
Contractor

FCBC
Queensferry Crossing

DRAGADOS | AMERICAN BRIDGE INTERNATIONAL
HOCHTIEF | MORRISON CONSTRUCTION

Project

# FORTH REPLACEMENT CROSSING

Document title

# VIBRATION MONITORING REPORT

## AUGUST 2016

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| **Rev** | **Rev. Date** | **Purpose of revision** | **Made** | **Reviewed** | **Approved** |

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| Document number<br>**REP-00290** | Rev<br>00 |

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## 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 August 2016. 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, footsteps or doors being slammed, 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 vibration, and damage resulting solely from well-controlled construction and demolition vibration is rare. There are many other mechanisms that 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 of FCBC construction-related vibration is highly unlikely.

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

**Table 1: Number of exceedances of thresholds set out in the CoCP**

***August 2016***

| 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** | 7 | 4 | 0 | 1 |
| **Butlaw Fisheries** | 2 | 1 | 0 | 0 |
| **Clufflat Brae** | 16 | 1 | 0 | 0 |
| **Dundas Home Farm** | 0 | 0 | 0 | 0 |
| **Echline** | 0 | 0 | 0 | 0 |
| **Inchgarvie Lodge** | 2 | 6 | 1 | 0 |
| **Scotstoun** | 0 | 0 | 0 | 0 |
| **Springfield** | 9 | 20 | 0 | 0 |
| **Tigh-Na-Grian** | 0 | 0 | 0 | 0 |
| **Whinnyhill** | 11 | 4 | 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 of the 3 axis that are 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 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 (night time) or 16-hour (day time) 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 however no exceedances were recorded as a result of the use of this equipment.

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

**2.13.** Within the Appendix B, there are gaps of missing data in the PPV and VDV at all locations. These occurred due to calibration of the vibration monitors.

## 3. CONCLUSION

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

**3.2.** 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 around the monitoring equipment.

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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 August 2016 |
|---|---|---|---|
| M1 | Whinny Hill | Network | • Earthworks/Fill placement<br>• Hope Street roadworks<br>• FT03 & FT04 works<br>• FT19 Works<br>• FT09/10 works<br>• Main carriageway Roadworks<br>• Rock breaking / crushing<br>• Gantry installation |
| M3 | Tigh-Na-Grian | Crossing | • Central Tower rebar, formwork, concreting works deck section lifts and stay cable installation works<br>• North Tower rebar, formwork, concreting works deck section lifts and stay cable installation works<br>• AVN Rebar and concrete works |
| M7 | Butlaw Fisheries | Crossing | • Central Tower rebar, formwork, concreting works deck section lifts and stay cable installation works<br>• South Tower rebar, formwork, concreting works deck section lifts and stay cable installation works<br>• Pier S1 works<br>• Pier S2 works<br>• Pier S3 Hydro-demolition<br>• AVS rebar & concrete deck works |
| M10 | Inchgarvie Lodge | Crossing | • Central Tower rebar, formwork, concreting works deck section lifts and stay cable installation<br>• South Tower rebar, formwork, concreting works deck section lifts and stay cable installation<br>• Pier S1 works<br>• Pier S2 works<br>• Pier S3 Hydro-demolition<br>• AVS rebar & concrete deck works<br>• South Abutment works<br>• Main carriageway roadworks<br>• Excavation of SuDS detention basin<br>• Gantry installation |
| M11 | Linn Mill | Network (close proximity to Crossing) | • AVS rebar & concrete deck works<br>• Main carriageway roadworks<br>• South Abutment works<br>• Excavation of SuDS detention basin<br>• Gantry installation |
| M13 | Clufflat Brae | Crossing | • AVS rebar & concrete deck works<br>• Main carriageway roadworks<br>• South Abutment works<br>• Gantry installation |
| M14 | Springfield | Network | • AVS rebar & concrete deck works<br>• Main carriageway roadworks<br>• South abutment works<br>• Gantry installation |
| M15 | Echline | Network | • AVS rebar & concrete deck works |

| | | | |
|---|---|---|---|
| | | | • South abutment works<br>• Main carriageway roadworks<br>• Gantry installation |
| M16 | Scotstoun | Network | • Footpath works<br>• Utility works<br>• B800 North and South road works including bridge works<br>• ESQ11 works<br>• Mainline roadworks<br>• Gantry installation |
| M17 | Dundas Home Farm | Network | • Utility works<br>• B800 North and South roadworks including bridge works<br>• Mainline roadworks<br>• Gantry installation |

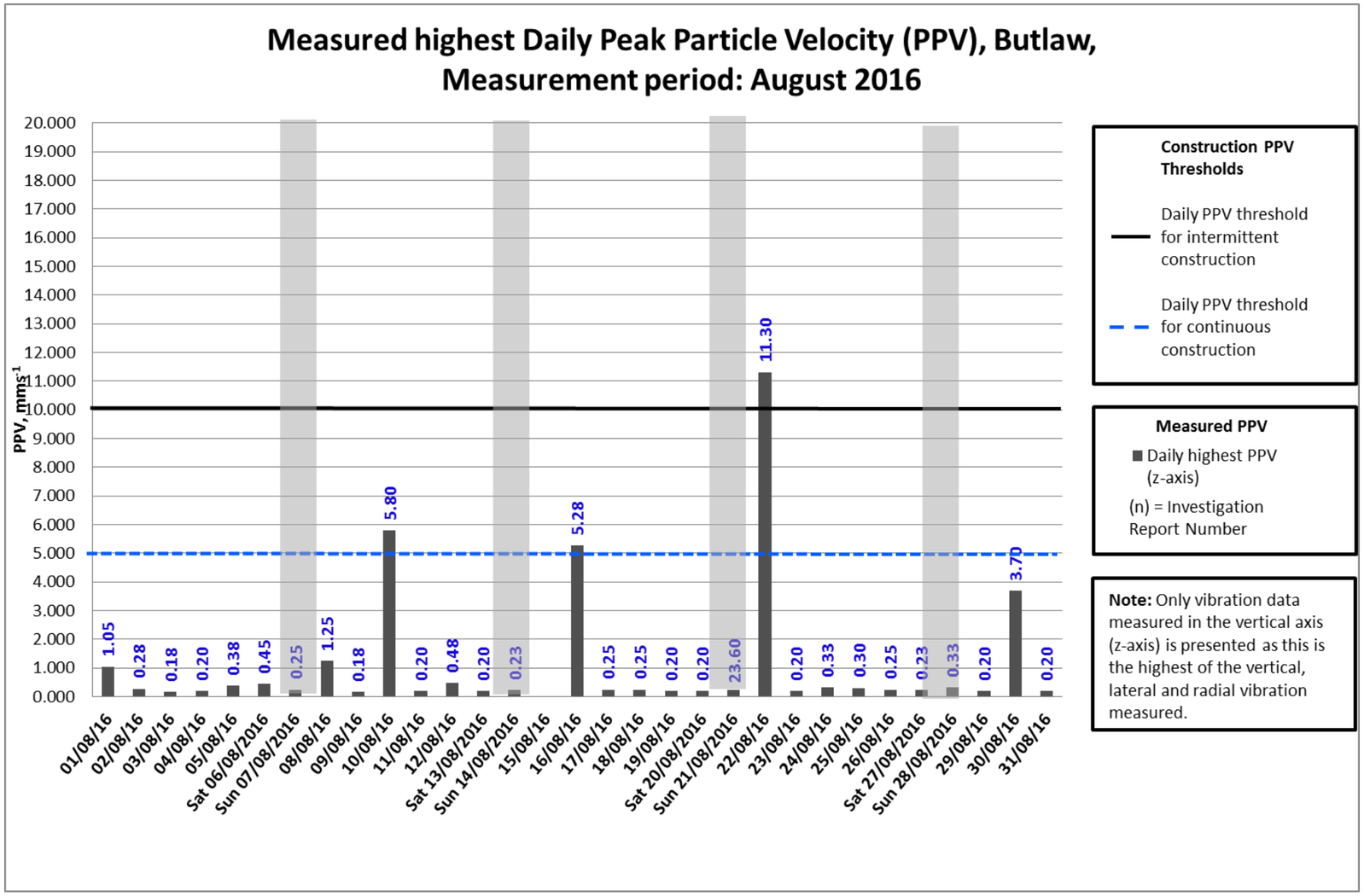
**Table 3: PCNV Predicted PPV & VDV Levels**

| 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 | 75 | 2000 | Roller/Whacker | 0.98 | 0.33 |
| 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 | 40 | 2000 | Roller/Whacker | 2.44 | 0.37 |
| Springfield | 50 | 300 | Roller/Whacker | 1.77 | 0.33 |
| Tigh-Na-Grian | 200 | 200 | N/A | - | - |
| Whinny Hill | 180 | 1800 | Roller/Whacker | 0.383 | 0.04 |

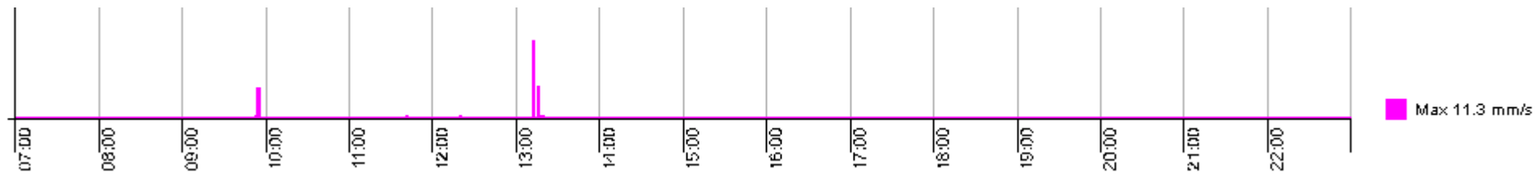
**Notes on Table 3**

- All plant used during construction activities has been assessed with respect to vibration. The only plant utilised 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 an average distance (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 a minimum distance from the nearest receptor.

# APPENDIX B – VIBRATION GRAPHS

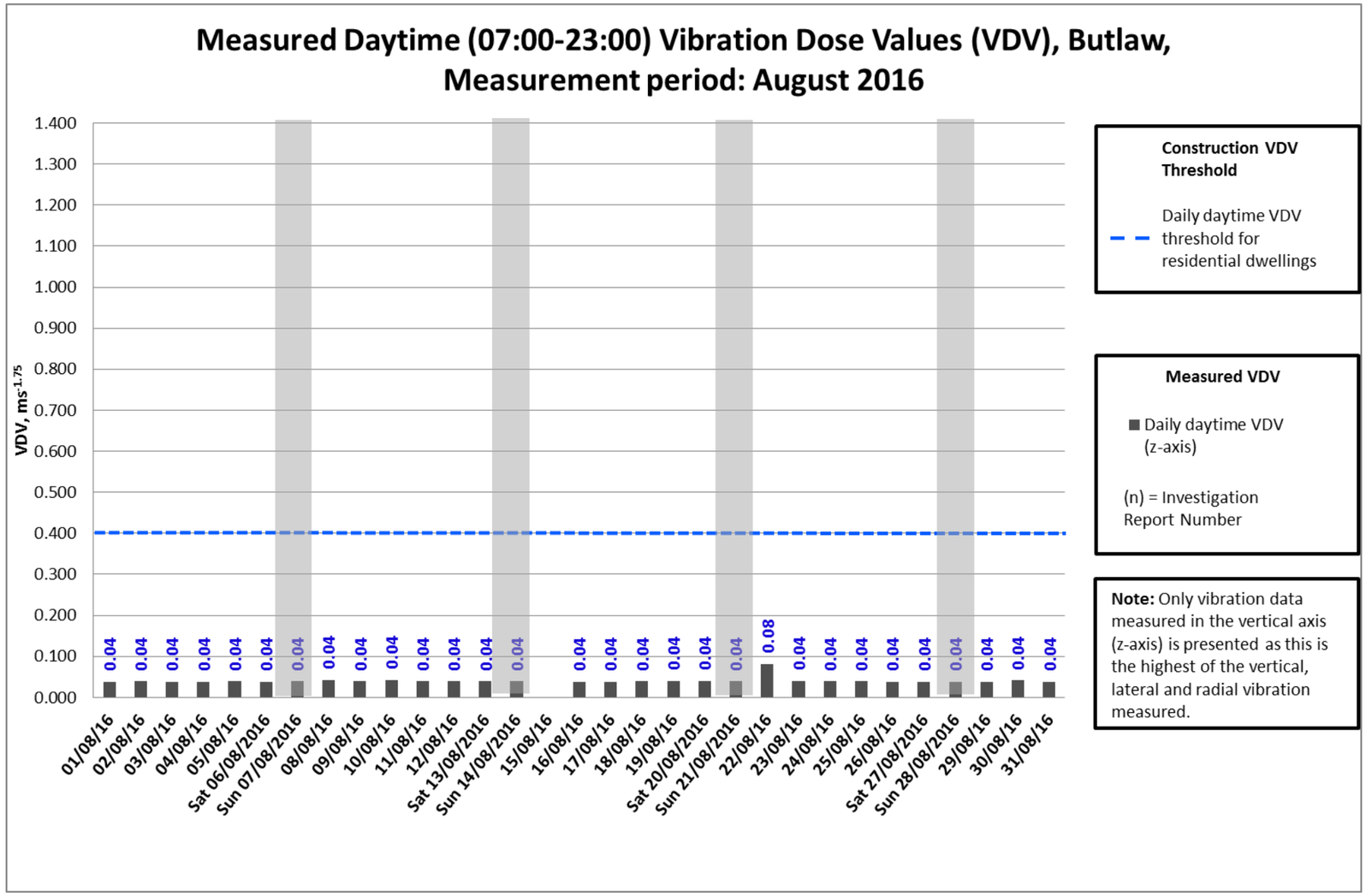

Measured highest Daily Peak Particle Velocity (PPV), Butlaw,
Measurement period: August 2016
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
1.05
0.28
0.18
0.20
0.38
0.45
0.25
1.25
0.18
5.80
0.20
0.48
0.20
0.23
5.28
0.25
0.25
0.20
0.20
23.60
11.30
0.20
0.33
0.30
0.25
0.23
0.33
0.20
3.70
0.20
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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 10th and 16th of August have been investigated and were found to be caused by the environmental department carrying out calibration/ maintenance on the noise and vibration monitors.

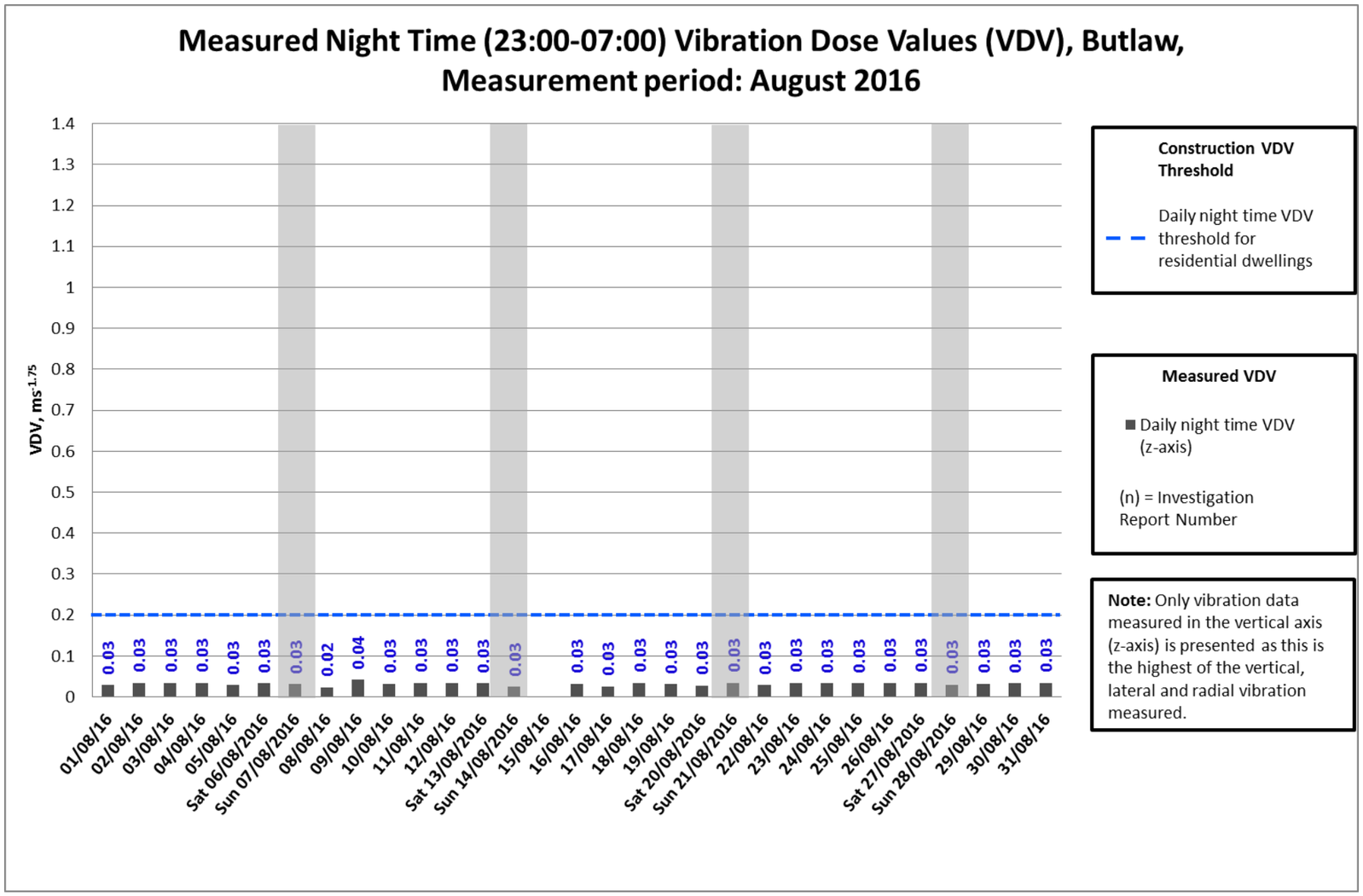



Exceedance on the 22nd August has been investigated and found to be caused by the resident cutting the grass where the vibration is situated at approximately 1320. Exceedance at approximately 0950 has been investigated and found to be caused by the environmental department carrying out maintenance on the noise monitor.

Data missing on the 15th August was caused by the annual calibration of the vibration monitor.




Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.

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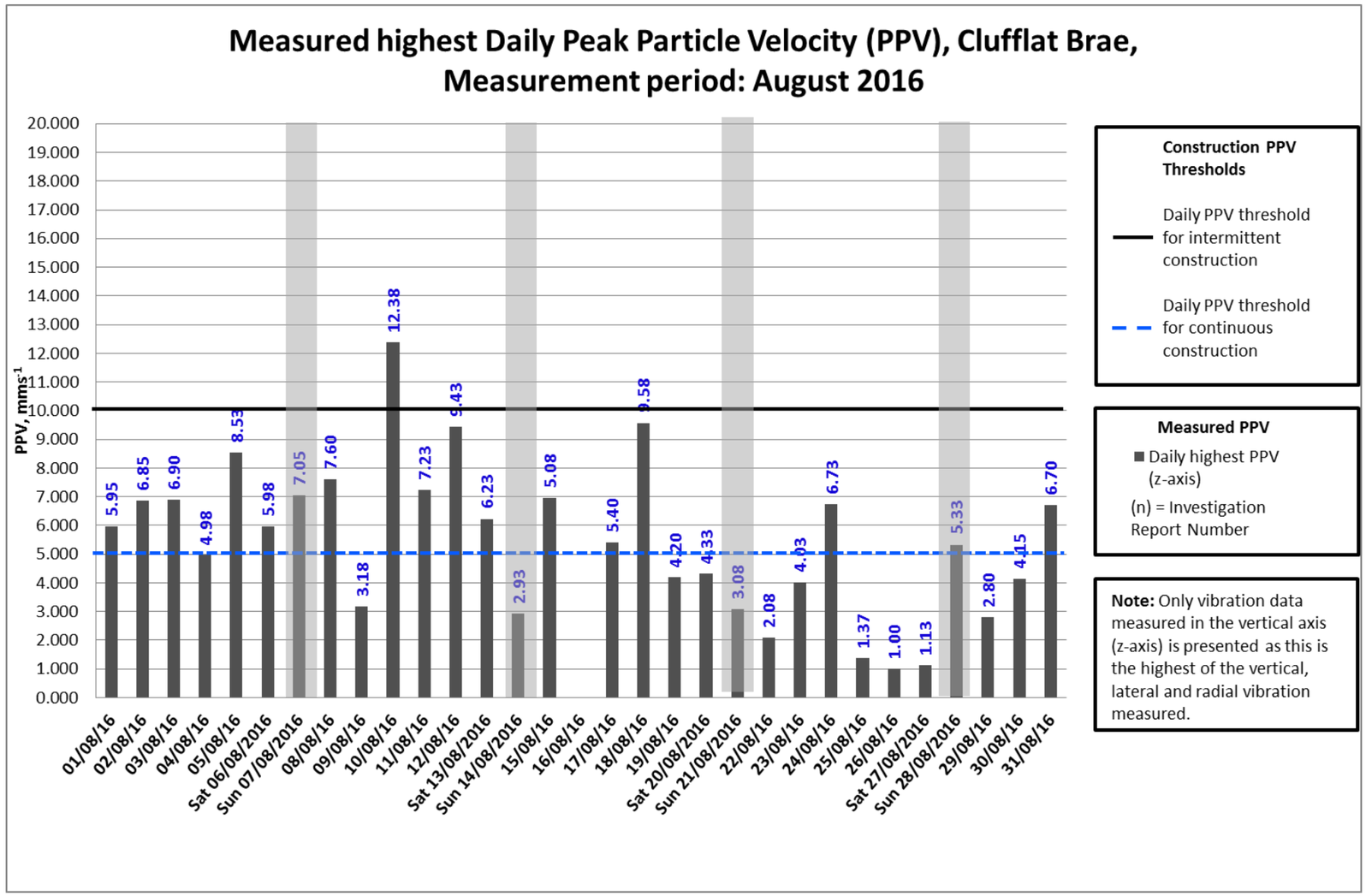
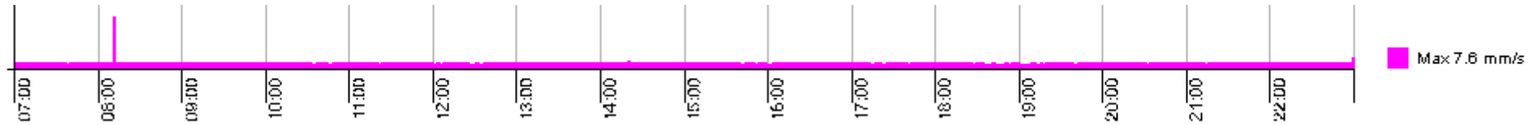
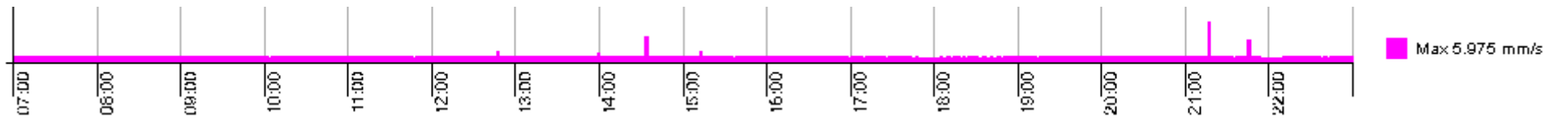

Measured highest Daily Peak Particle Velocity (PPV), Clufflat Brae,
Measurement period: August 2016
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
5.95
6.85
6.90
4.98
8.53
5.98
7.05
7.60
3.18
12.38
7.23
9.43
6.23
2.93
5.08
5.40
9.58
4.20
4.33
3.08
2.08
4.03
6.73
1.37
1.00
1.13
5.33
2.80
4.15
6.70
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.

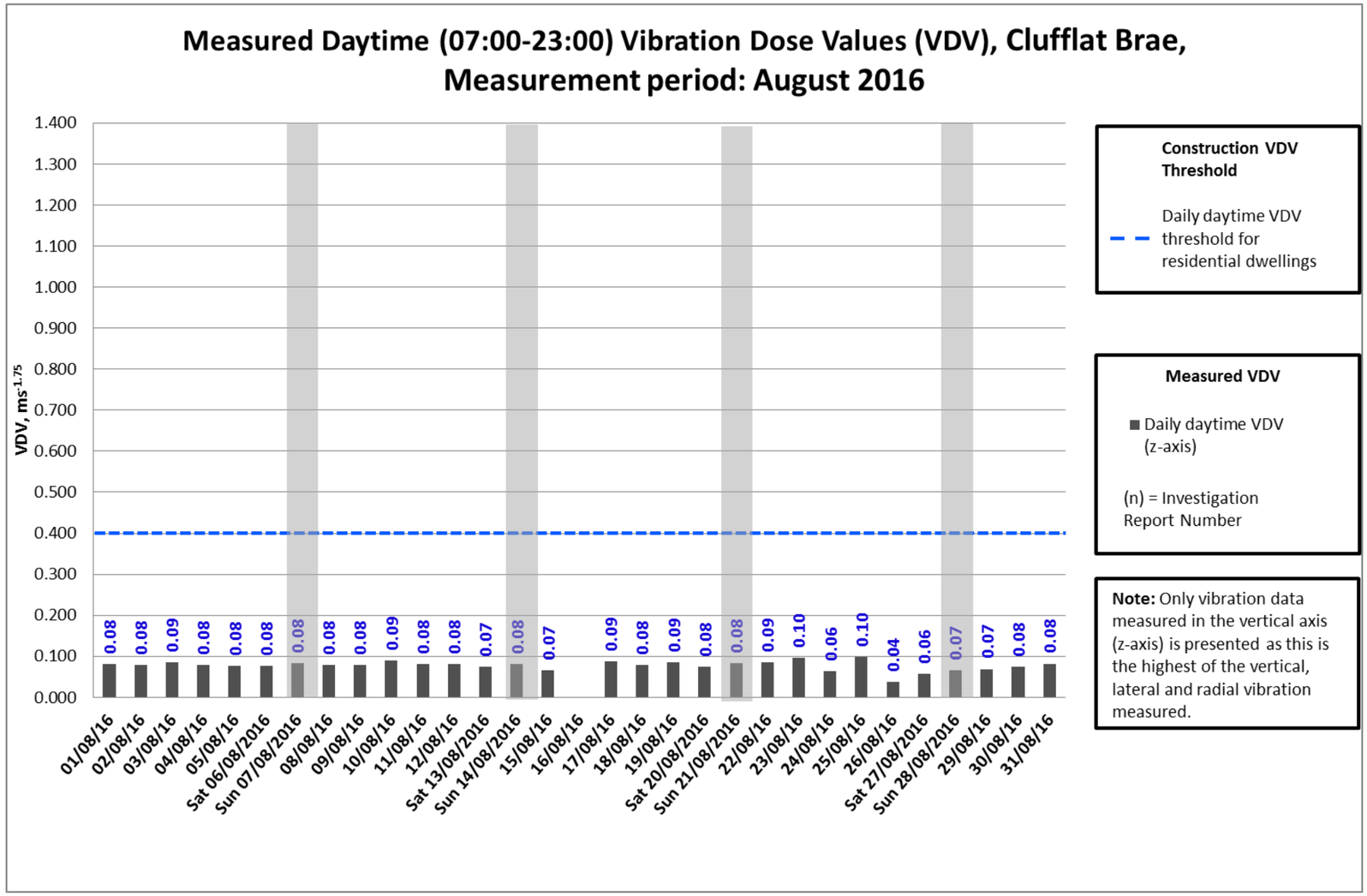



Exceedances on the 1st, 2nd, 3rd, 5th, 8th, 11th, 15th, 17th and 31st have been investigated and found to be caused by individual isolated events (graph above from the 08/08/2016). With the monitor being located in a public amenity area there is a likelihood that the exceedances seen above have been caused by pedestrian use of this area. However it is worth noting during this period there has been excavation works ongoing at the Suds pond east of the south abutment approximately 30m away. Due to this and the fact there isn't any supporting evidence to state otherwise these exceedances may have been caused by these works.




Exceedances on the 6th, 7th, 10th, 12th, 13th, 18th, 24th and 28th of August have been investigated and found to be caused out with construction working hours and therefore it is unlikely that construction related activity was the cause of these events (graph above from the 06/08/2016).

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

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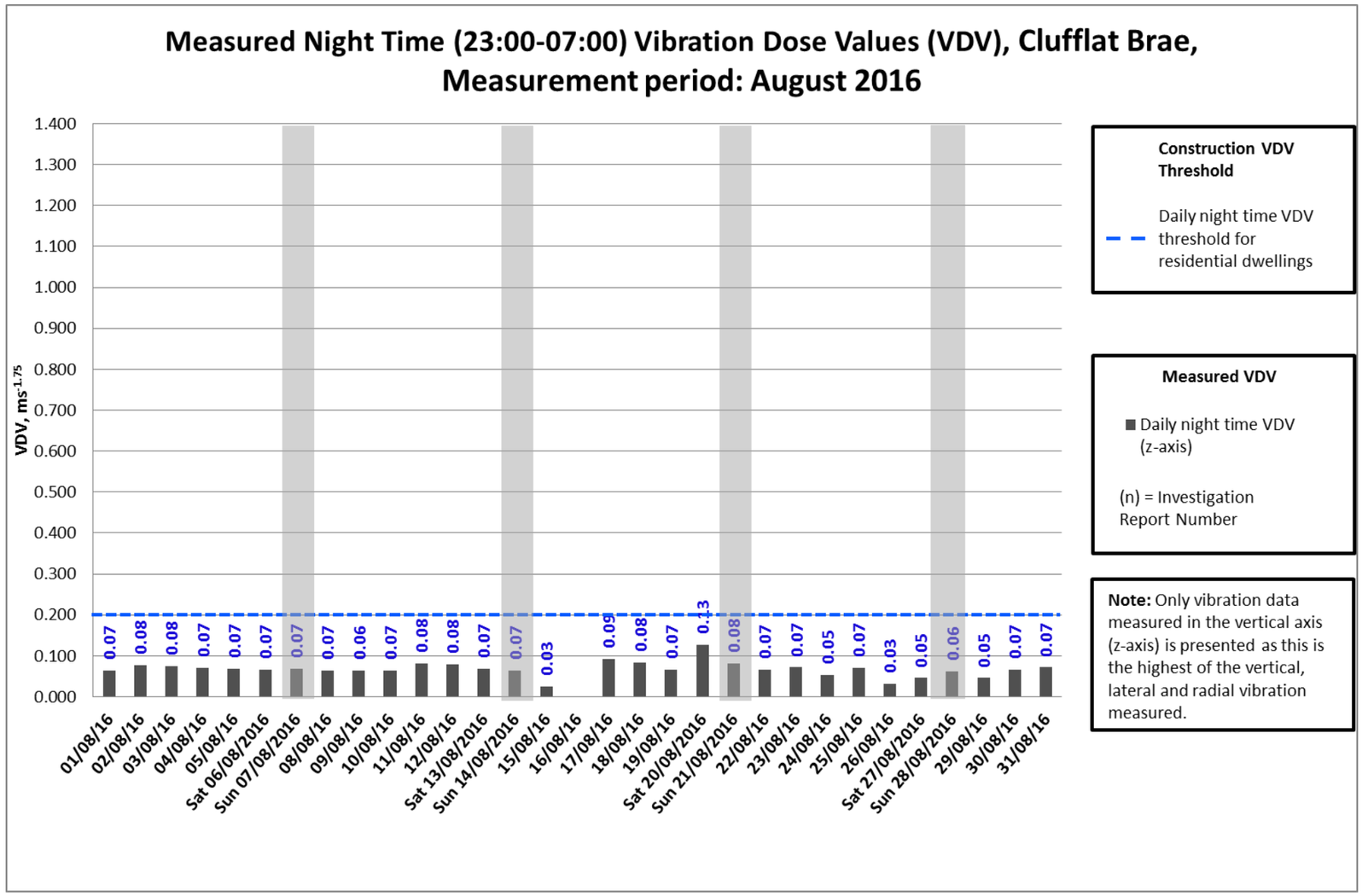


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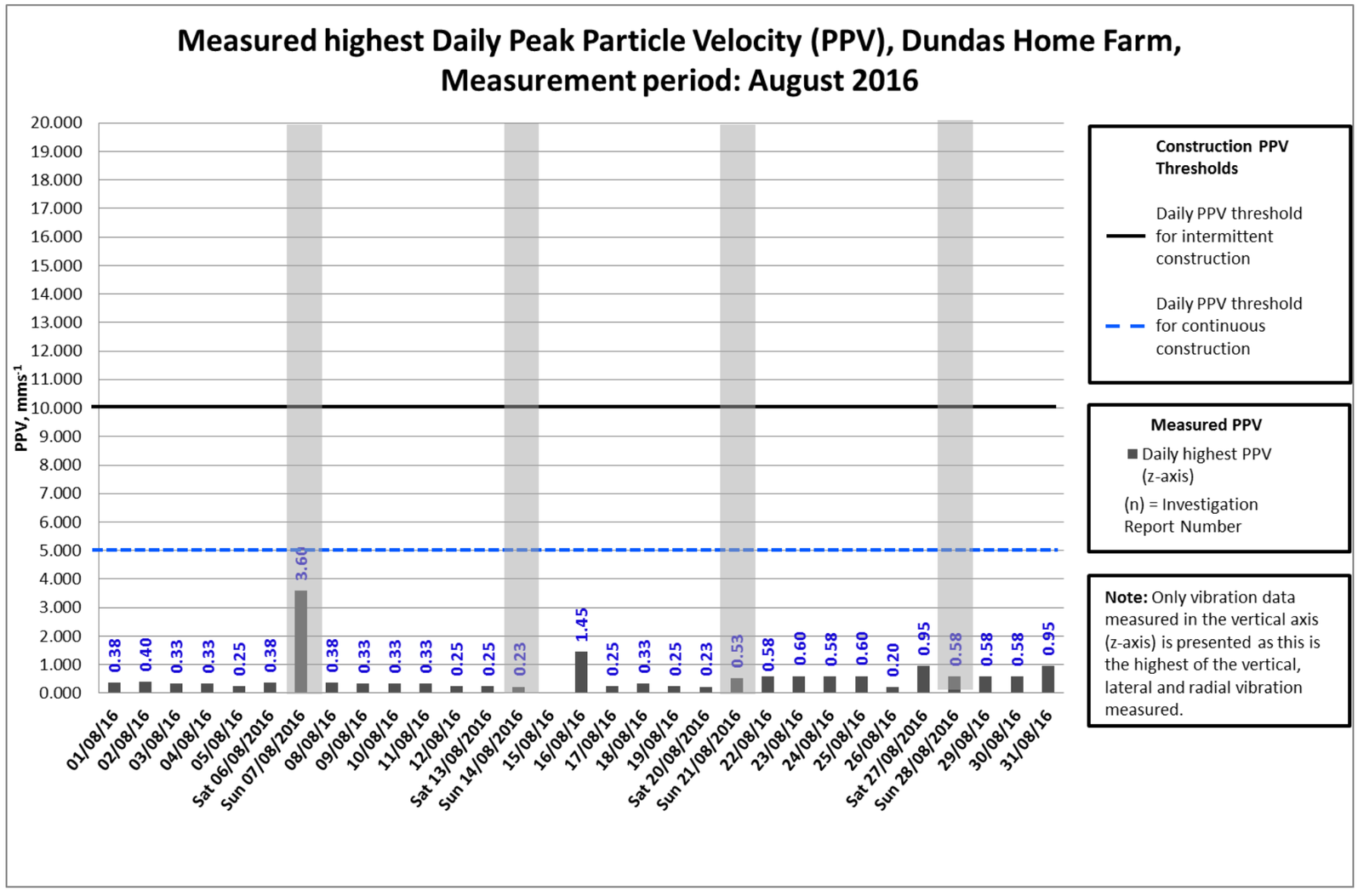


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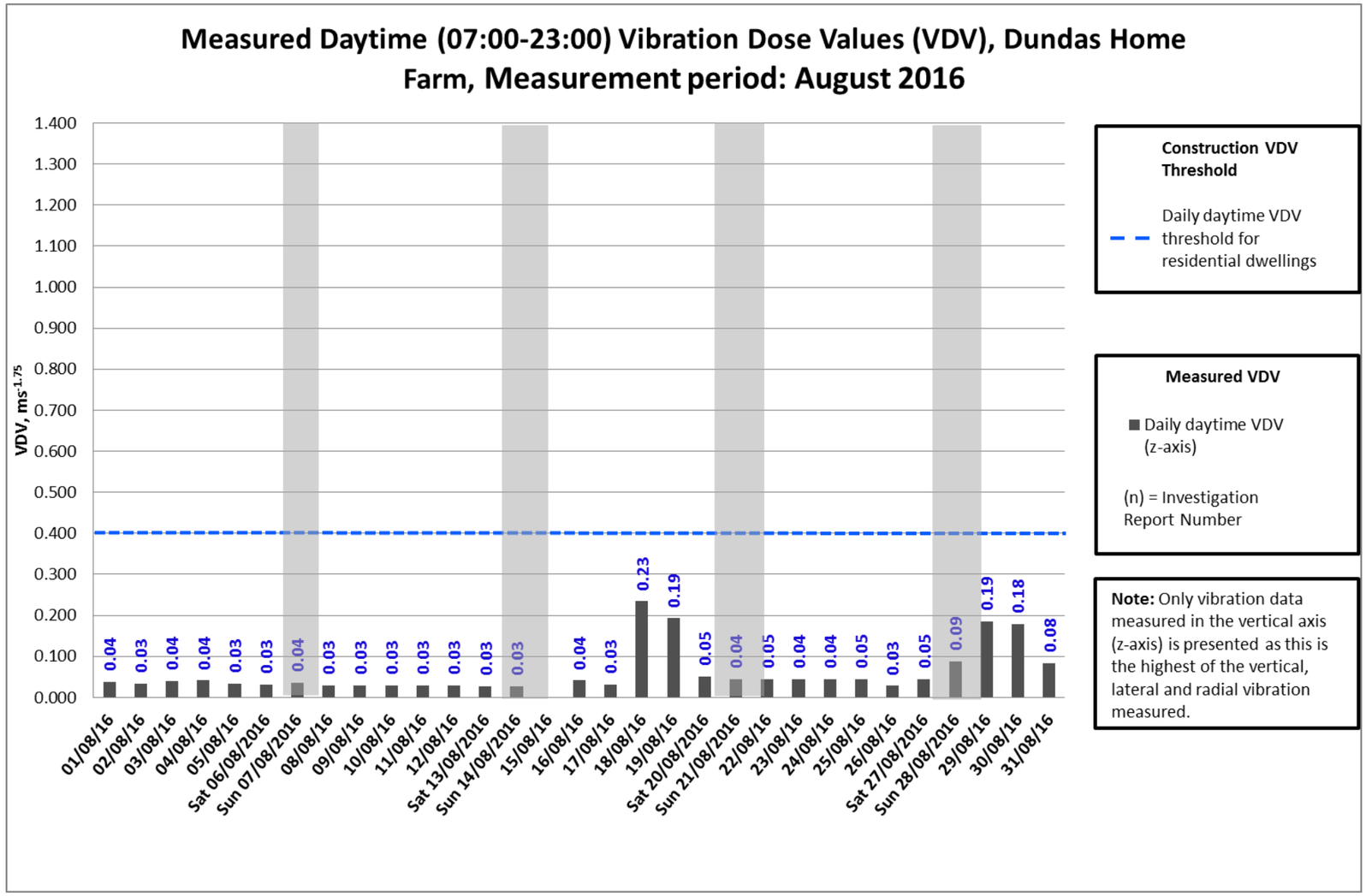


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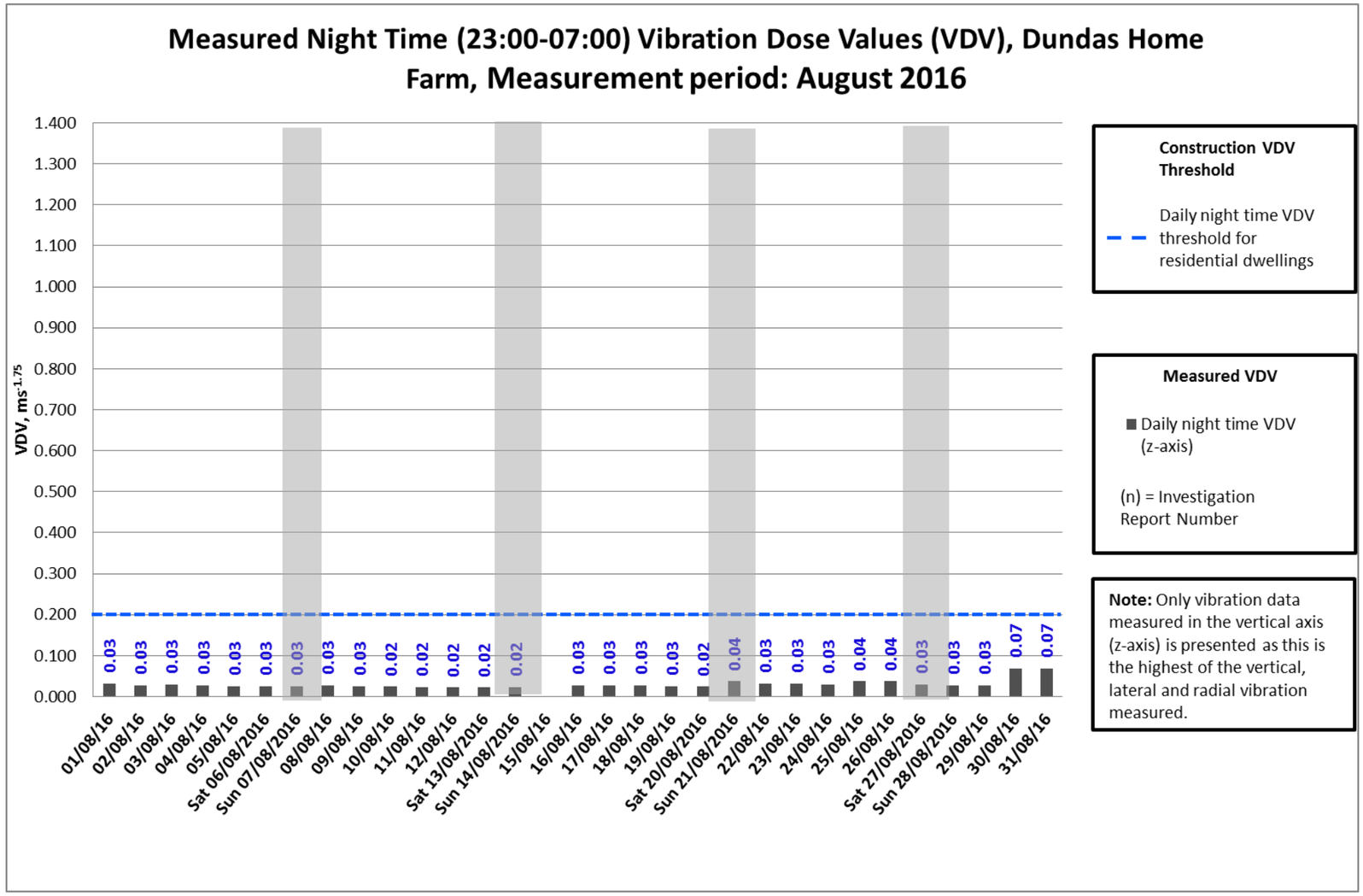


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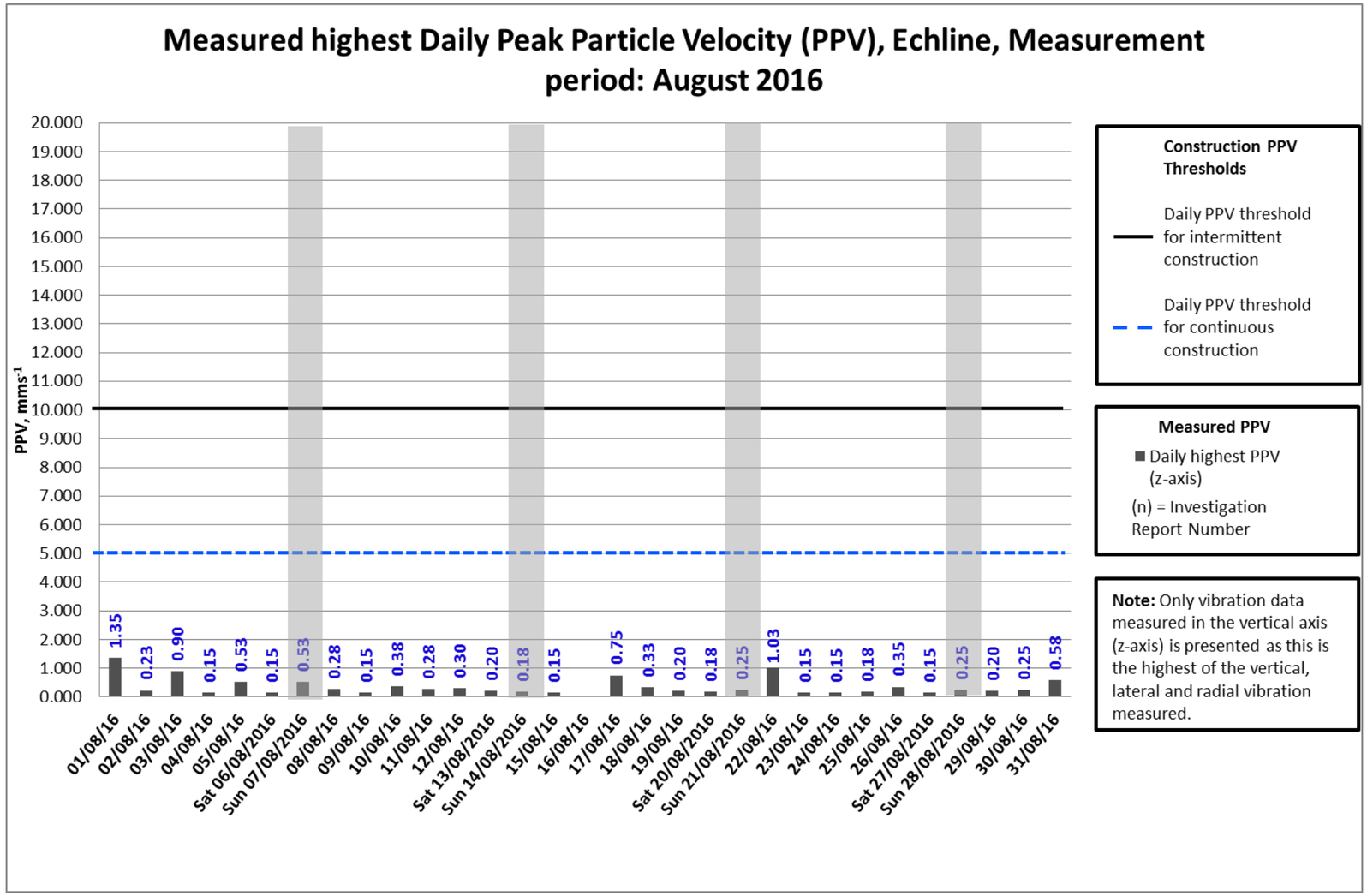


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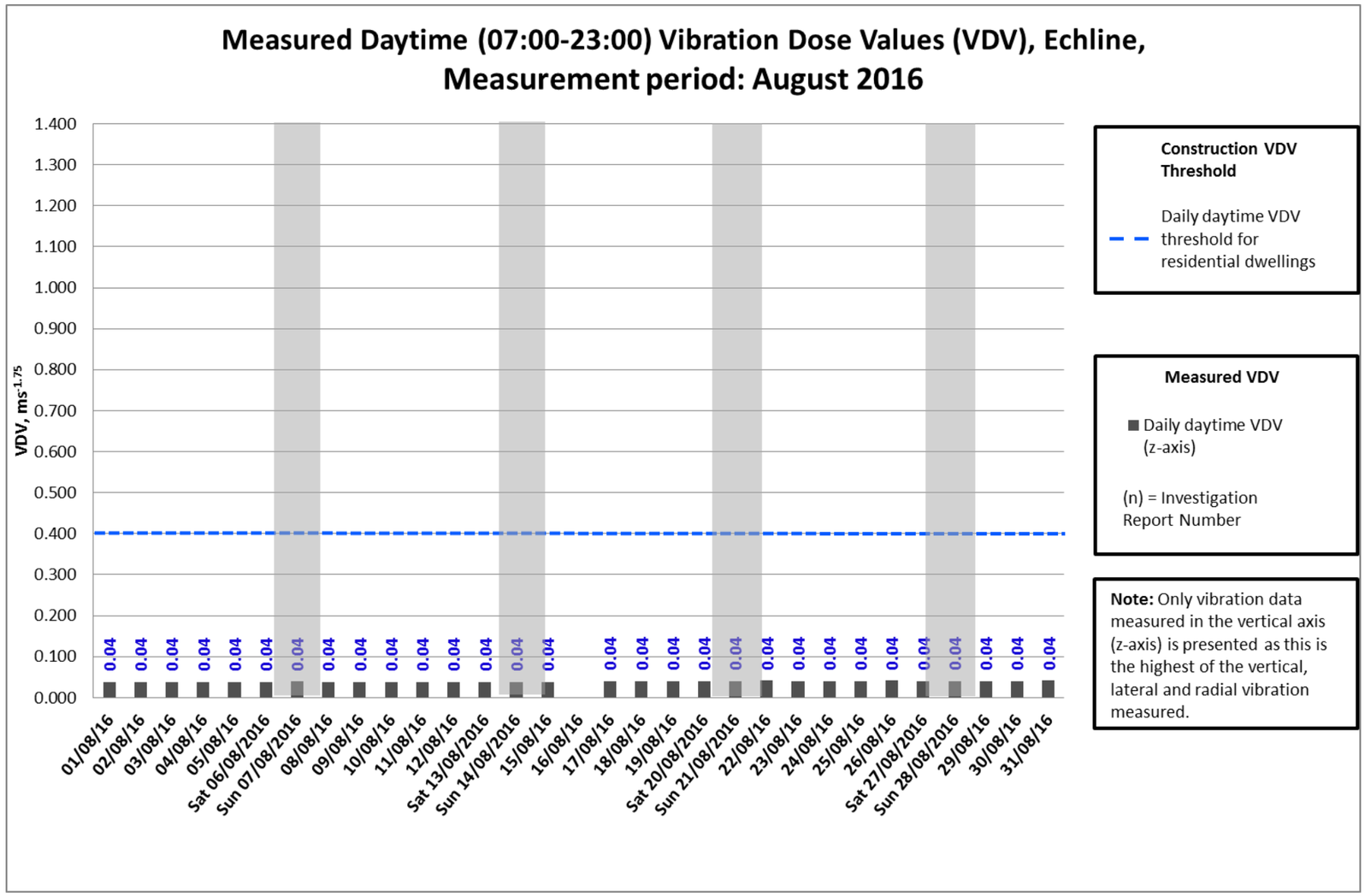


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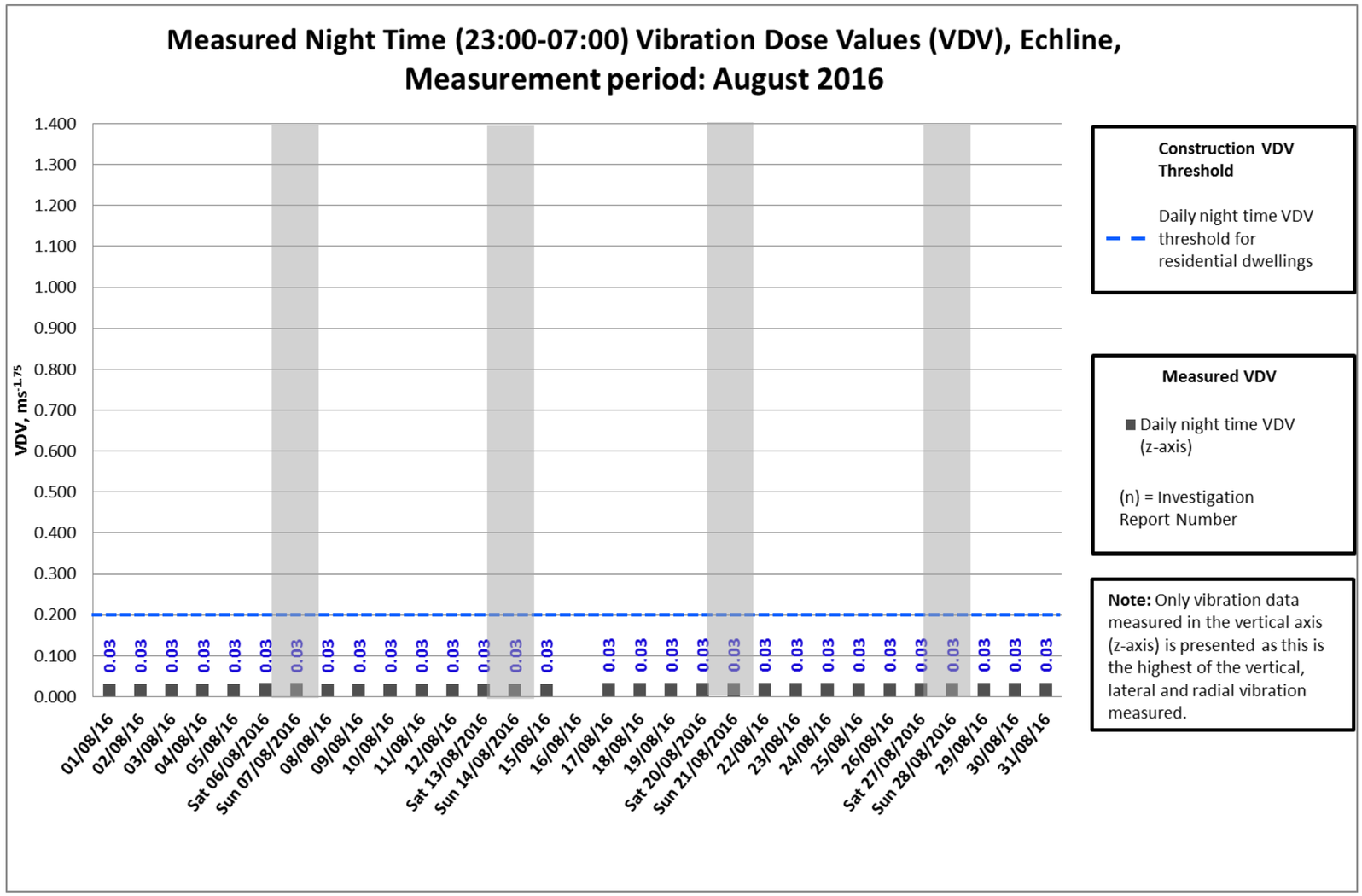


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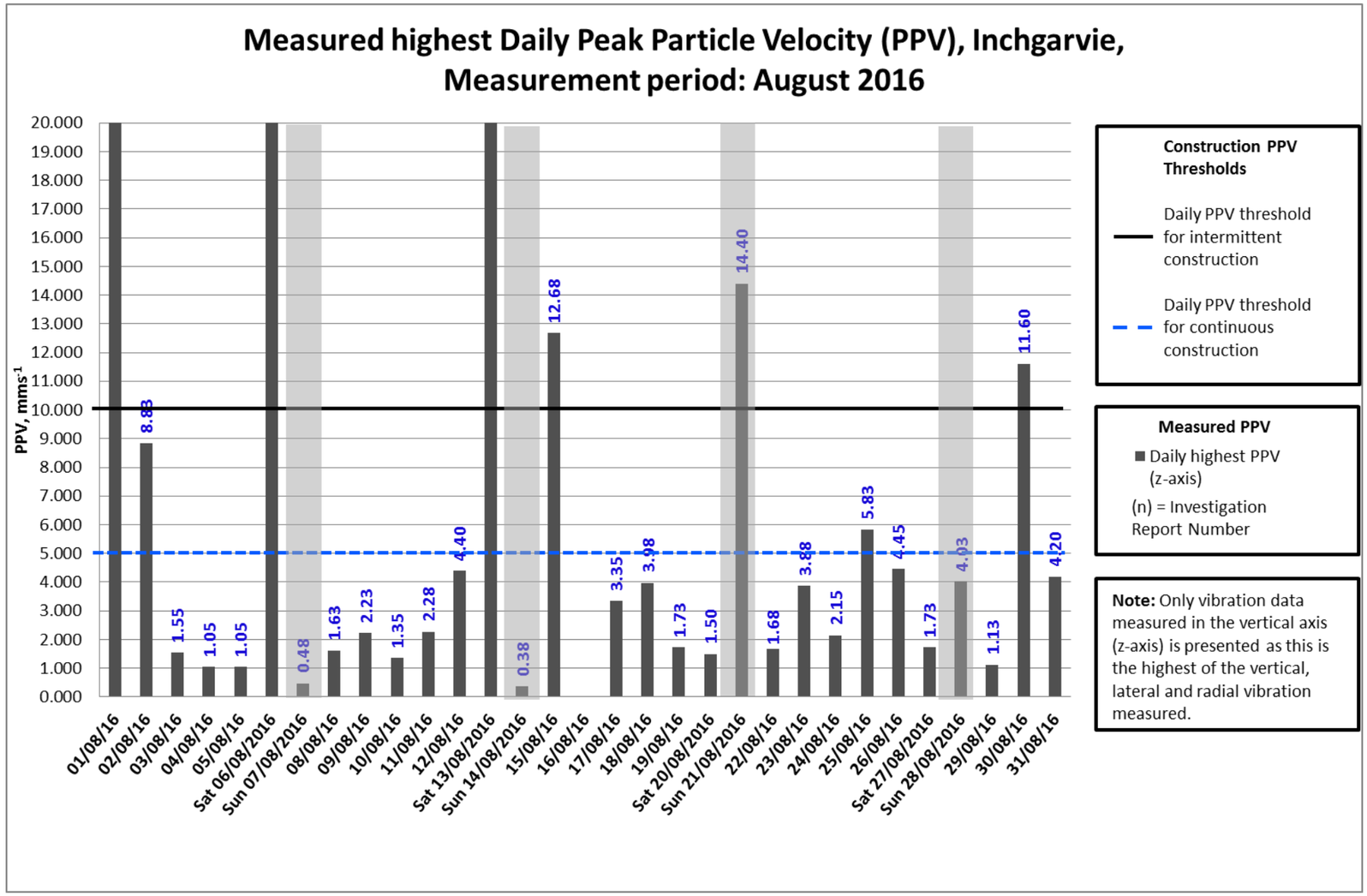
Measured highest Daily Peak Particle Velocity (PPV), Inchgarvie,
Measurement period: August 2016
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
8.88
1.55
1.05
1.05
0.48
1.63
2.23
1.35
2.28
4.40
0.38
12.68
3.35
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14.40
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3.88
2.15
5.83
4.45
1.73
4.93
1.13
11.60
4.20
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
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10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
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17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
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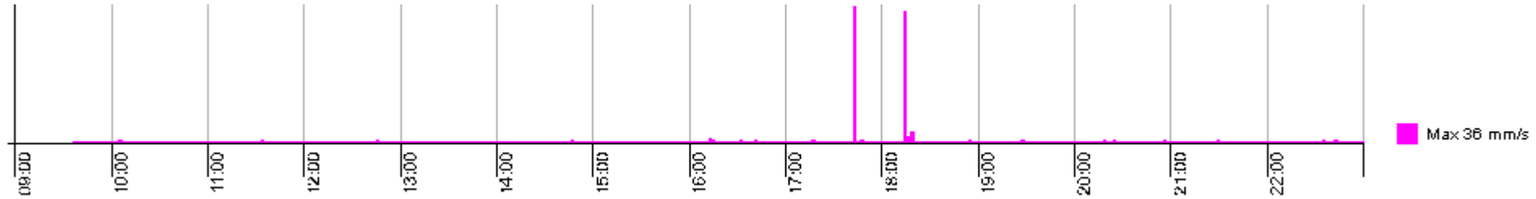
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
Construction PPV Thresholds
Daily PPV threshold for intermittent construction
Daily PPV threshold for continuous construction
Measured PPV
Daily highest PPV (z-axis)
(n) = Investigation Report Number
Note: Only vibration data measured in the vertical axis (z-axis) is presented as this is the highest of the vertical, lateral and radial vibration measured.

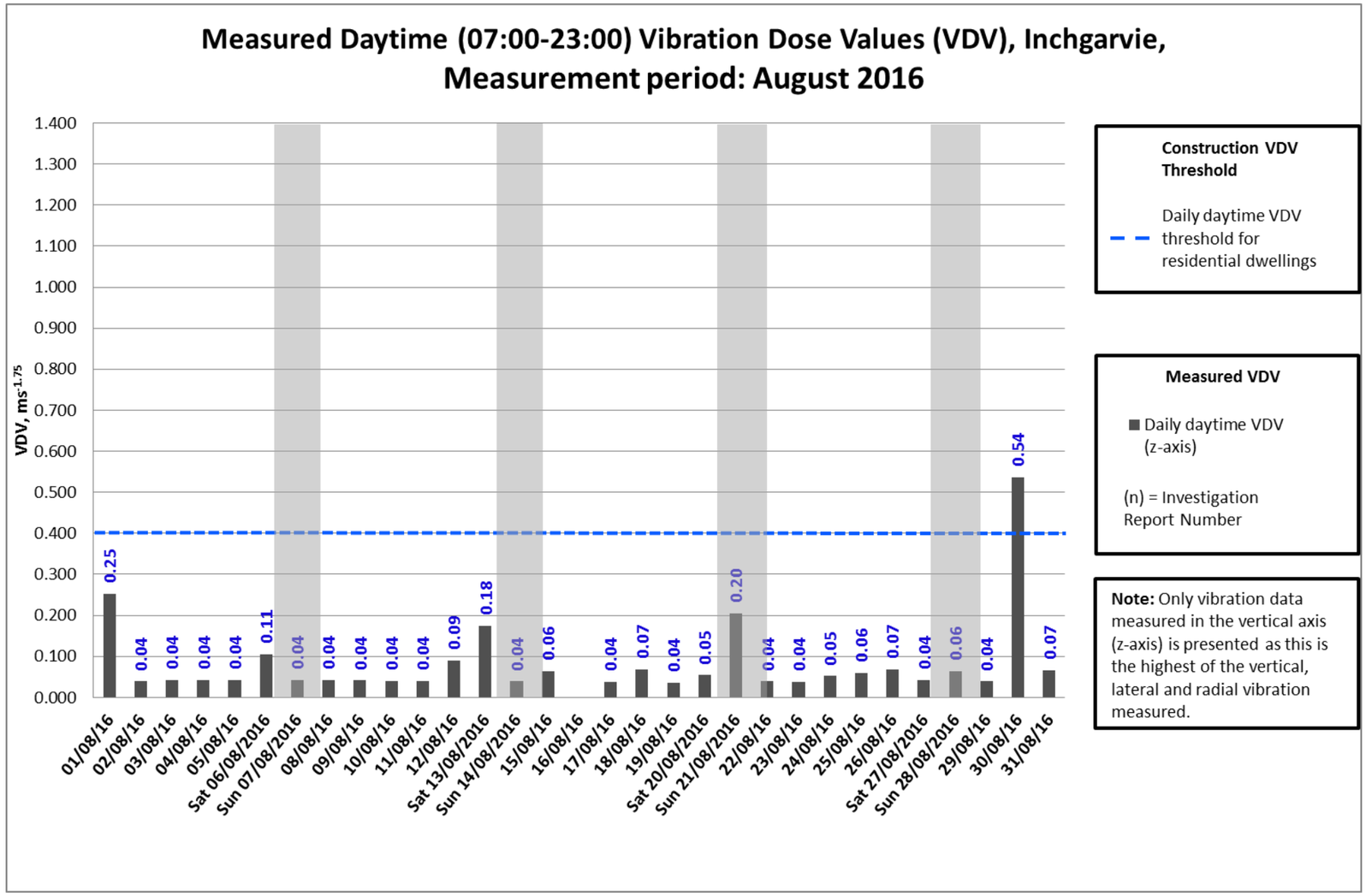

Exceedances on the 2nd, 13th, 15th and 21st of August have been investigated and found to be caused by individual isolated events that are unlikely to have been construction related activities (graph above from the 02/08/2016). During this period, the resident at the property where the monitor is situated had ongoing private construction works. It is likely that exceedances within the graph above were caused by the private works at the property, rather than construction activities connected with the new bridge crossing and supporting infrastructure. However it is worth noting during this period that there has been excavation works ongoing at the SuDS pond east of the south abutment, approximately 40m away. Due to the proximity of the excavation works and the fact there isn't any supporting evidence to state otherwise, these exceedances may have been caused by these works.

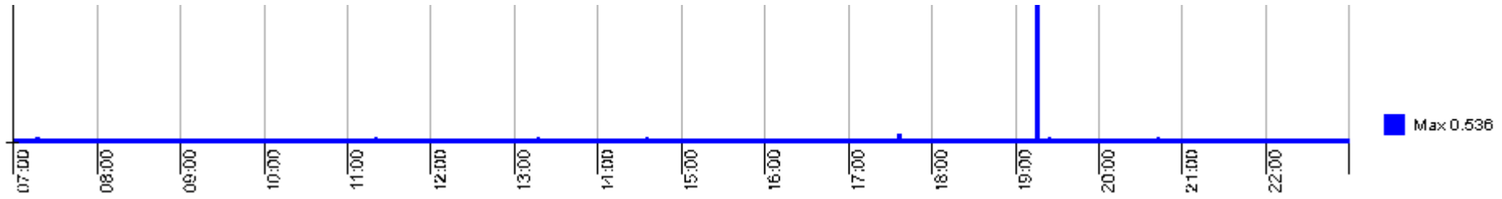

Exceedances on 25th and 30th of August have been investigated and found to have been caused out with construction working hours and therefore it is unlikely that construction related activates were the cause of these events (graph above from the 30/08/2016).




Exceedances on the 1st and 6th of August have been investigated and found to have been caused by the resident cutting the grass close to where the monitor was situated.

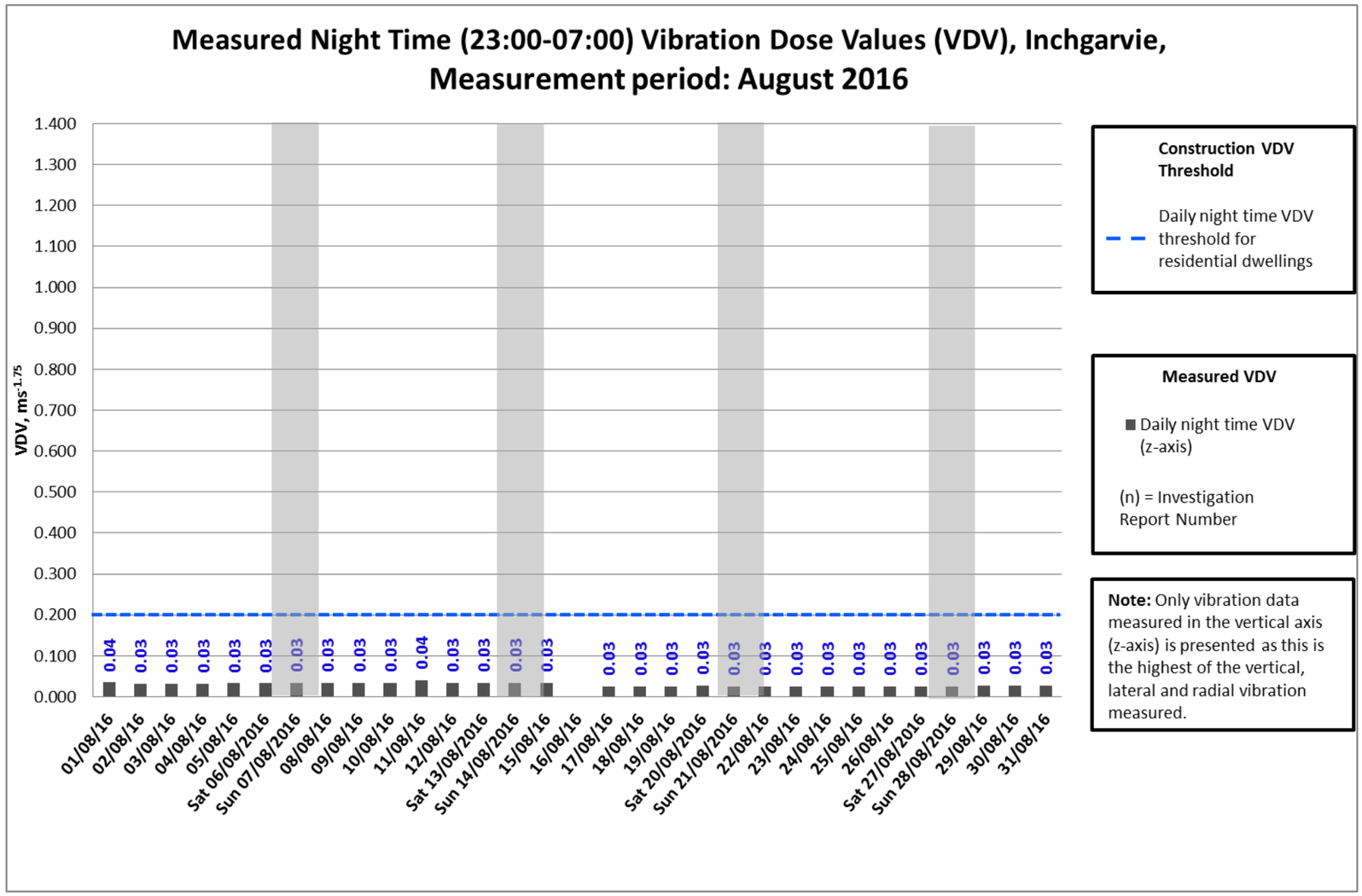
Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.


Measured Daytime (07:00-23:00) Vibration Dose Values (VDV), Inchgarvie,
Measurement period: August 2016
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
0.25
0.04
0.04
0.04
0.04
0.11
0.04
0.04
0.04
0.04
0.04
0.09
0.18
0.04
0.06
0.04
0.07
0.04
0.05
0.20
0.04
0.04
0.05
0.06
0.07
0.04
0.06
0.04
0.54
0.07
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.

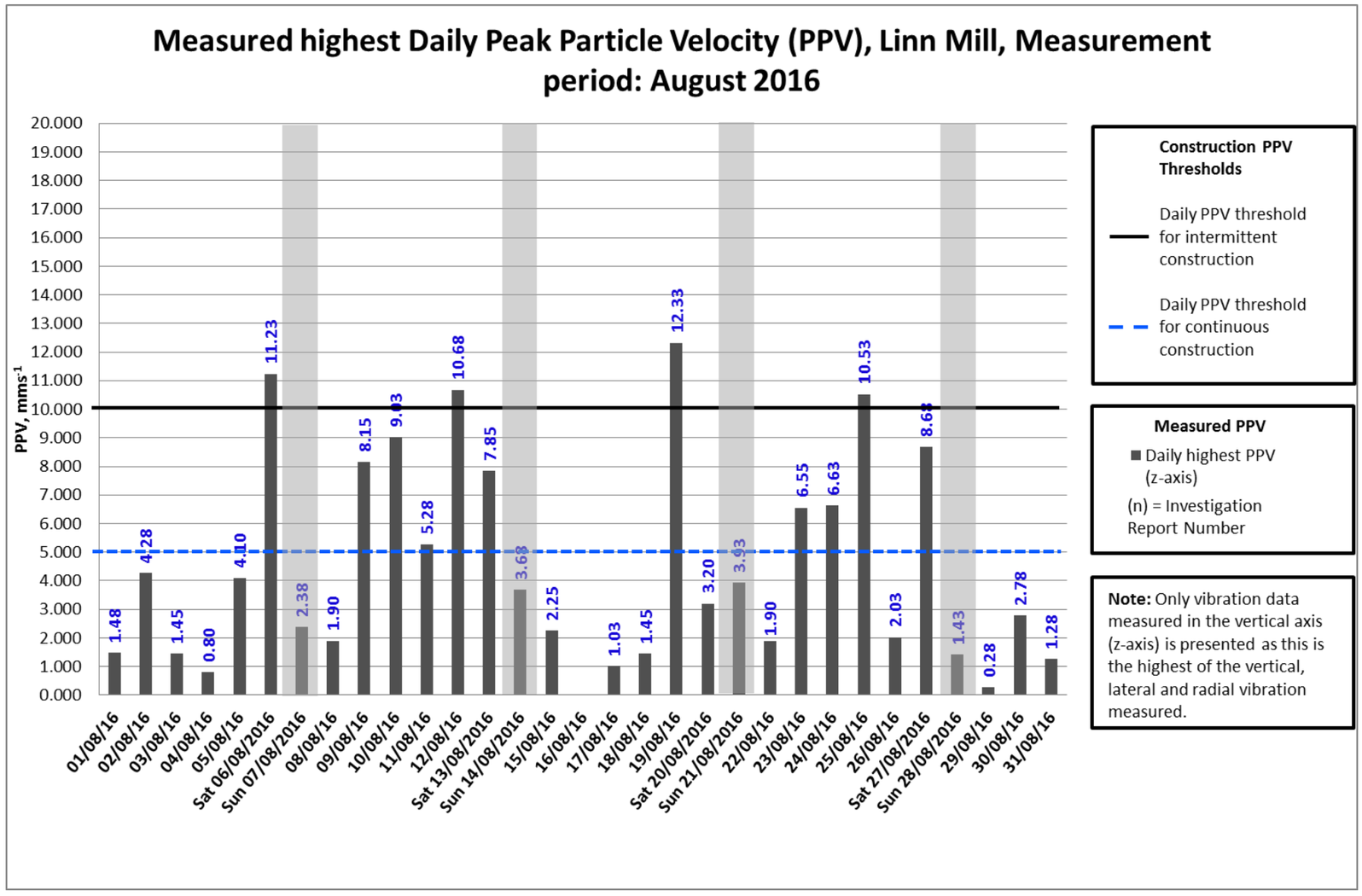


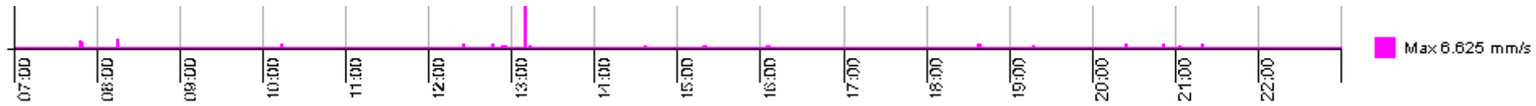

Exceedance 30th of August has been investigated and found to be caused out with construction working hours and therefore it is unlikely that construction related activities were the cause of this event (graph above from the 30/08/2016).

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

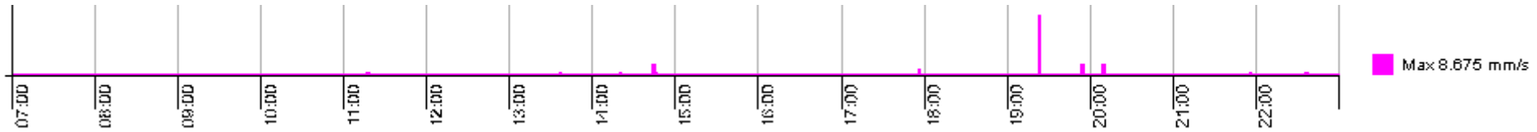



Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.


Measured highest Daily Peak Particle Velocity (PPV), Linn Mill, Measurement period: August 2016
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
1.48
4.28
1.45
0.80
4.10
11.23
2.38
1.90
8.15
9.03
5.28
10.68
7.85
3.68
2.25
1.03
1.45
12.33
3.20
3.93
1.90
6.55
6.63
10.53
2.03
8.68
1.43
0.28
2.78
1.28
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.

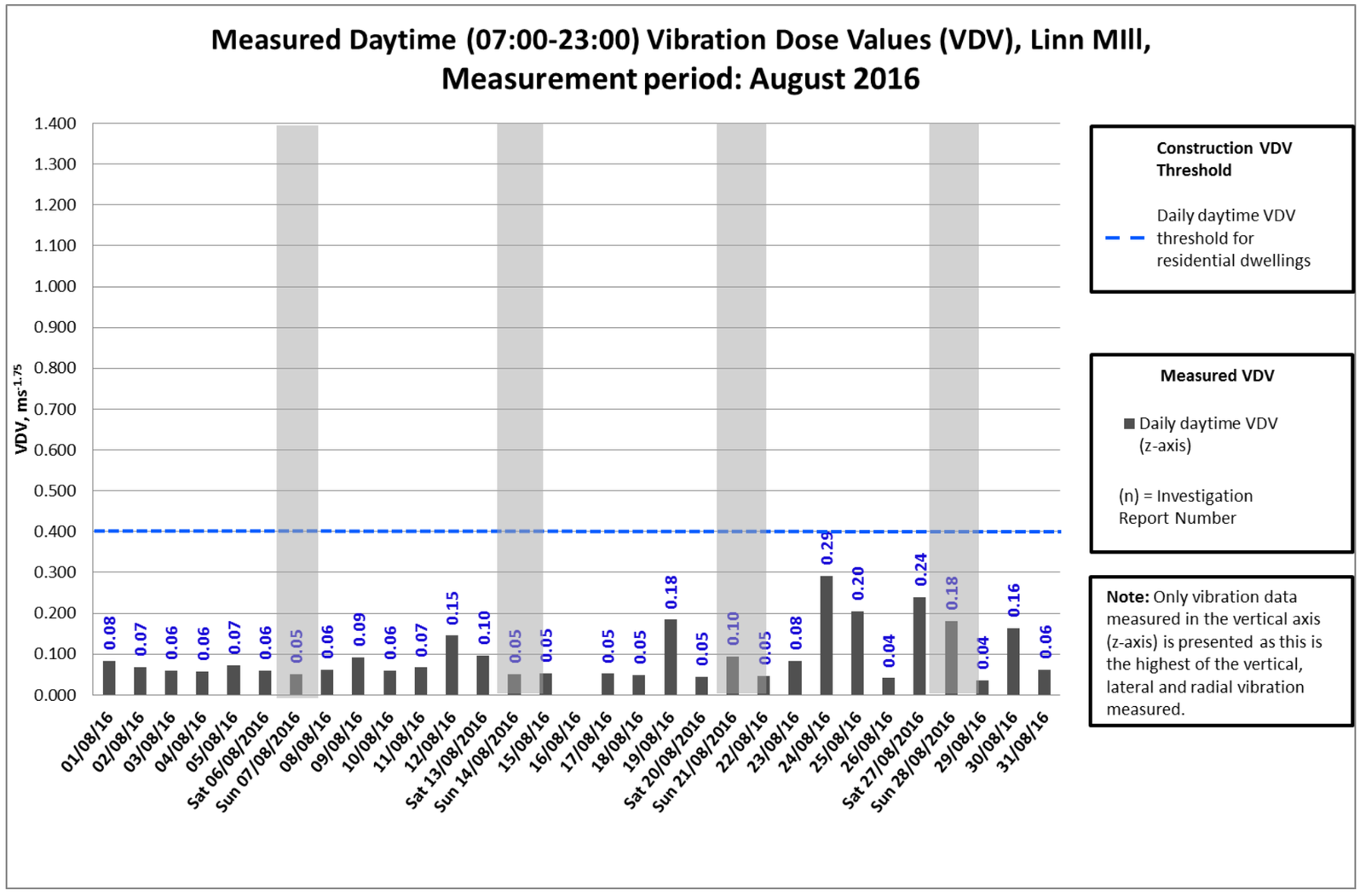



Exceedances on the 6th, 9th, 10th, 11th, 12th, 13th, 19th, 23rd, 24th and 25th of August have been investigated and found to have been caused by individual isolated events that are unlikely to have been construction related activities (graph above from the 24/08/2016).

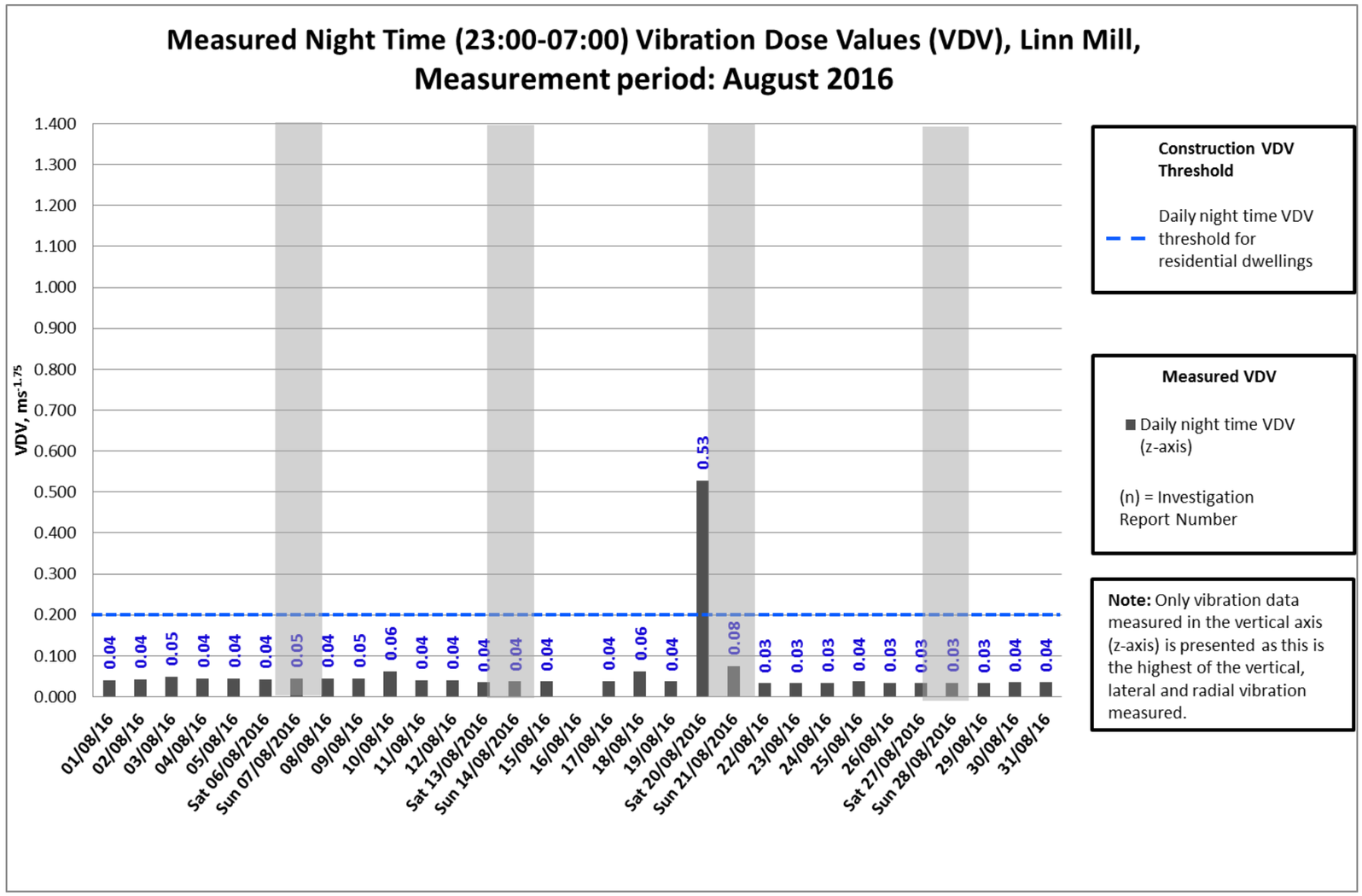


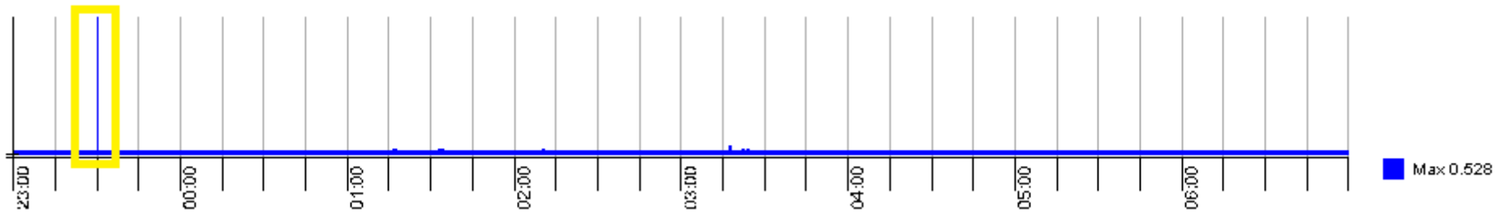

Exceedance on the 27th of August has been investigated and found to have been caused out with construction working hours and therefore it is unlikely that construction related activities was the cause for this event (graph above from the 27/08/2016).

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.



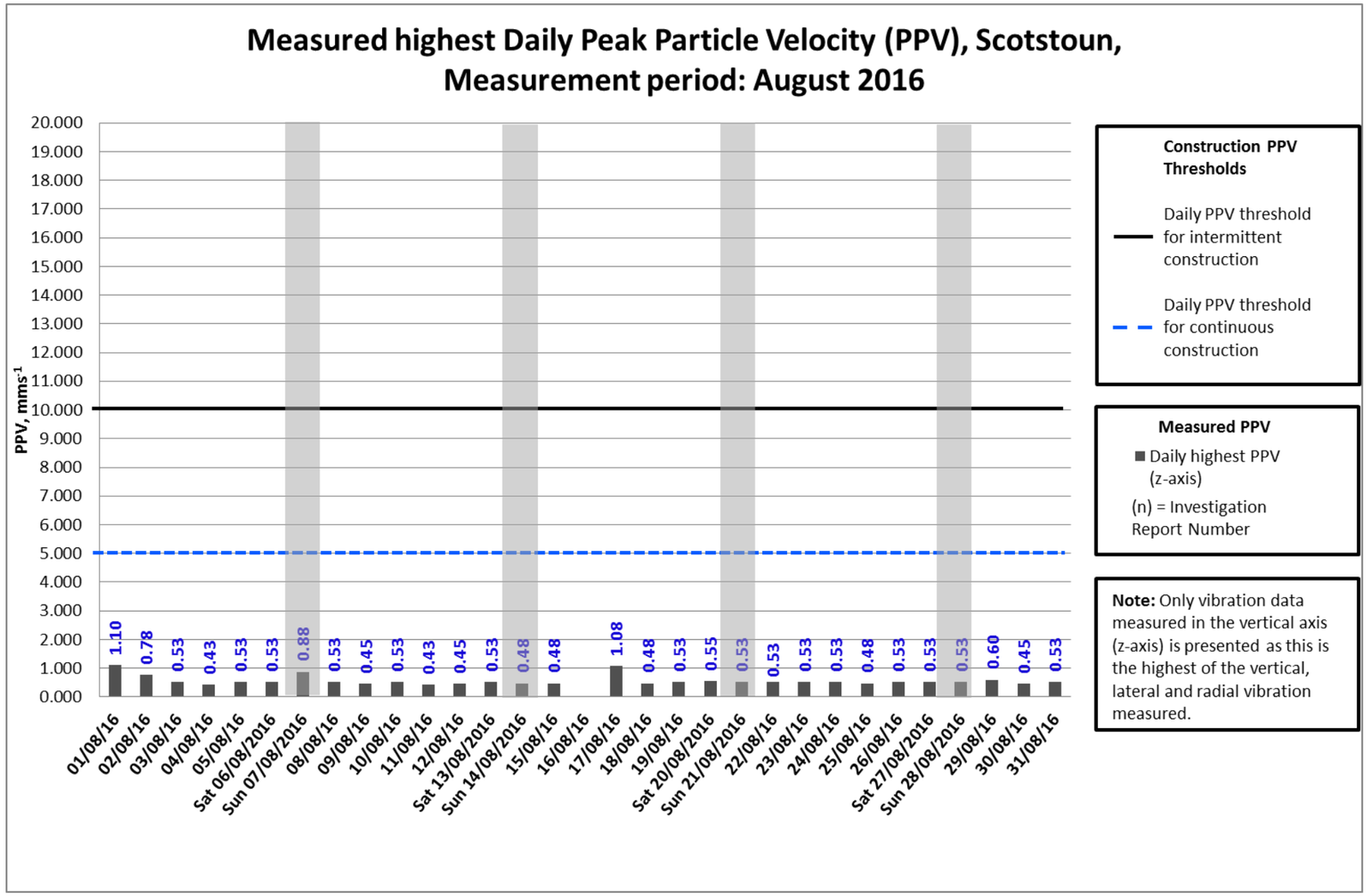

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.


Measured Night Time (23:00-07:00) Vibration Dose Values (VDV), Linn Mill,
Measurement period: August 2016
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
0.53
0.04 0.04 0.05 0.04 0.04 0.04 0.05 0.04 0.05 0.06 0.04 0.04 0.04 0.04 0.04 0.04 0.06 0.04 0.08 0.03 0.03 0.03 0.04 0.03 0.03 0.03 0.03 0.04 0.04
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.

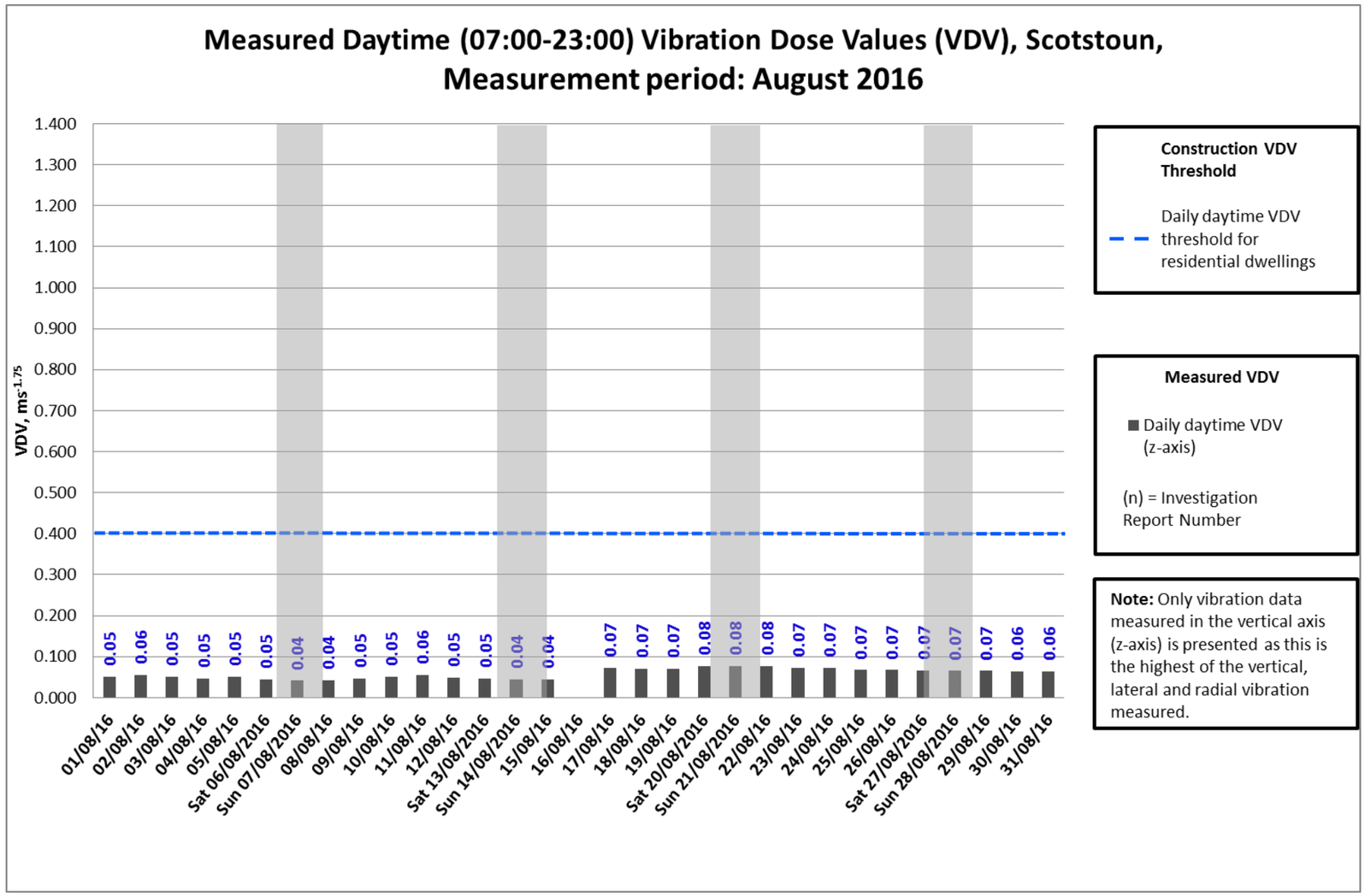



Exceedance on the 20th has been investigated and found to be caused out with construction working hours and therefore it is unlikely that construction related activities was the cause for this event (graph above from the 20/08/2016).

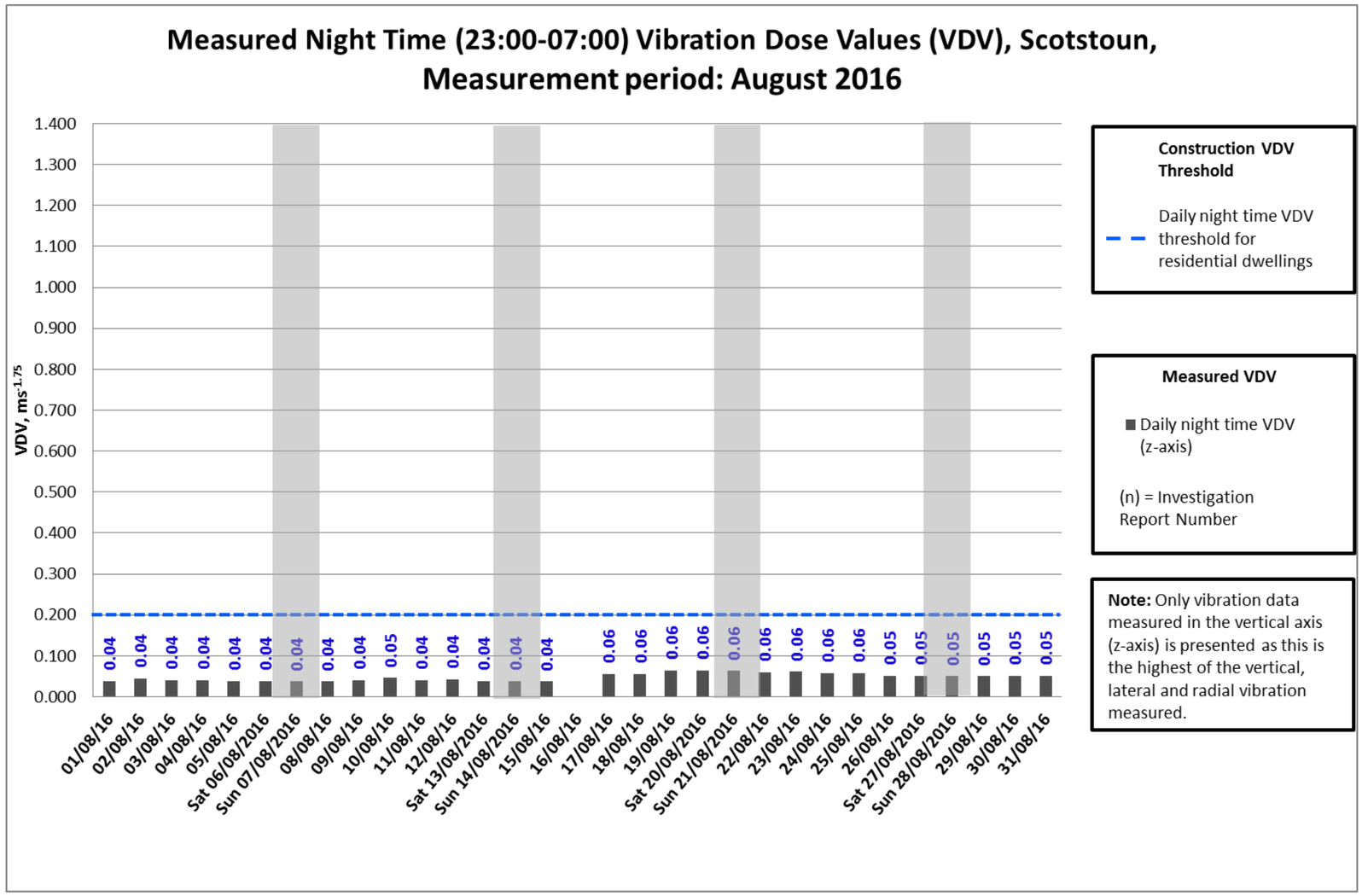
Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.



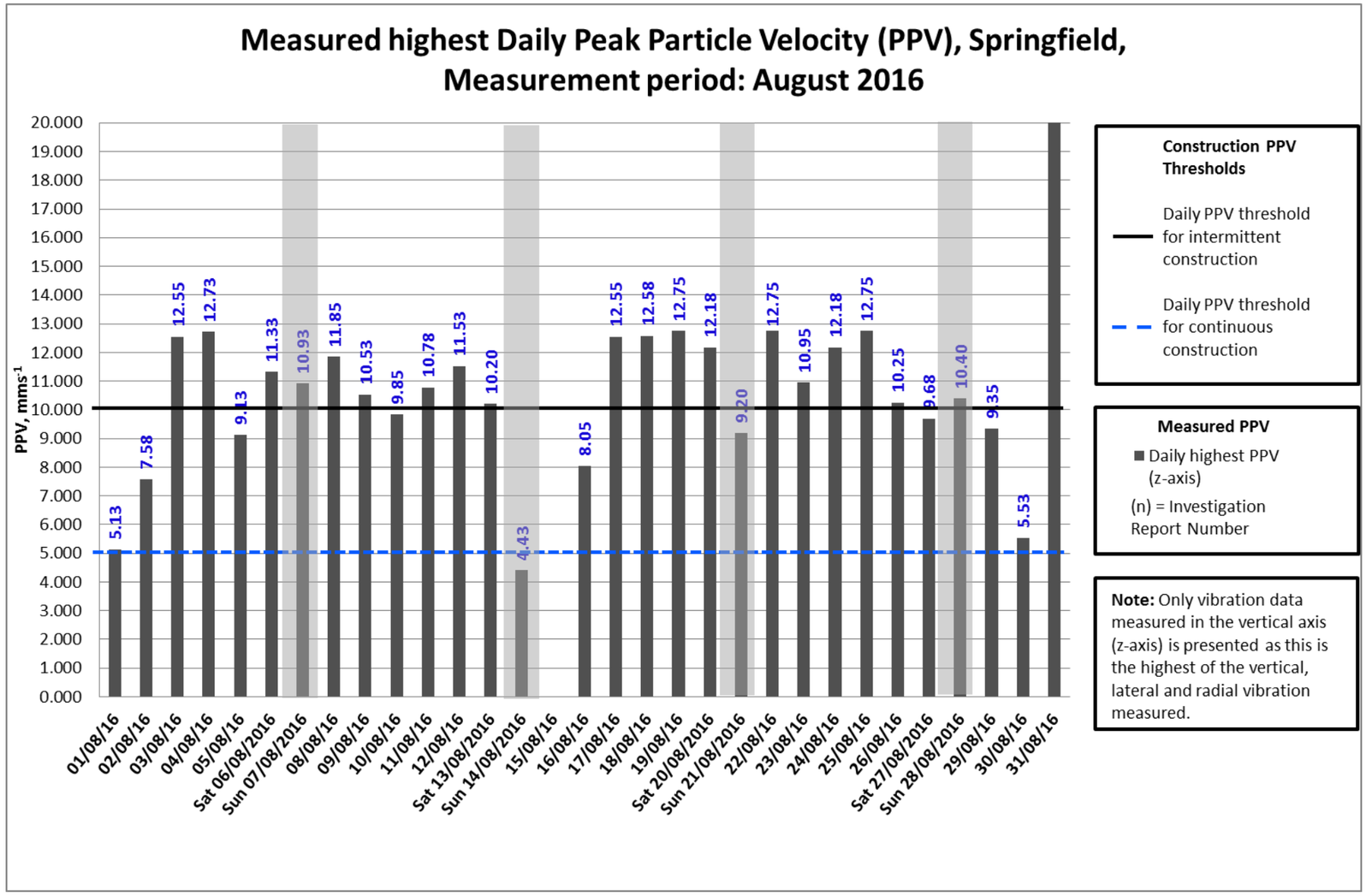

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

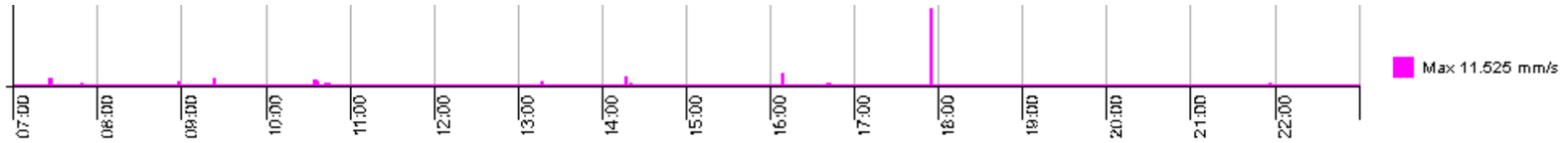



Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

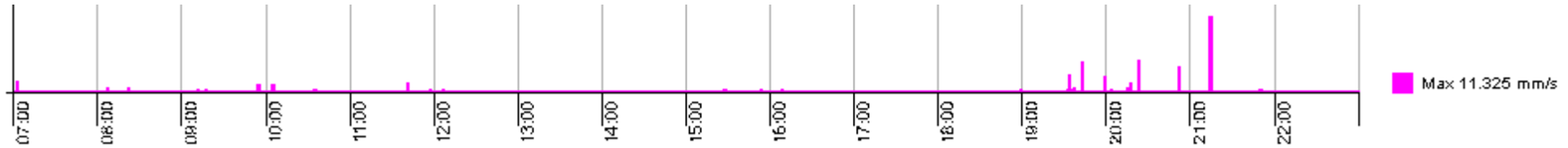



Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.


Measured highest Daily Peak Particle Velocity (PPV), Springfield,
Measurement period: August 2016
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
5.13
7.58
12.55
12.73
9.13
11.33
10.93
11.85
10.53
9.85
10.78
11.53
10.20
4.43
8.05
12.55
12.58
12.75
12.18
9.20
12.75
10.95
12.18
12.75
10.25
9.68
10.40
9.35
5.53
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.

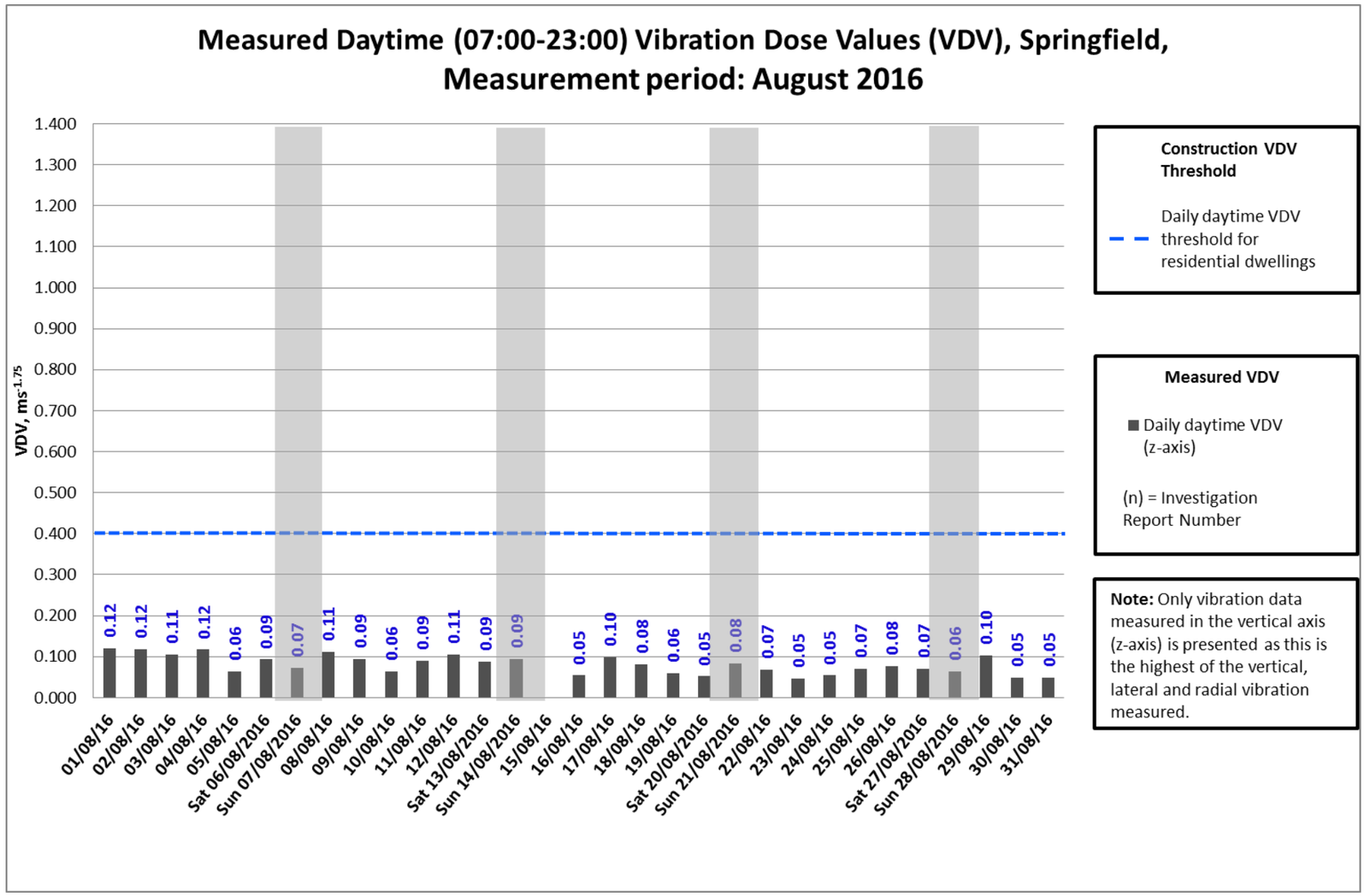



Exceedances on the 1st, 2nd, 4th, 5th, 8th, 10th, 11th, 12th, 15th, 18th, 19th, 20th, 22nd, 23rd, 24th, 25th, 26th, 30th and 31st of August have been investigated and found to have been caused by individual isolated events that are unlikely to have been construction related activities (graph above from the 12/08/2016). The closest works were located approximately 260m away which consists mainly of road surfacing. Due to the distance to the nearest works it is unlikely the exceedances stated above were caused by the Forth Crossing works.

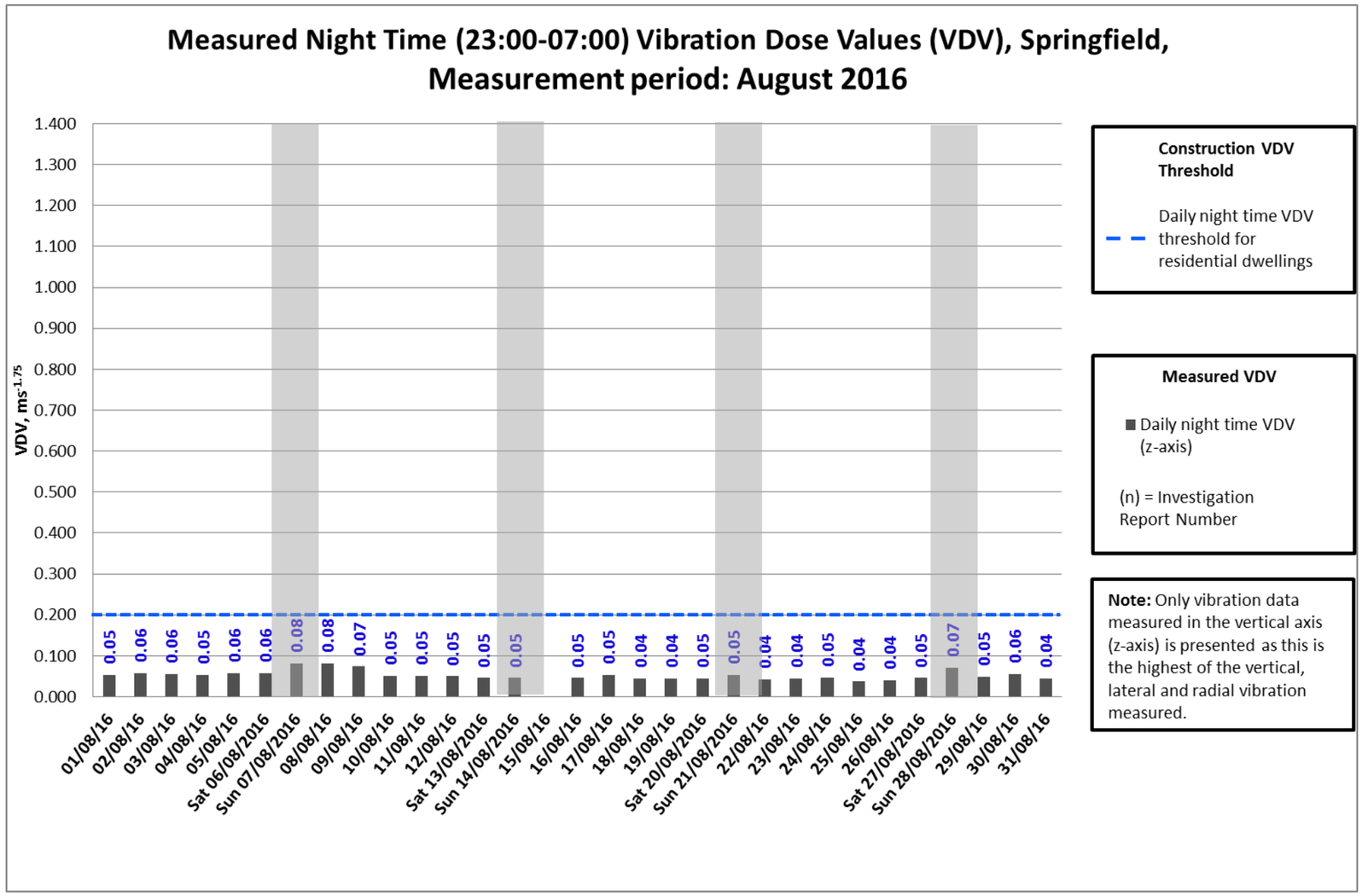



Exceedances on the 6th, 7th, 9th, 16th, 17th, 21st, 27th, 28th and 29th of August have been investigated and found to be caused out with construction working hours and therefore it is unlikely that construction related activities were the cause for these exceedances (graph above from the 27/08/2016).

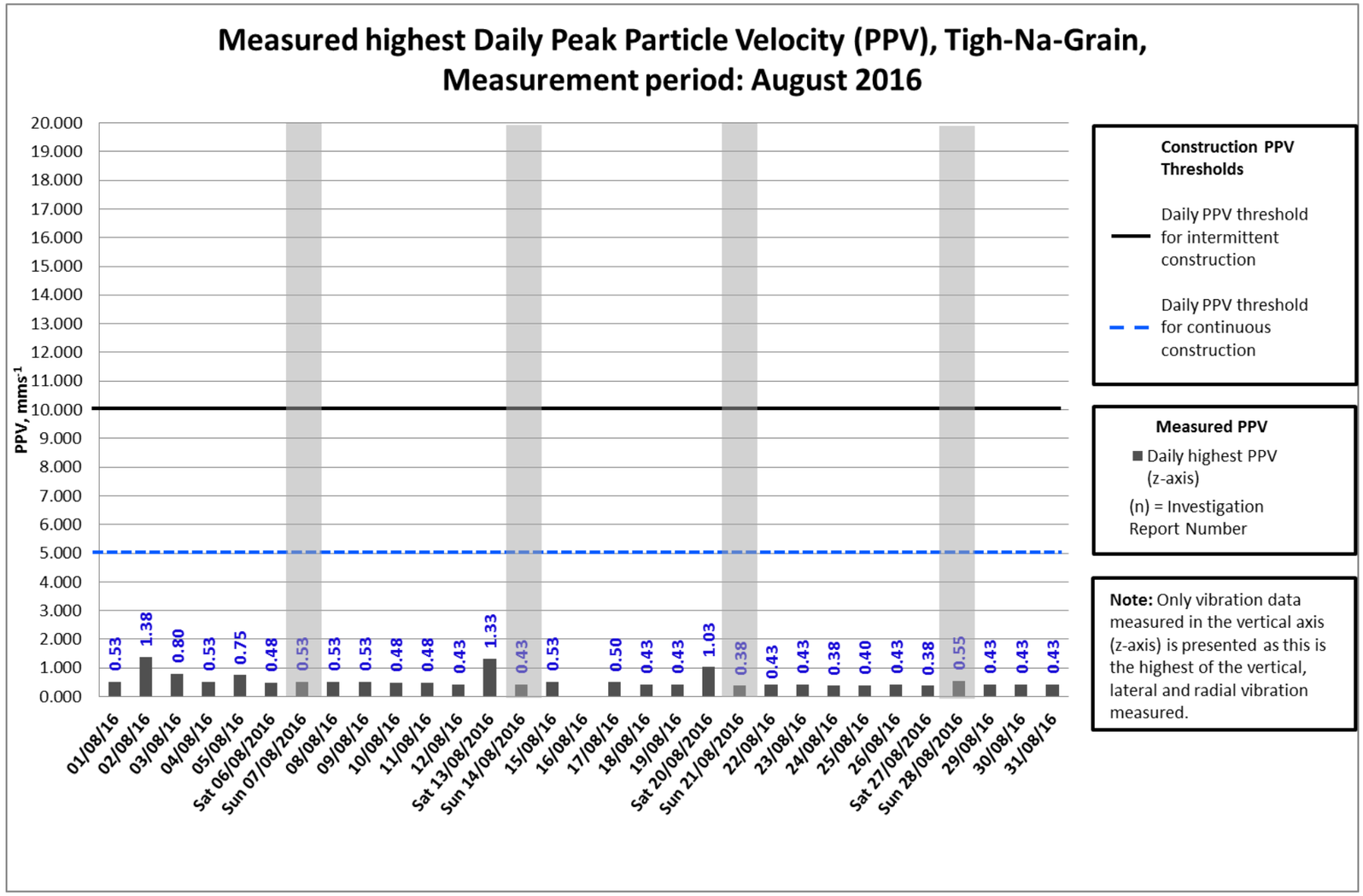
Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.



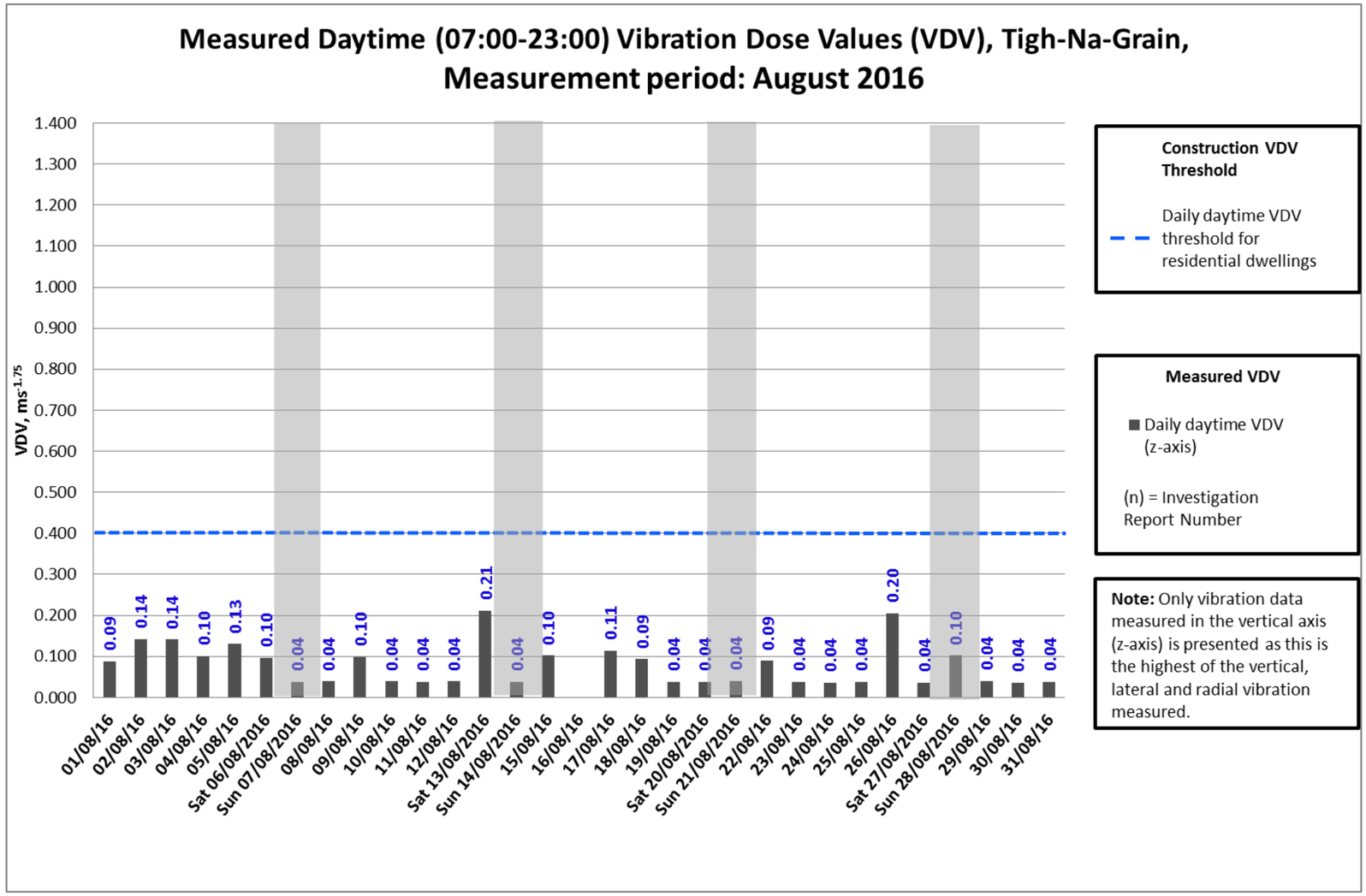

Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.



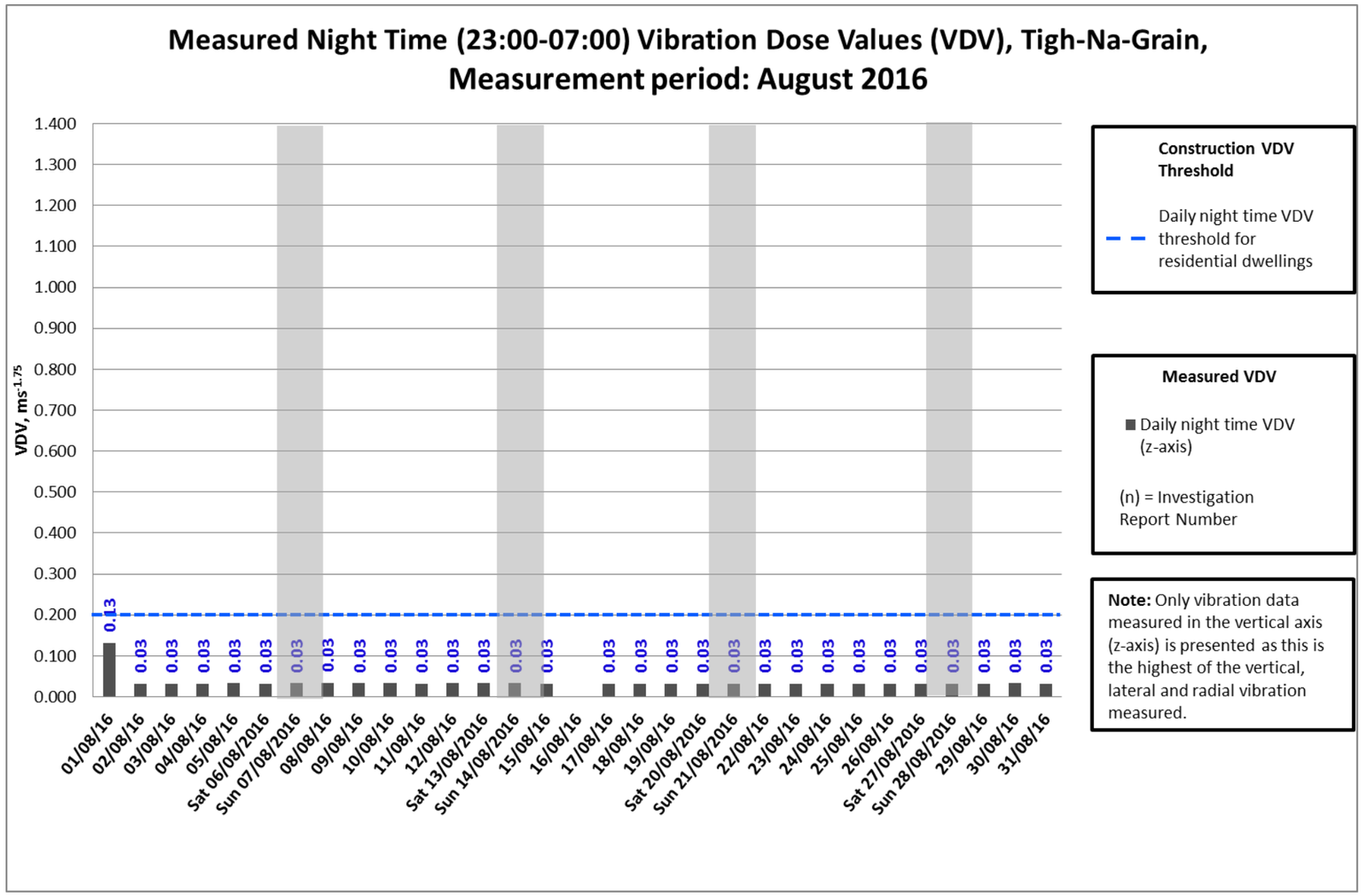

Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.



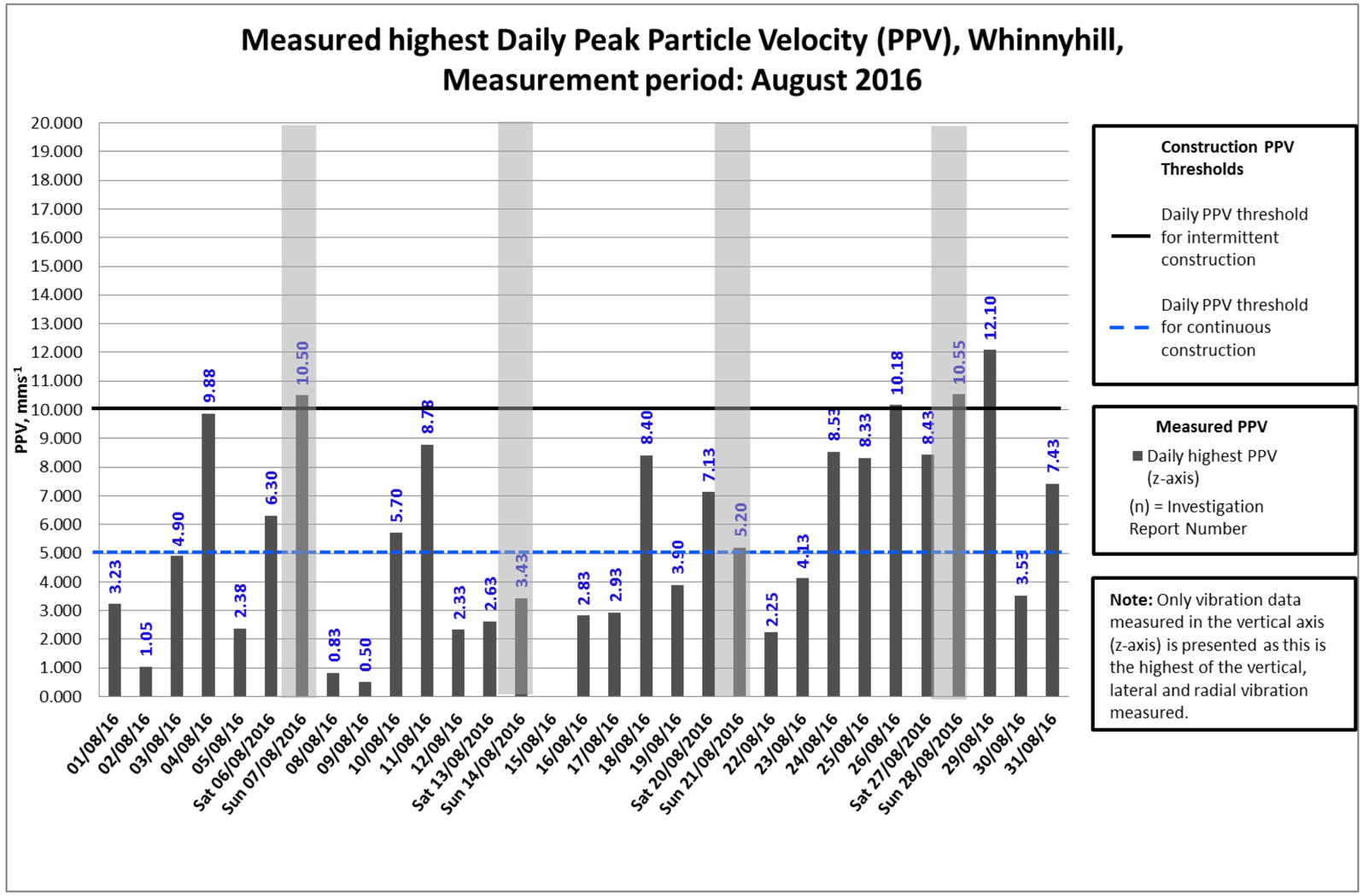

Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

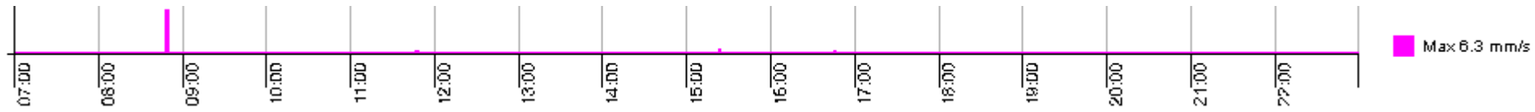



Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.




Data missing on the 16th of August was caused by the annual calibration of the vibration monitor.

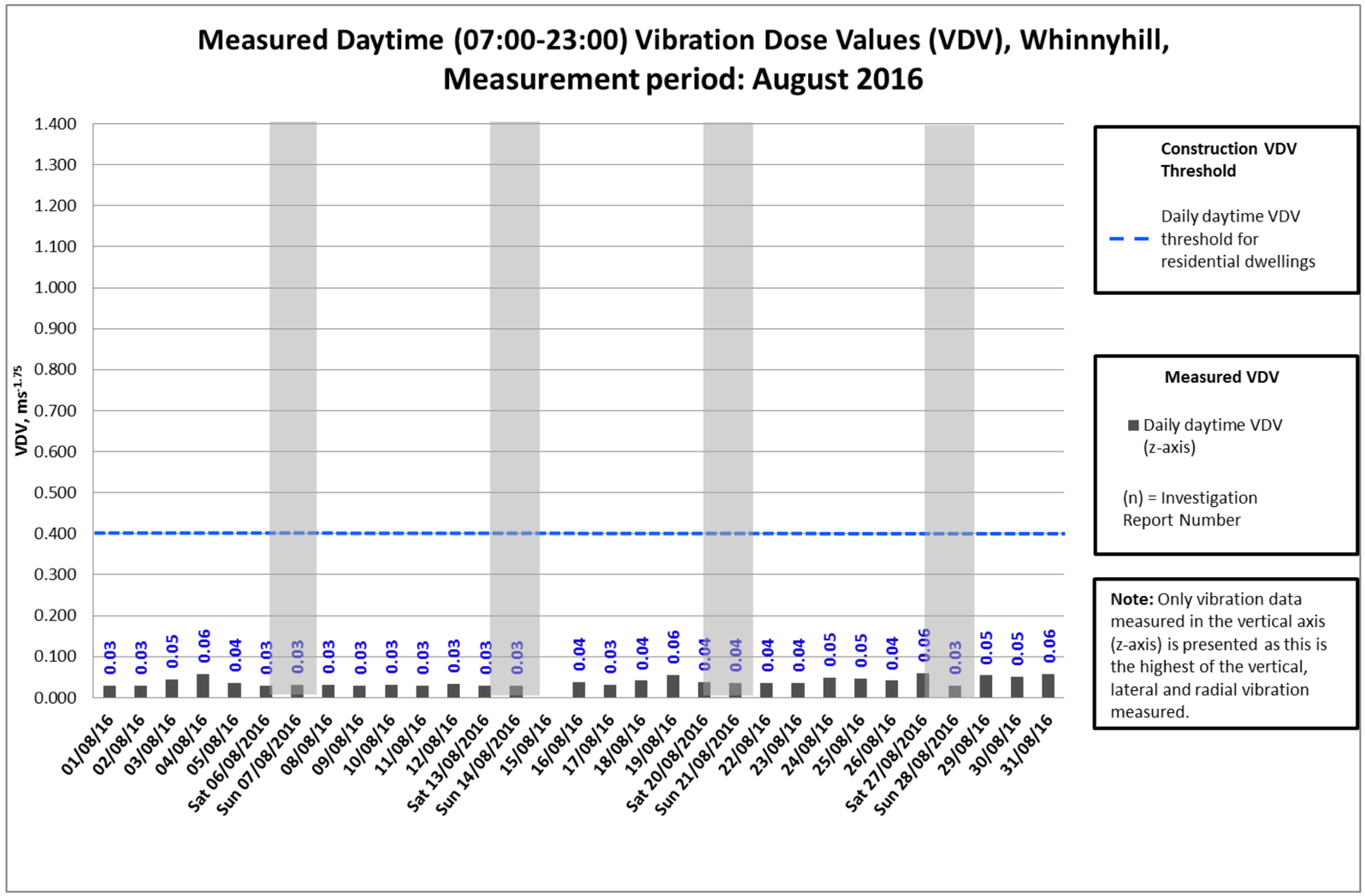

Measured highest Daily Peak Particle Velocity (PPV), Whinnyhill,
Measurement period: August 2016
PPV, mms-1
20.000
19.000
18.000
17.000
16.000
15.000
14.000
13.000
12.000
11.000
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
3.23
1.05
4.90
9.88
2.38
6.30
10.50
0.83
0.50
5.70
8.78
2.33
2.63
3.43
2.83
2.93
8.40
3.90
7.13
5.20
2.25
4.13
8.53
8.33
10.18
8.43
10.55
12.10
3.53
7.43
01/08/16
02/08/16
03/08/16
04/08/16
05/08/16
Sat 06/08/2016
Sun 07/08/2016
08/08/16
09/08/16
10/08/16
11/08/16
12/08/16
Sat 13/08/2016
Sun 14/08/2016
15/08/16
16/08/16
17/08/16
18/08/16
19/08/16
Sat 20/08/2016
Sun 21/08/2016
22/08/16
23/08/16
24/08/16
25/08/16
26/08/16
Sat 27/08/2016
Sun 28/08/2016
29/08/16
30/08/16
31/08/16
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.



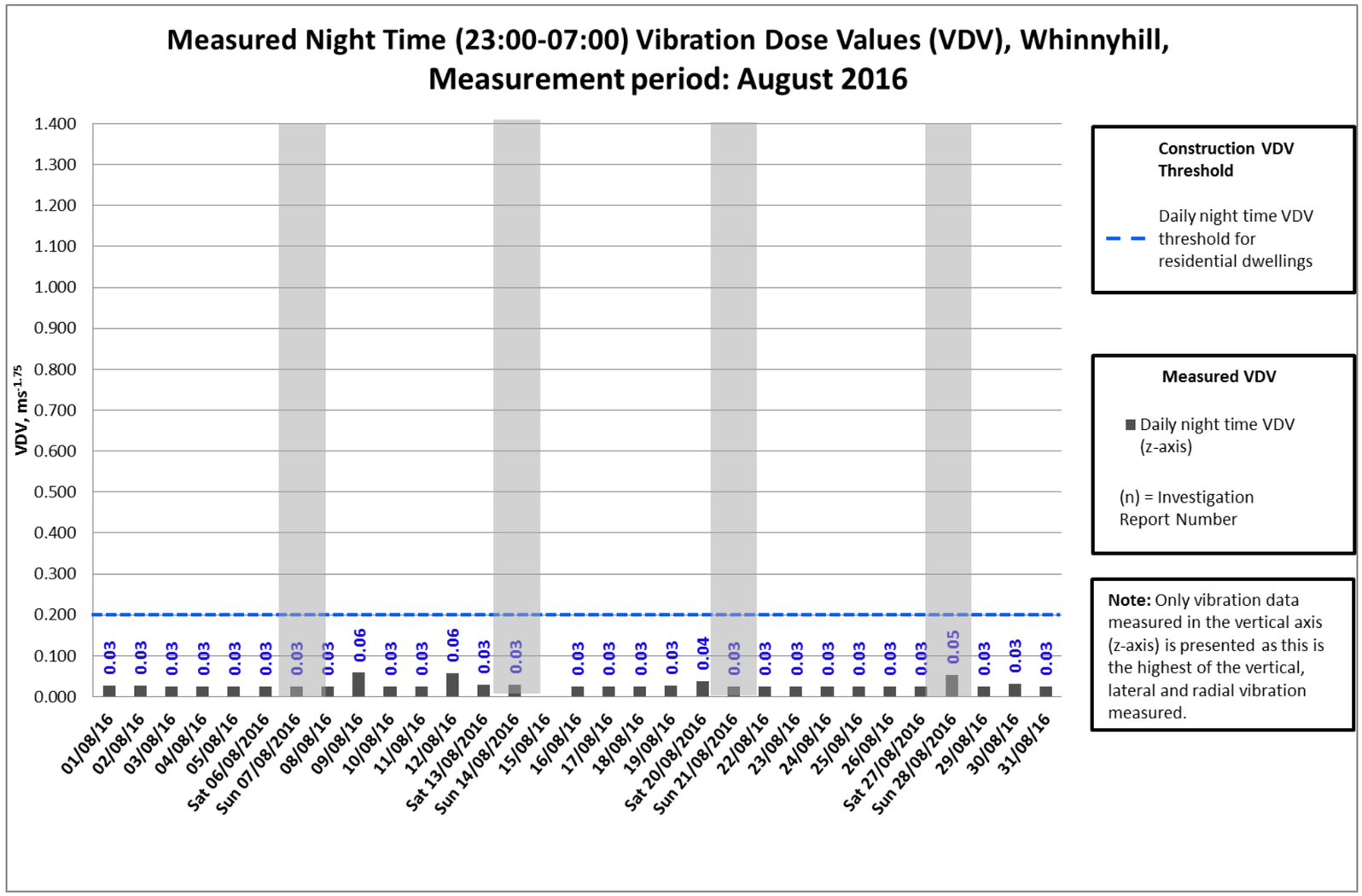

Exceedances on the 6th, 11th, 18th, 24th, 25th, 26th, 28th, 29th and 31st of August have been investigated and found to have been caused by individual isolated events that are unlikely to have been construction related activities (graph above from the 06/08/2016).


Exceedances on the 4th, 7th, 10th, 20th, 21st and 27th of August have been investigated and found to have been caused out with construction working hours and therefore it is unlikely that construction related activities were the cause for these exceedances (graph above from the 04/08/2016).

Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.




Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.




Data missing on the 15th of August was caused by the annual calibration of the vibration monitor.