Contractor

Forth Crossing Bridge Constructors

HOCHTIEF Solutions
American Bridge International
DRAGADOS
Morrison Construction

Project

FORTH REPLACEMENT CROSSING

Document title

VIBRATION MONITORING REPORT

NOVEMBER 2015

00	06/11/15	First draft	MRN	SWR	SWR
Rev	**Rev. Date**	**Purpose of revision**	**Made**	**Reviewed**	**Approved**

Document status

FOR REVIEW

Made by Michael Richardson	Checked By: Steven Westwater
Initials: MRN	Initials: SWR

Document number	Rev
REP-00260	00

Contents

Appendices:

INTRODUCTION

1.1. Monitoring of construction vibration is being undertaken by FCBC during the construction of the new Forth Crossing and associated road network. This report covers the month of November 2015. The objective of this report is to detail the vibration monitoring that has been undertaken across the site during this period, which has been done so in accordance with the Code of Construction Practice (CoCP), and Noise and Vibration Management Plan (NVMP).

1.2. FCBC carefully risk assesses noise & vibration likely to result from all construction activities, through the production of Plans for Control of Noise & Vibration (PCNVs). During the preparation of PCNVs, vibration prediction assessments are made. These assessments illustrate that no construction plant, equipment or methodology to be used by FCBC are envisaged to induce any levels of vibration at sensitive receptors that would exceed the vibration threshold levels stated in the CoCP. These assessments/predictions have been validated by means of the vibration monitoring results displayed in this report.

2. MONITORING SUMMARY

2.1. Due to the location and sensitivity of vibration monitoring equipment, the exceedances presented in the graphs included in the appendices of this report do not represent levels generated by construction, but rather show local interference around the monitoring equipment. This can include, for example, Residential activity, or indeed any significant movements occurring close to the monitoring equipment.

2.2. According to the BS5228-2 (2009) there is minimal documented proof of actual damage to structures or their finishes resulting from construction, and damage resulting solely from well-controlled construction and demolition vibrations is rare. There are many other mechanisms which cause damage, especially in decorative finishes, and it is often incorrectly concluded that vibrations from construction and demolition sites are to blame. In many cases it is not possible to ascertain the exact source of vibration, though it is possible to rule out construction as a source on an activity basis.

2.3. The works carried out in each of the various construction work areas as well as the related vibration assessments are summarised in Appendix A.

2.4. Considering the distances between the various construction work areas and sensitive receptors as well as working methods utilised, the risk of any damage to structures or nuisance to residents occurring as a result FCBC construction related vibration is highly unlikely.

2.5. The number of threshold exceedances at the various vibration monitoring stations during the period in question are shown in Table 1 below.

Table 1: Exceedances of thresholds set out in the CoCP

November 2015

Location	PPV Exceedance		VDV Exceedance	
	Continuous (5 mm.s^{-1})	***Intermittent (10 mm.s^{-1})***	***Day (0.4 m.s$^{-1.75}$)***	***Night (0.2 m.s$^{-1.75}$)***
Linn Mill	4	8	1	2
Butlaw Fisheries	0	1	0	0
Clufflat Brae	12	0	0	0
Dundas Home Farm	0	0	0	0
Echline	0	0	0	0
Inchgarvie Lodge	4	2	0	0
Scotstoun	0	0	0	0
Springfield	3	4	0	0
Tigh-Na-Grian	0	0	0	0
Whinnyhill	5	0	0	0

2.6. Peak Particle Velocity (PPV) is used to measure vibration through a solid surface. When a vibration is measured, the point at which the measurement takes place can be considered to have a particle velocity. This particle vibration will take place in three dimensions (x, y and z).

2.7. The Peak Particle Velocity is the highest velocity that is recorded during a particular event, and as such is appropriate for the measurement of activities such as blasting, piling and compacting. The thresholds for the Forth Replacement Crossing are 5 mm.s^{-1} for continuous construction (e.g. piling), and 10 mm.s^{-1} for intermittent construction (e.g. blasting).

2.8. These thresholds are set to protect against building damage. For this monitoring period, all the exceedances have been investigated thoroughly and appear to have been generated as a result of standalone, instantaneous events mostly arising from local interferences, the exact source of which remains unknown.

2.9. Vibration Dose Value (VDV) is a metric used in vibration monitoring. It is calculated by taking the fourth root of the integral of the fourth power of acceleration after it has been frequency-weighted. The frequency-weighted acceleration is measured in $m.s^{-2}$ and the time period over which the VDV is measured is in seconds. This yields VDVs in $m.s^{-1.75}$.

2.10. The vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period, is recommended in BS 6472 as the appropriate measure to evaluate human exposure to vibration in buildings in residential and other uses.

2.11. During the monitoring period, vibratory rollers and whacker plates were used intermittently at several locations around the site. No exceedances were recorded as a result of the use of this equipment, where exceedances did occur it resulted from non-project related activity around the monitor.

2.12. In addition, detailed investigation of all exceedances (i.e. review of PPV levels over 30 seconds periods) has shown that each resulted from isolated, non-construction related events, which likely occurred close to the monitoring station.

2.13. Within the Appendix B, there are short gaps of missing data in the PPV and VDV graphs. These occurred due to a power supply problem.

1. CONCLUSION

1.1. Considering the distance between FCBC construction works and sensitive receptors, the methods of working utilised and programme of works. The risk of damage to structures or nuisance to residents resulting from vibration is highly unlikely.

1.2. Due to the location and sensitivity of vibration monitoring equipment, the exceedances presented in the graphs included in the appendices of this report are unlikely to be generated by construction, but rather show local interference and maintenance around the monitoring equipment. The exceedance at Echline corner that can be found in appendix B was only caused by localised works nearby the monitor with no use of vibration emitting plant.

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APPENDIX A – MONITORING LOCATIONS & VIBRATION ASSESSMENTS FROM RELEVANT PCNVs

Table 2: Monitoring Locations

Ref.	Monitoring Location	Crossing or Network	Main Construction Activities During November 2015
M1	Whinny Hill	Network	• Earthworks/Fill placement • New Ferrytoll Road • FT03&FT04 deck works • FT09 works • FT19 Works • Roadworks
M3	Tigh-Na-Grian	Crossing	• Central Tower rebar, formwork, concreting works Deck section lifts • North Tower rebar, formwork, concreting works , deck section lifts • Pier N1 rebar formwork & concrete works • AVN works
M7	Butlaw Fisheries	Crossing	• Pier S1 rebar, formwork & concrete works • Pier S2 rebar, formwork & concrete works • Central Tower rebar, formwork, concreting works deck section lifts • South Tower rebar, formwork, concreting works, deck section lifts • AVS – rebar, formwork & concrete works
M10	Inchgarvie Lodge	Crossing	• AVS – Rebar, formwork & concrete works • Pier S1 rebar, formwork & concrete works, • Pier S2 rebar, formwork & concrete works • Central Tower rebar, formwork, concreting works deck section lifts • South Tower rebar, formwork, concreting works, deck section lifts • Main Carriageway earthworks
M11	Linn Mill	Network (close proximity to Crossing)	• AVS – Rebar, formwork & concrete works • No night time or Sunday construction in the vicinity

			• Main carriageway works
M13	Clufflat Brae	Crossing / Network	• AVS – Rebar, formwork & concrete works • No night time or Sunday daytime construction in vicinity. • Main Carriageway works
M14	Springfield	Network	• AVS –Rebar, formwork & concrete works • No night time or Sunday daytime construction in vicinity. • Earthworks South Abutment area • Main carriageway works
M15	Echline	Network	• AVS – Rebar, formwork & concrete works • No night time or Sunday construction in the vicinity • Earthworks South Abutment area • Main Carriageway works
M16	Scotstoun	Network	• Footpath works • Utility works • B800 North roadworks including bridge works • B800 bridge demolition • B800 piling works • SB Bus link barrier works
M17	Dundas Home Farm	Network	• Utility works • B800 South roadworks including bridge works • B800 bridge demolition • B800 piling works • SB bus link • Main carriageway works

Table 2: The main construction activities undertaken in the locality of each of the vibration monitors during the period of November 2015.

Table 3: PCNV Predicted PPV & VDV Levels

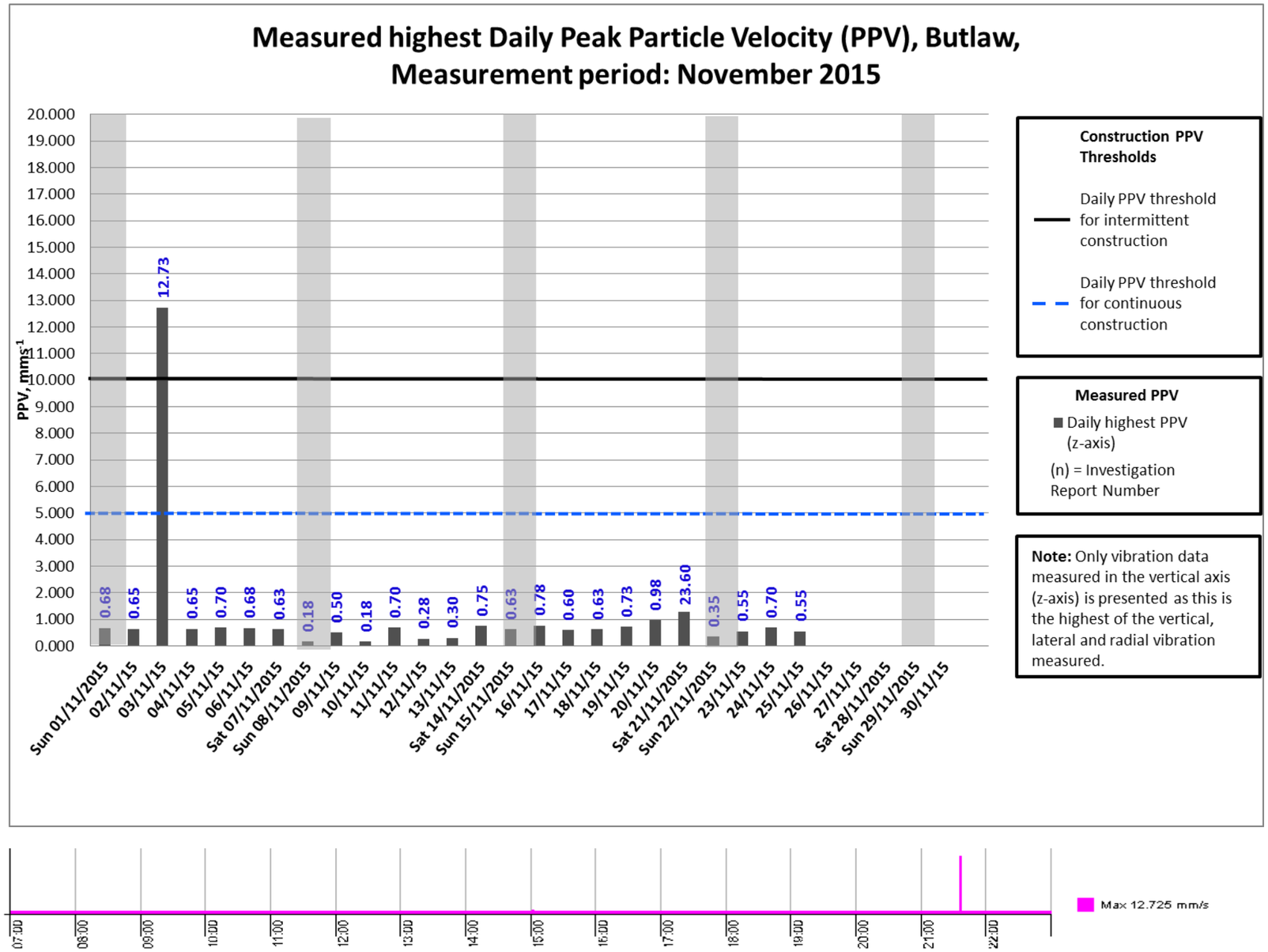
Monitor	Minimum distance from work areas (m)		Type of vibration emitting plant/activity operated at nearest work areas	Worst case predicted vibration levels	
	Day (07:00-19:00)	Night (19:00-07:00)		PPV (mm/s)	eVDV ($m.s^{-1.75}$)
Butlaw Fisheries	130	160	Roller/Whacker	0.44	0.23
Clufflat Brae	40	90	Roller/Whacker	2.44	0.37
Dundas	325	325	Piling	0.28	0.15
Echline	40	1000	Roller/Whacker	2.44	0.37
Inchgarvie Lodge	50	40	Roller/Whacker	1.77	0.33
Linn Mill	60	250	Roller/Whacker	1.36	0.33
Scotstoun	110	110	Piling	0.82	0.45
Springfield	50	300	Roller/Whacker	1.77	0.33
Tigh-Na-Grian	200	200	N/A	-	-
Whinny Hill	108	1800	Roller/Whacker	0.19	0.1

Table 3: The distances from vibration monitors to the closest work areas for both day and night time periods. It also lists worst case PPV and eVDV calculations exhibited at the vibration monitors, resulting from the maximum vibration inducing plant operated at the nearest work areas.

Notes on Table 3

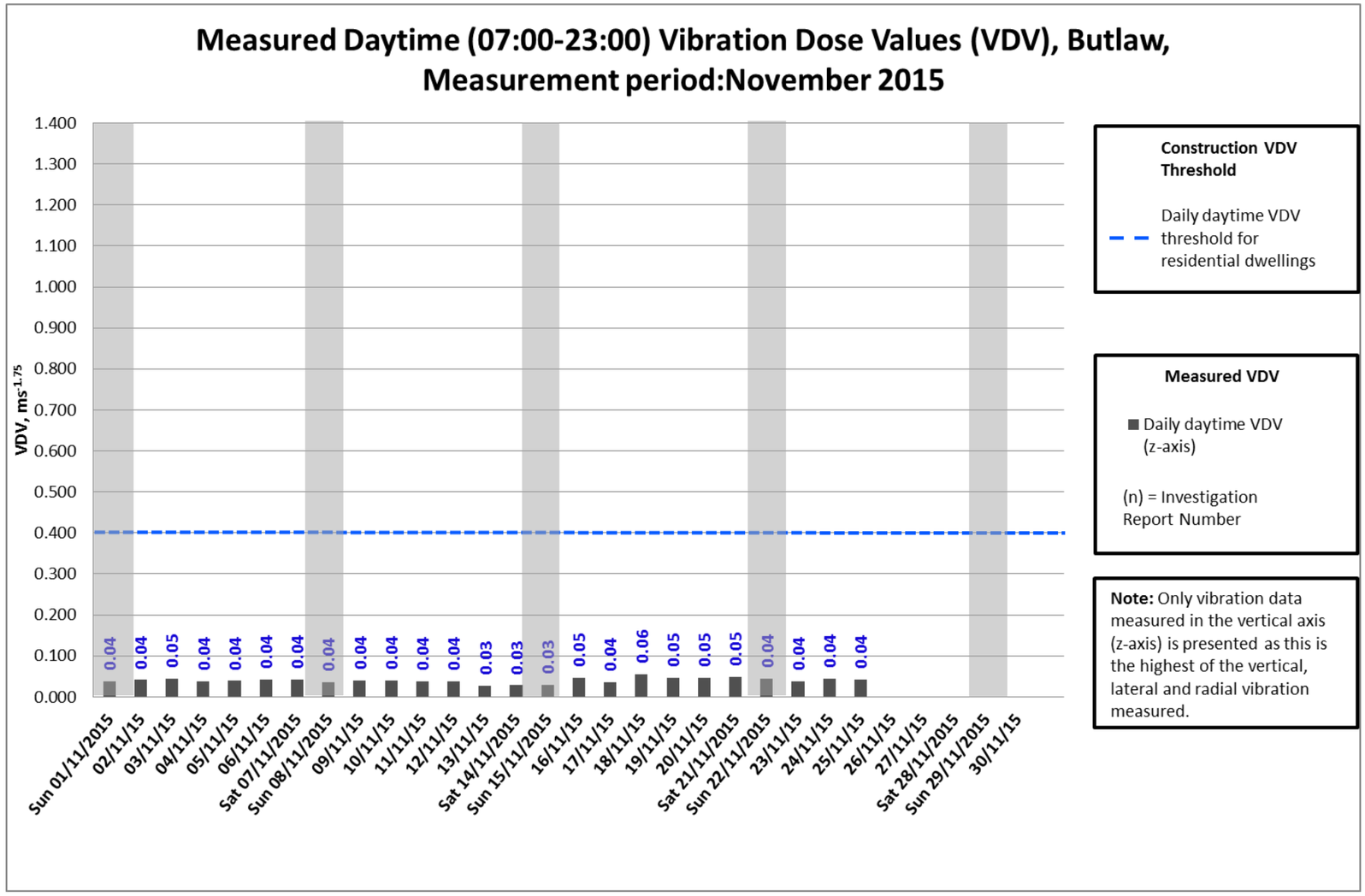
- All plant used during construction activities has been assessed with respect to vibration. The only plant utilised over the period in question considered to generate appreciable levels of vibration was a vibratory roller and a whacker plate (NOTE: Hydraulic rock breakers which typically generate 4.5mm/s @ 5m, 0.4mm/s @ 20m, 0.1mm/s @ 50m, have been discounted due to the distances of use from the closest receptors).
- Vibratory rollers were not operated within 20m of any sensitive receptor.
- Whacker plates were not utilised within 40m of any occupied sensitive receptor.
- All roller eVDV values in the table above are based on the worst case scenario of a vibratory roller remaining in continuous operation for 2 hours at an average distance of 100m from the nearest occupied receptors.
- All whacker plate eVDV values in the table above are based on the worst case scenario of a whacker plate remaining in continuous operation for 2 hours, at a minimum distance (40m) from the nearest receptor.

APPENDIX B – VIBRATION GRAPHS

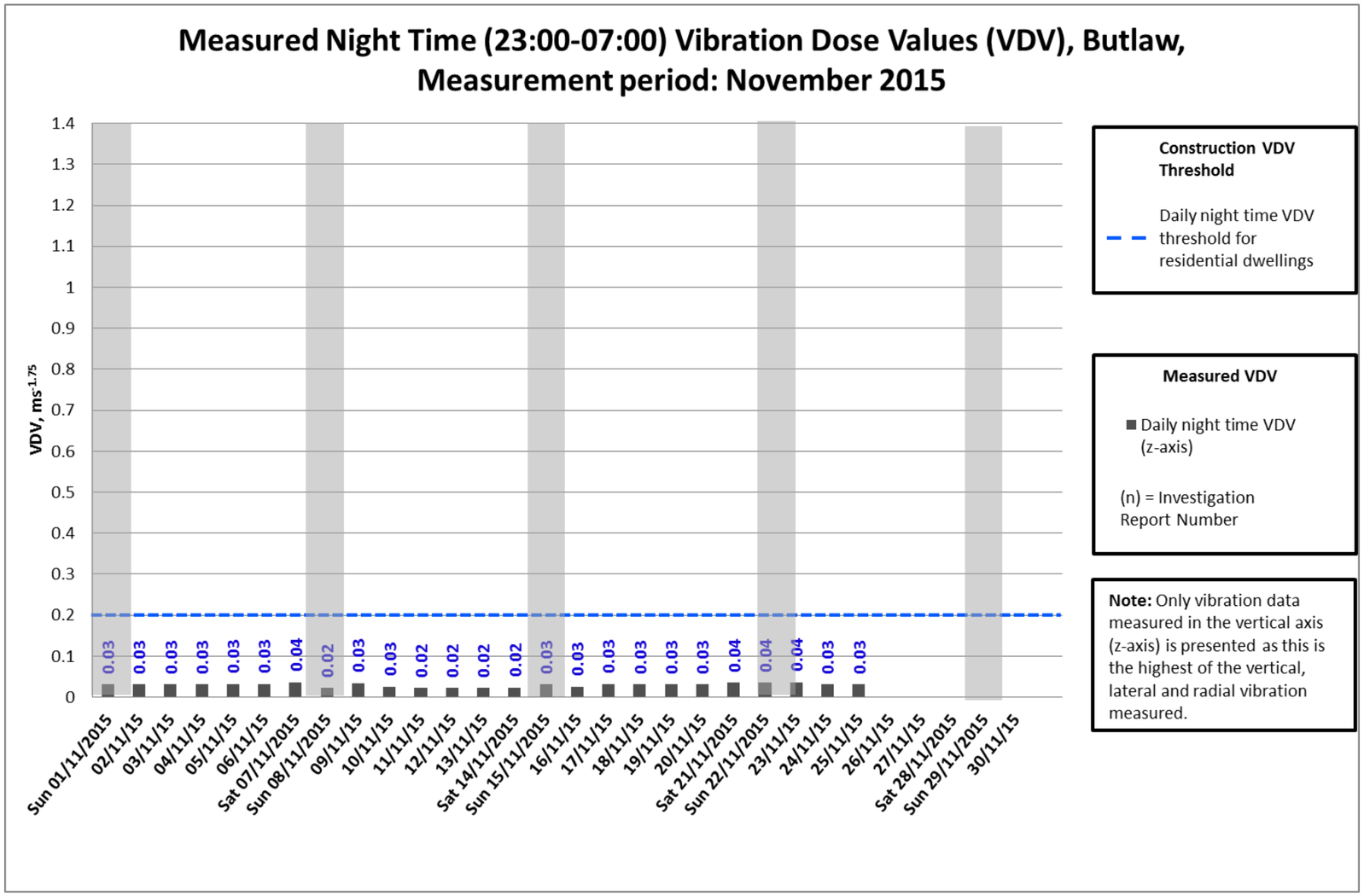


Exceedance on the 03/11/15 has been investigated and found that the exceedance was out with working hours and highly unlikely to be caused by construction related activities.

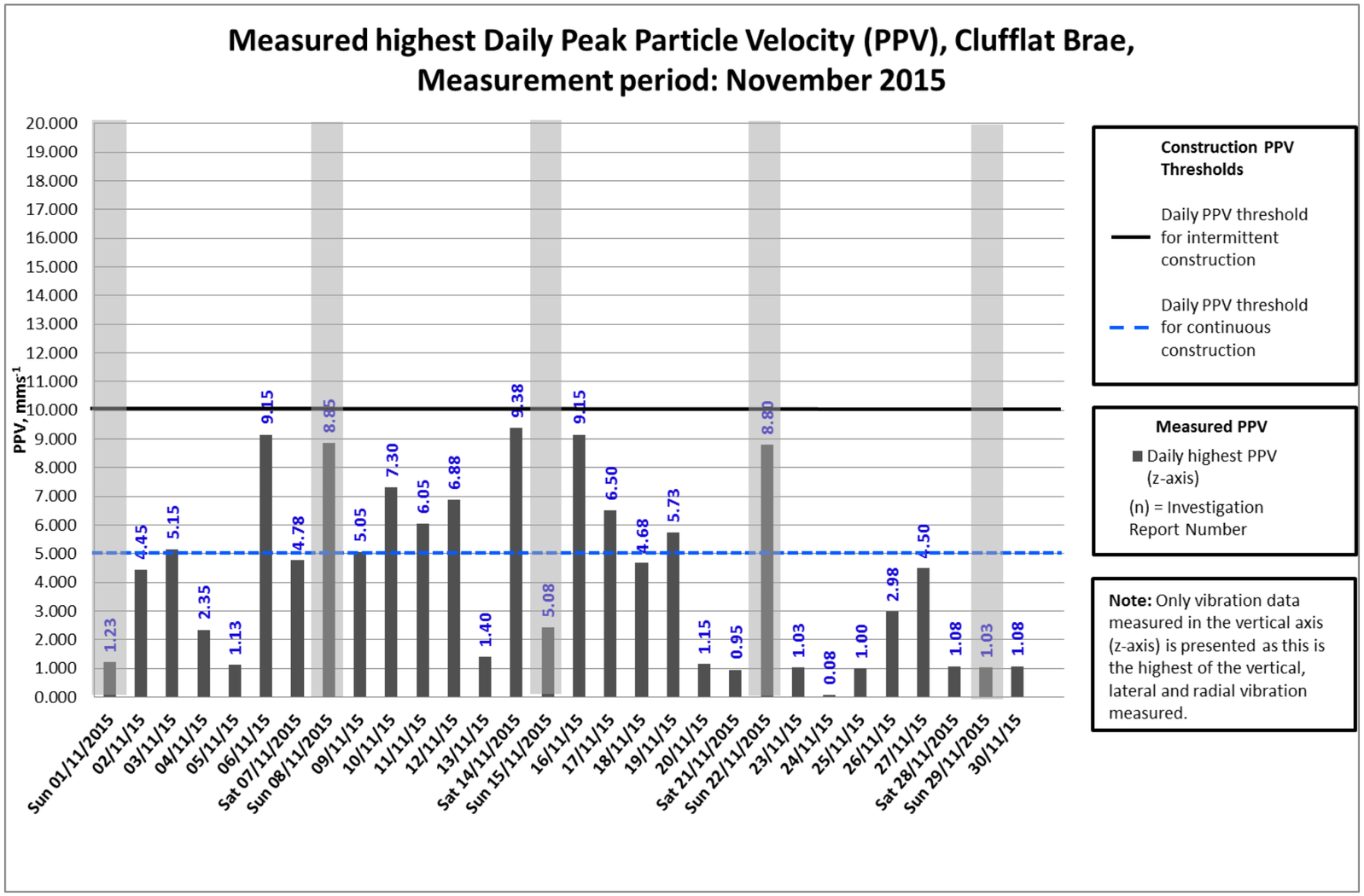
Vibration levels missing from 26/11/15-30/11/15 was caused by a power fault at the monitor this has since been repaired.



Vibration levels missing from 26/11/15-30/11/15 was caused by a power fault at the monitor this has since been repaired.

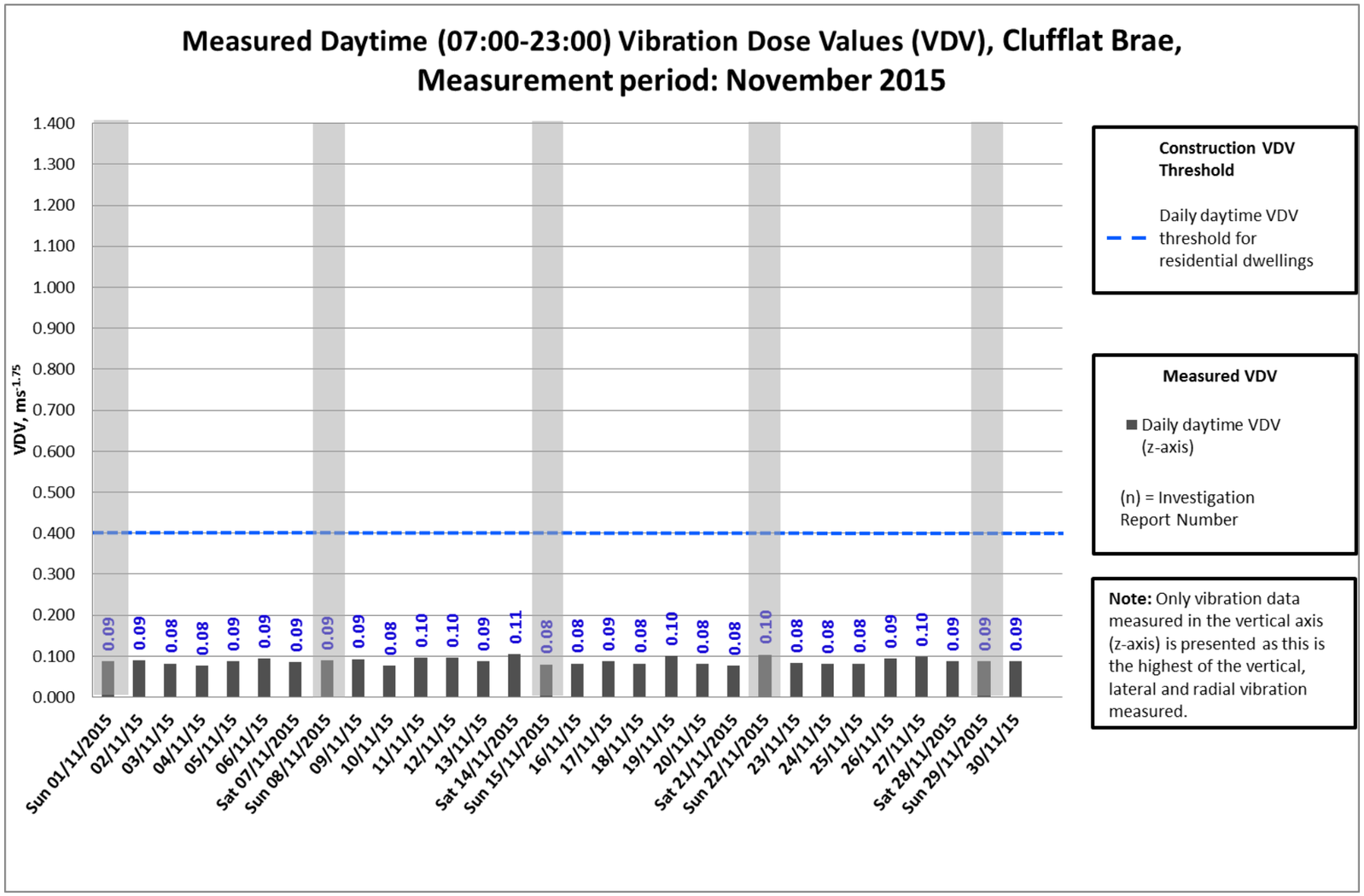


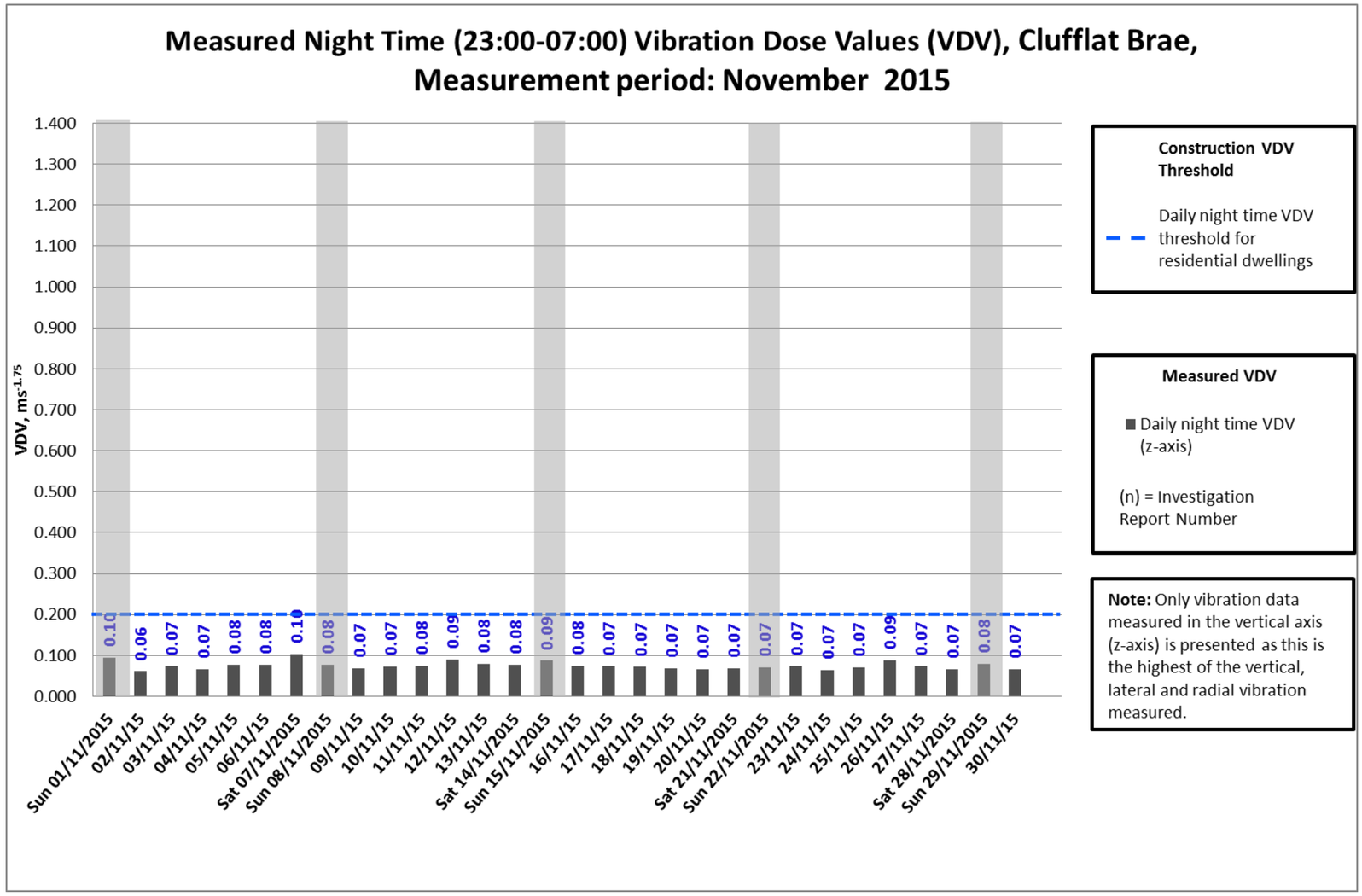
Vibration levels missing from 26/11/15-30/11/15 was caused by a power fault at the monitor this has since been repaired.



Exceedance on the 3rd, 6th, 9th, 10th, 11th, 12th, 14th, 16th, 17th, and 19th of November have been investigated and found to be one off isolated events which are highly unlikely to be caused by construction related activities (graph above from the 06/11/2015).

Exceedances on the 8th and 22nd of November were caused on a day that is out of normal working hours and are highly unlikely to be caused by construction related activities.


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Clufflat Brae,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.09 0.09 0.08 0.08 0.09 0.09 0.09 0.09 0.09 0.08 0.10 0.10 0.09 0.11 0.08 0.08 0.09 0.08 0.10 0.08 0.08 0.10 0.08 0.08 0.08 0.09 0.10 0.09 0.09 0.09
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Clufflat Brae,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.10 0.06 0.07 0.07 0.08 0.08 0.10 0.08 0.07 0.07 0.08 0.09 0.08 0.08 0.09 0.08 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.09 0.07 0.07 0.08 0.07
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
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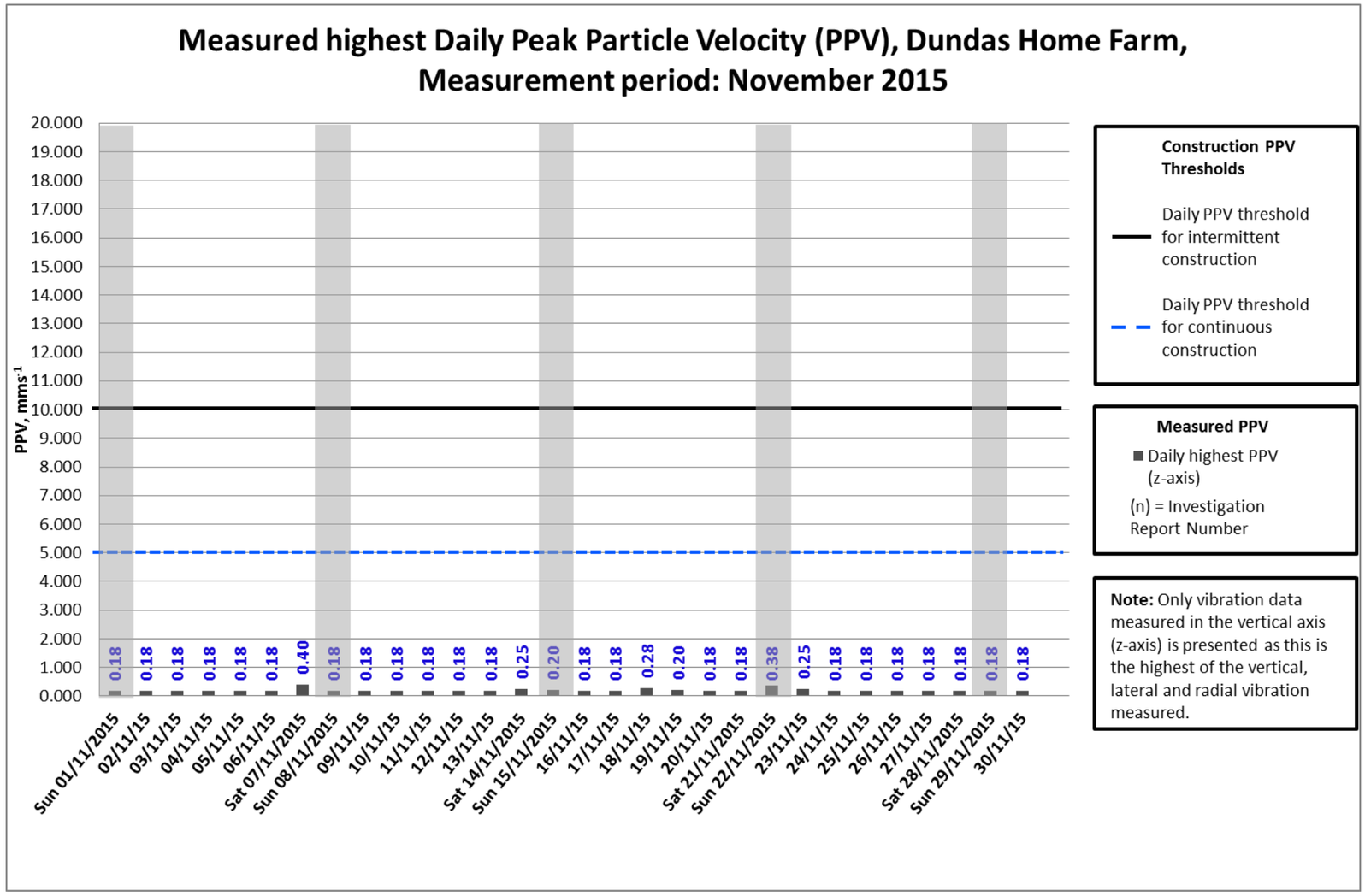
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured highest Daily Peak Particle Velocity (PPV), Dundas Home Farm,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.18 0.18 0.18 0.18 0.18 0.18 0.40 0.18 0.18 0.18 0.18 0.18 0.25 0.20 0.18 0.18 0.28 0.20 0.18 0.18 0.38 0.25 0.18 0.18 0.18 0.18 0.18 0.18
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
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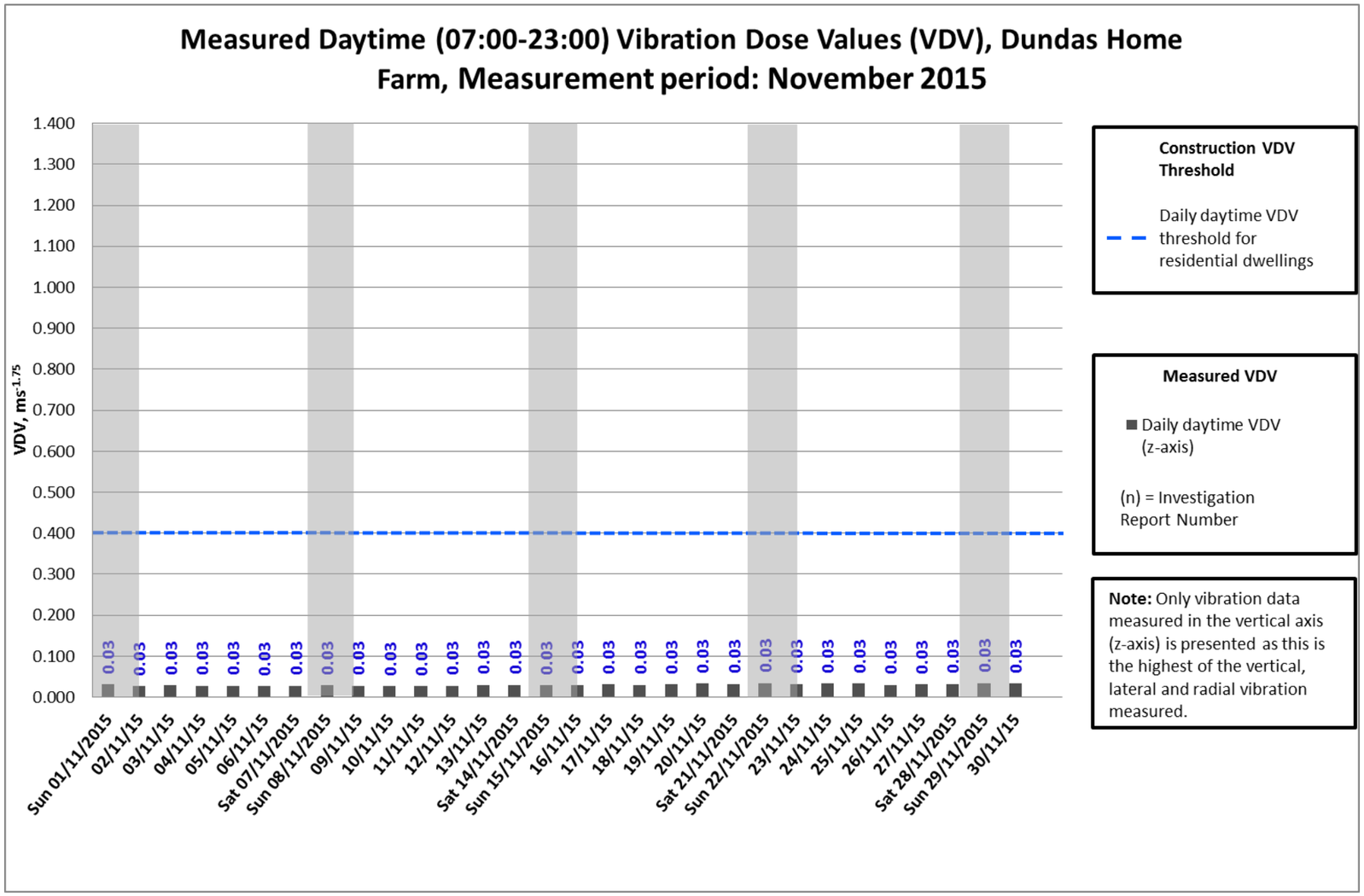
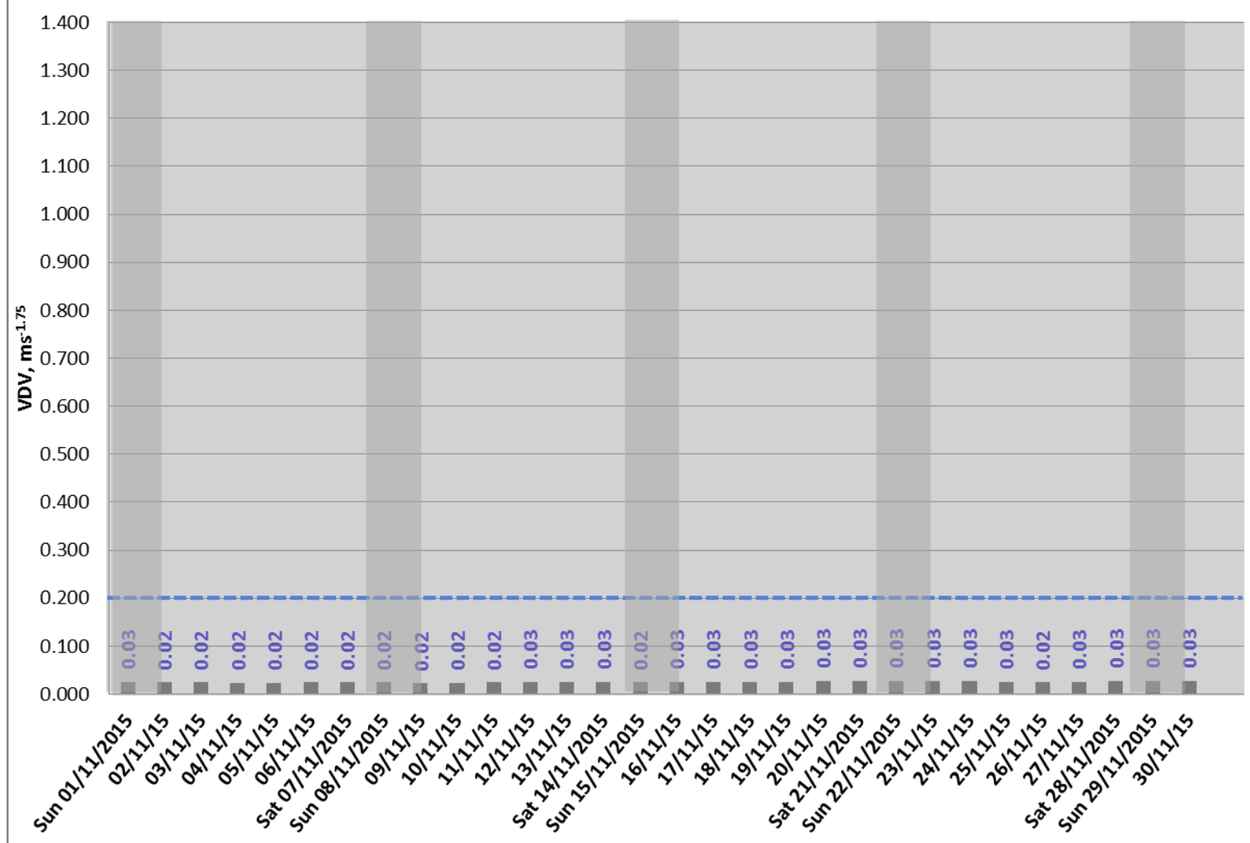
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Dundas Home Farm, Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.03
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Dundas Home Farm, Measurement period: November 2015



Construction VDV Threshold

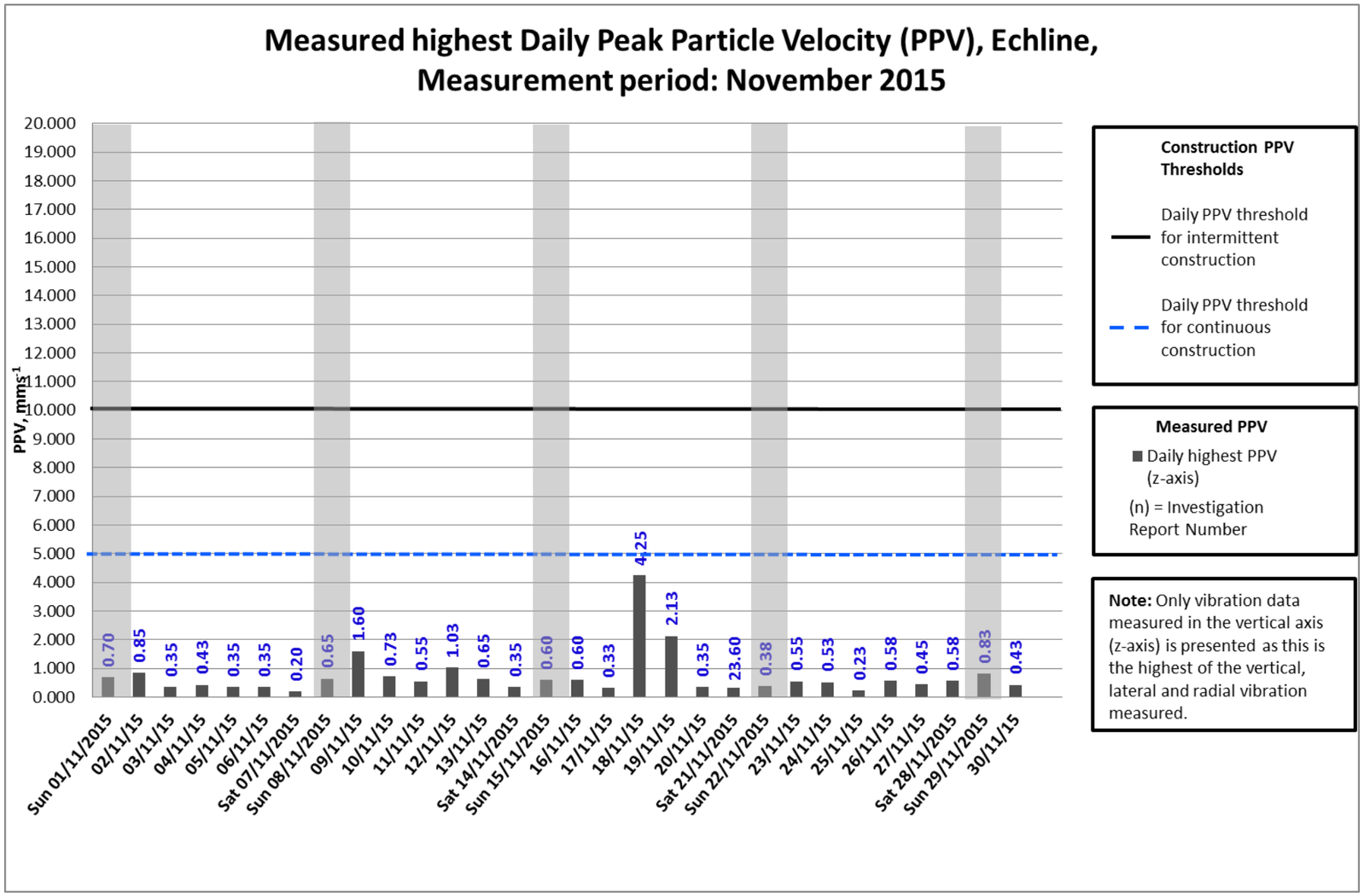
Daily night time VDV threshold for residential dwellings

Measured VDV

Daily night time VDV (z-axis)

(n) = Investigation Report Number

Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured highest Daily Peak Particle Velocity (PPV), Echline,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.70
0.85
0.35
0.43
0.35
0.35
0.20
0.65
1.60
0.73
0.55
1.03
0.65
0.35
0.60
0.60
0.33
4.25
2.13
0.35
23.60
0.38
0.55
0.53
0.23
0.58
0.45
0.58
0.83
0.43
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
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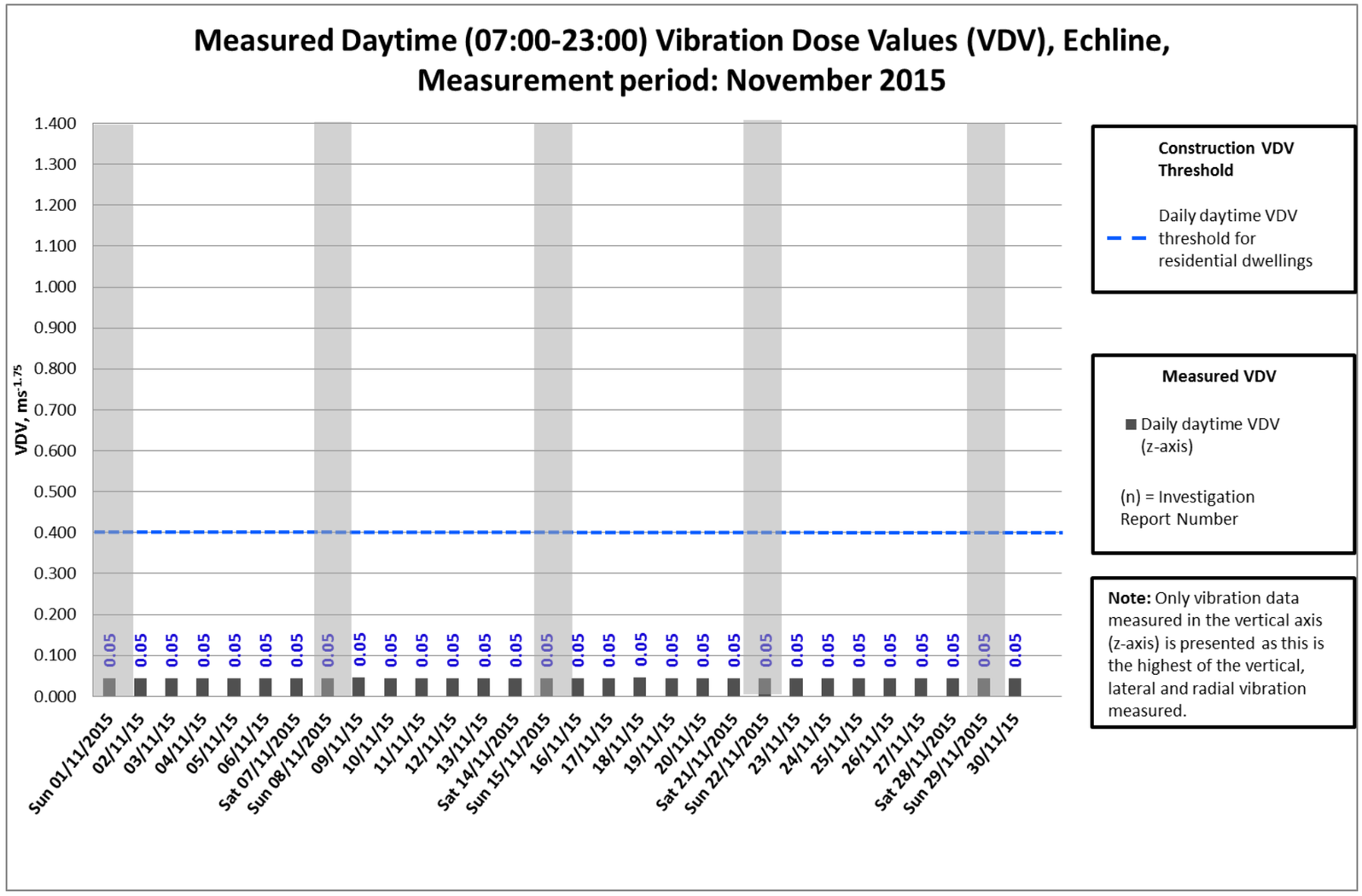
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Echline,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.05
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
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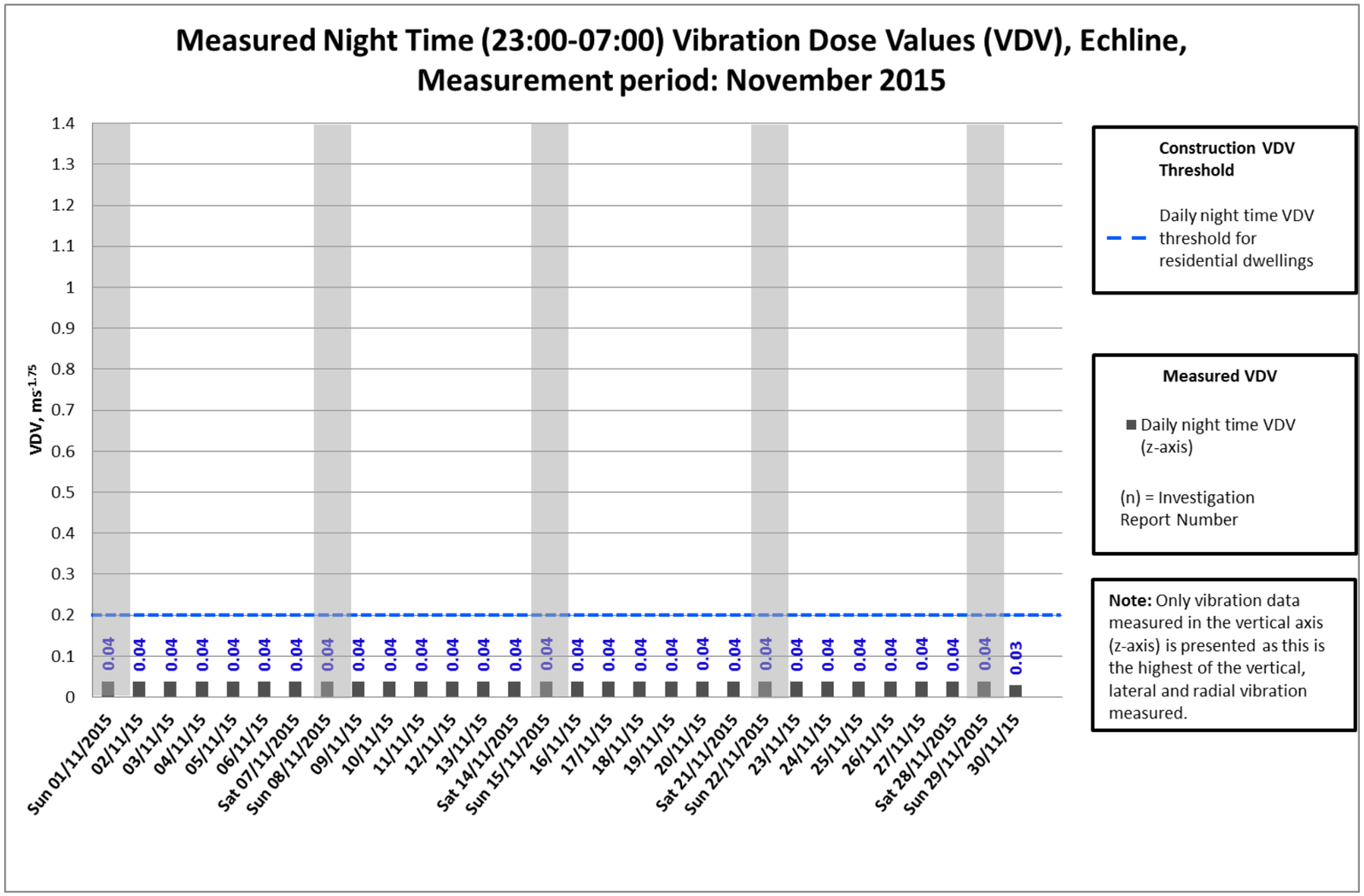
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Echline,
Measurement period: November 2015
VDV, ms-1.75
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.03
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
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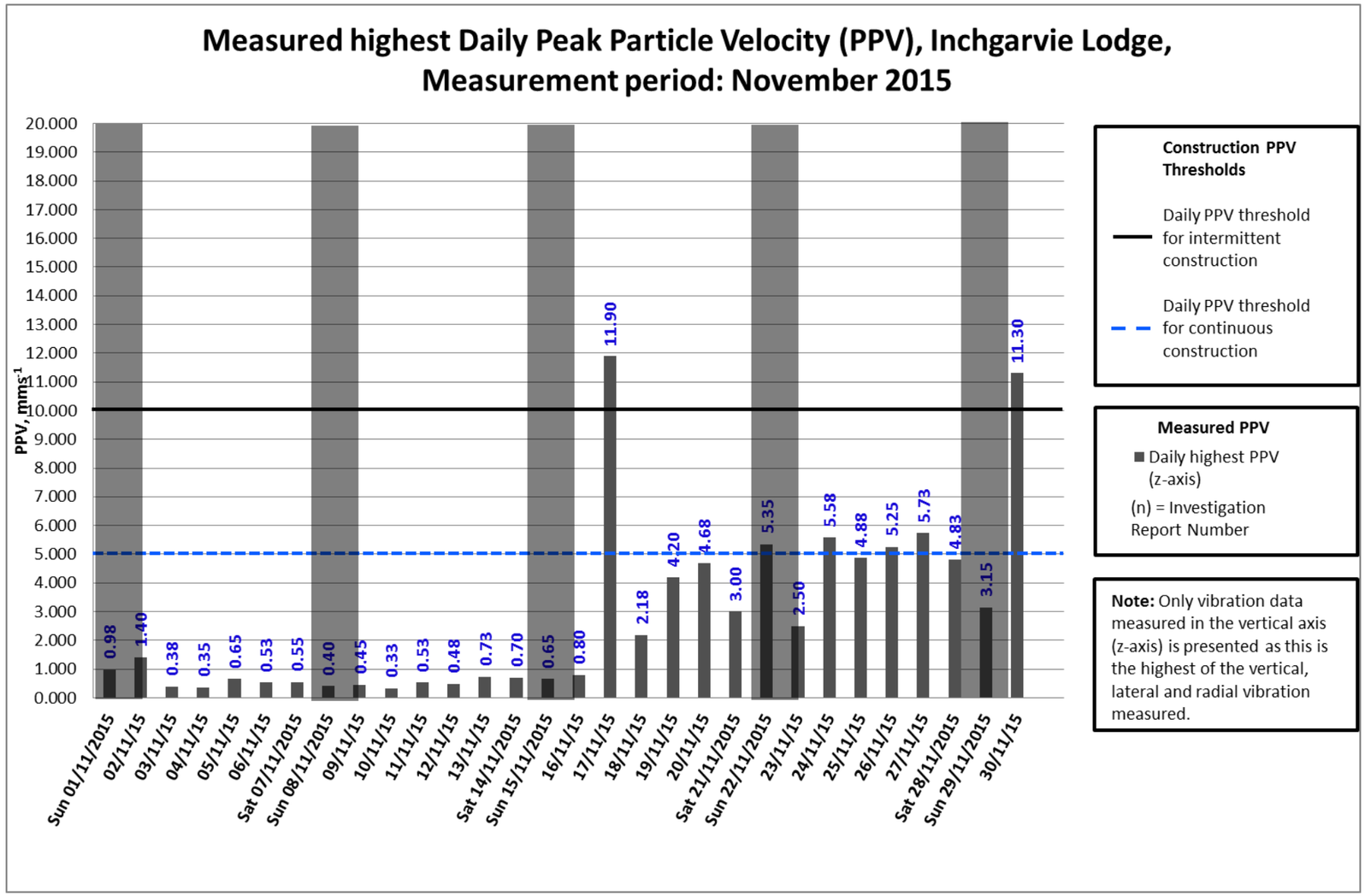
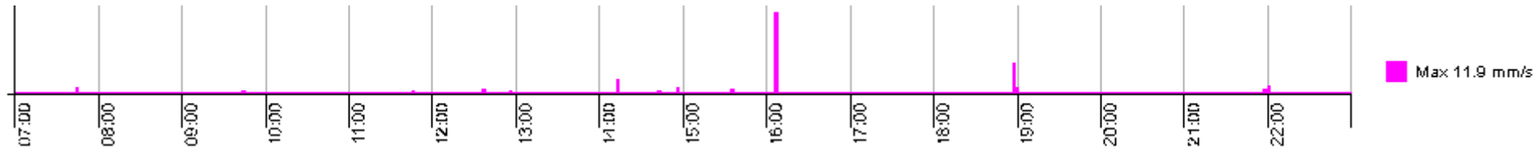
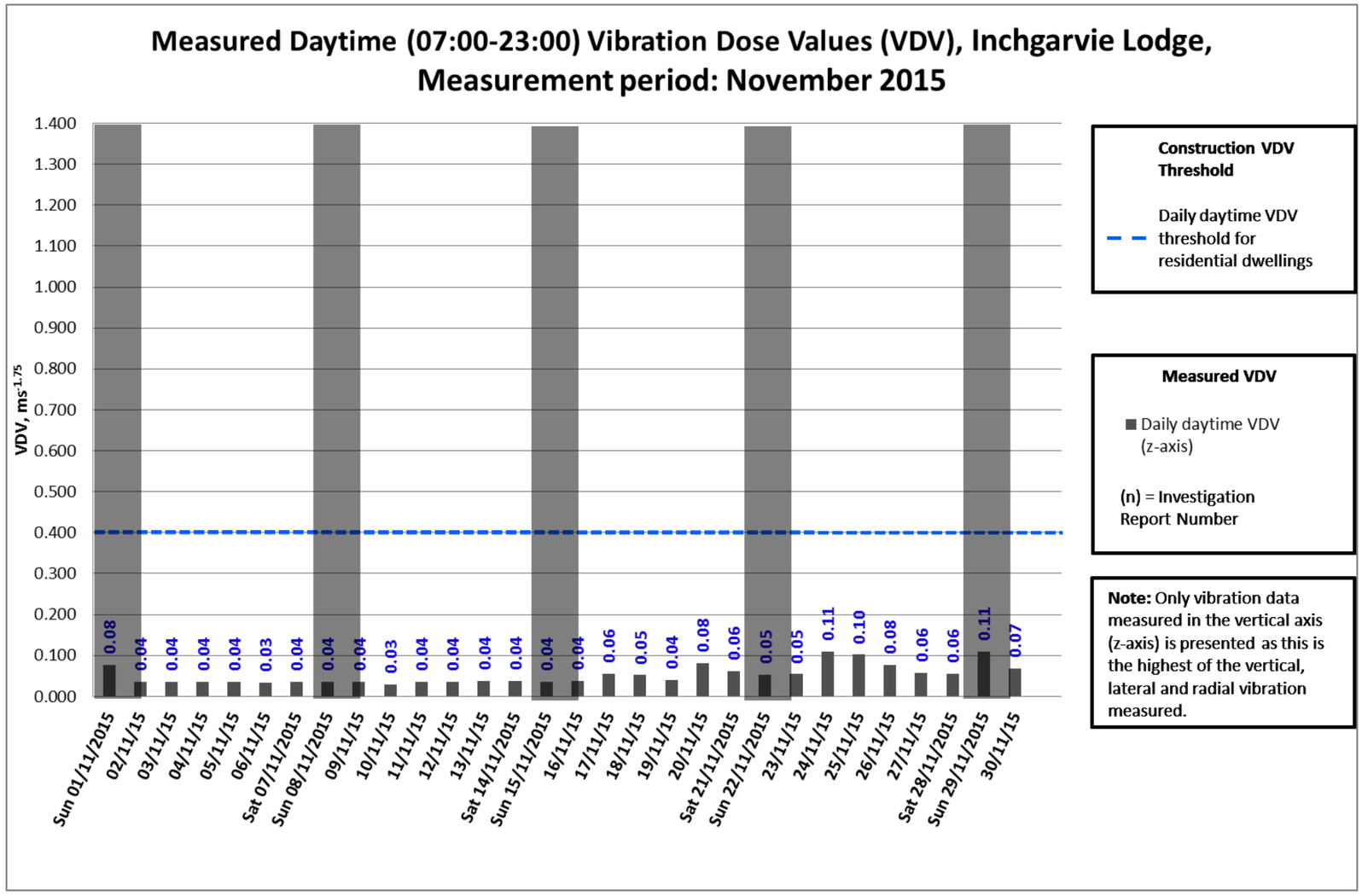
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

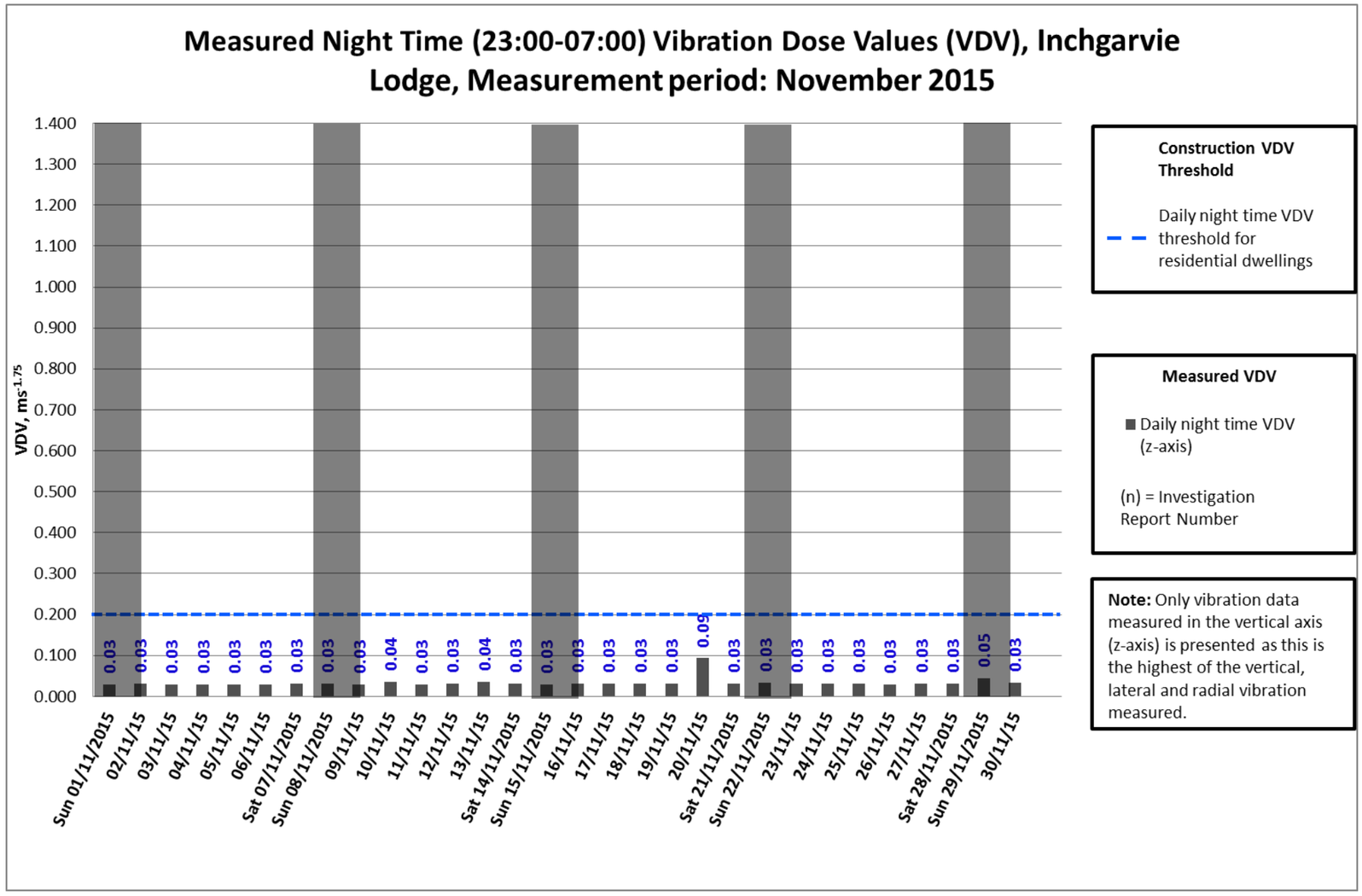

Measured highest Daily Peak Particle Velocity (PPV), Inchgarvie Lodge,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.98
1.40
0.38
0.35
0.65
0.53
0.55
0.40
0.45
0.33
0.53
0.48
0.73
0.70
0.65
0.80
11.90
2.18
4.20
4.68
3.00
5.35
2.50
5.58
4.88
5.25
5.73
4.83
3.15
11.30
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

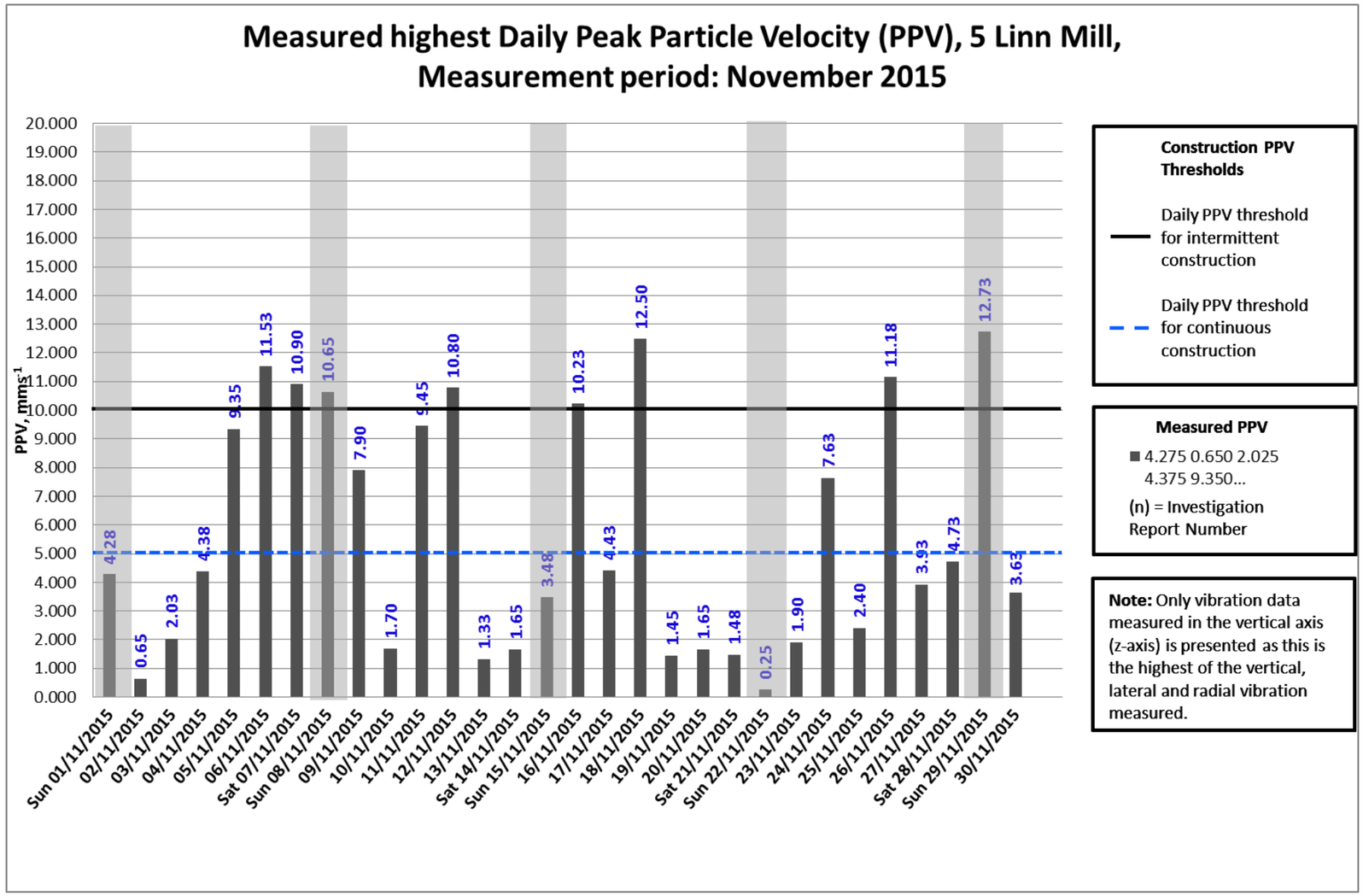


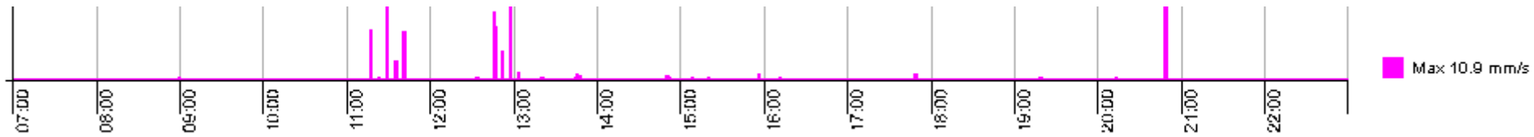
Exceedances on the 17th, 26th, and 27th have been investigated and found to be caused by isolated events that are highly unlikely to be caused by construction related activities.

Exceedances on the 22nd, 24th and 30th have been investigated and found to be out with working hours and are highly unlikely to be caused by construction related activities.

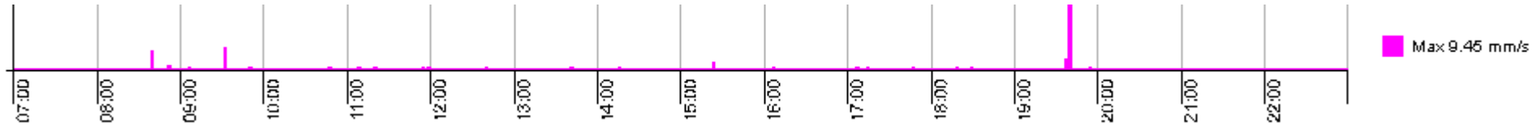

Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Inchgarvie Lodge,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.08 0.04 0.04 0.04 0.04 0.03 0.04 0.04 0.04 0.03 0.04 0.04 0.04 0.04 0.04 0.04 0.06 0.05 0.04 0.08 0.06 0.05 0.05 0.11 0.10 0.08 0.06 0.06 0.11 0.07
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Inchgarvie Lodge, Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.04 0.03 0.03 0.04 0.03 0.03 0.03 0.03 0.03 0.09 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.05 0.03
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

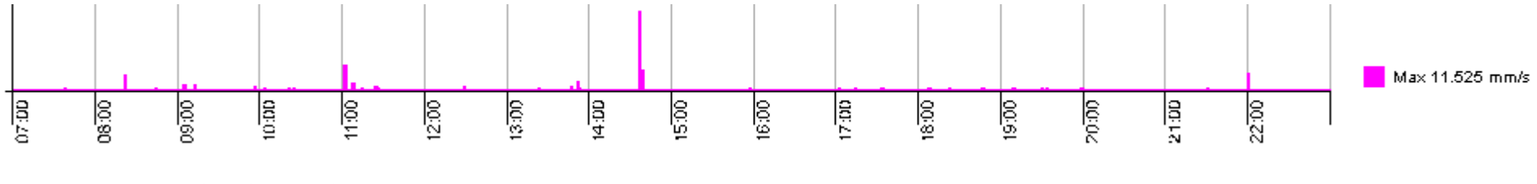

Measured highest Daily Peak Particle Velocity (PPV), 5 Linn Mill,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
4.28
0.65
2.03
4.38
9.35
11.53
10.90
10.65
7.90
1.70
9.45
10.80
1.33
1.65
3.48
10.23
4.43
12.50
1.45
1.65
1.48
0.25
1.90
7.63
2.40
11.18
3.93
4.73
12.73
3.63
Sun 01/11/2015
02/11/2015
03/11/2015
04/11/2015
05/11/2015
06/11/2015
Sat 07/11/2015
Sun 08/11/2015
09/11/2015
10/11/2015
11/11/2015
12/11/2015
13/11/2015
Sat 14/11/2015
Sun 15/11/2015
16/11/2015
17/11/2015
18/11/2015
19/11/2015
20/11/2015
Sat 21/11/2015
Sun 22/11/2015
23/11/2015
24/11/2015
25/11/2015
26/11/2015
27/11/2015
Sat 28/11/2015
Sun 29/11/2015
30/11/2015
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
4.275 0.650 2.025 4.375 9.350...
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.



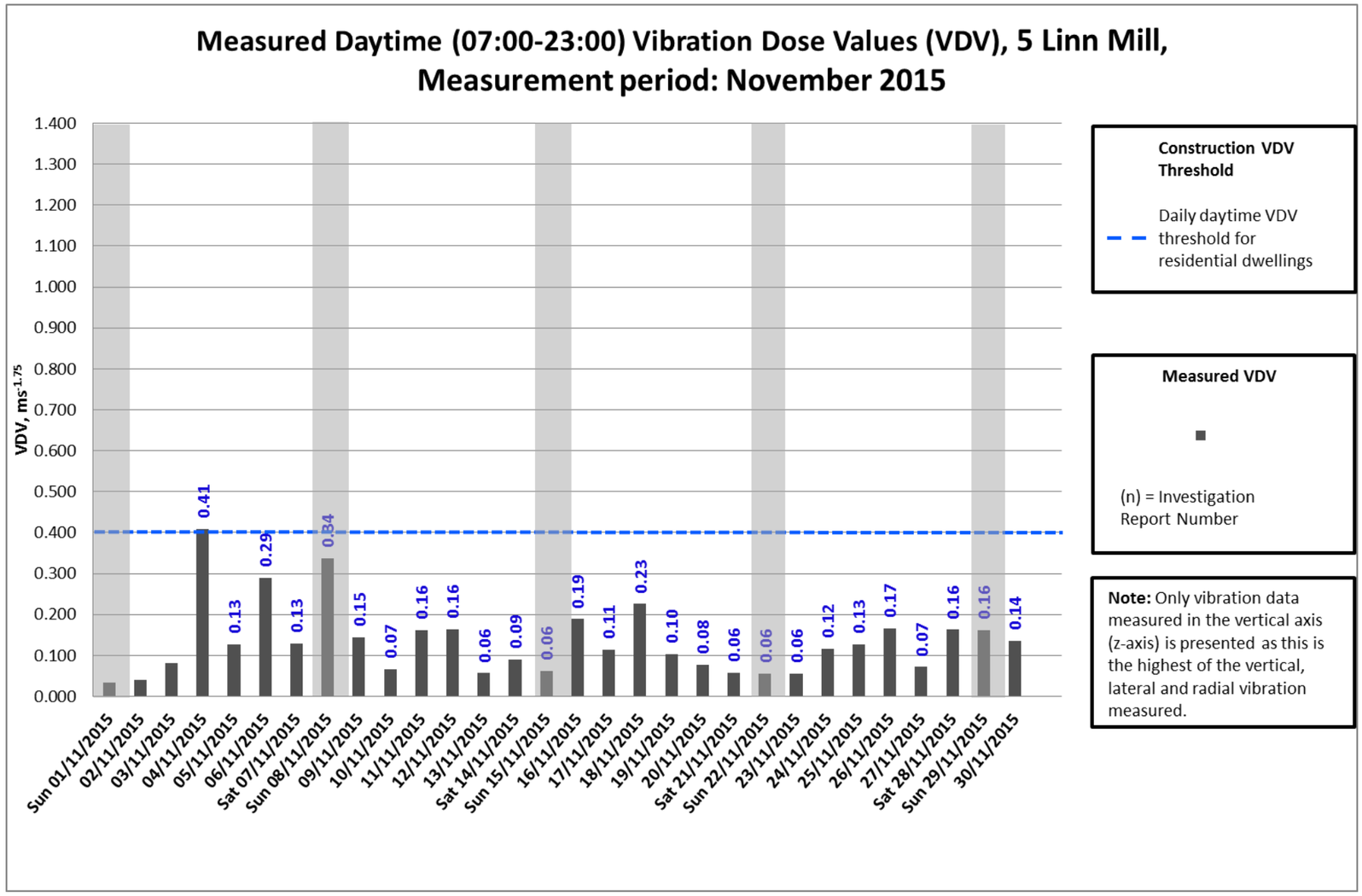
Exceedances on the 5th, 7th, 9th, 12th, 16th, and 26th have been investigated and the results are inconclusive to the defined source of the vibration however these intermittent vibration levels are highly likely to have been caused by the local residents movement to get logs from his/her log store outside which is located closely to FCBC's vibration monitor (graph above from the 07/11/2015).



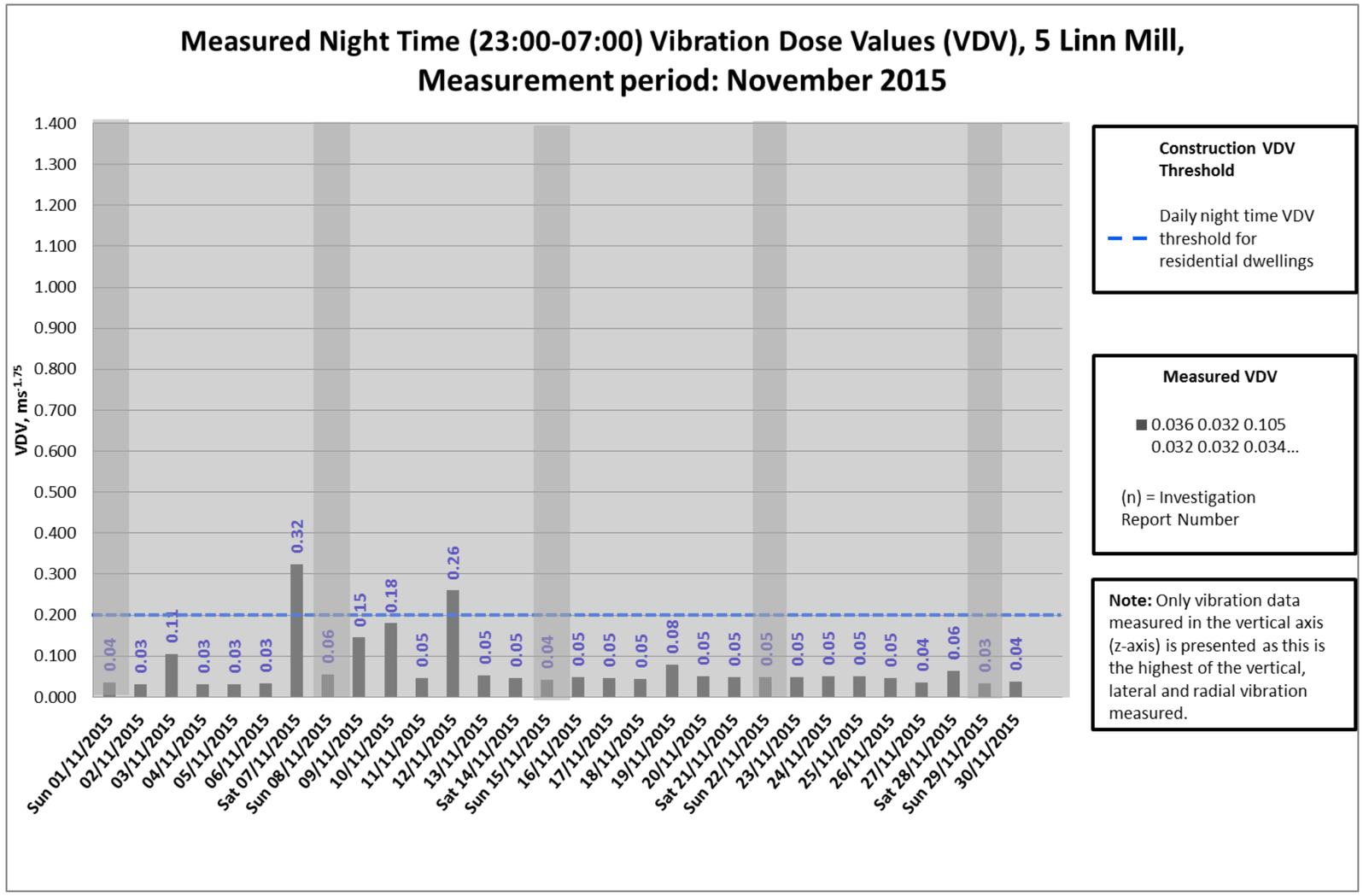
Exceedances on the 8th, 11th, and 29th have been investigated and found to be out with construction working hours and is highly unlikely to be caused by construction related activities (graph above from the 11/11/2015).

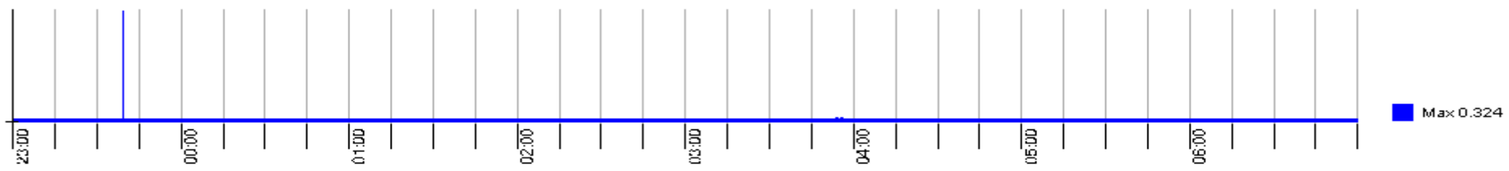


Exceedances on the 6th, 18th and 24th have been investigated and found to be one off isolated events which are highly unlikely to be caused by construction related activities (graph above from the 06/11/2015).

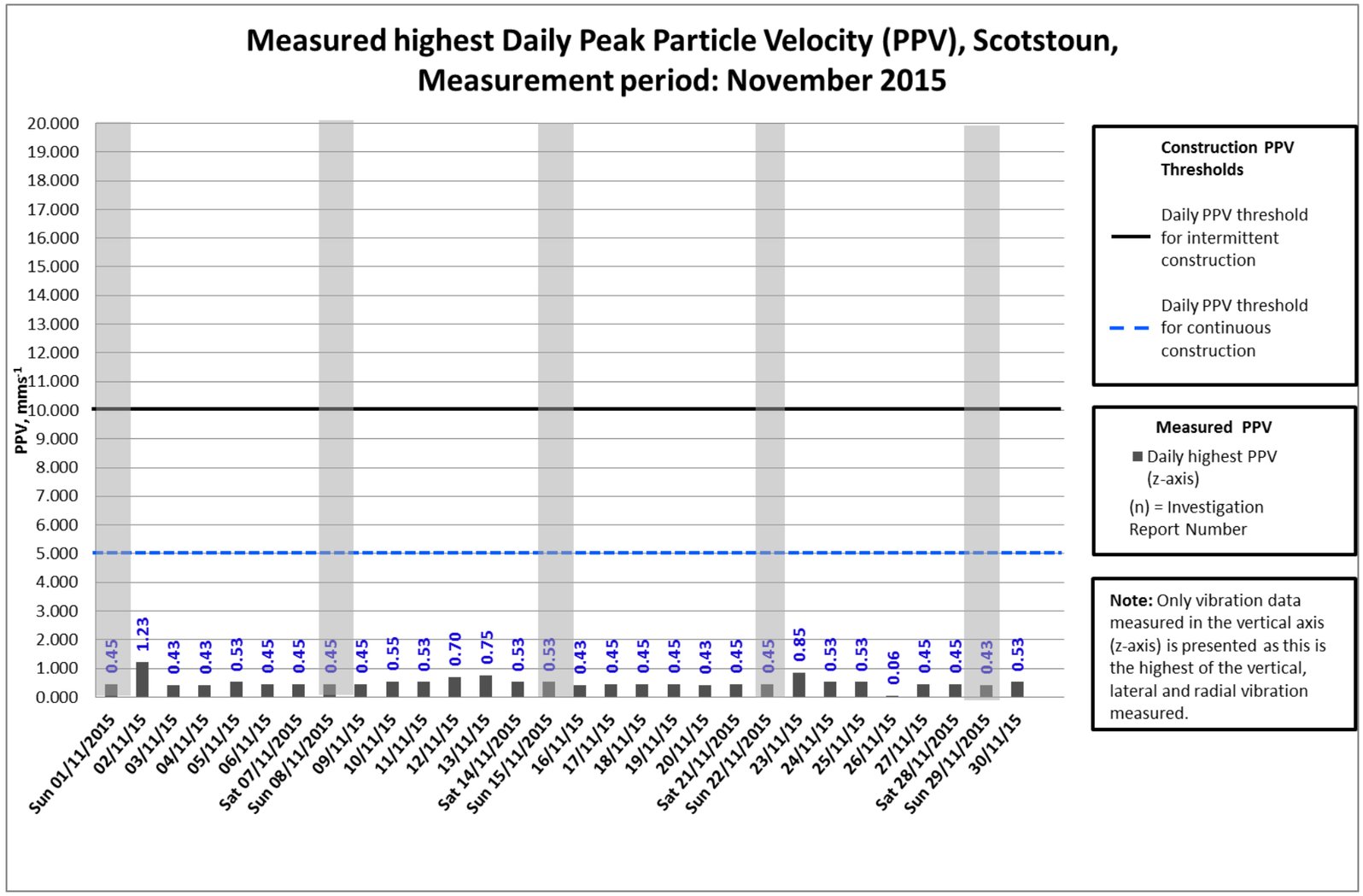


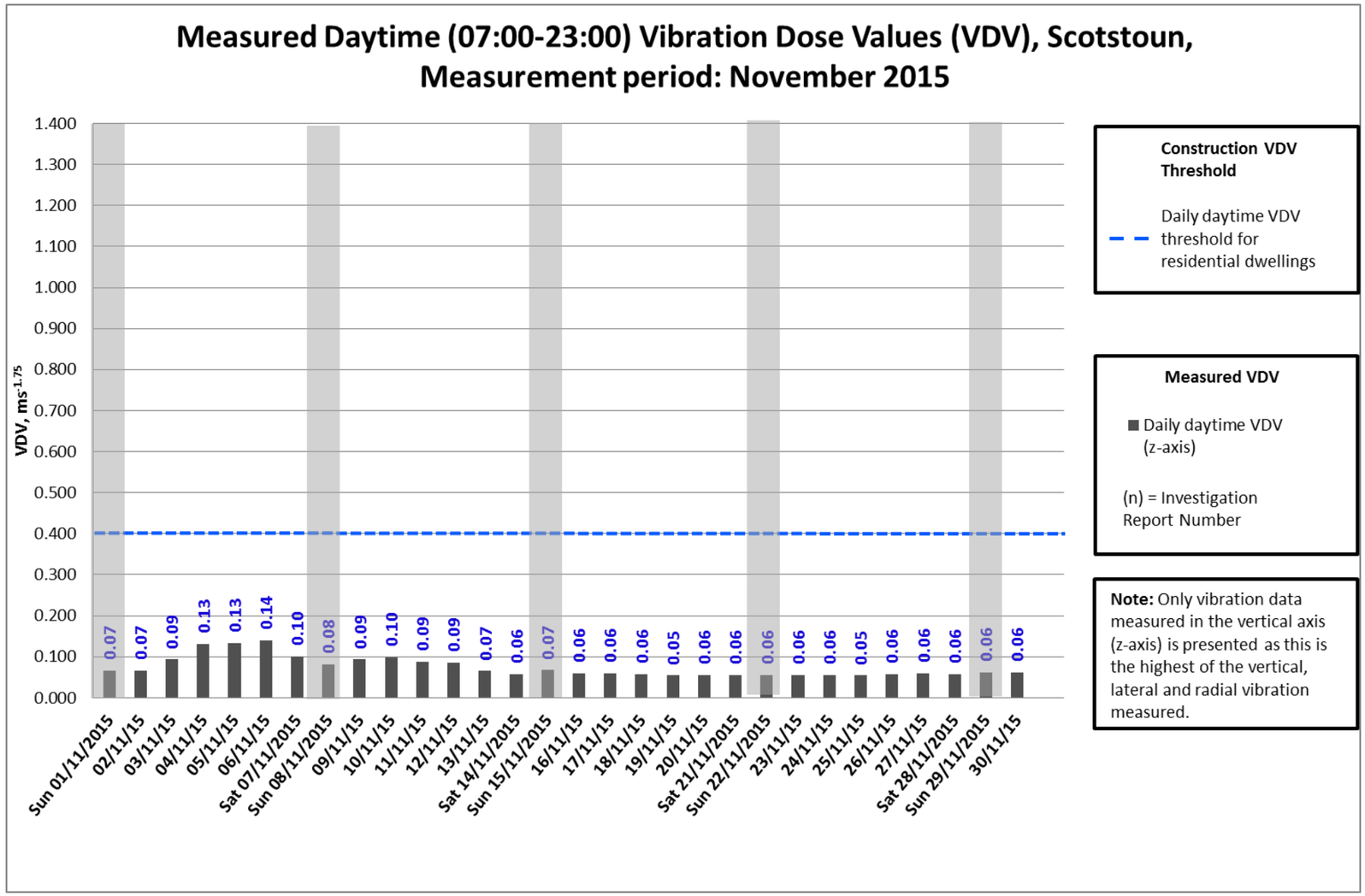
Exceedance on the 04/11/2015 has been investigated and the results are inconclusive to the defined source of the vibration however these two isolated events are highly likely to have been caused by the local residents movement to get logs from his/her log store outside which is located closely to FCBC's vibration monitor.

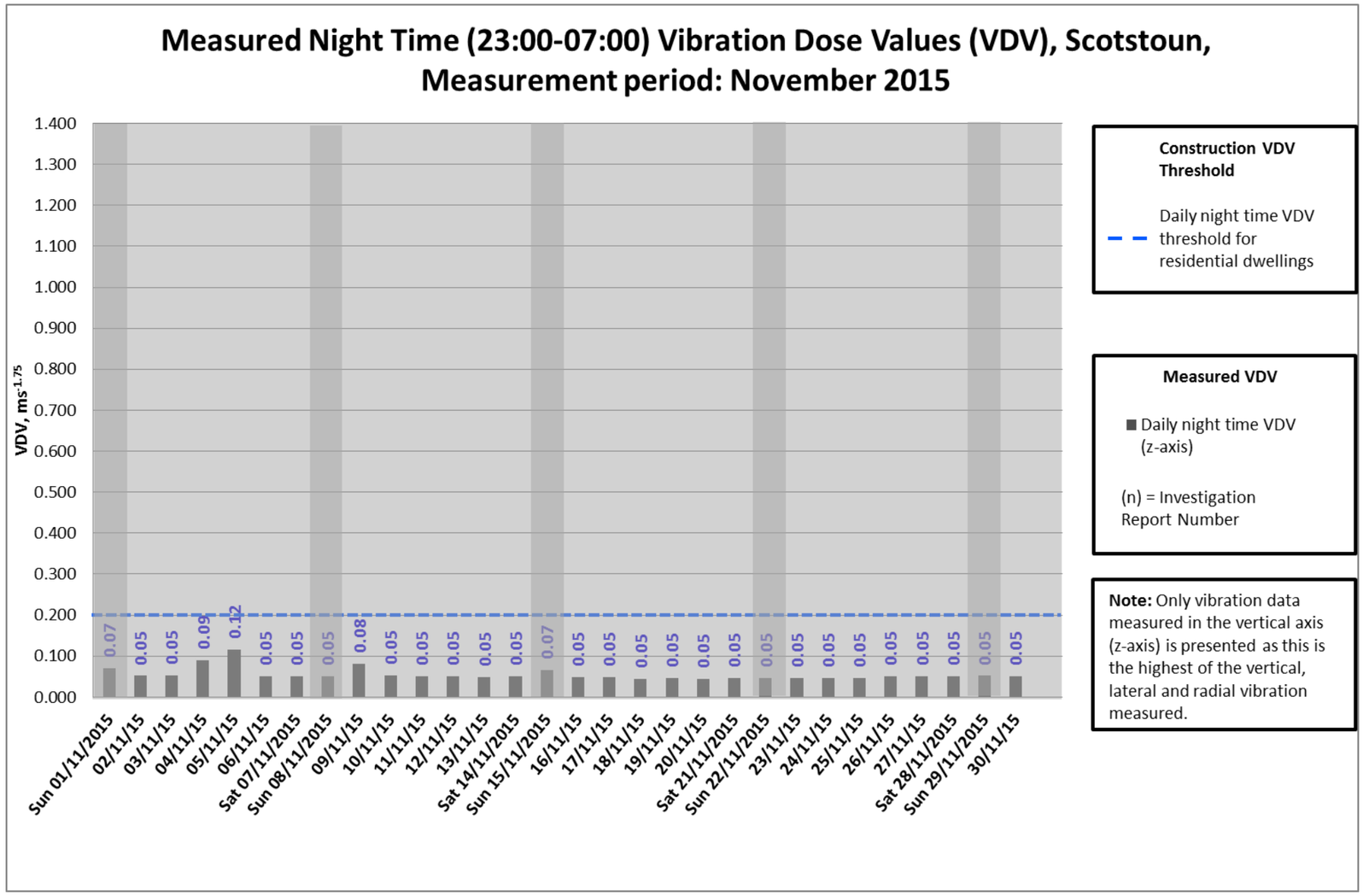


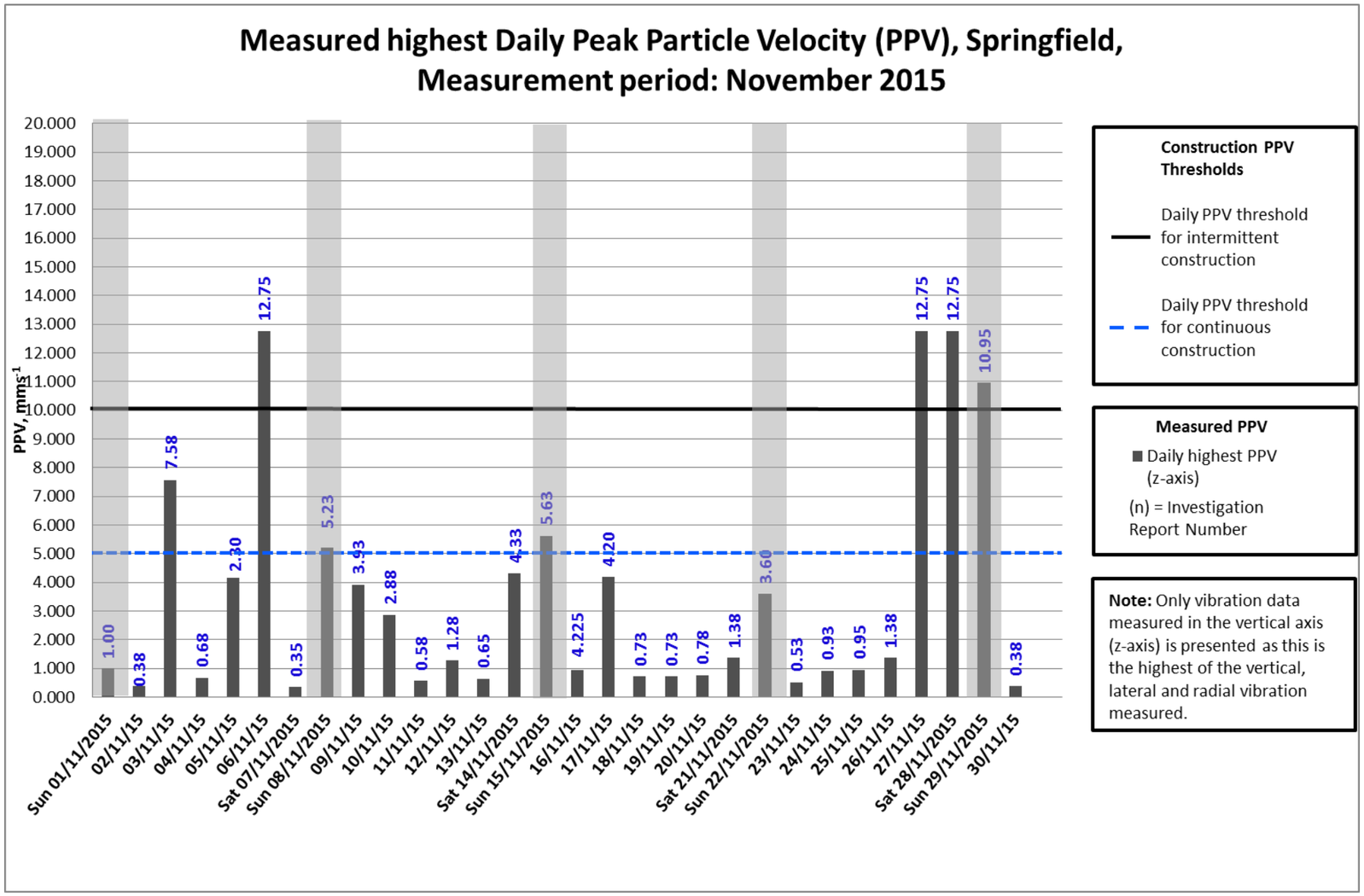


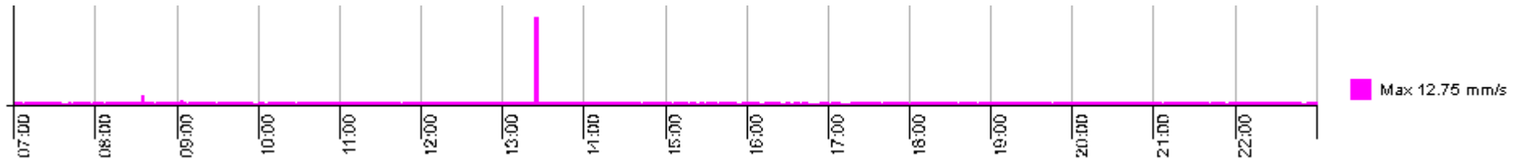
Exceedance on the 7th and 12th of November have been investigated and found to be one off isolated events out with construction working hours and are highly unlikely to have been caused by construction related activities (graph above from the 07/11/2015).


Measured highest Daily Peak Particle Velocity (PPV), Scotstoun,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.45
1.23
0.43
0.43
0.53
0.45
0.45
0.45
0.45
0.55
0.53
0.70
0.75
0.53
0.53
0.43
0.45
0.45
0.45
0.43
0.45
0.45
0.85
0.53
0.53
0.06
0.45
0.45
0.43
0.53
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

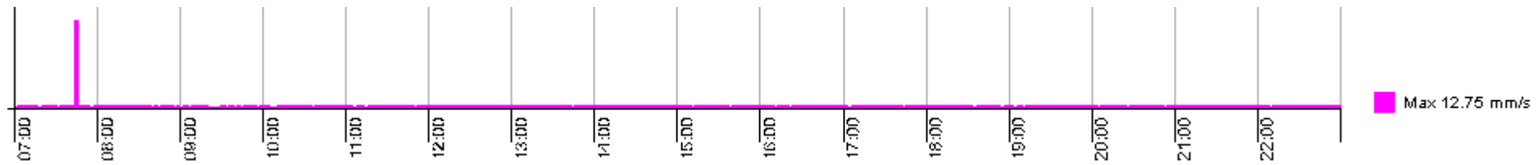

Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Scotstoun,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.07 0.07 0.09 0.13 0.13 0.14 0.10 0.08 0.09 0.10 0.09 0.09 0.07 0.06 0.07 0.06 0.06 0.06 0.05 0.06 0.06 0.06 0.06 0.06 0.05 0.06 0.06 0.06 0.06 0.06
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Scotstoun,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.07
0.05
0.05
0.09
0.12
0.05
0.05
0.05
0.08
0.05
0.05
0.05
0.05
0.05
0.07
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

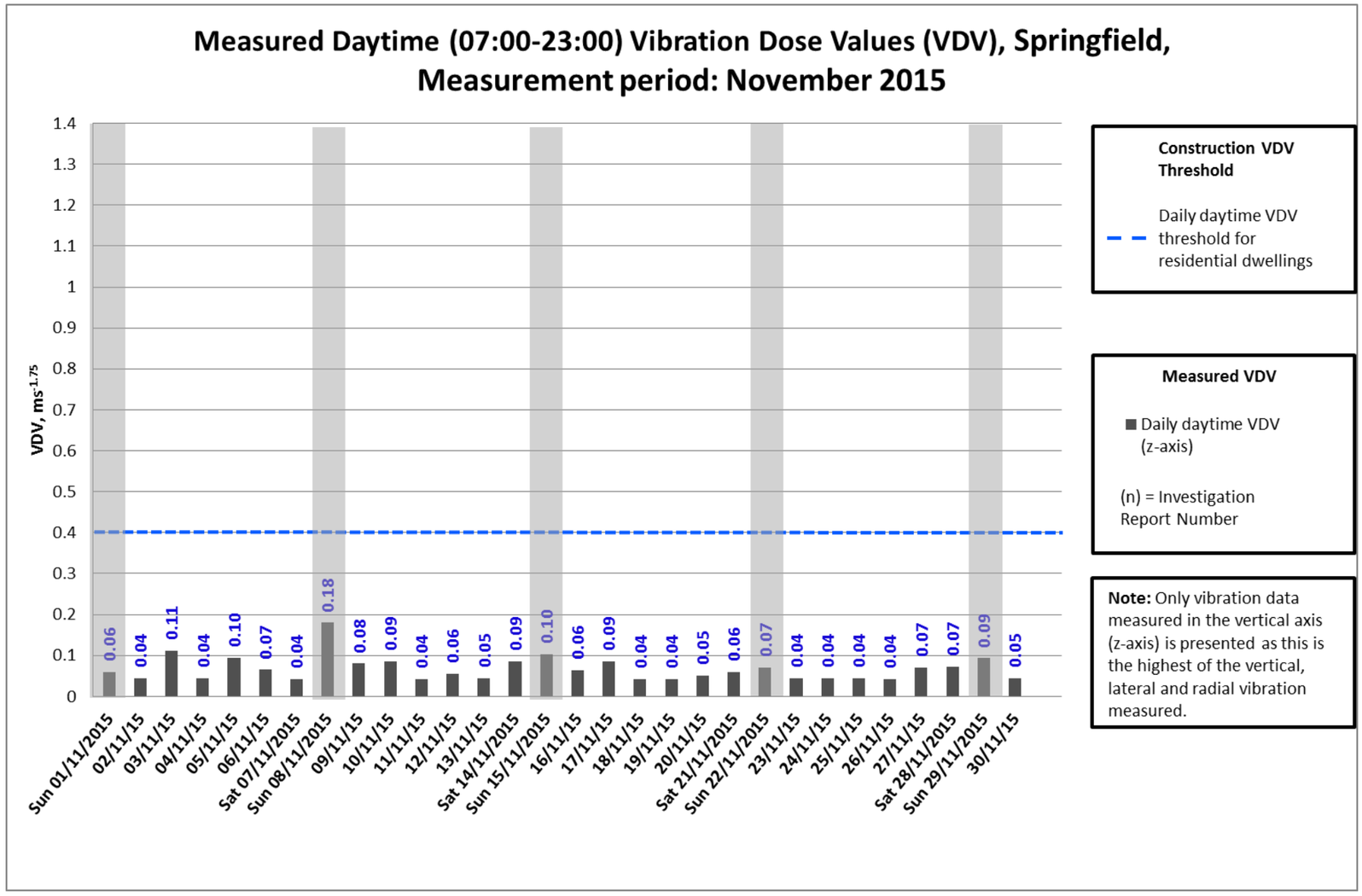

Measured highest Daily Peak Particle Velocity (PPV), Springfield,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
1.00
0.38
7.58
0.68
2.30
12.75
0.35
5.23
3.93
2.88
0.58
1.28
0.65
4.33
5.63
4.225
4.20
0.73
0.73
0.78
1.38
3.60
0.53
0.93
0.95
1.38
12.75
12.75
10.95
0.38
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

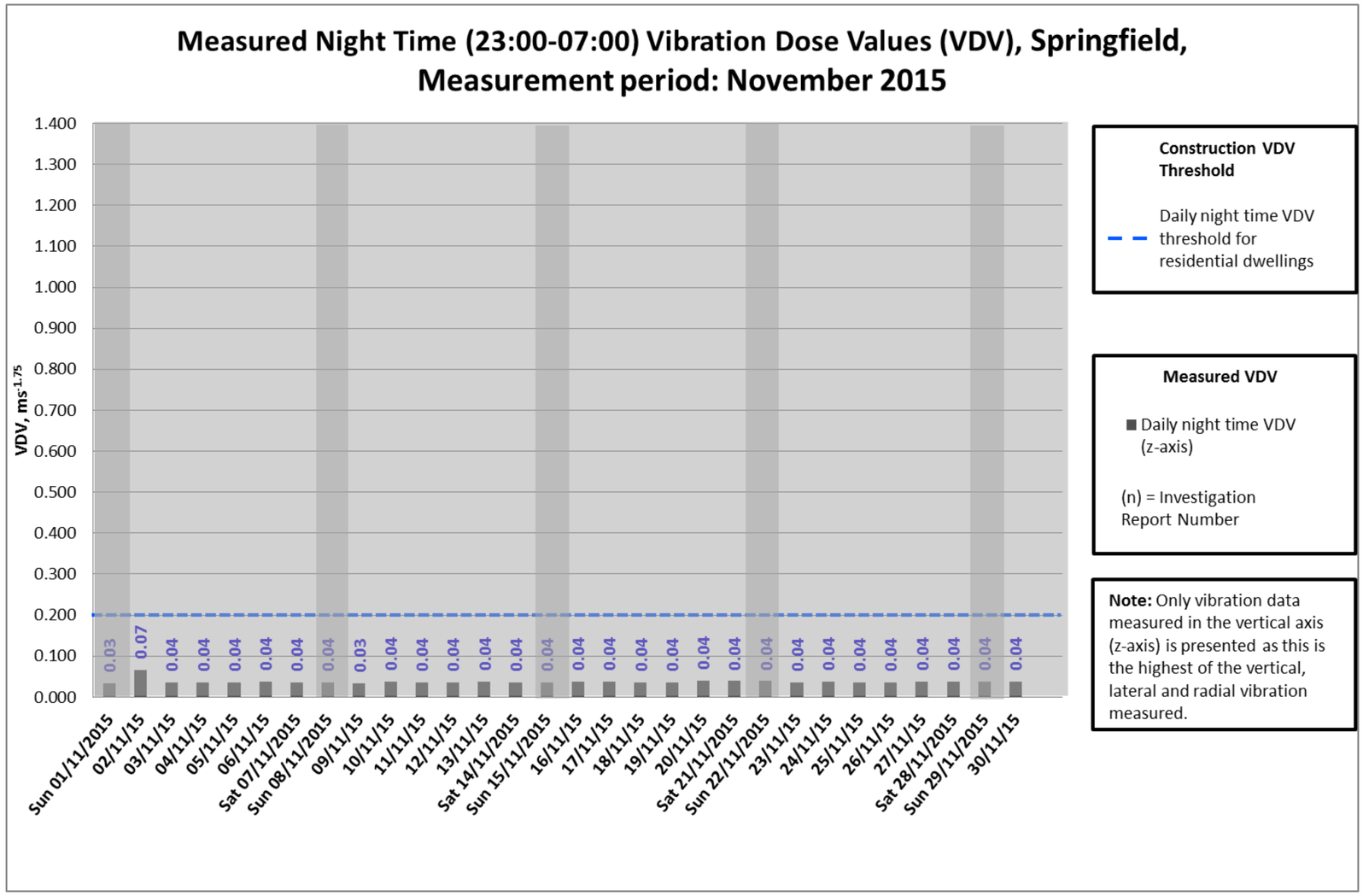


Exceedances on the 3rd, 6th, and 28th have been investigated and found to be caused by one off isolated events that are highly unlikely to have been caused by construction related activities (graph above from the 06/11/2015).



Exceedance on the 8th, 15th, 27th, and 29th have been investigated and found to be out with construction working hours and are highly unlikely to have been caused by construction related activities (graph above from the 27/11/2015).


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Springfield,
Measurement period: November 2015
VDV, ms-1.75
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.06
0.04
0.11
0.04
0.10
0.07
0.04
0.18
0.08
0.09
0.04
0.06
0.05
0.09
0.10
0.06
0.09
0.04
0.04
0.05
0.06
0.07
0.04
0.04
0.04
0.04
0.07
0.07
0.09
0.05
Sun 01/11/2015
02/11/15
03/11/15
04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
09/11/15
10/11/15
11/11/15
12/11/15
13/11/15
Sat 14/11/2015
Sun 15/11/2015
16/11/15
17/11/15
18/11/15
19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
23/11/15
24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Springfield,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.03 0.07 0.04 0.04 0.04 0.04 0.04 0.04 0.03 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04
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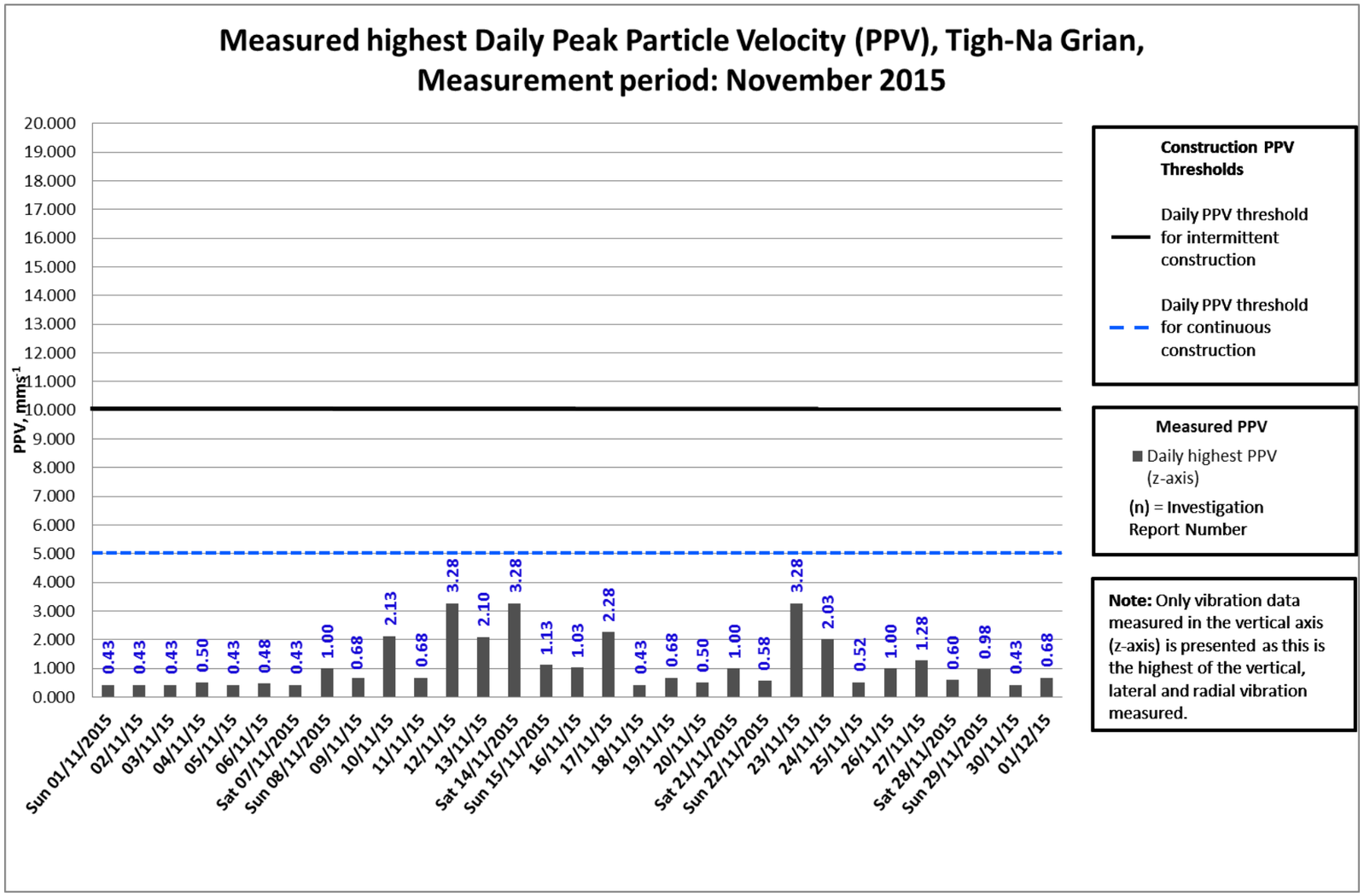
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured highest Daily Peak Particle Velocity (PPV), Tigh-Na Grian,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.43 0.43 0.43 0.50 0.43 0.48 0.43 1.00 0.68 2.13 0.68 3.28 2.10 3.28 1.13 1.03 2.28 0.43 0.68 0.50 1.00 0.58 3.28 2.03 0.52 1.00 1.28 0.60 0.98 0.43 0.68
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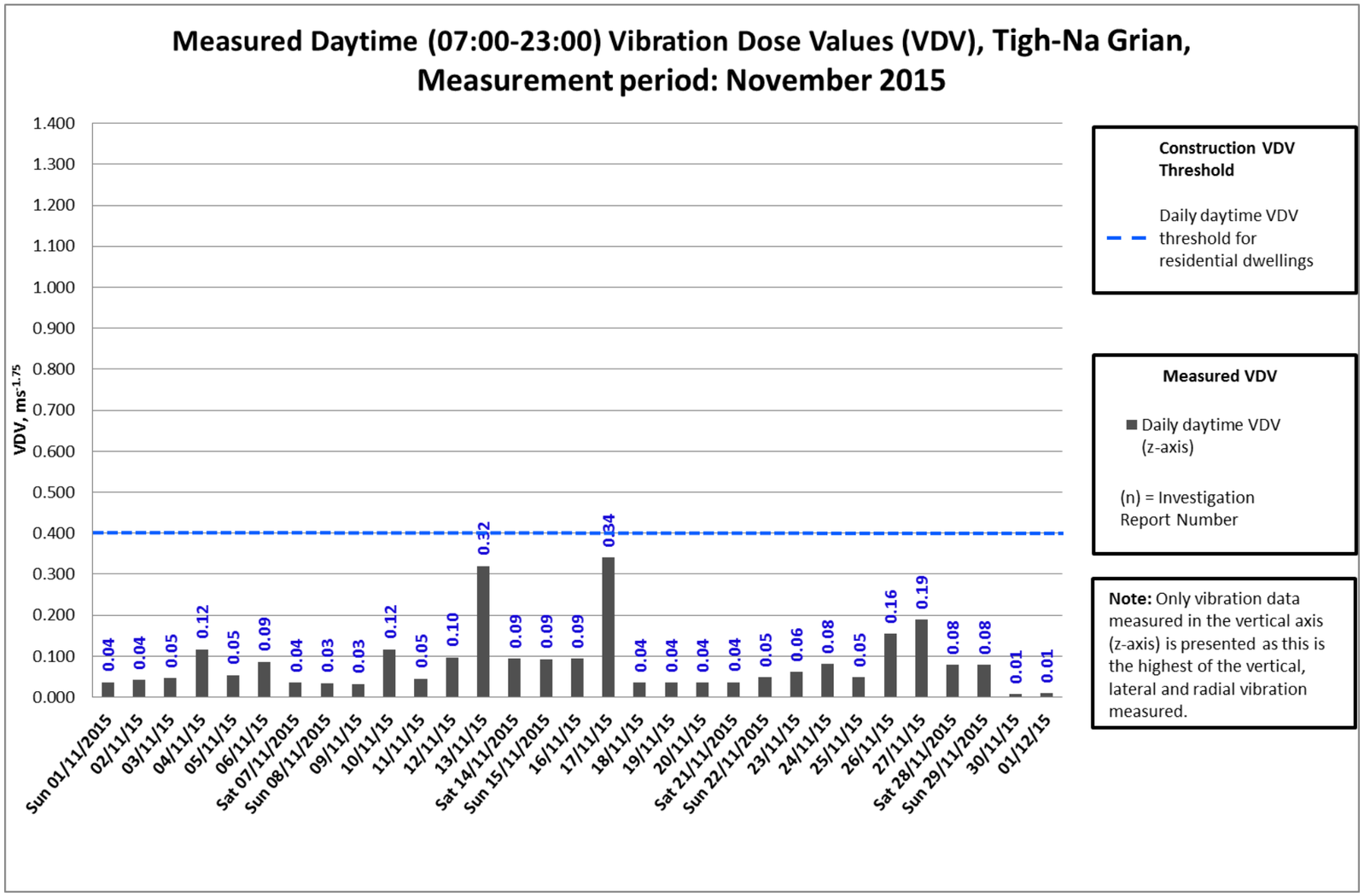
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
01/12/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Tigh-Na Grian,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.04 0.04 0.05 0.12 0.05 0.09 0.04 0.03 0.03 0.12 0.05 0.10 0.32 0.09 0.09 0.09 0.34 0.04 0.04 0.04 0.04 0.05 0.06 0.08 0.05 0.16 0.19 0.08 0.08 0.01 0.01
Sun 01/11/2015
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04/11/15
05/11/15
06/11/15
Sat 07/11/2015
Sun 08/11/2015
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13/11/15
Sat 14/11/2015
Sun 15/11/2015
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19/11/15
20/11/15
Sat 21/11/2015
Sun 22/11/2015
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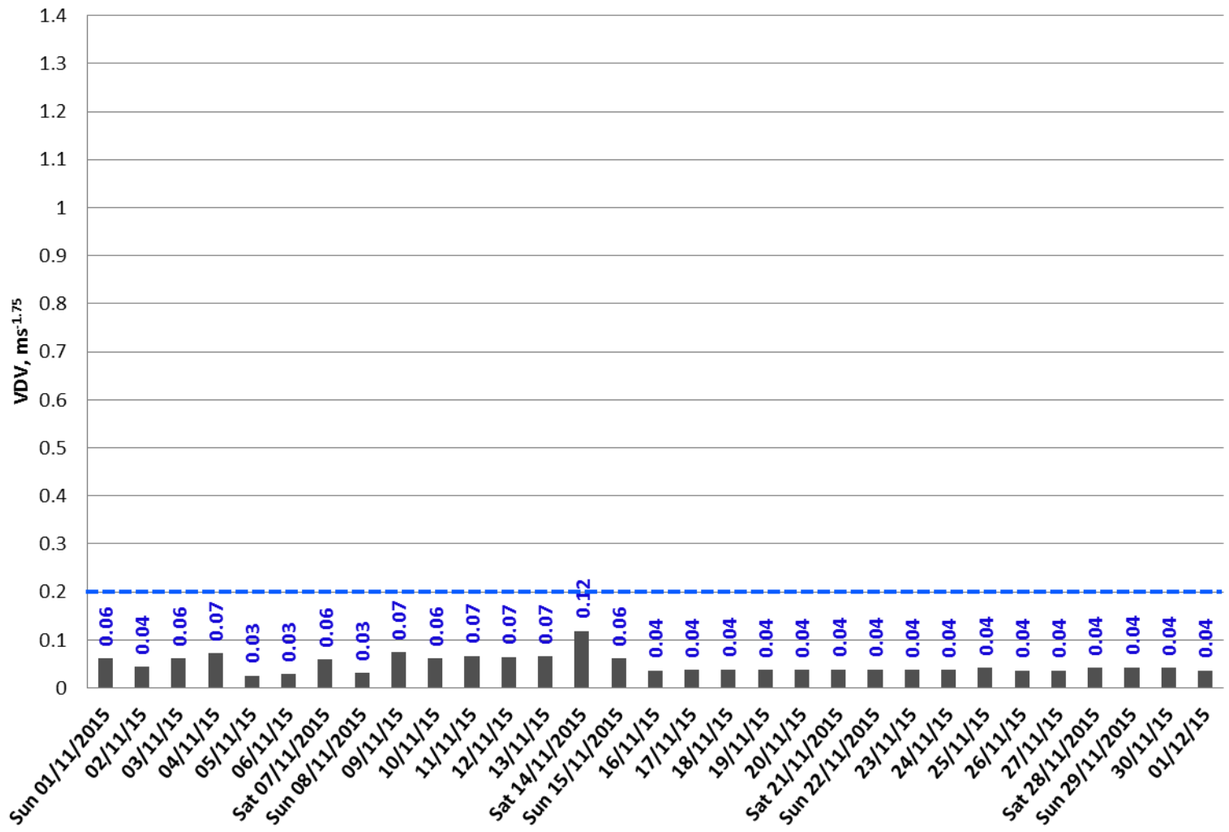
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
01/12/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Tigh-Na Grian, Measurement period: November 2015



Construction VDV Threshold

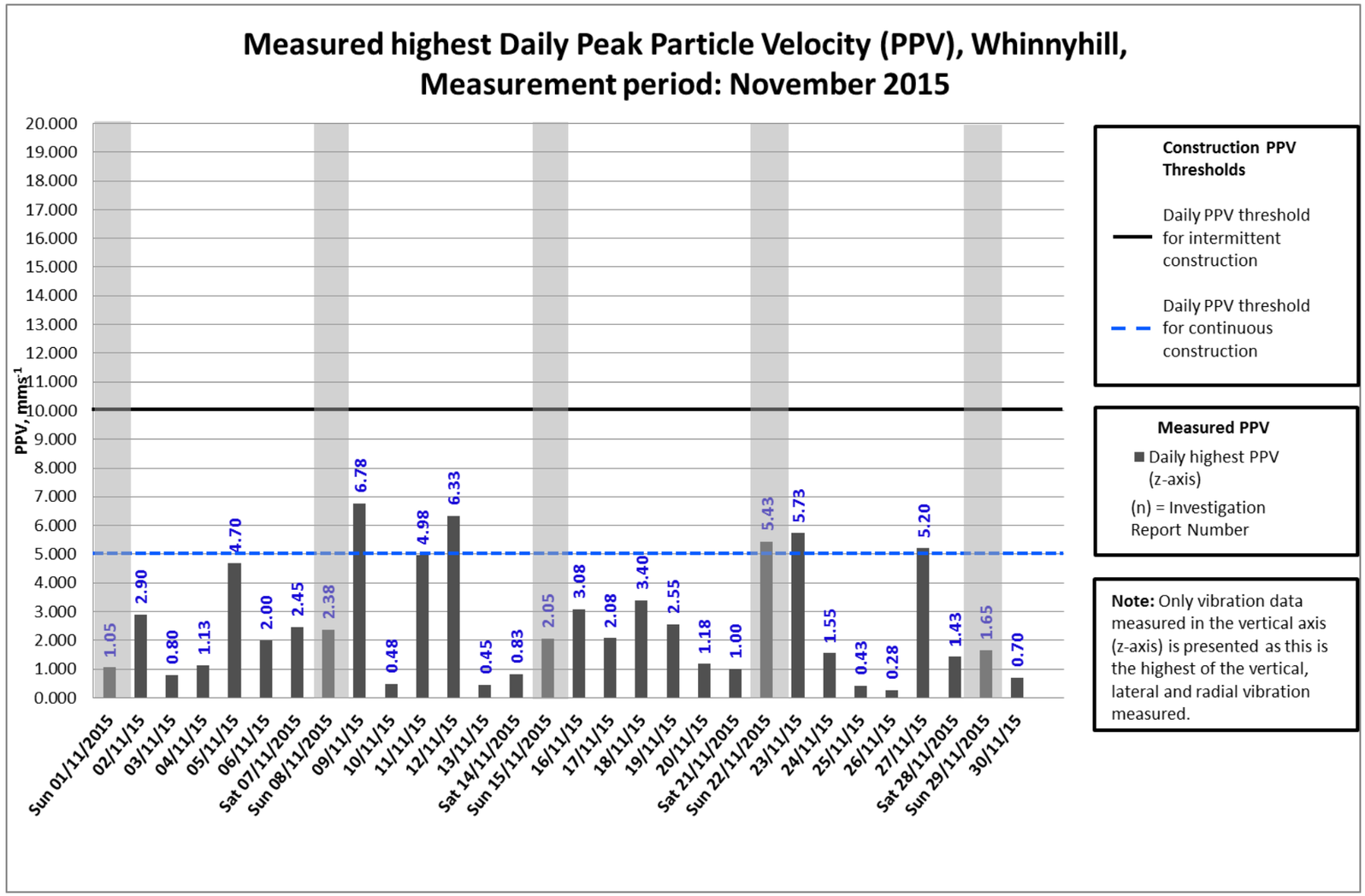
Daily night time VDV threshold for residential dwellings

Measured VDV

Daily night time VDV (z-axis)

(n) = Investigation Report Number

Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured highest Daily Peak Particle Velocity (PPV), Whinnyhill,
Measurement period: November 2015
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
1.05
2.90
0.80
1.13
4.70
2.00
2.45
2.38
6.78
0.48
4.98
6.33
0.45
0.83
2.05
3.08
2.08
3.40
2.55
1.18
1.00
5.43
5.73
1.55
0.43
0.28
5.20
1.43
1.65
0.70
Sun 01/11/2015
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Sun 08/11/2015
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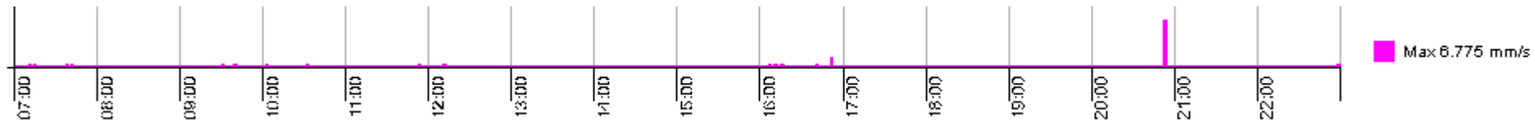
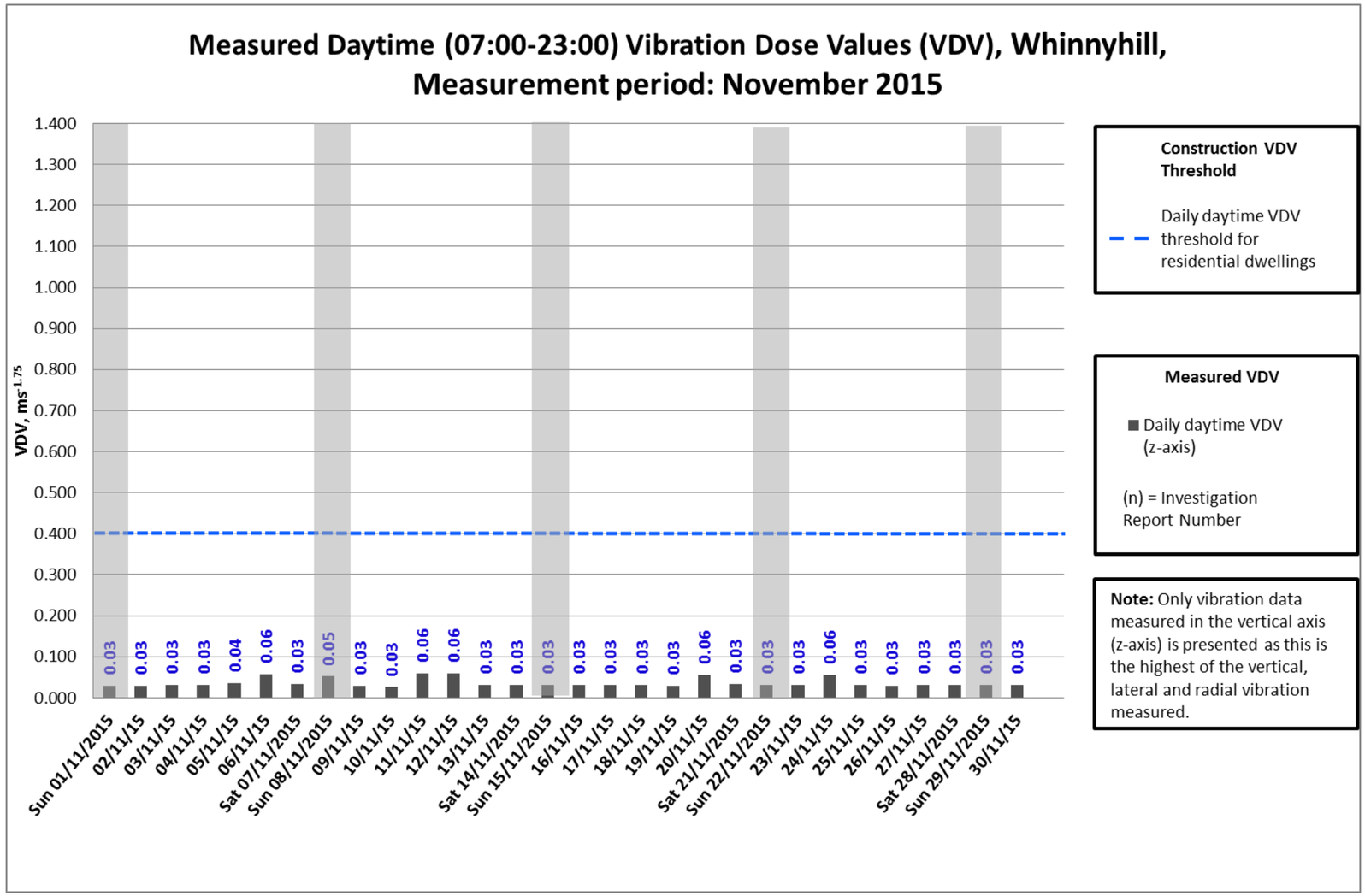
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.



Exceedances on the 9th, 12th, and 22nd of November have been investigated and found to be caused out with construction working hours and are highly unlikely to be caused by construction related activities (graph above from the 09/11/2015).

Exceedances on the 23rd and 27th of November have been investigated and found to be individual isolated events that are highly unlikely to be cause by construction related activities (graph above from the 27/11/2015).


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Whinnyhill,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.03 0.03 0.03 0.03 0.04 0.06 0.03 0.05 0.03 0.03 0.06 0.06 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.06 0.03 0.03 0.03 0.06 0.03 0.03 0.03 0.03 0.03 0.03
Sun 01/11/2015
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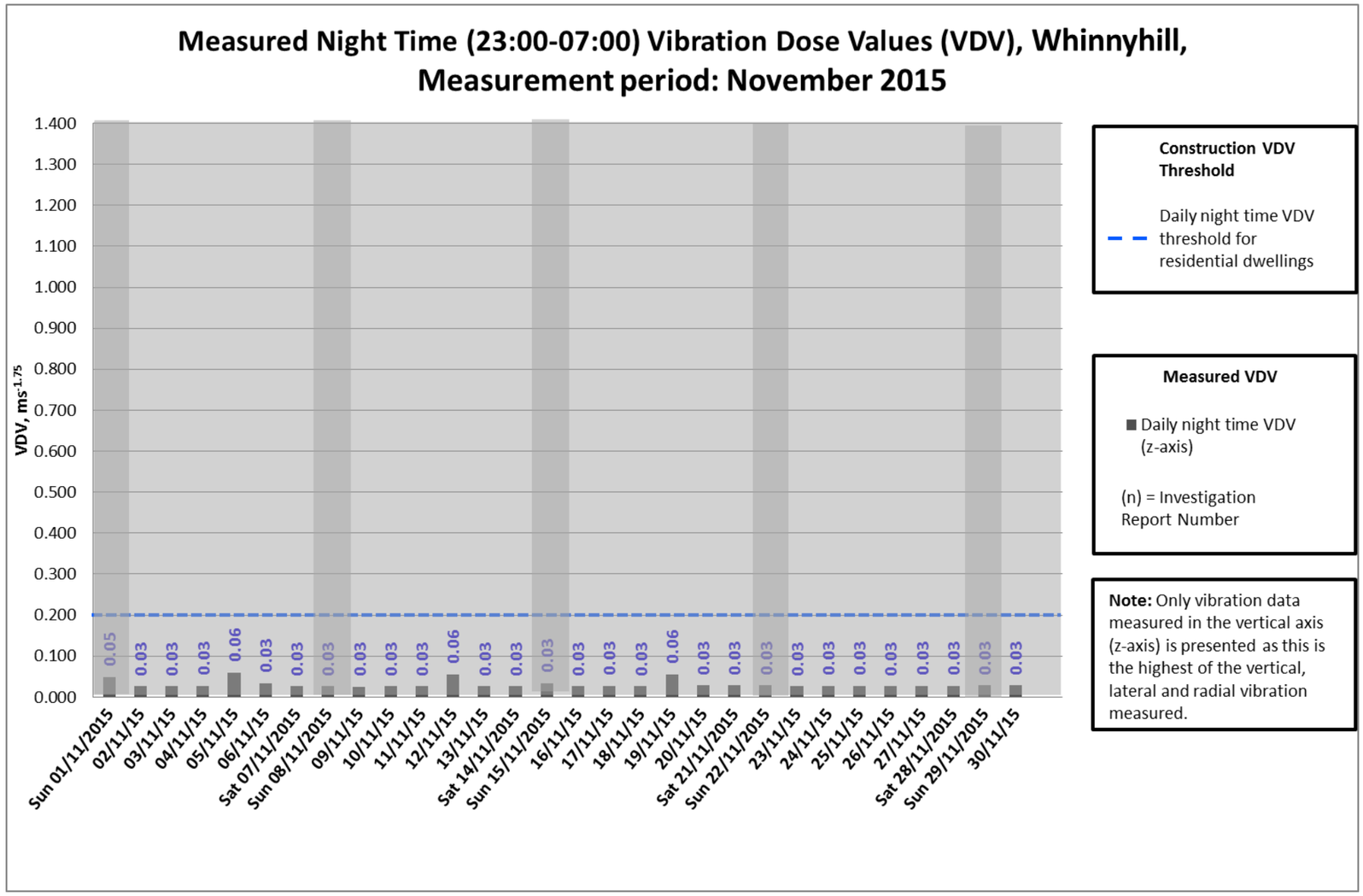
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily daytime VDV threshold for residential dwellings
Measured VDV
Daily daytime VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Whinnyhill,
Measurement period: November 2015
VDV, ms-1.75
1.400
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0.05
0.03
0.03
0.03
0.06
0.03
0.03
0.03
0.03
0.03
0.03
0.06
0.03
0.03
0.03
0.03
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0.06
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Sun 01/11/2015
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Sat 07/11/2015
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24/11/15
25/11/15
26/11/15
27/11/15
Sat 28/11/2015
Sun 29/11/2015
30/11/15
Construction VDV Threshold
Daily night time VDV threshold for residential dwellings
Measured VDV
Daily night time VDV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.