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## VERVE ENERGY

### WARRADARGE WIND FARM WARRADARGE

### BACKGROUND NOISE MONITORING

MARCH 2012

OUR REFERENCE: 14290-5-11250-01



DOCUMENT CONTROL PAGE

**BACKGROUND NOISE MONITORING  
WARRADARGE**

Job No: 11250-01

Document Reference: 14290-5-11250-01

**FOR  
VERVE ENERGY**

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<b>Author:</b>	George Watts	<b>Checked By:</b>	Tim Reynolds	
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## 1. INTRODUCTION

Herring Storer Acoustics was commissioned by Verve Energy to carry out background noise monitoring for the proposed Warradarge Wind Farm development.

The proposed development site is located on private farming land in Warradarge, approximately 240km north of Perth and 18km east of Eneabba.

The proposed wind farm consists of up to 100 wind turbines, with a maximum generating capacity of 250 MW.

See Appendix A for locations of background noise monitoring and wind measurement masts.

The background noise monitoring has been carried out in accordance with the EPA of South Australia "*Wind Farms – Environmental noise guidelines – July 2009*" (Guidelines) which is the guidelines recognised by the Department of Environment and Conservation for the assessment of wind farms.

## 2. SUMMARY

Based on the results of background noise monitoring within the proposed wind farm development area, the applicable criteria for each location is as listed in Table 2.1

**TABLE 2.1 – NOISE CRITERIA BASED ON BACKGROUND NOISE LEVELS, dB(A)**

Location	WIND SPEED AT 10m ABOVE GROUND LEVEL (m/s)						
	3	4	5	6	7	8	9
1	37	37	37	38	40	42	44
2	35	35	35	35	37	39	41
3	38	39	39	40	41	42	44

## 3. METHODOLOGY

Background noise levels were monitored at three locations within the proposed development area in accordance with the Guidelines and AS4959-2010. Locations are detailed in Table 3.1 and the monitoring location map is attached in Appendix A.

**TABLE 3.1 – MONITORING LOCATION DETAILS**

Location	Easting	Northing
1	356887	6690058
2	358165	6687158
3	355325	6681021
Wind Measurement Mast 1	352736	6685888
Wind Measurement Mast 2	354229	6682679

The background noise monitoring locations were chosen to give representative locations for the noise sensitive premises that were highlighted during the initial noise impact assessment as potentially being exposed to noise emissions associated with the proposed wind farm at close to the base criteria of 35 dB(A).

Monitored noise levels were then paired with corresponding wind data, provided by the wind measurement masts located within the development by Verve Energy. The wind measurement masts recorded wind speeds at heights of 40, 60 and 80m above ground level.

Rain affected data was removed from the collected data using weather information provided by the Bureau of Meteorology rainfall monitoring site, located at Coorow.

Background noise levels were plotted against the corresponding wind speed measurement, calculated at 10m above ground level, assuming a linear wind shear rate (see Appendix C).

The wind measurement mast closest to the background noise monitoring location was utilised in the calculation i.e. Wind measurement mast 1 was utilised for Locations 1 and 2, with Wind measurement mast 2 utilised for Location 3.

The relevant regression line providing the best correlation co-efficient for each location was determined (from linear to third order). The calculated regression line equations were then used to ascertain the background noise ( $L_{A90,10 \text{ minutes}}$ ) at each integer wind speed to determine the relevant noise criteria for the wind farm development, which should not exceed whichever is the greater of;

- 35 dB(A), or
- The background noise ( $L_{A90,10 \text{ minutes}}$ ) by more than 5 dB(A).

Calibration certificates for meters used are attached in Appendix E.

Automatic noise data loggers were established on 19 January 2012 and retrieved on 6 March 2012, storing data at 10 minute intervals. Details of each monitoring site are listed in Table 3.2 below.

**TABLE 3.2 – MONITORING LOCATION DETAILS**

Location	Noise Logger Details			Location Details	
	Make	Model	Serial Number	Height Above Ground Level (m)	Distance to Nearest Building Structure (m)
1	RTA Technology	RTA02	052	1.2	~20
2	RTA Technology	RTA01	091	1.5	~20
3	RTA Technology	RTA01	069	1.5	> 1000

## 4. RESULTS

Background noise monitoring regression analysis results for each of the three locations is presented in Appendix C, with time history charts presented in Appendix D.

Refer to Appendix A and B for location information for each noise logger.

The noise floor of the loggers utilised appears to have affected the data collected at location 3. This has been confirmed through testing of the automatic noise data logger used during the monitoring period. The data for wind speeds less than 7m/s has been impacted by the noise floor. Given that the critical wind speed for the turbines is in the order of 8m/s (as this corresponds to the highest noise level produced by the turbines) and the data at this wind speed – and higher – is valid, the collected data has still been used. It is also noted that location 3 is situated greater than 1000m from the nearest building structure, hence is not a critical background noise monitoring location.

The total number of valid sample data pairs for each monitoring location is listed below in Table 4.1.

**Table 4.1 – VALID SAMPLE POINTS**

Monitoring Location	Number Valid Sample Data Pairs
1	5952
2	2501
3	5870

The calculated relevant regression line equations for each location are listed below;

**Monitoring Location 1**

$$y = -0.0183x^3 + 0.6188x^2 - 4.1625x + 39.777$$

**Monitoring Location 2**

$$y = -0.013x^3 + 0.381x^2 - 1.5347x + 28.336$$

**Monitoring Location 3**

$$y = -0.0059x^3 + 0.2248x^2 - 1.144x + 35.065$$

It is noted that in the above equations,  $y = L_{A90}$  (dB(A)) and  $x$  = wind speed at 10 metres height (m/s).

Based on the above calculated regression lines, Table 4.2 summarises the background noise at each location for each integer wind speed.

**TABLE 4.2 – BACKGROUND NOISE LEVELS,  $L_{A90,10 \text{ minutes}}$  [dB(A)]**

Location	WIND SPEED AT 10m ABOVE GROUND LEVEL (m/s)						
	3	4	5	6	7	8	9
1	32	32	32	33	35	37	39
2	32	32	33	33	34	34	35
3	33	34	34	35	36	37	39

## 5. CRITERIA

The noise criteria for new wind farm developments, based on the Guidelines, is for the predicted noise level to not exceed whichever is the greater of;

- 35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or,
- 40 dB(A) at relevant receivers in localities in other zones, or
- the background noise ( $L_{A90,10 \text{ minute}}$ ) by more than 5 dB(A).

In accordance with the Guidelines, a “rural living” zone is a rural-residential “lifestyle” area intended to have a relatively quiet amenity. The area should not be used for primary production other than to produce food, crops or keep animals for the occupiers’ own use, consumption and/or enjoyment.

If there is any uncertainty about the zone, and whether the rural living criteria should be applied, the question should be resolved in consultation with the relevant environmental protection authority and council for the area concerned.

Through discussions with John MacPherson, Principal Environmental Noise Officer of the Department of Environment and Conservation, it is understood that the Department of Environment and Conservation has the expectation that the “rural living” zone is applicable for the receivers in the proposed development area.

Hence the applicable criteria for the proposed wind farm development based on the background noise monitoring are listed below in Table 5.1.

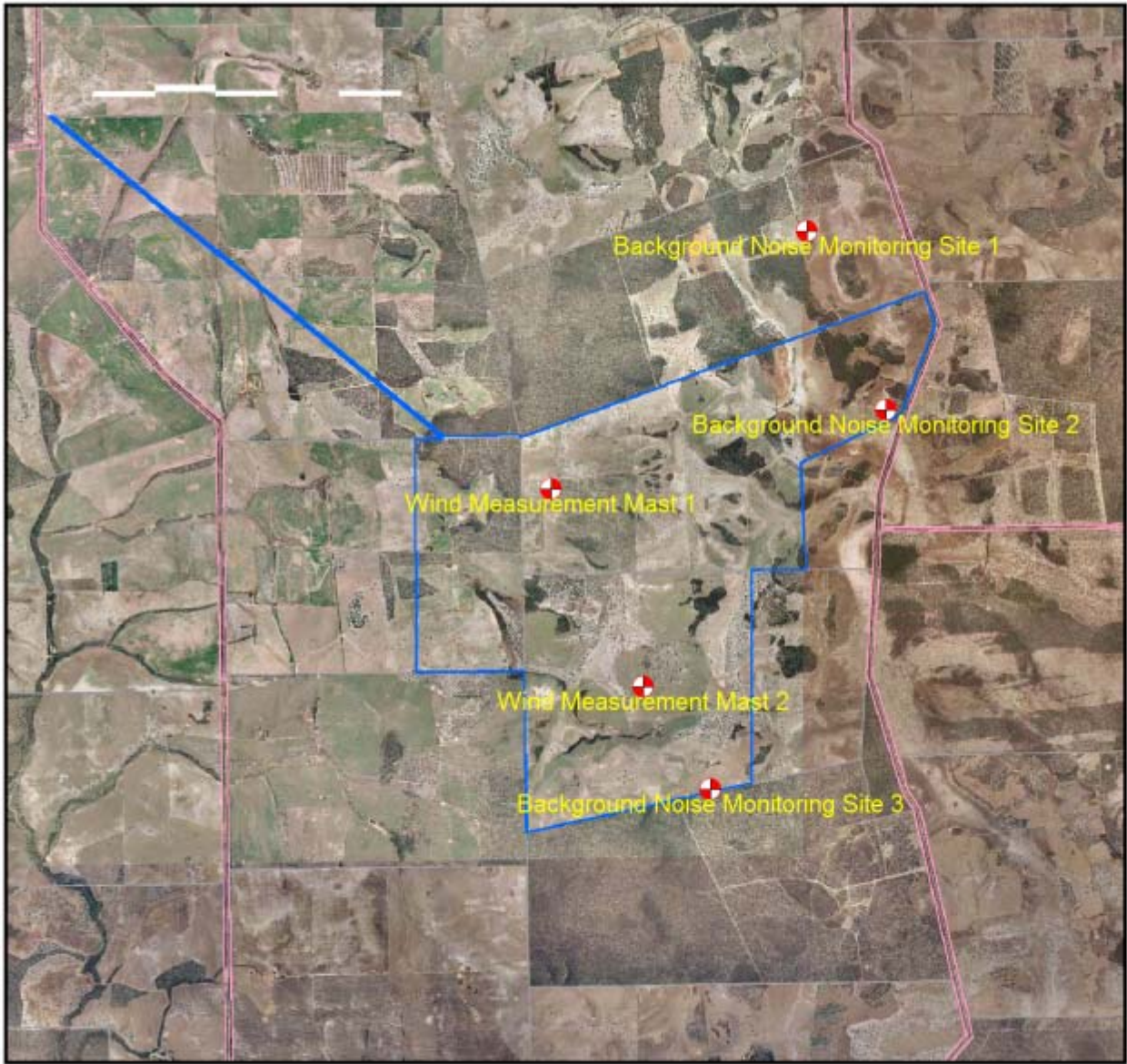
**TABLE 5.1 – NOISE CRITERIA BASED ON BACKGROUND NOISE LEVELS, dB(A)**

Location	WIND SPEED AT 80m ABOVE GROUND LEVEL (m/s)						
	3	4	5	6	7	8	9
1	37	37	37	38	40	42	44
2	35	35	35	35	37	39	41
3	38	39	39	40	41	42	44

# **APPENDIX A**

## MONITORING LOCATIONS





Warradarge Wind Farm  
Background Noise  
Monitoring Locations

Background Noise Monitoring  
Locations & Wind Monitoring  
Mast Locations

Locality  
Map



Length scale 1:70000  
00.25 0.5 1 1.5 2 2.5 3 km



Signs and symbols

 Monitoring Location

Job No : 11250  
Calc Ref : BNM and Masts Geofile

# **APPENDIX B**

## **MONITORING LOCATION DETAILS**

## Location 1





## Location 2





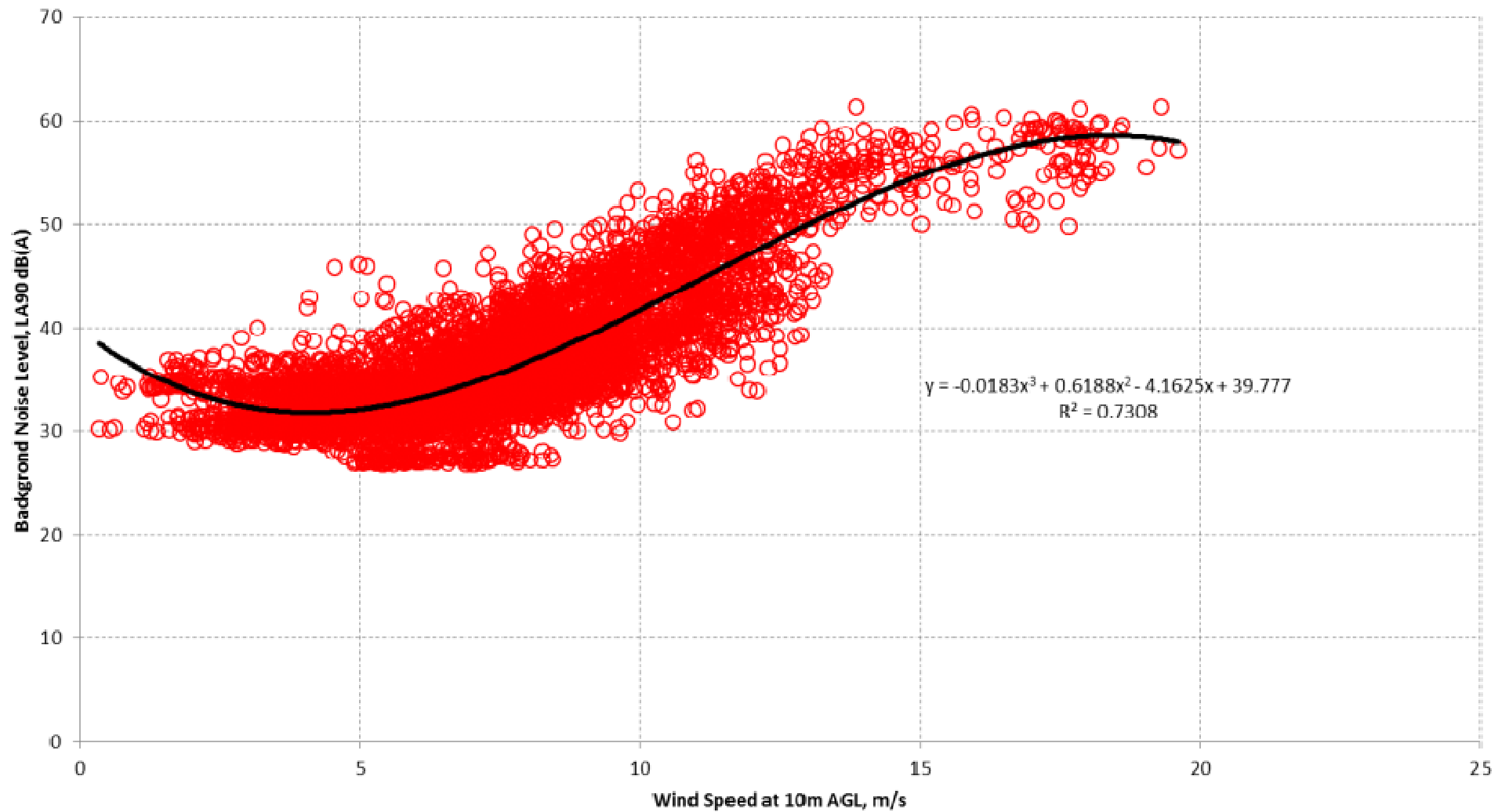
## Location 3



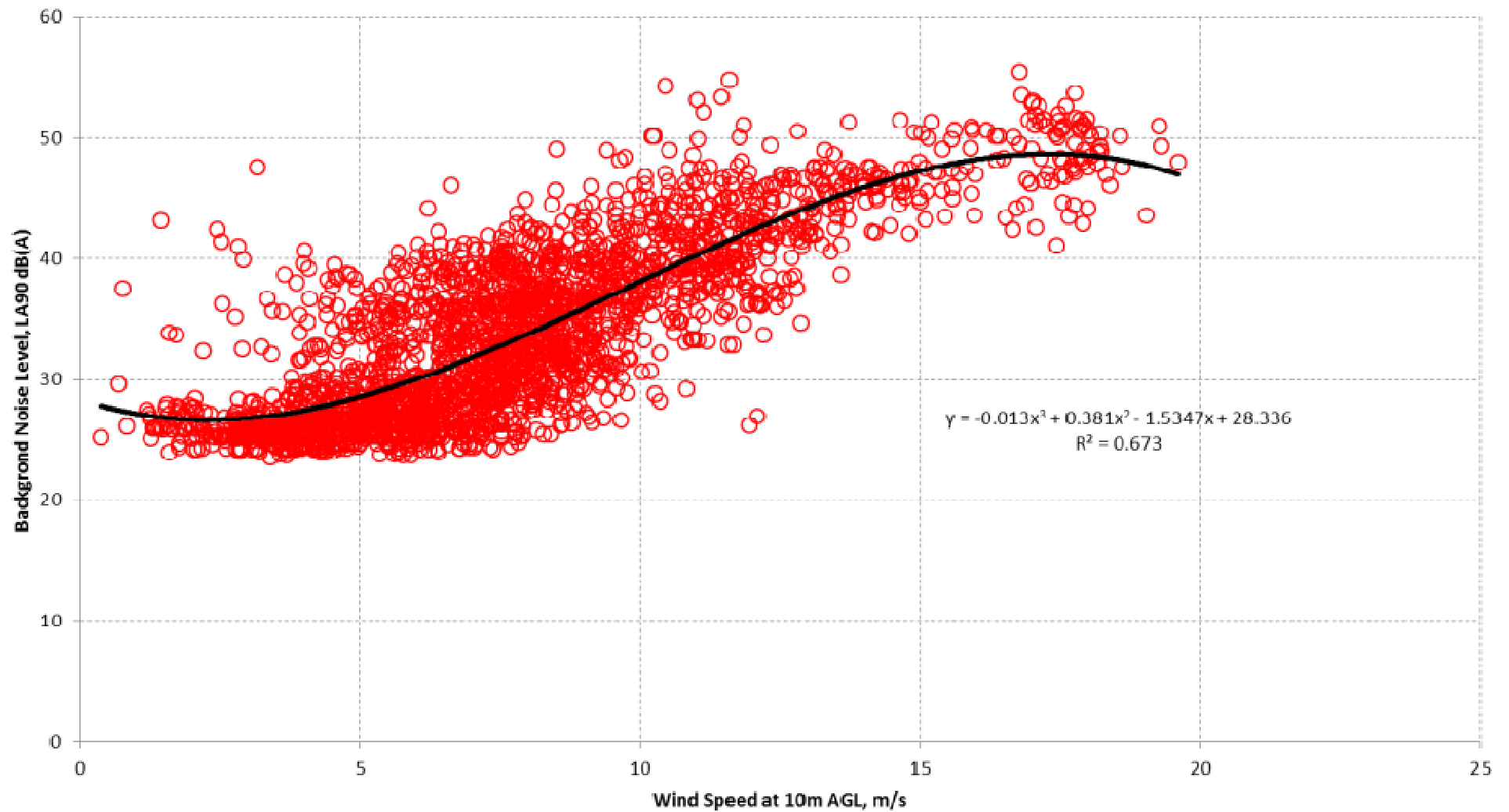
## **APPENDIX C**

BACKGROUND NOISE LEVELS vs WIND SPEED PLOTS

# Warradarge Wind Farm Background Noise Monitoring Site 1 Mast 1

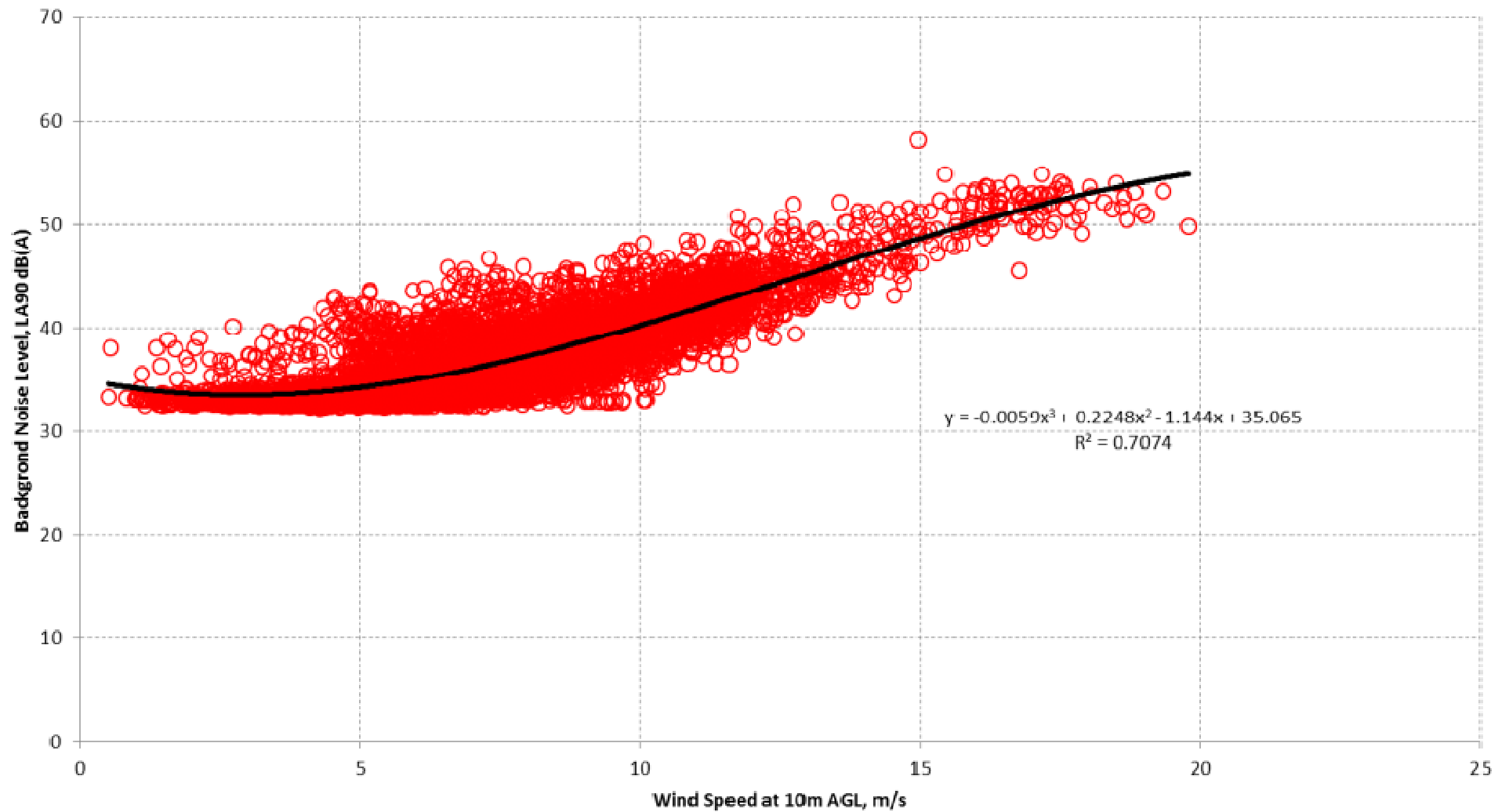


# Warradarge Wind Farm Background Noise Monitoring Site 2 Mast 1





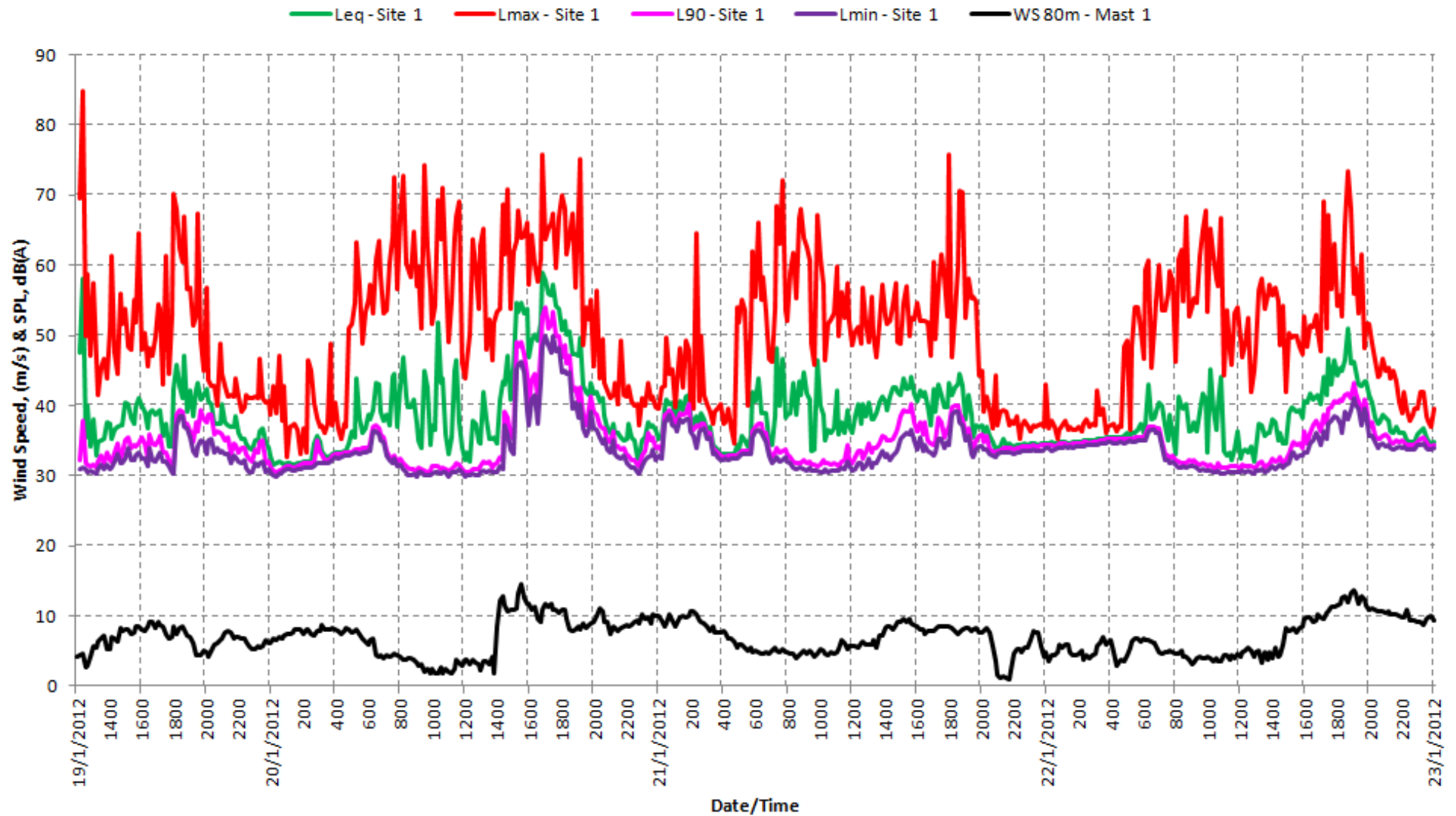
### Warradarge Wind Farm Background Noise Monitoring Site 3 Mast 2



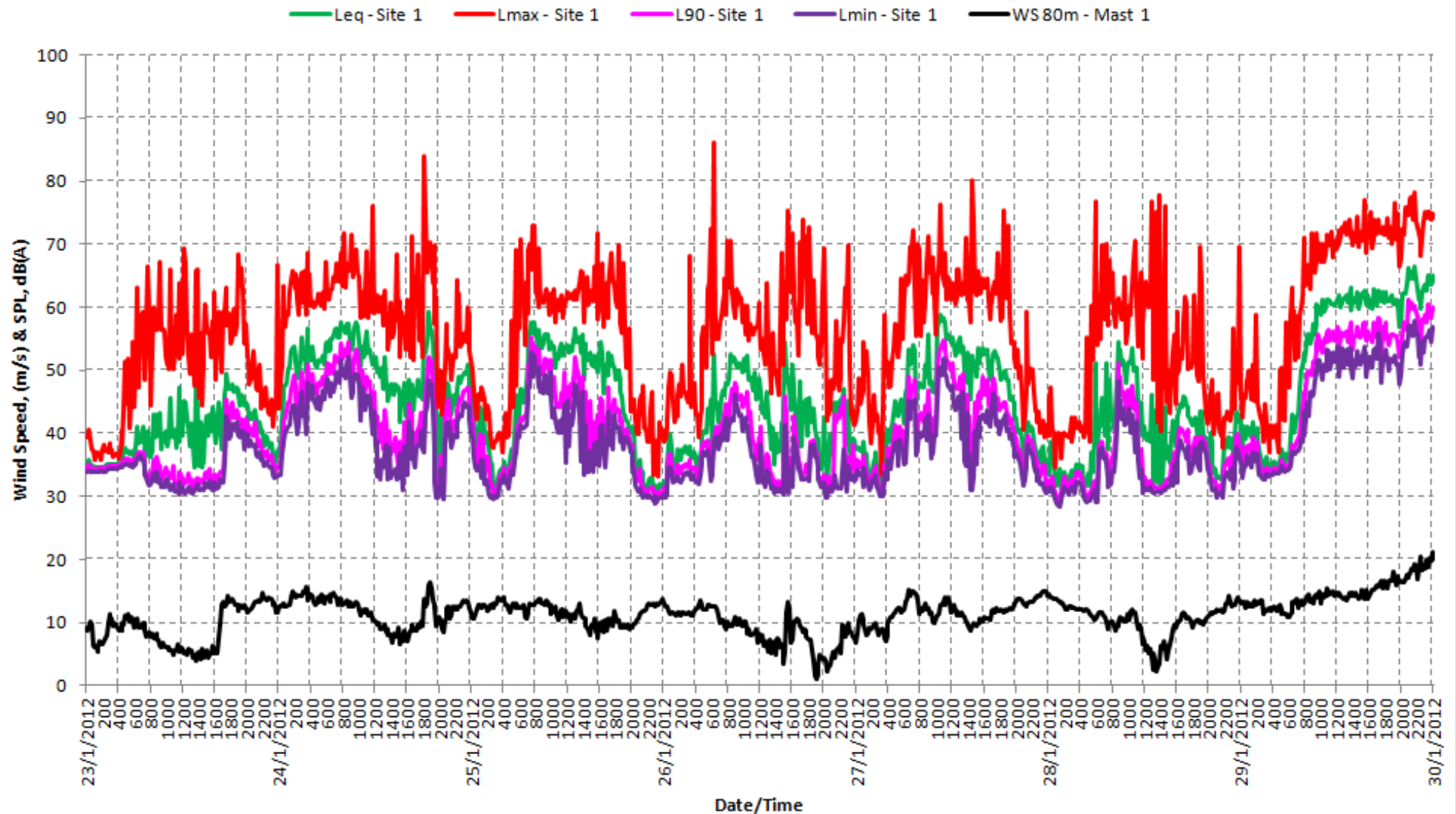
## **APPENDIX D**

### **BACKGROUND NOISE LEVELS TIME HISTORY PLOTS**

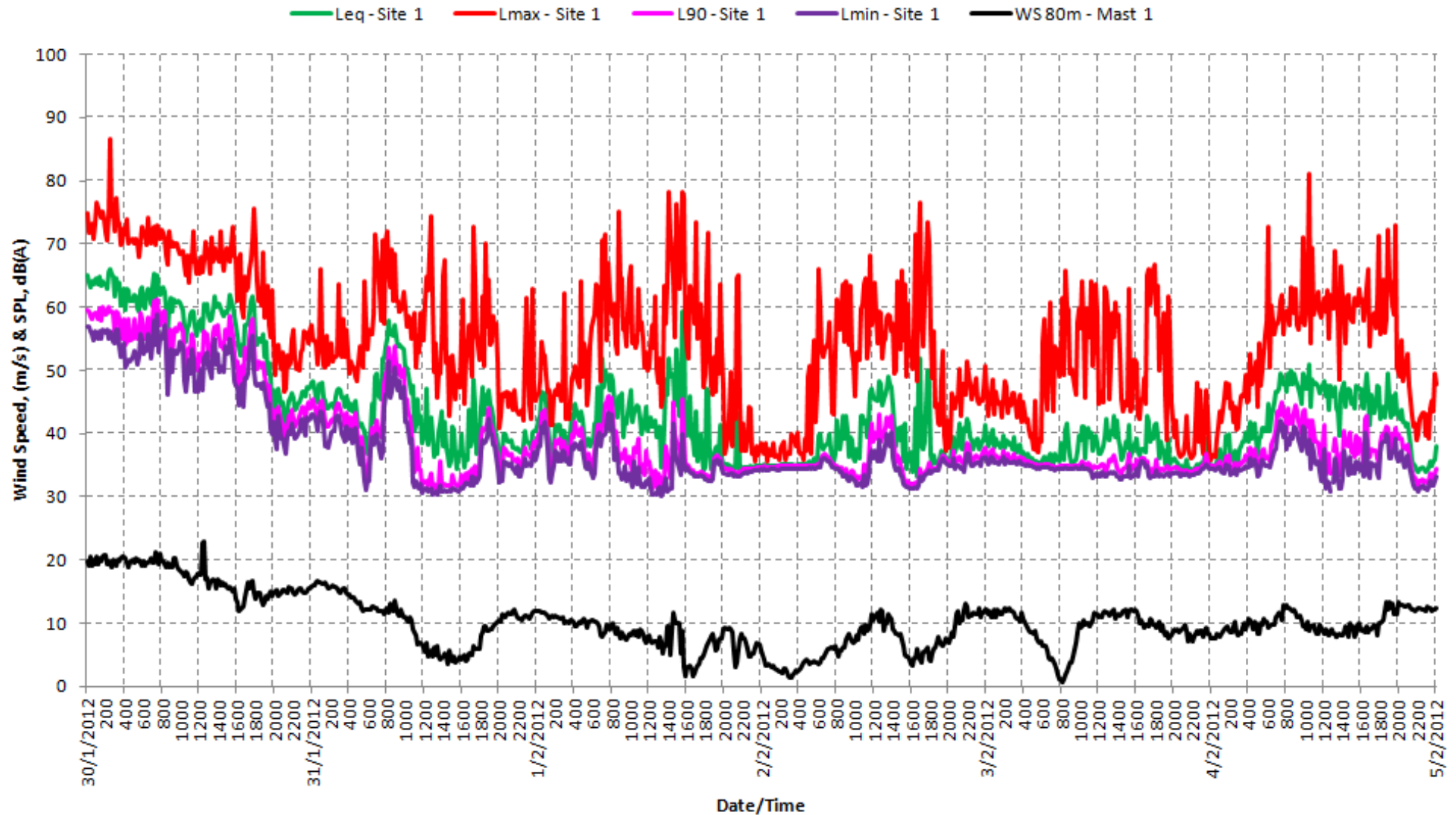
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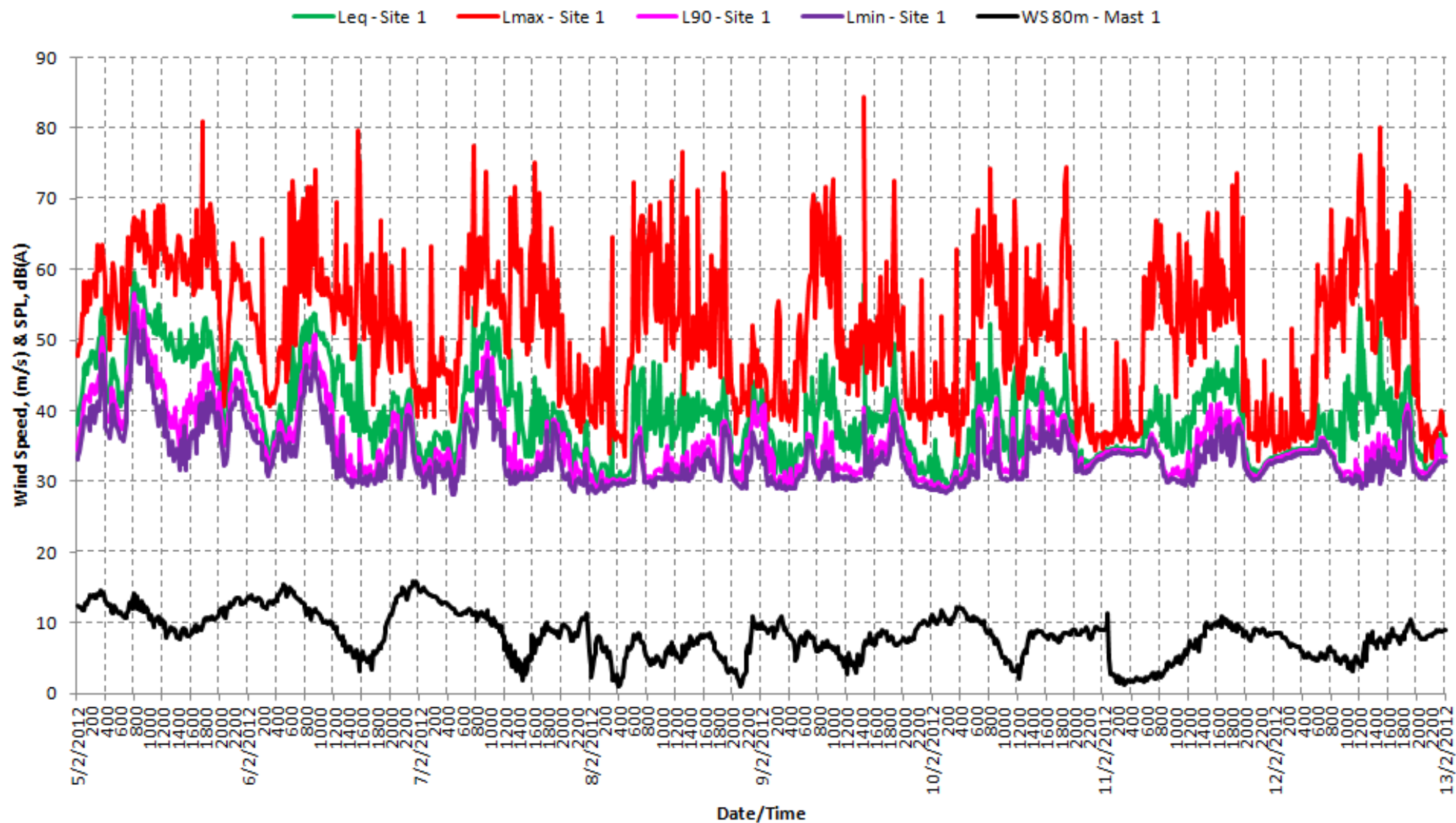
## Background Noise Monitoring Site 1 19/1/2012 - 26/1/2012



## Background Noise Monitoring Site 1 30/1/2012 - 5/2/2012

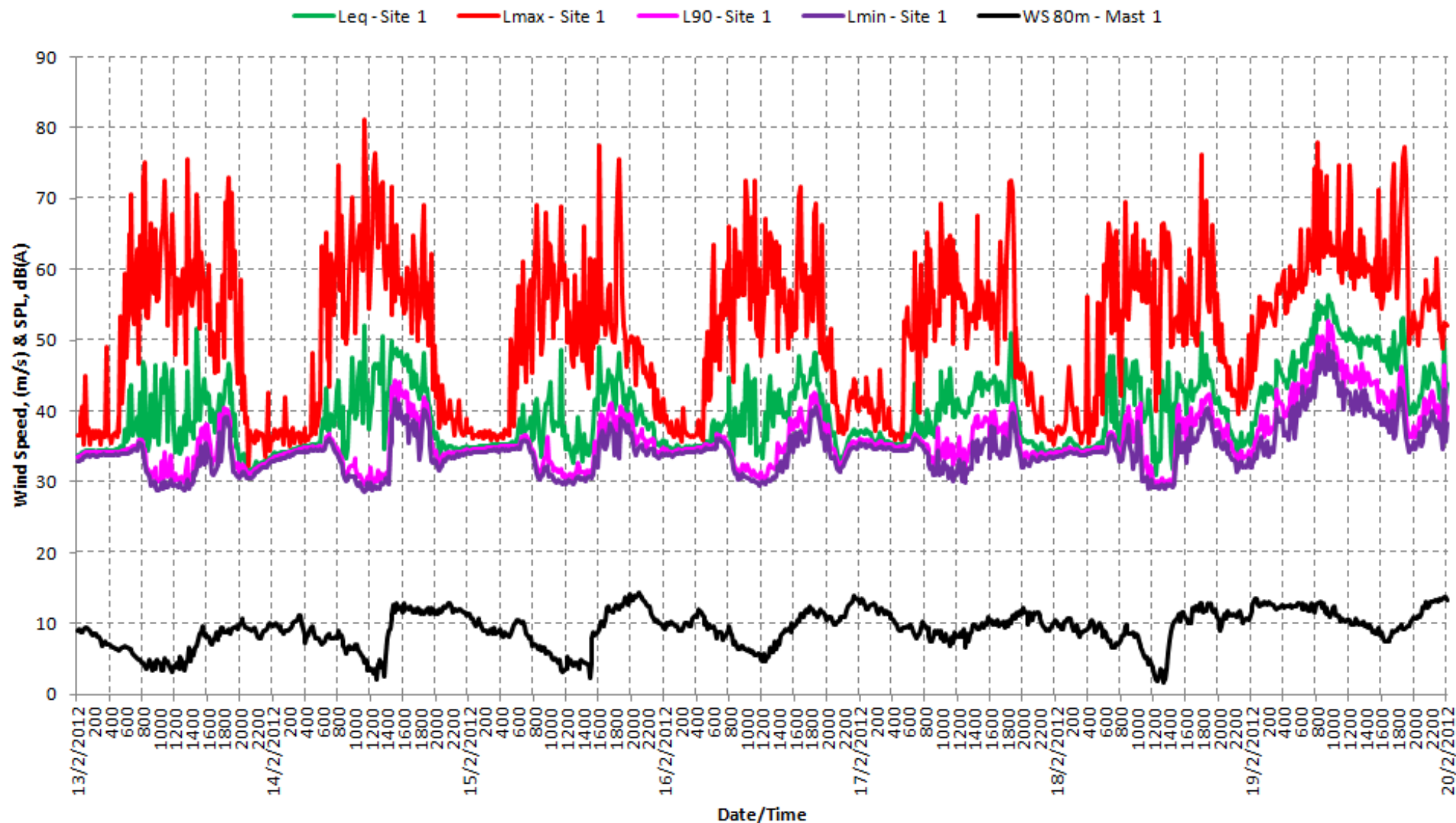


## Background Noise Monitoring Site 1 5/2/2012 - 12/2/2012

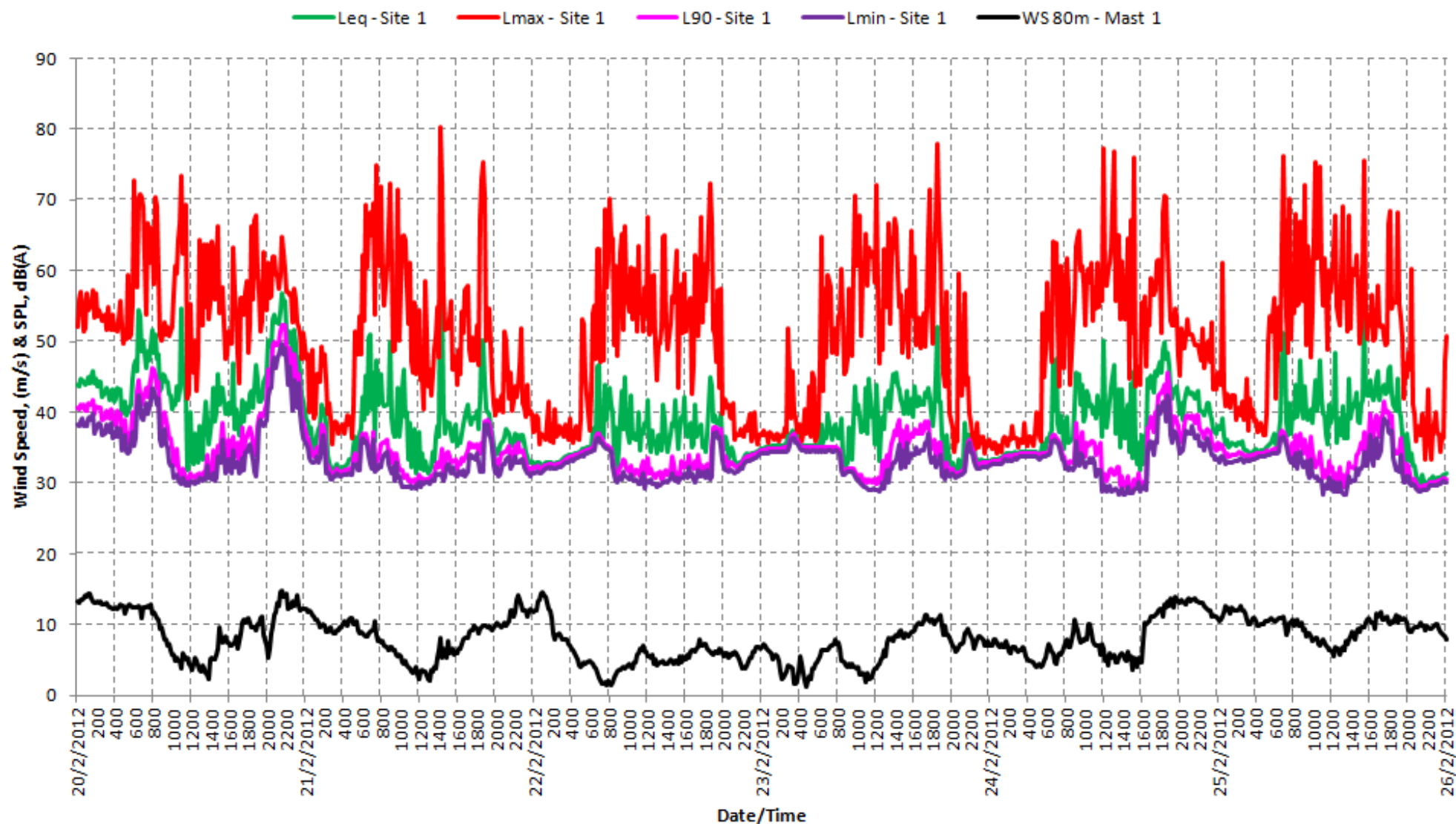




## Background Noise Monitoring Site 1 13/2/2012 - 20/2/2012

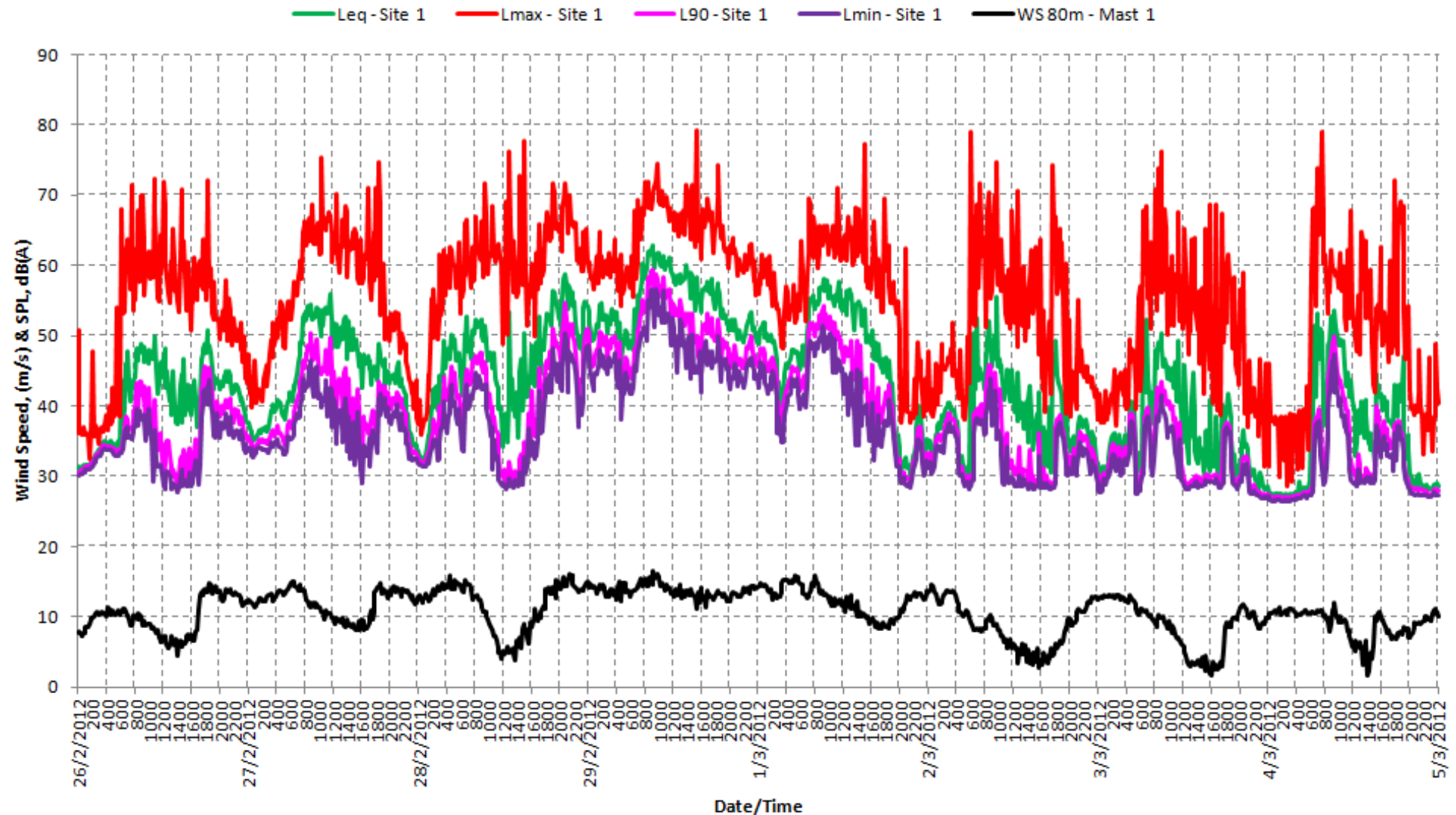


## Background Noise Monitoring Site 1 20/2/2012 - 26/2/2012



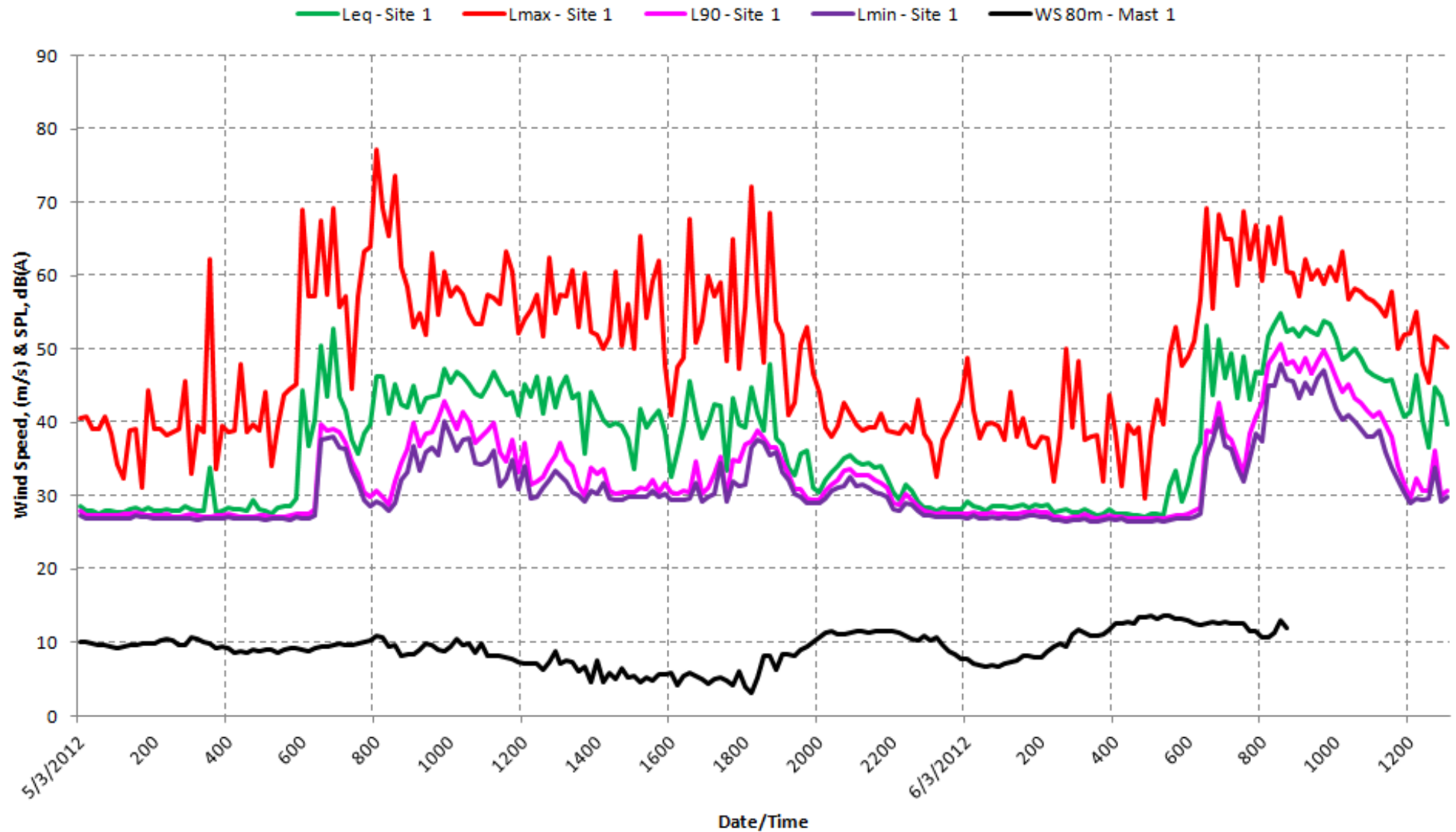


## Background Noise Monitoring Site 1 26/2/2012 - 5/3/2012

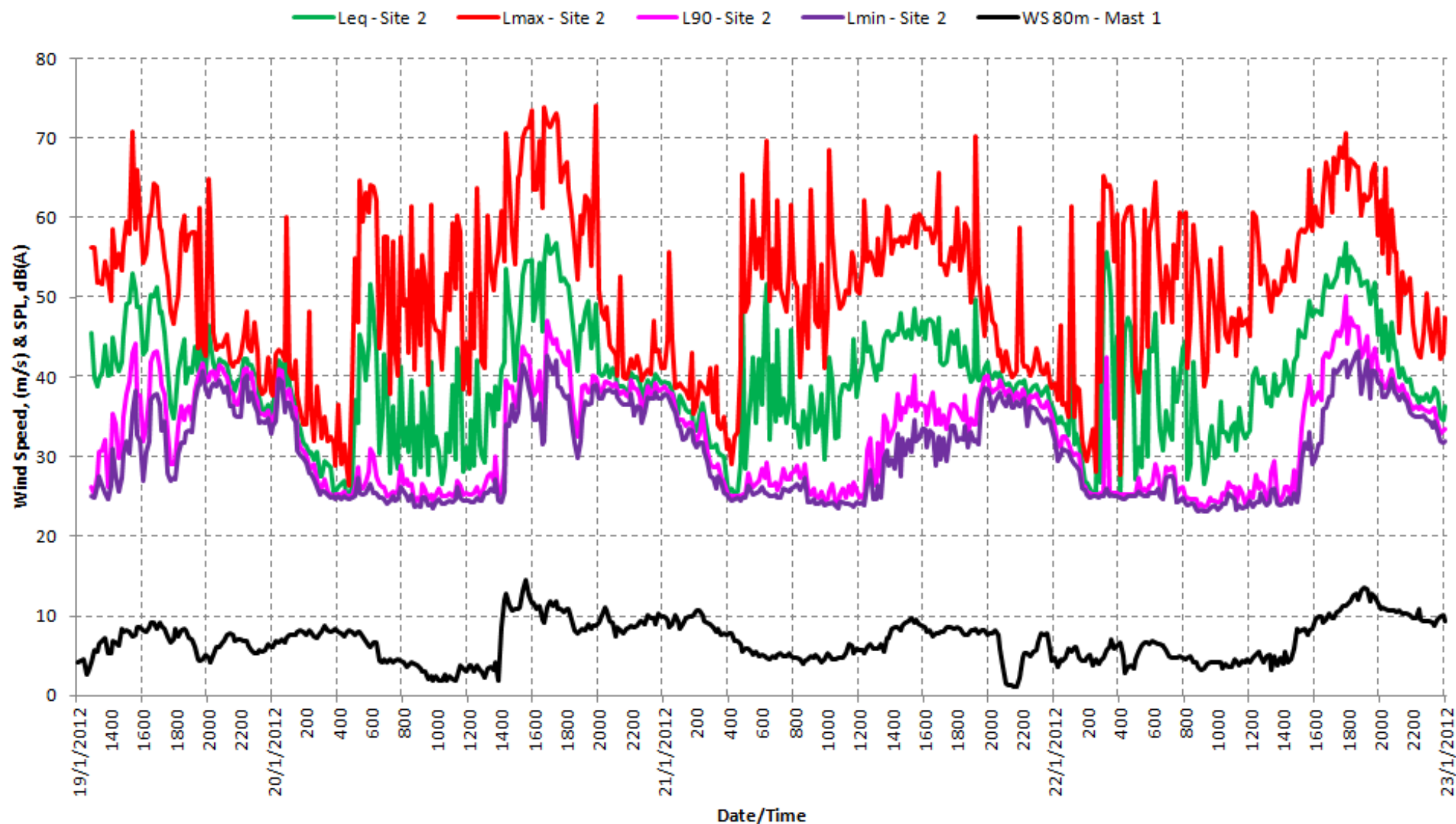


## Background Noise Monitoring Site 1

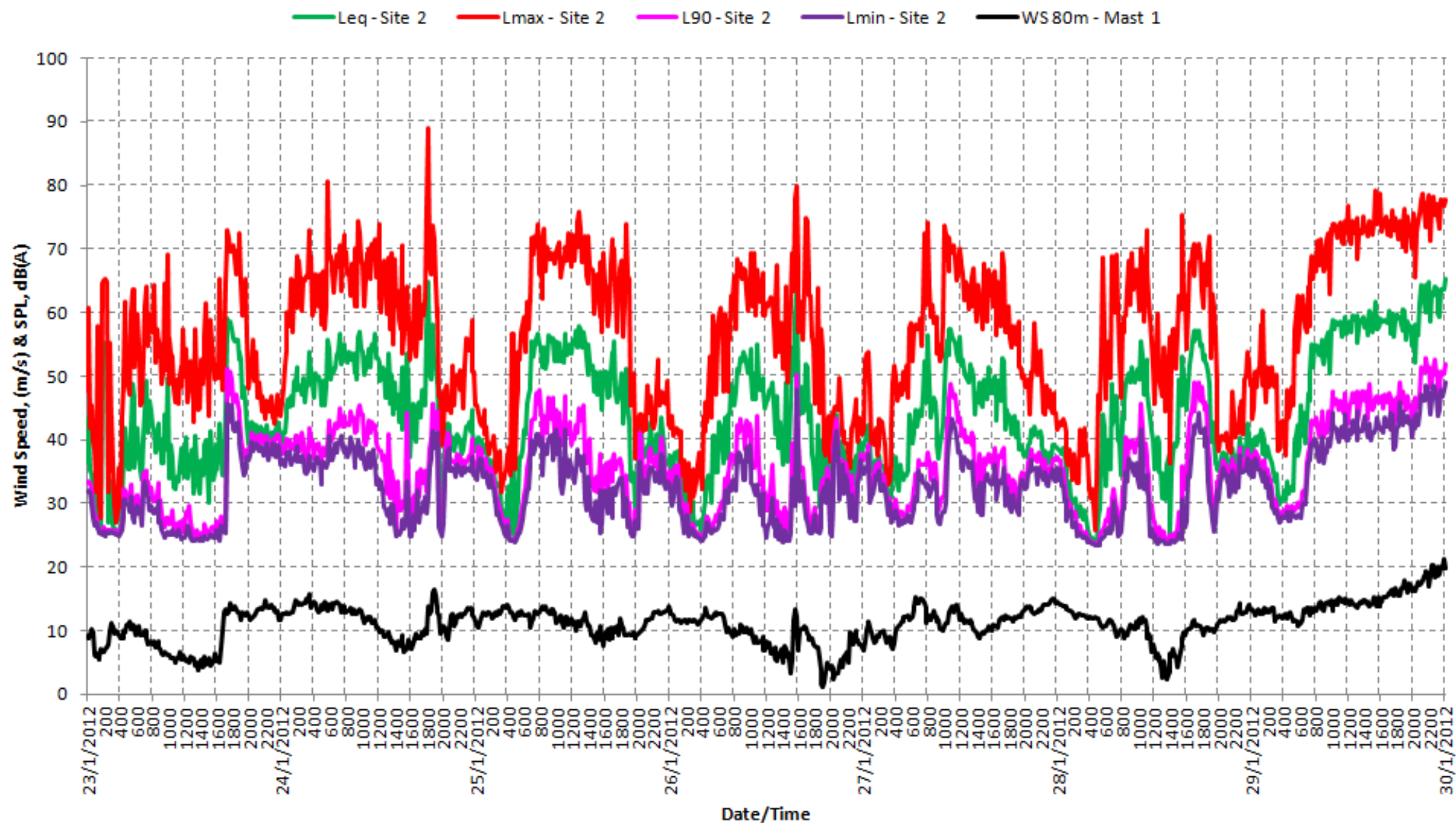
5/3/2012 - 6/3/2012



## Background Noise Monitoring Site 2 19/1/2012 - 23/1/2012

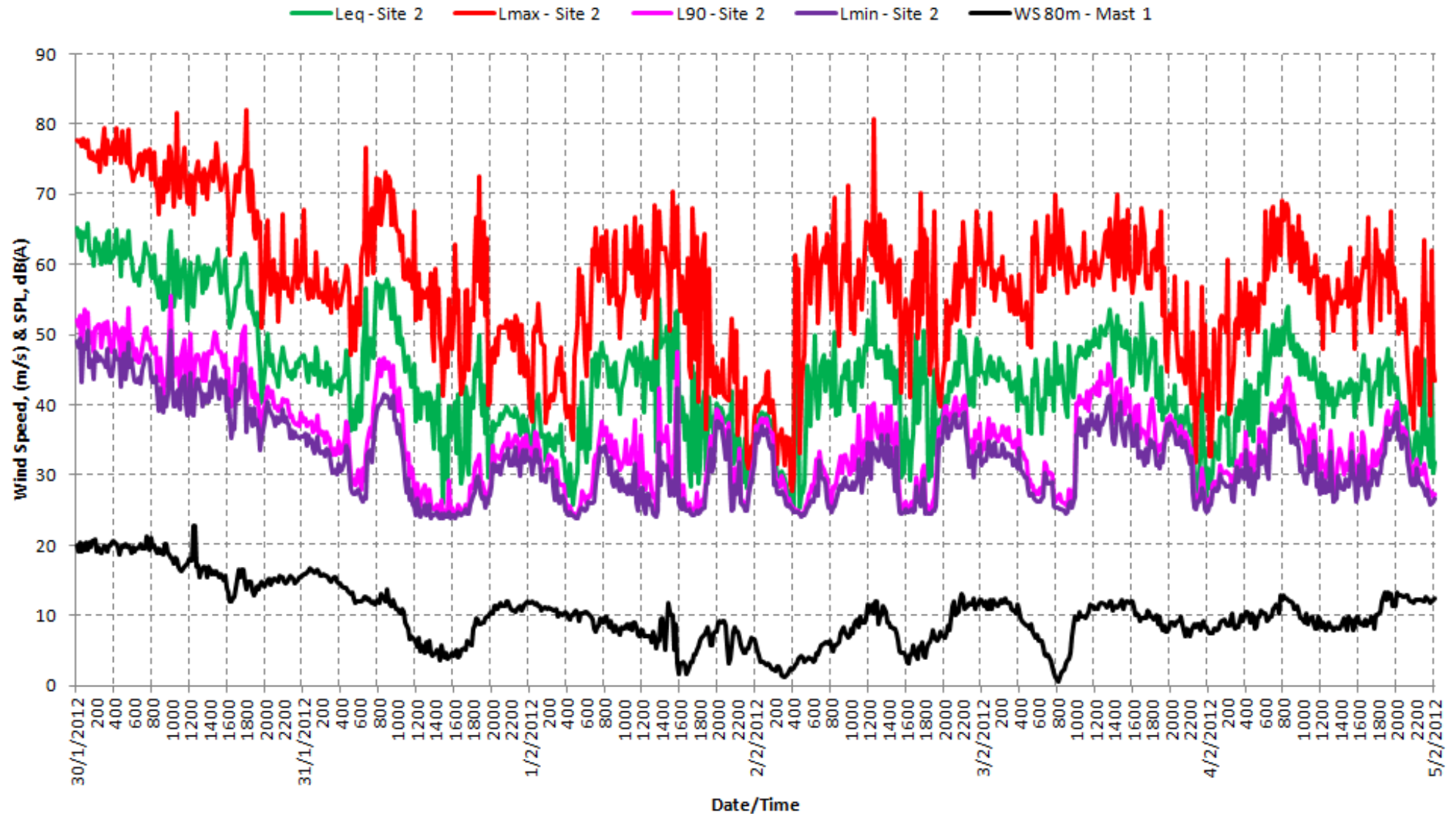


## Background Noise Monitoring Site 2 23/1/2012 - 30/1/2012

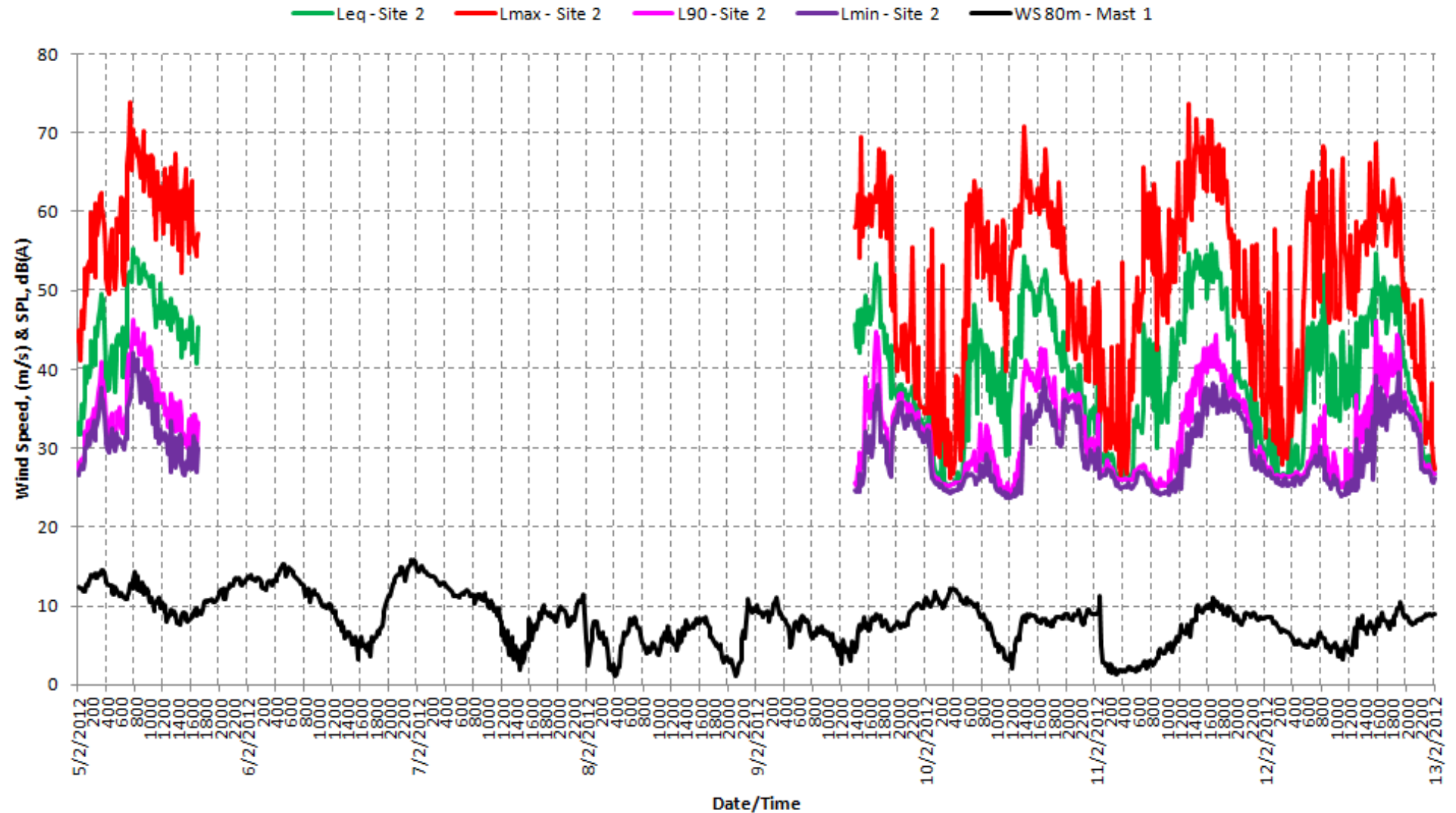




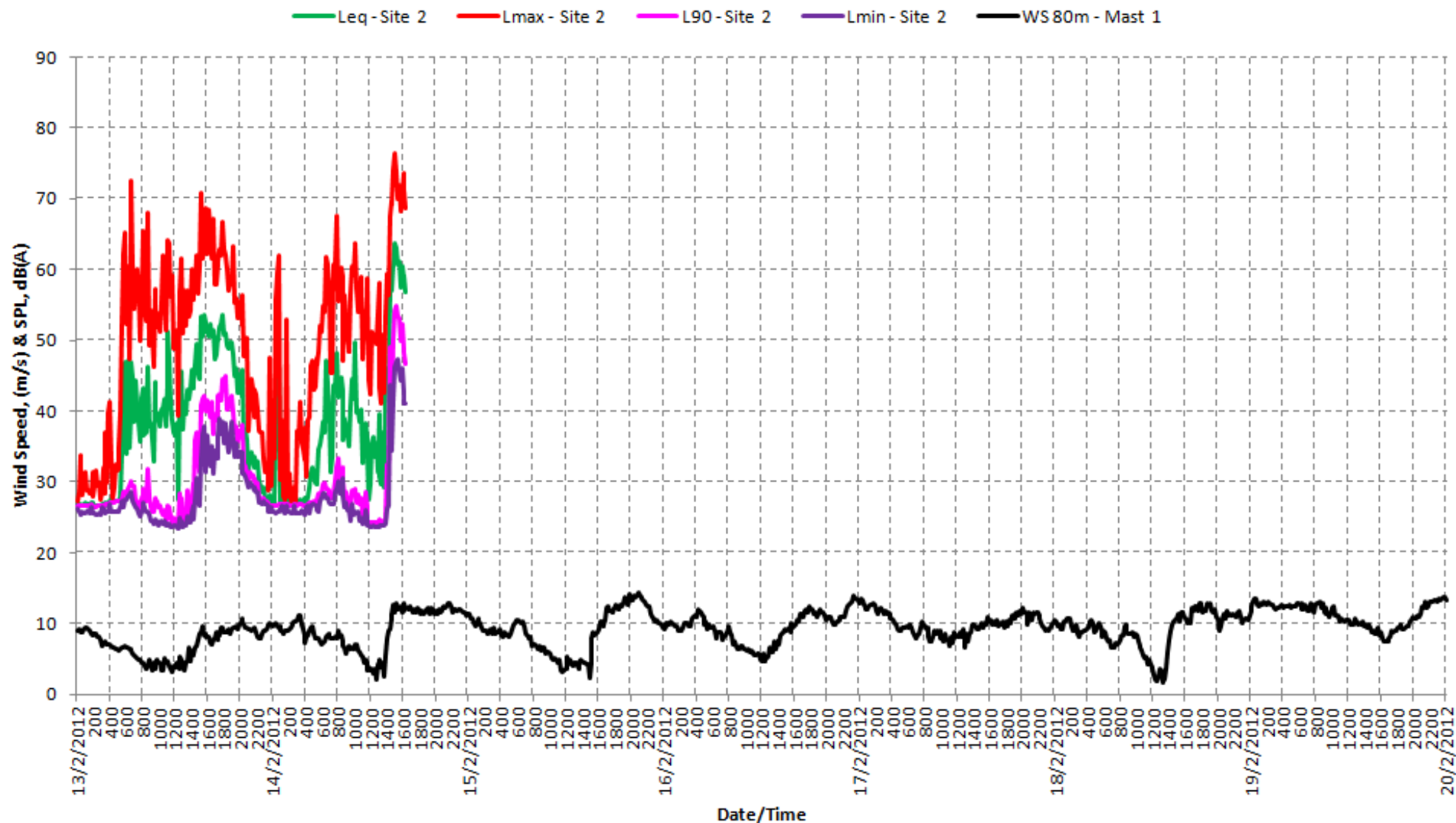
## Background Noise Monitoring Site 2 30/1/2012 - 5/2/2012



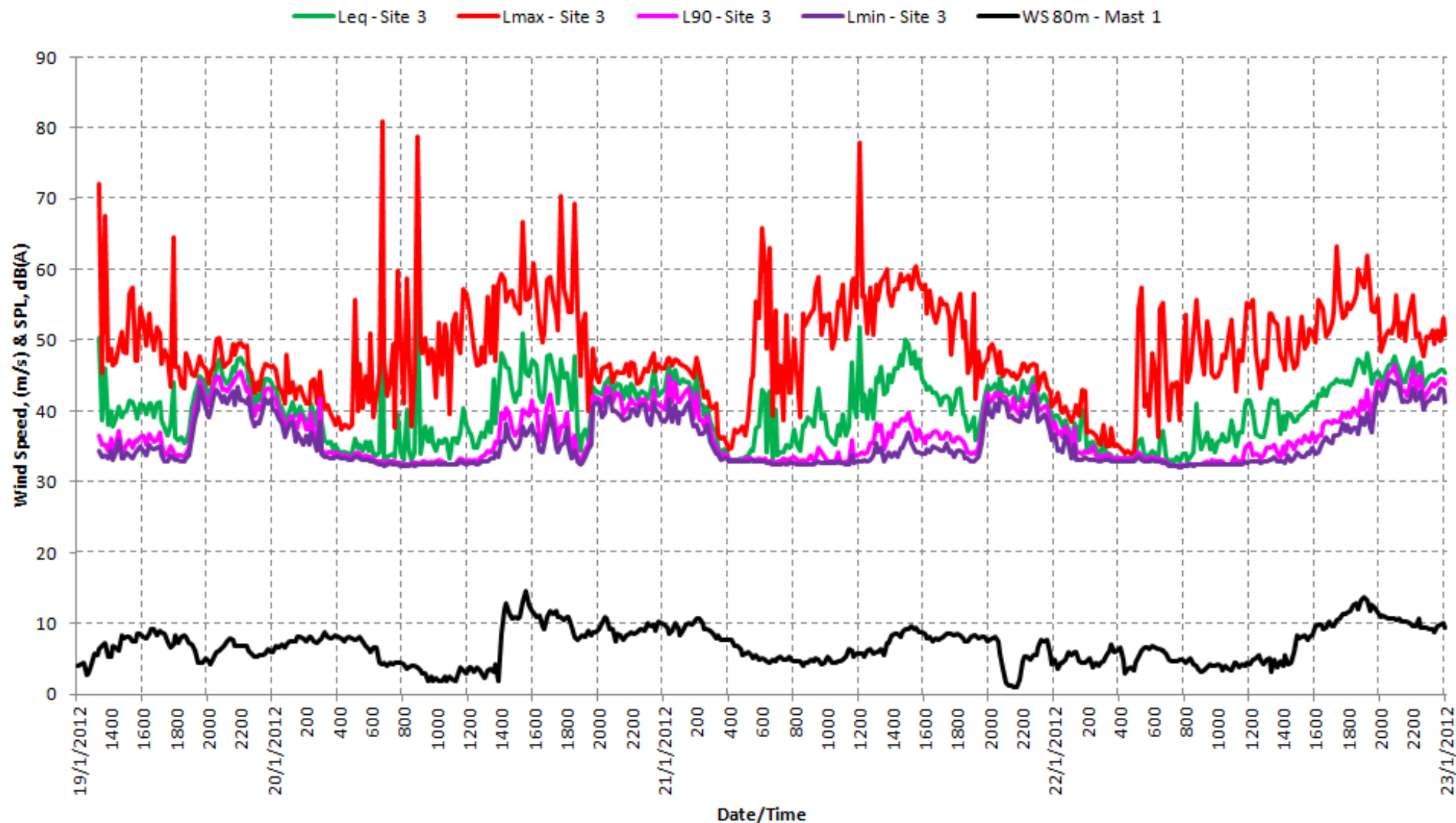
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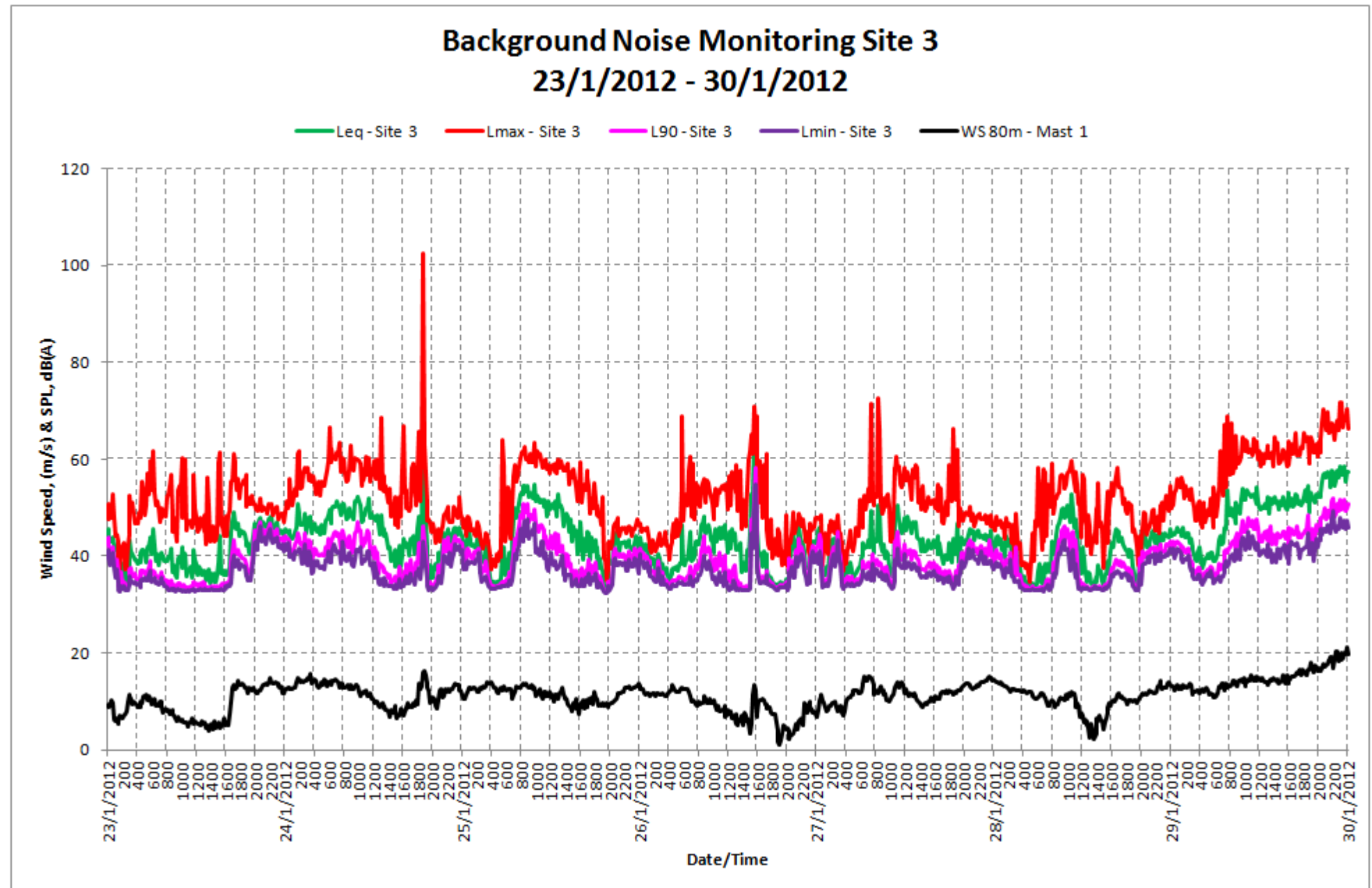
## Background Noise Monitoring Site 2 13/2/2012 - 20/2/2012



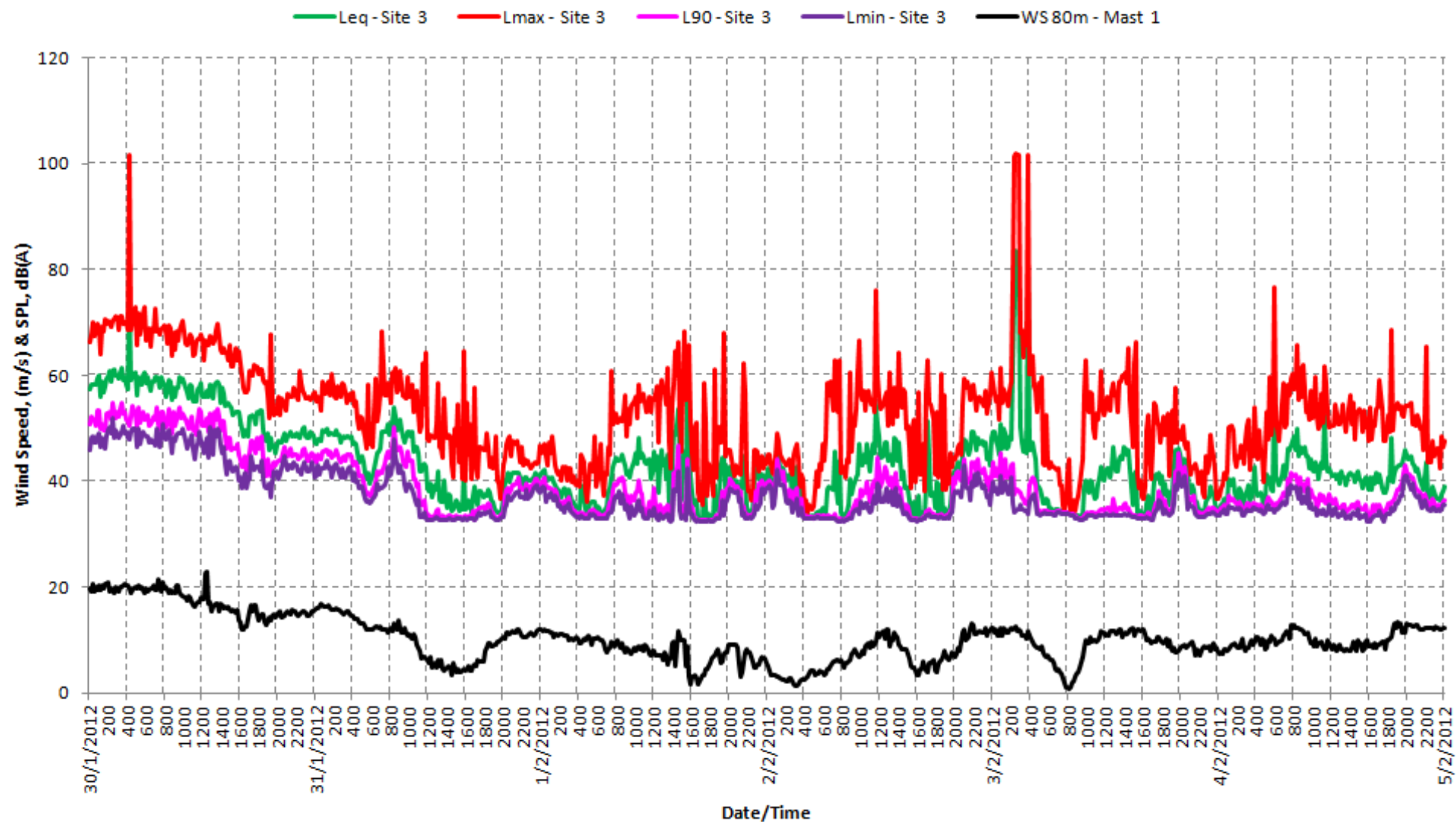
## Background Noise Monitoring Site 3 19/1/2012 - 23/1/2012



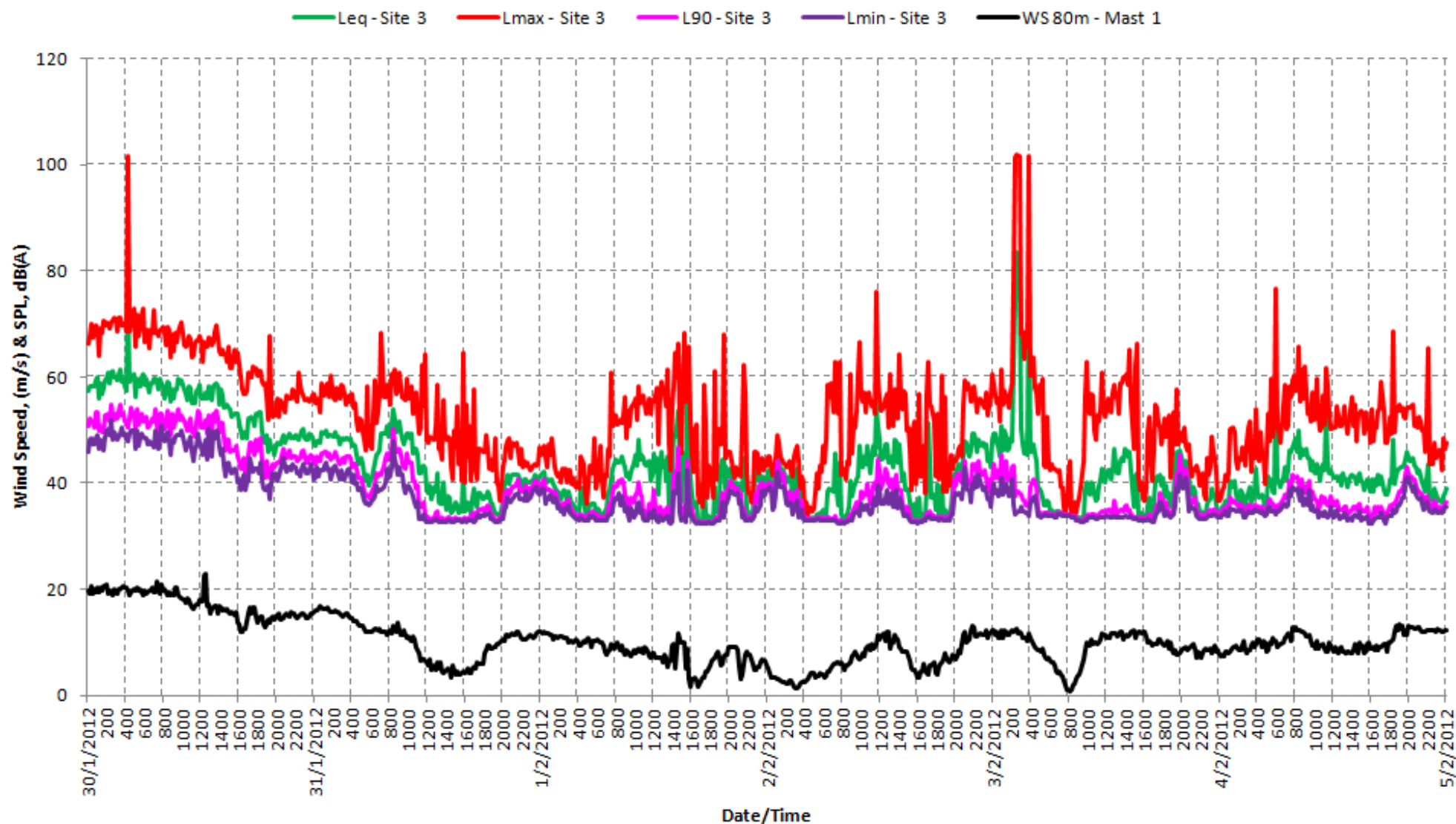




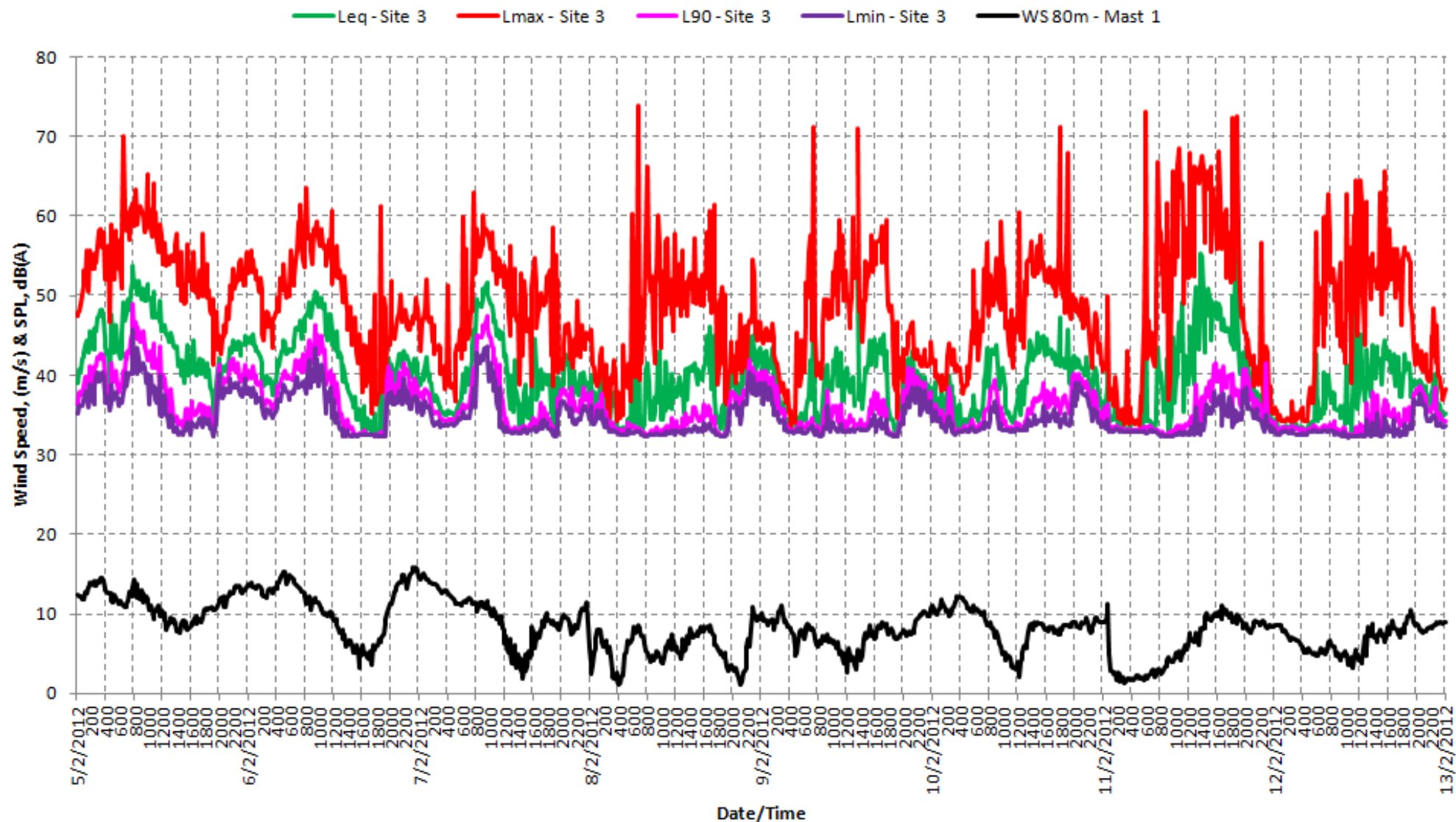
### Background Noise Monitoring Site 3 30/1/2012 - 5/2/2012



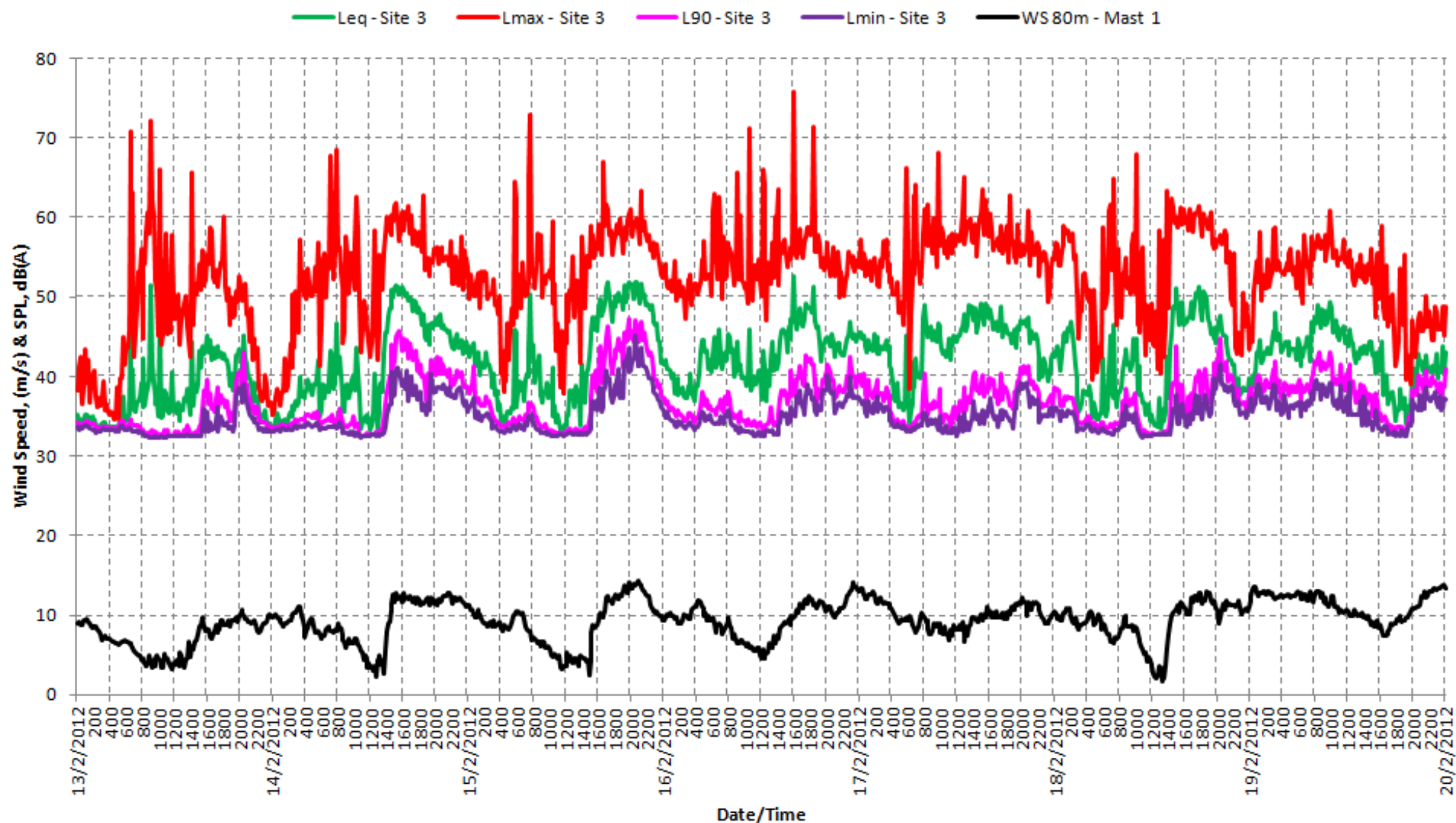
## Background Noise Monitoring Site 3 30/1/2012 - 5/2/2012



## Background Noise Monitoring Site 3 5/2/2012 - 13/2/2012

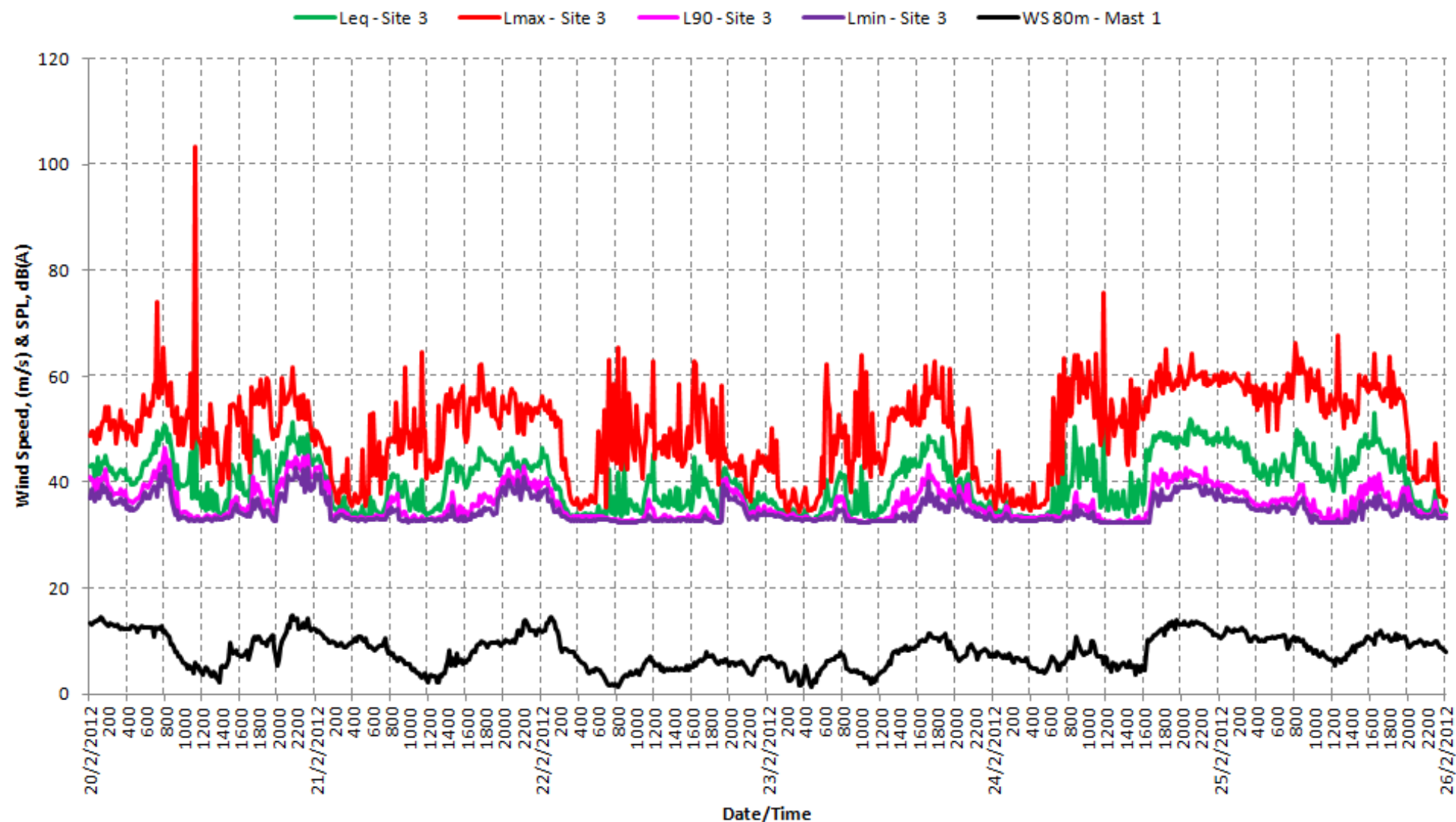


## Background Noise Monitoring Site 3 13/2/2012 - 20/2/2012

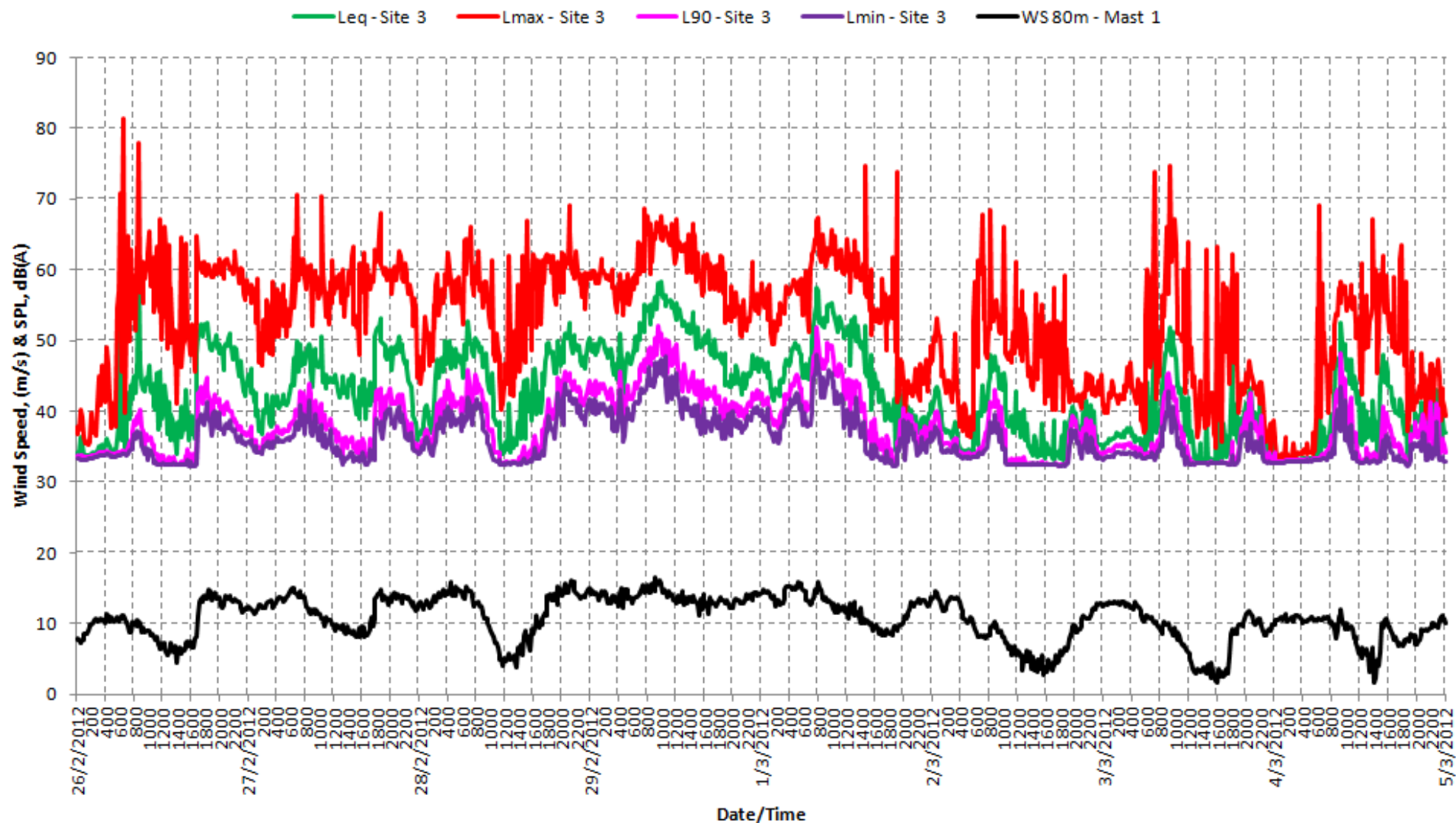




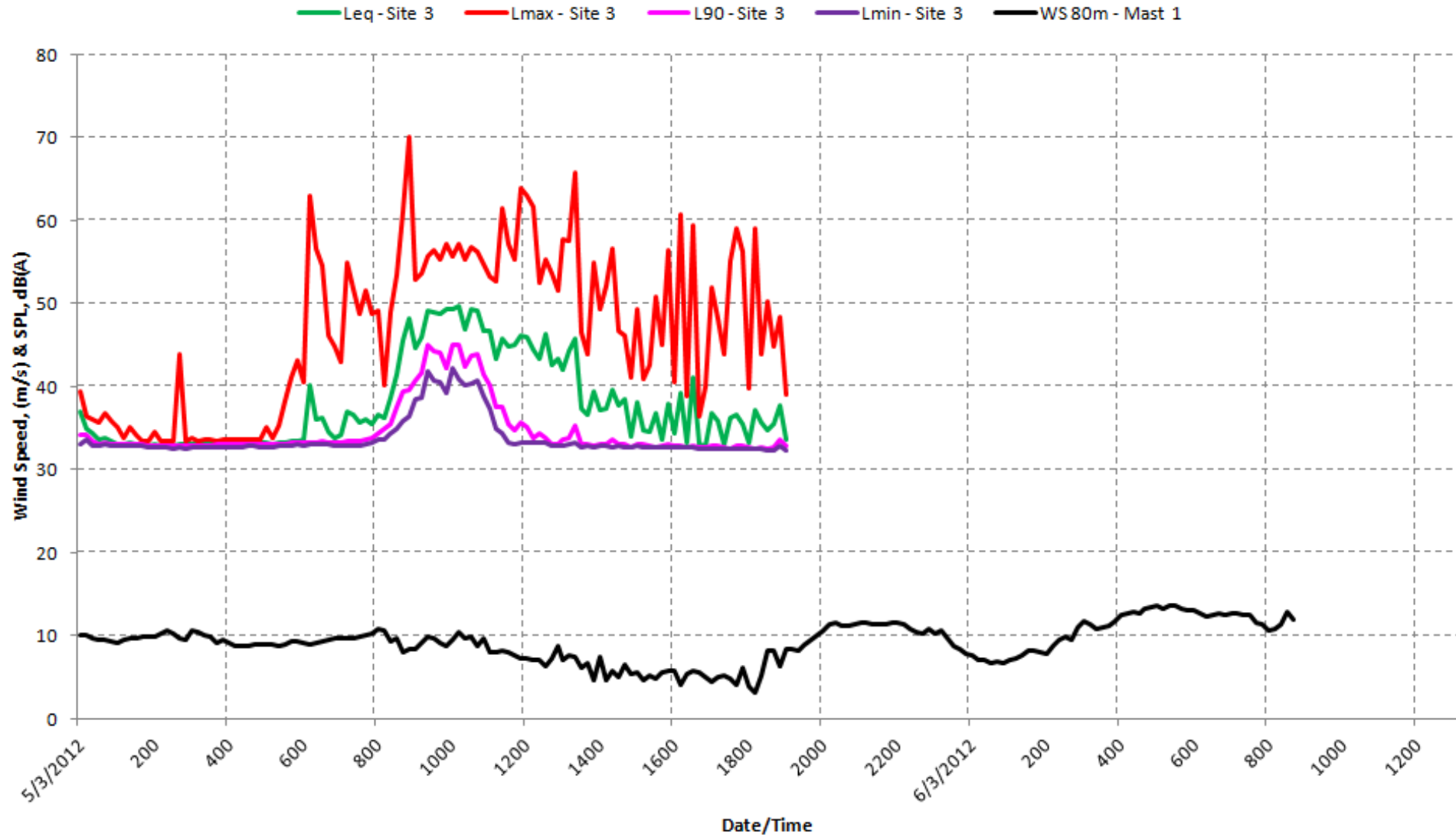
## Background Noise Monitoring Site 3 20/2/2012 - 26/2/2012



## Background Noise Monitoring Site 3 26/2/2012 - 5/3/2012



## Background Noise Monitoring Site 3 5/3/2012 - 6/3/2012





# **APPENDIX E**

## **CALIBRATION CERTIFICATES**



Instrulabs Pty. Ltd.

## SOUND LEVEL METER CALIBRATION CERTIFICATE

THIS IS TO CERTIFY THAT THE SOUND LEVEL METER : RTA Logger , Black Box 1  
S/N: Logger 69 Class 1

OWNED BY : Herring Storer Acoustics  
34/11 Preston Street

HAS BEEN CALIBRATED ON : 03-September-10

DATE OF ISSUE : 06-September-10

And adjusted according to AS 1259.1-1990, AS 1259.2-1990, AS/NZS 4476:1997 that incorporate specifications for and procedures for calibrating Sound Level Meters and their Filter Set if applicable.

<b>Acoustic Tests</b> AS 1259.1-1990		
<b>Complies</b>	clause 1/10.2.2	Absolute Acoustic Sensitivity
<b>Complies</b>	clause 1/10.2.3	Acoustic Check on A Weighting
<b>Electrical Tests</b> AS 1259.1-1990		
<b>Complies</b>	clause 1/10.2.3	Frequency Response – A Weighting
<b>Complies</b>	clause 10.4.5	RMS Detector
<b>Complies</b>	clause 10.4.2	Fast and Slow Time Weighting Characteristic
<b>Complies</b>	clause 10.3.3	Level Range
<b>Complies</b>	clause 8.9, 8.10	Indicator Linearity
<b>Complies</b>	clause 10.3.4	Self Generated Noise

Calibrated by : **Jason Dixon** , NATA Signatory  
Accredited Calibration Officer

Reviewed by : **Erik Fry** , NATA Signatory  
Managing Director Instrulabs Pty. Ltd.

Signature :

Report No : 426

Temperature °C	Pressure hPa
21	1019

The tests, calibrations, or measurements covered by this document are traceable to Australian National Standards of Measurement. This certificate is issued without alteration or erasure. It may not be copied or reproduced except in full without the express written permission of the issuing laboratory.



WORLD RECOGNISED  
ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements

ACCREDITATION NUMBER 1943 - Since 1985

Accredited for compliance with ISO/IEC 17025:2005

19 Argyle Street, Bentley, WA. 6102, Ph: + 61 8 9356 7999 Fax: + 61 8 9356 9444

email: [info@instrulabs.com.au](mailto:info@instrulabs.com.au) web: [www.instrulabs.com.au](http://www.instrulabs.com.au)

Doc. ID: 017 Page 1 of 1

Approved by Erik Fry 07/04/2009



Instrulabs Pty Ltd

### SOUND LEVEL METER CALIBRATION CERTIFICATE

THIS IS TO CERTIFY THAT THE SOUND LEVEL METER : RTA Logger Model: RTA02  
S/N: 052 Class 2

OWNED BY : Herring Storer Acoustics  
34/11 Preston Street, Como WA, 6152

HAS BEEN CALIBRATED ON : 11/July/2011

according to AS 1259.1-1990, AS 1259.2-1990, AS/NZS 4476:1997 that incorporate specifications for and procedures for calibrating Sound Level Meters and their Filter Set if applicable.

Pass/Fail		
<b>Acoustic Tests</b> AS 1259.1-1990		
Pass	clause 1/10.2.2	Absolute Acoustic Sensitivity
Pass	clause 1/10.2.3	Acoustic Check on A Weighting
<b>Electrical Tests</b> AS 1259.1-1990		
Pass	clause 1/10.2.3	Frequency Response -- Weighting A
Pass	clause 10.4.5	RMS Detector
Pass	clause 10.4.2	Fast and Slow Time Weighting Characteristic
Pass	clause 8.9, 8.10	Indicator Linearity
Pass	clause 10.3.2	Overload Indication Test
Pass	clause 10.3.4	Self Generated Noise
<b>Integrating/Averaging Meters only</b> AS 1259.2-1990		
Pass	clause 9.3.2	Time Averaging
Pass	clause 9.3.3	Indicator Linearity

Calibrated by : Jason Dixon , NATA Signatory

Reviewed by : Erik Fry , NATA Signatory, General Manager

Signatures :

Report No : 681

Issue Date : 11-July-2011

Temperature °C	Pressure hPa
23	1018

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Accredited for compliance with ISO/IEC 17025:2005  
19 Argyle Street, Bentley, WA. 6102, Ph: + 61 8 9356 7999 Fax: + 61 8 9356 9444  
email: [info@instrulabs.com.au](mailto:info@instrulabs.com.au) web: [www.instrulabs.com.au](http://www.instrulabs.com.au)  
Doc. ID: IL-017 Page 1 of 1 Approved by Erik Fry 07/04/2009

# RTA TECHNOLOGY PTY LTD

Level 9, 418A Elizabeth Street., Surry Hills NSW 2010 AUSTRALIA  
Ph: (02) 9281 2222 Fax: (02) 9281 2220 Email: rtatech@rtagroup.com.au  
Website: www.rtagroup.com.au ABN 56 003 290 140

## Certificate of Calibration Sound Level Meter

**Calibration Date** 18/02/2010 **Job No** RA706 **Operator** AL  
**Client Name** HERRING STORER ACOUSTICS  
**Client Address** SUITE 34, 11 PRESTON STREET, COMO, 6952

### Test Item

<b>Instrument Make</b>	RTA Technology Pty Ltd	<b>Model</b>	RTA01	<b>Serial No</b>	#091
<b>Microphone Make</b>	RTA Technology Pty Ltd	<b>Model</b>	RTA01	<b>Serial No</b>	#091
<b>Preamplifier Make</b>	RTA Technology Pty Ltd	<b>Model</b>	RTA01	<b>Serial No</b>	#091
<b>Ext'n Cable Make</b>	Nil	<b>Model</b>	N/A	<b>Serial No</b>	N/A
<b>Accessories</b>	Nil				

<b>SLM Type</b>	2
<b>Filters Class</b>	N/A

<b>Temp deg C</b>	23.0
<b>RH %</b>	43.0
<b>Bar Pressure hPa</b>	1018

#### Applicable Standards:

Australian Standard AS1259.1 1990 "Sound Level Meters Part 1: Non-integrating"  
Australian Standard AS1259.2 1990 "Sound Level Meters Part 2: Integrating-averaging"

#### Applicable Work Instruction:

RWI-08 SLM Verification.doc

#### Traceability:

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

#### Scope:

This certificate is issued on the basis that the instrument complies with the manufacturer's specification. See "Sound Level Meter Verification - Summary of Tests" page for an itemised list of results for each test.

#### Uncertainty:

Unless otherwise stated, the uncertainty of measurement is  $\pm 0.14\text{dB}$ . The uncertainty is stated at a confidence level of 95% using a k factor of 2.



NATA Accredited Laboratory  
Number 14966

Authorized Signatory:

Print Name: Renzo Tonin

Date: 15th March 2010

Template Document Name: RQT-02 (rev 40) SLM Verification