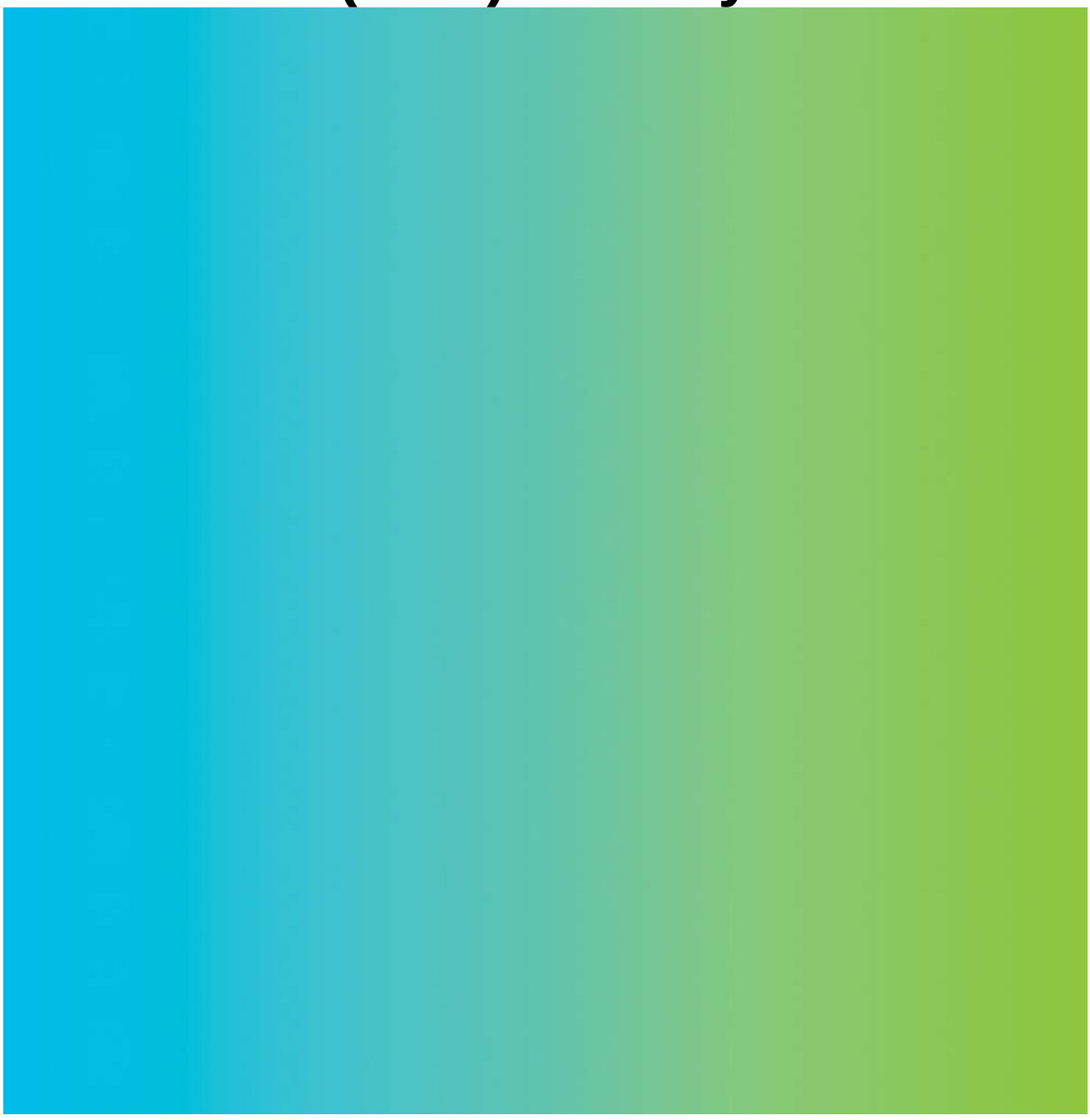
Assessment of Effectiveness of Acoustic Barriers for Stirling-Alloa-Kincardine (SAK) Railway Line



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Rail Noise Assessment

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Appendices

Assessment of Effectiveness of Acoustic Barriers for Stirling-Alloa-Kincardine (SAK) Railway Line

1 Introduction

1.1 AECOM was instructed by Clackmannanshire Council and Transport Scotland to undertake noise monitoring to confirm the effectiveness of the noise mitigation that was installed adjacent to sections of the Stirling Alloa Kincardine Railway line following the findings of the AECOM Noise Modelling Report (**Job No: 60051581 Reference: JN692DP**) issued in October 2009.

1.2 Noise monitoring was initially undertaken at 11 selected properties in May 2012 and further monitoring was undertaken in August 2012. The selected 11 properties were chosen as representative of the worst case scenario at each of the sections of track where properties were identified as qualifying for acoustic mitigation and are therefore deemed to be representative of the 44 qualifying properties. Continuous rail noise level measurements were initially undertaken between Tuesday 22nd and Friday 25th May 2012, for a minimum period of 48 hours. Following the completion of these noise level measurements it was decided by Clackmannanshire Council and Transport Scotland that another period of noise monitoring was required as Network Rail had undertaken engineering works along the railway during the measurements undertaken in May. The additional rail noise level measurements were undertaken between Tuesday 31st July and Saturday 4th August 2012. However, during this monitoring period it was also found that maintenance work had occurred along the railway line[1].

1.3 A brief description of the SAK works relevant to this assessment is provided in Section 2. Section 3 contains an Executive Summary of the findings of the assessment. The requirements for assessment of mitigation in respect of railway noise identified within the Environmental Statement and further AECOM reports are reproduced in Section 4. The rail noise calculation methodology is presented in Section 5, and the assessment of rail noise in Section 6. Section 7 provides a comparison of noise levels with and without acoustic mitigation, at the properties where monitoring was undertaken. Finally, a summary and conclusions can be found in Section 8.

1.4 A glossary of acoustical terminology is included as Appendix 1.

1.5 A list of the instrumentation used during the measurement period is included as Appendix 2.

1.6 The site notes for the noise measurement periods are presented as Appendix 3.

1.7 Maps showing the location of the acoustic mitigation are presented in Appendix 4.

[1] During onsite checks throughout the measurement period this maintenance was not found to have an adverse affect on the noise monitoring at the selected properties during periods of manned monitoring.

2 A Brief Description of the Site

2.1 The (SAK) rail line comprises of approximately 21km of track between Stirling Station and Longannet Power Station in Kincardine. It provides passenger services from Alloa to Stirling and freight services to Longannet Power Station.

2.2 The re-opening of the rail line involved reconstructing the line between Stirling and Kincardine along its former route and upgrading the existing railway route between Kincardine and Longannet Power Station. The section of the route from Stirling to Alloa has been re-opened to passenger and freight trains, with a new railway station located at Alloa and a freight only connection through to Kincardine and on to Longannet Power Station.

2.3 The rail line passes within the Stirling Council, Clackmannanshire Council and Fife Council areas.

3 Executive Summary

3.1 The noise impact assessment shows that the acoustic mitigation has been successful in reducing noise levels at the majority of the properties.

3.2 Clackmannanshire Council and Transport Scotland requested that AECOM confirm the effectiveness of the barriers. The mitigation has reduced noise levels at all measured locations, of which 9 out of the 11 properties are now below the day time mitigation trigger level. The mitigation can therefore be considered as successful at 42 of the 44 properties that qualified for noise barriers. The two properties which require further analysis are The Gables and 16 Ochil View.

3.3 The Gables met with the mitigation criteria during the August monitoring period and 16 Ochil View met with the mitigation criteria on one of the days in August, however, during the other monitoring periods the measured noise levels at the properties exceeded the mitigation criteria as a consequence of an increased number of trains.

3.4 At The Gables there has been a reduction in the noise levels from train noise as a consequence of the installed acoustic mitigation. The difference between both measurement periods shows that the barrier is offering between a 4.9 dB(A) and 5.8 dB(A) reduction in respect of passenger trains even with an increase in the number of trains, and a 1.4 dB(A) benefit in respect of freight trains. The total measured ambient noise levels exceeded the mitigation trigger level by 0.1 and 0.4 dB during the May monitoring period.

3.5 At 16 Ochil View there has been little overall impact on the noise levels primarily due to site constraints in constructing the barrier. Due to the proximity of the property to a level crossing, the acoustic mitigation is limited as a consequence of the gap required to permit vehicular access. Further analysis has shown that by extending the barrier along the southern garden boundary of the property by 17m and increasing the barrier height to 2.5m will further reduce noise levels by 2.9 dB(A). With this additional level of mitigation it is predicted that the acoustic criterion will be met.

4 Criteria for Assessment

Day Time Mitigation Criteria

4.1 The criterion for assessment in respect of mitigation is reproduced from the Environmental Statement below.

Mitigation Criteria for Assessment as Presented in the Environmental Statement

"... all properties subject to a facade noise level (due to railway noise) equal to or greater than 55 dB $L_{Aeq,18h}$ (approximately 52 dB $L_{Aeq,18h}$ free-field) and subject to an increase in free-field noise level equal to or greater than 5 dB(A) were considered in need of mitigation"[2].

Night-time Mitigation Criteria

4.2 "*Additionally, the occurrence of $L_{Amax,fast}$ values above 60 dB at the facades of residential properties during night-time (23:00 – 07:00) is appropriate for assessing the impact of the railway movements specific to sleep disturbance"*[3].

4.3 AECOM have previously discussed the adoption of this criterion in the previous noise monitoring period undertaken in January 2009 (detailed in **AECOM Report Job No: 60051518** Reference: M001.001), which is reproduced below.

4.4 *"Although, throughout the Environmental Statement, it is stated that there is to be no timetabled night-time railway movements, i.e., between the hours of 24:00 and 06:00 hours, it is also stated in Volume 2, p.189. "Additionally, the occurrence of $L_{Amax,fast}$ values above 60 dB at the facades of residential properties during night-time (23:00-07:00) is appropriate for assessing the impact of the railway movements specific to sleep disturbance". However, no information in relation to the qualifying number of occurrences of this maximum level was provided within the Environmental Statement. To assess the significance of impact for the night time period it is essential that the number of events which exceed the suggested trigger level of 60dB $L_{Amax,fast}$ is also included within the criteria. The level of 60dB $L_{Amax,fast}$ is derived from World Health Organisation (WHO) Guidelines for Community Noise precautionary guideline value of 45dB $L_{Amax,fast}$ inside a bedroom with the windows open. In respect of this precautionary guideline value the WHO advise that indoor sound pressure levels in bedrooms should not exceed approximately 45 dB $L_{Amax,fast}$ more than 10–15 times per night. To avoid the situation whereby all 10-15 events occur within the same hour and being deemed acceptable because they do not occur throughout the night-time period, it is advisable to assume not more than 2 events in any one hour period throughout the night time duration to avoid sleep disturbance.*

4.5 *The basis of the assessment of potential night time noise disturbance referred to in the Environmental Statement is the absolute maximum levels referred to within the World Health Organisation (WHO)*

[2] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 2 – Topic Specific Report, February 2003. P 195

[3] Stirling - Alloa - Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill - Environmental Statement Volume 2 – Topic Specific Report, February 2003. p189

document entitled Guidelines for Community Noise. However, it has been explained that the WHO guidelines can be interpreted as providing a conservative and precautionary approach to noise impact assessment. This is because they represent noise levels at which it is possible to start detecting effects and below which effects can be assumed to be negligible, and values exceeding the recommended noise levels are not necessarily indicative of significant adverse impacts. Furthermore, there is no evidence that anything other than a small minority of the population exposed to noise at the WHO guideline noise levels find them to be particularly onerous in the context of their daily lives.

4.6 *The internal level of 45 dB $L_{Amax,fast}$ is based on an external level of 60dB $L_{Amax,fast}$ and a reduction of 15dB(A) for a partially open window. Whether the assessment should be made with the window open or closed is also an issue for consideration.*

4.7 *However, the appropriate night time maximum noise levels and the provision of mitigation has previously been addressed by the Scottish Parliament in respect of the following schemes: Edinburgh Tram Lines, Glasgow Airport Rail Link (GARL) and Edinburgh Airport Rail Link (EARL). Both the Edinburgh Tram Line and EARL noise and vibration policies clearly state that the maximum level which should not be exceed more than twice in any one hour is in fact 82dB $L_{Amax,fast}$.*

4.8 *The justification for the use of 82dB $L_{Amax,fast}$ previously adopted by the Scottish Parliament in relation to maximum level of noise from train pass bys is based on the fact that sleep disturbance from noise is a complex subject and one over which there is some debate. The subject has been reviewed by various authorities. The most relevant review was carried out at the request of the UK government by a Committee led by Dr CGB Mitchell in 1990-1991. The Committee's remit was to provide the then Secretary of State for Transport with recommendations for national noise standards for noise insulation for new railways which equitably relate to the standard set by regulations for new highways. The Committee comprised 8 leading experts in transportation noise. Over the course of a year the Committee reviewed the scientific evidence on transportation noise from the UK and abroad, considering contributions from 52 local authorities and 30 consultants, operators and professional bodies, and produced its report 'Railway Noise and the Insulation of Dwellings', ("Mitchell Report"). The Mitchell Reports concludes that 'Noise from railways causes less disturbance to sleep than does noise from roads. The noise differential in favour of rail for equal sleep disturbance is at least 5dBA. Studies have tentatively suggested to avoid sleep disturbance the façade noise level from railways should be no more than 60 dBA $L_{Aeq,T}$ and the maximum noise level should be no more than 85 dBA L_{Amax}, with the additional proviso that there should be no more than 20 'noise events' per night (Section 3.7 and 4.2)'.*

4.9 *The Department for Transport did not include an L_{Amax} limit in the 1996 Insulation Regulations, but the L_{Amax} limit recommended in the Mitchell Report to avoid sleep disturbance remains (i.e. 85dB at façade level, which is 82dB away from the façade in the free-field – at least 3.5m away from hard reflecting surfaces apart for the ground).*

4.10 *In view of the above it was considered appropriate to adopt a level of 82dB $L_{Amax,fast}$ (free field) not being exceeded more than twice in any one hour period during night-time hours as a threshold for consideration of mitigation measures. It should also be noted that in considering the appropriateness of mitigation measures cognisance must be taken of acceptable standards in terms of traffic, safety, environmental and economic issues."*

Properties Identified as Meeting the Aforementioned Criteria

4.11 The SAK Noise Modelling Report (Ref 60051581 JN692DP) issued in October 2009 identified 62 properties which were predicted to experience façade noise levels from trains that exceeded $L_{Aeq,18hr}$ 55 dB and also exceeded the pre-existing ambient noise level by 5 dB(A). A site survey was then undertaken and each of the identified properties were visited, during this survey it was found that there were 18 properties which had existing barriers/fences which acted as an acoustic barrier. Therefore in terms of the daytime mitigation criteria there were 44 properties where acoustic mitigation was offered.

4.12 There were no properties which met with the qualifying criteria in relation to night-time noise levels.

5 Rail Noise Calculation Methodology

5.1 The railway noise was measured and predicted in accordance with the requirements of the Department of Transport *Calculation of Rail Noise (CRN)*[4] publication. These methodologies are used to determine the $L_{Aeq,18hr}$ dB rail noise level for the daytime period (06:00 – 00:00 hours).

5.2 The predicted daytime $L_{Aeq,T}$ noise levels were assessed in accordance with the criteria for assessment identified within the Environmental Statement, as detailed within Section 4.

5.3 The properties selected as monitoring locations were taken to be representative of all properties where recommended noise mitigation was installed. When determining whether or not there is a 5dB increase in the train noise $L_{Aeq,18hr}$ above the pre-existing background noise level, measured noise levels presented in the Environmental Statement were used. At locations where there was no available background data in the Environmental Statement noise levels were measured by AECOM prior to the installation of the acoustic mitigation. The noise levels selected from the Environmental Statement and AECOM measurements have been taken as representative of the pre-existing noise levels for all surrounding properties. A precautionary approach was adopted whereby the pre-existing noise levels have been rounded down to the nearest whole number.

5.4 Maps showing the locations of installed barriers can be viewed in Appendix 4. These maps were as provided by AECOM to the contractor responsible for construction of the acoustic mitigation. However, it is understood that minor alterations were made to the final positions of the barriers and AECOM have not yet been provided with the final maps showing the minor alterations.

[4] The Department of Transport (1995) Cal*culation of Railway Noise (CRN).* HMSO

6 Measured Rail Noise Assessment

May Monitoring Period

6.1 Noise level measurements were undertaken at 11 selected properties where mitigation in the form of an acoustic barrier had been installed to mitigate SAK railway noise in accordance with the Environmental Statement noise mitigation criteria (see Section 4, above). AECOM's Noise Modelling Report (Job No: 60051581 Reference: JN692DP) issued in October 2009, details the properties that were found to qualify for acoustic mitigation. The selected 11 properties were chosen as representative of the worst case scenario at each of the sections of track where properties were identified as qualifying for acoustic mitigation. The selected properties are shown in Table 1 and also in Figures A.1 – A.11 in Appendix 3.

Table 1: Location of Noise Monitoring Equipment

Selected Property with Noise Monitoring Equipment Installed	
46 Wallace Gardens, Causewayhead, FK9 5LS	75 Grange Road, Alloa, FK10 1LU
52 Alloa Road, Causewayhead, FK9 5LN	25 Alexandra Drive, Alloa, FK10 2DQ
16 The Sheilings, Cambus, FK10 2NN	Ochilview, Clackmannan, FK10 4DJ
37 Moubray Gardens, Cambus, FK10 2NQ	16 Ochilview, Kincardine, FK10 4QG
8 Alloa Road, Cambus, FK10 2NT	Station House, Kincardine, FK10 4LT
The Gables, Alloa Road, Cambus, FK10 2NT	-

6.2 The measured rail noise levels, at the selected eleven residential properties was undertaken in accordance with the methodology detailed in Calculation of Railway Noise, (CRN)[5] using on-site noise level measurements.

6.3 Unattended on-site train noise level measurements were undertaken between Tuesday 22nd May and Friday 25th May 2012 at the eleven selected existing residential properties along the route. The additional noise level measurements were undertaken between Tuesday 31st July and Saturday 4th August 2012 at ten of the selected existing residential properties along the route. During this second period of noise monitoring noise level measurements were only undertaken at 10 of the selected properties because it was not possible to gain access to the garden area of 25 Alexandra Drive, as this property is used as a schoolhouse and was closed for the summer holiday period.

6.4 Furthermore, attended satellite on-site noise level measurements were undertaken at each of the properties at varying times throughout the overall measurement period. The purpose of these satellite measurements was to compare with the unattended measurement data results and also to record the weather conditions and local noise climate, subjectively. The results of the additional measurement periods are contained within the detailed site notes, presented as Appendix 3.

[5] The Department of Transport (1995) *Calculation of Railway Noise (CRN)*. HMSO

6.5 Noise level measurements of D.B. Schenker (formerly E.W.S) and Freightliner freight train movements and where applicable SPT passenger train movements were undertaken using sound level meters located in the rear garden areas of the identified properties. The measurement period was for a minimum of 48 hours. Details of the instrumentation used during the measurement are provided in Appendix 2.

6.6 The microphones were positioned at a height of 1.5m above the ground (approximately equivalent to ground floor window height). The sound level meters were placed within 'all weather kit[6]' casings and secured within the rear garden areas of each of the properties being assessed. All measurements were undertaken with the microphone positioned 1m from the façade.

6.7 At each location the microphone was positioned outside the window of interest, i.e., ground floor living room areas/bedroom area windows. At each location the measurement position had direct line of sight of the SAK acoustic barrier and the rail track beyond.

6.8 During the second round of measurements, the sound level meters were installed at the same location as the measurements undertaken in May. At 16 The Sheilings the sound level meter was located approximately 5m to the east of the previous measurement location. This was due to a gazebo located at the previous monitoring location, (see photographs in Appendix 3).

6.9 The noise monitoring equipment was calibrated both before and after the measurement period using an acoustic calibrator, which has itself been calibrated against a reference set traceable to National and International Standards, at each measurement location. There was no shift greater than 0.2 dB in the observed calibration on any of the sound level meters.

6.10 The weather conditions, throughout the May measurement period were dry with occasional light easterly breezes. During the August monitoring period the overall weather conditions were dry and relatively calm with occasional light easterly breezes, there was a period of very light rain on the afternoon of 03/08/2012 which lasted approximately 15 minutes. A breakdown of the environmental conditions recorded at intervals throughout the measurement period, are presented within the detailed site notes within Appendix 3.

6.11 During the May measurement period the daily numbers of trains, 113 in total, passing along the SAK line are presented in Table 2 and for the second period (August) there were 104 trains, as summarised in Table 3.

[6] 'All weather kit' encompasses a sound level meter with pre-amp secured within a weather-tight plastic case with the microphone on an extension cable attached to a pole and fitted with a windshield

Table 2: Train Numbers Passing Existing Properties along SAK Line during May Monitoring

Train Type	Day 1	Day 2
Stirling – Alloa (Passenger)	41	41
Stirling – Kincardine (Freight)	16	15

*Please note that at some of the properties one of the freight trains actually passed the property during the daytime period during both days.

Table 3: Train Numbers Passing Existing Properties along SAK Line during August Monitoring

Train Type	Day 1	Day 2
Stirling – Alloa (Passenger)	41	41
Stirling – Kincardine (Freight)	12	10

6.12 The overall $L_{Aeq,T}$ train noise level during each of the relevant time periods were calculated using the measured train data, using individual measured SELs. To assess the noise level associated with the total train pass-bys at each location, the individual measured SELs were summed using Equation (1), as prescribed by CRN:

$$L_{Aeq(T)} = 10 \times \log\left[\frac{10^{\left(SEL_1/10\right)} + 10^{\left(SEL_2/10\right)} + \ldots 10^{\left(SEL_n/10\right)}}{T_t}\right] \quad (1)$$

(where: the SEL_n is the n^{th} measured single event level for a given train type and T_t is the total time in seconds of the $L_{Aeq,T}$ to be determined).

6.13 The predicted ambient noise level is the total measured train noise level combined with the pre-existing background noise level, taken from either the Environmental Statement, prior to the train line coming into use, or the AECOM noise measurements undertaken in 2009, with the railway in operation. Tables 4 and 5 present the daytime noise levels for the May and August monitoring periods, respectively.

Table 4: Measured May 2012 Daytime Noise Levels at Mitigated Residential Properties along the SAK Route, with Rail Line in Operation

Measurement Period on 23/05/2012 between 06:00 – 00:00 hours (18 hour Daytime Period)					
Property	**Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Pre existing Background Noise Level $L_{Aeq,18hr}$ (dB)#**	**New Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)**
Station House, Kincardine	51.2	51.2	-	53.0 (ES)	**55.2**
16 Ochil View, Kincardine	56.2	56.2	-	46.0 (ES)	**56.6**
Ochilview, Clackmannan	45.3	45.3	-	46.0 (ES)	**48.7**
25 Alexandra Drive, Alloa*	52.9	51.9	46.3	55.0 (A)	**57.1**
75 Grange Road, Alloa	53.8	51.8	49.5	55.0 (A)	**57.5**
The Gables, Cambus	53.9	52.6	48.0	49.0 (A)	**55.1**
8 Alloa Road, Cambus	53.7	52.5	47.6	53.0 (ES)	**56.4**
37 Moubray Gardens, Cambus	51.5	50.5	44.6	53.0 (ES)	**55.3**
16 The Sheilings, Cambus	53.0	52.0	46.3	53.0 (ES)	**56.0**
56 Alloa Road, Causewayhead	51.5	50.0	46.2	55.0 (A)	**56.6**
46 Wallace Gardens, Causewayhead	53.5	52.6	45.8	49.0 (ES)	**54.8**
Measurement Period on 24/05/12 between 06:00 – 00:00 hours (18 hour Daytime Period)					
Property	**Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Pre existing Background Noise Level $L_{Aeq,18hr}$ (dB)**	**New Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)**
Station House, Kincardine	50.9	50.9	-	53.0 (ES)	**55.1**
16 Ochil View, Kincardine	55.8	55.8	-	46.0 (ES)	**56.2**
Ochilview, Clackmannan	45.0	45.0	-	46.0 (ES)	**48.5**
25 Alexandra Drive, Alloa	53.3	51.7	48.3	55.0 (A)	**57.2**
75 Grange Road, Alloa	54.3	52.4	49.7	55.0 (A)	**57.7**
The Gables, Cambus	54.3	52.9	48.8	49.0 (A)	**55.4**
8 Alloa Road, Cambus	52.3	50.6	47.4	53.0 (ES)	**55.7**
37 Moubray Gardens, Cambus	51.9	50.8	45.5	53.0 (ES)	**55.5**
16 The Sheilings, Cambus	55.0	54.3	46.9	53.0 (ES)	**57.1**
56 Alloa Road, Causewayhead**	-	-	-	55.0 (A)	**-**
46 Wallace Gardens, Causewayhead	53.3	52.3	46.3	49.0 (ES)	**54.7**

#Criterion for mitigation was set out in the Environmental Statement and when determining whether or not there is a 5 dB increase in the train noise $L_{Aeq,18hr}$, above the pre-existing ambient noise level the measured data, from both the Environmental Statement and AECOM noise monitoring in 2009 (denoted by an ES or A in the above table), have been used as a proxy for ambient noise levels at properties located near to where the measurements were undertaken.
*measurements at 25 Alexandra Drive did not commence until 09:43 as access to the rear garden was not permitted until that time
** Measurements at 56 Alloa Road were not undertaken due to a fault with the noise monitoring equipment noted during the last day of monitoring whilst the meter was being inspected.

Table 5: Measured August 2012 Daytime Noise Levels at Mitigated Residential Properties along the SAK Route, with Rail Line in Operation

Measurement Period on 02/08/2012 between 06:00 – 00:00 hours (18 hour Daytime Period)					
Property	**Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Pre existing Background Noise Level $L_{Aeq,18hr}$ (dB)#**	**New Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)**
Station House, Kincardine	50.7	50.7	-	53.0 (ES)	**55.0**
16 Ochil View, Kincardine	54.4	54.4	-	46.0 (ES)	**55.0**
Ochilview, Clackmannan	45.2	45.2	-	46.0 (ES)	**48.6**
75 Grange Road, Alloa	53.4	51.0	49.6	55.0 (A)	**57.3**
The Gables, Cambus	52.7	51.3	47.1	49.0 (A)	**54.2**
8 Alloa Road, Cambus	51.2	49.4	46.3	53.0 (ES)	**55.2**
37 Moubray Gardens, Cambus	50.1	48.6	44.6	53.0 (ES)	**54.8**
16 The Sheilings, Cambus	51.6	50.0	46.3	53.0 (ES)	**55.4**
56 Alloa Road, Causewayhead	49.0	47.0	44.8	55.0 (A)	**56.0**
46 Wallace Gardens, Causewayhead	51.2	50.0	45.0	49.0 (ES)	**53.2**
Measurement Period on 03/08/12 between 06:00 – 00:00 hours (18 hour Daytime Period)					
Property	**Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)**	**Pre existing Background Noise Level $L_{Aeq,18hr}$ (dB)#**	**New Predicted Ambient Noise Level $L_{Aeq,18hr}$ (dB)**
Station House, Kincardine	49.5	49.5	-	53.0 (ES)	**54.6**
16 Ochil View, Kincardine	53.4	53.4	-	46.0 (ES)	**54.1**
Ochilview, Clackmannan	46.8	46.8	-	46.0 (ES)	**49.4**
75 Grange Road, Alloa	52.7	50.0	49.3	55.0 (A)	**57.0**
The Gables, Cambus	51.3	49.3	47.1	49.0 (A)	**53.3**
8 Alloa Road, Cambus	50.8	48.5	46.8	53.0 (ES)	**55.0**
37 Moubray Gardens, Cambus	49.2	47.3	44.7	53.0 (ES)	**54.5**
16 The Sheilings, Cambus	49.9	48.0	45.3	53.0 (ES)	**54.7**
56 Alloa Road, Causewayhead	48.9	46.5	45.2	55.0 (A)	**56.0**
46 Wallace Gardens, Causewayhead	50.9	49.4	45.4	49.0 (ES)	**53.1**

#Criterion for mitigation was set out in the Environmental Statement and when determining whether or not there is a 5 dB increase in the train noise $L_{Aeq,18hr}$, above the pre-existing ambient noise level the measured data, from both the Environmental Statement and AECOM noise monitoring in 2009 (denoted by ES or A in the above table), have been used as a proxy for ambient noise levels at properties located near to where the measurements were undertaken.

6.14 As previously stated in Paragraph 4.1 the threshold for mitigation as outlined within the Environmental Statement[7] states that "*These results were used to assess the need for mitigation in the form of lineside barriers. Applying the methodology discussed previously, all properties subject to a facade noise level (due to railway noise) equal to or greater than 55 dB $L_{Aeq,18h}$ (approximately 52 dB $L_{Aeq,18h}$ free-field) and subject to an increase in free-field noise level equal to or greater than 5 dB(A) were considered in need of mitigation*". Therefore the threshold for mitigation is a minimum predicted railway façade noise level of 55 dB(A) or more and an increase of 5 dB(A) or more in the pre-existing background noise level.

[7] Stirling – Alloa – Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill – Environmental Statement Volume 2 – Topic Specific Report February 2003. P 195

6.15 However, the Environmental Statement does not state how effective the mitigation should be. Indeed the Environmental Statement states that *"It can be seen that 95 properties would be exposed to a long-term daytime noise level in excess of 55 dB $L_{Aeq,18hr}$ (after mitigation)...By considering a requirement for noise mitigation for areas subject to increases above 5 dB(A) (and above 55 dB(A)) it is considered that short-term annoyance has been reduced as far as reasonably practicable*"[8].

6.16 As can be seen in Tables 4 and 5, for each day of noise level measurements all of the predicted ambient noise levels are now below the identified mitigation trigger level, with the exception of 16 Ochil View during the May measurement period and one day of the August measurement period, and The Gables, during the May measurement time period.

6.17 As previously stated, noise measurements at **16 Ochil View,** Kincardine demonstrated that during one day of the August two day monitoring period the measured noise levels met with the daytime mitigation criteria. During the May monitoring period and one day of the two day August monitoring period the noise levels were in excess of the mitigation criteria. The reason for this can be attributed to the increased number of freight trains which were running during both periods (16 and 14 in May and 12 in August when the mitigation criterion was exceeded, and 10 in August when the mitigation criterion was met). However, due to the proximity of the property to a level crossing, the acoustic mitigation is limited as a consequence of the gap required to permit vehicular access.

6.18 Noise measurements at **The Gables, Cambus** demonstrated, that during the August monitoring period the measured noise levels met with the daytime mitigation criteria. However, during the May monitoring period the noise levels were in excess of the mitigation criteria. The reason for this can be attributed to the increased number of freight trains which were running during both periods (16 and 14 in May and 12 and 10 in August).

6.19 Further discussion of the measured noise levels at the aforementioned properties is provided in Section 7.

[8] Stirling-Alloa Kincardine Railway (Route Re-opening) and Linked Improvements (Scotland) Bill Environmental Statement Volume.3 Supporting Information February 2003 pages 166 - 167

7 Comparison of Measured Noise Levels Before and After Acoustic Mitigation

7.1 As has been previously stated there were 2 properties for which the noise mitigation appeared to not meet with the Environmental Statement noise mitigation criteria. These are:

- 16 Ochil View, Kincardine (during both days in May and one day in August)
- The Gables, Cambus (during both days in May)

7.2 However, as previously stated the Environmental Statement does not qualify the extent and effectiveness of the acoustic barrier and indeed goes on to advise that even with the acoustic mitigation recommended in the Environmental Statement there will be some properties which still be subject to noise levels above $L_{Aeq,18hr}$ 55 dB.

7.3 The aforementioned two properties were previously monitored by AECOM prior to the introduction of acoustic mitigation and this additional information facilitates a further analysis of the noise levels at these two properties.

16 Ochil View, Kincardine

7.4 Table 6 provides a comparison of the measured noise levels at 16 Ochil View with and without the mitigation in place.

Table 6: Comparison of Measured Noise Levels at 16 Ochil View

	Without Mitigation in Place		With Mitigation in Place			
Date of Measurement	**17/02/10**	**18/02/10**	**23/05/12**	**24/05/12**	**02/08/12**	**03/08/12**
Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)	53.8	55.3	56.2	55.8	54.4	53.4
Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)	53.8	55.3	56.2	55.8	54.4	53.4
Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)	-	-	-	-	-	-
No of Passenger Trains	0	0	0	0	0	0
No of Freight Trains	9	11	16	15	12	10

7.5 During the monitoring before and after acoustic mitigation was installed there was not one day when the train numbers were the same to allow for a direct comparison of the noise levels.

7.6 However it can be seen from Table 6 that the most comparable results would be those obtained on 18/02/10 and those obtained on 02/08/12 where there were 11 and 12 freight trains respectively.

7.7 The difference between the measured freight train $L_{Aeq,18hr}$ noise level between 18/02/10 and 02/08/12 was 0.9 dB(A), in effect the noise level has been reduced in spite of a greater number of trains.

7.8 Furthermore it can be seen that the difference between the measured freight train, $L_{Aeq,18hr,}$ noise level between 17/02/10 and 03/08/12 was 0.4 dB(A). This is even with an extra train running on the 3rd of August.

7.9 Also, 16 Ochil View is directly adjacent to a level crossing and it is therefore impracticable to install acoustic mitigation which would completely break the line of sight between the railway line and the

property. Subjectively the effect of the reduced extent of the barrier was noted whilst on site. Further analysis of the noise levels at this property has shown that by extending the barrier along the southern garden boundary by 17m and increasing the height of the barrier to 2.5m, noise levels will be reduced by 2.9 dB(A).

The Gables, Cambus

7.10 Table 7 provides a comparison of the measured noise levels at The Gables with and without the mitigation in place.

Table 9: Comparison of Measured Noise Level at The Gables

	Without Mitigation in Place		With Mitigation in Place			
Date of Measurement	**27/01/09***	**28/01/09**	**23/05/12**	**24/05/12**	**02/08/12**	**03/08/12**
Total Measured Train Noise Level $L_{Aeq,18hr}$ (dB)	-	56.7	53.9	54.3	52.7	51.3
Measured Freight Train Noise Level $L_{Aeq,18hr}$ (dB)	-	54.3	52.6	52.9	51.3	49.3
Measured Passenger Train Noise Level $L_{Aeq,18hr}$ (dB)	-	52.9	48.0	48.8	47.1	47.1
No of Passenger Trains	-	34	41	41	41	41
No of Freight Trains	-	15	17	15	12	10

*No Measurements undertaken due to equipment failure

7.11 During the monitoring before and after acoustic mitigation was installed there was one day when the freight train numbers were the same to allow for a direct comparison of the noise levels.

7.12 The difference between the measured freight train $L_{Aeq,18hr}$ noise level between 28/01/09 and 24/05/12 was 1.4 dB(A).

7.13 It can be seen from Table 7 that there were 34 passenger trains during the monitoring period in 2009, before mitigation was installed and 41 passenger trains each day in 2012, after mitigation was installed. The number of train movements would indicate that the noise levels in 2012 should be higher than in 2009 if the barrier was not having any effect at this location. The difference between both measurement periods shows that the barrier is offering between a 4.9 dB(A) and 5.8 dB(A) reduction in respect of passenger trains even with an increase in the number of trains.

8 Conclusions

8.1 AECOM was instructed by Clackmannanshire Council and Transport Scotland to undertake noise monitoring to determine the effectiveness of mitigation, which was installed along the Stirling Alloa Kincardine Railway line following the findings of the AECOM Noise Modelling Report (Job No: 60051581 Reference: JN692DP) issued in October 2009.

8.2 The identified mitigation trigger level as defined within the Environmental Statement for mitigation is described in Section 4.

8.3 On-site train noise level measurements were undertaken on Wednesday 23rd May 2012, Thursday 24th May 2012, Thursday 2nd August 2012 and Friday 3rd August 2012 at eleven (ten during the August monitoring) selected existing residential properties along the route. At each location the microphone was positioned outside the closest window of interest, ground floor living room areas/bedroom area windows, where practicable.

8.4 From the measured results presented within Tables 4 and 5 it can be seen that all of the measured noise levels now fall within the identified mitigation trigger level as defined within the Environmental Statement, with the exception of 16 Ochil View during the May measurement period and one day of the August monitoring period and The Gables, during the May measurement period. At these properties the measured ambient noise levels, at a distance of 1m from the façade of the property is greater than $L_{Aeq,18hr}$ 55.0 dB and also subject to an increase in free-field noise level of 5 dB or more.

8.5 It should be appreciated that the Environmental Statement does not qualify the extent and effectiveness of the acoustic barrier and indeed advises that even with the acoustic mitigation recommended in the Environmental Statement there will be some properties which still be subject to noise levels above $L_{Aeq,18hr}$ 55.0 dB.

8.6 Further analysis of the noise levels at properties where the noise levels remain in excess of the identified mitigation trigger level as defined within the Environmental Statement has been undertaken to determine reasons why this is the case at the identified properties during the May measurement period.

8.7 At The Gables it has been determined that there has been a reduction in the noise levels from train noise as a consequence of acoustic mitigation. The total measured ambient noise levels exceed the mitigation trigger level by less than 1 dB. The exceedances are 0.1 dB and 0.4 dB, however the barrier is providing 1.4 dB(A) in respect of freight trains and between 4.9 – 5.8 dB(A) in respect of passenger trains.

8.8 At 16 Ochil View there has been a small reduction in the train noise level following the introduction of the acoustic barrier. The level of improvement is limited as a consequence of the proximity of the level crossing and the gap in the barrier. Further analysis of noise levels at this property has shown that by extending the barrier along the southern garden boundary by 17m and increasing the height of the barrier to 2.5m noise levels will be reduced by 2.9 dB and therefore would be predicted to meet with the mitigation criteria.

Appendix 1 – Glossary of Acoustical Terminology

Ambient Noise

Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

Background Noise

Background Noise is normally defined as the A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using time weighting, F, and quoted to the nearest whole number. However in this report background noise refers to the $L_{Aeq,T}$ noise level measured at each property in the absence of noise from train pass bys.

"A" Weighting (dB(A))

The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear. It is used in the assessment of risk of damage of hearing due to noise.

Decibel (dB)

The range of audible sound pressures is approximately 2×10^{-5} Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0dB to 140dB.

Mathematically:

Sound Pressure Level (dB) = $20 \log \{p(t)/P_o\}$
Where $P_o = 2 \times 10^{-5}$ Pa

Frequency (Hz)

The number of cycles per second, for sound this is subjectively perceived as pitch.

Frequency Spectrum

Analysis of the relative contributions of different frequencies that make up a noise.

L **A10,T**

The A-weighted sound pressure level of the residual noise in decibels exceeded for 10% for a given time interval. This is the parameter defined by the government to describe road traffic noise.

L **Aeq,T**

Equivalent Continuous A-weighted Sound Pressure Level. The value of the A-weighted sound pressure level in decibels of continuous steady sound within a specified time interval, T, has the same mean-square sound pressure as a sound that varies with time. It is quoted to the nearest whole number of decibels.

Noise

Unwanted sound.

L **Amax,fast**

The maximum RMS A-weighted sound pressure level occurring within a specified time period. Fast time weighting indicates sound pressure level measurements undertaken using a 125-millisecond moving average time weighting period.

Appendix 2 – Instrumentation Used

Equipment Used during May Noise Monitoring

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2507254

Brüel & Kjær Microphone Type 4189
Serial Number 2542984

Brüel & Kjær Sound Analysis Software BZ 5503

Brüel & Kjær Sound Level Calibrator Type 4231
Serial Number 2545421

Rion NL-52 Class 1 Sound Level Meter

Sound Level Meter: Serial No:	00410085
Microphone Model: UC-59:	02436
Pre-Amp NH-25:	10078
Sound Level Meter: Serial No:	00510142
Microphone Model: UC-59:	02847
Pre-Amp NH-25:	10135
Sound Level Meter: Serial No:	00810301
Microphone Model: UC-59:	02757
Pre-Amp NH-25:	10295
Sound Level Meter: Serial No:	00510148
Microphone Model: UC-59:	02853
Pre-Amp NH-25:	10141
Sound Level Meter: Serial No:	00410082
Microphone Model: UC-59:	02431
Pre-Amp NH-25:	10075
Sound Level Meter: Serial No:	00610193
Microphone Model: UC-59:	02535
Pre-Amp NH-25:	10187
Sound Level Meter: Serial No:	00320641
Microphone Model: UC-59:	00390
Pre-Amp NH-25:	10649
Sound Level Meter: Serial No:	00320640
Microphone Model: UC-59:	03389
Pre-Amp NH-25:	10648
Sound Level Meter: Serial No:	00320643
Microphone Model: UC-59:	03392
Pre-Amp NH-25:	10651
Sound Level Meter: Serial No:	00610205
Microphone Model: UC-59:	02547
Pre-Amp NH-25:	10199

Sound Level Meter: Serial No: 00610177
Microphone Model: UC-59: 02519
Pre-Amp NH-25: 10171

Rion NC-74 Class 1 Acoustic Calibrator
NC-74: 34494309

Equipment Used during August Noise Monitoring

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2507254

Brüel & Kjær Microphone Type 4189
Serial Number 2542984

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827271

Brüel & Kjær Microphone Type 4189
Serial Number 2820211

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827268

Brüel & Kjær Microphone Type 4189
Serial Number 2820203

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827274

Brüel & Kjær Microphone Type 4189
Serial Number 2820209

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827275

Brüel & Kjær Microphone Type 4189
Serial Number 2820210

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827263

Brüel & Kjær Microphone Type 4189
Serial Number 2799502

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827270

Brüel & Kjær Microphone Type 4189
Serial Number 2820205

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827266

Brüel & Kjær Microphone Type 4189
Serial Number 2820202

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827269

Brüel & Kjær Microphone Type 4189
Serial Number 2820204

Brüel & Kjær Hand Held Analyser Type 2250
Serial Number 2827273

Brüel & Kjær Microphone Type 4189
Serial Number 2820208

Brüel & Kjær Sound Analyser Type 2260
Serial Number 2391258

Brüel & Kjær Microphone Type 4189
Serial Number 2470805

Brüel & Kjær Sound Analysis Software BZ 5503

Brüel & Kjær Sound Level Calibrator Type 4231
Serial Number 2545421

Brüel & Kjær Sound Level Calibrator Type 4231
Serial Number 2389067