Balfour Beatty VINCI Working on behalf of HS2

Contract No 1MC08

Noise Demonstration Report for the Long Itchington Wood and Offchurch area

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Revision Summary

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GLOSSARY OF TERMS

Term	Description
AFARP	As far as is reasonably practicable
ARFC	All reasonably foreseeable circumstances
BS	British Standard
CRTN	Calculation of Road Traffic Noise
dB	Decibel
dB(A)	'A' weighted Decibel.
Downside	In the direction away from London and towards Birmingham
EIA	Environmental impact assessment
EMRs	Environmental Minimum Requirements
ES	Environmental Statement
LOAEL	Lowest observed adverse effect level
LPA	Local planning authority
L_{pAeq}	'A' weighted equivalent continuous sound level
L_{pAFmax}	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.
SOAEL	Significant observed adverse effect level
the Act	The High-Speed Rail (London – West Midlands) Act 2017
TNPM	Train Noise Prediction Model
U&As	Undertakings and Assurances
Upside	In the direction towards London and away from Birmingham

Executive Summary

This report describes the options considered for the additional airborne noise mitigation in the Long Itchington Wood and Offchurch area and discusses the final mitigation design solution and resultant noise impact at receptors. It sets out a justification for the mitigation design in compliance with planning forum notes 10 and 14.

The report shows that no additional mitigation beyond the noise attenuation produced by the built-in earthworks is reasonably practicable in the Long Itchington Wood and Offchurch area.

1. INTRODUCTION

Background and Aim

This Noise Demonstration Report is compiled in accordance with the High Speed Two (HS2) Phase 1 Planning Memorandum (paragraph 7.5.2) and Planning Forum Note 14[1]: Operational Noise from the Railway and Altered Roads.

The information in this Noise Demonstration Report shows, as far as is reasonably practicable at the current 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 reassurance in advance of the request for approval under paragraph 9 that the mitigation is appropriate and will present an opportunity to raise concerns.

This NDR is for the Schedule 17 Paragraph 3 application and future reports will be provided for later stages including Schedule 17 Paragraph 9 application.

In addition to the requirements to control airborne noise set out in Information Paper E20[2], mitigation is also required to meet any undertakings and assurances that are relevant to the Long Itchington Wood and Offchurch area. U&A 2220 is relevant to this area but has no impact on the mitigation design.

Structure of Report

- Site Location
- Policy, Requirements and Standards
- Description of the Works
- Methodology
- Assumptions
- Results
- Conclusions

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833184/PFN_14_Operational_Noise.pdf
[2] Information paper E20: Control of airborne noise from altered roads and the operational railway

2. SITE LOCATION

This report considers noise levels and mitigation in the Long Itchington Wood and Offchurch area.

The relevant section of track is approximately 5029m long between the northern portal of the Long Itchington Wood tunnel (approximate chainage 128+750) and the River Leam Viaduct (approximate chainage 133+779) and includes the following assets:

- Long Itchington Wood Tunnel North Portal
- Welsh Road Embankment
- Longhole Viaduct
- Grand Union Canal Embankment
- Offchurch Cutting
- Offchurch Greenway Green Overbridge
- Hunningham Road Overbridge
- Ash Beds Embankment
- Ash Beds Cutting
- Footpath W129y Overbridge
- River Leam Embankment

The assessment area comprises communities located downside (in the direction away from London but towards Birmingham) and upside of the track consisting of a mix of residential and non-residential receptors, the latter comprising of general commercial and industrial buildings. These receptors form three assessment areas:

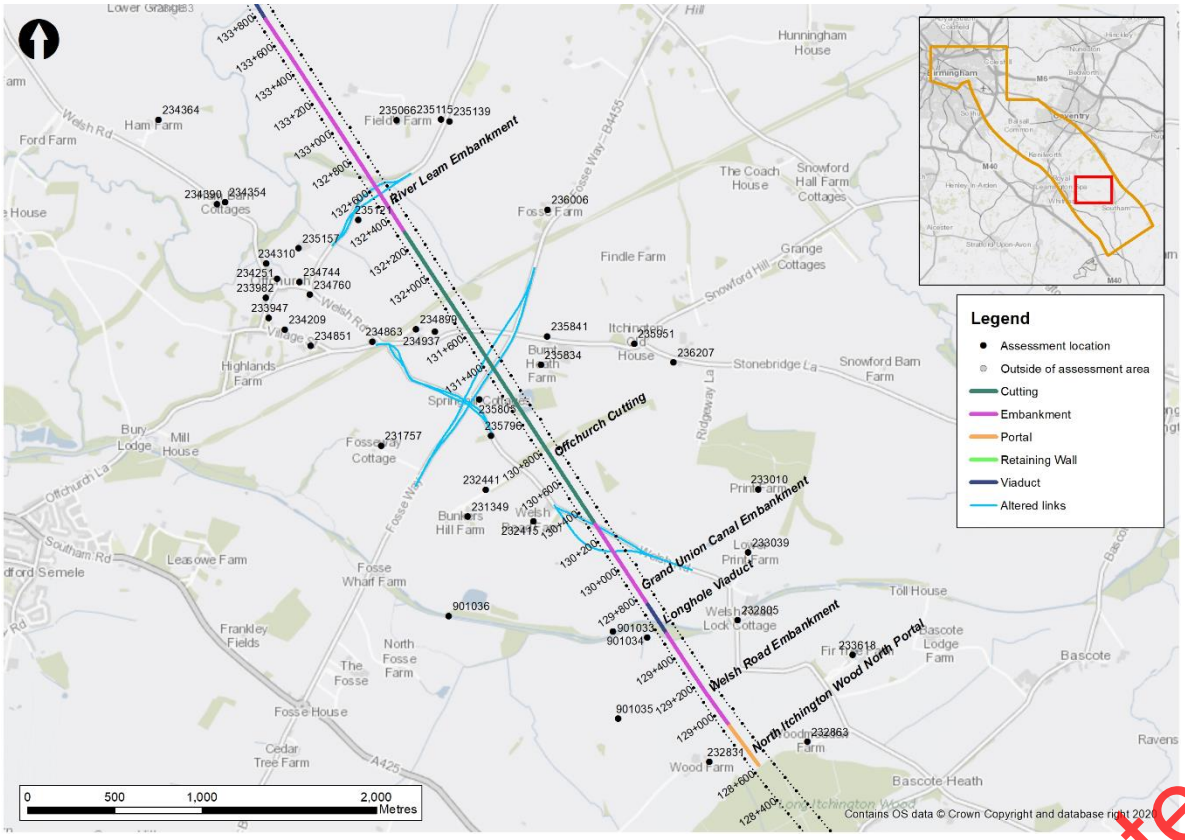
- Welsh Road (south) with 15 dwellings;
- Welsh Road (north) with 27 dwellings;
- Village Street/Offchurch Lane (upside) with 31 dwellings.

There are 39 isolated dwellings that do not form part of any community.

The non-residential receptors are located on the downside and upside comprising 10 classified as G5 (offices and general commercial) and two classified as G2 (sound recording and broadcast studios).

Figure 1 presents the alignment of the track showing the main features in different colours, with chainages and the relevant assessment locations as reported in the ES (as amended). Greyed out points represent locations that are outside the Long Itchinton Wood and Offchurch area and are therefore considered in other noise demonstration reports.

Figure 1. Long Itchington Wood and Offchurch and surrounding area with nearby receptor locations, chainages and engineering features.



Baseline noise levels were obtained from the operational noise Community Forum Area report CFA16, Ladbroke and Southam, Operational assessment Sound, noise and vibration[3] and Community Forum Area report CFA17, Offchurch and Cubbington, Operational assessment Sound, noise and vibration[4] as updated by SES/AP2[5,6].

Description of significant adverse effects due to operational noise identified at the time of the ES

The ES did not identify any significant adverse effect due to operational noise in Long Itchington Wood and Offchurch area.

[3] CFA16 Ladbroke and Southam operational assessment (SV-004-016)
[4] CFA17 Offchurch and Cubbington operational assessment (SV-004-017)
[5] Supplementary Environmental Statement and Additional Provision 2 Environmental Statement Volume 2 Community forum area report CFA16 Ladbroke and Southam;
[6] Supplementary Environmental Statement and Additional Provision 2 Environmental Statement Volume 2 Community forum area report CFA17 Offchurch and Cubbington

Amendments and changes to the design within the SES and APs

Supplementary Environmental Statement and Additional Provision (SES/AP) 2 of the Environmental Statement Volume 2, Community forum area report CFA17, Offchurch and Cubbington[6] , introduced an amendment to the design that may have affected operational noise as set out in Table 1.

Table 1. AP2 amendment to the design that may affect operational noise

Description of the original scheme or AP1 revision	Description of the AP2 revised scheme
Diversion of National Cycle Route 41 from Long Itchington Road onto Offchurch Greenway over new green bridge crossing the route of the Proposed Scheme and then across a field to re-join its existing route on Fosse Way.	Replacement of the cycleway link between the existing Offchurch Greenway and Fosse Way proposed in the original scheme with a new cycle and pedestrian bridge over Fosse Way. This amendment will require approximately 1.5ha of additional land permanently, of which 0.27ha is agricultural land. A ramp will connect the bridge to Fosse Way and a cycle path on the east verge of Fosse Way will connect the bridge to Long Itchington Road. A link between Footpath W192 and Offchurch Greenway will also be provided. Landscape mitigation planting will be provided on the new earthworks.

The SES/AP2 reported that an assessment was undertaken to determine whether operational noise levels from the AP2 revised scheme would result in a likely significant effect. It was found that there were no new or different operational effects for sound, noise and vibration as a result of the amendment.

3. POLICY, REQUIREMENTS AND STANDARDS

High Speed Two (HS2) is the Government's proposal for a new, high speed north-south railway. The proposal is being taken forward in two phases: Phase One will connect London with Birmingham and the West Midlands and Phase Two will extend the route to Manchester, Leeds and beyond.

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 the works, 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 (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 as one of the specific grounds, the LPA may refuse to approve plans or specifications 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". This ties in with HS2 Ltd commitment to reduce airborne noise as far as is reasonably practicable (AFARP).

The following section provides a summary of the Environmental Minimum Requirements (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.

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[7] 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[8]; or
- would not be likely to be environmentally significant[9]; 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 Directive[10]; or (ii) article 4(2) of and paragraph 13 of Annex 2 to the EIA Directive[11]; 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.

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

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

[7] High Speed Rail (London-West Midlands) Environmental Minimum Requirements General Principles https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618074/General_principles.pdf

[8] *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.*

[9] *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.*

[10] *2011 consolidated EIA Directive (2011/92/EU).*

[11] *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.*

circumstances (ARFC), does not exceed the lowest observed adverse effect level (LOAEL) at residential receptors.

Where it is not reasonably practicable to achieve this objective, HS2 and their contractors will reduce airborne noise as far as is reasonably practicable (AFARP).

HS2 and their contractors are required to consider the following measures to control operational noise, ranked in order of desirability:

- reduce noise generation at source;
- reduce noise propagation through noise barriers and/or landscape earthworks; and
- reduce the amount of noise entering eligible properties through the offer of noise insulation.

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) at residential receptors.

The applicable LOAEL and SOAEL values for residential receptors are presented in Appendix A.

Undertakings and assurances

There are is one undertaking and assurance (U&A) that is specifically applicable to the Long Itchington Wood and Offchurch area. Undertaking & Assurance 2220 between the Secretary of State for Transport and the Canal and River Trust has an acoustic provision as follows:

- 1.2.11 "*The design of acoustic barriers should subject to their satisfying the requirement of the EMR's, be low level and as close as reasonably practicable to the tracks to minimise visual impact*"

The lowest standard height concrete parapet of 1.2m above railhead, which is the minimum height of parapet, has been incorporated into the design of Longhole Viaduct, the structure which takes the Proposed Scheme across the Grand Union Canal. This will provide acoustic screening such that compliance with EMRs will be achieved (see Section 3 of this report for explanation of EMRs).

Mitigation Appraisal Requirements

HS2 and their contractors are required to consider a list of potential mitigation measures and undertake a proportionate Cost Benefit Analysis (CBA) and consider all relevant acoustic and non-acoustic costs and benefits including:

- Monetary benefit of noise reduction compared to cost;
- Engineering practicability;
- Impacts on other environmental disciplines, including landscape and visual; and,
- Consultation and stakeholder engagement responses.

4. DESCRIPTION OF THE WORKS

The Long Itchington Wood and Offchurch area encompasses an area between the northern portal of Long Itchington Wood tunnel and River Leam Viaduct. At the southern end of the area, the track is on Welsh Road Embankment which changes to Grand Union Canal Embankment past Longhole Viaduct. The track then enters the Offchurch cutting which transits into River Leam Embankment to the north of the area.

Design changes since the Hybrid Bill

The changes to the design since the Hybrid Bill are as follows:

- Welsh Road Embankment: minor changes to the extent of the embankment to incorporate alignment changes adopted during Scheme Design. The impact on the extent of the asset is mitigated through optimisation of the functional cross sections and slope angles;
- Grand Union Canal Embankment: changes are made in the vertical alignment which raises the track by approximately 1m and the length has been extended by 45m to accommodate the loss of a span for Longhole Viaduct. There is a slight increase to the width of the embankment due to track vertical alignment change;
- Offchurch Cutting: due to raising of the track alignment throughout, the cutting has become narrower;
- Longhole Viaduct: the total length has been reduced by one span (approximately 45m) and earthworks around the north abutment have been extended / changed to accommodate the loss of a bridge span;

- Ash Beds Embankment: the vertical track alignment is raised by approximately 1m. Some of Ash Beds Cutting has now become Ash Beds Embankment due to the track level rises.
- River Leam Embankment: vertical track alignment is raised by approximately 0.5m throughout the embankment;
- Changes in gradient of earthworks: Ash Beds Cutting: Scheme design was 1 vertical (v):2.5 horizontal (h) and has become 1v:2h, River Leam Embankment: Scheme design was 1v:2.5h and has become 1v:1h; and
- Footpath W129y Overbridge overall span has been reduced to suit the new track levels.

Scheme Design Updates

Scheduled works that are specifically part of this application are set out above. Scheme design updates that have been considered in the noise modelling are set out below:

- The track alignment incorporates a reduction of the spacing distance between track axes from 5000mm to 4700mm for high-speed sections of the Phase 1 scheme;
- Standard viaduct parapets are non-absorbent and 1.2m above railhead compared with absorbent and 1.4m above railhead at the time of the ES but where additional noise mitigation is needed the height is increased and absorption is introduced; and
- Concrete robust kerbs (which were not present at the time of the ES) of height 0.35m above railhead and 2m from the nearest track centreline have now been incorporated into in the scheme design.

The routewide reduction of the distance between track alignments, combined with the closer alignment of noise barriers has the capacity to provide a greater noise shielding effect.

Two further changes impact modelled noise levels routewide. These are:

- the track support system has been revised to concrete slabs in lieu of ballasted track envisaged in the ES; and
- the just-TSI compliant trains model which was the noisiest have been removed, the revised source terms are provided in Table 14.

ES mitigation

At the time of the ES, mitigation considered consisted of a 200m long and 3m tall noise barrier located trackside from chainage 132+565 to 132+765 on the downside.

At the time of the ES there were three major, eight moderate and three minor daytime impacts, and three major, seven moderate and five minor night-time impacts above L_{Aeq} LOAEL. There were also 103 impacts reported above L_{pAFmax} LOAEL. No assessment locations were exposed above SOAEL at the time of the ES.

Candidate mitigation options

The primary objective of this report is to provide evidence that all reasonable steps are taken into the Proposed Design so that the combined airborne noise from the railways and altered roads, predicted in all reasonably foreseeable circumstances (ARFC), does not exceed the lowest observed adverse effect level (LOAEL) at residential receptors.

Where it is not reasonably practicable to achieve this objective, various noise mitigation scenarios are proposed and evaluated against the noise criteria and the non-acoustic criteria i.e. visual and landscape effects, engineering practicability and value for money.

The Proposed Design corresponds to the option that reduces airborne noise as far as is reasonably practicable (AFARP).

In this section, the main outcome of the impact assessment is presented. First, a comparison of Option 0 (no additional noise mitigation) with the Phase 1 ES (and supplementary environmental statements, SESs, and additional provisions, (APs) design is made in terms of noise effects. Then, each noise mitigation design option is analysed and compared to determine the “as far as reasonably practicable” (AFARP) scenario, considering both the resulting noise impact classification and as previously mentioned, the non-acoustic criteria.

A total of seven options (see Table 3) were considered on downside and another three options (see Table 4) on the upside before reaching The Design for which consent is sought. A brief description and analysis of each of these is set out below together with a short explanation of the reason why this was not the final design solution. This analysis is presented for the downside (trains travelling away from London and on the western side) and for the upside (trains travelling towards London and on the eastern side).

A classification has been used to rank the noise assessment outcomes and landscape and visual outcome in each case. These classifications are set out in Table 2.

Table 2. Impact classifications for noise and landscape/visual when comparing options

Classification	Noise assessment	Benefit in comparison with cost	Environmental Implication
✓✓	Materially beneficial reduction in noise levels; removal of one or more significant adverse effects on a community basis	Substantial benefits and/or relatively low mitigation cost	Significantly better or materially better effects than the ES mitigation
✓	Reduction in the number of major, minor or moderate impacts for receptors above LOAEL but no material change	Some benefits and/or relatively high mitigation cost	Better effects than the ES but not materially better effects
~	Similar number of major, minor or moderate impacts for receptors above LOAEL and no material change	Comparable benefits and mitigation costs with the ES design	About the same effects as the ES mitigation
×	Increase in the number of major, minor or moderate impacts for receptors above LOAEL but no material change	Reduced benefits or increased costs in comparison with the ES design	Worse effects than the ES but not materially worse effects
××	Materially adverse increase in noise levels, number of major, minor or moderate impacts for receptors above LOAEL	Substantially reduced benefits of increased costs in comparison with the ES design	Significantly worse or materially worse effects than the ES mitigation

Downside

No additional mitigation is proposed on the downside.

Mitigation options were considered for the downside but not selected for one or more of the reasons set out below. In each case mitigation was not selected because it:

- would be considerably more expensive than the recommended option, with only marginal further reduction in noise levels compared with the recommended option; and/or
- produces a greater adverse visual impact than the recommended option with only marginally improved acoustic benefit.

In the absence of additional mitigation (Option 0, below) noise is reduced compared to the ES as two residential assessment locations that would have been exposed to noise above LOAEL in the daytime and night-time would no longer be exposed to noise above this level. This is due to a combination of changes in the HS2 train source terms, flows and the alignment and earthworks in the current design.

The candidate mitigation options for additional mitigation that were considered included:

- Option 1 (shown in Figure 2) was a 2m high, 200m long trackside barrier which was proposed in the ES at a height of 3m. This barrier would extend north from Hunningham Road Bridge along the railside of the Offchurch express feeder auto-transformer station between two cuttings to the north and south. However, analysis showed that this barrier would produce little additional benefit in comparison with Option 0 and would have a low benefit in comparison to cost and is therefore not recommended.
- Options 2 and 3 (shown in Figure 2) were a 3m and a 4m high barrier respectively, at the same location as option 1. These options produced little additional benefit in comparison with Option 0 and had a low benefit in comparison to cost and are therefore not recommended.
- Option 4 (shown in Figure 3) was a 3m tall, 250m long trackside barrier immediately to the north of the Long Itchington Wood Tunnel north portal to address a LOAEL exceedance at receptor 232831. Analysis showed that this would have minimal impact on noise reduction at the receptor and this option is therefore not recommended.
- Option 5 (shown in Figure 4) was a 4m tall, 1250m long trackside barrier within Offchurch Cutting to address LOAEL exceedances in the Welsh Road Community. Analysis showed that the barrier would reduce the number of receptors exposed above LOAEL by only by one in the day in comparison to Option 0. This option would have a low benefit in comparison to cost and is therefore not recommended.
- Option 6 (shown in Figure 5) was a 3m tall, 320m long trackside barrier within Offchurch Cutting to address LOAEL exceedances in Village Street and Offchurch Lane. Analysis showed that the benefit of this barrier was marginal at these receptors and had a low benefit in comparison to cost. This option is therefore not recommended.
- Option 7 (shown in Figure 6) was a 3m tall, 100m long trackside barrier within the Offchurch Cutting to address a LOAEL exceedance at assessment location 235121. Analysis showed that the benefit of this barrier was marginal at this assessment location, resulting in a low benefit in comparison to cost. This option is therefore not recommended.

A summary analysis for the mitigation scenarios that were considered on the downside are presented in the Table 3. The table shows Option 0 in the highlighted grey cells as the final design solution, as other candidate mitigation options would not have

impacted the number of receptors exposed above LOAEL, and had a low benefit in comparison to cost.

Figure 2. Downside Options 1, 2 and 3

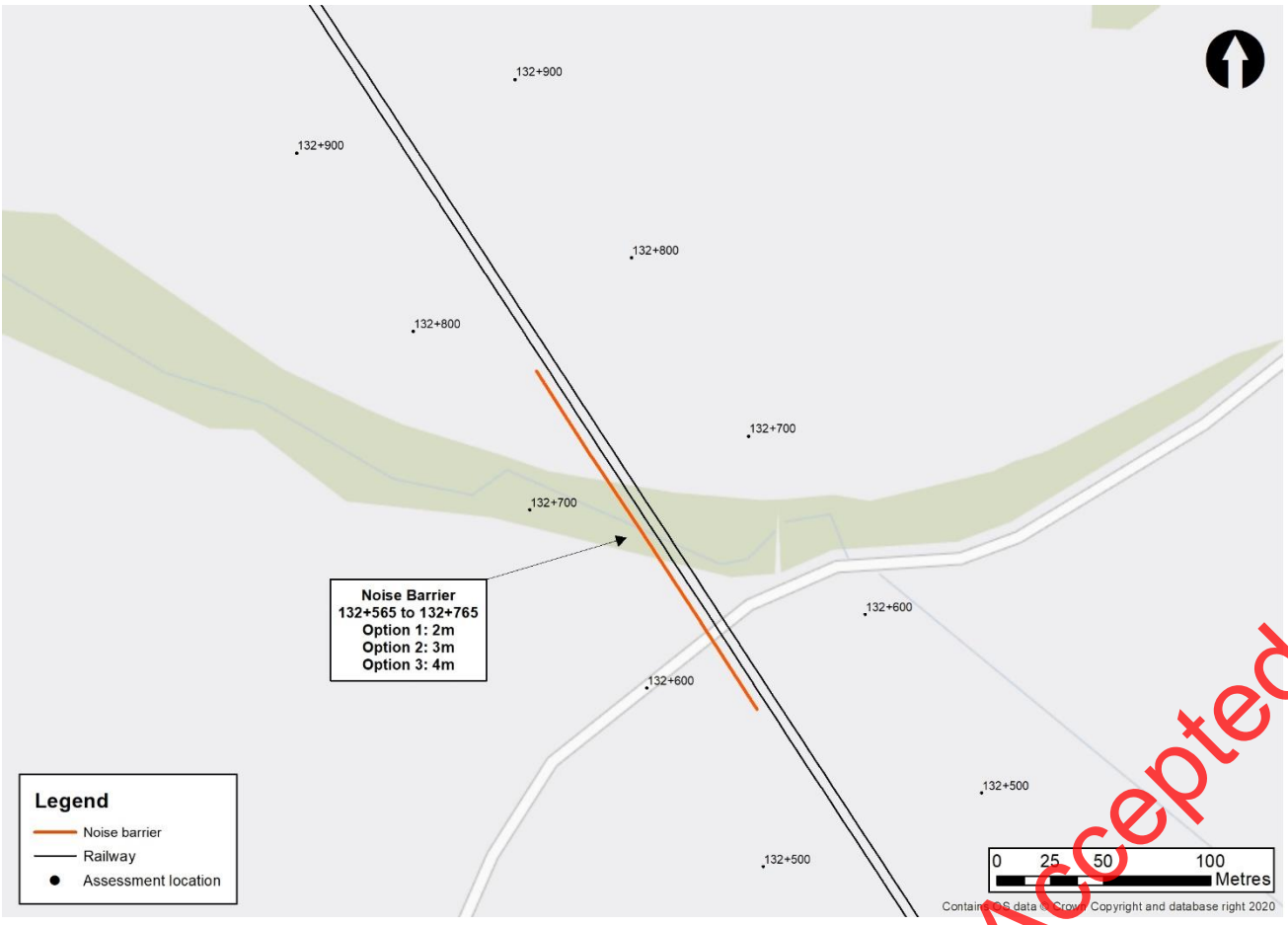


Figure 3. Downside Option 4

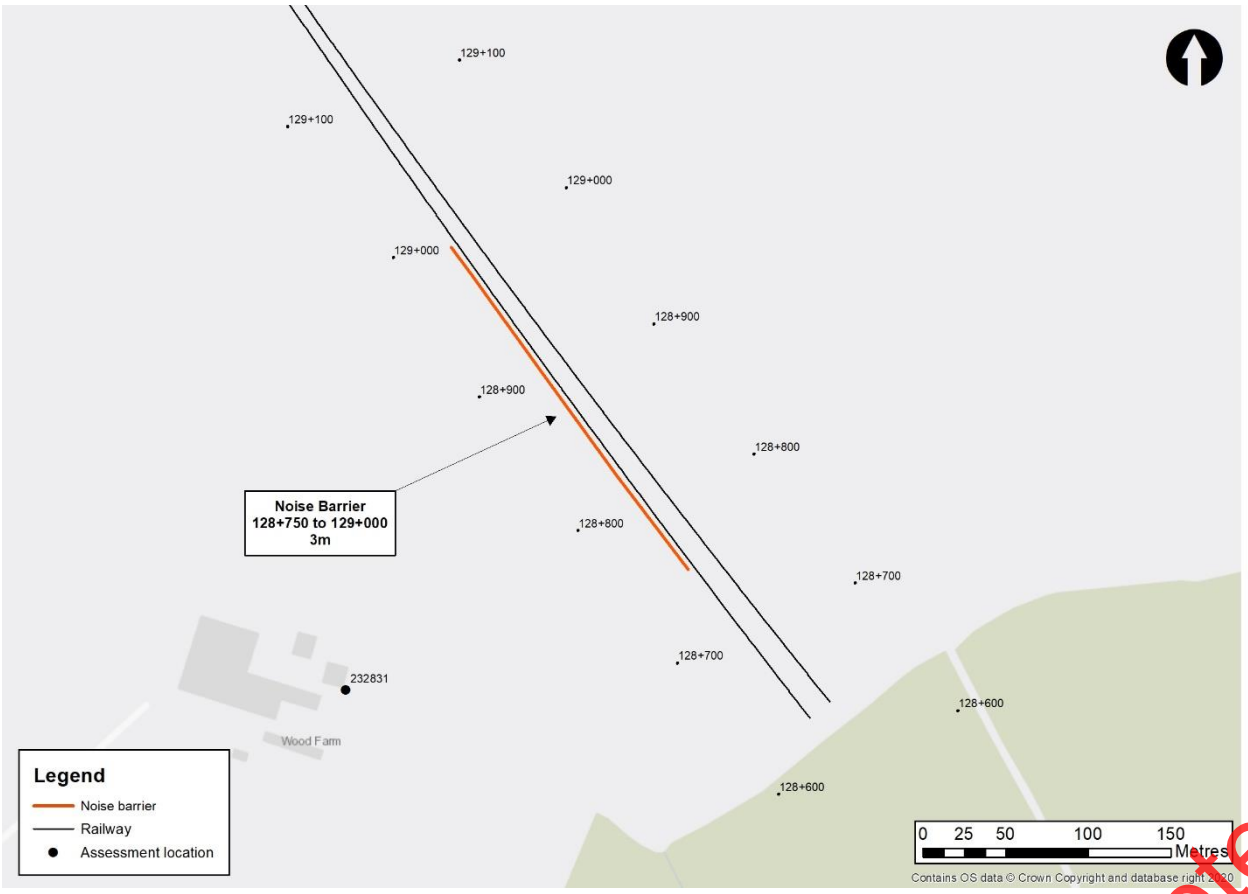


Figure 4. Downside Option 5

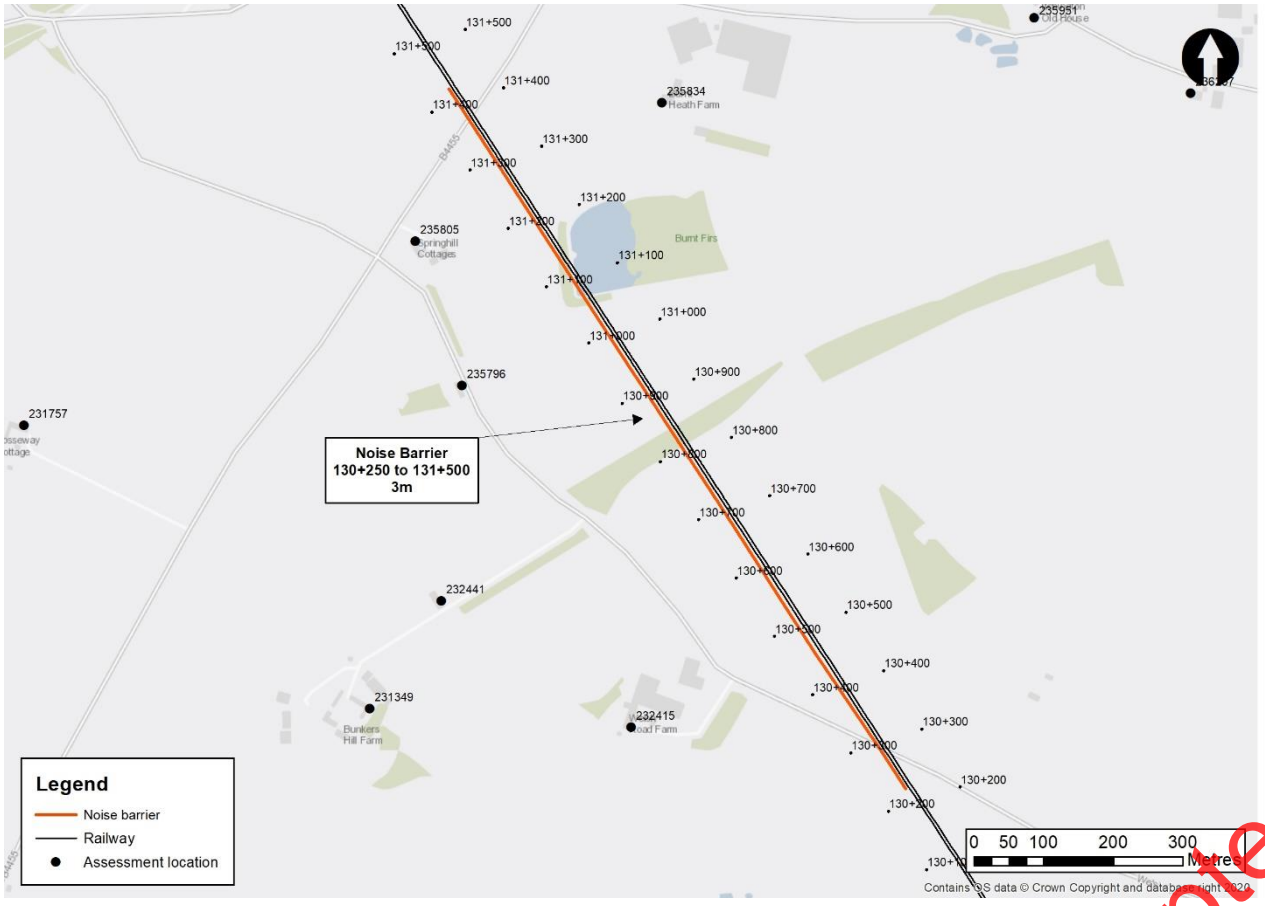


Figure 5. Downside Option 6

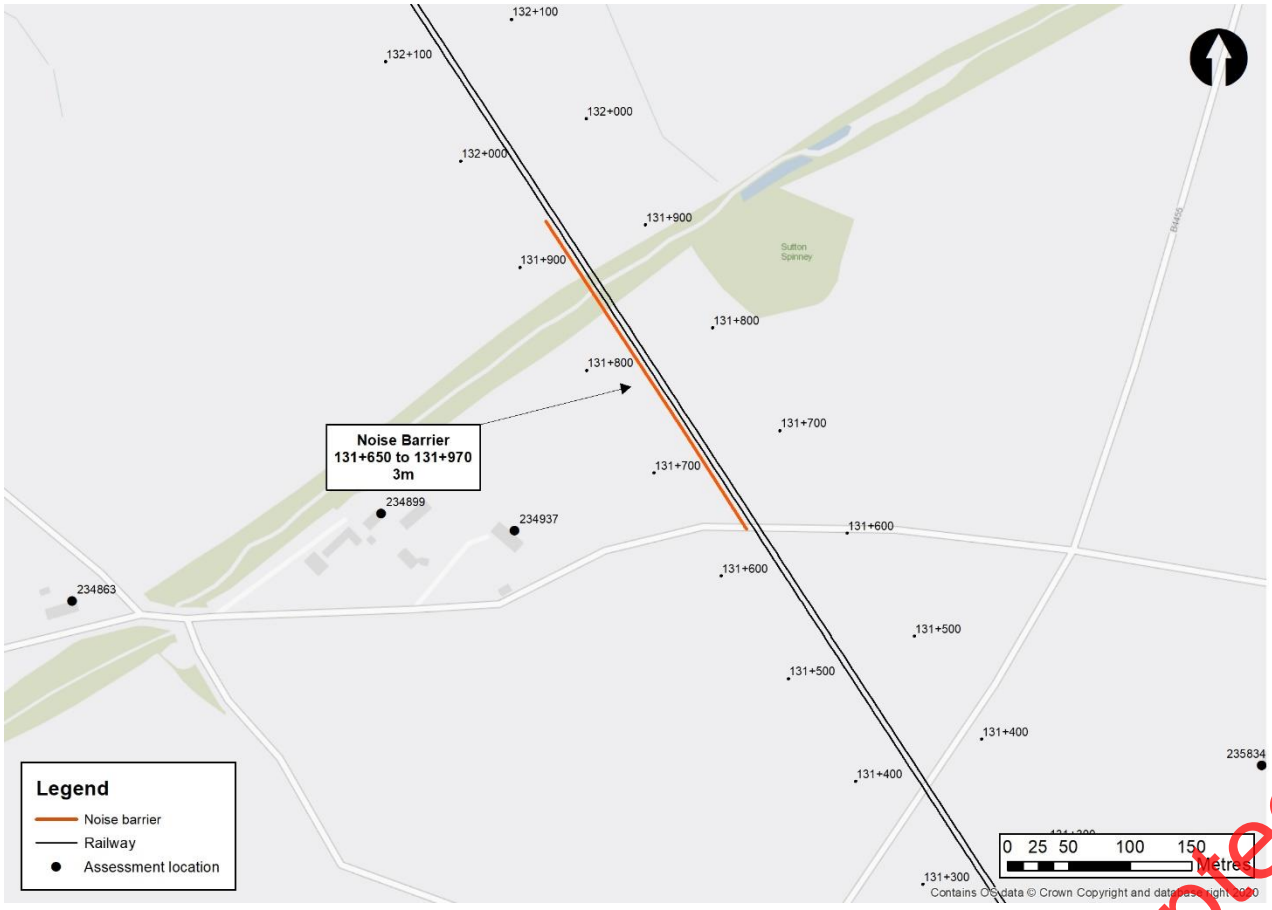


Figure 6. Downside Option 7

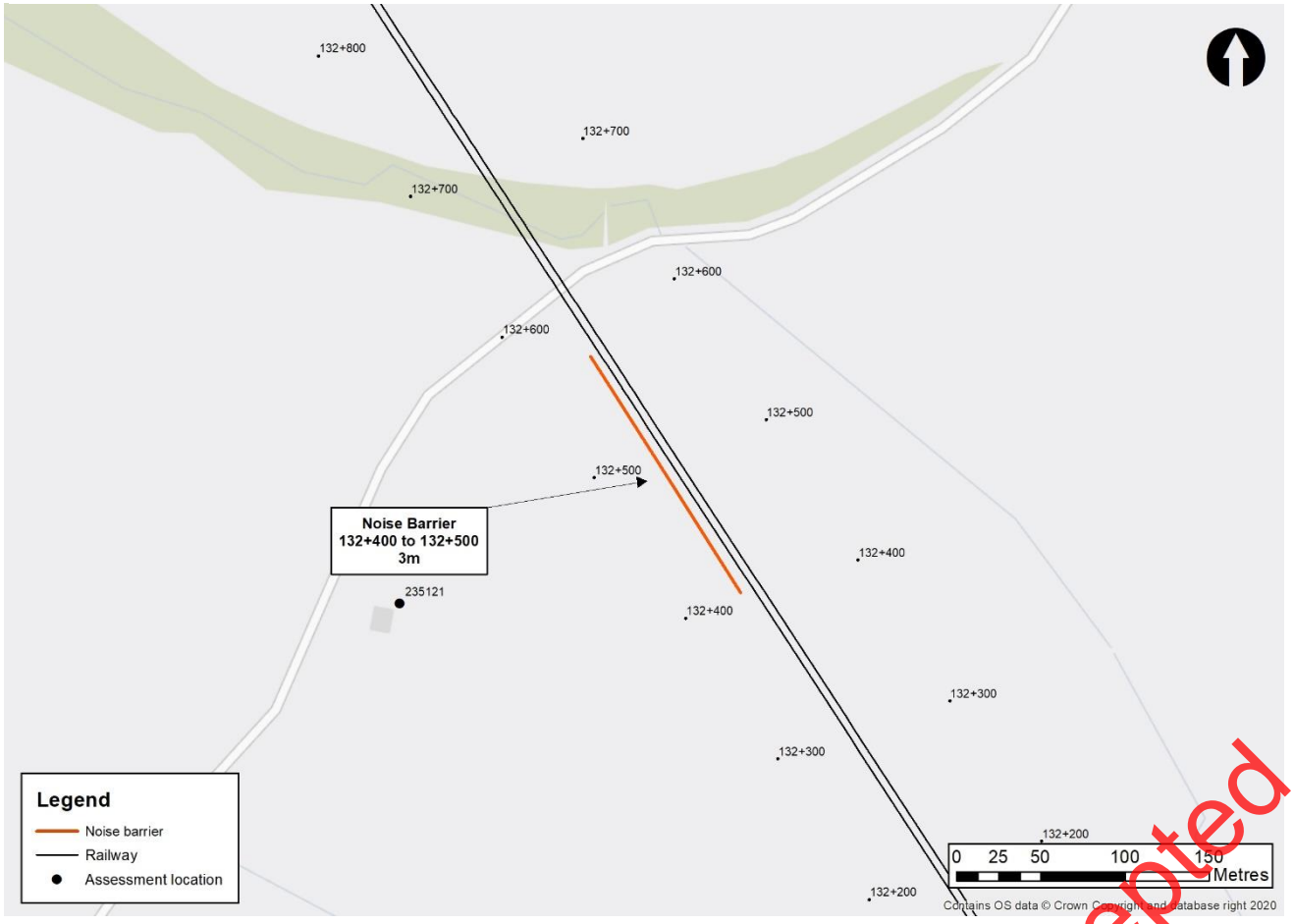


Table 3. Downside option appraisal summary table (recommended option highlighted in grey)

Scenario	Description	Noise benefit to relative cost[1]	Noise Material Change[2]	Engineering Constraints	Environmental Implication[3]	Consultation / Stakeholder[4]
Option 0	No mitigation other than natural screening provided by earthworks	~ No additional mitigation cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	✓ Improved visual impact	Further stakeholder engagement req'd.
Option 1	2m from 132+565 to 132+765 (200m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	✓ Improved visual impact	Further stakeholder engagement req'd.
Option 2	3m from 132+565 to 132+765 (200m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	✓ Improved visual impact	Further stakeholder engagement req'd.
Option 3	4m from 132+565 to 132+765 (200m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	~	Further stakeholder engagement req'd.
Option 4	3m from 128+750 to 129+000 (250m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	× Increased visual impact	Further stakeholder engagement req'd.
Option 5	4m from 130+250 to 131+500 (1250m long)	~ Low benefit compared to cost	✓ Additional receptor reduced below daytime LOAEL compared with the no mitigation scenario. No material change.	No additional constraints	~	Further stakeholder engagement req'd.
Option 6	3m from 131+650 to 131+970 (320m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	~	Further stakeholder engagement req'd.
Option 7	3m from 132+400 to 132+500 (100m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	~	Further stakeholder engagement req'd.

Note:

1. Value for money compared to the ES design (or equivalent design)
2. Using EIA methodologies
3. Impacts on other environmental disciplines, including landscape and visual
4. Further stakeholder engagement is required as part of the Schedule 17 process to which this NDR contributes under PFN 14.

Upside

No additional mitigation is proposed on the upside.

Mitigation options were considered for the upside but not selected for one or more of the reasons set out below. In each case mitigation was not selected because it:

- would be considerably more expensive than the recommended mitigation with only marginal further reduction in noise levels compared with the recommended option; and/or
- produces a greater adverse visual impact than the recommended option with only marginally improved acoustic benefit.

In the absence of additional mitigation (option 0) noise is reduced compared to the ES as two assessment locations that would have been exposed to noise above LOAEL in the daytime and one assessment location in the night-time would no longer be exposed to noise above this level.

The candidate mitigation options that were considered included:

- Option 1 (shown in Figure 7) was a 3m high, 850m long trackside barrier consisting of sections located on Welsh Road Embankment, Longhole Viaduct and Grand Union Canal Embankment. This barrier addressed a LOAEL exceedance at assessment location 233039. Analysis showed that this barrier would provide little benefit in noise terms in comparison with option 0 and result in a low benefit in comparison to cost. Option 1 is therefore not recommended.
- Option 2 (shown in Figure 8) was a 3m high, 300m long trackside barrier within Offchurch Cutting to address LOAEL exceedance at assessment location 235834. Analysis showed that this barrier would produce no change in the noise impact classification at this assessment location in comparison with Option 0 and would have a low benefit in comparison to cost. Option 2 is therefore not recommended.
- Option 3 (shown in Figure 9) was a 3m high, 550m long trackside barrier within the Ash Beds Cutting tying into River Leam Embankment to the north to address LOAEL exceedances at assessment locations 235066, 235115 and 235139. Analysis showed that this barrier would reduce the number of impacts above L_{pAeq} LOAEL by three but would have a low benefit in comparison to cost. Option 3 is therefore not recommended.

A summary analysis for the mitigation scenarios that were considered on the upside is presented in Table 4. The table shows Option 0 in the highlighted grey cells as the final design solution, as other candidate mitigation options had little or no impact on the number of receptors exposed above LOAEL, and had a low benefit in comparison to cost.

Figure 7. Upside Option 1

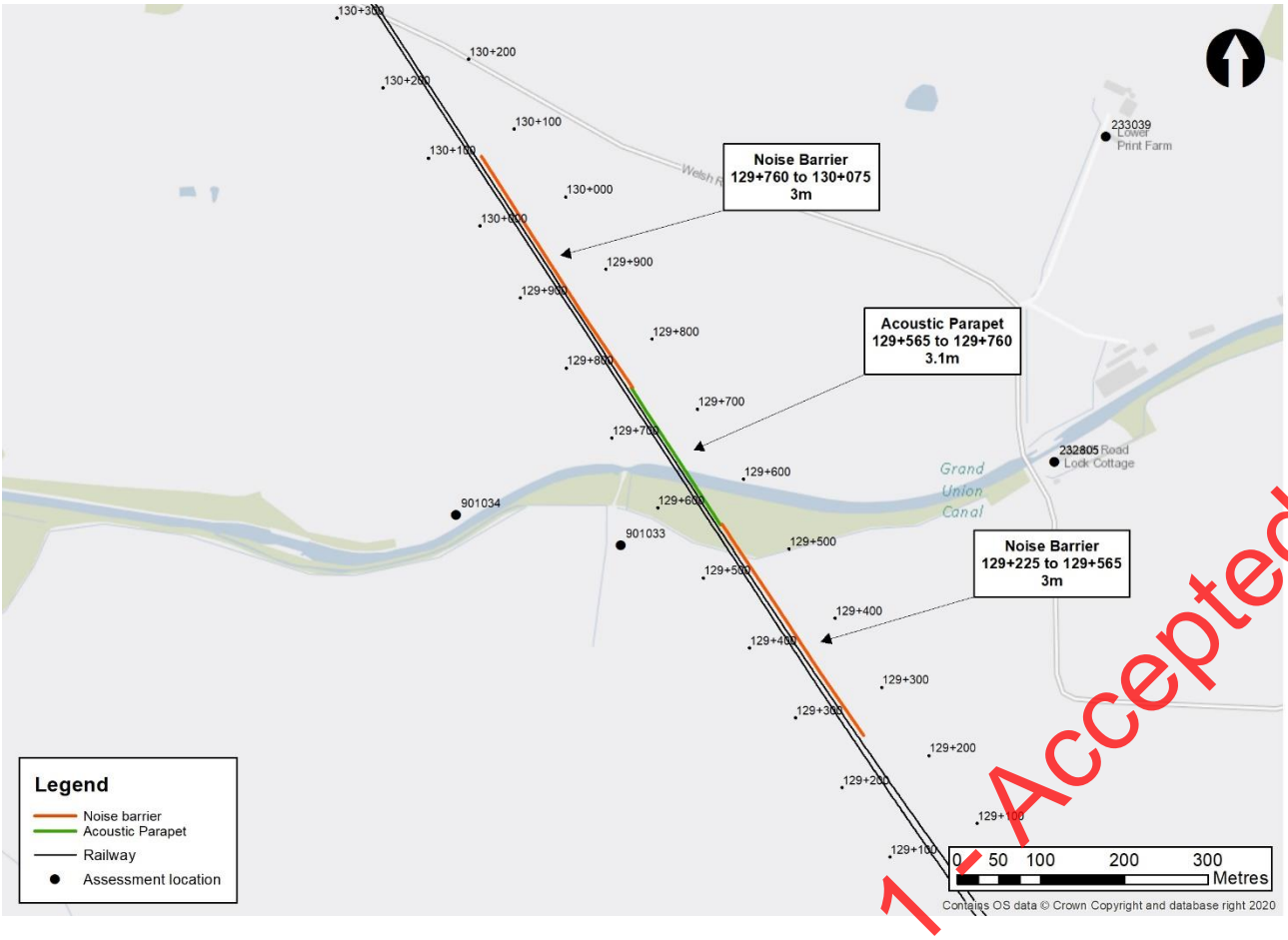


Figure 8. Upside Option 2

Figure 9. Upside Option 3

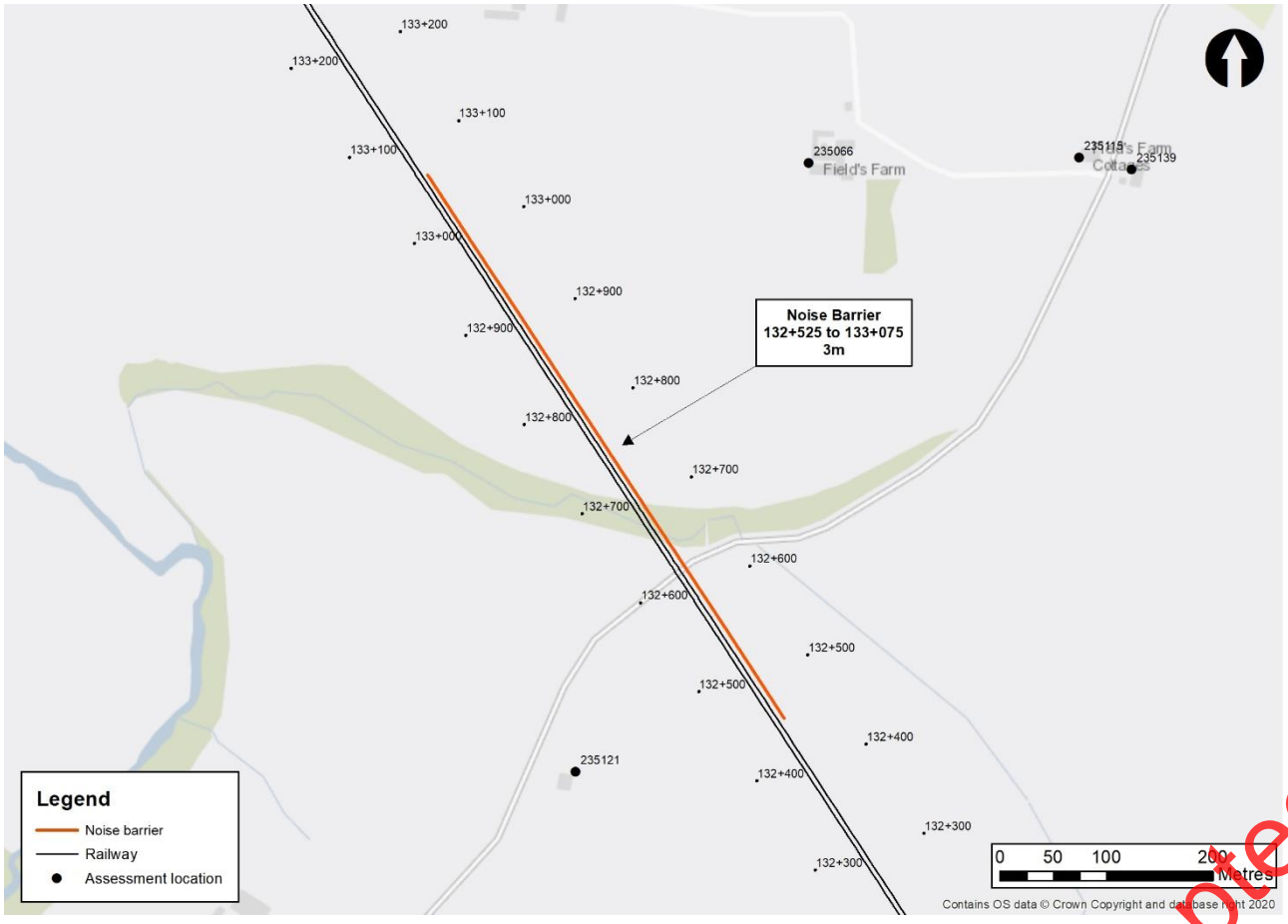


Table 4. Upside option appraisal summary table (recommended option highlighted in grey)

Scenario	Description	Noise benefit to relative cost[1]	Noise Material Change[2]	Engineering Constraints	Environmental Implication[3]	Consultation / Stakeholder[4]
Option 0	No mitigation other than natural screening provided by earthworks	~ No additional mitigation cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	~	Further stakeholder engagement req'd.
Option 1	Noise Barrier 3m from 129+225 to 129+565 and from 129+760 to 130+075 and acoustic barrier on top of parapet at 3.1m from 129+565 to 129+760 (850m long)	~ Low benefit compared to cost	✓ Additional assessment location reduced below daytime LOAEL compared with no mitigation scenario. No material change.	No additional constraints	× Increased visual impact	Further stakeholder engagement req'd.
Option 2	3m from 131+125 to 131+425 (300m long)	~ Low benefit compared to cost	✓ Fewer receptors exposed to daytime and night-time LOAEL. No material change.	No additional constraints	~	Further stakeholder engagement req'd.
Option 3	3m from 132+525 to 133+075 (550m long)	~ Low benefit compared to cost	✓ Three additional receptors reduced below daytime LOAEL compared with no mitigation scenario. No material change.	No additional constraints	~	Further stakeholder engagement req'd.

Note:

1. Value for money compared to the ES design (or equivalent design)
2. Using EIA methodologies
3. Impacts on other environmental disciplines, including landscape and visual
4. Further stakeholder engagement is required as part of the Schedule 17 process to which this NDR contributes under PFN 14.

5. METHODOLOGY

Calculation Methodology

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

Airborne noise from the operational railway has been assessed according to the HS2 methodology which requires predictions of noise emission from five discrete sources at different heights above the top of the rail to represent the sources of noise associated with High Speed Rail. The total noise emission from the train is calculated from the sum of contribution of these sources, individually corrected for propagation to the assessment location. The methodology includes corrections to account for future rolling stock being quieter than current TSI-compliant trains and to allow representation of an individual track to better allow for divergence of the up and down tracks. Two tracks have been accounted for in the calculations.

Airborne noise from altered roads

Airborne noise from altered roads has been calculated and 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).

Assessment Methodology

In accordance with the information paper E20 and the EIA methodology, the impact of The Design is assessed against:

- The number of residential properties exceeding the Lowest Observed Adverse Effect Level (LOAEL);
- The number of residential properties exceeding the Significant Observed Adverse Effect Level (SOAEL);
- The number of residential properties with noise impacts;
- The number of properties eligible for noise insulation; and
- The number of non-residential properties with noise impacts, although none of these are considered sensitive.

The outcomes of this assessment are presented in Section 7.

6. ASSUMPTIONS

The assumptions for the assessments can be seen in Appendix C of this report. These include the available information at this stage of the design. For the operational railway these are assumed train service patterns, track form, rolling stock parameters and noise sources, and planned operational train speeds; for civil engineering assets the design of noise barriers and other mitigating devices.

The validation of the methodology and potential uncertainty is described below.

Uncertainties and Limitations

The Train Noise Prediction Method (TNPM) 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 ±3dB(A). Consistent with the Hybrid Bill Scheme the mean levels predicted with 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 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

The proposed mitigation design was described in Section 4. Noise levels predicted for the proposed Noise Mitigation Design (titled 'The Design' in the option description), as well as the noise levels calculated in the Phase 1 ES and those that would be experienced for the proposed civil engineering assets design without any additional noise barrier (named No Mitigation), are provided in Table 5 and Table 6 for L_{pAeq} and L_{pAFmax} respectively. Where no additional mitigation is proposed beyond the scheme as presented, then values under 'No Mitigation' will be the same as those under 'The Design'.

Tabulated values only indicate assessment locations where LOAEL has been exceeded in any category (shaded in blue). Calculations for all receptors irrespective of level are presented in Appendix D.

Tables show the noise levels due to 'Proposed Scheme only' (operational railway and altered roads) and also the Do Something noise levels by combining Proposed Scheme noise levels and Baseline noise levels, for the cases mentioned above, namely:

- the ES design (after SES & APs);
- the No Mitigation design (current design of civil engineering assets without any additional noise barrier); and
- the Design (recommended mitigation option).

The assessment location IDs correspond to those used in the Phase 1 ES study, to allow for direct comparison. This is the case for assessment location IDs that represent individual receptor locations as well as groups of receptors. All values reported in tables are rounded to the nearest decibel.

All noise levels presented in the tables are free-field and include the following:

- Daytime noise level $L_{pAeq,07:00\text{-}23:00}$ denoted *;
- Night-time noise level $L_{pAeq,23:00-07:00}$ denoted **; and
- Maximum noise levels due to HS2 trains $L_{pAF,max}$ in the Proposed Scheme only column denoted *; the value is always for the HS2 conventional compatible train (CC).

It is further noted:

- Where the Proposed Scheme modifies an existing source, i.e. road or railway realignments, the Proposed Scheme only level in the table includes the sound

from the modified source; In this situation the Do something level (Opening year baseline + Year 15 traffic, denoted ***) has been corrected so as to not double count the sound associated with the road or railway on its new and existing alignment;

- The Proposed-Scheme-Only noise levels are calculated assuming Year 15 traffic;
- The Do-Nothing noise levels correspond to expected Opening year baseline sound levels;
- The Do-Something noise levels are determined as the combination of Opening year baseline sound levels and noise levels due to the Proposed Scheme for Year 15 traffic;
- Receptor label G is for: (G1) theatres, large auditoria and concert halls, (G2) sound recording and broadcast studios, (G3) places of meeting for religious worship, courts, cinemas, lecture theatres, museums and small auditoria or halls, (G4) schools, colleges, hospitals, hotels and libraries, and (G5) offices and general commercial premises; and
- Receptor label R denotes residential properties.

Table 5. Noise level summary of the Design compared to the ES Design – all levels are $L_{pAeq,T}$

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**		**ES Design Proposed Scheme only**		**ES Design Do Something*** **		**No Mitigation Proposed Scheme only**		**No Mitigation Do Something*** **		**The Design Proposed Scheme only**		**The Design Do Something*** **	
ID	Area represented	Type of receptor	Number of impacts	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB
231349	Welsh Road, Offchurch	R	6	61	43	50	41	61	45	48	39	61	44	48	39	61	44
231757	Fosse Way,	R	3	54	49	49	42	54	50	48	41	54	49	48	41	54	49
232415	Welsh Road, Offchurch	R	1	56	38	55	46	58	47	54	45	58	46	54	45	58	46
232441	Welsh Road, Offchurch	R	3	54	49	51	43	55	50	50	42	55	50	50	42	55	50
232805	Welsh Road, Offchurch	R	1	64	52	56	46	64	53	54	45	64	53	54	45	64	53
232831	Leamington Road, Ufton	R	2	41	33	53	44	54	44	53	44	53	44	53	44	53	44
233010	Bascote Southam	R	1	49	37	49	40	52	41	46	37	51	40	46	37	51	40
233039	Bascote Southam	R	1	49	37	52	43	54	44	50	41	52	42	50	41	52	42
234863	Long Itchington Road, Offchurch	R	4	56	51	50	41	57	51	46	38	56	51	46	38	56	51
234899	Long Itchington Road, Offchurch	R	3	51	46	54	44	56	48	51	42	53	47	51	42	53	47
234937	Long Itchington Road, Offchurch	R	3	51	46	57	48	58	50	54	45	55	48	54	45	55	48
235066	Hunningham Road, Offchurch	R	1	49	39	55	46	56	47	56	46	57	47	56	46	57	47
235115	Hunningham Road, Offchurch	R	2	50	39	51	42	54	44	51	41	53	43	51	41	53	43
235121	Hunningham Road, Offchurch	R	1	46	34	58	49	58	49	57	48	57	48	57	48	57	48
235139	Hunningham Road, Offchurch	R	1	50	39	51	42	54	43	50	41	53	43	50	41	53	43
235796	Welsh Road, Offchurch	R	1	66	48	57	49	66	50	56	48	66	50	56	48	66	50
235805	Fosse Way, Offchurch	R	4	66	65	58	50	66	65	57	49	65	65	57	49	65	65
235834	Burnt Heath Farm, Offchurch	R	2	53	35	52	42	54	42	52	42	55	42	52	42	55	42
235841	Long Itchington Road, Offchurch	R	2	65	47	51	43	65	47	51	43	65	47	51	43	65	47

* Day denotes $L_{pAeq,07:00-23:00}$

** Night denotes $L_{pAeq,23:00-07:00}$

*** The Do something level (Opening year baseline + Year 15 traffic) has been corrected so as to not double count the sound associated with the road or railway on its new and existing alignment

Table 6. Noise level summary of the Design compared to the ES Design – all levels are L_{pAFMax}

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**	**ES Design Proposed Scheme only**	**No Mitigation Proposed Scheme only**	**The Design Proposed Scheme only**
ID	Area represented	Type of receptor	Number of impacts	L_{pAFmax} dB	L_{pAFmax} * dB	L_{pAFmax} * dB	L_{pAFmax} * dB
231349	Welsh Road, Offchurch	R	6	50	66	66	66
232415	Welsh Road, Offchurch	R	1	45	73	72	72
232441	Welsh Road, Offchurch	R	3	56	60	65	65
232805	Welsh Road, Offchurch	R	1	62	74	74	74
232831	Leamington Road, Ufton	R	2	38	71	70	70
232863	Welsh Road West, Bascote	R	1	42	66	65	65
233010	Bascote Southam	R	1	47	66	65	65
233039	Bascote Southam	R	1	47	71	68	68
233618	Bascote Southam	R	2	42	64	63	63
233947	School Hill, Offchurch	R	2	63	64	60	60
233982	School Hill, Offchurch	R	6	75	61	60	60
234209	Village Street, Offchurch	R	15	47	64	61	61
234251	Welsh Road, Offchurch	R	5	54	63	62	62
234310	Welsh Road, Offchurch	R	6	54	64	65	65
234354	Welsh Road, Cubbington	R	3	61	66	66	66
234364	Welsh Road, Cubbington	R	5	69	68	66	66
234390	Welsh Road, Cubbington	R	1	61	66	63	63
234744	Welsh Road, Offchurch	R	6	54	65	62	62
234760	Welsh Road, Offchurch	R	2	59	66	61	61
234851	Village Street, Offchurch	R	4	58	61	59	59
234863	Long Itchington Road, Offchurch	R	4	55	65	59	59
234899	Long Itchington Road, Offchurch	R	3	50	66	65	65
234937	Long Itchington Road, Offchurch	R	3	50	64	67	67
235066	Hunningham Road, Offchurch	R	1	46	71	70	70
235115	Hunningham Road, Offchurch	R	2	43	68	68	68
235121	Hunningham Road, Offchurch	R	1	39	73	73	73
235139	Hunningham Road, Offchurch	R	1	43	68	68	68
235157	Hunningham Road, Offchurch	R	2	39	64	65	65
235796	Welsh Road, Offchurch	R	1	55	68	66	66
235805	Fosse Way, Offchurch	R	4	67	68	67	67

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**	**ES Design Proposed Scheme only**	**No Mitigation Proposed Scheme only**	**The Design Proposed Scheme only**
ID	Area represented	Type of receptor	Number of impacts	L_{pAFmax} dB	L_{pAFmax} * dB	L_{pAFmax} * dB	L_{pAFmax} * dB
235834	Burnt Heath Farm, Offchurch	R	2	32	64	65	65
235841	Long Itchington Road, Offchurch	R	2	41	61	61	61
236006	Fosse Way, Offchurch	R	4	62	61	57	57

* denotes L_{pAFmax} in the 'Proposed Scheme only' column; the value is always for the HS2 conventional compatible train (CC)

The number of receptors predicted to exceed LOAEL and SOAEL for the proposed mitigation design and reported in the ES is presented in Table 7. Change classification of impacts is presented in Table 8.

Table 7. Number of residential receptors exceeding LOAEL and SOAEL in The Design and the ES Design

	> LOAEL but < = SOAEL			> SOAEL		
	Total Day	Total Night	Total L_{pAFmax}	Total Day	Total Night	Total L_{pAFmax}
The Design	26	31	99	0	0	0
ES Design	38	42	103	0	0	0

Table 8. Number of major, moderate and minor community impacts due to The Design and the ES Design

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
The Design	3	3	1	4	5	4
ES Design	3	3	8	7	3	5

As seen in the tables, for the proposed design, the number of residential receptors exposed above LOAEL has been reduced for day, night and L_{pAFmax} compared with the ES. In the absence of any additional mitigation, the reduction in noise levels can be attributed to a combination of changes in the HS2 train source terms, flows and the alignment and earthworks in the current design.

None of the residential receptors would exceed the SOAEL level and none would qualify for sound insulation to control operational noise.

The number of non-residential receptors that exceed the noise impact levels set out in Appendix A and which are subject to a significant adverse effect is set out in Table 9.

Table 9. Number of non-residential receptors that exceed the noise impact levels and are subject to significant adverse effects

	Exceed the noise impact levels		Subject to significant adverse effects	
	Total Day	Total Night	Total Day	Total Night
The Design	0	0	0	0
ES Design	0	0	0	0

The table shows that no non-residential receptors exceed the noise impact levels or would be subject to a significant adverse effect.

8. CONCLUSIONS

This report demonstrates that all reasonable steps have been taken to ensure that the predicted cumulative airborne noise from altered roads and operational railways in all foreseeable practical circumstances, does not exceed the lowest observed adverse effect levels. Where it has not been reasonably practicable to achieve this objective, the report shows how airborne noise has been reduced as far as reasonably practicable. The mitigation has been assessed as far as reasonably practicable at this stage of the design process and has been shown to result in effects within the scope of those reported in the HS2 ES. As such the report complies with the requirements of planning forum notes 10 and 14.

Appendix A – LOAEL and SOAEL values from Information Paper E20

The below tables outline the applicable LOAEL and SOAEL values, and design objectives from Information Paper E20.

Table 10. Noise effect levels for permanent residential buildings from the operation of altered roads and railway

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 11. Noise impact levels for noise sensitive non-residential buildings and external amenity spaces from the operation of altered roads and railway

Examples	Day 0700 - 2300	Night 2300 - 0700
Large and small auditoriums; concert halls; sound recording & broadcast studios; and theatres	60 L_{pAFMax} 50 $L_{pAeq, 16hr}$	60 L_{pAFMax} 50 $L_{pAeq, 8hr}$
Places of meeting for religious worship; courts; cinemas; lecture theatres; museums; and small auditoriums or halls	50 $L_{pAeq, 16hr}$	n/a
Schools; colleges; hospitals; hotels; and libraries	50 $L_{pAeq, 16hr}$	45 $L_{pAeq, 8hr}$
Offices and external amenity spaces	55 $L_{pAeq, 16hr}$	n/a

Appendix B – Detailed Technical Methodology

Airborne Noise from the Operational Railway

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 Environmental Statement 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. Figure 10 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 C.

Figure 10. Train noise sources

The speed dependence relationships for each of the above sources, in terms of SEL, which is used to predict $L_{pAeq,T}$ at the receptors, are:

- $R_{SEL} + 20\log_{10}V$ for rolling sound;
- $B_{SEL} + 60\log_{10}V$ for body aerodynamic sound;
- $S_{SEL} - 10\log_{10}V$ for starting sound (V < 250 kph); and
- $P_{SEL} + 60\log_{10}V$ 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} is not applicable for predictions of airborne noise when train speeds are 250 kph or above.

The speed dependence relationships for each of the above sources, in terms of L_{pAFmax} are:

- $R_{LpAF,max} + 30\log_{10}V$ for rolling sound;
- $B_{LpAF,max} + 70\log_{10}V$ for body aerodynamic sound;
- $S_{LpAF,max}$ for starting sound; and
- $P_{LpAF,max} + 70\log_{10}V$ 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 $P_{LpAF,max}$ is the source term for pantograph and pantograph recess maximum sound and V is the train speed in kph.

To account for the differing source heights resulting in different distance attenuation, ground absorption and shielding the calculations for propagation from source to receptors have been 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 1 at the receptor location to provide a single figure value.

$$L_{pAFmax}=MAX[(R_{LpAF,max} \oplus B_{LpAF,max} \oplus S_{LpAF,max}) , (R_{LpAF,max} \oplus P_{LpAF,max} \oplus S_{LpAF,max})] \quad \text{(Equation 1)}$$

Where $\oplus$ is the symbol for logarithmical addition of values.

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 calculated in accordance with the methodology set out in the Calculation of Road Traffic Noise (CRTN) and assessed in accordance with the updated procedure in the Design Manual for Roads and Bridges (DMRB).

When there have been no significant changes since the ES study, 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.

Noise levels used in the assessment

The baseline (Do-Nothing) noise level is the LAeq for the daytime or night-time as reported in the CFA report of the ES and amended by the APs/SESs.

There are three values for the noise level due to HS2 traffic: the daytime L_{Aeq}, the night-time L_{Aeq} and the L_{AFmax}. The daytime L_{Aeq} is a combination of noise from the HS2 trains calculated using NoiseMap for the daytime service pattern and source terms, added to the noise from the daytime L_{Aeq} for altered links at a receptor. A similar calculation is carried out for night-time L_{Aeq} values using a combination of night-time L_{Aeq} for the HS2 trains combined with the night-time L_{Aeq} for altered links. The L_{AFmax} traffic noise is the maximum L_{AFmax} for the night-time service pattern for the HS2 sources using the same methodology as set out in the ES. The daytime/ night-time HS2 traffic L_{Aeq} and the L_{AFmax} for residential receptors are compared with the respective LOAEL and SOAEL values for dwellings as set out in Information Paper E20, Control of airborne noise from altered roads and the operational railway and which are also set out in Appendix A.

Do-Something levels are the noise levels with HS2. There are three values for Do-Something: the daytime L_{Aeq}, the night-time L_{Aeq} and the L_{AFmax}. The daytime L_{Aeq} is a combination of the daytime Do-Nothing L_{Aeq} less the associated daytime L_{Aeq} contribution from the links that are to be altered, the daytime L_{Aeq} from the trains, and

the daytime L_{Aeq} from the altered links. The night-time Do-Something level is calculated in a similar way but using the night-time levels in each case. The Do-Something L_{AFmax} is the same as the HS2 traffic L_{AFmax}. The correction applied when the scheme modifies a link, involving the subtraction of the noise that would be altered by HS2 is done so as not to double count the sound associated with the link on its new and existing alignment.

For the ES cases, the values used in calculations for Do-Nothing, HS2 traffic and Do-Something are as reported in the CFA report of the ES updated where appropriate by the APs or SESs. For the proposed design, noise from the HS2 trains is calculated using NoiseMap for the daytime service pattern in Table 13 and source terms given in Table 14. In both cases where receptors have multiple assessment heights, the maximum value corresponding to HS2 traffic is used in the subsequent analysis.

Classification of impact

The Do-Something noise levels are compared with the Do-Nothing noise levels for the daytime and night-time. These differences are classified as major, minor, moderate, negligible, or beneficial as set out below. The number of major, moderate and minor impacts are reported in Table 8.

Table 12. Classification of noise impact

Do-Something less Do-Nothing	Impact classification
10dB or more	Major
5dB to 9.9dB	Moderate
3dB to 4.9dB	Minor
0dB to 2.9dB	Negligible
<0dB	Beneficial

On a precautionary basis the design exercise has considered mitigation for all receptors that would be exposed to noise at or above LOAEL (not just above LOAEL) with calculations carried out to the nearest 0.1dB. The summary tables set out above for the Design and ES comparison present noise levels rounded to the nearest 1dB as presented in the Community Forum Area reports for consistency and assessment locations are highlighted only when the unrounded levels are equal to, or exceed LOAEL.

Relevant U&As

When considering candidate mitigation any U&As setting out required noise levels, mitigation types or heights etc. are also considered and over-ride any barrier height reduction that could otherwise be achieved through noise control identified as reasonably practicable by considering the monetary benefit of noise reduction compared to cost and other influencing factors.

Non-residential receptors

The noise impact on non-residential receptors is calculated and reported. When the HS2 traffic noise exceeds the noise impact level professional judgement is used to determine if a new significant adverse effect arises, and includes factors such as whether a significant adverse effect was reported at the time of the ES and SES and the baseline noise level at the receptor.

Appendix C – Assumptions

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 13 and train source data in Table 14, normalised to 200m long trains.

Table 13. Train flow data

Scheme	Train	Daytime Flow, 16h 07:00 – 23:00	Night-time Flow, 8h 23:00 – 07:00
Phase 1 Year 15 Flows	CC (360kph)	22	1
	CC (330kph)	191	12
	CP (360kph)	22	1
	CP (330kph)	222	13

Table 14. Train source data

Source	SEL dB at 25m		L_{pAFmax} dB at 25m	
	Conventional Compatible train	Captive train	Conventional Compatible train	Captive train
Rolling	92	92	89	89
Body Aerodynamic	92	90	89	87
Start-up / Power	74	74	73	73
Pantograph Well	n/a	n/a	n/a	n/a
Raised Pantograph	76	76	78	78

Note: Sound emissions from each train running at 320kph on assumed HS2 infrastructure, expressed in terms of the SEL and L_{pAFmax} 25 m from nearest track and 3.5m above ground

Where swing nose crossovers were envisaged in the ES, no correction to the rolling sound source term was applied. For other crossovers a correction factor of +2.5dB

defined in CRN was applied to the affected track segments when predicting airborne noise from the railway.

A +1dB correction has been applied to track sections on viaducts.

Noise from porous portals

Train sources (rail/wheel interface, body aerodynamic, start-up, and pantograph) will continue to produce noise while within a tunnel/ porous portal and some of this will be transmitted into the community through the openings on the roof of the porous portal and at the open end of the porous portal. Noise contribution from these sources has been considered by retaining the track length within the porous portals with a 10dB attenuation and positioning the source at the top of the porous portal. This is the same assumption as was made at the time of the ES.

Appendix D - Calculation results at all receptors

Table 15 and Table 16 show the predicted L_{pAeq} noise levels for the daytime and night-time, and predicted L_{pAFmax} noise levels respectively. The information in these tables is similar to the results presented within the main body of the report except that noise levels in this appendix are reported for all assessment locations as opposed to only for assessment locations where LOAEL is exceeded.

Table 15. Noise level summary of the Design compared to the ES Design – all levels are $L_{pAeq,T}$

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**		**ES Design Proposed Scheme only**		**ES Design Do Something**		**No Mitigation Proposed Scheme only**		**No Mitigation Do Something**		**The Design Proposed Scheme only**		**The Design Do Something**	
ID	Area represented	Type of receptor	Number of impacts	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB
231349	Welsh Road, Offchurch	R	6	61	43	50	41	61	45	48	39	61	44	48	39	61	44
231349	Bunkers Hill Farm, Welsh Road, Offchruch	G5	2	61	43	50	41	61	45	48	39	61	44	48	39	61	44
231349	Old Tractor Shed, Welsh Road, Offchurch (General Commercial)	G5	1	61	43	50	41	61	45	48	39	61	44	48	39	61	44
231757	Fosse Way	R	3	54	49	49	42	54	50	48	41	54	49	48	41	54	49
232415	Welsh Road, Offchurch	R	1	56	38	55	46	58	47	54	45	58	46	54	45	58	46
232441	Welsh Road, Offchurch	R	3	54	49	51	43	55	50	50	42	55	50	50	42	55	50
232805	Welsh Road, Offchurch	R	1	64	52	56	46	64	53	54	45	64	53	54	45	64	53
232831	Leamington Road, Ufton	R	2	41	33	53	44	54	44	53	44	53	44	53	44	53	44
232831	Wood Farm Leamington Road (General Commercial)	G5	1	41	33	53	44	54	44	53	44	53	44	53	44	53	44
232863	Welsh Road West, Bascote	R	1	43	35	48	39	49	40	48	38	49	40	48	38	49	40
233010	Bascote Southam	R	1	49	37	49	40	52	41	46	37	51	40	46	37	51	40
233039	Bascote Southam	R	1	49	37	52	43	54	44	50	41	52	42	50	41	52	42
233618	Bascote Southam	R	2	43	35	44	35	47	38	44	35	46	38	44	35	46	38
233947	School Hill, Offchurch	R	2	55	52	45	36	55	52	43	35	55	52	43	35	55	52
233947	Offchurch Village Hall, School	G3	1	55	52	45	36	55	52	43	35	55	52	43	35	55	52
233947	The Church Of St. Gregory, Village Street	G3	1	55	52	45	36	55	52	43	35	55	52	43	35	55	52

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**		**ES Design Proposed Scheme only**		**ES Design Do Something**		**No Mitigation Proposed Scheme only**		**No Mitigation Do Something**		**The Design Proposed Scheme only**		**The Design Do Something**	
ID	Area represented	Type of receptor	Number of impacts	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB
233982	School Hill, Offchurch	R	6	67	64	44	36	67	64	44	35	67	64	44	35	67	64
234209	Village Street, Offchurch	R	15	47	39	46	37	49	40	43	35	48	40	43	35	48	40
234251	Welsh Road, Offchurch	R	5	50	42	46	37	51	43	45	36	51	43	45	36	51	43
234251	The Stag At Offchurch, Welsh Road, Offchurch (Restaurant)	G5	1	50	42	46	37	51	43	45	36	51	43	45	36	51	43
234310	Welsh Road, Offchurch	R	6	50	42	46	37	51	43	45	36	51	43	45	36	51	43
234354	Welsh Road, Cubbington	R	3	62	45	46	37	62	46	47	38	62	46	47	38	62	46
234364	Welsh Road, Cubbington	R	5	55	51	47	38	56	51	47	38	56	51	47	38	56	51
234390	Welsh Road, Cubbington	R	1	65	48	45	36	65	48	46	37	65	48	46	37	65	48
234744	Welsh Road, Offchurch	R	6	50	42	48	39	52	44	46	37	51	43	46	37	51	43
234760	Welsh Road, Offchurch	R	2	58	50	48	39	59	50	45	36	58	50	45	36	58	50
234851	Village Street, Offchurch	R	4	59	51	47	38	59	51	44	37	59	51	44	37	59	51
234863	Long Itchington Road, Offchurch	R	4	56	51	50	41	57	51	46	38	56	51	46	38	56	51
234899	Long Itchington Road, Offchurch	R	3	51	46	54	44	56	48	51	42	53	47	51	42	53	47
234937	Long Itchington Road, Offchurch	R	3	51	46	57	48	58	50	54	45	55	48	54	45	55	48
235066	Hunningham Road, Offchurch	R	1	49	39	55	46	56	47	56	46	57	47	56	46	57	47
235115	Hunningham Road, Offchurch	R	2	50	39	51	42	54	44	51	41	53	43	51	41	53	43
235121	Hunningham Road, Offchurch	R	1	46	34	58	49	58	49	57	48	57	48	57	48	57	48
235139	Hunningham Road, Offchurch	R	1	50	39	51	42	54	43	50	41	53	43	50	41	53	43
235139	Offchurch Sports Club (Sports Club)	G5	1	50	39	51	42	54	43	50	41	53	43	50	41	53	43
235157	Hunningham Road, Offchurch	R	2	41	31	48	39	48	39	48	39	49	40	48	39	49	40
235157	Manor Farm, Hunningham Road (General Commercial)	G5	2	41	31	48	39	48	39	48	39	49	40	48	39	49	40
235796	Welsh Road, Offchurch	R	1	66	48	57	49	66	50	56	48	66	50	56	48	66	50

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**		**ES Design Proposed Scheme only**		**ES Design Do Something**		**No Mitigation Proposed Scheme only**		**No Mitigation Do Something**		**The Design Proposed Scheme only**		**The Design Do Something**	
ID	Area represented	Type of receptor	Number of impacts	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB	Day* dB	Night** dB
235805	Fosse Way, Offchurch	R	4	66	65	58	50	66	65	57	49	65	65	57	49	65	65
235834	Burnt Heath Farm, Offchurch	R	2	53	35	52	42	54	42	52	42	55	42	52	42	55	42
235841	Long Itchington Road, Offchurch	R	2	65	47	51	43	65	47	51	43	65	47	51	43	65	47
235841	Long Itchington Road, Offchurch (Trade Distribution)	G5	2	65	47	51	43	65	47	51	43	65	47	51	43	65	47
235951	Long Itchington Road, Offchurch	R	2	49	38	43	35	49	39	42	34	50	39	42	34	50	39
236006	Fosse Way, Offchurch	R	4	57	51	46	37	57	51	45	38	57	51	45	38	57	51
236207	Snowford Long Itchington	R	4	49	38	42	34	49	39	42	33	50	39	42	33	50	39
901033	Ufton Vale Farmlands A	LD	-	44	32	66	57	66	57	62	53	62	53	62	53	62	53
901034	Ufton Vale Farmlands 1	LD	-	44	32	60	51	60	51	56	47	56	47	56	47	56	47
901035	Ufton Vale Farmlands B	LD	-	30	22	52	43	52	43	50	41	50	41	50	41	50	41
901036	Ufton Vale Farmlands 4	LD	-	41	43	47	38	48	44	42	33	44	43	42	33	44	43

* Day denotes $L_{pAeq,T\ 07:00\text{-}23:00}$

** Night denotes $L_{pAeq,T\ 23:00\text{-}07:00}$

*** The Do something level (Opening year baseline + Year 15 traffic) has been corrected so as to not double count the sound associated with the road or railway on its new and existing alignment

Table 16. Noise level summary of the Design compared to the ES Design – all levels are L_{pAFMax}

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**	**ES Design Proposed Scheme only**	**No Mitigation Proposed Scheme only**	**The Design Proposed Scheme only**
ID	Area represented	Type of receptor	Number of impacts	L_{pAFmax} dB	L_{pAFmax} * dB	L_{pAFmax} * dB	L_{pAFmax} * dB
231349	Welsh Road, Offchurch	R	6	50	66	66	66
231349	Bunkers Hill Farm, Welsh Road, Offchruch (Office)	G5	2	50	66	66	66
231349	Old Tractor Shed, Welsh Road, Offchurch (General Commercial)	G5	1	50	66	66	66
231757	Fosse Way,	R	3	56	54	53	53
232415	Welsh Road, Offchurch	R	1	45	73	72	72
232441	Welsh Road, Offchurch	R	3	56	60	65	65
232805	Welsh Road, Offchurch	R	1	62	74	74	74
232831	Leamington Road, Ufton	R	2	38	71	70	70
232831	Wood Farm Leamington Road (General Commercial)	G5	1	38	71	70	70
232863	Welsh Road West, Bascote	R	1	42	66	65	65
233010	Bascote Southam	R	1	47	66	65	65
233039	Bascote Southam	R	1	47	71	68	68
233618	Bascote Southam	R	2	42	64	63	63
233947	School Hill, Offchurch	R	2	63	64	60	60
233947	Offchurch Village Hall, School	G3	1	63	64	60	60
233947	The Church Of St. Gregory, Village Street (Church)	G3	1	63	64	60	60
233982	School Hill, Offchurch	R	6	75	61	60	60
234209	Village Street, Offchurch	R	15	47	64	61	61
234251	Welsh Road, Offchurch	R	5	54	63	62	62
234251	The Stag At Offchurch, Welsh Road, Offchurch (Restaurant)	G5	1	54	63	62	62
234310	Welsh Road, Offchurch	R	6	54	64	65	65
234354	Welsh Road, Cubbington	R	3	61	66	66	66
234364	Welsh Road, Cubbington	R	5	69	68	66	66
234390	Welsh Road, Cubbington	R	1	61	66	63	63
234744	Welsh Road, Offchurch	R	6	54	65	62	62
234760	Welsh Road, Offchurch	R	2	59	66	61	61
234851	Village Street, Offchurch	R	4	58	61	59	59
234863	Long Itchington Road, Offchurch	R	4	55	65	59	59
234899	Long Itchington Road, Offchurch	R	3	50	66	65	65
234937	Long Itchington Road, Offchurch	R	3	50	64	67	67
235066	Hunningham Road, Offchurch	R	1	46	71	70	70
235115	Hunningham Road, Offchurch	R	2	43	68	68	68
235121	Hunningham Road, Offchurch	R	1	39	73	73	73
235139	Hunningham Road, Offchurch	R	1	43	68	68	68

Assessment location – *note: blue shading is used where noise levels in subsequent columns are at or above LOAEL*				**Do Nothing (Opening year baseline)**	**ES Design Proposed Scheme only**	**No Mitigation Proposed Scheme only**	**The Design Proposed Scheme only**
ID	Area represented	Type of receptor	Number of impacts	L_{pAFmax} dB	L_{pAFmax} * dB	L_{pAFmax} * dB	L_{pAFmax} * dB
235139	Offchurch Sports Club (Sports Club)	G5	1	43	68	68	68
235157	Hunningham Road, Offchurch	R	2	39	64	65	65
235157	Manor Farm, Hunningham Road (General Commercial)	G5	2	39	64	65	65
235796	Welsh Road, Offchurch	R	1	55	68	66	66
235805	Fosse Way, Offchurch	R	4	67	68	67	67
235834	Burnt Heath Farm, Offchurch	R	2	32	64	65	65
235841	Long Itchington Road, Offchurch	R	2	41	61	61	61
235841	Long Itchington Road, Offchurch (Trade Distribution)	G5	2	41	61	61	61
235951	Long Itchington Road, Offchurch	R	2	45	51	54	54
236006	Fosse Way, Offchurch	R	4	62	61	57	57
236207	Snowford Long Itchington	R	4	45	56	56	56
901033	Ufton Vale Farmlands A	LD	-	42	87	83	83
901034	Ufton Vale Farmlands 1	LD	-	42	76	76	76
901035	Ufton Vale Farmlands B	LD	-	29	70	70	70
901036	Ufton Vale Farmlands 4	LD	-	50	63	58	58

* denotes L_{pAFmax} in the 'Proposed Scheme only' column; the value is always for the HS2 conventional compatible train (CC)