Technical Services – Noise & Vibration
[redacted]

Technical Report

Reference: N&V – R2807

NOISE & VIBRATION INVESTIGATION AT [redacted]

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CONDITIONS OF ISSUE OF REPORT

QUERIES OR FURTHER INFORMATION

ANY QUERIES OR REQUESTS FOR ADDITIONAL INFORMATION ON THE SUBJECT OF THIS REPORT SHOULD BE ADDRESSED TO THE AUTHOR WHO MAY BE CONTACTED AT THE ADDRESS GIVEN ON THE TITLE PAGE.

1. COMPLAINT DETAILS

Complaint ref.	[redacted]		
Property location	Between Kennington and Oval on the Northern line (see Figure 1)	**LCS Codes**	<u>Northern</u> N144-N-NBLO 610 m N144-N-SBLO 175 m

[redacted]

Figure 1 – Map showing the Northern line in relation to the properties

A resident of Kennington Park Road has raised concern about the sudden onset of elevated noise from the underground trains operating between Kennington and Oval underground stations. The property is located within the Northern line track feature known as the Kennington Loop; the main tracks between Kennington and Oval underground stations follows underneath the route of Kennington Park Road.

The resident has lived in the basement property at [redacted] and reports that the elevated levels were first observed 24 June 2020. The resident complained of an “impulsive banging every 2-3 minutes with each passing train”, which had not been heard previously. Technical Services (Noise and Vibration) carried out a noise survey at [redacted] 28 July 2020. The resident requested that the adjacent property [redacted] was also assessed [redacted]

2. MEASUREMENT DETAILS

Noise and vibration measurements were made in the main bedroom of both properties using a four-channel computer-based acquisition system (01dB dB4 serial number 1C5617). The system was configured using dBConfig software to acquire three channels of acceleration from a triaxial accelerometer and one channel of sound pressure using a ½" condenser microphone (G.R.A.S. Type 26AC). Calibration of the complete system was carried out using an acoustic calibrator, which gave a sinusoidal calibration tone of 94 dB at a frequency of 1 kHz. The measurements were acquired over a sufficient period to capture a minimum of six train passes in both directions

The bedrooms comprised [redacted]. The microphone was fixed to a tripod at 1.5 m height and positioned away from any reflecting surfaces. The bedroom windows remained closed throughout the measurements. A triaxial accelerometer (Dytran model 3233A serial number 116) was placed directly onto concrete flooring in the fireplace alcove of [redacted] on the tiled floor of the ensuite bathroom in [redacted].

The time histories were analysed using dBTRAIT software (version 5.3.1 build 6). The vibration data were used in conjunction with Trackernet as a correlation marker for the time histories to indicate the proximity of an underground train and the direction of travel. The maximum A-weighted sound pressure level, fast time constant ($L_{AF,max}$) were determined for each train event. Background levels, in terms of the values that would be exceeded for 90 percent of the time were calculated for noise (L_{90}) and vibration (V_{90}) for the entire measurement period.

3. RESULTS OF NOISE MEASUREMENTS

Table 2 presents a summary of the maximum A-weighted Sound Pressure Level ($L_{AF,max}$) measured at the two properties on 28 July 2020. For completion, the $L_{AF,max}$ for each train measured during both surveys are presented in Table A1 ([redacted]) and Table A2 [redacted]) of the Appendix. Some data were excluded where external noise sources, such as overhead aircraft and road traffic, contributed to the overall value. A total of 35 train events were acquired during the survey, three of which were excluded from the analysis.

Background noise during the measurement period was 28 dB(A) for [redacted] and 27 dB(A) for [redacted]. The highest $L_{AF,max}$ values were measured for southbound train activity which ranged from 34 dB(A) to 45 dB(A). The lowest values were measured for northbound trains which ranged from 33 dB(A) to 39 dB(A). Overall, higher noise levels were measured for southbound trains where the median $L_{AF,max}$ for southbound and northbound trains were 43 dB(A) and 35 dB(A), respectively. The highest values measured in both properties were 45 dB(A) during southbound train activity.

Table 2. $L_{AF,max}$ in dB(A) for property [redacted] measured 28 July 2020

Property	Direction	No of Trains	Duration (minutes)	L_{A90}	$L_{AF,max}$		
					Min	Max	Median
[redacted]	Southbound	9	28	28	42	45	43
	Northbound	8			34	39	35
1[redacted]	Southbound	10	20	27	34	45	43
	Northbound	5			33	37	34

Figure 2 presents an example trace from dBTRAIT of the $L_{AF,max}$ and the V_{max} for a southbound train measured in [redacted]. From the vibration time history, 12 distinct peaks are observed during the event. The first and second peaks of the waveform correspond to the first and second wheelsets from the first carriage of the vehicle; peaks three and four correspond to the wheelsets of the second carriage and so on. This waveform could be expected when a train travels over a discontinuity in the track which is a known cause of noise and vibration from rail vehicles.

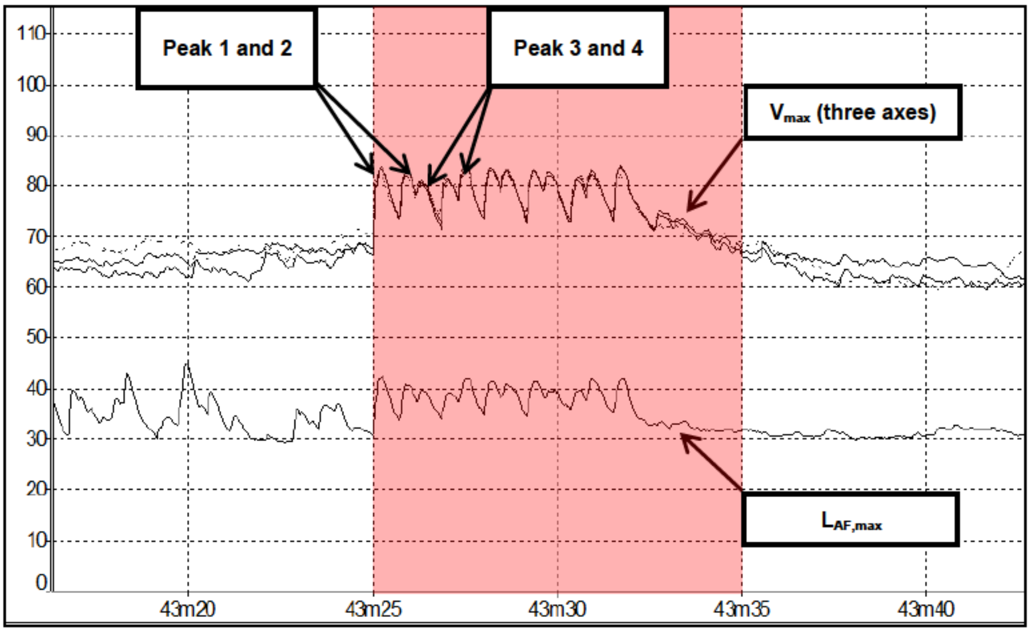

Figure 2. An example trace of $L_{AF,max}$ and V_{max} from a southbound train measured in [redacted] (The reference values are 20 µPa for sound pressure and 1 µms^{-2} for acceleration).

4. OBSERVATIONS

While the resident reports that noise and vibration is normally perceptible from underground train activity in both directions of the Northern line, it is the multiple impulses from the southbound trains that cause the greatest disturbance. The properties are located near to track points which indicate that the most likely source is the crossing nose of 14 points on the southbound track south of Kennington station (approximately 160m from the south end of Kennington platform 4), however a degraded rail joint in the same proximity or even 13 points closer to Kennington platforms could also be considered.

APPENDIX A

Table A1 Noise data for Northern Line Trains

28-Jul-20		Address	[redacted],			
Northern (KEN-OVA)		Measured by	Jose Barros and Marietta McIlraith			
$L_{90,27minutes}$ 28 dB(A)		Notes: Extraneous noise sources such as overhead aircraft and passing traffic; data from train 15 is not presented in the summary results.				
$V_{90,27minutes}$ (x) 60.0 dB, (y) 65.8 dB, (z) 61.7 dB						
Train	Direction	Time	V_{max} (dB)			L_{AFmax} (dB)
			x	y	z	
*1	NB	15:41:52	71.8	72.3	73.5	37.6
2	SB	15:43:25	83.5	83.7	83.0	42.1
3	NB	15:44:46	72.0	73.2	72.2	37.9
4	SB	15:47:47	83.0	83.4	81.7	42.9
5	NB	15:48:08	66.7	70.0	69.5	38.9
*6	SB	15:49:27	83.7	83.8	83.1	45.3
7	NB	15:50:50	70.4	72.4	71.8	35.3
*8	SB	15:52:29	83.1	83.6	82.7	41.9
*9	NB	15:53:47	72.6	74.1	73.4	34.1
10	SB	15:55:30	83.7	84.1	82.7	42.4
11	NB	15:56:38	73.7	74.4	73.2	34.0
12	SB	15:58:30	82.8	83.3	82.3	42.5
13	NB	15:59:36	72.8	74.1	72.3	33.9
14	SB	16:01:31	83.4	83.8	81.5	42.3
*15	NB	16:02:46	73.1	74.6	74.7	41.4
16	SB	16:04:28	83.7	84.4	82.7	42.5
17	NB	16:07:07	72.3	73.6	71.8	34.5
18	SB	16:07:23	83.8	84.3	81.9	42.7

Table A2 Noise data for Northern Line Trains

28-Jul-20		Address	[redacted],			
Northern (KEN-OVA)		Measured by	Jose Barros and Marietta McIlraith			
$L_{90,20minutes}$ 27 dB(A)		Notes: Extraneous noise sources such as overhead aircraft and passing traffic; data from trains 7 and 11 are not presented in the summary results.				
$V_{90,20minutes}$ (x) 60.0 dB, (y) 66.2 dB, (z) 61.5 dB						
Train	Direction	Time	V_{max} (dB)			L_{AFmax} (dB)
			x	y	z	
*1	SB	16:28:39	87.2	80.2	85.2	42.8
2	NB	16:29:12	75.6	67.7	72.5	33.3
3	SB	16:30:17	78.1	68.3	68.8	40.0
4	SB	16:31:44	87.0	79.4	84.6	43.3
5	NB	16:33:11	75.5	74.0	70.8	34.4
6	SB (around Kennington Loop)	16:34:04	78.4	69.5	67.8	33.6
*7	NB	16:36:06	79.0	70.6	71.2	37.1
8	SB	16:37:23	87.3	79.1	84.8	43.8
9	SB	16:37:53	79.0	70.6	74.2	42.4
10	SB	16:38:35	88.1	78.9	84.4	42.2
*11	NB	16:39:05	79.3	73.0	68.5	50.9
12	NB	16:40:34	75.7	69.9	71.6	36.0
13	SB(NB)	16:42:34	78.3	72.9	78.1	45.4
14	SB	16:44:37	88.0	78.8	84.7	42.8
15	NB	16:44:55	77.7	70.1	68.2	36.7
16	NB	16:46:58	75.0	69.6	71.0	33.5
17	SB	16:47:41	87.8	78.8	84.0	42.3