



Clare Hall

PROPOSED CAMBOURNE TO CAMBRIDGE BUSWAY – BIN BROOK CROSSING AND IMPACT ON CLARE HALL

Acoustics Proof of Evidence

Jonathan Blacklock, BEng (Hons), CEng, MIOA, MCIBSE

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1.0 EXECUTIVE SUMMARY

Introduction

- 1.1 The existing acoustic climate within the Clare Hall campus is relatively quiet with lots of external amenity spaces which the members and their families use to relax. The campus consists of the Porters Lodge and Ashley Library which are the main areas for studying. There are other buildings (Brian Pippard Building, College Flats, Gillian Beer Building, 9 & 9a Herschel Road, Michael Stoker Building, Leslie Barnett House, Salje Building, Paul Mellon Building, The Doshisha Room, Richard Eden Suite and the Robert Honeycombe Building) which are all residential dwellings for the students and fellows currently studying at Clare Hall.
- 1.2 Clare Hall Porters Lodge, the College Flats and the Brian Pippard Building are all situated within a very close proximity to the existing Rifle Range Road, at approximately 5.5m from the building façade to the closest edge of Rifle Range Road. The study rooms in Clare Hall are all single storey and directly overlook Rifle Range Road, with a low level of sound insulation offered by the building fabric. The College Flats and the Brian Pippard building have bedrooms directly overlooking Rifle Range Road and also benefit from private external amenity spaces (gardens or balconies) which face onto Rifle Range Road. When I visited the college campus, it was evident that some of these private amenity spaces were used by families as there were children's outdoor toys in the garden areas.
- 1.3 There is currently a small bridge spanning Bin Brook, which is approximately 30m from the Gillian Beer Building.

Existing Acoustic Climate

- 1.4 The existing sound levels on the balconies of Flat 5 of the College Flats were measured to be 48 dB $L_{Aeq,16h}$ and 46 dB $L_{Aeq,8h}$ for the day and nighttime periods respectively.
- 1.5 The existing sound levels on the balconies of Flat 8 of the Brian Pippard Building were measured to be 49 dB $L_{Aeq,16h}$ and 47 dB $L_{Aeq,8h}$ for the day and nighttime periods respectively.
- 1.6 The existing sound levels close to the Gillian Beer Building were measured by WSP to be 49 dB $L_{Aeq,16h}$ and 45 dB $L_{Aeq,8h}$ for the day and nighttime periods respectively.

Overview of Proposed Scheme

- 1.7 The proposals would introduce a guided busway along the stretch of Rifle Range Road and the construction of a new 14.3m wide bridge over Bin Brook. As part of the proposals, there will be only one Welfare Accommodation unit and vehicle turning point serving the whole development site. This has been proposed to be located directly adjacent to the Brian Pippard Building. It is said by the Applicant that the buses will be, as a minimum, a Euro IV compliant engine, with an "aspiration" for electric vehicles.
- 1.8 WSP has prepared and submitted an acoustic assessment in support of this application, within core document CD1-11.01.
- 1.9 The distance from the closest façades of Clare Hall, College Flats and the Brian Pippard Building to the nearside of the proposed guided busway has been scaled from the proposed drawings to be **less than 7m**.

- 1.10 The distance from the closest façades of Clare Hall, College Flats and the Brian Pippard Building to the nearside of the proposed Emergency & Maintenance Track has been scaled from the proposed drawings to be approximately **2.5m**.
- 1.11 The distance from the edge of the new bridge to the closest façade of the Gillian Beer Building has been scaled to be approximately **23m**.

Construction Noise

- 1.12 In paragraph 5.1.8 of the CD1-11.01 document, WSP have predicted that the construction noise will have a **significant adverse effect** on all properties within a **40m** radius of the works. WSP has stated in paragraph 5.1.10 that with the exception of the works for the new Bin Brook Bridge, all other works would take less than 10 days to complete, although there has been nothing provided to evidence this.
- 1.13 In paragraph 5.1.11 of the CD1-11.01 document WSP confirms that they have predicted that the works for the new Bin Brook Bridge **would cause a Significant Adverse Effect for the residents of the Gillian Beer Building**.
- 1.14 The Accommodation and Welfare unit will be in use for the entire duration of the project. It is reasonable to assume that all material deliveries, plant and equipment and workforce will all regularly use this area, so there would continuously be impulsive noises from this area adversely impacting the Clare Hall campus. Typically, this area would also house a security cabin which are usually manned 24 hours, 7 days per week, so it is most likely that there would be diesel generators outside the Brian Pippard Building, running continuously. The significance of this has not been assessed by WSP.
- 1.15 I have shown within the details of this Proof of Evidence that properties within a 60m radius of the construction works have been shown to be exposed to noise levels equivalent to the **Significant Observed Adverse Effect Level (SOAEL)**, which encompasses nearly all of the residential properties and study areas within the Clare Hall campus.
- 1.16 I predict that the construction noise level at the façade of the most impacted buildings, and their amenity spaces would be approximately **86 dB LAeq,T which is 21 dB higher than the SOAEL**. This level is significantly higher than the SOAEL and higher than the HSE recommend for the Upper Exposure Action Value, due to the distinct possibility for hearing impairment to people spending time in the external amenity areas.
- 1.17 I predict that the internal noise level, during the construction works would be approximately **69 dB LAeq,T**, which is **34 dB higher** than the WHO and BS 8233 recommend for bedrooms during the day.
- 1.18 Other than the use of BPM, WSP has not provided any advice on the levels of mitigation which will be required to minimise the adverse effect of the construction noise. Without mitigation, the noise levels caused by these works would be considered intolerable.

Construction Vibration

- 1.19 In paragraph 5.2.2 of the CD1-11.01 document, WSP have predicted that the construction vibration will have a **significant adverse effect** on all properties within a **15m** radius of the works using a two drum vibratory roller with a maximum amplitude of 0.4mm and roller width of 1.4m. WSP has stated in paragraph 5.2.3 that all works would take less than 10 days to complete, although there has been no

evidence provided to substantiate this. There has been no assessment of vibration made for the construction of the new Bin Brook Bridge by WSP.

- 1.20 The parameters for amplitude within Table E.1 of BS 5228-2 ranges from 0.4mm up to 1.72mm. The vibratory roller used for the vibration assessment, which resulted in the 15m buffer, therefore used the lowest value for the amplitude for the vibrating roller. I believe that contractors would be likely to opt to use a vibratory roller with a much higher amplitude than the one proposed by WSP, as the same level of compaction would be achieved, but with fewer pass-bys by using a vibratory roller with a higher level of vibration. Within my proof, I have assessed a standard JCB CT260-100 roller, with an amplitude of 0.56mm, which would increase WSP's **significant adverse effect** buffer to **19m** and **24m** for the steady state rolling and the machine starting up or stopping respectively. These numbers have a 50% possibility of being exceeded, so are to be considered optimistic.
- 1.21 The roller would be used for the Emergency and Maintenance Track as well as the busway. The roller would be working at a distance of only 2.5m from the closest façades of the Brian Pippard Building, College Flats and Clare Hall. WSP have not calculated the level of vibration anticipated at the façade of these buildings. I calculate that the vibration level would be approximately **13 mm/s PPV**.
- 1.22 DMRB states that at vibration levels greater than 10 mm/s PPV would be considered to be a **major adverse impact** and BS 5228-2 states that at levels above 10 mm/s PPV this level of vibration is likely to be **intolerable** for anything more than a very brief exposure.
- 1.23 Other than the use of BPM, WSP has not provided any advice on the levels of mitigation which will be required to minimise the adverse effect of the construction vibration. Without mitigation, the vibration levels caused by these works would be considered intolerable.

Operational Noise

- 1.24 WSP used a sound exposure level (SEL) of 72 dB(A) and 10 buses each way to predict the noise levels from the guided busway. Paragraph 5.4.71 of CD1-11.01 predicts that the operational noise level of the busway would be approximately **50 dB LAeq,1h**. This predicted noise level is **higher than the measured ambient sound levels** for the daytime at the measurement locations at Flat 5, Flat 8 and close to the Gillian Beer Building.
- 1.25 As the predicted noise level is above the Lowest Observed Adverse Effect Level (LOAEL) but below the SOAEL, WSP have concluded that no mitigation is required for the operational phase of the busway.
- 1.26 This level of 50 dB LAeq,1h is below the SOAEL, but is 2-3 dB higher than the current ambient sound levels. By assessing the change in noise levels, a 3 dB increase would be considered a minor change in the short term and a negligible change in the long term. Both of these are considered to be not significant.
- 1.27 My colleague measured several buses on a similarly rated section of the existing guided busway system, close to Kings Hedges Road and the average SEL was calculated to be **74 dB(A)**, but with a highest level of **77 dB(A)**.
- 1.28 I predict that the operational noise level at the façades of the Brian Pippard Building, College Flats, Clare Hall and their associated amenity spaces will be approximately **56 dB LAeq,1h**. This level is higher than the upper design limit (55 dB LAeq,T) for external amenity spaces, which currently are comfortably below the design level of 50 dB LAeq,T. This means that the usage of the private amenity spaces would be unsuitable and not in compliance with Policy 35 of the Cambridge City Local Plan or WHO and BS 8233 requirements.

- 1.29 This level of 56 dB $L_{Aeq,1h}$ is below the SOAEL, but is 8 – 9 dB higher than the current ambient sound levels. By assessing the change in noise levels, a 3 dB increase would be considered a **major** change in the short term and a **moderate** change in the long term. Both of these are considered to be a **significant adverse impact**.
- 1.30 I predict that the internal noise level, due to the operation of the busway, would be approximately **43 dB $L_{Aeq,T}$** , which is **8 dB higher** than the WHO and BS 8233 recommend for bedrooms during the day.
- 1.31 WSP have provided a further document, Environmental Statement (Addendum2 and Clarifications) which has recommended a planning condition to restrict nighttime bus journeys until the bus fleet are electric. I have discussed this in my Proof of Evidence and I do not think that this would be adequate to address the impact.
- 1.32 I believe that mitigation would need to be provided, should the proposal be regarded as otherwise acceptable. Recommendations for acoustic screening have been included within my Proof of Evidence, however I do not think that it will be possible to adequately mitigate the noise from the operation of the busway through acoustic screening, without significantly altering the Grade II* Listed Building. The Applicant has not proposed any additional mitigation and has also therefore not assessed the impacts associated with providing such mitigation.

2.0 QUALIFICATIONS AND EXPERIENCE

- 2.1 My name is Jonathan David Blacklock. I hold a Bachelor of Engineering (with honours) degree in Engineering from the Coventry University. I am a qualified Chartered Engineer.
- 2.2 I have been a full Member of the Institute of Acoustics (IOA) since September of 2007 and a full Member for the Chartered Institute of Building Services Engineers (CIBSE) since October of 2012. Create Consulting Engineers Ltd gained full accreditation with the Association of Noise Consultants (ANC) in 2022. Since becoming accredited, we have won several awards with the ANC for some of our select projects, due to the thorough background research and innovative approaches to problem solving.
- 2.3 I am employed as a Technical Director at Create Consulting Engineers Ltd and lead the Acoustics Team across all regions of the UK. I have over 19 years of experience in acoustic consultancy, covering both noise and vibration. Over the years, I have specialised in advising developers and landowners on the various aspects of acoustics, including providing advice of the most suitable mitigation systems for both noise and vibration.
- 2.4 I am a member of the Engineering Council Membership Committee and a member of the CIBSE CPD Panel. In 2023, I was elected by my peers as the Chairperson for the Eastern Branch of the Institute of Acoustics.
- 2.5 I was invited by Clare Hall to provide expert evidence regarding the proposed Cambourne to Cambridge Busway, specifically to examine the impact on Clare Hall. I can confirm that I assisted in the preparation of the Clare Hall's statement of case and that I have visited the Clare Hall campus on a number of occasions now to fully understand the area and the existing acoustic climate and the constraints associated with the site.
- 2.6 Additional sound level measurements were undertaken for this site by my colleague Mr. Sam Ward, MSc, BSc (Hons), MIOA. Sam is a full Member of the Institute of Acoustics and has six years of experience in Acoustics.

Witness Declaration

- 2.7 I hereby declare as follows;
- 2.8 This Proof of Evidence includes the facts which I regards as being relevant to the opinions which I have expressed, and the Inquiry's attention has been drawn to any matter which would affect the validity of that opinion.
- 2.9 I believe that the facts which I have stated in this Proof of Evidence are true and that the opinions expressed are correct.
- 2.10 I understand my duty to the Inquiry to help it with matters within my expertise and I have complied with that duty.



Jody Blacklock
BEng (Hons), CEng, MIOA, MCIBSE

3.0 INTRODUCTION

The Submitted Application

- 3.1 Create Consulting Engineers Ltd has been instructed to provide acoustic expertise relating to the application for the Cambourne to Cambridge Busway, referred to as the Proposed Development, in particular the section from the Bin Brook Bridge to the termination point at the junction of Rifle Range Road and Grange Road, adjacent to the Clare Hall campus. The application was submitted to the Secretary of State in accordance with the Transport and Works (Applications and Objections Procedure) 2006¹ for an order under sections 1, 3 and 5 of the Transport and Works Act 1992².
- 3.2 The application under inquiry is the Cambourne to Cambridge Order (REF: DPI/E0535/25/1) and involves the implementation, operation and maintenance of a guided busway between Cambourne and Cambridge.
- 3.3 The application was made by Cambridge City Council in conjunction with Greater Cambridge Partnership.

Scope of Works

- 3.4 This Proof of Evidence will focus on the noise and vibration matters, specifically the potential adverse impact on the Clare Hall complex and the associated residences.
- 3.5 The following objectives of this Proof of Evidence are to;
- Provide expert acoustics evidence in respect of the application and how I believe that it will impact on Clare Hall;
 - To assess the extent to which the application is compliant with the National Planning Policy Framework (NPPF)³ and associated national noise and vibration related guidance, including Noise Policy Statement for England (NPSE)⁴ and Planning Practice Guidance (PPG) – Noise⁵; and
 - To assess the extent to which there is compliance with the local noise policies, including Cambridge City Council Local Plan⁶, Greater Cambridge Supplementary Planning Document⁷ and Cambridge East Area Action Plan⁸.
- 3.6 My Proof of Evidence is structured in the following manner;
- Chapter two states my qualifications and experience with regards noise and vibration.

¹ S.I. 2006/1466 as amended by S.I. 2010/439, S.I. 2011/556, S.I. 2011/2085, S.I. 2012/147, S.I. 2012/1658, S.I. 2012/2590, S.I. 2013/755, S.I. 2014/469, S.I. 2015/377, S.I. 2015/627, S.I. 2015/1682, S.I. 2017/979, S.I. 2017/1070, S.I. 2019/311 and S.I. 2023/795.

² 1992 c.42; section 1 was amended by paragraphs 51 and 52 of Schedule 2 to the Planning Act 2008 (c.29). Section 5 was amended by S.I. 2012/1659

³ Ministry of Housing, Communities & Local Government, 2024. *National Planning Policy Framework (NPPF)*. [Online]. Available at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2> [Accessed March 2025].

⁴ Noise Policy Statement for England, Department for Environment, Food & Rural Affairs, 2010

⁵ Planning Practice Guidance – Noise (PPG-N) launched in 2014 and updated in 2019

⁶ Cambridge City Council – Cambridge Local Plan 2018: Policy 35

⁷ Greater Cambridge Shared Planning – Sustainable Design and Construction: Supplementary Planning Document (GCSP-SPD-2020) – relevant noise sections

⁸ Cambridge East Area Action Plan (2008) – Policy CE/26: Noise

- Chapter three is the introduction, including some background information and a brief overview of the Proposed Development.
- Chapter four provides a summary of the application background for the CtoC guided busway and the specifics of Clare Hall and the various buildings within the campus and the crossing over Bin Brook Bridge;
- Chapter five summarises the existing acoustic climate that Clare Hall is exposed to;
- Chapter six investigates the noise from the construction of the CtoC guided busway;
- Chapter seven discusses the impact of vibration from the construction of the CtoC guided busway;
- Chapter eight assesses the noise impact on Clare Hall during the operation of the CtoC guided busway
- Chapter nine assesses the operational vibration levels and the impact on Clare Hall;
- Chapter ten summarises the acoustic assessment submitted by WSP as part of the applicant (document CD1-11.01);
- Chapter eleven summarises the evidence provided by Create Consulting Engineers Ltd; and
- Chapter twelve provides concluding remarks and my expert opinions on the impacts of the proposed scheme onto Clare Hall, recommendations for mitigation and the residual impacts.

Brief Scheme Overview

- 3.7 The plans include a two-way busway of approximately 13.6 kilometres and emergency & maintenance track, starting at Cambourne, terminating at Grange Road, Cambridge. At this point, buses continuing into Cambridge City centre will turn right onto Grange Road, at the junction with Rifle Range Road. This junction will see the addition of a traffic light system.
- 3.8 Rifle Range Road runs along the southern boundary of Clare Hall, with a grass verge between. There are existing mature trees interspersed along the verge, which has been shown in Figure 4.6.
- 3.9 A new bridge has been proposed to go over Bin Brook, approximately 30m from the Gillian Beer House, which is used for student accommodation by Clare Hall. This is discussed later in this proof.
- 3.10 There is also a single site accommodation area (shown in dark blue) in Figure 3.1, including vehicle turning facility shown on the proposed plans along Rifle Range Road, which has been proposed to be situated directly outside the Brian Pippard building (shown in magenta) as highlighted in Figure 3.1 below.

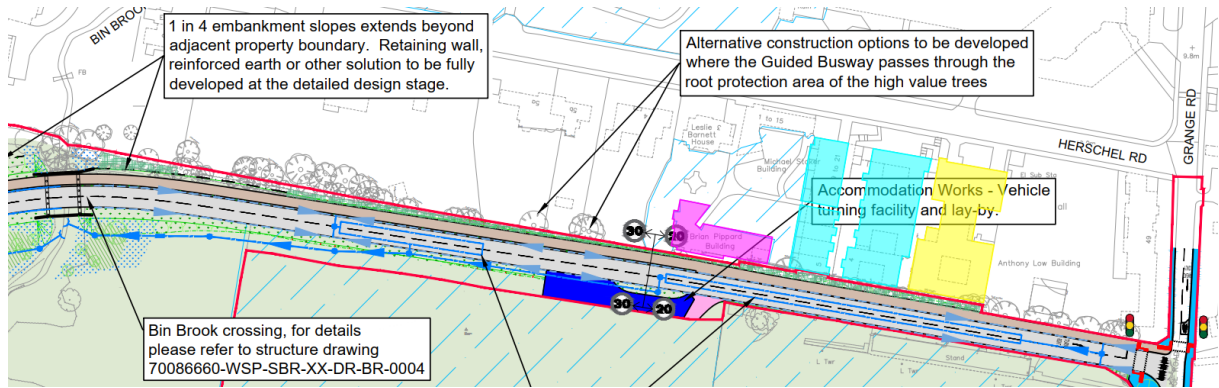


Figure 3.1: Excerpt of Proposed Site Plan⁹ (Sheet 17 of 17) Showing the Welfare Unit in Dark Blue, the Brian Pippard Accommodation building in Magenta, Clare Hall Accommodation Building in Cyan and the Main Clare Hall Building in Yellow

- 3.11 WSP has produced an Acoustic Technical Report to support the Environmental Statement in support of the proposal, document reference CD1-11.01. I have reviewed this document and prepared initial evidence in the form of a Statement of Case.
- 3.12 Clare Hall has submitted the Statement of Case, which included several points relating to noise and vibration and the Applicant has reviewed this and released an addendum to accompany the Environmental Statement¹⁰. I have reviewed this document.

Policy and Guidance

- 3.13 The planning policies and guidance documents considered to be most relevant to my evidence are within the following documents;
- National Planning Policy Framework (NPPF)
 - Planning Practice Guidance – Noise (PPG-N)
 - Noise Policy Statement for England (NPSE)
 - Cambridge City Council Local Plan (2018)
 - Policy 35: Protection of Human Health and Quality of Life From Noise and Vibration
 - Greater Cambridge Shared Planning – Sustainable Design and Construction Supplementary Planning Document (GCSP-SPD-2020)
 - Cambridge East Area Action Plan
 - Guidelines for Community Noise (1999) (WHO)
 - Night Noise Guidelines for Europe (2009) (WHO)
 - Design Manual for Roads and Bridges LA111 Noise & Vibration Rev 2 (2020) (DMRB)
 - Control of Pollution Act (1974)
 - Control of Noise at Work Regulations (2005)
 - Calculation of Road Traffic Noise (1988) (CRTN)
 - Converting the UK Traffic Noise Index $L_{A10,18h}$ to EU Noise Indices for Noise Mapping (2002) (Transport Research Laboratory Ltd)
- 3.14 The British Standards considered to be most relevant to my evidence are within the following documents;

⁹ Drawing Number: 70086660-WSP-HGN-XX-DR-HW-002017 Rev P10

¹⁰ Environmental Statement (Addendum 2 and Clarifications) – July 2025

- BS 8233 (2014) Guidance on Sound Insulation and Noise Reduction in Buildings
- BS 7445-2 (1991) Guide to the Acquisition of Data Pertinent to Land Use
- BS 7445-3 (1991) Description and Measurement of Environmental Noise
- BS EN ISO 16283-3 (2016) Acoustics – Field Measurement of Sound Insulation in Buildings and of Building Elements Part 3: Façade Sound Insulation
- ISO 362-1 (2022) Acoustics – Engineering Method for Measurement of Noise Emitted by Accelerating Road Vehicles Part 1 – M and N Categories
- BS 5228 Part 1 (Noise) (2009+A1:2014) Code of Practice for Noise and Vibration Control on Construction Sites
- BS 5228 Part 2 (Vibration) (2009+A1:2014) Code of Practice for Noise and Vibration Control on Construction Sites

National Planning Policy Framework (NPPF)

- 3.15 The National Planning Policy Framework (NPPF) replaces the previous version of the NPPF and the Planning Policy Statements (PPS) and Planning Policy Guidance (PPG), including the Department of the Environment's Planning Policy Guidance Note 24: 'Planning and Noise' (PPG 24), which was published in 1994. The main reference to noise within the latest version of the NPPF is at Paragraphs 187 (e) and 198:

'Paragraph 187 (e). "Planning policies and decisions should contribute to and enhance the natural and local environment by:

(e) 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; and."

'Paragraph 198. 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 life⁷²;
 (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.; and
 (c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.'

- 3.16 The reference number 72 cross references the National Policy Statement for England (2010) Explanatory Note.
- 3.17 Although some qualitative guidance on noise has been provided in the web-based Planning Practice Guidance document, there has been no alternative quantitative guidance proposed by the Government as a direct replacement for PPG24. This was due to the recognition that every site is different and that there is no single acceptable noise level, suitable for all applications.

Planning Practice Guidance – Noise (PPG-N) (2019)

- 3.18 On 6th March 2014, the Department for Communities and Local Government (DCLG) launched the National Planning Practice Guidance (NPPG) web-based resource to supersede previous planning guidance documents including PPG24 and provide clarification over all disciplinary sectors in the delivery of the design quality aspirations of the NPPF. This has been updated in July 2019.
- 3.19 The NPPG-Noise provides guidance on the assessment of noise, the needs to be considered when new developments may create additional noise and when developments would be sensitive to the prevailing acoustic environment.
- 3.20 The acoustic environment should be taken into account in the planning of new development and decision making should take the following into consideration:
- *‘whether or not significant adverse effect is occurring or likely to occur;*
 - *whether or not an adverse effect is occurring or likely to occur; and*
 - *whether or not a good standard of amenity can be achieved.’*
- 3.21 It then cross-references the Noise Policy Statement for England (2010) for further clarification on how to assess the overall effect of noise exposure.

Noise Policy Statement for England (NPSE)

- 3.22 The Noise Policy Statement for England (NPSE) was published in March 2010 and is the overarching statement of noise policy for England and applies to all forms of noise other than occupational noise, setting out the long-term vision of Government noise policy which is to:

‘Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.’

- 3.23 The vision is supported by the following aims which are reflected in paragraph 1.7 of the Noise Policy Statement for England:

‘Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *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 improvement of health and quality of life.’*

- 3.24 The Explanatory Note to the NPSE introduces three concepts to the assessment of the potential effects of noise:

- **‘NOEL** – No Observed Effect Level: *This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*
- **LOAEL** – Lowest Observed Adverse Effect Level: *This is the level above which adverse effects on health and quality of life can be detected.*
- **SOAEL** – Significant Observed Adverse Effect Level: *This is the level above which significant adverse effects on health and quality of life occur.’*

- 3.25 Unlike the now redundant PPG24, the three levels are not defined numerically in the NPSE, and for the SOAEL the NPSE makes it clear that the noise level is likely to vary depending upon the noise source, the receptor and the time of day/day of the week, etc. The need for more research to investigate what may represent a SOAEL for noise is acknowledged and the NPSE asserts that not stating specific SOAEL levels provides policy flexibility in the period until there is further evidence and guidance.

Cambridge City Council Local Plan (2018) – Policy 35: Protection of Human Health and Quality of Life From Noise and Vibration

- 3.26 As part of the Cambridge Local Plan (2018), a dedicated policy on noise and vibration has been compiled, Policy 35. This has been written primarily for the development of new noise sensitive properties but also talks about the introduction of new noise generating developments.

- 3.27 The fourth paragraph of the policy states;

“Noise generating development including industrial, trade or business / commercial uses with associated transport noise sources will be permitted where it can be demonstrated that any nearby noise sensitive uses (as existing or planned) will not be exposed to noise that will have an unacceptable adverse impact on health and quality of life both internally and externally.”

- 3.28 The policy refers back to the research by the WHO and how noise and vibration can have a significant adverse impact on a human’s health and quality of life, including the use of amenity spaces.

- 3.29 The policy requires any noise impact assessments that highlight an unacceptable noise impact to residents, through either noise exposure or noise generation, the noise impact must demonstrate in detail how the development will be designed, located and noise otherwise avoided or mitigated to reduce and minimise any unacceptable adverse impacts.

- 3.30 Paragraph 4.47 of the policy relates to the use of closing windows as part of the mitigation strategy. If a proposal requires the windows to be kept closed, then an alternative method of ventilation is necessary. It continues to say that;

“In the hierarchy of mitigation measures, noise should be mitigated at source and reliance on building envelope should be the last resort.”

Greater Cambridge Shared Planning – Sustainable Design and Construction Supplementary Planning Document (SPD) (GCSP-SPD-2020)

- 3.31 This supplementary planning document lays out the objectives and policies of Cambridge and South Cambridgeshire Local Plans, with a dedicated policy on noise and vibration. It defines noise as an unwanted sound, which is unpleasant and can cause disturbance and annoyance to residents.

- 3.32 Paragraph 3.6.45 of the SPD acknowledges that developments can generate significant amounts of noise and puts the onus on the LPA to ensure that “developments are appropriately located and designed so that they do not have an unacceptable impact on local communities and that noise sensitive developments are not subjected to unacceptably high levels of noise.”

- 3.33 The SPD refers back to the use of the NOEL, LOAEL and SOAEL as described in the NPSE and PPG-N in paragraph 3.6.51.

- 3.34 The SPD brings in the “Noise Exposure Effect Level Hierarchy” as shown in the below table.

Perception	Examples of effects / outcomes	Increasing effect level	Planning Action
No Effect			
Not noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Effect Level (NOAEL)			
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 (LOAEL)			
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 (SOAEL)			
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
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

Table 3.1: Noise Exposure Hierarchy as Defined in SPD

3.35 This table determines the four possible planning recommendations, which are;

A. Planning consent may be granted without any need for noise conditions – where a potential residential development site poses no or a negligible risk from a noise perspective, the GCPS

will typically not require any specific measures ("Grant Consent - No Objection on Noise Grounds");

B. Planning consent may be granted subject to the inclusion of suitable noise conditions in order to mitigate and reduce to a minimum the adverse effects of noise for example to address specific acoustic design aspects of a particular site or require a noise insulation scheme ("Grant Consent - No Objection - Minimise Noise");

C. Planning consent should be refused on noise grounds in order to avoid significant adverse effects of noise ("Refusal / Object - Avoid on Noise Grounds");

D. Planning consent should be refused on noise grounds in order to prevent unacceptable adverse effects of noise ("Refusal / Object - Prevent on Noise Grounds").

- 3.36 Paragraph 3.6.94 specifically looks at the requirements for a submission for a Noise Generating Development (NGD), which the third bullet point relates to "uses likely to generate a significant amount of traffic (defined as road traffic movements greater than 5% of Annual Average Daily Traffic)".
- 3.37 In my opinion, this should include the busway system as currently there is no regular traffic along Rifle Range Road and the introduction of the busway along Rifle Range Road would be an significant increase in traffic for these sensitive receptors.
- 3.38 Paragraph 3.6.126 of the SPD refers back to the Control of Pollution Act 1974 for controlling noise from construction sites. Importantly, it states that *"in certain situations, for instance where there is a proposal for a substantial development or infrastructure project, a Noise and Vibration Demolition and Construction Environmental Management Plan, detailing the management and control of noise and vibration, will be required as part of planning consent"*.

Cambridge East Area Action Plan (CEAAP)

- 3.39 Policy CE/26 of the CEAAP relates to noise The second bullet point of paragraph E1.14 requires noise to be kept to a minimum and in particular that there are no works that are audible at the site boundary outside permitted working hours.

Guidelines for Community Noise (1999) (WHO)

- 3.40 Noise is identified as an unwanted sound. It has long been acknowledged that noise pollution continues to grow and as such the impacts on the human population needed to be quantified.
- 3.41 Adverse health effects of noise to humans are far reaching, and can include, but is not limited to;
- Hearing impairment;
 - Loss of speech intelligibility;
 - Sleep disturbance;
 - Physiological functions;
 - Mental illness;
 - Performance;
 - Social and behavioural effects of noise; and
 - Vulnerable subgroups.

- 3.42 Based on the extensive research into these factors, the WHO Guidelines for Community Noise recommend the following guideline values for noise in specific environments, as can be seen in the table below.

Specific Environment	Critical Health Effects	L _{Aeq,T} (dB)	L _{AMAX,fast} (dB)
Dwelling, indoors	Speech intelligibility and moderate annoyance	35	–
Inside bedrooms	Sleep disturbance, night-time	30	45
Outdoor living area	Serious annoyance, daytime and evening	55	–
	Moderate annoyance, daytime and evening	50	–

Table 3.2: WHO Guideline Values for Community Noise

- 3.43 The document also states:

‘For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{AMAX} more than 10–15 times per night (Vallet & Varnet, 1991).’

- 3.44 These levels are reflected in the guidance provided in BS 8233 (2014).

Night Noise Guidelines for Europe (2009) (WHO)

- 3.45 The Night Noise Guidelines (NNG) aimed to present the conclusions of the working group, designated by the WHO, who were responsible for preparing the guidelines for exposure to noise during sleep and to understand the physical effects of noise on illness and sleep deprivation.

- 3.46 This was designed to be an extension to the above mentioned Guidelines for Community Noise.

Design Manual for Roads and Bridges LA111 Noise & Vibration Rev 2 (2020) (DMRB)

- 3.47 This standard provides guidance on the assessment of the impacts that road projects may have on levels of noise and vibration. Within this standard the requirements to be adhered to in the undertaking of noise and vibration assessments are set out. The standard provides guidance on the methodology to be used when assessing the noise and vibration impacts arising from all road projects, including new construction, improvements and maintenance.

- 3.48 This guidance also covers how noise and vibration relates to the UK Highways, including legislation, along with the overview of the assessment process. Mitigation and advice on the management of environmental effects is presented along with the monitoring and evaluation of these impacts.

- 3.49 DMRB states that for construction noise, the LOAEL is determined by the existing ambient sound level and the SOAEL is defined by the threshold level as calculated by the ABC method of BS 5228-1. A Major adverse impact would be experienced if the construction noise levels were 5dB or more above the SOAEL, a moderate adverse impact would be experienced if the construction noise was at the SOAEL but below SOAEL +5dB, a minor adverse impact would be experienced if the construction noise level was between the LOAEL and the SOAEL and a negligible impact would be below the LOAEL.

- 3.50 DMRB states that for construction vibration, the LOAEL is at 0.3 mm/s PPV and the SOAEL is at 1.0 mm/s PPV. A Major adverse impact would be experienced if the construction vibration levels were 10 mm/s

PPV or more, a moderate adverse impact would be experienced if the construction vibration was at the SOAEL but below 10 mm/s PPV, a minor adverse impact would be experienced if the construction vibration level was between the LOAEL and the SOAEL and a negligible impact would be below the LOAEL.

Control of Pollution Act (1974)

- 3.51 The Control of Pollution Act 1974 (COPA) plays a significant role in managing noise pollution, primarily focusing on regulating noise from construction sites and Noise Abatement Zones (NAZs).
- 3.52 It stresses the powers of the Local Authority and that the LPA are empowered to control noise from construction sites under Section 60 of COPA. This allows them to impose requirements on how works should be carried out to minimize nuisance, such as specifying machinery, working hours, and noise limits.
- 3.53 Section 61 of COPA enables contractors to proactively seek prior consent from the local authority before starting works that might generate significant noise. This is achieved by submitting a plan outlining methods for minimizing noise and vibration, including proposed working hours and machinery. Securing this consent can offer protection from potential legal action, such as a Section 60 Notice, if the contractor adheres to the agreed conditions.
- 3.54 The concept of "Best Practicable Means" (BPM) is a key defence against noise-related actions under the Act. It refers to implementing all reasonable measures to minimize noise, considering factors like local conditions, technical knowledge, and financial implications.

Control of Noise at Work Regulations (2005)

- 3.55 The Control of Noise at Work Regulations 2005 (CoNaW) aim to protect the general public, visitors and workers hearing from the dangers of excessive noise in the workplace. These regulations replaced the Noise at Work Regulations 1989 and introduced new requirements, including lower action levels for employer intervention and mandatory health surveillance (hearing checks) for workers regularly exposed to noise above specific levels.
- 3.56 The Lower Exposure Action Value (LEAV) is a daily, or weekly exposure of 80 dB(A), or a peak exposure of 137 dB(A). At these levels, hearing protection must be provided by the employer.
- 3.57 The Upper Exposure Action Value (UEAV) is a daily, or weekly exposure of 85 dB(A), or a peak exposure of 135 dB(A). At these levels, hearing protection must be provided by the employer and they must ensure that the hearing protection is worn. Hearing protection zones (HPZs) should be established and hearing surveillance offered.
- 3.58 The Exposure Limit Value (ELV) is a daily, or weekly exposure of 87 dB(A), or a peak exposure of 140 dB(A) and must not be exceeded.
- 3.59 Although this application is not directly relevant to a workplace, I have made reference to this regulation as the noise exposure I predict likely from the construction of the proposed busway would exceed the UEAV and would potentially place the residents of Clare Hall at serious risk to hearing impairment.

Calculation of Road Traffic Noise (1988) (CRTN)

- 3.60 The CRTN methodology, was published in 1988 by the UK Department of Transport, and is the most standard method for predicting noise levels from road traffic. It is widely used within Environmental Noise Assessments for infrastructure and development projects.

Converting the UK Traffic Noise Index $L_{A10,18h}$ to EU Noise Indices for Noise Mapping (2002) (Transport Research Laboratory Ltd)

- 3.61 In the UK the environmental assessment of road traffic noise is typically based on the procedures described in the 'Calculation of Road Traffic Noise' document. This index differs greatly to the noise indices proposed by the EU. This document provides a means of applying an 'end correction' to obtain the relevant EU indices from the calculated values of L_{A10} . Within this document is also a methodology for the conversion between different indices and time weighting, to enable to conversion of calculated and measured levels of road traffic noise into other indices for assessment.

BS 8233 (2014) Guidance on Sound Insulation and Noise Reduction in Buildings

- 3.62 British Standard 8233 (2014) 'Guidance on sound insulation and noise reduction for dwellings' provides guidance on limits for internal noise in common types of domestic and non-domestic buildings. The guidance is primarily intended for steady, continuous sources (such as noise from road traffic), but are also commonly used to provide a reasonable basis for assessing the suitability of noise levels within a dwelling. Careful interpretation and application of the guideline noise levels is often necessary.
- 3.63 The standard suggests the following internal ambient noise levels for dwellings;

Activity	Location	Day-Time Period	Night-Time Period
		07:00 – 23:00	23:00 – 07:00
Resting	Living Room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40 dB $L_{Aeq,16hour}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

NOTE 7 – 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

Table 3.3: BS 8233 (2014) Indoor Ambient Noise Levels

- 3.64 Note 4 of Section 7.7.2 of BS 8233 states:

"Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values."

- 3.65 Note 5 of BS 8233 states:

"If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level."

- 3.66 Section 7.7.3.2 recommends that noise levels in external amenity areas should ideally not exceed 50 dB $L_{Aeq,T}$ and that 55 dB $L_{Aeq,T}$ should be considered as an upper limit.

BS 7445-2 (1991) Guide to the Acquisition of Data Pertinent to Land Use

- 3.67 This standard was written to act as a guide to ensure that the acquisition of data for environmental noise is gathered uniformly between practicing acousticians and allowing a uniform assessment of the compatibility of land use from the existing and predicted noise levels.

BS 7445-3 (1991) Description and Measurement of Environmental Noise

- 3.68 This forms part of the broader BS 7445 series and focuses on the application of the noise limits and data, which is necessary to assess the compliance. It does not provide the limits, but does provide the guidance on how these limits should be set.

BS EN ISO 16283-3 (2016) Acoustics – Field Measurement of Sound Insulation in Buildings and of Building Elements Part 3: Façade Sound Insulation

- 3.69 This standard was written to act as a guide to ensure that the measurement and calculation of the façade sound insulation of a building is completed uniformly between practicing acousticians.

ISO 362-1 (2022) Acoustics – Engineering Method for Measurement of Noise Emitted by Accelerating Road Vehicles Part 1 – M and N Categories

- 3.70 This is also referred to as the “Pass-by noise test” as it standardises the method for measuring the noise emitted by accelerating road vehicles. This is specifically geared towards passenger and goods vehicles.

BS 5228 Part 1 (Noise) (2009+A1:2014) Code of Practice for Noise and Vibration Control on Construction Sites

- 3.71 The British Standard 5228 – Part 1 (2009) gives recommendations for basic methods of noise control relating to construction sites, including sites where demolition, remediation, ground treatment or related civil engineering works are being carried out, and open sites, where work activities/operations generate significant noise levels, including industry-specific guidance.
- 3.72 The legislative background to noise control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities. This part of BS 5228 provides guidance concerning methods of predicting noise and assessing its impact on those exposed to it.
- 3.73 The document contains a method of setting noise limits to surrounding areas, referred to as the ‘ABC Method’. In essence, the residual ambient noise level ($L_{Aeq,T}$) is determined and rounded to the nearest 5 dB, this is then compared against the category A threshold. A site operating above the defined threshold has the potential to generate a significant effect.
- 3.74 The threshold values and method to determine these is shown in Table 3.4 below:

Assessment category and threshold value period	Threshold value (dB)		
	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 potential 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 potential 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 - Applied to residential receptors only.			
^{A)} Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.			
^{B)} Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.			
^{C)} Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are greater than Category A values.			
^{D)} 19:00 - 23:00 weekdays, 13:00 - 23:00 Saturdays and 07:00 - 23:00 Sundays			

Table 3.4: The ABC Method

- 3.75 The LOAEL is generally defined as the existing ambient sound level and the SOAEL is the relevant threshold value for categories A, B and C. If the predicted noise exceeds the SOAEL threshold value, then it should be mitigated accordingly.

BS 5228 Part 2 (Vibration) (2009+A1:2014) Code of Practice for Noise and Vibration Control on Construction Sites

- 3.76 Part 2 of BS 5228 (2009) gives recommendations for basic methods of vibration control relating to construction and open sites where work activities/operations generate significant vibration levels, including industry-specific guidance.
- 3.77 The legislative background to vibration control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities. Guidance is provided concerning methods of measuring vibration and assessing its effect on the environment.
- 3.78 The typical threshold of perception of vibration in the PPV range is between 0.14 mm/s⁻¹ to 0.3 mm/s⁻¹. As vibrations increase above these values, they have differing impacts. The following table provides guidance on the effects of vibration levels:

Vibration Level ^{A) B) C)}	Effect
0.14 mm/s ⁻¹	Vibration might be just perceptible in the most sensitive of situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s ⁻¹	Vibration might be just perceptible in residential environments.
1.0 mm/s ⁻¹	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.

Vibration Level ^{A) B) C)}	Effect
10 mm/s ⁻¹	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.
<p>A) The magnitudes of the values presented apply to a measurement position that is representative of the point of entry to the recipient.</p> <p>B) A transfer function (which relates an external level to an internal level) needs to be applied if only external measurements are available</p> <p>C) Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to and degree of adverse comment.</p>	

Table 3.5: Table B.1 Guidance on the effects of vibration (From BS 5228-1 Part 2)

4.0 SITE LOCATION AND DESCRIPTION

- 4.1 Clare Hall is abutted by Rifle Range Road to the south, Herschel Road to the north and Grange Road to the East.
- 4.2 The junction of Rifle Range Road and Grange Road is directly adjacent to the southeast section of Clare Hall, a college for advanced study at the University of Cambridge.
- 4.3 The site location has been shown in Figure 4.1 below;

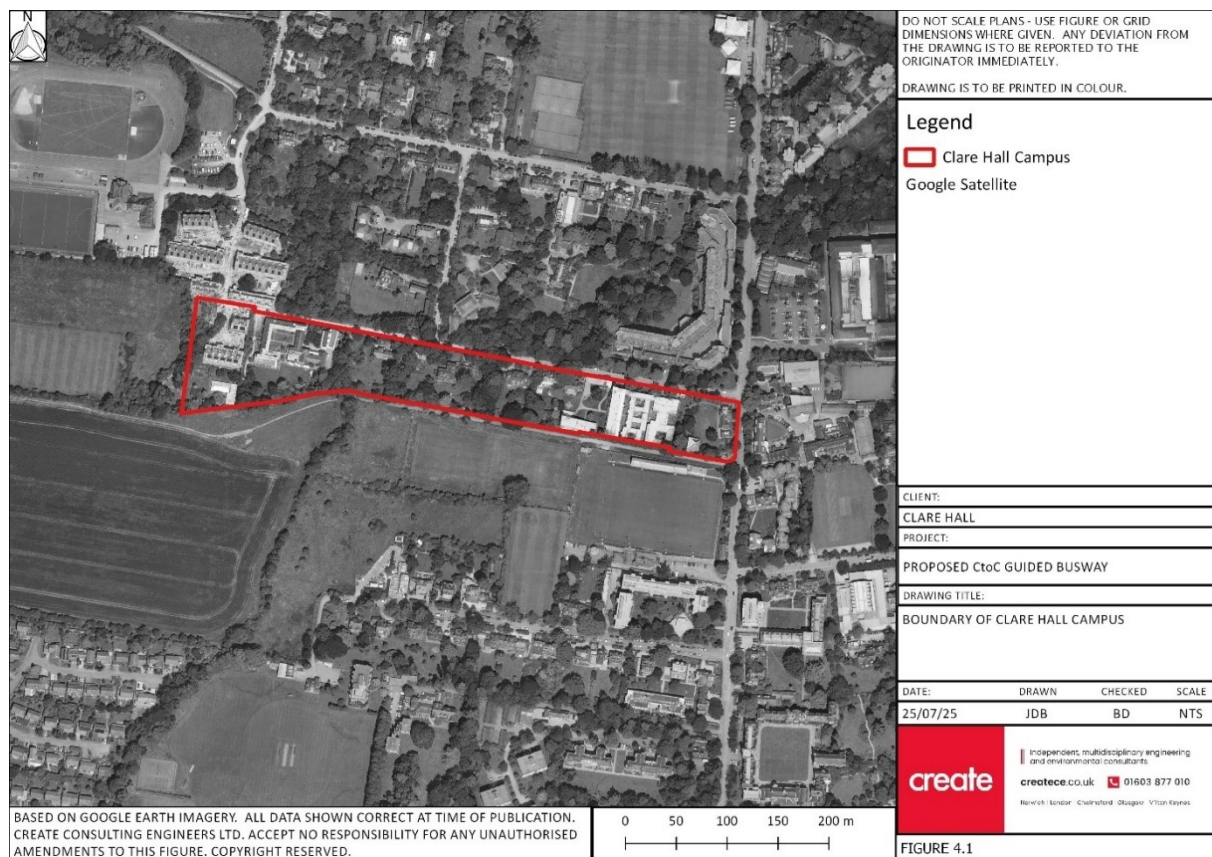


Figure 4.1: Boundary of the Clare Hall Campus, Cambridge

Clare Hall Further Details

- 4.4 The Clare Hall campus consists of multiple buildings, The college campus consists of the main Clare Hall building approximately 65 metres from Grange Road and the Ashby Library and McLean Studies, which are used as study areas, meeting rooms and offices. There are also numerous residential accommodation buildings throughout the campus. To the west of the site, there is a multi-gym and swimming pool. There is also the Anthony Low Building, closer to Grange Road which is currently a student facility, used for relaxation. This building is proposed to be demolished and replaced with a concert theatre, which could have impacts on the usage of the theatre, without additional acoustic mitigation and design considerations.
- 4.5 The site plan shown in Figure 4.2 shows the layout of these buildings discussed within this Proof and Figure 4.3 gives a breakdown of the various building uses throughout the campus.



Figure 4.2: Site Plan of Clare Hall Campus, Cambridge

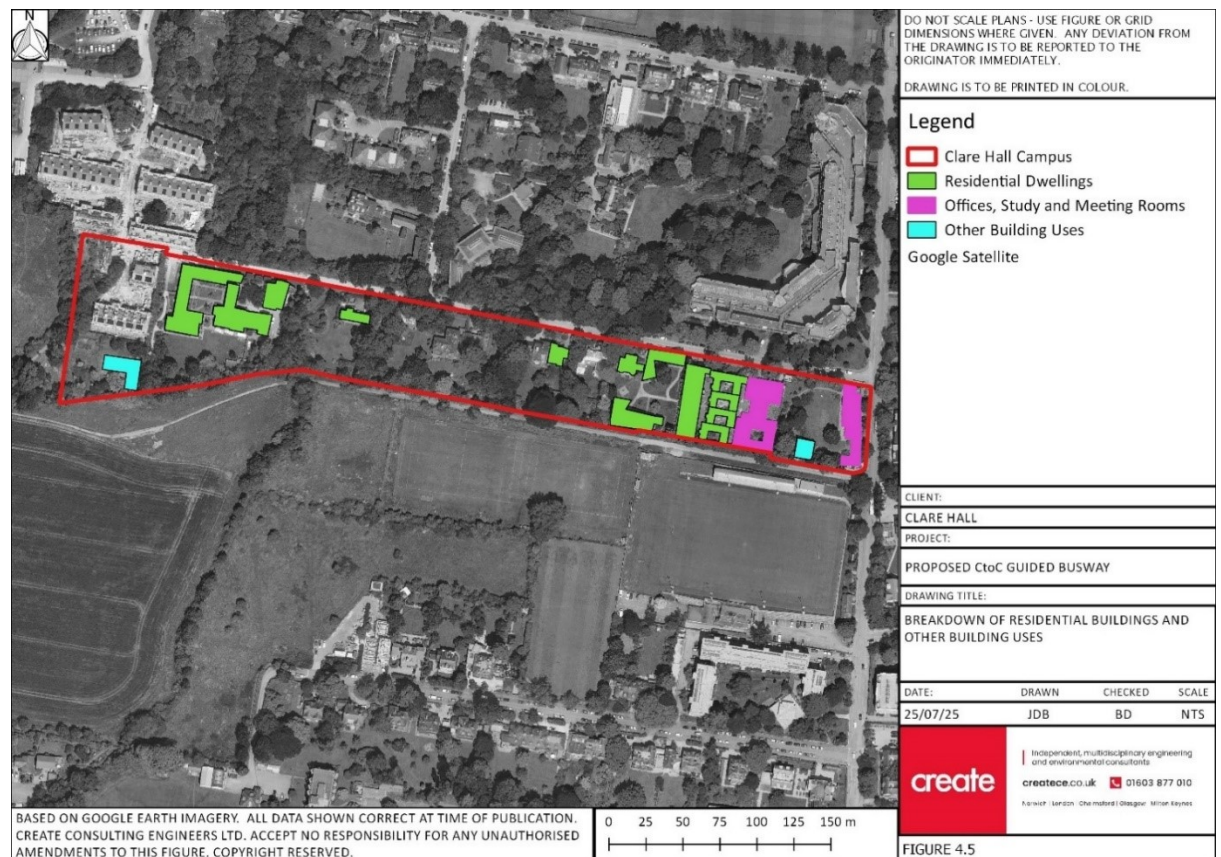


Figure 4.3: GIS Image Showing Location of Residential and Educational Buildings

- 4.6 Within the main Clare Hall building, Porters Lodge, there are several small study rooms, offices and meeting rooms, some of which are used for study purposes, all set out over a single storey. I understand that the usage of the small offices is likely to change to study rooms. There are six small rooms and one larger meeting room; all of which overlook Rifle Range Road to the south, with a direct line of sight to the proposed busway.
- 4.7 In line with the requirements of Table 6 of BS 8233¹¹ the internal sound level for these offices should be between **35 dB L_{Aeq,T}** and **40 dB L_{Aeq,T}**. The distance to Rifle Range Road was measured to be approximately 5.5 metres, from the façade of the main Clare Hall building, Clare Hall accommodation block and The Brian Pippard building, to the closest edge of the existing roadway.
- 4.8 As the area was not deemed to be heavily trafficked at the time of construction, there was no requirement for construction materials, including glazing and ventilation, to be acoustically rated. Should the building have been located in the centre of Cambridge for example, then the sound insulation requirements for the construction materials would have been far greater.
- 4.9 All of these rooms have timber single glazed windows, with a louvre to the side, providing cooling and ventilation. During the summer months, it is common practice for the windows to be partially open and the louvred vents fully open to assist with natural ventilation and cooling, whilst the louvred vents can be used all year round for added ventilation. At the time of design and construction, the ambient noise levels did not warrant any additional noise mitigation to be necessary.



Figure 4.4: Illustration of the Typical Glazing at Clare Hall Overlooking Rifle Range Road and Location of Window in Relation to the Wider Campus

- 4.10 There are additional buildings along Rifle Range Road, at approximately 100 metres west of Grange Road, close to the main Clare Hall building, which are all living accommodation for the visiting students. In line with table 4 of BS 8233, an internal ambient noise level of **35 dB L_{Aeq,T}** is desirable during the day and **30 dB L_{Aeq,T}** is desirable during the nighttime. Three of these accommodation units

¹¹ BS 8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

are set out so that the bedrooms overlook Rifle Range Road, at a distance of 5.5 metres to the closest edge of the existing Rifle Range Road.

- 4.11 These buildings also have timber single glazed windows, with a louvre to the side, providing ventilation. During the summer months, the windows are often partially open with the louvred vents fully open to assist with natural ventilation. In addition, these accommodation plots have an outside private amenity space. A portion of the visiting students have young families and during my site visits there was clear evidence of some of the spaces being used by these children.
- 4.12 Further down Rifle Range Road sits the Brian Pippard Building at an approximate distance of 150 metres west of Grange Road. The Brian Pippard Building is at an approximate distance of 5.5 metres from the existing Rifle Range Road. This building has eight apartments with bedrooms overlooking Rifle Range Road, laid out over the ground, first and second floors. These bedrooms benefit from double glazed windows, which appeared to be a standard 4/6/4 configuration¹². There is also a patio door leading onto either a ground floor private amenity space, or onto a balcony, which I observed being used for outdoor private amenity spaces by the residents. When I was provided access into these bedrooms, it was noted that the windows and patio doors were left partially open. It is understood that these remain partially open when ventilation is required.



Figure 4.5: Glazing and Balconies at the Brian Pippard Building Overlooking Rifle Range Road and Location of Window in Relation to the Wider Campus

¹² Double glazing consisting of 4mm pane of glass, with 6mm air void and further 4mm pane of glass. This is a fairly basic double glazing unit, offering up to 30 dB R_w sound reduction.

- 4.13 Gillian Beer House sits further into the Clare Hall campus at approximately 415 metres west of Grange Road and 30 metres northwest of the existing Bin Brook bridge, where the CtoC bus route has been proposed to cross the Brook. As part of the plans, this bridge is to be replaced with a new, much larger bridge structure. There are four bedrooms overlooking Rifle Range Road to the south and two other bedrooms to the east, again overlooking Rifle Range Road. Assuming the centre of the new bridge is the same as the centre of the extending bridge, this would reduce the distance to Gillian Beer House. The effect of this has been discussed in Chapter 6 of this proof.
- 4.14 Other buildings offering accommodation lie across the campus, including the Robert Honeycomb Building (45m from Rifle Range Road), West Court Gate (35m from Rifle Range Road), Leslie Barnett House (40m from Rifle Range Road) and the Michael Stoker Building (50m from Rifle Range Road). These are all slightly further away from the proposed CtoC route, as indexed by the parenthesised distances. It was noted that all buildings only rely on natural ventilation to prevent overheating during the warmer periods of weather.

Rifle Range Road Further Details

- 4.15 Rifle Range Road is currently a private single track road with a lockable vehicular gate set back from the junction of Grange Road. Rifle Range Road is currently used infrequently by the college maintenance team and deliveries for either the Cambridge University rugby facility or Clare Hall. These are understood to be the only vehicles which currently use Rifle Range Road. Other users of Rifle Range Road include dog walkers and general pedestrians or cyclists.
- 4.16 Rifle Range Road is approximately 3.75 metres wide and appears to be a lightweight tarmac finish. At the closest point, the edge of this existing single track road is 5.5 metres to both, Clare Hall and the Brian Pippard Building and can be seen in Figure 4.6.



Figure 4.6: View Along Rifle Range Road From Clare Hall Towards Grange Road

5.0 MITIGATION

WSP Reported Mitigation Methods

Construction Noise and Vibration Mitigation

- 5.1 In CD1-11.01 WSP has identified the mitigation measures to be embedded as part of the scheme, as set out in the CoCP, which is to be secured by condition, should the proposed busway be approved.
- 5.2 The use of Best Practicable Means (BPM), as defined in the Control of Pollution Act 1974, was the only form of mitigation proposed to deal with construction noise and vibration. This includes controlling the noise and vibration at source, the use of acoustic screening and the avoidance of potentially sensitive periods of the day or night.
- 5.3 WSP applied a reduction of 5 dB for the embedded mitigation and all construction noise predictions, carried out by WSP within CD1-11.01 have been included with the 5 dB reduction already being applied. This would be a sensible reduction for the embedded mitigation.

Operational Noise and Vibration Mitigation

- 5.4 In paragraph 4.3.1 of CD1-11.01 WSP have stated that there is “**no need for any specific measures to mitigate noise and vibration impacts from the operational scheme**”.

Create Response to Proposed Mitigation Methods

Construction Noise and Vibration Mitigation

- 5.5 The use of BPM is accepted to be a suitable method for reducing construction noise and vibration levels, however given the noise and vibration levels I predict will be more likely, especially at the closest receptors within Clare Hall, a specific construction noise and vibration assessment should be undertaken, prior to any decisions on the planning being made.
- 5.6 As is detailed later within my Proof, the sound levels that the residents will be exposed to at the façade of their properties, and their private amenity spaces, will exceed the noise limits that the Health and Safety Executive deem to be safe to a person’s hearing.
- 5.7 Although the use of BPM is best practice, in reality this focuses on noise much more than vibration. Later in my Proof I have shown the vibration levels which I believe will be present at the façade of the properties within Clare Hall overlooking Rifle Range Road. The use of BPM will not resolve, or significantly reduce my predicted unreasonable levels of vibration.
- 5.8 Alternative low noise and low vibration methods would need to be employed for the works along Rifle Range Road, along with extensive acoustic screening. Even with the acoustic screening being used, I predict that the noise levels will be **Noticeable and Disruptive** or **Noticeable and Very Disruptive** to the residents of Clare Hall and should be avoided or prevented from happening when considered against the Greater Cambridge Shared Planning SPD.

Operational Noise and Vibration Mitigation

- 5.9 The noise levels I have predicted for the operational phase will exceed the upper design threshold value of 55 dB(A) for the external amenity spaces, which are currently considerably lower than the design threshold of 50 dB(A). For this reason, I believe that mitigation is required for the operation of the guided busway, so I disagree with paragraph 4.3.1 of CD1-11.01.
- 5.10 The simplest method for mitigation is to treat the noise at source or increase the distance from the noise source to the receiver. In this instance, it could warrant selecting a different route, which is further away from noise sensitive receptors. The next step could be to improve the sound insulation of the buildings, through the provision of acoustic glazing and ventilation. This would however be restricted by the Grade II* listing of Clare Hall, and would not mitigate the noise for the private amenity spaces.
- 5.11 Noise mitigation from the busway could involve acoustic screening between the proposed emergency and maintenance access track and the Brian Pippard and Clare Hall buildings. It must be highlighted that the residents of the Brian Pippard Building are set out over three storeys so the barrier would need to be of sufficient height to provide shielding for the upper floors.
- 5.12 In order to break the direct line of sight, for people in a standing position on the second floor balcony, to the wheels of the buses, the barrier would need to be 6.19m tall, when situated at the edge of the access and maintenance track, 2.5m from the façade of the Brian Pippard Building, as shown in Figure 5.1. By breaking the direct line of site, a 5 dB reduction would be provided by the acoustic barrier.

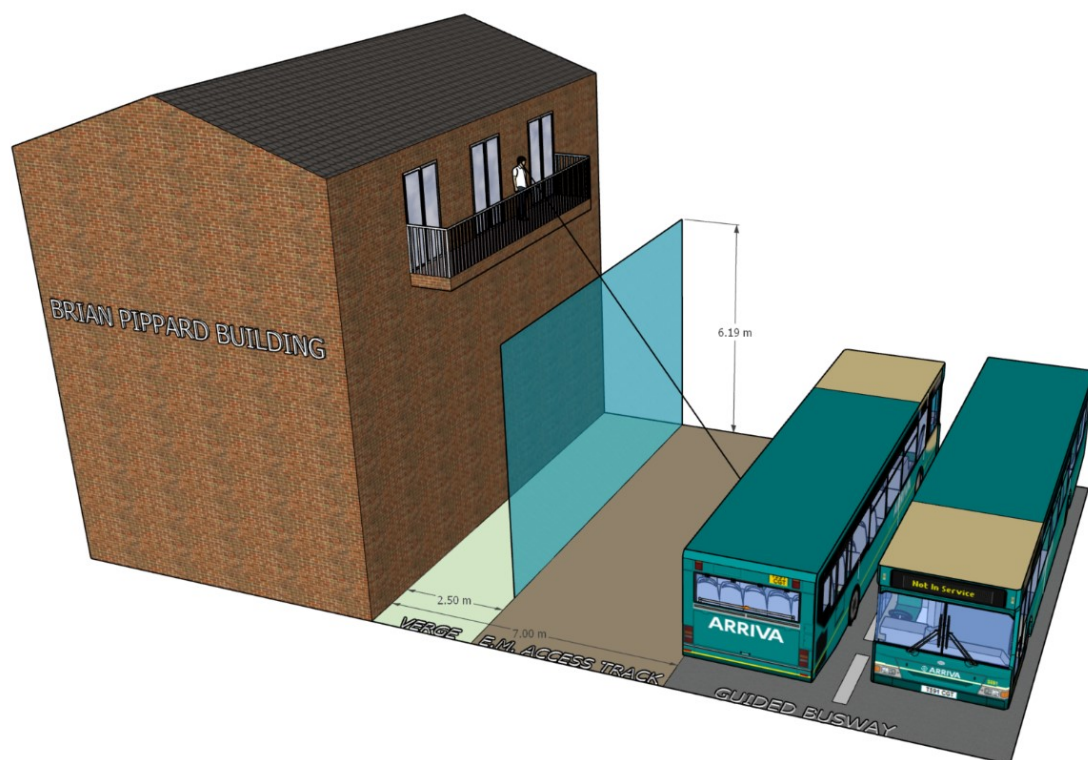


Figure 5.1: Example of 6.19m Tall Acoustic Barrier

- 5.13 An alternative to a tall acoustic barrier would be to cantilever the top section of the barrier over the top of the buses as shown in Figure 5.2.



Figure 5.2: Example of Cantilevered Acoustic Barrier
(Picture of the Expressway Section near the Tzu Chi Hospital at Taichung, Taiwan, photo courtesy of Raychung Acrylic)

- 5.14 It must be noted that Figures 5.1 and 5.2 are merely examples of suitable acoustic barriers. I am not suggesting that acoustic barriers such as these would appropriate mitigation at this location – this would need to be assessed as part of a wider exercise involving heritage consultants – however, the figures help to demonstrate the scale of mitigation screening that would be required in order to make the operation of the busway acceptable to the receptors of Clare Hall, which could be considered to be visually imposing and significant in scale.

6.0 BASELINE ACOUSTIC ENVIRONMENT

WSP Reported Baseline Sound Levels

- 6.1 The acoustic report CD1-11.01 included baseline long term noise monitoring at 5 locations, ML1 through to ML5 and three short-term attended measurements at RTN1 through to RTN3. The excerpt of Plate TRI-2-113 has been included below in Figure 6.1.

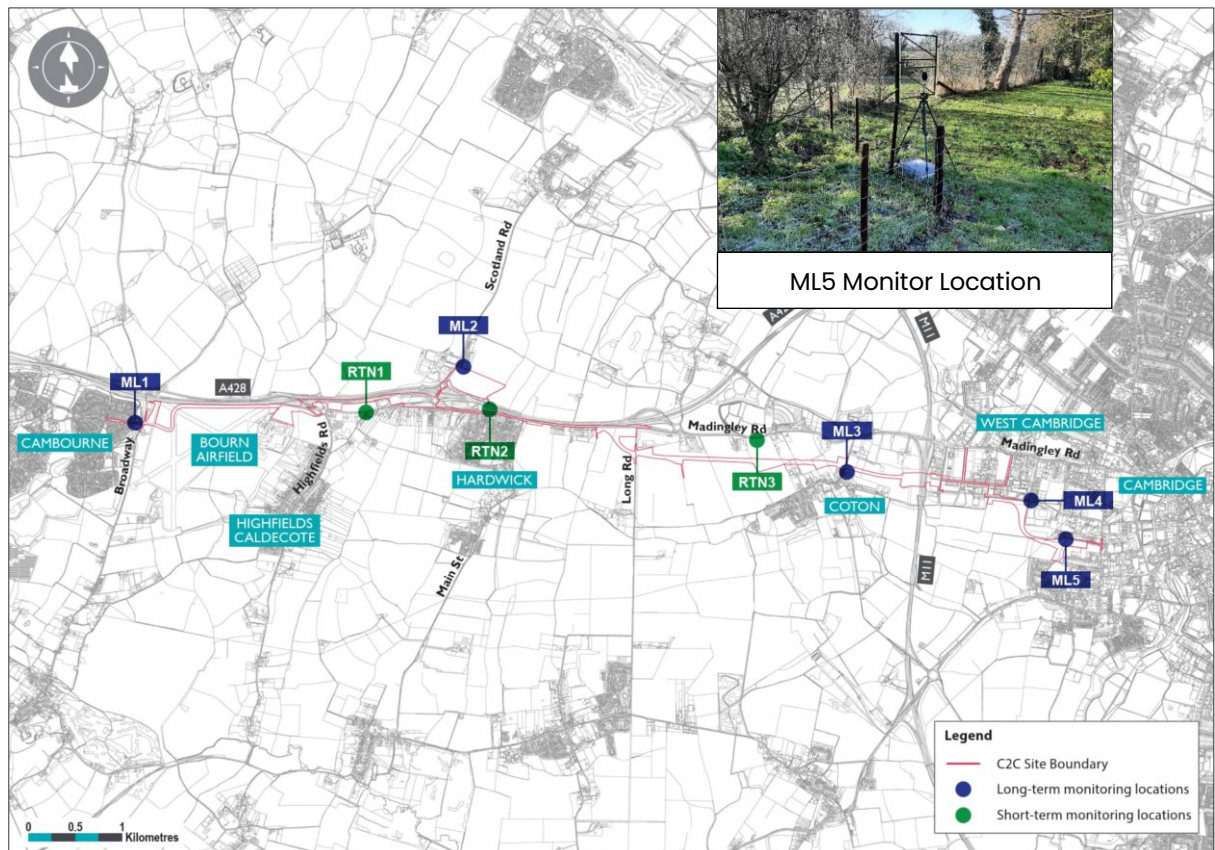


Figure 6.1: Excerpt of Plate T1-2-1 Noise Monitor Locations From WSP Report CD1-11.01

- 6.2 The only location relevant to Clare Hall was ML5, which was in the south garden of 9 Herschel Road. This property is part of the student accommodation provided by Clare Hall of the campus, but is not within the main area of Clare Hall. The monitoring location was close to the existing bridge over Bin Brook. For reference, ML5 was approximately 200m west of the Brian Pippard Building.
- 6.3 Ambient noise monitoring was carried out over a 4 day period from the 12th January to the 16th January 2022. I was not able to use these measurements due to a relatively large degree of uncertainty associated with the measurements, as will be discussed in the following paragraphs. For this reason, I was required to undertake additional noise monitoring at cost to my client.
- 6.4 Paragraph 8.2 of BS 7445-2¹⁴ states that the meteorological conditions (i.e. rainy, drizzly, dry, direction and speed of the wind etc) shall be recorded and paragraph 9 suggests that it should be reported. In paragraph 5.4.3.3 it states that wind speeds should be between 1 and 5 m/s (equates to

¹³ From Document CD1-11.01, Dated November 2024

¹⁴ BS 7445-2:1991 – Guide to the Acquisition of Data Pertinent to Land Use

approximately 2 mph and 11 mph), with no strong temperature inversions near the ground or heavy precipitation. There was no description for the meteorological conditions over the course of the baseline noise monitoring within the WSP acoustic report. Without this data being included, the level of uncertainty pertaining to the baseline acoustic data increases.

- 6.5 In BS 7445-3¹⁵, section 6 provides details of what should be included in a report, which includes the meteorological details under paragraph (e). With this detail being emitted from the WSP acoustic report, the reliance on the data is questionable.
- 6.6 A brief review of the historical data for Cambridge suggests that the average wind speeds were generally within the requirements for BS 7445, although the wind speeds exceeded 11 mph on the 16th January and there appears to have been periods of rain.

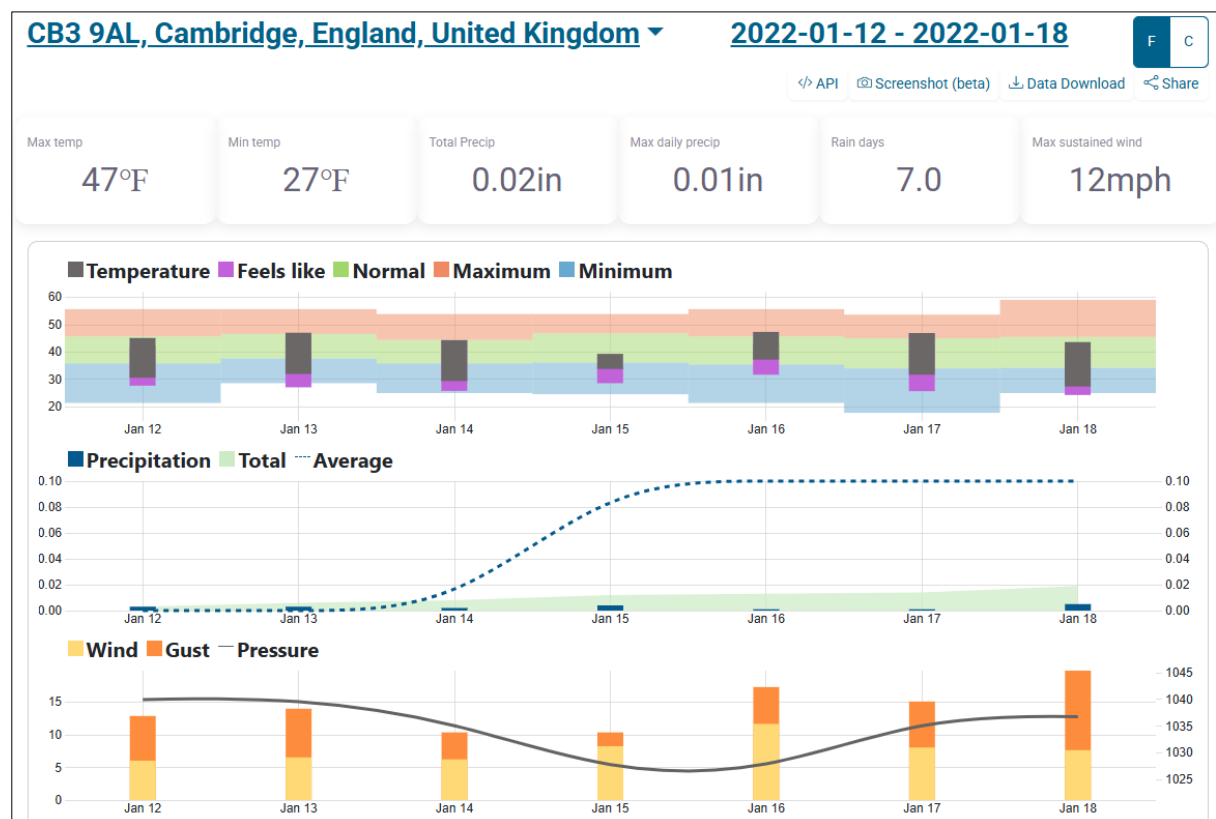


Figure 6.2: Historical Weather Data From The Internet¹⁶

- 6.7 Adverse weather conditions during the baseline measurements can affect the measured sound levels. Without the conditions during measurements being documented, there is an increased level of uncertainty to the noise levels referred to in the WSP report.
- 6.8 There was also no reference to the calibration of the equipment used to ascertain the baseline noise data. Paragraph (d) of section 6 of BS 744-3 requires details of the calibration for the instrumentation used. Although there is specific information on the instrumentation in Appendix C of CD1-11.01, there is no mention as to whether the equipment was within, or outside of, the laboratory calibration dates, if it had been field calibrated at both the beginning and end of the monitoring periods, or the degree of

¹⁵ BS 7445-3:1991 Description and measurement of environmental noise – Guide to application to noise limits, Published 28th June 1991

¹⁶ [Historical weather data for CB3 9AL, Cambridge, England, United Kingdom](https://www.visualcrossing.com/weather-history/CB3%209AL,%20Cambridge,%20England,%20United%20Kingdom/us/2022-01-12/2022-01-18/) - <https://www.visualcrossing.com/weather-history/CB3%209AL,%20Cambridge,%20England,%20United%20Kingdom/us/2022-01-12/2022-01-18/>

drift in the sensitivity of the microphone during the monitoring duration. All of this information is required to reduce the uncertainty of the baseline acoustic measurement data.

- 6.9 The baseline acoustic climate at ML5 was reported to range from 46 dB to 51 dB $L_{Aeq,16h}$, with an average of 49 dB $L_{Aeq,16h}$ for the daytime periods. For the nighttime, it was reported that the baseline ambient levels ranged from 43 dB to 48 dB $L_{Aeq,8h}$, with an average of 45 dB $L_{Aeq,8h}$.
- 6.10 Ambient sound levels equal to or lower than 50 dB $L_{Aeq,16h}$ for the daytime and 45 dB $L_{Aeq,8h}$ during the nighttime would suggest that windows can currently be used to provide ventilation for either daytime or nighttime. These are the limits from BS 8233¹⁷ for suitable internal noise levels for the daytime and nighttime periods respectively, with the assumption of a 15 dB reduction provided by a partially open window. The ambient sound levels measured by WSP would therefore result in suitable internal sound levels with the use of natural ventilation. This corroborates what was witnessed by multiple windows left partially open during previous site visits.
- 6.11 BS 8233 also recommends that it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$. From the measurements taken by WSP it has been shown that currently the ambient sound levels around Clare Hall fit within the requirements of BS 8233.
- 6.12 The 10th percentile, which is generally used to describe the road traffic noise level, was reported to range between 48 dB and 55 dB $L_{A10,18h}$, with an average of 52 dB $L_{A10,18h}$.
- 6.13 The background sound level, typically determined by the 90th percentile was not reported. I feel that this is an important sound level to report as this assists when determining the overall acoustic climate and indeed context for the area. The background sound level is the underlying sound level that is present most of the time, excluding any intermittent sounds. This is important when assessing the impact of specific noise sources onto an environment, such as the CtoC guided busway onto the residential apartments and study areas at Clare Hall.

Create Consulting Engineers Measured Sound Levels

- 6.14 Mr Sam Ward, MSc, BSc (Hons), MIOA of Create Consulting Engineers Ltd attended site and installed long-term unmanned noise monitoring at two locations within the confines of the main Clare Hall college campus. The monitoring locations were both on the first floor balconies of residential accommodation units, overlooking Rifle Range Road as shown in the following figure. The weather was monitored using a PCE-FWS-20N weather station with data logger. All monitoring took place between the 5th and 10th March 2025.
- 6.15 Temperatures during the baseline noise monitoring ranged from -0.2 °C up to 20.7 °C. The maximum average wind speed was measured at 2.0 m/s, with the highest gust measured as 4.8 m/s. There was no rain for the duration. The weather was therefore deemed to be suitable for environmental noise monitoring purposes. Full details have been appended to this report.
- 6.16 The sound level monitors were both Class 1 Norsonic 140 sound level meters fitted with environmental kits. The units were calibrated to 113.9 dB at 1 kHz, as per the manufacturer's handbook, before and after the measurements. The drift in microphone sensitivity was within reasonable tolerances. The equipment list, along with calibration information, has been included within Appendix B of this Proof of Evidence.

¹⁷ BS 8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

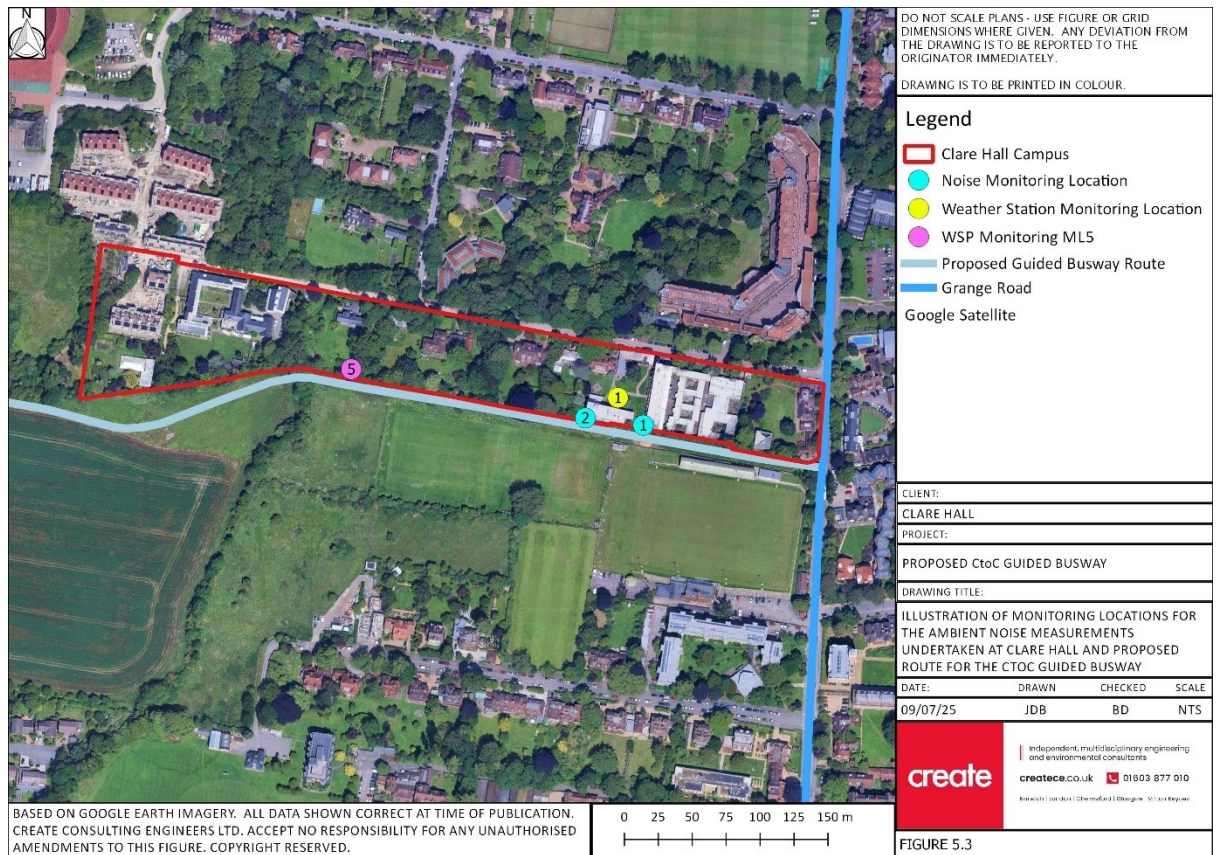


Figure 6.3: Location of Ambient Noise Monitors

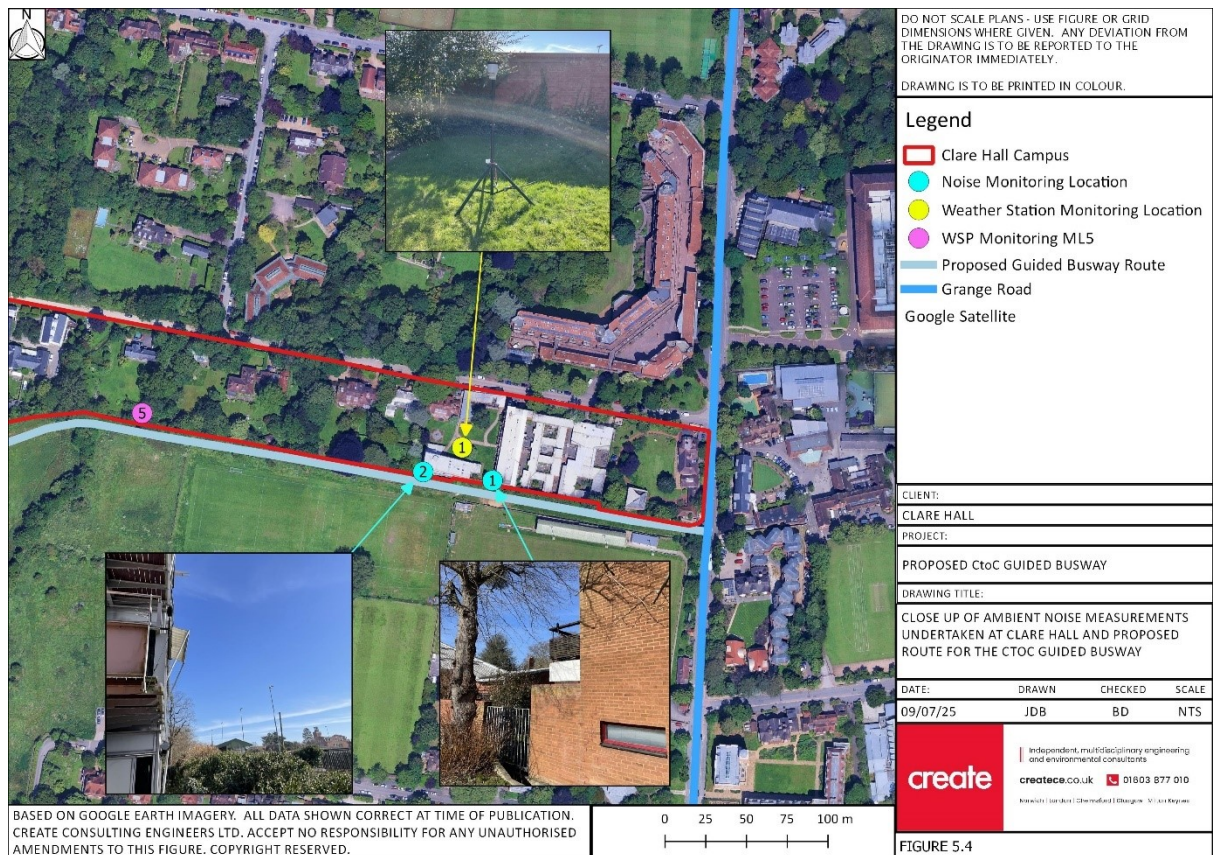


Figure 6.4: Close Up View of Monitoring Locations With Photographs

Location 1 – Clare Hall

- 6.17 Location 1 was the balcony of Flat 5 of Clare Hall, directly outside the bedroom overlooking Rifle Range Road. The microphone was more than 1.5m away from any reflecting surfaces. Corrections for façade reflections have not been added to the following figures.
- 6.18 The measured ambient sound levels at Flat 5 ranged from 46 dB to 51 dB $L_{Aeq,16h}$ with an average of 48 dB $L_{Aeq,16h}$ for the daytime periods. For the nighttime, the ambient sound level was measured to range from 44 dB to 49 dB $L_{Aeq,8h}$ with an average of 46 dB $L_{Aeq,8h}$.
- 6.19 The 10th percentile was measured to range between 45 dB and 53 dB $L_{A10,18h}$ with an average of 50 dB $L_{A10,18h}$.
- 6.20 The 90th percentile ranged from 36 dB to 52 dB $L_{A90,1hr}$ for the daytime background sound level. The representative day time background sound level was 38 dB $L_{A90,1hr}$. Nighttime background sound levels ranged from 35 dB to 51 dB $L_{A90,15mins}$ with a representative nighttime background sound level of 37 dB $L_{A90,15mins}$.

Location 2 – Brian Pippard Building

- 6.21 Location 2 was on the balcony of the bedroom of Flat 8 of the Brian Pippard Building, overlooking Rifle Range Road. The microphone was more than 1.5m away from any reflecting surfaces. Corrections for façade reflections have not been added to the following figures.
- 6.22 The measured ambient sound levels at Flat 8 ranged from 45 dB to 52 dB $L_{Aeq,16h}$ with an average of 49 dB $L_{Aeq,16h}$ for the daytime periods. For the nighttime, the ambient sound level was measured to range from 41 dB to 51 dB $L_{Aeq,8h}$ with an average of 48 dB $L_{Aeq,8h}$.
- 6.23 The 10th percentile was measured to range between 44 dB and 56 dB $L_{A10,18h}$ with an average of 52 dB $L_{A10,18h}$.
- 6.24 The 90th percentile ranged from 35 dB to 55 dB $L_{A90,1hr}$ for the daytime background sound level. The representative day time background sound level was 38 dB $L_{A90,1hr}$. Nighttime background sound levels ranged from 35 dB to 55 dB $L_{A90,15mins}$ with a representative nighttime background sound level of 37 dB $L_{A90,15mins}$.

Comparison of WSP and Create Baseline Noise Measurements

Measurement Location	Daytime Ambient Sound Level dB $L_{Aeq,16h}$	Daytime Road Traffic Noise Level dB $L_{A10,18h}$	Night-time Ambient Sound Level dB $L_{Aeq,8h}$
Flat 5 Clare Hall (by Create)	46 – 51 dB Average: 48 dB (–1 dB)	45 – 53 dB Average: 50 dB (–2 dB)	44 – 49 dB Average: 46 dB (+1 dB)
Flat 8 Brian Pippard (by Create)	45 – 52 dB Average: 49 dB (+0 dB)	44 – 56 dB Average: 52 dB (+0 dB)	41 – 51 dB Average: 47 dB (+2 dB)
ML5 (by WSP)	46 – 51 dB Average: 49 dB	48 – 55 dB Average: 52 dB	43 – 48 dB Average: 45 dB

Table 6.1: Overview of Uncorrected Create Baseline Sound Level Monitoring (Values Shown in Brackets is the Difference Between Create and WSP Measurements)

- 6.25 I have not applied corrections for façade reflections but if others consider that façade reflections should be considered, then the sound levels measured by Create should be reduced by a factor of 3 dB, resulting in the following sound levels;

Measurement Location	Daytime Ambient Sound Level dB L _{Aeq,16h}	Daytime Road Traffic Noise Level dB L _{A10,18h}	Night-time Ambient Sound Level dB L _{Aeq,8h}
Flat 5 Clare Hall (by Create)	43 – 48 dB Average: 45 dB (–4 dB)	42 – 50 dB Average: 47 dB (–5 dB)	41 – 46 dB Average: 43 dB (–2 dB)
Flat 8 Brian Pippard (by Create)	42 – 49 dB Average: 46 dB (–3 dB)	41 – 53 dB Average: 49 dB (–3 dB)	38 – 48 dB Average: 44 dB (–1 dB)
ML5 (by WSP)	46 – 51 dB Average: 49 dB	48 – 55 dB Average: 52 dB	43 – 48 dB Average: 45 dB

Table 6.2: Comparison of WSP and Corrected Create Baseline Sound Level Monitoring (Value Shown in Brackets is the Difference Between Create and WSP Measurements)

- 6.26 Background sound levels measured during this most recent baseline monitoring period were considered to be relatively low, given the semi urban environment where Clare Hall is located.
- 6.27 A full set of measurement data has been included in the Appendix C of this Proof of Evidence and has been provided to the applicant.

Additional Noise Measurements by Create Consulting Engineers Ltd

- 6.28 It was reported in CD1-11.01 that the buses proposed will be single decker buses, 12m long and containing a Euro VI compliant engine. The use of Euro VI buses has also been referred to within the recently submitted Addendum 2 in paragraph 4.1.2. In addition to the baseline noise measurements taken for this project, Mr Ward of Create therefore visited a section of the existing Cambridge Guided Busway to measure the sound levels of similar buses to those that have been proposed for this busway.
- 6.29 Mr Ward also measured the sound insulation properties of the glazing units overlooking Rifle Range Road at an office in the main Clare Hall building and the bedroom of Flat 4a in line with the Global Loudspeaker Method from BS EN ISO 16283-3¹⁸.

Guided Busway Noise Measurements

- 6.30 In total, 17 individual bus movements were measured by Mr Ward. Measurement distances ranged from 1m up to 6m. The proposed bus route will primarily be running at 30 mph, but drawing 70086660-WSP-HGN-XX-DR-HW-002017 Rev P10 shows the speed will reduce to 20 mph outside the Brian Pippard Building, as shown in the excerpt in Figure 5.5.

¹⁸ BS EN ISO 16283-3:2016 – Acoustics – Field Measurement of Sound Insulation in Buildings and of Building Elements Part 3: Façade Sound Insulation.

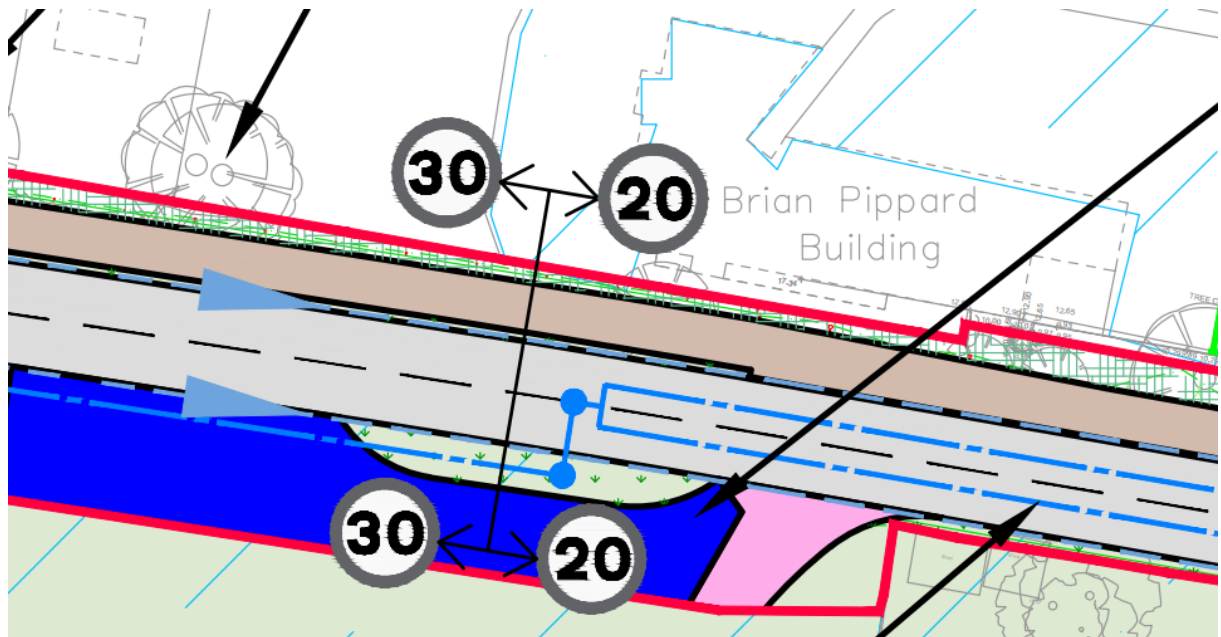


Figure 6.5: Excerpt of 70086660-WSP-HGN-XX-DR-HW-002017 Rev P10 Showing the Proposed Speed Limit Zone Change and Brian Pippard Building

- 6.31 The following locations were specifically chosen to be as representative as possible, as some stretches of the existing busway the speed limits were 20 mph (in the south to north direction in Figure 5.6) and others at 30 mph (in the east to west direction in Figure 5.6). There were also measurements taken of buses idling and pulling away. All measurements were calculated to produce the Sound Exposure Level (SEL) for that event.

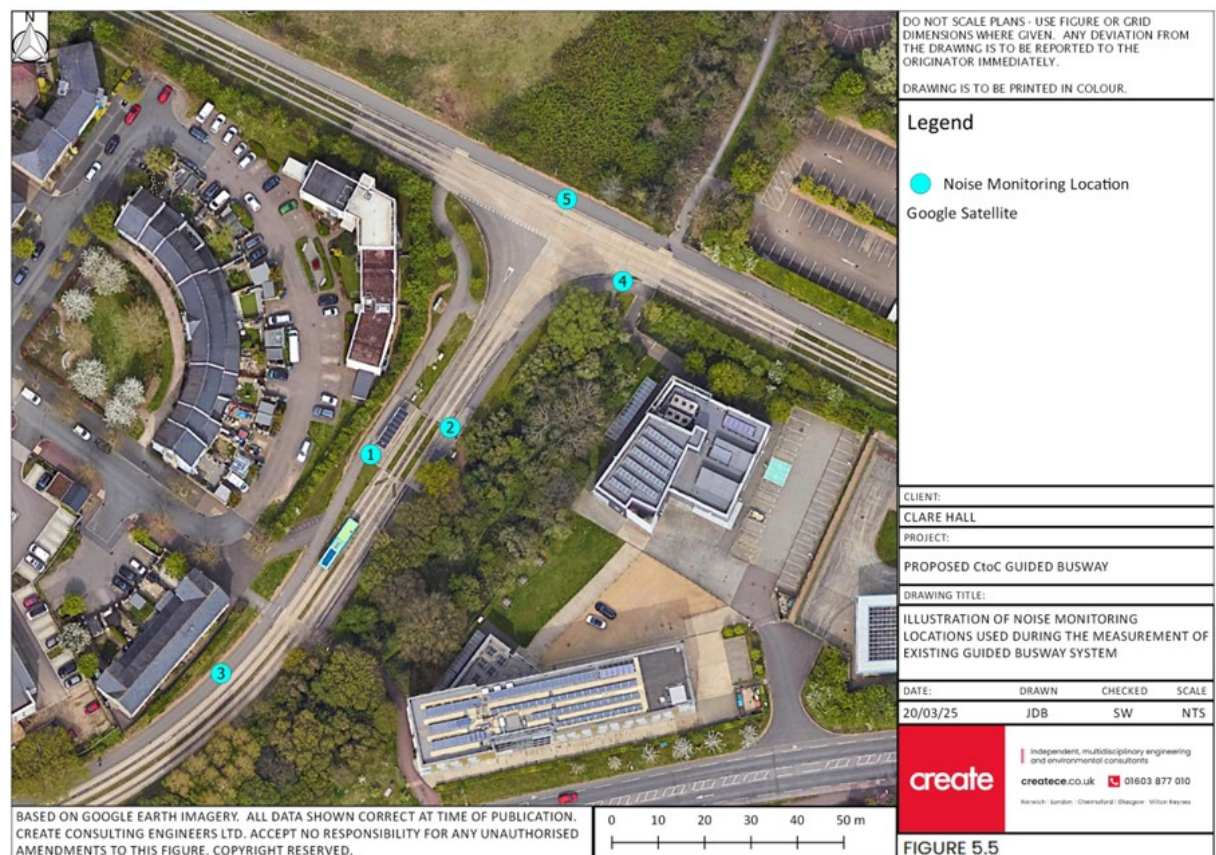


Figure 6.6: Location of Manned Bus Noise Measurements for Existing Guided Busway

- 6.32 The measurements at the existing guided busway were centred around the junction north of Kings Hedges Road, Cambridge, with the closest postcode being CB4 2HY.
- 6.33 The SEL levels measured at a distance of 1m ranged from 75 dB(A) up to 87 dB(A) for different bus movements. The SEL measurements at 6m ranged from 68 dB(A) up to 76 dB(A). The SEL measurements were then calculated back to a distance of 10m, and they ranged from 65 dB(A) up to 77 dB(A). The logarithmic average was **74 dB(A)**. This method allowed us to directly compare the 10m SEL to the 10m SEL used by WSP.
- 6.34 The SEL used by WSP for a bus pass-by was **72 dB(A)**. A difference of **2 dB(A)** is therefore apparent, but at the worst case, the difference used in the model could be as high as **5 dB(A)** based on the highest SEL calculated by Create. Details of the measurements have been included in Appendix D of this Proof of Evidence.
- 6.35 There was only a 1 dB difference noted between buses travelling at 20 mph and 30 mph. All buses measured were Euro VI, with the exception of one, which was a diesel hybrid model. This exhibited similar noise levels to the Euro VI buses.
- 6.36 It is commonly accepted that at low speeds, electric buses will be far quieter than diesel Euro VI buses. It must be noted however that at speeds lower than 20 kph (approximately 12 mph) electric vehicles **must** be fitted¹⁹ with acoustic sound systems to improve safety and prevent them from being too quiet. Also, ISO 362-1²⁰ acknowledges that at speeds above 50 kph (approximately 30 mph) the tyre noise becomes the dominant noise source.

¹⁹ <https://www.gov.uk/government/news/new-noise-systems-to-stop-silent-electric-cars-and-improve-safety>

²⁰ ISO 362-1 Acoustics – Engineering Method for Measurement of Noise Emitted by Accelerating Road Vehicles Part 1 – M and N Categories (2022)

Façade Sound Insulation Calculations

- 6.37 Façade sound insulation tests were conducted through the building façades of a study room directly overlooking Rifle Range Road at Clare Hall and Flat 4a of Clare Hall, both of which directly overlook Rifle Range Road.
- 6.38 The windows were both of a similar construction, with single glazed timber windows. There was a louvred vent to one side, with a hinged timber cover. The main difference between the windows was that the windows in the office were top hung and in Flat 4a, they were side hung. The vents were slightly different arrangements, most notably the vent could be opened completely in the office, but the curtain restricted the angle of opening for the bedroom vent.



Figure 6.7: Office Window Partially Open with Ventilation Louvre Shown Closed – View of Louvre From Outside. Note: There was no Obstruction to Open Ventilation Louvres in the Study Room



Figure 6.8: Apartment 4a Bedroom Window With Louvre Behind Curtain – View to Right of Restricted Opening for Louvre

- 6.39 Sound insulation testing was conducted in general accordance with the Global Loudspeaker Method of BS EN ISO 16283-3. From the measurements, the sound insulation performance of the façades was calculated to be as below;
- Windows partially open and vents closed – 16 dB $D_{Is,2m}$ (office) and 18 dB $D_{Is,2m}$ (flat);
 - Windows closed and vents open – 13 dB $D_{Is,2m}$ (office) and 20 dB $D_{Is,2m}$ (flat); and
 - Windows closed and vents closed – 25 dB $D_{Is,2m}$ (office) and 30 dB $D_{Is,2m}$ (flat).

- 6.40 An overview of the results from the measurements have been included in Appendix E of this Proof of Evidence, but for ease of reading the results have been tabulated below;

Room Reference	Conditions	dB D _{Is,2m}
Residential Flat 4a	Window Closed/Vents Closed	30
	Window Closed/Vent Open	20
	Window Partially Open/Vents Closed	18
Study Room	Window Closed/Vents Closed	25
	Window Closed/Vent Open	13
	Window Partially Open/Vents Closed	16

Table 6.3: Sound Insulation for the Separating Façades Overlooking Rifle Range Road

- 6.41 In each case, the worst performing façade test was noted to be for the study room. In my opinion, the reason that the study room façade performed less effectively than the façade of the residential unit, would most likely be due to the building structure which appeared to be of a more lightweight construction. Although not tested in the windows open / vents open configuration, the results of this would most likely be lower than those measured in both cases due to the larger open area.
- 6.42 In paragraph 5.4.23 of document CD1-11.01, reference is made to a reduction of 15 dB for a partially open window. This is a somewhat outdated assumption as it was originally detailed within the 1999 WHO Guidelines²¹. More extensive research has been carried out, when preparing for the WHO Night noise Guidelines for Europe²², which now refers to a reduction of between 10 dB and 15 dB, as confirmed by the measurement results in Table 6.3.
- 6.43 As the windows at Clare Hall provide the only form of fresh air ventilation to the occupants. If the vents and windows were to both be left open during warmer periods during the summer, it is therefore likely that the reduction of 15 dB for a partially open window, as assumed by WSP in CD1-11.01, would be lower.
- 6.44 The receptors at Clare Hall would therefore be subjected to higher sound levels internally than WSP have accounted for during both the construction and operation of the proposed busway.

²¹ Guidelines for Community Noise: 1999, World Health Organisation

²² Night Noise Guidelines for Europe: 2009, World Health Organisation

7.0 CONSTRUCTION NOISE

WSP Reported Construction Noise Levels

- 7.1 WSP stated in paragraph 5.1.8 of CD1-11.01 that for sensitive properties within a 40m buffer it has been predicted that a significant noise effect may occur as a result of the construction works. The buffer zone was shown by the purple section in Plate TR1-5-1.
- 7.2 WSP indicate in Plate TR1-5-3 of CD1-11.01 that there would only be two sensitive receptors in the final section, between Brook Bridge and Grange Road. The two locations WSP have highlighted are the Gillian Beer Building and 9 and 9a Herschel Road as shown below in Figure 7.1. This is incorrect, as there are many additional sensitive buildings within the Clare Hall campus which have not been considered, as has been discussed in the earlier sections of this report and shown below.



Figure 7.1: Image Showing The Sensitive Receptors Considered by WSP in TR1-5-3

- 7.3 An excerpt of TR1-5-3 from CD1-11.01 has been included in Figure 7.2, with the remainder of the accommodation units surrounded by the green section, which I have overlaid.

Plate TR1-5-3 - Sensitive receptors with significant construction noise effects – near Bin Brook Bridge

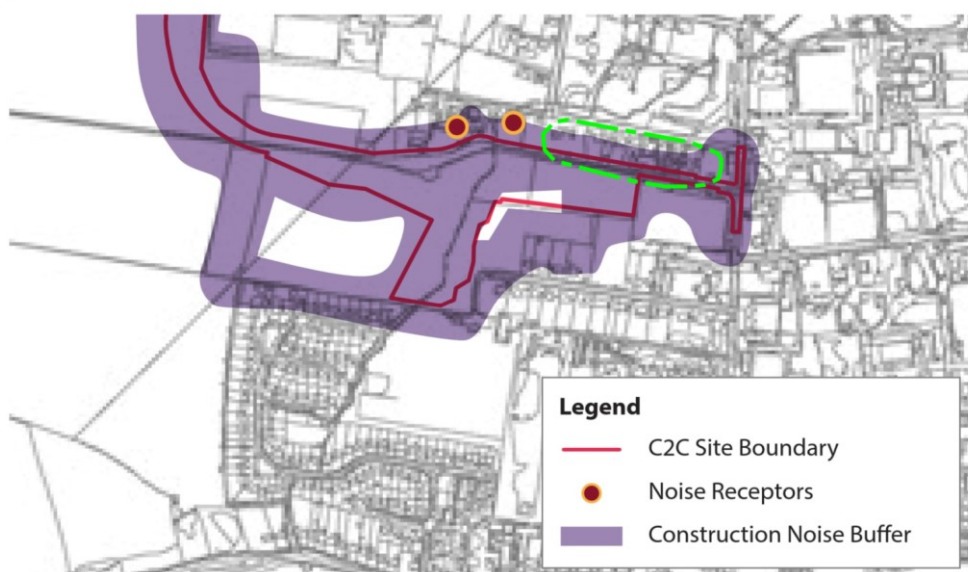


Figure 7.2: Excerpt of TR1-5-3 Showing the Omitted Sensitive Receptors by Green Dashed Line

- 7.4 The purple 40m Construction Noise Buffer that WSP have proposed, defines the area of predicted significant noise effect. It can be seen that this will include the vast majority of the accommodation units within the Clare Hall campus, including the Brian Pippard building, Clare Hall accommodation and the main Clare Hall Building.

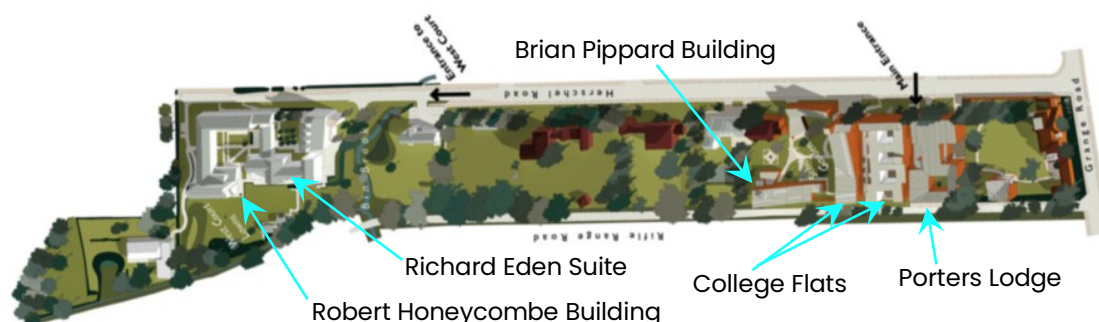


Figure 7.3: Image Showing The Omitted Sensitive Receptors Shown in Green Area of Figure 7.2

- 7.5 These additional buildings should have been considered as sensitive as they are either residential dwellings or places of research and study where concentration is of paramount importance.
- 7.6 With construction noise, there are two effect levels, the first being the Lowest Observed Adverse Effect Level (LOAEL) and the second being the Significant Observed Adverse Effect Level (SOAEL).
- 7.7 The LOAEL is equal to the existing ambient sound level. An exceedance above the LOAEL would only result in a minor impact, but would be clearly noticeable over the existing ambient sound levels.
- 7.8 The SOAEL is derived by the ABC²³ method in BS 5228 Part 1²⁴ which again is based on the existing ambient sound level. This defines the maximum threshold value for construction noise, which should not be exceeded, in order to minimise a potential significant adverse effect. The ambient sound level is rounded to the nearest 5dB. If it is below the Category A threshold value (65 dB $L_{Aeq,T}$), then the Category A threshold value is to be used. If the value is equal to the Category A threshold value, then Category B value (70 dB $L_{Aeq,T}$) applies. If the rounded value is greater than the Category A threshold value, then the Category C value (75 dB $L_{Aeq,T}$) applies.
- 7.9 Table TRI-3-1 of the WSP report has referred to the Lowest Observed Adverse Effect Level (LOAEL) being less than or equal to 52 dB $L_{Aeq,T}$. The sound levels measured by WSP at ML5 was 49 dB $L_{Aeq,16h}$, so in this instance, the LOAEL stated by WSP should have been 49 dB $L_{Aeq,T}$. In practice, however, the significance of the LOAEL being exceeded for construction noise, as long as it is below the SOAEL, is classed as being "Minor" and therefore would be considered as "Not Significant" in line with Table 3.58 of the DMRB LA111²⁵. An exceedance of the LOAEL would still be clearly noticeable though.
- 7.10 For the majority of the works, there will be 2 main phases of works to create the proposed guided busway along Rifle Range Road, these being;
- Site Clearance/Earthworks; and
 - Road/Structure Construction.

²³ Section E.3.2 Example Method 1 – The ABC Method from BS 5228-1

²⁴ BS 5228-1:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites – Part 1: Noise

²⁵ Design Manual for Roads and Bridges – LA111 Noise and Vibration Revision 2

- 7.11 The items of plant WSP proposed would be used for each of these works have been included below in Table 7.1;

Site Clearance Equipment Type	BS 5228-1 Calculation Method			Road/ Structure Construction Equipment Type	BS 5228-1 Calculation Method		
	dB at 10m	Number of Units	Percent on Time		dB at 10m	Number of Units	Percent on Time
Tracked Excavator	76	2	50%	Dump Truck	79	1	25%
Dozer	78	2	50%	Asphalt Paver	75	1	50%
Dump Truck	79	1	25%	Vibratory Roller	75	1	50%
Road Sweeper	76	1	25%	Excavator with hydraulic breaker	83	1	10%
				Road Planer	82	1	25%

Table 7.1: WSP Assumed Plant for Main Work Stages

- 7.12 It must be noted that there has been no allowance made for deliveries of materials to site, or the removal of spoils from the works.
- 7.13 WSP have referred to the application of Best Practicable Means (BPM), as defined in the Control of Pollution Act²⁶, as the only means of mitigation. Whilst not specifying any particular mitigation, WSP have referenced the use of noise control at source, acoustic screening, public communications and avoiding potentially sensitive periods. These have been detailed in the Code of Construction Practice which is intended to be secured by conditions in the deemed planning permission, if approved.
- 7.14 WSP have attributed a reduction of 5 dB for the implementation of BPM, which appears to be a reasonable assumption. I agree with the calculation method used by WSP.
- 7.15 WSP has concluded that any noise sensitive receptor within a distance of **40m** from the site clearance works, would experience sound levels above **65 dB L_{Aeq,T}**. This is the point at which WSP have correctly surmised that a **Significant Effect** is likely to occur, and the same for **36m** from the main construction works.
- 7.16 As discussed previously, Clare Hall is located at approximately **5.5m** from the edge of the existing roadway, which, from our calculations, would result in a sound level of **81 dB L_{Aeq,T}** (86 dB L_{Aeq,T} unmitigated) at the façade of the buildings for the Site Clearance works and **80 dB L_{Aeq,T}** (85 dB L_{Aeq,T} unmitigated) for the main construction of the busway. This is classed as a **Major Impact** in line with Table TRI-3-1 of the WSP report. These calculations have been based on the WSP assumed plant.
- 7.17 From a detailed review of CD1-11.01, and Appendix D, WSP did not provide any predicted sound levels from the construction of the new Bin Brook Bridge in their application documents. It is unclear if they have assumed that the same plant and equipment would be used for the construction of the replacement bridge over Bin Brook.
- 7.18 It is my opinion that the construction processes and duration of works will be substantially different from those intended for the construction of the road, and therefore this is a significant omission.

²⁶ Control of Pollution Act (1974) – available at <https://www.legislation.gov.uk/ukpga/1974/40>

Create Assessed Construction Noise Levels

- 7.19 For the section of CtoC guided busway adjacent to Clare Hall, I am of the opinion that there would be additional works required beyond the Site Clearance and Construction phases, as well as additional plant and equipment required to complete these tasks, as shown in Table 7.2 below.

Construction Noise Calculations Along Rifle Range Road Adjacent to Clare Hall

- 7.20 As can be seen in Figure 4.6, the length of Rifle Range Road up to Bin Brook has a tarmac finish. This would need to be broken, or cut into smaller sections, then removed from site. This would involve additional plant which has not been accounted for in WSP's calculations. The proposed plans also show the only Accommodation Works for the whole construction site, being in front of the Brian Pippard building. It is likely that there would also be generators used for power, potentially operating continuously, especially if there is a security cabin located in the Accommodation Works. Based on my personal experience, I have assumed that the following plant could be required for these sections;

Site Clearance Equipment Type	BS 5228-1 Calculation			Road/ Structure Construction Equipment Type	BS 5228-1 Calculation		
	dB at 10m	Method Number of Units	Percent on Time		dB at 10m	Method Number of Units	Percent on Time
Tracked Excavator	76	2	50%	Dump Truck (Tipping)	79	1	25%
Dump Truck (empty)	87	2	10%	Dump Truck (empty)	87	1	10%
Dump Truck (Tipping)	79	1	15%	Asphalt Paver	75	1	50%
Road Planer	82	1	5%	Vibratory Roller	80	1	50%
Excavator with hydraulic breaker	83	1	25%	Excavator with hydraulic breaker	83	1	10%
Hand Held Pneumatic Breaker	86	1	25%	Generator	66	1	100%
HGV to remove waste	80	1	10%	Delivery Lorry	80	1	10%
Dozer	79	1	50%				
Vibratory Roller	80	1	25%				
Generator	66	1	100%				

Table 7.2: Assumed Plant Based on Additional Rifle Range Road Works Required

- 7.21 Using the same calculation method as WSP, I predict that the sound levels at the façades of the residential Brian Pippard and Clare Hall blocks would be **86 dB LAeq,T** (91 dB LAeq,T unmitigated) and **82 dB LAeq,T** (87 dB LAeq,T unmitigated) for the Site Clearance and Road/Structure Construction respectively. These are **16 dB** and **12 dB** higher than the point where WSP have stated that a **Major Impact** would be anticipated.

- 7.22 These levels are more than 10 dB above the Noise Insulation Trigger Levels included in Table E.2 of BS 5228 Part 1.
- 7.23 It is acknowledged that in the DMRB it states that a major, or moderate magnitude of impact will occur for a duration exceeding 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any 6 consecutive months. Even if the works are for a shorter period of time, I consider it clear that, at these predicted levels, the noise levels would be so high as to be intolerable for the residents in the dwellings and for the staff and fellows concentrating within Clare Hall. It would make it impractical to use these rooms for their intended purposes whilst the proposed works are taking place.
- 7.24 The proposed site plan²⁷, previously submitted, shows the only Accommodation Works for the entire works compound will be situated outside the Brian Pippard building. Once installed in this location, this area will be used for vehicles as a turning point, but could also be used to store the plant and equipment. In my experience, these areas usually include a diesel generator for power to the welfare cabins and manned security cabin. Generators for the security cabins would most likely run continuously through the day and nighttime hours. I assume that once the Accommodation Works have been installed, this area would be used on a daily basis for the duration of the works, especially as this appears to be the only site accommodation along the entire route.
- 7.25 There has not been any information provided relating to the project programme, showing how long the works along Rifle Range Road will take to complete. The proposed works will involve the following elements.
- Installation of Accommodation Welfare unit;
 - Removal of the existing roadway;
 - Removal of compacted stone beneath current tarmac topping;
 - Excavation to required depth (approximately 0.5m);
 - Backfilling of hardcore layer;
 - Compaction of hardcore layer;
 - Installation of concrete kerb guideway;
 - Laying of tarmac topping;
 - Removal of existing Bin Brook Crossing; and
 - Installation of new Bin Brook Bridge.
- 7.26 As the Accommodation Works will likely be one of the first elements of the works to be completed, it is likely that the proposed works along Rifle Range Road will therefore extend for more than 10 days and will most likely will be generating significant noise levels for the majority of the project duration.
- 7.27 I am therefore of the opinion that the works involved in the construction of the proposed guided busway along Rifle Range Road would result in a **Significant Adverse Impact** in accordance with the DMRB and BS 5228 Part 1. I believe that the proposals would seriously impact the residents of the accommodation blocks and the workers within Clare Hall from the construction noise of the proposed guided busway along Rifle Range Road.
- 7.28 Additionally, with the poor acoustic performance of the glazing and ventilation units measured, I anticipate that the sound levels inside the dwellings could be as high as **69 dB L_{Aeq,T}**.

²⁷ Proposed Site Plan (Sheet 17 of 17) Drawing Number 70086660-WSP-HGN-XX-DR-HW-002017 Rev P10

- 7.29 These potential internal sound levels from the proposed construction works would likely **exceed** the requirements of BS 8233 for a bedroom during daytime use (stated in Table 4 of BS 8233 as 35 dB $L_{Aeq,16hour}$) by **34 dB**. They would likely also **exceed** the BS 8233 requirements for a meeting room (stated in Table 6 of BS 8233 as 35 – 45 dB $L_{Aeq,T}$) by **24 – 34 dB**. I believe that whilst the proposed works are carried out, adjacent to these buildings, the internal noise levels would be intolerable. The noise levels would be so high that the residents would not be able to use them for their intended purpose.
- 7.30 As stated previously, each of the individual accommodation units along Rifle Range Road also benefit from a private amenity space. Paragraph 7.7.3.2 of BS 8233 states that “it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$, which would be acceptable in noisier environments.” The existing sound levels in these amenity spaces currently comply with the requirements of BS 8233 for a desirable external noise level.
- 7.31 The construction works from the proposed works along Rifle Range Road would result in levels of approximately 82 dB $L_{Aeq,T}$, some **32 dB higher** than the “desirable” level and **27 dB higher** than the maximum “upper guideline” limit. As with the internal noise levels, the external amenity spaces would be intolerable and could not be useable by either individuals or families residing at these properties.
- 7.32 For context 80 dB(A) is also the Lower Exposure Action Value (LEAV) for the Control of Noise at Work Regulations 2005²⁸. Although not directly comparable to this situation, multiple avenues of research have shown that by being exposed to noise levels at 80 dB(A) or above can contribute to the advancement of a person’s hearing loss.

Construction Noise Calculations For Proposed Bin Brook Bridge Section

- 7.33 The section of the route around Bin Brook would need to have a substantial bridge constructed, to allow the **14.3m wide** carriageway, as shown by submission document, CD1-16.06, drawing number 70086660-WSP-SBR-XX-DR-BR-0004 Rev P04 to cross the waterway. The extract of this drawing has been included below in Figure 7.4.

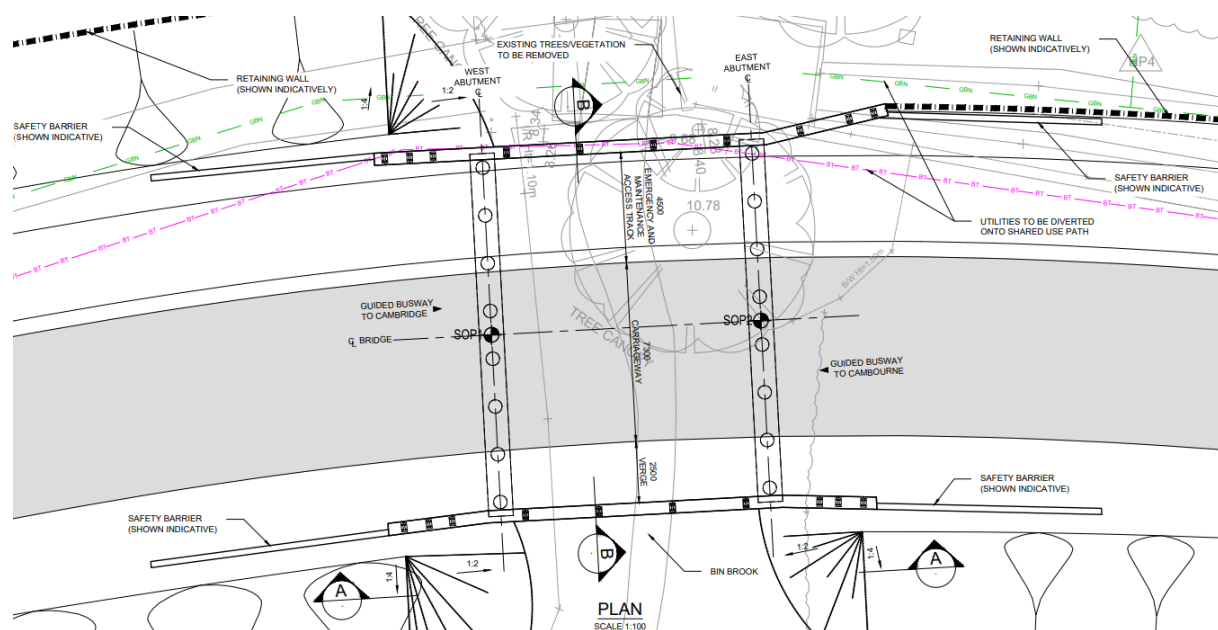


Figure 7.4: Excerpt of 70086660-WSP-SBR-XX-DR-BR-0004 Rev P04 Showing Width of the Proposed Bin Brook Bridge

²⁸ The Control of Noise at Work Regulations 2005 – <https://www.legislation.gov.uk/uksi/2005/1643/contents/made>

- 7.34 The distance from the centre of the existing bridge to the Gillian Beer Building is approximately 30m, so for the proposed 14.3m wide bridge, the distance from the periphery of the bridge construction site would be approximately 23m, assuming the same centre line for both the existing and proposed waterway crossings.
- 7.35 From my personal experience, I have assumed that the following plant and equipment could be required for the bridge construction;

Bridge Construction Equipment Type	BS 5228-1 Calculation Method		
	dB at 10m	Number of Units	Percent on Time
Crane	77	1	15%
Wheeled Backhoe	69	1	25%
Concrete Pump & Truck	67	1	10%
Cutting Tools	87	1	5%
Piling Rig	87	1	25%
Gas Cutter (Top of Piles)	68	1	10%
Generator	66	1	100%
Telehandler	71	1	25%
Asphalt Paver	75	1	25%

Table 7.3: Assumed Plant for Construction of New Bin Brook Bridge

- 7.36 Using the previous calculation methodology, I predict that the sound levels at the façade of the Gillian Beer Building residential block would be **70 dB L_{Aeq,T}** (75 dB L_{Aeq,T} unmitigated). This predicted noise level is above the point at which WSP state that a **Major Impact** would be anticipated. A selection of the construction noise calculations have been included in Appendix F of this Proof of Evidence.
- 7.37 As stated previously, for a major impact to be considered a significant effect, then the sound levels need to continue to for a period of 10 days (or nights) in a continuous 15 day period, or more than 40 days in a 6 month period.
- 7.38 From experience, I believe that the works involved in the construction of the new Bin Brook Bridge would last longer than 10 days, potentially up to 3 weeks. In paragraph 5.1.10 of CD1-11.01, WSP have also assumed that these works would extend past the criteria of the previous paragraph, so WSP have rightly stated in paragraph 5.1.11 of CD1-11.01 that receptors close to Bin Brook Bridge **are predicted to experience significant adverse effects as a result of the construction works** for the new waterway crossing.
- 7.39 I am therefore of the opinion that the construction of the new Bin Brook Bridge would result in a **Significant Adverse Impact** for the residents of the Gillian Beer Building, in accordance with the DMRB and BS 5228 Part 1.

General Comments on Construction Noise Predictions

- 7.40 As explained above I consider that in WSP's assessment of the noise impacts from the construction of the CtoC guided busway, the choice of proposed plant and machinery would appear to be optimistic. In my opinion the works would likely involve the use of more noise generating plant than WSP have assumed. The WSP calculations also did not allow for any deliveries to the proposed site or removal of spoils from the works.
- 7.41 Given the predicted sound levels from the works along Rifle Range Road, the predicted sound levels will far exceed the required sound levels recommended in the WHO guidance and BS 8233 for external amenity spaces, internal bedrooms and office spaces. I am therefore of the opinion that, even if the works are there for less than 10 days, the sound levels for the days that the works are there would be untenable and incompatible with the continued use of the affected rooms.
- 7.42 The vehicles turning, welfare cabins and associated plant with the Accommodation Works will presumably be in situ outside the Brian Pippard residential building for the duration of the works, which has not been quantified by WSP.
- 7.43 No noise calculations have been provided by WSP for the construction of the new Bin Brook Bridge crossing. I believe that this will constitute a **Significant Adverse Impact** to the residents at the Gillian Beer Building.
- 7.44 From our calculations, all sensitive properties within a **60m** radius of the proposed CtoC works along Rifle Range Road would be exposed to construction noise levels of 65 dB $L_{Aeq,T}$ or above, including the 5 dB reduction for mitigation that WSP have assumed. As can be seen in Figure 6.1, this would include nearly all of the buildings within the Clare Hall college campus. With the exception of the main Clare Hall building, which is used for study and research, **all** other buildings are used for residential accommodation.
- 7.45 Due to the degree of works involved in the construction of the guided busway along Rifle Range Road and the construction of the proposed Bin Brook replacement bridge, I predict a **Significant Adverse Impact** at the various building façades.

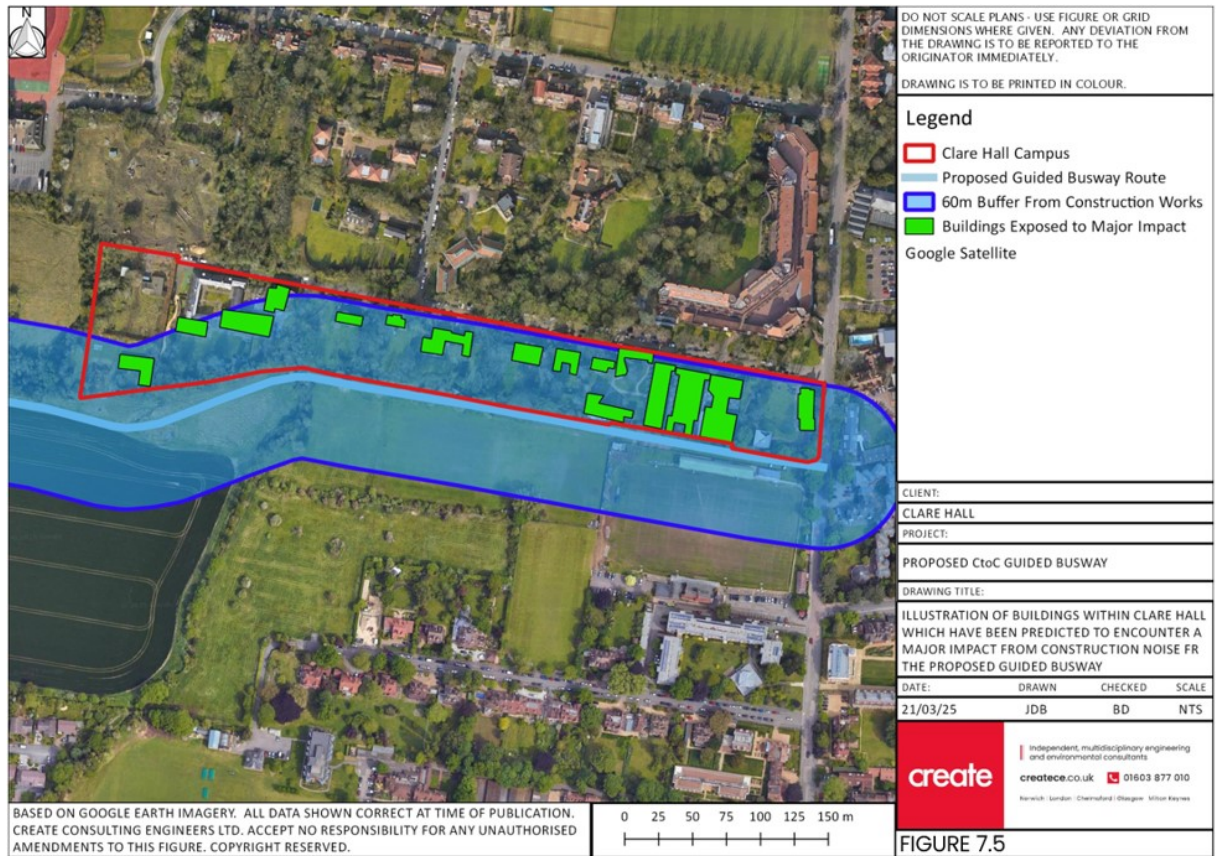


Figure 7.5: Illustration of the Impact From Construction of the Proposed Guided Busway

8.0 CONSTRUCTION VIBRATION

WSP Reported Construction Vibration Levels

- 8.1 WSP have stated in Table T1-3-2 that a **Significant Effect** would be expected at a level of **1.0 PPV mm/s** or higher.
- 8.2 The calculations that WSP used assumed a two drum vibratory roller, with a maximum amplitude of 0.4mm and a roller width of 1.4m. This equates to a level of 1 mm/s PPV at 15m, assuming a 33% chance of exceeding the criterion.
- 8.3 In paragraph 5.2.1 of the WSP Acoustic Report, the report states that all buildings within a 15m radius of the proposed construction works would encounter a **Significant Effect**.
- 8.4 The WSP acoustic report has identified that there would be several sensitive receptors which would be exposed to these high levels of vibration. These receptors include the Brian Pippard Building, Clare Hall, as well as other residential properties along Cranmer Road and Gough Way. In the total scheme, 95 receptors were highlighted as being at risk of these high levels of vibration.
- 8.5 The calculations within Table E.1 of BS 5228-2 suggest that the amplitude of vibratory rollers can be anywhere between 0.4 and 1.72 mm. The use of a roller with amplitude of 0.4mm is quite low and would be considered an optimistic assumption, at best. Modern vibratory rollers use higher amplitude levels, so that the rate of compaction is greater.
- 8.6 It is therefore my opinion that this choice of vibratory roller represents the absolute best case. In reality I believe that the contractors would use vibratory rollers with a greater amplitude, in order to compact the substrate and surface as efficiently and quickly as possible. A roller with a higher amplitude would compress the substrate in fewer passes than the roller selected by WSP.
- 8.7 In my opinion a significantly more powerful vibratory roller would be the preferred plant by the contractors.

Create Assessed Construction Vibration Levels

Construction Vibration Calculations For Proposed CtoC Guided Busway by Clare Hall Campus

- 8.8 Using the same calculation methodology as WSP, I predict that the same roller would result in vibration levels at the Brian Pippard Building and Clare Hall of **3.1 mm/s PPV** and **2.9 mm/s PPV** for the startup and steady state operations respectively. This is higher than WSP have calculated due to the closer distance between the buildings and the proposed works site.
- 8.9 I have repeated the same calculation for the best and worst case amplitudes for vibratory rollers, from 0.4mm up to 1.72mm. The distance where the Significant Effect could be felt, could be between 15m (for the 0.4mm amplitude roller) up to 87m (for the roller with amplitude of 1.72mm). Using a mid-range vibratory roller, with amplitude of 1.06mm, the distance where the Significant Effect could be witnessed, could be 50m.
- 8.10 The JCB CT260-100 roller, uses twin 1m drums, with an amplitude of 0.56mm. The use of this roller, as an example, would result in an increased distance of 19m and 24m from the vibratory roller in the steady state operation and start up/run down states respectively **before** the predicted level reduces

to below the significant effect level. The College Flats, Porters Lodge and the Brian Pippard buildings are well within that buffer zone, so will experience vibration levels far higher than 1.0 mm/s PPV.

- 8.11 I have predicted that the vibration levels at the Brian Pippard Building and Clare Hall would be **5.5 mm/s** and **5.1 mm/s** for the start-up and steady state operations respectively. These levels are calculated on a distance of **5.5m**, i.e. from the edge of the existing roadway to the façade of Clare Hall.
- 8.12 The drawing submitted for the proposed site plan, 70086660-WSP-HGN-XX-DR-HW-002017 Rev P10 shows that the edge of the Emergency & Maintenance Access Track is proposed to be situated **2.5m** from the closest façade of The Brian Pippard Building and Clare Hall. This reduced distance would increase the vibration levels at the Brian Pippard Building and Clare Hall to approximately **12.9 mm/s** and **12.3 mm/s** for the start-up and steady state operations respectively.
- 8.13 Table B.1 of BS 5228-2²⁹ states that at 10 mm/s “Vibration is likely to be **intolerable** for any more than a very brief exposure to this level in most building environments”. This would suggest that the proposed works would generate vibration levels that would be intolerable for the residents of the accommodation units in The Brian Pippard Building and Clare Hall and would make it extremely difficult to concentrate whilst working in Clare Hall.
- 8.14 I acknowledge that the vibration levels experienced externally would generally be higher than those experienced internally, due to an “unknown” transfer function from outside to inside. Without undertaking specialist vibration testing, it is not possible to simply predict the transfer function, which would then allow me to predict the likely internal vibration levels from the construction works. In my opinion however, the criteria is to the base of the building, so the internal levels are irrelevant.
- 8.15 Similar to the effects of noise, DMRB LA111 and BS 5228-2 suggest that for a major impact to be considered a significant effect, then the vibration levels need to continue to for a period of 10 days (or nights) in a continuous 15 day period, or more than 40 days in a 6 month period.
- 8.16 As discussed in the construction noise chapter of this Proof, there has not been any information provided relating to the project programme, showing how long the works along Rifle Range Road will take to complete. As the proposed works will likely involve many elements, it is possible that the works along Rifle Range Road could extend for more than 10 days. I am therefore of the opinion that a **Significant Adverse Impact** could be encountered for the works along Rifle Range Road and that it is not possible for WSP to state that a significant adverse impact would not occur.
- 8.17 Even if the works are for a shorter period than 10 days, I consider it clear that, at these predicted levels, the vibration levels would be so high as to be intolerable for the residents in the dwellings and for the staff and fellows concentrating in Clare Hall. It would make it impractical to use these rooms for their intended purposes whilst the proposed works are taking place.

²⁹ BS 5228-2:2009+A1:2014 Code of Practice for Noise & Vibration Control on Construction and Open Sites – Part 2: Vibration

Construction Vibration Calculations For Proposed Bin Brook Bridge

- 8.18 I understand that if piling is required for the proposed replacement Bin Brook Bridge, then continuous flight auger (CFA) piling would be used, as stated in paragraph 3.2.6 of CD1-11.01. We would look for this to be conditioned if approved.
- 8.19 This method of piling generates low levels of vibration.
- 8.20 If alternative piling is to be used, such as impact driven sheet piling, then the vibration levels would be far greater and would warrant a dedicated vibration assessment for the piling works.
- 8.21 Based on the use of CFA piling, it is therefore my opinion that vibration from the construction of the new Bin Brook Bridge should not be problematic for the residential properties at the Gillian Beer Building.

General Comments on Construction Vibration Predictions

- 8.22 The vibratory roller that WSP has selected for their calculations is the lowest in the range provided in BS 5228 Part 2. During construction of the CtoC guided busway, from my experience, contractors would typically opt for a vibratory roller with a greater degree of amplitude in order to reduce the time for the works. The use of a roller with a higher amplitude would result in higher vibration levels within the buildings.
- 8.23 With the vibratory roller proposed by WSP, WSP has predicted that all properties within a 15m radius of the works would experience relatively high levels of vibration. The plans show that the closest point of works would only be 2.5m from the external façade of Clare Hall and the Brian Pippard building. As the propagation of vibration is a logarithmic function, i.e. not a linear decline, the levels experienced at Clare Hall and The Brian Pippard building would be far higher than WSP have suggested.
- 8.24 WSP have not predicted the vibration levels that would be present at these buildings and have only provided a distance (15m) where the vibration levels would be approximately 1 mm/s PPV.
- 8.25 I am therefore of the opinion that vibration would be a **significant adverse impact** for the residential properties at the Brian Pippard Building, residents at Clare Hall and the fellows and staff at Clare Hall.

9.0 OPERATIONAL NOISE

WSP Reported Operational Noise Levels

- 9.1 WSP has used a sound exposure level (SEL) of **72 dB(A)** at a distance of 10m and 10 buses passing, each way, every hour. In paragraph 5.4.29 of CD1-11.01, WSP detail the proposed buses to be used as a Euro VI compliant engine, *“with an aspiration for electric vehicles to be introduced”*. This has also been discussed in paragraphs 4.1.3 through to 4.1.5 of the Environmental Statement (Addendum 2 and Clarifications) document, but with nothing definitive being proposed to be secured. As the term “aspiration” relates to a desire, it would be inappropriate to assume the future use of electric buses on this proposed busway when assessing likely levels of impact. Therefore, the assumption of Euro VI compliant engine would tend towards a representative assessment of the proposals.
- 9.2 As discussed previously, Create have measured various Euro VI buses on an existing stretch of the existing Cambridge Busway system, at 20 mph, 30 mph and stopping and starting. I calculated the average SEL to be **74 dB(A)** at 10m, **2 dB** higher than the WSP value, but with a maximum SEL of **77 dB(A)** being calculated.

Day Time Noise Levels

- 9.3 The WSP CD1-11.01 report broke the various lengths of the bus route into set areas to establish the approximate operational noise levels for each area. The section most applicable to Clare Hall is the West Cambridge fringe (Newnham), as detailed in paragraphs 5.4.71 through to 5.4.77 of CD1-11.01. The WSP report predicted that the resultant sound pressure level would have been approximately **50 dB LAeq,1h**. This level of 50 dB LAeq,1h has been calculated to a distance of **8m**.
- 9.4 WSP calculated that the internal noise levels would be 35 dB. This is equal to the internal noise criteria that WSP has provided in Table TRI-3-6 of CD1-11.01 for the daytime periods.
- 9.5 WSP have only briefly considered the impact of the operational noise levels of the CtoC guided busway on the amenity spaces for the dwellings within the Clare Hall campus, but at a distance of 8m and using a lower SEL of 72 dB(A) rather than the average SEL of 74 dB(A), or indeed the noisier buses with an SEL of 77 dB(A).
- 9.6 As the amenity spaces currently have been shown by WSP and Create to comfortably comply with the requirements of both WHO and BS 8233, I am of the opinion that this is an important factor, which provides important context to this site. I believe that any adverse impact must be considered as the operation of the busway would have a long term impact on these residents.
- 9.7 WSP state in paragraph 4.3.1 of CD1-11.01 that “The assessment has identified no need for any specific measures to mitigate noise and vibration impacts from the operational scheme”. In my opinion, this is incorrect, as will be discussed in this section of my Proof.

Nighttime Noise Levels

- 9.8 The WSP report predicted that the resultant sound pressure level would have been approximately **50 dB LAeq,1h**. This level of 50 dB LAeq,1h has been calculated to a distance of **8m** to any building.

- 9.9 WSP calculated that the internal noise levels would be 35 dB. This is **higher** than both the internal noise criteria that WSP has provided in Table TR1-3-6 of CD1-11.01 and the LOAEL as defined in TR1-3-4 of CD1-11.01 for the night-time periods.

Create Assessed Operational Noise Levels

- 9.10 As can be seen in Figure 9.1, the distance from the edge of the guided busway has been measured to be approximately 7m from the various façades of Clare Hall and the Brian Pippard Building.

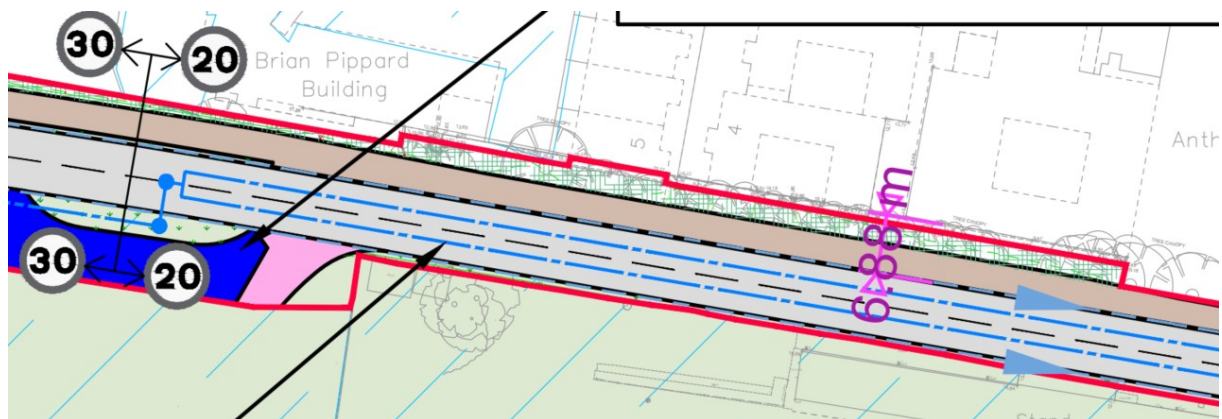


Figure 9.1: Excerpt of Drawing 70086660-WSP-HGN-XX-DR-HW-002017 (Sheet 17 of 17) with the Scaled Dimension of 6.88m from Edge of Guided Busway to Clare Hall

- 9.11 Using the SEL of 74 dB(A) from paragraph 5.30, the noise model created by Create Consulting has predicted that the resultant sound level from the guided busway at the façades of the Brian Pippard Building and Clare Hall would be approximately **56 dB $L_{Aeq,1h}$** at a distance of 7m.
- 9.12 This resultant sound level is **7 dB** and **8 dB higher** than the existing average ambient sound levels measured at the Brian Pippard Building and Flat 5 of Clare Hall respectively. It is also **7 dB higher** than the average ambient sound level measured at ML5 by WSP. It is important to stress that this predicted noise level is using the average SEL from Create's measurements, so the predicted level is higher than that of WSPs modelling.
- 9.13 This is **1 dB higher** than the daytime **LOAEL** provided by WSP in TR1-3-4 of CD1-11.01 and Table 3.49.1 of the DMRB.
- 9.14 Assuming a sound reduction of 18 dB for the tested partially open window with closed vents in the bedroom, then the internal ambient noise level would **exceed** the recommended limits of the WHO and BS 8233 for daytime noise levels within a bedroom by **3 dB**.
- 9.15 Assuming the sound reduction of 13 dB for the open vents in the office, then the internal ambient noise level would **exceed** the recommended internal noise level for offices by **3 dB**.
- 9.16 If I were to apply the highest SEL of 77 dB(A), then the resultant sound level would be **59 dB $L_{Aeq,1h}$** . This is **10 dB higher** than the WSP measurement at ML5 and **4 dB higher** than the daytime **LOAEL**. It would also mean that the noise levels in the bedroom and offices would **exceed** the noise criteria by **6 dB** during the daytime.
- 9.17 It is important to note that in paragraph 3.50 of the DMRB, it states;

*“LOAELs and SOAELs shall be modified where it is proportionate and merited by local circumstances which can include, **but are not limited to**³⁰:*

- 1) Noise sensitive receptors that have reduced sensitivity to noise or vibration e.g., sensitivity to noise is reduced if receptors have good insulation;*
- 2) Noise sensitive receptors that have an increased sensitivity to noise or vibration e.g., if a building is regularly used by people with hearing impairments, it is likely to be more sensitive to the users, as noise affects speech intelligibility at lower levels than would for those with non-impaired hearing.”*

- 9.18 Point 1 of this text from DMRB refers to increasing the LOAEL due to buildings with a high degree of noise insulation. It has already been shown that the existing construction of Clare Hall has a low level of sound insulation, so in my opinion the reverse should apply, i.e., reducing the levels of the LOAEL and SOAELs. To reiterate the existing level of sound insulation is appropriate for the existing acoustic climate.
- 9.19 Point 2 of the text refers to receptors having an increased sensitivity to noise or vibration. The academics attending Clare Hall, in my opinion, would indeed be more sensitive to noise and vibration, as the primary usage of the institution is to study and research, both of which require significant levels of concentration. If the noise conditions are not conducive to quiet study, it would not be possible to use the spaces within the Clare Hall campus for their intended purposes.
- 9.20 In my opinion, the LOAEL and SOAEL values used by the DMRB and WSP would be more relevant to the Clare Hall location, if the values were lowered, which would result in the predicted noise levels exceeding the LOAEL by a greater amount during the day and exceeding the SOAEL during the nighttime.
- 9.21 Table TR1-3-3 of the WSP report details the scale of effect of the operational noise levels. It states that an increase of 5 dB or more would be considered a **Major Impact**, which would be considered a **Significant Effect**, depending on context. This is replicated from the DMRB LA111 Table 3.54a “Magnitude of Change – Short Term”.
- 9.22 Both of these tables assess the difference in the 10th percentile sound levels (dB L_{A10,T}), over an 18 hour period. The use of this descriptor is typical for assessing road traffic noise. In this instance though, the sound levels should be calculated in accordance with CRTN³¹ and then converted through to the L_{A10,18hr} value using the formulae within the TRL Document PR/SE/451/02³². The prediction methodology within CRTN however, has a lower traffic flow threshold of 50 vehicles per hour for deriving the most suitable L_{A10,T} noise levels. Twenty vehicles (10 buses each way) per hour falls below this lower threshold, so should not be used.
- 9.23 Within the TRL document, equation 2.5 suggests that there is a direct correlation between the L_{A10,18h} and L_{Aeq,16h} values, where;
- $$L_{A10} - L_{Aeq} \approx 3 \text{ dB}$$
- 9.24 As there is no accepted method to compare road traffic noise levels for less than 50 vehicles per hour, by taking this direct correlation into consideration, I believe that the change in absolute noise levels can be assessed in a similar fashion, as shown in Table 9.1 below.

³⁰ Text from excerpt of the DMRB was intentionally highlighted by me to stress this point.

³¹ CRTN – Calculation of Road Traffic Noise: 1988

³² Transport Research Laboratory (TRL) Ltd – Converting the UK Traffic Noise Index LA10,18h to EU Noise Indices for Noise Mapping: 2002

Short Term Noise Change (dB L _{Aeq,1h})	Long Term Noise Change (dB L _{Aeq,1h})	Magnitude of Change	Significance of Impact
< 1.0	< 3.0	Negligible	Not Significant
1.0 to 2.9	3.0 to 4.9	Minor	Not Significant
3.0 to 4.9	5.0 to 9.9	Moderate	Significant
≥ 5.0	≥ 10.0	Major	Significant

Table 9.1: Significance of Change in Sound Levels

- 9.25 From the above table, this would suggest that the introduction of the guided busway would result in an **increase of 7–8 dB**, which would be considered a **Major** change in the short term and a **Moderate** change in the long term. Both are considered to be a **Significant Adverse Impact** for the residents of the various buildings within the Clare Hall campus.
- 9.26 The use of the tables from DMRB LA111 should be used in conjunction with the context of the area. DMRB states that *“If a project changes the acoustic character of an area, it can be appropriate to conclude a minor magnitude of change in the short term and/or long term is a likely significant effect.”*
- 9.27 With respect to context, my opinion is that what is proposed would change the acoustic character of the area surrounding Clare Hall, especially the accommodation units further away from Grange Road, as they are currently situated in a fundamentally semi-rural environment, with open fields to the south. The introduction of a guided busway **will** change the acoustic character of the area and ultimately impact on the useability of the Clare Hall amenities.

Nighttime Noise Levels

- 9.28 For the nighttime hours (23:00h to 00:00h and 06:00h to 07:00h) I have not been made aware of the proposed timetables, however it has been assumed that there would be a reduced usage during these times. I have therefore looked at the sound levels at Clare Hall and The Brian Pippard building, as a result of 2 buses (one each direction) over a 15 minute period. Create have predicted that the sound level at the façades would be approximately 50 dB L_{Aeq,15mins} when using the average SEL of 74 dB(A). Internally, that could result in internal noise levels of approximately 37 dB L_{Aeq,T}, within the bedrooms overlooking Rifle Range Road. This is 7 dB higher than the required level of 30 dB L_{Aeq,T} within bedrooms during the night.
- 9.29 Furthermore the proposed operating times are shown to be during a period of the nighttime which is recognised as significantly more impactful to people’s quality of sleep, i.e. as people are falling asleep and when people are likely to wake prematurely. I see no evidence that this was considered in WSP’s assessment.
- 9.30 Paragraph 4.1.5 of the Environmental Statement (Addendum 2 and Clarifications) document suggests that *“a planning condition could restrict the numbers of bus movements during the 06:00h – 07:00h and 23:00h – 07:00h periods ... until such time as the bus fleet are electric”*.
- 9.31 As stated in paragraphs 5.37 of this Proof of Evidence, should the proposed bus fleet move to electric, then as the buses accelerate and slow down, the acoustic warning sound system would start for safety reasons. Additionally, the section adjacent to the Brian Pippard Building, is shown to be 30 mph, which is where ISO 362 suggests that the tyre noise is the dominant noise source for most vehicles. It must therefore be questioned, just how much quieter electric buses would be than the Euro VI buses. The Applicant has not provided an assessment accounting for these factors.

- 9.32 For context the average measured ambient sound levels between 23:00h and 00:00h was calculated to be 43.4 dB $L_{Aeq,15mins}$. Between 06:00h and 07:00h, the average ambient sound levels were calculated to be 48.6 dB $L_{Aeq,15mins}$.
- 9.33 The predicted sound level of a single bus passing the windows of these accommodation units has therefore been predicted to be 1 dB higher than the average measured sound level for the period between 06:00h and 07:00h and 7 dB higher than the average recorded sound level between 23:00h and 00:00h.

Amenity Spaces

- 9.34 There are a variety of outdoor amenity spaces around Clare Hall, including the private amenity spaces previously discussed (balconies and gardens) and other shared amenity spaces.
- 9.35 As specified in the WSP report, WHO Guidelines and BS 8233, the design target sound level for outdoor amenity spaces should ideally be at, or below, 50 dB $L_{Aeq,T}$. The upper design limit, which should not be exceeded, is 55 dB $L_{Aeq,T}$.
- 9.36 The current land usage results in external amenity spaces which are below the design target sound level of 50 dB $L_{Aeq,T}$.
- 9.37 To add clarity, the average hourly noise level of 56 dB $L_{Aeq,1h}$ would be the equivalent noise level at the private amenity spaces for the properties overlooking Rifle Range Road. This noise level **exceeds** the WHO and BS 8233 upper design limit of 55 dB $L_{Aeq,T}$ so would result in unacceptable noise levels during the day in these areas which are specifically designed for play, rest and relaxation. This adverse impact does not comply with Policy 36 of the Cambridge Local Plan.
- 9.38 If the buses used were at the noisier range of the measured SELs, then the average hourly noise level could be as high as 59 dB $L_{Aeq,T}$. This is significantly higher than the WHO and BS 8233 stipulate and also would not comply with the Cambridge Local Plan.
- 9.39 This would significantly alter the amenity spaces, from currently being within the limits and then exceeding the noise limits, if the bus route is approved and constructed.

General Comments on Operational Noise Predictions

- 9.40 I have shown that based on the average SEL for a Euro IV bus being 74 dB(A), the predicted level will be 7 to 8 dB higher than the existing ambient sound level, which would be considered to be a **Moderate** magnitude of change in the long term. This constitutes a **Significant Adverse Impact**.
- 9.41 The internal noise levels within the residential apartments have been predicted to be at 38 dB $L_{Aeq,1h}$ and 32 dB $L_{Aeq,15mins}$ for the daytime and nighttime respectively. BS 8233 and WHO Guidelines recommend internal noise levels of 35 dB $L_{Aeq,T}$ and 30 dB $L_{Aeq,T}$ for the daytime and nighttime respectively. It can be seen that the predicted noise levels within the bedrooms overlooking Rifle Range Road would **exceed** the WHO and BS 8233 criteria for both day and night times.
- 9.42 The internal noise levels within the offices, study rooms and meetings rooms of Clare Hall have been predicted to be approximately 43 dB $L_{Aeq,T}$. The recommended noise levels for this type of space are between 35 dB $L_{Aeq,T}$ and 40 dB $L_{Aeq,T}$. It can be seen therefore that the predicted internal noise levels within the rooms within Clare Hall main building would **exceed** the criteria for daytime.

- 9.43 The noise levels in the private amenity spaces have been predicted to be approximately 56 dB $L_{Aeq,1h}$. The recommended noise level for external amenity spaces is 50 dB $L_{Aeq,T}$, but with an upper limit of 55 dB $L_{Aeq,T}$. It can therefore be seen that the criteria for external amenity spaces would be **exceeded**.
- 9.44 This conflicts with Policy 35 of the Cambridge Local Plan as I have demonstrated that the introduction of the noise generating busway will result in the existing noise sensitive properties throughout the Clare Hall campus will be exposed to noise levels that will have an unacceptable adverse impact on health and quality of life, both internally and externally.
- 9.45 I have shown that the introduction of the CtoC guided busway in this area would alter the context of the area.
- 9.46 From the predicted levels, I have calculated that, in line with the DMRB, as a result of the proposed CtoC guided busway, with the proposed timetable of 10 buses both directions, every hour, there would be a **major magnitude of change** in the short term and a **moderate magnitude of change** in the long term for the residents at the Clare Hall campus. For clarification, both moderate and major magnitudes of change are considered to result in a **significant adverse impact**.
- 9.47 Between the hours of 23:00h to 00:00h, I have not been furnished with a proposed timetable so have also assessed the noise of a single bus passing in front of the bedroom windows. I predict that during these hours, the sound of a single bus passing would be 67 dB $L_{Aeq,T}$, which is 24 dB higher than the average measured sound levels for these times.
- 9.48 Between the hours of 06:00h to 07:00h, I have not been furnished with a proposed timetable so have also assessed the noise of a single bus passing in front of the bedroom windows. I predict that during these hours, the sound of a single bus passing would be 67 dB $L_{Aeq,T}$, which is 19 dB higher than the average measured sound levels for these times.

10.0 OPERATIONAL VIBRATION

- 10.1 The WSP report did not assess the impact of operational vibration.
- 10.2 Create acknowledges that vibration from the operation of the guided busway should not cause any concern for the residents or users of Clare Hall or The Brian Pippard Building.

11.0 SUMMARY OF SUBMITTED ACOUSTIC ASSESSMENT

- 11.1 CD1-11.01, the WSP Noise and Vibration report, has assessed the entirety of the Cambourne to Cambridge guided busway and provides only a broad overview of the proposed scheme and the impacts on various receptors.
- 11.2 The report included baseline noise monitoring at locations along the proposed route, including only a single location within the Clare Hall campus, close to the existing Bin Brook Bridge. The report did not however include any meteorological or calibration data from the period of baseline monitoring. The report also did not reveal the background sound levels within the area, so it was not possible to understand the true acoustic climate of the area, which would tend to help define the context of the application site.
- 11.3 The report has not identified that the Clare Hall campus is a noise and vibration sensitive receptor, which is an important omission. The Clare Hall campus includes teaching, studying and learning spaces which attracts studying fellows from across the world. Some of these fellows have families, some of which reside in one of the many residential buildings within the campus. The buildings which would be most impacted by the proposed scheme include the main Clare Hall building where the studies are based, which also offers several residential apartments overlooking the location of the proposed busway; The Brian Pippard Building, which consists solely of residential apartments, again directly overlooking the location of the proposed guided busway; and the Gillian Beer Building which is within a short distance from the location of the new Bin Brook Bridge.
- 11.4 In my opinion, insufficient attention has been given to the physical construction of the guided busway. The selection of plant for the Site Clearance and Road / Structure Construction phases³³ appears to be quite limited and there has been no allowance for any deliveries of raw materials to site, or for any to be taken away from site. This would result in higher noise levels during the construction of the busway than has been calculated. It is likely that these deliveries would continue along Rifle Range Road for the entire duration of the works, as this section outside the Brian Pippard Building has been shown to have the only Accommodation Welfare and access point. This would appear to be a serious omission from WSP's calculations and assumptions.
- 11.5 WSP have shown that, based on their construction plant assumptions, the Clare Hall campus will fall within the 40m Construction Noise Buffer³⁴ however have not included the remaining noise sensitive receptors throughout the Clare Hall campus, as shown in Figure 6.1. The construction noise calculations have only been calculated to define the 40m buffer (referred to as a worst-case scenario). At this distance of 40m, the sound level should be a maximum of 65 dB $L_{Aeq,T}$. These levels include the reduction of 5 dB for mitigation.
- 11.6 No consideration has been given to the noise levels which would be experienced at the façade of the buildings within the Clare Hall campus, some of which are only 5.5 m away from the existing Rifle Range Road and 2m from the proposed access and maintenance track. At this distance, the sound levels experienced at Clare Hall and the Brian Pippard building would be far greater than 65 dB $L_{Aeq,T}$, and would be in excess of 80 dB $L_{Aeq,T}$. For context 80 dB(A) is also the Lower Exposure Action Value (LEAV) for the Control of Noise at Work Regulations 2005. Although not directly comparable to this situation, multiple avenues of research have shown that being exposed to noise levels at 80 dB(A) or above can cause hearing loss.

³³ Table TR1-D-1 – Construction Phase Plant and Assumptions From Appendix D of CD1-11.01

³⁴ Plate TR1-5-3 – Sensitive receptors with significant noise effects – near Bin Brook Bridge from CD1-11.01

- 11.7 WSP have relied upon the wording within DMRB which states that a significant effect occurs when the works extend for 10 or more days or nights in any 15 consecutive days or nights; or a total number of days exceeding 40 in any 6 consecutive months. Although I acknowledge this point, I am of the opinion that in this context these levels do create a significant adverse effect, even if they only happen for a few days, as it would not be possible to use the spaces within the Clare Hall campus for their intended purposes due to the high noise levels.
- 11.8 There have been no calculations provided for the construction noise of the new Bin Brook Bridge. WSP have alluded to³⁵ the fact that the construction of Bin Brook Bridge will extend beyond 10 or more days or nights in any 15 consecutive days or nights. WSP have acknowledged that the Gillian Beer and Salje Buildings within the campus would be subjected to a **Significant Adverse Impact** during the construction of the new Bin Brook Bridge.
- 11.9 With regards to the section of the report pertaining to vibration, WSP have not considered the likely levels of vibration at any particular properties, instead have suggested a vibration buffer zone of 15m, which equates to a predicted vibration level of 1 mm/s PPV.
- 11.10 WSP have referred to the use of a small ride on roller with an amplitude of 0.4mm. For reference, the BS 5228 Part 2 parameter range for amplitude, when calculating vibration from vibratory compaction, is between 0.4mm and 1.72mm. The vibration calculations have been carried out using the lowest possible vibratory roller.
- 11.11 Regardless of the use of very optimistic plant, WSP have suggested that properties within a 15m buffer from the works would be subjected to a significant adverse effect. As with the noise calculations, no effort has been made to assess the level of vibration at the façade of the properties, but WSP have stated that all properties within a 15m radius would experience a significant adverse effect. Using the same roller and calculations as WSP I predict that at the closest point of compaction (scaled to be 2.5m from drawings) the vibration levels at Clare Hall and the Brian Pippard building could be 6.9 mm/s PPV and 6.1 mm/s PPV. These levels are far above those that BS 5228 suggests that complaints will arise.
- 11.12 Again, WSP have relied upon the wording within DMRB that due to the short duration for these works, no significant vibration effects are expected. Again, I am of the opinion that these levels would nevertheless constitute a significant adverse effect because of their severity and the impact on the particularly sensitive land use.
- 11.13 I have shown that through the use of our SEL calculations, the operation of the busway will result in a Significant Adverse Impact during the day and has the potential to cause a Significant Adverse Impact during the nighttime, depending on the bus timetables.
- 11.14 The operation of the busway will result in internal noise levels exceeding the recommendations of the World Health Organisation and British Standards for bedrooms during the daytime and for the two hours of operation during the nighttime.
- 11.15 The operation of the busway will result in internal noise levels exceeding the recommended levels by British Standards for offices, meeting rooms and study rooms during the daytime.

³⁵ Paragraph 5.1.10 of CD1-11.01

- 11.16 The external amenity spaces will be exposed to higher noise levels than the maximum noise limit stipulated by the Local Policies, WHO and BS 8233.

12.0 SUMMARY OF CREATE ACOUSTIC EVIDENCE

- 12.1 Create have attended site and measured the existing ambient and background sound levels, to compare against those undertaken by WSP. The ambient sound levels measured were within an acceptable level for comparison purposes. The background sound levels were measured to be approximately 38 dB $L_{A90,1\text{hour}}$ and 37 dB $L_{A90,15\text{mins}}$ for the daytime and nighttime periods. These are considered to be quite low, and reflect my subjective experience whilst on site.
- 12.2 Sound emissions of guided buses along the existing guided busway section close to Kings Hedges Road were measured and the average SEL of these movements were calculated to be between 65 dB(A) and 77 dB(A), with an average of **74 dB(A)**. The SEL levels used by WSP were **72 dB(A)**. The difference between 20 mph and 30 mph was deemed to be negligible.
- 12.3 The degree of sound insulation provided by the façade components of Clare Hall and the Brian Pippard building, overlooking the proposed CtoC guided busway, was measured using the Global Loudspeaker Method from BS EN ISO 16283-3. The results showed that the existing construction provided a relatively low level of sound insulation, although not problematic under the current scenario.
- 12.4 I disagree with the small number of vehicles that WSP have assumed will be used to construct this proposed CtoC guided busway. I have provided the list of plant and equipment I feel would be suitable for a job of this scale, for both the Site Clearance and Road/Structure Construction. Assuming the same 5 dB reduction for various mitigation strategies, I calculated that the sound level at the façade of Clare Hall and the Brian Pippard Building would be closer to **86 dB $L_{Aeq,T}$** and **82 dB $L_{Aeq,T}$** for the Site Clearance and Road/Structure Construction respectively. These residential units also include external amenity spaces, such as gardens and balconies. There was evidence of this when I was shown around the site, as there were children's outdoor toys and lounging furniture. Residents would not be able to enjoy their amenity spaces whilst these works are underway, if the scheme is approved. I consider this to be a **Major Adverse Impact**.
- 12.5 I predict that using the assumed list of plant I have provided, the 40m buffer zone should increase to 60m, before the noise levels reduce to 65 dB $L_{Aeq,T}$ or below.
- 12.6 The proposed site plan shows a single Accommodation Works area for the entire construction site. This is proposed to be located in front of the Brian Pippard building. This will be situated here for presumably, the entire duration of the works. Potentially, this could also include a welfare cabin and security hut. If this is the case, then a diesel generator would almost certainly be used to supply power to the security hut, which would be required 24/7. This has not been considered by WSP.
- 12.7 These predicted noise levels far exceed the requirements of BS 8233 and the WHO Guidelines.
- 12.8 I have considered the impact of noise from the construction of the new Bin Brook Bridge. The worst impacted residential property would be the Gillian Beer Building, which would be exposed to noise levels in the region of **70 dB $L_{Aeq,T}$** , including the 5 dB reduction for mitigation that WSP had previously assumed. WSP have rightly concluded that these works would likely take longer than 10 days to complete. This level constitutes a **Major Adverse Impact** which would be considered a **Significant Adverse Effect**.
- 12.9 With regards to vibration, I disagree with the use of the vibratory roller with the lowest possible vibration amplitude. This would effectively underestimate the likely levels of vibration. However, even

using the same roller as WSP, the same calculations show that vibration levels of approximately **5.5 mm/s PPV** would be anticipated at the façade of the closest properties, Clare Hall and the Brian Pippard Building. BS 5228 Part 2 states that at levels of **1.0 mm/s PPV, complaints are likely**.

- 12.10 I believe that the contractors constructing the guided busway would likely use a roller with a greater amplitude as this would reduce the construction times. If this was the case, then a different roller has been shown to have the potential to reach vibration levels of approximately **12-13 mm/s PPV**. BS 5228 Part 2 states that at vibration levels greater than **10 mm/s PPV are likely to be intolerable**.
- 12.11 I do not think that the vibration levels from the construction of Bin Brook Bridge would generate significant vibration levels, assuming that the CFA piling is used.
- 12.12 If the CtoC guided busway was to be granted, then I have predicted that the sound levels would be approximately **56 dB LAeq,1h** at the façades of Clare Hall and the Brian Pippard Building. This is approximately 8 dB higher than the existing ambient sound level so would be easily discernible above the existing sound levels. This increase would be classes as being a **Major Adverse Impact** in line with the DMRB.
- 12.13 These levels would also exceed the recommended internal noise levels for bedrooms during both the day and night times, and offices during the day. Currently these buildings within Clare Hall comply with regulations and the introduction of the busway would see the recommended noise limits be exceeded.
- 12.14 Similarly with the external amenity spaces, the existing sound levels comply with the Local Policies, WHO Guidelines and BS 8233. Should the busway be approved, then the external amenity spaces would exceed even the upper limits and would therefore be unfit for purpose.
- 12.15 As it stands, there have been no proposals for mitigation for the operation of the busway to mitigate these proposed impacts. Without dramatically altering the building structure of this Listed Building, I do not think that noise mitigation for the operational phase of the busway would be possible.

13.0 CONCLUSIONS

- 13.1 As has been shown in chapter 11, there were some notable omissions from the WSP report.
- 13.2 Most importantly WSP did not consider Clare Hall, or any of the accommodation units, other than the Gillian Beer building, to be a noise sensitive property. I disagree with this and would stress that for Clare Hall to continue to attract world leading fellows for research at their facility, it must provide an acoustic climate which is suitable for the sustained quiet study and contemplation for which Clare Hall was designed to provide, which it currently does.
- 13.3 At no point within the WSP report, were construction noise or construction vibration levels assessed to any properties. Instead, WSP referred to a 40m (65 dB[A]) noise buffer and a 15m (1mm/s PPV) vibration buffer. When the properties are situated 5.5m from the existing edge of Rifle Range Road (and 2.5m from the nearside of the proposed guided busway) they will be exposed to dramatically higher levels than those at the edge of the buffer zones, potentially as high as **86 dB L_{Aeq,T}**.
- 13.4 When using the plant assumed by WSP, the noise levels at the façade of Glare Hall and the Brian Pippard Building, from construction noise, would be equivalent to a noisy factory floor, which exceeds the LEAV of the Control at Noise at Work Regulations, as these noise levels are harmful to one's health.
- 13.5 The WSP construction noise calculations did not include for any deliveries of materials coming into, or leaving, the site.
- 13.6 The predicted construction noise levels will **significantly adversely impact** all buildings within a 60m buffer along Rifle Range Road.
- 13.7 Vibration levels from the Site Clearance and Road/Structure Construction of the guided busway system will be above the level where complaints will arise and, depending on the amplitude for the rollers, would be closer to being intolerable.
- 13.8 The operational noise levels for the busway have been predicted to be at **56 dB L_{Aeq,1h}**, using the proposed bus timetable. This is a large increase and would be considered a **Major Impact**, resulting in a **Significant Adverse Effect**.
- 13.9 The operational noise levels would result in internal noise levels exceeding the requirements of the WHO and BS 8233 for bedrooms and office spaces, particularly given the low levels of sound insulation provided by the façade of the buildings.
- 13.10 Likewise, external private amenity spaces would exceed the requirements of BS 8233 and the WHO.
- 13.11 In my expert opinion, WSP has not considered the impact of the proposals in adequate detail for the multiple sensitive receptors within the Clare Hall campus, and nor has sufficient attention been paid to the requirements for quiet study and contemplation areas within the Clare Hall campus.
- 13.12 There has been very little reference to mitigation throughout the CD1-11.01 report, and there has been no reference to mitigation for the operational phase, which I have shown will result in exceeding all noise limits for internal and external areas, assuming the proposed bus timetabling.
- 13.13 Given the height of the second floor balcony in the Brian Pippard Building, a suitable acoustic barrier would need to break the line of sight. This could be either through the use of a 6.19m high acoustic

barrier, or a shorter acoustic barrier with a cantilevered top section providing coverage over the top of the buses.

- 13.14 In my opinion, I do not think that it will be possible to sufficiently mitigate the noise from the operation of the busway without significantly altering the Grade II* Listed Building.

14.0DISCLAIMER

- 14.1 Create Consulting Engineers Ltd disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report.
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APPENDIX A

Glossary of Acoustic Terminology

dB(A)

The human ear is less sensitive to low (below 125 Hz) and high (above 16 kHz) frequency sounds. A sound level meter can be used to duplicate the ear's variable sensitivity to sound across a spectrum of frequencies. This is achieved by building a filter into the instrument with a similar frequency response to that of the average ear. This is called an "A-weighting filter". Measurements of sound made with this filter are called A-weighted sound level measurements and the unit is dB(A).

$L_{eq,T}$

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level L_{eq} . The L_{eq} is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period (T).

$L_{10,T}$

This is the minimum level exceeded for not more than 10% of the time period (T). This parameter is often used as a "not to exceed" criterion for noise.

$L_{90,T}$

This is the minimum level exceeded for not more than 90% of the time period (T). This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{fmax}

This is the maximum sound pressure level that has been measured over a period using a fast time constant.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 10 such octave bands whose centre frequencies are defined in accordance with international standards.

Addition of noise from several sources

Noise from different sound sources combine, on a logarithmic scale, to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than one alone and 3 identical sources produce a 5 dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6 dB for each doubling of distance from the noise source. Sound energy from line sources (e.g., stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Sound intensity is not perceived directly at the ear; rather it is transferred by the complex hearing mechanism to the brain where acoustic sensations can be interpreted as loudness. This makes hearing perception highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a reasonable guide to help explain increases or decreases in sound levels for many acoustic scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud
20	About 4 times as loud

Barriers

Outdoor barriers can be used to reduce environmental noises, such as traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and its construction.

Reverberation control

When sound falls on the surfaces of a room, part of its energy is absorbed and part is reflected back into the room. The amount of reflected sound defines the reverberation of a room, a characteristic that is critical for spaces of different uses as it can affect the quality of audio signals such as speech or music. Excess reverberation in a room can be controlled by the effective use of sound-absorbing treatment on the surfaces, such as fibrous ceiling boards, curtains and carpets.

IANL

IANL or 'Internal Ambient Noise Level' refers to the recorded (or predicted) $L_{Aeq,T}$ within a dwelling, office, commercial unit or treatment space. IANL typically defines a design limit or range.

APPENDIX B

Calibration Information for Monitoring Equipment

Equipment No.	Equipment	Make/Model	Certification	
44	Class 1 Sound Level Meter	Norsonic 140 RTA	Serial Number	
			1407844	
			Cert No.	
			1160286	
			Calibration Date	
			04/04/2024	
	Preamplifier	Norsonic 1209	Serial Number	
			1209.23401	
			Cert No.	
			1160286	
			Calibration Date	
			04/04/2024	
	Microphone	Norsonic 1225	Serial Number	
			1255.496021	
			Cert No.	
			1160286	
			Calibration Date	
			04/04/2024	
Calibrated Level Before:		113.9	Sens	- 25.8
Calibrated Level After:		114.1	Sens	- 25.9

Equipment No.	Equipment	Make/Model	Certification	
1	Acoustic Calibrator	Norsonic 1251	Serial Number	
			125134963	
			Cert No.	
			1164831	
			Calibration Date	
			08/07/2024	

Equipment No.	Equipment	Make/Model	Certification	
45	Class 1 Sound Level Meter	Norsonic 140 RTA	Serial Number	
			1407845	
			Cert No.	
			1160287	
			Calibration Date	
			04/04/2024	
	Preamplifier	Norsonic 1209	Serial Number	
			1209.23402	
			Cert No.	
			1160287	
			Calibration Date	
			04/04/2024	
	Microphone	Norsonic 1225	Serial Number	
			1255.496034	
			Cert No.	
			1160287	
			Calibration Date	
			04/04/2024	
Calibrated Level Before:		113.9	Sens	- 25.8
Calibrated Level After:		114.0	Sens	- 25.8

Person in charge of measurement: Sam Ward MIOA, Jody Blacklock, MIOA

Other people present: n/a

Measurement parameters: Leq, L90, 1/3 octave

APPENDIX C

Baseline Noise Monitoring Results

		1407844 First Floor Flat					1407844 Brian Pippard Flat				
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
		LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T	LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T
05/03/2025	13:00	45.5	47.1	42.4	41.4	65.2	47.1	48.3	44.2	43.3	71.2
	14:00	45.8	47	42.5	41.5	63.3	47.5	48.6	44.2	43.1	67
	15:00	44.4	45.6	42	41.2	64.2	46.3	47.5	44	43.1	70.4
	16:00	45.8	47.3	42.5	41.3	66.6	46.5	48.2	44.3	42.9	62.6
	17:00	48	49.5	45.1	43.7	71.3	49.5	51.1	46.9	45.7	65.4
	18:00	48.7	50.2	47.1	46.3	61.7	51.4	52.6	49.9	49	62.4
	19:00	48.1	48.9	47.1	46.3	58.5	51.4	52.4	50.3	49.3	60.6
	20:00	47.8	49.1	46.1	45.3	70.3	50.2	51.4	48.7	47.8	63
	21:00	47	48.5	45.2	43.8	60	50.2	51.6	48.5	45.7	58.6
	22:00	46.3	47.8	44.4	43.3	54.4	49.3	51.1	47.2	45.9	56.7
	23:00	46.2	47.8	43.2	40.6	64.3	49	51	45.7	43.1	60.8
	00:00	44.5	46.8	41.2	39.2	52.2	46.8	49.1	43.3	41.4	63.9
	01:00	45.5	47.6	42.4	39.5	58.7	52.1	50.3	44.1	41.5	83.4
	02:00	43.8	46	39.8	36.4	52	46.6	48.9	42.7	37.7	57.4
	03:00	45.2	47.3	42.3	39.4	52.4	48.3	50.4	45.4	42.3	56.4
	04:00	46.9	48.4	45	43.7	54.7	50	51.7	47.8	46.6	55.8
	05:00	53.6	52.9	45.7	44.5	77.2	52.5	54.6	49.3	48.2	60.4
	06:00	51.7	52.9	49.6	48.3	65.9	55.3	56.9	53.1	51.9	73.9
	07:00	53.2	54.7	51.3	50.3	71.6	56.7	58	54.7	53	69.3
	08:00	52.9	54.9	49.7	48.3	70	55.9	57.5	53.5	52.3	68.3
	09:00	51.4	52.8	48.7	47.5	66.7	54.9	56.7	51.7	50	70.6
	10:00	48.8	51.1	45.1	42.8	64	51.2	53.8	47.3	44.7	62
	11:00	46.5	48.6	42.6	41.6	61.2	46.5	48.2	44.1	42.9	60.9
	12:00	48	50.4	43.6	42.1	68.4	50.3	51.3	45.5	43.9	74
	13:00	47.3	49.4	43.4	42.2	70.2	47.4	49.1	45	43.8	66.8
	14:00	48.9	51.2	45.1	43.9	74.7	49.4	51.2	46.9	45.7	64.7
	15:00	49.3	49.4	45.1	44.2	72.3	50.3	51.1	47.4	46.2	70.1
	16:00	47.8	49.3	45.2	44.1	63.9	49.8	51.4	47.4	46.1	61.7
	17:00	49.4	50.3	47.6	46.9	64.2	51.9	52.8	50	49.1	72.6
	18:00	48.1	49.3	45.9	45.2	67.5	51.4	53.1	48.8	47.8	71.6

		1407844 First Floor Flat					1407844 Brian Pippard Flat				
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
		LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T	LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T
06/03/2025	19:00	48.5	49.4	45	44.2	71.2	50.3	51.6	47.8	46.8	70.5
	20:00	45.4	46.8	43.6	42.8	63.1	48.5	49.8	46.7	45.9	69.6
	21:00	44.6	45.8	42.9	42.1	56.8	47.5	48.9	45.8	44.8	57.3
	22:00	44.4	45.8	42.7	41.8	56.9	47.6	49.3	45.8	44.8	54.7
	23:00	44.1	45.6	42.3	40.4	52.4	47.9	49.6	45.7	43.5	53.5
	00:00	43.1	44.7	41	39.8	65.2	46.4	48.1	44.1	42.7	61.7
	01:00	42.5	44.4	39.3	37.5	51	45.9	48.1	42.5	40.3	58.3
	02:00	42.3	44.4	39	36.5	49.2	46.2	48.4	42.4	39	54.5
	03:00	44.5	46.4	42	40.2	51.7	48.1	49.9	45.7	43.6	55
	04:00	46.4	48.2	44.2	42.6	52.2	50.2	52.1	47.7	46.1	57.4
	05:00	51.7	50.2	44.5	43.3	75.5	50.7	52.3	48.3	46.8	72.8
	06:00	50.2	51	47.7	46.8	67.4	53.3	54.7	51.4	50.4	70.6
	07:00	55.1	58.5	50	49.1	65.4	55.5	56.8	53.8	53.1	67.2
	08:00	54.5	58.2	49.1	48.2	74.1	56.4	57.5	51.7	50.8	71.9
07/03/2025	09:00	51.4	54.1	46.7	44.7	68.5	57.8	61.8	50.3	47.2	72.1
	10:00	53	57.6	43.5	42.3	76.9	50.3	52.8	45.9	44.5	68.2
	11:00	44.6	46.4	42.4	41.6	59.6	46.9	48.6	44.4	43.3	69.8
	12:00	49.1	48.6	42.6	41.8	82.3	51	50.2	44.4	43.1	83.7
	13:00	56.3	59.1	42.5	41.4	86.5	55.6	57.5	44.3	42.7	82
	14:00	45.1	46.9	42.4	41.5	61.9	47	48.8	44.3	42.7	64
	15:00	45.5	46.8	43.7	42.8	64.9	48	49.5	46	45.1	68.1
	16:00	46.8	46.9	42.4	41.3	69.2	46.5	48.3	43.9	42.7	66.3
	17:00	47.1	48.4	42.9	41.9	73.3	47.6	49.3	44.3	43.1	77.3
	18:00	45.4	46.1	42.7	42	64.7	46.5	47.8	44.2	43.4	66.8
	19:00	44.5	45.3	43.1	42.3	61.4	46	47	45	44.1	62.8
	20:00	44	45.3	42.3	41.4	54.9	46	47.1	44.6	43.7	67.6
	21:00	43.8	44.8	42.1	41.4	61.4	46.5	47.6	44.7	43.8	67
	22:00	43	44.7	40.5	39.1	60.8	45.3	47.3	42.5	41.2	56.8
08/03/2025	23:00	41.2	42.5	39.6	38.6	53.3	43.8	45.6	41.6	39.9	59
	00:00	41.3	42.3	38.5	37	64.2	44.4	45.9	40.6	38.7	68.1

		1407844 First Floor Flat					1407844 Brian Pippard Flat				
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
		LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T	LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T
	01:00	40.8	42.6	37.6	36.1	58	44.4	46.9	40.2	38.1	61.5
	02:00	40.4	42.6	37.4	36	47.8	44.6	47.2	40.2	38	54.2
	03:00	38.6	40.2	36.5	35.2	47.9	40.5	42.7	37.9	36.6	52.4
	04:00	38	39.8	35.6	34.4	49.5	39.5	41.5	36.8	35.3	56.8
	05:00	50.1	47	38.5	37.4	77.7	43.7	45.3	40.1	38.7	68.4
	06:00	44.2	45	41.4	40.5	65.5	46.9	47.7	43.8	42.5	72.2
	07:00	44	45.4	41.8	40.9	64	46.8	47.4	43.1	42.3	77.5
	08:00	44.8	46.1	43	42.3	63.7	46.6	47.5	44.7	43.8	70.7
	09:00	45.1	46.1	42.3	41	63	46	46.7	42.8	41.8	68.6
	10:00	46.8	45.2	41	40.2	68	43.8	44.9	41.7	40.9	66.1
	11:00	42.8	44	39.6	38.7	61.2	43.4	44.6	40.2	39.2	64.5
	12:00	43.6	45.7	40.1	38.8	62.5	45.2	47.1	40.5	39.4	70
	13:00	43.9	46.4	40.5	39.2	62.2	44.5	47	41	39.6	62.2
	14:00	48.5	49.2	40.7	39.6	73.1	48.9	49.5	41.1	40	72.8
	15:00	46.5	48.2	41.1	39.9	71.7	45.6	48.2	41.5	40.6	63.1
	16:00	47	47.7	40.9	39.9	78.4	45.4	46.2	40.7	39.7	69.7
	17:00	48.6	45.9	39.6	38.6	74.5	44.4	45.7	39.9	39	68
	18:00	46.8	44.4	40.4	39.5	71.6	46.5	45.5	40.7	39.9	70
	19:00	42.8	43.7	41.4	40.8	66.9	43	44	41.9	41.3	56.1
	20:00	42.5	43.6	41.1	40.5	59.5	42.7	43.5	41.5	40.9	62.9
	21:00	45.4	43.7	40.9	40.1	79.6	43.1	43.8	41.4	40.6	67.7
	22:00	42	43.1	40.6	39.9	54.5	42.3	43.4	40.9	40.2	53.2
	23:00	41.8	43	40	39.1	57.9	41.9	43.1	40.3	39.3	57.1
	00:00	40.1	41.4	38.7	37.9	45.8	40.8	42	39	38.1	68.4
	01:00	39.3	40.6	37.1	35.9	59.2	39.9	41.2	37.5	36.1	58.7
	02:00	38.3	39.9	36.4	35.2	48.2	39.1	40.7	36.8	35.5	53
	03:00	38.5	40.3	36.4	35.3	52.3	40.1	41.4	37.1	35.3	68.4
	04:00	37.6	39.1	36	35.2	50.5	39.5	40	36.5	35.7	71.1
	05:00	50.1	44.4	37.8	36.4	76.5	47.9	42.7	38	36.6	78.3
09/03/2025	06:00	46.7	43.5	38.7	37.8	76.2	41.7	42.5	38.7	37.7	69.4

		1407844 First Floor Flat					1407844 Brian Pippard Flat				
		dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
		LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T	LAeq,1hr	LA10,1hr	LA90,1hr	LA99,1hr	LAFmax,T
10/03/2025	07:00	43.3	44.3	40.2	39.3	71	43	43.9	40.6	39.7	62.1
	08:00	43.5	44.2	40.6	40	72	43.1	44	41.3	40.6	59.8
	09:00	42.2	43.9	38.4	36.9	63.2	42.9	42.6	38.1	37.1	71.1
	10:00	43	45.1	38.8	37.4	65.2	42.1	43.4	37.8	36.7	62.6
	11:00	44.7	45.5	38.6	37.6	68.8	44	44.4	38.4	37.1	70.4
	12:00	42.3	43.2	38.1	37	68	44.4	43.5	37.5	36.5	77.7
	13:00	51.5	51.6	39.4	37.8	73.2	50.5	48.7	38	36.4	73.2
	14:00	51.3	54	40.3	38.4	75.8	48.1	51.1	38.9	37.1	71.6
	15:00	42.8	45.1	38	36.8	63	43.9	43.8	37.5	36.4	78.2
	16:00	41.1	43.1	37.5	36.4	62.4	40.2	42	36.7	35.6	62
	17:00	42.8	44.5	37.7	36.8	68.9	41.8	44.3	37.2	36.2	64.9
	18:00	49.3	51.1	37.9	36.8	71.8	49.9	50.5	37.3	36.3	72.4
	19:00	40.7	42	37.7	36.5	62	40.7	42.2	37.6	36.1	58.3
	20:00	41.2	42	37.5	36.5	68.3	40.6	42	37.6	36.7	61.3
	21:00	40.7	41.3	37.1	36.3	65.9	41.4	41.3	37.6	36.8	70.3
	22:00	40.2	41.9	37.6	36.6	55.8	40.2	41.7	38.3	37.1	54.2
	23:00	41	41.5	37.6	36.6	62.1	41.4	42.9	38.8	37.6	62.3
	00:00	38.3	39.6	36.7	35.8	49.1	39.4	40.7	37.5	36.5	61.5
	01:00	38.7	40.5	36.5	35.2	47	39.4	41.2	37	35.4	50.3
	02:00	37.8	39.8	35.2	33.5	58.3	38.1	40.5	35	33.2	45.5
	03:00	38.9	40.8	36.2	34.8	45	39.1	41.3	35.7	34.5	53.3
	04:00	41.8	43.6	39.3	37.7	49	40.1	41.9	37.5	36.4	50.8
	05:00	53	53.7	42	40.9	78	42.5	42.9	37.5	36.6	65.5
	06:00	45.6	46.8	43.7	42.4	62.3	43.9	45.2	41.7	40.8	61.4
	07:00	46	46.8	43.7	42.8	71.8	46.4	45.6	41.6	40.7	75.9
	08:00	45.4	46.7	43.2	42.1	64.2	45.1	47.5	41.4	40.3	63.7
	09:00	46.8	47.4	43.5	43	73.2	45.7	47.3	41.5	40.7	71.8

APPENDIX D

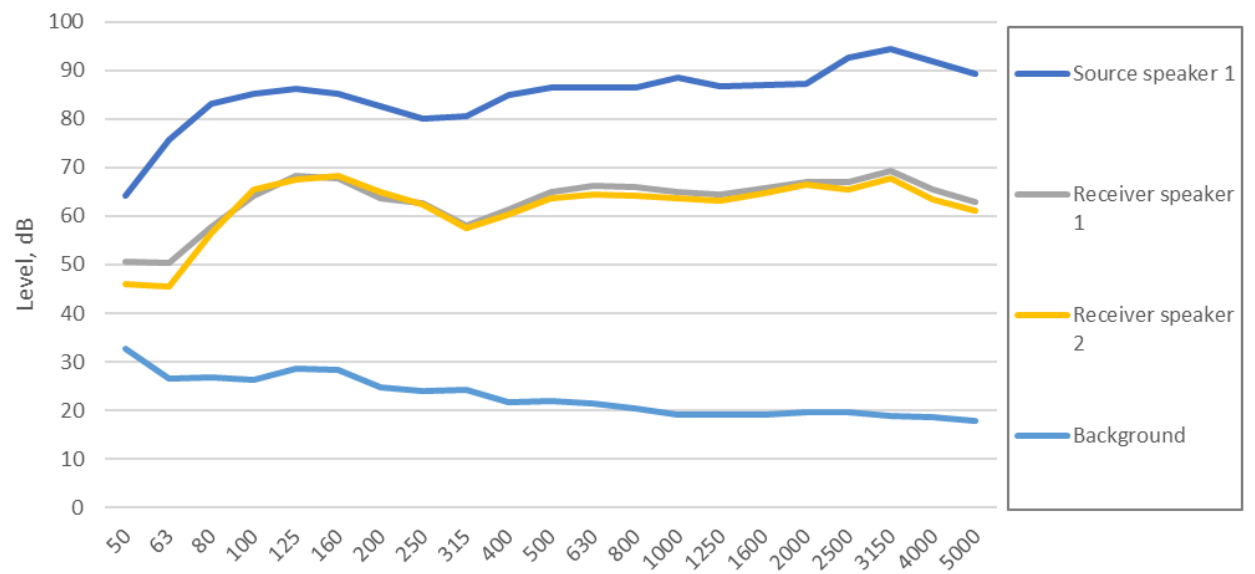
Guided Busway Noise Measurement Results

Notes	Distance of Measurement	SEL	Duration	LAeq
Passing at 20mph, then stopping/Idling/Pulling away	3m	82.4	00:01:12	63.9
Passing at 20mph, pulling up to a stop/Idling/Pulling away	1m	87.2	00:01:03	69.2
Passby at 20mph	1m	84	00:00:15	72.3
Passby at 20mph	1m	75.9	00:00:15	64
Idling and pulling away	1m	86	00:00:44	64
Passby at 20mph, idling and pulling away	1m	80.4	00:00:33	65.3
Double decker passby	1m	77.5	00:00:24	63.9
Junction turn in at 20mph	1m	74.8	00:00:21	61.6
Bus pulling up, stopping and turning out left	6m	70.6	00:00:15	59.3
Bus turning in to junction at 20 mph	6m	75.6	00:00:14	64
Turning out left (slowly)	6m	67.9	00:00:15	57.5
double decker passby at 30mph	1m	80.5	00:00:22	67
Passing at 20mph, then stopping/Idling/Pulling away	1m	84.5	00:01:00	66.7
passby	1m	83.7	00:00:11	73.4
Idling and pulling away	1m	84.3	00:00:21	71.2
pull up and idle	1m	85.1	00:01:09	66.8
passby	1m	85.4	00:00:15	73.7
Bus at 20 MPH	1m		00:00:33	68.1
Bus at 30 MPH	1m		00:00:22	67

APPENDIX E

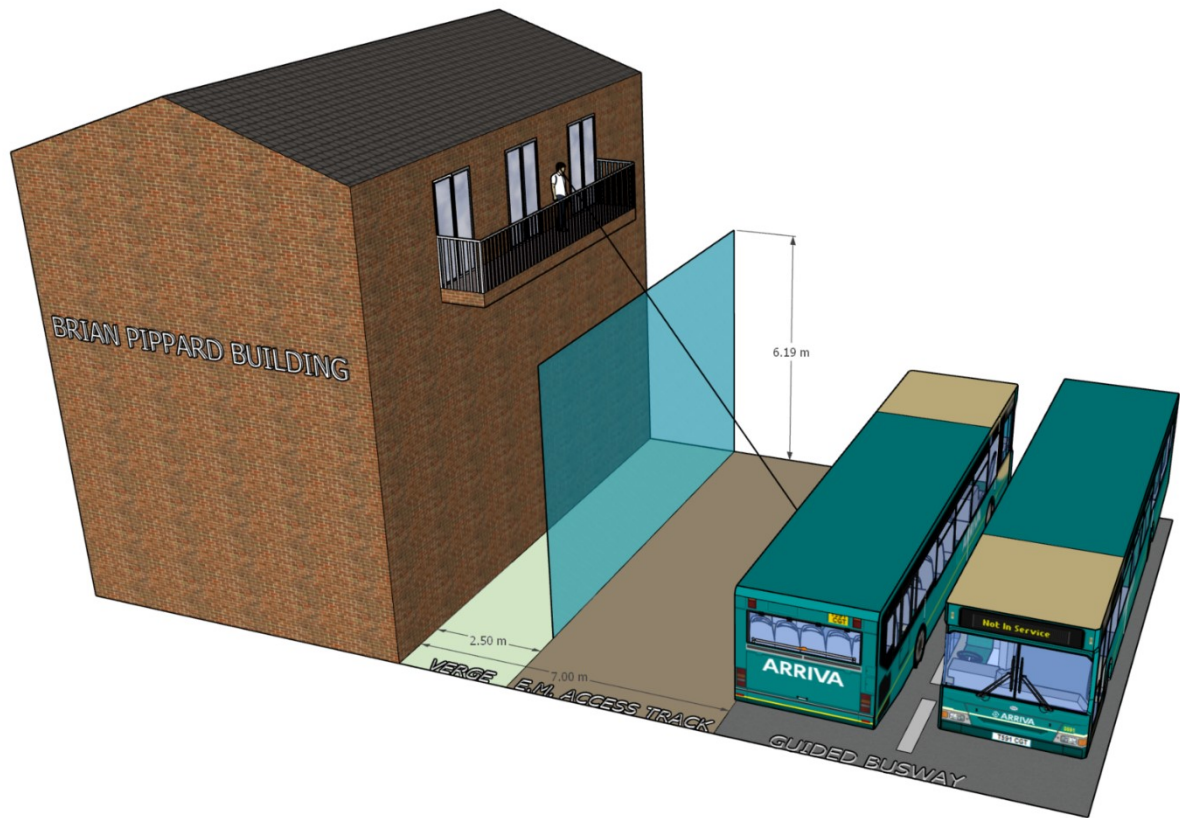
Sound Insulation Noise Measurement Results

Example of Measurement Results From Residential Flat 4a – Windows Closed/Vents Open



APPENDIX F

Barrier Attenuation Calculations



With 6.19m tall Acoustic Barrier, the direct line of sight would be broken, resulting in a 5dB reduction across all frequencies.

Clare Hall

PROPOSED CAMBOURNE TO CAMBRIDGE BUSWAY – BIN BROOK CROSSING AND IMPACT ON CLARE HALL

Acoustics Proof of Evidence

Jonathan Blacklock, BEng (Hons), CEng, MIOA,
MCIBSE

The information contained within this report and any appendices or supporting information provided are to be treated as confidential.



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