Appendix A AECOM noise impact assessment

A.1 The AECOM 61 page noise report is appended after this page.

Bedlington Railway Station

Noise Impact Assessment

Northumberland County Council

Project reference: Northumberland Line Upgrades
Project number: 60628487

December 2020

Quality information

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1. Introduction

1.1 Purpose

AECOM has been commissioned by Northumberland County Council (NCC) to complete a noise and vibration impact assessment to accompany the application for planning permission for a new rail station in Bedlington. The station will primarily consist of a new platform for railway passengers (the proposed development). The proposed development is a part of the proposed Northumberland railway line upgrades to re-introduce passenger services between Ashington and Northumberland Park (NL Upgrades).

1.2 NL Upgrades

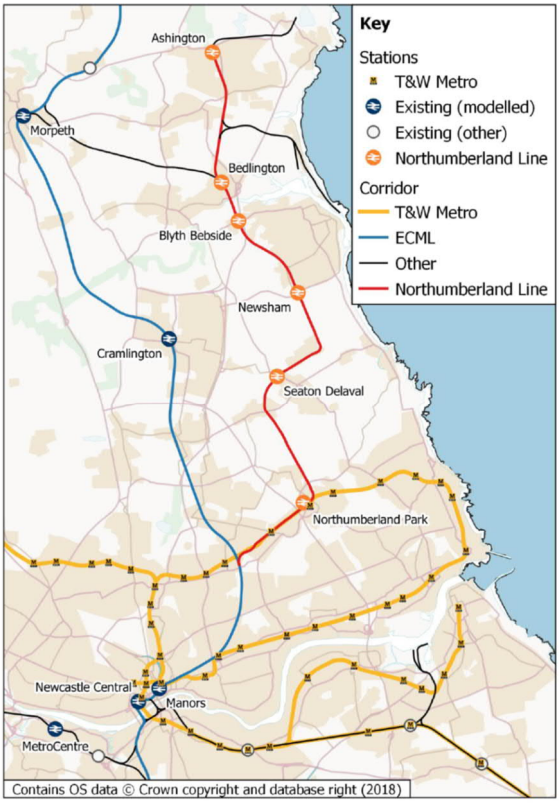
The NL Upgrades will enable the introduction of new passenger services along an existing rail corridor which is presently used only for freight trains. The passenger services will use approximately 6.4 km of the East Coast Main Line and 16 km of existing track, as shown in Figure 1.

At present, alongside the use of existing stations (such as Manors and Newcastle Central) where no works will be required, the construction of six new stations is proposed:

- Ashington;
- Bedlington;
- Blyth Bebside;
- Newsham;
- Seaton Delaval; and
- Northumberland Park (an existing 'Metro' station which will require a new rail platform and pedestrian access etc.)

The proposed NL Upgrades will introduce a total of 32 new train movements in each direction (64 in total) per day, with the line planned to open and start operations in 2024. The timings of the freight trains which currently use the line are not anticipated to significantly change.

Figure 1. The Northumberland Line route and stations



The proposed new passenger trains are assumed to be 3-carriage Class 158 DMUs. Disk-braked DMU passenger trains all emit very similar sound levels; therefore, this will be representative of the eventual train type. These are likely to be upgraded to Vivarail Class 230 D-Train BEMU battery powered trains but the date for the upgrade is yet to be defined. As part of the NL Upgrades, much of the railway track will be renewed, involving replacement of the existing rails and sleepers.

1.3 Proposed Development

The proposed development is anticipated to include new platforms on either side of the railway line. The proposed development will also introduce new car parks and access roads, footways, shelters and signs. The new platform will incorporate a new public address (PA) system.

No new building services plant or significant amendments to the track layout in the vicinity of the station is proposed. The track through the station is proposed to be re-railed and the formation is to be renewed. No demolition of existing buildings is proposed. The proposed timings of the passenger train movements at the new station are provided in Table 1 below.

Table 1 Passenger Train Times

Time	Origin	Destination	Comment
05:51	Heaton	Ashington	Empty rolling stock, does not stop, not on Sundays
06:11 to 19:11	Ashington	Newcastle	Train movements at this time each hour between these times
06:15	Heaton	Ashington	Empty rolling stock, does not stop, not on Sundays
06:38 to 22:38	Ashington	Newcastle	Train movements at this time each hour between these times
06:54 to 22:54	Newcastle	Ashington	Train movements at this time each hour between these times
07:21 to 20:21	Newcastle	Ashington	Train movements at this time each hour between these times
20:17	Ashington	Heaton	Empty rolling stock, does not stop, not on Sundays
23:11	Ashington	Heaton	Empty rolling stock, does not stop, not on Sundays

1.4 Scope of Assessment

The noise and vibration impact assessment scope of works is as follows:

- Review plans and mapping data to identify nearby noise (and vibration) sensitive receptors (NSRs).
- Undertake baseline sound and vibration measurements at locations representative of these NSRs.
- Qualitative assessment of potential construction noise and vibration impacts, in accordance with the guidance in BS 5228:2009+A1 2014 'Code of practice for noise and vibration control from construction and open sites – Part 1: Noise' (BS 5228-1)[1].
- Assessment of the impact of a change in the ambient sound levels at nearby NSRs due to operation of the station generated by the PA system, car parking and trains.
- Assessment of the impact of a change in the vibration levels at nearby NSRs due to the trains in accordance with the guidance in BS 6472-1:2008 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting'[2]
- Assessment of the impact of Public Address (PA) system sound using British Standard BS 4142:2014 + A1:2019 'Methods for rating and assessing industrial and commercial sound'[3]
- Assess the impact of changes in road traffic noise due to construction and operation of the scheme in accordance with the Highways England document Design Manual for Roads and Bridges LA111[4].

A glossary of acoustic terminology can be found in Appendix A.

1.5 Noise Sensitive Receptors

All nearby NSRs are existing residential properties, they have been identified from ordnance survey mapping data. The identified NSRs are listed in Table 2 and shown in Figure 2 in Appendix B along with the proposed development redline boundary. No nearby non-residential NSRs have been identified.

Table 2 Receptors

Receptor Number	Represented Properties
R1	1 Sleekburn House
R2	26 to 32 Blenheim Drive
R3	24 Blenheim Drive
R4	22 and 23 Blenheim Drive
R5	14 to 21 Blenheim Drive
R6	Clayton Arms
R7	5A, 8A and 9 Station Street
R8	2A, 4A and 7A Ravensworth Terrace
R9	1 to 3 Park Terrace
R10	4 to 6 Park Terrace
R11	The Gables, 7 Park Terrace
R12	3 West View
R13	30 West View
R14	24 to 29 West View
R15	18 to 23 West View

1 British Standards Institution (2014). BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise'
2 British Standards Institution, (2008). BS 6472-1:2008 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration sources other than blasting'
3 British Standards Institution (2019). BS 4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'
4 Highways England (2020). Design Manual for Roads and Bridges LA111 Noise and vibration Version 2

Receptor Number	Represented Properties
R16	17 West View

The above scope, as well as the assessment and baseline survey methodologies (described in Section 3 and Section 5 of this report) were agreed with the Environmental Protection Officer (EPO) at NCC by e-mail.

2. Legislative and Planning Policy Context

This section describes the policy and legislation that is relevant to assessment of noise for the NL scheme.

2.1 Legislation

The Environmental Protection Act 1990 and the Control of Pollution Act 1974 provide powers to local authorities for controlling noise and vibration from construction sites and similar works.

2.1.1 Environmental Protection Act 1990

The Environmental Protection Act 1990[5] prescribes 'noise (and vibration) emitted from premises (including land) so as to be prejudicial to health or a nuisance' as a statutory nuisance.

Local Authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either the abatement of the nuisance; or works to abate the nuisance to be carried out; or it prohibits or restricts the activity. Contravention of a notice without reasonable excuse is an offence. A right of appeal to the Magistrates Court exists within 21 days of the service of a noise abatement notice.

No statutory noise limits exist for determining a nuisance, therefore the Local Authority can take account of various guidance documents and existing case law when investigating complaints. Lower noise level limits are generally applied when considering the acceptability of a planning permission than those which would be used when considering whether an existing noise source amounts to a statutory nuisance. Demonstrating the use of best practicable means to minimise noise levels is an accepted defence against a noise abatement notice.

Section 122 of the Railways Act 1993[6] provides a defence to actions in nuisance' for licensed railway undertakers and operators in connection with the use of rolling stock on any track, or use any land comprised in a network, station or light maintenance depot for or in connection with the provision of network services, station services or light maintenance services.

When considering a planning application, Local Authority Environmental Health Officers are obliged to consider whether the development under consideration has the potential to cause a statutory nuisance and to use the planning process to avoid this outcome if possible.

2.1.2 Control of Pollution Act 1974

The Control of Pollution Act 1974 (CoPA)[7] requires that Best Practicable Means (BPM) (as defined in Section 72 of CoPA) are adopted to control construction noise on any given site as far as reasonably practicable. Sections 60 and 61 of the CoPA provide the main legislation regarding enabling works and construction site noise and vibration. If noise complaints are received, a Section 60 notice may be issued by NTC with instructions to cease work until specific conditions to reduce noise have been adopted.

Section 61 of the CoPA provides a means to apply for prior consent to carry out noise generating activities during construction. Once prior consent has been agreed under Section 61, a Section 60 notice cannot be served provided the agreed conditions are maintained on-site.

5 Environmental Protection Act 1990, c. 79. Available at https://www.legislation.gov.uk/ukpga/1990/43/contents (accessed 06/11/20)6 Railways Act (1993), ch. 122. Available at https://www.legislation.gov.uk/ukpga/1993/43/contents (accessed 06/11/20)7 Control of Pollution Act 1974, c. 60 and 61. Available at https://www.legislation.gov.uk/ukpga/1974/40/part/III/crossheading/construction-sites (accessed 07/11/20)

6 Railways Act (1993), ch. 122. Available at https://www.legislation.gov.uk/ukpga/1993/43/contents (accessed 06/11/20)7 Control of Pollution Act 1974, c. 60 and 61. Available at https://www.legislation.gov.uk/ukpga/1974/40/part/III/crossheading/construction-sites (accessed 07/11/20)

7 Control of Pollution Act 1974, c. 60 and 61. Available at https://www.legislation.gov.uk/ukpga/1974/40/part/III/crossheading/construction-sites (accessed 07/11/20)

Whilst construction noise and vibration are factors which can be considered during the planning process, Local Authorities have alternative powers under Sections 60 and 6 of CoPA to regulate these issues if complaints arise.

2.1.3 Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996

The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996[8] (NIR) specify that the responsible authority has a duty to carry out, or make a grant to cover the cost of, noise insulation works to residential buildings if specific criteria are met. It applies to new or altered railways but not to intensification (a change in the number or type of trains). There are separate criteria for day (06:00h-00:00h) and night (00:00h-06:00h) periods and meeting either one is sufficient for insulation works to be required.

In the assessment, a 'relevant noise level' is defined in the NIR as the highest total train sound level within 15 years of the new or altered railway becoming operational, with the total sound being the sum of the sound from trains on the existing railway and the sound from trains on the new/altered track.

The following criteria are included in the NIR and all three criteria must be met for an eligible building to qualify for insulation works:

1. The relevant noise level is 68 dB L_{Aeq} or more during the day or 63 dB L_{Aeq} or more during the night.
2. The relevant noise level is higher by at least 1 dB than the sound from the existing tracks).
3. The trains operating on the new/altered infrastructure contribute at least 1 dB to the relevant noise level.

The limit in the NIR is a level at the façade of the property and includes a correction of 2.5 dB for reflection of sound of the façade.

2.2 Planning Policy

2.2.1 National Planning Policy Framework

The revised National Planning Policy Framework (NPPF)[9] was published in February 2019. It sets out the Government's planning policies for England and describes how these are expected to be applied. This NPPF supersedes the previous versions published in March 2012 and July 2018.

The revised NPPF maintains the presumption in favour of sustainable development which should be delivered in accordance with three main objective areas: economic, social and environmental (Paragraph 8). The revised NPPF aims to enable local people and their local authorities to produce their own distinctive local and neighbourhood plans, which should be interpreted and applied in order to meet the needs and priorities of their communities.

Policies and objectives which are of particular relevance to noise and vibration include Paragraph 170:

"planning policies and decisions should contribute to and enhance the natural and local environment by…preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans…"

Paragraph 180 also states:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a. mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;

8 The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996, Statutory Instrument No. 428.
9 Department for Communities and Local Government (DCLG), (2019); National Planning Policy Framework.

b. identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason [….]"

With regards to 'adverse effects' and 'significant adverse effects', the NPPF refers to the Noise Policy Statement for England (NPSE)[10] (see below).

2.2.2 Noise Policy Statement for England (2010)

The NPSE seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The Statement applies to all forms of noise, including environmental noise, neighbour noise, and neighbourhood noise.

The NPSE sets out the long-term vision of the government's noise policy, which is to *"promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".*

This long-term vision is supported by three aims:

- *"Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvements of health and quality of life."*

The 'Explanatory Note' within the NPSE provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the following concepts:

- *No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;*
- *Lowest Observable Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and*
- *Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.*

The aims can therefore be interpreted as follows (within the context of Government policy on sustainable development):

- The first aim is to avoid noise levels above the SOAEL.
- To consider situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and minimise the effects. However, this does not mean that such adverse effects cannot occur.

It is recognised that the LOAEL and SOAEL do not have single objective noise-based levels that are applicable to all sources of noise in all situations. The defined levels are likely to be different for different sources, receptors and at different times of the day.

This report assesses the potential noise impacts of the proposed development and mitigation is identified as required to avoid significant adverse effects as per the first aim of the NPSE.

2.2.3 Planning Practice Guidance (2018)

The Planning Practice Guidance (PPG)[11] was published on the 6th March 2014 to provide more in-depth guidance to the NPPF. The PPG aims to make planning guidance more accessible, and to ensure that the guidance is kept up to date.

The PPG states that local planning authorities should take account of the acoustic environment and in doing so consider:

- *"whether or not a significant adverse effect is occurring or likely to occur;*

10 Department for Environment Food and Rural Affairs (Defra), (2010); Noise Policy Statement for England.
11 Department for Communities and Local Government (DCLG), (2017); Planning Practice Guidance.

- *whether or not an adverse effect is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved."*

Further details on the noise exposure hierarchy are provided in Table 3, which has been reproduced from PPG[12].

Factors to be considered in determining whether noise is a concern are identified by PPG. This includes the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise, and cumulative effects.

Regarding mitigating noise effects on residential development, the PPG highlights that effects may be partially off-set if residents have access to a relatively quiet façade as part of their dwelling or a relatively quiet amenity space (private, shared or public).

Table 3 Planning Practice Guidance Definitions Relating to Noise Effect Levels

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid through use of appropriate mitigation whilst taking into account the social and economic benefit
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent through use of appropriate mitigation

2.2.4 Local Policy

Within the Northumberland Local Plan[13], there is a policy relating specifically to noise, within Policy POL2 "Pollution and air, soil and water quality". This stipulates:

> *"Development proposals in locations where they would cause, or be put at unacceptable risk of harm from, or be adversely affected by pollution by virtue of the emissions of fumes, particles, effluent, radiation, smell, heat, light, noise or noxious substances will not be supported."*

Noise also sits within the following strategies and policies:

- Policy STP 5 "Health and wellbeing (Strategic Policy)", in relation to preventing negative impacts upon noise pollution;
- Policy QOP 2 "Good design and amenity", in relation to minimising adverse impacts on amenity;
- Policy TRA 2 "The effects of development on the transport network", in relation to minimising any adverse impact on communities and the environment; and

12 Paragraph: 005 Reference ID: 30-005-20140306
13 Northumberland County Council (2019) *Northumberland Local Plan*. Available at: https://northumberland-consult.objective.co.uk/portal/planning/localplan/reg19

- Policy ENV 4 “Tranquillity, dark skies and a sense of rurality”, in relation to minimising noise generated during construction and thereafter to conserve tranquillity.

Within the Northumberland Local Plan, the Northumberland railway is considered to be a key driver for growth in South East Northumberland and therefore a key aspiration of NCC:

> *“A key priority of the Council is to secure the future reintroduction of passenger rail services on the existing line between Benton Junction and Woodhorn ('The Northumberland Line'), provided that any significant adverse impact on the environment and communities can be mitigated.”*

3. Assessment Methodology

3.1 Construction

As details of the proposed construction schedule and plant to be used are not available at this stage, a quantitative construction noise and vibration assessment has not been carried out. Instead a qualitative assessment focussing on best practicable means has been completed. This considers the potential for significant effects to occur based on distance and timings of the proposed works but does not quantitatively assess the impact of the proposed works.

3.1.1 Construction Noise

The construction noise assessment has been based on British Standard BS 5228-1:2009+A1 2014 ‘Code of practice for noise and vibration control from construction and open sites – Part 1: Noise’ (BS 5228-1)[14].

BS 5228-1 provides practical information on construction noise and vibration reduction measures and promotes a ‘Best Practicable Means’ approach to control noise and vibration. The calculation method provided in BS 5228-1 is based on the number and types of equipment operating, their associated sound power level (L_w), and the distance to receptors, together with the effects of any screening.

BS 5228-1 contains a methodology for the assessment of the significance of effect of construction noise in relation to the ambient noise levels, known as the "ABC method". The criteria for significance provided in BS 5228-1 are reproduced in Table 4.

Table 4 Construction Noise Threshold of Potentially Significant Effect at Dwellings

Assessment Category	Threshold Value (dB) $L_{Aeq,T}$		
	Category A [a)]	Category B [b)]	Category C [c)]
Night-time (23:00 – 07:00)	45	50	55
Evenings and Weekends [d)]	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

NOTE 1: A potentially significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values) then a potentially significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.

NOTE 3: Applies to residential receptors only.

Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.

Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.

19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.

14 British Standards Institution (2014). BS 5228-1:2009+A1:2014 ‘Code of practice for noise and vibration control on construction and open sites – Part 1: Noise’

For the appropriate period (night, evening/weekend, day), the ambient noise level is determined and rounded to the nearest 5 dB. The appropriate Threshold Value is then determined. The construction noise level is then compared with this Threshold Value. If the noise level from the works exceeds the Threshold Value, then there is the potential for a significant effect to occur. However, in line with best practice, this indicator of a potential significant effect is then further considered using professional judgement and accounting for a range of other factors, including:

- the duration of the impact. Based on the guidance in BS 5228-1, construction noise levels above the Threshold Value for less than 10-days (or 10-evenings/weekends or nights) in any 15 consecutive days, or 40-days or less (or 40 evenings/weekends or nights) in any 6-month consecutive period would not normally be considered significant;
- the timing of the impact, night-time impacts being more likely to be considered significant than daytime impacts;
- the location of the impact at the receptor, for example, a receptor may contain areas which are more or less sensitive than others, e.g. in a school, its office spaces or kitchens would be considered less sensitive than the classrooms; and
- the nature, times of use and design of the receptor, e.g. a receptor which is not used at night would not be considered sensitive to night-time construction works.

3.1.2 Construction Vibration

The construction vibration assessment has been based on British Standard BS 5228-2:2009+A1 2014 'Code of practice for noise and vibration control from construction and open sites – Part 2: Vibration' (BS 5228-2)[15].

Vibration due to construction activities has the potential to result in adverse impacts at nearby sensitive receptors. BS 5228-2 indicates that vibration impacts depend on the activity, ground conditions and receptor distance.

Table 5 details Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of construction vibration effects on human receptors based on guidance contained in BS 5228-2.

Table 5 Magnitude of Vibration (PPV) Effects

Peak Particle Velocity Level	Description	Magnitude of Impact
0.14 to < 0.3 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Very Low
0.3 to < 1 mm/s	Vibration might be just perceptible in residential environments.	Low
1.0 to < 10 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Medium
>= 10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High

The vibration criteria presented in Table 5 relates to the sensitivity of building occupants to vibration. Whether an effect is significant requires additional consideration using professional judgement, taking account of the duration and frequency of the effect, as well as the time of day that the effect would be experienced.

In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration levels are controlled to those specified by annoyance then it is highly unlikely that buildings will be damaged by construction vibration.

15 British Standards Institution (2014). BS 5228-2:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration'

3.2 Operational Sound

3.2.1 Change in ambient sound level

The assessment methodology combines the predicted sound from all sources likely to be emitted during operation of the railway station (i.e. trains, car parking and PA system) for comparison with the current ambient sound levels established from a baseline survey which is described in Section 5.

To predict the sound from the trains and car parking, a model of the railway line and surroundings has been developed in CadnaA version 2020 MR2 sound mapping software. This includes the sound from the moving freight and passenger trains, the passenger trains when stopped at the station, car park and new access road. Moving train sound is predicted in accordance with Calculation of Railway Noise[16] (CRN) which includes a minimum train speed of 20 km/h, when the trains are stopped the predictions are in accordance with ISO 9613-2[17]. The proposed freight train compositions are assumed to remain as per the current scenario, passenger trains are taken to be Class 158 DMUs. The proposed battery powered EMU trains are anticipated to emit lower sound levels than the DMUs, therefore the assessment considers the worst-case scenario.

CRN allows prediction of the free-field (i.e. disregarding reflection from the property façade) train sound level in terms of the $L_{Aeq,18h}$. Predictions have been undertaken at ground and first-floor level for each NSR. The limits in the NIR are façade levels, therefore, to allow comparison with the predictions, the limits have been adjusted to a free-field level by subtracting 2.5 dB i.e. 65 dB L_{Aeq} during the day and 60 dB L_{Aeq} at night. As the applicable guidance detailed below is in terms of the $L_{Aeq,16h}$, the $L_{Aeq,18h}$ and $L_{Aeq,16h}$ are assumed to be equivalent. The difference between these parameters is typically no more than 1 dB.

Car parks generate sound by vehicles access the parking area, approaching a parking bay, door slamming and vehicles leaving. The combined car park sound level has been established using the Bavarian State Office for the Environment publication 'Parking lot noise study - Recommendations for the calculation of noise emissions from parking lots, truck stops and bus stations as well as multi-storey car parks and underground garages' (2007)[18]. This describes measured sound levels from a total of 105 car parks and provides a method for calculating the emitted $L_{Aeq,1h}$ based on number of spaces and car park type, which factors in how frequently parking spaces will empty and be taken. Further details on the predictions are provided in Appendix C.

Predictions of PA system sound have been undertaken by Acoustics Plus Ltd on behalf of Kilborn Consulting, as described in the 'System Design and Noise Impact Study' document dated June 2020[19] (PA Noise Report). This report describes the Network Rail performance requirements, which include that "*the system shall provide a minimum SPL of 10dBA above normal ambient noise levels at all times within the range of 65dBA up to the maximum SPL level unless environmental noise pollution issues prevent this figure being achieved.*" Predictions were undertaken of the likely sound levels at five nearby receptors (equating to R1, R2, R4, R8 and R9), whilst achieving a minimum SPL on the platform of 65 dB(A). The predictions were undertaken at ground floor level, the first-floor level has been assumed to be the same as the ground floor level. The modelling undertaken did not include the garden fences discussed above. The modelling was based on the GRIP Stage 3 design of the proposed development and the predicted sound levels at receptors may change as the design progresses. The relevant sections of this report to this assessment have been extracted and are provided in Appendix D.

The IEMA 'Guidelines for Environmental Noise Impact Assessment'[20] have been used to assess the impact of a change in ambient sound level due to the project. These provide guidance on how to undertake a noise impact assessment, with particular focus on the context of an EIA. They aim to apply to all types of new development. On the impact of noise level changes, they state that "*For broad band sounds which are very similar in all but magnitude, a change or difference in noise level of 1 dB is just perceptible under laboratory conditions, 3 dB is perceptible under most normal conditions, and a 10 dB increase generally appears to be twice as loud. These broad principles may not apply where the change in noise level is due to the introduction of a noise with different frequency and/or temporal characteristics compared to sounds making up the existing noise climate. In which case, changes of less than 1 dB may be perceptible under some circumstances.*"

16 Calculation of Railway Noise 1988, Department of Transport, HMSO.
17 International Standards Organisation (1996). ISO 9613-2 1996 'Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation'
18 Bayer. Landesamt für Umwelt (editor): Parkplatzalärmstudie 6. Aufl. Augsburg (2007)
19 Kilborn Consulting (2020). 'System Design and Noise Impact Study' Report ref. 60601435-ACM-01-PL-REP-ETL-000001, Issue: A01. 18th June 2020
20 Institute of Environmental Management & Assessment (2014). Guidelines for Environmental Noise Impact Assessment.

The IEMA Guidelines provide criteria for magnitude of impacts due to noise level changes from a project, as shown in Table 6.

Table 6 Categorising the magnitude of the Basic Noise Change

Noise Change, dB	Impact
0	Very low
0.1 to 2.9	Low
3 to 4.9	Medium
5 to 9.9	High

Also relevant to the impact of the ambient sound is the absolute development sound level. The 1999 World Health Organisations (WHO) guidelines[21] provide external daytime guideline levels *"on balconies, terraces and outdoor living areas"* in terms of a continuous $L_{Aeq,16h}$ noise level of 55 dB to protect the majority of people from being seriously annoyed and 50 dB $L_{Aeq,16h}$ to prevent the majority of people being moderately annoyed.

The WHO guidelines also provide criteria to prevent sleep disturbance due to individual noisy events, stating "*For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night*."

Guidance for the assessment of internal ambient noise levels within residential properties is provided within BS 8233[22], as outlined in Table 7. The BS 8233 guidance is closely aligned to the WHO community noise guidelines detailed above.

Table 7 BS 8233 Indoor ambient noise levels for dwellings

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16h}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

Note 7 to the above Table states "*Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.*"

3.2.2 PA system noise

As far as AECOM is aware there is no specific relevant legislation or guidance relating to the assessment of noise from Public Address (PA) systems at surface stations. London Underground guidance document G-148 *Manual of Good Practice - Public Address Systems - Noise Management* cites the use of British Standard BS 4142 as a method of assessment.

BS 4142 explicitly states that it is not intended for PA systems and a PA system needs to be heard above background noise to be effective; hence, whether it is suitable for this assessment purpose is arguable. Nevertheless, it continues to be applied to PA systems at London Underground and other stations.

In the absence of any other specific guidance an outline assessment has been undertaken to provide an indication of the level of impact from PA noise on the NSRs which is based on the methodology set out in BS 4142. The basis of BS 4142 is a comparison between the *background sound level* in the vicinity of residential locations and the *rating level* of the sound source under consideration. The relevant parameters in this instance are as follows:

- *Background sound level* – $L_{A90,T}$ – defined in the Standard as the 'A' weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels;

21 World Health Organisation (1999). Guidelines for Community Noise, 1999.
22 British Standards Institute (2014). BS 8233: 2014 'Guidance on sound insulation and noise reduction for buildings'.

- *Specific sound level* – $L_{Aeq,Tr}$ – the equivalent continuous 'A' weighted sound pressure level produced by the specific sound source at the assessment location over a given time interval, T;
- *Residual sound level* – $L_{Aeq,T}$ - the equivalent continuous 'A' weighted sound pressure level at the assessment location in the absence of the specific sound source under consideration, over a given time interval, T; and
- *Rating level* – $L_{Ar,Tr}$ – the *specific sound level* plus any adjustment made for the characteristic features of the sound such as tonality, impulsivity and intermittency.

When comparing the *background* and the *rating* sound levels, the standard states that:

a. *"Typically, the greater the difference, the greater the magnitude of impact.*

b. *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending upon the context.*

c. *A difference of around +5 dB is likely to be an indication of an adverse impact, depending upon the context.*

d. *The lower the rating level is to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending upon the context."*

Importantly, as indicated above, BS 4142:2014 requires that the *rating level* of the sound source under assessment be considered in the context of the environment when defining the overall significance of the impact. The standard suggests that in assessing the context, all pertinent factors should be taken into consideration, including the following:

- *"The absolute level of sound;*
- *The character and level of the residual sound compared to the character and level of the specific sound; and*
- *The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions."*

Full details of the specific PA broadcast messages, their duration, number and timings are not currently available. An assessment of likely PA system noise impacts has been undertaken based on the results of the predictions in the PA Noise Report and the measured baseline sound levels described in Section 5.

3.3 Train vibration

Guidance on the assessment of vibration impacts generated by trains on nearby residential properties is available in BS 6472-1 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting'[23]. The Standard assesses human exposure to vibration in terms of the Vibration Dose Value (VDV).

The VDV increases by the same factor if either the acceleration is doubled while the duration of exposure remains constant; or if the acceleration is kept constant and the duration of exposure increases 16-fold.

BS 6472-1 requires that the VDV be determined separately for the 16-hour daytime (07:00-23:00) and 8-hour night-time (23:00-07:00) periods.

To determine the impact of the proposed development, the future vibration levels have been predicted. It was intended to use the results of the baseline survey to determine the current VDV for a freight train passby and the current overall VDV levels during the day and night. However, due to a malfunction with the vibration monitoring equipment during the survey, it was not possible to use measured levels.

The acceleration generated by a train passby typically double for each doubling of speed. However, change in speed will also reduce the duration of the passby, as mentioned above VDV is related to duration (t) by a factor of $t^{0.25}$. Freight train passbys typically generate much higher VDV levels than passenger trains, particularly further from the track. This is partially due to the length of freight trains which increases the duration. Freight trains also have one layer of suspension (as opposed to the two layers in passenger trains), this means they generate much

23 British Standards Institution, (2008). BS 6472 Guide to Evaluation of Human Exposure to Vibration in Buildings.

greater levels of vibration at frequencies below 10 Hz. The rate of vibration decay with distance reduces significantly with increasing frequency, therefore the overall vibration levels from freight trains are greater at properties further from the track.[24] It is not possible to robustly derive the acceleration of a passenger train from a measured freight train passby; therefore, the freight and passenger trains are assumed to generate the same levels of acceleration prior to a correction for speed. This is highly likely to be a significant overestimate.

The guidance on human annoyance from vibration in BS 6472-1 is presented in Table 8.

Table 8 Vibration Dose Value ranges and probabilities of adverse comment within residential buildings

Vibration level (VDV $ms^{-1.75}$)		Probability of adverse comment
Day (07:00 – 23:00)	Night (23:00 – 07:00)	
0.2 - 0.4	0.1 - 0.2	Low
0.4 - 0.8	0.2 - 0.4	Possible
> 0.8	> 0.4	Probable

As the properties are already exposed to vibration from freight trains on the railway line, it is arguably more important to consider the potential impact of the change in the vibration levels than whether the above levels are exceeded. This point is not addressed by BS 6472 but was addressed in the HS2 EIA. Where appreciable levels of vibration were present in the baseline, it applied the criteria set out in Table 9, therefore these are used within this assessment. As vibration levels were not measured during the survey, this prediction exercise has been undertaken to determine the ratio of the likely future to current VDV levels for comparison with the criteria in Table 9. The simplified calculation process discussed above to determine this ratio is dependent on speed and duration and is independent of the actual vibration level.

Table 9 Impact of change in Vibration Dose Value where appreciable vibration is present

Change Classification	Impact criteria (% increase or decrease in VDV)
Negligible	≤ 25
Minor	25 to 40
Moderate	> 40 to 100
Major	> 100

3.4 Road traffic noise

Operational traffic noise impacts due to increases in traffic flows on existing roads have been estimated based on the Calculation of Road Traffic Noise[25] (CRTN) methodology for the calculation of the Basic Noise Level (BNL) at a reference distance of 10m from the nearside carriageway. Predictions have been undertaken for each link included in both the “with” and “without” traffic scenarios for the year 2039. This assessment methodology is adapted from the DMRB requirements for noise assessment of affected routes more than 600 m from a road scheme.

Construction traffic flows have not been provided; therefore, it has not been possible to undertake an assessment of potential noise impacts due to increases in traffic flows during construction. Construction traffic noise impacts will be mitigated via the measures to be outlined in the Construction Traffic Management Plan.

The criteria for the assessment of changes in road traffic noise levels have been taken from Table 3.1 of DMRB and are provided in Table 10.

Table 10 Classification of Magnitude of Traffic Noise Impacts

Noise Change Band	Magnitude of Impact

24 ‘Notes on technical issues for the vibration assessment for the Chiltern Line Upgrade through Wolvercote’. Available at https://mycouncil.oxford.gov.uk/documents/s24011/EWR%20condition%2019%20vibration%20-%20Appendix%2029.pdf. Accessed on 12/11/2020.
25 Department of Transport/Welsh Office, (1998); Calculation of Road Traffic Noise.

0 dB(A)	No change
0.1 – 0.9 dB(A)	Negligible
1 – 2.9 dB(A)	Minor adverse
3 – 4.9 dB(A)	Moderate adverse
5 dB(A) or more	Major adverse

4. Embedded Mitigation

Potential environmental effects have been or will be avoided, prevented, reduced or off-set through the integration of measures into the design and / or management of the proposed development. These are outlined below for the construction and operational phases and will be taken into account as part of the assessment of the likely significant effects.

4.1 Construction

Mitigation measures that are typically applicable to construction sites will be included within the Construction Environmental Management Plan (CEMP) that will be prepared for the proposed development after receipt of planning permission. Preparation and compliance with a final CEMP, which will be based on the outline CEMP submitted with this planning application, is proposed to be secured by planning condition.

The outline CEMP submitted with this planning application requires that the final CEMP will include a detailed construction noise and vibration assessment, including predictions of construction noise and vibration levels at nearby NSRs for comparison with suitable noise level limits. This assessment will be used to identify the mitigation measures which should be incorporated. Predictions will also be undertaken of potential construction traffic noise impacts once sufficiently detailed information is available. The CEMP will also detail the proposed construction noise and vibration surveys and a range of BPM giving regard to the guidance in BS 5228 as described below.

The CEMP will include requirements to set up appropriate mechanisms to communicate with local residents. These will be used to highlight potential periods of disruption during the construction phase, with appropriate complaint procedures put in place.

The construction contractor(s) will undertake and report noise and vibration surveys as is necessary to demonstrate compliance with all noise and vibration commitments and the requirements of the final CEMP.

The application of best practice measures through the implementation of the CEMP will minimise construction noise and vibration impacts. Best practicable means includes the following:

- modern plant should be selected which complies with the latest EC noise emission requirements.
- proper use of plant with respect to minimising noise emissions and regular maintenance. All vehicles and mechanical plant used for the purpose of the works should be fitted with effective exhaust silencers and should be maintained in good efficient working order;
- selection of inherently quiet plant where appropriate. Electrical plant items (as opposed to diesel powered plant items) should be used wherever practicable. All major compressors should be ‘sound reduced’ models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use. All ancillary pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers;
- machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum;
- the loading and unloading of materials should take place away from residential properties, ideally in locations which are acoustically screened from nearby noise sensitive receptors;
- materials should be handled with care and be placed, not dropped. Materials should be delivered during normal working hours;
- all ancillary plant such as generators, compressors and pumps should be positioned to cause minimum noise disturbance, i.e. furthest from receptors or behind close boarded noise barriers. If necessary, acoustic enclosures should be provided and/or acoustic shielding;
- good community relations should be established and maintained throughout the construction process. This should include informing residents on progress and ensuring measures are put in place to minimise noise and vibration impacts.
- construction contractors should be obliged to adhere to the codes of practice for construction working and piling given in BS 5228 and the guidance given therein minimising noise emissions from the site; and

- site operations and vehicle routes should be organised to minimise the need for reversing movements, and to take advantage of any natural acoustic screening present in the surrounding topography;
- no employees, subcontractors and persons employed on the site should cause unnecessary noise from their activities e.g. excessive 'revving' of vehicle engines, music from radios, shouting and general behaviour etc. All staff inductions at the site should include information on minimising noise and reminding them to be considerate of the nearby residents;
- as far as practicable, noisier activities should be planned to take place during periods of the day which are generally considered to be less noise sensitive i.e. not particularly early or late in the day;
- measures should be put in place to ensure that employees know that minimisation of noise will be important at the site; and
- reference should be made to the Building Research Establishment, BRE 'Pollution Control' guidelines, Parts 1-5 (BRE, 2003).

4.2 PA System Noise

The PA system will be operated in accordance with accepted best practice and this is proposed to be secured by planning condition. Further details on the proposed condition are provided in Section 7.3. Best practice measures have been adapted from the guidance in the London Underground 'Manual of Good Practice, Public Address Systems - Noise Management' Number G-148, dated October 2007[26], as shown below. This site is considered a "noise affected site" in the context of the below guidance.

- General Guidance
  - PA systems should be designed, installed and operated to be compatible with relevant legislation including the Disability Discrimination Act 1995 (DDA) and Environment Protection Act 1990.
  - All PA systems (for trains and other Network Rail premises) in operation adjacent to residential properties should be configured to minimise noise pollution to neighbours whilst taking into account the operator's obligation to provide necessary information to its customers whilst on the network.
  - Any alteration carried out on a PA system to reduce noise pollution:

    a) Should not affect the Sound Pressure Level (SPL) of pre-evacuation or emergency evacuation messages; and

    b) Should be assessed for overall impact on the PA system performance with any consequential risk appropriately mitigated.
  - Noise controls should be integrated to take into account the number of train and station PA announcements, PA operating times and sound pressure levels.
  - Noise controls implemented at a given site should be documented and traceable. Deviations from agreed noise controls should be subject to safety change or similar change reviewing process.
  - A unified process should be used to co-ordinate, record and resolve PA noise complaints from neighbours and customers.
  - Conflicts between environmental noise guidance and Network Rail systems and safety standards should be managed and collectively resolved between Network Rail and other contractors.
- Message Strategy
  - Message sequences and frequencies on trains and stations should comply with the necessary systems and safety standards and guidance.
  - Where compliance with systems and safety requirements could result in complaints or noise abatements the station Group Station Manager (GSM) or Train Operations Manager (TOM) should raise this concern with the relevant systems and safety manager and environment manager for resolution.

26 'Manual of Good Practice, Public Address Systems - Noise Management' Number G-148. London Underground. October 2007.

  - At noise affected sites consideration should be given to reducing the total number of PA broadcasts made to adjacent residential properties.
  - At noise affected sites where customers can be informed locally regarding service information, consideration should be given to inhibiting the Long Line PA.
  - At noise affected sites PA Pre-announcement chimes should be inhibited for non-emergency broadcasts.
  - At noise affected sites all non-emergency PA messages should be inhibited as a minimum for weekdays between 2300 and 0700 and where possible reduced between 1900 and 2300 or other times as required by local conditions. Similar restrictions should be considered as required for weekends and public Bank holidays.

- Operational
  - Station staff and train operators where practicable should be encouraged to use the DVA (Digital Voice Announcer) to make routine or repetitive announcements to customers to ensure that broadcasts are made with consistent clarity and loudness to avoid PA amplifiers being overdriven, potentially leading to noise complaints.
  - GSMs and TOMs should consider upgrading Legacy train and station PA systems to include automated DVA's for announcement of routine messages with consistent loudness and clarity.
  - The GSM should ensure station staff required to operate the PA equipment in the course of their duties have been adequately trained and are proficient in the correct operation of their station PA equipment.
  - PA announcements to zones fitted with Ambient Noise Sensors (ANS) should (where possible) be made when the ambient noise level has settled from the peak level i.e. not whilst the train is approaching or leaving the platforms. This is to prevent the ANS lifting the broadcast levels 10dB higher than the sampled background noise.
  - At noise affected sites train PA announcements should be avoided when train doors are open. ANS controlled train PA should be avoided during high ambient noise levels.
  - Where practicable train operators should ensure PA message duplication between train and station broadcasts are avoided. TOMs should ensure that train operators are made aware of PA operational restrictions at specific stations and that these are observed.
  - For noise affected sites except for emergencies, station and line control room staff should ensure all PA announcements (recorded or live) conform to the noise reduction measures documented and agreed between Network Rail and the Local council and or residents.
  - Fire alarm tests should be scheduled during off-peak times on appropriate days to minimise disturbance to adjacent residential properties.

Ambient Noise Sensing (ANS) microphones and controllers will be installed as part of the PA system that will allow the output level to adapt to the ambient sound level.

5. Baseline Monitoring

5.1 Overview

Continuous unmanned sound and vibration measurements were undertaken between 16:09h on Friday 25th September and 12:24h on Thursday 1st October 2020, encompassing weekdays and a weekend at one location in the garden of 26 Blenheim Drive (R2). This is considered representative of R1 to R5 and R7 to R10. R6 and R7 are closer to Palace Road, Clayton Street and Ravensworth Street than R2, therefore baseline sound levels are likely to be higher due to the sound of vehicles on these roads. R11 to R13 are close to Barrington Road, again this is likely to mean baseline sound levels are higher than at R2.

It was not possible to obtain vibration data. However, for the reasons set out at section 6.4, this has had no material impacts upon the assessing findings within this report.

Manned sound measurements were undertaken at a location at the northern end of West View (near R16 and considered representative of R14 and R15) between 21:52h and 22:22h on 1st October and 06:50 and 07:20 on 2nd October. The timing of the manned measurements was selected to represent the quietest time periods when the trains may operate. Both monitoring locations are illustrated in Figure 3 in Appendix B. The proposed monitoring procedures were agreed by e-mail with the NCC EHO.

Measurements were undertaken during the ongoing coronavirus outbreak, which may have resulted in baseline sound levels being lower than typical because typical road, air and rail transport usage have been reduced by travel restrictions and social distancing measures. Other sound sources may also have been affected – for example, due to changes in operating patterns at industrial and commercial premises. The assessment determines the impact of the proposed development based on the anticipated change in ambient sound level, therefore measuring a low baseline sound level ensures that a worst-case scenario is assessed.

The sound monitoring was undertaken with due regard to the guidance in BS 7445-2: 1991 'Description and Measurement of Environmental Noise'.

5.2 Instrumentation

The instrumentation used to conduct the surveys is detailed in Table 11.

Table 11 Monitoring Equipment Details

Measurement type	Equipment type	Model number	Serial number
Unmanned	Sound and Vibration Meter	SVAN 958	14692
Manned	Sound Level Meter	Norsonic 140	1403077
Both	Calibrator	Brüel & Kjær 4231	2217877

All the above instrumentation has in-date laboratory calibration certificates which can be provided on request. Each sound level meter was calibrated immediately before and after each survey period and no changes greater than +/- 0.2 dB were noted.

Various sound level indicators were logged every 15-minutes, including the equivalent noise level ($L_{Aeq,T}$) and statistical indices such as background sound levels ($L_{A90,T}$) as well as 1/3 octave band data. Sound pressure levels were also logged every second. The sound measurements were taken at a height which was between 1.2 and 1.5 metres above ground level and located at least 3.5 metres from any vertical reflecting surfaces.

5.3 Meteorological Conditions

During the manned measurements, meteorological conditions were monitored and observed to be within the requirements of BS 7445 and BS 4142. For the unmanned measurements, meteorological conditions were obtained from publicly available date (www.skylink.com). The nearest weather station to the proposed development is located at Newcastle International Airport, approximately 14 km to the south-west. Periods when rainfall occurred have been excluded from the sound level measurements, along with periods when the wind speed was in excess of 5 m/s as required by BS 4142.

5.4 Results

The results of the unattended baseline sound monitoring are summarised below in Table 12. The $L_{Aeq,T}$ values for each of the periods are the logarithmic average of the 15-minute data. The L_{A90} is the lowest 10th-percentile of the 15-minute measured levels over the relevant time period.

Table 12 Unmanned baseline monitoring results

Date	Time Period (hh:mm)	$L_{Aeq,T}$ (dB)	L_{A90} (dB)
Friday 25th September	16:09 to 23:00	57	41
	23:00 to 07:00	42	37
Saturday 26th September	07:00 to 23:00	54	42
	23:00 to 07:00	54	36
Sunday 27th September	07:00 to 23:00	46	38
	23:00 to 07:00	42	36
Monday 28th September	07:00 to 23:00	54	34
	23:00 to 07:00	52	28
Tuesday 29th September	07:00 to 23:00	54	38
	23:00 to 07:00	50	28
Wednesday 30rd September	07:00 to 23:00	52	34
	23:00 to 07:00	36	29
Thursday 1st October	07:00 to 12:24	54	40
	23:00 to 07:00	52	27
Total	07:00 to 23:00	53	38
	23:00 to 07:00	50	32

A time history plot of the measured sound levels, showing those time periods excluded due to poor weather conditions, is provided in Figure 5 in Appendix B.

The dominant sound source observed at the beginning of the monitoring period was a passing train and the noise it made moving over rail welds. Other sounds sources observed were distant traffic, distant industry, vehicles moving over nearby level crossings on Station Road and Barrington Road, and a railway semaphore signal changing. The dominant sound source observed at the end of the monitoring period was distant traffic. Other sounds sources observed were birdsong, distant sawing or industry, dogs and insects.

The results of the manned sound survey are provided in Table 13. Notes were made on sound sources contributing to the measurements during the survey, these are also provided in the Table.

Table 13 Manned baseline sound monitoring results

Date	Start Time (hh:mm)	End Time (hh:mm)	$L_{Aeq,15min}$ (dB)	$L_{A90,15min}$ (dB)	Observed Sound Sources
Thursday 1st October	21:52	22:07	35	29	Distant road traffic dominant, also noted were animals in the nearby shrubbery, flowing water from a nearby drain or stream and dogs in the distance.
	22:07	22:22	35	30	
Friday 2nd October	06:50	07:05	51	47	Distant road traffic and birdsong dominant, also noted were animals in the nearby shrubbery and flowing water from a nearby drain or stream.
	07:05	07:20	51	47	

The measured sound levels from the unmanned monitoring, over the time periods when the manned monitoring was undertaken, have been identified. During the evening period, they varied between 35 and 44 dB $L_{Aeq,15min}$ (logarithmic average of 41 dB $L_{Aeq,15min}$) and 30 and 41 dB $L_{A90,15min}$ (average of 36 dB $L_{A90,15min}$). During the morning period, they varied between 40 and 67 dB $L_{Aeq,15min}$ (logarithmic average of 61 dB $L_{Aeq,15min}$) and 33 and 42 dB $L_{A90,15min}$ (average of 38 dB $L_{A90,15min}$). The unusually large (27 dB) range observed in the $L_{Aeq,15\,min}$ during the morning period is an indicator of whether a freight train passed the monitoring location in the measurement.

When a freight train passed by, the ambient level was between 58 and 67 dB $L_{Aeq,15\ min}$. Without a freight train, the ambient level was between 40 and 45 dB $L_{Aeq,15\ min}$. Comparison of these levels with those in Table 13 indicates that, in the absence of the freight trains, in the morning the ambient and *background sound levels* at the manned monitoring location are higher than at the unmanned one. In the evening, the sound levels at the manned location were similar to the quietest periods in the unmanned monitoring.

5.5 Freight Train Sound

The Network Rail working timetable has been used, in conjunction with the 1-second time history from the measurement data, to identify the freight train passbys within the measurements. There are between zero (on a Sunday) and 10 passbys per day and 2 per night, on a typical weekday there are 9 passbys per day and 2 per night. The typical sound exposure level (L_{AE}) of a freight train passby is 91 dB. Using the L_{AE} of each train passby and the number of movements, the procedures in CRN have been employed to calculate the contribution of the freight trains to the overall ambient sound levels at the receptors. Excluding Sunday, the typical ambient daytime sound level generated by the freight trains is around 53 dB $L_{Aeq,16h}$. Excluding Sunday, the average daytime ambient sound level was 54 dB $L_{Aeq,16h}$ meaning that the freight trains were the dominant contributor to this parameter on these days. The contribution from other sound sources appears to have increased the ambient sound level by 1 dB, therefore the ambient sound level from these sources is around 47 dB $L_{Aeq,16h}$, which is noted as being similar to the ambient sound level on Sunday (46 dB $L_{Aeq,16h}$). It therefore appears that the contribution of other sound sources than freight trains to the ambient sound level at the unmanned location is similar throughout the week.

6. Assessment

The following assessment of impacts includes the embedded mitigation described in Section 4.

6.1 Construction Noise and Vibration

The measured daytime and weekend baseline sound levels, rounded to the nearest 5 dB, are 5 dB or more below the Category A Threshold Values within BS 5228-1. During the night, the baseline sound levels are equal to the Category A Threshold Values. On this basis the applicable Threshold Values for the construction noise assessment at all receptors are:

- 65 dB L_{Aeq} 07:00 and 19:00 Monday to Friday and Saturdays 07:00 – 13:00.
- 55 dB L_{Aeq} 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.
- 50 dB L_{Aeq} at all other times.

The assumed construction schedule is based on a 79-hour programme i.e. constructing between 22:00 hrs Thu to 05:00 hrs Mon. The works at the station are anticipated to last from October 2022 to February 2023 (i.e. around 4 months). Construction works are anticipated to involve the following activities:

- Site clearance and earthworks, including excavation
- Platform civils works
- Construction of new access road and car park
- Landscaping
- Finishing

The earthworks stage, which is expected to involve the use of excavators and dump trucks, is likely to generate the highest noise levels.

The closest properties to the proposed works are around 6 m of the redline boundary. At this distance it is considered likely that, without additional mitigation beyond the BPM outlined in Section 4.1, the above Threshold Values will be exceeded by some of the works. It is also possible that vibration from the works could result in moderate or major impacts based on the criteria in Table 5. The works which are undertaken at night present the greatest risk of resulting in significant noise and vibration effects. Given the duration of the proposed works, significant disturbance of the residents is anticipated unless the recommended mitigation set out in Section 7.1 is carried out.

6.2 Change in Ambient Sound Levels

Table 1 shows that six passenger trains are anticipated per night (23:00 to 07:00), of which only four will stop at the station. If a night-time curfew is not adopted, the PA system night-time operations would only be from around 06:00 to 07:00. The intermittent sound of the PA system over this one hour would not significantly affect the overall night-time (23:00 to 07:00) ambient sound levels. The predicted sound exposure level of a passenger train movement at the monitoring location is 72 dB L_{AE} for the up line and 70 dB L_{AE} for the down line. Combined with the sound from the four trains which stop at the station, but disregarding the contribution from other sound sources, the calculated night-time passenger train sound level is 53 dB L_{Aeq}. For partially open or closed windows, BS 8233 recommends assuming 15 or 33 dB reductions respectively. This would result in internal levels of 38 (windows partially open) or 20 (windows closed) dB L_{Aeq}. With windows closed, the internal level would be significantly below the 30 dB L_{Aeq} criterion for night-time sound in the standard. It is considered that windows are relatively unlikely to be left open for the entire night-time and the windows closed scenario is much more likely to occur. Six events per night is also below the criterion for sleep disturbance due to individual events (10 to 15 events per night) in the WHO guidelines. On this basis, night-time impacts due to the proposed development ambient sound levels are considered acceptable.

The predicted car parking, PA system, future passenger and freight train railway movements sound levels at ground and first floor level for each receptor is provided in Table 14. The predicted overall development sound levels (passenger trains, car parking and PA system) are then combined with the current ambient sound level (which includes the freight trains) to identify a future ambient sound level. This is compared with the measured

ambient sound level (53 dB $L_{Aeq,16h}$) at ground floor level to identify the impact of the change in accordance with the criteria in Table 6. The measured ambient sound level has been assumed to be representative of all identified receptors. The sound of freight trains is provided because the NL Upgrades may result in changes to the freight sound levels, particularly where line speeds are anticipated to change. The sound of freight trains is associated with the wider NL Upgrades rather than the proposed development. However, it is considered a potential cumulative impact to those of the proposed development.

The current ambient sound levels at first floor are likely to be higher than measured, due to the reduced screening from nearby sound sources. The current ambient sound levels at first floor are not known; therefore, it is not possible to identify the likely change. A change in external ambient sound levels may not be directly experienced inside a property, where the ambient sound climate is affected by the sound sources inside the building such as conversation and television. At upper floors, there is no external receptor (i.e. amenity area such as a garden) to be affected by the change in external sound levels. Therefore, only the likely internal proposed development sound levels are considered when assessing the potential impact of the development at these locations. The adopted approach is a UK industry standard when undertaking noise impact assessments.

Table 14 Predicted future free-field sound levels

NSR	Floor Level	Freight Train $L_{Aeq,16h}$ (dB)	Proposed Car Park and Access Road $L_{Aeq,16h}$ (dB)	Proposed Passenger Train $L_{Aeq,16h}$ (dB)	Proposed PA System $L_{Aeq,16h}$ (dB)	Overall Development Sound $L_{Aeq,16h}$ (dB)	Future Ambient Sound $L_{Aeq,16h}$ (dB)*	Change from Measured $L_{Aeq,16h}$ (dB)	Magnitude of Impact
R1	Ground	50	26	59	51	60	61	7.8	High
	First	51	27	63	51	63	64	N/a	N/a
R2	Ground	49	29	58	48	58	60	6.5	High
	First	49	29	60	48	60	61	N/a	N/a
R3	Ground	45	10	56	N/a	56	58	5.0	High
	First	45	12	58	N/a	58	59	N/a	N/a
R4	Ground	49	32	53	42	53	56	3.0	Medium
	First	49	33	55	42	55	57	N/a	N/a
R5	Ground	48	32	48	N/a	48	54	1.2	Low
	First	48	33	52	N/a	52	55	N/a	N/a
R6	Ground	50	12	48	N/a	48	54	1.2	Low
	First	50	16	49	N/a	49	54	N/a	N/a
R7	Ground	39	12	46	N/a	46	54	0.7	Low
	First	40	16	49	N/a	49	54	N/a	N/a
R8	Ground	47	27	56	45	57	58	5.1	High
	First	47	28	58	45	59	60	N/a	N/a
R9	Ground	45	33	52	45	53	56	3.1	Medium
	First	47	34	54	45	55	57	N/a	N/a
R10	Ground	45	36	47	N/a	47	54	1.0	Low
	First	45	38	50	N/a	50	55	N/a	N/a
R11	Ground	43	35	45	N/a	45	54	0.7	Low
	First	44	37	47	N/a	47	54	N/a	N/a
R12	Ground	41	30	40	N/a	40	53	0.2	Low
	First	43	32	42	N/a	43	53	N/a	N/a

NSR	Floor Level	Freight Train $L_{Aeq,16h}$ (dB)	Proposed Car Park and Access Road $L_{Aeq,16h}$ (dB)	Proposed Passenger Train $L_{Aeq,16h}$ (dB)	Proposed PA System $L_{Aeq,16h}$ (dB)	Overall Development Sound $L_{Aeq,16h}$ (dB)	Future Ambient Sound $L_{Aeq,16h}$ (dB)*	Change from Measured $L_{Aeq,16h}$ (dB)	Magnitude of Impact
R13	Ground	50	30	41	N/a	41	53	0.3	Low
	First	51	32	44	N/a	44	54	N/a	N/a
R14	Ground	50	33	43	N/a	43	53	0.4	Low
	First	52	34	45	N/a	45	54	N/a	N/a
R15	Ground	49	34	43	N/a	43	53	0.4	Low
	First	53	36	47	N/a	48	54	N/a	N/a
R16	Ground	53	27	47	N/a	47	54	1.0	Low
	First	53	28	48	N/a	48	54	N/a	N/a

* Future ambient sound level is logarithmic sum of overall development sound level and measured ambient sound level (53 dB $L_{Aeq,16h}$ at all NSRs)

Impacts of low magnitude are predicted at all receptors except R9, where the impact magnitude is medium, and R1 to R3 and R8, where impacts are high. At some NSRs, the predicted future ambient sound levels exceed the WHO guidelines criterion of 55 dB $L_{Aeq,16h}$ as follows:

- R1 – 6 dB and 9 dB at ground and first floor respectively
- R2 – 5 dB and 6 dB at ground and first floor respectively
- R3 – 3 dB and 4 dB at ground and first floor respectively
- R4 and R9 – 1 dB and 2 dB at ground and first floor respectively
- R8 – 3 dB and 5 dB at ground and first floor respectively

Given that medium and high impacts are anticipated, and the WHO guidelines are expected to be exceeded at the above NSRs, mitigation is proposed to reduce impacts at these locations. To determine the focus of mitigation, the dominant sound source in the predictions at this location has been identified to be the stationary passenger trains at the platforms. This sound source was included in the proposed passenger train sound levels in which also includes the moving passenger trains.

6.3 PA System Noise

The daytime assessment has been undertaken over a 1-hour period between the hours of 07:00 and 23:00. The time between 06:00 and 07:00 is classed as night-time. The PA Noise Report has assumed one announcement of 30 seconds duration will be made in each 5-minute period. Consistent with the principles of BS 4142 as described above, a 15-minute assessment period has been applied to the night-time assessment. The impacts have been assessed at R1, R2, R4, R8 and R9 as these are the NSRs at which the PA system sound levels have been predicted. The unmanned monitoring location is considered representative of all these NSRs.

A key aspect of the BS 4142 assessment procedure is the comparison between the *rating level* and the *background sound level*. The *rating level* is the L_{Aeq} of the *specific sound source* only but takes account of notable acoustic features such as tonality, percussiveness etc. As stated in Section 3.2.2 a character correction of up to 15 dB could be applied to the specific sound. For this assessment a + 5 dB character correction been applied to the *specific sound level* to obtain the *rating level* based upon +2 dB penalty for a tone and +3 dB for impulsivity, both of which are just perceptible at the NSR.

Following statistical analysis of the *background sound levels* (L_{A90}) measured during the unmanned baseline survey, as detailed in Section 3, the daytime and night-time representative levels have been determined. Graphs of the measured *background sound levels* during the day and between 06:00 hrs and 07:00 hrs are provided in Figure 6 and Figure 7 in Appendix B. Based on these graphs, levels of 38 and 37 dB L_{A90}, during the day and night-time respectively, are representative of a reasonable worst-case.

The results of the BS4142 assessment for both the day and night-time periods are shown in Table 15. For the sake of brevity, the phrase “depending on the context” has been omitted from the conclusions.

Table 15 BS 4142 Assessment

NSR	06:00 to 07:00					07:00 to 23:00				
	L_s (dB)	$L_{Ar,Tr}$ (dB)	L_{A90} (dB)	$L_{Ar,Tr}$ – L_{A90} (dB)	Conclusion	L_s (dB)	$L_{Ar,Tr}$ (dB)	L_{A90} (dB)	$L_{Ar,Tr}$ – L_{A90} (dB)	Conclusion
R1	51	56	37	19	Significant adverse impact	51	56	38	18	Significant adverse impact
R2	48	53	37	16	Significant adverse impact	48	53	38	15	Significant adverse impact
R4	42	47	37	10	Significant adverse impact	42	47	38	9	Adverse impact
R8	45	50	37	13	Significant adverse impact	45	50	38	12	Significant adverse impact
R9	45	50	37	13	Significant adverse impact	45	50	38	12	Significant adverse impact

Table 15 shows that during the day and night-time periods, the BS 4142 assessment indicates a significant adverse impact at all identified NSRs, depending on the context, except for R4, where daytime impacts are adverse.

Further mitigation options will be explored as part of the detailed design of the PA system. It may be necessary to explore the possibility of flexibility in the Network Rail requirements that minimum PA system sound pressure levels on the platform are 65 dB(A) and 10 dB above the ambient sound level on the platform. This requirement does include the caveat that “unless environmental noise pollution issues prevent this figure being achieved”.

The PA system sound levels reported in Table 15 are required to achieve the Network Rail requirements at the loudest times of the day, when *background sound levels* are likely to be higher than shown in the Table. Assuming it is possible to deviate from these requirements; the PA system sound level would then be controlled by the ANS microphones and controllers, installation of which is considered best practice, proposed to be required as a condition of consent as discussed in Section 4.2. The PA system sound level would then vary depending on the ambient sound level on the platform, which is also directly related to the *background sound level* at the NSRs i.e. when *background sound levels* are low, PA system sound levels will also be low and vice versa. On that basis, the impacts presented in Table 15 represent a significant worst-case which may not actually occur.

To avoid a significant adverse impact in accordance with the criteria in BS 4142: 2014, it would be necessary for the PA system sound *rating level* not to exceed the *background sound level* by more than 5 dB. Between the hours of 6 and 7, this would require the PA system sound level at the NSR to not exceed 37 dB L_{Aeq} (a reduction in the PA system sound of 14 dB). Between the hours of 06:00 and 07:00 the primary concern would be sleep disturbance therefore it is necessary to consider the PA system sound levels likely to occur inside the nearby properties. Assuming a 15 dB reduction for a partially open window in accordance with BS 8233, the internal level would be 22 dB L_{Aeq}. This is significantly below the 30 dB L_{Aeq} criterion for night-time sound in the standard, however BS 8233 states that the criteria apply to sound “without a specific character”. Sound has a specific character if it “contains features such as a distinguishable, discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content”. The PA system sound is considered to have a specific character and therefore BS 8233 indicates that lower limits may be appropriate. However, AECOM is not aware of alternative guidance which could be applied as a limit to the internal sound level from the PA system; therefore, the assessment in accordance with BS 4142 (i.e. based on external sound levels, rather than the internal criteria in BS 8233) is deemed more appropriate.

Whilst a daytime (07:00 to 23:00) assessment is presented in Table 15, this assumes a constant PA system sound level over this time period and assesses against the typical worst-case *background sound level* over this time. As discussed above, the PA system sound levels will vary over time with the ambient sound level on the platform. As the *background sound levels* at NSRs and ambient sound levels at the platform vary over the course of a day, it is not possible to define an absolute daytime PA system sound level limit at nearby NSRs which would protect residential amenity and achieve appropriate sound levels on the platform. However, section 7.3 sets out the means by which the impact of PA system noise can be controlled to an appropriate level.

6.4 Operational Vibration

As mentioned in section 5.1baseline vibration data were not measured. As discussed in section 3.3, the adopted vibration assessment methodology is robust irrespective of the absence of baseline data.

It is understood that the speed of the freight trains at this location will remain as current, with a speed of around 32 km/h; therefore, the VDV of a freight train passby is assumed to stay the same as the current situation.

It is understood that as the passenger trains pass the unmanned monitoring location, their speeds will be around 20 km/h travelling in both directions. The length of the freight trains is typically around 400 m and the passenger train length will be 69 m, therefore the durations of the passbys are around 45 s (freight) and 12 s (passenger). The VDVs for the passenger trains are therefore anticipated to be lower than the freight VDVs by a factor of 0.45.

Assuming 9 freight train movements per day and 2 per night, the $VDV_{07:00\ to\ 23:00}$ and $VDV_{23:00\ to\ 07:00}$ are factors of 1.73 and 1.18 greater, respectively, than the VDV of a single passby. This represents the current scenario.

Based on the assumption that a passenger train generates the same acceleration as a freight train, 64 passenger train movements per day will generate a $VDV_{07:00\ to\ 23:00}$ that is a factor of 1.27 greater than the VDV of a single freight train passby. Therefore, the combined $VDV_{07:00\ to\ 23:00}$ of all train types for the future scenario is 1.84 times

greater than the VDV of a single freight train passby. This represents an increase of 6% on the current daytime vibration levels at the nearby receptors, which is classified as a negligible impact.

Six passenger trains movements per night are predicted to generate a $VDV_{23:00\ to\ 07:00}$ that is a factor of 0.7 times the VDV of a single freight train passby. The combined future $VDV_{23:00\ to\ 07:00}$ is 1.22 times the VDV of a single freight train passby, an increase of 3% on the current night-time vibration levels, classified as a negligible impact.

6.5 Road Traffic Noise

Operational road traffic noise has been assessed by considering the change in the forecast road traffic flows in 2039 both with and without the Proposed Development with reference to both the CRTN and DMRB. The predicted changes in noise levels are presented in Table 16.

Table 16 Operational Traffic Noise Effects

Link	2039 Baseline and Committed Development $L_{A10,18h}$ dB	2039 Baseline + Committed + Proposed Development $L_{A10,18h}$ dB	Change in Noise Level dB	Magnitude of Impact
Station Road West	65.6	65.6	0.0	No change
Melrose and Jubilee Terrace	62.4	62.4	0.0	No change
Station Road Central	66.2	66.3	0.1	Very low
Palace Road	65.1	65.1	0.0	Very low
Station Road East	59.3	59.3	0.0	No change
Ravensworth Street, S BR Average	64.4	64.5	0.1	Very low
Ravensworth Street, N BR	62.1	62.1	0.0	No change
Barrington Road	60.5	60.5	0.0	No change

The calculations show that road traffic noise levels are anticipated to either stay the same or increase by 0.1 dB $L_{A10,18h}$. Therefore, noise impacts due to changes in road traffic flows are not anticipated.

6.6 Assumptions and Limitations

It should be noted than any assessment of sound levels has an associated degree of uncertainty. Although modelling and measurement processes have been carried out in such a way to reduce such uncertainty, it is unavoidable that some remains. The assessment undertaken has made several worst-case assumptions. These assumptions, combined with the known accuracy of the adopted calculation methods, mean that the margin of error incorporated into the assessment is sufficient to avoid the identified sources of uncertainty from worsening the conclusions.

The noted sources of uncertainty in this assessment are discussed in Appendix E.

7. Mitigation

Sections 6.4 and 6.5 show that operational vibration and road traffic noise impacts are considered acceptable without the need for mitigation; therefore, these are omitted from the below discussion. Mitigation options for the remaining impacts are provided below.

7.1 Construction Noise and Vibration

Construction noise and vibration will be generated throughout each proposed 79-hour possession over the construction period. Whilst Best Practical Measures (BPM) are to be implemented in the construction activities (as discussed in Section 4.1), further mitigation beyond BPM is recommended to avoid significant disturbance by the construction activities.

To mitigate the noise emissions from construction works, use of site or activity boundary acoustic barriers to screen neighbouring receptors is likely to be required. The use of site boundary or activity boundary temporary noise barriers can reduce construction noise levels by around 10 dB if line-of-sight from the plant to the receptor is blocked.

When planning the works, it will be necessary to consider the number and type of plant required to complete the work and the timing, duration and phasing of the works. For example:

- where practicable, noisy works should be interspersed between quieter works to provide periods of respite;
- where practicable, the works should be phased to ensure that the noisiest operations are performed during the least sensitive times;
- minimising the duration of the works is generally beneficial, if higher noise levels may result in a significant reduction in the overall duration of the works this should be considered; and
- phasing of works at the closest approach to properties where possible to give periods of respite.

If the implementation of all reasonable mitigation measures and BPM still results in construction noise levels exceeding the Threshold Values, BS 5228-1 does recommend further options such as the provision of noise insulation to affected habitable rooms.

BS 5228-1 also provides example noise limits for determining eligibility for noise insulation and temporary rehousing which are above the Threshold Values. To qualify for insulation or temporary rehousing these noise limits would have to be exceeded *"for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months."* (BS 5228-1 section E.4).

Qualification under this criteria and the adopted mitigation measures which go beyond BPM will be specified in the CEMP described in Section 4.2.

7.2 Ambient Sound

Changes in ambient sound level due to the proposed development are anticipated to result in worst-case impacts of high magnitude at R1 to R3 and R8. Ambient sound levels are also anticipated to exceed the external daytime sound level criterion in BS 8233 at NSRs R1 to R4, R8 and R9.

As mentioned in Section 6.2, the dominant sound source in the predictions at the worst affected NSRs is the stationary passenger trains at the platform. Therefore, this source should be the primary focus of mitigation. AECOM have been supplied with measurements of the sound of a stationary BEMU train which show that the levels at 7.5 m from the track are no more than 40 dB L_{Aeq} which is likely to be inaudible at the receptor. If the DMU trains are replaced with the BEMUs, this sound source will be removed. The calculations described in Section 6.2 have been updated to identify the overall development sound levels without the contribution of the stationary trains. The highest overall development sound level is 48 dB $L_{Aeq,16h}$ which occurs at the first floor of R15 and R16. Assuming a current ambient sound level of 53 dB $L_{Aeq,16h}$ at these locations, the change due to the proposed development is 1 dB, which is a low impact. The limit in the WHO guidelines is also not exceeded, therefore, if the DMU trains are upgraded to BEMUs, further mitigation to reduce ambient sound levels due to the proposed development would not be required.

If the BEMUs are not deployed, to reduce the sound of the trains the only feasible options are: to erect a barrier to block the line of sight to the nearby NSRs; and/or application of acoustically absorbent lining to the vertical trackside surfaces of each platform from ground up to the platform level. A 3.5m high barrier fence has therefore been included in the station design between the western platform and the nearby properties (R1 and R2), the fence continues along the northern edge of the railway up to the boundary with R4, at a height of 2.1m. A barrier is also included to the rear edge of the eastern platform (blocking line of sight to R8 and R9), this has been assigned a height of 2.2 m from ground level (a height of 1.2 m above the platform level). The locations of the proposed barriers are shown in Figure 4. This figure includes a proposed development design plan which is subject to change and details within this figure other than the barrier design should not be relied upon. The computational model of the railway and surroundings has been updated to include these barriers and the proposed absorption, this has been used to predict the mitigated railway sound levels.

It has not been possible to update the model of the PA system sound to identify the actual effect of the proposed barriers. The barrier to R1 to R4 has been assumed to achieve a 5 dB reduction in the PA system sound which is likely assuming it at least partially blocks line of sight from the NSR to the speakers. The eastern barrier is not likely to block line of sight from the NSR to the speakers therefore this has been assumed to provide 0 dB of attenuation to R8 and R9. If the barrier fully blocks line of sight, the reduction would be expected to be around 10 dB therefore these assumptions are considered a reasonable worst-case. Table 17 provides an updated version of Table 14 with this mitigation in place.

In order to be effective, the amount of noise transmitted through the barrier must be significantly less than what passes over the top (and round the edges). The effectiveness of a material to prevent the transmission of noise is determined by the thickness and surface density of the material used to construct the barrier. To be effective, the noise level due to noise being transmitted through the barrier must be at least 10 dB below the noise level due to noise passing over the top (and round the edges).

Regarding timber barriers a minimum surface density of 15 kg/m^2 is recommended. Note that timber density is very variable, therefore a surface density of 15 kg/m^2 allows for a degree of variability. Most properly engineered timber barriers use either 30+mm thick timbers or ‘double-skinned’ timber barriers. Wood must be close boarded with no air gaps between panels or at the bottom.

Sound ’leaks’, due to holes, slits, cracks or gaps through or beneath a noise barrier can seriously reduce the barrier performance and must be avoided.

As the platforms are raised above the tracks, the platform between the tracks and NSR can provide some screening to the train sound. However, the train sound can be reflected off the opposite vertical platform surface and towards a nearby NSR. Lining of the platform surfaces will reduce the level of this reflected sound. An acoustic absorption coefficient of 0.9 has been assumed for the acoustic lining in the modelling which should be achievable.

Table 17 shows that the impact at all NSRs, with the proposed mitigation in place, is no worse than low, which is acceptable. At R1, the proposed development noise levels are below the limit of 55 dB $L_{Aeq,16h}$ at ground floor but at first floor they are above this limit. A taller barrier would be required between the down line platform and R1 to reduce noise levels further, but this would be likely to result in an unacceptable visual impact on the occupants at the ground floor of this property. Assuming windows are kept closed, the internal noise levels at the first floor of R1 would be around 25 dB $L_{Aeq,16h}$ which is below the limit of 35 dB $L_{Aeq,16h}$ in BS 8233. Whether or not the occupants of R1 need to open their windows to provide adequate ventilation to the property is not known. If adequate ventilation can be provided without the need to open windows, then the internal noise levels are expected to be below the limit in BS 8233 for most of the time. Any exceedances of the internal noise level limit would be of short duration when windows are open and not expected to result in a significant effect on the resident. If this is not the case, it is proposed that an offer is made to the owner/occupier to install an alternative ventilation method to the noise-sensitive rooms (i.e. bedrooms and lounges / living rooms) at first floor which have windows facing the railway.

The NIR provide a further mechanism for reducing internal noise levels, however the predicted noise levels in Table 17 indicate that none of the NSRs will experience noise levels in excess of the 65 dB $L_{Aeq,18h}$ (free-field) criterion for eligibility. In addition, the proposed development does not introduce significant alterations to the track, therefore the NIR do not apply at this location.

It is proposed that impacts are controlled via a condition of consent requiring provision and maintenance of the barriers and acoustic absorption described in this report.

Table 17 Predicted future free-field sound levels with proposed mitigation

NSR	Floor Level	Freight Train $L_{Aeq,16h}$ (dB)	Proposed Car Park and Access Road $L_{Aeq,16h}$ (dB)	Proposed Passenger Train $L_{Aeq,16h}$ (dB)	Proposed PA System $L_{Aeq,16h}$ (dB)	Overall Development Sound $L_{Aeq,16h}$ (dB)	Future Ambient Sound $L_{Aeq,16h}$ (dB)	Change from Measured $L_{Aeq,16h}$ (dB)	Magnitude of Impact
R1	Ground	39	20	48	46	50	55	1.9	Low
	First	48	26	57	46	57	59	N/a	N/a
R2	Ground	40	27	48	43	49	54	1.5	Low
	First	43	29	53	43	53	56	N/a	N/a
R3	Ground	37	10	46	N/a	46	54	0.9	Low
	First	41	12	50	N/a	50	55	N/a	N/a
R4	Ground	41	31	44	37	45	54	0.6	Low
	First	45	33	47	37	48	54	N/a	N/a
R8	Ground	39	27	48	45	50	55	1.7	Low
	First	43	28	52	45	53	56	N/a	N/a
R9	Ground	41	33	47	45	49	55	1.5	Low
	First	45	34	50	45	52	55	N/a	N/a

7.3 PA System Noise

For the PA system to be intelligible it needs to be audible (typically a minimum of 6-10 dB above the ambient sound levels on the platform) and this will need to be considered in setting any maximum output level. Assuming the PA system sound reductions discussed in Section 7.2, significant adverse impacts are still anticipated at R1, R2, R8 and R9 during the day and night.

If a deviation from the NR requirement of a minimum sound pressure level of 65 dB(A) at all areas of the platform can be agreed, it should be feasible to achieve intelligibility for the PA system whilst avoiding significant adverse effects on nearby NSRs. For example, it may be possible to:

- change the system design such that the minimum sound level criterion is met on only part of the platform at noise-sensitive times; or
- introduce platform zoning i.e. turning off or decreasing the level of certain loudspeaker circuits at noise-sensitive times.

It is proposed that PA system noise impacts are controlled via a condition of planning consent requiring implementation of best practice measures to minimise noise impacts as discussed in Section 4.2 and restriction of PA system operations to 07:00 to 23:00 only. It may also include the following:

- Installation of automated audio control within the PA system which can be set to a maximum allowable sound level over specific operational hours when ambient sound levels are low, to be agreed with the EPO. This control could be set to override the proposed ANS system.
- Agreement between the EPO and station operator on suitable curfew times (if 07:00 to 23:00 is deemed to insufficient) prior to commencement of operations as required.
- Commissioning of the PA system prior to commencement of operations to determine suitable PA system sound levels. The EPO should be invited to attend this exercise.

8. Summary

AECOM has been commissioned by Northumberland County Council (NCC) to complete a noise and vibration impact assessment to accompany the application for planning permission for the proposed new railway station at Bedlington.

During the construction of the proposed development, noise and vibration emissions from the works have the potential to disturb the nearby residents. This is primarily because, in order to conduct the works safely, a 79-hour programme of works is proposed i.e. constructing between 22:00hrs Thu to 05:00hrs Mon. The works at the station are anticipated to last from June to November 2022 (i.e. around 5 months). BPM will be employed to minimise adverse effects, and these will be defined within the CEMP, which will also include a detailed construction noise and vibration assessment which will define the additional specific mitigation measures required.

The noise impact due to the operation of the development has been assessed by predicting the likely daytime ambient sound levels at nearby sensitive receptors. At most receptors, the change in the ambient sound levels is assessed as an impact of low magnitude, however at R9 the impact magnitude is medium and at R1 to R3 and R8 impacts are high. The predicted external ambient sound levels at R1 to R4, R8 and R9 are anticipated to exceed the criterion from the WHO guidelines by up to 6 dB at ground floor and up to 9 dB at first floor.

The stationary trains are anticipated to be the dominant sound source in the future ambient sound levels. The proposed development does not result in exceedance of the criteria in the NIR and noise impacts are anticipated to reduce to acceptable levels if the DMU trains are replaced with BEMUs. If the BEMUs are not deployed, barriers are anticipated to be required, along with acoustically absorbent lining to the trackside surface of each platform. The proposed barriers in this report achieve noise levels which are compliant with the adopted criteria at all nearby properties, except for the first floor of R1. Assuming windows are kept closed, the internal noise levels at the first floor of R1 would be below the applicable limit. It may be necessary to offer to install an alternative method of ventilation in the noise sensitive rooms at first floor of R1 that have windows facing the railway.

The PA system sound levels have been predicted based on outline design. An assessment of the potential noise impact of the PA has been conducted in accordance with the guidance in BS 4142. The assessment indicates that there is the potential for significant adverse impacts; therefore a curfew is proposed restricting PA system operations to less noise-sensitive times of the day. Further options for mitigation of the PA system sound have been identified and these will be considered throughout the design iteration and system comissioning process to minimise noise impacts on nearby sensitive receptors.

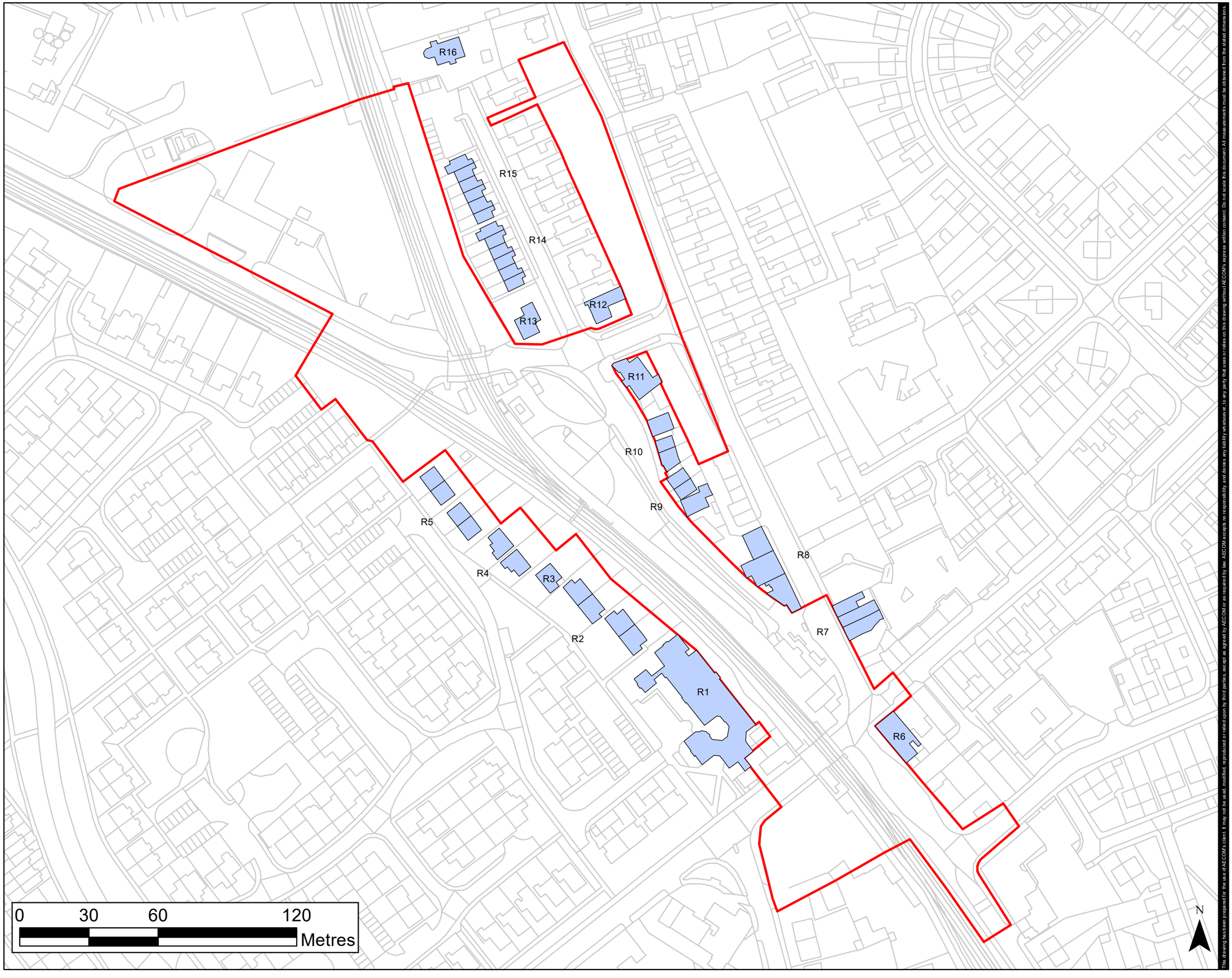
Appendix A Glossary

Term	Definition
Decibel (dB)	The range of audible sound pressures is approximately 2 x 10^{-5} Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0dB to 140dB. Mathematically Sound Pressure level = 20 log {p(t)/p_0} Where P_0 = 2 x 10^{-5} Pa.
A" Weighting (dB(A))	The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear. It is used in the assessment of risk of damage of hearing due to noise.
Frequency (Hz)	The number of cycles per second, for sound this is subjectively perceived as pitch.
Frequency Spectrum	Analysis of the relative contributions of different frequencies that make up a noise.
Ambient Sound	Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far (*The ambient sound comprises the residual sound and the specific sound when present).*
Ambient Sound Level $L_a = L_{Aeq,T}$	Equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T.
Background Sound Level $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
Equivalent Continuous A-weighted Sound Pressure Level $L_{Aeq,T}$	Value of the A-weighted sound pressure level in decibels of continuous steady sound that, within a specified time interval, T = $t_2 - t_1$, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation: $$L_{Aeq,T} = 10lg_{10}\left\{\left(\frac{1}{T}\right)\int_{t1}^{t2}\left[p_A\frac{(t)^2}{{p_0}^2}\right]dt\right\}$$ Where p_0 is the reference sound pressure (20μPA); and $P_A(t)$ is the instantaneous A-weighted sound pressure level at time t
Measurement Time Interval T_m	Total time over which measurements are taken (*This may consist of the sum of a number of non-contiguous, short-term measurement time intervals)*
Rating level $L_{Ar,Tr}$	Specific sound level plus any adjustment for the characteristic features of the sound
Reference Time Interval, T_r	Specified interval over which the specific sound level is determined (*This is 1 h during the day from 07:00 h to 23:00 h and a shorter period of 15 min at night from 23:00 h to 07:00 h*)
Residual Sound	Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound
Residual sound level $L_r = L_{Aeq,T}$	Equivalent continuous A-weighted sound pressure level of the residual sound in a given situation at the assessment location over a given time interval, T.
Specific sound level $L_s = L_{Aeq,Tr}$	Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given time interval, T.
Specific Sound Source	Sound source being assessed
$L_{A10,T}$	The A-weighted sound pressure level of the residual noise in decibels exceeded for 10% for a given time interval. This is the parameter defined by the government to describe road traffic noise
L_{AFmax}	The maximum RMS A-weighted sound pressure level occurring within a specified time period. Fast time weighting indicates sound pressure level measurements undertaken using a 125-millisecond moving average time weighting period
VDV	Vibration Dose Value (VDV) is a form of energy averaged vibration level. The vibration dose value has a time-dependency which means that a two-fold decrease in vibration magnitude is equivalent to a 16-fold decrease in the duration of the vibration, i.e. the measured VDV is much more sensitive to changes in vibration level, than changes in vibration duration. For this report the VDV was calculated as defined in BS 6472-1:2008. $$VDV_{day/night} = \left(\int_0^T \alpha^4(t)dt\right)^{0.25}$$ Where: • $VDV_{day/night}$ is the vibration dose value

- α(t) is the frequency-weighted acceleration using W_b (vertical vibration) or W_d (horizontal vibration) as appropriate.
- T is the total period of the day or night during which vibration can occur.

For this report VDV is a cumulative measurement of the vibration level received over an 8-hour or 16-hour period

Appendix B Figures



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Project Title:

NORTHUMBERLAND LINE UPGRADES

Client:

NORTHUMBERLAND COUNTY COUNCIL

LEGEND

- Receptors
- Redline boundary

AECOM Internal Project No:

60628487

Drawing Title:

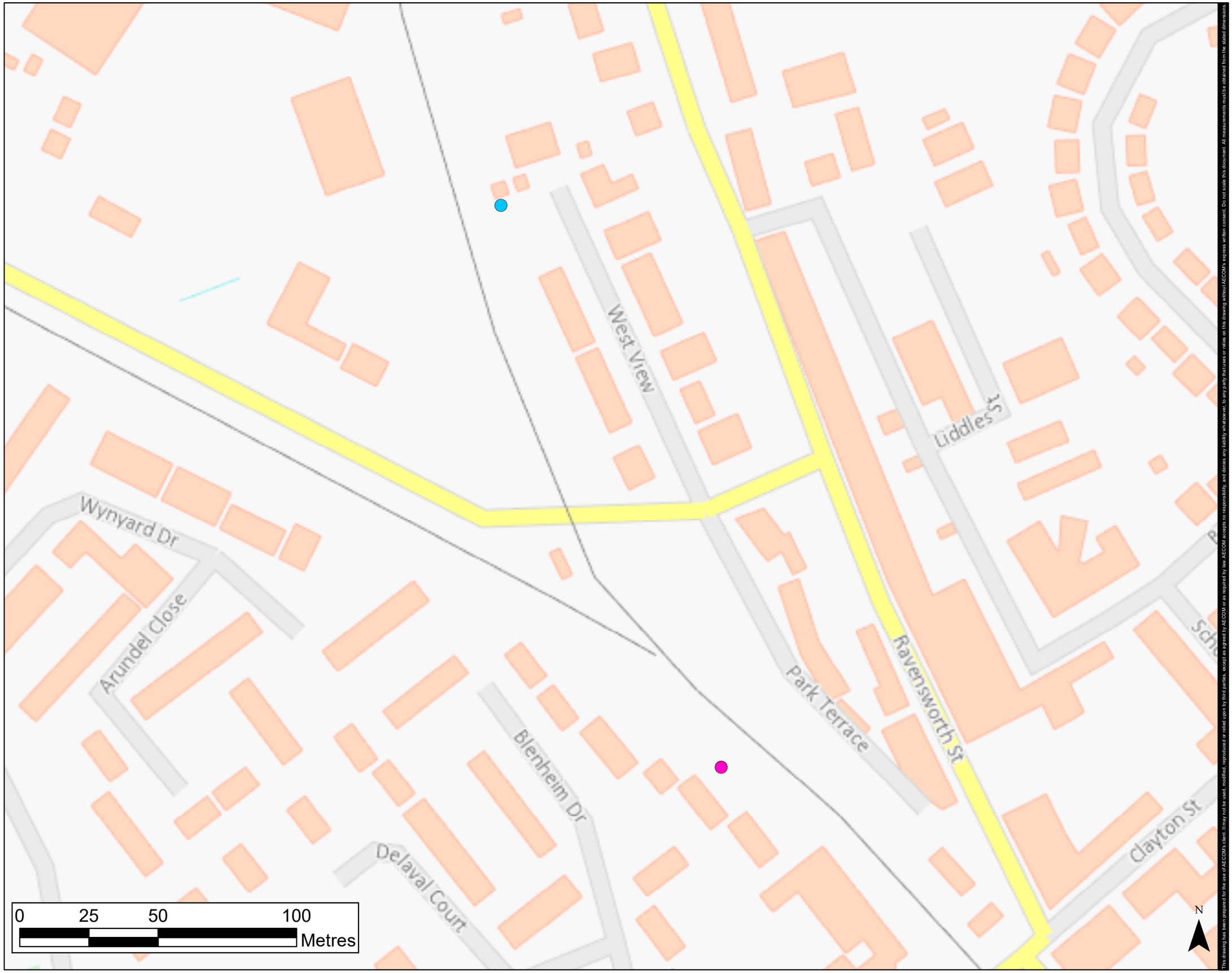
Bedlington Station
Noise Sensitive Receptors

Scale at A3: 1:1,500

Drawing No: 1	Rev:
FIGURE 1	001

Drawn:	Chk'd:	App'd:	Date:
TB	TB	SC	19/11/20

Filename: C:\Users\seckin.basturk\AECOM Directory\Birton, Timothy - Northumberland Line WebTAG\Receptor location drawings\ReceptorLocation_5_Bedlington.mxd



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Project Title:

NORTHUMBERLAND LINE UPGRADES

Client:

NORTHUMBERLAND COUNTY COUNCIL

LEGEND

- Short-Term Sound Monitoring Location
- Long-Term Sound and Vibration Monitoring Location

AECOM Internal Project No:
60628487

Drawing Title:

Bedlington
Baseline Monitoring Locations

Scale at A3: 1:1,250

Drawing No: 1	Rev:
FIGURE 2	001

Drawn:	Chk'd:	App'd:	Date:
CJ	TB	SC	06/11/20

Filename: \\nm-man-001\data\Projects\60628487 Northumberland Railway Line Upgrades\500_Deliverables\504_Sketches\Monitoring Locations PDFs\MonitoringLocation_5_Bedlington.mxd

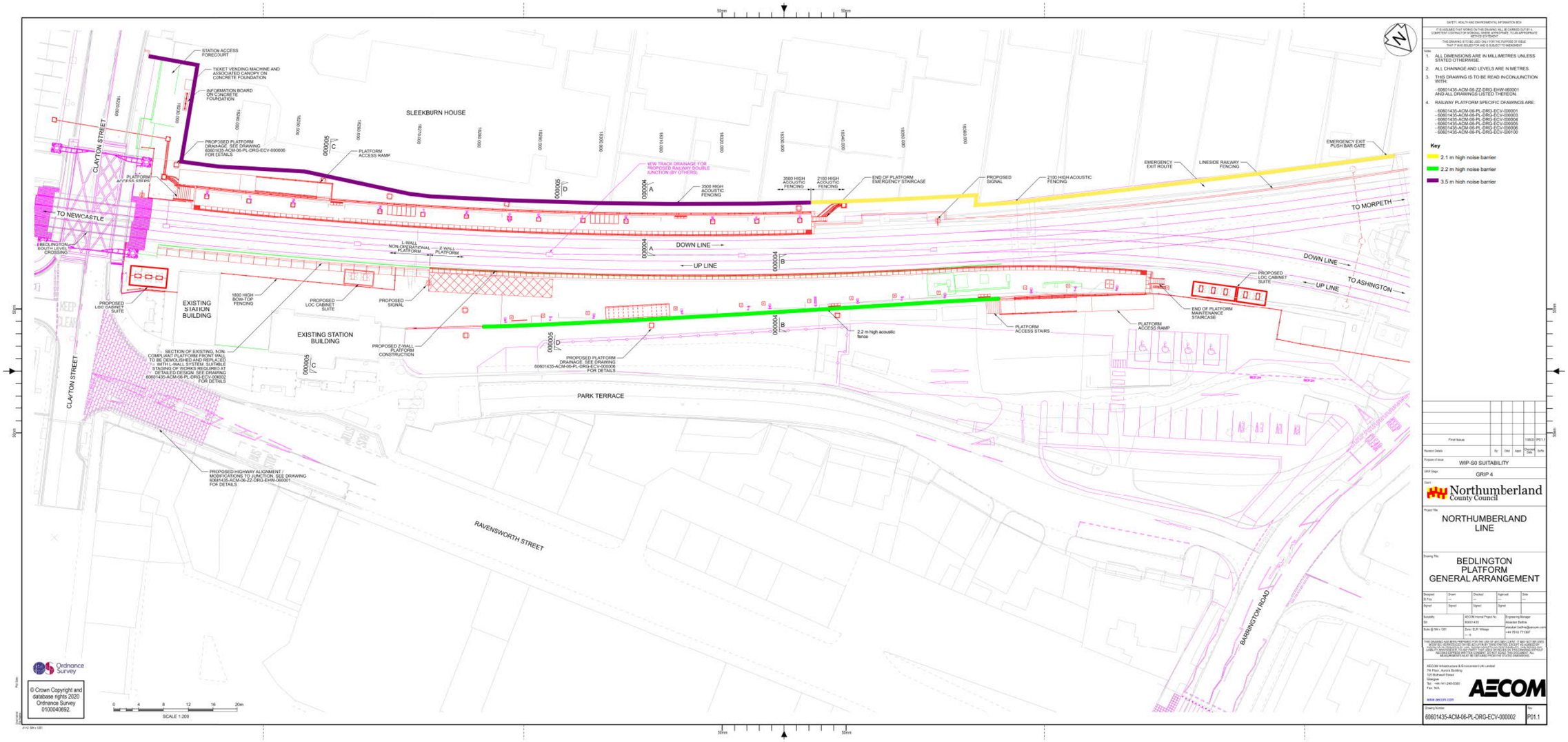

Figure 4 Noise Barrier Locations

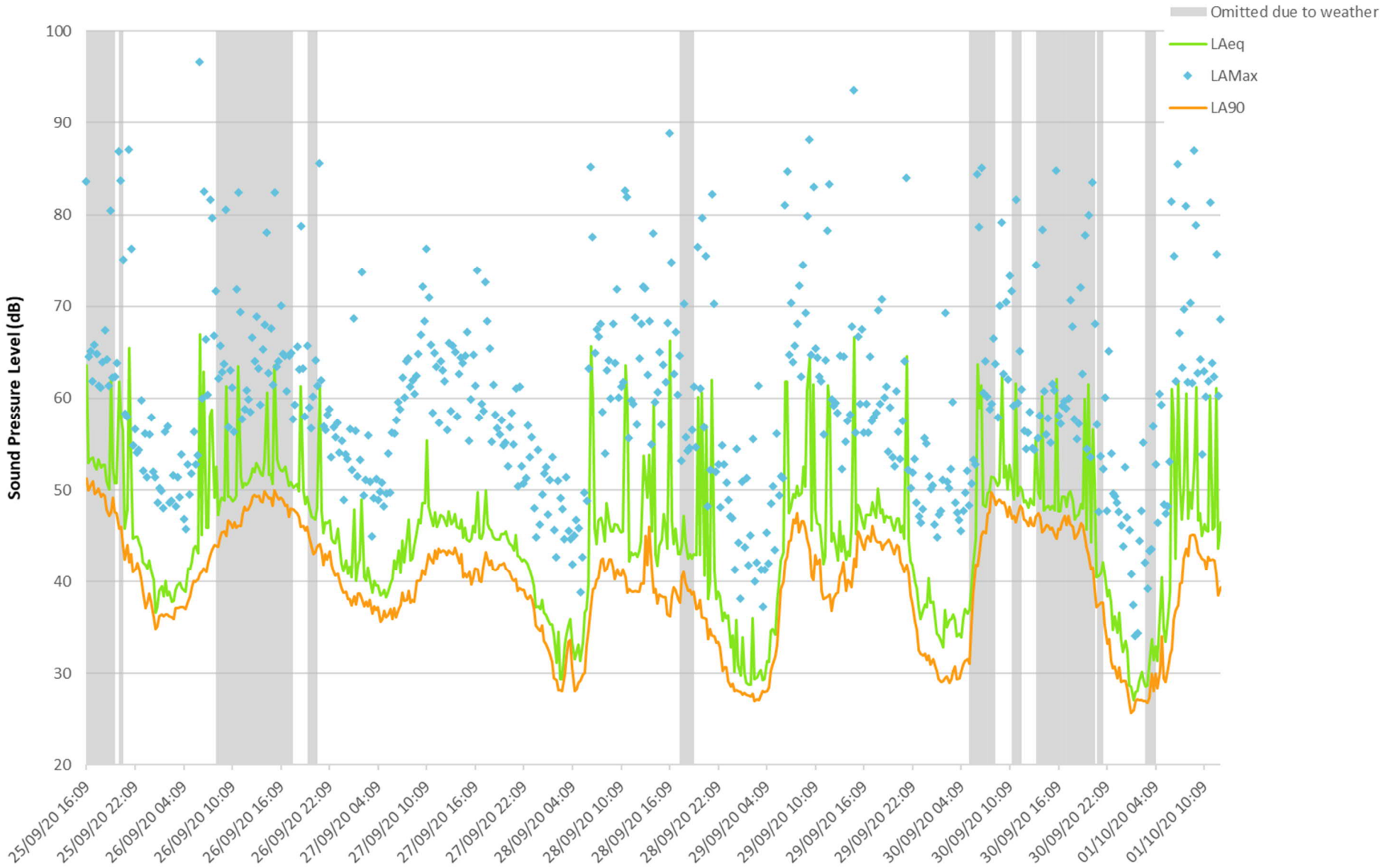

Figure 5 Unmanned Sound Monitoring Results

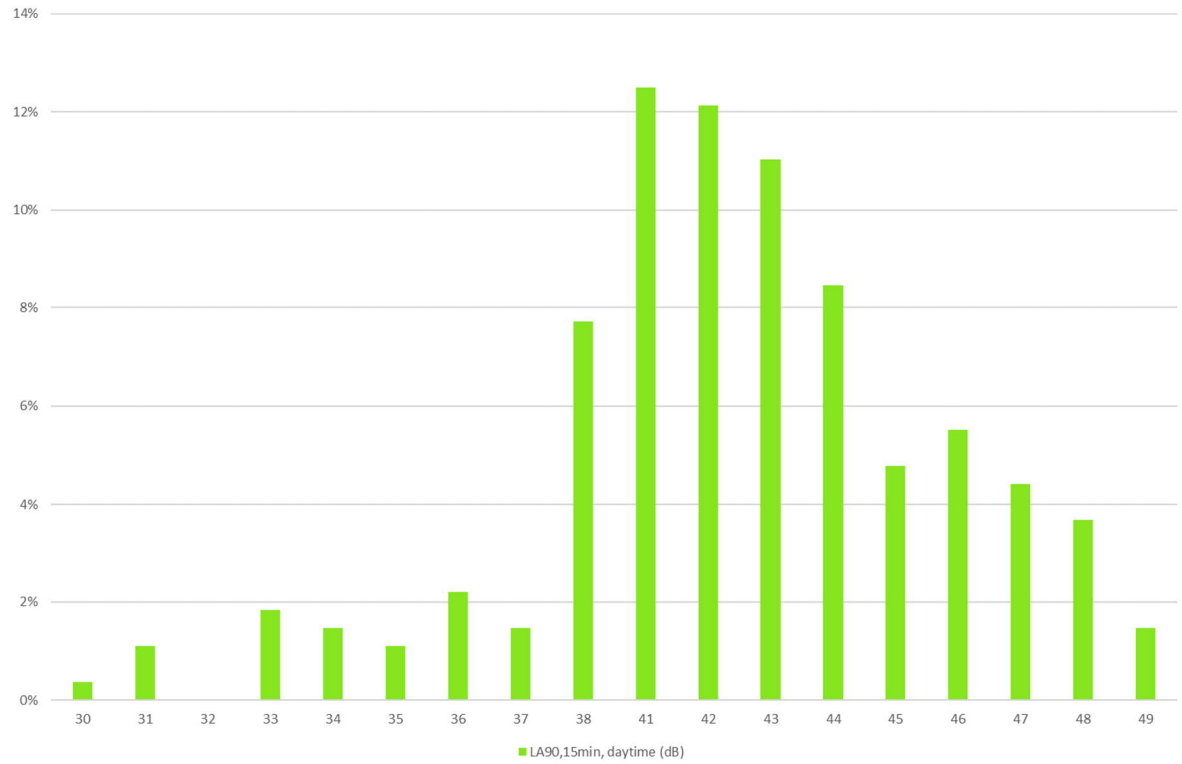

Figure 6 Daytime background sound levels

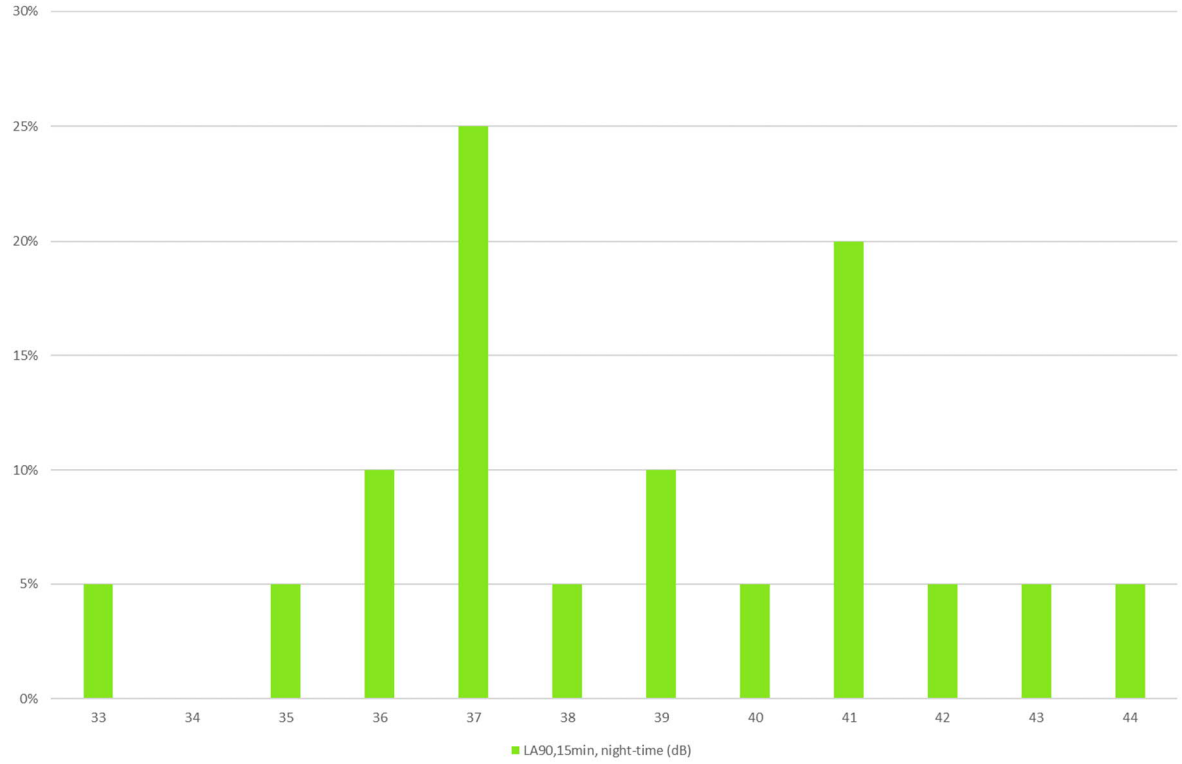

Figure 7 Night-time (06:00 to 07:00) background sound levels

Appendix C Acoustic Modelling of Railway Sound

C.1 Prediction Methodology

Modelling of sound levels from the proposed scheme have been undertaken using CadnaA (version 2020 MR1) acoustic modelling software. This software implements various sound propagation calculation methodology for different sound source types included in the model. The sound from railway sources has been calculated in accordance with the method set out in the Calculation of Railway Noise (CRN) (Department of Transport, HMSO 1995) and sound from idling trains were calculated following the method set out in the ISO 9613-2:1996 Attenuation of sound during propagation outdoors.

C.2 Acoustic Modelling Input Data

Data sources used for this modelling are shown in Table C.1.

Table C.1 Data sources

Data	Source file	Received From
OS mapping	TopographicArea.shp AddressBasePlus_FULL_2020-09-16_001	NCC
Existing topography	Northumberland Lines Complete_260620_OS.dwg DRONE-SURVEY - OS.dwg	AECOM
	LIDAR-DTM-2m-2019-NZ26ne LIDAR-DTM-2m-2019-NZ27ne LIDAR-DTM-2m-2019-NZ27se LIDAR-DTM-2m-2019-NZ28ne LIDAR-DTM-2m-2019-NZ28se LIDAR-DTM-2m-2019-NZ36nw LIDAR-DTM-2m-2019-NZ37nw LIDAR-DTM-2m-2019-NZ37sw LIDAR-DTM-2m-2019-NZ38sw	Publicly available LIDAR data downloaded from environment.data.gov.uk
Proposed topography, station layouts and tracks	60601435-ACM-01-ZZ-DRG-ECV-000001.dgn 60601435-ACM-03-ZZ-DRG-ECV-000001.dgn 60601435-ACM-04-ZZ-DRG-ECV-000001.dgn 60601435-ACM-05-ZZ-DRG-ECV-000001.dgn 60601435-ACM-06-ZZ-DRG-ECV-000001.dgn 60601435-ACM-07-ZZ-DRG-ECV-000002.dgn Proposed track layout on local grid.dwg	AECOM
Proposed railway movements, train speed profiles and railway gradient	RailSys fahrdynamik & plots - C66+665.88t IIA-C 75mph_UP.xlsx RailSys fahrdynamik & plots - C66+2438.40t IIA-C 60mph_DN.xlsx RailSys fahrdynamik & plots - 3car C158_DN_20200728.xlsx RailSys fahrdynamik & plots - 3car C158_UP_20200728.xlsx	SLC Rail, 27/10 – 03/11/2020
Road traffic movements on proposed station access roads	Ashington DS AADT Sensitivity Test.pdf Bebside DS AADT Sensitivity Test.pdf Bedlington DS AADT Sensitivity Test.pdf Newsham DS AADT Sensitivity Test.pdf NPark DS AADT.pdf SD DS AADT Sensitivity Test.pdf	AECOM

C.3 Acoustic Model Settings

Acoustic modelling has been undertaken using the following model settings:

- Maximum search radius of 2000 m.
- Maximum number of reflections: 1
- Noise predictions carried out at height of:
  - 1.5 m above ground to represent sound monitoring locations.
- As building height data were not included in the provided datasets, a default building height of 6.5 m has been assigned to all buildings with the exception of those with a footprint smaller than 10 m^2, which has been assigned a default height of 2.0 m.
- Ground absorption has been set as below:
  - A ground absorption value of G=1.0 (representing soft grounds) has been assigned to areas classified as natural land within OS mapping.
  - Remaining areas set to G=0.0 (representing hard grounds).
- All proposed station access road surfaces assumed to be impervious bitumen, such as hot rolled asphalt (HRA), with 1.5 mm texture depth.
- Rail track assumed to be continuous welded rail on concrete or timber sleepers and ballast (CRN track correction factor of 0 dB).

Train details and used for railway noise modelling are shown in Table C.2.

Table C.2 Train Details

Train Movements	Train Type / Number of Vehicles	Vehicle CRN Noise Correction (dB)	
		Rolling	Full Power
Passenger trains operating between Ashington and Newcastle: - 32 daytime movements for each direction (northbound and southbound); and - 1 night-time northbound movement (empty train, before the start of the service in the morning).	Class 158 / 3	7.6	N/A
Freight train 1: 4 daytime movements for each direction (loaded northbound and empty southbound), operating along the entire scheme	Class 66 / 1	13.0	-13.4
	4 axle IIA type C wagons / 24	7.1 (loaded) 10.4 (empty)	N/A
Freight train 2: 4 daytime movements for each direction (empty northbound and loaded southbound), operating along the entire scheme	Class 66 / 1	13.0	-13.4
	HTA 4 axle / 24	7.1 (loaded) 10.4 (empty)	N/A
Freight train 3: 1 daytime movement for each direction, operating between West Sleekburn junction and Bedlington only	Class 66 / 1	13.0	-13.4
	2 axle PCA hopper wagons / 23	12.0	N/A

The provided train speed profile and railway gradient information were processed to identify those railway segments where locomotives will be on full-power as per the guidance in CRN. To do this, the following rules were adopted:

- Where railway gradient is lower than 10%, trains with increasing speed are assumed to be on full-power.
- Where railway gradient is equal or higher than 10%, trains with increasing or constant speed are assumed to be on full-power.

It is understood that each passenger train will be idling at stations, for a maximum period of 1 minute between arrival and departure. The only exception to this is the Ashington station where the idling period is 9 minutes for each train. The sound emissions from idling trains was modelled with the following assumptions:

- Sound power level of the idling passenger train (Class 158) = 107.4 dB
- Idling train was modelled as a line source (~61 m long) located on the relevant railway centre line along the relevant station, at 0.4 m above the ground.

Appendix D PA Sound Design Report

1.2. APL has been instructed by Kilborn Consulting to model the proposed public address system (PA) which will provide audio coverage to the public areas of Bedlington station. APL shall also outline the potential noise impact of the use of the proposed PA system upon adjacent residential occupiers following the station development.

1.3. The purpose of the PA is to provide audible and intelligible customer information. The performance of the PA system is determined objectively using the following parameters:

(a) Sound pressure level (SPL);

(b) Speech Transmission Index for Public Address (STIPA)

1.4. STI requirements should be attained for a SPL level that is adequate to maintain a reasonable signal-noise ratio over and above existing ambient noise levels.

1.5. With regard to system performance, APL has been advised that the following performance requirements are applicable (extracted from Network Rail Standard NR/L2/TEL/30134 Issue2).

8.1.1 Loudspeaker Coverage

Loudspeakers shall be positioned so that the minimum required sound pressure levels (SPL) can be achieved in areas specified by the Sponsor. Areas that need to be considered include:

a) Passenger Waiting Room

b) Ticket/Booking Hall

c) At platform waiting areas (defined as the first passenger-used door at front of train to the last passenger-used door at rear of train of the longest train stock used at the station)

d) Concourse area

8.1.3 Minimum Levels

The system shall provide a minimum SPL of 10dBA above normal ambient noise levels at all times within the range of 65dBA up to the maximum SPL level unless environmental noise pollution issues prevent this figure being achieved.

8.1.5 Maximum Levels

The system shall not exceed an average SPL over 8 hours of 85dBA and a maximum SPL of 90dBA.

8.4 Speech Intelligibility

The PA system shall have a minimum STI target of 0.5 in the areas specified in section 8.1.1 and 0.45 in acoustically difficult areas with due consideration given during the design to the reverberation time in all enclosed areas.

1.6. There are no specific standards or performance specifications in relation to noise overspill from PA systems. Network Rail Standard NR_L2_TEL_30134 Iss 2 acknowledges the issue in para 8.13 by stating *"The system shall provide a minimum SPL of 10dBA above normal ambient noise levels at all times within the range of 65dBA up to the maximum SPL level unless environmental noise pollution issues prevent this figure being achieved."*

1.7. BS4142:2014 Methods for rating and assessing industrial and commercial sound is often quoted when assessing the likelihood of complaint from a variety of sound sources. However, the revision to the standard in 2014 states (note item g):

"The standard is not intended to be applied to the rating and assessment of sound from:

a) recreational activities, including all forms of motorsport;

b) music and other entertainment;

c) shooting grounds;

d) construction and demolition;

e) domestic animals;

f) people;

g) public address systems for speech"

1.8. Notwithstanding the above and in the absence of any other specific guidance, the noise limits for the new PA system shall therefore be defined as follows:

- *For new PA systems the noise emissions should not exceed the 'marginal significance' rating level of +5dB above background noise levels as defined in BS 4142:1997 during defined operational periods. This was determined to be 07:00-22:00hrs. The PA system would not be available for use outside of these hours, with the exception of safety critical announcements;*
- *Non-residential receptors are out of the scope of this methodology and will be looked at on a case-by-case if deemed necessary.*
- *In the event that the new system is used for emergency evacuation purposes (voice alarm, VA), the VA mode is considered to be exempt from the noise limits and is not included in the assessment*

1.9. In order to determine the allowable specific noise level in accordance with the procedure described above, an evaluation of the following was undertaken:

(a) *Background noise measurements obtained by Acoustics Plus;*

(b) *Predictions of noise from the proposed PA system at the nearest noise sensitive properties (using acoustic modelling);*

2. Background Information

2.1. In the case of Bedlington Station, a new PA system is proposed to provide audible and intelligible customer information announcements. It is the intention to provide the ability to broadcast audio along the full length of the platforms.

2.2. Given the location of the station and its proximity to residential properties, it is likely that the normal operation of the PA system will be audible at adjacent noise sensitive properties around the station. A site location plan showing the stations proximity to residential properties is shown in Figure 1 below. For clarity, the nearest noise sensitive properties (along with the proposed platforms) have been outlined.

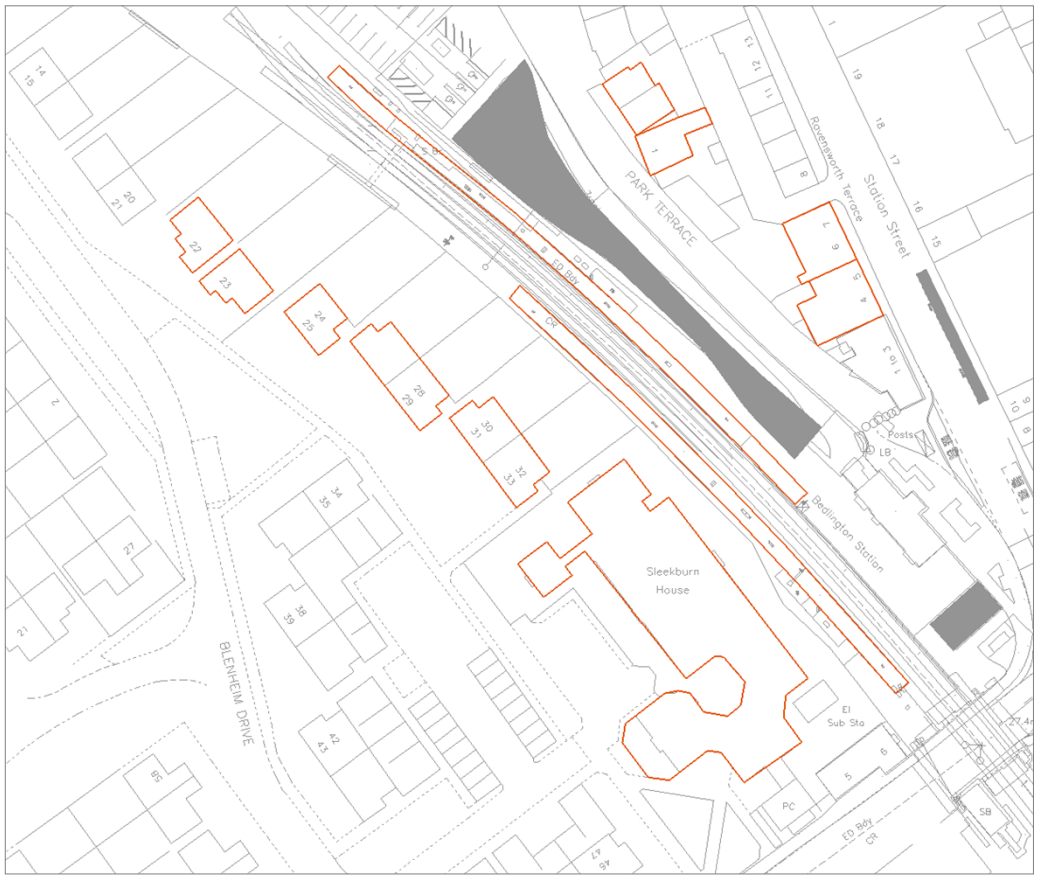

Figure 1 – Site Location Plan

2.3. The new PA system will be designed based on best practice noise mitigation measures as a standard part of the system design process. This will include the adoption of the latest available technology and the selection/positioning of loudspeakers to minimise noise nuisance to nearby residents.

2.4. The standard mitigation design measures shall include:

(a) The use of ambient noise sensing microphones to limit the volume of PA broadcast levels. ANS microphones will be installed on the platform. This will allow the PA system to automatically detect the local ambient noise conditions for each zone and to adjust PA announcement levels to an appropriate level. In this way broadcast levels can be reduced to the minimum required during quieter periods at the station, hence minimising the noise impact at nearby properties;

(b) Level reduction during unsociable hours. The new systems' configuration software will allow the automatic reduction of PA system output levels during early morning and/or late evening hours;

(c) Optimisation of loudspeaker layout designs. The noise impact of a distributed PA system can be minimised by:

- *keeping loudspeaker positions as low as practically possible;*
- *using a larger number of evenly distributed loudspeakers set at lower power;*
- *aiming loudspeakers appropriately towards the platform area and in the opposite direction to neighbouring properties, where possible.*

2.5. Measurements of ambient noise at the proposed location of the station were obtained during typical traffic hours on 16th June 2020.

2.6. The following average ambient noise level was measured and is considered as representative of existing noise levels experienced at the nearest noise sensitive properties. A level vs time history plot is shown in Figure 2. The highlighted events were excluded from the overall ambient noise survey project results.

Location	L_{eq} Octave band ambient noise level (dB)							dBA
	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
	52	46	42	44	40	37	30	48

Table 1 – Station background noise measurements

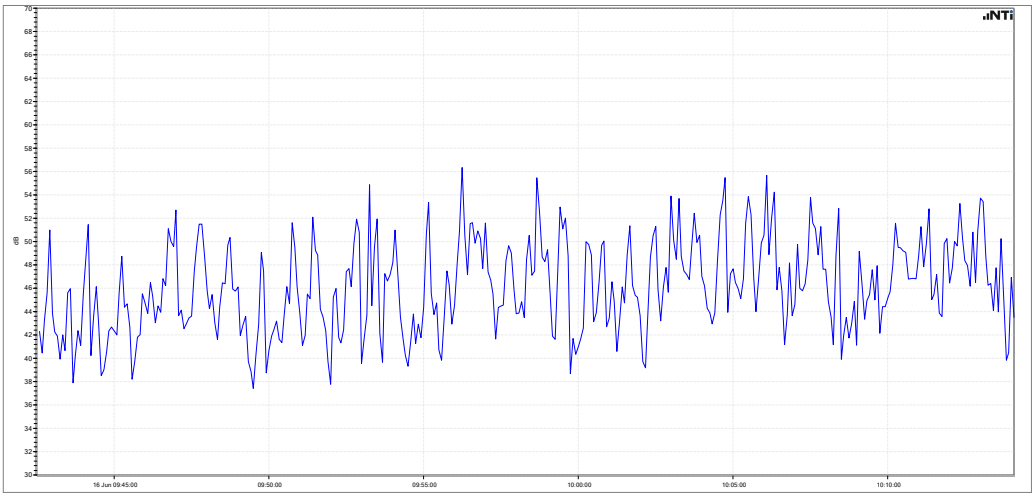

Figure 2 – Ambient noise level v time plot

3. Loudspeaker Design

3.1. The acoustic models were created using Enhanced Acoustic Simulator for Engineers (EASE 4.4.61.16 AURA Module 4.0).

3.2. Acoustic modelling using EASE consists of the following steps:

(a) *The import of geometry data from a CAD based program such as AutoCAD or SketchUp.*

(b) *The assigning of acoustic properties of each surface within the model (to include absorption coefficients and scatter).*

(c) *The placement and definition of proprietary loudspeakers (to include sensitivity and directivity).*

(d) *The calculation of relevant acoustic parameters, such as SPL and STIPa.*

3.3. The geometry data was extracted from scaled drawings provided by Kilborn Consulting. Minimal station detail was available, other than the likely lighting post spacing which was advised to be 12m.

3.4. The 3D geometry utilised for the purposes of acoustic modelling is shown in Figure 3 below. The lighting posts have been employed for loudspeaker placement.

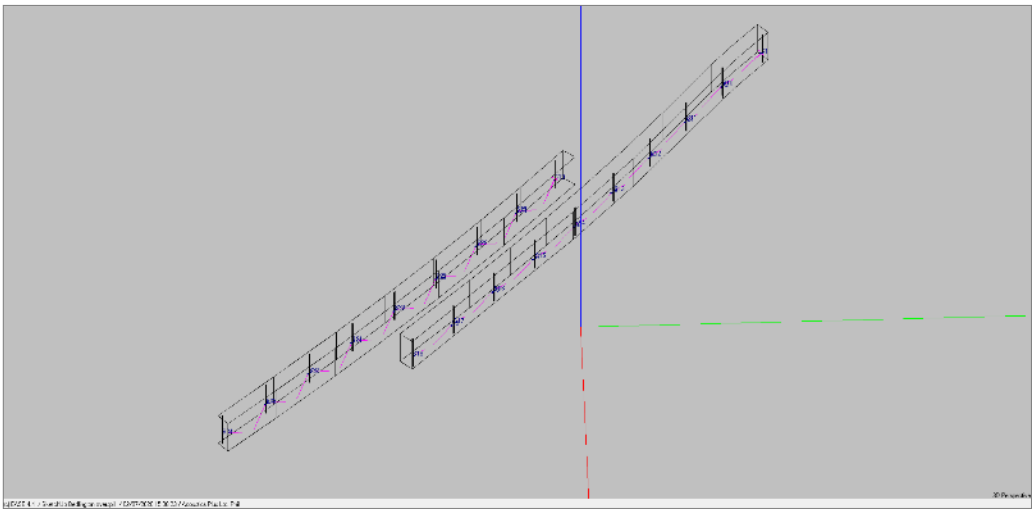

Figure 3 – Platform acoustic model

3.5. The design of the proposed public address system consists of projector loudspeakers mounted on the lighting posts at a height of 2.8m. The overall gain of the public address system has been adjusted to achieve a minimum SPL on the platform of 65dBA, which is more than 10dB above ambient noise levels.

3.6. The design has utilised an increased number of loudspeakers to ensure individual loudspeakers can be powered as low as possible to minimise noise overspill to nearby noise sensitive properties.

3.7. The acoustic modelling exercise produced the following predictions of audibility and intelligibility (see Figures 4 and 5). The predictions are based on a 1m grid of receiver positions at a height of 1.6m above finished floor level, in accordance with the requirements of para 8.1.2 of NR/L2/TEL/30134 Issue2.

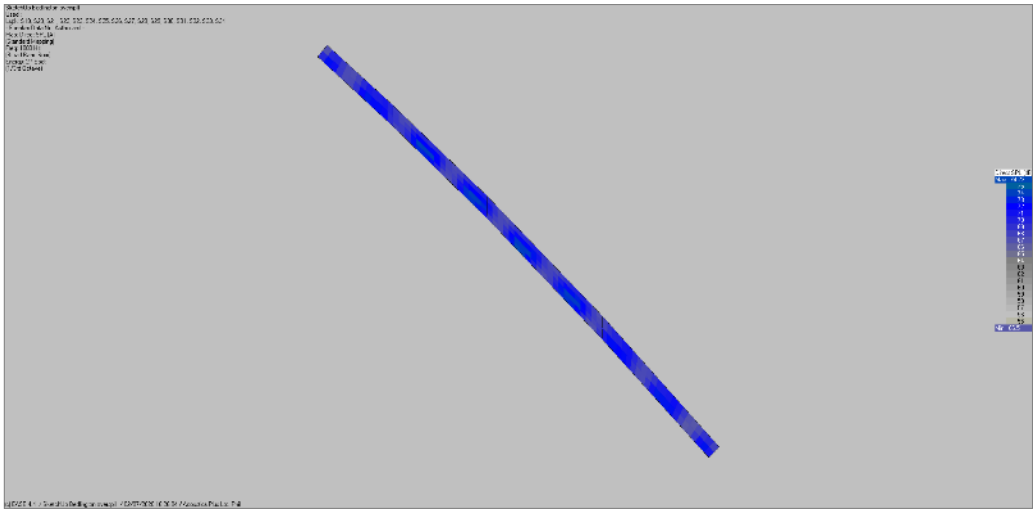

Figure 4 – Platform SPL predictions

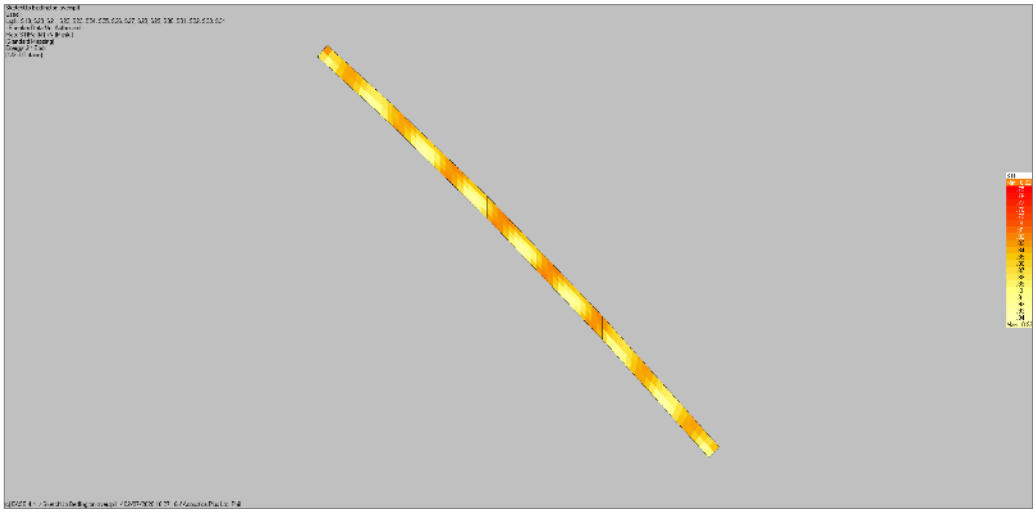

Figure 5 – Platform STIPA predictions

3.8. The average sound pressure level on platform 1 is 70dBA. The average speech intelligibility rating ($\bar{x}$ - σ) is 0.823 STIPA. The predictions of STIPA account for signal masking and prevailing ambient noise levels.

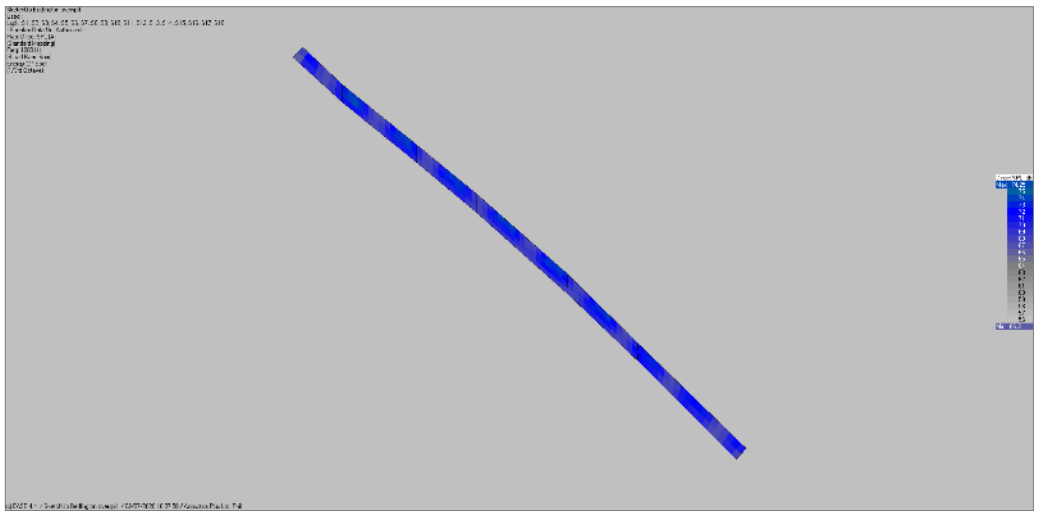

Figure 6 – Platform 2 SPL predictions

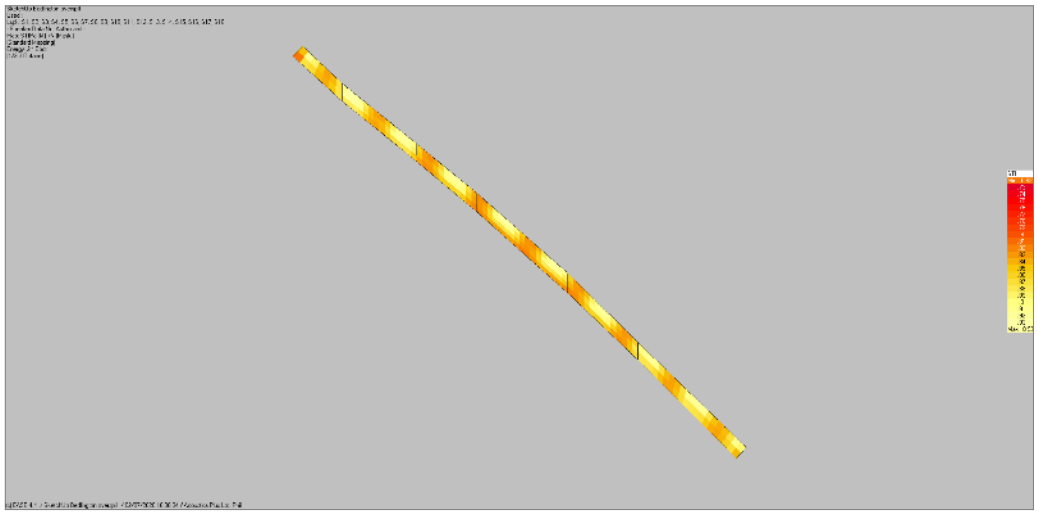

Figure 7 – Platform 2 STIPA predictions

3.9. The average sound pressure level on platform 2 is 70dBA. The average speech intelligibility rating ($\bar{x}$ - σ) is 0.823 STIPA. The predictions of STIPA account for signal masking and prevailing ambient noise levels.

4. Noise Assessment

4.1. A noise assessment was undertaken to predict the noise overspill from the station. An acoustic model was used to predict how the noise from the PA system will propagate away from the station premises, factoring in loudspeaker placement and directivity, announcement frequency and proximity of noise sensitive properties. The model was used to predict the specific noise level at a number of the worst affected receptor locations for the station.

4.2. Since the PA systems will not be in constant use, a correction was applied to account for the typical duration and frequency of PA broadcasts at the station. Whilst the exact number or duration of future announcements cannot be determined exactly, it is considered that allowing for an announcement of duration 30 seconds every 5 minutes would seem reasonable.

4.3. The following formula was used to adjust the sound pressure level, L_p, for on-time correction over a 1 hour reference period:

ΔL_p, dB = 10log (T_o / T_r)

Where:

T_o = On-time interval and,

T_r = reference time interval (1 hour

4.4. From the foregoing example of announcement duration and frequency, the calculation would be as follows:

Revised on-time correction = 10log (360/3600) = -10dB

4.5. Given that the acoustic characteristics of the announcements can be considered to be significantly different to the existing ambient noise, a +5 dB distinct character correction was assumed as part of the assessment in determining rating noise levels.

4.6. From the foregoing, the noise impact assessment was based on a minimum platform announcement level of 65dBA (extracted from NR_L2_TEL_30134 Iss 2) and corrected as follows:

On time correction = -10dB

Acoustic character correction = +5dB

4.7. The background noise measurements used in the assessment were obtained by APL and are reported in Table 2 below.

4.8. The target noise levels based on the preceding assumptions are therefore as follows:

BS4142 calculation	Daytime
Measured background noise level, dB $L_{A90,T}$ in area	40dBA
Target excess of rating level over background noise level, dB(A)	5dB
Target rating level, dB at the nearest residential property	45dBA

TABLE 2 – BS4142 TARGET NOISE LEVELS

4.9. In order to calculate the noise impact of the proposed PA system, an acoustic model of the station was used. This acoustic model correctly accounted for the placement and directivity of the speakers together with the distance from the platform speakers to the adjacent noise sensitive properties. The acoustic model utilised a GRIP 3 OS plan.

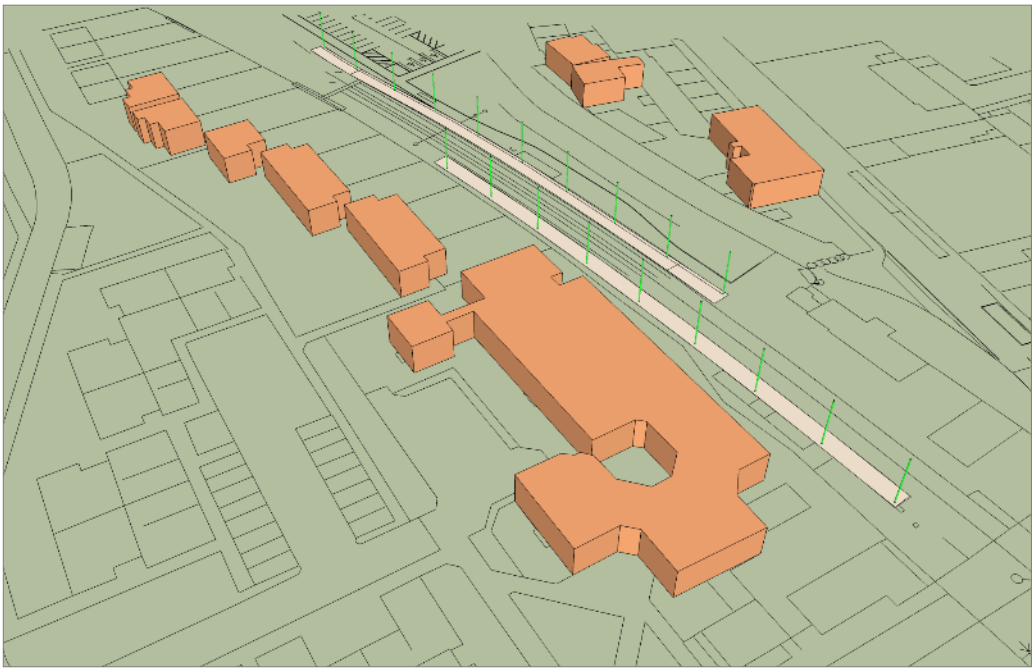

Figure 8 – Noise sensitive properties

4.10. This model was imported into acoustic modelling software in order to calculate the noise impact. Listener 'seats' were placed at 8No. noise sensitive façades.

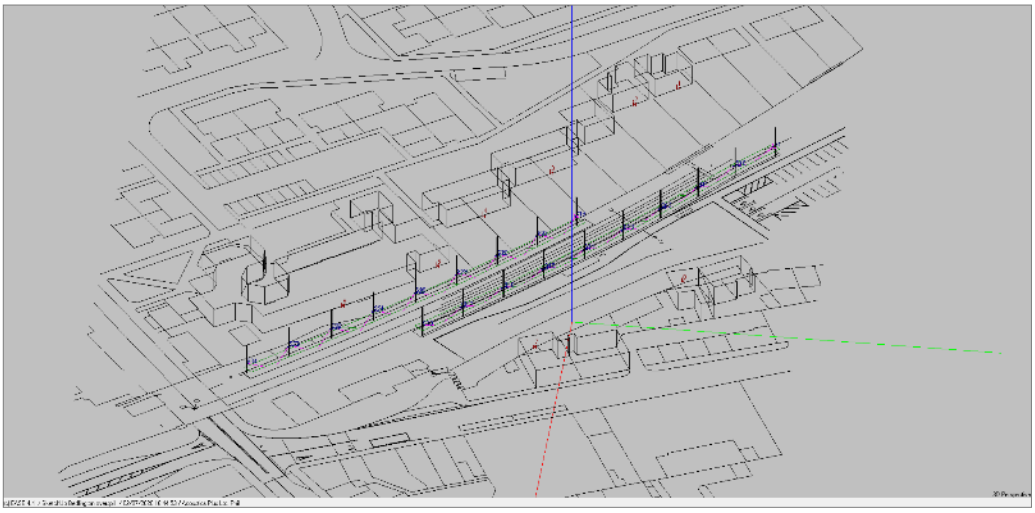

Figure 9 – Station acoustic model showing listener positions

4.11. The noise impact was calculated at 8No. listener seats as indicated in Figure 9. The following results were obtained at each listener position, based on an average platform announcement level of 70dBA and a minimum SPL of 65dBA. For the purposes of this assessment it has been assumed that the PA announcements would occur on both platforms simultaneously.

Noise impact assessment	Predicted noise level	Excess over target rating level
Listener seat 1	46dBA	+1dB
Listener seat 2	47dBA	+2dB
Listener seat 3	50dBA	+5dB
Listener seat 4	53dBA	+8dB
Listener seat 5	56dBA	+11dB
Listener seat 6	54dBA	+9dB
Listener seat 7	50dBA	+5dB
Listener seat 8	50dBA	+5dB

Table 3 – BS4142 rating level

5. Comments

5.1. In order to meet the minimum SPL requirements outlined in para 8.1.3 of Network Rail Standard NR/L2/TEL/30134 Issue2, the noise impact assessment demonstrates that there is a likelihood of adverse impact, particularly during the evening period when the background noise around the station is likely to be lower.

5.2. Given the proximity of noise sensitive properties adjacent to the proposed station, it is considered impossible to meet the minimum Network Rail SPL requirements whilst meeting the proposed target rating levels.

5.3. Notwithstanding the above and given the very low ambient noise levels, it would be possible to operate the PA system at a lower level to minimise the loss of amenity risk whilst still maintaining a minimum SPL of 10dBA above normal ambient noise levels at all times.

5.4. A worst case scenario has been considered, with PA broadcasts occurring from both platforms simultaneously. A lower noise impact would be expected with PA broadcasts from one platform only.

Appendix E Sources of Uncertainty

The following sources of uncertainty have been noted:

- Future railway sound predictions have utilised the calculation method in CRN. The CRN calculation method assumes a smooth track and does not account for rail or wheel roughness. The report produced by AEAT on behalf of Defra "Rail and wheel roughness – implications for noise mapping based on the Calculation of Railway Noise procedure"[27] recommends a correction to the predicted level using CRN to account for the rail roughness. The correction varies from 0 dB (at speeds of less than 42 km/h) to a maximum of around 5 dB at speeds of 200 km/h. At the train speeds anticipated in the vicinity of the proposed development (between 0 and around 60 km/h), this correction is around 1 dB or less. A 1 dB change would not significantly alter the conclusions of this assessment. The current condition of the railway track is not known therefore the calculations undertaken to inform this assessment have not accounted for any present roughness or potential reduction in roughness due to the proposed NL Upgrades. It is also a requirement of the NIR that the calculation method in CRN is used when determining property eligibility.
- Road traffic sound emissions have been based on provided traffic flow data for the year 2039. The uncertainty in these data (discussed in the Transport Assessment) is therefore also present in this assessment.
- Building heights have been estimated as described in section C.3. Where screening due to existing buildings exists, a degree of uncertainty in predicted sound pressure levels at the receptors will result from the use of these estimates. The main source of sound in the predictions is the trains passing by the properties, at which point there will be direct line of sight between the property and the track. Therefore this uncertainty is expected to be minimal.
- Predictions of future train vibration are based on standard assumptions which will have a wide degree of accuracy. In particular, the assumption that the acceleration generated by freight and passenger train passbys is unlikely to be accurate, in reality passenger trains are likely to generate much lower levels of acceleration. Therefore the assessment considers a worse impact than is likely to occur.
- The modelling of PA system sound has been undertaken by a third party. AECOM Acoustics has relied upon the results but have not validated the model. Therefore, the uncertainty in these predictions is unknown. The modelling will be refined during the detailed design stage and this will decrease the associated uncertainty. The predictions of the sound level at R9 are based on an indicative masterplan layout submitted as part of the outline planning application. Before the properties can be constructed or occupied, a detailed planning application has to be submitted which may change the locations of the closest properties to the railway, which would change the railway noise levels.

In addition, any measurement of existing ambient or background sound levels will be subject to a degree of uncertainty. Environmental sound levels vary between days, weeks, and throughout the year due to variations in source levels and conditions, meteorological effects on sound propagation and other factors. Hence, any measurement survey can only provide a sample of the ambient levels. Every effort is made to ensure that measurements are undertaken in such a way to provide a representative sample of conditions, such as avoiding periods of adverse weather conditions, and school holiday periods (which are often considered to result in atypical sound levels). However, a small degree of uncertainty will always remain in the values taken from such a measurement survey.

27 Defra Research Report, AEAT (2004). Rail and wheel roughness – implications for noise mapping based on the calculation of railway noise procedure.

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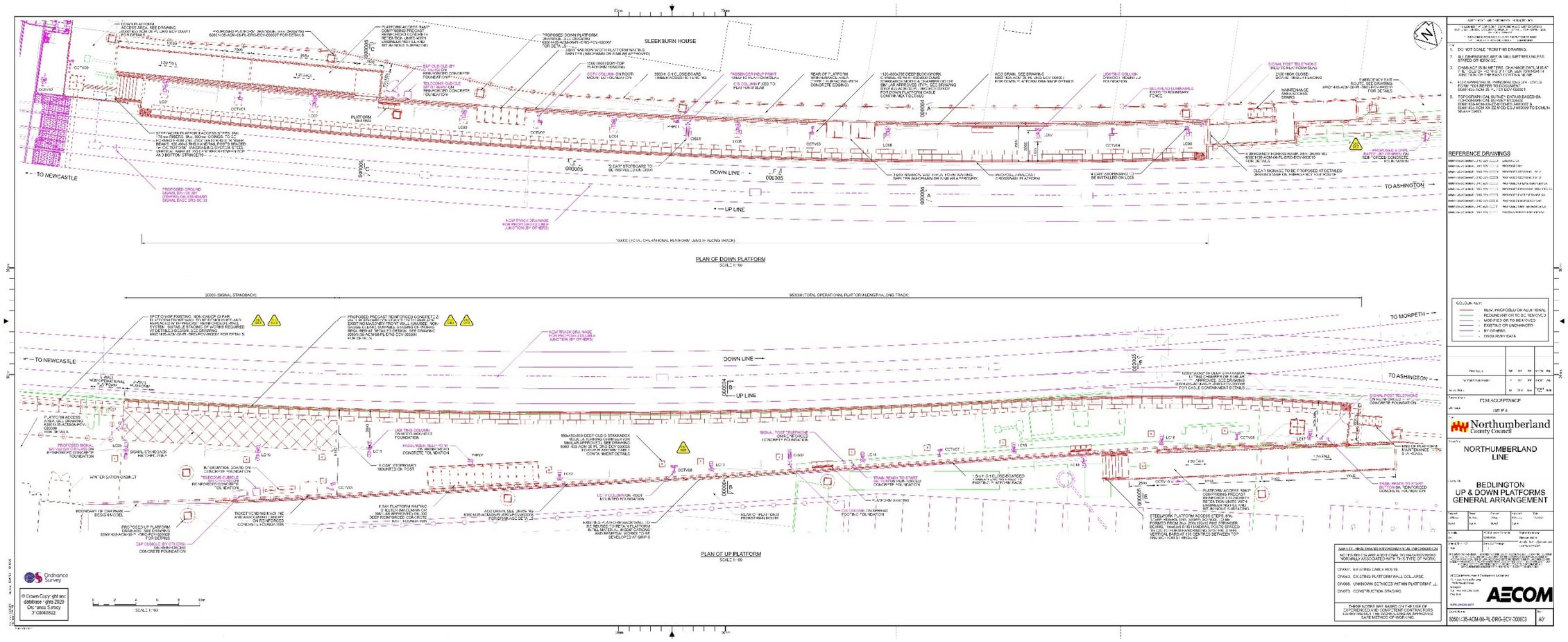
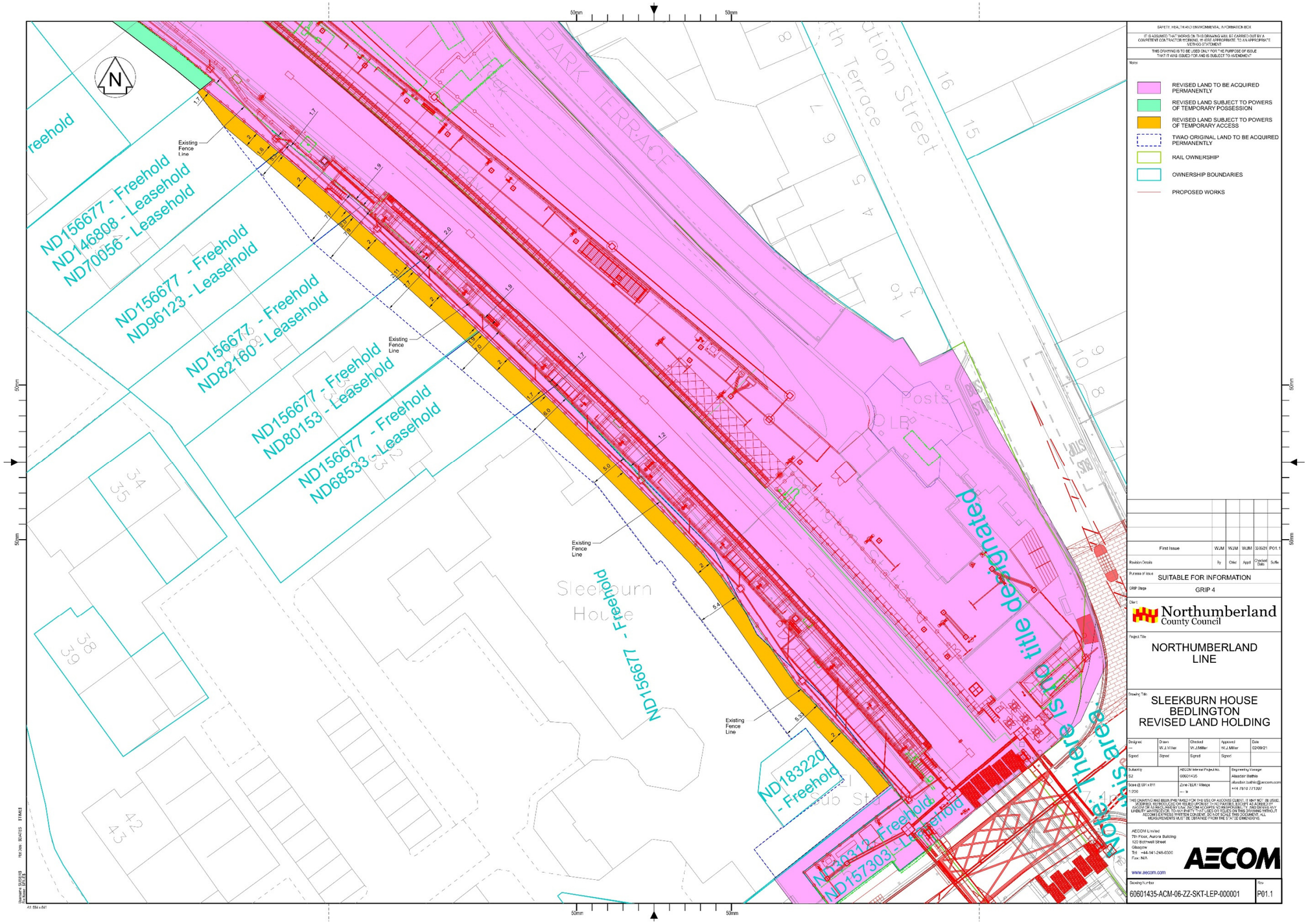
Appendix B Drawings and Land holding changes

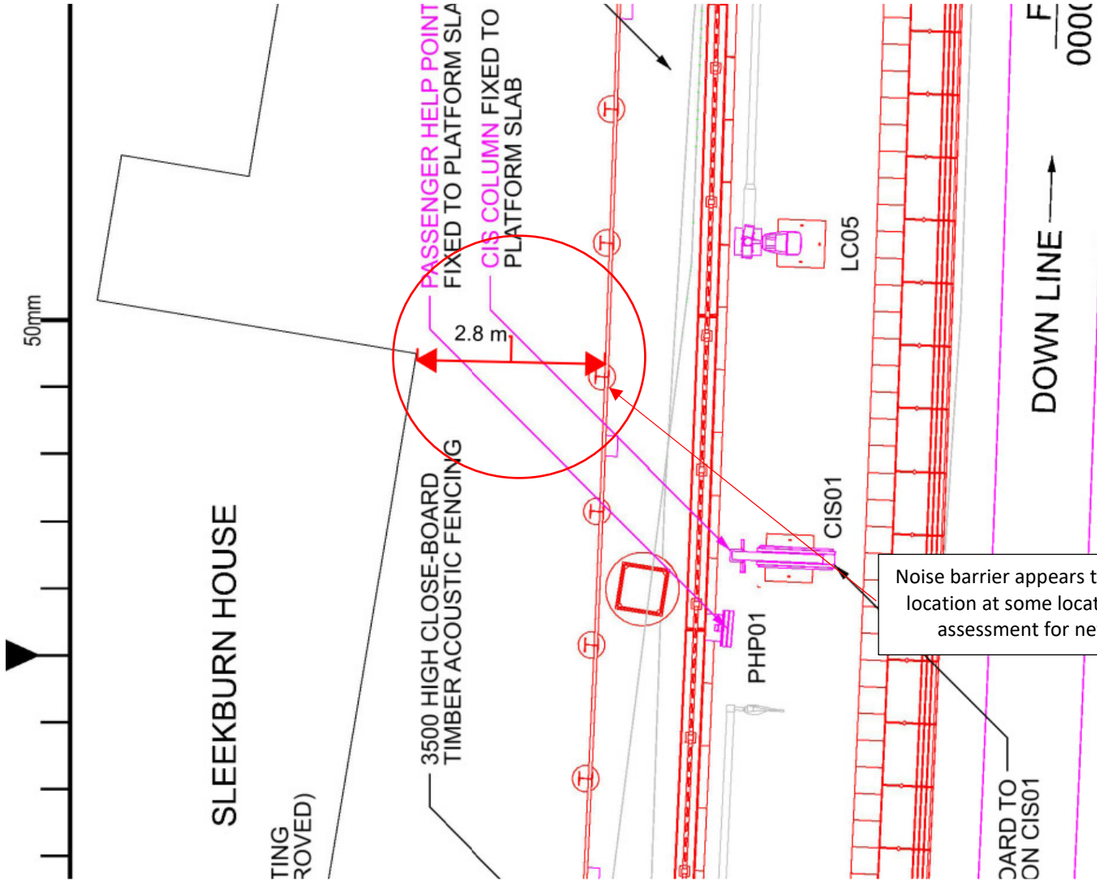
B.1 AECOM Bedlington Up & Down Platforms General Arrangement Drawing, 14/05/21



B.2 AECOM Sleekburn House Bedlington Revised Land Holding Drawing, 02/09/21



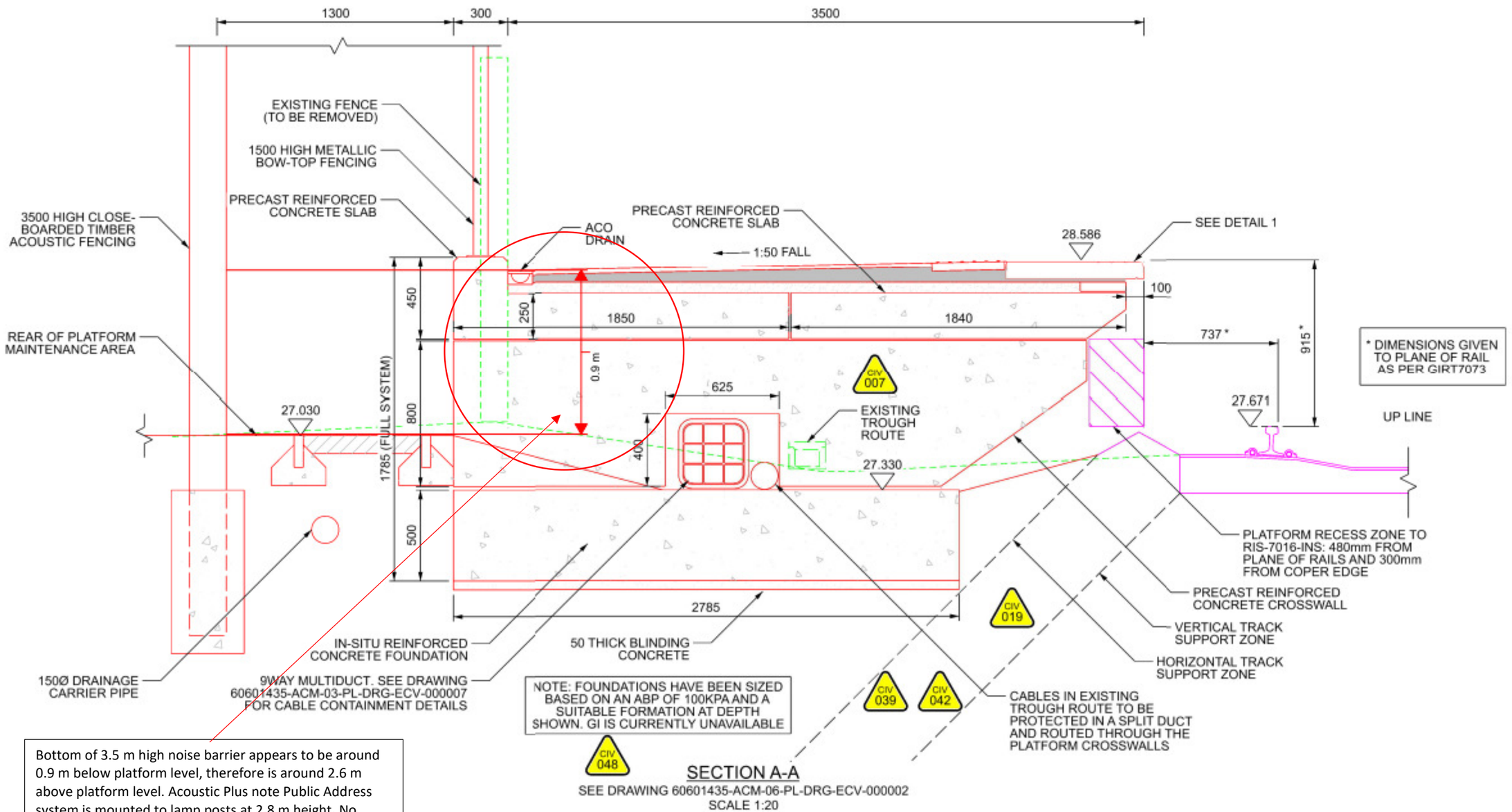
B.3 Mark-up to AECOM drawing excerpt: Change of 3.5 m high barrier position following revised Land Holding Drawing



AECOM drawing dated 14/05/21
(basis for noise assessment)

AECOM drawing dated 02/09/21

B.4 Marked-up noise barrier height relative to platform: Excerpt from AECOM Bedlington Platform Sections Sheet 1 of 2 dated 14/05/21



Bottom of 3.5 m high noise barrier appears to be around 0.9 m below platform level, therefore is around 2.6 m above platform level. Acoustic Plus note Public Address system is mounted to lamp posts at 2.8 m height. No drawing showing location of speakers, it is assumed likely the 2.8 m height is above platform level.

Appendix C Relevant correspondence

C.1 **Memo from AECOM to SLC, in response to Planning Application objection. Dated 26th July 2021**.

AECOM

AECOM Limited
1 Tanfield
Edinburgh EH3 5DA
United Kingdom

T: +44 131 301 8600
aecom.com

Project name:
Northumberland Line Upgrades

Project ref:
60628487

To:
Alannah Healey
SLC

CC:

From:
Tim Britton

Date:
26 July 2021

Memo

Subject: Response to objection to planning application for Bedlington Station

The objection received from Bernicia in regard to the above planning application includes concerns regarding the noise impacts of the proposed development on the residents of Sleekburn House. The following responses are provided:

Paragraph 1.2 states "*the works are proposed to be undertaken between 22:00 hours and 05:00 hours; we would submit that the entire period comprises "sensitive times"*." This is a misunderstanding of the proposed construction hours, which, over the construction schedule, will be between 22:00 on Thursday and 05:00 on the following Monday, potentially including activities during both the daytime and night-time. This includes times which are typically considered less noise sensitive (e.g. during the day). British Standard BS 5228-1:2009+A1 contains a methodology for the assessment of the significance of effect of construction noise in relation to the ambient noise levels, known as the "ABC method". This method identifies threshold values for noise impacts depending on the time period as follows:

- Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00) – highest threshold value (i.e. least sensitive to noise)
- 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays
- Night-time (23:00 – 07:00) – lowest threshold value (i.e. most sensitive to noise)

For typical residential properties, the time between 09:00 and 17:00 on a weekday is commonly defined as less sensitive than the remaining hours for which the BS 5228-1 highest threshold value applies. This is because typically the residents are at work, although it is recognised that, in the case of Sleekburn House, this is unlikely to be the case. Nevertheless, the times when the works will be conducted include between 07:00 to 19:00 on Fridays and 07:00 to 13:00 on Saturdays, which would fall into the least sensitive times of the day according to BS 5228-1.

Paragraph 1.3 states "*BS 5228-1 advises noise insulation measures and temporary rehousing where the construction noise levels are above the threshold values for more than a total of 40 days in any 6 consecutive months. On the basis of the above construction schedule that threshold is likely to be met.*" It should be recognised that the works will only be undertaken between Thursday and Monday i.e. 3 or 4 days per week or approximately 50% of the total duration of the works at the station. The noise emissions from the works will also vary with the activities that are undertaken. Construction noise levels will also depend on the distance of the works from the property. Whilst works at the platform location will be relatively close to the property, those at the car park will be further away and therefore quieter. With the level of construction information currently available, it is not apparent at this stage whether or not the threshold values will be exceeded for a total of 40 days in any 6 month period.

Paragraph 1.3 goes on to state "*No mitigation has as yet been proposed to Bernicia in respect of potential noise insulation works at Sleekburn House, and therefore it is not yet known whether any mitigation measures would adequately address the predicted noise levels*." The mitigation measures to Sleekburn House have been discussed with the Northumberland County Council Environmental Health Officer, who has recommended that the currently installed trickle ventilators are surveyed to confirm that they provide adequate background ventilation as per the requirements of Part F of the Building Regulations. Assuming that this is the case, opening these ventilators will provide adequate ventilation to the building for most of the time, with windows only needing to be opened to provide purge ventilation. A contractor has been engaged and Bernicia have granted access to survey the installed trickle ventilators in the building.

Paragraph 1.3 goes on to state "*it is not acceptable to leave such a matter to a planning condition and that the assessment should instead be undertaken now as part of the process for determining the Application.*" At present, a construction contractor has not been appointed and as such the construction methods and plant to be used are not known. Therefore, the assessment requested cannot be conducted and a qualitative construction noise and vibration assessment has been carried out. The matter is not being left to a planning condition, rather, as is appropriate for temporary issues such as construction noise, it will be controlled using the council's powers under the Control of Pollution Act 1974 (CoPA). The construction contractor will apply to the local authority for 'prior consent' to undertake the works under Section 61 of the CoPA. Under Section 60 of CoPA the local authority can serve a notice specifying how construction works should be carried out, including working hours and noise/vibration limits. Breaching the terms of the notice is an offence.

Paragraph 1.4 states "*Acceptable internal noise levels in respect of these properties are identified as only being capable of being achieved if windows are kept closed. This is not an acceptable means of mitigating the noise levels.*" The Bedlington Station noise impact assessment (NIA) identified that, with windows closed and trickle ventilators open, internal daytime railway noise levels would comply with the relevant criterion in British Standard BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings'. This calculation is based on an assumed typical acoustic performance for the installed trickle ventilators. The actual acoustic performance will be confirmed during the survey mentioned above. With windows open, the internal noise levels are anticipated to exceed the adopted criterion; however, as discussed above, this should be a relatively infrequent occurrence.

Section 122 of the Railways Act 1993 provides Network Rail with a 'statutory authority as a defence to actions in nuisance'. The impacts identified in the NIA as a result of introducing new trains onto the railway fall within this statutory authority; therefore, there is no legislative requirement to mitigate them. Whilst the criteria in BS 8233 define "desirable ambient noise levels", the only legislative requirement on Network Rail to mitigate operational train noise impacts is the Noise Insulation Regulations (Railways and Other Guided Transport Systems) 1996. These Regulations apply to new or altered railways but not to intensification, therefore they do not apply to the proposed development. Nevertheless, the NIA identifies that the noise level criteria in the Regulations are not exceeded at Sleekburn House.

C.2 Email from SLC Property to Northumberland County Council about Construction times, dated 1st October 2021

Alannah Healey <Alannah.Healey@slcproperty.co.uk>
Fri 10/1/2021 4:32 PM
To: Gordon Halliday <Gordon.Halliday@northumberland.gov.uk>

Dear Gordon,
Thanks for your email. I have summarised indicative timescales below. Please note, these have been taken from the latest draft programme and are likely to change likely as the programme develops. All timescales include an allowance for 2-3 months site clearance/enabling works and a month or so for demobilisation.

The 'overall timescales' for construction are as follows:

Bedlington: 3 months for car parks, 5 months for platforms, preceded by 2-3 months of demolition and site preparation/clearance works. The Park Terrace Car Park will be one of the last sites to be completed, as it is the intention of the contractor to utilise this land as a compound and will only complete construction once those cabins are removed. This means that the construction is likely to be spread over an 18 month window but construction **will not be continuous**.

Bebside: The construction of the station and car park is proposed to be approximately 17 months. The construction of the foot and cycle bridge is proposed to be approximately 11 months. The construction of the foot and cycle bridge will occur concurrently to the station and car park.

I hope this helps, in the meantime any questions or queries, please do not hesitate to get in touch.

Kind Regards

Alannah Healey MSc MRTPI
Chartered Planner

C.3 **SLC Property response to objection to planning application, dated 6th October 2021**.

SLC Property

Gordon Halliday

Northumberland County Council (NCC)

6th October 2021

Subject: Response to objection to planning application for the proposed Bedlington station on behalf of Bernicia Group (Application Ref: 21/01106/CCD)

This statement seeks to respond to those concerns raised by Bernicia relating to the impacts on residential amenity of the proposed new station at Bedlington station and provide reassurances to those residents.

Noise Attenuation Fencing

It is acknowledged that there will be an increase in noise associated with construction and operation of a railway station at Bedlington. The only feasible and reasonable mitigation option is to erect a barrier to block the line of sight to the nearby Noise Sensitive Receptor (NSRs). In order to be effective, the amount of noise transmitted through the barrier must be significantly less than what passes over the top (and round the edges). The effectiveness of a material to prevent the transmission of noise is determined by the thickness and surface density of the material used to construct the barrier. At Sleekburn House, a 3.5 metre barrier is required between the down line platform and the property to ensure that the impact for the NSR is low. This is assessed in both the Noise Impact Assessment submitted in support of the application, and the Noise Memo submitted in support of the application on the 26th July 2021.

Daylight Study

One of the concerns raised by Bernicia is that residents will experience a 'total loss of privacy and/or daylight' during construction and operation of the railway station.

At present, the proposed attenuation fencing adjacent to Sleekburn House is 3.5 meters which is an increase in height of 0.9 metres from the existing fence. It is acknowledged that the fence, whilst being located within a 'similar' position to the existing fence, deviates from the existing fence line, being closer to the building façade by up to 1.3m in some places. Notwithstanding these deviations, the Sleekburn House Daylight Study submitted in support of this application identifies that whilst there will be a visual change in the rooms assessed, this will not result in a 'noticeable' daylight loss for the existing rooms at Sleekburn House.

As such, in providing a noise mitigation solution, it is acknowledged that the scheme may result in an adverse visual impact. However, it is considered that the need to mitigate noise impacts outweighs the change in views from those identified rooms.

Landscape and Visual Amenity

It is acknowledged that the introduction of attenuation fencing will reduce the 'openness' of the existing views at Sleekburn House. While some existing trees and green space will need to be removed to construct the attenuation fencing, platform and associated infrastructure, the project will only remove what is absolutely necessary to enable construction/use of the station.

SLC Property

The submitted landscape design is an outline scheme of the intended layout. As such, any tree removals are indicative only at this stage, as there has been no contractor involvement in the preparation of the Arboricultural Impact Assessment and other documents submitted as part of the planning application and available on the NCC planning portal for application (ref: 21/01106/CCD). The applicant is prepared to accept a condition to be imposed on the grant of any planning permission that would require a 'final' Tree Protection Plan and Arboricultural Method Statement to be submitted. This would then enable the scheme to confirm those trees which are capable of being retained for the approval of the local planning authority. The project team will endeavour and work hard to retain trees wherever possible and is committed to working with the council and their arboriculturalist and landscape officers to agree those trees which are to be removed, and the appropriate methods for such removal.

At the detailed design stage, further discussions and consultation will be undertaken with NCC's landscape officers to review the proposed site boundaries, the planting palette and full the extent of the proposed works. The applicant will seek to work with Bernicia to agree the detailed landscape design and provide compensatory planting where possible within the constraints of the site.

Anti-social Behaviour

The response also raised concerns relating to anti-social behaviour which could affect safety and perceptions of safety for local residents. The scheme will include CCTV and appropriate safety measures to ensure that the concerns of residents are mitigated. The details of those measures including the specific locations of CCTV will be the subject of a planning condition associated with any decision notice. Furthermore, it is considered the 3.5 metre height of the noise attenuation fencing will provide privacy screening for those residents between the station access and the residents of Sleekburn House when the railway station is operational.

Summary

It is considered that the height of the fence balances the competing needs of providing sufficient noise attenuation and privacy screening whilst retaining appropriate daylight conditions. However, the applicant is content to work with Bernicia should they request that the height of the fencing be increased to provide additional privacy. It should be noticed noted that any increase to the height of the fence has the potential to lead to a further reduction in internal daylight to one or more rooms at Sleekburn House.

The submitted scheme has sought to balance the competing interests of potential impacts on residential amenity together with the strategic public benefits that will directly result from the new railway station development. It is noted that there is a requirement to meet accessibility standards by providing a pedestrian ramp from Clayton Street and to meet operational standards for platform lengths and widths. On balance, it is considered that the significant public benefits associated with the proposed railway station outweigh the harm resulting from the loss of a small amount of private garden ground and the resultant minor impacts on residential amenity.

Mitigation measures are proposed as part of this planning application to minimise the impact of the scheme on residential amenity, including noise impacts. It is anticipated the mitigation measure will be discussed and agreed with NCC and will be secured by way of suitably worded planning conditions, including the submission of a detailed Construction Environment Management Plan. The applicant will engage with Bernicia where possible through both the planning application process and the Transport and Works Act Order process to agree suitable measures to protect the residential amenity of those residents.

C.4 Email sent from AECOM to Sanderson Weatherall, with regard to noise barrier location, dated 7th October 2021

Smedley, Matthew
to Adrian, Liz, Peter, Russell, me

Thu, 7 Oct, 14:22 (1 day ago)

Liz,

Apologies for the delayed response – I appreciate that you are under tight timescales in providing your advice to Bernicia.

I understand that Jay Miller has provided you with CAD files of the existing and proposed fence line. PDF drawings were included with the planning application and are attached for assistance.

We have investigated the discrepancy between the TWAO and planning application drawings picked up by Nick. The drawings reference the same station model, including the existing and proposed fence. Therefore, there isn't a need to identify a revised proposed fence line on the drawings. The difference arises from the position of the Sleekburn House which is shown differently depending upon the background mapping being used. In this case, the planning application drawings have relied upon drone survey data to locate Sleekburn House, whereas the TWAO drawings use OS mapping. The third attached drawing illustrates the differences. Clearly there will need to be some rationalisation of this data to ensure that we arrive at the most accurate position, which we would suggest is confirmed on site.

Unconnected to the above, it has also become apparent that the noise assessment has modelled the noise barrier in a slightly incorrect location. The modelled location is closer to Sleekburn House than that shown on the drawings. We have now corrected the location of the fence in the noise model (so that it is slightly closer to the track) which results in the daytime railway noise level at first floor level of Sleekburn House reducing by 0.4dB. We would be happy to share the updated shape file with your consultants if that would assist.

Apologies again for the delay – but it took some time to investigate the above matters.

I should also highlight that NCC's solicitors are preparing a draft letter of assurance which will be sent to Bernicia's solicitors before the end of the week in connection with the objection to the TWA Order. It will set out assurances in respect of the proposed land take and mitigation measures which will be taken to seek to address your client's concerns as set out in their objection.

Regards

Matthew Smedley, BA (Hons), Dip TP, MRTPI
Associate Director – Town Planner
Environment and Sustainability

Appendix D Noise survey

D.1 Measurements

D.2 Measurements of the existing noise environment were obtained by my colleague, Dr Weigang Wei PhD MIOA on my behalf, between the 21st September 2021 and 24th September 2021.

D.3 Long term measurements were continuously measured between 21-24th September 2021, with shorter attended measurements and observation on 21st September 2021.

D.4 The measurement location is shown in Figure 1.

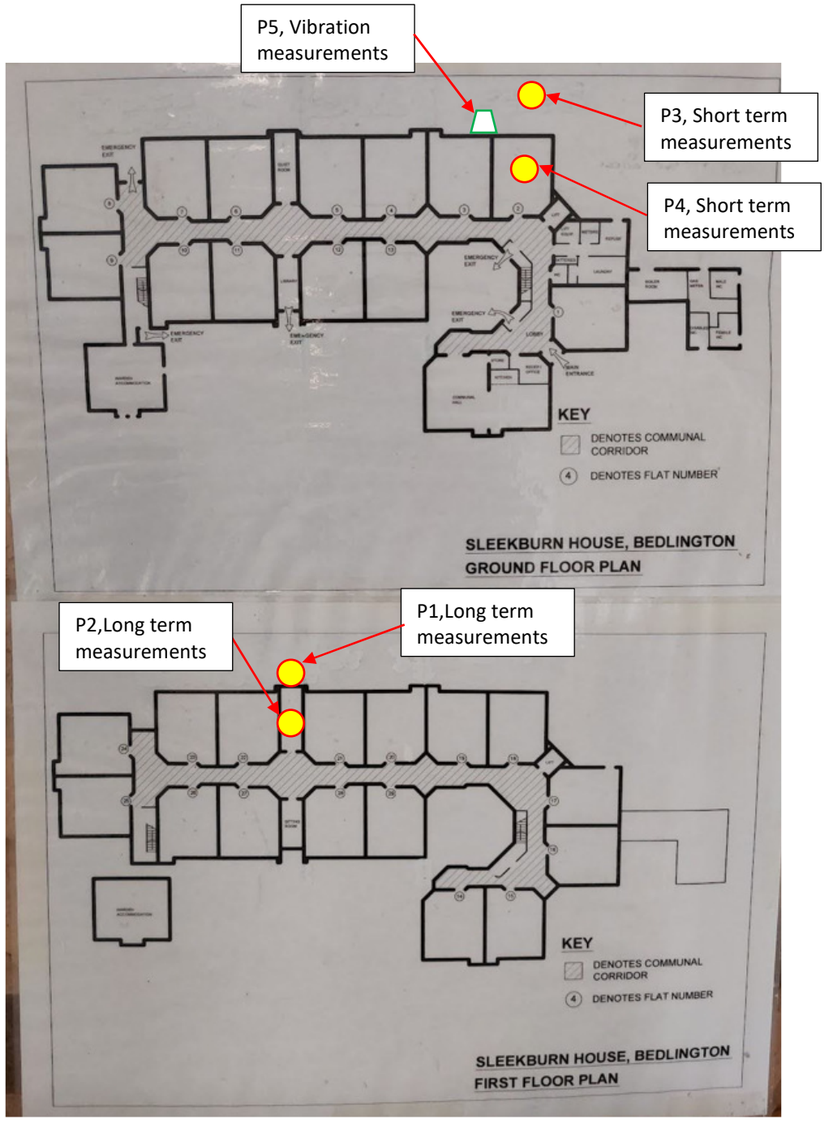


Figure 1: Measurement locations

D.5 Measurements could only be made in the rooms shown as these were unoccupied at the time.

- P1: Extended from first floor window as pictured, approximately 1 m from façade at shown in Figure 2;
- P2: located 1.5 m above floor at location pictured as shown in Figure 2;
- P3: located at 1.5 m above ground, 3 m from façade as shown in Figure 3 ; and
- P4: located 1.5 m above floor at location pictured in Figure 3.

Figure 2: Long term measurement in progress – P1 and P2

Figure 3: Short term measurement in progress – P3 & P4

D.6 Short term measurement positions are used to measure the closed glazing and open ventilator performance, and open window performance to ground floor level.

D.7 Long term measurement is used to measure the baseline sound environment at first floor level and the sound reduction due to an open window at first floor level.

D.8 Vibration measurements were also undertaken. As the levels were found to be negligible with no change in outcome from the AECOM assessment, survey results and not presented or assessed.

D.9 The equipment used is listed in Table 1.

Equipment	Model	Serial no.
Sound Level Meter	Norsonics 118	31697
Calibrator	Norsonics 1251	31286
Sound Level Meter	Norsonics 140	1403423
Calibrator	Norsonics 1251	32198

Table 1: Equipment used

D.10 All sound level meters and calibrators used meet the technical specifications of BS 7445 and have current calibration certificates traceable to national standards. The equipment was field-calibrated before and after the measurement with no significant drift in sensitivity noted.

D.11 The weather was considered suitable for environmental noise measurement. When the equipment was set up, it was a little cloudy, temperature was 15°C and wind speed was less than 1 m/s at the rear garden. When the equipment was collected the wind speed was around 1 m/s at the rear garden, cloudy and no rain.

D.12 Existing noise sources

D.13 The main noise source observed is road traffic, with occasional railway traffic and noise from trees.

D.14 Measured noise results

D.15 All noise levels at P1 are considered as façade levels, and a -3 dB correction is applied to determine free-field levels. Measurements at P3 are considered to be free-field and no correction is required.

D.16 I have analysed the measurement data, and $L_{Aeq,T}$ results are presented in Table 2.

D.17 The free-field train maximum noise levels L_{AFmax}, continuous equivalent noise levels $L_{Aeq,T}$ and the calculated Sound Exposure Level (SEL) are shown in Table 3.

Description	Start date and time	Duration	$L_{Aeq,T}$ dB
P1 & P2: External & internal noise comparison. First floor top hung, 1.2x2.4 m window, open 135 mm (maximum possible)	21/09/2021 13:09	9:50:36	54.0 (outside) 43.4 (inside)
	22/09/2021 07:00	16:00:00	53.0 (outside) 41.6 (inside)
	23/09/2021 07:00	16:00:00	53.9 (outside) 42.4 (inside)
	24/09/2021 07:00	6:24:28	52.2 (outside) 41.4 (inside)
	21/09/2021 23:00	8:00:00	49.2 (outside) 37.3 (inside)
	22/09/2021 23:00	8:00:00	51.8 (outside) 40.3 (inside)
	23/09/2021 23:00	8:00:00	49.8 (outside) 38.0 (inside)
P3 & P4: External & internal noise comparison. Ground floor top hung, 1.2x2.4 m window, open 135 mm (maximum possible)	21/09/2021 12:04	00:03:28	50.4 (outside) 37.1 (inside)
P3 & P4: External & internal noise comparison. Ground floor top hung, 1.2x2.4 m window closed, and trickle ventilator open	21/09/2021 12:14	0:08:38	51.6 (outside) 26.0 (inside)

Table 2: Measured $L_{Aeq,T}$ noise levels; outside are free-field

Start date and time	Duration	Free-field L_{AFmax}, dB	Free-field $L_{Aeq,T}$ dB	Calculated SEL
21/09/2021 14:20	0:03:20	84	73	96
21/09/2021 21:20	0:02:18	81	69	90
22/09/2021 06:10	0:02:46	82	70	92
22/09/2021 10:32	0:02:18	81	68	89
22/09/2021 13:47	0:02:16	78	69	90
22/09/2021 15:59	0:02:21	76	66	88
22/09/2021 19:02	0:01:28	81	72	92
22/09/2021 20:05	0:00:50	76	70	87
22/09/2021 20:39	0:01:12	83	71	89
22/09/2021 21:23	0:02:19	81	69	90
23/09/2021 06:16	0:02:23	90	73	94
23/09/2021 06:44	0:01:25	76	66	85
23/09/2021 07:16	0:01:05	82	73	91
23/09/2021 10:31	0:02:27	79	67	88
23/09/2021 13:52	0:02:38	80	68	90
23/09/2021 16:01	0:02:58	79	66	89
23/09/2021 19:24	0:02:31	79	68	90
23/09/2021 21:13	0:03:33	89	73	96
24/09/2021 06:14	0:02:44	84	68	91
24/09/2021 06:42	0:02:40	82	67	89
24/09/2021 09:01	0:02:36	79	67	89
24/09/2021 10:39	0:04:35	74	65	89

Table 3: Measured L_{AFmax}, $L_{Aeq,T}$ and calculated SEL of train events at P1

D.18 The train events identified include a worst case 6-7 events during the daytime (07:00-23:00) and 1-2 events during the night-time (23:00-07:00). This is consistent with AECOMs findings.

D.19 Calculated sound insulation

D.20 Based on the noise measurements shown in Table 2, I have calculated existing performance for a partially open windows to the ground floor and first floor, and for a typical closed window with ventilator open on the basis of the indoor and outdoor free-field noise level difference, as shown in Table 4.

Floor	Window condition	Attenuation dB
0	Open, 135 mm	13
0	Closed	26[2]
1	Open, 135 mm	11[1]

Table 4: Calculated sound reduction of different window conditions

[1]Average of results
[2]The test results may be limited by the background noise in the room. To reduce uncertainty a loudspeaker would need to be used externally to generate higher noise levels than that of the ambient sound.

D.21 Comparison with AECOM noise data

D.22 A comparison with the AECOM noise data is shown in Table 5. The AECOM data was measured at a different location at ground floor level, as described in their report. It is understood the measurements by AECOM are free-field, therefore free-field levels are compared.

Parameter	AECOM	Richard Hinton (Apex Acoustics)
Daytime LAeq, 16 hr range	46-54 dB	52-54 dB
Night-time LAeq, 8 hr range	36-54 dB	49-52 dB
Open window attenuation	15 dB[1]	Ground floor: 13 dB First floor: 11 dB
Closed window attenuation	33 dB[1]	Ground floor: 26[2] dB

Table 5: Comparison of noise data

[1]Assumed with guidance of BS 8233
[2]Limited by background sound, so considered worst case performance

Appendix E BS 4142 review

E.1 Introduction

E.2 BS 4142: 2014 clearly states the use of the standard is outside the scope for assessment of Public Address systems used for speech, as per the excerpt from clause 1.3 (g) shown below:

1.3 The determination of noise amounting to a nuisance is beyond the scope of this British Standard.

Sound of an industrial and/or commercial nature does not include sound from the passage of vehicles on public roads and railway systems.

The standard is not intended to be applied to the rating and assessment of sound from:

a) recreational activities, including all forms of motorsport;

b) music and other entertainment;

c) shooting grounds;

d) construction and demolition;

e) domestic animals;

f) people;

g) public address systems for speech; and

h) other sources falling within the scopes of other standards or guidance.

A1 The methodology set out in Clauses 7, 8, and 9 of this standard is not intended to be used to assess the extent of the impact at indoor locations. Internal sound levels can be taken into account as outlined in Clause 11. A1

A1 The standard is not intended to be applied to the assessment of indoor sound levels. A1

E.3 This appendix does not seek to validate the use of the standard, but to determine if the conclusions of AECOM and Acoustic Plus are valid should the limits they set out on the basis of this standard be implemented.

E.4 The sound source data used in my assessment is as per the Acoustic Plus reported sound levels at the Sleekburn House receptor. Background sound data is as reported by AECOM.

E.5 Impact criteria

E.6 An excerpt from BS 4142 Section 11 is shown below:

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause 8) from the rating level (see Clause 9).

NOTE 1 More than one assessment might be appropriate.

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

E.7 Initial assessment outcome

Parameter	Daytime (07:00-23:00)	Night-time (23:00-07:00)	BS 4142 Clause applicable	Commentary
Background sound	38 dB L_{A90}	37 dB L_{A90}	8.1.4	AECOM report Table 15
Specific Sound, L_s	51 dB $L_{Aeq,\ 1\ hr}$	51 dB $L_{Aeq,\ 15\ min}$	7.3.6	Provided in the Acoustic Plus report, Appended to the AECOM noise report: See Appendix A. Calculated on the basis of an absolute level of 61 dB(A), for an event that occurs for 30 seconds every 5 minutes within the assessment period.
Acoustic features	+13 dB	+18 dB	9.2	As the source does not exist, it is necessary to consider representative sound sources. The sound of Swindon Station Announcements is considered to be typical of most stations regardless of size, as available here: https://youtu.be/2Qe6PRLTvnI Given an absolute sound level of 61 dB(A) at the receptor, that is around 7-9 dB higher than existing daytime ambient sound and 9-12 dB higher than existing night-time sound (See Appendix D), any character is likely to be clearly and highly perceptible during the day and night periods. The following penalties are considered applicable: • Tonality: announcement chime – 4 dB (day) 6 dB (night); • Impulsivity: a rapid change in noise level is anticipated when an announcement occurs, given absolute sound level against existing ambient sound – 6 dB (day) 9 dB (night); • Intermittency: announcements have identifiable on/off characteristics – 3 dB (day/night)
Rating level, $L_{Ar,Tr}$	64 dB	69 dB		
Excess of Rating level over background sound	+ 26 dB	+ 32 dB	11	The initial assessment results indicate the likelihood of "significant adverse impact", depending on context. The Rating level is + 16 dB and + 22 dB greater than the onset level for Significant Adverse impact for the daytime and night-time periods respectively. To achieve a "low impact", the noise would need to be attenuated by ≥ 32 dB.

Table 6: BS 4142 initial assessment

E.8 Uncertainty, Clause 10 of BS 4142

E.9 The largest uncertainty in the assessment would be associated with A) the accuracy of the specific sound data, as calculated by Acoustics Plus, and B) PA Systems are outside the scope of the standard.

E.10 Regarding the calculated PA system noise uncertainty, AECOM state in Appendix E of their report: *"The modelling of PA system sound has been undertaken by a third party. AECOM Acoustics has relied upon the results but have not validated the model. Therefore, the uncertainty in these predictions is unknown. The modelling will be refined during the detailed design stage and this will decrease the associated uncertainty."*

E.11 Context considerations according to BS 4142 Section 11, points 1-3

E.12 BS 4142 states that where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the absolute sound level; the character and level of the residual sound compared to the character and level of the specific sound; and, the sensitivity of the receptor and any existing design measures to mitigate sound.

E.13 Whilst the time weighted noise level without penalties for acoustic features is 51 dB $L_{Aeq,\ 1\ hr}$ daytime and 51 dB $L_{Aeq,\ 15\ min}$ night-time, the absolute noise level of a single 30 second announcement is 61 dB(A) at Sleekburn House, of which is assessed to occur every 5 minutes when trains are scheduled. When determining an impact significance, BS 4142 requires the initial estimate of the impact to be adjusted subject to context, including for "1)*The absolute level of sound".* The context is that the absolute sound is significantly higher than other residual sound, and would be clearly perceptible (as required by Network Rail requirements to function as a PA system), and many events occur throughout the station operation period.

E.14 PA System announcements do not form part of the current residual sound climate, and would result in sounds incongruous to the existing acoustic environment. BS 4142 states the context of "*2)The Character and level of the residual sound compared to the character and level of the specific sound*" should be considered when determining impact significance. This is considered to be addressed sufficiently by acoustic character penalties.

E.15 The third context point of BS 4142 includes "*3) The sensitivity of the receptor…*". Sleekburn House is sheltered accommodation, occupied by elderly people who spend the majority of time within their accommodation and as such have a higher likelihood of exposure to adverse noise impacts. There is currently no specific acoustic design measures in place to deal with future changes in the railway use.

E.16 Adjusted assessment outcome due to context

E.17 Based on my above context considerations, the outcome of "significant adverse impact" is not adjusted.

E.18 However, the levels that constitute a low impact, adverse impact and significant adverse impact as shown in paragraph E.6 are not considered appropriate, given the context as outlined. The levels of adverse impact are likely to occur at a lower level. As the assessment of PA systems are also outside the scope of BS 4142, this is another indication that the limits listed may not be appropriate.

E.19 It is considered that rated sound would likely have to be below the background sounds level to reduce audibility and avoid adverse impacts given the characters associated with the sound. Where sound is at or above the background sound level, this would likely lead to occupants having to close their windows most of the time and therefore their quality of life as experienced currently would be diminished due to change in acoustic character of the area.

E.20 Comparison with AECOM assessment outcome

Parameter	AECOM result	Richard Hinton result
Character penalties	+ 5 dB Day & Night	+ 13 dB Day + 18 dB Night
Rating level	56 dB $L_{Ar,Tr}$ Day & Night	64dB $L_{Ar,Tr}$ Day 69 dB $L_{Ar,Tr}$ Day
Excess of Rating level over background sound	+ 18 dB Day + 19 dB Night	+ 26 dB Day + 32 dB Night

Table 7: Comparison with AECOM BS 4142 results

Appendix F Internal noise levels due to PA System

F.1 On the basis of the existing Sleekburn House window sound insulation figures presented in Table 4, I have calculated the internal noise levels due to the PA system only, with results shown in Table 8.

Windows	Parameter	Ground floor room	First floor room
Window closed, trickle vent open	External free-field sound pressure level, dB(A)	61	61
	Façade level difference, dB	-26	-26
	Indoor sound pressure levels, dB(A)	**35**	**35**
Open window	External free-field sound pressure level, dB(A)	61	61
	Façade level difference, dB	-13	-11
	Indoor sound pressure levels, dB(A)	**48**	**50**

Table 8: Indoor noise due to single PA System noise event

Appendix G Internal ambient noise levels

G.1 I have determined the free-field external ambient noise levels representative of the Sleekburn House façade as shown in Table 9.

Level	Parameter	dB	Comments
Ground floor	Daytime $L_{Aeq,16\ hr}$	55	AECOM Table 17
	Night-time $L_{Aeq,8\ hr}$	49	AECOM Section 6.2 states 53 dB L_{Aeq} at their baseline survey monitoring location, accounting for the 4 trains that stop at the station. No comment is provided on why the other two trains timetabled have not been included. I cannot include for these in my review, as the reported SEL level appears to represent a train that stops. The level may be different from a train that does not. Based on their monitoring location shown in Appendix B of their report, the centred distance to the tracks is 15 m and that from Sleekburn House to tracks is 12 m. A correction for noise propagation is applied to give the level at Sleekburn House: 53 dB+10*$\log_{10}$(15/12)=54dB. To account for the other ambient sound of 2 freight trains, AECOM report a typical SEL of 91 dB which is consistent with our findings. Therefore, 2 trains is calculated to equate 49.4 dB $LA_{eq,\ 8hr}$ on basis of 91-10*log10(288800 seconds)+10*log(2 events). The combined ambient train noise is calculated on this basis. The PA noise is excluded, as it is not clear on the on-time over an 8-hour night period. Ambient levels may be higher accounting for this. 6 dB attenuation is attributed to the noise barrier. Some uncertainty can be expected.
First floor	Daytime $L_{Aeq,16\ hr}$	59	AECOM Table 17
	Night-time $L_{Aeq,8\ hr}$	53	$L_{Aeq,\ 8\ hr}$ determined as above. Corrected for first floor line of site, according to daytime result difference: 59 dB – 55 dB = +4 dB.

Table 9: A-weighted external free-field noise levels, with 3.5 m barrier attenuation, used to calculate internal levels

G.2 AECOM have not provided L_{AFmax} values in their assessment, therefore it is not possible to review the impact of maximum noise events. Given a reported Single Event Level (SEL) of 72 dB and 71 dB for each track direction, the L_{AFmax} is assumed based on the difference of 1-12 dB between existing freight train L_{AFmax} and SEL values, as shown in Appendix D. As such, for the highest SEL level of 72 dB, the L_{Afmax} is assumed to be around 60-71 dB L_{AFmax}. Accounting for sound propagation the position of Sleekburn House façade as discussed in Table 9, the maximum noise levels would be 61-72 dB L_{AFmax}. Accounting for the 6 dB barrier attenuation at ground floor level, the L_{AFmax} would reduce to 55-66 dB. Considering the difference between ground and first floor levels are reported in Table 9, the maximum noise levels outside the first floor windows would be 59-71 dB L_{AFmax}.

G.3 On the basis of the existing Sleekburn House window sound insulation level difference values presented in Table 4, I have calculated the internal noise levels due to the trains with results shown in Table 10.

Windows	Level	Calculated internal levels		
		Daytime dB $L_{Aeq,\ 16\ hr}$	Night-time dB $L_{Aeq,\ 8\ hr}$	Maximum noise events dB L_{AFmax}
Window closed, trickle vent open	Ground floor	29	23	29-40[1]
	First floor	33	27	33-45[1]
Open window	Ground floor	42	36	42-53[1]
	First floor	48	42	48-60[1]

Table 10: Summary of calculated worst-case internal ambient noise levels

[1] 60 new events during the day (07:00-23:00), and 6 new events at night (23:00-07:00)

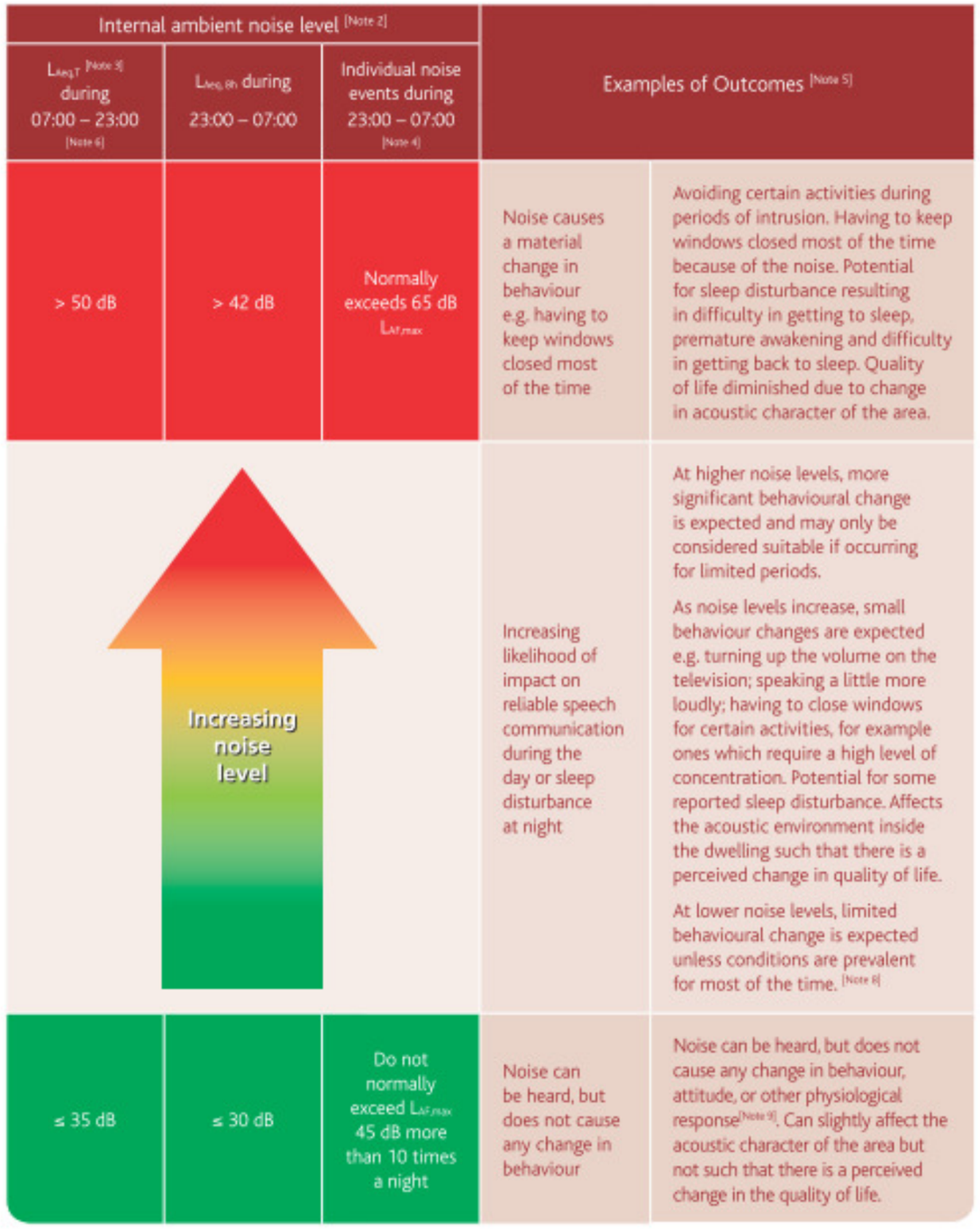
G.4 When the windows are closed, the noise levels are below BS 8233 guideline levels as set out in Table 7 of the AECOM report. When windows are open, the noise levels would exceed the guideline levels for daytime resting and night-time sleeping.

G.5 In regards to maximum noise events AECOM refer to World Health Organisation (WHO) guidance in Section 3.2.1 of their report, that is: *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night."*

G.6 The maximum noise levels should not be discounted during the daytime from any assessment of context. Considering the age profile of the residents, the likelihood that rooms would be occupied during the day is greater, and the likelihood residents may wish to sleep during the day is greater; which they can currently do without exceeding that criterion on the basis there is typically 0-10 freight train events per day. When windows are open, the maximum noise level from the trains would be high and therefore this will result in occupants having to close their windows for a much longer period of time than which they need to currently.

G.7 To determine the potential risk from noise when windows are open, the guidance of the Acoustics Ventilation and Overheating: Residential Design Guide, is referred to for considering noise during the overheating condition.

G.8 Table 3-3 of the guide provides example outcomes due to rising noise levels, and is reproduced overleaf.



G.9 These outcomes are compared to the calculated internal noise levels when windows are open, with my results shown in Table 11.

Level	Parameter	Internal noise level, dBA	AVO Guide outcome
Ground floor	Daytime, $L_{Aeq,16\ hr}$	42	*As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life.*
	Night-time, $L_{Aeq,\ 8\ hr}$	36	
First floor	Daytime, $L_{Aeq,16\ hr}$	48	*At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods.*
	Night-time, $L_{Aeq,\ 8\ hr}$	42	*Avoiding certain activities during periods of intrusion. Having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.*

Table 11: AVO guide outcome for Sleekburn House noise impact, when windows open