



Contractor



Forth Crossing Bridge Constructors

HOCHTIEF Solutions
American Bridge International
DRAGADOS
Morrison Construction

Project **FORTH REPLACEMENT CROSSING**

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VIBRATION MONITORING REPORT
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1. INTRODUCTION

- 1.1.** In accordance with the Code of Construction Practice (CoCP) and Noise and Vibration Management Plan, FCBC have risk assessed all construction activities through the PCNV process.

- 1.2.** During the preparation of the PCNVs, assessment/prediction of vibration levels showed that no plant or equipment used, or construction activity carried out was envisaged to induce any level of vibration at receptors that would exceed threshold levels of vibration in the CoCP. This assessment/prediction was confirmed by means of permanent vibration monitoring.

2. MONITORING SUMMARY

- 2.1.** Due to the location and sensitivity of vibration monitoring equipment, the results presented in the graphs included in the appendices of this report do not represent vibration levels created by construction, but rather show local interference around the monitoring equipment. This can include doors being slammed or movement close to the location of the vibrok causing elevated vibration levels.
- 2.2.** According to the BS5228-2 (2009) there is hardly any documented proof of actual damage to structures or their finishes 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. It is not possible to ascertain the exact cause of vibration, though it is possible to rule out construction as a cause on an activity basis.
- 2.3.** The works carried out in each construction area as well as vibration assessments of the works are summarised in Appendix A.
- 2.4.** Due to the distance between the works and the receptors and the methods of working renders the risk of damage to structures or nuisance to the residents due to vibration is highly unlikely.
- 2.5.** The number of exceedances during construction are shown in Table 1 below.

Table 1- Exceedances of thresholds set out in the COCP

November

Location	PPV		VDV		
	5 mm.s ⁻¹	10 mm.s ⁻¹	Day	Eve	Night
Clufflat Brae	7	15	5		
5 Linn Mill	2	3	2		
Barracks East	0	0	0		1
Barracks West	0	0	0		0
Butlaw Fisheries	1	2	4		0
Dundas Home Farm	0	0	0		
Echline	0	3	1		
Inchgarvie Lodge	1	2	1		0
Springfield	4	4	5		
Tigh ni Grian	2	1	19		19

December

Location	PPV		VDV		
	5 mm.s ⁻¹	10 mm.s ⁻¹	Day	Eve	Night
Clufflat Brae	6	3	7		
5 Linn Mill	2	3	4		
Barracks East	0	1	1		0
Barracks West	0	1	1		1
Butlaw Fisheries	0	0	3		0
Dundas Home Farm	0	0	2		
Echline	0	0	0		
Inchgarvie Lodge	1	1	3		0
Springfield	3	5	5		
Tigh ni Grian	12	10	11		1

January

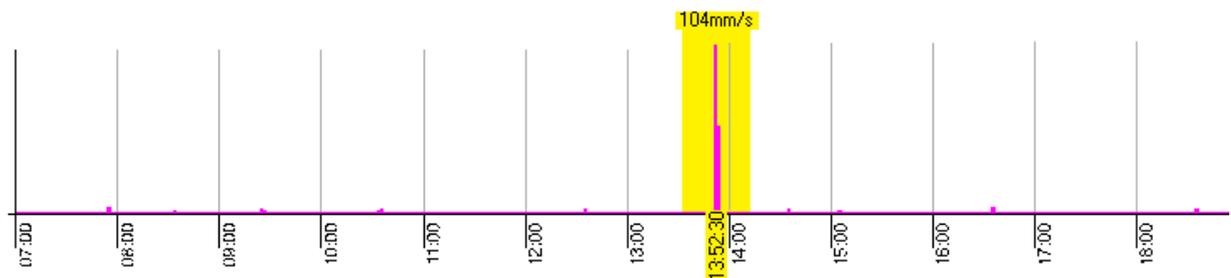
Location	PPV		VDV		
	5 mm.s ⁻¹	10 mm.s ⁻¹	Day	Eve	Night
Clufflat Brae	3	2	4		
5 Linn Mill	0	4	22		
Barracks East	0	0	0		1
Barracks West	0	0	0		0
Butlaw Fisheries	0	0	0		0
Dundas Home Farm	0	0	0		
Echline	0	1	0		
Inchgarvie Lodge	0	0	2		0
Springfield	6	0	4		
Tigh ni Grian	5	9	4		2

- 2.6.** Peak Particle Velocity (PPV) - 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 maximum velocity that is recorded during a particular event, and as such is appropriate for the measurement of activities such as blasting and piling. The thresholds for the Forth Replacement Crossing are 5 mm.s^{-1} for continuous construction (e.g. piling) and 10 mms^{-1} for intermittent construction (i.e. blasting).
- 2.8.** These thresholds are set to protect against building damage. During the monitoring period, there was no construction activities taking place that could cause levels of PPV vibration that would trigger an 'event'; i.e. give a PPV reading on any of the vibroks.
- 2.9.** Vibration Dose Value (VDV) - 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 V DVs in $\text{m.s}^{-1.75}$
- 2.10.** During the monitoring period, vibratory rollers were used intermittently at several locations around the site in the construction of haul roads. Due to the distances of the rollers away from any receptors none of the exceedances in VDV levels can be associated with the use of vibratory rollers.
- 2.11.** In addition, detailed investigation of exceedances (i.e. review of PPV levels over 30 seconds periods) showed that all the exceedances are isolated events that occurred due to activities other than construction and adjacent to the transducer. Below is an example of one of such investigations which is an exceedance of 104 mm.s^{-1} occurred on 23/11/11. As can be seen this

was a single isolated event which seems to be due to sources other than construction activities.

Calibrate by: SEP 12

Ev 011	Cont	Max	Time	Date
Event	104mm/s	13:52:30	23/11/11	
Hour 1	.725mm/s	07:54:10	23/11/11	
Hour 2	.275mm/s	08:34:10	23/11/11	
Hour 3	.400mm/s	09:25:10	23/11/11	
Hour 4	.425mm/s	10:34:50	23/11/11	
Hour 5	.175mm/s	11:00:10	23/11/11	
Hour 6	.600mm/s	12:35:00	23/11/11	
Hour 7	104mm/s	13:52:30	23/11/11	
Hour 8	.475mm/s	14:35:10	23/11/11	
Hour 9	.325mm/s	15:05:30	23/11/11	



2.12. Within the Appendix A, there are short gaps of missing data in the PPV and VDV graphs. These are mainly due to:

- short power cuts causing the Vibrocks to turn off and not turning back on when the power supply is restored; or
- Vibrocks being sent back to the head office for emergency maintenance as the data could not be downloaded.

3. Conclusion

- 3.1.** Due to the distance between the works and the above receptors and the method of working renders the risk of damage to structures or nuisance to the residents due to vibration is highly unlikely.

- 3.2.** Due to the location and sensitivity of vibration monitoring equipment, the results presented in the graphs included in the appendices of this report do not represent vibration levels created by construction, but rather show local interference around the monitoring equipment. This can include doors being slammed or movement close to the location of the vibrok causing elevated vibration levels.

APPENDIX A – VIBRATION ASSESSMENTS OF RELEVANT PCNVs

Butlaw Fisheries				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low.</p> <p>Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible.</p> <p>Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>

Butlaw Fisheries				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0018	Nov 11	Drilling works for Beamer Rock excavation	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	There are no predicted vibration impacts from the proposed techniques.

Barracks West				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low.</p> <p>Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible.</p> <p>Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	<p>Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at</p>

Barracks West				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
				the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0018	Nov 11	Drilling works for Beamer Rock excavation	<ol style="list-style-type: none"> 1. Construction of drilling platform 2. Drilling works 	There are no predicted vibration impacts from the proposed techniques.

Barracks East				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low. Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible. Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	<p>Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.</p>

Barracks East				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0011	Jan 12	Main Crossing-Bridge Works	<ol style="list-style-type: none"> 1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting. 	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generate appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0018	Nov 11	Drilling works for Beamer Rock excavation	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	There are no predicted vibration impacts from the proposed techniques.

Inchgarvie House				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low. Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible. Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	<p>Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.</p>

Inchgarvie House				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0005	Dec 11	Establish Site Compound at Ferrytoll	Construction of site offices, welfare accommodation, site stores, car parking and installation of utility supplies.	The predicted vibration levels are below the 5mm/s threshold set out in the CoCP.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0011	Jan 12	Main Crossing-Bridge Works	<ol style="list-style-type: none"> 1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting. 	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generated appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Linn Mill				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low. Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible. Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	<p>Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.</p>

Linn Mill				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0005	Dec 11	Establish Site Compound at Ferrytoll	Construction of site offices, welfare accommodation, site stores, car parking and installation of utility supplies.	The predicted vibration levels are below the 5mm/s threshold set out in the CoCP.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0011	Jan 12	Main Crossing-Bridge Works	<ol style="list-style-type: none"> 1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting. 	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generated appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Linn Mill				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0013	Dec 12	Placing Safety Barrier along the E/B verge of A904 at Echline	1. Setting Up and removal of Traffic Management and placing safety barrier along the eastbound verge of A904 at Echline.	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Clufflat Brae				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0005	Dec 11	Establish Site Compound at Ferrytoll	Construction of site offices, welfare accommodation, site stores, car parking and installation of utility supplies.	The predicted vibration levels are below the 5mm/s threshold set out in the CoCP.

Clufflat Brae				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0011	Jan 12	Main Crossing-Bridge Works	<ol style="list-style-type: none"> 1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting. 	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generated appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Springfield				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Springfield				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0011	Jan 12	Main Crossing-Bridge Works	1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting.	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generate appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0013	Dec 12	Placing Safety Barrier along the E/B verge of A904 at Echline	1. Setting Up and removal of Traffic Management and placing safety barrier along the eastbound verge of A904 at Echline.	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Echline				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0005	Dec 11	Establish Site Compound at Ferrytoll	Construction of site offices, welfare accommodation, site stores, car parking and installation of utility supplies.	The predicted vibration levels are below the 5mm/s threshold set out in the CoCP.
PCNV0007	Dec 11 to Jan 12	South 2 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. Earthworks – Soil Strip/Creation of Noise Bunds/Formation of Access Tracks/SUD's Ponds 3. Drainage – Echline Field Drainage/SUD's Ponds/Temporary Earthworks Drainage/SUD's Ponds Outfalls 4. Roadwork's – Access Tracks 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Echline				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0011	Jan 12	Main Crossing-Bridge Works	1.S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation3. N2 Foundation – Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting.	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generate appreciable levels of vibration due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0013	Dec 12	Placing Safety Barrier along the E/B verge of A904 at Echline	1. Setting Up and removal of Traffic Management and placing safety barrier along the eastbound verge of A904 at Echline.	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

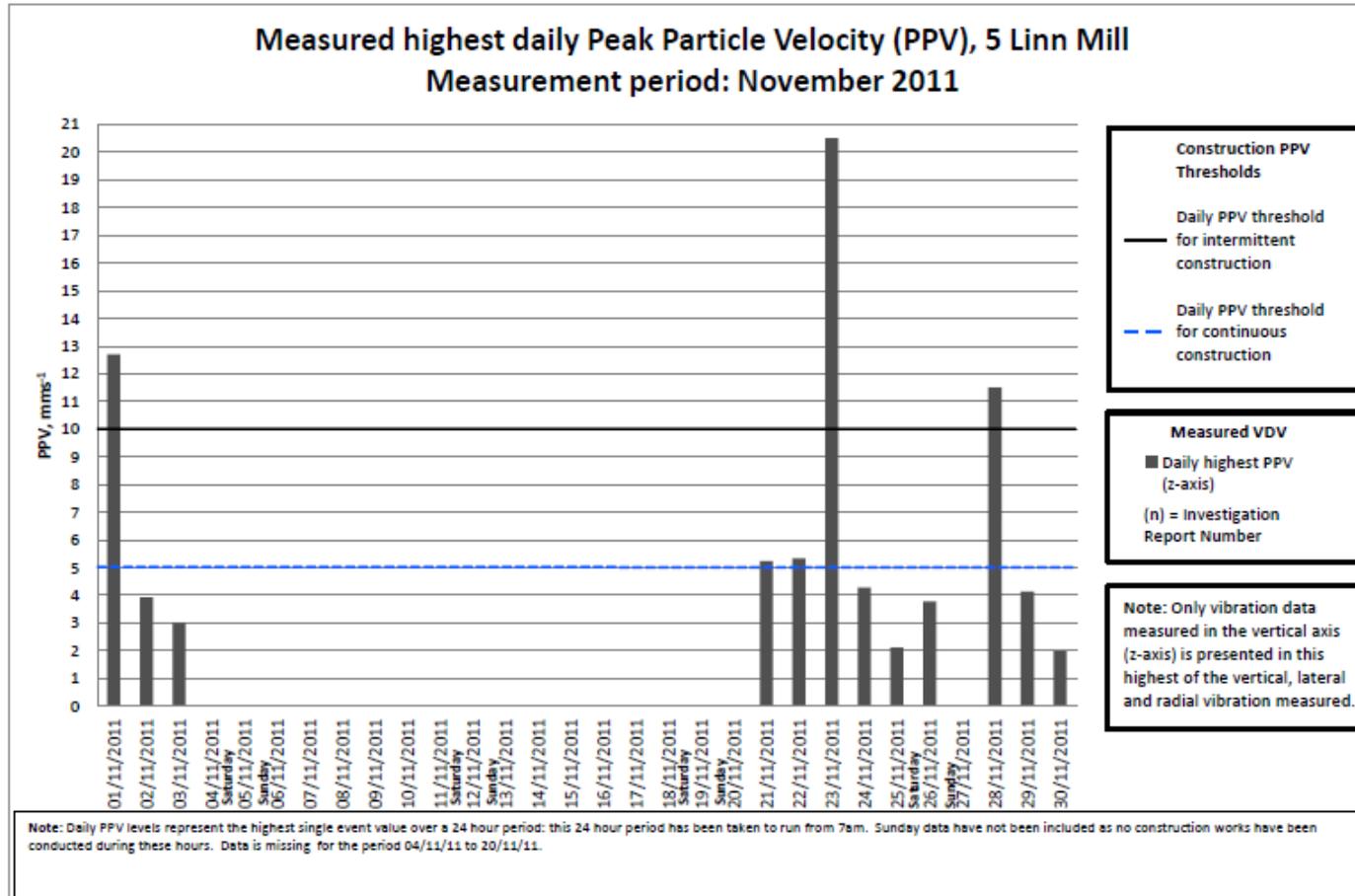
Dundas Home Farm				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.
PCNV0005	Dec 11	Establish Site Compound at Ferrytoll	Construction of site offices, welfare accommodation, site stores, car parking and installation of utility supplies.	The predicted vibration levels are below the 5mm/s threshold set out in the CoCP.
PCNV0008	Dec 11 to Jan 12	South 1 Works	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	The equipment to be used in these activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.

Tigh-ni Grian				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0002	Dec 11 to Jan 12	Marine-based Geotechnical	Marine drilling of exploratory boreholes and recovery of soil and geological samples	<p>Significant levels of vibration are not anticipated. A risk assessment has gauged the risk of vibration impacts to be negligible based on the available historic evidence (presented below) that the vibration levels are expected to be very low. Only the cable percussive methods are likely to generate any perceptible vibration. The closest property to this investigation technique is Tigh-na-Grian which is approximately 182m away.</p> <p>Historic data from BS5228: Part 2 Table D1 Refs 1, 2, 3 & 4 indicate that the PPV vibration levels reduce to less than 1.8 mm/s at 6m from the activity of driving a casing into a variety of materials. No historic data exists for 182m but the vibration levels based on the historic data out to 6m show that vibration levels are likely to be very low at 182m and therefore the impact is negligible. Additional attended vibration monitoring will be undertaken should complaints arise and the works managed to a practical minimum duration to reduce any exposure.</p>
PCNV0004	Nov 11 to Dec 11	Site Clearance Works	Removal of vegetation to allow construction of the permanent works. This involved cutting, mulching, chipping and removing timber from site. Clearing top soil and storing in designated locations.	<p>Significant levels of vibration are not anticipated at the receptor locations for the majority of the operations. Hand-held machines such as chainsaws will not generate significant levels of off-site vibration. Machines, such as the stump grinder, chipper or mulcher, will only be used at distances of greater than 40m from the receptors. The soil stripping activities will be undertaken at the closest distances to sensitive receptors using plant that is most likely to generate groundborne vibration; this sub-phase of works has the greatest potential to cause off-site vibration.</p>

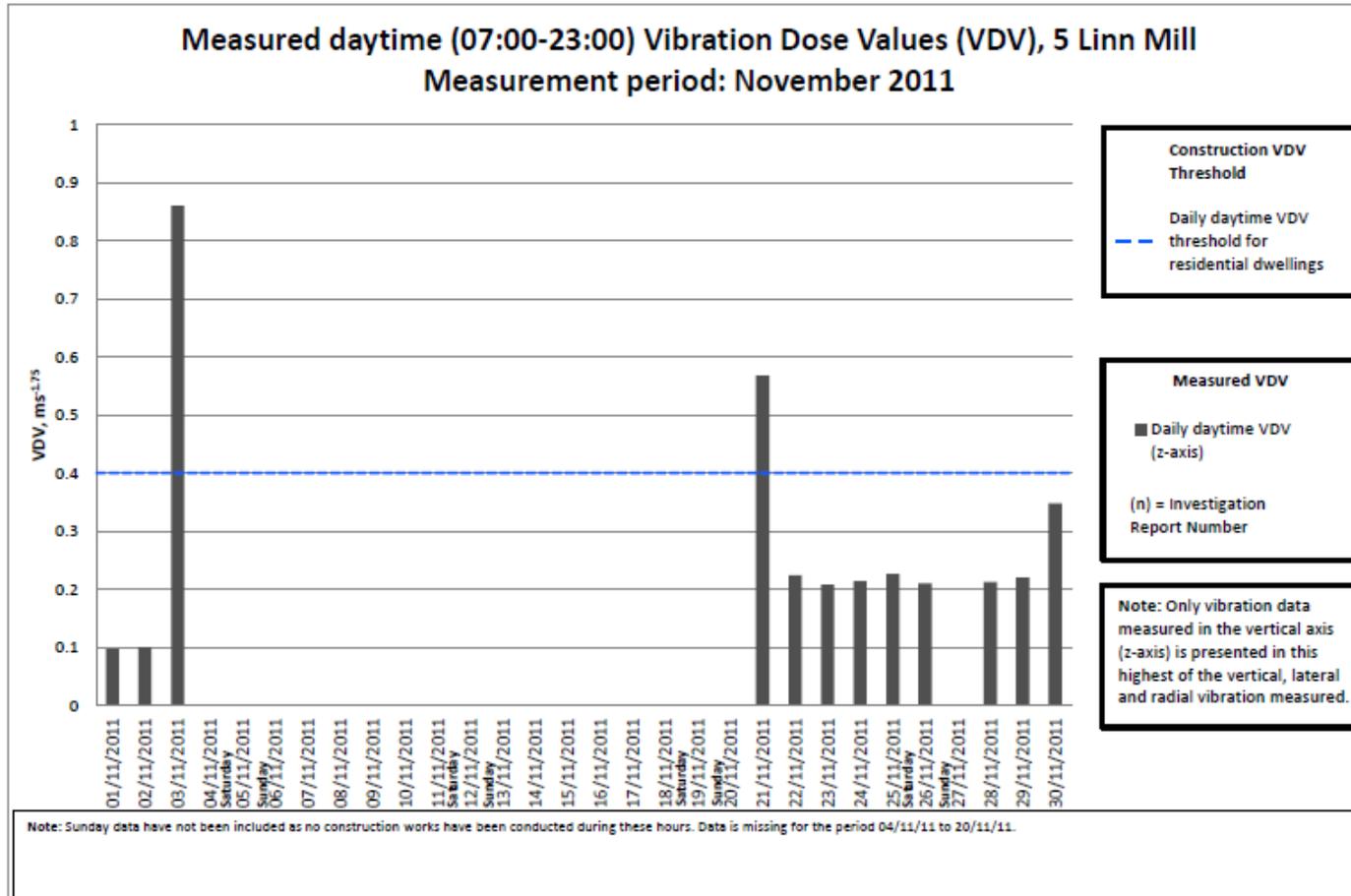
Tigh-ni Grian				
Relevant PCNV No.	Relevant Date	PCNV Name	Particulars of works to be carried out	Vibration Assessment
PCNV0010	Jan 12	North 1 Works	Drilling Shot Holes; Removal of Blasted Rock; Structure; Filling; Removal of Blasted Rock; Soil Mixing; Piled Embankment; Sewer Diversions; Working Platform; Ground Improvement.	The equipment to be used in these activities do not generate appreciable levels of vibration, also the distances to the closest occupied receptors are over 300m so therefore no assessment has been undertaken.
PCNV0011	Jan 12	Main Crossing-Bridge Works	<ol style="list-style-type: none"> 1. S7 Foundation –Construction of Working Platform at S7 as well as Construction of S7 foundation 2. S8 Foundation –Construction of Working Platform at S8 as well as Construction of S8 foundation 3. N2 Foundation –Construction of Working Platform to N2 as well as Construction of N2 foundation including drilling shot holes for blasting. 	Nearest property to the works is Inchgarvie House which is 39m from foundation S8. All other works are in excess of 50m for the works. The highest levels of vibration are likely to be generated by the vibratory roller during the hard-standing preparation. Hydraulic rock breakers which would typically generate 4.5 mm/s @ 5m, 0.4 @ 20m, 0.1 @ 50m will not generated appreciable levels of vibration levels due to the distance from the closest receptor. Equipment to be used in all other activities do not generate appreciable levels of vibration and therefore no assessment has been undertaken.
PCNV0018	Nov 11	Drilling works for Beamer Rock excavation	<ol style="list-style-type: none"> 1. Fencing – Permanent LMA and temporary fencing for environmental mitigation, commitments and site security. 2. BP Protection Works – Access Points, Concrete Protection Slab and Fencing. 3. Early Planting – Echline Strip to be ploughed and rotivated in preparation for tree planting by hand. 	There are no predicted vibration impacts from the proposed techniques.

APPENDIX B – VIBRATION GRAPHS

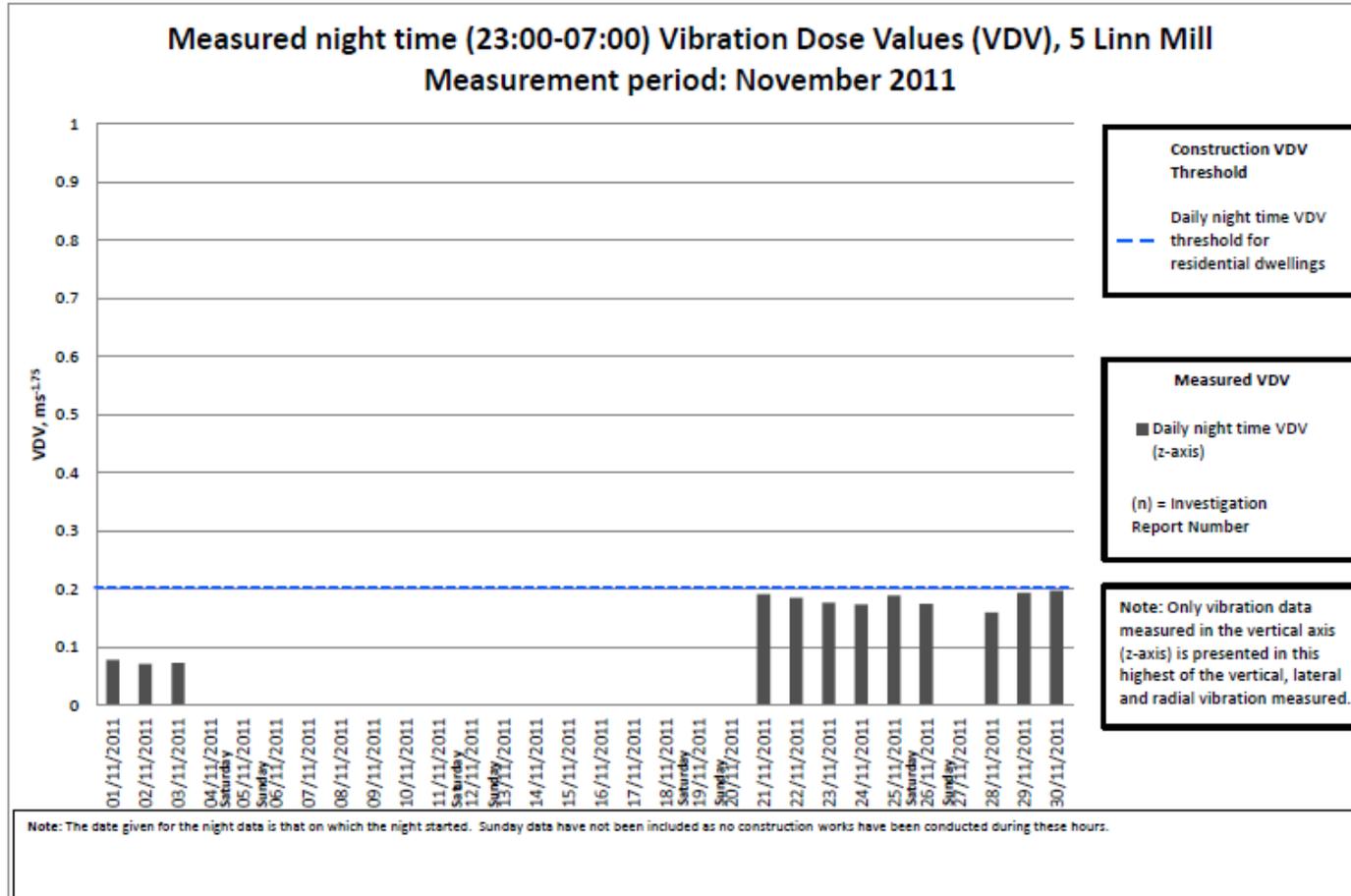
PPV at 5 Lin Mill – November 2011



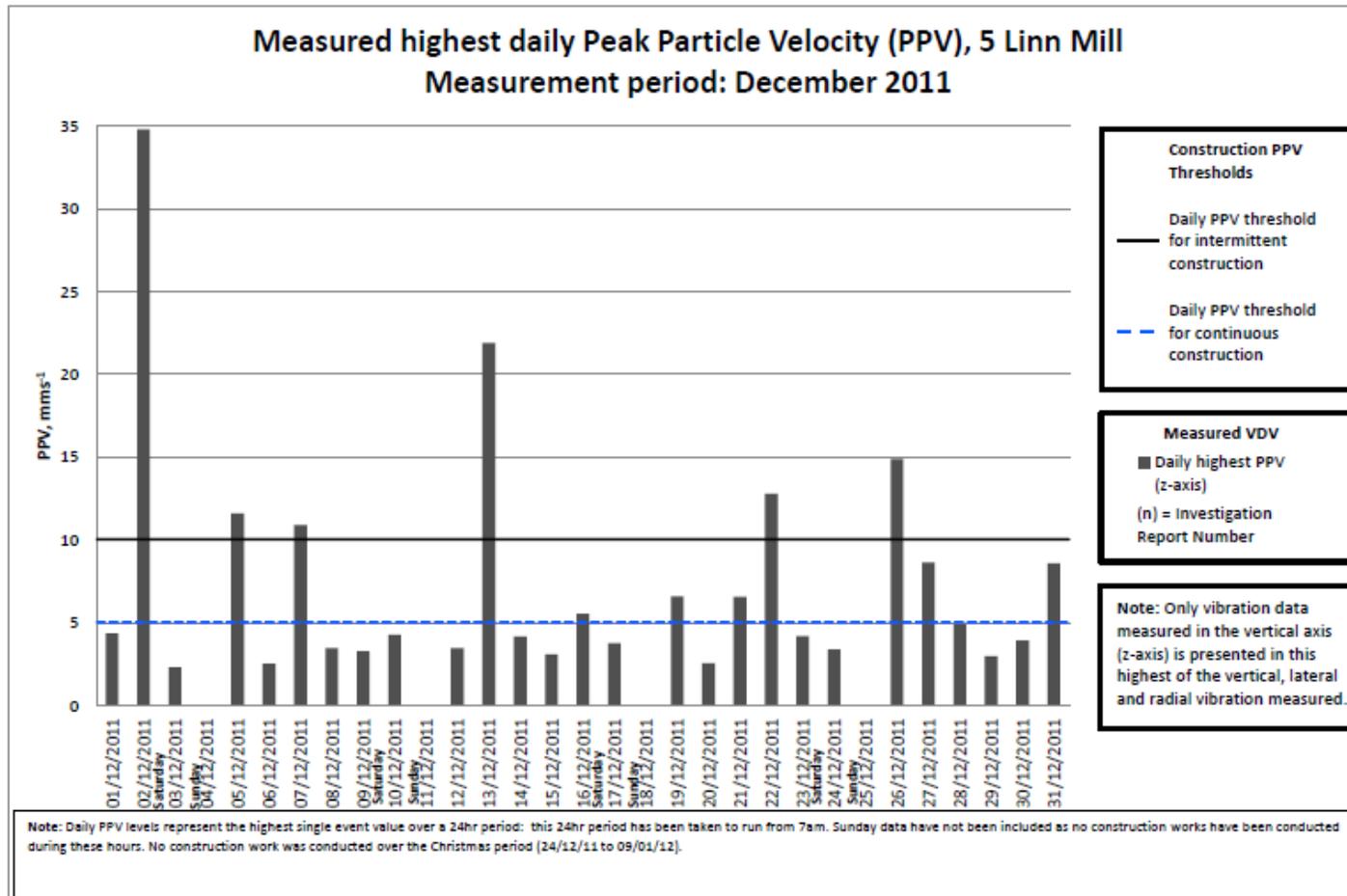
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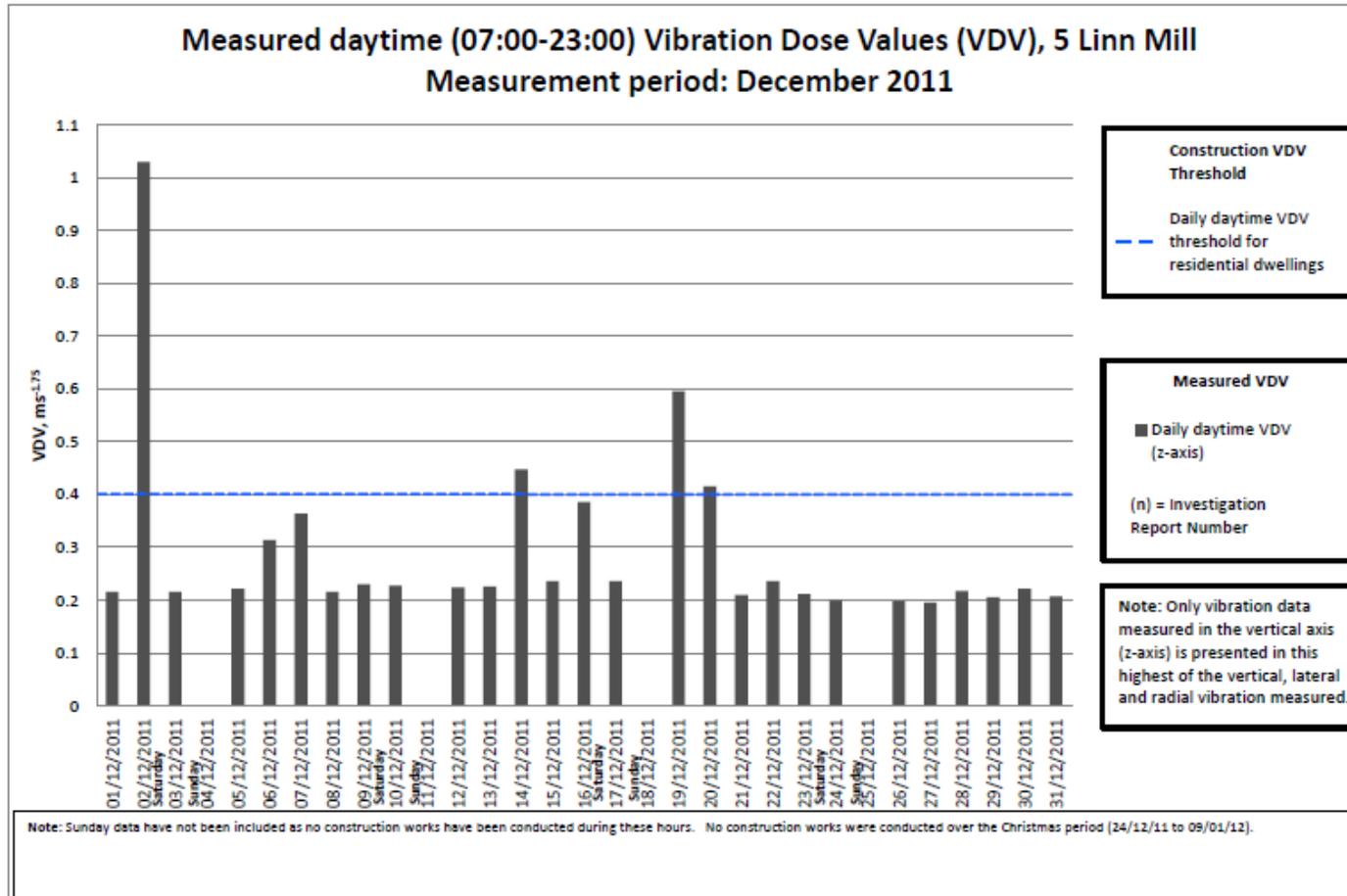
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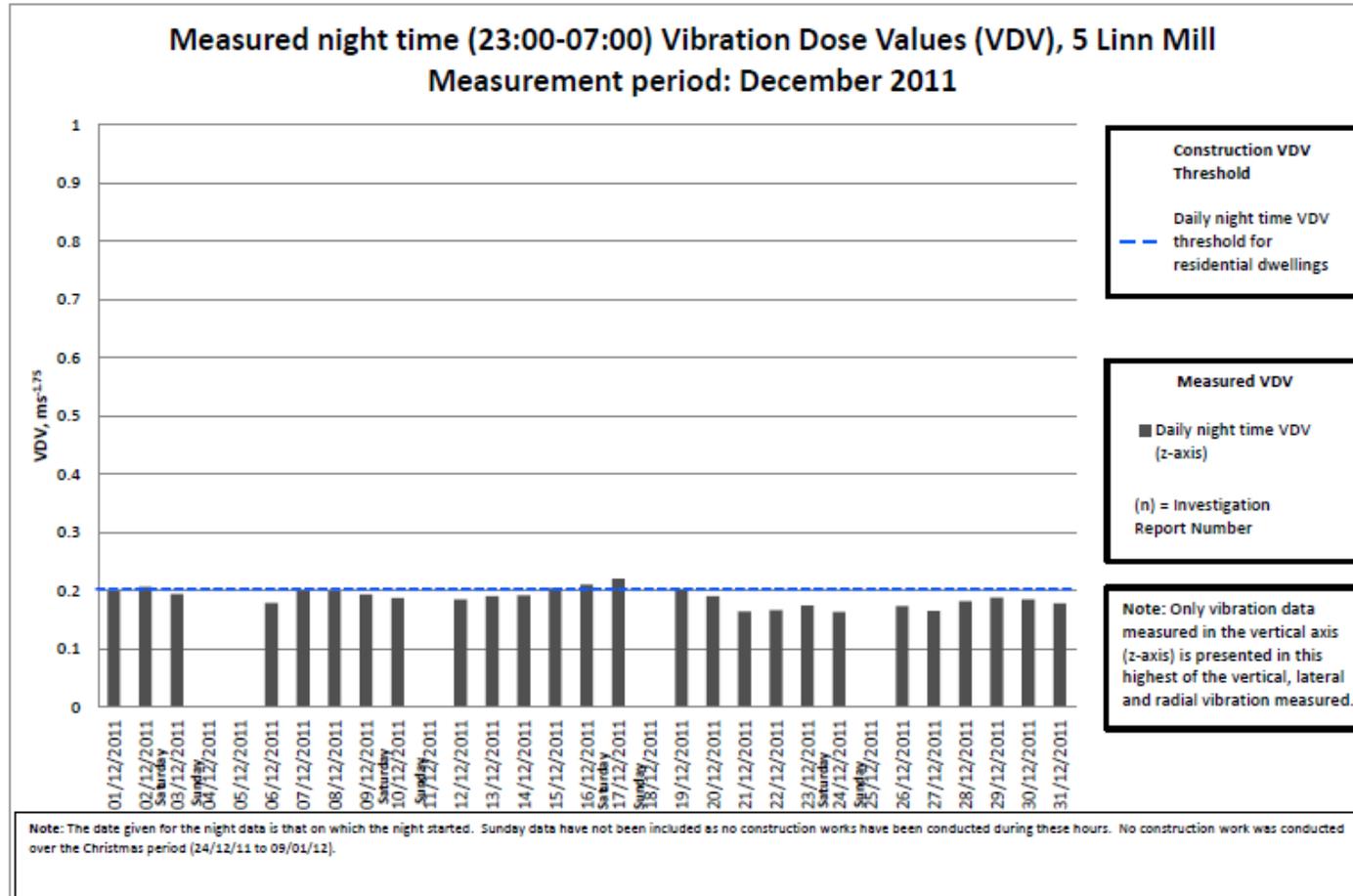
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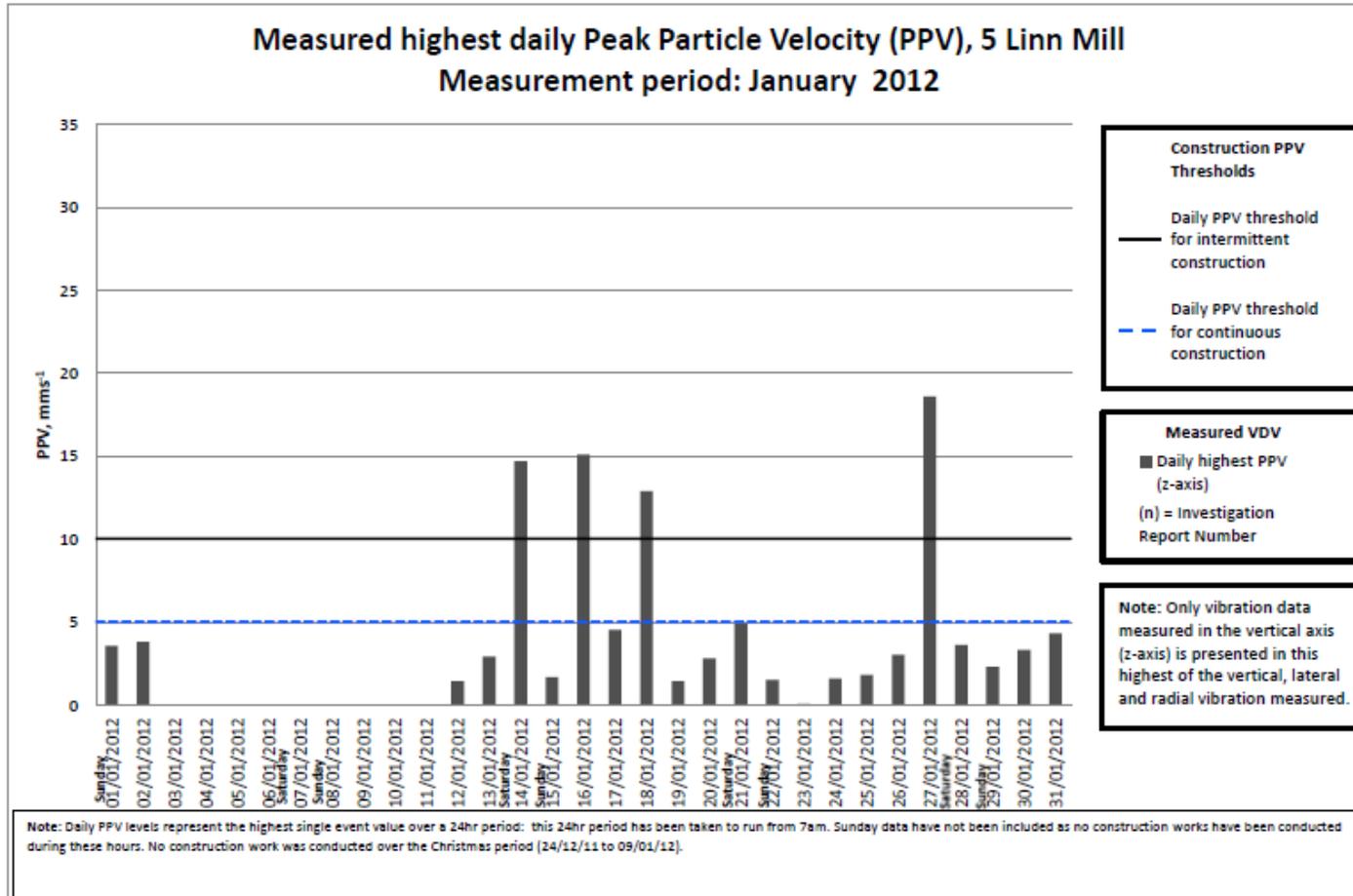
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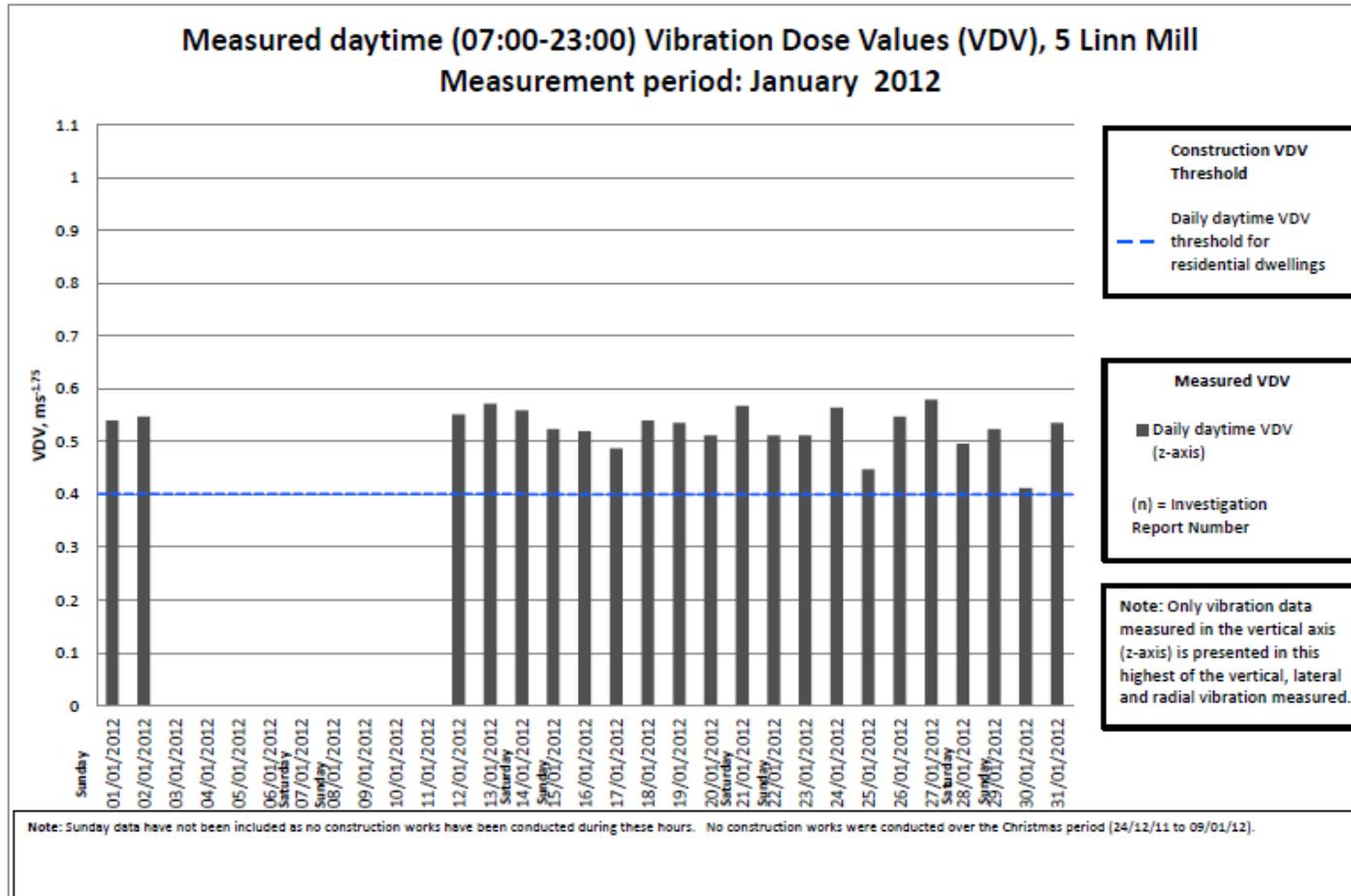
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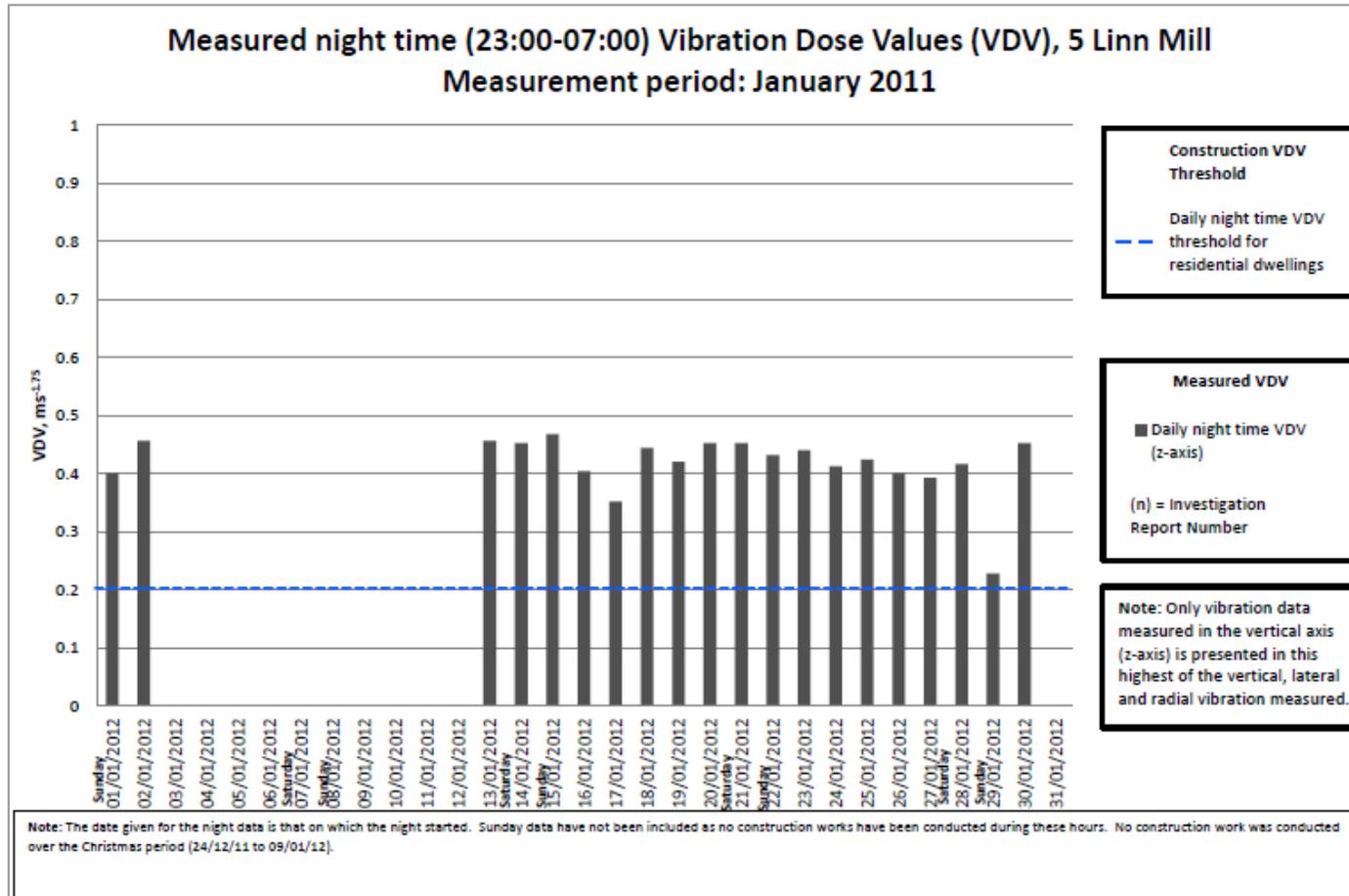
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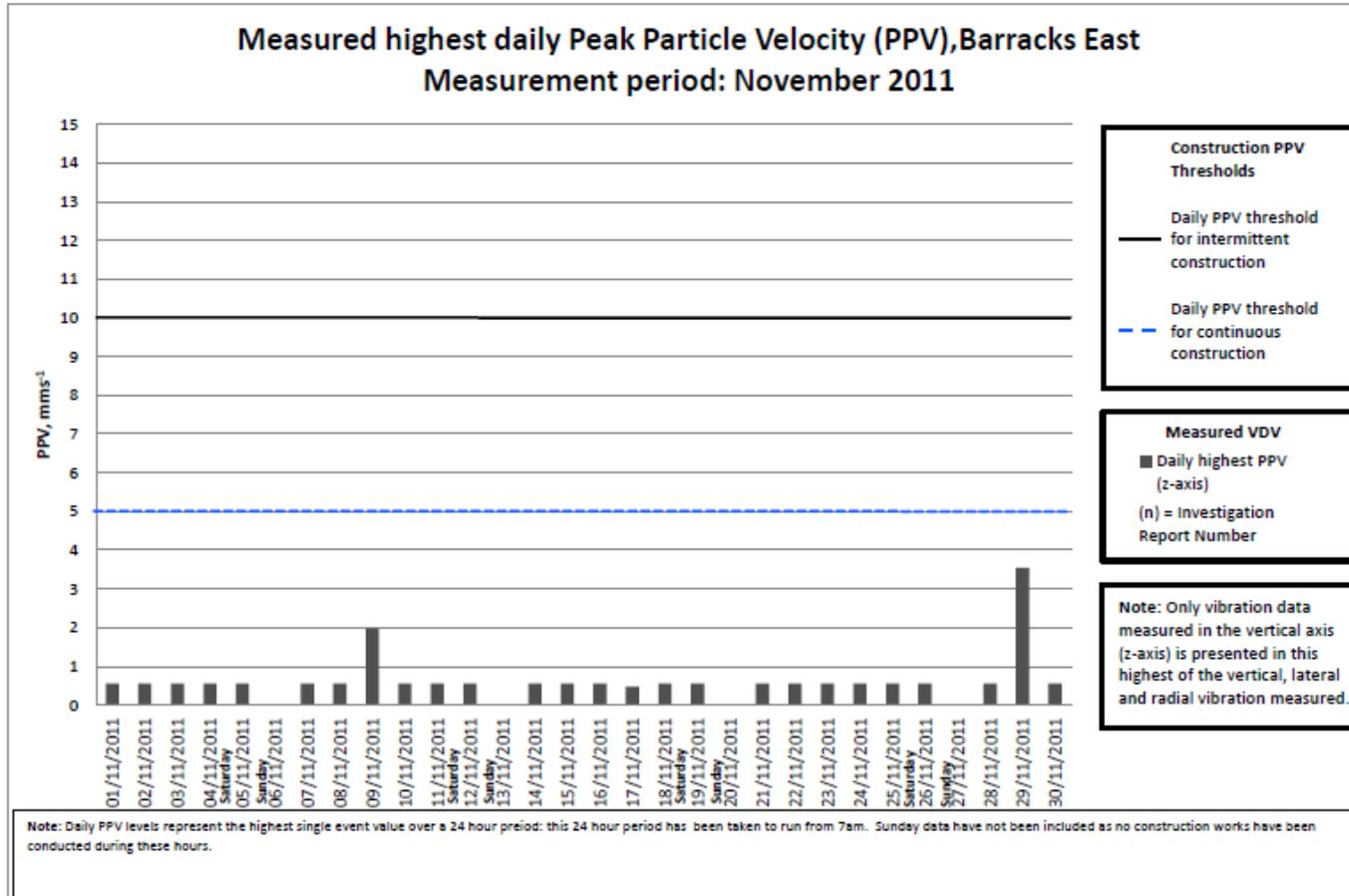
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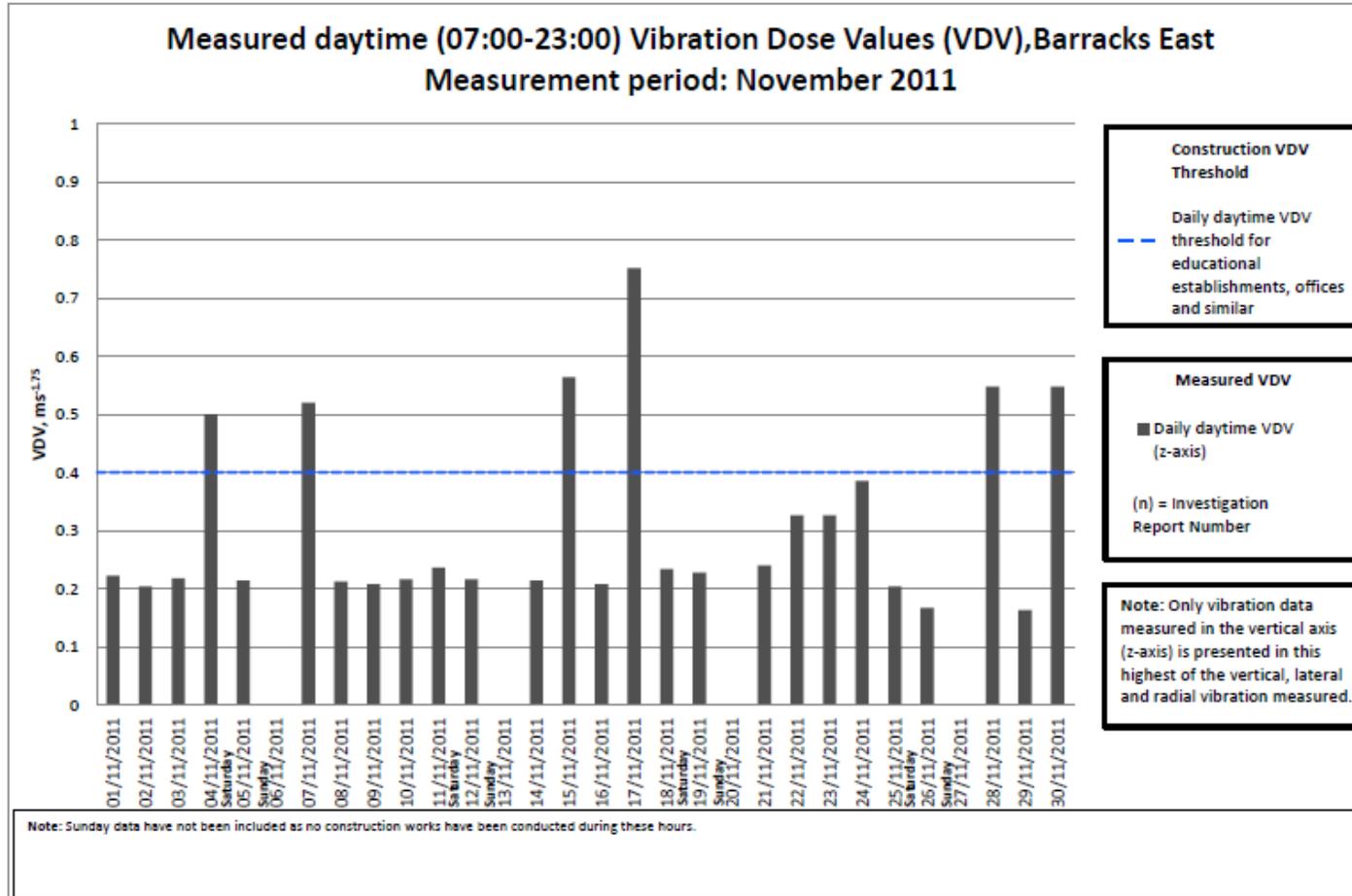
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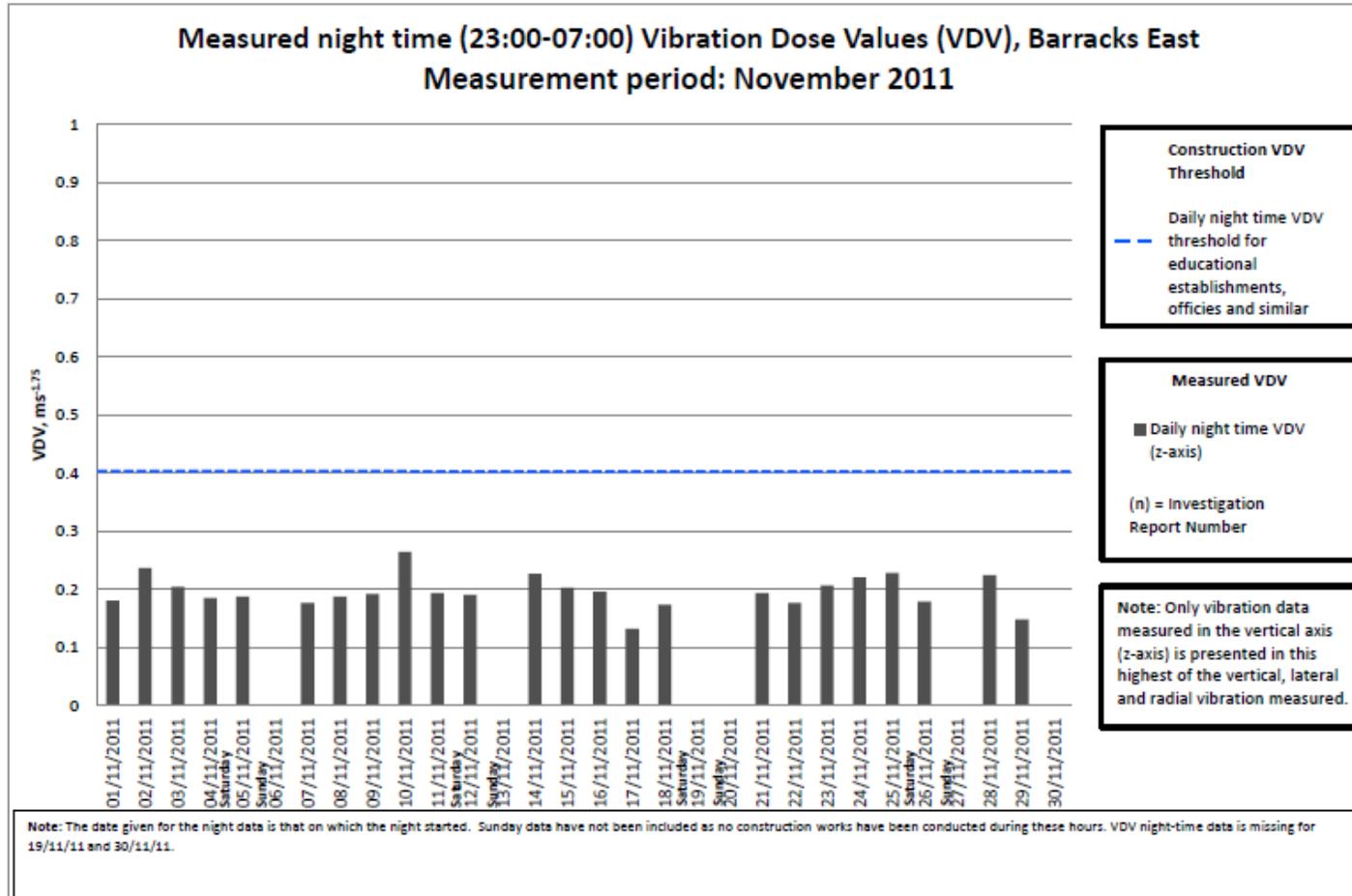
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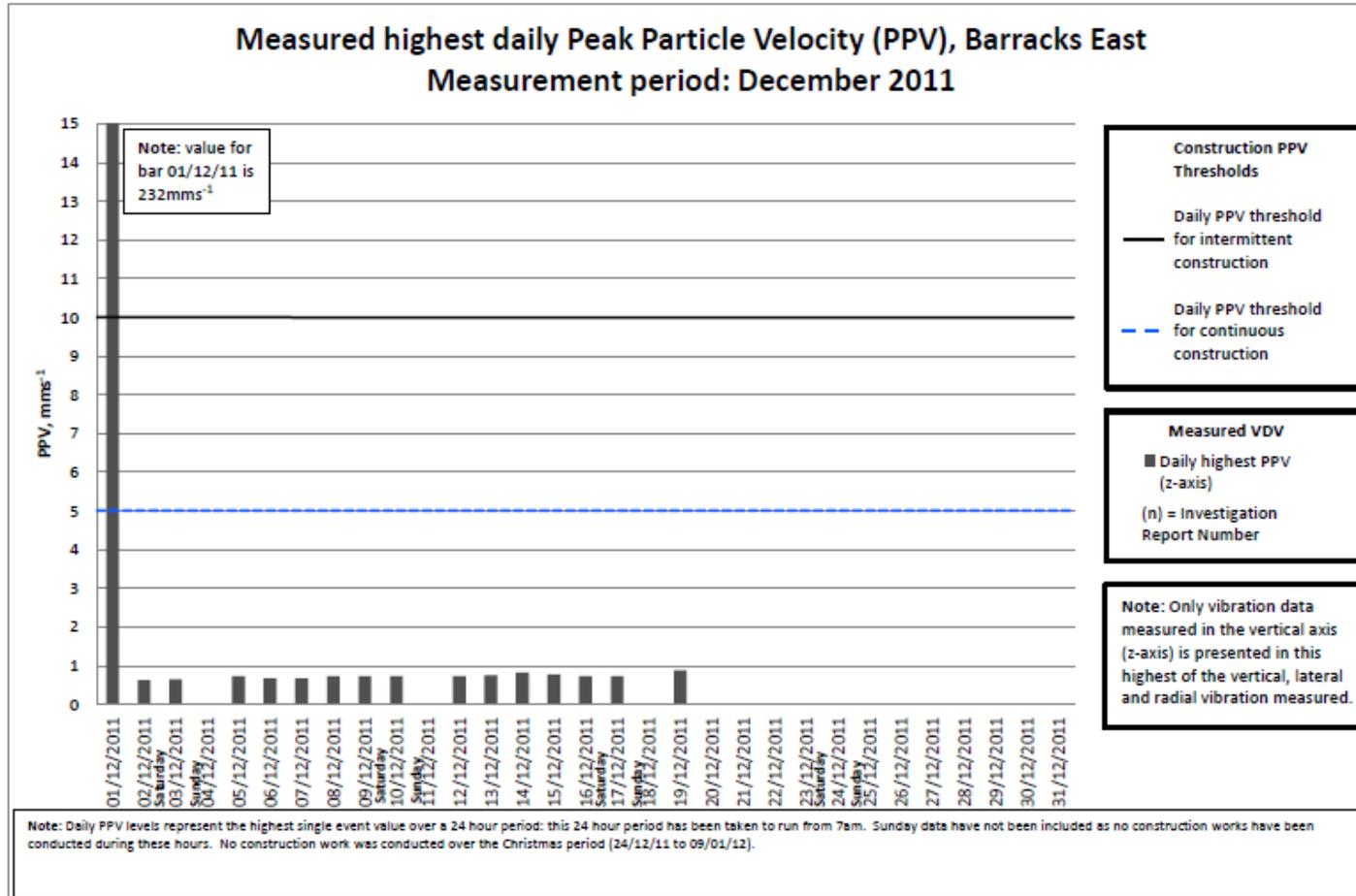
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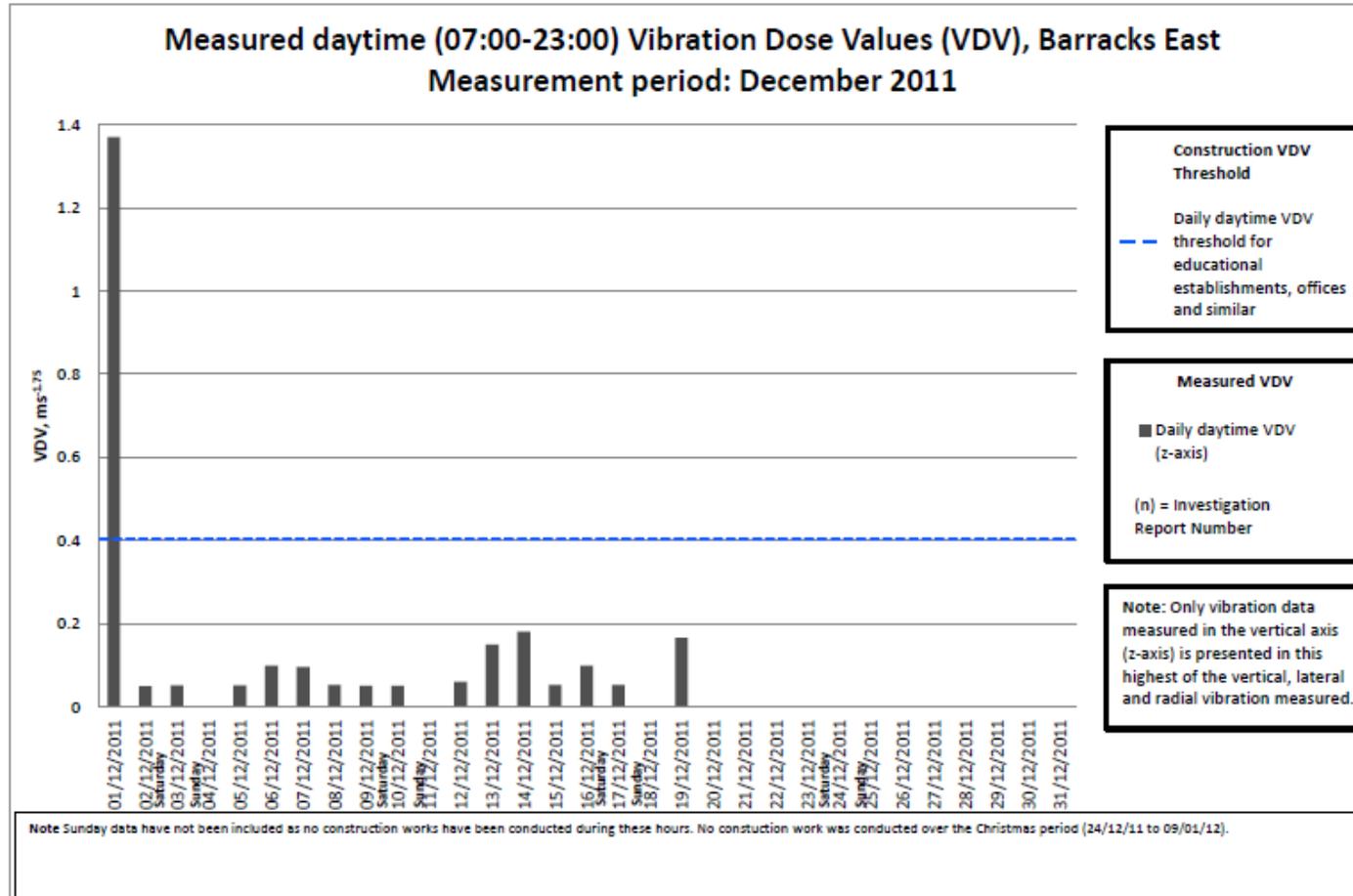
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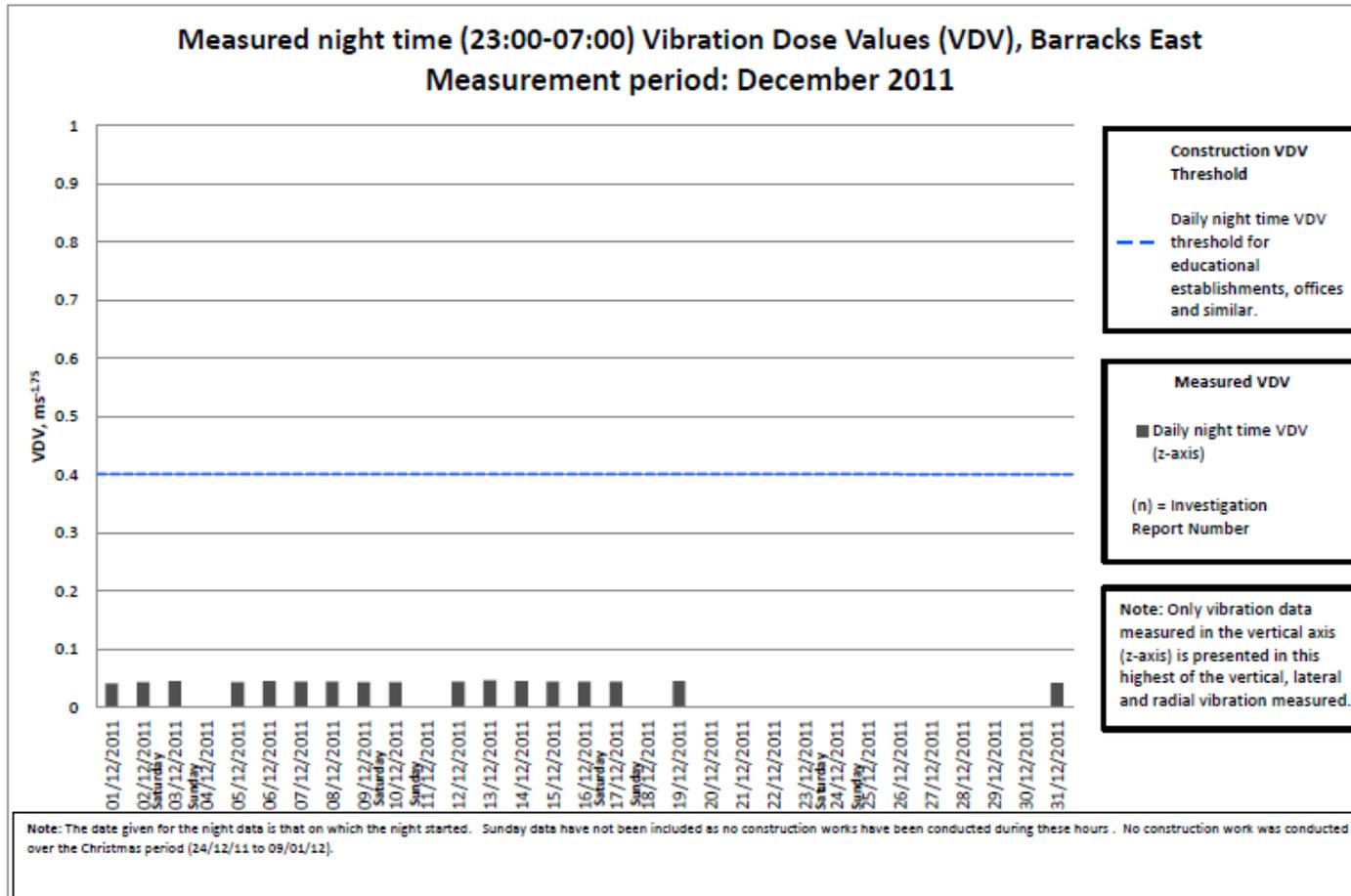
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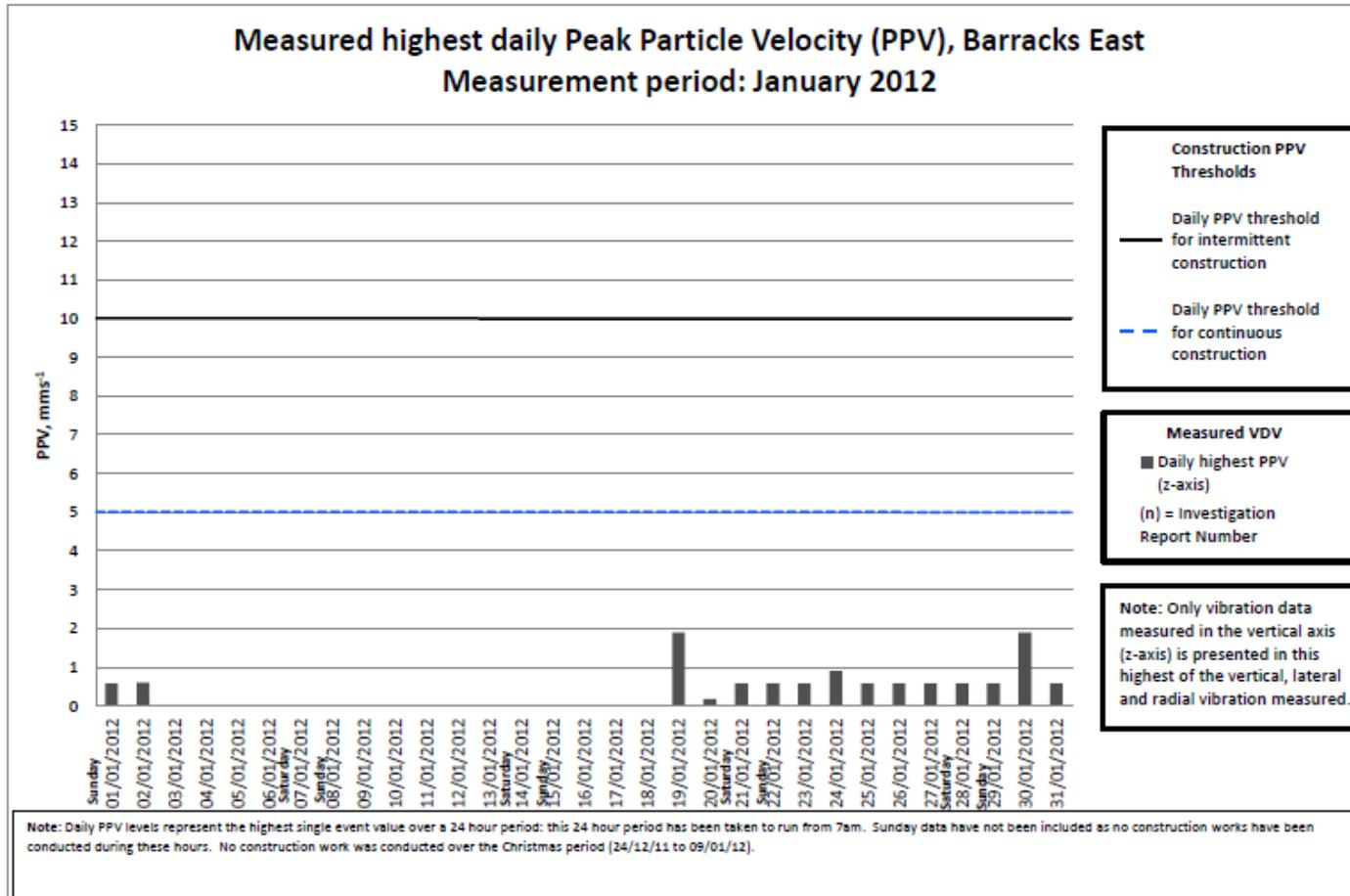
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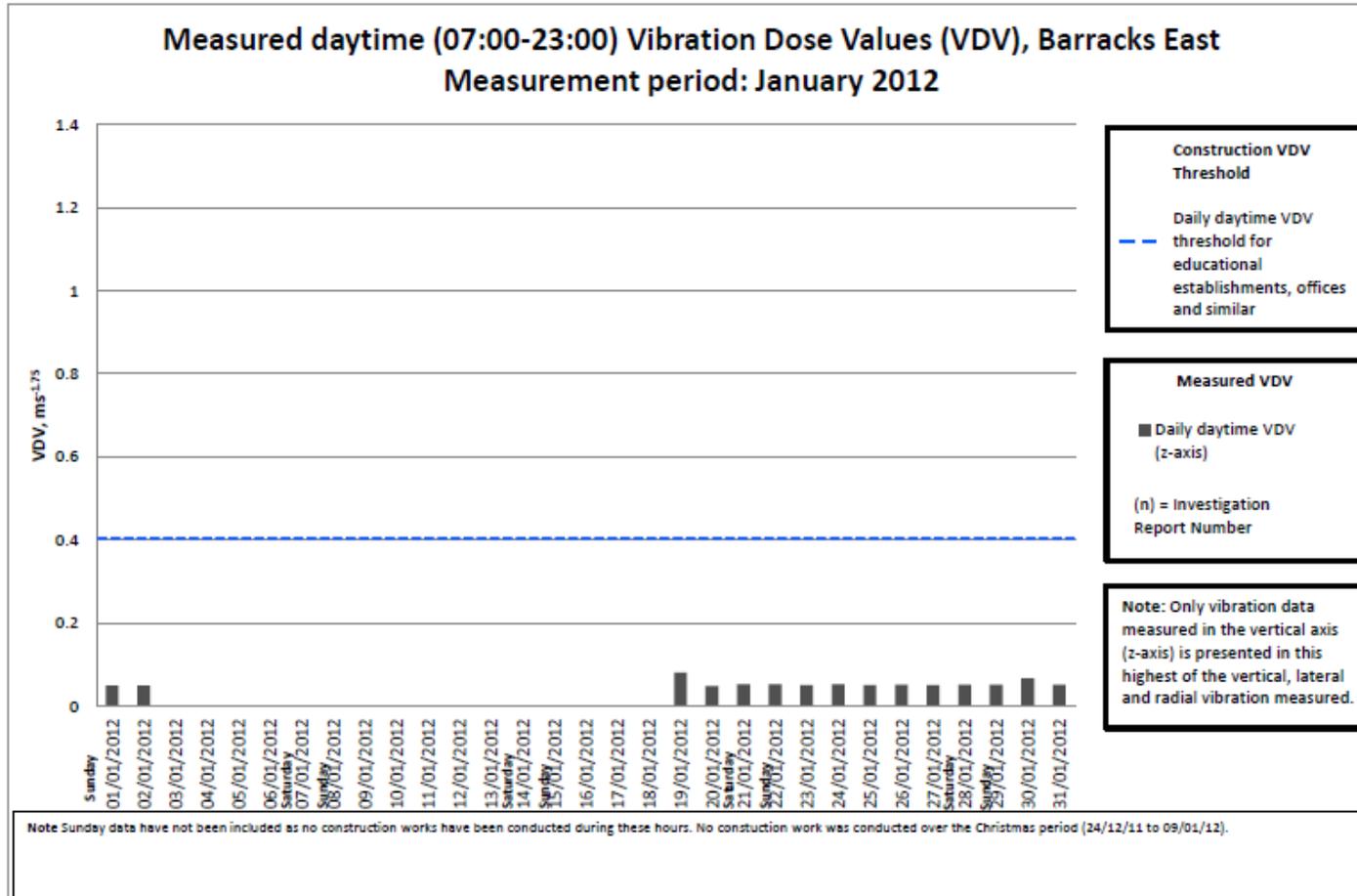
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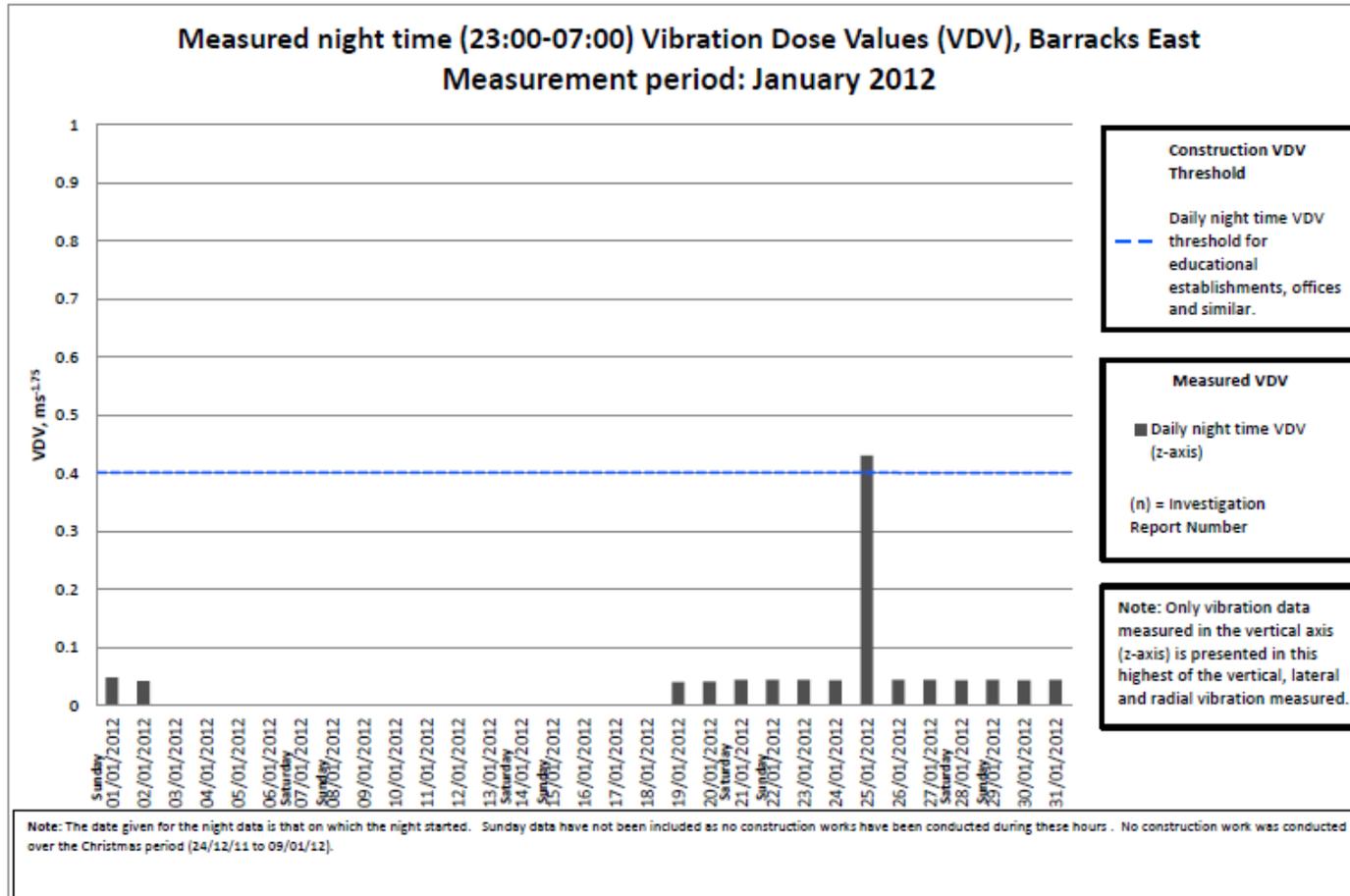
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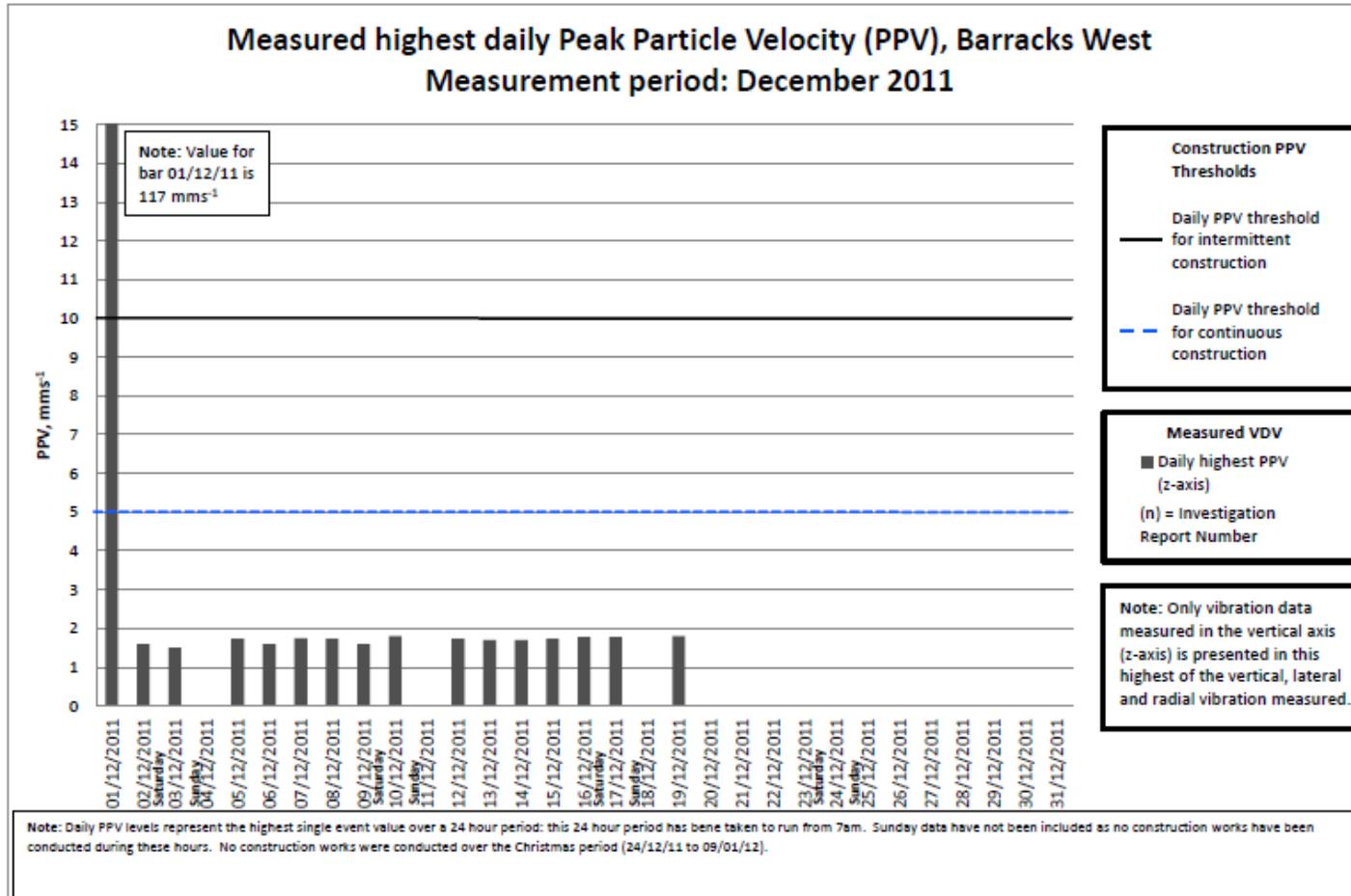
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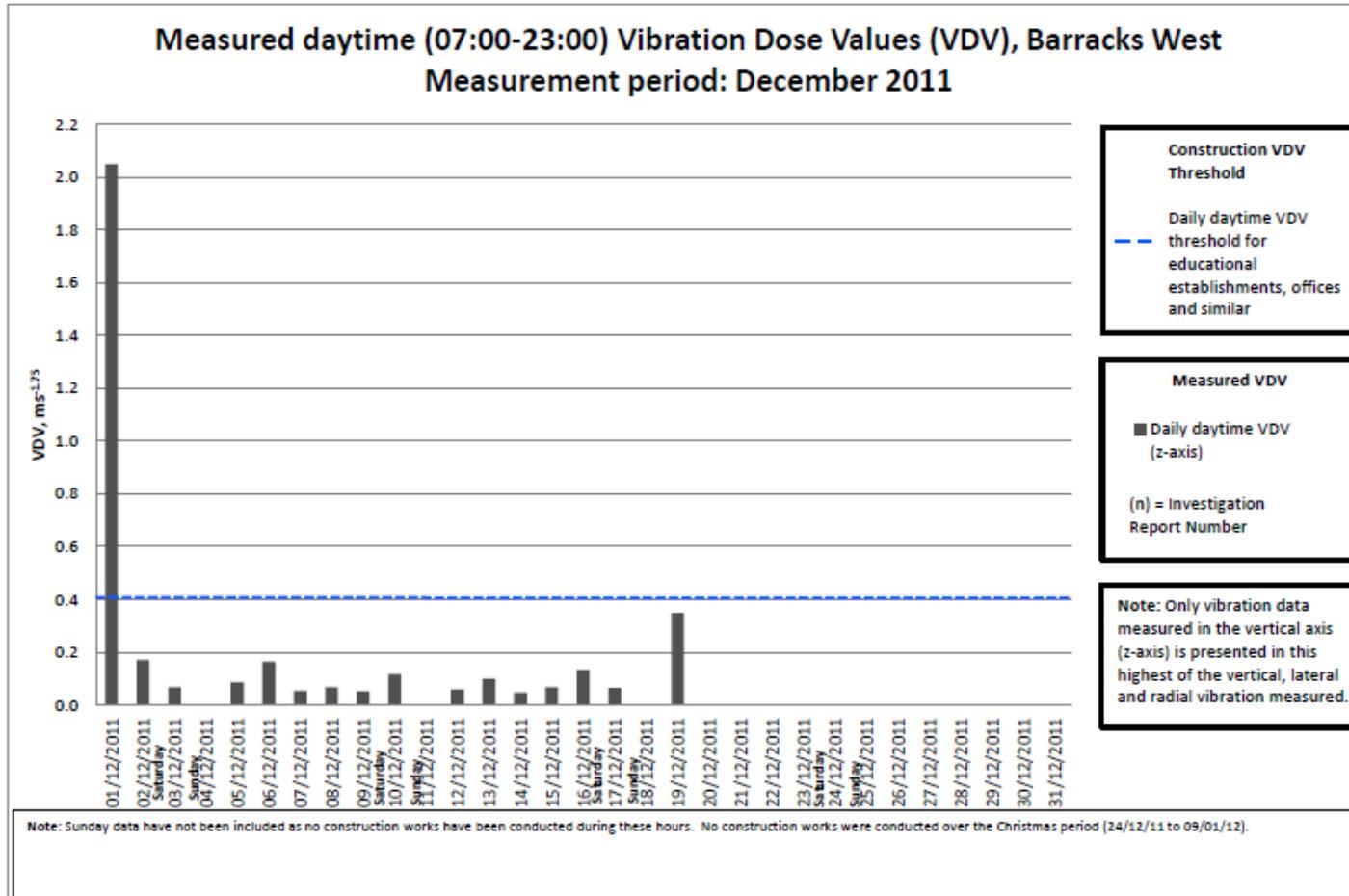
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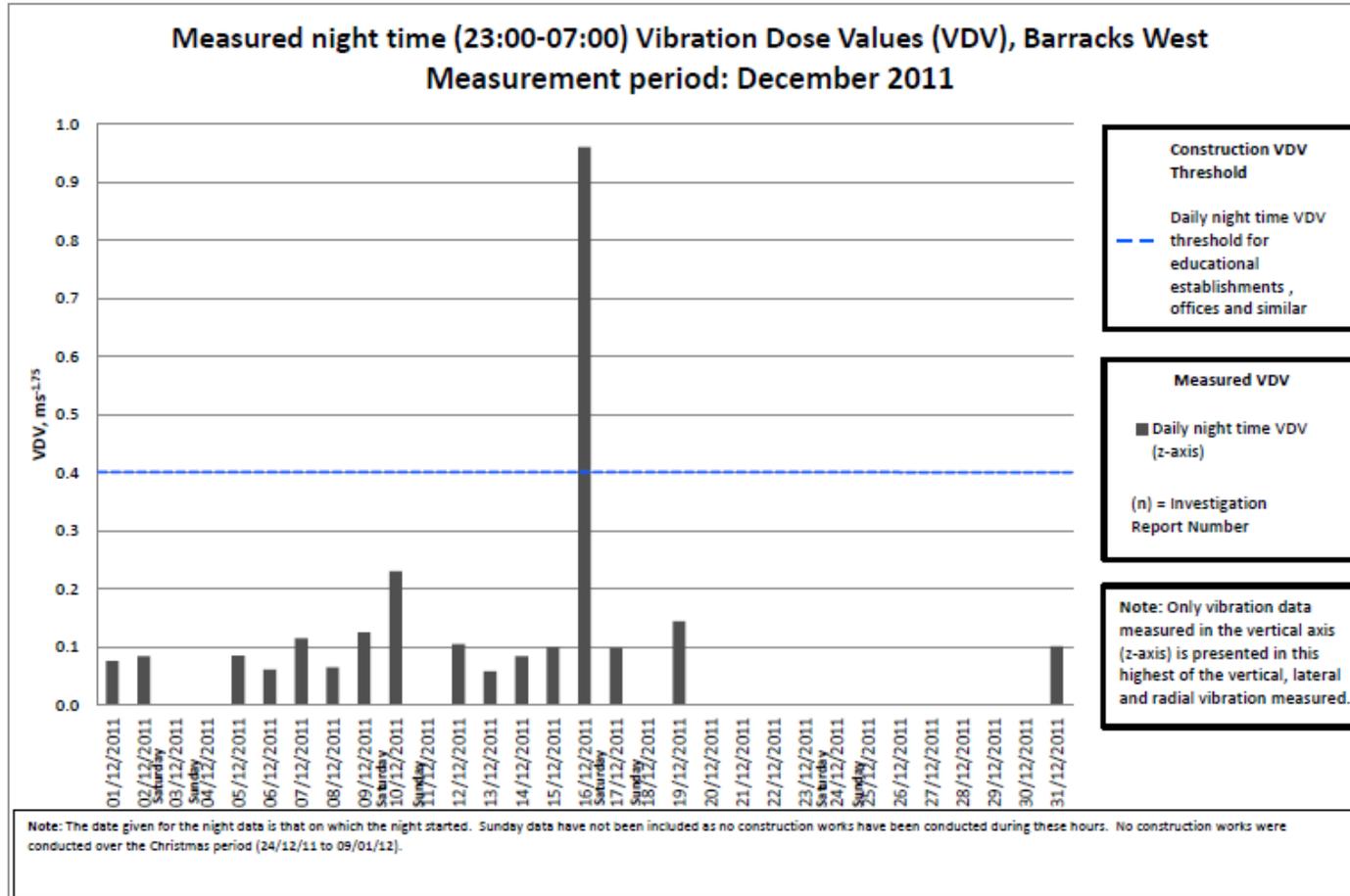
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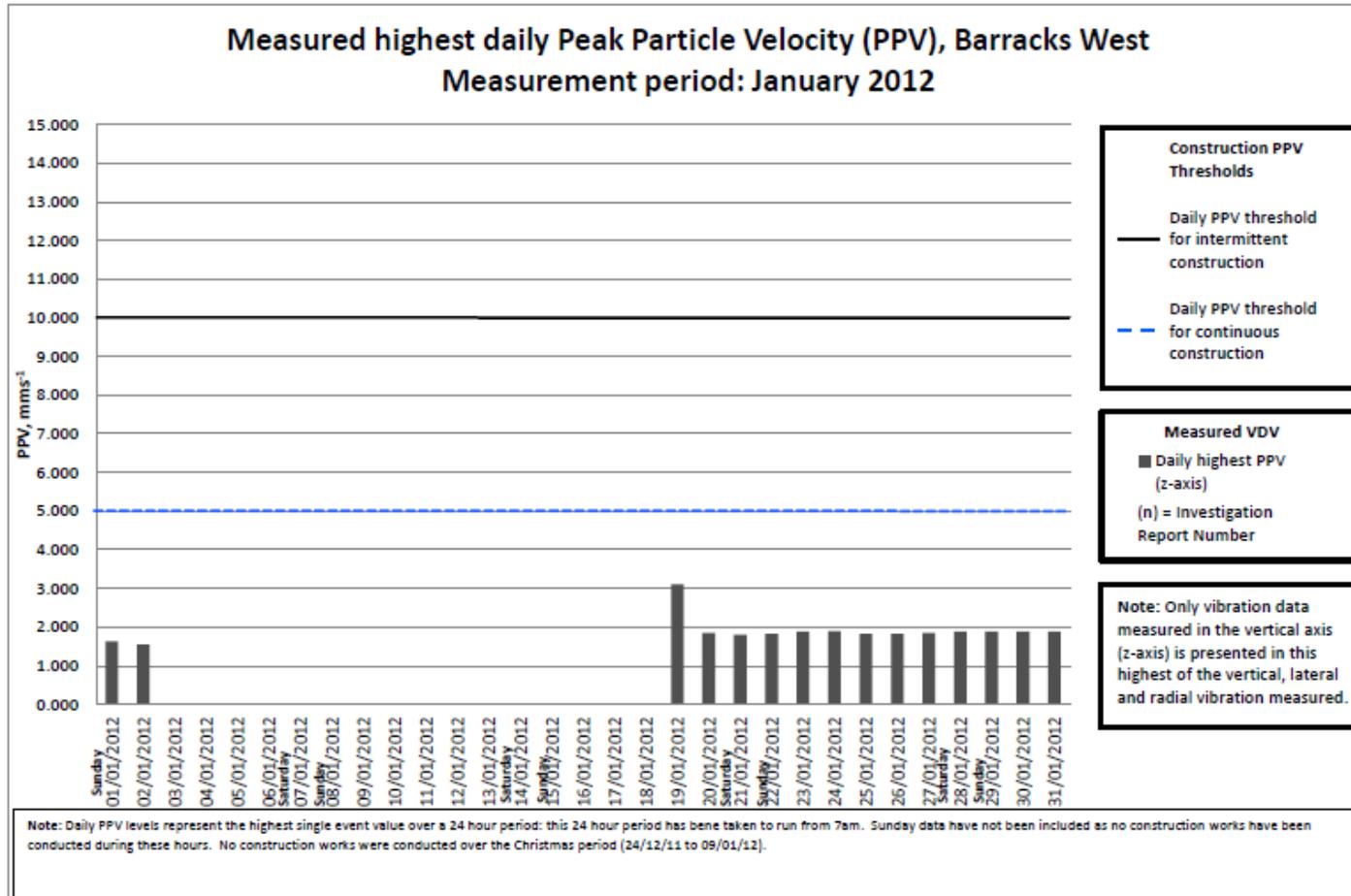
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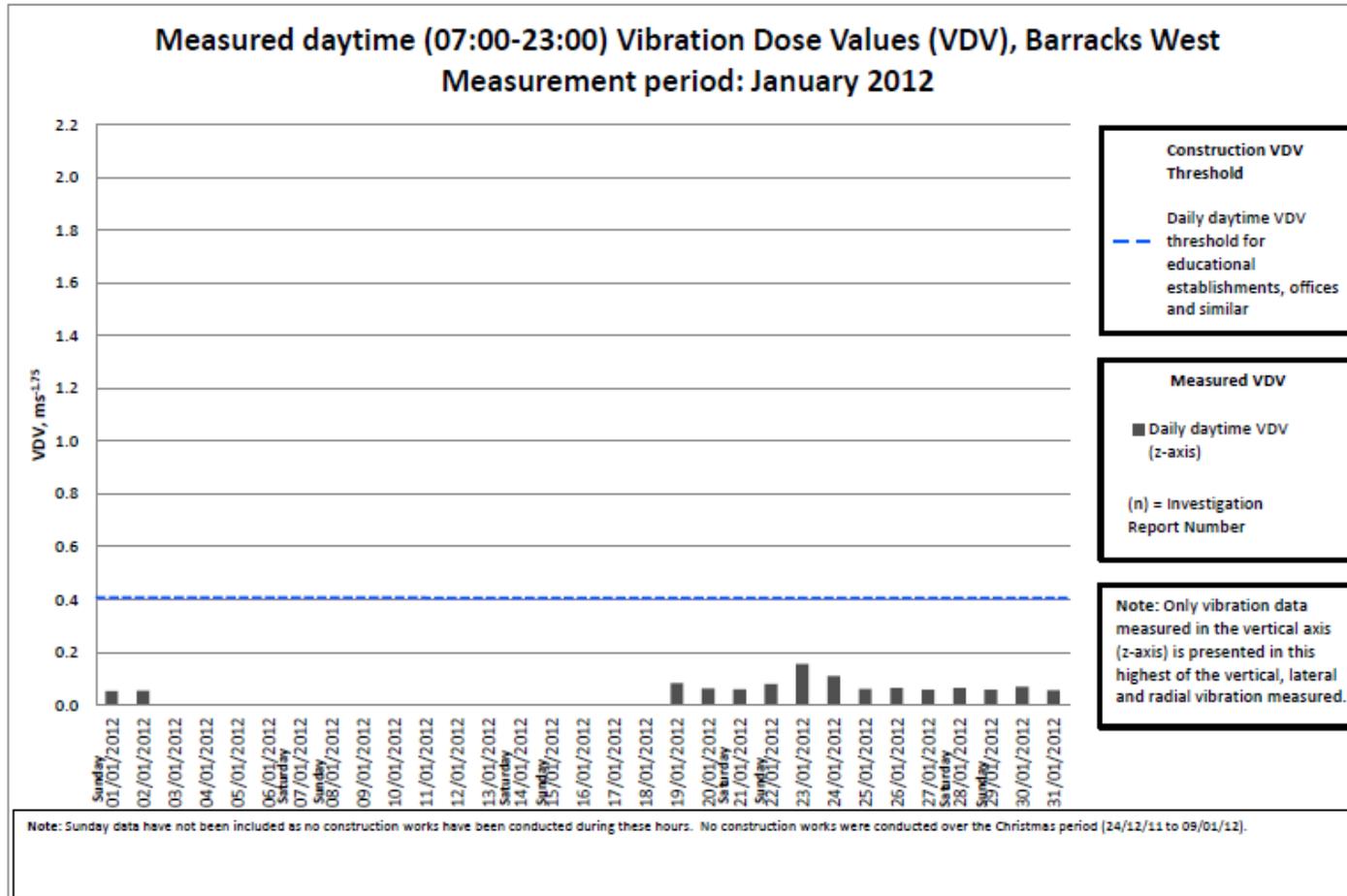
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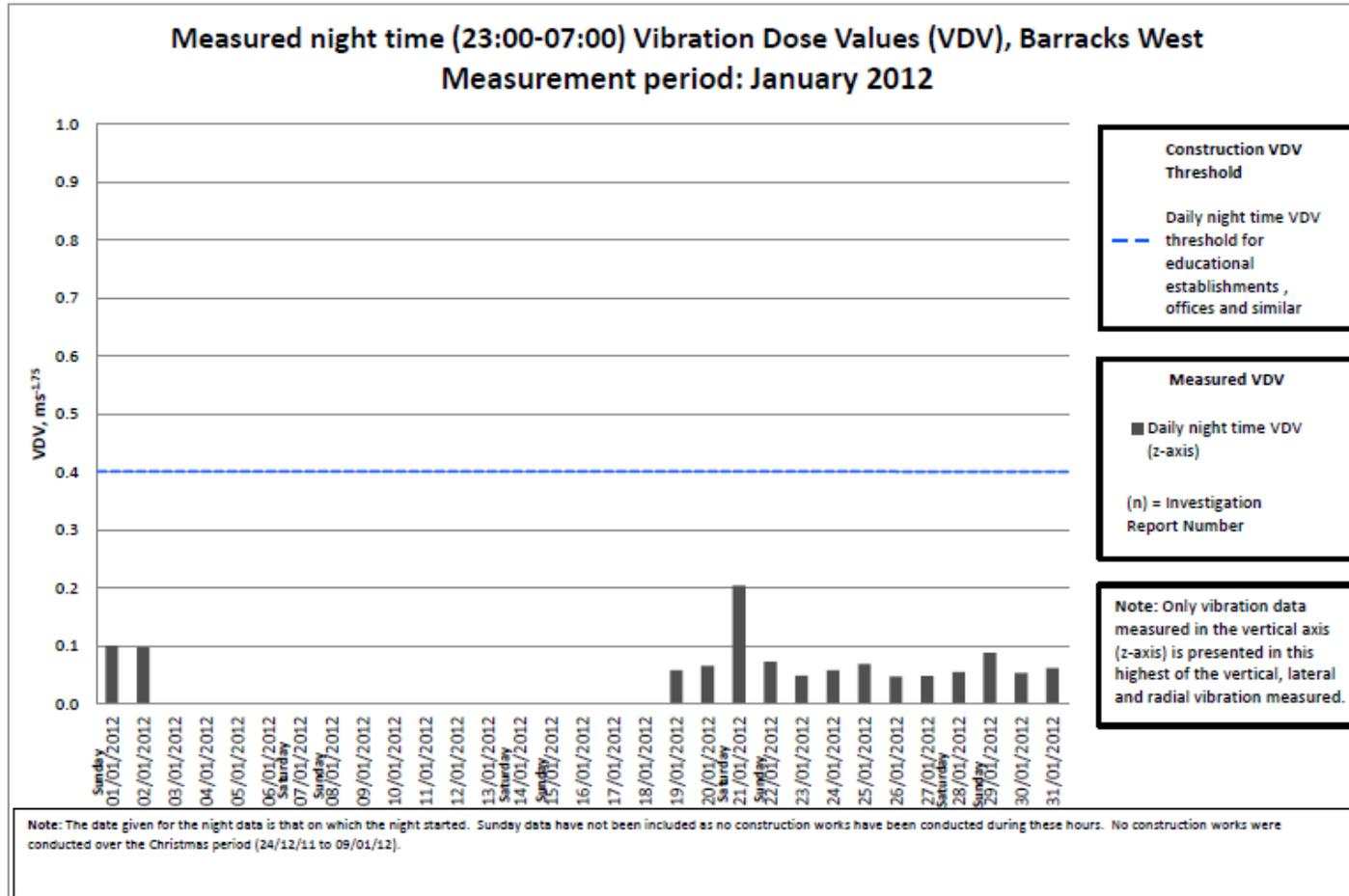
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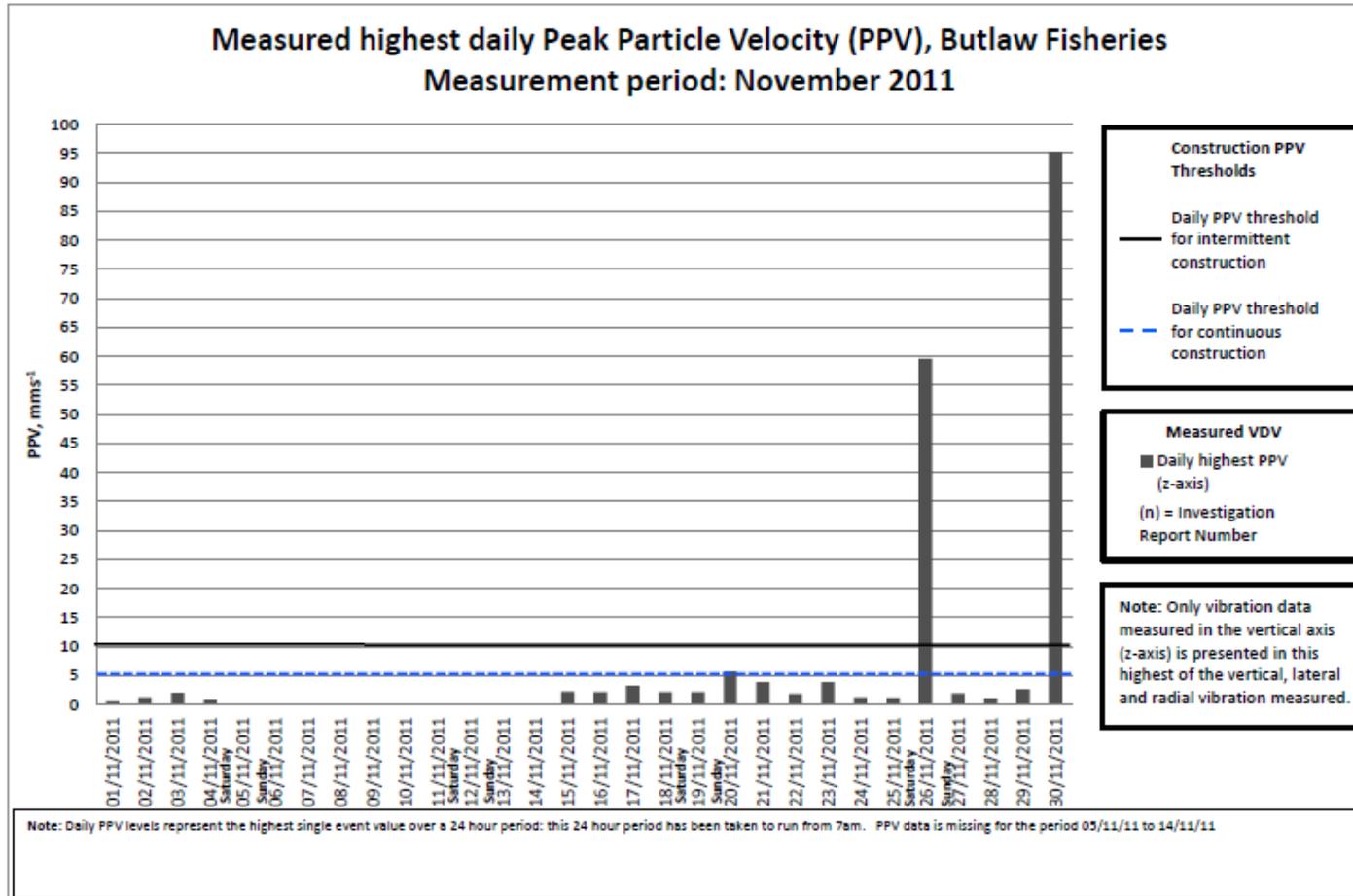
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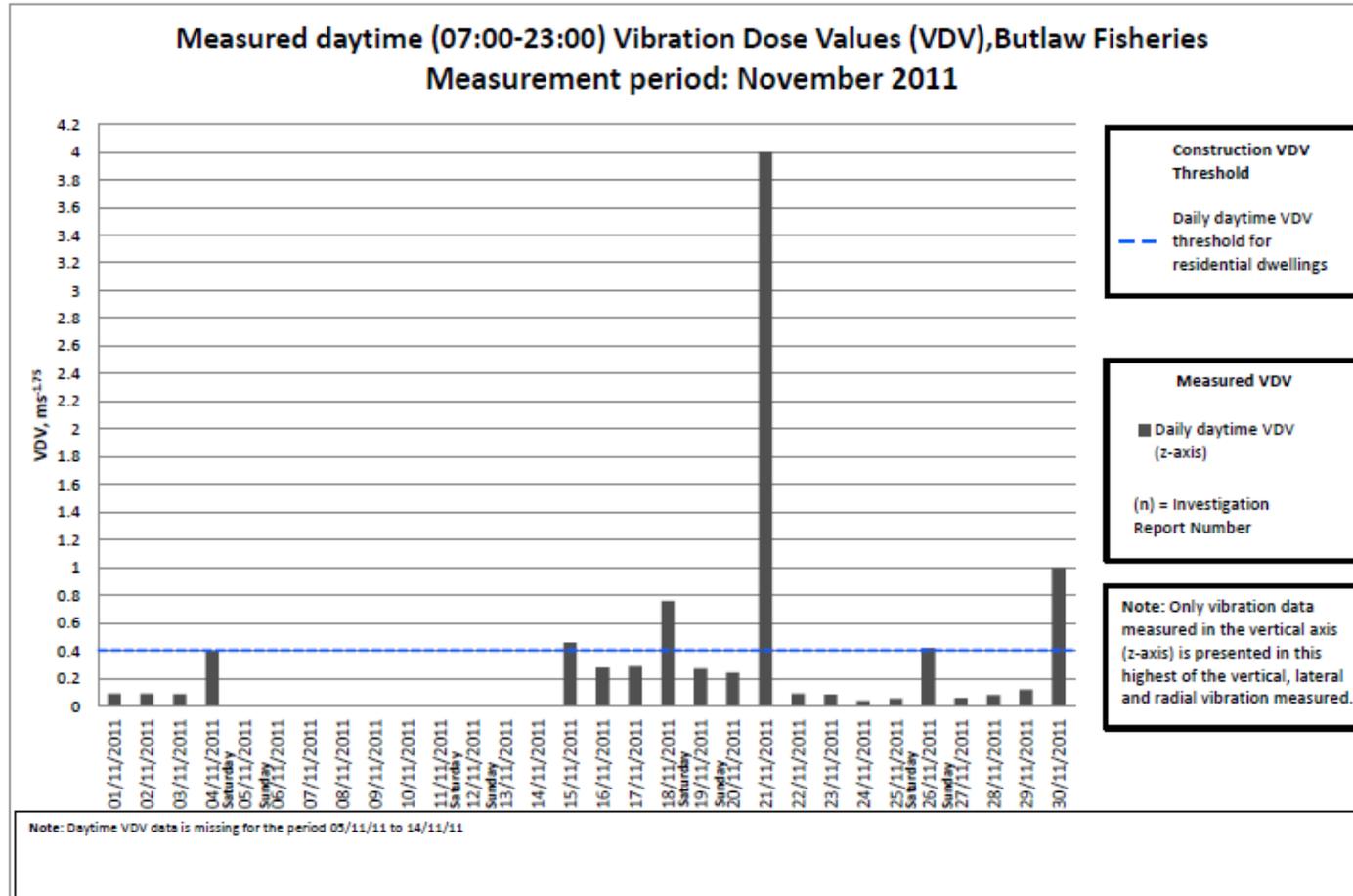
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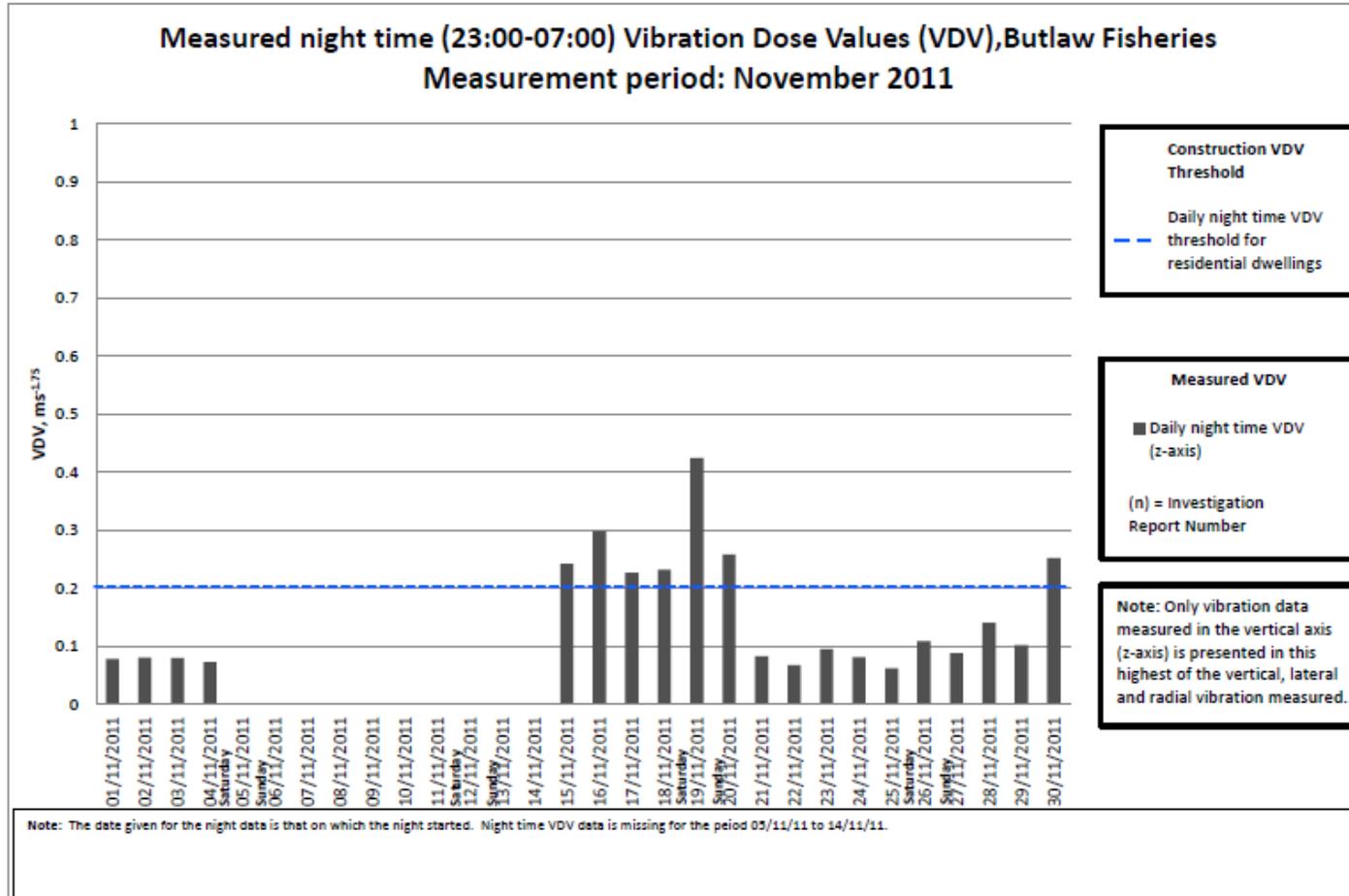
PPV at Butlaw Fisheries – November 2011



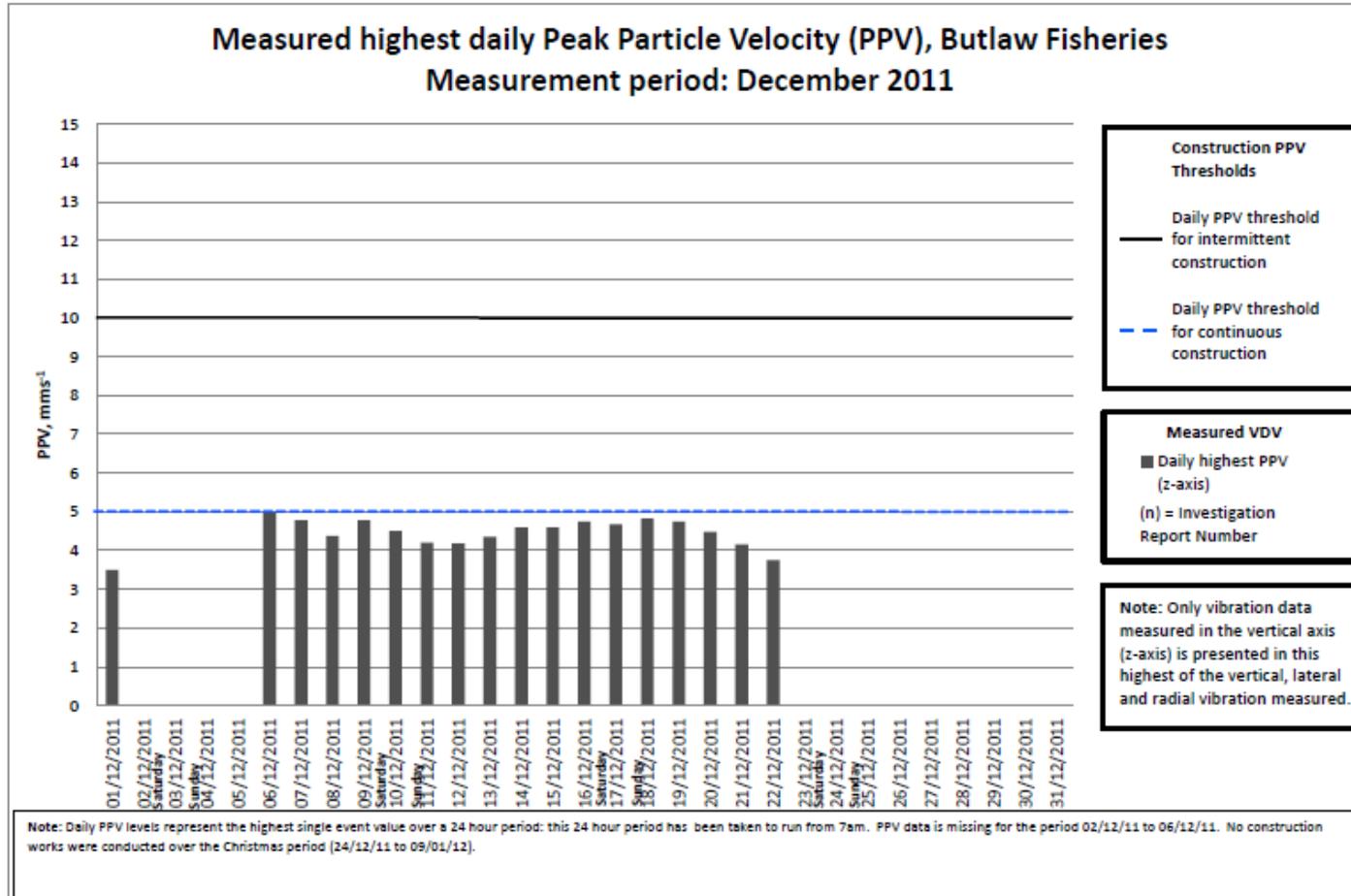
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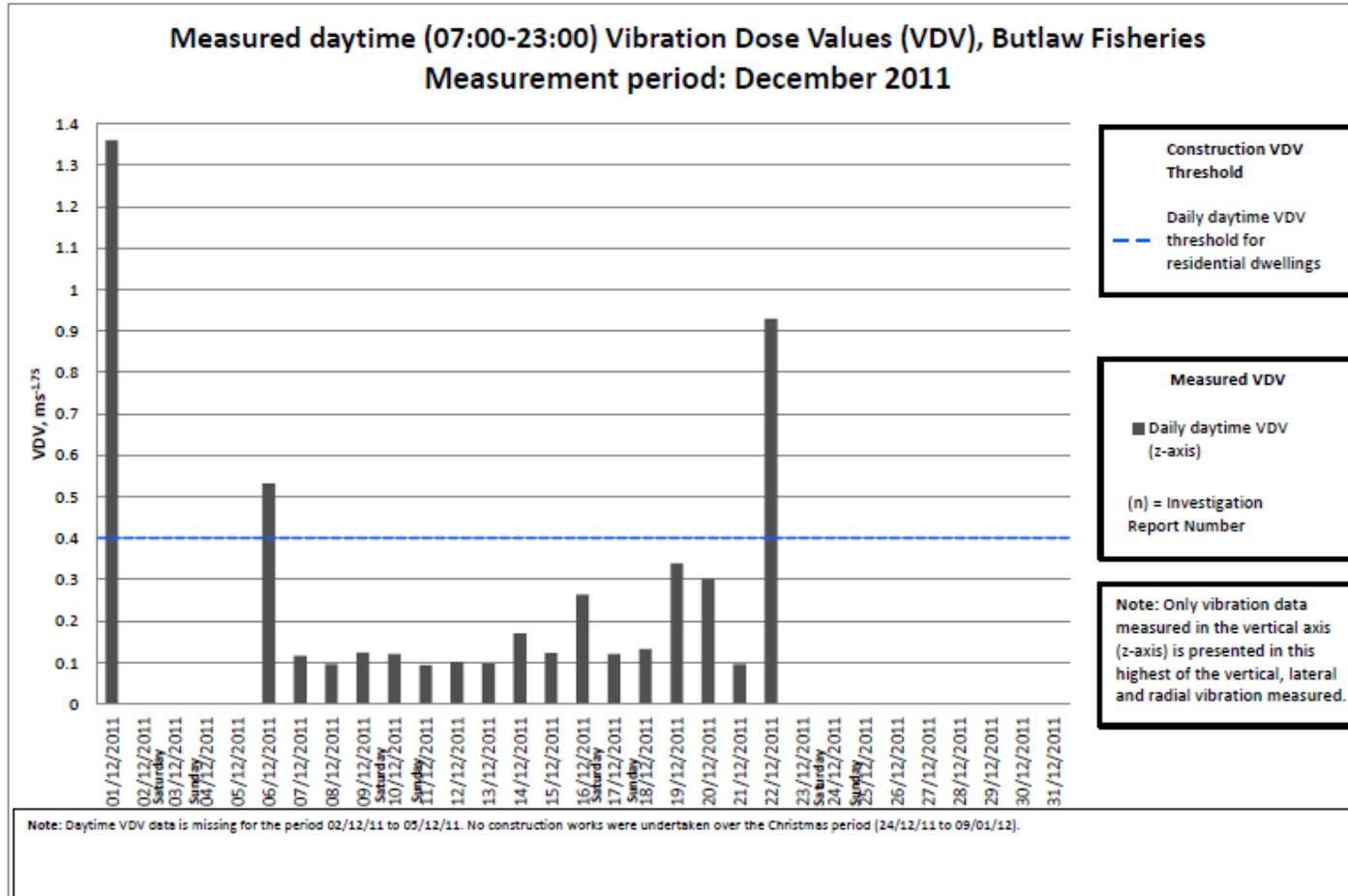
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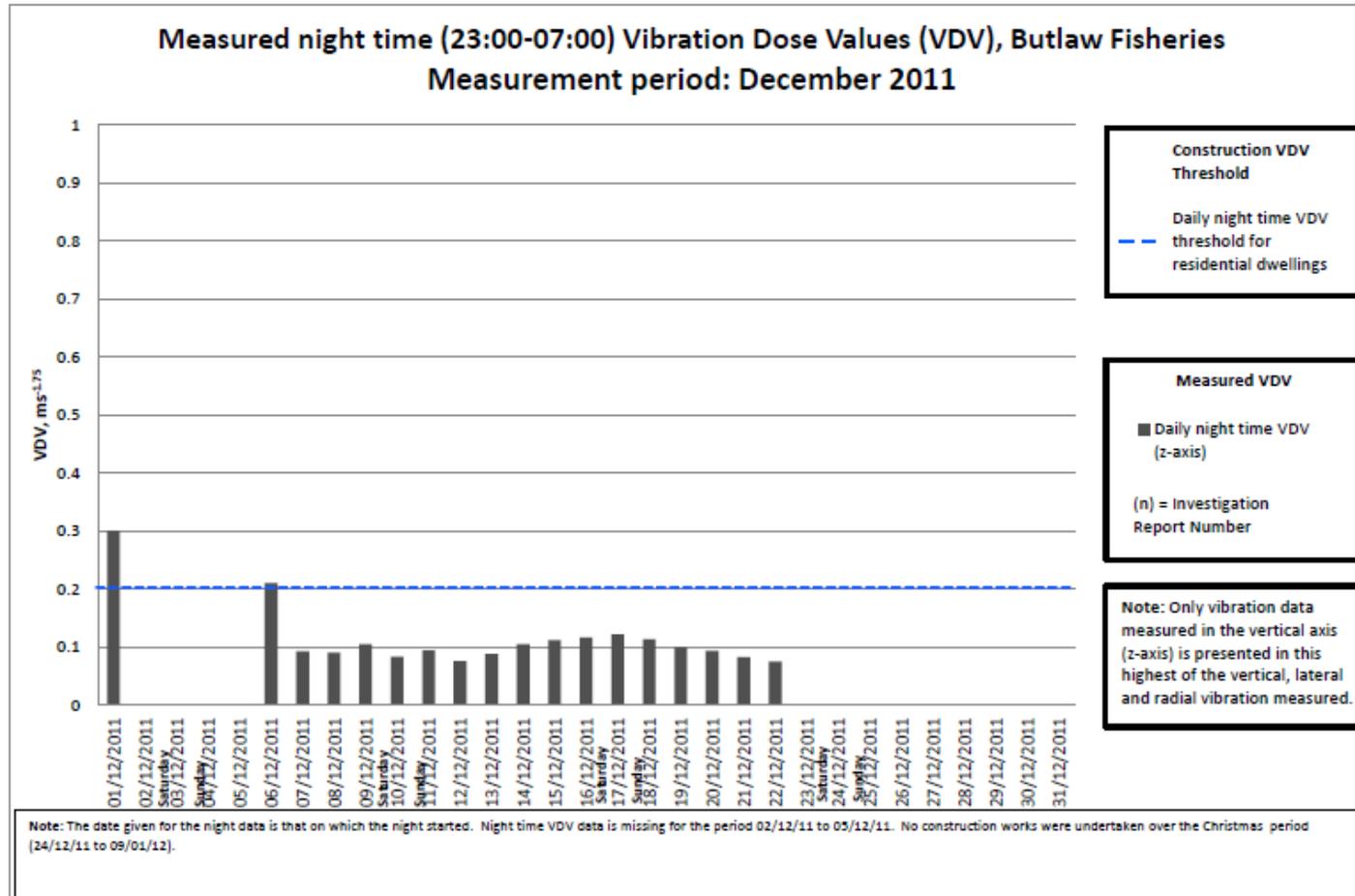
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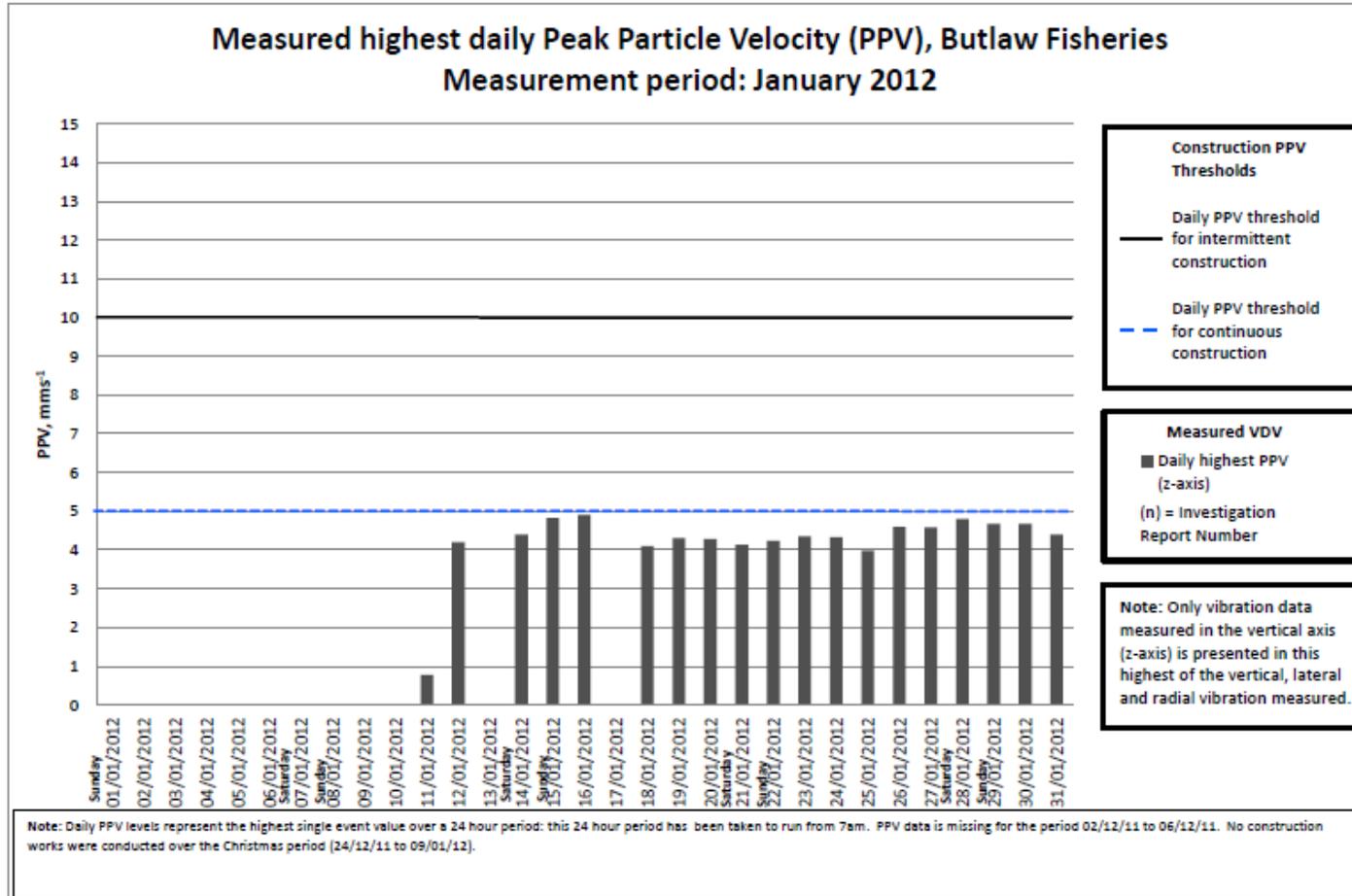
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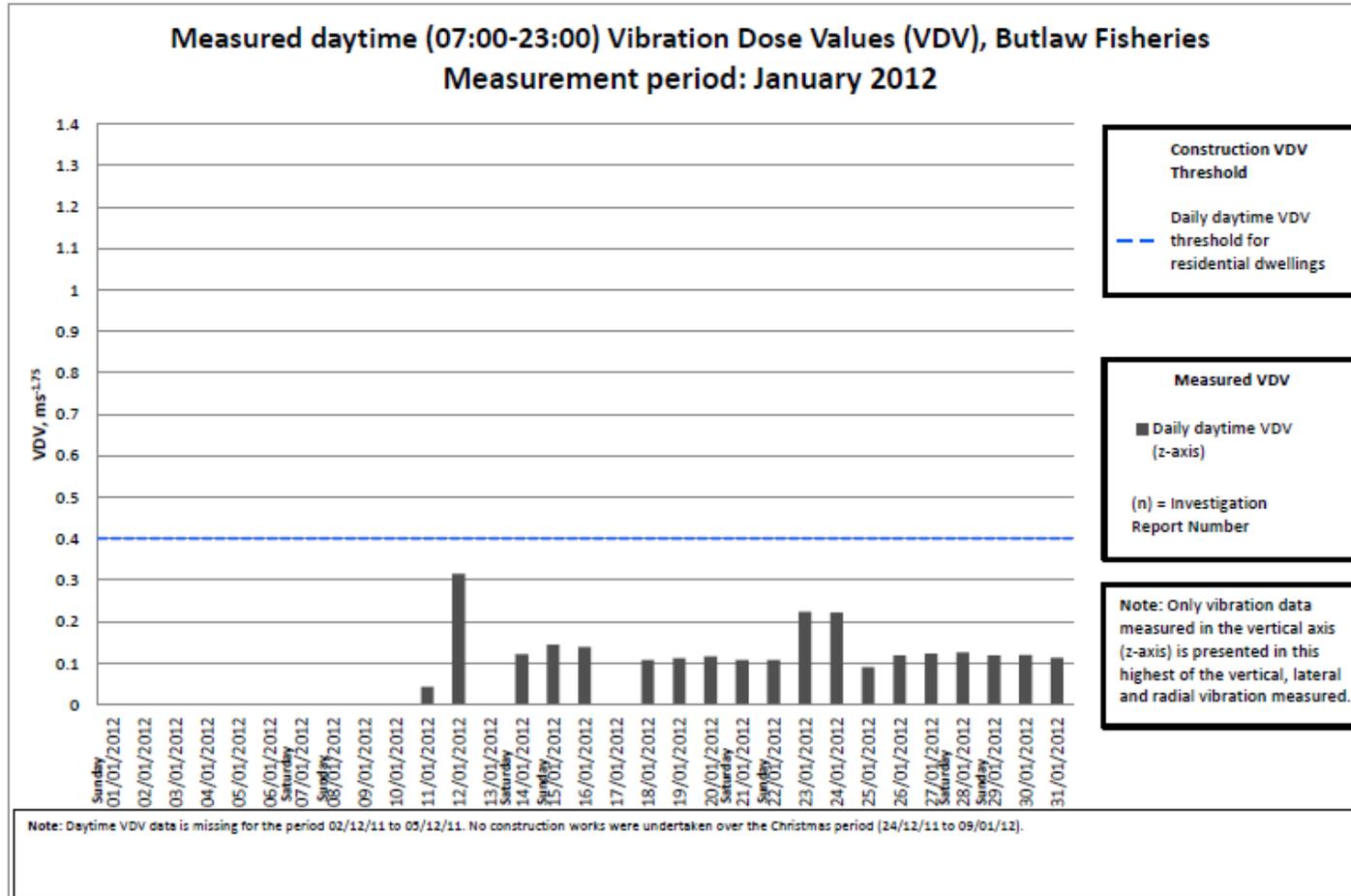
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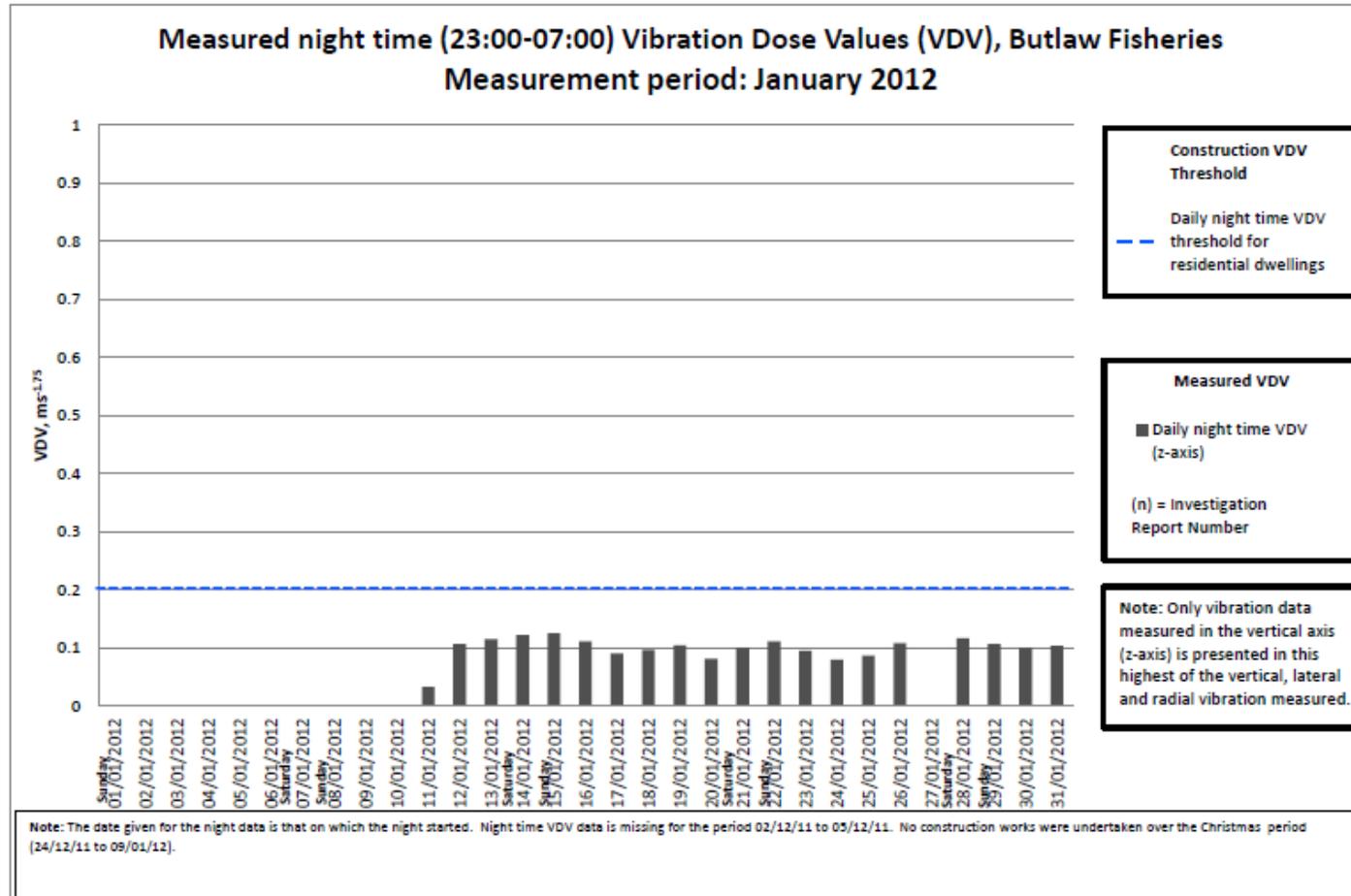
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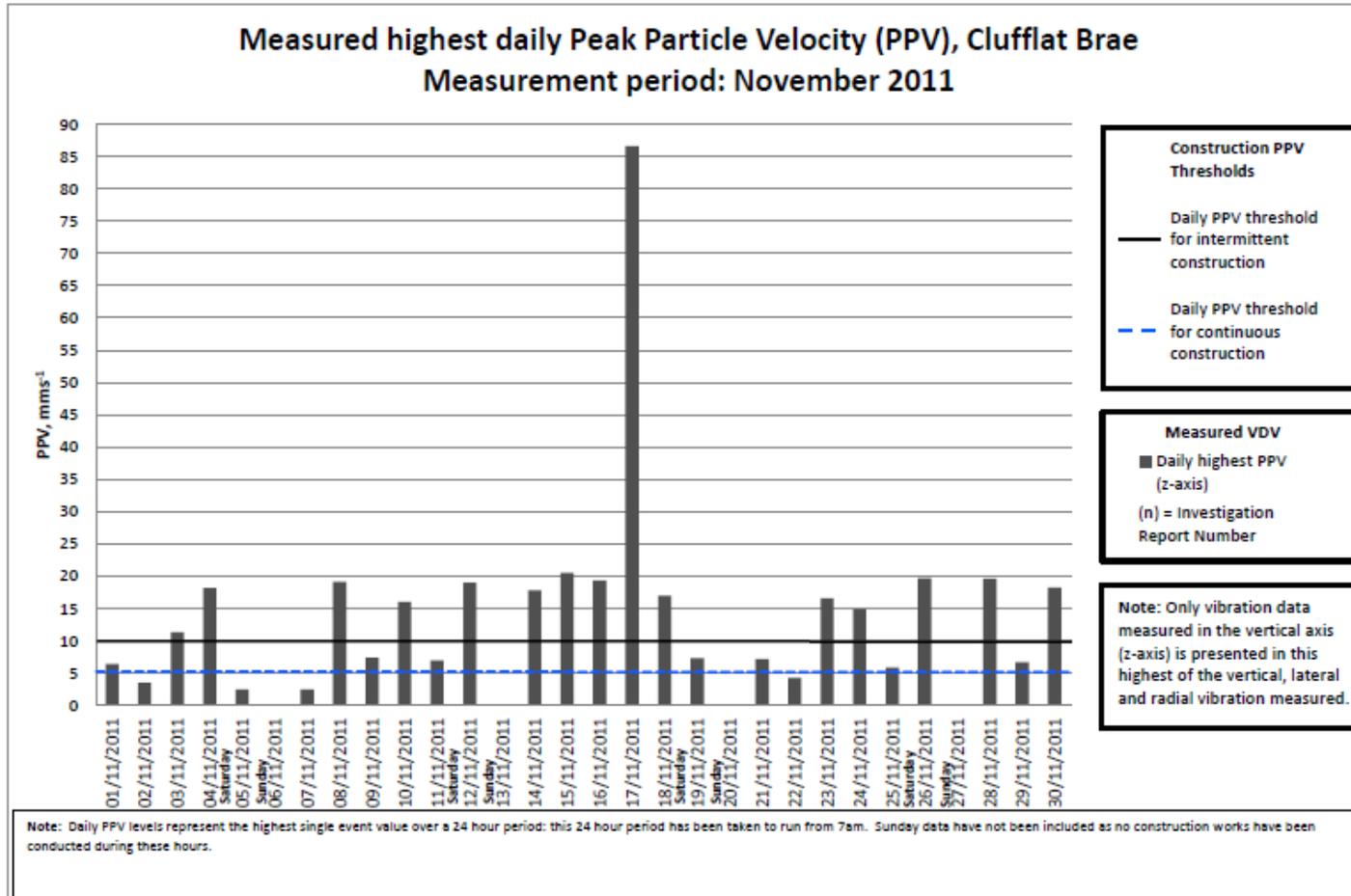
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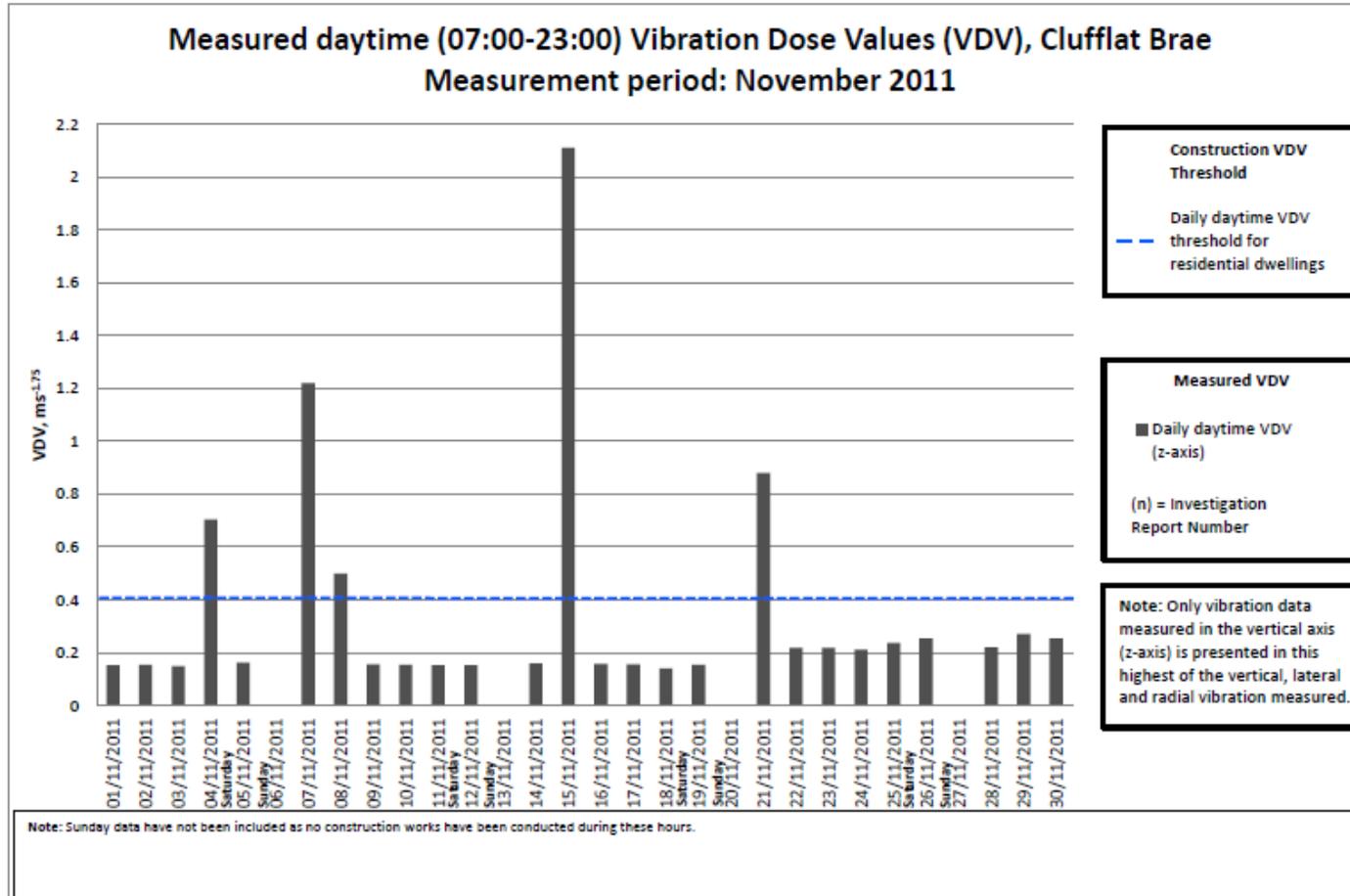
Night-time VDV at Butlaw Fisheries – January 2012



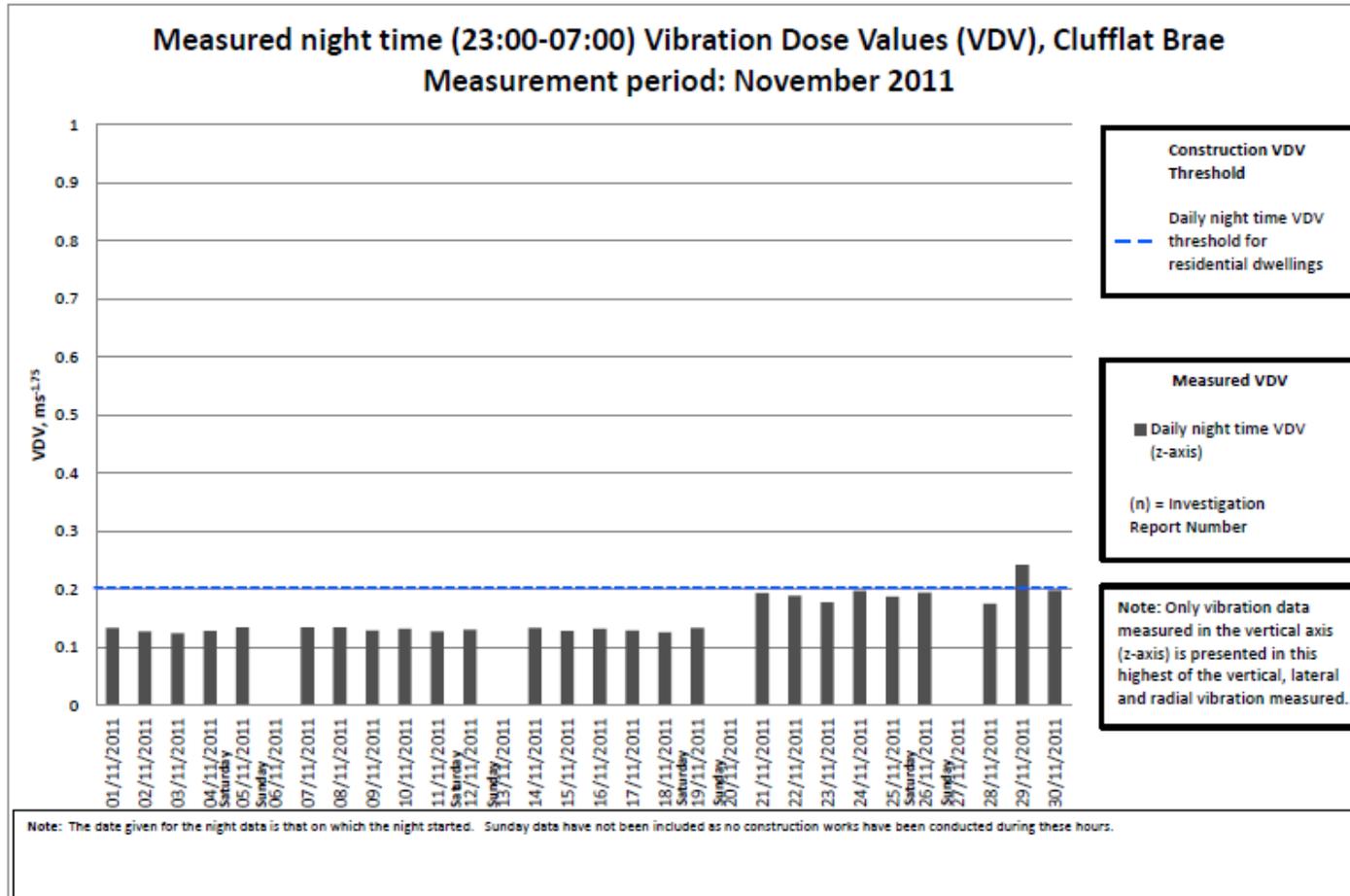
PPV at Cufflat Brae – November 2011



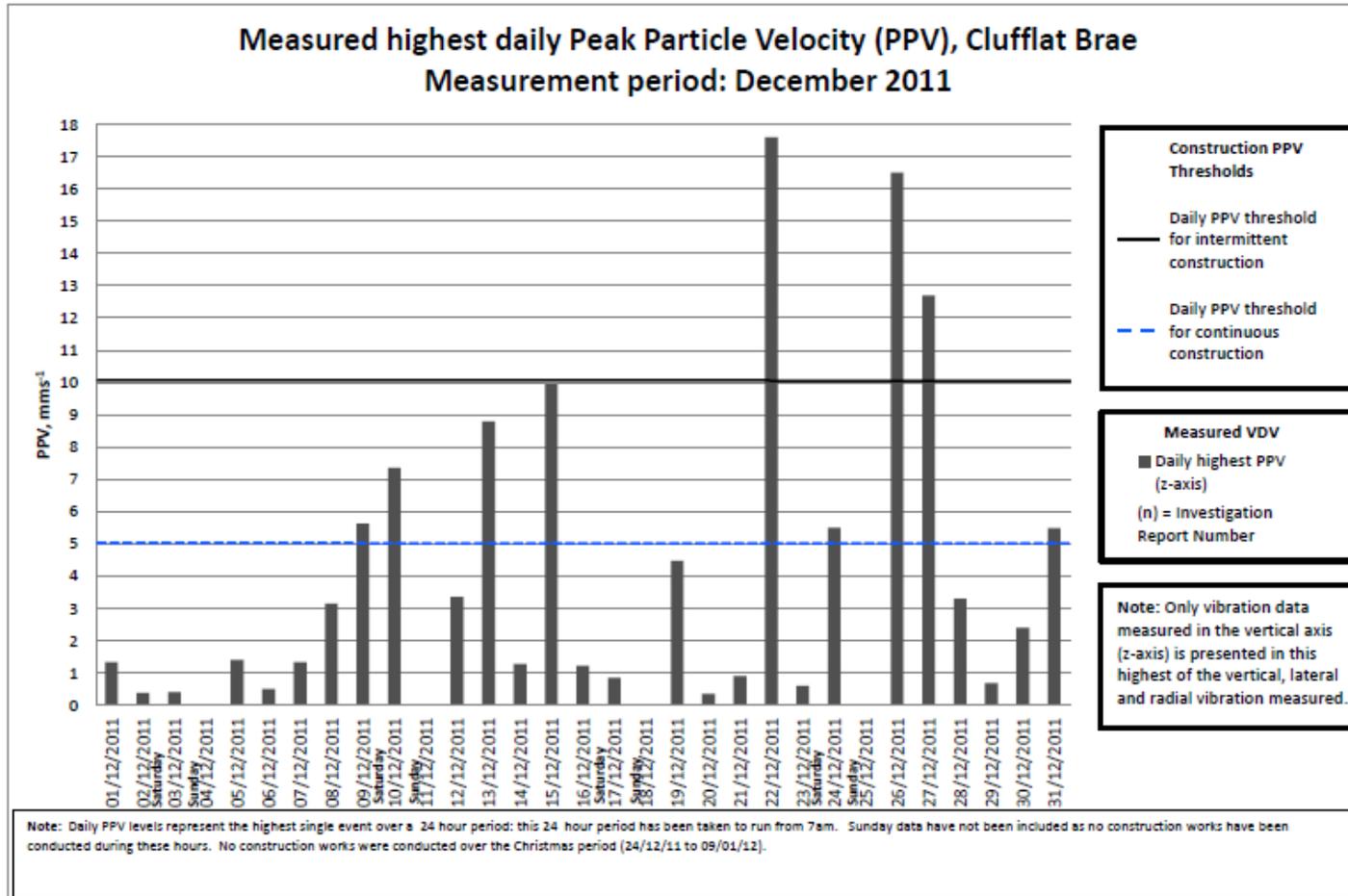
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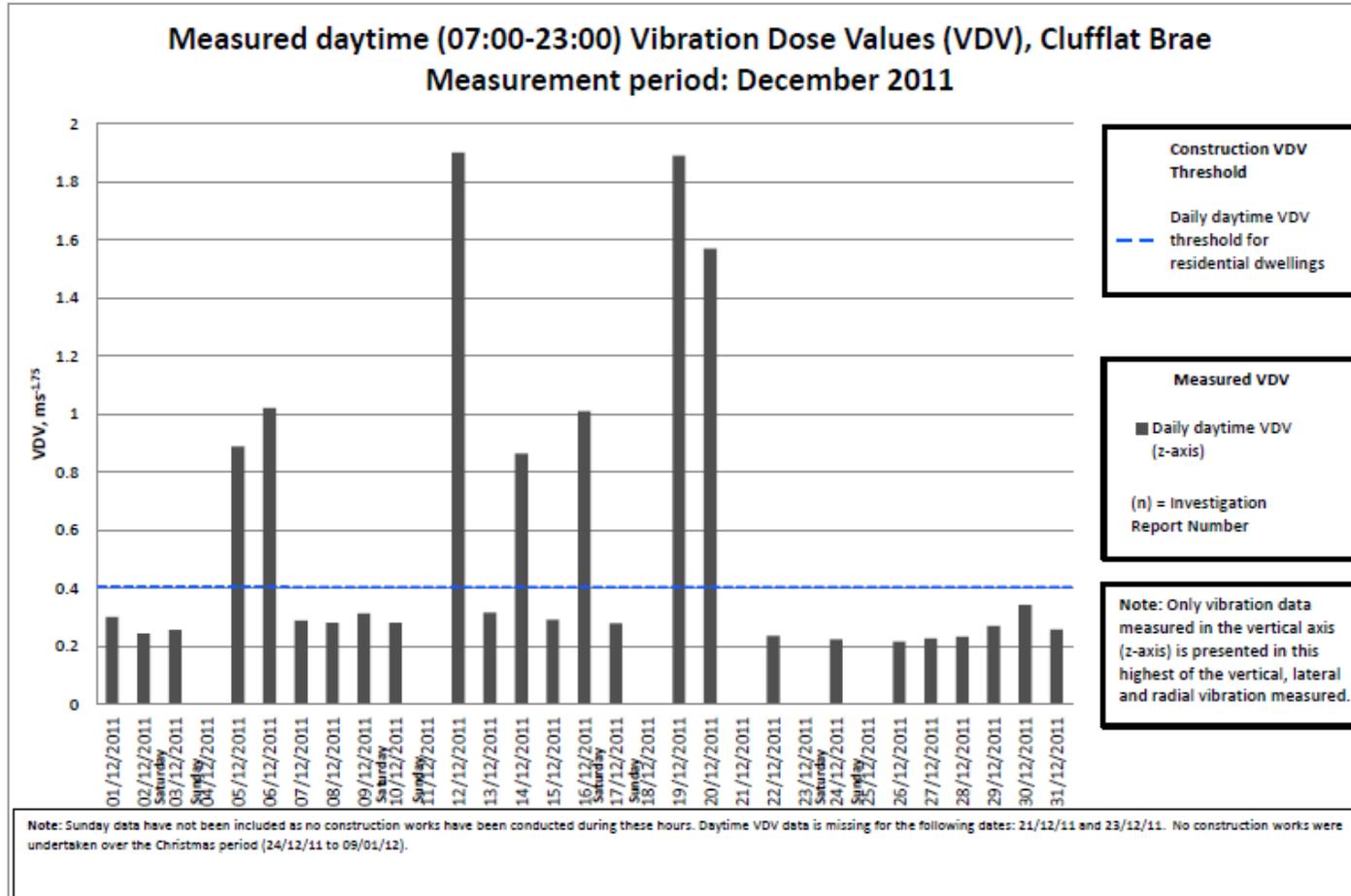
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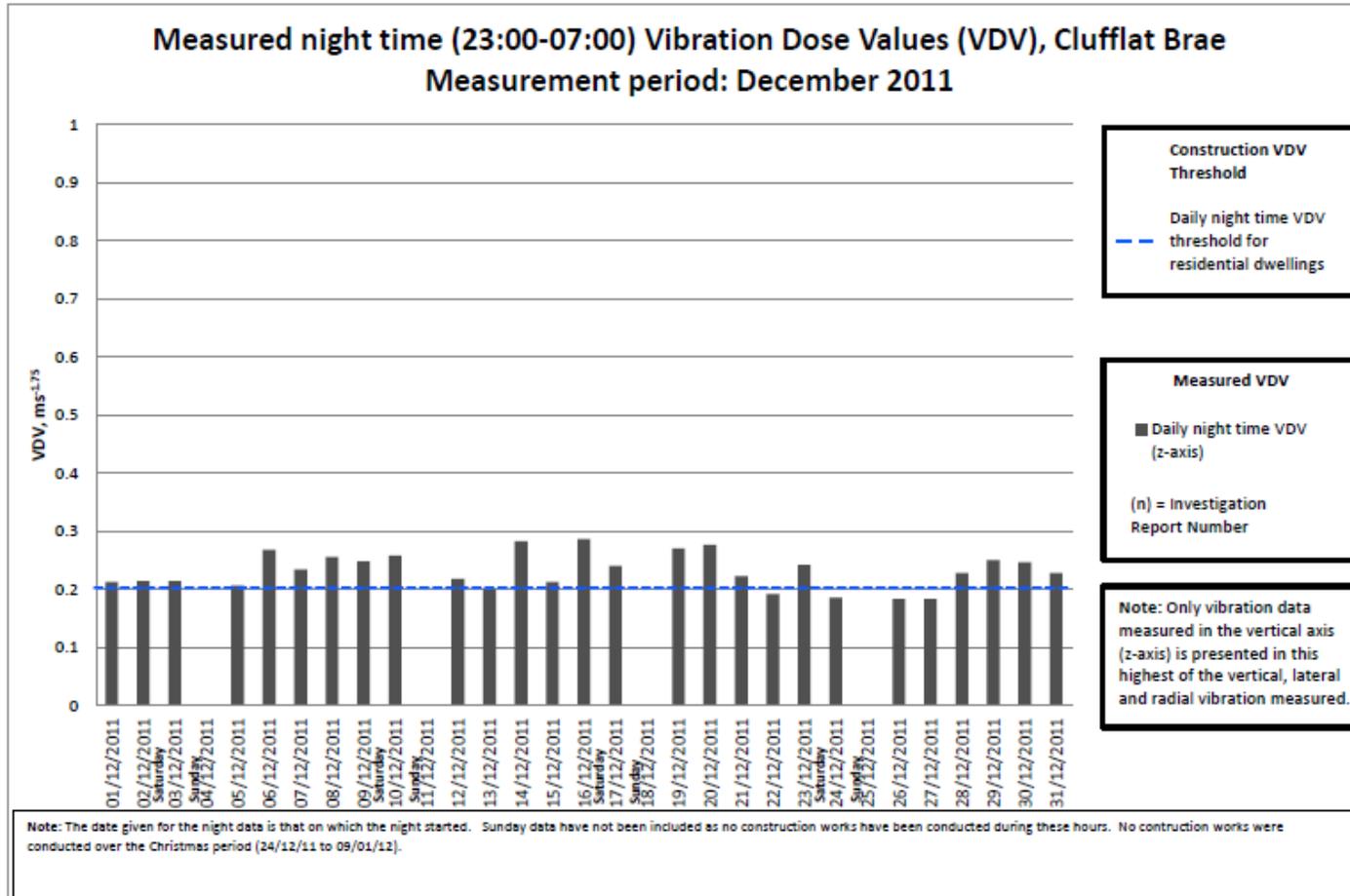
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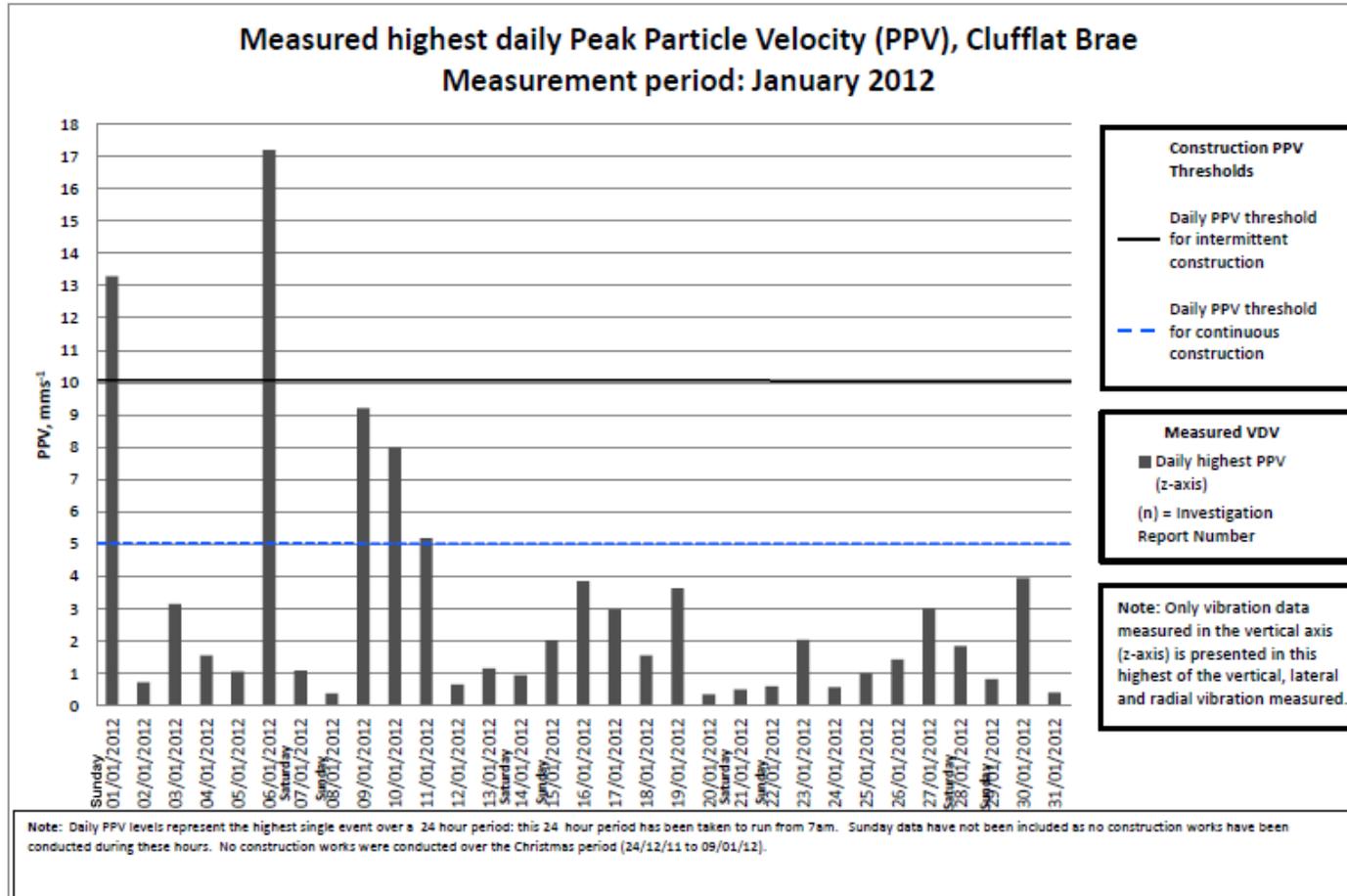
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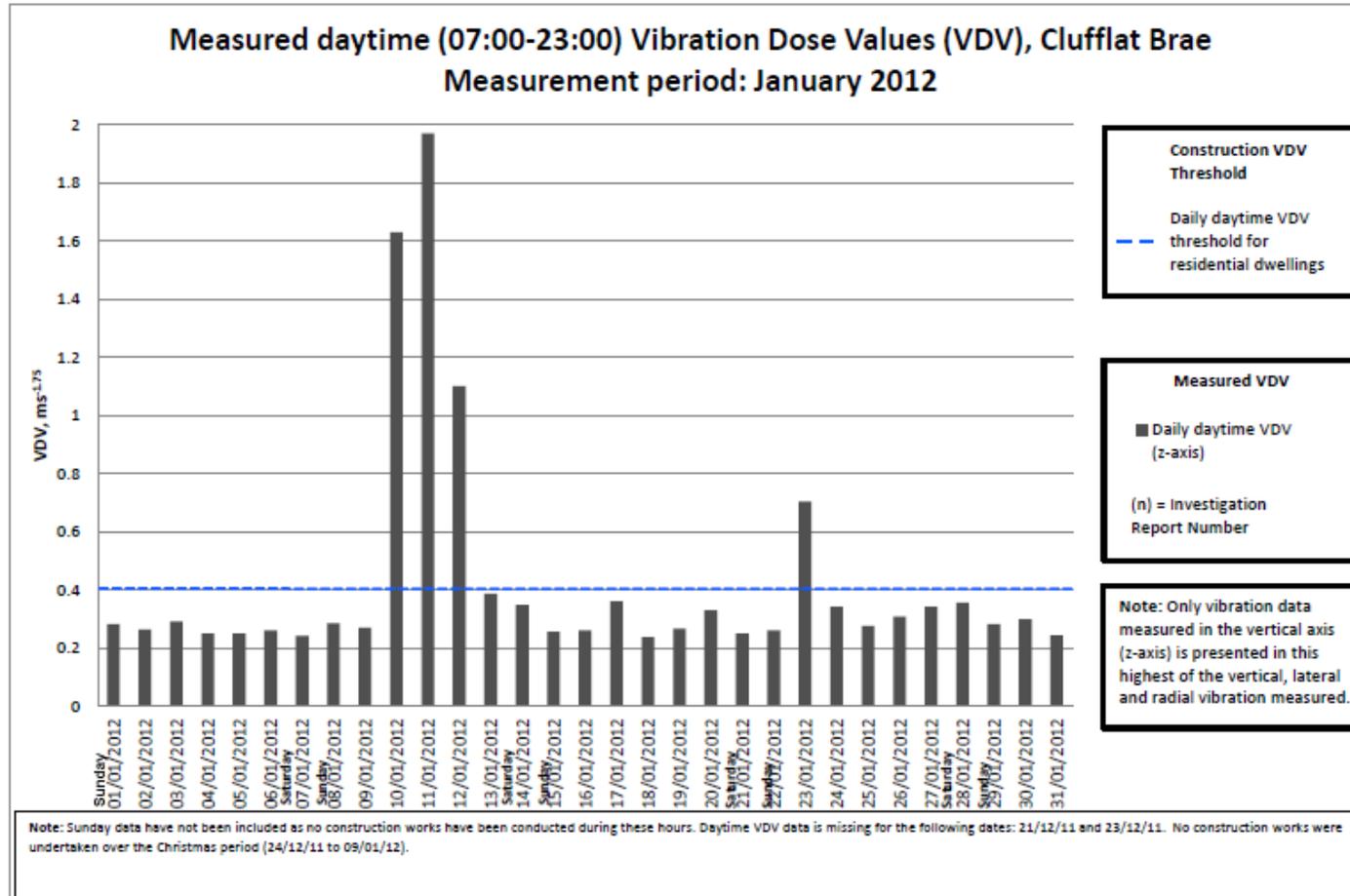
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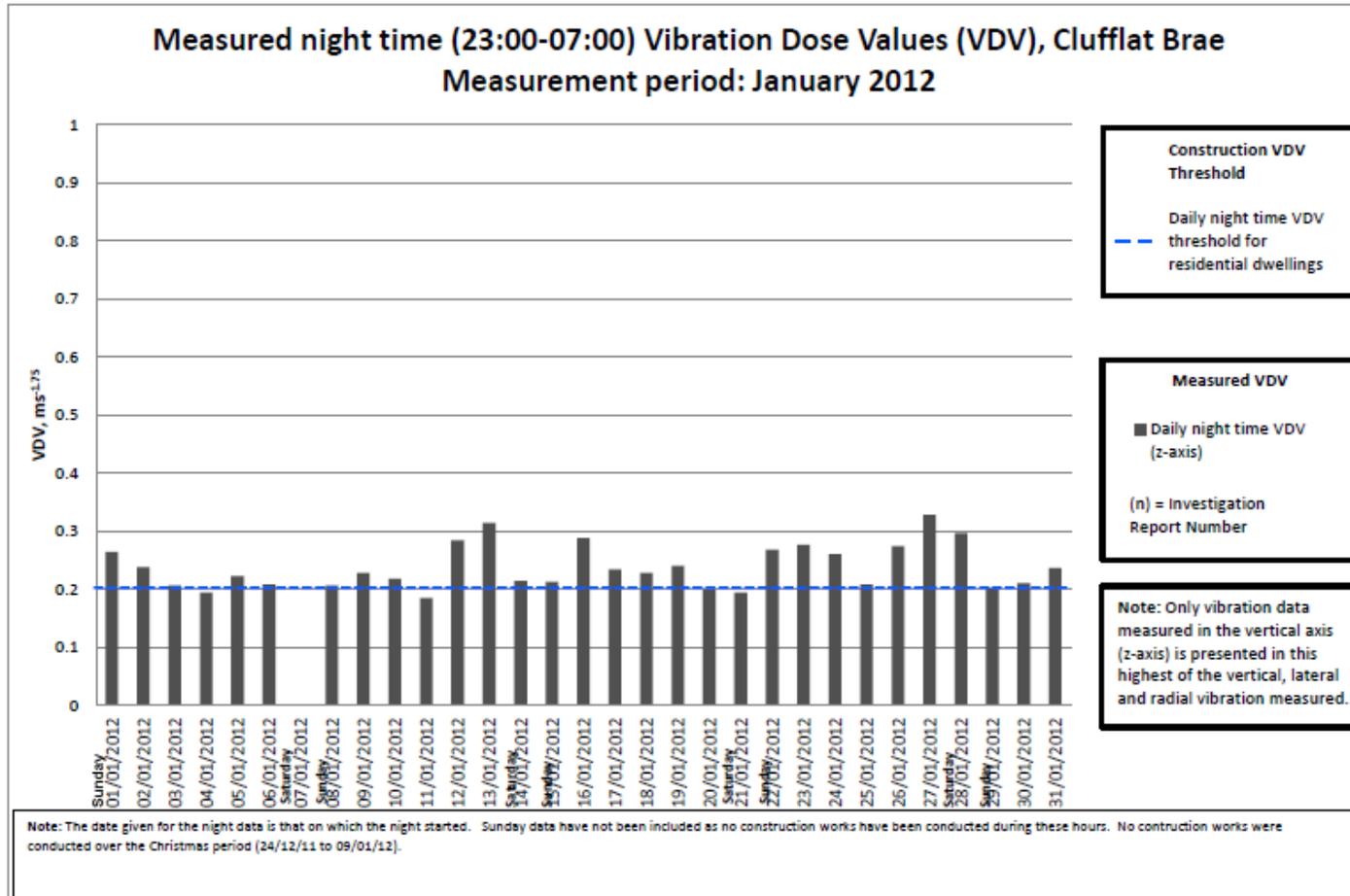
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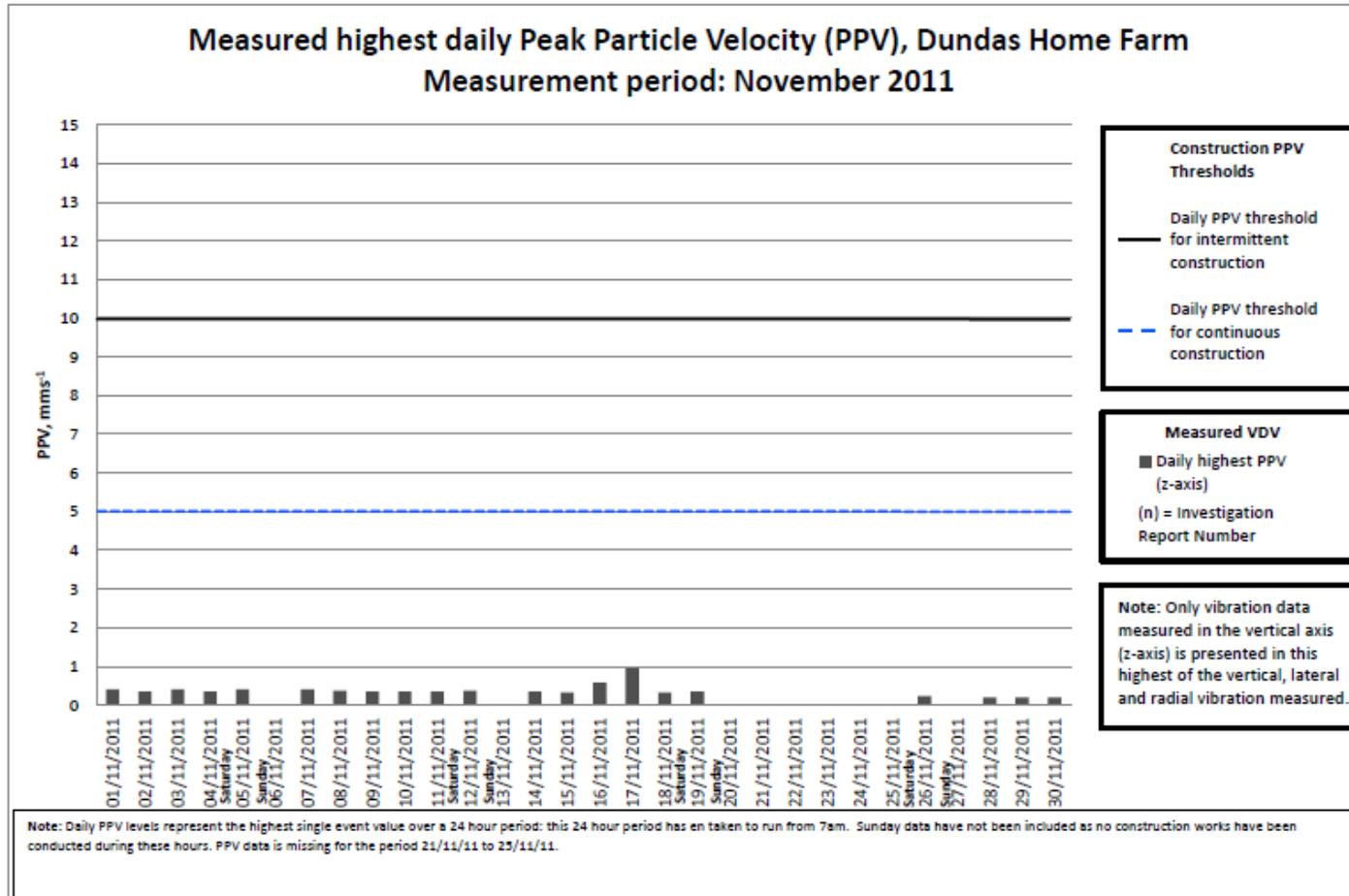
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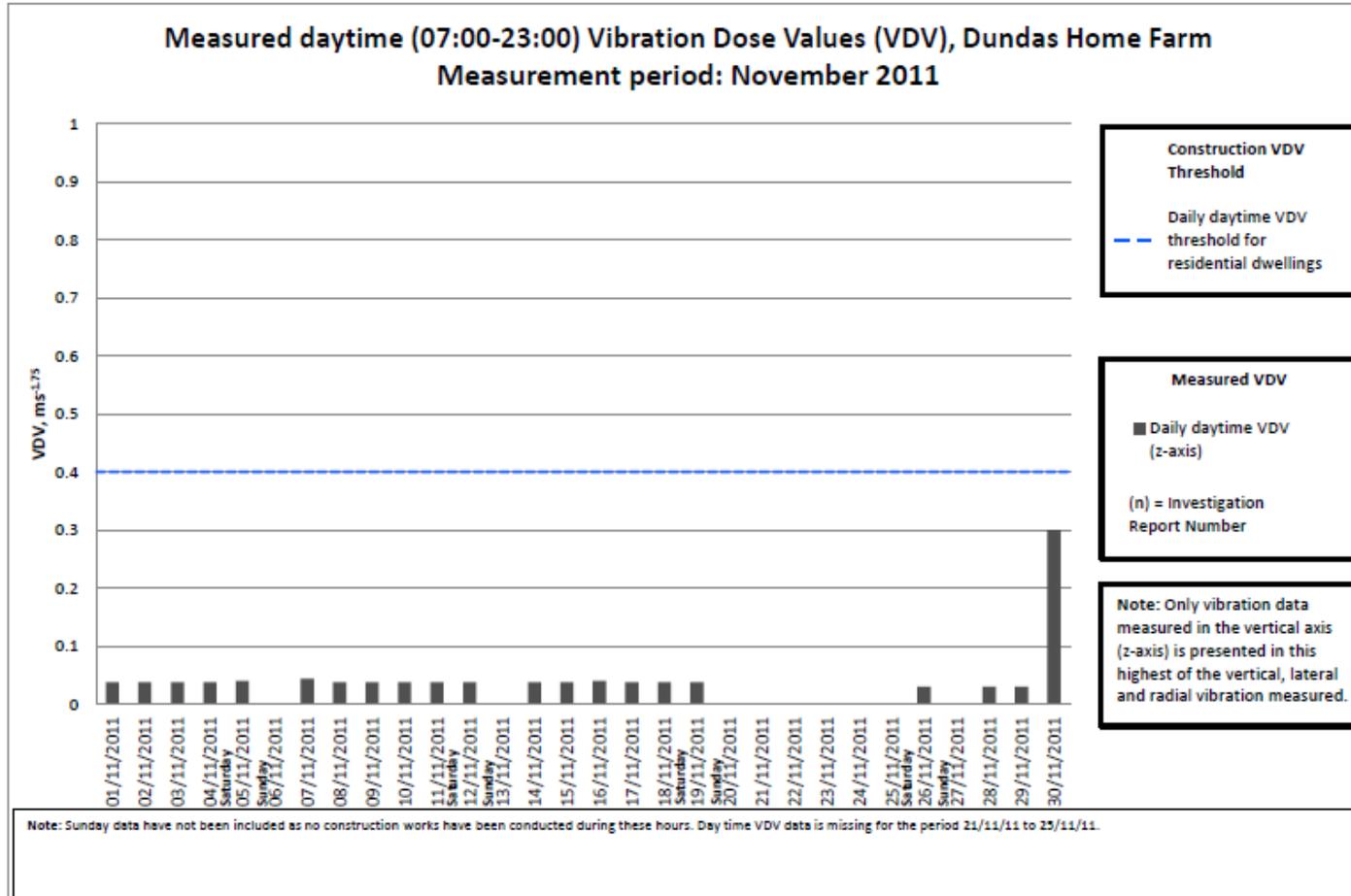
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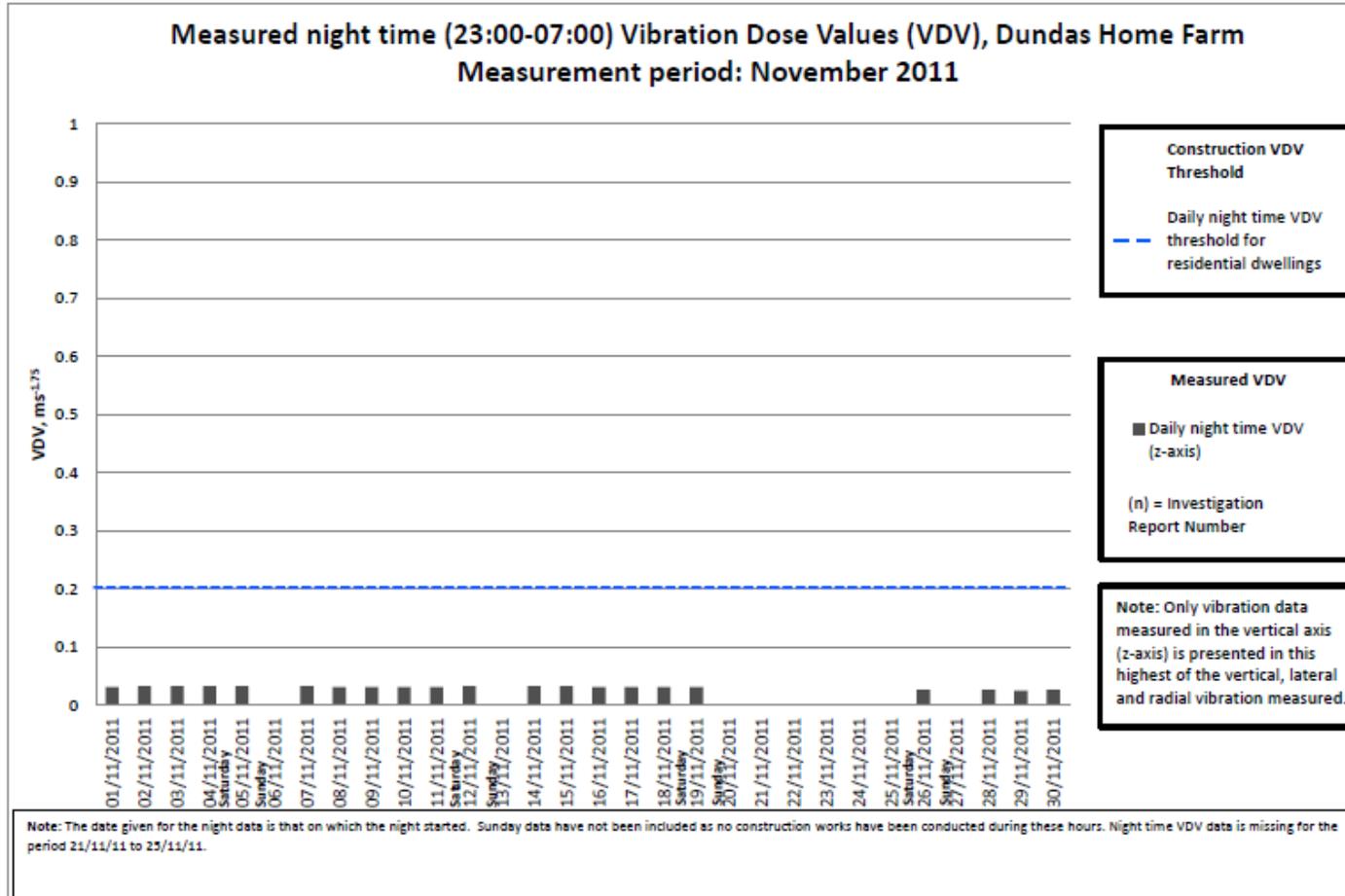
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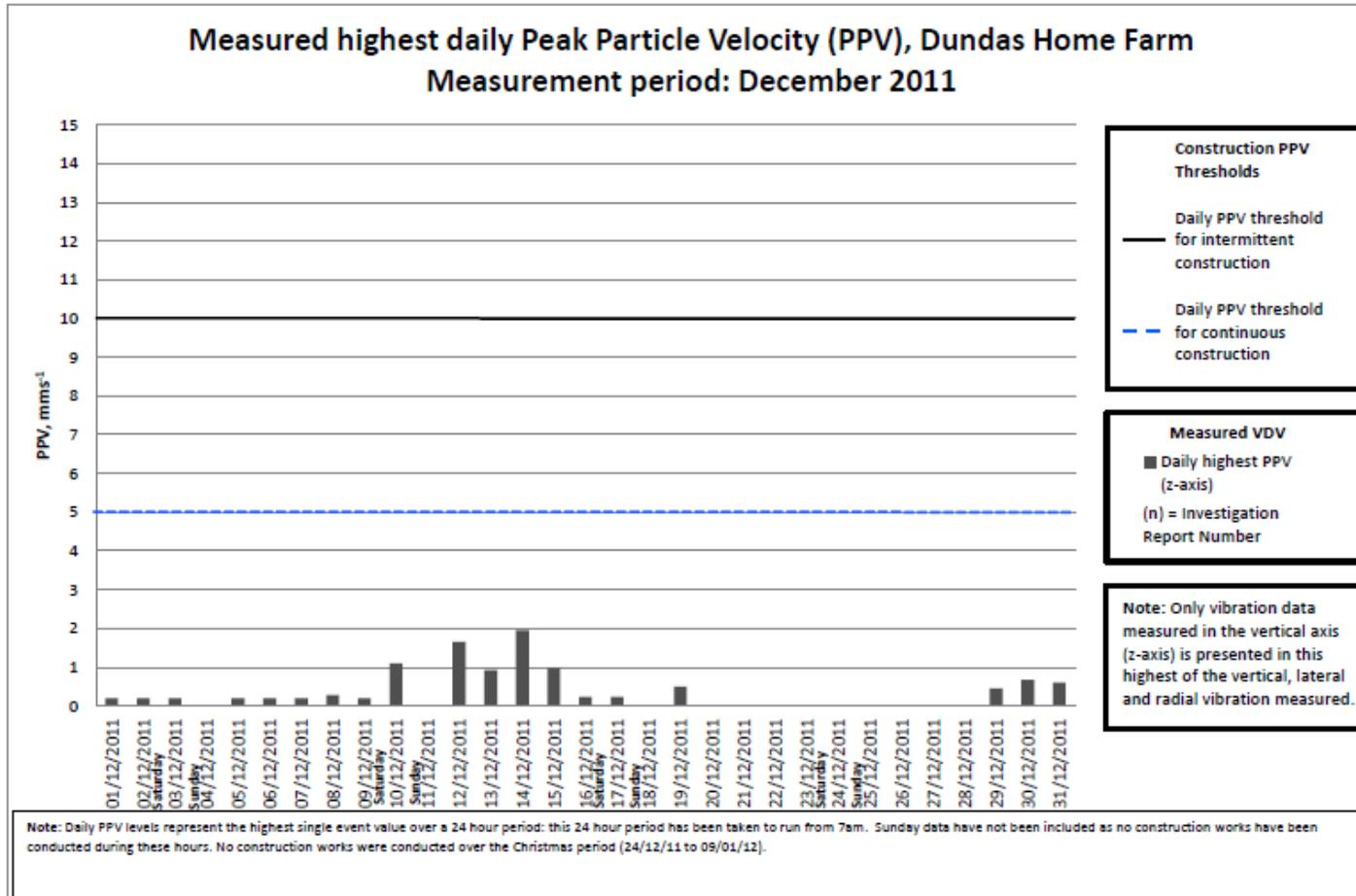
Daytime VDV at Dundas Home Farm – November 2011



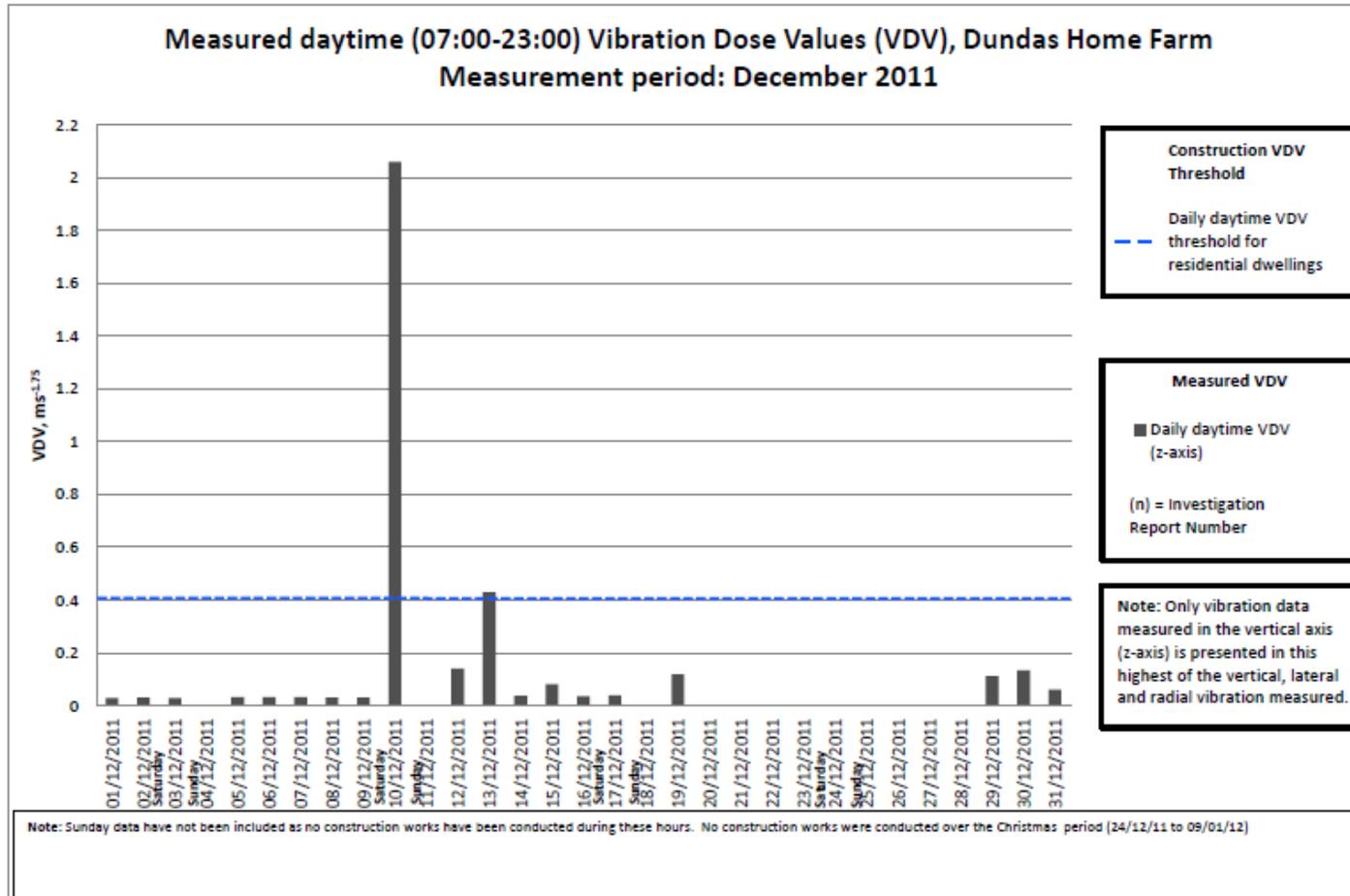
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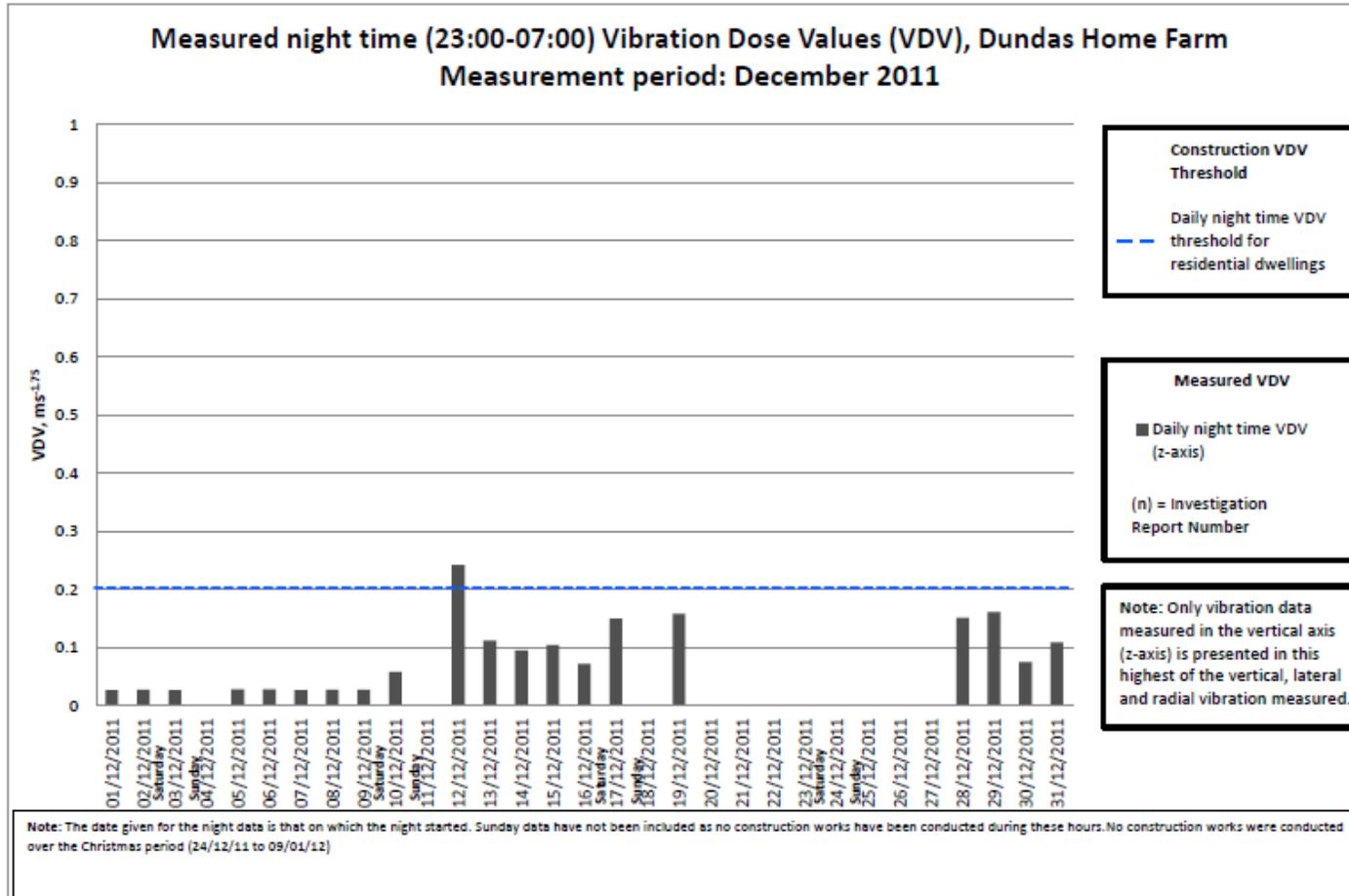
PPV at Dundas Home Farm – December 2011



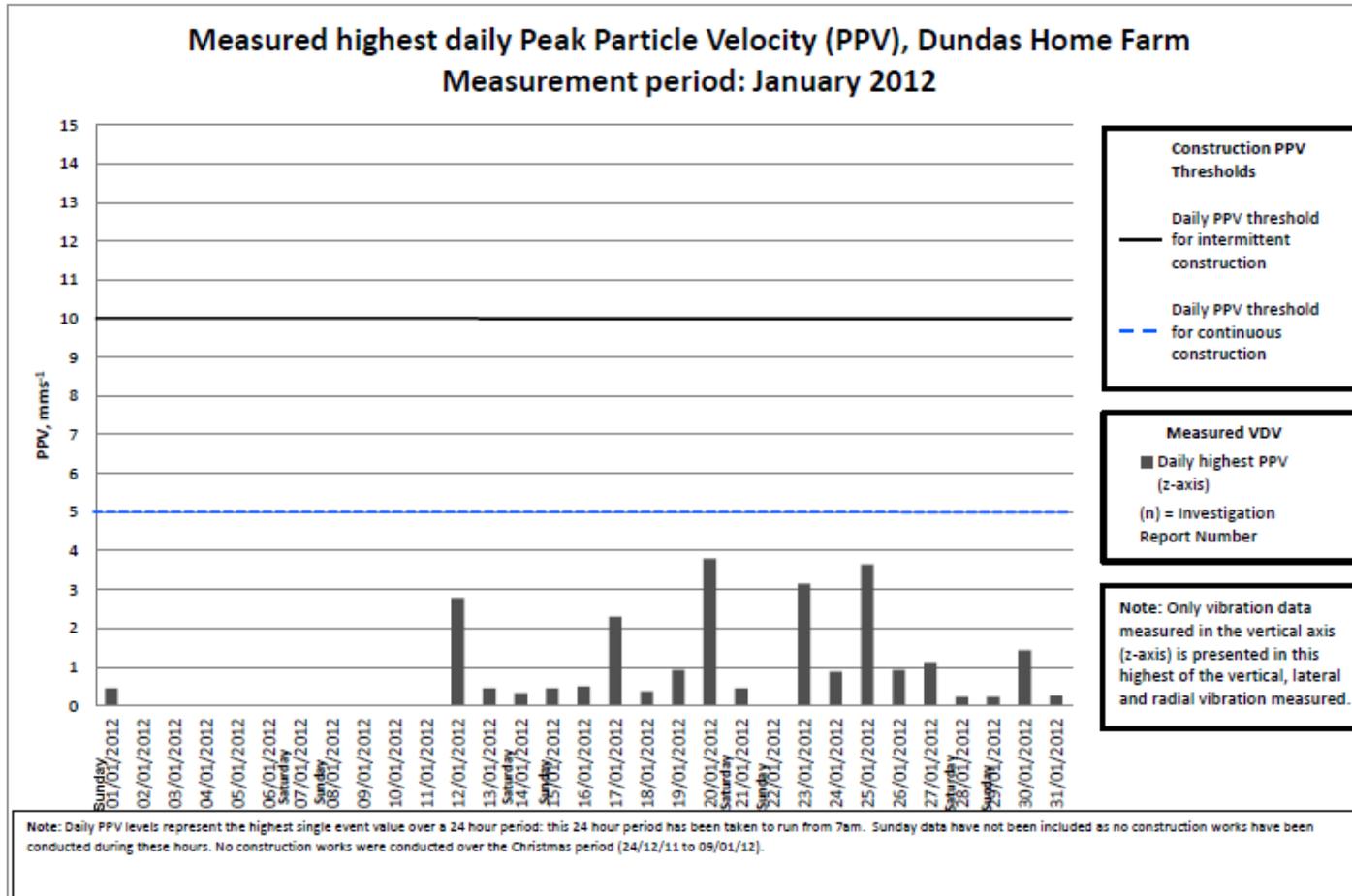
Daytime VDV at Dundas Home Farm – December 2011



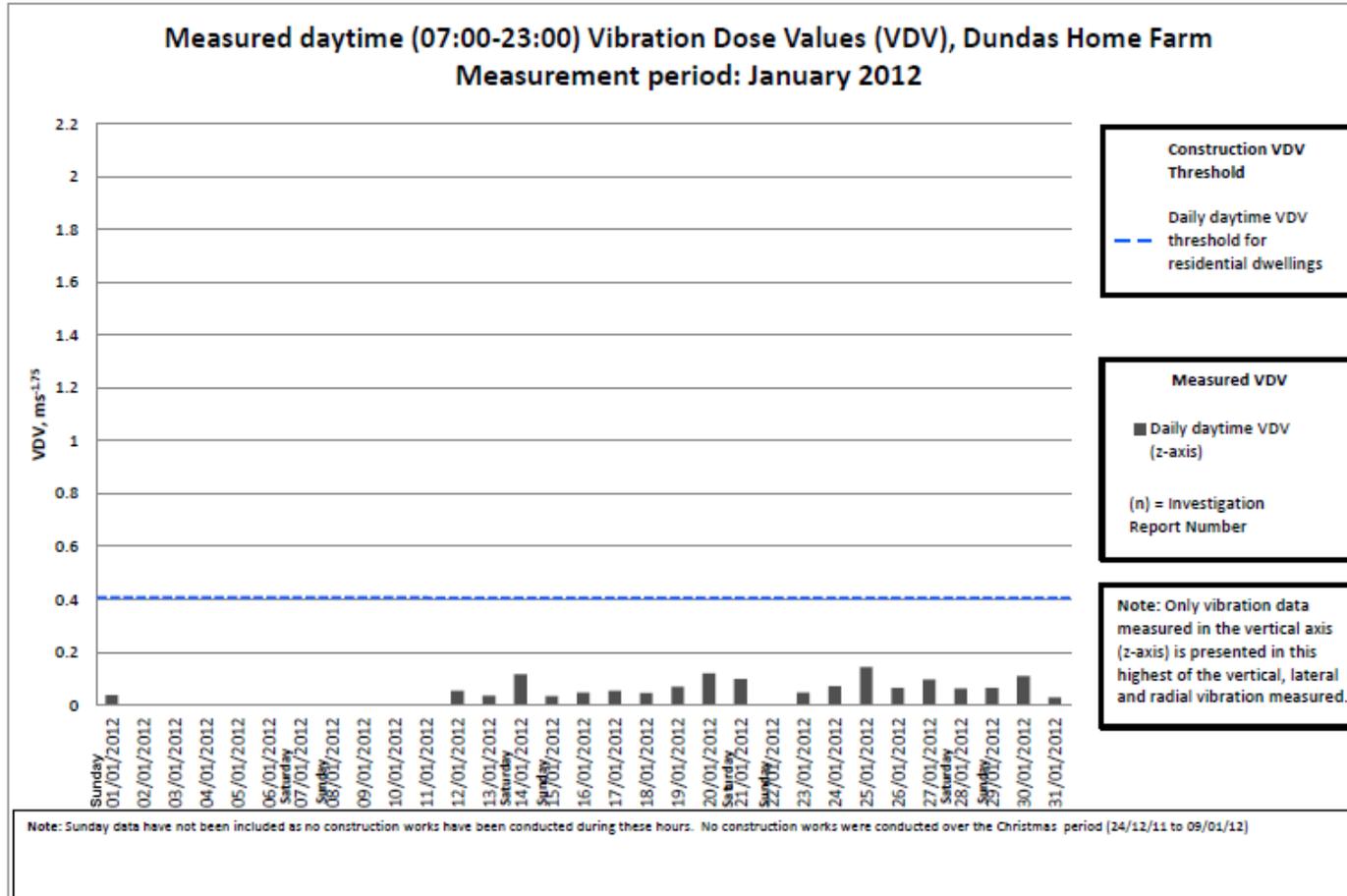
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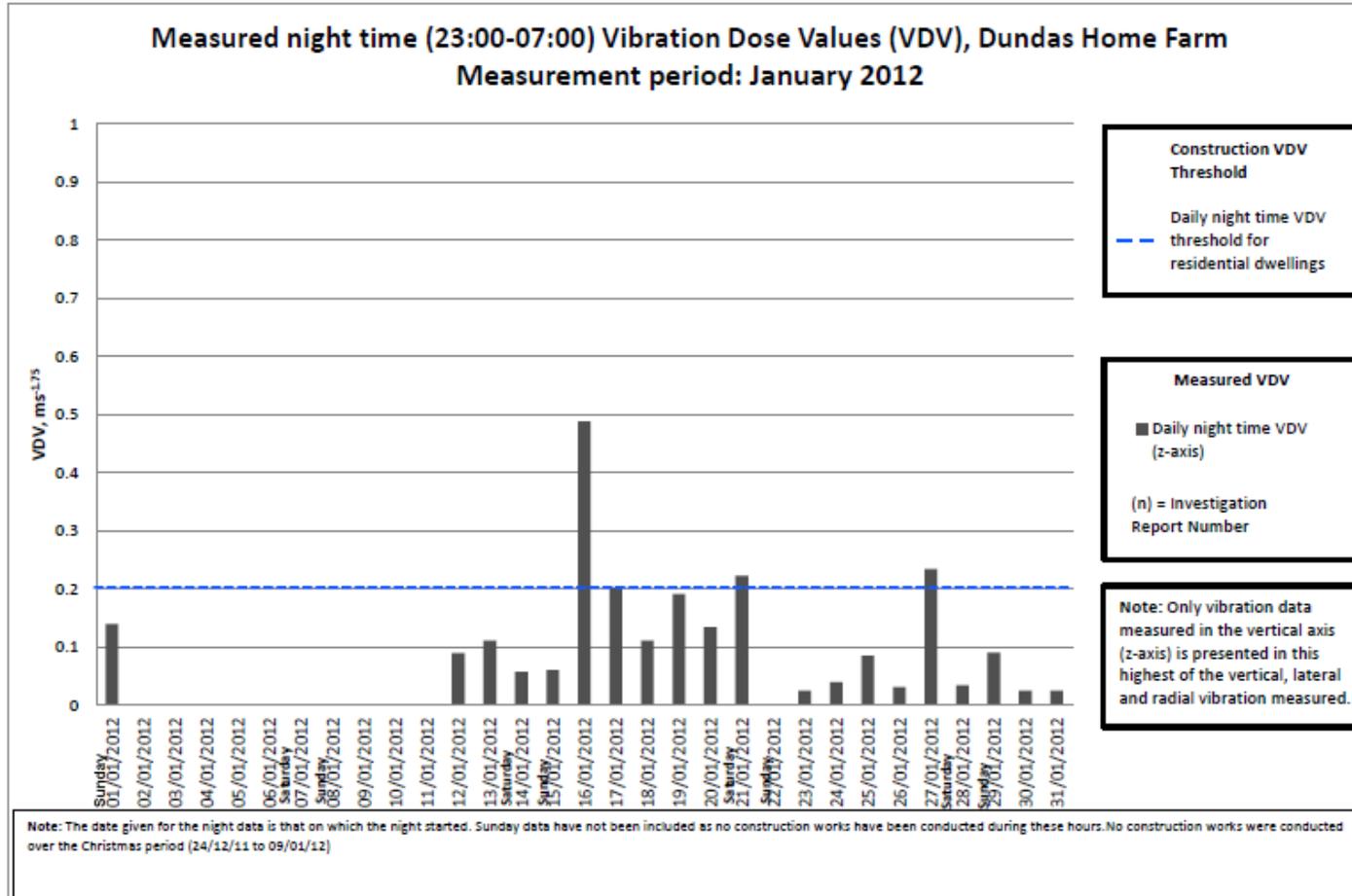
PPV at Dundas Home Farm – January 2012



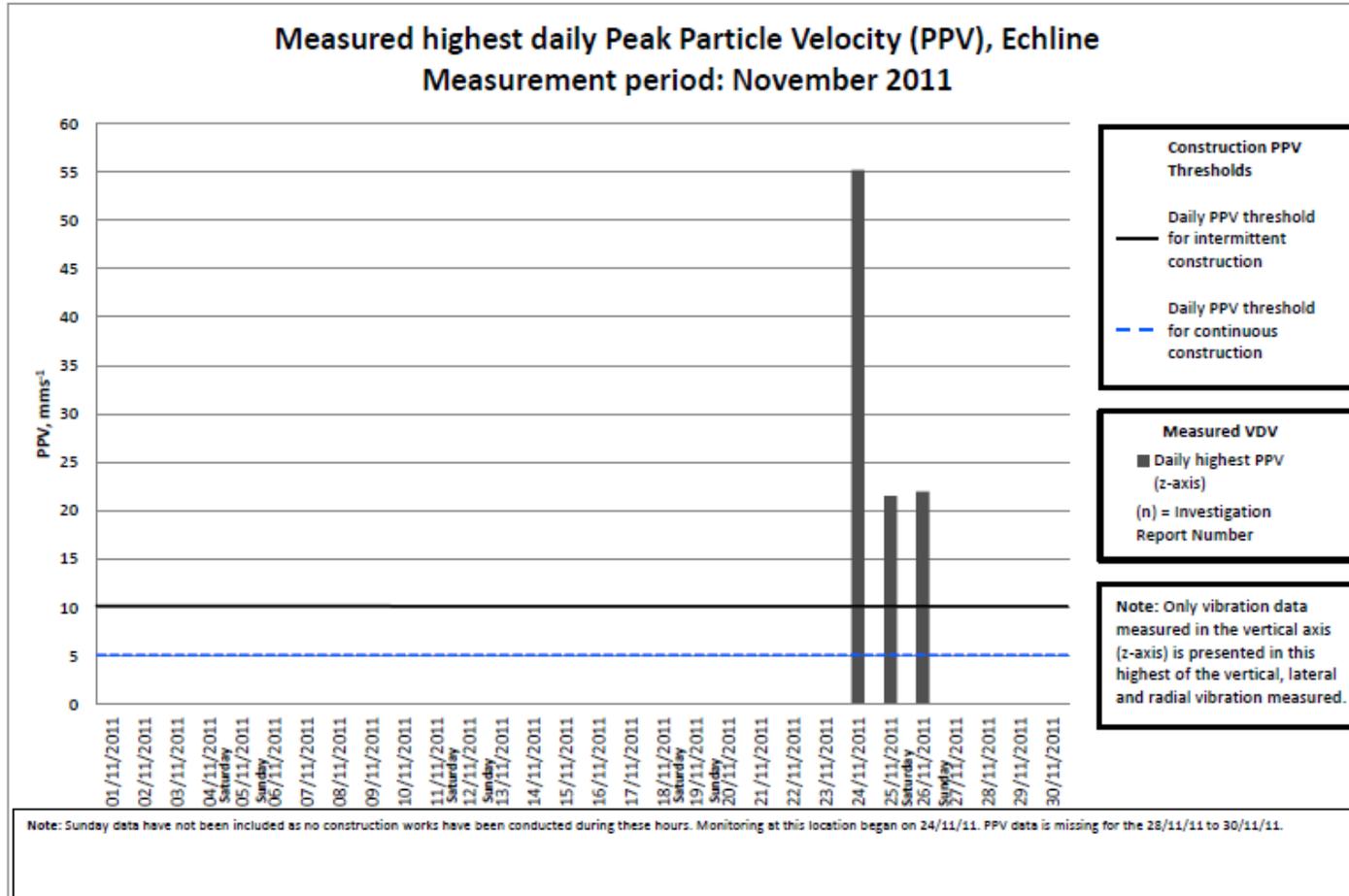
Daytime VDV at Dundas Home Farm – January 2012



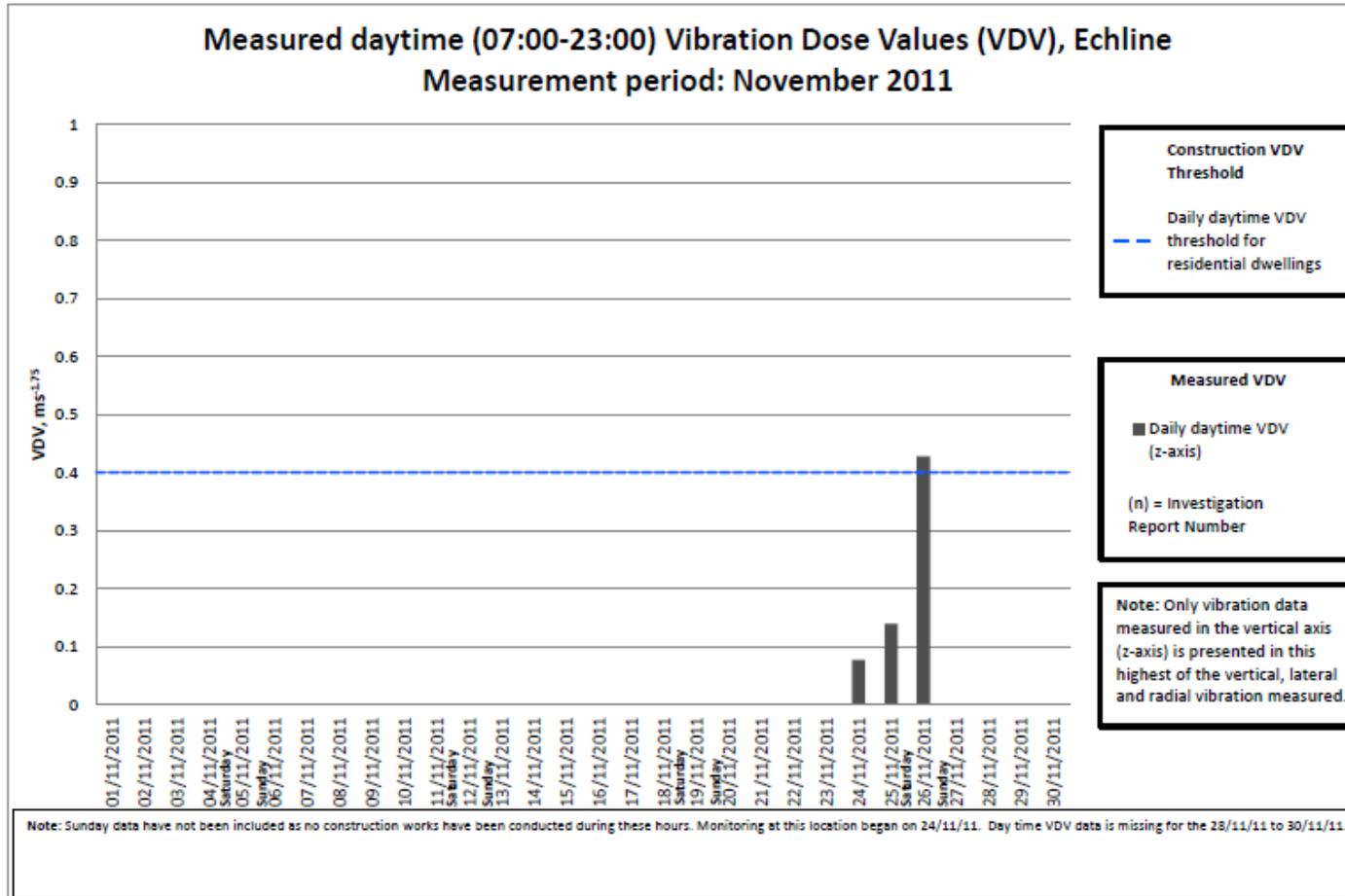
Night-time VDV at Dundas Home Farm – January 2012



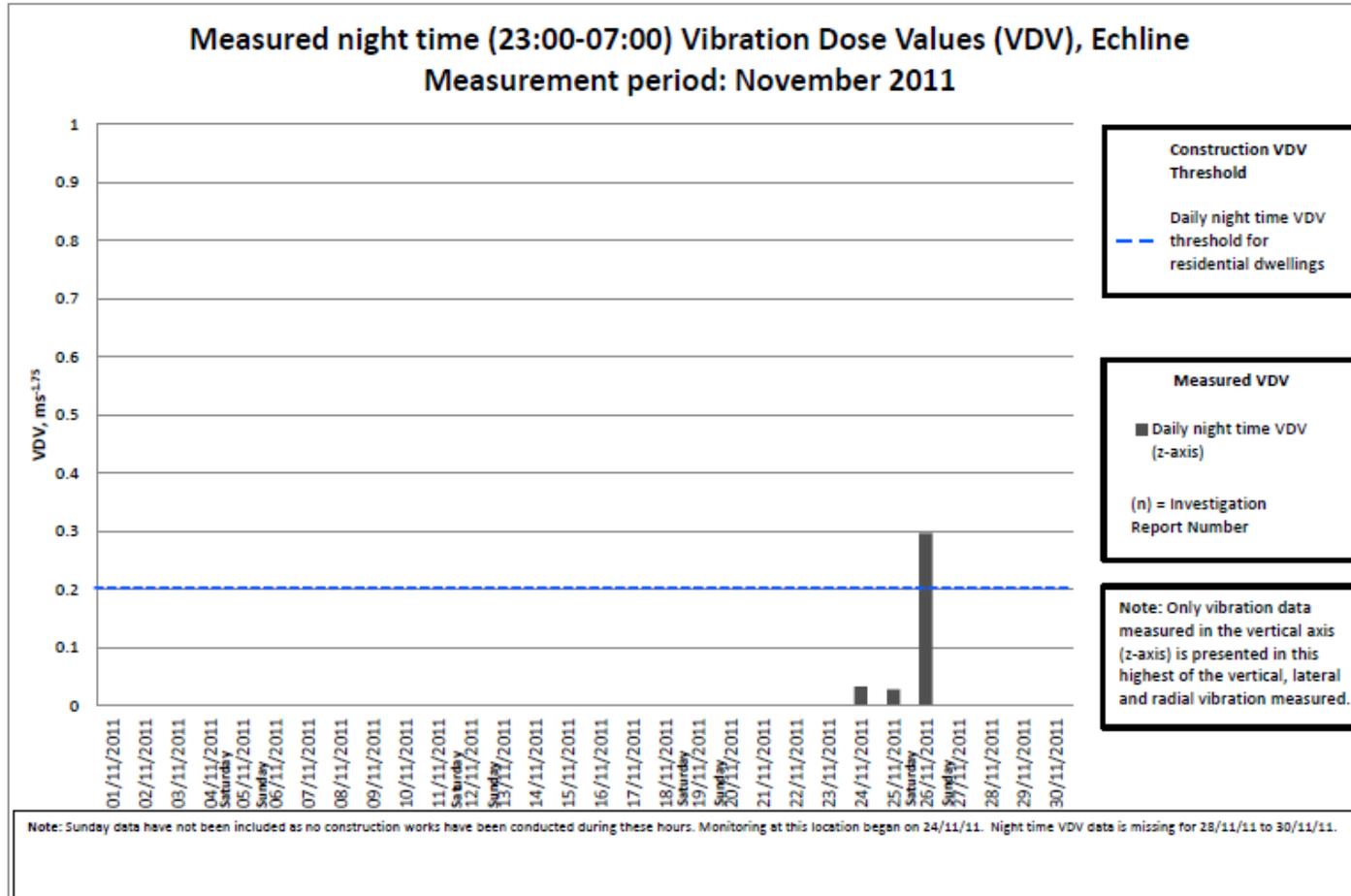
PPV at Echline – November 2011



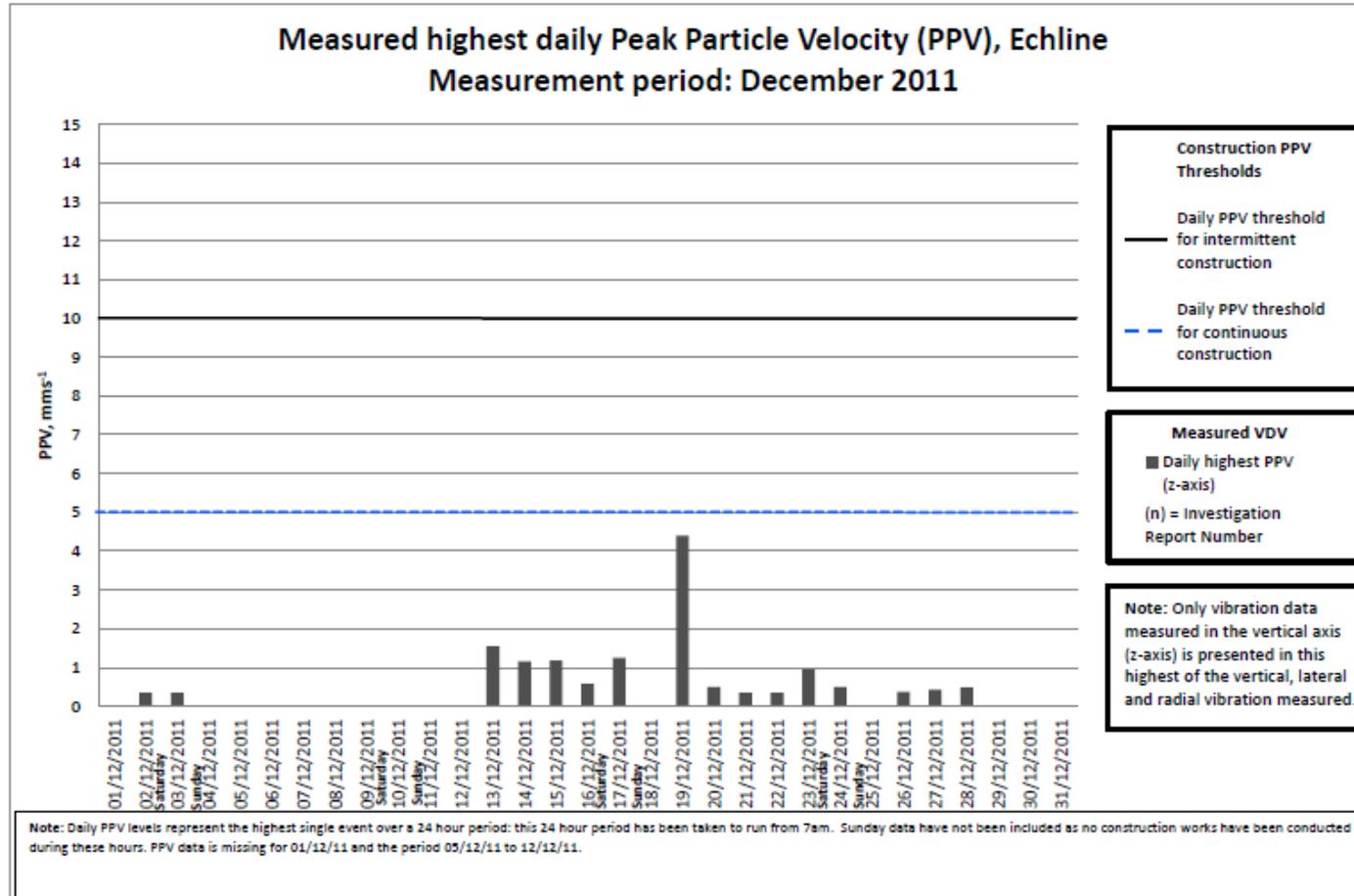
Daytime VDV at Echline – November 2011



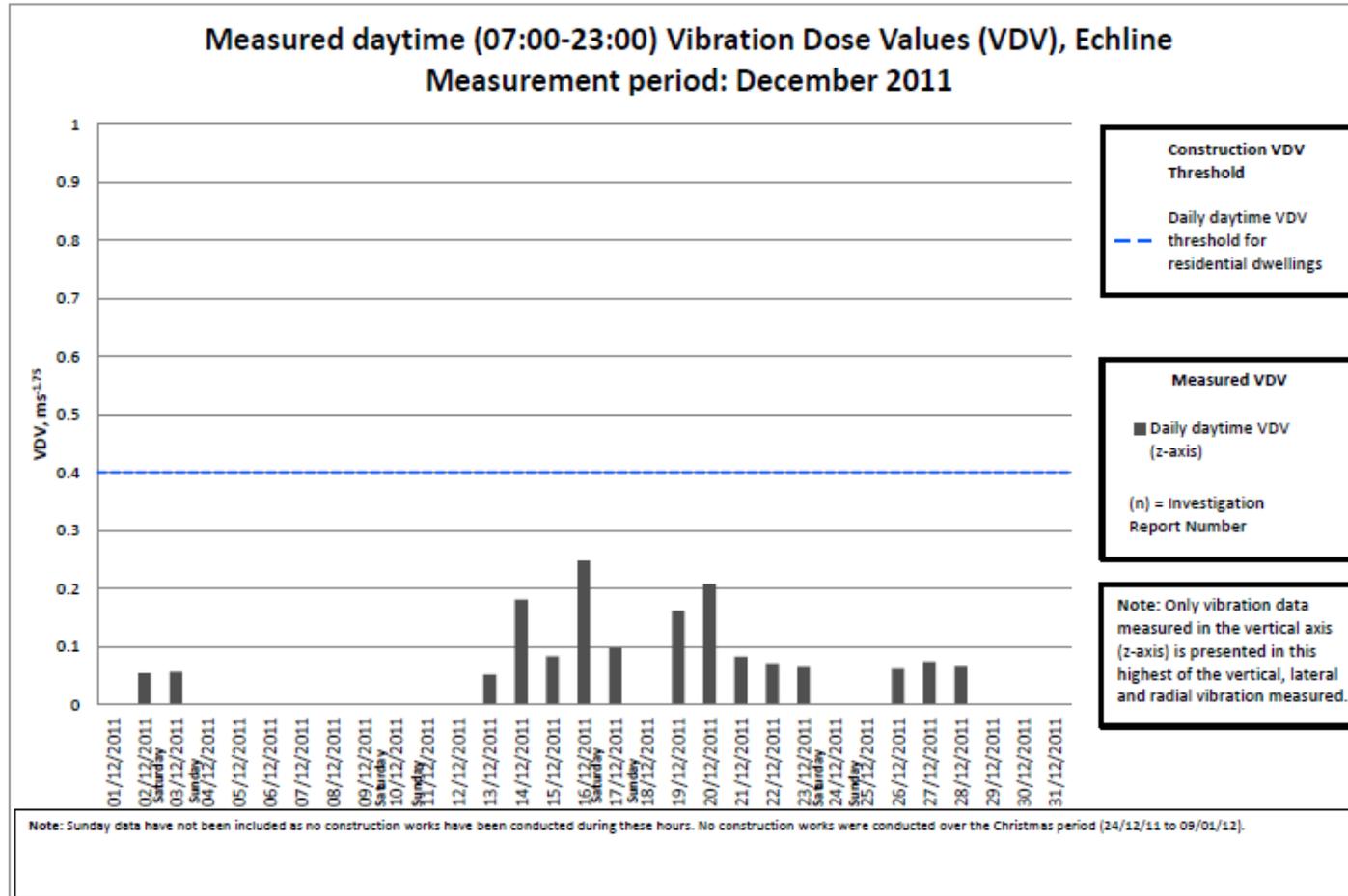
Night-time VDV at Echline – November 2011



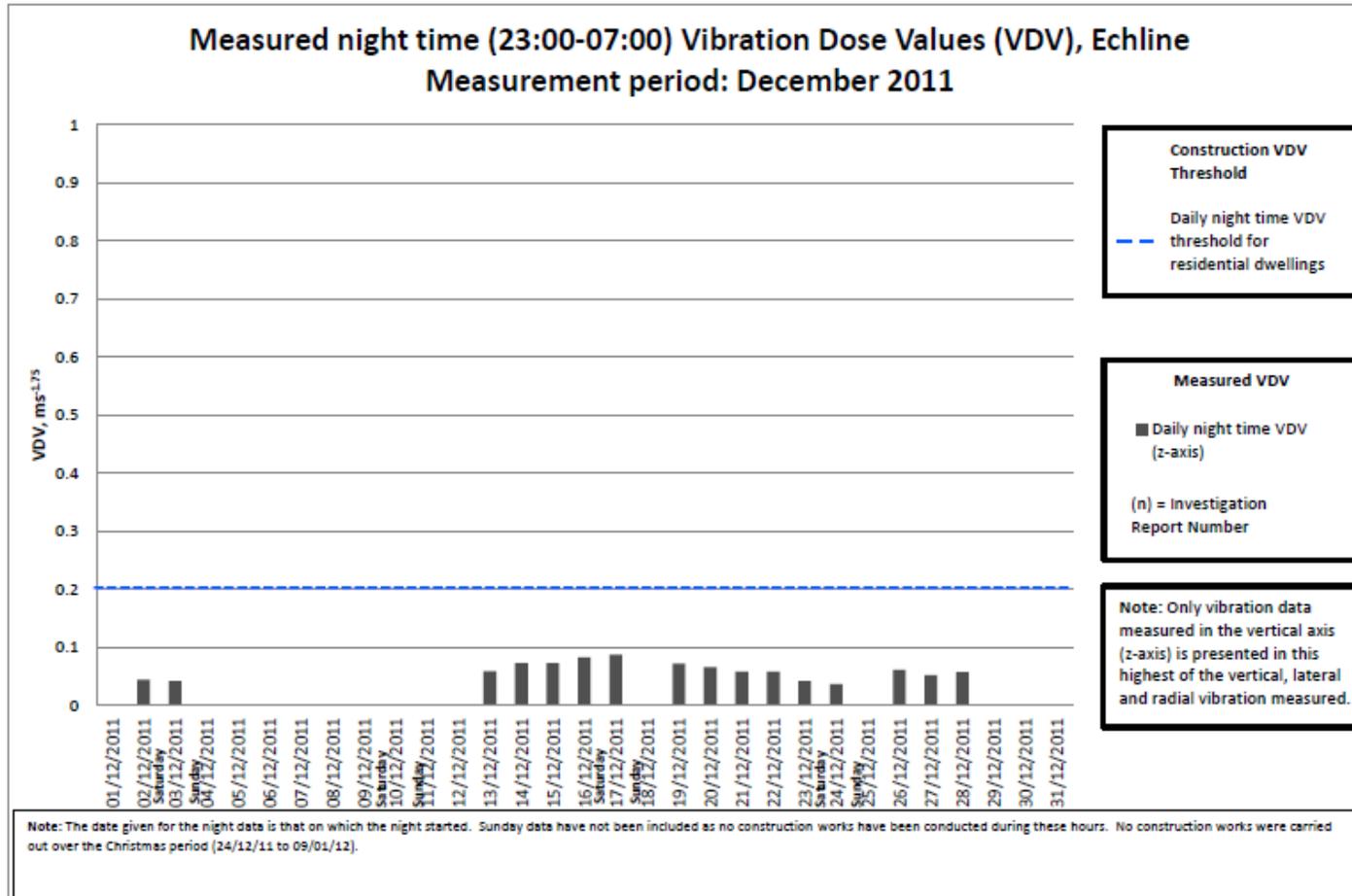
PPV at Echline – December 2011



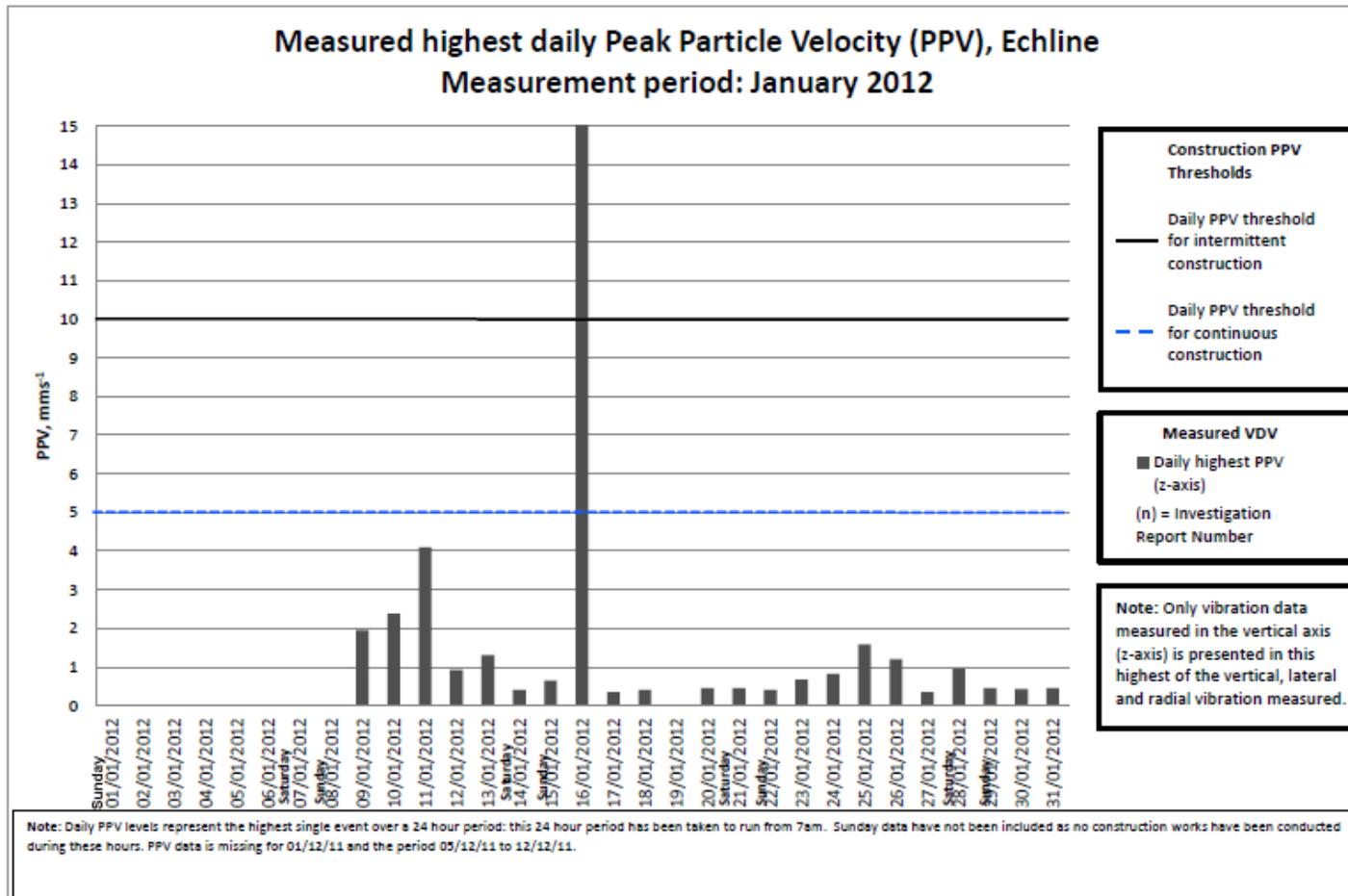
Daytime VDV at Echline – December 2011



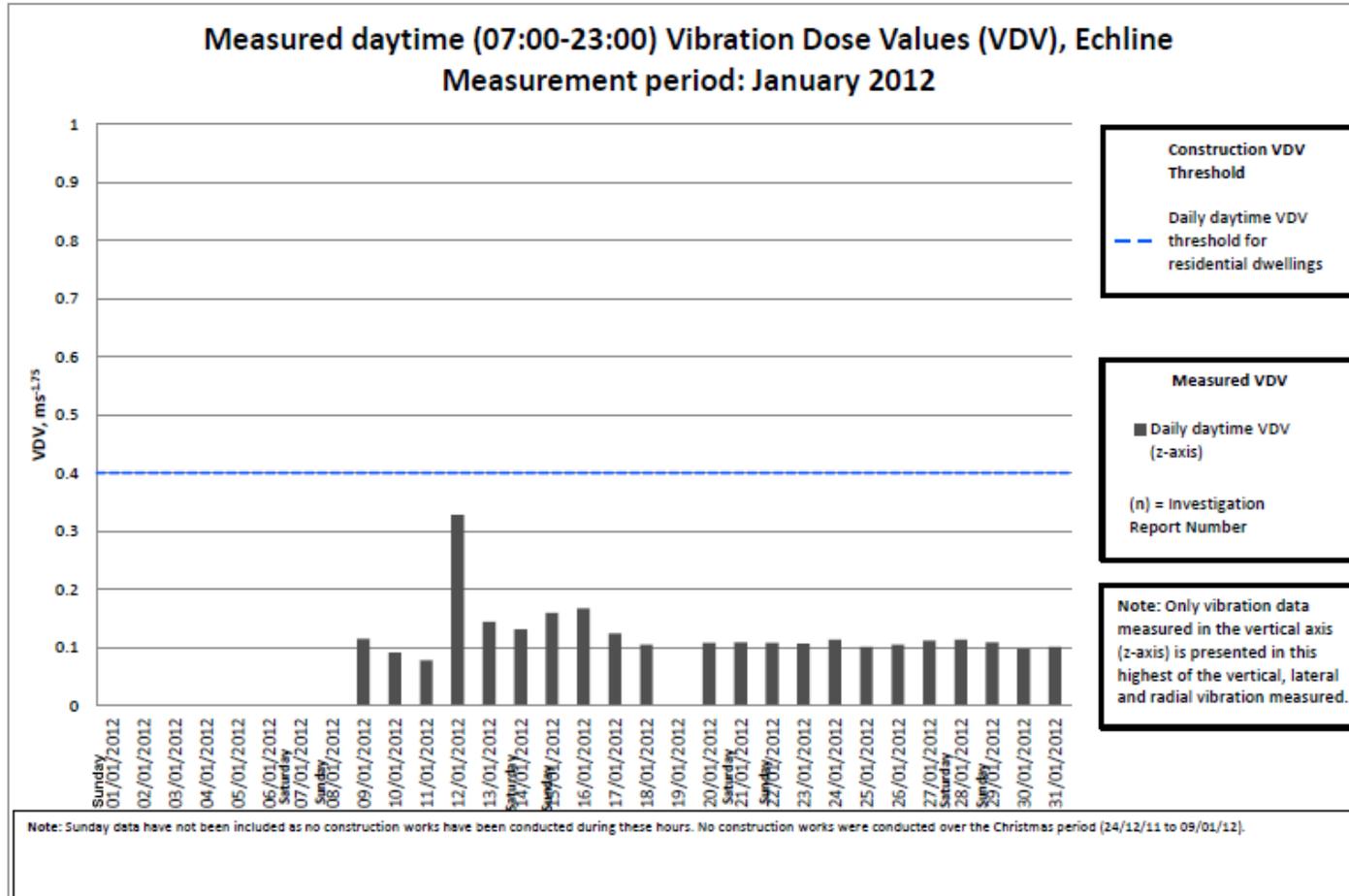
Night-time VDV at Echline – December 2011



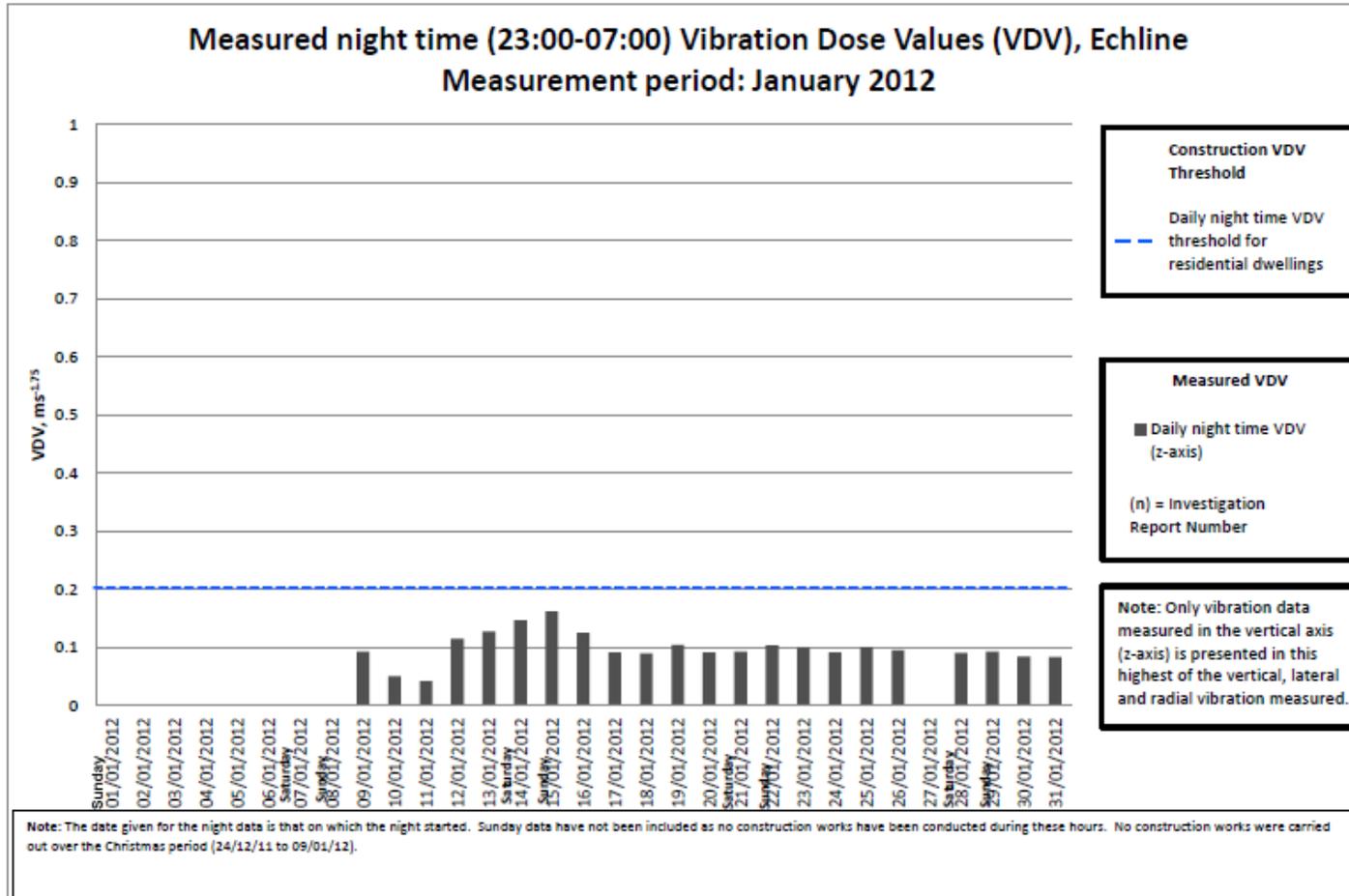
PPV at Echline – January 2012



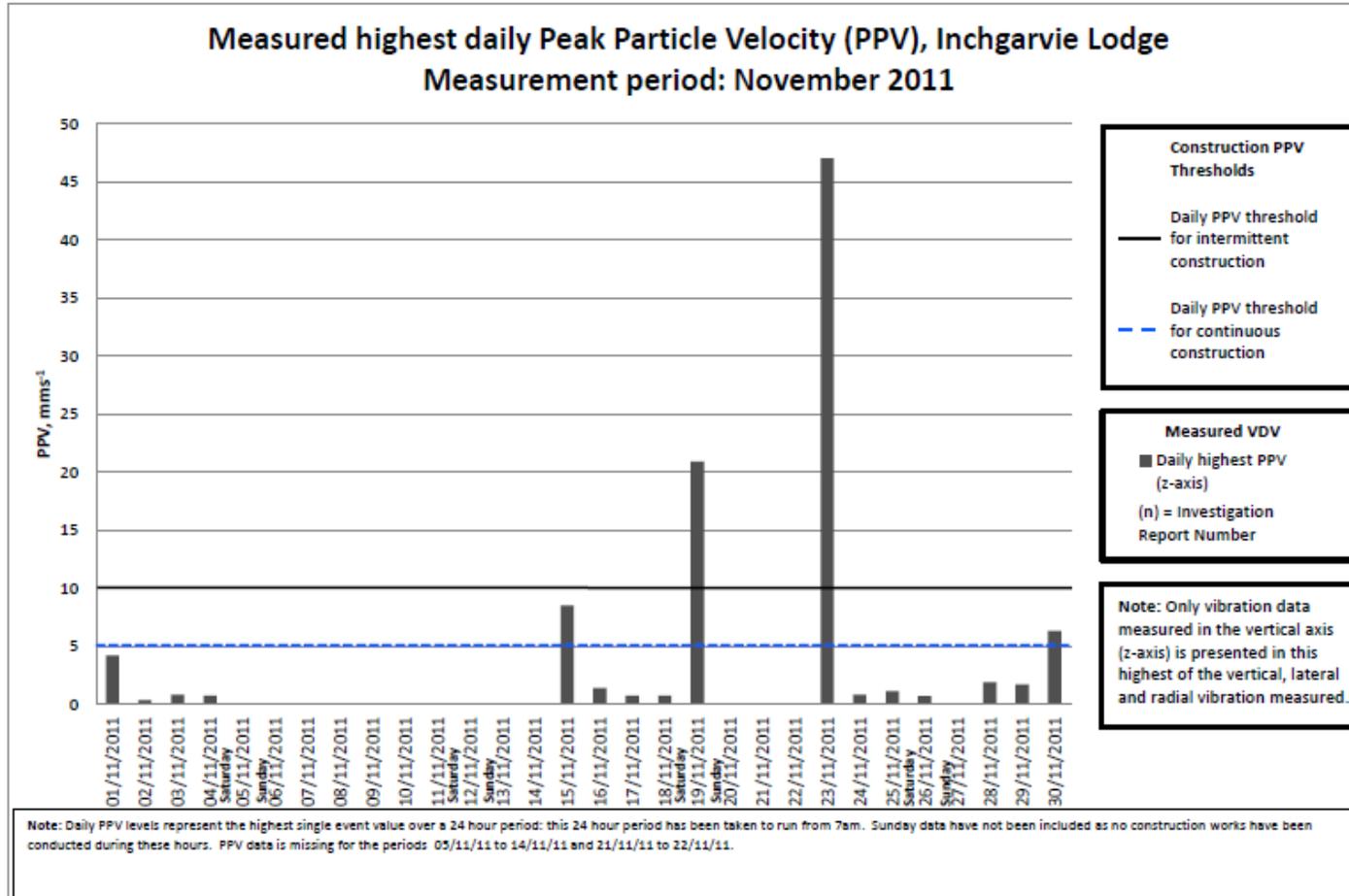
Daytime VDV at Echline – January 2012



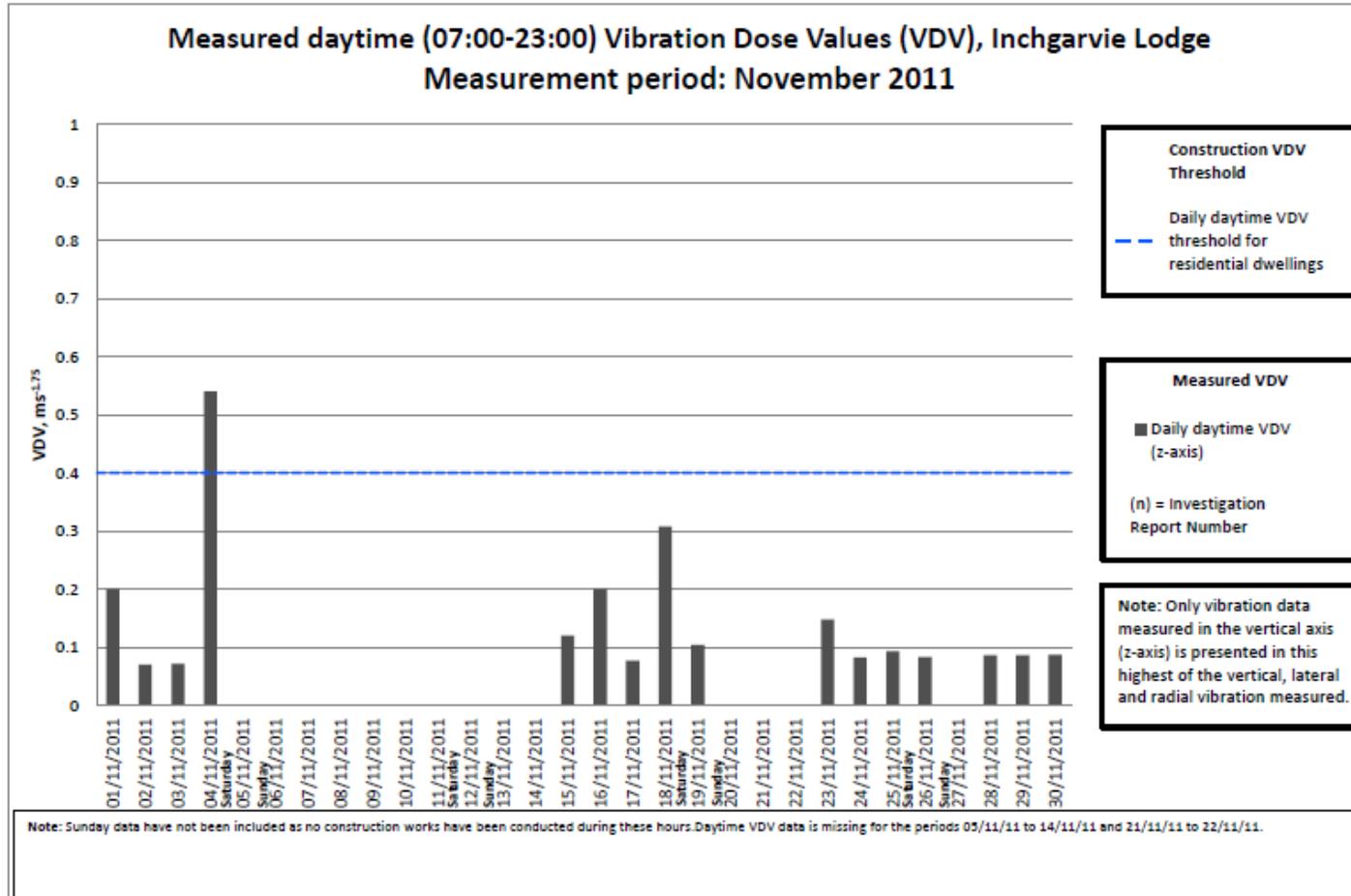
Night-time VDV at Echline – January 2012



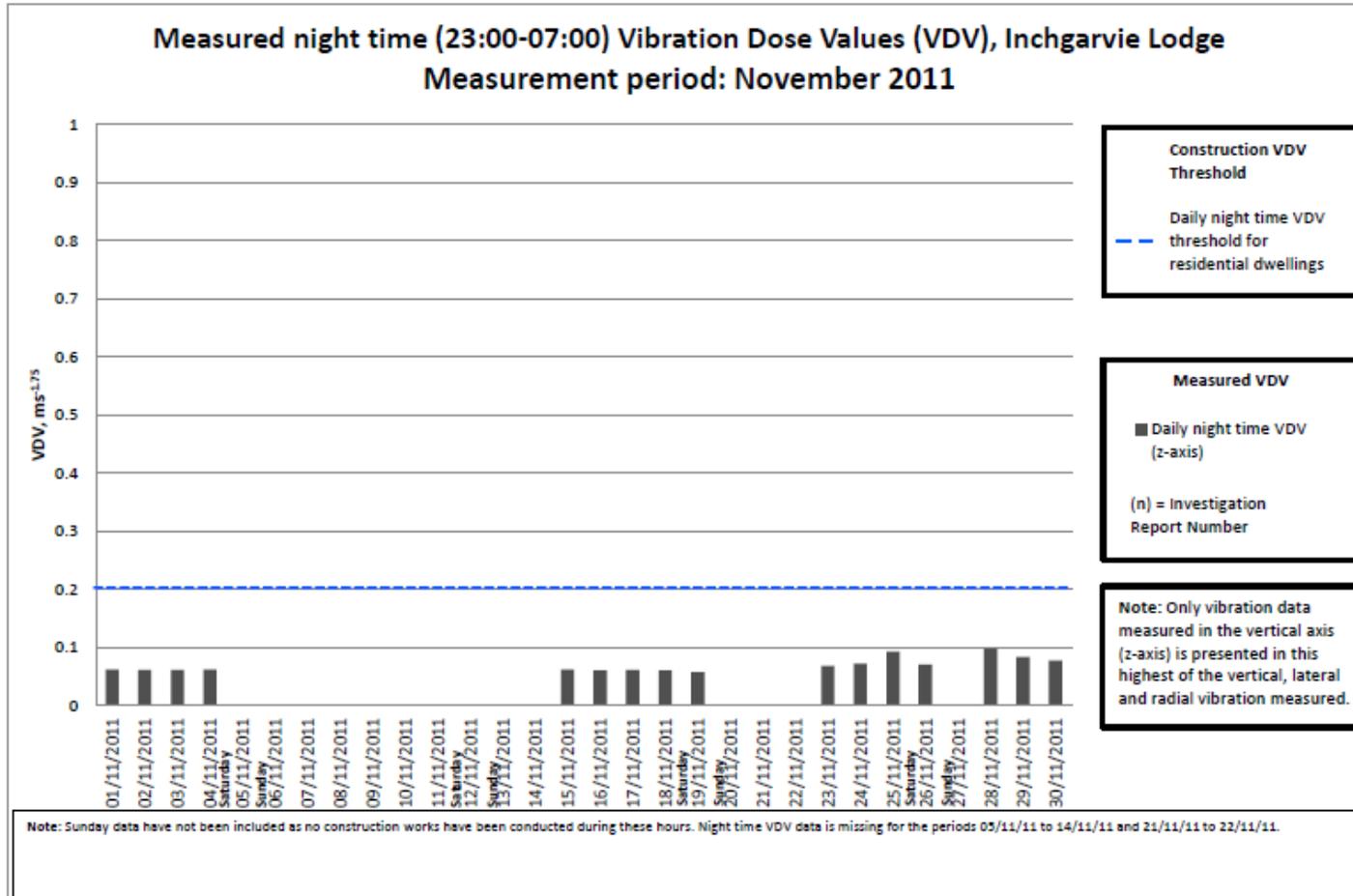
PPV at Inchgarvie Lodge – November 2011



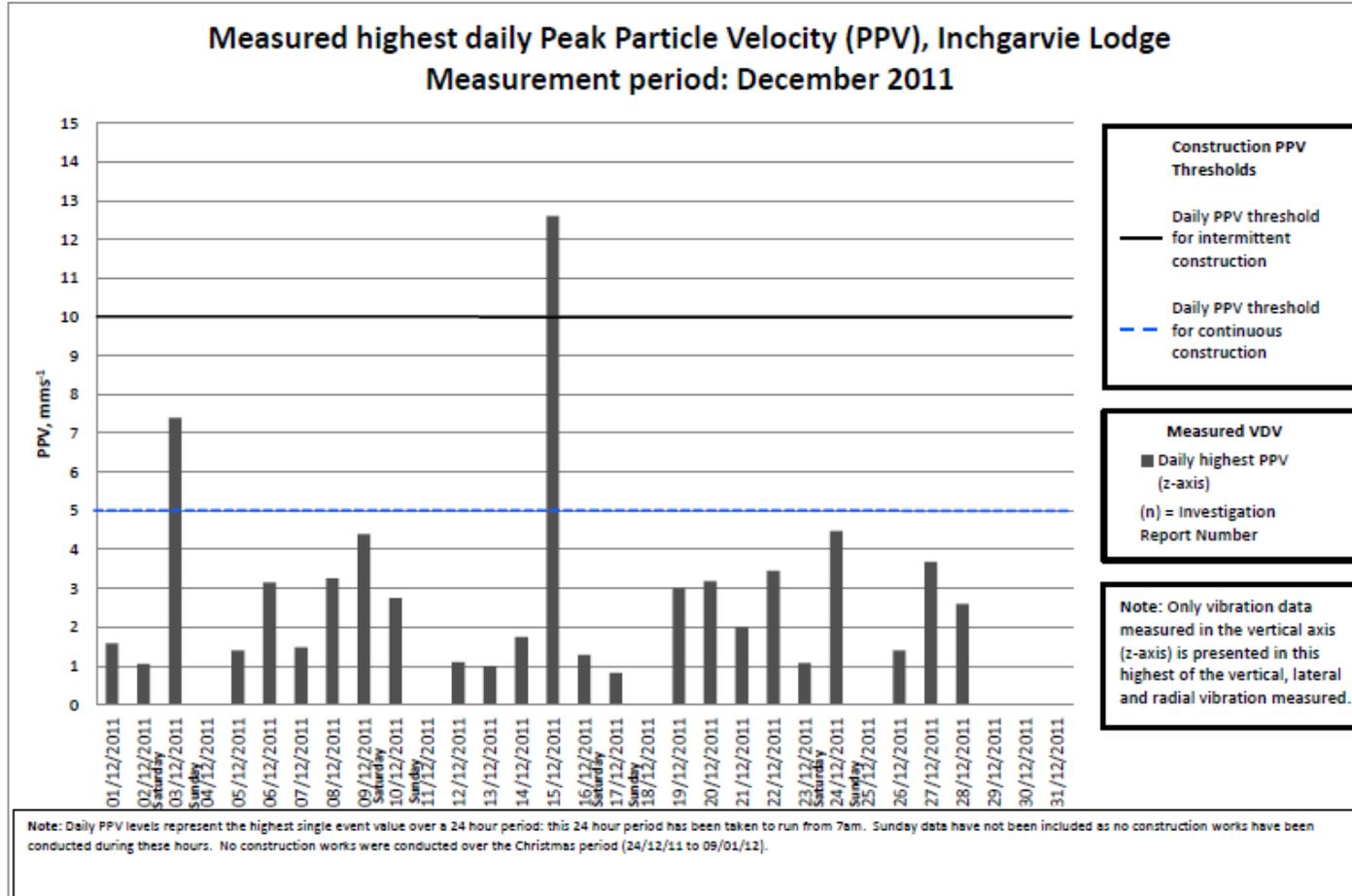
Daytime VDV at Inchgarvie Lodge – November 2011



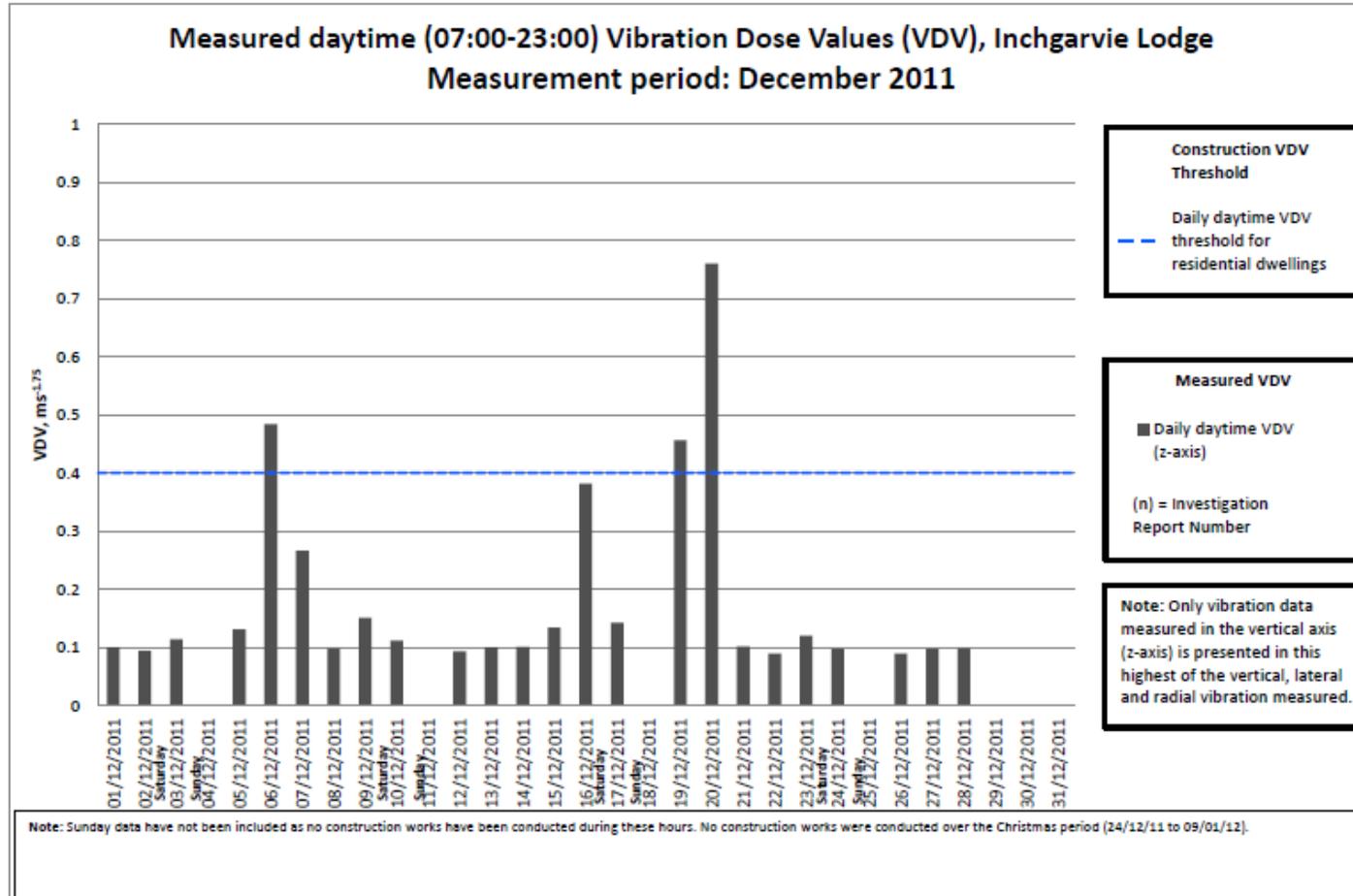
Night-time VDV at Inchgarvie Lodge – November 2011



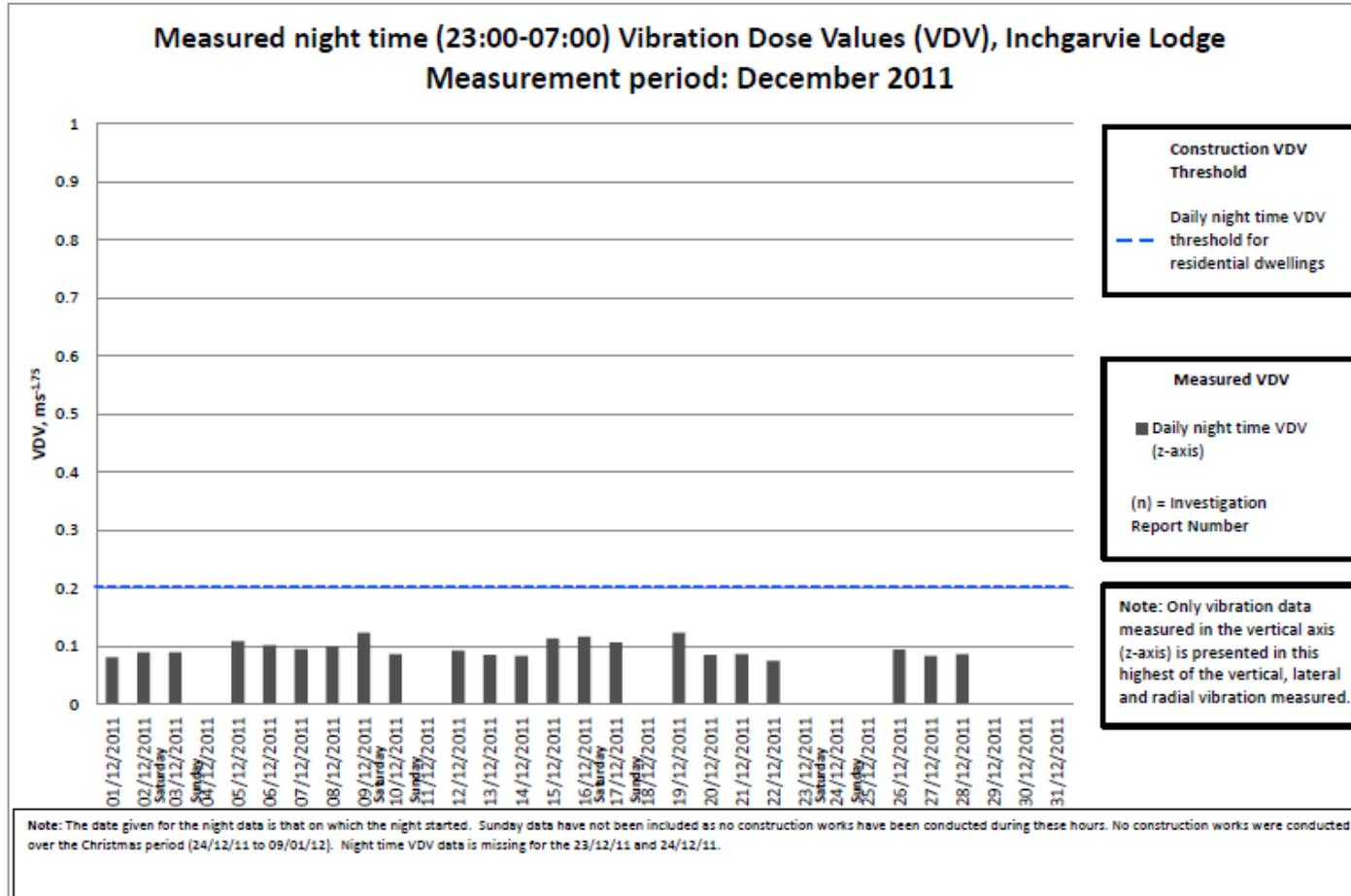
PPV at Inchgarvie Lodge – December 2011



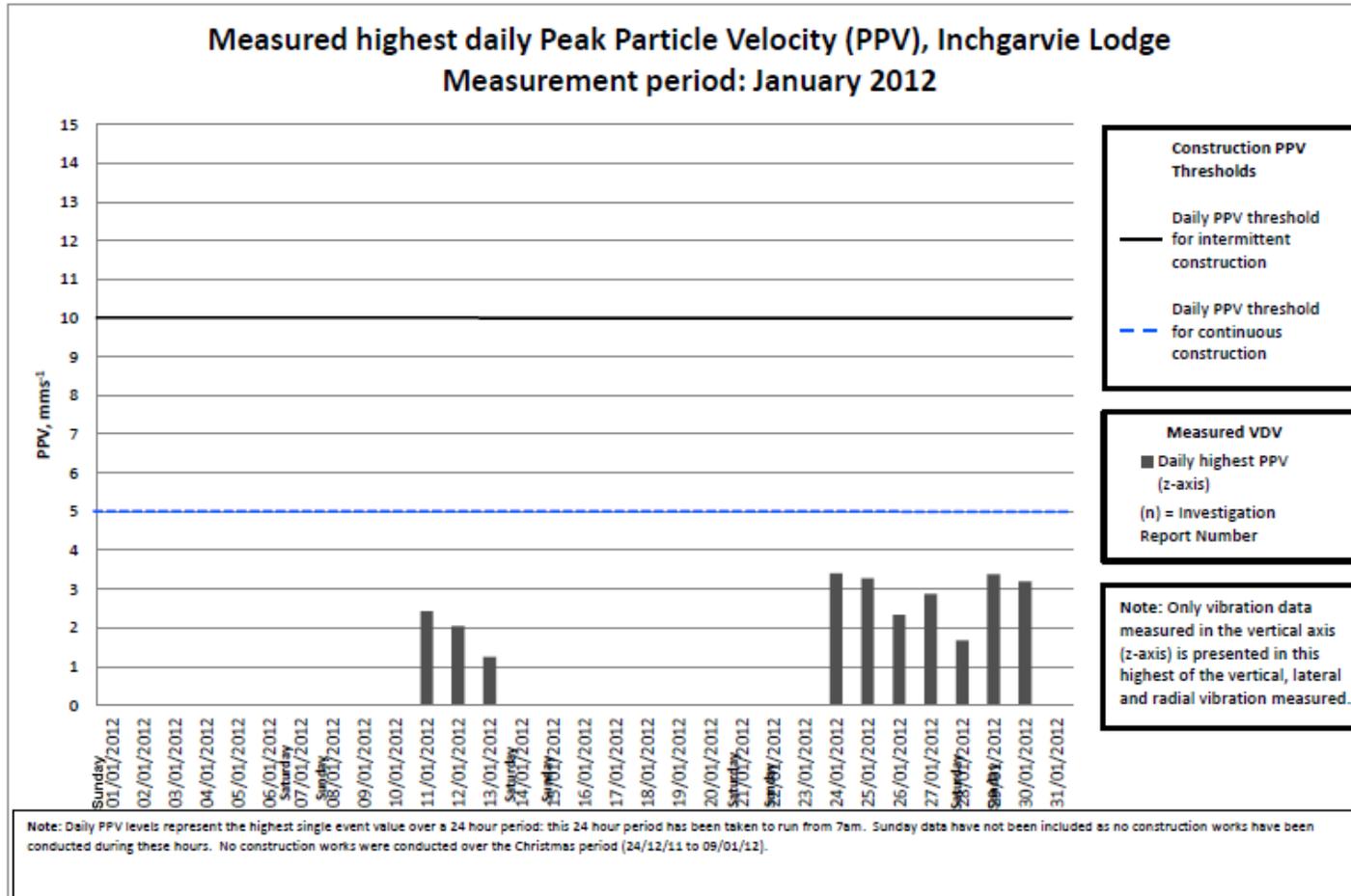
Daytime VDV at Inchgarvie Lodge – December 2011



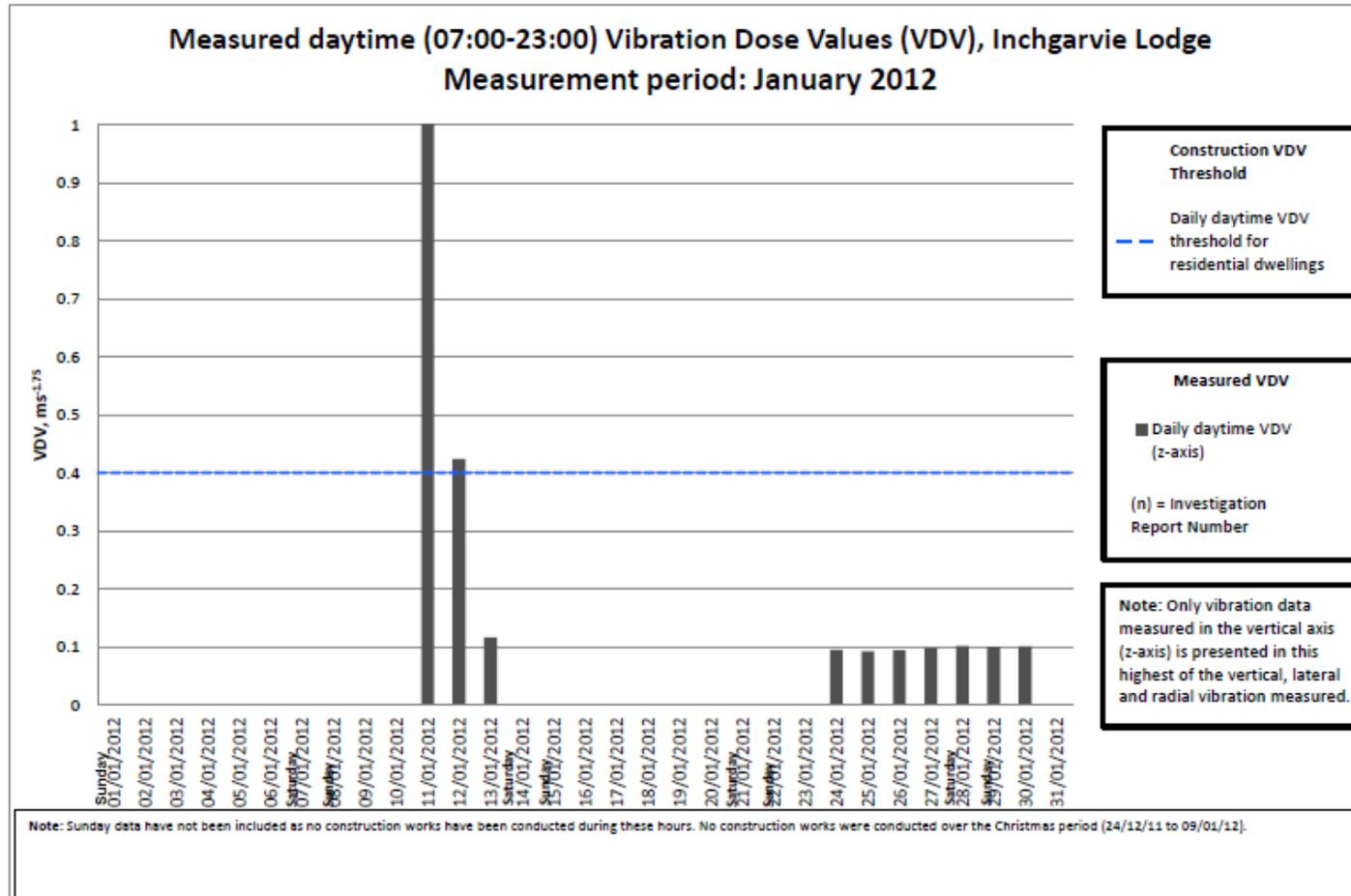
Night-time VDV at Inchgarvie Lodge – December 2011



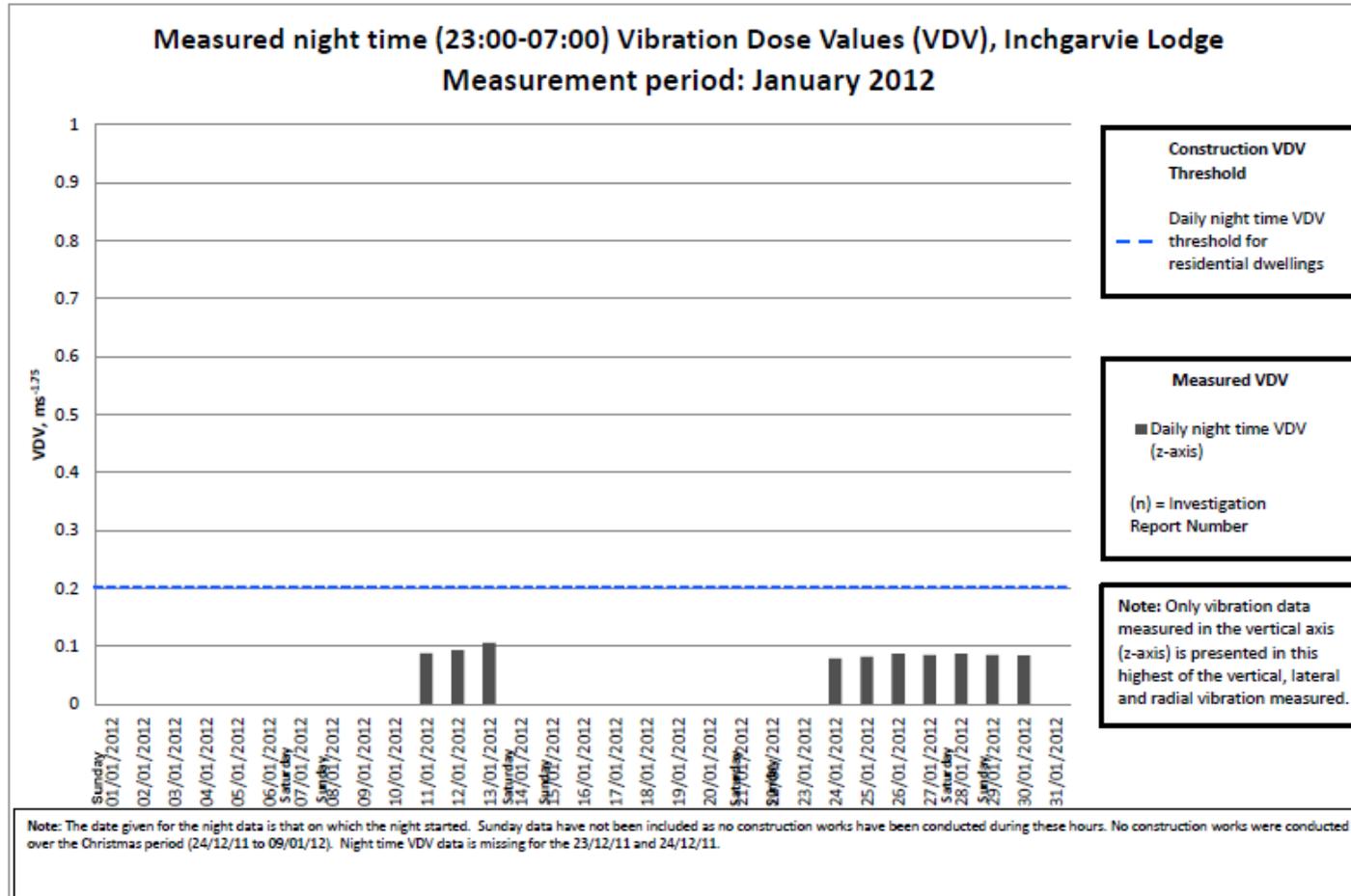
PPV at Inchgarvie Lodge – January 2012



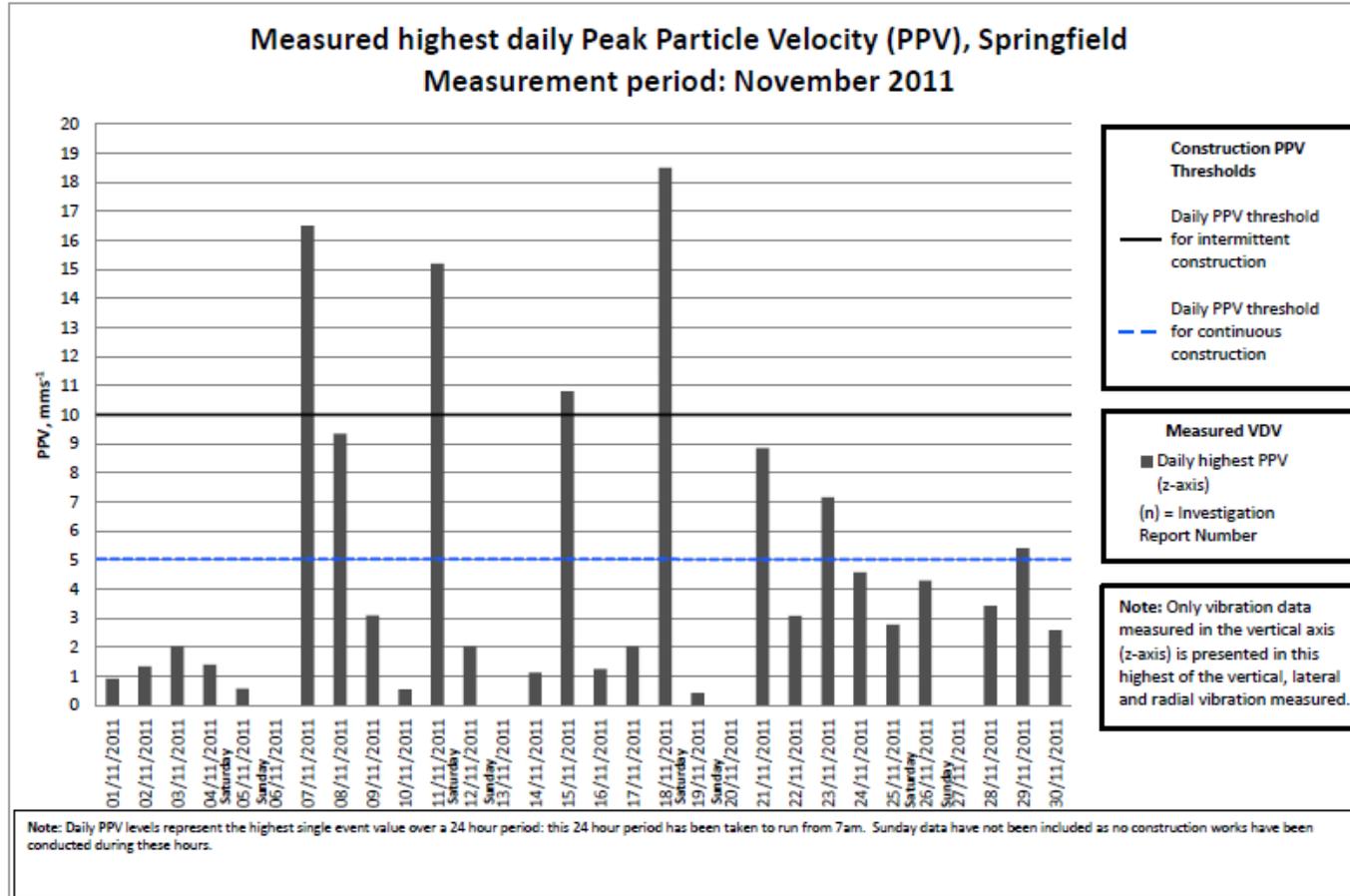
Daytime VDV at Inchgarvie Lodge – January 2012



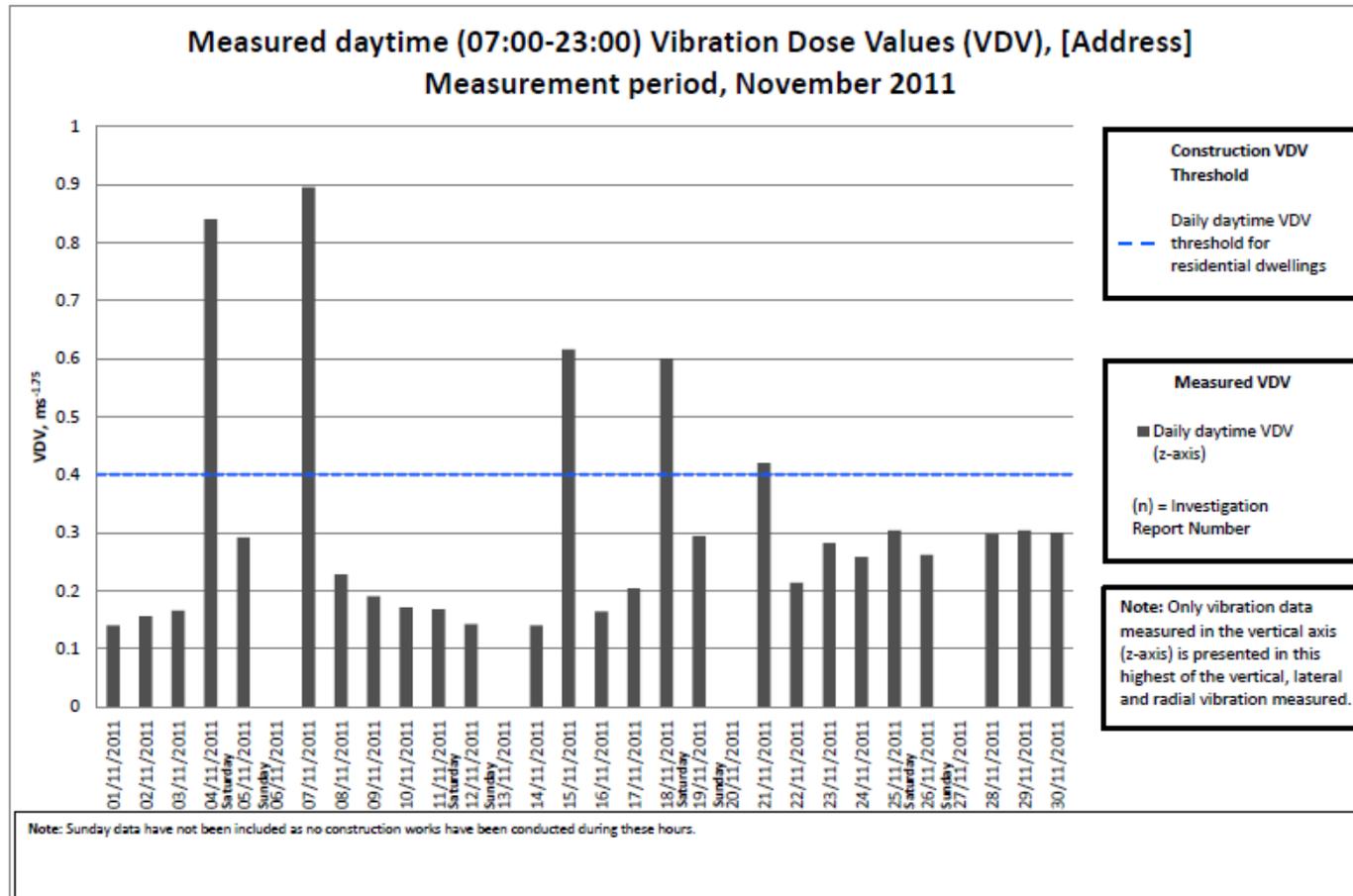
Night-time VDV at Inchgarvie Lodge – January 2012



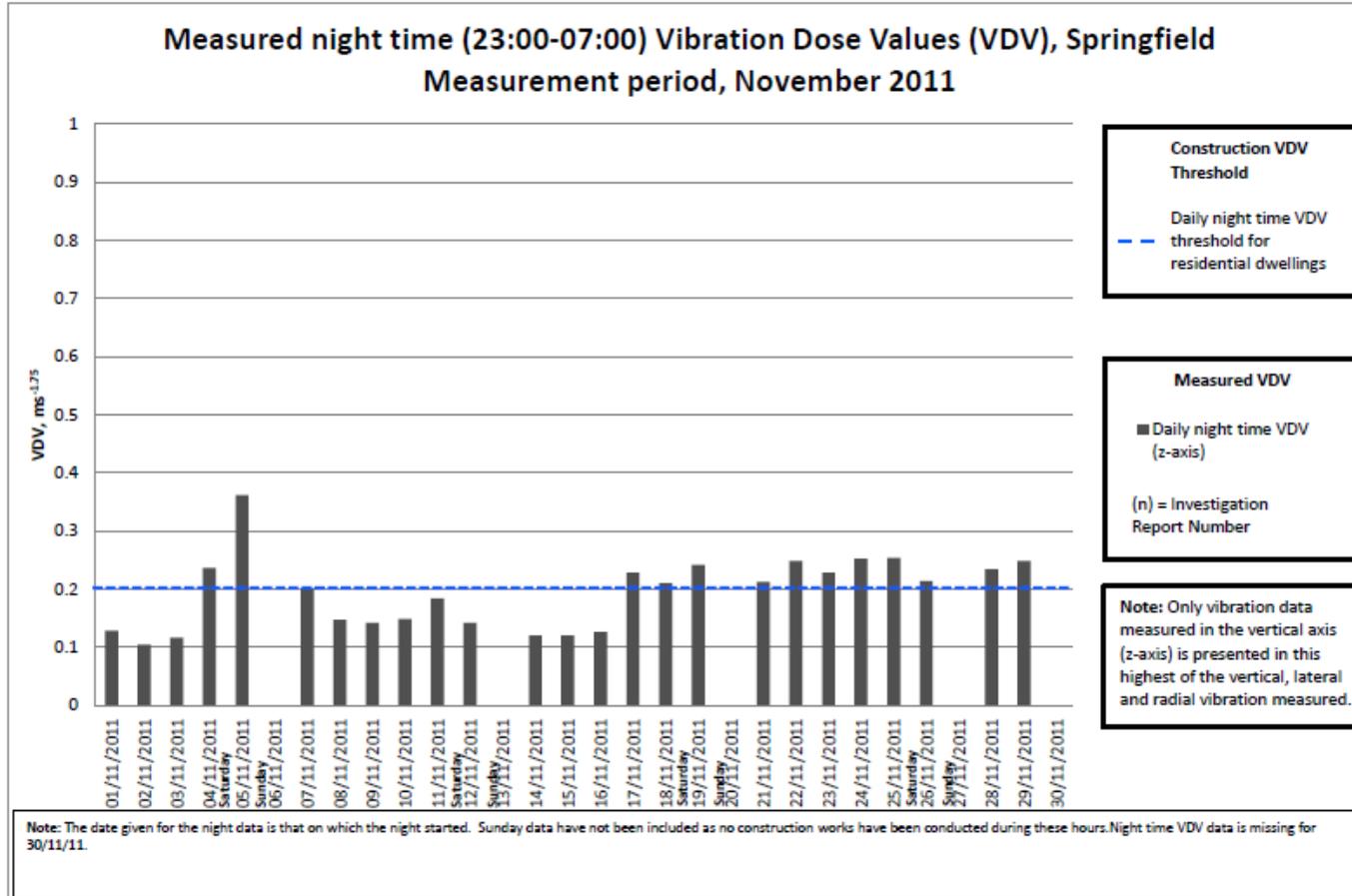
PPV at Springfield – November 2011



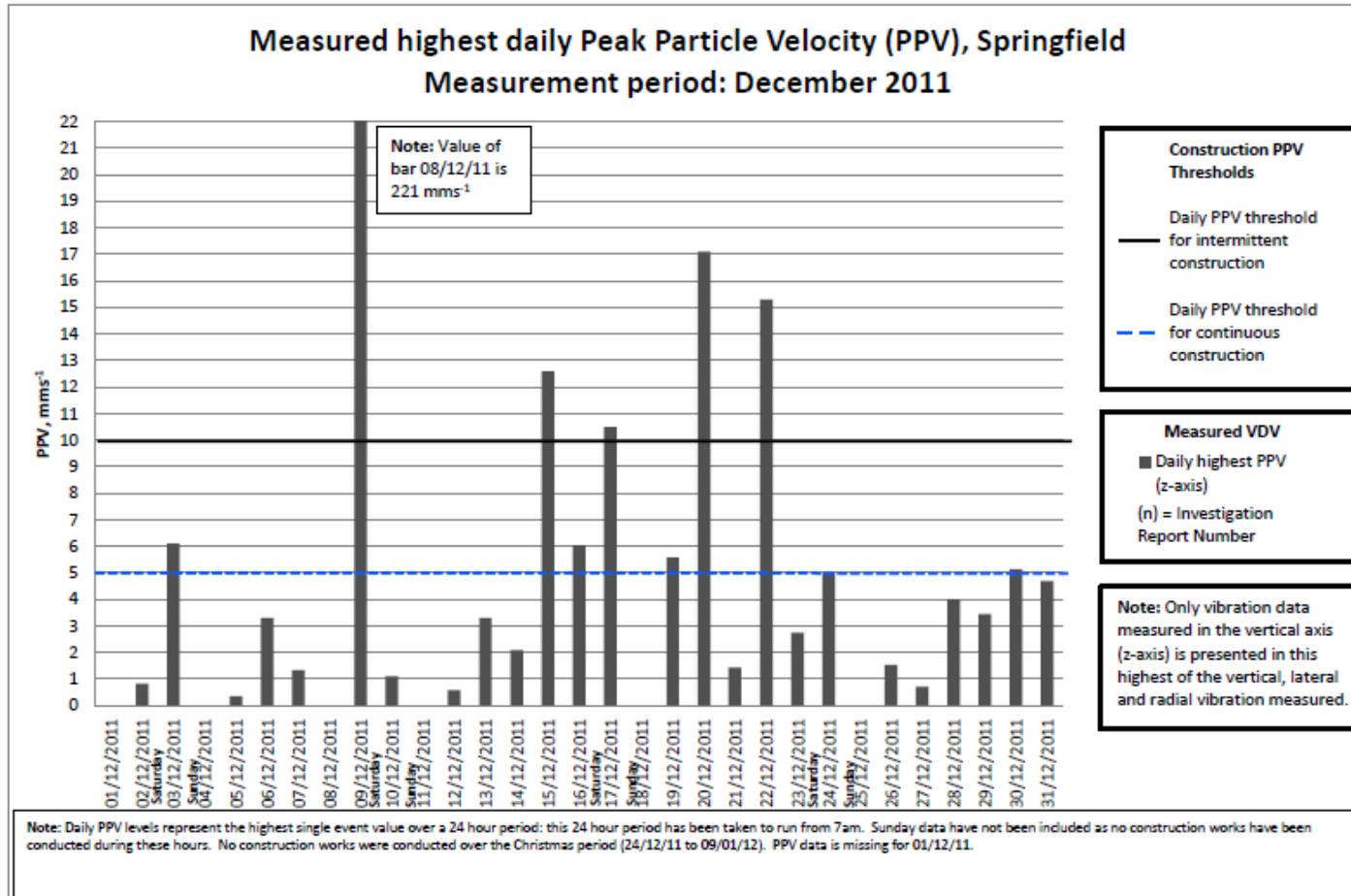
Daytime VDV at Springfield – November 2011



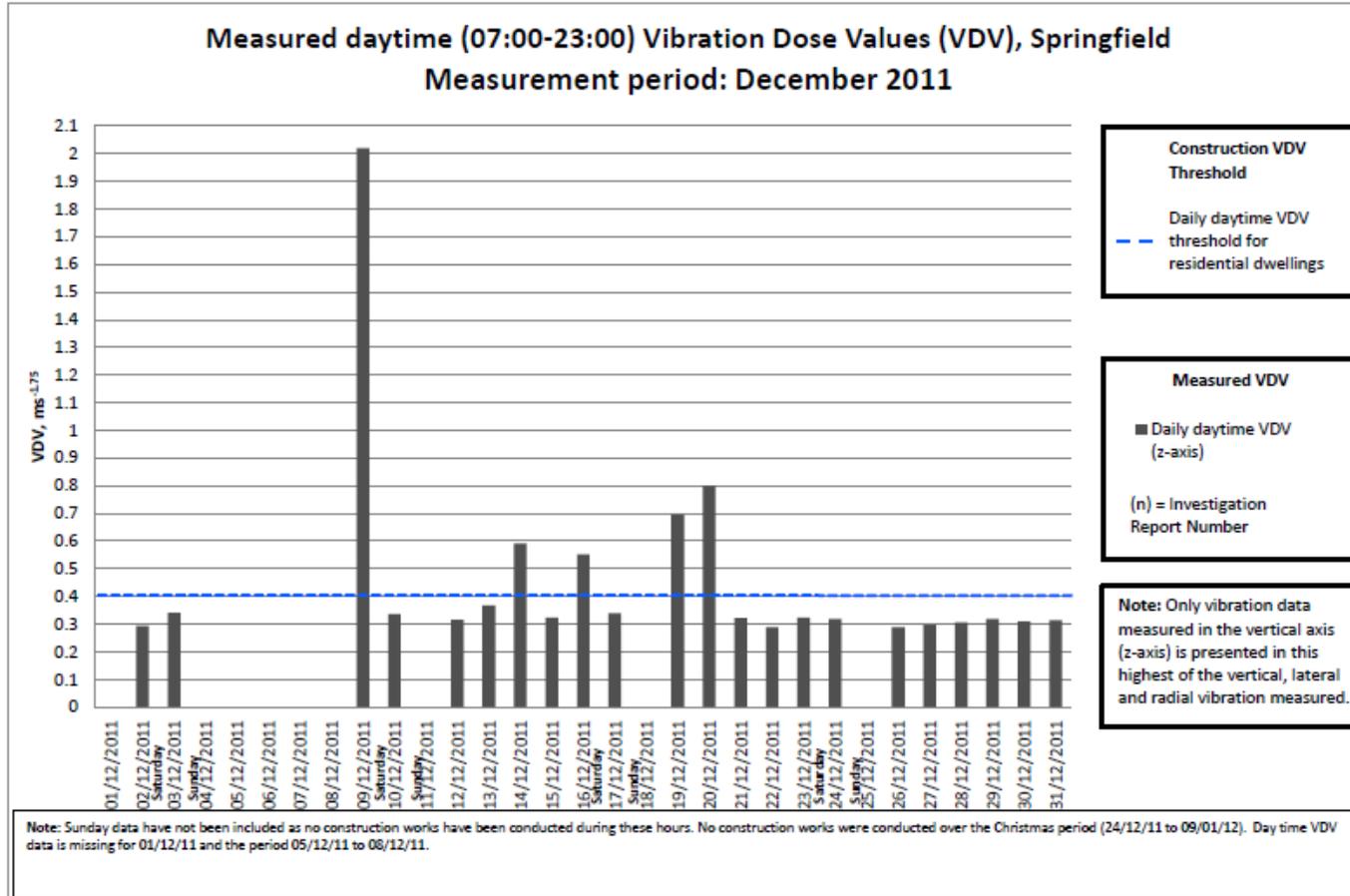
Night-time VDV at Springfield – November 2011



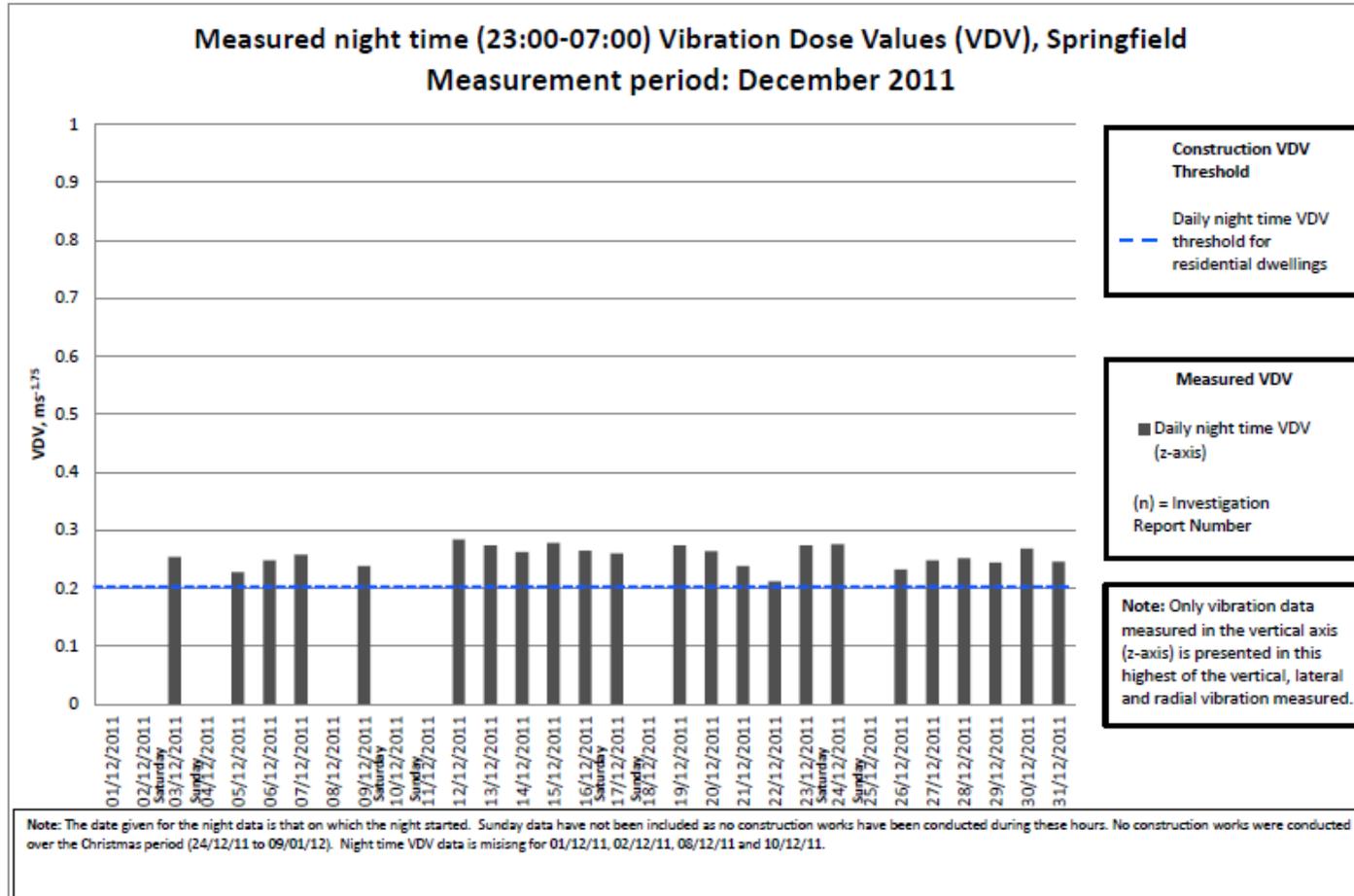
PPV at Springfield – December 2011



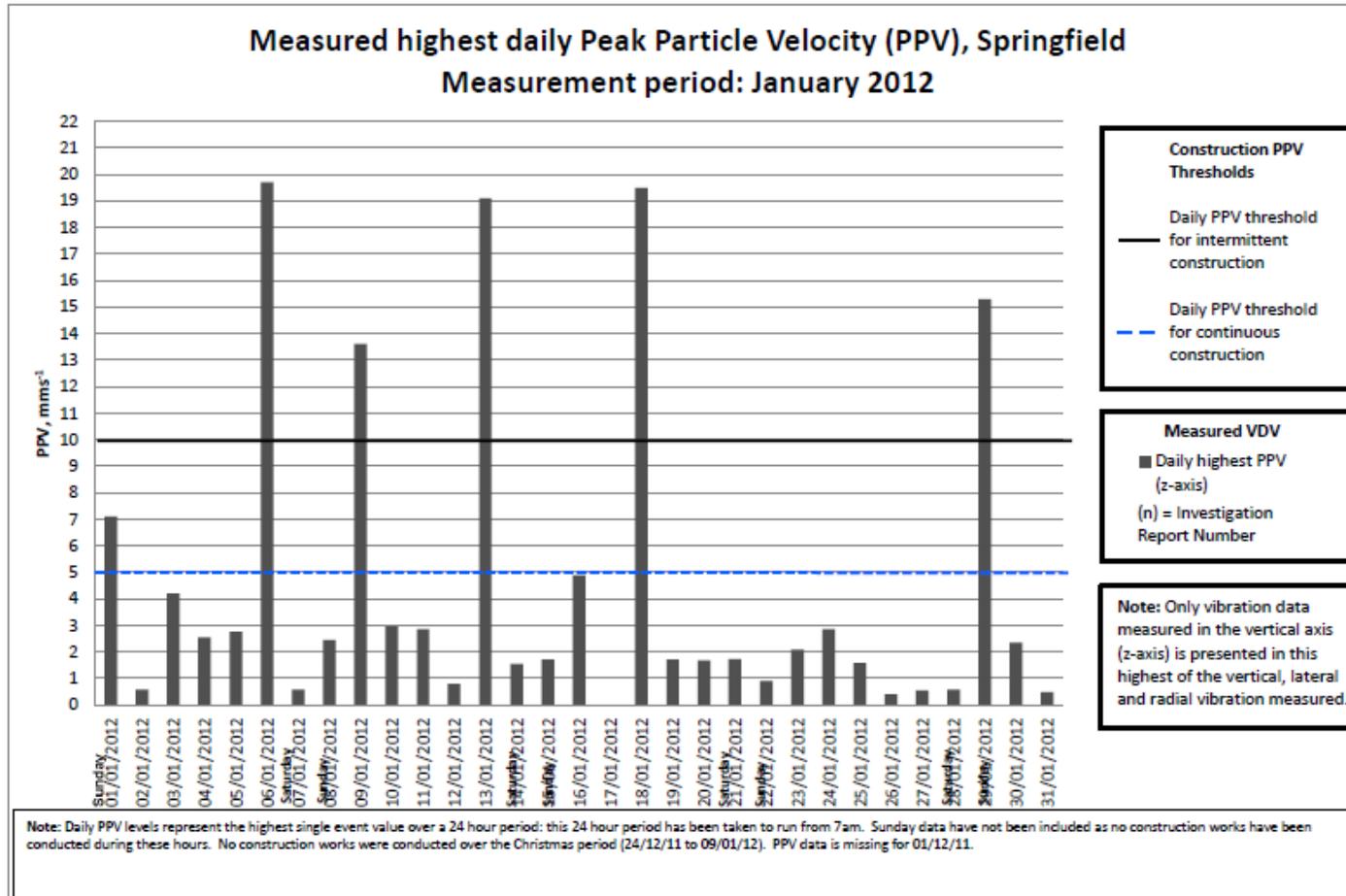
Daytime VDV at Springfield – December 2011



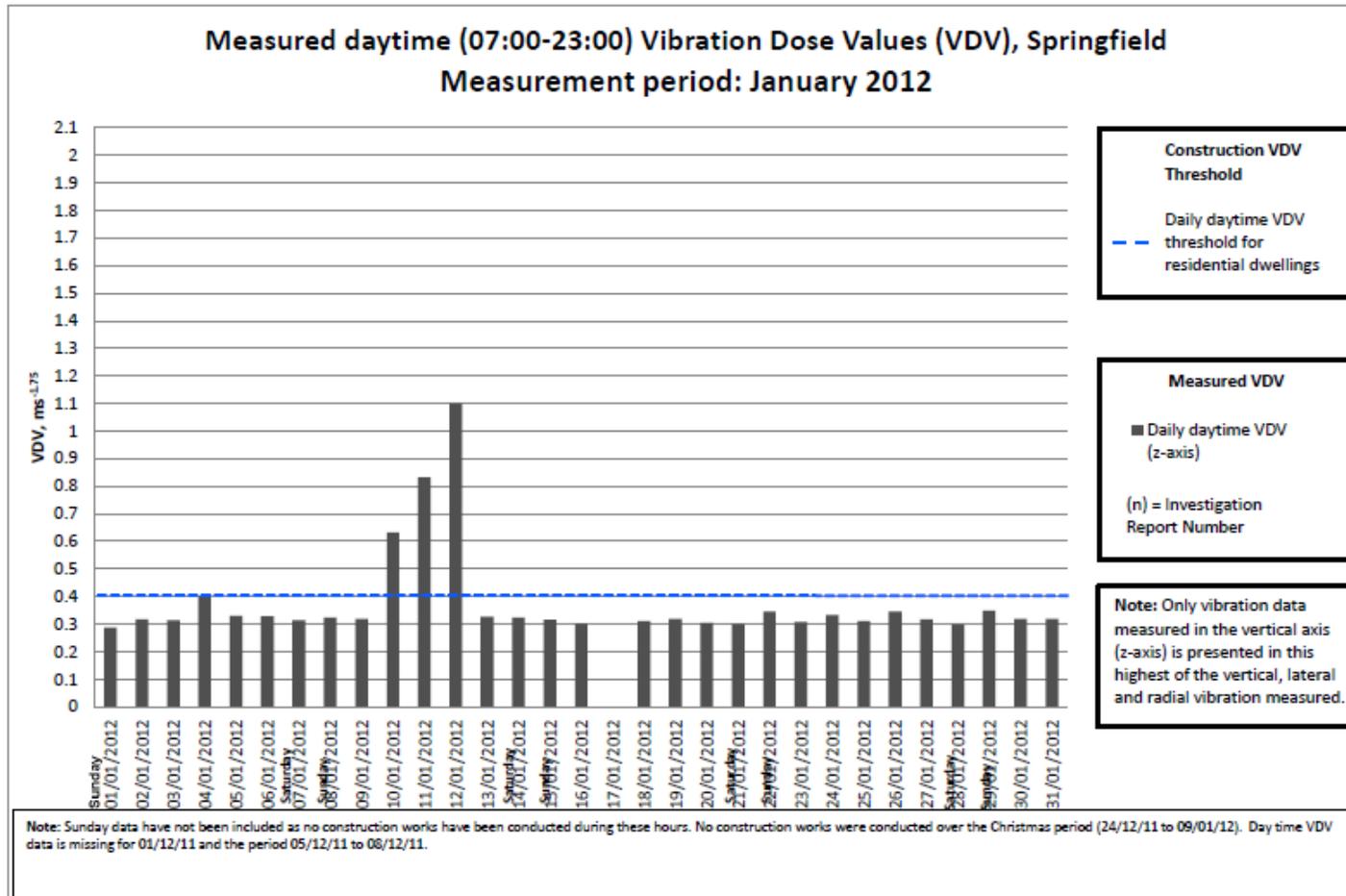
Night-time VDV at Springfield – December 2011



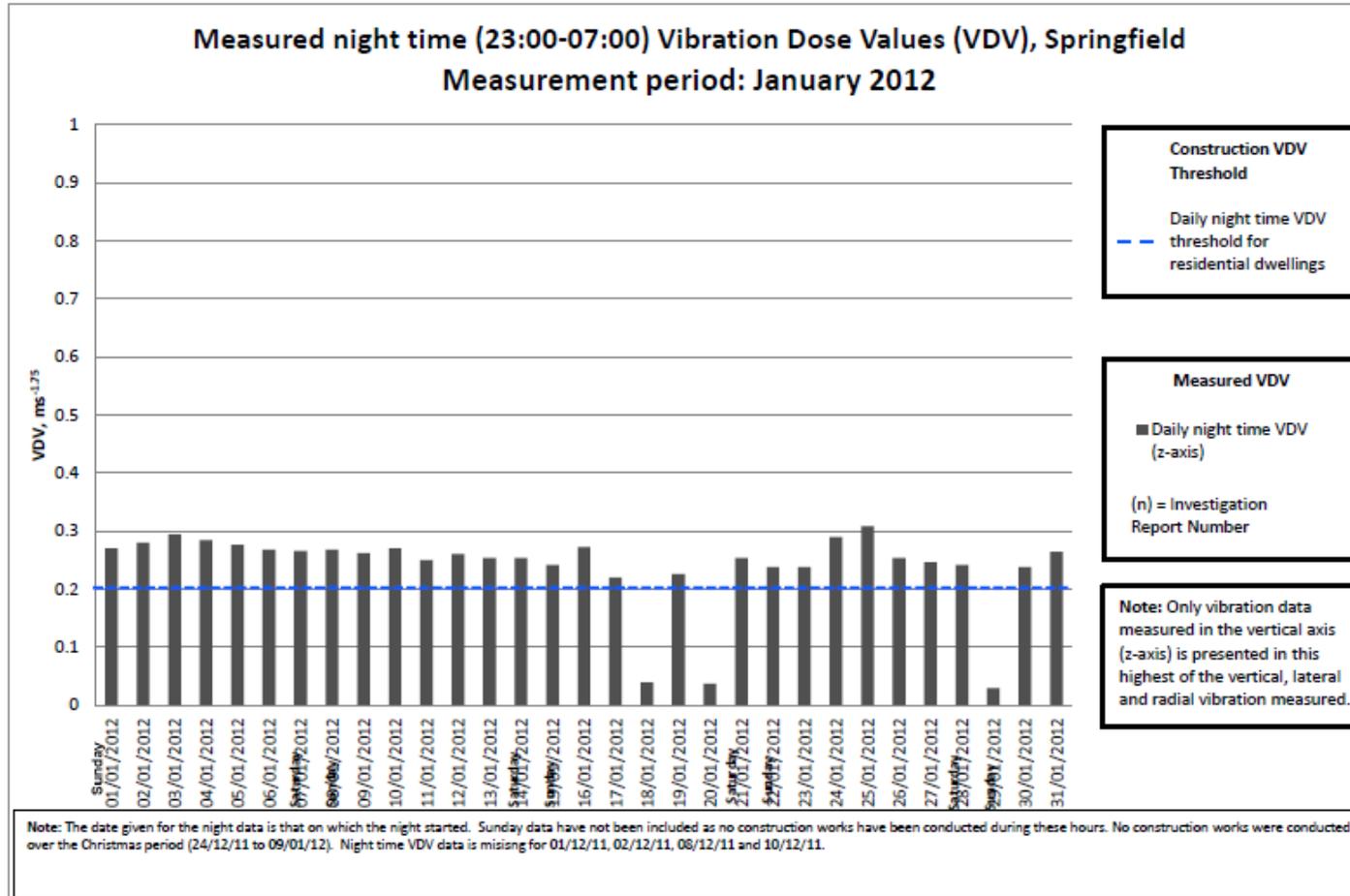
PPV at Springfield – January 2012



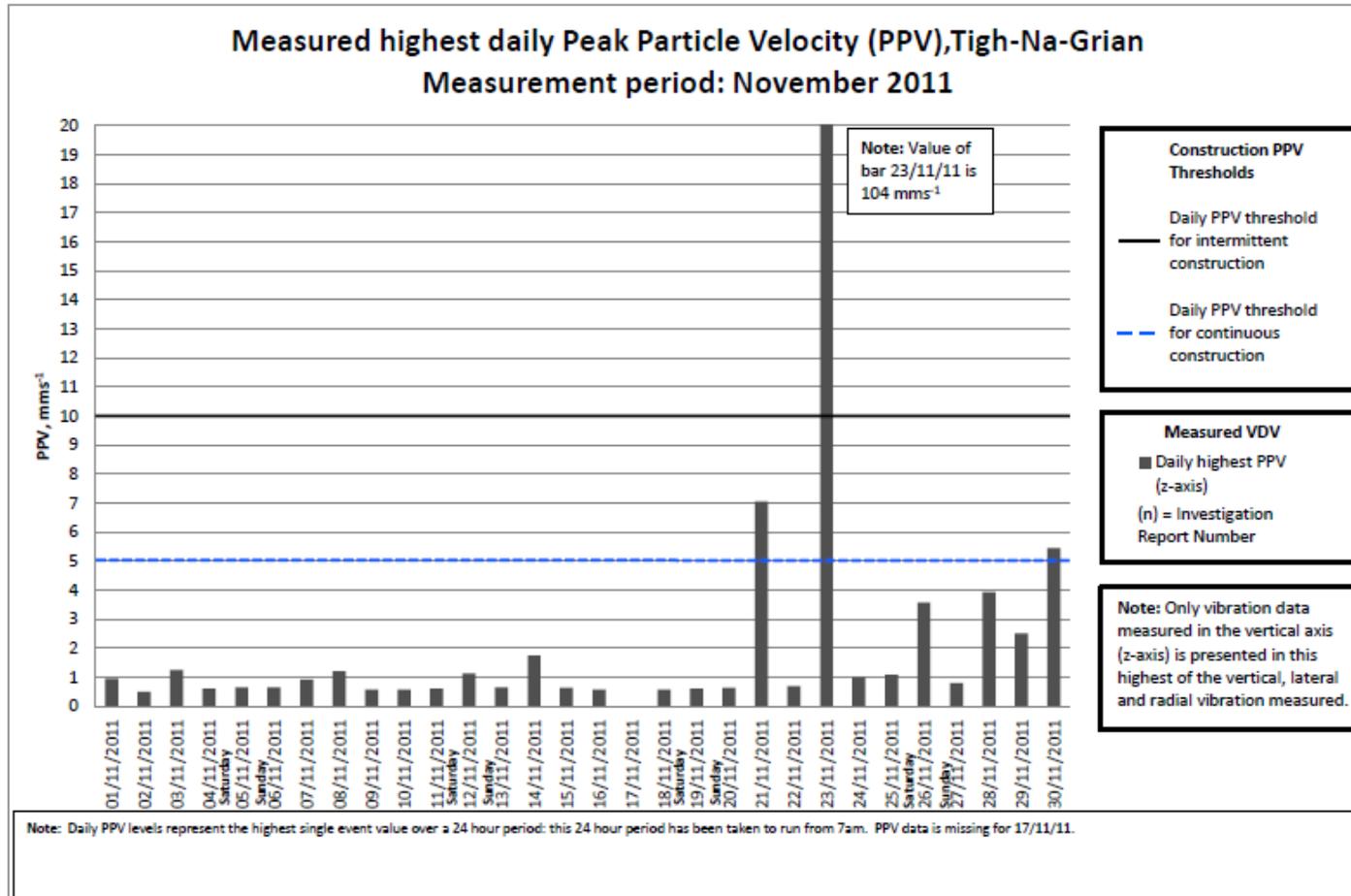
Daytime VDV at Springfield – January 2012



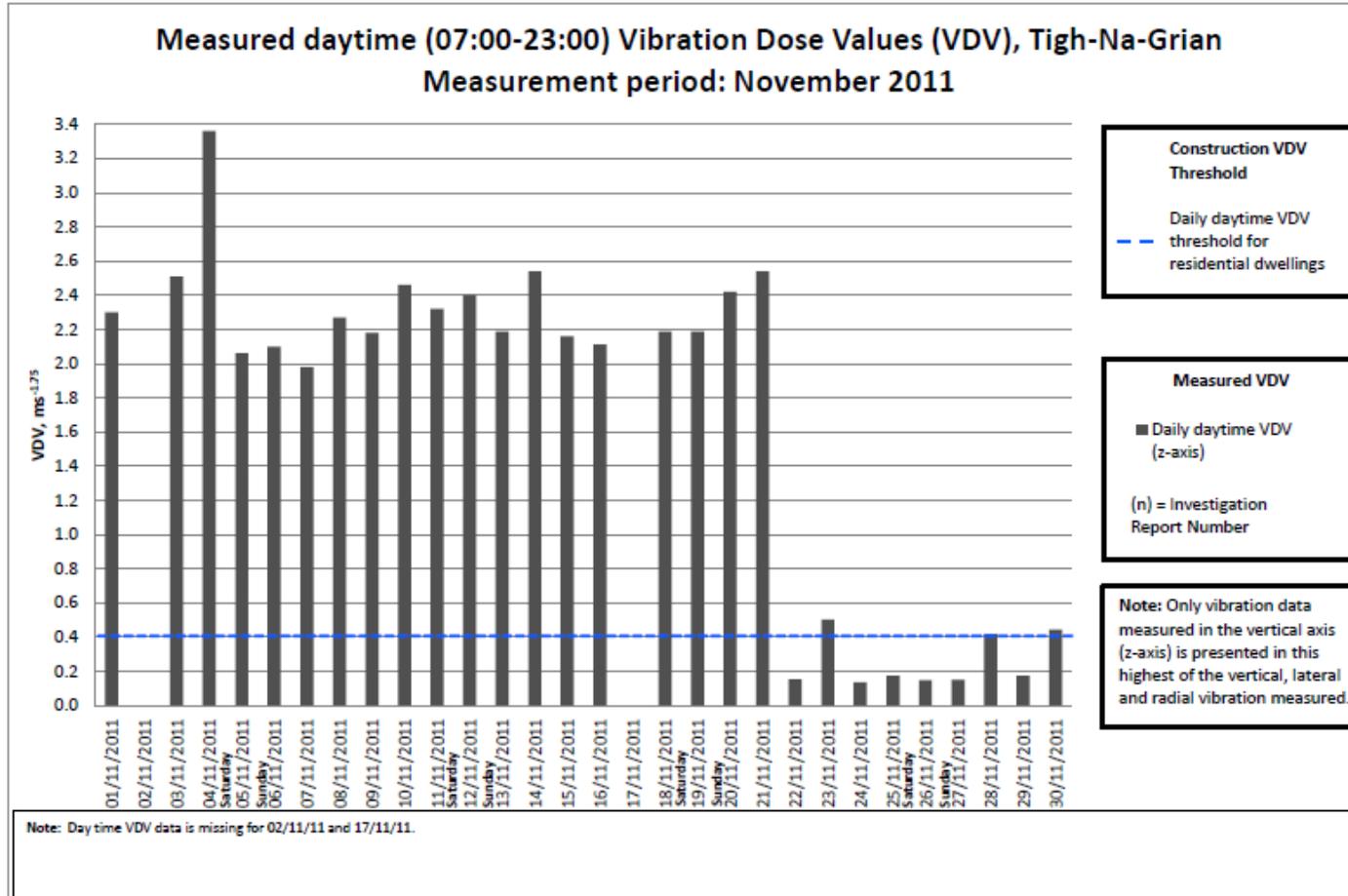
Night-time VDV at Springfield – January 2012



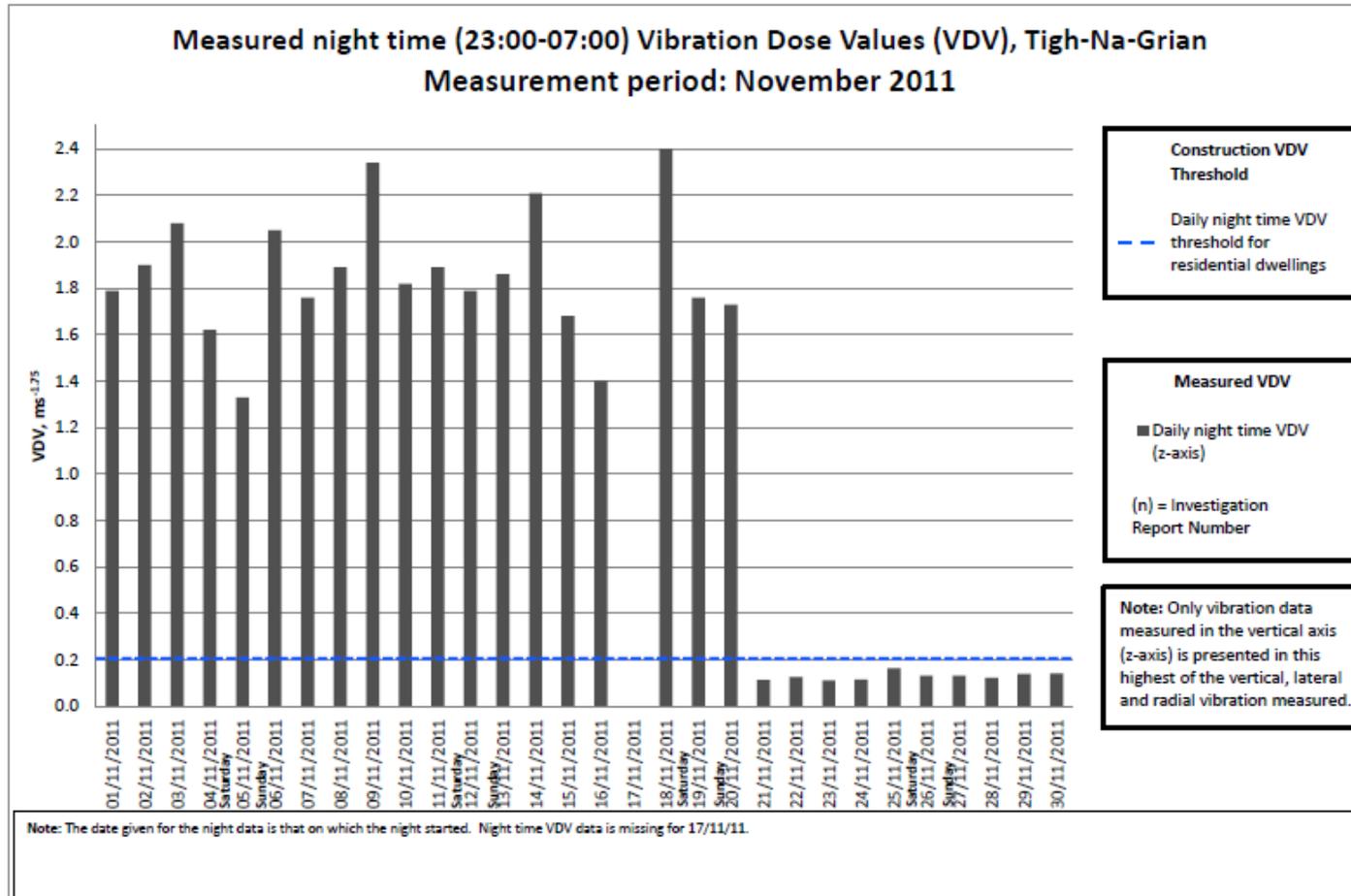
PPV at Tigh-Na-Grian – November 2011



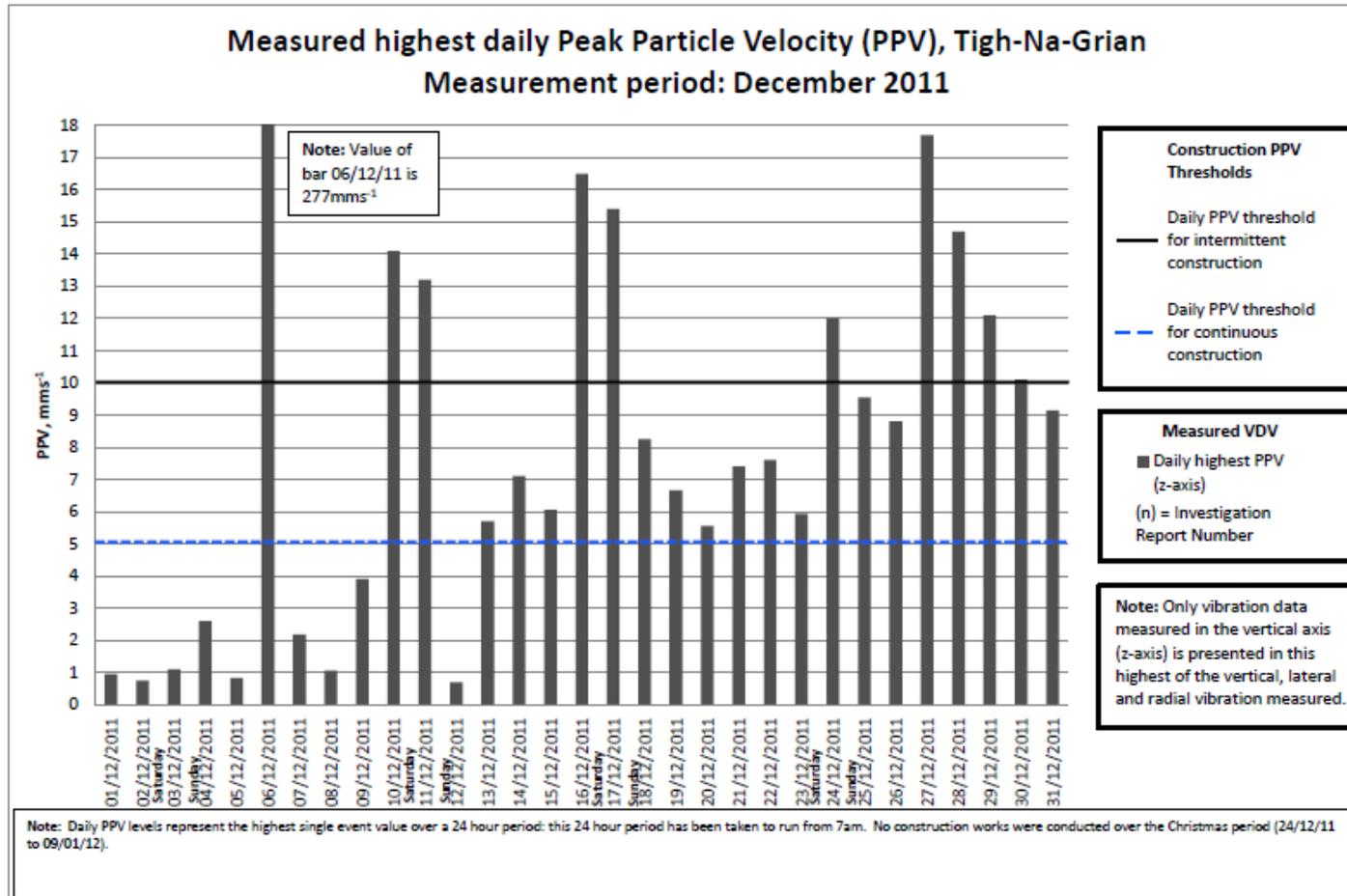
Daytime VDV at Tigh-Na-Grian – November 2011



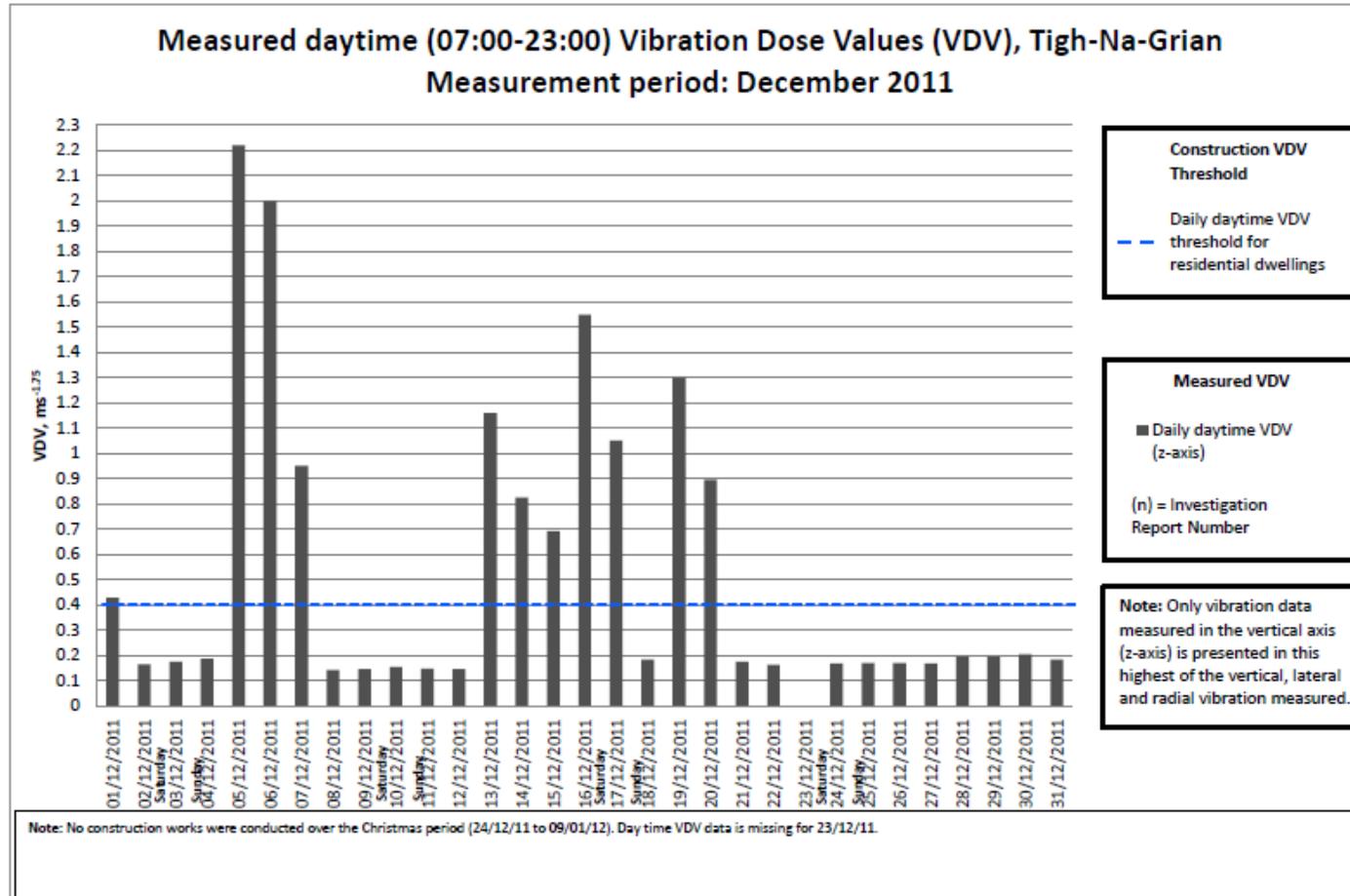
Night-time VDV at Tigh-Na-Grian – November 2011



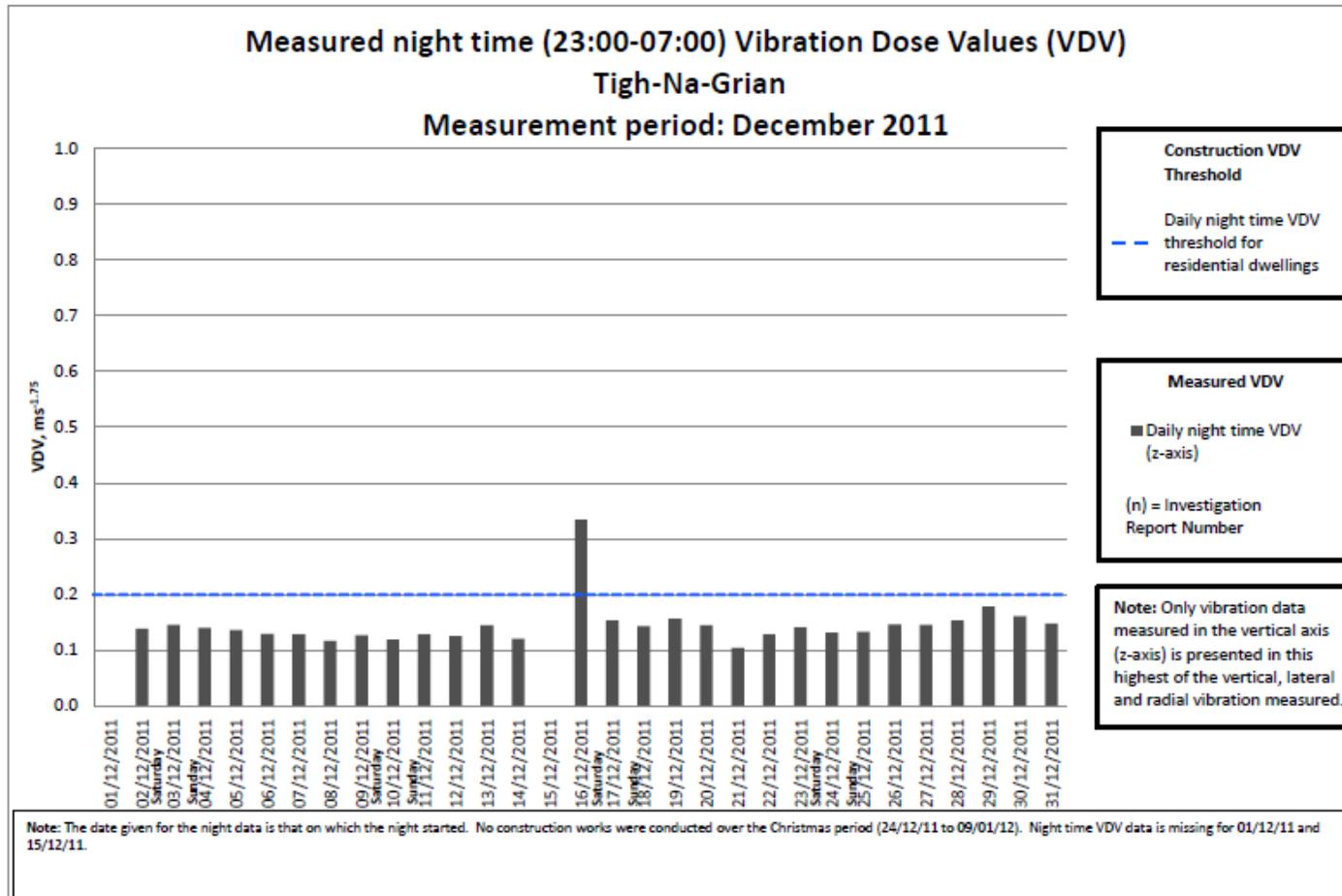
PPV at Tigh-Na-Grian – December 2011



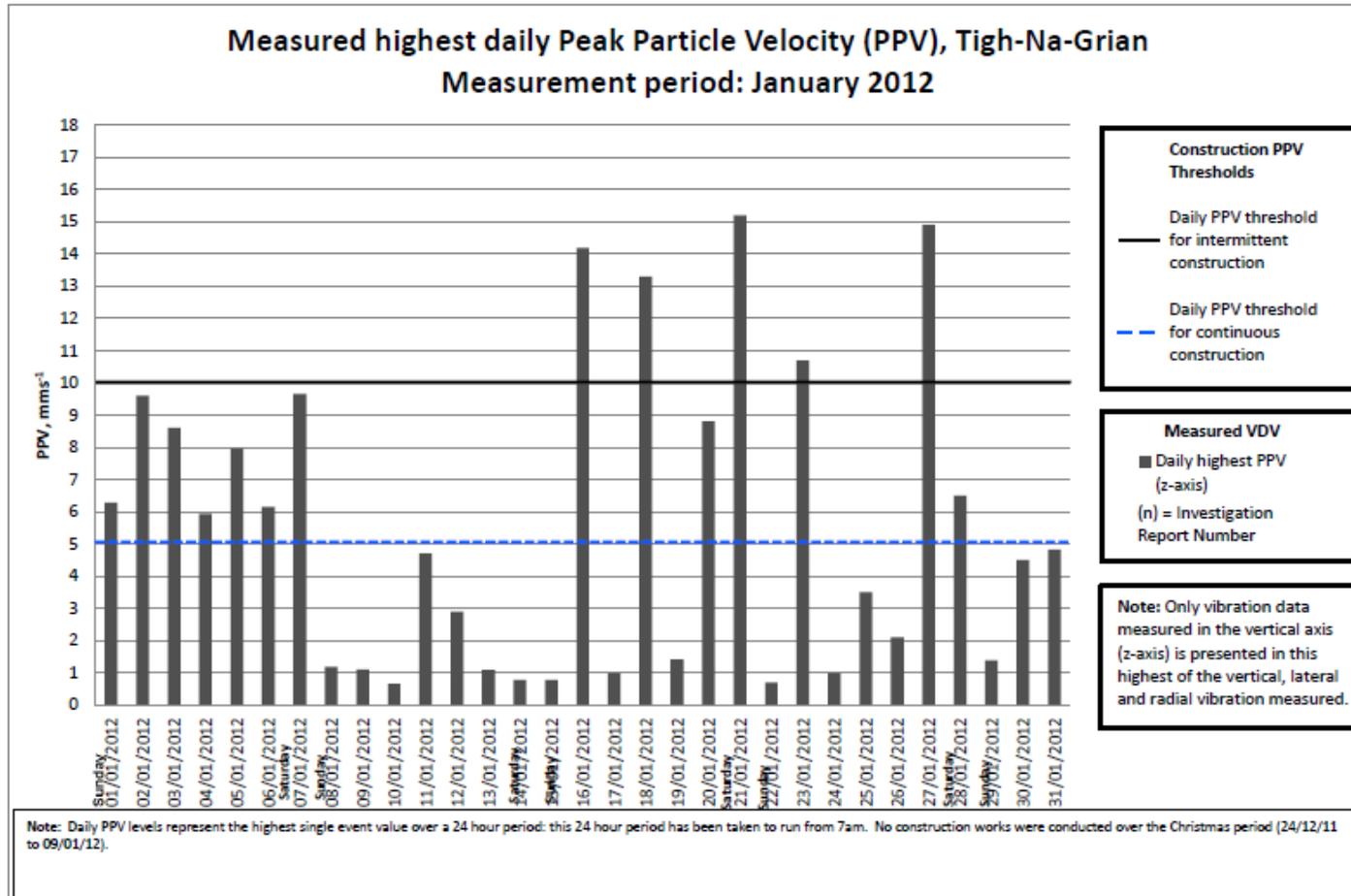
Daytime VDV at Tigh-Na-Grian – December 2011



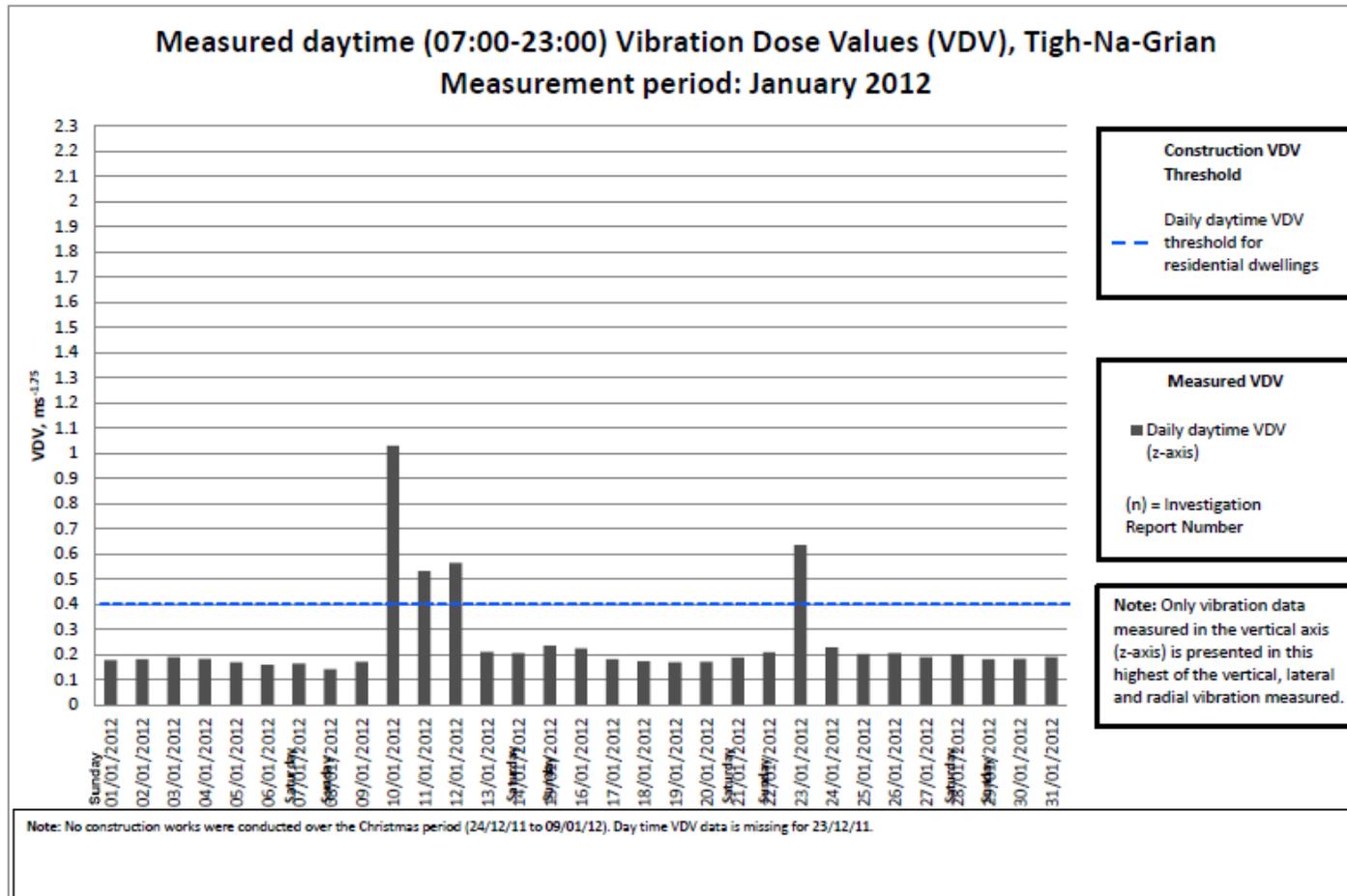
Night-time VDV at Tigh-Na-Grian – December 2011



PPV at Tigh-Na-Grian – January 2012



Daytime VDV at Tigh-Na-Grian – January 2012



Night-time VDV at Tigh-Na-Grian – January 2012

