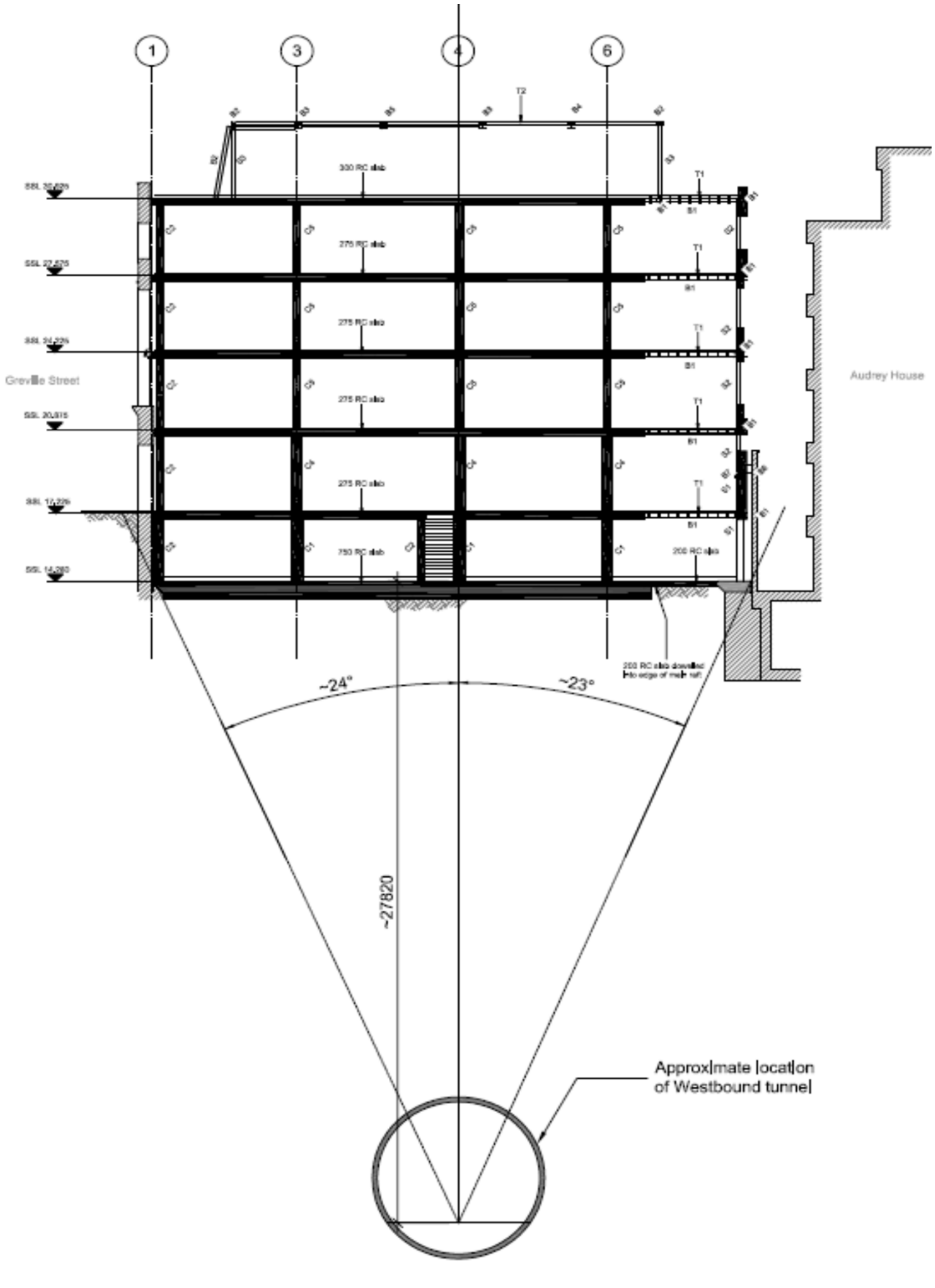
Introduction

These calculations will provide an assessment of the noise and vibration impact resulting from the Crossrail tunnel below the site. The Crossrail document *Information for Developers* dated December 2016 provides key information about Crossrail, predicted vibration and a methodology for determining noise and vibration levels in a new development.

Location of tunnel



Calculation

Crossrail requires that the ground borne noise level from the passage of trains in their tunnels in the centre of any noise-sensitive room is predicted in all reasonably foreseeable circumstances to not exceed the levels given in Table 1 in *Information for Developers*

The workshops in the basement will be assumed to be similar to office spaces and therefore the maximum sound pressure level, L_{ASmax} = 40 dB

The soil radial velocity will be calculated from a distance,r from the tunnel using the equation from section 5 of *Information for Developers* below:

$$L_r = L_t - 4.34\frac{\omega\eta r}{c_s} - 10\log_{10}\left[\frac{r_0 + r}{r_0}\right]$$

Where

L_t = the tunnel radio velocity for a tunnel radius of r_0

ω = angular frequency of each 1/3 octave band in radians per second

η = soil loss factor

c_s = phase speed of compression waves in soil

r = distance to room

r_0 = radius of tunnel

Below are the numerical values used and where they have been taken from:

η	0.1	from Crossrail *Groundborne Noise and Vibration Prediction Validation on DLR Greenwich technical report*
C_s	1611	from Crossrail *Groundborne Noise and Vibration Prediction Validation on DLR Greenwich technical report*
r	27.82	from page 1 of the calculations
r_0	3.5	from Crossrail *Information for Developers*

In reference to page 1 of the calculations the angle of visible levels to receiving vibration from Crossrail is approximately +/- 24^o

In reference to drawing C122-OVE-R4-DDA-CR001_Z-11023 the speed limit is 80km/h in the tunnel directly beneath. Therefore the tunnel radio velocity values in table 1 in appendix A of *Information for Developers* will be used as below for 0^o and the corresponding L_r values for each frequency and position. For the appropriate frequencies the value of the 'A-weighting' has been applied in accordance with advice fro Rupert Taylor.

L_t		L_r		
Hz	**0**	**w**	**0**	A-weighting
20	90	125.7	29	-50.5
25	91	157.1	36	-44.7
31.5	100	197.9	50	-39.4
40	103	251.3	57	-34.6
50	95	314.2	53	-30.2
63	92	395.8	53	-26.2
80	88	502.6	52	-22.5
100	90	628.3	57	-19.1
125	94	785.4	62	-16.1
160	88	1005.3	58	-13.4

Calculation of L_p, is the 1/3 octave band sound pressure to compare with the allowable maximum sound pressure is:

$$L_p = L_v - 27dB$$

Where L_v is the root mean square vibration velocity in dB re 1 nanometer second:

Calculation of L_v and L_p are calculate below for each frequency:

Frequency	L_v	L_p
20	29	2
25	36	9
31.5	50	23
40	57	30
50	53	26
63	53	26
80	52	25
100	57	30
125	62	35
160	58	31

Therefore the average value of the 1/3 octave band sound pressure level is 24 dB < 40dB, therefore within acceptable limits