14/00150/DISC

Noise Scheme of Assessment for Route Section F

Chiltern Railways

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Reference: 0221083/11/F07

Author: Jamie Hogg

Technical Reviewer: Mike Fraser

For and on behalf of
Environmental Resources Management

Approved by: Kirsten Berry

Signed:

Position: Partner

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ANNEXES

1 INTRODUCTION

In October 2012, the Secretary of State made the Chiltern Railways (Bicester to Oxford Improvements) Order 2012 (the Order). This Transport and Works Act Order authorises the construction and operation of an improved railway between Bicester and Oxford. The Order is accompanied by a planning direction (or 'deemed planning permission') granted by the Secretary of State, which is subject to a number of conditions.

Certain of the planning conditions require that detailed designs or other information are submitted to, and approved by, the local planning authority, which may be either the Cherwell District Council, or Oxford City Council, or both.

The conditions relating to operational noise comprise 19(1) to 19(14) which require approval of *Schemes of Assessment* of the predicted noise and vibration impacts of Phases 1, 2A and 2B by the relevant local planning authorities. This document forms one such *Scheme of Assessment* and sets out both the methodology that has been used to assess noise from the Order Scheme, identifying the requirements for noise mitigation measures and the effects of operation noise with mitigation.

Planning condition 19(1) requires operational noise monitoring and mitigation to be carried out in accordance with the *Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1)* (The Policy). The requirements for mitigation result from both The Policy and the planning conditions, which operate together to ensure that noise mitigation is appropriately specified.

The scope of this *Scheme of Assessment* covers noise as a result of railway vehicles using the Order Scheme following the principles of The Policy. Vibration from the Order Scheme is addressed in a separate *Scheme of Assessment*.

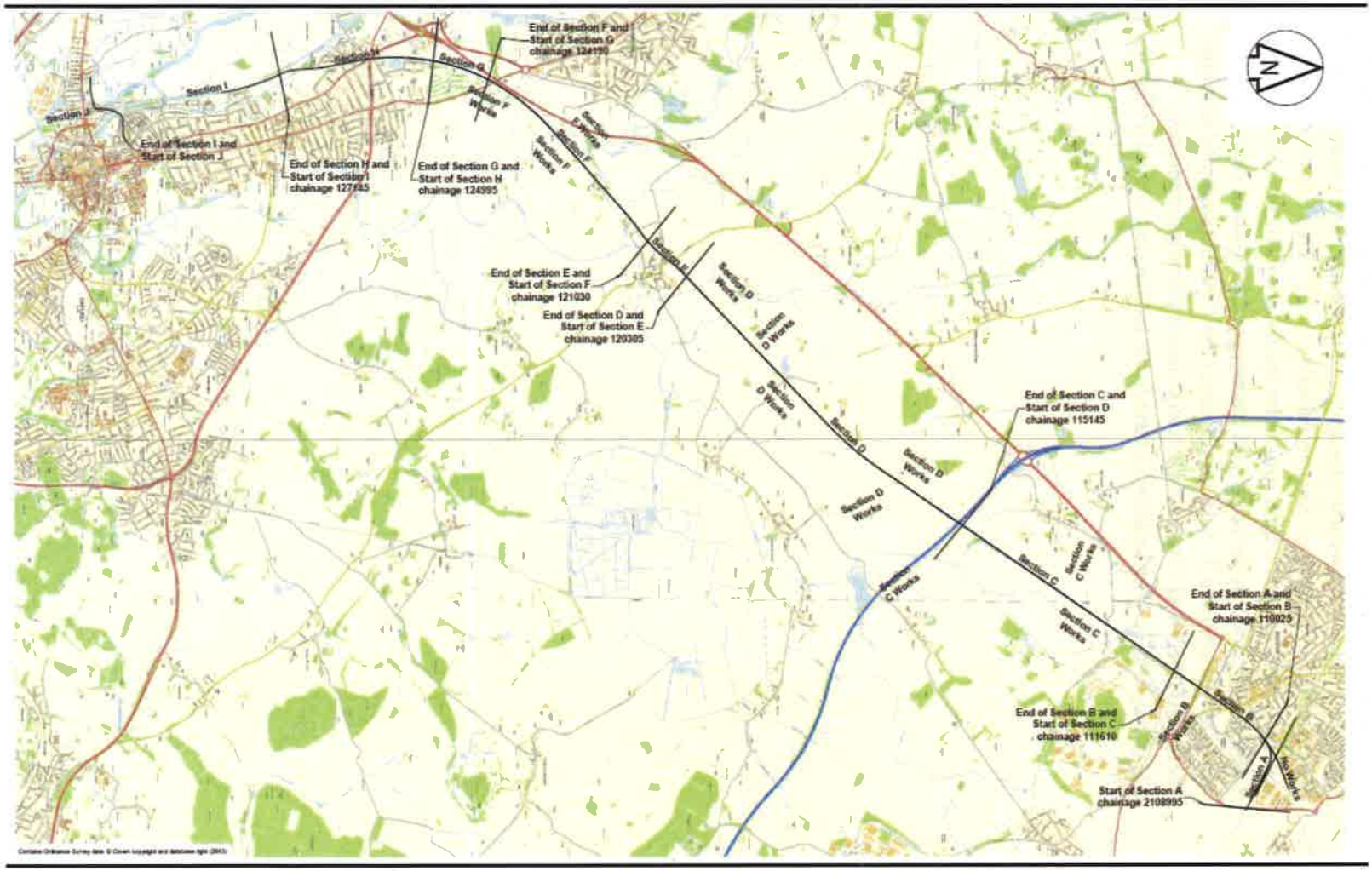
Directional public address systems will be used that minimise the impact on nearby properties whilst maintaining audibility on platforms. The station operator will establish appropriate sound levels for station public address systems and will seek to address complaints, if they are received from occupiers of noise sensitive premises, as far as is reasonably practicable within railway safety requirements.

Although mitigation measures for noise from fixed plant are not covered in The Policy, standards are set in the Environmental Statement (ES) (1), and these will be implemented during the design process.

(1) Transport and Works Order Application Document CD/1.16, volume 2, chapter 6.

Since the work on the Order Scheme will progress in sections, the planning conditions require *Route Sections* to be defined, and a separate *Scheme of Assessment* is to be undertaken for each *Route Section*. The Order Scheme has been divided into 10 *Route Sections* (labelled A – J). This *Scheme of Assessment* covers *Route Section F*, which runs from the south of Islip to Oxford Parkway Station, as defined in the approved discharge of conditions document, *Discharge of Condition 3 - Sections* (Oxford City Council planning reference 13/00918/CND and Cherwell District Council planning reference 13/00106/DISC). The locations of the *Route Sections* are shown in *Figure 1.1*.

Figure 1.1 ***Route Sections***



This document has been structured as follows:

- *Chapter 2* establishes the principles for evaluating noise from the operation of the Order Scheme;
- *Chapter 3* sets out the method used to predict noise from the railway;
- *Chapter 4* presents the existing baseline noise conditions, including additional baseline measurements which were found to be appropriate to inform the mitigation design;
- *Chapter 5* presents the results of the evaluation of noise from the operation of the Order Scheme, and the noise mitigation required; and
- *Chapter 6* describes the monitoring protocol that will be adopted to monitor noise.

A copy of The Policy is provided at *Annex A* for reference and the relevant planning conditions are included in *Annex B*. *Annex C* provides a glossary of acoustic terms. *Annex D* provides supporting information and where necessary, calculations and printouts from recognised computer software, to show how the standards of noise mitigation set out in The Policy will be achieved as required by the planning conditions. *Annex E* sets out details of the baseline noise data to which this document refers.

2 PRINCIPLES FOR THE EVALUATION OF NOISE FROM THE ORDER SCHEME

2.1 INTRODUCTION

The method for evaluating when noise impacts occur is based on the methodology in the ES (volume 2, chapter 6). The procedures for identifying when noise mitigation will be implemented are defined in The Policy following an approach that is consistent with the ES. Key extracts from The Policy are repeated in the following sections. The paragraph numbering presented in square brackets corresponds to The Policy. The Policy is provided in full at *Annex A*.

2.2 PRINCIPLES OF THE NOISE AND VIBRATION MITIGATION POLICY

[2.1] *The Policy is intended to ensure that noise and vibration mitigation is provided on a fair basis for all landowners and occupiers affected by the Order Scheme.*

[2.2] *The Promoter is committed to using the Best Practicable Means (1) to design the railway so as to avoid significant noise and vibration impacts at existing sensitive receptors (e.g. residential properties, educational buildings and places of worship). The first preference will be to apply necessary noise control measures at source where this is reasonably practicable. These may include rail damping or other infrastructure measures to reduce noise at source. Where this is not reasonably practicable or sufficient to mitigate significant noise impacts, the Promoter will:*

- *where they are effective and reasonably practicable to install, provide noise barriers to mitigate noise between the track and sensitive receptors; and*
- *after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, offer noise insulation to properties where residual noise impacts on sensitive receptors remain high.*

[2.3] *The Promoter will consult with landowners and occupiers who may be affected by noise and vibration to explain the mitigation measures that are proposed.*

The assessment of noise uses technical terms, which are described in Annex A (of The Policy). The provision for noise mitigation will be based on two sets of absolute noise levels (2). The first are 'Noise Impact Threshold' levels, below which noise impacts are never significant. The second set of levels are the 'Noise Insulation Trigger' levels. These are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field (3) noise levels.

(1) Best Practicable Means are defined in Section 72 of the Control of Pollution Act 1974 as those measures which are "reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge, financial considerations and compatibility with safety and safe working conditions"
(2) The standards relate to disturbance of building occupants, and do not relate to specific effects such as speech interference.
(3) Free-field means away from reflective surfaces, except the ground.

Noise Impact Threshold Levels: *Day* - $L_{Aeq,\ (0700\text{-}2300\ hours)}$ *55 dB* [1]
Night – $L_{Aeq,\ (2300\text{-}0700\ hours)}$ *45 dB*

[2.4] *Where train noise is predicted to be above either of these threshold levels, but where the level is still less than that set out in the Noise Insulation Regulations requiring noise insulation to be provided, the Promoter will provide mitigation measures to reduce the adverse impact of noise. These will vary according to the extent to which the train noise level exceeds the threshold levels and the extent to which overall noise is increased above the existing or ambient noise level, as follows:*

- *exceedances of 3 dB or greater and increases of 3 dB or greater – mitigation at source through rail infrastructure solutions will be implemented where reasonably practicable;*

- *exceedances of greater than 5 and up to 7 dB and increases of greater than 5 dB and up to 7 dB - at source and/or in the form of noise barriers if reasonably practicable and have no other negative effects; and*

- *exceedances of greater than 7dB and increases of greater than 7dB – at source through rail infrastructure solutions and where these cannot be reasonably practicably achieved, noise barriers will be provided, where reasonably practicable.*

These standards are consistent with those applied in the Environmental Statement, where noise mitigation is considered at source for impacts that are greater than 3 dB and in the form of noise barriers for impacts above a minimum of 5 dB. (Noise impacts in the ES are calculated by considering both the exceedance of the threshold criteria and the increase in overall noise, and taking the lower of the two.) The noise benefits of noise barriers are more likely to outweigh any dis-benefits, where the noise increase is above 7 dB. There are certain locations where because of the topography of the railway and adjacent properties, safety or visual impact, barriers cannot be installed or will not be effective.

[2.5] *Noise barriers or other noise attenuating infrastructure solutions will achieve noise reductions in most areas, to near to the existing noise levels. However residual noise impacts may still occur at particular locations. If, after consideration of the effects of noise mitigation measures at source, any of the Noise Insulation Trigger levels is still exceeded, then noise insulation to relevant properties will be offered, provided the corresponding existing or ambient noise level is routinely exceeded by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations. The noise level thresholds at which this will be offered are shown below in terms of free-field noise levels that are equivalent to the façade levels provided for in the Regulations.*

(1) $L_{Aeq,\ T}$ is the A-weighted equivalent sound level over the period T. A-weighting is a frequency weighting that replicates the frequency response of the ear. $L_{Aeq,\ T}$ is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. It is recommended parameter for train noise.

Noise Insulation Trigger Levels — *Day* > $L_{Aeq,\ (0600\text{-}0000\ hours)}$ *66 dB* (1)
Night > $L_{Aeq,\ (0000\text{-}0600\ hours)}$ *61 dB*

[2.6] *Even with the mitigation in paragraph 2.5, some of the properties close to the railway may still experience residual noise impacts that may be classed as 'high'. A 'high' impact is the equivalent of a noise impact of greater than +10 dB. If these properties are not already to be provided with insulation under the Noise Insulation Regulations, they will be offered additional mitigation, which is likely to be in the form of noise insulation.*

[2.7] *If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field)at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance, except where ambient maximum noise levels are already above the predicted train noise level. One or two events per night would not be interpreted as regular, but the 8 assumed freight movements each night in Phase 2B are considered to be regular. In those very few locations likely to have such noise effects, additional noise attenuation measures will be taken to include the offer of noise insulation to affected properties. This form of mitigation is particularly effective in addressing night-time noise impacts when noise levels inside buildings are the key factor as regards sleep disturbance. The following additional criterion for noise insulation is therefore being applied.*

Significant impact, need for further mitigation likely to be noise insulation: — *Night* > L_{Amax} *82 dB* (2)

Section 1.7 of The Policy includes the commitment to refine the mitigation that was developed for the ES following the principles set out in The Policy. It is intended to ensure that the residual noise effects at any location are no worse than those reported in the ES.

Refined noise level predictions were modelled during the public inquiry and the results of this analysis were communicated to third parties who had a specific interest in noise levels. These were reported in the *Note on Refined Noise Modelling and Monitoring* (CRCL/INQ/32). The public inquiry confirmed that it was Chiltern Railways' intention to ensure, where practicable, that residual noise effects at these receptors are no worse than reported.

2.3 *ADDITIONAL MITIGATION REQUIREMENTS IN PLANNING CONDITIONS*

There were no specific commitments made during the public inquiry to provide mitigation in this *Route Section*, or to carry out further baseline monitoring, that is not otherwise covered by The Policy or the planning conditions.

(1) Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations, where it is defined as 0600 hours to midnight. These noise levels are free-field values that are equivalent to the values defined in the Noise Insulation Regulations.
(2) L_{Amax} is a measure of the peak noise level, A-weighted.

3 RAIL NOISE PREDICTION METHODOLOGY

3.1 SELECTION OF ASSESSMENT SCENARIO

This section describes the railway noise prediction methodology that has been used in this *Scheme of Assessment*.

The Policy was developed to allow for a sequence of construction (as described in paragraphs 1.1 to 1.3 of The Policy). In this sequence *Phases 1* and *2A* were expected to be undertaken by Chiltern Railways soon after the Order was granted. Further works, in *Phase 2B*, were expected to take place at a later date, and to be undertaken either by the East West Rail (EWR) Consortium or others on behalf of Network Rail. However, the EWR project is being progressed and it is now intended to carry out all of the works authorised by the Order (ie all of the Phases set out above) during a single combined construction period. Therefore, this *Scheme of Assessment* includes mitigation designed to take account of the combined railway noise from all of the phases of the Order Scheme (*Phase 1*, *2A* and *2B*).

The Order Scheme, as now to be built, includes double track throughout *Route Sections A* to *H*, resulting in tracks in some locations being closer to receptors than would have been the case if only *Phases 1* and *2A* were to be built. This Scheme of Assessment has been based on the assumed train frequencies for *Phase 2B* set out in The Policy, and assesses a 'worst case' in terms of unmitigated noise impact. Until other parts of EWR, between Bicester and Bletchley, have permission and are built, the additional freight and passenger services, assumed for *Phase 2B*, as described in paragraphs 1.8 and 1.9 of The Policy, are unlikely to be operated. The 'worst case' assessed in this *Scheme of Assessment* will not arise until those services are operating.

3.2 METHODOLOGY

Noise sensitive receptors (NSRs) were identified in the ES to represent properties likely to be worst affected by noise from the Order Scheme. Subsequently, additional receptors were included which represented third parties who had a specific interest in noise levels during the public inquiry. Noise levels at these receptors have been predicted according to the methodology in the CRN [1] for L_{Aeq} noise levels, whilst the Nordic Method [2] has been used to calculate maximum noise levels. Details of the train types and service information that have been used in the prediction of noise levels are presented in *Annex D*.

(1) Calculation of Railway Noise 1995. The DoT

(2) Nord 2000 New Nordic Prediction Method for Rail Traffic Noise, H J Jonasson and S Storeheier, 2001.

Although the results of this assessment have only been presented numerically for the NSRs outlined above, all NSRs have been considered when determining noise mitigation. *Figure* 5.1 in *Section* 5 presents all noise mitigation measures in this *Route Section* as well as residual noise levels contours.

An initial assessment of eligibility for noise insulation under the Noise Insulation Regulations [1] (NIR or the Regulations) has been carried out. This has been based on noise from trains in accordance with the Regulations. Noise levels have been predicted according to the methodology in the CRN, using the time periods specified in the Regulations (the day-time period is defined as the period of 18 hours between 06.00 and midnight, the night-time period means the period of six hours between midnight and 06.00). Train service levels have been adjusted accordingly.

3.3 *Model Inputs*

The Policy requires that noise and vibration mitigation will be designed based on the assumptions in paragraphs 1.8 and 1.9 of The Policy (see *Annex A*) regarding the numbers and timing of train movements. These and the other assumptions that have been used, for example in relation to types of rolling stock and train lengths, are the same as those used in the ES, except for the exclusion of an assumed Cross Country passenger service that is no longer planned.

Speed profiles and other input data have been used to model the worst case likely noise levels. The source information and assumptions that were assumed for the modelling are discussed in detail in *Annex D*.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (as amended 1998).

4 EXISTING BASELINE NOISE

4.1 SUMMARY OF MEASURED DATA

4.1.1 Introduction

The Policy includes standards that take into account the change in existing noise levels, consequently an understanding of the baseline noise environment is required to assess the need for noise mitigation. The sources of baseline noise data that have been used in this *Scheme of Assessment* are described in this section.

The baseline noise levels assumed in this *Scheme of Assessment* are summarised at the end of this section. The detailed baseline noise measurement results are included in *Annex E*.

4.1.2 Environmental Statement Baseline Monitoring

Representative NSR locations in the *Route Section* covered by this *Scheme of Assessment* were identified in the ES (volume 2, chapter 6) as follows:

- ES 11 Kareol;
- ES 12 Mill Farm, Mill Street; and
- ES 13 Northfield Cottages.

In addition, the following NSRs, identified subsequently during the public inquiry (representing a third party with a specific interest in noise levels), fall within this *Route Section*:

- PI 7 Prospect House, Mill Street;
- PI 8 The Grange, Mill Street;
- PI 9 Curtesy House, Mill Street;
- PI 10 Orchard Cottage, Mill Street;
- PI 11 Greengage Barn, Mill Street;
- PI 12 3 Mill Barn, Mill Street; and
- PI 13 4 Mill Barn, Mill Street.

Baseline noise levels have been measured and reported in the ES, at 23 Noise Monitoring Locations (NMLs) along the Order Scheme route, in order to assess the existing noise environment. Noise surveys were carried out between June 2nd and September 11th, 2009. Monitoring locations were chosen to identify the existing noise climate in areas likely to be most affected by the Order Scheme.

Figures 6.1a to *6.1q* of the ES show the NMLs. The following NML lies within this *Route Section*:

- NML(ES) 7 (Kareol).

This monitoring location and the NSRs at which noise has been assessed are identified in *Figure 5.1*.

4.1.3 *Subsequent Baseline Monitoring for the Public Inquiry*

Since publication of the ES, additional long-term, unattended monitoring has been carried out at several locations along the route. These surveys have been used to increase the baseline coverage in some areas, notably in Islip and in the Wolvercote area of north Oxford, where the topography and road locations may result in significant differences in existing noise levels. In other areas along the Order Scheme route, monitoring has been carried out in order to increase the level of detail. The results were reported in the Proof of Evidence of Michael Fraser at the public inquiry (1).

The additional noise monitoring was carried out in June and August 2010, at the following locations:

- Whimbrel Close, Bicester;
- Mill Street, Islip;
- Lakeside, Oxford;
- Blenheim Drive, Oxford; and
- Stone Meadow, Oxford.

The measurements at Islip are relevant to *Route Section F* covered by this *Scheme of Assessment*. The measurement location is shown in *Figure 5.1* as NML(PI) 2.

The measured noise levels are presented in *Tables E2.2* and *E2.3* of *Annex E.*

Monitoring was carried out over a period of several days so that unusual events and bad weather could be excluded. Measurements were made between the 18th and 21st of August 2010. The measurements (which do not include train noise) gave a range of 45 to 47 dB L_{Aeq} during the day, and 38 to 42 dB L_{Aeq} at night.

4.2 *BASELINE NOISE LEVELS ADOPTED FOR THE ASSESSMENT*

4.2.1 *Non-Statutory Provisions*

Ambient noise levels were found to vary from time to time, and in general the lowest ambient L_{Aeq} levels have been used to ensure a worst case assessment.

(1) Proof of Evidence of Michael Fraser (Noise and Vibration) CRCL/P/9/B).

The adopted baseline noise levels at NSRs are summarised in *Table 4.1*. This table identifies the NMLs at which noise measurements were taken, and the predicted train noise that has been added.

Table 4.1 ***Baseline Noise Levels Assumed for Scheme of Assessment – $L_{Aeq, period}$ (Free-field)***

Receptor	Noise Level without Trains, dB		NML Used	Noise Level with Baseline Trains, dB	
	$L_{Aeq, day}$	$L_{Aeq, night}$		$L_{Aeq, day}$	$L_{Aeq, night}$
PI 7 Prospect House, Mill Street	45	38	*NML(PI) 2*	45	38
PI 8 The Grange, Mill Street	45	38	*NML(PI) 2*	46	39
PI 9 Curtesy House, Mill Street	45	38	*NML(PI) 2*	45	38
PI 10 Orchard Cottage, Mill Street	45	38	*NML(PI) 2*	45	38
ES 11 Kareol	45	28	*NML(ES) 7*	55	52
PI 11 Greengage Barn, Mill Street	45	28	*NML(ES) 7*	45	33
PI 12 3 Mill Barn, Mill Street	45	28	*NML(ES) 7*	47	41
PI 13 4 Mill Barn, Mill Street	45	28	*NML(ES) 7*	48	42
ES 12 Mill Farm, Mill Street	45	28	*NML(ES) 7*	47	39
ES 13 Northfield Cottages	45	28	*NML(ES) 7*	48	42

4.2.2 *Statutory Provisions*

An initial assessment of eligibility for noise insulation under the NIR has been carried out. This assessment uses the time periods specified in the Regulations. The day-time period is defined as the period of 18 hours between 06.00 and midnight, while the night-time period means the six hours between midnight and 06.00.

The Regulations give a specific term for existing noise i.e. 'prevailing noise level', which is defined as the level of noise caused by the movement of trains on railways immediately before the start of construction. One of the steps in determining eligibility under the Regulations is to determine that noise from the Order Scheme exceeds the prevailing noise level by at least 1 dB(A).

The prevailing noise level has been predicted for NSRs in this *Route Section*, based on existing service levels as set out in *Annex D*. The results are presented in *Table 4.2*.

Table 4.2 ***Predicted Prevailing Noise Level (Free-field)***

Receptor	Predicted Prevailing Noise Level (Free-field), dB(A)	
	$L_{Aeq,day}$	$L_{Aeq,night}$
PI 7 Prospect House, Mill Street	26	25
PI 8 The Grange, Mill Street	35	34
PI 9 Curtesy House, Mill Street	26	25
PI 10 Orchard Cottage, Mill Street	26	25
ES 11 Kareol	54	53
PI 11 Greengage Barn, Mill Street	33	32
PI 12 3 Mill Barn, Mill Street	43	42
PI 13 4 Mill Barn, Mill Street	45	43
ES 12 Mill Farm, Mill Street	41	40
ES 13 Northfield Cottages	44	43

5 RESULTS OF THE EVALUATION OF NOISE FROM THE OPERATION OF THE ORDER SCHEME AND THE NOISE MITIGATION REQUIRED

5.1 INTRODUCTION

Planning condition 19(11) requires that:

The submitted schemes of assessment shall include a list of properties assessed and the results of the assessment at each.

In accordance with the condition, this section contains the list of properties that have been assessed and the results of the assessment at each location.

The results are reported in *Table 5.1* and *Table 5.2* and more detailed results are shown in *Annex D*.

5.2 PRACTICABILITY AND SELECTION OF NOISE MITIGATION

5.2.1 *Noise Control using Track and Wheel Based Measures to Reduce Noise at Source*

Track designs with an acoustic plenum (1) under the track and a low upstand, which have been used on light rail and tram schemes, were considered, but advice from the scheme engineers suggested that these were not appropriate for a high-speed or heavy haul railway.

Reductions in noise can be achieved by mitigating noise from vehicles at source and wheel dampers have been considered for this purpose. A test was carried out to consider the potential benefits of this noise control measure, the details of which are provided in *Annex D*. The results showed that under optimum conditions (for wheel dampers to be most effective), a reduction of less than 1 dB could be expected in the night time period (the time period critical to the assessment of impacts). Although Chiltern Railways could adopt such measures on their trains, neither they nor Network Rail could insist that other train operators using the line adopt such measures. On this basis, wheel dampers have been excluded as a practicable mitigation measure.

Track discontinuities on switches and crossings can result in elevated noise levels at nearby receptors. To minimise these, the design team has looked into the use of low noise designs such as 'lift over' crossings. However, the team's experience and research into such systems has shown that while these exist for light rail, they are not available for use on heavy rail schemes.

Rail dampers have been applied to railways in other countries, but they are not 'type approved' for use on the UK railway network on the relatively high

(1) An airspace which works as an acoustic silencer.

speed sections of track which are required for this project. Tata Steel has provided details of the only application in the UK of its Silent Track product, which is in a central London environment. Technical details of the performance of this product are provided in *Annex D*. Type approval requires substantial technical appraisal by Network Rail and there is no guarantee that such approval would be granted for application on this Scheme in time for it to be used. On this basis, the use of rail dampers will not be pursued as a practicable mitigation measure on this and other *Route Sections*.

Higher noise levels can occur when trains pass over steel or iron bridges compared to at-grade ballasted track as a result of the bridge structure vibrating and radiating noise, particularly when the rails are connected directly to it. Standard noise enhancement correction factors are provided in CRN to enable the effect of this to be calculated in the absence of structure specific data. Vibration isolating track form, using resilient track fixing clips, offer a potential method of reducing noise radiated from the bridge structure. The use of this type of track fixing option has, therefore, been considered on the Cherwell Viaduct (OXD 46).

Ballasted track will be used on this bridge as it reduces the need for track maintenance and there is sufficient depth to allow for it. The ballast layer will also provide vibration isolation between the track and the bridge, reducing the level of structure radiated noise (compared with direct fixing). The use of ballasted track, however, precludes the use of resilient track fixing clips as an additional track isolation measure, and it will not be used in this case.

Since no noise study data were available to quantify the reduction in track radiated noise from the use of ballasted track, the modelling has followed a conservative approach which assumes no reduction (ie the full bridge enhancement correction of 9 dB(A) has been included).

5.2.2 *Noise Barriers*

After considering noise control measures at source, the use of noise barriers to reduce significant noise impacts, as far as reasonably practicable, has been determined for locations where noise mitigation is required. Network Rail advises that there are constraints on the height to which barriers can be built and maintained, in a rail environment, which are summarised in *Box 5.1.* Noise barriers will be installed as close to the nearest running rail as is permitted by Network Rail, normally at a distance of 2.6 metres. Where barriers are proposed, they will normally be built to a height of 2.5 m, relative to rail height. Where lower heights have to be provided, this is set out in *Table* 5.1.

Box 5.1 ***Constraints on the Practicability of Noise Barriers***

Health and Safety

Under the Construction, Design and Management Regulation (2007) and the European Common Safety Method, the risks associated with the construction and maintenance of infrastructure must be reduced as far as reasonably practicable. These risks will increase with barrier height. Some specific examples are provided below:

- Barriers which are more than 3 m tall cannot practically be maintained from ground level, and instead, access platforms are required. These carry with them increased risks, including health and safety risks from working at height.
- Maintenance using access platforms can only be performed when trains are not running, ie, at night.
- Smaller fences pose less of a risk of obstructing the railway should extreme weather cause them to fail.

Difficulty

- In some locations, particularly on the public/non-railway side of the barrier, steep embankments can make it difficult or impossible to use access platforms.
- It is expected that the route will be electrified in the future. Once this happens, there will be a risk of people and equipment straying into the electrical cable exclusion zone for taller barriers and power to the overhead electrical cables will need to be isolated.
- Taller barriers require proportionately much larger foundations, to resist increased wind loading which results from the larger surface area. Where these foundations occur on top of embankments, there is a risk that the embankments may be destabilised.
- Large foundations may coincide with underground services and culverts. In avoiding these, it may be necessary to use non-standard barrier panel lengths which have associated higher costs and reduced flexibility.

Cost

The total installation cost, assuming good ground conditions and flat ground, rises in an approximately linear fashion with barrier height. Within this, the mobilisation costs (which remain the same for any height of barrier), mask the effect of the foundation costs (which rise far more rapidly with barrier height) on this total. In practice, the foundation costs are likely to have a greater effect on the overall cost where ground conditions are poor such as at the top of most railway embankments (which are generally built of ash and other waste).

Additional potential constraints on barrier height, including their landscape and visual impact, have also been taken into consideration. This process is summarised in *Table 5.1*.

Table 5.1 Design Considerations for Noise Mitigation

Area	Purpose of Noise Mitigation	Up / Down Line [1]	Start Chainage [2] (m)	End Chainage [2] (m)	Noise Barrier [3]	
					Input from Design Team on Practicability	Further Potential Constraints on Proposed Barrier
Kareol level crossing master's house, Islip	To protect Kareol level crossing master's house	Down	121180	121235	The maximum practicable height for a barrier is 2.5m (above rail height). Detailed input from the design team is presented in *Box 5.1*.	Barrier at 2.5 m high would reduce light to two windows facing the track and possibly windows facing the rear garden. 2.5 m barrier may also be out of keeping with scale of property as a whole. Barrier height will therefore be restricted to 2 m. The property lies particularly close to the railway. The property boundary / boundary of the Order Scheme permanent land take lies approximately 2.2 m from the nearest rail. It will be necessary to construct the noise barrier at this boundary instead of at the standard distance of 2.6 m from the nearest rail.
Southwest Islip	To protect properties on Mill Street	Up	121180	121360		A barrier height of 1.5 m is predicted to be sufficient to eliminate noise impacts from the Order Scheme at nearby properties, with the exception of 3 Mill Barn. A residual impact of 1 dB is predicted at this property with a 1.5 m high barrier, however the owners of this property expressed a preference for a 1 m high barrier and so this residual impact is considered acceptable.
		Up	121360	121405		A barrier height of 2 m is predicted to be sufficient to eliminate significant noise impacts from the Order Scheme at nearby properties.
		Up	121405	121515		A barrier height of 1.5 m is predicted to be sufficient to eliminate significant noise impacts from the Order Scheme at nearby properties.

Area	Purpose of Noise Mitigation	Up / Down Line [1]	Start Chainage [2] (m)	End Chainage [2] (m)	Noise Barrier [3]	
					Input from Design Team on Practicability	Further Potential Constraints on Proposed Barrier
To the south of Islip	To protect Northfield Farm and Cottages	Up	122000	122125		There are existing trees alongside the railway. Therefore, a 2.5 m barrier is not expected to result in any significant visual or overshadowing effects.

1) The Order Scheme (*Phase 1*, *2A* and *2B*) includes double track throughout *Route Sections A* to *H*. The tracks are identified as an 'Up' line (which carries trains running from Bicester to Oxford) and a 'Down' line (which carries trains running from Oxford to Bicester). As trains drive on the left, the Up line lies to the southeast of the Down line.
2) Project chainage for the Bletchley Line.
3) Barrier heights in this report are quoted relative to rail height. As a result, if the barrier is located on higher ground than the rail, then the actual height of the barrier will be lower than the quoted height. Conversely, if the barrier is located on lower ground than the rail, then the actual height of the barrier will be higher than the quoted height.

The length of the noise barrier adjacent to the Northfield Cottages is restricted by the Cherwell Viaduct (chainage 121910 m to 122000 m); the existing structure of the Cherwell Viaduct was not designed to resist the significant wind loading that noise barriers are subject to. It is not reasonably practicable to fundamentally redesign and reconstruct this multi-span viaduct to provide a noise barrier.

5.2.3 *Noise Control at Receiver*

Eligibility for further mitigation in the form of noise insulation has been established in The Policy (sections 2.5, 2.6 and 2.7 which are reproduced in *Section 2* of this *Scheme of Assessment*). Residential buildings will be considered for noise insulation where, even with other mitigation, the external noise levels result in a noise impact that meets the criteria in The Policy.

Following local authority approval of this *Scheme of Assessment* and the mitigation outlined, a detailed schedule of properties eligible for noise insulation will be compiled. This will be verified by contact with individual property owners and a building survey. *Table 5.2* presents the noise mitigation which is to be offered (including noise insulation).

5.3 *Results of the Noise Modelling Following Application of the Specified Noise Mitigation*

Noise mitigation, as detailed above in *Table 5.1* has been included in the noise modelling and residual impacts from the Order Scheme have been predicted at the NSRs identified in *Section 4*.

The location of the proposed noise mitigation measures are presented in *Figure 5.1*. Railway chainage numbers (provided by Network Rail) are provided in *Table 5.1*. The results of the noise modelling are presented in *Table* 5.2.

Figure 5.1 presents a noise contour figure, showing a variety of key noise predictions at a height of 5 m above ground (1st floor level) to represent the worst affected floor for the majority of NSRs. The following noise contours are included:

- Predicted residual (free field) noise level, $L_{Aeq,8h}$ of 45dB(A), for the night time period 23.00 - 07.00. Properties that lie outside the 45 dB(A) contour are not expected to experience a significant noise impact as a result of the Order Scheme.

- A residual impact of 10 dB for the night time period 23.00 - 07.00. Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.

- A maximum (free field) noise level $L_{Amax,s}$ of 82 dB(A). Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.

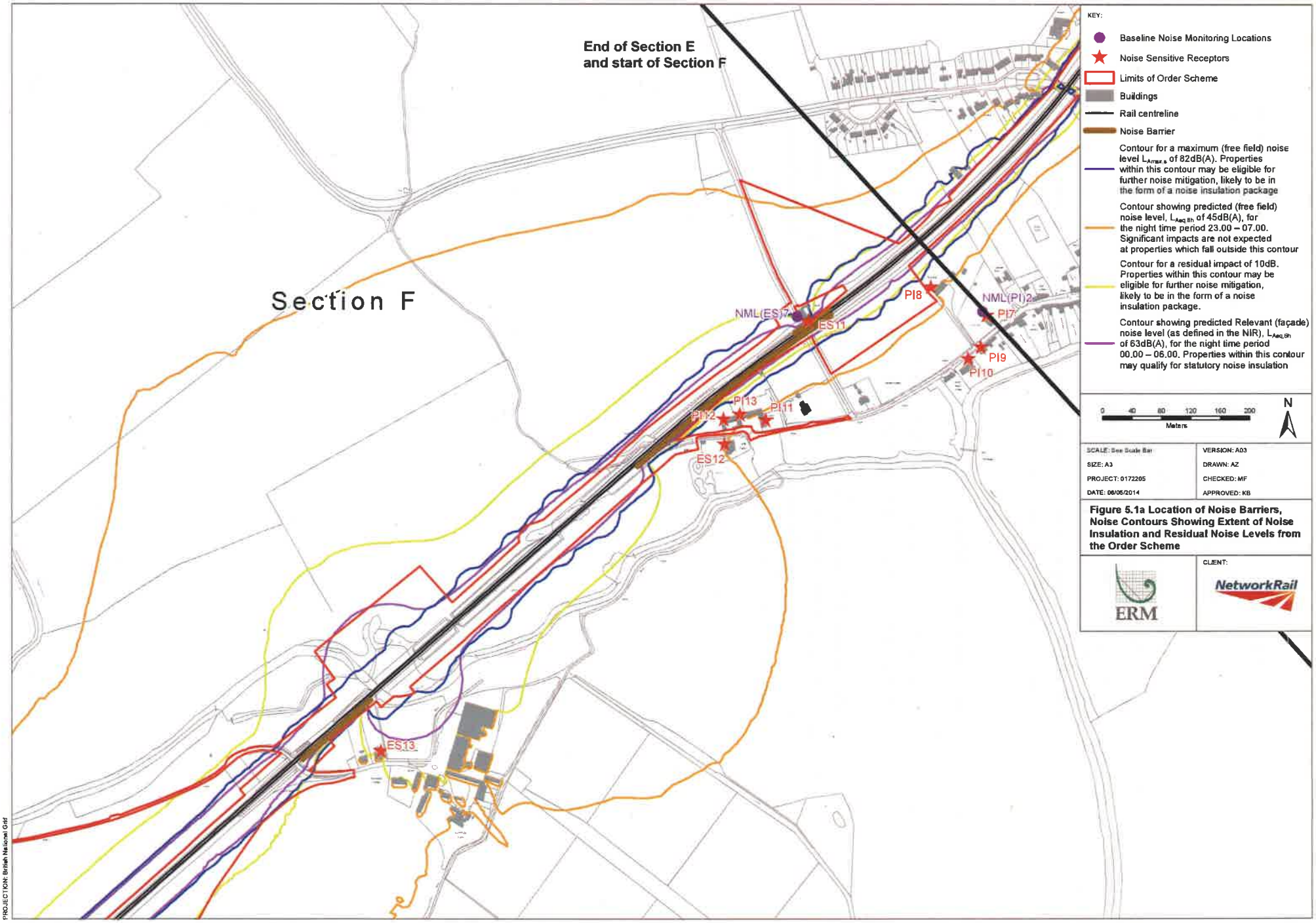
- Predicted relevant noise level (as defined in the NIR), $L_{Aeq,6h}$ of 63 dB(A), for the night time period 00.00 – 06.00. Properties within this contour may qualify for statutory noise insulation.

Use of the barriers proposed and additional noise insulation as outlined above will enable the noise from the Order Scheme to be mitigated in accordance with the principles of The Policy.

5.4 *INSTALLATION OF MITIGATION*

As set out in paragraph 1.11 of The Policy, noise mitigation measures will be installed prior to the commencement of the passenger rail services.

The approach being adopted allows for all residents to be kept informed at key stages and for those in properties immediately adjoining the railway, where mitigation measures are planned, to be kept informed individually and consulted at appropriate stages.



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Path: T:\Projects\0172205ChilternGIS_AZ_SG\MAPS\NOISE\SectionF\Figure 5_1a - Section F Noise Contours - A01.mxd

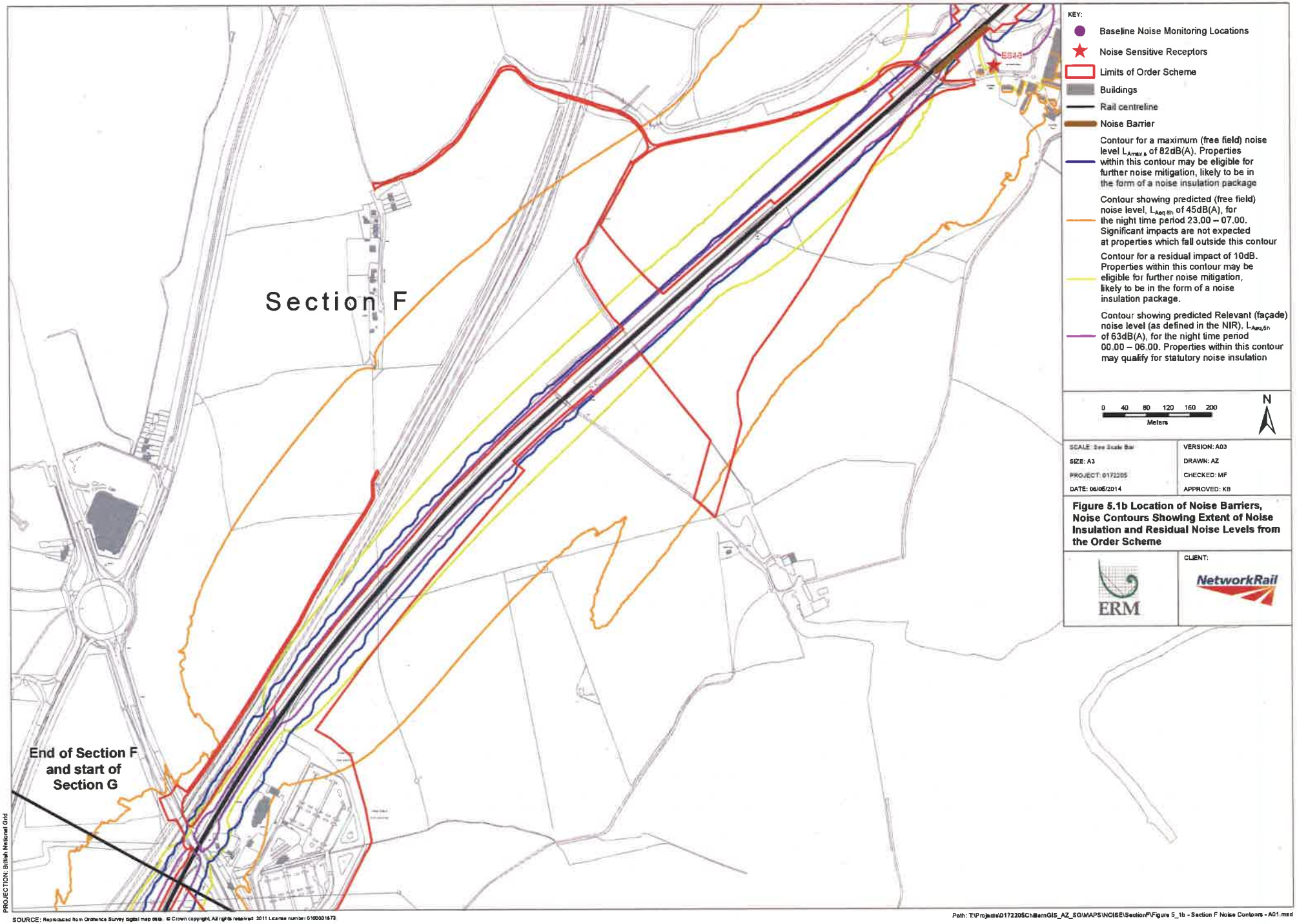
Section F
End of Section F and start of Section G
ES45
KEY:
Baseline Noise Monitoring Locations
Noise Sensitive Receptors
Limits of Order Scheme
Buildings
Rail centreline
Noise Barrier
Contour for a maximum (free field) noise level $L_{Amax,s}$ of 82dB(A). Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package
Contour showing predicted (free field) noise level, $L_{Aeq,8h}$ of 45dB(A), for the night time period 23.00 – 07.00. Significant impacts are not expected at properties which fall outside this contour
Contour for a residual impact of 10dB. Properties within this contour may be eligible for further noise mitigation, likely to be in the form of a noise insulation package.
Contour showing predicted Relevant (façade) noise level (as defined in the NIR), $L_{Aeq,6h}$ of 63dB(A), for the night time period 00.00 – 06.00. Properties within this contour may qualify for statutory noise insulation
0 40 80 120 160 200
Meters
N
SCALE: See Scale Bar
VERSION: A03
SIZE: A3
DRAWN: AZ
PROJECT: 0172205
CHECKED: MF
DATE: 06/05/2014
APPROVED: KB
Figure 5.1b Location of Noise Barriers, Noise Contours Showing Extent of Noise Insulation and Residual Noise Levels from the Order Scheme
ERM
CLIENT:
NetworkRail
PROJECTION: British National Grid
SOURCE: Reproduced from Ordnance Survey digital map data. © Crown copyright, All rights reserved. 2011 License number 0100031673
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Table 5.2 ***Results of the Noise Modelling***

Receptor	Relevant Floor[1]	Predicted Unmitigated Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ [2]	Proposed Mitigation	Predicted Residual Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ [2]	Noise Insulation (statutory [3] or non-statutory [4])
		Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)			Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)		
PI 7 Prospect House, Mill Street	1st floor	0	0	63	none	0	0	63	No
PI 8 The Grange, Mill Street	2nd floor	0	5	79	none	0	5	79	No
PI 9 Curtesy House, Mill Street	1st floor	0	0	65	none	0	0	65	No
PI 10 Orchard Cottage, Mill Street	1st floor	0	0	67	none	0	0	67	No
ES 11 Kareol	Ground floor	14	15	98	2m barrier [5]	0	1	79	No
PI 11 Greengage Barn, Mill Street	Ground floor	0	4	74	1.5m barrier [5]	0	0	66	No
PI 12 3 Mill Barn, Mill Street	1st floor	6	14	82	1.5m barrier [5]	0	1	73	No
PI 13 4 Mill Barn, Mill Street	Ground floor	7	15	87	2m barrier [5]	0	0	73	No
ES 12 Mill Farm, Mill Street	2nd floor	3	11	79	1.5m barrier [5]	0	0	70	No
ES 13 Northfield Cottages	2nd floor	7	14	76	2.5m barrier [5]	5	13	74	Yes Non-statutory

Receptor	Relevant Floor[1]	Predicted Unmitigated Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ [2]	Proposed Mitigation	Predicted Residual Impact (Free-field)		Maximum Noise Level, $L_{Amax,night}$ [2]	Noise Insulation (statutory [3] or non-statutory [4])
		Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)			Daytime ($L_{Aeq,16h}$)	Night-time ($L_{Aeq,8h}$)		

1) Worst affected floor level.
2) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: *If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance.* Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.
3) An estimation of the properties that may be eligible for statutory noise insulation under the NIR is presented. The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties.
4) Eligibility for non-statutory noise insulation is presented for the receptors identified in this report. The Promoter will confirm the extent of the mitigation required following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties. Further properties may be eligible in locations close to switches and crossings as the maximum noise level prediction methodology does not take account of this type of track form. Noise measurements will be carried out once the Order Scheme becomes operational to identify whether additional properties qualify. This is described further in *Section D3* of *Annex D*.
5) Barrier height relative to rail height.

As discussed in *Section 3*, although the results of this assessment have only been presented numerically for the NSRs identified in the ES and additional receptors representing third parties who had a specific interest in noise levels during the public inquiry, all NSRs have been considered when determining noise mitigation.

Mitigation measures are presented in *Table 5.1* and *Figure 5.1* to protect all NSRs in accordance with The Policy.

6 NOISE MONITORING AFTER CONSTRUCTION

Planning condition 19(1) requires that:

Operational noise and vibration monitoring and mitigation shall be carried out in accordance with the Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1, referred to in this condition as "the Policy") and this condition.

Condition 19(6) requires further that:

Any monitoring of noise and vibration shall be undertaken in accordance with the approved scheme of assessment and the Policy.

The noise monitoring scheme will follow the requirements of The Policy as follows:

[2.1] *A noise and vibration monitoring scheme for the Phase 1 and 2A works will be implemented to ensure that the performance of the mitigation measures that are installed achieve the levels of noise mitigation predicted by the design contractor, whose design instructions will include the requirement to achieve the residual noise levels set out in the Environmental Statement. The monitoring scheme will include the carrying out of surveys, the first being undertaken at around 6 months after the opening of the railway for Chiltern Railways passenger services, at locations agreed with the local planning authorities. A second survey will be undertaken 18 months after opening. If defects in construction or performance are identified in the first survey, these will be corrected in a timely manner by the contractor. If any defects in construction or performance are found in the second survey these will also be corrected in a timely manner by the contractor. The same procedure for post construction monitoring surveys and the remedy of defects or performance will be undertaken after the Phase 2B works have been completed and EWR services introduced.*

[2.2] *The results of the Phase 1 and 2A monitoring will be published in an easily accessible format on the Chiltern Railways website and in the project newsletter and will be made available, either in hard copy of in electronic format, to any person requesting the information. Arrangements for publishing the surveys after Phase 2B will be agreed with the local planning authorities.*

Because the Order Scheme is now being implemented as a single construction project only one noise monitoring programme is required. This will consist of two monitoring rounds at approximately 6 months and 18 months after the opening of the railway for railway services. The monitoring will consist of noise measurements carried out at the key receptors (for example those in the ES). Measurement locations will be agreed with the local planning authorities. The measurements will consist of measurements of sound exposure level and L_{Amax} at the most exposed floor of the NSRs. The individual measurements will be used to calculate the appropriate period L_{Aeq} values that represent the

train service outlined in The Policy and the ES (i.e. the full frequency of service).

As it is the performance of the mitigation measures that is required to be understood, measurements will also be made at an open location, where no mitigation is required, for a representative sample of trains. This will ensure that the unmitigated train noise levels are consistent with the assumptions made in the modelling. If, for some reason these are different to those that were assumed, the measured mitigated levels will be adjusted to take this difference into account so that the real effect of the mitigation can be established.

The results will be published in accordance with The Policy.

Annex A

Noise and Vibration Mitigation Policy

CD/1.29/2.1

NOISE AND VIBRATION MITIGATION POLICY

THE CHILTERN RAILWAYS (BICESTER TO OXFORD IMPROVEMENTS) ORDER

TRANSPORT AND WORKS ACT 1992

ERM

Chiltern Railways

JANUARY 2011

SUMMARY OF THE NOISE AND VIBRATION POLICY

The Noise and Vibration Policy has been adopted by Chiltern Railways to ensure that mitigation of noise and vibration from trains using the railway authorised by the Chiltern Railways (Bicester to Oxford Improvements) Order is provided on a fair basis for all occupiers and landowners along the route between Bicester and Oxford.

The Policy has been based on extensive research and modelling and offers a high standard of mitigation, comparable with other similar railway schemes in Britain.

The Policy will ensure that the following are achieved:

(i) Noise will be reduced at source where it is reasonably practicable to do so.

(ii) Where this is not reasonably practicable, noise barriers or noise insulation to properties will be provided, where necessary, in accordance with relevant standards.

(iii) Where predicted noise levels exceed relevant levels set out in the Noise Insulation (Railways and Other Guided Systems) Regulations, noise insulation will be offered to the occupiers of eligible buildings to the standards required by those Regulations and provided at their request.

(iv) At other locations, where statutory noise levels are not exceeded but where significant noise impacts are predicted, noise will be mitigated wherever reasonably practicable. Significant noise impacts include a significant increase in noise in an already noisy area, or the significant exceedance of stringent thresholds in an area where the ambient noise is currently low. Chiltern Railways has chosen to offer this high standard of mitigation. It is not a statutory requirement.

(v) Vibration from trains will not cause damage to structures, and even without mitigation, will be likely only to give rise to 'adverse comments from occupiers being possible' at a few properties that are located very close to the railway. At these locations, appropriate mitigation measures will be provided.

These commitments and the ways in which the Policy will be implemented are set out in the remainder of this Policy.

The Policy, which has been agreed with Network Rail, applies to any works authorised by the Transport and Works Act Order.

1. *HOW WILL THE POLICY BE APPLIED?*

INTRODUCTION

1.1. Chiltern Railway has applied for the Chiltern Railways (Bicester to Oxford Improvements) Order. The Order, if made, would allow for the railway works to be carried out in phases. Phase 1 consists of those works required to allow the operation of Chiltern Railways' proposed London Marylebone to Oxford passenger services together with the freight services that currently operate on the Bletchley to Oxford line between Bicester and Oxford. Phase 2A, which is the lowering of the trackbed of the Wolvercot Tunnel , will be undertaken at the same time as the Phase 1 works.

1.2. The Phase 1 and 2A works will be carried out as soon as the Order is approved, so that their passenger services can start no later than May 2013. Further works, in Phase 2B, will take place at a later date and be undertaken either by the East West Rail (EWR) consortium or others on behalf of Network Rail (NR). The Phase 2B works are mainly those to provide double track between the MoD depot at Bicester and Islip and through the Wolvercot Tunnel.

1.3. The Noise and Vibration Mitigation Policy has been prepared by Chiltern Railways and agreed by Network Rail. It will be applied, in the first instance, by Chiltern Railways when designing in detail, building and operating the works in Phase 1 and 2A. EWR, or others on behalf of NR, when they undertake the Phase 2B works, will also apply this policy. Hereafter, in this policy, the organisation which builds the relevant works is called the 'Promoter'.

1.4. The purpose of this policy is to set out the Promoter's commitments to mitigating noise and vibration effects arising from operation of the railway. These are based on the commitments made in the Environmental Statement [(1)].

1.5. The mitigation of noise and vibration effects during construction will be the responsibility of the Contractor, who will have to work within and abide by an approved Code of Construction Practice.

1.6. Chiltern Railways' consultants, Environmental Resources Management, have carried out an assessment of the likely effects of noise and vibration which is reported in the Environmental Statement [(2)] . This has been undertaken by:

- identifying representative noise sensitive receptors (primarily residential properties) along the entire railway route;
- measuring current actual noise levels at these locations;

(1) Chiltern Railways (Bicester to Oxford Improvements) Order, Environmental Statement, ERM, 2009
(2) See chapter six (of volume 2) of the Environmental Statement which accompanies the Transport and Works Act Order Application.

- predicting likely future noise levels, based on noise measurements relating to the actual types of passenger and freight trains that will be used on the railway;
- comparing these predicted levels against noise impact assessment criteria and outlining, where necessary, appropriate mitigation measures.

1.7. The detailed design of the Phase 1 and 2A works will be developed by Chiltern Railways' appointed contractor. This will involve refinement of the mitigation following the principles set out in this policy. This will ensure that the residual noise effects at any location are no worse than those reported in the Environmental Statement.

1.8. The assessment of noise and vibration has been based on two operational patterns of new train services:

- After the implementation of the works in Phases 1 and 2A, operational services will consist of up to two Chiltern Railways passenger trains per hour each way. The passenger trains will replace the existing passenger service operated by First Great Western between Bicester Town and Oxford stations.
- After the implementation of the East West Rail (EWR) link including works in Phase 2B, there are likely to be an additional two passenger trains per hour each way.

Neither Chiltern Railways or EWR will be running passenger trains throughout the night, and services in late evening and early morning will be at a reduced frequency. A small number of passenger trains may arrive in Oxford after midnight or depart from Oxford before 0600.

1.9. In the operation of Phase 1 and 2A, there are likely to be no more freight trains than operate at present, as there will be no new freight destinations that can be served. When the East-West Rail (EWR) link is in operation, there may be more freight trains. For this reason, additional freight services were included in the noise assessment in the Environmental Statement, so that this reflects a reasonable planning scenario. The actual number of freight services will reflect national freight demand, but will be limited to the maximum number of available freight 'paths' (1 per hour in each direction). Experience shows that about half of the available freight train paths are likely to be used on a given day, which would suggest a reasonable planning scenario of 8 freight train movements between 11pm and 7am. Freight trains will not use the 'new' railway line between Oxford North Junction (where the Bicester to Oxford Line meets the Oxford-Banbury main line) and Oxford, but instead will use the existing main line, as at present.

1.10. The noise and vibration mitigation will be designed based on the assumptions in paragraph 1.8 and 1.9 regarding the numbers and timing of train movements.

INSTALLATION OF NOISE MITIGATION MEASURES

1.11. Noise mitigation measures in accordance with this policy will be installed during the Phase 1 and 2A works, to be completed before the commencement of Chiltern Railways passenger services. Before the Phase 2B works take place, any additional noise mitigation measures made necessary by those works and the services in the reasonable planning scenario for Phase 2B will be designed. The assessment of noise and vibration for Phase 2B will cover all parts of the route, where service frequencies are expected to increase in Phase 2B. The mitigation measures will be installed before the Phase 2B works are brought into use. After each Phase of works, the effectiveness of the noise insulation measures installed will be monitored, as detailed in para 2.11.

2. *HOW IS NOISE ASSESSED TO DETERMINE APPROPRIATE MITIGATION?*

PRINCIPLES

2.1. The Noise and Vibration Policy is intended to ensure that noise and vibration mitigation is provided on a fair basis for all landowners and occupiers affected by the Order Scheme.

2.2. The Promoter is committed to using the Best Practicable Means (1) to design the railway so as to avoid significant noise and vibration impacts at existing sensitive receptors (e.g. residential properties, educational buildings and places of worship). The first preference will be to apply necessary noise control measures at source where this is reasonably practicable. These may include rail damping or other infrastructure measures to reduce noise at source. Where this is not reasonably practicable or sufficient to mitigate significant noise impacts, the Promoter will:

- where they are effective and reasonably practicable to install, provide noise barriers to mitigate noise between the track and sensitive receptors; and

- after considering all practicable mitigation measures that can be taken at source (i.e. within the railway corridor), including noise barriers, offer noise insulation to properties where residual noise impacts on sensitive receptors remain high.

(1) Best Practicable Means are defined in Section 72 of the Control of Pollution Act 1974 as those measures which are "reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge, financial considerations and compatibility with safety and safe working conditions"

2.3. The Promoter will consult with landowners and occupiers who may be affected by noise and vibration to explain the mitigation measures that are proposed.

The assessment of noise uses technical terms, which are described in Annex A. The provision for noise mitigation will be based on two sets of absolute noise levels [1]. The first are 'Noise Impact Threshold' levels, below which noise impacts are never significant. The second set of levels are the 'Noise Insulation Trigger' levels. These are the noise levels predicted at the most exposed windows to noise sensitive rooms in noise sensitive buildings, and are free-field [2] noise levels.

Noise Impact Threshold levels: *Day* - $L_{Aeq,\ (0700\text{-}2300\ hours)}$ *55 dB* [3]
Night – $L_{Aeq,\ (2300\text{-}0700\ hours)}$ *45 dB*

2.4. Where train noise is predicted to be above either of these threshold levels, but where the level is still less than that set out in the Noise Insulation Regulations requiring noise insulation to be provided, the Promoter will provide mitigation measures to reduce the adverse impact of noise. These will vary according to the extent to which the train noise level exceeds the threshold levels and the extent to which overall noise is increased above the existing or ambient noise level, as follows:

- exceedances of 3 dB or greater and increases of 3 dB or greater – mitigation at source through rail infrastructure solutions will be implemented where reasonably practicable;

- exceedances of greater than 5 and up to 7 dB and increases of greater than 5 dB and up to 7 dB -- at source and/or in the form of noise barriers if reasonably practicable and have no other negative effects;

- exceedances of greater than 7dB and increases of greater than 7dB – at source through rail infrastructure solutions and where these cannot be reasonably practicably achieved, noise barriers will be provided, where reasonably practicable.

These standards are consistent with those applied in the Environmental Statement, where noise mitigation is considered at source for impacts that are greater than 3 dB and in the form of noise barriers for impacts above a minimum of 5 dB. (Noise impacts in the ES are calculated by considering both the exceedance of the threshold criteria and the increase in overall noise, and taking the lower of the two.) The noise benefits of noise barriers are more likely to outweigh any dis-benefits, where the noise increase is above 7 dB. There are certain locations where because of the topography of the railway

(1) The standards relate to disturbance of building occupants, and do not relate to specific effects such as speech interference.
(2) Free-field means away from reflective surfaces, except the ground.
(3) $L_{Aeq,T}$ is the A-weighted equivalent sound level over the period T. A-weighting is a frequency weighting that replicates the frequency response of the ear. $L_{Aeq,T}$ is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. It is recommended parameter for train noise.

and adjacent properties, safety or visual impact, barriers cannot be installed or will not be effective.

2.5. Noise barriers or other noise attenuating infrastructure solutions will achieve noise reductions in most areas, to near to the existing noise levels. However residual noise impacts may still occur at particular locations. If, after consideration of the effects of noise mitigation measures at source, any of the Noise Insulation Trigger levels is still exceeded, then noise insulation to relevant properties will be offered, provided the corresponding existing or ambient noise level is routinely exceeded by at least 1dB. Noise insulation will be provided in accordance with the Noise Insulation (Railways and Other Guided Systems) Regulations. The noise level thresholds at which this will be offered are shown below in terms of free-field noise levels that are equivalent to the façade levels provided for in the Regulations.

Noise Insulation Trigger Levels	*Day* $> L_{Aeq,\ (0600\text{-}0000\ hours)}$ *66 dB* (1)
	Night $> L_{Aeq,\ (0000\text{-}0600\ hours)}$ *61 dB*

2.6. Even with the mitigation in paragraph 2.5, some of the properties close to the railway may still experience residual noise impacts that may be classed as 'high'. A 'high' impact is the equivalent of a noise impact of greater than +10 dB. If these properties are not already to be provided with insulation under the Noise Insulation Regulations, they will be offered additional mitigation, which is likely to be in the form of noise insulation.

2.7. If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field)at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance, except where ambient maximum noise levels are already above the predicted train noise level. One or two events per night would not be interpreted as regular, but the 8 assumed freight movements each night in Phase 2B are considered to be regular. In those very few locations likely to have such noise effects, additional noise attenuation measures will be taken to include the offer of noise insulation to affected properties. This form of mitigation is particularly effective in addressing night-time noise impacts when noise levels inside buildings are the key factor as regards sleep disturbance. The following additional criterion for noise insulation is therefore being applied.

Significant impact, need for further mitigation likely to be noise insulation:	*Night* $> L_{Amax}$ *82 dB* (2)

(1) Day is generally defined as 0700-2300 hours, except in the Noise Insulation Regulations, where it is defined as 0600 hours to midnight. These noise levels are free-field values that are equivalent to the values defined in the Noise Insulation Regulations

(2) L_{Amax} is a measure of the peak noise level, A-weighted.

MITIGATION OF VIBRATION

2.8. The levels of vibration resulting from passenger and freight trains operating on the new railway will be far below the levels that might cause structural damage to buildings. However, the additional trains may give rise to perceptible levels of ground vibration in adjacent occupied properties. Vibration Dose Value (VDV) (1) is a measure of the accumulated level of ground vibration over a period, and, through the application of BS6472 (2) , is a standard metric for predicting the likelihood of adverse comments from building occupants. The standard gives the following threshold VDV levels at or below which the probability of adverse comment is low:

- Day (0700 – 2300 hours) - 0.4 $m/s^{1.75}$
- Night (2300 – 0700 hours) - 0.2 $m/s^{1.75}$

2.9. By comparison, the measured levels from the types of passenger and freight trains that will be used on the new railway, running on standard ballasted track, suggest that even at 8 m from the track the levels will be 0.14 $m/s^{1.75}$ during the day and 0.12 $m/S^{1.75}$ at night which are very much less than the "adverse comment" thresholds set out above. Trackforms will be designed and installed adjacent to occupied vibration sensitive receptor buildings using Best Practicable Means to keep within the thresholds.

2.10. Where existing vibration levels are already above either of the thresholds set out above, mitigation will be considered where the change in VDV is 50% or more as a result of the Phase 1, 2A and 2B works.

MONITORING AND MAINTENANCE

Monitoring

2.11. A noise and vibration monitoring scheme for the Phase 1 and 2A works will be implemented to ensure that the performance of the mitigation measures that are installed achieve the levels of noise mitigation predicted by the design contractor, whose design instructions will include the requirement to achieve the residual noise levels set out in the Environmental Statement. The monitoring scheme will include the carrying out of surveys, the first being undertaken at around 6 months after the opening of the railway for Chiltern Railways passenger services, at locations agreed with the local planning authorities. A second survey will be undertaken 18 months after opening. If defects in construction or performance are identified in the first survey, these will be corrected in a timely manner by the contractor. If any defects in construction or performance are found in the second survey, these will also be corrected in a timely manner by the contractor. The same procedure for post construction monitoring surveys and the remedy of defects or performance

(1) Vibration Dose Value, VDV, is the vibration metric recommended in BS6472 -1, 2008 for the assessment of annoyance from railway vibration. It is a measure of the overall vibration dose throughout a day or night period. It is highly weighted towards peaks and has the units $m/s^{1.75}$

(2) BS6472: 2008 Guide to Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) Part 1 Vibration Sources Other than Blasting.

will be undertaken after the Phase 2B works have been completed and EWR services introduced.

2.12. The results of the Phase 1 and 2A monitoring will be published in an easily accessible format on the Chiltern Railways website and in the project newsletter and will be made available, either in hard copy of in electronic format, to any person requesting the information. Arrangements for publishing the surveys after Phase 2B will be agreed with the local planning authorities.

Maintenance

2.13. The railway, and in particular the wheel and rail surfaces, will be maintained so as to minimise noise and vibration at sensitive receivers.

OTHER NOISE MITIGATION

Station Announcements

2.14. Directional public address systems will be used that minimise the impact on nearby properties whilst maintaining audibility on platforms. The station operator will establish appropriate sound levels for station Public Address systems and will seek to address complaints, if they are received from occupiers of noise sensitive premises, as far as is reasonably practicable within railway safety requirements.

Train Stabling and Servicing

2.15. Chiltern Railways trains will not be stabled or serviced in the carriage sidings at the north end of Oxford station. Drivers will be instructed to shut down engines if the train is not to be moved within 5 minutes of arrival at Oxford station, and all Chiltern trains are equipped with automatic systems to shut down the engines if the train has been standing for more than 15 minutes.

Train Horns

2.16. Safety regulations require train drivers to sound the train's horn to warn of their approach in certain situations, for example, at certain level crossings or where there is risk of collision. This is essential, but after the Phase 1 works are completed, all of the present level crossings, except London Road, Bicester will be permanently closed and the situations where horns need to be sounded will be much reduced. There will be audible alarms on the crossing at London Road, Bicester and horns will not be used except in emergency. Although it is an inherent feature of the scheme rather than a specific mitigation measure, the reduction in horn noise will reduce noise impacts from this distinctive noise source, and so it has been noted in this section.

ANNEX A NOISE TERMINOLOGY

WHAT IS 'NOISE'?

A.1 The terms "sound" and "noise" tend to be used interchangeably, but noise can be defined as unwanted sound. Your neighbour may enjoy the sound of his music at 2am but you would be disturbed by the noise.

A.2 Sound is a normal and desirable part of life. However, when noise is imposed on people (such as from industry, construction or transportation) it can lead to disturbance, annoyance and other undesirable effects.

A.3 It is relatively straightforward to physically measure sound with a sound level meter, but it is a different matter to quantify the sound in terms of how noisy it is perceived to be and the effects it may cause.

A.4 For this reason we draw on various standards and guidelines that relate a measured noise level to the effect it is likely to have. These guidelines are generally based on large scale social surveys that have produced accepted, all be it approximate, relationships between noise level and effect.

AN EXPLANATION OF NOISE LEVELS

A.5 Noise is measured and quantified using decibels (dB). This scale is logarithmic, which means that noise levels do not add up or change according to simple linear arithmetic. For example, any two equal noise sources added together give only an increase of 3dB higher than the individual levels (e.g. 60 dB + 60 dB = 63 dB, not 120 dB). This represents what happens in practice when two equal sounds coincide; the ear perceives only a slight increase in noise and not a doubling.

The following table provides examples typical of noise levels.

Examples of Noise Levels on the Decibel Scale

Noise Level dB(A)*	Typical noise source / example
0	Threshold of hearing (lowest sound an average person could hear)
30	Quiet bedroom at night
40	Whispered conversation at 2 metres
50	Conversational speech at 1 metre
60	Busy general office
70	Loud radio indoors
70 – 75	Existing trains at Lakeside
80	Lorry at 30 kph at 7 metres
90	Lawnmower at 1 metre

*The dB(A) scale is a particular way of measuring the different frequencies in sound designed to match how the human ear works, called 'A'-weighting.

A.6 The way human hearing works is conveniently similar to the logarithmic changes in noise.

- An increase of 1 dB in noise levels cannot usually be heard (except possibly in 'laboratory' conditions).
- An increase of 3 dB is generally accepted as the smallest change that is noticeable in ordinary conditions.
- An increase of 5dB is clearly perceptible.
- An increase of 10dB seems to be twice as loud.

HOW IS NOISE MEASURED?

A.7 There is a little more to the measurement of noise than pointing a sound level meter and taking a reading. Because noise tends to vary over time, we need to find a way of measuring it in a manner which represents the variation in noise level that also reflects people's perception of how noisy it is. Over the years a number of different ways to measure noise (metrics or parameters) have been developed as the best ways of representing different types of noise sources (single events, industry, road traffic, railway, aircraft etc). Those relevant to the Chiltern Railways are introduced below.

NOISE MEASUREMENT PARAMETERS

A.8 The parameter or metric $L_{Aeq,T}$ is called the continuous equivalent sound level. It is a widely used noise parameter that represents a varying noise level by calculating the constant noise level that would have the same energy content over the measurement time period. The letter 'A' denotes that 'A'-weighting has been used and 'eq' indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous sound level, measured over time period 'T'.

A.9 Detailed surveys have been carried out into people's responses to different sources of noise and these have been used to define which noise metrics provide good relationships with perceived noisiness. PPG 24 which deals with the assessment of environmental noise from sources for example, advocates $L_{Aeq\ Period}$ for all types of transportation noise.

A.10 It is important to appreciate that whilst L_{Aeq} does give a measure of the accumulated noise over a period of time it is not like a conventional (arithmetic) average. It is in fact a logarithmic average. The effect of this is to give a high weighting to high noise levels even if they are relatively short lived or infrequent peaks.

A.11 The difference between arithmetic and logarithmic (L_{Aeq}) averaging can be illustrated by considering the average age of a class of 30 children and their teacher. Suppose the children are 5 years old and the teacher is 40 years old. The arithmetic average age is just 6, whereas the logarithmic (L_{eq}) average is 16. This partly explains why L_{eq} has been found to be a good indicator of the

effects of noise that comprise a series of varying signals over a period of time, such as railway noise.

A.12 An L_{Aeq} level can be calculated over different time periods depending on the characteristics of the noise and how people are exposed to it. If the noise is steady, a relatively short measurement period will be sufficient to characterise it. If it fluctuates randomly or has cyclical elements, then a longer measurement period will be required to obtain a representative sample. Some standards specify a measurement period, but 10 to 15 minutes is often adequate to obtain repeatable results. In terms of train noise for Chiltern Railways, the approach that has been taken is to identify the noise levels from individual trains and to use these to calculate the noise levels over suitable day and night periods.

Annex B

Relevant Planning Conditions

The Planning Condition 19(1) to (14) which relate to operational noise are shown below.

1. Operational noise and vibration monitoring and mitigation shall be carried out in accordance with the Noise and Vibration Mitigation Policy, January 2011 (Inquiry document CD/1.29/2.1, referred to in this condition as "the Policy") and this condition. In the event of any conflict between the two, this condition shall prevail.

2. Development shall not commence within each Individual Section, until a detailed scheme of assessment of predicted noise impacts during operation of Phase 1 and 2A of the railway works, predicted vibration effects of the railway with Phases 1, 2A and 2B and details of proposed monitoring and mitigation measures, has been submitted to and approved in writing by the local planning authority.

3. The schemes of assessment of the predicted noise impacts of Phase 1 and 2A and of Phase 2B on the Individual Section or Sections that abut Wendlebury Gate Stables shall also identify measures that should be taken to ensure, insofar as reasonably practicable, that the noise caused by individual passing trains, using the railway, does not significantly impede voice communication over a distance of 30 metres within either the "large riding school" or the "small riding school" at those Stables, or within the paddock opposite Bramlow. For direct voice communications (i.e. without electro- acoustic assistance), the term "not significantly impede" shall be taken to mean that the speech intelligibility shall be at least "fair" at an increased (i.e. "loud") vocal effort as defined in BS EN ISO 9921:2003 Ergonomics Assessment of Speech Communications. The assessment method used shall be the Speech Interference Level as described in Annex E to that Standard. The assessment shall be based on a native female speaker facing the rider under instruction and the standard to be achieved will be for alert situations where short known words are used and the wind speed is less than 5 metres per second. A correction factor of -5dB shall be used to convert the standard for male voices to female voices. If personal communications or sound reinforcement systems are proposed, the assessment methodology shall be subject to the approval of the independent expert appointed in accordance with Condition 19.9. This part of the condition shall not apply if, at the time of assessment, the Stables are no longer a licensed riding establishment under the Riding Establishments Act 1964.

4. The schemes of assessment of the predicted noise impacts of Phase 1 and 2A and of Phase 2B on the Individual Section or Sections that abut 45 Lakeside shall also identify measures that shall be taken to ensure that the noise caused by passing trains in the Studio at 45, Lakeside does not exceed 35dB $L_{Aeq,\ 30\ min}$ and 55dB $L_{A1,\ 30\ min}$, the standards to be met by music teaching rooms as defined in Building Bulletin 93, Acoustic Design of Schools (Table 1.1).

5. Where vibration mitigation measures required for Phase 2B can be installed cost-effectively during the Phase 1 and 2A works, this shall be done. All mitigation measures, including those prescribed in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996, required for Phase 1 and 2A shall be installed as soon as possible after commencement of the works and no later than the date on which a passenger rail service is resumed on that section of railway.

6. Any monitoring of noise and vibration shall be undertaken in accordance with the approved scheme of assessment and the Policy.

7. Before the commencement of the laying of the second track between the MoD Depot at Bicester and Islip, a detailed scheme of assessment of the predicted noise impacts arising from the works and from the additional services assessed as likely to operate under Phase 2B in the Environmental Statement and details of proposed mitigation measures, which achieve the standards for noise and vibration attenuation set out in the Policy, shall be submitted to and approved in writing by the local planning authority.

8. Any vibration mitigation measures not already installed during the Phase 1 and 2A works necessary for Phase 2B shall be installed during the Phase 2B works. All mitigation measures, including those prescribed in the Noise Insulation Regulations (Railways and Other Guided Transport Systems) 1996, required for Phase 2B shall be undertaken as soon as possible after commencement of the works and completed no later than the date on which the second track is brought into use.

9. The submitted schemes of assessment shall show how the standards of noise mitigation set out in the Policy will be achieved. Supporting calculations, or printouts of inputs and outputs from recognised computer software, shall be provided. Each scheme shall be accompanied by a report, prepared by an independent expert previously approved in writing by the local planning authority, on the robustness of the noise-related elements of the scheme of assessment. Noise mitigation measures shall be permanently installed as approved.

10. The submitted schemes of assessment shall show how the standards of vibration mitigation set out in the Policy will be achieved. Supporting calculations or empirical data, or a combination of the two, shall be provided. Each scheme shall be accompanied by a report, prepared by an independent expert previously approved in writing by the local planning authority, on the robustness of the vibration-related elements of the scheme of assessment. Vibration mitigation measures shall be permanently installed as approved.

11. The submitted schemes of assessment shall include a list of properties assessed and the results of the assessment at each. By the times that the mitigation measures are due to be brought into use, notice shall be served on the local planning authority of the mitigation measures that have been installed for each property assessed.

12. The situation may arise in which Chiltern finds "not reasonably practicable" the provision of mitigation measures that otherwise would be required by the Policy. In such circumstances, the mitigation measure or an equally effective substitute previously approved in writing by the local planning authority shall be installed in the timescale set out in item 1.10 of the Policy, unless the local planning authority has confirmed, in writing, its agreement that the mitigation in question is not reasonably practicable and that there is no suitable substitute.

13. Where noise barriers are promoted in an approved scheme of assessment, they shall be installed only once the local planning authority has given written approval of their size, appearance and location. Noise barriers shall be maintained in their approved form and may be removed only with the written approval of the local planning authority.

14. Development shall be in accordance with the approved schemes and this condition.

Annex C

Glossary of Acoustic Terms

C1 GLOSSARY OF ACOUSTIC TERMS

Decibels

Noise levels are measured using the decibel scale. This is not an additive system of units (as for example, metres or kilograms are) but a proportional system (a logarithmic progression). A change of 10 dB corresponds to a perceived doubling in loudness; changes in environmental noise of less than 3 dB are not normally regarded as noticeable.

A-weighting

Environmental noise measurements and levels are usually expressed using a variation of the decibel scale, which gives less weight to low frequencies and very high frequencies. This system was derived to correspond to the reduced sensitivity of the human hearing mechanism to these frequencies.

$L_{Aeq,\,T}$ *-Equivalent Continuous Sound Level*

The L_{Aeq} level gives a single figure to describe a sound that varies over a given time period, T. It is the A-weighted steady sound level that would result in the same sound energy at the receiver as occurred in practice with the varying level. It is derived from the logarithmic summation of the sound signal and so unlike a conventional (linear) average it gives additional weighting to higher levels.

Sound Exposure Level - SEL

The noise level at the reception point which if maintained constant over a period of one second would cause the same sound energy to be received as would be received from a given noise event. The standard UK rail prediction methodologies use this as a source term for noise prediction for individual railway vehicles, which can then be combined to predict the $L_{Aeq,\,T}$ noise levels defined above.

Background Noise Level - L_{A90}

Background noise level is a measure of the low level of noise that occurs between the higher levels from particular events, for example passing vehicles. This may be abbreviated to BNL and the symbol is L_{A90}. It is the value exceeded for 90% of the time period being considered. Note that it is higher than the minimum noise level but may be regarded as the typical noise level during 'quiet periods'.

LA10

Similarly to the L_{A90} described above , L_{A10} is the noise level which is exceeded for 10 per cent of the time.

Maximum Noise Levels

The $L_{Amax,s}$ is the highest value of the sound level over the specified period. It is sometimes referred to as 'peak' noise level. However, the term 'peak' has a special meaning in acoustics and the expression 'maximum' is preferable to avoid confusion. The 's' stands for slow response, which is the metric which has been used throughout this assessment.

Annex D

Noise Prediction Methodology

D1 INTRODUCTION

The main *Scheme of Assessment* document summarises the assessment of the potential noise and vibration impacts from the operation of the Order Scheme. This *Annex* describes in detail the prediction methodologies that have been used and the assumptions regarding the train operations which are relevant to *Route Section F*.

Section D2 describes how the general assumptions that have been used are derived and describes those assumptions that are relevant to the prediction of the L_{Aeq} parameter, which is the default parameter for railway noise. *Section D3* provides more detail on the additional procedures developed to predict maximum (L_{Amax}) noise levels. *Section D4* describes the detailed results from modelling outputs to supplement those provided in the main *Scheme of Assessment*.

D2 GENERAL RAILWAY NOISE MODELLING METHODOLOGY

D2.1 NOISE PREDICTION METHODOLOGY

Noise levels (in terms of the L_{Aeq} parameter) at the nearest noise sensitive receptors from the railway have been predicted according to CRN [1] in order to establish the requirements for mitigation.

D2.2 MODEL INPUTS

D2.2.1 *Introduction*

This section presents the source information and assumptions that have been used to model noise from the Order Scheme at the nearest noise sensitive receptors. When predicting noise from the railway, the track was divided into segments by the modelling software following the procedures in CRN, the lengths of these track segments were determined by factors such as train speed. Each segment is then treated as a separate line source and the noise contribution from each segment is summed to obtain the total predicted noise level at the receptors. As set out in the main *Scheme of Assessment* document, railway noise from all of the phases of the Order Scheme (*Phase 1*, *2A* and *2B*) have been assessed, which includes double track throughout *Route Sections A* to *H*. The tracks are identified as an 'Up' line (which carries trains running from Bicester to Oxford) and a 'Down' line (which carries trains running from Oxford to Bicester). As trains drive on the left, the Up line lies to the southeast of the Down line.

D2.2.2 *Topographical Data*

The topographical data, provided from the project engineers Atkins (for the railway corridor) and Bluesky (for the wider area), were used to create the three dimensional ground model used in the noise model. In some cases, the model was refined based on site observations or assumptions.

D2.2.3 *Receptor Heights*

The receptor height, and particularly the height of noise sensitive windows, is important to accurately predict noise levels where barriers are intended to be used to mitigate noise levels. Heights of the tops of windows have been used to predict the effects of noise from the Order Scheme.

Tools such as Google Street View and observations made from public rights of way have been used to make a reasonable assumption about window heights in this *Route Section*.

(1) Calculation of Railway Noise 1995. The DoT

Where window heights have been estimated by counting the number of brick courses on the building façade, one brick course has been assumed to be 7.5 cm in height. Where door heights have been used, a value of 2.1 m has been assumed as the height of an average door. The height of the sensitive receptors in this *Route Section* are shown in *Table D2.1.*

Table D2.1 Receptor Height Characteristics

ES / PI Receptor Number (1)	Calculated Height	Comments
PI 7 Prospect House, Mill Street	1st floor 6m	(3)
PI 8 The Grange, Mill Street	2nd floor 7.5m	(2)
PI 9 Curtesy House, Mill Street	1st floor 6m	(3)
PI 10 Orchard Cottage, Mill Street	1st floor 6m	(3)
ES 11 Kareol	Ground floor 2.1m	Estimated using the door height
PI 11 Greengage Barn, Mill Street	Ground floor 2.3m	Estimated by counting number of bricks
PI 12 3 Mill Barn, Mill Street	1st floor 7m	Estimated by counting number of bricks
PI 13 4 Mill Barn, Mill Street	Ground floor 2.3m	Estimated by counting number of bricks
ES 12 Mill Farm, Mill Street	2nd floor 7.5m	Estimated using the door height
ES 13 Northfield Cottages	2nd floor 7.5m	(2)

1) Receptors identified during the Environmental Statement were given receptor numbers, which have been presented here. Additional receptor locations to represent third parties who requested noise level predictions during the public inquiry period have been considered. These receptors have been given the prefix 'PI'.
2) Property inaccessible. A cautious assumption of 7.5 m has been used for the top floor window of this two or three storey building. Impacts are based on the floor where predicted train noise levels were highest.
3) Unmitigated noise predictions show no impacts at this location and so no noise barriers have been included. As a result, window heights are not crucial to the assessment of residual impacts and a conservative value of 6 m has been assumed for the top floor window of this two storey building. Impacts are based on the floor where predicted train noise levels were highest.

D2.2.4 Rail Cant

The cant of a railway track is the difference in elevation between the two rails. This is normally required where the railway is curved, raising the outer edge. CRN specifies that the train noise for most vehicles (except locomotives on full power) should be modelled as a source line that is positioned at the railhead (top of the rail). This reflects the fact that the main source of noise from vehicles operating on the railway is located at the railhead.

Where there is a difference between rail heights the higher of the two has been used, which will reduce the predicted effectiveness of noise barriers and is therefore a cautious assumption.

D2.2.5 *Rail Enhancements*

Higher noise levels can occur when trains pass over different types of track or structures such as bridges. Properties which lie in close proximity may receive higher levels of noise as a result.

CRN specifies source enhancement corrections that have been applied along the route where necessary.

Source enhancement corrections for this *Route Section* are summarised in *Table* D2.2.

Table D2.2 ***Source Enhancement Corrections***

Reason for Source Enhancement	Structure	Start Chainage (m)	End Chainage (m)	CRN Correction Applied
Metal Underbridge	Cherwell Viaduct (OXD 46)	121910	122000	+9

D2.2.6 *Stations*

Oxford Parkway Station is located within *Section F*. The engineering drawings show the location of the platforms and these have been modelled as screening edges in the noise model. The characteristics of the platforms are shown in *Table D2.3*.

Table D2.3 ***Oxford Parkway Station Platform Characteristics***

Platform	Start Chainage (m)	End Chainage (m)	Distance from the track (cm)	Height from the track (cm)
Up line	123821	124049	75	91
Down line	123824	124044	75	91

D2.2.7 *Existing Trains*

Existing Passenger Train Types

The First Great Western (FGW) passenger service, which existed at the time the ES baseline measurements were taken, consisted of Class 165 DMUs. Since the ES was written other vehicles, such as Class 168 DMUs, have been used by Chiltern Railways, which currently runs this service. These would result in a similar noise source term (approximately 0.6 dB higher) to a Class

165. A Class 165 DMU has been assumed when predicting baseline train noise which results in a conservative assessment of baseline noise.

Existing Passenger Train Movements

Passenger service levels were based on the *First Great Western Oxford to Bicester timetable for the period 17th May 2009 to 12th December 2009*. This service is now provided by Chiltern Railways, having been taken over in May 2011. Current timetabled services are very similar to those previously operated by First Great Western, and consequently, the same assumptions regarding service level, and the train noise source term in the baseline situation, have been made.

Existing Freight Train Types

Class 66 locomotives are currently used by the vast majority of UK freight operators and have been assumed for this assessment. At present, freight trains typically comprise 15 wagons, with occasional shorter trains.

Existing Freight Train Movements

At present, freight train movements are understood to be:

- up to one stone train using the line in each direction each day to Banbury Road;
- one train in each direction most days to the Bicester MoD; and
- one train in each direction, with occasionally two, to the Calvert Waste Terminal.

This is summarised in *Table D2.4* below, the second column is relevant to this *Route Section* (indicated by bold type).

Table D2.4 Current Freight Train Movements

	Train movements per day from the North Junction to Banbury Road stone sidings	**Train movements per day from Banbury Road sidings to MOD sidings**	**Train movements per day from the MOD sidings to Bicester**
Stone Train	2	**0**	0
Trains to Bicester MoD	2	**2**	0
Calvert Waste Terminal	2-4	**2-4**	2-4
Total	6-8	**4-6**	2-4

Route Section F runs from the south of Islip to Oxford Parkway Station, and accordingly, 4-6 freight movements have been assumed for the existing situation. To present a conservative assessment, two trains each day in each direction (four freight movements), has been adopted.

Presently one freight train runs during the night-time period (early in the morning), taking waste from the Calvert Waste Terminal. All other freight trains run during the daytime.

Summary of All Modelled Existing Train Movements

The relevant data for this *Route Section* are contained in the third row of data in *Table D2.5* (indicated by bold type).

Table D2.5 Modelled Baseline Train Movements along the Route

Area	Number of Existing Chiltern Train Movements		Number of Freight Train Movements	
	Day (07.00 – 23.00)	Night (23.00 – 07.00)	Day (07.00 – 23.00)	Night (23.00 – 07.00)
North of Bicester Town Station	0	0	1	1
Bicester Town Station to the MoD Sidings	20	2	1	1
MoD Sidings to the Banbury Road Sidings	**20**	**2**	**3**	**1**
Banbury Road Sidings to the Oxford North Junction	20	2	5	1
Oxford North Junction to Oxford Station	0(1)	0(1)	0(1)	0(1)

1) Baseline noise surveys along this section of the route include measured train noise and so no modelling has been included.

D2.2.8 Order Scheme Trains

Overview of Order Scheme Passenger Trains

Trains will run from 06.00 through to 01.00. However, there will be a reduced Chiltern Railways service between 21.00 and 01.00 each evening/night. This is described further below. A full service frequency has been assumed for EWR trains from 05.30 to 01.00 as required in The Policy.

Order Scheme Chiltern Railways Passenger Trains

Chiltern Railways will run a service between Oxford and London, via Bicester. The train stock will comprise Class 168 DMUs. These will be run as a train of up to eight cars during peak hours (between 07.00 and 09.00 and between 17.00 and 19.00), and four cars during off-peak hours. This is based on service forecasts for the year 2026.

The noise modelling has been based on a service frequency of two Chiltern Railways trains per hour in each direction for the majority of the day but with a reduction in service to one train per hour in each direction after 22.00, with one train from Oxford to Bicester between 21.00 and 22.00 and no trains from Oxford to Bicester after midnight. There is consequently a total of 61

movements during the day (07.00 – 23.00) and 7 movements during the night (23.00 – 07.00). This service pattern is presented in *Table D2.6*.

Order Scheme EWR Passenger Trains

EWR will run a passenger service using this line, from Reading to Bedford and onwards. The choice of engines/rolling stock had not been finalised during the ES and public inquiry, and so a reasonable worst case assumption of Class 172 DMUs has been adopted. Based on a 15 year forecast, these have been modelled as 3 car trains. The service will operate at a frequency of two trains per hour in each direction from 05.30 to 01.00 each day. No information on a reduction in service frequency early in the morning and late at night is available and so the full service frequency has been assumed throughout the service period (05.30 – 01.00). This results in a total of 64 movements during the day (07.00 – 23.00) and 14 movements during the night (23.00 – 07.00), as shown in *Table* D2.6.

Summary of All Order Scheme Passenger Train Movements

The assumed passenger train movements from the Chiltern Railways and EWR services are summarised in *Table D2.6*. As required, the Order Scheme mitigation has been designed to follow the assumptions specified in The Policy.

Table D2.6 Passenger Service with the Order Scheme

Time	Chiltern Passenger Service. Number of Train Movements		EWR Passenger Service. Number of Train Movements	
	Oxford to Bicester	Bicester to Oxford	Oxford to Bicester	Bicester to Oxford
05.00 – 06.00	0	0	1	1
06.00 – 07.00	2	2	2	2
07.00 – 08.00	2	2	2	2
08.00 – 09.00	2	2	2	2
09.00 – 10.00	2	2	2	2
10.00 – 11.00	2	2	2	2
11.00 – 12.00	2	2	2	2
12.00 – 13.00	2	2	2	2
13.00 – 14.00	2	2	2	2
14.00 – 15.00	2	2	2	2
15.00 – 16.00	2	2	2	2
16.00 – 17.00	2	2	2	2
17.00 – 18.00	2	2	2	2
18.00 – 19.00	2	2	2	2
19.00 – 20.00	2	2	2	2
20.00 – 21.00	2	2	2	2
21.00 – 22.00	1	2	2	2
22.00 – 23.00	1	1	2	2
23.00 – 00.00	1	1	2	2
00.00 – 01.00	0	1	2	2
Total	**33**	**35**	**39**	**39**

1) Normally Chiltern Railways passenger trains will comprise 4 cars. During peak hours (between 07.00 – 09.00 and between 17.00 – 19.00), the trains will comprise 8 cars.

Order Scheme Freight Trains

Freight trains will generally be hauled by Class 66 locomotives. As outlined above, these engines are used by the vast majority of the UK freight locomotive fleet, and this is expected to continue for the foreseeable future. Although this could change over time, newer locomotives (eg the new Class 68 locomotives on order for Freightliner, which runs waste trains to the Calvert Waste Terminal), are likely to be quieter. Freight trains currently comprise up to 26 wagons. National planning is moving towards 30-wagon trains, and consequently this length of train has been adopted in this assessment.

Freight trains are expected to travel between the Oxford North Junction and Bicester, as part of the Order Scheme. These trains already run between Oxford and Banbury and so form a part of the baseline between Oxford Station and the Oxford North Junction.

The maximum number of freight paths (time slots where freight trains could run), is one per hour in each direction (ie 32 movements in a 16 hour day and 16 movements in an 8 hour night). However, experience of freight path usage suggests that this would be an unrealistic assumption. A value for the likely frequency of freight trains has been calculated based on the current freight

path usage through Oxford, in order to produce a reasonable assumption, as follows:

- During the busiest (16h) daytime period, 53 freight paths exist and 28 freight trains run, producing a utilisation factor of 53%. This utilisation figure has been used to produce a figure of 17 freight trains per day (based on 32 x 0.53 movements, and after rounding up to the nearest whole number).

- During the busiest (8h) night-time period, 32 freight paths exist and 14 trains run, producing a utilisation factor of 44%. This has been rounded up to 50%, which gives a value of eight freight trains per night (based on 16 x 0.5 movements) which has been used in this assessment.

The assumed train movements are summarised in *Table D2.7*.

Freight trains will have a maximum speed of either 97 kph or 121 kph depending on the class of engine. A top speed of 121 kph has been used throughout as a conservative assumption (where line speeds and limits permit). Line speed limits along the route as well as specific speed limits for freight trains will decrease freight train speeds along sections of the route. All train speeds are described in *Section D2.2.9* and *D2.2.10* below.

Summary of All (Passenger and Freight) Order Scheme Trains

Table D2.7 presents a summary of the number of trains assumed in the noise modelling. These assumptions have been specified in The Policy. As required, the Order Scheme mitigation has been designed to follow the assumptions in The Policy.

Table D2.7 ***Summary of Modelled Train Movements with the Order Scheme***

Area	Number of Chiltern Train Movements		Number of EWR Train Movements		Number of Freight Train Movements	
	Day 07.00 – 23.00	Night 23.00 – 07.00	Day 07.00 – 23.00	Night 23.00 – 07.00	Day 07.00 – 23.00	Night 23.00 – 07.00
Bicester Chord	61	7	0	0	0	0
North of Gavray Junction	0	0	64	14	17	8
Gavray Junction to the MoD Sidings	61	7	64	14	17	8
MoD Sidings to the Banbury Road Sidings	61	7	64	14	17	8
Banbury Road Sidings to the Oxford North Junction	61	7	64	14	17	8
Oxford North Junction to Oxford Station	61	7	64	14	0 (1)	0 (1)

1) Freight trains that currently use the Banbury-Oxford mainline are expected to divert via the Order Scheme between North of Gavray Junction and Oxford North Junction. At Oxford North Junction they will rejoin the mainline through Oxford as they would have done prior to diversion. Therefore, no additional movements are expected as a result of the Order Scheme in this area.

D2.2.9 Train Speed Limits

Line speeds define the maximum allowed train speeds along various sections of the route. These are effectively speed limits on the railway. For the purpose of defining line speeds, the route has been split into areas. These areas, with their associated line speeds, are presented in *Table D2.8* below. Additional speed restrictions for freight trains in the area of the Oxford North Junction have also been included.

The sections of the route which are relevant to this *Scheme of Assessment* are shown in bold type.

Table D2.8 ***Speed Limits Along the Proposed Alignment[1]***

Area	Passenger Train Speed Limit Up Line (kph)	Passenger Train Speed Limit Down Line (kph)	Freight Speed Limit Up Line (kph)	Freight Speed Limit Down Line (kph)
North of the Bicester Chord (no Chiltern Railways trains)	161	161	121	121
Bicester Chord (only Chiltern Railways trains)	64	64	(no freight trains use Chord)	(no freight trains use Chord)
Bicester Chord to Bicester Town Station	161	161	121	121
Bicester Town Station to South of Oxford Parkway Station	**161**	**161**	**121**	**121**
Wolvercot Tunnel area	TBC[1]	TBC[1]	TBC[1]	TBC[1]
Oxford North Junction	TBC[1]	TBC[1]	TBC[1]	TBC[1]
Oxford North Junction to close to Oxford Station	TBC[1]	TBC[1]	TBC[1]	TBC[1]
Oxford Station area	TBC[1]	TBC[1]	TBC[1]	TBC[1]

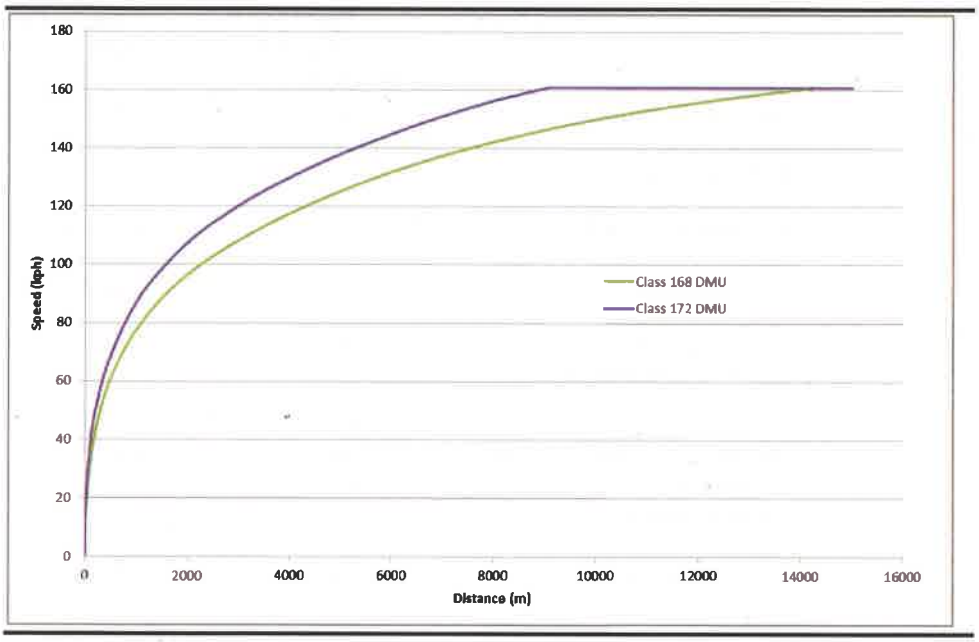
1) TBC = Speeds to be confirmed when relevant Schemes of Assessment are submitted.

D2.2.10 *Train Acceleration Profile*

This section discusses the actual train speeds that are expected to be achieved by trains using the railway given the speed limits discussed in *Section D2.2.9* and the train acceleration and deceleration profiles. These train speeds have been used in the noise modelling of this *Scheme of Assessment.*

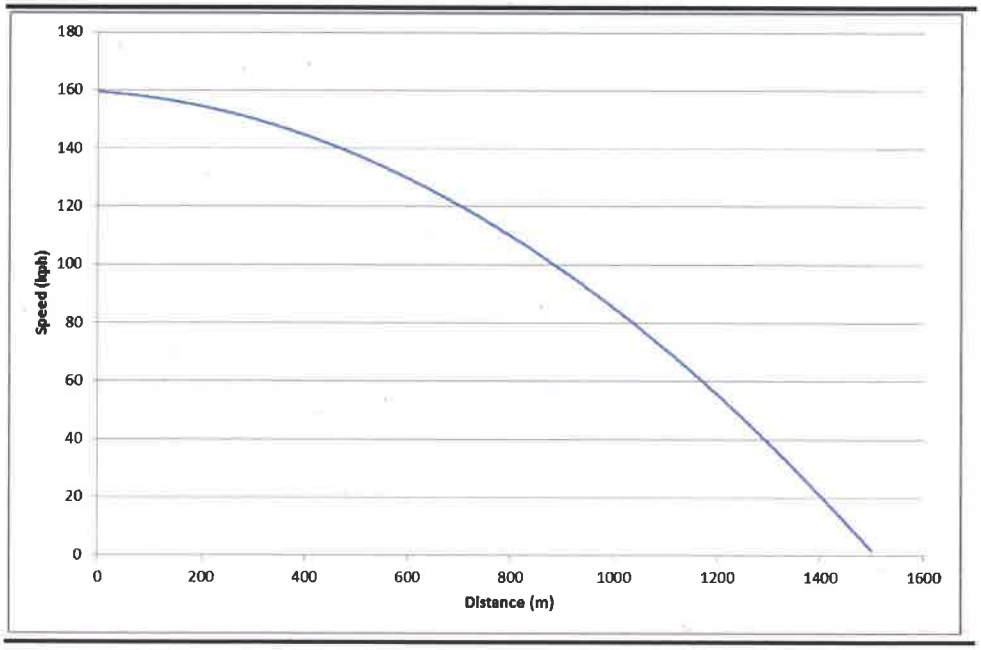
Chiltern Railways train stock will comprise Class 168 DMUs whilst Class 172 DMUs have been adopted as a reasonable worst case assumption for the EWR service. Acceleration data for these trains has been provided, by Chiltern Railways fleet department, for unladen trains on level track. These data are presented in *Figure* D2.1 below.

Figure D2.1 ***Acceleration Profiles for a Class 168 DMU and Class 172 DMU (Unladen Trains on Level Track)***



Deceleration data have been based on the document 'Bicester to Oxford Line Speed Profiles'(1), which presents the results of speed modelling for a Class 168 DMU. These data are presented in *Figure D2.2* below. Data for the Class 172 DMU is not readily available and so it has been necessary to use the data for the Class 168 DMU.

Figure D2.2 ***Deceleration Profile for a Class 168 DMU***



(1) ART-CRCL-2011-2. Bicester to Oxford Line Speed Profiles.Advanced Rail Technologies. D.Potter, D.Wilkinson. V1.0. 07/04/2011

Within *Route Section F*, assumptions regarding train acceleration / deceleration are listed below.

- Chiltern Railways trains using the Up line (travelling towards Oxford) will be accelerating (out of Bicester Town station), achieving a speed of 150 kph by the time they reach the boundary between *Route Section E* and *F*. They continue to accelerate for a further 1.6 km (to a speed of 155 kph) before beginning to decelerate on their approach to Oxford Parkway station. Oxford Parkway Station lies in *Route Section F*, close to the boundary with *Route Section G*.

- Chiltern Railways trains using the Down line (travelling towards Bicester) accelerate away from Oxford Parkway Station, reaching a speed of 108 kph by the time they cross the boundary between *Route Section F* and *E*.

- After leaving Bicester Town Station, EWR trains using the Up line (travelling towards Oxford) will be travelling at the maximum line speed of 161 kph as they enter *Route Section F*. Approximately 1.4 km into this route section, they begin to decelerate as they begin their approach to Oxford Parkway station.

- EWR trains using the Down line will accelerate away from Oxford Parkway Station, reaching a speed of 120 kph by the time they cross the boundary between *Route Section F* and *E*.

- Freight trains will not stop at stations and will therefore accelerate and decelerate only in response to changes in the speed limits. Within *Route Section F*, the speed limit is 121 kph and it is assumed that trains will run at this speed in both directions.

D2.2.11 ***Signal Stopping***

Signals are present at a number of locations along the route. Normal operation is that trains will not encounter any signal stops and therefore will not slow down. Assuming no signal stops enables a conservative assessment for passenger trains, which has been adopted here.

Should trains be required to stop at a signal, diesel locomotives may produce significantly higher levels of noise when accelerating away from rest on full power. Because it is expected to occur only infrequently, average noise levels over the assessment period are not expected to be significantly affected.

The Policy requires that maximum noise levels ($L_{Amax,s}$) which regularly exceed 82 dB at night, at noise sensitive receptors, may trigger a requirement for non-statutory noise insulation to be offered. Since these stopping events are expected to occur infrequently, it is considered unlikely that more than one such event will affect a noise sensitive receptor in any single night time period. A single event occurring at night would not change the requirements

for noise mitigation as set out in The Policy, and therefore the effect of diesel locomotives stopping at signals has not been included in the modelling.

D2.2.12 *Additional Details Regarding Noise Mitigation Measures*

Noise mitigation measures are discussed in the main *Scheme of Assessment* document. This section provides additional details that have been omitted from the *Scheme of Assessment* to improve clarity.

Wheel Dampers

Reductions in noise can be achieved by mitigating noise from vehicles at source and wheel dampers have been considered for this purpose. Whilst the Promoter could apply mitigation to their vehicles, they have no power to require other train operating companies to do so. Therefore, when considering the potential benefit of this noise control measure, it has been assumed that it will not be adopted by freight train operators .

Analysis of the potential benefits of using wheel dampers has been conducted. Train service patterns assumed for the analysis are those adopted for the majority of the route (from the Gavray Junction to the Oxford North Junction), details are provided at *Section D2.2.8*. In this analysis, wheel dampers have been assumed to reduce overall train noise by 3 dB(A). Three scenarios have been considered, to represent operating conditions on the majority of the route. They are listed below:

- *Scenario 1*. Passenger and freight trains are assumed to run at full line speed.
- *Scenario 2*. Passenger trains are assumed to run at half line speed as they accelerate and decelerate between stops. Freight trains are assumed to run at full line speed.
- *Scenario 3*. Passenger and freight trains are assumed to run at a lower speed (of 97 kph). This is expected to be comparable to operating conditions in the North Oxford area.

The results, which compare train noise with and without wheel dampers, are presented below in *Table D2.9*.

Table D2.9 ***Predicted Effect of Wheel Dampers as a Mitigation Measure***

Scenario	Mitigated	Predicted Free Field Train Noise Level ($L_{Aeq,T}$) at 25 m, dB			
		Day (16h)	Night (8h)		
		Total	Passenger	Freight	Total
1. Passenger and freight trains are assumed to run at full line speed.	No	64.5	56.7	60.0	61.7
	Yes	63.0	53.7	60.0	61.0
2. Passenger trains are assumed to run at half line speed as they accelerate and decelerate between stops. Freight trains are assumed to run at full line speed.	No	61.9	50.7	60.0	60.5
	Yes	61.3	47.7	60.0	60.3
3. Passenger and freight trains are assumed to run at a lower speed (of 97kph). This is expected to approximate operating conditions in the North Oxford area.	No	61.3	52.4	58.1	59.2
	Yes	60.2	49.4	58.1	58.7

The results show that the greatest benefit from the use of wheel dampers as a mitigation measure is experienced for *Scenario 1*, in which passenger and freight trains run at full speed. In this scenario, wheel dampers are predicted to reduce overall train noise levels by approximately 1.5 dB during the day and 0.7 dB at night. In *Scenario 2*, where freight trains run at full speed but passenger trains run somewhat slower, the contribution from passenger trains to overall train noise levels is lower and therefore the benefit of the wheel dampers is reduced. In *Scenario 3*, both passenger trains and freight trains run at a reduced speed. Wheel dampers are predicted to reduce overall train noise levels by 1.1 dB during the day and 0.5 dB at night.

Wheel dampers have been assumed to reduce overall train noise by 3 dB, however it has also been assumed that they will not be adopted for use on freight trains. As can be seen in *Table D2.9*, the contribution to overall train noise is higher from freight trains than from passenger trains, particularly for *Scenario 2* where passenger train speeds (and consequently noise levels) are reduced. As a result, the effectiveness of wheel dampers in reducing overall train noise is limited.

Curve Noise

Curve noise was considered in the ES and based on the likely curve radius of the Bicester Chord it was considered unlikely to occur. However, the effects of curve noise are difficult to predict and mitigate prior to operation. If it occurs once the Order Scheme is operational and leads to complaints from local residents, mitigation measures will be considered and discussed with the relevant local authority.

D2.3 NOISE SOURCE DATA

Data for some of the train noise sources that have been modelled in this assessment are not available in CRN. These sources are listed below with a description of the data that have been used.

- Class 66 locomotive (off power). CRN correction data from Additional Railway Noise Source terms for "Calculation of Railway Noise 1995" (1) have been used.

- Class 172 DMU (off power). A CRN correction value for Class 168 DMU (off power) has been adopted as a reasonable substitution. This is the same correction as used for similar DMUs such as the Class 170.

- Freight train vehicles. A CRN correction value for a *Disc Braked Freight Vehicle (4 axles)* has been adopted and the model has been calibrated using measured data (see *Section D2.4 Freight Train Noise Measurement Survey*).

D2.4 FREIGHT TRAIN NOISE MEASUREMENT SURVEY

Freight trains may haul a variety of different wagons and containers. Noise source levels for an 'average' freight vehicle have been based on measurements carried out at Oddington Crossing House. Measurements were made of 11 freight trains between the 26th and 28th of August 2009. Measurements were made at a height of 1.5 m in free field conditions, level with the façade of the property (at a distance of 5.3 m from the track), in accordance with the guidance given in BS 7445. The results of these measurements are presented in *Table D2.10*.

These data were then used to calibrate the noise model so that an appropriate freight vehicle type could be selected from CRN, with a source correction which best represented measured noise levels (whilst not being quieter). The chosen freight vehicle was a *Disc Braked Freight Vehicle (4 axles)* with a CRN correction value of +7.5 dB.

Using this CRN vehicle for a freight train hauled by a Class 66 locomotive produces a predicted noise level (SEL as defined in *Annex C*) at Oddington Crossing House of 94 dB(A). The average measured noise level (SEL) of a freight train under the same operating conditions at Oddington Crossing House was 92 dB(A). This showed that robust predictions could be based on the predicted values in CRN based on the freight vehicle type above, and that they would be likely to result in slightly higher noise levels by 2 dB(A).

The train speed at this location is currently lower than it will be with the Order Scheme and reflects the maximum line speed (40 mph).

(1) Additional Railway Noise Source terms for "Calculation of Railway Noise 1995", Defra 2007

Table D2.10 Noise Level Measurements of Freight Trains at Oddington Crossing House

Date	Time	Noise Level (SEL Free Field), dB(A)	Freight Train Type
26.08.09	05.05	90	4M60 waste
	12.05	94	4V60 waste
	12.20	94	6A49 MoD
	14.35	91	6A48 MoD
27.08.09	12.32	83	6A49 MoD
	14.35	90	6A48 MoD
	20.35	95	6M49 waste
28.08.09	05.20	93	4M60 waste
	12.07	92	4V60 waste
	12.43	90	6A49 MoD
	14.34	85	6A48 MoD
Average (logarithmic)		**92**	

D3 ADDITIONAL PROCEDURES FOR PREDICTION OF MAXIMUM NOISE LEVELS

D3.1 REQUIREMENTS FOR PREDICTION OF MAXIMUM NOISE LEVELS

CRN enables predictions to be carried out using the L_{Aeq} parameter. In most cases it is this parameter that determines the need for mitigation in The Policy (see *Annex A*).

However, The Policy also contains thresholds in terms of the maximum noise level (L_{Amax}) (1), and in some cases, very close to the track, the maximum noise may exceed the relevant mitigation threshold before the L_{Aeq}. The Policy states that:

"If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact... except where ambient maximum noise levels are already above the predicted train noise."

Where such an impact is identified the need for further mitigation (likely to be noise insulation) is investigated.

D3.2 PREDICTION METHODOLOGY

CRN does not provide a methodology to predict maximum noise levels (L_{Amax}). However, it does contain relevant noise source terms for the trains that will use the railway, in the SEL parameter (see *Annex C*), at 25 m from the track. Additional noise source terms are also provided in an addendum to CRN (2).

Maximum noise levels can be predicted from SEL noise source terms by assuming that the noise during a train pass-by follows a nearly flat topped profile (3) in terms of rolling noise, using the equation originally proposed by the Noise Advisory Council (4). A second equation, based on work by Kurzweil, is presented in the Transport Noise Reference Book(5). The two prediction methods show close agreement.

Maximum noise levels at 25 m from the nearest rail have been predicted based on CRN noise source terms for the Class 168 DMU, Class 172 DMU and Class 66 diesel locomotive that will use the railway. Maximum noise levels for freight wagons are lower than the noise from the locomotive for freight trains, and so these have not been considered.

(1) The "slow" time constant is applied following the approach in PPG24 from which this measure is derived.
(2) Additional Railway Noise Source Terms for "Calculation of Railway Noise 1995", AEAT for Defra, 2007.
(3) Transport Noise Reference Book (equation 15.21 for rolling noise), Nelson, 1987.
(4) A Guide to the Measurement and Prediction of the Equivalent Continuous Sound Level Leq, The Noise Advisory Council, 1978.
(5) Transport Noise Reference Book (equation 15.24), Nelson, 1987.

CRN contains two source terms for diesel locomotives;

- one for "locomotives under full power", where engine noise is a significant component of the noise which can result in higher noise at low speeds; and
- a second which is always dominant at higher speeds where rolling noise (noise from the rail/wheel interaction) is the key noise source.

In order to trigger further mitigation, The Policy requires regular exceedences of the maximum noise level threshold. Occasional exceedences are not considered to be regular and therefore are not relevant to the assessment of noise mitigation and no mitigation would be offered as a result. Since there will be no more than the occasional instances of locomotives under "full power" close to receptors with the Order Scheme, the source term for rolling noise has been adopted to determined mitigation requirements rather than one for "full power".

The source terms for the three types of trains that are expected to use the track are as shown in *Table D3.1*.

Table D3.1 ***Source Terms Assumed for Analysis***

Type of Vehicle	SEL at 25m (from CRN), dB	L_{Amax} at 25m (Converted from SEL), dB	Uncertainty
Class 168 DMU - Chiltern Railways	31.2 + 20*log(155) +7.6 = 82.6	82.4 (2)	Not stated.
Class 172(1) DMU - East West Rail (worst case)	31.2 + 20*log(161) +7.6 = 82.9	82.9 (3)	Standard deviation 0.4 dB(A).
Class 66 Freight Locos (the most likely freight loco based on vehicles trends)	31.2 + 20*log(121) +13 = 85.9	84.1 (4)	Not stated.

1) No data, based on Class 170 DMU.
2) Calculated for the highest speed in this *Route Section*, of 155 kph.
3) Calculated for the highest speed in this *Route Section*, of 161 kph.
4) Calculated for a typical speed for this *Route Section*, of 121 kph.

D3.3 PROPAGATION MODEL

D3.3.1 Method of Modelling Rolling Noise Close to Trains

Models for maximum noise levels from trains often include propagation, assuming the noise behaves like a line source. However, researchers (eg Peters (1)) have highlighted that a dipole directivity model was the most accurate for predicting the rise and decay of rolling noise as a train passed a

(1) S Peters, 'The Prediction of Railway Noise Profiles', Journal of Sound and Vibration, Volume 32, No 1, 1974, pages 87-99

receiver. In some research this approach is used to simulate the total noise from a train, by modelling noise from individual wheels with appropriate directivity.

Models which simulate individual wheels as described above are not available in commercially available noise models, and manually implementing this sort of procedure on a scheme-wide scale would be prohibitive. Additionally, Peters' paper acknowledges that there are limitations to the prediction method, in that it does not include frequency information or a range of vehicle types. It also does not include engine noise, or take account of geometry. A method is required which can predict maximum noise levels under a wider range of circumstances, including those where noise mitigation has been applied.

Therefore, the approach in this assessment has sought to find a method that is available in SoundPlan(1), which takes into account the distribution of sources along a train and their height above the rail, and which applies a suitable directivity to noise from the train.

The Nordic Method

The Nordic Method (2) has been used and is implemented using the SoundPlan software package. This method, which is often referred to as Nord 2000, considers an input sound power for each type of train. A standard set of rail vehicles which are operational in Nordic countries are available as noise source terms for use in this method. In order to give appropriate predictions for the types of trains within the Order Scheme, a standard Nordic Method source term has been adjusted so that the predicted maximum noise levels give the same result as those derived in *Section D3.2* at 25 m.

The noise source in the Nordic Method is divided between 7 locations on a train. Horizontally, one source is located at the centre of the train, whilst the remaining three pairs of sources are located either side of this, at distances of L/2, L/4 and L/8 (where L is the length of the train). The directivity term that is applied to the maximum noise calculation in the horizontal plane is:

$$\Delta(\emptyset) = 10\log(0.15 + 0.85\sin^2(\emptyset)) + 2$$

The sources are treated as three pairs and one single source, and these sources are located at 4 heights, which are specified for particular train types or that can be defined by the user. The heights of 0.01, 0.35, 0.7 and 2.5 m above the railway, specified for the IC3 "Flexliner" DMU, have been assumed when predicting noise from the Class 168 and the Class 172 DMU.

The predicted values for DMUs at distances between 2 and 25 m are shown for the Nordic Method in *Table D3.2* for a Class 168 Predictions have been based on a Danish DMU Passenger train (IC3 "Flexliner"). The overall length

(1) SoundPlan v.7.1, the software package which has been used for the project noise modelling.
(2) Nord 2000 New Nordic Prediction Method for Rail Traffic Noise, H J Jonasson and S Storeheier, 2001.

of the train has been modelled as 24 m to reflect a typical Class 168 vehicle length (rounded from 23.6 m). The values have then been adjusted, by subtracting 1.1 dB(A) for a Class 168 DMU, to give the same value at 25 m as that predicted using the CRN noise source term and the equation proposed by the Noise Advisory Council (described in *Section D3.2*) at typical train speeds in the area. Due to the higher speed at which the EWR trains pass through the section a correction of -1.2 dB(A) would be appropriate for a Class 172 DMU.

Table D3.2 ***Predicted Noise Levels for a Class 168 / Class 172 DMU Following the Nordic Method***

	Predicted Maximum Noise Level (L_{Amax})		
Distance to Train (m)	**Class 168 DMU at 155 kph, dB (1)**	**Class 172 DMU at 161 kph, dB (1)**	**Class 66 Loco at 121 kph, dB (1)**
2	95.6	96.0	102.3
4	93.0	93.4	99.8
6	91.3	91.7	97.5
8	89.8	90.2	95.3
10	88.5	89.0	93.3
12	87.4	87.9	91.7
14	86.5	86.9	90.3
15	86.0	86.5	89.6
18	84.7	85.2	87.8
20	84.0	84.5	86.7
22	83.3	83.8	85.7
24	82.7	83.2	84.6
25	82.4	82.9	84.1

1) The source levels for the modelling were taken from the database in the Nordic Method, and have been calibrated to match the noise levels at 25 m for the trains listed in this table which are relevant to this railway.

D3.3.2 Treatment of Freight Locomotives

The noise from a freight locomotive, such as the Class 66 loco which is modelled in this *Scheme of Assessment*, is likely to comprise noise from the rail/wheel interface as well as a component from the engine. As outlined above for DMUs, the Nordic Method recognises these different elements and splits the noise from a train into seven individual point sources with equal sound power. These include a source at the centre of the train, which represents the engine.

There is one limitation in the Nordic Method when it is used to predict noise from freight locomotives; the source terms are for complete freight trains rather than simply the locomotive. Since much of the energy on a complete train is from rail wheel noise, the source term over emphasises the contribution of the wheels compared to the engine for a single freight locomotive. This results in a propagation characteristic that does not follow the expected, broadly spherical, pattern which would be expected for a freight locomotive.

In order to model an appropriate spreading pattern, the locomotive length has been set to 1 m in the model. This source is then moved along the track in the model and results in spreading, which is within 1 dB of spherical spreading. The source term has then been appropriately calibrated to give the same maximum noise level at 25 m as the one predicted using CRN for a Class 66 locomotive by adding 7.5 dB to the predicted levels. The correction required is relatively large as a result of the short modelled train length. This relationship is valid to as close as 4 m from the track, which covers the range of interest for this *Scheme of Assessment*. The predicted maximum noise level values for a Class 66 loco at distances between 2 and 25 m are shown for the Nordic Method in *Table D3.2*.

The freight locomotive modelled assumes heights of 0.01, 0.35, 0.7 and 2.5 m above the railway. Since these sources have equal sound power, the engine noise sound power is equal to the total sound power plus 10 x log (1/7) dB (ie 8.5 dB(A) lower than the total sound power). As freight speeds are expected to be high and freight locomotives are expected to be off-power in the area covered by this *Scheme of Assessment*, rail/wheel noise will dominate and this is considered to be a reasonable assumption.

Effect of Switches and Crossings

The Nordic method does not provide a correction to account for the presence of track discontinuities that may exist at switches and crossings. The effect of these on maximum noise levels is therefore not quantified in the noise modelling. However, within this *Route Section*, there are no switches and crossings close to NSRs.

Weather Conditions

The Nordic Method, as implemented in the current version of SoundPlan, uses an average of weather conditions in the calculation procedure despite specifying down-wind propagation. However, the predicted maximum noise levels are only of interest at receptors very close to the railway, and at these distances meteorological conditions will not have a significant effect on the predicted noise levels.

D4 RESULTS OF THE NOISE MODELLING

This section provides further details of the noise modelling results to supplement the data provided in the main *Scheme of Assessment* document. Details of the predicted train noise with, and without, mitigation are provided, as well as baseline noise levels and the resulting total noise level. The changes in noise levels, as a result of the Order Scheme are also shown where relevant.

Table D4.1 presents the results of the noise modelling without noise mitigation measures (other than those inherent in the design of the railway).

Table D4.2 presents the results of the noise modelling with noise mitigation.

Details of the noise mitigation are presented in *Section 5* of the main *Scheme of Assessment* document and are supplemented by figures identifying receptor locations, baseline noise monitoring locations and the location of the noise mitigation. Additionally, noise contours are presented for predicted night time train noise at a level of 45 dB(A), the threshold of a significant impact (ignoring the effects of baseline noise which may increase this threshold).

Table D4.1 Results of the Noise Modelling Without Mitigation (Free-field)

Receptor	Relevant Floor [1]	Predicted Train Noise / Exceedence of Threshold [2], dB		Baseline Noise Level (Without Baseline Trains / With Baseline Trains) [3], dB		Resulting Total Noise Level / Change in Noise Level [3], dB		Predicted Unmitigated Impact [4], dB		Maximum Noise Level ($L_{Amax,night}$) [5], dB
		Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Night
PI 7 Prospect House, Mill Street	1st floor	43 / **0**	40 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	63
PI 8 The Grange, Mill Street	2nd floor	52 / **0**	50 / **5**	45 / 45	38 / 39	53 / **8**	50 [6] / **11**	0	5	79
PI 9 Curtesy House, Mill Street	1st floor	43 / **0**	40 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	65
PI 10 Orchard Cottage, Mill Street	1st floor	43 / **0**	41 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	67
ES 11 Kareol	Ground floor	69 / **14**	67 / **22**	45 / 55	28 / 52	69 [6] / **14**	67 [6] / **15**	14	15	98
PI 11 Greengage Barn, Mill Street	Ground floor	51 / **0**	49 / **4**	45 / 45	28 / 33	52 / **7**	49 [6] / **16**	0	4	74
PI 12 3 Mill Barn, Mill Street	1st floor	61 / **6**	59 / **14**	45 / 47	28 / 41	61 [6] / **14**	59 [6] / **18**	6	14	82
PI 13 4 Mill Barn, Mill Street	Ground floor	62 / **7**	60 / **15**	45 / 48	28 / 42	62 [6] / **14**	60 [6] / **18**	7	15	87
ES 12 Mill Farm, Mill Street	2nd floor	58 / **3**	56 / **11**	45 / 47	28 / 39	59 / **12**	56 [6] / **17**	3	11	79

Receptor	Relevant Floor [1]	Predicted Train Noise / Exceedence of Threshold [2], dB		Baseline Noise Level (Without Baseline Trains / With Baseline Trains) [3], dB		Resulting Total Noise Level / Change in Noise Level [3], dB		Predicted Unmitigated Impact [4], dB		Maximum Noise Level ($L_{Amax,night}$) [5], dB
		Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Night
ES 13 Northfield Cottages	2nd floor	62 / 7	59 / 14	45 / 48	28 / 42	62 [6] / 14	59 [6] / 17	7	14	76

1) Worst affected floor level.

2) As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night

3) Noise from existing train movements was removed from measured baseline noise levels. The 'Resulting Total Noise Level' combines predicted train noise from the Order Scheme with existing baseline noise (without existing train noise as this will be replaced by the Order Scheme). The 'Change in Noise Level as a Result of the Order Scheme' compares the 'Resulting Total Noise Level' with existing baseline noise levels. Predicted train noise from existing railway traffic has been added to these baseline noise levels (from which existing train movements were removed) to represent the existing baseline noise situation for a 16h day and an 8h night. However, within this *Route Section*, existing train movements are minimal and are not expected to have a significant effect on existing noise levels.

4) The predicted impact is calculated as the lower of:
   - the amount by which train noise levels are predicted to exceed the threshold criteria. As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00-23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00-07.00\ hours)}$ at night; and
   - the change in noise level as a result of the Order Scheme (compared to the baseline noise level including trains).

5) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance. Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.

6) Train noise is predicted to be the dominant noise source at the nearest noise sensitive receptors. Where this is the case, baseline noise levels do not significantly influence the resulting total noise level and so this level will be the same as the predicted train noise.

Table D4.2 Results of the Noise Modelling With Mitigation (Free-field)

Receptor	Relevant Floor [1]	Predicted Train Noise / Exceedence of Threshold [2], dB		Baseline Noise Level (Without Baseline Trains / With Baseline Trains) [3], dB		Resulting Total Noise Level / Change in Noise Level [3], dB		Predicted Mitigated Impact [4], dB		Maximum Noise Level ($L_{Amax,night}$) [5], dB
		Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Night
PI 7 Prospect House, Mill Street	1st floor	42 / **0**	40 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	63
PI 8 The Grange, Mill Street	2nd floor	52 / **0**	50 / **5**	45 / 46	38 / 39	53 / **7**	50 [6] / **11**	0	5	79
PI 9 Curtesy House, Mill Street	1st floor	41 / **0**	39 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	65
PI 10 Orchard Cottage, Mill Street	1st floor	42 / **0**	39 / **0**	45 / 45	38 / 38	47 / **2**	42 / **4**	0	0	67
ES 11 Kareol	Ground floor	55 / **0**	53 / **8**	45 / 55	28 / 52	55 [6] / **0**	53 [6] / **1**	0	1	79
PI 11 Greengage Barn, Mill Street	Ground floor	40 / **0**	38 / **0**	45 / 45	28 / 33	46 / **1**	38 [6] / **5**	0	0	66
PI 12 3 Mill Barn, Mill Street	1st floor	48 / **0**	46 / **1**	45 / 47	28 / 41	50 [6] / **3**	46 [6] / **5**	0	1	73
PI 13 4 Mill Barn, Mill Street	Ground floor	47 / **0**	45 / **0**	45 / 48	28 / 42	49 / **1**	45 [6] / **3**	0	0	73
ES 12 Mill Farm, Mill Street	2nd floor	48 / **0**	45 / **0**	45 / 47	28 / 39	50 / **3**	46 [6] / **7**	0	0	70

Receptor	Relevant Floor [1]	Predicted Train Noise / Exceedence of Threshold [2], dB		Baseline Noise Level (Without Baseline Trains / With Baseline Trains) [3], dB		Resulting Total Noise Level / Change in Noise Level [3], dB		Predicted Mitigated Impact [4], dB		Maximum Noise Level ($L_{Amax,night}$) [5], dB
		Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Day ($L_{Aeq,16h}$)	Night ($L_{Aeq,8h}$)	Night
ES 13 Northfield Cottages	2nd floor	60 / 7	58 / 13	45 / 48	28 / 42	60 / 12	58 [6] / 16	5	13	74

1) Worst affected floor level.

2) As described in the Noise and Vibration Mitigation Policy and in *Section 2.3* of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00 - 23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00 - 07.00\ hours)}$ at night

3) Noise from existing train movements was removed from measured baseline noise levels. The 'Resulting Total Noise Level' combines predicted train noise from the Order Scheme with existing baseline noise (without existing train noise as this will be replaced by the Order Scheme). The 'Change in Noise Level as a Result of the Order Scheme' compares the 'Resulting Total Noise Level' with existing baseline noise levels. Predicted train noise from existing railway traffic has been added to these baseline noise levels (from which existing train movements were removed) to represent the existing baseline noise situation for a 16h day and an 8h night. However, within this *Route Section*, existing train movements are minimal and are not expected to have a significant effect on existing noise levels.

4) The predicted impact is calculated as the lower of:
   - the amount by which train noise levels are predicted to exceed the threshold criteria. As described in the Noise and Vibration Mitigation Policy and in *Section* 2.3 of the main *Scheme of Assessment* document, the noise impact threshold levels are 55 dB, $L_{Aeq\ (07.00 - 23.00\ hours)}$ during the day and 45 dB, $L_{Aeq\ (23.00 - 07.00\ hours)}$ at night; and
   - the change in noise level as a result of the Order Scheme (compared to the baseline noise level including trains).

5) The Policy requires the consideration of maximum noise levels in relation to the provision of non-statutory noise insulation. The Policy states: If maximum pass-by free-field noise (L_{Amax}, the instantaneous 'peak' as the train passes) regularly exceeds 82 dB (free-field) at night, this is considered to be a significant impact, based on guidance on the prevention of sleep disturbance. Therefore only predicted maximum noise levels at night are presented here. The highest predicted maximum noise level from freight and passenger trains has been reported.

6) For NSRs where train noise is the dominant noise source, baseline noise levels do not significantly influence the resulting total noise level and so this level will be the same as the predicted train noise.

Table D4.3 presents an estimation of those properties that may be eligible for noise insulation under The Noise Insulation (Railways and Other Guided Transport Systems) Regulations [1]. The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation specified in it) and will make formal offers following a building survey to identify eligible properties.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (Ammended 1998).

Table D4.3 ***Estimation of Eligibility for Statutory Noise Insulation Under The Noise Insulation (Railways and Other Guided Transport Systems) Regulations***

Receptor	'Prevailing'(1) Noise Level ($L_{Aeq,T}$), dB		Predicted 'Relevant' (2) (Façade) Noise Level ($L_{Aeq,T}$), dB		Likely to be Eligible (4)
	Day-time (3)	Night-time (3)	Day-time (3)	Night-time (3)	
PI 7 Prospect House, Mill Street	26	25	44	42	No
PI 8 The Grange, Mill Street	35	34	54	52	No
PI 9 Curtesy House, Mill Street	26	25	44	42	No
PI 10 Orchard Cottage, Mill Street	26	25	44	42	No
ES 11 Kareol	54	53	57	55	No
PI 11 Greengage Barn, Mill Street	33	32	42	40	No
PI 12 3 Mill Barn, Mill Street	43	42	50	48	No
PI 13 4 Mill Barn, Mill Street	45	43	50	48	No
ES 12 Mill Farm, Mill Street	41	40	50	48	No
ES 13 Northfield Cottages	44	43	63	60	No

1) The prevailing noise level is defined in the Regulations and is the noise level from trains before the Order Scheme is built.
2) The relevant noise level is defined in the Regulations and is the noise level from all trains following implementation of the scheme. The predicted relevant noise level includes the noise mitigation outlined in this Scheme of Assessment.
3) For the purpose of the Regulations, the day-time period is defined as 06.00 to 00.00 and the night-time is defined as 00.00 - 06.00
4) An estimation of the properties which may be eligible for noise insulation under the Regulations is presented. A property may be eligible under the Regulations if train noise exceeds the (façade) threshold levels (of 68 dB during the day-time and 63 dB during the night-time). Other conditions which must also be met are set out in the Regulations. The Promoter will confirm the extent of the mitigation required under the Regulations following the acceptance of this *Scheme of Assessment* (and the mitigation outlined in it) and a building survey to identify eligible properties.

Annex E

Supporting Baseline Information

E1 METHODOLOGY

E1.1 INTRODUCTION

This *Annex* provides details of the noise measurements that have been used in the noise assessment.

E1.2 MEASUREMENT LOCATIONS

As discussed in *Section 4* of the main *Scheme of Assessment* document, noise measurements were carried out to inform the Environmental Statement (ES). The measurement location relevant to this *Route Section* is:

- NML(ES) 7 (Kareol).

The measurements at this location were short sample measurements during the day and night periods.

Since publication of the ES, additional long-term, unattended monitoring was carried out at several locations to inform the public inquiry. These surveys have been used to increase the baseline coverage in some areas, notably in Islip and in the Wolvercote area of north Oxford where the topography and road locations may result in significant differences in existing noise levels. In other areas monitoring has been carried out in order to increase the level of detail.

Additional noise monitoring was carried out in June and August 2010, at the following locations:

- Whimbrel Close, Bicester;
- Mill Street, Islip;
- Lakeside, Oxford;
- Blenheim Drive, Oxford;
- Stone Meadow, Oxford.

Monitoring at each location was carried out over a period of several days so that unusual events and bad weather could be excluded.

Noise measurements at Mill Street were carried out in the rear garden of Cotswold House (NML (PI) 2) which is in *Route Section E* (close to *Route Section F*).

The noise monitoring locations for *Route Section F* are shown in *Figure 5.1* of the main body of the *Scheme of Assessment*.

E1.3 SURVEY PROCEDURE

Measurements were made of the existing noise environment during the day-time and night-time in accordance with BS 7445 (1). Class 1 sound level meters have been used. All sound level meters were within their calibration period. Sound level meters were calibrated before use, and the calibration levels were checked after the survey. No deviation of greater than 1 dB was noted.

Noise monitoring equipment was mounted on a tripod so that the microphone was in a free-field position. It was situated approximately 1.5 m above ground level close to receptors at NML(ES) 7 (Kareol), and on a tall (2.6 m) tripod at NML(PI) 2 (Cotswold House), to avoid screening from the garden fence so that noise levels represented those experienced at first floor windows.

Monitoring at the ES location was carried out on an attended sample basis. Monitoring at NML(PI) 2 (Cotswold House) was carried out over a period of several days so that unusual events and bad weather could be excluded if necessary. Weather data were used from the nearby Met Office weather station at Benson to identify periods where the measurements may have been adversely affected during unattended measurements.

(1) British Standard (BS) 7445: Description and measurement of environmental noise, Part 1, Guide to quantities and procedures (2003)

E2 MEASURED NOISE LEVELS

E2.1 NOISE LEVEL MEASUREMENTS CARRIED OUT FOR THE ES

The attended noise samples recorded during the ES at NML(ES) 7 (Kareol) are reported in *Table E2.1*. None of the measurements include noise from existing trains.

Table E2.1 Attended Measurement Survey Results

Measurement Position	Date	Time	Duration (Mins)	Sound Pressure Level (dB)				Description of Noise Climate	Meteorological Conditions
				L_{Aeq}	L_{A90}	L_{A10}	L_{Amax}		
NML(ES) 7 (Kareol)	2 June 09	12.47	15	49	31	50	70	Distant traffic dominates. Bird song, leaves rustling, aeroplanes overhead can also be heard	Dry with a gentle breeze
	2 June 09	13.02	15	45	30	44	66		
	2 June 09	01.45	10	28	26	29	42	Distant traffic dominates.	Dry and still
	2 June 09	01.56	10	28	26	30	41		

E2.2 NOISE MEASUREMENTS AT COTSWOLD HOUSE, MILL STREET (NML (PI) 2)

The measurements at Cotswold House may have included some train noise. Freight train movements were identified using freight analysis data provided by Chiltern Railways, which detailed movements and timings of freight trains along the route. Where they noticeably increased noise levels, they have been removed. Passenger train noise was too low at this location to influence the measurements.

The measured values are summarised in *Table E2.2* and detailed in *Table E2.3*.

Table E2.2 Summary of Noise Measurements at Cotswold House (NML (PI) 2)

Date	Time Period	Noise Level (free-field), $L_{Aeq,period}$ dB
18.08.2010 - 19.08.2010	Night-time (2)	38
19.08.2010	Day time (1)	45
19.08.2010 - 20.08.2010	Night-time (2)	40
20.08.2010	Day time (1)	47
20.08.2010 - 21.08.2010	Night-time (2)	42

(1) Daytime hours from 07.00 to 23.00
(2) Night-time hours from 23.00 to 07.00

Table E2.3 Detailed Survey Results at Cotswold House (NML (PI) 2)

Date	Start Time	Duration (hours)	Noise Level (free-field), dB		
			$L_{Aeq,1h}$	$L_{A90,1h}$	$L_{A10,1h}$
2010/08/18	23:00:00.00	1	38.7	36.5	40.9
2010/08/19	00:00:01.00	1	37.3	34.6	39.1
2010/08/19	01:00:01.00	1	37.9	34.7	40.2
2010/08/19	02:00:01.00	1	38.0	34.3	40.2
2010/08/19	03:00:01.00	1	38.2	34.4	39.9
2010/08/19	04:00:01.00	1	39.3	37.0	41.4
2010/08/19	05:00:01.00	1	41.2	38.3	42.7
2010/08/19	06:00:01.00	1	44.4	42.1	45.6
2010/08/19	07:00:00.00	1	45.2	43.7	46.7
2010/08/19	08:00:00.00	1	42.4	39.9	44.2
2010/08/19	09:00:00.00	1	42.2	39.2	44.4
2010/08/19	10:00:00.00	1	44.3	39.4	45.9
2010/08/19	11:00:00.00	1	46.2	39.9	48.1
2010/08/19	12:00:00.00	1	46.4 (1)	41.1	48.6
2010/08/19	13:00:00.00	1	45.1 (1)	40.0	47.9
2010/08/19	14:00:00.00	1	46.1	41.2	48.2
2010/08/19	15:00:00.00	1	45.1	40.2	47.4
2010/08/19	16:00:00.00	1	44.5	41.3	47.1
2010/08/19	17:00:00.00	1	49.1	40.0	46.6
2010/08/19	18:00:00.00	1	45.1	40.2	46.7
2010/08/19	19:00:00.00	1	43.2	40.4	45.6
2010/08/19	20:00:00.00	1	40.7	37.5	43.2
2010/08/19	21:00:01.00	1	40.7	36.9	43.9
2010/08/19	22:00:01.00	1	39.2	36.6	41.0
2010/08/19	23:00:01.00	1	39.2	36.0	41.0
2010/08/20	00:00:01.00	1	36.7	34.4	38.9
2010/08/20	01:00:01.00	1	43.0	34.8	46.8

Date	Start Time	Duration (hours)	Noise Level (free-field), dB		
			$L_{Aeq,1h}$	$L_{A90,1h}$	$L_{A10,1h}$
2010/08/20	02:00:00.00	1	37.9	34.2	39.6
2010/08/20	03:00:01.00	1	36.5	33.7	38.6
2010/08/20	04:00:01.00	1	38.3	35.1	39.9
2010/08/20	05:00:01.00	1	39.3	36.4	40.8
2010/08/20	06:00:01.00	1	42.3	39.4	44.0
2010/08/20	07:00:00.00	1	43.5	41.2	45.0
2010/08/20	08:00:00.00	1	43.2	41.1	44.5
2010/08/20	09:00:00.00	1	43.3	41.0	45.1
2010/08/20	10:00:00.00	1	46.3	41.4	47.4
2010/08/20	11:00:00.00	1	46.2	42.5	48.9
2010/08/20	12:00:00.00	1	49.3	44.0	52.1
2010/08/20	13:00:00.00	1	49.3	44.6	52.9
2010/08/20	14:00:00.00	1	50.6	44.9	53.3
2010/08/20	15:00:00.00	1	48.8	42.5	52.7
2010/08/20	16:00:00.00	1	49.5	44.1	52.4
2010/08/20	17:00:00.00	1	49.2	44.0	51.5
2010/08/20	18:00:00.00	1	49.9	43.0	51.8
2010/08/20	19:00:00.00	1	44.3	41.1	46.7
2010/08/20	20:00:00.00	1	44.4	39.6	44.6
2010/08/20	21:00:00.00	1	39.0	36.9	40.8
2010/08/20	22:00:01.00	1	39.0	36.1	41.5
2010/08/20	23:00:01.00	1	40.1	36.1	42.2
2010/08/21	00:00:01.00	1	38.9	35.7	41.5
2010/08/21	01:00:01.00	1	37.2	33.7	39.5
2010/08/21	02:00:01.00	1	39.0	34.8	42.5
2010/08/21	03:00:01.00	1	38.9	34.6	41.4
2010/08/21	04:00:01.00	1	49.1	34.6	40.9
2010/08/21	05:00:00.00	1	40.8	36.9	43.0
2010/08/21	06:00:01.00	1	42.1	39.2	44.5

1) These hours included freight trains which were excluded from the average baseline L_{Aeq}.

At Cotswold House, Mill Street (NML(PI) 2), measurements were made between the 18th and 21st of August 2010. The measurements (which do not include train noise) gave a range of 45 to 47 dB L_{Aeq} during the day, and 38 to 42 dB L_{Aeq} at night.

At Kareol level crossing masters house (NML(ES) 7), measurements were carried out on the 2nd June 2009. The measurements (which do not include train noise) gave a range of 45 to 49 dB L_{Aeq} during the day, and 28 dB L_{Aeq} at night.

The baseline noise levels measured at NML(PI) 2 are expected to be representative of existing noise levels at NSRs along the north eastern half of Mill Street (Prospect House, Curtesy House, Orchard Cottage and the Grange), whilst baseline noise levels measured at NML(ES) 7 are expected to be representative of existing noise levels at NSRs to the south west of this (Kareol, Mill Farm, Mill Barns and the Northfield Cottages). Lower noise levels were measured at night as a result of increased screening of noise from road traffic from the A34. In addition, the adopted measured baseline noise levels are low and do not affect the assessment of impacts for this *Route Section*.

Baseline train noise has been predicted for the NSRs in this *Route Section* and has been added to the measured baseline noise level without train noise to produce the baseline noise level with trains.

The adopted baseline noise levels at NSRs considered in this assessment are summarised in *Table E3.1*.

Table E3.1 ***Baseline Noise Levels Assumed for Scheme of Assessment – $L_{Aeq,period}$ (Free-field)***

Receptor	Noise Level without Trains, dB		NML Used	Noise Level with Baseline Trains, dB	
	$L_{Aeq, day}$ (1)	$L_{Aeq, night}$ (2)		$L_{Aeq, day}$ (1)	$L_{Aeq, night}$ (2)
PI 7 Prospect House, Mill Street	45	38	*NML(PI) 2*	45	38
PI 8 The Grange, Mill Street	45	38	*NML(PI) 2*	46	39
PI 9 Curtesy House, Mill Street	45	38	*NML(PI) 2*	45	38
PI 10 Orchard Cottage, Mill Street	45	38	*NML(PI) 2*	45	38
ES 11 Kareol	45	28	*NML(ES) 7*	55	52
PI 11 Greengage Barn, Mill Street	45	28	*NML(ES) 7*	45	33
PI 12 3 Mill Barn, Mill Street	45	28	*NML(ES) 7*	47	41
PI 13 4 Mill Barn, Mill Street	45	28	*NML(ES) 7*	48	42
ES 12 Mill Farm, Mill Street	45	28	*NML(ES) 7*	47	39
ES 13 Northfield Cottages	45	28	*NML(ES) 7*	48	42

1) The daytime period for this assessment is taken to be from 07.00 to 23.00.
2) The night-time period for this assessment is taken to be from 23.00 to 07.00.

An initial assessment of eligibility for noise insulation under the Noise Insulation (Railways and Other Guided Transport Systems) Regulations (1) (the Regulations) has been carried out. This assessment uses the time periods specified in the Regulations; the day-time period is defined as the period of 18 hours between 06.00 and midnight, whilst the night-time period means the six hours between midnight and 06.00.

The Regulations give a specific term for existing noise ie 'prevailing noise level', which is defined as the level of noise caused by the movement of trains on railways immediately before the start of construction. One of the steps in determining eligibility under the Regulations is to identify when noise from the Order Scheme exceeds the prevailing noise level by at least 1 dB(A).

The prevailing noise level has been predicted for NSRs in this *Route Section*, based on existing service levels as set out in *Annex D*. The results are presented in *Table E3.2*.

(1) The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996 (Ammended 1998).

Table E3.2 ***Predicted Prevailing Noise Level (Free-field)***

Receptor	Predicted Prevailing Noise Level (Free-field), dB(A)	
	$L_{Aeq,day}$	$L_{Aeq,night}$
PI 7 Prospect House, Mill Street	26	25
PI 8 The Grange, Mill Street	35	34
PI 9 Curtesy House, Mill Street	26	25
PI 10 Orchard Cottage, Mill Street	26	25
ES 11 Kareol	54	53
PI 11 Greengage Barn, Mill Street	33	32
PI 12 3 Mill Barn, Mill Street	43	42
PI 13 4 Mill Barn, Mill Street	45	43
ES 12 Mill Farm, Mill Street	41	40
ES 13 Northfield Cottages	44	43

The prevailing noise level is normally higher at locations closer to the existing railway except where significant screening reduces its level. At all NSRs noise from the Order Scheme is predicted to exceed the prevailing noise level by at least 1 dB(A). Consequently, when determining eligibility, only the exceedence of the threshold values (and other requirements set out in the Regulations) need be considered.

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