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Silverton Wind Farm Modification 3 Noise Impact Assessment

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Silverton Wind Farm Modification 3

Noise Impact Assessment

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Table of Contents

1	INTRODUCTION	4
2	SITE LAYOUT	5
3	LEGISLATION & GUIDELINES	9
3.1	SA EPA Wind Farm Noise Guidelines	9
3.2	World Health Organisation (WHO) Guidelines	10
4	BACKGROUND NOISE LEVELS	11
4.1	Monitoring locations - 2016	11
5	NOISE ASSESSMENT	14
5.1	Model Inputs	14
5.2	Assessment of Tonality and Infrasound	15
5.3	Noise Model Predictions	16
5.4	Noise Assessment	17
6	CONCLUSION	18

TABLES

Table 1	Receptor locations (UTM, GDA 94)	6
Table 2	Silverton Wind Farm - proposed WTG locations (UTM, GDA 94)	7
Table 3	WHO Guideline values for environmental noise in specific environments	10
Table 4	Monitoring locations	11
Table 5	Wind mast details	12
Table 6	Background noise regression equations	13
Table 7	Predicted WTG Noise Levels	16

FIGURES

Figure 1	Site overview (image courtesy Google Earth)	5
Figure 2	Worst case noise profile	14
Figure 3	Worst case frequency spectrum	15

Appendix A Background Noise Monitoring Summary

Appendix B Noise Assessment Graphs

Appendix C Noise Contour Map

Appendix D Background Noise Monitoring Data

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) have been engaged by NGH Environmental Pty Ltd to complete a noise impact assessment for a proposed modification to the approved Silverton Wind Farm, located approximately 5 km north of the Silverton township on the Barrier Ranges, approximately 25 km northwest of Broken Hill in far western NSW. SLR (previously Heggies Pty Ltd) has been involved with the project since 2007 having previously completed the original noise impact assessments for Silverton Wind Farm Environmental Assessment.

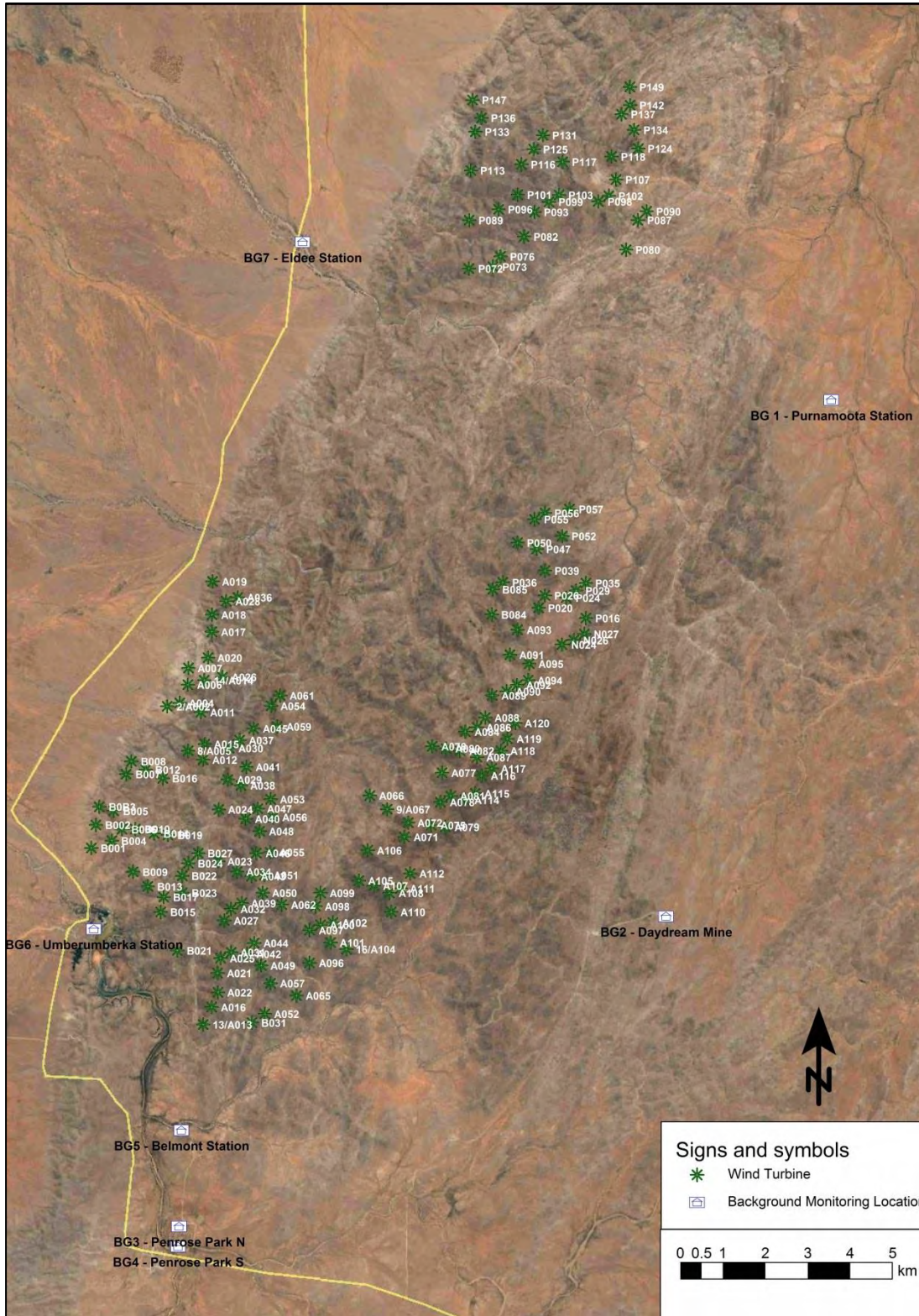
The modified project utilises a reduced number of wind turbine generators (WTGs), each with greater size and capacity. A layout of up to 172 WTGs is now being considered, whereas the approved wind farm had 282 WTGs. Modification 3 is seeking to increase the tip height of the wind turbines to 180 m and the capacity to 5 MW to allow for improvements in wind turbine technology. This noise impact assessment is based on the wind turbines being considered in the current tender process being undertaken by the Proponent with a capacity of approximately 3.2 MW to 3.6 MW being considered.

Background noise monitoring data has been re-collected in the region surrounding the project in order to establish a more current and comprehensive data set.

2 SITE LAYOUT

Figure 1 shows the locations of all background monitoring locations for receptors and the proposed WTG positions of the modified layout for Silverton Wind Farm.

Figure 1 Site overview (image courtesy Google Earth)



A tabulated list of the receptors with details including their position and distance to closest WTG and their project involved host property status are included in **Table 1**.

A tabulated list of the proposed WTG positions for the modified layout for Silverton Wind Farm is included in **Table 2**.

Table 1 Receptor locations (UTM, GDA 94)

ID		Location	X (m East)	Y (m North)	Closest WTG (km)	Project Involved?
S10		Silverton, Willangee Rd	520508	6472376	5.6	
S11		Silverton, Thackaringa St	520663	6472010	5.9	
S12		Silverton, Layard St	520976	6471892	6.0	
S14		Silverton, Silverton Rd	521947	6472277	5.4	
S15		Silverton, Burke St	520956	6472316	5.5	
S16		Silverton, Burke St	521243	6472275	5.5	
S17		Silverton, Layard St	521025	6472557	5.3	
S17		Silverton, Layard St	521065	6472551	5.3	
S18		Silverton, Burke St	521169	6472417	5.4	
S19		Silverton, Gipps St	521305	6472779	5.0	
S20		Silverton, unnamed road	521310	6473016	4.8	
S21		Silverton, unnamed road	521349	6473120	4.7	
S22		Silverton, unnamed road	521491	6473190	4.6	
S24a	BG3	Silverton, Penrose Park N	521566	6472440	5.3	
S24b	BG4	Silverton, Penrose Park S	521585	6472431	5.3	
S25		Silverton, Burke St	521376	6472210	5.6	
S25		Silverton, Loftus	521403	6472255	5.5	
S27		Silverton, unnamed road	522282	6472652	5.0	
S28		Silverton, Silverton Rd	522122	6472266	5.4	
S28		Silverton, Silverton Rd	522186	6472304	5.4	
S29		Silverton, Silverton Rd	521918	6471763	5.9	
SL2	BG7	Eldee Station	524750	6496054	3.8	Y
SL3	BG1	Purnamoota Station	536946	6492457	5.8	Y
SL3		Limestone Station	535925	6469159	14.5	
SL6	BG6	Umberumberka	519709	6479956	1.6	
SL9	BG5	Belmont Station	521763	6475177	2.6	Y

Table 2 Silverton Wind Farm - proposed WTG locations (UTM, GDA 94)

Name	X (m East)	Y (m North)	Name	X (m East)	Y (m North)
A001	521255	6484972	A105	525966	6481089
A002	521451	6485194	A106	526174	6481803
A004	521748	6485275	A107	526318	6480971
A005	521944	6484148	A108	526684	6480801
A006	521937	6485705	A110	526728	6480353
A007	521950	6486096	A111	526951	6480907
A011	522244	6485055	A112	527172	6481256
A012	522296	6483936	A114	528466	6482991
A013	522300	6477700	A115	528707	6483144
A014	522326	6485809	A116	528855	6483562
A015	522337	6484306	A117	529094	6483730
A016	522498	6478109	A118	529312	6484147
A017	522501	6486951	A119	529461	6484431
A018	522506	6487354	A120	529650	6484801
A019	522523	6488136	B001	519665	6481857
A020	522414	6486340	B002	519773	6482400
A021	522639	6478912	B003	519854	6482829
A022	522647	6478457	B004	520150	6482029
A023	522649	6481544	B005	520192	6482731
A024	522666	6482765	B006	520388	6482299
A025	522709	6479262	B007	520483	6483596
A026	522753	6485885	B008	520608	6483900
A027	522800	6480150	B009	520650	6481296
A028	522840	6487673	B010	520702	6482304
A029	522880	6483469	B012	520949	6483703
A030	522910	6484211	B013	520996	6480951
A031	522959	6479400	B014	521145	6482200
A032	522958	6480422	B015	521301	6480351
A034	523099	6481299	B016	521349	6483500
A036	523116	6487761	B017	521371	6480702
A037	523158	6484397	B019	521470	6482164
A038	523190	6483332	B021	521691	6479443
A039	523209	6480558	B022	521805	6481201
A040	523301	6482548	B023	521807	6480803
A041	523318	6483767	B024	521951	6481497
A042	523333	6479363	B027	522182	6481734
A043	523438	6481194	B031	523446	6477745
A044	523500	6479619	B084	529096	6487357
A045	523486	6484672	B085	529117	6487949
A046	523550	6481737	N024	530746	6486651
A047	523584	6482784	N026	531028	6486754
A048	523629	6482252	N027	531274	6486898
A049	523666	6479088	P016	531310	6487272
A050	523705	6480803	P020	530198	6487515
A051	523741	6481218	P024	530847	6487753

Name	X (m East)	Y (m North)	Name	X (m East)	Y (m North)
A052	523751	6477950	P026	530348	6487806
A053	523888	6483006	P029	531079	6487920
A054	523902	6485206	P035	531311	6488098
A055	523877	6481759	P036	529353	6488113
A056	523942	6482584	P039	530352	6488391
A057	523889	6478671	P047	530154	6488900
A059	524041	6484718	P050	529701	6489049
A061	524115	6485450	P052	530753	6489205
A062	524150	6480523	P055	530102	6489602
A065	524498	6478381	P056	530349	6489749
A066	526224	6483094	P057	530924	6489840
A067	526630	6482769	P072	528555	6495507
A071	527037	6482118	P073	529121	6495550
A072	527128	6482454	P076	529301	6495791
A075	527670	6482396	P080	532258	6495951
A076	527690	6484252	P082	529855	6496260
A077	527923	6483630	P087	532532	6496648
A078	527886	6482939	P089	528562	6496646
A079	528001	6482353	P090	532743	6496855
A080	528020	6484202	P093	530103	6496838
A081	528131	6483084	P096	529254	6496902
A082	528347	6484148	P098	531600	6497087
A084	528472	6484598	P099	530442	6497080
A086	528748	6484699	P101	529705	6497245
A087	528749	6483997	P102	531854	6497219
A088	528942	6484929	P103	530680	6497240
A089	529104	6485451	P107	532020	6497604
A090	529444	6485547	P113	528603	6497818
A091	529523	6486409	P116	529793	6497961
A092	529690	6485698	P117	530762	6498021
A093	529699	6486999	P118	531914	6498144
A094	529954	6485809	P124	532544	6498333
A095	529977	6486200	P125	530082	6498319
A096	524805	6479151	P131	530298	6498647
A097	524804	6479923	P133	528708	6498730
A098	524945	6480485	P134	532446	6498773
A099	525061	6480798	P136	528853	6499056
A100	525063	6480046	P137	532149	6499142
A101	525300	6479630	P142	532351	6499357
A102	525355	6480100	P147	528643	6499477
A104	525673	6479474	P149	532347	6499786

3 LEGISLATION & GUIDELINES

The noise criteria adopted for the original Noise Impact Assessment for the Silverton Wind Farm EIS in 2008 as well as this updated assessment are based on the South Australia EPA *Noise Guidelines for Wind Farms*, 2003 (SA EPA Guidelines). The SA EPA Guidelines are still the current assessment guideline adopted in NSW.

In December 2011 NSW Department of Planning and Infrastructure released a document for consultation, the *Draft NSW Planning Guidelines – Wind Farms*, which included “*Appendix B: NSW wind farm noise guidelines*”. Whilst these guidelines currently remain in draft status, the approach and methodology undertaken in this updated assessment of Silverton Wind Farm are consistent with the requirements of the draft guidelines.

3.1 SA EPA Wind Farm Noise Guidelines

The SA EPA Guidelines recommend the following noise criteria for new wind farms,

“The predicted equivalent noise level ($L_{Aeq, 10min}$), adjusted for tonality in accordance with these guidelines, should not exceed:

- 35 dBA, or
- the background noise level by more than 5 dBA,

whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.”

The SA EPA Guidelines also provide information on measuring background noise levels and the requirements for the number of valid data points to be obtained and the methodology for excluding invalid data points. It also outlines the process for determining lines of best fit for the background data and determination of the noise limit.

The SA EPA Guideline explicitly states that the “swish” or normal modulation noise from wind turbines is a fundamental characteristic of such turbines; however, it specifies that tonal or annoying characteristics of turbine noise should be penalised.

A 5 dBA penalty should be applied to the measured noise level if an “authorised” officer determines that tonality is an issue and that tonality should be assessed in a way acceptable to the EPA.

The Guideline does not provide an assessment for the potential of low frequency noise or infrasound, but it does state that recent turbine designs do not appear to generate significant levels of infrasound, as the earlier turbine models did.

The SA EPA Guideline accepts that wind farm developers commonly enter into agreements with private landowners in which they are provided compensation. The guideline is intended to be applied to premises that do not have an agreement with the wind farm developer. This does not absolve the obligations of the wind farm developer entirely as appropriate action can be taken under the *Environmental Protection Act* if a development ‘unreasonably interferes’ with the amenity of an area. The guideline lists that there is unlikely to be unreasonable interference if:

- a formal agreement is documented between the parties
- the agreement clearly outlines to the landowner the expected impact of the noise from the wind farm and its effect on the landowner’s amenity
- the likely impact of exposure will not result in adverse health impacts (e.g. the level does not result in sleep disturbance)

A noise agreement would only be required under those turbine configurations where the SA EPA Guidelines would be exceeded for that particular property.

3.2 World Health Organisation (WHO) Guidelines

Where noise levels at project-involved residences do not comply with the SA EPA Guidelines, the proponent intends to enter into agreements with the owners of those residences to achieve noise criteria in accordance with World Health Organisation (WHO) Guidelines. The proponent will apply those guidelines as necessary to ensure that the project does not result in an 'unreasonable interference' with the amenity or cause any adverse health effects at those residences. (See **Section 3.1**)

The WHO publication '*Guidelines for Community Noise*' identifies the main health risks associated with noise and derives acceptable environmental noise limits for various activities and environments.

The appropriate guideline limits are listed in **Table 3** below.

Table 3 WHO Guideline values for environmental noise in specific environments

Specific Environment	Critical Health Effect(s)	L _{eq} (dBA)	Time base (hours)	L _{Max} (dBA, Fast)
Outdoor living area	Serious Annoyance, daytime & evening	55	16	-
	Moderate annoyance, daytime & evening	50	16	-
Dwelling indoors	Speech Intelligibility & moderate annoyance, daytime & evening	35	16	
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance – window open, night-time	45	8	60

For the assessment of project involved residences the adopted external criteria of 45 dBA or the level given by the SA EPA Guideline criteria, where higher, will be adopted. Effectively this becomes 45 dBA or background + 5 dBA, whichever is the higher.

4 BACKGROUND NOISE LEVELS

In the original Noise Impact Assessment for the Silverton Wind Farm EA background noise monitoring for the three baseline sites was conducted for a period of approximately 2 weeks in November - December 2007. The noise data was statistically correlated to a wind speed value at 10 metres above ground.

A more comprehensive background noise monitoring campaign was completed in May-June 2016 at seven locations (which include the original three locations) for a period of 4 weeks each, with the noise data being statistically correlated to a wind speed value at hub height.

4.1 Monitoring locations - 2016

Noise monitoring was completed at seven locations which are representative of the nearest receptors to the Silverton Wind Farm. The monitoring sites are shown in **Figure 1** and are described in **Table 4**.

Table 4 Monitoring locations

BG ID	Receptor ID	Location	Description
BG1	SL34	Purnamoota Station	Project involved landholder residence located to the north-east of the project.
BG2		Daydream Mine	Historic mine tourist attraction, non-residential, although frequented by the public.
BG3	S24a	Penrose Park N	Penrose Park is a Caravan / Camping park located on north side of Silverton township. This location is at the northern side of Penrose Park and is intended as being indicative of the noise conditions experienced at residential properties on the northern fringe of Silverton township.
BG4	S24b	Penrose Park S	Penrose Park is a Caravan / Camping park located on north side of Silverton township. This location is at the southern side of Penrose Park and is intended as being indicative of the noise conditions experienced in the Silverton township. This location was monitored in 2007 for the original EA.
BG5	SL9	Belmont Station	Project involved landholder residence located to the south of the project.
BG6	SL6	Umberumberka	Caretaker residence to Umberumberka Reservoir located to the south-west of the project. This location was monitored in 2007 for the original EA.
BG7	SL2	Eldee Station	Project involved landholder residence located to the north-west of the project. This location was monitored in 2007 for the original EA.

Refer to **Appendix A** for the precise location of noise monitoring equipment recorded by GPS, with photographs of their position taken from each compass direction, equipment details and serial numbers etc.

The SA EPA Guidelines recommend that the measurement locations should be located at least 5 metres from a reflecting surface (other than the ground) and within 20 metres of a residence. Careful consideration was given to avoiding undue influence from extraneous local noise sources and monitoring equipment was typically placed on side of the receptor that will be closest to WTGs.

A local weather station was deployed at each receptor monitoring site with key meteorological indices being recorded at approximately microphone height to assist in the screening of valid data e.g. removing data potentially affected by rainfall or excessive wind speed on the microphone windsock. Any periods of data that were clearly affected by extraneous noise sources (eg pumps, insects, birds, frogs etc) were removed from the analysis data set.

Simultaneous to the baseline noise monitoring the wind speed was monitored at wind masts throughout the proposed site. For data correlation purposes the wind speed for a given background monitoring location was allocated to the wind mast operating nearest to that location, such that it would be indicative of the wind speed at future WTGs closest to that receptor.

Table 5 Wind mast details

Wind Mast	height	Easting	Northing	Nearest Background Locations
SIL04	80m	532304	6499143	Purnamoota Station, Daydream Mine, Eldee Station
SIL07	70m	525014	6475303	Umberumberka, Belmont Station, Silverton

The noise monitoring data is presented as a time history (2 days per graph) for each monitoring location in **Appendix D** and includes L₁₀, L_{eq}, and L₉₀ noise indices as well as the derived hub height wind speed. The graphs also show the periods when data was excluded from the regression data sets.

The valid background noise monitoring data was statistically regressed against the derived hub height wind speed for the relevant wind mast for each receptor. The details including the total number of monitoring intervals and valid data points as well as the resulting scatter graphs and regression curves are included in **Appendix A** for each monitoring location.

Table 6 shows the background noise at each monitoring location, regressed to a third order polynomial function. Regressions were completed for an “all day” data set and a “night-time only” (22:00 to 7:00) data set.

Table 6 Background noise regression equations

BG ID	Receptor ID	Representative of Locations	Night-time only Background Noise Equation	All day Background Noise Equation
BG1		Purnamoota Station SL34	$y = -0.0034x^3 + 0.1116x^2 - 0.4893x + 23.754$ $R^2 = 0.0803$	$y = -0.0013x^3 + 0.0362x^2 - 0.0633x + 31.996$ $R^2 = 0.0068$
BG2		Daydream Mine SL10	$y = -0.0029x^3 + 0.056x^2 + 0.8134x + 19.734$ $R^2 = 0.0886$	$y = 0.0351x^3 - 0.8824x^2 + 7.2253x + 13.639$ $R^2 = 0.0902$
BG3		Silverton township – north S24a, S22, S21, S20, S19, S27	$y = 0.0057x^3 + 0.1112x^2 - 2.1343x + 29.363$ $R^2 = 0.3098$	$y = 0.0165x^3 - 0.2431x^2 + 1.007x + 27.491$ $R^2 = 0.235$
BG4	S24b	Silverton township S24b, S10, S11, S14, S15, S16, S17, S18, S25a, S25b, S28, S29	$y = -0.0138x^3 + 0.6094x^2 - 6.2532x + 46.65$ $R^2 = 0.1385$	$y = 0.0157x^3 - 0.2252x^2 + 0.5004x + 38.792$ $R^2 = 0.1047$
BG5	SL9	Belmont Station SL9	$y = -0.0104x^3 + 0.4675x^2 - 3.7784x + 26.316$ $R^2 = 0.4742$	$y = 0.0049x^3 + 0.0304x^2 - 0.1579x + 22.307$ $R^2 = 0.386$
BG6	SL6	Umberumberka SL6	$y = -0.0045x^3 + 0.0745x^2 + 1.631x + 16.363$ $R^2 = 0.3272$	$y = 0.0099x^3 - 0.2051x^2 + 2.277x + 26.124$ $R^2 = 0.1696$
BG7	SL2	Eldee Station SL2	$y = -0.0148x^3 + 0.4849x^2 - 4.2764x + 46.423$ $R^2 = 0.0535$	$y = 0.0007x^3 + 0.0307x^2 - 0.3569x + 41.894$ $R^2 = 0.0267$

Noise limits were for each monitoring site were established for the “all day” data set in accordance with the SA EPA Guideline. A night target was also produced for indicative purposes only in accordance with the Draft NSW Guideline.

5 NOISE ASSESSMENT

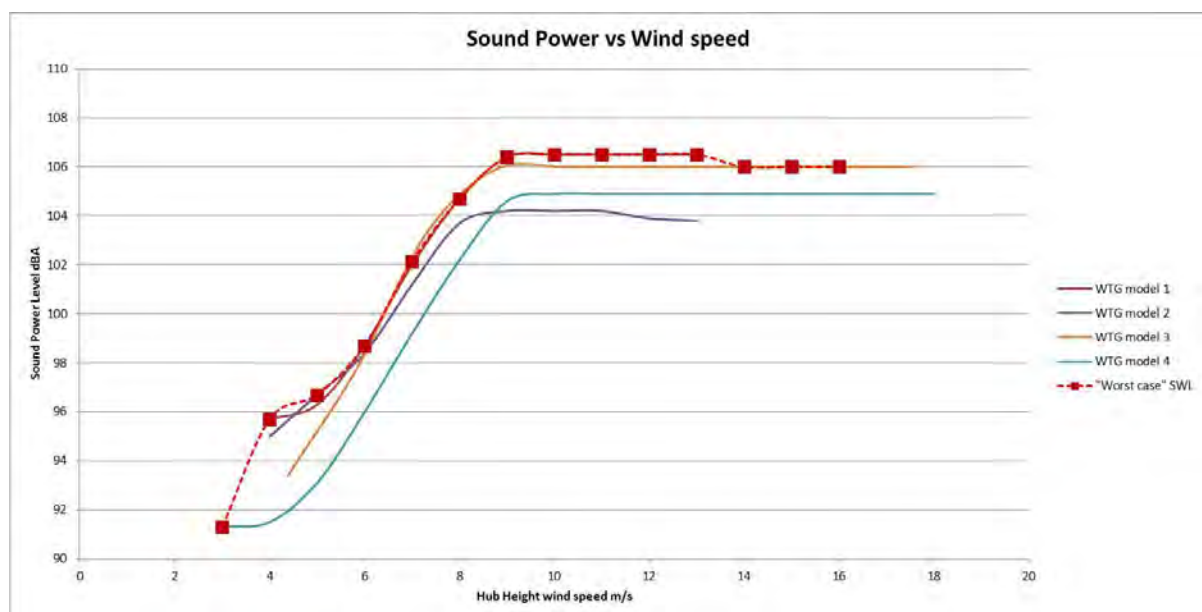
5.1 Model Inputs

The Silverton Wind Farm Project is currently undertaking a competitive EPC process which has not been concluded. Accordingly there are a number of different manufacturers and WTG models currently being considered for the project and in order to not preferentially consider one model over another a worst case WTG noise profile was developed.

Noise emissions for the WTG's being considered have been determined or estimated by the manufacturers from measurements conducted in accordance with International Standard IEC 61400-11.

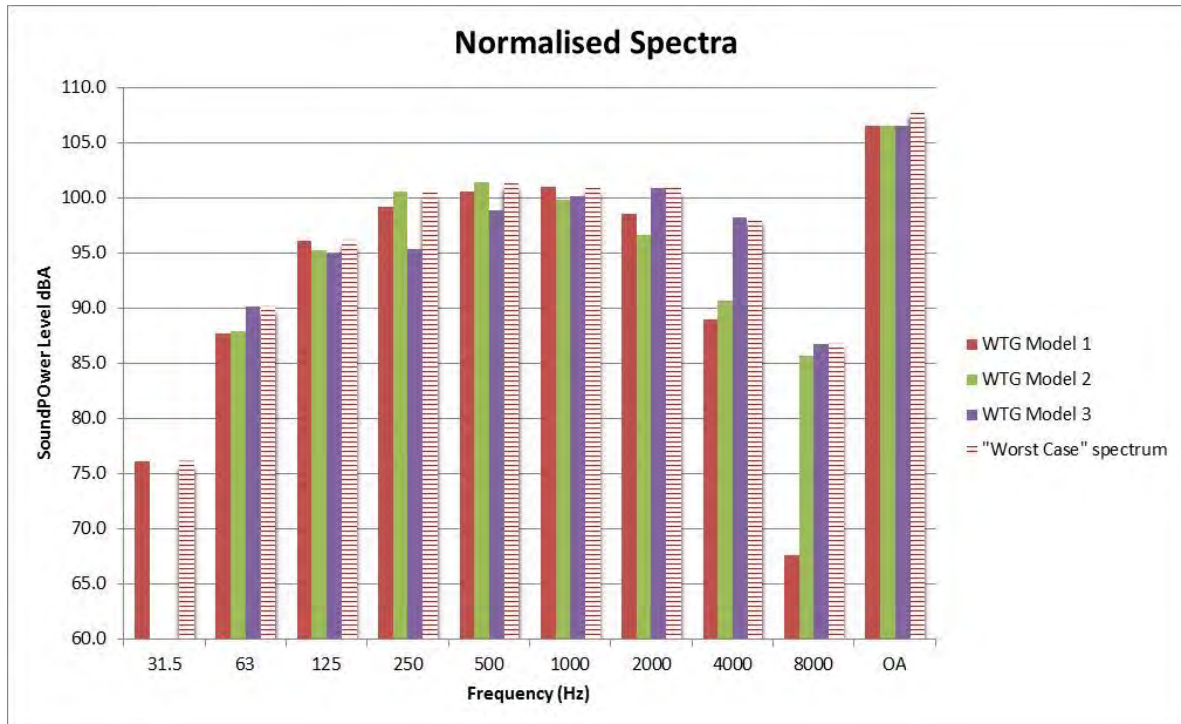
The worst case noise profile was developed through a process where the provided Sound Power levels for four WTG models were normalised against a hub height wind speed. The highest A-weighted sound power level of all available data at each integer wind speed was selected. The resulting profile is a hybrid that represents the highest possible value across the wind speed range, refer to **Figure 2**.

Figure 2 Worst case noise profile



A worst case frequency spectrum was also derived, whereby for the four WTG models where a spectrum was available the spectrum was normalised to highest value of the worst case noise profile (106.5 dBA). The highest octave band frequency level for all WTG's was selected, with the resulting worst case spectrum having an overall sound power level of 108 dBA, which is to say that the worst case spectrum results in a sound power level approximately 1.5 dBA higher than the loudest WTG being considered. Refer to **Figure 3**.

Figure 3 Worst case frequency spectrum



The above provides a significantly conservative approach which we anticipate would result in noise levels approximately 2 dBA to 4 dBA higher than what would have resulted were specific WTG models modelled as opposed to a worst case noise profile and worst case spectrum. Notwithstanding the above, if the worst case approach undertaken is shown to comply then it can be safely assumed that any of the WTGs being considered would comply by a more significant margin.

The hub height of the proposed modification to Silverton Wind Farm will be higher than that assumed previously for the approved project, however, it is not yet finalised as the tender bids being considered provide differing rotor diameter and tower combinations. For the purposes of the assessment being undertaken a hub height of 110 metres above ground level has been adopted.

It is anticipated should this modification to the Silverton Wind Farm be granted approval and a successful tenderer be selected a Revised Noise Impact Assessment for the final layout and WTG model will be undertaken and submitted.

5.2 Assessment of Tonality and Infrasound

A part of IEC 61400-11 noise testing is to conduct an assessment of the audibility of any tones present.

The tonal audibility is assessed using the methodology outlined in *Joint Nordic Method Version 2 – Objective Method for Assessing the Audibility of Tones in Noise (JNM2)*. It should be noted that JNM2 imposes a sliding scale tonality penalty commencing when the tonal audibility $\Delta L_{A,k} > 4$ dB, and reaches the maximum allowable penalty of +6 dB when the tonal audibility $\Delta L_{A,k} > 10$ dB. The absence of any audible tones when tested in the near field as per IEC 61400-11 requirements, ensures that no audible tones will be experienced in the far field at receptors.

Of the four WTG manufacturers that have supplied tonal audibility $\Delta L_{A,k}$ values or statements there is no evidence of any tones present of sufficient magnitude to justify a penalty.

Infrasound is not tested as an obligatory part of IEC 61400-11. It is noted that, in general, modern WTG's do not exhibit significant infrasound emissions.

5.3 Noise Model Predictions

The ISO 9613 noise model incorporates a 'hard ground' assumption and includes one-third octave band calculated effects for air absorption, ground attenuation and topographic shielding. It is noted that ISO 9613 equations predict for average downwind propagation conditions and also hold for average propagation under a well-developed moderate ground-based temperature inversion.

The estimated accuracy of the prediction model is approximately ± 3 dBA.

For indicative purposes the WTG noise levels from the proposed modification and worst case noise profile WTG was calculated for the reference wind condition of 8 m/s at 10 m AGL and listed in **Table 7**. A copy of the assessment graphs for the worst case noise profile WTG over the range of wind speeds are presented in **Appendix B**. The predicted noise contour plot is presented in **Appendix C**.

Table 7 Predicted WTG Noise Levels

ID	Receptor	dBA Leq
S10	Silverton, Willangee Rd	30.3
S11	Silverton, Thackaringa St	29.9
S12	Silverton, Layard St	29.9
S14	Silverton, Silverton Rd	30.8
S15	Silverton, Burke St	30.5
S16	Silverton, Burke St	30.6
S17	Silverton, Layard St	30.9
S18	Silverton, Burke St	30.9
S19	Silverton, Gipps St	30.8
S20	Silverton, unnamed road	31.4
S21	Silverton, unnamed road	31.7
S22	Silverton, unnamed road	31.9
S24a	Silverton, Penrose Park 1	32.1
S24b	Silverton, Penrose Park 2	30.9
S25	Silverton, Burke St	30.9
S25	Silverton, Loftus	30.6
S27	Silverton, unnamed road	31.4
S28	Silverton, Silverton Rd	30.8
S29	Silverton, Silverton Rd	30
SL2	Eldee Station	31.7
SL3	Purnamoota Station	25.9
SL5	Limestone Station	12.3
SL6	Umberumberka	41.6
SL9	Belmont Station	35.3
SL10	Daydream Mine	31.2

5.4 Noise Assessment

All receptor locations are predicted to be below the minimum 35 dBA limit with the exception of Receptor SL6 and SL9.

Review of the noise assessment graphs presented in **Appendix B**, which considers the full range of wind speeds and the influence of ambient background noise masking, shows that predicted worst case profile WTG noise levels comply with the SA EPA Guideline criteria for all wind speeds at both receptor SL6 and SL9. Therefore, the SA EPA Guideline criteria are complied with at all surrounding receptors.

As discussed previously, the worst case WTG noise profile and frequency spectrum modelling approach is anticipated to be between 2 dBA and 4 dBA higher in noise level when compared to what would have resulted were any specific WTG modelled. Therefore, it can be assumed that any of the WTGs being considered would comply by a more significant margin than indicated in this worst case noise profile assessment.

Notwithstanding the above, it is anticipated that a Revised Noise Impact Assessment for the final WTG selection and layout will be undertaken and submitted prior to construction.

6 CONCLUSION

SLR has conducted a noise impact assessment of the proposed modification to Silverton Wind Farm.

Computer noise modelling using the standard ISO9613 algorithm was completed for a worst case noise profile based on data received for up to four alternative WTG models being considered. It should be noted that the worst case noise profile approach is likely to be conservative and we would anticipate that any of the WTGs being considered would likely result in lower noise (estimated 2-4 dBA) than that indicated in this assessment.

The noise assessment for the worst case noise profile shows that the SA EPA Guideline criteria are complied with at all surrounding receptors.

Appendix A Background Noise Monitoring

Noise Logger Summary

Site Address: Purnamoota Station 54J 537085 mE 6492410 mS
Measurement period: 3 May to 14 June 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3004637

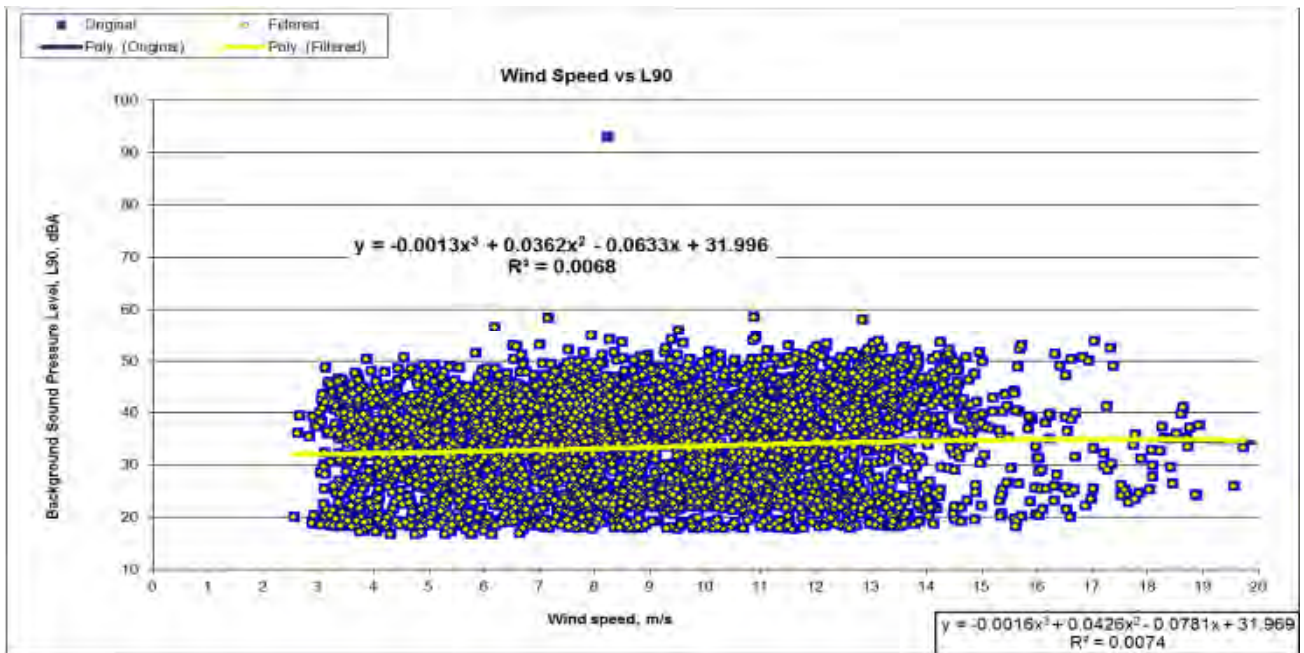
Logger Location Map (not to scale)



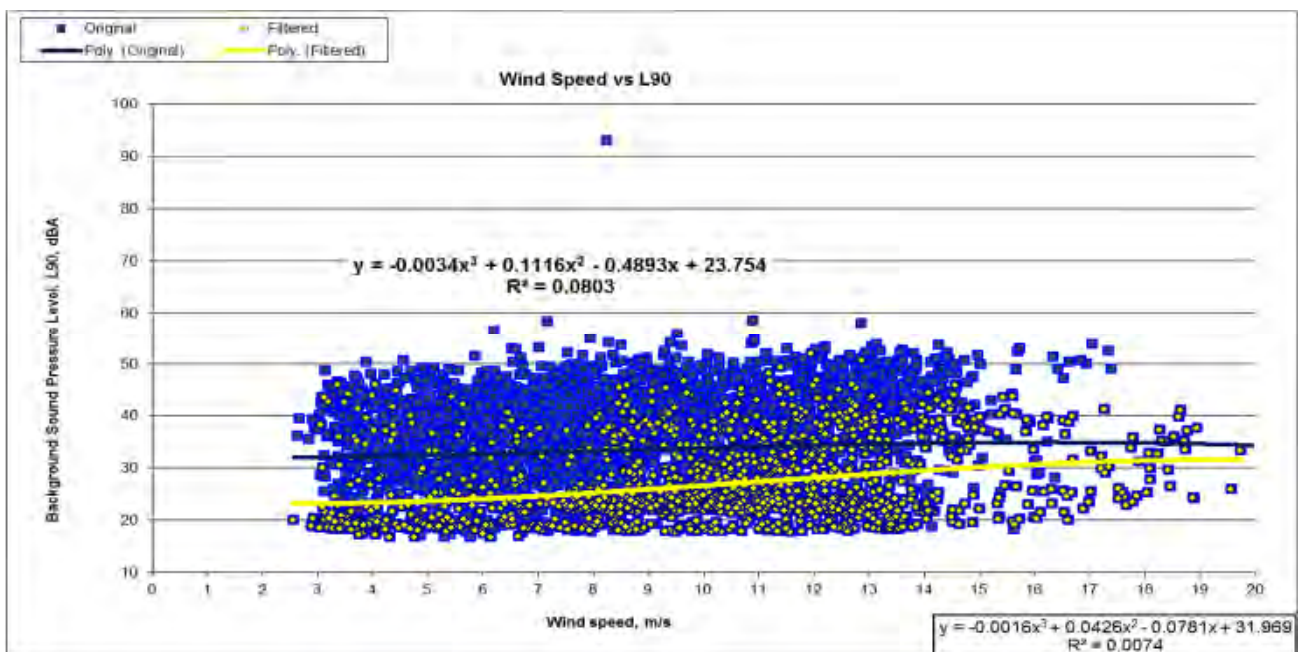
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring intervals all day	4546
Valid all-day samples	4199
Number of monitoring intervals night	2230
Valid night samples	1559

Noise Logger Summary

Site Address: Daydream Mine 54J 533196 mE 6480245 mS
Measurement period: 3 to 31 May 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3003632

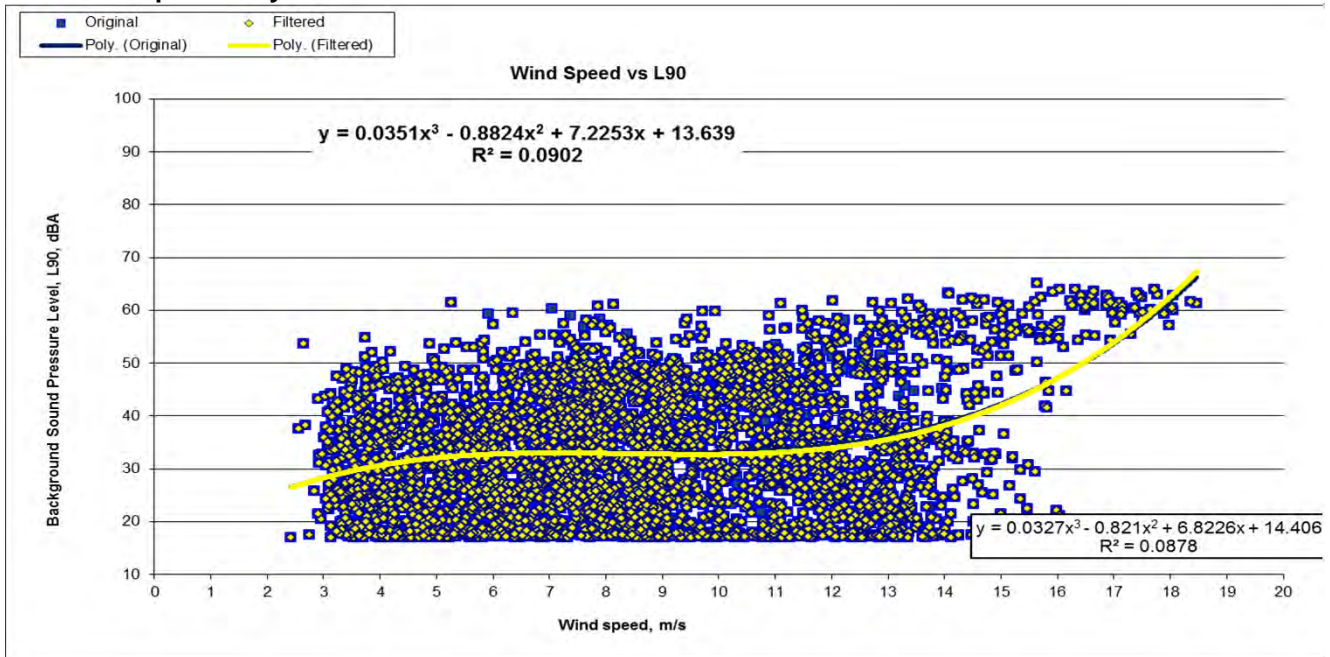
Logger Location Map (not to scale)



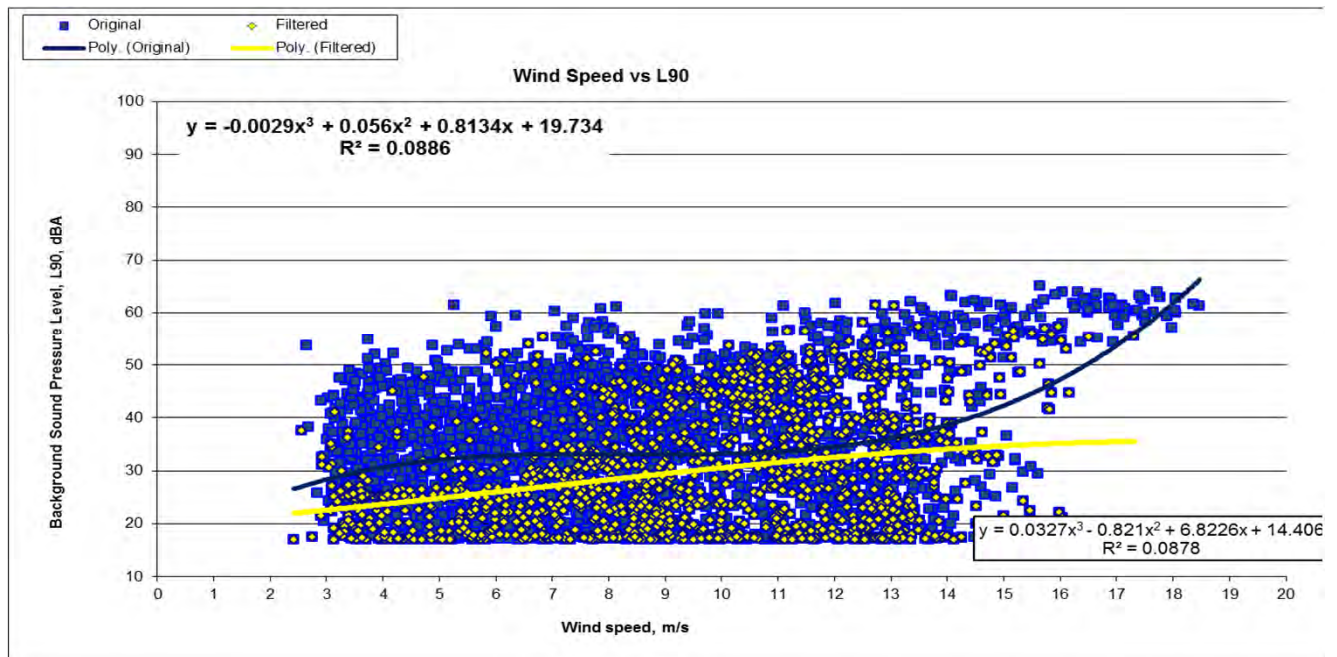
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring samples all-day	4296
Valid all-day samples	3862
Number of monitoring samples night	2080
Valid night samples	1455

Noise Logger Summary

Site Address: Penrose Park North 54J 521730 mE 6472943 mS
Measurement period: 3 31 May 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3004635

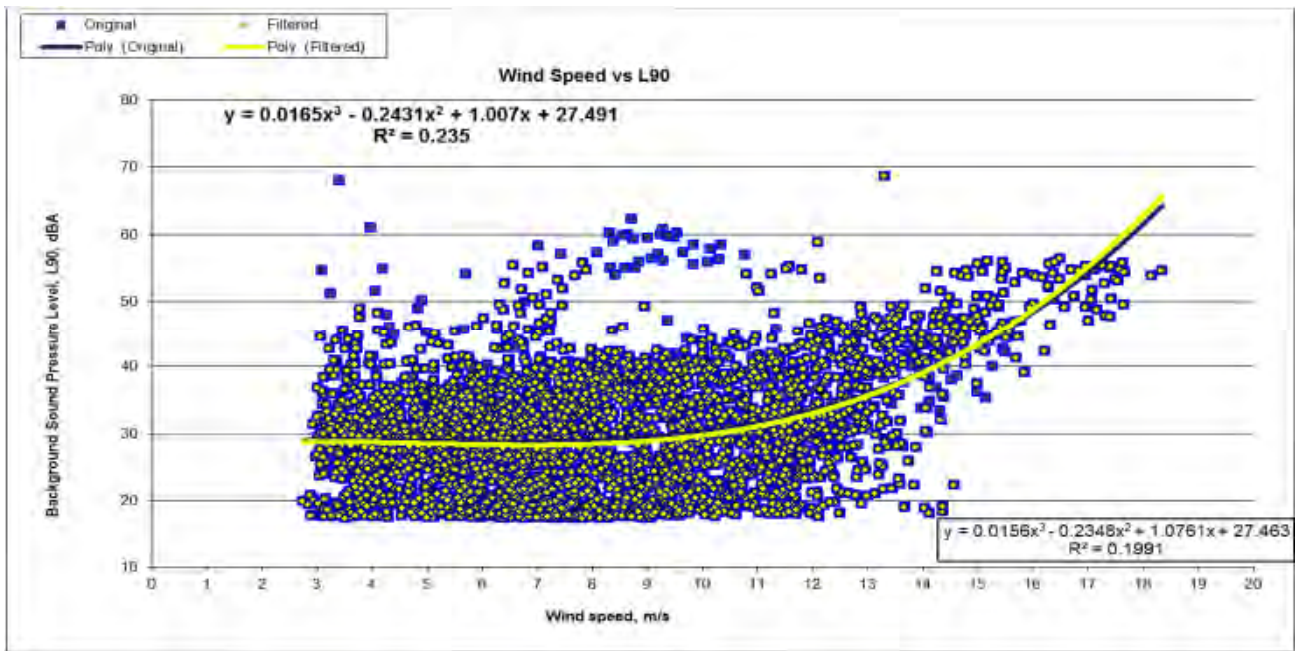
Logger Location Map (not to scale)



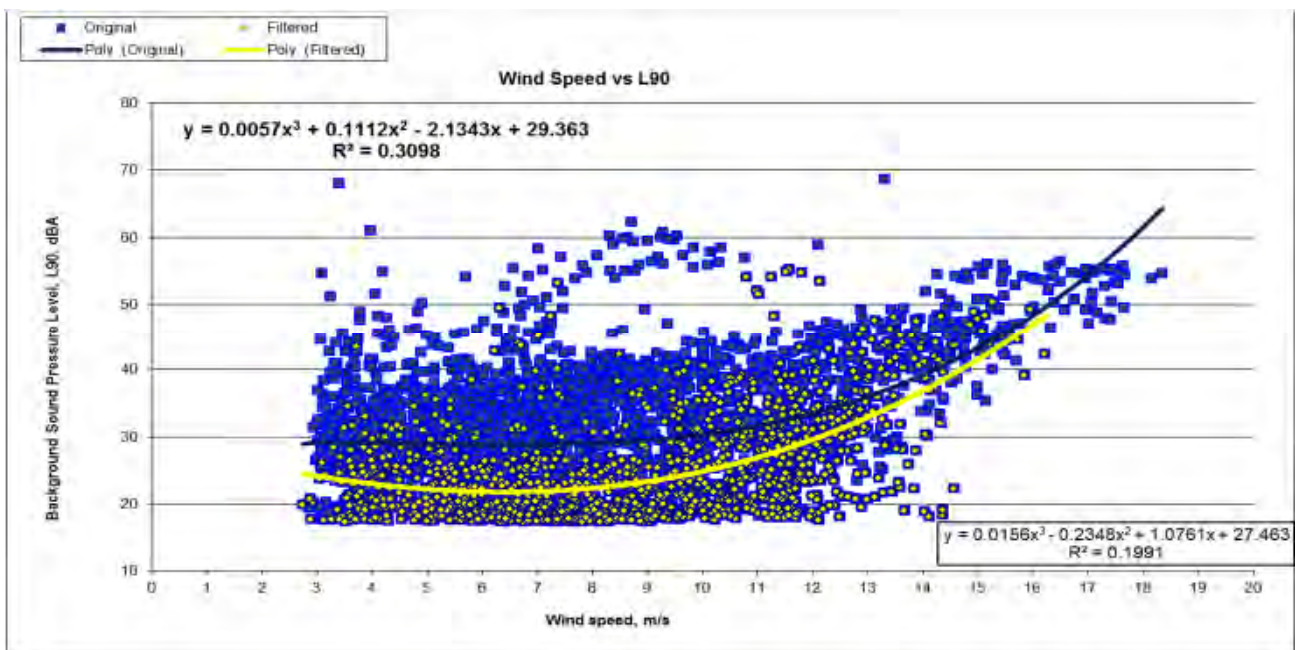
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring samples all-day
 Valid all-day samples
 Number of monitoring samples night
 Valid night samples

4015
 3467
 1937
 1372

Noise Logger Summary

Site Address: Penrose Park South 54J 521705 mE 6472469 mS
Measurement period: 3 to 31 May 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3004632

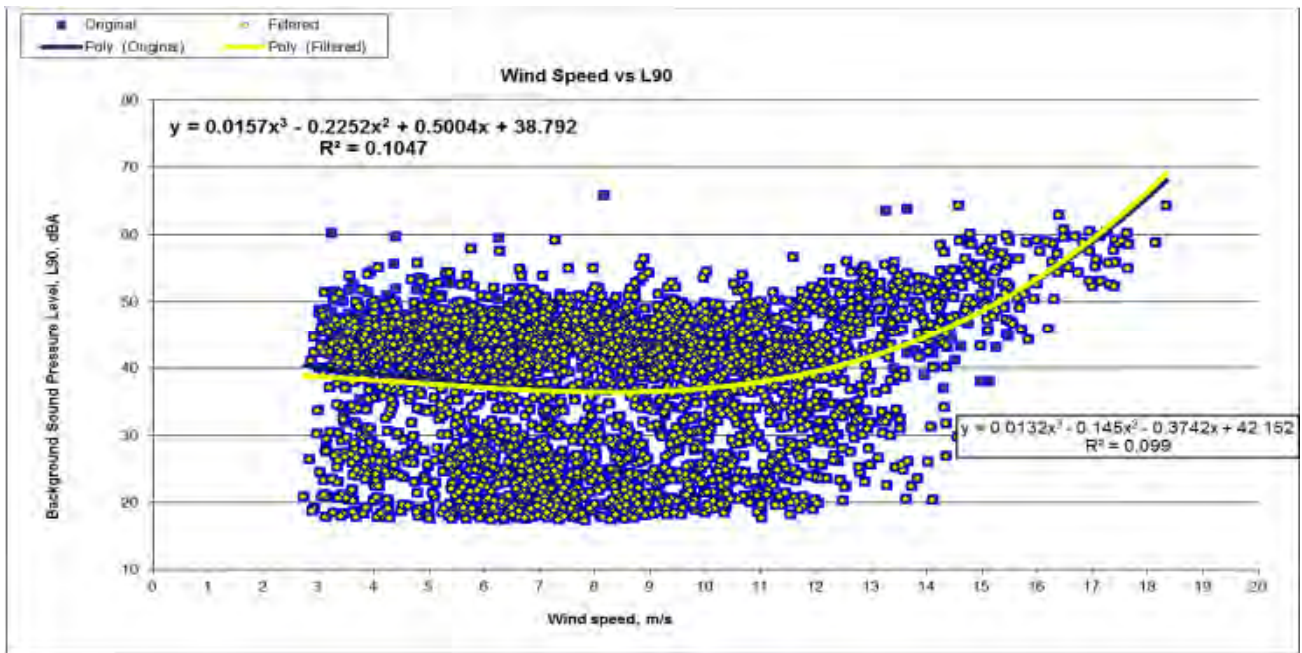
Logger Location Map (not to scale)



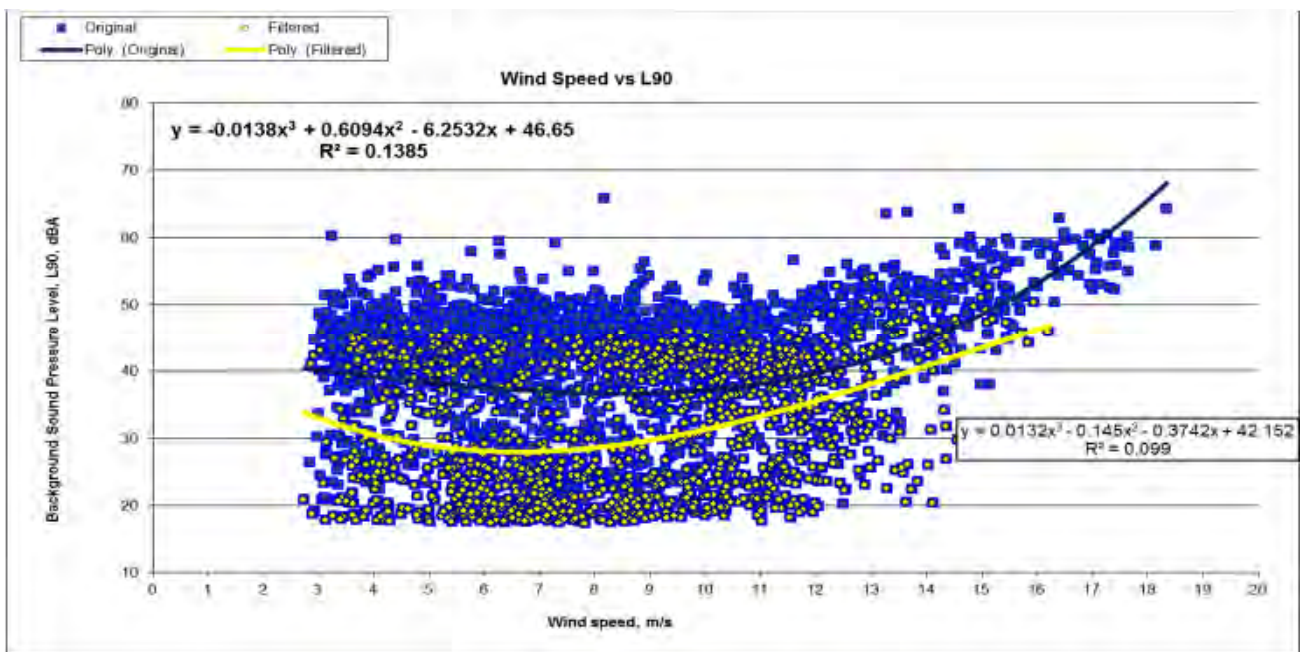
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring samples all-day
 Valid all-day samples
 Number of monitoring samples night
 Valid night samples

4005
 3406
 1974
 1368

Noise Logger Summary

Site Address: Belmont Station 54J 521783 mE 6475209 mS
Measurement period: 3 to 31 May 2016
Microphone position: 1.5 m above roundabout, free field
Logger Serial No.: 3004638

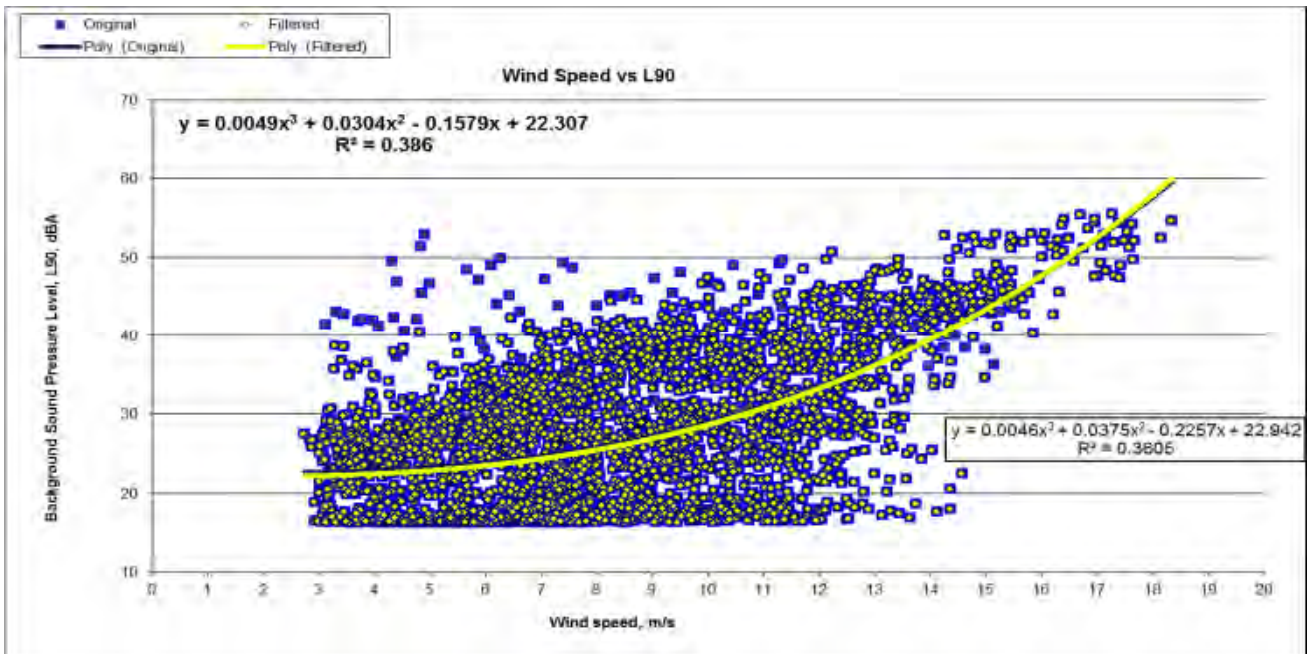
Logger Location Map (not to scale)



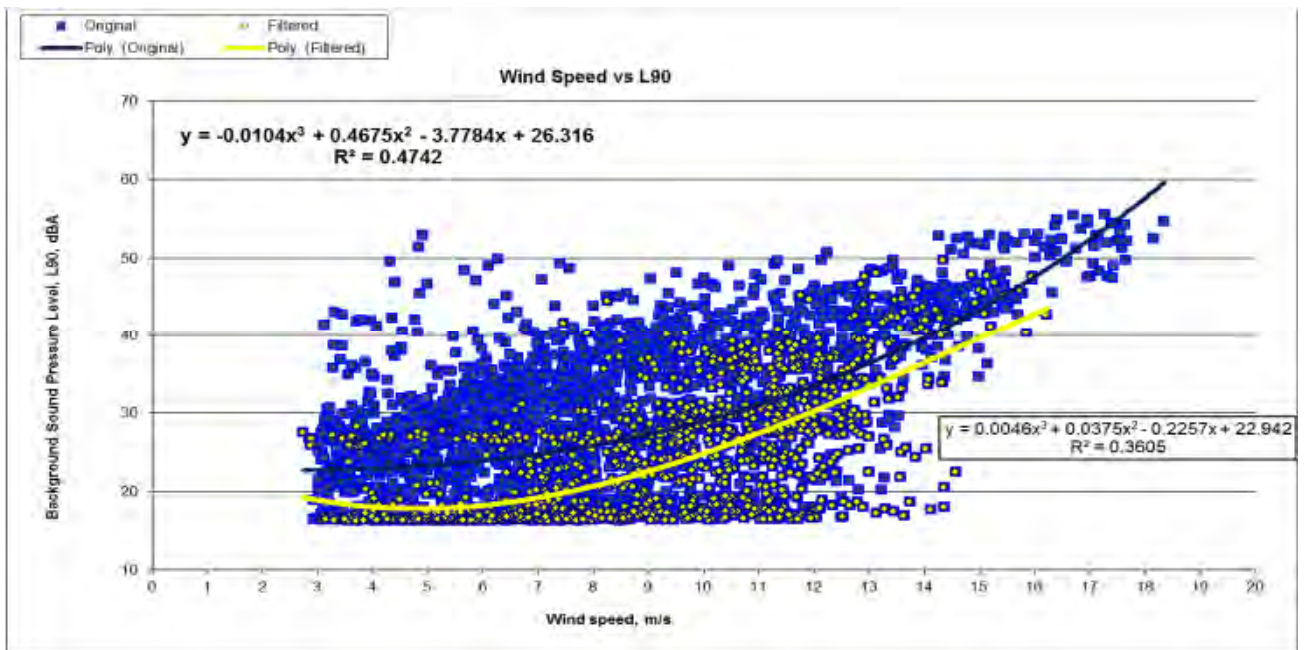
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring samples all-day
Valid all-day samples
Number of monitoring samples night
Valid night samples

4018
3498
1920
1379

Noise Logger Summary

Site Address: Umberumerka Reservoir 54J 519721 mE 6479947 mS
Measurement period: 3 to 31 May 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3004710

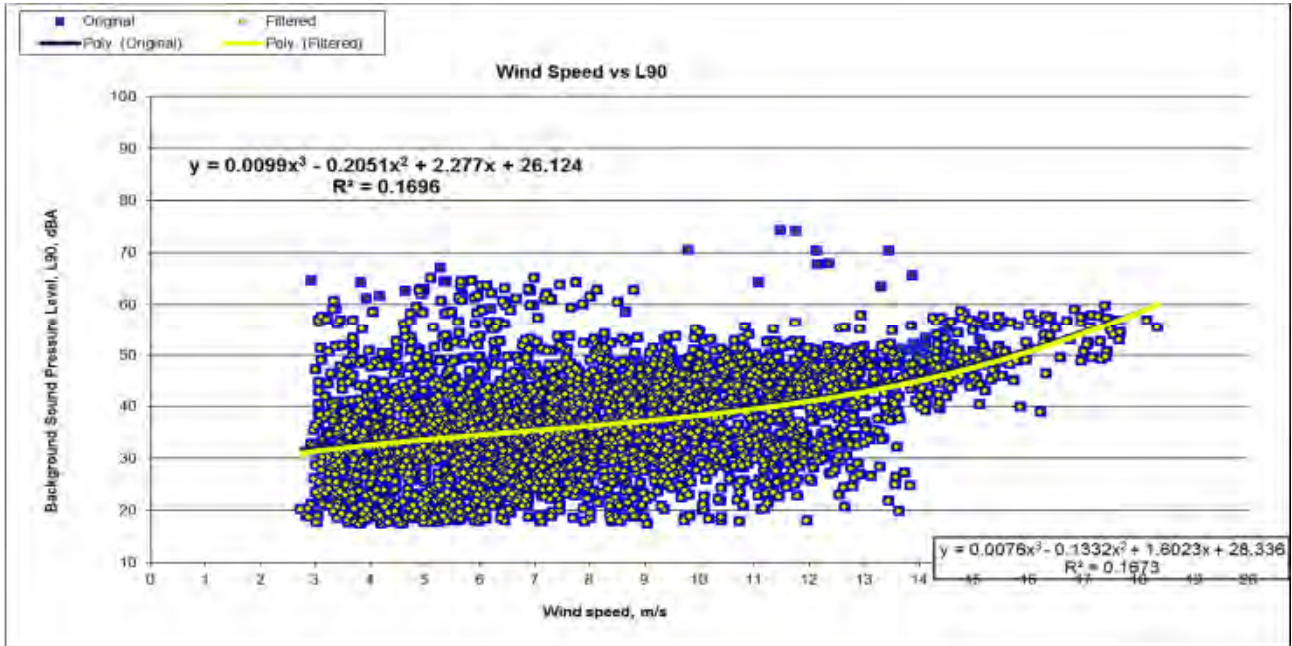
Logger Location Map (not to scale)



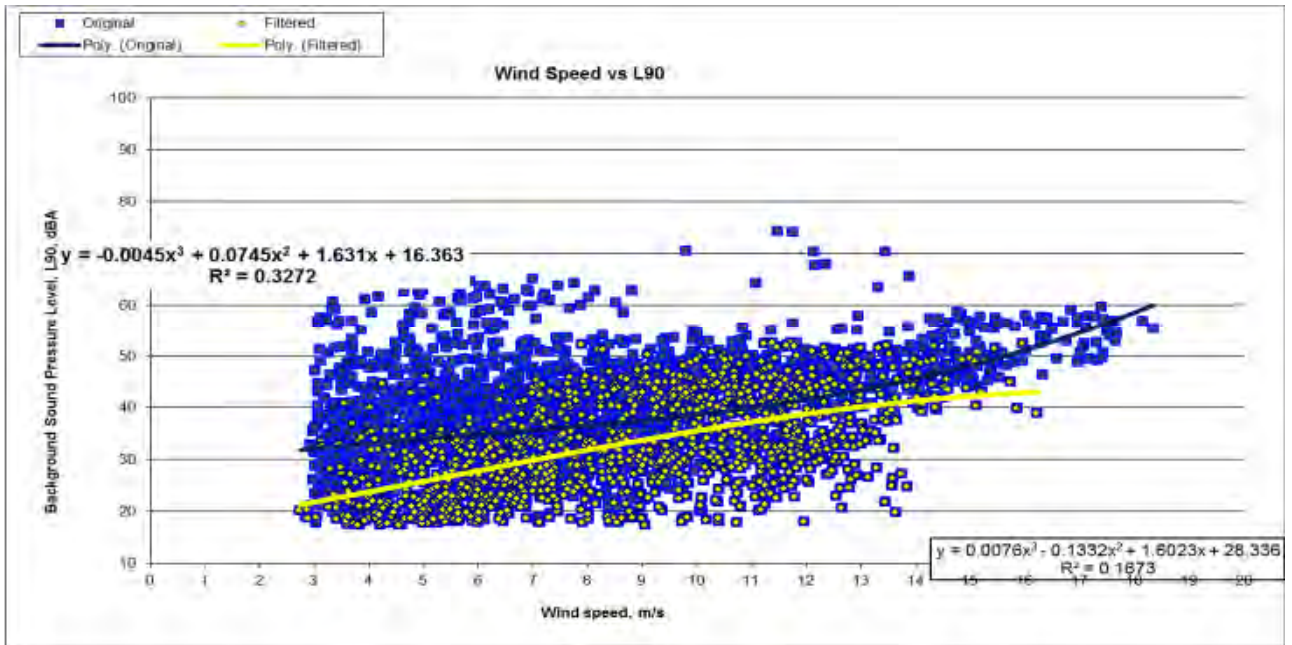
Logger In Situ N,E,S,W



Scatter Graph All Day



Scatter Graph Night



Number of monitoring samples all-day	3923
Valid all-day samples	3394
Number of monitoring samples night	1857
Valid night samples	1328

Noise Logger Summary

Site Address: Eldee Station 54J 524638 mE 649130 mS
Measurement period: 3 to 31 May 2016
Microphone position: 1.5 m above ground, free field
Logger Serial No.: 3004636

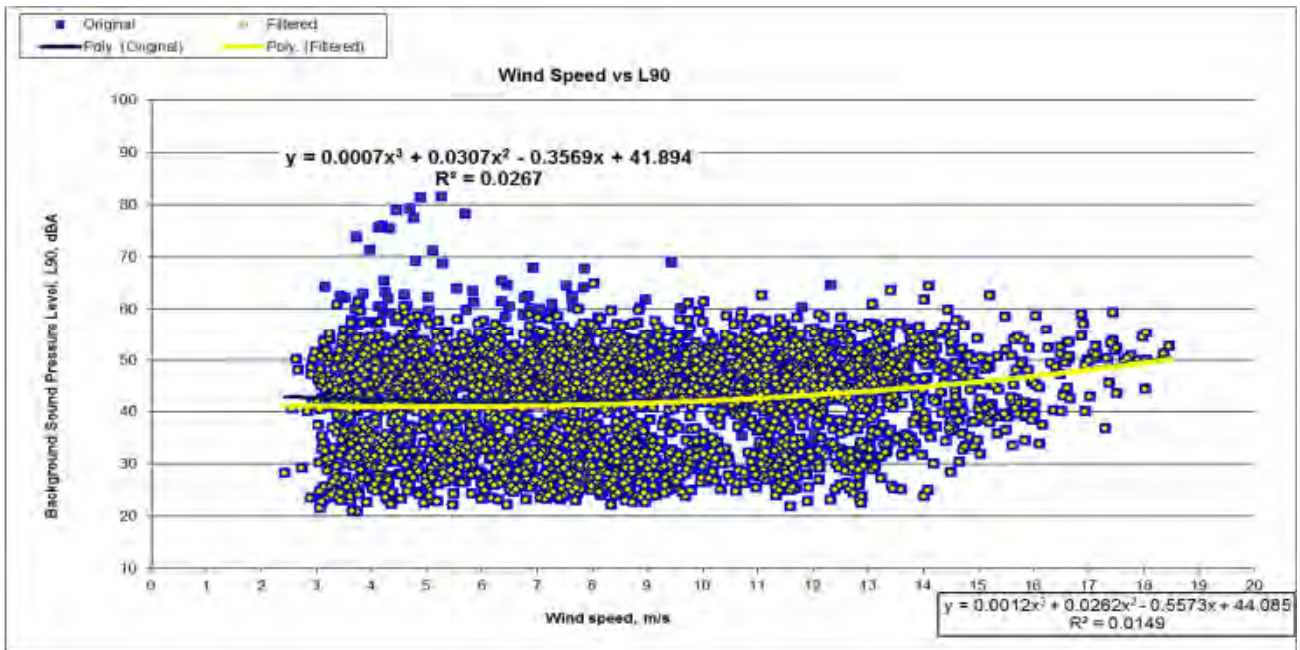
Logger Location Map (not to scale)



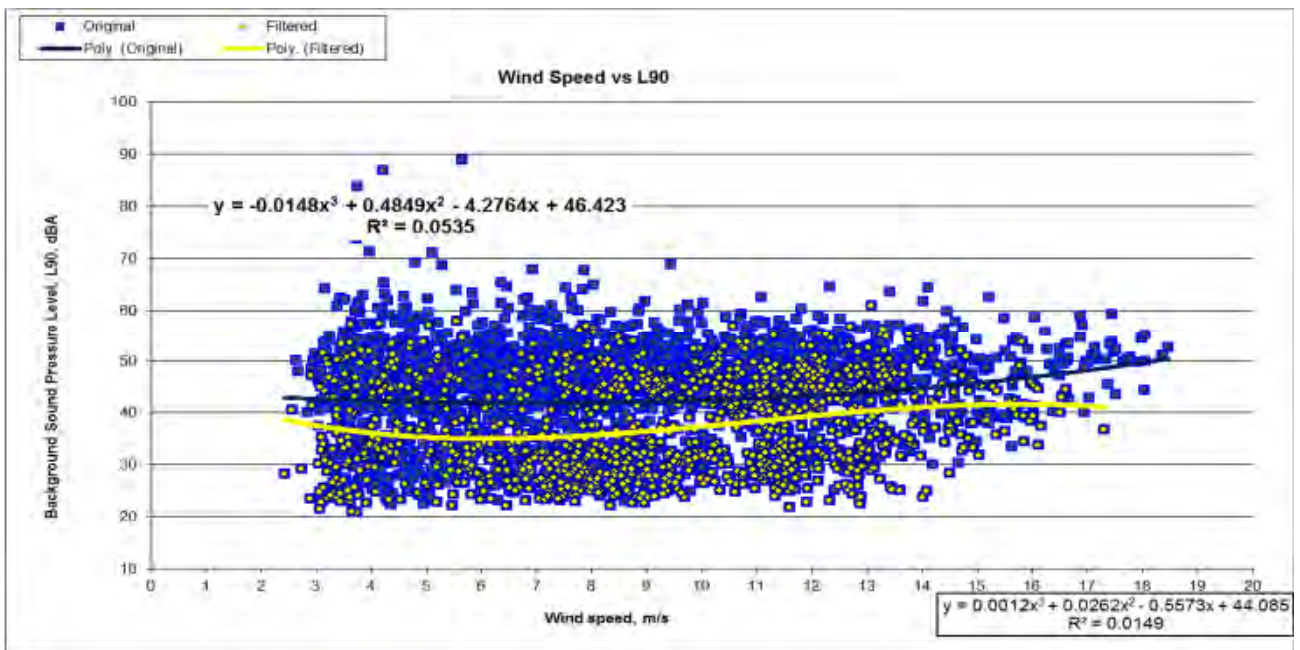
Logger In Situ N,E,S,W



Scatter Graph All Day

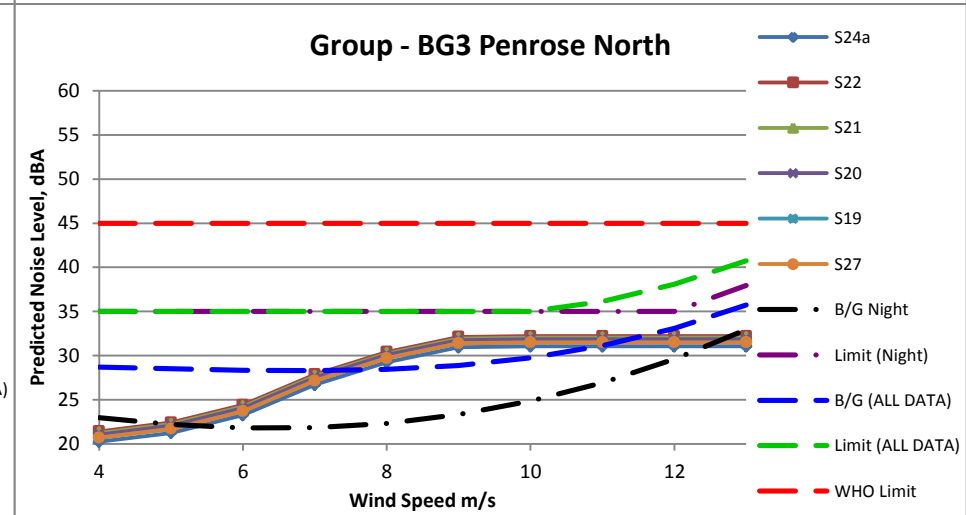
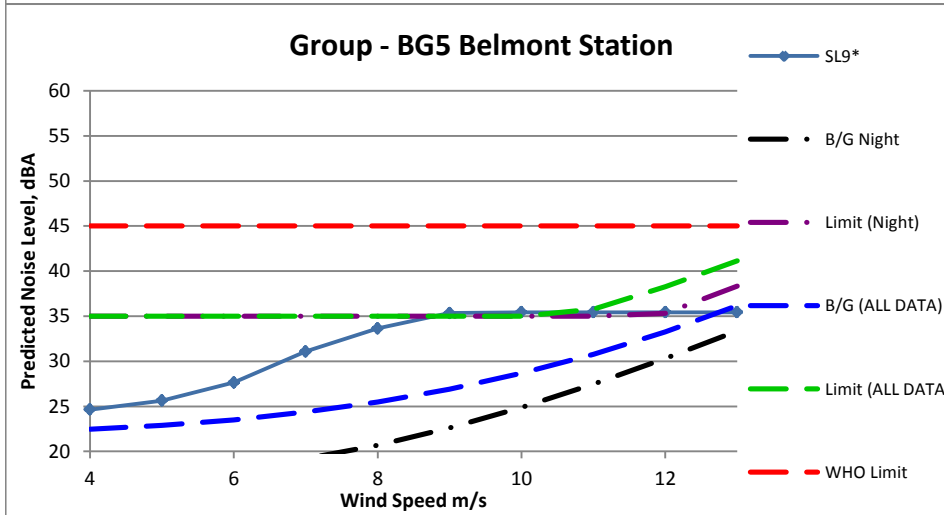
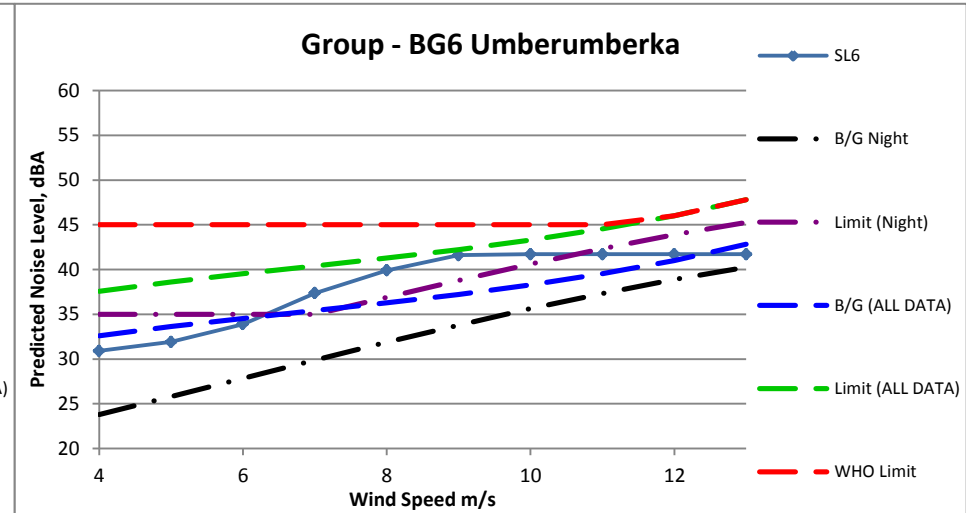
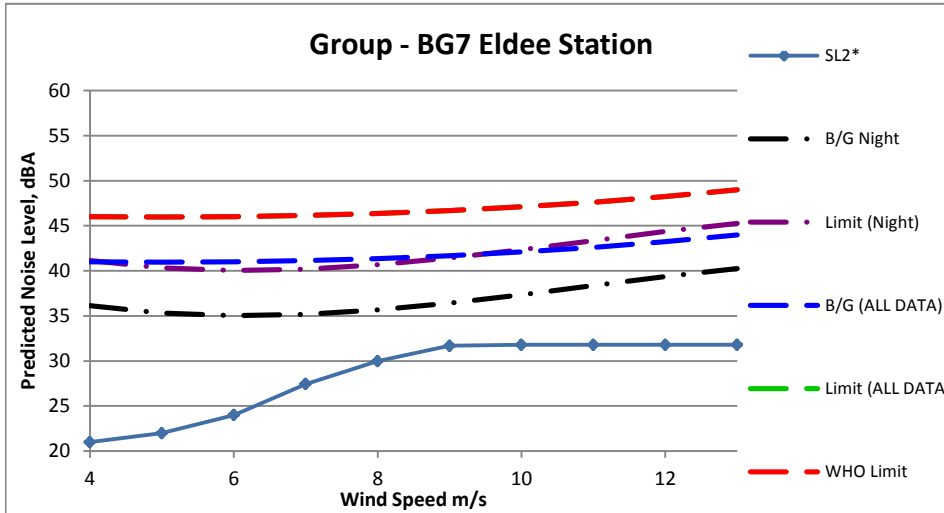


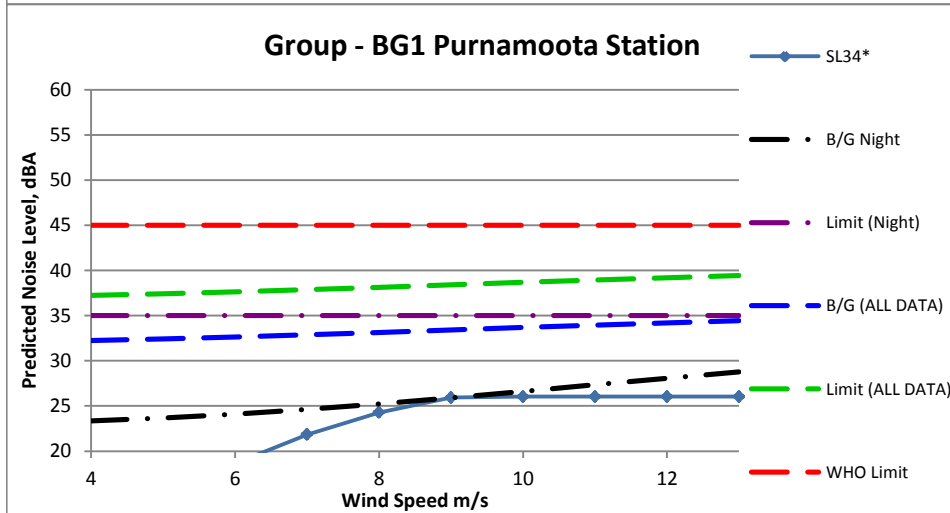
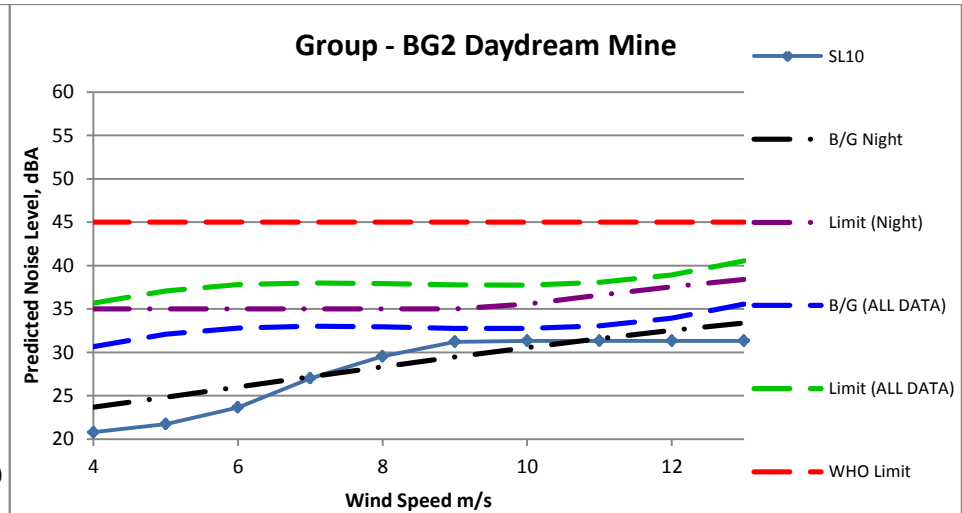
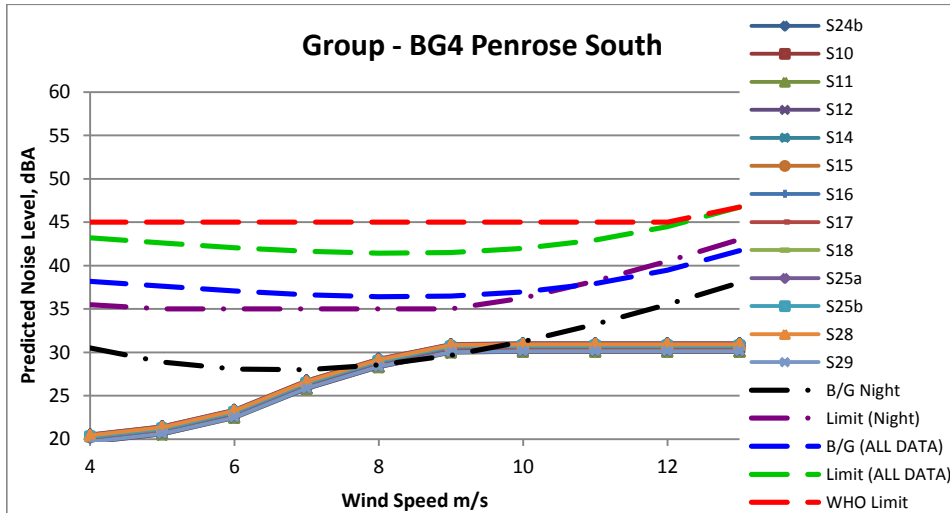
Scatter Graph Night



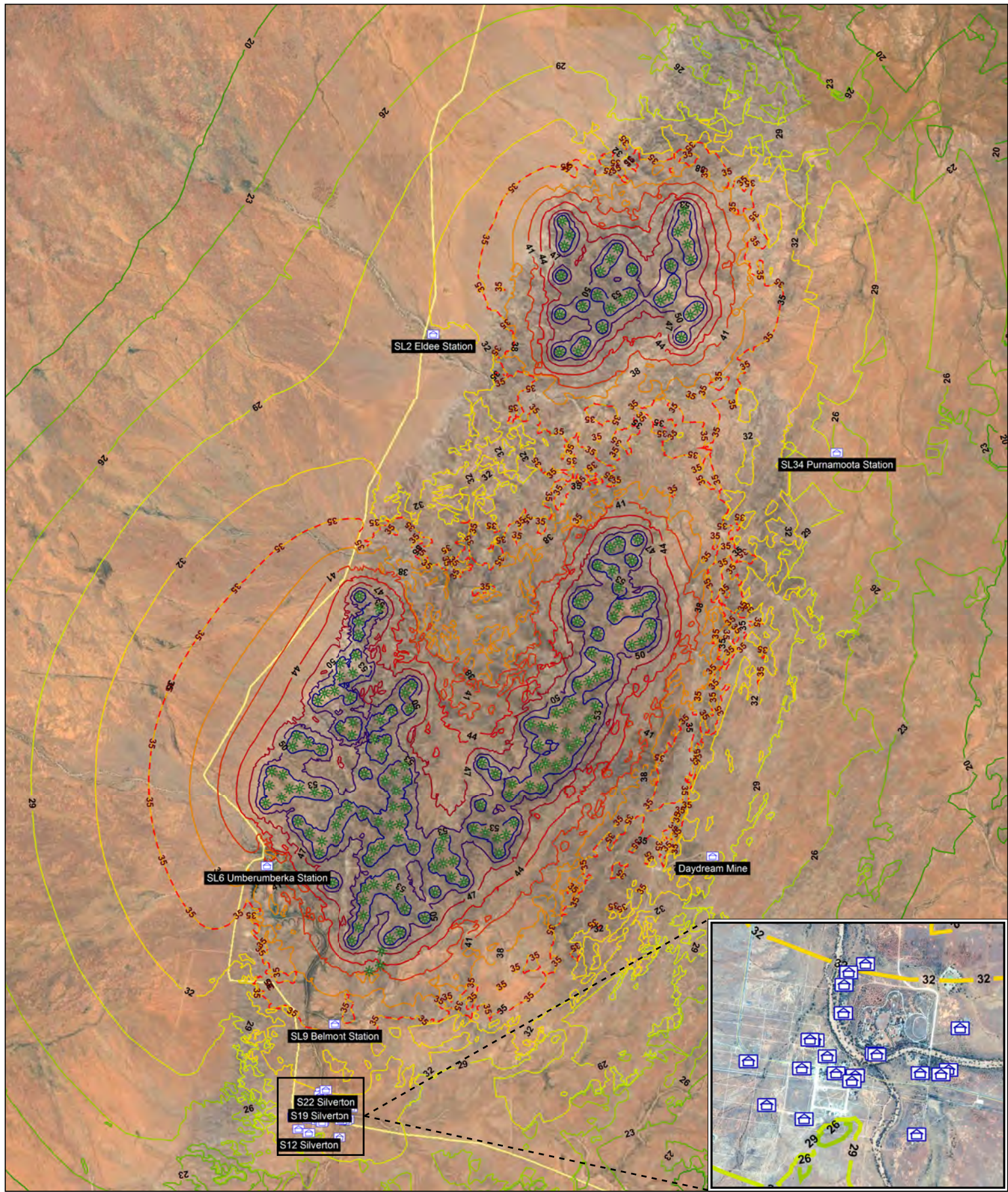
Number of monitoring samples all-day	3909
Valid all-day samples	3385
Number of monitoring samples night	1817
Valid night samples	1293

Appendix B Noise Assessment Graphs





Appendix C Noise Contour Map



CLIENT: AGL	PROJECT NO.: 640.11265
PROJECT: Silverton Wind Farm Modification Noise Impact Assessment	PREDICTION METHOD: ISO 9613-2:1996
TITLE: Silverton Wind Farm Grid Noise Map	MAP NO.: 1
	REPORT NO.: 640.11265-R1
DESCRIPTION: 172 X Worst-case WTG Noise Profile Hub Height - 110 m	DATE: 19/07/2016
	PREPARED: DWW

Predicted WTG Noise Level dBA, Leq

20 <=	20
20 <	23
23 <	26
26 <	29
29 <	32
32 <	35
35 <	38
38 <	41
41 <	44
44 <	47
47 <	50
50 <	53
53 <	

LEGEND

- Wind Turbine
- Receptor
- 35 dBA Minimum Limit

SCALE AND ORIENTATION

Scale 1:106017

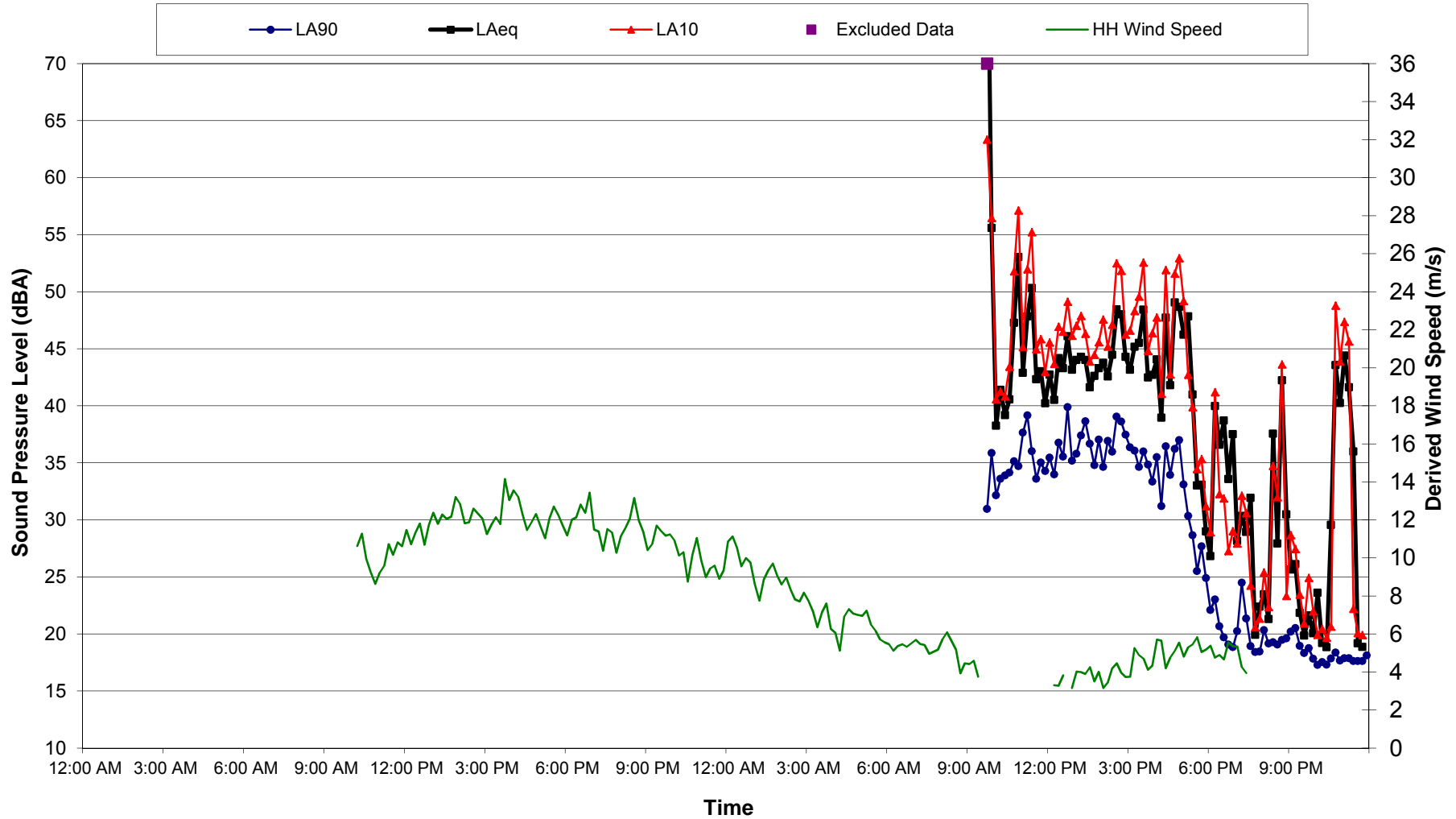
Appendix C

SLR Consulting Australia Pty Ltd

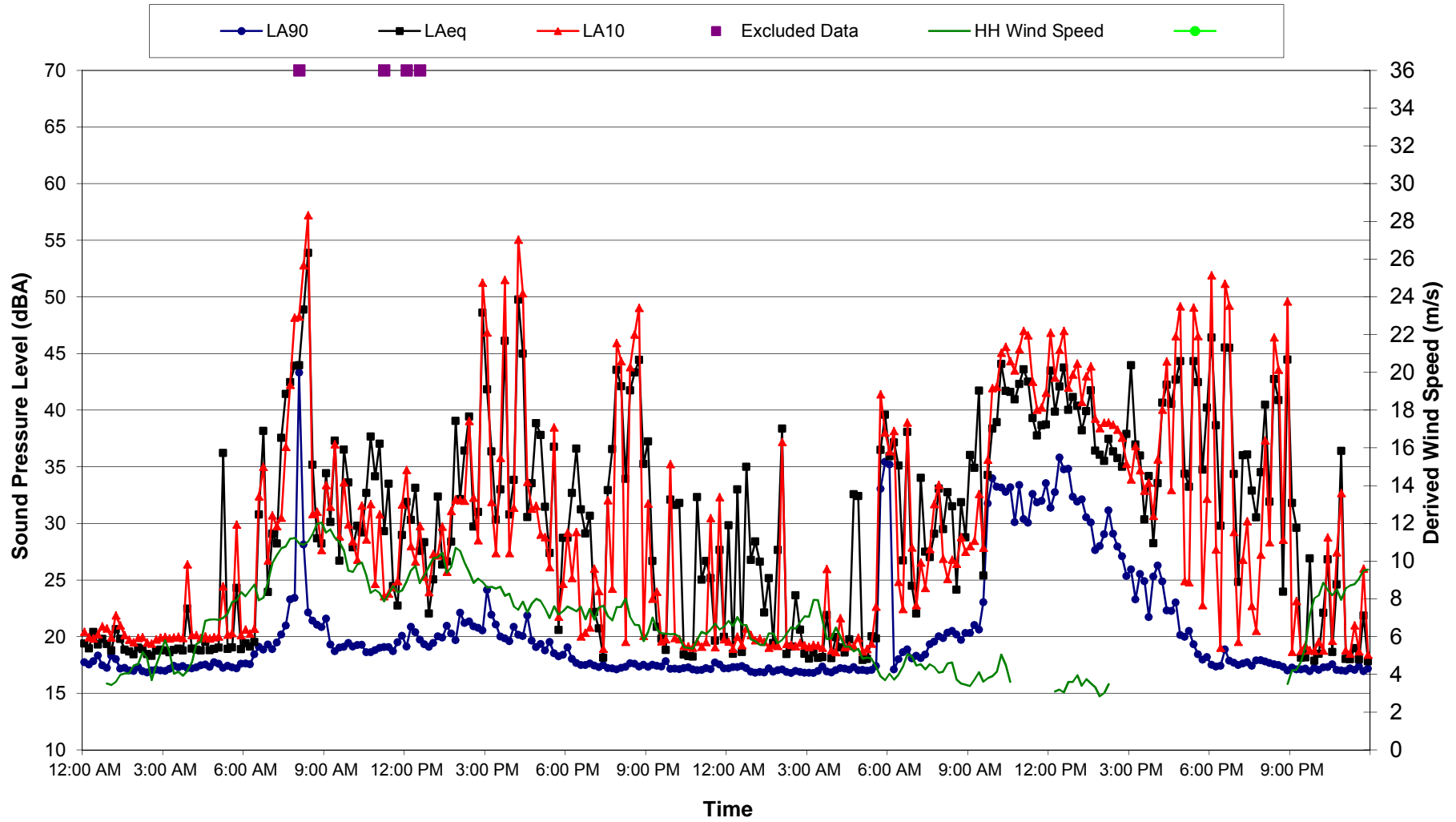
ABN 29 001 584 612
Suite 6, 131 Bulleen Rd
Balwyn North VIC 3104

Appendix D Noise Monitoring Data

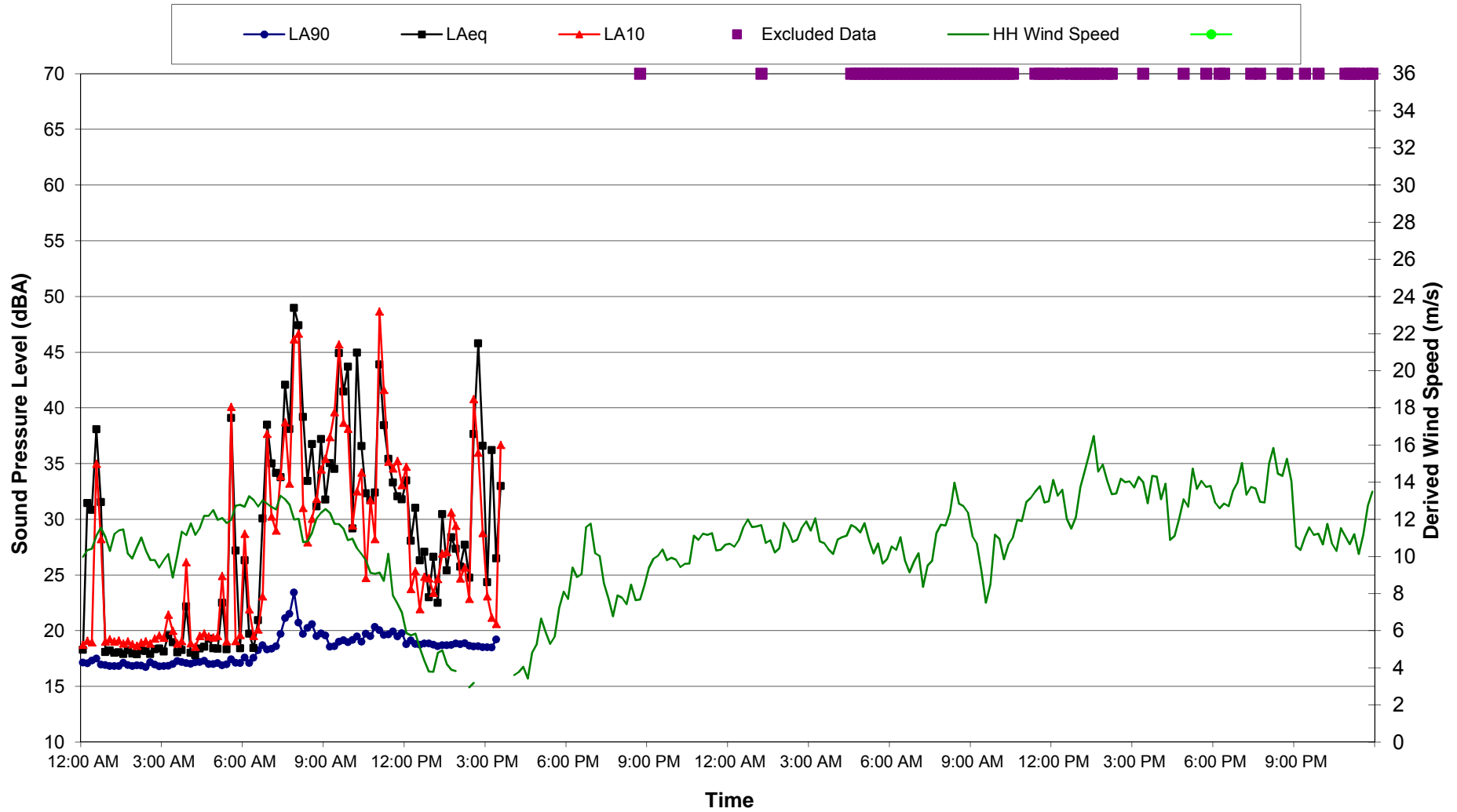
Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 3 and 4 May 2016



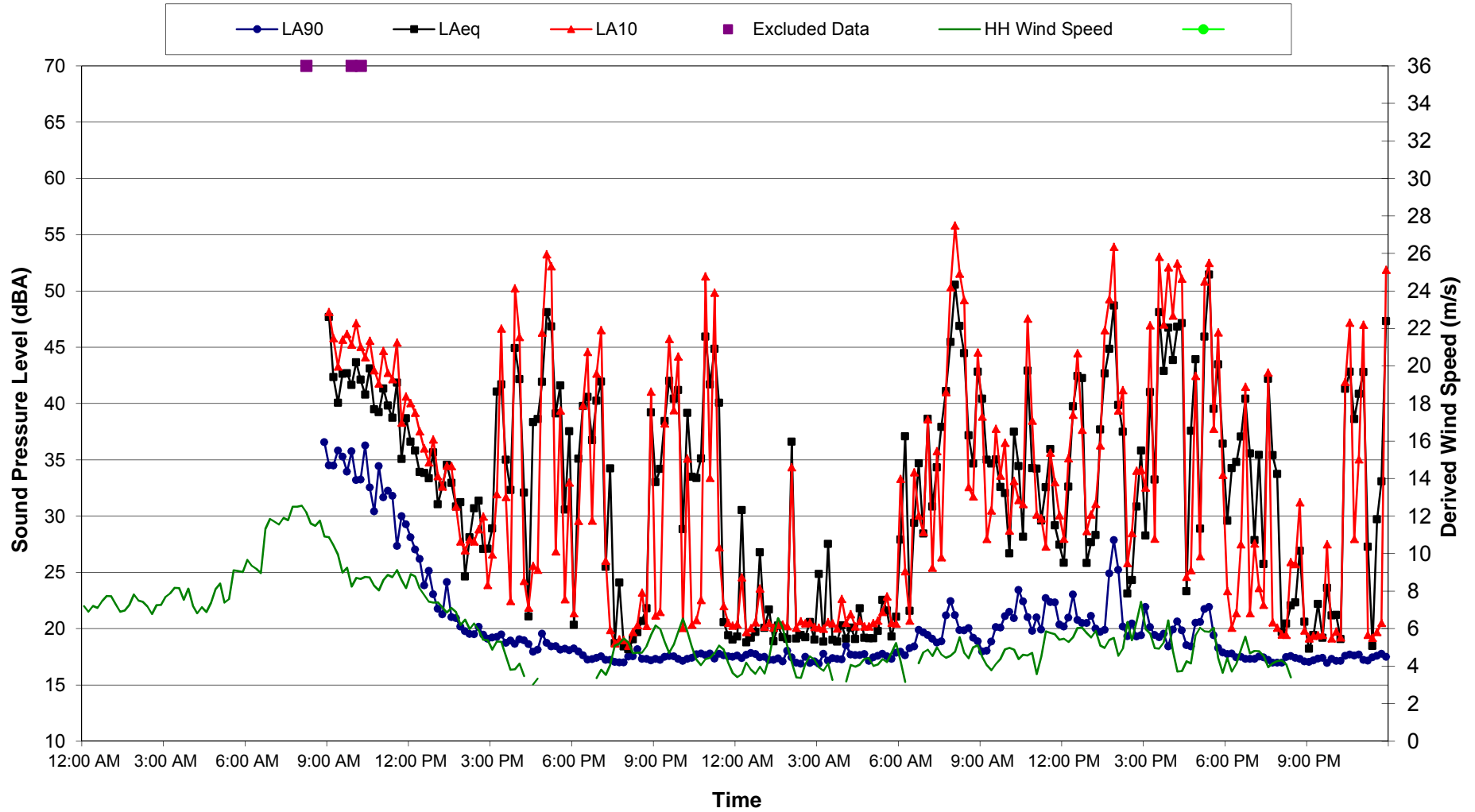
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016**



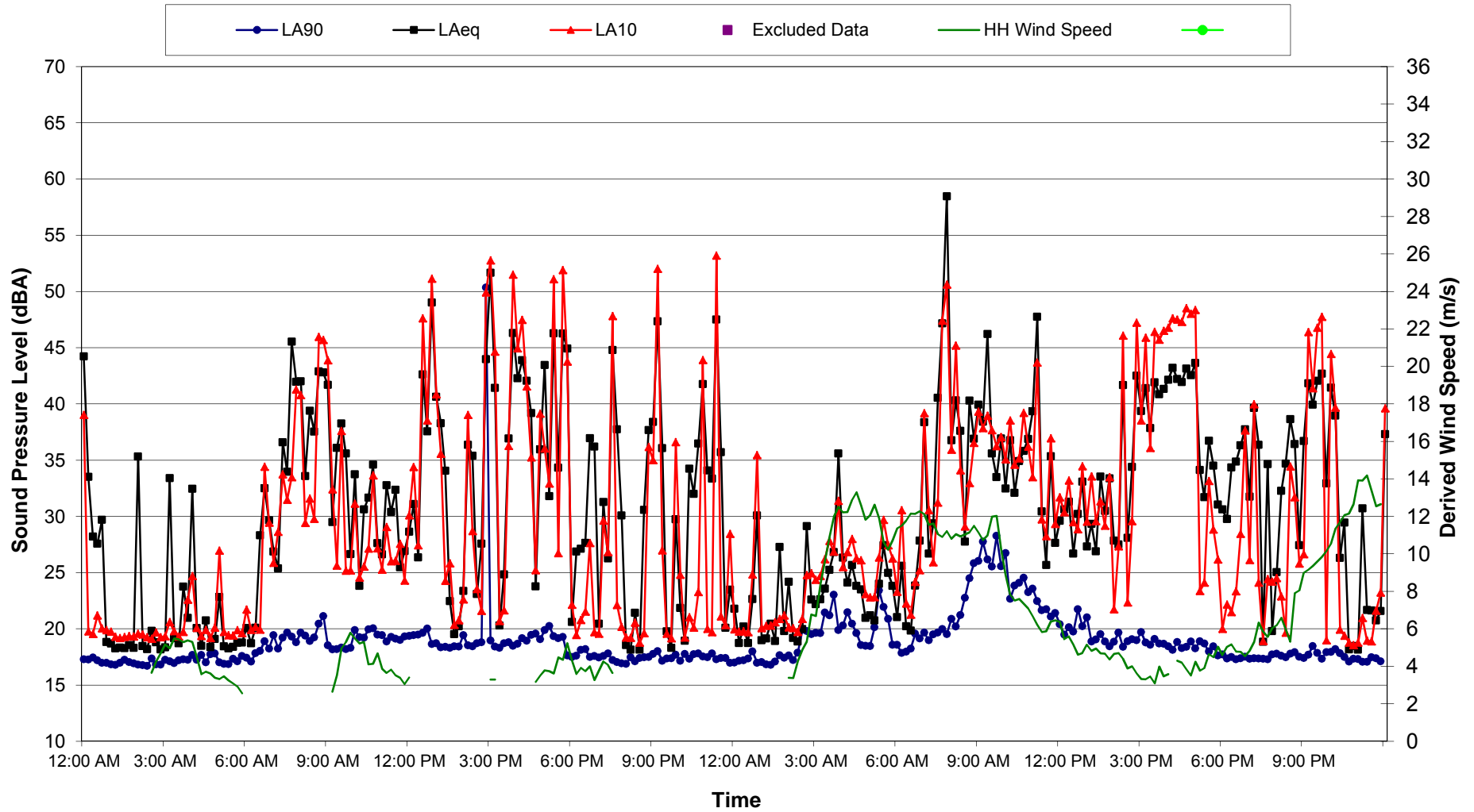
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 7 and 8 May 2016**



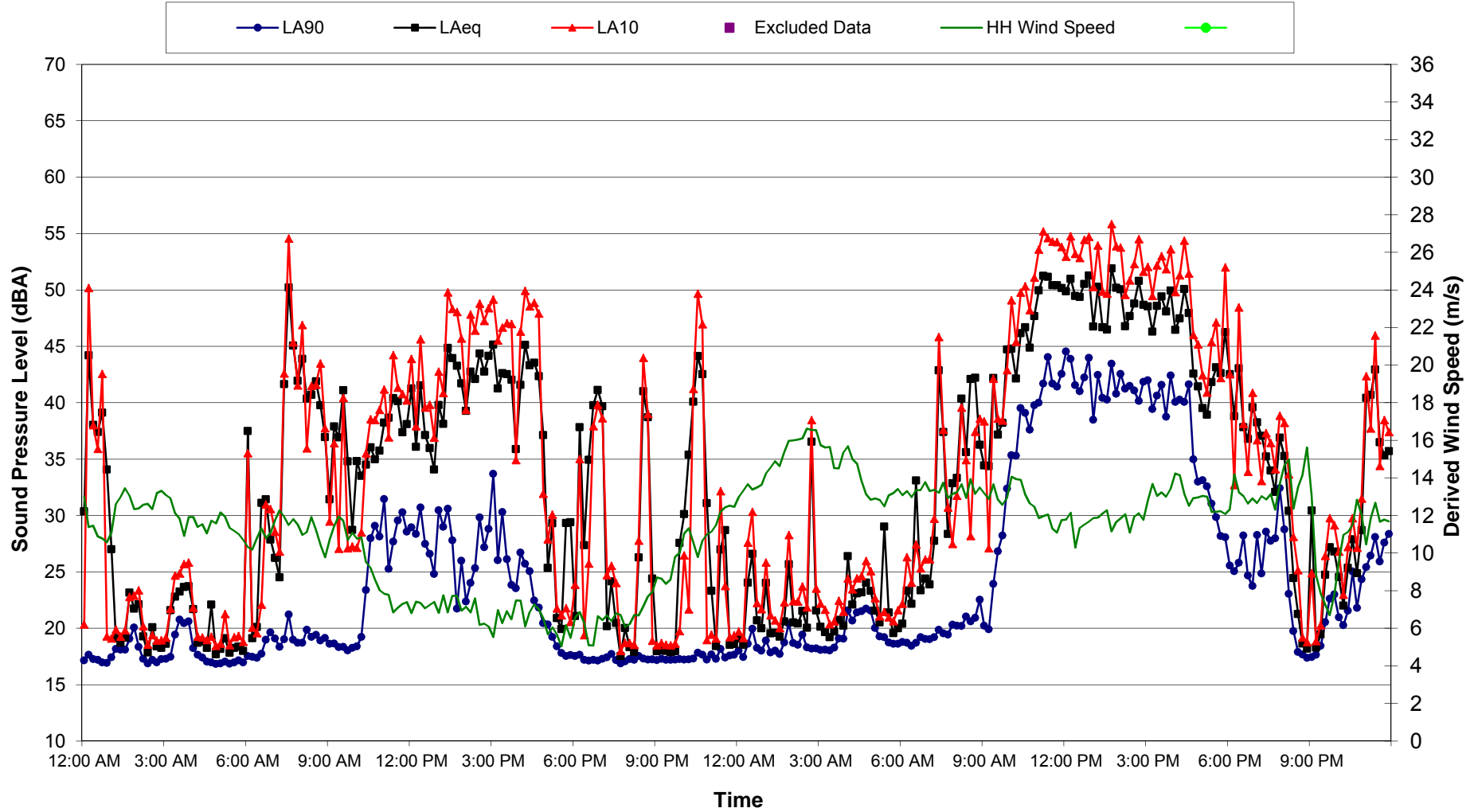
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 17 and 18 May 2016**



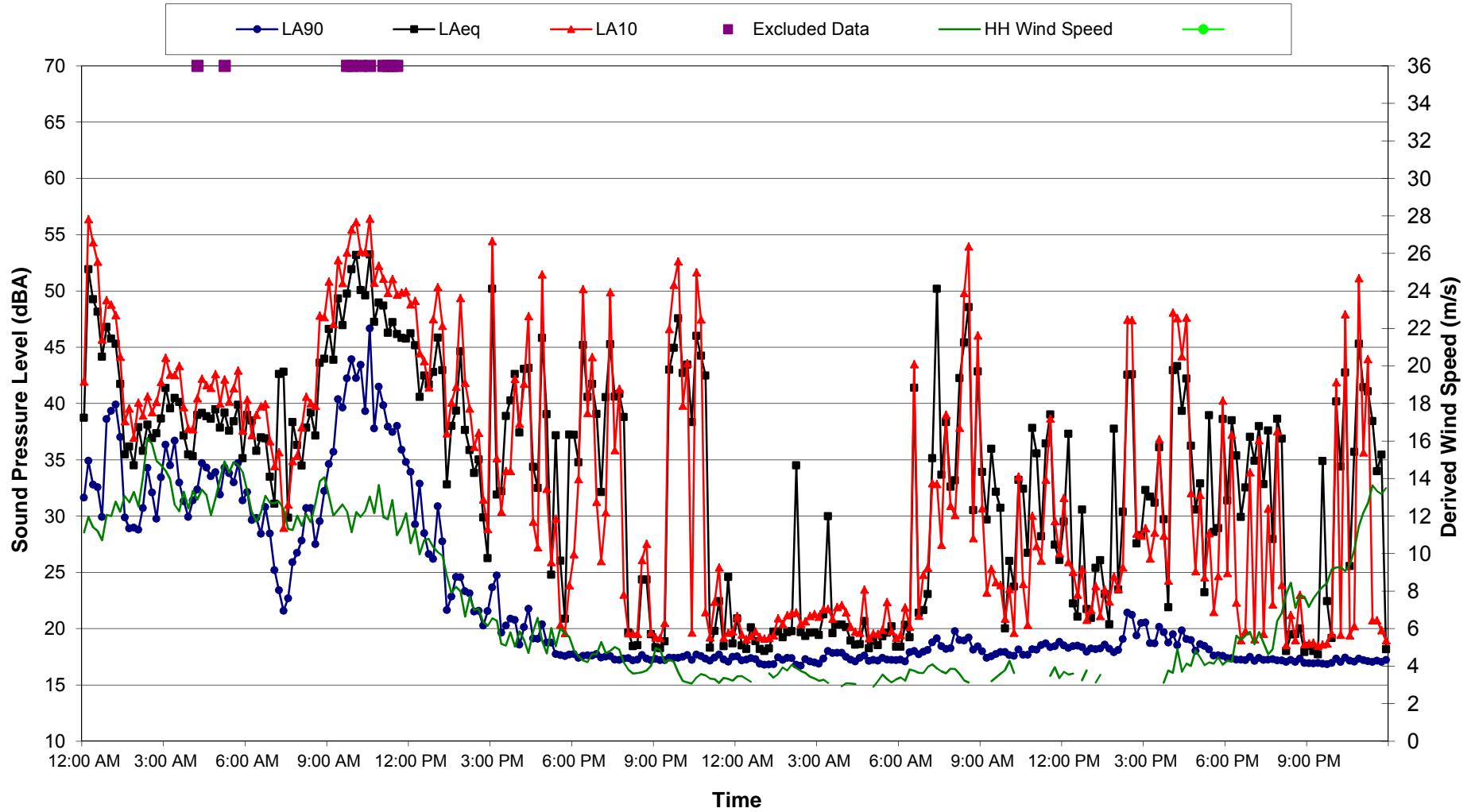
Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 19 and 20 May 2016



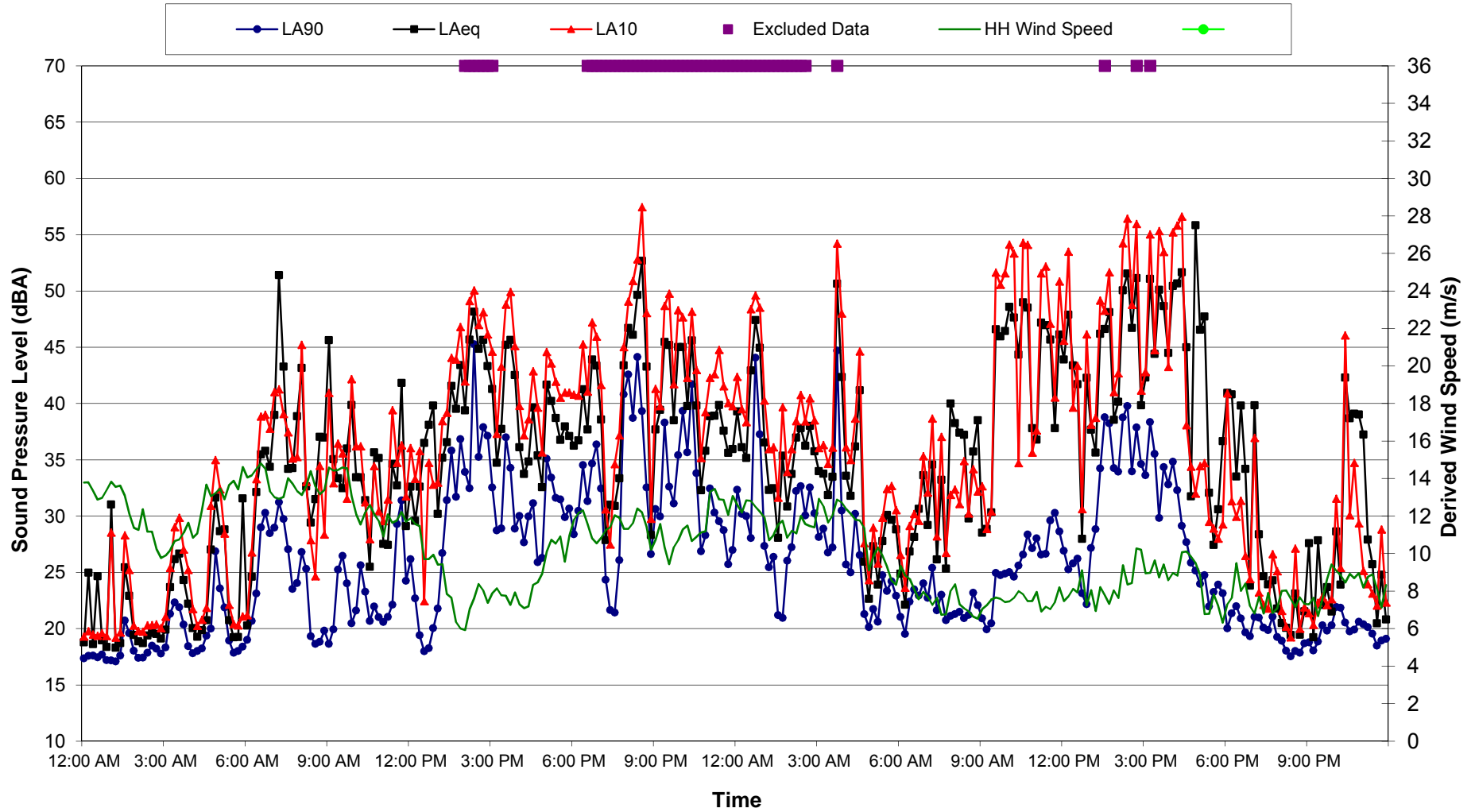
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 21 and 22 May 2016**



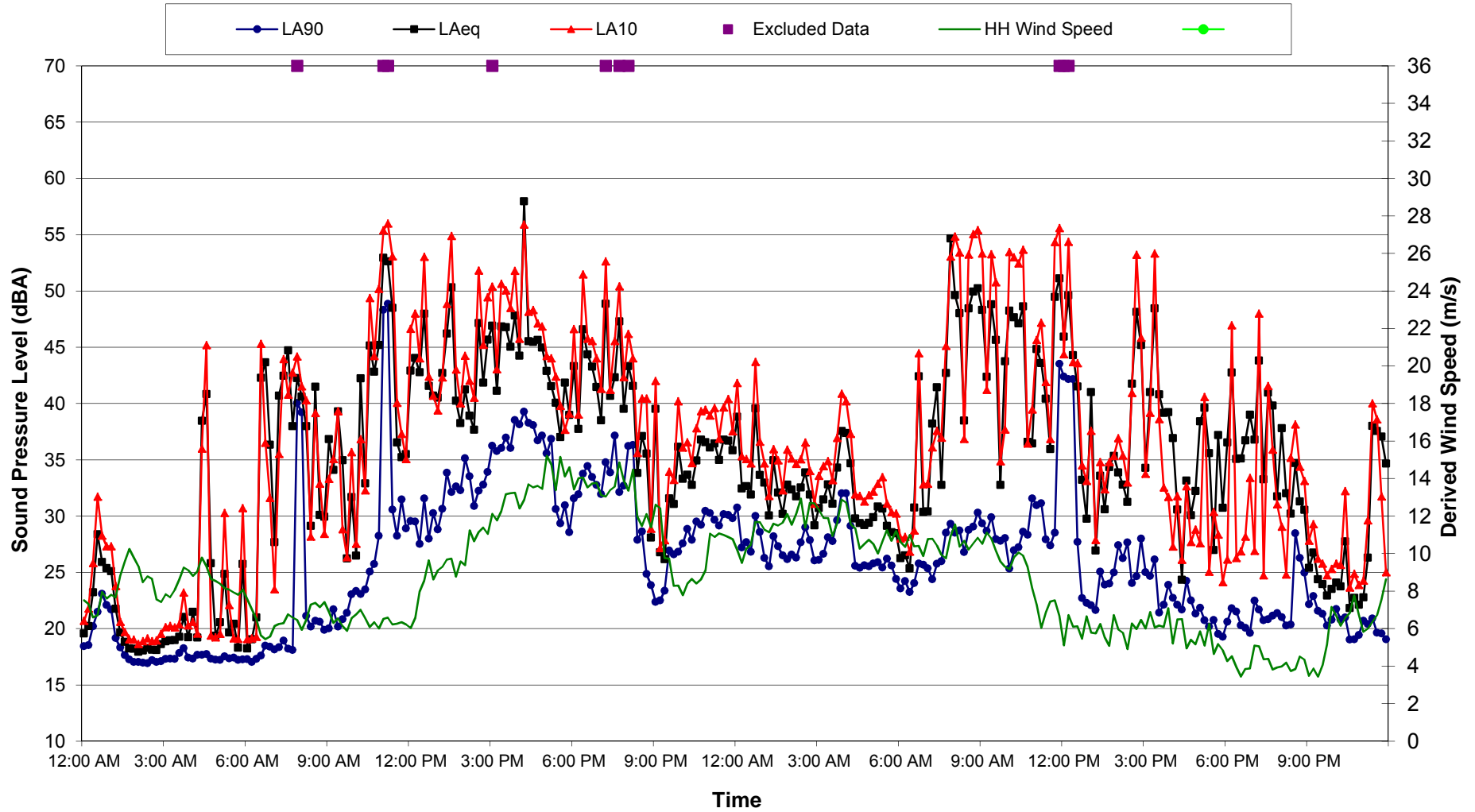
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 23 and 24 May 2016**



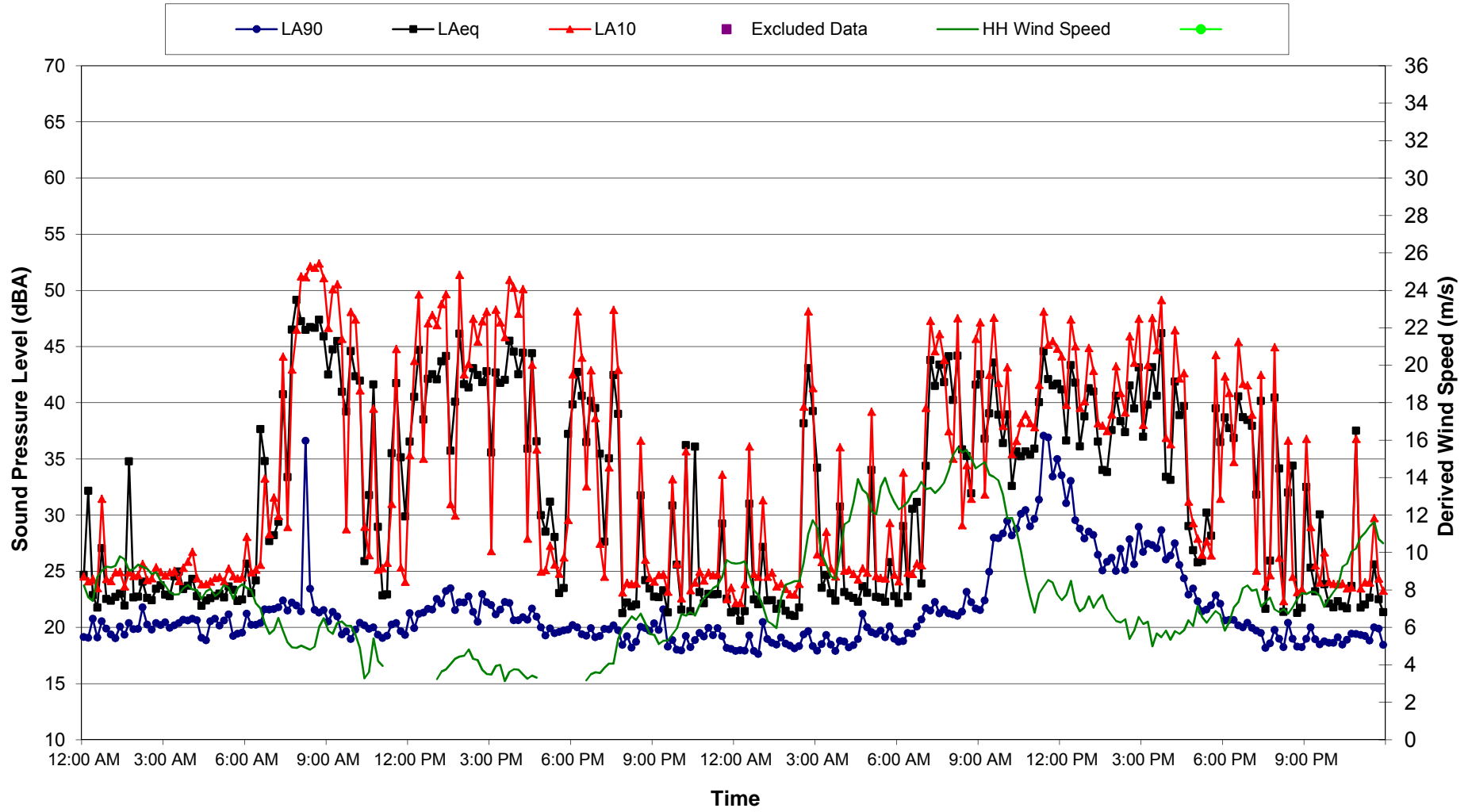
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



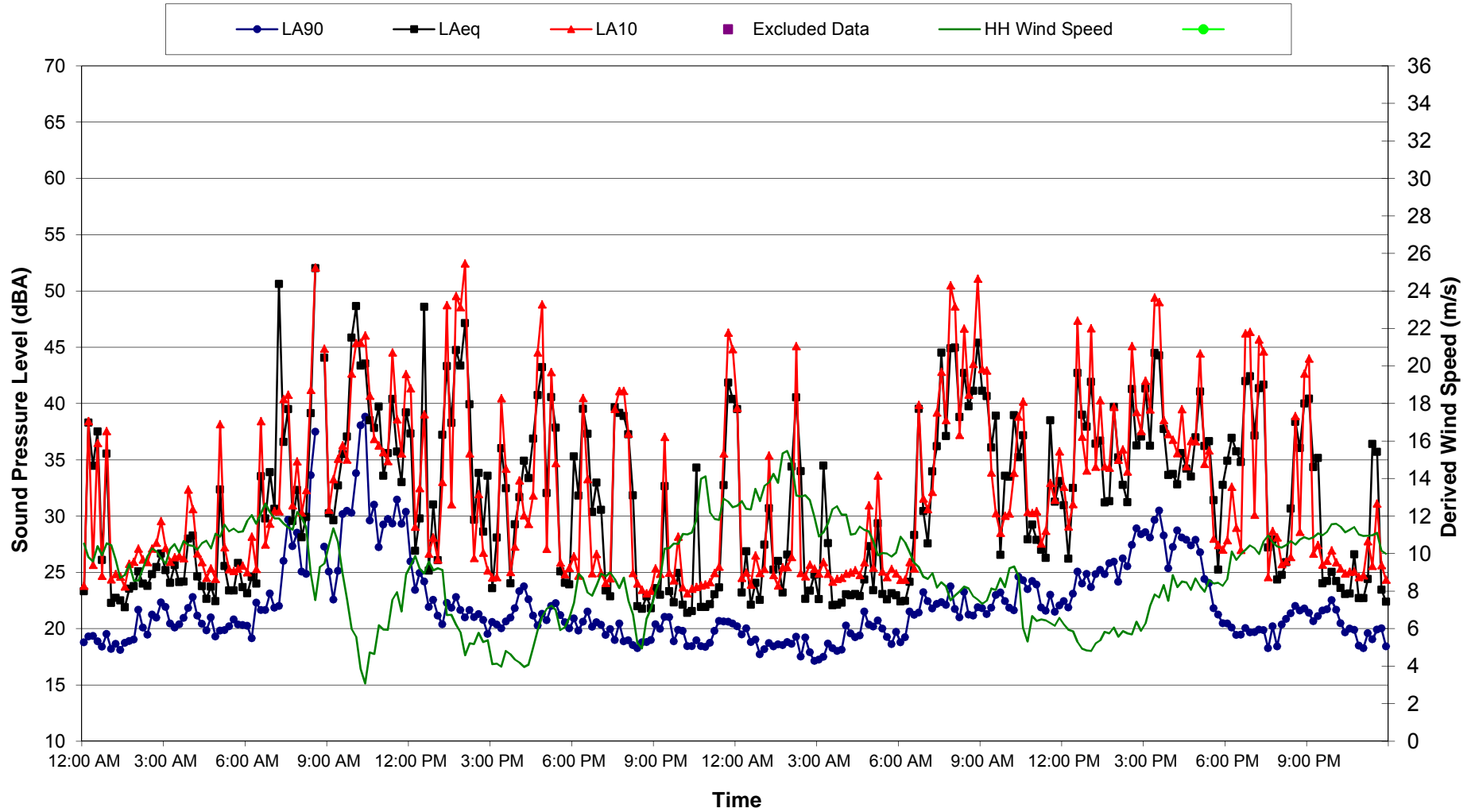
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**



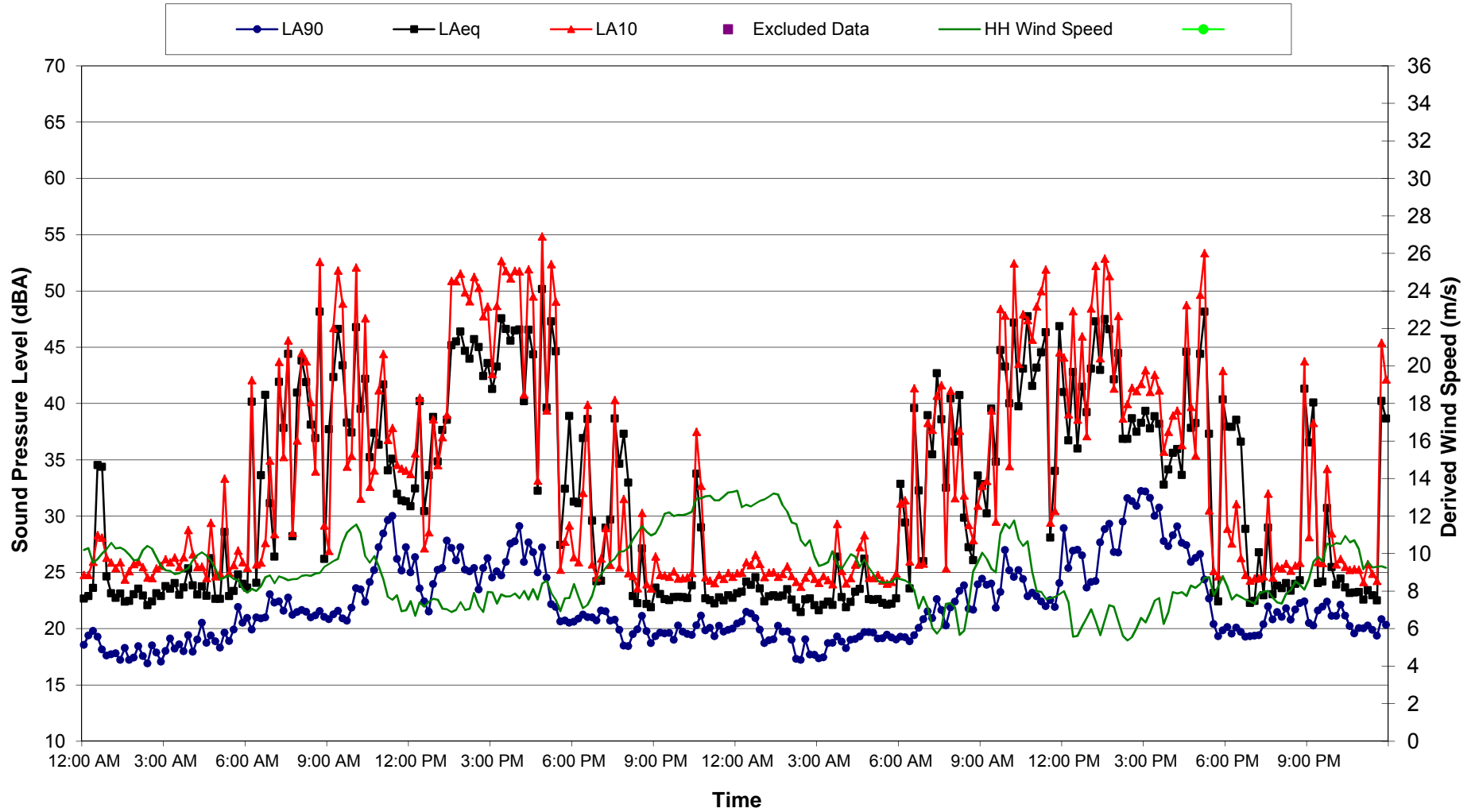
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016**



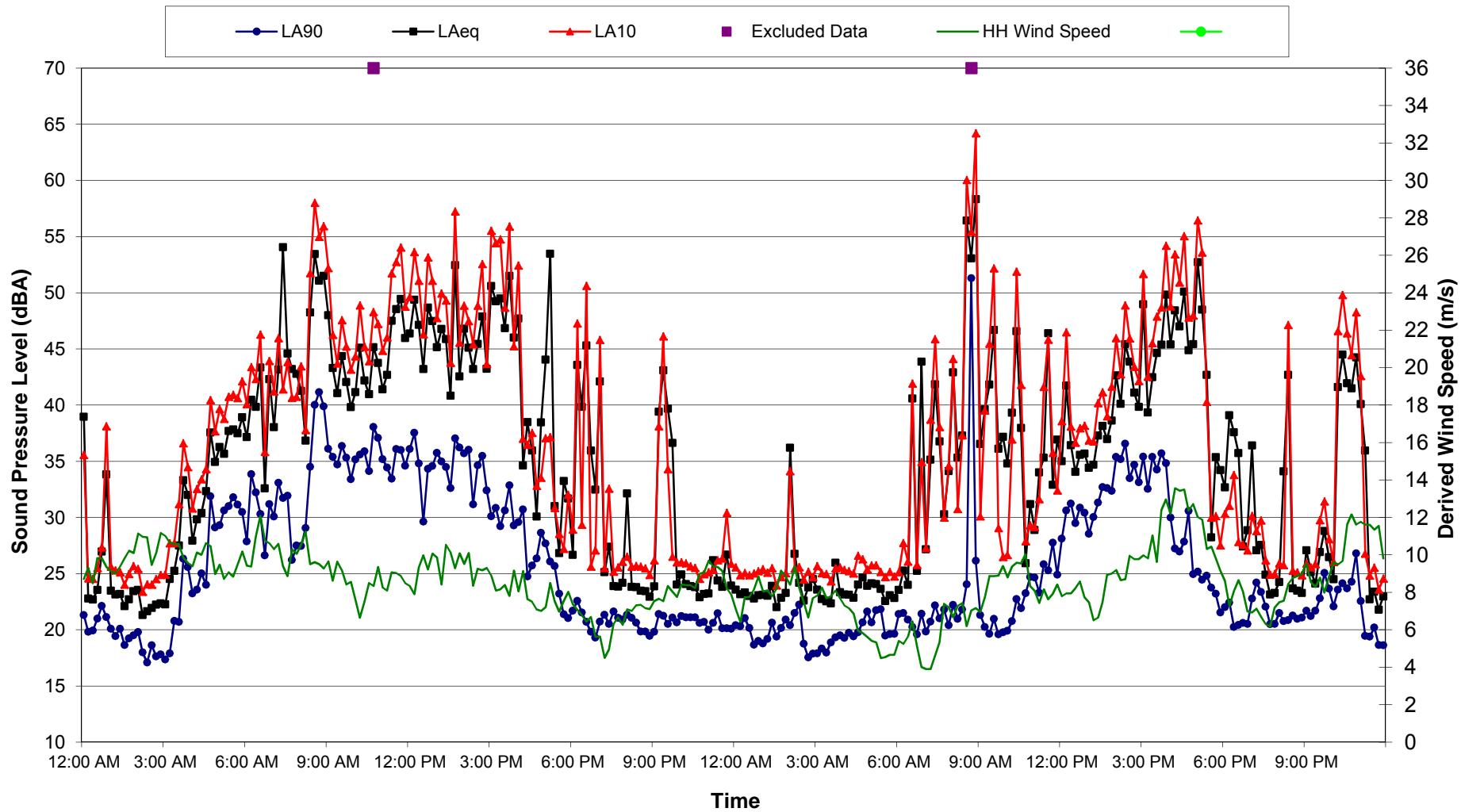
Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 31 May and 1 June 2016



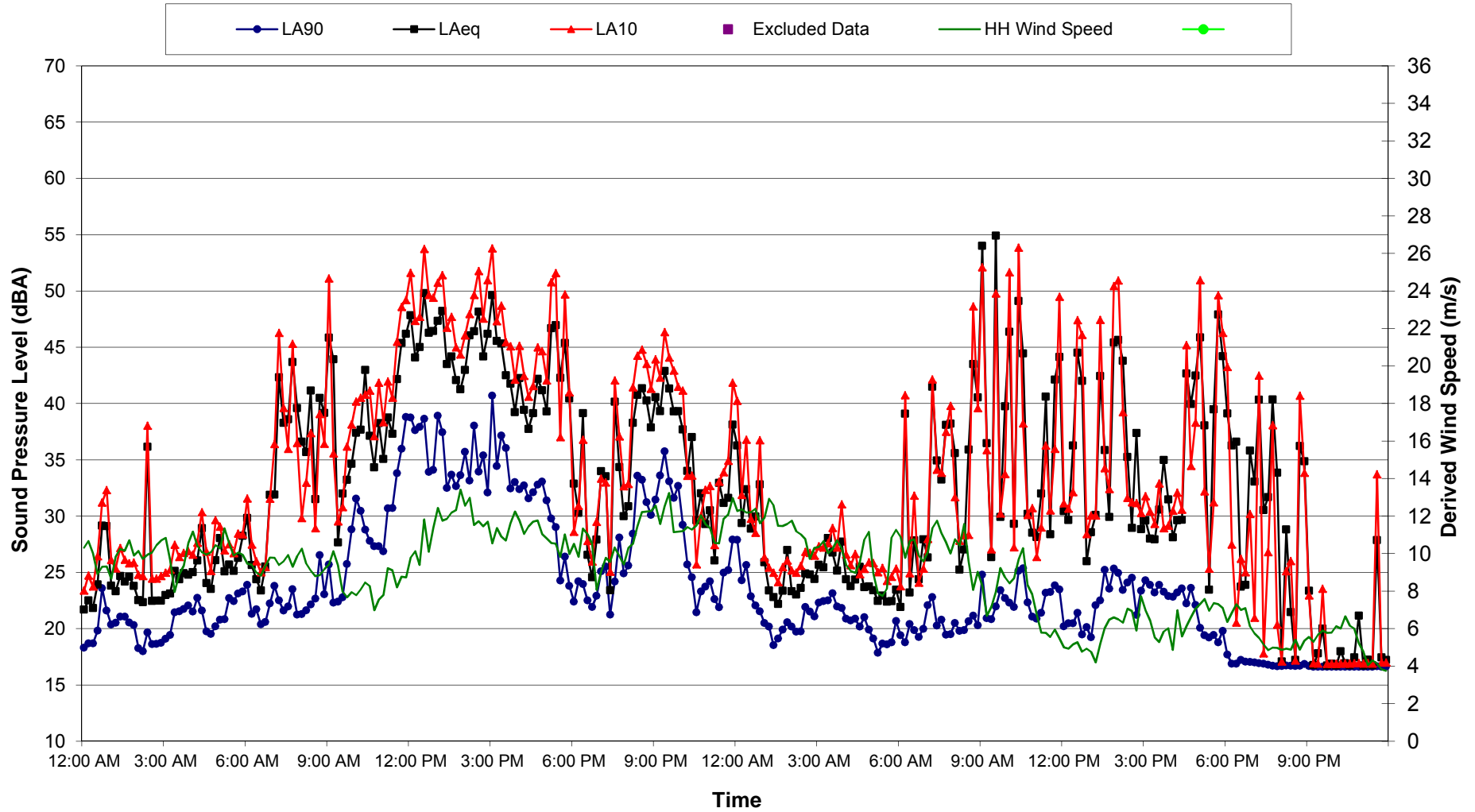
Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 2 and 3 June 2016



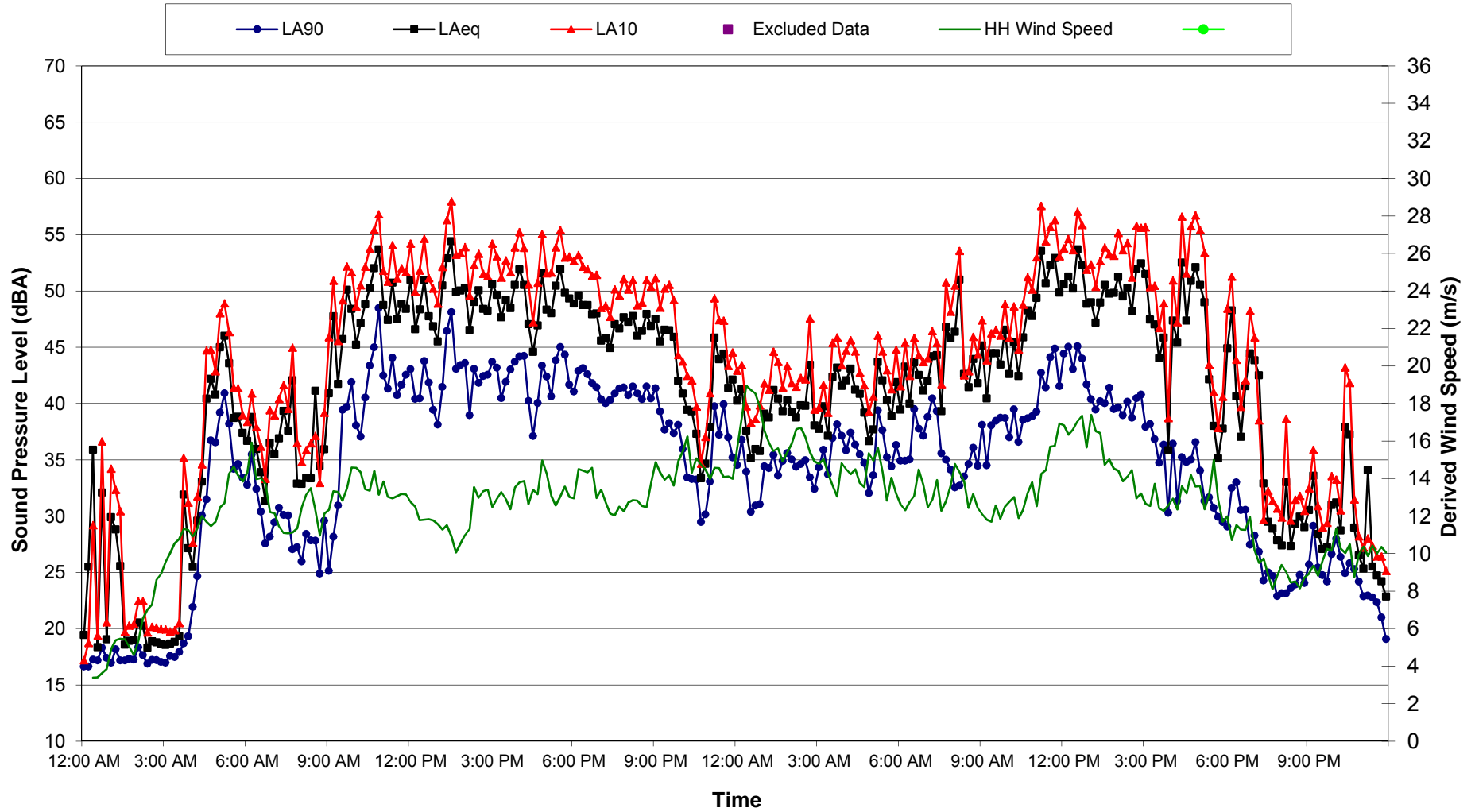
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 4 and 5 June 2016**



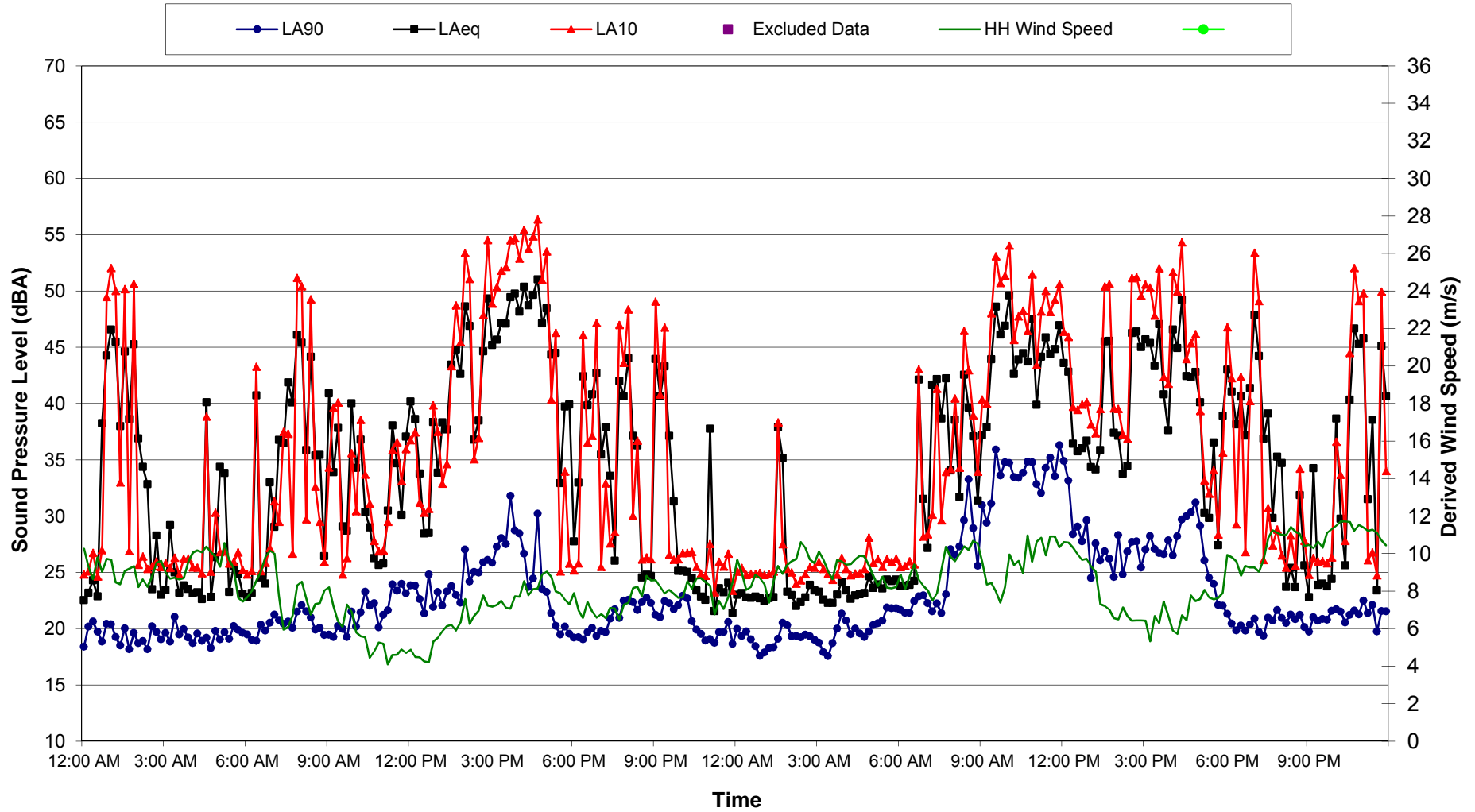
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 6 and 7 June 2016**



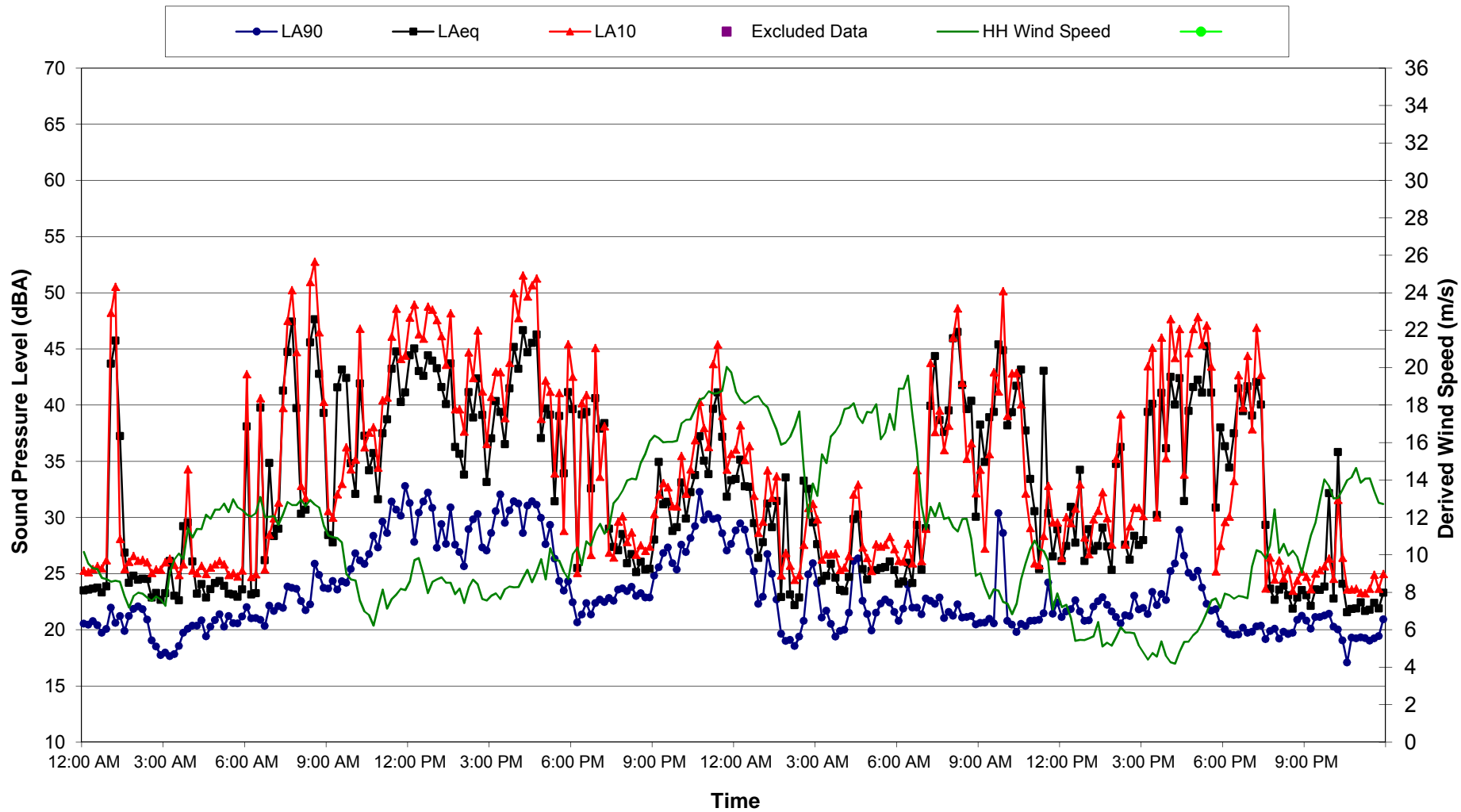
Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 8 and 9 June 2016



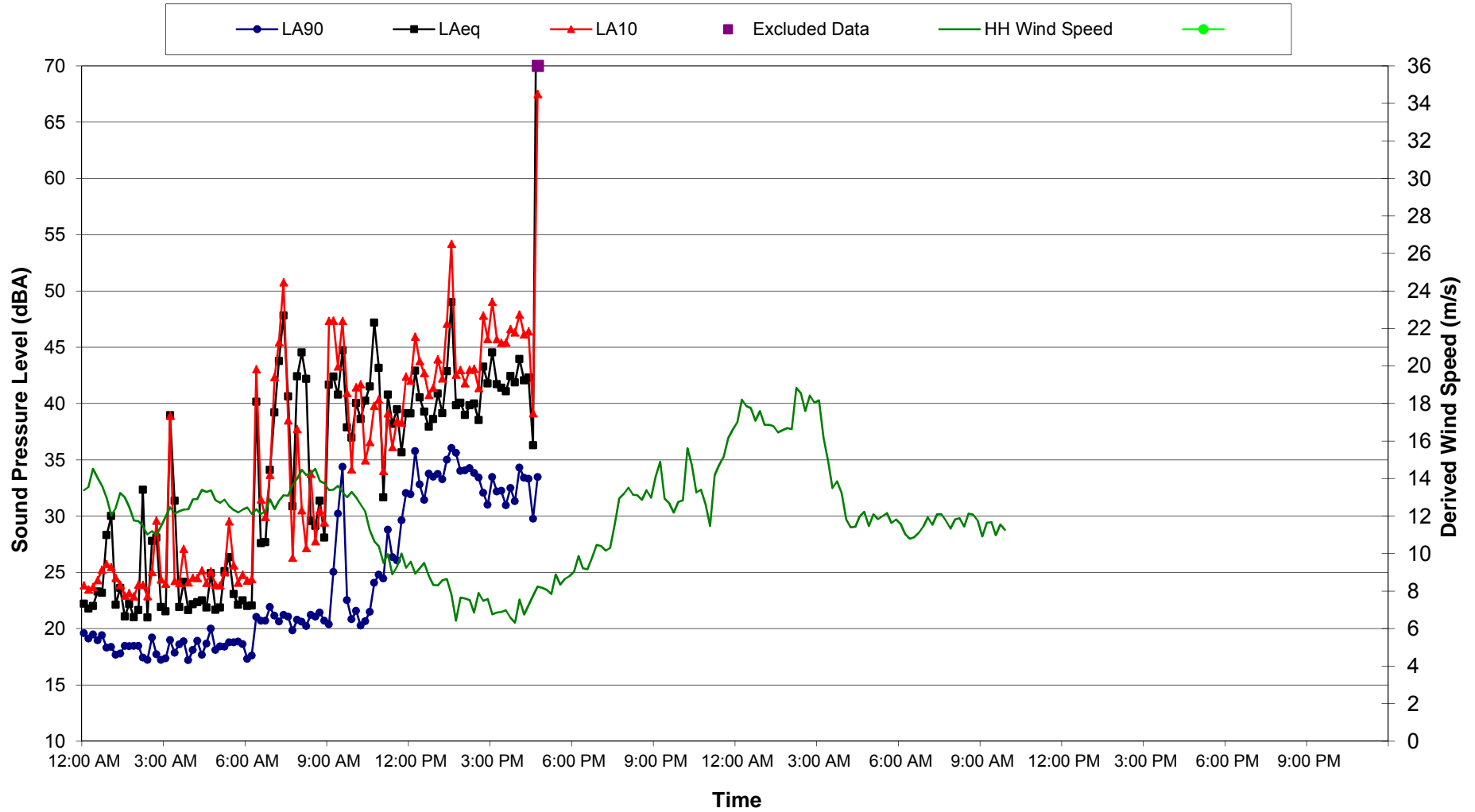
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Ambient Noise Data - 10 and 11 June 2016**



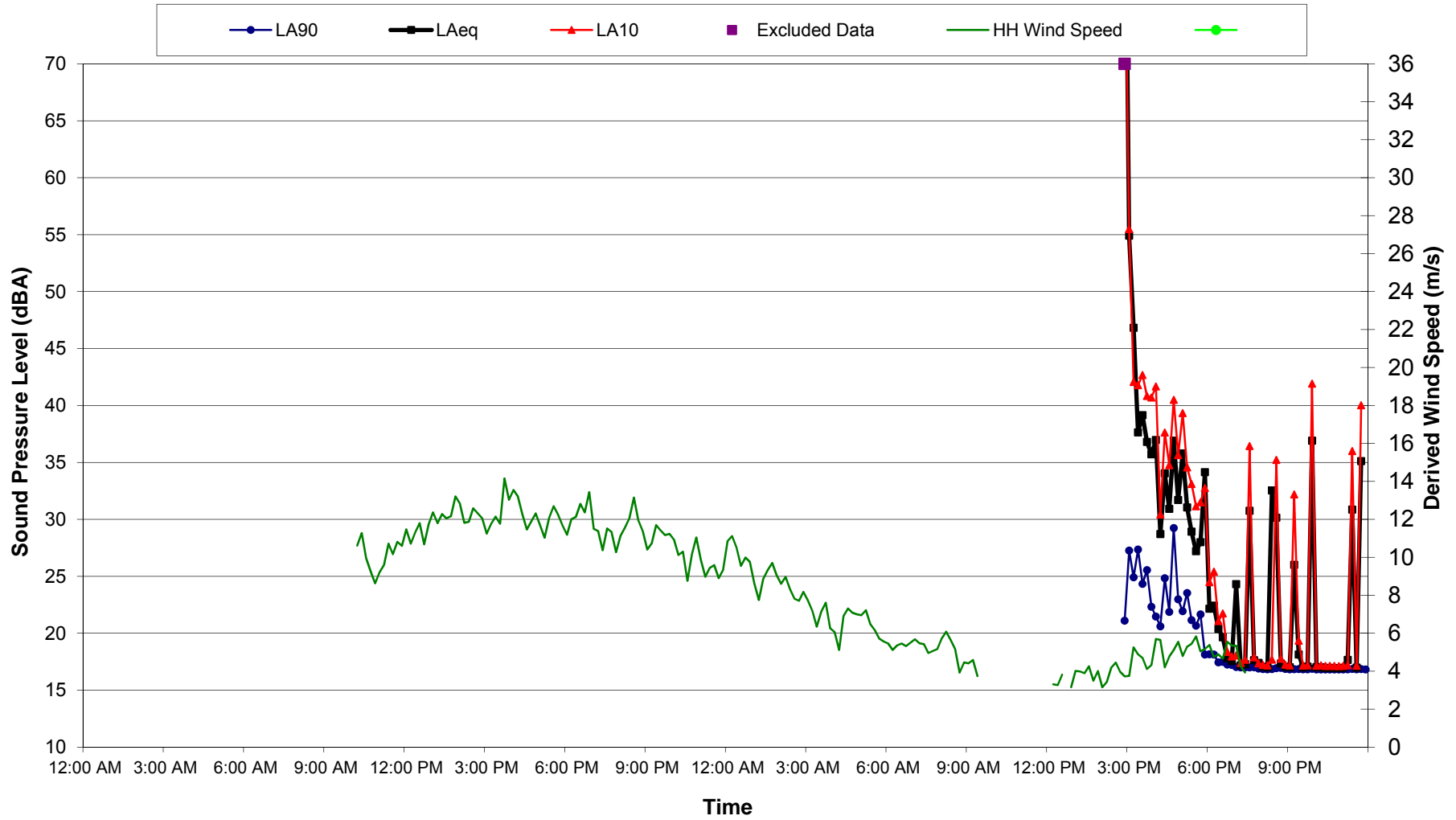
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 12 and 13 June 2016**



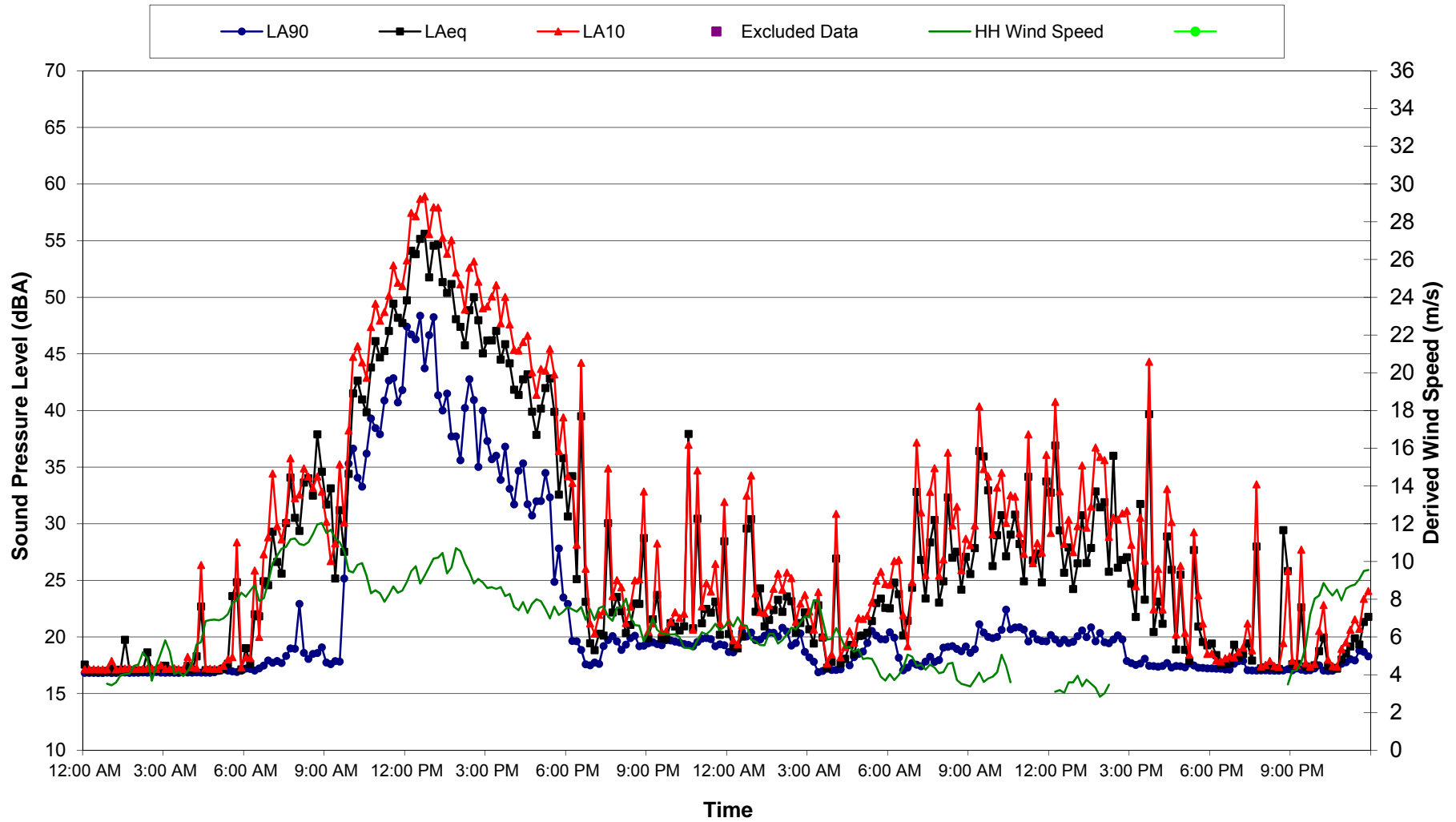
**Location Purnamoota Station - Silverton Wind Farm
Ambient Noise Data - 14 and 15 June 2016**



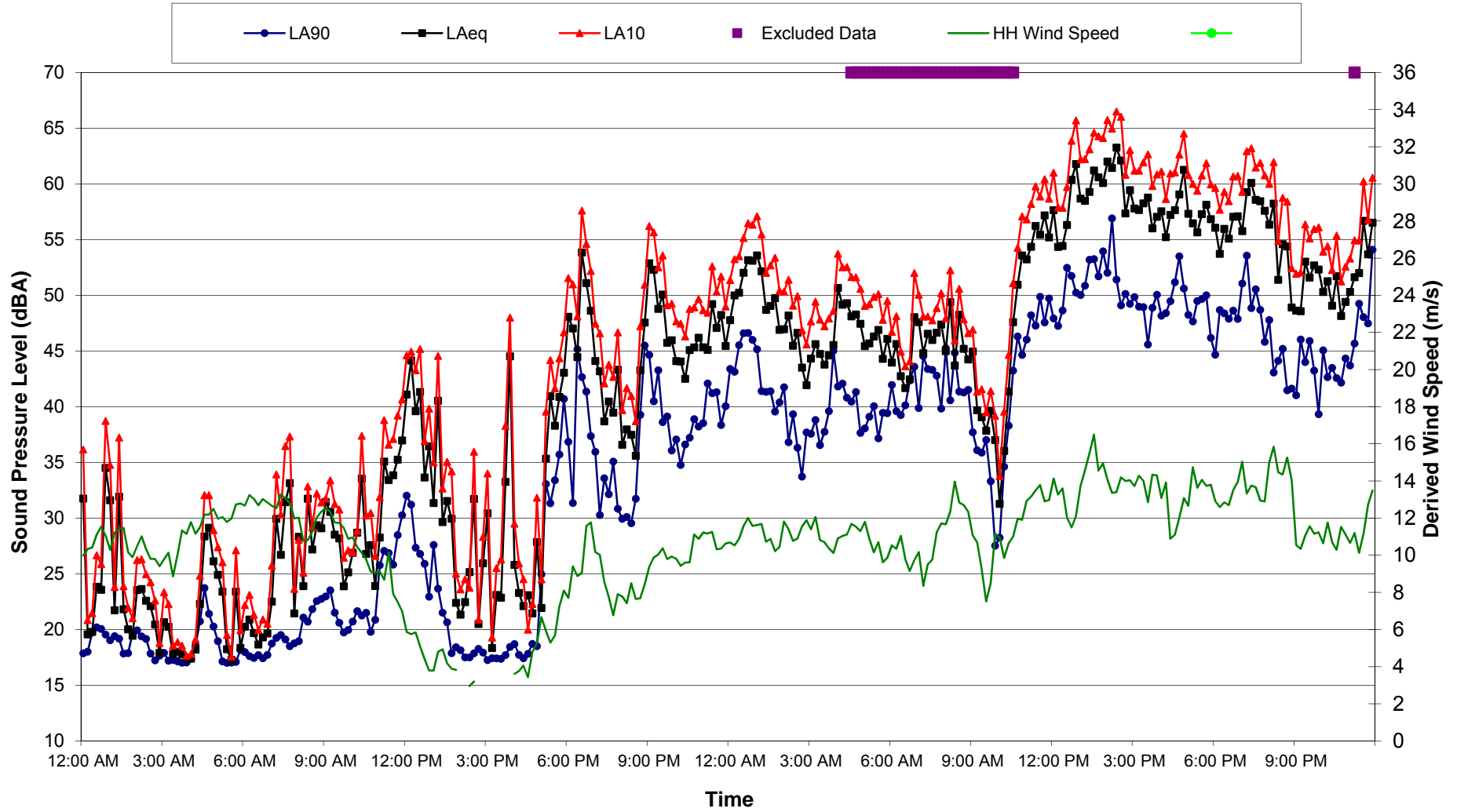
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 3 and 4 May 2016



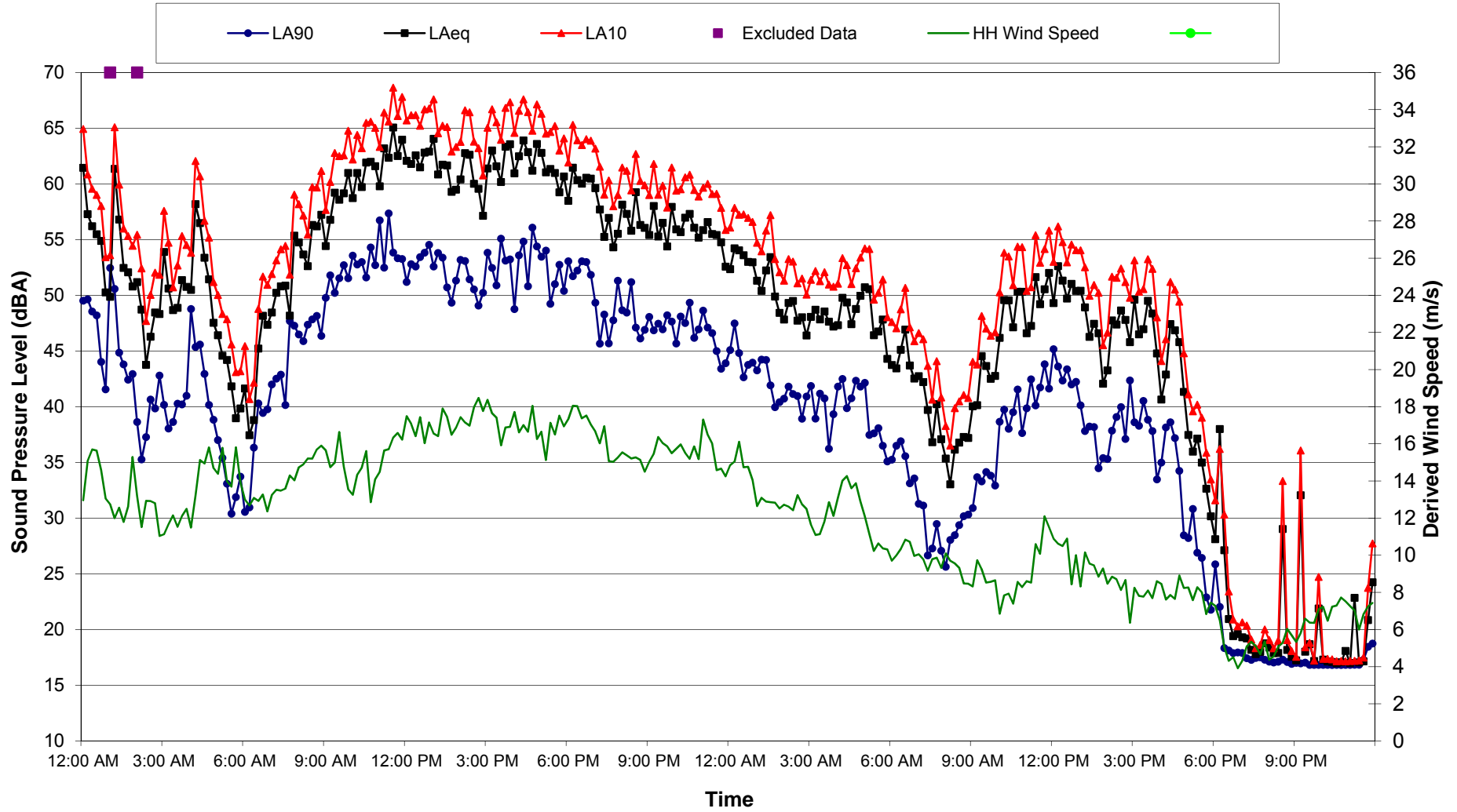
Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016



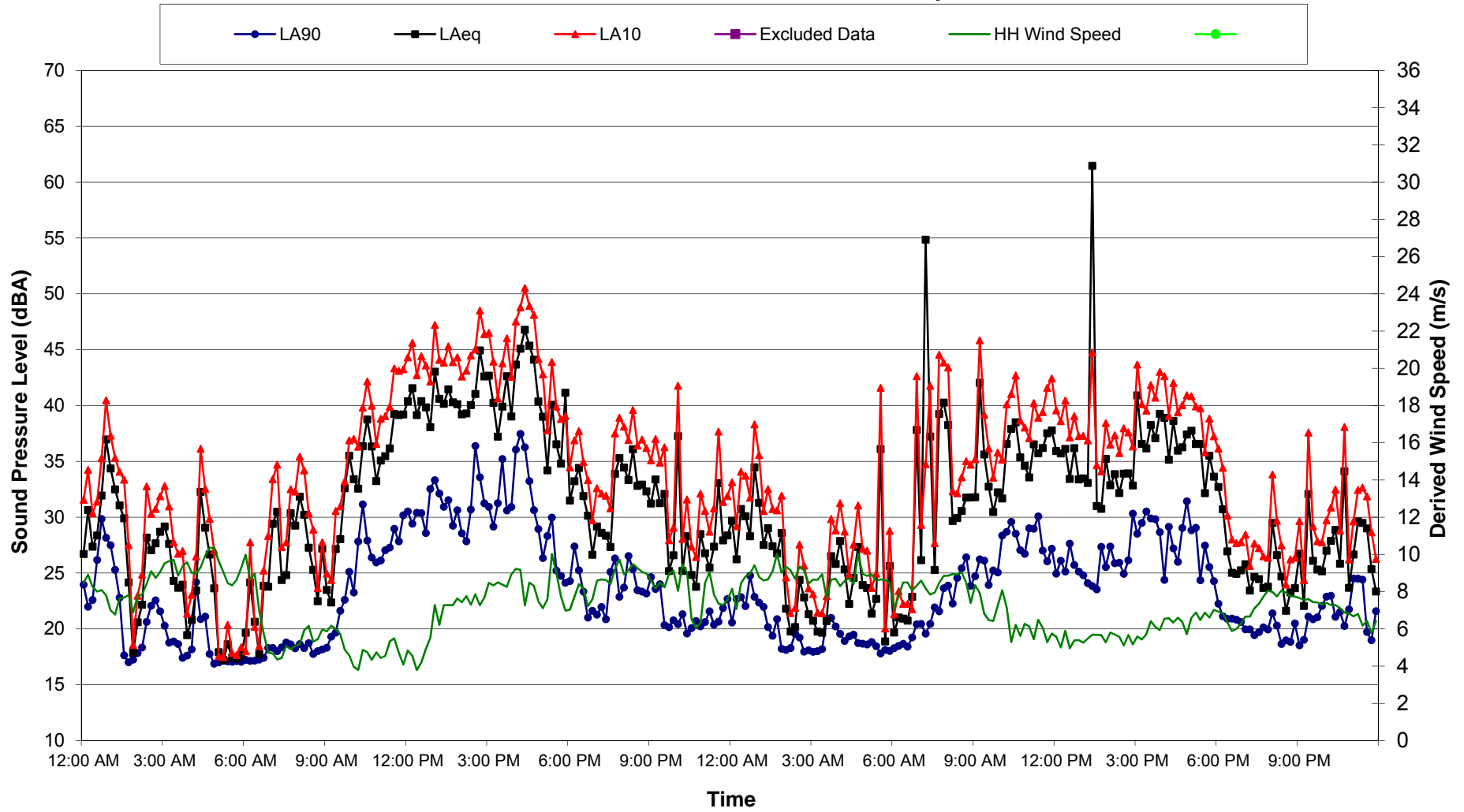
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 7 and 8 May 2016



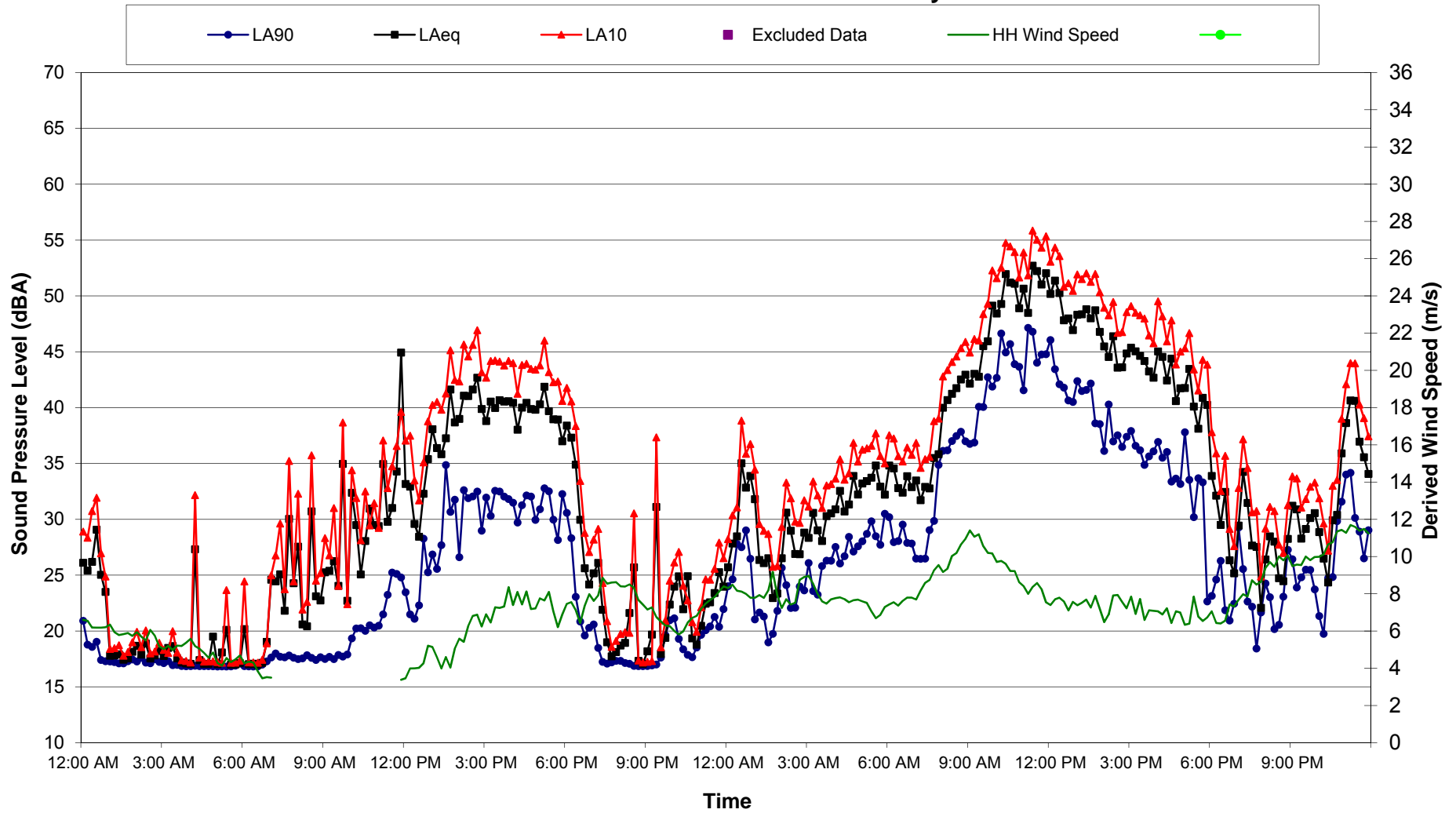
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 9 and 10 May 2016**



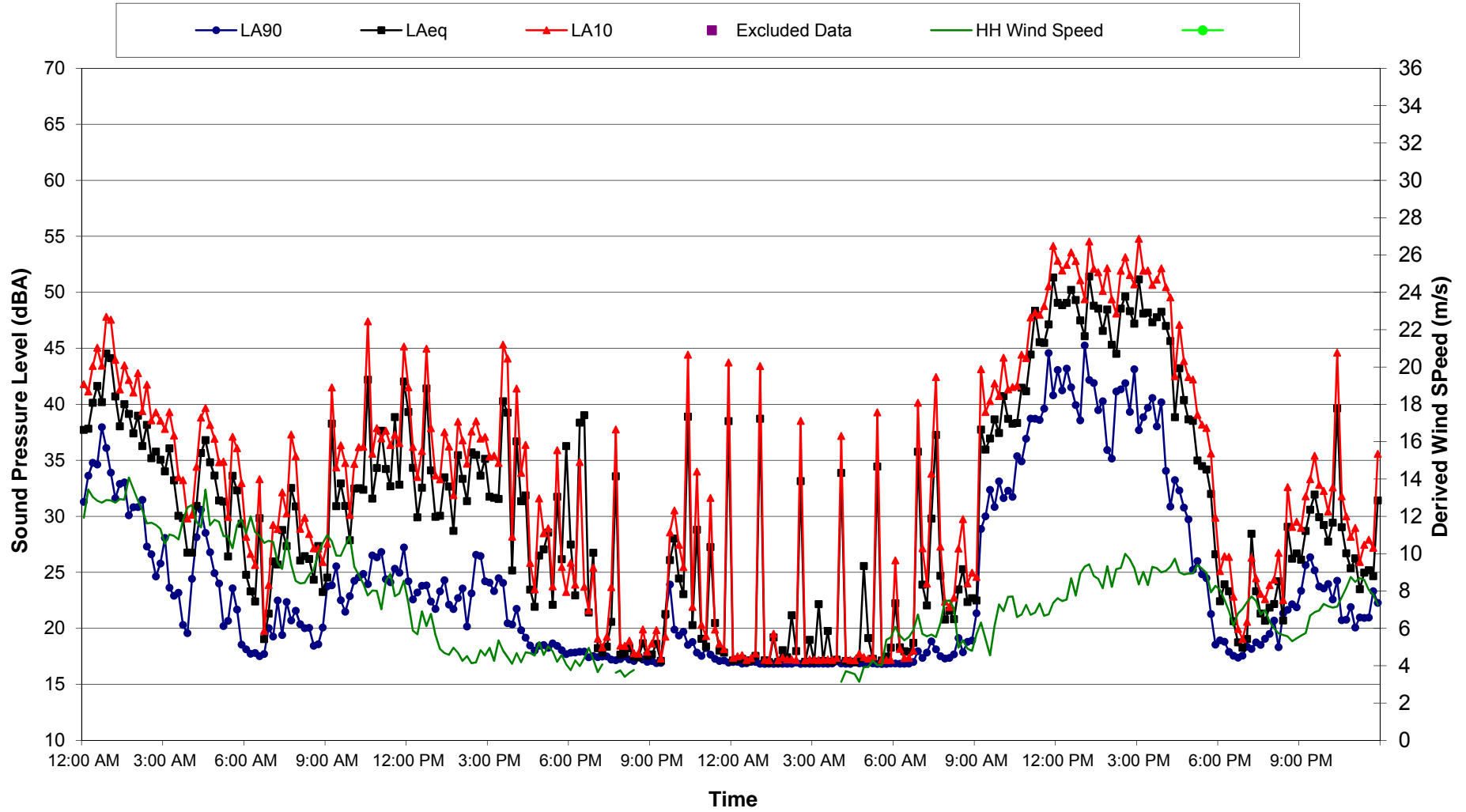
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Ambient Noise Data - 11 and 12 May 2016**



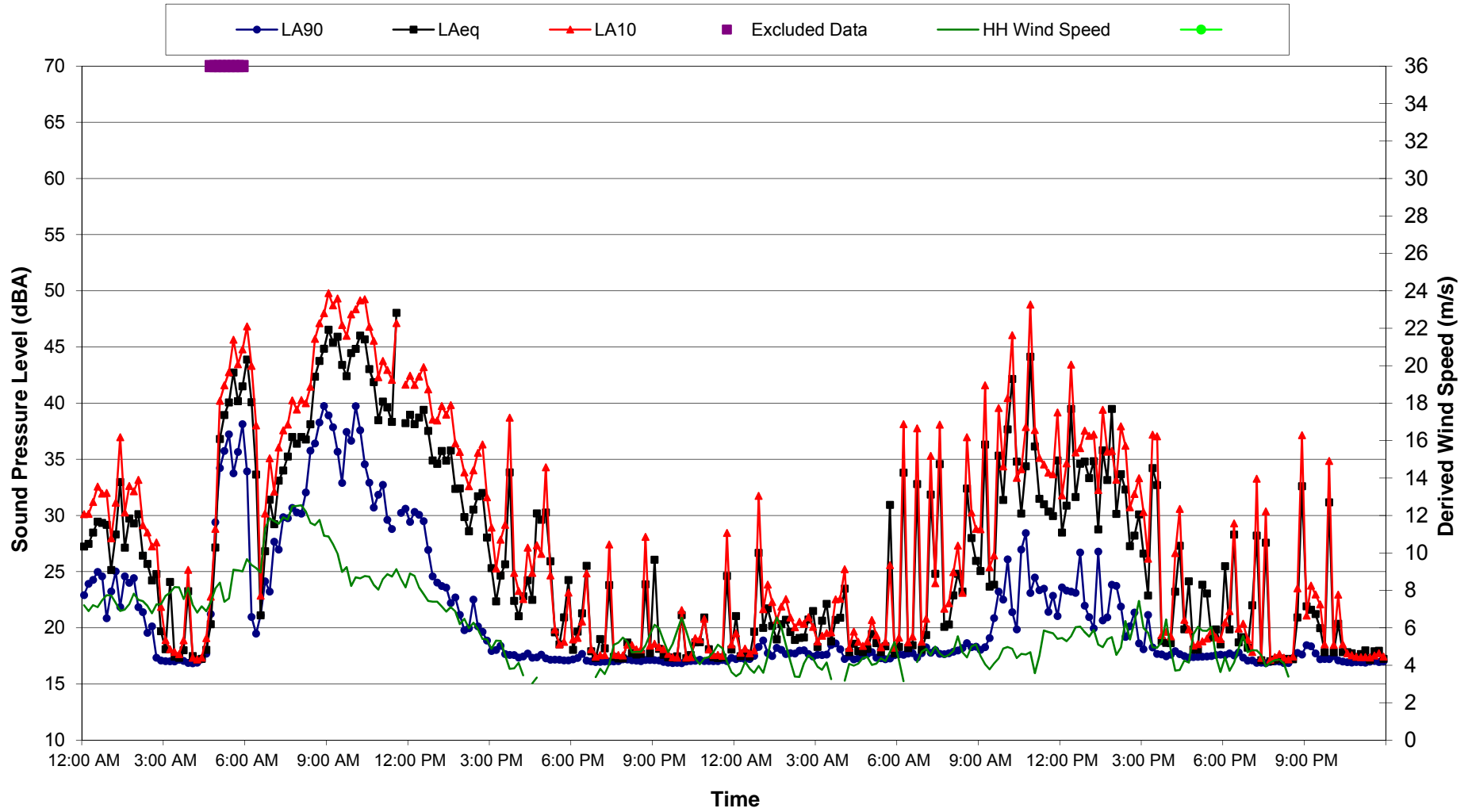
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 13 and 14 May 2016**



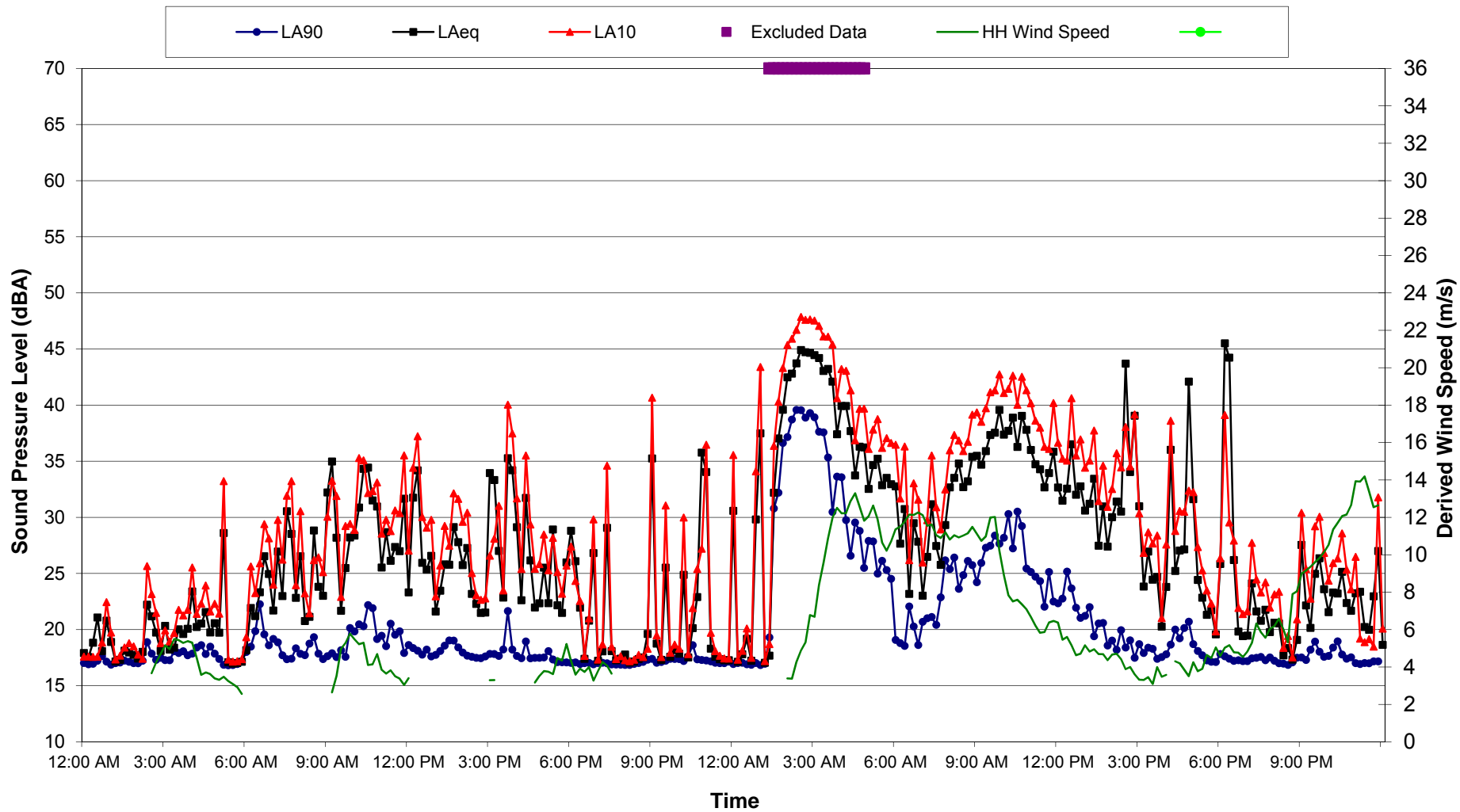
Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 15 and 16 May 2016



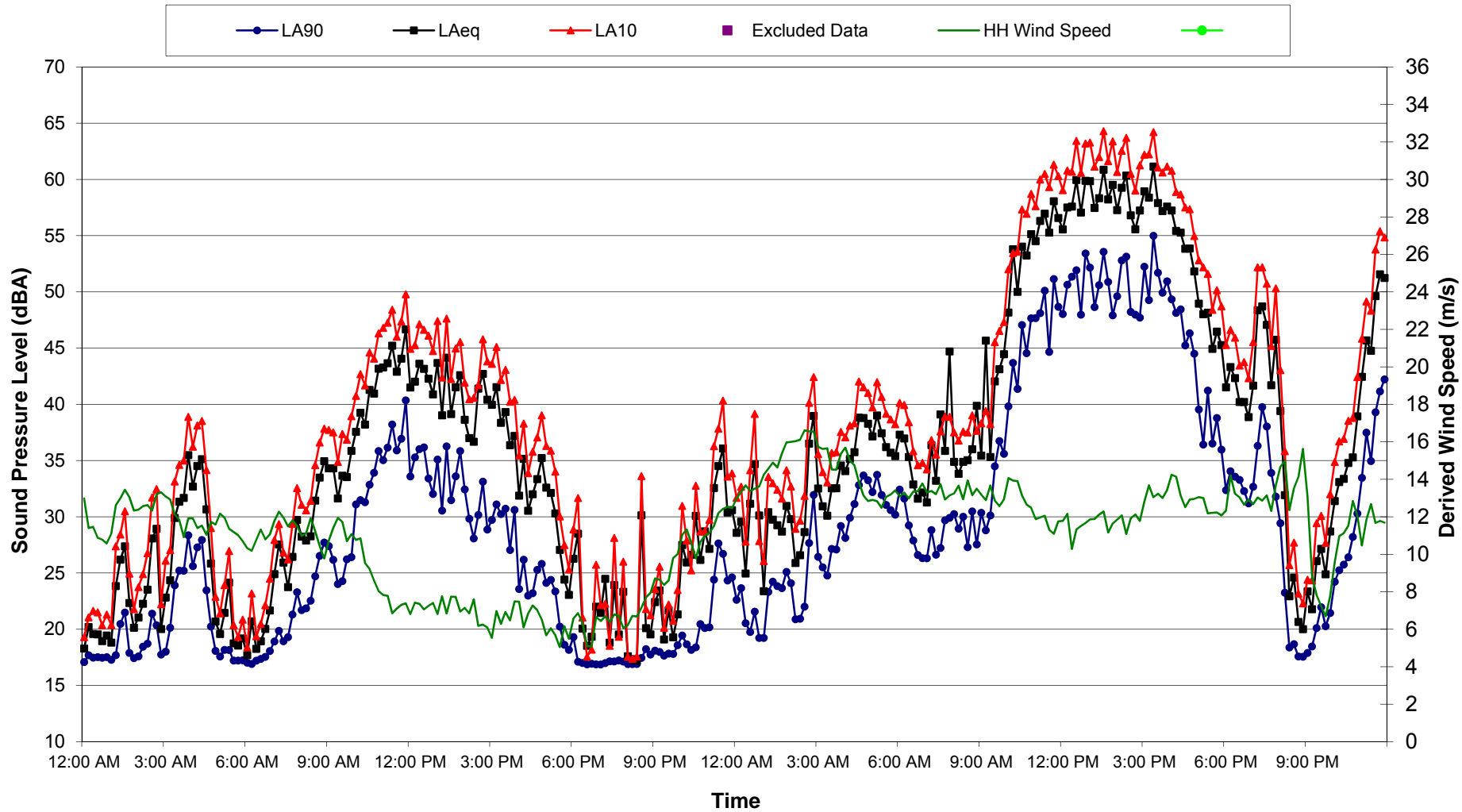
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 17 and 18 May 2016**



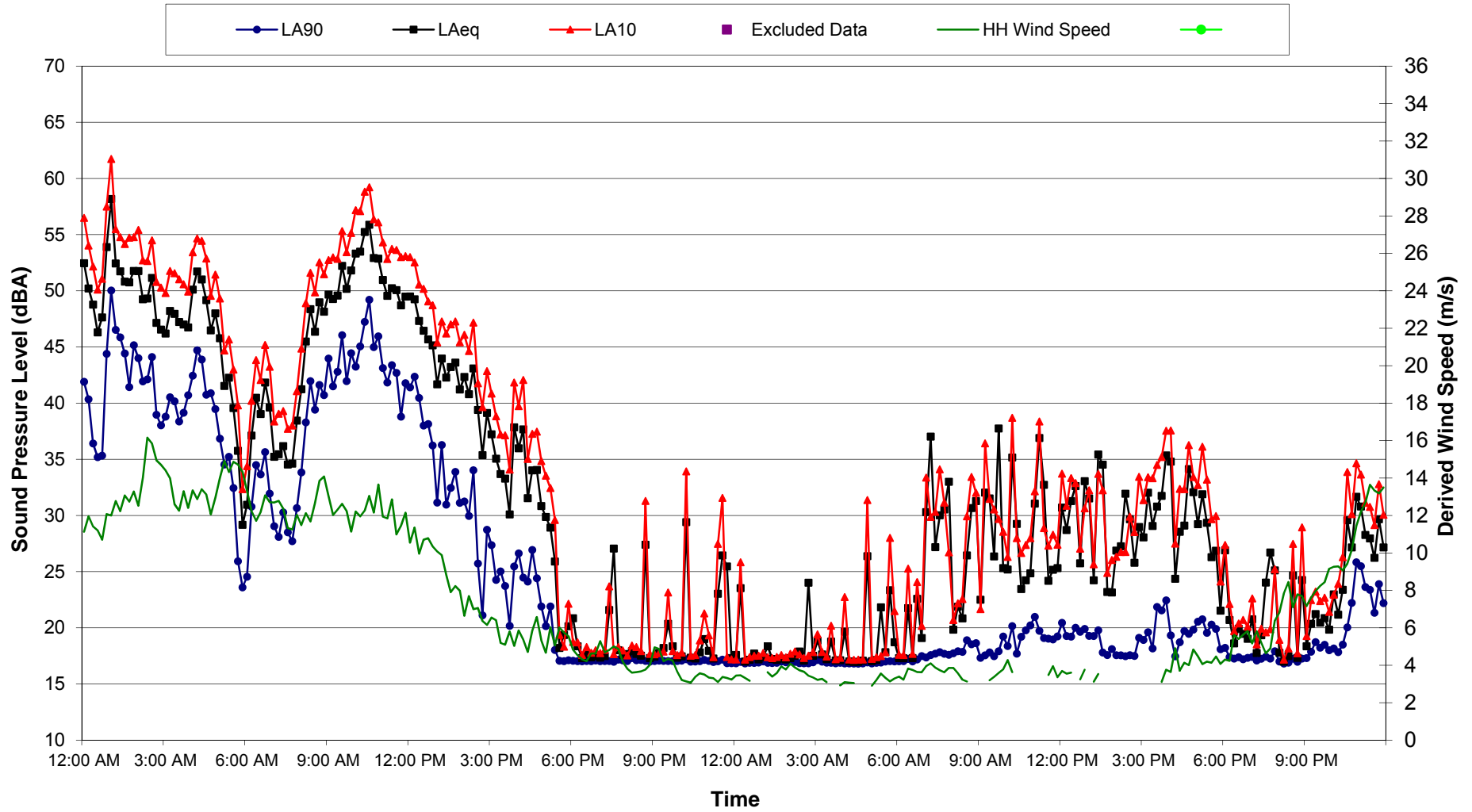
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 19 and 20 May 2016



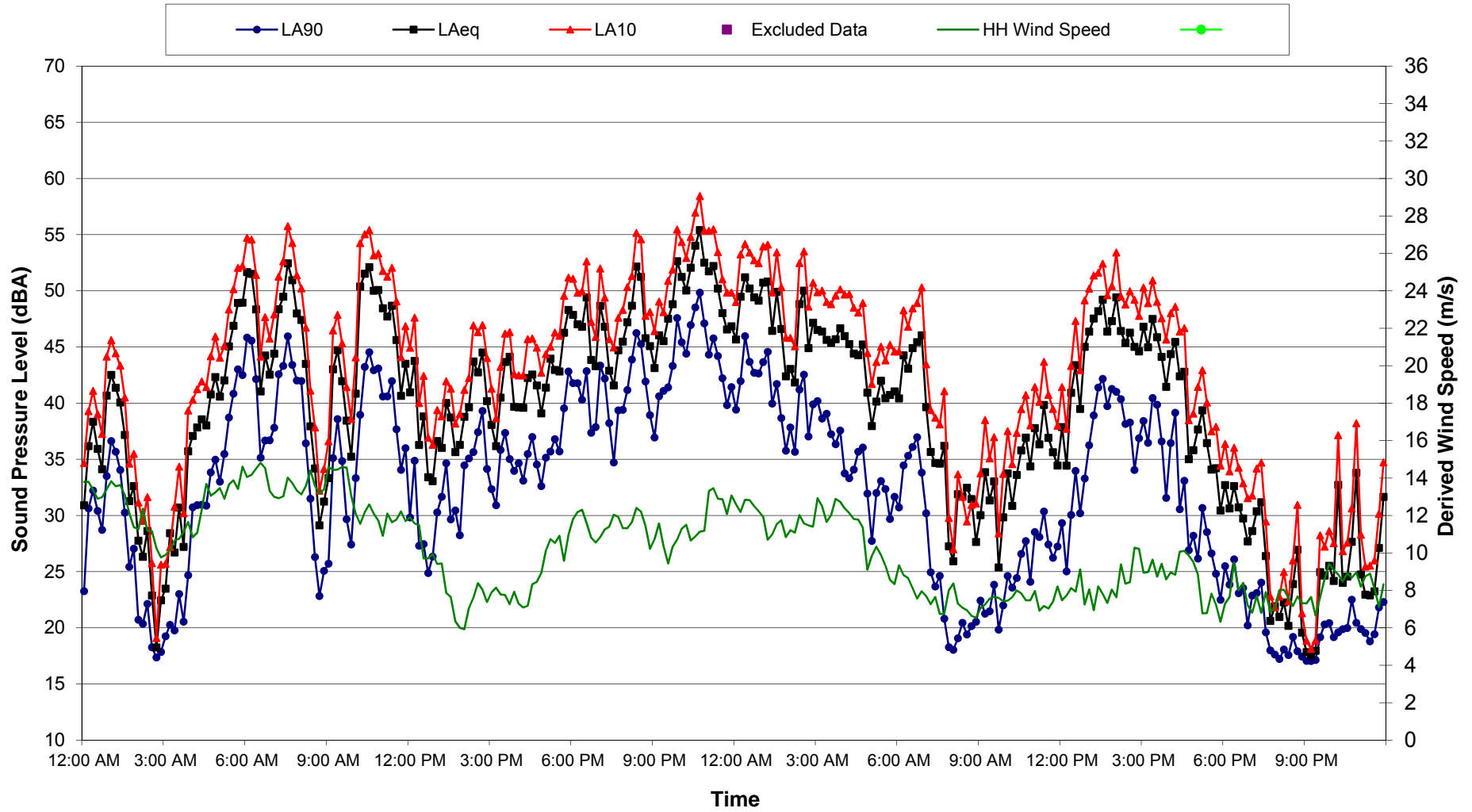
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 21 and 22 May 2016**



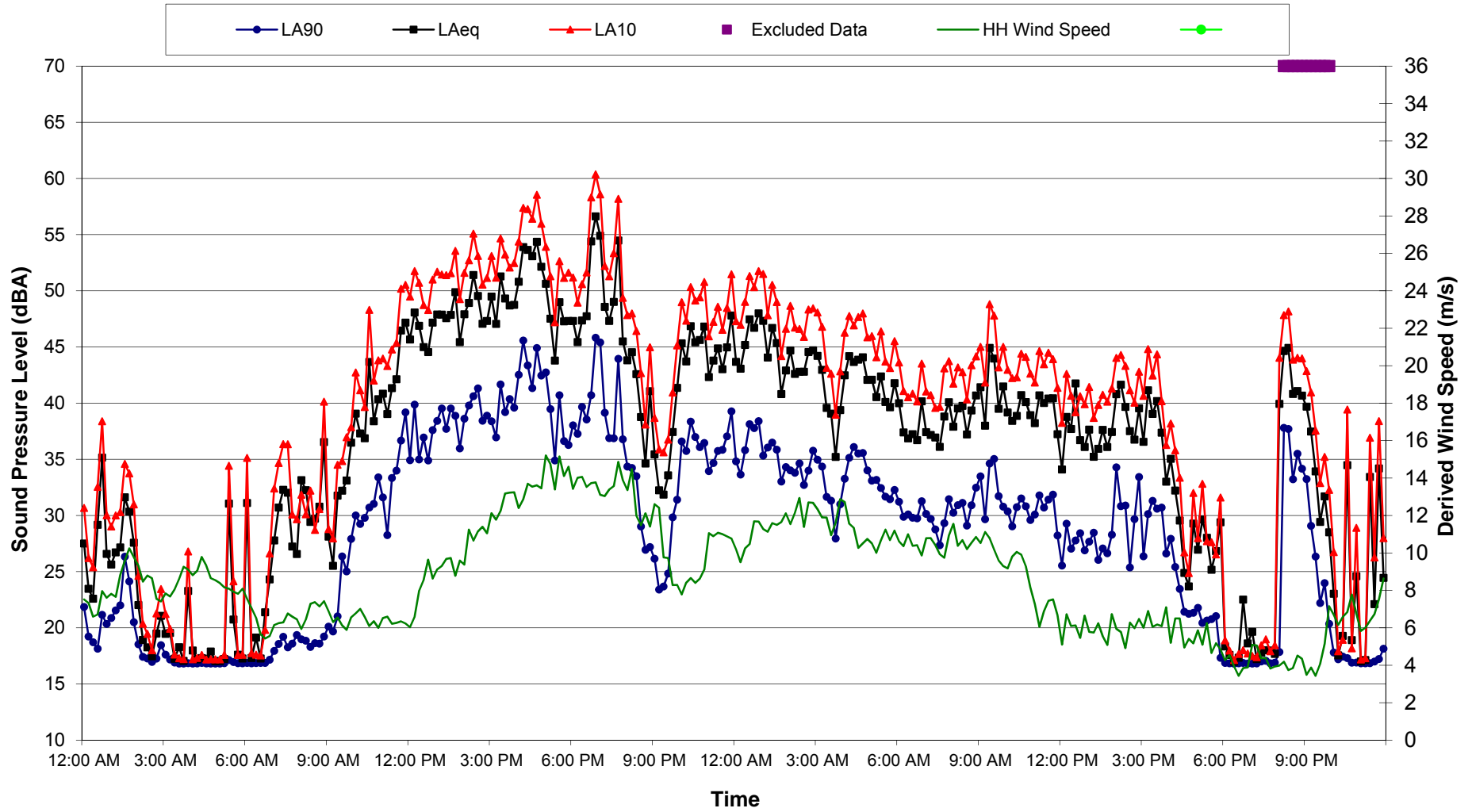
Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 23 and 24 May 2016



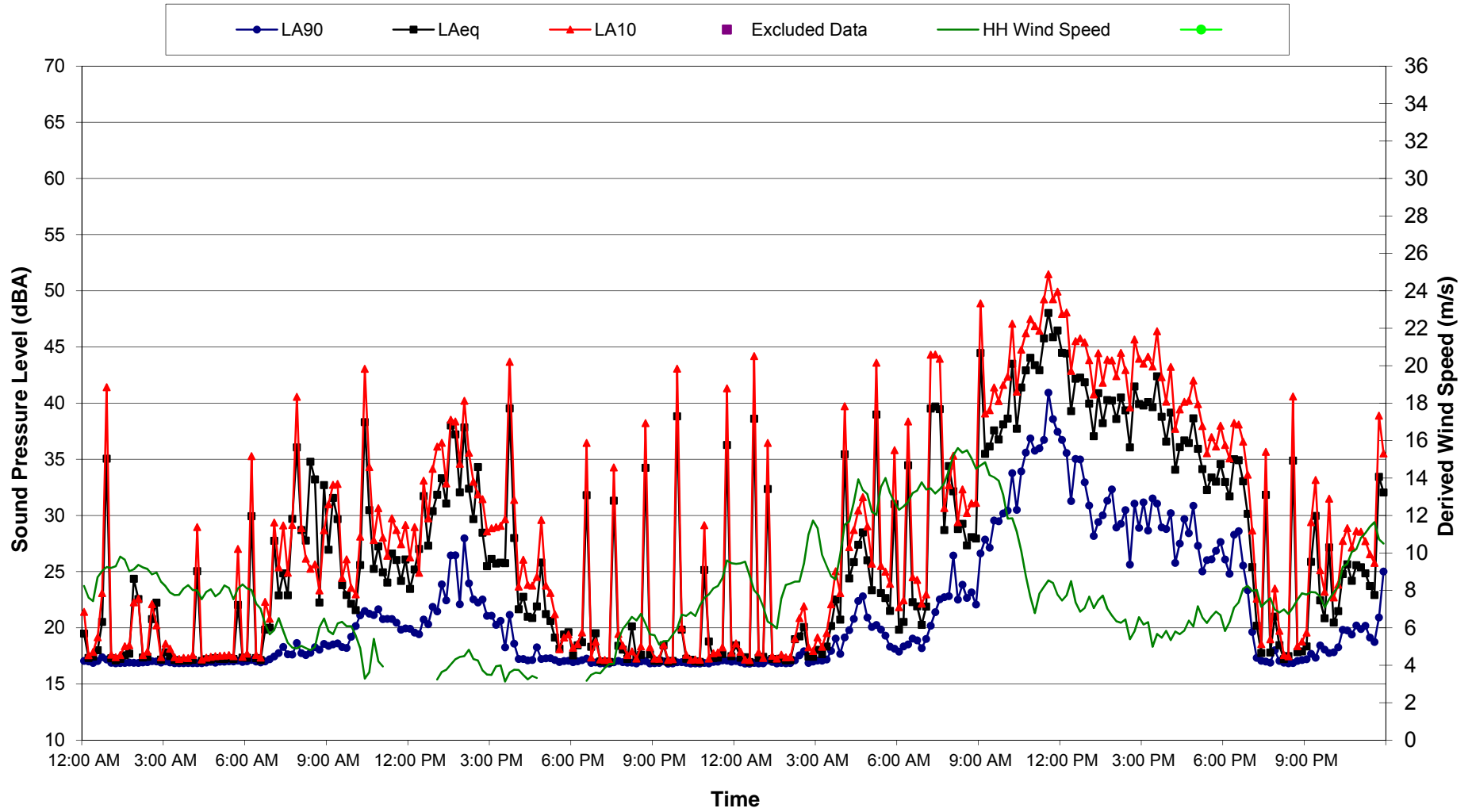
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



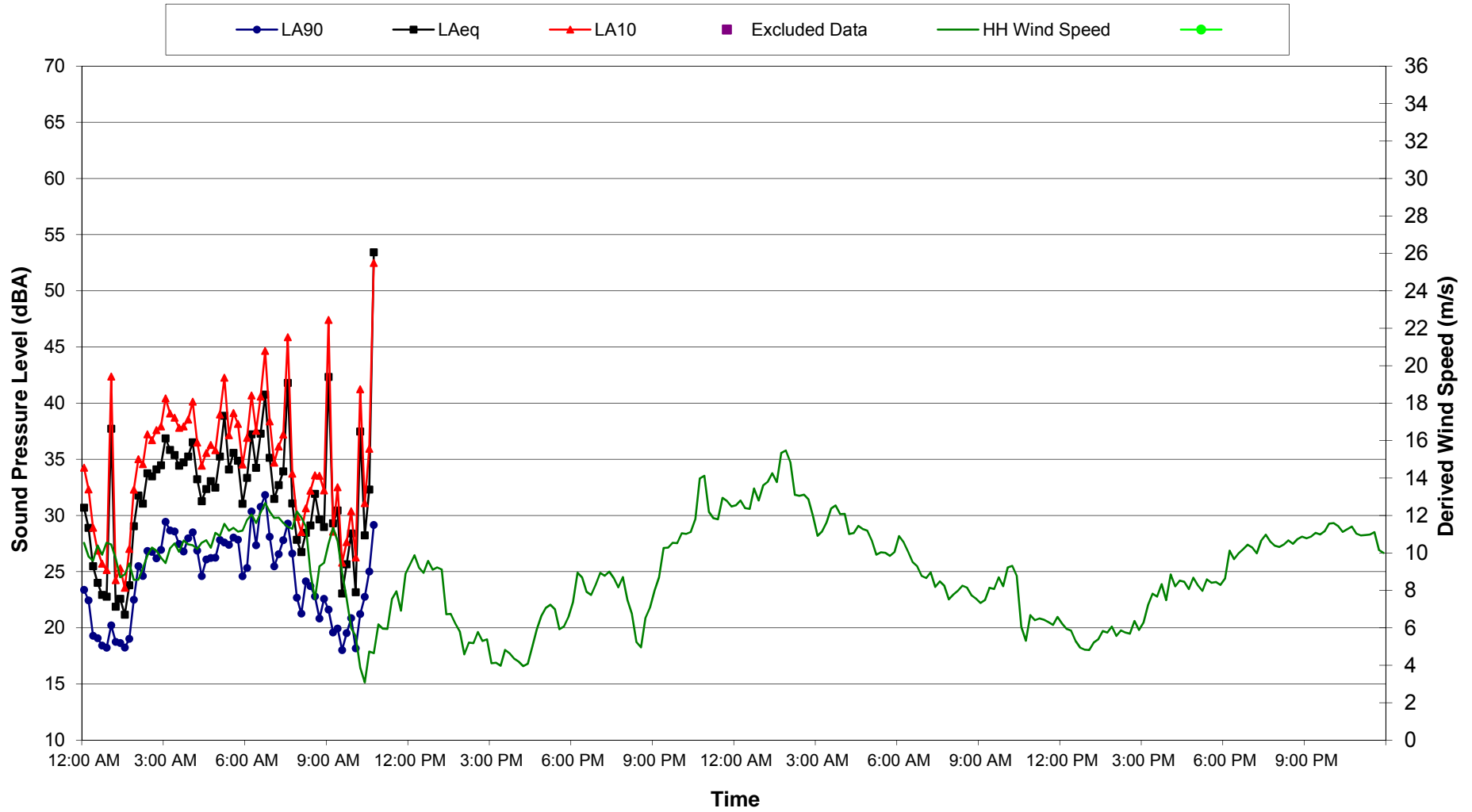
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**



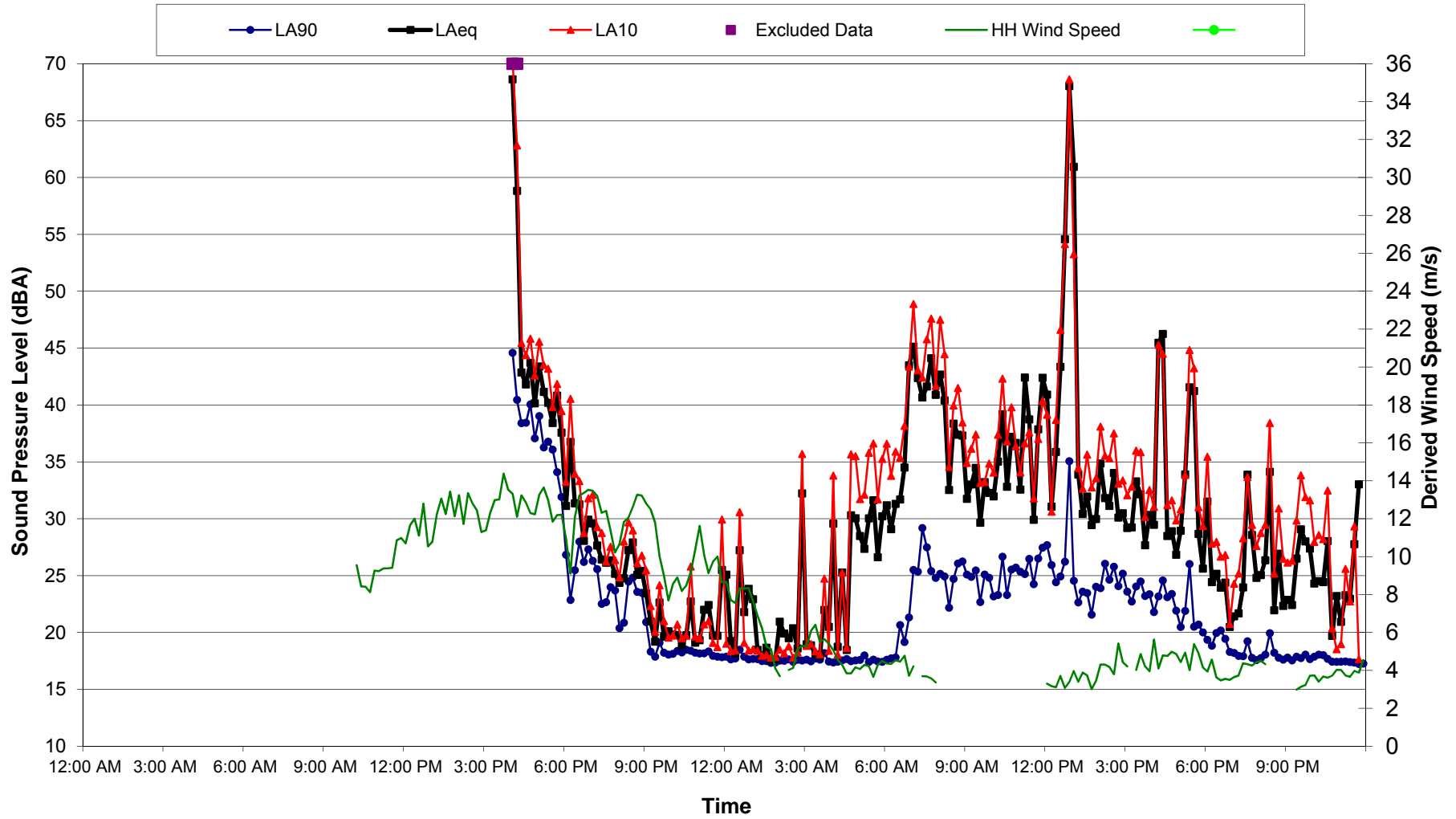
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016**



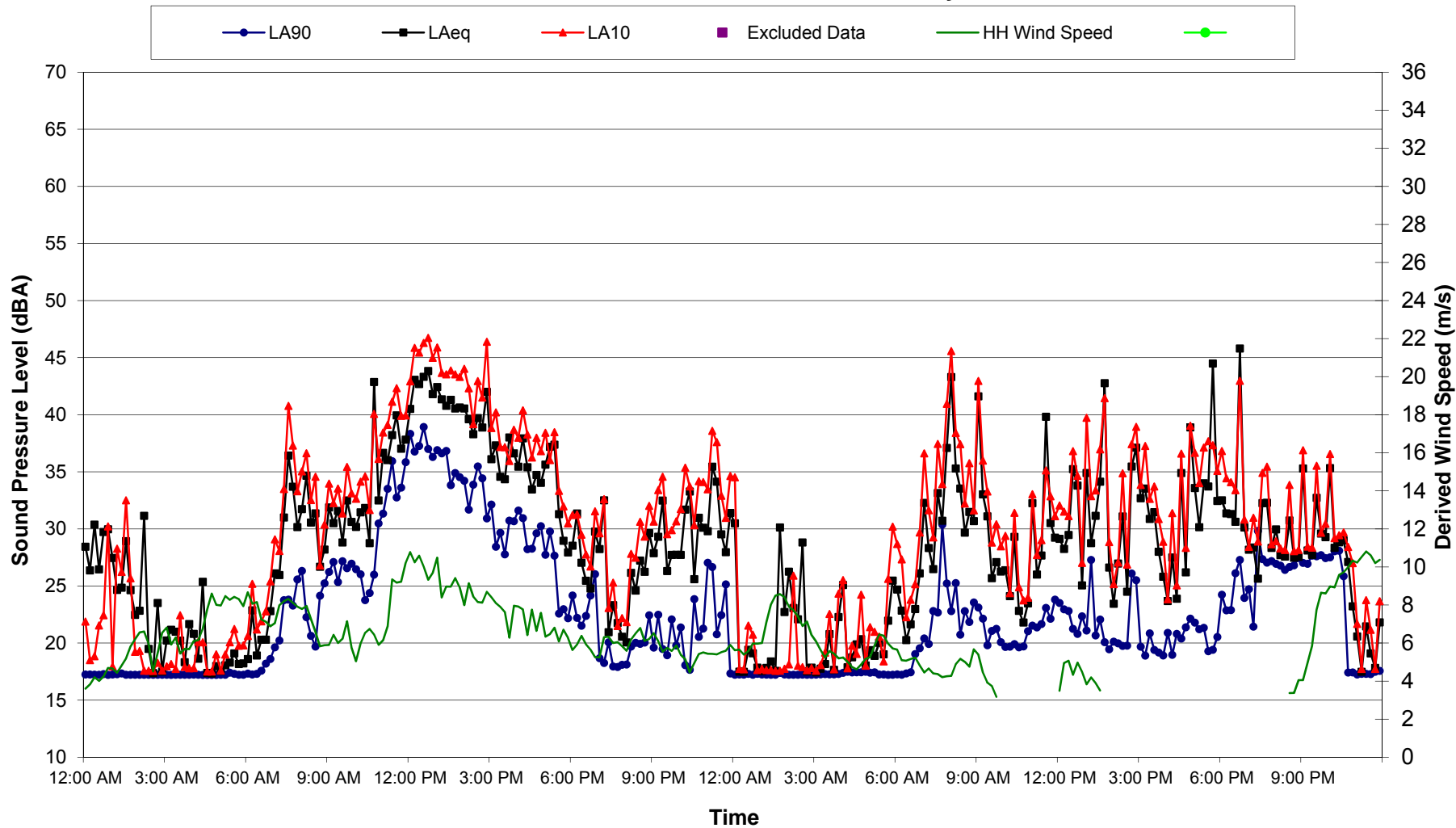
Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 31 May and 1 June 2016



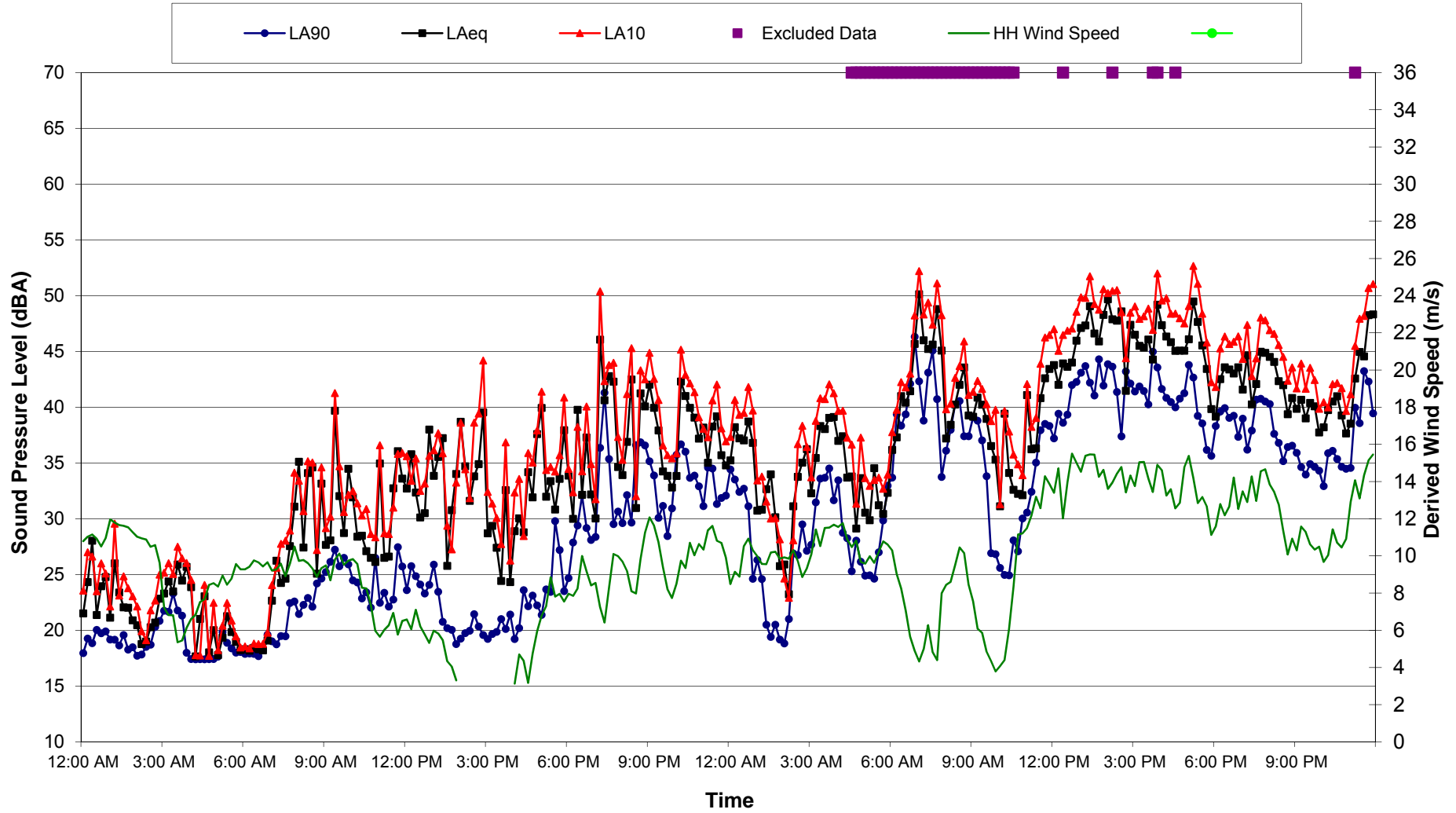
Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 3 and 4 May 2016



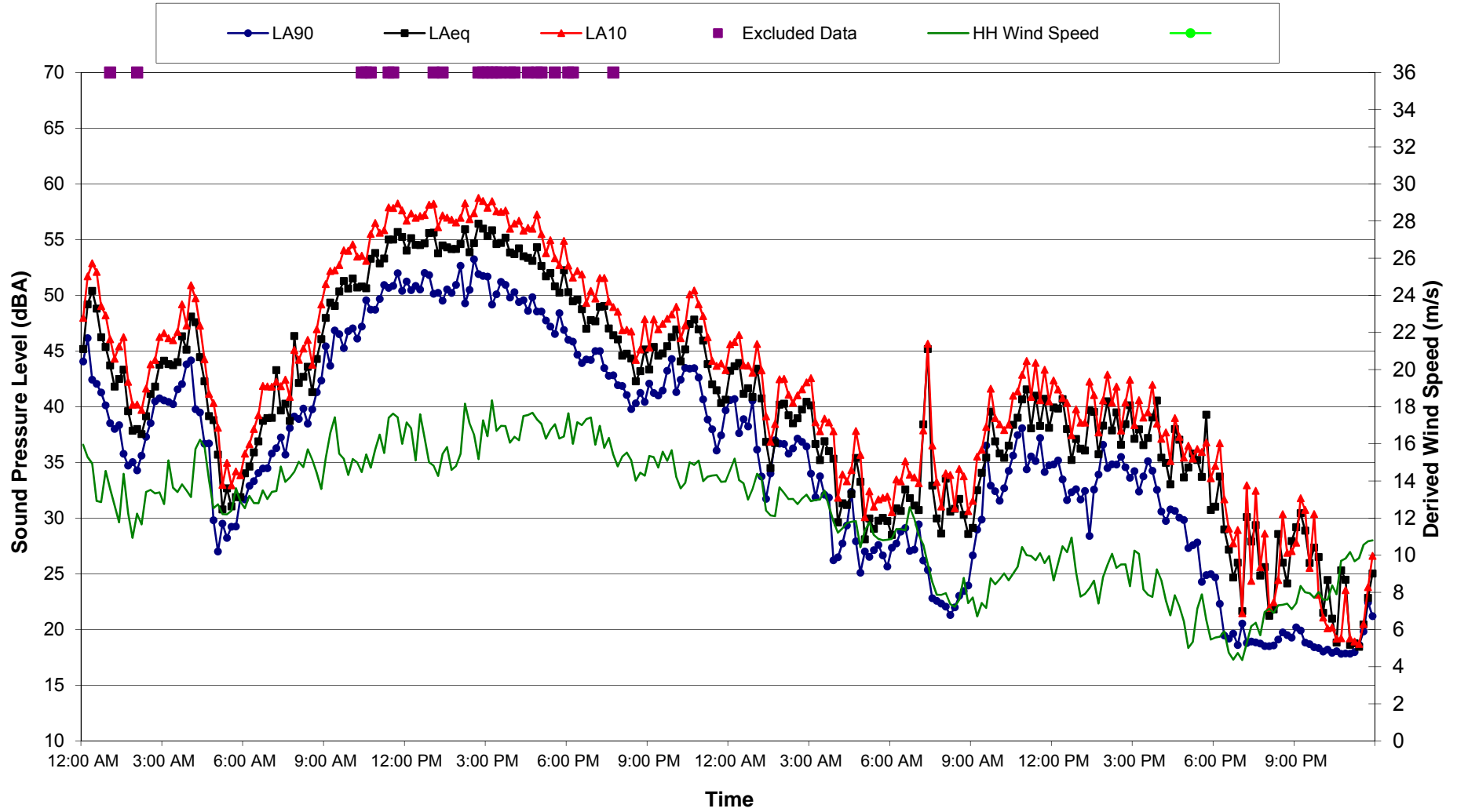
Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016



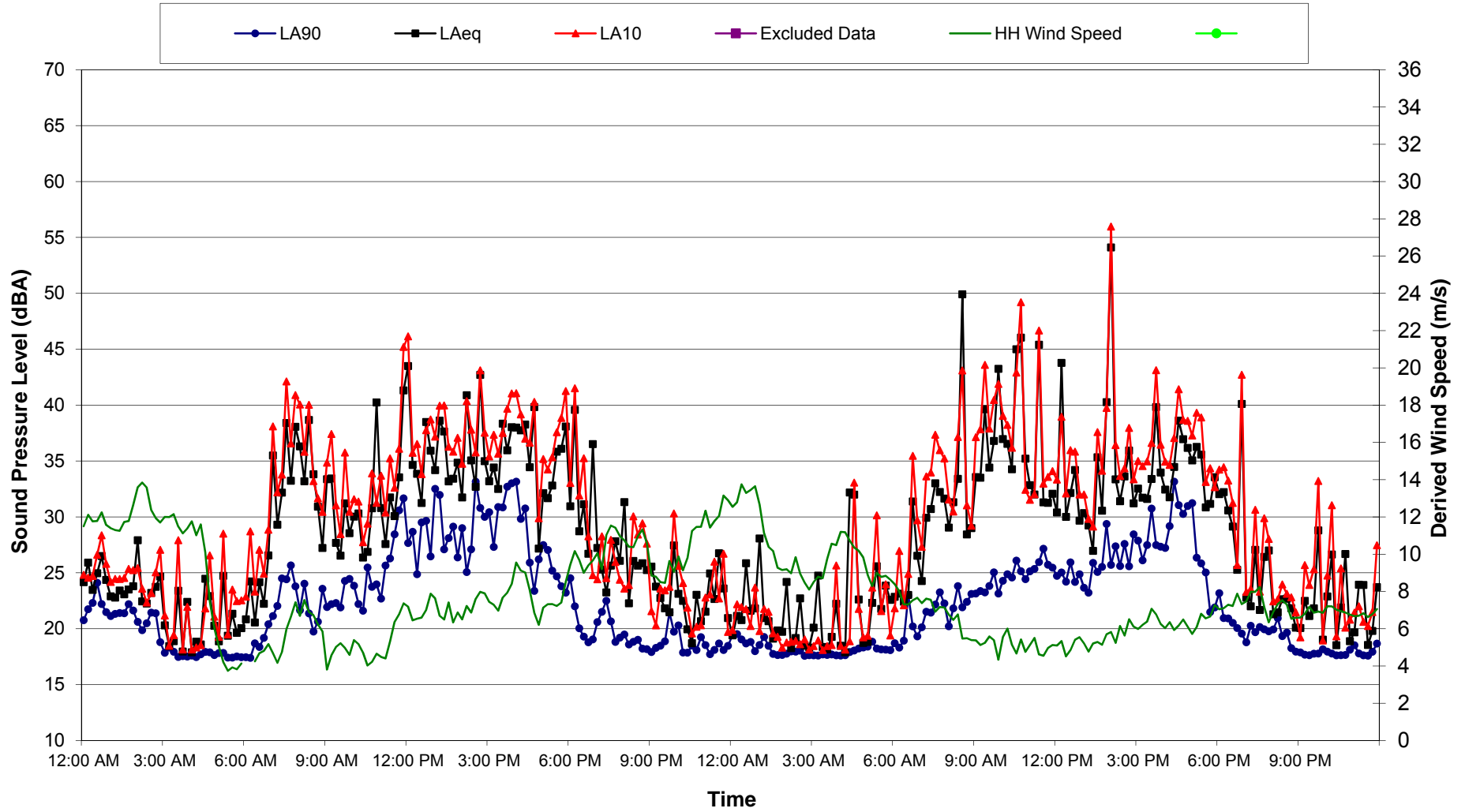
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 7 and 8 May 2016**



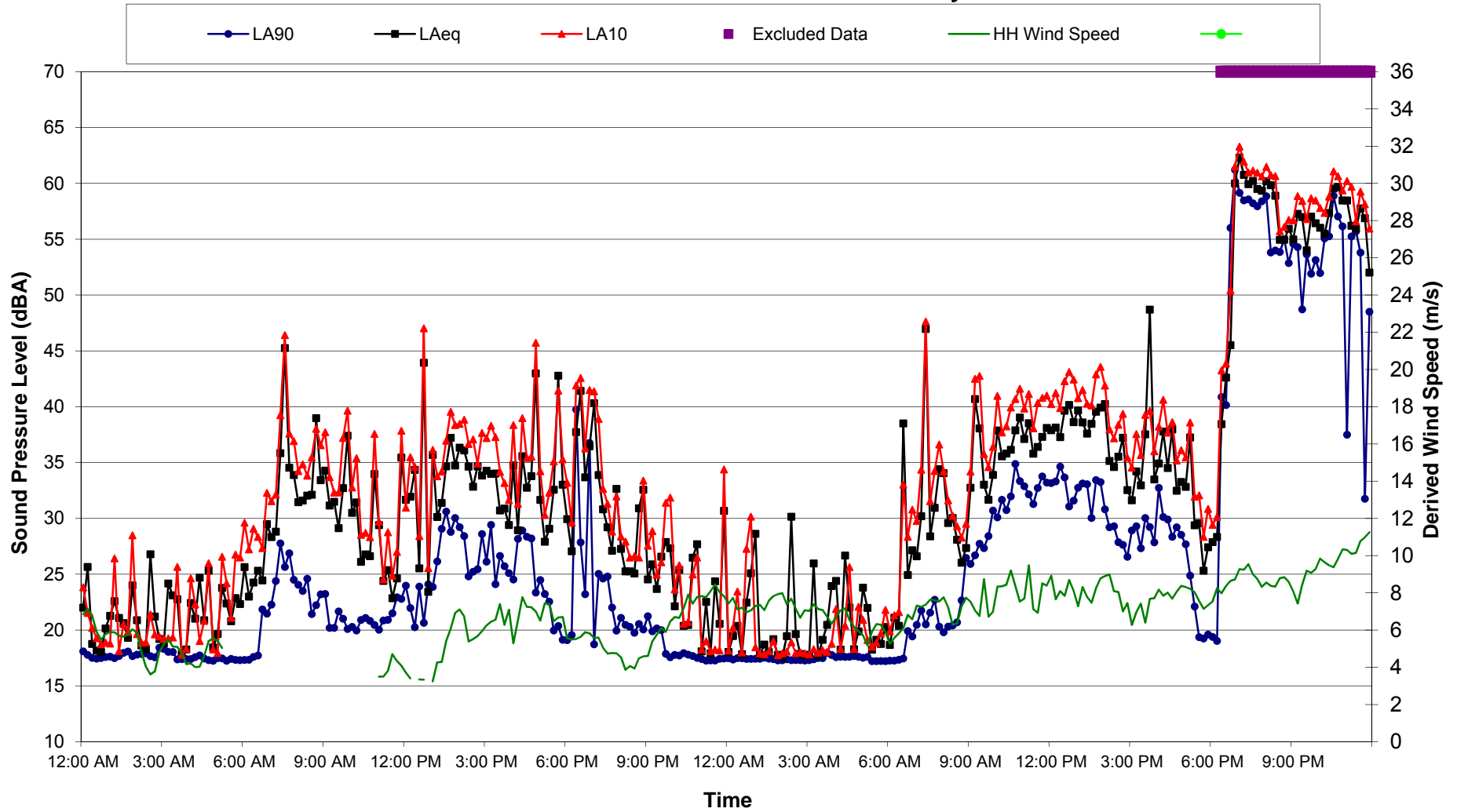
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 9 and 10 May 2016**



Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 11 and 12 May 2016



Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 13 and 14 May 2016

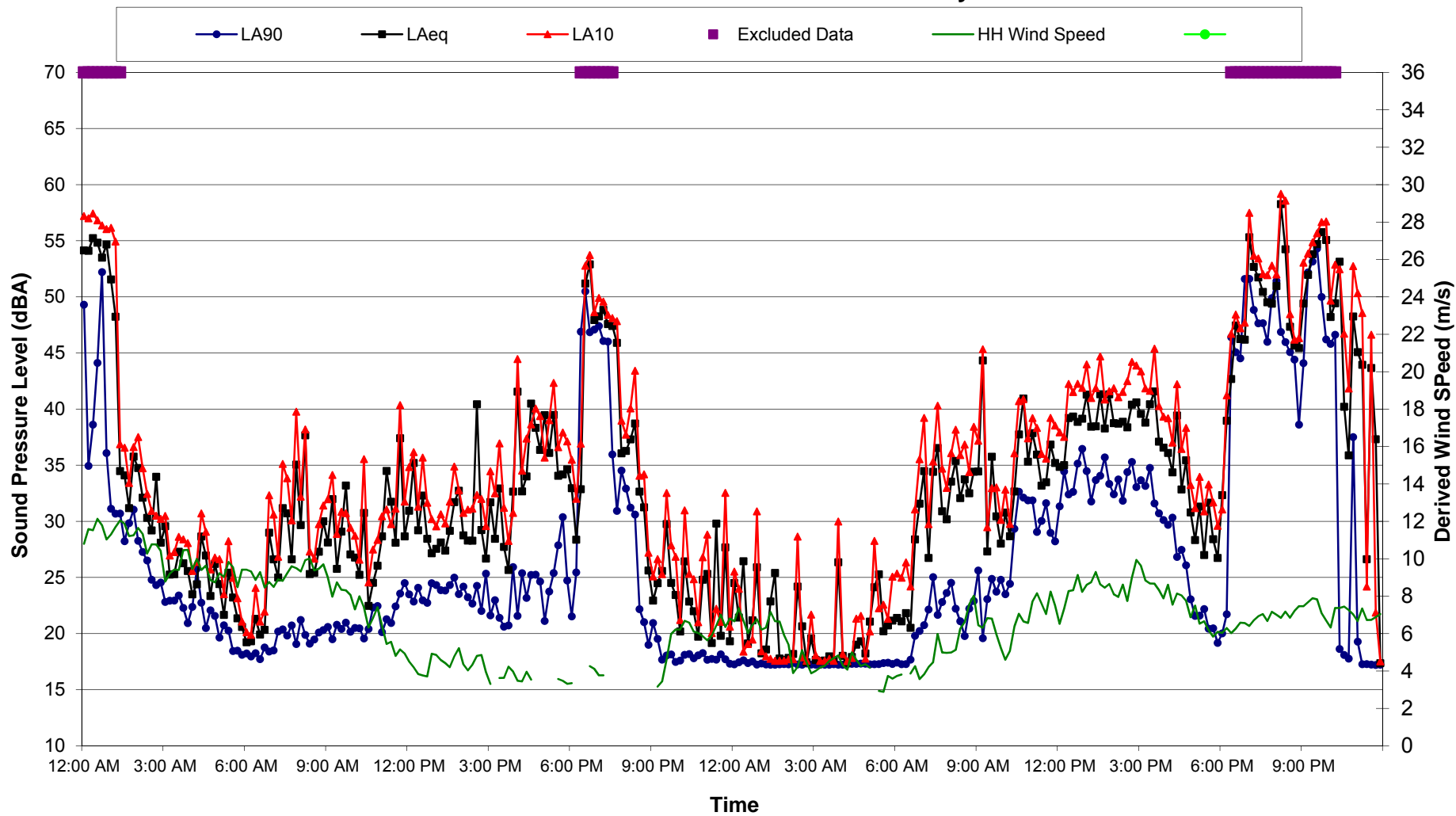


Appendix D

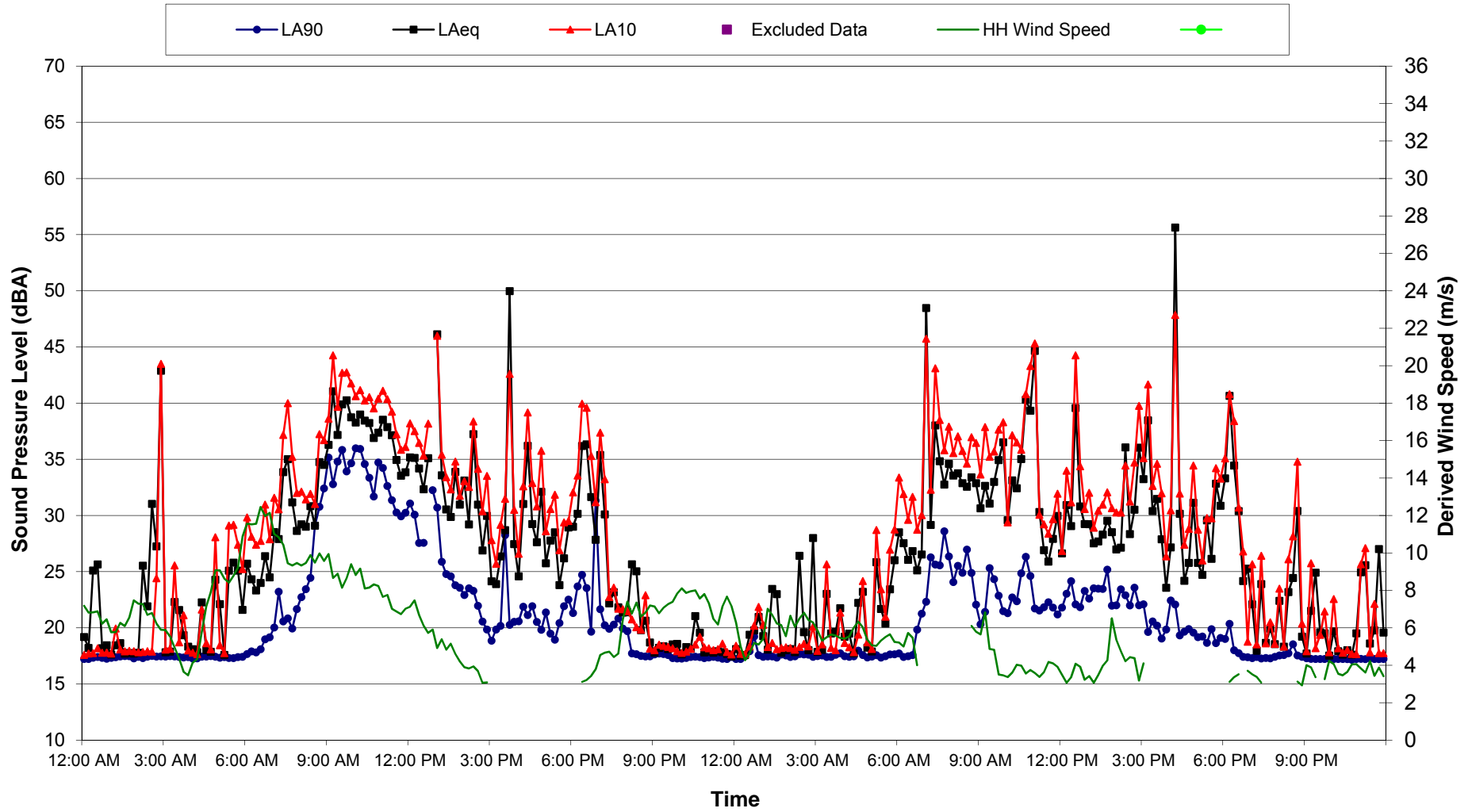
640.11265

Level Wind vs Time

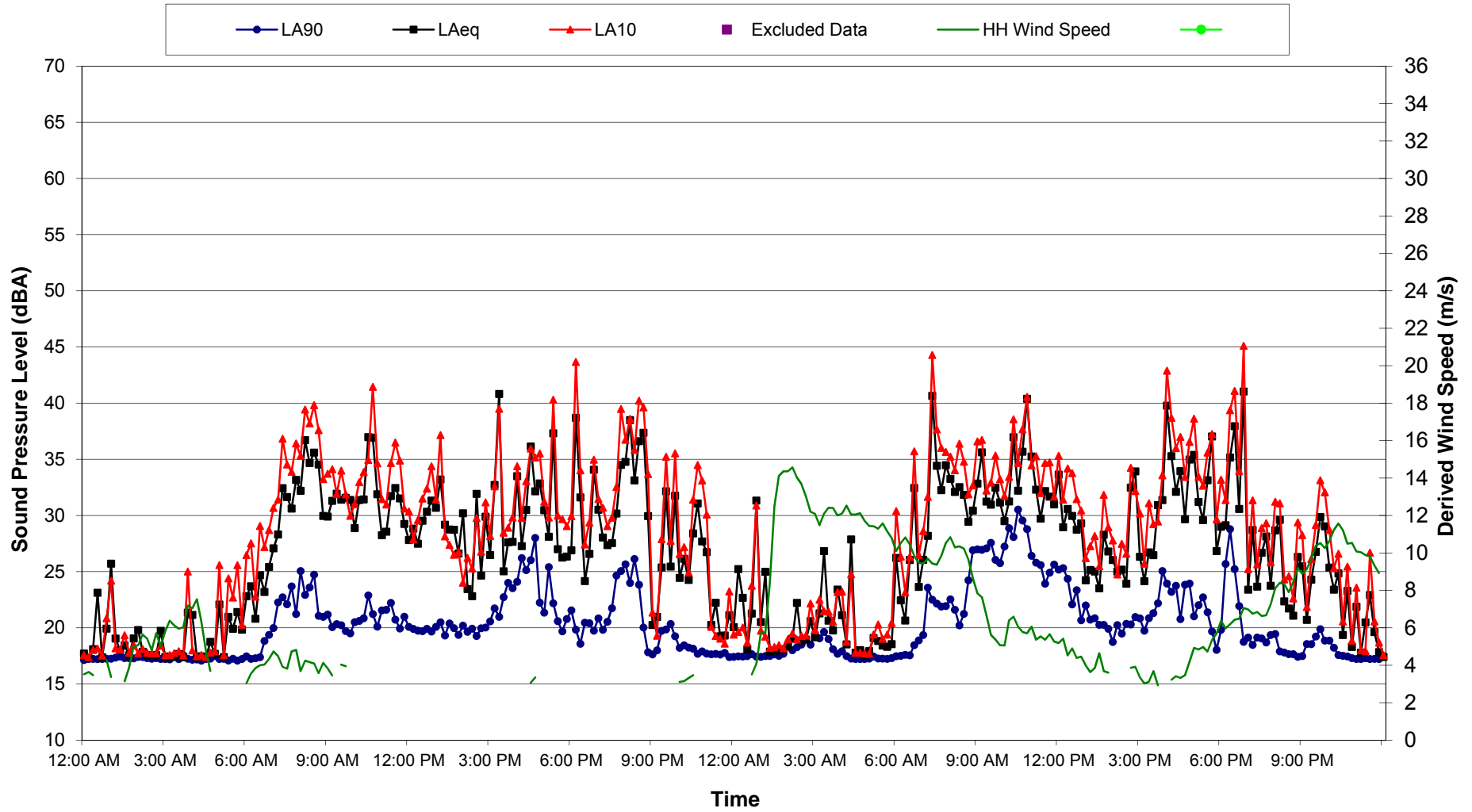
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 15 and 16 May 2016**



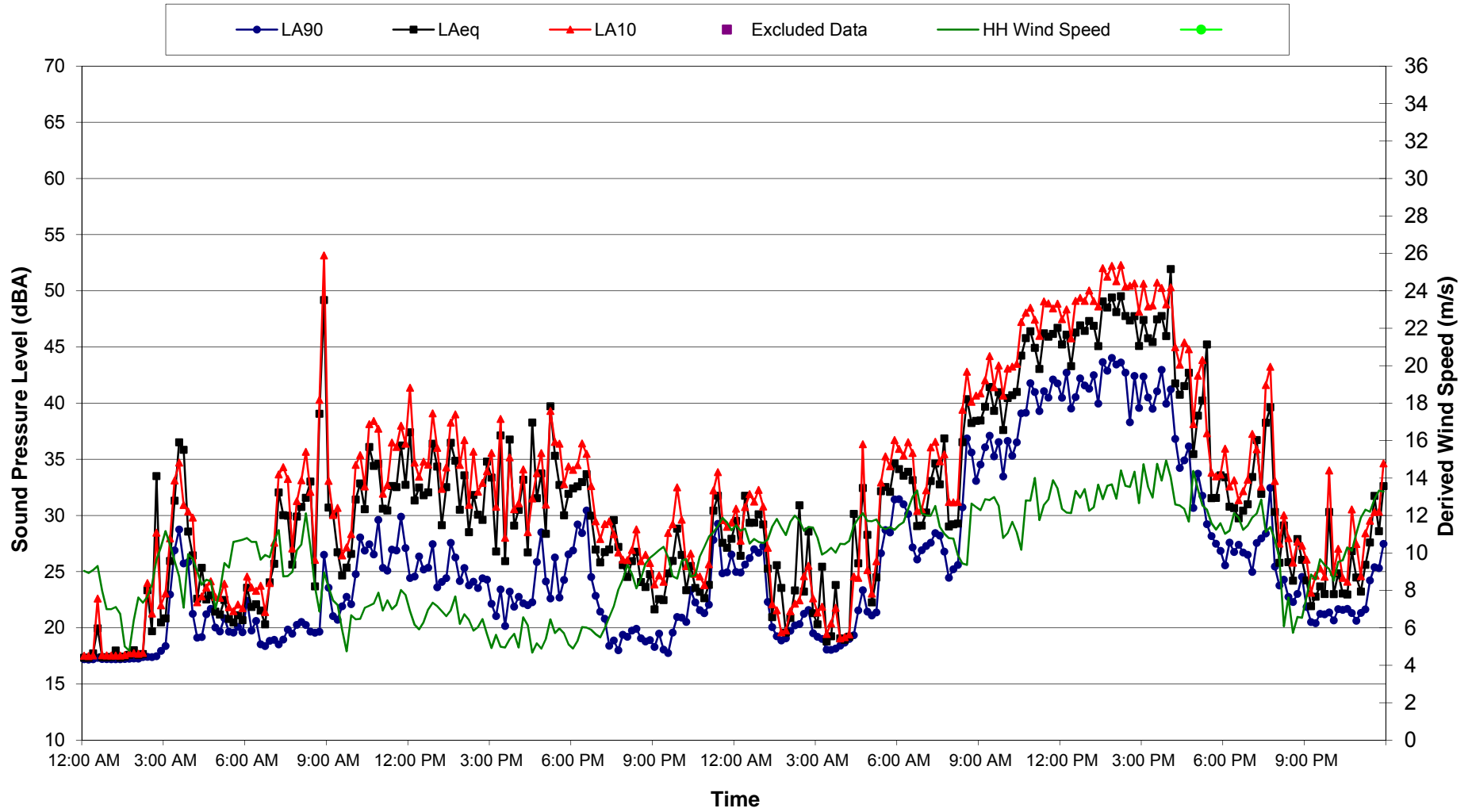
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 17 and 18 May 2016**



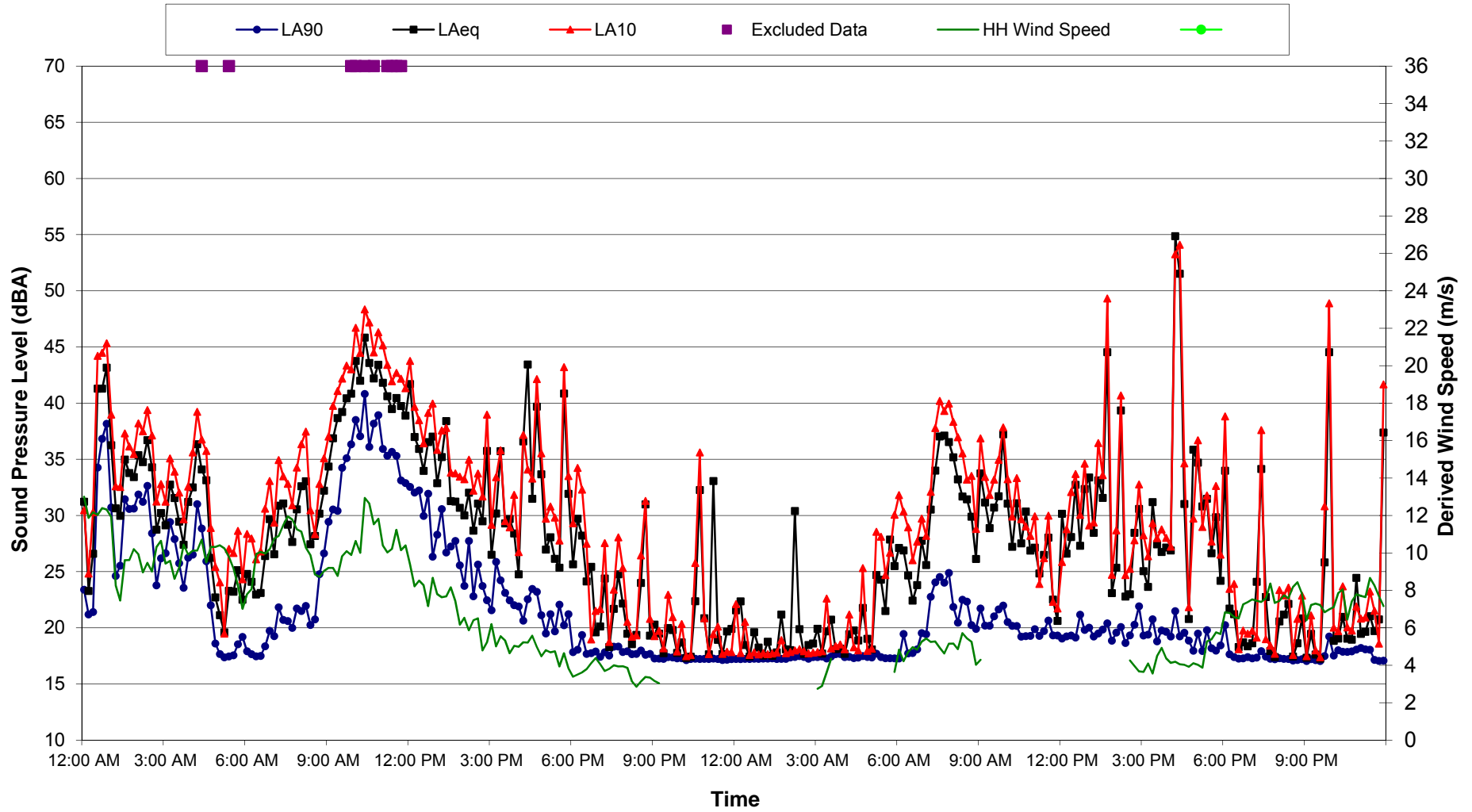
Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 19 and 20 May 2016



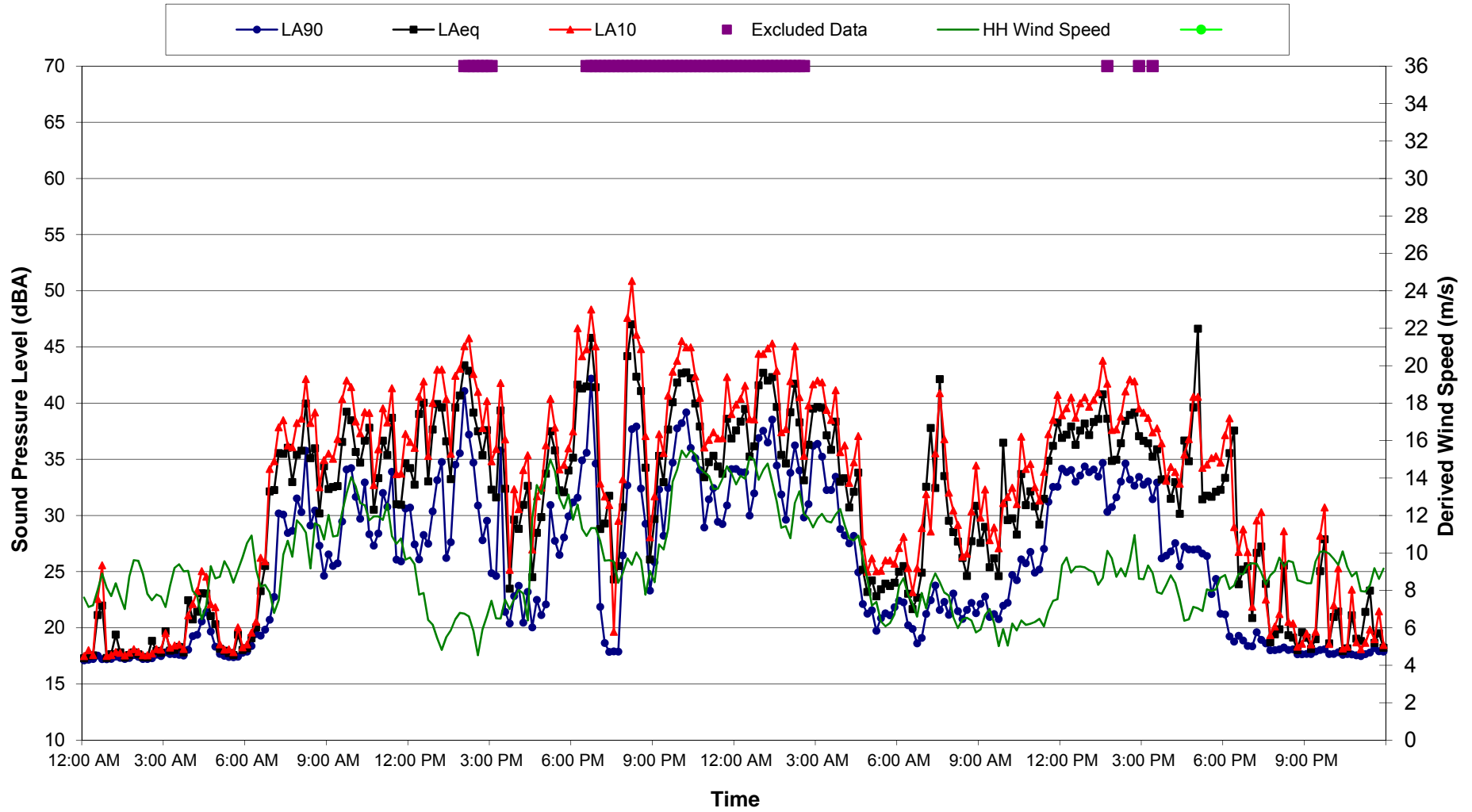
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 21 and 22 May 2016**



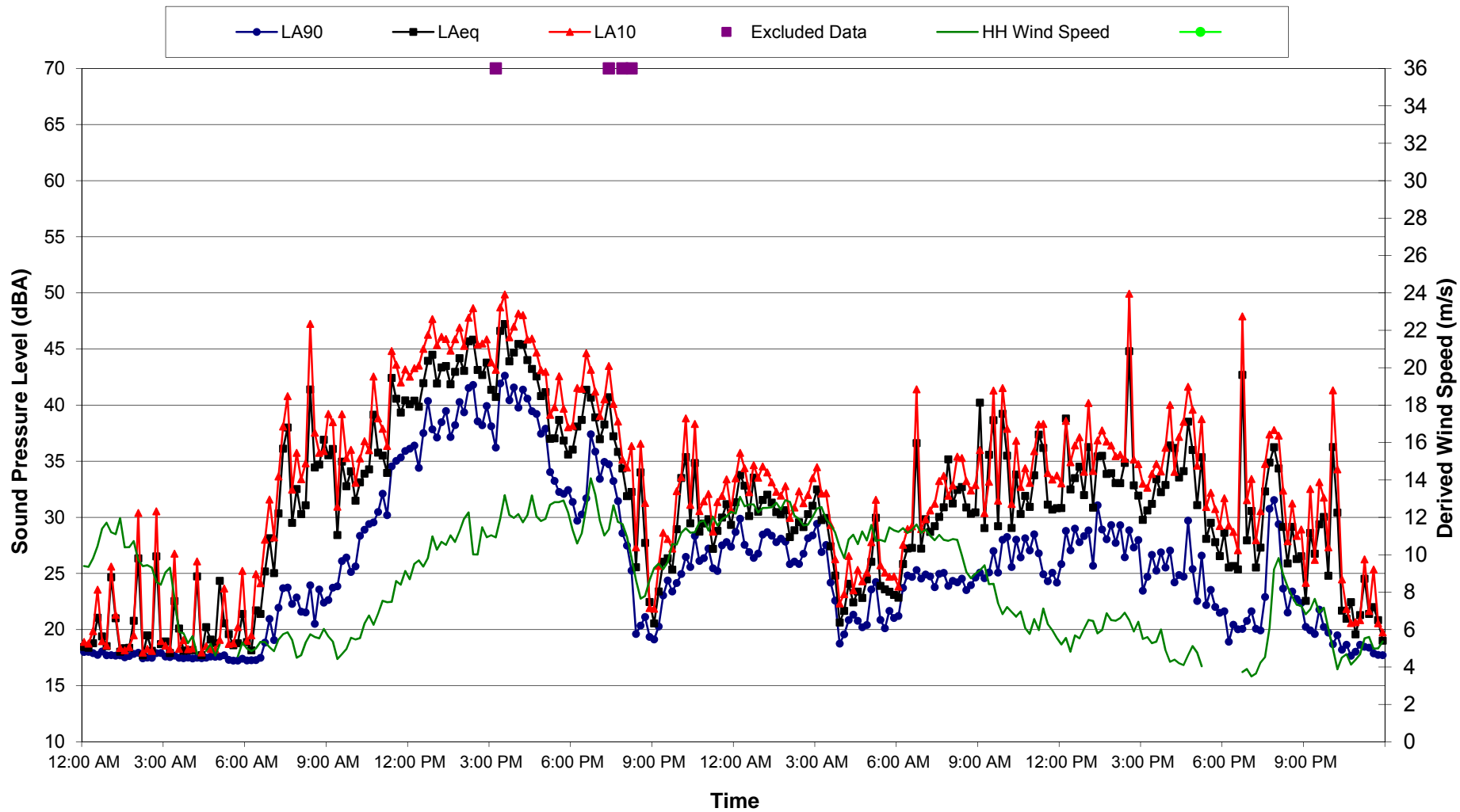
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 23 and 24 May 2016**



**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**

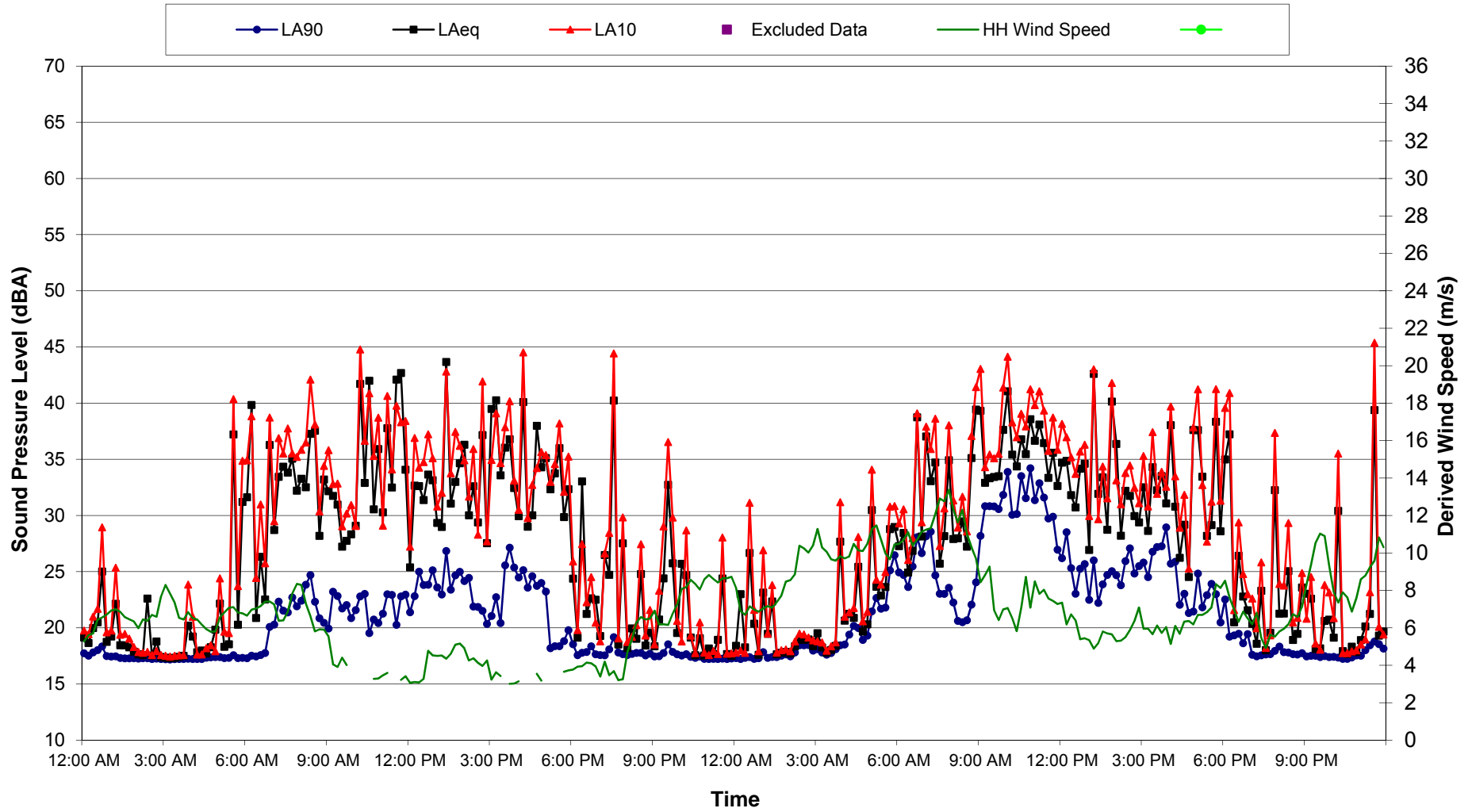


Appendix D

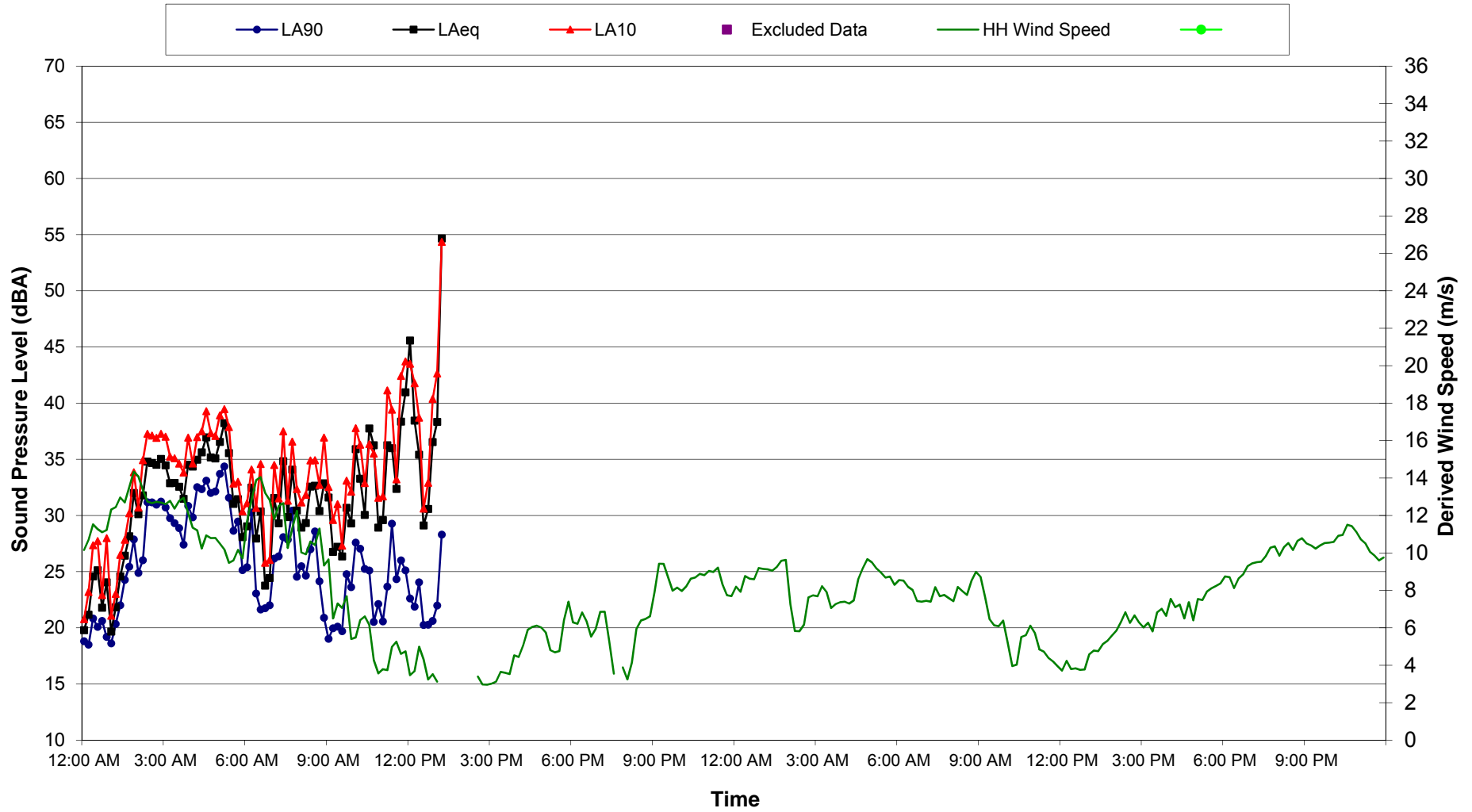
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Level Wind vs Time

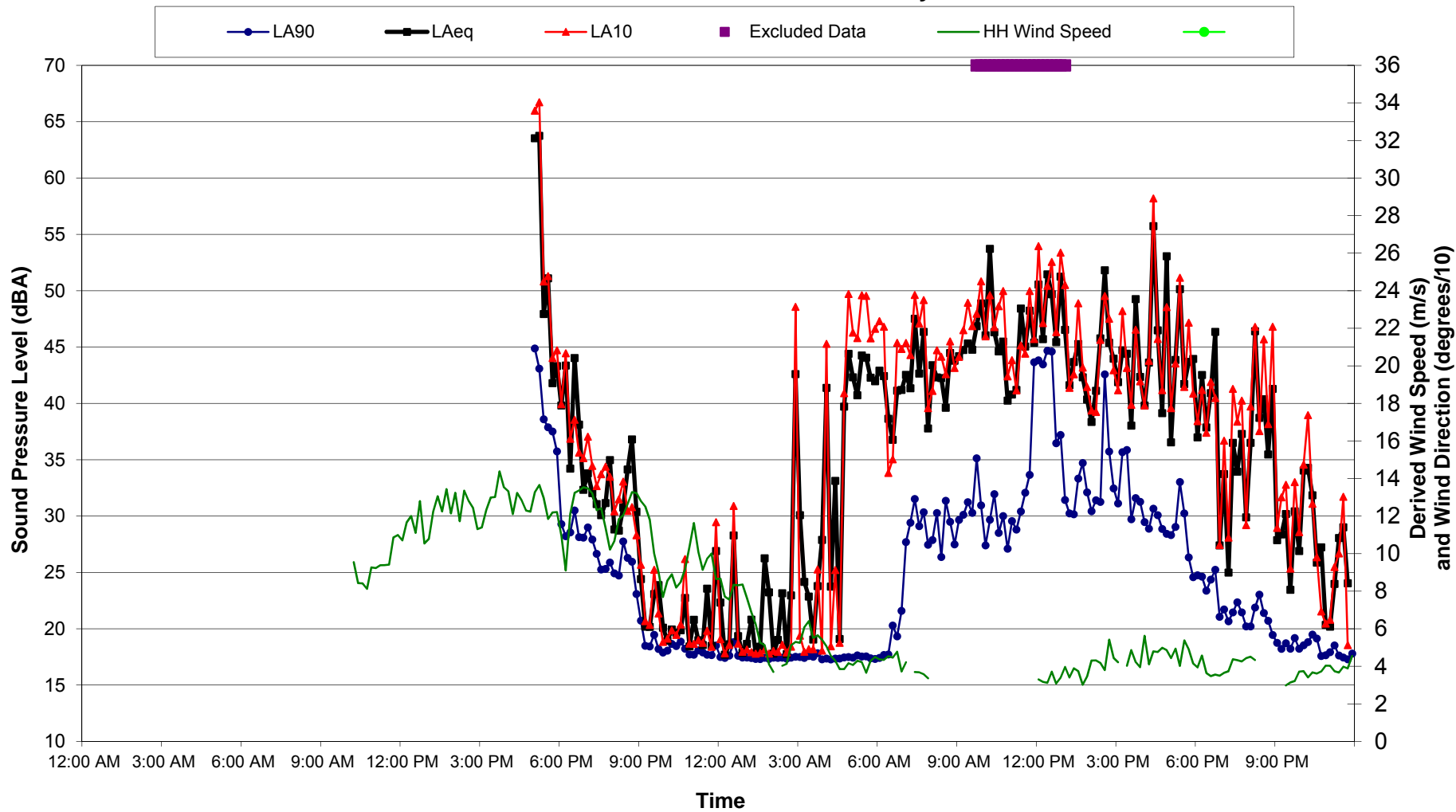
**Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016**



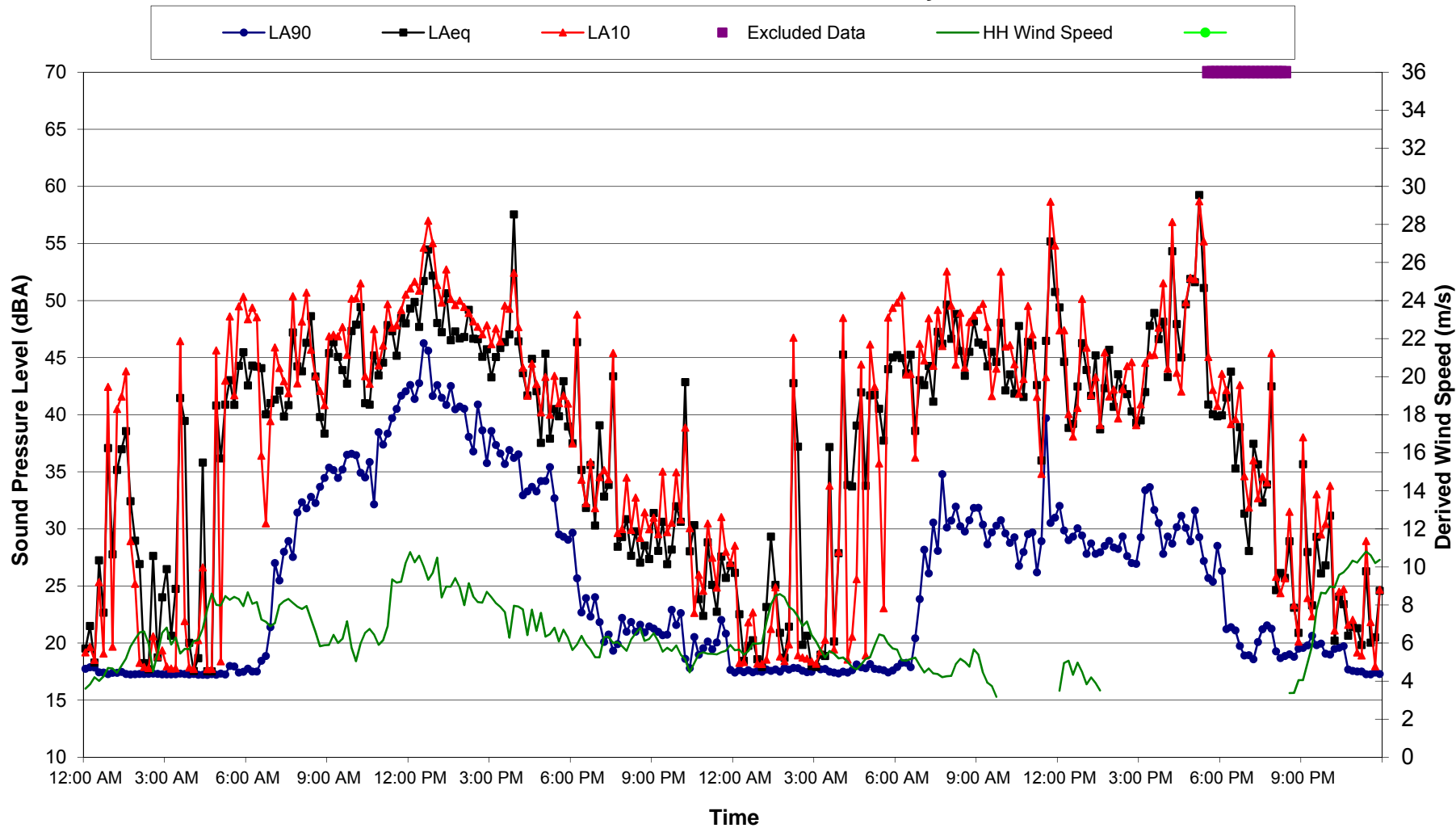
Location Penrose Park North - Silverton Wind Farm
Ambient Noise Data - 31 May and 1 June 2016



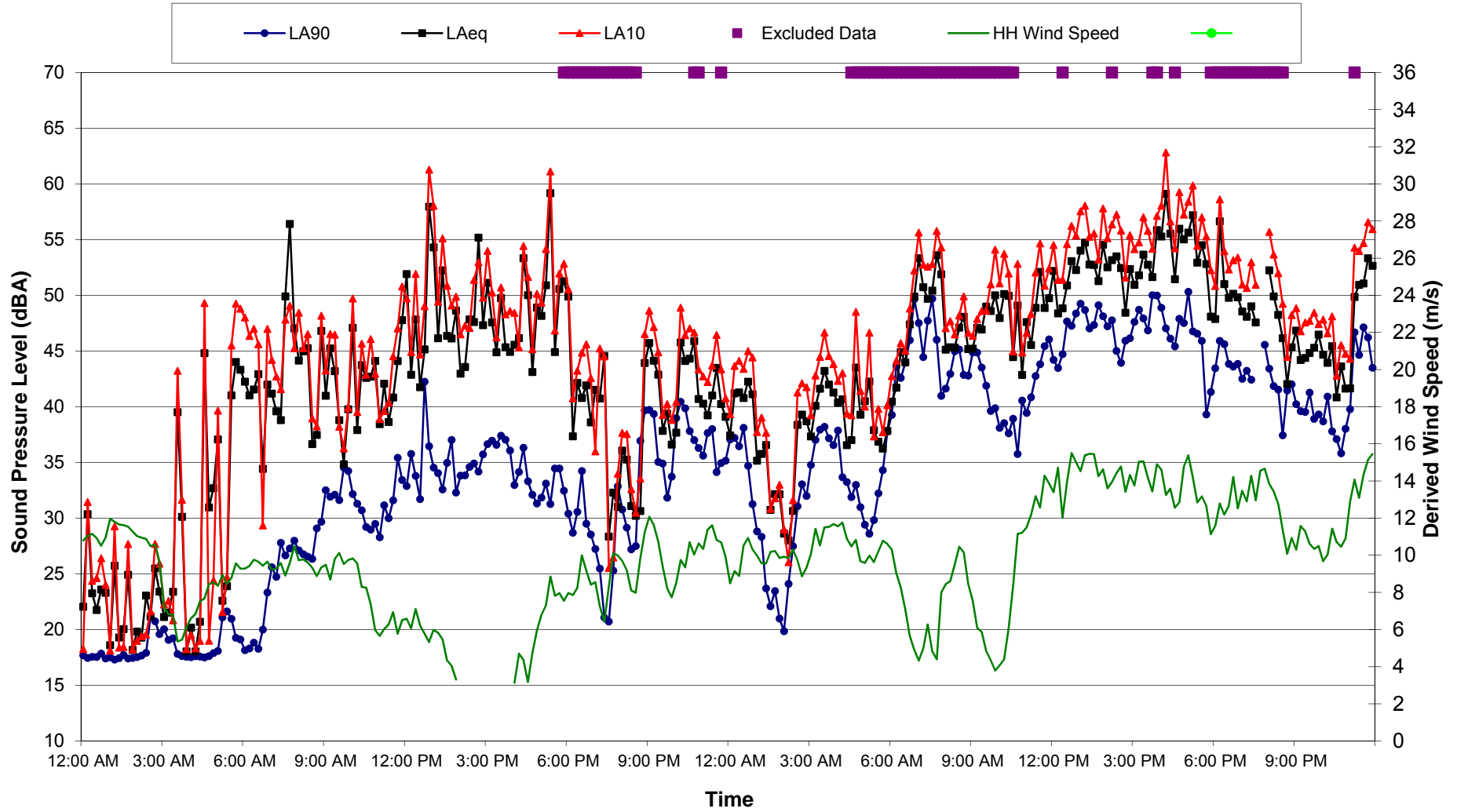
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 3 and 4 May 2016



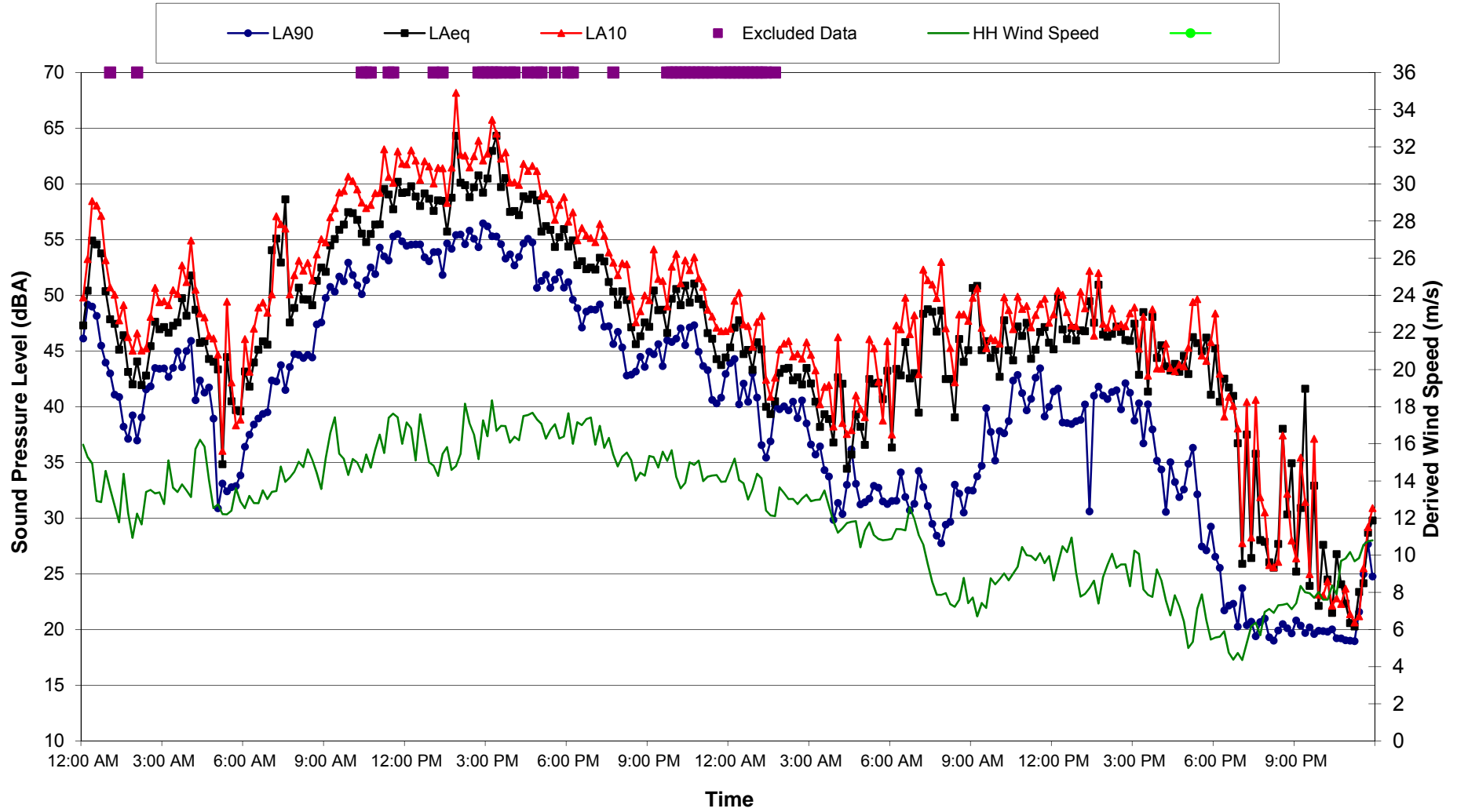
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 5 and 6 May 2016



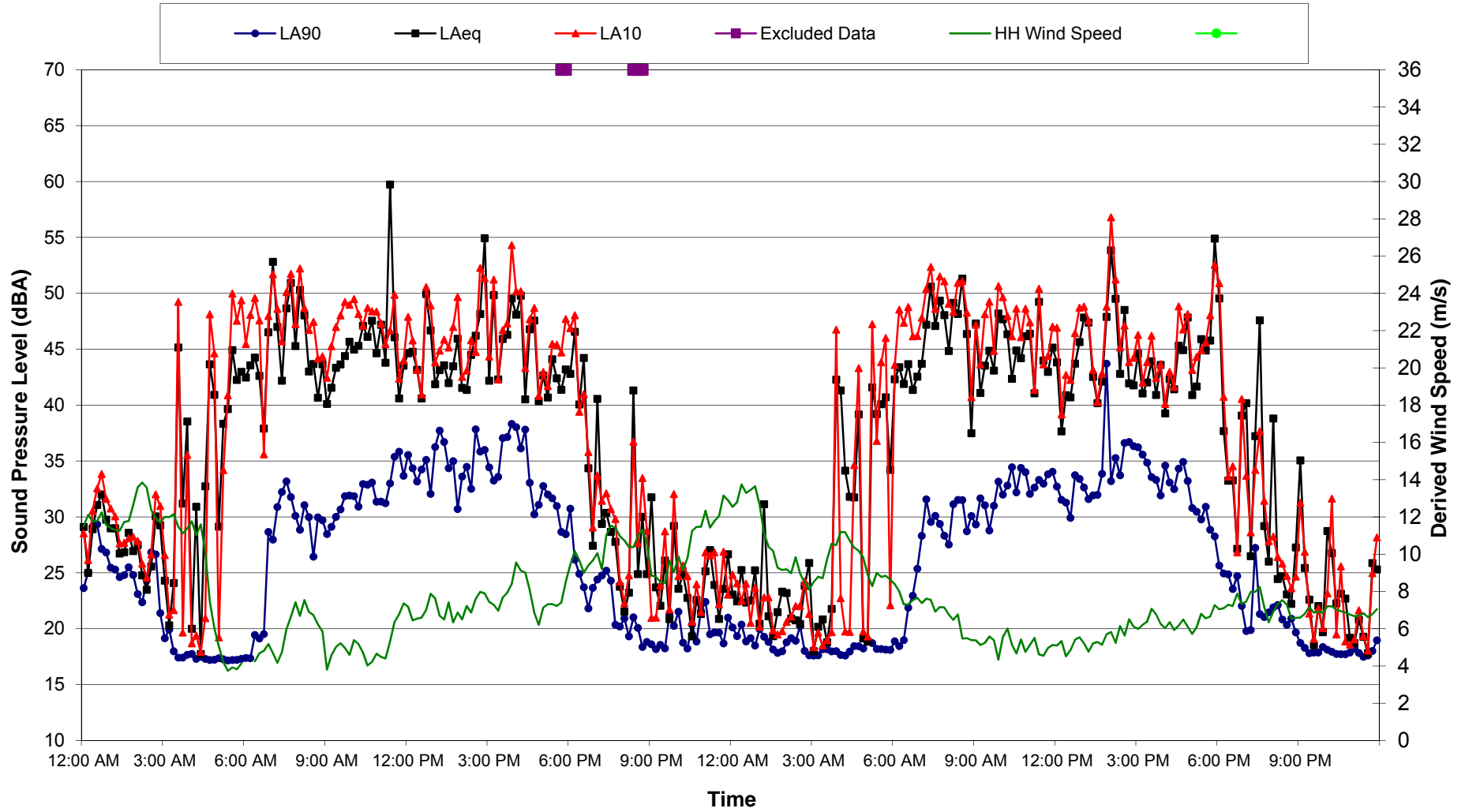
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 7 and 8 May 2016**



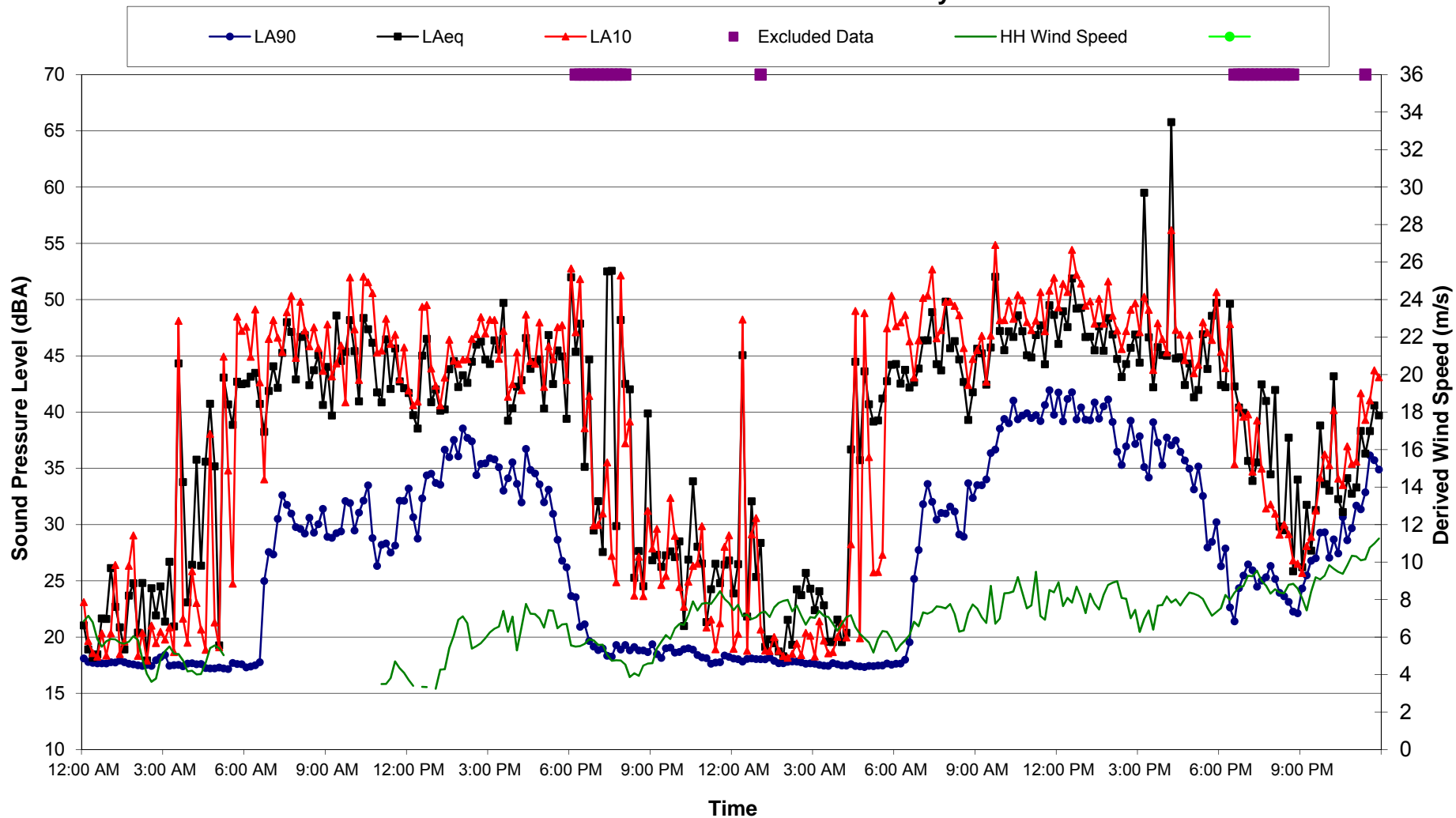
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 9 and 10 May 2016**



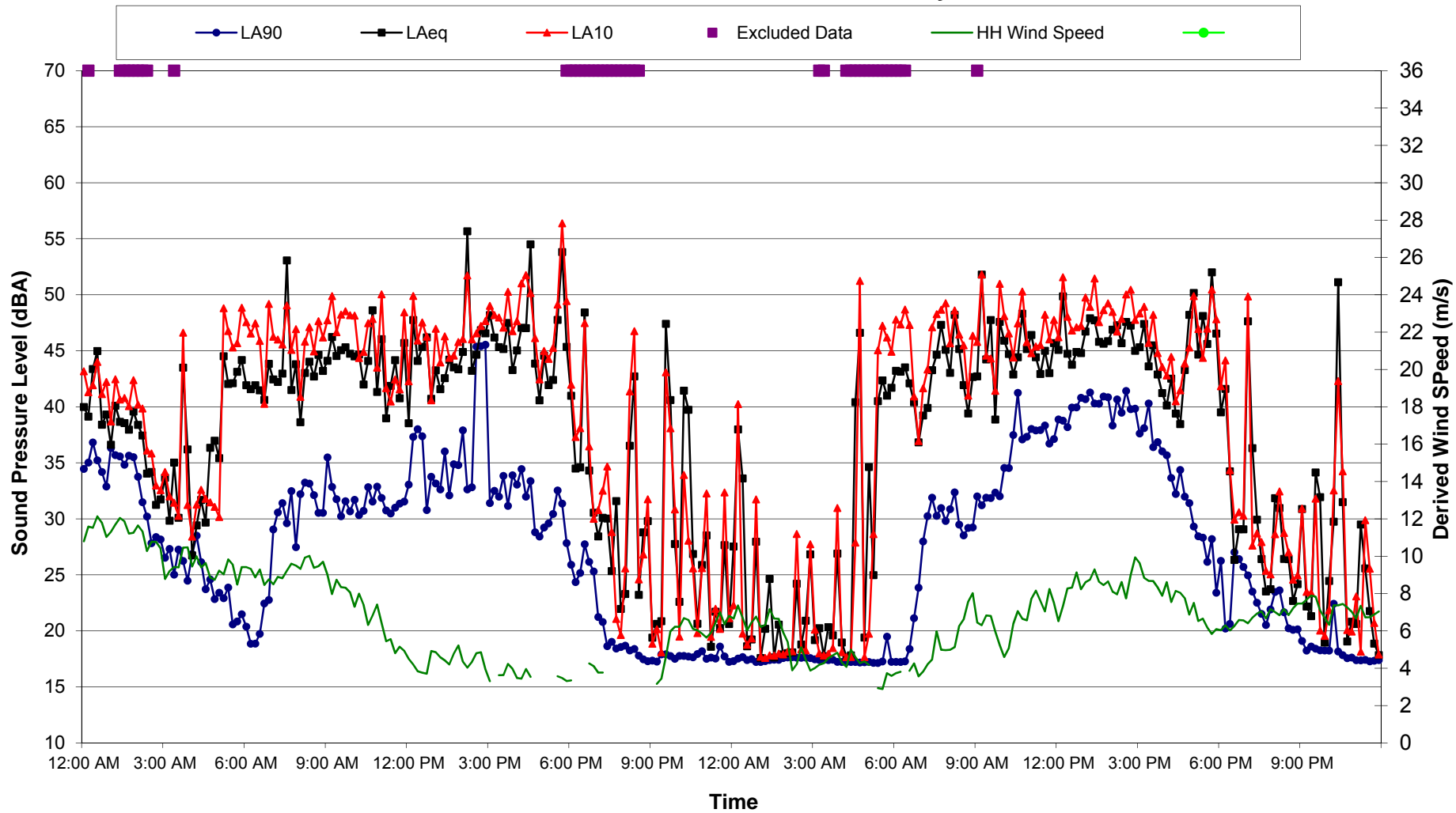
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 11 and 12 May 2016**



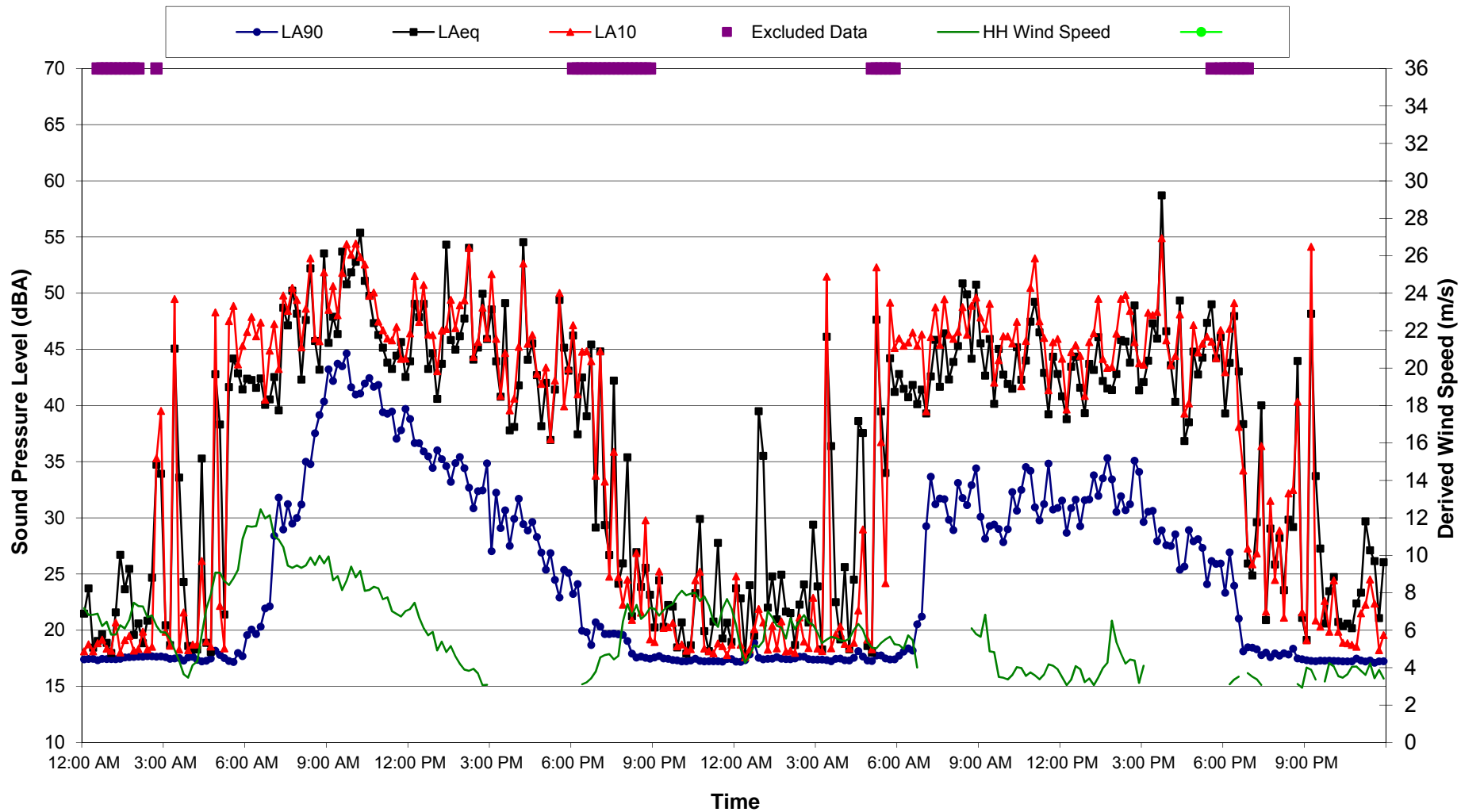
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 13 and 14 May 2016



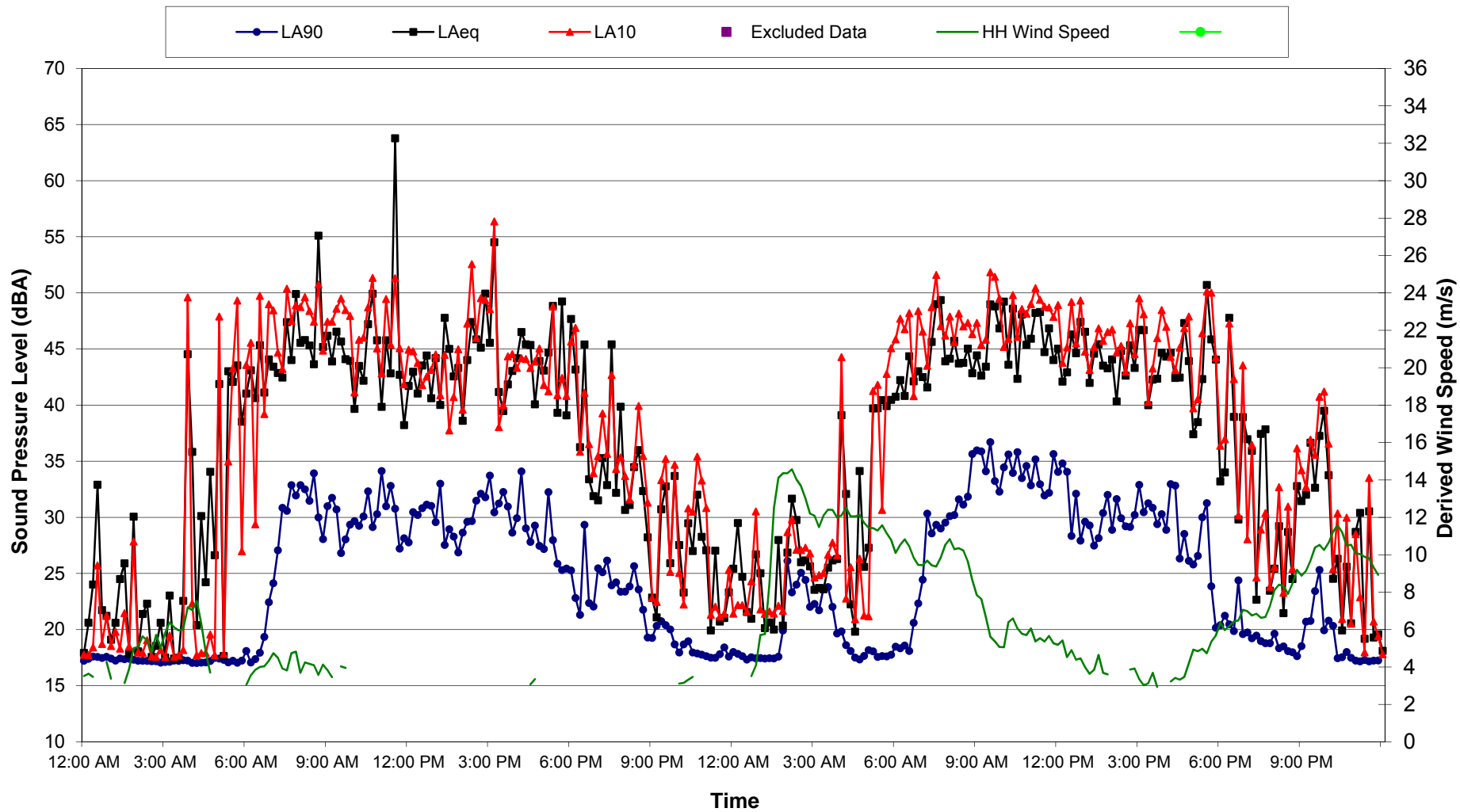
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 15 and 16 May 2016



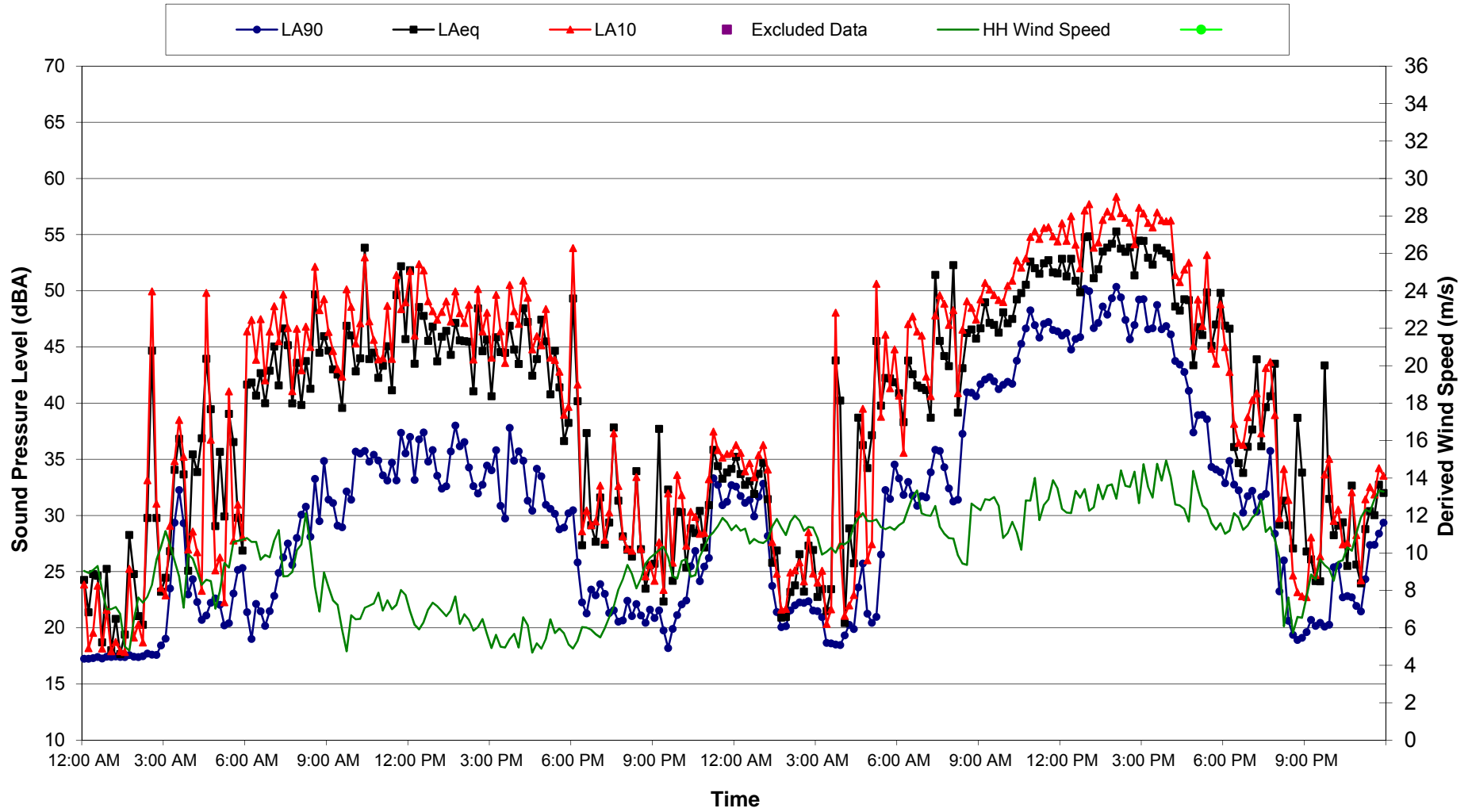
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 17 and 18 May 2016



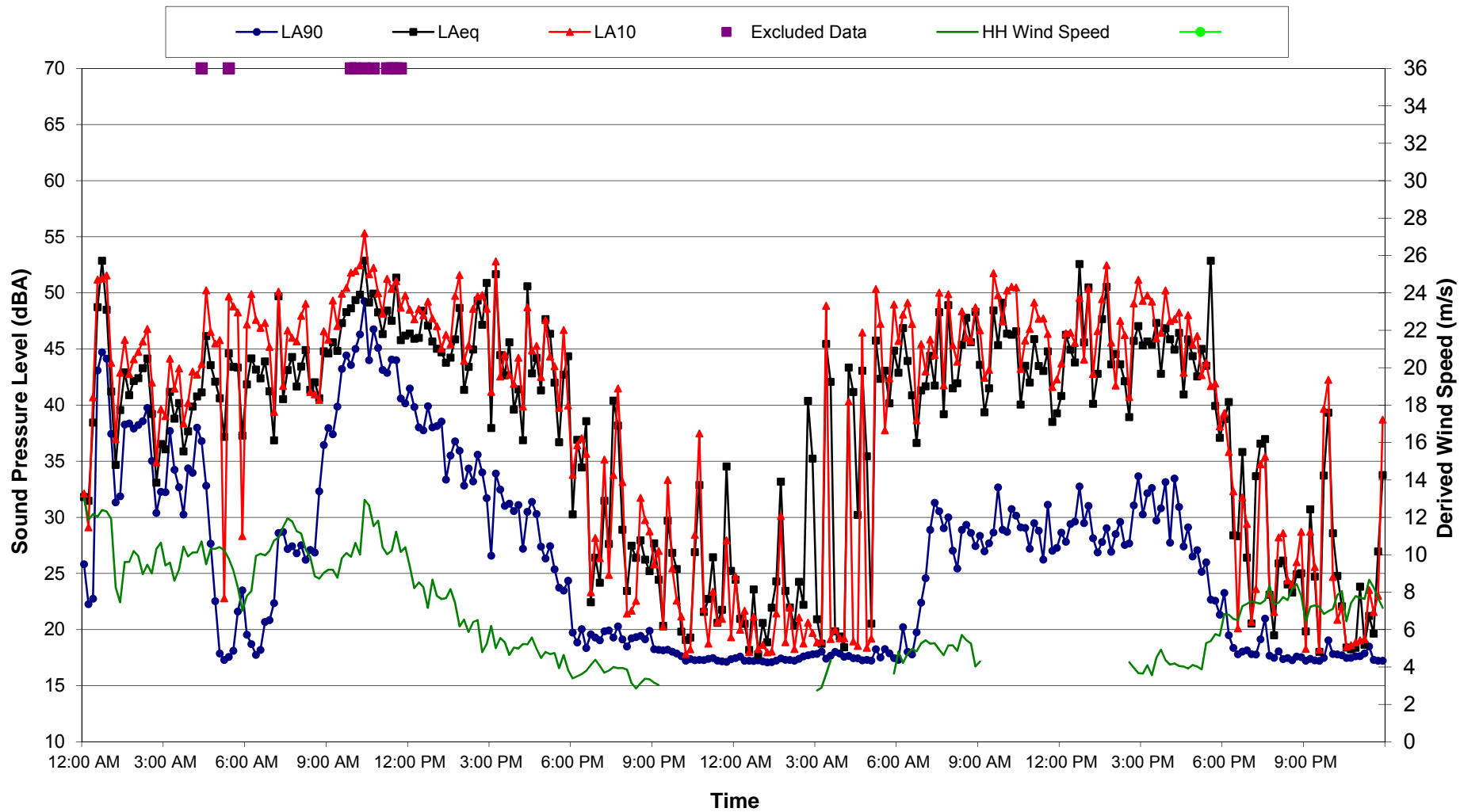
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 19 and 20 May 2016



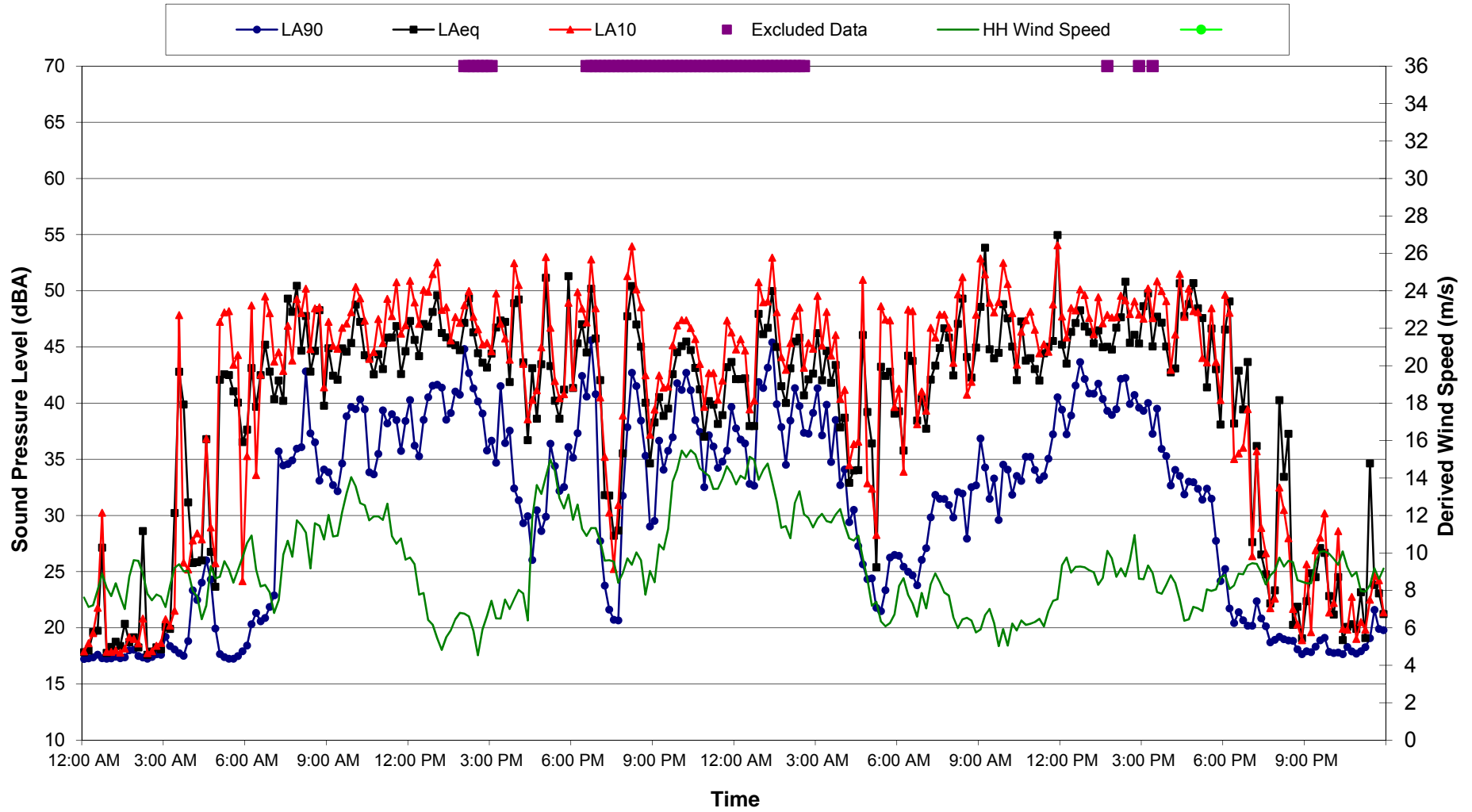
Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 21 and 22 May 2016



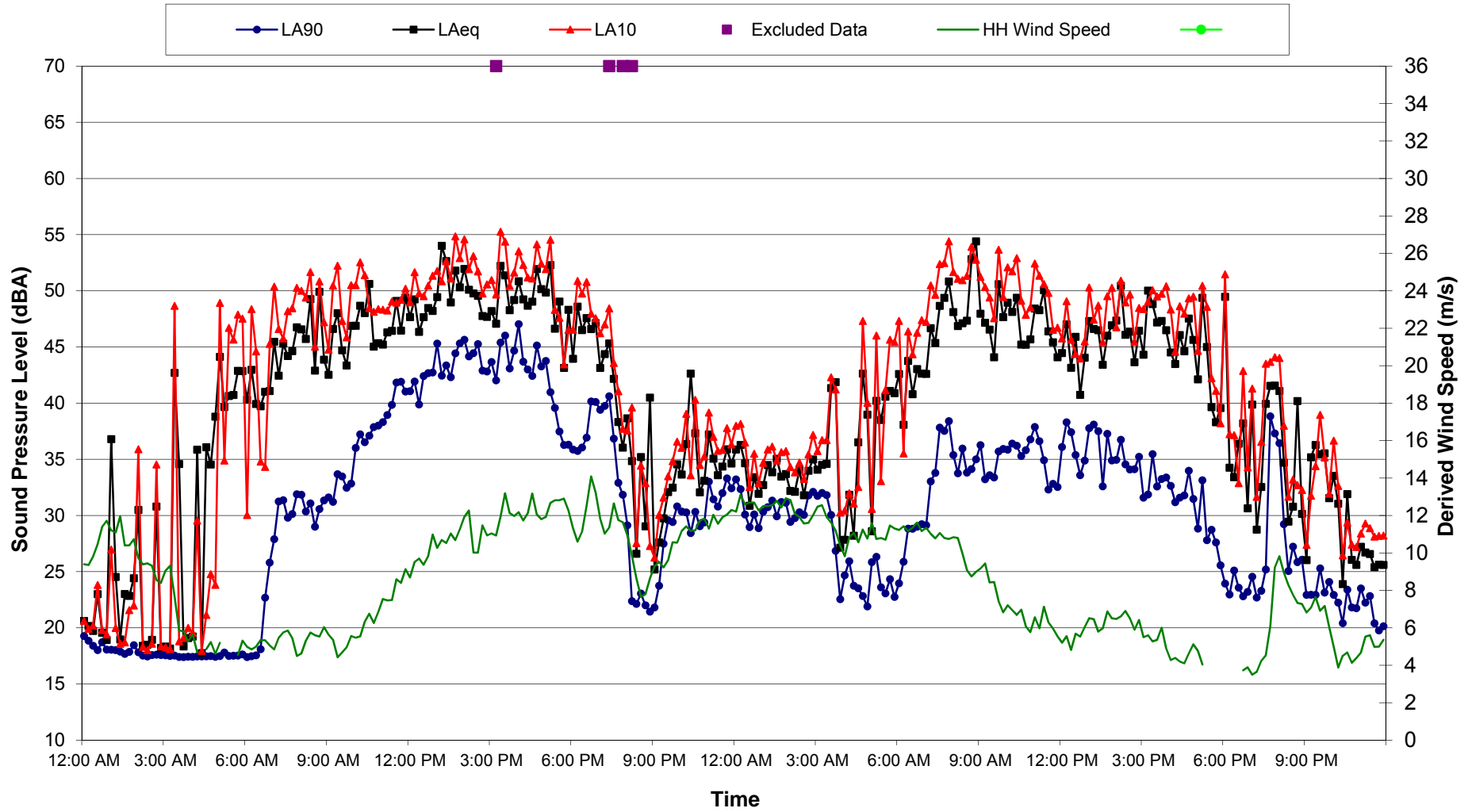
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 23 and 24 May 2016



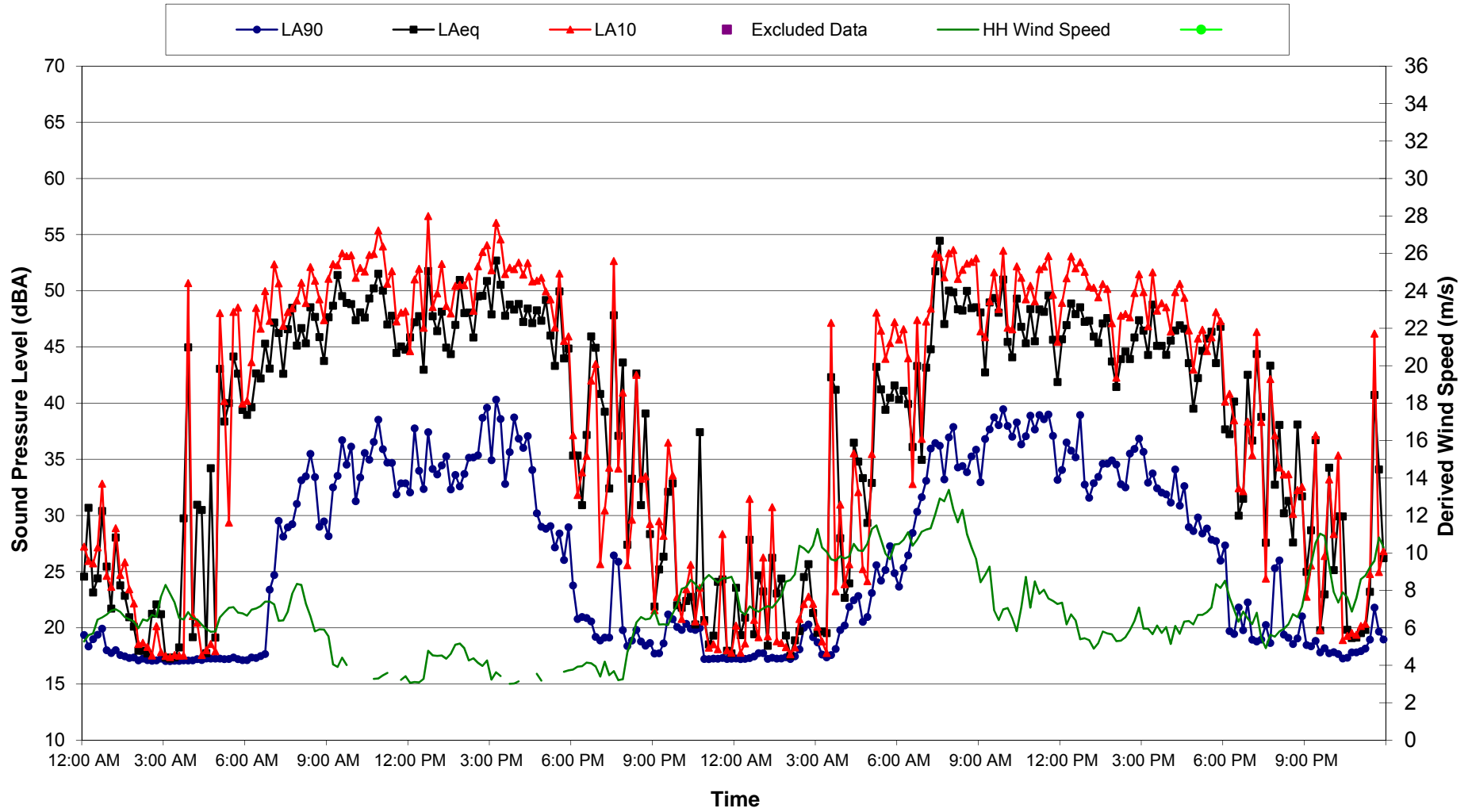
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



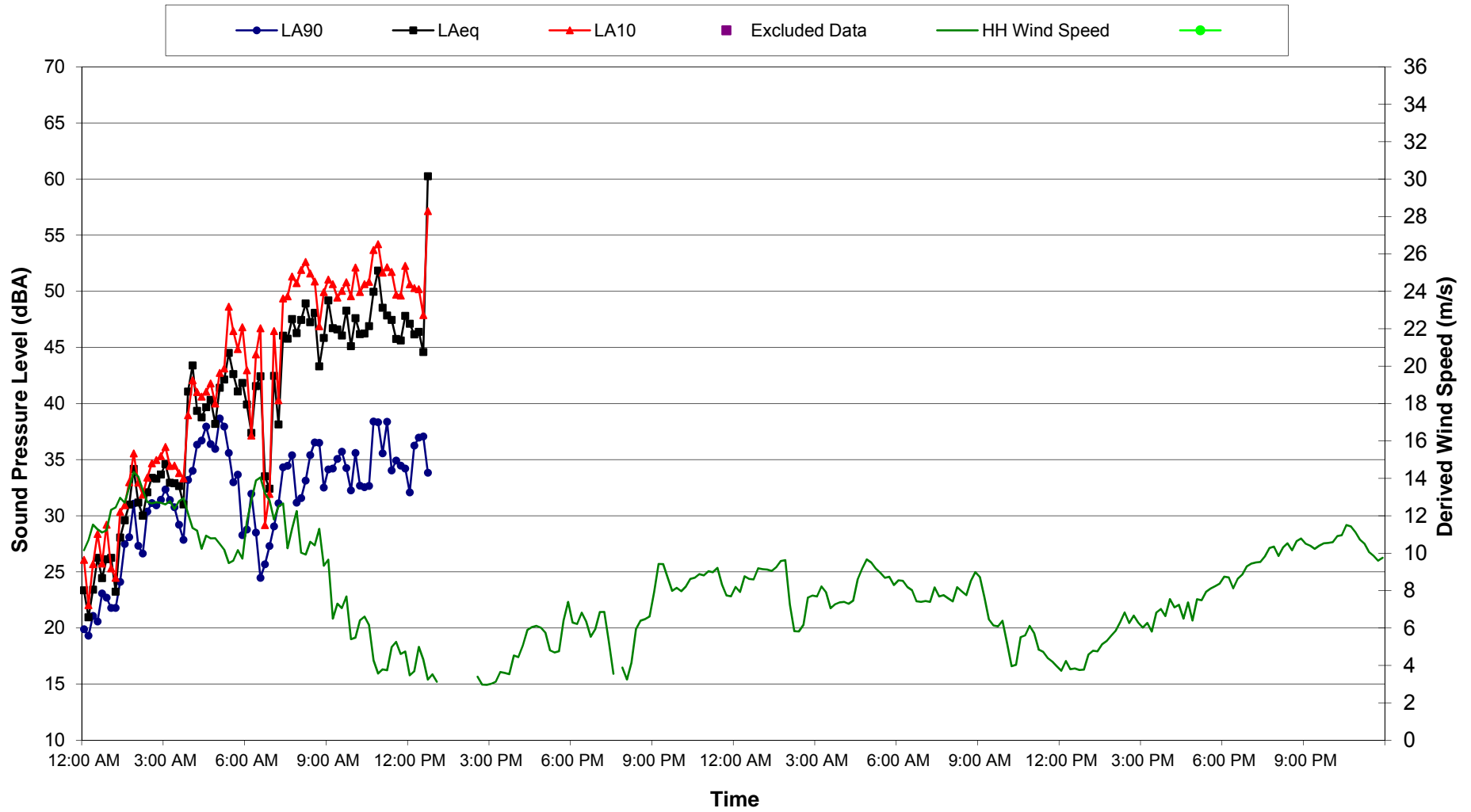
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**



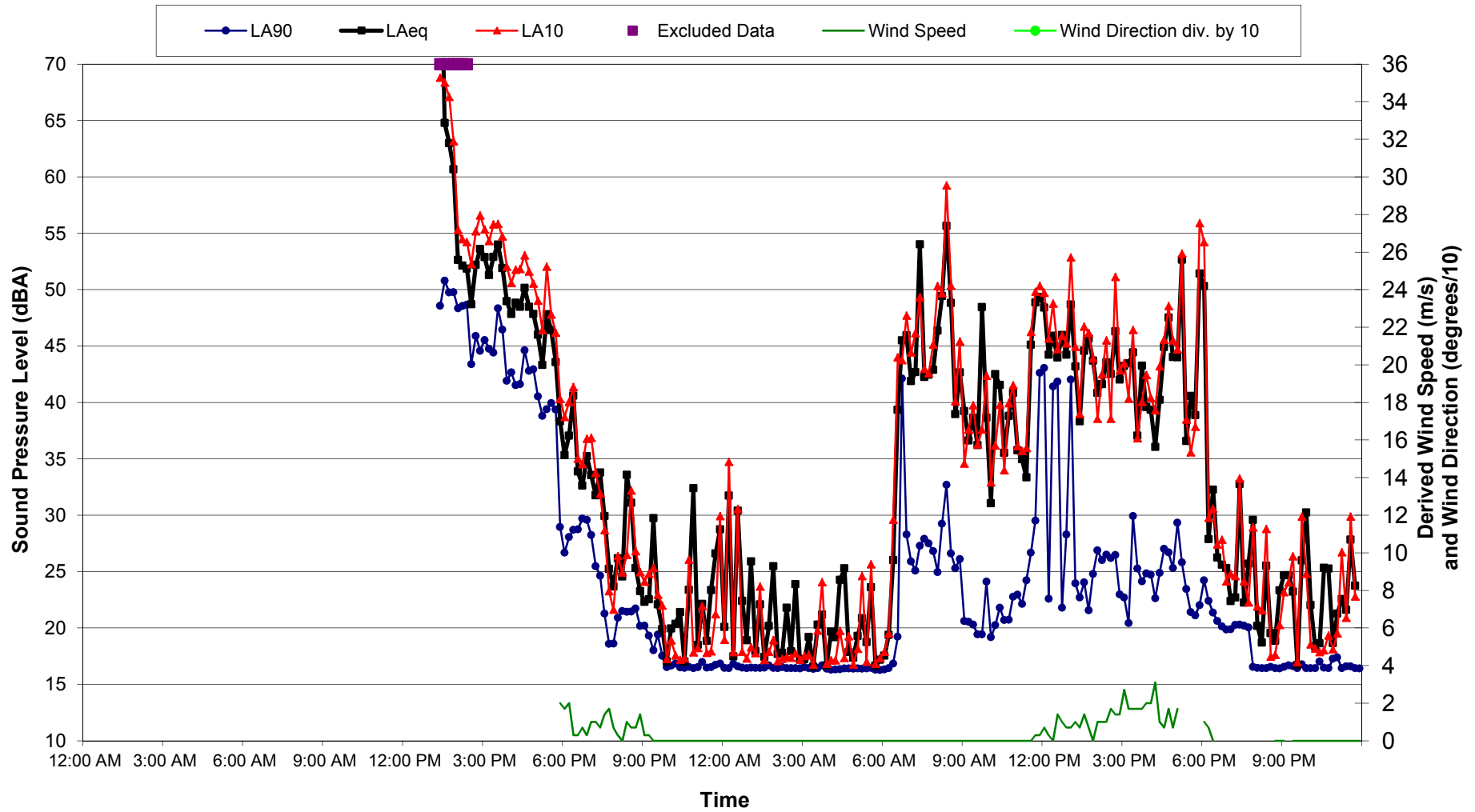
**Location Day Dream Mine - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016**



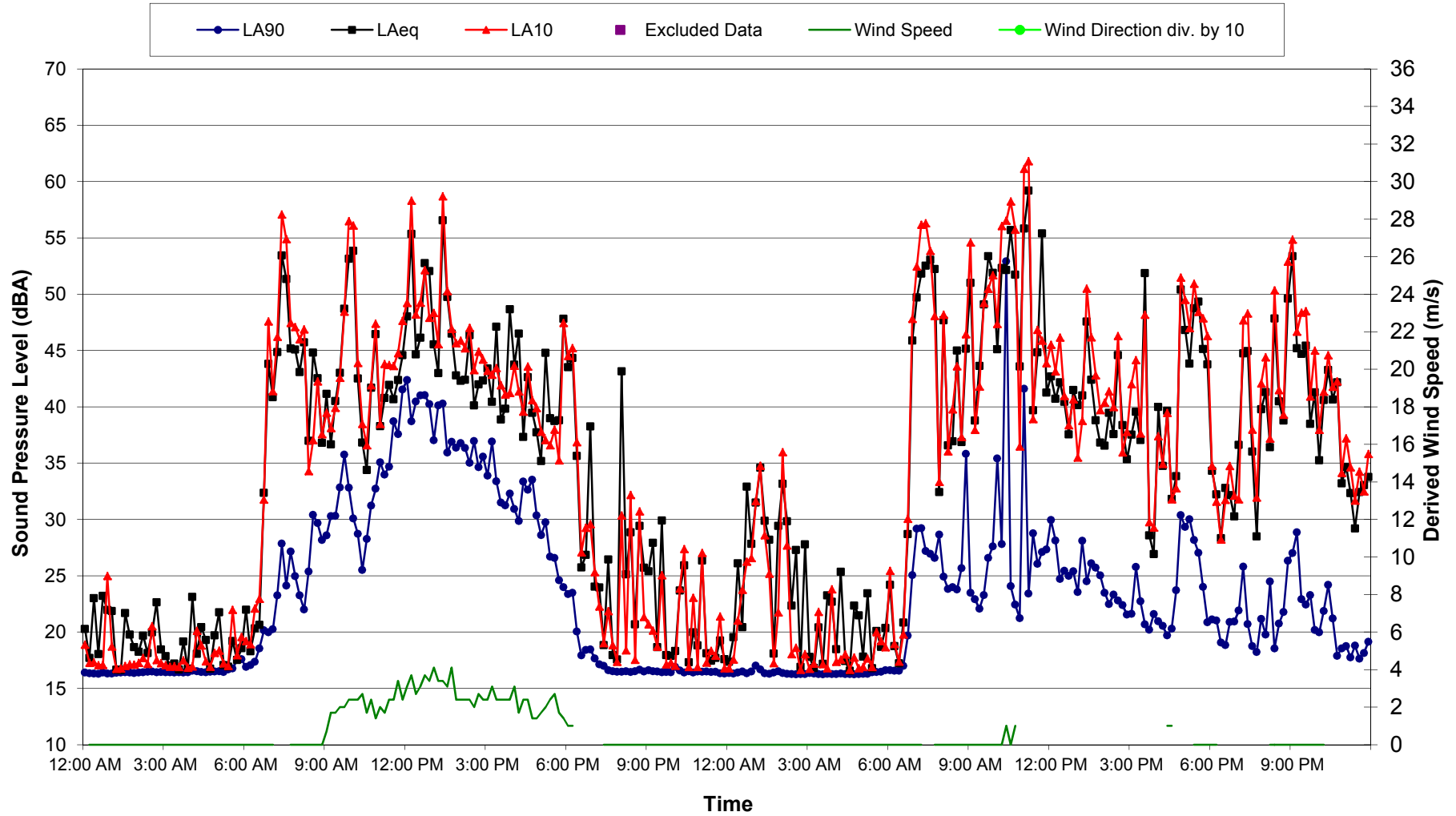
Location Day Dream Mine - Silverton Wind Farm Ambient Noise Data - 31 May and 1 June 2016



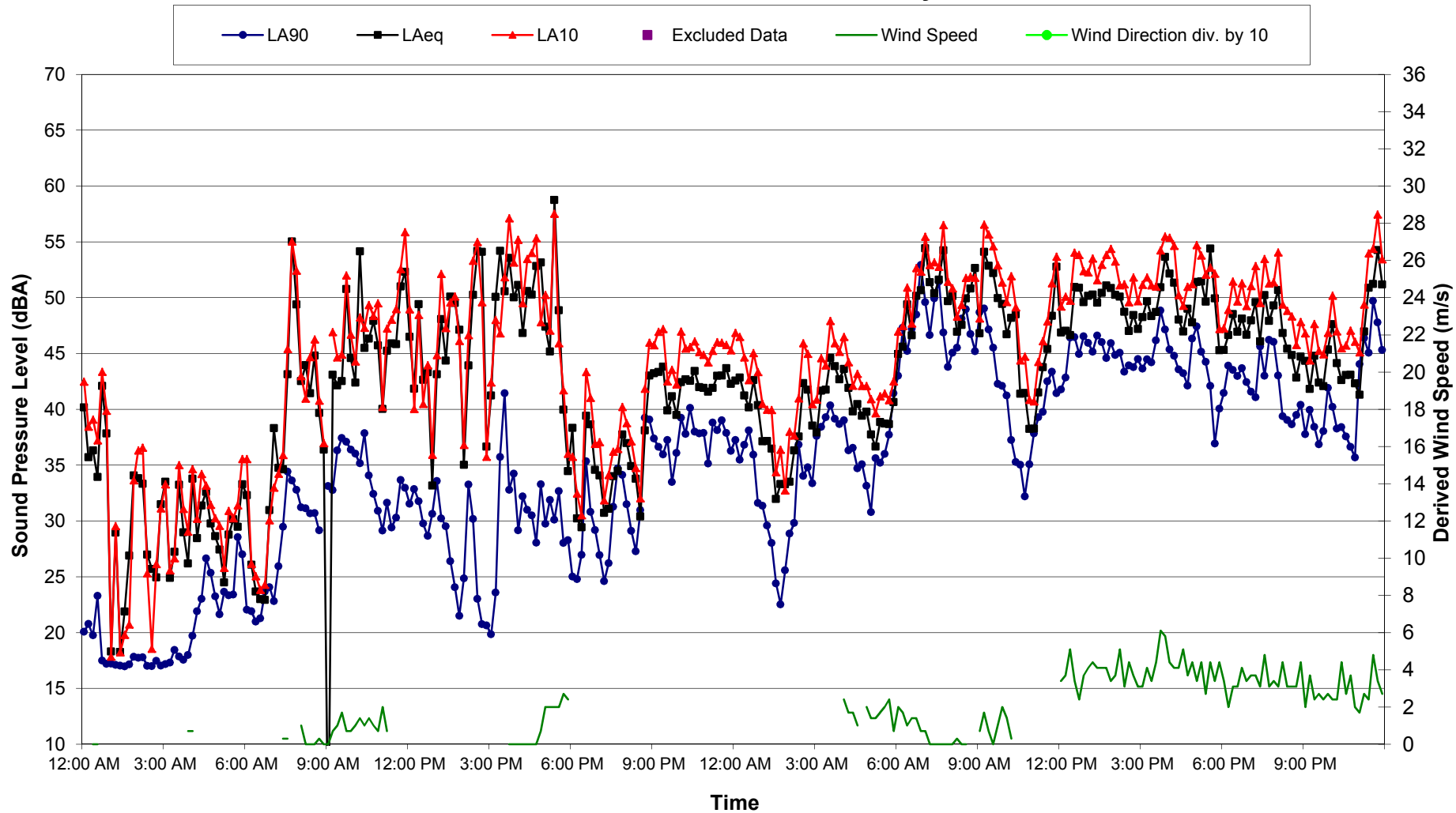
**Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 3 and 4 May 2016**



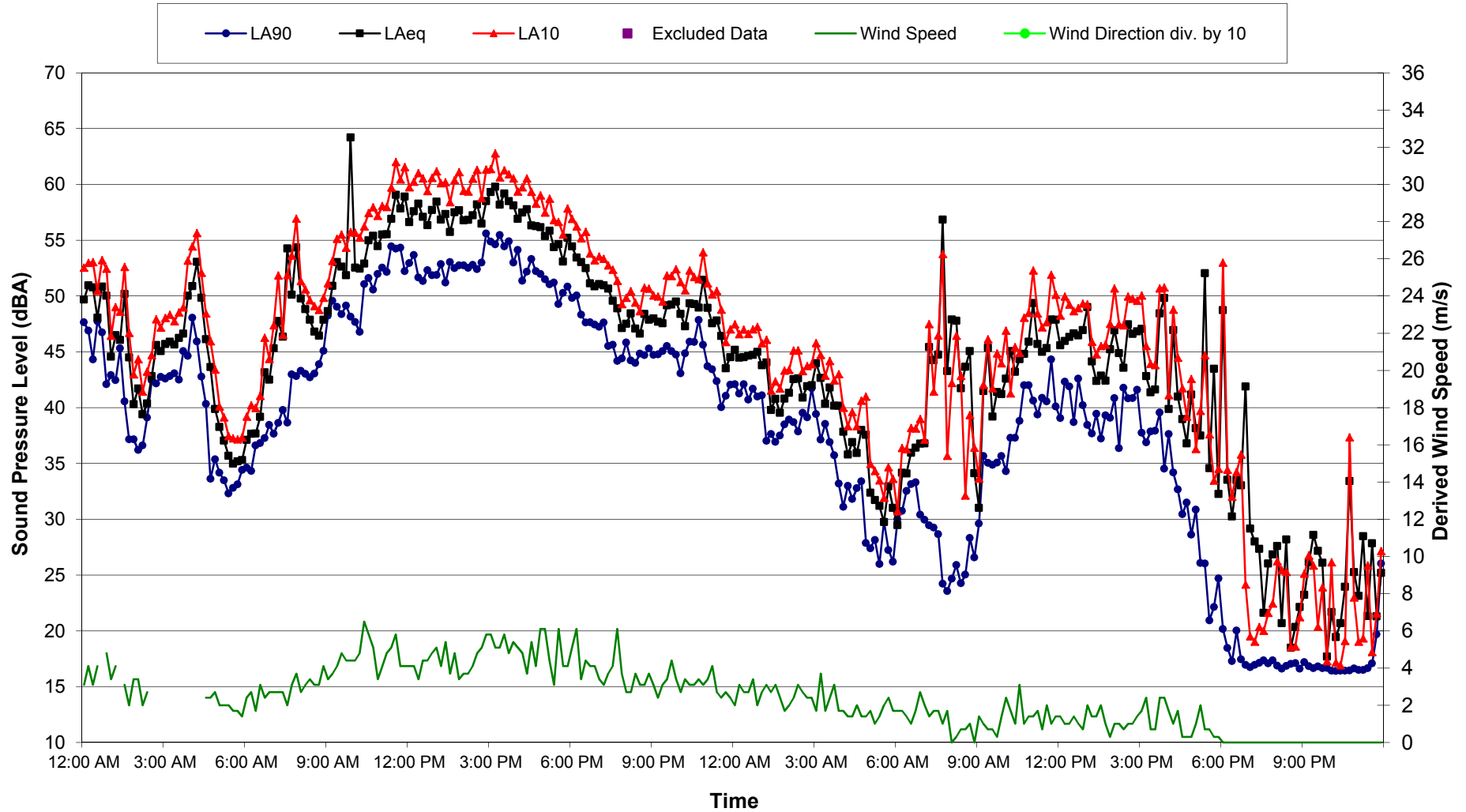
**Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016**



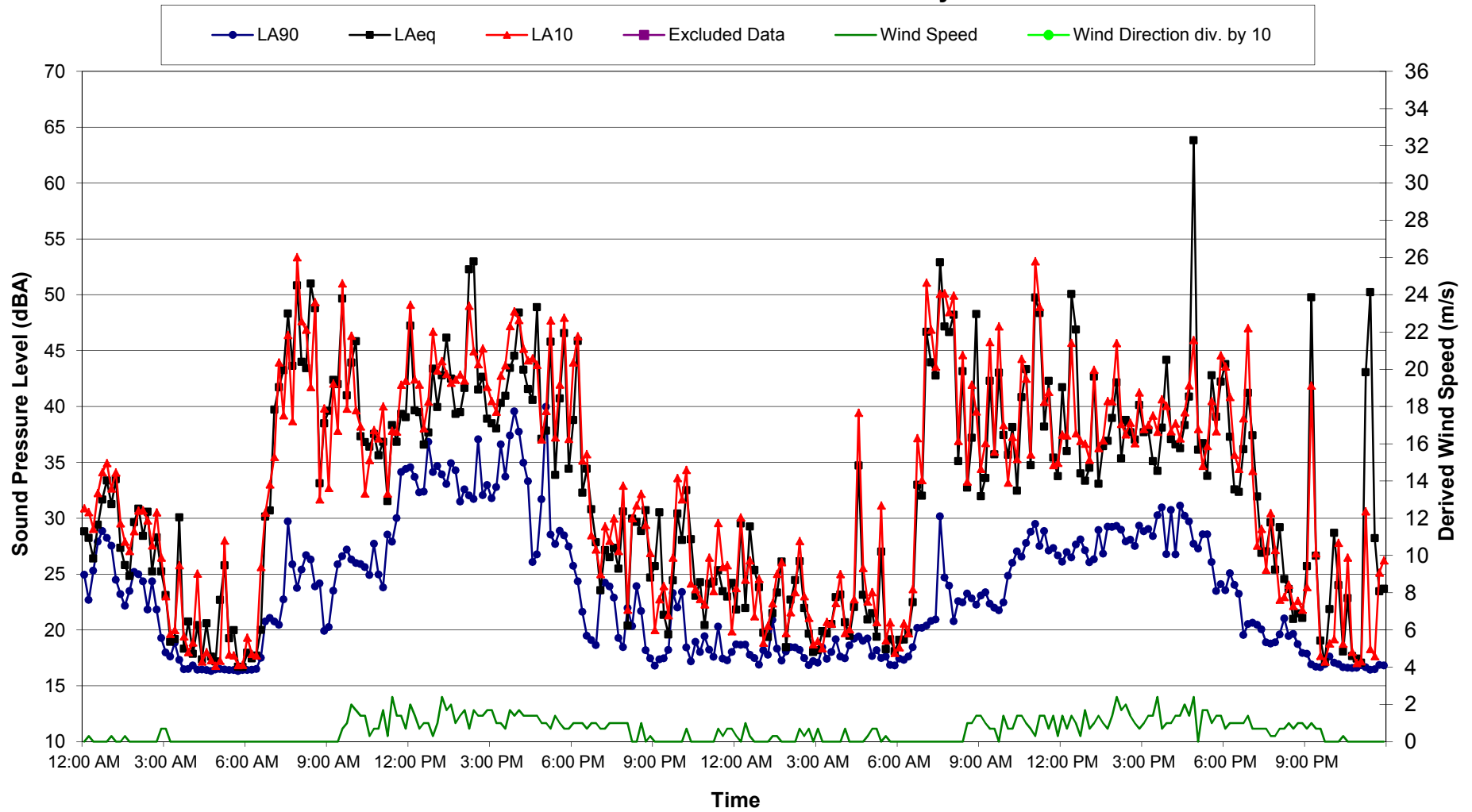
Location Belmont Station - Silverton Wind Farm Ambient Noise Data - 7 and 8 May 2016



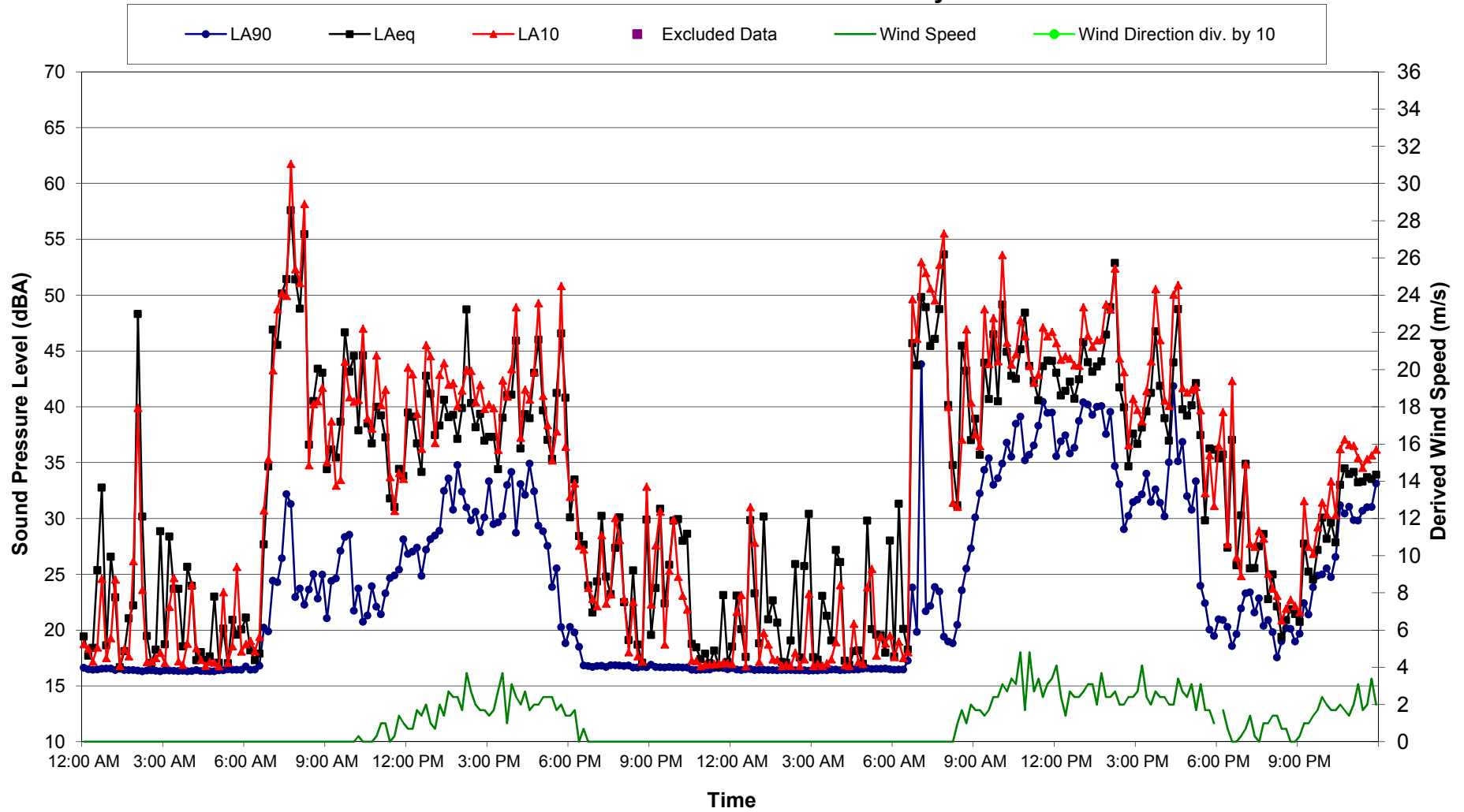
Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 9 and 10 May 2016



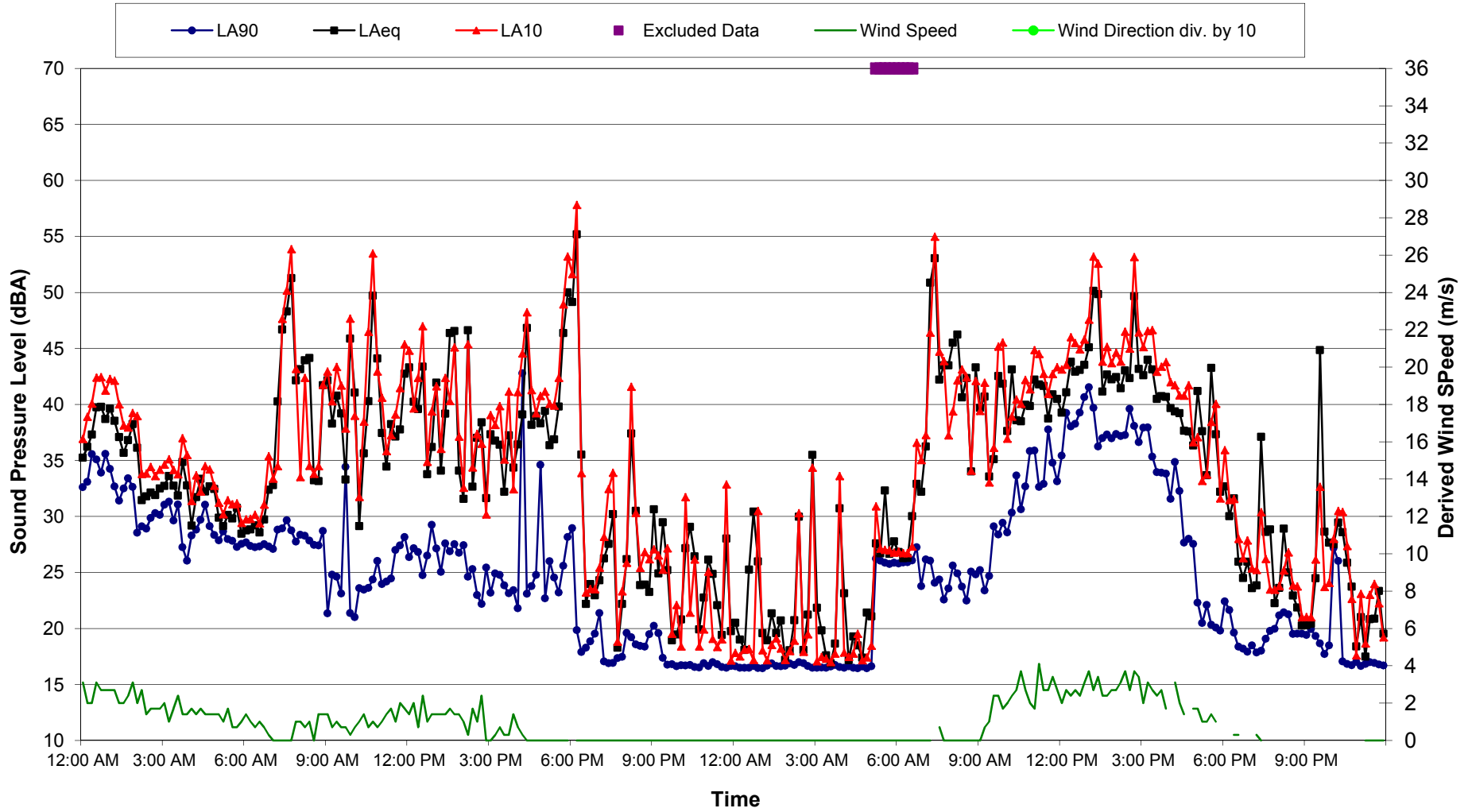
Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 11 and 12 May 2016



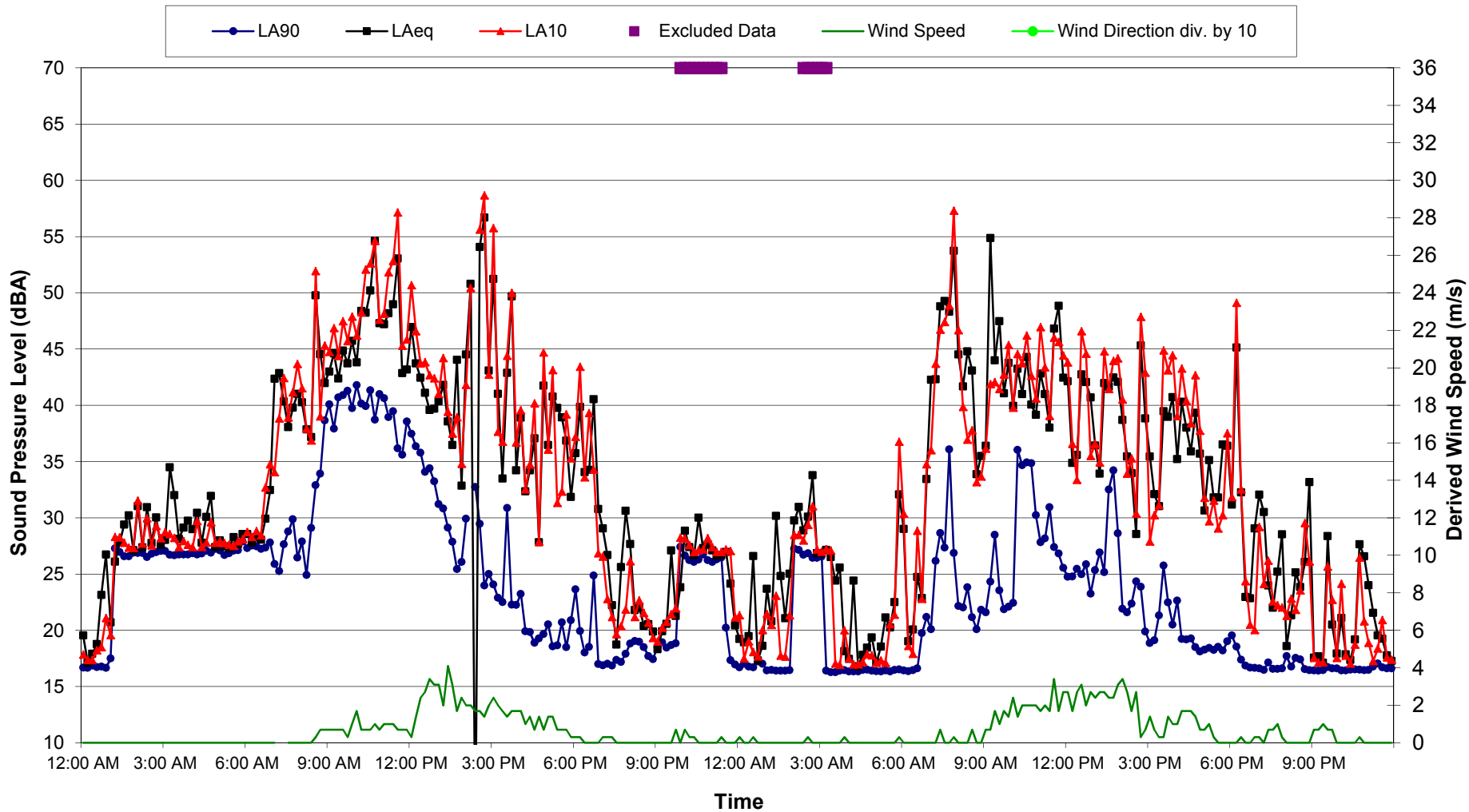
**Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 13 and 14 May 2016**



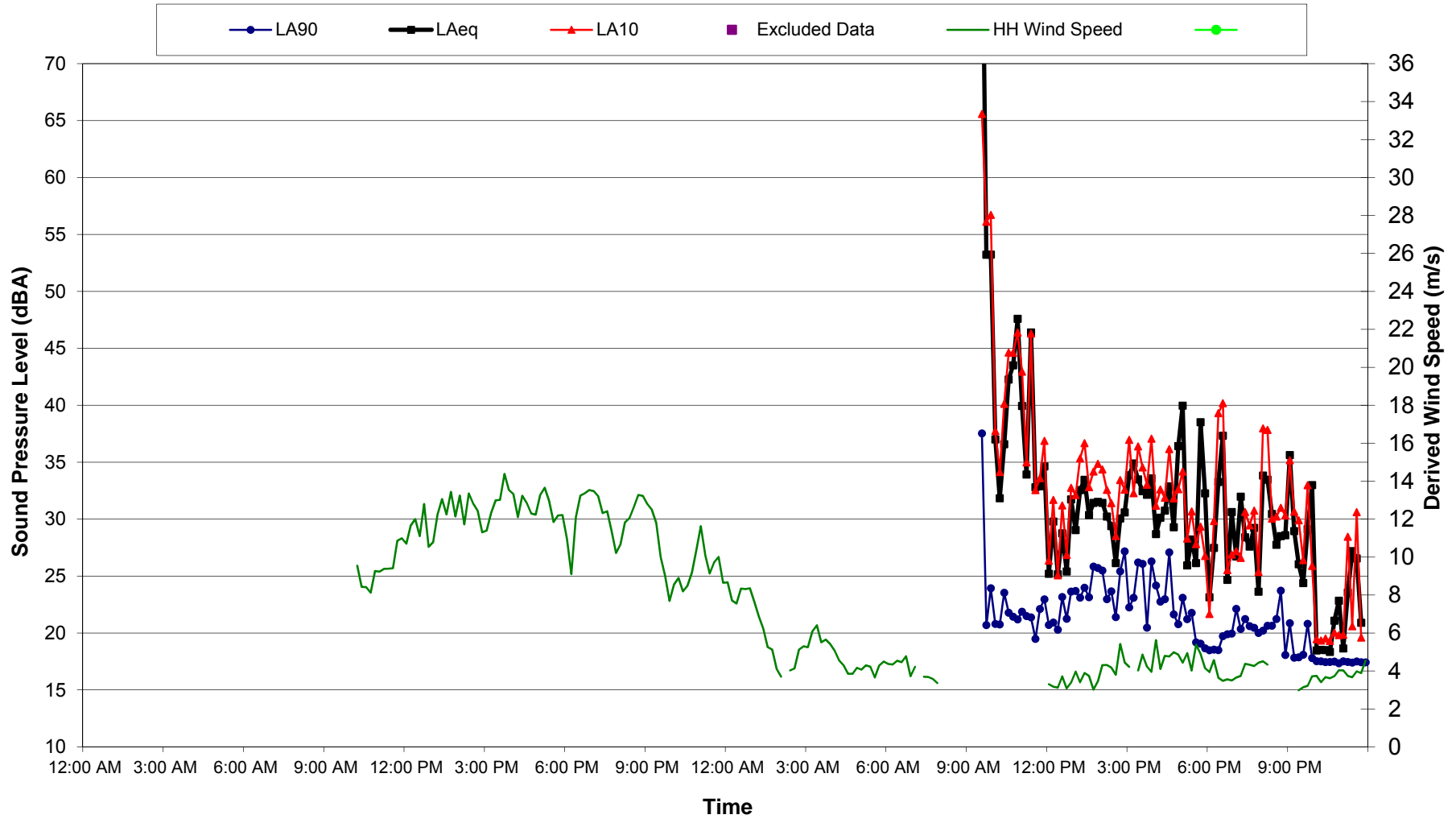
**Location Belmont Station - Silverton Wind Farm
Ambient Noise Data - 15 and 16 May 2016**



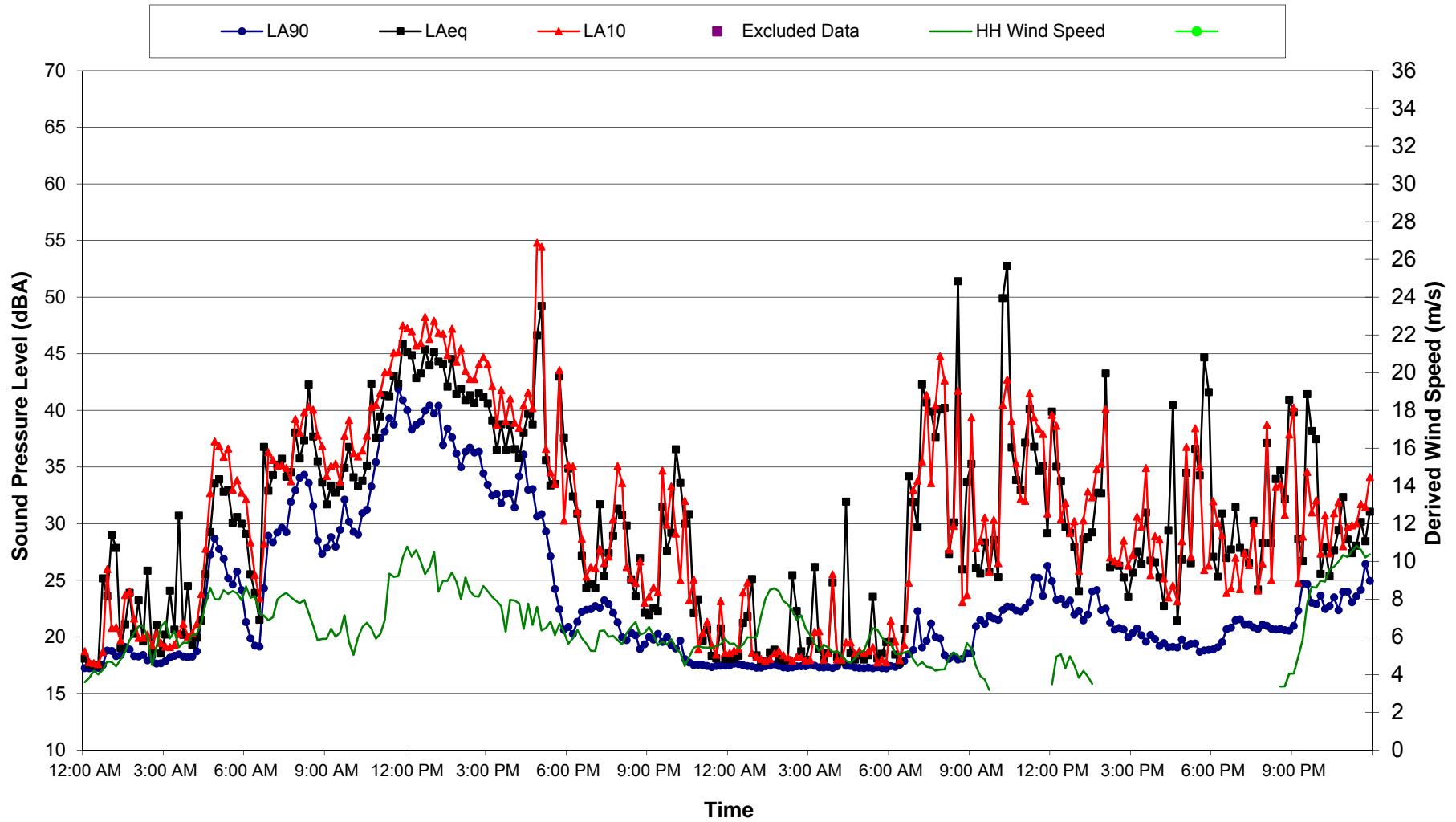
Location Belmont Station - Silverton Wind Farm Ambient Noise Data - 17 and 18 May 2016



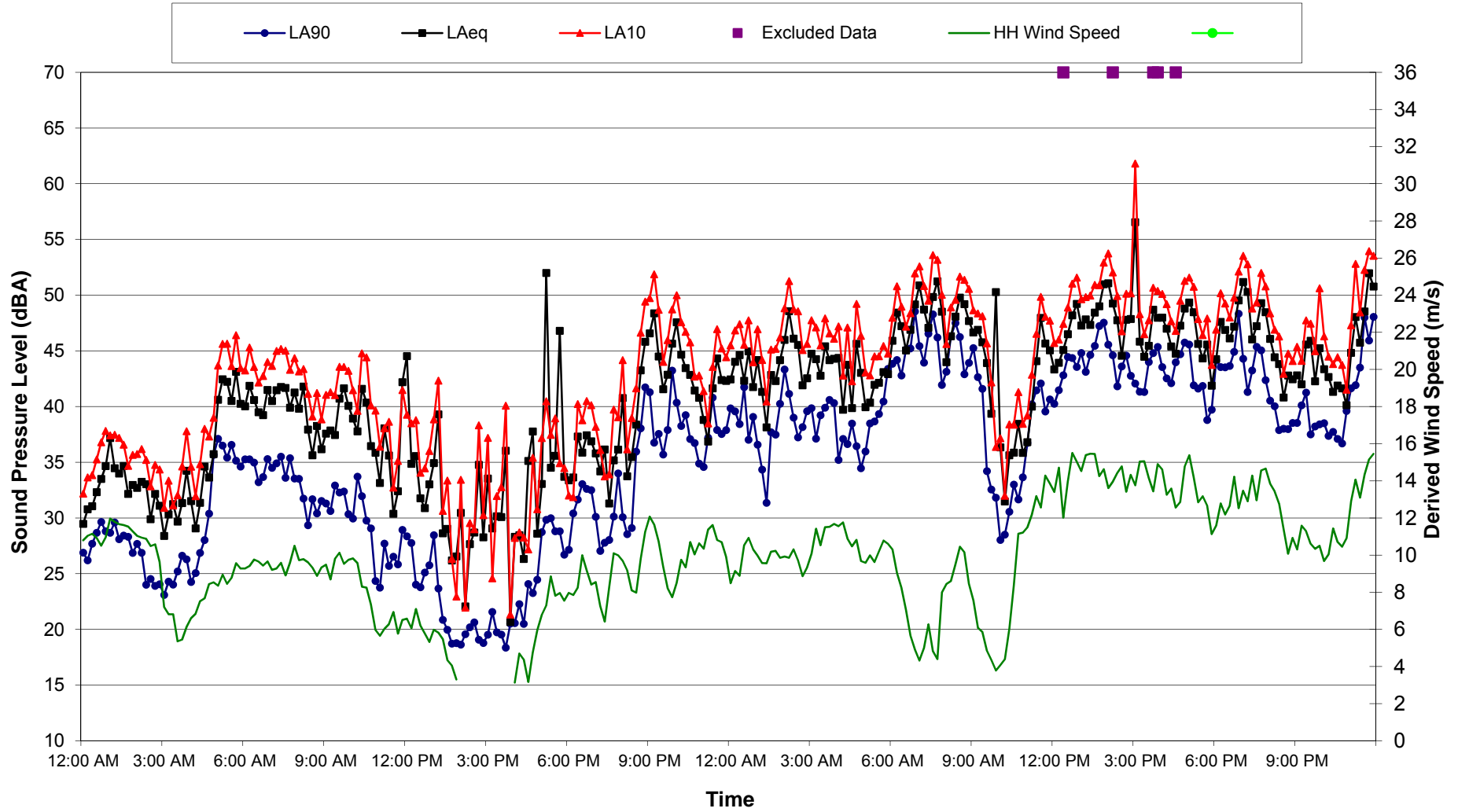
Location Umberumberka - Silverton Wind Farm Ambient Noise Data - 3 and 4 May 2016



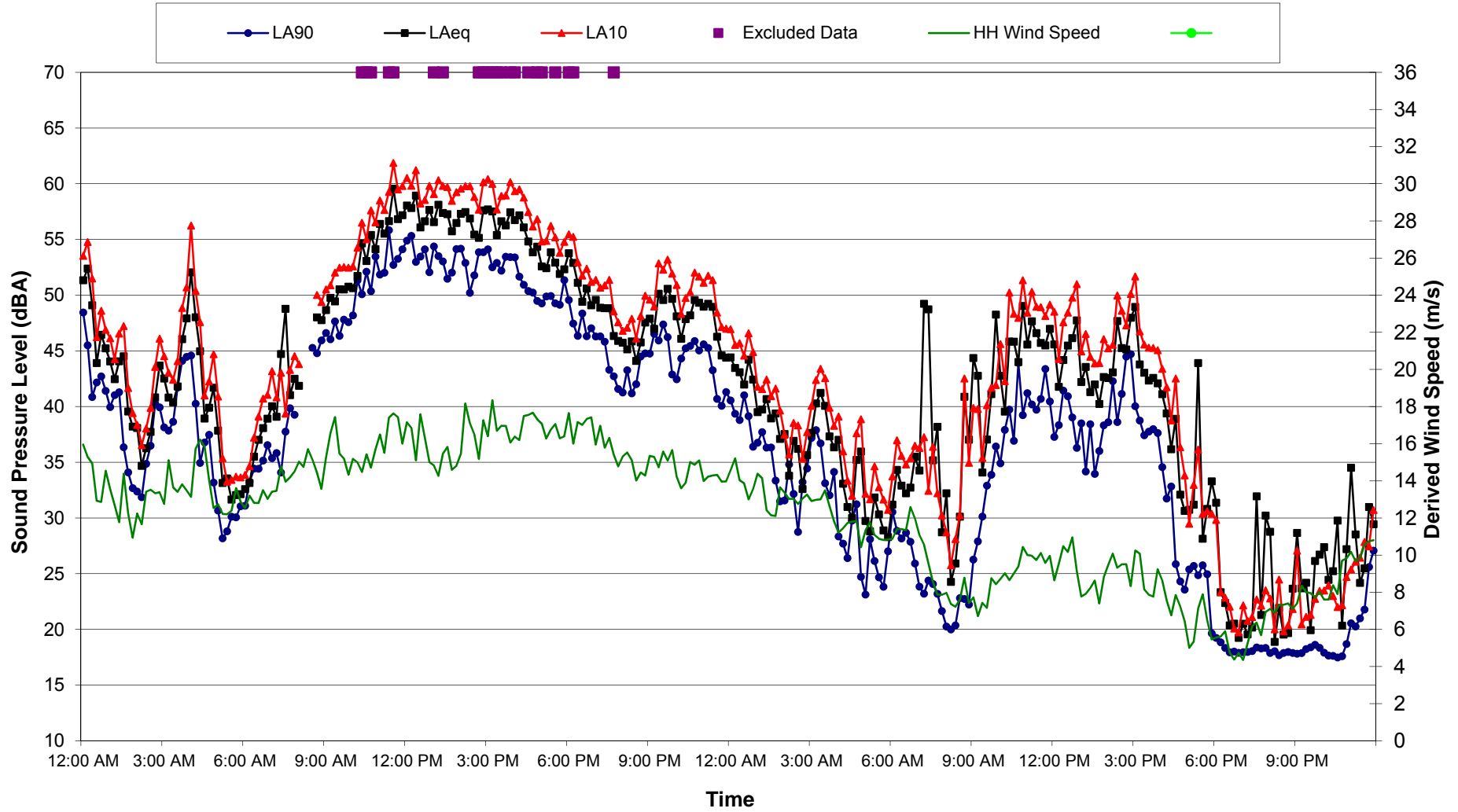
Location Uumberberka - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016



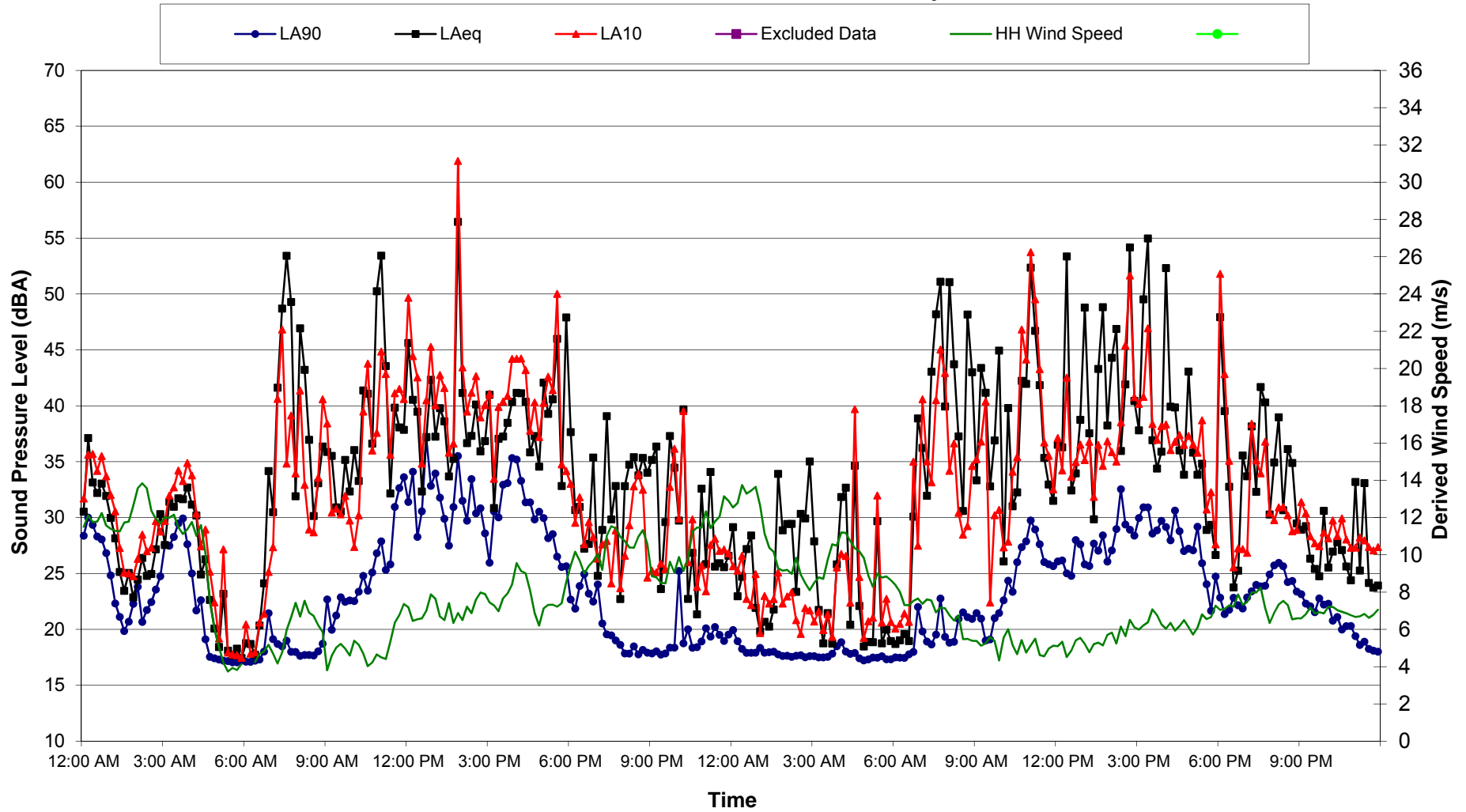
Location Umberumberka - Silverton Wind Farm Ambient Noise Data - 7 and 8 May 2016



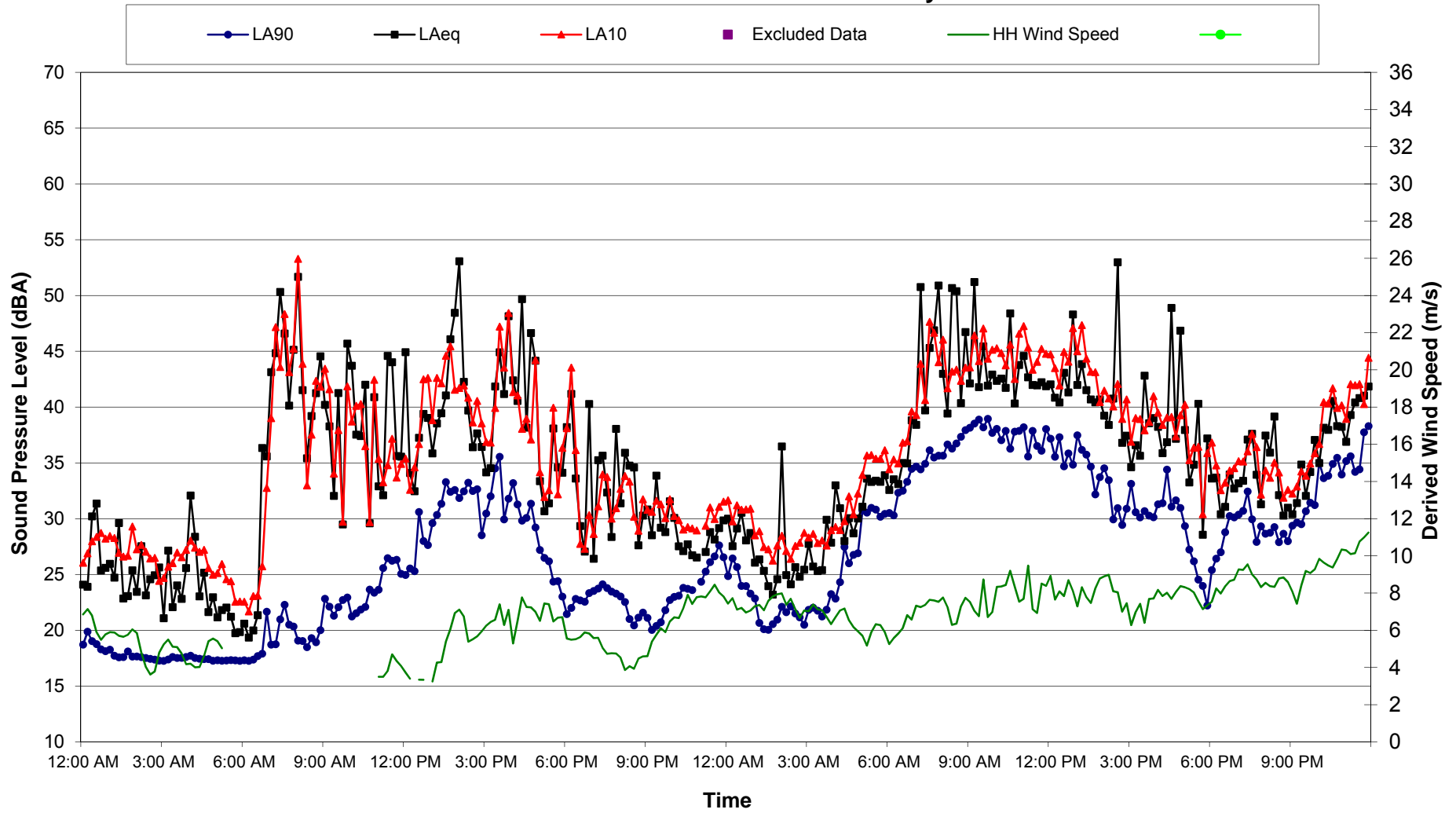
Location Umberumberka - Silverton Wind Farm Ambient Noise Data - 9 and 10 May 2016



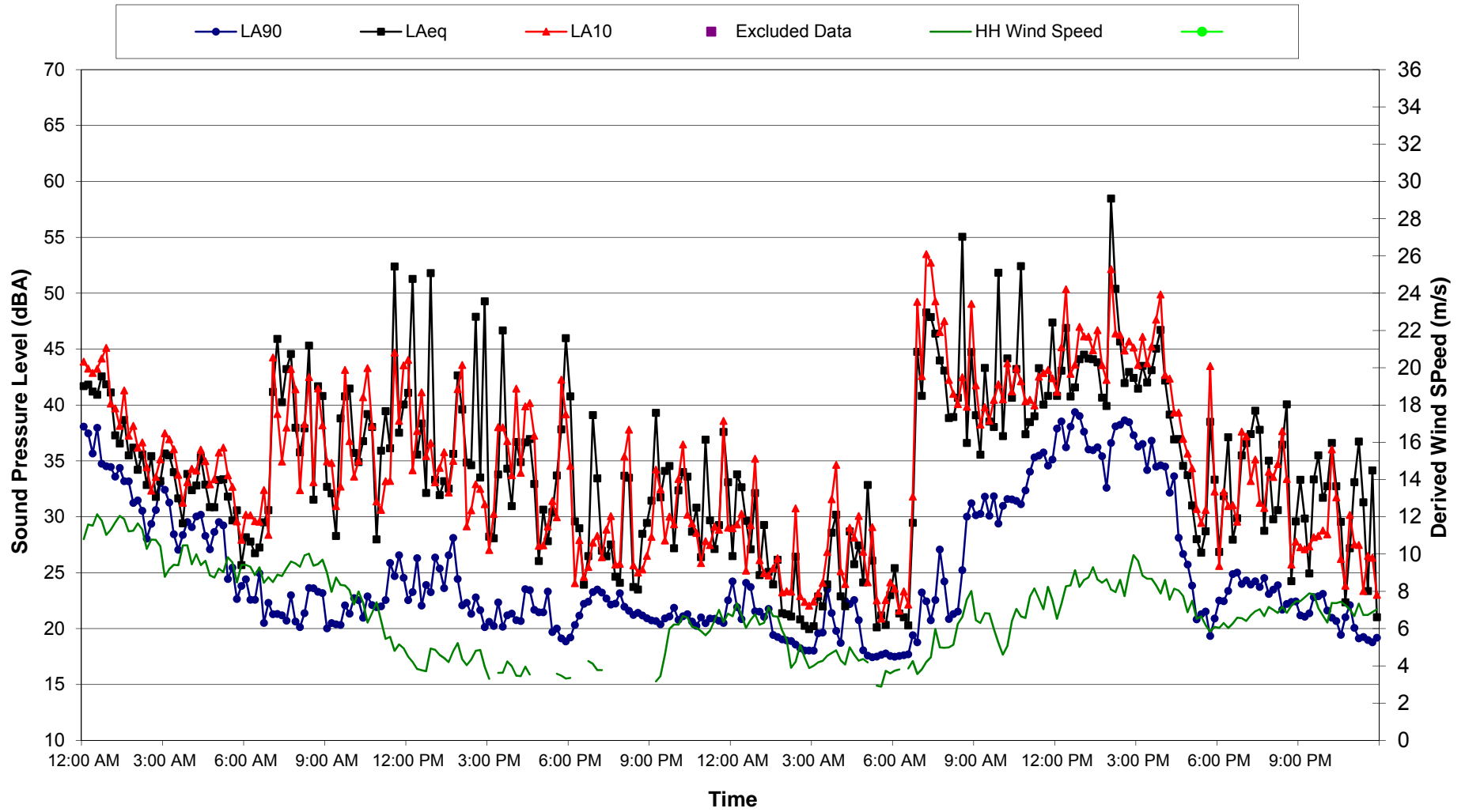
Location Uumberberka - Silverton Wind Farm
Ambient Noise Data - 11 and 12 May 2016



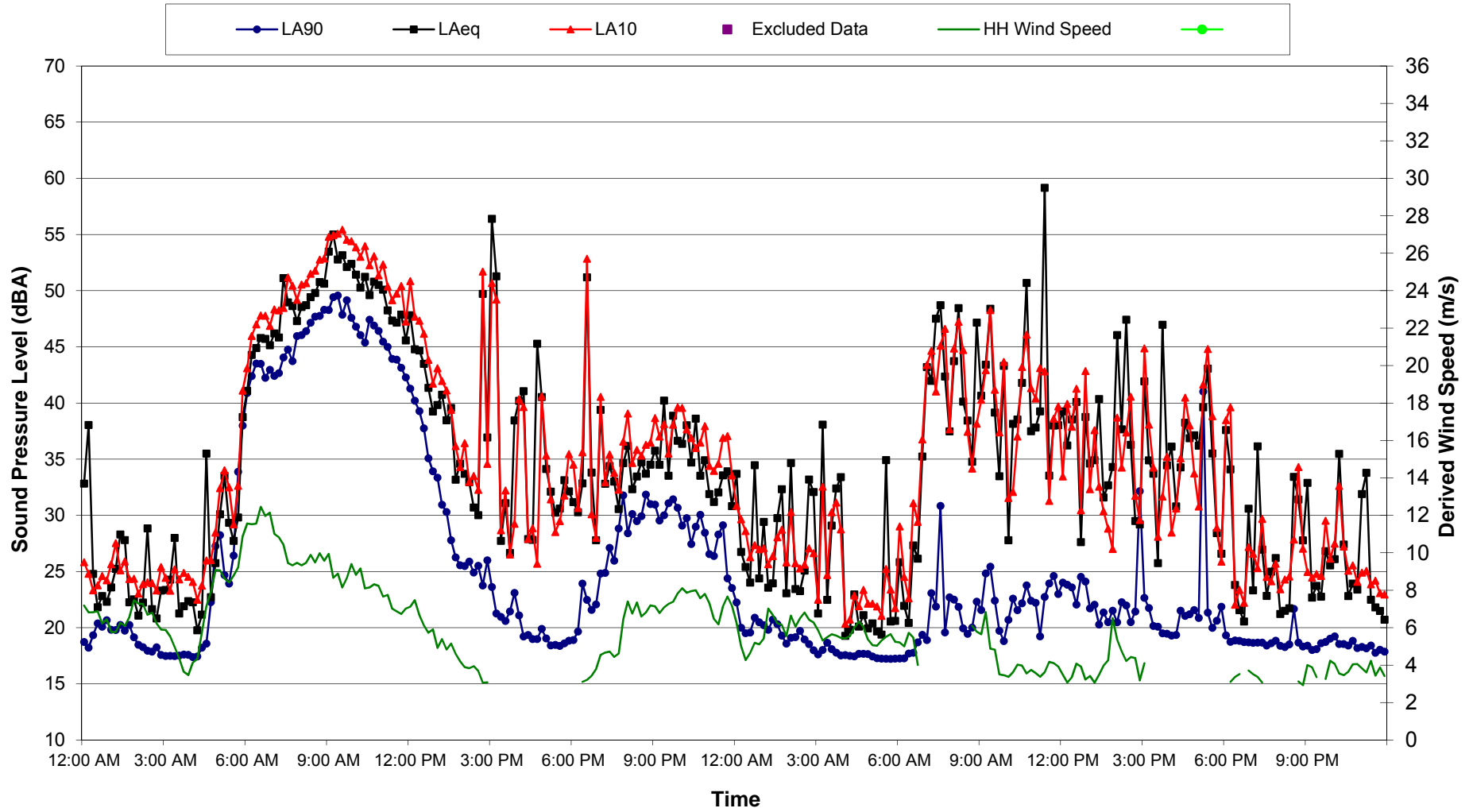
Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 13 and 14 May 2016



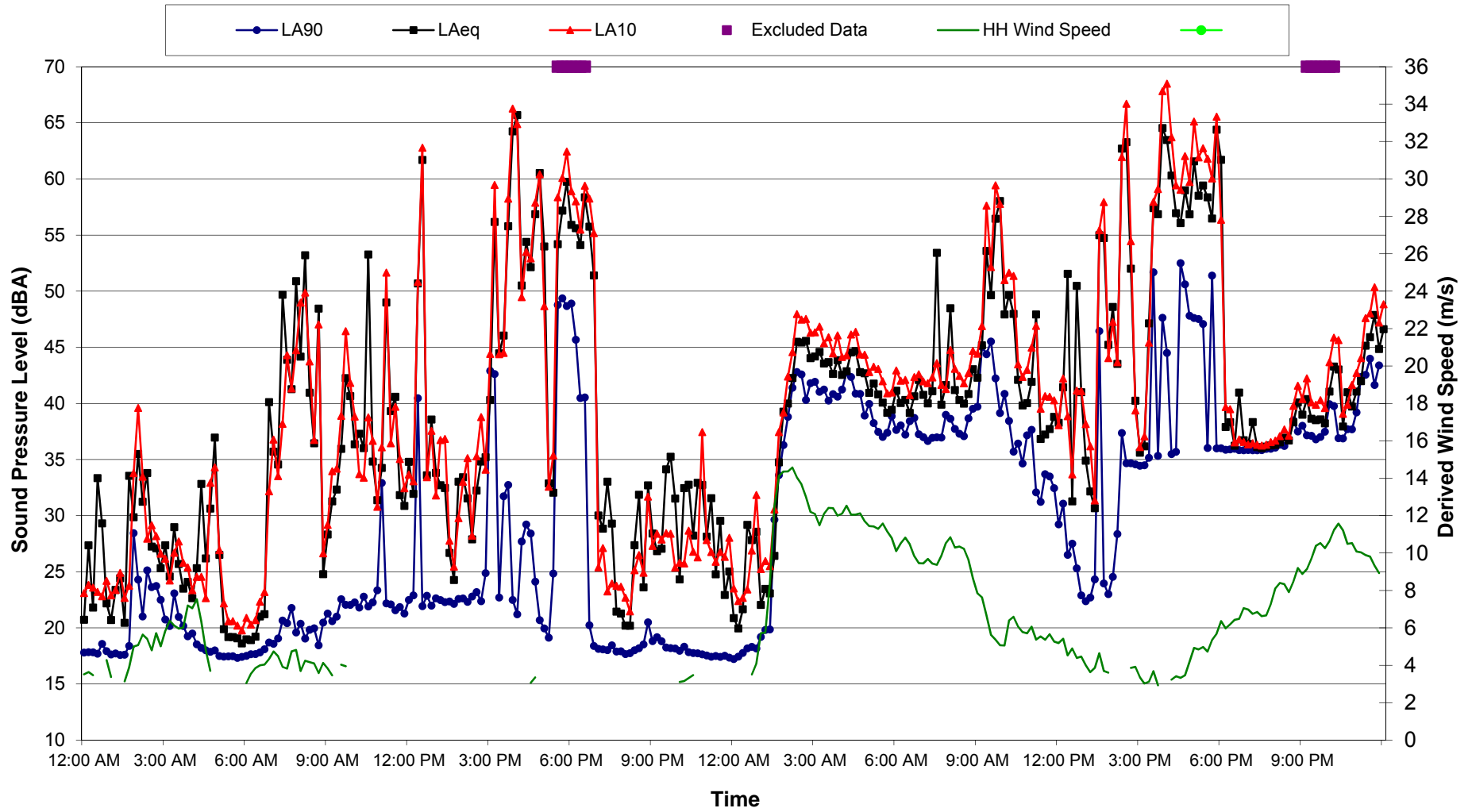
Location UMBERUMBERKA - SILVERTON WIND FARM
Ambient Noise Data - 15 and 16 May 2016



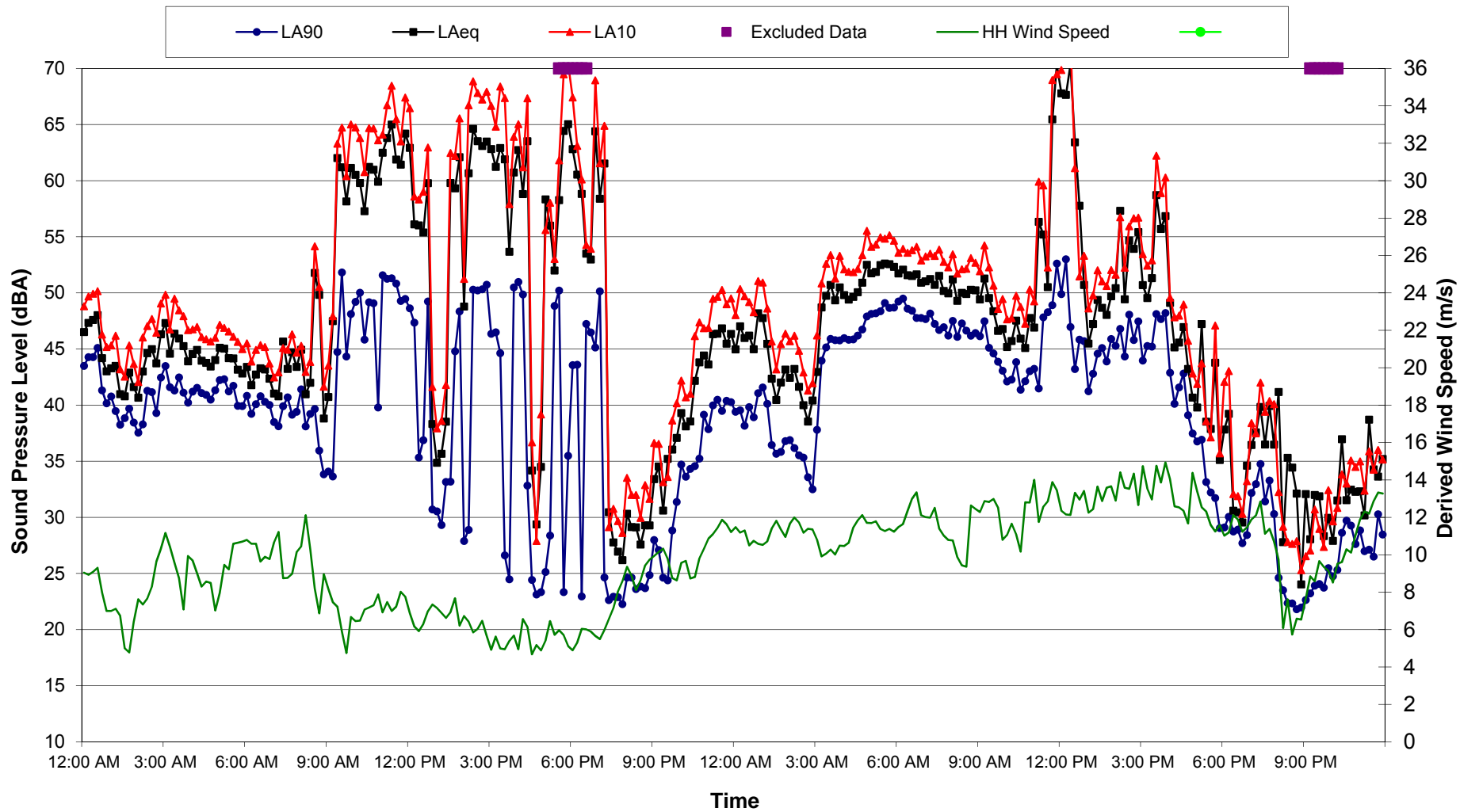
Location Umberumberka - Silverton Wind Farm Ambient Noise Data - 17 and 18 May 2016



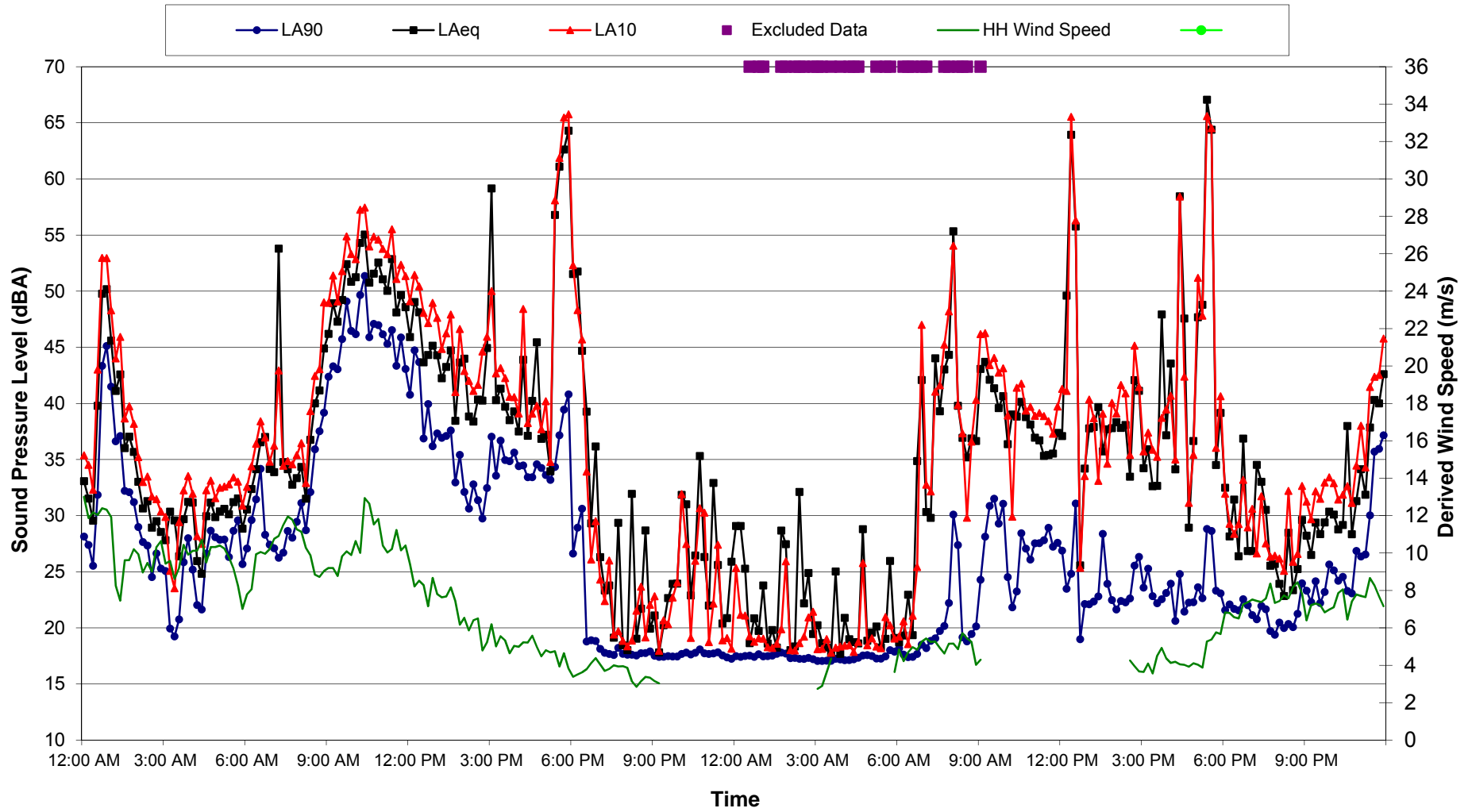
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 19 and 20 May 2016**



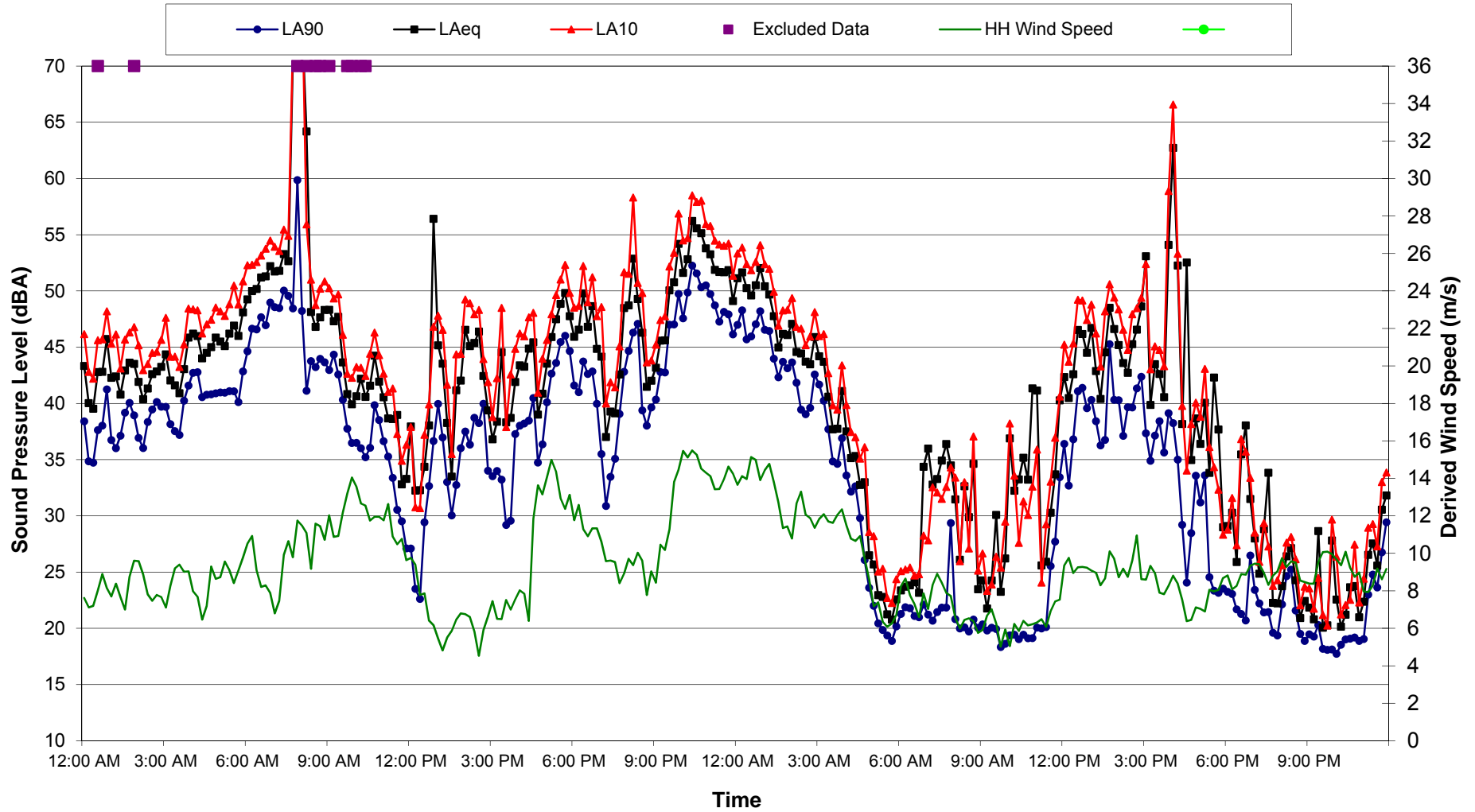
Location Uumberberka - Silverton Wind Farm Ambient Noise Data - 21 and 22 May 2016



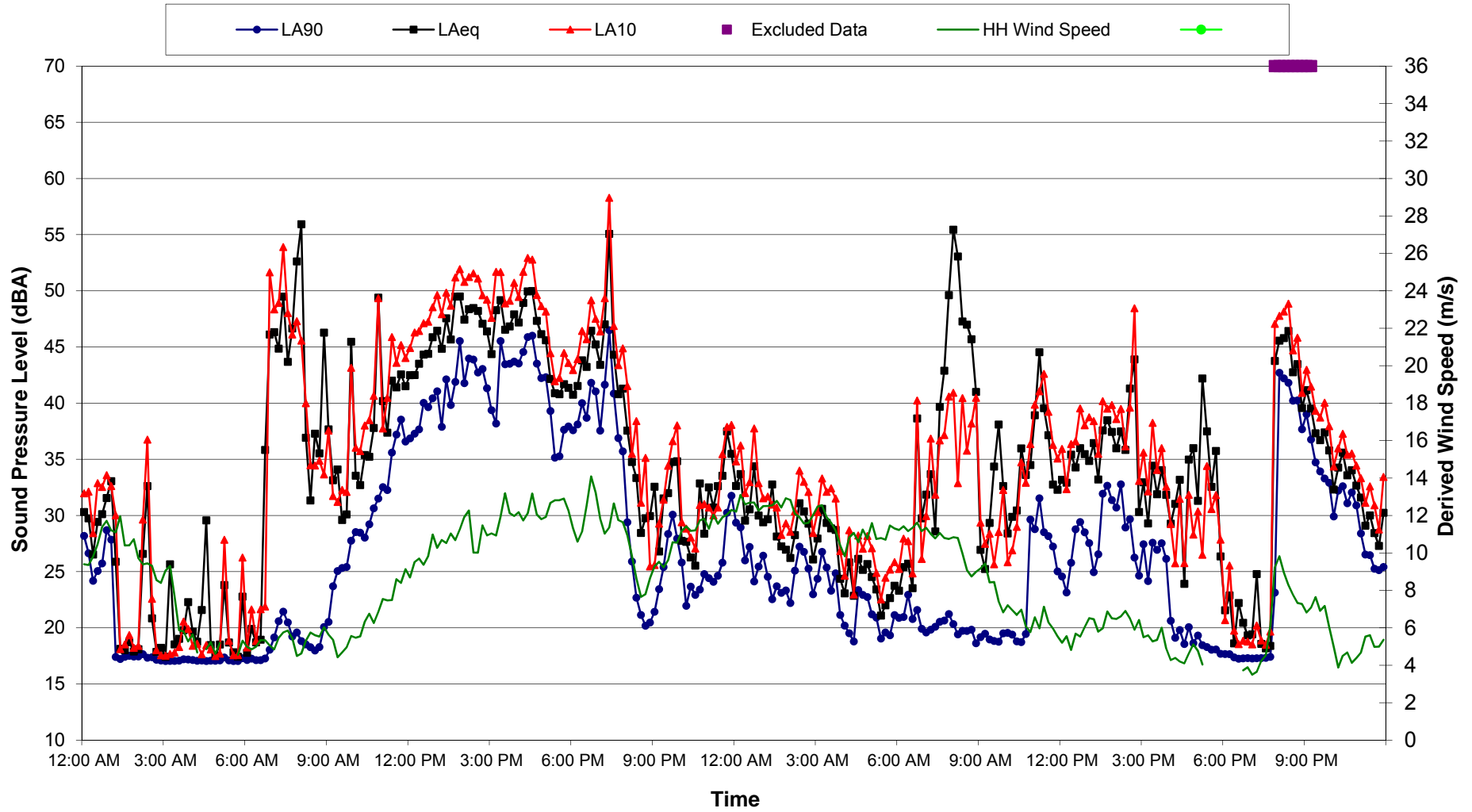
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 23 and 24 May 2016**



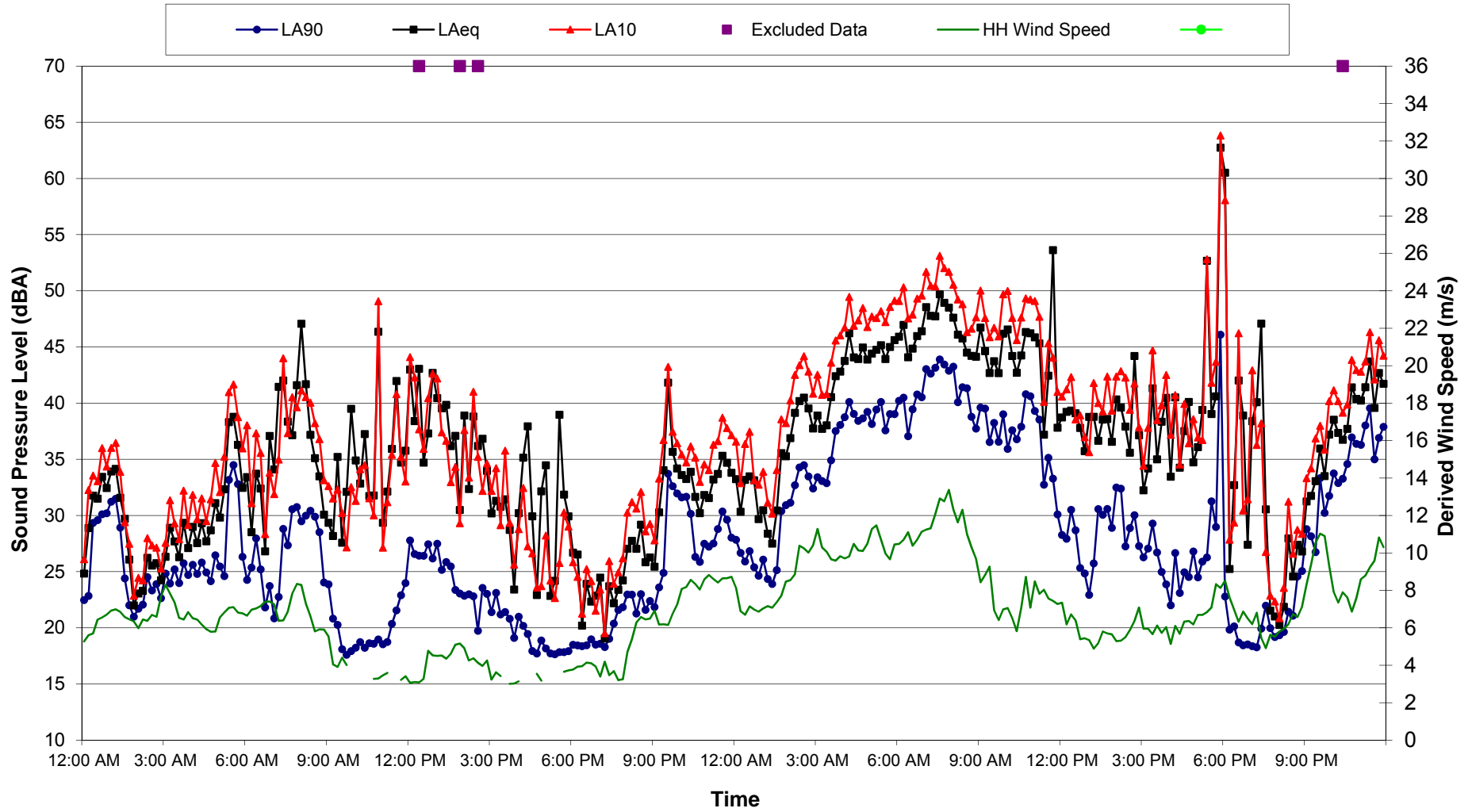
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



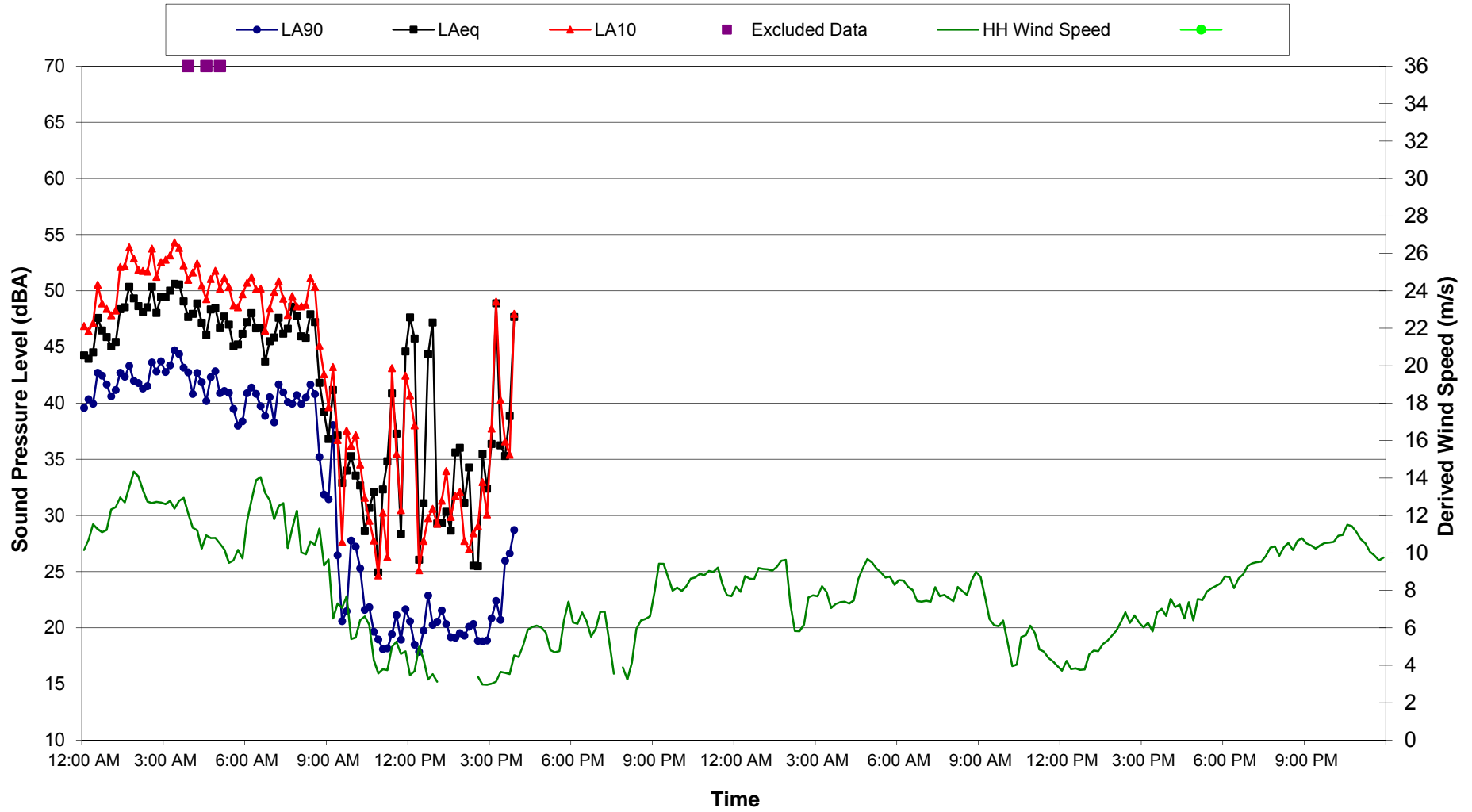
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**



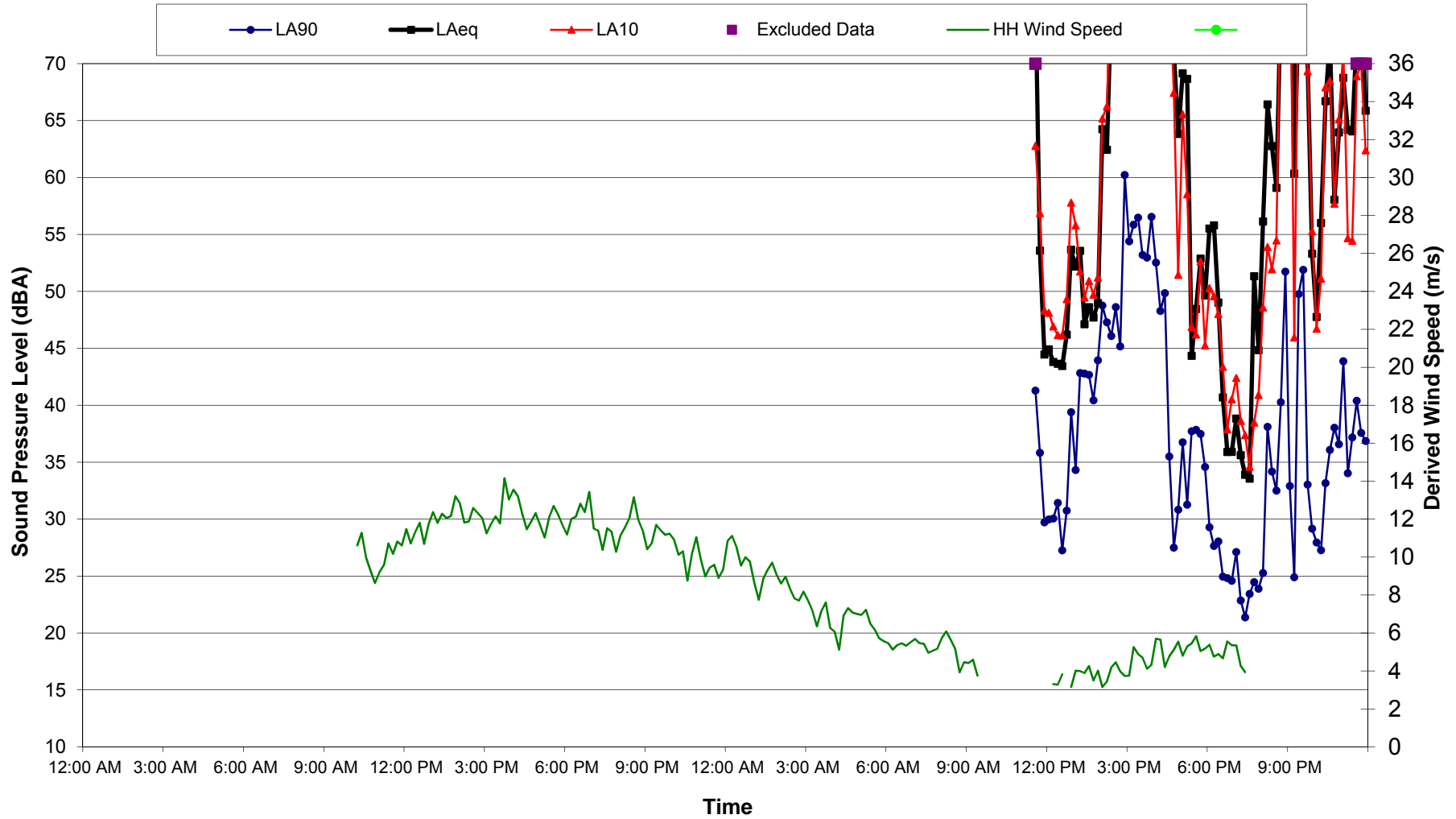
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016**



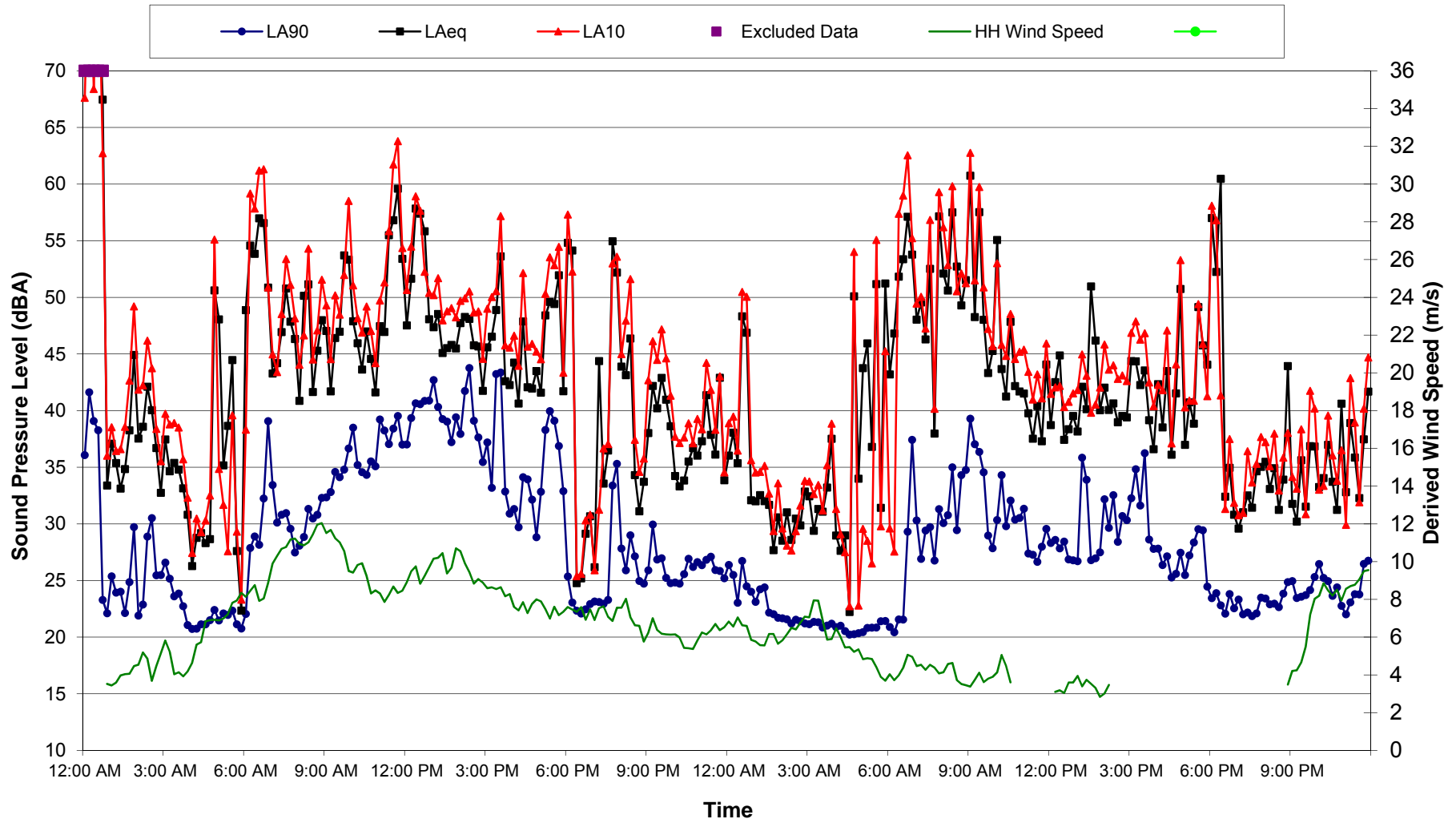
**Location Umberumberka - Silverton Wind Farm
Ambient Noise Data - 31 May and 1 June 2016**



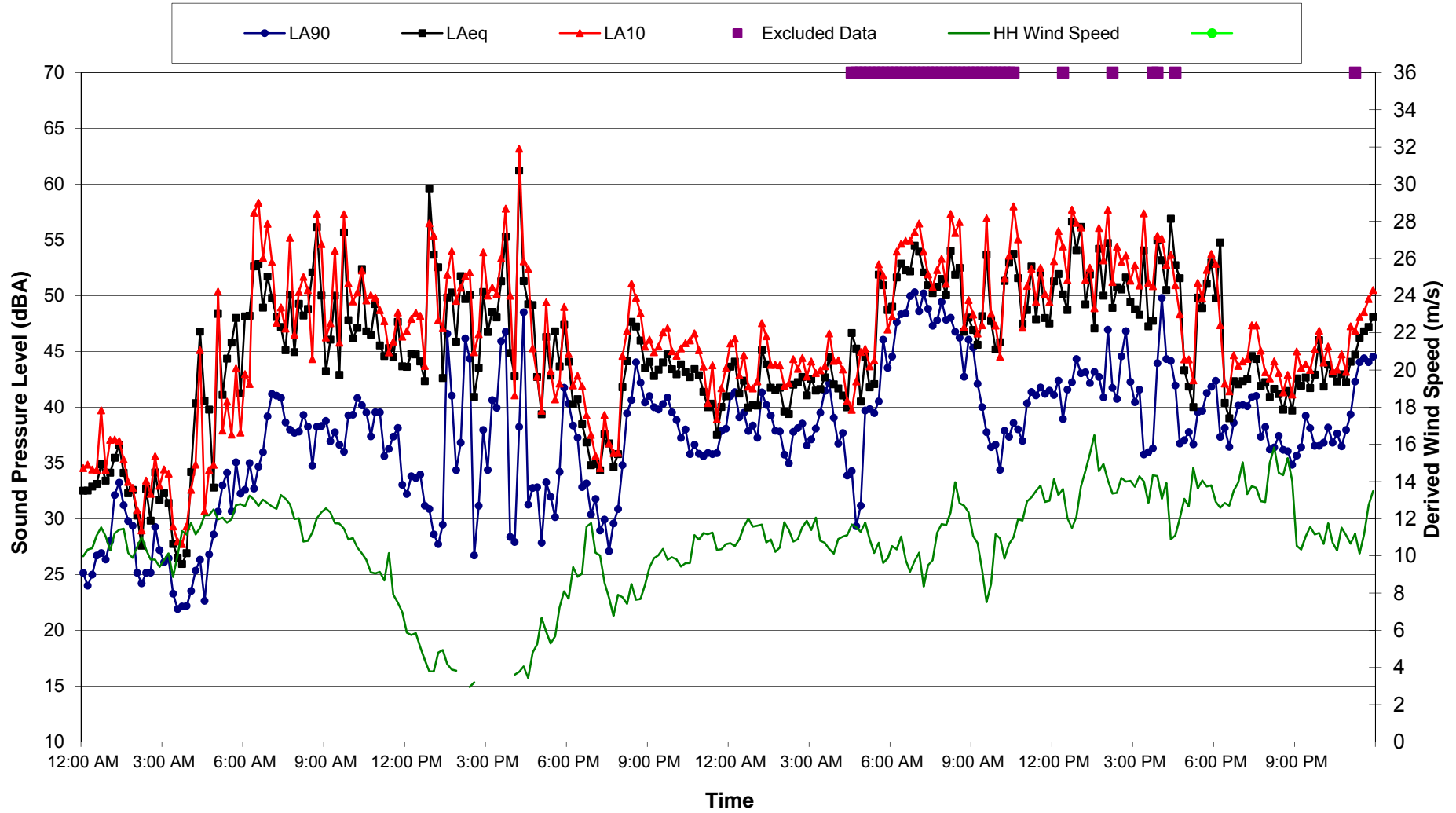
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 3 and 4 May 2016**



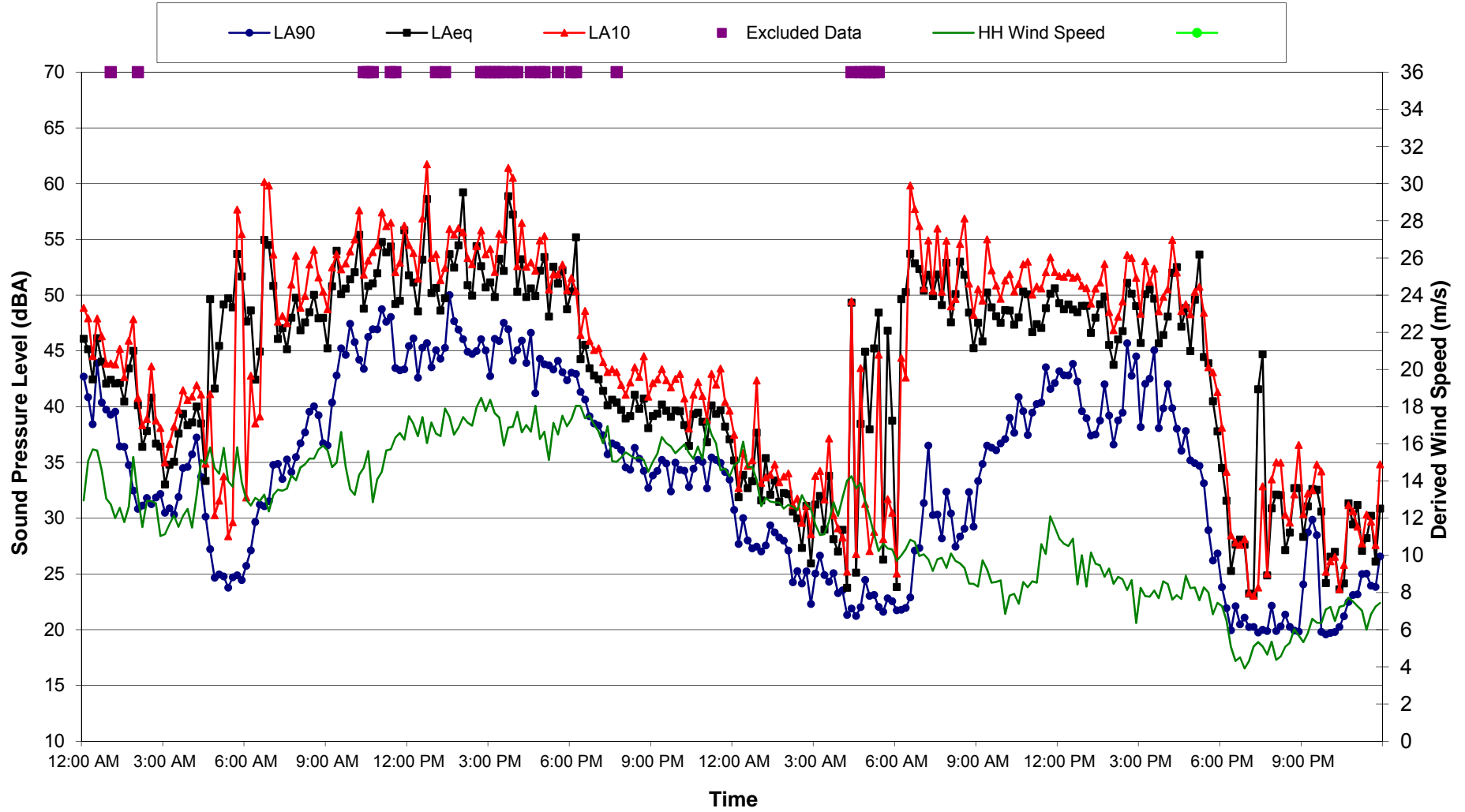
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 5 and 6 May 2016**



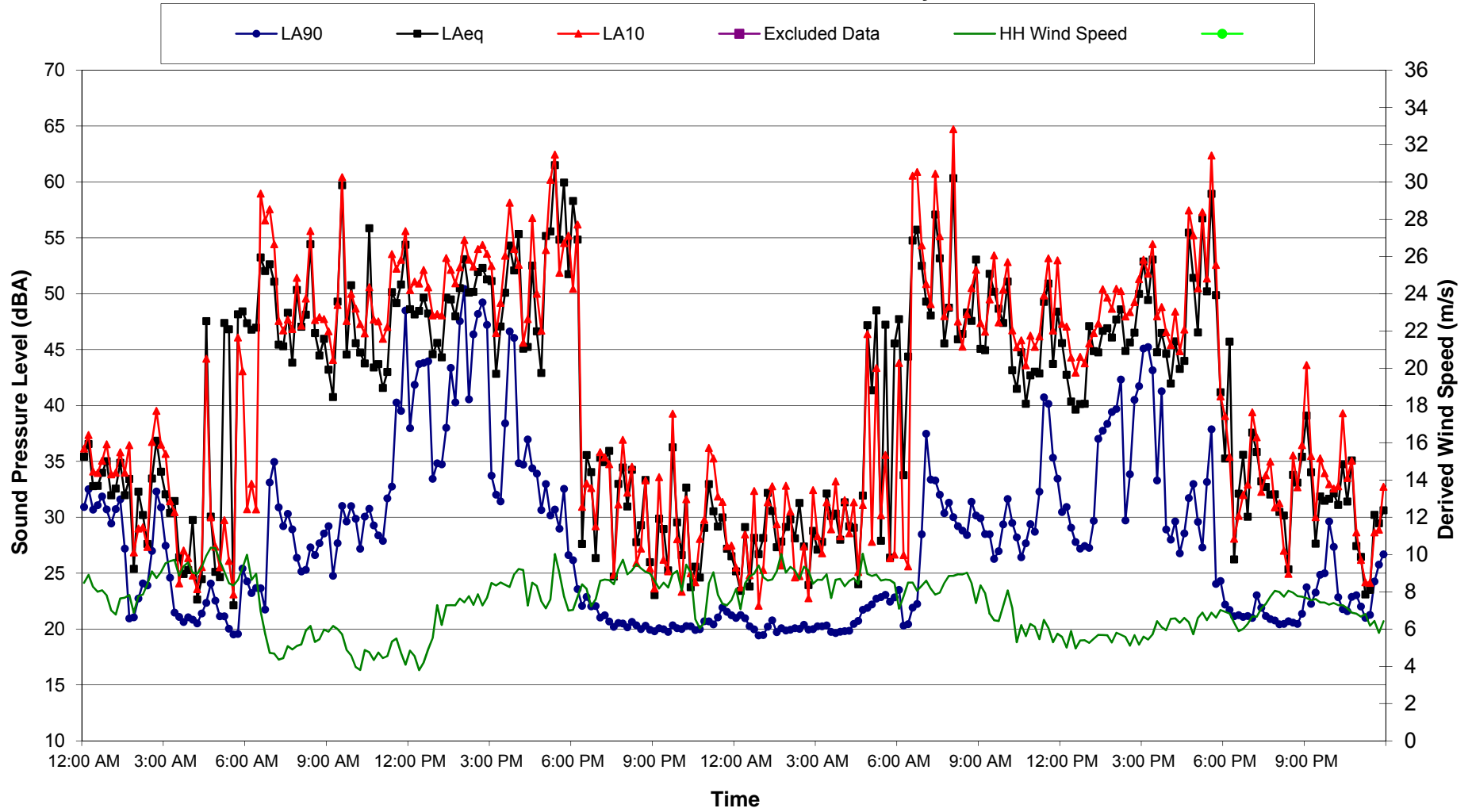
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 7 and 8 May 2016**



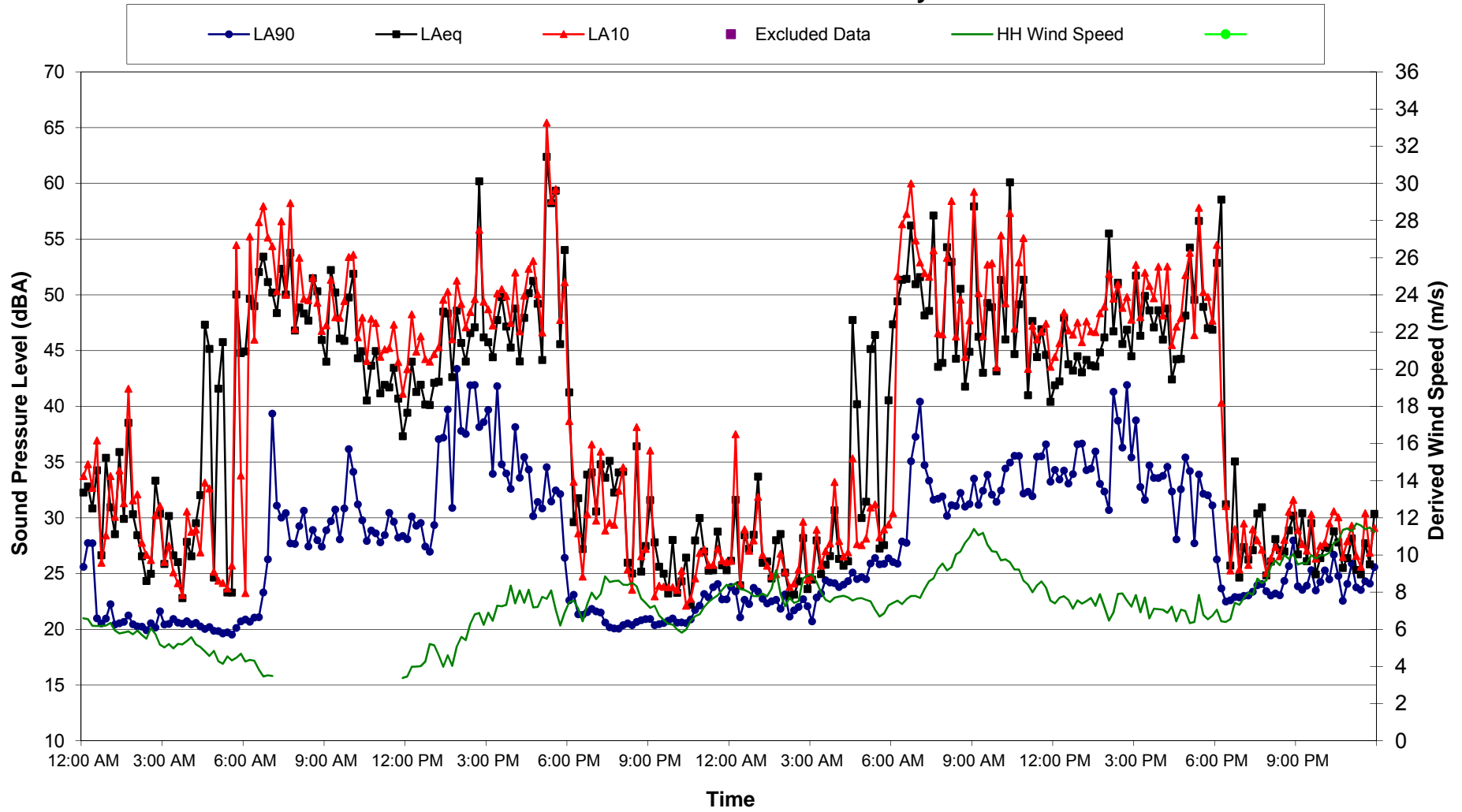
Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 9 and 10 May 2016



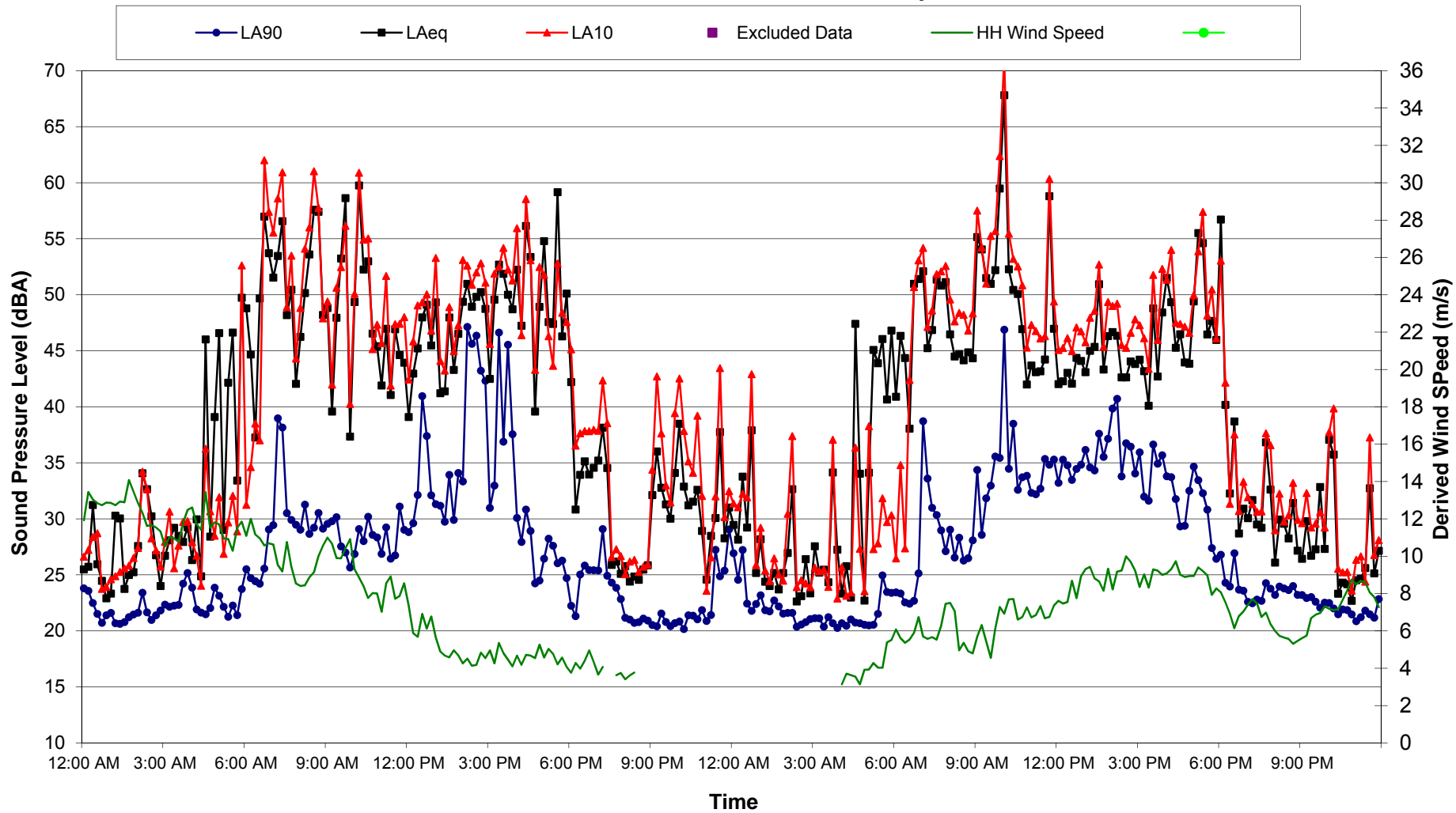
Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 11 and 12 May 2016



**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 13 and 14 May 2016**



Location Eldee Station - Silverton Wind Farm Ambient Noise Data - 15 and 16 May 2016

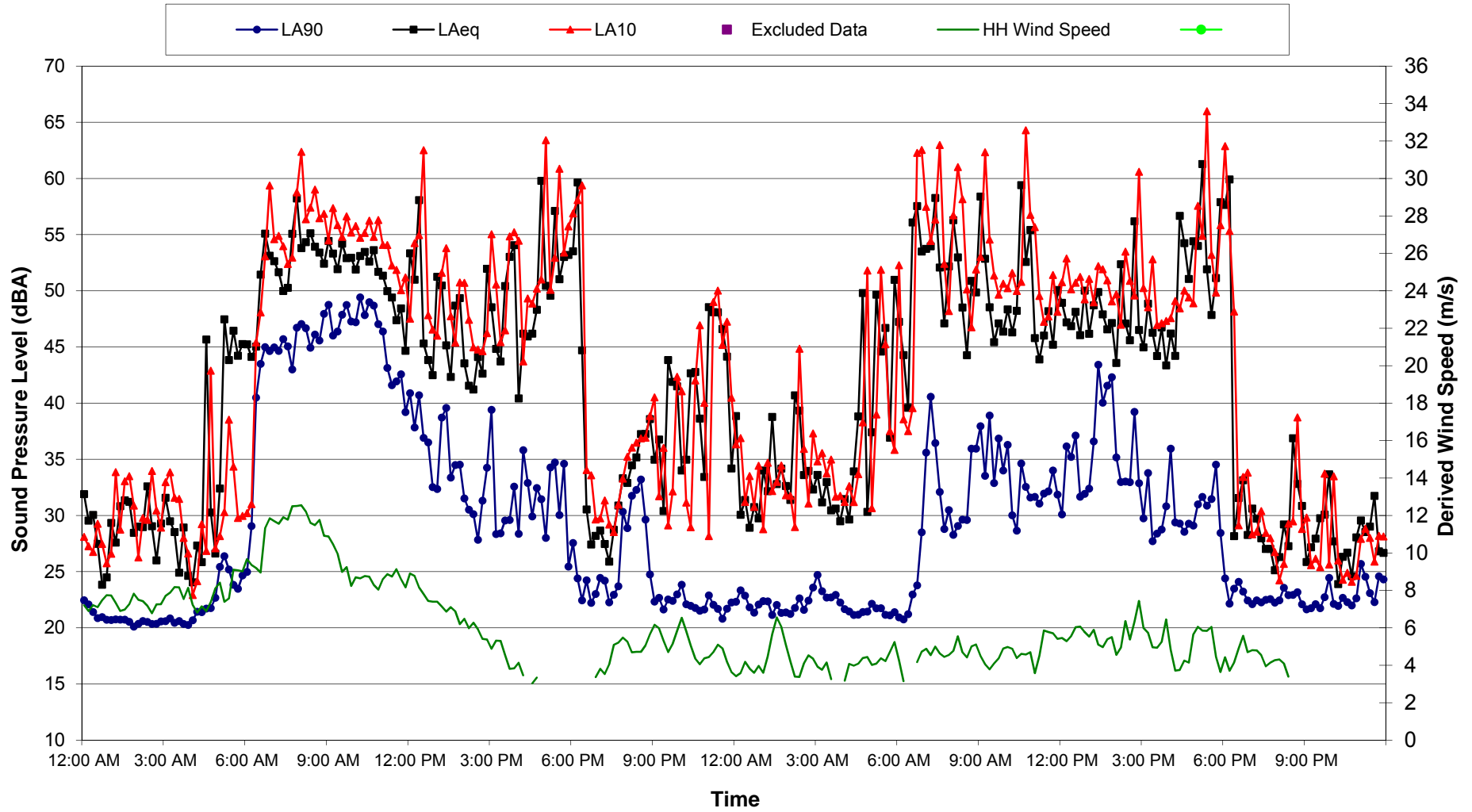


Appendix D

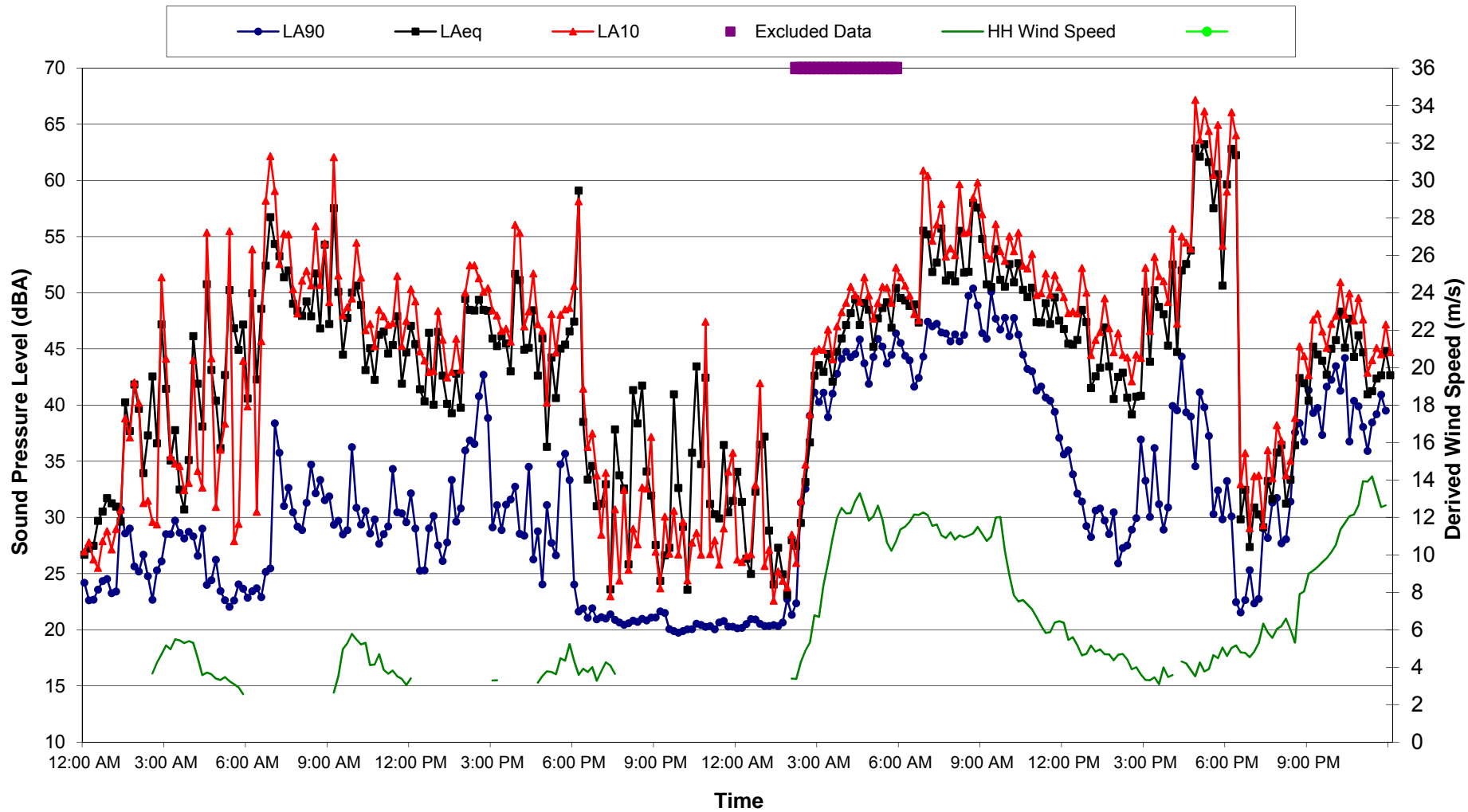
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Level Wind vs Time

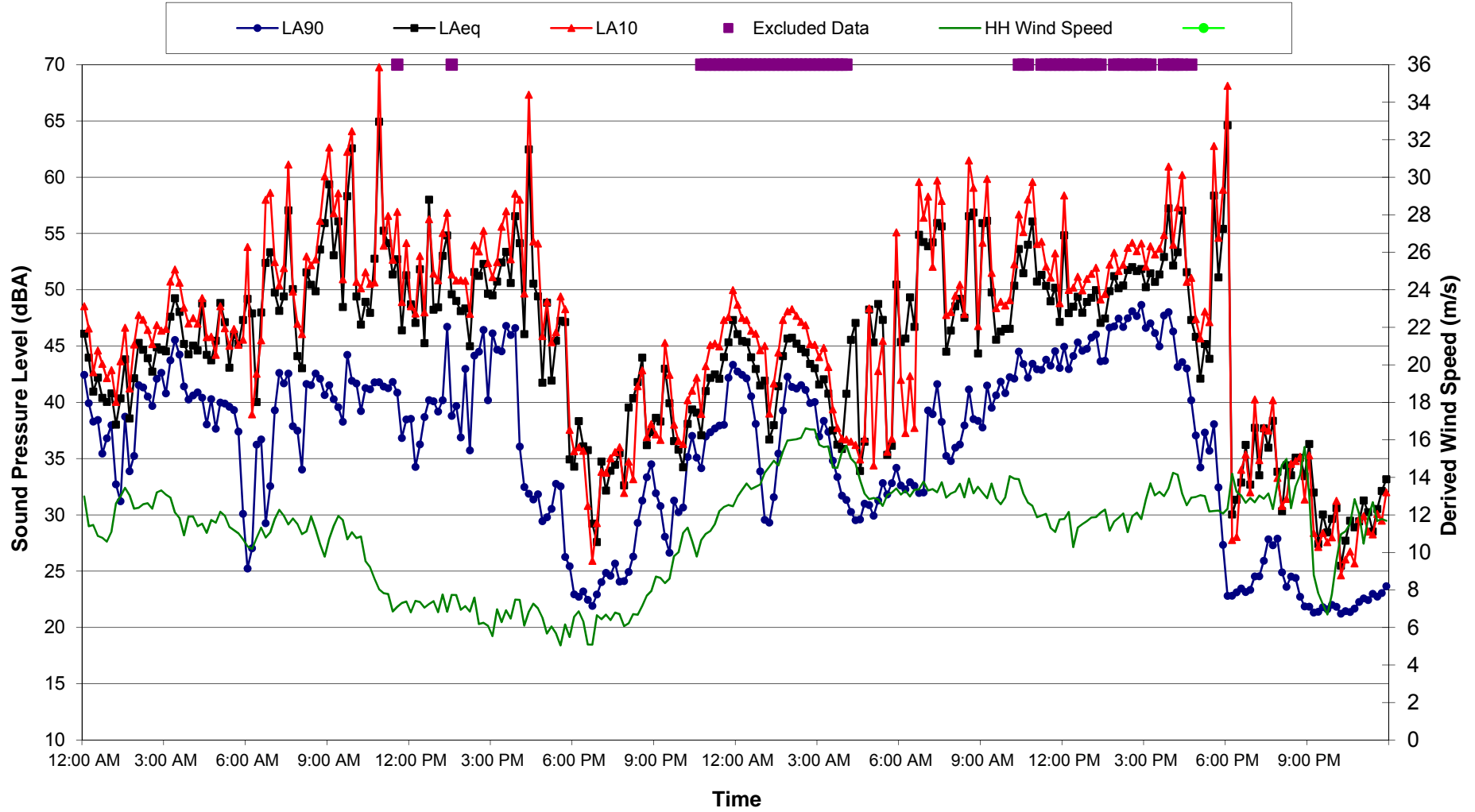
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 17 and 18 May 2016**



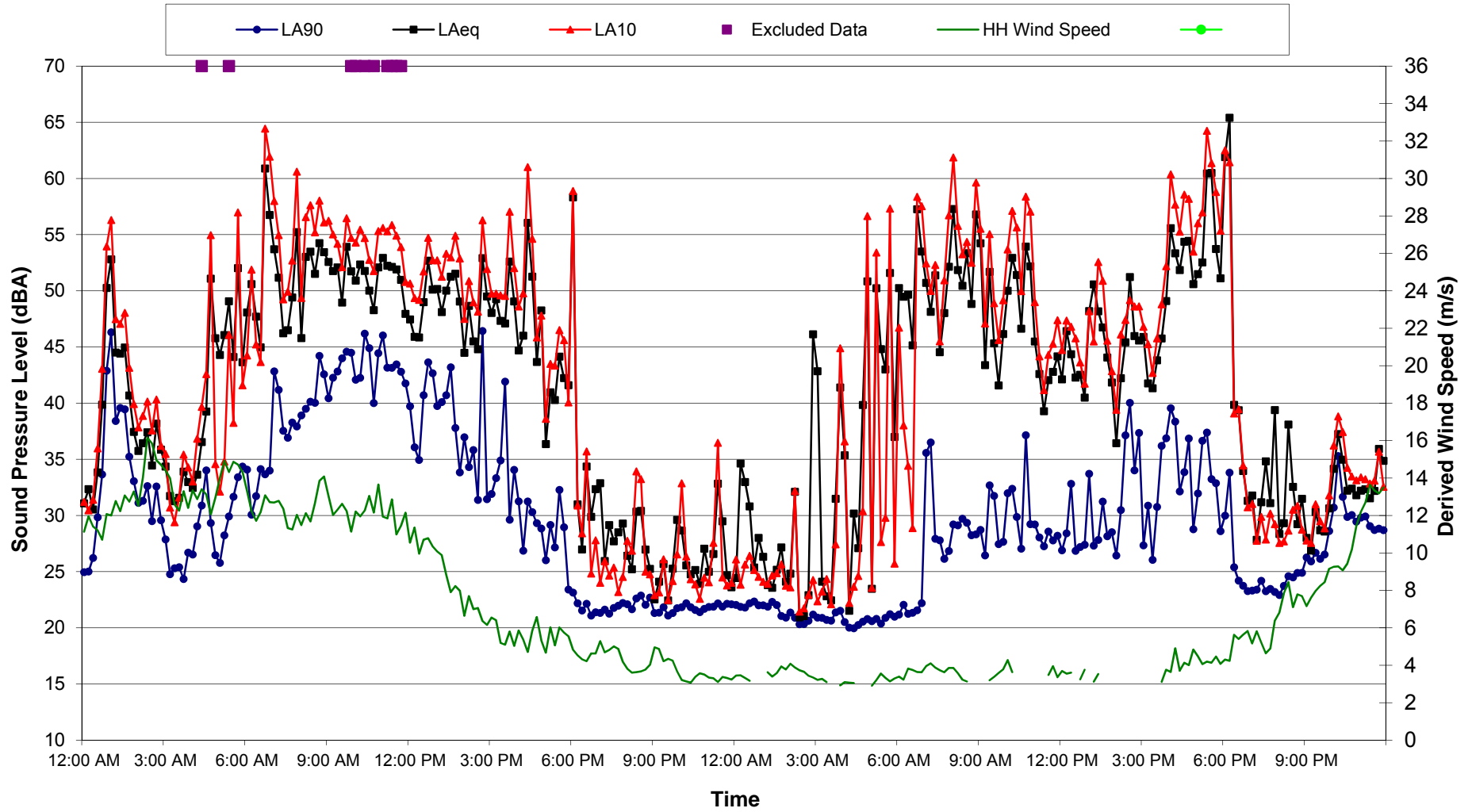
Location Eldee Station - Silverton Wind Farm Ambient Noise Data - 19 and 20 May 2016



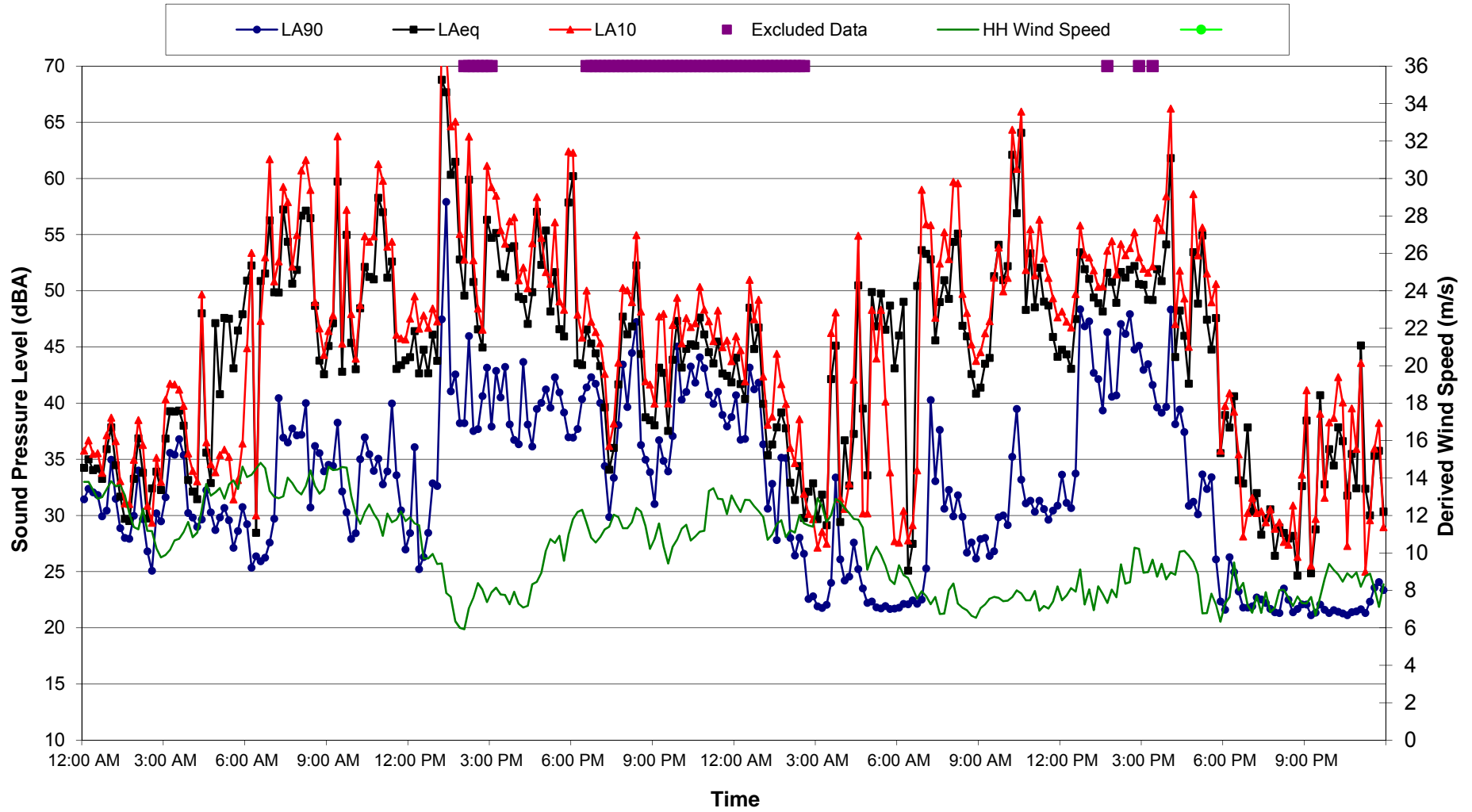
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 21 and 22 May 2016**



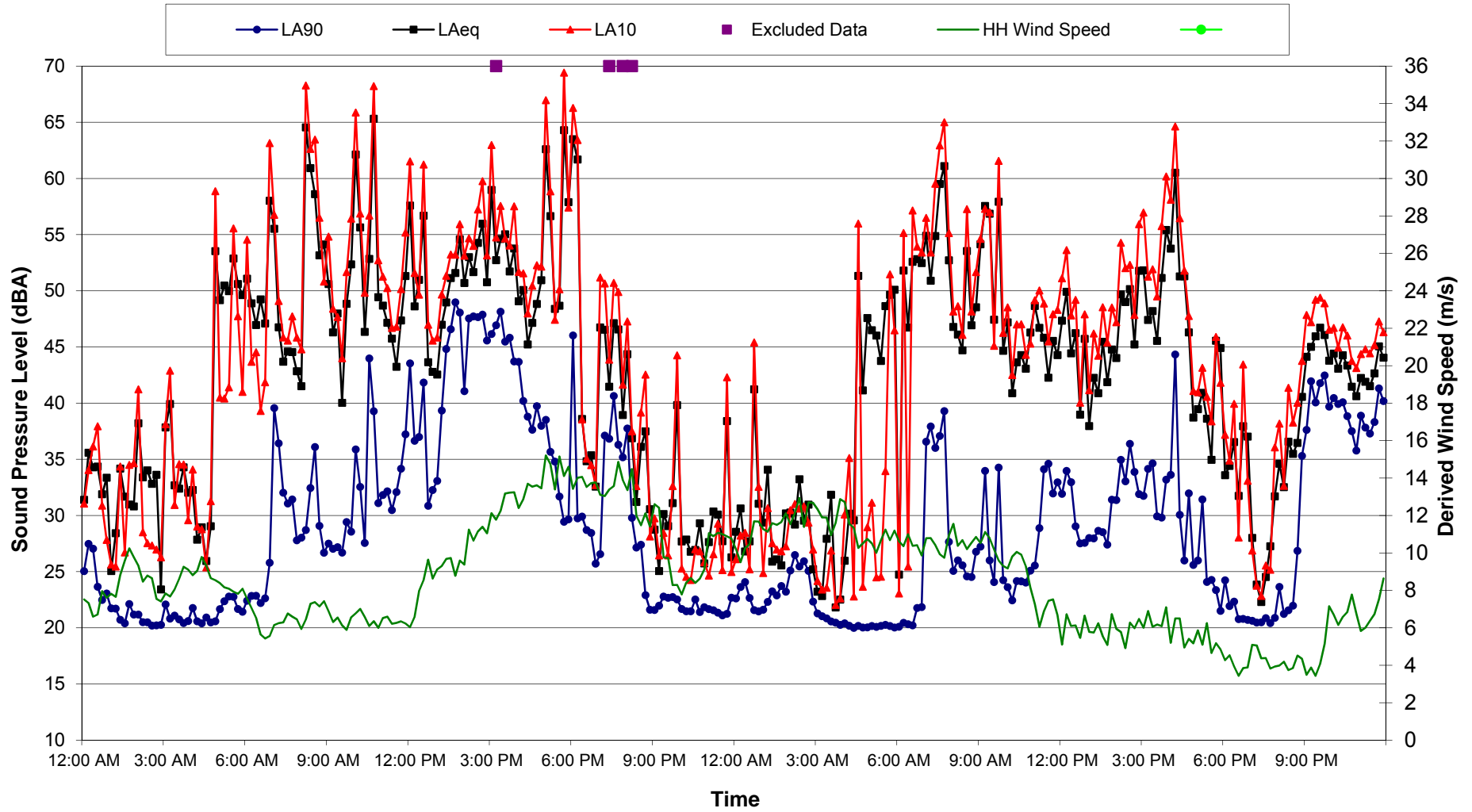
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 23 and 24 May 2016**



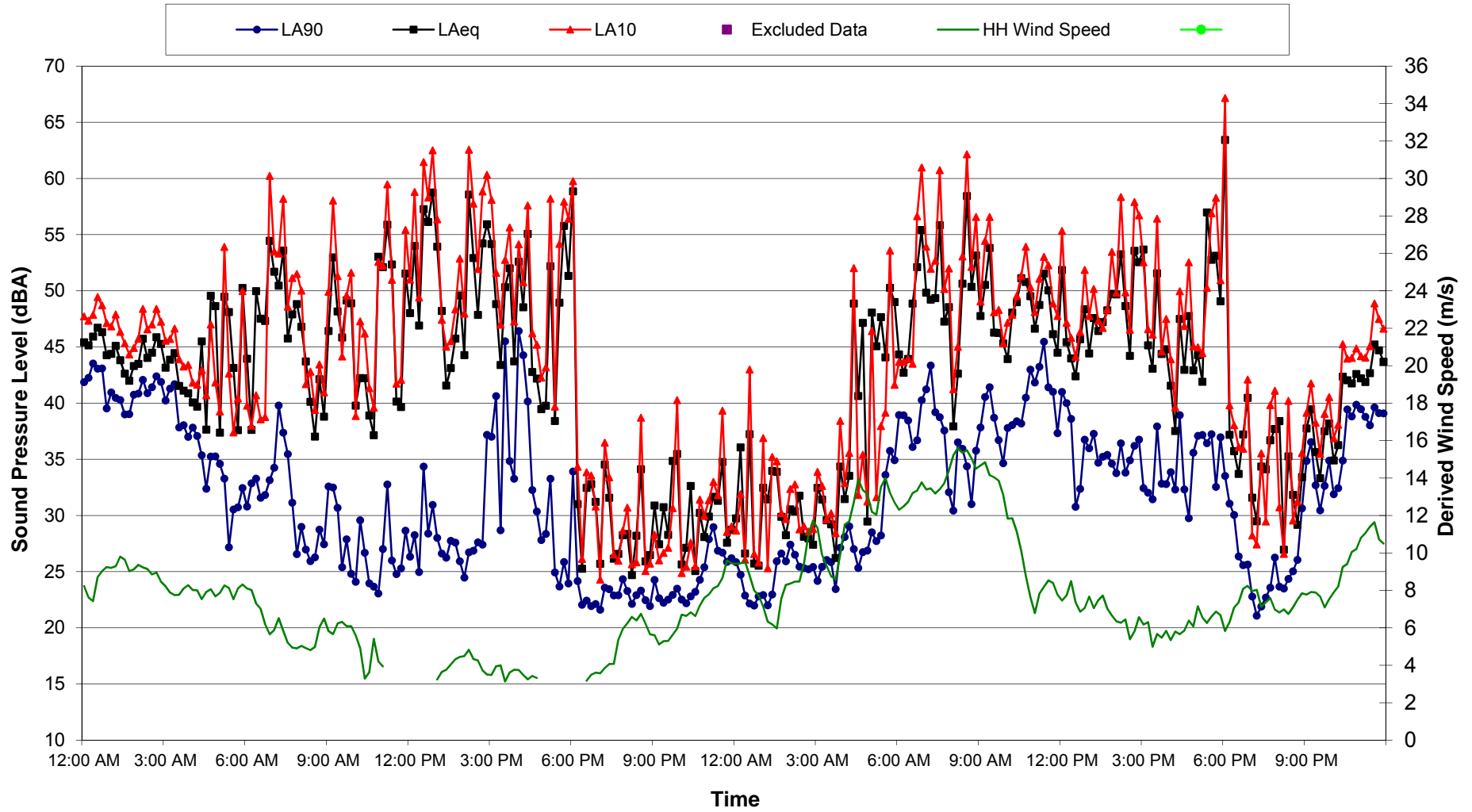
**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 25 and 26 May 2016**



**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 27 and 28 May 2016**



Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 29 and 30 May 2016



**Location Eldee Station - Silverton Wind Farm
Ambient Noise Data - 31 May and 1 June 2016**

