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KINGSCLIFF PUBLIC SCHOOL
ENVIRONMENTAL MONITORING

Noise and Vibration Monitoring Compliance Report

12 Orient Street, Kingscliff, NSW 2487

January 2024

For:

Richard Crookes Construction

By:

ENV Services

Date:

15/03/2024

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Job No:	ENV216223
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Revision:	**Date:**	**Details:**
v1	15/03/2024	First version issued to Client
V2	19/01/2024	Second version issued to Client
V3	02/02/2024	Third version issued to Client
V4	15/03/2024	Fourth version issued to Client.

SCOPE OF ENGAGEMENT AND LIMITATIONS

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TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

ENV has been engaged by Richard Crookes Construction to conduct noise and vibration monitoring during the redevelopment of the Kingscliff Public School (KPS), located at 12 Orient Street, Kingscliff, NSW 2487. The Site is legally identified as Lot 1 of Deposited Plan (DP) 384195.

This Noise and Vibration Monitoring Compliance Report has been prepared to assess the impact of construction noise and vibration on nearby sensitive receivers during construction hours. This information will then be used to validate existing controls or recommend additional mitigation measures to alleviate impact on sensitive receivers.

2 OBJECTIVES

The overarching goal of carrying out noise and vibration monitoring during the school redevelopment is to minimise environmental impacts and disturbance to the community, especially sensitive receivers immediately adjacent to the project. The KPS Noise and Vibration Management Plan (NVMP) stipulates noise and vibration thresholds that are required to be met for the works package. Monitoring of site activities is subsequently carried out as a measure of compliance to determine whether thresholds are exceeded at the adjacent sensitive receivers. Subsequently, if site specific limits are exceeded, additional mitigation measures specified within the NVMP will be implemented to mitigate impact on the surrounding community.

3 ASSESSMENT CRITERIA

The project specific noise and vibration criteria has been outlined in the KPS NVMP Rev. 10 (ENV 2024). The noise criteria for the site have been determined by Noise and Vibration Impact Assessment (2021) undertaken by Acoustic Works. All project criteria are in alignment with technical standards publish by the NSW EPA and the SSD – 8378620 Consent Conditions for Noise and Vibration Monitoring.

3.1 Noise Assessment Criteria

Rating background levels (RBL) at sensitive receivers were calculated for the Project by Acoustic Works in 2021. Subsequently, these rating background levels are used to calculate project specific construction noise management levels (NML) at each sensitive receiver as per the requirements set within the ICNG (2009). Noise management levels for each receiver grouping are identified in the KPS NVMP and are listed in Table 1 below.

Table 1. Project Specific Noise Criteria

Time Period	Receiver 1 (R1)		Receiver 2 to 4 (R2 – R4)	
	Criteria $L_{eq\ (15min)}$ dBA		Criteria $L_{eq\ (15min)}$ dBA	
	Noise Affected	Highly Noise Affected	Noise Affected	Highly Noise Affected
Standard Construction Hours	54	75	52	75
Outside Standard Construction Hours (OOHW – Day time only)	49		47	

During the reporting period, the noise and vibration monitor were setup to capture noise and vibration intensive demolition and construction activities on the school buildings and adjoining sensitive receivers. Therefore, for this reporting period the noise criteria during the specified construction hours of 7am – 6pm Monday to Friday and 7am – 1pm Saturday are;

- **NML: 52dB ($LAeq_{15min}$), and**
- **Highly noise affected level of 75dB ($LAeq_{15min}$)**

Noise levels were predicted to exceed the adopted noise affected thresholds at the sensitive receivers with the inclusion of mitigation measures. During demolition, noise levels were predicted to reach (83dB $LAeq_{15min}$) at the sensitive receivers. Therefore, a key metric for assessing the success of noise mitigation measures is to the number of formal complaints. Subsequently the CNVMP (2024) key performance indicator for the site is to minimize the number of complaints received over the duration of the project.

3.2 Vibration Assessment Criteria

Vibration Criteria are outlined within the *KPS NVMP Revision 10* (ENV 2024) for the site. The German DIN 4150-3 sets the vibration criteria for structural damage and the NSW *Assessing Vibration: a technical guideline* sets the vibration criteria for human exposure.

3.2.1 Vibration Criteria for Structural Vibration

The vibration criteria for structural damage is assessed against the German DIN-4150-3:2016-12. There are two (2) types of vibration as classified in the DIN 4150-3 which include:

- Short Term Vibration: vibration that does not occur often enough to cause material fatigue and whose development over time and duration is not suitable for producing a significant increase in vibration due to resonance in the particular structure.
- Long Term Vibration: any type of vibration not covered by the definition of "short-term vibration".

Both short and long-term vibration is measured in maximum velocity (Peak Particle Velocity (PPV)) in mm/s. Due to the nature of vibration sources (vibratory roller, demolition, movement of machinery & rock breaking) sporadically being utilised throughout the construction phase of the project, the type of vibration at the site is considered short term. Table 2 sets out the guideline values for vibration velocity, for evaluating the effects of short-term vibration on structures.

Table 2 - Guideline Values for Short Term Vibration

Type of Structure	Guideline values for, v_i *max* in mm/s				
	Foundation, all directions, i = x, y, z, at a frequency (Hz) of			Topmost floor, horizontal direction, i = x, y	Floor slabs, vertical direction, i = z
	1 – 10	10 – 50	50 – 100	All Frequencies	All Frequencies
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	**20 – 40**	40 – 50	40	20
Residential buildings and buildings of similar design and/or occupancy	5	**5 – 15**	15 – 20	15	20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings)	3	3 – 8	8 – 10	8	20

Sensitive receivers affected are likely to include the residential dwellings and school buildings located proximal to the vibration source. The school buildings are closer to the vibration source and are considered a commercial structure and subsequently the vibration criteria is set above that of the adjacent residences. Construction machinery generally emit a frequency of 10-50 Hz with the vibration being monitored at the foundation of the impacted building. Therefore, criteria for short term vibration criteria for structural damage has been adopted from the DIN-4150:3 outlined below.

- The guideline values for vibration for school buildings is **40mm/s.**
- The guideline values for vibration on residential receivers is **15mm/s.**

3.2.2 Vibration Criteria for Human Exposure

There are three types of vibration as classified in the Assessing Vibration Technical Guideline 2006 which include:

- Continuous – vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted RMS (root mean squared) acceleration values.
- Impulsive – rapid build up to a peak followed by a damped decay that may or may not involve several cycles. The duration is short, typically less than 2 seconds. Impulsive vibration (no more than three occurrences in an assessment period) is assessed on the basis of acceleration values.
- Intermittent – interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. Intermittent vibration is assessed on the basis of vibration dose values.

Continuous vibration is a broadly used to measurement to measure annoyance (Human Comfort) in the community. Sensitive receivers affected are likely to be the residential dwellings and some school buildings may be affected but are closer to the vibration source and have criteria above that of

residences. Therefore, criteria for continuous vibration for human response at residences and schools during the day have been adopted from the Assessing Vibration Technical Guideline 2006, outlined below.

- The guideline values for continuous vibration for school buildings is **0.04 m/s^2 (maximum z axis), or 0.028m/s^2 (maximum x & y axis)**
- The guideline values for continuous vibration on residential receivers is **0.02 m/s^2 (maximum z axis), or 0.014m/s^2 (maximum x & y axis)**

Table 2: Weighted RMS Vibration Acceleration Values for continuous and impulsive vibration

Type	Location	Assessment Period	Preferred values m/s^2		Maximum values m/s^2	
			z-axis	x & y axis	z-axes	x & y axes
Continuous Vibration	Critical Areas	Day or Night-time	0.005	0.0036	0.01	0.0072
	Residences	**Day time**	**0.01**	**0.0071**	**0.02**	**0.014**
		Night-time	0.007	0.005	0.014	0.01
	Offices, Schools & Places of Worship	**Day or Night-time**	**0.02**	**0.014**	**0.04**	**0.028**
	Workshops	Day or Night-time	0.04	0.029	0.08	0.058
Impulsive Vibration	Critical Areas	Day or Night-time	0.005	0.0036	0.01	0.0072
	Residences	Day time	0.3	0.21	0.6	0.42
		Night-time	0.1	0.071	0.2	0.14
	Offices, Schools & places of Worship	Day or Night-time	0.64	0.46	1.28	0.92
	Workshops	Day or Night-time	0.64	0.46	1.28	0.92

4 SITE ACTIVITIES

Site activities during the monitoring period (11 October – 12 December) included demolition works, earthworks, loading out construction and demolition waste, importing fill and soil compaction using vibratory roller/vibraplates. The monitor was targeting expected high levels of noise and vibration created during demolition and compaction activity associated with the redevelopment of the school.

5 METHODOLOGY

The noise and vibration monitor was commissioned on the afternoon of the 11th October 2023 at approximately 12:40PM by a suitably qualified Environmental Scientist (Timothy Bischof). The unit was installed on the southern side of Building A to determine the noise and vibration impact on the adjoining structure, Building G. The meter was located within the demolition and construction envelop due to security reasons and is directly exposed to interference (i.e footsteps in close proximity to meter) from construction personnel actively working within the area.

The location of the noise and vibration meter was relocated throughout the monitoring period as demolition and earthworks progressed. The location of monitoring points and relevant dates are located illustrated in **Appendix A, Figure 2** and photographs of the noise monitor and general construction works are provided in Appendix B. The monitor was placed one metre away from the façade of the nearest building and at a height of 1.5 m above ground level. Noise Monitoring is generally conducted in accordance with AS 1055:2018 – Acoustics – Description and Measurement of Environmental Noise with Calibrated equipment. The monitor was erected within 1m of a temporary fence, however, this fence is not considered to be reflective. The meter provided RCC with instantaneous SMS alert notifications when noise levels of 75 $LAeq_{15min}$ dB_A were recorded and vibration exceeded 5mm/s.

Vibration monitoring was conducted in accordance *with Assessing Vibration: a technical guideline* (DECC 2006) and the DIN-4150. Noise monitoring was conducted in accordance *AS 1055.2018 Acoustics - Description and measurement of environmental noise*, and the *Interim Construction Noise Guideline* (DECC, 2009). Noise and vibration monitoring was also in accordance with the KPS CNVMSP Rev 10 (ENV 2024). Vibration data was calculated as RMS acceleration for continuous vibration for human response and as velocity for structural damage. Continuous vibration methods are discussed in in *Assessing vibration: a technical guideline* (NSW Department of Environment and Conservation, 2006), DIN: 4150:3 and the KPS CVNMSP Rev 10 (ENV 2024).

Noise and vibration on site were monitored continuously 24 hours per day, seven days per week using a SVAN 958AG Class 1, four-channel noise and vibration monitor. Vibration was monitored via three channels on orthogonal axes to assess vibration received on three different planes, represented by x, y, or z, for which there are different functions and vibration criteria. The highest recorded vibration was compared against the relevant axis. Whilst noise data was averaged over a 15-minute period to produce a running $LAeq_{15\ min}$ result.

The monitor operated continuously regardless of weather conditions, including during periods with winds of greater than 5 m/s and during periods of rainfall. Noise from sources other than construction works on-site have not been excluded. As such, the noise data presented here includes background noise as well as noise produced by construction activities on-site representing worst case noise emissions at the site.

Vibration axes weighting functions, data transformations, and noise functions were calculated using the supporting software for the monitor, SvanPC++ version 3.4.9. This software was also used to produce plots presented in the appendices.

6 RESULTS AND DISCUSSION

6.1 Noise

Figures 3 - 4 provided within **Appendix B** present a summary of the $LAeq_{(15min)}$ values recorded during the reporting period. The most sensitive NML of 52dBA was exceeded during and after construction hours with the NML being exceeded most mornings between 4:00am & 6:00am, before construction begins. Between 22nd October & 25th October, noise exceeded the NML at all times (including overnight outside constructions hours). Recorded daytime noise levels on Sundays (outside construction hours) reached a maximum between 55.5dBA to 75.8dBA (8:22am 03/12/2023). Due to the site being in close proximity of the roadway, the ocean and being located within a residential area (urban hum), background noise often exceeded the NML of 52dBA outside construction hours making compliance with the 52dBA NML practically impossible during construction hours.

As such, noise mitigation measures were focused on limiting demolition and construction noise to remain below the highly noise affected criteria of 75 dBA. Noise monitoring between the 11th - 26th October and 4th - 13th December was undertaken to assess noise at the school receivers. Noise monitoring occurring between 26th October - 4th December was undertaken to assess noise impacts to the adjoining residents with the noise monitor repositioned to three locations around the site boundary to assess compliance as illustrated in Appendix A, Figure 2. An adjustment to the recorded noise levels between the 26th October to the 4th December was calculated for all exceedances (Table 3) to compensate for the natural attenuation between the location of the noise monitor and the sensitive receivers.

The following calculation was applied to calculate the adjusted noise levels at the adjacent residential receivers.

$$SPL2 = SPL1 - 20\log\left(\frac{R2}{R1}\right)$$

Where:

SPL1 = Sound pressure level at point 1;

SPL2 = Sound pressure level at point 2;

R1 = Distance from the sound source to point 1; and

R2 = Distance from the sound source to point 2.

Table 3 KPS highly noise affected criteria (>75dBA) exceedances within reporting period

Date	Start (time)	Stop (time)	LAeq 15 min dB(A)	Adjusted LAeq 15 min dB(A)
11/10/2023	12:22pm	2:07pm	79.8	-#
11/10/2023	3:07pm	3:07pm	75.5	-#
12/10/2023	8:52am	9:07am	76.2	-#
12/10/2023	11:22am	11:52am	80.0	-#
12/10/2023	1:52pm	2:07pm	81.4	-#
13/10/2023	7:37am	9:07am	78.7	-#
13/10/2023	11:22am	3:07pm	81.5	-#
14/10/2023	8:22am	11:37am	92.3	-#
14/10/2023	4:37pm	4:37pm	79.2	-#
16/10/2023	8:52am	9:37am	77.4	-#
16/10/2023	11:22am	11:53am	81.3	-#
16/10/2023	1:52pm	3:22pm	81.9	-#
17/10/2023	7:07am	7:22am	78.3	-#
17/10/2023	8:22am	12:07pm	80.5	-#
17/10/2023	1:52pm	3:52pm	86.9	-#
18/10/2023	7:22am	9:22am	90.5	-#
18/10/2023	10:22am	2:07pm	90.4	-#
18/10/2023	3:22pm	4:07pm	75.5	-#
19/10/2023	8:37am	9:07am	81.1	-#
19/10/2023	11:22am	12:07pm	82.6	-#
19/10/2023	1:52pm	3:07pm	81.2	-#
19/10/2023	4:22pm	4:22pm	75.8	-#
20/10/2023	9:07am	9:07am	77.7	-#
20/10/2023	11:22am	1:07pm	82.3	-#
20/10/2023	1:52pm	2:07pm	76.4	-#
20/10/2023	4:22pm	4:22pm	78.2	-#
23/10/2023	7:22am	7:22am	77.3	-#
23/10/2023	8:52am	8:52am	81.1	-#
23/10/2023	11:22am	11:52am	79.6	-#
23/10/2023	1:52pm	3:22pm	82.5	-#

Date	Start (time)	Stop (time)	LAeq 15 min dB(A)	Adjusted LAeq 15 min dB(A)
23/10/2023	4:07pm	4:07pm	75.6	-#
24/10/2023	7:52am	10:07am	80.0	-#
24/10/2023	11:07am	11:52am	82.2	-#
24/10/2023	1:07pm	3:37pm	83.9	-#
25/10/2023	9:07am	9:22am	75.2	-#
25/10/2023	3:07pm	3:07pm	76.0	-#
26/10/2023	8:52am	9:07am	79.9	64.3
30/10/2023	4:52pm	4:52pm	80.1	64.5
31/10/2023	7:52am	8:37am	81.7	66.1
02/11/2023	11:07am	1:22am	77.0	61.4
04/11/2023	11:22am	11:22am	75.5	59.9
13/11/2023	8:07am	8:07am	78.3	62.7
13/11/2023	3:37pm	3:52pm	78.2	62.6
14/11/2023	7:52am	7:52am	76.6	61.0
15/11/2023	7:52am	8:07am	78.2	62.6
15/11/2023	10:37am	10:37am	75.9	60.3
15/11/2023	1:37pm	1:37pm	75.8	60.2
16/11/2023	11:52am	12:07pm	77.9	62.3
17/11/2023	8:07am	8:07am	75.2	59.2
17/11/2023	9:22am	9:22am	75.6	60.0
30/11/2023	12:37pm	12:37pm	75.4	59.8
03/12/2023	8:22am	8:22am	75.8	60.2
04/12/2023	1:52pm	2:07pm	79.1	-#
04/12/2023	4:07pm	5:07pm	76.0	-#
05/12/2023	8:37am	9:07am	77.5	-#
05/12/2023	11:22am	11:52am	79.7	-#
05/12/2023	1:52pm	2:07pm	79.3	-#
05/12/2023	3:22pm	4:22pm	77.7	-#
06/12/2023	9:07am	9:07am	75.5	-#
06/12/2023	11:22am	11:52am	80.4	-#
06/12/2023	1:52pm	2:07pm	77.3	-#
06/12/2023	3:07pm	3:52pm	79.0	-#
07/12/2023	8:52am	9:07am	76.6	-#
07/12/2023	11:22am	11:52am	81.6	-#

NOTE: # No adjustment required – monitor located within school grounds to assess impact on educational facility

As predicted in the noise assessment conducted by Acoustic Works in 2021 and outlined in the CNVMSP, the $LAeq_{15min}$ exceeded the highly noise affected threshold on multiple occasions when monitoring was conducted to determine the impact on classrooms. Noise levels recorded between 11-26th October and 4-13th December are likely to demonstrate 'worst case' as the noise monitor was situated in the centre of the school to monitor noise and vibration on school receivers. Recorded values during this time are shown to have significantly greater noise levels than the residential receivers. Calculated noise levels using the sound attenuation calculation determined the highest noise level on residential receivers during the project was 66.1dBA, well below the highly noise affected threshold.

The vast majority of highly noise affected exceedances were brief and under three hours at a time in-line with the INCG recommendations to limit noisy activities. Instantaneous SMS notifications were sent to the RCC project manager when noise levels exceeded 75dBA. ENV understands no formal respite periods were implemented during the works, however, noisy works and complaints were handled through active community consultation. Noise levels on the school receivers were managed through consultation and moving classrooms away from noisy areas.

To mitigate the noise impacts to local residents, RCC implemented the following noise mitigation controls:

- Community consultation advising residents and the school of noisy works.
- Liaising with the KPS to move active classrooms away from noisy works.
- Adaptive noise monitoring to determine noise levels at receivers and instant SMS notifications if noise levels exceeded 75dBA.
- Noise affected works were only undertaken during daytime construction hours.
- Complaints management system investigating the source and noise levels throughout construction; and
- Daily review of noise data (automated reports).

6.2 Vibration Results for Structural Damage

Vibration Values for short term structural damage are shown in Appendix A, Figure 12. Vibration exceedances on the 11/10/2023, 26/10/2023, 13/11/2023, 21/11/2023, 23/11/2023 & 04/12/2023 are not construction related and were caused by setting up or moving the vibration monitor.

6.2.1 Commercial Structures

Monitoring Location 1 was selected to monitor vibration on the school structures (classified as commercial structures). During the monitoring period there were two (2) vibration exceedances above the Commercial vibration limit outlined in Table 4.

Table 4 - Vibration Exceedance: Commercial Structures

Date	Start (time)	Stop (time)	Receiver	PPV (mm/s)
20/10/2023	4:57pm	4:57pm	Commercial (school)	197
07/12/2023	3:42pm	3:42pm	Commercial (school)	45
Commercial (School) Maximum Limit				**40**

The vibration exceedance quickly peaked at 197mm/s at 4:57pm on the 20th October 2023 and immediately dropped well below the vibration limit. During this time, the monitor was situated at Location 1 (Appendix A, Figure 2) adjoining Building G. This exceedance was sharp and decayed quickly with no other vibration events of this magnitude detected immediately thereafter.

Works during this time were associated with the demolition of the adjacent school building subject to redevelopment. As the vibration peaked and dropped immediately and no other vibration events of this magnitude were detected, it is assumed that the concrete slab the accelerometer (vibration meter) was situated on received a direct impact causing the large spike. The magnitude of this spike may have been isolated to the immediate area of the vibration plate (accelerometer), however this spike is still considered an exceedance.

A second exceedance on the 7th December 2023 at 3:42pm was detected peaking at 45mm/s. The spike immediately dropped below the adopted vibration criteria for commercial buildings. During this time, the monitor was situated at Location 1 (Appendix A, Figure) adjoining Building G.

Works during this time were bulk earthworks and fill compaction utilsing vibratory rollers. To mitigate vibration emission and potential impact, RCC proactively adopted the use of smaller vibratory rollers whereby a 10t roller was utilized. To further mitigate vibration levels, the amplitude setting of the vibratory drum of the roller was set as low as possible to alleviate impact whilst ensuring level 1 compaction as per the project requirements was obtained to meet geotechnical requirements. ENV have been advised that level 1 compaction was not possible without the use of vibratory rollers.

Based on the outcomes of the monitoring event, ENV recommends a dilapidation survey to be conducted on Building G to ensure structural or cosmetic damage has not occurred.

6.2.2 Residential Structures

Monitoring Locations 2-4 were selected to monitor vibrations on the nearby residential receivers. Vibration of residential receivers was undertaken between the 26th October 2023 to the 4th December 2023 as indicated on Appendix A, Figure 12. All vibration events were below the residential limit for structural damage.

6.3 Vibration for Human Response

Vibration values (RMS) for continuous vibration are shown in Appendix A, Figure 9-11. Vibration exceedances recorded on the 13/11/2023, 23/11/2023 & 04/12/2023 are not construction related and were caused by setting up or moving the vibration monitor. Table 5 illustrates the vibration exceedances for the Project.

Table 5 Vibration Exceedances : Human Response

Date	Start (time)	Stop (time)	Assessment Receiver	Peak RMS m/s^2 X Axis	Peak RMS m/s^2 Y Axis	Peak RMS m/s^2 Z Axis
15/11/2023	1:35pm	1:35pm	Residential	N/A	N/A	0.026
16/11/2023	10:28am	12:20pm	Residential	N/A	N/A	0.047
16/11/2023	3:41pm	4:04pm	Residential	N/A	N/A	0.049
17/11/2023	8:06am	8:06am	Residential	0.038	N/A	N/A
23/11/2023	10:20am	11:05am	Residential	N/A	0.016	0.021
Continuous Vibration (Human Response) Assessment Criteria						
Residential Limit				**0.014**	**0.014**	**0.02**
Offices Schools & Places of Worship				**0.028**	**0.028**	**0.04**

Note: only the axis with the exceedance has been included in the table.

The vibration exceedances appear to have occurred during bulk earthworks and soil compaction works with the use of vibratory rollers and earthmoving machinery. To mitigate vibration levels, RCC utilized smaller vibratory compaction equipment (reduced the vibratory roller from a 12 tonne to a 10 tonne roller) on the 16th November after vibration exceedance on the 15th November. To further mitigate vibration levels, the intensity of the vibratory roller was reduced as low as possible to obtain level 1 compaction as per the project requirements. ENV have been advised that level 1 compaction was not possible without the use of vibratory rollers.

During the 15th – 17th November, the noise monitor was located on the western boundary of the site with Orient Street and the laneway on the northern boundary providing a buffer zone to reduce vibration on the residential receivers. Due to access, security and power concerns, monitoring equipment was not installed at the nearest residential receiver.

Vibration exceedance on the 23rd November between 10:20am and 11:05am was caused by localised vibration generated from trucks entering the site over the steel grid within 2m of the vibration monitor. It is anticipated the vibration generated from this event would be negligible at the residential receiver approximately 26m away on the other side of Sutherland Street. However, this exceedance is considered a noncompliance for human response. The highlighted exceedance on the 23rd of February (following the exceedance caused by the movement of trucks) at approximately 12pm as indicated on Figure 10 was caused by the physical movement of the monitor to a secondary monitoring location.

There was a single spike above the maximum residential criteria at 0.021m/s^2 (Y axis) at 6:27PM on 19th October 2023 however, the monitor was located at the centre of the school and is below the maximum threshold (0.028m/s^2) for educational facilities and is therefore not considered an exceedance.

Vibration was managed through the following mitigation measures:

- Targeted vibration monitoring towards school and residential structures.
- Exceedance SMS notifications to alert site managers of vibration exceedances.
- The use of smaller and non-vibratory rollers to compact material.
- Following up complaints with targeted monitoring and review of actual vibration data.
- Community consultation; and.
- Daily review of vibration data (automated reports).

The vibration recorded during the monitoring period are considered 'worse case' as the monitor was located within the school site boundaries at all times and vibration at the residential sensitive receivers are expected to be lower than the recorded levels due to the distance from the works.

Figure 3 illustrates the location of the vibratory compaction works and the closest residential receivers. All receivers excluding 11 Sutherland Street are 30m or greater from the vibratory compaction works. 11 Sunderland Street was approximately 25m from the vibration works and within the 30m vibration envelope specified within the Noise and Vibration Management Plan. The vibration exceedances on the 15/11/2023 to 23/11/2023 exceeded the residential human response criteria, however, did not exceed the residential criteria for structural damage. However, as vibratory works were within 30m of the dwelling, ENV recommends a dilapidation survey to be conducted on 11 Sutherland Street to determine if any cosmetic damage occurred.

7 CONCLUSION

During the monitoring period, the recorded $LAeq_{15min}$ results exceeded the adopted NML's and the highly noise affected threshold. However, after calculating the noise attenuation from the residential receivers to the site works area, all noise impacts on the residential receivers were below the highly noise affected threshold. Noise exceeded the highly noise affected threshold at the school receivers however, this was managed through consultation with the school and moving classrooms away from high noise generating construction activities.

Two (2) vibration events exceeded the Maximum Commercial Limit for short term vibration for structural damage. The vibration on the 20/10/2023 appeared to be in relation to the demolition of former school buildings and the exceedance on the 07/12/2023 was in relation to bulk earthworks and vibratory compaction works. The monitor was located at Monitoring Location 1 within the center of the school to assess vibration impacts on Building G. ENV recommends a dilapidation survey to be undertaken on Building G to determine if any structural or cosmetic damage occurred.

Vibration monitoring for human response detected five (5) separate events exceeding the residential vibration limit. During this time, RCC implemented mitigation measures specified within the approved NVMP which included active consultation with the community advising of the proposed noisy works, carrying out targeted noise and vibration monitoring to verify results against site limits, utilization of smaller and non-vibratory machinery, real-time notification of noise and vibration exceedances to the Site Manager through SMS notifications, daily review of noise and vibration data and the investigation of complaints through the complaints handling procedure.

8 REFERENCES

ENV Solutions (2022). *Kingscliff Public School Redevelopment – Construction Noise and Vibration Management Sub Plan - Version 10 – March 2024*

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New South Wales. Environment Protection Authority (2017). *Noise Policy for Industry*

New South Wales. Department of Environment and Conservation. Noise Policy Section. (2006). *Assessing vibration: A technical guideline*.

Standards Australia (2018). *AS 1055.2018 Acoustics - Description and measurement of environmental noise*

Transport for NSW (2023). *Construction Noise and Vibration Guideline*. EMF-NV-GD-0060

APPENDIX A

Site and Monitor Locations

Legend

Site Location

0 1 2km

Figure 1 – Site Location
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
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Legend

1 11th-26th October & 4th December – 13th December

2 26th October – 13th November & 21st – 23rd November

3 13th – 20th November

4 23rd November - 4th December

General Works Area

Image Source: Coffs Harbour Council Online Mapping (2022)

Figure 2 – Noise and Vibration Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

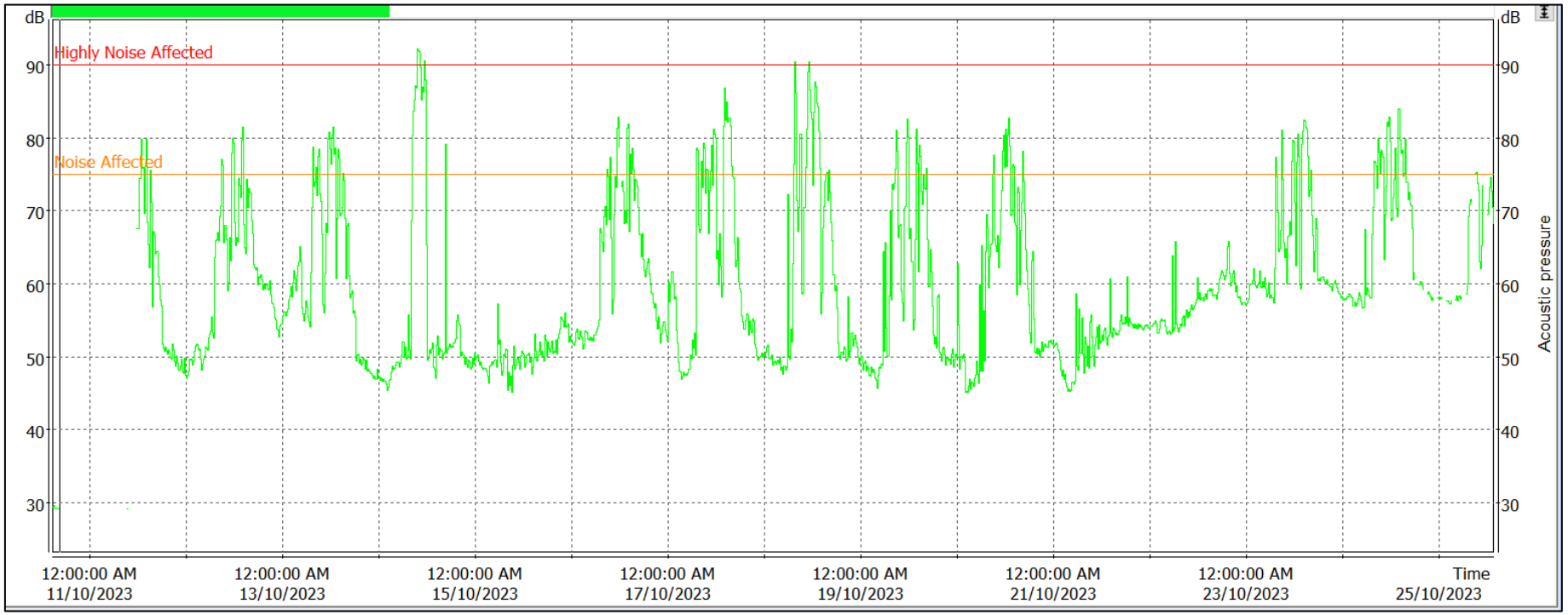
ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

Figure 3 – Vibratory Works in Relation to Sensitive Receivers
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

Image Source: Near Maps (Provided by RCC)

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



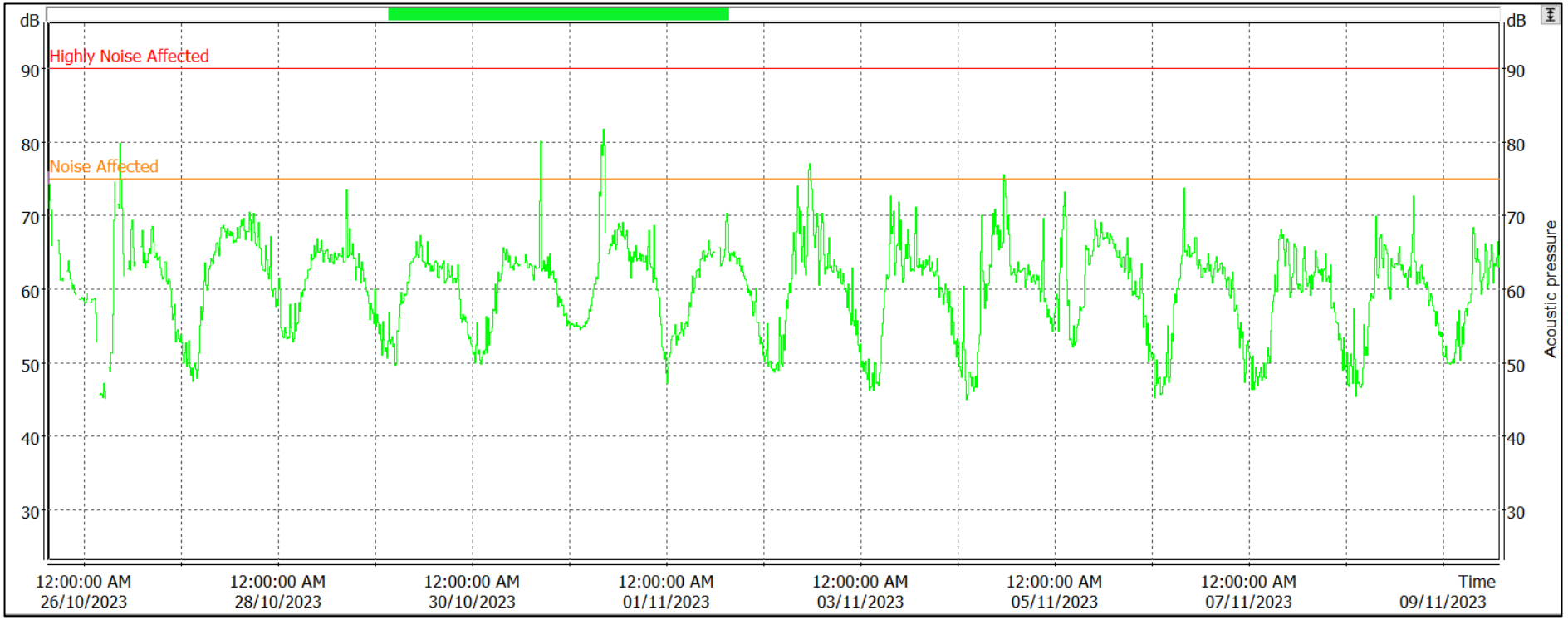
Legend

LAeq dBA 15min

Figure 4 – Noise Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



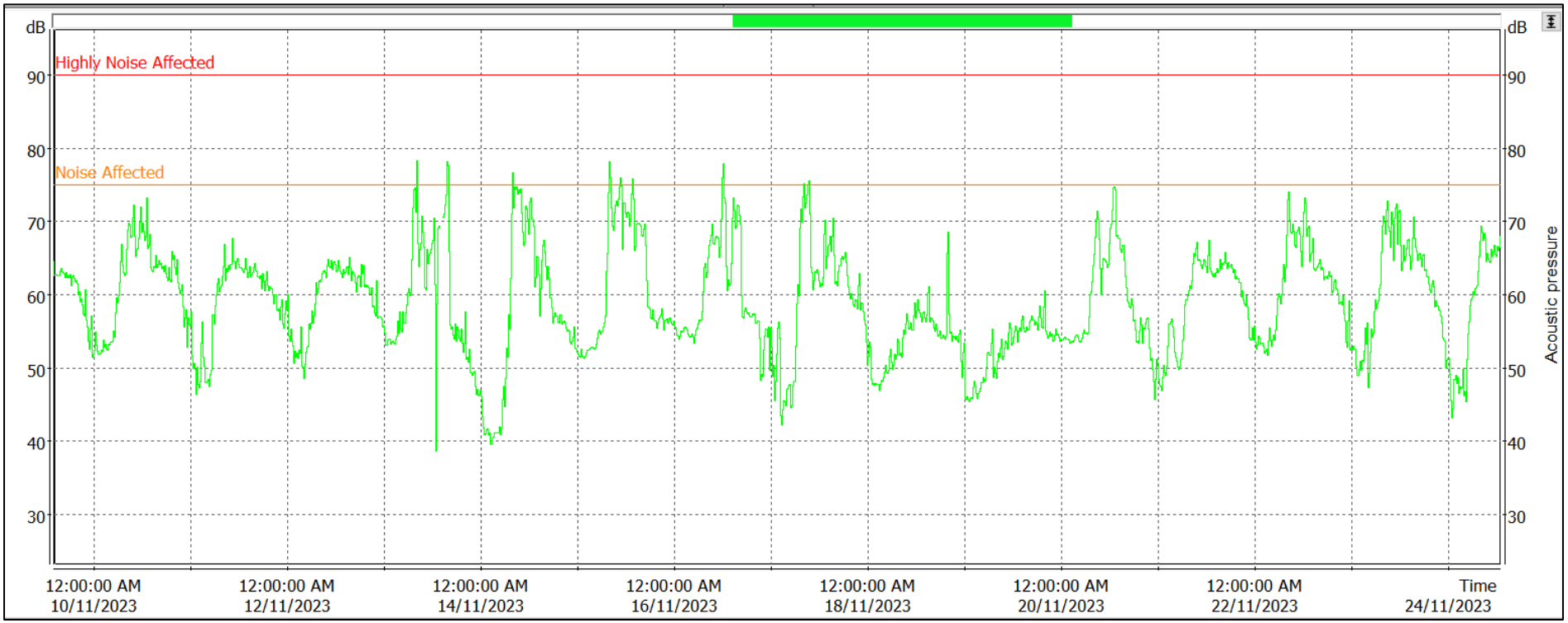
Legend

LAeq dBA 15min

Figure 5 – Noise Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



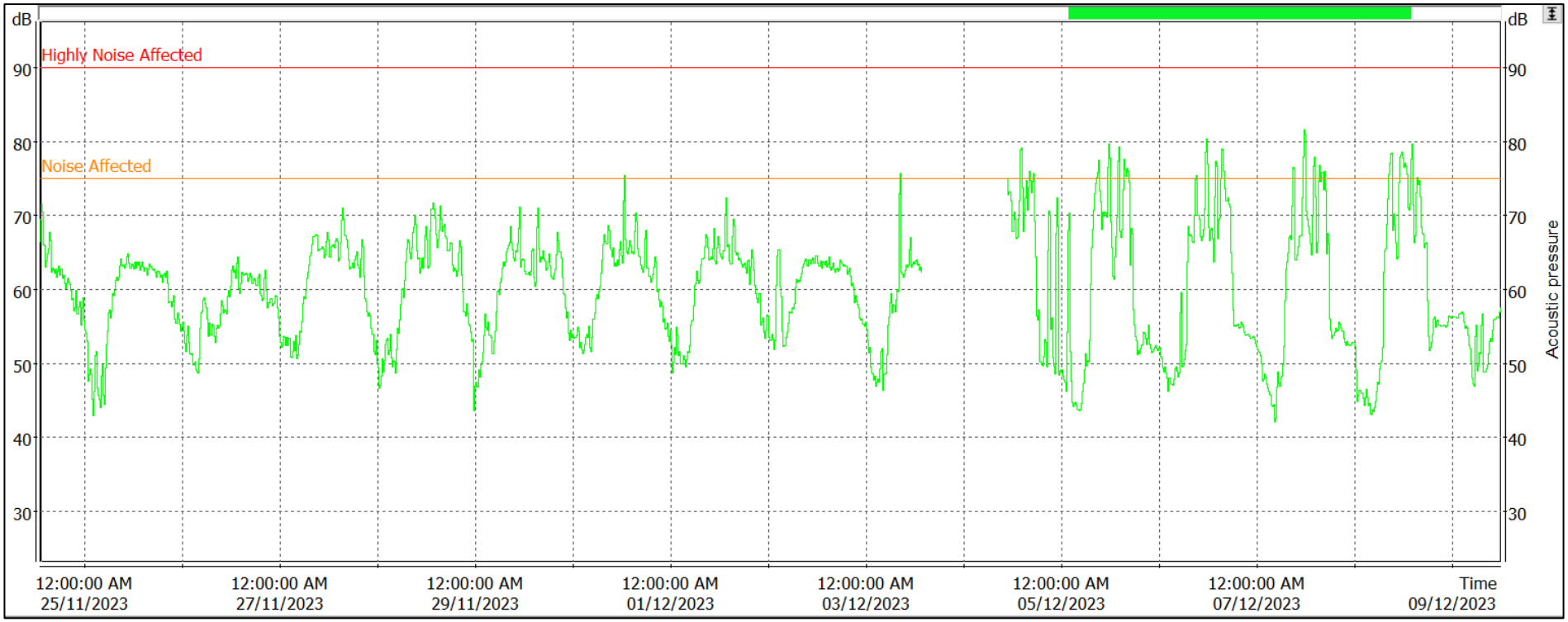
Legend

LAeq dBA 15min

Figure 6 – Noise Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



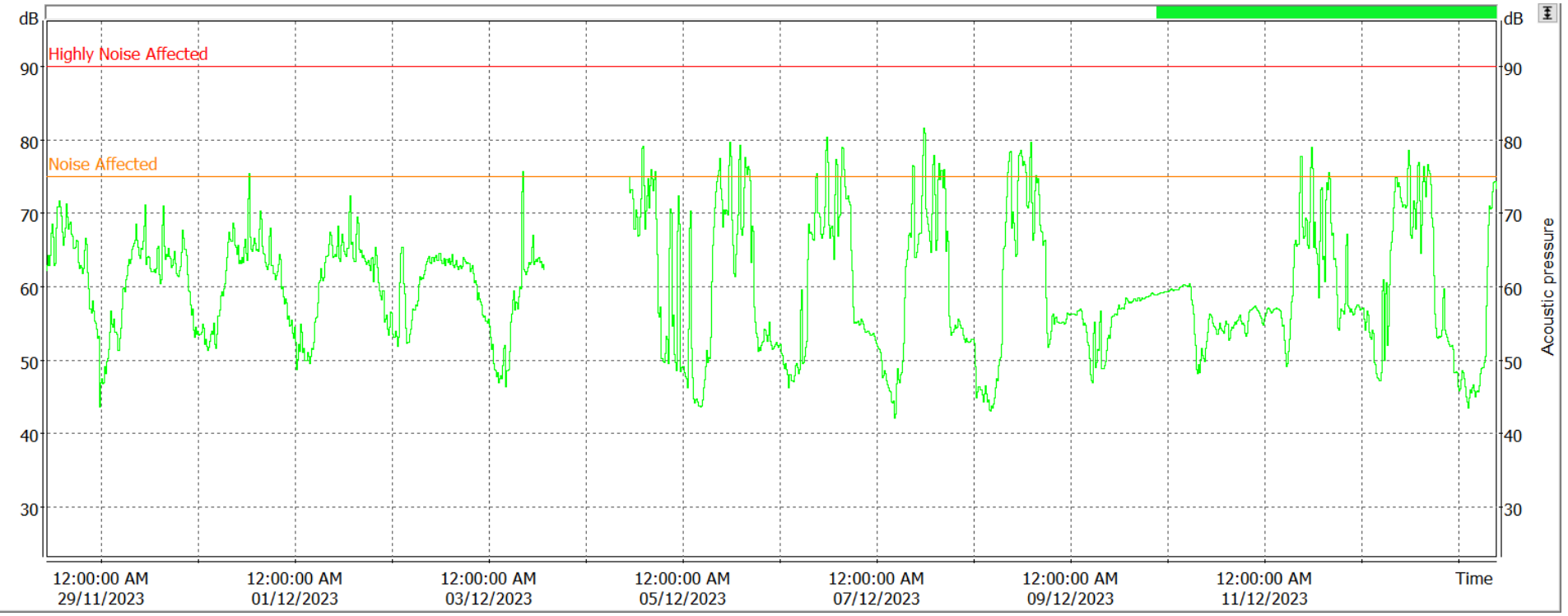
Legend

LAeq dBA 15min

Figure 7 – Noise Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



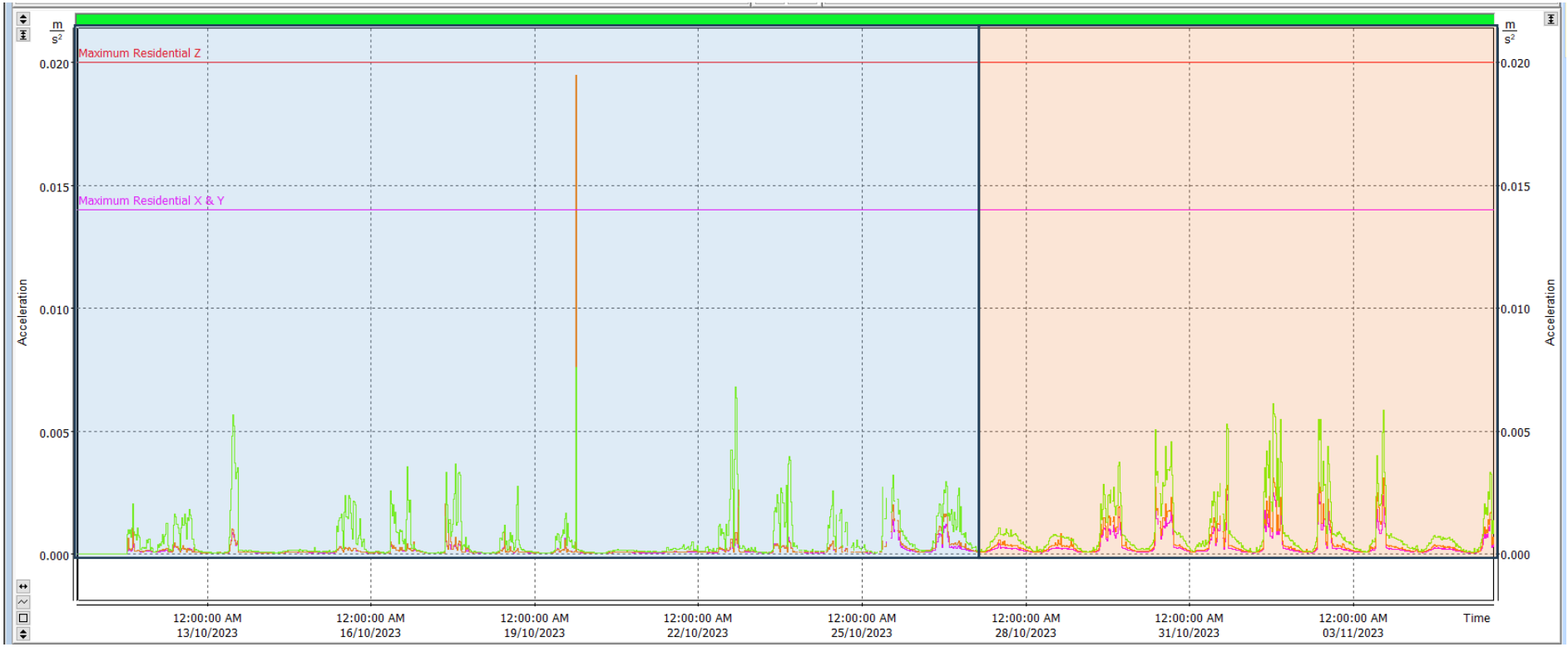
Legend

LAeq dBA 15min

Figure 8 – Noise Monitoring
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



Legend

X Axis

Y Axis

Z Axis

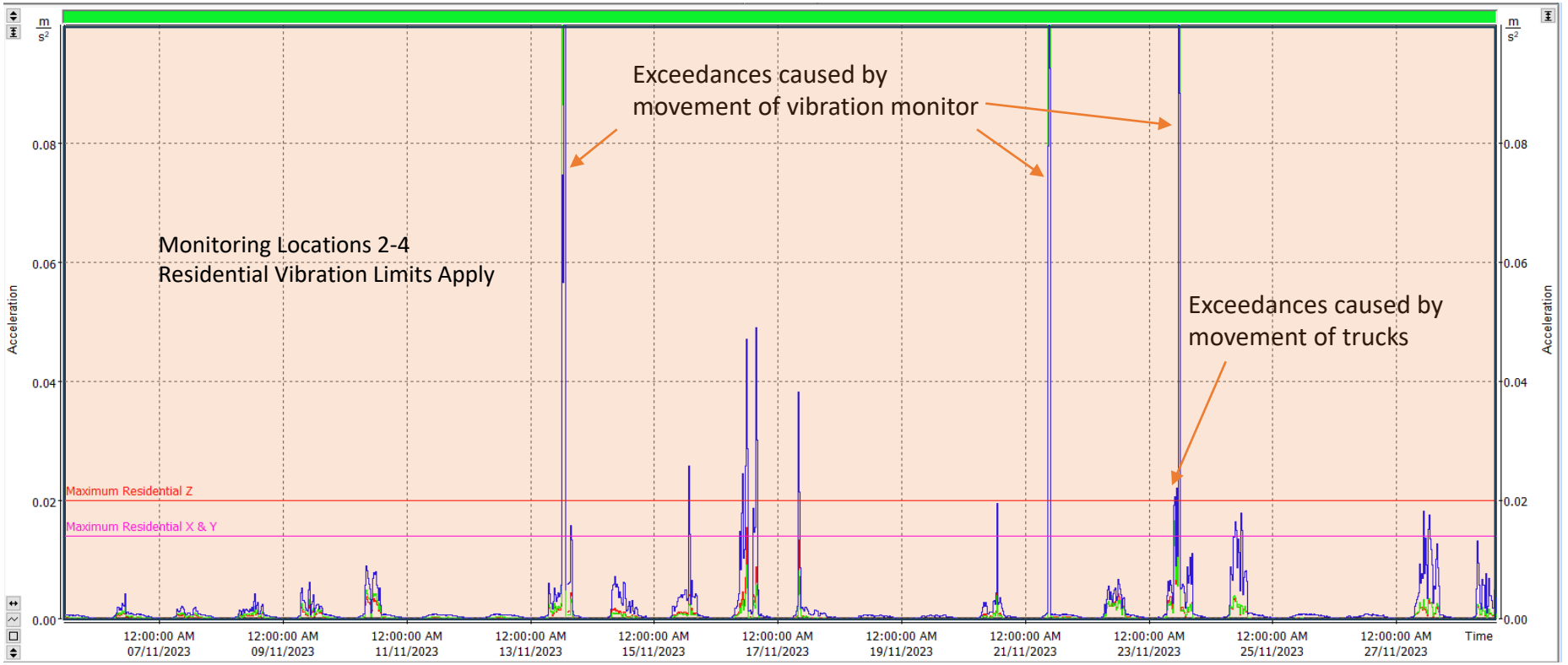
Monitoring Location 1
Commercial Vibration Limits Apply

Monitoring Locations 2-4
Residential Vibration Limits Apply

Figure 9 – Vibration Monitoring for Human Response
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



Legend

X Axis

Y Axis

Z Axis

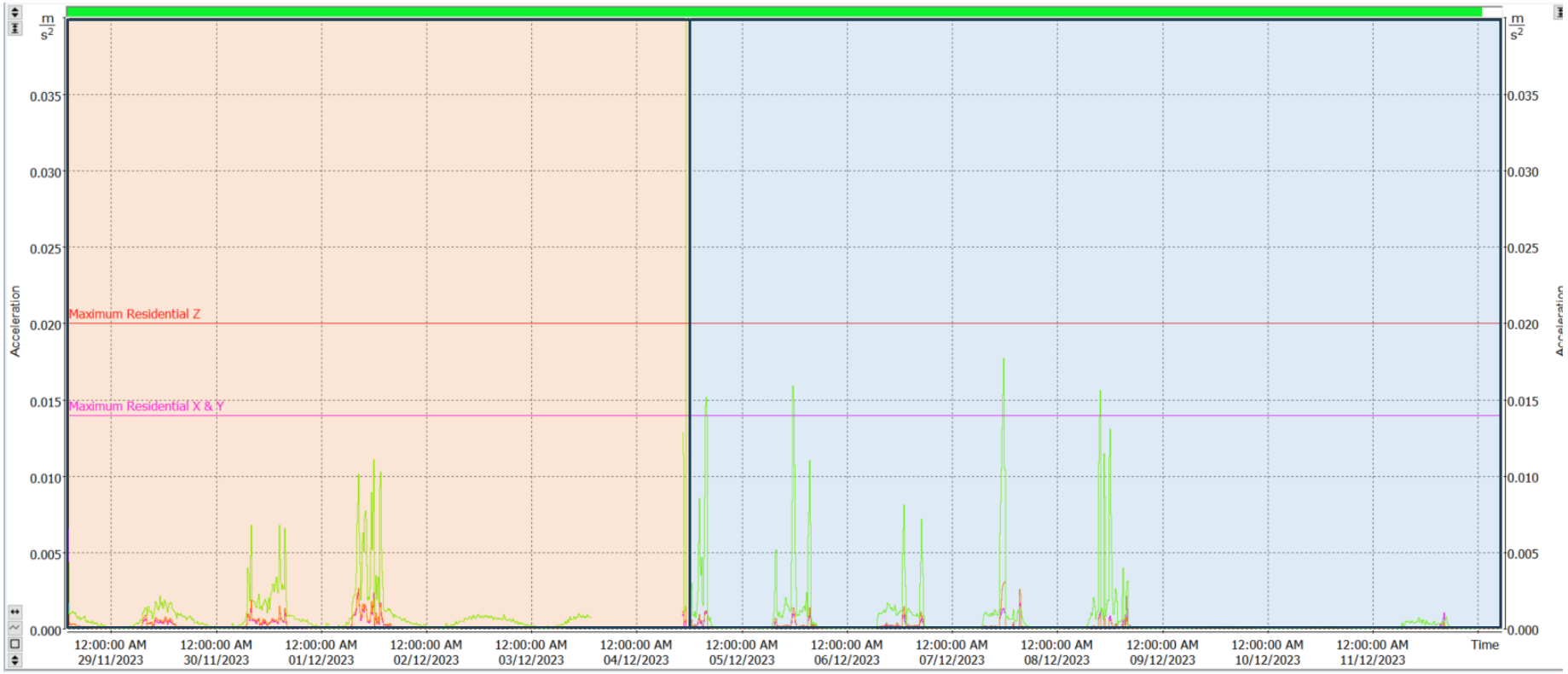
Monitoring Location 1
Commercial Vibration Limits Apply

Monitoring Locations 2-4
Residential Vibration Limits Apply

Figure 10 – Vibration Monitoring for Human Response
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



Legend

X Axis

Y Axis

Z Axis

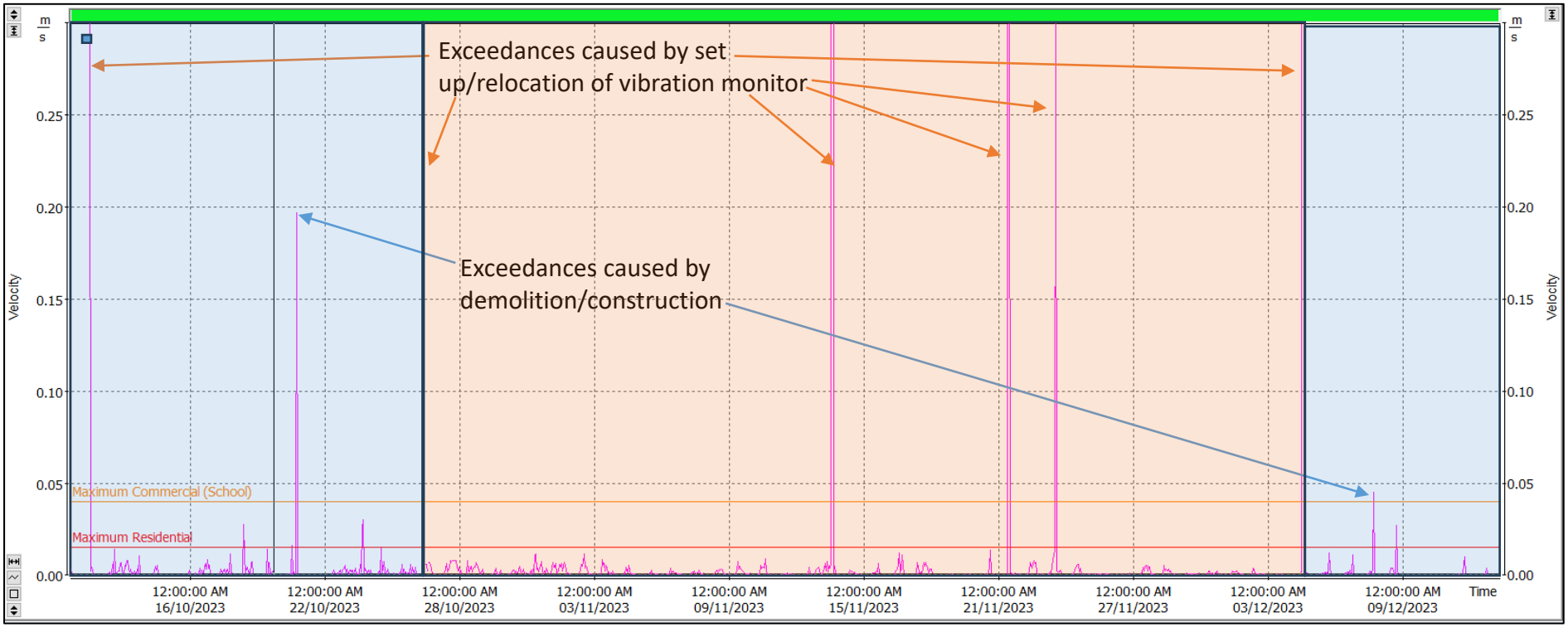
Monitoring Location 1
Commercial Vibration Limits Apply

Monitoring Locations 2-4
Residential Vibration Limits Apply

Figure 11 – Vibration Monitoring for Human Response
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY



Velocity

Monitoring Location 1
Commercial Vibration Limits Apply

Monitoring Locations 2-4
Residential Vibration Limits Apply

Figure 12 – Vibration Monitoring for Structural Damage
12 Orient Street, Kingscliff NSW 2487

Project: Noise and Vibration Monitoring
Client: Richard Crookes Construction
ENV Project Number: 216223

ENV Solutions
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APPENDIX B

Photographs

ENV Solutions
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PHOTOGRAPHIC LOG

Client Name	Site Location	Project
Richard Crookes Construction	12 Orient Street, Kingscliff, NSW	Noise Monitoring

Photo No.	Date
1	10/11/2023

Description

Image showing noise monitor location 1.

Photo No.	Date
2	20/11/2023

Description

Image showing noise monitor location 2.

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

PHOTOGRAPHIC LOG

Client Name	Site Location	Project
Richard Crookes Construction	12 Orient Street, Kingscliff, NSW	Noise Monitoring

Photo No.	Date
3	13/11/2023

Description

Image showing noise monitor location 3.

Photo No.	Date
4	13/11/2023

Description

Image showing earthworks.

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

PHOTOGRAPHIC LOG

Client Name	Site Location	Project
Richard Crookes Construction	12 Orient Street, Kingscliff, NSW	Noise Monitoring

Photo No.	Date
5	24/10/2023

Description

Image showing building C to be demolished

Photo No.	Date
6	13/11/2023

Description

Image showing demolished area and earthworks.