

MELBOURNE METRO RAIL PROJECT ENVIRONMENT EFFECTS STATEMENT
INQUIRY AND ADVISORY COMMITTEE

MMRA TECHNICAL NOTE

TECHNICAL NOTE NUMBER: 042

DATE: 19 August 2016

PRECINCT: All Precincts

EES/MAP BOOK REFERENCE: Technical Appendix I – Noise and Vibration (Noise and Vibration Impact Assessment)

SUBJECT: Response to Dr John Heilig’s Request for Further Information

NOTE:

1. In the course of preparing his Expert Witness Statement, Dr John Heilig requested the following further information in respect of aspects of the Noise and Vibration Impact Assessment (EES Technical Appendix I):

- a. *Vibration Attenuation Plots*

Appendix B includes Figure B.4 for the TBM and Road header vibration attenuation plots. MMRA is requested to also provide the attenuation plots with other reference vibration curves.

- b. *Frequency content of TBM and Road header source vibration*

Frequency content is not provided in Appendix B reporting. MMRA is requested to provide frequency content curves.

- c. *Floor Loss Reference*

Appendix B states that ‘Vibration levels would be lower on higher floors of the multi-story building. MMRA is requested to provide a reference for the floor loss coefficients used in the calculations.

- d. *Cross Passages*

Appendix B did not provide an assessment of the cross passages. MMRA is requested to provide the results of the assessment of cross passages.

- e. *Property Envelopes*

Appendix B did not provide a summary of property impacts in terms of

the number of property days affected. MMRA is requested to provide property envelopes as discussed.

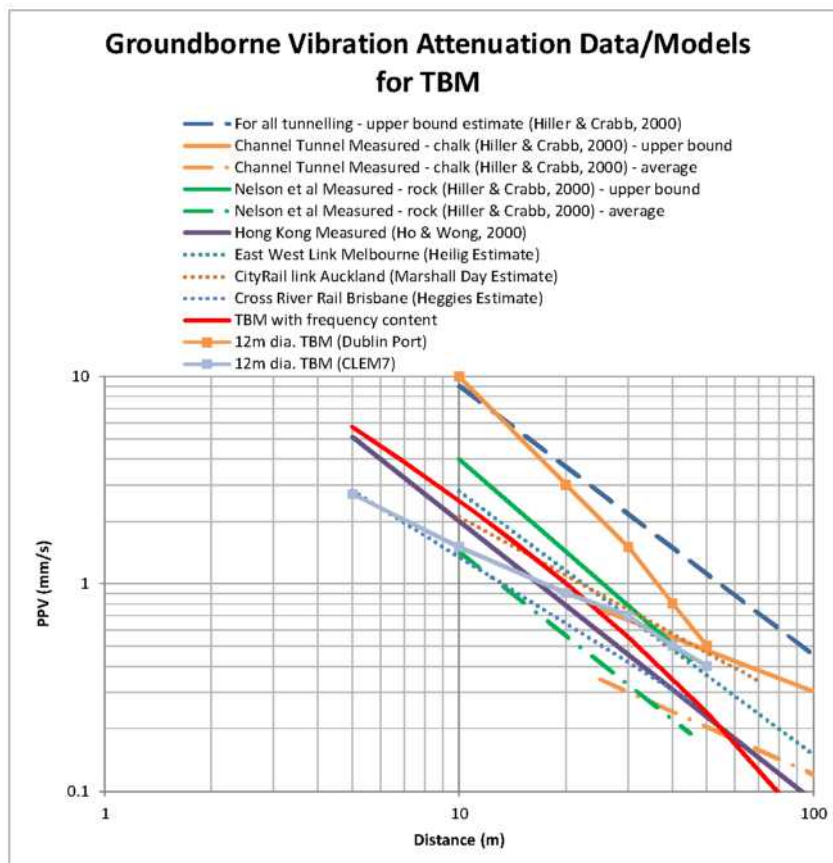
f. Domain Area Assessment

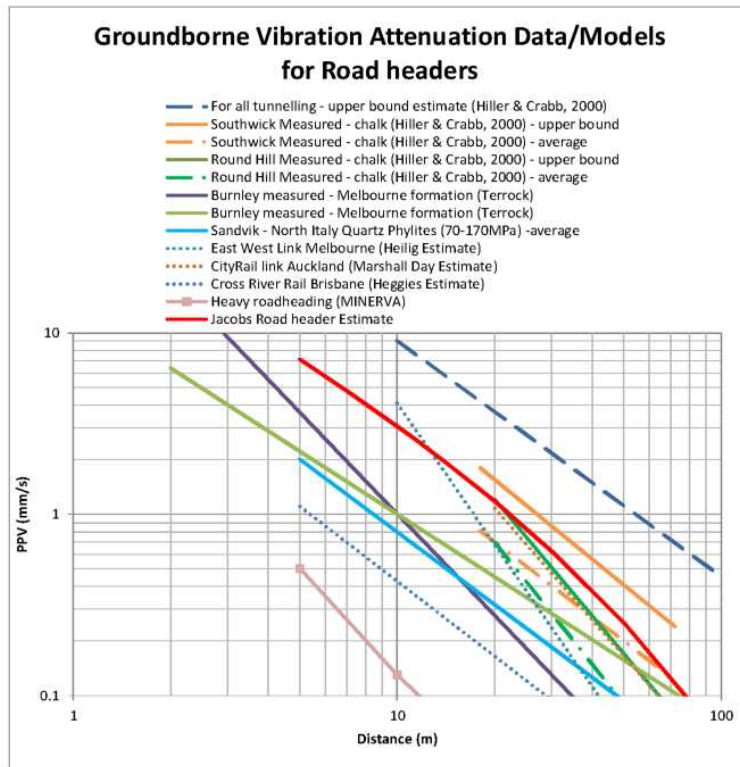
Appendix B provided an assessment of the Domain area, but after review it was found there were some buildings not correctly identified. MMRA is requested to provide a summary of impacts in this area.

2. This technical note responds to Dr Heilig's requests.

RESPONSE TO REQUEST A:

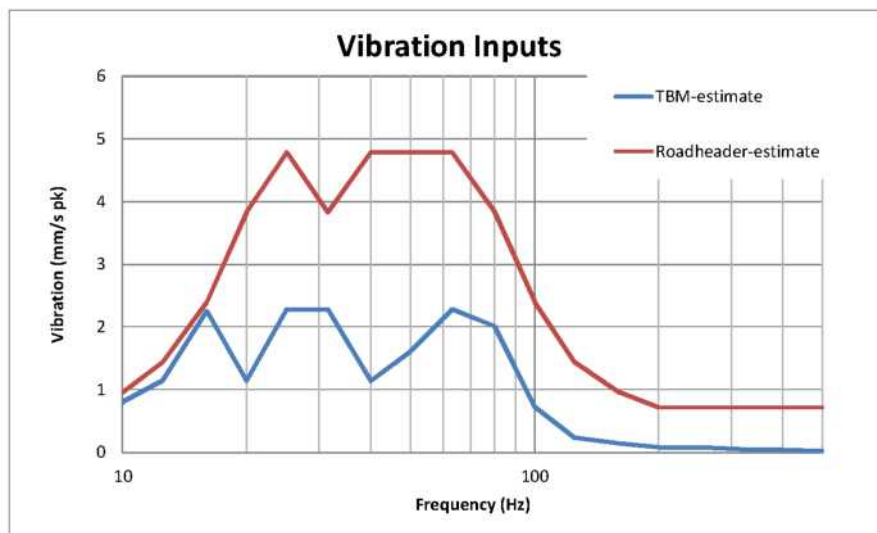
3. The figures below show (in red) the attenuation plots adopted in the Noise and Vibration Impact Assessment in respect of TBM and road-header excavation respectively. The figures also show other vibration estimates and test results for the purposes of comparison.





RESPONSE TO REQUEST B:

- The figure below sets out the third octave plots for the ground vibration spectra assumed at a 5m reference distance from the source.



RESPONSE TO REQUEST C:

- Floor loss values were sourced from Table 16.2 in Transportation Noise Reference Book by Paul Nelson (Butterworth, 1987). These are set out below:

Table 16.2 Point source below building—attenuation of acceleration level per floor in dB

Frequency (Hz)	Floor level above grade									
	1	2	3	4	5	6	7	8	9	10
<i>Floor-to-floor distance: 3 m (10 ft)</i>										
31	2	2	2	1	1	1	1	1	1	1
63	3	2	2	2	2	1	1	1	1	1
125	3	3	2	2	2	2	2	1	1	1
250	3	3	3	3	3	3	3	2	2	2
500	4	4	3	3	3	3	3	3	3	3
1K	5	5	4	4	4	4	4	3	3	3
<i>Floor-to-floor distance: 3.7 m (12 ft)</i>										
31	2	2	2	2	1	1	1	1	1	1
63	3	2	2	2	2	1	1	1	1	1
125	3	3	3	2	2	2	2	1	1	1
250	4	4	3	3	3	2	2	2	2	2
500	4	4	4	4	4	3	3	3	3	3
1K	5	5	5	4	4	4	4	4	4	4

RESPONSE TO REQUEST D:

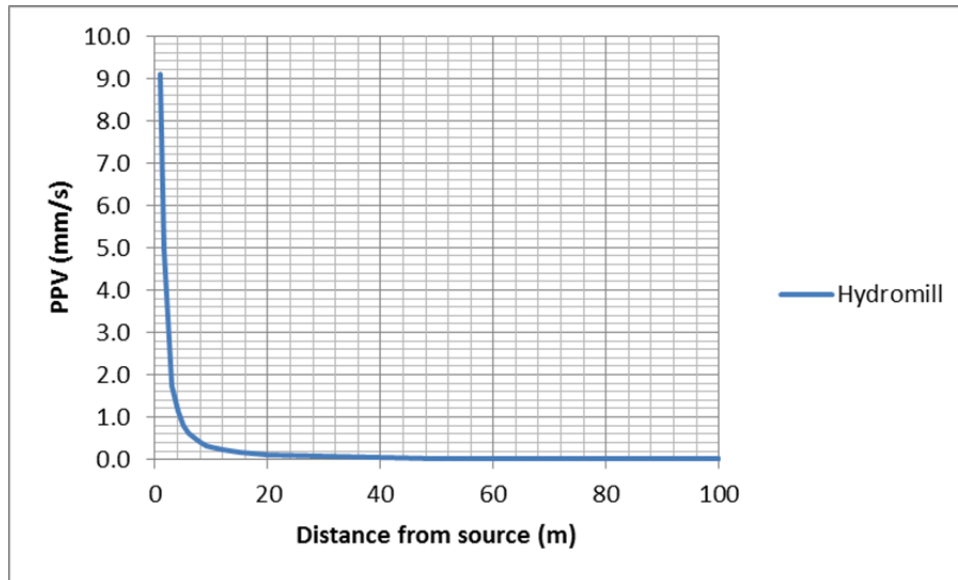
6. The twin-bore tunnels would incorporate a number of cross passages. The final number and location of cross passages would be determined in consultation with the Metropolitan Fire Brigade. The Concept Design includes construction of 22 cross passages linking the tunnels at locations along the alignment (see **Attachment A**). An assessment has now been undertaken based on these cross passage locations and a construction methodology that utilises a low vibration source, being an excavator with a milling attachment as nominated by the Project’s construction adviser.
7. The criteria and methodology adopted for the assessment of ground-borne noise and vibration impacts from the construction of the cross passages are generally in accordance with the approach outlined in Appendix B of the NVIA.
8. Vibration source levels and spectral characteristics are dependent on the excavation equipment type and size and the ground conditions through which excavation is proposed to occur. The vibration source level and propagation relationship for cross passage excavation have been based on a hydromill vibration source level in rock ground conditions from the FTA guideline (page 12-12).
9. The frequency spectrum defined for the hydromill is based on the assumption that the majority of vibration is in the 31.5 Hz one third octave frequency band.
10. The ground vibration at receiver locations has been estimated based the formula provided in the FTA guideline:

$$PPV = 0.4318 \times (7.62/d)^{1.5}$$

Where PPV = peak particle velocity, in mm/s

d = slope distance from the receiver location to the closest edge of the tunnel (m)

11. The equation has been modified to account for PPV in mm/s as opposed to the FTA guideline which quotes PPV in inch/s. A crest factor of 2 was assumed for the hydromill source and the operating time was assumed to be 60% of any work interval.
12. The source vibration level versus distance is given in the figure below.



Hydromill source vibration level versus distance

13. The assessment of impacts for ground-borne noise and vibration depends on the receiver type (e.g. residential, commercial), the building type (size and construction), the time of day, and the source-receiver distance. In order to assess the potential for impacts along the tunnel alignment, a screening assessment for ground-borne noise and vibration was first carried out by considering the most sensitive receiver type, building type and time of day, being a single story residential receiver at night.
14. The screening assessment for cross passage construction resulted in the identification of a 'critical' source-receiver distance of 18-19m based on ground-borne noise and human comfort vibration at night. Any source-receiver distances greater than this are predicted not to have perceptible ground-borne noise and vibration impacts due to Cross Passage Construction.
15. Based on the screening assessment, only two cross passages for the Concept Design are predicted to have the potential for ground-borne noise and vibration impacts, and warrant more detailed consideration. These are cross passages 6 and 16 located in North Melbourne and at Domain respectively.

Cross Passage 6

16. The critical distance is calculated to be 18.3m for a residential receiver. The closest property to the cross passage is a small residential building at 81 Courtney Street, North Melbourne, which is 18.4m from the cross passage. Based on the model, the ground-borne noise and vibration levels at this receiver are predicted to be marginally below the threshold for management actions for both

parameters.

Cross Passage 16

17. The critical distance is calculated to be 11m for a commercial building. The closest property is at 342 St Kilda Road, which is 10 - 11m from the cross passage. Based on the results of the model, the vibration levels at this receiver are predicted to be just above the 'preferred' VDV daytime guideline target for a commercial receiver and therefore just within the category 'low probability of adverse comment'.

Conclusion

18. Based on the ground-borne noise and vibration assessment outlined above there are not predicted to be any ground-borne noise and vibration impacts at 20 of the 22 cross passages. For 2 of the cross passages (cross passages 6 and 16), the impacts are predicted to be either marginally over or marginally under the threshold for management actions.
19. Cross passages would be included in the noise and vibration model prepared for the detailed design and adopted construction methodology for the preferred contractor. As required by the Environmental Performance Requirements, vibration measurements would be undertaken and assessed with respect to the Guideline Targets specified in the Environmental Performance Requirements and, where appropriate, management actions undertaken if required.

RESPONSE TO REQUEST E:

20. The methodology adopted in the vibration and ground-borne noise assessment is set out in Section B.1.3 of Appendix B to the NVIA. In total, vibration and ground-borne noise predictions were completed in respect of approximately 3000 buildings located in the vicinity of the rail alignment and construction work sites.
21. The results of the initial vibration and ground-borne noise assessment for tunneling works are set out in the figures contained within part B.4 of Appendix B to the NVIA. The results for additional construction works are set out in the figures contained within part B.5 of Appendix B to the NVIA.
22. The tables set out below summarise that information in a different format to that presented in Appendix B to the NVIA:
 - a. **Figure 1** shows maximum predicted Vibration Dose Values for receivers due to tunneling (for both TBM and road header construction) and station cavern excavation (using road headers);
 - b. **Figure 2** shows the maximum predicted ground-borne noise levels due to tunneling and station excavation;
 - c. **Figure 3** shows the duration that each relevant receptor are predicted to exceed the maximum VDV and ground-borne noise levels due to tunneling;
 - d. **Figure 4** shows the duration that each relevant receptor are predicted to

exceed the maximum VDV and ground-borne noise levels due to station cavern excavation.

23. The following is noted in respect of these summary tables:

- a. Vibration thresholds in respect of human comfort (vibration dose values, **VDV**) have been set at the 'maximum' level identified in BS6472-1:2008 (corresponding to a 'low probability' of adverse comment, refer to Table B.5 of Appendix B and EPR NV9);
- b. Ground-borne noise thresholds have been set at the night time guideline target specified in the NSW Interim Construction Noise Guideline, Department of Environment and Climate Change, July 2009 (35dBA, refer to Table B.7 of Appendix B and EPR NV11), and at a level 10dBA above the night time guideline (deemed to be a level that would be 'moderately intrusive').
- c. Where buildings along the alignment contain multiple dwellings, estimates have been made concerning the number of affected residences. Allowances have been made concerning the propagation of vibration impacts within tall buildings (i.e. vibration impacts are less in higher parts of a building) by adopting the 'floor loss' values from Table 16.2 in Transportation Noise Reference Book by Paul Nelson (Butterworth, 1987).

24. A single result is presented in respect of each commercial building (calculated at the ground floor) regardless of the number of tenancies.

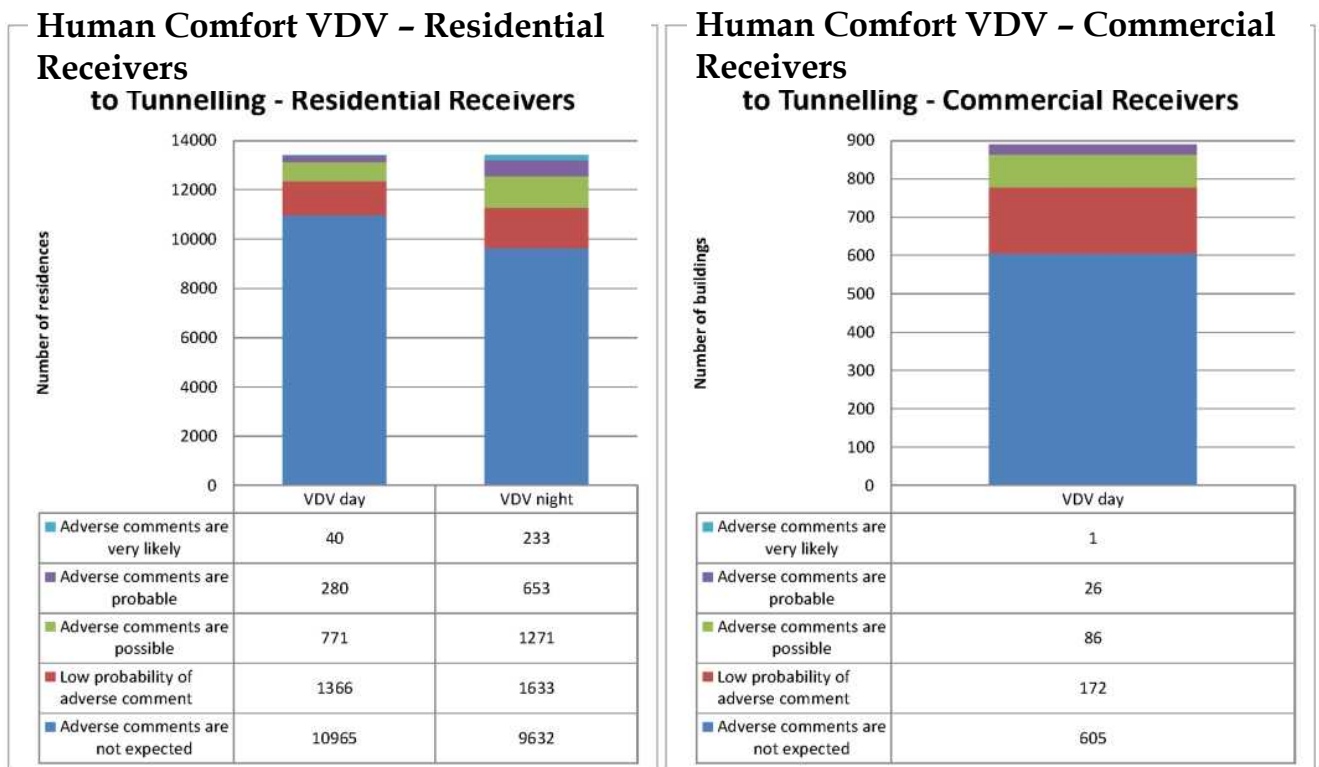


Figure 1: Maximum predicted vibration levels for receivers due to tunneling and station cavern excavation

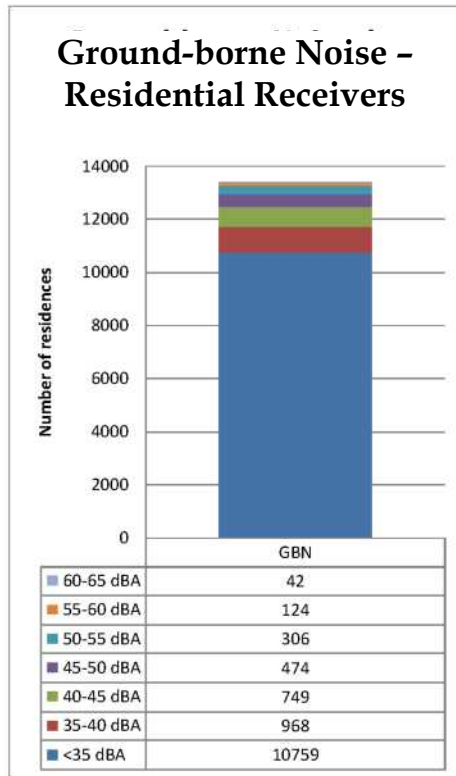


Figure 2: Maximum predicted ground-borne noise levels due to tunneling & station cavern excavation

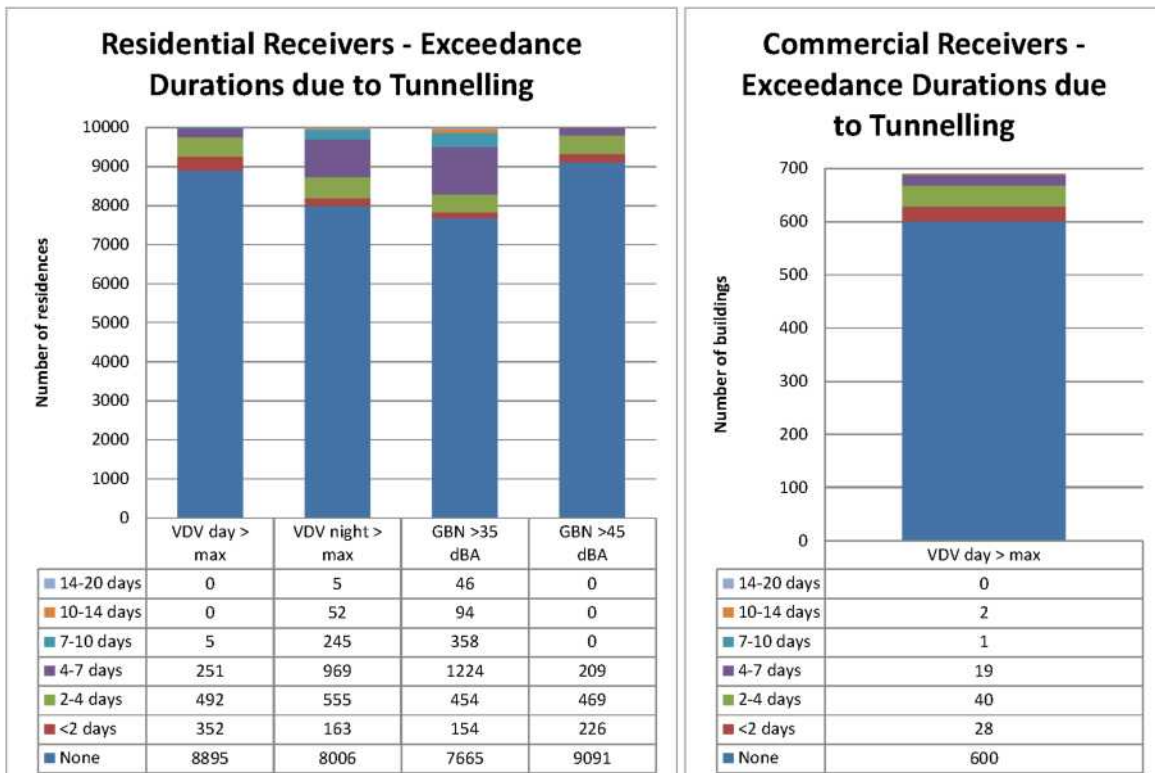


Figure 3: Duration above maximum vibration dose value level and ground-borne noise levels due to station cavern excavation

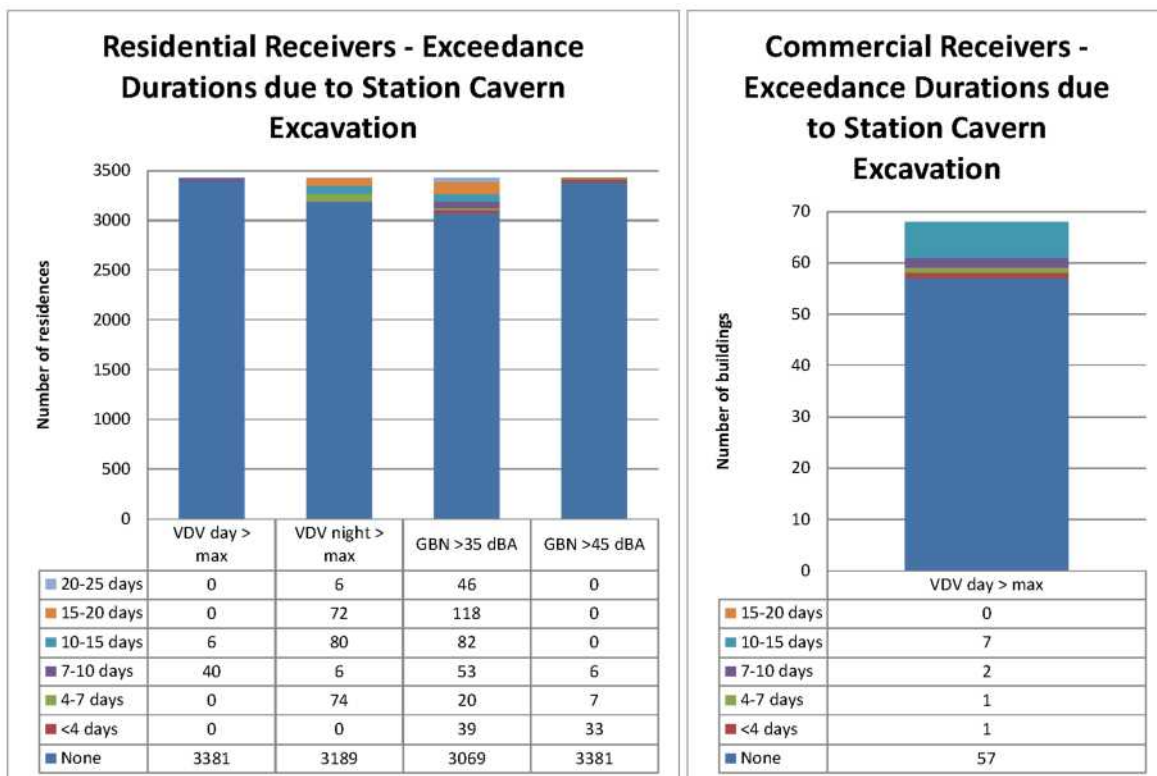


Figure 4: Duration above maximum vibration dose value level and ground-borne noise levels due to station cavern excavation

RESPONSE TO REQUEST F:

25. In the course of preparing the property envelopes set out above, a detailed review of potential receivers was undertaken. That review found that in the vast majority of cases, potential receivers had been correctly identified and assessed as part of Appendix B to the NVIA.

26. Within the Domain precinct, a number of potential receivers previously characterized as residential are in fact either commercial or educational in character. These are listed below:

- a. 312-318 St Kilda Road (commercial)
- b. 324-330 St Kilda Road (commercial)
- c. 340 St Kilda Road (educational)
- d. 412 St Kilda Road (commercial)
- e. 1 Bowen Crescent (commercial)

27. In addition, the following additional potential receivers were identified:

- a. 344 St Kilda Road (commercial)
- b. 346 St Kilda Road (commercial)
- c. 348 St Kilda Road (residential)

- d. 380 St Kilda Road (commercial)
- e. 416a St Kilda Road (residential)
- f. 416 St Kilda Road (residential)
- g. 418 St Kilda Road (residential).

28. Within the Domain precinct, one potential receiver was previously characterized as commercial, whereas it is in fact a largely residential receiver (from Level 2 and above), with commercial receivers on the lower floors. This is the property located at 1 Albert Road

CORRESPONDENCE:

No correspondence.

ATTACHMENTS:

- A. Cross passages plan