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

# Acoustic Mitigation Design Report – Twyford Viaduct to Turweston Cutting

## 1MC06-CEK-EV-REP-CS06-000002

| Rev | Date | Author | Checked by | Approved by | Revision Details | EKFB Reviewer |
|---|---|---|---|---|---|---|
| C02 | 14/03/2022 | M.V.D.Merwe | P.Tallantyre | A.Dawson | Revised in line with comments | Zara Rostance |
| C01 | 09/05/2020 | M.V.D.Merwe | P.Tallantyre | A.Dawson | First issue | Cyrille Beaux |
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| Stakeholder review required (SRR) | Purpose of SRR |
|---|---|
| ☐ County / District / London Borough Council | ☐ Acceptance |
| ☐ LOV | ☐ Approval |
| ☐ LUL | ☐ No Objection |
| ☐ NRL | ☐ Consent |
| ☐ TFL | |
| ☐ Utilities Company | |
| ☐ Other (please specify) | |

# Contents

# Images



# Tables

# Appendices

## APPENDIX A

**Noise Modelling Methodology**

# List of Abbreviations

| | |
|---|---|
| CBA | Cost Benefit Analysis |
| dB | Decibel |
| DS | Do Something |
| DN | Do Nothing |
| ES | Environmental Statement |
| SES | Supplementary Environmental Statement |
| LOAELs | Lowest Observed Adverse Effect Levels |
| SOAELs | Significant Observed Adverse Effect Levels |
| NPV | Net Present Value |
| ToR | Top of Rail |

# EXECUTIVE SUMMARY

This report presents the civil engineering asset acoustic analysis for C2 IDR G – Twyford Embankment to Turweston Embankment (Chainage 80+862 to 95+405).

Section 3 details a methodology that meets the requirements of "Technical Standard – Acoustic design of civil engineering assets" and discusses the comparison of whole-life costs and benefits of noise barrier options as per 'HS2 Phase 1 Operational Noise and Vibration EMRs – Material Difference'. Whole life costs used are based on EK noise barrier costs compiled in May 2019. Section 4 summarises how the methodology has been effectively applied to C2 IDR G.

Noise model sources terms and technical assumptions are in accordance with the technical assumptions issued by HS2 limited in Technical Note: Assumption for Phase 1 operational ground-borne sound, vibration, and airborne sound assessment. Document no: PH1-HS2-EN-PPR-000-000052 (August 2018).

The report concludes by recommending acoustic mitigation design, presented in Section 5, as follows:

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) |
|---|---|---|---|---|---|
| Twyford Viaduct | 81+219* | 82+289 | Down | 1089 | 4 |
| | 82+289 | 82+349 | Down | 60 | 1.85 |
| | 82+289 | 82+349 | Up | 60 | 1.25 |
| | 82+349 | 82+500 | Down | 151 | 3 |
| Godington Viaducts | No mitigation in the form of noise barriers required. Mitigation afforded by the scheme and earthworks design | | | | |
| Chetwode Newton Purcell | 85+060 | 87+200 | Up | 2140 | 5 |
| | 87+800 | 88+000 | Up | 200 | 3 |
| Finmere to Mixbury | 89+900 | 90+480 | Up | 580 | 3 |
| Westbury | No mitigation in the form of noise barriers required. Mitigation afforded by the scheme and earthworks design | | | | |

*The barrier falls within IDR K, but has been assessed as part of a composite barrier system to afford protection to the Twyford community

*Table 1 Noise Barrier Design Summary*

# Introduction

This report presents the civil engineering asset acoustic analysis for C2 IDR G – Twyford Embankment to Turweston Embankment (Chainage 80+862 to 95+405).

This report recommends an acoustic mitigation solution based on an evaluation of the whole-life costs and benefits of noise barrier options that are used to specify the acoustic mitigation design and consideration of material change in accordance with HS2 Phase 1 Operational Noise and Vibration EMRs – Material Difference (1TS01-ARP-CN-NOT-000-000001).

The acoustic design of HS2 civil engineering assets which could affect noise and/or vibration in the surrounding environment has been undertaken using “Technical Standard – Acoustic design of civil engineering assets”, document no.: HS2-HS2-EN-STD-000-000003-P05.

The modelling of rail noise has been carried out in the NoiseMap™ noise modelling software which accords to the noise modelling procedures adopted for the HS2 ES, using the November 2018 HS2 Ltd noise source terms and service patterns and modelling assumptions (Technical Note: Assumption for Phase 1 operational ground-borne sound, vibration and airborne sound assessment Document no. PH1-HS2-EN-NOT-000-000002).

The noise model results have been assessed against the HS2 Environmental Statement and the Environmental Minimum Requirements. The provisions in Planning Forum Note 14 - Operational Noise from the Railway and Altered Roads have been adopted.

“Technical Standard – Acoustic design of civil engineering assets” requires that ‘Where there are no robust monetary costs (e.g. for visual impacts) or monetary benefits (e.g. for vibration levels) available, the above process should be methodically followed to highlight uncertainties and compare options on an equal basis with reference to guidance contained in Defra NANR 201. The appraisal has been carried out in accordance with this requirement.

When considering if all reasonable steps have been taken to control noise in accordance with HS2 Ltd.'s objectives, the design procedure outlined in the Technical Standard requires a list of potential mitigation measures to be identified and a proportionate Cost Benefit Analysis (CBA) to be undertaken in accordance with HM Treasury guidelines and take into account 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.

The appraisal has been carried out in accordance with this requirement.

The methodology set out in Department for Transport’s Transport Analysis Guidance (TAG) Unit A3.2 has been followed in determining the monetary benefit of the noise reduction provided by the civil engineering asset. The appraisal has been carried out using the guidance issued by HS2 Ltd. guidance on the version of TAG to be used and its application to ensure consistency across the project. Guidance on the application of TAG as found in “WebTAG application for the assessment of operational airborne noise control”, document no.: 1TS01-ARP-CN-NOT-000-000002-P01 has been followed. Guidance on material difference presented in “HS2 Phase 1 Operational Noise and Vibration EMRs – Material Difference”, document no.: 1TS01-ARP-CN-NOT-000-000001-P01 has also been adopted

The noise mitigation design is summarised in Section 5.

- Asset – IDR G
- Asset Area

This report covers the area C2 IDR G – Twyford Embankment to Turweston Embankment (Chainage 80+862 to 95+405).

The noise modelling for IDR G has considered the design changes proposed to date and considers ground models issued as listed below which incorporate any changes to earthworks and landscaping:

## Twyford to Chetwode

The location and appearance of Twyford Viaduct, Godington East Viaduct and Godington West Viaduct, PBI/5A Accommodation Overbridge and the other structures for approval are shown on the following drawings for approval.

Twyford to Chetwode General Arrangement Plan – For Approval Sheet 1 of 2 - 1MC06-CEK-TP-DGA-CS06_CL10-000011
Twyford to Chetwode General Arrangement Plan – For Approval Sheet 2 of 2 - 1MC06-CEK-TP-DGA-CS06_CL10-000012

Twyford Viaduct General Arrangement Plan - For Approval - 1MC06-CEK-TP-DGA-CS06_CL10-000017

Twyford Viaduct Plan Details - For Approval - 1MC06-CEK-TP-DGA-CS06_CL10-000019
Twyford Viaduct Elevation and Longitudinal Section - For Approval - 1MC06-CEK-TP-DSE-CS06_CL10-000027
Twyford Viaduct Abutment Section - For Approval - 1MC06-CEK-TP-DSE-CS06_CL10-000029

Twyford Viaduct Superstructure and Pier Elevation and Section - 1MC06-CEK-TP-DSE-CS06_CL10-000013
Twyford Viaduct Superstructure Longitudinal Section - 1MC06-CEK-TP-DSE-CS06_CL10-000014
Twyford Viaduct Plan on Deck Details - 1MC06-CEK-TP-DDE-CS06_CL10-000012
Twyford Viaduct Reflected Soffit Plan Details - 1MC06-CEK-TP-DDE-CS06_CL10-000013
Twyford Viaduct Noise Barrier Details - 1MC06-CEK-TP-DDE-CS06_CL10-000015
Twyford Viaduct Noise Barrier Transition Details - 1MC06-CEK-TP-DDE-CS06_CL10-000022
Godington East and West Viaducts General Arrangement Plan - For Approval - 1MC06-CEK-TP-DGA-CS06_CL10-000021
Godington East and West Viaducts Plan Details - For Approval - 1MC06-CEK-TP-DGA-CS06_CL10-000023

Godington East and West Viaducts and Twyford Viaduct Pier Details - 1MC06-CEK-TP-DGA-CS06_CL10-000025
Godington East and West Viaducts and Twyford Viaduct Superstructure Exploded Axonometric - 1MC06-CEK-TP-DGA-CS06_CL10-000026
Godington East and West Viaducts Noise Barrier Details - 1MC06-CEK-TP-DDE-CS06_CL10-000001
Godington East and West Viaducts Plan on Deck Details - 1MC06-CEK-TP-DDE-CS06_CL10-000003

Godington East and West Viaducts Reflected Soffit Plan Details - 1MC06-CEK-TP-DDE-CS06_CL10-000004

Godington East and West Viaducts Plan Details – For Approval - 1MC06-CEK-TP-DGA-CS06_CL10-000023
Godington East and West Viaducts Elevations and Section – For Approval - 1MC06-CEK-TP-DSE-CS06_CL10-000033
Godington East and West Viaducts Abutment - 1MC06-CEK-TP-DSE-CS06_CL10-000035Section

Godington East and West Viaducts Superstructure and Pier Elevation and Section - 1MC06-CEK-TP-DSE-CS06_CL10-000006
Godington East and West Viaducts Superstructure Longitudinal Section - 1MC06-CEK-TP-DSE-CS06_CL10-000007
PBI/5A Accommodation Overbridge Plan on Deck – For Approval - 1MC06-CEK-TP-DPL-CS06_CL10-000067
Godington East Culvert Plans and Sections
For Approval - 1MC06-CEK-TP-DPL-CS06_CL10-000069
Godington West Culvert Plans and Sections –1MC06-CEK-TP-DPL-CS06_CL10-000071
PBI/5A Accommodation Overbridge
Longitudinal Section and Elevation – For
Approval - 1MC06-CEK-TP-DSE-CS06_CL10-000031
PBI/5A Accommodation Overbridge Cross - 1MC06-CEK-TP-DDE-CS06_CL10-000019
Section and Parapet Details - For Approval

**Twyford Viaduct and Godington East Viaduct and Godington West Viaduct**

Twyford Viaduct (chainage 82+290 to 82+350), Godington East Viaduct (chainage 84+070 to 84+145) and Godington West Viaduct (chainage 84+392 to Ch 84+467) will carry the HS2 line over Padbury Brook and its floodplain. Only part of Godington East and Godington West Viaducts falls within this package, the remaining parts fall within the CDC's administrative area.

Twyford Viaduct crosses Padbury Brook approximately 250m northeast of the village of Twyford. The viaduct is a compact and low-lying structure minimising impact on farmland and the adjoining riparian woodland. The viaduct will be visible from PRoW PBI/6/3 that passes close to and beneath the structure, therefore, the appearance and legibility of the viaduct at a close distance is of particular importance.

Godington East Viaduct and Godington West Viaduct also cross Padbury Brook, together with a connecting section of embankment straddling a pronounced bend in the watercourse approximately 2km northwest of Twyford. As with Twyford Viaduct, the structures will be experienced at close quarters due to the alignments of PRoW CHW/24/2 and PROW/9/3 passing near to each viaduct.
Given the close proximity of the viaducts to one another, commonality of detail and structural form is considered to be important. As such, the viaducts have been developed as a family of structures with a similar structural form comprising of a prestressed concrete U beam and in-situ slab deck supported on bearings at intermediate twin leaf piers and low-level wall abutments. The parapets are precast and will be stitched to the in-situ deck.

Godington East Viaduct and Godington West Viaduct are four spans 'identical twins' with Twyford Viaduct being the more compact sibling at three spans.
The total length of Twyford Viaduct is approximately 60m (3x20m spans and abutments), 12.15m wide with the track height approximately 5m above existing ground level. The existing ground level ranges from 83m to 88m AOD.

The total length of Godington East and Godington West Viaducts are 75m in length, 12.75m wide with the track height approximately 5.5m above existing ground level. The existing ground level ranges from 86m to 89m AOD. The approach embankments either side of the viaducts will provide a ramp from the ground level to deck level.

The proposed earthworks for approval are shown on the following drawings for approval. Landform Plans and Earthwork Cross Sections have been provided to indicate the existing and proposed ground levels.

Twyford to Chetwode General Arrangement Plan – For Approval Sheet 1 of 2 - 1MC06-CEK-TP-DGA-CS06_CL10-000011

Twyford to Chetwode General Arrangement Plan – For Approval Sheet 2 of 2 - 1MC06-CEK-TP-DGA-CS06_CL10-000012

Twyford to Chetwode Proposed Landform Plan Sheet 1 of 2 - 1MC06-CEK-TP-DPL-CS06_CL10-000013

Twyford to Chetwode Proposed Landform Plan Sheet 2 of 2 - 1MC06-CEK-TP-DPL-CS06_CL10-000014

Twyford to Chetwode Earthworks Cross Sections Sheet 1 of 3 - 1MC06-CEK-TP-DSE-CS06_CL10-000001

Twyford to Chetwode Earthworks Cross Sections Sheet 2 of 3 - 1MC06-CEK-TP-DSE-CS06_CL10-000002

Twyford to Chetwode Earthworks Cross Sections Sheet 3 of 3 - 1MC06-CEK-TP-DSE-CS06_CL10-000003

Twyford to Chetwode Pond Details and Sections - 1MC06-CEK-TP-DDE-CS06_CL10-000028

**Twyford Embankment (Part of) and Cowley Embankment**

Twyford Viaduct requires earthworks to lift the ground to the levels required for the viaduct. Twyford Viaduct will be up to 5m above (track height) existing ground level. The existing ground level ranges from 83m to 88m AOD.

The approach embankments either side of Twyford Viaduct will provide a ramp from ground level to deck level. The approach embankments comprise of Twyford Embankment and Cowley Embankment.

Twyford Embankment extends from chainage 80+862 to 82+289, with the section subject to approval under this Schedule 17 application commencing from chainage 82+200. The total length of the embankment is approximately 1,425m long, of which approximately 89m falls within the site. The landscape mitigation earthworks will be up to 9.5m in height above existing ground level.

Cowley Embankment will be approximately 396m in length and extend from chainage 82+349 to 82+745. The Cowley Embankment Asset includes landscape mitigation earthworks. The total length of the landscape mitigation earthworks is approximately 300m.

The inward slopes for these embankments will be 1 in 4. The outward slope of Twyford Embankment is variable and 1 in 8 for Cowley Embankment.

On the western sides of the Twyford and Cowley Embankment tree and shrub planting and grassland is proposed. On the eastern sides of the Twyford and Cowley Embankment grassland is proposed. The landscaping will help soften and overtime integrate the landscape mitigation earthworks.

The earthworks design for Twyford Embankment and Cowley Embankment is shown on the Twyford to Chetwode Earthworks Cross Sections Sheet 1 of 3 (Drawing No. 1MC06-CEK-TP-DSE-CS06_CL10-000001).

**Twyford Cutting**

Twyford Cutting is required to allow the HS2 line to pass beneath the PBI/5A Accommodation Overbridge.

The cutting will be approximately 1,140m in length and extend from chainage 82+745 to 83+886. It will be up to 5m below existing ground level. The existing ground level ranges from 90m to 95m AOD. The width of the cutting ranges from approximately 6m to 20m.

Earthworks will be carried out to create new 1 in 4 slopes. Grassland is proposed on the slopes.

The earthworks design for Twyford Cutting is shown on the Twyford to Chetwode Earthworks Cross Sections Sheet 2 of 3 (Drawing No. 1MC06-CEK-TP-DSE-CS06_CL10-000002).

**Godington East Embankment**

Godington East Viaduct requires earthworks to lift the ground to the levels required for the viaduct. Godington East Viaduct will be up to 5.5 m above (track height) existing ground level. The existing ground level ranges from 85m to 90m AOD.

The approach embankments either side of Godington East Viaduct will provide a ramp from ground level to deck level. The approach embankments comprise Godington East Embankment and Godington West Embankment. Godington West Embankment is outside of the site and falls within CDC (it will be the subject of a separate Schedule 17 application).

Godington East Embankment will be approximately 184m in length and extend from chainage 83+886 to 84+070. The embankment will be up to 3m in height above existing ground level.

The engineered profile of the embankment has a slope gradient of 1 in 2.

The earthworks design for Godington East Embankment and Godington West Embankment is shown on the Twyford to Chetwode Earthworks Cross Sections Sheet 3 of 3 (Drawing No. 1MC06-CEK-TP-DSE-CS06_CL10-000003).

**Godington West Embankment**

The proposed Godington East and West Viaducts require earthworks to lift the intervening ground to the levels required for the viaducts.

Godington West Embankment will extend from Chainage 84+070 to 84+392. The total length of the embankment is approximately 322m long. The embankment sits entirely within the site. The embankment will be up to 4.5 m above existing ground. The existing ground level ranges from 86m to 86.5 m AOD.

The engineered profile of the embankment has a slope gradient of 1:2.

The landscape earthwork design for Godington West Embankment is shown on the Earthworks Cross Sections Drawings Sheets 1 of 2 and 2 of 2 (Drawing Nos. 1MC06-CEK-TP-DSE-CS06_CL10-000020 and 1MC06-CEK-TP-DSE-CS06_CL10-000021).

**Chetwode Embankment (Part of)**

Godington West Viaduct requires earthworks to lift the ground to the levels required for the viaduct. Godington West Viaduct will be up to 5.5 m above existing ground level. The existing ground level ranges from 85m to 90m AOD.

The approach embankments either side of Godington West Viaduct will provide a ramp from ground level to deck level. The approach embankments comprise of Chetwode Embankment (Part of) and Godington West Embankment. Godington West Embankment is outside of the site and falls within CDC (it will be the subject of a separate Schedule 17 application).

Chetwode Embankment extends from chainage 84+467 to 84+925, with the section subject to approval under this Schedule 17 application ending at chainage 84+900. The total length of the engineered track embankment is approximately 458m, of which approximately 433m falls within the site.

The Chetwode Embankment Asset includes landscape mitigation earthworks. The total length of the landscape mitigation earthworks is approximately 480m, of which approximately 300m falls within the site. The landscape mitigation earthworks will be up to 9m above existing ground. The existing ground level ranges from 85m to 90m AOD.

At Chetwode embankment, the landscape mitigation earthworks (east side) backslopes have been graded out to 1 in 28 in order to return the land to agricultural use and to tie-in with existing smooth flowing contours. Inward slopes will be 1 in 4.

Woodland and hedgerow planting will be used on the east side to re-establish the original field boundary and to help integrate and or screen the HS2 assets.

The earthworks design for Chetwode Embankment is shown on the Twyford to Chetwode Earthworks Cross Sections Sheet 3 of 3 (Drawing No. 1MC06-CEK-TP-DSE-CS06_CL10-000003).

## Chetwode to Turweston

**Chetwode Cutting**

Value Engineering (VE) and Optioneering proposes the raising of HS2 lines by up to 3m through the Chetwode Cutting.

Chetwode Cutting has been designed with 1V:3H slopes compared to 1V:4H at ERD. The width of the cutting has been reduced and 2m wide trapezoidal cunettes now proposed for track drainage compared to filter drains at ERD. 1V in 4H rear slopes will be adopted on the west side of the landscape bunds.

Barton Hartshorn Embankment has been slightly steepened to 1V:2H from 1V:2.5H at ERD.

Barton to Mixbury Cutting has changed from 1V in 2.5H with blanket layer to a 1V in 3.5H chainage from start to 89+550 and 1Vin 2.5H chainage from 89+550 to end. Track drainage solutions are 2m trapezoidal cunettes representing a change from filter drains at ERD.

Westbury Embankment slopes have changed from 1V:2.5H at ERD to 1V:2H at Scheme Design representing a steepening of the slopes. This change has the potential to reduce land take and the volume of material required for construction.

The Westbury Viaduct design has changed from a U-shape prestressed concrete beams solution at ERD to a double composite viaduct solution at Scheme Design. The solution proposed reduces the material quantities to be used for the construction of the viaduct, as the number of supports have been reduced and foundations dimensions (pile and pile caps) have been optimised.

The length of the viaduct has been increased by approximately 10m at either end, increasing the total length from 300m to 320m. In addition, abutment heights are reduced, and the abutment foundations and walls are simplified.

Grovehill Embankment slopes have changed from 1V:2.5H at ERD to 1V:2H at Scheme Design representing a steepening of the slopes.

At Turweston the track interval has been reduced from 5 to 4.7m in line with VE 103. The lower section of the slopes of Turweston Cutting (093-L1) remain at 1V:2H, however, a rock buttress (stone fill) will be added from the toe of cutting slopes up to track height in parts in line with the geotechnical design; no additional land take is required. The blanket layer on has been removed from some of the upper section of slopes (northern half) resulting in slackening from 1 in 2 to 1 in 2.5 in line with the geotechnical design. A 4m bench has been included where the height of the slope is greater than 10m.

Mixbury Embankment slopes have changed from 1V:2.5H at ERD to 1V:2H at Scheme Design representing a steepening of the slopes. This change has the potential to reduce land take and the volume of material required for construction.

- Hybrid Bill Summary

## Twyford to Chetwode

**Twyford**

IDR G lies between Chainage 80+862 (southern end of the Twyford Viaduct) and Chainage 95+405. The noise modelling and mitigation design does however consider a composite barrier system that extend south into IDR K (Calvert North between Ch 80+150 and Ch 80+862).

The assessment area as presented in the “London-West Midlands Environmental Statement, Volume 5 Map books Sound, noise and vibration (Part 2 of 4) November 2013’ (CFA13) is shown on Images 1 and 2.

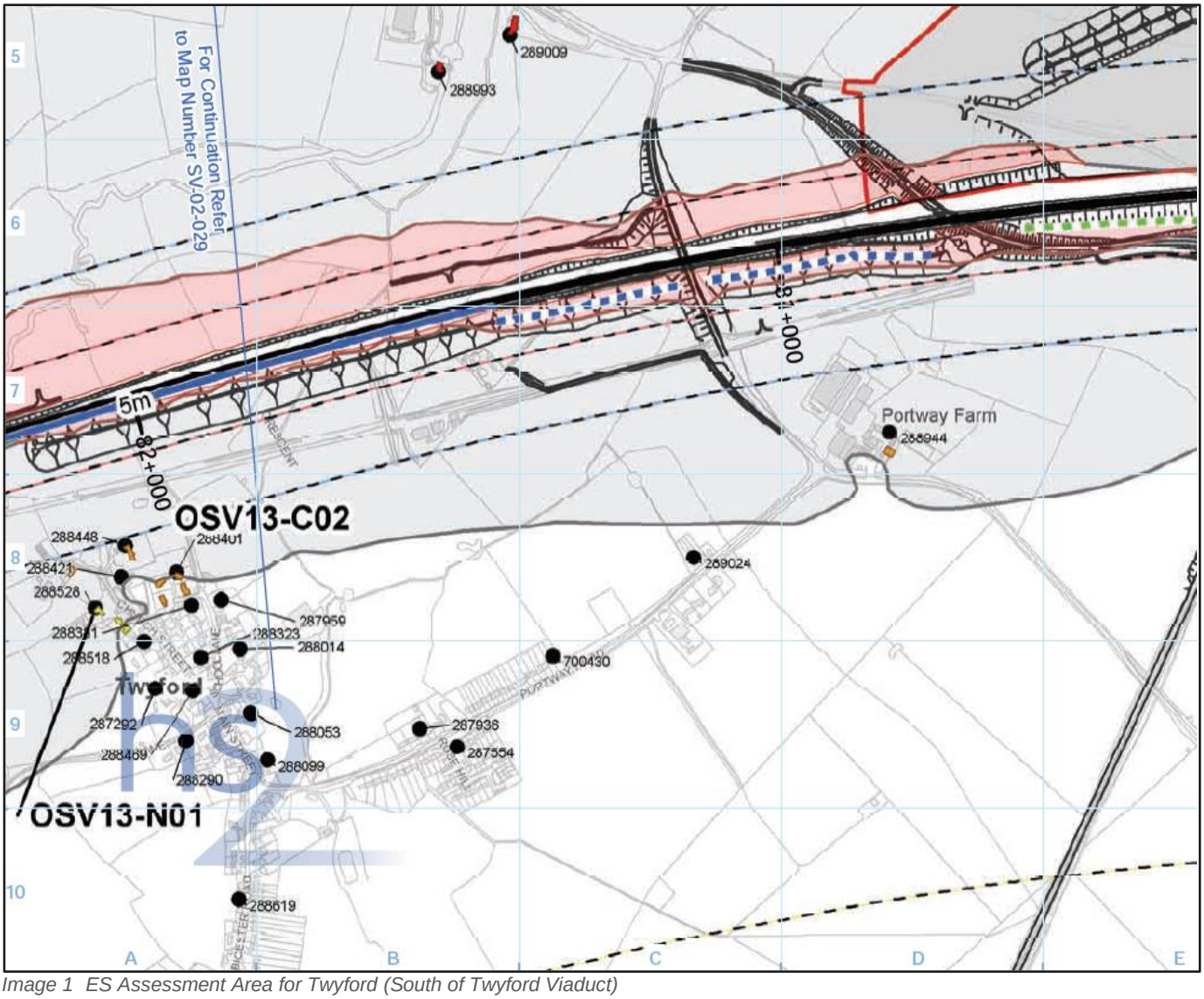


*Image 1 ES Assessment Area for Twyford (South of Twyford Viaduct)*

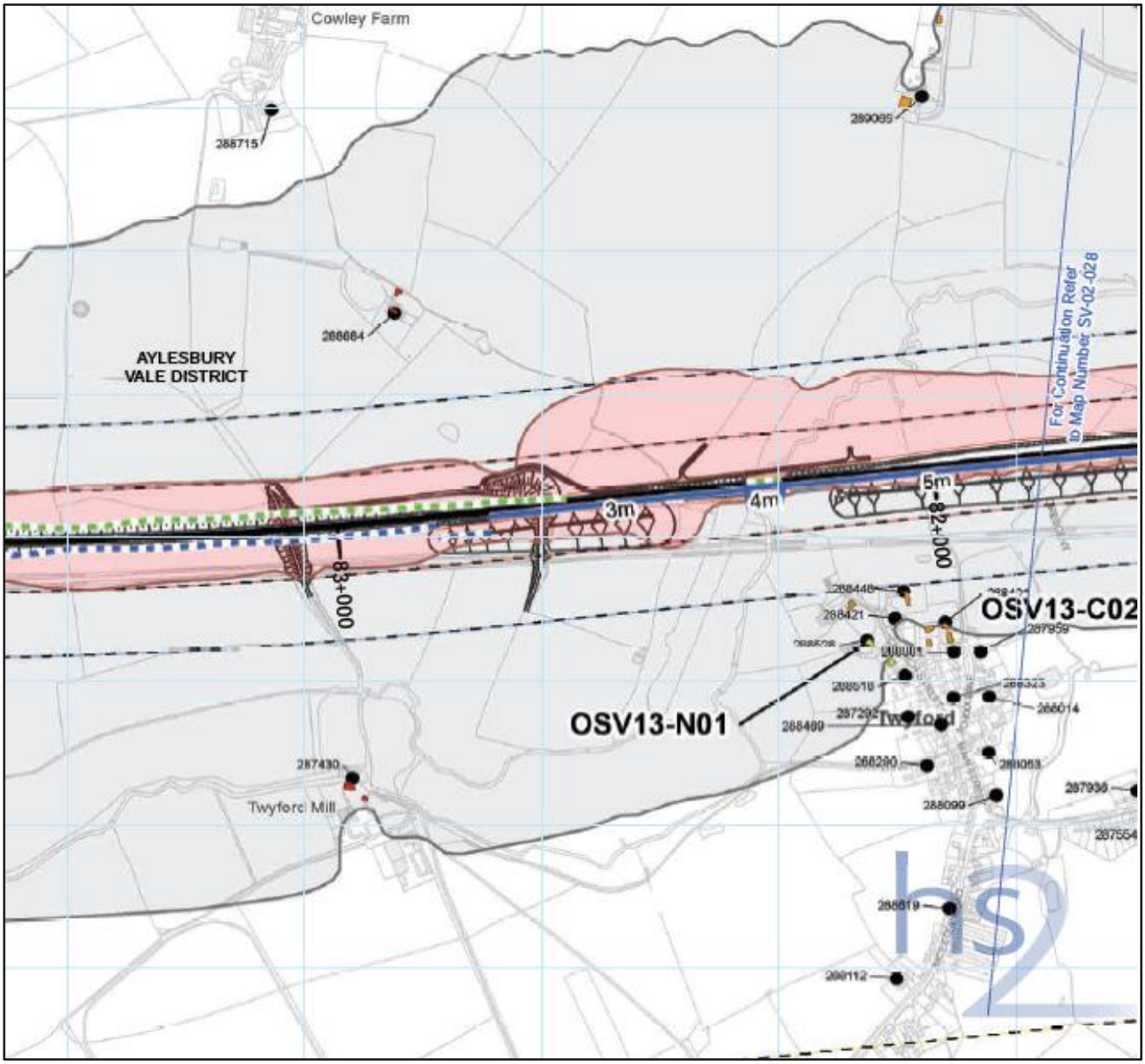


*Image 2 ES Assessment Area for Twyford (Twyford Viaduct and north)*

Image 1 and Image 2 indicate significant effects (OSV13-CO2) to the west of the HS2 alignment in the residential area of Twyford.

The ES reported that approximately 10 dwellings in the vicinity of Grange Close and Church Street closest to the route and their associated shared community open areas (local playing fields with clubhouse). Forecast increases in sound from the railway are likely to cause a moderate adverse effect on the acoustic character of the area around the closest approximately five properties. The effect on the acoustic character around the properties in this area that are located further from the railway would be a minor effect.

The ES reported that St. Mary's Church is identified, on a precautionary basis, as being subject to a significant adverse effect denoted by OSV13-N01 in Table 3 and Image 1 and Image 2. This may take the form of the activity disturbance to the people using the church.

The ES indicated the need for noise barriers to the west of the HS2 line as follows:

- 5m barrier south of viaduct (Ch 081+390 to Ch082+250)
- 4m barrier placed on the viaduct robust kerb (Ch 082+250 to 082+320)
- 3m barrier north of the viaduct (Ch 082+320 to 082+750)

To the east of the HS2 alignment there are isolated receptors that an adverse noise change, but the adverse effects are not considered to be significant on a community basis.

The receptor locations consider for the mitigation design for Twyford are presented on Image 3 below.

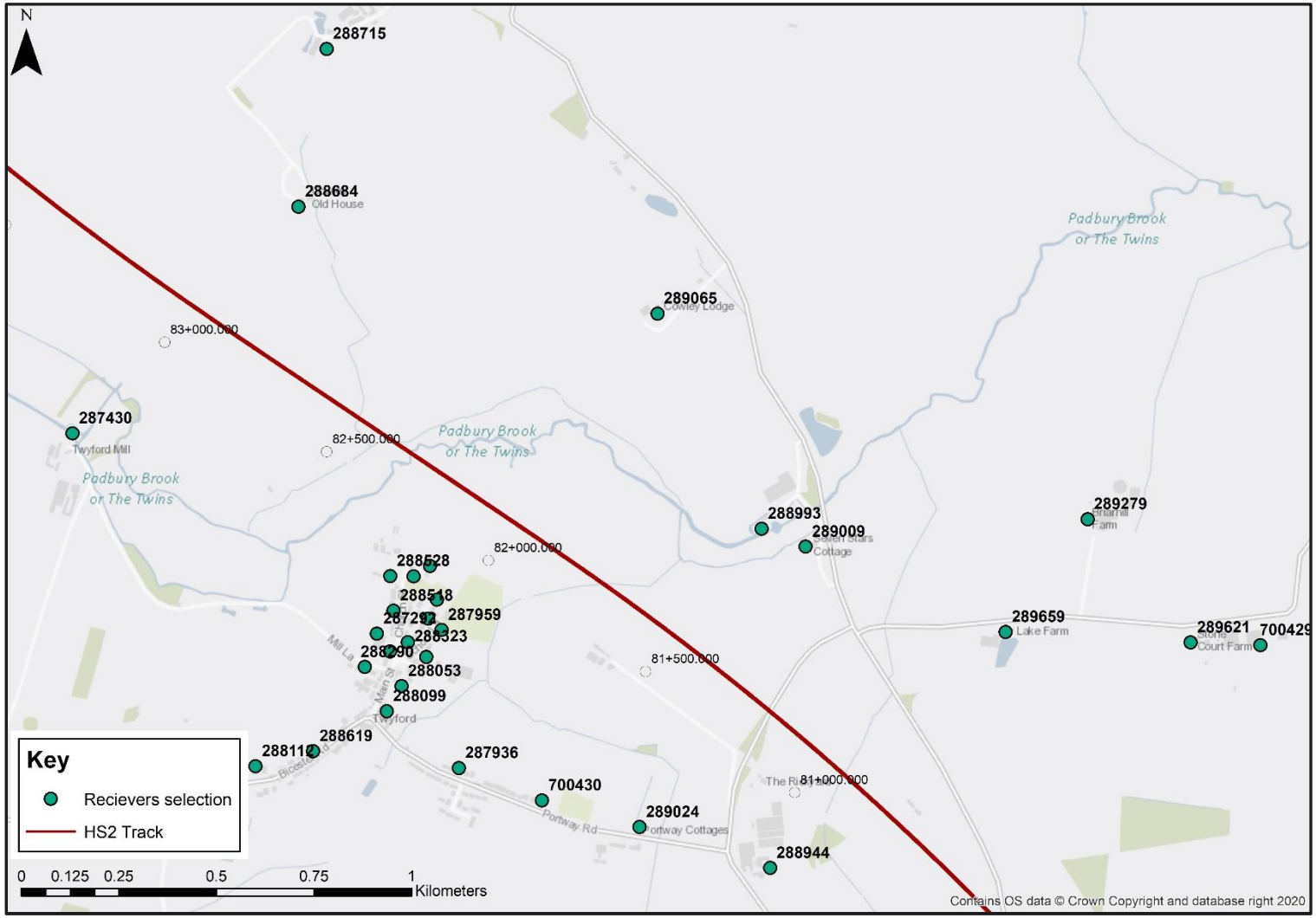


*Image 3 Receptor Locations for Twyford*

**Godington**

The assessment area as presented in the “London-West Midlands Environmental Statement, Volume 5 Map books Sound, noise and vibration (Part 2 of 4) November 2013’ CFA13 on Image 4.

Image 4 shows noise barriers to the east of the HS2 alignment. The residential settlement of Godington is however located to the west of the HS2 alignment and there are isolated receptor locations located to the east.

No significant effect was reported in the ES for the area between Chainage 83+500 and Ch 84+700 as shown on Image 4.

Receptor ID 274854 on the outskirts of Godington show a Moderate noise change, but the effect is not considered significant on a community basis.

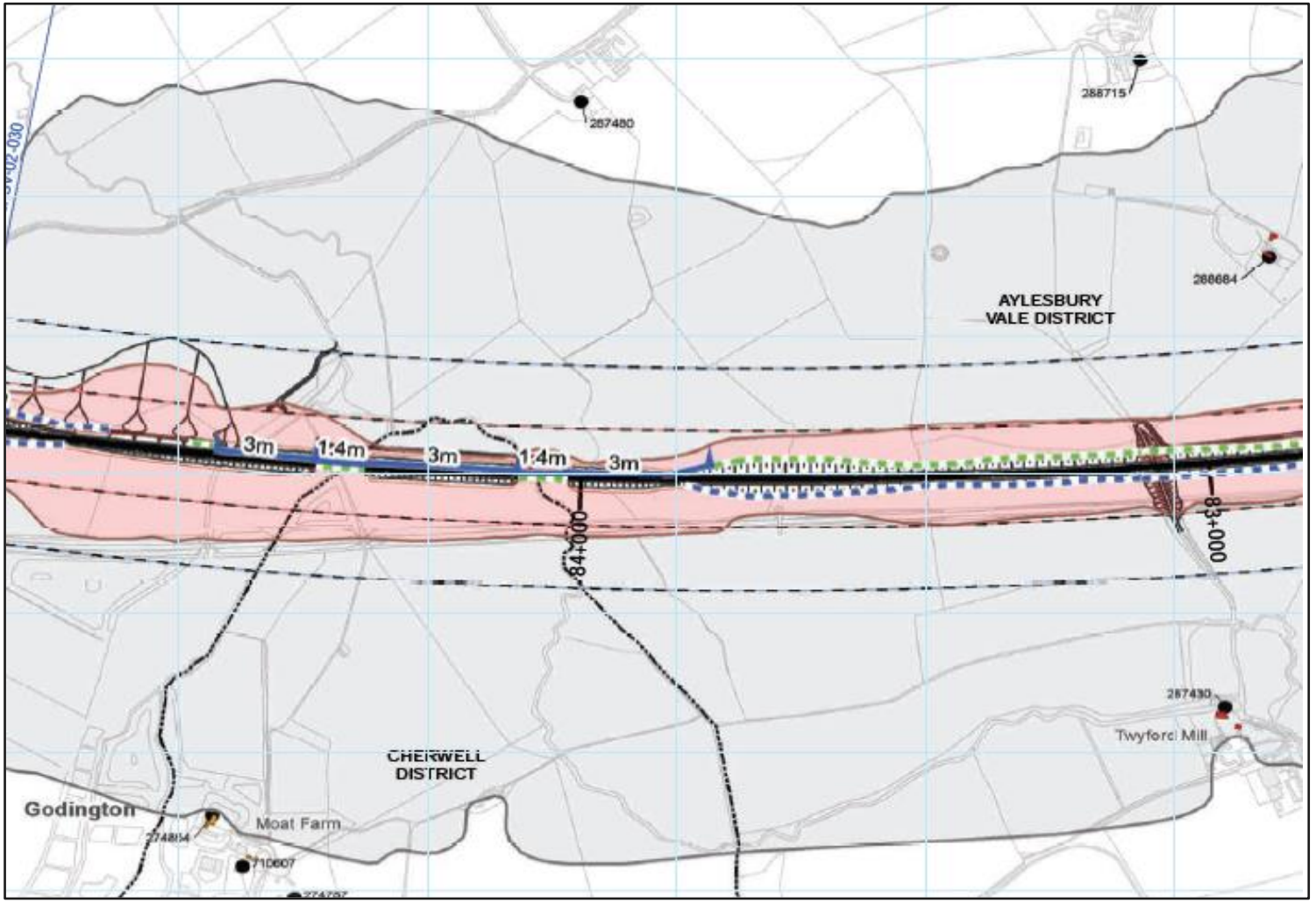


*Image 4 ES Assessment Area for Godington Viaducts*

The receptor locations consider for the mitigation design for Godington are presented on Image 5 below.

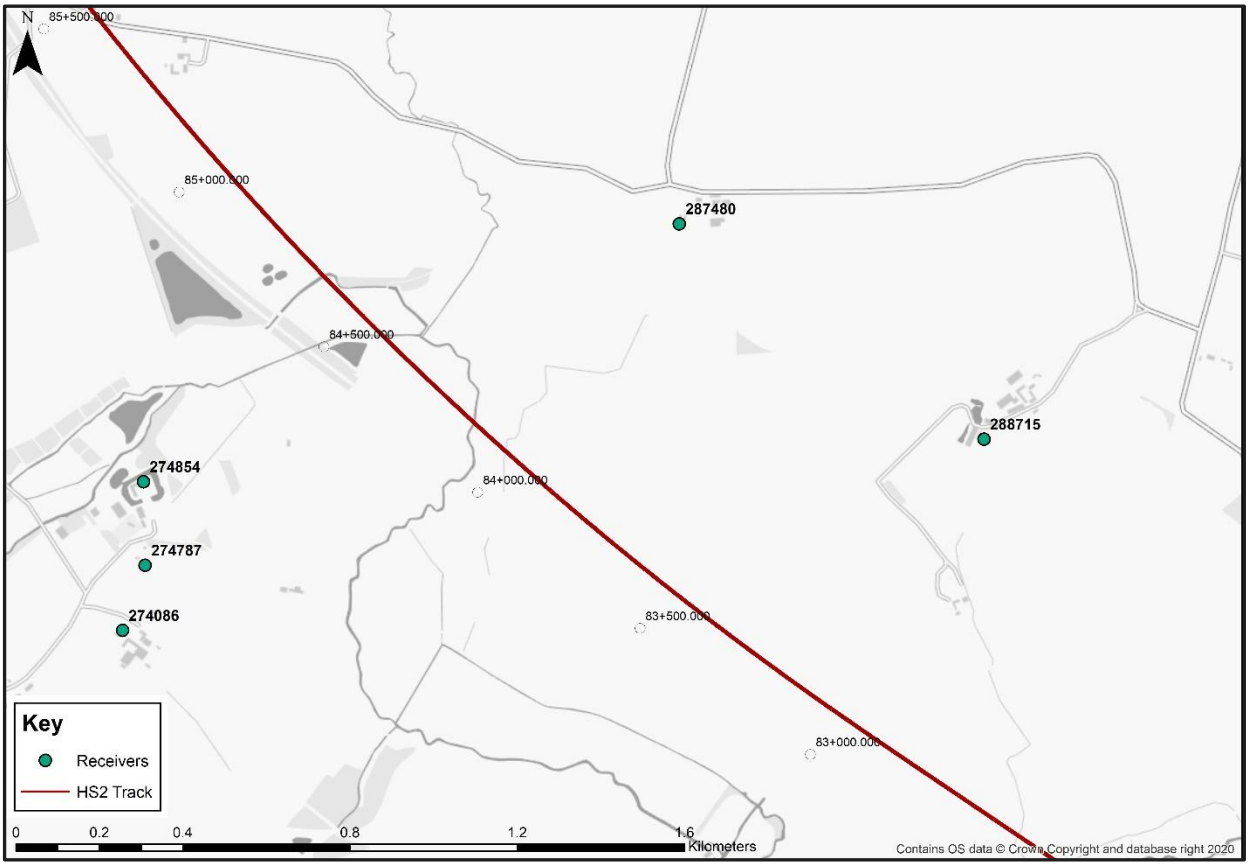


*Image 5 Receptor Locations for Godington*

## Chetwode to Newton Purcell

### Chetwode

The assessment area as presented in the "London-West Midlands Environmental Statement, Volume 5 Map books Sound, noise and vibration (Part 2 of 4) November 2013' (CFA13) is shown in Image 6.

At Chetwode, to the east of the HS2 alignment, the ES indicated a significant effect as shown on Image 6 (OSV 13-C03).

At Chetwode the ES reported that approximately 25 dwellings in the vicinity of the road that runs through Chetwode and their associated shared community open areas. Forecast increases in sound from the railway are likely to cause a major adverse effect on the acoustic character of the area around the closest approximately five properties. The effect on the acoustic character around the properties in this area that are located further from the railway would generally be moderate.

In the ES it was reported that the assessment identified approximately 25 residential dwellings, close to the Proposed Scheme, would exceed the daytime trigger threshold set in the Regulations. It is therefore estimated that these buildings are likely to qualify for noise insulation under the Regulations. These dwellings are indicated on Volume 5: Map Book - Sound, noise and vibration, Map series SV-02-030 (as shown on Image 6).

- Rosehill Barns and Rosehill Farm, Chetwode Receptor ID 27414;
- The Hermitage, Chetwode receptor reference 275251; and
- proposed residential property in committed development ref. CFA13/4 to be located closest to the route, receptor reference Receptor ID 711004

The Chetwode area was subject to further assessment in the Supplementary ES (SES4 AP5). (Image 7). SES4-013-001 (Operational noise) – considers the area between 085+000 to 087+000 and provides for a 5m high noise fence barrier along the eastern side of the route from Rosehill Farm to The Hermitage in Chetwode, plus an extension to provide continuous barrier north to Barton Hartshorn Railway Wood.

As a result of the amendment in SES4 -013-001, a different significant effect was reported as shown on Image 7.

### Newton Purcell

Image 6 indicates that the ES did not report any significant effects in Newton Purcell. The residential area of Newton Purcell to the west of the HS2 alignment lies marginally outside the LOAEL contour as shown on Volume 5: Map Book - Sound, noise and vibration, Map series SV-02-030.

Receptor ID 277206, ID 277221 and 277239 lie close to the HS2 alignment. The realignment of the A4421 Buckingham Road takes the road alignment further away from the receptor locations, which has a positive effect on the overall noise levels and noise change at these receptors.

The design change reduces the sound level forecast at The Hermitage such that it is below the daytime trigger threshold included in the Noise Insulation (Railways and other Guided Transport Systems) Regulations 1996. The forecast level is also below the discretionary night-time and maximum noise insulation trigger levels. The SES reported that Rosehill Barns, Rosehill Farm and the proposed residential property in committed development ref. CFA13/4 remain likely to qualify for noise insulation following the design change.

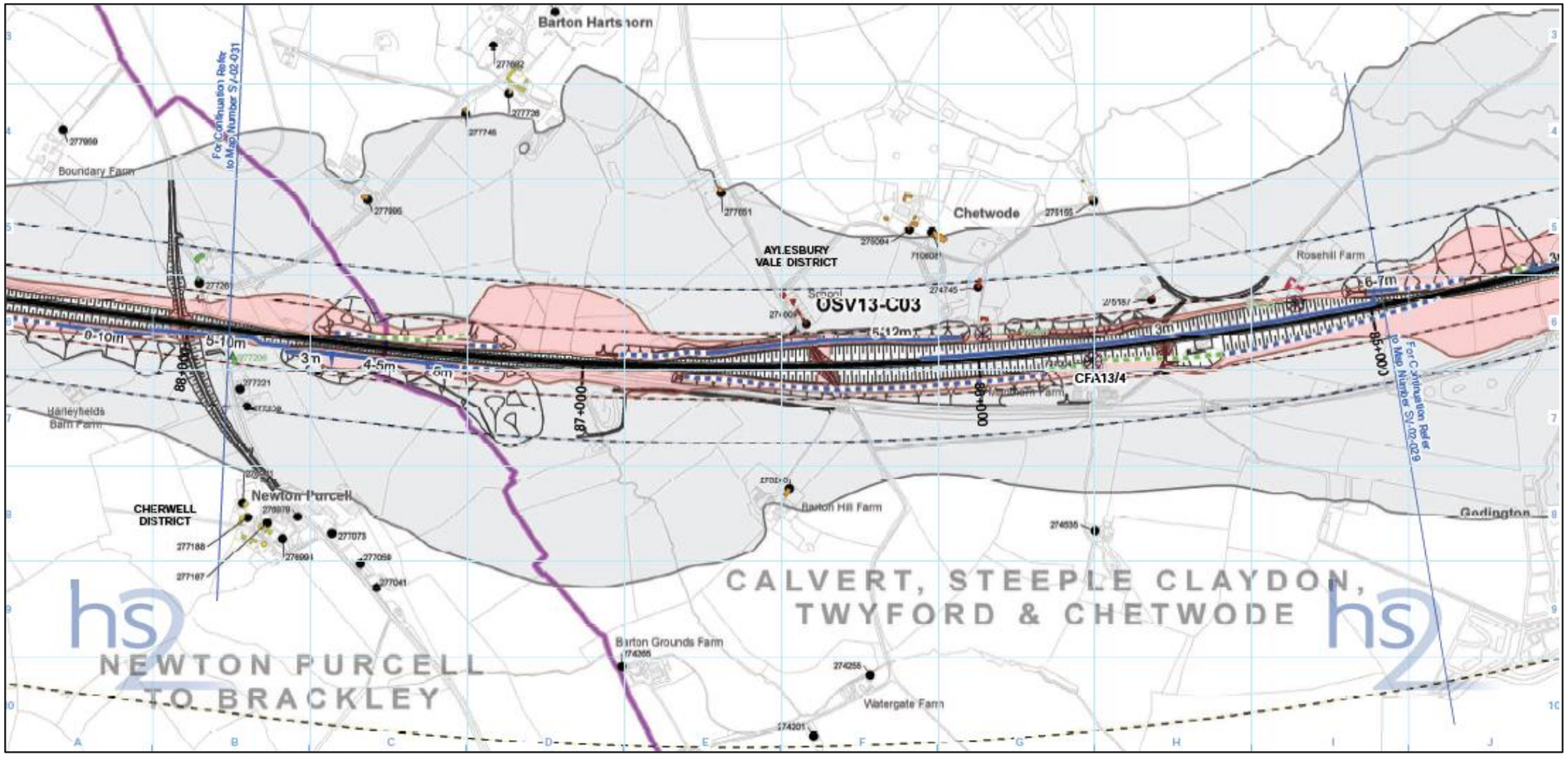


*Image 6 ES Assessment Area for Chetwode/ Newton Purcell*

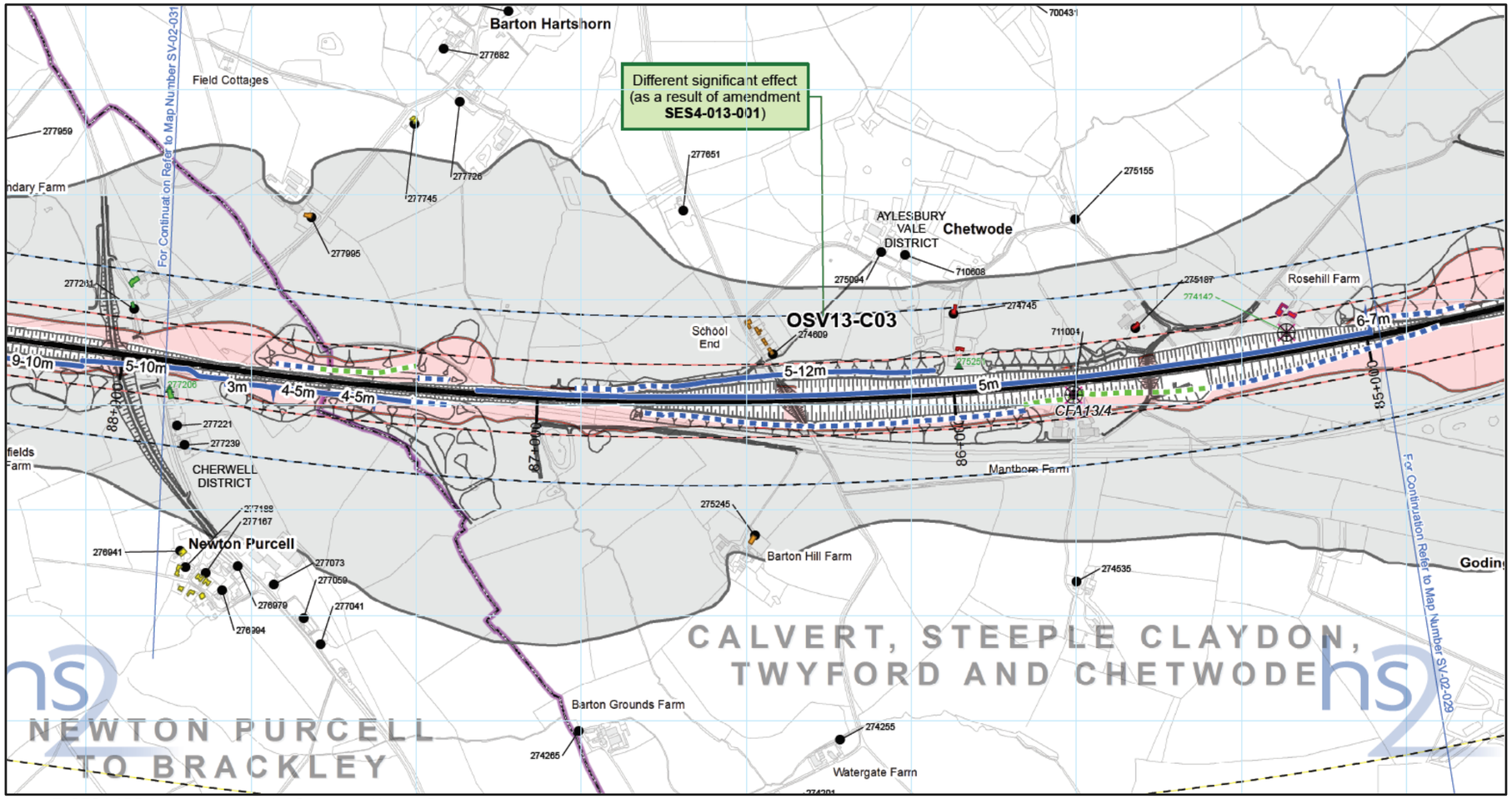


*Image 7 SES4 AP5 Assessment Area for Chetwode/ Newton Purcell*

The receptor locations consider for the mitigation design for Chetwode (Image 8) and Netwon Purcell (Image 9) are presented below.

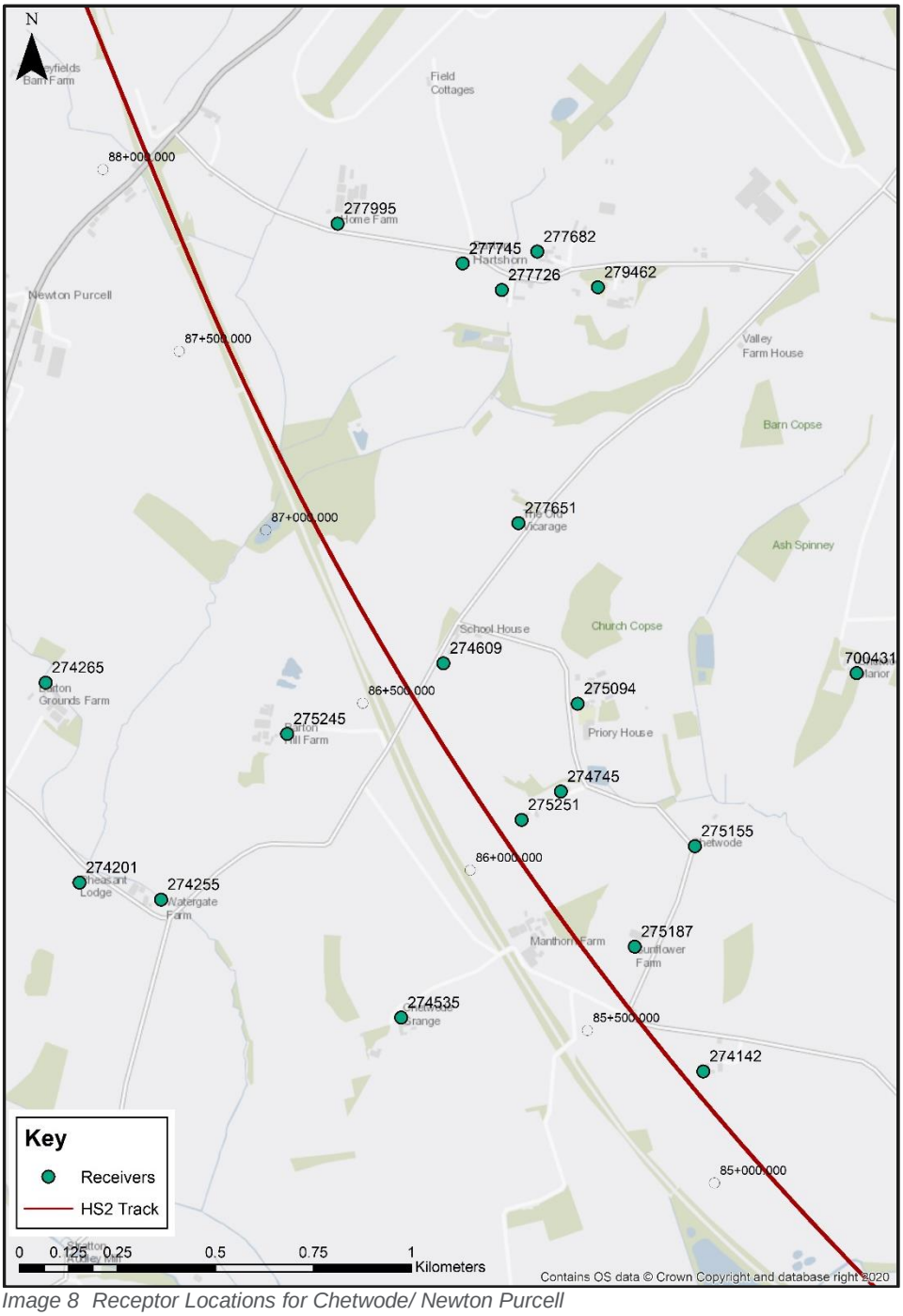


*Image 8 Receptor Locations for Chetwode/ Newton Purcell*


*Image 9 Receptor Locations for Newton Purcell*

**Finmere to Mixbury**

The assessment area as presented in 'The "London-West Midlands Environmental Statement, Volume 5 Map books Sound, noise and vibration (Part 2 of 4) November 2013' CFA14 is shown below in Image 9.

The ES, as shown on Image 10, showed a significant effect (OSV14-C01) to the east of the HS2 alignment. Mitigation is provided to the east of the HS2 alignment in the form of earthworks, with a height above ToR indicated at 10 to 12m.

The ES reported that due to airborne rail noise, approximately 10 dwellings to the west of Finmere in the vicinity of the residential community area around Warren Farm on Banbury Road, will experience a significant effect.

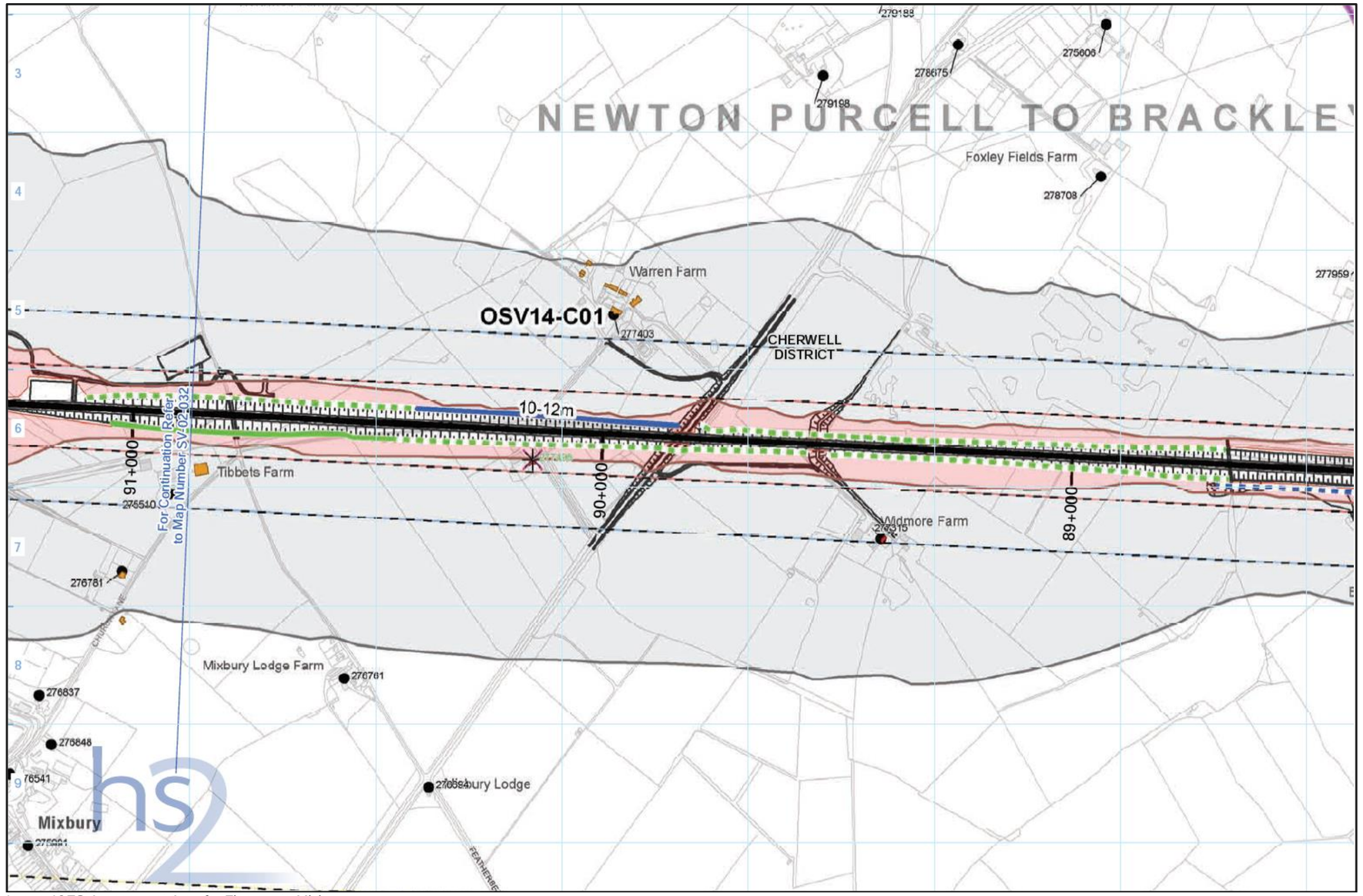


*Image 10ES Assessment Area for Finmere to Mixbury*

The receptor locations consider for the mitigation design for Finmere to Mixbury are presented on Image 8 below.

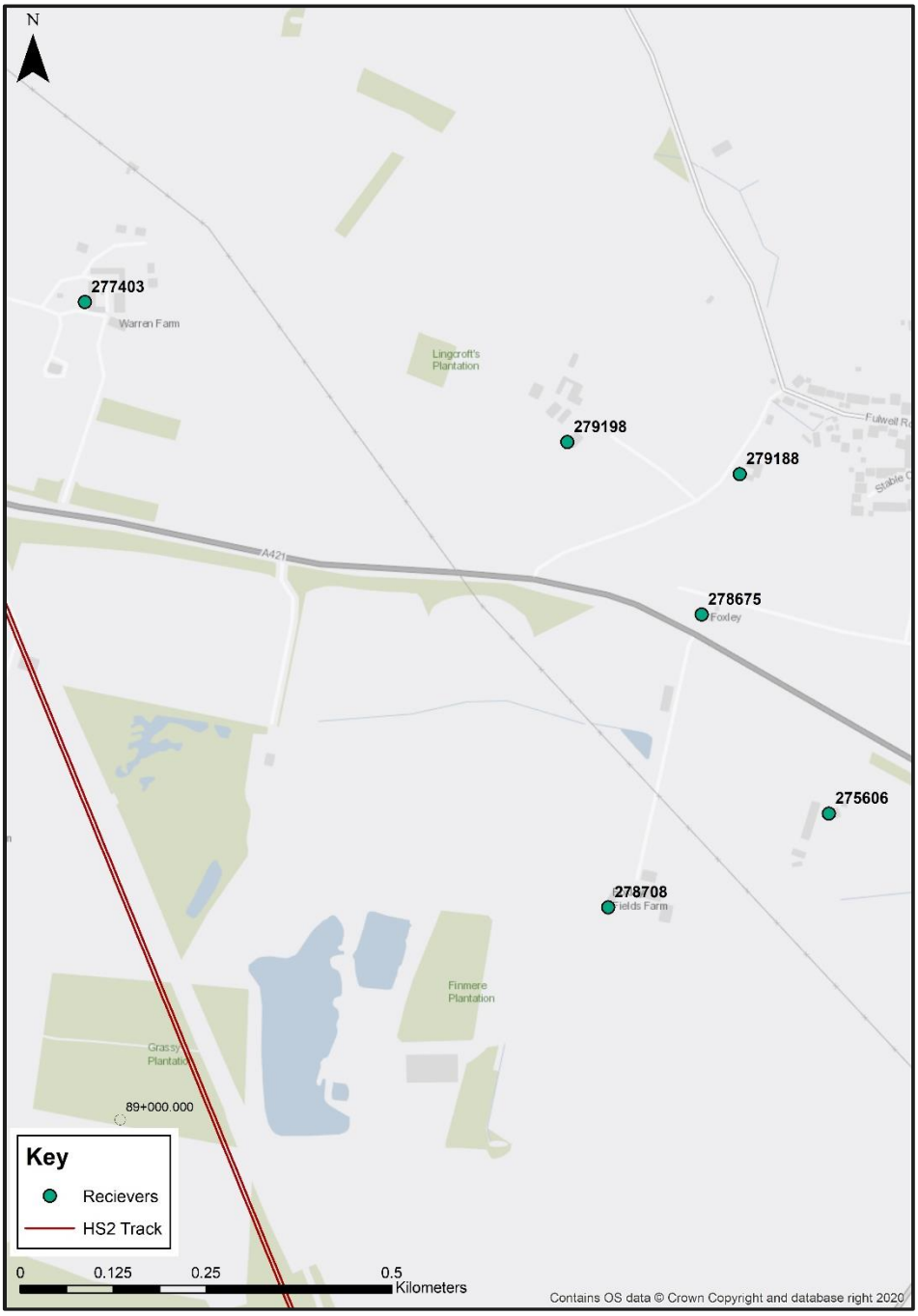


*Image 11 Receptor Locations for Finmere/ Mixburyl*

## Westbury to Turweston

The assessment area as presented in the “London-West Midlands Environmental Statement, Volume 5 Map books Sound, noise and vibration (Part 2 of 4) November 2013’ CFA14 is shown below on Image 12.

The ES assessment indicated that the communities would benefit from the barrier arrangement shown Table 29 below.

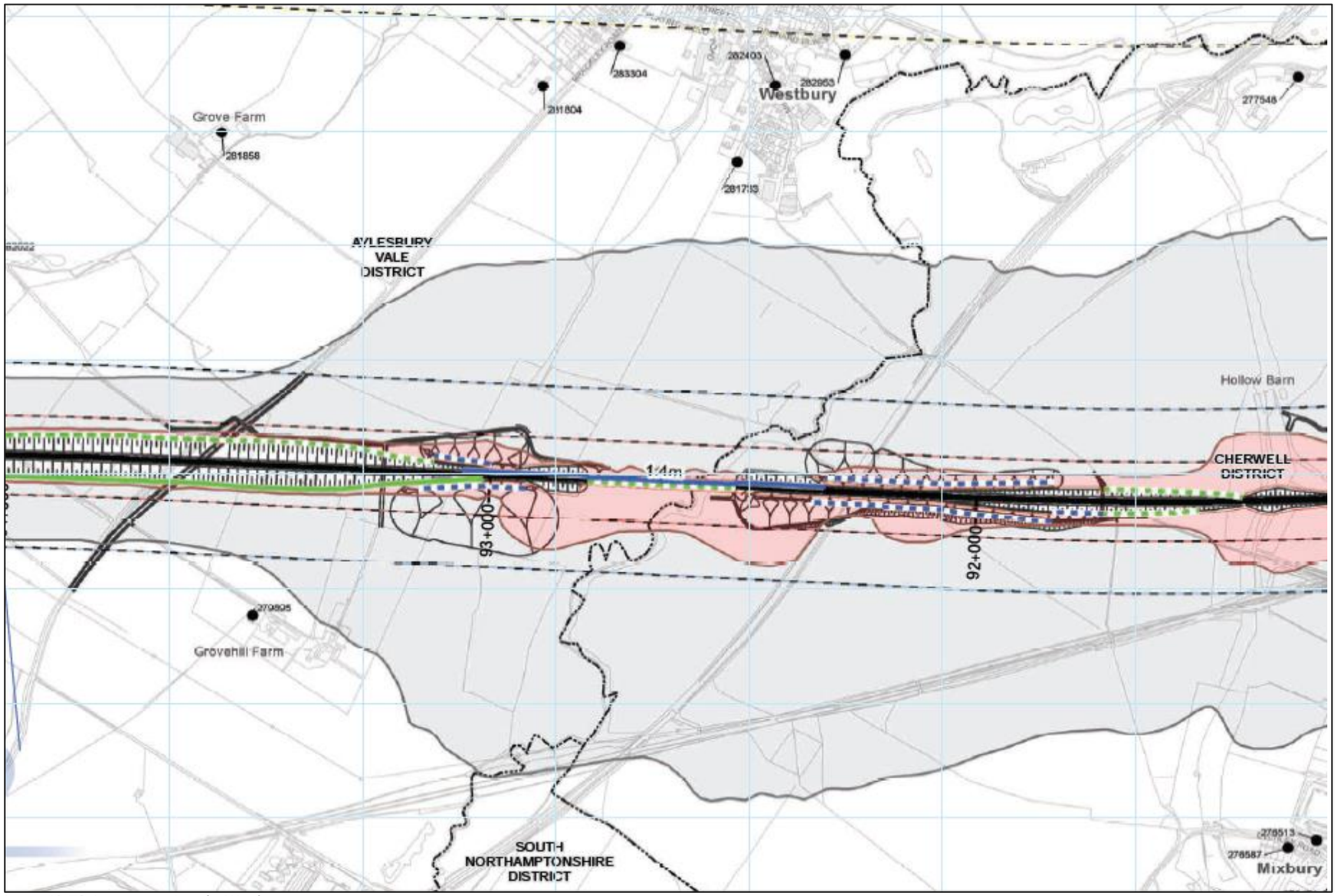


*Image 12 ES Assessment Area for Westbury*

The receptor locations consider for the mitigation design for Westbury are presented on Image 13 below.

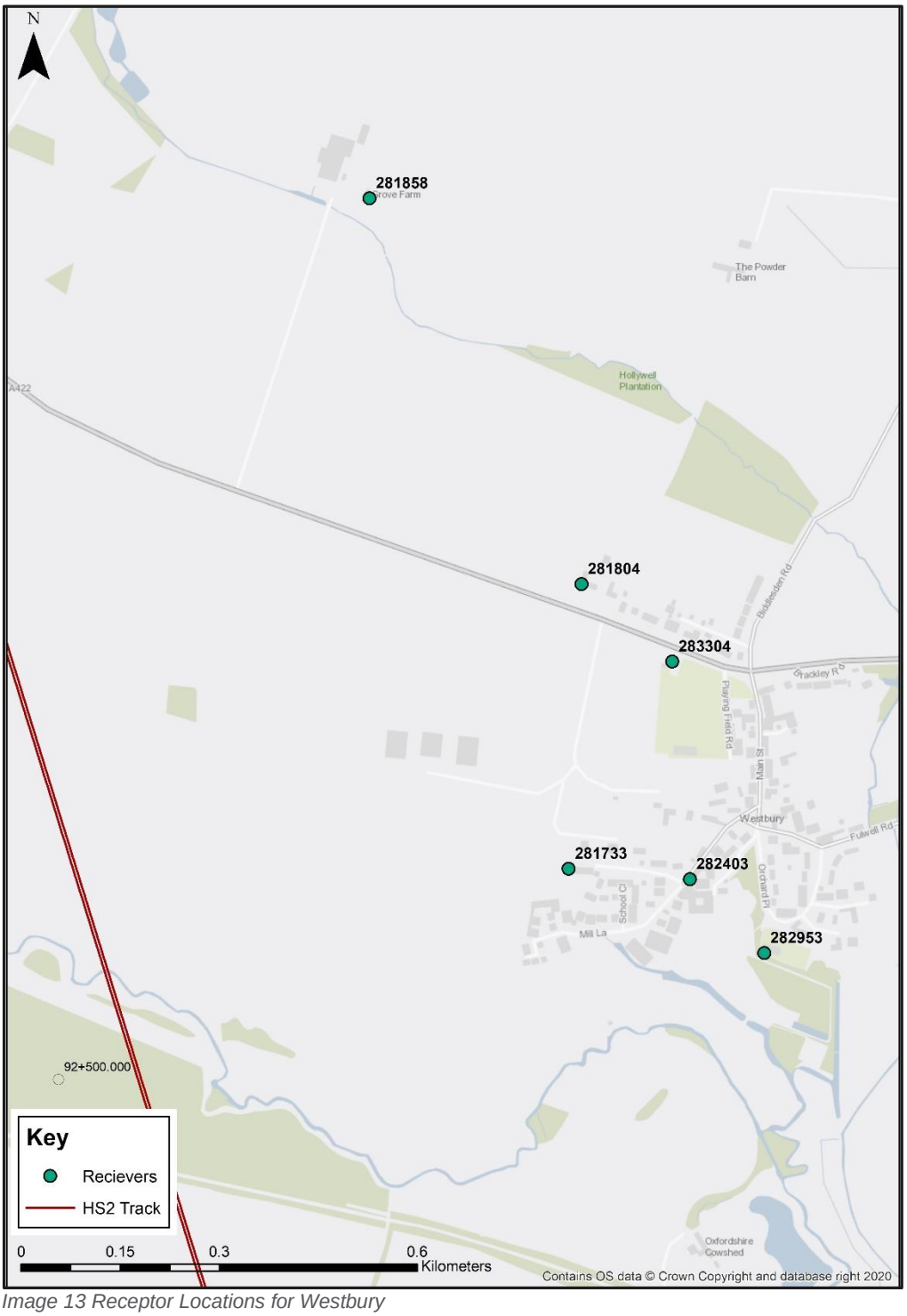


*Image 13 Receptor Locations for Westbury*

## Scheme Design Changes since ES

*VE 107 Raise Chetwode and Barton to Mixbury Cuttings*

The purpose of the Value Engineering proposal is to raise the HS2 alignment by up to 3m at the bottom of Chetwode cutting and raise the HS2 alignment by 1.2m at the bottom of the Barton Miixbury cutting. The intention is to reduce the cutting excavation volume. This option would affect the HS2 alignment on a total length of 5100m, from Ch 83+400 to 88+500, and would cover the following assets:

- Godington West Viaduct max 0.05m level change
- Chetwode Embankment max 1.3m level change
- Chetwode Cutting max 3.0m level change
- Barton Hartshorn Embankment max 0.4m level change
- Barton to Mixbury Cutting max 1.2m level change

*VE-125 Raise Turweston Cutting*

Value Engineering proposal for a track alignment trough Turweston Cutting, a main line asset located towards the north end of section C2.3, approximate chainage 92+052 to 96+496. Raising the vertical alignment by a maximum of 2.367m through Turweston Cutting to reduce the overall excavation volumes, the slope mitigation measures, and the extent and scale of the piled slab mitigation measures.

The VE option has the following key benefits:
- Reduction in cutting volume
- Reduction in the slope mitigation measures
- Reduction in the extent of the piled heave slab

**Scheme Wide Design Changes**

Scheme wide design updates that have been considered in the noise modelling are set out below and are based on a track alignment which incorporates the reduction of track centres from 5m to 4.7m c/c.

- The HS2 face of the noise barrier 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 track support system has been revised to track slab for the HS2 main lines compared to a ballasted system adopted at the time of the ES preparation. The changes in noise source level are presented in Section 3. The revised noise source terms include the removal of TSI compliant trains.

Key design changes to the Viaduct since ES include:

- At ES stage the noise barrier was placed on the robust kerb. The proposed design considers the barrier at the parapet location.
- Track spacing changed from 5.0m to 4.7m, which brings parapets closer to the tracks)
- Reduced offset from track to robust kerb (from 2.2m to 2.025m at scheme design)
- Reduction in walkway width from 0.8m to 0.7m

Overall reduction in viaduct cross section – taking above items into account. Reduced from 14.3m wide at ES Design to 12.250m at scheme design (overall reduction of 2.050m).

## Optimisation of Earthworks Design at Locations where Noise Barriers are Indicated

Table 2 below describes the constraints to further improving the acoustic performance of the earthworks design for IDR G.

| Asset | Constraints |
|---|---|
| Twyford Viaduct | Switches and crossings are located on the Up Side (east), which does not allow the earthworks to be placed any closer to the track alignment<br><br>Chainage 82+400 to Ch 85+200 earthworks have a 1:4 slope. The earthworks design is constrained by the 100-year flood plain and the provision of flood compensation areas.<br><br>At Chainage 82+400 a 5m high embankment has been provided. The LLAU is very narrow and doesn't not provide space for increasing the earthwork |
| Chetwode Cutting | At Ch 85+000 a 5m high (approx. 2km long) earthwork has been provided. This is the maximum height that can be achieved as there is a pinch in the LLAU at Rosehill Farm<br><br>At Chainage 85+300 a bund has been provided within the allowable limits of the LLAU<br><br>Ch 85+400 (Up Side) earthworks have a 1:4 slope, which is the maximum slope that can be achieved with the available materials.<br><br>Chainage 85+700 to Ch87+900 (east) a 6m bund has been provided which is the maximum that can be achieved. The outward slopes are 1:8 as there is a requirement to hand land back for agriculture.<br><br>86+000 to 86+100 the earthworks are limited to address visual impacts at a heritage listed building.<br><br>Chainage 86 + 800 the LLAU is tucked in tighter to the alignment to accommodate the road and the 3m bund is the maximum achievable.<br><br>Ch 86+900 Barton Hartshorn embankment – drainage needs to be accommodated within a tight LLAU, restricting the eight of the earthworks. |
| Chetwode | At Manthorne Farm there was a Schedule 17 requirement to reduce the proposed 5m embankment. There is insufficient space to increase the height of the 3.5m bund. Manthorne Farm is constraint to increasing earthworks as the landform need to accommodate an operational farm. |
| Barton to Mixbury Cutting | At Newton Purcell the proposed noise barrier has been placed trackside to reduce visual impacts.<br><br>Land drainage and a tight LLAU constrains the size and height of the earthworks.<br><br>Chainage 89+900 to Ch 90+480 space is constrained by provision of an access road and the LLAU. A gas main on the up-side provides further constraints to increasing the size of the earthworks. |

| | |
|---|---|
| Westbury Embankment | Chainage 92+300 to Ch92+400 earthworks are shown as up to 8m high. The Design is currently under review to consider a 2m track lift as part of VE125.<br>At Grove Hill there is a need to accommodate a GSMR compound.<br>Earthworks are constrained by a footpath and access to drainage ponds. |

*Table 2 Optimisation of the Eartworks Design*

## • Methodology

The assessment has been carried out with due consideration of the following documentation:

- Environmental Statement and associated documentation, for the definition of LOAELs/SOAELs and corresponding numerical values, dB definition for the impact classifications and identification of significant effects both for individual receptors and for a group of receptors on a community basis;
- HS2 Phase 1 Information Papers E20 on HS2 Ltd.'s overall noise objectives on HS2 Phase 1;
- HS2 Phase 1 Operational Noise and Vibration EMRs – Material Difference (1TS01-ARP-CN-NOT-000-000001) to identify whether changes in noise constitute new or materially different significant effects;
- Technical Standard – Acoustic design of civil engineering assets, Document no.: HS2-HS2-EN-STD-000-000003-P05 for design guidance and design process to demonstrate compliance with HS2 requirements;
- WebTAG Application for the Assessment of Operational Airborne Noise Control (1TS01-ARP-CN-NOT-000-000002) for application of WebTAG for the assessment of airborne noise control, definition of Net Present Value (NPV);
- Excel spreadsheet "tag-workbook-noise-1dB-Aug-18-Template.xlsx" to support the application of WebTAG for local HS2 noise mitigation assessments based on 1dB noise changes; and
- Planning Forum Note 14 - Operational Noise from the Railway and Altered Roads for approach to demonstrating that noise from the operational railway and altered roads has been reduced 'as far as reasonably practicable' in parallel with seeking Schedule 17 approvals.

## • Acoustic performance of Noise Barriers

Noise modelling has been carried out in accordance with the Train Noise Prediction Method (TNPM) incorporated in NoiseMap noise modelling software. 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 LpAFmax. This means that the difference between predicted and measured sound levels is typically within ±3dB(A). Consistent with the Hybrid Bill Scheme the mean values levels are presented in this report.

An assessment has been carried out to determine the in-situ insertion loss for the noise barriers in the NoiseMap model at Receptor IDs considered in this assessment. The highest insertion loss achieved in situ at any the Receptor IDs under consideration is presented in Table 2 below.

| Scenario | Insertion Loss dB |
|---|---|
| Twyford- | |
| 4m | 6 |
| 3m north/ 5m south | 6 |
| 4m north/ 5m south | 7 |
| 3m north/ 4m south extended | 7 |
| 3m north/ 5m south extended | 7 |
| Godington | |
| 1m Barrier | 0 |
| 2m Barrier | 1 |
| 3m Barrier | 2 |
| Chetwode | |
| 3m | |
| 4m | |
| 5m | |
| Newton Purcell | |
| 1m | 1 |
| 2m | 2 |
| 3m | 3 |

*Table 3 Noise Barrier Insertion Loss*

- # Noise Modelling Methodology

The appraisal relates to the modelling and consideration of airborne noise in accordance with HS2 Technical Standard – Prediction of ground-borne sound, vibration and airborne sound from operation Document no.: HS2-HS2-EN-STD-000-000002 (PO5).

The modelling does not consider noise from stationary systems or fixed plant. The modelling and assessment of fixed plant in accordance with Technical Standard – Acoustic design of stationary systems

Document no.: HS2-HS2-EN-STD-000-000004 will be carried out at detailed scheme design and in accordance with the assessment methodology and prediction methods set out in this standard.

The modelling of rail noise has been carried out in the NoiseMap™ noise modelling software which implements the prediction methodology set out in Document no.: HS2-HS2-EN-STD-000-000002 (PO5). The noise model source terms and model assumptions are in accordance with Technical Note: Assumption for Phase 1 operational ground-borne sound, vibration and airborne sound assessment Document no.: PH1-HS2-EN-NOT-000-000002.

The ES set the impact criteria according to the nature of the noise source, the sensitivity of the receptor and the local context; to reflect the effect that the noise or vibration of the Proposed Scheme exerts on any given receptor.

The assessment methodology for this appraisal has followed the methodology set out in the ES Volume 5 Technical Appendices 'Scope and methodology report CT-001-000/1 as amended by addendum (CT-001-000/2)' to allow for a meaningful comparison with the ES results.

Full details of the noise modelling methodology can be found in Appendix A.

om altered roads

Airborne noise from altered roads has been assessed in accordance with the methodology in Appendix C. 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 HD213-11 Rev1* (DMRB)[1].

- Appraisal Process

The WebTAG Application for the Assessment of Operational Airborne Noise Control (1TS01-ARP-CN-NOT-000-000002) for application of WebTAG for the assessment of airborne noise control provides a definition of Net Present Value (NPV). The assessment requires the definition of a study area allowing an interpretation of noise levels and property counts for the WebTAG Net Present Value calculations.

The monetised Net Present Value of the noise levels is calculated using the excel-template "*tag-workbook-noise-1dB-Aug-18-Template.xlsx*" issued by HS2. The noise source is set to 'rail'. In this example it is assumed that the opening year is 2028, the forecast year is 2043 and the current year is 2018.

"Technical Standard – Acoustic design of civil engineering assets" requires each mitigation scenario to be compared to a reference scheme (unmitigated or with embedded mitigation only). The reference scheme (unmitigated or with embedded mitigation only) would represent a 'Do Minimum' scenario. The 'Do Nothing' scenario becomes relevant when assessing the NPV.

In order to undertake a noise valuation of the mitigation scenarios above, the NPV of both mitigation options need to be compared to a reference case. When comparing the NPV of noise change to cost of noise control, the HS2 guidance listed in Table 6 applies.

[1] DMRB HD213-11 Rev1 as referenced in the HS2 Guidance has been revised (LA 111 Noise and Vibration) but does not alter the criteria for considering road traffic noise.

Calculations are carried out to determine the Whole-life economic costs of the mitigation measures. The barrier costs are presented in Table 6 and are based concrete barriers. The barrier costs are per linear metre and include installation, footings and foundations. Costs were compiled by EK in May 2019 and are the most up to date at the time of writing.

The cost estimates (construction costs) are based on a cost estimate per m plus a cost per m estimated total life cycle operational cost, calculated using the HS2 Unit Rates Calculator: Bridging Structures – HS2 URC-BR P13 May 2018, which includes for:

- maintenance & replacement costs of relevant bridge elements
- operational costs for routine maintenance and General/Principal Inspections.

The estimate above does not include for remote condition monitoring costs or any other activities. Remote condition monitoring costs are to be determined from the Instrumentation & Monitoring Plan, which will be developed at detailed design. These costs will be updated once the Noise Barrier Approval in Principal document is accepted by HS2. Whole Life Costs (WLC) are based on a 60-year period in line with the costs used in the AFARP assessments in the ES and through the parliamentary process.

| Description | ES costs | | EK – May 2019 | |
|---|---|---|---|---|
| | Base + Prelims | Base + Prelims + WLC | Base + Prelims | Base + Prelims + WLC |
| 2m high (1m above rail) | - | - | £670 | £736 |
| 3m high (2m above rail) | £495 | £743 | £1,005 | £1,071 |
| 3.5m high (2.5m above rail) | - | - | £1,173 | £1,239 |
| 4m high (3m above rail) | £627 | £941 | £1,340 | £1,406 |
| 4.5m high (3.5m above rail) | - | - | £1,508 | £1,574 |
| 5m high (4m above rail) | £957 | £1436 | £1,675 | £1,741 |
| 5.5m high (4.5m above rail) | - | - | £1,843 | £1,909 |
| 6m high (5m above rail) | £930 | £1841 | £2,010 | £2,076 |
| 6.5m high (5.5m above rail) | - | - | £2,178 | £2,244 |
| 7m high (6m above rail) | - | - | £2,345 | £2,411 |
| 7.5m high (6.5m above rail) | - | - | £2,513 | £2,579 |

*Table 4 Whole-life barrier costs per linear metre*

The end requirement and conclusion as to whether a barrier presents value for money is based upon the following Cost Benefit Ratio (CBR) defined through consideration of the WebTAG NPV and the Whole Life Cost as defined by HS2 and presented within Table 7.

| Ratio of WebTAG NPV / long-life cost | Guidance |
|---|---|
| >1.0 | Clear indication that noise control should be included in the design. |
| >0.2 and <1.0 | 1. Further consider other mitigation design objectives and weight that should be given to them with reference to any precedence for such weighting such as that used by HS2 for an Environmental Impact Assessment or petition management.<br>2. Whether there is any 'material difference' between the noise effects forecast for the proposed scheme design compares to any previous published results such as the ES and SES reports.<br>3. Engage as early as possible with HS2 Ltd to seek further guidance |
| < 0.2 | Clear indication that noise control should NOT typically be included in the design.<br>1. Further consider other mitigation design objectives and weight that should be given to them with reference to any precedence for such weighting such as that used by HS2 for an Environmental Impact Assessment or petition management<br>2. Whether there is any 'material difference' between noise effects forecast for the proposed scheme design compared to any previous published results such as the ES and SES reports.<br>3. Engage as early as possible with HS2 Ltd to seek further guidance |

*Table 5 HS2 Guidance on ratio of WebTAG Net Present Value to life cost of noise mitigation measures*

# • Acoustic Design of Civil Engineering Assets

Modelling has been carried out for C2 IDR G – Twyford Embankment to Turweston Embankment (Chainage 80+862 to 95+405).

The noise modelling for IDR G has considered the design changes proposed to date and considers ground models issued as listed below which incorporate any changes to earthworks and landscaping:

- C3D Surface Model - Snake Grid - IDR G: 1MC06-CEK-EV-MOD-C002-000013 P01
- Non C3D Surface Model - Snake Grid - IDR G: 1MC06-CEK-EV-MOD-C002-000014 P01

The noise modelling has identified locations where it is indicated that mitigation in the form acoustic barriers would be required. The locations identified were tested against those identified as requiring acoustic barriers in the London-West Midlands Environmental Statement, Volume 5, Technical Appendices, CFA13 Operational assessment (SV-004-013) as amended (SES/ AP).

The assessment and consideration of mitigation within IDR G is split into the following key community areas:

- Twyford Viaduct (Section 4.1);
- Godington Viaducts (Section 4.2);
- Chetwode and Newton Purcell (Section 4.3):
  - Barriers on Down-Side (West of HS2 Trace) (Section 4.3.1);
  - Barriers on Up-Side (East of HS2 Trace) (Section 4.3.2);
  - Newton Purcell (Section 4.3.3);
- Finmere to Mixbury (Section 4.4); and,
- Westbury Viaduct (Section 4.5)

## • Twyford Viaduct

Noise models have been complied for the Options summarised in Table 8 as follows:

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Barrier Design Option 1** (4m barrier on either side of the viaduct with a 1.85m on the viaduct),
- **Barrier Design Option 2** (3m barrier north of the viaduct; 5m barrier south of the viaduct with a 1.85m barrier on the viaduct)
- **Barrier Design Option 3** (4m barrier north of the viaduct; 5m barrier south of the viaduct; with a 1.85m barrier on the viaduct);
- **Barrier Option 4** (3m barrier north of the viaduct; 4m barrier south of the viaduct extended south by 277m to West Street overbridge; with a 1.85m barrier on the viaduct)
- **Barrier Option 5** (3m barrier north of the viaduct; 5m barrier south of the viaduct extended south by 277m to West Street overbridge; with a 1.85m barrier on the viaduct)
-

The noise predictions at each receptor for the ES design and Noise Barrier Design Options 1, to 5 are presented in below. The Tables in this section below present the ES reported operational noise levels as amended through the SES and AP amendments.

- The ES (as amended) prediction Tables include noise predictions for the proposed Scheme (Year 15 flows), the future baseline without Scheme (in the opening year) and the overall Do Something noise level (the Opening baseline + the year 15 flows).

- The Scheme Design Tables include the predictions for the Do Something Scheme Design (the Opening baseline + the year 15 Design flows) without noise barriers as mitigation and then with the noise barrier options being considered; compared against the ES/ SES Do Something noise levels.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) | Comments |
|---|---|---|---|---|---|---|
| ES mitigation (AP5) – performance presented in 'Do Something ES (Appendix A) | 081+390 | 082+250 | Down | 860 | 5 | Mitigation ID 081-NB1W<br>EOC recommendation to increase the barrier height to 5m above rail on up (east) side of the alignment between Ch 081+440 and 082+550 for study area CSV13-C02. NOTE (1): On advice of EOC in Sept 13, the start point for the 5m barrier was adjusted to Ch 081+390 (50m longer at southern end) |
| | 082+250 | 082+320 | Down | 70 | 4 | Mitigation ID 081-NB1W<br>4m Barrier on viaduct |
| | 082+320 | 082+750 | Down | 430 | 3 | Mitigation ID 082-NB1W<br>Noise barrier (3m above rail) |
| Scheme design bund provision | 82+500 | 82+850 | Down | 350 | 4 | 1 in 4 inside slope as per standard earthwork sections |
| Noise Barrier Design Option 1 | 81+489* | 82+289 | Down | 800 | 4 | Absorptive barrier 4m above ToR |
| | 82+289 | 82+349 | Down | 60 | 1.85 | Absorptive barrier at parapet |
| | 82+289 | 82+349 | Up | 60 | 1.25 | Absorptive barrier at parapet |
| | 82+349 | 82+499 | Down | 150 | 4 | Absorptive barrier 4m above ToR |
| Noise Barrier Design Option 2 | 81+489* | 82+289 | Down | 800 | 5 | Absorptive barrier 5m above ToR |
| | 82+289 | 82+349 | Down | 60 | 1.85 | Absorptive barrier at parapet |
| | 82+289 | 82+349 | Up | 60 | 1.25 | Absorptive barrier at parapet |
| | 82+349 | 82+499 | Down | 150 | 3 | Absorptive barrier 3m above ToR |
| Noise Barrier Design Option 3 | 81+489* | 82+289 | Down | 800 | 5 | Absorptive barrier 5m above ToR |
| | 82+289 | 82+349 | Down | 60 | 1.85 | Absorptive barrier at parapet |
| | 82+289 | 82+349 | Up | 60 | 1.25 | Absorptive barrier at parapet |
| | 82+349 | 82+499 | Down | 150 | 4 | Absorptive barrier 4m above ToR |
| Noise Barrier Design Option 4 (extended barrier) | 81+212* | 82+289 | Down | 1077 | 4 | Absorptive barrier 4m above ToR |
| | 82+289 | 82+349 | Down | 60 | 1.85 | Absorptive barrier at parapet |
| | 82+289 | 82+349 | Up | 60 | 1.25 | Absorptive barrier at parapet |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 82+349 | 82+499 | Down | 150 | 3 | Absorptive barrier 3m above ToR |
| Noise Barrier Design Option 5 (extended barrier) | 81+212* | 82+289 | Down | 1077 | 5 | Absorptive barrier 4m above ToR |
| | 82+289 | 82+349 | Down | 60 | 1.85 | Absorptive barrier at parapet |
| | 82+289 | 82+349 | Up | 60 | 1.25 | Absorptive barrier at parapet |
| | 82+349 | 82+499 | Down | 150 | 3 | Absorptive barrier 3m above ToR |

*The barrier falls within IDR K, but has been assessed as part of a composite barrier system to afford protection to the Twyford community.

*Table 6 Summary of noise mitigation options – Twyford*

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in Table 9.

The No Barrier Mitigation Option (mitigation in the form of earthworks) modelled within the scope of this report is shown to return more Major and Moderate impacts than reported in the ES, indicating that mitigation in the form of acoustic barriers would be necessary.

Within the works undertaken supporting this report it can be seen that the proposed design and changes to the earthworks indicate that, without the acoustic barrier recommended in the ES, there would be far more impacts in the Major and Moderate range for the daytime than presented at ES stage. Mitigation in the form of acoustic barriers is therefore required.

The Barrier Mitigation Design Options consider noise barriers on the west side (Down Side) of the HS2 alignment to provide acoustic screening to the Twyford community. On the viaduct noise barriers have been considered on both sides of the HS2 trace.

In addition, the current viaduct design places the barrier at the parapet, rather than at the robust kerb as specified through the ES Design. A sensitivity test was carried to determine the mitigation options for the barrier viaduct, and it was determined that the changed viaduct design allowed for the 4m viaduct barrier in the ES to be reduced to 1.85m at the parapet location.

| Design Option | Noise impact and benefit | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | | 10 | 12 | 9 | N/A | N/A | N/A |
| | Minor | 5 | | | | | | |
| | Moderate | 7 | 7 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 12 | 19 | | | | | |
| No Noise Barrier | Negligible | | 8 | 68 | 60 | N/A | N/A | N/A |
| | Minor | 24 | 34 | | | | | |
| | Moderate | 38 | 18 | | | | | |
| | Major | 6 | 8 | | | | | |
| | Total above LOAEL | 68 | 68 | | | | | |
| Noise Barrier Design Option 1 | Negligible | | 10 | 19 | 9 | £108,053 | £1,719,951 | 0.06 |
| | Minor | 3 | | | | | | |
| | Moderate | 16 | 7 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 19 | 19 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 | Negligible | | 10 | 19 | 9 | £108,053 | £1,669,366 | 0.06 |
| | Minor | 3 | | | | | | |
| | Moderate | 16 | 7 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 19 | 19 | | | | | |
| | Engineering and operational compatibility | | | Barrier height comparable to ES Scheme, no challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height comparable to ES scheme, (viaduct barrier lower than ES) therefore visual effects marginally beneficial | | | | |
| Noise Barrier Design Option 3 | Negligible | | 10 | 19 | 9 | £122,317 | £1,987,951 | 0.06 |
| | Minor | 5 | | | | | | |
| | Moderate | 14 | 7 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 19 | 19 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height comparable to ES scheme, therefore visual effects are neutral. Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 4 (extended barrier) | Negligible | | 3 | 12 | 9 | £113,744 | £2,508,266 | 0.05 |
| | Minor | 5 | | | | | | |
| | Moderate | 7 | 7 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 12 | 12 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES scheme, but extended south; no challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme but extended south, visual impacts increased with barrier to south and 3m track lift | | | | |
| Noise Barrier Design Option 5 (extended barrier) | Negligible | | 3 | 12 | 9 | £130,622 | £2,524,874 | 0.05 |
| | Minor | 5 | 2 | | | | | |
| | Moderate | 7 | 5 | | | | | |
| | Major | | 2 | | | | | |
| | Total above LOAEL | 12 | 12 | | | | | |
| | Engineering and operational compatibility | | | Barrier height comparable to ES Scheme, but extended south; no challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height comparable to ES scheme, visual impacts increased with barrier to south and 3m track lift. Barrier would be visible above earthworks design, presenting an unacceptable visual impact. | | | | |

*Table 7 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Twyford*

The cost benefit analysis scores of 0.05 to 0.06 for the Barrier Mitigation Design Options indicates that the mitigation should not typically be included in the design as identified through the rating scheme presented in Table 7.

Barrier Mitigation Option 1 (4m barrier) and Barrier Option 2 (5m barrier south of the viaduct and 3m barrier north of the viaduct) shows 9 more Moderate impacts for daytime than the ES (16 Moderate impacts compared to 7 in the ES).

Analysis of the noise data, as presented in Table 9 and Table 10 below indicated that the additional Moderate impacts were at Receptor locations on Portway Road to the south of Twyford. To mitigate the impacts on Portway Road, Barrier Mitigation Option 4 and barrier Mitigation Design Option 5 considered extending the noise barrier to the south.

Barrier Mitigation Design Option 4 reduces the Moderate impacts shown for Option 3 from 14 to 7, which matches the Moderate impacts reported in the ES.

Table 10 presents the receptor locations where rail noise exceeds LOAEL. A comparison is presented between the noise predictions in the ES and the predictions for the No Noise Barrier Option and the Noise Barrier Mitigation Options Considered.

| 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: - 4m barrier; 1.85m on viaduct | | Option 1+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 3m barrier north and 5m south; 1.85m on viaduct | | 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 |
| 288469 | Main Street, Twyford | 4 | 50 | 38 | 47 | 38 | 52 | 41 | 51 | 42 | 54 | 43 | 47 | 38 | 52 | 41 | 47 | 38 | 52 | 41 |
| 288619 | Bicester Road, Twyford | 30 | 48 | 39 | 43 | 34 | 49 | 40 | 47 | 38 | 51 | 41 | 43 | 33 | 49 | 40 | 43 | 33 | 49 | 40 |
| 288944 | Twyford, Buckingham | 1 | 47 | 38 | 52 | 43 | 53 | 44 | 54 | 45 | 55 | 46 | 54 | 45 | 55 | 46 | 54 | 45 | 55 | 46 |
| 287936 | Portway Road, Twyford | 24 | 45 | 43 | 45 | 36 | 48 | 44 | 49 | 40 | 51 | 45 | 46 | 37 | 49 | 44 | 46 | 37 | 49 | 44 |
| 288014 | School Lane, Twyford | 6 | 50 | 44 | 47 | 38 | 51 | 45 | 51 | 41 | 53 | 46 | 48 | 38 | 52 | 45 | 48 | 38 | 52 | 45 |
| 288053 | Main Street, Twyford | 4 | 45 | 43 | 45 | 36 | 48 | 44 | 49 | 39 | 50 | 45 | 46 | 36 | 48 | 44 | 46 | 36 | 48 | 44 |
| 288099 | Portway Road, Twyford | 12 | 45 | 43 | 43 | 34 | 47 | 44 | 47 | 38 | 49 | 44 | 44 | 35 | 48 | 44 | 44 | 35 | 48 | 44 |
| 288112 | Bicester Road, Twyford | 18 | 48 | 39 | 43 | 34 | 49 | 40 | 47 | 38 | 51 | 41 | 42 | 33 | 49 | 40 | 42 | 33 | 49 | 40 |
| 288290 | Mill Lane, Twyford | 14 | 50 | 38 | 47 | 38 | 52 | 41 | 52 | 42 | 54 | 44 | 47 | 37 | 52 | 41 | 47 | 38 | 52 | 41 |
| 700430 | Portway Road, Twyford | 2 | 45 | 43 | 46 | 37 | 48 | 44 | 50 | 41 | 51 | 45 | 48 | 39 | 50 | 44 | 48 | 39 | 50 | 44 |
| 288323 | Church Street, Twyford | 6 | 50 | 44 | 46 | 37 | 51 | 45 | 50 | 41 | 53 | 46 | 47 | 37 | 52 | 45 | 47 | 37 | 52 | 45 |
| 288381 | Grange Close, Twyford | 8 | 48 | 39 | 48 | 39 | 51 | 42 | 53 | 43 | 54 | 45 | 49 | 39 | 51 | 42 | 49 | 39 | 51 | 42 |
| 288401 | Grange Close, Twyford | 4 | 46 | 37 | 51 | 42 | 52 | 43 | 56 | 47 | 56 | 47 | 51 | 42 | 52 | 43 | 51 | 42 | 52 | 43 |
| 288421 | St Mary's Church Twyford (Church) | 1 | 42 | 32 | 51 | 42 | 52 | 42 | 57 | 48 | 58 | 48 | 52 | 42 | 52 | 43 | 52 | 42 | 52 | 43 |
| 288448 | Church Street, Twyford | 2 | 50 | 40 | 53 | 44 | 55 | 45 | 59 | 50 | 60 | 50 | 53 | 43 | 55 | 45 | 53 | 44 | 55 | 45 |
| 288518 | Church Street, Twyford | 8 | 47 | 42 | 47 | 38 | 50 | 43 | 52 | 43 | 54 | 46 | 48 | 39 | 51 | 44 | 48 | 39 | 51 | 44 |
| 288528 | Church Street, Twyford | 3 | 51 | 45 | 51 | 42 | 54 | 47 | 57 | 48 | 58 | 50 | 51 | 42 | 54 | 47 | 51 | 42 | 54 | 47 |
| 289024 | Portway Road, Twyford | 7 | 45 | 43 | 49 | 40 | 50 | 45 | 52 | 42 | 53 | 46 | 51 | 42 | 52 | 45 | 51 | 42 | 52 | 45 |
| 287292 | Church Street, Twyford | 1 | 49 | 43 | 49 | 39 | 52 | 45 | 54 | 44 | 55 | 47 | 48 | 39 | 52 | 44 | 48 | 39 | 52 | 45 |
| 287430 | Mill Lane, Twyford | 2 | 47 | 34 | 53 | 44 | 54 | 44 | 53 | 44 | 54 | 44 | 53 | 43 | 54 | 44 | 53 | 43 | 54 | 44 |
| 287959 | School Lane, Twyford | 6 | 48 | 41 | 49 | 39 | 51 | 43 | 53 | 43 | 54 | 45 | 49 | 40 | 52 | 43 | 49 | 40 | 52 | 43 |

| 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 | | Option 3 Scheme only: - 4m north 5m south; 1.85m on viaduct | | Option 3+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 4 Scheme only: - 3m north 4m south extended; 1.85m on viaduct | | Option 4+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 5 Scheme only: - 3m north 5m south extended; 1.85m on viaduct | | Option 5+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 |
| 288469 | Main Street, Twyford | 4 | 50 | 38 | 47 | 38 | 52 | 41 | 47 | 37 | 52 | 41 | 47 | 38 | 52 | 41 | 46 | 37 | 52 | 40 |
| 288619 | Bicester Road, Twyford | 30 | 48 | 39 | 43 | 34 | 49 | 40 | 42 | 33 | 49 | 40 | 43 | 33 | 49 | 40 | 42 | 33 | 49 | 40 |
| 288944 | Twyford, Buckingham | 1 | 47 | 38 | 52 | 43 | 53 | 44 | 54 | 45 | 55 | 46 | 54 | 44 | 55 | 45 | 54 | 44 | 55 | 45 |
| 287936 | Portway Road, Twyford | 24 | 45 | 43 | 45 | 36 | 48 | 44 | 45 | 36 | 48 | 44 | 45 | 35 | 48 | 44 | 44 | 34 | 47 | 44 |
| 288014 | School Lane, Twyford | 6 | 50 | 44 | 47 | 38 | 51 | 45 | 47 | 37 | 52 | 45 | 47 | 38 | 52 | 45 | 46 | 37 | 51 | 45 |
| 288053 | Main Street, Twyford | 4 | 45 | 43 | 45 | 36 | 48 | 44 | 45 | 35 | 48 | 44 | 45 | 36 | 48 | 44 | 44 | 35 | 48 | 44 |
| 288099 | Portway Road, Twyford | 12 | 45 | 43 | 43 | 34 | 47 | 44 | 43 | 34 | 47 | 44 | 43 | 34 | 47 | 44 | 42 | 33 | 47 | 43 |
| 288112 | Bicester Road, Twyford | 18 | 48 | 39 | 43 | 34 | 49 | 40 | 42 | 33 | 49 | 40 | 42 | 33 | 49 | 40 | 42 | 32 | 49 | 40 |
| 288290 | Mill Lane, Twyford | 14 | 50 | 38 | 47 | 38 | 52 | 41 | 46 | 37 | 52 | 41 | 47 | 37 | 52 | 41 | 46 | 37 | 51 | 40 |
| 700430 | Portway Road, Twyford | 2 | 45 | 43 | 46 | 37 | 48 | 44 | 48 | 38 | 50 | 44 | 46 | 37 | 49 | 44 | 45 | 36 | 48 | 44 |
| 288323 | Church Street, Twyford | 6 | 50 | 44 | 46 | 37 | 51 | 45 | 46 | 36 | 51 | 45 | 46 | 37 | 52 | 45 | 45 | 36 | 51 | 45 |
| 288381 | Grange Close, Twyford | 8 | 48 | 39 | 48 | 39 | 51 | 42 | 48 | 38 | 51 | 42 | 49 | 39 | 51 | 42 | 47 | 38 | 51 | 41 |
| 288401 | Grange Close, Twyford | 4 | 46 | 37 | 51 | 42 | 52 | 43 | 50 | 41 | 52 | 42 | 51 | 41 | 52 | 43 | 50 | 40 | 51 | 42 |
| 288421 | St Mary's Church Twyford (Church) | 1 | 42 | 32 | 51 | 42 | 52 | 42 | 51 | 42 | 51 | 42 | 52 | 42 | 52 | 43 | 51 | 41 | 51 | 42 |
| 288448 | Church Street, Twyford | 2 | 50 | 40 | 53 | 44 | 55 | 45 | 52 | 43 | 54 | 45 | 53 | 43 | 54 | 44 | 52 | 43 | 54 | 44 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 288518 | Church Street, Twyford | 8 | 47 | 42 | 47 | 38 | 50 | 43 | 47 | 38 | 50 | 43 | 48 | 38 | 50 | 44 | 47 | 37 | 50 | 43 |
| 288528 | Church Street, Twyford | 3 | 51 | 45 | 51 | 42 | 54 | 47 | 51 | 41 | 54 | 47 | 51 | 42 | 54 | 47 | 51 | 41 | 54 | 47 |
| 289024 | Portway Road, Twyford | 7 | 45 | 43 | 49 | 40 | 50 | 45 | 51 | 41 | 52 | 45 | 49 | 40 | 50 | 45 | 48 | 39 | 50 | 44 |
| 287292 | Church Street, Twyford | 1 | 49 | 43 | 49 | 39 | 52 | 45 | 48 | 38 | 52 | 44 | 48 | 39 | 52 | 44 | 48 | 38 | 51 | 44 |
| 287430 | Mill Lane, Twyford | 2 | 47 | 34 | 53 | 44 | 54 | 44 | 53 | 43 | 54 | 44 | 53 | 43 | 54 | 44 | 53 | 43 | 54 | 44 |
| 287959 | School Lane, Twyford | 6 | 48 | 41 | 49 | 39 | 51 | 43 | 48 | 39 | 51 | 43 | 49 | 39 | 51 | 43 | 48 | 38 | 51 | 43 |

*Table 8 Consideration of Material Change at most affected receptor grouping*

Table 11 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario.

Table 11 shows that barrier Mitigation Option 4 matches the Minor. Moderate and Major impacts reported in the ES.

Barrier Mitigation Option 5 reduces the Moderate night-time impact at Receptor ID 288448 to a Minor impact. This receptor location represents 2 impacts and Mitigation Option 5 would therefore not represent a material change. The additional cost of Mitigation Design Option 5 and the associated visual impacts, with the barrier being visible above the proposed earthworks design, means that Option 5 is not a viable option.

Considering the daytime and night-time rail noise Leq predictions at the noise receptor locations, the proposed mitigation would be:

- 3m noise barrier north of the Twyford Viaduct (Down Side)
- 1.85m barrier at the viaduct parapet (Down Side)
- 4m barrier south of the viaduct, extended to the West Street overbridge

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM – Design (No Barrier ) | | Option 1 - DM - 4m Barrier north and south | | Option 2 - DM - 3m north Barrier and 5m south | | Option 3 - DM - 4m north Barrier and 5m south | | Option 4 - DM - 4m south extended Barrier and 3m north | | Option 5 - DM - 3m north and 5m south extended barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 288469 | Main Street, Twyford | 4 | # | 2 | 3 | 4 | 5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| 288619 | Bicester Road, Twyford | 30 | | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 288944 | Twyford, Buckingham | 1 | ~ | 6 | 6 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 8 | 7 |
| 287936 | Portway Road, Twyford | 24 | # | 3 | 1 | 6 | 2 | 4 | 1 | 4 | 1 | 3 | 1 | 3 | 1 | 2 | 1 |
| 288014 | School Lane, Twyford | 6 | | 2 | 1 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 |
| 288053 | Main Street, Twyford | 4 | # | 3 | 1 | 5 | 2 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 1 |
| 288099 | Portway Road, Twyford | 12 | | 2 | 1 | 4 | 1 | 3 | 1 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 0 |
| 288112 | Bicester Road, Twyford | 18 | | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 288290 | Mill Lane, Twyford | 14 | # | 2 | 3 | 4 | 6 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 2 |
| 700430 | Portway Road, Twyford | 2 | # | 4 | 1 | 6 | 2 | 5 | 1 | 5 | 1 | 5 | 1 | 4 | 1 | 3 | 1 |
| 288323 | Church Street, Twyford | 6 | | 2 | 1 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| 288381 | Grange Close, Twyford | 8 | # | 3 | 3 | 6 | 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 288401 | Grange Close, Twyford | 4 | OSV13-C02 | 6 | 6 | 10 | 10 | 6 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 5 | 5 |
| 288421 | St Mary's Church Twyford (Church) | 1 | OSV13-C02 | 9 | 11 | 16 | 16 | 10 | 11 | 10 | 11 | 9 | 10 | 10 | 11 | 9 | 10 |
| 288448 | Church Street, Twyford | 2 | OSV13-C02 | 4 | 5 | 10 | 10 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 4 | 4 |
| 288518 | Church Street, Twyford | 8 | # | 3 | 1 | 7 | 4 | 4 | 2 | 4 | 2 | 3 | 1 | 3 | 2 | 3 | 1 |
| 288528 | Church Street, Twyford | 3 | OSV13-C02 | 3 | 2 | 7 | 5 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 |
| 289024 | Portway Road, Twyford | 7 | # | 5 | 1 | 8 | 3 | 7 | 2 | 7 | 2 | 7 | 2 | 5 | 2 | 5 | 1 |
| 287292 | Church Street, Twyford | 1 | ~ | 3 | 2 | 6 | 4 | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 1 | 2 | 1 |
| 287430 | Mill Lane, Twyford | 2 | ~ | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 | 7 | 10 |
| 287959 | School Lane, Twyford | 6 | # | 3 | 2 | 6 | 4 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 2 |

*Table 9 Consideration of Receptors above LOAEL at most affected receptor grouping - Twyford*

The predicted $L_{max}$ levels for the No Barrier Option and Barrier Design Options 1 to 5 are shown in Table 12 below.

The $L_{max}$ predictions presented in Table 18 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (3m) | Lmax Design Option 2 | Lmax Design Option 3 | Lmax Design Option 4 | Lmax Design Option 5 | Lmax ES Design |
|---|---|---|---|---|---|---|---|---|---|
| 288469 | Main Street, Twyford | 4 | 65 | 63 | 63 | 63 | 63 | 63 | 64/67 |
| 288619 | Bicester Road, Twyford | 30 | 62 | 61 | 61 | 61 | 61 | 61 | 61/64 |
| 288944 | Twyford, Buckingham | 1 | 65 | 65 | 65 | 65 | 65 | 65 | 67/70 |
| 287936 | Portway Road, Twyford | 24 | 60 | 60 | 60 | 60 | 60 | 60 | 57/60 |
| 288014 | School Lane, Twyford | 6 | 63 | 60 | 60 | 60 | 60 | 60 | 59/62 |
| 288053 | Main Street, Twyford | 4 | 63 | 60 | 60 | 60 | 60 | 60 | 56/59 |
| 288099 | Portway Road, Twyford | 12 | 59 | 58 | 58 | 58 | 58 | 58 | 55/58 |
| 288112 | Bicester Road, Twyford | 18 | 63 | 60 | 60 | 60 | 60 | 60 | 61/64 |
| 288290 | Mill Lane, Twyford | 14 | 65 | 62 | 62 | 62 | 62 | 62 | 66/69 |
| 700430 | Portway Road, Twyford | 2 | 62 | 62 | 62 | 62 | 62 | 62 | 59/62 |
| 288323 | Church Street, Twyford | 6 | 62 | 59 | 59 | 59 | 59 | 59 | 57/61 |
| 288381 | Grange Close, Twyford | 8 | 66 | 61 | 61 | 61 | 61 | 61 | 59/63 |
| 288401 | Grange Close, Twyford | 4 | 74 | 67 | 67 | 67 | 67 | 67 | 68/71 |
| 288421 | St Mary's Church Twyford (Church) | 1 | 76 | 70 | 70 | 70 | 70 | 70 | 66/70 |
| 288448 | Church Street, Twyford | 2 | 77 | 73 | 73 | 73 | 73 | 73 | 70/73 |
| 288518 | Church Street, Twyford | 8 | 66 | 62 | 62 | 62 | 62 | 62 | 59/63 |
| 288528 | Church Street, Twyford | 3 | 76 | 71 | 71 | 71 | 71 | 71 | 68/71 |
| 289024 | Portway Road, Twyford | 7 | 66 | 66 | 66 | 66 | 66 | 66 | 66/69 |
| 287292 | Church Street, Twyford | 1 | 66 | 63 | 63 | 63 | 63 | 63 | 68/71 |
| 287430 | Mill Lane, Twyford | 2 | 66 | 66 | 66 | 66 | 66 | 66 | 66/69 |
| 287959 | School Lane, Twyford | 6 | 65 | 62 | 62 | 62 | 62 | 62 | 59/63 |

*Table 10 Consideration of Receptors above LOAEL at most affected receptor grouping - Aston le Walls*

The cost benefit analysis for the $L_{max}$ predictions is presented in Table 13. The cost benefit analysis scores of <0.1 for all Mitigation Options indicates that the mitigation should not typically be included in the design as stipulated in the rating scheme presented in Table 7.

All Barrier Mitigation Design Options present with the same number of impacts above LOAEL, and all impacts above LOAEL match the impacts reported in the ES. $L_{max}$ levels at all receptor locations are slightly lower than the ES, apart from 2 Receptor IDs (Receptor ID 288053 and Receptor ID 288518). The slight increase in $L_{max}$ levels at the two Receptor locations is attributed to the track lift.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 163 | N/A | 0 | N/A | N/A | N/A |
| No Noise Barrier | 163 | 0 | 0 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 163 | 0 | 0 | £70,538 | £1,719,951 | 0.04 |
| Noise Barrier Design Option 2 | 163 | 0 | 0 | £70,538 | £1,669,366 | 0.04 |
| Noise Barrier Design Option 3 | 163 | 0 | 0 | £70,538 | £1,987,951 | 0.04 |
| Noise Barrier Design Option 4 (extended barrier) | 163 | 0 | 0 | £70,538 | £2,508,266 | 0.03 |
| Noise Barrier Design Option 5 (extended barrier) | 163 | 0 | 0 | £73,706 | £2,524.874 | 0.03 |

*Table 11 Cost Benefit Analysis $L_{max}$ Levels – Twyford*

Based on the appraisal in Table 9, Table 10 and Table 11 for $L_{eq}$ daytime and night-time, the comparison of receptors above LOAEL in Table 12 and the appraisal of $L_{max}$ values in Table 13, the recommendation is that Barrier Mitigation Design Option 4 is adopted into the design (3m high barrier).

- Ch 81+212 to Ch 82+290 — 4m above rail, absorptive barrier on west side
- Viaduct (Ch 82+289 to 82+349) — 1.85m above rail, absorptive on west side
- Viaduct (Ch 82+289 to 82+349) — 1.25m above rail, absorptive barrier on east side
- Ch 82+349 to Ch82+500 — 3m above rail absorptive barrier on west side

- Godington Viaducts

Noise models summarised in Table 14 have been complied for the following:

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Noise Barrier Design Option 1** (1m barrier),
- **Option 2** (2m barrier) and
- **Option 3** (3m barrier), all including the scheme design earthworks.

The noise predictions at each receptor for the ES design and Noise Barrier Design Options 1, 2 and 3 are presented below. The section below present the ES reported operational noise levels as amended through the SES and AP amendments.

- The ES prediction Tables include noise predictions for the proposed Scheme (Year 15 flows), the future baseline without Scheme (in the opening year) and the overall Do Something noise level (the Opening baseline + the year 15 flows).

- The Scheme Design Tables include the predictions for the Do Something Scheme Design (the Opening baseline + the year 15 Design flows) without noise barriers as mitigation and then with the noise barrier options being considered; compared against the ES/ SES Do Something noise levels.

The ES had proposed a 1.4m high barrier on east side of the viaduct. The community of Godington is located to the west of the HS2 alignment. The noise modelling for the Design as set out below has considered the noise barrier on the west of the HS2 alignment. At ES stage the viaduct design assumed the acoustic barriers on the viaduct would be positioned on top of the robust kerb. The proposed viaduct design included in the noise model places the noise barrier at the parapet.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) | Comments |
|---|---|---|---|---|---|---|
| ES mitigation (AP5) – performance presented in 'Do Something ES (Appendix B) | 084+550 | 085+100 | Up | 550 | 3 - 4 | Mitigation ID 084-M6E<br>EOC TN requires 3m equivalent noise mitigation between 085+000 and 086+700 on up (east) side of alignment (EOC Mitigation Ref: 121). Ch 084+800 and 85+000 this requirement is met through the provision of a mitigation earthwork with a crest height of 3-4m. |
| | 083+800 | 084+640 | Up | 840 | 3 | Mitigation ID 084-NB1E<br>Noise barrier (3m above rail) / 1.4m kerb barrier on viaduct<br>Standard noise barrier (3m above rail) at the top of the engineered slopes. For the two short sections of viaduct, the requirement has |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | been met through the provision of a 1.4m kerb barrier within the structure of the viaducts on the up (east) side. |
| Scheme design bund provision | 84+620 | 85+040 | Up | 420 | Min 5 | Varies from 5m above TOR at 84+620 to 5m above GL at 85+040 |
| Noise Barrier Design Option 1 | 83+900 | 84+070 | Down | 170 | 1 | Absorptive barrier |
| | 84+070 | 84+145 | Down | 75 | 1,25 | Absorptive barrier at viaduct parapet |
| | 84+145 | 84+392 | Down | 247 | 1 | Absorptive barrier |
| | 84+392 | 84+467 | Down | 90 | 1.25 | Absorptive barrier at viaduct parapet |
| | 84+467 | 84+650 | Up | 183 | 1 | Absorptive barrier |
| Noise Barrier Design Option 2 | 83+900 | 84+070 | Down | 170 | 2 | Absorptive barrier |
| | 84+070 | 84+145 | Down | 75 | 1,25 | Absorptive barrier at viaduct parapet |
| | 84+145 | 84+392 | Down | 247 | 2 | Absorptive barrier |
| | 84+392 | 84+467 | Down | 90 | 1.25 | Absorptive barrier |
| | 84+467 | 84+650 | Up | 183 | 2 | Absorptive barrier |
| Noise Barrier Design Option 3 | 83+900 | 84+070 | Down | 170 | 3 | Absorptive barrier |
| | 84+070 | 84+145 | Down | 75 | 1,25 | Absorptive barrier at viaduct parapet |
| | 84+145 | 84+392 | Down | 247 | 3 | Absorptive barrier |
| | 84+392 | 84+467 | Down | 90 | 1.25 | Absorptive barrier |
| | 84+467 | 84+650 | Up | 183 | 3 | Absorptive barrier |

*Table 12 Summary of noise mitigation options – Godington Viaducts*

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in the Table 15 for the above mitigation design options.

A cost benefit analysis score of 0.00 is calculated for Design Options 1,2 and 3; this indicates that mitigation should not typically be included in the design.

The No Barrier Option shows the same number of impacts above LOAEL as the ES and the same number of Minor, Moderate and Major impacts as the ES.

Barrier Mitigation Design Options 1, Option 2 and Option 3 do not result in any improved acoustic performance over the Design (no barrier option), also present with the same number of Minor, Moderate and Major impacts as was presented in the ES.

| Design Option | Noise impact and benefit | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | 0 | 2 | 2 | 2 | N/A | N/A | N/A |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 2 | 2 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 2 | ~~4~~2 | | | | | |
| No Noise Barrier | Negligible | 0 | 2 | 2 | 2 | N/A | N/A | N/A |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 2 | 2 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 2 | 4 | | | | | |
| Noise Barrier Design Option1 | Negligible | 0 | 2 | 2 | 2 | £0 | £463,680 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 2 | 2 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 2 | 4 | | | | | |
| | Engineering and operational compatibility | | | ES considered Barriers on opposite side of alignment. Barrier height lower than ES Scheme, no particular challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 | Negligible | 0 | 2 | 2 | 2 | £752 | £674,730 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 2 | 2 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 2 | 4 | | | | | |
| | Engineering and operational compatibility | | | ES considered Barriers on opposite side of alignment. Barrier height lower than ES Scheme, no particular challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 3 | Negligible | 0 | 2 | 2 | 2 | £866 | £885,780 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 2 | 2 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 2 | 4 | | | | | |
| | Engineering and operational compatibility | | | ES considered Barriers on opposite side of alignment. Barrier height lower than ES Scheme, no particular challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than or comparable to ES scheme, therefore visual effects are reduced. | | | | |

*Table 13 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Godington Viaducts*

Table 16 presents the receptor locations where rail noise exceeds LOAEL. Receptor locations where rail noise exceeds LOAEL are shaded in red. A comparison is presented between the noise predictions in the ES and the predictions for the No Noise Barrier Option and the Noise Barrier Mitigation Options Considered.

It was reported in the ES that rail noise levels were predicted to exceed LOAEL at Receptor ID 74854. This receptor location represents 2 impacts, and the adverse effect was not considered significant on a community basis. Table 16 shows that for the Design option (no noise barrier) and for the Barrier Mitigation Options, the rail noise impacts above LOAEL remain, but would not be significant on a community basis.

| 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: - 1m barrier; 1.85m on viaduct | | Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 2m barrier; 1.85m on viaduct | | Option 2+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 3 Scheme only: - 3m 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 |
| 274787 | Godington, Bicester | 1 | 44 | 41 | 49 | 39 | 50 | 44 | 49 | 39 | 50 | 43 | 49 | 39 | 50 | 43 | 48 | 39 | 49 | 43 | 47 | 38 | 49 | 43 |
| 274854 | Godington, Bicester | 2 | 43 | 36 | 50 | 41 | 51 | 42 | 50 | 41 | 51 | 42 | 50 | 41 | 51 | 42 | 50 | 41 | 51 | 42 | 49 | 40 | 50 | 42 |
| 274086 | Godington, Bicester | 1 | 44 | 41 | 46 | 37 | 48 | 43 | 47 | 37 | 49 | 43 | 46 | 37 | 48 | 42 | 46 | 36 | 48 | 42 | 45 | 36 | 48 | 42 |

*Table 14 Consideration of Material Change at most affected receptor grouping*

Table 17 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES did not identify any significant effects in Godington. Receptor ID 74854. represents 2 impacts, and was shown to experience a Moderate noise change, but the adverse effect was not considered significant on a community basis.

The Design Option with no noise barriers and Noise Barrier Design Options 1 to Option 3 do not present with any additional effects over what was reported in the HS2 Phase 1 ES.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 1m Barrier | | DM - 2m Barrier | | DM - 3m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 274787 | Godington, Bicester | 1 | # | 6 | 2 | 6 | 2 | 6 | 2 | 5 | 2 | 5 | 2 |
| 274854 | Godington, Bicester | 2 | ~ | 8 | 6 | 8 | 6 | 8 | 6 | 8 | 6 | 7 | 6 |
| 274086 | Godington, Bicester | 1 | # | 4 | 2 | 5 | 2 | 4 | 1 | 4 | 1 | 4 | 1 |

*Table 15 Consideration of Receptors above LOAEL at most affected receptor grouping - Godington*

The predicted $L_{max}$ levels for the No Barrier Option and Barrier Design Options 1 to 3 are shown in Table 18 below as compared to the ES reported $L_{max}$ levels. The $L_{max}$ predictions presented in Table 18 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (1m) | Lmax Design Option 2 (2m) | Lmax Design Option 3 (3m) | Lmax ES |
|---|---|---|---|---|---|---|---|
| 274787 | Godington, Bicester | 1 | 65 | 65 | 65 | 65 | 63/66 |
| 274854 | Godington, Bicester | 2 | 67 | 67 | 67 | 67 | 65/68 |
| 274086 | Godington, Bicester | 1 | 62 | 62 | 62 | 62 | 61/64 |

*Table 16 $L_{Amax}$ levels for the Mitigation Design Options considered compared to ES – Free-Field*

Table 18 shows that the predicted $L_{max}$ levels for the ES and for the Mitigation Options considered are similar, with all receptor locations showing noise levels above LOAEL.

The noise barrier mitigation options considered to not show any acoustic benefit over the Design option with no noise barriers.

The cost benefit analysis for the $L_{max}$ predictions are presented in the Table 19. The cost benefit analysis score of 0.00 for Barrier Mitigation Design Options 1, 2 and 3 indicates that mitigation should not typically be included in the design.

$L_{max}$ levels for the No Mitigation Option and Barrier Mitigation Design Options 1, 2 and 3 all identify show the same impact locations above LOAEL as presented in the ES.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 4 | N/A | 0 | N/A | N/A | N/A |
| No Noise Barrier | 4 | 0 | 0 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 4 | 0 | 0 | £0 | £463,680 | 0.00 |
| Noise Barrier Design Option 2 | 4 | 0 | 0 | £0 | £674,730 | 0.00 |
| Noise Barrier Design Option 3 | 4 | 0 | 0 | £0 | £885,780 | 0.00 |

*Table 17 Cost Benefit Analysis $L_{max}$ Levels – Godington Viaducts*

Based on the appraisal for $L_{eq}$ daytime and night-time in Table 15 and Table 16 and Table 17, and the appraisal for $L_{max}$ values in Table 18 and Table 19, it is recommended that noise barriers would not be considered as part of the mitigation design The Design option that presents the narrowing of the track corridor and the earthworks design provides appropriate mitigation and is the recommended mitigation option.

- Chetwode and Newton Purcell

The following noise models as summarised in Table 20 have been compiled for Chetwode (east of the HS2 alignment), which take into consideration SES4-013-001 (noise mitigation at Chetwode)

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Noise Barrier Design Option 3** (3m barriers)
- **Noise Barrier Design Option 4** (4m barriers)
- **Noise Barrier Design Option 5** (5m barriers)

The following noise models as summarised in Table 20 have been compiled for Newton Purcell:

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Noise barrier Design Option 1** (1m barrier)
- **Noise Barrier Design Option 2** (2m barriers)
- **Noise Barrier Design Option 3** (3m barriers)

The noise predictions at each receptor for the ES design and Noise Barrier Design Options 1 and 2 are presented in the section below. The assessment Tables below present the ES reported operational noise levels as amended through the SES and AP amendments.

- The ES prediction Tables include noise predictions for the proposed Scheme (Year 15 flows), the future baseline without Scheme (in the opening year) and the overall Do Something noise level (the Opening baseline + the year 15 flows).

- The Scheme Design Tables include the predictions for the Do Something Scheme Design (the Opening baseline + the year 15 Design flows) without noise barriers as mitigation and then with the noise barrier options being considered; compared against the ES/ SES Do Something noise levels.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) | Comments |
|---|---|---|---|---|---|---|
| ES mitigation (AP5) – performance presented in 'Do Something ES (Appendix C) | 084+550 | 085+100 | Up | 550 | 3 - 4 | Mitigation ID 084-M6E<br>EOC TN requires 3m equivalent noise mitigation between 085+000 and 086+700 on up (east) side of alignment (EOC Mitigation Ref: 121). For the short section of alignment that runs from Godington embankment into Chetwode cutting (Ch 084+800 and 85+000), this requirement is met through the provision of a mitigation earthwork with a crest height of 3-4m. |
| | 085+000 | 086+150 | Up | 1150 | 3 | Mitigation ID 085-NB1E<br>Noise barrier (3m above rail) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Note: mitigation amended as part of SES4-013-001 (noise mitigation at Chetwode) - Provision of a 5m high noise fence barrier along the eastern side of the route from Rosehill Farm to The Hermitage in Chetwode, replacing the 3m high noise fence barrier proposed at this location in the SES3 scheme. (see details below) |
| 085+400 | 085+800 | Down | 400 | - | Mitigation ID 085-IN1W<br>Chetwode Cutting provides noise benefit on the left (west) side of the alignment between Ch 085+400 and 085+800. |
| 087+300 | 087+550 | Up | 250 | - | Mitigation ID 087-IN1E<br>Barton to Mixbury Cutting provides noise benefit on the right (east) side of the alignment between Ch 087+300 and 087+550 [note: Part of this benefit can be attributed incremental benefits from engineering earthworks associated with Footpath BHA/2 overbridge]. |
| 087+100 | 087+750 | Down | 650 | - | Mitigation ID 087-M2W<br>Noise bund and landscape earthworks. Noise mitigation for Newton Purcell between Ch 087+370 and 087+700 (EOC Mitigation Ref: 28). Earthwork assumed to be 3m high in this location. |
| 087+700 | 088+100 | Down | 400 | 3 | Mitigation ID 087-NB1W<br>EOC TN requires 3m equivalent noise mitigation between 087+370 to 088+370 on down (west) side of alignment (EOC Mitigation Ref: 28). For the section of alignment between Ch 087+700 to 088+100, this requirement has been met by the provision of a standard height barrier (3m above rail) at the top of the Barton to Mixbury cutting. |
| 088+000 | 088+700 | Down | 700 | 3 | Mitigation ID 088-M1W<br>Noise bund and landscape earthworks. EOC TN requires 3m equivalent noise mitigation between 087+370 to 088+370 on |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | down (west) side of alignment (EOC Mitigation Ref: 28). Earthwork assumed to be 3m high in this location. |
| | 087+300 | 087+550 | Up | 250 | - | Mitigation ID 083-IN1E<br>Barton to Mixbury Cutting provides noise benefit on the right (east) side of the alignment between Ch 087+300 and 087+550 |
| | 085+000 | 087+000 | Up | 2000 | 5 | Mitigation ID AP5-NB3E<br>Provision of a 5m high noise fence barrier along the eastern side of the route from Rosehill Farm to The Hermitage in Chetwode, replacing the 3m high noise fence barrier proposed at this location in the SES3 scheme. This mitigation also incorporates an extension to the noise fence barrier for a length of approximately 1km to provide continuous barrier north to Barton Hartshorn Railway Wood. This will provide continuous noise fence barrier of approximately 2km in length.<br>Replaces mitigation ID 085-NB1E - see tab 'C252 Design Mitigation Schedule'. |
| Scheme design bund provision | 85+320 | 85+520 | Up | 200 | 3 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 85+680 | 85+920 | Up | 240 | 6 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 86+100 | 86+440 | Up | 340 | 5 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 86+530 | 86+940 | Up | 410 | 3 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 87+250 | 87+700 | Up | 450 | 3 | 1 in 4 inside slope as per standard earthwork sections |
| | 85+900 | 86+440 | Down | 540 | 5 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 86+490 | 86+800 | Down | 310 | 3 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 87+200 | 87+780 | Down | 580 | 5 above EGL | 1 in 4 inside slope as per standard earthwork sections |
| | 88+070 | 88+480 | Down | 410 | 3 above EGL | 1 in 4 inside slope as per standard earthwork sections |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 85+060 | 87+200 | Up | 2140 | 2 | Absorptive |
| Noise Barrier Design Option 1 | 85+550 | 85+900 | Down | 350 | 1 | Absorptive |
| | 87+800 | 88+000 | Down | 350 | 1 | Absorptive |
| | 85+060 | 87+200 | Up | 2140 | 1 | Absorptive |
| Noise Barrier Design Option 2 | 85+550 | 85+900 | Down | 350 | 2 | Absorptive |
| | 87+800 | 88+000 | Down | 350 | 2 | Absorptive |
| | 85+060 | 87+200 | Up | 2140 | 2 | Absorptive |
| Noise Barrier Design Option 3 | 85+550 | 85+900 | Down | 350 | 3 | Absorptive |
| | 87+800 | 88+000 | Down | 350 | 3 | Absorptive |
| | 85+060 | 87+200 | Up | 2140 | 3 | Absorptive |
| Noise Barrier Design Option 4 (SES4-013-001) | 85+060 | 87+200 | Up | 2140 | 4 | Absorptive |
| Noise Barrier Design Option 5 (SES4-013-001) | 85+060 | 87+200 | Up | 2140 | 5 | Absorptive |

*Table 18 Summary of noise mitigation options – Chetwode/ Newton Purcell*

In accordance with the requirements to determine whether the design changes result in a material change, the appraisal has considered the grouping or communities of receptors most affected by airborne noise in this area, namely the receptors in Chetwode and Newton Purcell.

- Barriers on Up-Side (East of HS2 Trace) - Chetwode

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in Table 21.

The proposed design and changes to the earthworks indicate that, without the acoustic barrier recommended in the ES, there would be far more instances of impacts in the Major category for the night-time period than reported at the ES stage (12 Major impacts as opposed to 4 in the ES case). Mitigation in the form of acoustic barriers is therefore required.

The cost benefit analysis score of 0.00 for Mitigation Design Option 1; and 0.01 for Mitigation Design Option 2, Option 3 and Option 4; and 0.04 for Option 5 indicate that the mitigation should not typically be included in the design. Mitigation would however need to be provided to mitigate adverse noise effects as presented in the appraisal in Table 22 and Table 23.

The Design Option (no noise barrier) and barrier Mitigation Design Option 1, Option 2, Option 3 and Option 4 all result in 12 Major impacts at night, which is 8 more than the 4 Major impacts for night-time reported in the SES. This indicates a worsening of the significant effect reported in the SES4 Scheme.

Noise Barrier Mitigation Design Option 5 (5m barrier above ToR) reduces the Major impacts at night to 4, which matches Major impacts reported in the SES, and also removes 2 Minor night-time impacts reported in the SES.

| Design Option | Number of Noise Impacts | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | | | 14 | 16 | N/A | N/A | N/A |
| | Minor | 0 | 2 | | | | | |
| | Moderate | 9 | 10 | | | | | |
| | Major | 5 | 4 | | | | | |
| | Total above LOAEL | 14 | 16 | | | | | |
| No Noise Barrier | Negligible | | | 15 | 15 | N/A | N/A | N/A |
| | Minor | 1 | 0 | | | | | |
| | Moderate | 9 | 3 | | | | | |
| | Major | 5 | 12 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| Noise Barrier Design Option 1 | Negligible | | | 15 | 15 | £0 | £1,582,400 | 0.00 |
| | Minor | 1 | 0 | | | | | |
| | Moderate | 9 | 3 | | | | | |
| | Major | 5 | 12 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 | Negligible | | | 15 | 15 | £8,607 | £2,302,650 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 9 | 3 | | | | | |
| | Major | 5 | 12 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 3 | Negligible | | | 15 | 15 | £20,436 | £3,022,900 | 0.01 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 9 | 3 | | | | | |
| | Major | 5 | 12 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 4 | Negligible | | | 13 | 13 | £43,996 | £3,743,150 | 0.01 |
| | Minor | | | | | | | |
| | Moderate | 9 | 2 | | | | | |
| | Major | 5 | 12 | | | | | |
| | Total above LOAEL | 13 | 13 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 5 | Negligible | | | 13 | 13 | £191,999 | £4,463,400 | 0.04 |
| | Minor | | | | | | | |
| | Moderate | 9 | 10 | | | | | |
| | Major | 5 | 4 | | | | | |
| | Total above LOAEL | 13 | 13 | | | | | |
| | Engineering and operational compatibility | | | Barrier height equivalent to ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height equal to ES scheme, therefore no increase in visual effects. | | | | |

*Table 19 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Chetwode Up-Side*

The predicted noise levels from the ES and the Design Mitigation Options for the receptor locations on the up-side around Chetwode are presented in Table 22 below.

Table 22 shows that Mitigation Design Options1 to 3 have similar total numbers of impacts above LOAEL when compared to the ES (as amended in SES4). The mitigation options considered do however present with much higher noise changes that reported in SES4 and therefore the significant impact is changed and adverse when compared to SES 4.

Noise barrier Mitigation Design Option 1, Option 2, Option 3 and Option 4 have 12 Major impacts at night, 8 more Major night-time impacts than reported in the SES, which reported 4 major impacts. This indicates a worsening of the significant effect reported in the SES4 Scheme for these barrier mitigation options.

Noise barrier Mitigation Design Option 5 reduces the rail noise levels at the receptors above LOAEL to levels that match or slightly improve on the rail noise levels reported in the SES. Noise Barrier Mitigation Design Option 5 (5m barrier above ToR) also removes the rail noise level above the WHO night-time noise limit of 55dB at Receptor ID 274142 reported in the SES (above SOAEL) to below 55dB, reducing the exceedance of SOAEL to an exceedance above LOAEL.

| 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: - 1m barrier; | | Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 2m 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 |
| 275094 | School End, Chetwode | 5 | 42 | 36 | 47 | 38 | 48 | 40 | 49 | 40 | 50 | 41 | 49 | 40 | 50 | 41 | 49 | 40 | 50 | 41 |
| 277682 | Barton Hartshorn, Buckingham | 8 | 47 | 40 | 46 | 37 | 49 | 41 | 46 | 37 | 50 | 42 | 46 | 36 | 50 | 42 | 45 | 36 | 49 | 42 |
| 277726 | Barton Hartshorn, Buckingham | 8 | 47 | 40 | 47 | 38 | 50 | 42 | 48 | 39 | 51 | 42 | 48 | 39 | 51 | 42 | 48 | 38 | 50 | 42 |
| 277745 | Barton Hartshorn, Buckingham | 2 | 47 | 40 | 49 | 40 | 51 | 43 | 49 | 40 | 51 | 43 | 49 | 40 | 51 | 43 | 49 | 39 | 51 | 43 |
| 279462 | Barton Hartshorn, Buckingham | 2 | 47 | 40 | 44 | 36 | 49 | 41 | 46 | 37 | 50 | 42 | 46 | 36 | 49 | 42 | 45 | 35 | 49 | 41 |
| 700431 | Chetwode, Buckingham | 2 | 45 | 35 | 39 | 29 | 46 | 36 | 40 | 31 | 46 | 36 | 40 | 31 | 46 | 36 | 40 | 31 | 46 | 36 |
| 275155 | Chetwode, Buckingham | 2 | 42 | 36 | 47 | 38 | 48 | 40 | 49 | 39 | 50 | 41 | 49 | 39 | 50 | 41 | 49 | 39 | 50 | 41 |
| 275187 | Chetwode, Buckingham | 1 | 42 | 33 | 56 | 47 | 56 | 47 | 59 | 50 | 59 | 50 | 59 | 50 | 59 | 50 | 59 | 50 | 59 | 50 |
| 275251 | Chetwode, Buckingham | 1 | 45 | 35 | 61 | 52 | 61 | 52 | 66 | 56 | 66 | 56 | 66 | 56 | 66 | 56 | 65 | 56 | 65 | 56 |
| 274142 | Chetwode, Buckingham | 2 | 43 | 31 | 65 | 56 | 65 | 56 | 71 | 61 | 71 | 61 | 71 | 61 | 71 | 61 | 69 | 60 | 69 | 60 |
| 274609 | Chetwode, Buckingham | 8 | 52 | 38 | 56 | 47 | 58 | 48 | 59 | 50 | 60 | 50 | 59 | 50 | 60 | 50 | 59 | 50 | 60 | 50 |
| 274745 | Chetwode, Buckingham | 1 | 42 | 36 | 52 | 43 | 53 | 44 | 54 | 45 | 54 | 45 | 54 | 45 | 54 | 45 | 54 | 45 | 54 | 45 |
| 277651 | Chetwode, Buckingham | 1 | 52 | 38 | 48 | 39 | 53 | 42 | 51 | 42 | 55 | 43 | 51 | 41 | 55 | 43 | 50 | 41 | 54 | 43 |
| 277995 | Barton Hartshorn, Buckingham | 1 | 47 | 40 | 55 | 46 | 56 | 47 | 55 | 45 | 55 | 46 | 55 | 45 | 55 | 46 | 54 | 45 | 55 | 46 |

| 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 | | Option 3 Scheme only: - 3m barrier | | Option 3+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 4 Scheme only: - 4m barrier | | Option 4+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 5 Scheme only: - 5m barrier | | Option 5+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 |
| 275094 | School End, Chetwode | 5 | 42 | 36 | 47 | 38 | 48 | 40 | 49 | 39 | 50 | 41 | 48 | 39 | 49 | 41 | 47 | 38 | 48 | 40 |
| 277682 | Barton Hartshorn, Buckingham | 8 | 47 | 40 | 46 | 37 | 49 | 41 | 45 | 36 | 49 | 42 | 44 | 35 | 49 | 41 | 44 | 35 | 49 | 41 |
| 277726 | Barton Hartshorn, Buckingham | 8 | 47 | 40 | 47 | 38 | 50 | 42 | 48 | 38 | 50 | 42 | 46 | 37 | 50 | 42 | 46 | 37 | 50 | 42 |
| 277745 | Barton Hartshorn, Buckingham | 2 | 47 | 40 | 49 | 40 | 51 | 43 | 49 | 39 | 51 | 43 | 48 | 38 | 50 | 42 | 48 | 38 | 50 | 42 |
| 279462 | Barton Hartshorn, Buckingham | 2 | 47 | 40 | 44 | 36 | 49 | 41 | 45 | 35 | 49 | 41 | 43 | 34 | 48 | 41 | 43 | 33 | 48 | 41 |
| 700431 | Chetwode, Buckingham | 2 | 45 | 35 | 39 | 29 | 46 | 36 | 40 | 31 | 46 | 36 | 39 | 30 | 46 | 36 | 38 | 29 | 46 | 36 |
| 275155 | Chetwode, Buckingham | 2 | 42 | 36 | 47 | 38 | 48 | 40 | 49 | 39 | 50 | 41 | 48 | 38 | 49 | 40 | 47 | 37 | 48 | 40 |
| 275187 | Chetwode, Buckingham | 1 | 42 | 33 | 56 | 47 | 56 | 47 | 59 | 50 | 59 | 50 | 58 | 48 | 58 | 48 | 56 | 46 | 56 | 47 |
| 275251 | Chetwode, Buckingham | 1 | 45 | 35 | 61 | 52 | 61 | 52 | 65 | 56 | 65 | 56 | 62 | 53 | 62 | 53 | 60 | 51 | 60 | 51 |
| 274142 | Chetwode, Buckingham | 2 | 43 | 31 | 65 | 56 | 65 | 56 | 69 | 60 | 69 | 60 | 66 | 56 | 66 | 56 | 63 | 54 | 63 | 54 |
| 274609 | Chetwode, Buckingham | 8 | 52 | 38 | 56 | 47 | 58 | 48 | 59 | 50 | 60 | 50 | 57 | 48 | 58 | 48 | 56 | 46 | 57 | 47 |
| 274745 | Chetwode, Buckingham | 1 | 42 | 36 | 52 | 43 | 53 | 44 | 54 | 45 | 54 | 45 | 53 | 43 | 53 | 44 | 51 | 42 | 52 | 43 |
| 277651 | Chetwode, Buckingham | 1 | 52 | 38 | 48 | 39 | 53 | 42 | 50 | 41 | 54 | 43 | 48 | 39 | 53 | 41 | 47 | 38 | 53 | 41 |
| 277995 | Barton Hartshorn, Buckingham | 1 | 47 | 40 | 55 | 46 | 56 | 47 | 54 | 45 | 55 | 46 | 54 | 45 | 55 | 46 | 54 | 45 | 55 | 46 |

*Table 20 Consideration of Material Change at most affected receptor grouping*

Table 23 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES (as amended in SES 4) identified significant effects in Chetwode.

Mitigation Option 5 shows a slight improvement over the SES, with the Moderate impact at Receptor ID 27745 (2 impacts) removed. This does not however represent a material benefit.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 1m Barrier | | DM - 2m Barrier | | DM - 3m Barrier | | DM - 4m Barrier | | DM - 5m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 275094 | School End, Chetwode | 5 | # | 6 | 4 | 8 | 5 | 8 | 5 | 8 | 5 | 8 | 5 | 7 | 5 | 6 | 4 |
| 277682 | Barton Hartshorn, Buckingham | 8 | | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| 277726 | Barton Hartshorn, Buckingham | 8 | # | 3 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 |
| 277745 | Barton Hartshorn, Buckingham | 2 | | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 2 | 3 | 2 |
| 279462 | Barton Hartshorn, Buckingham | 2 | # | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| 700431 | Chetwode, Buckingham | 2 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 275155 | Chetwode, Buckingham | 2 | # | 6 | 4 | 8 | 5 | 8 | 5 | 8 | 5 | 8 | 5 | 7 | 4 | 6 | 4 |
| 275187 | Chetwode, Buckingham | 1 | OSV13-C03 | 14 | 14 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 16 | 15 | 14 | 14 |
| 275251 | Chetwode, Buckingham | 1 | OSV13-C03 | 16 | 17 | 21 | 21 | 21 | 21 | 20 | 21 | 20 | 21 | 17 | 18 | 15 | 16 |
| 274142 | Chetwode, Buckingham | 2 | OSV13-C03 OSV13-D01 | 22 | 25 | 28 | 30 | 28 | 30 | 26 | 29 | 26 | 29 | 23 | 25 | 20 | 23 |
| 274609 | Chetwode, Buckingham | 8 | OSV13-C03 | 6 | 9 | 8 | 12 | 8 | 12 | 8 | 12 | 8 | 12 | 6 | 10 | 5 | 9 |
| 274745 | Chetwode, Buckingham | 1 | OSV13-C03 | 11 | 8 | 12 | 9 | 12 | 9 | 12 | 9 | 12 | 9 | 11 | 8 | 10 | 7 |
| 277651 | Chetwode, Buckingham | 1 | # | 1 | 3 | 3 | 5 | 3 | 5 | 2 | 5 | 2 | 5 | 1 | 3 | 1 | 3 |
| 277995 | Barton Hartshorn, Buckingham | 1 | ~ | 9 | 7 | 8 | 6 | 8 | 6 | 8 | 6 | 8 | 6 | 8 | 6 | 8 | 6 |

*Table 21 Consideration of Receptors above LOAEL at most affected receptor grouping – Chetwode*

The $L_{max}$ predictions presented in Table 24 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (1m) | Lmax Design Option 2 (2m) | Lmax Design Option 3 (3m) | Lmax Design Option 4 (4m) | Lmax Design Option 6 (5m) | Lmax ES |
|---|---|---|---|---|---|---|---|---|---|
| 275094 | School End, Chetwode | 5 | 64 | 64 | 64 | 64 | 62 | 60 | 59/62 |
| 277682 | Barton Hartshorn, Buckingham | 8 | 61 | 60 | 59 | 59 | 59 | 59 | 59/62 |
| 277726 | Barton Hartshorn, Buckingham | 8 | 63 | 63 | 63 | 63 | 63 | 63 | 63/65 |
| 277745 | Barton Hartshorn, Buckingham | 2 | 62 | 62 | 62 | 62 | 62 | 62 | 62/65 |
| 279462 | Barton Hartshorn, Buckingham | 2 | 63 | 63 | 63 | 63 | 63 | 63 | 59/62 |
| 700431 | Chetwode, Buckingham | 2 | 53 | 53 | 53 | 53 | 52 | 52 | 59/62 |
| 275155 | Chetwode, Buckingham | 2 | 62 | 62 | 62 | 62 | 62 | 62 | 59/62 |
| 275187 | Chetwode, Buckingham | 1 | 75 | 75 | 75 | 75 | 74 | 74 | 70/72 |
| 275251 | Chetwode, Buckingham | 1 | 80 | 80 | 80 | 80 | 78 | 76 | 75/79 |
| 274142 | Chetwode, Buckingham | 2 | 87 | 87 | 86 | 86 | 82 | 79 | 81/84 |
| 274609 | Chetwode, Buckingham | 8 | 74 | 74 | 74 | 74 | 72 | 70 | 70/72 |
| 274745 | Chetwode, Buckingham | 1 | 69 | 69 | 69 | 69 | 68 | 65 | 65/68 |
| 277651 | Chetwode, Buckingham | 1 | 65 | 65 | 65 | 65 | 65 | 65 | 63/66 |
| 277995 | Barton Hartshorn, Buckingham | 1 | 69 | 69 | 69 | 69 | 69 | 69 | 69/71 |

*Table 22 LAmax levels for the Mitigation Design Options considered compared to ES – Free-Field*

At Receptor ID 274142 (represents 2 impacts), the $L_{max}$ levels in the ES and in the mitigation design options considered are predicted to be above SOAEL, which indicates noise insulation (NI) would be required.

The cost benefit analysis for the $L_{max}$ prediction is presented in Table 25. The cost benefit analysis scores of 0.00 and 0.01 for Options 1 and 2 respectively indicate that the mitigation should not typically be included in the design.

The ES shows 2 more impacts above LOAEL than the mitigation design options considered.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 44 | N/A | 2 | N/A | N/A | N/A |
| No Noise Barrier | 42 | 0 | 2 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 42 | 0 | 2 | £0 | £1,582,400 | 0.00 |
| Noise Barrier Design Option 2 | 42 | 0 | 2 | £10,579 | £2,302,650 | 0.01 |
| Noise Barrier Design Option 3 | 42 | 0 | 2 | £15,265 | £3,022,900 | 0.01 |
| Noise Barrier Design Option 4 | 42 | 0 | 0 | £26,282 | £3,743,150 | 0.01 |
| Noise Barrier Design Option 5 | 42 | 0 | 0 | £40,962 | £4,463,400 | 0.01 |

*Table 23 Cost Benefit Analysis $L_{max}$ Levels – Chetwode Up-Side*

Based on the appraisals in Table 21, Table 22 and Table 23 for $L_{eq}$ daytime and night-time; and the appraisals of $L_{max}$ values in Tables 24 and 25, the recommendation is that the Barrier Mitigation Design Option 5 is adopted (5m high barrier).

- Ch 85+060 - Ch 87+200 5m above rail, absorptive barrier on east side

- Chetwode (Barriers on Down-Side Ch 85+400 to Ch 85+900)

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in Table 26.

Barrier Mitigation Design Option 1 considers a 2m barrier and Barrier Mitigation Option Design 2 considers a 3m barrier. The cost benefit analysis score of 0.00 for both Design Options indicates that the mitigation should not typically be included in the design.

Table 26 shows one major impact for daytime and night-time at Receptor ID 711004, a committed development (1 impact) in very close proximity to the track alignment. In Table 27it is indicated that this receptor qualifies for noise insulation, which is in line with the findings in the ES.

| Design Option | Number of Noise Impacts | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | | | 1 | 1 | N/A | N/A | N/A |
| | Minor | | | | | | | |
| | Moderate | 1 | 1 | | | | | |
| | Major | 1 | 1 | | | | | |
| | Total above LOAEL | 1 | 1 | | | | | |
| No Noise Barrier | Negligible | | | 1 | 1 | N/A | N/A | N/A |
| | Minor | | | | | | | |
| | Moderate | 1 | 1 | | | | | |
| | Major | 1 | 1 | | | | | |
| | Total above LOAEL | 1 | 1 | | | | | |
| Noise Barrier Design Option 1 | Negligible | | | 1 | 1 | £0 | £423,045 | 0.00 |
| | Minor | | | | | | | |
| | Moderate | 1 | 1 | | | | | |
| | Major | 1 | 1 | | | | | |
| | Total above LOAEL | 1 | 1 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 | Negligible | | | 1 | 1 | £0 | £555,370 | 0.00 |
| | Minor | | | | | | | |
| | Moderate | 1 | 1 | | | | | |
| | Major | 1 | 1 | | | | | |
| | Total above LOAEL | 1 | 1 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |

*Table 24 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Chetwode (South)*

The predicted noise levels from the ES and the two Design Mitigation Options for the receptor locations on the down-side around Chetwode are presented in Table 27 below.

Table 27 shows that Mitigation Design Options 1 and 2 do not have any acoustic benefit in reducing impacts above LOAEL over the Design option with no noise barriers.

Table 27 shows an exceedance of SOAEL for daytime and night-time at Receptor ID 711004, a committed development (1 impact) in very close proximity to the track alignment. It is indicated that this receptor qualifies for noise insulation, which is in line with the findings in the ES.

| 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 274201 | Newton Purcell, Buckingham | 1 | 50 | 42 | 41 | 31 | 51 | 42 | 41 | 32 | 51 | 42 | 41 | 31 | 51 | 42 | 41 | 31 | 51 | 42 |
| 274255 | Newton Purcell, Buckingham | 1 | 50 | 42 | 41 | 32 | 51 | 42 | 41 | 32 | 51 | 42 | 41 | 32 | 51 | 42 | 41 | 32 | 51 | 42 |
| 274265 | Newton Purcell, Buckingham | 1 | 51 | 43 | 38 | 29 | 51 | 43 | 37 | 28 | 51 | 43 | 37 | 28 | 51 | 43 | 37 | 28 | 51 | 43 |
| 275245 | Newton Purcell, Buckingham | 1 | 47 | 38 | 52 | 43 | 53 | 44 | 51 | 42 | 53 | 44 | 51 | 42 | 53 | 44 | 51 | 42 | 53 | 44 |
| 274535 | Chetwode, Buckingham | 3 | 45 | 35 | 47 | 38 | 49 | 40 | 48 | 39 | 50 | 40 | 48 | 39 | 50 | 40 | 48 | 38 | 50 | 40 |
| 711004 | Committed Development CFA13/4 | 1 | 42 | 33 | 76 | 67 | 76 | 67 | 75 | 66 | 75 | 66 | 74 | 63 | 74 | 63 | 70 | 61 | 70 | 61 |
| | Daytime level above SOAEL. Night-time level above WHO Interim night-time guideline level of 55dB. Indicates qualification for noise insulation | | | | | | | | | | | | | | | | | | | |

*Table 25 Consideration of Material Change at most affected receptor grouping – Chetwode (Down Side)*

Table 28 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES identified significant effects in Chetwode (OSV13 -C03), in terms of which Receptor ID 275245 was reported to experience a Moderate noise change for daytime and night-time.

Table 28 shows that the barrier mitigation options considered do not afford any additional acoustic benefit over the Design (with no noise barriers). Barrier Design Mitigation Option 2 and Option 3 do not alter the adverse effects reported in the ES.

Table 28 shows one major impact for daytime and night-time at Receptor ID 711004, a committed development (1 impact) in very close proximity to the track alignment. In Table 27 it is indicated that this receptor qualifies for noise insulation, which is in line with the findings in the ES.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 2m Barrier | | DM - 3m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night |
| 274201 | Newton Purcell, Buckingham | 1 | | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 274255 | Newton Purcell, Buckingham | 1 | | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 274265 | Newton Purcell, Buckingham | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 275245 | Newton Purcell, Buckingham | 1 | OSV13-C03 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 274535 | Chetwode, Buckingham | 3 | # | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 711004 | Committed Development CFA13/4 | 1 | OSV13-C03<br>OSV13-D03 | 34 | 34 | 33 | 33 | 32 | 30 | 28 | 28 |

*Table 26 Consideration of Receptors above LOAEL at most affected receptor grouping – Chetwode Down Side*

The Lmax predictions presented in Table 29 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the Lmax LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (2m) | Lmax Design Option 2 (3m) | Lmax ES Design |
|---|---|---|---|---|---|---|
| 274201 | Newton Purcell, Buckingham | 1 | 60 | 60 | 60 | 58/61 |
| 274255 | Newton Purcell, Buckingham | 1 | 56 | 56 | 56 | 55/58 |
| 274265 | Newton Purcell, Buckingham | 1 | 50 | 50 | 50 | 50/52 |
| 275245 | Newton Purcell, Buckingham | 1 | 67 | 67 | 67 | 67/70 |
| 274535 | Chetwode, Buckingham | 3 | 63 | 63 | 62 | 61/63 |
| 711004 | Committed Development CFA13/4 | 1 | 92 | 89 | 87 | 91/94 |
| | Exceedance of SOAEL | | | | | |

*Table 27 LAmax levels for the Mitigation Design Options considered compared to ES-Chetwode Down Side – Free-Field*

Table 29 shows that the $L_{max}$ predictions for the Design Option with no noise barrier and the noise barrier options considered present the same $L_{max}$ levels, therefore mitigation in the form of noise barriers would not offer any acoustic benefit in reducing $L_{max}$ noise levels at receptors in Chetwode to the west of the HS2 alignment.

At Receptor ID 711004 (Committed Development) SOAEL is predicted to be exceeded for all mitigation options, which is in line with the ES $L_{max}$ predictions. Predicted Lmax levels for the Design Option (no noise barrier) are slightly lower than the Lmax level predicted in the ES. This receptor is indicated to qualify for noise insulation.

The cost benefit analysis for the $L_{max}$ prediction is presented in Table 30. The cost benefit analysis score for both options of 0.00 indicates that the mitigation should not typically be included in the design.

The Design option with noise barriers (mitigation afforded by the earthworks design) shows one less impact above LOAEL than reported in the ES.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 6 | N/A | 1 | N/A | N/A | N/A |
| No Noise Barrier | 5 | 0 | 1 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 5 | 0 | 1 | £0 | £423,045 | 0.00 |
| Noise Barrier Design Option 2 | 5 | 0 | 1 | £0 | £555,370 | 0.00 |

*Table 28 Cost Benefit Analysis $L_{max}$ Levels – Chetwode Down-side*

Based on the appraisal for $L_{eq}$ daytime and night-time in Table 26, Table 27 and Table 28, and the appraisal for $L_{max}$ values in Table 29 and Table 30, it is recommended that noise barriers would not be considered as part of the mitigation design The Design option that presents the narrowing of the track corridor, and the earthworks design provides appropriate mitigation and is the recommended mitigation option.

- Barriers at Newton Purcell

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in Table 31.

The cost benefit analysis scores of 0.02, 0.03 and 0.04 for Mitigation Designs Options 1, 2 and 3 respectively indicate that the mitigation should not typically be included in the design.

Table 31 indicates two more Moderate impacts above LOAEL for daytime for the Design Option without noise barriers and for Noise Barrier Mitigation Design Option 1 than reported in the ES.

With Noise Barrier Option 2, the barrier2m above ToR reduces one of the daytime Moderate impacts to a Minor impact, resulting in one more Moderate and one more Minor impact than the ES.

Noise barrier Option 3 (3m barrier above ToR) removes the Moderate impact shown for Option 2, resulting in one more Minor impact for daytime than reported in the ES.

All the Mitigation Design Options remove the 4 Minor night-time impacts reported in the ES.

The noise predictions are further analysed in Table 32 and Table 33.

| Design Option | Number of Noise Impacts | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | 11 | 15 | 4 | 4 | N/A | N/A | N/A |
| | Minor | 4 | 4 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 19 | | | | | |
| No Noise Barrier | Negligible | 4 | 10 | 6 | 0 | N/A | N/A | N/A |
| | Minor | 4 | 0 | | | | | |
| | Moderate | 2 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 10 | 10 | | | | | |
| Noise Barrier Design Option 1 | Negligible | 4 | 10 | 6 | 0 | £8,806 | £374,850 | 0.02 |
| | Minor | 4 | 0 | | | | | |
| | Moderate | 2 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 10 | 10 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no particular challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 | Negligible | 4 | 10 | 6 | 0 | £19,308 | £492,100 | 0.03 |
| | Minor | 5 | 0 | | | | | |
| | Moderate | 1 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 10 | 10 | | | | | |
| | Engineering and operational compatibility | | | Barrier height comparable to ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height comparable to ES scheme, therefore visual effects neutral. | | | | |
| Noise Barrier Design Option 3 | Negligible | 2 | 9 | 5 | 0 | £22,792 | £609,350 | 0.04 |
| | Minor | 5 | 0 | | | | | |
| | Moderate | 1 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 8 | 9 | | | | | |
| | Engineering and operational compatibility | | | Barrier height higher than ES Scheme, therefore more panels and substantial foundations required. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height higher than ES scheme, therefore visual effects higher. | | | | |

*Table 29 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Newton Purcell*

The predicted noise levels from the ES and the two Design Mitigation Options for the receptor locations around Newton Purcell are presented in Table 32 below.

Table 32 that there are fewer receptor locations with rail noise levels above LOAEL than was the case in the ES.

The predicted rail noise levels at Receptor ID 277206 and ID 277239 are however higher than was reported in the ES, with a 7dB increase at receptor ID 277206 for the daytime rail noise and 6dB for the night-time for the Design Option (no noise barrier and Noise Barrier Option 1. Barrier Mitigation Design Option 3 (3m barrier above ToR) reduces the rail noise level to +5dB above the rail noise level reported in the ES.

The increase in rail noise at these receptor IDs is attributed to the track lift through the area.

| 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: - 1m barrier; | | Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 2m barrier; | | Option 2+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 3 Scheme only: - 3m 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 |
| 276941 | Newton Purcell, Buckingham | 1 | 46 | 42 | 51 | 44 | 51 | 44 | 51 | 41 | 52 | 44 | 51 | 41 | 52 | 44 | 51 | 41 | 52 | 44 | 50 | 41 | 51 | 44 |
| 276979 | Newton Purcell, Buckingham | 1 | 71 | 68 | 52 | 44 | 71 | 68 | 50 | 40 | 71 | 68 | 50 | 40 | 71 | 68 | 50 | 40 | 71 | 68 | 49 | 40 | 71 | 68 |
| 276994 | Fulwell House, Brackley | 1 | 45 | 39 | 46 | 38 | 48 | 41 | 46 | 36 | 49 | 41 | 46 | 36 | 49 | 41 | 46 | 36 | 48 | 41 | 46 | 36 | 48 | 41 |
| 277041 | Newton Purcell, Buckingham | 5 | 61 | 58 | 47 | 37 | 62 | 58 | 47 | 37 | 61 | 58 | 47 | 37 | 61 | 58 | 47 | 37 | 61 | 58 | 47 | 37 | 61 | 58 |
| 277059 | Newton Purcell, Buckingham | 5 | 61 | 58 | 48 | 39 | 62 | 58 | 48 | 38 | 61 | 58 | 48 | 38 | 61 | 58 | 48 | 38 | 61 | 58 | 48 | 38 | 61 | 58 |
| 277073 | Newton Purcell, Buckingham | 2 | 66 | 63 | 52 | 44 | 66 | 63 | 48 | 39 | 66 | 63 | 48 | 39 | 66 | 63 | 48 | 39 | 66 | 63 | 48 | 39 | 66 | 63 |
| 277167 | Newton Purcell, Buckingham | 4 | 45 | 39 | 49 | 42 | 49 | 42 | 49 | 40 | 51 | 42 | 49 | 40 | 51 | 42 | 49 | 40 | 51 | 42 | 48 | 39 | 50 | 42 |
| 277188 | Newton Purcell, Buckingham | 3 | 46 | 41 | 50 | 43 | 50 | 43 | 49 | 40 | 51 | 44 | 49 | 40 | 51 | 44 | 49 | 40 | 51 | 43 | 49 | 39 | 51 | 43 |
| 277206 | Newton Purcell, Buckingham | 1 | 60 | 54 | 60 | 51 | 60 | 51 | 67 | 57 | 65 | 56 | 67 | 57 | 65 | 56 | 66 | 57 | 64 | 56 | 65 | 56 | 63 | 55 |
| 277221 | Newton Purcell, Buckingham | 3 | 55 | 49 | 53 | 44 | 56 | 50 | 54 | 44 | 57 | 49 | 54 | 44 | 57 | 49 | 54 | 44 | 56 | 49 | 54 | 44 | 56 | 49 |
| 277239 | Newton Purcell, Buckingham | 4 | 55 | 49 | 57 | 49 | 57 | 49 | 59 | 50 | 59 | 50 | 59 | 50 | 59 | 50 | 59 | 50 | 58 | 50 | 58 | 49 | 58 | 50 |

*Table 30 Consideration of Material Change at most affected receptor grouping*

Table 33 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES did not identify any significant effects on a community basis in Newton Purcell.

The Design Option (no noise barrier), Noise Barrier Option 1 and Noise Barrier Design Options 2 do present additional effects over what was reported in the HS2 Phase 1 ES, with more Minor and Moderate effects.

Noise barrier Option 3 does remove the Minor effects for daytime reported in the ES at Receptor ID 276941, ID 277188 (total of 4 impacts) and the Minor impacts for night-time at ID 277167 (4 impacts).

There are however additional Minor impacts reported for Noise Barrier Option 3 at Receptor ID 277206, ID 277221 and ID 277239. The additional effects are reported at receptors close to the HS2 alignment.

At Receptor ID 277206, the ES reported a beneficial noise change due to the realignment of the A4421 Buckingham Road. The realignment moved further north away from the receptor locations, thereby reducing road noise levels and resulting in an improvement (-3dB for night-time) at Receptor ID 277206. The modelling of rail noise and road noise to consider the track lift and design changes through the area indicates, that with a 3m barrier (Barrier Mitigation Option 3) the night-time noise change at ID 277206 would be +1dB, which is a Negligible change.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 1m Barrier | | DM - 2m Barrier | | DM - 3m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 276941 | Newton Purcell, Buckingham | 1 | ~ | 4 | 2 | 6 | 2 | 6 | 2 | 6 | 2 | 5 | 2 |
| 276979 | Newton Purcell, Buckingham | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 276994 | Fulwell House, Brackley | 1 | # | 3 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 |
| 277041 | Newton Purcell, Buckingham | 5 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 277059 | Newton Purcell, Buckingham | 5 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 277073 | Newton Purcell, Buckingham | 2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 277167 | Newton Purcell, Buckingham | 4 | ~ | 4 | 3 | 6 | 3 | 6 | 3 | 6 | 3 | 5 | 3 |
| 277188 | Newton Purcell, Buckingham | 3 | ~ | 4 | 2 | 5 | 3 | 5 | 3 | 5 | 2 | 5 | 2 |
| 277206 | Newton Purcell, Buckingham | 1 | | 0 | -3 | 5 | 2 | 5 | 2 | 4 | 2 | 3 | 1 |
| 277221 | Newton Purcell, Buckingham | 3 | | 1 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 1 | 0 |
| 277239 | Newton Purcell, Buckingham | 4 | | 1 | 0 | 4 | 1 | 4 | 1 | 3 | 1 | 3 | 1 |

*Table 31 Consideration of Receptors above LOAEL at most affected receptor grouping – Newton Purcell*

The $L_{max}$ predictions presented in Table 34 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (1m) | Lmax Design Option 2 (2m) | Lmax Design Option 3 (3m) | Lmax ES |
|---|---|---|---|---|---|---|---|
| 276941 | Newton Purcell, Buckingham | 1 | 65 | 65 | 65 | 65 | 61/64 |
| 276979 | Newton Purcell, Buckingham | 1 | 64 | 64 | 64 | 63 | 61/64 |
| 276994 | Fulwell House, Brackley | 1 | 60 | 60 | 60 | 60 | 56/59 |
| 277041 | Newton Purcell, Buckingham | 5 | 63 | 63 | 63 | 63 | 63/66 |
| 277059 | Newton Purcell, Buckingham | 5 | 62 | 62 | 62 | 62 | 62/65 |
| 277073 | Newton Purcell, Buckingham | 2 | 62 | 62 | 62 | 62 | 62/65 |
| 277167 | Newton Purcell, Buckingham | 4 | 64 | 64 | 64 | 63 | 60/63 |
| 277188 | Newton Purcell, Buckingham | 3 | 64 | 64 | 64 | 64 | 60/63 |
| 277206 | Newton Purcell, Buckingham | 1 | 82 | 82 | 81 | 79 | 74/77 |
| 277221 | Newton Purcell, Buckingham | 3 | 68 | 68 | 68 | 67 | 65/68 |
| 277239 | Newton Purcell, Buckingham | 4 | 74 | 74 | 74 | 73 | 68/71 |

*Table 32 LAmax levels for the Mitigation Design Options considered compared to ES-Chetwode Down Side – Free-Field*

The cost benefit analysis for the $L_{max}$ prediction is presented in Table 35. The cost benefit analysis score of 0.01 for all three Mitigation Design Options indicates that the mitigation should not typically be included in the design.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 30 | N/A | 0 | N/A | N/A | N/A |
| No Noise Barrier | 30 | 0 | 0 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 30 | 0 | 1 | £5,096 | £374,850 | 0.01 |
| Noise Barrier Design Option 2 | 30 | 0 | 1 | £6,608 | £492,100 | 0.01 |
| Noise Barrier Design Option 3 | 30 | 0 | 1 | £6,608 | £609,350 | 0.01 |

*Table 33 Cost Benefit Analysis $L_{max}$ Levels - Newton Purcell*

Based on the appraisals in Table 31, Table 32 and Table 33 for $L_{eq}$ daytime and night-time, and the appraisals of $L_{max}$ values in Table 33 and Table 34, the recommendation is that earthworks design provides the required mitigation.

- Finmere to Mixbury

The following noise models as summarised in Table 35 have been compiled for Finmere to Mixbury.

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Noise Barrier Design Option 1** (1m barriers)
- **Noise Barrier Design Option 2** (2m barriers)
- **Noise Barrier Design Option 3** (3m barriers)

The Tables in this section present the ES reported operational noise levels.

- The ES prediction Tables include noise predictions for the proposed Scheme (Year 15 flows), the future baseline without Scheme (in the opening year) and the overall Do Something noise level (the Opening baseline + the year 15 flows).

- The Scheme Design Tables include the predictions for the Do Something Scheme Design (the Opening baseline + the year 15 Design flows) without noise barriers as mitigation and then with the noise barrier options being considered as compared against the ES/ SES Do Something noise level.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) | Comments |
|---|---|---|---|---|---|---|
| ES Mitigation (AP5) - performance presented in 'Do Something ES (Appendix D) | 089+900 | 090+400 | Up | 500 | 4 | Mitigation ID 090-NB1E<br>Noise barrier (4m above rail)<br>EOC recommendation to increase the barrier height to 4m above rail on up (east) side of the alignment between 089+900 and 090+400. This requirement has been met through the provision of a 4m barrier at the TOP of the Barton to Mixbury cutting (Ref: OSV14-C02 |
| | 090+440 | 091+050 | Down | 610 | - | Mitigation ID 090-IN1W<br>Barton to Mixbury Cutting provides mitigation for a significant noise effect on the left (west) side of the alignment between Ch 090+440 and 091+050. |
| Scheme design bund provision | None. | | | | | |
| Noise Barrier Design Option 1 | 89+900 | 90+480 | Up | 580 | 1 | Absorptive barrier |
| Noise Barrier Design Option 2 | 89+900 | 90+480 | Up | 580 | 2 | Absorptive barrier |

| | | | | | | |
|---|---|---|---|---|---|---|
| Noise Barrier Design Option 3 | 89+900 | 90+480 | Up | 580 | 3 | Absorptive barrier |

*Table 34 Summary of noise mitigation options – Finmere to Mixbury*

In accordance with the requirements to determine whether the design changes result in a material change, the appraisal has considered the grouping or communities of receptors most affected by airborne noise in this area, namely the receptors around Finmere and Mixbury.

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented below in Table 36 for the Mitigation Design Options.

The cost benefit analysis score is 0.01 for Barrier Mitigation Design Option 4 and 0.00 for Barrier Mitigation Design Options 1, 2 and 3, which indicates that acoustic mitigation should not normally be considered as identified through the rating scheme presented in Table 6.

It is indicated that without barrier mitigation in place, there would be an improvement whereby 9 Moderate daytime impacts as reported in the ES are reduced to Minor Impacts, which represents a beneficial material change.

Noise Barrier Mitigation Design Options 1, 2, and 3 present no acoustic benefit over the No Mitigation Option, neither through CBA nor material change. Design Option 4 (5m barrier) reduces the 9 Minor daytime impacts to Negligible impacts.

| Design Option | Number of Noise Impacts | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | 6 | 14 | 9 | 1 | N/A | N/A | N/A |
| | Minor | 0 | 1 | | | | | |
| | Moderate | 9 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| No Noise Barrier | Negligible | 6 | 15 | 9 | 0 | N/A | N/A | N/A |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 9 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| Noise Barrier Design Option 1 (1m) | Negligible | 6 | 15 | 9 | 0 | £0 | £408,480 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 9 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 2 (2m) | Negligible | 6 | 15 | 9 | 0 | £0 | £594,405 | 0.00 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 9 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 3 (3m) | Negligible | 6 | 15 | 9 | 0 | £0 | £780,330 | 0.00 |
| | Minor | 9 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects are reduced. | | | | |
| Noise Barrier Design Option 4 (5m) | Negligible | 15 | 15 | 0 | 0 | £7,648 | £1,152,180 | 0.01 |
| | Minor | 9 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 15 | 15 | | | | | |
| | Engineering and operational compatibility | | | Barrier height higher than ES Scheme, therefore more panels and substantial foundations required. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height higher than ES scheme, therefore greater visual effects. | | | | |

*Table 35 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Finmere to Mixbury*

The predicted noise levels in Finmere and Mixbury from the ES and the levels predicted for each considered Design Mitigation Option are presented in Table 37; the receptors above LOAEL have been shaded in red.

| 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: - 1m barrier; | | Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 2m 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** |
| 275606 | Banbury Road, Finmere | 1 | 58 | 52 | 40 | 31 | 58 | 52 | 39 | 30 | 58 | 52 | 39 | 30 | 58 | 52 | 39 | 30 | 58 | 52 |
| 278675 | Banbury Road, Finmere | 2 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 |
| 278708 | Foxley Fields Farm, Finmere | 1 | 49 | 37 | 46 | 37 | 50 | 40 | 46 | 36 | 51 | 40 | 46 | 36 | 51 | 40 | 46 | 36 | 51 | 40 |
| 279188 | Banbury Road, Finmere | 1 | 49 | 47 | 45 | 37 | 50 | 47 | 44 | 36 | 50 | 47 | 44 | 36 | 50 | 47 | 44 | 36 | 50 | 47 |
| 279198 | A421, Finmere | 1 | 49 | 47 | 49 | 41 | 51 | 47 | 48 | 40 | 51 | 48 | 47 | 40 | 51 | 48 | 47 | 40 | 51 | 48 |
| 277403 | Banbury Road, Finmere | 9 | 50 | 48 | 55 | 50 | 55 | 50 | 53 | 47 | 55 | 50 | 53 | 47 | 55 | 50 | 53 | 46 | 55 | 50 |

| 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 3 Scheme only: - 3m barrier | | Option 3+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 4 Scheme only: - 5m 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** |
| 275606 | Banbury Road, Finmere | 1 | 58 | 52 | 40 | 31 | 58 | 52 | 39 | 30 | 58 | 52 | 39 | 30 | 58 | 52 | 39 | 30 | 58 | 52 |
| 278675 | Banbury Road, Finmere | 2 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 | 43 | 35 | 71 | 65 |
| 278708 | Foxley Fields Farm, Finmere | 1 | 49 | 37 | 46 | 37 | 50 | 40 | 46 | 36 | 51 | 40 | 46 | 36 | 51 | 40 | 46 | 36 | 51 | 40 |
| 279188 | Banbury Road, Finmere | 1 | 49 | 47 | 45 | 37 | 50 | 47 | 44 | 36 | 50 | 47 | 44 | 36 | 50 | 47 | 44 | 36 | 50 | 47 |
| 279198 | A421, Finmere | 1 | 49 | 47 | 49 | 41 | 51 | 47 | 48 | 40 | 51 | 48 | 47 | 40 | 51 | 48 | 47 | 40 | 51 | 48 |
| 277403 | Banbury Road, Finmere | 9 | 50 | 48 | 55 | 50 | 55 | 50 | 53 | 47 | 55 | 50 | 52 | 46 | 54 | 50 | 52 | 46 | 54 | 50 |

*Table 36 Consideration of Material Change at most affected receptor grouping*

Table 38 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES did not identify any significant effects in Finmere/ Mixbury. The No Barrier Option and Noise Barrier Design Options 1 to 3 do not present with any additional effects over what was reported in the HS2 Phase 1 ES.

The Design option with no noise barrier, Barrier Mitigation Option 1 and Barrier Mitigation Option 2 show the same impacts as the ES.

Barrier Mitigation Option 3 (3m barrier) reduces the Moderate impact at Receptor ID 277403 (9 impacts) from Moderate to Minor.  Barrier Mitigation Design Option 4 (5m barrier) does not show any acoustic benefit over Option 3.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 1m Barrier | | DM - 2m Barrier | | DM - 3m Barrier | | DM - 5m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 275606 | Banbury Road, Finmere | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 278675 | Banbury Road, Finmere | 2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 278708 | Foxley Fields Farm, Finmere | 1 | # | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| 279188 | Banbury Road, Finmere | 1 | | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 279198 | A421, Finmere | 1 | | 2 | 0 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 |
| 277403 | Banbury Road, Finmere | 9 | OSV14-C01 | 5 | 2 | 5 | 2 | 5 | 2 | 5 | 2 | 4 | 2 | 4 | 2 |

*Table 37 Consideration of Receptors above LOAEL at most affected receptor grouping – Finmere /Mixbury*

The $L_{max}$ predictions presented in Table 39 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (1m) | Lmax Design Option 2 (2m) | Lmax Design Option 3 (3m) | Lmax ES |
|---|---|---|---|---|---|---|---|
| 275606 | Banbury Road, Finmere | 1 | 53 | 53 | 53 | 53 | 51/54 |
| 278675 | Banbury Road, Finmere | 2 | 55 | 55 | 55 | 55 | 56/59 |
| 278708 | Foxley Fields Farm, Finmere | 1 | 59 | 59 | 59 | 59 | 58/62 |
| 279188 | Banbury Road, Finmere | 1 | 54 | 54 | 54 | 54 | 55/58 |
| 279198 | A421, Finmere | 1 | 57 | 57 | 57 | 57 | 59/62 |
| 277403 | Banbury Road, Finmere | 9 | 66 | 66 | 66 | 66 | 62/65 |

*Table 38 LAmax levels for the Mitigation Design Options considered compared to ES – Free-field*

Table 39 shows the Design Option (no noise barrier) and Barrier Mitigation Options 1 to 4 all present fewer $L_{max}$ impacts above LOAEL (10) as compared to the ES (14 impacts above LOAEL). The various mitigation options all show the same impacts above LOAEL, with noise barriers affording no additional benefit to reducing $L_{max}$ impacts above LOAEL.

The cost benefit analysis for the $L_{max}$ predictions is presented in Table 40. The cost benefit analysis score of 0.00 for all Noise Barrier Mitigation Design Options indicates that mitigation should not typically be included in the design.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 14 | N/A | 0 | N/A | N/A | N/A |
| No Noise Barrier | 10 | 0 | 0 | N/A | N/A | N/A |
| Noise Barrier Design Option 1 | 10 | 0 | 0 | £0 | £408,480 | 0.00 |
| Noise Barrier Design Option 2 | 10 | 0 | 0 | £0 | £594,405 | 0.00 |
| Noise Barrier Design Option 3 | 10 | 0 | 0 | £0 | £780,330 | 0.00 |
| Noise Barrier Design Option 4 | 10 | 0 | 0 | £4,194 | £1,152,180 | 0.00 |

*Table 39 Cost Benefit Analysis $L_{max}$ Levels – Finmere to Mixbury*

Based on the appraisals in Table 36, Table 37 and Table 38 for $L_{eq}$ daytime and night-time, and the appraisals of $L_{max}$ values in Table 39 and Table 40, the recommendation is that the Barrier Mitigation Design Option 3 is adopted (3m high barrier). Although total impact numbers are the same for barrier options 1,2 and 3, Barrier Mitigation Option 3 (3m barrier) has been selected as it reduces the impacts at Receptor ID 277403 (9 impacts) from moderate to minor.

- Ch 89+900 – Ch 90+480 3m above rail, absorptive barrier on east side

- Westbury

The following noise models as summarised in Table 41 have been compiled for Westbury.

- **No Noise Barrier** case as a baseline including the scheme design and earthworks.
- **Noise Barrier Design Option 1** (1m barriers)
- **Noise Barrier Design Option 2** (2m barriers)
- **Noise Barrier Design Option 3** (3m barriers)

The Tables in the section below present the ES reported operational noise levels as amended through the SES and AP amendments.

- The ES prediction Tables include noise predictions for the proposed Scheme (Year 15 flows), the future baseline without Scheme (in the opening year) and the overall Do Something noise level (the Opening baseline + the year 15 flows).

- The Scheme Design Tables include the predictions for the Do Something Scheme Design (the Opening baseline + the year 15 Design flows) without noise barriers as mitigation and then with the noise barrier options being considered as compared against the ES/ SES Do Something noise level.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) | Comments |
|---|---|---|---|---|---|---|
| ES Mitigation (AP5) - performance presented in 'Do Something ES (Appendix E) | 092+270 | 092+500 | Up | 230 | 2 | Noise Mitigation ID 092-NB1E<br>Noise barrier (2m above rail)<br>EOC recommendation to provide low barriers (2m above rail) on the approach embankments to Westbury viaduct on the up (east) side of the alignment between Ch 092+320 to 092+500 (Ref: Study area CSV14-C03). NOTE: CP2 Operational noise mitigation checks and critical changes identifies an additional length of barrier between 092+270 and 092+320, |
| | 092+500 | 092+800 | Up | 300 | 1.4 | Mitigation ID 092-NB2E<br>Noise barrier (1.4m kerb barrier on viaduct). EOC recommendation to provide a 1.4 kerb barrier across Westbury viaduct on the up (east) side of the alignment between Ch 092+500 to 092+800 |
| | 092+850 | 093+060 | Up | 210 | 2 | Mitigation ID 092-NB3E<br>Noise barrier (2m above rail). EOC recommendation to provide |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | low barriers (2m above rail) on the approach embankments to Westbury viaduct on the up (east) side of the alignment between Ch 092+320 to 092+550 |
| | 093+000 | 095+550 | Down | 2550 | - | Turweston Cutting provides mitigation for a significant noise effect on the left (west) side of the alignment between Ch 093+000 to 095+550 |
| | 093+100 | 095+360 | Up | 2260 | - | Turweston Cutting provides noise benefit on the right (east) side of the alignment between Ch 093+100 and 095+360. |
| Scheme design bund provision | 91+900 | 92+280 | Up | 380 | 3 min | Varies from 3m above GL at 91+900 to 3m above TOR at 92+280 |
| | 91+780 | 92+280 | Down | 500 | 3 min | Varies from 3m above GL at 91+780 to 3m above TOR at 92+280 |
| | 93+000 | 93+200 | Up | 200 | 3 min | Varies from 3m above TOR at 93+000 to 3m above GL at 93+200 |
| | 93+000 | 93+230 | Down | 230 | 3 min | Varies from 3m above TOR at 93+000 to 3m above GL at 93+230 |
| Noise Barrier Design Option 1 | 92+320 | 92+535 | Up | 215 | 1 | Absorptive barrier |
| | 92+535 | 92+855 | Up | 320 | 1.25 | Absorptive barrier on viaduct parapet |
| | 92+855 | 93+080 | Up | 225 | 1 | Absorptive barrier |
| Noise Barrier Design Option 2 | 92+320 | 92+535 | Up | 215 | 2 | Absorptive barrier |
| | 92+535 | 92+855 | Up | 320 | 1.25 | Absorptive barrier on viaduct parapet |
| | 92+855 | 93+080 | Up | 225 | 2 | Absorptive barrier |
| Noise Barrier Design Option 3 | 92+320 | 92+535 | Up | 215 | 3 | Absorptive barrier |
| | 92+535 | 92+855 | Up | 320 | 1.25 | Absorptive barrier on viaduct parapet |
| | 92+855 | 93+080 | Up | 225 | 3 | Absorptive barrier |

*Table 40 Summary of noise mitigation options – Westbury Viaduct*

A cost benefit analysis has been carried out for the daytime and night-time $L_{eq}$ levels and the results are presented in Table 42 for the above mitigation design options.

| Design Option | Noise impact and benefit | | | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost |
|---|---|---|---|---|---|---|---|---|
| | Impacts above LOAEL | | | TOTAL IMPACTS (sum of minor - major) | | WebTAG Change | | |
| | | Day | Night | Day | Night | | | |
| ES Levels | Negligible | 0 | 0 | 0 | 0 | N/A | N/A | N/A |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 0 | 0 | | | | | |
| No Noise Barrier | Negligible | 0 | 0 | 0 | 0 | N/A | N/A | N/A |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 0 | 0 | | | | | |
| Noise Barrier Design Option 1 | Negligible | 0 | 0 | 0 | 0 | £18,378 | £666,560 | 0.01 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 0 | 0 | | | | | |
| | Engineering and operational compatibility | | | Barrier height lower than ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height lower than ES scheme, therefore visual effects neutral. | | | | |
| Noise Barrier Design Option 2 | Negligible | 0 | 0 | 0 | 0 | £23,357 | £813,960 | 0.01 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 0 | 0 | | | | | |
| | Engineering and operational compatibility | | | Barrier height comparable to ES Scheme, no challenges to buildability. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height comparable to ES scheme, therefore visual effects neutral. | | | | |
| Noise Barrier Design Option 3 | Negligible | 0 | 0 | 0 | 0 | £23,357 | £961,360 | 0.01 |
| | Minor | 0 | 0 | | | | | |
| | Moderate | 0 | 0 | | | | | |
| | Major | 0 | 0 | | | | | |
| | Total above LOAEL | 0 | 0 | | | | | |
| | Engineering and operational compatibility | | | Barrier height higher than ES Scheme, therefore more panels and substantial foundations required. | | | | |
| | Visual Impacts/ compatibility with HS2 Design Vision | | | Barrier height higher than ES scheme, therefore visual effects higher. | | | | |

*Table 41 Cost Benefit Analysis $L_{eq}$ Daytime and Night-time – Westbury Viaduct*

The cost benefit analysis score of 0.01 for the Barrier Mitigation Design Options considered indicates that acoustic mitigation would not typically be justifiable.

Table 42 indicates that for all options and at the time of the ES there are no rail noise impacts above LOAEL, which is confirmed in Table 43, which compares the ES and the levels predicted for each considered Design Mitigation Option; the receptors above LOAEL have been shaded in red.

| 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: - 1m barrier; | | Option 1 +Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 2 Scheme only: - 2m barrier; | | Option 2+Opening Year Baseline +Year 15 Traffic LAeq dB | | Option 3 Scheme only: - 3m 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** |
| 281733 | Mill Lane, Westbury | 51 | 51 | 42 | 46 | 37 | 52 | 44 | 49 | 39 | 52 | 44 | 48 | 39 | 53 | 44 | 46 | 37 | 52 | 43 | 46 | 36 | 52 | 43 |
| 281804 | Brackley Road, Westbury | 5 | 49 | 41 | 43 | 34 | 50 | 42 | 45 | 37 | 50 | 42 | 44 | 35 | 50 | 42 | 43 | 33 | 50 | 42 | 42 | 33 | 50 | 42 |
| 281858 | Westbury, Brackley | 1 | 52 | 47 | 40 | 32 | 52 | 47 | 38 | 28 | 52 | 47 | 38 | 28 | 52 | 47 | 38 | 28 | 52 | 47 | 38 | 28 | 52 | 47 |
| 282403 | Mill Lane, Westbury | 14 | 49 | 41 | 43 | 33 | 50 | 42 | 45 | 36 | 50 | 42 | 44 | 34 | 50 | 42 | 43 | 33 | 50 | 42 | 42 | 33 | 50 | 42 |
| 282953 | Orchard Place, Westbury | 3 | 49 | 41 | 43 | 34 | 50 | 42 | 45 | 37 | 50 | 42 | 44 | 34 | 50 | 42 | 42 | 33 | 50 | 42 | 42 | 32 | 50 | 42 |
| 283304 | Brackley Road, Westbury | 11 | 49 | 41 | 42 | 33 | 50 | 42 | 45 | 36 | 50 | 42 | 44 | 34 | 50 | 42 | 42 | 33 | 50 | 42 | 41 | 32 | 50 | 42 |

*Table 42 Consideration of Material Change at most affected receptor grouping*

Table 44 below summarises the changes in noise levels due to each scenario, compared with Do Nothing scenario. The ES did not identify any significant effects in Westbury. The No Barrier Option and Noise Barrier Design Options 1 to 3 do not present with any additional effects over what was reported in the HS2 Phase 1 ES.

| ID | Area Represented | No of Impacts Represented | Significant Effect | ES Design | | Change in Noise Levels Compared with Do-Nothing Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | DM - ES Design | | DM - No Barrier | | DM - 1m Barrier | | DM - 2m Barrier | | DM - 3m Barrier | |
| | | | | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night |
| 281733 | Mill Lane, Westbury | 51 | | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 281804 | Brackley Road, Westbury | 5 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 281858 | Westbury, Brackley | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 282403 | Mill Lane, Westbury | 14 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 282953 | Orchard Place, Westbury | 3 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 283304 | Brackley Road, Westbury | 11 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

*Table 43 Consideration of Receptors above LOAEL at most affected receptor grouping - Westbury*

The $L_{max}$ predictions presented in Table 45 are free-field predictions and would therefore be compared against a LOAEL of 57.5dB as corrected from the $L_{max}$ LOAEL of 60dB.

| ID | Area Represented | No of Impacts Represented | Lmax No Barrier Option | Lmax Design Option 1 (1m) | Lmax Design Option 2 (2m) | Lmax Design Option 3 (3m) | Lmax ES |
|---|---|---|---|---|---|---|---|
| 281733 | Mill Lane, Westbury | 51 | 66 | 66 | 66 | 66 | 59/62 |
| 281804 | Brackley Road, Westbury | 5 | 61 | 61 | 61 | 61 | 56/59 |
| 281858 | Westbury, Brackley | 1 | 51 | 51 | 51 | 51 | 50/53 |
| 282403 | Mill Lane, Westbury | 14 | 59 | 59 | 59 | 59 | 55/58 |
| 282953 | Orchard Place, Westbury | 3 | 62 | 62 | 62 | 62 | 58/61 |
| 283304 | Brackley Road, Westbury | 11 | 60 | 60 | 60 | 60 | 55/58 |

*Table 44 LAmax levels for the Mitigation Design Options considered compared to ES – Free-Field*

The cost benefit analysis for the $L_{max}$ predictions are presented in Table 46. The cost benefit analysis scores of 0.00 for Noise Barrier Mitigation Design Options 1 and 2 indicate that the mitigation should not typically be included in the design.

The $L_{max}$ levels for the No Barrier Mitigation Option, Barrier Mitigation Design Option 1 and Barrier Mitigation Design Option 2 all show an equivalent number of impacts (84 impacts) above LOAEL as presented in the ES (84 impacts).

The $L_{max}$ increases noted at all receptors except 281858 may be attributed to the changes in scheme design since the ES, including but not limited to elevation of the track by 3m since the writing of the ES.

| Design Option | Number of Noise Impacts | | | | Estimated additional cost over unmitigated design | Noise to Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Above LOAEL | Above SOAEL (77.5LAmax) and more than 20 events per night | Significant Effect above SOAEL | WebTAG Change | | |
| ES Levels | 84 | N/A | 0 | N/A | N/A | N/A |
| No Noise Barrier | 84 | 0 | 0 | N/A | N/A | N/A |
| Noise Barrier Design Option 2 | 84 | 0 | 0 | £0 | £666,560 | 0.00 |
| Noise Barrier Design Option 2 | 84 | 0 | 0 | £0 | £813,960 | 0.00 |
| Noise Barrier Design Option 3 | 84 | 0 | 0 | £0 | £961,360 | 0.00 |

*Table 45 Cost Benefit Analysis $L_{max}$ Levels – Westbury Viaduct*

Based on the appraisal for $L_{eq}$ daytime and night-time in Table 42, Table 43 and Table 44, and the appraisal for $L_{max}$ values in Table 45 and Table 46, it is recommended that noise barriers would not be considered as part of the mitigation design The Design option that presents the narrowing of the track corridor and the earthworks design provides appropriate mitigation and is the recommended mitigation option.

- Summary of Acoustic Barrier Requirements

Based upon the assessments and considerations informing this report the noise barrier requirements for IDR G are summarised below.

| Location | Start Chainage | End Chainage | Up/Down Line | Length (m) | Height above ToR (m) |
|---|---|---|---|---|---|
| Twyford Viaduct | 81+219* | 82+289 | Down | 1089 | 4 |
| | 82+289 | 82+349 | Down | 60 | 1.85 |
| | 82+289 | 82+349 | Up | 60 | 1.25 |
| | 82+349 | 82+500 | Down | 151 | 3 |
| Godington Viaducts | No mitigation in the form of noise barriers required. Mitigation afforded by the scheme and earthworks design | | | | |
| Chetwode Newton Purcell | 85+060 | 87+200 | Up | 2140 | 5 |
| | 87+800 | 88+000 | Up | 350 | 3 |
| Finmere to Mixbury | 89+900 | 90+480 | Up | 580 | 3 |
| Westbury | No mitigation in the form of noise barriers required. Mitigation afforded by the scheme and earthworks design | | | | |

*The barrier falls within IDR K, but has been assessed as part of a composite barrier system to afford protection to the Twyford community

# APPENDIX A

## Noise Modelling Methodology

Number of Pages: 3

**Noise Modelling Methodology**

The noise modelling is based on the procedures as described below.

- *The source heights used in the prediction of airborne sound from HS2 trains are modelled as follows:*
  - ***rolling sound, at a height of 0m above rail head**, which includes sound emitted by the wheels and the track;*
  - ***body aerodynamic sound, at a height of 0.5m above rail head**, which includes sound generated by flow in the lower regions of the train;*
  - ***starting sound, at a height of 2.0m above rail head**, which includes sound generated by power, traction and auxiliary systems;*
  - ***pantograph recess aerodynamic sound at a height of 4.0m above rail head**; and*
  - ***raised pantograph aerodynamic sound at a height of 5.0m above rail head**.*

*In the prediction 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.*

The noise modelling presents predictions 15 years from the opening of the HS2 line in accordance with the HS2 ES, and maintains the same assumptions made in the ES with regard to modelling variables such as meteorological conditions and wind speeds.

In November 2018 HS2 Ltd Instructed the Main Works Construction Contractors (MWCCs) (EDC 052-Update of noise and vibration source terms for MWCC & SDSC acoustic design) to use a revised train service pattern together with the revised noise source terms for the noise assessment from that presented in the ES, as shown in Table 3 (PH1-HS2-EN-PPR-000-000052 Phase 1 Flow Information for Acoustics Modelling). The revised flow pattern and noise source data has been presented to the Phase 1 Planning Forum Environmental Health sub-group and is implemented across all noise modelling and prediction.

| SEL Source | Captive (CP) train same as ES mitigated train, Conventional Compatible (CC) train with 1dB total increase at 360 km/h due to body aerodynamic noise. No Just TSI train (TSI trains excluded). | |
|---|---|---|
| | **CP on Slab** | **CC on Slab** |
| R (rolling noise) | 42.1 dB | 42.1 dB |
| B (body aerodynamic) | -59.9 dB | -57.9 dB |
| S (starting/traction noise) | 98.7 dB | 98.7 dB |
| P (recess) (pantograph recess) | N/A | N/A |
| P (pantograph) | -74.3 dB | -74.3 dB |
| Total $L_{Aeq,Tp}$ at 320 km/h | 90.0 dB | 90.9 dB |
| Total $L_{Aeq,Tp}$ at 350 km/h | 91.9 dB | 93.0 dB |
| Total $L_{Aeq,Tp}$ at 360 km/h | 92.5 dB | 93.6 dB |

*Table A1 Noise Source Terms (August 2018)*

The train flow pattern information is provided in PH1-HS2-EV-MOD-000-000002 P01 Phase 1 Flow Information for Acoustics Modelling' as presented in Table 5.

| Fleet Composition | Section | Speed km/h | Total 16hr Day | Total 8hr Night |
|---|---|---|---|---|
| Conventional Compatible (Catch-Up) | 3A | 360 | 22 | 1 |
| Conventional Compatible (330) | 3B | 330 | 191 | 12 |
| Captive (Catch-Up) | 3C | 360 | 22 | 1 |
| Captive (330) | 3D | 330 | 222 | 13 |
| **Total** | | | **460 (Rounded)** | **30 (Rounded)** |

*Table A2 Train Flows (one way) to inform sound assessment (November 2018)*