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Evan Buntoro
Project Manager
Randwick City Council

RE: Vibration Monitoring – Portion of Waratah Avenue (Between Arthur Lane and Belmore Road), Randwick NSW

1 Introduction

Sydney Environmental Group (SEG) have been engaged by Randwick City Council (hereafter referred to as 'the client'), to advise the client on vibration generating activities undertaken during the Waratah Avenue Plaza Project, located at portion of Waratah Avenue between Arthur Lane and Belmore Road, Randwick NSW (hereafter referred to as the 'site').

SEG have been advised by the client that the project involves closing down a portion of Waratah Avenue and developing the area into an urban plaza. As part of the scope of works, the client will utilise milling machinery to remove asphalt road materials within the site, and hydraulic excavators to excavate soil and crush concrete using a hydraulic hammer.

SEG have been engaged to assess ground-borne vibration levels at adjacent residential receptors and assess those levels against relevant guidance for the duration of vibration inducing works.

Considerations into vibration impacts have been made using the NSW Department of Environment and Conservation's Assessing Vibration: a technical guideline (AVTG 2006), British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2. (BS), and German Standard DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures (DIN). SEG note that there are no relevant Australian Standards for vibration.

2 Sampling Methodology

SEG installed two (2) 'Profound Vibra' vibration monitors fitted with tri-axis geophones on the 18th of May 2023 to the external walls of properties adjacent the site (25 Waratah Avenue and 68 Belmore Road, Randwick NSW). The siting of monitors was selected to address particular resident concerns. Monitors were mounted to the walls of each structure using a concrete screw and the supplied mounting bracket for the vibration monitor. Refer to **Figure 1** for monitor locations.

Mounting of the monitors was undertaken in accordance with DIN 45669-2 Measurement of vibration emission – Part 2: Measuring method June 2005. Geophones were affixed using the supplied mounting bracket and screws to solid brick (25 Arthur Lane) and Sandstone wall materials (68 Belmore Road). The location of monitors is provided in **Figure 1**.

3 Construction Vibration Guidelines

The effects of vibration on buildings can be divided into the following main assessment categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed ('tactile vibration');
- Those where a building's contents may be affected (for example, the operation of vibration sensitive equipment such as microscopes in hospitals); and
- Vibration affecting the buildings and structures in terms of their susceptibility to damage ('structural damage').

3.1 Vibration Causing Equipment

Based on an assessment of site activities, SEG considers the current highest impact vibratory activities on-site will be caused by the use of milling machines for removal of road-base materials and a 5t hydraulic excavator to excavate soils and crush concrete footpath slabs.

3.2 Human Comfort Vibration

The Department of Environment and Conservation's (DEC) Assessing Vibration: a technical guideline (2006) provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV) rather

than a continuous vibration level. The VDV is dependent upon the level and duration of the vibration event, as well as the number of events occurring during the daytime or night-time period.

3.3 Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment found in most buildings that is not particularly vibration sensitive. For most receivers, the controlling vibration criterion is the human comfort criterion, and it is therefore not normally required to set separate criteria in relation to the effect of construction vibration on typical building contents. Where appropriate, objectives for the satisfactory operation of vibration sensitive critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

3.4 Structural Damage Vibration

Structural damage vibration limits are based on Australian Standard AS 2187: Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives and British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2. These standards provide frequency-dependent vibration limits related to cosmetic damage, noting that cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

The recommended vibration limits from BS 7385 for transient vibration for minimal risk of cosmetic damage to residential and industrial buildings are shown in **Table 2**. The vibration guide values are for the base of the building. SEG note that no vibration monitors are affixed directly to residential structures and as such, no direct comparison can be made between results obtained from this assessment and guideline values.

Table 1 British Standard 7385 Transient Vibration Levels for Minimal Cosmetic Damage Risk

Type of Building	Peak Component Particle Velocity in Frequency Rande of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures (Industrial and/or heavy commercial buildings)	50 mm/s at 4 Hz and above	
Unreinforced or light framed structures. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15Hz increasing to 50 mm/s at 40 Hz and above

Based on the results of initial testing. Milling equipment on-site appears to produce ground borne vibrations at a frequency range of 20 – 40 Hz. The most conservative value for unreinforced residential structures of 20 mm/s has been selected.

3.5 Vibration Monitoring Results

A summary of maximum vibration values recorded across the day are presented in **Appendix A**. Vibrations measured and correlated to the expected frequency of vibration inducing equipment. General frequency ranges recorded for vibrations induced by site equipment have been observed to range from ≈ 20 – 40 Hz. Using an approximate polynomial, SE have chosen a limit of 24 mm/s based on a conservative assumption of vibrations occurring at 20 Hz and extrapolating an approximate polynomial curve from information provided in **Table 1**. $(0.0207 \times Hz^2 + 0.0611 \times Hz + 14.424) \approx 24$ mm/sec at 20 Hz.

No exceedances of the adopted criteria were noted for the duration of the monitoring period.

4 Conclusion

SEG have reviewed site data (refer **Appendix A**), and available guideline values available. Based on the assessments undertaken so far, SEG conclude the following:

- Vibration levels measured at residences adjacent to the site between the 5th to the 10th of June 2023 were found to be well below relevant criteria; and
- Vibration reduction methodologies implemented on-site are considered adequate and above industry best practice, and as such, no further controls are recommended.

Should you have any further questions regarding information provided in this letter, please do not hesitate to contact the undersigned.

Sincerely yours,

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FIGURES

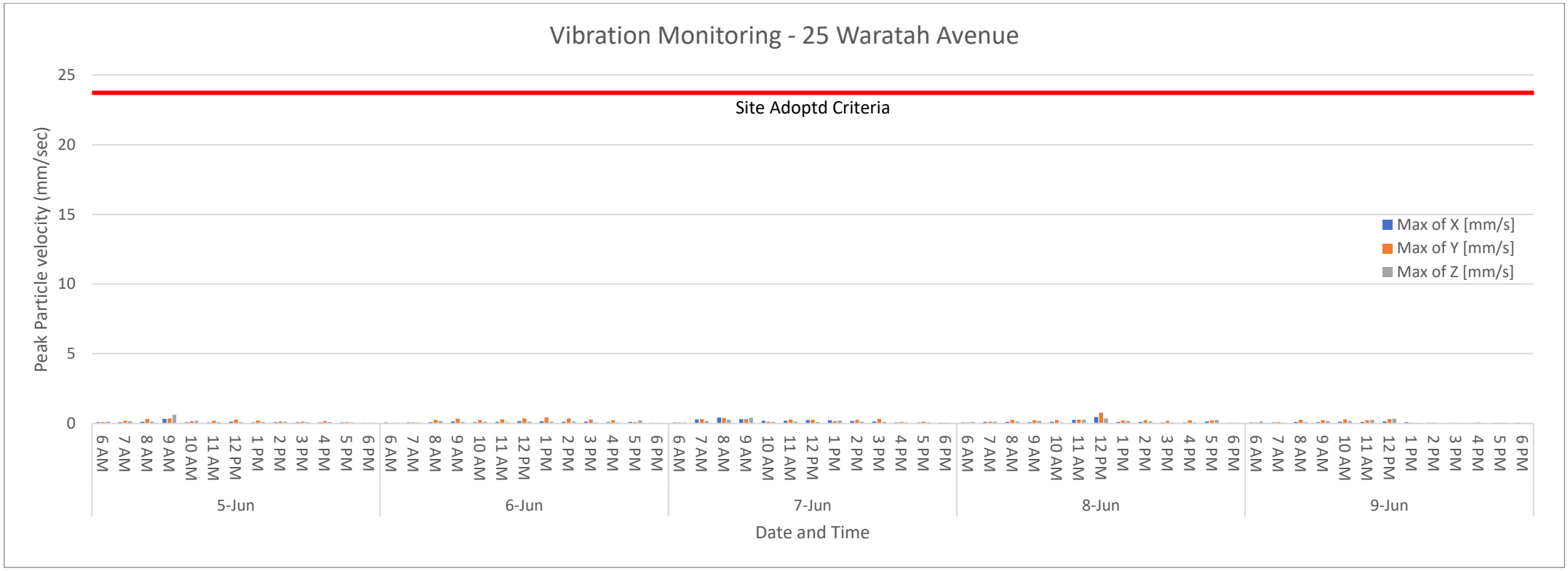
SITE PHOTOGRAPHS

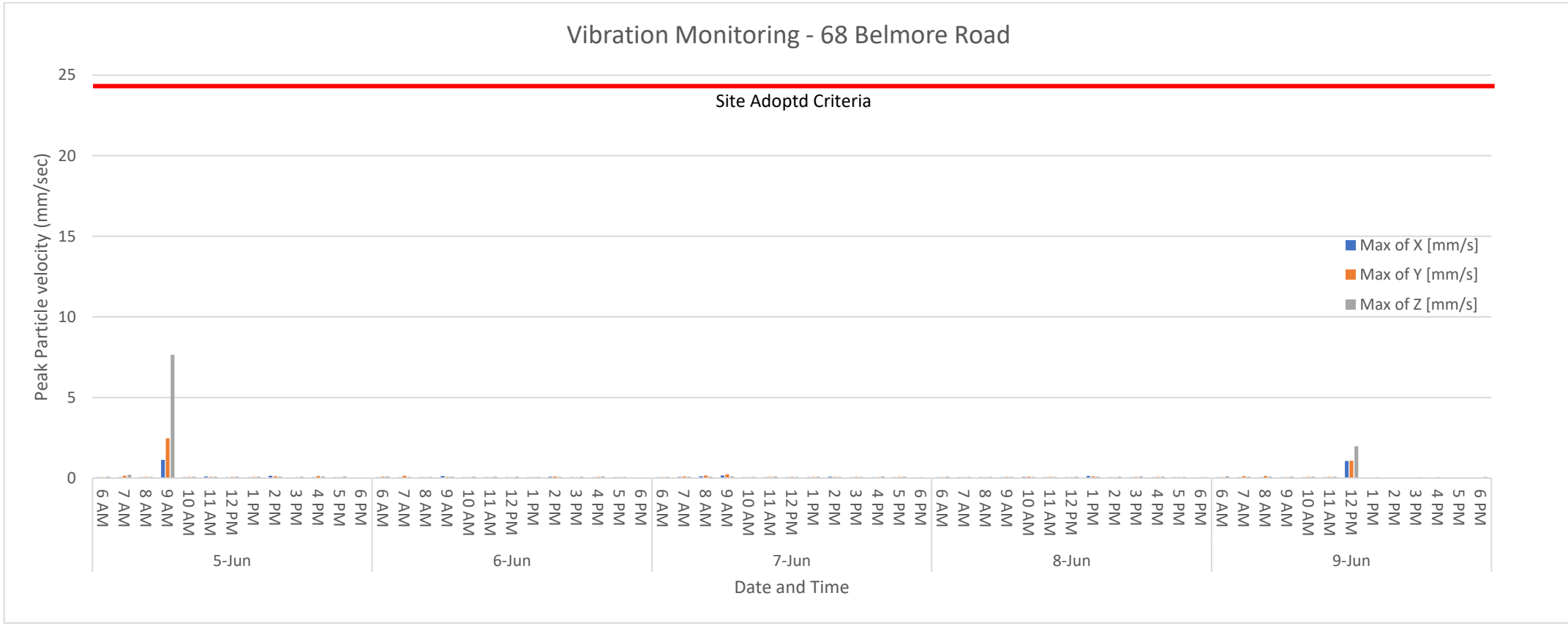
Photograph 1 Location of 'Monitor 1', affixed to the brick façade (within the gas meter enclosure) on the northern side of the building, approximately 15 m from the closest edge of works.

Photograph 2 Location of 'Monitor 2', affixed to the sandstone façade on the western side of the building, approximately 5 m from the closest edge of works. Note that the monitor has been affixed through an existing drilled hole in the sandstone which will be re-affixed at the completion of monitoring.

APPENDIX B

VIBRATION RESULTS SUMMARY TABLES


Vibration Monitoring - 25 Waratah Avenue
Peak Particle velocity (mm/sec)
25
20
15
10
5
0
Site Adoptd Criteria
Max of X [mm/s]
Max of Y [mm/s]
Max of Z [mm/s]
6 AM 7 AM 8 AM 9 AM 10 AM 11 AM 12 PM 1 PM 2 PM 3 PM 4 PM 5 PM 6 PM
5-Jun
6-Jun
7-Jun
8-Jun
9-Jun
Date and Time


Vibration Monitoring - 68 Belmore Road
Site Adoptd Criteria
Peak Particle velocity (mm/sec)
25
20
15
10
5
0
Max of X [mm/s]
Max of Y [mm/s]
Max of Z [mm/s]
6 AM 7 AM 8 AM 9 AM 10 AM 11 AM 12 PM 1 PM 2 PM 3 PM 4 PM 5 PM 6 PM
5-Jun
6-Jun
7-Jun
8-Jun
9-Jun
Date and Time