (shopping)	1	49	40	47	38
357971	Nash Lee Lane Wendover	6	55	47	53	44
357877	Nash Lee End, Wendover	1	43	35	42	33
*	Non-Residental					

Table 22 – Operational airborne noise, Proposed Design compared to HS2 Phase 1 ES Design for Wendover North Cutting – Up-Side

The predicted noise levels (L_{Aeq} daytime and night-time) for the **Proposed Design** (mitigation in the form of earthworks) presents compared to the ES on average for all receptors a slight increase (0.2 dB) for daytime and a slight decrease (-0,2 dB) for night-time. For all receptors above LOAEL the noise levels are similar (0 dB) to the ES.

The predicted noise levels above LOAEL (L_{Aeq} daytime and night-time) for the **Proposed Design** (mitigation in the form of earthworks) have been compared against the Phase 1 ES and are presented in Table 23.

	Observed Adverse Effect Level	Total Day	Total Night
Proposed Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	13	20
ES		20	21

Table 23 – Number of dwellings exceeding LOAEL in the Design and ES (L_{Aeq}) – Wendover North Cutting – Up-Side

The information presented within Table 23and Table 23 shows fewer exceedances above LOAEL for rail noise only, for the **Proposed Design** (mitigation in the form of earthworks) compared to the Phase 1 ES.

Table 24 shows that when considering the impact of rail noise alone, the **Proposed Design** (mitigation in the form of earthworks) results in no change in the number of impacts compared to those reported in the ES (as amended).

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
Proposed Design (noise mitigation in the form of earthworks)	0	0	7	7	0	0
ES	0	0	7	7	0	0

Table 24 – Number of receptors identifying impacts in the Design and ES (L_{Aeq}) – Wendover North Cutting – Up-Side

The **Proposed Design** does not result in the removal of the moderate impacts at Receptor ID 357199, and therefore would not result in the removal of significant effect OSV10-C04 reported in the ES. This is as expected given that prevailing ambient noise levels (in the absence of the new railway) would be significantly influenced by the proximity of these receptors to the A413 and the existing railway line.

The L_{max} levels for the **Proposed Design** (mitigation in the form of earthworks) have been compared against the Phase 1 ES and are presented in Table 25 below.

Locations where noise level rail noise levels are predicted to exceed the daytime LOAEL of 57.5dB (free field) are highlighted in red. Table 25 indicates that the Design shows fewer exceedances above LOAEL than the HS2 Phase 1 ES.

ID	Area Represented	No of Impacts Represented	Lmax Proposed Design	Lmax ES Design
314803	Triangle Business Park, Rabans Lane Industrial (office)	19	64	64/67
358148	Wendover Road, Weston Turville	18	58	59/62
358410	Wendover Road Stoke Mandeville	2	56	59/62
358677	Wendover Road Stoke Mandeville	3	58	58/61
358721	Aylesbury Road Wendover	7	50	51/54
358776	Nash Lee End, Wendover	1	52	53/56
367404	Aylesbury Road Wendover	2	52	53/56
314865	Wendover Road, Stoke Mandeville	1	62	61/64
355734	Nash Lee Road Wendover	7	62	63/65
357199	Nash Lee Lane, Wendover	7	74	73/76
357950	Nash Lee End, Wendover (shopping)	1	60	60/62
357971	Nash Lee Lane Wendover	6	67	67/69
357877	Nash Lee End, Wendover	1	55	57/60
*	Non-residental			

Table 25 – Operational L_{Amax} noise levels compared against ES receptors – Wendover North Cutting – Up-Side

The exceedances above the LOAEL for the L_{Amax} predictions are summarised in Table 26.

Barrier Design Option	Observed Adverse Effect Level	Total Night
Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	42
ES		45

Table 26 – Number of dwellings exceeding LOAEL in the Proposed Design and ES for L_{Amax} – Wendover North Cutting – Up-Side

Generally, the assessment shows small decreases in levels, attributable to changes in the design and the removal of the TSI trains from the fleet. The assessment of the **Proposed Design** (mitigation in the form of earthworks) predicts a small decrease in L_{Amax} exceedances (42) above the LOAEL as reported in the HS2 Phase 1 ES (45).

Overall, it is considered that the acoustic performance of the **Proposed Design** (mitigation in the form of earthworks) compared to the ES is neutral.

7.2.2 Wendover North Cutting – Down-Side (West)

The noise predictions at each receptor for the Phase 1 ES Design, and the **Proposed Design** (noise mitigation in the form of earthworks) are presented in Table 27 and summarised in Table 28.

Table 27 presents a comparison of the rail noise predictions as the mitigation design focuses on mitigation of the rail noise contribution at receptor locations. The cumulative noise including the Opening year baseline +15 Year Traffic L_{Aeq},dB (future baseline + rail noise +road traffic noise) is presented in Appendix F.

Receptor locations are shaded in red where a LOAEL value is predicted to be exceeded.

ID	Area Represented	No of Impacts Represented	ES Scheme		Proposed Design	
			Day	Night	Day	Night
314444	Nash Lee Road, Terrick	13	48	39	45	35
314652	Nash Lee Road, Terrick	1	59	50	57	48
314668	Nash Lee Road, Terrick	1	58	50	58	48
314704	Nash Lee Road, Terrick	4	60	51	59	50
314625	Nash Lee Farm, Nash Lee	6	52	43	49	40
312509	Nash Lee Road, Terrick	5	48	39	45	36
313421	Risborough Road, Stoke Mandeville	2	56	47	54	47
313337	Risborough Road, Stoke Mandeville	8	51	42	49	39
357521	Ellesborough Road, Wendover	5	35	27	32	22
357547	Ellesborough Road, Wendover	5	35	27	33	24
357601	Ellesborough Road, Wendover	5	35	27	34	24
357663	Ellesborough Road, Wendover	1	45	36	41	32
357730	Ellesborough Road, Wendover	4	45	36	43	34
359465	Ellesborough Road, Wendover	4	32	23	31	22
359523	Ellesborough Road, Wendover	3	34	26	34	24
700324	Ellesborough Road, Wendover	1	35	27	33	23
700328	Ellesborough Road, Wendover	2	37	29	35	25
700323	Ellesborough Road, Wendover	1	36	27	37	28

Table 27 – Operational airborne noise, Proposed Design compared to HS2 Phase 1 ES Design for Wendover North Cutting – Down-Side

The predicted noise levels (L_{Aeq} daytime and night-time) for the **Proposed Design** (mitigation in the form of earthworks) presents compared to the ES on average for all receptors similar values (0 dB) for daytime and a slight decrease (-0,5 dB) for night-time. For all receptors above LOAEL the predicted noise levels presents compared to the ES on average a slight decrease (-0.1 dB) for daytime and a slight decrease (-0,3 dB) for night-time.

	Observed Adverse Effect Level	Total Day	Total Night
Proposed Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	8	14
ES		22	22

Table 28 – Number of dwellings exceeding LOAEL in the Design and ES (L_{Aeq}) – Wendover North Cutting – Down-Side

The information presented within Table 28 shows fewer exceedances above LOAEL for rail noise only, for the **Proposed Design** (mitigation in the form of earthworks) compared to the ES (as amended).

Table 29 shows that when considering the impact of rail noise alone, the **Proposed Design** (mitigation in the form of earthworks) results in the avoidance of moderate impacts during night-time, but an increase in minor impacts during night time compared to those reported in the ES (as amended).

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
Proposed Design (noise mitigation in the form of earthworks)	0	0	0	0	7	7
ES	0	0	0	5	7	3

Table 29 – Number of receptors identifying impacts in the Design and ES (L_{Aeq}) – Wendover North Cutting – Down-Side

The Proposed Design Option avoids the significant effect OSV10-C04 reported in the ES by removing the minor night-time effect at Receptor ID 314668 and also reduces the moderate effects reported in the ES at ID 314652 and ID 314704 to minor impacts.

The reduction in 5 moderate impacts represents a material benefit using the EIA methodology.

The L_{max} levels for the **Proposed Design** (mitigation in the form of earthworks) have been compared against the ES (as amended) and are presented in Table 30 below.

Locations where noise level rail noise levels are predicted to exceed the daytime LOAEL of 57.5dB (free field) are highlighted in red. Table 30 indicates that the Design shows fewer exceedances above LOAEL than the HS2 Phase 1 ES.

ID	Area Represented	No of Impacts Represented	Lmax Proposed Design	Lmax ES Design
314444	Nash Lee Road, Terrick	13	60	61/64
314652	Nash Lee Road, Terrick	1	71	65/70
314668	Nash Lee Road, Terrick	1	66	65/68
314704	Nash Lee Road, Terrick	4	70	70/73
314625	Nash Lee Farm, Nash Lee	6	65	65/68
312509	Nash Lee Road, Terrick	5	60	63/66
313421	Risborough Road, Stoke Mandeville	2	68	70/73
313337	Risborough Road, Stoke Mandeville	8	63	61/64
357521	Ellesborough Road, Wendover	5	49	49/52
357547	Ellesborough Road, Wendover	5	51	51/54
357601	Ellesborough Road, Wendover	5	53	53/56
357663	Ellesborough Road, Wendover	1	54	55/58
357730	Ellesborough Road, Wendover	4	56	55/58
359465	Ellesborough Road, Wendover	4	51	50/53
359523	Ellesborough Road, Wendover	3	57	57/60
700324	Ellesborough Road, Wendover	1	56	55/58
700328	Ellesborough Road, Wendover	2	54	55/58
700323	Ellesborough Road, Wendover	1	60	60/63

Table 30 – Operational L_{Amax} noise levels compared against ES receptors – Wendover North Cutting – Down-Side

The exceedances above the LOAEL for the L_{Amax} predictions are summarised in Table 31.

Barrier Design Option	Observed Adverse Effect Level	Total Night
Design (noise mitigation in the form of earthworks)	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	41
ES		57

Table 31 – Number of dwellings exceeding LOAEL in the Proposed Design and ES for L_{Amax} – Wendover North Cutting – Down-Side

Generally, the assessment shows small decreases in levels, attributable to changes in the design and the removal of the TSI trains from the fleet. The assessment of the **Proposed Design** (mitigation in the form of earthworks) predicts a decrease in L_{Amax} exceedances (41) above the LOAEL as reported in the HS2 Phase 1 ES (57).

Overall, it is considered that the acoustic performance of the **Proposed Design** (mitigation in the form of earthworks) represents a material benefit compared to the ES.

8 Conclusions

The report demonstrates how all reasonable steps have been taken to reduce airborne sound from the operational railway, predicted in all reasonably foreseeable circumstances, in order not to exceed defined values for LOAEL from the Phase 1 ES. Where it has not been reasonably practicable to achieve this objective, the report shows how airborne sound has been reduced in accordance with the principles of AFARP.

The earthworks designs have been enhanced to optimise their performance against a range of criteria including the acoustic effects; landscape and visual effects; engineering practicality, and stakeholder engagement. This process has been used to optimise the design of the scheme and reduce the noise impacts as far as reasonably practicable.

For **Wendover Green Tunnel North Portal to Wendover North Cutting** the assessment shows that, on balance, the overall change in the acoustic performance is neutral compared to that reported in the ES (as amended). The visual impacts associated with the proposed earthworks mitigation design is a notable landscape and visual benefit. Particularly at a location which is within the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range elevated views from the realigned PRoW which traverses over the tunnel in proximity to the north portal.

For **Wendover North Cutting – Up-Side** the assessment shows that, on balance, the overall change in the acoustic performance is neutral compared to that reported in the ES (as amended). The visual impacts associated with the proposed earthworks mitigation design will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties.

For **Wendover North Cutting – Down-Side** the assessment shows, on balance, there is a material benefit and that the likely significant effect reported in the ES (as amended) will be avoided. The visual impacts associated with the proposed earthworks mitigation design will have a clearly evident landscape and visual benefit, particularly at a location which is within the immediate setting of the Chilterns AONB and within an area visible from the elevated views from Bacombe Hill and Combe Hill to the south. The removal of the barrier would also be experienced in short range views form B4009 Nash Lee Road and adjacent residential properties.

APPENDIX A

Schedule 17 Application Boundary – Nash Lee

Number of Pages: 1

A High-Speed Design Partnership

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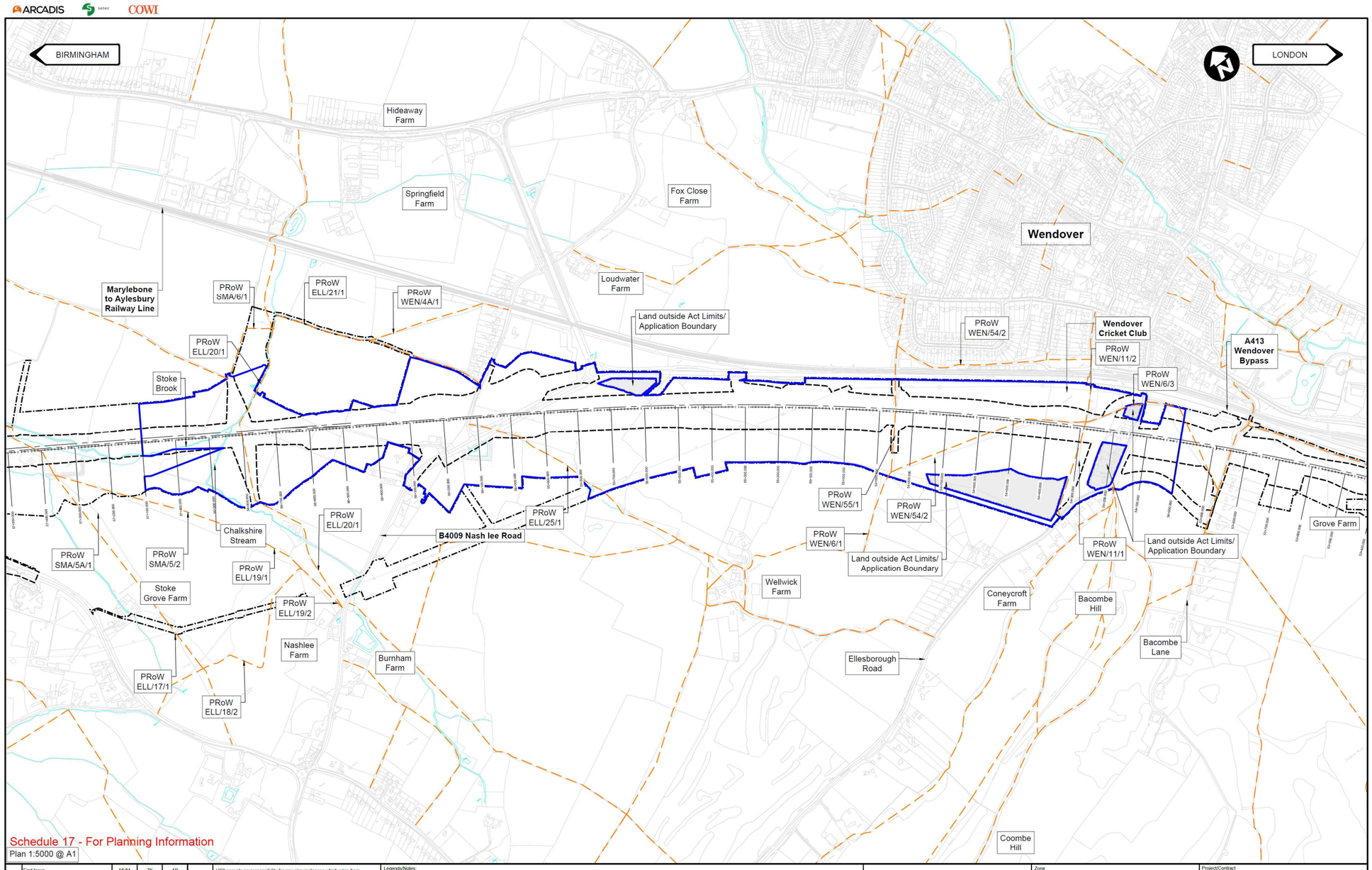
High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley
1MC06-CEK-TP-REP-CS03_CL06-000002



Schedule 17 - For Planning Information

Plan 1:5000 @ A1

Rev	Description	Drawn	Checked	Approved	HS2 App
C01	First Issue	MVM 19/05/2022	ZK 19/05/2022	AB 19/05/2022	
P06	Revised in line with comments	BK 17/03/2022	ZK 17/03/2022	AB 17/03/2022	
P05	Revised in line with comments	BK 28/10/2021	ZK 29/10/2021	JR 29/10/2021	
P04	Revised in line with comments	BK 30/04/2021	ZK 30/04/2021	AB 30/04/2021	
P03	Revised in line with comments	JK 10/09/2020	ZK 10/09/2020	AB 10/09/2020	

Drawing produced in HS2 SnakeGrid (HS2P1+14) coordinate system

Scale with caution as distortion can occur.

Legends/Notes:

- Schedule 17 Application Boundary
- LOD (Limits of Deviation)
- LLAU (Limits of Land to be Acquired or Used)
- HS2 Tracks
- PRoW (Public Rights of Way)
- Existing Watercourses

HS2

Registered in England
Registration No. 06791686
Registered office:
2 Snow Hill, Queensway,
Birmingham, B4 6GA

Creator/Originator	CEK
Zone	CS03
Design Stage	SCHEME DESIGN
Drawing Title	Nash Lee Site Location Plan
Design Status	A3
Suitability	Suitable for Scheme Design
Project/Contract	1MC06
Discipline/Function	Town & Country Planning
Drawn	M.V.Mhatre
Checked	Z.Krezinger
Approved	A.Barbour
Date	19/05/2022
Scale	AS SHOWN
Size	A1
Drawing No.	1MC06-CEK-TP-DLO-CS03_CL06-000002
Rev.	C01

APPENDIX B

LOAEL and SOAEL Values from Information Paper E20 and E21

Number of Pages: 2

Time of day	Lowest Observed Adverse Effect Level (dB)	Significant Observed Adverse Effect Level (dB)
Day (0700 – 2300)	50 $L_{pAeq, 16hr}$	65 $L_{pAeq, 16hr}$
Night (2300 – 0700)	40 $L_{pAeq, 8hr}$	55 $L_{pAeq, 8hr}$
Night (2300 – 0700)	60 L_{pAFMax} (at the façade, from any nightly noise event)	80 L_{pAFMax} (at the façade, from more than 20 nightly train passbys), or 85 L_{pAFMax} (at the façade, from 20 or fewer nightly train passbys)

Table C1 - Noise effect levels for permanent residential buildings

Ground-borne noise	Lowest Observed Adverse Effect Level	L_{pASMax} [dB]	35
	Significant Observed Adverse Effect Level	L_{pASMax} [dB]	45
Vibration	Lowest Observed Adverse Effect Level	VDVday[$ms^{-1.75}$]	0.2
		VDVnight[ms-1.75]	0.1
	Significant Observed Adverse Effect Level	VDVday[$ms^{-1.75}$]	0.8
		VDVnight[$ms^{-1.75}$]	0.4

Table C2 - Ground-borne noise and vibration effect levels for permanent residential buildings

Examples	L_{pASMax} [dB]
Large auditoria; and concert halls	25
Sound recording & broadcast studios; theatres, and small auditoria	30
Places of meeting for religious worship; courts; cinemas; lecture theatres; museums; and small auditoria or halls	35
Offices; schools; colleges, hospitals; hotels; and libraries	40

Table C3 - Ground-borne noise impact levels for non-residential buildings

Examples	VDVday [ms-1.75]	VDVnight [ms-1.75]
Hotels; hospital wards; and education dormitories	0.2	0.1
Offices; Schools; and Places of Worship	0.4	n/a
Workshops	0.8	n/a
Vibration sensitive research and manufacturing (e.g. computer chip manufacture); hospitals with vibration sensitive equipment / operations; universities with vibration sensitive research equipment / operations	Risk assessment will be undertaken based on the information currently available for the relevant equipment /process, or where information provided by the building owner or equipment manufacturer.	

Table C4 - Ground-borne vibration impact levels for non-residential buildings

APPENDIX C

Detailed Technical Methodology

Number of Pages: 2

Airborne Rail Noise

Rail noise modelling has been undertaken using the NoiseMap software package. This implements the airborne noise calculation methodology (commonly referred to as the Train Noise Prediction Model (TNPM)). This validated methodology has been used for the HS2 ES and, prior to that, the detailed design of the Channel Tunnel Rail Link (HS1). The method to predict airborne sound from operation has modelled the propagation including the following effects: topography, ground type, reflections, shielding by barriers and buildings, air absorption, and meteorology.

The TNPM methodology allows for sources of varying heights to be put onto the same track segments. Image D1 shows the heights of the five sources defined as distances above rail. The source terms which have been used for each of these source contributions are set out in Appendix E.

Image D1: Train noise sources

- *In the predictions of airborne noise from HS2 trains, the speed dependence relationships for each of these sources, in terms of SEL shall be:*
  - R_{SEL} *+ 20log10V for rolling sound;*
  - B_{SEL} *+ 60log10V for body aerodynamic sound;*
  - S_{SEL} *- 10log10V for starting sound (V < 250 kph); and*
  - P_{SEL} *+ 60log10V for pantograph and pantograph recess sound.*

  where R_{SEL} is the source term for rolling sound, B_{SEL} is the source term for body aerodynamic sound, S_{SEL} is the source term for starting sound and P_{SEL} is the source term for pantograph and pantograph recess sound and V is the train speed in kph. S_{SEL} shall not be included for predictions of airborne noise when train speeds are 250 kph or above.
- *The corresponding speed dependence relationships for each of these sources, in terms of L_{pAFmax}, which shall be assumed in the prediction of airborne noise for each of these sources are:*
  - $R_{LpAF,max}$ *+ 30log10V for rolling sound;*
  - $B_{LpAF,max}$ *+ 70log10V for body aerodynamic sound;*

- $S_{LpAF,max}$ *for starting sound; and*
- $P_{LpAF,max}$ *+ 70log10V for pantograph and pantograph recess sound.*

- *Where $R_{LpAF,max}$ is the source term for rolling maximum sound, $B_{LpAF,max}$ is the source term for body aerodynamic maximum sound, $S_{LpAF,max}$ is the source term for starting sound and PLpAF,max is the source term for pantograph and pantograph recess maximum sound and V is the train speed in kph.*

- *The method to predict airborne sound from operation shall model the propagation in order to consider, but not limited to, the following effects: topography, ground type, reflections, shielding by barriers and buildings, air absorption and meteorology.*

- *The total pass-by L_{pAFmax} is computed using the following equation:*

$$L_{pAFmax} = MAX\ [\ (R_{LpAF,max} \oplus B_{LpAF,max} \oplus S_{LpAF,max})\ ,\ (R_{LpAF,max} \oplus P_{LpAF,max} \oplus S_{LpAF,max})]$$

- *To account for the differing source heights resulting in different distance attenuation, ground absorption and shielding etc. the calculations for propagation from source to receptors will be undertaken for each source individually for both $L_{pAeq,T}$ and $L_{pAF,max}$ calculations. $L_{pAeq,T}$ will be logarithmically summed at the receptor location to provide a single figure value and $L_{pAF,max}$ will be summed in accordance with equation above at the receptor location to provide a single figure value.*

Predictions of airborne sound take into account the acoustic performance of civil engineering assets, trackwork and trains throughout the life of the operational railway with a maintenance programme agreed with HS2 and thereby account for all reasonably foreseeable circumstances in accordance with HS2 Information Paper E20.

Predictions of airborne sound from existing conventional railways unaltered by the proposed scheme and construction railways have been made in accordance with the technical memorandum the Calculation of Railway Noise (CRN), the CRN Supplement 1 and the AEAT supplementary sources terms. This will include source terms and rolling noise corrections as specified by the CRN methodology.

Airborne Noise from Altered Roads

Airborne noise from altered roads has been assessed in accordance with the methodology set out in the Calculation of Road Traffic Noise (CRTN) and the updated procedure in the Design Manual for Roads and Bridges (DMRB) HD213-11 Rev1.

Where there has been no significant changes since the ES, results from road noise calculations from roads altered by the scheme presented for the ES have been utilised. This data will be updated as further information comes available.

Ground-borne Noise and Vibration from the Operational Railway

A vibration scoping exercise has been undertaken to investigate if ground-borne noise and vibration has the potential to cause additional adverse effects compared to the ES and the various Additional Provisions (AP) and Supplementary Environmental Assessments (SES), published in 2015 due to the assets in this Schedule 17 application. This scoping exercise showed that there are no changes since the ES affecting ground-borne noise and vibration. Therefore, no further detailed predictions and assessment has been undertaken for ground-borne noise and vibration.

APPENDIX D

Assumptions

Number of Pages: 4

Rail Modelling Assumptions

The HS2 rolling stock and service pattern is made up of two train fleets:

- Phase 1 fleet will be made up of Conventional Compatible (CC) trains that can run on both the High Speed and the classic rail network, and,
- Phase 2b fleet will be made up of Captive (CP) trains that are dedicated to the High Speed network.

Train service pattern data is summarised in Table D1, normalised to 200m long trains and the noise source terms are presented in Table D2 and D3 for 330kph and 360kph respectively.

	Route Section	200m trains per section	400m trains per section	Total rains per section	Equivalent 200m trains per section	One-way train flow assumptions (equivalent 200m trains)								
						05.30-06.00	06-07.00	Standard hour	21-22.00	22-23.00	23-00.00	Total (24hr)	**Total Day (16hr)**	**Total Night (8hr)**
London to Birmingham / The North	3	6.0	12.0	**18.0**	30.0	5	20	30	25	15	5	490	460	30
└---> Conventional Compatible (Catch-Up)	3A	1.5	0.0	**1.5**	1.5	0	1	2	1	0	0	23	22	1
└---> Conventional Compatible (330)	3B	4.5	4.0	**8.5**	12.5	2	8	13	10	6	2	203	191	12
└---> Captive (Catch-Up)	3C	0.0	0.8	**0.8**	1.5	0	1	2	1	0	0	23	22	1
└---> Captive (330)	3D	0.0	7.3	**7.3**	14.5	2	9	15	12	7	2	235	222	13

Table D1 – Train flow data

Source	SEL dB at 25m		LpAF,max dB at 25m	
	Conventional Compatible train	Captive train	Conventional Compatible train	Captive train
Rolling	92	92	89	89
Body Aerodynamic	93	91	90	88
Start-up / Power	74	74	73	73
Pantograph Well	n/a	n/a	n/a	n/a
Raised Pantograph	77	77	79	79

Note: Sound emissions from each train running at 330kph on assumed HS2 infrastructure, expressed in terms of the SEL and L_{pAFmax} 25 m from nearest track and 3.5m above ground

Table D2 – Train source data at 330 kph

Source	SEL dB at 25m		LpAF,max dB at 25m	
	Conventional Compatible train	Captive train	Conventional Compatible train	Captive train
Rolling	93	93	90	90
Body Aerodynamic	95	93	92	90
Start-up / Power	73	73	73	73
Pantograph Well	n/a	n/a	n/a	n/a
Raised Pantograph	79	79	82	82

Note: Sound emissions from each train running at 360kph on assumed HS2 infrastructure, expressed in terms of the SEL and L_{pAFmax} 25 m from nearest track and 3.5m above ground

Table D3 – Train source data at 360 kph

APPENDIX E

Nash Lee - L_{AFmax} data

Number of Pages: 6

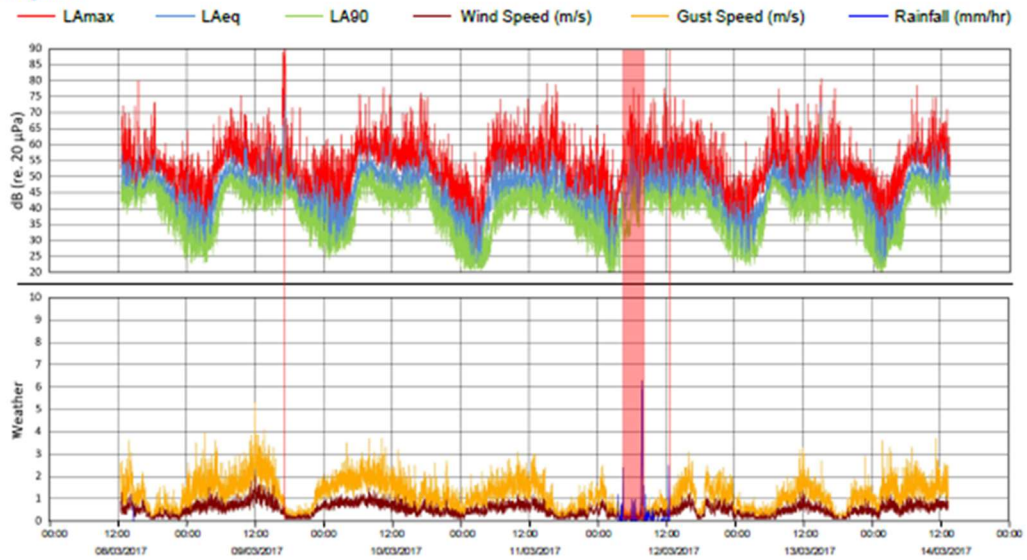
Nash Lee - L_{AFmax} data

The measurements were taken at the Bridleways over a period of 7 days during 8th to 14th March 2017 (see Image E1 below). The measurements are free field (away from reflecting surfaces).

Image E1 – Map Measuring Location Wendover

Monitoring Location BN034L is located within the rear garden of 5 Bridleways, Wendover, Aylesbury. The noise monitoring survey was conducted between 8th March 2017 and 14th March 2017. The microphone was mounted to a tripod, 1.5m above ground and within free-field location.

Graphs:



Weather conditions during monitoring:

Average wind speed and gusts below 5 m/s during the monitoring. Short periods of rain were recorded on Wednesday 8 and Sunday 12.

Measured Sound Pressure Levels: dB LA90 (dB LAeq)

Highlighted cells affected by adverse weather

Date	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Wed 08/03													42 (53)	41 (49)	42 (49)	41 (50)	43 (48)	45 (50)	44 (51)	39 (48)	36 (46)	34 (44)	32 (41)	26 (42)
Thu 09/03	24 (39)	25 (38)	25 (37)	24 (36)	27 (40)	32 (47)	43 (51)	47 (52)	45 (52)	43 (51)	41 (52)	41 (47)	41 (48)	40 (48)	40 (50)	41 (48)	41 (53)	44 (66)	43 (48)	37 (46)	35 (41)	32 (42)	32 (43)	28 (41)
Fri 10/03	26 (41)	26 (40)	27 (37)	28 (39)	29 (40)	34 (48)	43 (53)	46 (54)	45 (53)	43 (51)	41 (52)	41 (51)	40 (50)	40 (48)	41 (50)	40 (49)	42 (51)	46 (53)	41 (50)	35 (46)	34 (44)	32 (43)	29 (40)	24 (37)
Sat 11/03	22 (36)	21 (35)	21 (33)	21 (31)	23 (41)	27 (47)	33 (50)	38 (50)	39 (49)	38 (50)	41 (50)	41 (52)	39 (49)	40 (50)	38 (48)	40 (50)	40 (52)	38 (47)	37 (47)	35 (43)	31 (43)	31 (43)	29 (41)	27 (44)
Sun 12/03	26 (41)	21 (39)	20 (35)	21 (35)	31 (43)	32 (49)	38 (52)	36 (51)	41 (48)	41 (50)	40 (48)	39 (50)	41 (50)	38 (50)	39 (49)	40 (48)	40 (49)	40 (50)	41 (48)	37 (45)	34 (45)	31 (43)	28 (38)	25 (37)
Mon 13/03	24 (36)	24 (34)	22 (34)	24 (37)	28 (40)	34 (46)	43 (51)	46 (51)	43 (50)	38 (48)	37 (47)	39 (46)	38 (48)	39 (49)	37 (64)	41 (48)	40 (48)	41 (50)	39 (46)	40 (46)	35 (46)	33 (44)	28 (43)	25 (40)
Tue 14/03	21 (36)	20 (32)	22 (34)	28 (37)	28 (40)	31 (46)	42 (51)	47 (52)	46 (51)	44 (51)	40 (51)	39 (51)	42 (52)	42 (49)										

Observations and subjective description of sound climate at monitoring location:

Daytime construction works were being undertaken at a nearby property during the monitoring period. During daytime visits the background sound level (LA90) was dominated by road traffic noise on the A413. Other daytime sources included aircraft flyovers and occasional construction noise and birdsong. During night-time periods road traffic noise on the A413 was the dominant source for the background sound. Other sources included wind noise and birdsong.

Measurement Uncertainty:

No seasonal noise sources, known road closures or diversions were observed during the monitoring period near the measurement location. Construction works could have affected some daytime background sound levels during unattended periods.

Historical annual average wind speed is typically between 1 m/s and 8 m/s from westerly direction. The measured wind speeds are considered within typical values.

Apart from the affected periods as highlighted above, the measured noise levels are considered representative of typical background sound levels at the measurement location.

The L_{AFmax} levels were recorded over 1-minute periods. The results were subsequently analysed to obtain a frequency distribution of the L_{AFmax} levels for each night period (23:00 to 07:00 hours).

A summary of the number of L_{AFmax} levels exceeding the free field LOAEL and SOAEL values (57.5, 77.5 and 82.5dB) is presented in Table F1. Total no. of exceedances is 314 for the time-period in question.

Date	No. of L_{AFmax} above LOAEL 57.5dB	No. of L_{AFmax} above SOAEL 77.5dB	No. of L_{AFmax} above SOAEL 82.5dB
08-09/03/2017	42	0	0
09-10/03/2017	94	0	0
10-11/03/2017	55	0	0
11-12/03/2017	60	0	0
12-13/03/2017	37	0	0
13-14/03/2017	26	0	0

Table F1 – No. of L_{AFmax} levels exceeding the free field LOAEL and SOAEL value (57.5, 77.5 and 82.5dB)

The results for each night period are presented in the following images E2 to E8. Image E8 show all measurements in the same histogram.

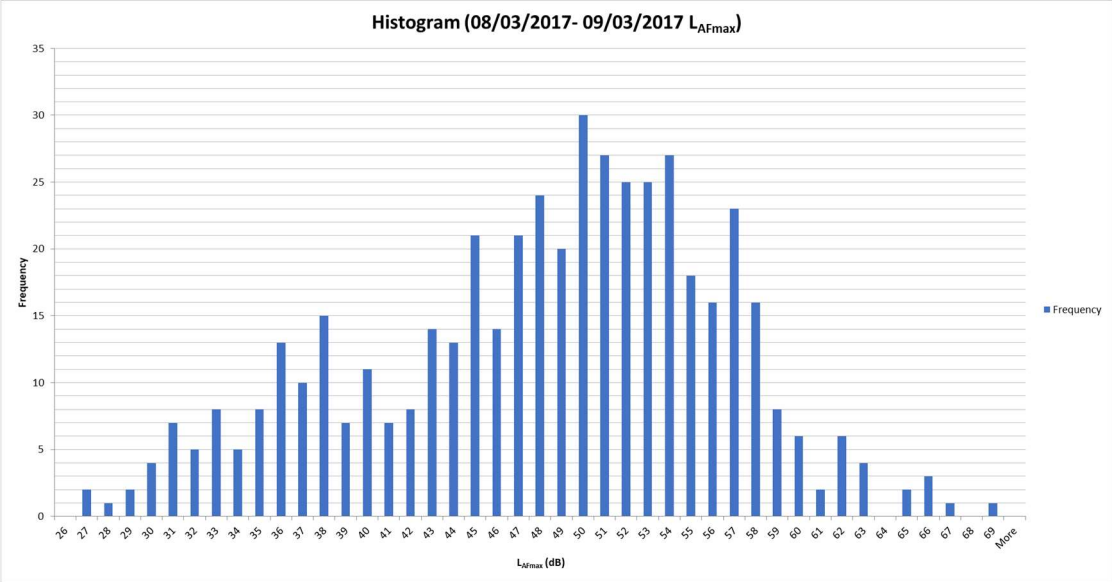


Image E2 – Measurement 23:00 8th to 07:00 9th March 2017

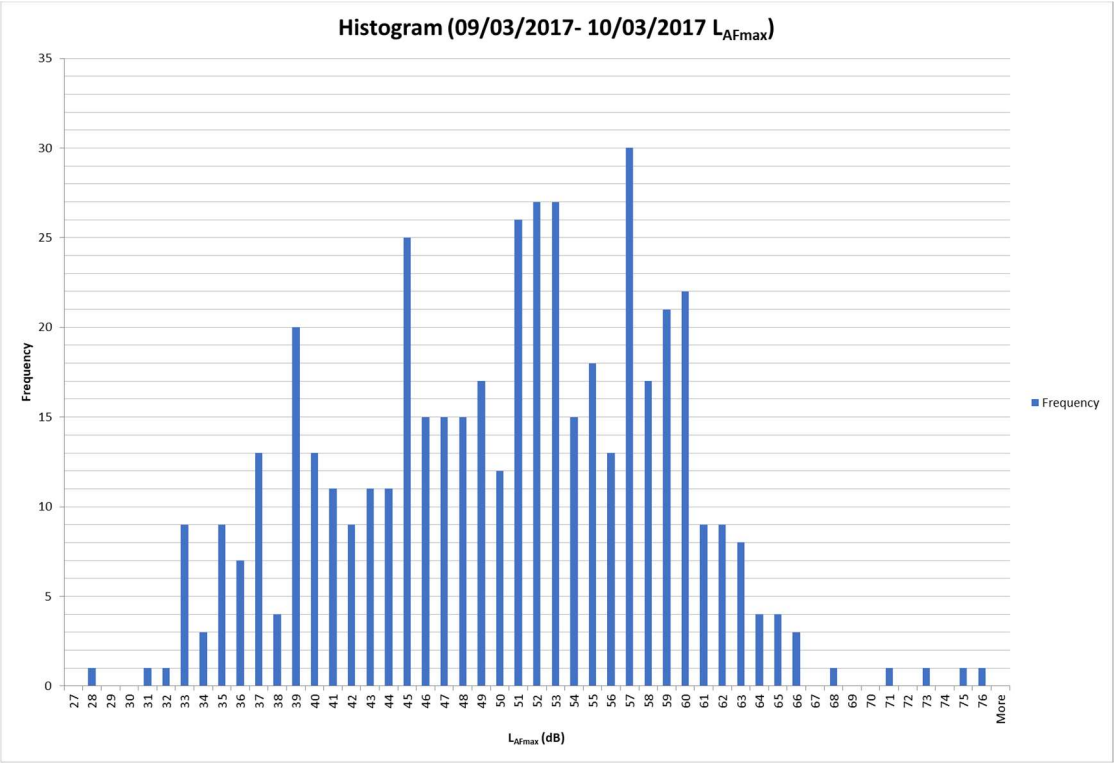


Image E3 – Measurement 23:00 9th to 07:00 10th March 2017

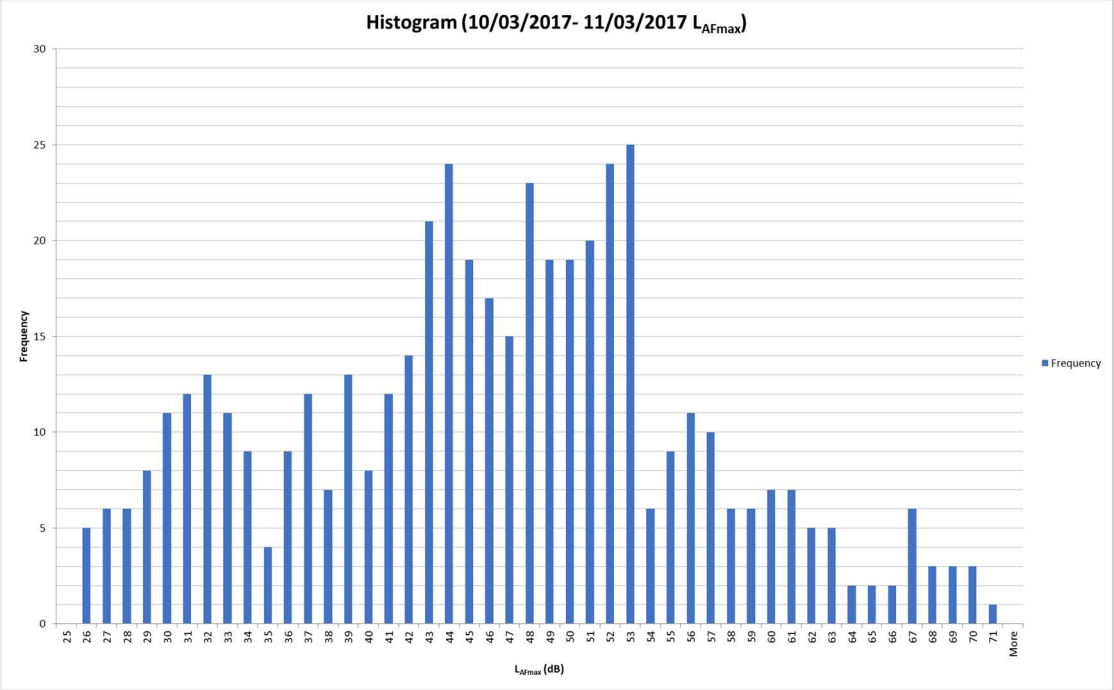


Image E4 – Measurement 23:00 10th to 07:00 11th March 2017

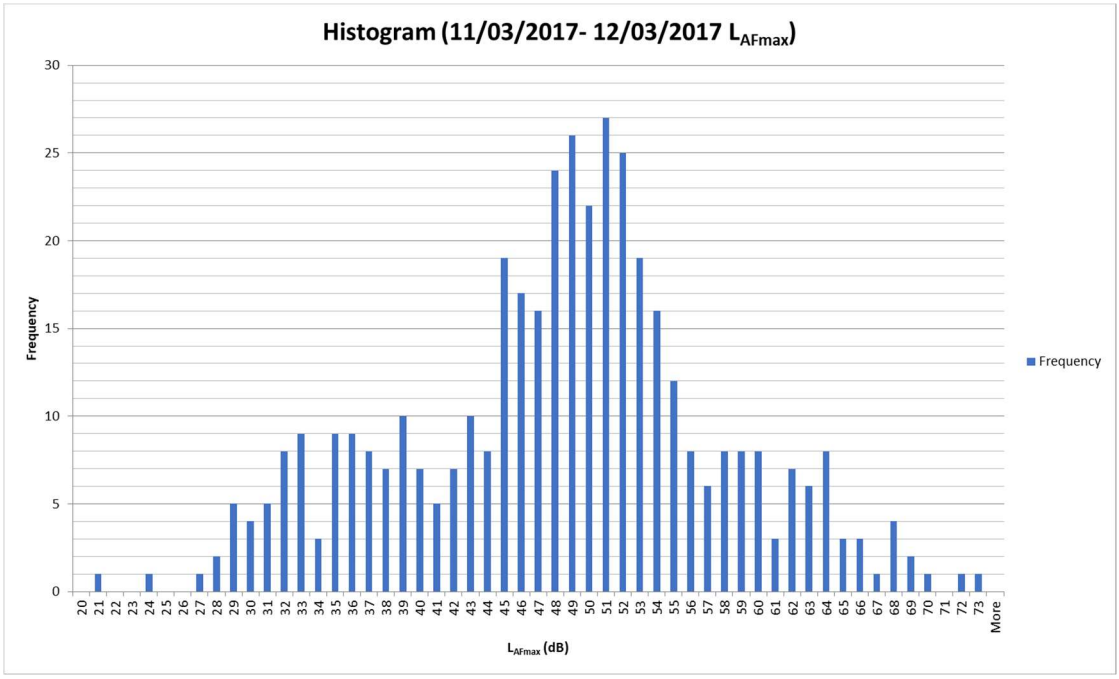


Image E5 – Measurement 23:00 11th to 07:00 12th March 2017

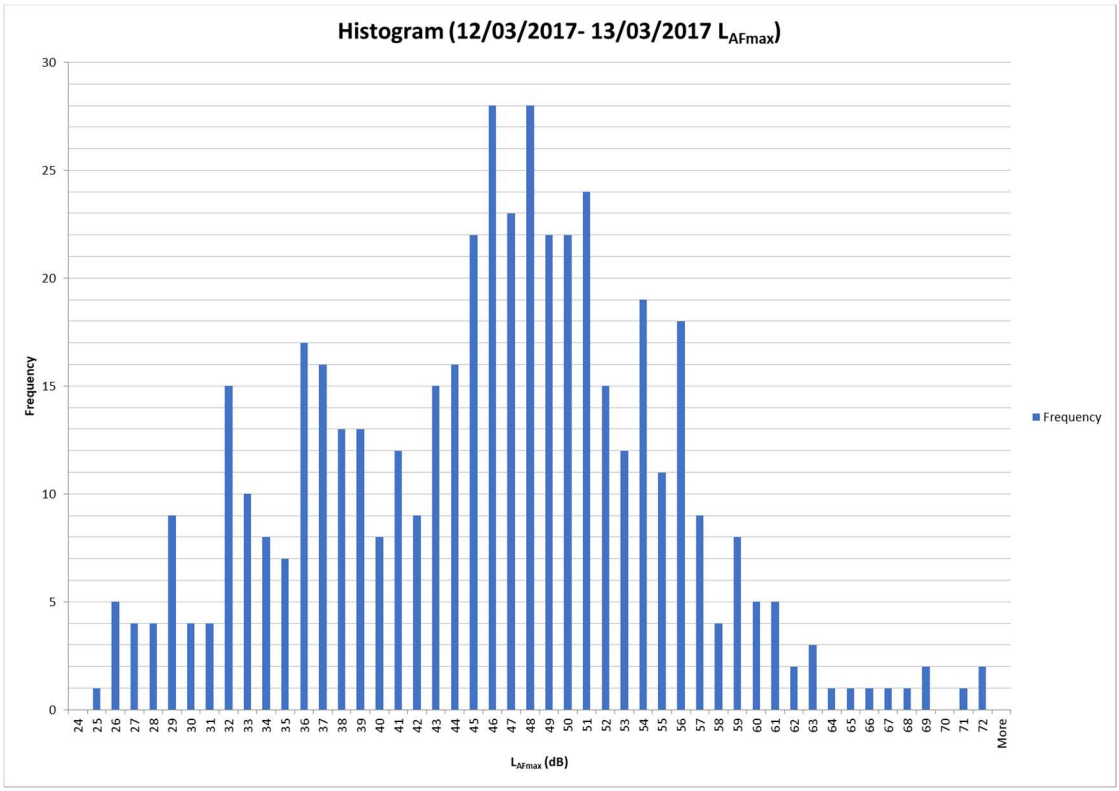


Image E6 – Measurement 23:00 12th to 07:00 13th March 2017

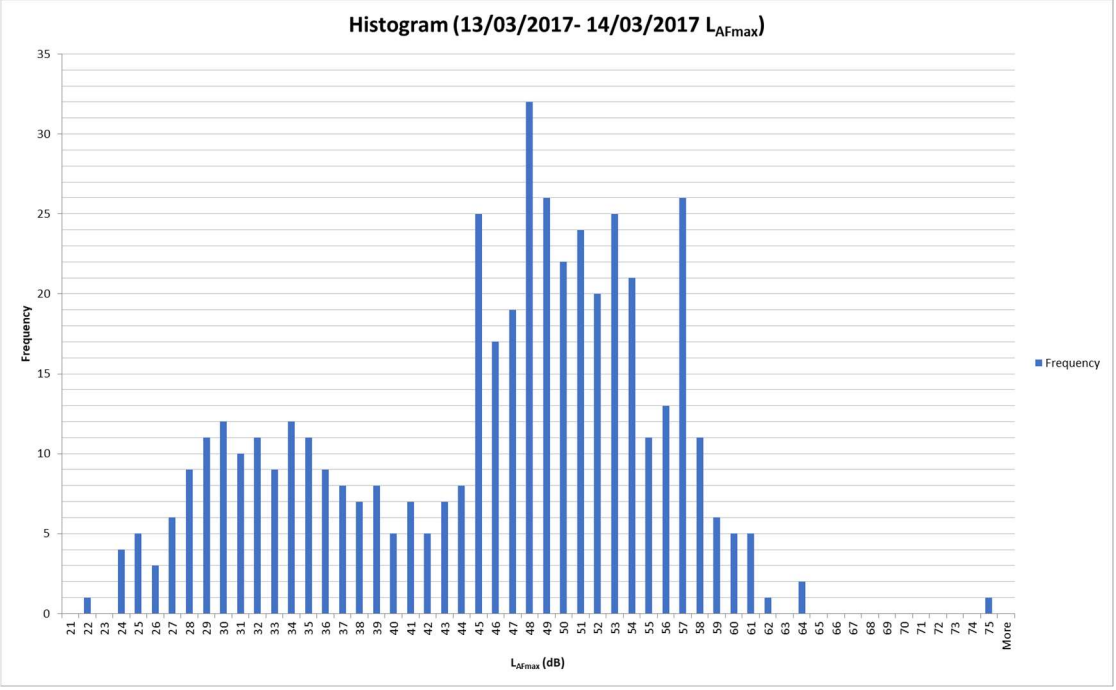


Image E7 – Measurement 23:00 13th to 07:00 14th March 2017

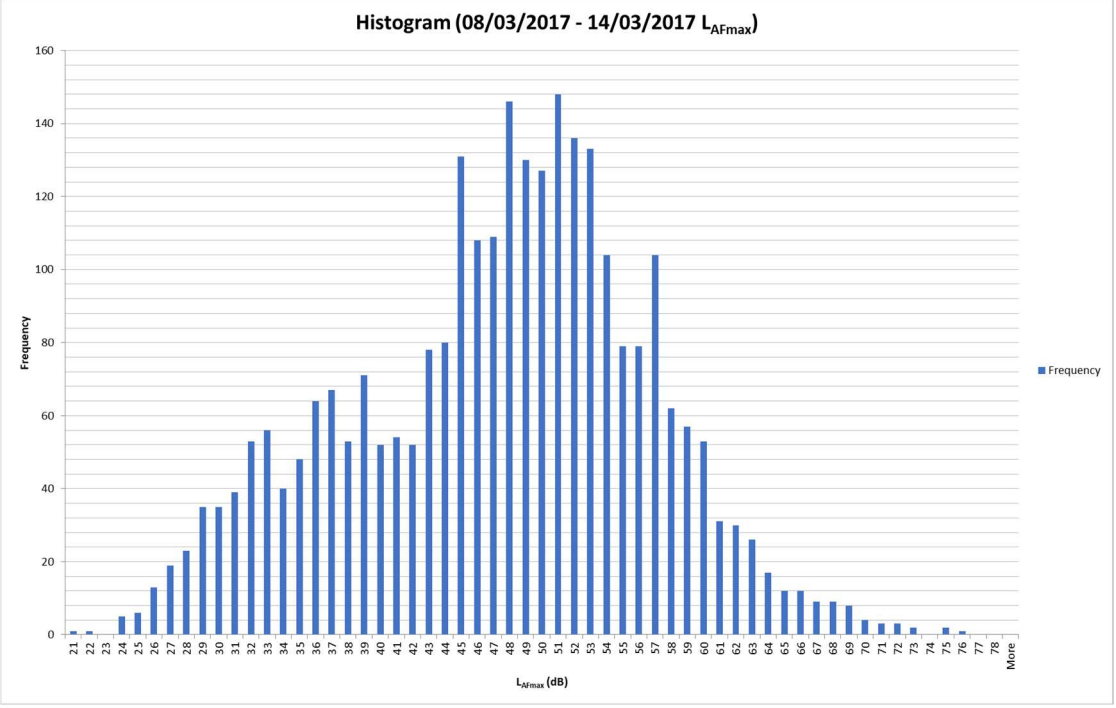


Image E8 – Measurement summary 8th to 14th March 2017

APPENDIX F

Overall Operational Noise for Design compared to ES – Wendover Green Tunnel North Portal to Wendover North Cutting

Number of Pages: 2

ID	Area Represented	No of Impacts	Do Nothing (Opening Year baseline)		ES Design Scheme Noise Only		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Option 1 Scheme only: - 4m barrier;		Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB		Option 2 Scheme only: - 5m barrier;		Option 2+Opening Year Baseline +Year 15 Traffic LAeq dB	
			Day	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
365001	Lionel Avenue, Wendover	24	46	45	39	30	47	45	38	28	47	45	37	28	47	45	37	27	46	45
365130	Aylesbury Road, Wendover	15	50	43	36	28	50	43	35	25	50	43	34	25	50	43	34	25	50	43
365216	Aylesbury Road, Wendover	10	50	43	37	28	50	43	36	26	50	43	35	26	50	43	35	26	50	43
365280	Aylesbury Road, Wendover	1	46	45	40	31	47	45	39	30	47	45	39	29	47	45	38	29	47	45
365348	Aylesbury Road, Wendover	37	66	59	35	26	66	59	34	25	66	59	34	24	66	59	33	24	66	59
366563	Lionel Avenue, Wendover	38	46	45	37	28	47	45	36	26	46	45	35	26	46	45	34	25	46	45
362513	Dobbins Lane, Wendover	22	53	44	39	30	53	44	38	28	53	44	37	27	53	44	36	27	53	44
362638	Thornton Crescent, Wendover	49	59	53	39	30	59	53	39	30	59	53	39	29	59	53	37	28	59	53
362785	Bridleways, Wendover	22	50	45	45	36	52	45	45	35	51	45	43	34	51	45	42	33	51	45
362860	Dobbins Lane, Wendover	83	53	44	38	29	53	44	37	28	53	44	37	27	53	44	36	26	53	44
363661	Dobbins Lane, Wendover	19	50	41	42	33	50	41	41	31	51	41	40	30	50	41	39	29	50	41
364087	Orchard Close, Wendover	37	50	41	37	28	50	41	36	27	50	41	36	26	50	41	35	26	50	41
364294	The Cedars, Wendover	53	50	41	39	30	50	41	38	29	50	41	37	28	50	41	37	27	50	41
366705	Lionel Avenue, Wendover	32	46	45	42	33	48	45	41	32	47	45	41	31	47	45	40	30	47	45
700327	Bridleways, Wendover	1	50	45	45	36	52	45	45	35	51	45	43	34	51	45	42	33	51	45

ID	Area Represented	No of Impacts	Do Nothing (Opening Year baseline)		ES Design Scheme Noise Only		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Option 3 Scheme only: - 6m barrier;		Option 3+Opening Year Baseline +Year 15 Traffic LAeq dB		Option 4 Scheme only: - 10m barrier;		Option 4+Opening Year Baseline +Year 15 Traffic LAeq dB	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
365001	Lionel Avenue, Wendover	24	46	45	39	30	47	45	38	28	47	45	36	27	46	45	34	24	46	45
365130	Aylesbury Road, Wendover	15	50	43	36	28	50	43	35	25	50	43	34	24	50	43	32	23	50	43
365216	Aylesbury Road, Wendover	10	50	43	37	28	50	43	36	26	50	43	35	25	50	43	34	24	50	43
365280	Aylesbury Road, Wendover	1	46	45	40	31	47	45	39	30	47	45	38	28	47	45	36	26	46	45
365348	Aylesbury Road, Wendover	37	66	59	35	26	66	59	34	25	66	59	33	24	66	59	32	22	66	59
366563	Lionel Avenue, Wendover	38	46	45	37	28	47	45	36	26	46	45	34	25	46	45	32	23	46	45
362513	Dobbins Lane, Wendover	22	53	44	39	30	53	44	38	28	53	44	35	26	53	44	32	22	53	44
362638	Thornton Crescent, Wendover	49	59	53	39	30	59	53	39	30	59	53	37	27	59	53	33	24	59	53
362785	Bridleways, Wendover	22	50	45	45	36	52	45	45	35	51	45	42	32	51	45	38	29	50	45
362860	Dobbins Lane, Wendover	83	53	44	38	29	53	44	37	28	53	44	35	25	53	44	31	22	53	44
363661	Dobbins Lane, Wendover	19	50	41	42	33	50	41	41	31	51	41	38	29	50	41	35	25	50	41
364087	Orchard Close, Wendover	37	50	41	37	28	50	41	36	27	50	41	35	25	50	41	32	23	50	41
364294	The Cedars, Wendover	53	50	41	39	30	50	41	38	29	50	41	36	27	50	41	33	24	50	41
366705	Lionel Avenue, Wendover	32	46	45	42	33	48	45	41	32	47	45	39	30	47	45	36	27	46	45
700327	Bridleways, Wendover	1	50	45	45	36	52	45	45	35	51	45	41	32	51	45	38	29	50	45

APPENDIX G

Overall Operational Noise for Design compared to ES – Wendover North Cutting – Up-Side

Number of Pages: 1

ID	Area Represented	No of Impacts	Do Nothing (Opening Year baseline)		ES Design Scheme Noise Only		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Option 1 Scheme only: - 2m barrier;		Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB		Option 2 Scheme only: - 3m barrier;		Option 2 +Opening Year Baseline +Year 15 Traffic LAeq dB		Option 3 Scheme only: - 4m barrier;		Option 3 +Opening Year Baseline +Year 15 Traffic LAeq dB	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
314803	Triangle Business Park, Rabans Lane Industrial (office) *	19	54	47	52	43	56	49	50	41	56	48	50	40	55	48	50	40	55	48	50	40	55	48
358148	Wendover Road, Weston Turville	18	54	47	46	37	54	48	44	34	54	47	44	34	54	47	43	34	54	47	43	34	54	47
358410	Wendover Road Stoke Mandeville	2	54	47	45	36	54	48	43	33	54	47	43	33	54	47	43	33	54	47	42	33	54	47
358677	Wendover Road Stoke Mandeville	3	54	47	46	37	54	48	44	34	54	47	44	34	54	47	44	34	54	47	43	34	54	47
358721	Aylesbury Road Wendover	7	73	66	40	32	73	66	38	29	73	66	38	29	73	66	38	28	73	66	38	28	73	66
358776	Nash Lee End, Wendover	1	54	47	41	33	54	47	39	30	54	47	39	30	54	47	39	30	54	47	39	29	54	47
367404	Aylesbury Road Wendover	2	51	43	39	30	51	43	38	28	51	43	38	28	51	43	38	28	51	43	37	28	51	43
314865	Wendover Road, Stoke Mandeville	1	54	47	49	41	55	48	48	39	55	48	48	39	55	48	48	38	55	48	48	38	55	48
355734	Nash Lee Road Wendover	7	54	46	50	41	55	47	50	40	55	47	50	40	55	47	49	40	55	47	48	39	55	47
357199	Nash Lee Lane, Wendover	7	51	46	60	51	60	52	60	51	60	52	58	50	59	52	58	49	59	51	57	48	58	51
357950	Nash Lee End, Wendover (shopping) *	1	56	51	49	40	57	51	47	38	57	51	47	38	57	51	47	38	57	51	47	37	57	51
357971	Nash Lee Lane Wendover	6	56	51	55	47	58	51	53	44	58	52	53	44	58	52	53	43	58	52	52	42	57	52
357877	Nash Lee End, Wendover	1	54	46	43	35	55	46	42	33	54	46	42	33	54	46	42	32	54	46	42	32	54	46
*	Non-Residental																							

APPENDIX H

Overall Operational Noise for Design compared to ES – Wendover North Cutting – Down-Side

Number of Pages: 1

ID	Area Represented	No of Impacts Represented	Do Nothing (Opening Year baseline)		ES Design Scheme Noise Only		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Option 1 Scheme only: - 2m barrier;		Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB		Option 2 Scheme only: - 3m barrier;		Option 2 +Opening Year Baseline +Year 15 Traffic LAeq dB		Option 3 Scheme only: - 4m barrier;		Option 3 Opening Year Baseline +Year 15 Traffic LAeq dB	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
314444	Nash Lee Road, Terrick	13	56	45	48	39	56	46	45	35	56	46	44	35	56	45	44	35	56	45	44	34	56	45
312509	Nash Lee Road, Terrick	5	56	45	48	39	56	46	45	36	56	46	45	35	56	46	45	35	56	45	45	35	56	45
314652	Nash Lee Road, Terrick	1	57	46	59	50	61	51	57	48	60	50	57	47	60	50	57	47	60	50	56	47	60	50
314668	Nash Lee Road, Terrick	1	57	46	58	50	58	50	58	48	58	48	58	48	58	48	58	48	58	48	57	48	58	47
314704	Nash Lee Road, Terrick	4	57	46	60	51	61	51	59	50	60	50	59	50	60	50	59	49	60	50	58	49	60	49
314625	Nash Lee Farm, Nash Lee	6	56	45	57	43	52	47	49	40	57	46	49	40	57	46	49	39	57	46	49	39	57	46
312509	Nash Lee Road, Terrick	5	56	45	56	39	48	46	45	36	56	46	45	35	56	46	45	35	56	45	45	35	56	45
313421	Risborough Road, Stoke Mandeville	2	54	45	58	47	56	49	54	47	57	48	53	43	56	47	53	43	56	47	52	43	56	47
313337	Risborough Road, Stoke Mandeville	8	54	45	55	42	51	47	49	39	55	46	48	38	55	46	47	38	55	46	47	38	55	46
357521	Ellesborough Road, Wendover	5	51	44	35	27	51	44	32	22	51	44	32	22	51	44	32	22	51	44	32	22	51	44
357547	Ellesborough Road, Wendover	5	54	47	35	27	54	47	33	24	54	47	33	24	54	47	33	24	54	47	33	24	54	47
357601	Ellesborough Road, Wendover	5	60	53	35	27	60	53	34	24	60	53	34	24	60	53	34	24	60	53	34	24	60	53
357663	Ellesborough Road, Wendover	1	49	43	45	36	50	43	41	32	50	43	41	32	50	43	41	32	50	43	41	32	50	43
357730	Ellesborough Road, Wendover	4	49	43	45	36	50	44	43	34	50	43	43	34	50	43	43	34	50	43	43	34	50	43
359465	Ellesborough Road, Wendover	4	52	46	32	23	52	46	31	22	52	46	31	22	52	46	31	22	52	46	31	22	52	46
359523	Ellesborough Road, Wendover	3	50	43	34	26	50	43	34	24	50	43	34	24	50	43	34	24	50	43	34	24	50	43
700323	Ellesborough Road, Wendover	1	50	43	36	27	50	43	37	28	50	43	37	28	50	43	37	28	50	43	37	28	50	43
700324	Ellesborough Road, Wendover	1	50	43	35	27	50	43	33	23	50	43	33	23	50	43	33	23	50	43	33	23	50	43
700328	Ellesborough Road, Wendover	2	52	46	37	29	53	46	35	25	52	46	35	25	52	46	35	25	52	46	35	25	52	46
700323	Ellesborough Road, Wendover	1	50	43	36	27	50	43	37	28	50	43	37	28	50	43	37	28	50	43	37	28	50	43