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PREPARED: Monday, 11 July 2022

THE FITZROVIA, TOTTENHAM COURT ROAD LONDON; CROSSRAIL 2 IMPACT ASSESSMENT

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AS11860/CR2 VDV	Summary of VDV Calculation
Appendix A	Acoustic Terminology
Appendix B	AKT II Reference Drawings

Project Ref:	11860	**Title:**	The Fitzrovia, Tottenham Court Road London
Report Ref:	11860.220707.CR1	**Title:**	Crossrail 2 Impact Assessment
Client Name:	Avison Young, 65 Gresham Street, London, EC2V 7NQ		
Project Manager:	Matt Sugden		
Report Author:	Matt Sugden		

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1.0 INTRODUCTION

1.1 Planning Condition 24 of the Decision Notice relating to the noise and vibration impact from Crossrail 2 at the new The Fitzrovia development at 247 Tottenham Court Road (application ref 2020/3583/P) states:

Prior to commencement of any development other than site clearance, preparation and structural demolition to the existing slab level, detailed design and construction method statements for all the ground floor structures, foundations and basements and for any other structures below ground level, including piling (temporary and permanent), shall be submitted to and approved in writing by the Local Planning Authority which:

(i) Accommodate the proposed location of the Crossrail 2 structures including tunnels, shafts and temporary works,

(ii) Accommodate ground movement arising from the construction thereof,

(iii) Mitigate the effects of noise and vibration arising from the operation of the Crossrail 2 railway within the tunnels and other structures.

The development shall be carried out in all respects in accordance with the approved design and method statements. All structures and works comprised within the development hereby permitted which are required by paragraphs (i), (ii) and (iii) of this condition shall be completed, in their entirety, before any part of the building[s] [is] [are] occupied.

2.0 PERCEPTION OF UNDERGROUND TRAIN NOISE

2.1 Generally, with underground railways, such as the proposed Crossrail 2 line, the most commonly experienced noise within a building is *'groundborne noise'*. This is due to vibration in the building structure caused by train pass-bys, generated at the interface between the train wheels and the track. This vibration is not generally perceptible as tactile vibration to occupants, but causes small movements in floors and walls, such that they radiate airborne noise into the space. In simple terms, this is the reason that underground trains can be heard in buildings when occupants are not aware of any tactile vibration. It should be stressed that the very small movements required for noise re-radiation cannot be felt or seen in structural elements. Neither are they of any significance to the structural integrity, being many orders of magnitude below even minor vibration damage criteria.

2.2 Generally, the passage of trains is perceived as a low frequency 'rumble'. These levels of noise vary dependent upon a number of factors including soil type; foundation type; building structure and floor level under consideration.

3.0 CROSSRAIL 2: NOISE AND VIBRATION DESIGN AIMS

3.1 In the Crossrail 2 document *Tunnel Section: Information for Developers:* December 2020, Section 4 paragraph 4.2 states;

Where a developer proposes a new development (or modifications to the foundations or basements of an existing development) within the safeguarded area, they should ensure that the foundations are designed so that the levels of vibration and groundborne noise generated within the building from operation of Crossrail 2 trains remain within the design aims defined in Tables 1 and 2 … The developer should assess the potential for these

impacts and design and implement any measures necessary to achieve these design aims on the assumption that Crossrail 2 will adopt an operational track system with an equivalent performance to the high performance standard track used by Crossrail 1 ...

3.2 GROUNDBORNE NOISE

3.2.1 The new building comprises, flexible commercial/retail uses and back-of-house/plant areas at basement and ground floor levels, with commercial office and residential uses at first to fifth floor levels. The appropriate design aims from Table 1 of the Crossrail 2 document are as follows:-

BUILDING	LEVEL/MEASURED $L_{Amax,f}$
Offices	≤ 40dB
Residential buildings	≤ 35dB

3.3 GROUNDBORNE VIBRATION

3.3.1 The operational design aims for groundborne vibration are presented in Table 2 of the Crossrail 2 document as vibration dose value, VDV.

VDV $ms^{-1.75}$ DAYTIME (07:00 – 23:00 HOURS)	VDV $ms^{-1.75}$ NIGHT-TIME (23:00 – 07:00 HOURS)
≤ 0.31	≤ 0.18

4.0 BASIS OF THE ASSESSMENT

4.1 Technical data in relation to the proposed Crossrail 2 scheme for rolling stock including carriage numbers, train length and train speed has been used as shown in the Crossrail document *Crossrail 2 Tunnel Section: Information for Developers:* December 2020 or as previously advised by Crossrail.

4.2 The document, at its Appendix B, gives details of a model used to predict values for the radial velocity of the tunnel wall at various points on the tunnel circumference in 1/3 octave bands from 10Hz to 250Hz in dB re: 1 nanometre/sec. These calculated values have been based on the use of Crossrail 1 track system, Sateba S312S3. An assessment using the published data may, therefore, be considered a worst case.

4.3 The current relationship between the building foundation and Crossrail 2 tunnel is shown in AKT II drawing references 4190-S-HSK-107 P2 and 4190-S-HSK-073 P5. These are appended to this report for reference.

4.4 In order to provide a screening process as to the likely impact on the new building, the radial velocity has been predicted at the closest element of the building structure to the tunnel, i.e. the toe of the closest piles, and considers the levels 'visible' to it from the tunnel wall radiation. The equation in Appendix B: Paragraph 5.2 of the *'Information for Developers'* document is shown below.

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

Where:- L_t is the tunnel wall radial velocity;

L_r is the soil radial velocity at distance r;

r is the distance of the closest pile toe to the tunnel wall in metres;

r_o is the tunnel radius (3.6 metres);

C_s is the phase speed of the compression waves in London Clay (1610m/s);

ŋ is the loss factor for London Clay, taken as 0.1.

4.5 Owing to the rapid acceleration of the new trains, it is assumed in the calculations that trains will be travelling at near maximum speed of 100km/h below the building.

4.6 It is assumed that there is unity transfer function between the soil radial velocity at the closest foundation structure and the rms velocity of the basement surfaces, L_v, i.e. $L_v \approx L_r$. This enables a worst-case value for the sound pressure level for groundborne noise, L_p, to be determined from the approximate relationship $L_p = L_v - 27$dB, as specified within paragraph 5.1 of the Crossrail 2 document. The input vibration levels from the Crossrail document are rms values, but the associated time weighting is not stated. It has been assumed, therefore, that the calculated sound pressure levels L_p will be compatible with the design aim values expressed in terms of an $L_{Amax,F}$ parameter.

5.0 NOISE AND VIBRATION ASSESSMENT

5.1 It is understood that the closest tunnel of the current alignment runs slightly beyond the piling line to the east of the site. Sensitivity testing of the varying proximity of the tunnel wall to the closest pile and corresponding radial velocity, i.e. between 6° and 27° from vertical (0°), shows Section 3 of the AKT II sectional drawing to represent the most onerous orientation in terms of the resulting incident soil radial velocity, L_r.

5.2 In order to ensure a conservative assessment, the calculation has been based upon the highest tunnel wall radial velocity given in each 1/3 octave band for the 0° and 9°angle, rather than attempting to interpolate between the two datasets.

5.3 PREDICTION OF GROUNDBORNE NOISE FROM CROSSRAIL 2

5.3.1 Floor to floor attenuation has been calculated following the guidance provided in the *ANC Guidelines: Measurement & Assessment of Groundborne Noise & Vibration 2020*, which suggests that an attenuation level of 2dB per floor over the first five floors is reasonable.

5.3.2 The following table shows the noise levels expected to be caused by Crossrail 2 within the new building at each level.

LOCATION	GROUNDBORNE NOISE L_{AFMAX}
Basement (commercial/retail)	35dB
Ground floor (commercial/retail)	33dB
First floor (commercial/residential)	31dB
Second – fifth floor floor (commercial/residential)	<31dB

5.3.3 A summary of the calculation is provided in AS11860/CR2 SPL.

5.3.4 The above predicted levels are in accordance with or below the required Crossrail 2 design aims of $L_{Amax,F}$ 40dB and 35dB for the commercial/retail and residential units, respectively. This indicates that, with adoption of the basic Crossrail 1 resilient track baseplate, satisfactory levels of groundborne noise will exist in the completed building.

5.3.5 Given that the above predictions represent a 'worst case' assessment, and the finished system is likely to use a lower track stiffness than assumed in the calculations, the actual levels of groundborne noise are likely to be lower than indicated.

5.4 PREDICTION OF GROUNDBORNE VIBRATION FROM CROSSRAIL 2

5.4.1 The calculation summarised in AS11860/CR2 VDV shows the estimated vibration dose values, eVDV, from the Crossrail 2 vibration input, after correction for the new building details, etc. This is based on the published indication of a maximum 30 trains per hour in each direction. An average of 20 trains per hour has been used in the calculations over a 16-hour 'Daytime' period from 07:00 to 23:00 hours. As a 'worst case', two calculations have been provided on the basis that the vibration is entirely vertical vibration or entirely horizontal vibration, when in fact it will be a mixture of the two directions giving a lower impact than shown.

5.4.2 The calculated values of eVDV for 'Daytime' are as follows:-

LOCATION	VDV $ms^{-1.75}$ VERTICAL	VDV $ms^{-1.75}$ HORIZONTAL
Basement	0.017	0.002

5.4.3 When compared to the Crossrail 2 design aims from Table 2 of the Crossrail 2 document, shown in Section 3.3 of this report, the values are significantly lower than those required.

5.4.4 The calculation indicates the train movements are likely to result in less than '*Low probability of adverse comment*' (0.4 - 0.8$ms^{-1.75}$) from Table 1 of section 6, BS6472-1: 2008: *Evaluation of human exposure to vibration in buildings*, for both vertical and horizontal components.

5.4.5 Whilst no details are available of 'Night-time' (23:00 – 07:00 hours) operation, it is expected that there will be significantly reduced numbers of train movements. The above assessment, therefore, represents an overestimate of night-time effects.

5.4.6 The likely Crossrail 2 track/slab arrangements would be expected to result in lower levels than those indicated above for daytime for both vertical and horizontal components.

6.0 CONCLUSIONS

6.1 The drafted planning condition 24 set in response to planning application ref. 2020/3583/P requires the consideration of the impact of the proposed future Crossrail 2 underground railway on the proposed new The Fitzrovia building.

6.2 Information has been used in relation to the vibration input signal, rolling stock, including carriage numbers, track insert type, likely tunnel details etc., from the *Crossrail 2 Tunnel Section: Information for Developers:* December 2020. These details and those of the proposed foundation arrangements, provided by AKT II structural engineers, have been used to predict the likely 'worst case' levels of groundborne noise and vibration within the first floor office of the new development.

6.3 These predictions have shown that levels of groundborne noise within the development will not be above the Crossrail 2 'design aims' of $L_{Amax,F}$ 40dB for within retail and commercial uses and $L_{Amax,F}$ 35dB within residential premises.

6.4 Predicted levels of groundborne vibration in terms of an estimated Vibration Dose Value have also been shown to be significantly below those given as 'design aims' by Crossrail.

Matt Sugden

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Site ref. **The Fitzrovia, 247 Tottenham Court Road**
Crossrail 2 Report

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+ Propagation to foundation @ 6 degrees

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

				100km/hr		1/3rd octave centre frequency Hz											
				Lt (speed/angle specific - data		**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**dB(A)**	
r_0	3.9	m		dB re 1 nanometer/sec		75.3	90.6	84.2	85.7	78.6	80.5	86.2	82.8	85.4	86.5	75.8	66.6		
r	22.8	m																	
					Lr	66.2	81.3	74.6	75.8	68.3	69.7	74.8	70.6	72.2	72.0	59.7	48.6		
c_s	1610	m/sec		A weighting		-50.5	-44.7	-39.4	-34.6	-30.2	-26.2	-22.5	-19.1	-16.1	-13.4	-10.9	-8.6		
η*	0.1	Clay			Lv	15.7	36.6	35.2	41.2	38.1	43.5	52.3	51.5	56.1	58.6	48.8	40.0	**62.0**	dB(A) re 1 nanometer/sec
																		-27	Corr Factor assuming Lr = Lv

Lp=Lv-27dB(A)

Lower Ground Floor	**35.0 dB(A)**
Ground Floor	**33.0 dB(A)**
First Floor	**31.0 dB(A)**

** From Handbook of Urban Rail Noise:*

	1/3rd Octave	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**
Lr/Lv	dB re 1 nanometer/sec	66.2	81.3	74.6	75.8	68.3	69.7	74.8	70.6	72.2	72.0	59.7	48.6

Convert Velocity to Acceleration v=aω̇ Simplistic sinusoidal conversion

From dB	Velocity m/s	2.03542E-06	1.15878E-05	5.3882E-06	6.1664E-06	2.6045E-06	3.0593E-06	5.4675E-06	3.3819E-06	4.0822E-06	3.96552E-06	9.68404E-07	2.68845E-07
	acceleration m/s^2	0.000255812	0.001820436	0.00106658	0.00154999	0.00081833	0.00121114	0.00274862	0.00212521	0.00320653	0.003987097	0.00121709	0.000422355
	acceleration dB re 10^{-6}g	**28.3**	**45.4**	**40.7**	**44.0**	**38.4**	**41.8**	**48.9**	**46.7**	**50.3**	**52.2**	**41.9**	**32.7**

+ Based on Crossrail 2 Information for Developers: December 2020

Calculation 11860/CR2 SPL

Site ref. The Fitzrovia, 247 Tottenham Court Road VDV Calculation

Crossrail 2 Impact

rtical Vibration

Number of trains	60	trains per hour maximum
Say	20	trains per hour on average each way
Total Daytime	16	hour day
Total Daily Number of Trains, On Average	640	trains/day 2 way
(9 car train 30 x tunnel diameter of 6.7m = 205m long)	205	
t, total duration of vibration exposure (s)	7.38	At 100kph (27.78m/s) 9 car train passage takes 7.38 seconds

	1/3rd Octave Band Centre Frequency Hz											
	20	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**
Acceleration Levels from Lp Calc. dB re10^{-6}g	28.3	45.4	40.7	44.0	38.4	41.8	48.9	46.7	50.3	52.2	41.9	32.7
Acceleration Levels m/s^2	0.00026	0.00182	0.00107	0.00155	0.00082	0.00121	0.00275	0.00213	0.00321	0.00399	0.00122	0.00042
Wb weighting factor	0.7088	0.5973	0.4906	0.395	0.3118	0.2389	0.1734	0	0	0	0	0
Weighted Acceleration m/s^2	0.00018132	0.001087346	0.000523265	0.0006122	0.00025515	0.0002893	0.0004766	0	0	0	0	0
Resultant (weighted acceleration squared)	3.28768E-08	1.18232E-06	2.73806E-07	3.748E-07	6.5104E-08	8.372E-08	2.272E-07	0	0	0	0	0
acceleration rms a(t)	0.001496606											

eVDV	**0.01737**

Below a *'Low probability of adverse comment' f*or offices (0.4 to 0.8 ms$^{-1.75}$)

Note in Table 1 Section 6 BS6472-1: 2008

Below a *'Low probability of adverse comment' f*or residential day (07;00-23:00h) [0.2 to 0.4 ms$^{-1.75}$]
& residential night (23:00 - 07:00h) [0.1 - 0.2 ms$^{-1.75}$]

Table 1 Section 6 BS6472-1: 2008

rizontal Vibration

Number of train	60	trains per hour maximum
Say	20	trains per hour on average each way
Total Daytime	16	hour day
Total Daily Number of Trains, On Average	640	trains/day 2 way
(9 car train 30 x tunnel diameter of 6.7m = 205m long)	205	
t, total duration of vibration exposure (s)	7.38012959	At 100kph (27.78m/s) 9 car train passage takes 7.38 seconds

	1/3rd Octave Band Centre Frequency Hz											
	20	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**
Acceleration Levels from Lp Calc. dB re10^{-6}g	28.3	45.4	40.7	44.0	38.4	41.8	48.9	46.7	50.3	52.2	41.9	32.7
Acceleration Levels m/s^2	0.000256	0.001820	0.001067	0.001550	0.000818	0.001211	0.002749	0.002125	0.003207	0.003987	0.001217	0.000422
Wd weighting factor	0.1	0.08	0.063	0.049	0.039	0.03	0.021	0	0	0	0	0
Weighted Acceleration m/s^2	2.55812E-05	0.000145635	6.71946E-05	7.595E-05	3.1915E-05	3.633E-05	5.772E-05	0	0	0	0	0
Resultant (weighted acceleration squared)	6.54398E-10	2.12095E-08	4.51511E-09	5.768E-09	1.0186E-09	1.32E-09	3.332E-09	0	0	0	0	0
acceleration rms a(t)	0.000194468											

eVDV	**0.00226**

Below a *'Low probability of adverse comment' f*or offices (0.4 to 0.8 ms$^{-1.75}$)

Note in Table 1 Section 6 BS6472-1: 2008

Below a *'Low probability of adverse comment' f*or residential day (07;00-23:00h) [0.2 to 0.4 ms$^{-1.75}$]
& residential night (23:00 - 07:00h) [0.1 - 0.2 ms$^{-1.75}$]

Table 1 Section 6 BS6472-1: 2008

1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.

Noise Sound that is unwanted by or disturbing to the perceiver.

Frequency The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.

dB(A): Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A.

L_{eq}: A notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc).

The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction.

Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.

L_{max}: The maximum sound pressure level recorded over a given period. L_{max} is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged L_{eq} value.

VDV The Vibration Dose Value (VDV) yields a consistent assessment of continuous, intermittent and occasional vibration and correlates well with subjective response. It is used to assess the acceptability of building vibration with respect to human response.

1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz.

The most commonly used octave bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

INTERPRETATION

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

AS11860 THE FITZROVIA, 247 TOTTENHAM COURT ROAD

APPENDIX B

AKT II REFERENCE DRAWINGS

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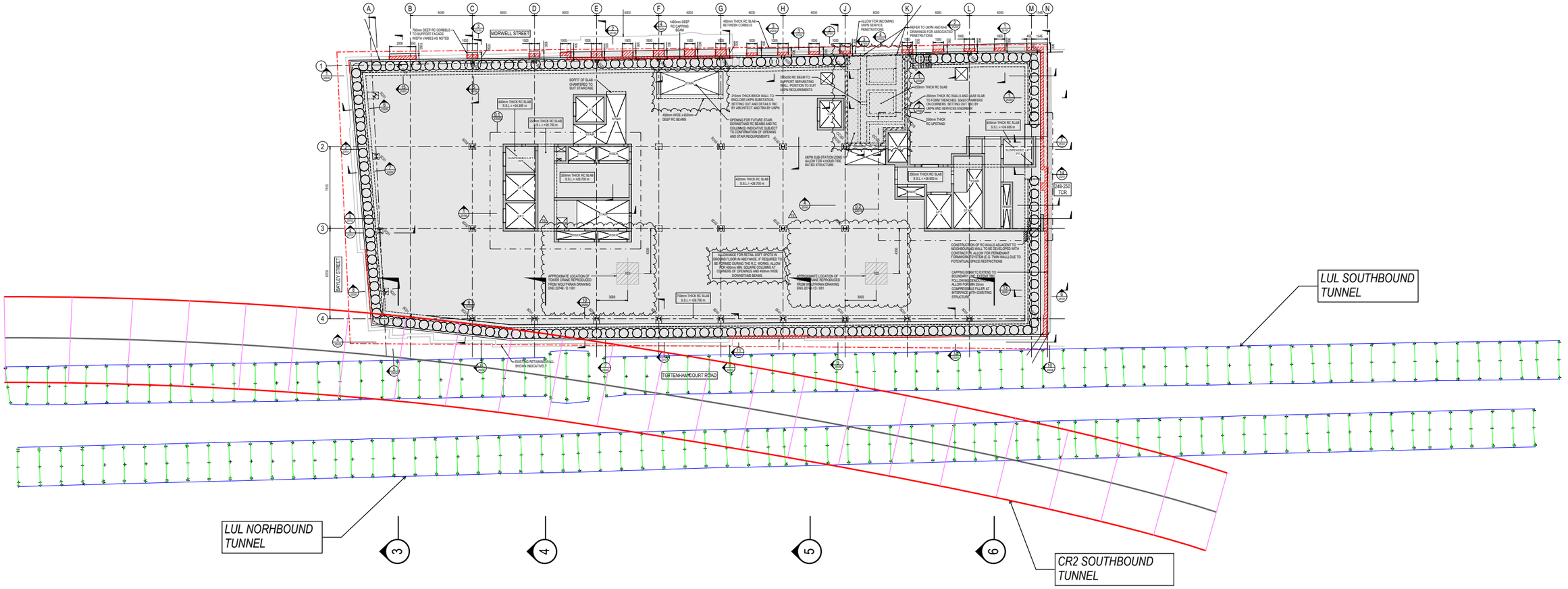
NORTH

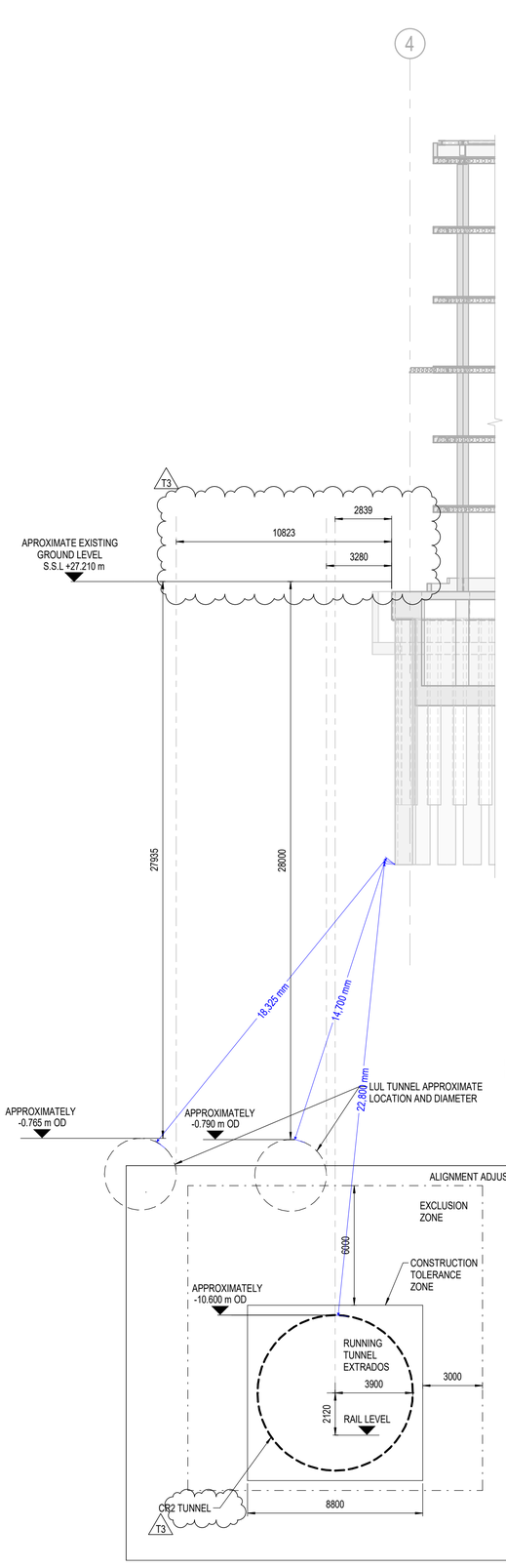


NOTE:
FOR SECTIONS REFER TO DRAWING
4190-AKT-XX-ZZ-DR-S-00103

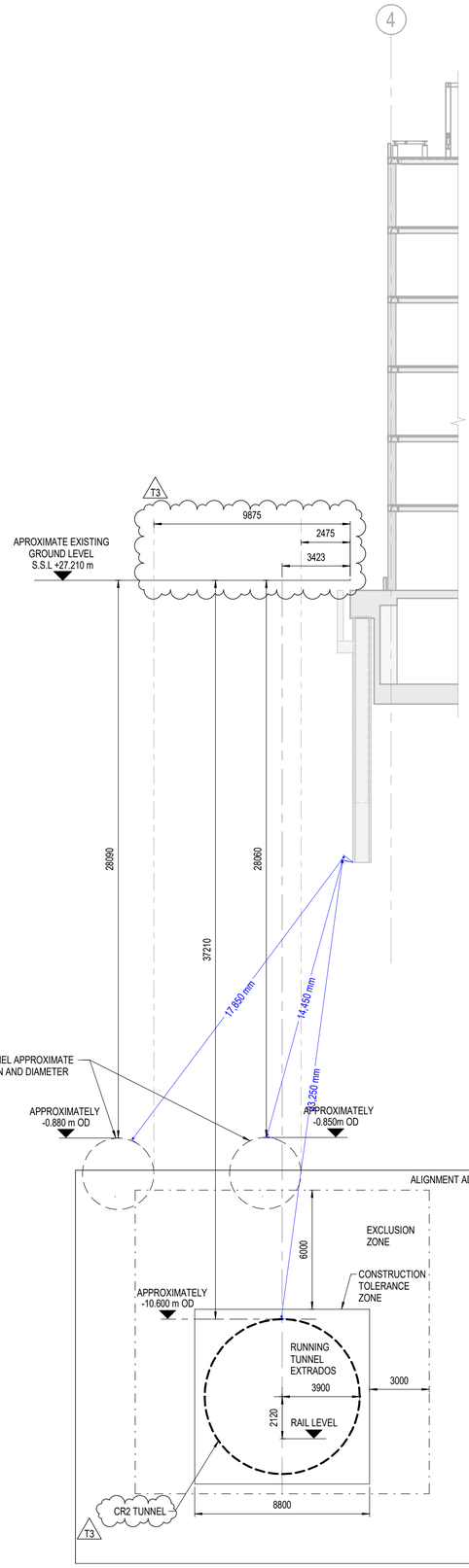
REV	DATE	BY	CHECKED	DESCRIPTION
P2	08.07.2022	SP		
P1	07.07.2022	SP	-	SECTION MARKS ADDED FOR INFORMATION

akt II

PROJECT THE FITZROVIA		TITLE LUL & CR2 TUNNEL PROXIMITY	
DATE 07.07.2022	SCALE 1:400 @ A3	CAD FILENAME -	STATUS INFORMATION
DRAWN SP	CHECKED -	PROJECT No. 4190	DRAWING No. 4190-S-HSK-107 REV P2



SECTION 3 (00101)
1 : 150



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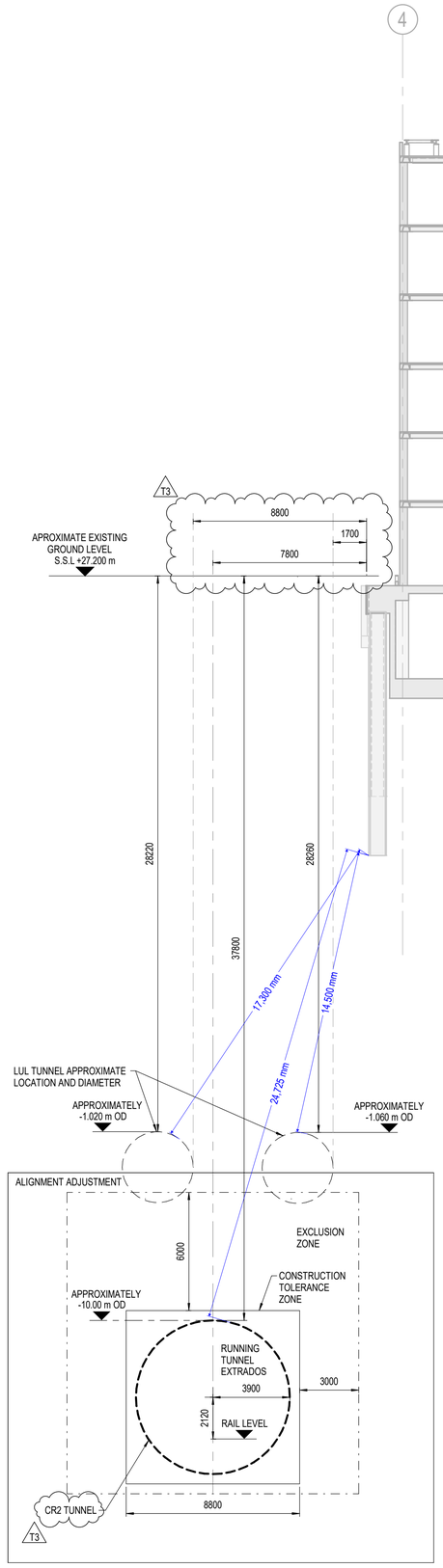
1 : 150



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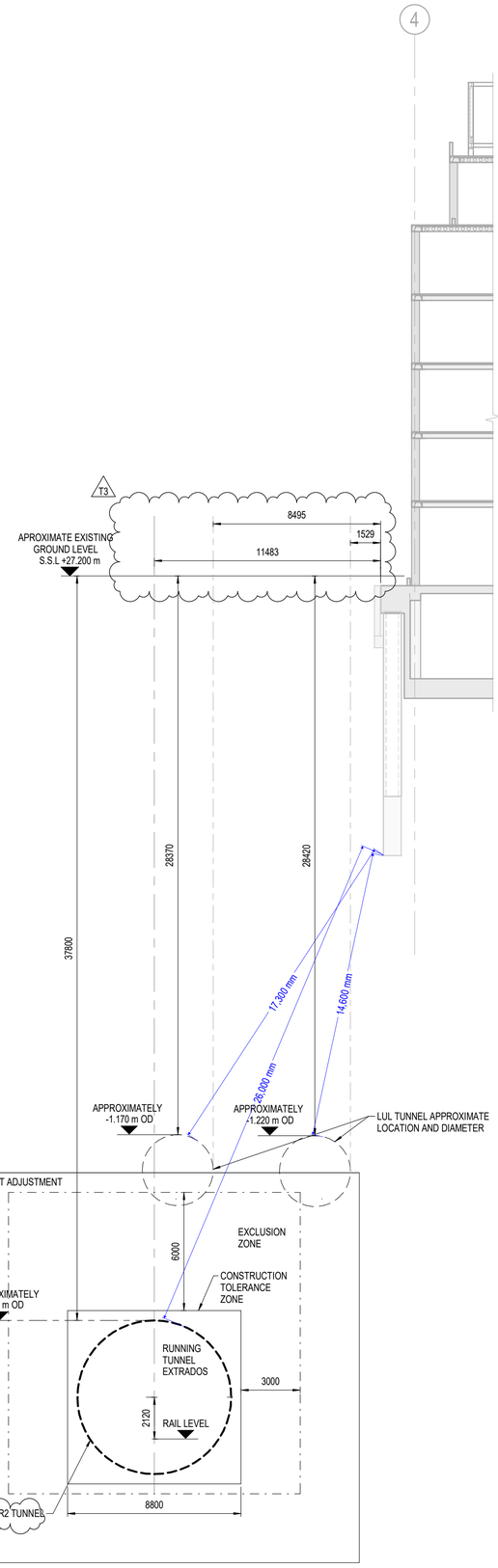

SECTION
1 : 150

NOTES

1. DO NOT SCALE FROM THIS DRAWING
2. ALL DIMENSIONS IN mm UNO
3. FOR GENERAL NOTES, SEE DRAWINGS 4190-AKT-XX-XX-DR-S-00001 TO 00008. FOR MOVEMENTS AND TOLERANCES, SEE DRAWINGS 4190-AKT-XX-XX-DR-S-00010 TO 00014. FOR BEAM AND COLUMN SCHEDULES SEE DRAWING 4190-AKT-ZZ-XX-DR-S-00300
4. ALL DIMENSIONS RELATING TO EXISTING & ADJACENT STRUCTURES, PARTY WALLS ARE BASED ON ARCHIVE INFORMATION OR LIMITED SURVEY INFORMATION AND ARE THEREFORE SUBJECT TO CONFIRMATION ON SITE.
5. CONCRETE GRADE – C35/45 UNO
6. ALL STEELWORK GRADE S355 UNO
7. FOR GENERAL NOTES ON SITE WIDE HEALTH AND SAFETY INFORMATION REFER TO DRAWING 4190-AKT-XX-XX-DR-S-00005 SECTION 18
8. REFER TO LIFT TRADE CONTRACTOR DRAWINGS FOR ALL LIFT BUILDERS WORKS, INCLUDING HOLES FOR MONITOR BUTTONS, CAST-IN FIXINGS, LIFTING EYES ETC
9. ALL PRECAST ELEMENTS TO BE DESIGNED BY OTHERS. REFERENCE SHOULD BE MADE TO THE ARCHITECT'S INFORMATION REGARDING PRECAST STAIRS
10. FIRE RATING FOR STRUCTURAL ELEMENTS 60 MINUTES AND 120 MINUTES FOR FIREFIGHTING STAIR AND LIFT ENCLOSURE U.N.O.REFERENCE SHOULD BE MADE TO JENSEN HUGHES' FIRE STRATEGY REPORT: BL5251/R1 ISSUE 4
11. WATERPROOFING TO ARCHITECT'S DETAILS

LUL TUNNEL POSITION BASED ON LINE AND LEVEL SURVEY CARRIED OUT BY MURPHY GEOSPATIAL 25/02/2022

CR2 TUNNEL POSITION, GEOMETRY AND TOLLERANCES REPRODUCED FROM 'CROSSRAIL 2 TUNNEL SECTION INFORMATION FOR DEVELOPERS DEC 2020'

DEPTH OF PILES SHOWN INDICATIVELY. TBC FOLLOWING DESIGN BY PILING SPECIALIST SUBCONTRACTOR

akt II

PROJECT THE FITZROVIA		TITLE PROXIMITY OF CROSSRAIL 2 TUNNEL	
DATE 08/07/2022	SCALE 1:150 @ A1	CAD FILENAME -	STATUS FOR INFORMATION
DRAWN SP	CHECKED -	PROJECT No. 4190	DRAWING No. 4190-S-HSK-073 REV P6