1 June 2023

To whom it may concern,

RE: Noise & Vibration Monitoring Reporting – May 2023

As part of SSD Approval 39170713 Conditions B14 & B17, BESIX Watpac are to monitor and report on the impacts and environmental performance of the development and the effectiveness of the implemented management measures. To meet the requirements of above conditions, weekly monitoring for noise & vibration has occurred. The results for monitoring during May 2023 can be found within.

Yours sincerely,

Mark Cahalin
Senior Project Manager
BESIX Watpac

CONSTRUCTION NOISE AND VIBRATION REPORT

Client:
MOITS PTY LTD

Stage 3 St. George Hospital, 16 Kensington Street, Kogarah

19 June 2023
Ref: PAR-23661-NVR-W01[C]

Monitoring Period:
12 May 2023 to 18 May 2023

Ref: Par-23661-W01[C]
19 June 2023

NOISE & VIBRATION MONITORING REPORT
St. George Hospital

For Duration:
12 May 2023 – 18 May 2023

Prepared for:
Peter Zwamborn
Moits
142 Wicks Rd, Macquarie Park NSW 2113

Document Authorization

For and on behalf of Paragon Engineering

Michael Duong
Civil Engineer

Sinan Habeeb
Civil Engineer

Quality information

Revision history

Revision	Report Status	Date	Author	Reviewer
A	1st Revision	7 June 2023	MD	SH
B	2nd Revision	16 June 2023	MD	SH
C	3rd Revision	19 June 2023	MD	SH

Distribution

Revision	No. of copies	Format	Distributed to	Date
A	1	PDF	Moits	7 June 2023
B	1	PDF	Moits	16 June 2023
C	1	PDF	Moits	19 June 2023

Executive Summary

Paragon Engineering was commissioned by Moits to provide vibration & noise monitoring services during the redevelopment activities for the site located at St. George Hospital. The project comprises of excavation and construction of a new Medical facility with two basement carpark

This report provides vibration and noise monitoring information for the excavation and construction of a new Medical facility with two basement carpark at the above site. Vibration monitoring was initiated to assess the potential of structural damage to the surrounding properties. Based on the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**.

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for highly noise affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*. Two vibration data logger and three noise monitor were used. The loggers are equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

The vibration results found in *Table 6* summarise the maximum daily peak particle velocity (PPV) recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 14 dB(A) for the Noise Affected NML and up to 07 dB(A) for highly noise affected while noise monitor at Location 1 was within the criteria set for this site. It is found that many of the triggers from Location 1 are caused by workers and patience within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and rooms with operating equipment to avoid these false triggers.

Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Table of Contents

Executive Summary ---- ii

List of Figures ---- iii

1. Introduction ---- 1

1.1 Background ---- 1

1.2 Site Information ---- 1

1.3 Objectives ---- 2

2. Sensitive Receivers ---- 2

3. Vibration & Noise Sources and Criteria ---- 3

3.1 Vibration Sources ---- 3

3.2 Noise Sources ---- 4

3.3 Applicable Standards ---- 4

3.4 Vibration Criteria ---- 5

3.5 Noise Criteria ---- 7

4. Methodology ---- 8

4.1 Vibration & Noise Instrument ---- 8

4.2 Site setup and Monitoring Procedure ---- 8

5. Monitoring Results ---- 9

6. Discussion and Recommendations ---- 10

7. Conclusions ---- 11

List of Figures

Figure 1 Sensitive Vibration Receiver 2

Figure 2 Sensitive Noise Receiver 3

Figure 3 Guideline values for PPV as per DIN-4150 6

Figure 4 Site setup 8

List of Tables

Table 1 Working Hours 1
Table 1 Potential noise sources 4
Table 2 guideline values for vibration velocity (BS 7385) 5
Table 3 guideline values for vibration velocity (DIN 4150) 6
Table 5 Construction noise management levels 7
Table 6 maximum daily vector sum peak particle velocity values 9
Table 7 Daily Measured Noise Levels – Location 1 dB(A) 9
Table 8 Daily Measured Noise Levels – Location 2 dB(A) 9

List of Appendices

Appendix 1 – Vibration Monitoring Data 13
Appendix 2 – Noise Monitoring Data 17

1. Introduction

1.1 Background

Paragon Engineering was commissioned by Moits to provide vibration and noise monitoring services during the redevelopment works that is located at St. George Hospital for the proposed redevelopment located at St George Hospital. The project comprises of piling, excavation and construction of a new Medical facility with two basement carpark.

1.2 Site Information

The project is located at St. George Hospital. The Stage 3 redevelopment includes the piling, excavation and construction of a new Medical facility with two basement carpark. The nearest vibration and noise sensitive receivers are shown in *Figure 1* and *Figure 2* below.

Working Hours

The Project construction working hours shall be in accordance with approved DA Condition C4-C8 as described below:

Table 1 Working Hours

Activity	Permitted working hours
C4. Construction including the delivery of materials to and from site:	❖ Monday to Friday – 7:00am to 6:00pm inclusive ❖ Saturday - 8:00am to 1:00 pm ❖ Sunday & public holidays - No work permitted
C5. Not withstanding condition C4, provide noise levels do not exceed the existing background level plus 5dB, work may also be undertaken during the following hours:	❖ Monday to Friday – 6:00am to 7:00pm inclusive ❖ Saturday - 1:00pm to 5:00 pm ❖ Sunday & public holidays - No work permitted
C6. Construction activities may be undertaken outside of the hours in condition C4 and C5 if Required:	❖ By the police or a public authority for the delivery of vehicles, plant or materials; or ❖ In an emergency to avoid the loss of life, damage to property or to prevent environment harm; or ❖ Where the works are inaudible at the nearest sensitive receivers; or ❖ For the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or ❖ Where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works
C7. Notification of such construction activities as referenced in Condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.	

Activity	Permitted working hours
C8. Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:	❖ Monday to Friday – 9:00am to 12:00pm ❖ Monday to Friday - 2:00pm to 5:00 pm ❖ Saturday – 9:00am to 12:00pm ❖ Sunday & public holidays - No work permitted

1.3 Objectives

The purpose of this document is to provide a practical construction vibration and noise monitoring information to assess the potential structural damage and human comfort in the surrounding properties, compare the collected vibration and noise results against the recommended criteria and to provide a discussion about the mitigation measures to reduce the vibration and noise occurring.

2. Sensitive Receivers

Sensitive Vibration Receivers

The nearest vibration sensitive receivers are identified in *Figure 1* and listed below:

- ❖ M1, Medical Facility on the Southern boundary of the site.
- ❖ M2, Medical Facility on the Norther boundary of the site along Kensington St.
- ❖ M3, Medical Facility on the Norther boundary of the site along Kensington St.
- ❖ H1, Fire Station (heritage) on the Western side of the boundary.
- ❖ SW, Sydney Water asset along the Northern boundary of the site along Kensington St.

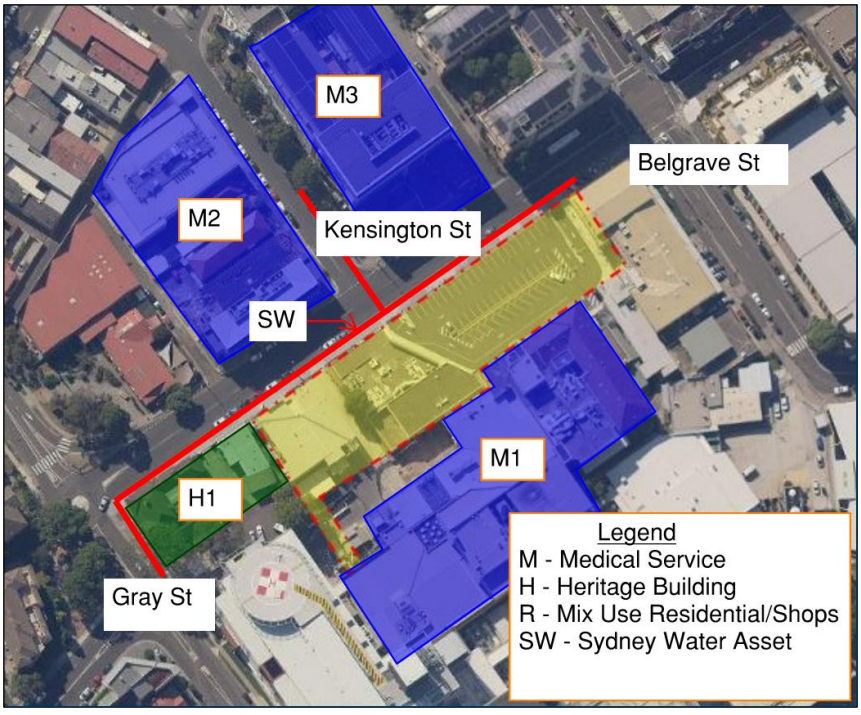


Figure 1 Sensitive Vibration Receiver

Sensitive Noise Receivers

The nearest noise sensitive receivers are identified in *Figure 2* and listed below:

- R1, Residential buildings on the Northern boundary of the site along Kensington St.
- R2, Residential buildings on the Eastern boundary of the site along Belgrave St.
- M1, Medical Facility on the Southern boundary of the site.
- M2, Medical Facility on the Norther boundary of the site along Kensington St.
- M3, Medical Facility on the Norther boundary of the site along Kensington St.
- S1, Educational Facility on the North-western boundary of the site along Kensington St.
- H1, Fire Station (heritage) on the Western side of the boundary.

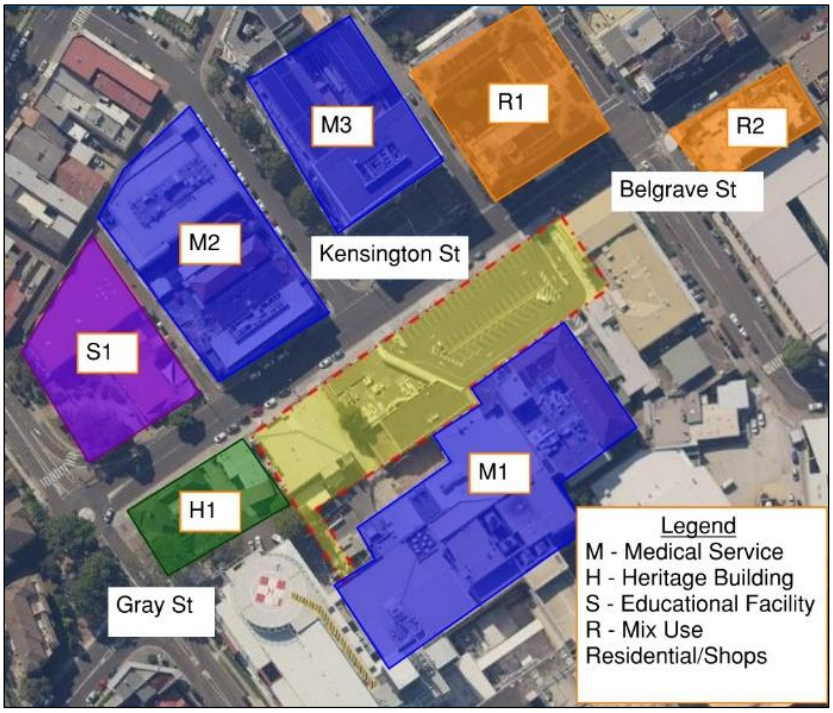


Figure 2 Sensitive Noise Receiver

3. Vibration & Noise Sources and Criteria

3.1 Vibration Sources

Vibration can be caused by various external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

The potential source of vibration in this project is likely to be caused by hydraulic excavators with jackhammers, saws and other various construction activities which may be categorised as intermittent/short term sources of vibration.

3.2 Noise Sources

The noise sources likely to be associated with the works mentioned in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering are shown in *Table 2* below.

Table 2 Potential noise sources

Stages	Equipment	Sound Power Level dB(A)
Demolition	Excavator with hydraulic hammer (30t-40t)	117
	Concrete Saw	117
	Truck & Dog	101
Excavation	Excavator with hydraulic hammer (30t-40t)	117
	Bobcat	100
	Concrete Saw	117
	Truck & Dog	101
Structure	Powered hand tools	95
	Bobcat	100
	Concrete pump	103
	Truck & Dog	101

3.3 Applicable Standards

The list below illustrates the relevant reports, standards, guidelines or policies that has been used during the preparation of this report:

- Department of Environment and Conservation (NSW) Publication, Interim Construction Noise Guideline
- Australian Standard "AS ISO 6393:2019, Earth-moving machinery - Determination of sound power level - Stationary test conditions"
- Department of Environment and Conservation (NSW) Publication, Assessing Vibration: a technical guideline (Feb 2006)
- Australian Standard "AS 2436-2010, Guide to noise and vibration control on construction, p and maintenance sites"
- International organization for Standardization "ISO 5348:2021, Mechanical vibration and shock Mechanical mounting of accelerometers"
- German Standard "DIN 4150-3:2016-12, Vibration in buildings - part 3: effects on structures"
- Australian Standard "AS ISO 2631.2.2014, Mechanical Vibration and Shock – Evaluation of human exposure to whole-body vibration. Part 2: Vibration in buildings (1-80Hz)"
- British Standard "BS 7385-2:1993, Evaluation and measurement for vibration in buildings – Part 2 Guide to damage levels from groundborne vibrations"
- Australian Standard "AS 2187.2-2006, Explosives – storage and Use. Part 2: Use of Explosives"
- Paragon Engineering, Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023

3.4 Vibration Criteria

In this report, the effect of vibration on the asset's integrity and the potential to cause structural damage will be assessed. Vibration may cause damage to a building structure, ranging from minor hairline cracking to major structural defect.

The Australian Standards *AS 2187.2* states that vibration guide values and the methods of assessing the structural response prepared by *BS 7385-2* and *(USBM) RI 8507* are applicable to the Australian Conditions.

The *British Standard BS-7385-2, Evaluation and measurement for vibration in buildings –Part 2: Guide to damage levels from groundborne vibrations* provides the vibration limits to reduce the risk of structural damage to buildings. *Table 3* below outline the frequency-dependent vibration criteria for residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

The *BS 7385* states that when continuous vibration causes dynamic loading such that the dynamic loading magnifies the structural dynamic response especially in low frequency range, up to 50% reduction may be applied on the values listed in Table 3.

Table 3 guideline values for vibration velocity (BS 7385)

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or frame structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	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 15 Hz increasing to 50 mm/s at 40 Hz and above

The *DIN 4150, Vibrations in buildings - Part 3: Effects on structures* is used to assess the likelihood of structural damage to nearby structures. Figure 3 below outline the frequency-dependent vibration criteria for Heritage, residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

Table 4 guideline values for vibration velocity (DIN 4150)

Structure	Guideline values for velocity (mm/s)				
	Vibration at the foundation at a frequency of:			Topmost floor, horizontal direction i=x,y	Floor slabs, vertical direction, i=z
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequency	All frequency
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 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 to 8	8 to 10	8	20[b]

[b] in the case of building types, it may be necessary to lower the relevant guideline value markedly to prevent minor damage

The DIN standard defines 'damage' to include cracks forming in plastered surfaces of walls, existing cracks in a building becoming enlarged, and separation of lightweight walls from load bearing walls. Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure. The *DIN 4150* states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage as these limits are generally recognised as being conservative.

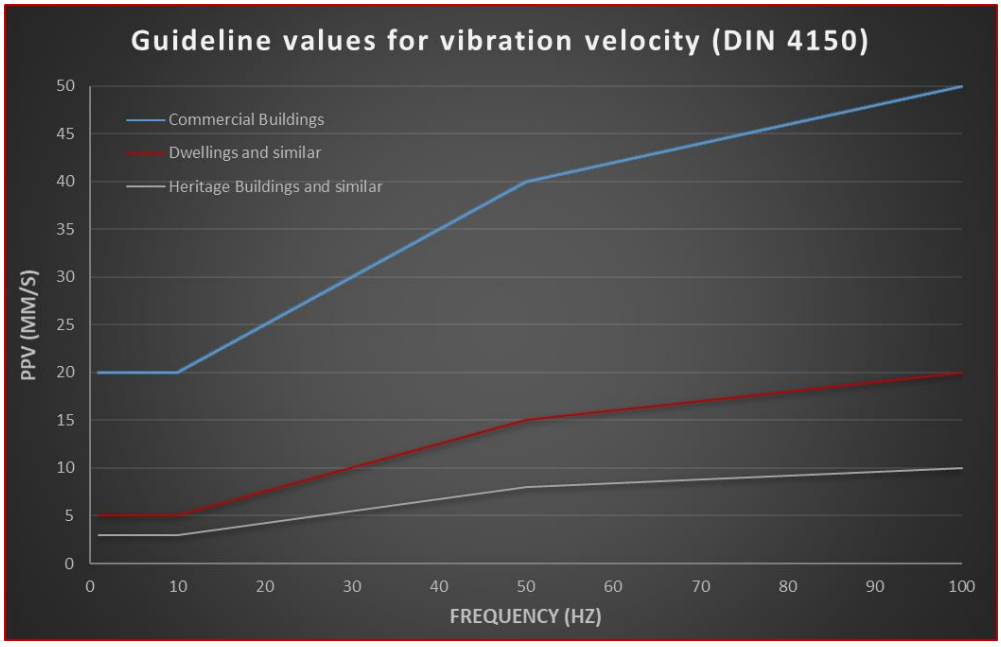


Figure 3 Guideline values for PPV as per DIN-4150

In accordance with the recommendations from the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**. Figure 4 shows the location of each vibration monitor.

3.5 Noise Criteria

The construction Noise Management Levels (NMLs) for the Project have been nominated in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering as shown in *Table 5*. Figure 4 shows the location of each noise monitor.

Table 5 Construction noise management levels

Noise Source	Time Period	Receiver	Construction NMLs – Laeq(15min)	Highly Noise Affect
Construction Noise	❖ 07:00am to 6:00pm, Monday to Friday ❖ 08:00am to 01:00pm, Saturday ❖ No site works shall be undertaken on Sundays or public holidays.	R1	68	75
		R2	68	
		S1	45/55[a]	--
		H1	70	--
		M1	55/65[a,b]	--
		M2	55/65[a,b]	--
		M3	55/65[a,b]	--

a - Noise Management Level of 55 dB(A) for internal noise monitoring or 65dB(A) for external noise monitoring

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for Highly Noise Affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*.

4. Methodology

4.1 Vibration & Noise Instrument

Two vibration Data logger with a 2.0 Hz tri-axial geophone and two noise monitors were used, the logger is equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

4.2 Site setup and Monitoring Procedure

Vibration Monitor

The geophone was firmly mounted in the ground in accordance with the manufacturer's recommendations & the Australian Standards AS 2775–2004 Mechanical vibration and shock – Mechanical mounting of accelerometers / the ISEE Field practice guidelines for blasting seismographs 2020 as applicable, the geophone was orientated as recommended by the manufacturer in the direction of the vibration source. Vibration Monitor 1 was installed on the wall within the mammogram waiting room and Vibration Monitor 2 was installed on the ground adjacent to the MRI room as can be seen in *Figure 4*. Each device was set to continuous daily monitoring mode at one-minute intervals recording velocities along the three orthogonal axes, i.e. x-axis / radial (back to chest), y-axis / transverse (right side to left side) or z-axis / vertical (foot to head) along with their corresponding frequencies.

Noise Monitor

The noise monitor was mounted on a solar stand in accordance with the manufacturer's recommendations. The monitor is oriented with the camera facing the direction of the noise source as per the recommendation of the manufacturer. The monitor was located to be as close to the sensitive noise receiver as possible as shown in *Figure 4* below. Each device was set to continuous daily monitoring at 15-minute intervals recording $L_{Aeq(15min)}$.

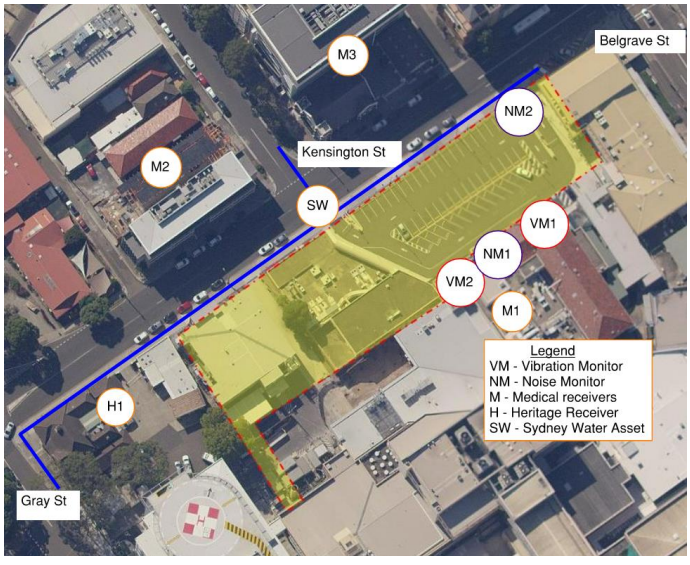


Figure 4 Site setup

5. Monitoring Results

Vibration Monitoring

The maximum daily vibration PPV values are summarised in the following table:

Table 6 maximum daily vector sum peak particle velocity values

Date	Max. vector sum PPV (mm/s) – Monitor 1	Max. vector sum PPV (mm/s) – Monitor 2	Criteria PPV (mm/s)
Fri 12/05/2023	**0.4**	--	**3.0**
Sat 13/05/2023	**0.1**	--	**3.0**
Mon 15/05/2023	**1.7**	--	**3.0**
Tue 16/05/2023	**2.4**	--	**3.0**
Wed 17/05/2023	**0.4**	--	**3.0**
Thu 18/05/2023	**1.4**	**0.4**	**3.0**

Noise Monitoring

A summary of the measured $L_{aeq(15minute)}$ noise levels at the monitoring location is shown below:

Table 7 Daily Measured Noise Levels – Location 1 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected
Fri 12/05/2023	--	--	**55**
Sat 13/05/2023	--	--	**55**
Mon 15/05/2023	--	--	**55**
Tue 16/05/2023	--	--	**55**
Wed 17/05/2023	--	--	**55**
Thu 18/05/2023	**50**	**Nil**	**55**

Table 8 Daily Measured Noise Levels – Location 2 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected	Highly Noise Affected
Fri 12/05/2023	**62**	Nil/Nil	**68**	**75**
Sat 13/05/2023	**52**	Nil/Nil	**68**	**75**
Mon 15/05/2023	**82**	14/07	**68**	**75**
Tue 16/05/2023	**67**	Nil/Nil	**68**	**75**
Wed 17/05/2023	**67**	Nil/Nil	**68**	**75**
Thu 18/05/2023	**70**	02/Nil	**68**	**75**

6. Discussion and Recommendations

As can be seen from the previous section and the graphs below, the peak particle velocity values were below the criteria which is set for this project.

Table 7 summarise the noise levels recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 14 dB(A) for the Noise Affected NML and up to 07 dB(A) for highly noise affected while noise monitor at Location 1 was within the criteria set for this site. Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Best management practice

When short-term works such as piling, demolition and construction give rise to impulsive vibrations, undue restriction on vibration values may significantly prolong these operations and result in greater annoyance. Short-term works are works that occur for a duration of approximately one week. In circumstances where work is short term, vibration controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Feasible and reasonable mitigation measures should be applied and best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation program should be instituted.

An example of a possible management strategies are listed below:

- Restrict the times during which high vibration values occur to the least sensitive times of the day
- Ensure piling and earthmoving/breaking activities are organised and do not occur at the same time or less impact equipment is used if values have been exceeded in multiple occurrences
- Typical issues covered in a consultation program include a public contact point for handling complaints
- Early notification of proposed operations and any significant change to operations

The following recommendations provide reasonable noise control measures to reduce noise impacts to sensitive receivers.

- Doubling of distance between source and receiver where possible, example when loading materials
- Using barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or the receiver.
- Using mounds as a temporary or permanent noise barriers
- Engine casing lagged with acoustic insulation and plywood
- Use electric motors in preference to diesel or petrol

In addition to physical noise controls, the following general noise management measures should be followed:

- Use less noisy plant and equipment, where feasible and reasonable

- Plant and equipment should be properly maintained
- Provide special attention to the use and maintenance of silencing equipment fitted to plants to ensure they perform as intended
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel, example locate concrete pump at maximum distance from the sensitive receivers
- Avoid any unnecessary noise when carrying out manual operations and when operating plant

Any equipment not in use for extended periods during construction work should be switched off

Complaint Management

An effective community relations program is essential to keep the stakeholders informed throughout the project development process, to obtain valuable data related to the project, and to become aware of any project-related impacts in a timely manner. Additionally, the community is likely to be more understanding and accepting of the vibration where the information provided is frank, does not attempt to understate the likely vibration impacts and if commitments made are firmly adhered to. A range of media could be used to notify the community before and during construction, including use of community meetings, individual contact and letterbox drops. Contact details for complaints and further information, including emergency phone numbers, should be readily available to the community.

7. Conclusions

The vibration results found in *Table 6* summarise the maximum daily peak particle velocity PPV recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 14 dB(A) for the Noise Affected NML and up to 07 dB(A) for highly noise affected while noise monitor at Location 1 was within the criteria set for this site. It is found that many of the noise triggers from Location 1 are caused by workers and equipment within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and rooms with operating equipment to avoid these false triggers. Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Important information about this report

Introduction

This report has been prepared by Paragon for you, in accordance with the agreed scope, schedule and budget. The opinions, recommendations and conclusions set out herein has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared. It is based on information gained from site conditions. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterization of site conditions is an interpretation of information collected during assessment, in accordance with industry practice. This interpretation is not a complete description of all conditions on or in the vicinity of the site, due to the inherent variation in spatial and temporal vibration information. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to other sites, nor can it be used when the nature of the specific purpose changes from that which we agreed.

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Paragon. The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete. This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of defect(s) or other effects can change over time, as a result of either natural processes or human influence. Paragon should be kept appraised of any such events and should be consulted for further investigations if any changes are noted.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Paragon assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report. To avoid misuse of the information presented in your report, we recommend that Paragon be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report.

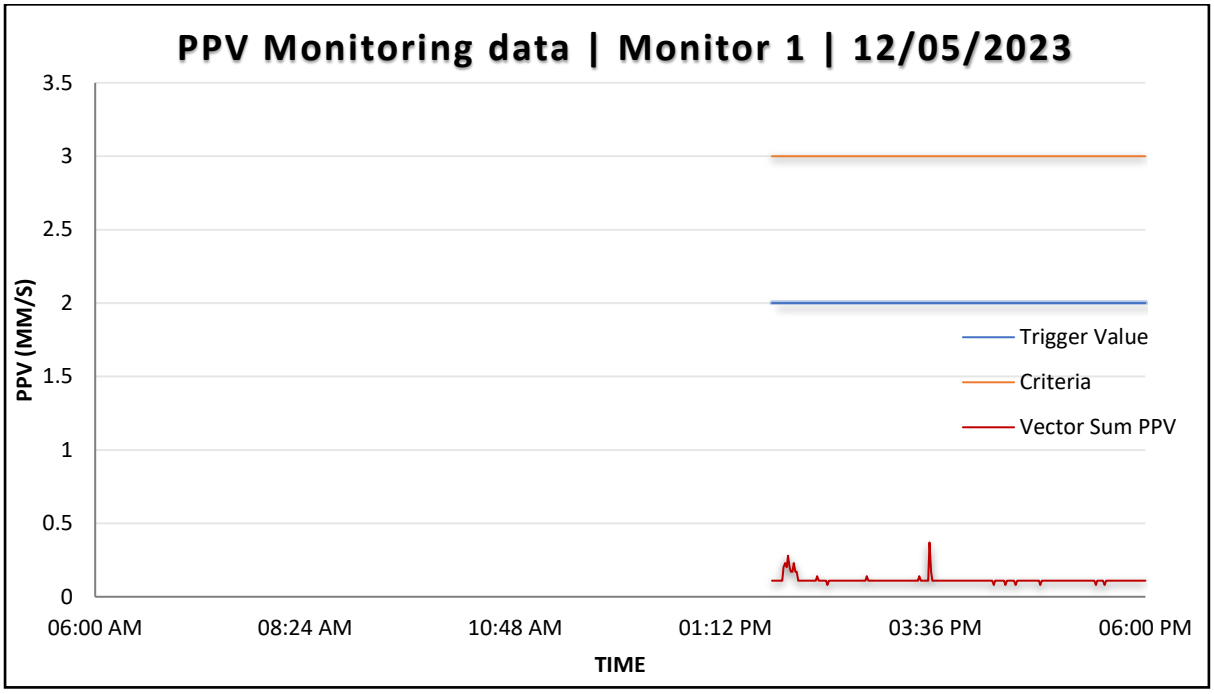
Interpretation by other professionals

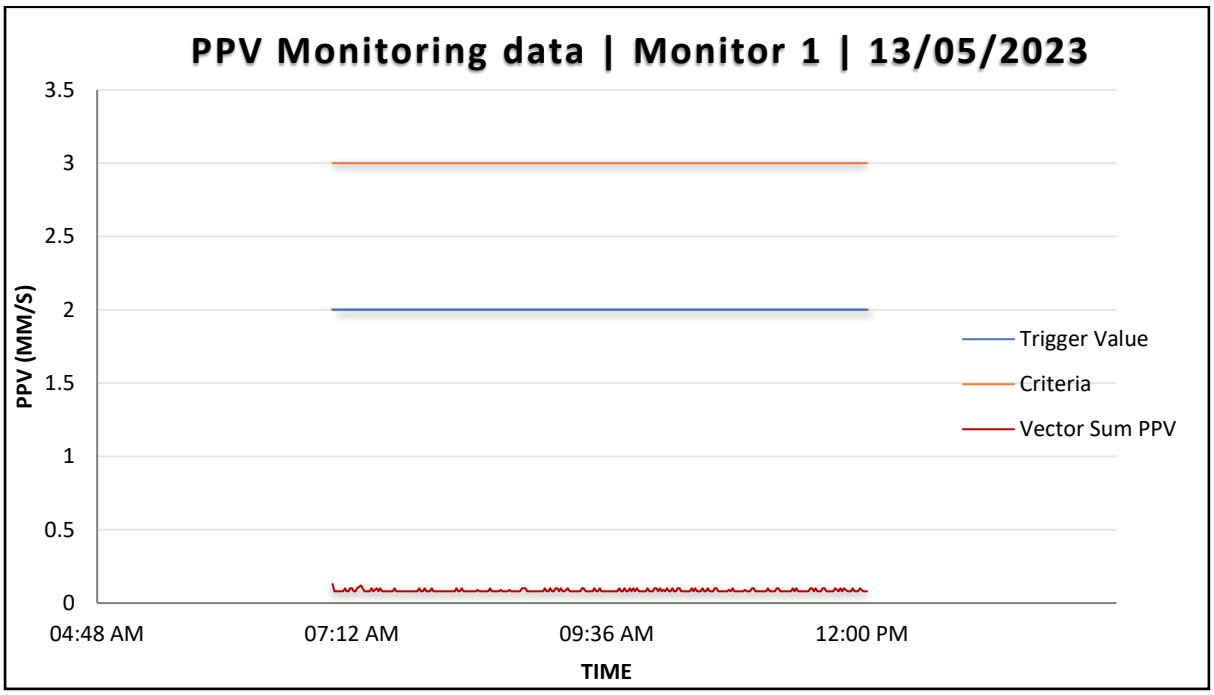
Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings. Given Paragon prepared the report and has familiarity with the site, Paragon is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Paragon disowns any responsibility for such misinterpretation.

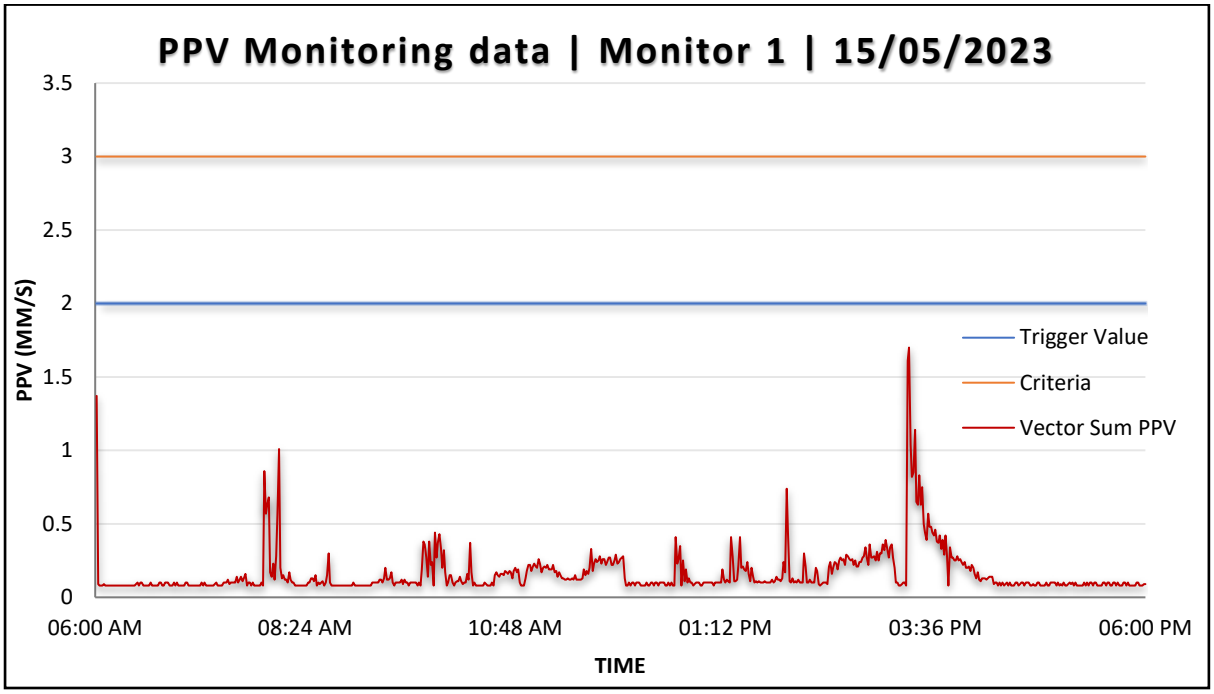
Data should not be separated from the report

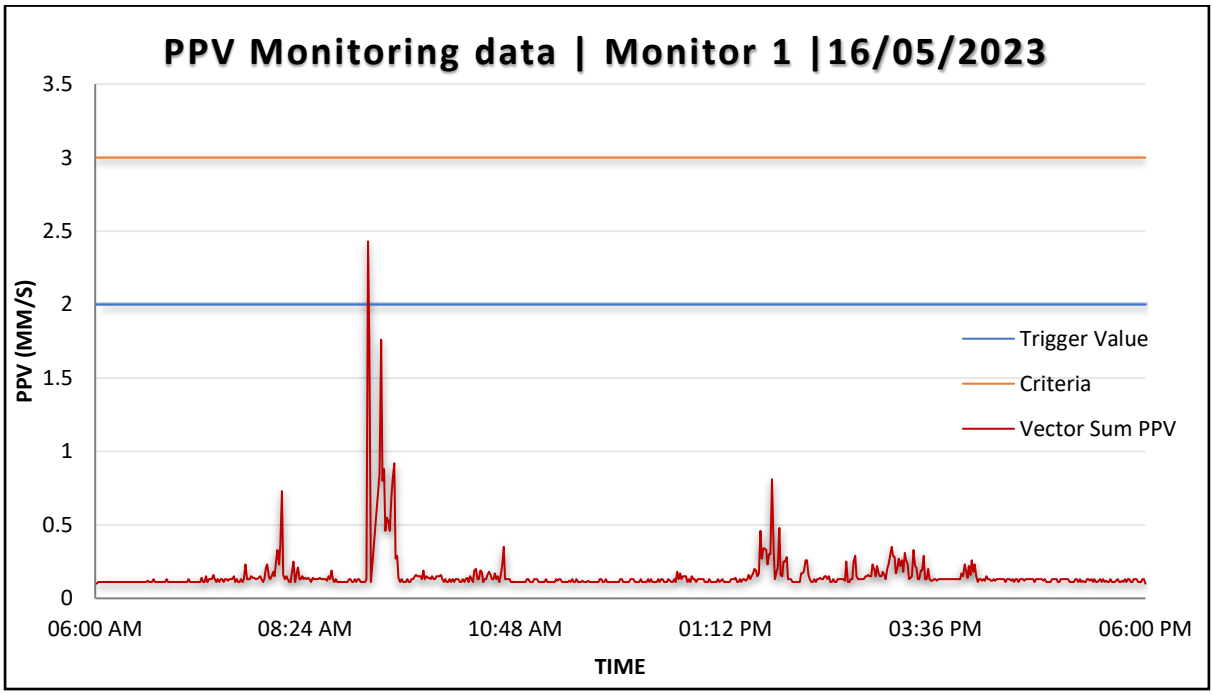
The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, acquired data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way. This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

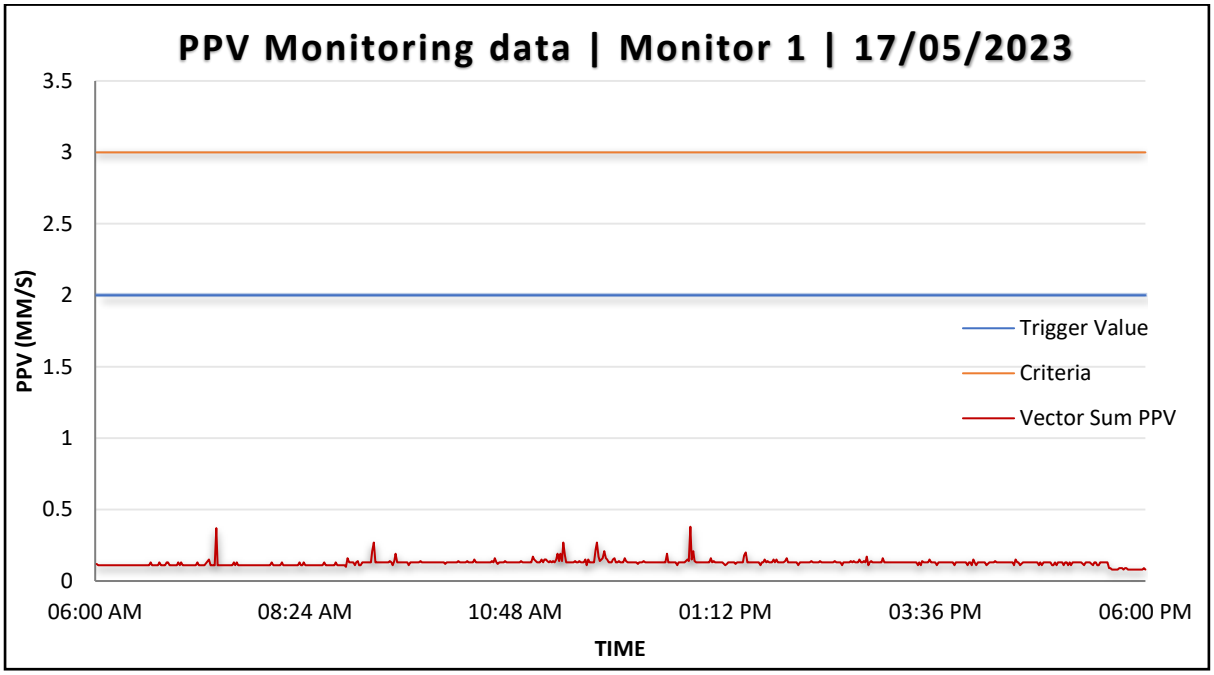
Appendix 1 – Vibration Monitoring Data

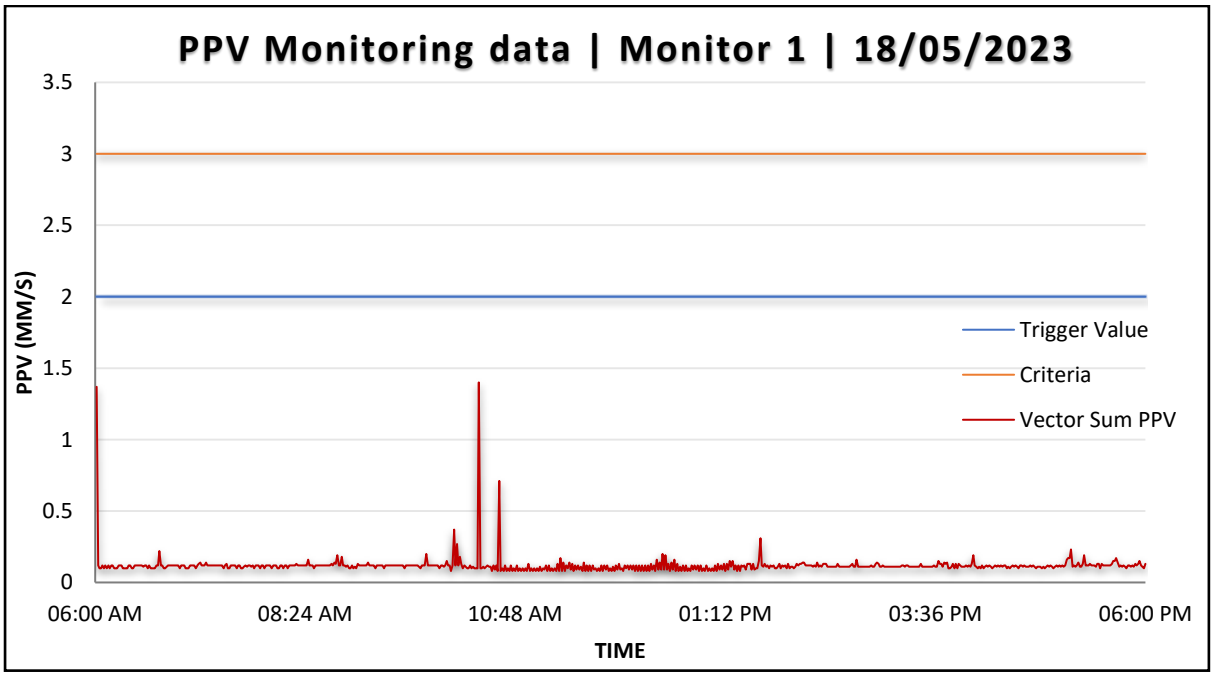


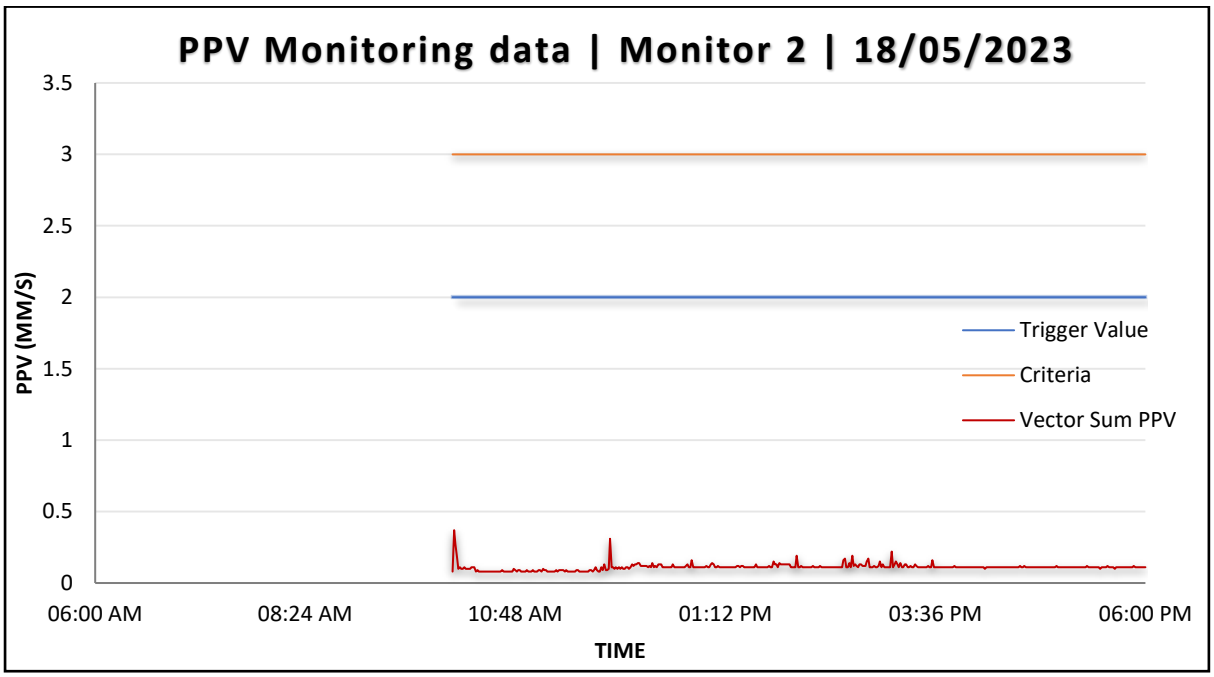



PPV Monitoring data | Monitor 1 | 15/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

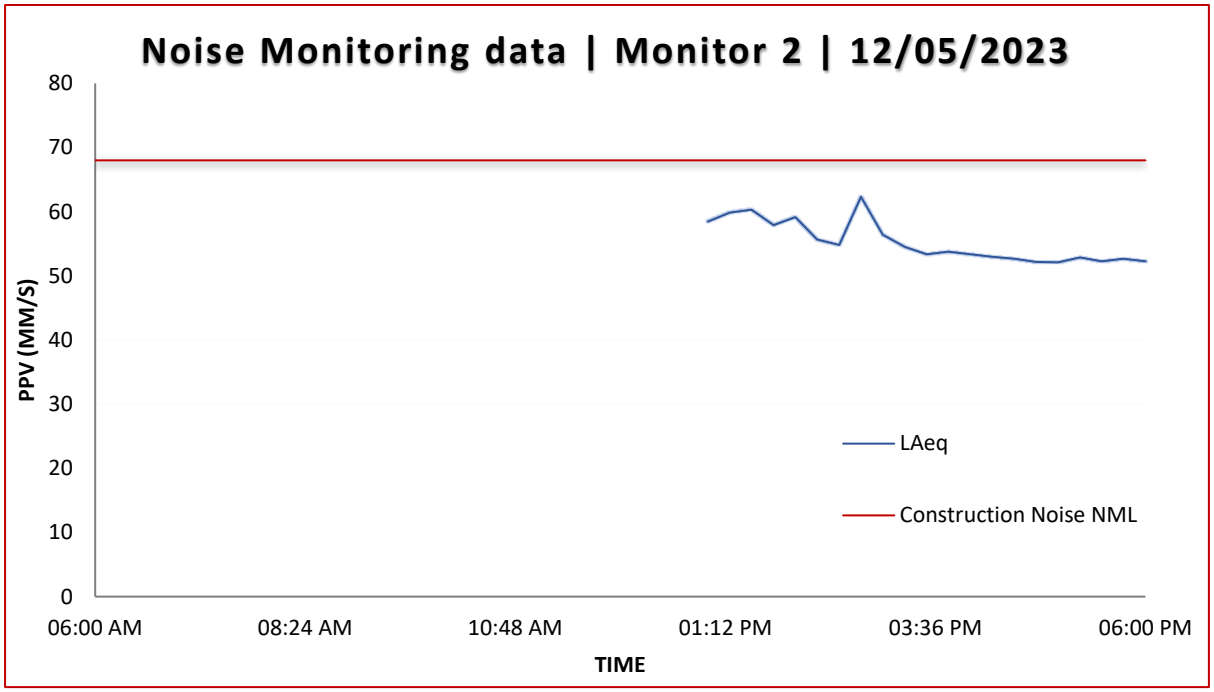

PPV Monitoring data | Monitor 1 |16/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

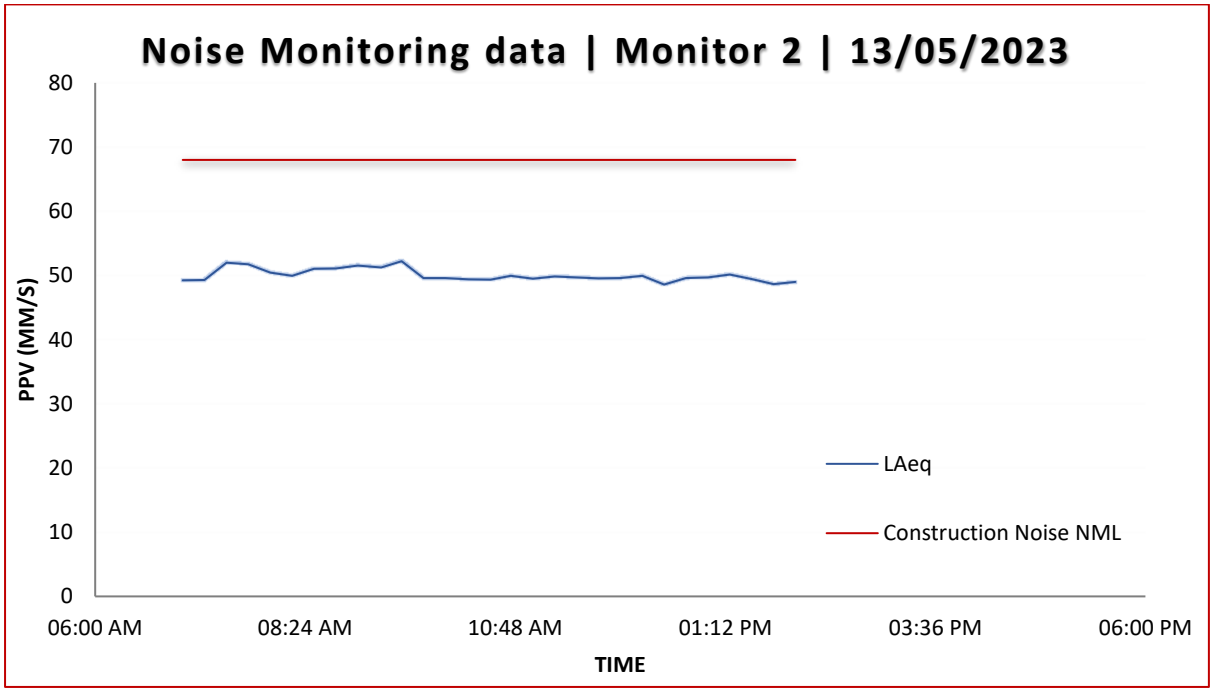

PPV Monitoring data | Monitor 1 | 17/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

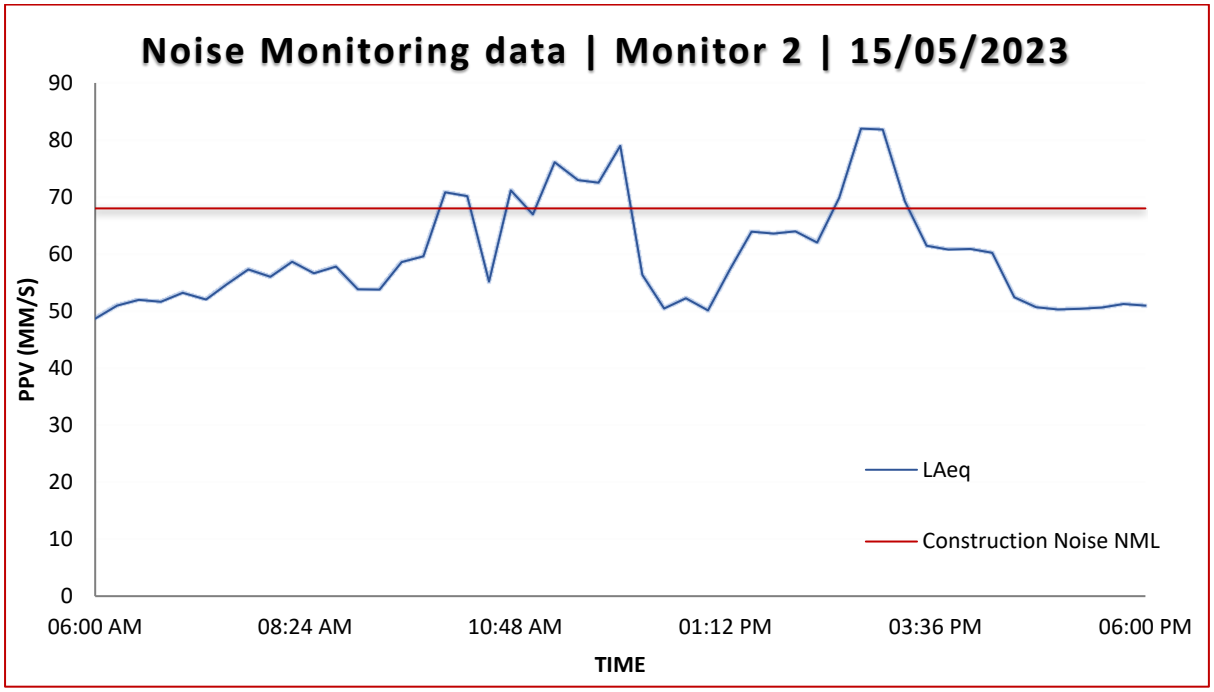

PPV Monitoring data | Monitor 1 | 18/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

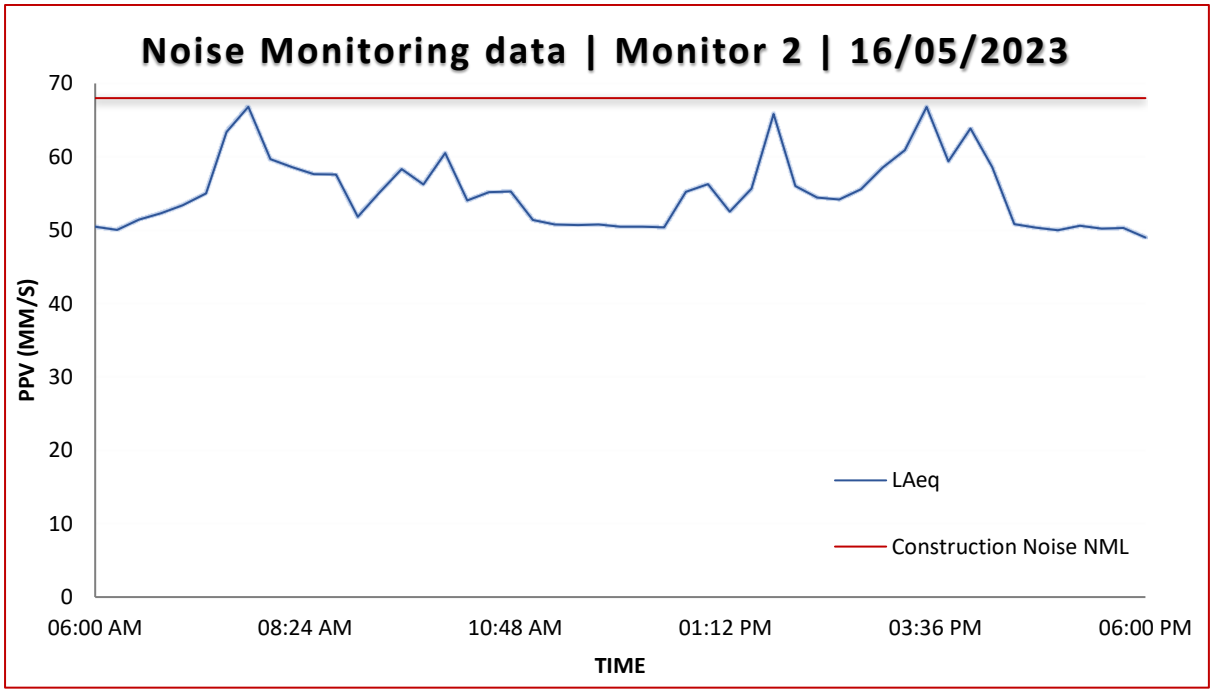

PPV Monitoring data | Monitor 2 | 18/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

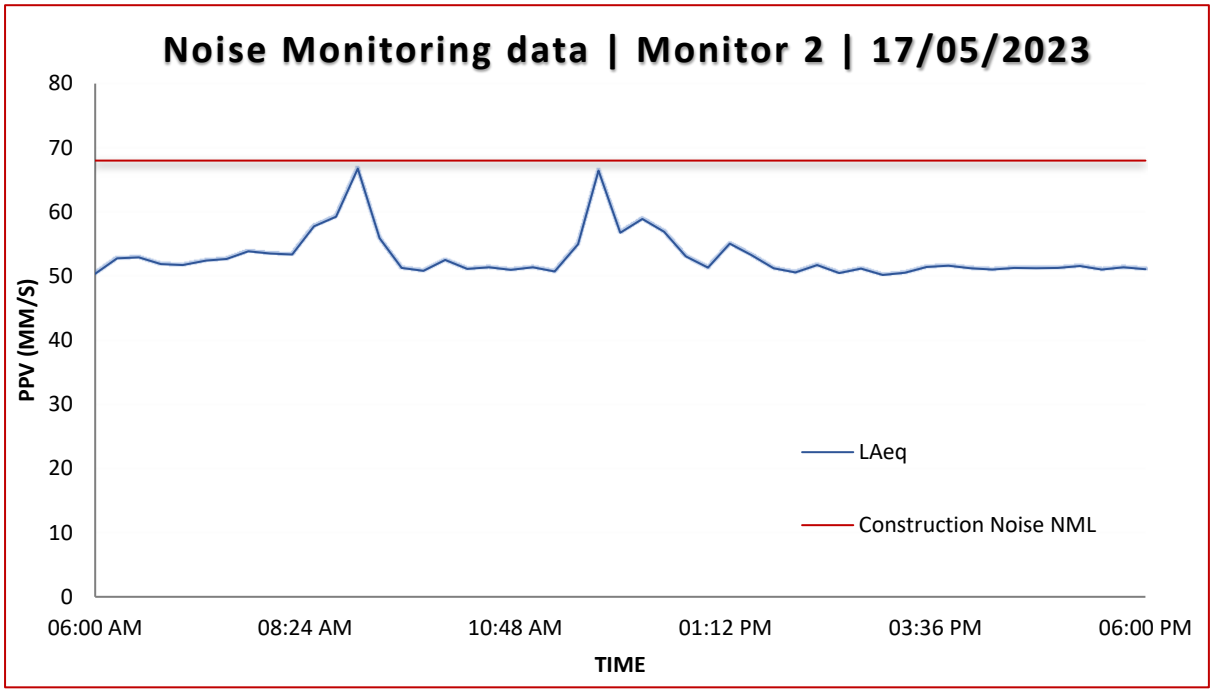
Appendix 2 – Noise Monitoring Data

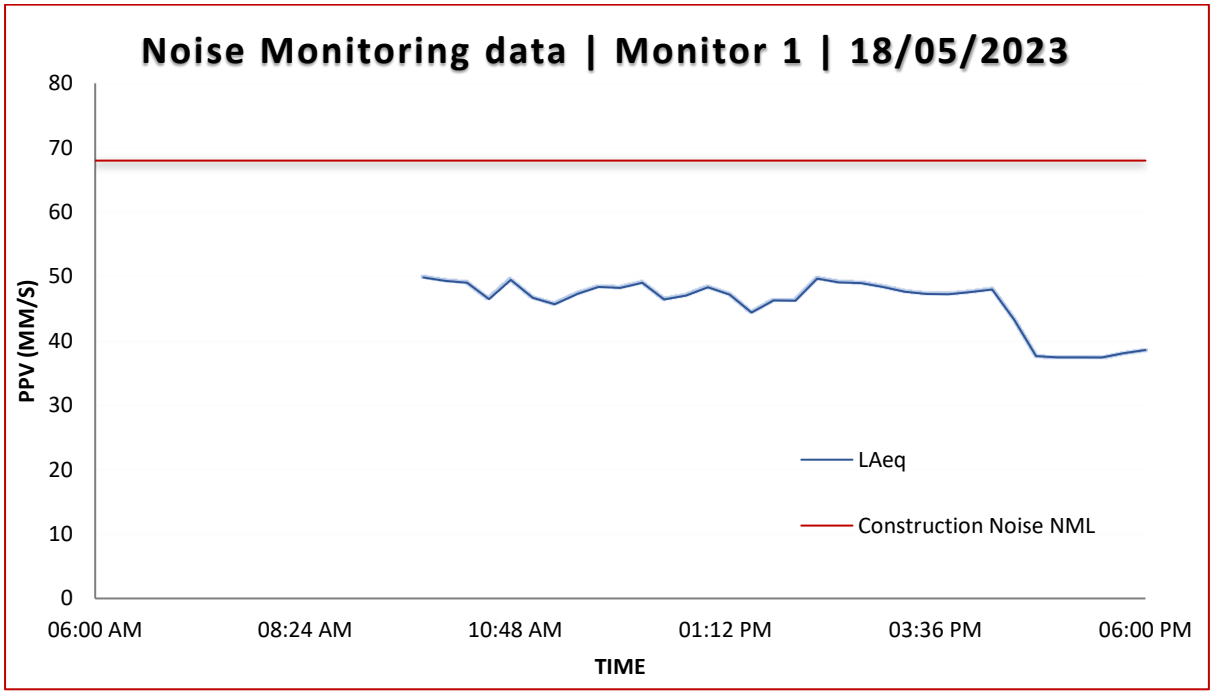


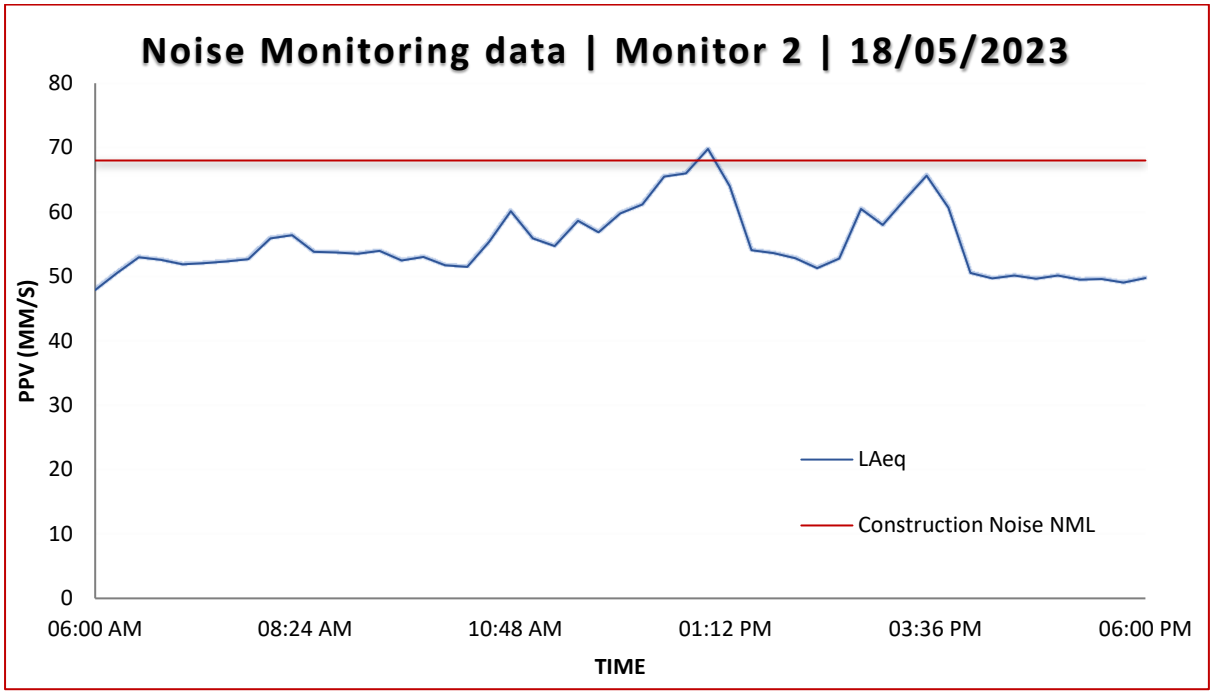



Noise Monitoring data | Monitor 2 | 15/05/2023
PPV (MM/S)
90
80
70
60
50
40
30
20
10
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
LAeq
Construction Noise NML


Noise Monitoring data | Monitor 2 | 16/05/2023
PPV (MM/S)
70
60
50
40
30
20
10
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
LAeq
Construction Noise NML


Noise Monitoring data | Monitor 2 | 17/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 1 | 18/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 18/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

CONSTRUCTION NOISE AND VIBRATION REPORT

Client:
MOITS PTY LTD

Stage 3 St. George Hospital, 16 Kensington Street, Kogarah

19 June 2023
Ref: PAR-23661-NVR-W02[C]

Monitoring Period:
19 May 2023 to 25 May 2023

Ref: Par-23661-W02[C]
19 June 2023

NOISE & VIBRATION MONITORING REPORT
St. George Hospital

For Duration:
19 May 2023 – 25 May 2023

Prepared for:
Peter Zwamborn
Moits
142 Wicks Rd, Macquarie Park NSW 2113

Document Authorization

For and on behalf of Paragon Engineering

Michael Duong
Civil Engineer

Sinan Habeeb
Civil Engineer

Quality information

Revision history

Revision	Report Status	Date	Author	Reviewer
A	1st Revision	7 June 2023	MD	SH
B	2nd Revision	16 June 2023	MD	SH
C	3rd Revision	19 June 2023	MD	SH

Distribution

Revision	No. of copies	Format	Distributed to	Date
A	1	PDF	Moits	7 June 2023
B	1	PDF	Moits	16 June 2023
C	1	PDF	Moits	19 June 2023

Executive Summary

Paragon Engineering was commissioned by Moits to provide vibration & noise monitoring services during the redevelopment activities for the site located at St. George Hospital. The project comprises of excavation and construction of a new Medical facility with two basement carpark

This report provides vibration and noise monitoring information for the excavation and construction of a new Medical facility with two basement carpark at the above site. Vibration monitoring was initiated to assess the potential of structural damage to the surrounding properties. Based on the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**.

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for highly noise affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*. Two vibration data logger and two noise monitors were used. The loggers are equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

The vibration results found in *Table 6* summarise the maximum daily peak particle velocity (PPV) recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 05 dB(A) for the Noise Affected NML however, remains within the highly noise affected criteria. Location 1 and have exceeded the criteria by up to 01 dB(A). It is found that many of the triggers from Location 1 are caused by workers and patients within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and operating equipment to avoid these false triggers.

Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Table of Contents

Executive Summary ---- ii

List of Figures ---- iii

1. Introduction ---- 1

1.1 Background ---- 1

1.2 Site Information ---- 1

1.3 Objectives ---- 2

2. Sensitive Receivers ---- 2

3. Vibration & Noise Sources and Criteria ---- 3

3.1 Vibration Sources ---- 3

3.2 Noise Sources ---- 4

3.3 Applicable Standards ---- 4

3.4 Vibration Criteria ---- 5

3.5 Noise Criteria ---- 7

4. Methodology ---- 8

4.1 Vibration & Noise Instrument ---- 8

4.2 Site setup and Monitoring Procedure ---- 8

5. Monitoring Results ---- 9

6. Discussion and Recommendations ---- 10

7. Conclusions ---- 11

List of Figures

Figure 1 Sensitive Vibration Receiver 2

Figure 2 Sensitive Noise Receiver 3

Figure 3 Guideline values for PPV as per DIN-4150 6

Figure 4 Site setup 8

List of Tables

Table 1 Working Hours 1
Table 1 Potential noise sources 4
Table 2 guideline values for vibration velocity (BS 7385) 5
Table 3 guideline values for vibration velocity (DIN 4150) 6
Table 5 Construction noise management levels 7
Table 6 maximum daily vector sum peak particle velocity values 9
Table 7 Daily Measured Noise Levels – Location 1 dB(A) 9
Table 8 Daily Measured Noise Levels – Location 2 dB(A) 9

List of Appendices

Appendix 1 – Vibration Monitoring Data 14
Appendix 2 – Noise Monitoring Data 20

1. Introduction

1.1 Background

Paragon Engineering was commissioned by Moits to provide vibration and noise monitoring services during the redevelopment works that is located at St. George Hospital for the proposed redevelopment located at St George Hospital. The project comprises of piling, excavation and construction of a new Medical facility with two basement carpark.

1.2 Site Information

The project is located at St. George Hospital. The Stage 3 redevelopment includes the piling, excavation and construction of a new Medical facility with two basement carpark. The nearest vibration and noise sensitive receivers are shown in *Figure 1* and ***Error! Reference source not found.*** below.

Working Hours

The Project construction working hours shall be in accordance with approved DA Condition C4-C8 as described below:

Table 1 Working Hours

Activity	Permitted working hours
C4. Construction including the delivery of materials to and from site:	❖ Monday to Friday – 7:00am to 6:00pm inclusive ❖ Saturday - 8:00am to 1:00 pm ❖ Sunday & public holidays - No work permitted
C5. Not withstanding condition C4, provide noise levels do not exceed the existing background level plus 5dB, work may also be undertaken during the following hours:	❖ Monday to Friday – 6:00am to 7:00pm inclusive ❖ Saturday - 1:00pm to 5:00 pm ❖ Sunday & public holidays - No work permitted
C6. Construction activities may be undertaken outside of the hours in condition C4 and C5 if Required:	❖ By the police or a public authority for the delivery of vehicles, plant or materials; or ❖ In an emergency to avoid the loss of life, damage to property or to prevent environment harm; or ❖ Where the works are inaudible at the nearest sensitive receivers; or ❖ For the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or ❖ Where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works
C7. Notification of such construction activities as referenced in Condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.	

Activity	Permitted working hours
C8. Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:	❖ Monday to Friday – 9:00am to 12:00pm ❖ Monday to Friday - 2:00pm to 5:00 pm ❖ Saturday – 9:00am to 12:00pm ❖ Sunday & public holidays - No work permitted

1.3 Objectives

The purpose of this document is to provide a practical construction vibration and noise monitoring information to assess the potential structural damage and human comfort in the surrounding properties, compare the collected vibration and noise results against the recommended criteria and to provide a discussion about the mitigation measures to reduce the vibration and noise occurring.

2. Sensitive Receivers

Sensitive Vibration Receivers

The nearest vibration sensitive receivers are identified in *Figure 1* and listed below:

- M1, Medical Facility on the Southern boundary of the site.
- M2, Medical Facility on the Norther boundary of the site along Kensington St.
- M3, Medical Facility on the Norther boundary of the site along Kensington St.
- H1, Fire Station (heritage) on the Western side of the boundary.
- SW, Sydney Water asset along the Northern boundary of the site along Kensington St.

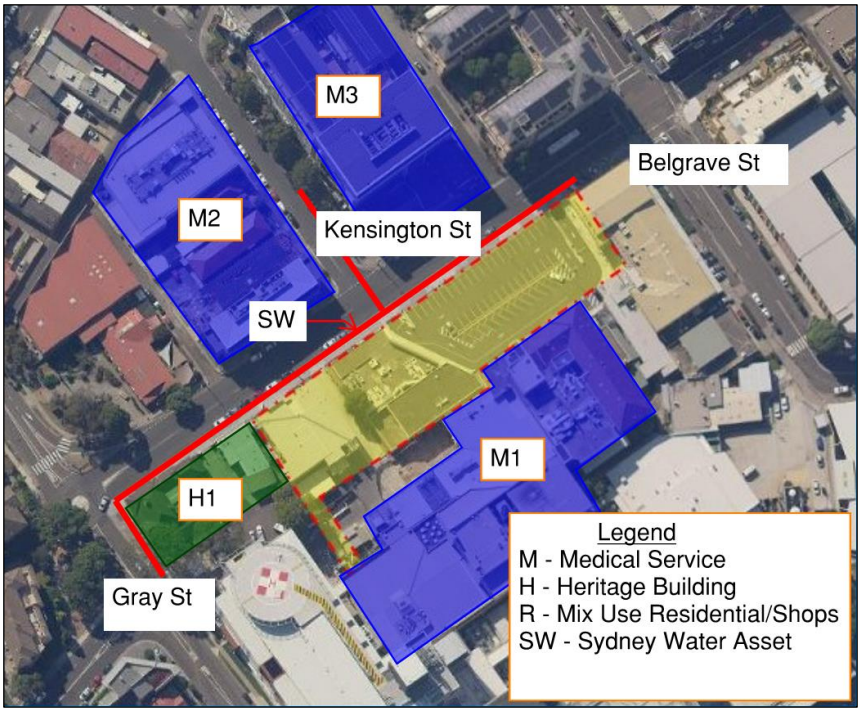


Figure 1 Sensitive Vibration Receiver

Sensitive Noise Receivers

The nearest noise sensitive receivers are identified in *Figure 2* and listed below:

- R1, Residential buildings on the Northern boundary of the site along Kensington St.
- R2, Residential buildings on the Eastern boundary of the site along Belgrave St.
- M1, Medical Facility on the Southern boundary of the site.
- M2, Medical Facility on the Norther boundary of the site along Kensington St.
- M3, Medical Facility on the Norther boundary of the site along Kensington St.
- S1, Educational Facility on the North-western boundary of the site along Kensington St.
- H1, Fire Station (heritage) on the Western side of the boundary.

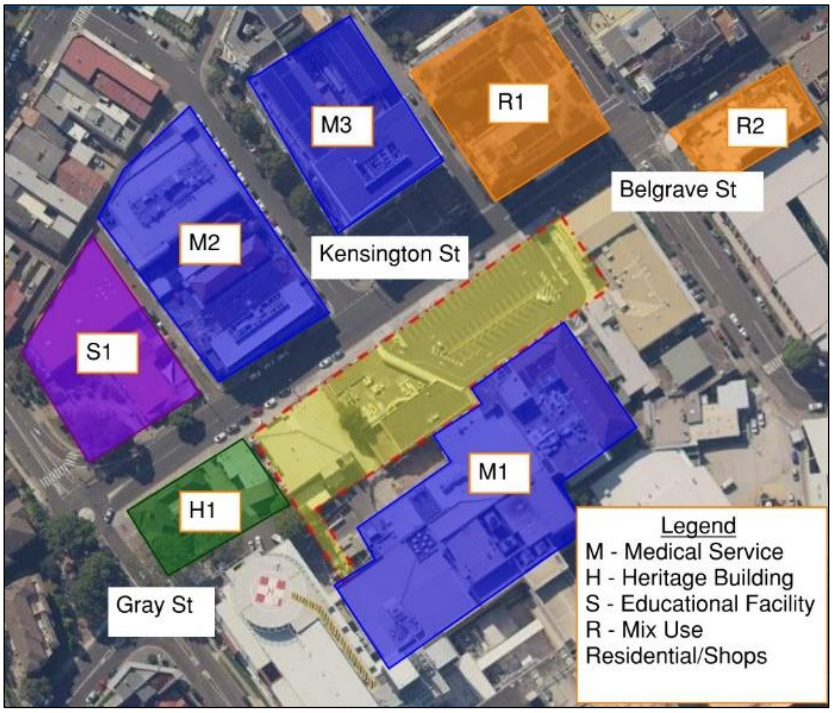


Figure 2 Sensitive Noise Receiver

3. Vibration & Noise Sources and Criteria

3.1 Vibration Sources

Vibration can be caused by various external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

The potential source of vibration in this project is likely to be caused by hydraulic excavators with jackhammers, saws and other various construction activities which may be categorised as intermittent/short term sources of vibration.

3.2 Noise Sources

The noise sources likely to be associated with the works mentioned in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] prepared by Paragon Engineering are shown in *Table 2* below.

Table 2 Potential noise sources

Stages	Equipment	Sound Power Level dB(A)
Demolition	Excavator with hydraulic hammer (30t-40t)	117
	Concrete Saw	117
	Truck & Dog	101
Excavation	Excavator with hydraulic hammer (30t-40t)	117
	Bobcat	100
	Concrete Saw	117
	Truck & Dog	101
Structure	Powered hand tools	95
	Bobcat	100
	Concrete pump	103
	Truck & Dog	101

3.3 Applicable Standards

The list below illustrates the relevant reports, standards, guidelines or policies that has been used during the preparation of this report:

- Department of Environment and Conservation (NSW) Publication, Interim Construction Noise Guideline
- Australian Standard "AS ISO 6393:2019, Earth-moving machinery - Determination of sound power level - Stationary test conditions"
- Department of Environment and Conservation (NSW) Publication, Assessing Vibration: a technical guideline (Feb 2006)
- Australian Standard "AS 2436-2010, Guide to noise and vibration control on construction, p and maintenance sites"
- International organization for Standardization "ISO 5348:2021, Mechanical vibration and shock Mechanical mounting of accelerometers"
- German Standard "DIN 4150-3:2016-12, Vibration in buildings - part 3: effects on structures"
- Australian Standard "AS ISO 2631.2.2014, Mechanical Vibration and Shock – Evaluation of human exposure to whole-body vibration. Part 2: Vibration in buildings (1-80Hz)"
- British Standard "BS 7385-2:1993, Evaluation and measurement for vibration in buildings – Part 2 Guide to damage levels from groundborne vibrations"
- Australian Standard "AS 2187.2-2006, Explosives – storage and Use. Part 2: Use of Explosives"
- Paragon Engineering, Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31st March 2023.

3.4 Vibration Criteria

In this report, the effect of vibration on the asset's integrity and the potential to cause structural damage will be assessed. Vibration may cause damage to a building structure, ranging from minor hairline cracking to major structural defect.

The Australian Standards *AS 2187.2* states that vibration guide values and the methods of assessing the structural response prepared by *BS 7385-2* and *(USBM) RI 8507* are applicable to the Australian Conditions.

The *British Standard BS-7385-2, Evaluation and measurement for vibration in buildings –Part 2: Guide to damage levels from groundborne vibrations* provides the vibration limits to reduce the risk of structural damage to buildings. *Table 3* below outline the frequency-dependent vibration criteria for residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

The *BS 7385* states that when continuous vibration causes dynamic loading such that the dynamic loading magnifies the structural dynamic response especially in low frequency range, up to 50% reduction may be applied on the values listed in Table 3.

Table 3 guideline values for vibration velocity (BS 7385)

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or frame structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	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 15 Hz increasing to 50 mm/s at 40 Hz and above

The *DIN 4150, Vibrations in buildings - Part 3: Effects on structures* is used to assess the likelihood of structural damage to nearby structures. Figure 3 below outline the frequency-dependent vibration criteria for Heritage, residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

Table 4 guideline values for vibration velocity (DIN 4150)

Structure	Guideline values for velocity (mm/s)				
	Vibration at the foundation at a frequency of:			Topmost floor, horizontal direction i=x,y	Floor slabs, vertical direction, i=z
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequency	All frequency
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 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 to 8	8 to 10	8	20[b]

[b] in the case of building types, it may be necessary to lower the relevant guideline value markedly to prevent minor damage

The DIN standard defines 'damage' to include cracks forming in plastered surfaces of walls, existing cracks in a building becoming enlarged, and separation of lightweight walls from load bearing walls. Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure. The *DIN 4150* states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage as these limits are generally recognised as being conservative.

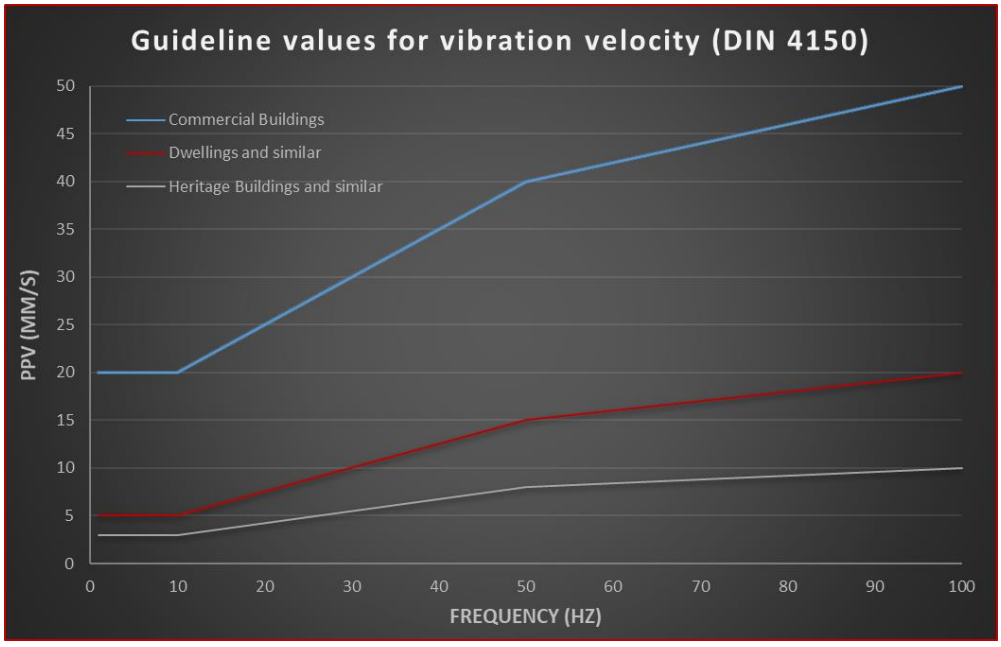


Figure 3 Guideline values for PPV as per DIN-4150

In accordance with the recommendations from the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**. Figure 4 shows the location of each vibration monitor.

3.5 Noise Criteria

The construction Noise Management Levels (NMLs) for the Project have been nominated in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering as shown in *Table 5*. Figure 4 shows the location of each noise monitor.

Table 5 Construction noise management levels

Noise Source	Time Period	Receiver	Construction NMLs – Laeq(15min)	Highly Noise Affect
Construction Noise	❖ 07:00am to 6:00pm, Monday to Friday ❖ 08:00am to 01:00pm, Saturday ❖ No site works shall be undertaken on Sundays or public holidays.	R1	68	75
		R2	68	
		S1	45/55[a]	--
		H1	70	--
		M1	55/65[a,b]	--
		M2	55/65[a,b]	--
		M3	55/65[a,b]	--

a - Noise Management Level of 55 dB(A) for internal noise monitoring or 65dB(A) for external noise monitoring

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for Highly Noise Affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*.

4. Methodology

4.1 Vibration & Noise Instrument

Two vibration Data logger with a 2.0 Hz tri-axial geophone and two noise monitors were used, the logger is equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

4.2 Site setup and Monitoring Procedure

Vibration Monitor

The geophone was firmly mounted in the ground in accordance with the manufacturer's recommendations & the Australian Standards AS 2775–2004 Mechanical vibration and shock – Mechanical mounting of accelerometers / the ISEE Field practice guidelines for blasting seismographs 2020 as applicable, the geophone was orientated as recommended by the manufacturer in the direction of the vibration source. Vibration Monitor 1 was installed on the wall within the mammogram waiting room and Vibration Monitor 2 was installed on the ground adjacent to the MRI room as can be seen in *Figure 4*. Each device was set to continuous daily monitoring mode at one-minute intervals recording velocities along the three orthogonal axes, i.e. x-axis / radial (back to chest), y-axis / transverse (right side to left side) or z-axis / vertical (foot to head) along with their corresponding frequencies.

Noise Monitor

The noise monitor was mounted on a solar stand in accordance with the manufacturer's recommendations. The monitor is oriented with the camera facing the direction of the noise source as per the recommendation of the manufacturer. The monitor was located to be as close to the sensitive noise receiver as possible as shown in *Figure 4* below. Each device was set to continuous daily monitoring at 15-minute intervals recording $L_{Aeq(15min)}$.

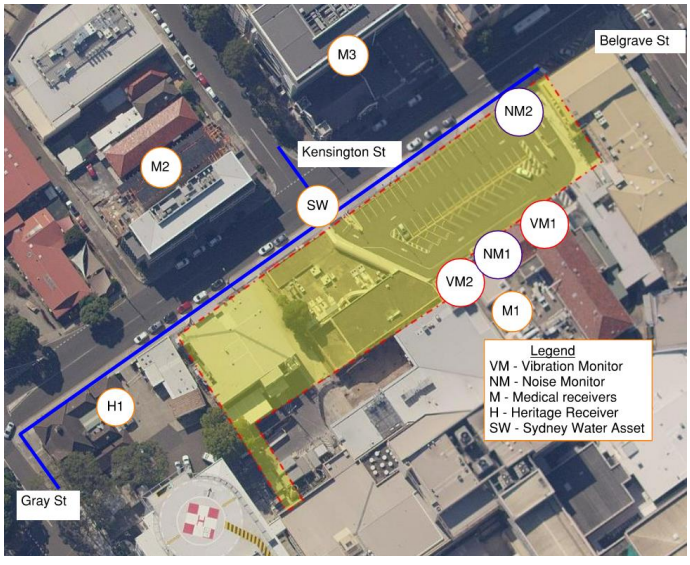


Figure 4 Site setup

5. Monitoring Results

Vibration Monitoring

The maximum daily vibration PPV values are summarised in the following table:

Table 6 maximum daily vector sum peak particle velocity values

Date	Max. vector sum PPV (mm/s) – Monitor 1	Max. vector sum PPV (mm/s) – Monitor 2	Criteria PPV (mm/s)
Fri 19/05/2023	**0.4**	**0.3**	**3.0**
Sat 20/05/2023	**0.1**	**0.3**	**3.0**
Mon 22/05/2023	**0.2**	**0.5**	**3.0**
Tue 23/05/2023	**0.3**	**0.5**	**3.0**
Wed 24/05/2023	**0.4**	**0.9**	**3.0**
Thu 25/05/2023	**0.3**	**0.4**	**3.0**

Noise Monitoring

A summary of the measured $L_{aeq(15minute)}$ noise levels at the monitoring location is shown below:

Table 7 Daily Measured Noise Levels – Location 1 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected
Fri 19/05/2023	**53**	**Nil**	**55**
Sat 20/05/2023	**39**	**Nil**	**55**
Mon 22/05/2023	**53**	**Nil**	**55**
Tue 23/05/2023	**52**	**Nil**	**55**
Wed 24/05/2023	**51**	**Nil**	**55**
Thu 25/05/2023	**56**	**01**	**55**

Table 8 Daily Measured Noise Levels – Location 2 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected	Highly Noise Affected
Fri 19/05/2023	**66**	**Nil/Nil**	**68**	**75**
Sat 20/05/2023	**50**	**Nil/Nil**	**68**	**75**
Mon 22/05/2023	**63**	**Nil/Nil**	**68**	**75**
Tue 23/05/2023	**68**	**Nil/Nil**	**68**	**75**
Wed 24/05/2023	**71**	**03/Nil**	**68**	**75**
Thu 25/05/2023	**73**	**05/Nil**	**68**	**75**

6. Discussion and Recommendations

As can be seen from the previous section and the graphs below, the peak particle velocity values were below the criteria which is set for this project.

Table 7 summarise the noise levels recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 05 dB(A) for the Noise Affected NML however, remains within the highly noise affected criteria. Location 1 and have exceeded the criteria by up to 01 dB(A). Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Best management practice

When short-term works such as piling, demolition and construction give rise to impulsive vibrations, undue restriction on vibration values may significantly prolong these operations and result in greater annoyance. Short-term works are works that occur for a duration of approximately one week. In circumstances where work is short term, vibration controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Feasible and reasonable mitigation measures should be applied and best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation program should be instituted.

An example of a possible management strategies are listed below:

- Restrict the times during which high vibration values occur to the least sensitive times of the day
- Ensure piling and earthmoving/breaking activities are organised and do not occur at the same time or less impact equipment is used if values have been exceeded in multiple occurrences
- Typical issues covered in a consultation program include a public contact point for handling complaints
- Early notification of proposed operations and any significant change to operations

The following recommendations provide reasonable noise control measures to reduce noise impacts to sensitive receivers.

- Doubling of distance between source and receiver where possible, example when loading materials
- Using barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or the receiver.
- Using mounds as a temporary or permanent noise barriers
- Engine casing lagged with acoustic insulation and plywood
- Use electric motors in preference to diesel or petrol

In addition to physical noise controls, the following general noise management measures should be followed:

- Use less noisy plant and equipment, where feasible and reasonable
- Plant and equipment should be properly maintained
- Provide special attention to the use and maintenance of silencing equipment fitted to plants to ensure they perform as intended
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel, example locate concrete pump at maximum distance from the sensitive receivers
- Avoid any unnecessary noise when carrying out manual operations and when operating plant

Any equipment not in use for extended periods during construction work should be switched off

Complaint Management

An effective community relations program is essential to keep the stakeholders informed throughout the project development process, to obtain valuable data related to the project, and to become aware of any project-related impacts in a timely manner. Additionally, the community is likely to be more understanding and accepting of the vibration where the information provided is frank, does not attempt to understate the likely vibration impacts and if commitments made are firmly adhered to. A range of media could be used to notify the community before and during construction, including use of community meetings, individual contact and letterbox drops. Contact details for complaints and further information, including emergency phone numbers, should be readily available to the community.

7. Conclusions

The vibration results can be found in *Table 6* and the noise results can be found in *Table 7.* The vibration results found in *Table 6* summarise the maximum daily peak particle velocity PPV recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 05 dB(A) for the Noise Affected NML however, remains within the highly noise affected criteria. Location 1 and have exceeded the criteria by up to 01 dB(A). It is found that many of the noise triggers from Location 1 are caused by workers and equipment within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and rooms with operating equipment to avoid these false triggers. Further monitoring is recommended, and vibration and noise controls should be

implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Important information about this report

Introduction

This report has been prepared by Paragon for you, in accordance with the agreed scope, schedule and budget. The opinions, recommendations and conclusions set out herein has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared. It is based on information gained from site conditions. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterization of site conditions is an interpretation of information collected during assessment, in accordance with industry practice. This interpretation is not a complete description of all conditions on or in the vicinity of the site, due to the inherent variation in spatial and temporal vibration information. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to other sites, nor can it be used when the nature of the specific purpose changes from that which we agreed.

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Paragon. The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete. This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of defect(s) or other effects can change over time, as a result of either natural processes or human influence. Paragon should be kept appraised of any such events and should be consulted for further investigations if any changes are noted.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Paragon assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report. To avoid misuse of the information presented in your report, we recommend that Paragon be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report.

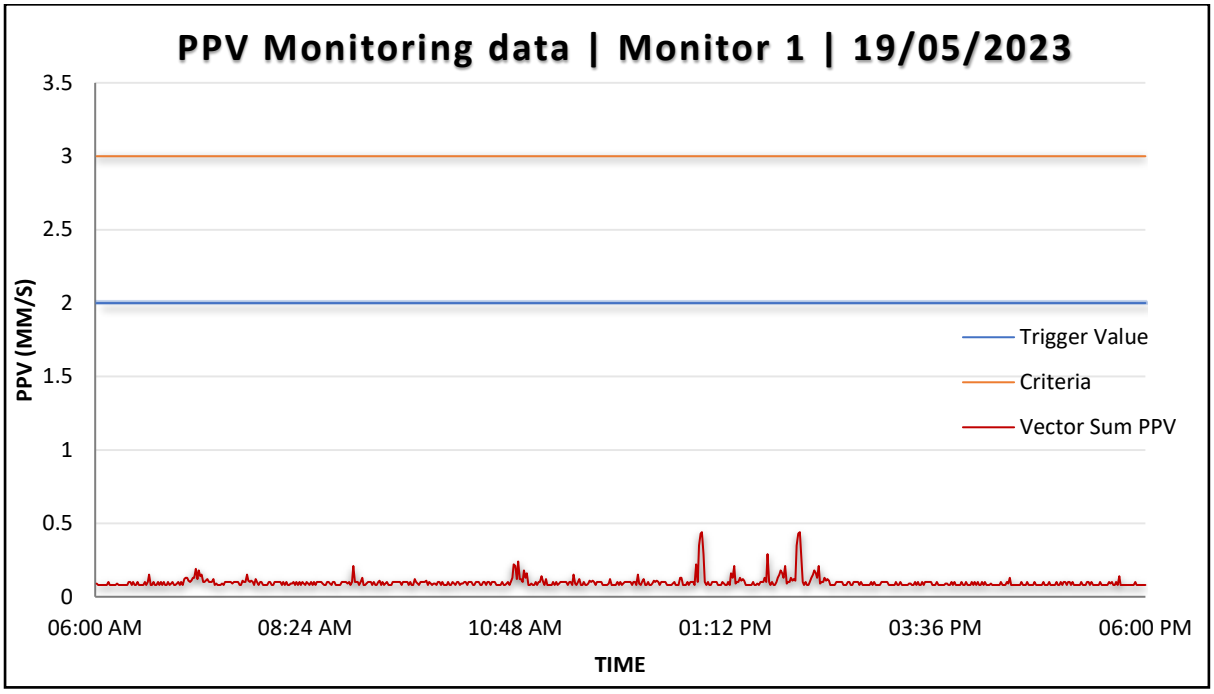
Interpretation by other professionals

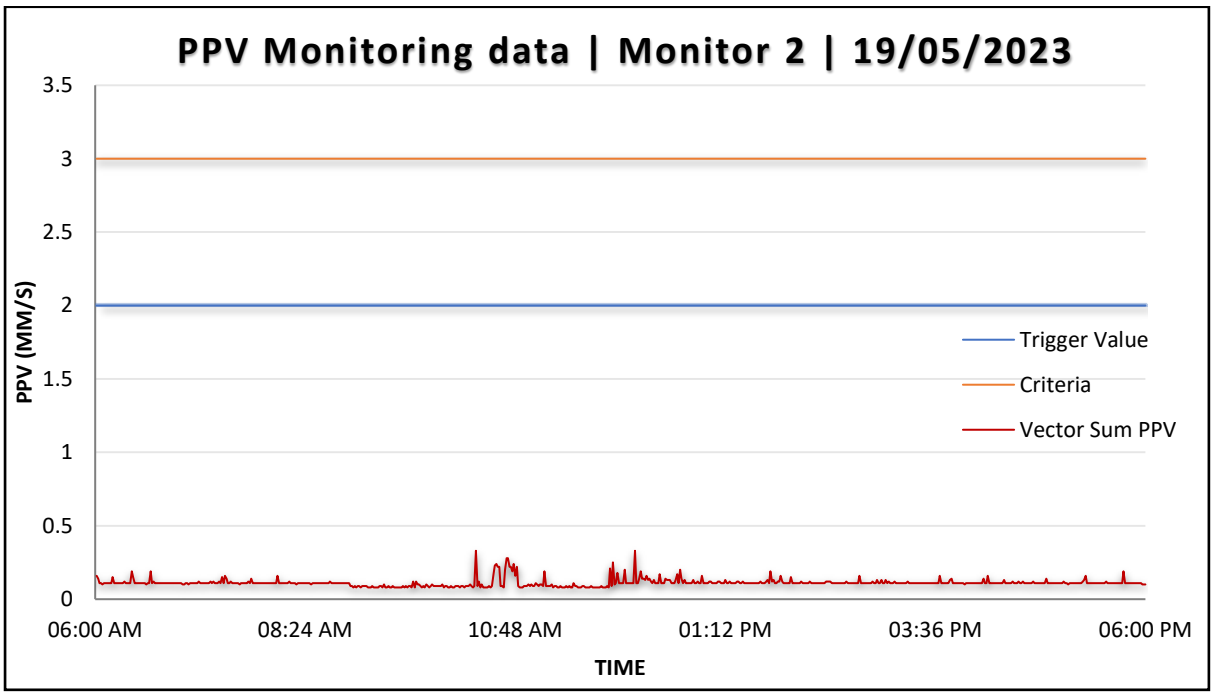
Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings. Given Paragon prepared the report and has familiarity with the site, Paragon is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Paragon disowns any responsibility for such misinterpretation.

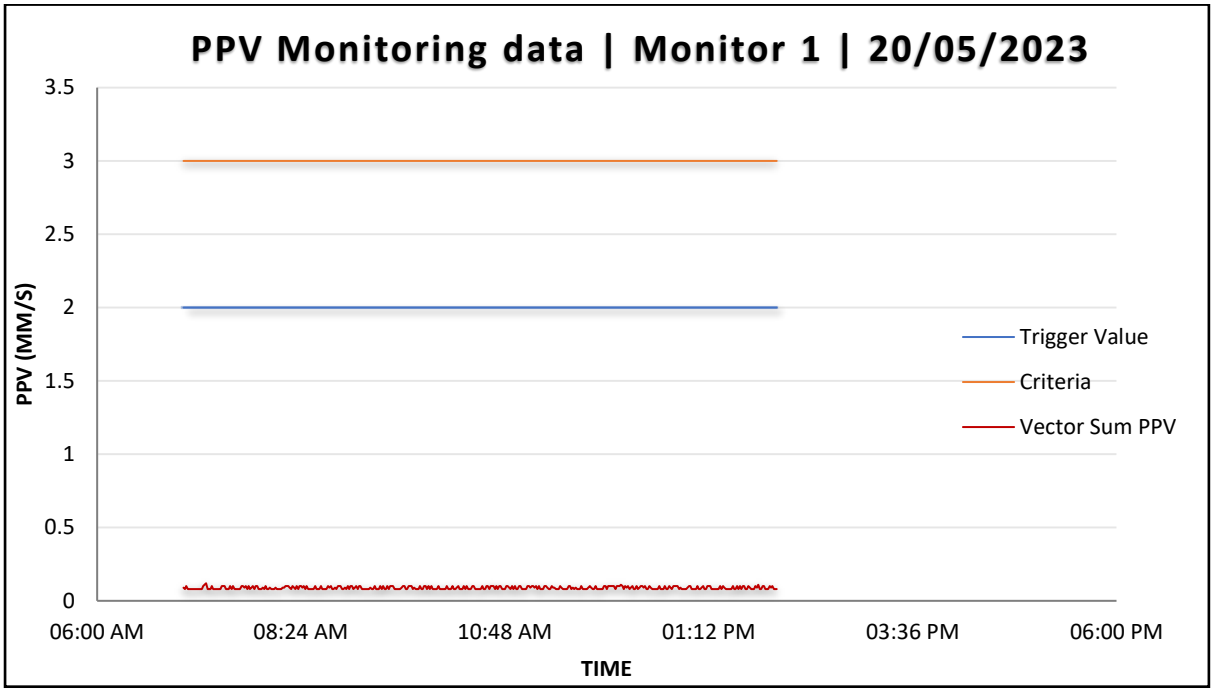
Data should not be separated from the report

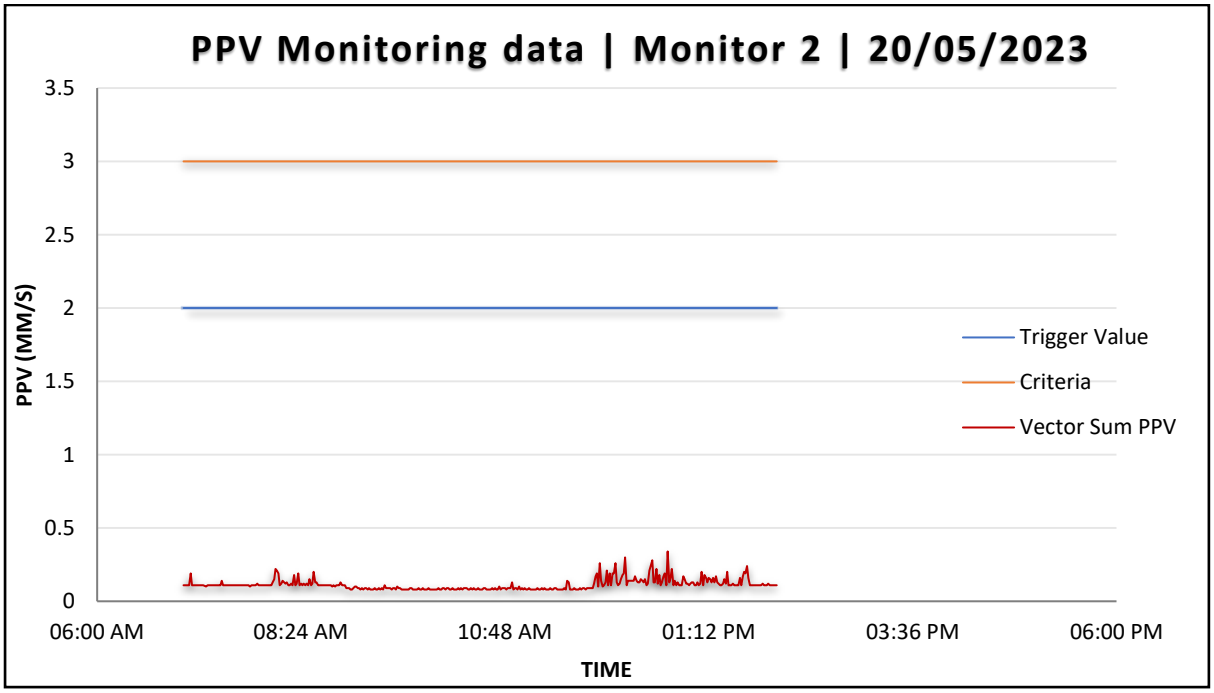
The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, acquired data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way. This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

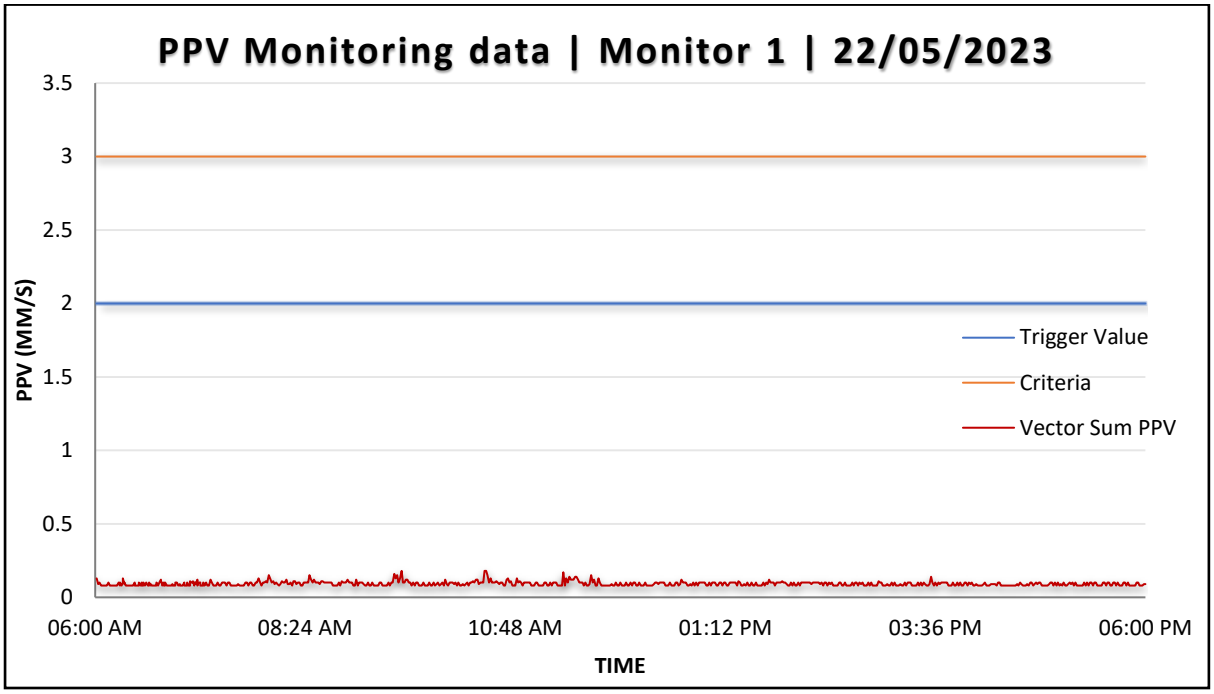
Appendix 1 – Vibration Monitoring Data

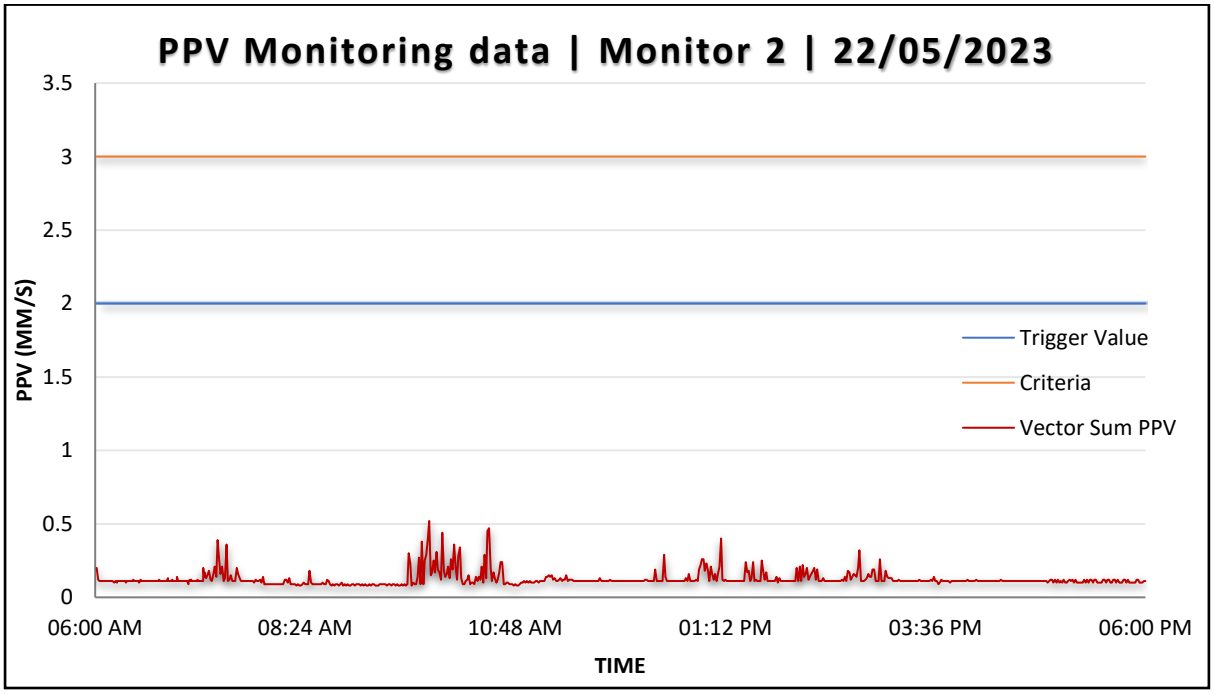


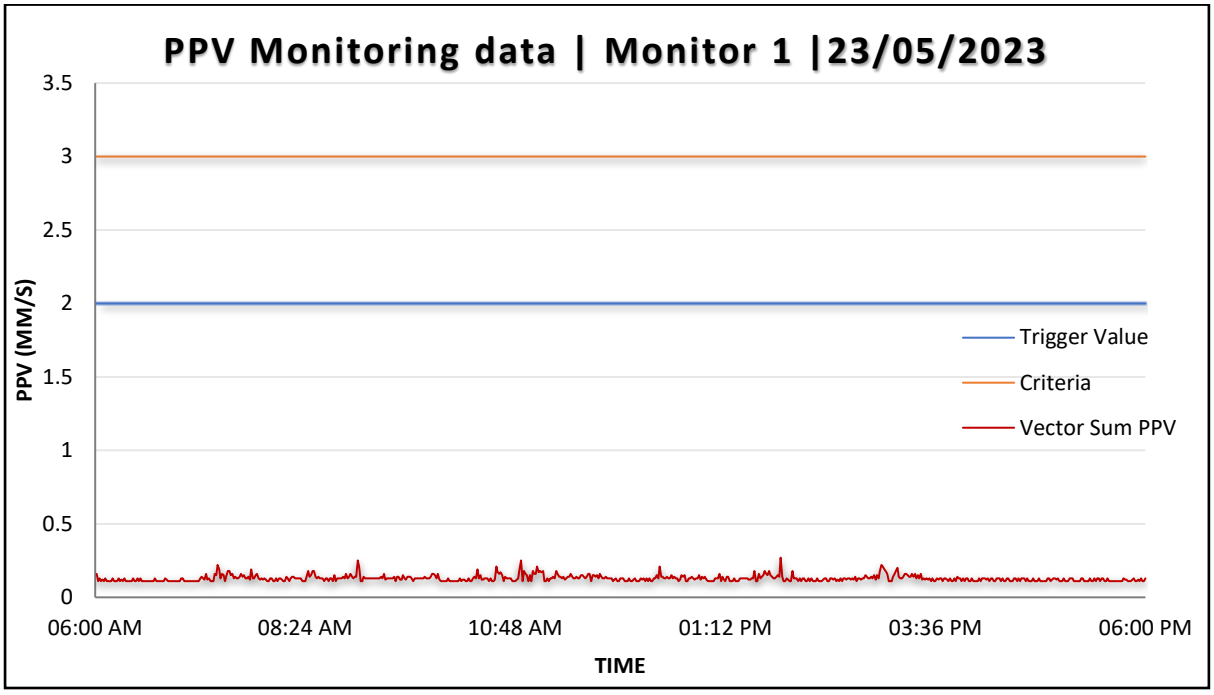


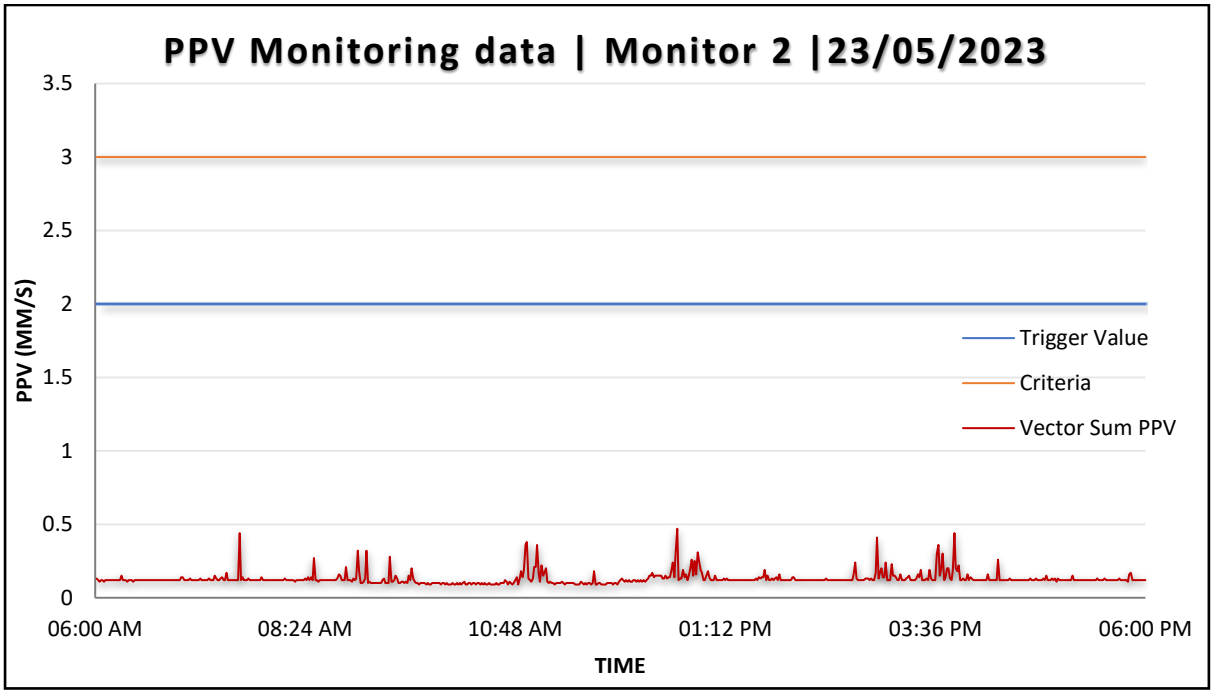

PPV Monitoring data | Monitor 1 | 20/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

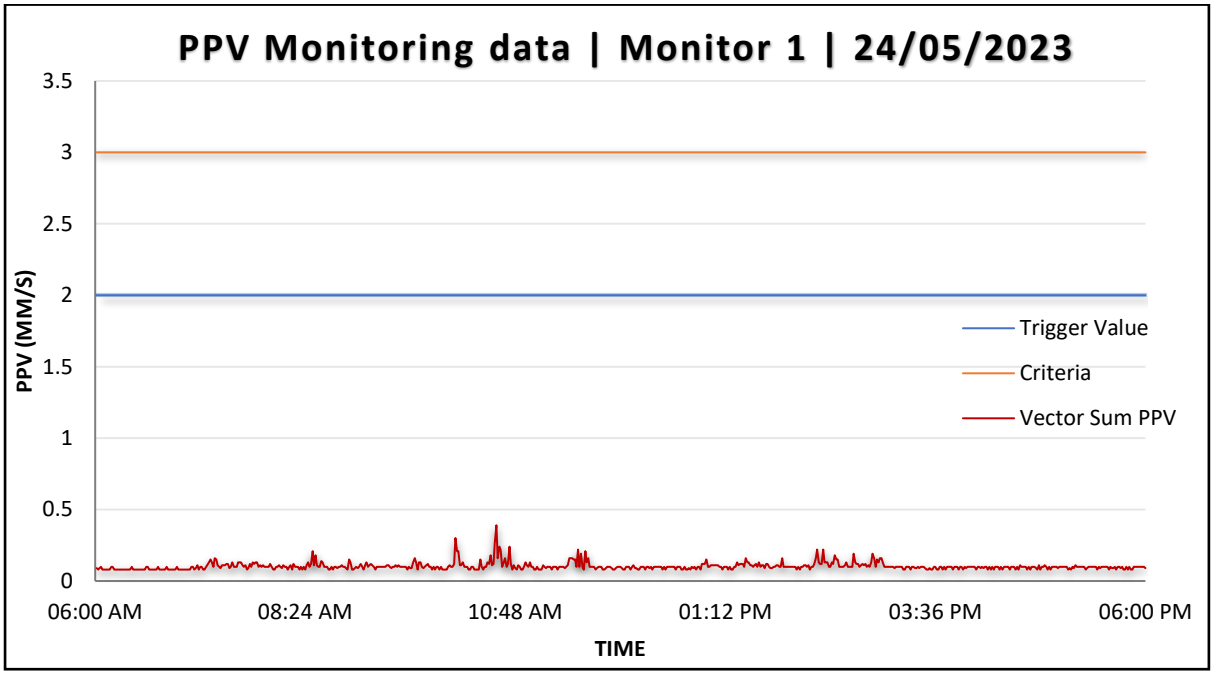

PPV Monitoring data | Monitor 2 | 20/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

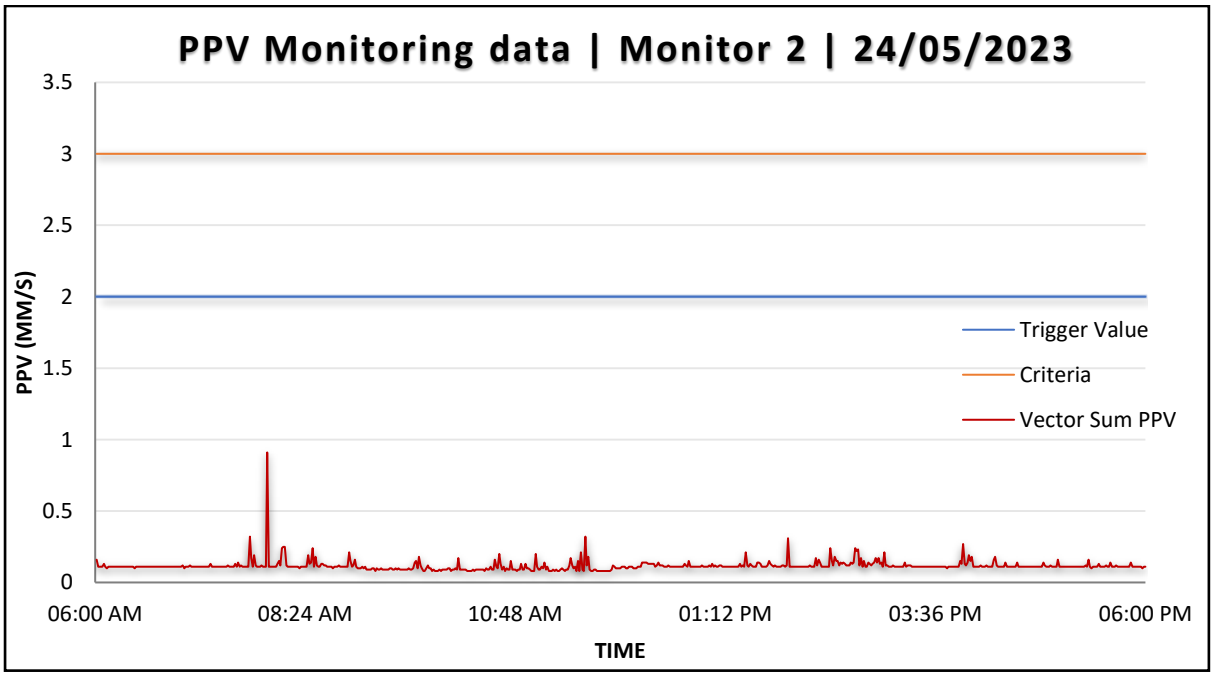

PPV Monitoring data | Monitor 1 | 22/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

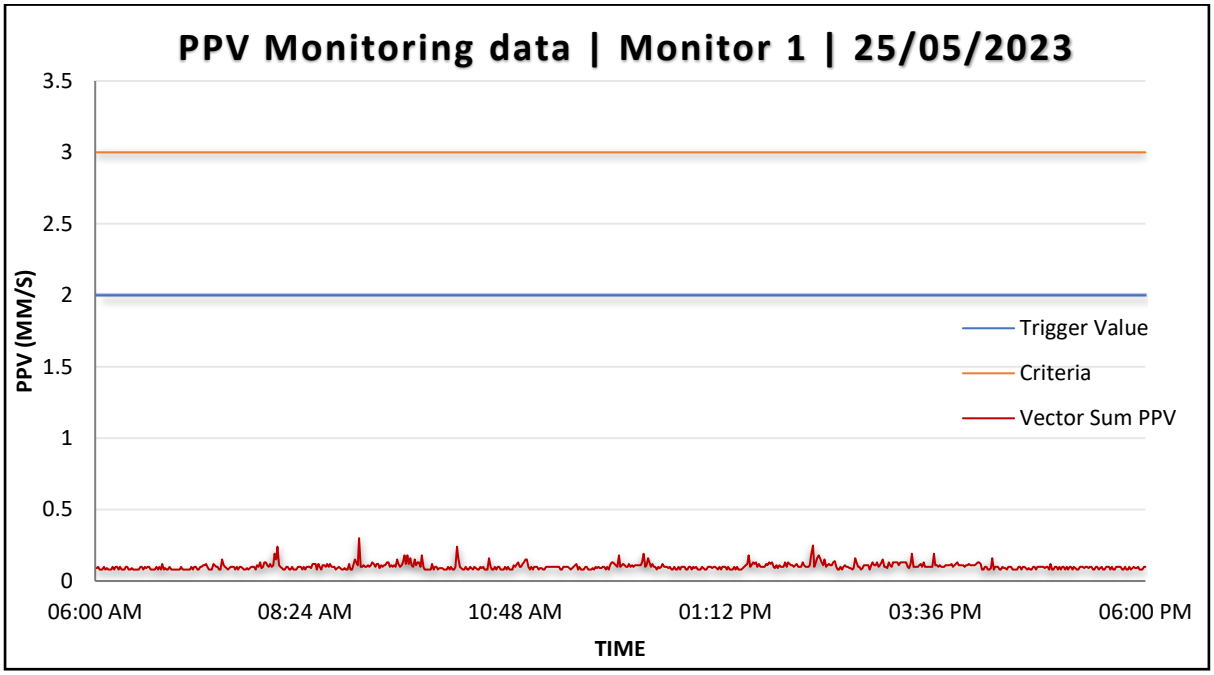

PPV Monitoring data | Monitor 2 | 22/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

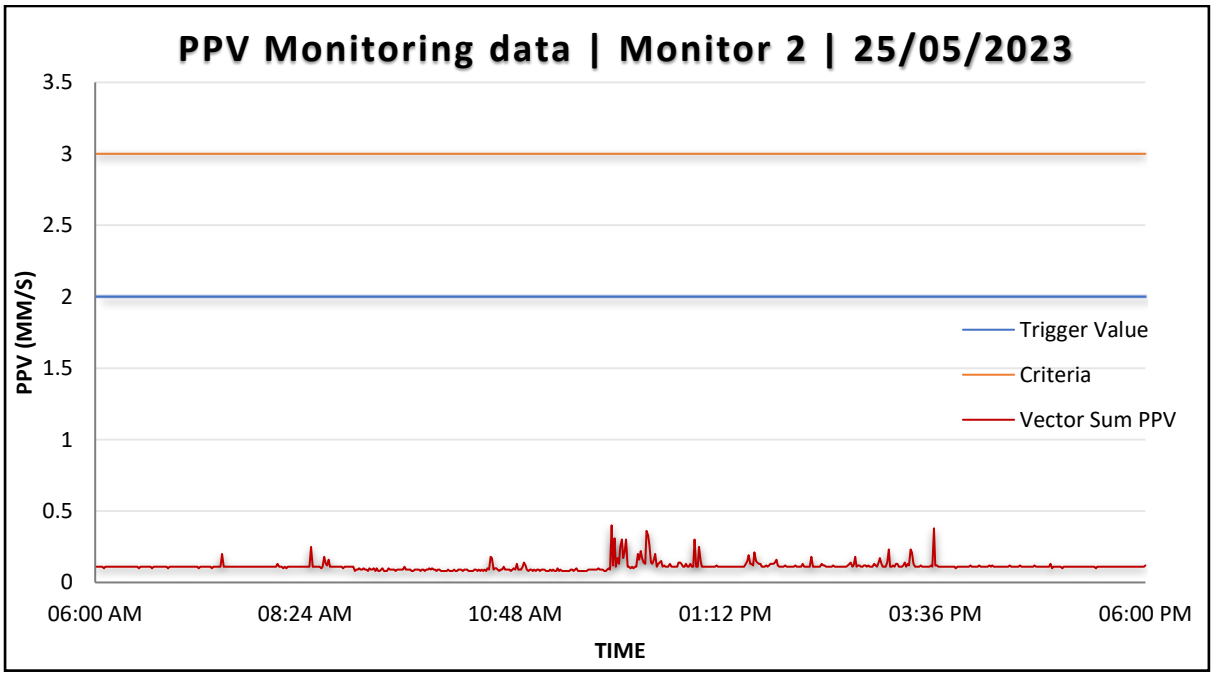

PPV Monitoring data | Monitor 1 |23/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


PPV Monitoring data | Monitor 2 |23/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

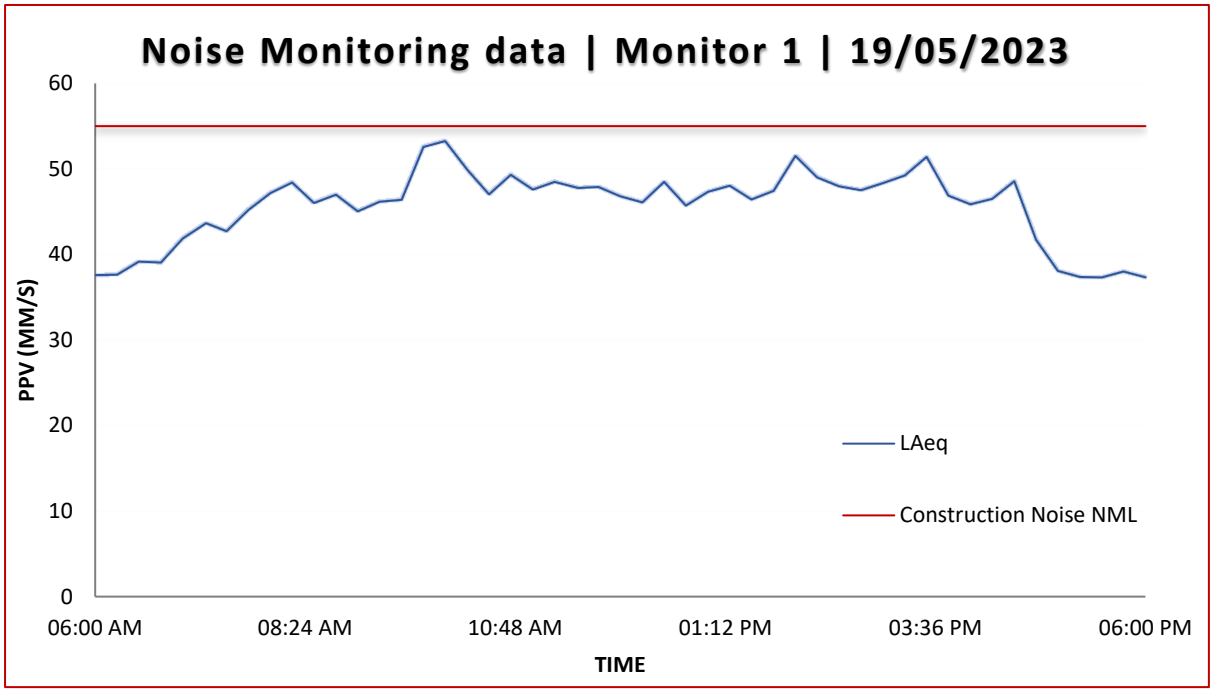

PPV Monitoring data | Monitor 1 | 24/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

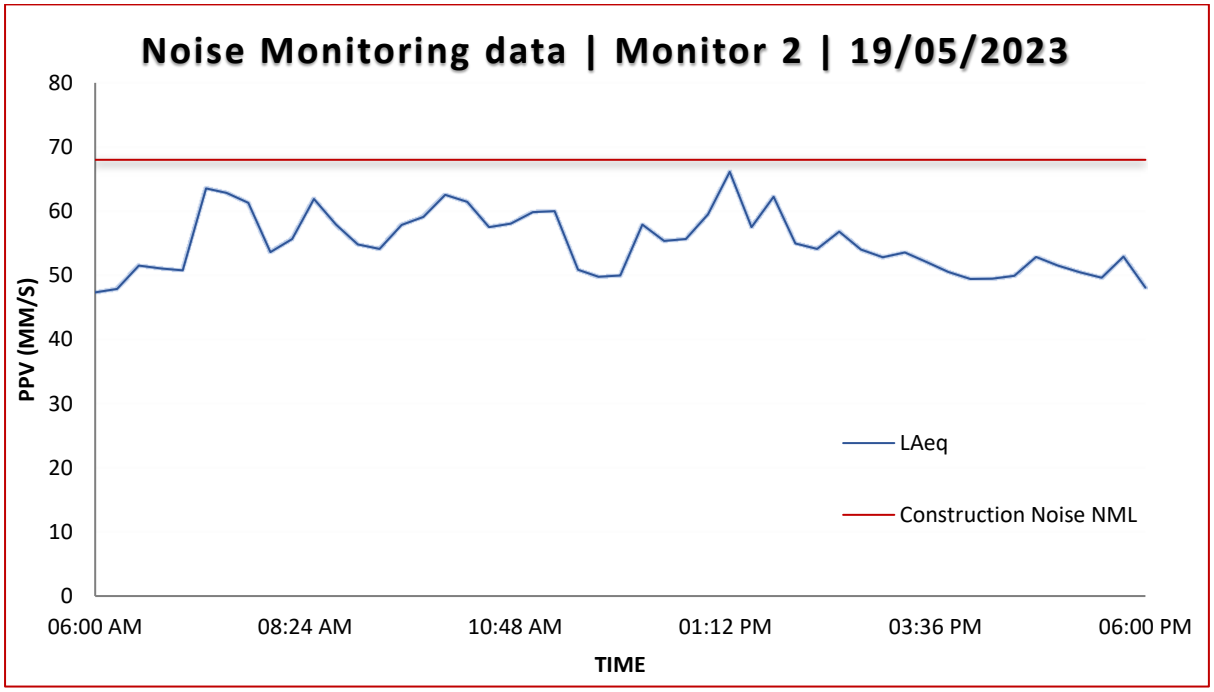

PPV Monitoring data | Monitor 2 | 24/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

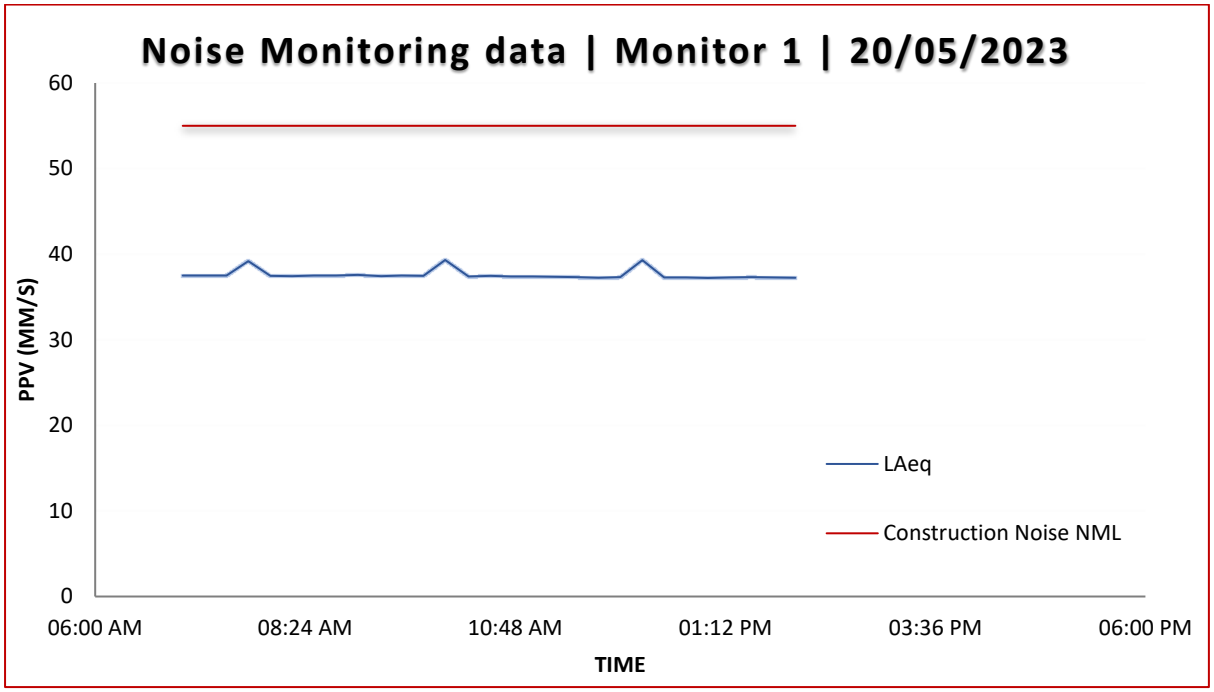

PPV Monitoring data | Monitor 1 | 25/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

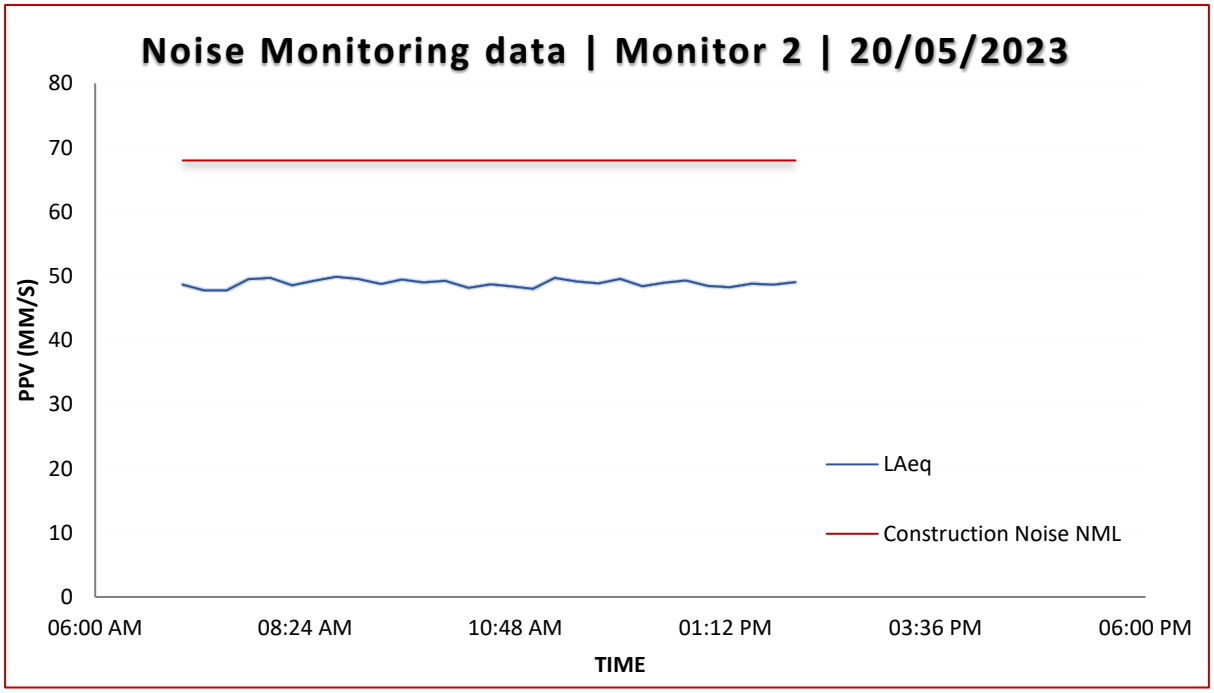

PPV Monitoring data | Monitor 2 | 25/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
Trigger Value
Criteria
Vector Sum PPV
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

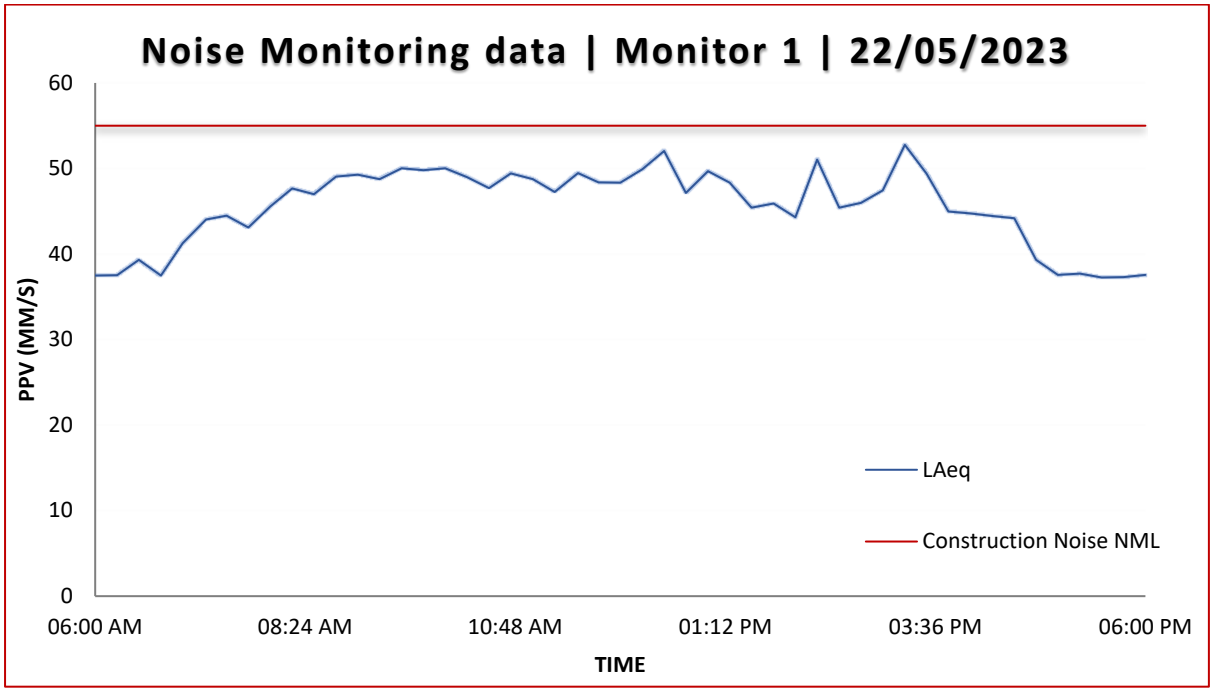
Appendix 2 – Noise Monitoring Data

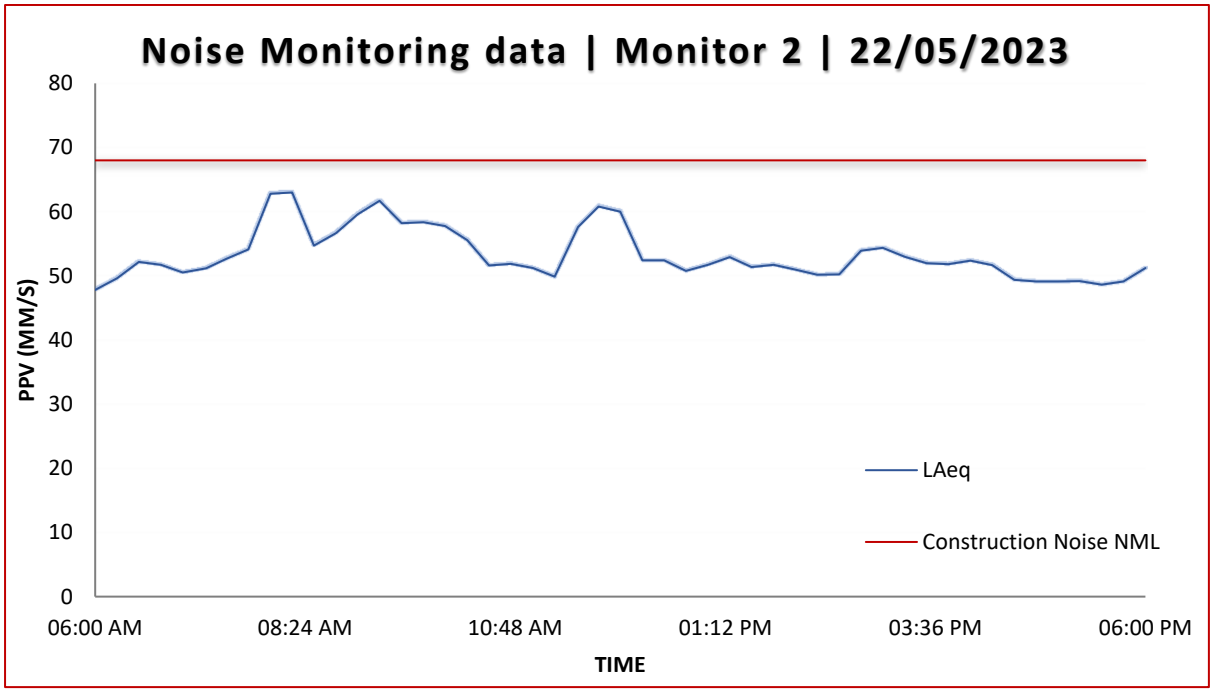


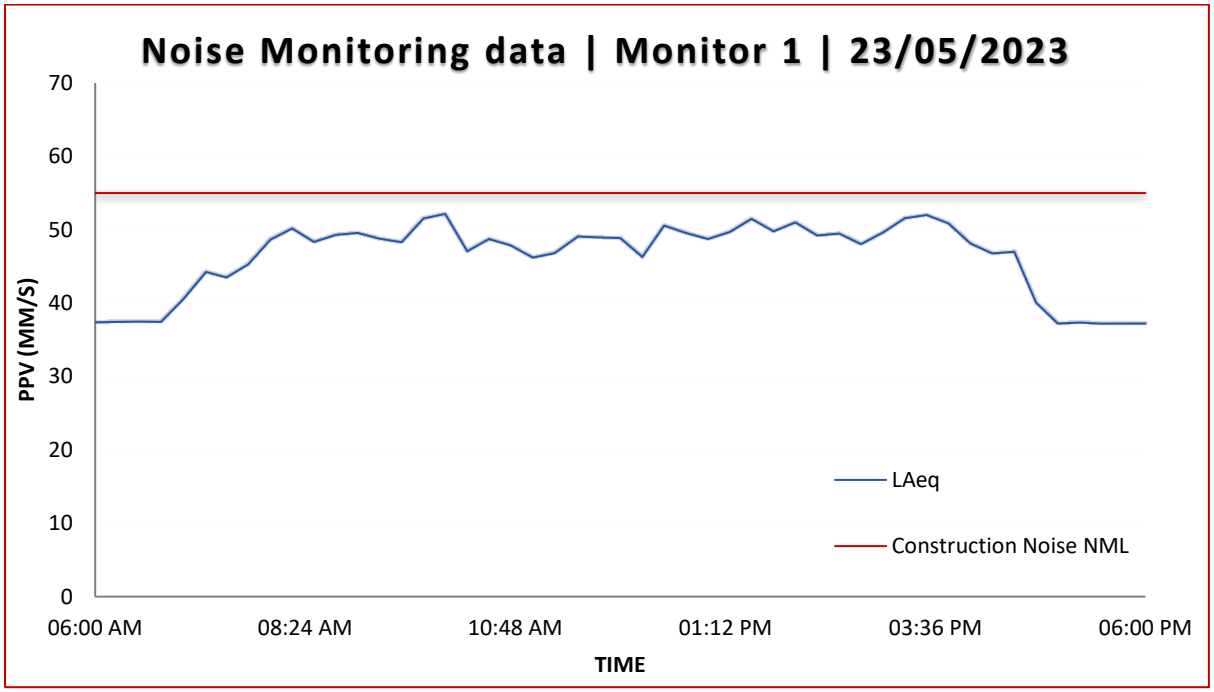


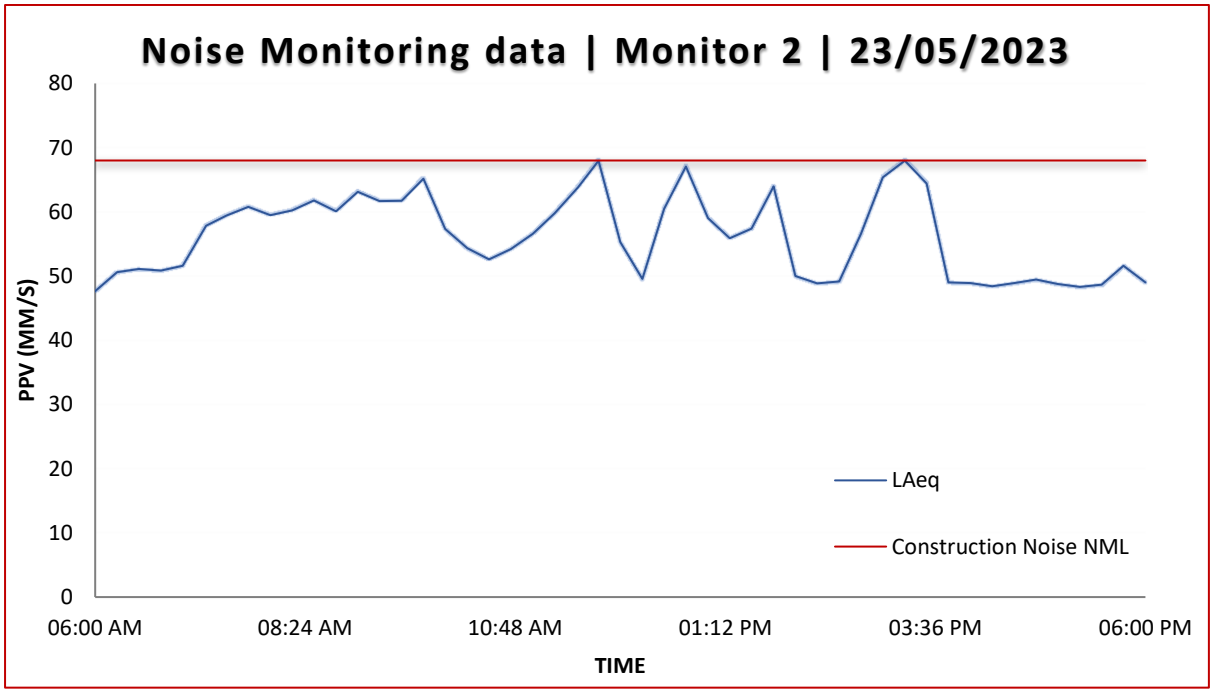

Noise Monitoring data | Monitor 1 | 20/05/2023
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

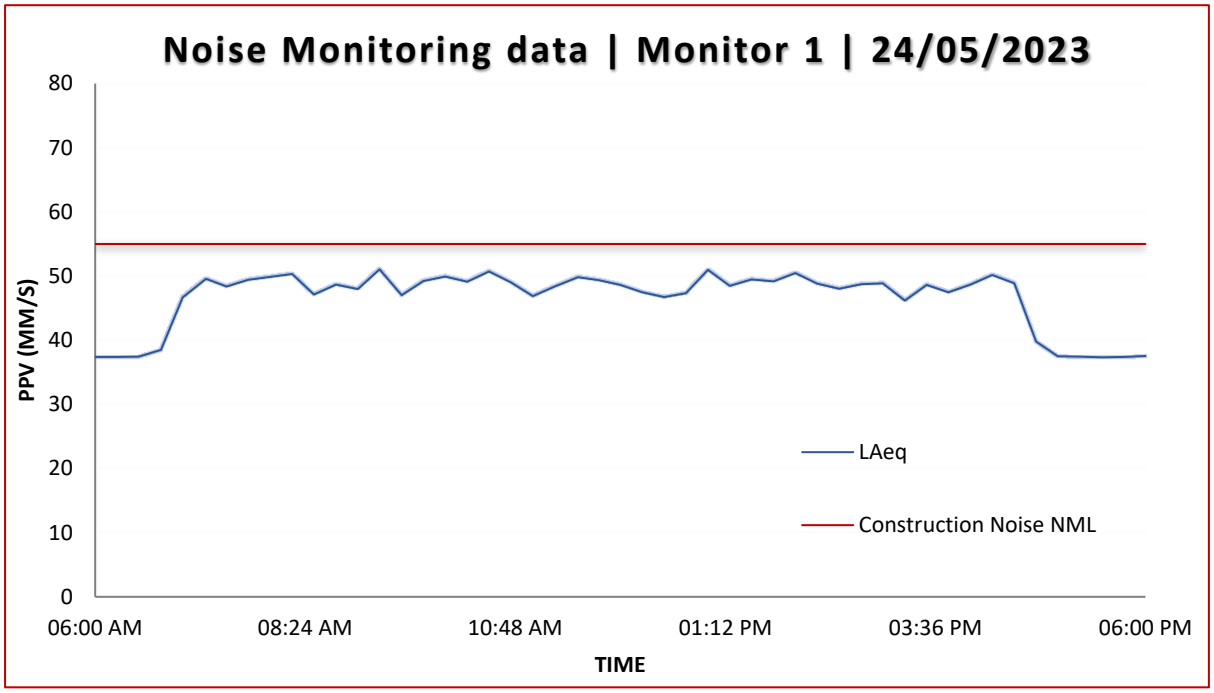

Noise Monitoring data | Monitor 2 | 20/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

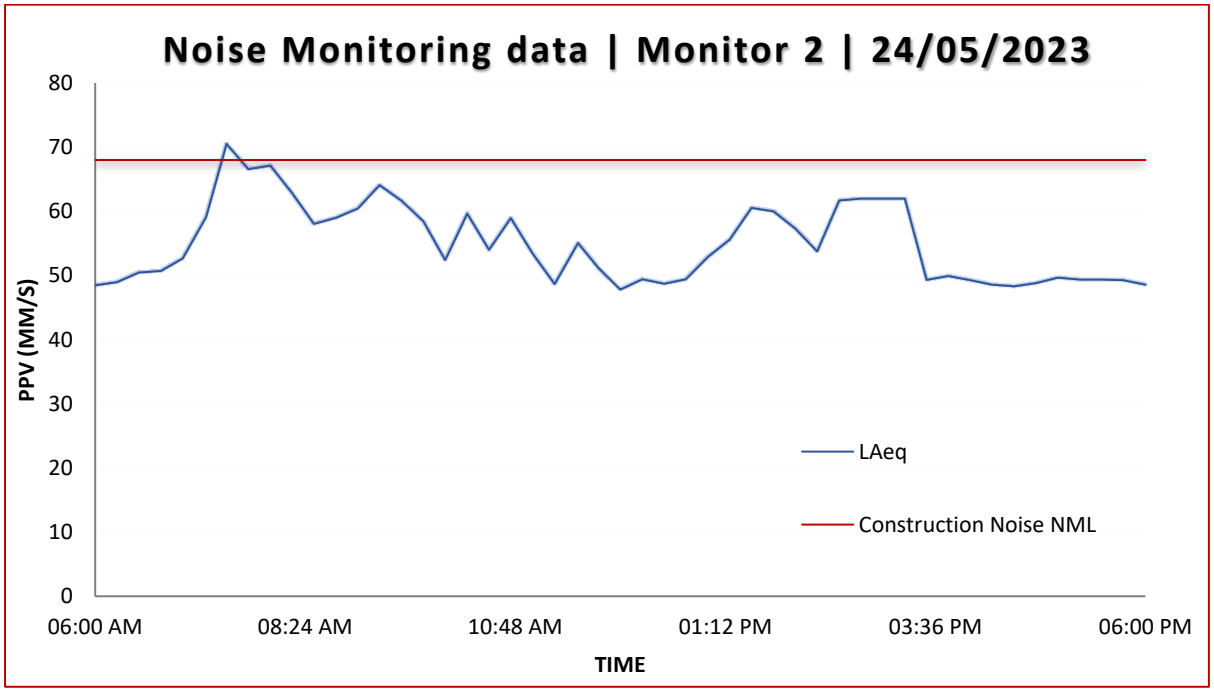

Noise Monitoring data | Monitor 1 | 22/05/2023
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

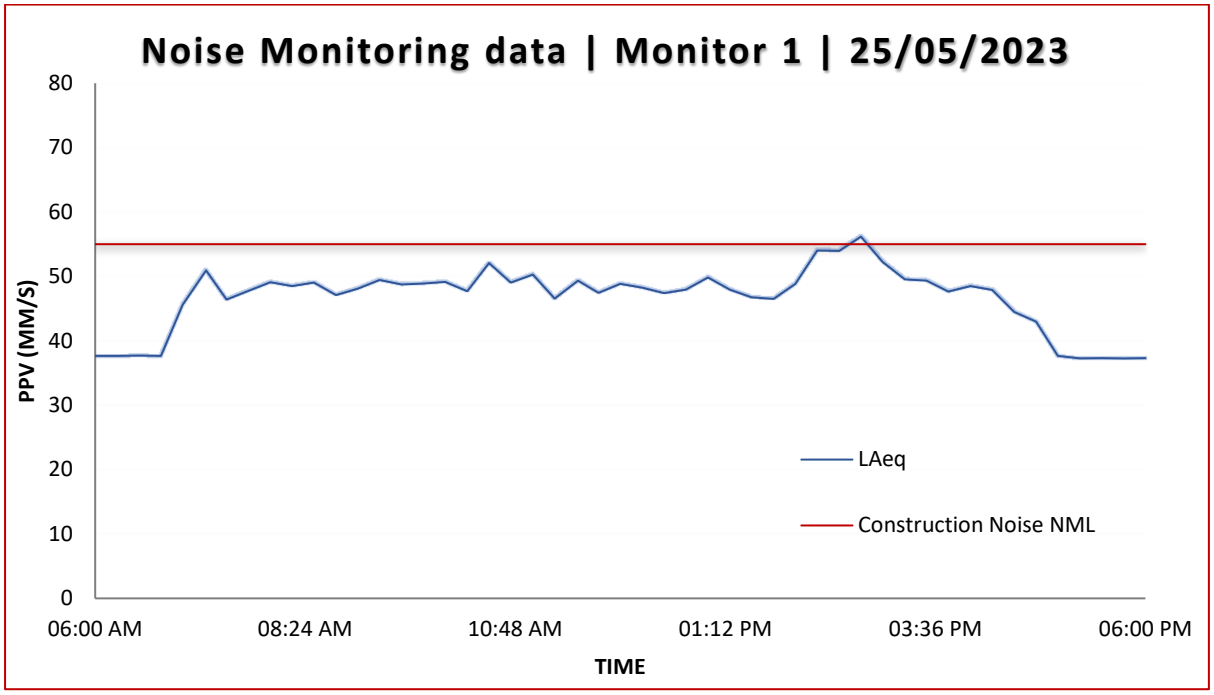

Noise Monitoring data | Monitor 2 | 22/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

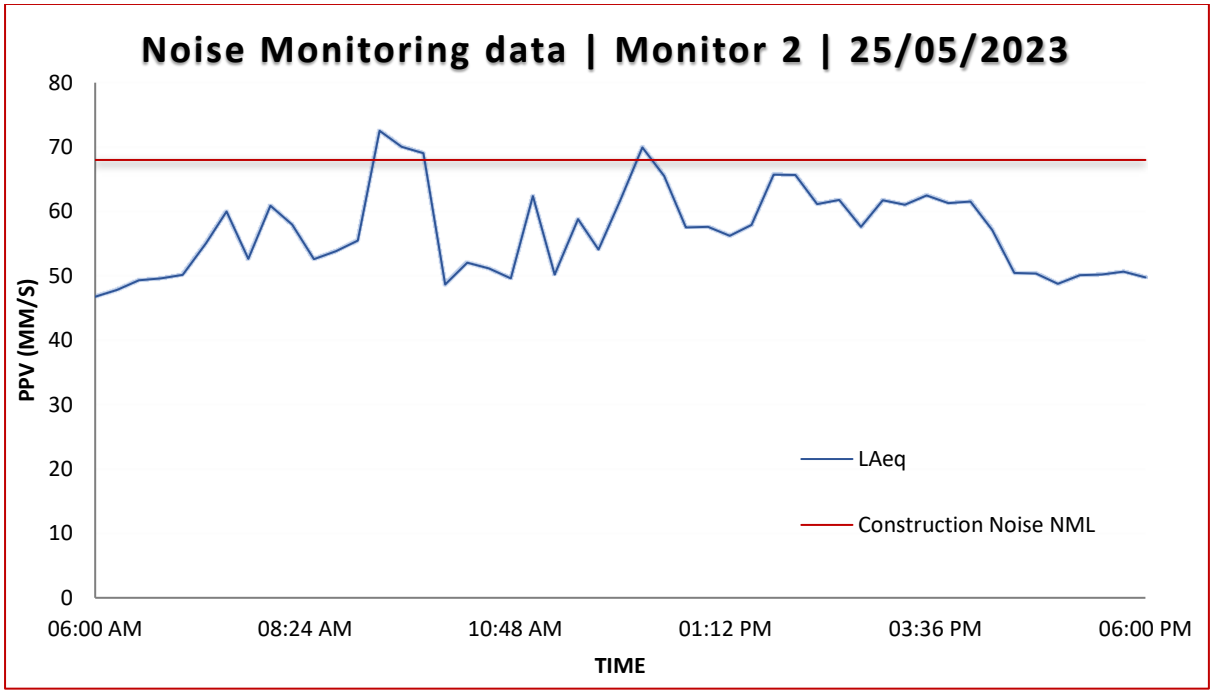

Noise Monitoring data | Monitor 1 | 23/05/2023
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 23/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 1 | 24/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 24/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 1 | 25/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 25/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

CONSTRUCTION NOISE AND VIBRATION REPORT

Client:
MOITS PTY LTD

Stage 3 St. George Hospital, 16 Kensington Street, Kogarah

19 June 2023
Ref: PAR-23661-NVR-W03[C]

Monitoring Period:
26 May 2023 to 01 June 2023

Ref: Par-23661-W03[C]
19 June 2023

NOISE & VIBRATION MONITORING REPORT
St. George Hospital

For Duration:
26 May 2023 – 01 June 2023

Prepared for:
Peter Zwamborn
Moits
142 Wicks Rd, Macquarie Park NSW 2113

Document Authorization

For and on behalf of Paragon Engineering

Michael Duong
Civil Engineer

Sinan Habeeb
Civil Engineer

Quality information

Revision history

Revision	Report Status	Date	Author	Reviewer
A	1st Revision	7 June 2023	MD	SH
B	2nd Revision	16 June 2023	MD	SH
C	3rd Revision	19 June 2023	MD	SH

Distribution

Revision	No. of copies	Format	Distributed to	Date
A	1	PDF	Moits	7 June 2023
B	1	PDF	Moits	16 June 2023
C	1	PDF	Moits	19 June 2023

Executive Summary

Paragon Engineering was commissioned by Moits to provide vibration & noise monitoring services during the redevelopment activities for the site located at St. George Hospital. The project comprises of excavation and construction of a new Medical facility with two basement carpark

This report provides vibration and noise monitoring information for the excavation and construction of a new Medical facility with two basement carpark at the above site. Vibration monitoring was initiated to assess the potential of structural damage to the surrounding properties. Based on the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**.

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for highly noise affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*. Two vibration data logger and three noise monitor were used. The loggers are equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

The vibration results found in *Table 6* summarise the maximum daily peak particle velocity (PPV) recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 10 dB(A) for the Noise Affected NML and up to 03 dB(A) for highly noise affected. Location 1 and Location 3 have exceeded the criteria by up to 02 dB(A). It is found that many of the triggers from Location 1 are caused by workers and patience within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and rooms with operating equipment to avoid these false triggers.

Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Table of Contents

Executive Summary ---- ii

List of Figures ---- iii

1. Introduction ---- 1

1.1 Background ---- 1

1.2 Site Information ---- 1

1.3 Objectives ---- 2

2. Sensitive Receivers ---- 2

3. Vibration & Noise Sources and Criteria ---- 3

3.1 Vibration Sources ---- 3

3.2 Noise Sources ---- 4

3.3 Applicable Standards ---- 4

3.4 Vibration Criteria ---- 5

3.5 Noise Criteria ---- 7

4. Methodology ---- 8

4.1 Vibration & Noise Instrument ---- 8

4.2 Site setup and Monitoring Procedure ---- 8

5. Monitoring Results ---- 9

6. Discussion and Recommendations ---- 10

7. Conclusions ---- 12

List of Figures

Figure 1 Sensitive Vibration Receiver 2

Figure 2 Sensitive Noise Receiver 3

Figure 3 Guideline values for PPV as per DIN-4150 6

Figure 4 Site setup 8

List of Tables

Table 1 Working Hours 1
Table 1 Potential noise sources 4
Table 2 guideline values for vibration velocity (BS 7385) 5
Table 3 guideline values for vibration velocity (DIN 4150) 6
Table 5 Construction noise management levels 7
Table 6 maximum daily vector sum peak particle velocity values 9
Table 7 Daily Measured Noise Levels – Location 1 dB(A) 9
Table 8 Daily Measured Noise Levels – Location 2 dB(A) 9

List of Appendices

Appendix 1 – Vibration Monitoring Data 14
Appendix 2 – Noise Monitoring Data 20

1. Introduction

1.1 Background

Paragon Engineering was commissioned by Moits to provide vibration and noise monitoring services during the redevelopment works that is located at St. George Hospital for the proposed redevelopment located at St George Hospital. The project comprises of piling, excavation and construction of a new Medical facility with two basement carpark.

1.2 Site Information

The project is located at St. George Hospital. The Stage 3 redevelopment includes the piling, excavation and construction of a new Medical facility with two basement carpark. The nearest vibration and noise sensitive receivers are shown in *Figure 1* and *Figure 2* below.

Working Hours

The Project construction working hours shall be in accordance with approved DA Condition C4-C8 as described below:

Table 1 Working Hours

Activity	Permitted working hours
C4. Construction including the delivery of materials to and from site:	❖ Monday to Friday – 7:00am to 6:00pm inclusive ❖ Saturday - 8:00am to 1:00 pm ❖ Sunday & public holidays - No work permitted
C5. Not withstanding condition C4, provide noise levels do not exceed the existing background level plus 5dB, work may also be undertaken during the following hours:	❖ Monday to Friday – 6:00am to 7:00pm inclusive ❖ Saturday - 1:00pm to 5:00 pm ❖ Sunday & public holidays - No work permitted
C6. Construction activities may be undertaken outside of the hours in condition C4 and C5 if Required:	❖ By the police or a public authority for the delivery of vehicles, plant or materials; or ❖ In an emergency to avoid the loss of life, damage to property or to prevent environment harm; or ❖ Where the works are inaudible at the nearest sensitive receivers; or ❖ For the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or ❖ Where a variation is approved in advance in writing by the Planning Secretary or her nominee if appropriate justification is provided for the works
C7. Notification of such construction activities as referenced in Condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.	

Activity	Permitted working hours
C8. Rock breaking, rock hammering, sheet piling, pile driving and similar activities may only be carried out between the following hours:	❖ Monday to Friday – 9:00am to 12:00pm ❖ Monday to Friday - 2:00pm to 5:00 pm ❖ Saturday – 9:00am to 12:00pm ❖ Sunday & public holidays - No work permitted

1.3 Objectives

The purpose of this document is to provide a practical construction vibration and noise monitoring information to assess the potential structural damage and human comfort in the surrounding properties, compare the collected vibration and noise results against the recommended criteria and to provide a discussion about the mitigation measures to reduce the vibration and noise occurring.

2. Sensitive Receivers

Sensitive Vibration Receivers

The nearest vibration sensitive receivers are identified in *Figure 1* and listed below:

- ❖ M1, Medical Facility on the Southern boundary of the site.
- ❖ M2, Medical Facility on the Norther boundary of the site along Kensington St.
- ❖ M3, Medical Facility on the Norther boundary of the site along Kensington St.
- ❖ H1, Fire Station (heritage) on the Western side of the boundary.
- ❖ SW, Sydney Water asset along the Northern boundary of the site along Kensington St.

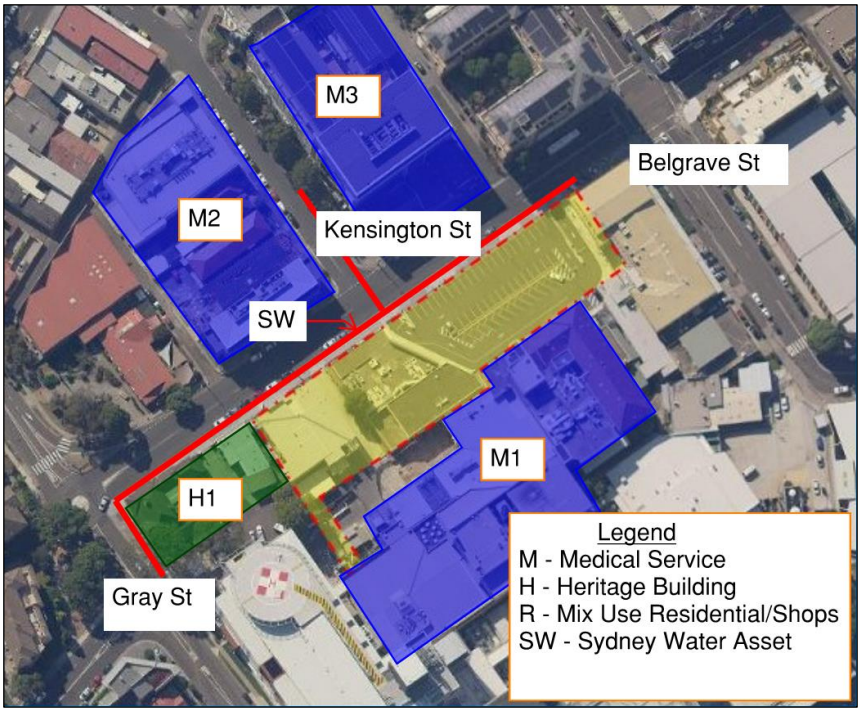


Figure 1 Sensitive Vibration Receiver

Sensitive Noise Receivers

The nearest noise sensitive receivers are identified in *Figure 2* and listed below:

- R1, Residential buildings on the Northern boundary of the site along Kensington St.
- R2, Residential buildings on the Eastern boundary of the site along Belgrave St.
- M1, Medical Facility on the Southern boundary of the site.
- M2, Medical Facility on the Norther boundary of the site along Kensington St.
- M3, Medical Facility on the Norther boundary of the site along Kensington St.
- S1, Educational Facility on the North-western boundary of the site along Kensington St.
- H1, Fire Station (heritage) on the Western side of the boundary.

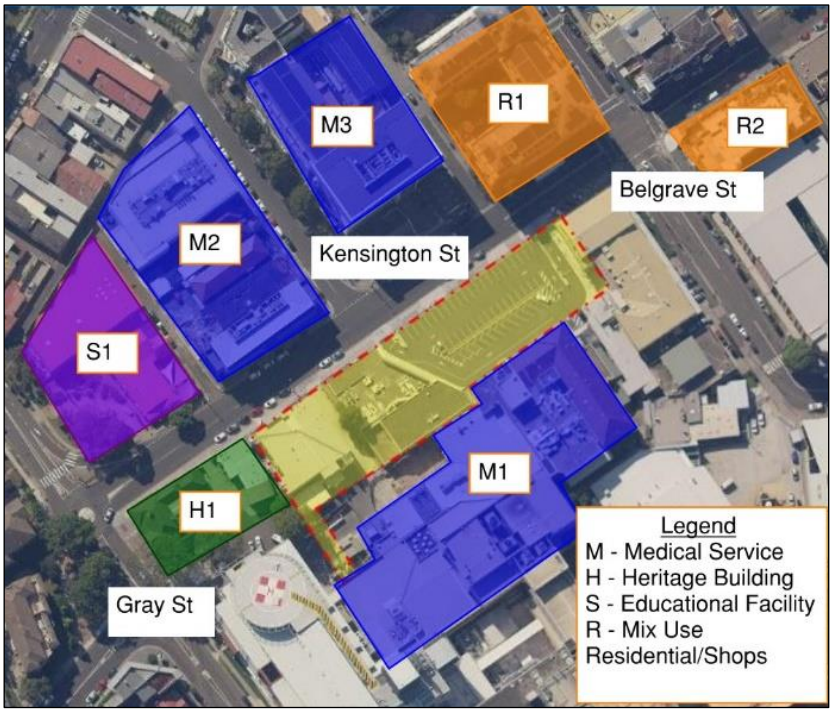


Figure 2 Sensitive Noise Receiver

3. Vibration & Noise Sources and Criteria

3.1 Vibration Sources

Vibration can be caused by various external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time).

The potential source of vibration in this project is likely to be caused by hydraulic excavators with jackhammers, saws and other various construction activities which may be categorised as intermittent/short term sources of vibration.

3.2 Noise Sources

The noise sources likely to be associated with the works mentioned in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering are shown in *Table 2* below.

Table 2 Potential noise sources

Stages	Equipment	Sound Power Level dB(A)
Demolition	Excavator with hydraulic hammer (30t-40t)	117
	Concrete Saw	117
	Truck & Dog	101
Excavation	Excavator with hydraulic hammer (30t-40t)	117
	Bobcat	100
	Concrete Saw	117
	Truck & Dog	101
Structure	Powered hand tools	95
	Bobcat	100
	Concrete pump	103
	Truck & Dog	101

3.3 Applicable Standards

The list below illustrates the relevant reports, standards, guidelines or policies that has been used during the preparation of this report:

- Department of Environment and Conservation (NSW) Publication, Interim Construction Noise Guideline
- Australian Standard "AS ISO 6393:2019, Earth-moving machinery - Determination of sound power level - Stationary test conditions"
- Department of Environment and Conservation (NSW) Publication, Assessing Vibration: a technical guideline (Feb 2006)
- Australian Standard "AS 2436-2010, Guide to noise and vibration control on construction, p and maintenance sites"
- International organization for Standardization "ISO 5348:2021, Mechanical vibration and shock Mechanical mounting of accelerometers"
- German Standard "DIN 4150-3:2016-12, Vibration in buildings - part 3: effects on structures"
- Australian Standard "AS ISO 2631.2.2014, Mechanical Vibration and Shock – Evaluation of human exposure to whole-body vibration. Part 2: Vibration in buildings (1-80Hz)"
- British Standard "BS 7385-2:1993, Evaluation and measurement for vibration in buildings – Part 2 Guide to damage levels from groundborne vibrations"
- Australian Standard "AS 2187.2-2006, Explosives – storage and Use. Part 2: Use of Explosives"
- Paragon Engineering, Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023

3.4 Vibration Criteria

In this report, the effect of vibration on the asset's integrity and the potential to cause structural damage will be assessed. Vibration may cause damage to a building structure, ranging from minor hairline cracking to major structural defect.

The Australian Standards *AS 2187.2* states that vibration guide values and the methods of assessing the structural response prepared by *BS 7385-2* and *(USBM) RI 8507* are applicable to the Australian Conditions.

The *British Standard BS-7385-2, Evaluation and measurement for vibration in buildings –Part 2: Guide to damage levels from groundborne vibrations* provides the vibration limits to reduce the risk of structural damage to buildings. *Table 3* below outline the frequency-dependent vibration criteria for residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

The *BS 7385* states that when continuous vibration causes dynamic loading such that the dynamic loading magnifies the structural dynamic response especially in low frequency range, up to 50% reduction may be applied on the values listed in Table 3.

Table 3 guideline values for vibration velocity (BS 7385)

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or frame structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	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 15 Hz increasing to 50 mm/s at 40 Hz and above

The *DIN 4150, Vibrations in buildings - Part 3: Effects on structures* is used to assess the likelihood of structural damage to nearby structures. Figure 3 below outline the frequency-dependent vibration criteria for Heritage, residential and commercial buildings. These levels have been established such that no damage would occur up to the limits. The levels are generally considered conservative, i.e. vibration levels that exceed the limits would not necessarily translate into structural damage.

Table 4 guideline values for vibration velocity (DIN 4150)

Structure	Guideline values for velocity (mm/s)				
	Vibration at the foundation at a frequency of:			Topmost floor, horizontal direction i=x,y	Floor slabs, vertical direction, i=z
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequency	All frequency
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	20
Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 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 to 8	8 to 10	8	20[b]

[b] in the case of building types, it may be necessary to lower the relevant guideline value markedly to prevent minor damage

The DIN standard defines 'damage' to include cracks forming in plastered surfaces of walls, existing cracks in a building becoming enlarged, and separation of lightweight walls from load bearing walls. Most commonly specified "safe" structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure. The *DIN 4150* states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage as these limits are generally recognised as being conservative.

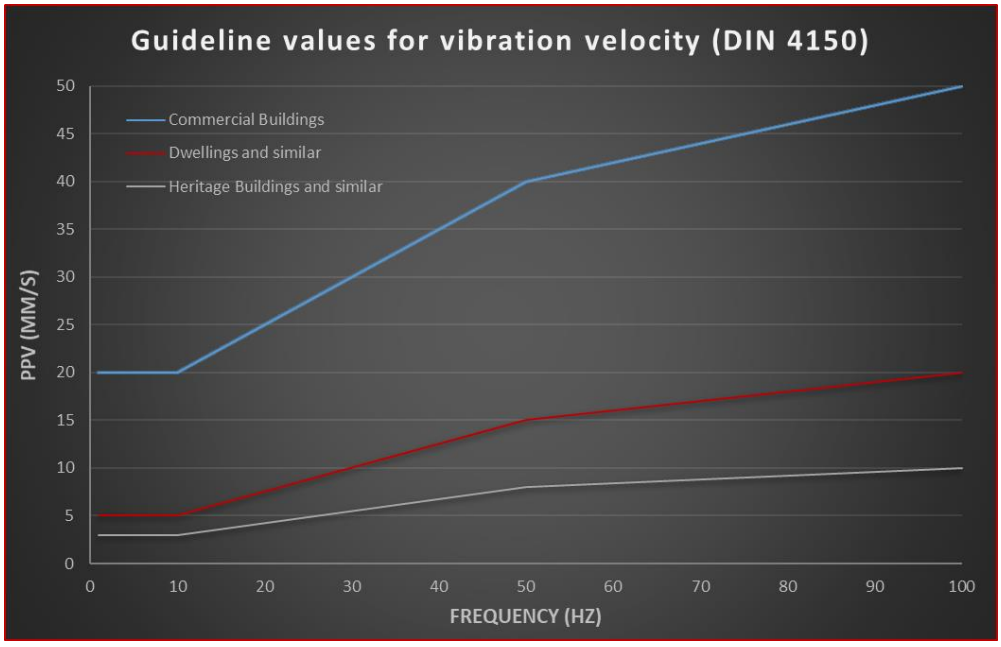


Figure 3 Guideline values for PPV as per DIN-4150

In accordance with the recommendations from the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering, the criteria "*Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2)"* has been considered for the heritage building and Medical facility with sensitive equipment where the criteria/trigger is set to **3mm/s**. Figure 4 shows the location of each vibration monitor.

3.5 Noise Criteria

The construction Noise Management Levels (NMLs) for the Project have been nominated in the Construction Noise & Vibration Monitoring Plan, Ref # VIB-23661-NVMP[B] dated 31 May 2023 prepared by Paragon Engineering as shown in *Table 5*. Figure 4 shows the location of each noise monitor.

Table 5 Construction noise management levels

Noise Source	Time Period	Receiver	Construction NMLs – Laeq(15min)	Highly Noise Affect
Construction Noise	❖ 07:00am to 6:00pm, Monday to Friday ❖ 08:00am to 01:00pm, Saturday ❖ No site works shall be undertaken on Sundays or public holidays.	R1	68	75
		R2	68	
		S1	45/55[a]	--
		H1	70	--
		M1	55/65[a,b]	--
		M2	55/65[a,b]	--
		M3	55/65[a,b]	--

a - Noise Management Level of 55 dB(A) for internal noise monitoring or 65dB(A) for external noise monitoring

The Construction Noise Management levels have been established for the nearest noise sensitive residential and Hospital receivers. For mix use residential/office receivers, $L_{Aeq(15min)}$ values are set to be **68dB(A)** for noise affected and **75dB(A)** for Highly Noise Affected for when occupied through the day. For medical receivers, the nominated $L_{Aeq(15min)}$ values are set to be **55dB(A)** for internal noise monitoring and **65dB(A)** for external noise monitoring as shown in *Table 5*.

4. Methodology

4.1 Vibration & Noise Instrument

Two vibration Data logger with a 2.0 Hz tri-axial geophone and three noise monitors were used, the logger is equipped with on-board modem which provides remote monitoring communication functions, system status and vibration and noise triggers are instantly reported through mobile SMS function.

4.2 Site setup and Monitoring Procedure

Vibration Monitor

The geophone was firmly mounted in the ground in accordance with the manufacturer's recommendations & the Australian Standards AS 2775–2004 Mechanical vibration and shock – Mechanical mounting of accelerometers / the ISEE Field practice guidelines for blasting seismographs 2020 as applicable, the geophone was orientated as recommended by the manufacturer in the direction of the vibration source. Vibration Monitor 1 was installed on the wall within the mammogram waiting room and Vibration Monitor 2 was installed on the ground adjacent to the MRI room as can be seen in *Figure 4*. Each device was set to continuous daily monitoring mode at one-minute intervals recording velocities along the three orthogonal axes, i.e. x-axis / radial (back to chest), y-axis / transverse (right side to left side) or z-axis / vertical (foot to head) along with their corresponding frequencies.

Noise Monitor

The noise monitor was mounted on a solar stand in accordance with the manufacturer's recommendations. The monitor is oriented with the camera facing the direction of the noise source as per the recommendation of the manufacturer. The monitor was located to be as close to the sensitive noise receiver as possible as shown in *Figure 4* below. Each device was set to continuous daily monitoring at 15-minute intervals recording $L_{Aeq(15min)}$.

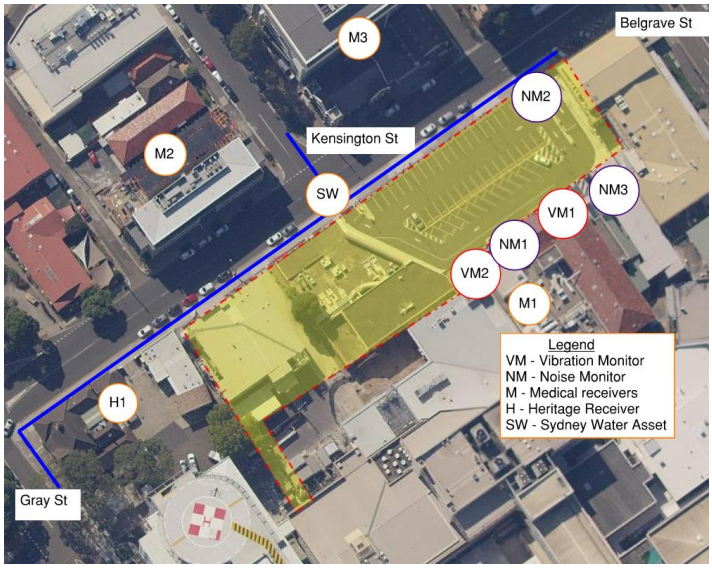


Figure 4 Site setup

5. Monitoring Results

Vibration Monitoring

The maximum daily vibration PPV values are summarised in the following table:

Table 6 maximum daily vector sum peak particle velocity values

Date	Max. vector sum PPV (mm/s) – Monitor 1	Max. vector sum PPV (mm/s) – Monitor 2	Criteria PPV (mm/s)
Fri 26/05/2023	**0.4**	**0.4**	**3.0**
Sat 27/05/2023	**0.2**	**0.6**	**3.0**
Mon 29/05/2023	**0.5**	**0.4**	**3.0**
Tue 30/05/2023	**0.3**	**0.7**	**3.0**
Wed 31/05/2023	**0.2**	**0.9**	**3.0**
Thu 01/06/2023	**0.3**	**1.8**	**3.0**

Noise Monitoring

A summary of the measured $L_{aeq(15minute)}$ noise levels at the monitoring location is shown below:

Table 7 Daily Measured Noise Levels – Location 1 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected
Fri 26/05/2023	**51**	**Nil**	**55**
Sat 27/05/2023	**39**	**Nil**	**55**
Mon 29/05/2023	**57**	**02**	**55**
Tue 30/05/2023	**56**	**01**	**55**
Wed 31/05/2023	**55**	**Nil**	**55**
Thu 01/06/2023	**54**	**Nil**	**55**

Table 8 Daily Measured Noise Levels – Location 2 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected	Highly Noise Affected
Fri 26/05/2023	**73**	**05/Nil**	**68**	**75**
Sat 27/05/2023	**60**	**Nil/Nil**	**68**	**75**
Mon 29/05/2023	**65**	**Nil/Nil**	**68**	**75**
Tue 30/05/2023	**70**	**02//Nil**	**68**	**75**
Wed 31/05/2023	**78**	**10/03**	**68**	**75**
Thu 01/06/2023	**73**	**05/Nil**	**68**	**75**

Table 9 Daily Measured Noise Levels – Location 2 dB(A)

Date	Measured Maximum Daytime Laeq(15minute) Noise Levels	Daytime Laeq(15minute) Noise Exceedance Affected	Construction Noise Goal Affected
Fri 26/05/2023	--	--	65
Sat 27/05/2023	--	--	65
Mon 29/05/2023	--	--	65
Tue 30/05/2023	53	Nil	65
Wed 31/05/2023	63	Nil	65
Thu 01/06/2023	67	02	65

6. Discussion and Recommendations

As can be seen from the previous section and the graphs below, the peak particle velocity values were below the criteria which is set for this project.

Table 7 summarise the noise levels recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 10 dB(A) for the Noise Affected NML and up to 03 dB(A) for highly noise affected. Location 1 and Location 3 have exceeded the criteria by up to 02 dB(A). Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Best management practice

When short-term works such as piling, demolition and construction give rise to impulsive vibrations, undue restriction on vibration values may significantly prolong these operations and result in greater annoyance. Short-term works are works that occur for a duration of approximately one week. In circumstances where work is short term, vibration controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Feasible and reasonable mitigation measures should be applied and best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation program should be instituted.

An example of a possible management strategies are listed below:

- Restrict the times during which high vibration values occur to the least sensitive times of the day
- Ensure piling and earthmoving/breaking activities are organised and do not occur at the same time or less impact equipment is used if values have been exceeded in multiple occurrences
- Typical issues covered in a consultation program include a public contact point for handling complaints
- Early notification of proposed operations and any significant change to operations

The following recommendations provide reasonable noise control measures to reduce noise impacts to sensitive receivers.

- Doubling of distance between source and receiver where possible, example when loading materials
- Using barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or the receiver.
- Using mounds as a temporary or permanent noise barriers
- Engine casing lagged with acoustic insulation and plywood
- Use electric motors in preference to diesel or petrol

In addition to physical noise controls, the following general noise management measures should be followed:

- Use less noisy plant and equipment, where feasible and reasonable
- Plant and equipment should be properly maintained
- Provide special attention to the use and maintenance of silencing equipment fitted to plants to ensure they perform as intended
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel, example locate concrete pump at maximum distance from the sensitive receivers
- Avoid any unnecessary noise when carrying out manual operations and when operating plant

Any equipment not in use for extended periods during construction work should be switched off

Complaint Management

An effective community relations program is essential to keep the stakeholders informed throughout the project development process, to obtain valuable data related to the project, and to become aware of any project-related impacts in a timely manner. Additionally, the community is likely to be more understanding and accepting of the vibration where the information provided is frank, does not attempt to understate the likely vibration impacts and if commitments made are firmly adhered to. A range of media could be used to notify the community before and during construction, including use of community meetings, individual contact and letterbox drops. Contact details for complaints and further information, including emergency phone numbers, should be readily available to the community.

7. Conclusions

The vibration results can be found in *Table 6* and the noise results can be found in *Table 7.* The vibration results found in *Table 6* summarise the maximum daily peak particle velocity PPV recorded and compared to the criteria set for this project. The PPV was within the criteria during the monitoring period. It should also be noted that the vibration amplitudes recorded by Paragon to date are relatively marginal. It is understood that Acoustic Logic (AL) is undertaking vibration monitoring for the MRI and Mammogram equipment, we understand that their reporting criteria has been specifically set for the monitoring of these equipment. Based on the above, and although the vibration measurement output and reporting methodologies of Paragon and AL are not directly comparable, both reports are in line and indicating compliance with the criterion set for structural damage and equipment tolerances, respectively.

The results found in *Table 7* summarises the noise level recorded for this project. During the monitoring period, noise monitor at Location 2 have exceeded the criteria by up to 10 dB(A) for the Noise Affected NML and up to 03 dB(A) for highly noise affected. Location 1 and Location 3 have exceeded the criteria by up to 02 dB(A). It is found that many of the triggers from Location 1 are caused by workers and patience within the same room and therefore, it is recommended that the monitor is placed in a room away from work spaces and rooms with operating equipment to avoid these false triggers. Further monitoring is recommended, and vibration and noise controls should be implemented to maintain the structural integrity of surrounding structures and avoid discomfort to surrounding residents.

Important information about this report

Introduction

This report has been prepared by Paragon for you, in accordance with the agreed scope, schedule and budget. The opinions, recommendations and conclusions set out herein has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared. It is based on information gained from site conditions. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterization of site conditions is an interpretation of information collected during assessment, in accordance with industry practice. This interpretation is not a complete description of all conditions on or in the vicinity of the site, due to the inherent variation in spatial and temporal vibration information. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to other sites, nor can it be used when the nature of the specific purpose changes from that which we agreed.

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Paragon. The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete. This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of defect(s) or other effects can change over time, as a result of either natural processes or human influence. Paragon should be kept appraised of any such events and should be consulted for further investigations if any changes are noted.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Paragon assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report. To avoid misuse of the information presented in your report, we recommend that Paragon be consulted before the report is provided to another party who may not be familiar with the background and the purpose of the report.

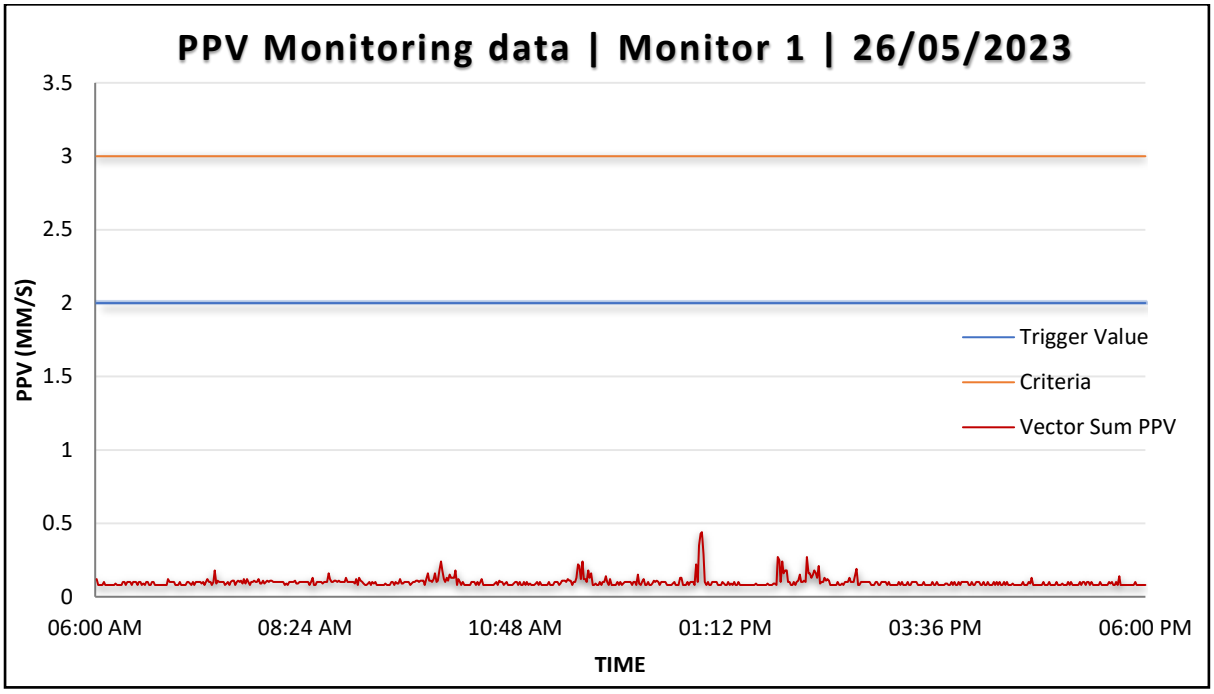
Interpretation by other professionals

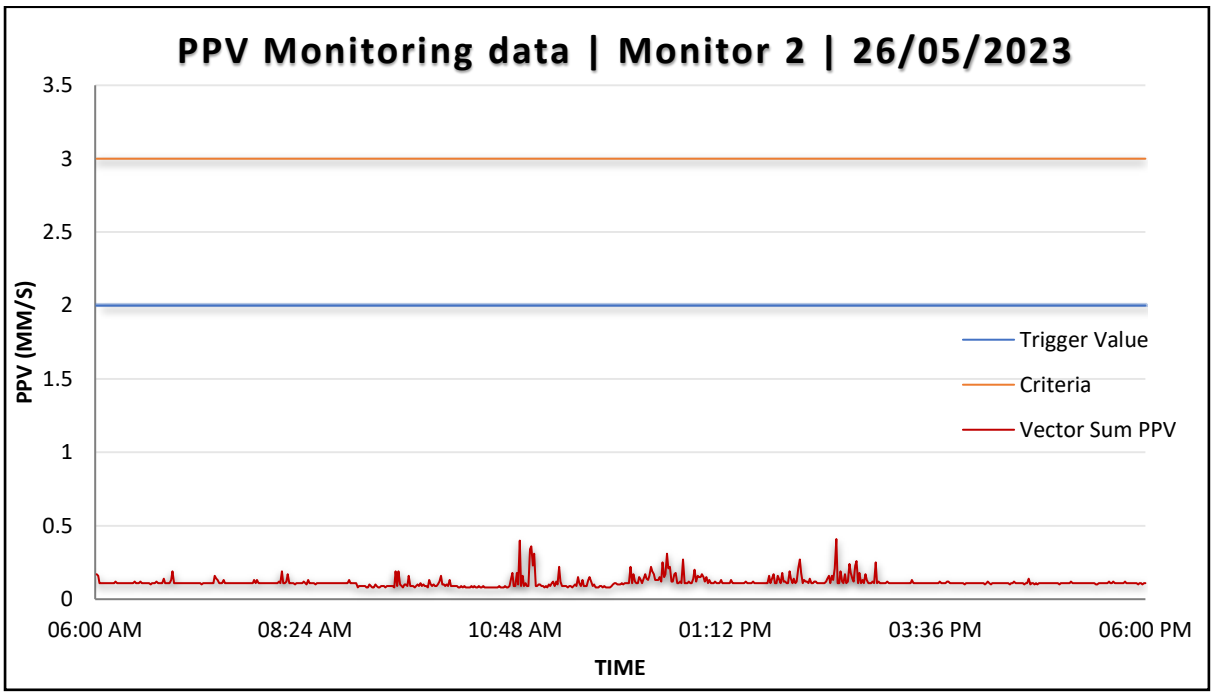
Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings. Given Paragon prepared the report and has familiarity with the site, Paragon is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Paragon disowns any responsibility for such misinterpretation.

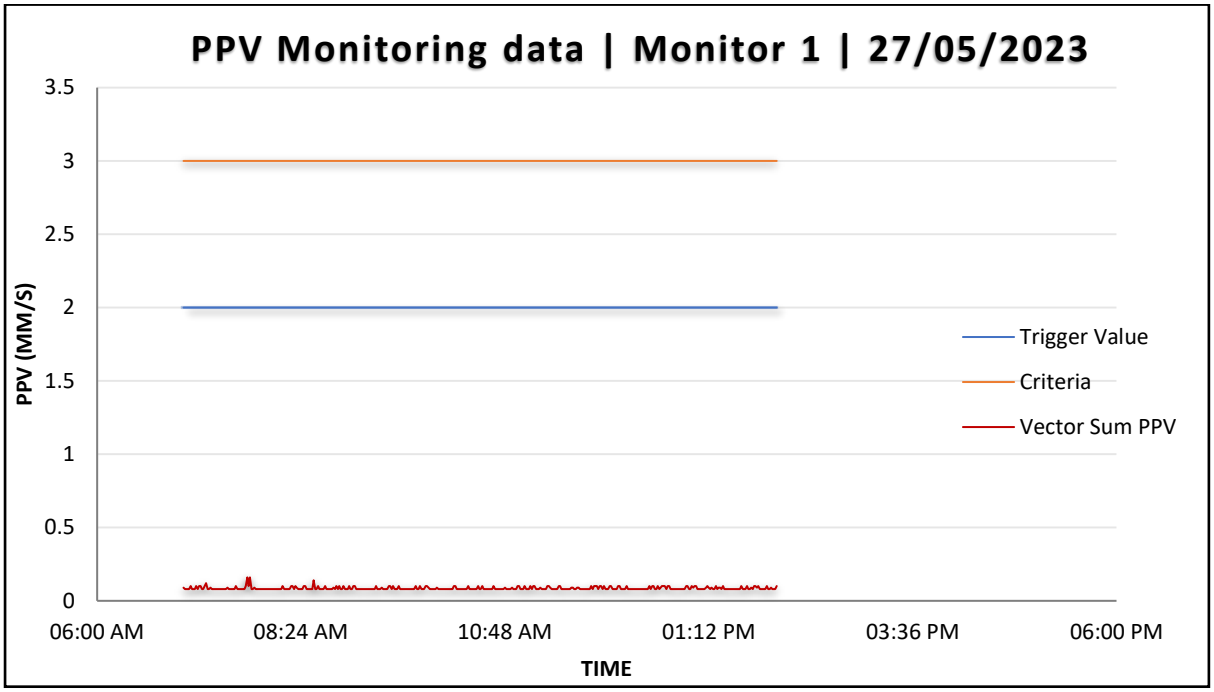
Data should not be separated from the report

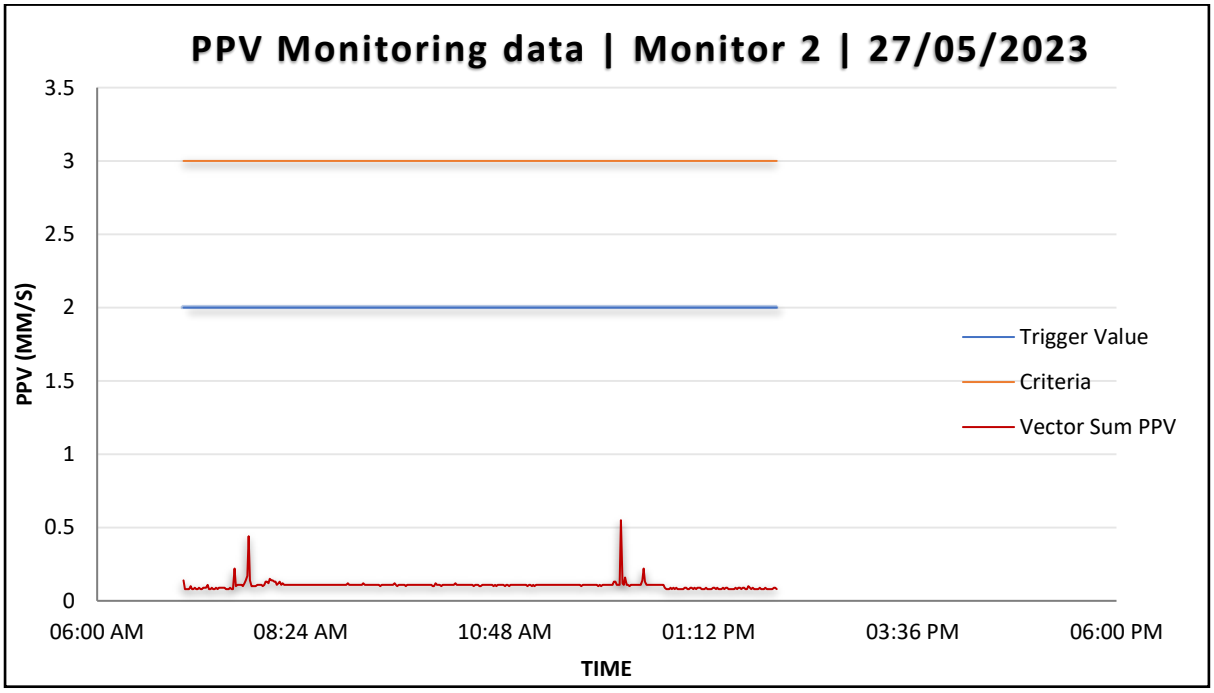
The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, acquired data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way. This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

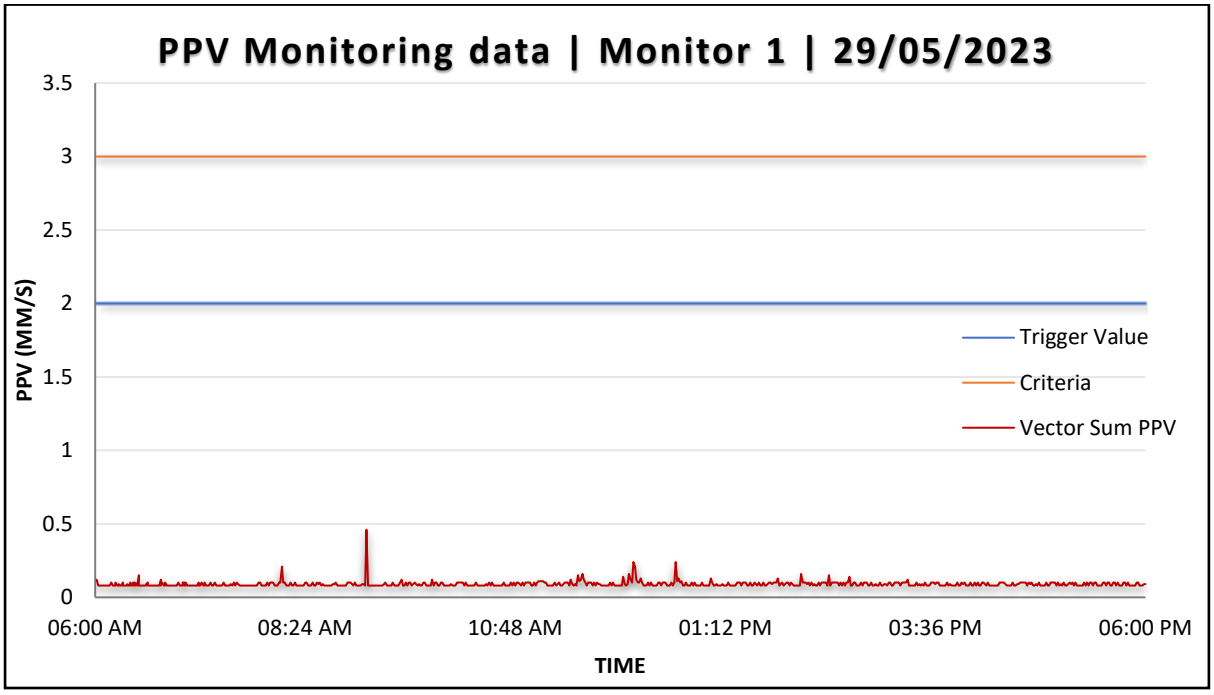
Appendix 1 – Vibration Monitoring Data

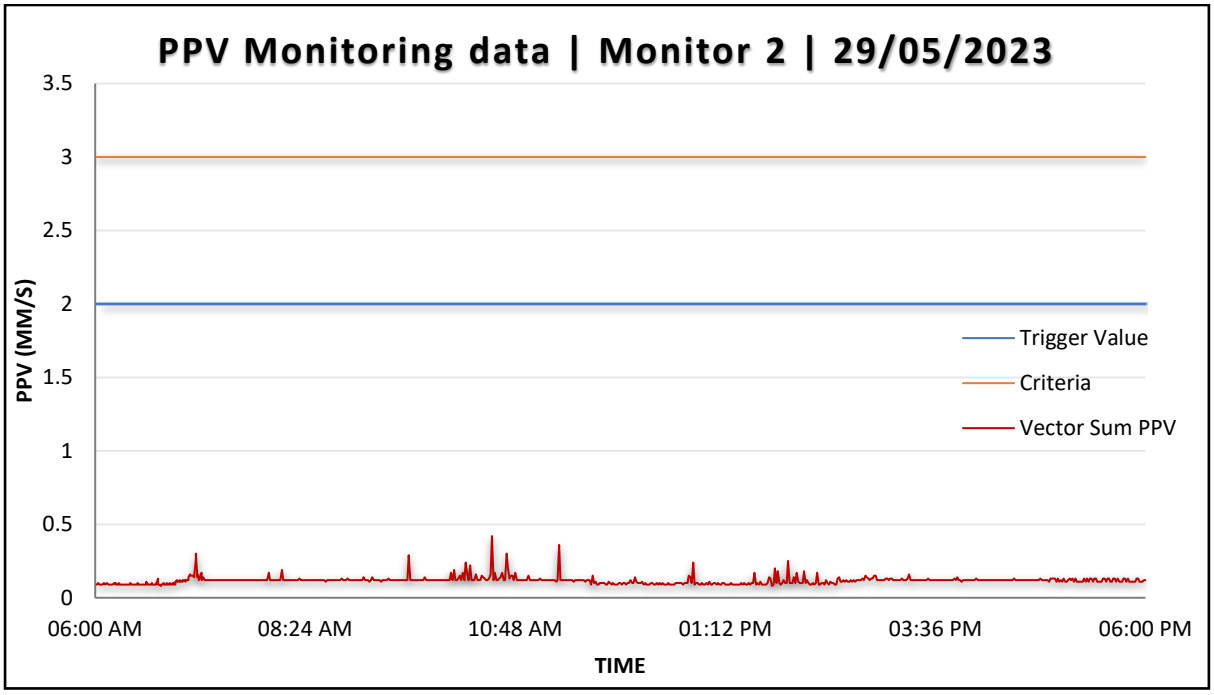


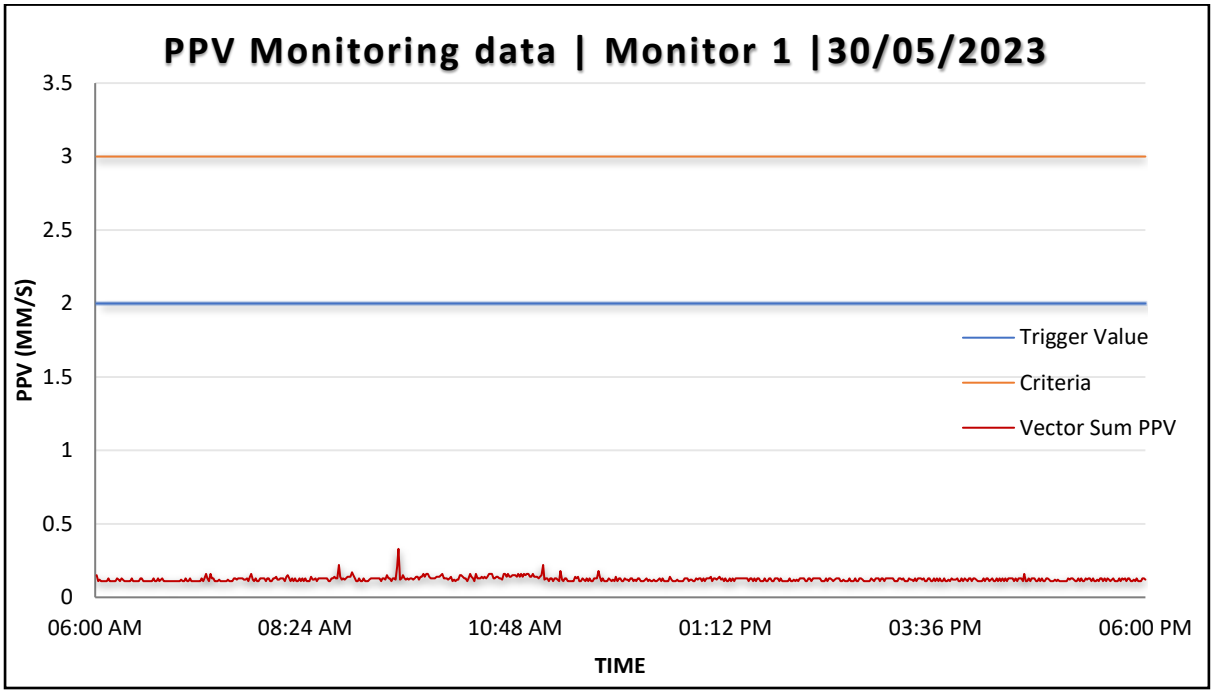


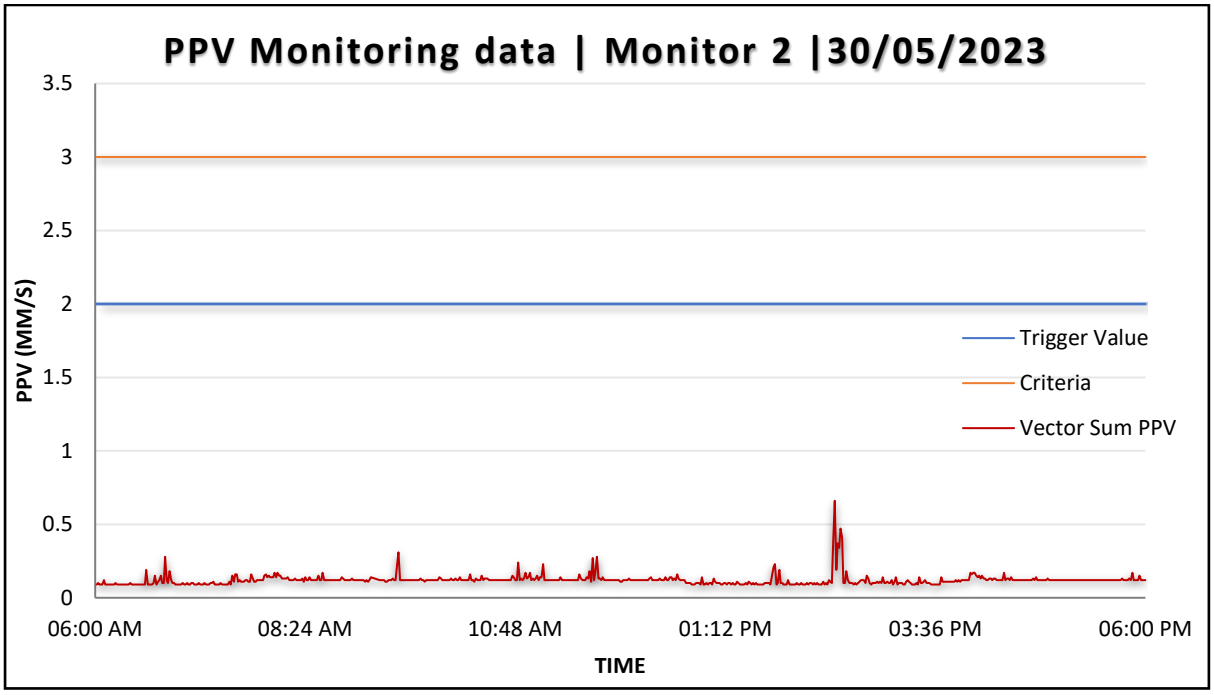

PPV Monitoring data | Monitor 1 | 27/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

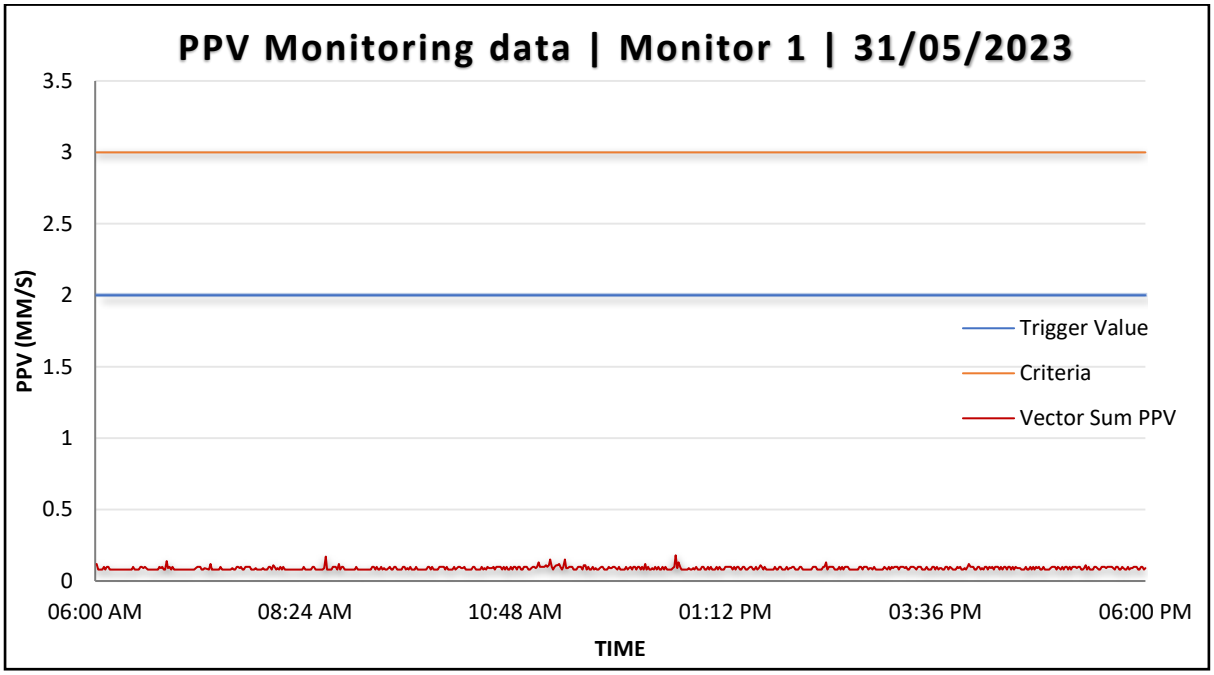

PPV Monitoring data | Monitor 2 | 27/05/2023
3.5
3
2.5
2
1.5
1
0.5
0
PPV (MM/S)
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

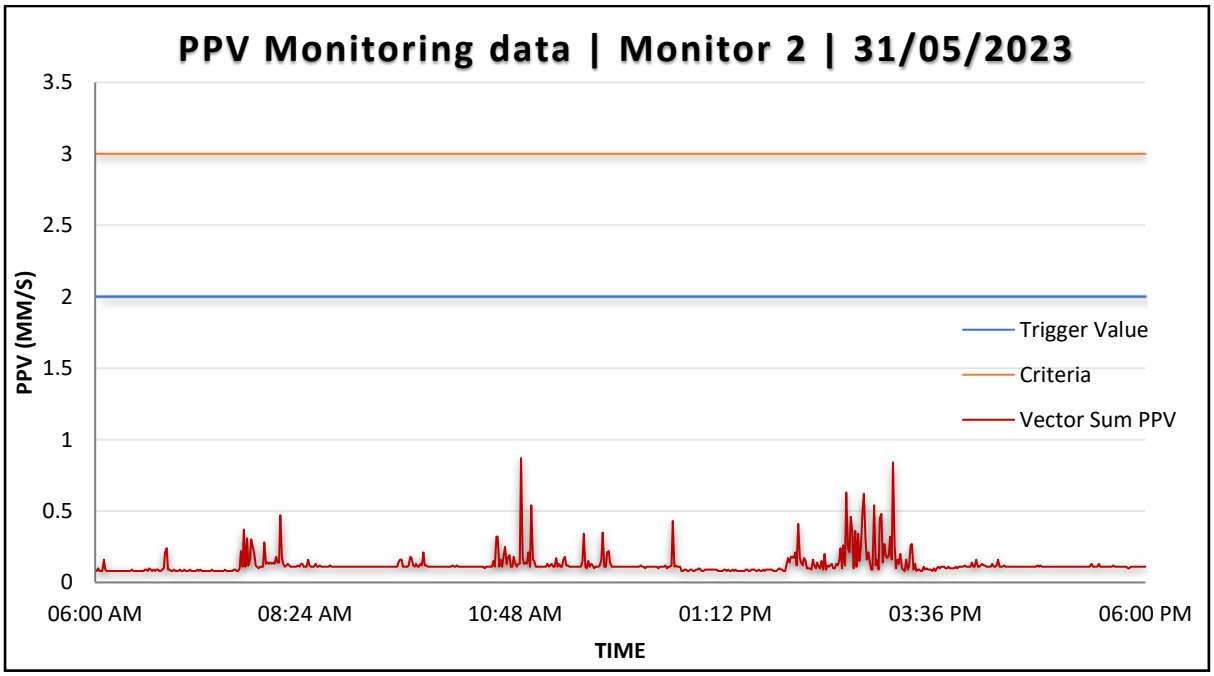

PPV Monitoring data | Monitor 1 | 29/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

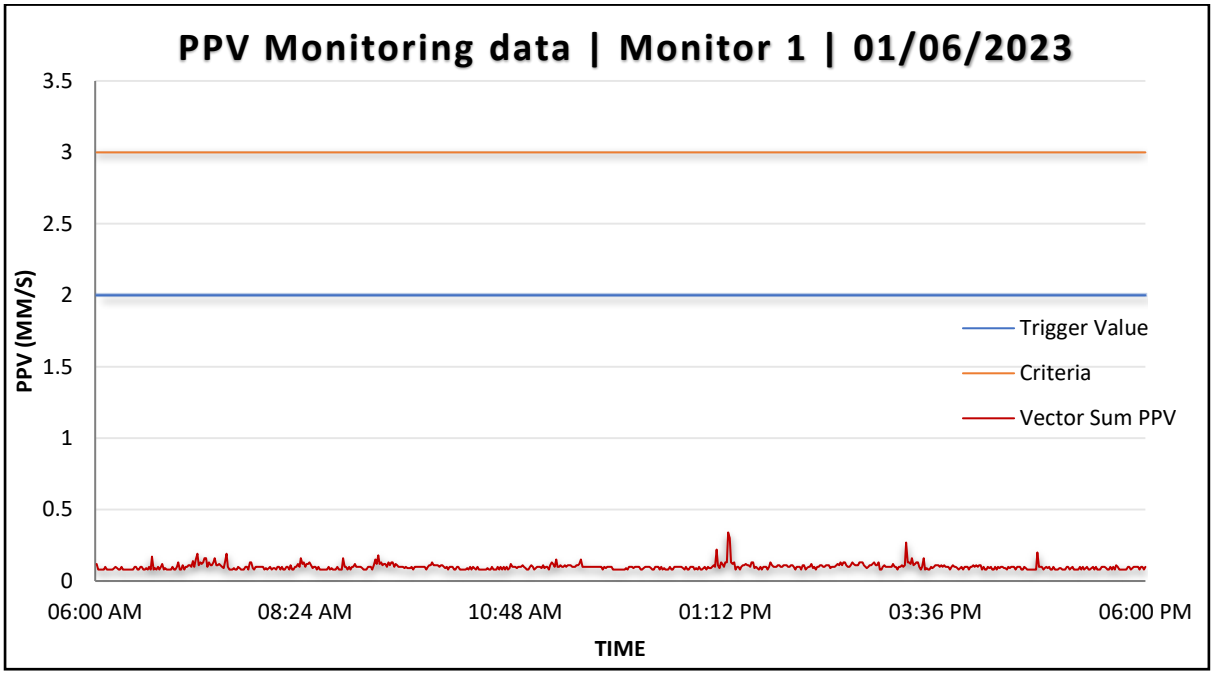

PPV Monitoring data | Monitor 2 | 29/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

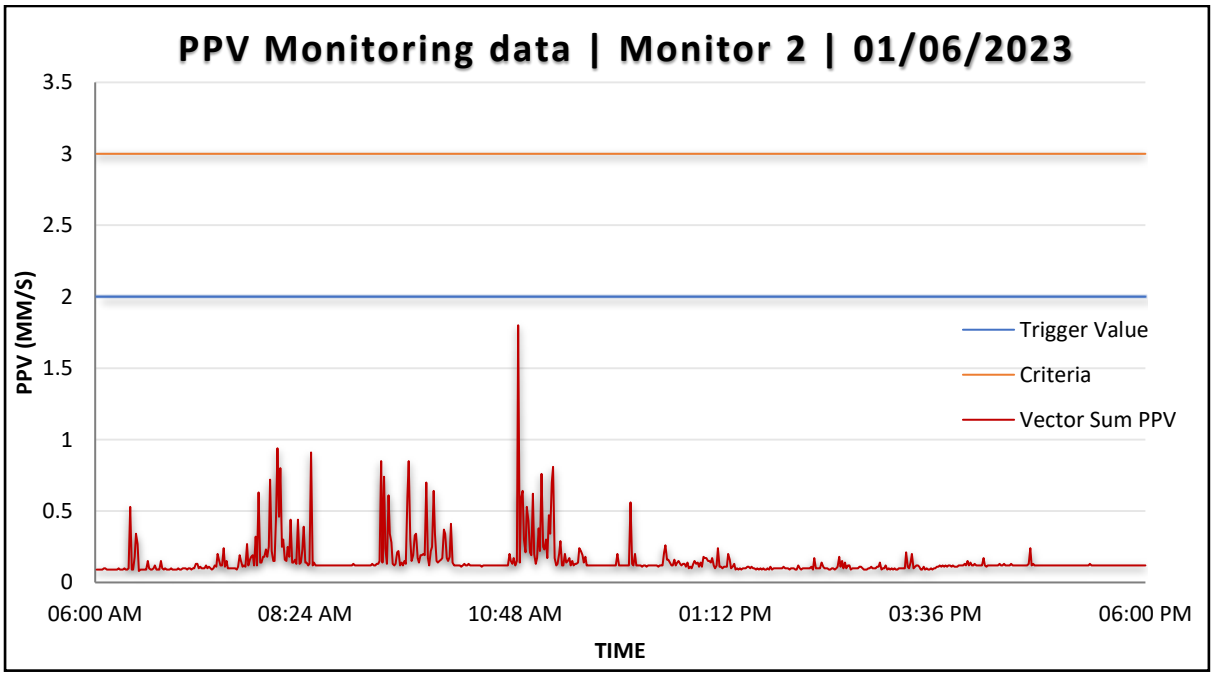

PPV Monitoring data | Monitor 1 |30/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV


PPV Monitoring data | Monitor 2 |30/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

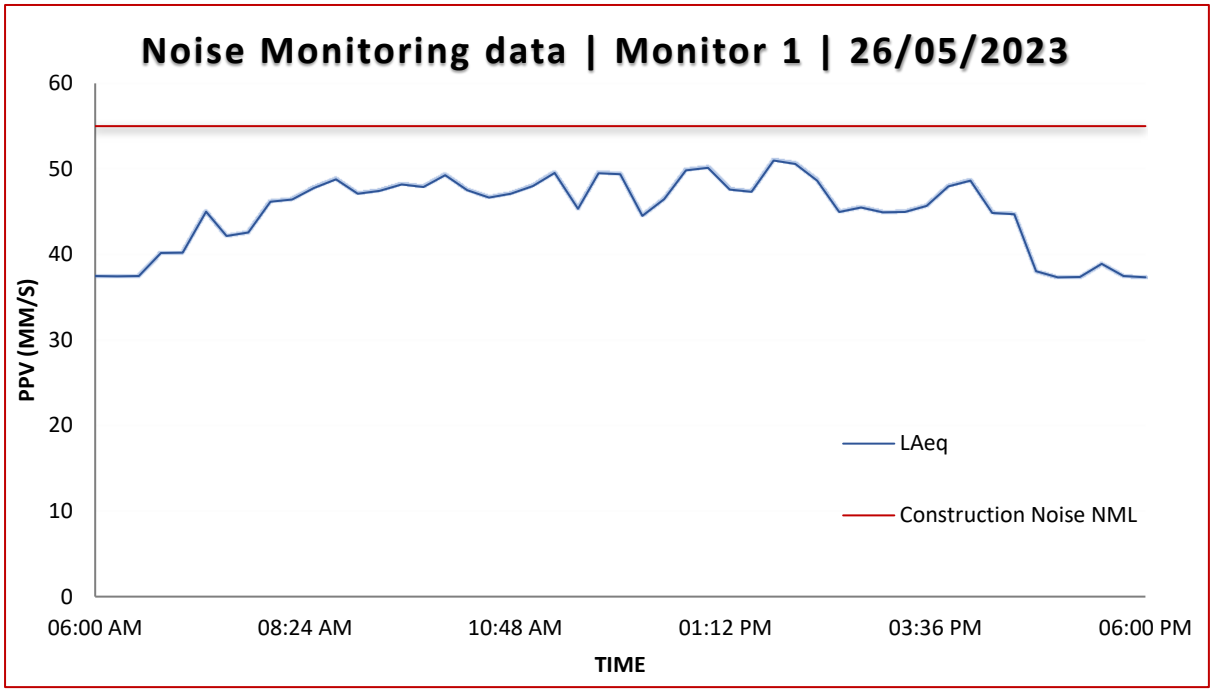

PPV Monitoring data | Monitor 1 | 31/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

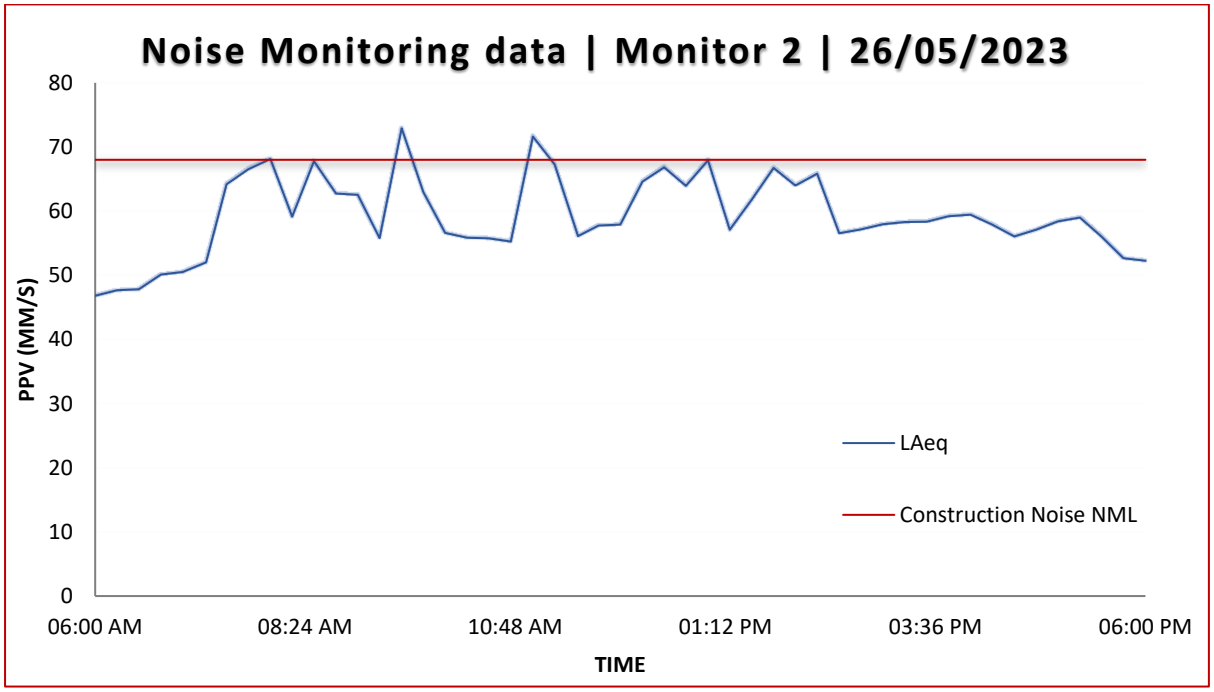

PPV Monitoring data | Monitor 2 | 31/05/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

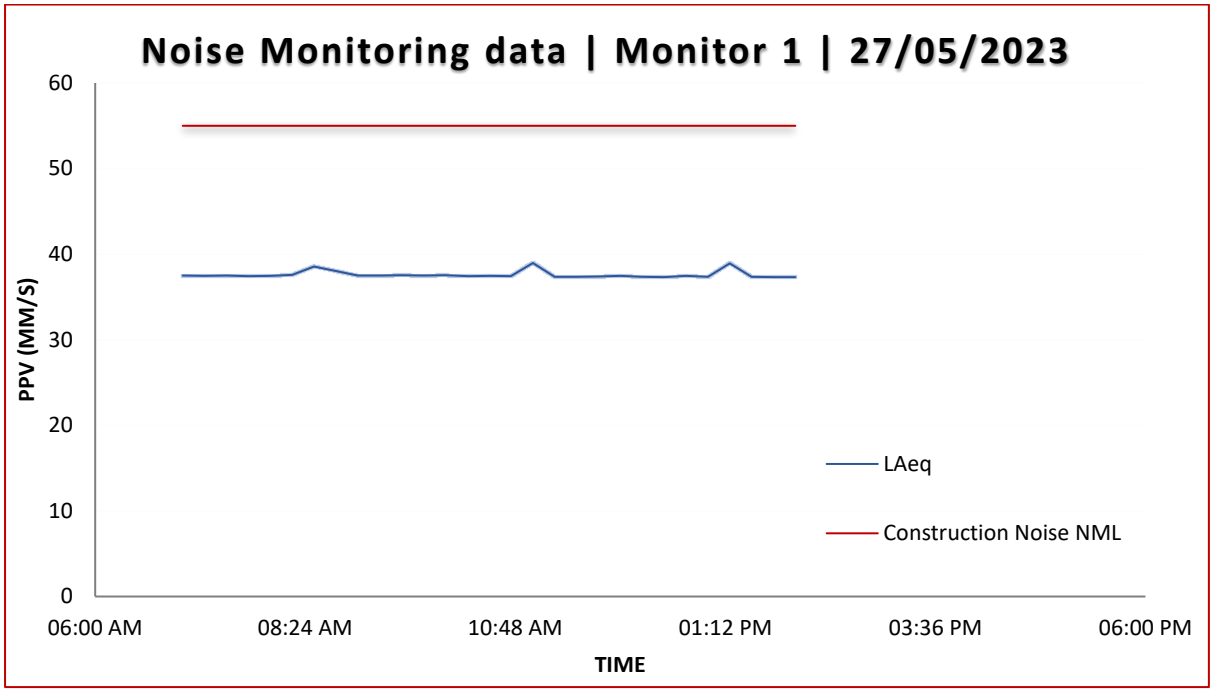

PPV Monitoring data | Monitor 1 | 01/06/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

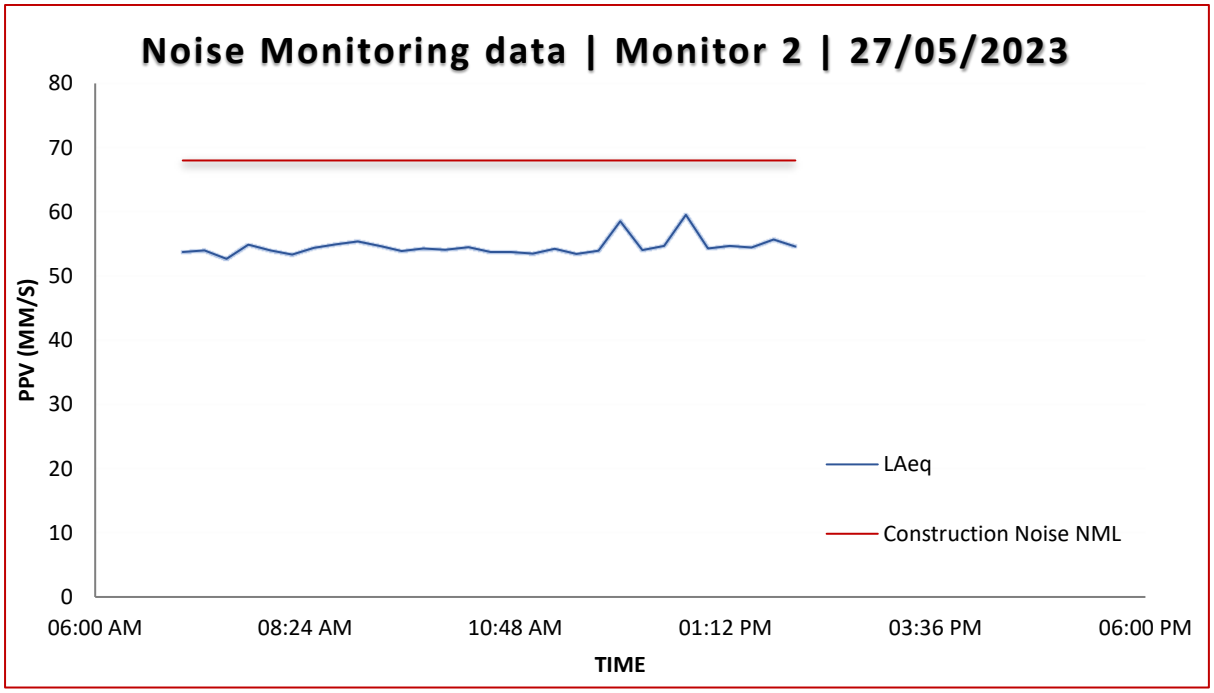

PPV Monitoring data | Monitor 2 | 01/06/2023
PPV (MM/S)
3.5
3
2.5
2
1.5
1
0.5
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
Trigger Value
Criteria
Vector Sum PPV

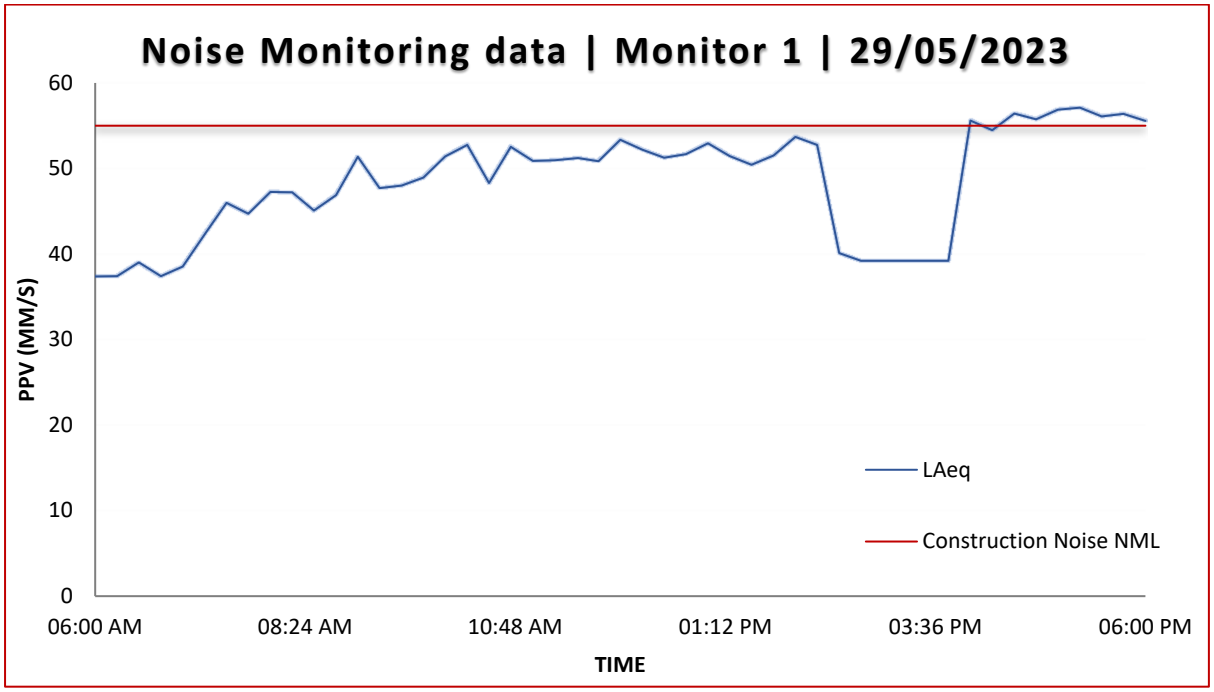
Appendix 2 – Noise Monitoring Data

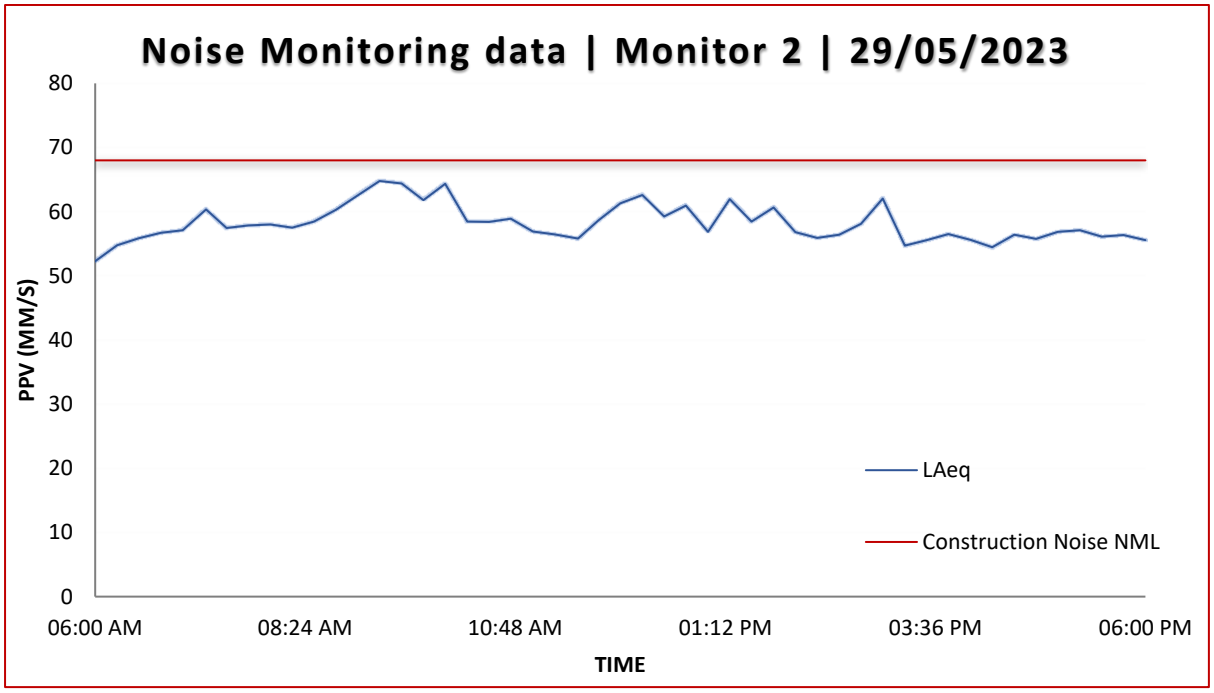


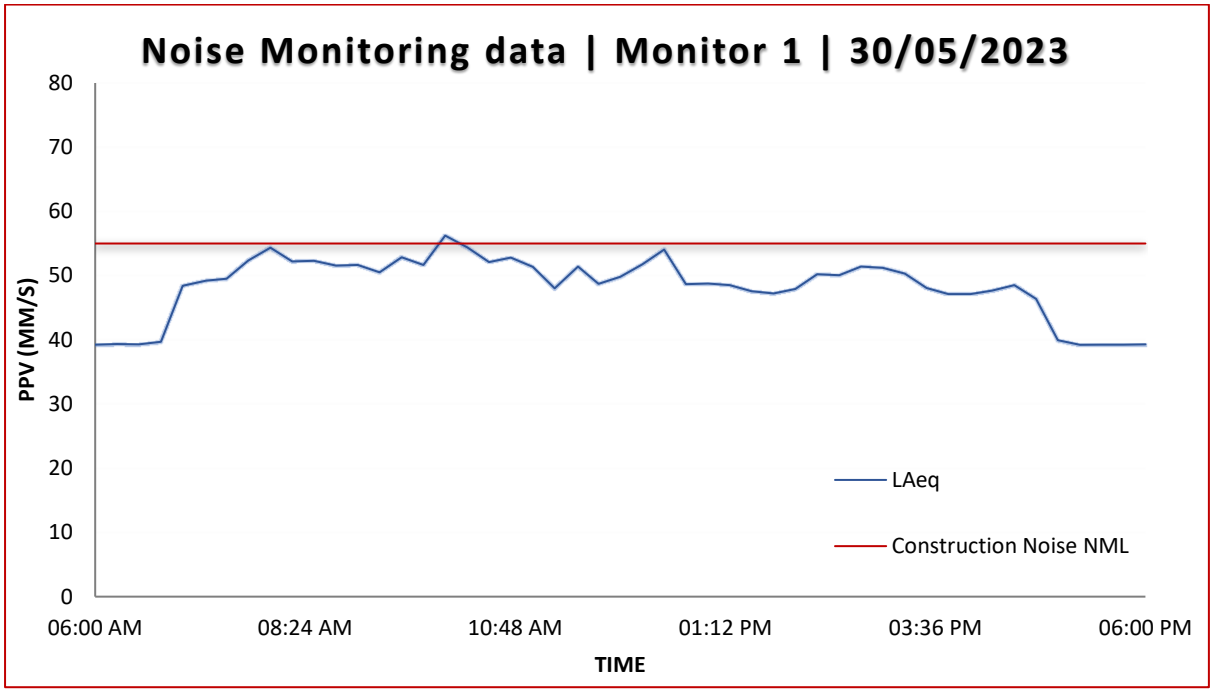


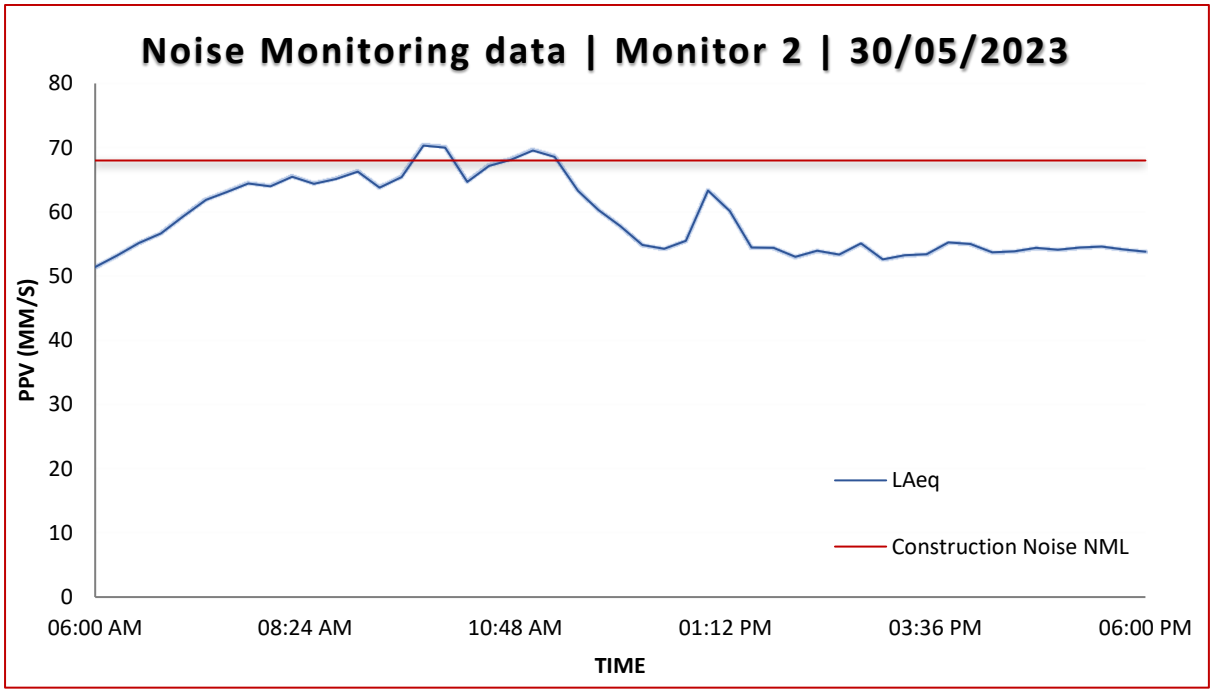

Noise Monitoring data | Monitor 1 | 27/05/2023
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

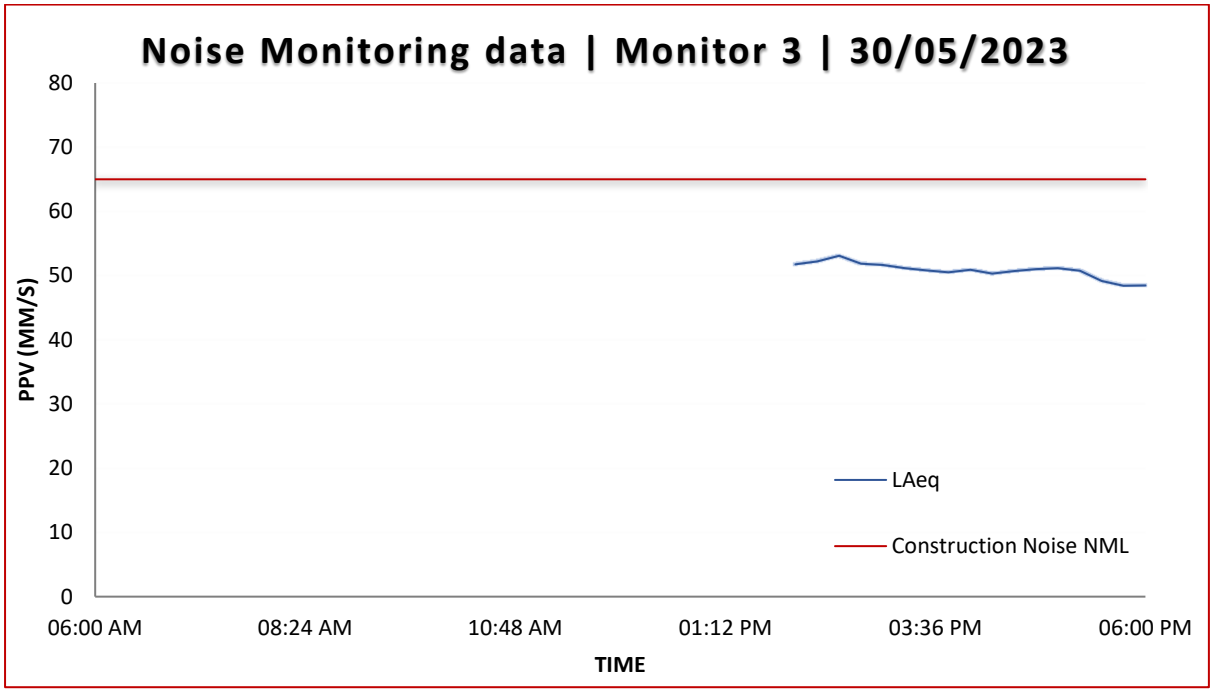

Noise Monitoring data | Monitor 2 | 27/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

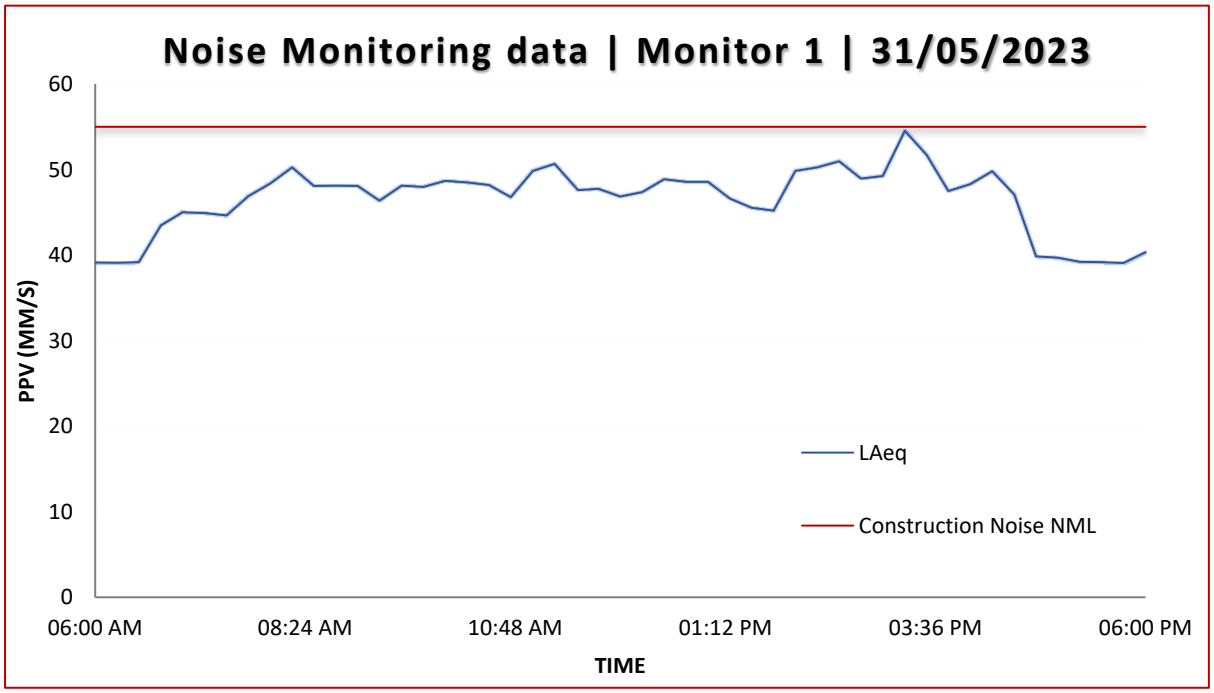

Noise Monitoring data | Monitor 1 | 29/05/2023
PPV (MM/S)
60
50
40
30
20
10
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
LAeq
Construction Noise NML

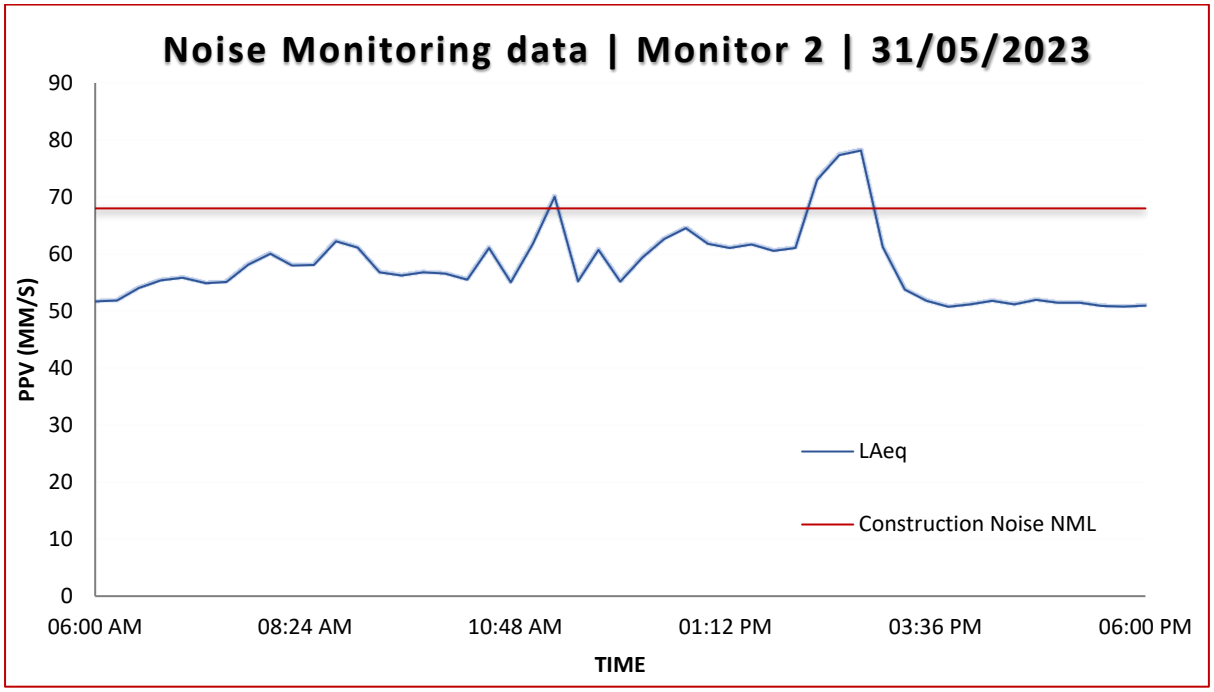

Noise Monitoring data | Monitor 2 | 29/05/2023
PPV (MM/S)
80
70
60
50
40
30
20
10
0
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME
LAeq
Construction Noise NML

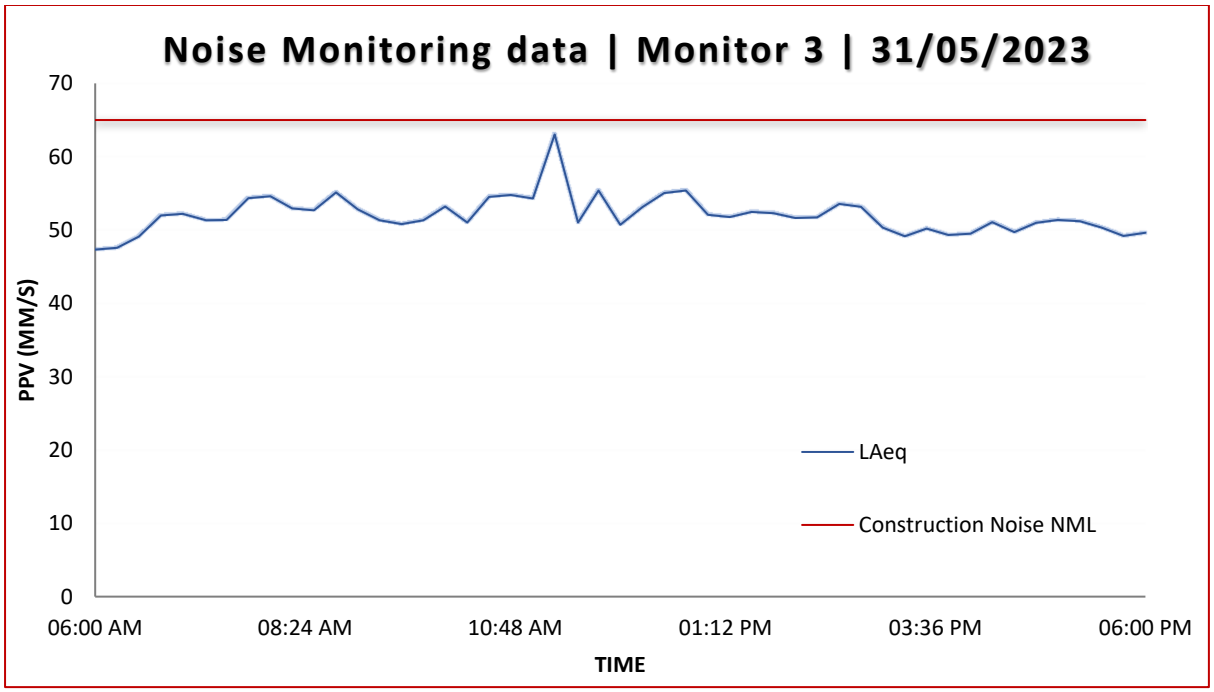

Noise Monitoring data | Monitor 1 | 30/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

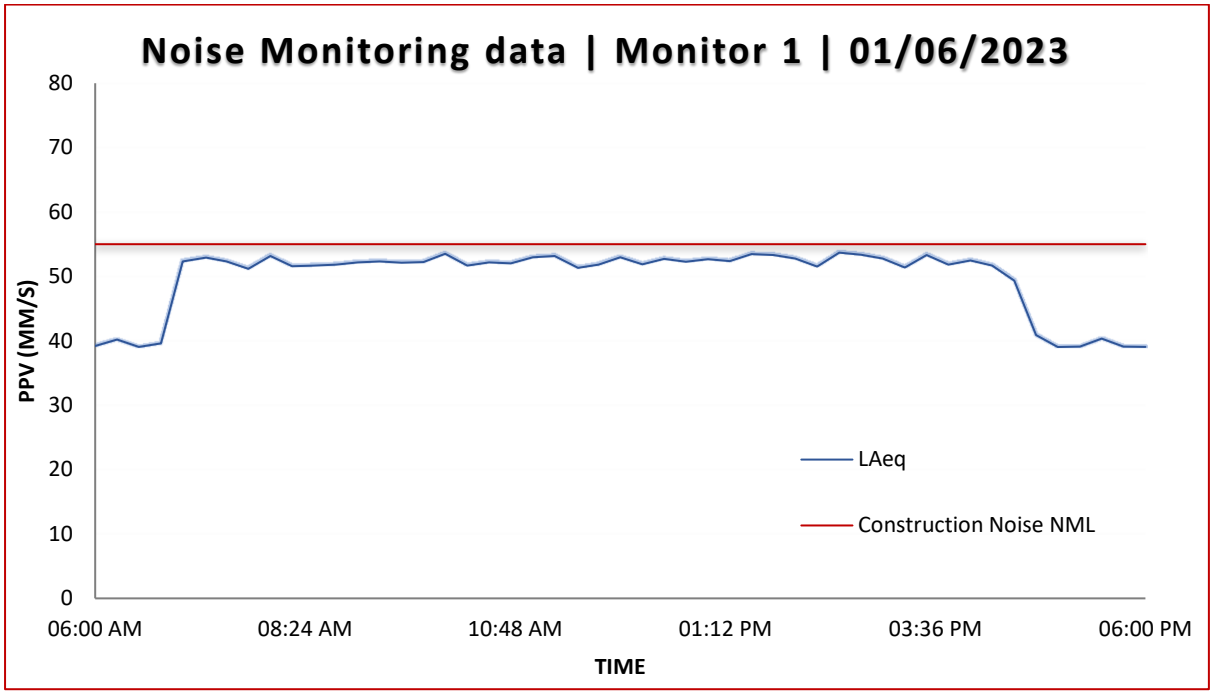

Noise Monitoring data | Monitor 2 | 30/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

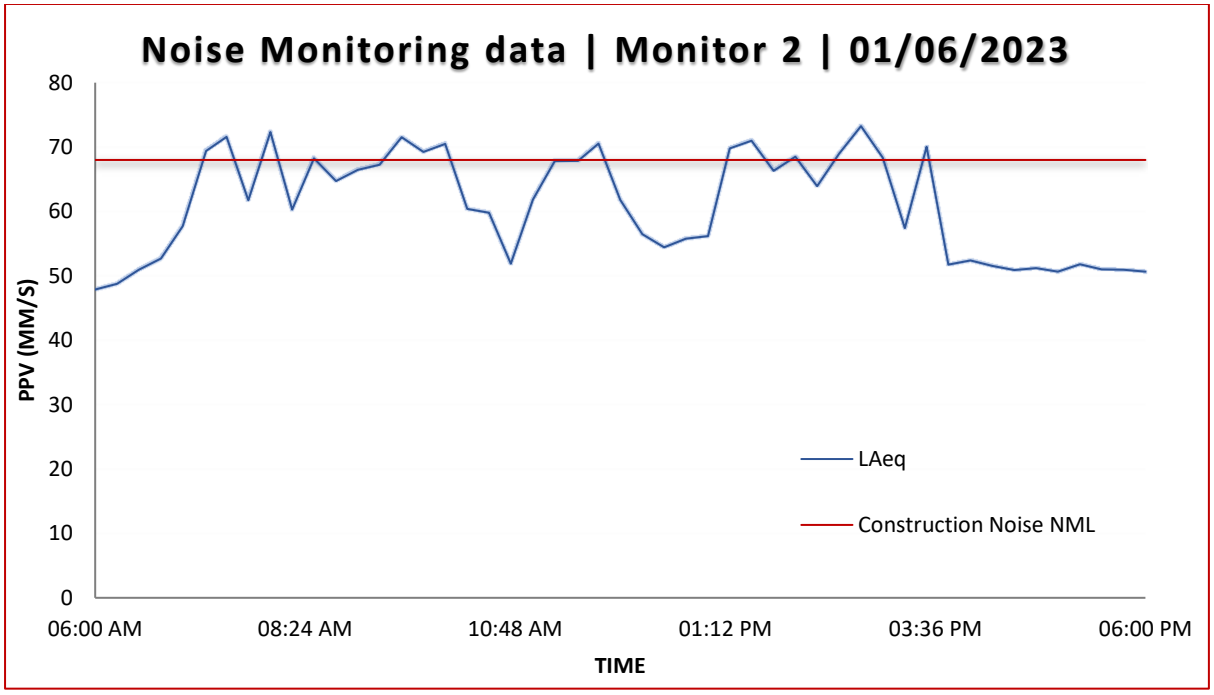

Noise Monitoring data | Monitor 3 | 30/05/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME

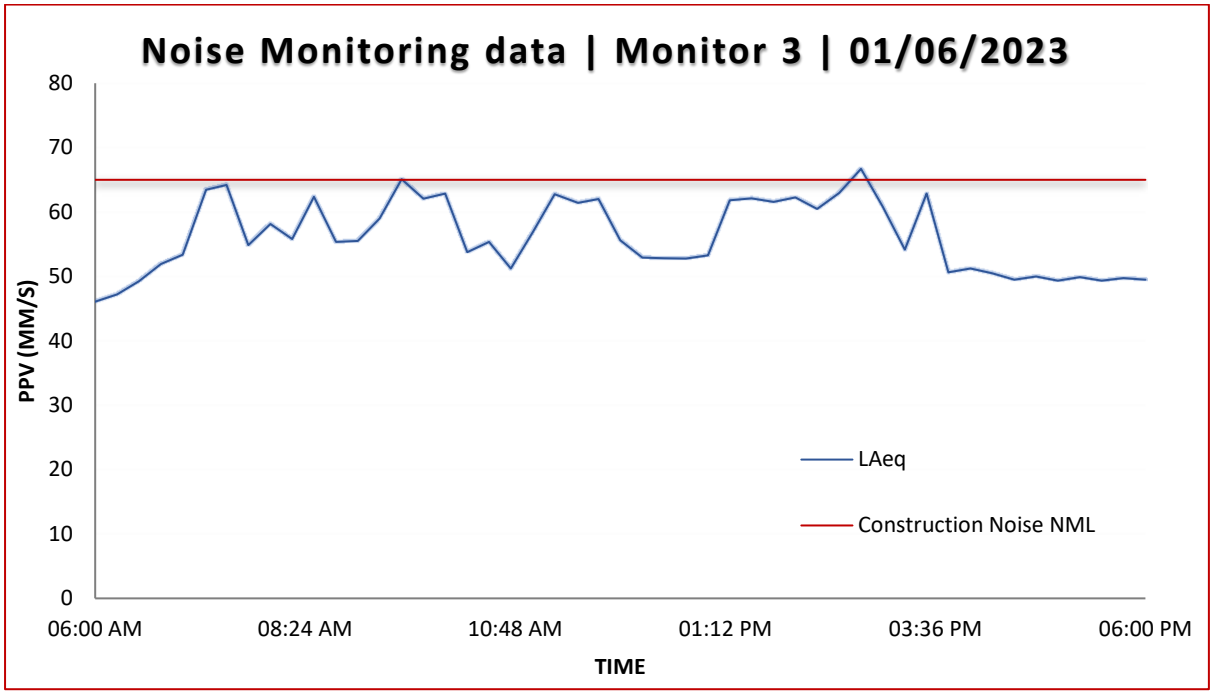

Noise Monitoring data | Monitor 1 | 31/05/2023
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 31/05/2023
PPV (MM/S)
90
80
70
60
50
40
30
20
10
0
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 3 | 31/05/2023
PPV (MM/S)
70
60
50
40
30
20
10
0
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 1 | 01/06/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 2 | 01/06/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME


Noise Monitoring data | Monitor 3 | 01/06/2023
80
70
60
50
40
30
20
10
0
PPV (MM/S)
LAeq
Construction Noise NML
06:00 AM
08:24 AM
10:48 AM
01:12 PM
03:36 PM
06:00 PM
TIME