Midland Metro

6.4 Noise and Vibration

6.4.1 Introduction

This section of the ES evaluates the noise and vibration impacts arising from the operation of the Wednesbury to Brierley Hill scheme. There are two main potential impacts that can arise from light rail scheme such as this. These are:

- airborne noise – noise from the system which propagates through the air to the receptor;
- ground vibration – vibration from the system which propagates via the ground into a receptor building.

Where predictions show a potential for noise and/or vibration impacts, outline mitigation measures are set out. Any residual impacts remaining after mitigation has been applied are described.

Appendix E provides additional details of the noise and vibration assessment.

Much of the Wednesbury to Brierley Hill scheme will run along a currently mothballed heavy rail corridor where a heavy rail service could be operated in the future, subject to reinstatement of sections of track and replacement signals. This assessment considers the operation of the scheme in the absence of any heavy rail service only. However, in the event that the heavy rail scheme is operated in the future, there is potential for cumulative noise impacts to occur as a result of the operation of both schemes (ie Midland Metro and the heavy rail service). It is likely that noise from a heavy rail services would be higher than that from Midland Metro, so the cumulative impact of Midland Metro would be small. Since the future of a heavy rail service is not known at this stage, this assessment considers the worst case with regard to the impact of Midland Metro (ie the operation of Midland Metro service in the absence of any future heavy rail service).

6.4.2 Baseline Environment

Noise Sensitive Receptors

Representative noise sensitive receptors that may potentially be subject to noise impacts as a result of the operation of the scheme are shown in

Figure 6.1 and listed below in *Table 6.10*. These have been identified on the basis of mapping, aerial photographs and site visits.

Table 6.10 Noise Sensitive Receptors

Location	Approx. horizontal distance to works (m)	Approx no of properties within 25m	Nearest Building Usage(s)
Existing Rail Corridor – Wednesbury to Tipton Road			
1 - Potters Lane	75	0	Industrial
2 - Eyston Avenue	400	0	Industrial
3 - Bagnall Street	150	0	Industrial
4 - Solly Grove	100	0	Residential
5 - Moors Mill Lane	160	0	Residential
6 - Eagle Lane	15	10	Residential
7 - Eagle Lane (near stop)	16	10	Residential
8 - Market Place	131	0	Commercial
9 - Bramah Way/ St Helens Avenue	18	60	Residential
10 - Dovecote Close	18	15	Residential

11 - Heath Close	30	15	Residential
12 - Church Lane	25	5	Residential
13 - Park Lane East	17	2	Residential
14 - Keeling St / Dairy Close	20	2	Residential
15 - Station St / Smith Place	18	3	Residential
16 - Jays Avenue	37	0	Residential
17 - Tudor Court	11	15	Residential
18 - Harrowby Drive / Carnegie Avenue	13	40	Residential
19 - Peel Street / Victoria Road	26	0	Residential
20 - Peel Street (far houses)	62	0	Residential
21 - Binfield Street	25	2	Residential
22 - Binfield Street / Mayfair Gardens	35	0	Residential
23 - Boscobel Avenue	35	0	Residential
24 - Fernwood Croft	24	2	Residential
25 - Park Lane West	35	0	Residential
26 - Newcomen Drive	250	0	Residential
27 - Lindley Avenue	16	4	Residential
28 - Birmingham New Road	15	4	Residential
Dudley Centre – Tipton Road to Blowers Green Road			
29 - Former Dudley Freightliner Development Site: motel, residential	20 200		Mixed use development, including housing
30 - Guest Hospital Development Site	100	-	To be converted to mixed use with housing and some health facilities
31 - Wolverton Road	220	0	Residential
32 - Castle Hill	14	~20	Commercial/ Residential

33 - Dudley Central Mosque	10	1	Religious
34 - Bourne Street	35	0	Residential
35 - Hall Street	160	0	Commercial
36 - New Road (eastern side)	55	0	Residential
37 - New Road (western side)	80	0	Residential
38 - Shaw Road	75	0	Industrial
Existing Rail Corridor – Blowers Green Road to Pensnett Canal			
39 - Blowers Green Road	230	0	Industrial
40 - Parkhead Locks open space	10	-	Amenity
41 - Buxton Road / Kent Place	45	0	Residential
42 - Wood Street	45	0	Residential
43 - Cochrane Road	26	7	Residential
Merry Hill – Pensnett Canal to Brierley Hill			
44 - Pedmore Road	45	0	Industrial
45 - Waterfront Development	20	Includes a number of commercial units	Commercial/ Office
46 – Former Brier School Development Area	70	-	Site allocated for commercial and residential use
47 - Buddhist Temple	25	1	Religious

One consideration in assessing the noise impact of the scheme is the change in ambient noise levels that it produces at noise sensitive receptors. Accordingly, baseline noise surveys have been carried out close to potentially affected noise sensitive receptors to determine the existing noise levels. A baseline noise survey was undertaken by WS Atkins in November 1999 to establish daytime noise conditions at 41 receptor locations along the route. An additional survey was undertaken by ERM in May and June 2002, at a selection of the same locations. The purpose of the additional measurements was twofold:

- firstly to check that the baseline noise level has not changed noticeably since November 1999; and
- secondly to carry out noise measurements during the quieter early morning (0600 to 0700 hours) and late evening (2300 hours to midnight) periods when the scheme is proposed to operate.

The June 2002 noise survey was undertaken as 10 minute samples of ambient noise measured at the various positions along the proposed route adjacent to the relevant receptors. The L_{A10}, L_{A90}, L_{Aeq} and L_{Amax} noise levels were recorded using a calibrated SvanTech 945 precision (Type 1) sound level meter. The monitoring equipment was mounted on a tripod so that the microphone was in a free-field position approximately 1.5 m above ground level adjacent to the receptor.

The noise surveys were carried out over three separate site visits on Thursday 30 May, Thursday 6 June and the night of Wednesday 12 to

Thursday 13 June 2002. The times of the surveys were selected to record the noise levels at representative periods over the anticipated hours of operation of the Midland Metro system (0600 to midnight). Particular attention was paid to the periods at the beginning and the end of the operating period which fall within the 8 hour night-time period from 2300 to 0700 hours. Thus the survey on Wednesday 12 June covered the period from 2125 hours through until 0044 hours on 13 June 2002. In addition, early morning measurements were recorded between 0525 to 0750 hours on Thursday 13 June 2002.

Further night-time surveys were undertaken on the 12th and 13th February 2003 in order to determine noise levels during the quietest period in which the scheme is to operate (ie approximately 2300 to 0000 hours) at the critical receptors where noise impacts had been predicted. The surveys were extended to 2200 to 0100 in order to allow sufficient time to include the majority of receptors in the survey. Ambient noise samples of approximately 10 minutes duration were measured using a fully calibrated Bruel and Kjaer Sound Level Meter, Type 2260.

Based on the results of the night-time surveys, it would appear that the average noise levels during the night-time hours when Midland Metro will operate (2300 to 0000 and 0600 to 0700) are typically 6 dB lower than the average daytime noise levels. This relationship has been used to derive the night-time noise levels at the few remaining locations along the route that were not surveyed.

A summary of the daytime and night-time noise levels are detailed in *Table 6.11* below.

Table 6.11 Summary of Ambient Noise Levels (Free-field dB)

Measurement Location	**L_{Aeq} Daytime (0700-2300)**	**L_{Aeq} Night-time (0600-0700 & 2300 to midnight)**
Existing Rail Corridor – Wednesbury to Tipton Road		
1 - Potters Lane	55	49
2 - Eyston Avenue	55	49
3 - Bagnall Street	55	49
4 - Solly Grove	55	49
5 - Moors Mill Lane	55	47
6 - Eagle Lane	60	50
7 - Eagle Lane (near station)	58	50
8 - Market Place	55	49
9 - Bramah Way/ St Helens Avenue	51	46
10 - Dovecote Close	51	43
11 - Heath Close	54	43
12 - Church Lane	60	54
13 - Park Lane East	62	59
14 - Keeling St / Dairy Close	60	42
15 - Station St / Smith Place	62	56
16 - Jays Avenue	62	50
17 - Tudor Court	55	50

18 - Harrowby Drive / Carnegie Avenue	52	42
19 - Peel Street / Victoria Road	55	43
20 - Peel Street (far houses)	50	43
21 - Binfield Street	51	42
22 - Binfield Street / Mayfair Gardens	50	54
23 - Boscobel Avenue	50	48
24 - Fernwood Croft	50	48
25 - Park Lane West	50	47
26 - Newcomen Drive	50	42
27 - Lindley Avenue	48	41
28 - Birmingham New Road	60	56
Dudley Centre – Tipton Road to Blowers Green Road		
29 – Former Dudley Freightliner Depot	54	48
30 - Guest Hospital	60	54
31 - Wolverton Road	65	59
32 - Castle Hill	71	65
33 – Dudley Central Mosque	67	61
34 - Bourne Street	70	64
35 - Hall Street	70	64
36 - New Road (eastern side)	65	59
37 - New Road (western side)	65	59
38 - Shaw Road	65	59
Existing Rail Corridor –Blower's Green Road to Pensnett Canal		
39 - Blowers Green Road	57	51
40 – Parkhead Locks open space	68	62

41 - Buxton Road / Kent Place	48	44
42 - Wood Street	55	51
43 - Cochrane Road	55	50
Merry Hill – Pensnett Canal to Brierley Hill		
44 - Pedmore Road	60	54
45 - Waterfront Development	51	45
46 – Former Brier School Development Area	51	45
47 - Buddhist Temple	51	45

Appendix E gives further details of the noise survey results. Although this baseline data is considered adequate for the EIA the Concessionaire will undertake a further, more detailed survey.

Ambient noise conditions along the route are discussed below.

Existing Route Corridor – Wednesbury to Tipton Road

A new junction on a viaduct adjacent to the Parkhill Estates Development off Smith Road will join the existing Line 1 to the alignment of the proposed scheme. The alignment follows the mothballed railway corridor, which passes through a predominantly industrial area until it reaches the Walsall Canal. The proposed Midland Metro route lies on the north-west side of the heavy rail route. Midland Metro will consist of a double track formation throughout this section, except for a short section at Dudley Port. Measurements of existing noise conditions undertaken in residential areas that may be affected by the proposal, indicate noise levels of 55 dB L_{Aeq}. These areas are presently affected by noise from the existing Line 1 of Midland Metro or by noise from road traffic on the A41 road. A provisional stop is located at Gold's Hill.

The proposed route continues west along the mothballed railway alignment, as a double track route. A tram stop is to be constructed in the vicinity of New Road and Eagle Lane. The alignment passes close to housing, with industrial premises on the south east side. It is anticipated that the Great Bridge Junior and Infant School will largely be shielded from any noise by the existing housing. Measurements on Eagle Lane, Bramah Way and St Helens Avenue indicate daytime noise levels in the range 51 to 58 dB L_{Aeq} with night-time noise levels falling to 46 to 50 dB L_{Aeq} (during the periods 2300 to midnight and 0600 to 0700 hours).

The proposed route continues along the mothballed railway alignment with housing on both sides. The alignment will be required to accommodate three lines along the majority of this section. This will consist of two for the tram system and one for the railway, apart from through the bridges under the West Coast Mainline (WCML) and the Birmingham canal, where only two lines are proposed; one for freight and one bi-directional line for the Midland Metro system. Tram stops are located at Horseley Road and at Dudley Port, adjacent to the WCML.

Measurements of existing noise conditions undertaken in the surrounding residential areas indicate daytime noise levels of typically 50 to 60 dB L_{Aeq}, with the quieter noise levels being experienced away from the WCML at Dovecote Close, Heath Close and at Harrowby Drive and Carnegie Avenue. Night-time noise levels in these areas are typically 42 to 46 dB L_{Aeq} (during the periods 2300 to midnight and 0600 to 0700 hours).

The proposed route continues parallel to the heavy rail route with housing along the north side of the track. The south side of the alignment is mainly, but not exclusively industrial. Three tram stops are proposed along this section at Sedgley Road East, east of Birmingham New Road and east of Tipton Road, where the proposed alignment leaves the railway corridor.

Throughout this section (except at the western end close to Birmingham New Road) current ambient noise levels are low. Measurements of existing daytime noise conditions, undertaken in residential areas along the route, range from 48 to 60 dB L_{Aeq}, the latter at Birmingham New Road due to influence of the existing road traffic flows. Away from Birmingham New Road the night-time noise levels are typically 41 to 47 dB L_{Aeq} (during the periods 2300 to midnight and 0600 to 0700 hours).

Dudley Centre – Tipton Road to Blowers Green Road

From Tipton Road the alignment passes through the former Dudley Freightliner depot on an embankment. Dudley MBC have issued a development brief for this site which includes housing, open space, leisure and food and drink. The route joins Castle Hill at the junction with Station Drive, where a provisional stop is located, and Trindle Road and runs along the central reservation of Castle Hill, before turning along Birmingham Street (North), into a remodelled bus station, where a tram stop is to be provided. The route then leaves the bus station along Birmingham Street (South) and King Street, and turns south adjacent to a remodelled Flood Street, before following Dudley Southern By-pass. A provisional stop is located on Flood Street. A stop is also located at New Road, adjacent to Dudley Southern By-pass.

Noise measurements in Dudley town centre indicate higher noise levels of between 65 to 71 dB L_{Aeq}. During the evening noise levels typically range between 54 and 64 dB L_{Aeq}.

Existing Rail Corridor – Blowers Green Road to Pensnett Canal

Along the full length of this section the proposed route runs in a shared formation, immediately to the south of the heavy rail line. For a distance of around 40 m over the existing Parkhead Viaduct the tram route will be single track. Tram stops are located at Cinder Bank, adjacent to Blower's Green Road and at Pedmore Road. A provisional stop is also provided at Canal Street.

On the eastern side of the Parkhead Viaduct the alignment runs through a predominantly industrial area. To the west of the area is mainly residential with open space adjacent to the Parkhead Locks. Industrial premises are located further north. Measurements of existing daytime noise conditions, undertaken at the locations within the vicinity of the route indicate noise levels between 48 to 62 dB L_{Aeq}. Night-time noise levels around the residential Pedmore Road area are around 54 to 56 dB with the relatively busy A4036 the major source of noise.

Merry Hill – Pensnett Canal to Brierley Hill

The final section of the alignment beyond Canal Street runs alongside commercial, retail and industrial land-uses. Noise sensitive receivers include the site of the former Brier School, which is subject to redevelopment proposals for residential and commercial uses, and the Buddhist Temple on Cottage Street. A hearing clinic is also located adjacent to Brierley Hill terminus on Cottage Street. Stops are located at the Waterfront development, Merry Hill and at the terminus. Measurements of the ambient noise within this area indicate noise levels in the region of 51 dB L_{Aeq}.

6.4.3 Assessment Methodology

Airborne Noise

Noise from new developments is often assessed in two ways:

- by comparing the levels of noise that are expected to be generated against absolute noise standards, such as those that indicate likely annoyance of disturbance with everyday activities; and/or
- by considering the change in ambient noise that will occur with the development in operation.

This assessment adopts both approaches using the following method.

Section E1.3 of *Appendix E* summarises the guidance offered in Planning Policy Guidance (PPG) 24 ([19]) and the statutory provisions of the Noise Insulation (Railways and other Guided Transport Systems) Regulations 1996. The way in which these relate to the proposed scheme is also described. The following standards for absolute (free-field) noise levels can be drawn from them.

Threshold of noise impacts: Day - $L_{Aeq,\ (0700\text{-}2300\ hours)}$ 55 dB

Night - $L_{Aeq,\ (2300\text{-}0700\ hours)}$ 45 dB

Unacceptable impact: Day - $L_{Aeq,\ (0600\text{-}2400\ hours)}$ 66 dB

Night - $L_{Aeq,\ (2400\text{-}0600\ hours)}$ 61 dB

It should be noted that the threshold levels are not specifically relevant to new rail development and there are no statutory requirements to achieve them. Instead they can be considered generally desirable noise levels.

Noise from the scheme will thus fall into one of three bands as follows.

1. Tram noise below threshold criteria – no impact.
2. Tram noise between threshold and unacceptable criteria – impacts depend on baseline noise level.
3. Tram noise above unacceptable criteria – severe impacts expected depending on baseline noise level.

Clearly, if the level of tram noise is below ambient noise, tram noise will be less noticeable and impacts are less likely. Hence a second tier of assessment is required in cases 2 and 3. In case 2 the predicted level of tram noise is added to the measured ambient noise level to establish the change in noise that would be expected, and this is assessed using the significance rating given in the Institute of Acoustics and the Institute of Environmental Assessment and Management's draft guidance on the Assessment of Environmental Noise ([20]). In case 3, the Noise Insulation Regulations require that an increase of only 1dB due to the new noise be mitigated (see *Appendix E* for details). *Table 6.12* below summarises the tram noise assessment criteria.

Table 6.12 Summary of Noise Assessment Criteria

Predicted Tram Noise Level $L_{Aeq,\ period}$	**Increase in Ambient (L_{Aeq}) Noise**	**Impact Descriptor**
Case 1		
Day < 55 dB (0700-2300 hrs)	N/A	No Impact
Night < 45 dB (2300-0700 hrs)	N/A	No Impact

Case 2		
Day > 55 dB (0700-2300 hrs) < 66 dB (0600-2400 hrs).	< 1 dB 1 to 3 dB 3 to 5 dB 5 to 10 dB >10 dB	No impact Slight impact Moderate impact Substantial impact Severe impact
Night >45 dB (2300-0700 hrs) < 61 dB (2400-0600 hrs)	< 1 dB 1 to 3 dB 3 to 5 dB 5 to 10 dB >10 dB	No impact Slight impact Moderate impact Substantial impact Severe impact
Case 3		
Day > 66 dB (0600-2400 hrs).	>1 dB	Significant impact, need for noise insulation triggered
Night > 61 dB (2400-0600 hrs)	>1 dB	Significant impact, need for noise insulation triggered

Maximum pass-by noise levels (L_{Amax}, the instantaneous 'peak' as the tram passes) are assessed against the PPG24 82 dB free-field noise standard for sleep disturbance.

In Case 3, there is a statutory requirement to offer noise insulation as a mitigation measure. In such situations Centro will preferably develop adequate mitigation measures at source, but if this is unsuccessful noise insulation will be provided to effected properties in accordance with the Noise Insulation (Railways and other Guided Transport Systems) Regulations 1996.

At the lower levels of noise impact in Case 2, there is no statutory requirement for mitigation. However, consideration will be given to developing mitigation measures where significant impacts are predicted and where it is reasonable and appropriate to do so. For example, if the sleep disturbance assessment criterion (L_{Amax} 82 dB) is exceeded, then mitigation at source will be provided as a priority if it is feasible to do so. It is recognised that a combination of many local factors will determine if noise mitigation is appropriate, including practicability, railway safety considerations, environmental dis-benefits (including visual impact and severance), numbers of people affected and cost effectiveness. These negative factors may outweigh the noise benefits of a noise barrier in more marginal cases (ie towards the lower end of Case 2). Mitigation is discussed further below.

Ground Vibration

Vibration Dose Value (VDV) is a measure of the accumulated level of ground vibration over a period and, through the application of BS 6472 ([21]) is the standard metric for predicting the likelihood of adverse comments from effected building occupants. The standard gives the following VDV levels at or below which the probability of adverse comments is low:

- Day (0700-2300 hours) 0.4 $m/s^{1.75}$; and
- Night (2300-0700 hours) 0.1 $m/s^{1.75}$.

These criteria have been used in this report as the basis of the assessment.

In addition to human perception of accumulated vibration, the movement of trams could potentially give rise to disturbing levels of ground vibration or groundborne noise for the brief period while the tram passes by particularly sensitive properties. Ground vibration is potentially perceptible above peak particle velocities (PPVs) of 0.1 mm/s rms, but higher levels are often experienced from other sources, and will often be acceptable.

There may also be concern that vibration from tram vehicles could damage building structures, particularly in the case of listed buildings. Vibration levels above which damage may potentially occur are as follows:

- reinforced or framed buildings 50 mm/s PPV; and
- un-reinforced or light framed buildings 15 mm/s PPV.

Groundborne noise (ie noise radiating from the ground within a receptor as a result of ground vibration) from the tram system will generally be at levels below noise arriving via the conventional airborne path, and for this reason is generally more of a concern for underground railways where

airborne noise is absent. However, particularly sensitive buildings, that may be well insulated against external airborne noise sources, could potentially be effected. A noise standard of L_{Amax} 40 dB is often adopted on underground railways, but may not be appropriate for special buildings housing particularly noise-sensitive uses.

6.4.4 Prediction Methodology

Noise

The established methodology for predicting noise from railways in the UK is the Calculation of Railway Noise (CRN), produced by the Department of Transport in 1995. It is a chart-based method developed for wide application to railways in the UK, and it advocates the use of noise measurements wherever possible. It is important to note that several particular features of the scheme are not typical of the type of railways for which the CRN prediction methodology was principally developed, namely:

- tram lengths are short;
- tram speeds are low;
- receivers are very close in some areas; and
- street-running track is used on short sections of the route (ie Dudley town centre and at Brierley Hill).

The noise predictions have been carried out using a spreadsheet noise model implementing calculation routines based on the CRN procedure. The source noise levels for the street running operation were based on measurements taken on Midland Metro Line 1 in Wolverhampton and reference to other comparable street-running systems. The source noise levels for ballasted track sections were based on a series of measurements undertaken by WS Atkins on the Midland Metro Line 1 together with measurements recorded by ERM close to Wednesbury Parkway stop (also on Line 1 of the Midland Metro).

Positional information relating to receiver buildings, reflective structures, terrain and the rail tracks were extracted from 1:1000 Ordnance Survey mapping and engineering drawings, and site inspections.

The frequency of the proposed service is a further important factor in determining L_{Aeq} noise levels. For the purposes of this assessment, the following future train service has been assumed:

- service start – 0600 hours;
- service finish – midnight;
- peak hours (0700-1900) Monday to Saturday– one vehicle every 6 minutes in each direction; and
- off-peak hours (other times, and all day Sunday) – one vehicle every 10 minutes in each direction.

Thus, in the peak daytime hour there will be one train pass-by every three minutes, and in the start-up and shut-down night-time hours (0600 to 0700 hours and 2300 to 0000) there will be a vehicle pass-by every five minutes.

Vibration

Estimates of levels of ground vibration have been made based on levels measured adjacent to comparable systems, including a detailed investigation into vibration levels from Phase 1 of the Manchester Metrolink in 1996 ([22]). The study involved 150 train pass-by vibration measurements, at four locations involving street running operation and three locations involving ballasted track running. The trackform of street running sections comprised welded rail mounted in an Edilon lined resilient trench. The results are summarised below in *Tables 6.13* and *6.14*.

Table 6.13 Measured Vibration Levels from the Manchester Metrolink – Street Running Sections at Full Speed

Distance to nearest rail (m)	Peak particle velocity (mm/s)	Weighted acceleration (m/s^2)	Estimated VDV_{day} ($m/s^{1.75}$)(1)
1 to 3	1.5 to < 2.0	0.06 to < 0.1	0.5 to < 1.0
3 to 5	1.0 to 1.2	0.03 to 0.06	0.2 to 0.5
5 to 10	0.6 to 1.0	0.01 to 0.03	0.08 to 0.2
10 to 15	0.3 to 0.6	0.005 to 0.01	0.03 to 0.08
15 to 20	0.15 to 0.3	0.003 to 0.005	0.015 to 0.03
(1) Vibration Dose Value			

Table 6.14 Measured Vibration Levels from the Manchester Metrolink – Ballasted Track Sections (at full speed)

Distance to nearest rail (m)	Peak particle velocity (mm/s)	Weighted acceleration (m/s^2)	Estimated VDV_{day} ($m/s^{1.75}$)(1)
1 to 3	0.8 to < 1.2	0.03 to < 0.06	0.25 to < 0.5
3 to 5	0.6 to 0.8	0.018 to 0.03	0.13 to 0.25
5 to 10	0.45 to 0.6	0.011 to 0.018	0.07 to 0.13
10 to 15	0.25 to 0.45	0.005 to 0.011	0.03 to 0.07
15 to 20	0.1 to 0.25	0.003 to 0.005	0.015 to 0.03
(1) Vibration Dose Value			

In addition, the design standard for the system includes a requirement that ground-borne vibration levels should not exceed a peak particle velocity level of 2mm/s, when assessed over any axis within a frequency bandwidth of 10-200Hz, measured 1 metre from the outside rail.

It is anticipated that the scheme will incorporate some form of resilient track mounting system for the street running sections through Dudley and Brierley Hill town centres. Given that the Edilon system (used on Manchester Metrolink) is not considered to be of a particularly high performance, the levels tabulated above are considered to provide a reasonably pessimistic estimate of the ground vibration levels that can be expected. The segregated section of the alignment will be laid with ballast track.

6.4.5 Noise Impacts

Table 6.15 summarises the predictions of noise from the operation of trams along the alignment. The first column of noise levels gives the predicted daytime peak hour noise levels, using the estimated operating speed and screening effect tabulated alongside. At this stage it has been necessary to use a simplistic method of estimating likely noise screening effects because the final track alignment and cutting/embankment profiles are not fixed.

The second column of noise levels shows the measured existing ambient noise level at each location. The third column gives the total noise arising from both the Metro and the current ambient noise. The fourth column gives the increase in ambient noise caused by the operation of Midland Metro.

The subsequent columns provide a corresponding assessment for the night-time periods when Midland Metro will be operating (2300 to 0000 and 0600 to 0700). Night-time noise predictions are omitted where the receptor is not residential, ie not sensitive to night-time noise impacts. The expected number of vehicles per hour during the night-time period is lower than during the day. This results in predicted $L_{Aeq,\ 1\ hour}$ noise levels during these night-time periods that are approximately 2 dB lower than during the day.

The final column gives the predicted peak (L_{Amax}) noise level.

Table 6.15 Summary of Predicted Noise Levels and Increases in Ambient Noise (dB $L_{Aeq,\ 1\ hour}$ free-field)

Representative Receptor		Estimated Speed (kph)	Estimated Screening (1)	Daytime				Night-time (0600-0700 and 2300-midnight) (2)				$L_{Amax,F}$ noise level
				Predicted noise level (peak hr)	Measured Ambient	Resulting total level	Change in $L_{Aeq\ 1\ hr}$	Predicted Noise Level (night hr)	Measured Ambient	Resulting total level	Change in $L_{Aeq\ 1\ hr}$	
1	Potters Lane	45	0	50.3	55	56	1					59
2	Eyston Avenue	55	0	44.3	55	55	0					46
3	Bagnall Street	50	0	48.0	55	56	1					54

4	Solly Grove	55	5	45.3	55	55	0	43.3	49	50	1	53
5	Moors Mill Lane	55	5	43.3	55	55	0	41.3	47	48	1	49
6	Eagle Lane	55	5	53.6	60	61	1	51.6	50	54	4	69
7	Eagle Lane (near station)	45	5	52.0	58	59	1	50.0	50	53	3	68
8	Market Place	60	5	44.7	55	55	0					51
9	Bramah Way / St Helens Drive	68	5	54.1	51	56	5	52.1	46	53	7	69
10	Dovecote Close	45	5	51.5	51	54	3	49.5	43	50	7	67
11	Heath Close	50	5	50.0	54	55	1	48.0	43	49	6	63
12	Church Lane	68	5	52.6	60	61	1	50.6	54	56	2	66
13	Park Lane East	45	5	51.8	62	62	0	49.8	59	59	0	67
14	Keeling St / Dairy Close	50	5	51.7	60	61	1	49.7	42	50	8	66
15	Station Street / Smith Place	35	5	50.0	62	62	0	48.0	56	57	1	66
16	Jays Avenue	60	0	55.2	62	63	1	53.2	50	55	5	67
17	Tudor Court	68	0	61.2	55	62	7	59.2	50	60	10	78
18	Harrowby Drive / Carnegie Avenue	75	0	61.1	52	62	10	59.1	42	59	17	77
19	Peel Street / Victoria Road	55	0	56.2	55	59	4	54.2	43	54	11	69
20	Peel Street (far house)	45	0	51.2	50	54	4	49.2	43	50	7	61
21	Binfield Street	45	0	55.1	51	57	6	53.1	42	53	11	69
22	Binfield Street / Mayfair Gardens	35	2	50.1	50	53	3	48.1	54	55	1	63

23	Boscobel Avenue	55	2	52.9	50	55	5	50.9	48	53	5	65
24	Fernwood Croft	62	2	55.2	50	56	6	53.2	48	54	6	69
25	Park Lane West	75	2	54.8	50	56	6	52.8	47	54	7	66
26	Newcomen Drive	68	2	45.6	50	51	1	43.6	42	46	4	49
27	Lindley Avenue	75	2	58.2	48	59	11	56.2	41	56	15	73
28	Birmingham New Road	45	2	55.3	60	61	1	53.3	56	58	2	71
29	Dudley Freightliner Depot	45	2	54.1	54	57	3	52.1	48	54	6	67
30	Guest Hospital	65	0	51.3	60	61	1	49.3	54	55	1	58
31	Wolverton Road	50	0	46.3	65	65	0	44.3	59	59	0	50
32	Castle Hill	50	0	60.3	71	71	0	58.3	65	66	1	75
33	Dudley Central Mosque	45	0	61.7	67	68	1					
34	Bourne Street	50	0	56.3	70	70	0	54.3	64	64	0	68
35	Hall Street	60	0	50.8	70	70	0					
36	New Road (east houses)	60	0	53.4	65	65	0	51.4	59	60	1	65
37	New Road (west house	60	0	51.8	65	65	0	49.8	59	59	0	62
38	Shaw Road	55	0	51.6	65	65	0					
39	Blowers Green Road	65	0	47.7	57	57	0					
40	Parkhead Locks open space	70	0	61.8	68	69	1					
41	Buxton Road / Kent Place	80	5	51.1	48	53	5	49.1	44	50	6	63

42	Wood Street	80	5	53.1	55	57	2	51.1	51	54	3	63
43	Cochrane Road	65	0	57.2	55	59	4	55.2	50	56	6	72
44	Pedmore Road	65	0	49.8	60	60	0	47.8	54	55	1	67
45	Waterfront Development	65	0	58.3	51	59	8					
46	Former Brier School Development Area	45	0	50.6	51	54	3	48.6	45	50	1	59
47	Buddhist Temple	45	0	56.1	51	57	6					

(1) Screening has been estimated as being 5dB when track is in a cutting, 2dB for an embankment and 0dB when the track is at receptor level estimated as being 5dB when track is in a cutting, 2dB for an embankment and 0dB when the track is at receptor level.

(2) Night-time noise levels have been predicted for residential properties only.

The addition of Midland Metro noise to the existing noise environment is expected to raise ambient noise levels at the majority, but not all receptors, by varying amounts. Whether or not this is significant depends not only on the size of the expected increase in noise but also on whether the absolute levels of tram noise are above the threshold levels for noise impacts during the day or night. The predicted noise levels are above the impact threshold levels for approximately half of the receptors. *Table 6.16* below summarises the potential impacts by reporting both the changes in day and night levels given above, and the exceedences of the day and night-time threshold values.

When averaged over a full 8 hour (2300 to 0700) night (for comparison with the PPG24 guidance level) the $L_{Aeq,\ 8\ hour}$ night level is 6 dB lower than the $L_{Aeq,\ 2300\text{-}2400}$ and $L_{Aeq\ 600\text{-}0700}$ hourly levels, which are themselves 2 dB lower than the $L_{Aeq\ peak\ hour}$ daytime level.

In no case are the noise insulation thresholds or the L_{Amax} standard exceeded.

Table 6.16 also outlines approximate numbers of receptors affected in cases where there are impacts of greater than 3dB, ie above 'slight' are predicted.

Table 6.16 Assessment of Noise Impacts

Representative Survey Position	Daytime (0700 – 2300)				Night-time (2300 – 0700)				Size of overall Impact (dB)	Comments
	Metro noise level $L_{Aeq,\ peak\ hour}$	Change in $L_{Aeq,\ peak\ hour}$	Exceedance of 55dB $L_{Aeq,\ 16\ hr}$ ([23])	Significance of Impact	Metro noise Level $L_{Aeq,\ 1\ hour}$ ([24])	Change in L_{Aeq} 1 hour level (dB)	Exceedance of 45 dB $L_{Aeq,\ 8hr}$ ([25])	Significance of Impact		
Existing Rail Corridor – Wednesbury to Tipton Road										
1 - Potters Lane	50.3	1	0	None					0	
2 - Eyston Avenue	44.3	0	0	None					0	
3 - Bagnall Street	48.0	1	0	None					0	

4 - Solly Grove	45.3	0	0	None	43.3	1	0	None	0	
5 - Moors Mill Lane	43.3	0	0	None	41.3	1	0	None	0	
6 - Eagle Lane	53.6	1	0	None	51.6	4	1	Slight	1	
7 - Eagle Lane (near station)	52.0	1	0	None	50.0	3	0	None	0	Care required in the layout of the tram stop to minimise noise from announcements etc.
8 - Market Place	44.7	0	0	None	42.7	1	0	None	0	
9 - Bramah Way/ St Helens Avenue	54.1	5	0	None	52.1	7	1	Slight	1	Approx 60 properties. The profile of the cutting may (already) provide some of the required acoustic screening.
10 - Dovecote Close	51.5	3	0	None	49.5	7	0	None	0	
11 - Heath Close	50.0	1	0	None	48.0	6	0	None	0	
12 - Church Lane	52.6	1	0	None	50.6	2	0	None	0	
13 - Park Lane East	51.8	0	0	None	49.8	0	0	None	0	
14 - Keeling Street / Dairy Close	51.7	1	0	None	49.7	8	0	None	0	
15 - Station Street / Smith Place	50.0	0	0	None	48.0	1	0	None	0	Care required in the layout of the Tram Stop to minimise noise from announcements etc
16 - Jays Avenue	55.2	1	0	None	53.2	5	2	Slight	2	
17 - Tudor Court	61.2	7	6	Substantial	59.2	10	8	Substantial	8	20- 40 properties (may include part of Jays Avenue)
18 - Harrowby	61.1	10	6	Substantial	59.1	17	8	Substantial	8	Up to 40

Drive/Carnegie Avenue										properties
19 - Peel Street / Victoria Road	56.2	4	1	Slight	54.2	11	3	Slight	3	
20 - Peel Street (far houses)	51.2	4	0		49.2	7	0	None	0	Care required when reconstructing bridge deck - to avoid noise amplification.
21 - Binfield Street	55.1	6	0	None	53.1	11	2	Slight	2	
22 - Binfield Street / Mayfair Gardens	50.1	3	0	None	48.1	1	0	None	0	Care required in the layout of the tram stop.
23 - Boscobel Avenue	52.9	5	0	None	50.9	5	0	None	0	
24 - Fernwood Croft	55.2	6	0	None	53.2	6	2	Slight	2	
25 - Park Lane West	54.8	6	0	None	52.8	7	2	Slight	2	
26 - Newcomen Drive	45.6	1	0	None	43.6	4	0	None	0	
27 - Lindley Avenue	58.2	11	3	Slight	56.2	15	5	Moderate	5	Approx 30 properties
28 - Birmingham New Road	55.3	1	0	None	53.3	2	2	Slight	2	Care required when reconstructing bridge deck – to avoid noise amplification.
Dudley Centre – Tipton Road to Blowers Green Road										
29 – Dudley Freightliner	54.1	3	0	None	52.1	6	1	Slight	1	
30 - Guest Hospital	51.3	1	0	None	49.3	1	0	None	0	
31 - Wolverton Road	46.3	0	0	None					0	
32 - Castle Hill	60.3	0	5	None	58.3	1	7	Slight	1	
33 – Dudley	61.7	1	6	Slight					1	

Central Mosque										
34 - Bourne Street	56.3	0	1	None	54.3	0	3	None	0	
35 - Hall Street	50.8	0	0	None					0	
36 - New Road (east)	53.4	0	0	None	51.4	1	0	None	0	
37 - New Road (west)	51.8	0	0	None	49.8	0	0	None	0	
38 - Shaw Road	51.6	0	0	None					0	
Existing Rail Corridor – Blower's Green Road to Pensnett Canal										
39 - Blowers Green Road	47.7	0	0	None					0	
40 – Parkhead Locks	61.8	1	6	Slight					1	
41 - Buxton Road / Kent Place	51.1	5	0	None	49.1	6	0	None	0	
42 - Wood Street	53.1	2	0	None	51.1	3	0	None	0	
43 - Cochrane Road	57.2	4	2	Slight	55.2	6	4	Moderate	4	Approx 20 properties
Merry Hill – Pensnett Canal to Brierley Hill										
44 - Pedmore Road	49.8	0	0	None	47.8	1	0	None	0	
45 – Waterfront Development	58.3	8	3	Slight					3	
46 – Former Brier School Development Area	50.6	3	0	None	48.6	1	0	None	0	
47 – Buddhist Temple	56.1	6	1	Slight					1	

The findings of the assessment show that slight impacts are expected to occur at fourteen locations. Whilst not desirable, these impacts are less than 3dB in excess of the stringent standards adopted for this assessment, and are not considered to be significant impacts. Mitigation is therefore not considered to be necessary.

There are four locations at which impacts greater than slight are predicted to occur. Predicted impacts at Lindley Avenue and at Cochrane Road are classed as moderate, and predicted impacts at Tudor Court and Harrowby Drive are classed as substantial. In all cases the potential for noise impact is greatest in the two hours of the night when Midland Metro is expected to operate (2300 hours to midnight and 0600 to 0700 hours), although daytime impacts are also predicted in most cases, but to a lesser extent. Whilst residential receptors are more sensitive to noise impacts in these night-time hours (as reflected in the stricter assessment criteria) these impacts will be of lesser duration than the daytime ones and could be considered less significant as a result.

With regard to the night-time period adopted in the Noise Insulation Regulations (midnight to 0600 hours) Midland Metro will make no noise. However, if local conditions permit, and practicable cost effective mitigation measures are available, the impacts described above should preferably be mitigated.

This assessment considers suitable internal noise standards based on open windows, and if windows are closed at least 10 dB of mitigation is provided to internal areas, ie sufficient to mitigate all the impacts predicted. Mitigation measures and residual impacts are discussed in more detail below.

In addition noise will be generated by audible announcements, Midland Metro vehicle door alarms and movement alarms. Mitigation measures will be considered for the proposed stops at Great Bridge, Horseley Road, Dudley Port, Sedgley Road East, Birmingham New Road and Pedmore Road. For example, quieter levels of announcements may be used at these sensitive locations, commensurate with the lower ambient noise levels.

6.4.6 Assessment of Vibration Impacts

The expected levels of ground vibration are below the criteria in *Section 6.4.3*, which relate to the structural integrity of buildings. Consequently, no impacts on buildings located adjacent to the scheme are expected to occur.

Ground vibration may be perceptible at receptors within approximately 20 m of the line (depending on final design details) such as the closest houses in Eagle Lane, Bramah Way, Dovecote Close, Station Street, Tudor Court, Harrowby Drive, Lindley Avenue, Mayfair Gardens, Birmingham New Road, Castle Hill, the Dudley Central Mosque and the Buddhist Temple in Brierley Hill. However, the estimated VDV levels of ground vibration are not expected to exceed the 0.4 $m/s^{1.75}$ daytime assessment criterion at distance beyond approximately 4 m from the tracks. Hence, whilst vibration may be

perceptible in some areas, due to its transient nature and low levels, is not expected to give rise to adverse comment and impacts are not expected to occur.

The Dudley Central Mosque and the Buddhist Temple in Brierley Hill may be particularly sensitive to noise and vibration impacts. If these buildings are well insulated from airborne noise, groundborne noise could potentially be more noticeable within them at quiet times. However, given the distance of separation of these buildings from the alignment unacceptable noise levels are not expected to occur.

6.4.7 Noise and Vibration Implications for the Wider Midland Metro Network

The Wednesbury to Brierley Hill scheme will necessitate expansion of the Midland Metro vehicle fleet and could potentially lead to an increase in the level of service on the existing line. Midland Metro vehicles operating on the extension could run directly onto Line 1, or alternatively passengers from Brierley Hill or Wolverhampton may have to change at Wednesbury in order to access Birmingham city centre. This will be decided by the Concessionaire in view of future demands for services. In either event the frequency of service on Line 1 could be increased leading to increases in period-averaged (L_{Aeq}) noise levels. Noise increases are not expected to be significant, (ie no greater than 3dB) and the option that introduces newer, potentially quieter vehicles could help to offset any increase on the existing line.

Experience of similar projects has shown that maintenance of the vehicles and the track is vital to minimising noise levels throughout the lifetime of the system. Centro is committed to a maintenance regime (this will be the responsibility of the Concessionaire) aimed at ensuring unnecessary increases in noise levels are avoided across the network.

6.4.8 Indirect and Cumulative Impacts due to Possible Heavy Rail

Where the existing heavy rail alignment has been adjusted to make way for Midland Metro there is a potential for an implied indirect impact caused by the relocation of that potential future noise source as a result of the Wednesbury to Brierley Hill scheme. For example, in some areas it will be necessary to slew the existing heavy rail alignment in order to accommodate the Midland Metro, such that they are located closer to residential properties than they would otherwise be. In reality these realignments will generally move the heavy rail tracks small distances compared to the separation of the tracks from sensitive receivers, so implied changes in heavy rail noise levels will be small. However, there may be some change in noise levels.

No detail of the future heavy rail proposals was available at the time of this assessment, other than it being a possibility. The use of a shared rail corridor for much of the proposed scheme has potential for two additional forms of noise impact, in addition to the 'direct' noise impacts of the Midland Metro vehicles assessed in this report. Where Midland Metro is to run though shared formation a heavy rail freight service could be introduced in the future, running a typical slow speed diesel freight service of perhaps one freight train per hour.

There is also the potential for cumulative noise impacts from the two train systems, although noise levels produced by the freight service are expected to be higher than those from Midland Metro.

6.4.9 Potential Impacts due to Changes in Road Traffic

Traffic data from the Transport Assessment (TA) ([26]) for the scheme centres around the Brierley Hill area. A significant decrease in the level of traffic is predicted along The Embankment, giving rise to a slight decrease in noise levels, of around 2 dB (assuming traffic speed and composition remain largely unaffected). A marginal increase in noise levels along Pedmore Road, approximately 1dB, is expected due to an estimated increase in traffic of around 20%. All other routes considered in the traffic assessment, including Dudley Road, Waterfront Way, High Street, Mill Street, Merry Hill and The Boulevard show estimated increases and decreases in traffic of less than 10%, which equate to an insignificant change in noise levels.

Consequently, no significant traffic-related noise impacts are expected to occur as a result of the proposed scheme.

6.4.10 Summary of Residual Impacts

Noise

Noise impacts have been assessed against the most stringent noise impact threshold criteria, taking into account changes in ambient noise expected to result from the proposed scheme. As a result, potentially significant noise impacts have been predicted in four areas (Lindley Avenue, Cochrane Road, Tudor Court and Harrowby Drive) affecting up to approximately 130 properties. Mitigation measures will be considered for each of these properties, although there is no statutory requirement to do this.

Whilst noise bunds and barriers may offer an effective mitigation measure for the rail corridor section it should be noted that the use of barriers is not necessarily appropriate for various reasons including the following:

- Track safety: There is an HMRI requirement to limit structures close to railway tracks so as to allow room for escape. This means that a noise barrier can be located no closer than approximately 3 m from the track. This may make barriers impracticable, for example on embankments.
- Train driver sight line requirements: On curves noise barriers could compromise line of sight ahead, and so may be impracticable.
- Visual impact: In highly visible locations noise barriers may not be desirable.
- Creation of crime havens: In built up areas, such as near stops noise barriers could create areas where criminal activity could be hidden from view and thus be encouraged.
- Construction and maintenance difficulties: Noise barriers may require deep foundations or be unstable on sloped land and can attract graffiti in certain locations.

At Tudor Court a noise barrier may be effective and practicable because the houses are directly exposed to the rail corridor, whereas in Harrowby Drive there are garden fences along the boundary of the rail corridor (which depending on their construction may provide some screening). At Lindley Avenue Midland Metro will be on embankment so there may be practical and safety difficulties in fitting a barrier in. At Cochrane Road easy public access could make a noise barrier susceptible to graffiti. It will be essential that all local factors are taken into account in deciding the suitability of noise barriers or bunds on the basis of a careful value judgement in each deserving case.

The assessment has identified locations where noise barriers may be required. The precise location and specification for noise barriers will ultimately need to be determined during the detailed design phase, which will follow a consent decision on the scheme. This process should include further refined noise predictions accounting more precisely for screening effects due to the final design of embankment and cutting profiles, and for other refinements to the scheme such as minor adjustments to the alignment, changes to train speeds etc. It may also be necessary to re-measure baseline noise levels in those areas where impacts are likely. Hence this assessment can only give an indication of the locations where the Concessionaire may be required to construct noise barriers. The final decision as to where to erect noise barriers will be made in consultation with the local authority and local residents. The design of the barriers will be in keeping with the local setting as far as possible, in consultation Sandwell MBC and/or Dudley MBC as appropriate.

Assuming that noise barriers are considered appropriate in most of these cases, it is anticipated that the majority of potentially significant noise impacts will be mitigated. Impacts ranked as slight in this assessment are not considered to warrant mitigation, so it is likely that slight residual noise impacts will occur in some areas. In these cases tram noise may be audible, and give rise to a slight increases in ambient noise levels. However highly disturbing levels are not expected to occur.

The ongoing maintenance regime will include provision for ensuring noise levels do not increase unnecessarily as a result of ware and tare throughout the lifetime of the proposed scheme.

In addition, there may be a need for careful design of the stops and their audible announcement systems. The use of screens at the rear of platforms in addition to directional speakers and signal limiting devices will help to minimise noise impacts from audible announcements. Volumes will also be lowered in sensitive locations.

Vibration

Ground vibration is expected to be perceptible at some receptors but not at levels that are likely to give rise to adverse comment or structural damage, provided a high quality resilient track-mounting system is adopted into the design of the street running sections. The assessment of impacts associated with vibration will also be subject to further investigation during the detailed design phase, as described above.
