Holcim

Strength. Performance. Passion.

2020 Annual Review

1 July 2018 – 31 December 2020

Rooty Hill Distribution Centre

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Title Block

Name of operation	Rooty Hill Distribution Centre
Name of operator	Holcim (Australia) Pty Ltd
Development consent / project approval #	PA 05_0051
Name of holder of development consent / project approval	Holcim (Australia) Pty Ltd
Annual Review start date	1 July 2018
Annual Review end date	31 December 2020

I, Rochelle Flack, certify that this audit report is a true and accurate record of the compliance status of Rooty Hill Distribution Centre for the period of 1 July 2018 – 31 December 2020 and that I am authorised to make this statement on behalf of Holcim (Australia) Pty Ltd.

Note.

a) _ The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.

b) _ The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement—maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents—maximum penalty 2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	Rochelle Flack
Title of authorised reporting officer	Site Manager
Signature of authorised reporting officer	
Date	06/07/2021

1 Statement of Compliance

See **Table 1** for the statement of commitments for the July 2018 to December 2020 reporting period for the Rooty Hill Distribution Centre (RHDC). **Table 3** details the non-compliances of the relevant approvals identified within the reporting period. **Table 2** presents the compliance status key used for the summary of non-compliances shown in **Table 3**.

Table 1: Statement of Commitments

Relevant Approval	Were all conditions complied with?
Project Approval 05_0051	NO – See **Table 3** for details.
EPL No. 20672	YES

Holcim applied to surrender the Environment Protection Licence during the reporting period. The EPA allowed Holcim to surrender the EPL 20672 on 18 June 2020. Therefore, the EPL was only valid from 1 July 2018 to 18 June 2020 during this Annual Review period.

Table 2: Compliance status key for Table 3

Risk level	Colour code	Description
High	Non-compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-compliant	Non-compliance with: • potential for serious environmental consequences, but is unlikely to occur; or • potential for moderate environmental consequences, but is likely to occur
Low	Non-compliant	Non-compliance with: • potential for moderate environmental consequences, but is unlikely to occur; or • potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

Source: Annual Review Guidelines (NSW Government, 2015).

Table 3: Summary of Non-Compliances

<table>
<tr><th>Relevant approval</th><th>Condition</th><th>Condition Description</th><th>Compliance status</th><th>Relevant Section in this Annual Review and Comment</th></tr>
<tr><td>PA 05_0051 MOD 2</td><td>6.4 Annual Performance Monitoring</td><td>The Proponent must submit a copy of the Annual Review to the Secretary, EPA, and Council each year, with:
i) the first Annual Review to be submitted within twelve months after the commencement of operation of the project; and
ii) the second and subsequent Annual Reviews to be submitted concurrently with the EPA's Annual Return.</td><td>Administrative Non-Compliance</td><td>Unfortunately, the requirement to complete the Annual Review was missed. The missed reporting periods following the last Annual Review include:
● July 2018 to June 2019, and
● July 2019 to June 2020.
This Annual Review covers the period 1 July 2018 to 31 December 2020 to present a complete summary of Holcim's environmental management and compliance at RHDC.</td></tr>
<tr><td>PA 05_0051 MOD 2</td><td>2.8A Air Quality</td><td>The Proponent must ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria in Table 2 at any residence on privately-owned land.
<table><tr><th>Pollutant</th><th>Averaging Period</th><th>Criterion</th></tr><tr><td>Particulate Matter < 10 µm (PM10)</td><td>Annual</td><td>[a, d] 25 µg/m^3</td></tr><tr><td>Particulate Matter < 10 µm (PM10)</td><td>24 hour</td><td>[b, d] 50 µg/m^3</td></tr></table></td><td>Low Non-Compliance</td><td>Section 6.2 Air Quality
Air quality monitoring results at HVAS 2 at Blacktown Sports Centre exceeded 24 hour criteria for PM_{10} on 28 February 2020 and 25 September 2020. It should be noted that extreme regional bushfires may have impacted the air quality results for December 2019 and the early months of 2020.

HVAS 1 exceeded 50 µg/m^3 on six occasions in 2020. Due to the high particulate matter results at HVAS 1, Holcim commenced planning for the relocation of the monitor to the boundary of the site in this reporting period.</td></tr>
</table>

<table>
<tr><th>Relevant approval</th><th>Condition</th><th>Condition Description</th><th>Compliance status</th><th>Relevant Section in this Annual Review and Comment</th></tr>
<tr>
<td></td>
<td></td>
<td>
<table>
<tr><td>Particulate Matter < 2.5 µm (PM2.5)</td><td>Annual</td><td>[a, d] 8 µg/m^3</td></tr>
<tr><td>Particulate Matter < 2.5 µm (PM2.5)</td><td>24 hour</td><td>[b, d] 25 µg/m^3</td></tr>
<tr><td>Total suspended particulates (TSP)</td><td>Annual</td><td>[a, d] 90 µg/m^3</td></tr>
</table>
Note:
“Reasonable and feasible avoidance measures” includes, but is not limited to, the operational requirements in conditions 2.8, 3.1(b) and 5.3(d) to develop and implement an air quality management system that ensures operational responses to the risks of exceedance of the criteria.
a Cumulative impact (ie increase in concentrations due to the development plus background concentrations due to all other sources).
b Incremental impact (ie increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development.
c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.
</td>
<td></td>
<td>Also note there were missed sample events across this reporting period, including in September and October 2018. There were several sampling events missed in 2019, with three sampling events recorded for May. A total of 54 sampling events for each HVAS for 2019 were recorded.</td>
</tr>
</table>

2 Introduction

Holcim (Australia) Pty Ltd (Holcim) is the owner and operator of the Rooty Hill Distribution Centre (RHDC), an aggregate storage and distribution facility located on Lot 1 DP 1150066 at 21 Kellogg Road, Rooty Hill, as seen in **Figure 1**. A Development Consent was granted in 2006 by the Land and Environment (L&E) Court (Decision No. 10406 of 2006) to construct and operate a distribution centre to receive aggregates by rail from Holcim's Lynwood Quarry. The RHDC officially commenced operations on 1 October 2015. The RHDC facility is the primary unloading and distribution centre for construction materials extracted from Lynwood Quarry (located in Marulan, NSW) into the Greater Sydney market.

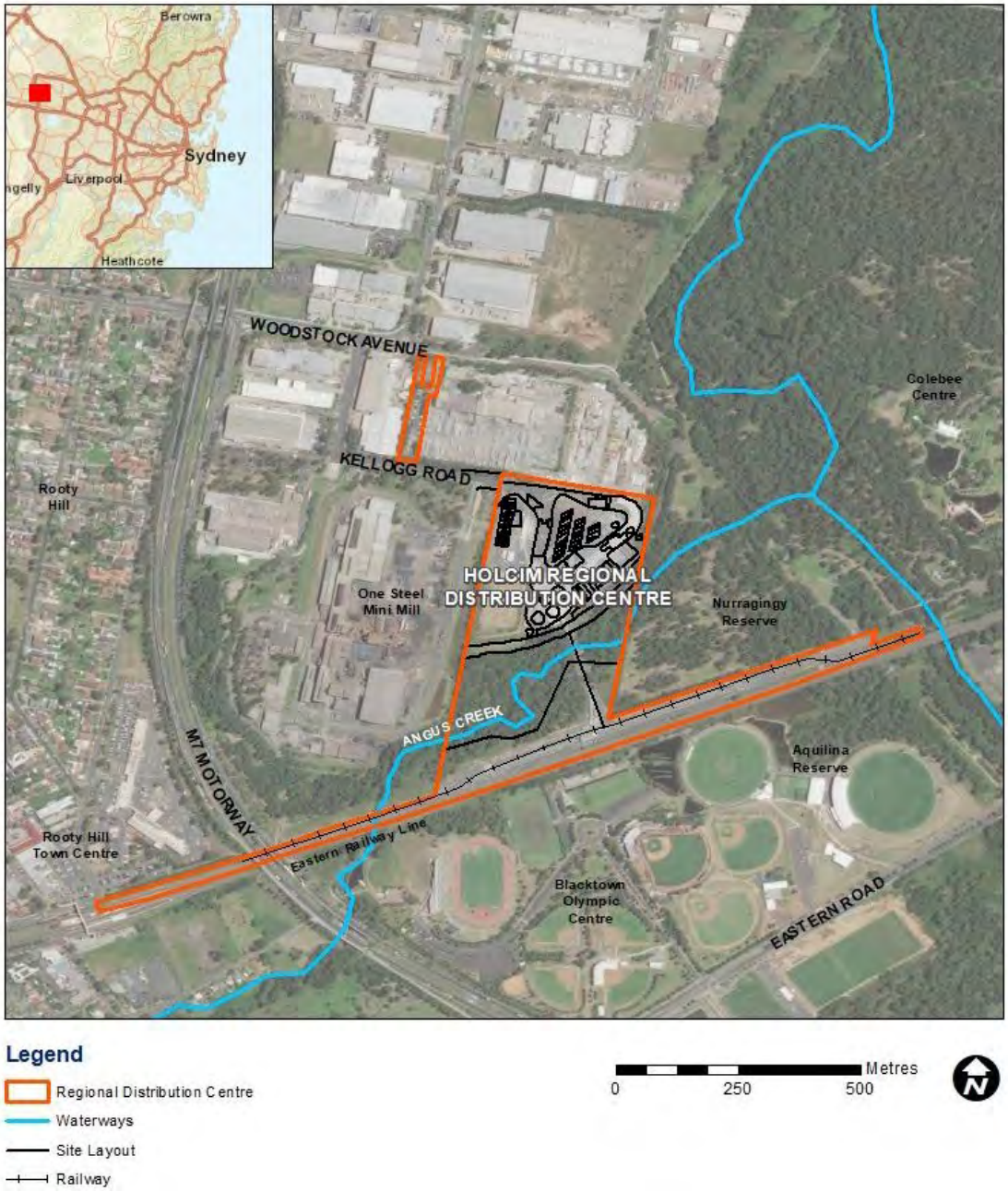

Figure 1: Rooty Hill Distribution Centre site locality and primary features (Holcim, 2021, *Draft OEMP*).

In accordance with Condition 6.3 (Annual Performance Monitoring) of the modified Project Approval 05_0051 the site is required to undertake an Annual Review of the site. These Annual Review requirements are presented in **Table 4**. The last Annual Review covered a reporting period of 1 July 2017 to 30 June 2018. This Annual Review will cover a reporting period of 1 July 2018 to 31 December 2020.

Table 4: Annual Review Requirements

Condition	**Section addressed in Annual Review**
The Proponent must, throughout the life of the project, prepare and submit to the Secretary, an Annual Review. The Annual Review must review the performance of the project against the Operation Environmental Management Plan (refer to condition 5.4 and condition 5.5 of this approval), the conditions of this approval and other licences and approvals relating to the project. The Annual Review must include, but not necessarily be limited to:	
a) details of compliance with the conditions of this approval;	Section 1 & 6
b) a copy of the Complaints Register (refer to condition 4.3 of this approval) for the preceding twelve-month period (exclusive of personal details), and details of how these complaints were addressed and resolved;	Section 9
c) a comparison of the environmental impacts and performance of the project against the environmental impacts and performance predicted in those documents listed under condition 1.1 of this approval;	Section 6, 7.1, and 8.1
d) results of all environmental monitoring required under this approval and other approvals, including interpretations and discussion by a suitably qualified person; and	Section 6, 7, & 8
e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Section 6, 7, & 8
f) a list of all occasions in the preceding twelve-month period when environmental performance goals for the project have not been achieved, indicating the reason for failure to meet the goals and the action taken to prevent recurrence of that type of incident.	Section 1, 6, & 11

This Annual Review has been prepared following the NSW Government's *Annual Review Guidelines: Post-approval requirements for State Significant Mining Developments* (October 2015).

2.1 Key Personnel

Site Manager

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3 Approvals

RHDC operates under the approvals listed in **Table 5**. The original Project Approval 05_0051 was modified in 2011 (MOD 1) to approve alterations to site layout. In 2017, the Project Approval was modified (MOD 2) to secure a larger area for material storage and handling.

Table 5: Approvals for RHDC Operations

Approval	Regulatory Authority	Date of Approval/Other
MOD 2 to PA 05_0051	Department of Planning, Industry & Environment (DPIE).	29 June 2017
MOD 1 to PA 05_0051	Department of Planning.	22 March 2011
L&E Court Decision No. 10406 of 2006.	Department of Planning & Environment (DP&E).	26 April 2006
EPL 20672	Environmental Protection Authority (EPA)	Anniversary Date: 28 September Surrendered: 18 June 2020

The EPL was surrendered on 18 June 2020; however it was still applicable for most of the Annual Review period.

4 Operations Summary

All operations undertaken at RHDC during the reporting period were undertaken in general accordance with the Project Approval. Fixed and mobile plant are serviced as required by their respective original equipment manufacturer's maintenance schedule and as required to ensure efficient and effective use. Maintenance of compliance based fixed and mobile plant is prioritised as required.

RHDC has approval to operate 24 hours a day, seven days a week. The site contained all construction activities within the hours specified in Condition 2.2 of the Project Approval during this report period. The timeframes are as follows:

a) 7:00am to 6:00pm, Mondays to Fridays,
b) 8:00am to 1:00pm on Saturdays, and
c) At no time on Sundays or public holidays.

Table 6 includes a summary of the product distributed from RHDC in each calendar year which apply to this Annual Review reporting period. The site has not exceeded amounts outlined in Condition 1.4 Limits of Approval of the Project Approval.

Table 6: Annual Production Summary (Calendar Year)

Material	Approval Limit	2018	2019	2020	2021 Forecast
Concrete Production (m^3)	200,000	68,700	53,547	94,722	75,000

As a part of the *Transport Management Protocol*, road trucks are covered when leaving the site. Compliance against this condition is audited and training is provided to drivers through the induction process. Monthly audits inspect the internal and external road conditions to ensure trucks are not carrying material out onto public roads.

Construction of the permanent concrete batching plant was completed on 13 December 2016 (outside this Annual Review), to replace the mobile plant which had been operating on the site since operation began in 2015. The construction certificates for this permanent infrastructure were obtained within this reporting period on 9 November 2018.

4.1 Next reporting period

It is anticipated that RHDC will continue to operate within the current footprint and scope of the existing operations.

Development activities proposed to be carried out at RHDC in 2021 include:

- Continued stockpiling of product.
- Continued operation of the concrete batching plant.
- Continued loading and unloading of product by truck and train.

5 Actions Required from Previous Annual Review

5.1 Holcim Proposed Actions from 2017-2018 Annual Review

Table 7 provides an update on the actions proposed to be undertaken by Holcim in the 2017-2018 Annual Review (noting this was the last Annual Review).

Table 7: Update on Holcim Proposed Actions for the Next Report Period

Improvement Action from Previous Annual Review	Works Undertaken
Environmental Management Systems The site is to implement a continuous improvement strategy in order to streamline processes, increase internal auditing and document control, and embed standard monitoring and reporting by using site staff rather than external consultants. SHEMS schedule and staff training is to be updated also.	Improvements made to Holcim's Environmental Management Systems through updating RHDC's OEMP and utilising an Environmental Monitoring Portal. Staff training was also revised in this reporting period. Holcim made compliance and good environmental outcomes a priority during this Annual Review period.
Management Plans Continue revision of Operational Environmental Management Plan (OEMP) and submit this to stakeholders for review and approval.	Holcim currently have an updated OEMP in draft. The OEMP is expected to be submitted to DPIE for approval by the end of 2021.
Air Quality Monitoring Relocate HVAS 1 to the site boundary by early 2019.	Not undertaken in this reporting period. This will be completed when the updated OEMP is approved. See **Section 6.2** for further details.
Batching Plant Construction Finish construction of the permanent concrete batching plant in the 2018-2019 reporting period.	Construction of the batching plant completed on 13 December 2016. Construction certificates were acquired for the batching plant and associated infrastructure, and temporary office on 9 November 2018. See **Section 5.2** for further details.

6 Environmental Performance

6.1 Noise

6.1.1 EIS Predictions

The Noise Impact Assessment of the 2005 Environmental Assessment Report (EAR) concluded that noise and vibration resulting from construction, traffic, and operations related to the project will comply with the project specific noise criteria for all periods. Furthermore, the maximum noise amenity levels at locations such as Blacktown Olympic Centre or Nurragingy Reserve would not be exceeded for all phases of the project.

The 2017 Environmental Assessment for MOD 2 found that the modification would cause a small increase in the noise levels at the residential receivers, however this increase would not exceed the approved noise criteria levels. No further management measures beyond those already in place were recommended.

6.1.2 Approved Criteria

The project must comply with the noise criteria in Condition 2.3 of the Project Approval as well as the noise monitoring criteria outlined in the *Noise Management Plan*. These approved criteria are shown in **Table 8**. Noise monitoring criteria from L3 (Noise limits) of EPL 20672 are the same as those in the Project Approval.

Table 8: Approved Noise Criteria (Project Approval 05_0051)

Location	Morning Shoulder (6am – 7am Monday to Saturday and 6am – 8am Sundays and Public Holidays	Day 7am – 6pm Monday to Saturday and 8am – 6pm Sundays and Public Holidays	Evening 6pm – 10pm Monday to Sunday	Night 10pm – 7am Monday to Saturday and 10pm – 8am Sunday	
	$L_{Aeq(15\ minute)}$ (dB(A))	$L_{Aeq(15\ minute)}$ (dB(A))	$L_{Aeq(15\ minute)}$ (dB(A))	$L_{Aeq(15\ minute)}$ (dB(A))	$L_{A1(1\ minute)}$ (dB(A))
Any residences in Station Street	39	44	44	39	53
Any Residences in Crawford Road	40	40	39	39	53
Any residences in Mavis Street	35	35	35	35	53
Nurragingy Reserve	When the Reserve is in use – L_{Aeq} 50 dB(A)				
Colebee Centre	When the Centre is in use – L_{Aeq} 50 dB(A)				
Blacktown Olympic Park (active recreation areas)	When active recreational areas of the Park are in use – L_{Aeq} 55 dB(A)				

6.1.3 Key Environmental Performance

The results of noise monitoring and assessments must be reported in Annual Reviews. Muller Acoustic Monitoring (MAC) undertook noise monitoring for Holcim in this report period at monitoring locations as per the Project Approval and EPL 20672. It is noted that MAC refer to the Crawford Road monitoring location in the approval criteria as Coughlan Crescent throughout the 2018, 2019, and 2020 reports. The MAC noise monitoring assessments do not measure noise in the Morning Shoulder Period, as operational activities are not taking place during this period.

During this reporting period, noise monitoring changed from a quarterly to annual basis. Therefore, the results outlined in this Annual Review report quarterly noise results until the second half of 2020. After this period Holcim's updated noise monitoring period ranges from 1 July 2020 to 30 June 2021. Therefore, there are no noise monitoring results presented in this report for quarters three or four of 2020. Holcim conducted the annual noise monitoring assessment for the new monitoring period in February 2021. Holcim will continue to conduct the annual noise monitoring assessment in the first quarter of the calendar year.

Table 9, **Table 10**, and **Table 11** summarise the noise monitoring results for this reporting period.

Table 9: Noise Monitoring Results and Compliance Summary for August – December 2018

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q3 - August 2018 ($LA_{eq(15\ min)}$)	Q4 - November 2018 ($LA_{eq(15\ min)}$)	Compliance
Day [1, 2]	N1	44	<35	<43	✓
	N2	40	<35	<49	✓
	N3	50 (when Nurragingy Reserve is in use)	38	<45	✓
	N3	50 (when Colebee Centre is in use)	38	<45	✓
	N4	55 (when active recreational areas of Blacktown Olympic Park are in use)	<35	<41	✓
Evening [1, 2]	N1	44	<35	<40	✓
	N2	39	<35	<44	✓
	N3	50 (when Nurragingy Reserve is in use)	<35	<42	✓
	N3	50 (when Colebee Centre is in use)	<35	<42	✓
	N4	55 (when active recreational areas of Blacktown Olympic Park are in use)	<35	<39	✓
Night [1, 2]	N1	39	<35	<34	✓
	N2	39	<35	<37	✓

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q3 - August 2018 ($LA_{eq(15\ min)}$)	Q4 - November 2018 ($LA_{eq(15\ min)}$)	Compliance
	N3	50 (when Nurragingy Reserve is in use)	<35	50	✓
	N3	50 (when Colebee Centre is in use)	<35	50	✓
	N4	55 (when active recreational areas of Blacktown Olympic Park are in use)	<35	<40	✓

Note 1: Noise criteria adopted from NMP.
Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

Table 10: Noise Monitoring Results and Compliance Summary for 2019

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q1 - March 2019 ($LA_{eq(15\ min)}$)	Q2 - May 2019 ($LA_{eq(15\ min)}$)	Q3 - July 2019 ($LA_{eq(15\ min)}$)	Q4 - October 2019 ($LA_{eq(15\ min)}$)	Compliance
Day [1, 2]	N1	44	<44	<44	<44	<42	✓
	N2	40	<40	<40	<40	<42	✓
	N3	50 (when Nurragingy Reserve is in use)	<48	41	<44	<48	✓
	N3	50 (when Colebee Centre is in use)	<48	41	<44	<48	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	50	<35	<42	<45	✓
Evening [1, 2]	N1	44	<38	<35	<38	<40	✓
	N2	39	<39	<37	<39	<38	✓
	N3	50 (when Nurragingy Reserve is in use)	<44	<40	<41	<50	✓
	N3	50 (when Colebee Centre is in use)	<44	<40	<41	<50	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	<45	47	<41	<43	✓
Night [1, 2]	N1	39	<36	<32	<35	<39	✓

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q1 - March 2019 ($LA_{eq(15\ min)}$)	Q2 - May 2019 ($LA_{eq(15\ min)}$)	Q3 - July 2019 ($LA_{eq(15\ min)}$)	Q4 - October 2019 ($LA_{eq(15\ min)}$)	Compliance
	N2	39	<31	<35	<39	<36	✓
	N3	50 (when Nurragingy Reserve is in use)	<48	<38	<42	<49	✓
	N3	50 (when Colebee Centre is in use)	<48	<38	<42	<49	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	<33	<45	<43	<40	✓
Morning Shoulder [1, 2]	N1	39	Not Operating	Not Operating	Not Operating	Not Operating	✓
	N2	40	Not Operating	Not Operating	Not Operating	Not Operating	✓
	N3	50 (when Nurragingy Reserve is in use)	Not Operating	Not Operating	Not Operating	Not Operating	✓
	N3	50 (when Colebee Centre is in use)	Not Operating	Not Operating	Not Operating	Not Operating	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	Not Operating	Not Operating	Not Operating	Not Operating	✓

Note 1: Noise criteria adopted from NMP.
Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

Table 11: Noise Monitoring Results and Compliance Summary for 2020

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q1 - January 2020 ($LA_{eq(15\ min)}$)	Q2 - April 2020 ($LA_{eq(15\ min)}$)	Compliance
Day [1, 2]	N1	44	<42	<40	✓
	N2	40	<40	<38	✓
	N3	50 (when Nurragingy Reserve is in use)	<50	<45	✓
	N3	50 (when Colebee Centre is in use)	<50	<45	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	<40	<45	✓
Evening [1, 2]	N1	44	<37	<35	✓
	N2	39	<39	<35	✓
	N3	50 (when Nurragingy Reserve is in use)	<37	<45	✓
	N3	50 (when Colebee Centre is in use)	<37	<45	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	<38	<45	✓
Night [1, 2]	N1	39	<33	<35	✓
	N2	39	<37	<35	✓

Assessment Period	Receiver	Quarrying Noise Criteria ($LA_{eq(15\ min)}$)	Q1 - January 2020 ($LA_{eq(15\ min)}$)	Q2 - April 2020 ($LA_{eq(15\ min)}$)	Compliance
	N3	50 (when Nurragingy Reserve is in use)	<37	<40	✓
	N3	50 (when Colebee Centre is in use)	<37	<40	✓
	N4	55 (when active recreational areas of the Blacktown Olympic Park are in use)	<39	<45	✓

Note 1: Noise criteria adopted from NMP.
Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

All noise results were below the noise criteria at all receivers during the monitoring events in this reporting period.

Long-term Trends

Noise monitoring reports from 2015 until the end of this reporting period record no exceedances in noise criteria. Noise emissions from site have been inaudible at the receivers and negligible in comparison to other sources of noise. The noise monitoring results represented in this Annual Review support RHDC's continued compliance with the Project Approval noise criteria.

6.1.4 Management Measures

The Operational Noise Management Protocol as well as the OEMP contain noise management measures including:

- During the morning shoulder and night-time periods the storage bins are not loaded from an empty state, front end loader reversing alarms are replaced with visual warnings, and conveyor start-up warnings are visual.
- Plant and equipment are maintained, fitted wherever practical with mufflers or noise insulation, and operated efficiently.
- Noise barriers and enclosures are inspected regularly.

6.1.5 Proposed Improvements

There are no further improvements proposed for noise management at RHDC.

6.2 Air Quality

6.2.1 EIS Predictions

The 2005 EAR reported the level of impact from the project to air quality would be acceptable, with no reason for concern regarding the health and safety of those within the project area or vicinity of (Volume 2, Section F). The MOD 2 Environmental Assessment (2017) complements these findings in that no exceedances of the 24-hour criteria are predicted to occur in the operation phase of the project.

6.2.2 Approved Criteria

Air quality monitoring at RHDC is compared to the monitoring criteria stipulated in Condition 2.8A of the Project Approval to ensure compliance. There are no air quality criteria outlined in EPL 20672.

Table 12: Air Quality Criteria from Project Approval 05_0051, Condition 2.8A

Pollutant	Averaging Period	Criterion
Particulate Matter < 10 µm (PM_{10})	Annual	[a, d] 25 µg/m^3
Particulate Matter < 10 µm (PM_{10})	24 hour	[b, d] 50 µg/m^3
Particulate Matter < 2.5 µm ($PM_{2.5}$)	Annual	[a, d] 8 µg/m^3
Particulate Matter < 2.5 µm ($PM_{2.5}$)	24 hour	[b, d] 25 µg/m^3

Pollutant	Averaging Period	Criterion
Total suspended particulates (TSP)	Annual	[a, d] 90 µg/m^3

Note:
"Reasonable and feasible avoidance measures" includes, but is not limited to, the operational requirements in conditions 2.8, 3.1(b) and 5.3(d) to develop and implement an air quality management system that ensures operational responses to the risks of exceedance of the criteria.
a Cumulative impact (ie increase in concentrations due to the development plus background concentrations due to all other sources).
b Incremental impact (ie increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development.
c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.
d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Secretary.

6.2.3 Key Environmental Performance

PM_{10} sampling was undertaken at two HVAS units owned and operated by Holcim in this reporting period. These PM_{10} results are summarised in **Table 13**, **Table 14**, and **Table 15**.

Table 13: 2018 HVAS PM10 Monitoring Results

Sample Date	HVAS 1 - Site Office PM_{10} (µg/m^3)	HVAS 2 - Blacktown Sports Centre PM_{10} (µg/m^3)
8/07/2018	9.3	2.4
14/07/2018	***101.0**	8.0
12/09/2018	17.2	18.8
18/10/2018	15.1	11.8
24/10/2018	**71.6**	25.7
30/10/2018	***119.0**	21.5
5/11/2018	39.7	**57.8**
11/11/2018	19.0	12.4
17/11/2018	**66.3**	10.6
29/11/2018	34.3	10.4
5/12/2018	31.0	15.7
11/12/2018	14.9	**66.0**
17/12/2018	**59.6**	24.9
23/12/2018	12.5	9.6

Sample Date	HVAS 1 - Site Office PM_{10} (µg/m^3)	HVAS 2 - Blacktown Sports Centre PM_{10} (µg/m^3)
29/12/2018	38.7	29.2
Sample Count	15	15
Short Term Exceedances	5	2
Average over Six-Month Period (July - December 2018) (including contamination)	43.3	21.7
Average over Six-Month Period (July - December 2018) (excluding contamination)	33.0	21.7

*Note: Results exceeding the short-term criteria are in **bold**. Results recorded with an asterisk note those impacted by contamination.*

PM_{10} levels in 2018 exceeded the 24-hour criteria on seven sampling occasions in total. Five of these exceedances were recorded at HVAS 1 on the 14 July 2018, 24 October 2018, 30 October 2018, 17 November 2018, and 17 December 2018. While exceedances at HVAS 2 occurred on 5 November 2018 and 11 December 2018. A six-month average for this period indicates the air quality at HVAS 1 exceeded annual average criteria for PM_{10}. 2018 results at HVAS 2 were consistent with the annual average criterion.

Table 14: 2019 HVAS PM_{10} Monitoring Results

Sample Date	HVAS 1 - Site Office PM_{10} (µg/m^3)	HVAS 2 - Blacktown Sports Centre PM_{10} (µg/m^3)
4/01/2019	41.0	27.7
10/01/2019	29.2	13.7
16/01/2019	NS	43.3
22/01/2019	36.7	25.1
3/02/2019	19.6	14.4
9/02/2019	38.6	22.5
15/02/2019	31.0	12.6
27/02/2019	**66.7**	26.7
5/03/2019	47.1	28.2
11/03/2019	**77.0**	47.1
17/03/2019	11.6	8.3
23/03/2019	20.0	15.1
4/04/2019	Equipment Error	15.4
10/04/2019	NS	15.0

Sample Date	HVAS 1 - Site Office PM_{10} (µg/m^3)	HVAS 2 - Blacktown Sports Centre PM_{10} (µg/m^3)
16/04/2019	NS	15.7
22/04/2019	NS	16.2
28/04/2019	NS	25.4
2/05/2019	NS	8.7
22/05/2019	NS	31.0
28/05/2019	NS	37.4
3/06/2019	Equipment Error	19.3
15/06/2019	NS	18.7
21/06/2019	NS	13.9
27/06/2019	NS	14.8
3/07/2019	46.1	28.6
9/07/2019	26.4	15.3
15/07/2019	16.8	46.1
21/07/2019	26.5	37.6
27/07/2019	31.3	15.1
2/08/2019	33.3	14.9
8/08/2019	**65.4**	**65.1**
14/08/2019	46.6	41.6
20/08/2019	30.5	18.6
26/08/2019	21.4	10.4
1/09/2019	10.2	9.9
7/09/2019	16.2	18.3
13/09/2019	46.2	25.9
19/09/2019	16.2	8.3
25/09/2019	40.8	14.8
1/10/2019	25.7	13.8
7/10/2019	**50.9**	22.0
13/10/2019	8.9	4.1
19/10/2019	**58.6**	40.7
25/10/2019	**74.3**	**62.7**
8/11/2019	26.0	22.5
12/11/2019	*188.0	*127.0
18/11/2019	*99.9	*83.0
24/11/2019	25.0	17.2
30/11/2019	*72.8	*60.8
6/12/2019	*91.5	*76.6
12/12/2019	*51.1	*30.3
18/12/2019	*46.4	*47.4
24/12/2019	*46.1	*33.2
31/12/2019	*75.0	*25.9

Sample Date	HVAS 1 - Site Office PM_{10} ($\mu g/m^3$)	HVAS 2 - Blacktown Sports Centre PM_{10} ($\mu g/m^3$)
Sampling Event Count	54	54
Short Term Exceedances (all samples)	12	6
Short Term Exceedances (Contamination and Extraordinary Events removed)	6	2
Annual Average (All Samples)	44.7	28.8
Annual Average (Contamination Removed)	35.2	23.3

*Note: NS stands for No Sample. Results recorded with an asterisk note those contaminated or impacted by extraordinary events. Results exceeding the short-term criteria and without note of contamination or extraordinary events are in **bold**.*

In 2019, the annual average PM_{10} at HVAS 1 was greater than the Project Approval criteria at 35.2 $\mu g/m^3$. This is a non-compliance with Condition 2.8A (Air Quality) of the Project Approval. Excluding contamination there were six occasions on which PM_{10} levels were greater than the 24-hour criterion of 50 $\mu g/m^3$ at HVAS 1. These exceedances occurred on 27 February 2019, 11 March 2019, 8 August 2019, 7 October 2019, 19 October 2019, and 25 October 2019.

The annual average at HVAS 2 was 23.3 $\mu g/m^3$ which is compliant with the Project Approval criteria. PM_{10} levels at HVAS 2 exceeded the 24-hour criterion on 8 August 2019 and 25 October 2019.

There were impacts to air quality in this report period as a result of regional bushfires. Samples taken on 12 November, 18 November, 30 November 2019, 6 December 2019, 12 December 2019, 18 December 2019, 24 December 2019, and 31 December 2019 were impacted by the bushfires as is reflected in the high ash content of these samples. As such, these samples have been removed to calculate the Annual Average (Contamination Removed) for both HVAS 1 and HVAS 2 in **Table 14**.

Table 15: 2020 HVAS PM_{10} Monitoring Results

Sample Date	HVAS 1 - Site Office PM_{10} ($\mu g/m^3$)	HVAS 2 - Blacktown Sports Centre PM_{10} ($\mu g/m_3$)
9/01/2020	*38.0	*27.8
11/01/2020	*81.7	*67.1
17/01/2020	*54.9	*36.7
29/01/2020	*64.9	*38.9
4/02/2020	*51.8	*33.5
10/02/2020	NS	8.1
16/02/2020	13.6	10.8
28/02/2020	20.3	**55.4**
5/03/2020	16.2	12.7
11/03/2020	45.9	NS - Damaged Filter

Sample Date	HVAS 1 - Site Office PM_{10} ($\mu g/m^3$)	HVAS 2 - Blacktown Sports Centre PM_{10} ($\mu g/m_3$)
17/03/2020	23.8	10.8
23/03/2020	40.3	20.2
29/03/2020	43.9	NS - Covid 19 Restrictions prevent access to equipment
4/04/2020	33.3	NS - Covid 19 Restrictions prevent access to equipment
10/04/2020	**60.6**	26.7
16/04/2020	24.3	25.7
22/04/2020	**64.6**	23.7
28/04/2020	*100.2	NS - Covid 19 Restrictions prevent access to equipment
4/05/2020	47.8	NS - Covid 19 Restrictions prevent access to equipment
10/05/2020	19.7	11.4
16/05/2020	17.5	12.1
22/05/2020	46.3	20.5
3/06/2020	46.3	NS
9/06/2020	35.5	21.3
15/06/2020	40.5	16.3
21/06/2020	13.8	22.2
27/06/2020	40.8	13.0
3/07/2020	44.7	25.3
9/07/2020	31.1	3.3
15/07/2020	45.5	18.9
21/07/2020	47.4	21.0
27/07/2020	27.5	11.2
2/08/2020	28.9	23.6
8/08/2020	14.7	22.8
14/08/2020	35.8	11.7
20/08/2020	39.8	35.6
26/08/2020	36.3	23.6
1/09/2020	56.2	22.2
7/09/2020	29.6	20.1
13/09/2020	34.2	17.9
19/09/2020	24.9	18.3
25/09/2020	**88.4**	**55.2**
1/10/2020	35.0	14.3
7/10/2020	33.3	10.3
13/10/2020	34.8	16.3
19/10/2020	33.5	14.2

Sample Date	HVAS 1 - Site Office PM_{10} ($\mu g/m^3$)	HVAS 2 - Blacktown Sports Centre PM_{10} ($\mu g/m_3$)
25/10/2020	13.0	5.5
31/10/2020	24.0	18.0
6/11/2020	30.5	10.8
12/11/2020	37.9	33.1
18/11/2020	28.5	22.6
24/11/2020	35.9	15.8
30/11/2020	**72.0**	34.7
6/12/2020	35.4	45.2
12/12/2020	**60.5**	13.4
18/12/2021	23.8	18.9
24/12/2020	27.0	19.5
Sampling Event Count	57	53
Short Term Exceedances (all samples)	10	7
Short Term Exceedances (contamination and extraordinary events removed)	5	2
Annual Average (all samples)	39.2	22.6
Annual Average (contamination removed)	36.1	20.3

*Note: NS stands for No Sample. Results recorded with an asterisk note those contaminated or impacted by extraordinary events. Results exceeding the short-term criteria are in **bold**.*

The 2020 average PM_{10} result at HVAS 1 was 37.7 $\mu g/m^3$. This exceeds the annual average criteria of 25 $\mu g/m^3$ and is therefore a non-compliance with Condition 2.8A (Air Quality) of the Project Approval. Short term (24-hour) exceedances were recorded on 10 April 2020, 22 April 2020, 28 April 2020, 1 September 2020, 25 September 2020, and 30 November 2020 at HVAS 1. There were six samples affected by contamination including by bushfires in 2020.

The annual average at HVAS 2 was compliant with the air quality criteria with a result of 20.4 $\mu g/m^3$. HVAS 2 recorded exceedances in the short-term criteria on 28 February 2020 and 25 September 2020, with the results 55.4 $\mu g/m^3$ and 55.2 $\mu g/m^3$. Access to HVAS 2 inside the Blacktown Sports Centre was limited during March, April, and May 2020 due to the Covid-19 Restrictions. Sampling events were missed because of this, as is shown in **Table 15**.

Elevated PM_{10} results from November 2019 until February 2020 at both HVAS 1 and HVAS 2 can be attributed to the severe bushfires occurring across the Sydney region. The following 2020 sampling events were notably impacted by the bushfires:

- 9 January 2020,
- 11 January 2020,
- 17 January 2020,
- 29 January 2020, and
- 4 February 2020.

In this reporting period, Holcim identified the need for more robust documentation processes to minimise instances of data misplacement. As a result, Holcim changed monitoring contractors and launched an online environmental data portal to record long-term results as well as flag short-term exceedances.

Depositional dust monitoring was also conducted at RHDC to monitor air quality impacts. The results of this monitoring is presented in **Table 16**, **Table 17,** and **Table 18**.

Table 16: 2018 Depositional Dust Monitoring Results

2018 Sample Period	Insoluble Solids (g/m^2/month)		
	DDG 1	DDG 2	DDG 3
September	4.7	3.7	2.8
October	3.0	2.3	3.7
November	2.7	1.6	1.3
December	7.8	3.7	2
Average	4.6	2.8	2.5

Table 17: 2019 Depositional Dust Monitoring Results

2019 Sample Period	Insoluble Solids (g/m^2/month)		
	DDG 1	DDG 2	DDG 3
January	4	7.1	3.3
February	2.1	1.9	1.7
March	2.7	2.8	1.5
April	5.3	2	2
May	3.3	2.2	1.5
June	3.2	3	2.8
July	2.9	3	1.9
August	1.5	1.7	1.2
September	NS	2.8	1.5
October	4.2	4.2	1.8
November	7.1	4.5	3.2
December	7.9	4.7	3.2
Annual Average	4.0	3.3	2.1

Note: NS stands for No Sample.

Table 18: 2020 Depositional Dust Monitoring Results

2020 Sample Period	Insoluble Solids (g/m^2/month)		
	DDG 1	DDG 2	DDG 3
January	5.2	3.4	2.5
February	3.6	1.3	0.9
March	3.6	1.3	0.9
April	3.3	NS	2.8

2020 Sample Period	Insoluble Solids (g/m^2/month)		
	DDG 1	DDG 2	DDG 3
May	7.7	NS	1.7
June	3.5	2.6	1.8
July	1.8	7.4	0.9
August	2.6	6.3	1.7
September	3.4	3	1.9
October	6.2	3	2.2
November	4.4	2.3	3.4
December	5.3	6.5	2.3
Annual Average	4.22	3.71	1.92

Note: NS stands for No Sample.

Long-Term Trends

Table 19 summarises the long-term PM_{10} results at RHDC. HVAS 1 has increased since the 2015-2016 reporting period but is consistent with the previous four years. HVAS 2 results have generally been consistent across the project lifetime.

Table 19: Long-term PM_{10} Monitoring Results

Monitor	PM_{10} Annual Average (µg/m^3)			
	October 2015 – September 2016	July 2017 – June 2018	2019 (contaminated samples removed)	2020 (contaminated samples removed)
HVAS 1	9.5	30.2	35.2	36.1
HVAS 2	24.2	25.0	23.3	20.3

Table 20 summarises the long-term depositional dust results at RHDC from the 2015-2016 Annual Review period. Trends identified for DDG 1 include a gradual increase in depositional dust levels. DDG 2 and DDG 3 record consistent depositional dust results.

Table 20: Long-term Depositional Dust Results

Monitor	Average (g/m^2/month)			
	October 2015 - September 2016	July 2017 – June 2018	2019	2020
DDG 1	1.9	3.1	4.0	4.2
DDG 2	3.4	2.8	3.3	3.2
DDG 3	1.8	1.3	2.1	1.9

6.2.4 Management Measures

The site undertook dust management measures throughout operations to ensure compliance with the Project Approval as well as the requirements of EPL 20672 during the period it was applicable (July 2018 – June 2020). Dust management measures undertaken as per these approvals include:

- Provision and use of a permanent water cart onsite.
- Provision and use of a permanent street sweeper onsite.
- Installation and use of water cannons on all stockpiles.
- All heavy vehicles exiting the site leave via the wheel wash (located at the weighbridge).
- Trucks cover loads at all times, except for during loading and unloading;
- Water sprays and covering of all material conveyors.

Additional management measures implemented at the site and outlined in the *Air/Dust Management Plan* include:

- Stockpile spray maintenance.
- Internal roads are swept to minimise dust and sediment tracking.
- Staff training for dust control measures, including recognising dust as a hazard of high priority for resolution.
- Scope of works for monitoring contractors to include cleaning and general maintenance of samplers.
- Site speed limits are signed and enforceable at all times.

As a result of an environmental audit and investigation into dust exceedances at the site in 2018, the relocation of HVAS 1 to the site boundary has been assessed in order for compliance to be more accurately assessed.

Holcim has implemented a systems improvement in this reporting period in the form of an online environmental data portal. The purpose of this is to collect reliable long-term data, retrieve data quickly, and alert sites. This will improve RHDC's ability to meet the Project Approval air quality criteria.

6.2.5 Proposed Improvements

In response to the persistent exceedances in PM_{10} at HVAS 1 across multiple reporting periods, the relocation of HAVS 1 from the site office to the site boundary will be addressed in OEMP updates. Issues associated with HVAS 1 include false negative results and inaccuracy.

6.3 Traffic Management

6.3.1 EIS Predictions

In Appendix D of Volume 3 of the 2005 EAR, a traffic assessment found that the existing road network around the project area would be sufficient for the performance of project-associated traffic. Furthermore, pedestrian safety was not found to be impacted as a result of the project. It was also noted that road upgrades may be necessary within the lifetime of the project. The 2010 and 2017 environmental assessments did not find any additional impacts to traffic volumes or routes as a result of RHDC operations.

6.3.2 Approved Criteria

Traffic management is outlined in the *RHDC Traffic Management Plan*, *RHDC Transport Code of Conduct (for Heavy Vehicles)*, and the OEMP. The Project Approval outlines requirements for traffic in Conditions 2.11 - 2.21A (Traffic and Transport).

6.3.3 Key Environmental Performance

There were no traffic incidents or non-compliances at RHDC within this Annual Review period. Holcim continue to execute traffic management measures consistent with the Project Approval.

6.3.4 Management Measures

Management measures for traffic are outlined in the OEMP (2015). Some of these key controls include:

- The Transport Code of Conduct and site driver requirements must always be complied with.
- Vehicles must be maintained and serviced regularly.
- Site roads and access must be monitored and kept in good order including in terms of road condition and sediment tracking.
- Speeds are limited to 20km/hr and traffic routes are signed.

6.3.5 Proposed Improvements

Holcim staff are responsible for regularly reviewing traffic management against the Transport Code of Conduct and OEMP. No areas for improvement were identified in this reporting period.

6.4 Summary of Environmental Performance

A summary of the performance of environmental management measures and sampling is detailed in **Table 21** below.

Table 21: Summary of Environmental Performance at RHDC

Aspect	Approval Criteria / EIS Prediction	Performance during the reporting period	Trend / Key management implications	Implemented / Proposed management actions
Noise	EAR predictions are all below the Project Approval criteria.	All noise monitoring results were compliant with the Project Approval and EPL 20672.	All noise monitoring results were compliant with criteria.	No further improvements proposed for noise management.
Air Quality	EAR (2005) and EA (2015) predictions are below the Project Approval criteria.	The majority of OEMP criteria are met. Some short-term exceedances in this period for PM_{10}, with several of these attributed to contamination or extraordinary events such as bushfires.	Air quality results remain consistent with the limited historical record. Depositional dust and PM_{10} levels increased between 2015 and 2020 at DDG1 and HVAS 1.	Continue to develop OEMP updates and submit to DPIE for approval.
Traffic	EAR predictions are consistent with the Project Approval conditions.	Met Project Approval criteria consistently.	Site consistently meets criteria.	No further improvements proposed for traffic management.
Water	EAR predictions are consistent with Project Approval conditions.	Majority of water quality results consistent with the *Soil and Water Management Plan*. Some exceedances in Dissolved Oxygen and Turbidity.	Exceedances in OEMP water quality criteria and ANZECC guidelines not attributed to RHDC. Therefore, this is not considered a non-compliance with the Project Approval.	Continue monitoring as per the OEMP. No further actions required.
Biodiversity and Rehabilitation	EAR predictions are consistent with Project Approval criteria.	Consistent with Project Approval.	All biodiversity and rehabilitation actions were done in accordance with the Landscape Management Plan and Project Approval in 2020.	No proposed actions for 2021. Continue biodiversity and rehabilitation management as per the LMP.

7 Water Management

7.1 EIS Predictions

7.1.1 Surface Water Quality

The Executive Summary from the 2005 EAR stated that *"the proposed RDC would not materially change the drainage patterns on the site*" and there would be no negative impact on Angus Creek from the project. Furthermore, modelling that was presented in the 2005 EAR showed there would be minor changes to flood levels as a result of the project.

Section 6.4 of the 2017 Environmental Assessment for MOD 2 outlines the negligible impact to the site surface water management systems that the small increase in runoff volume the RHDC Modification would create.

7.1.2 Aquatic Ecology

The Aquatic Ecology Impact Assessment (Volume 2, Section E) in the 2005 EAR found that there were no endangered ecological communities or threatened species within the riparian areas of the site. Angus Creek and Eastern Creek were categorised as disturbed lowland creeks.

7.1.3 Groundwater

The 2005 EAR found the RHDC would have minimal to no impact on the groundwater as a result of altered water flows due to increased impervious surfaces or sources of contamination such as spilled oils, fuels, or other chemicals stored on site.

7.2 Approved Criteria

The Project Approval requires surface water management at RHDC, including the expectation that Holcim follows best-practice guidelines for urban stormwater management. Holcim is expected to operate in accordance with:

- Protection of the Environment Operations Act 1997.
- Draft Guidelines – Watercourse Crossing Design and Construction (DPI Water).
- Why do Fish Need to Cross the Road? – Fish Requirements for Waterway Crossings (2004, NSW Fisheries).
- Policy and Guidelines for Fish Friendly Waterway Crossings (2004, NSW Fisheries).
- Water Sensitive Urban Design and Integrated Water Cycle Management, Blacktown Development Control Plan (2015).
- Sensitive Urban design Technical Guidelines for Western Sydney (upper Parramatta River Catchment Trust, 2004).
- Managing Urban Stormwater Soils and Construction: Volume 1 (the 'Blue Book') by Landcom.

As per Condition 2.28A (Aquatic Ecology) of the Project Approval as well as the Statement of Commitments, RHDC conduct a surface water and aquatic ecology monitoring program in Angus Creek and Eastern Creek which also includes monitoring locations in Nurragingy Reserve. Water quality monitoring and visual assessments for habitat and vegetation are required to occur as per the monitoring program.

Table 22 shows the site-specific criteria for water quality parameters in dry weather from the OEMP and *Soil and Water Management Plan*.

Table 22: Water Quality Trigger Criteria during Dry Weather (RHDC Soil and Water Management Plan).

Monitoring Location	Turbidity (NTU)	Dissolved Oxygen (% sat)	Electrical Conductivity (µS/cm)	pH	Total Nitrogen	Total Phosphorous
AE1	49.4	22.34 – 52.52	1242.598 – 3826.8	7.604 – 8.524	1.52	0.164
AE2	41.7	21.92 – 47.052	1267.8 – 4015.998	7.548 – 8.64	2	0.158
AE3	45.0	23.988 – 44.542	1181 – 4164.002	7.478 – 8.86	2.2	0.24
AE4	68.2	33.34 – 49.378	824.4 – 1643.198	7.252 – 8.674	3.18	0.2
AE5	90.8	31.482 – 51.04	791.398 – 1522.598	7.306 – 8.688	2.94	0.18
AE6	181.6	32.198 – 62.258	1770.668 – 5399.202	7.73 – 9.02	5.1	0.74

7.3 Key Environmental Performance

RHDC has conducted water monitoring as per the RHDC *Operational Environmental Management Plan*, the *Soil and Water Management Plan*, and *Operational Monitoring Program*. Water quality and aquatic ecology monitoring was undertaken by Niche Environment and Heritage in this reporting period. These reports can be found in **Appendix 2**. Monitoring occurred in the following periods:

- August 2018
- March 2019
- August 2019
- November 2019
- May 2020
- August 2020
- November 2020

7.3.1 Surface Water Quality

2018 Findings

The Spring 2018 visual assessment of stream health found that the streams were disturbed due to the overall anthropic impacts of the catchment, however had low active erosion, some exposed banks, and good native riparian vegetation.

Table 23: 2019 Water Quality Results

Sampling Period	Sampling Site	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (% sat)	Electrical Conductivity (µS/cm)	pH	Total Nitrogen (TKN + NOx) (mg/L)	Total Phosphorous (mg/L)
March 2019	**AE1**	14.32	7.5	**16.9**	2237	7.13	0.5	0.08
	AE2	15.91	42.5	**59.8**	510	7.87	0.6	0.11
	AE3	15.5	11.5	**15.0**	520	7.4	0.6	0.04
	AE4	14.08	33.2	**41.9**	754	7.47	0.8	0.1
	AE5	14.34	47.2	**52.5**	755	7.86	0.5	0.07
	AE6	14.53	16.4	**69.8**	2820	7.65	1.1	0.1
August 2019	**AE1**	8.89	13.5	**24.1**	2084	8.12	0.4	0.04
	AE2	11.86	**110.9**	**44.4**	402	7.96	1.1	0.02
	AE3	10.90	34.9	**28.6**	411	7.04	1.3	0.07
	AE4	9.31	48.3	**45.1**	435	7.44	0.5	0.04
	AE5	9.76	31.8	**47.2**	425	6.60	0.4	0.03
	AE6	9.02	5.3	**42.9**	3143	7.30	0.6	0.01
November 2019	**AE1**	16.46	6.1	**22.6**	342	6.51	0.6	0.12
	AE2	16.90	8.6	**34.9**	253	7.05	0.3	0.08
	AE3	16.81	6.6	**36.5**	220	7.32	0.4	0.07
	AE4	17.41	16.9	**65.6**	318	7.13	0.7	0.10
	AE5	17.48	19.09	**51.6**	311	7.25	0.6	0.10
	AE6	18.01	5.1	**47.9**	557	7.06	0.6	0.13
ANZECC (2000) Default Trigger Levels for Lowland Streams			6 - 50	80 - 110	125 - 2200	6.5 - 8	500	50

*Note: Values outside of the ANZECC (2000) DTLs are in **bold***

Table 24: 2020 Water Quality Results

Sampling Period	Monitoring Location	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (% sat)	Electrical Conductivity (µS/cm)	pH	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
May 2020	**AE1**	14.1	6.8	**58.3**	1009	7.33	1.0	0.03
	AE2	13.87	**2.3**	**53.7**	897	7.32	0.6	0.02
	AE3	13.84	8.8	**49.7**	874	7.42	0.7	0.04
	AE4	13.35	**622.0**	**75.8**	622	7.16	1.2	0.13
	AE5	13.33	**622.0**	**76.8**	622	7.32	1.5	0.19
	AE6	NS	NS	NS	NS	NS	NS	NS
August 2020	**AE1**	12.32	24.3	**70.4**	1226	7.79	1.6	0.04
	AE2	12.75	11.5	**68.3**	1229	7.7	1.8	0.07
	AE3	12.75	8.3	**68.9**	1236	7.71	1.7	0.07
	AE4	12.53	**71.5**	**79.8**	721	7.46	1.9	0.16
	AE5	12.42	**84.5**	**78.9**	724	7.44	2.7	0.16
	AE6	12.66	**3.7**	**76.6**	1483	7.87	1.9	0.03
November 2020	**AE1**	18.94	16.4	**33.7**	1684	7.65	0.7	0.05
	AE2	18.92	6.4	**41.9**	1368	7.51	0.5	0.04
	AE3	18.77	7.0	**37.5**	1365	7.35	0.4	0.05
	AE4	19.94	**70.6**	**47.5**	611	7.56	1.2	0.16
	AE5	19.19	17.5	**22.1**	1211	7.54	1.3	0.18
	AE6	19.66	8.2	**75.7**	1453	7.82	1.2	0.06
ANZECC (2000) Default Trigger Levels for Lowland Streams			6 – 50	80 - 110	125 - 2200	6.5 - 8	500	50

*Note: NS stands for Not Sampled. Values outside of the ANZECC (2000) DTLs are in **bold***

2019 Findings

Water quality results from 2019, shown in **Table 23**, remained consistent with the dry weather water quality triggers for all parameters. Similarly, when assessed against the ANZECC (2000) Default Trigger Levels for Lowland Streams water quality results were mostly within these criteria. Dissolved oxygen at all sites were consistently the exception to this, with all results below the DTL range.

The Autumn visual assessment on stream health was primarily consistent with the 2018 Spring assessment, however found turbidity at Angus Creek had decreased while Eastern Creek turbidity had increased. This change could not be conclusively linked to RHDC operations.

2020 Findings

Water quality monitoring was undertaken on three occasions in 2020, with the results summarised in **Table 24** above. The water quality monitoring during 2020 found all physiochemical and nutrient parameters were within the ANZECC criteria for the monitoring sites**,** except for dissolved oxygen and turbidity. However, results were primarily consistent with the site-specific dry weather parameters. Turbidity was consistently above ANZECC guidelines during 2020. Dissolved oxygen was below the ANZECC criteria of 80-110% on every sampling occasion. Low dissolved oxygen has been a consistent feature at the Angus Creek and Eastern Creek sites.

Storm events in 2020 caused some bank erosion at Angus Creek and Eastern Creek. However, by November 2020 monitoring found improved riparian vegetation health at both creeks.

Long-term Trends

In this report period, turbidity and dissolved oxygen were the only parameters that did not regularly meet the site-specific RHDC Water Quality Triggers for Dry Weather and ANZECC DTLs. This is an improvement from results in the 2015 – 2016 Annual Review period which indicated turbidity, dissolved oxygen, total nitrogen and total phosphorous were consistently above the site trigger values. pH has continued to approach neutral since the beginning of 2017.

Comparisons between the control upstream location as well as sampling sites in downstream Angus Creek across multiple reporting periods have concluded that the RHDC site is unlikely to be the cause of these exceedances in the local water quality profile.

With this is mind, this Annual Review does not consider these water quality exceedances as a non-compliance against Condition 5.5 Operation Environmental Management Plan of the Project Approval.

7.3.2 Aquatic Ecology

Aquatic ecology was monitored as per the bi-annual macroinvertebrate monitoring program. The same sampling sites were used for macroinvertebrate sampling. Across this Annual Review period the stream habitats exhibited a macroinvertebrate profile which indicates pollution, as supported by the SIGNAL2 assessments.

In 2019, a greater number of taxa were observed in Angus Creek downstream (AE3) than upstream sites (AE1 and AE2). Most of these were pollution tolerant, however a pollution-sensitive taxon, Leptoceridae, was also observed. Leptoceridae were also found in Eastern Creek. Aquatic ecology monitoring in 2019 presented a low SIGNAL2 score of 3, which was concluded as indicative of low abundance and diversity due to urban pollution.

Throughout 2020, Eastern Creek had slightly lower SIGNAL2 scores than Angus Creek, however both were categorised as SIGNAL2 score 3. This indicates severe pollution at the sites as well as a tolerance to pollution in the macroinvertebrates present in these waterways. Pollution sensitive macroinvertebrate families were found in Eastern Creek.

In summary, the reports by Niche Environment and Heritage found that it was highly unlikely that RHDC affected the stream ecology of the Angus Creek and Eastern Creek waterways. Multiple activities occurring upstream to the site have a higher potential to impact creek health than RHDC operations.

Long-term Trends

Macro-invertebrate assemblages slightly improved in the 2017-2018 Annual Review period, during the construction phase of the project; however the driving factor for this improvement is unknown. Excluding this change, the health of aquatic ecology has not seen significant improvement nor decline from 2015 to 2020. Macro-invertebrate monitoring has consistently shown the aquatic ecology in the local waterways are in poor ecological condition.

7.4 Management Measures

RHDC implement multiple management measures to maintain surface water quality and control storm water across the project area. The management measures for water on the site include:

- Storm water management measures (such as swales, detention basins, and gross pollutant traps) constructed to have minimal impacts to the flood regime and are regularly maintained.
- Silt traps and Humeceptors in place to capture runoff.
- Maintenance of detention basins on the northern side of the project area.
- Maintenance of a truck wash facilities.
- Minimisation of freshwater demand by storing and recycling water collected on site.

7.5 Proposed Improvements

Holcim will continue to collect surface water quality data to build a profile of the water quality at Angus Creek and Eastern Creek, and thus improve the site-specific monitoring parameters.

8 Rehabilitation and Landscape Management

8.1 EIS Predictions

The 2005 EAR stated that the project would require the removal of the Endangered Ecological Communities under the Threatened Species Conservation Act, including areas of Cumberland Plain Woodland and River-flat Eucalypt Forest. Threatened species, including *Grevillea juniperina ssp*. *juniperina* and the Cumberland Plain Land Snail, were identified outside of the development area.

8.2 Approved Criteria

The RHDC *Vegetation Management Plan* is to be implemented as per Condition 2.24 (Flora and Fauna) of the Project Approval. Rehabilitation monitoring is required in accordance with Condition 2.25. MOD 1 of the Project Approval outlines the need to implement a post-construction rehabilitation program, which includes a weed control program and planting local native species.

8.3 Key Environmental Performance

As a result of the findings of the EAR (2005), a Compensatory Habitat Package was agreed upon between Holcim, the Office of Environment and Heritage, and the Sydney Western Parklands Trust in July 2011 satisfying Condition 2.27 of PA 05_0051. Furthermore, RHDC's landscape management plans and procedures designed to control project impacts to surrounding threatened species.

The primary rehabilitation works undertaken in this reporting period was the maintenance of vegetated areas, as seen in the 2018 – 2020 Bushland Regeneration Report prepared by Toolijooa Environmental Restoration in **Appendix 3**. Weed management activities, such as slashing and herbicide spraying, were undertaken in bushland and revegetated areas at RHDC including the four Rehabilitation Zones. Primary weed species treated in this report period include *Ligustrum* spp. and *Asparagus aethiopicus*.

In 2017 6,565 native tubestock were planted on the landscape area of the project. Since then, the success of these planted tubestock has been monitored in accordance with the *Vegetation Management Plan*. Weed management was routinely conducted on these vegetated beds in this reporting period to prevent weed encroachment and ensure native vegetation success.

Long-term Trends

In the 2015 - 2016 report period Greening Australia stated 55% of the bushland area met the VMP target of less than 5% weed cover. RHDC vegetation continues to be monitored and maintained according to the Rehabilitation Zones. Planted and opportunistic native vegetation continue to mature in the RHDC Rehabilitation Zones.

8.4 Management Measures

The actions committed to within the VMP must be undertaken to achieve its performance criteria. The key management controls include:

- The use of local native species for rehabilitation vegetation.
- Monitoring the performance of plantings.
- Weed management.
- General maintenance of riparian areas, rehabilitated areas, and Juniper-leaved Grevillea northern and southern populations.

8.5 Proposed Improvements

There are no further improvements proposed for rehabilitation at RHDC for the next reporting period. Holcim will continue to identify areas for improvement in rehabilitation and landscape management for this project.

9 Community

Holcim has maintained community engagement measures during the reporting period by undertaking the following activities in accordance with Condition 4.1, 4.2 & 4.3 of the Project Approval:

- Maintenance of a website (containing publicly available documents).
- A telephone number, email, and postal address (on the website) for community complaints and feedback.
- A copy of the Complaints Register is maintained on the company website.
- All documents and items displayed on the website are regularly updated by Holcim staff.

Holcim has also communicated with the local community through periodic newsletters which provide information on the status of the project and its possible impacts. During previous reporting periods the RHDC Community Liaison Group was arranged to engage stakeholders. However, from 2017 and into this reporting period there has been no demand from community stakeholders for this group to be reassembled. RHDC staff continues to look for opportunities to engage with stakeholders.

9.1 Complaints

All complaints received by RHDC are documented in Holcim's internal reporting system, INX. A complaints register is made available to the public on Holcim's website, via the link:

https://www.holcim.com.au/community-complaint-register

There were zero community complaints regarding RHDC in 2018, 2019, nor 2020.

10 Independent Audit

After the approval of MOD 2 of the Project Approval, Condition 3.5A (Independent Environmental Auditing) directs Holcim to commission an independent expert to conduct an Independent Environmental Audit (IEA) of the project within one year, and every three years hence.

The IEA required within one year of the MOD 2 approval date (29 June 2017) was held on 12 December 2017. The 2017 IEA addressed Condition 3.5A but focused on Condition 3.5 of the Project Approval due to RHDC operating under MOD 1 for the majority of the audit period. The 2017 Audit Action Plan was developed to resolve non-compliances. All actions from this IEA Action Plan were closed out during this report period.

At the time of writing Holcim has engaged an expert team to conduct the required IEA and is awaiting approval from DPIE to settle an inspection date. The IEA is proposed to occur in December 2021 to satisfy PA 05_0051 Condition 3.5A.

11 Incidents and Non-Compliances

Incidents and non-compliances at RHDC in this Annual Review reporting period are summarised in **Table 25**.

Table 25: Summary of Incidents and Non-Compliances

Date	Incident/Non-Compliance	Action
During this period	**Condition 6.4 Annual Performance Monitoring** Unfortunately, an Annual Review was not submitted for the annual reporting periods between June 2018 and the present.	This Annual Review covers the period 1 July 2018 to 31 December 2020 to provide a summary of environmental management and compliance at RHDC.
Throughout the period	**Condition 2.8A Air Quality** Short-term exceedances in PM_{10} during 2019, 2018, and 2020.	On-site dust management undertaken and assessed. Improvements to the OEMP including the relocation of HVAS 1 to continue to be undertaken for this Annual Review period.

12 Activities to be completed in the next reporting period

The DPIE Annual Review Guidelines require the Annual Review to outline actions proposed during the next reporting period. The next reporting period will cover 1 January 2021 to 31 December 2021. The activities to be completed in the next report period are detailed in **Table 26**.

Table 26: Improvement Actions for 2021

Improvement Measure	Activities
Operational Environmental Management Plan (OEMP)	Holcim to finalise updates to the OEMP in 2021 and send this to DPIE for approval.
Air Quality Monitoring	Relocate HVAS 1 from the site office to the site boundary in order to more accurately reflect particulate levels on and off site which may be related to the project. This will be detailed in the OEMP and Holcim will liaise with the EPA and DPIE about the relocation.
Annual Review	Ensure the Annual Review is completely annually, with the next Annual Review to cover the 2021 calendar year and submitted to DPIE in March 2022.

13 Appendices

Appendix 1 – Noise Monitoring Reports by Muller Acoustics Consulting

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 3 Ending September 2018.

Prepared for: Holcim (Australia) Pty Ltd
September 2018
MAC180611--01RP1

MAC
Muller Acoustic Consulting

Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 3 Ending September 2018

Prepared for: Holcim (Australia) Pty Ltd

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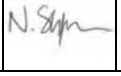
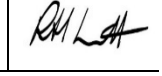
Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC180611-01RP1	Final	17 September 2018	Nicholas Shipman		Rod Linnett	

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APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Regional Distribution Centre (RDC), at Rooty Hill, NSW.

The monitoring has been conducted in accordance with RDC's Noise Management Plan (NMP) and the Noise Policy for Industry (NPI). This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending September 2018 and forms part of the noise monitoring program to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Noise Management Plan (NMP);
- Rooty Hill, Consolidated Consent, 2017 (Mod 2); and
- Australian Standard AS 1055.1:1997 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1).

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB L_{Aeq}				
Blacktown Olympic Park (Active	N4	When active recreational areas of the Park are in use – 55dB L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

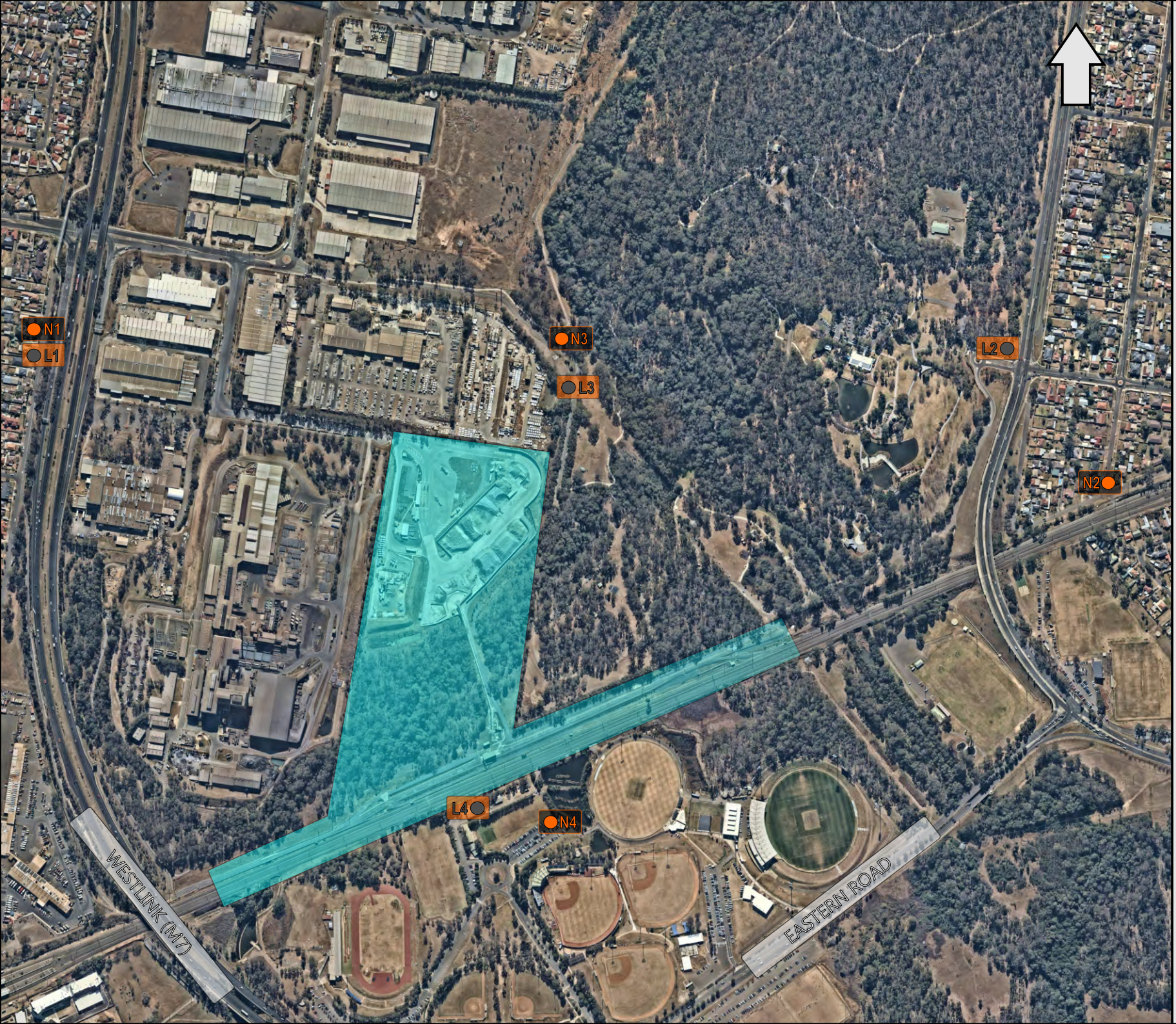

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

- N1 MONITORING LOCATION
- L1 LOGGER LOCATION
- SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055.1:1997 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1) and the RDC Consent. The measurements were carried out using Svantek Type 1, 971 noise analysers on Thursday 30 August 2018. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2004-Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minute attended periods during the daytime, evening and night time periods over the period of one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for more than seven days general accordance with the procedures described in Australian Standard AS 1055.1:1997 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1) and the RDC Consent. Noise measurements were carried out using Svantek Type 1, 977 noise analysers from Wednesday 22 August 2018 to Thursday 30 August 2018. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2004-Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
30/08/2018	12:34 (Day)	79	57	51	Dir: NW Wind Speed: 0.5m/s Rain: Nil	Traffic 51-79 Birds <52 Local residential noise 58-64 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	18:27 (Evening)	71	54	48	Dir: E Wind Speed: 1m/s Rain: Nil	Traffic 49-69 Wind in trees 35-38 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	22:25 (Night)	71	51	40	Dir: E Wind Speed: 1m/s Rain: Nil	Traffic 46-71 Birds 45-47 Local residential noise 48-50 Aircraft 36-38 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
30/08/2018	14:48 (Day)	70	54	46	Dir: NE Wind Speed: 0.5m/s Rain: Nil	Traffic 46-70 Birds 48-54 Aircraft 48-51 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	18:58 (Evening)	79	57	43	Dir: E Wind Speed: 1m/s Rain: Nil	Dog bark 45-79 Traffic 39-65 Train 45-58 Local residential noise 38-39 Aircraft 46-54 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	22:52 (Night)	68	46	41	Dir: E Wind Speed: 1m/s Rain: Nil	Traffic 39-68 Local residential noise 42-43 Train 46-57 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
30/08/2018	13:29 (Day)	67	49	43	Dir: NE Wind Speed: 0.1m/s Rain: Nil	Traffic 43-67 Birds 45-53 Local residential noise 46-50 Aircraft 47-49 Train 51-53 RDC plant noise 36-40
		RDC $L_{Aeq(15min)}$ Contribution				38
30/08/2018	18:00 (Evening)	64	51	49	Dir: E Wind Speed: 0.5m/s Rain: Nil	Traffic 48-61 Neighbouring sites <48 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	22:00 (Night)	64	52	49	Dir: E Wind Speed: 1m/s Rain: Nil	Traffic 48-63 Neighbouring site 45-55 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
30/08/2018	14:07 (Day)	67	52	47	Dir: NE Wind Speed: 0.5m/s Rain: Nil	Traffic 52-66 Train 52-55 Birds 46-63 Aircraft 47-56 Local residential noise 46-57 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	18:33 (Evening)	67	52	45	Dir: E Wind Speed: 0.5m/s Rain: Nil	Traffic 46-66 Pedestrians 46-62 Birds 52-54 Trains 48-66 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
30/08/2018	22:28 (Night)	82	68	55	Dir: N Wind Speed: 0.1m/s Rain: Nil	Traffic 50-81 Pedestrian crossing 52-54 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured $LA_{eq,period}$ dBA[2]	Measured Background Noise Level (LA_{90}) RBL dBA[2]
L1 (N1 Station Street)	Day	58	49
	Evening	53	43
	Night	52	37
L2 (N2 - Crawford Street)	Day	61	50
	Evening	59	50
	Night	58	39
L3 (N3 Nurraingy Reserve)	Day	52	44
	Evening	49	44
	Night	51	44
L4 (N4 Blacktown Olympic Park)	Day	61	45
	Evening	62	45
	Night	62	45

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017)

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Complaint
	dB, $L_{Aeq(15min)}$	dB, $L_{Aeq(15min)}$	
N1	<35	44	✓
N2	<35	40	✓
N3	38	50 (When in use)	✓
N4	<35	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Complaint
	dB, $L_{Aeq(15min)}$	dB, $L_{Aeq(15min)}$	
N1	<35	44	✓
N2	<35	39	✓
N3	<35	50 (When in use)	✓
N4	<35	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Complaint
	dB, $L_{Aeq(15min)}$	dB, $L_{Aeq(15min)}$	
N1	<35	39	✓
N2	<35	39	✓
N3	<35	50 (When in use)	✓
N4	<35	55 (When in use)	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three measurements conducted on Thursday 30 August 2018, satisfying the relevant noise limits. Extraneous noise sources included traffic, birds, local residential noise, train pass-by and neighbouring industrial sites

6.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during all three measurements conducted on Thursday 30 August 2018, satisfying the relevant noise limits for this location. Extraneous sources measured include traffic, birds, aircraft noise, dog bark, train pass-by and local residential noise.

6.3 Discussion of Results - Location N3

Attended measurements on Thursday 30 August 2018 identified that RDC noise was audible during one of the three measurements during the daytime period, although satisfied the relevant noise limits of 50dB $LA_{eq(daytime)}$. RDC sources audible on occasion included reversing alarms and general mobile plant engine noise. The RDC was inaudible during the evening and night measurements conducted on Thursday 30 August 2018 thus satisfying the applicable noise criteria. Extraneous sources audible during the attended surveys included traffic, birds, local residential noise, wind in trees and aircraft noise which generally masked RDC noise.

6.4 Discussion of Results - Location N4

RDC noise emissions were inaudible during all three measurements conducted on Thursday 30 August 2018, satisfying the relevant noise limits. Extraneous noise sources included traffic, train pass-by, birds, aircraft noise, local residential noise and pedestrians, all audible throughout both attended measurements.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance with the relevant noise criteria during Quarter 3, period ending September 2018.

Attended noise monitoring was completed on Thursday 30 August 2018 and unattended noise monitoring was undertaken between Wednesday 22 August 2018 and Thursday 30 August 2018 at four representative monitoring locations. The assessment has identified that noise emissions generated by RDC were audible on one occasion at N3, although remained below relevant noise criteria at all assessed residential receivers.

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Appendix A - Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

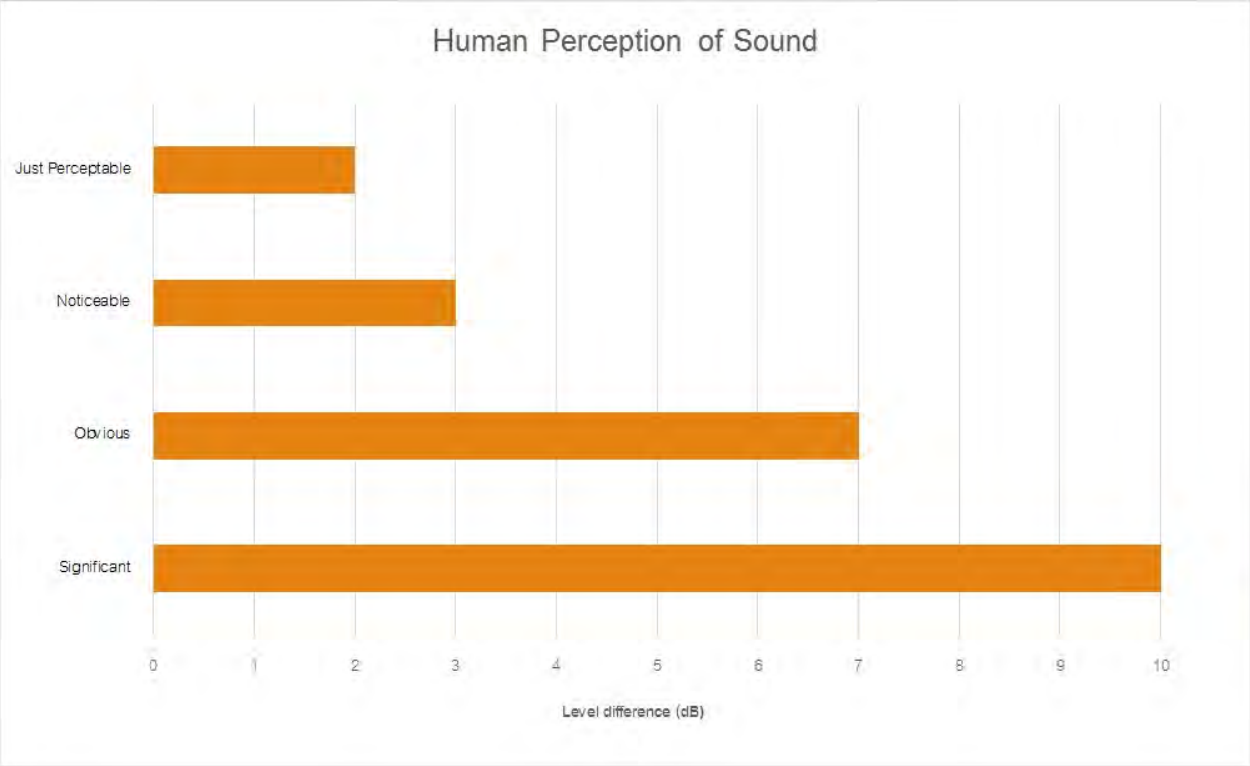
Table 1A Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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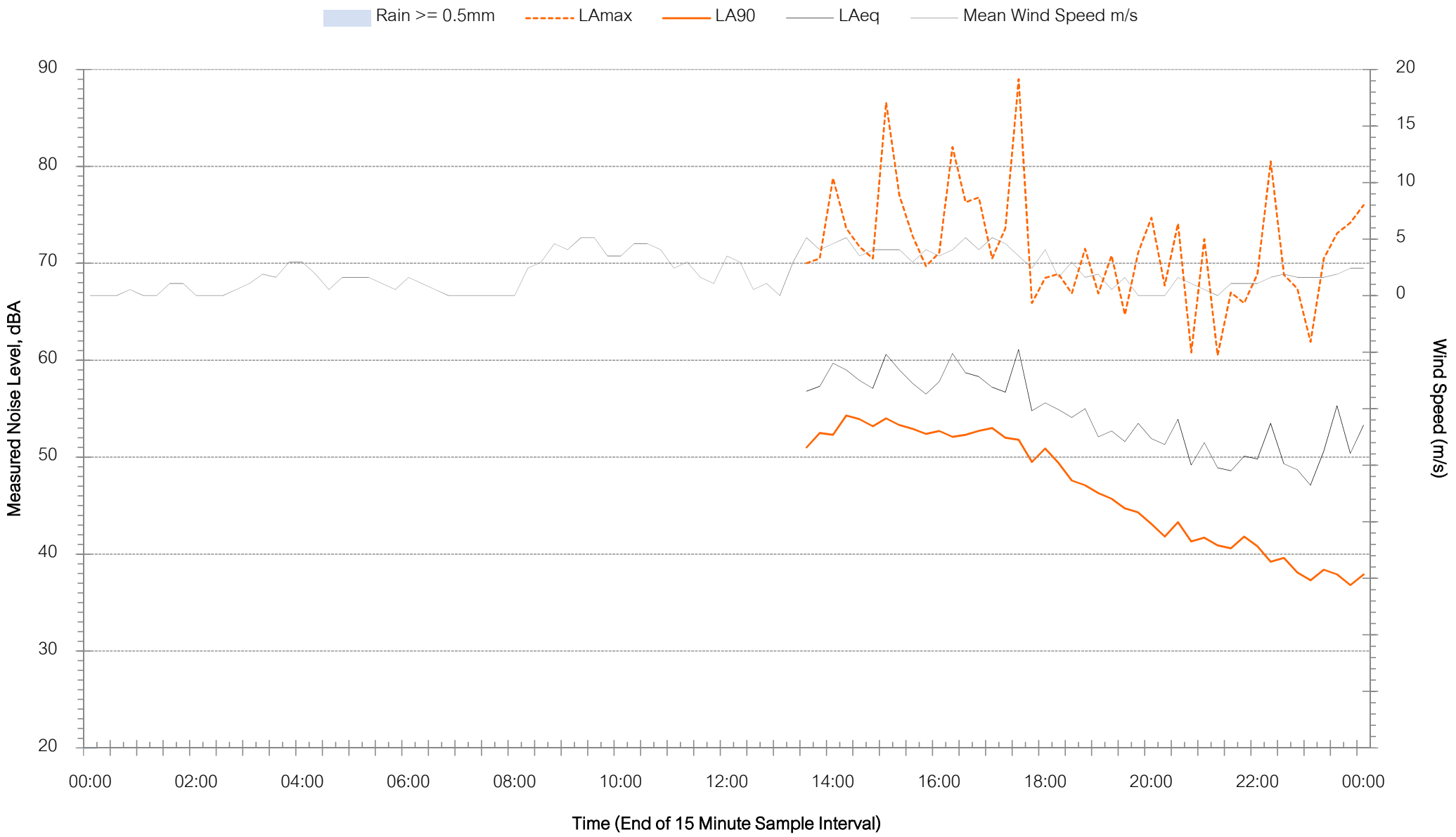
Appendix B – Unattended Noise Monitoring Charts

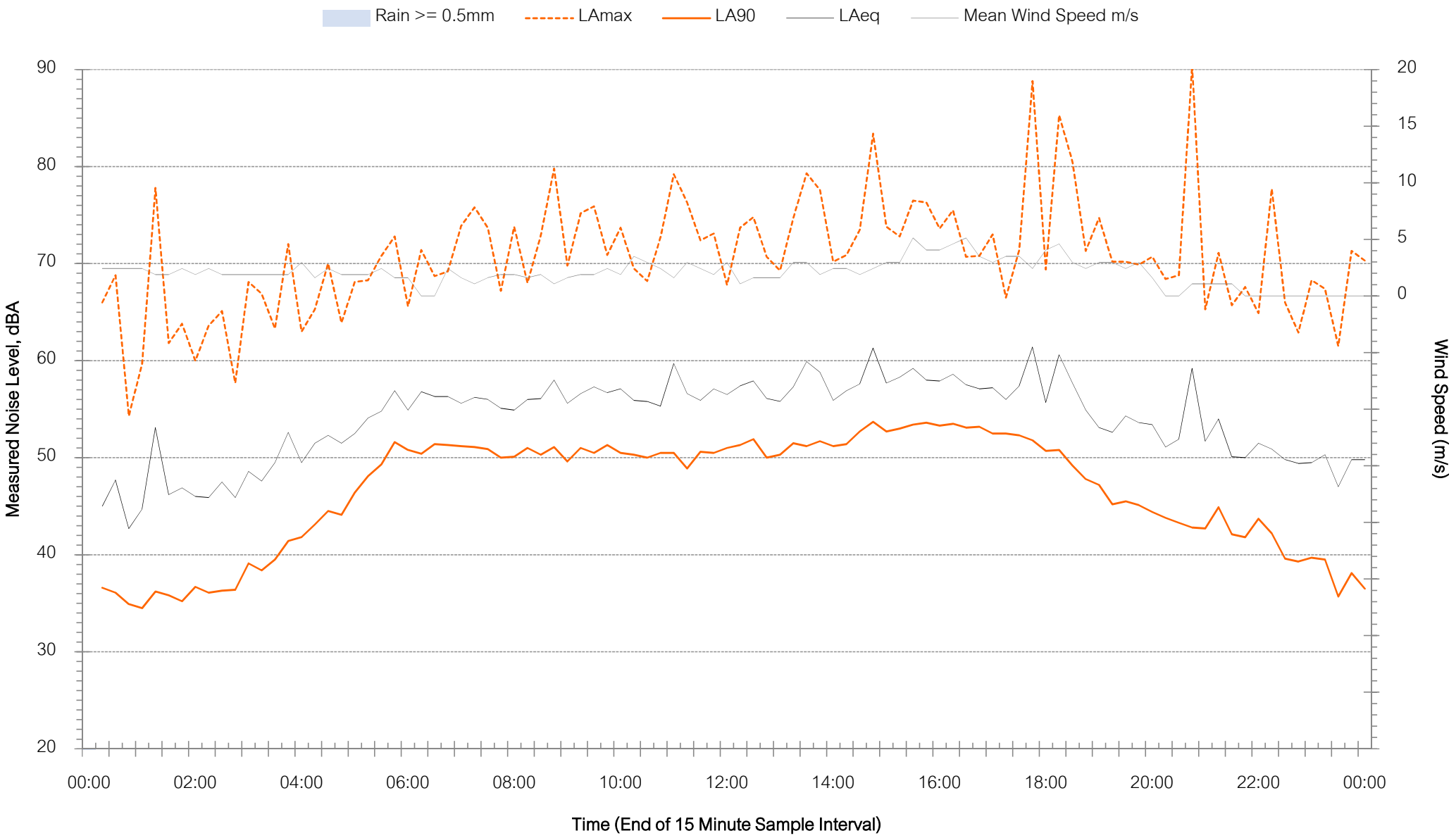
Background Noise Levels

Logger N1 - Wednesday 22 August 2018



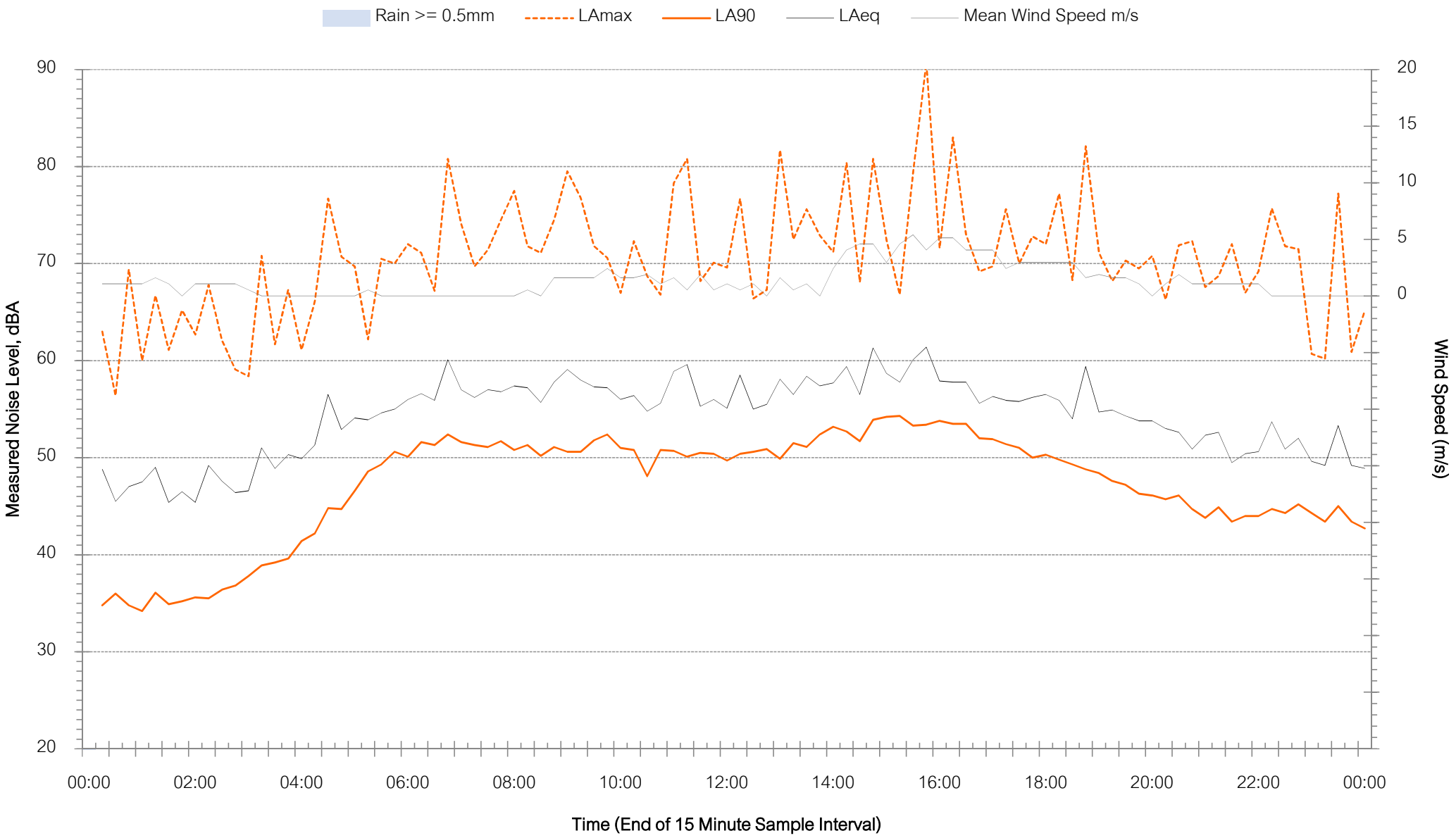
Background Noise Levels

Logger N1 - Thursday 23 August 2018



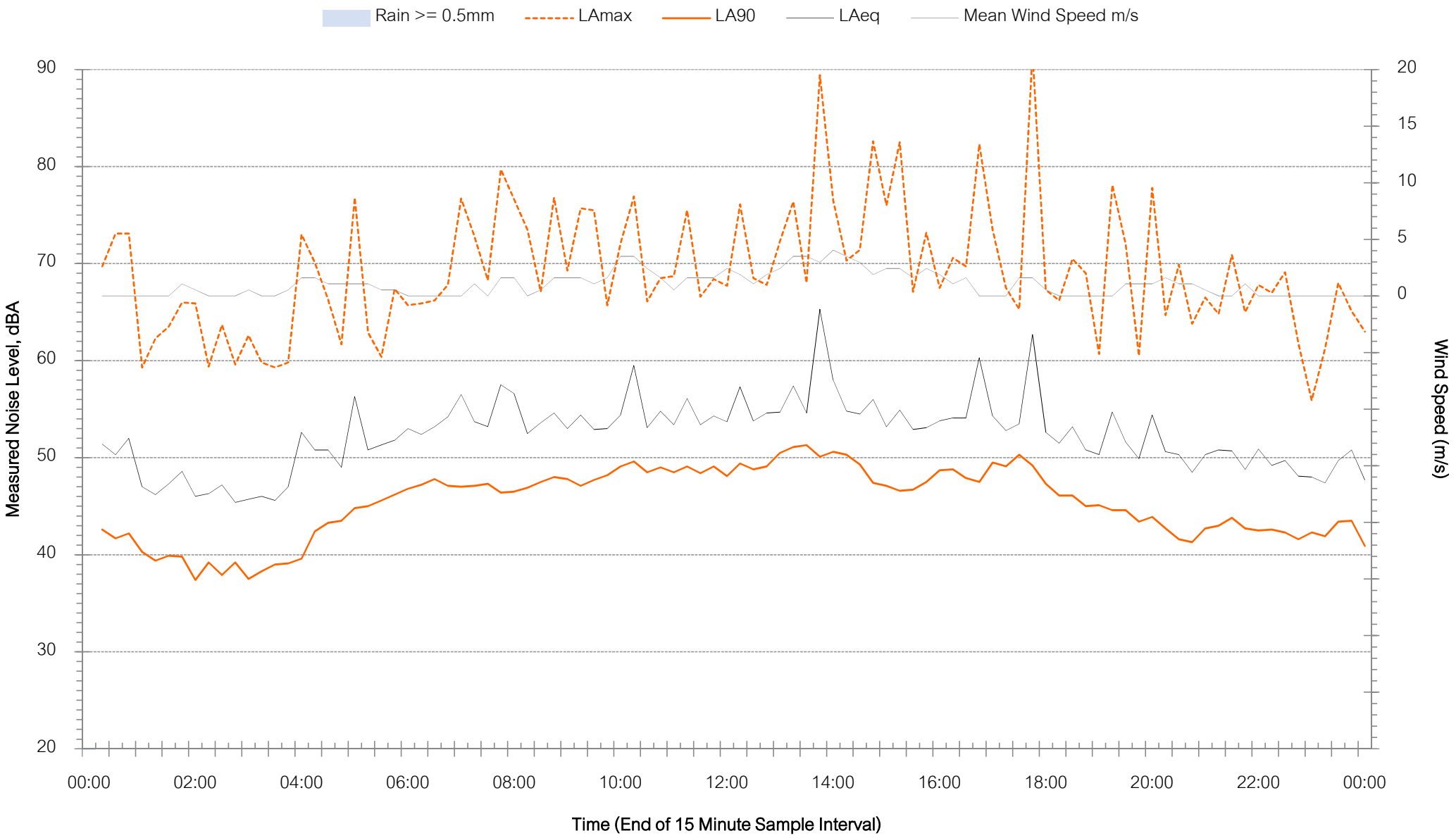
Background Noise Levels

Logger N1 - Friday 24 August 2018



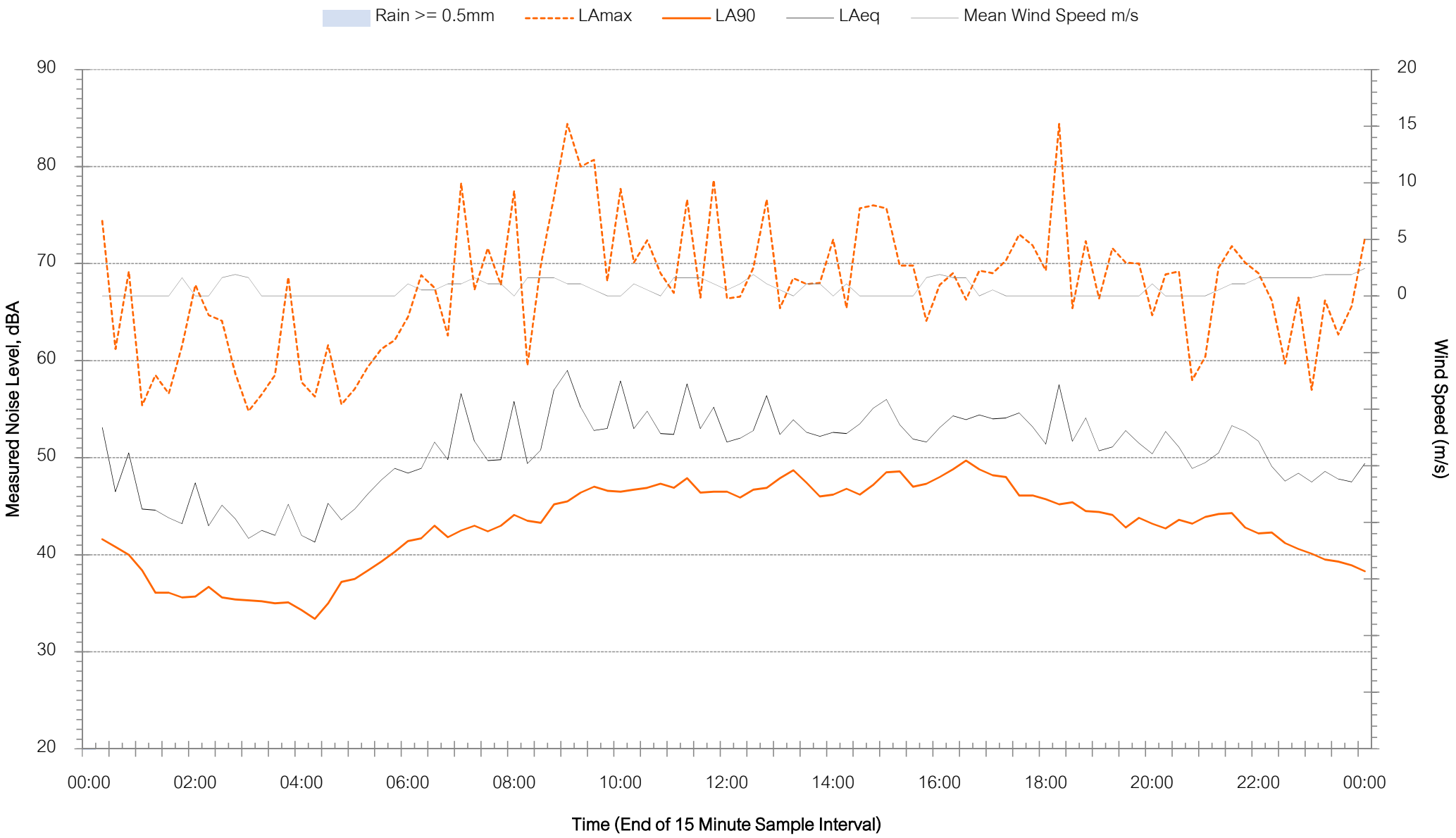
Background Noise Levels

Logger N1 - Saturday 25 August 2018



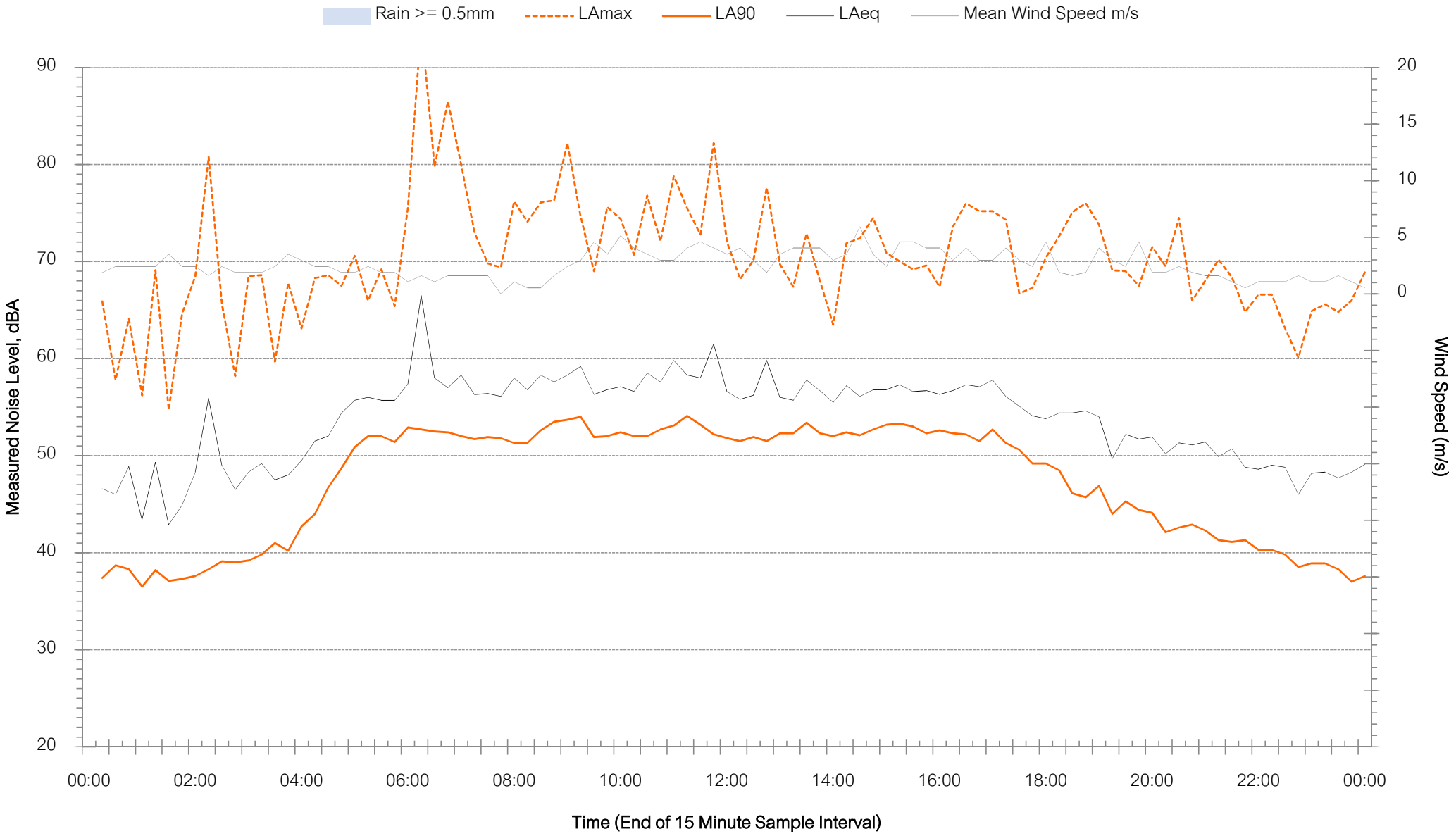
Background Noise Levels

Logger N1 - Sunday 26 August 2018



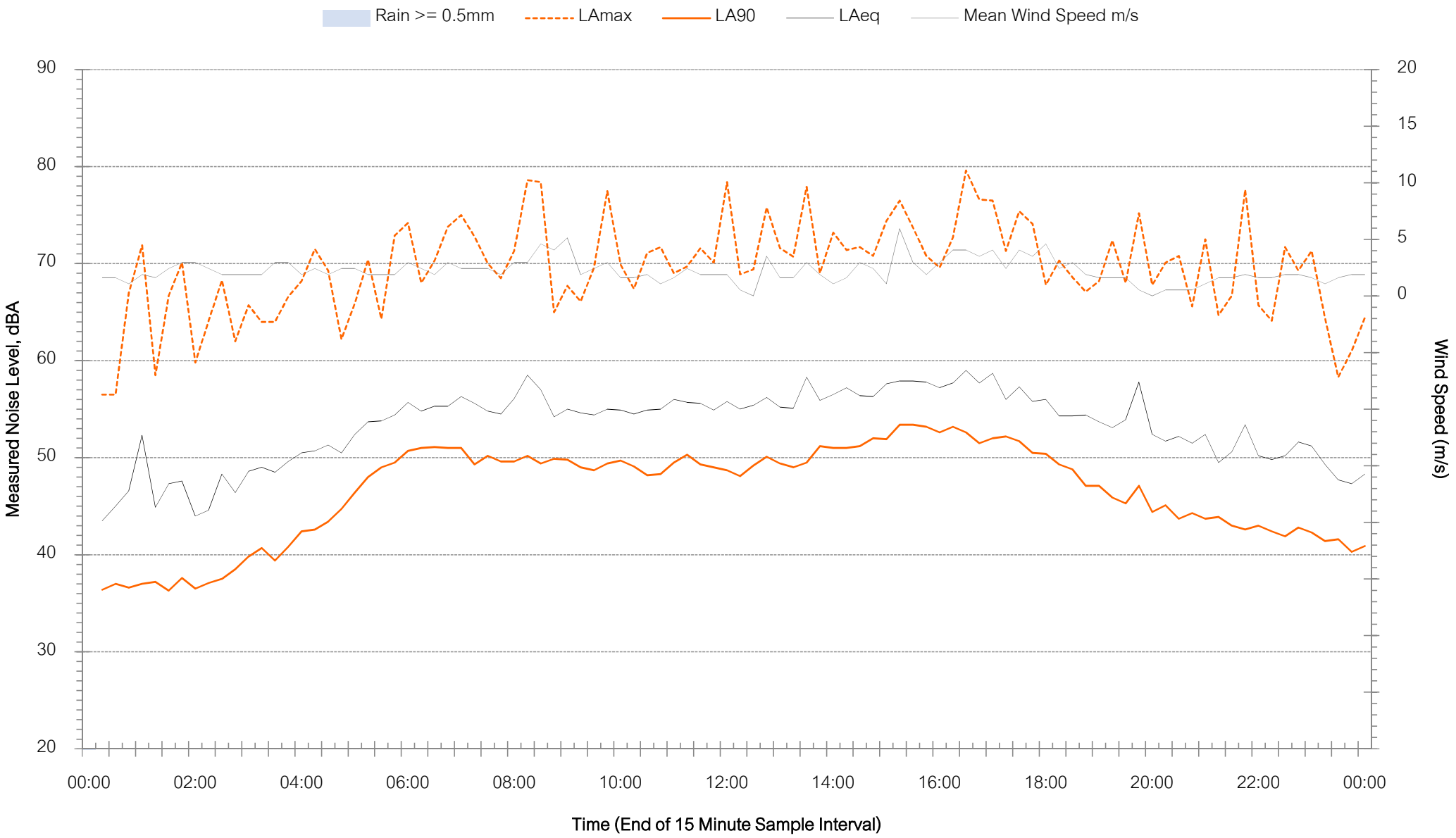
Background Noise Levels

Logger N1 - Monday 27 August 2018



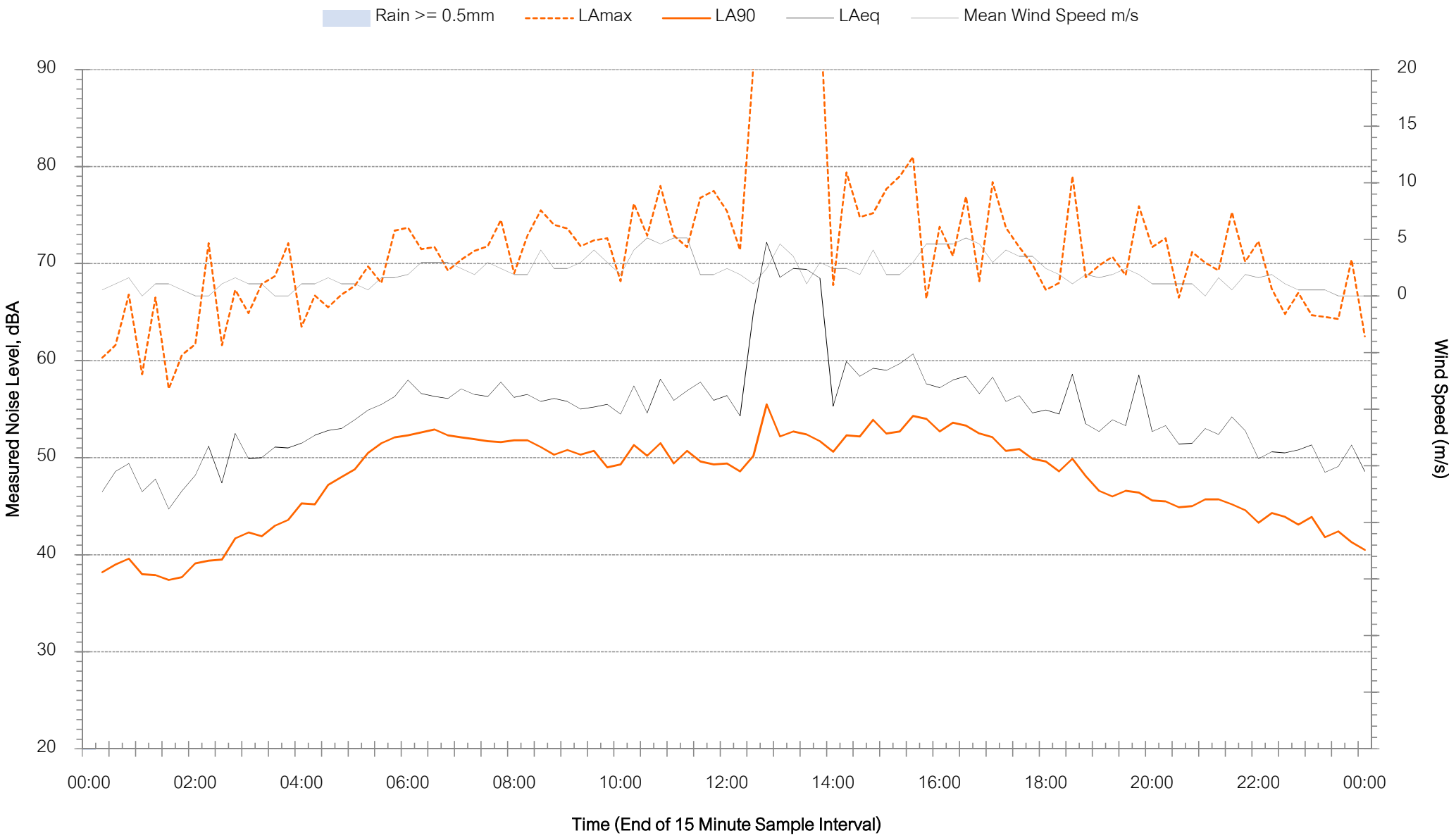
Background Noise Levels

Logger N1 - Tuesday 28 August 2018



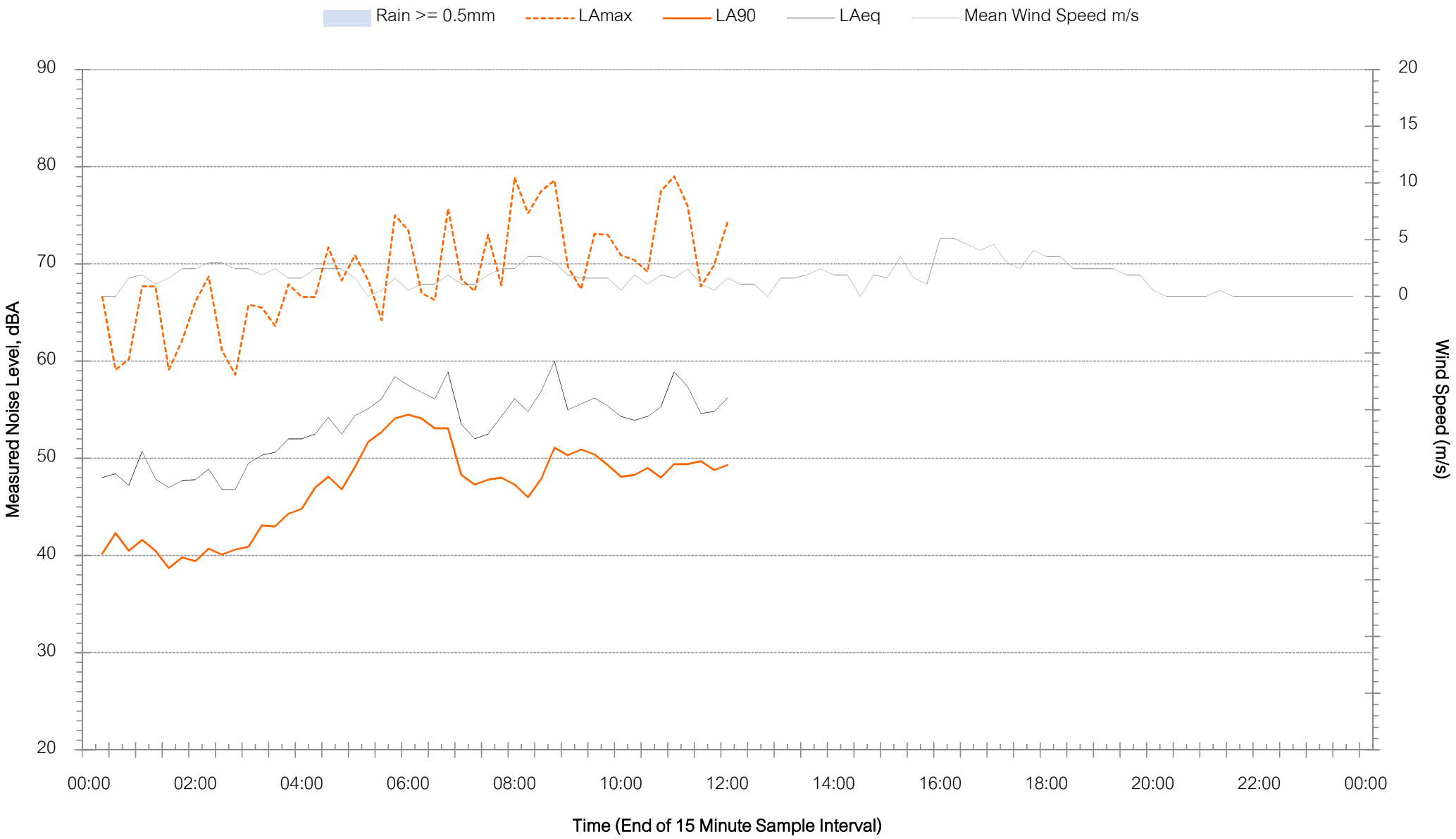
Background Noise Levels

Logger N1 - Wednesday 29 August 2018



Background Noise Levels

Logger N1 - Thursday 30 August 2018



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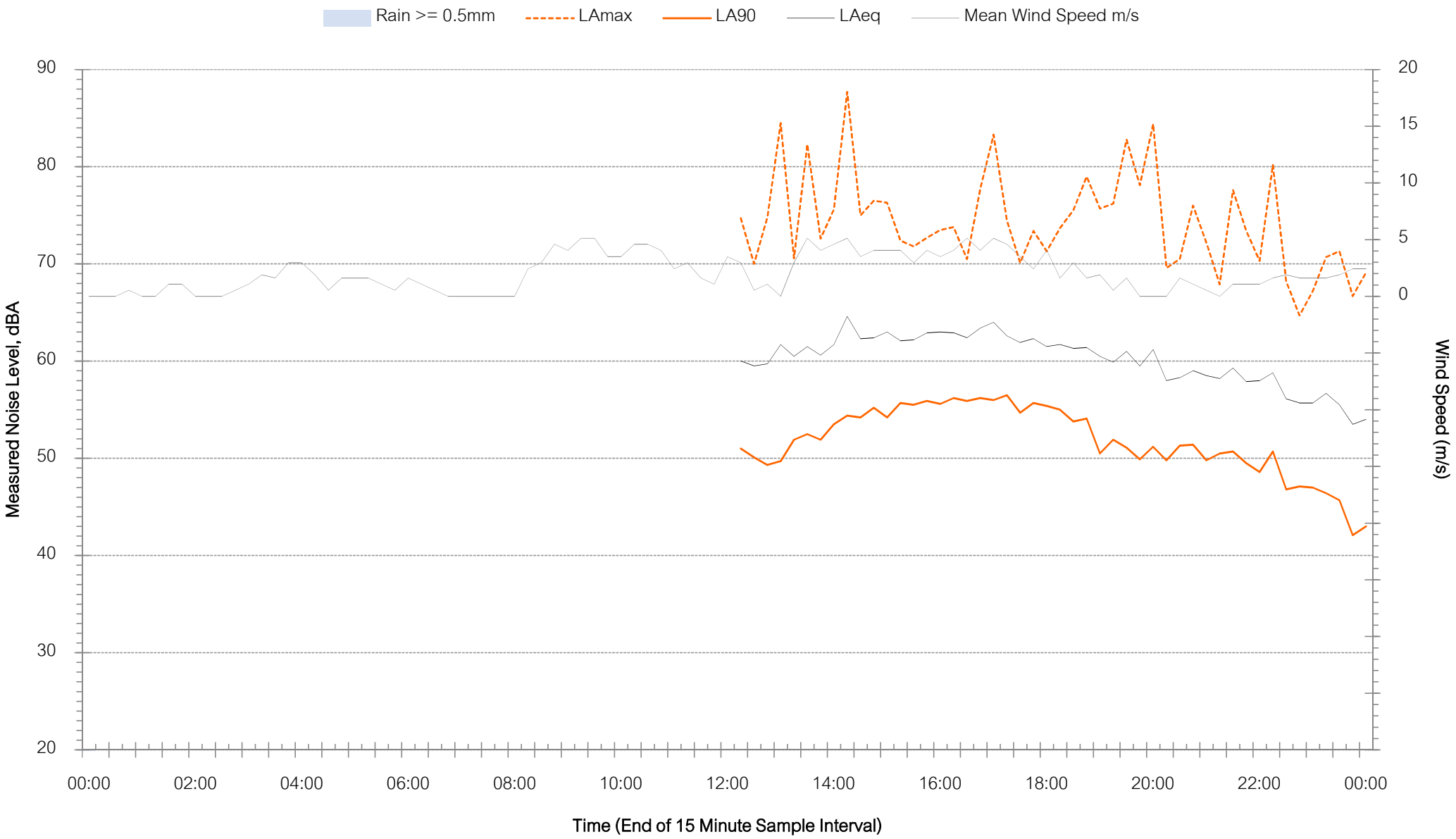

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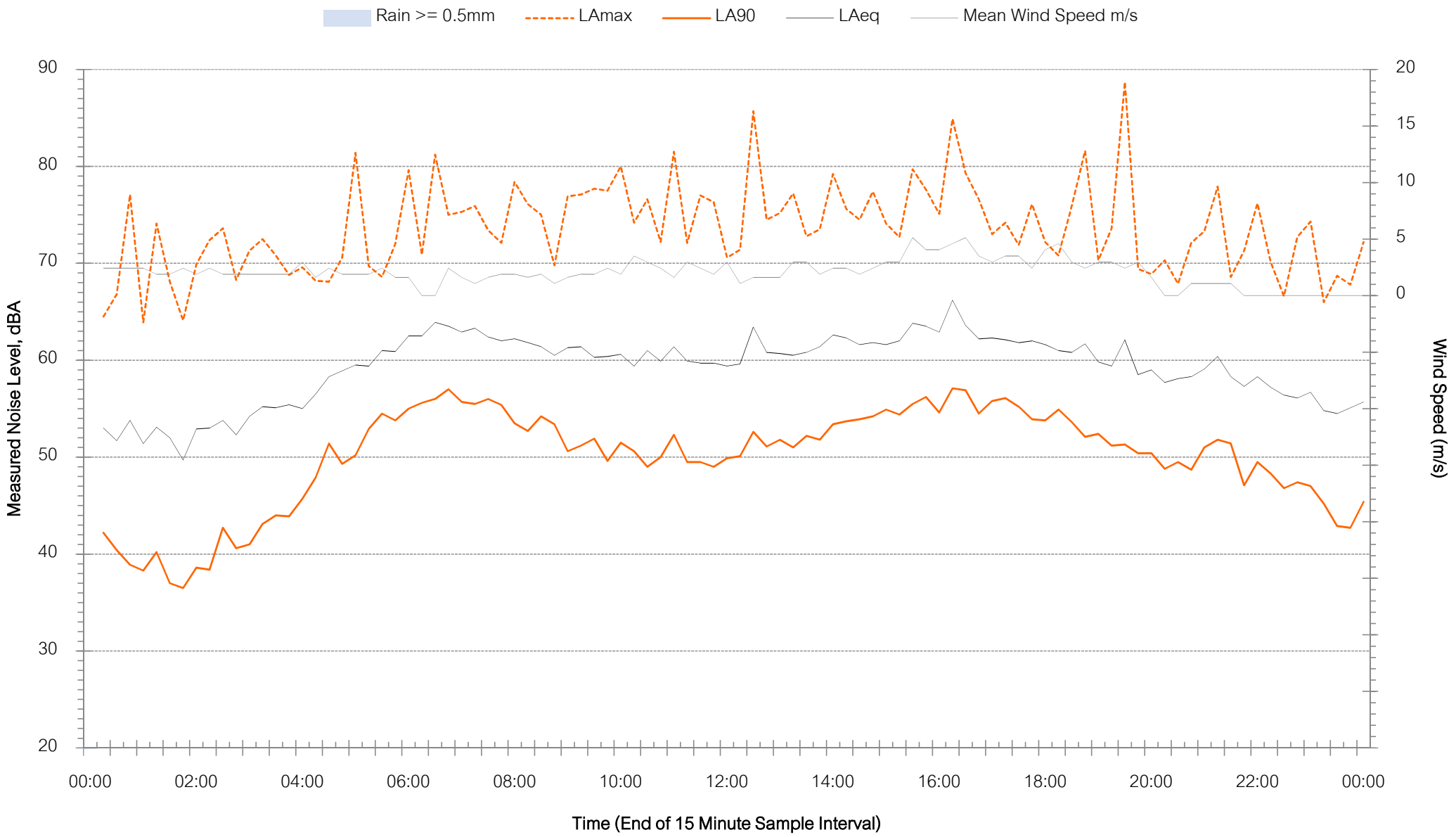
Logger N2 - Thursday 23 August 2018



Background Noise Levels

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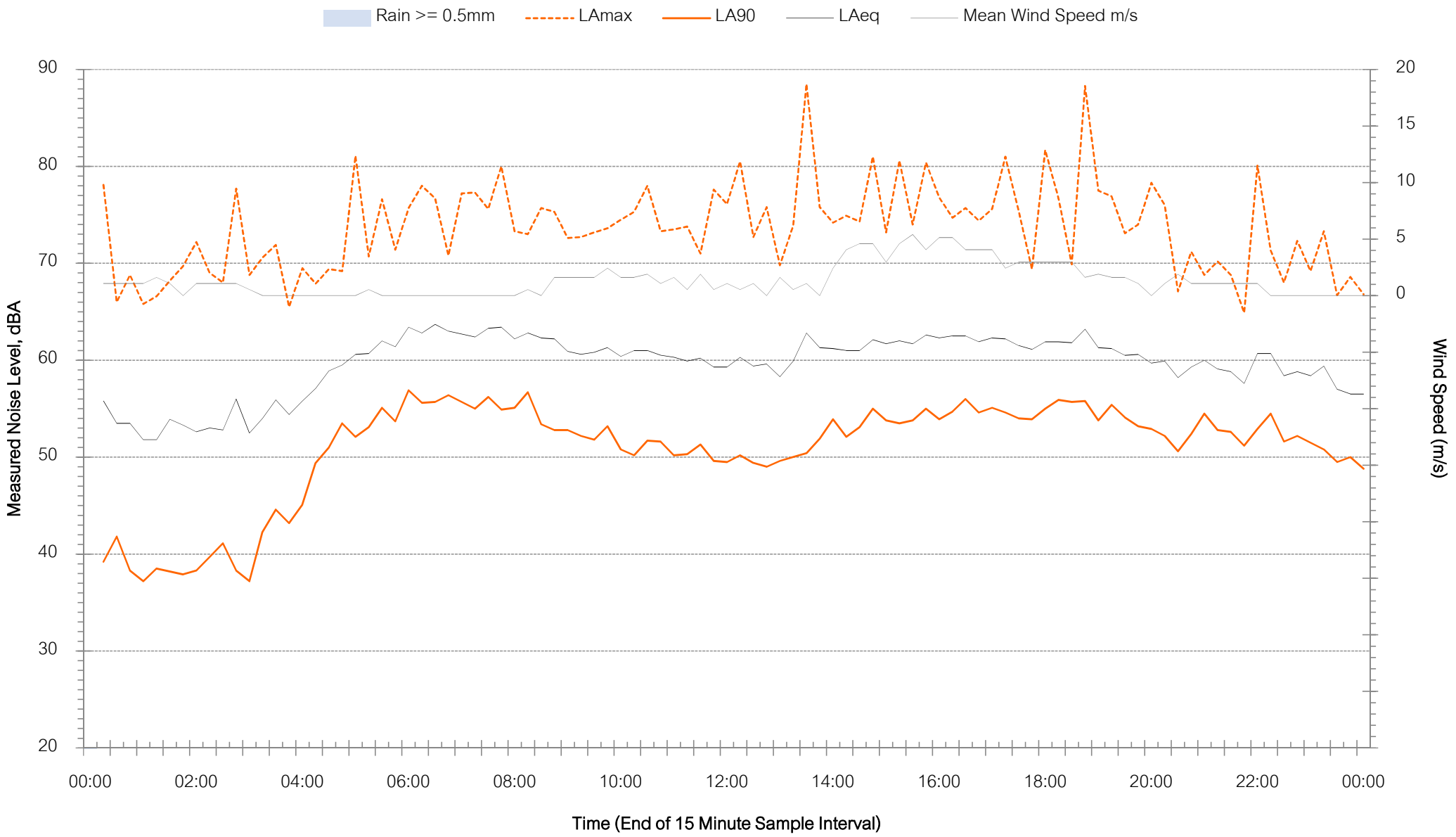
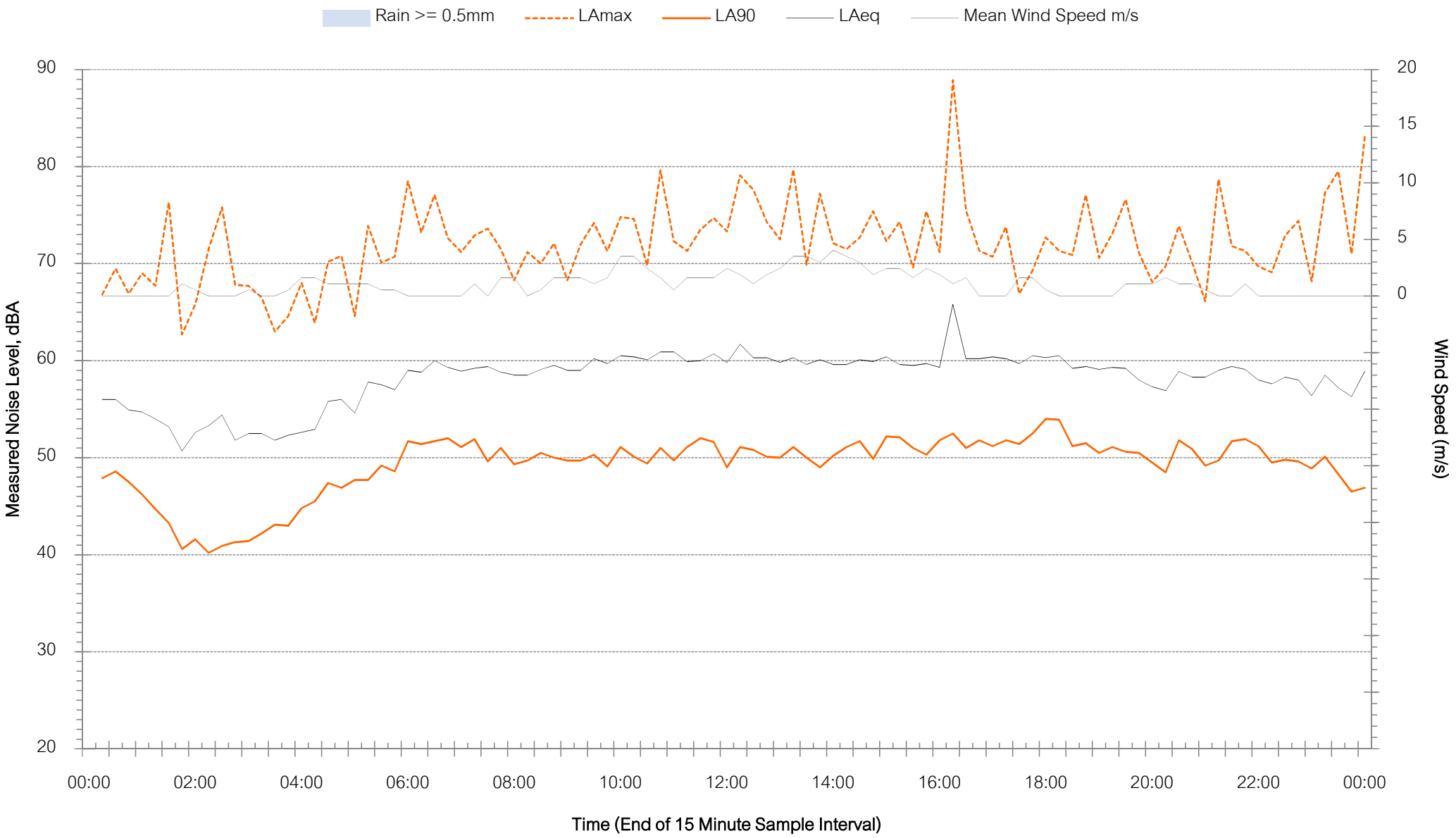


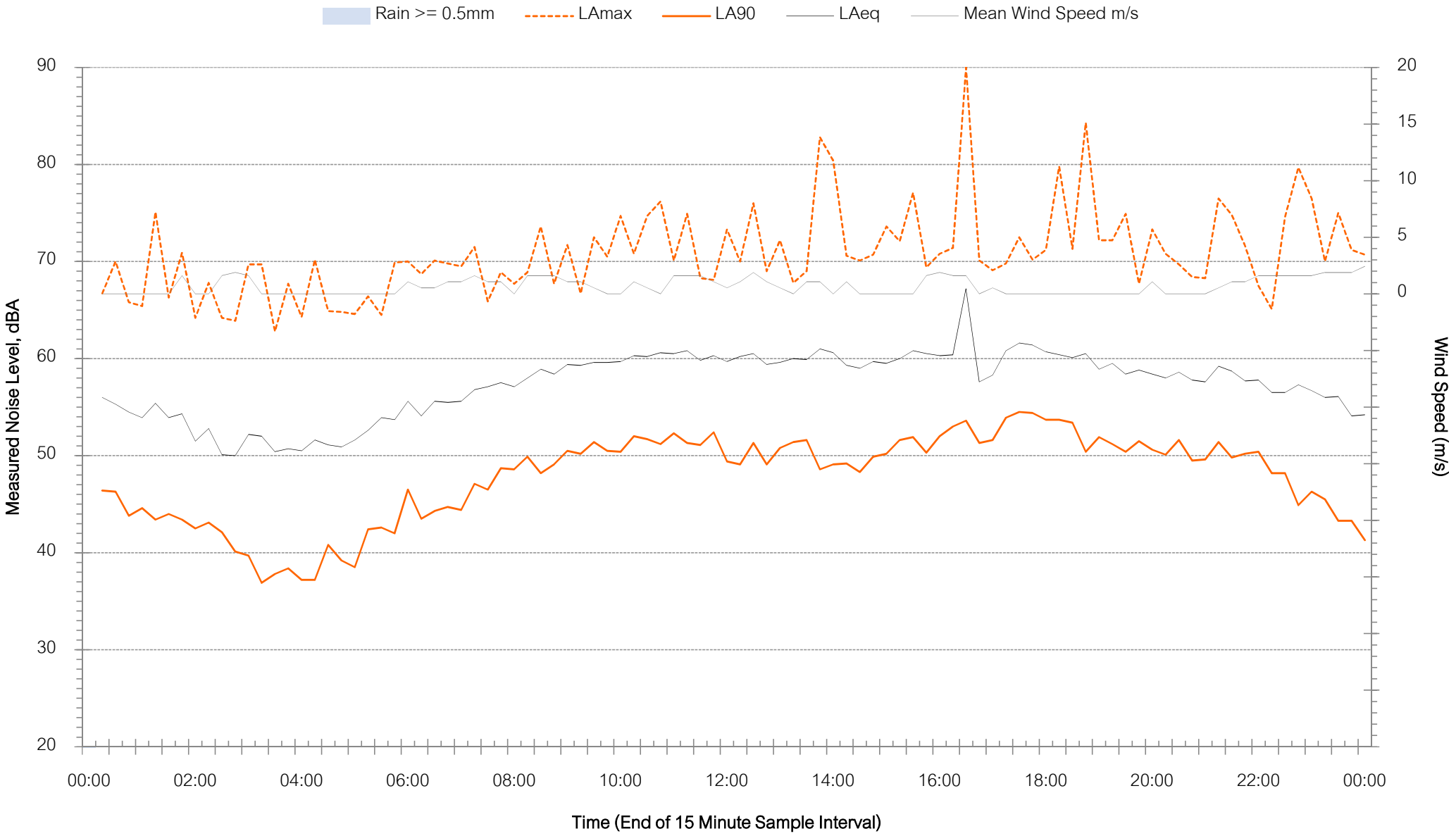
Background Noise Levels

Logger N2 - Saturday 25 August 2018



Background Noise Levels

Logger N2 - Sunday 26 August 2018



Background Noise Levels

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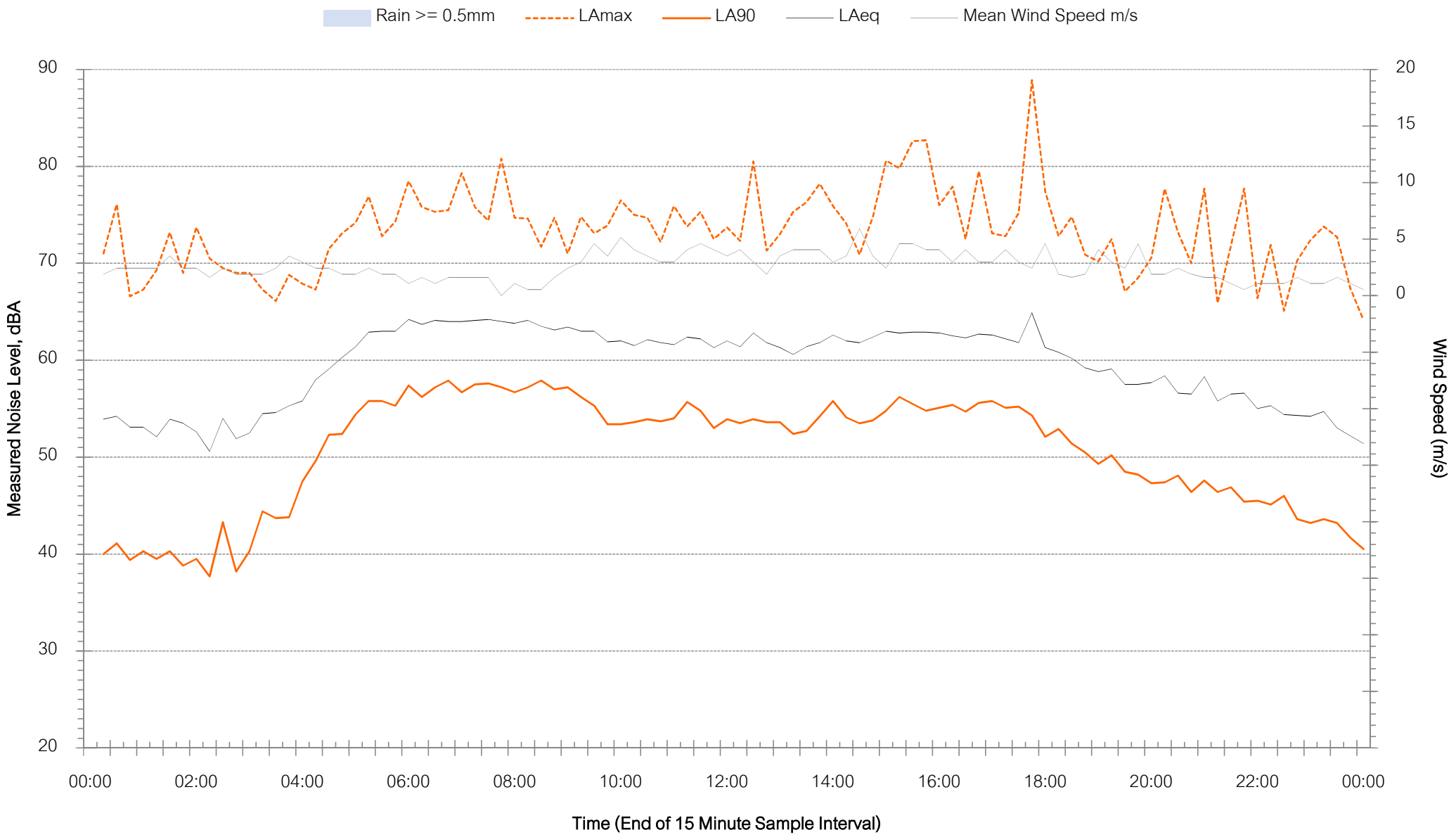
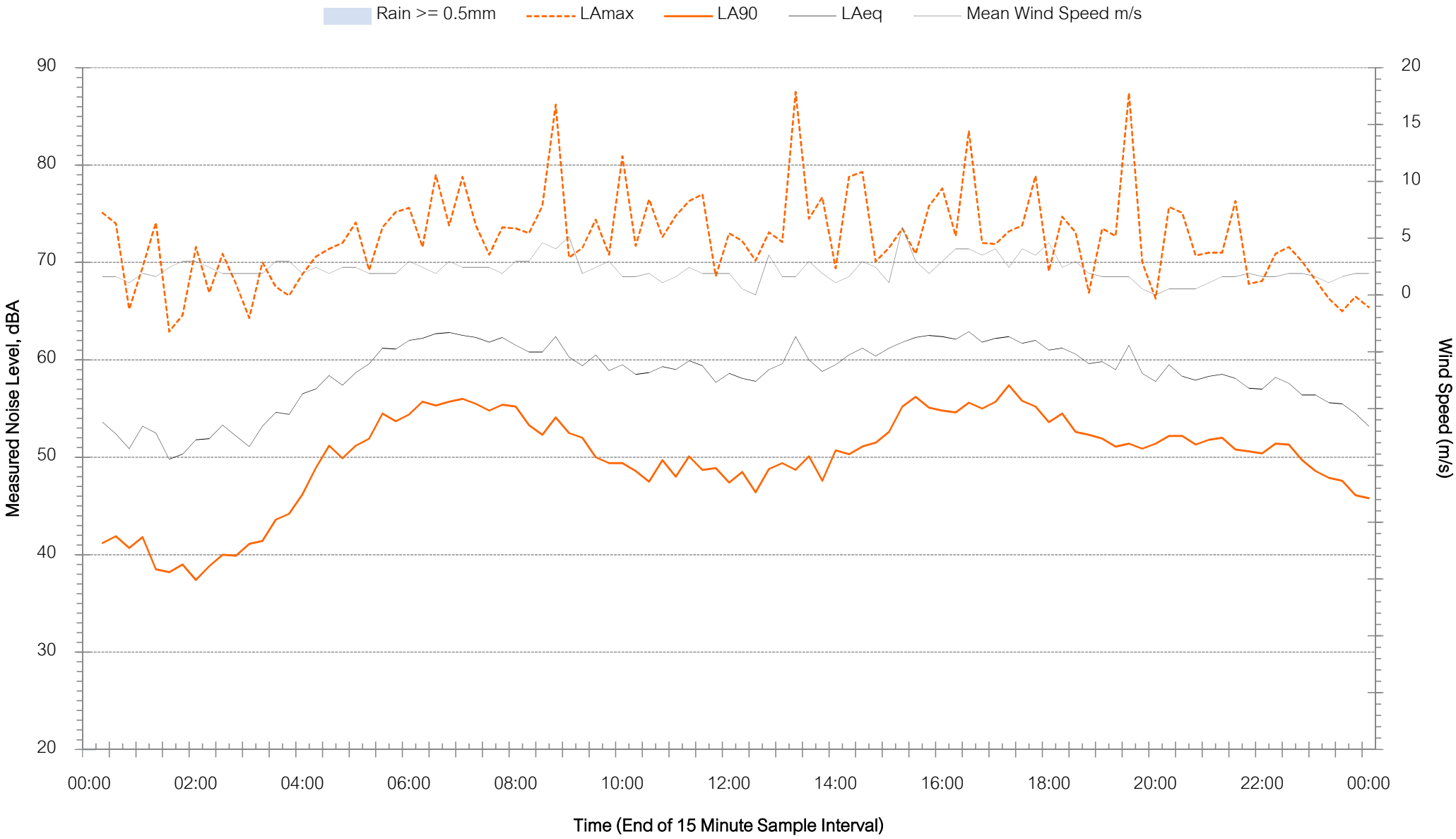


Background Noise Levels

Logger N2 - Tuesday 28 August 2018



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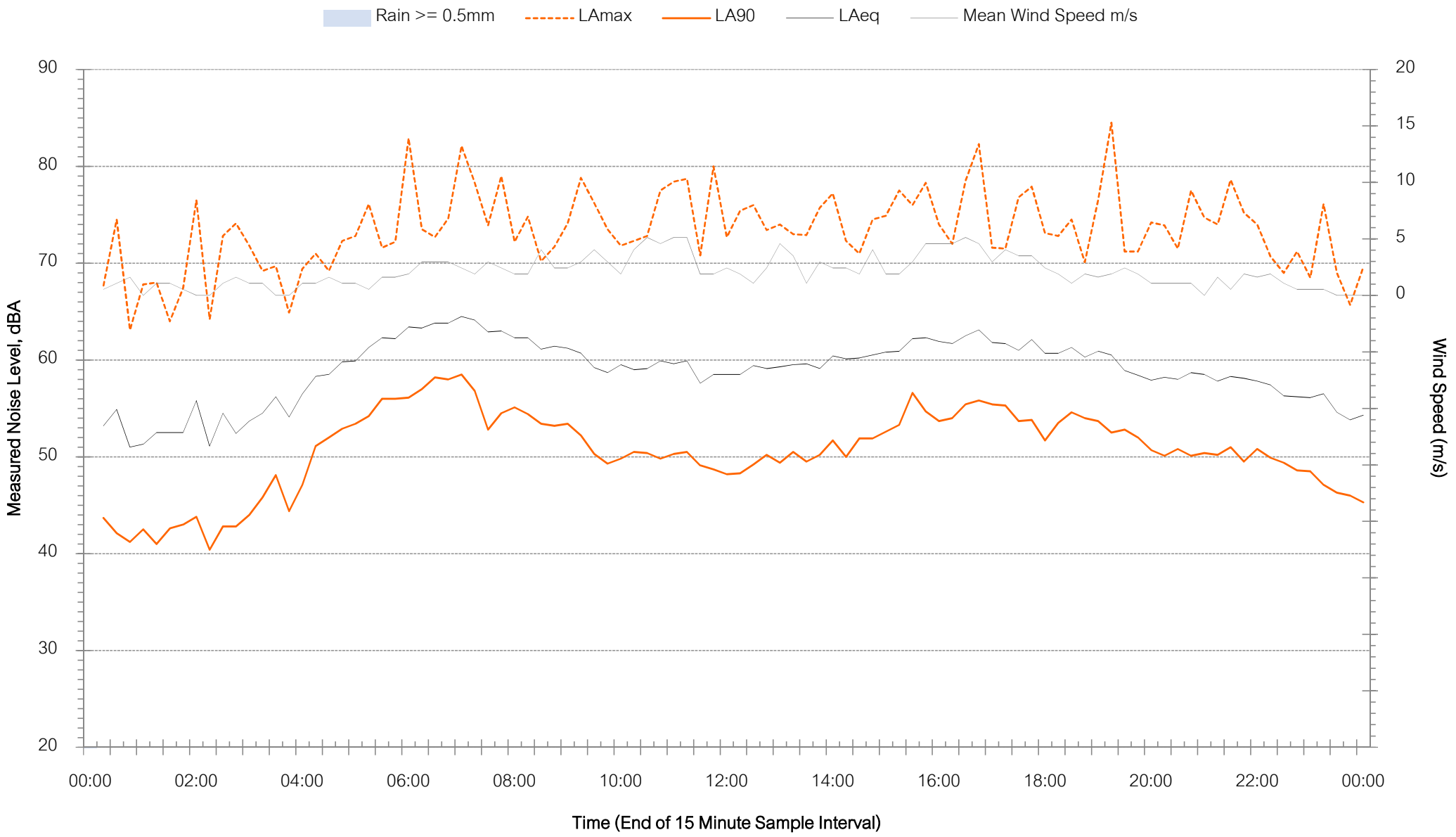

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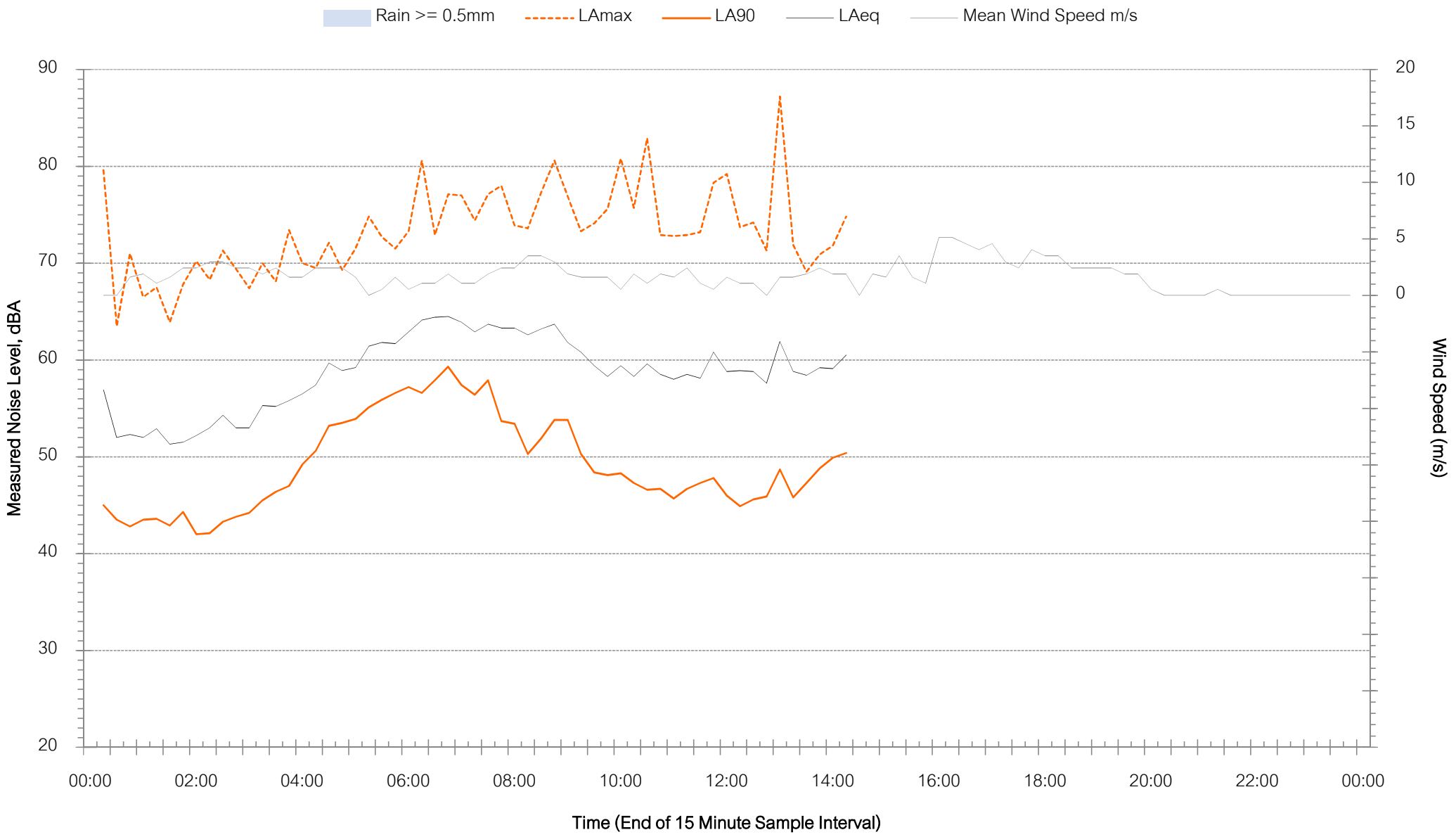

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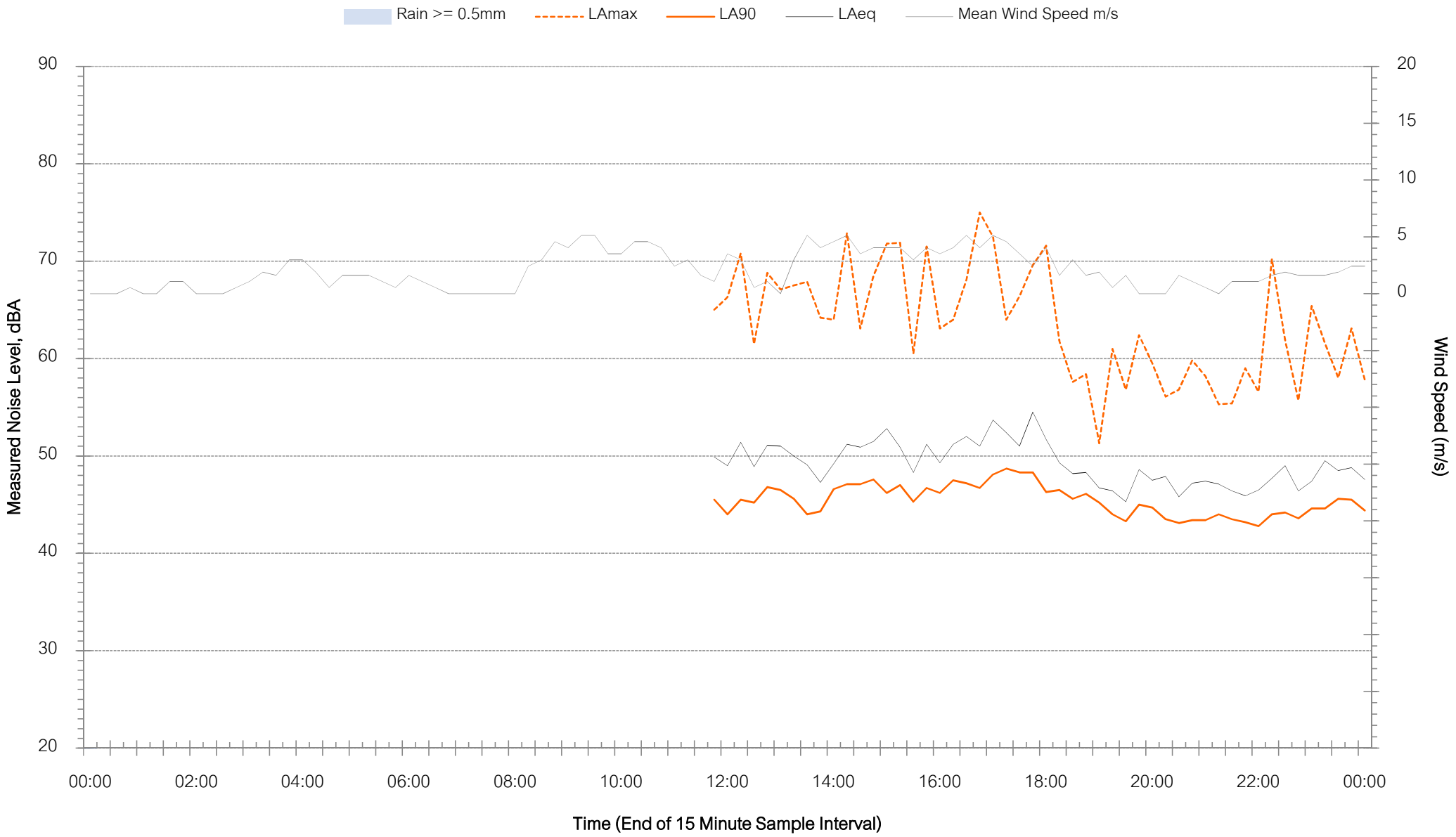

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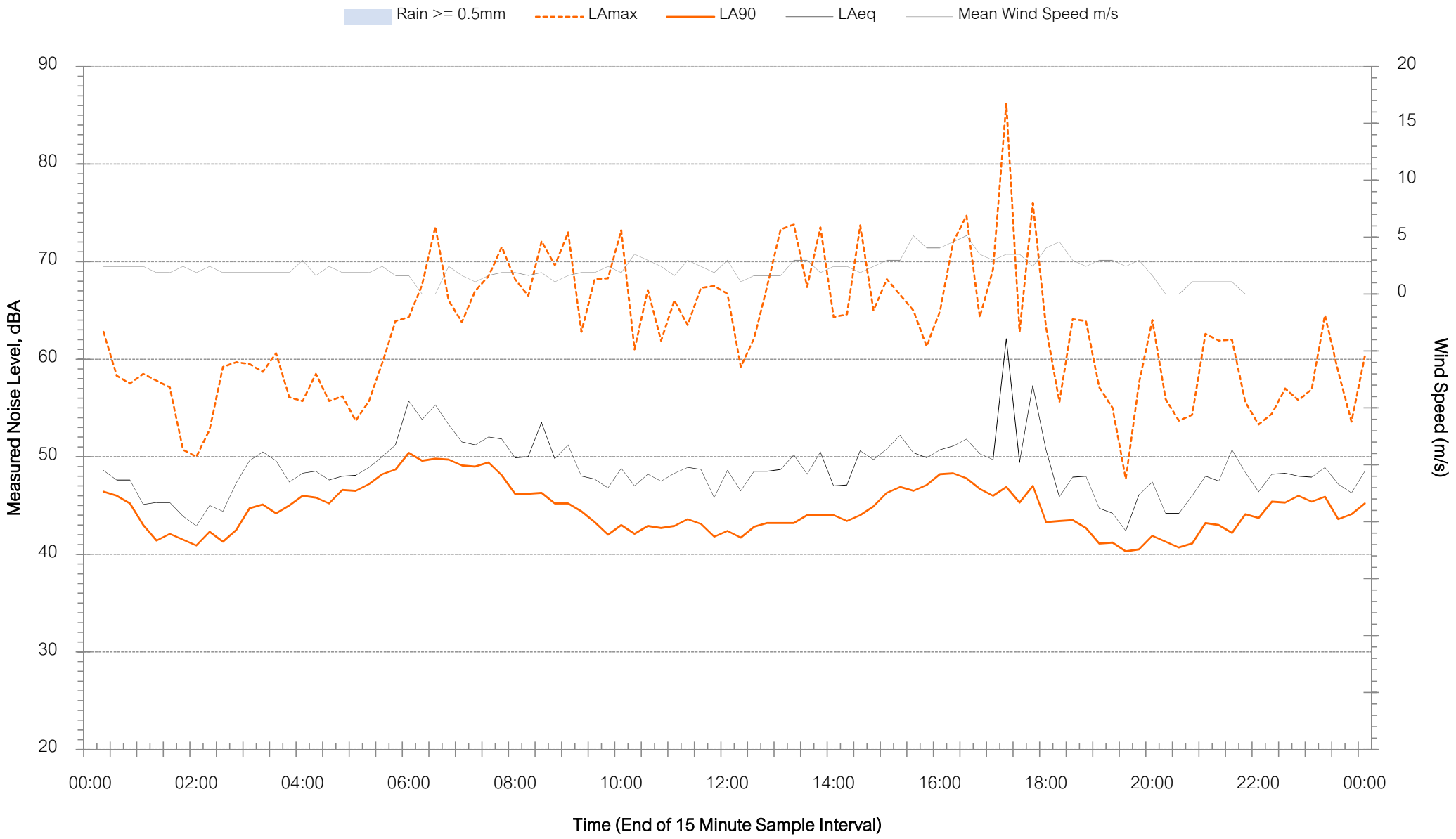

Background Noise Levels

Logger N3 - Friday 24 August 2018

Background Noise Levels

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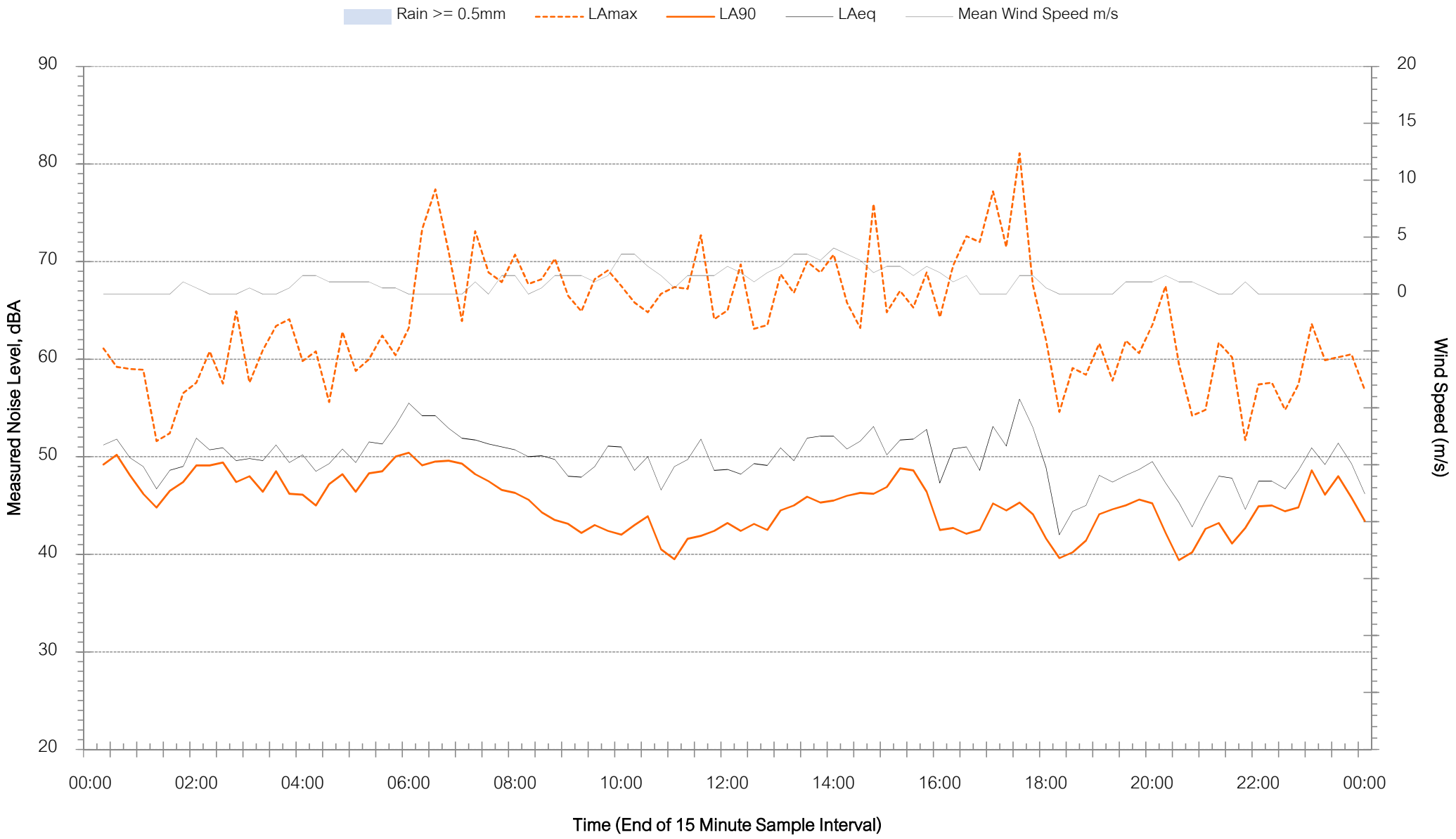

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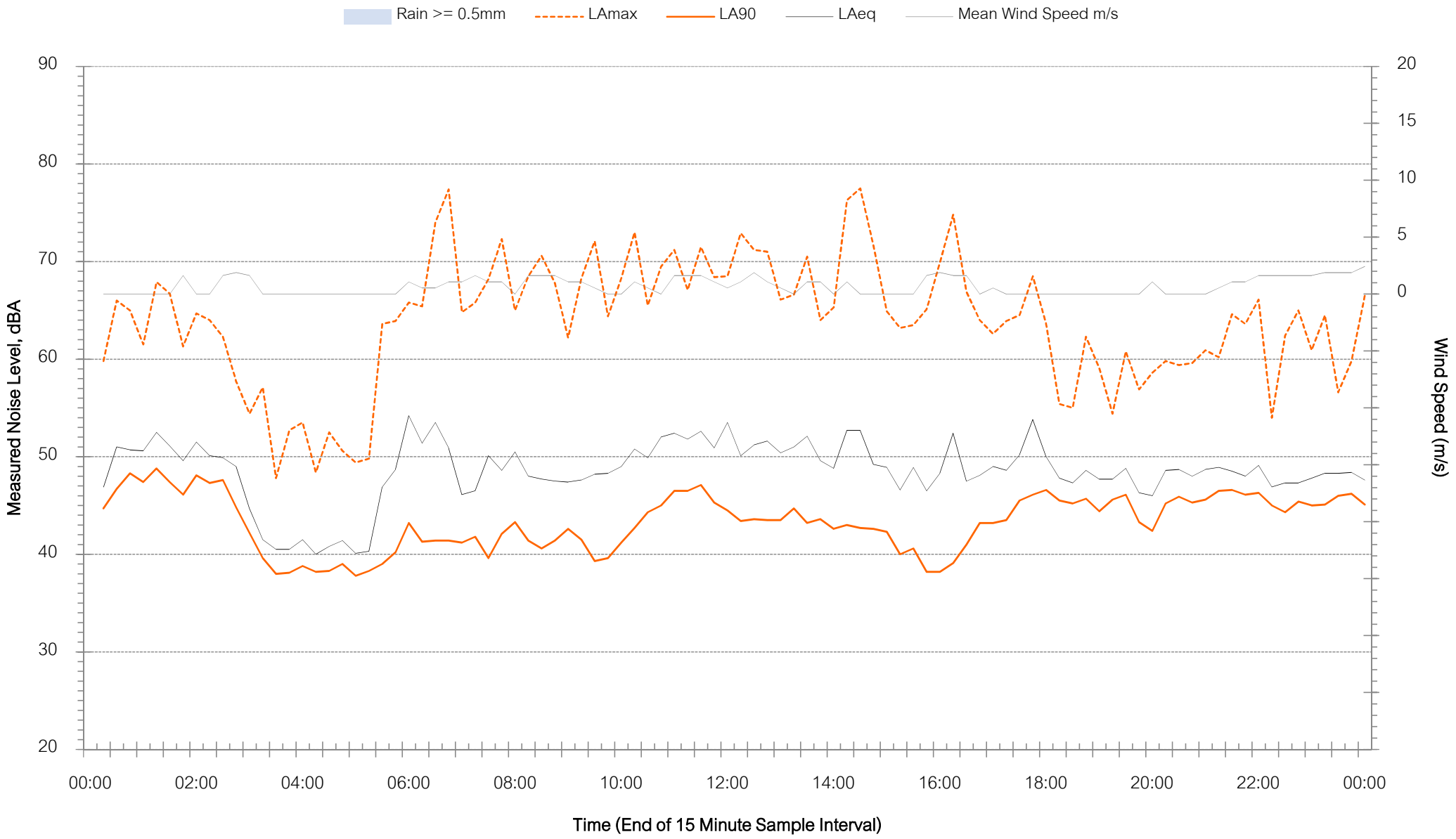

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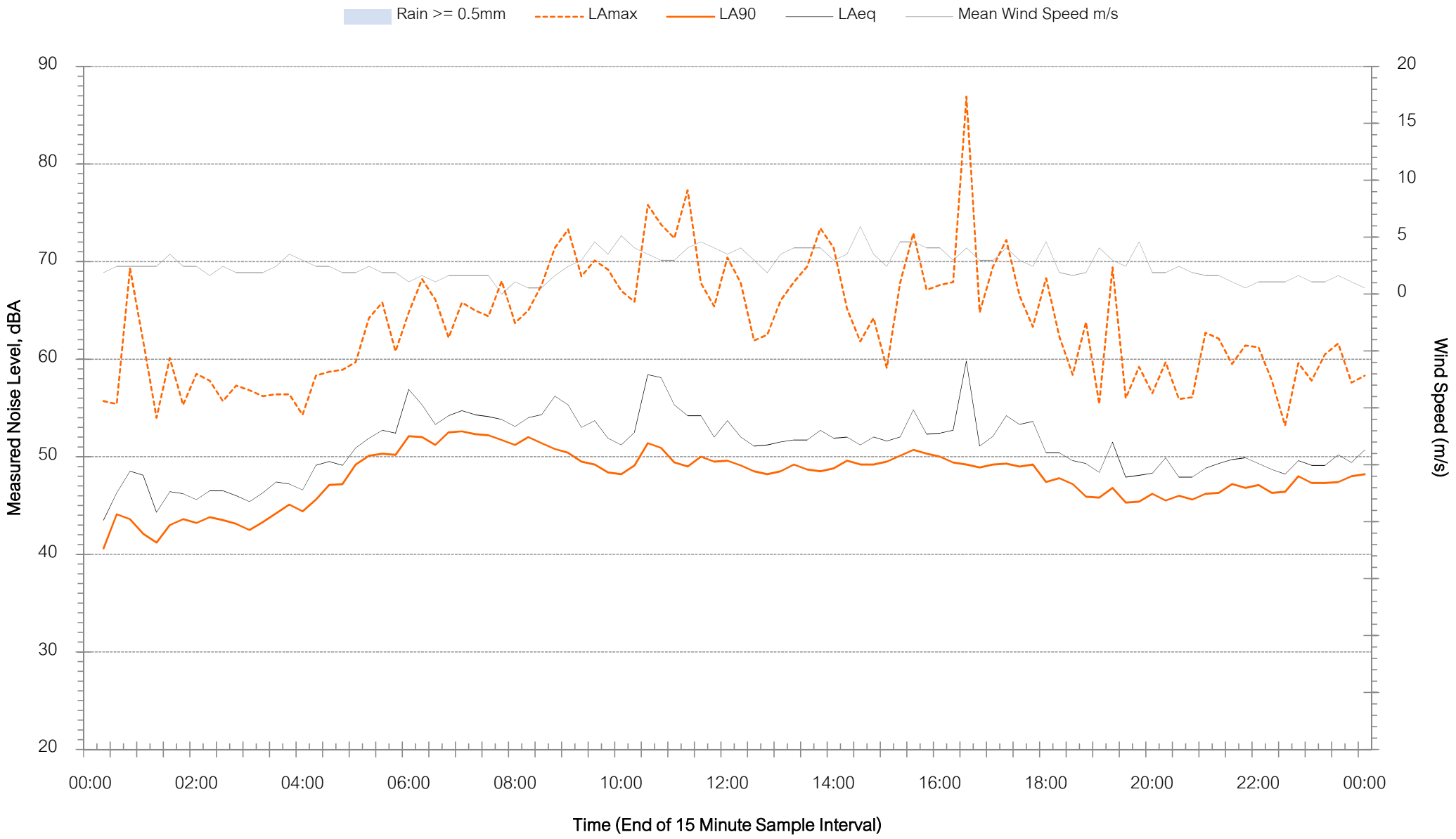

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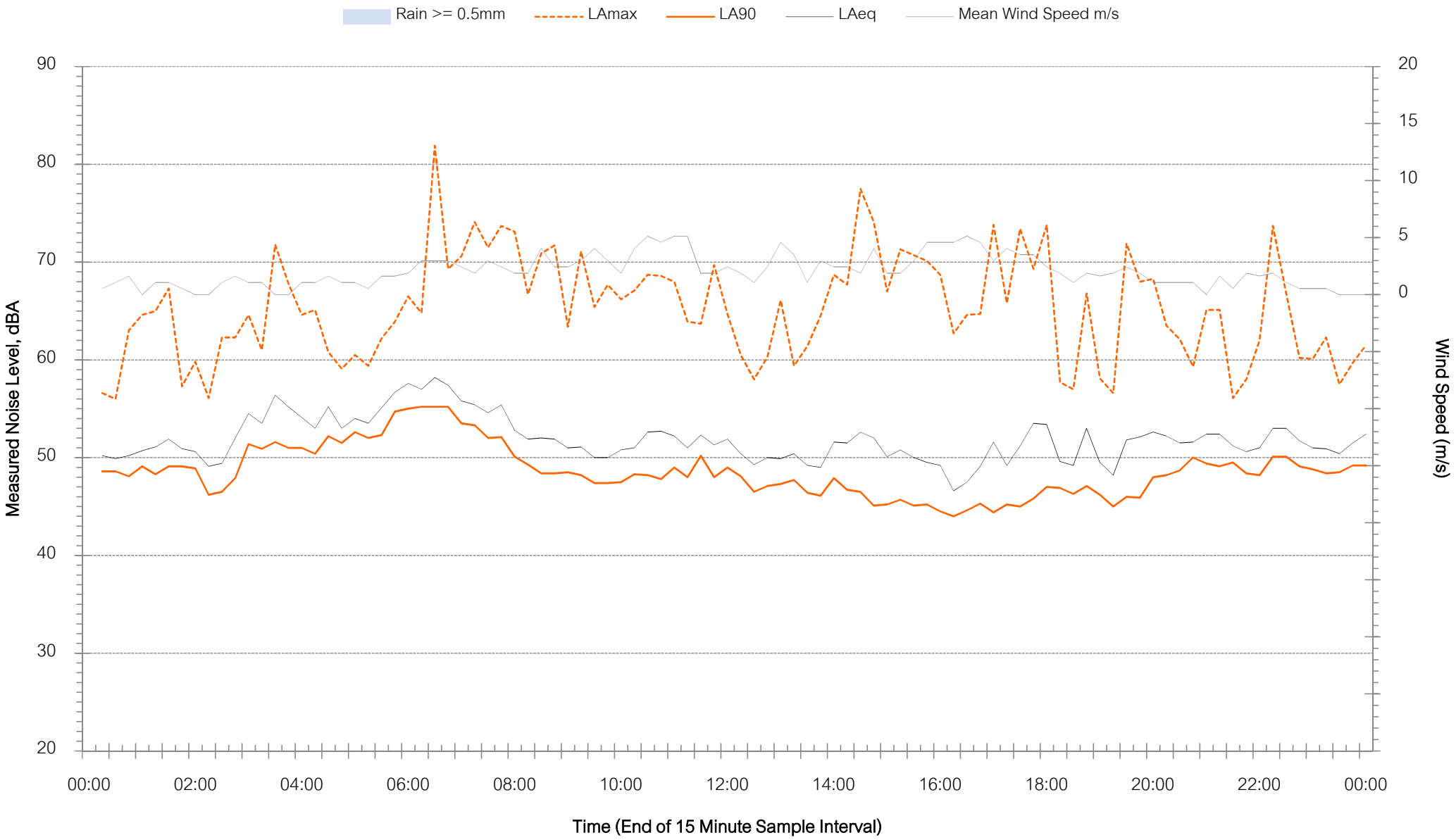

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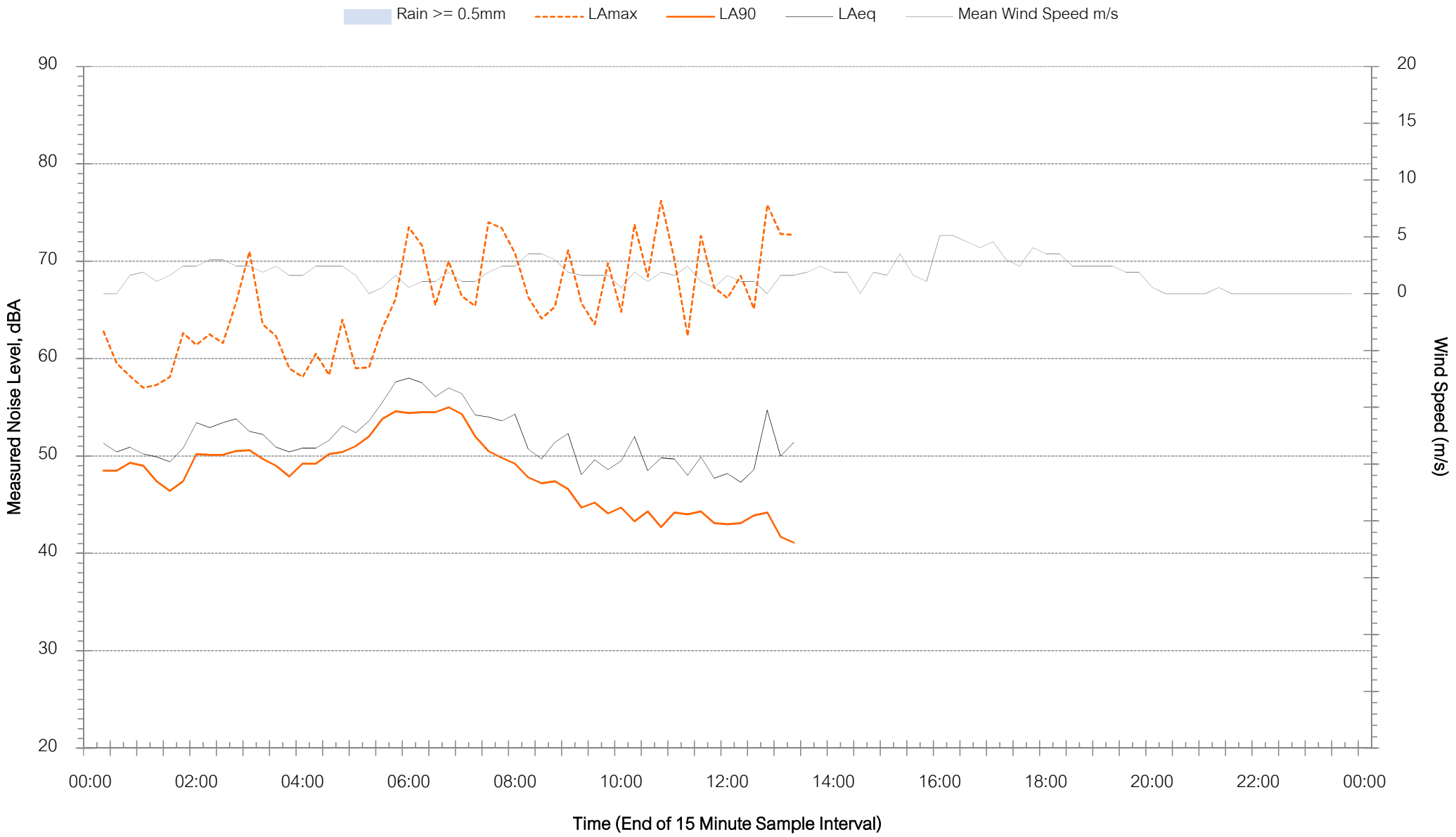

Background Noise Levels

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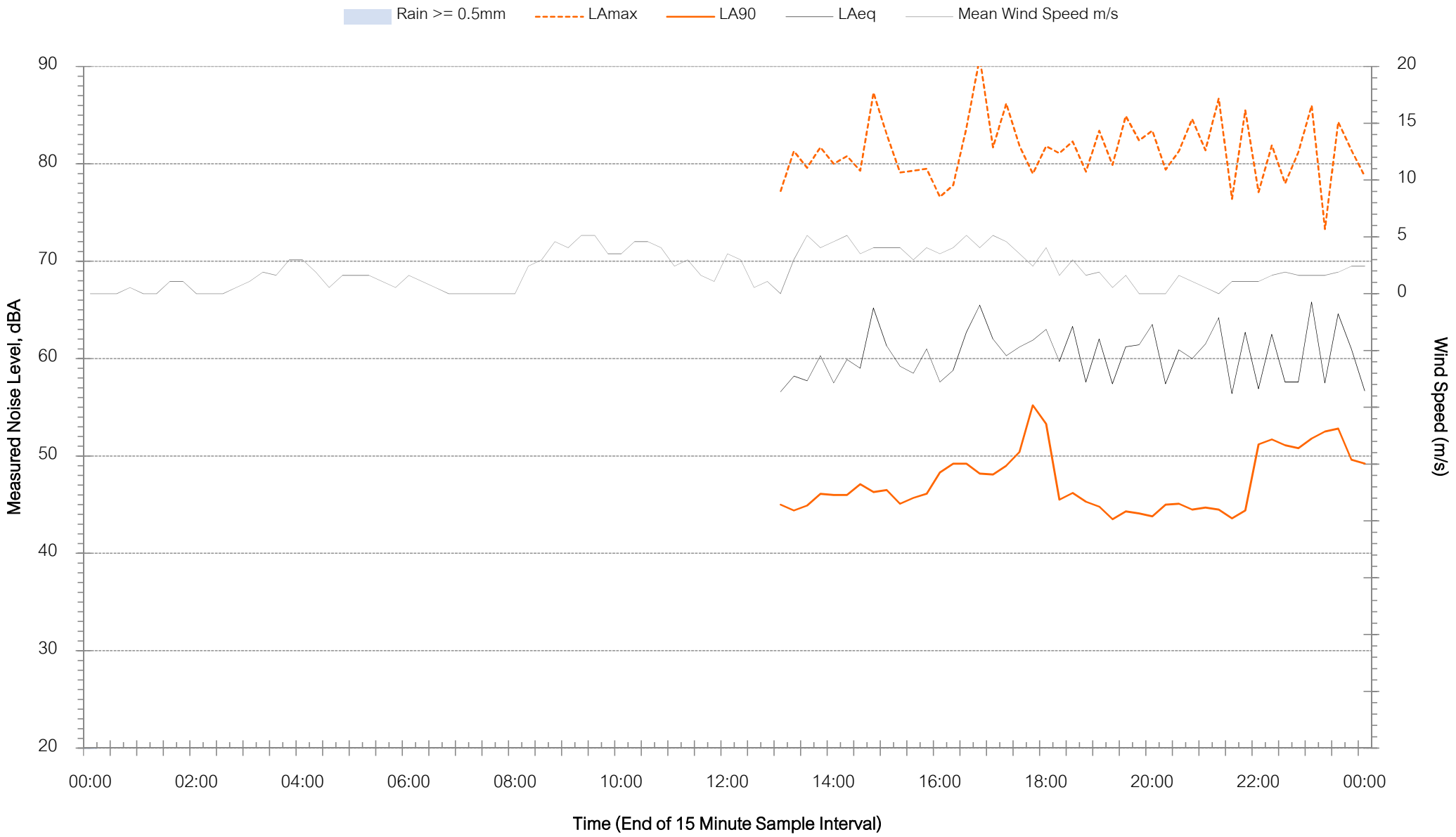

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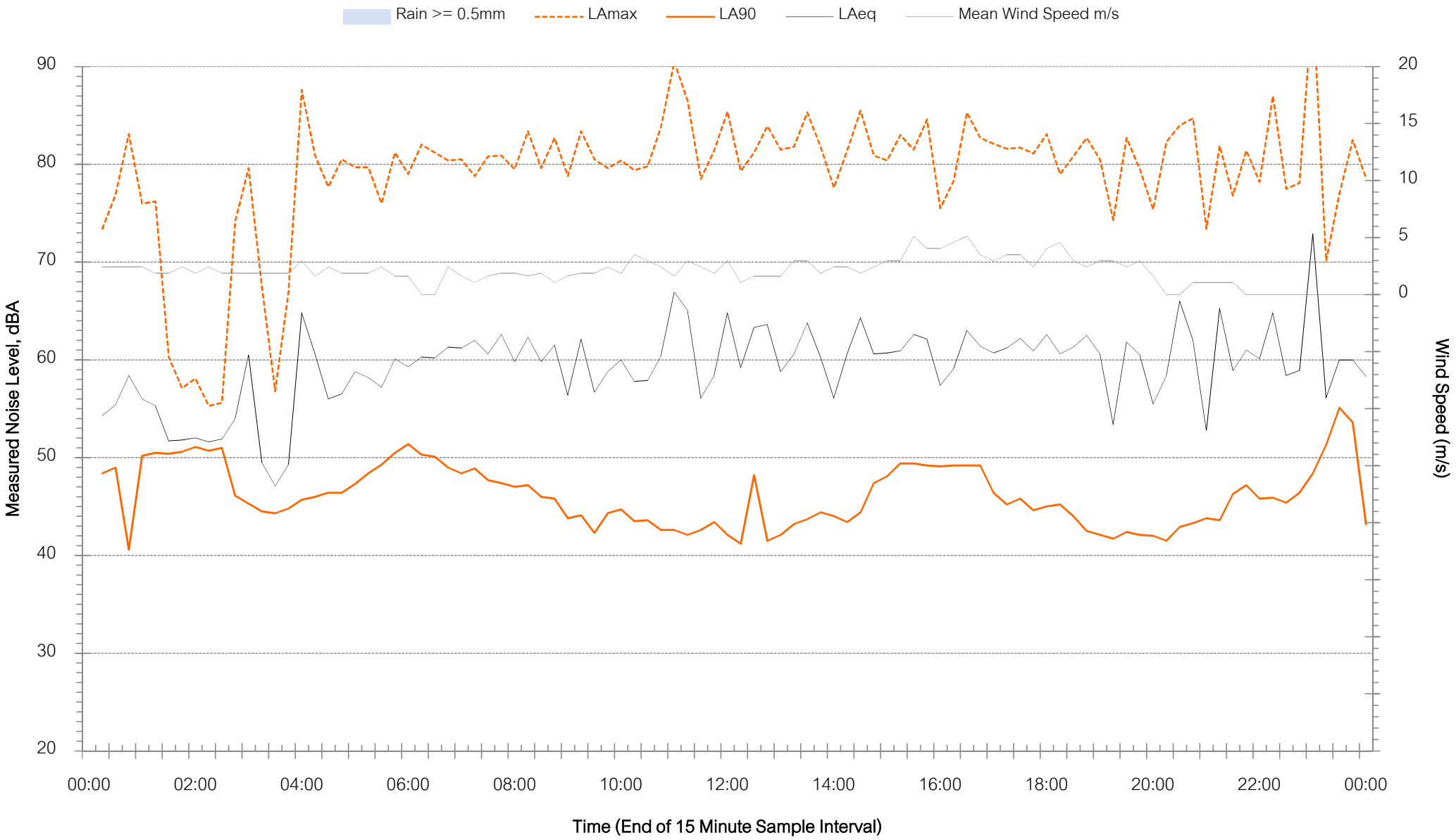

Background Noise Levels

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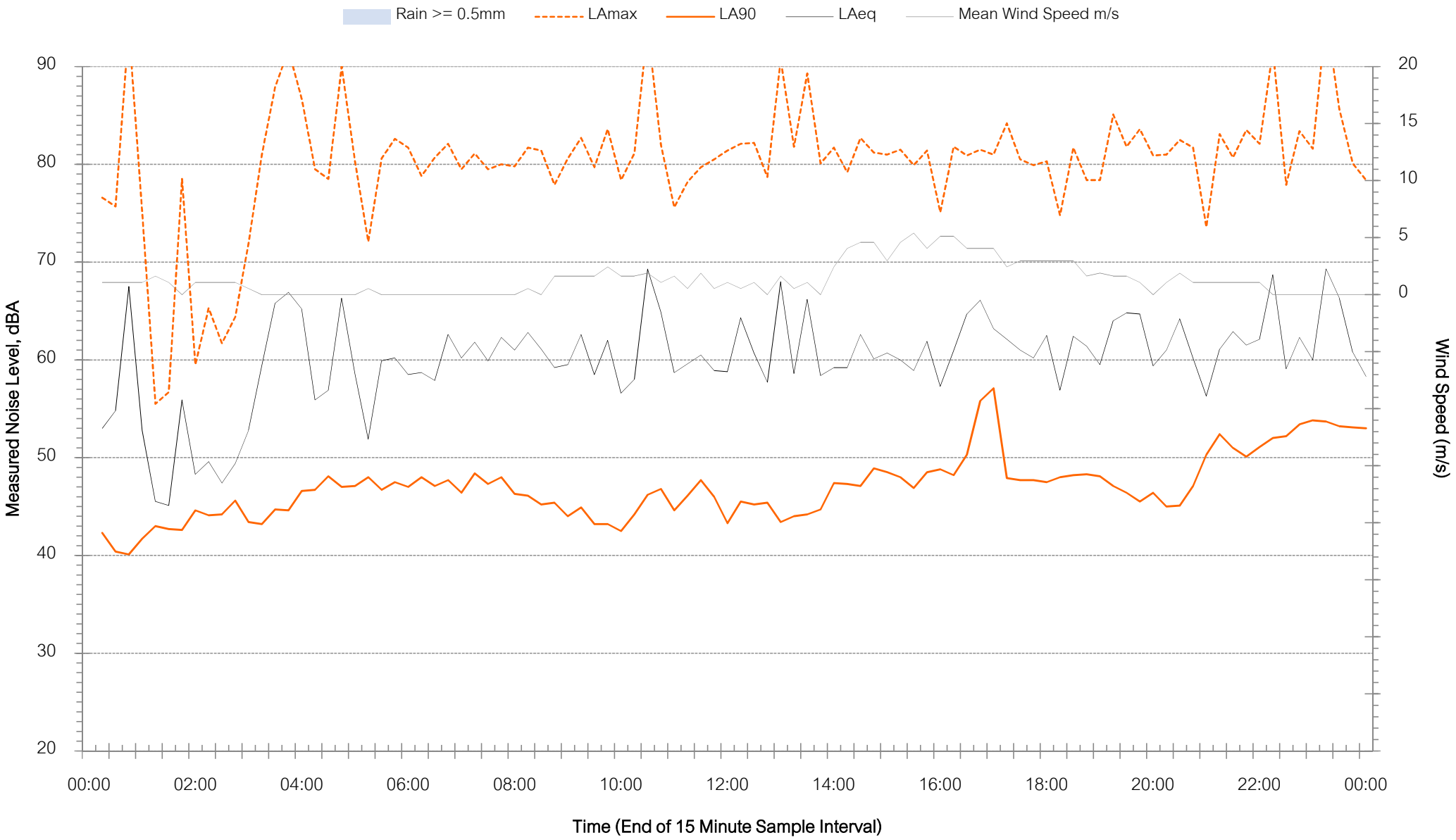

Background Noise Levels

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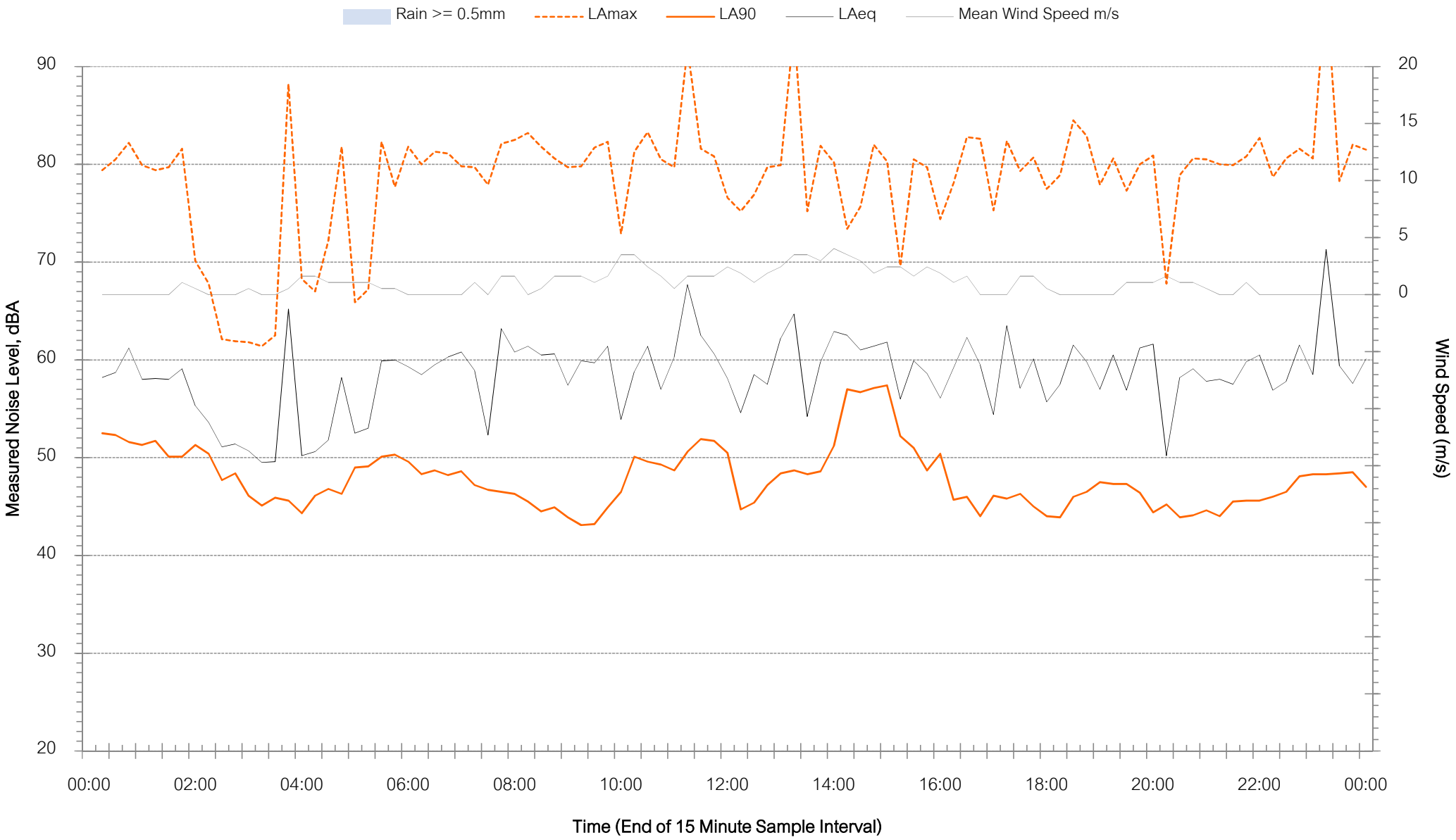

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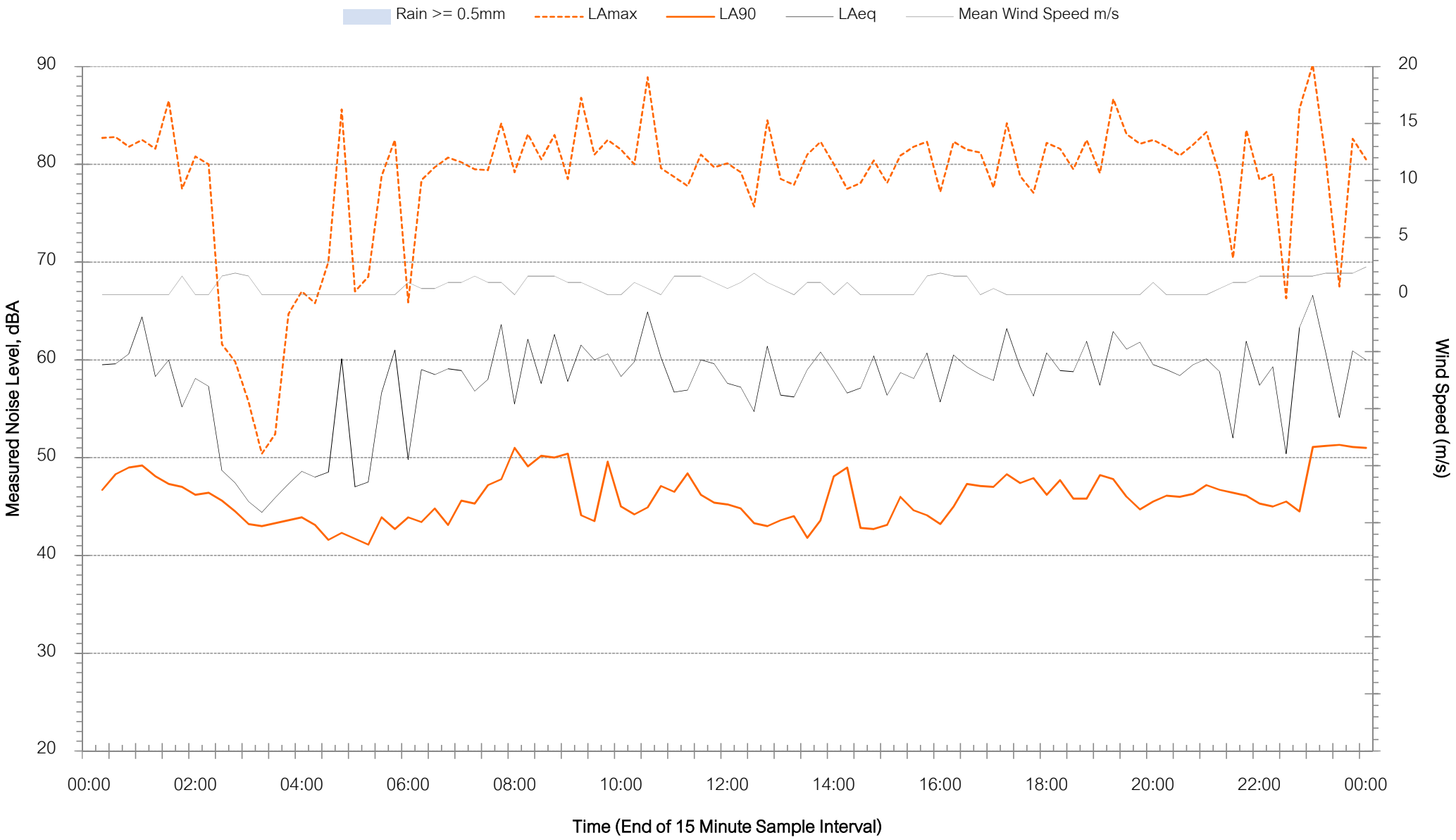

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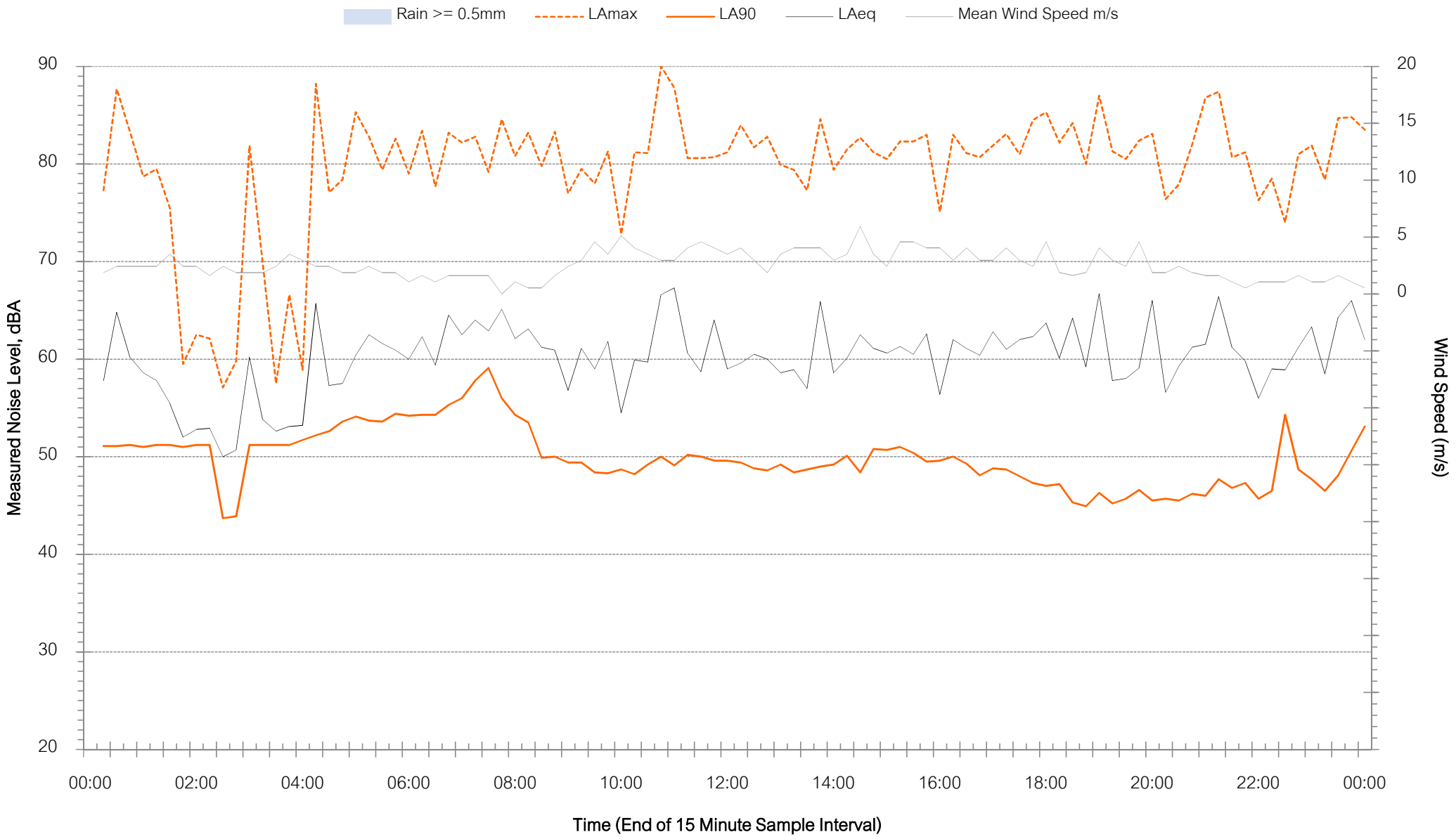

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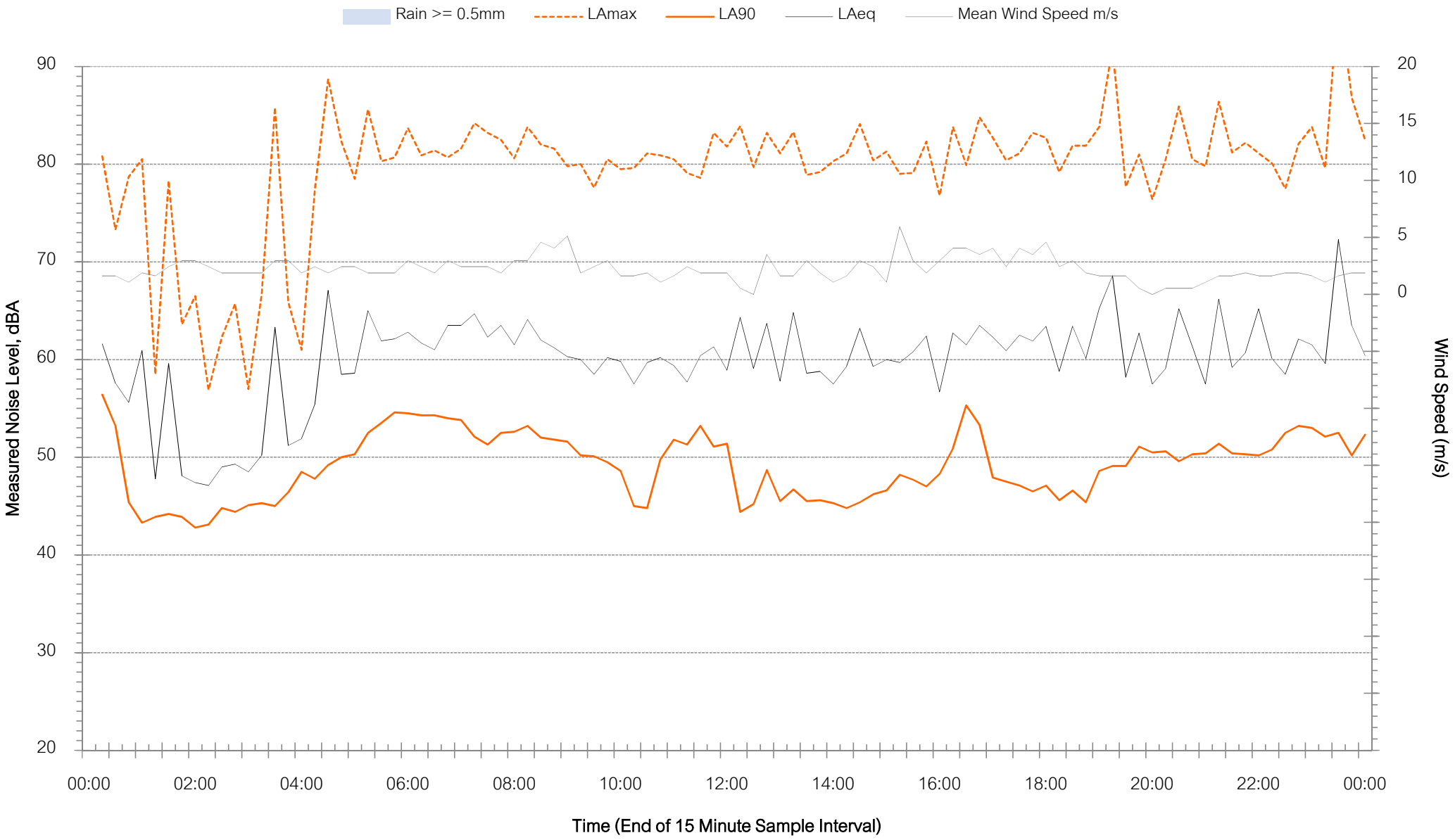

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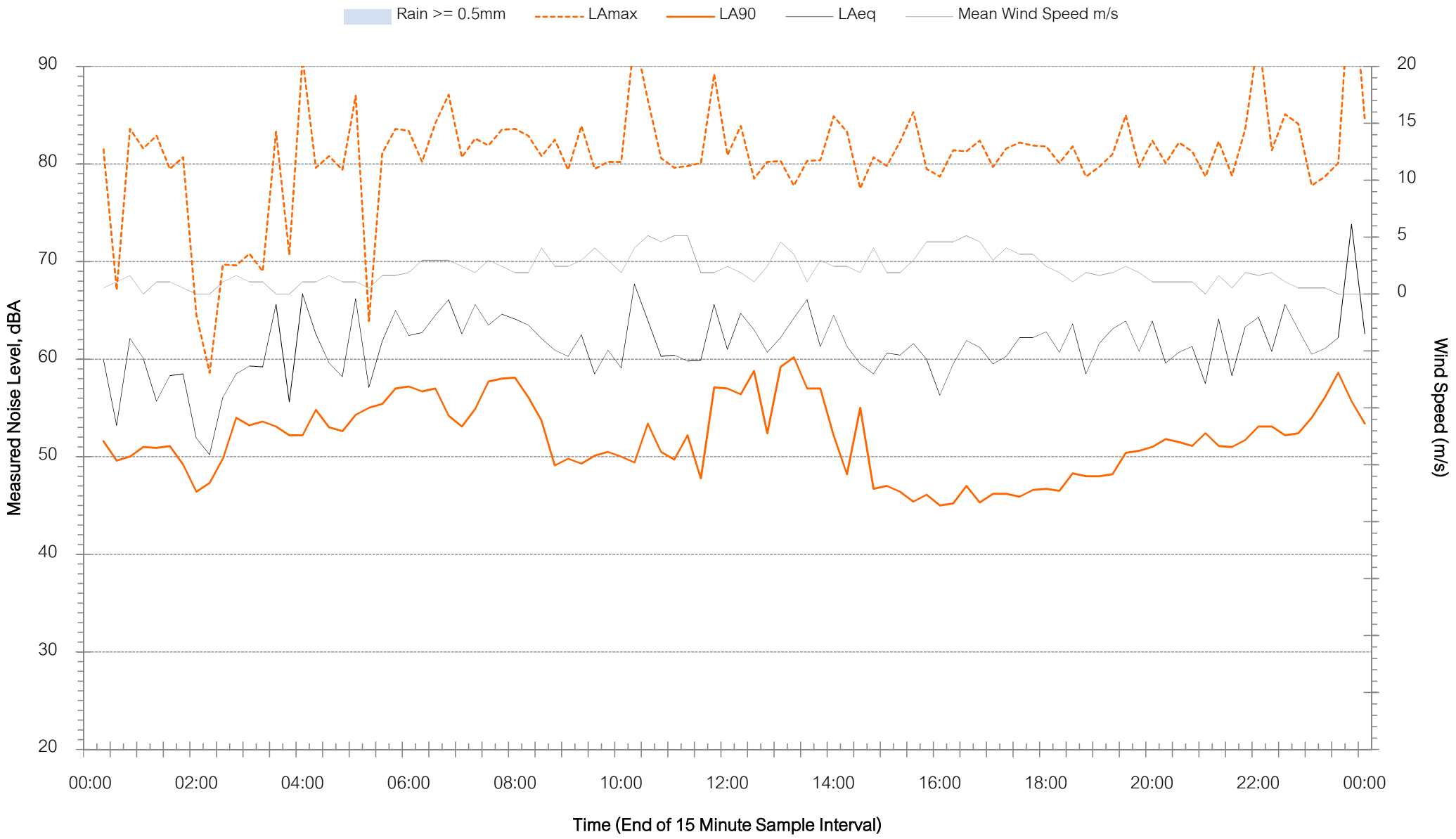

Background Noise Levels

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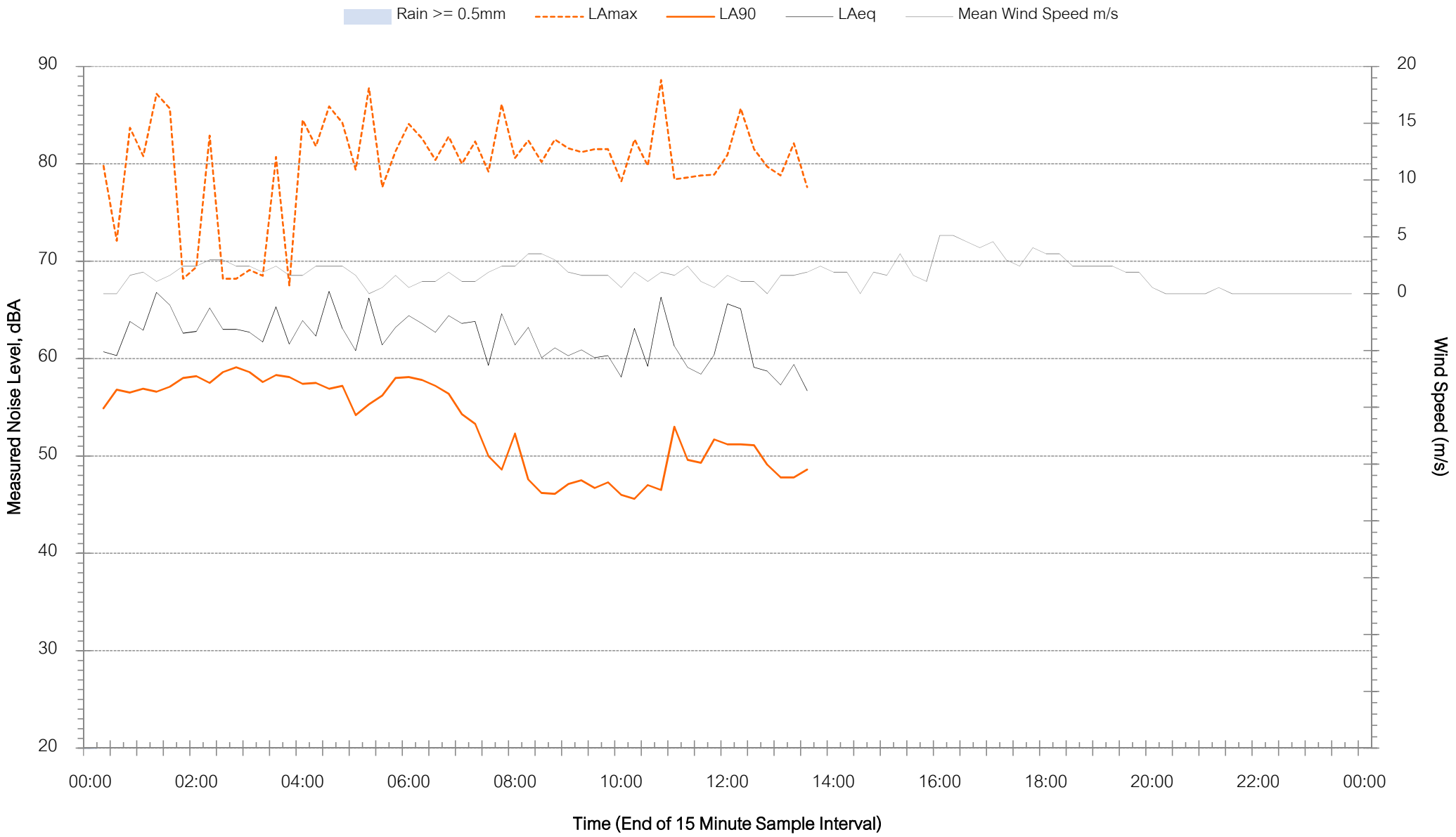

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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 4 Ending December 2018.

Prepared for: Holcim (Australia) Pty Ltd
December 2018
MAC180611--01RP2

Muller Acoustic Consulting

Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 4 Ending December 2018

Prepared for: Holcim (Australia) Pty Ltd

Prepared by: Muller Acoustic Consulting Pty Ltd
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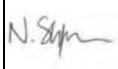
Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC180611-01RP2	Final	3 December 2018	Nicholas Shipman		Oliver Muller	

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending December 2018 and forms part of the noise monitoring program to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2); and
- Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1).

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

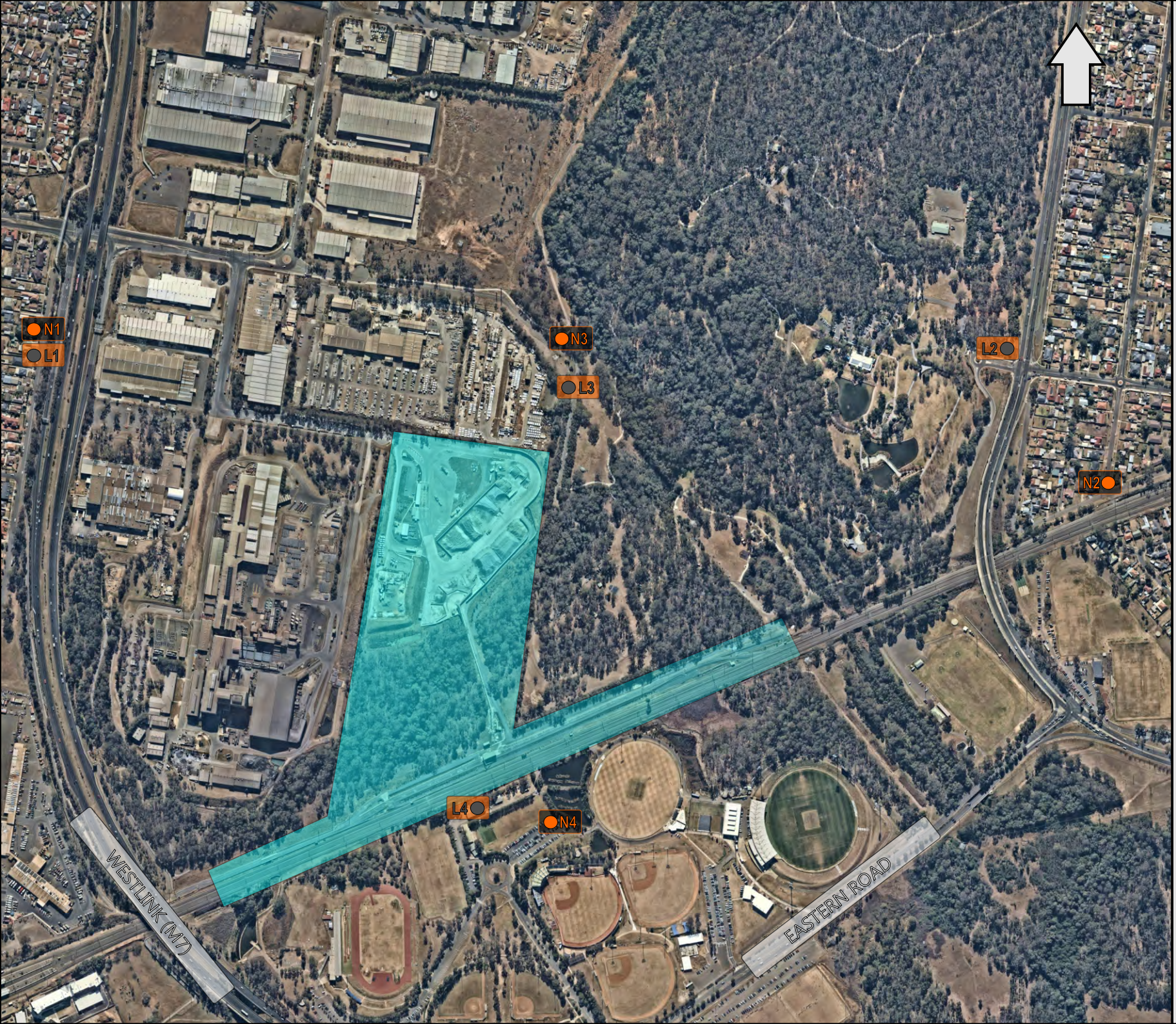

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

- N1 MONITORING LOCATION
- L1 LOGGER LOCATION
- SITE LOCATION

MAC
Muller Acoustic Consulting

*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1) and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Thursday 8 November 2018. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2004- Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for more than seven days general accordance with the procedures described in Australian Standard AS 1055:2018 - Acoustics - Description and measurement of environmental noise - General Procedures (AS1055.1) and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977 and 957 noise analysers from Thursday 8 November 2018 to Wednesday 21 November 2018. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672.1-2004- Electroacoustics - Sound level meters - Specifications. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/11/2018	15:55 (Day)	71	58	53	WD: S WS: 1m/s Rain: Nil	Traffic 46-71 Birds 46-58 Aircraft 54-60 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<43
08/11/2018	19:04 (Evening)	79	57	50	WD: S WS: 0.5m/s Rain: Nil	Birds 48-54 Traffic 48-79 Pedestrians 53-59 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<40
08/11/2018	22:02 (Night)	64	53	44	WD: S WS: 0.5m/s Rain: Nil	Traffic 43-64 Aircraft 48-60 Birds 44-56 Roadworks 41-49 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<34

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/11/2018	16:55 (Day)	88	66	59	WD: S WS: 2m/s Rain: Nil	Traffic 58-88 Wind <58 Lawn mowing <63 Birds <66 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<49
08/11/2018	18:21 (Evening)	79	61	54	WD: S WS: 1m/s Rain: Nil	Traffic 49-79 Birds 49-66 Traffic sirens <55 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<44
08/11/2018	22:45 (Night)	66	54	47	WD: S WS: 0.5m/s Rain: Nil	Traffic 48-66 Train 48-56 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<37

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/11/2018	16:19 (Day)	76	58	55	WD: S WS: 2m/s Rain: Nil	Wind in trees <52 Other industrial sites 52-58 Traffic 52-64 Train 52-75 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45
08/11/2018	18:44 (Evening)	71	56	52	WD: S WS: 1m/s Rain: Nil	Other industrial sites <53 Birds 53-57 Traffic 54-71 Aircraft 54-61 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<42
08/11/2018	22:21 (Night)	64	53	51	WD: S WS: 0.5m/s Rain: Nil	Other industrial sites 48-55 RDC site 48-52 Traffic 55-61 Aircraft 52-54
		RDC $L_{Aeq(15min)}$ Contribution				50

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/11/2018	17:42 (Day)	72	54	51	WD: S WS: 1.5m/s Rain: Nil	Local traffic 48-72 Birds 52-60 Local residential noise 52-60 Train 48-58 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<41
08/11/2018	18:00 (Evening)	69	53	49	WD: S WS: 1.5m/s Rain: Nil	Birds 49-65 Traffic 48-60 Local residential noise 48-54 Train 48-56 Aircraft 49-53 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<39
08/11/2018	23:05 (Night)	78	64	50	WD: S WS: 0.5m/s Rain: Nil	Traffic 44-78 Birds 46-52 Aircraft 48-54 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured $LA_{eq,period}$ dBA[2]	Measured Background Noise Level (LA_{90}) RBL dBA[2]
L1 (N1 Station Street)	Day	56	49
	Evening	53	42
	Night	52	35
L2 (N2 Crawford Street)	Day	58	48
	Evening	56	47
	Night	54	40
L3 (N3 Nurragingy Reserve)	Day	52	43
	Evening	52	41
	Night	51	42
L4 (N4 Blacktown Olympic Park)	Day	57	41
	Evening	55	41
	Night	57	42

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB, $LA_{eq(15min)}$	dB, $LA_{eq(15min)}$	
N1	<43	44	✓
N2	<49	40	✓
N3	<45	50 (When in use)	✓
N4	<41	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB, $LA_{eq(15min)}$	dB, $LA_{eq(15min)}$	
N1	<40	44	✓
N2	<44	39	✓
N3	<42	50 (When in use)	✓
N4	<39	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB, $LA_{eq(15min)}$	dB, $LA_{eq(15min)}$	
N1	<34	39	✓
N2	<37	39	✓
N3	50	50 (When in use)	✓
N4	<40	55 (When in use)	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three measurements conducted on Thursday 8 November 2018, satisfying the relevant noise limits. Extraneous noise sources included traffic, birds, aircraft noise, pedestrian activities and roadworks.

6.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during all three measurements conducted on Thursday 8 November 2018, satisfying the relevant noise limits for this location. Extraneous sources measured include traffic, wind, lawn mowing, birds, traffic sirens and train pass-by.

6.3 Discussion of Results - Location N3

Attended measurements on Thursday 8 November 2018 identified that RDC noise was audible during one of the three measurements during the night time period, although satisfied the relevant noise limits of 50dB $LA_{eq(daytime)}$. RDC sources audible on occasion included general mobile plant engine noise. The RDC was inaudible during the day and evening measurements conducted on Thursday 8 November 2018 thus satisfying the applicable noise criteria. Extraneous sources audible during the attended surveys included wind in trees, other industrial sites, traffic, train pass-by, birds and aircraft noise which generally masked RDC noise. For the night assessment period, the RDC $LA_{eq(15min)}$ contribution was 50dBA, at criteria although it is noted the receiver was not “in use”, hence criteria are only referenced for completeness.

6.4 Discussion of Results - Location N4

RDC noise emissions were inaudible during all three measurements conducted on Thursday 8 November 2018, satisfying the relevant noise limits. Extraneous noise sources included local traffic, birds, local residential noise, train pass-by and aircraft noise all audible throughout attended measurements at this location.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 4, ending December 2018.

Attended noise monitoring was conducted on Thursday 8 November 2018 and unattended noise monitoring was completed between Thursday 8 November 2018 and Wednesday 21 November 2018 at four representative monitoring locations. The assessment has identified that noise emissions generated by RDC were audible on one attended measurement occasion at N3, although remained below relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

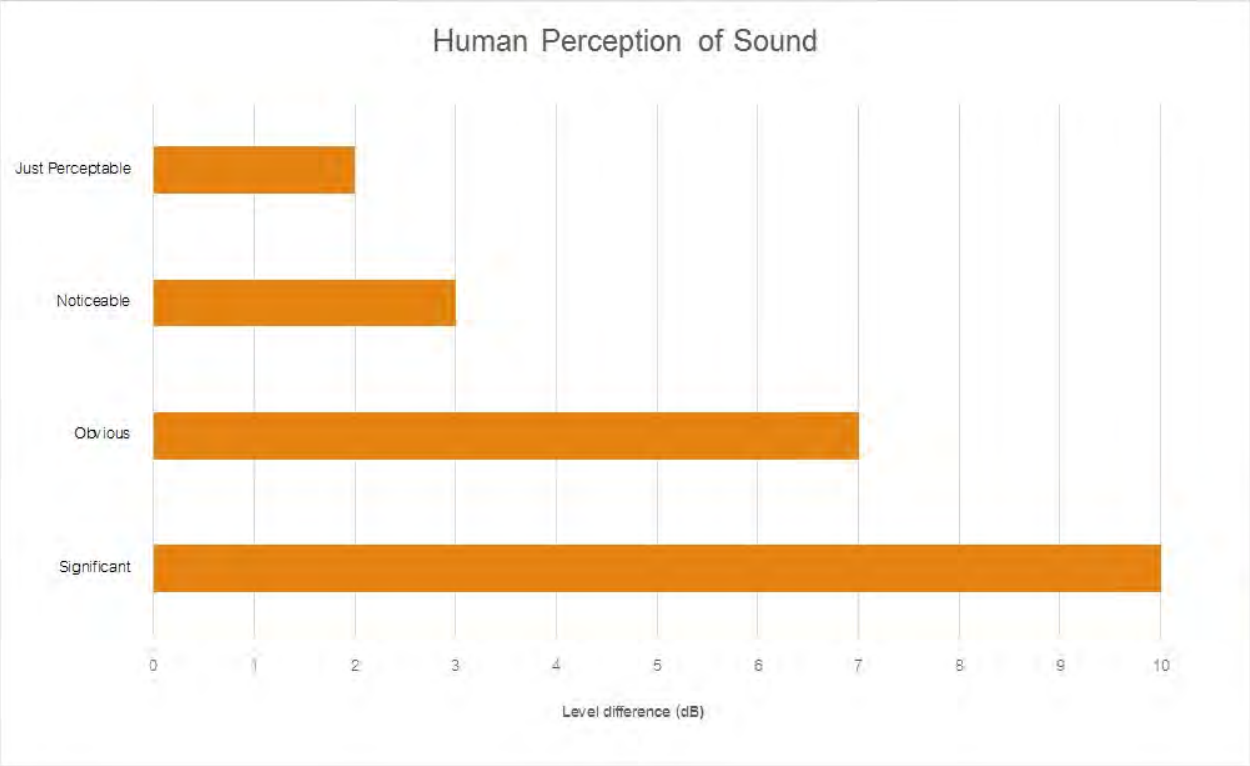
Table 1A Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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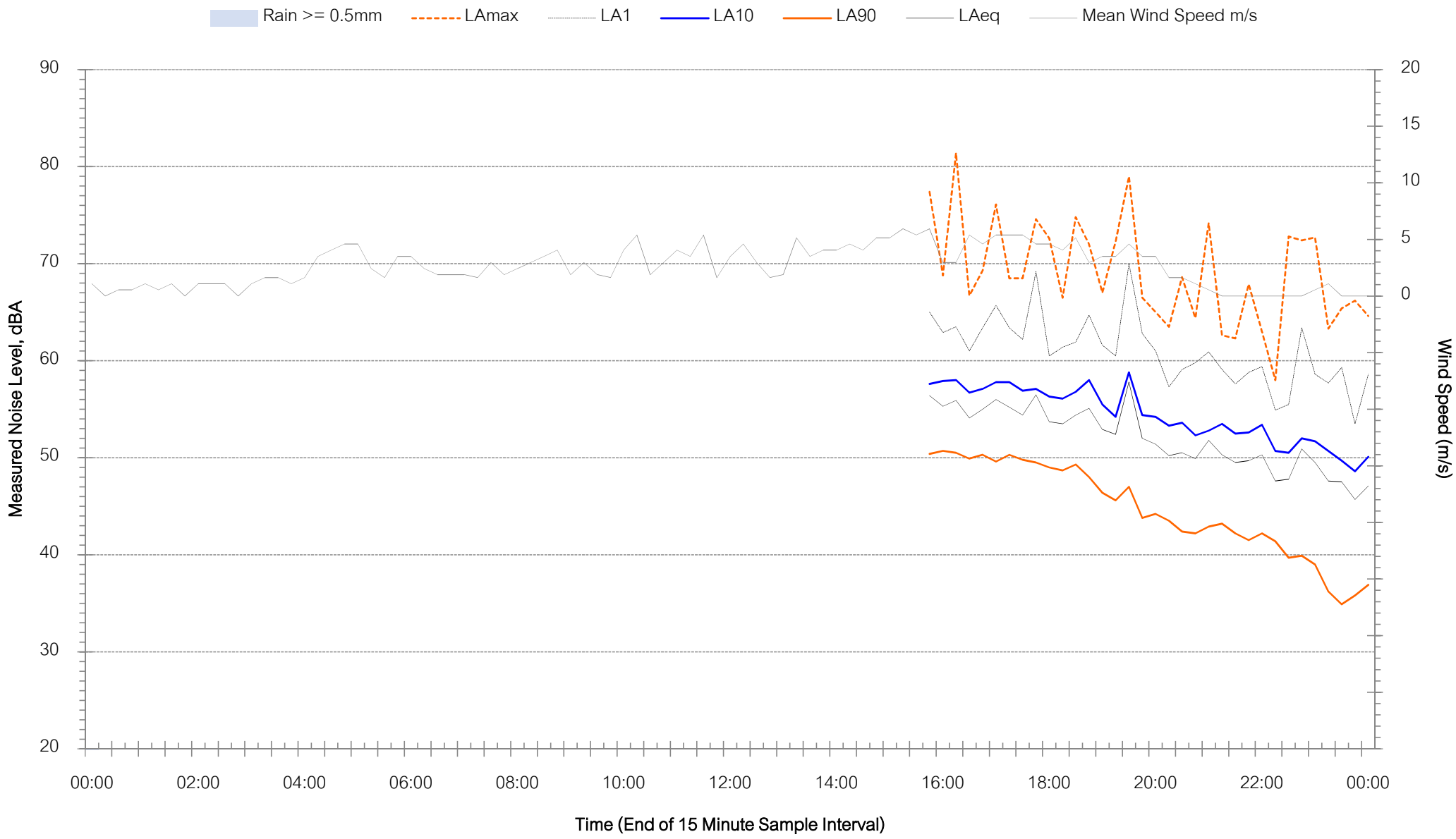
Appendix B – Unattended Noise Monitoring Charts

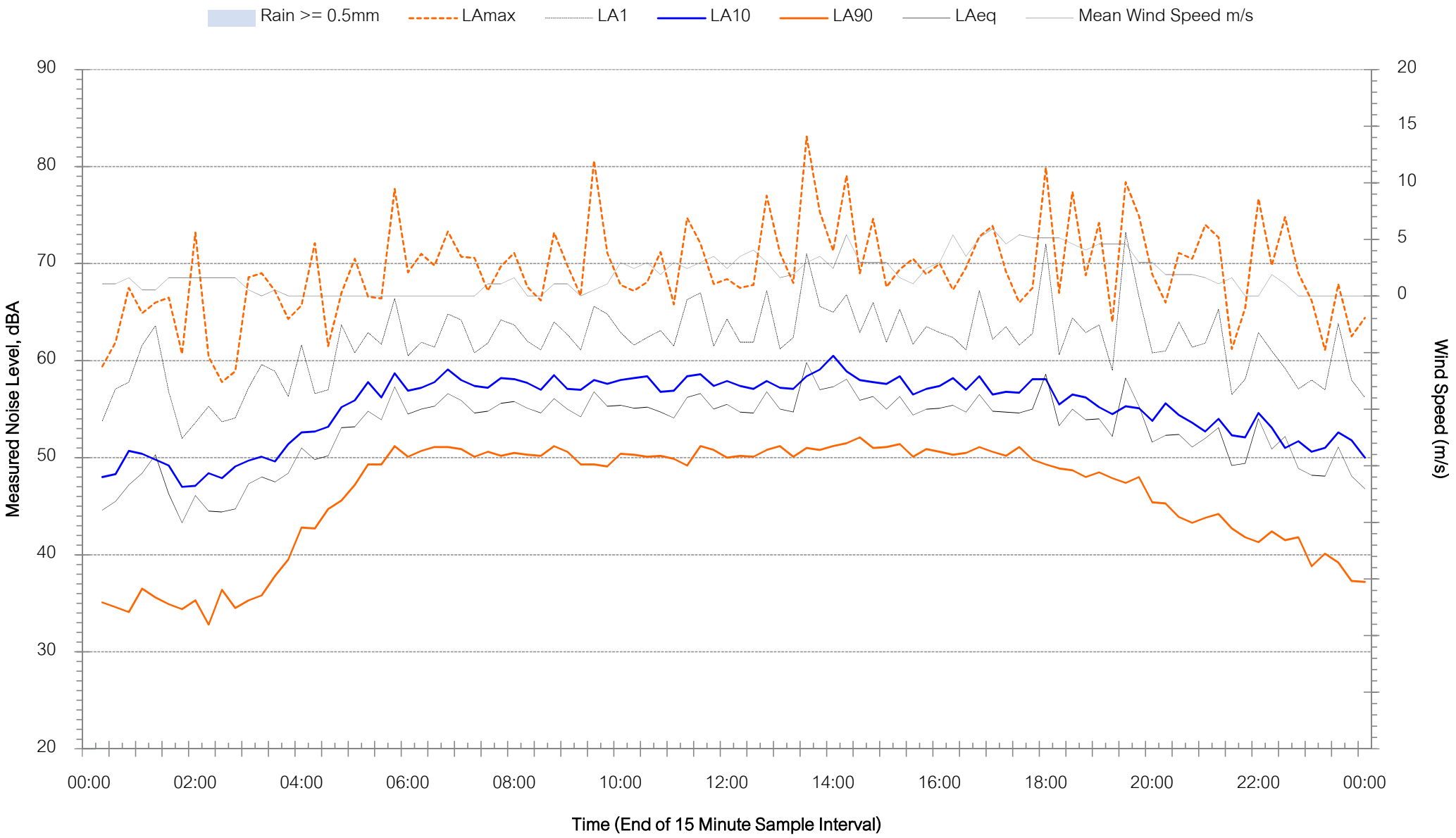
Background Noise Levels

Location N1 - Thursday 8 November 2018



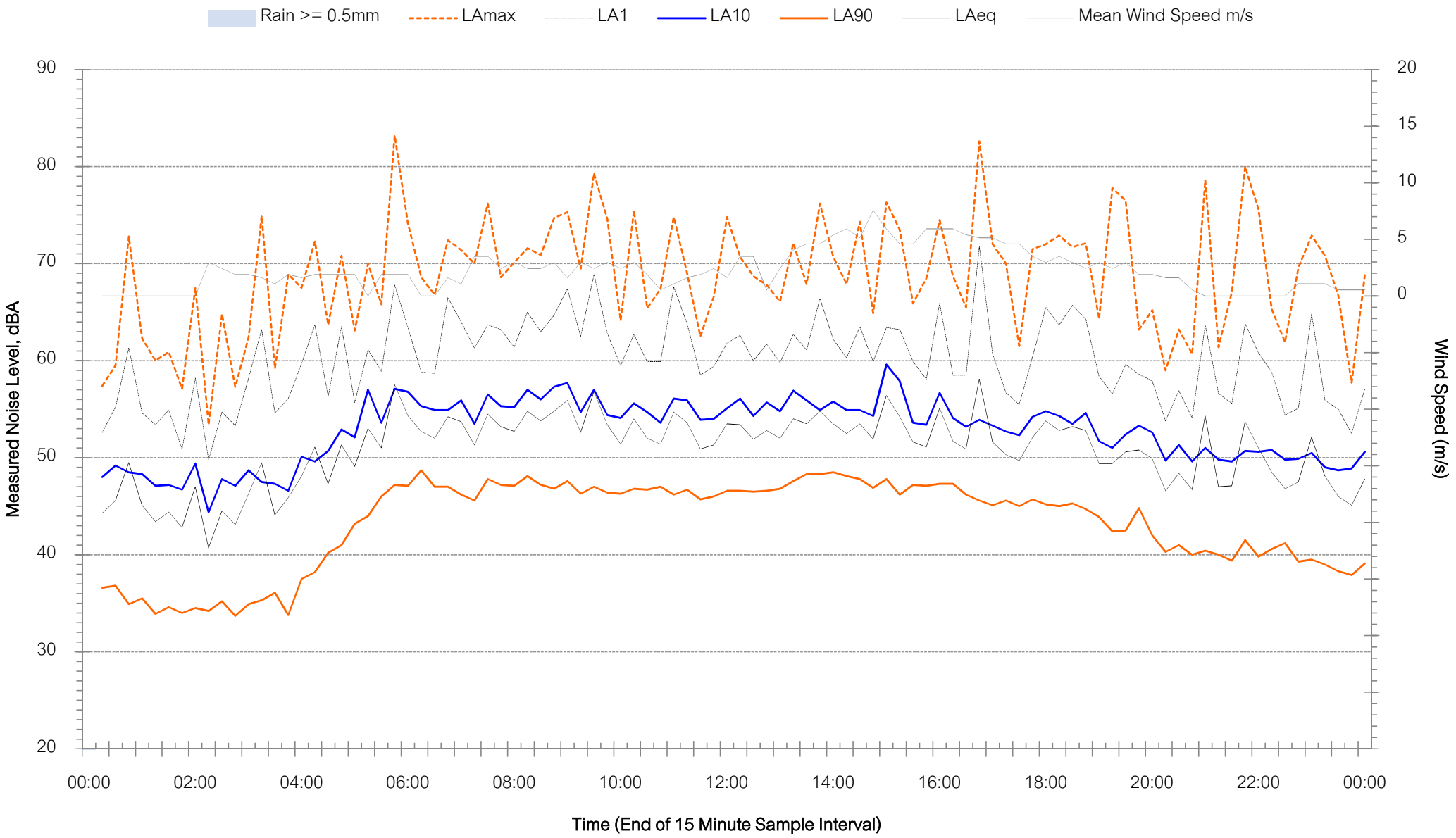
Background Noise Levels

Location N1 - Friday 9 November 2018



Background Noise Levels

Location N1 - Saturday 10 November 2018

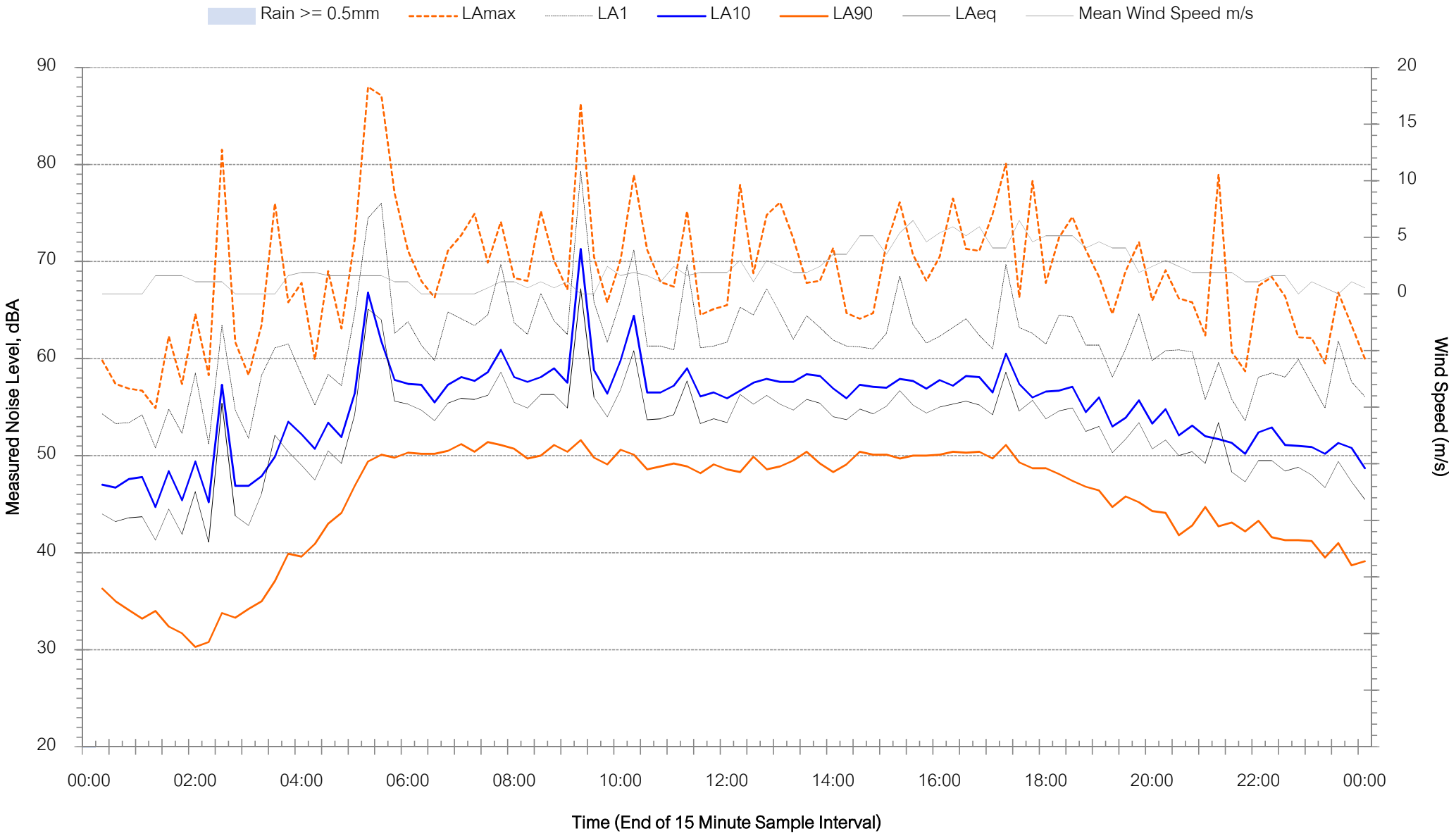


Background Noise Levels

Location N1 - Sunday 11 November 2018

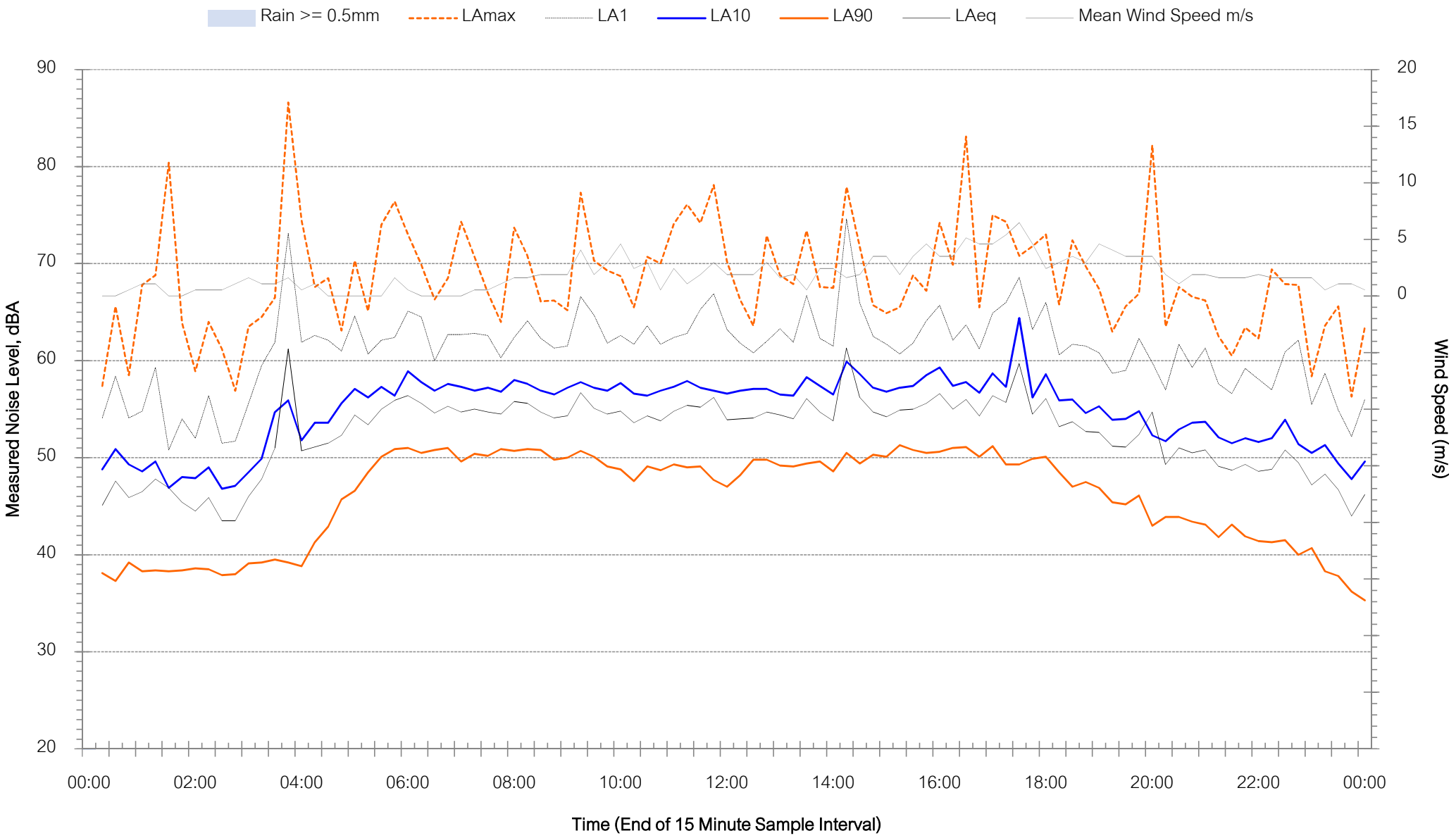
Background Noise Levels

Location N1 - Monday 12 November 2018



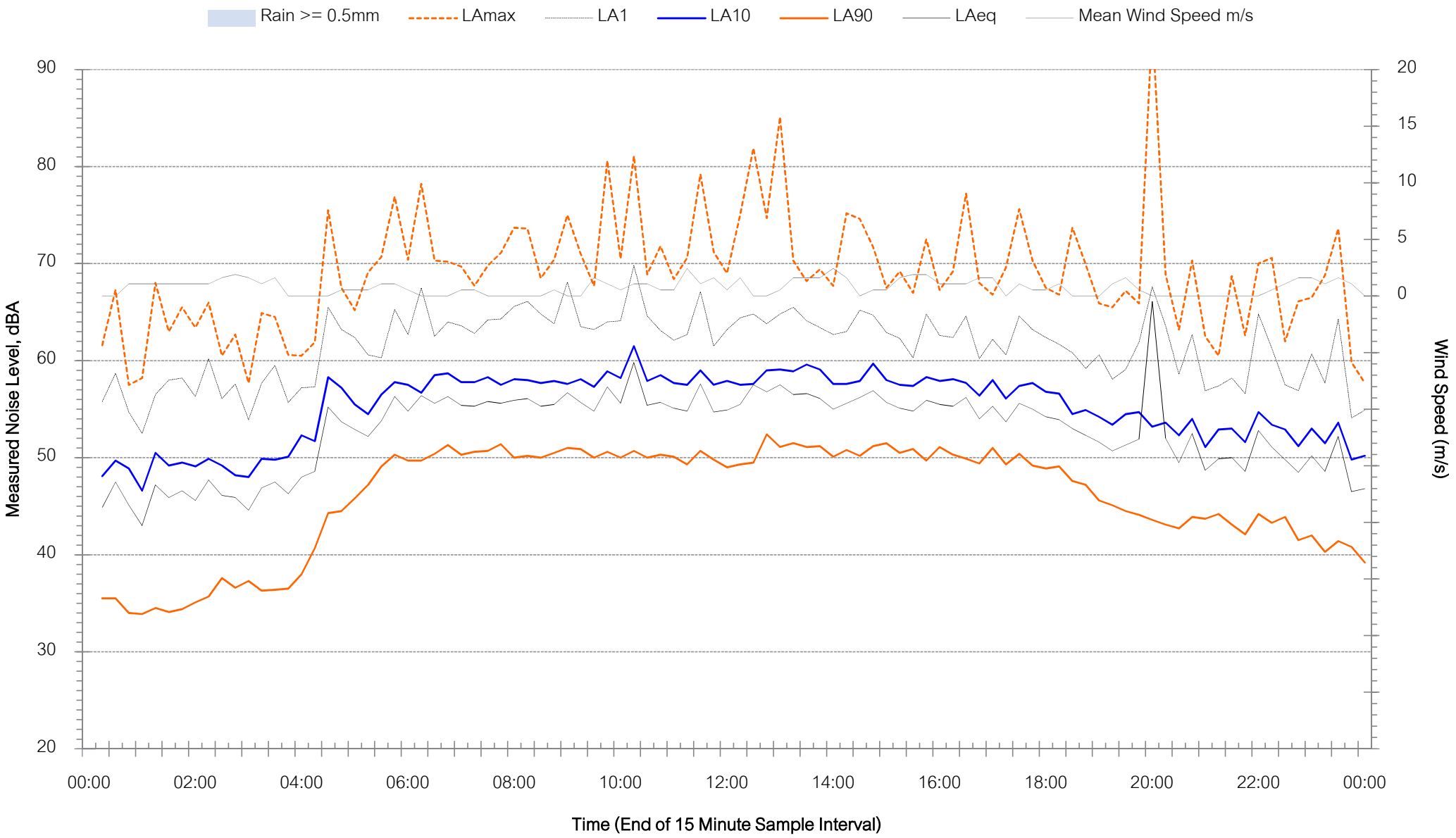
Background Noise Levels

Location N1 - Tuesday 13 November 2018



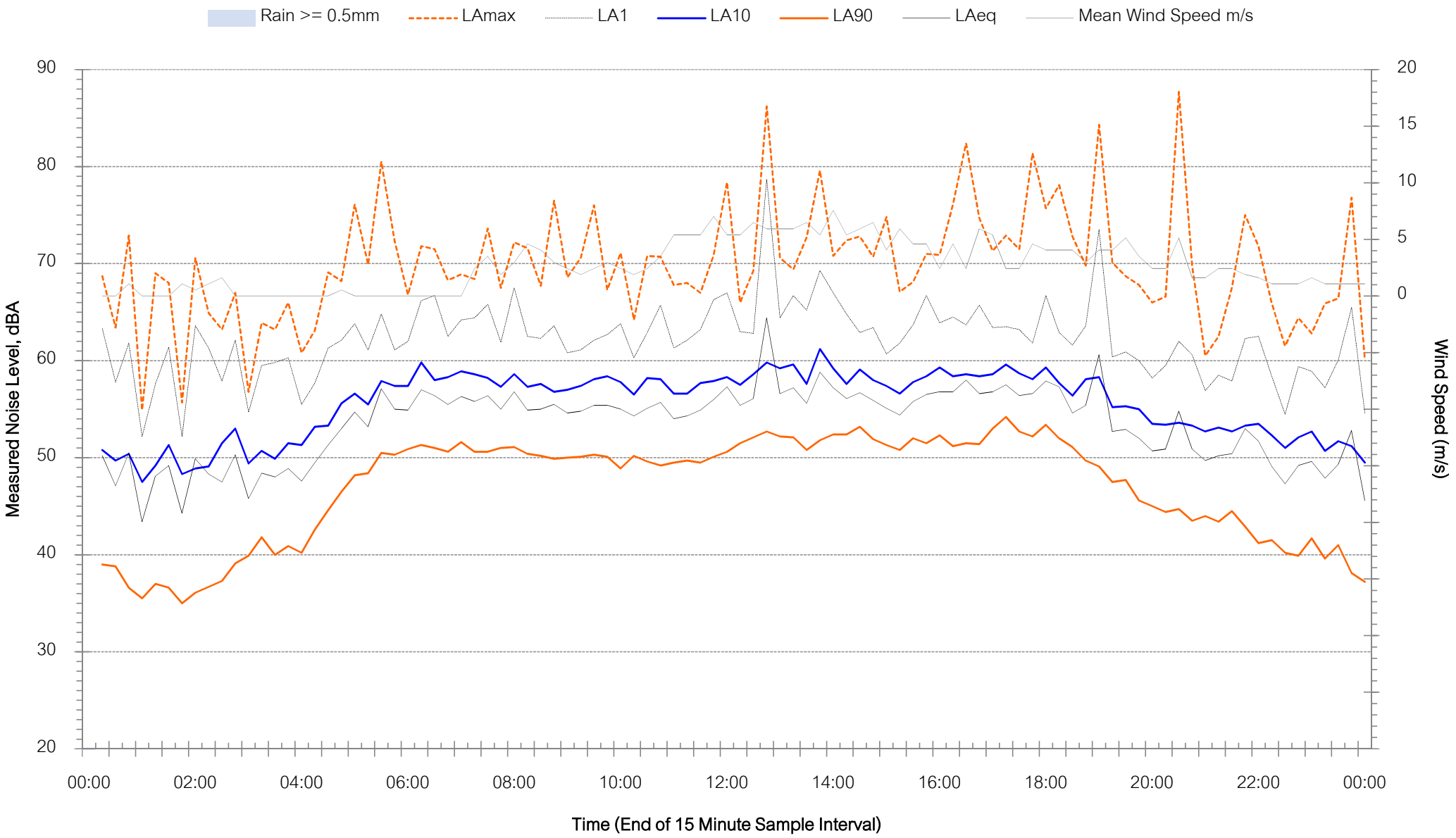
Background Noise Levels

Location N1 - Wednesday 14 November 2018



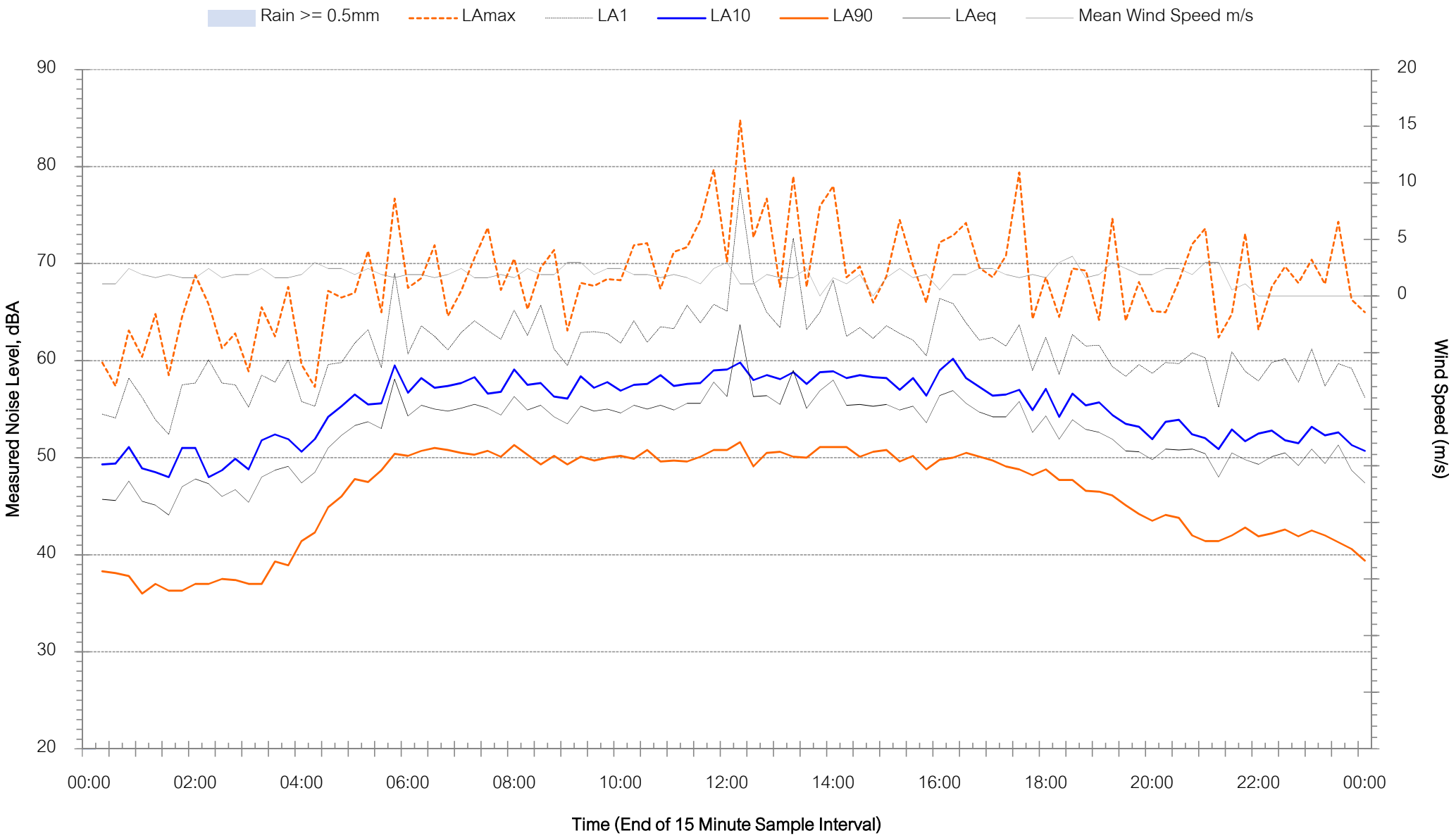
Background Noise Levels

Location N1 - Thursday 15 November 2018



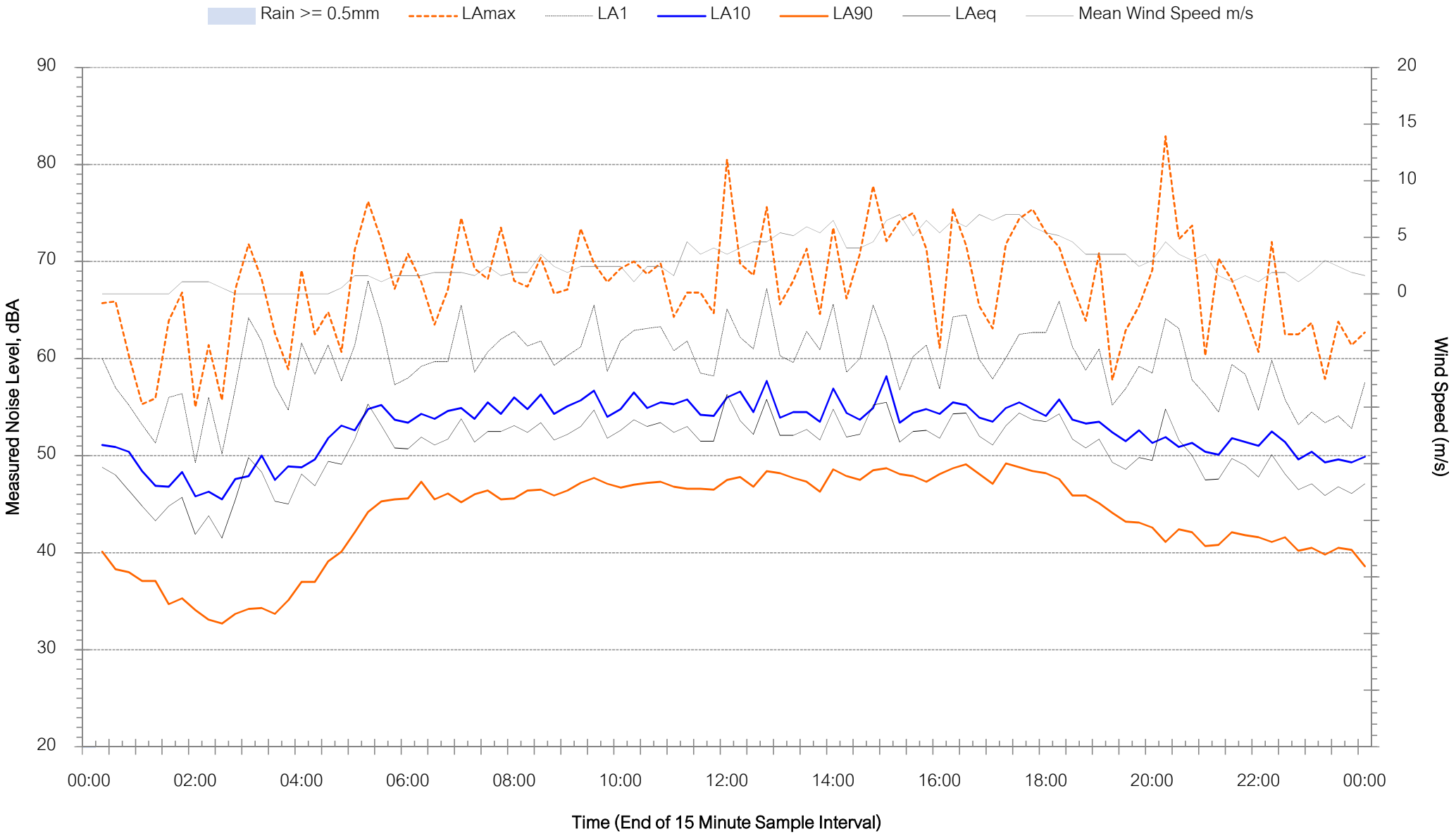
Background Noise Levels

Location N1 - Friday 16 November 2018



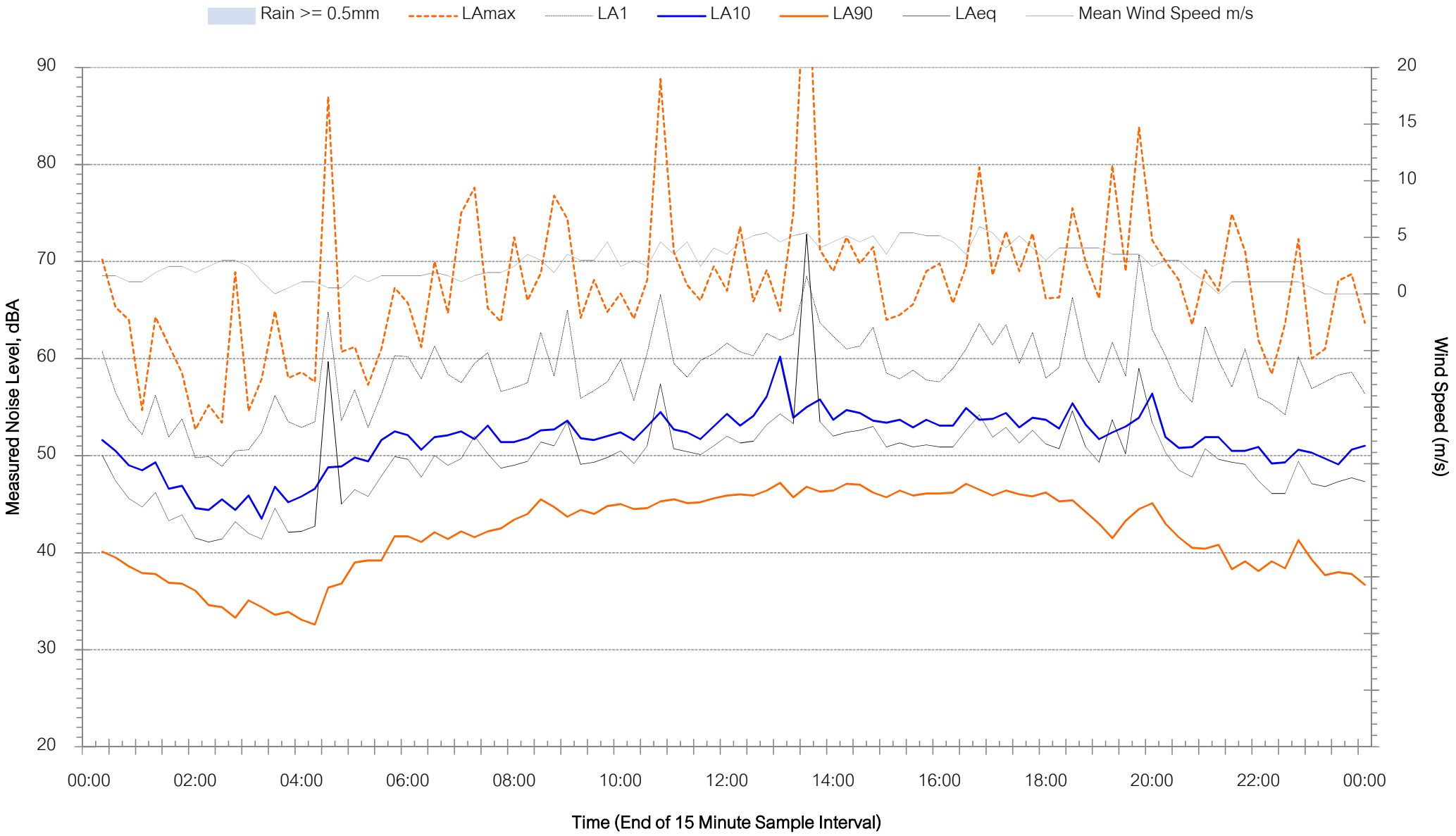
Background Noise Levels

Location N1 - Saturday 17 November 2018



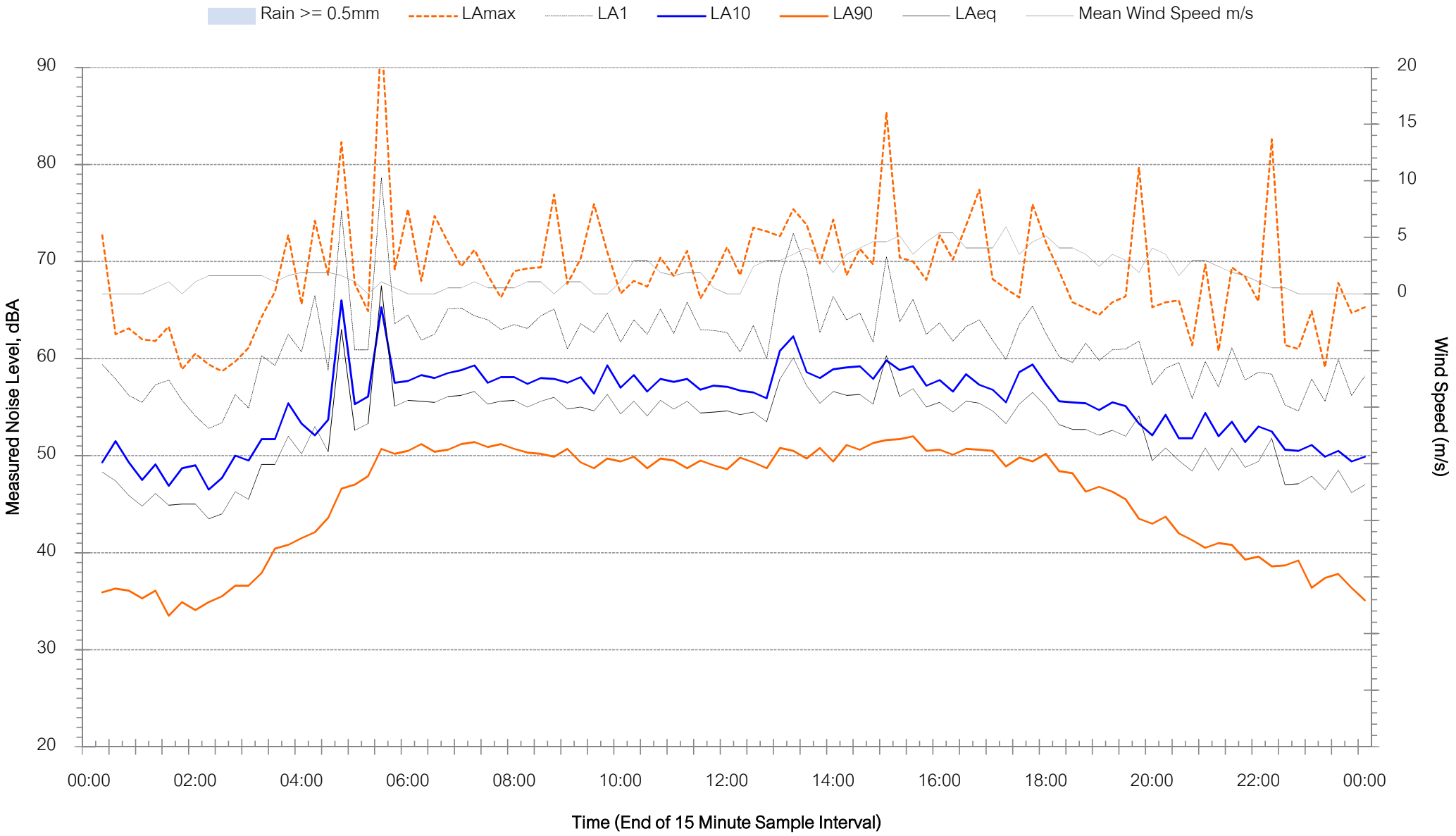
Background Noise Levels

Location N1 - Sunday 18 November 2018



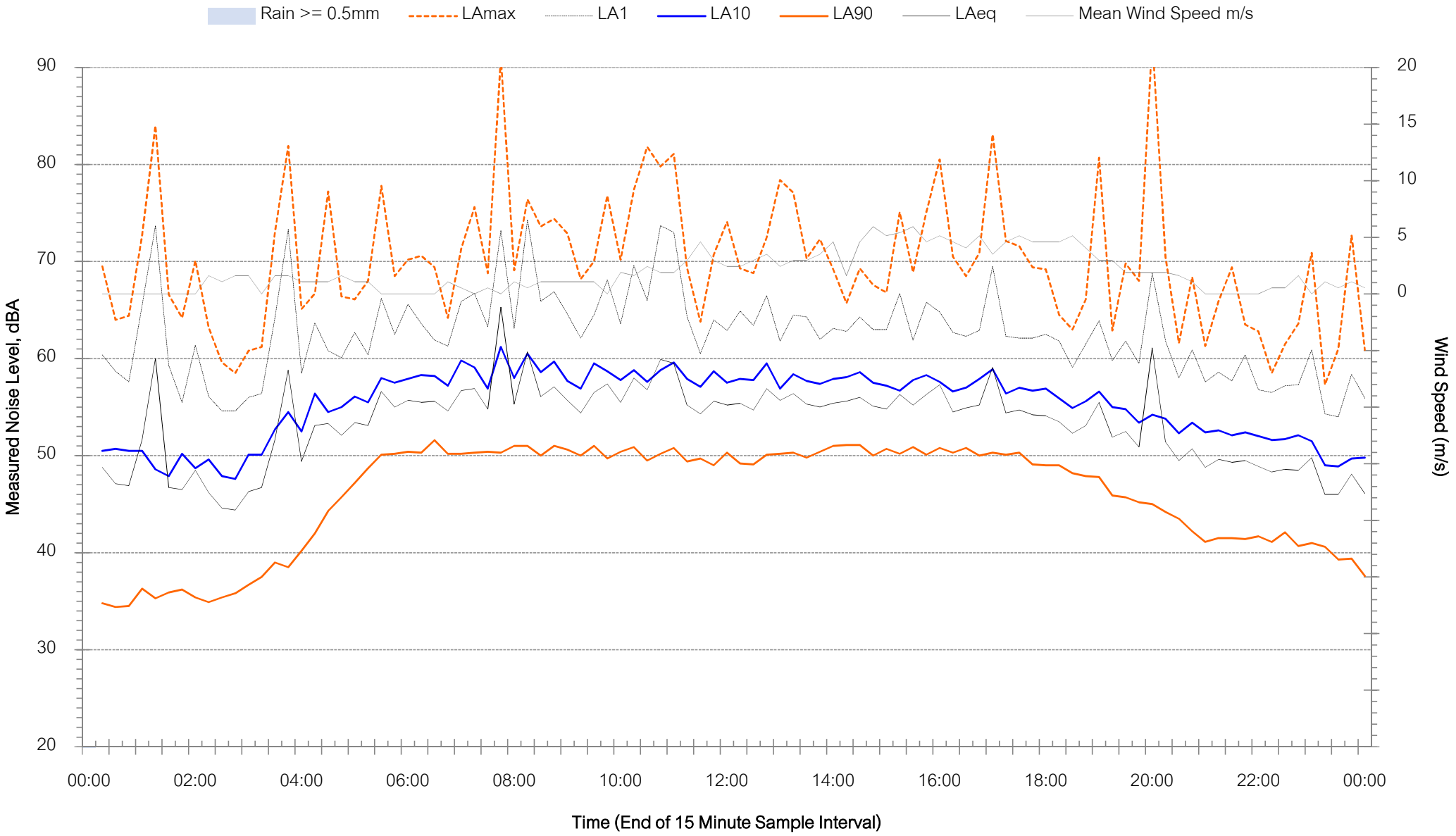
Background Noise Levels

Location N1 - Monday 19 November 2018



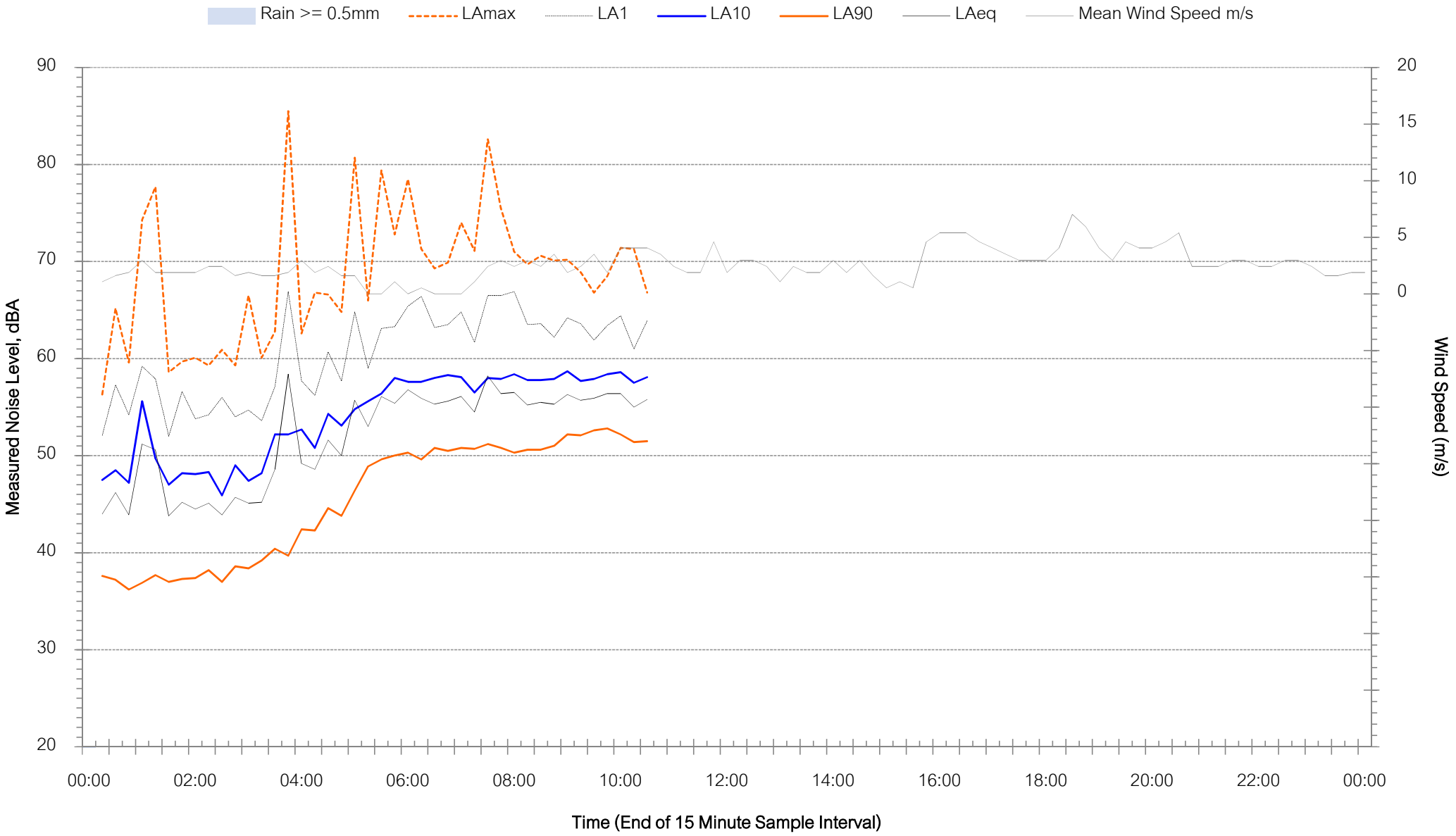
Background Noise Levels

Location N1 - Tuesday 20 November 2018



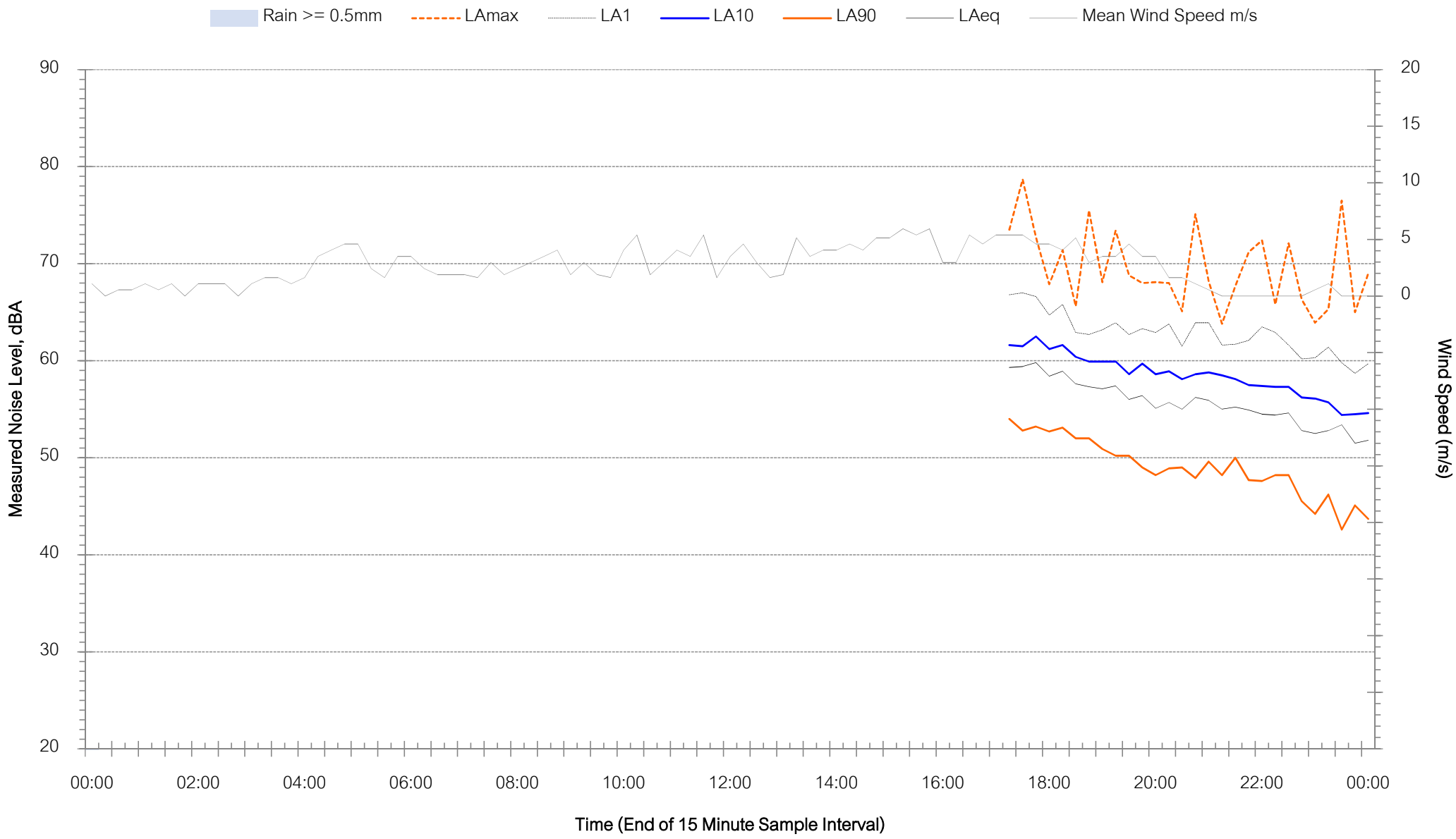
Background Noise Levels

Location N1 - Wednesday 21 November 2018



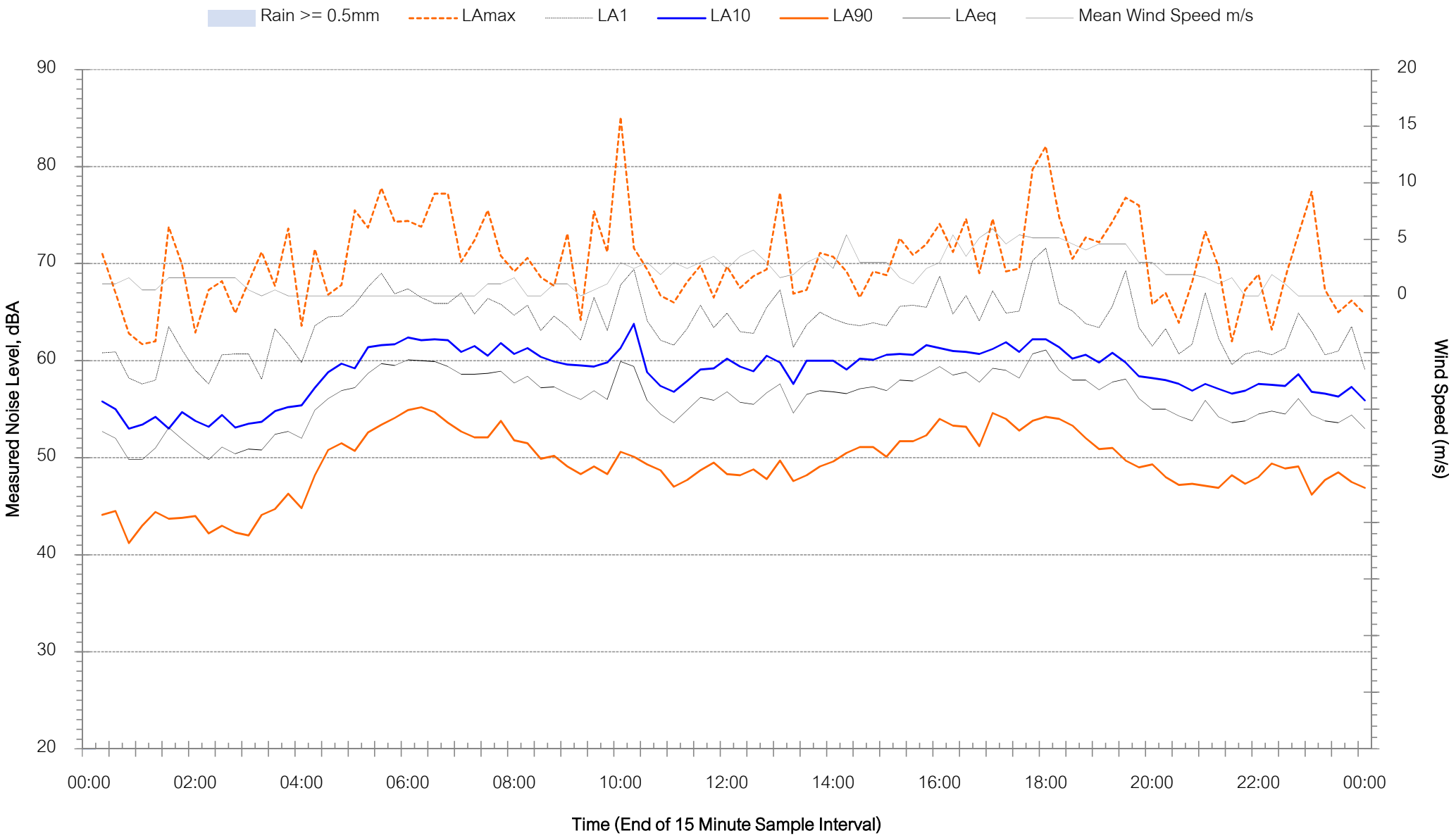
Background Noise Levels

Location - N2 - Thursday 8 November 2018



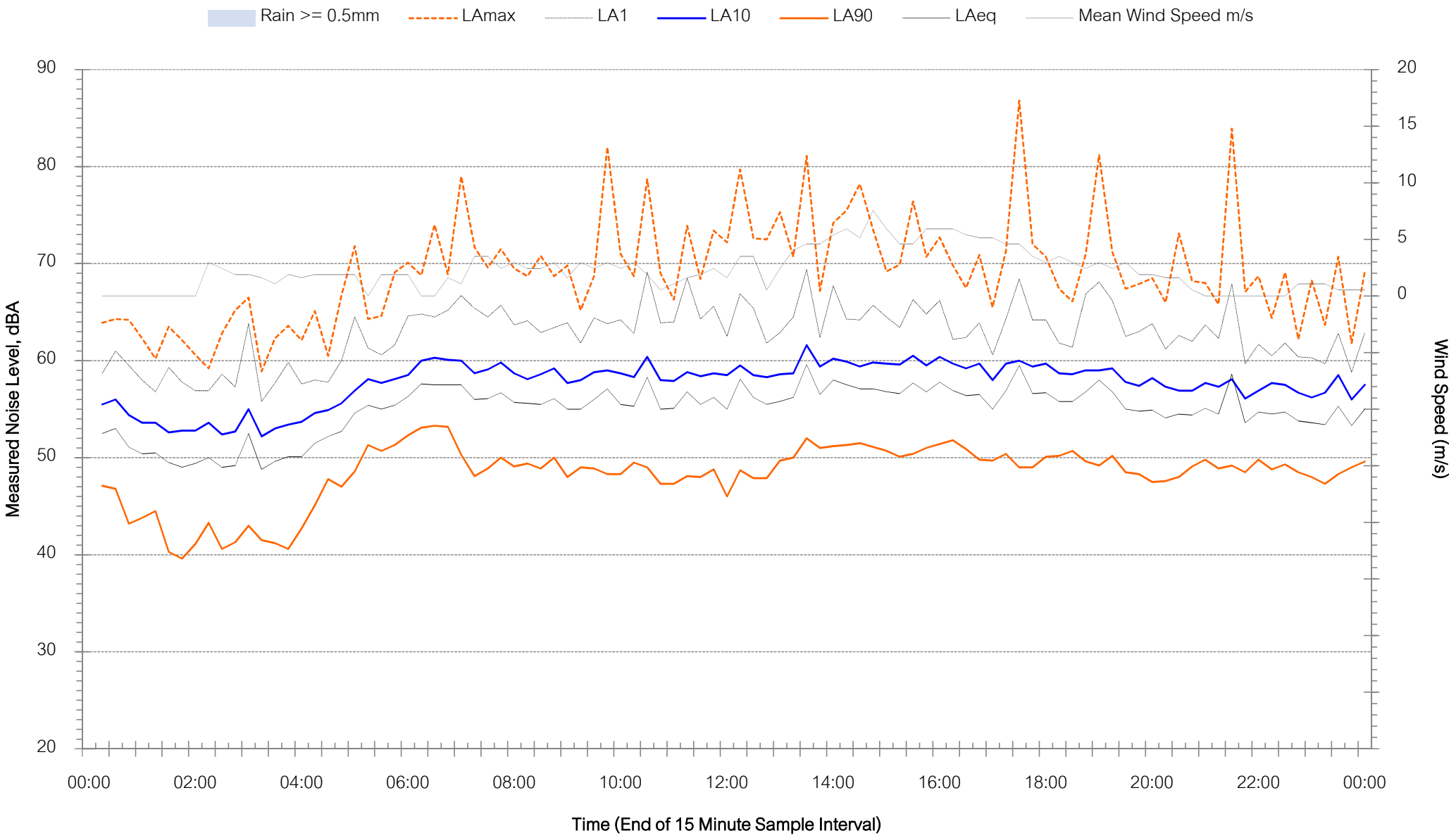
Background Noise Levels

Location - N2 - Friday 9 November 2018



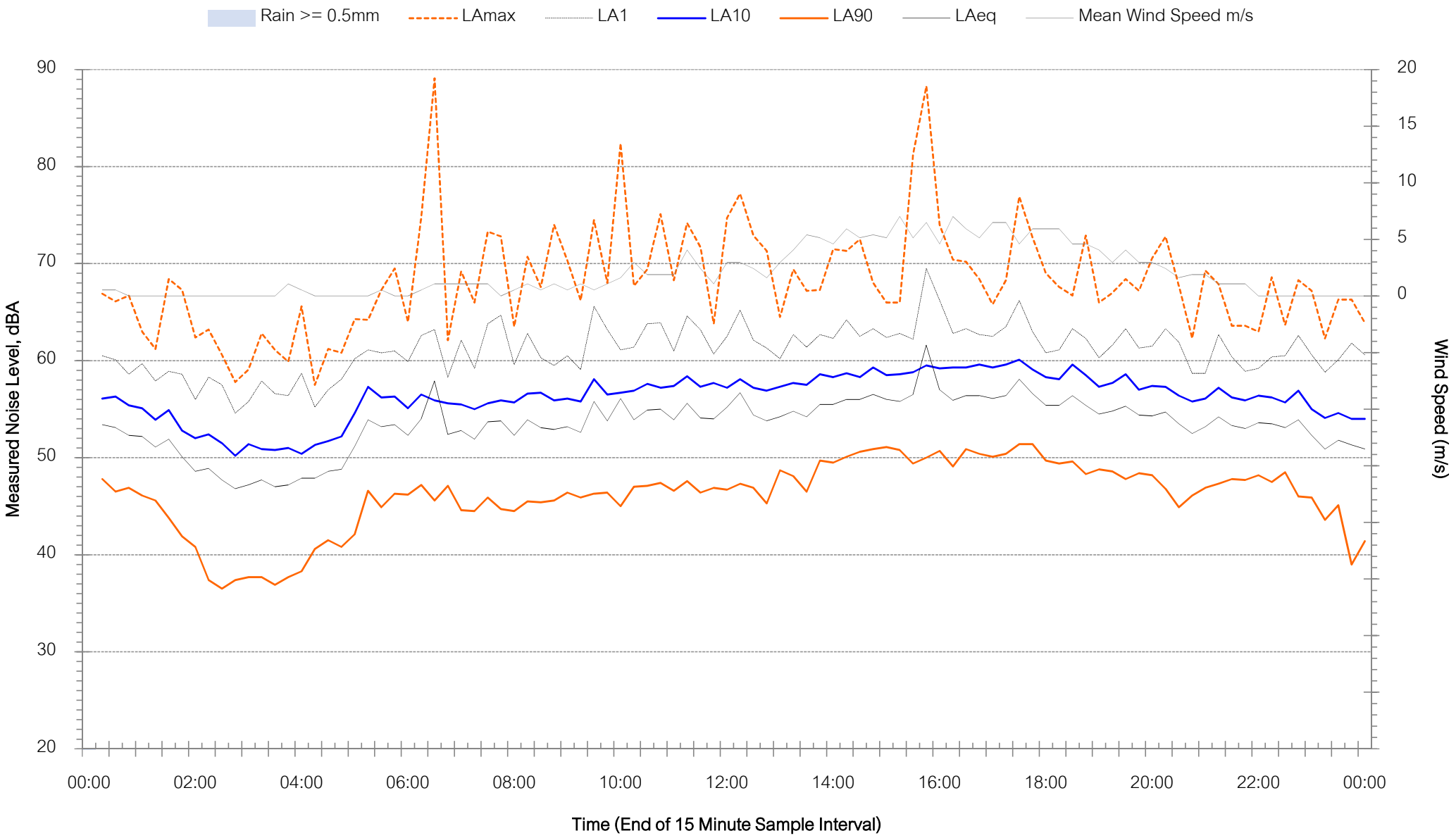
Background Noise Levels

Location - N2 - Saturday 10 November 2018



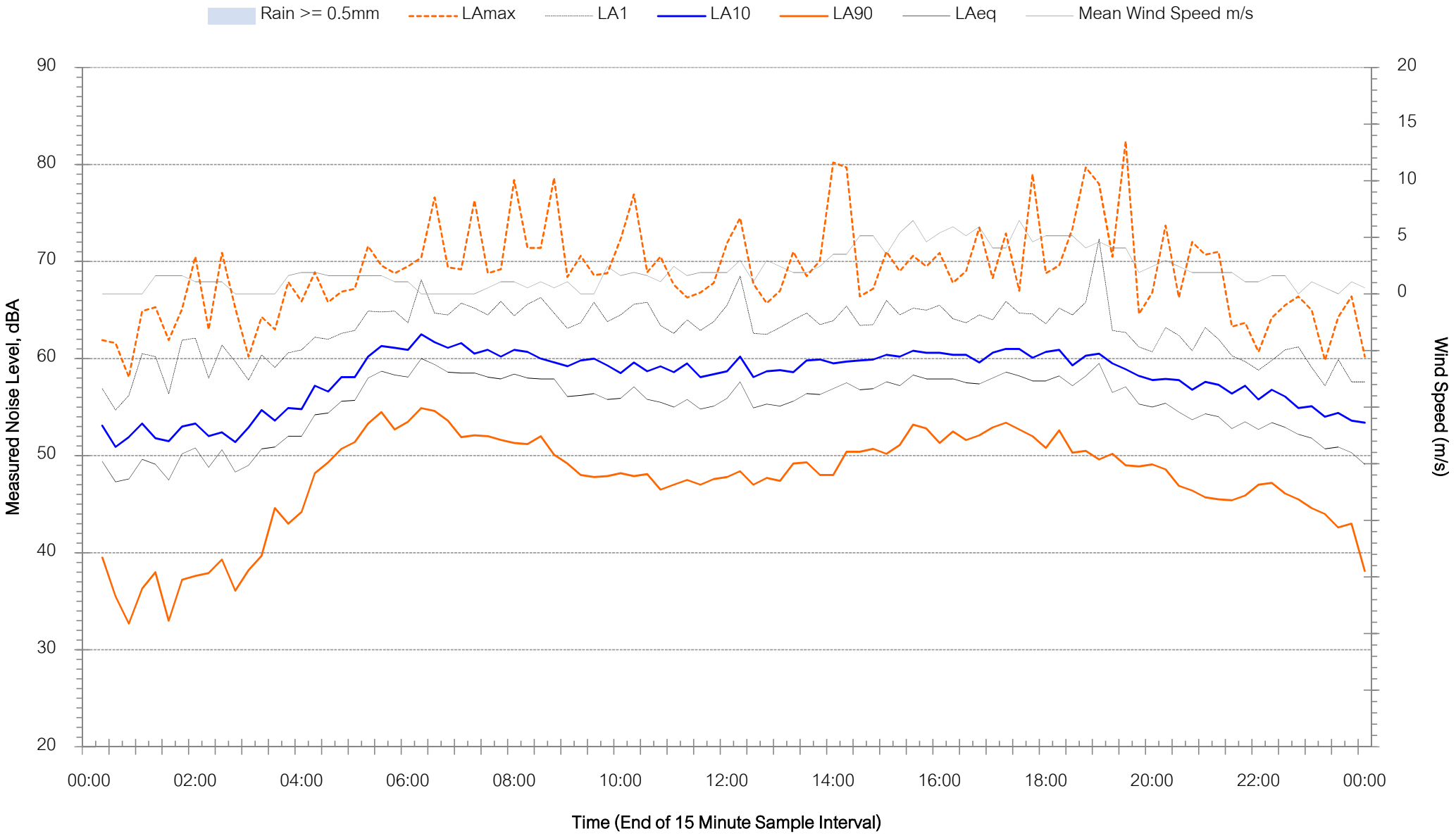
Background Noise Levels

Location - N2 - Sunday 11 November 2018



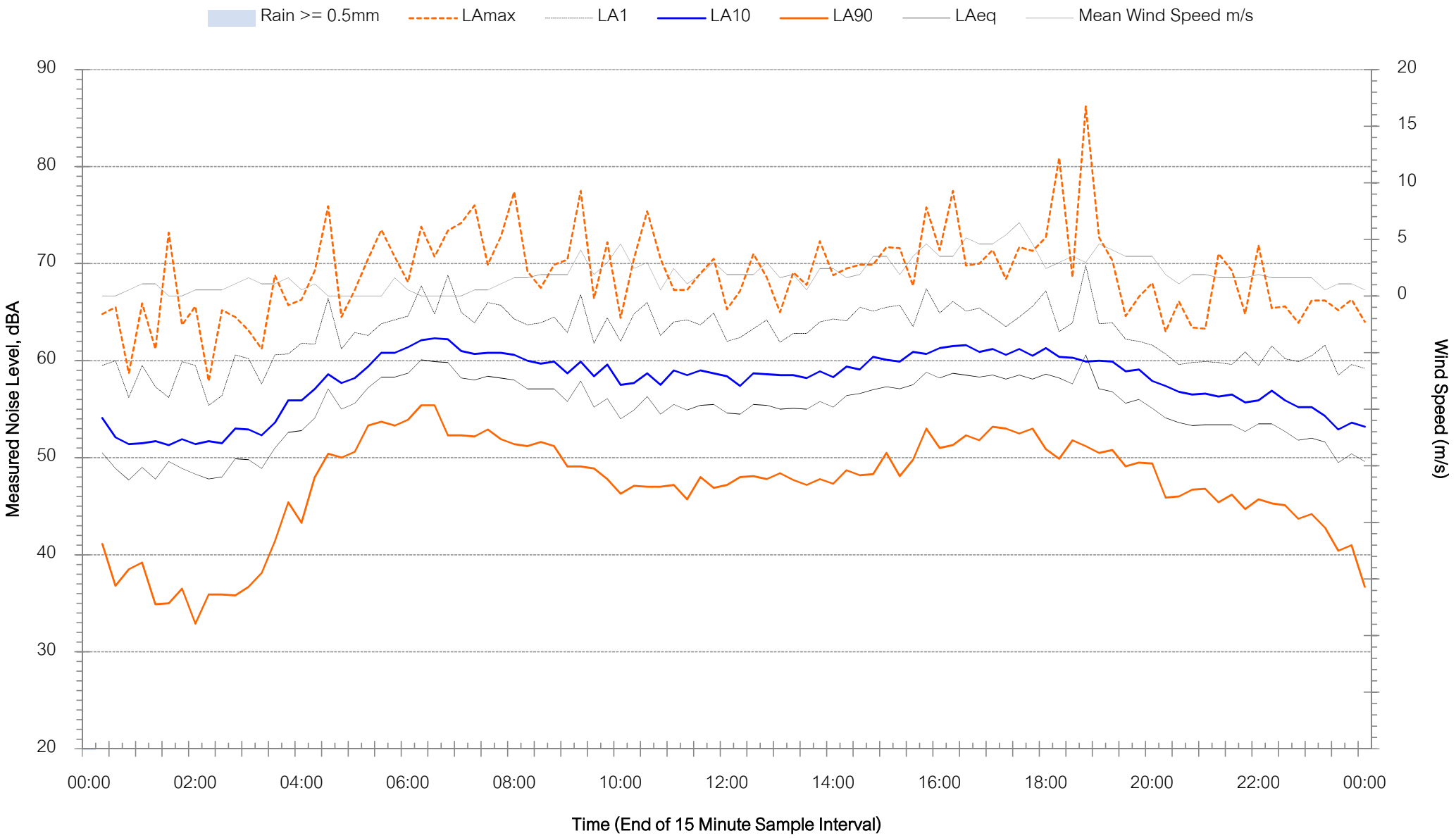
Background Noise Levels

Location - N2 - Monday 12 November 2018



Background Noise Levels

Location - N2 - Tuesday 13 November 2018



Background Noise Levels

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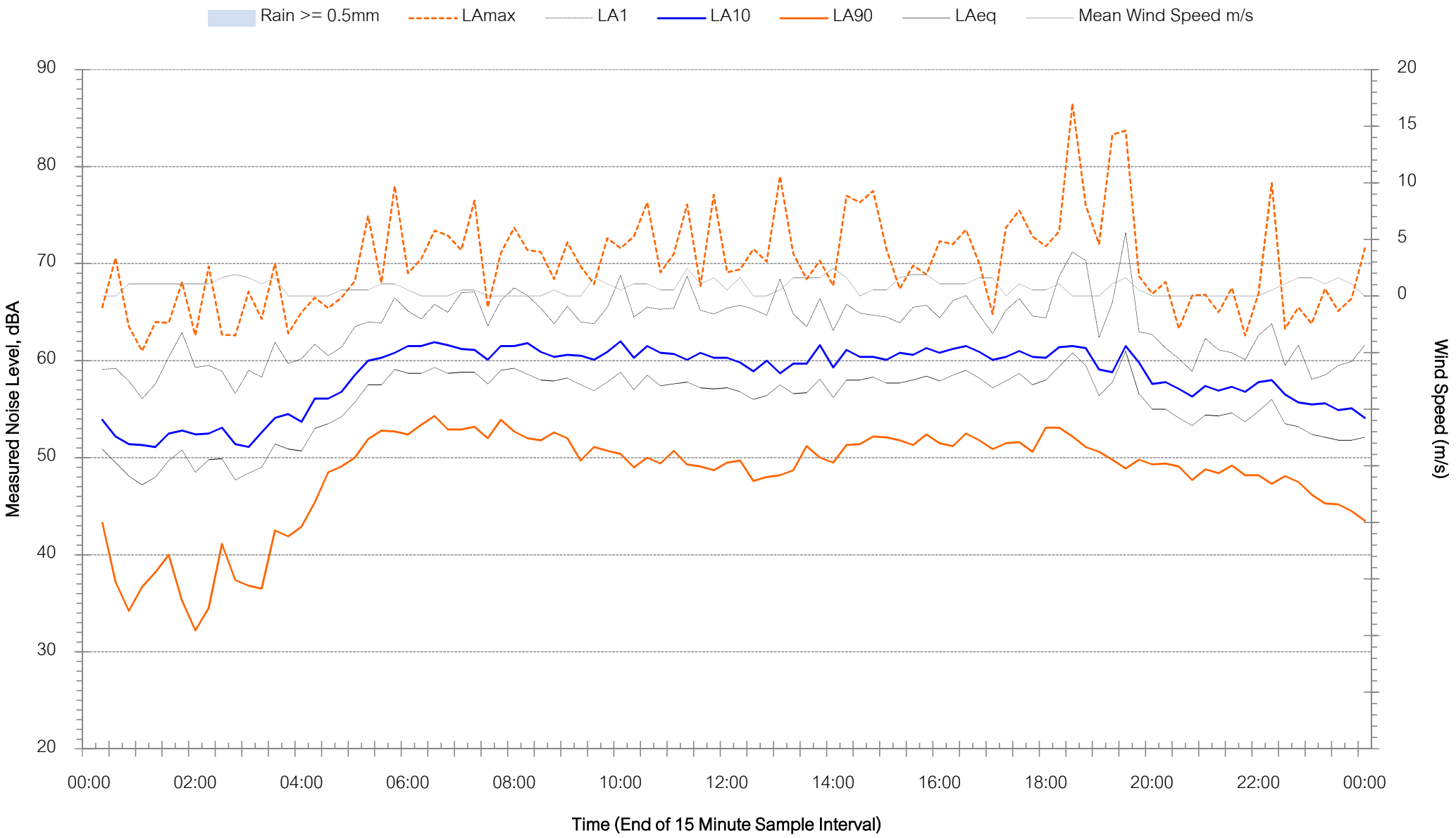

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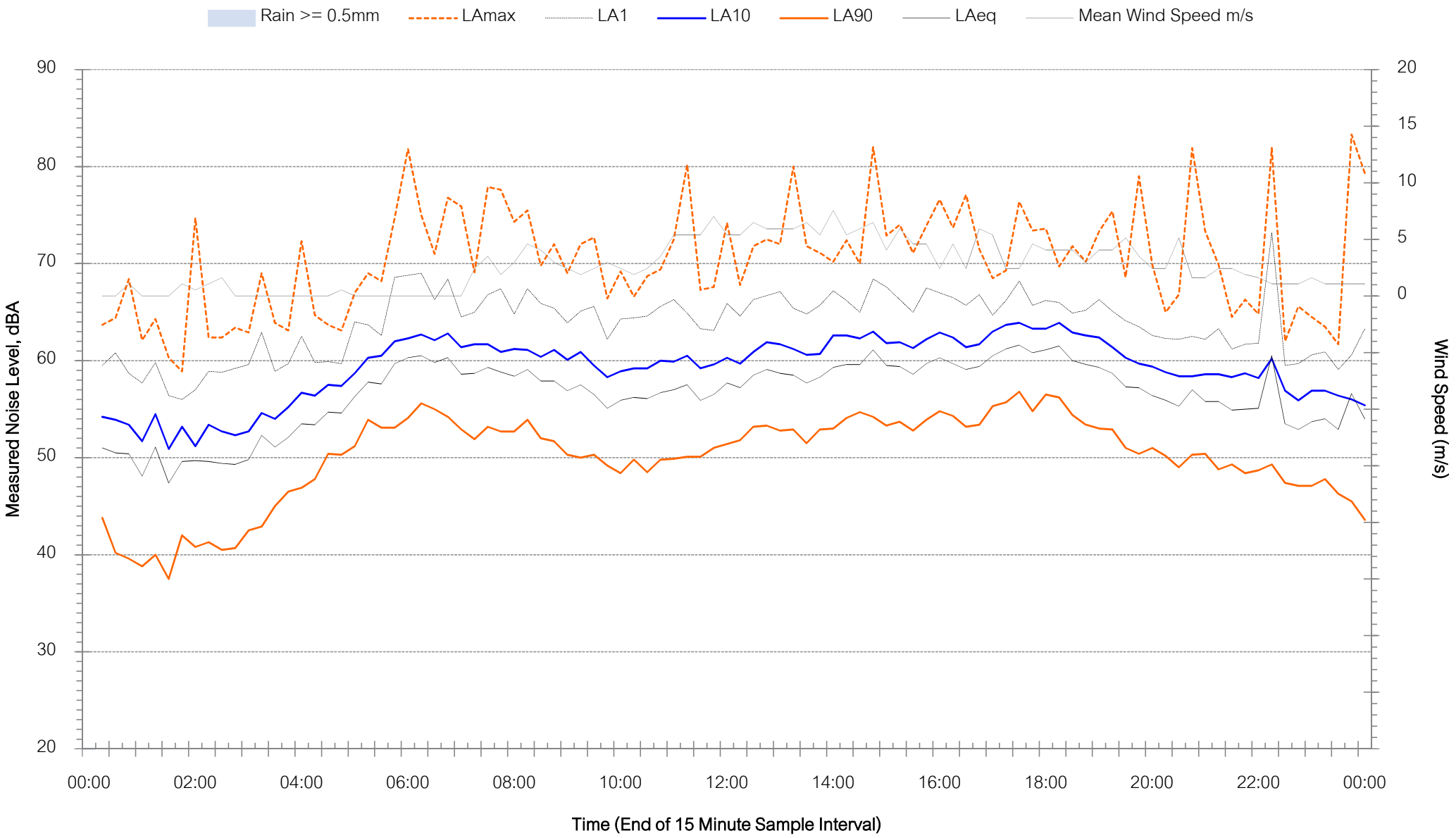

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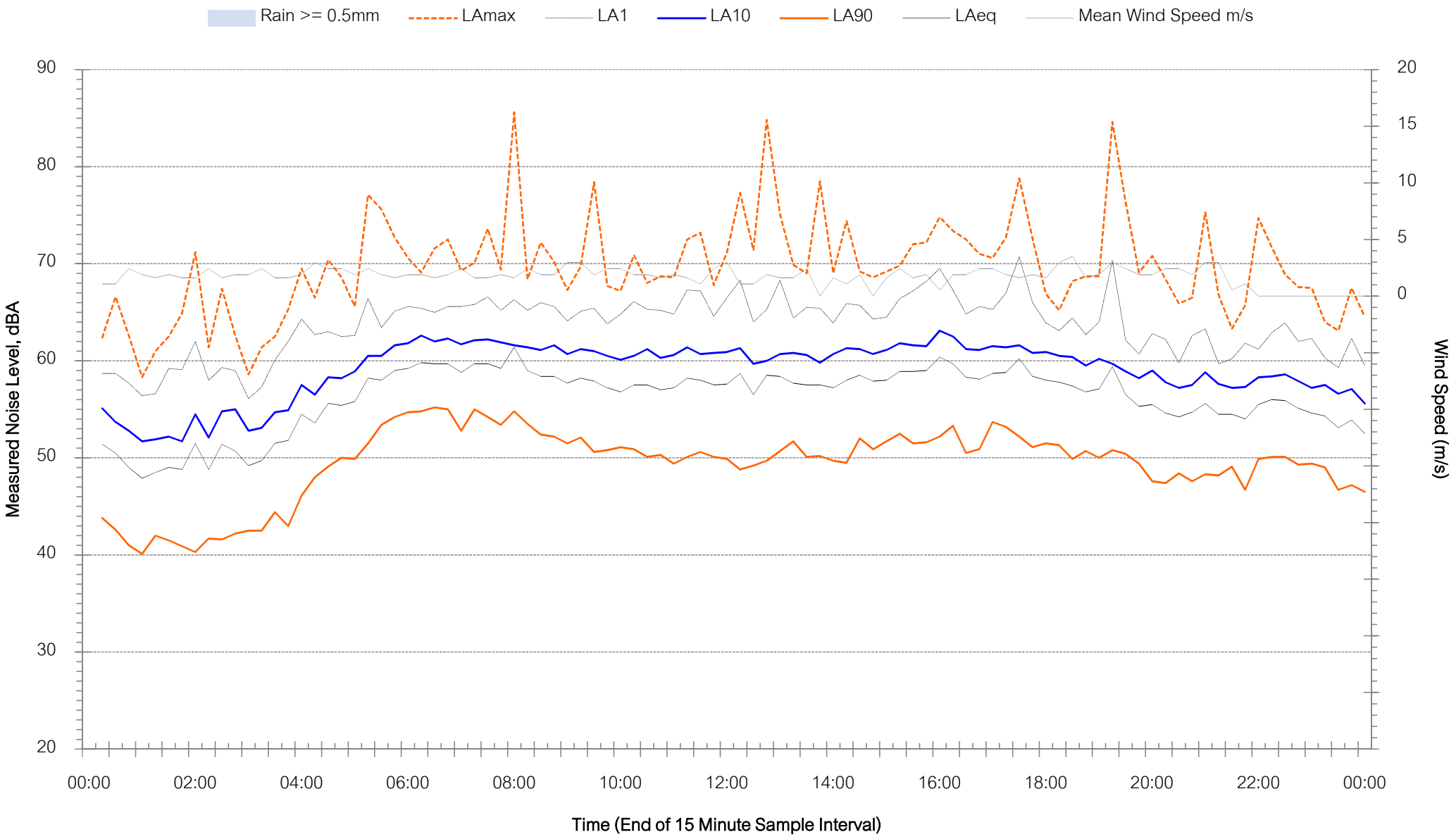

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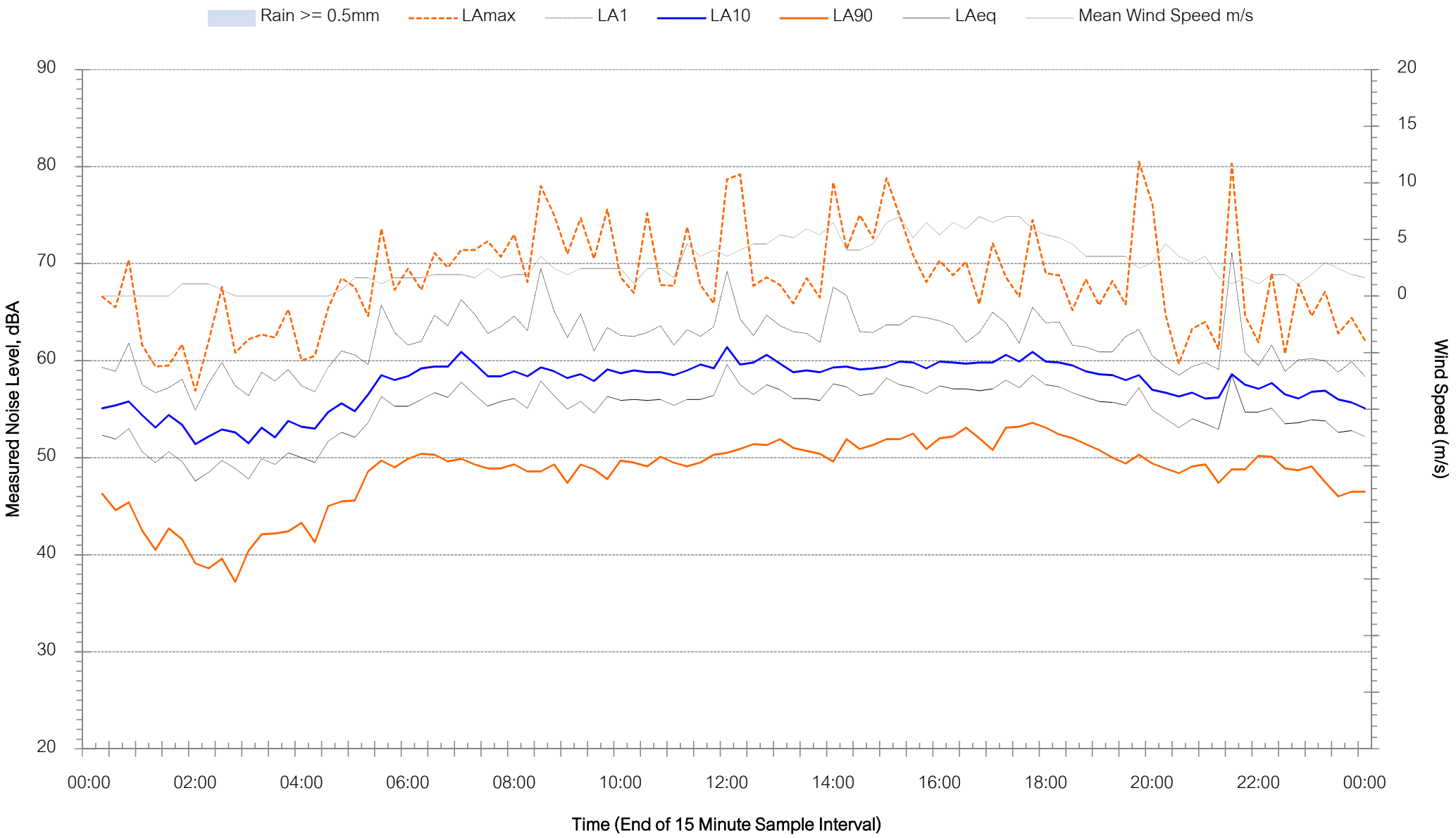

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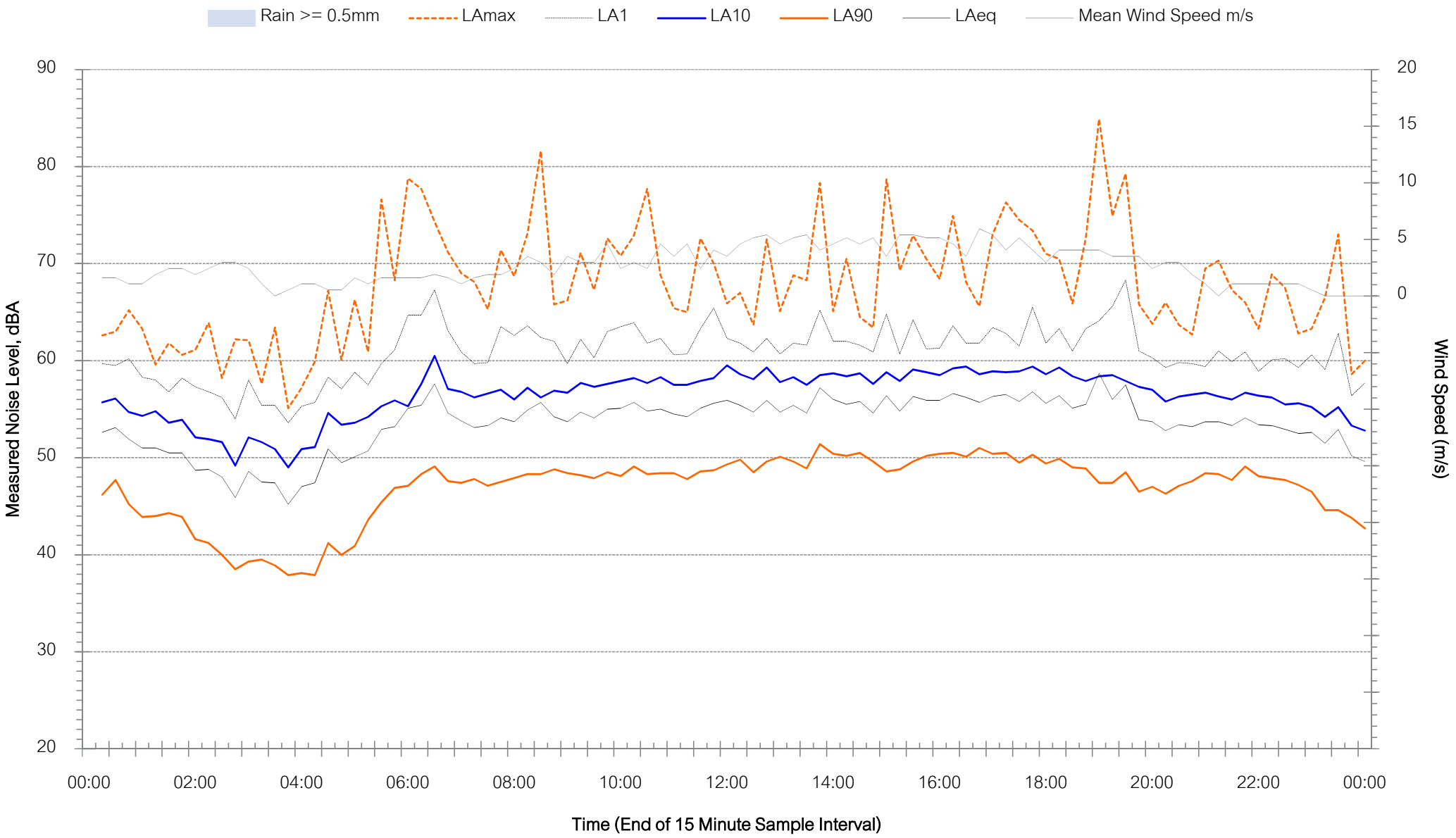

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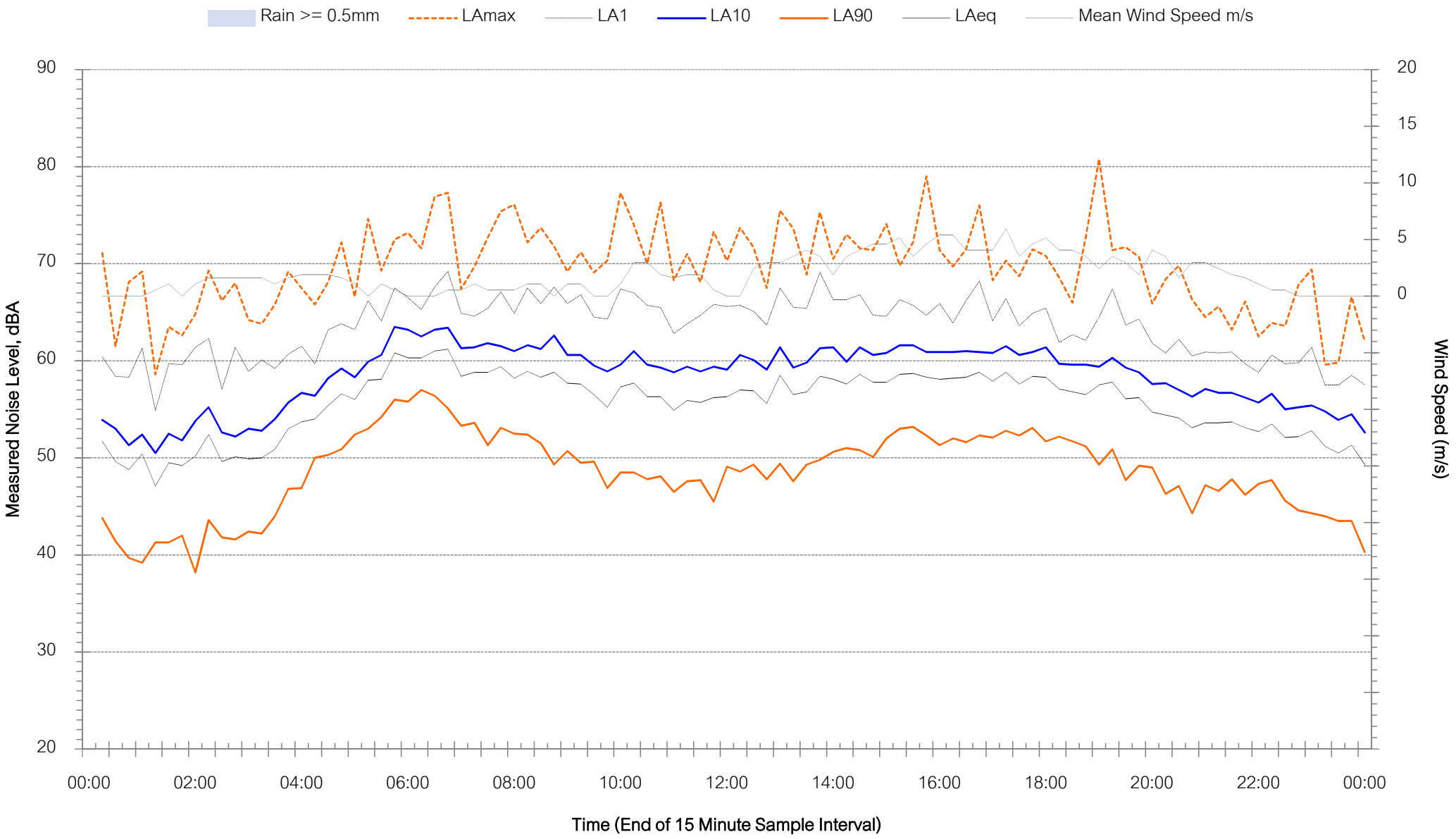

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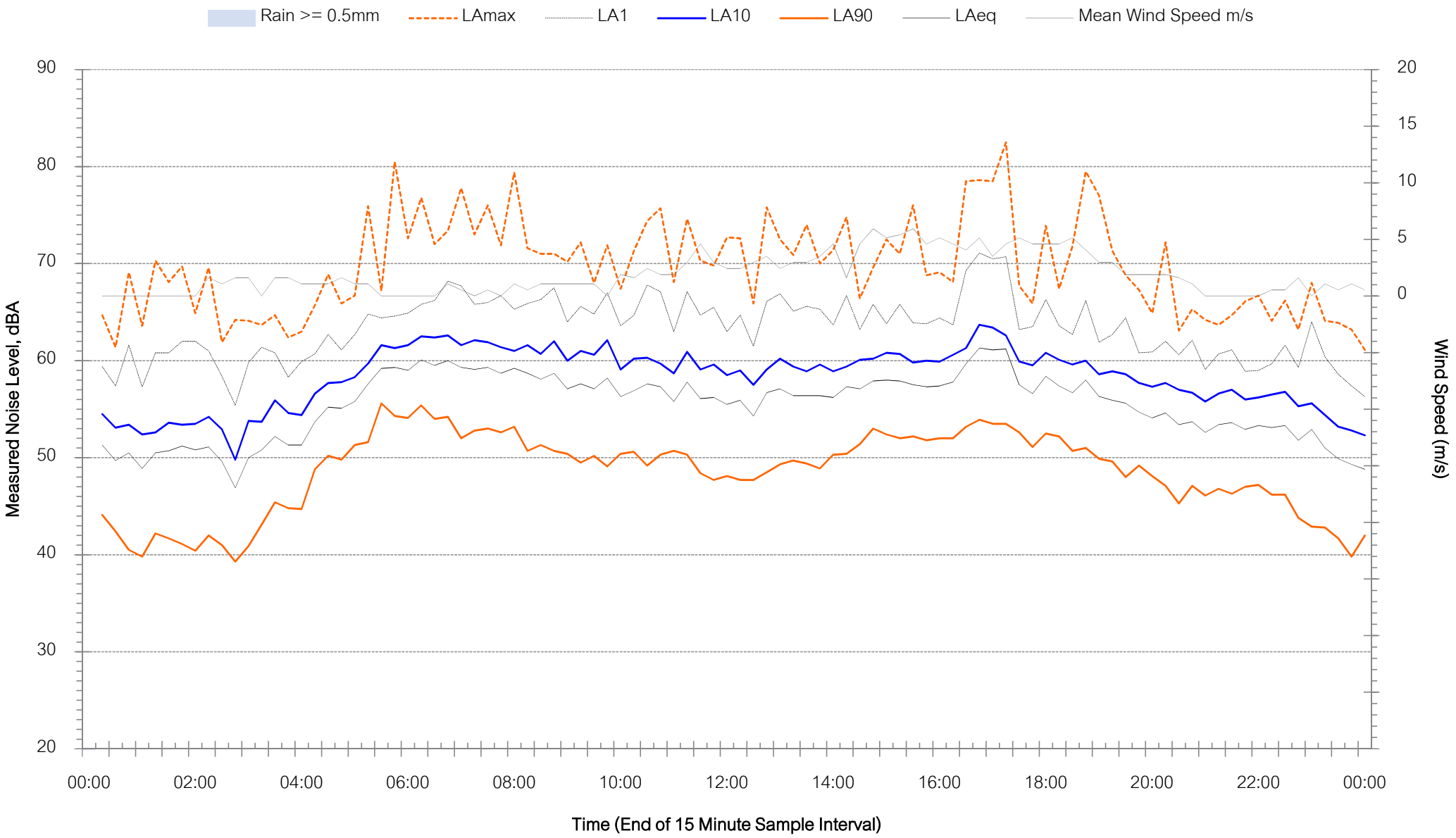

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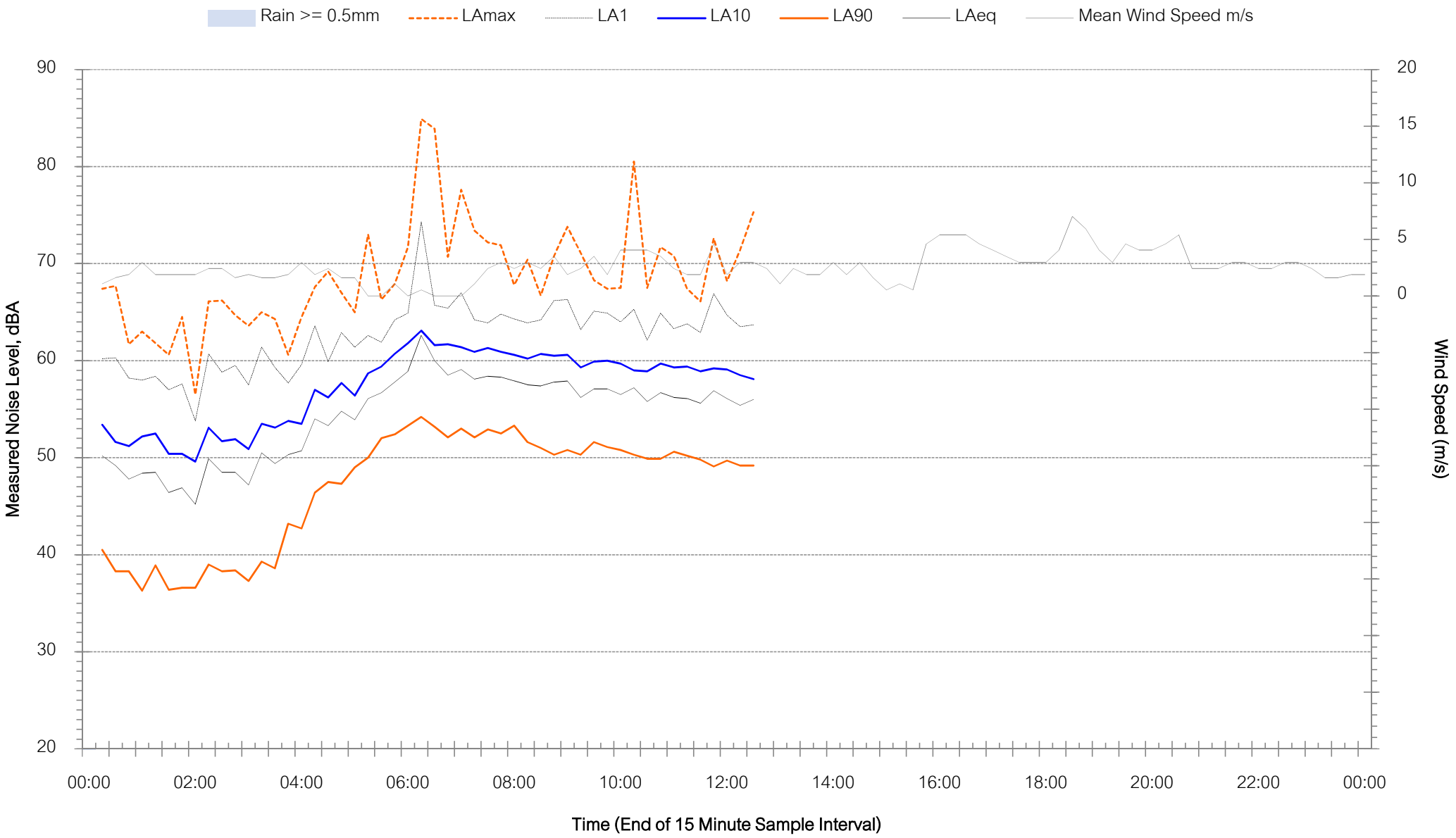

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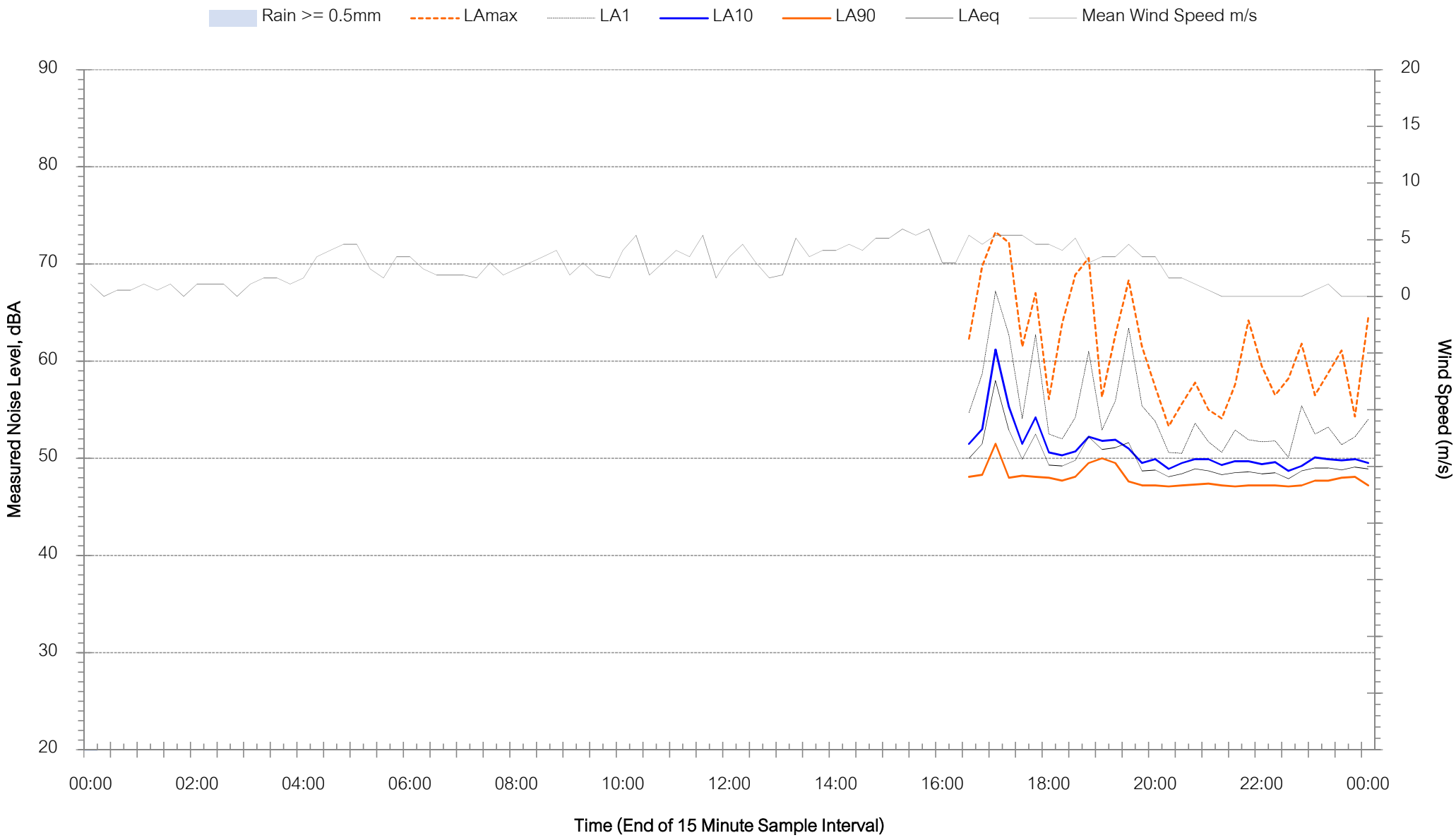

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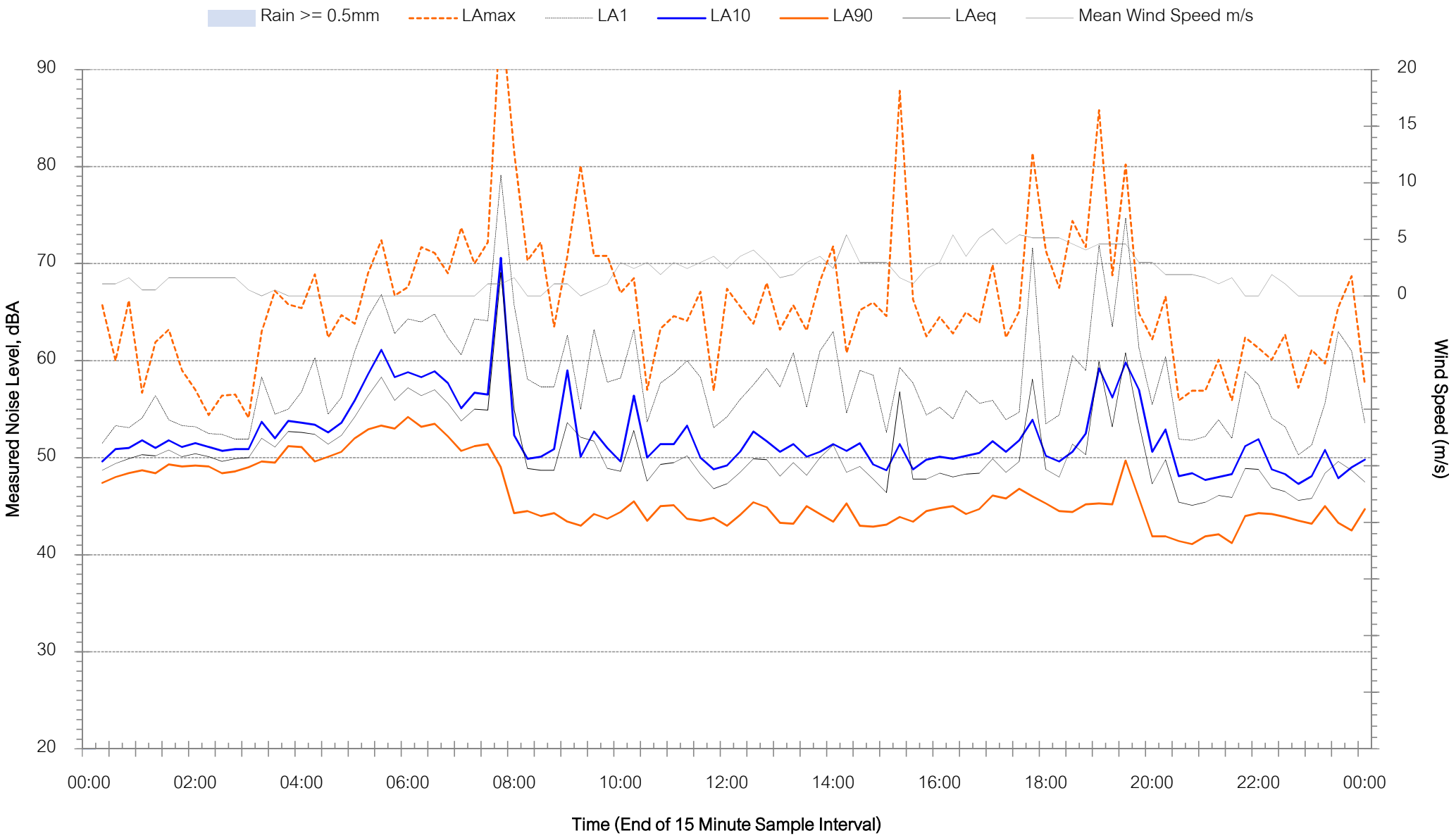

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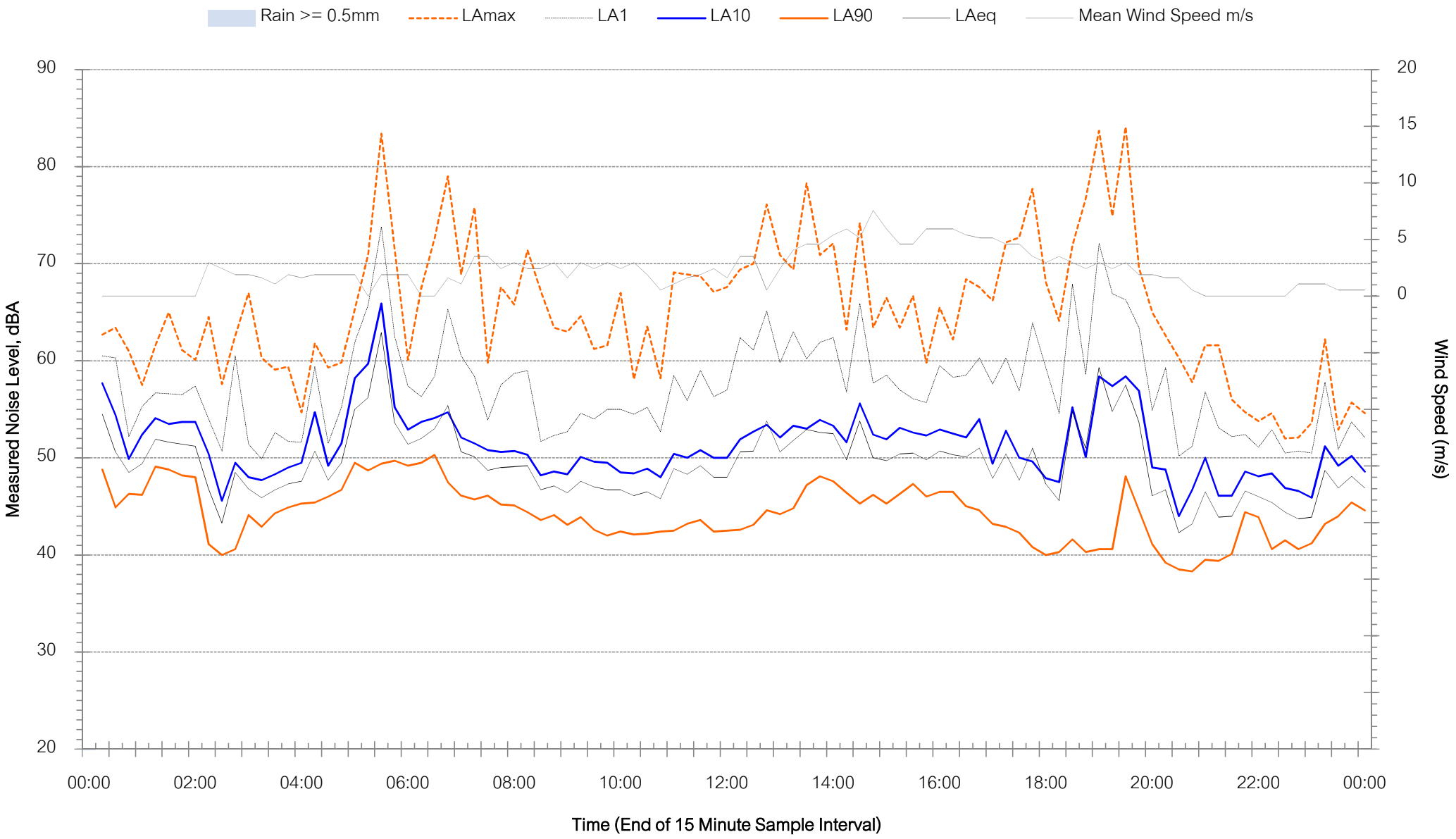

Background Noise Levels

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Background Noise Levels

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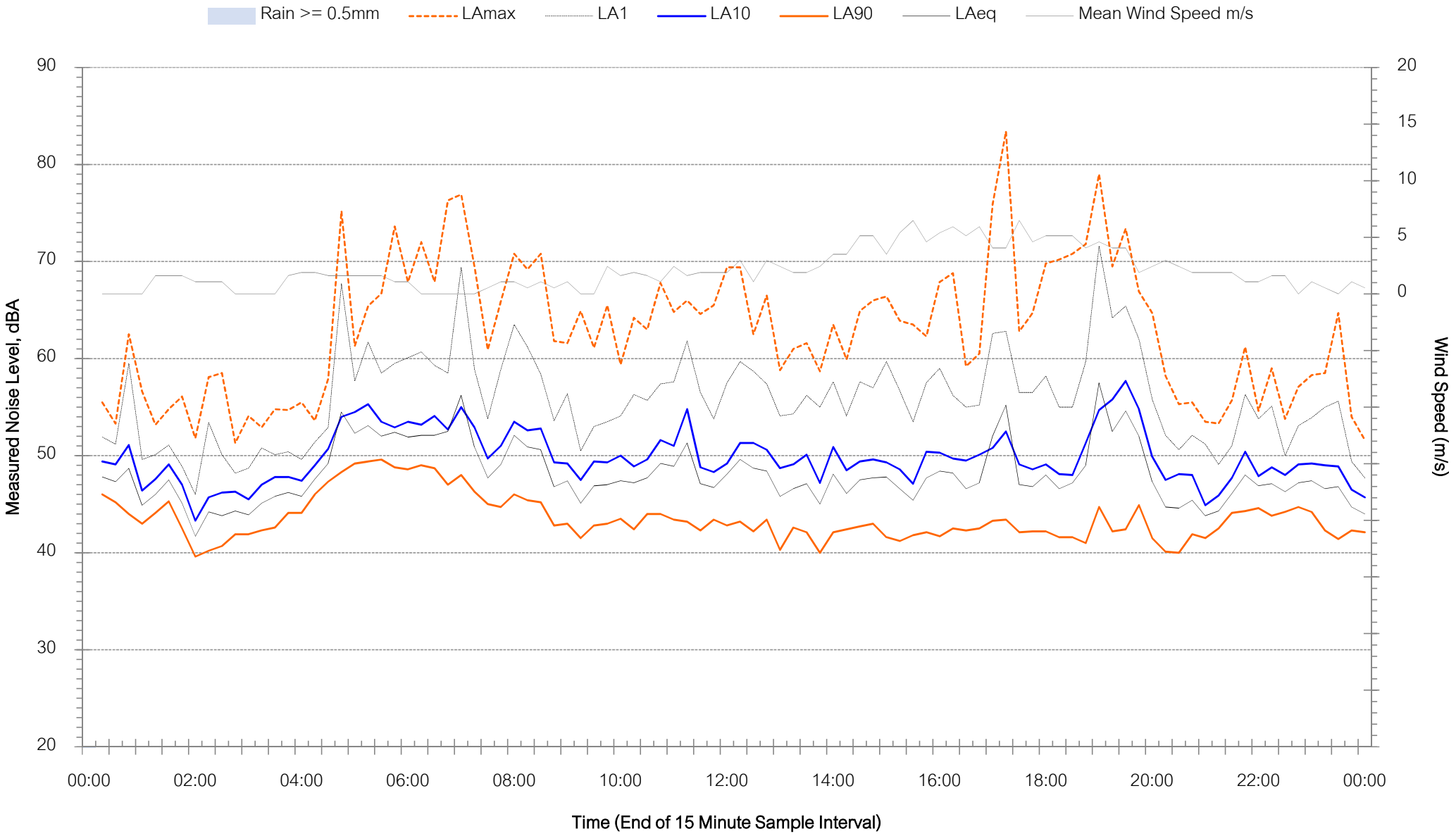

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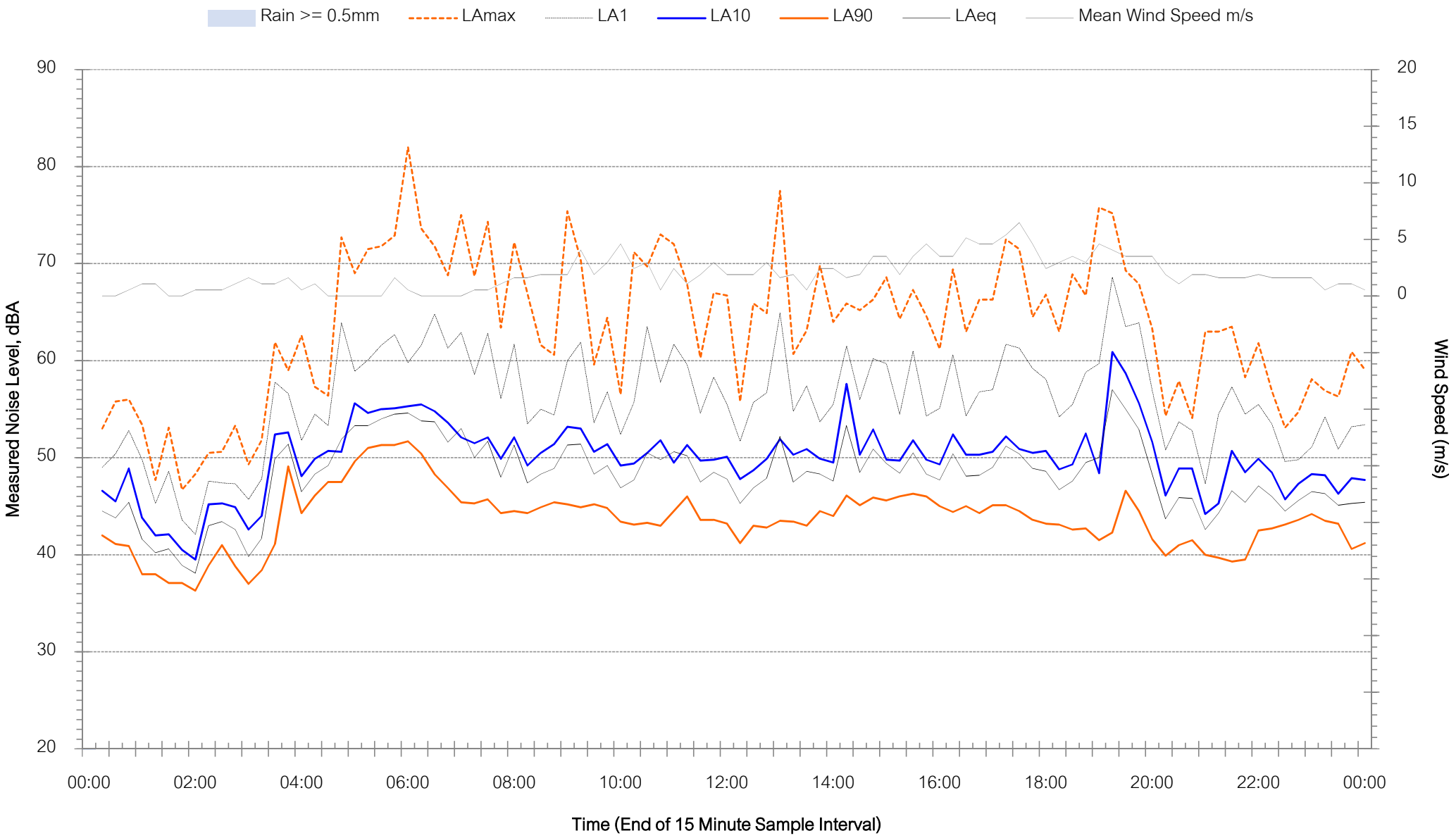

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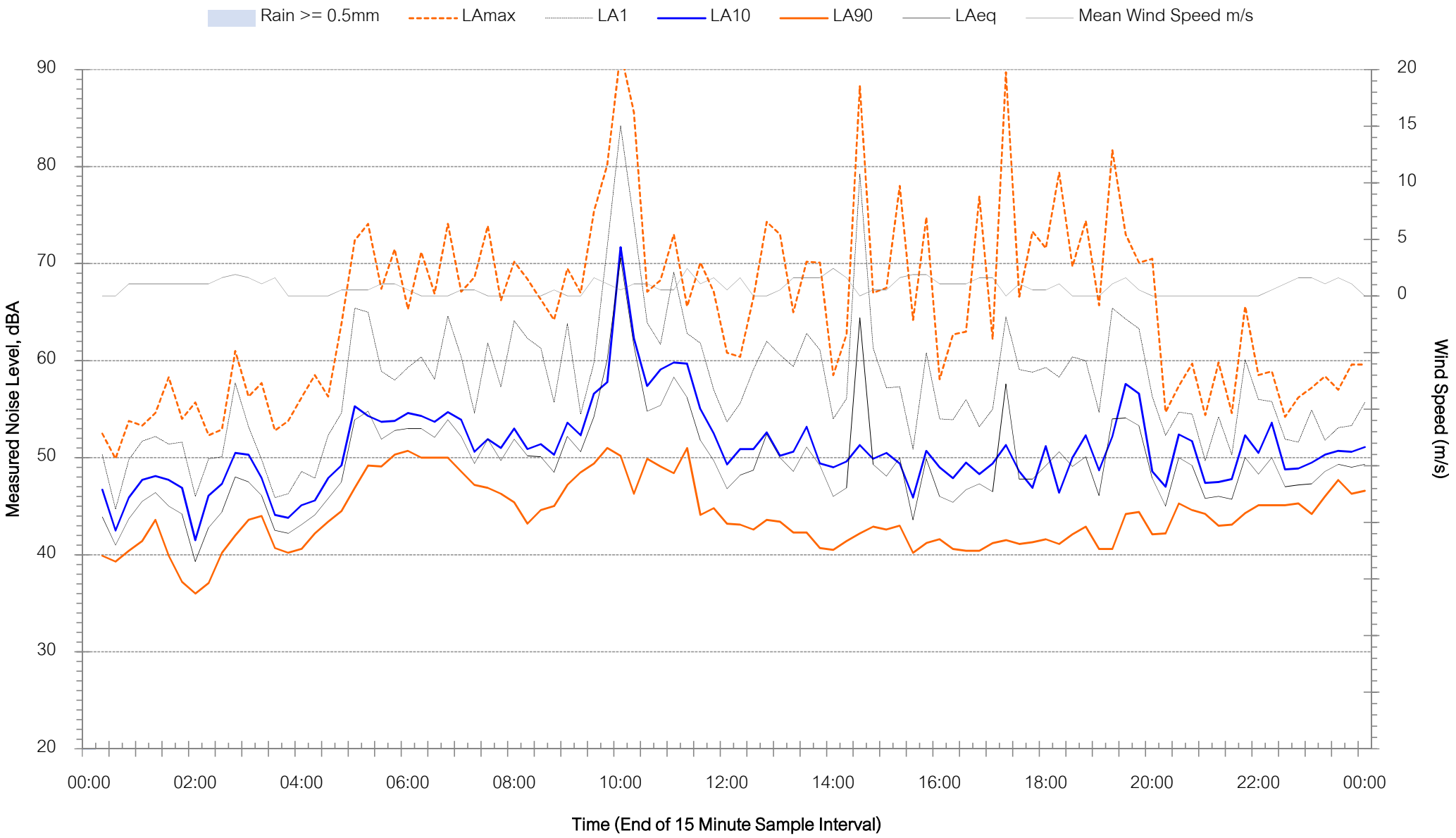

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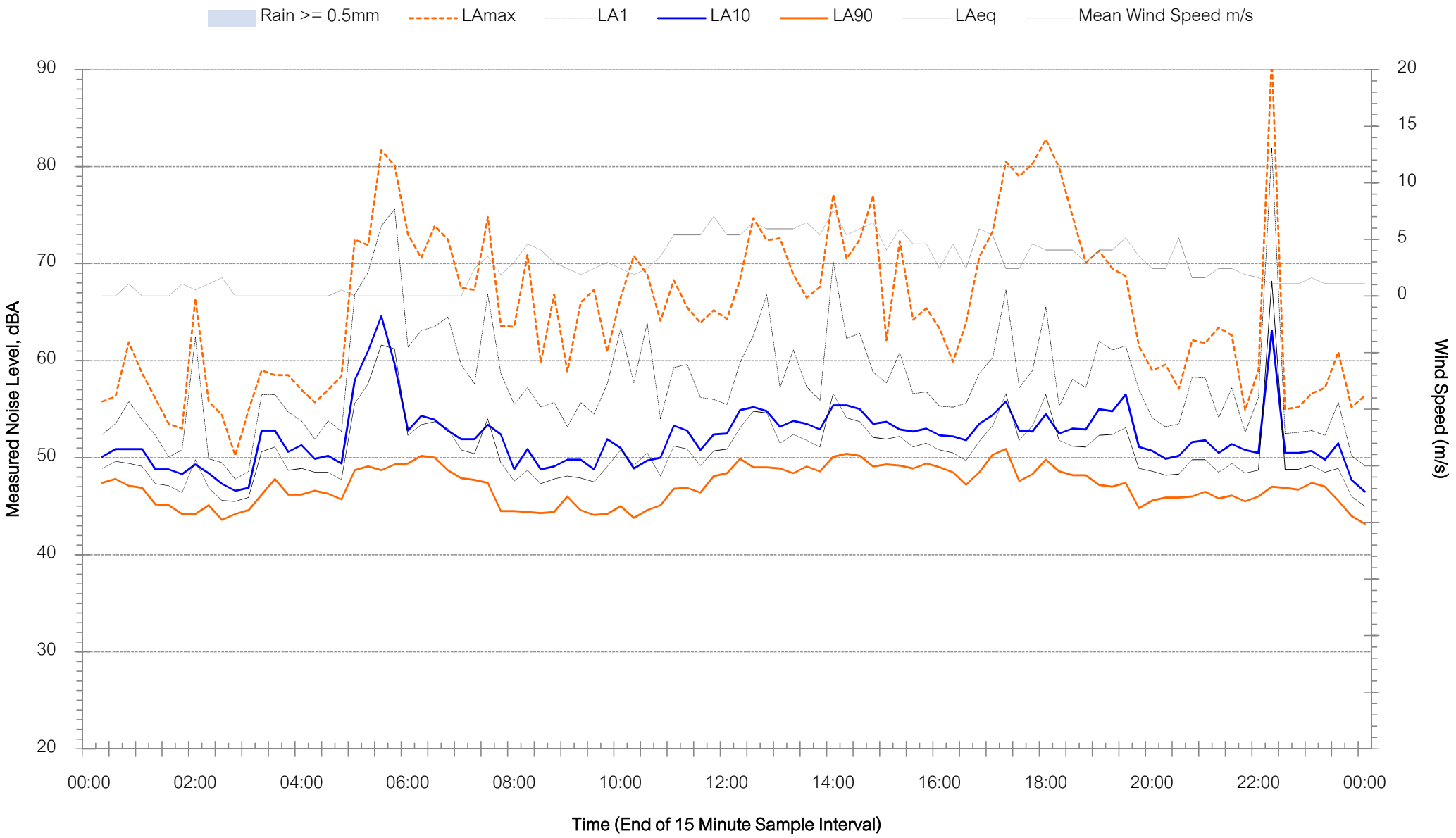

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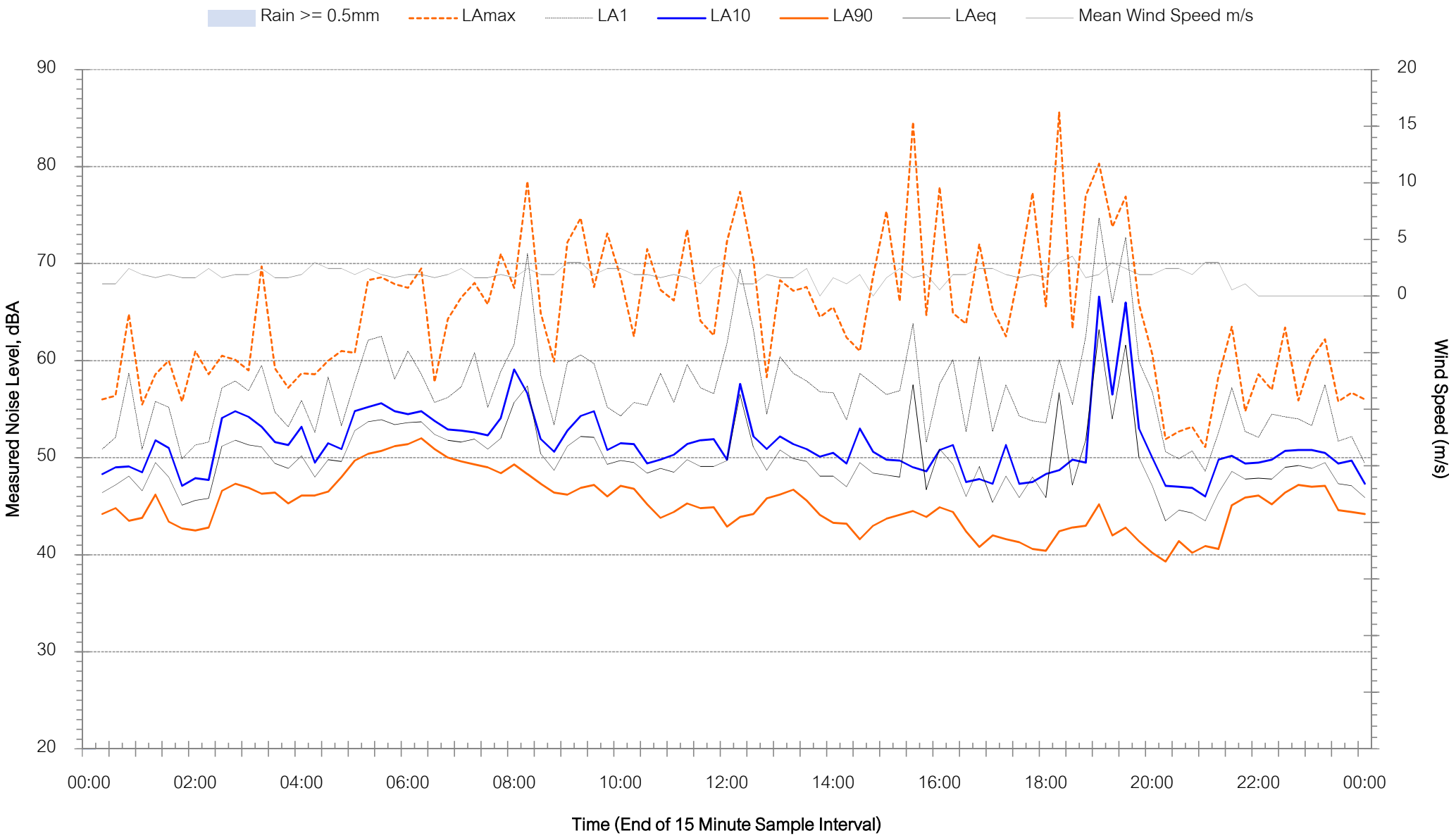

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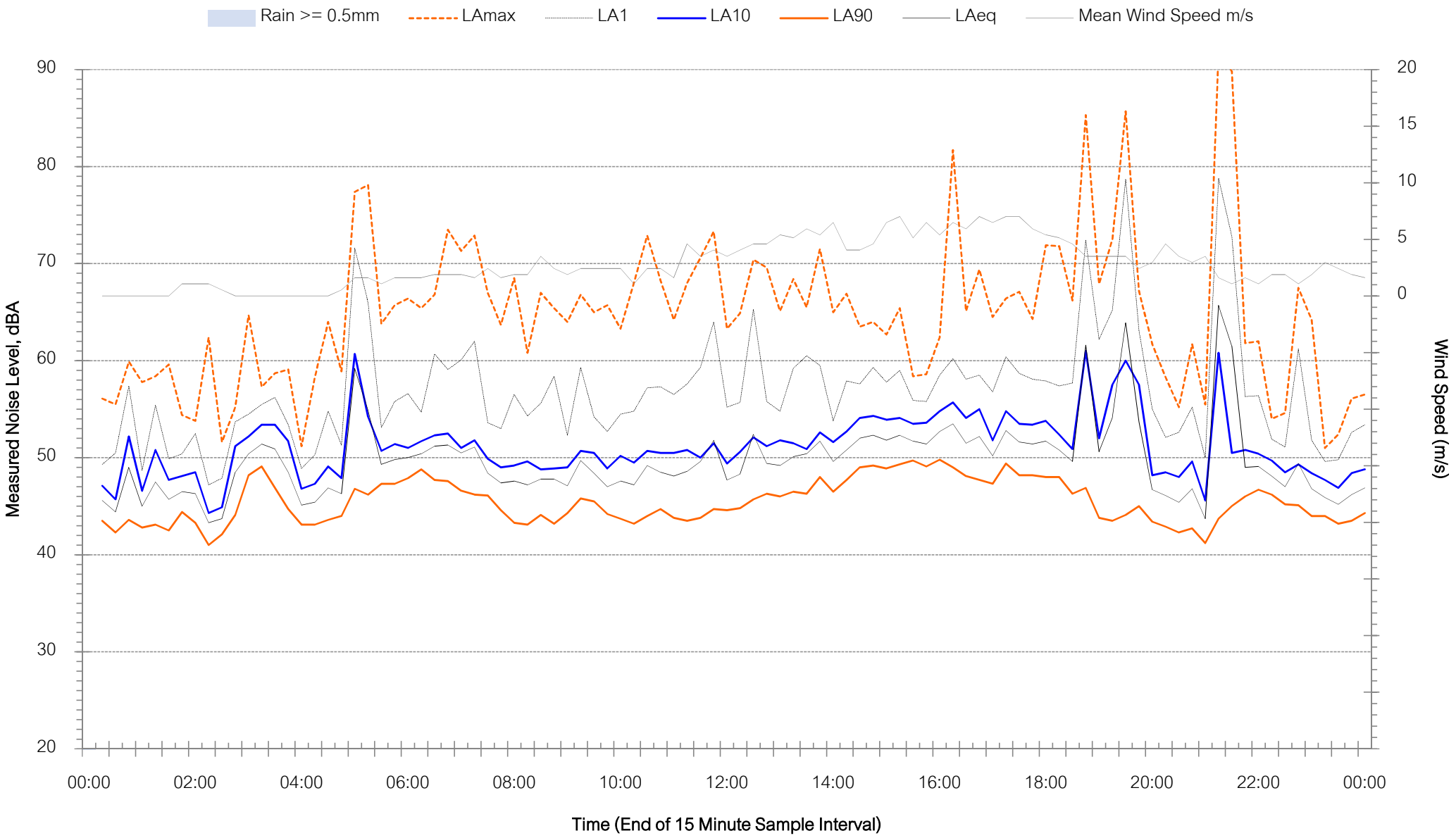

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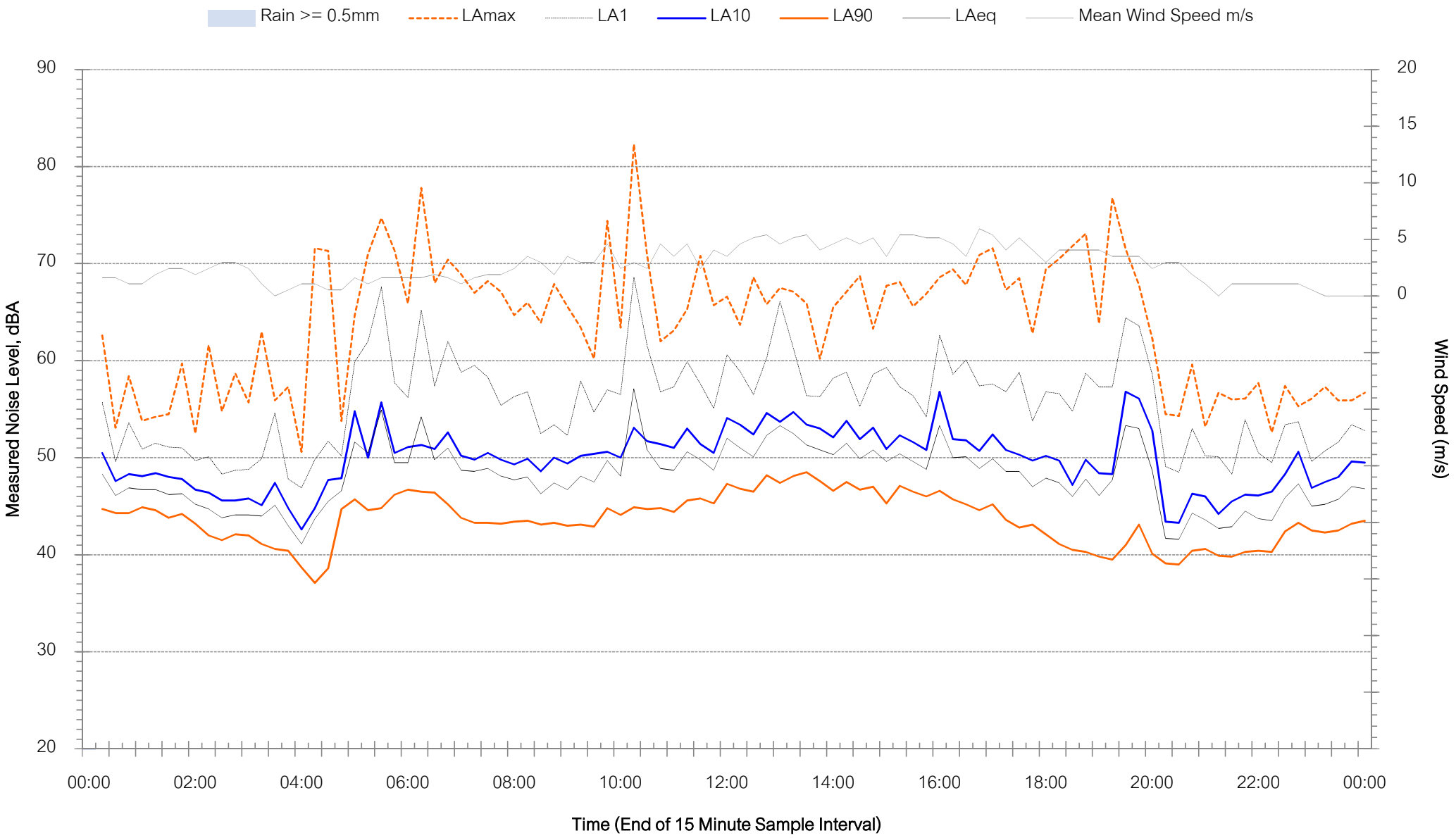

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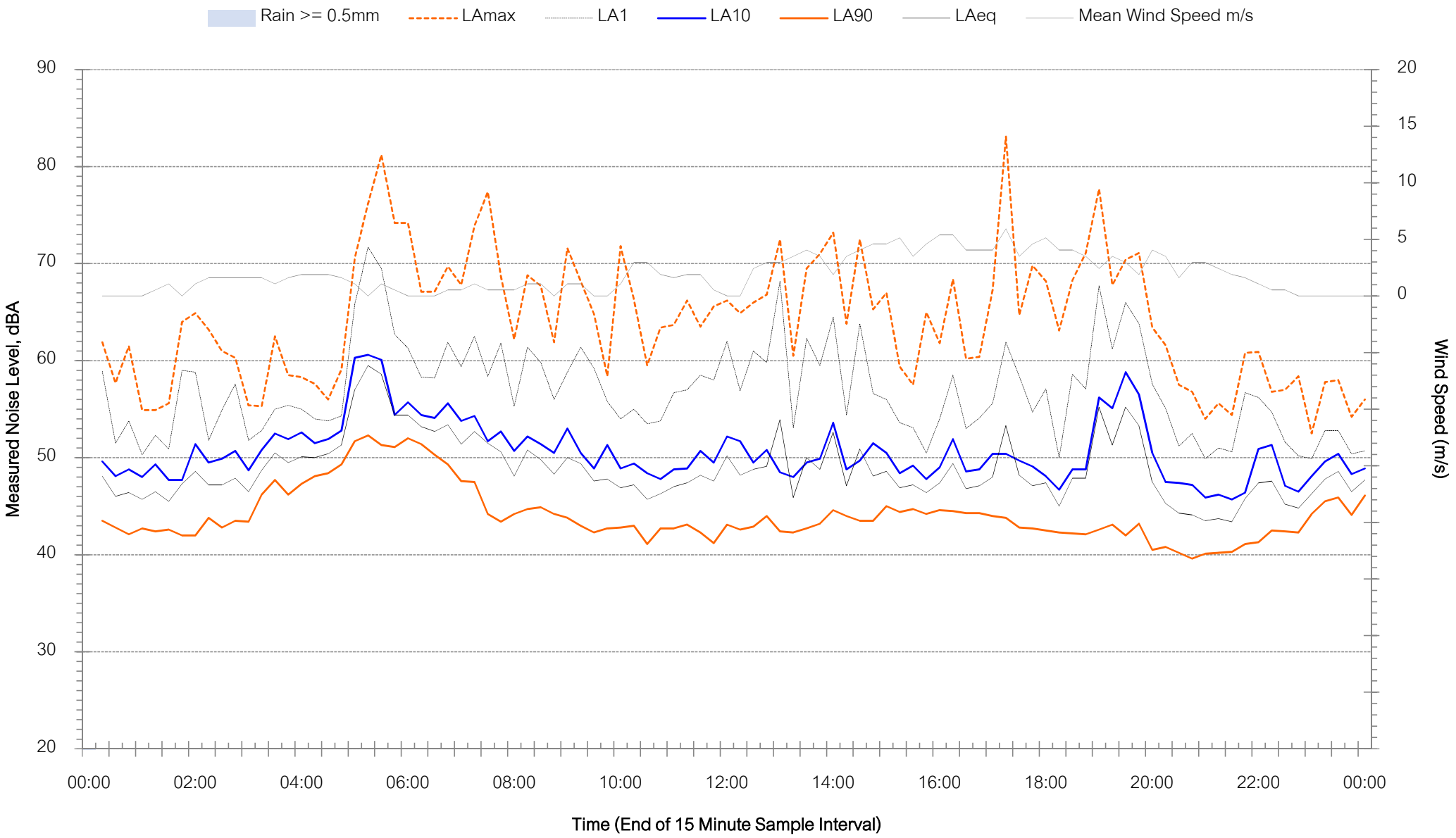

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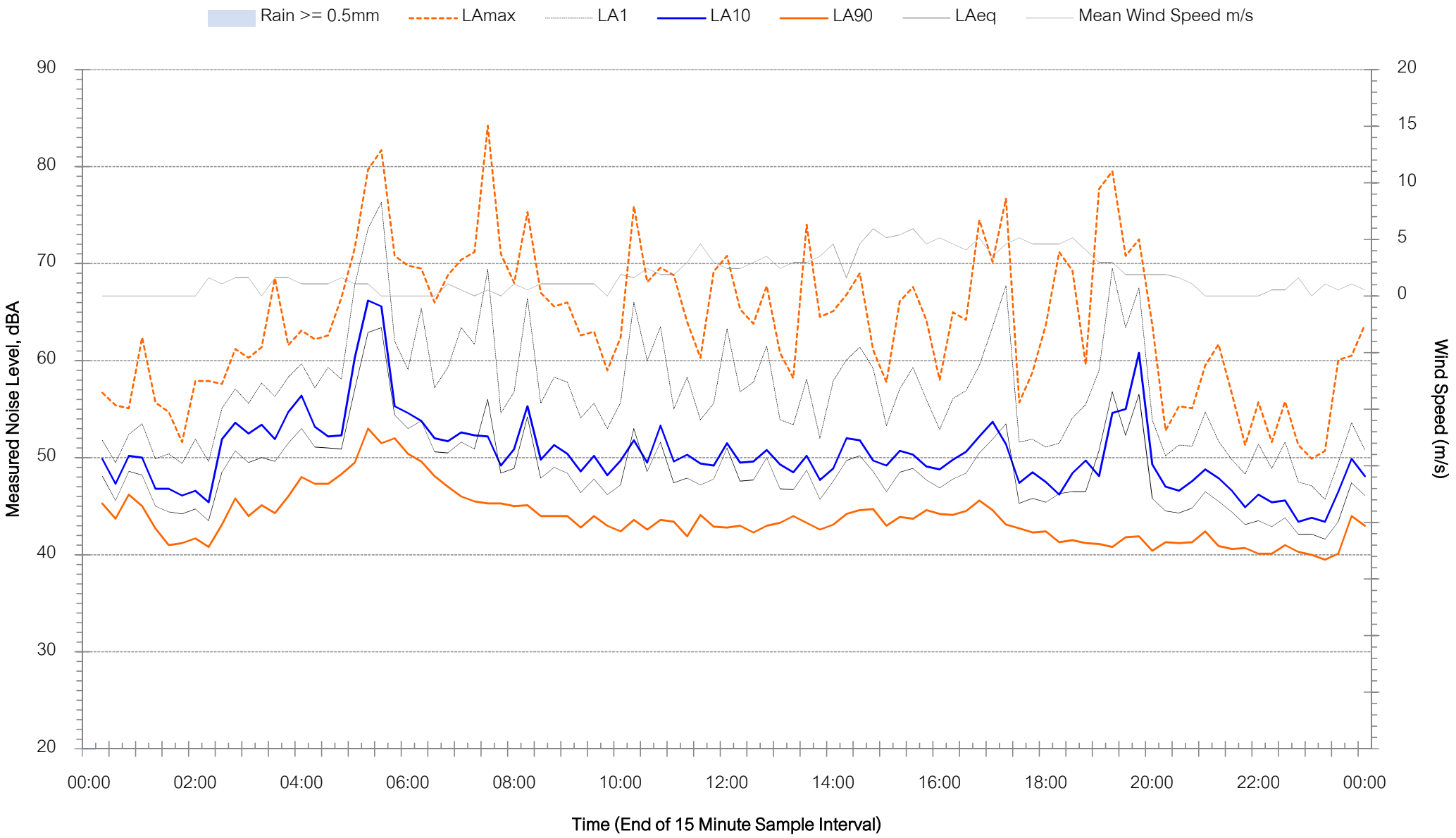

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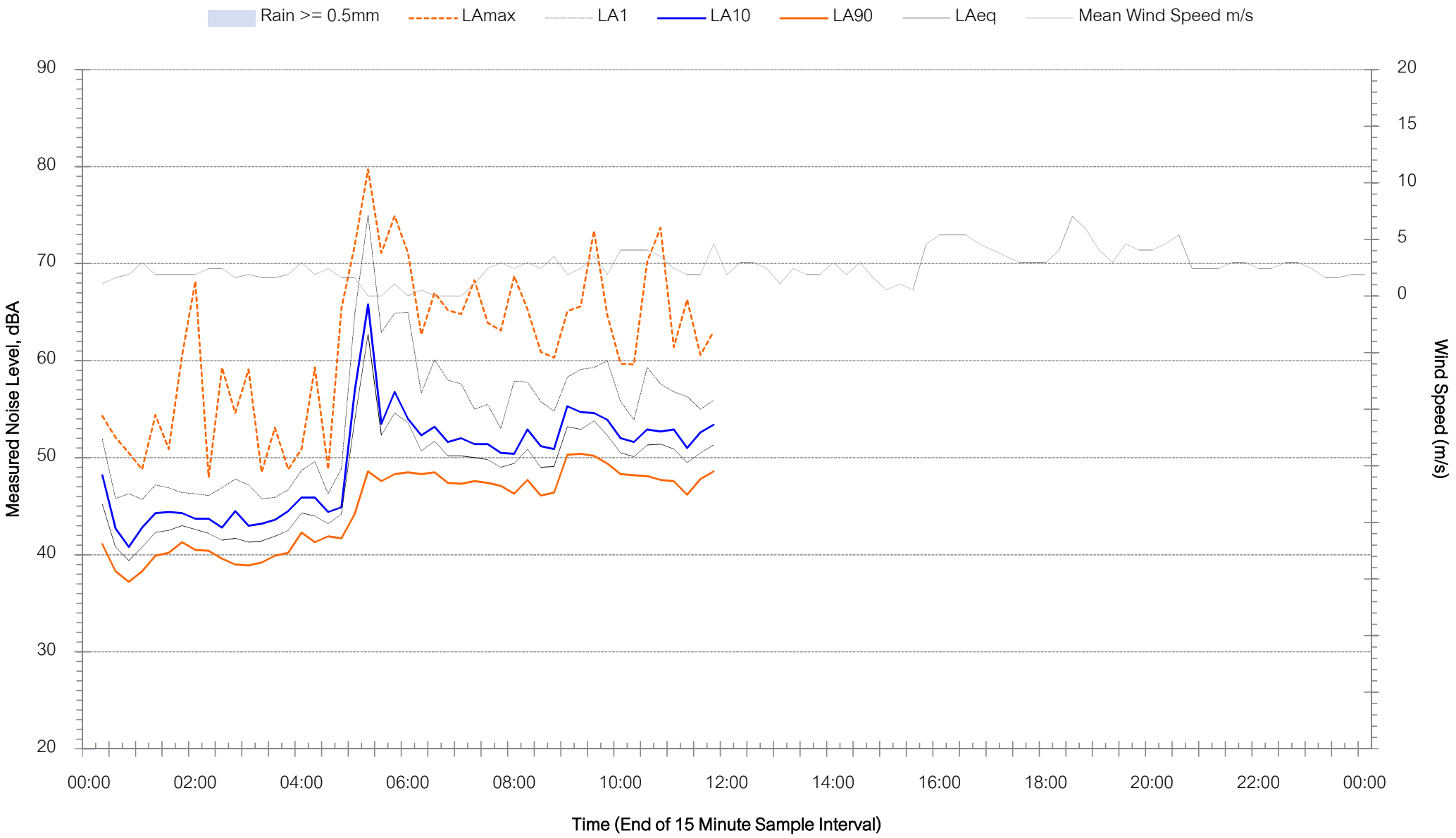

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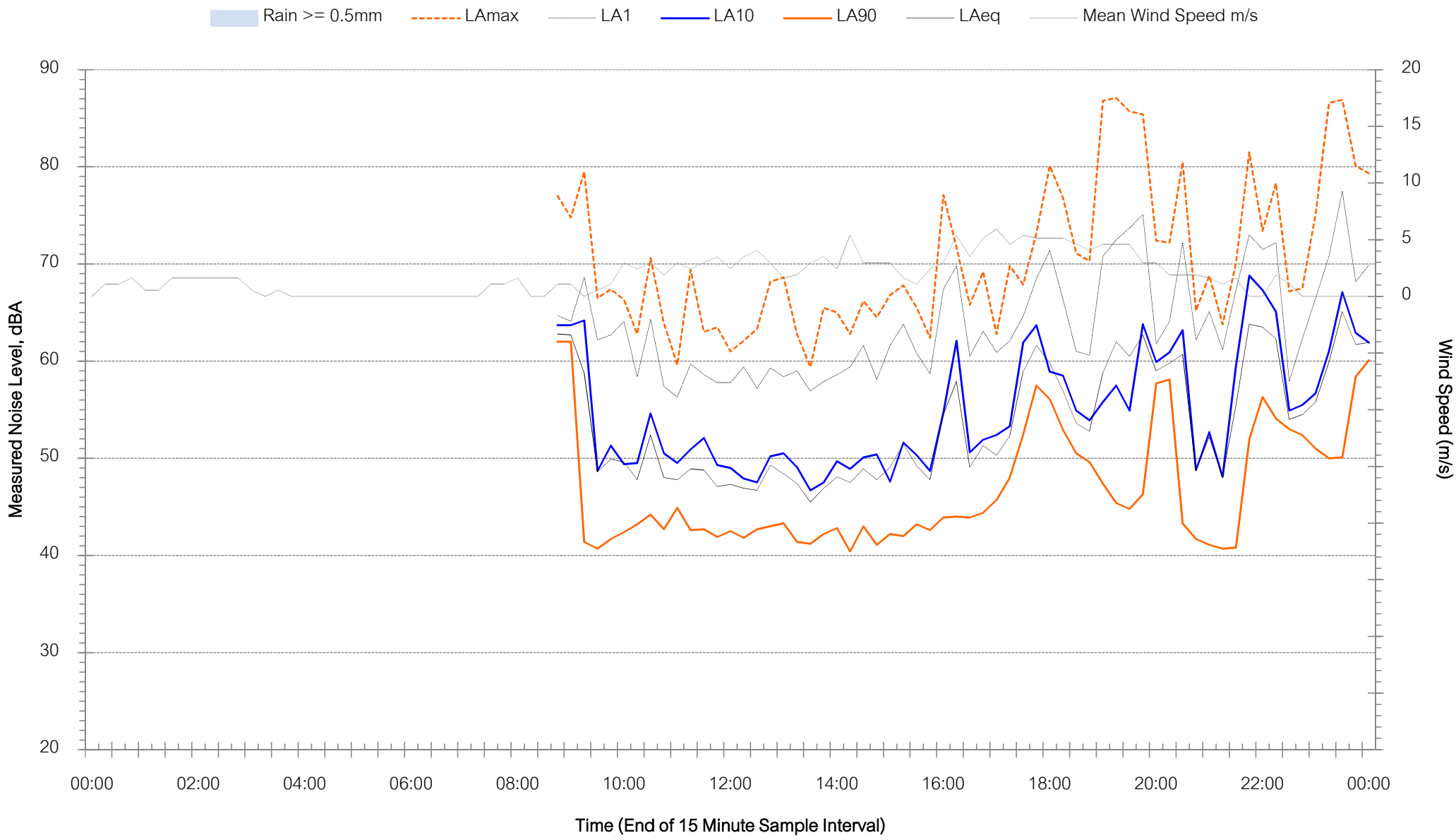

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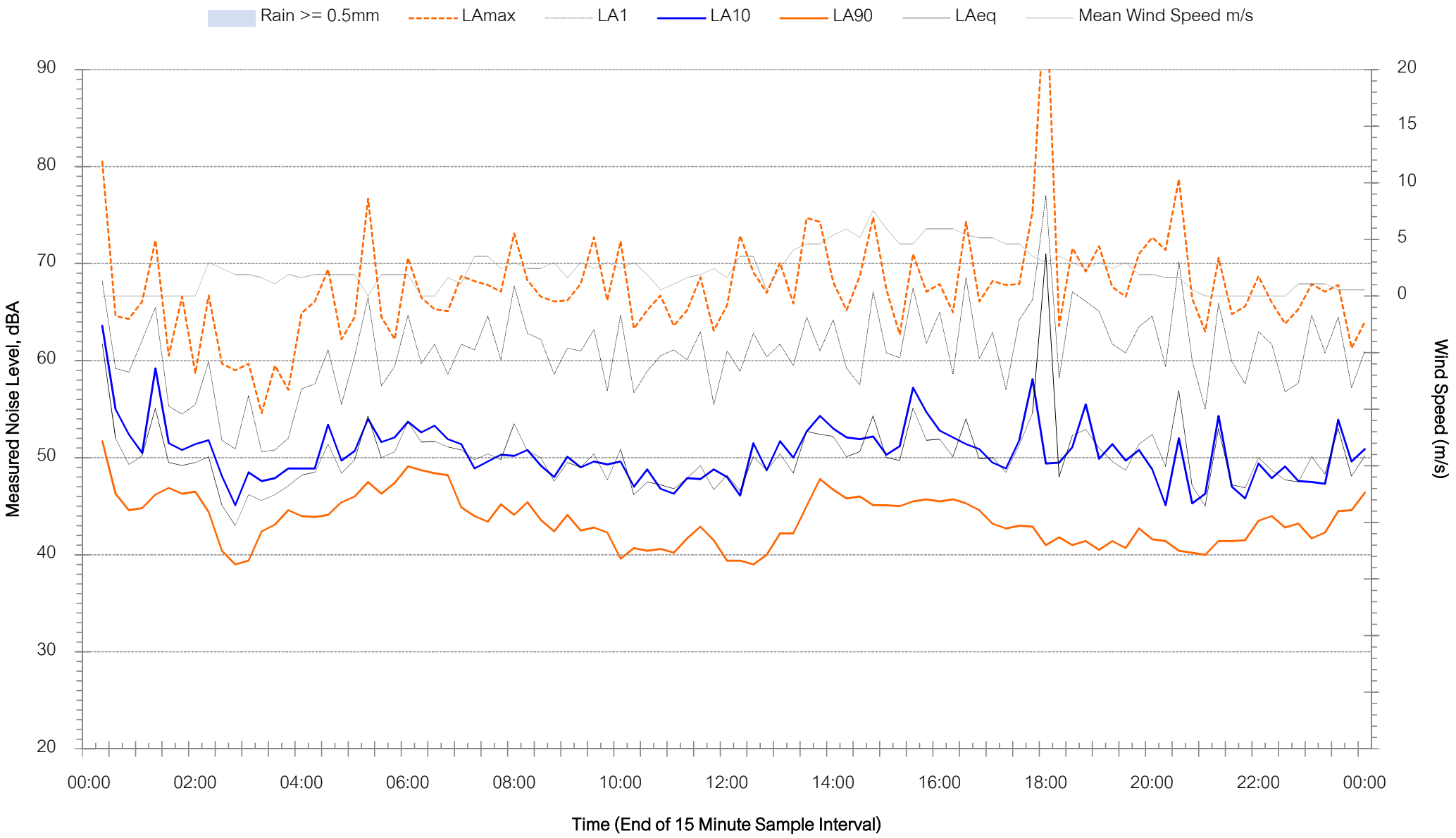

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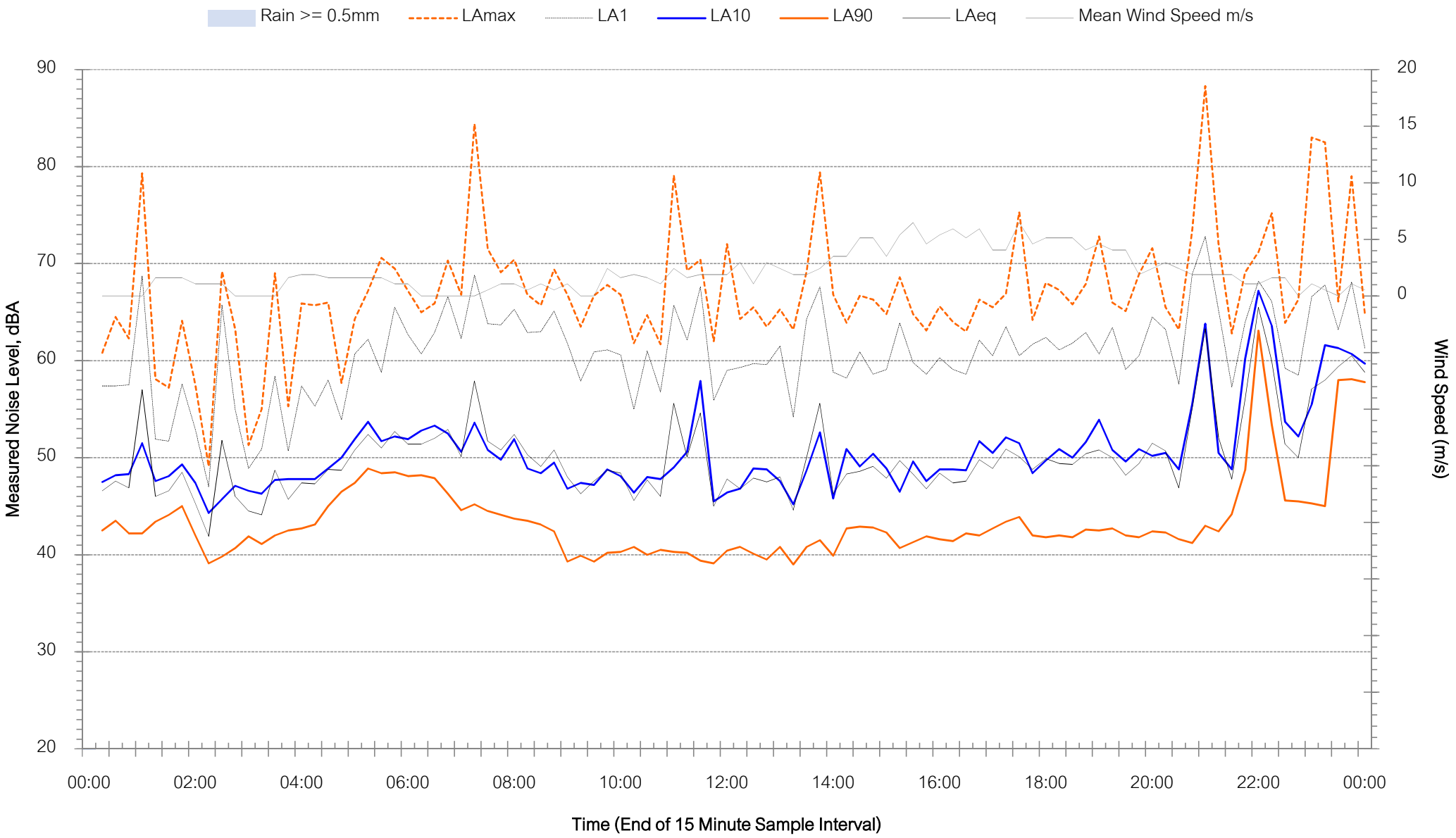

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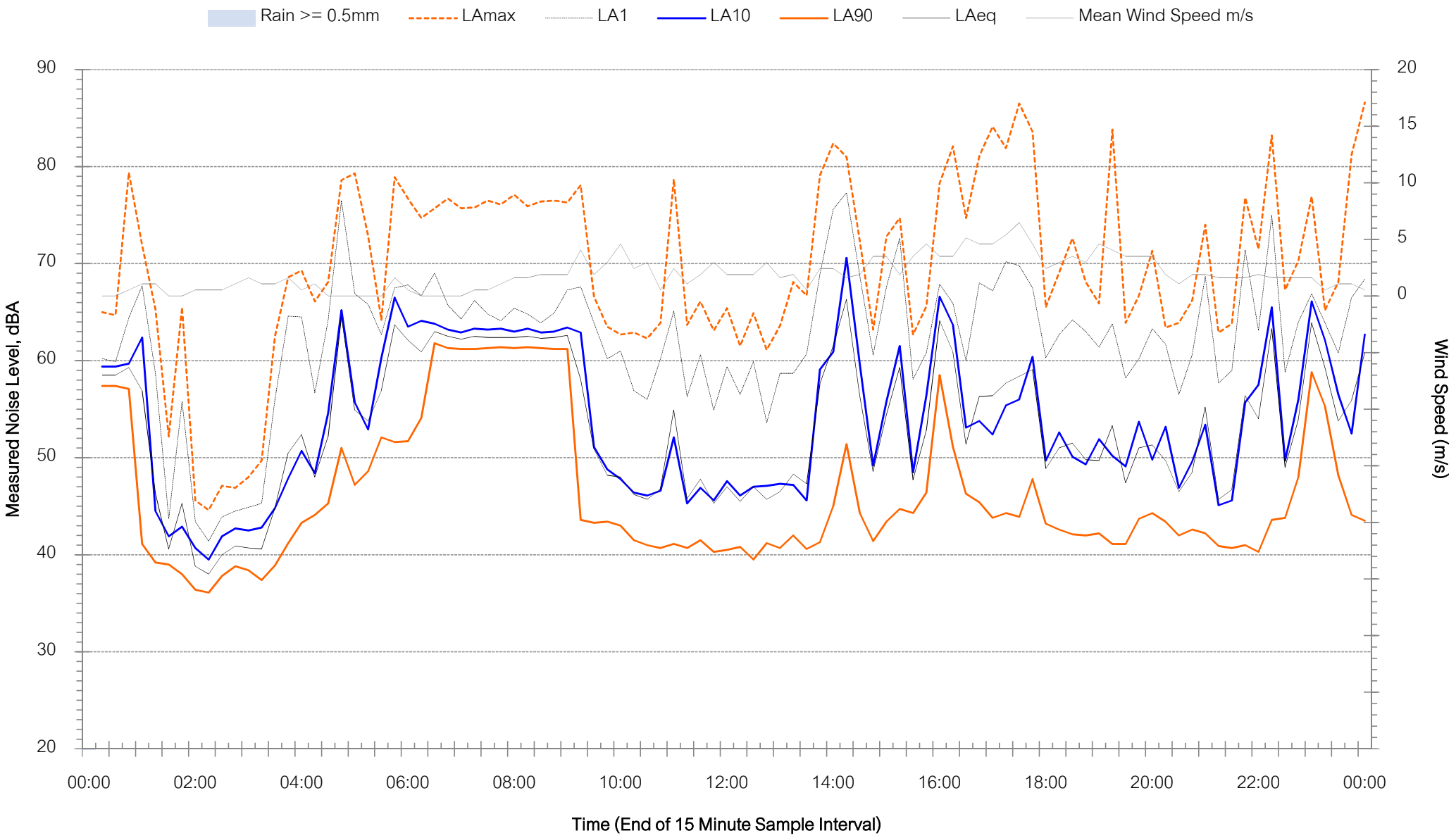

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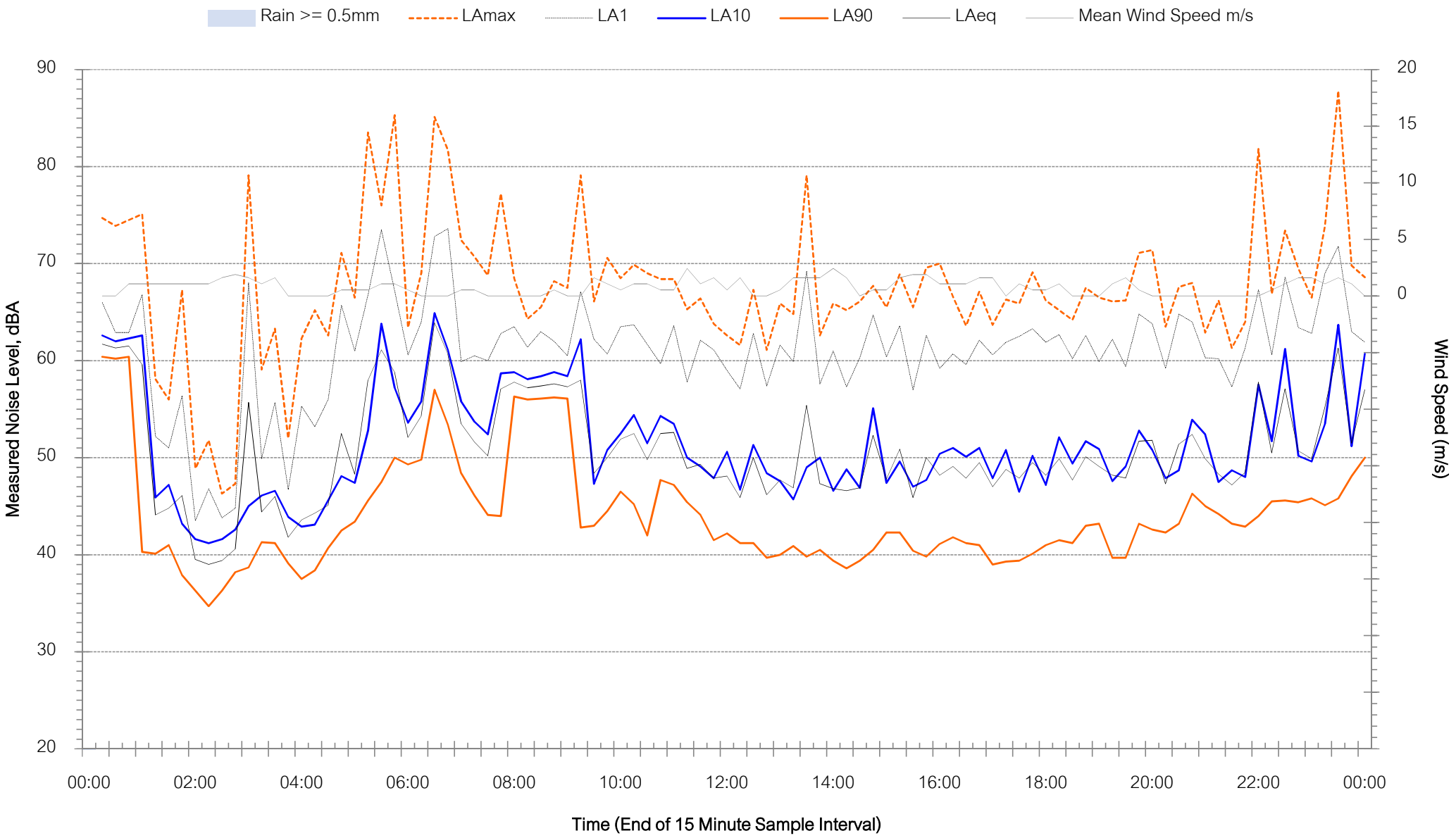

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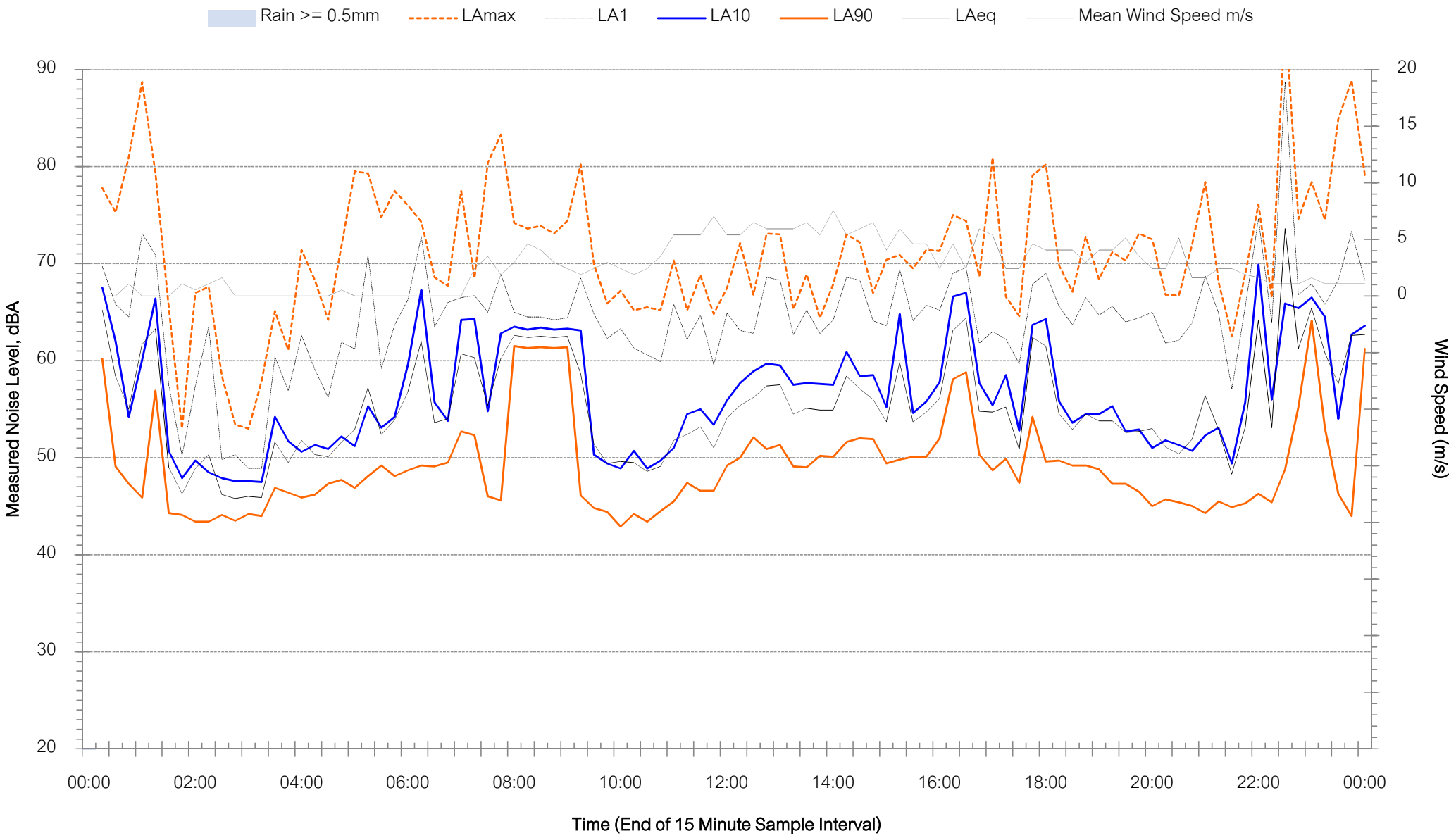

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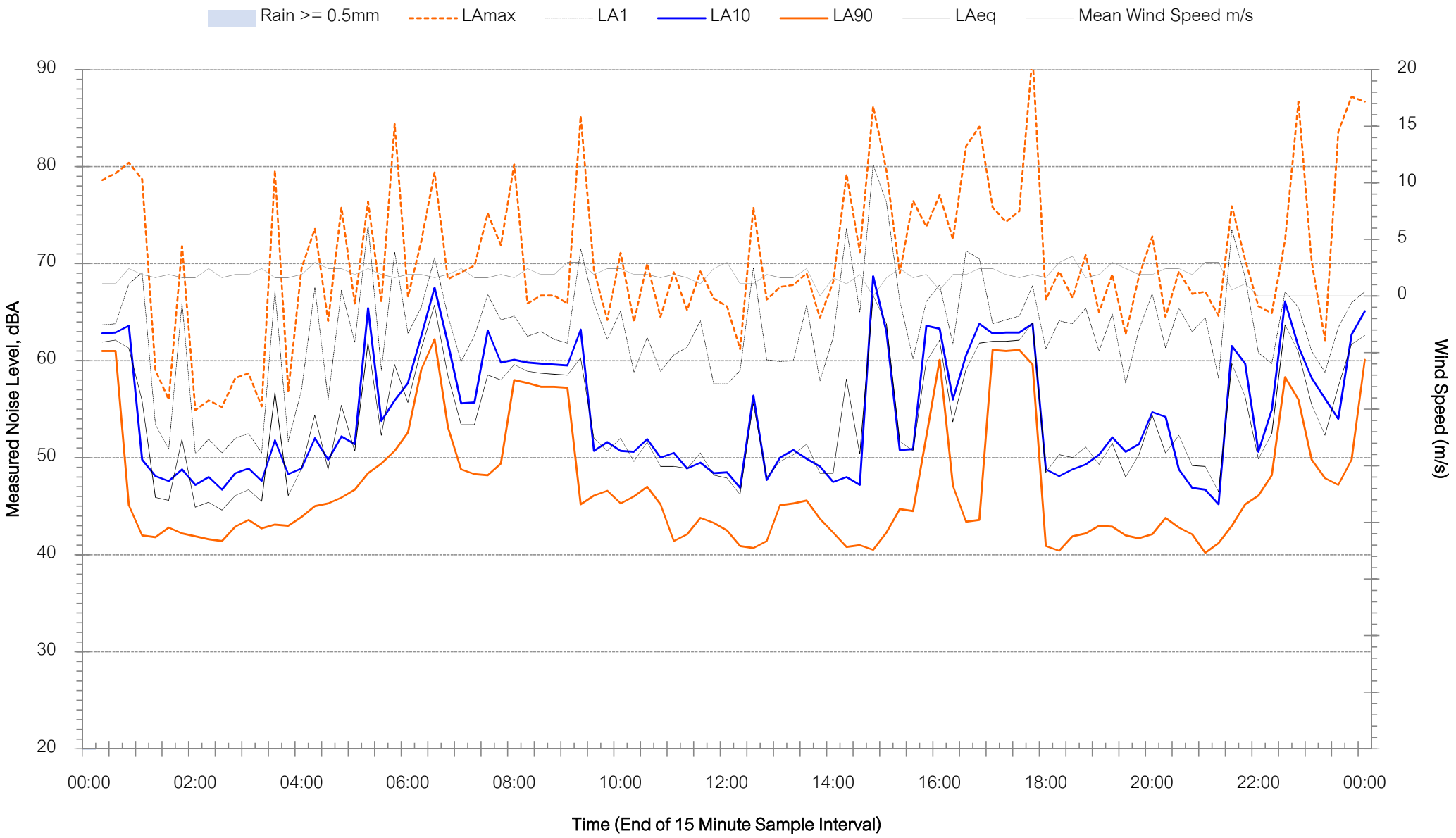

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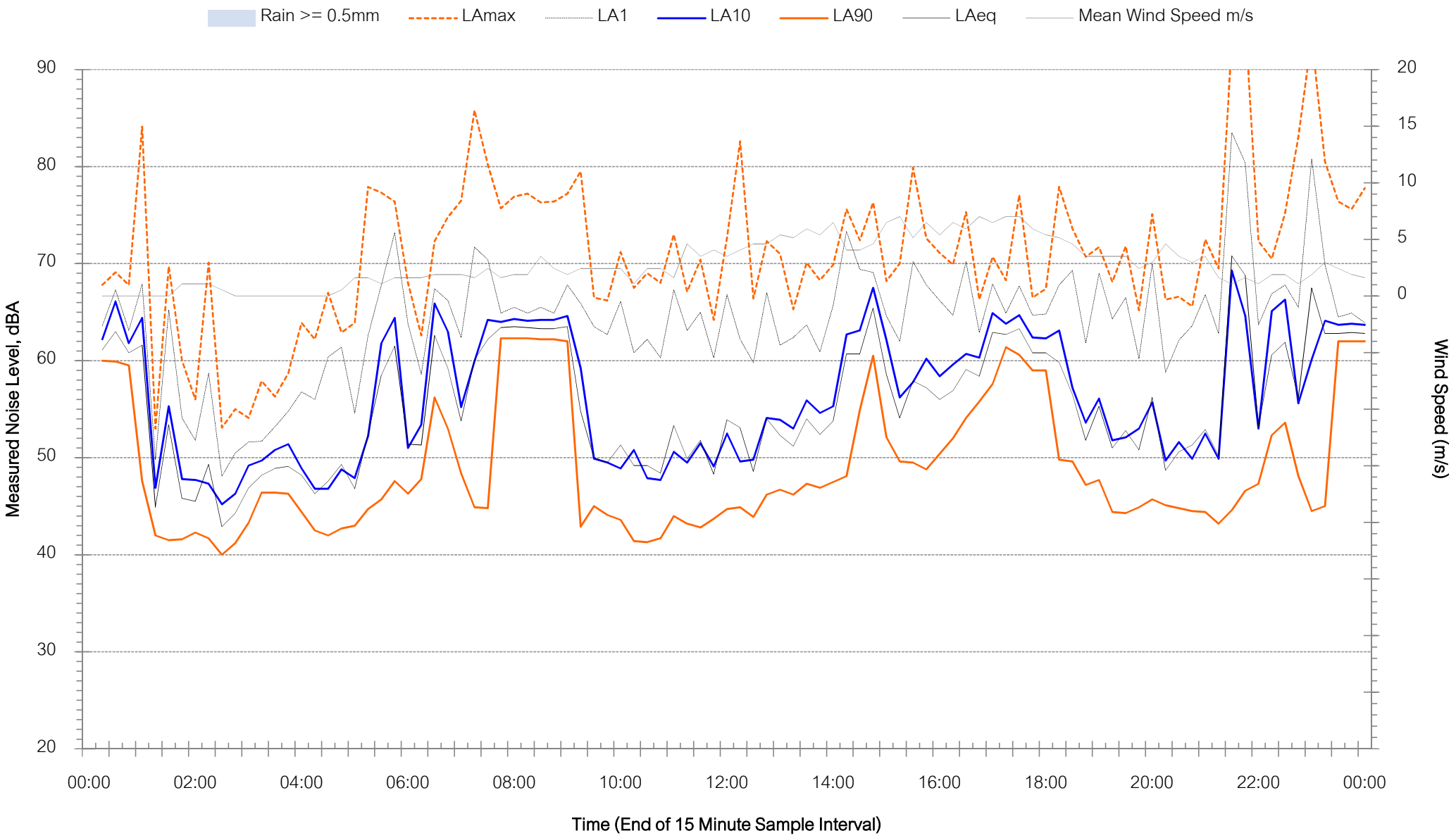

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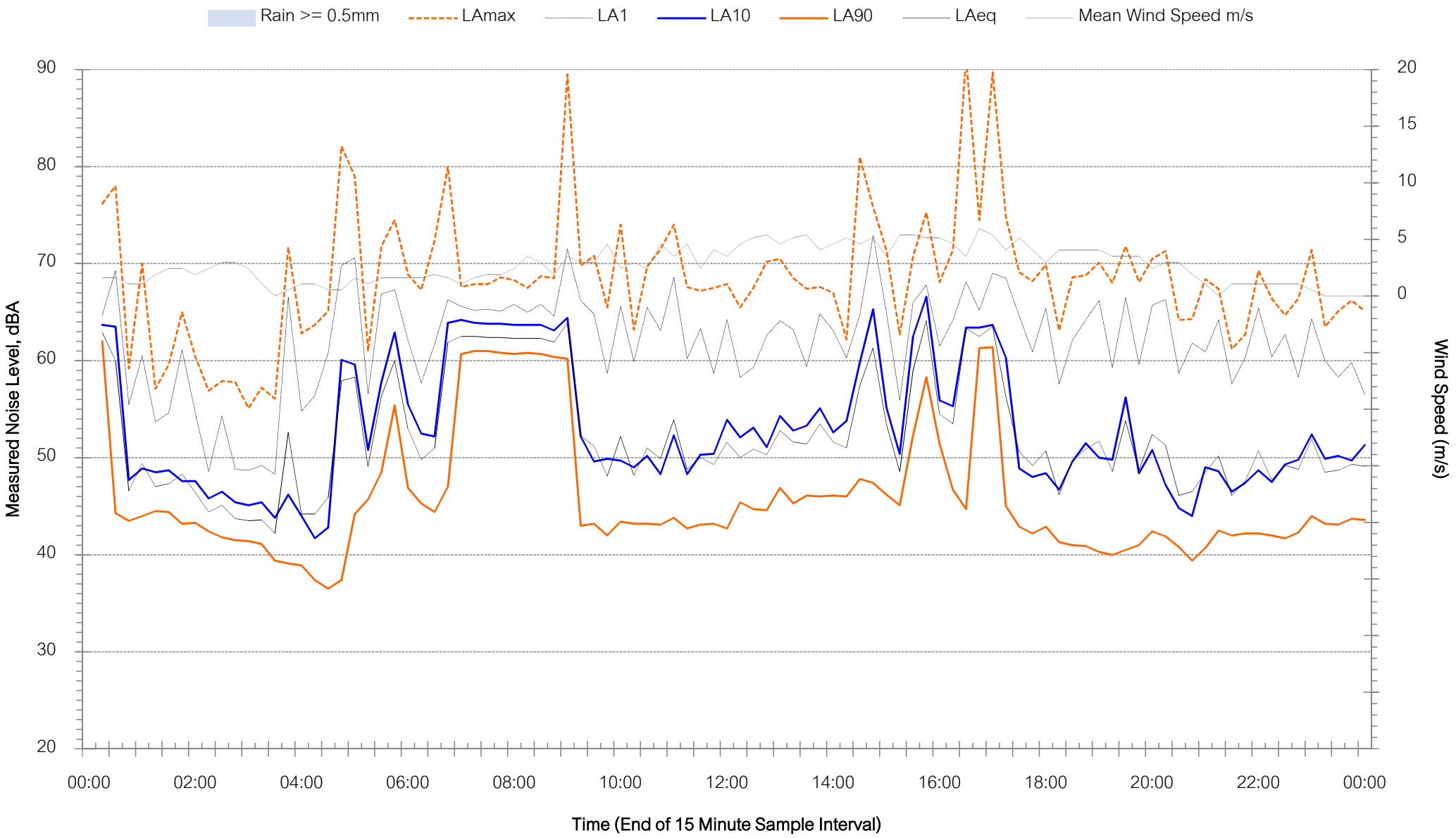

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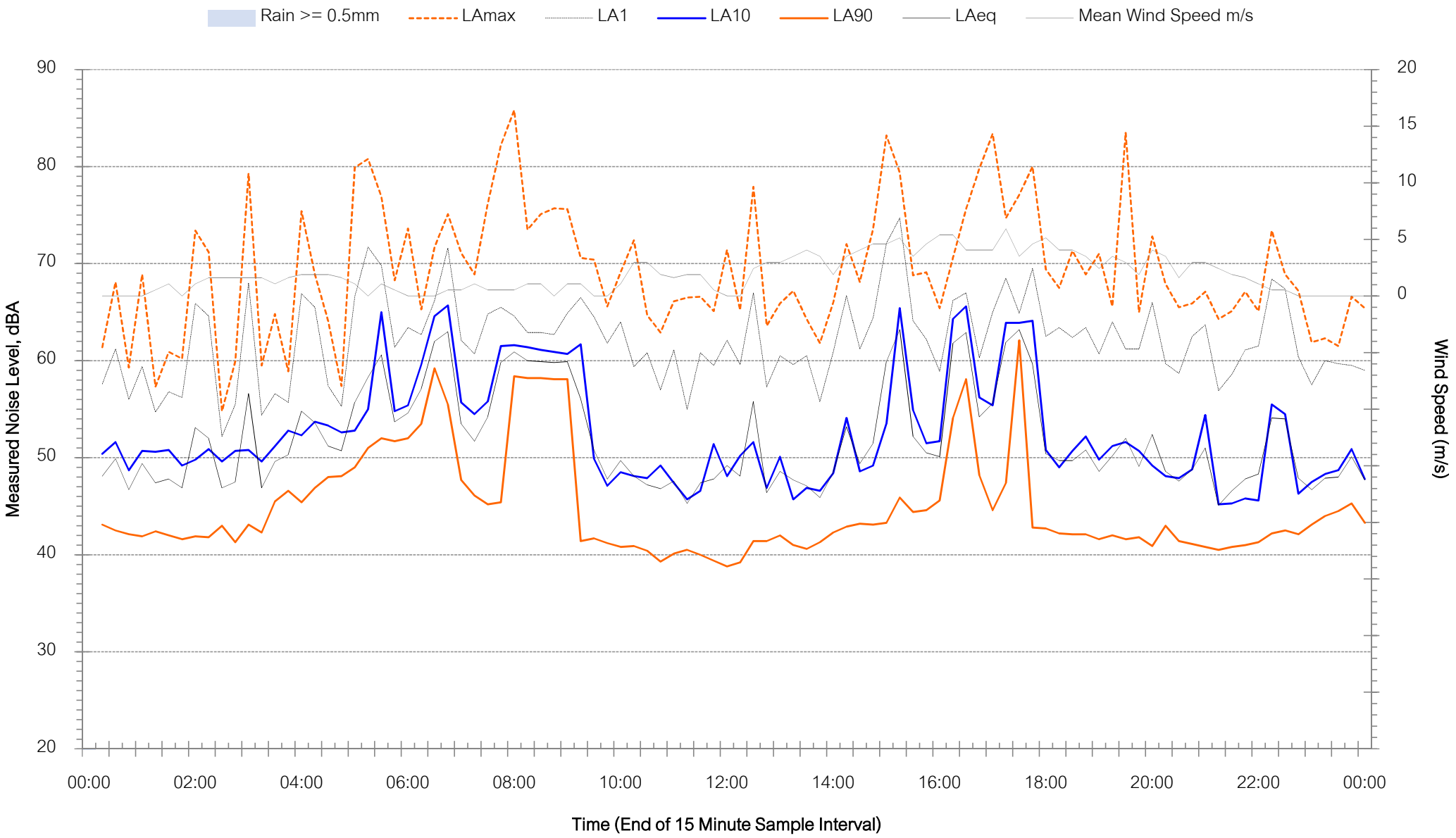

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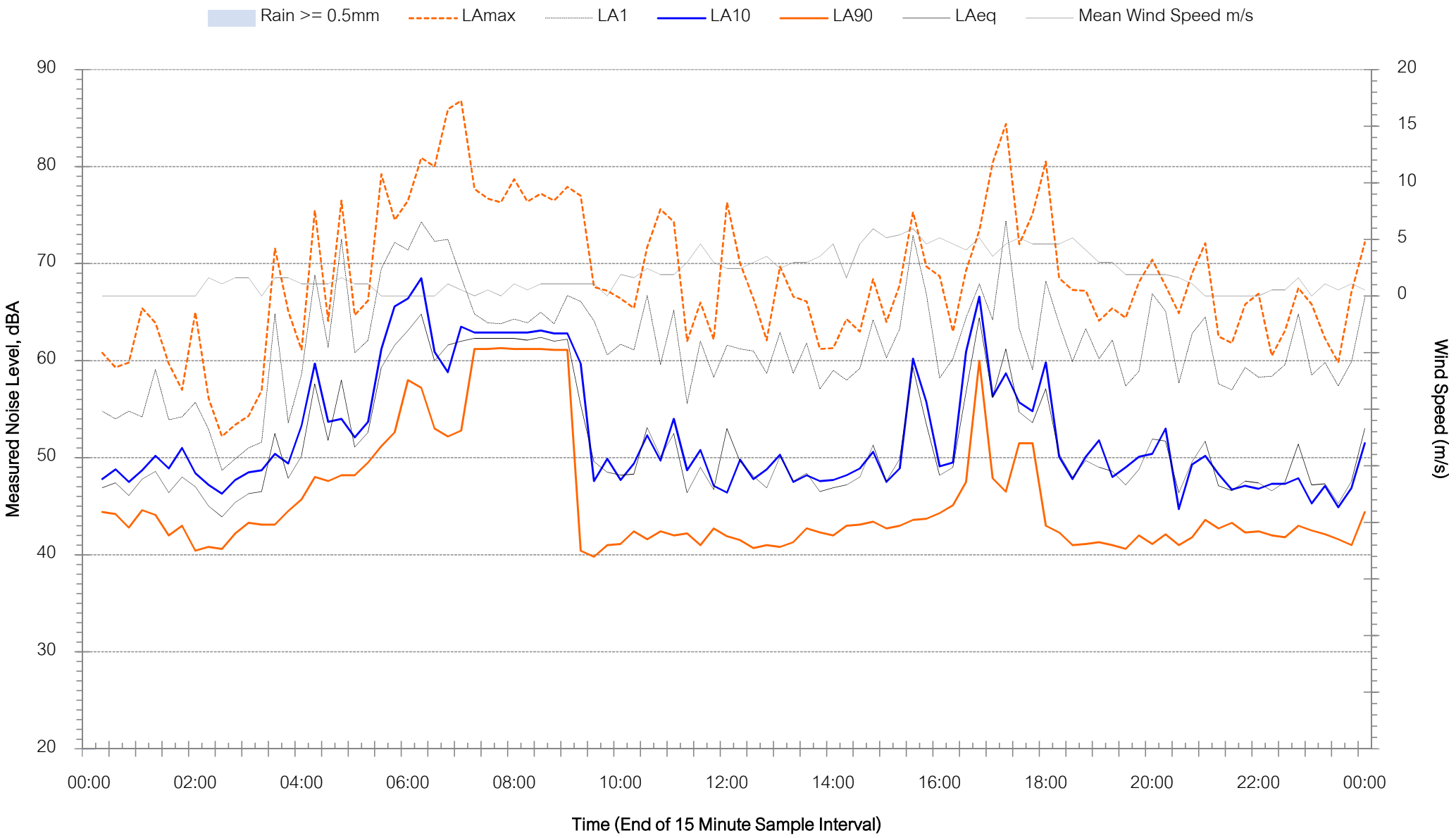

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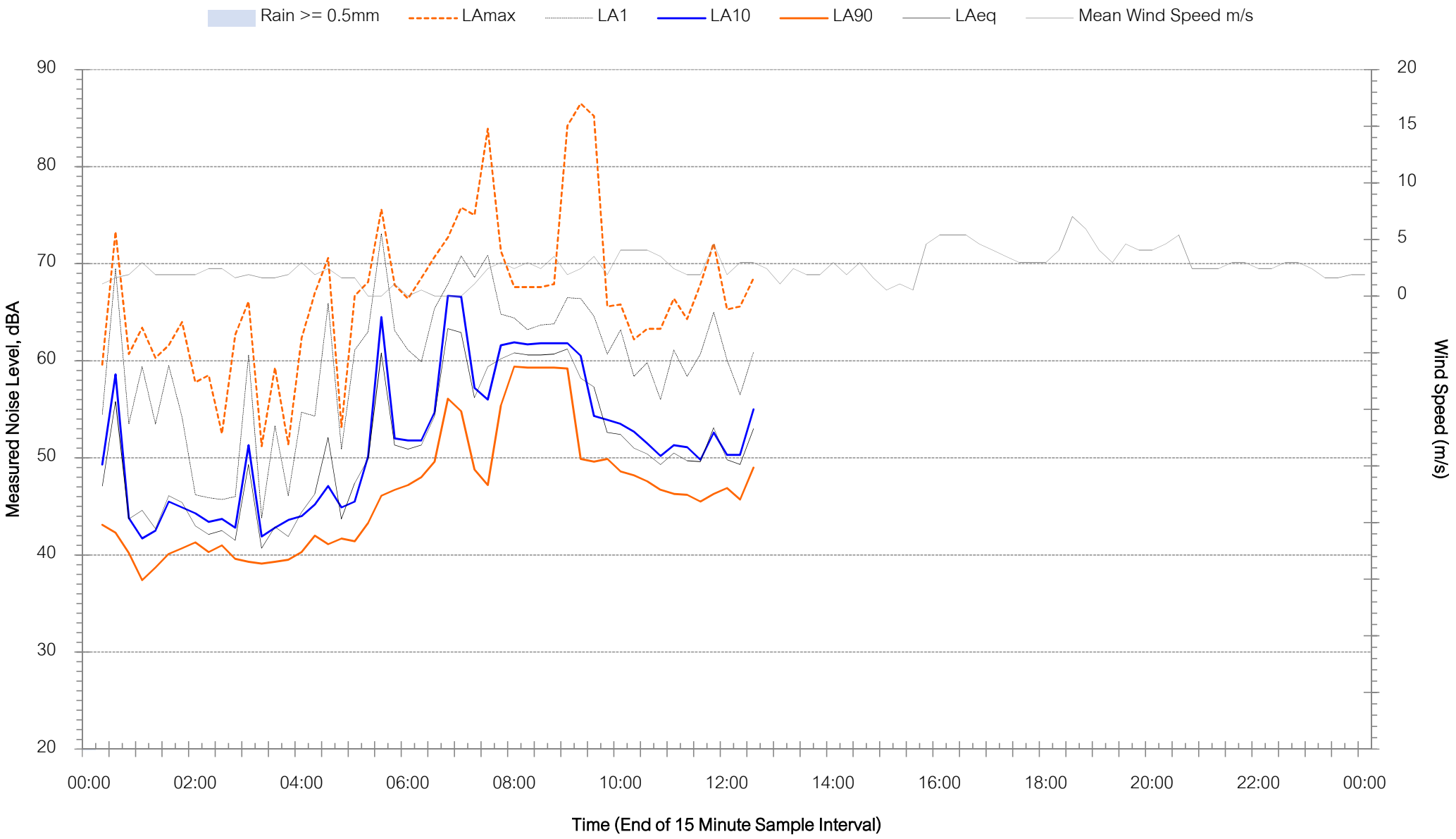

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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 1 Ending March 2019.

Prepared for: Holcim (Australia) Pty Ltd
March 2019
MAC180611--01RP3

Muller Acoustic Consulting

Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 1 Ending March 2019

Prepared for: Holcim (Australia) Pty Ltd

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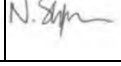
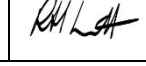
Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC180611-01RP3	Final	28 March 2019	Nicholas Shipman		Rod Linnett	

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APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending March 2019 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS IEC 61672:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

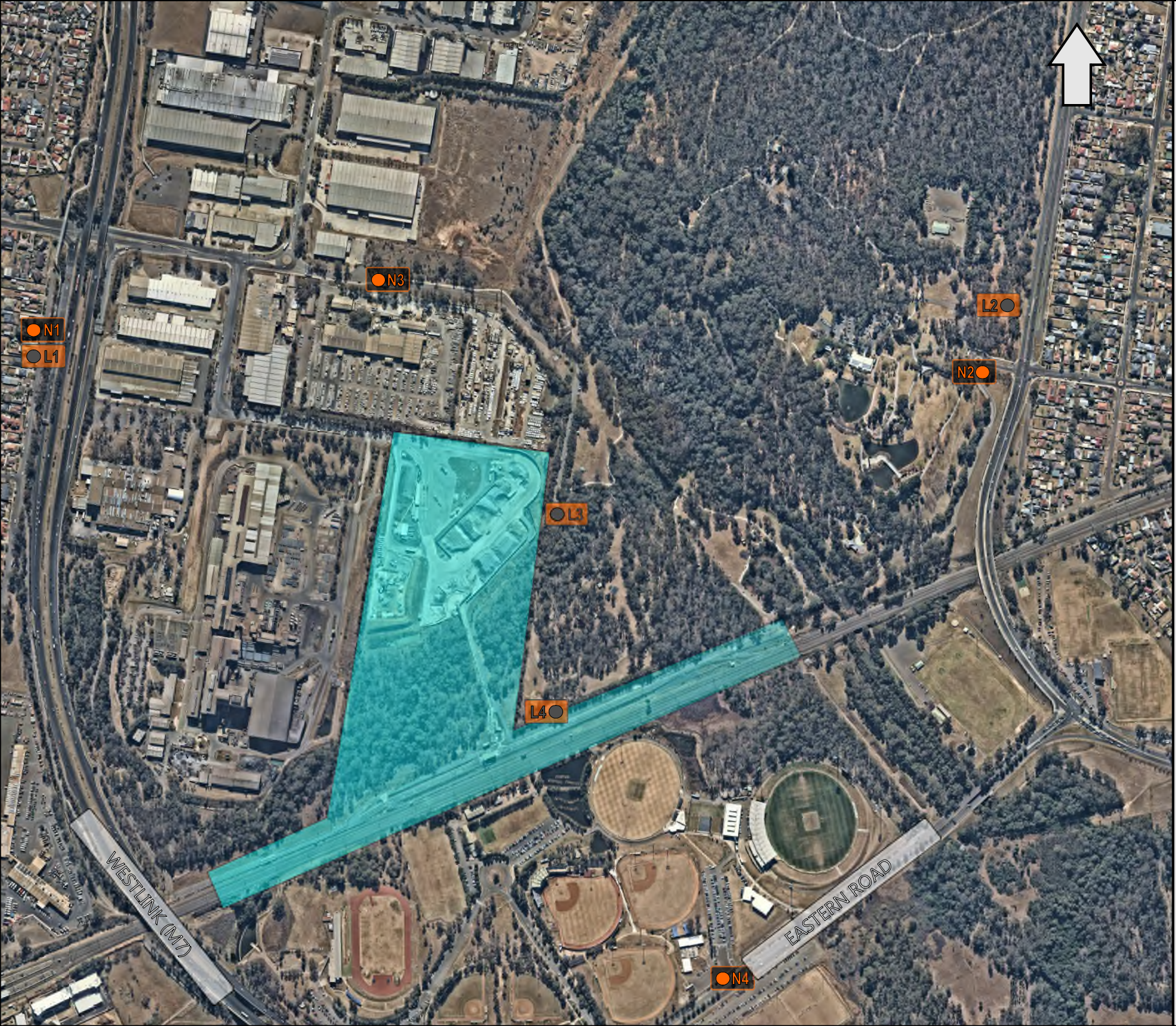

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

N1	MONITORING LOCATION
L1	LOGGER LOCATION
	SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Wednesday 13 March 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS NZS IEC 61672. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for more than seven days in general accordance with the procedures described AS 1055 and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977 and 957 noise analysers from Wednesday 13 March 2019 to Friday 22 March 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS IEC 61672. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
13/03/19	14:22 (Day)	67	57	54	WD: N WS: 1m/s Rain: Nil	Traffic 56-67 Wind in trees <56 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<44
13/03/19	20:10 (Evening)	81	58	48	WD: E WS: 1m/s Rain: Nil	Traffic 48-81 Local residential noise <48 Wind in trees <48 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<38
13/03/19	23:45 (Night)	75	53	46	WD: E WS: 0.1m/s Rain: Nil	Traffic 49-75 Insects <49 Train 50-52 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<36

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
13/03/19	15:20 (Day)	72	54	50	WD: N WS: 1m/s Rain: Nil	Traffic 49-71 Wind in trees <49 Birds 49-52 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40
13/03/19	20:56 (Evening)	67	59	54	WD: E WS: 2m/s Rain: Nil	Wind in trees 46-58 Train 54-60 Traffic 54-67 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<39
14/03/19	00:27 (Night)	60	50	41	WD: E WS: 0.1m/s Rain: Nil	Traffic 44-58 Train 41-46 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<31

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
13/03/19	15:02 (Day)	81	57	50	WD: N WS: 1m/s Rain: Nil	Holcim trucks <48 Holcim reverse alarms <48 Wind in trees <48 Traffic 48-81 Train 50-54 Aircraft 52-59 Birds <50
		RDC $L_{Aeq(15min)}$ Contribution				<48
13/03/19	20:32 (Evening)	67	56	54	WD: E WS: 2.5m/s Rain: Nil	Wind in trees 48-56 Traffic 50-67 Other industrial noise 54-56 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<44
14/03/19	00:05 (Night)	67	53	52	WD: E WS: 0.5m/s Rain: Nil	Other industrial noise 48-54 Holcim industrial hum <48 Traffic <52
		RDC $L_{Aeq(15min)}$ Contribution				<48

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
13/03/19	15:43 (Day)	78	62	55	WD: N WS: 0.5m/s Rain: Nil	Birds 49-53 Traffic 48-78 Train 52-56 Holcim trucks 48-50 Holcim reverse alarms <50 Holcim tipping 48-52
		RDC $L_{Aeq(15min)}$ Contribution				50
13/03/19	21:16 (Evening)	79	66	55	WD: E WS: 1m/s Rain: Nil	Traffic 44-79 Aircraft 44-54 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45
14/03/19	00:48 (Night)	77	58	43	WD: E WS: 0.5m/s Rain: Nil	Traffic 44-77 Birds 56-61 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<33

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq,period}$[2]	Measured Background Noise Level (LA_{90}) dB RBL [2]
L1 (N1 Station Street)	Day	58	50
	Evening	60	45
	Night	53	41
L2 (N2 Knox Road)	Day	59	50
	Evening	60	49
	Night	56	41
L3 (N3 Nurragingy Reserve)	Day	46	44
	Evening	45	44
	Night	45	43
L4 (N4 Olympic Park)	Day	59	44
	Evening	56	45
	Night	57	44

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<44	44	✓
N2	<40	40	✓
N3	<48	50 (When in use)	✓
N4	50	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<38	44	✓
N2	<39	39	✓
N3	<44	50 (When in use)	✓
N4	<45	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<36	39	✓
N2	<31	39	✓
N3	<48	50 (When in use)	✓
N4	<33	55 (When in use)	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three attended measurements conducted on Wednesday 13 March 2019, satisfying the relevant noise limits. Extraneous noise sources included traffic, wind in trees, local residential noise, insects and train pass-by.

6.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during all three attended measurements conducted on Wednesday 13 March 2019, satisfying the relevant noise limits for this location. Extraneous sources measured include traffic, wind in trees, birds and train pass-by.

6.3 Discussion of Results - Location N3

Attended measurements on Wednesday 13 March 2019 identified that RDC noise was audible during two of the three measurements during the daytime and night time period, although satisfied the relevant noise limits of 50dBA. RDC sources audible on occasion included general mobile plant engine noise, reverse alarms and general hum. The RDC was inaudible during the evening measurements conducted on Wednesday 13 March 2019 thus satisfying the applicable noise criteria. Extraneous sources audible during the attended surveys included wind in trees, traffic, train pass-by, aircraft noise, birds and other industrial noise which generally masked RDC noise. For the evening and night assessment period, it is noted the receiver was not “in use”, hence criteria are only referenced for completeness.

6.4 Discussion of Results - Location N4

RDC noise emissions were audible during one of three measurements conducted on Wednesday 13 March 2019. RDC sources audible during the daytime measurement included general mobile plant engine noise, reverse alarms and tipping. RDC noise contribution was estimated to be 50dBA, satisfying the relevant noise limits. Extraneous noise sources included birds, traffic, train pass-by and aircraft noise all audible throughout attended measurements at this location.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 1, ending March 2019.

Attended noise monitoring was conducted on Wednesday 13 March 2019 and unattended noise monitoring was completed between Wednesday 13 March 2019 and Friday 22 March 2019 at four representative monitoring locations. The assessment has identified that noise emissions generated by RDC were audible on some occasions throughout the attended monitoring, although remained below relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

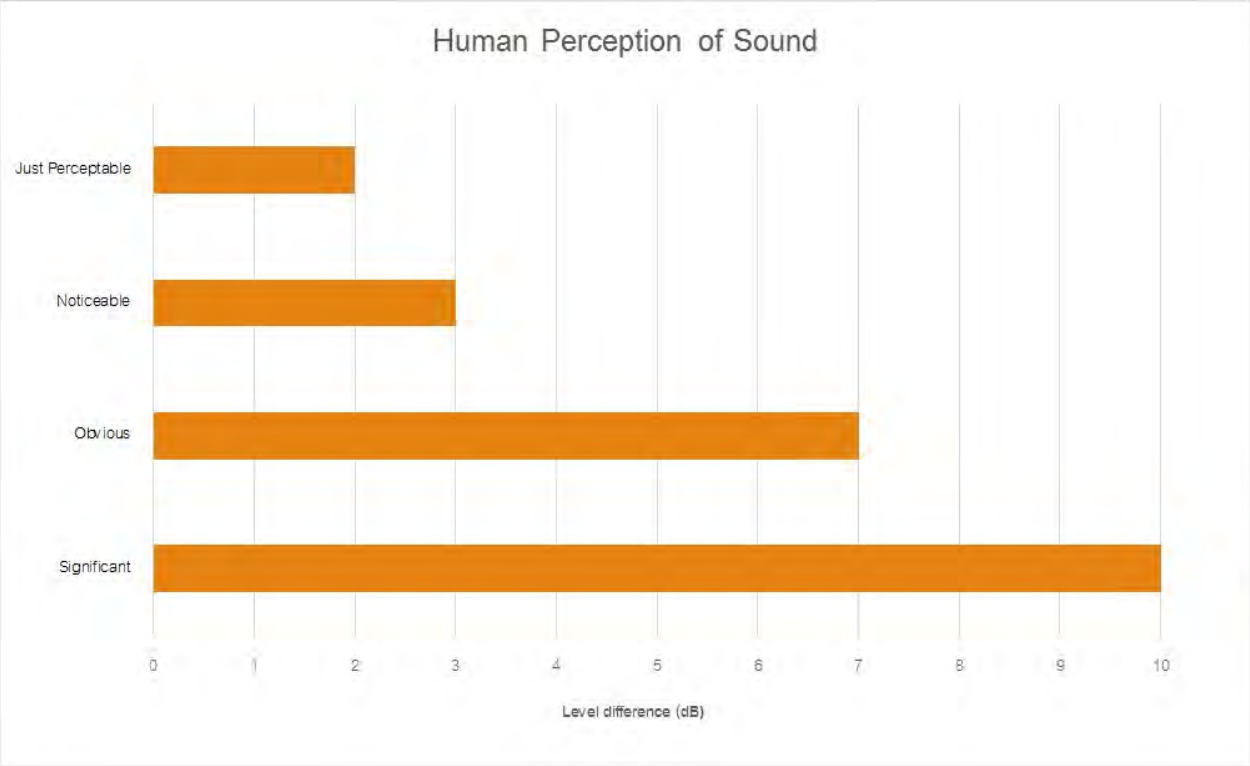
Table A1 provides a number of technical terms have been used in this report.

Table 1A Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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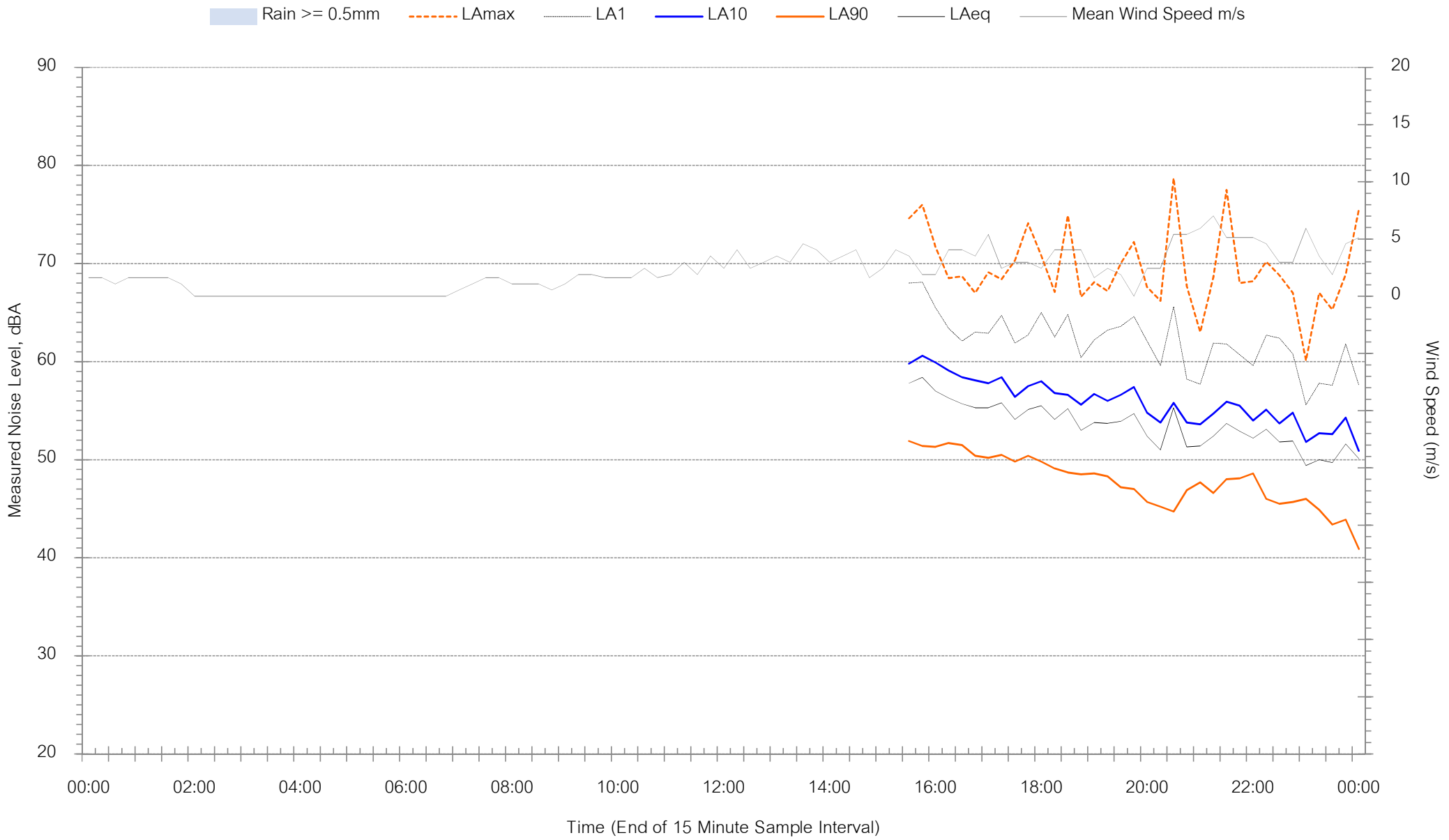
Appendix B – Unattended Noise Monitoring Charts

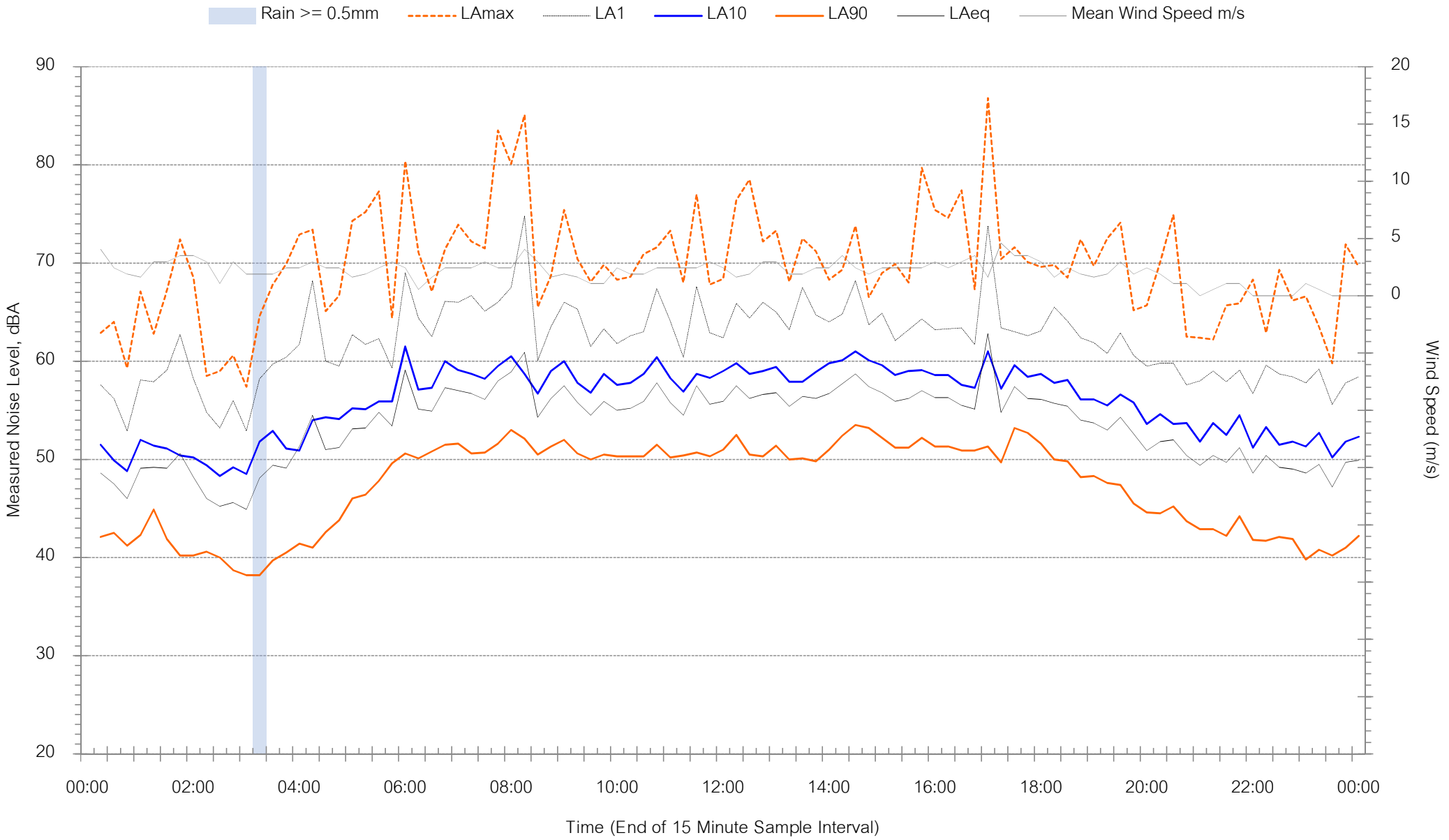
Background Noise Levels

Location - N1 - Tuesday 12 March 2019



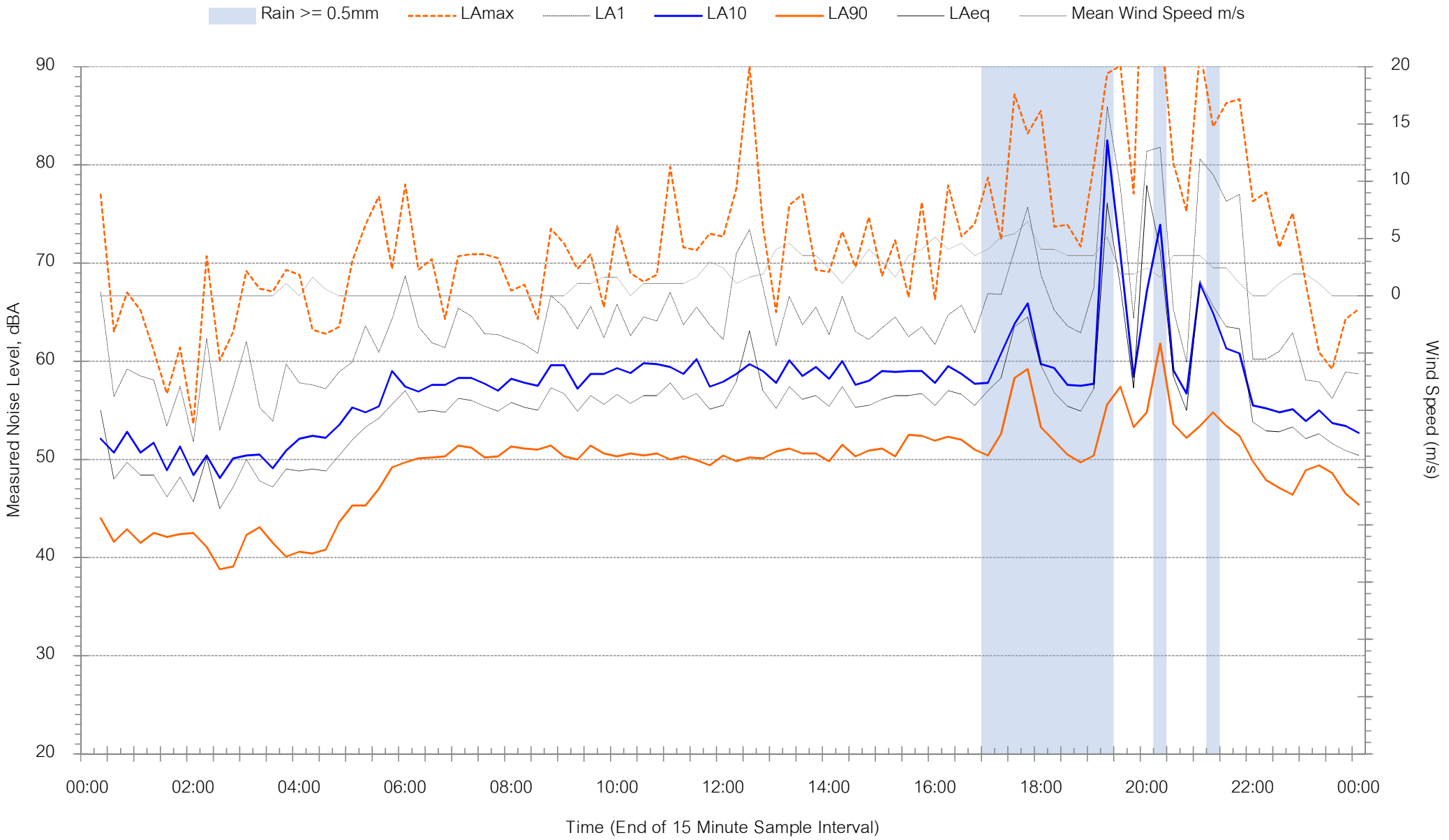
Background Noise Levels

Location - N1 - Wednesday 13 March 2019



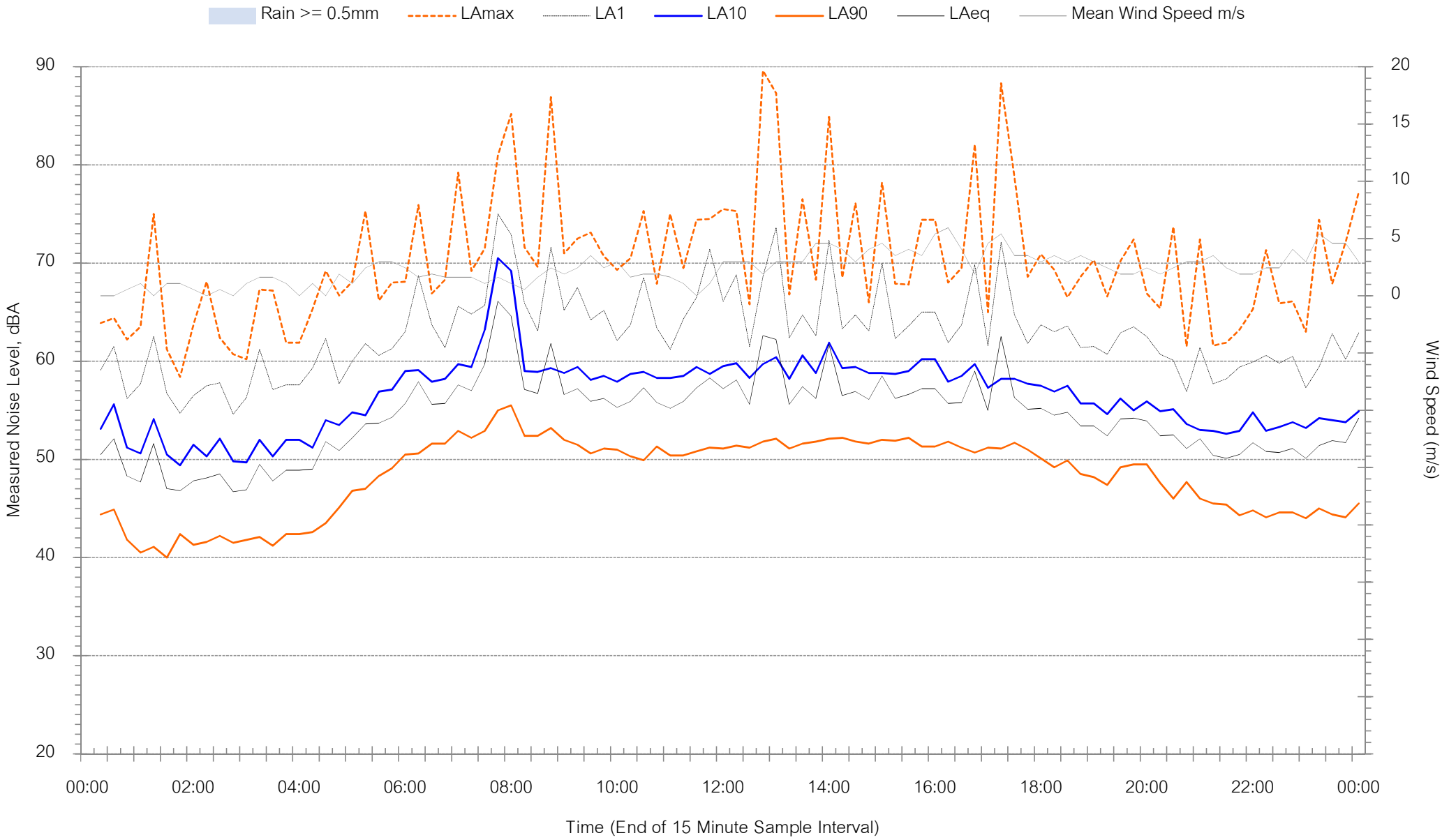
Background Noise Levels

Location - N1 - Thursday 14 March 2019



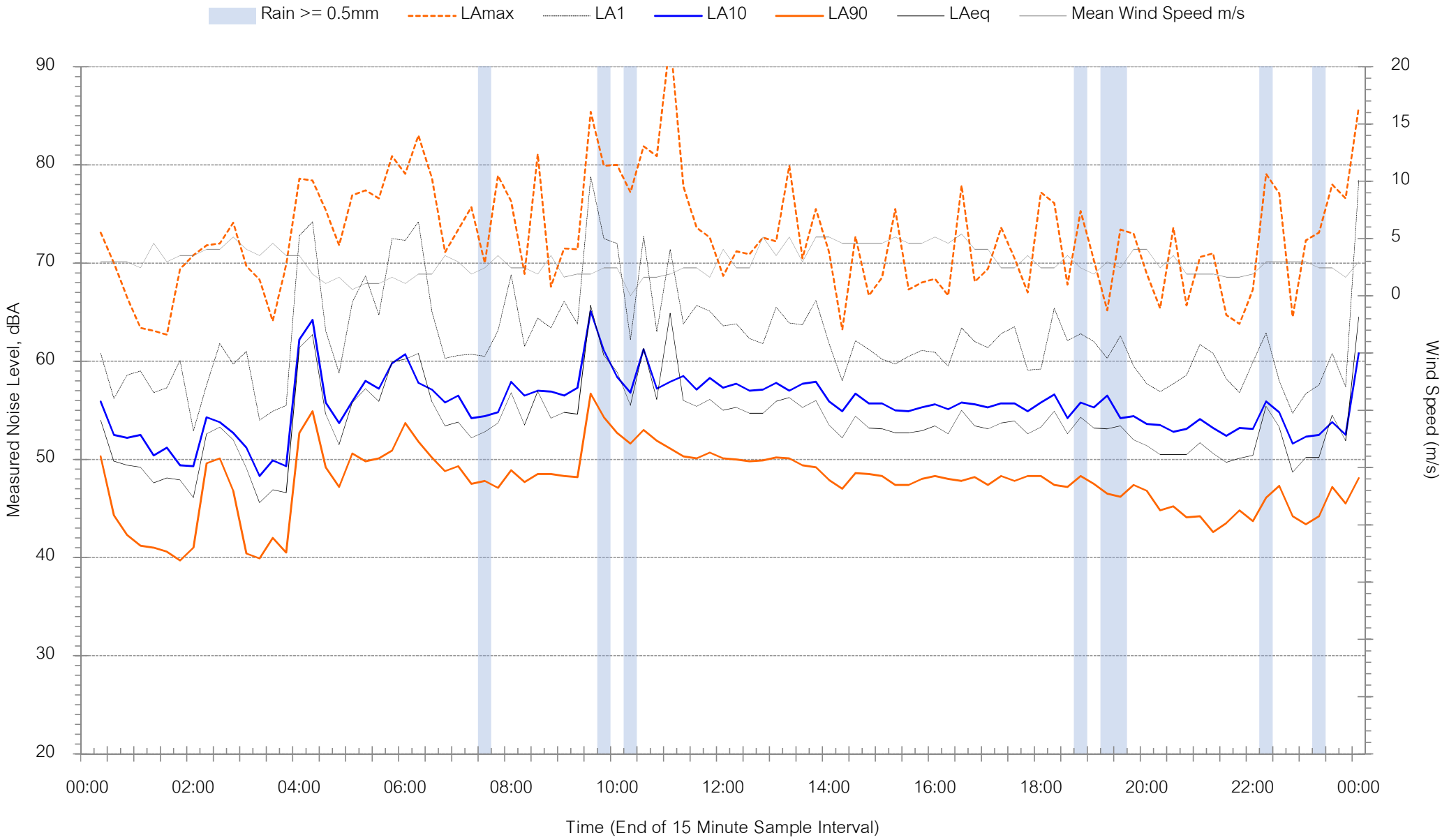
Background Noise Levels

Location - N1 - Friday 15 March 2019



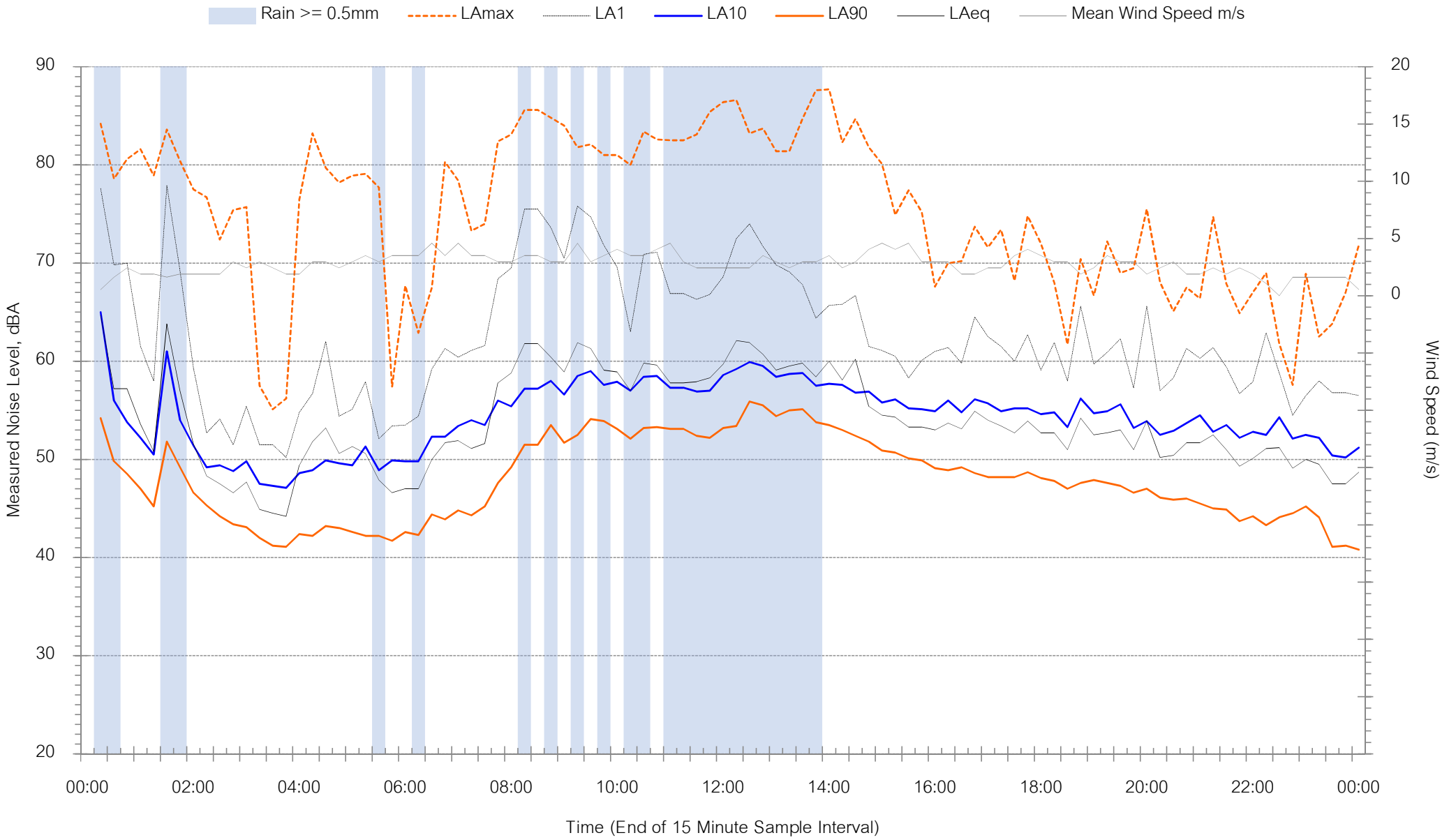
Background Noise Levels

Location - N1 - Saturday 16 March 2019



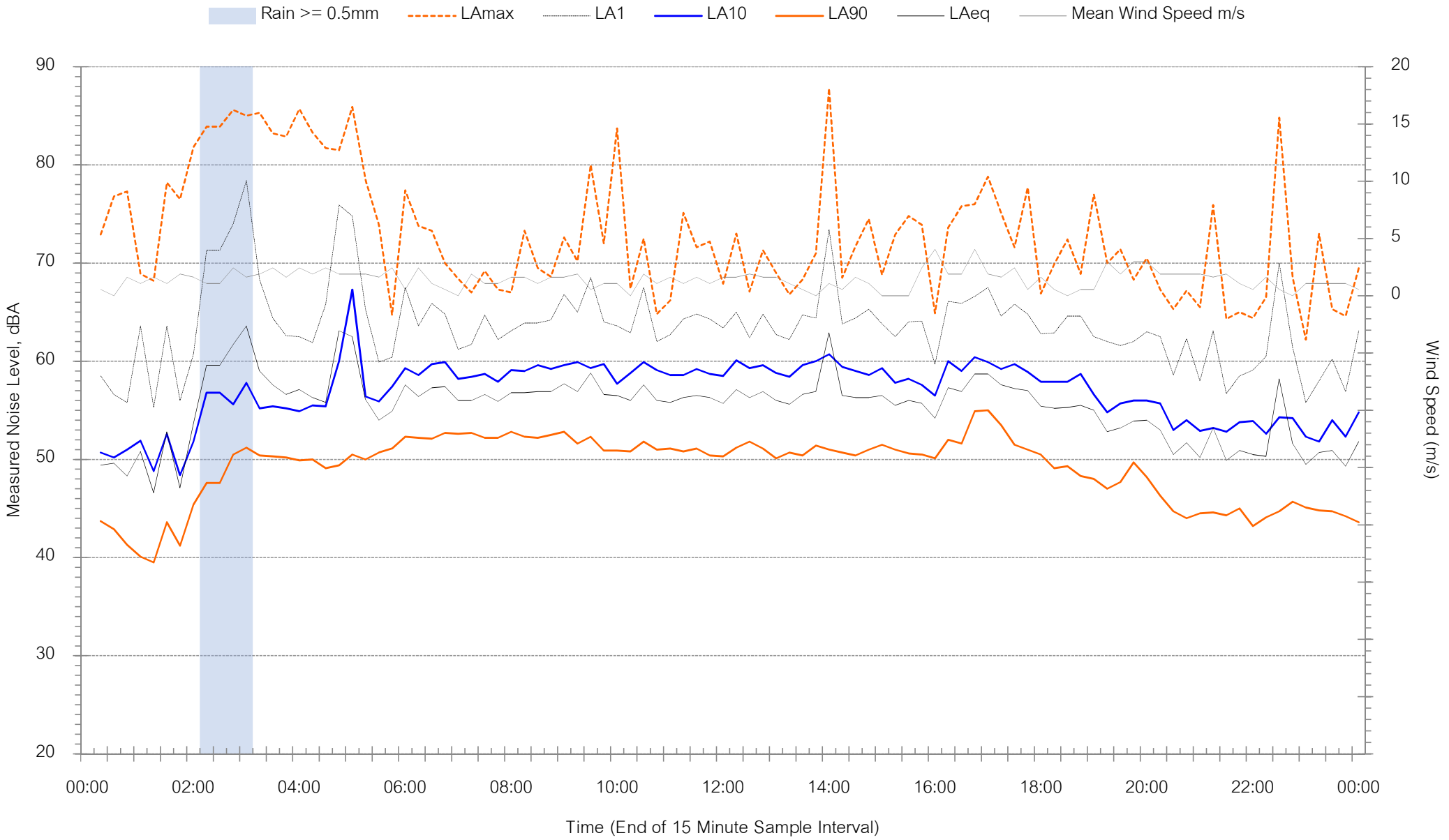
Background Noise Levels

Location - N1 - Sunday 17 March 2019



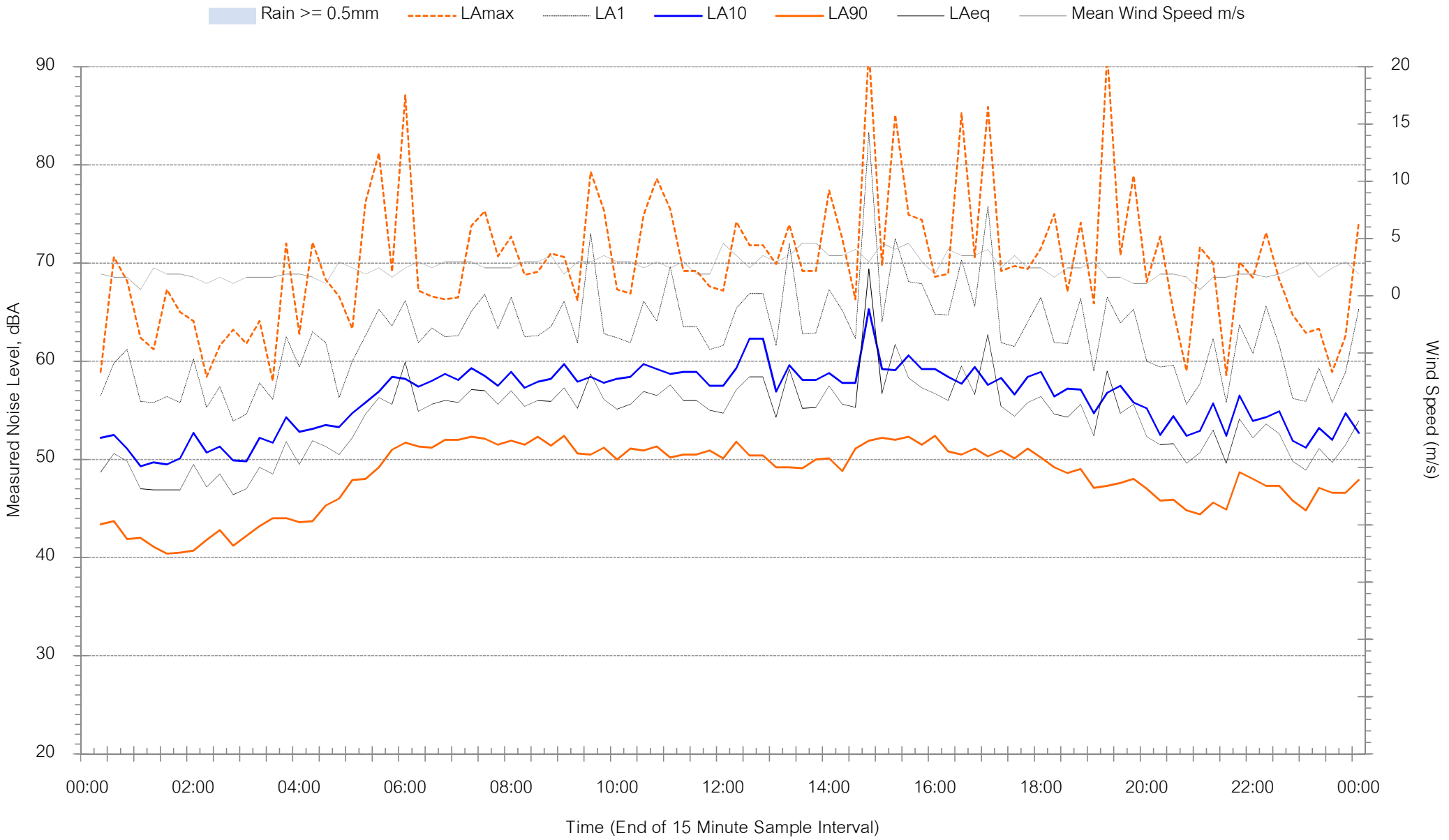
Background Noise Levels

Location - N1 - Monday 18 March 2019



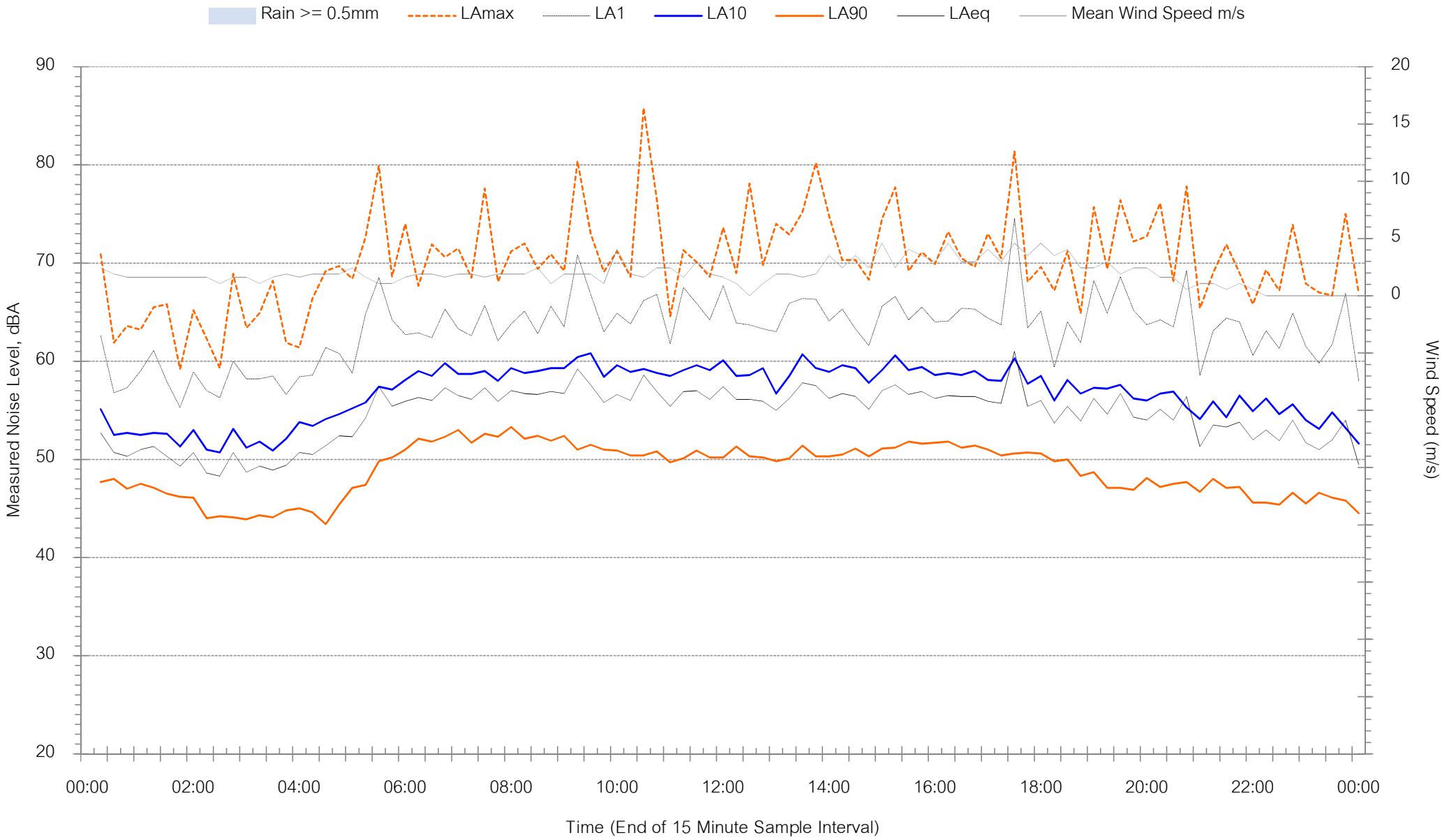
Background Noise Levels

Location - N1 - Tuesday 19 March 2019



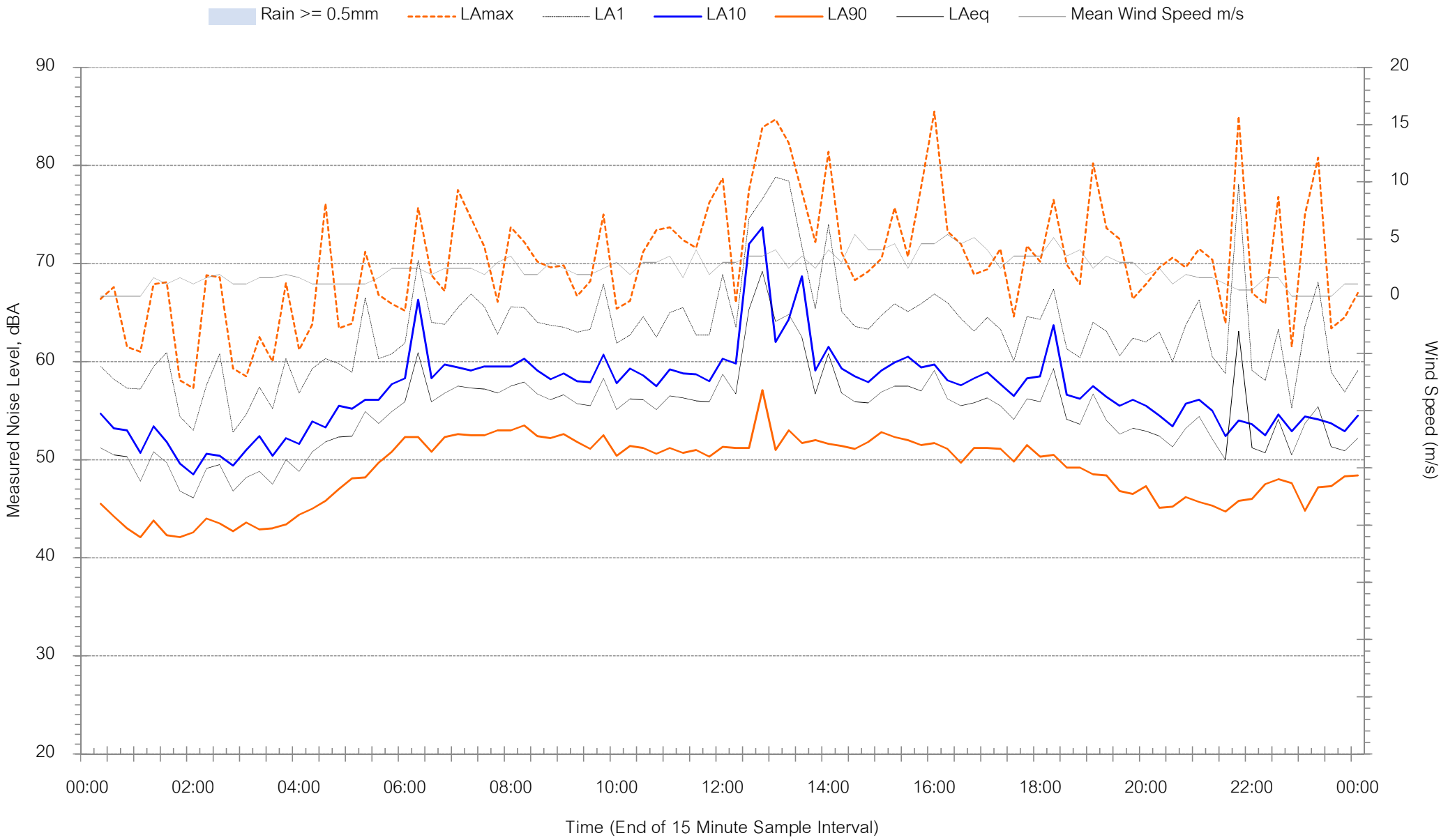
Background Noise Levels

Location - N1 - Wednesday 20 March 2019



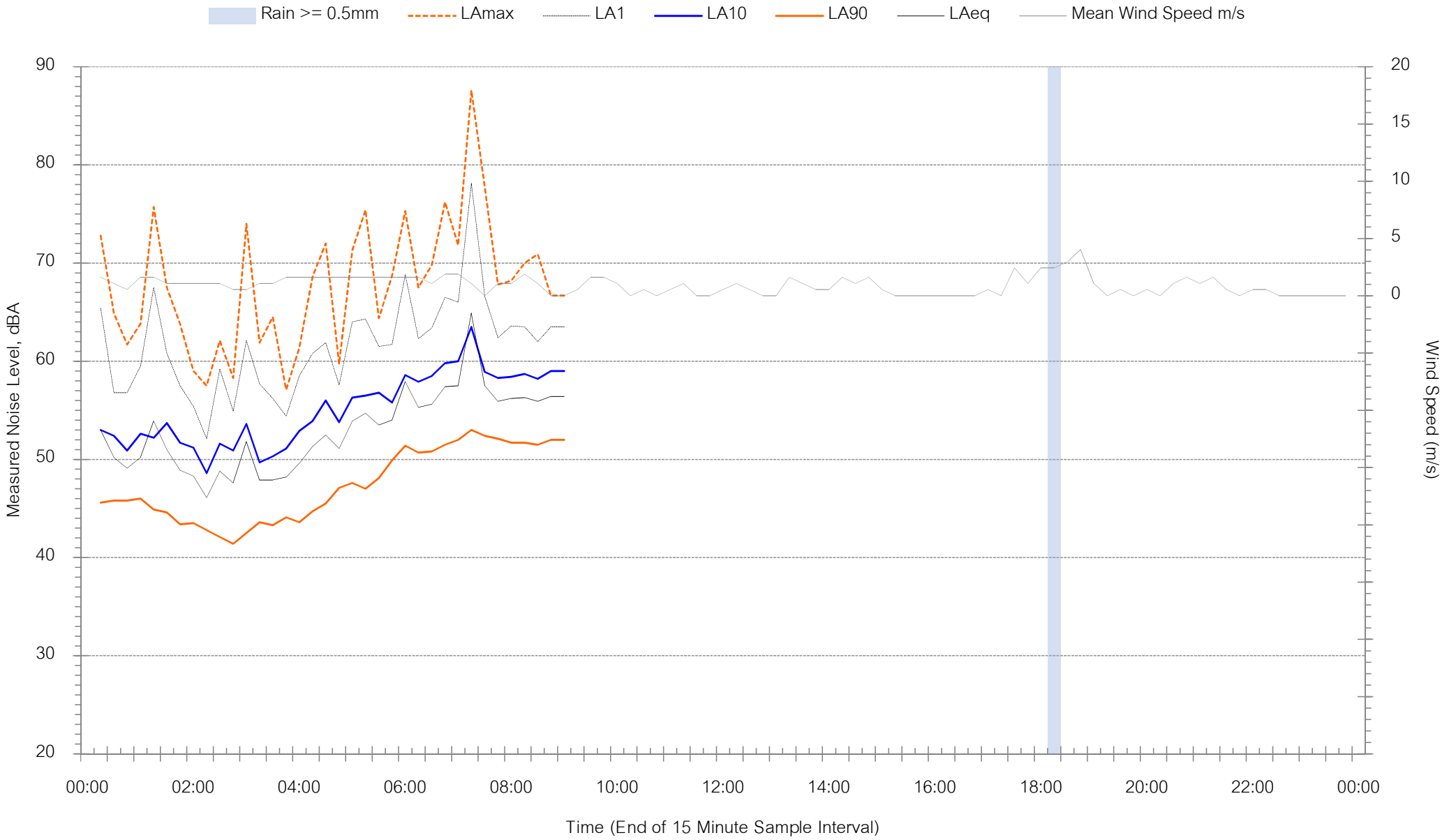
Background Noise Levels

Location - N1 - Thursday 21 March 2019



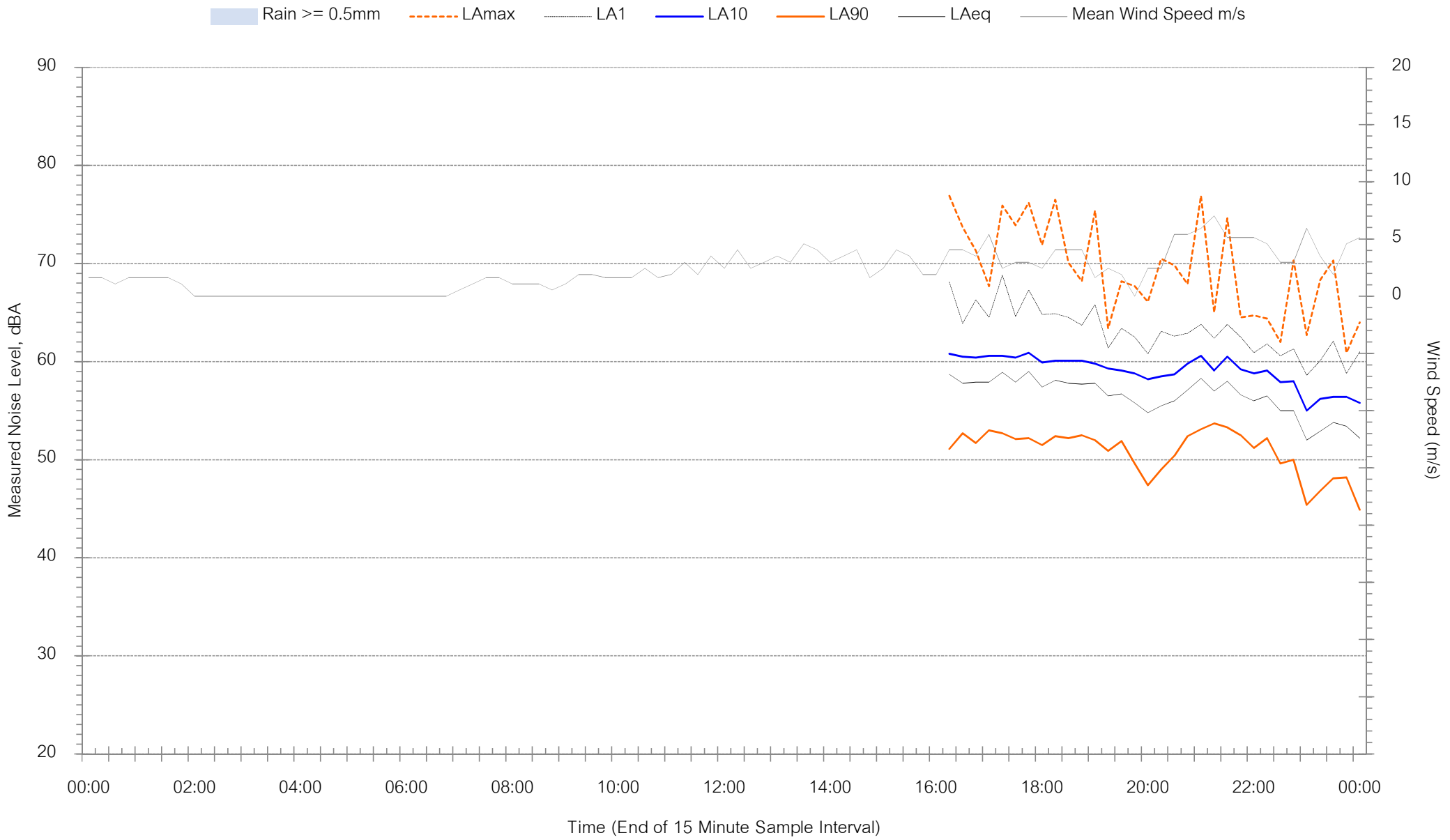
Background Noise Levels

Location - N1 - Friday 22 March 2019



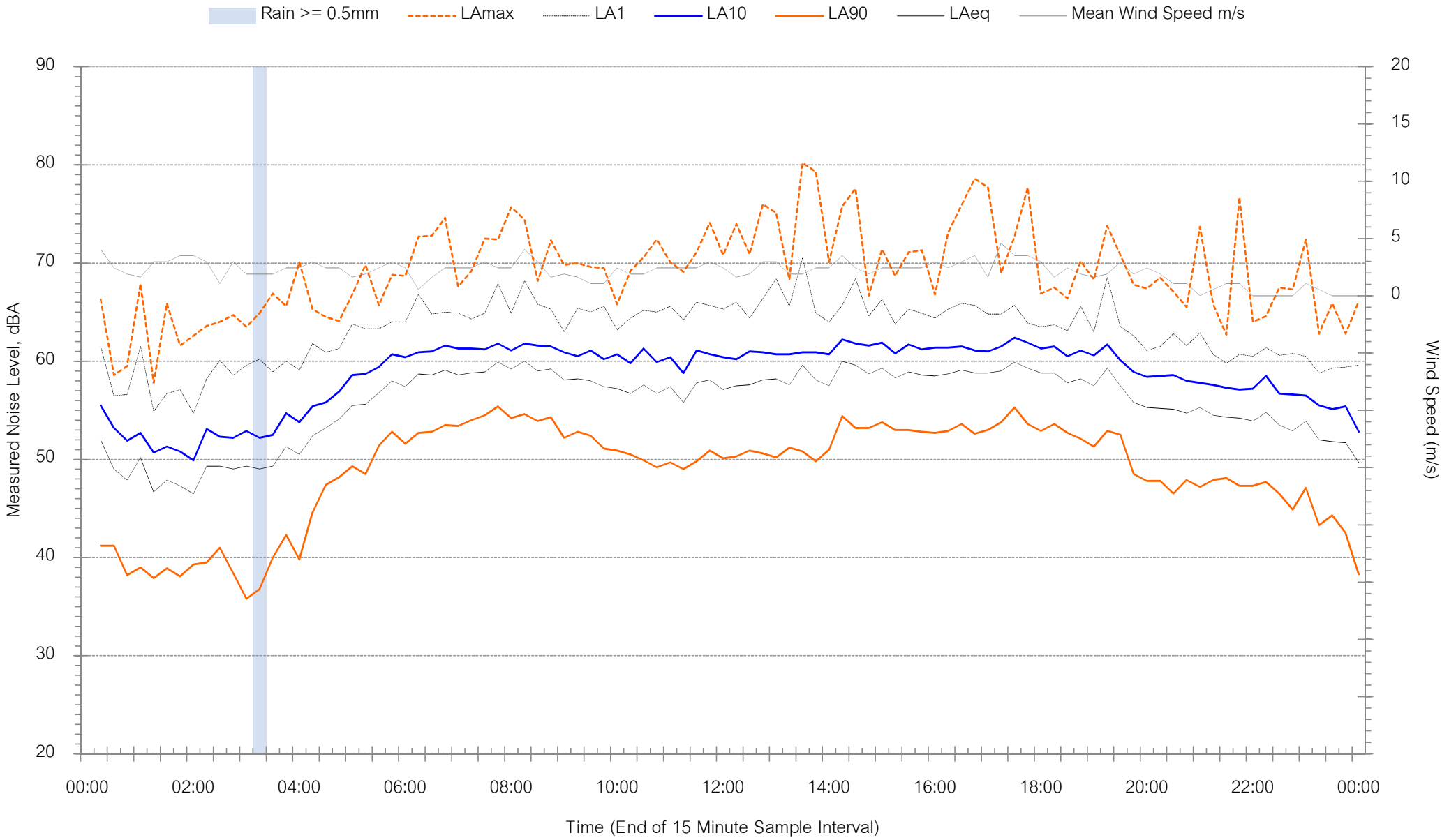
Background Noise Levels

Location - N2 - Tuesday 12 March 2019



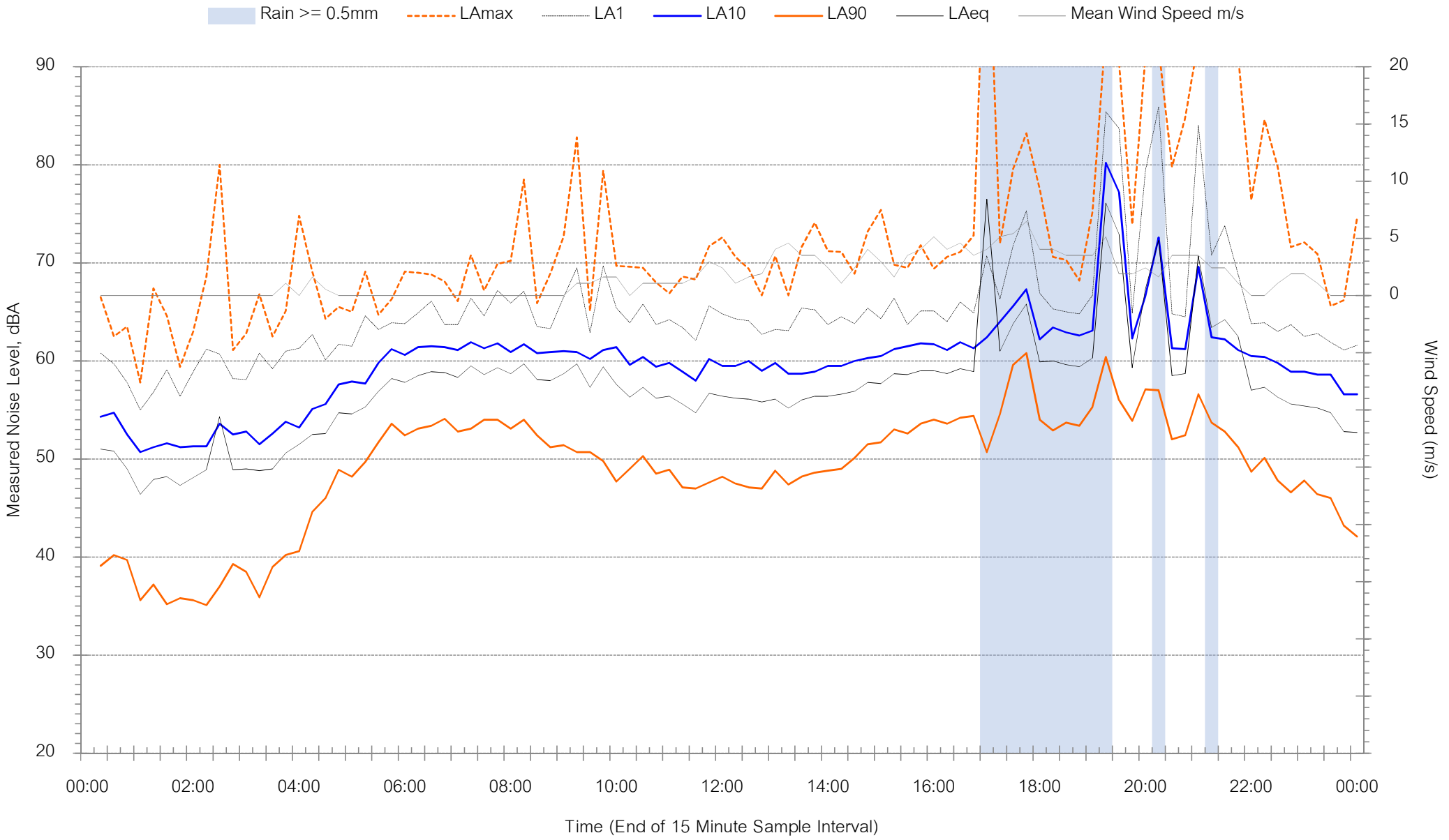
Background Noise Levels

Location - N2 - Wednesday 13 March 2019



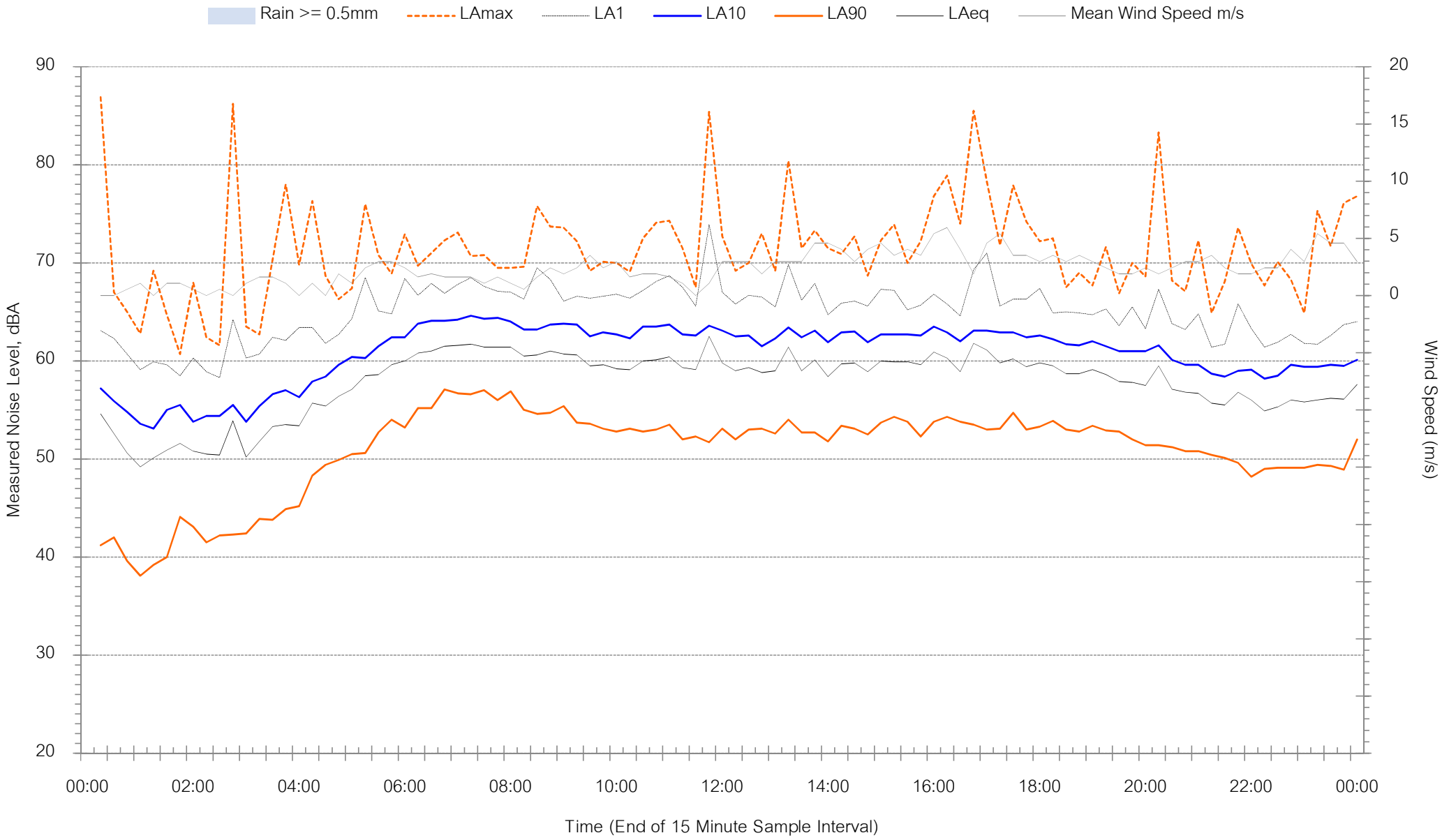
Background Noise Levels

Location - N2 - Thursday 14 March 2019



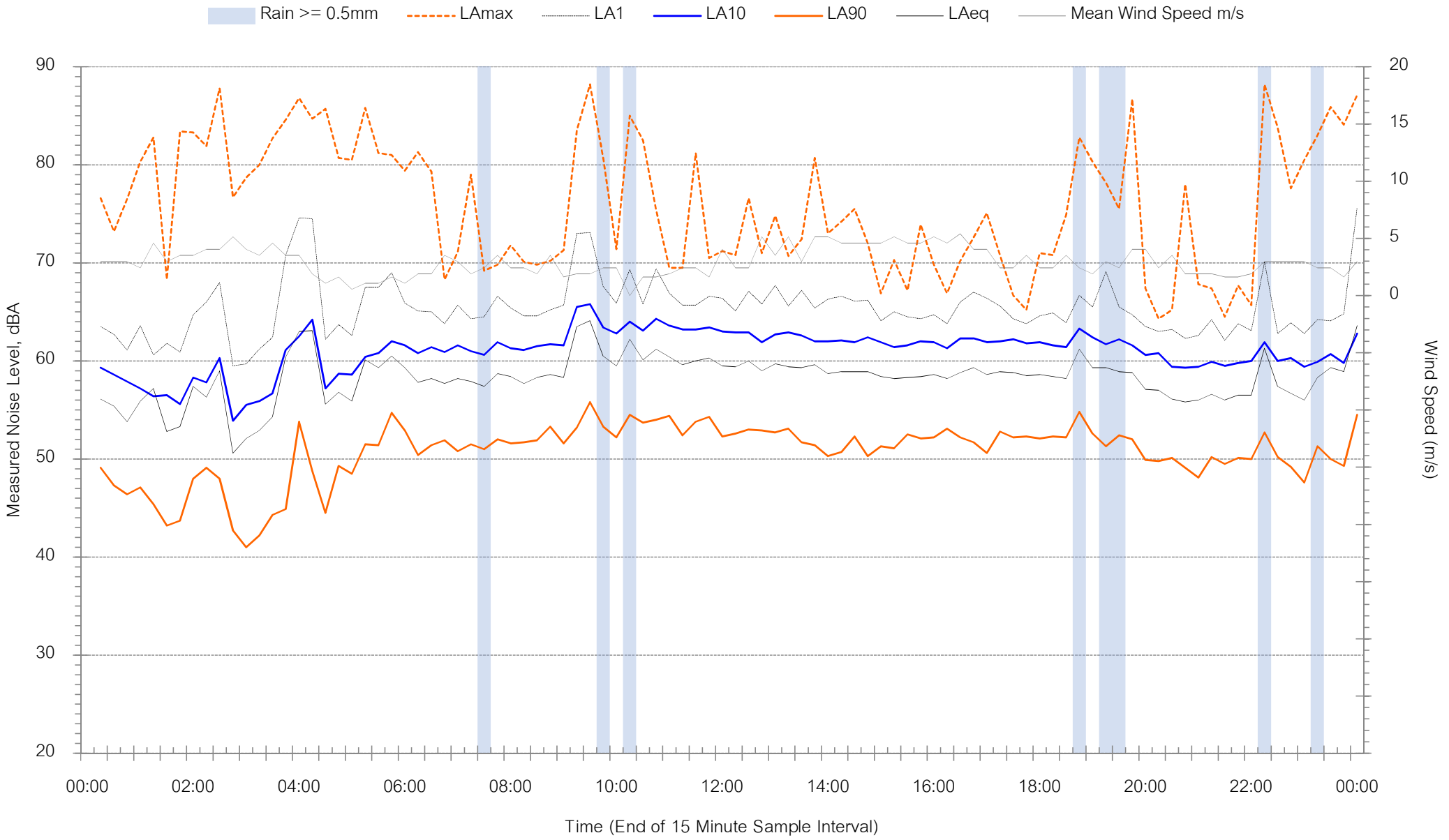
Background Noise Levels

Location - N2 - Friday 15 March 2019



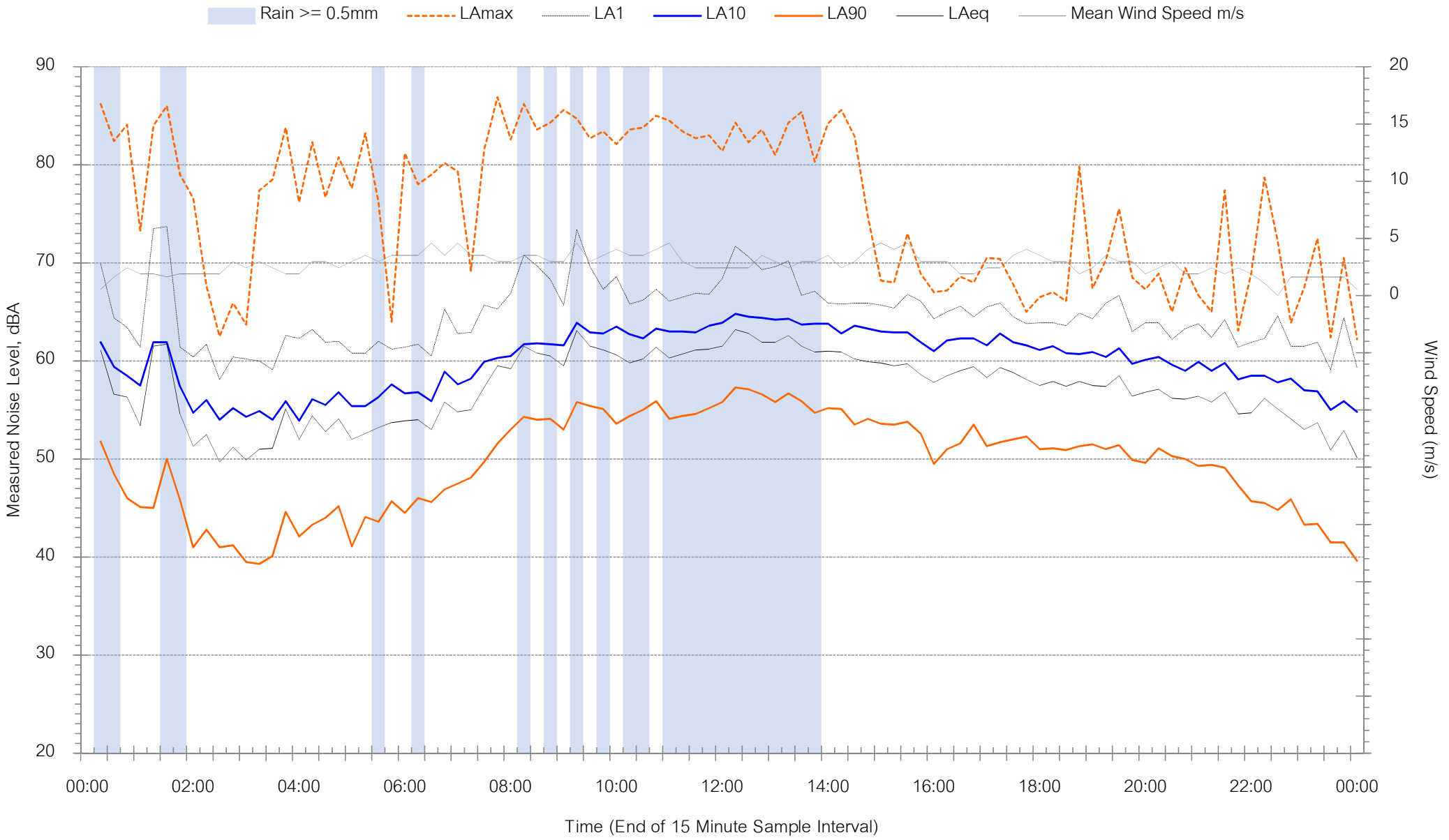
Background Noise Levels

Location - N2 - Saturday 16 March 2019



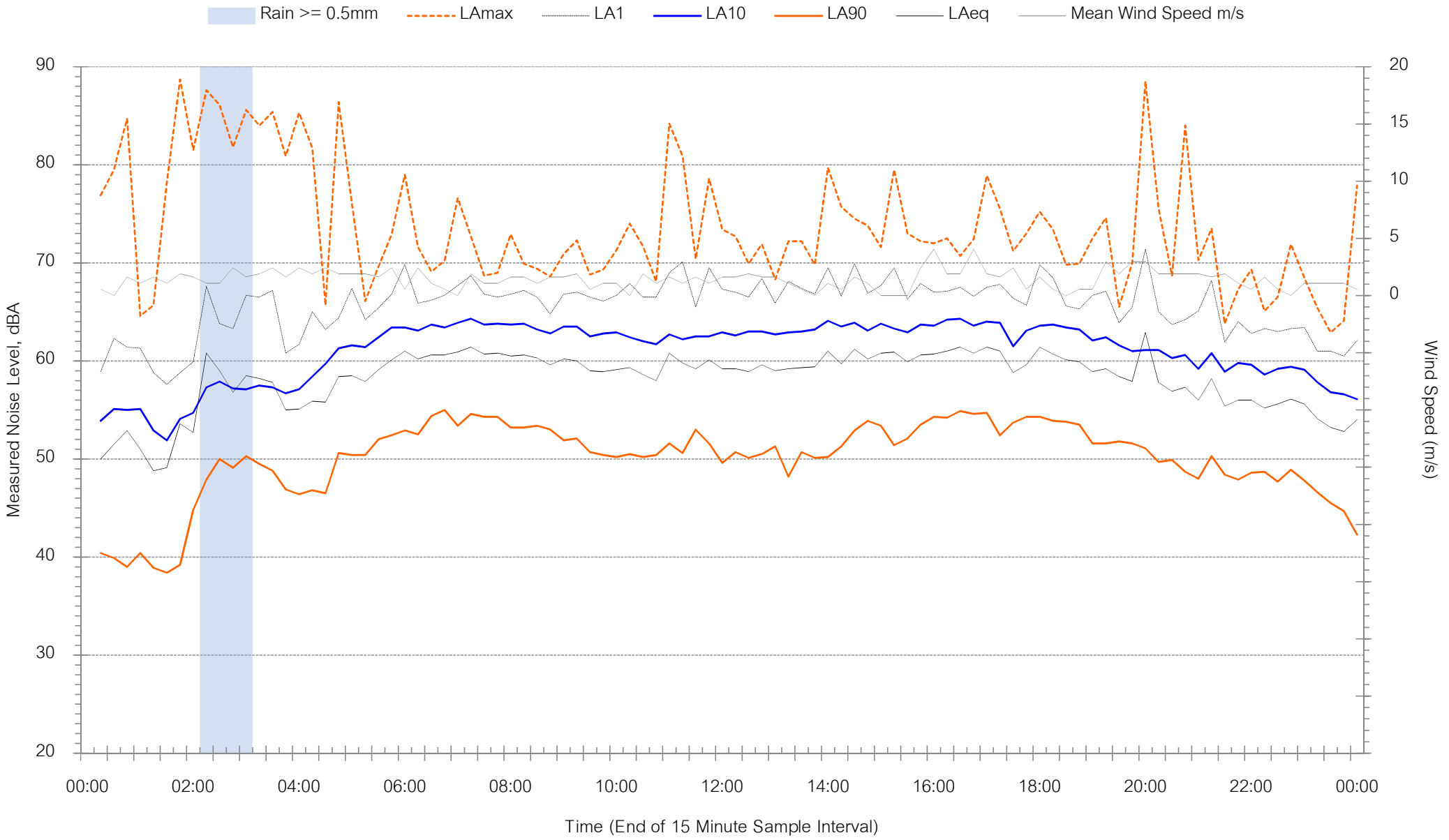
Background Noise Levels

Location - N2 - Sunday 17 March 2019



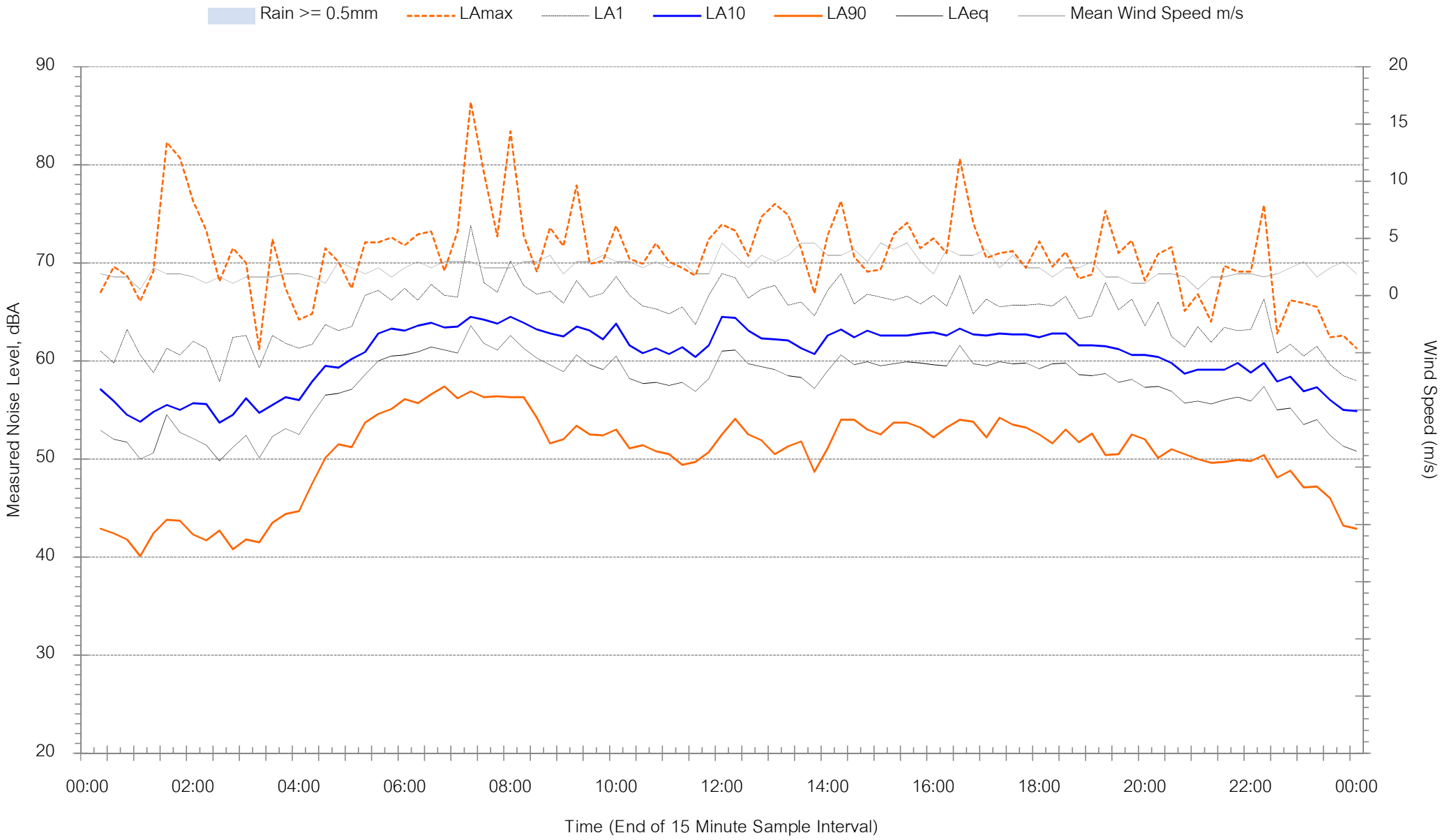
Background Noise Levels

Location - N2 - Monday 18 March 2019



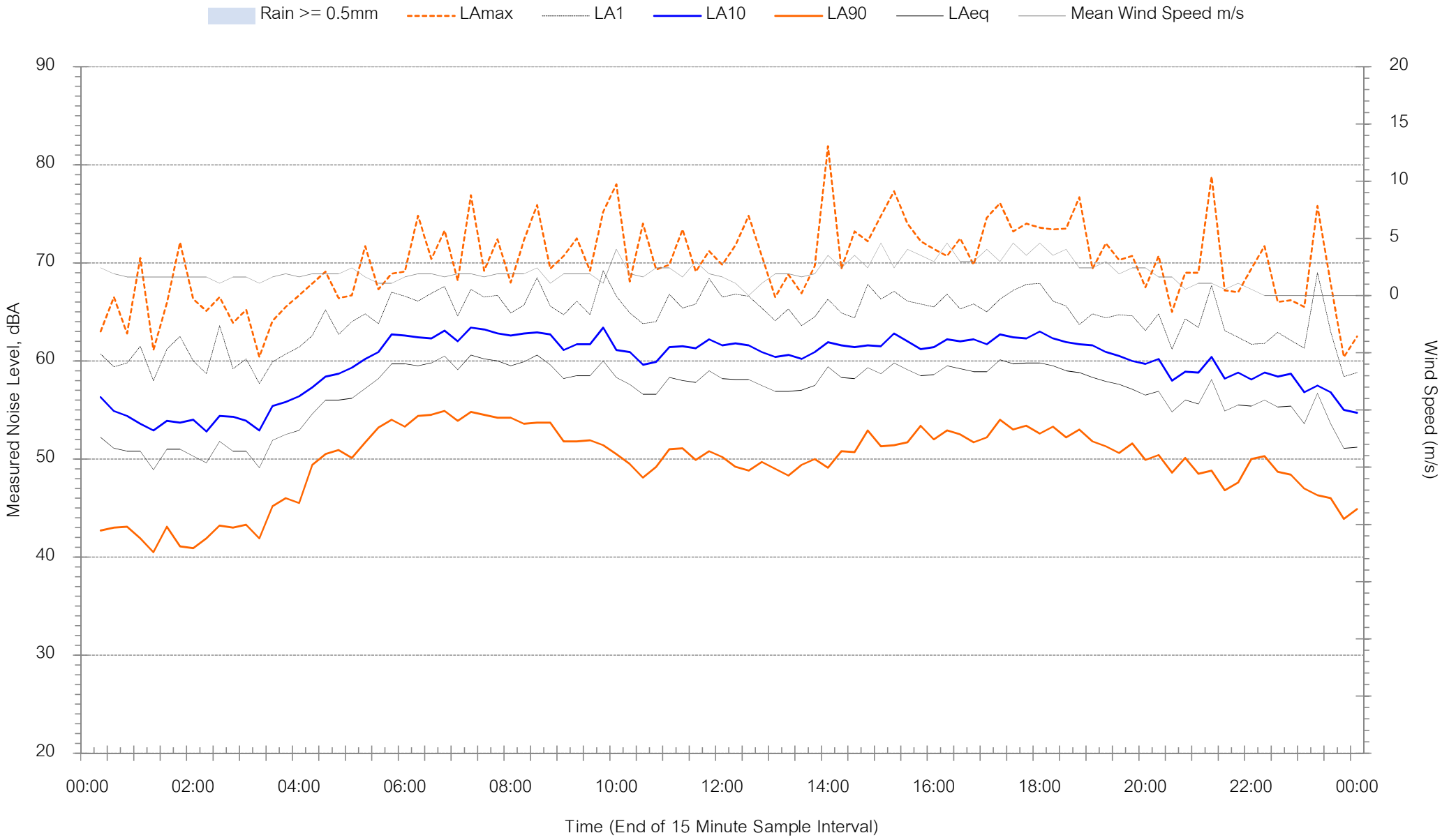
Background Noise Levels

Location - N2 - Tuesday 19 March 2019



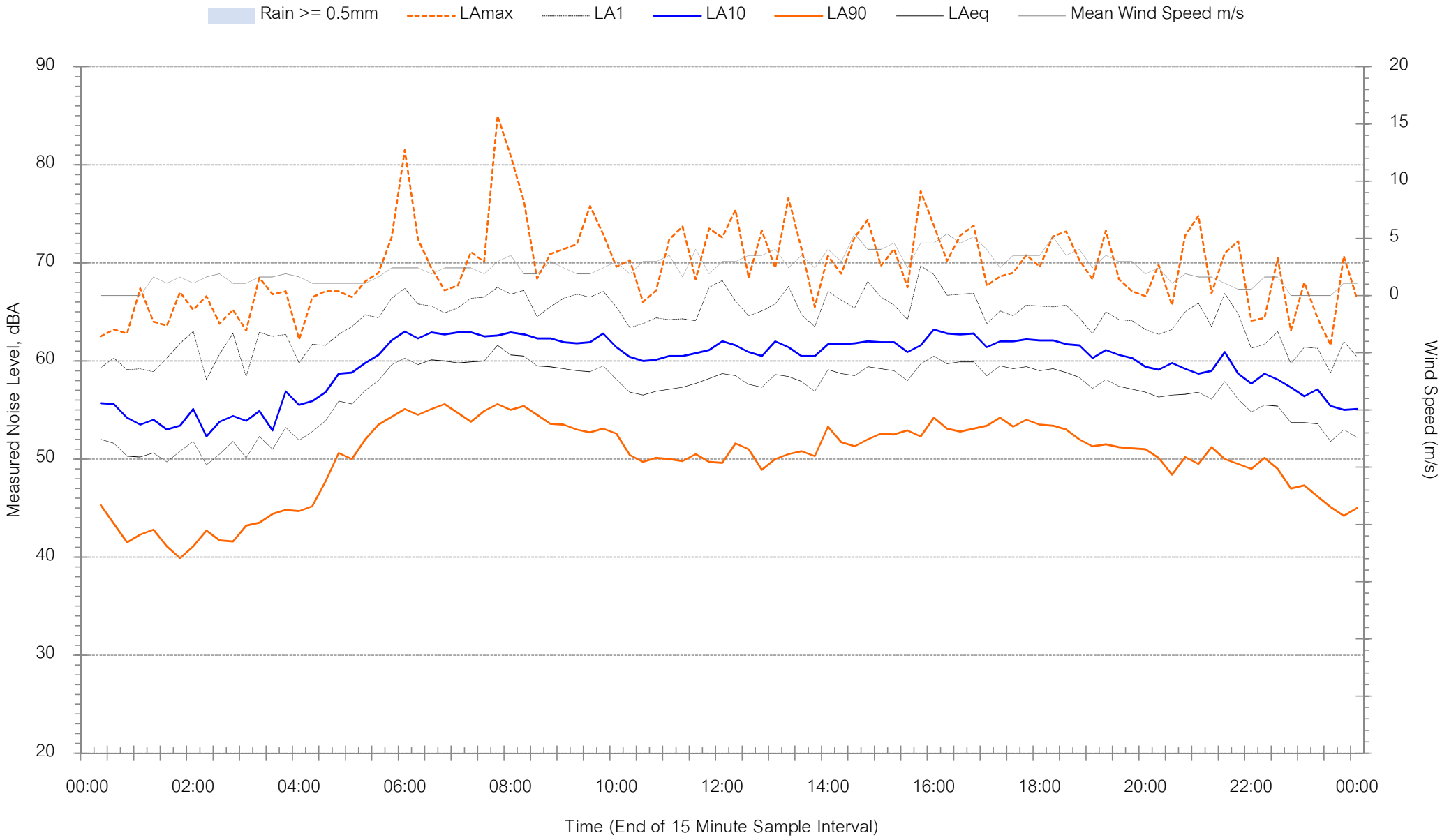
Background Noise Levels

Location - N2 - Wednesday 20 March 2019



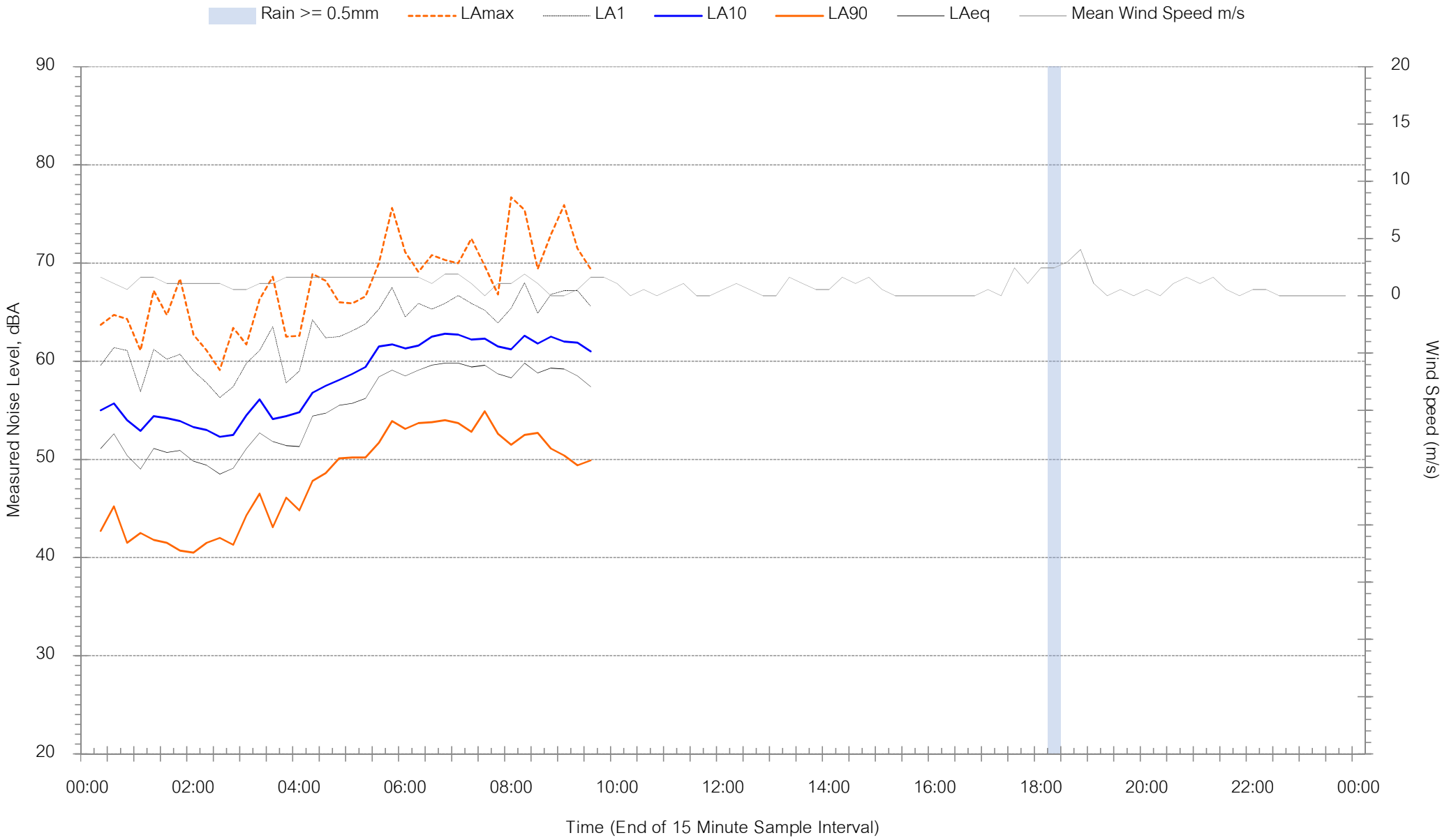
Background Noise Levels

Location - N2 - Thursday 21 March 2019



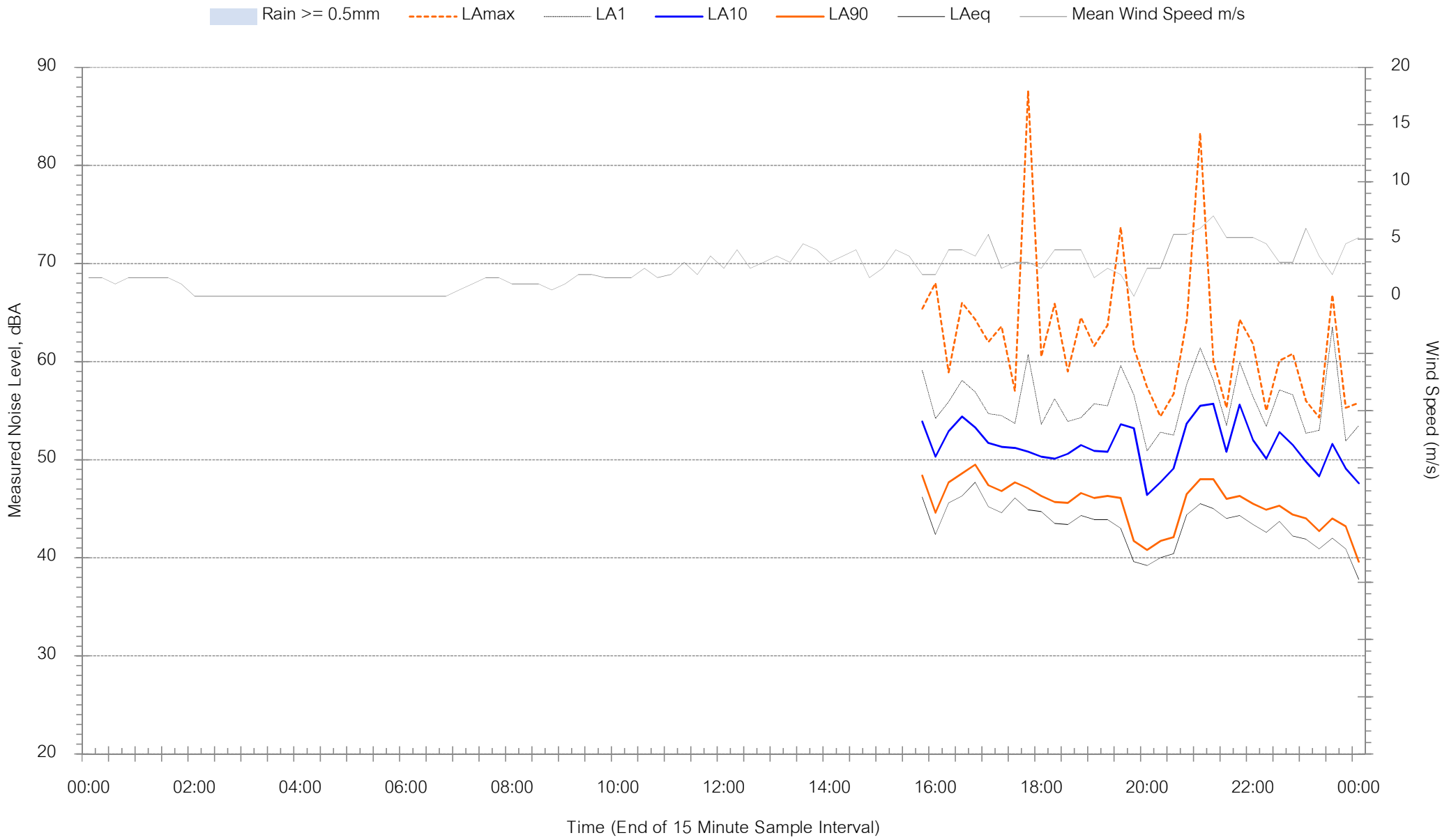
Background Noise Levels

Location - N2 - Friday 22 March 2019



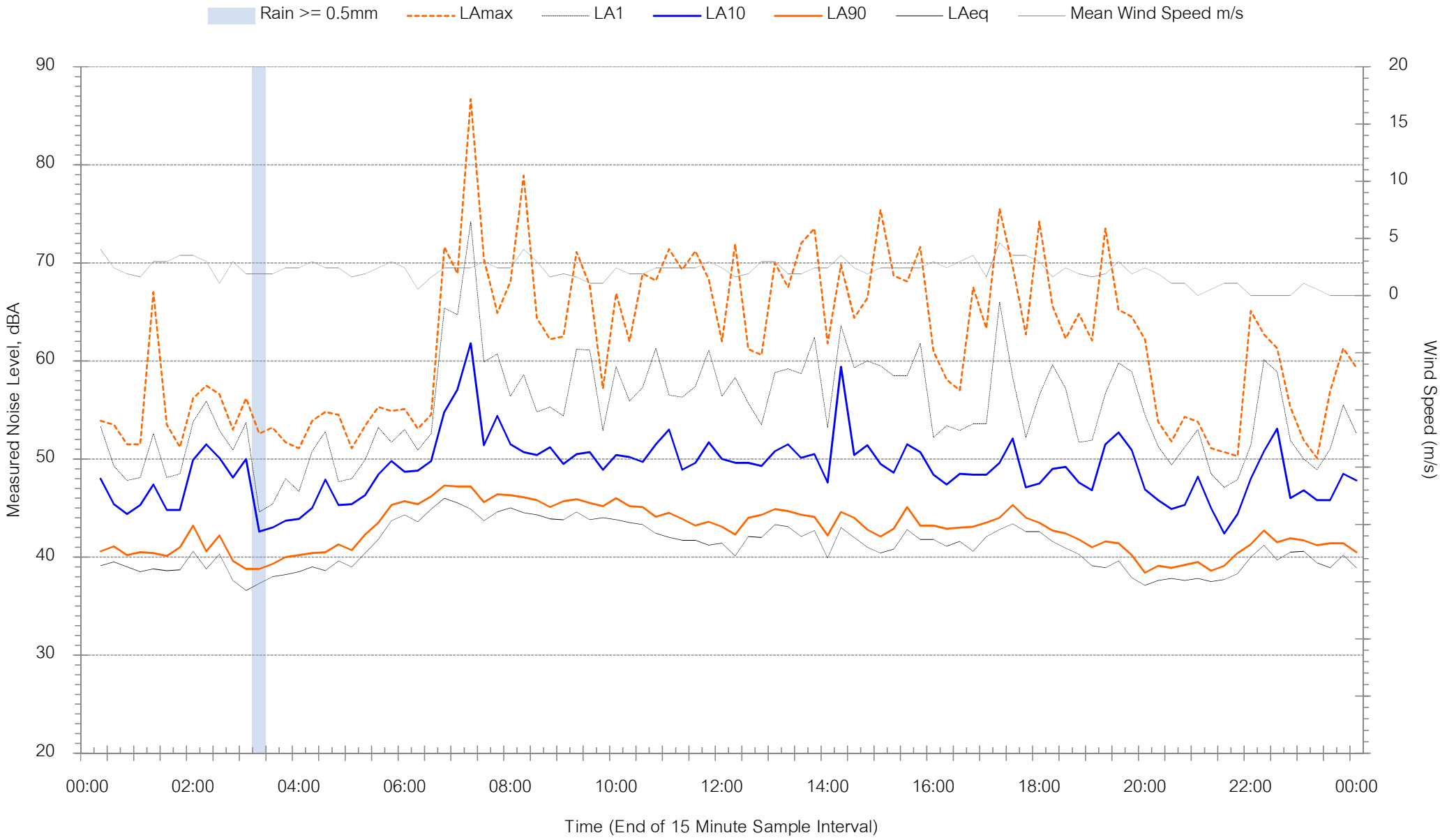
Background Noise Levels

Location - N3 - Tuesday 12 March 2019



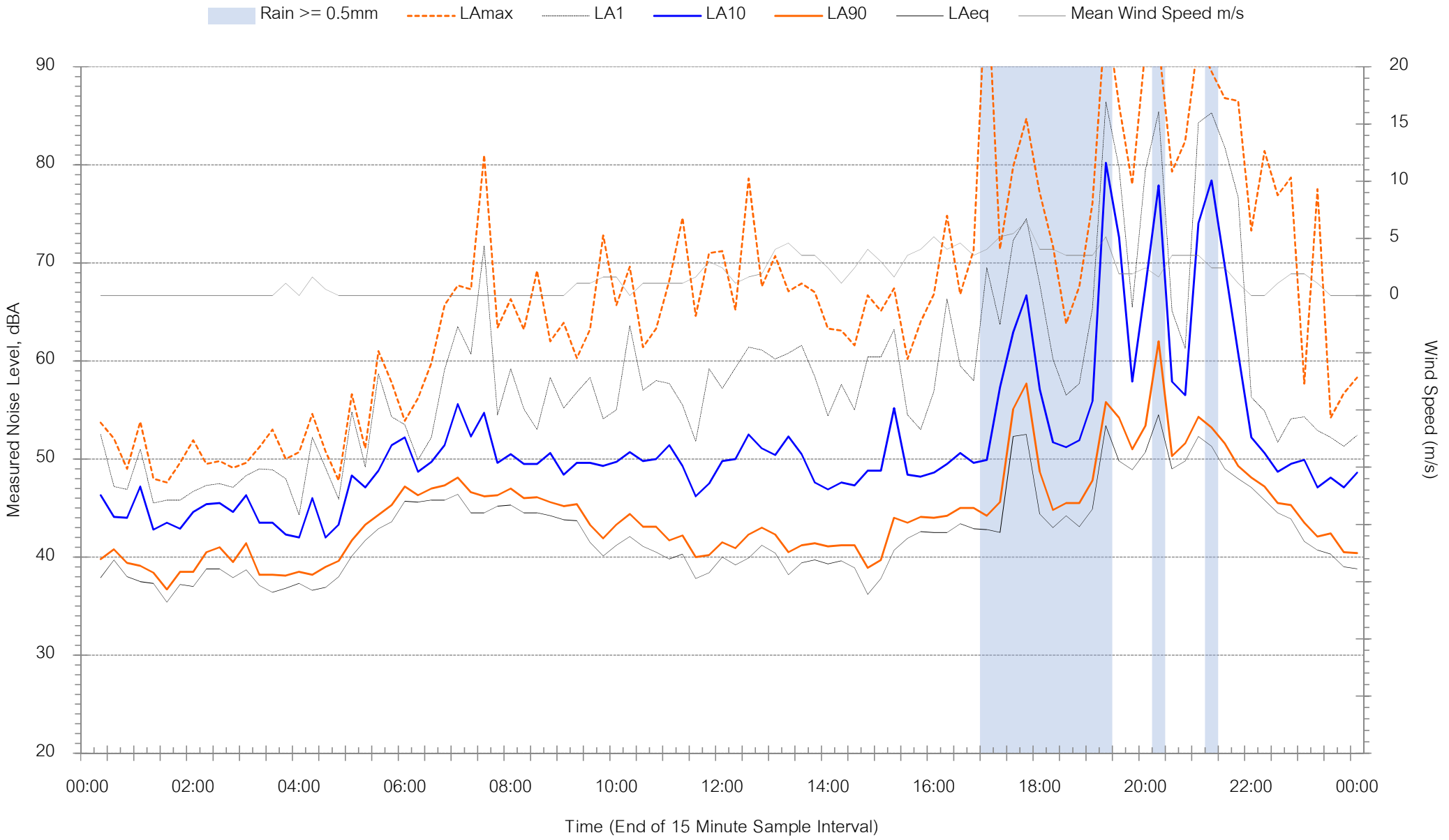
Background Noise Levels

Location - N3 - Wednesday 13 March 2019



Background Noise Levels

Location - N3 - Thursday 14 March 2019



Background Noise Levels

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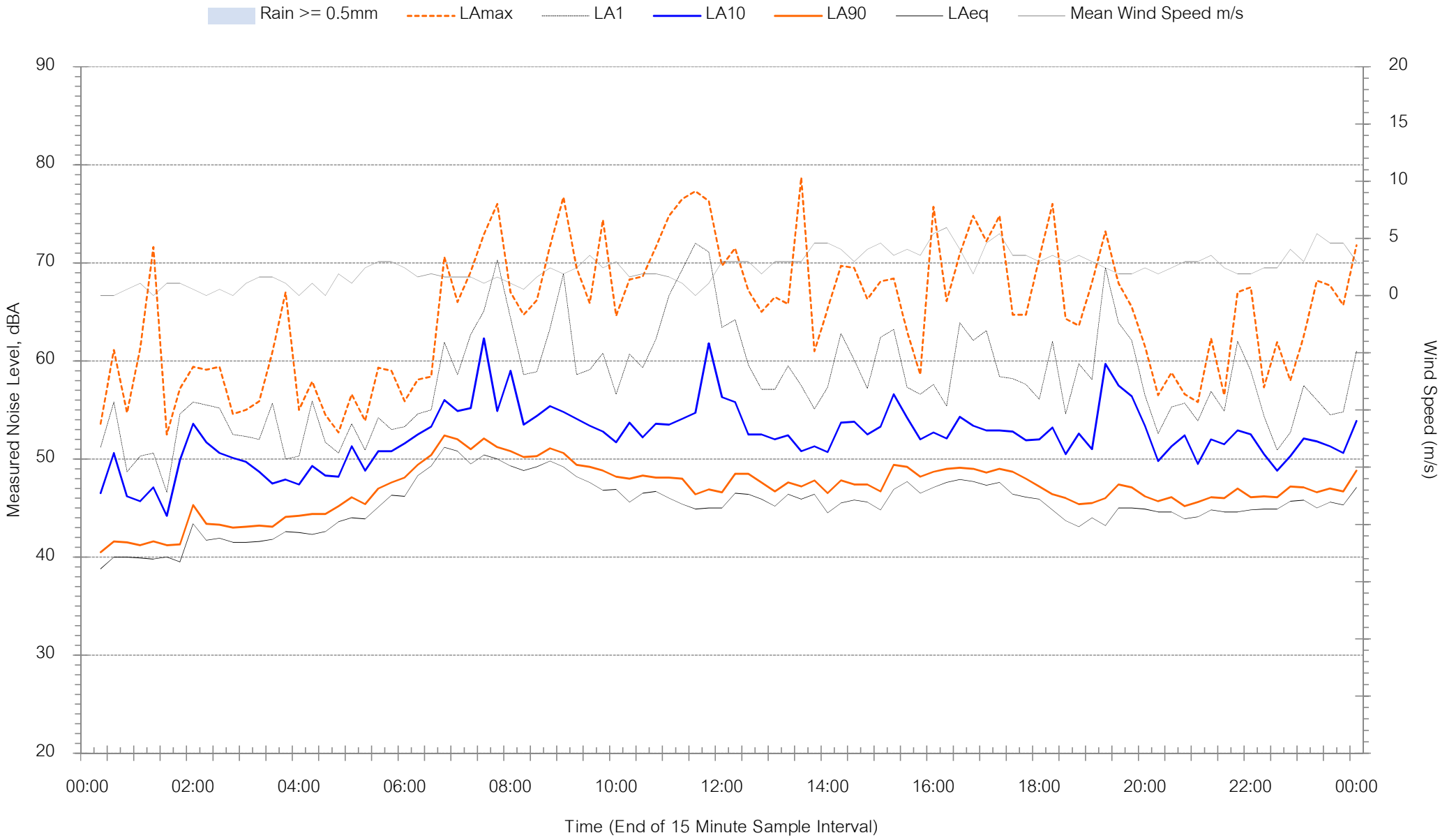
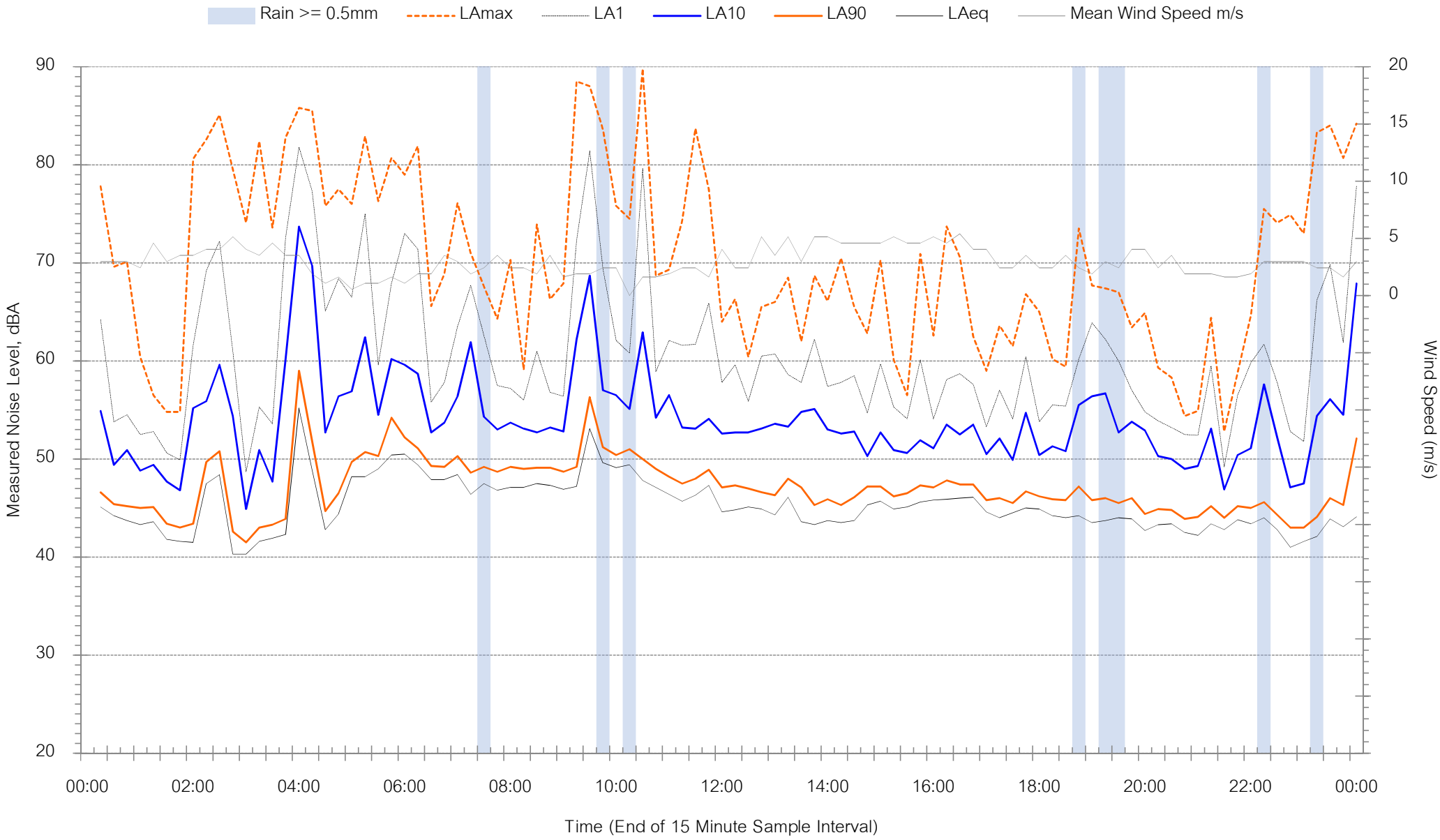


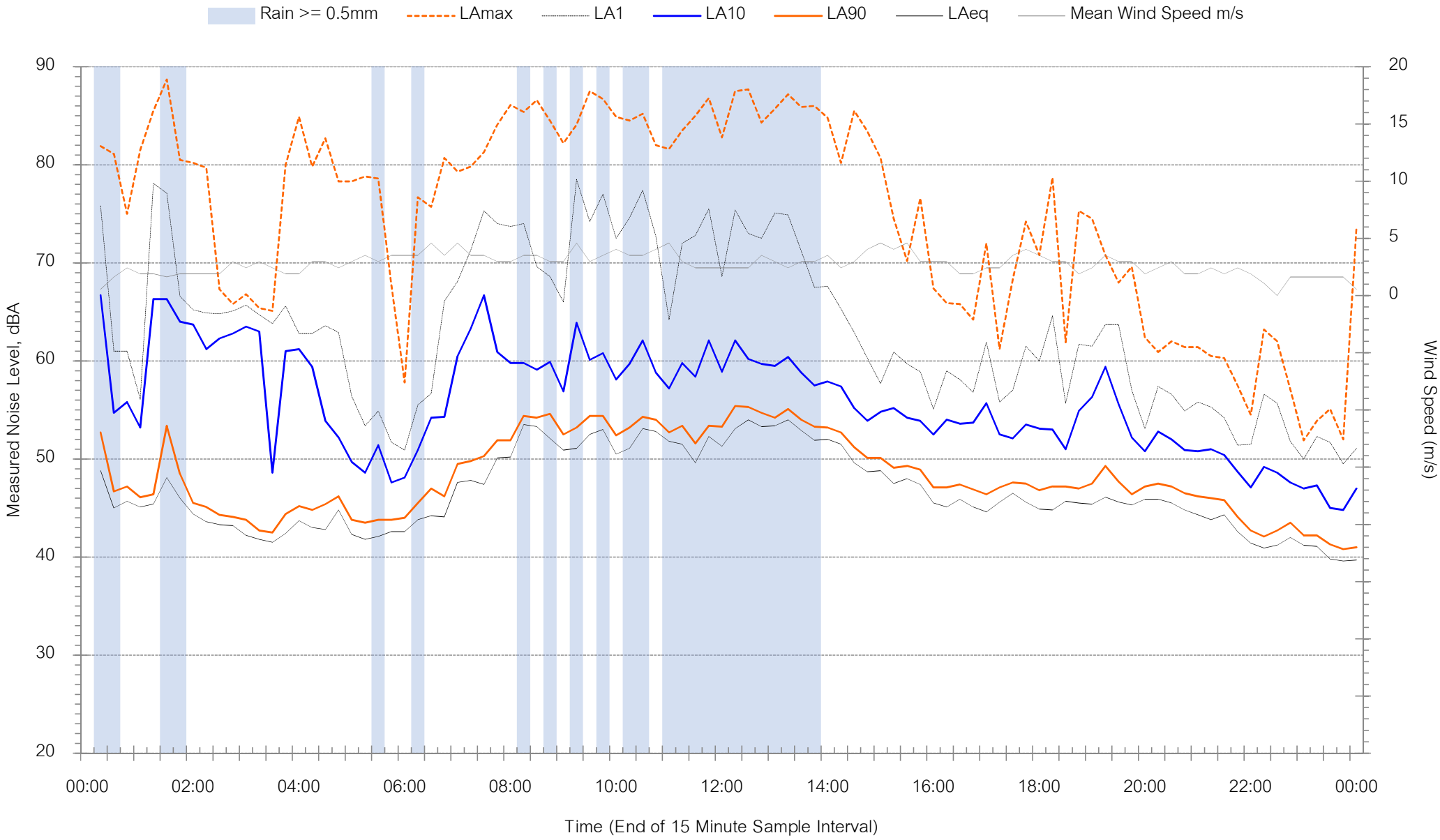
Background Noise Levels

Location - N3 - Saturday 16 March 2019



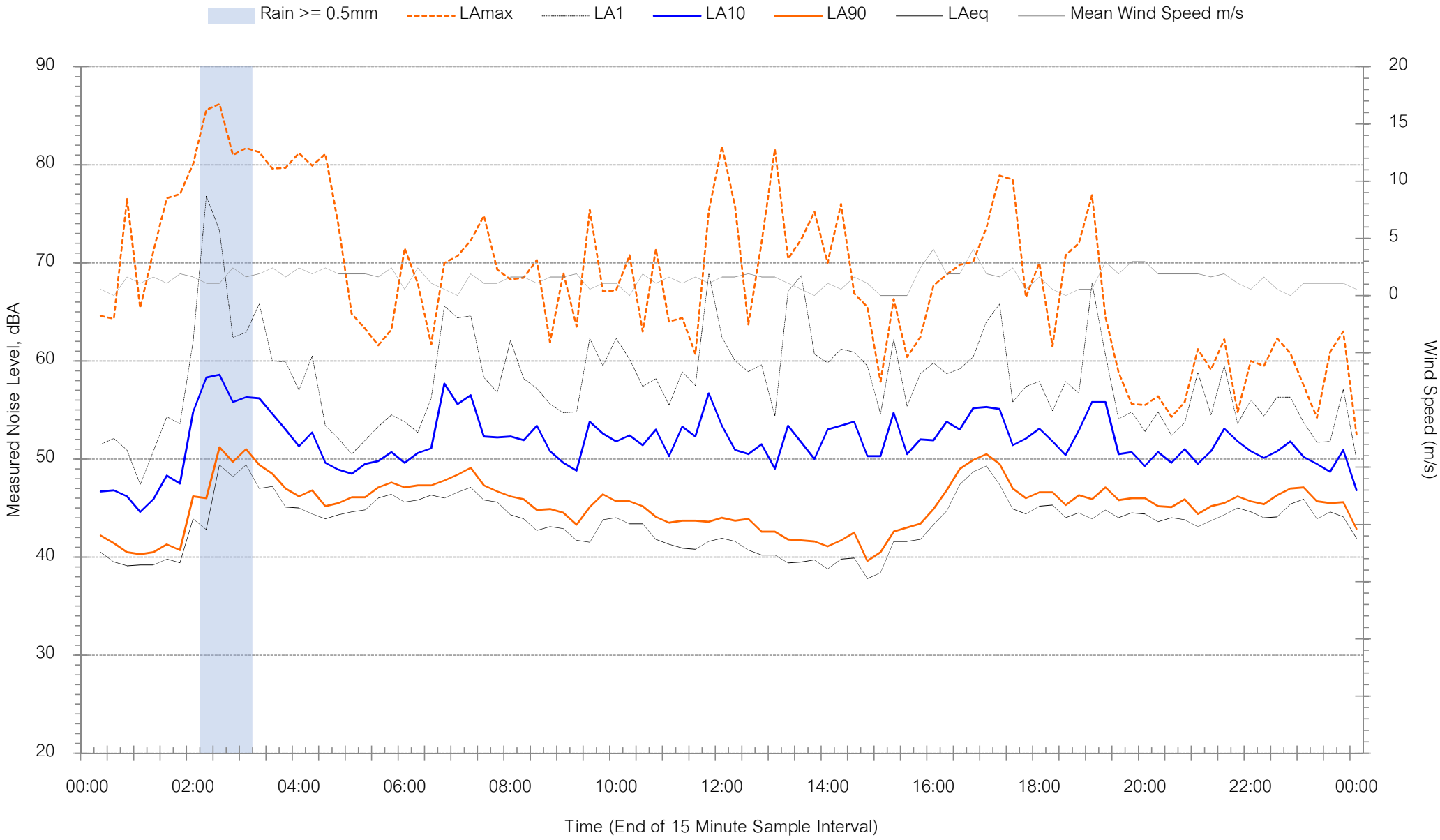
Background Noise Levels

Location - N3 - Sunday 17 March 2019



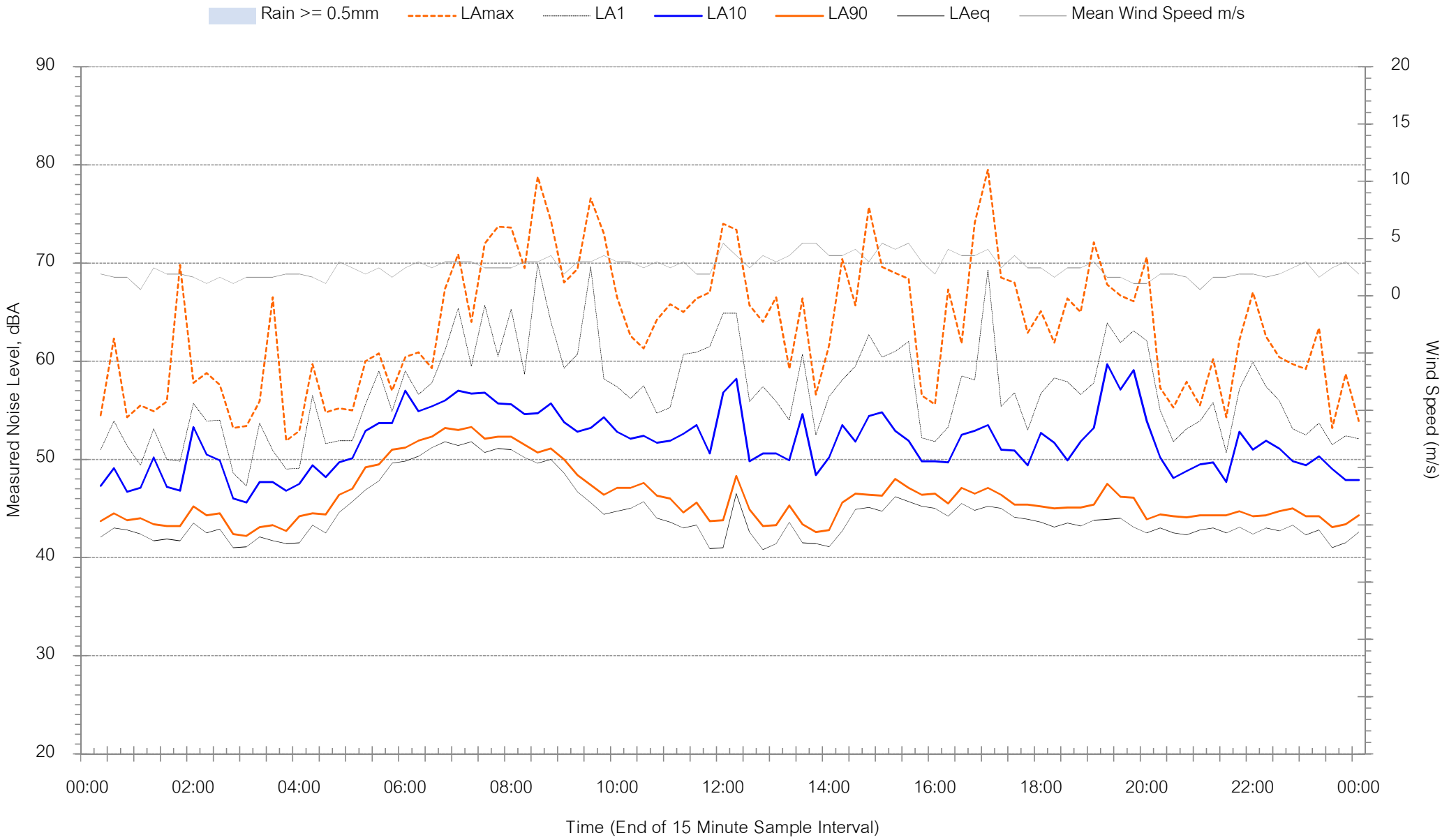
Background Noise Levels

Location - N3 - Monday 18 March 2019



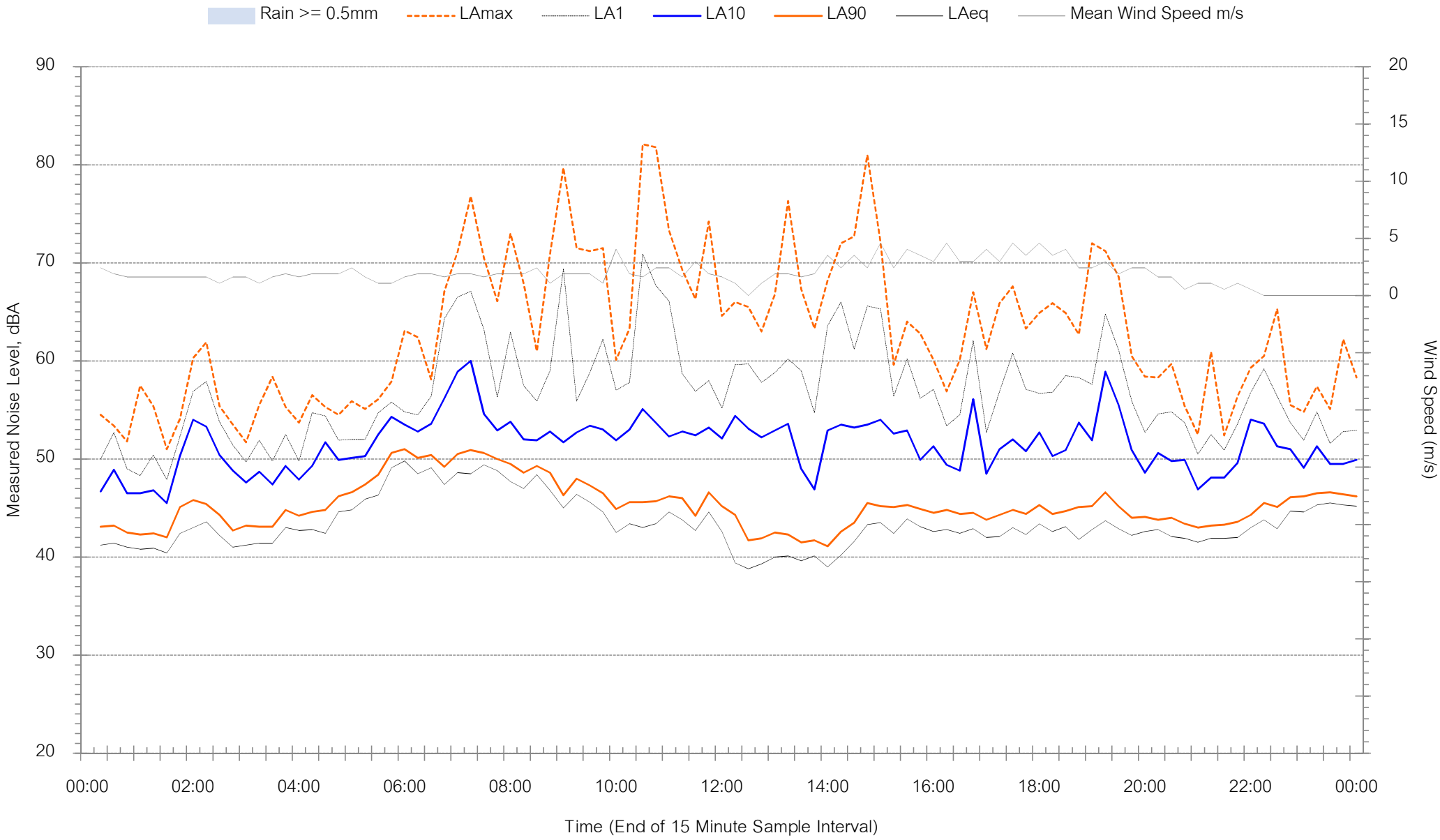
Background Noise Levels

Location - N3 - Tuesday 19 March 2019



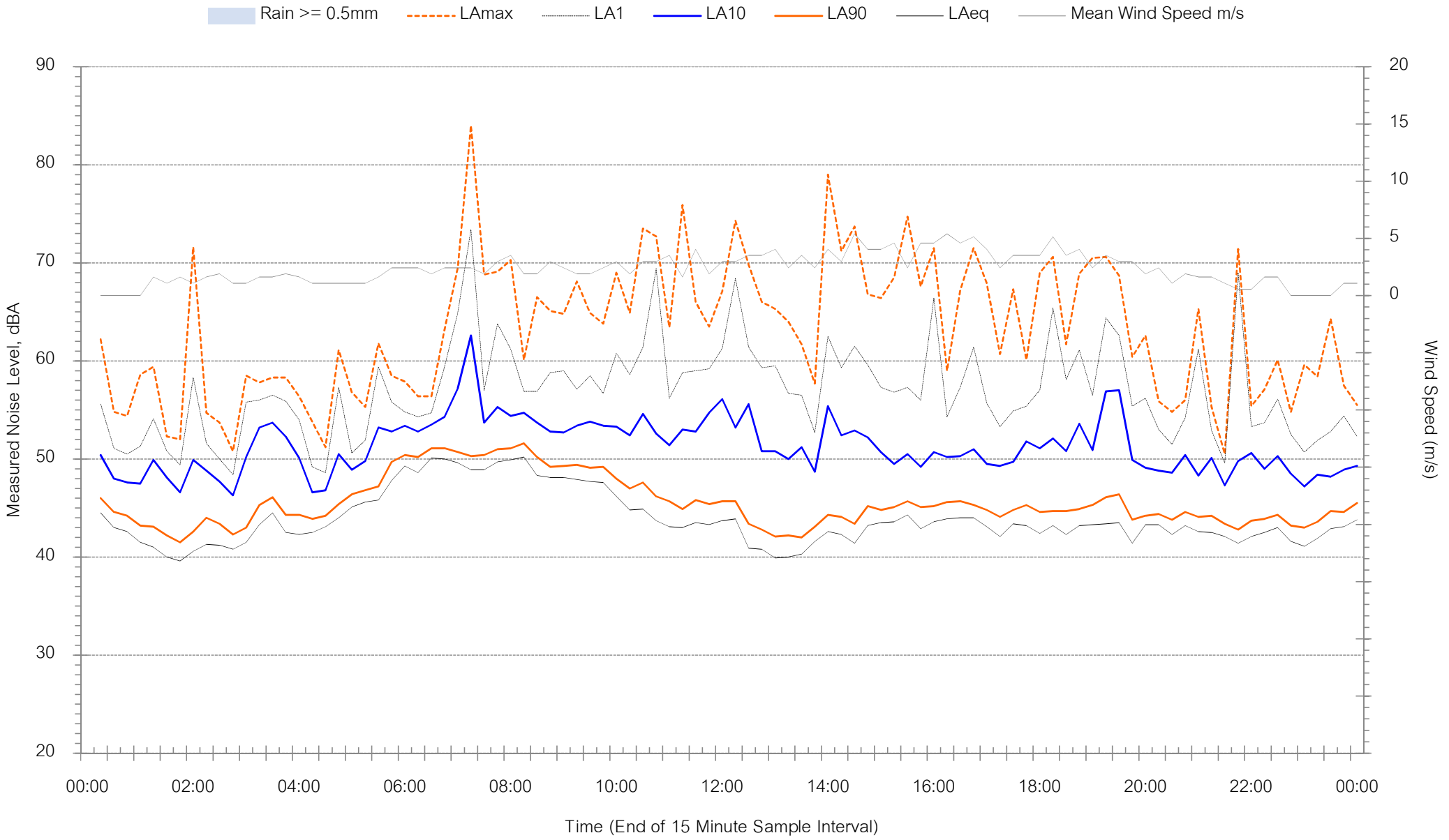
Background Noise Levels

Location - N3 - Wednesday 20 March 2019



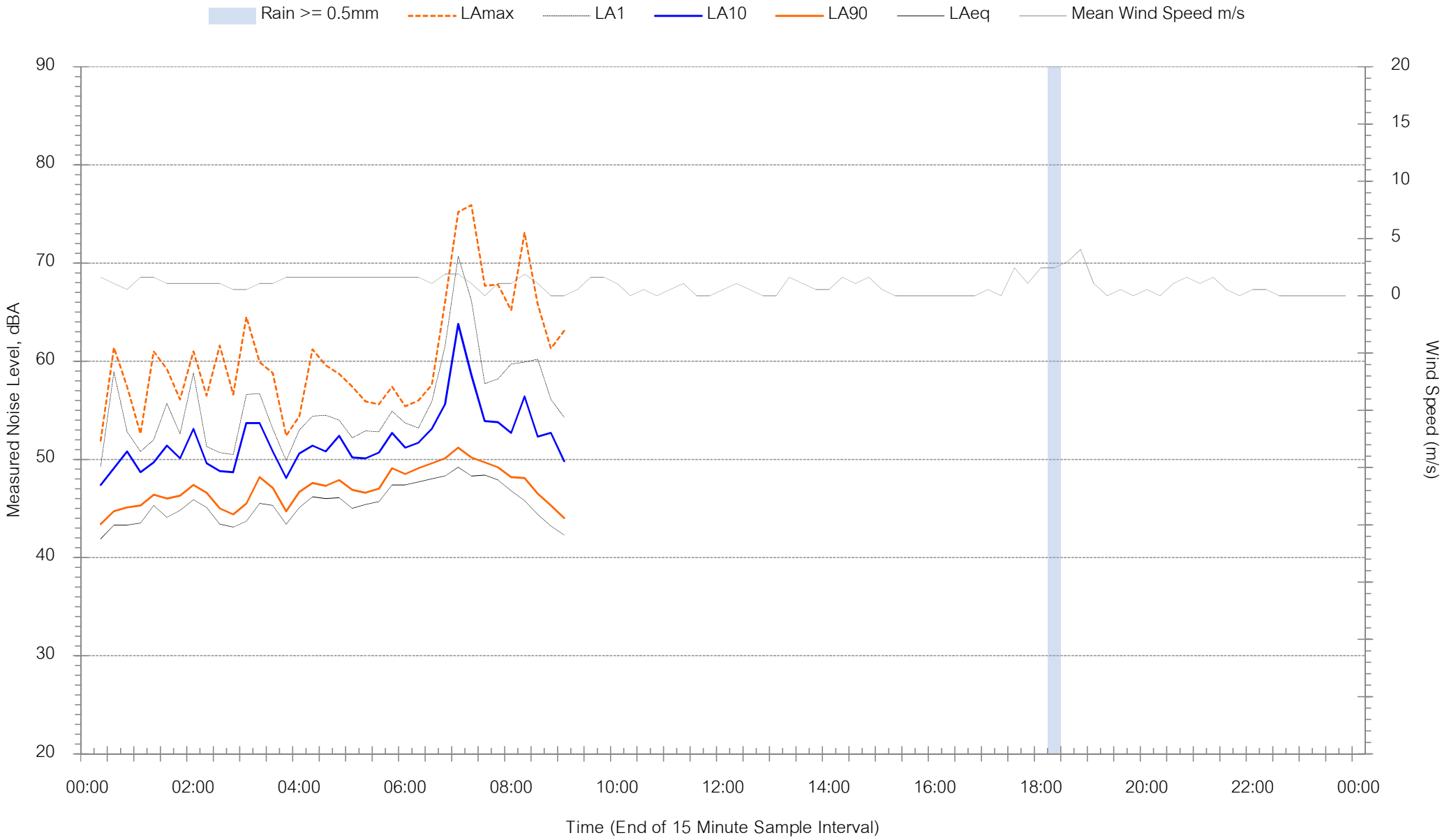
Background Noise Levels

Location - N3 - Thursday 21 March 2019



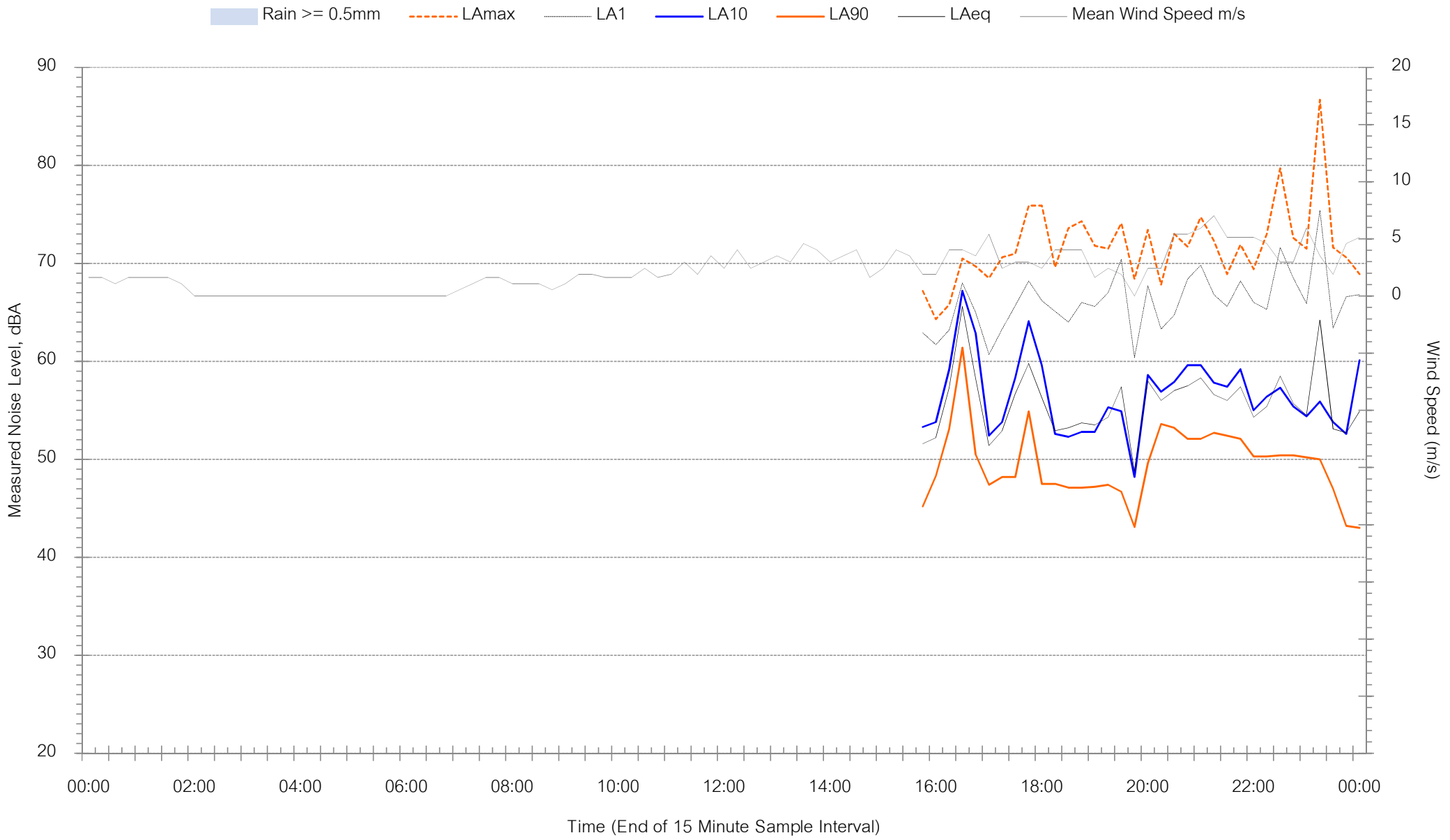
Background Noise Levels

Location - N3 - Friday 22 March 2019



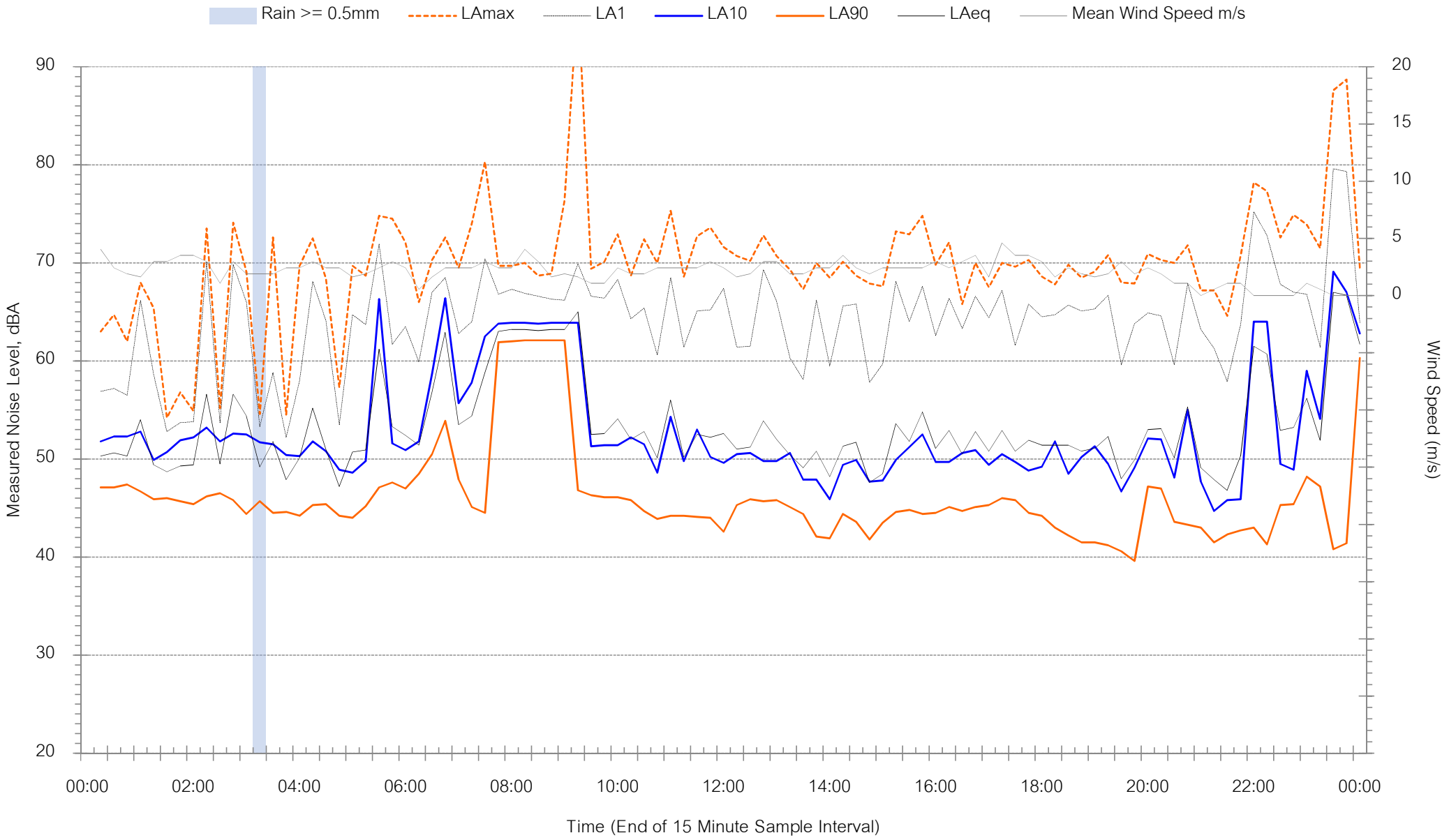
Background Noise Levels

Location - N4 - Tuesday 12 March 2019



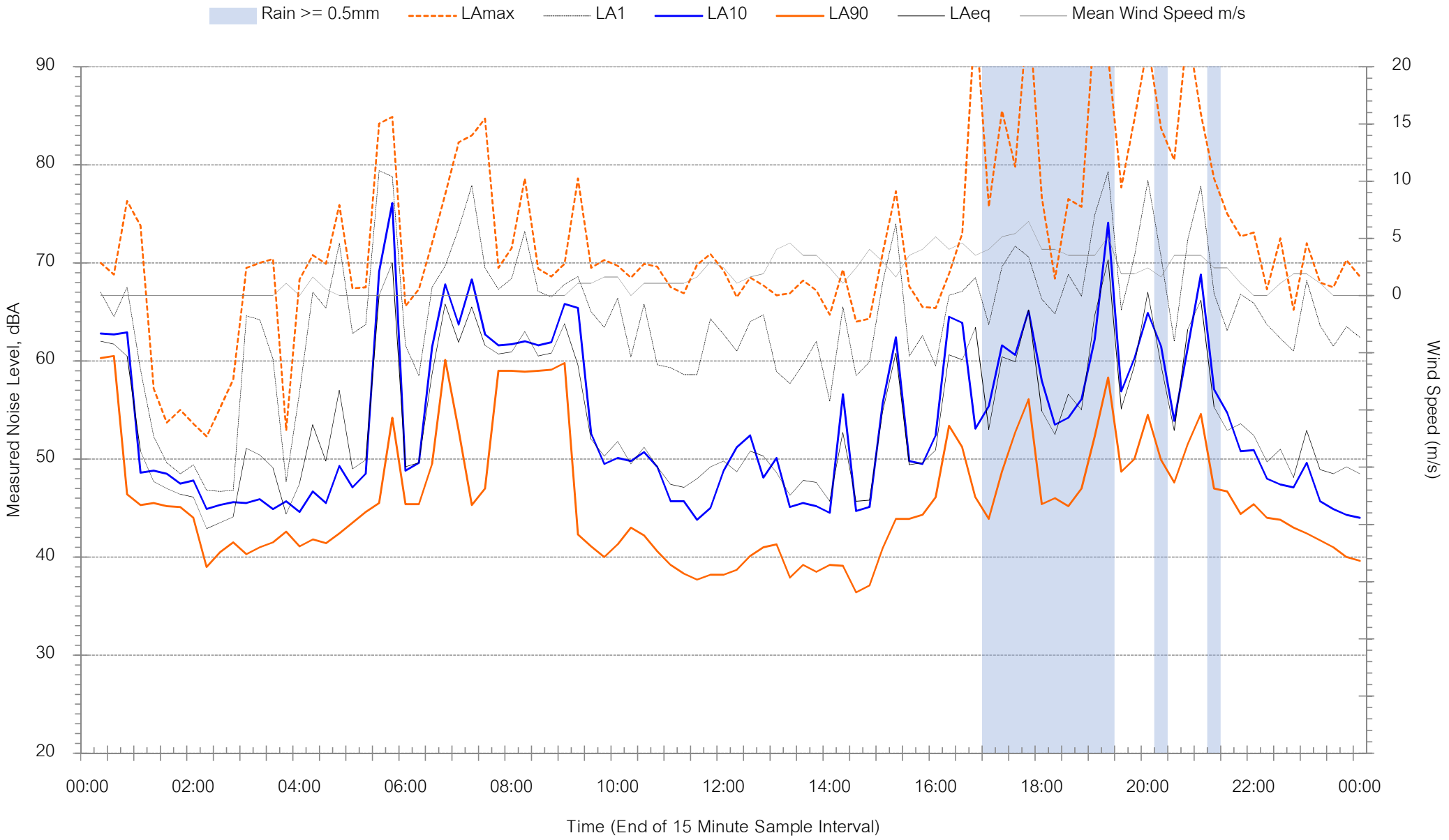
Background Noise Levels

Location - N4 - Wednesday 13 March 2019



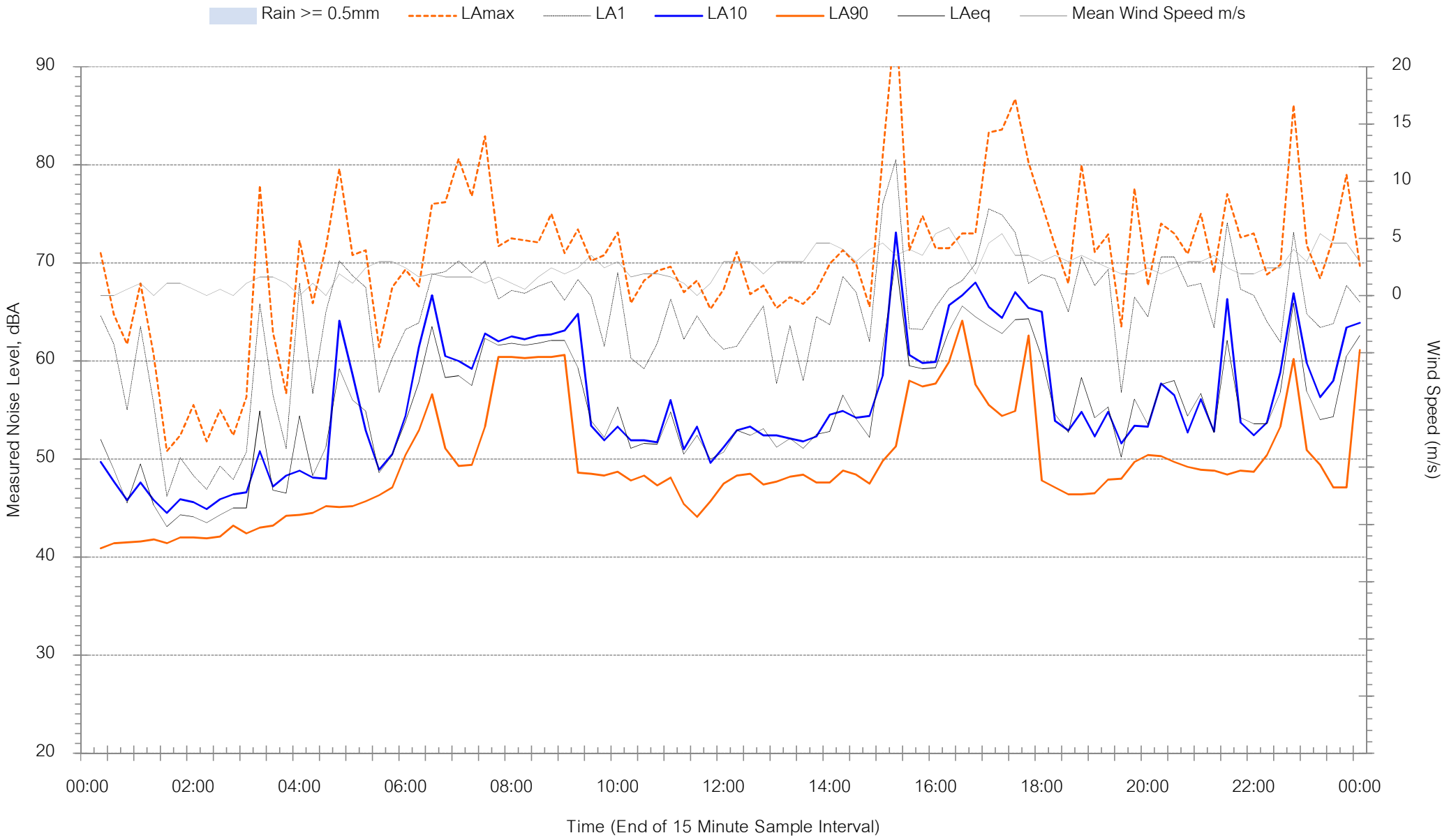
Background Noise Levels

Location - N4 - Thursday 14 March 2019



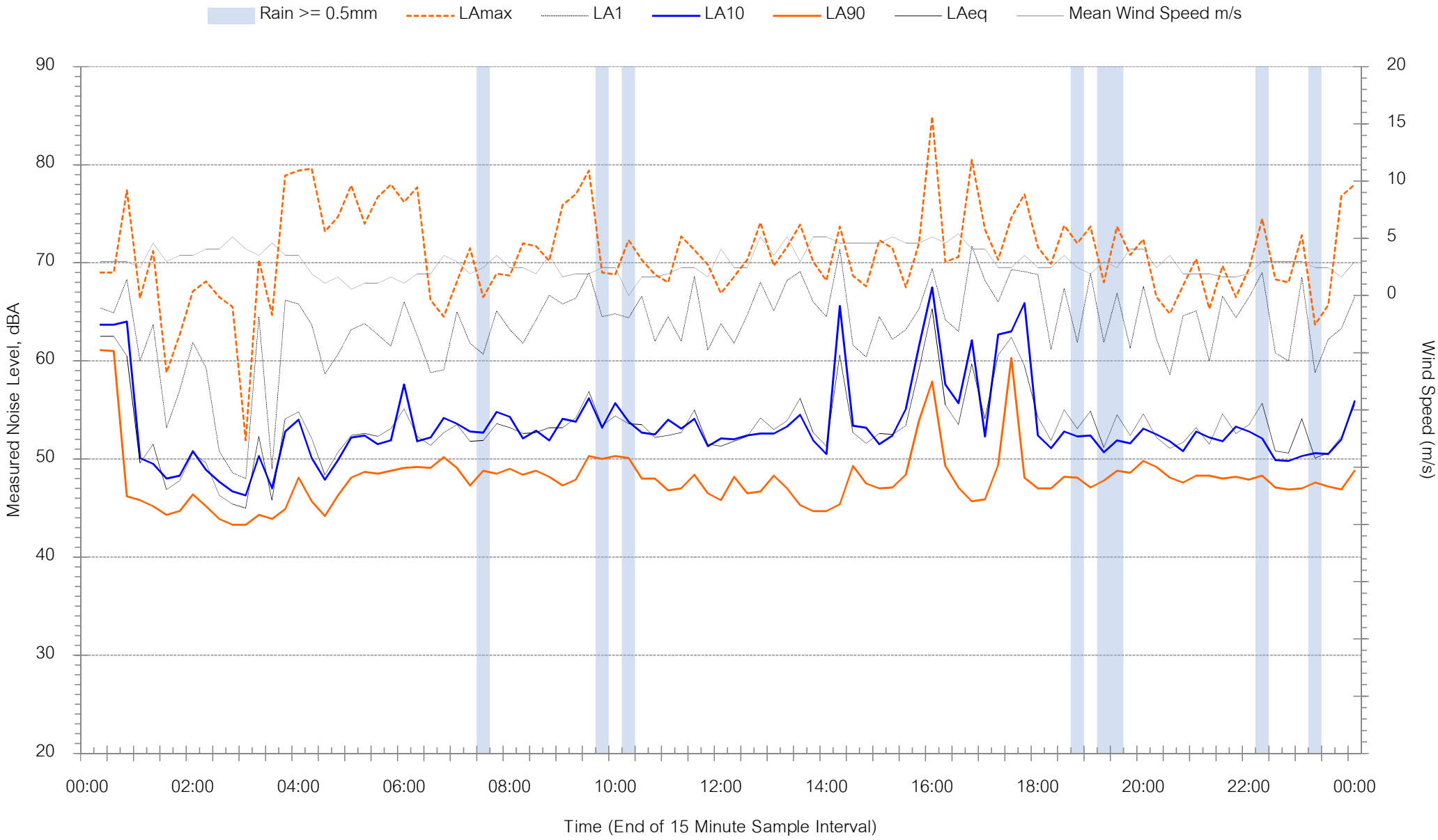
Background Noise Levels

Location - N4 - Friday 15 March 2019



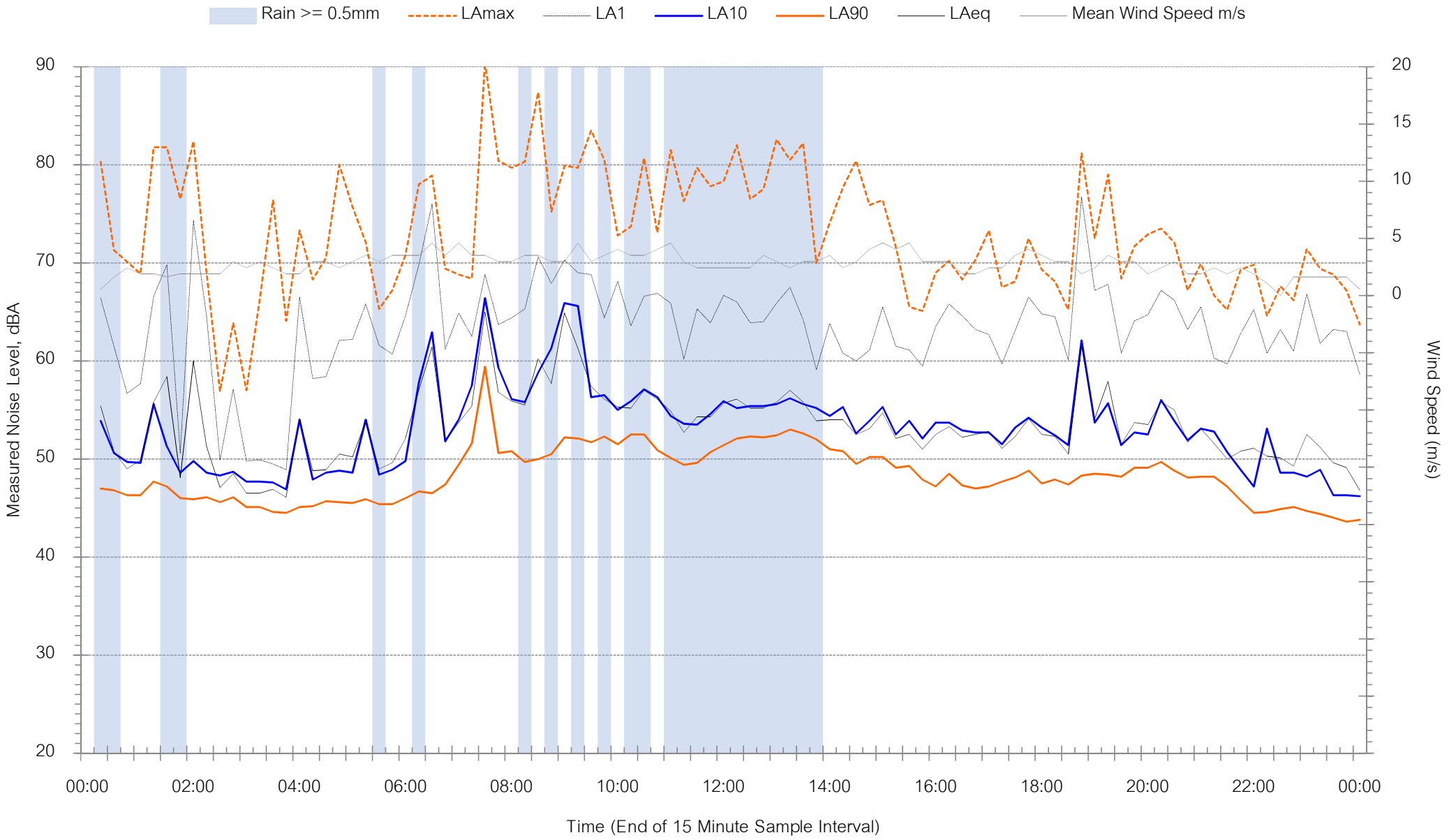
Background Noise Levels

Location - N4 - Saturday 16 March 2019



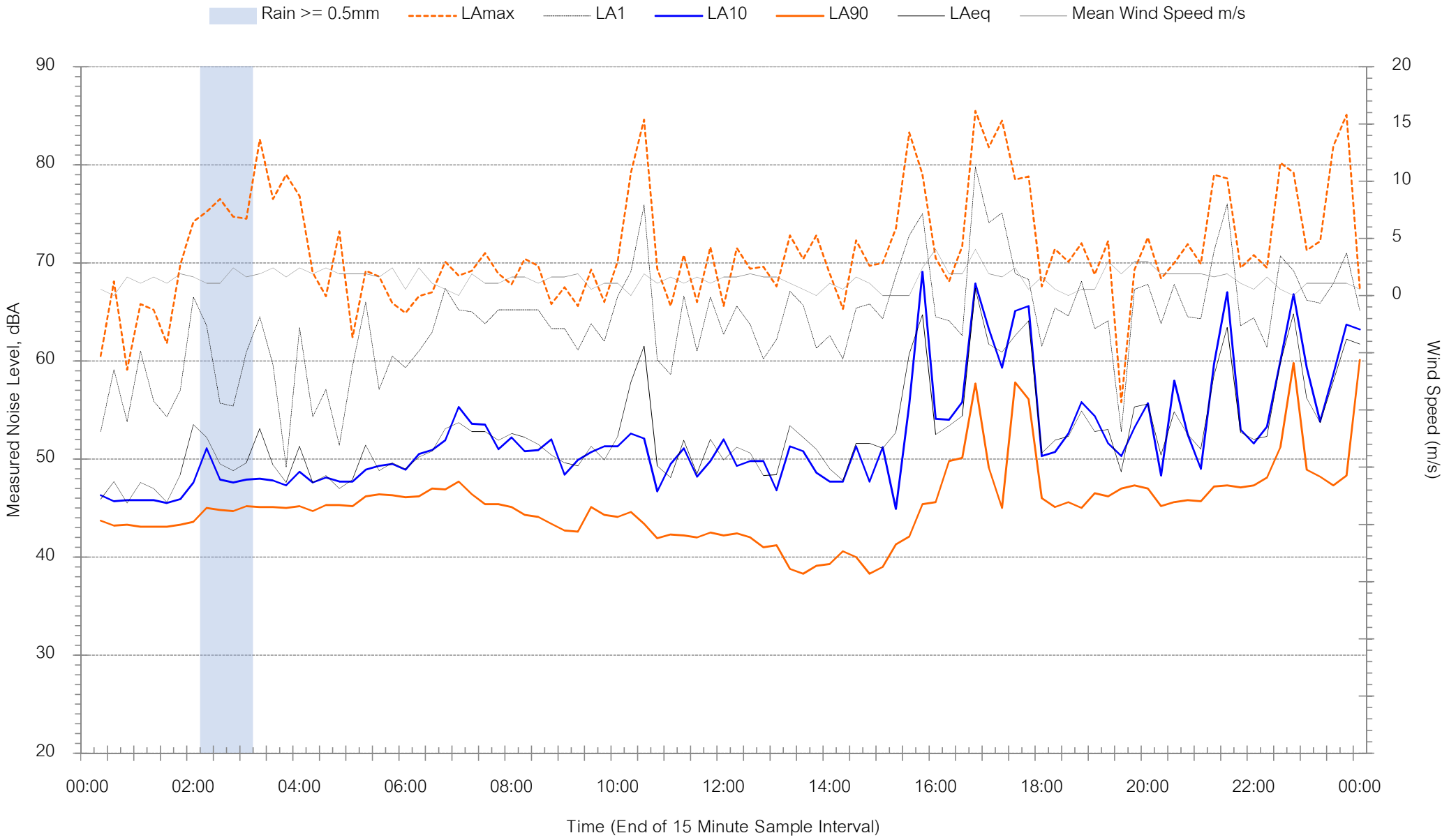
Background Noise Levels

Location - N4 - Sunday 17 March 2019



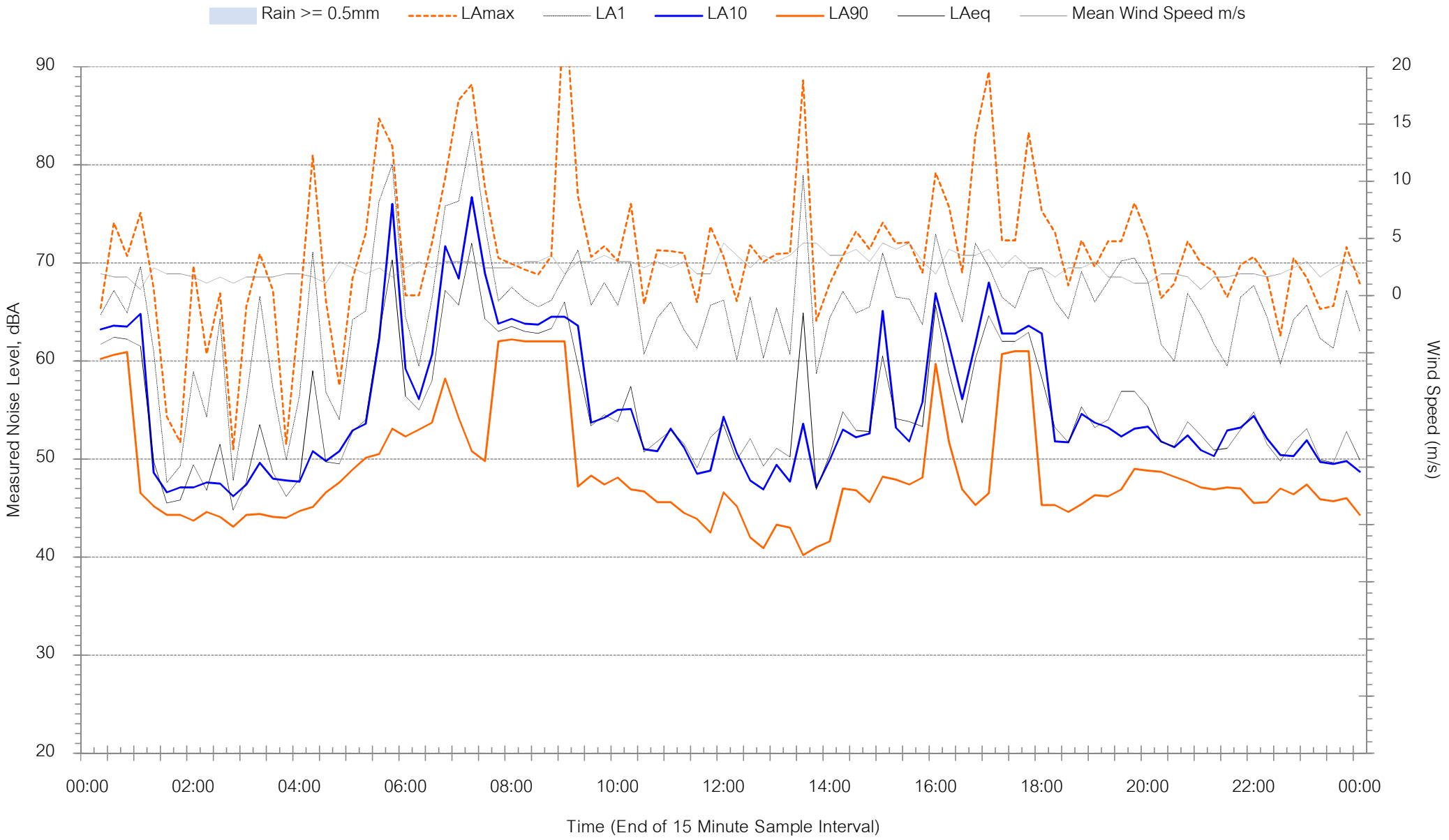
Background Noise Levels

Location - N4 - Monday 18 March 2019



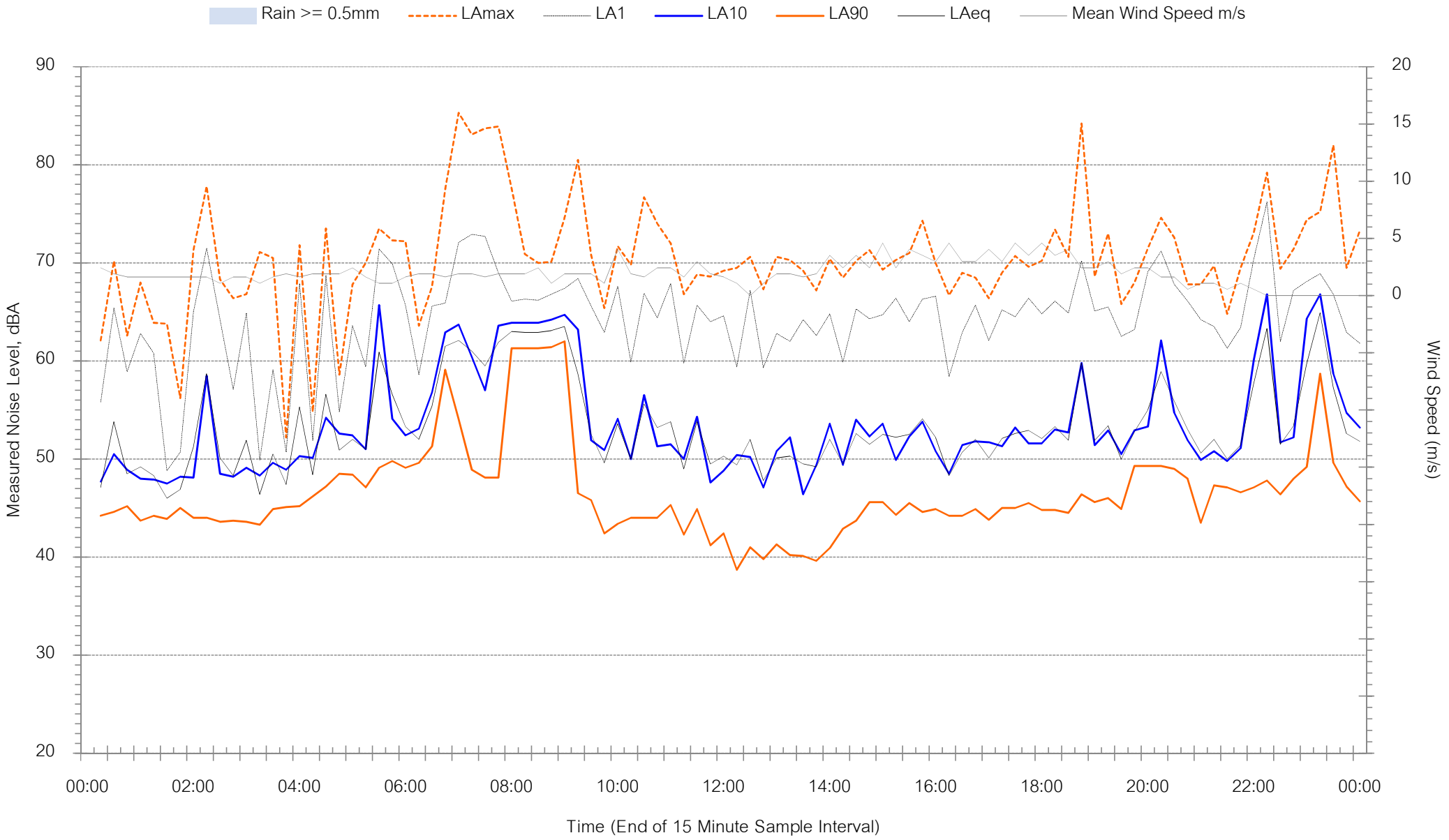
Background Noise Levels

Location - N4 - Tuesday 19 March 2019



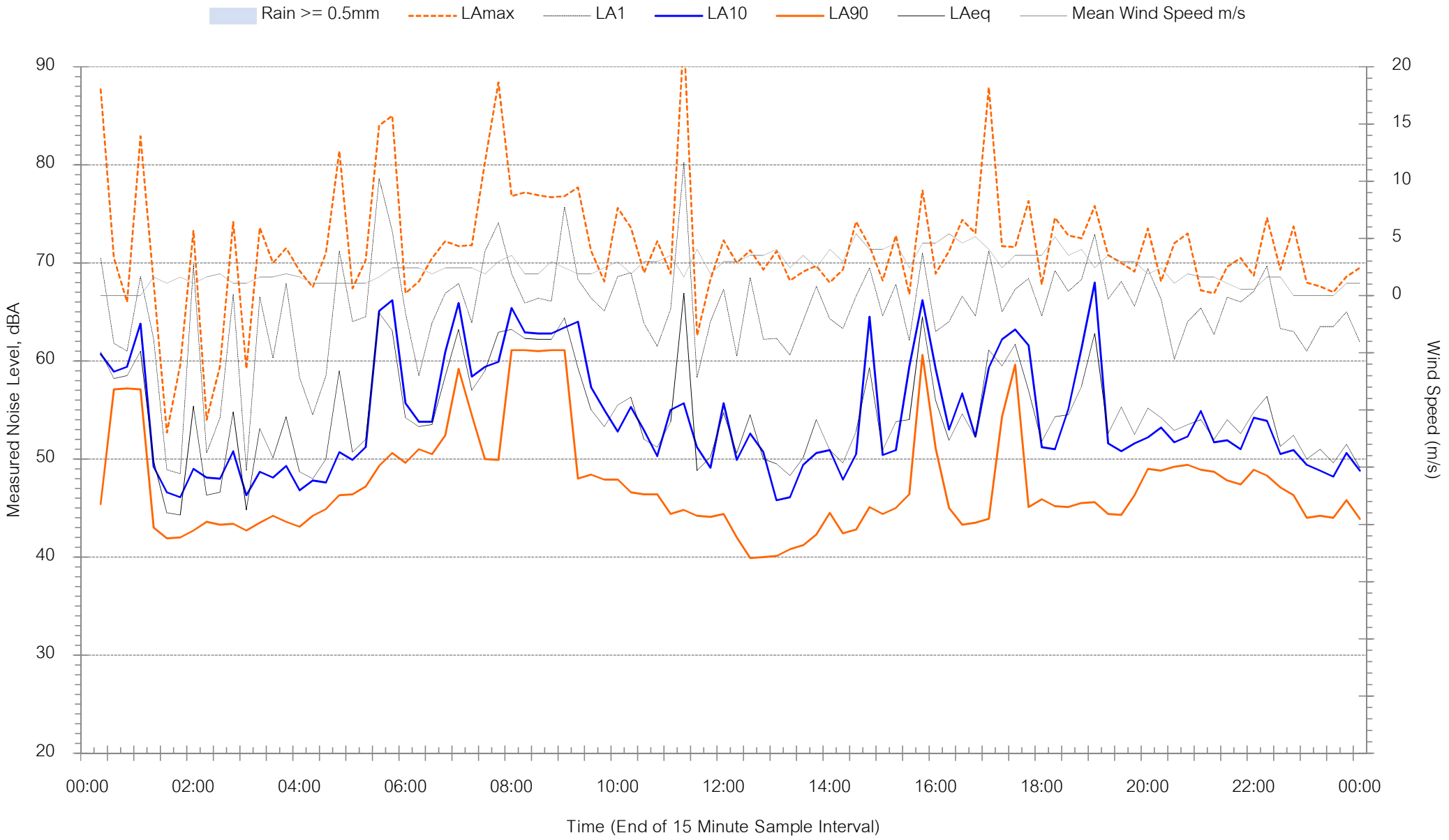
Background Noise Levels

Location - N4 - Wednesday 20 March 2019



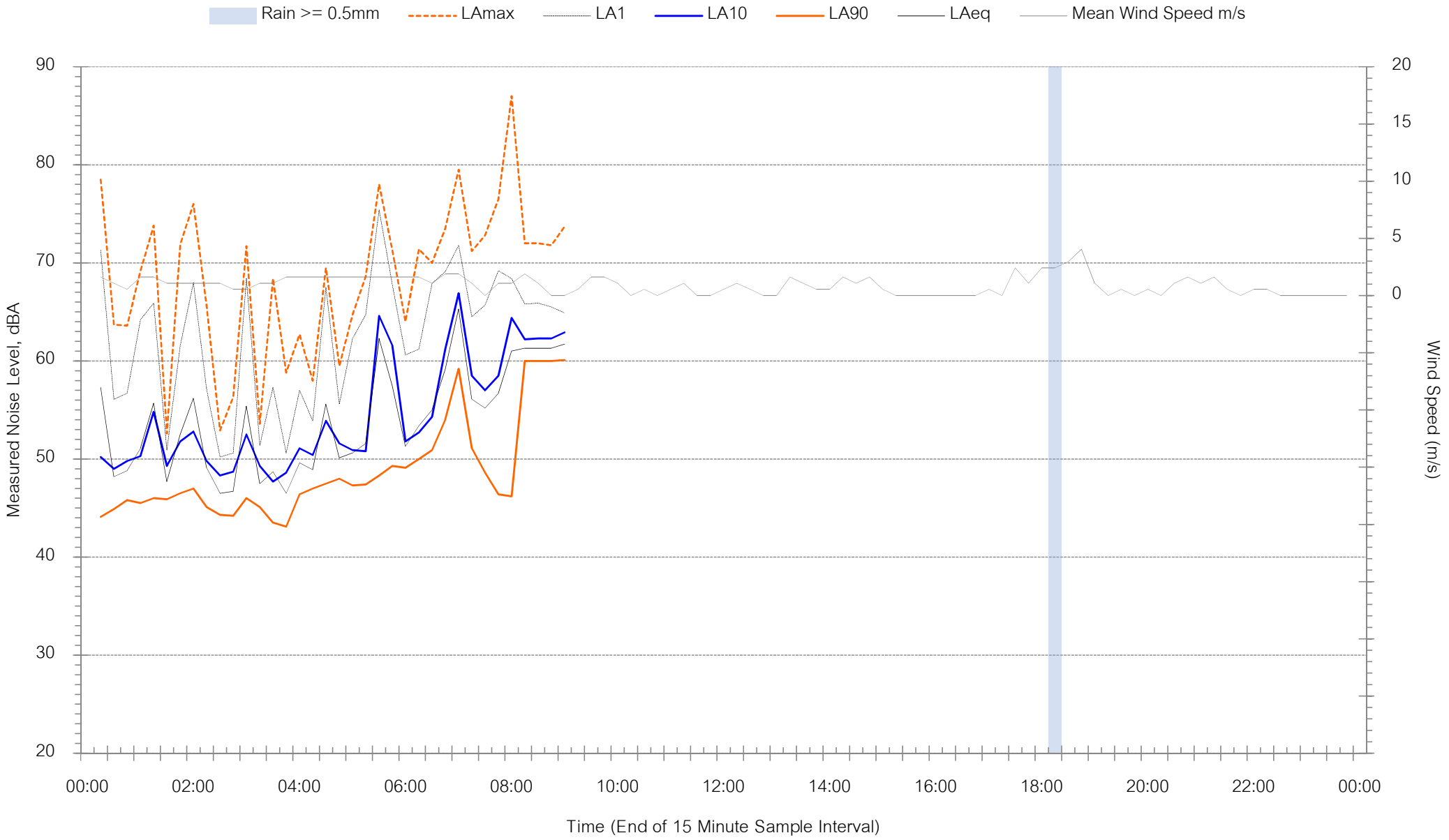
Background Noise Levels

Location - N4 - Thursday 21 March 2019



Background Noise Levels

Location - N4 - Friday 22 March 2019



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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 2 Ending June 2019.

Prepared for: Holcim (Australia) Pty Ltd
May 2019
MAC180611-01RP4

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Document Information

Noise Monitoring Assessment

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Quarter 2 Ending June 2019

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APPENDIX A – GLOSSARY OF TERMS

APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending June 2019 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS/NZS IEC 61672.1:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

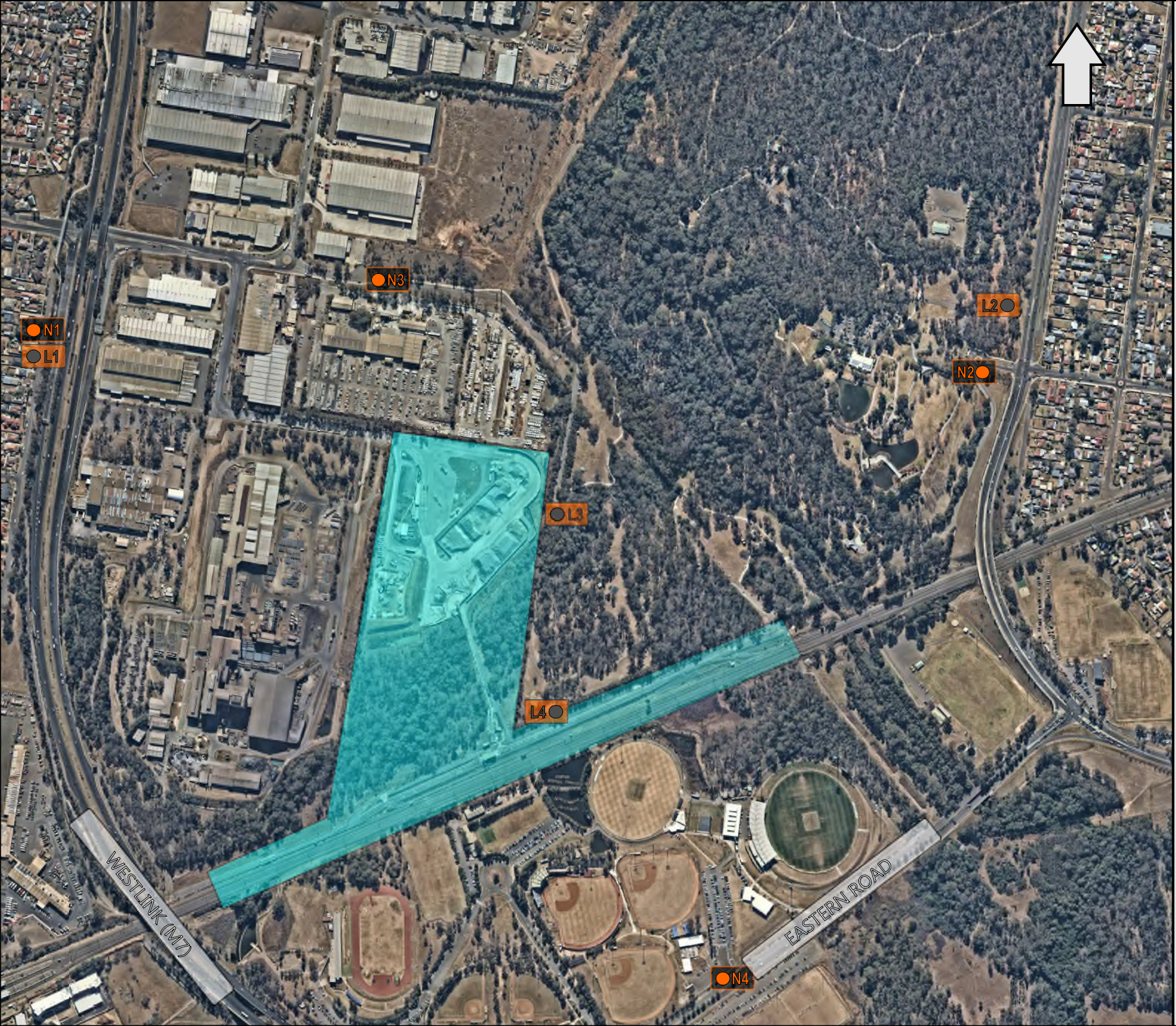

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

N1	MONITORING LOCATION
L1	LOGGER LOCATION
	SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Wednesday 8 May 2019 and Thursday 9 May 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019 Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for more than seven days in general accordance with the procedures described AS 1055:2018 and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977, 958 and 957 noise analysers from Wednesday 8 May 2019 to Thursday 16 May 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1.2019. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/05/2019	10:36 (Day)	67	56	51	WD: E WS: 0.6m/s Rain: Nil	Traffic 50-60 Birds 56-67 Hammering at house 57-60 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<41
08/05/2019	21:26 (Evening)	76	52	45	WD: W WS: 0.1m/s Rain: Nil	Traffic 46-76 Aircraft 49-50 Distant Cheering 45-48 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<35
08/05/2019	22:58 (Night)	68	50	42	WD: W WS: 0m/s Rain: Nil	Traffic 40-68 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<32

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/05/2019	09:46 (Day)	73	58	50	WD: E WS: 0.2m/s Rain: Nil	Traffic 50-56 Tree Mulching 60-73 Birds 50-55 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40
08/05/2019	20:41 (Evening)	74	54	50	WD: Still WS: 0m/s Rain: Nil	Traffic 50-74 Holcim Industrial Hum <37
		RDC $L_{Aeq(15min)}$ Contribution				<37
08/05/2019	22:18 (Night)	62	52	48	WD: W WS: 0.1m/s Rain: Nil	Traffic 44-62 Bats 45-48 Impact at Holcim Site 50
		RDC $L_{Aeq(15min)}$ Contribution				<35

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/05/2019	10:14 (Day)	73	50	41	WD: E WS: 0.4m/s Rain: Nil	Birds 40-45 Aircraft 40-73 Holcim Industrial Noise 37-53 Traffic in reserve 58-65
		RDC $L_{Aeq(15min)}$ Contribution				41
08/05/2019	21:05 (Evening)	67	53	50	WD: W WS: 0.1m/s Rain: Nil	Other industrial noise 50-67 Traffic 50-61 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40
08/05/2019	22:39 (Night)	61	52	48	WD: W WS: 0.2m/s Rain: Nil	Traffic 45-53 Other Industrial noise 50-61 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<38

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/05/2019	09:24 (Day)	65	52	46	WD: E WS: 0.1m/s Rain: Nil	Traffic 50-65 Train 54-59 Talking at Sports Centre 50-55 Impact at Holcim Site 53
		RDC $L_{Aeq(15min)}$ Contribution				<35
08/05/2019	20:15 (Evening)	68	56	52	WD: E WS: 0.1m/s Rain: Nil	Traffic 54-68 Holcim Industrial Hum <48 Impact at Holcim Site 54
		RDC $L_{Aeq(15min)}$ Contribution				47
08/05/2019	22:00 (Night)	85	67	55	WD: W WS: 0.1m/s Rain: Nil	Traffic 65-75 Sport Centre Gates 80-85 Crossing Beep 55-60 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in Table 6.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq(period)}$[2]	Measured Background Noise Level (LA_{90}) dB RBL [2]
L1 (N1 Station Street)	Day	56	49
	Evening	52	44
	Night	51	37
L2 (N2 Knox Road)	Day	58	48
	Evening	56	49
	Night	55	43
L3 (N3 Nurragingy Reserve)	Day	53	42
	Evening	51	46
	Night	51	44
L4 (N4 Olympic Park)	Day	59	40
	Evening	56	47
	Night	58	45

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<41	44	✓
N2	<40	40	✓
N3	41	50 (When in use)	✓
N4	<35	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<35	44	✓
N2	<37	39	✓
N3	<40	50 (When in use)	✓
N4	47	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<32	39	✓
N2	<35	39	✓
N3	<38	50 (When in use)	✓
N4	<45	55 (When in use)	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three attended measurements conducted on Wednesday 8 May 2019 and Thursday 9 May 2019, satisfying the relevant noise limits. Extraneous noise sources included traffic, local residential noise, and aircraft noise.

6.2 Discussion of Results - Location N2

RDC noise emissions were audible during the evening and night attended measurements conducted on Wednesday 8 May 2019, however satisfied the relevant noise limits for this location. RDC was inaudible during the daytime measurement satisfying the relevant noise limits for this location. Extraneous sources measured include traffic and works in the Nurragingy Reserve.

6.3 Discussion of Results - Location N3

Attended measurements on Wednesday 8 May 2019 and Thursday 9 May 2019 identified that RDC noise was audible during the daytime measurement at this location although satisfied the relevant noise limit= of 50dBA. Site operations were inaudible during the evening and night measurements which also satisfyied the relevant noise criteria. RDC sources audible on occasion included general mobile plant engine noise, reverse alarms and general bucket bangs / impact noise. Extraneous sources audible during the attended surveys included traffic, train pass-by, aircraft noise, birds and other industrial noise which generally masked RDC noise. For the evening and night assessment periods, it is noted the receiver was not “in use”, hence criteria are referenced for completeness.

6.4 Discussion of Results - Location N4

RDC noise emissions were audible during the day and evening measurements at the N4 monitoring location. RDC sources audible during the measurements included general mobile plant engine noise and impact noise. Noise emission from RDC complied with the applicable noise criteria during all three measurements although it is noted that the sports centre was not in use during the night period and criteria are referenced for completeness. Extraneous noise sources included birds, traffic, train pass-by and aircraft noise all audible throughout attended measurements at this location.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 2, ending June 2019.

Attended noise monitoring was conducted on Wednesday 8 May 2019 and Thursday 9 May 2019. Unattended noise monitoring was completed between Wednesday 8 May 2019 and Thursday 16 May 2019 at four representative monitoring locations. The assessment has identified that noise emissions generated by RDC were audible on some occasions throughout the attended monitoring, although remained below relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

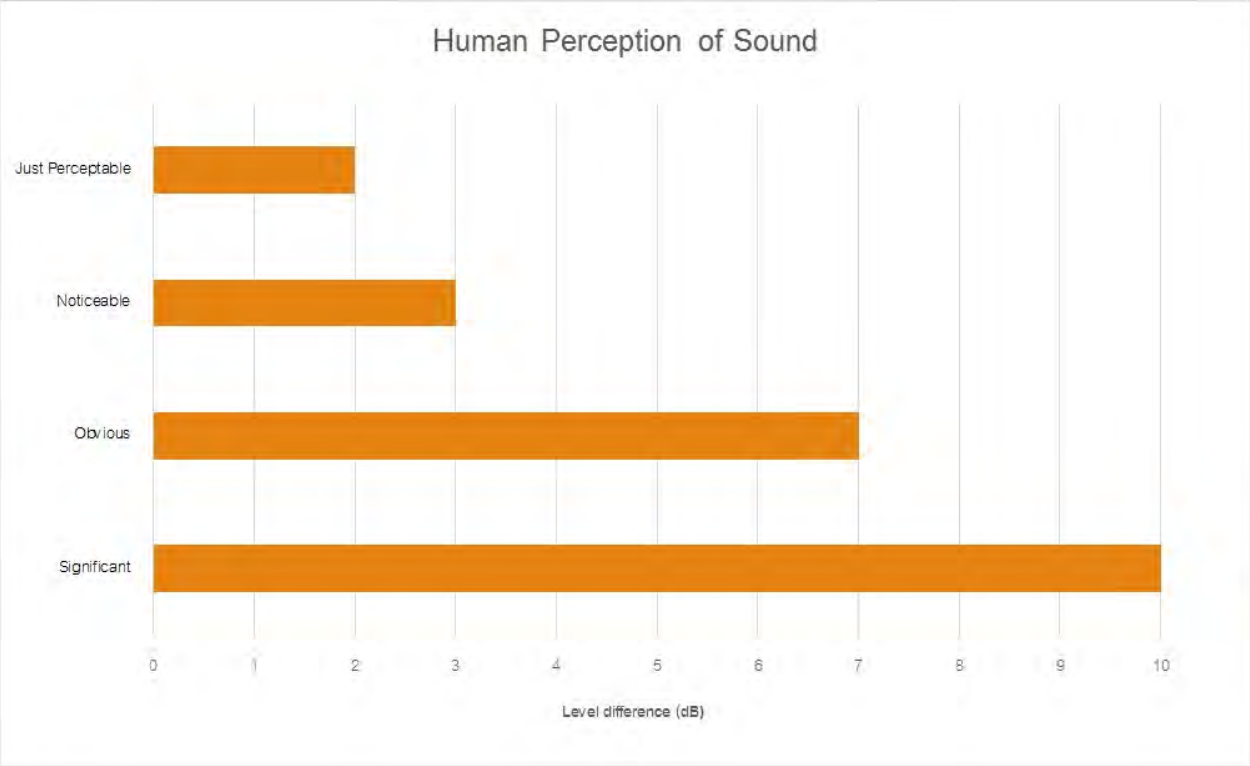
Table A1 provides a number of technical terms have been used in this report.

Table 1A Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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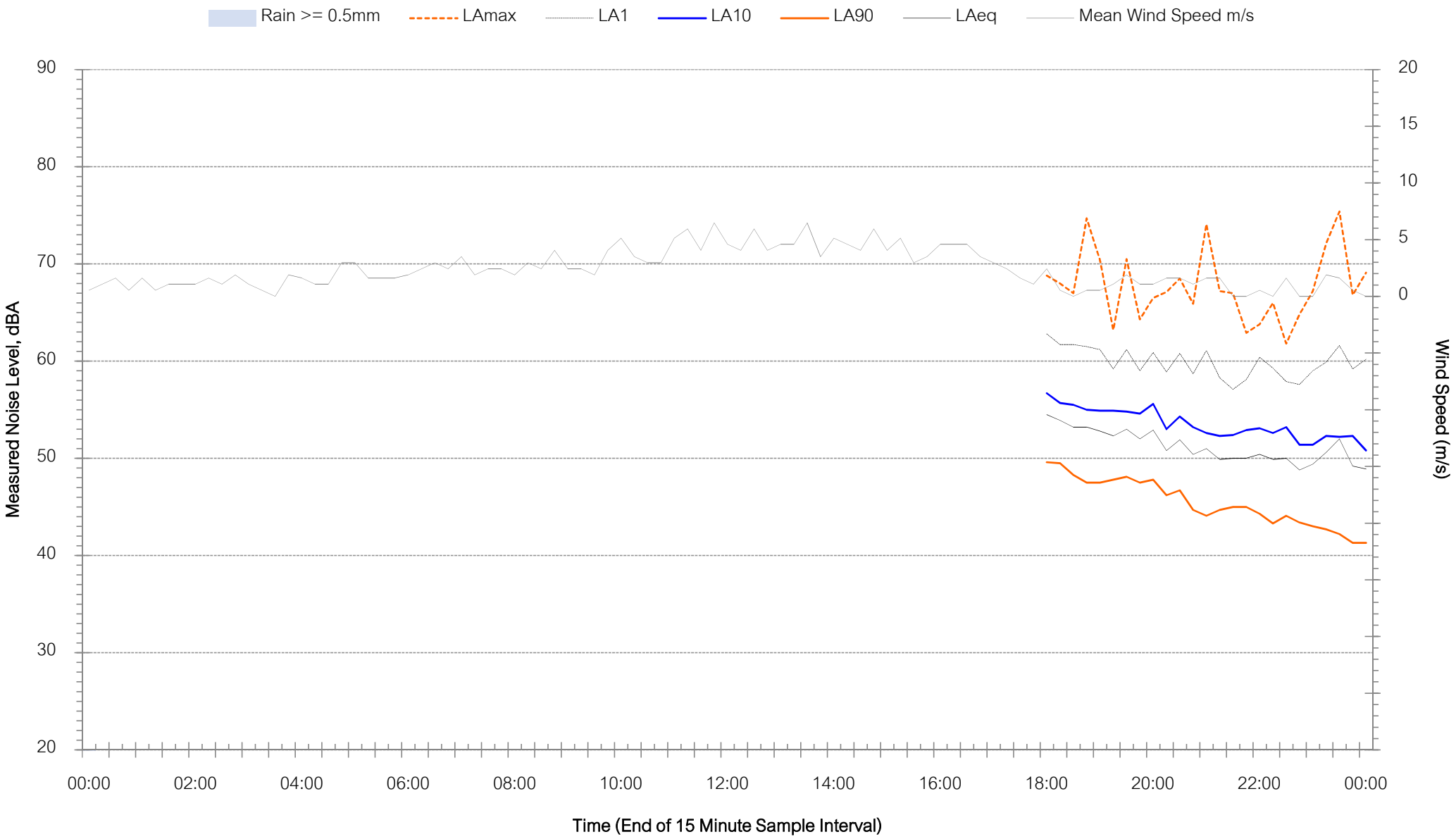
Appendix B – Unattended Noise Monitoring Charts

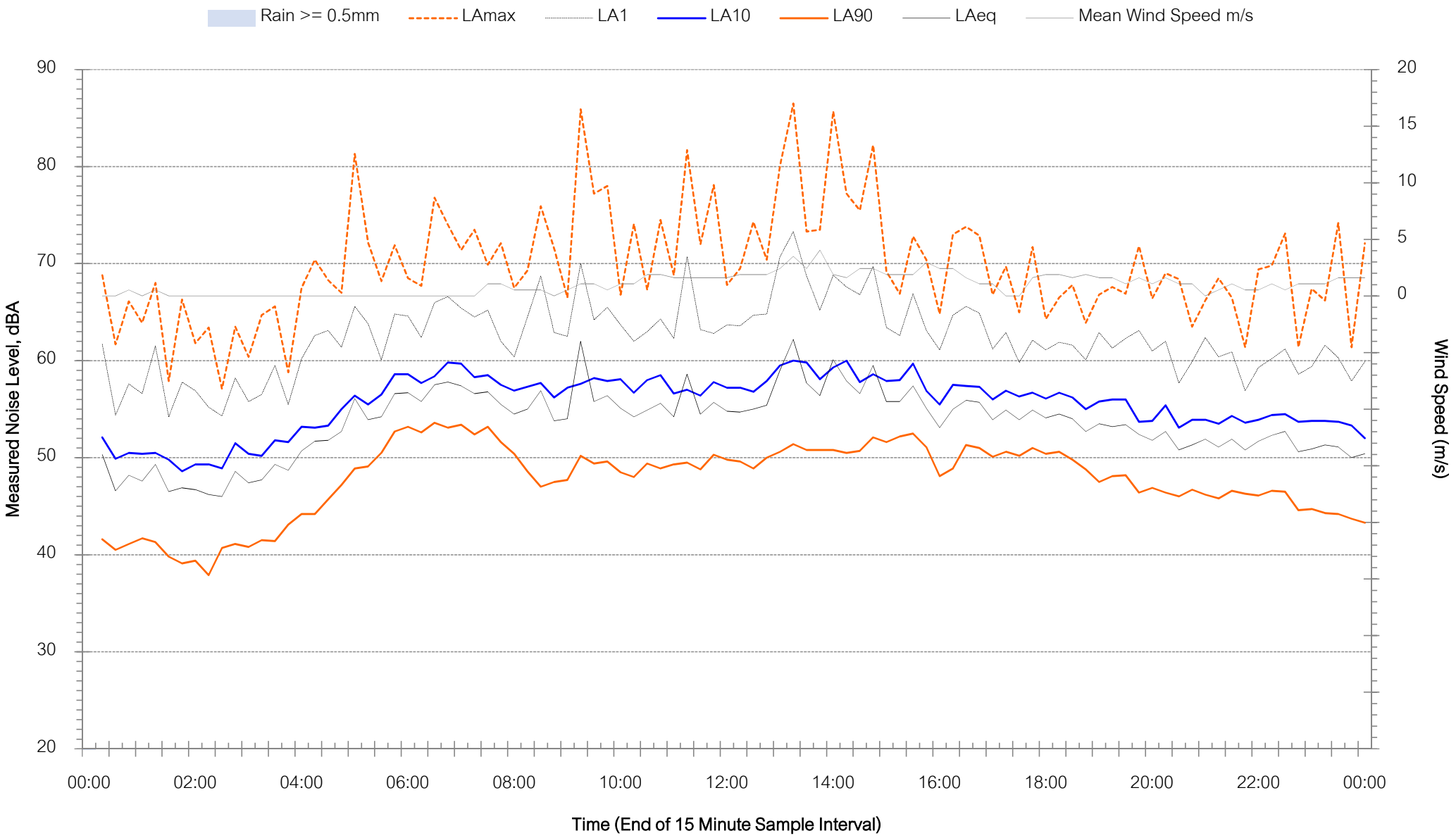
Background Noise Levels

Location - N1 - Wednesday 8 May 2019



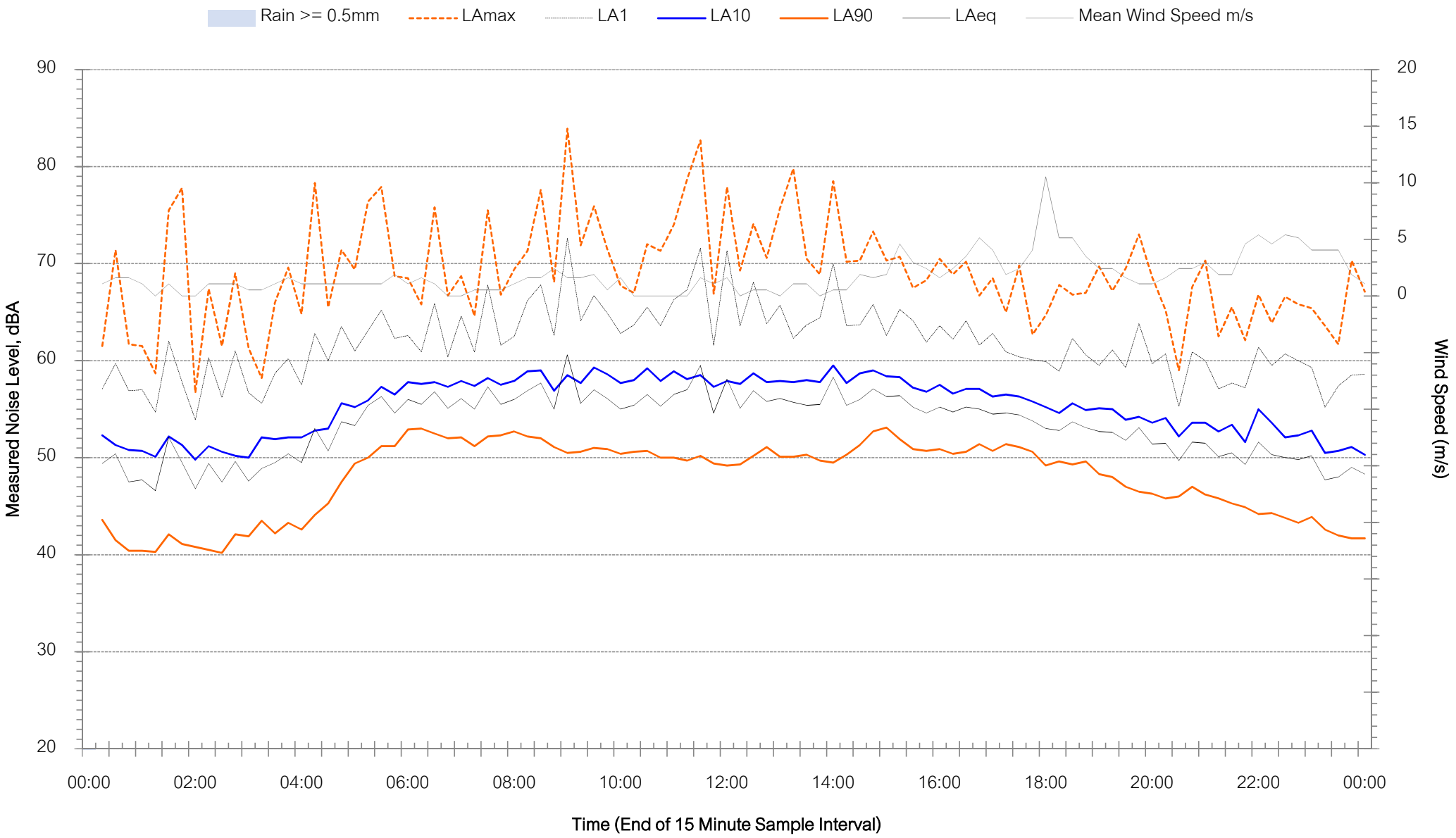
Background Noise Levels

Location - N1 - Thursday 9 May 2019



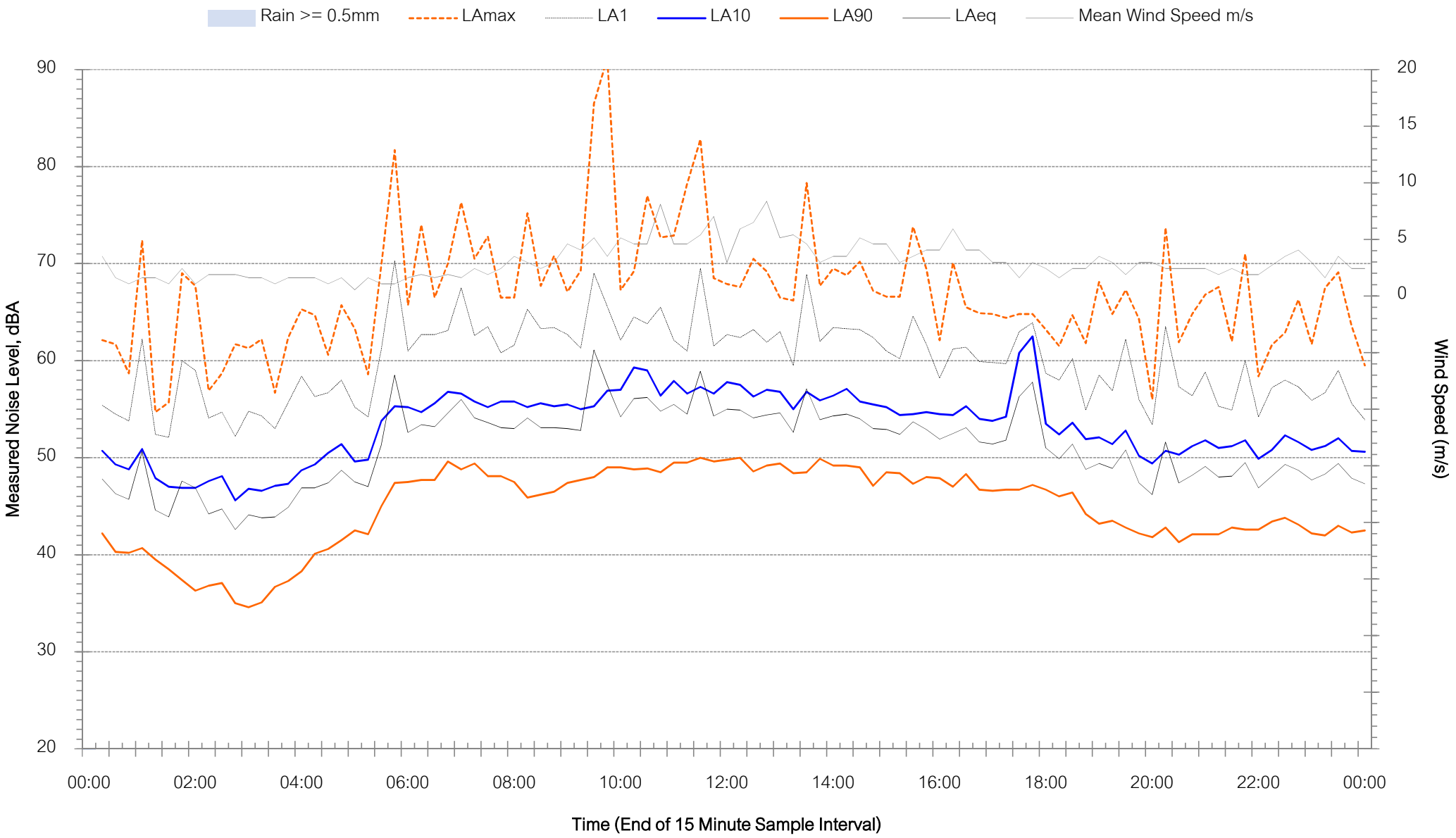
Background Noise Levels

Location - N1 - Friday 10 May 2019



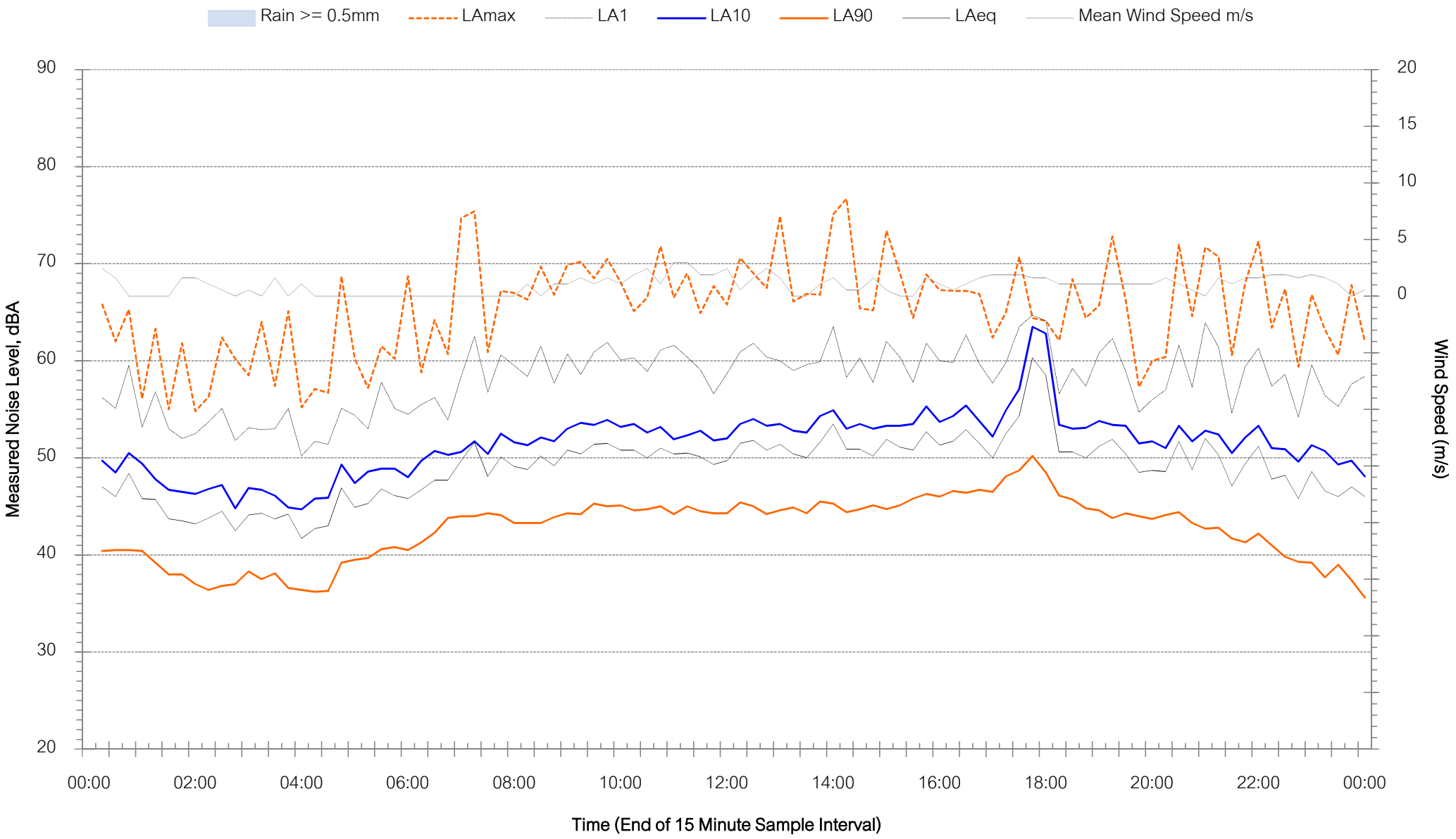
Background Noise Levels

Location - N1 - Saturday 11 May 2019



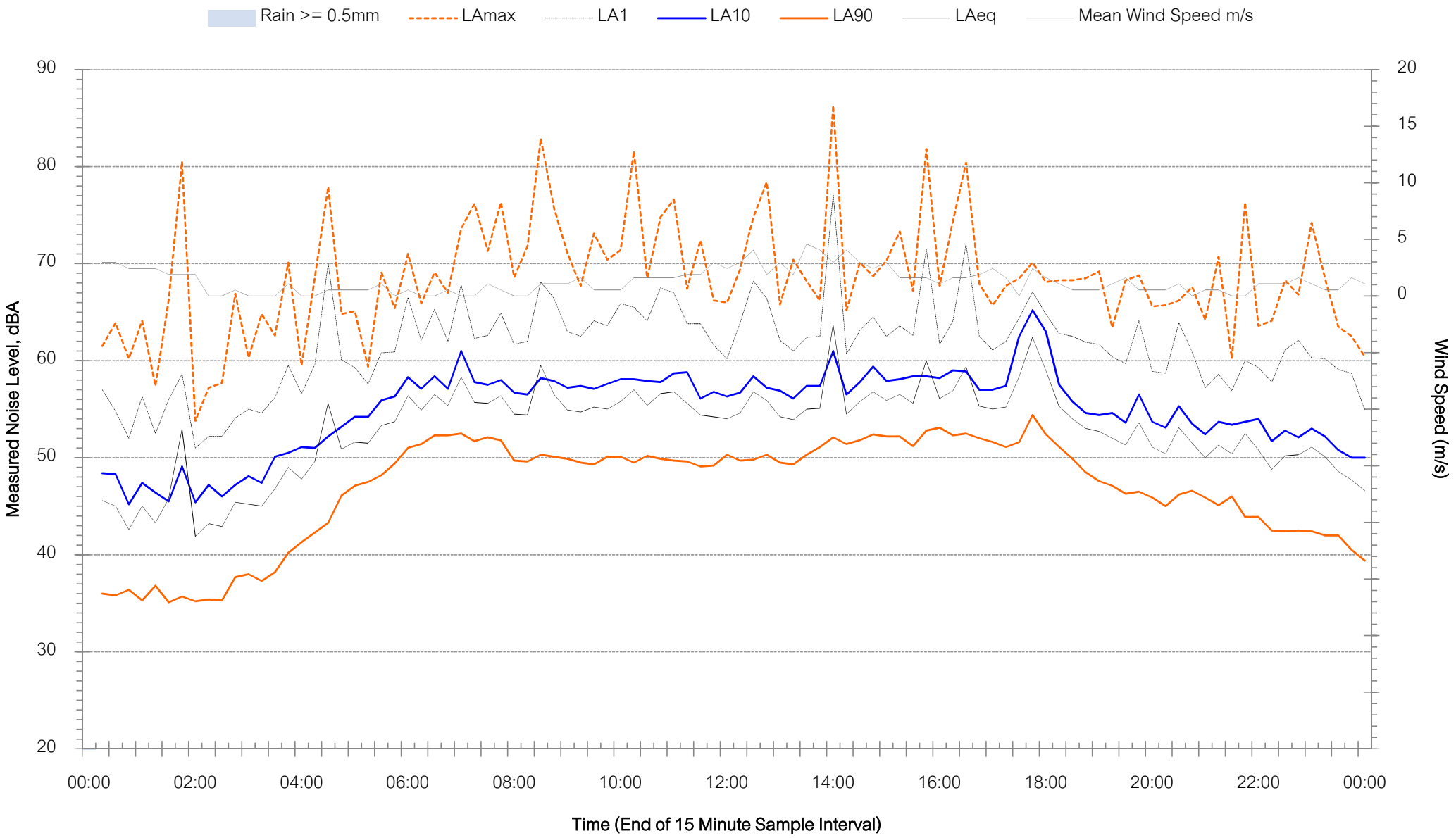
Background Noise Levels

Location - N1 - Sunday 12 May 2019



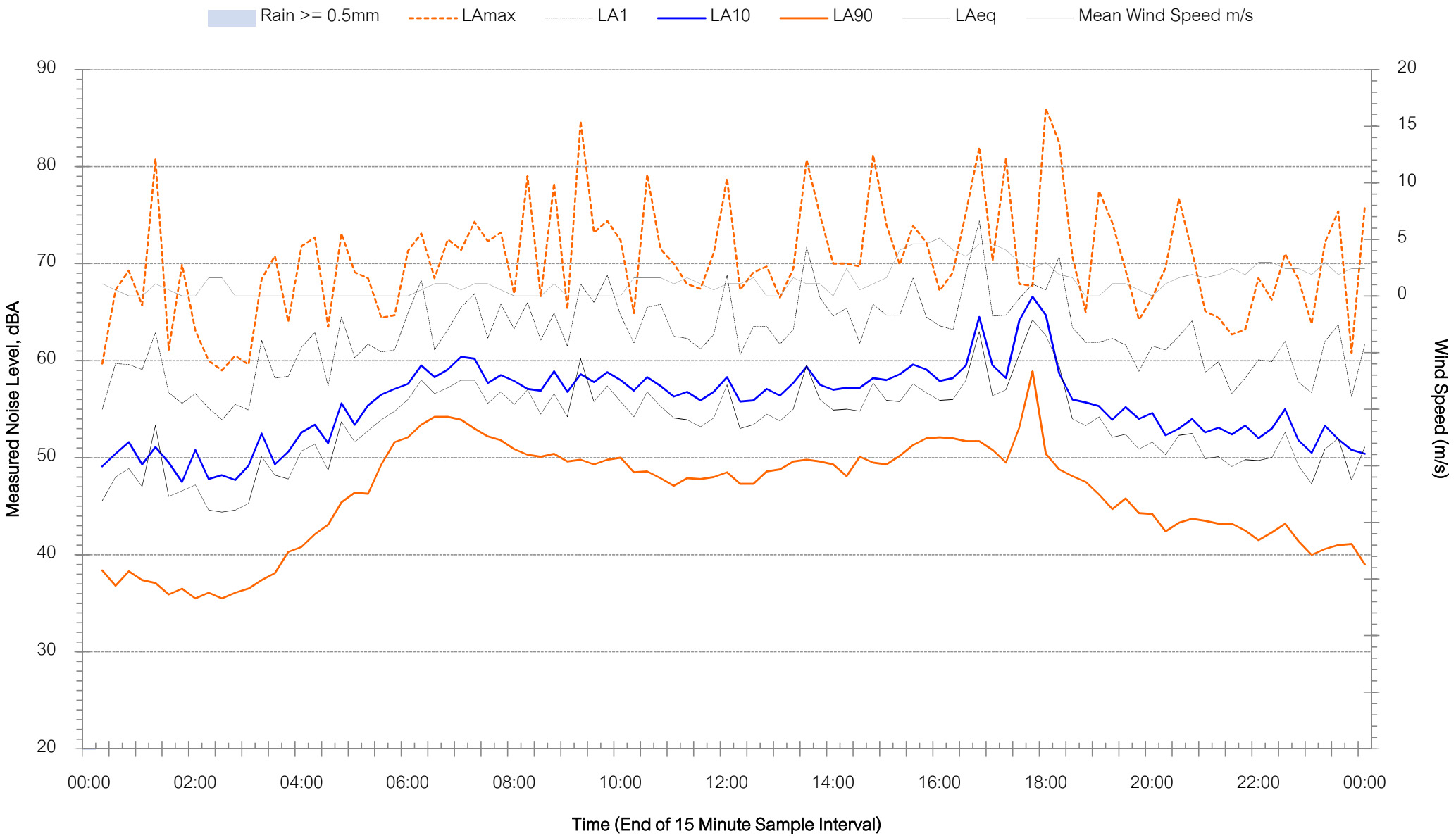
Background Noise Levels

Location - N1- Monday 13 May 2019



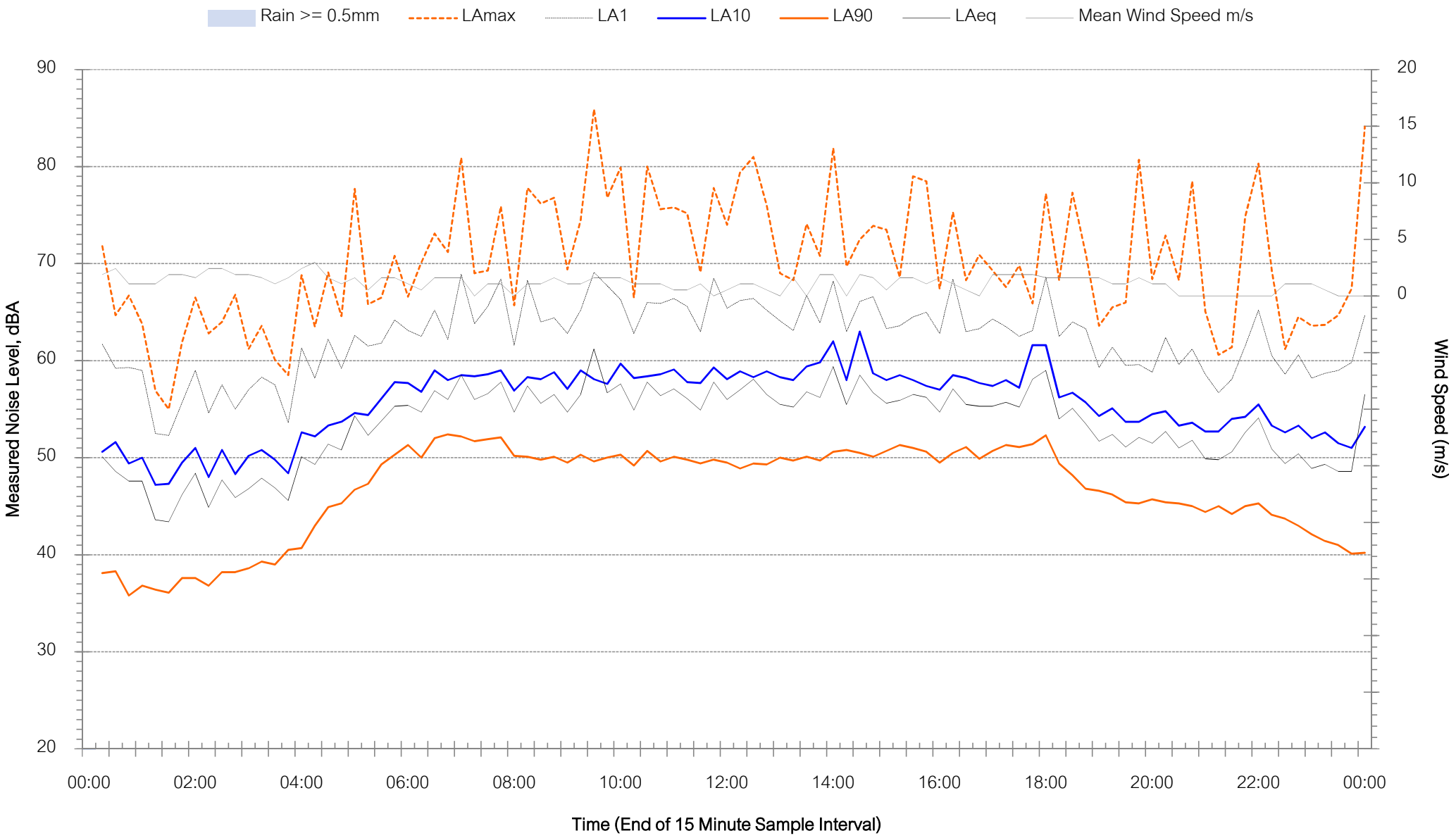
Background Noise Levels

Location - N1- Tuesday 14 May 2019



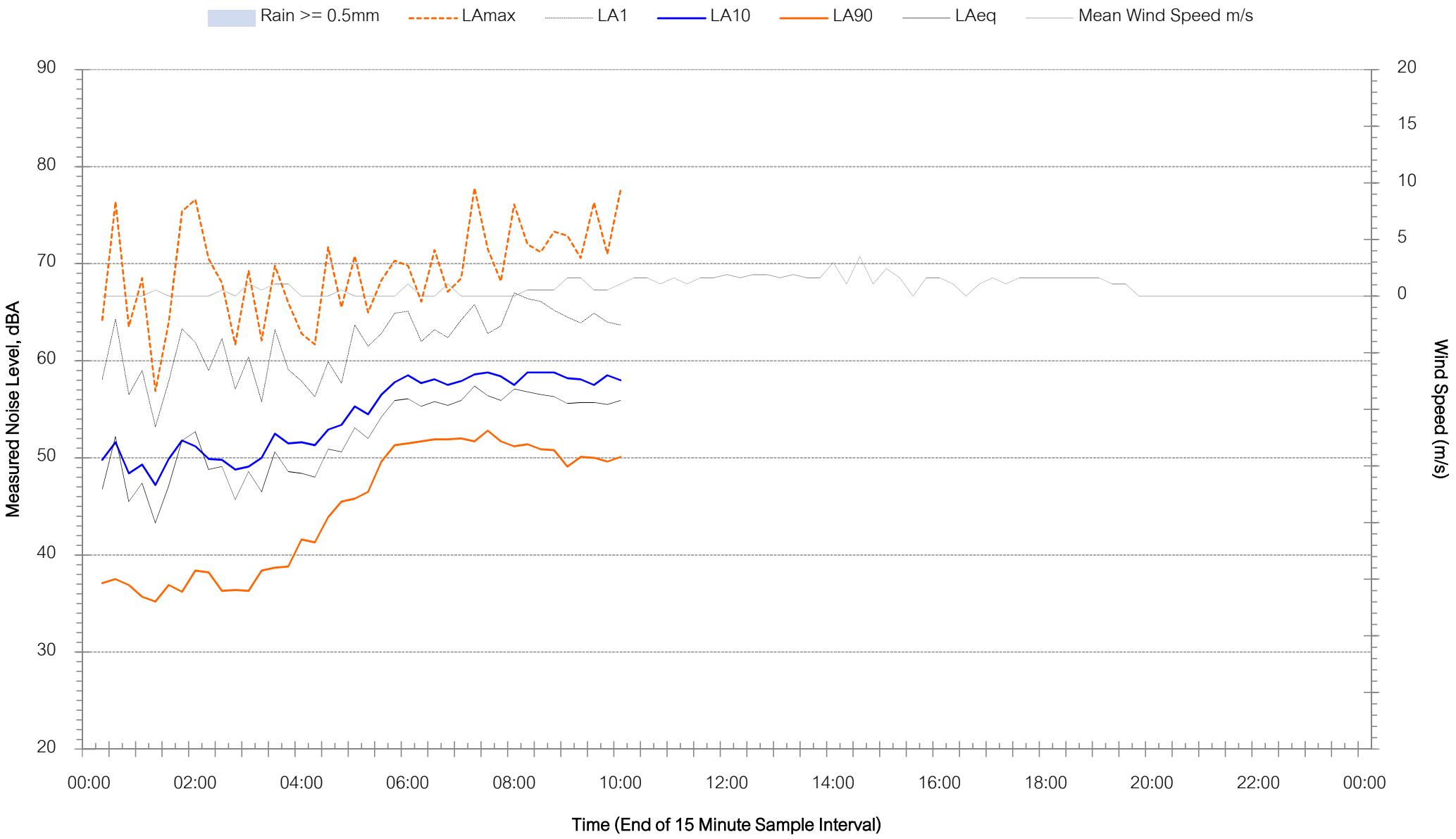
Background Noise Levels

Location - N1- Wednesday 15 May 2019



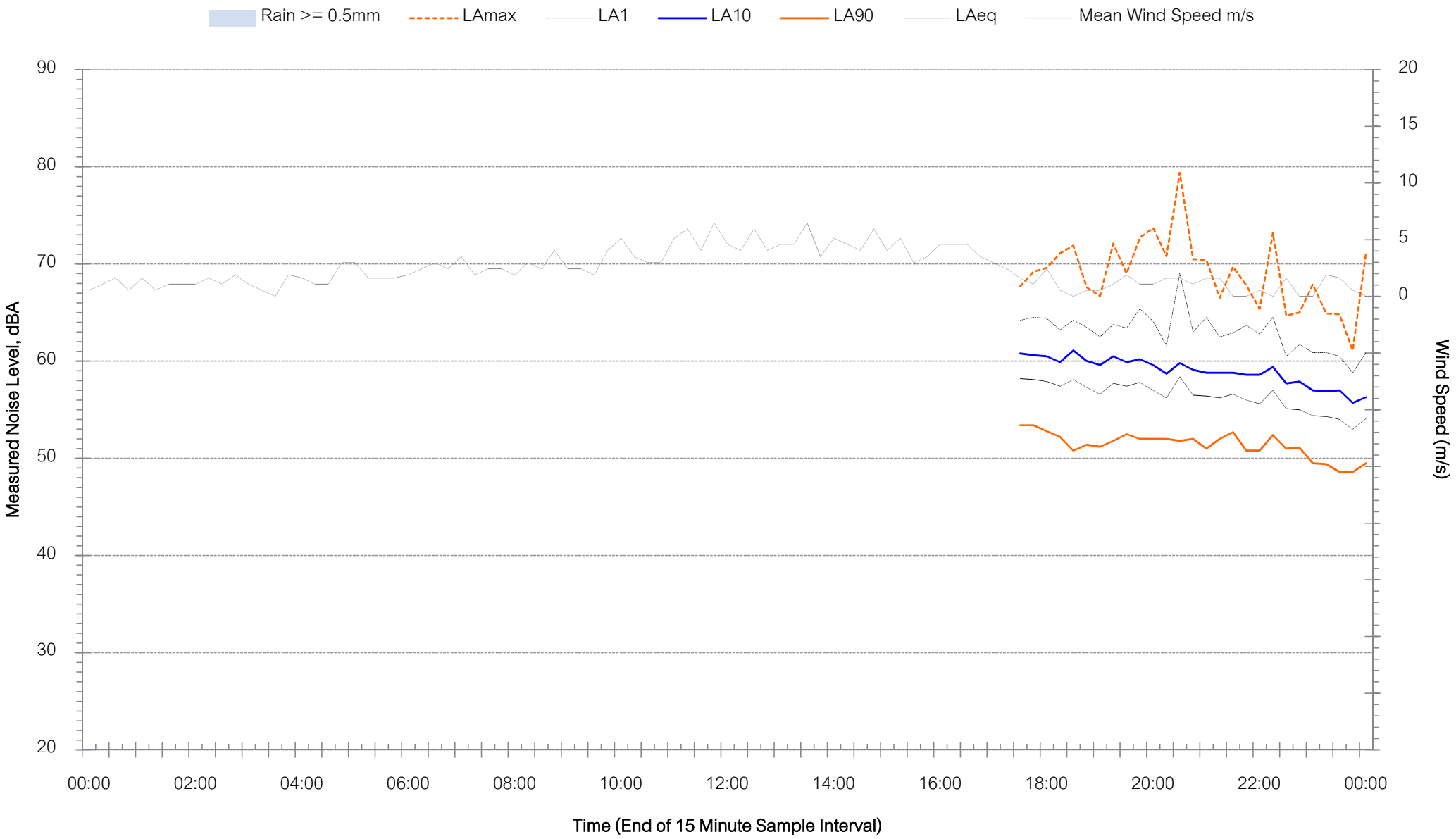
Background Noise Levels

Location - N1 - Thursday 16 May 2019



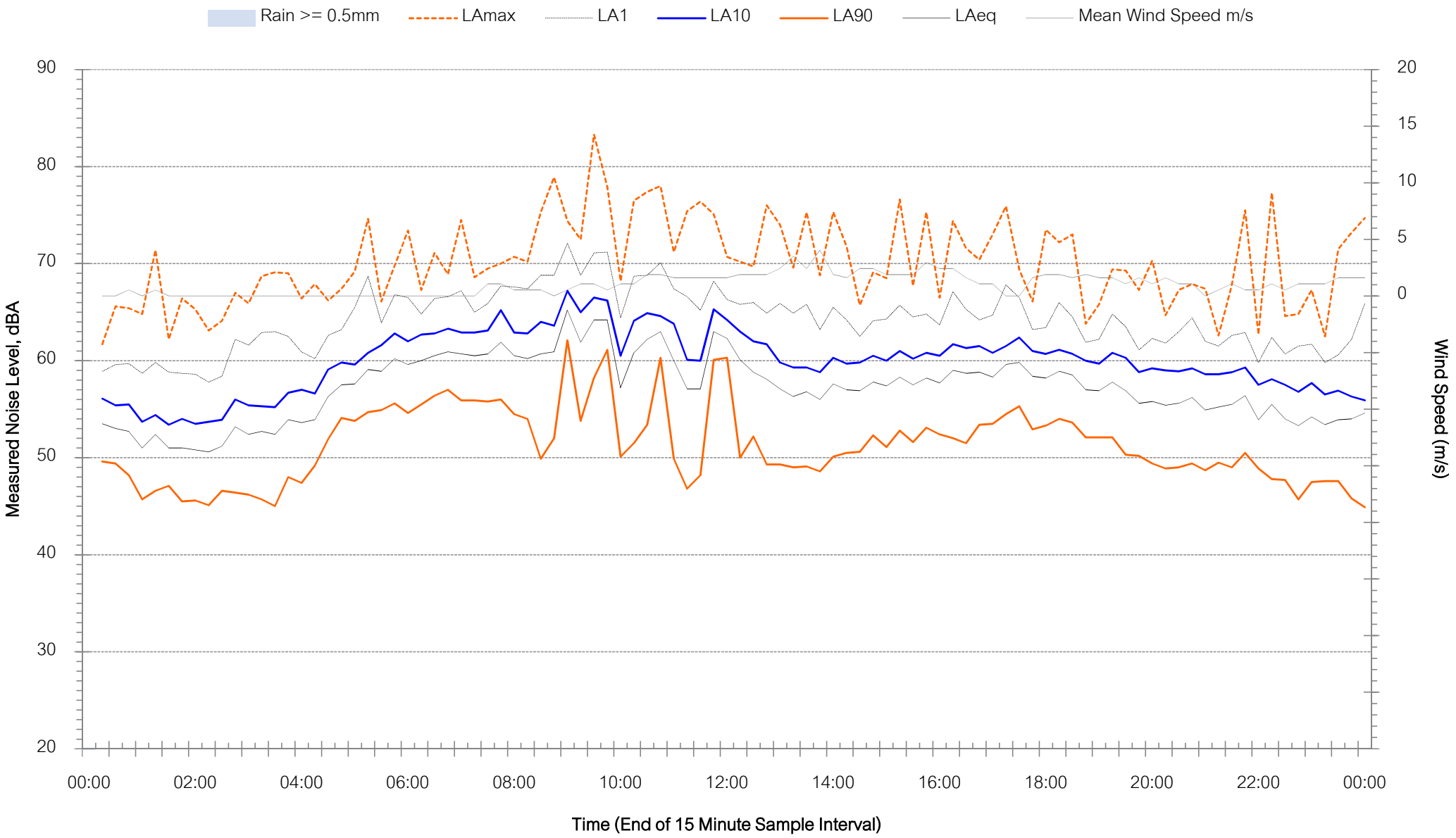
Background Noise Levels

Location - N2 - Wednesday 8 May 2019



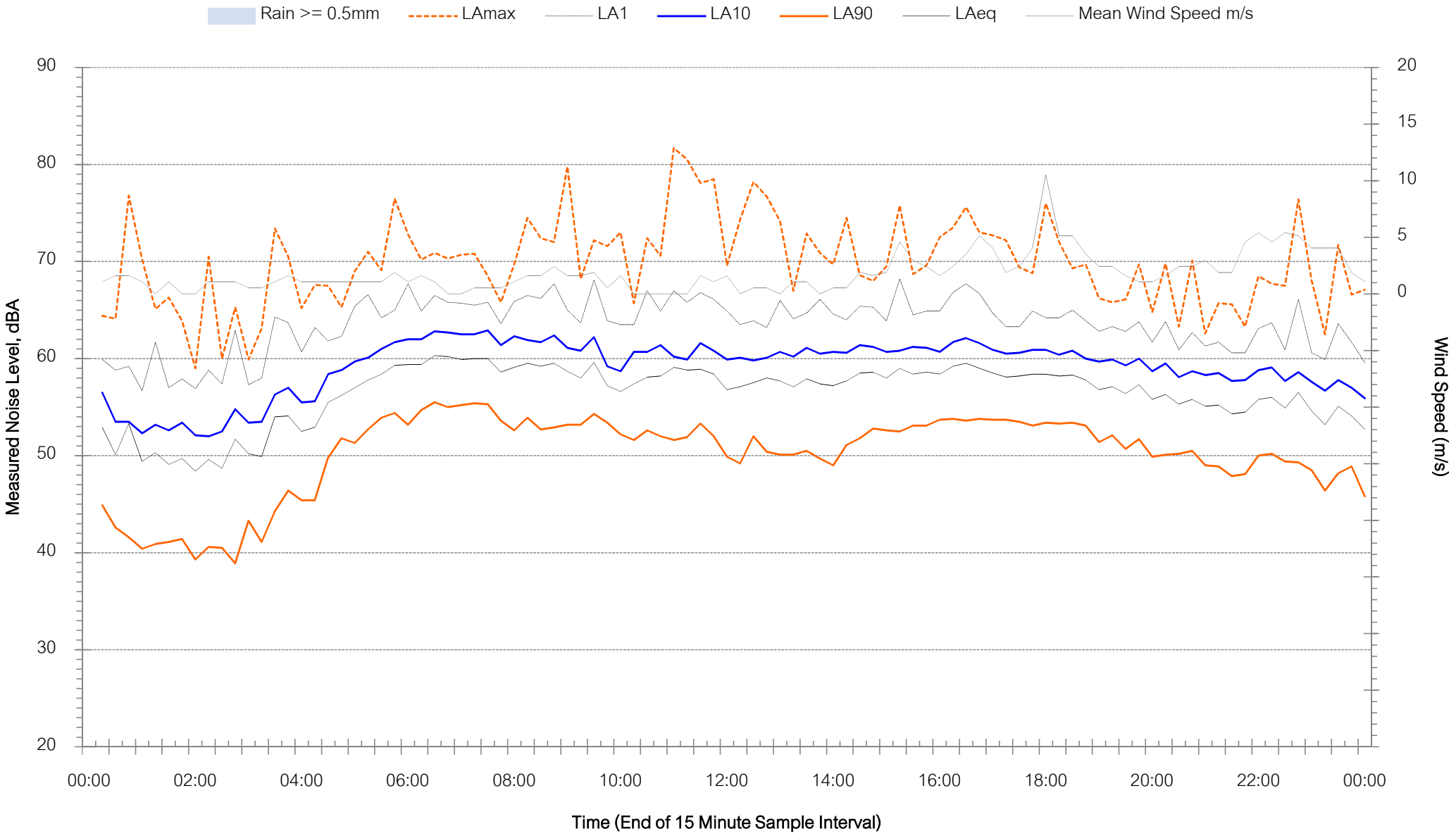
Background Noise Levels

Location - N2 - Thursday 9 May 2019



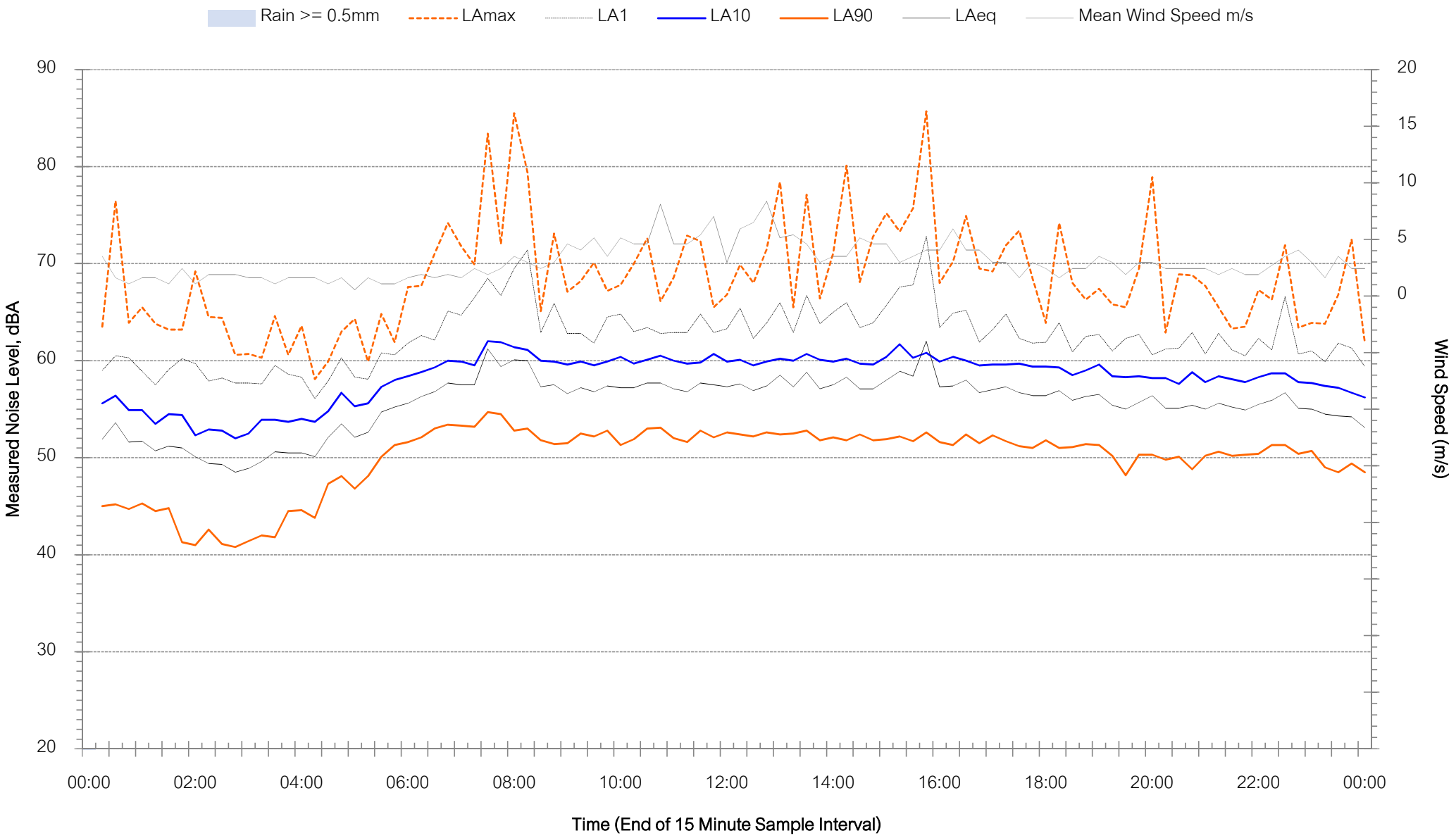
Background Noise Levels

Location - N2 - Friday 10 May 2019



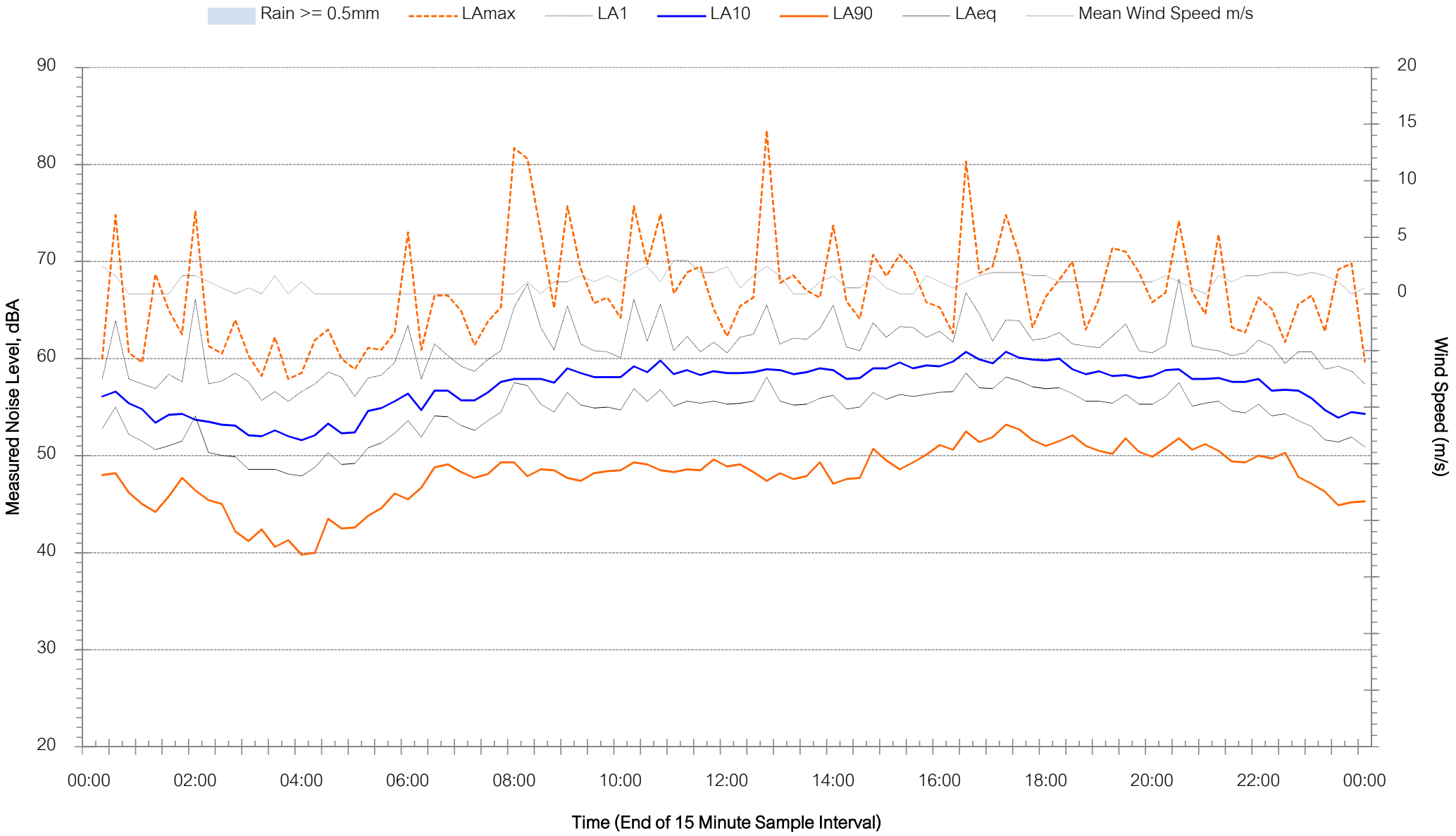
Background Noise Levels

Location - N2 - Saturday 11 May 2019



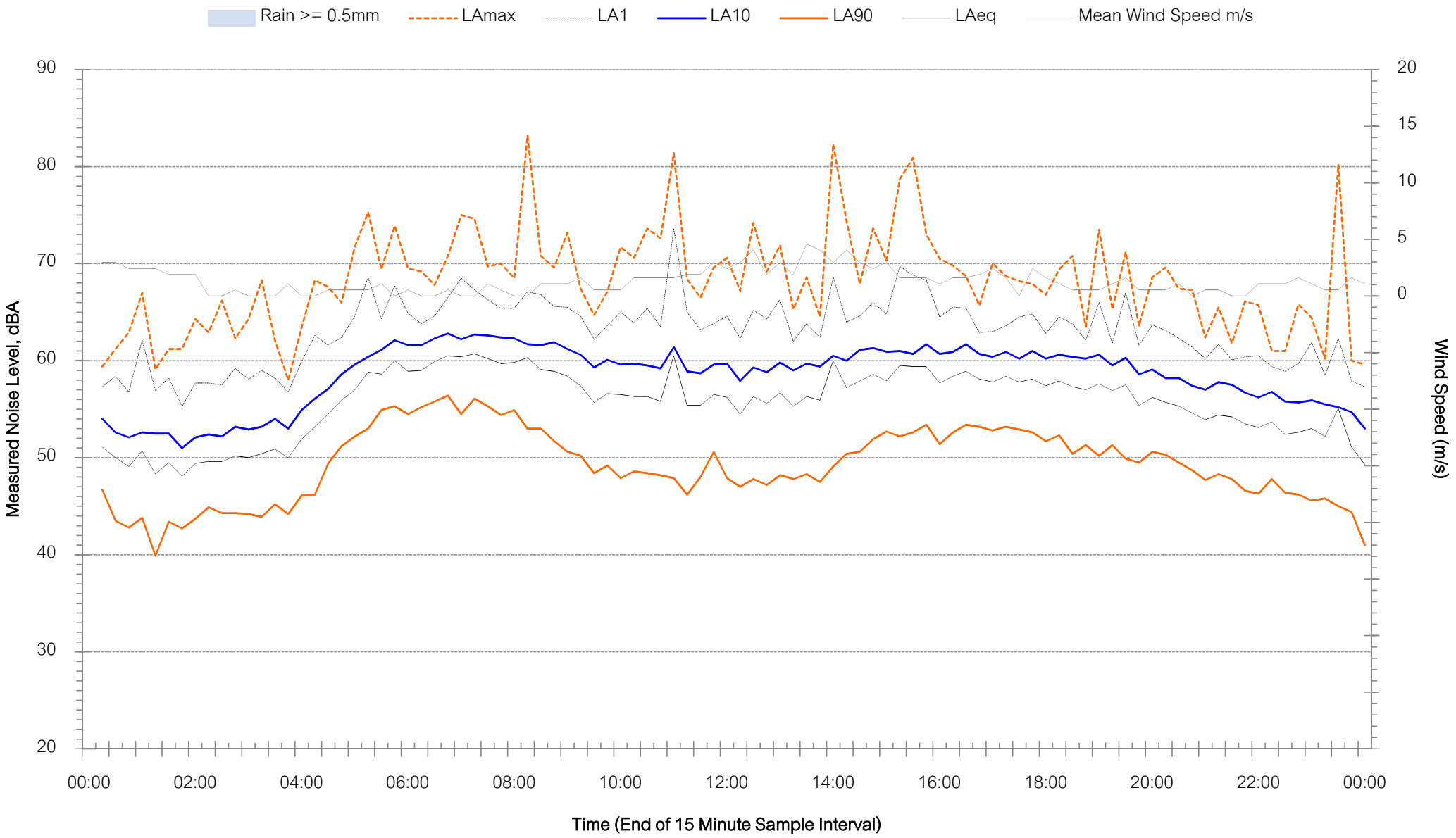
Background Noise Levels

Location - N2 - Sunday 12 May 2019



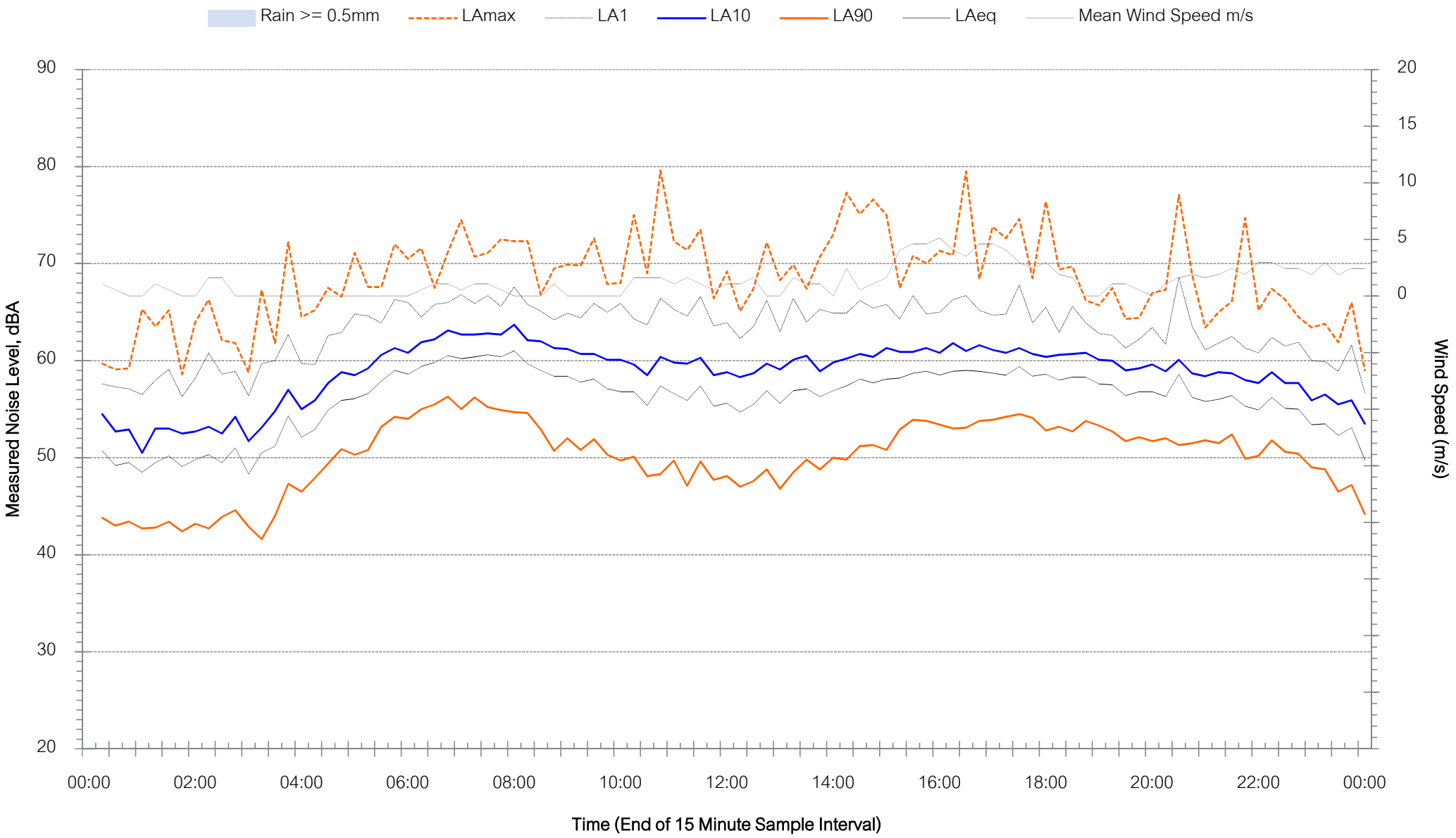
Background Noise Levels

Location - N2 - Monday 13 May 2019



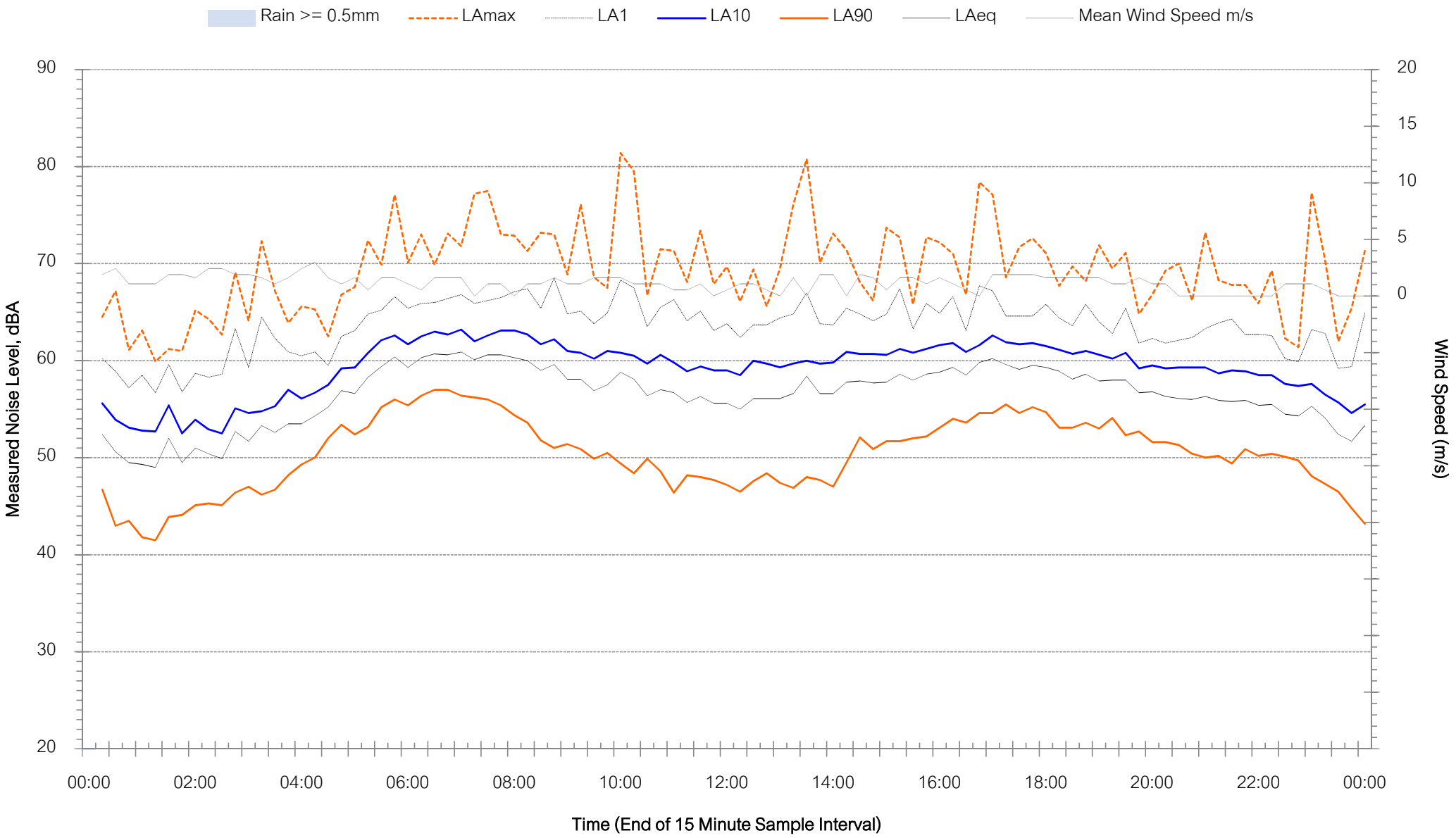
Background Noise Levels

Location - N2 - Tuesday 14 May 2019



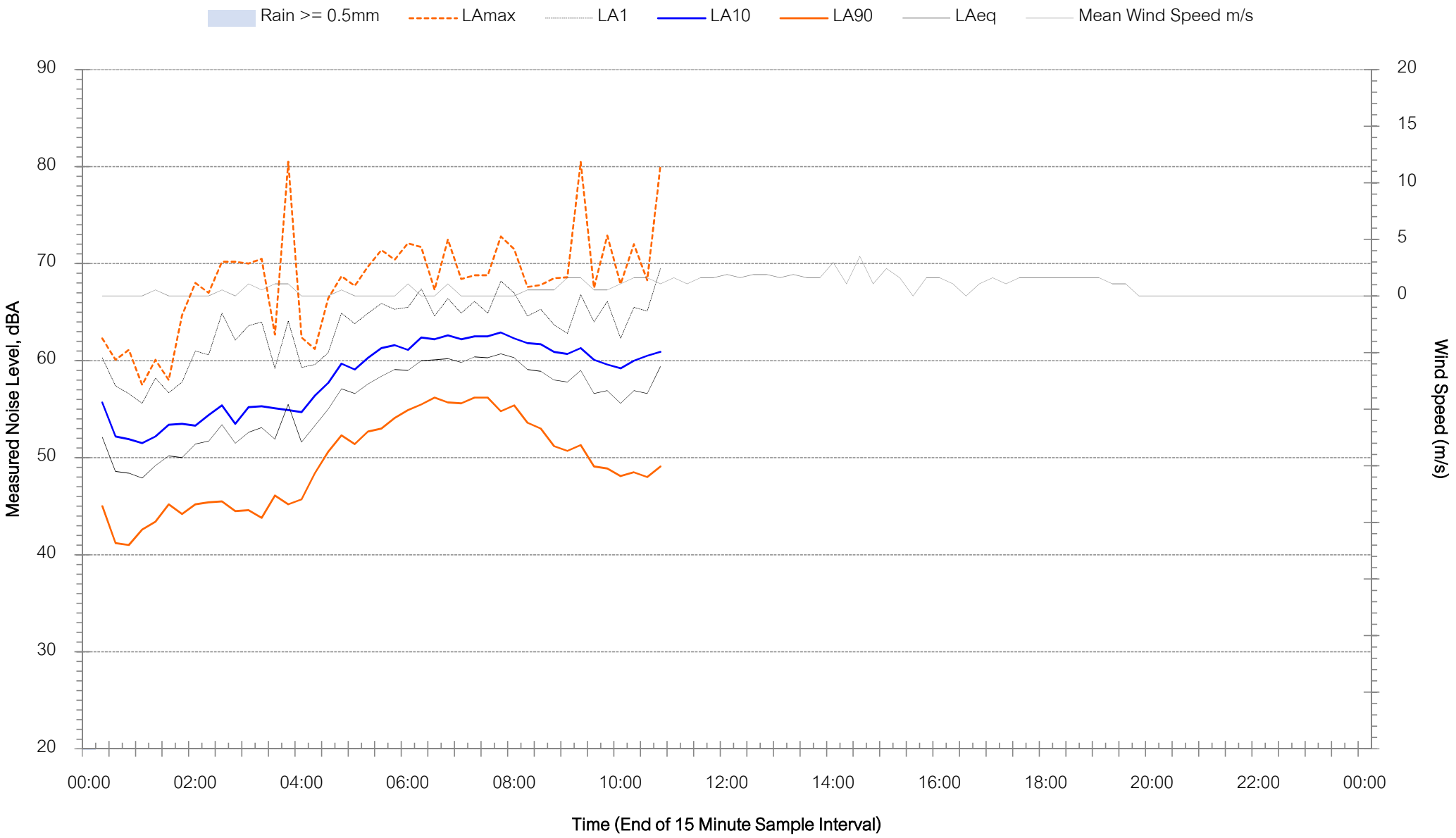
Background Noise Levels

Location - N2 - Wednesday 15 May 2019



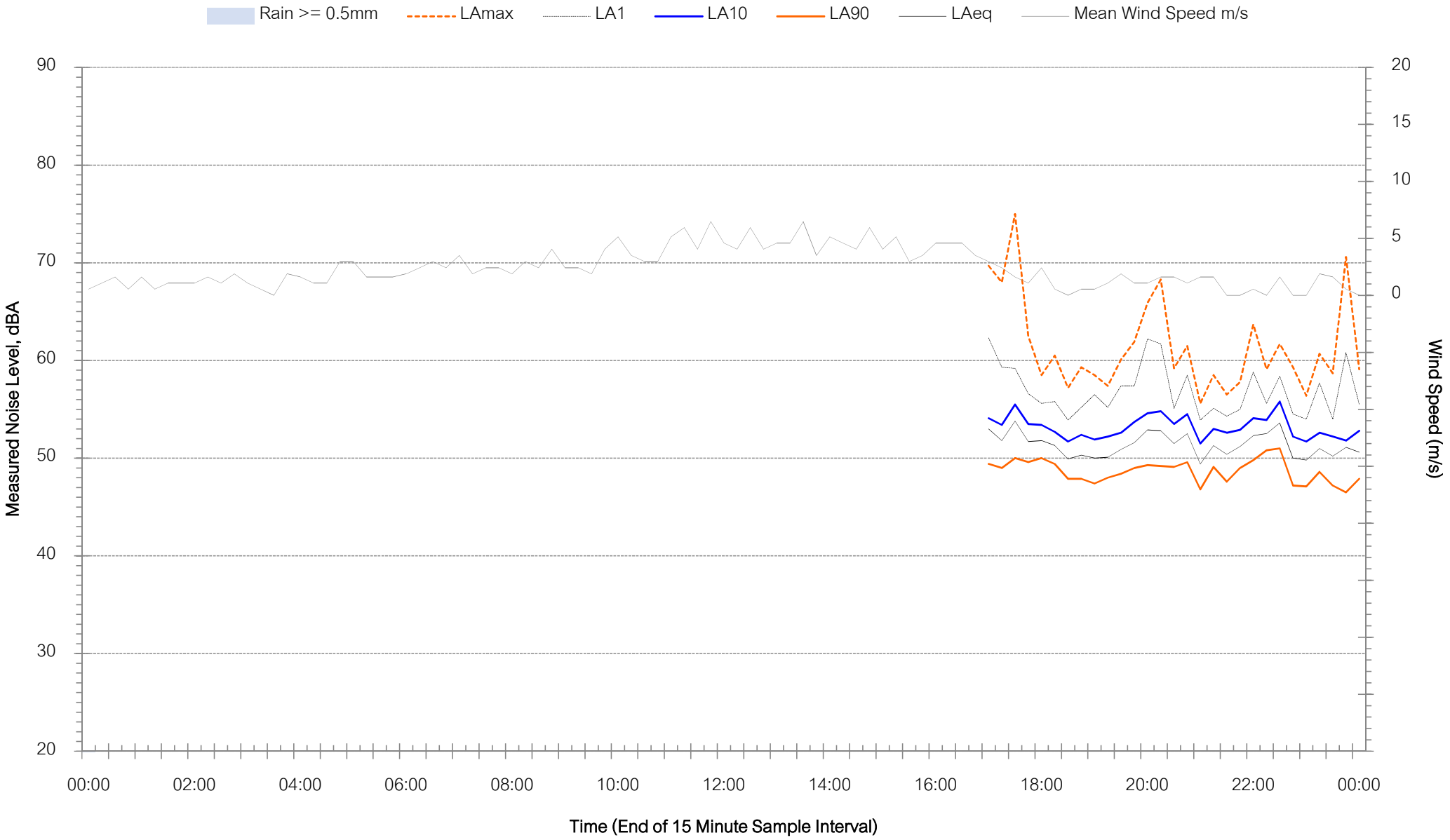
Background Noise Levels

Location - N2 - Thursday 16 May 2019



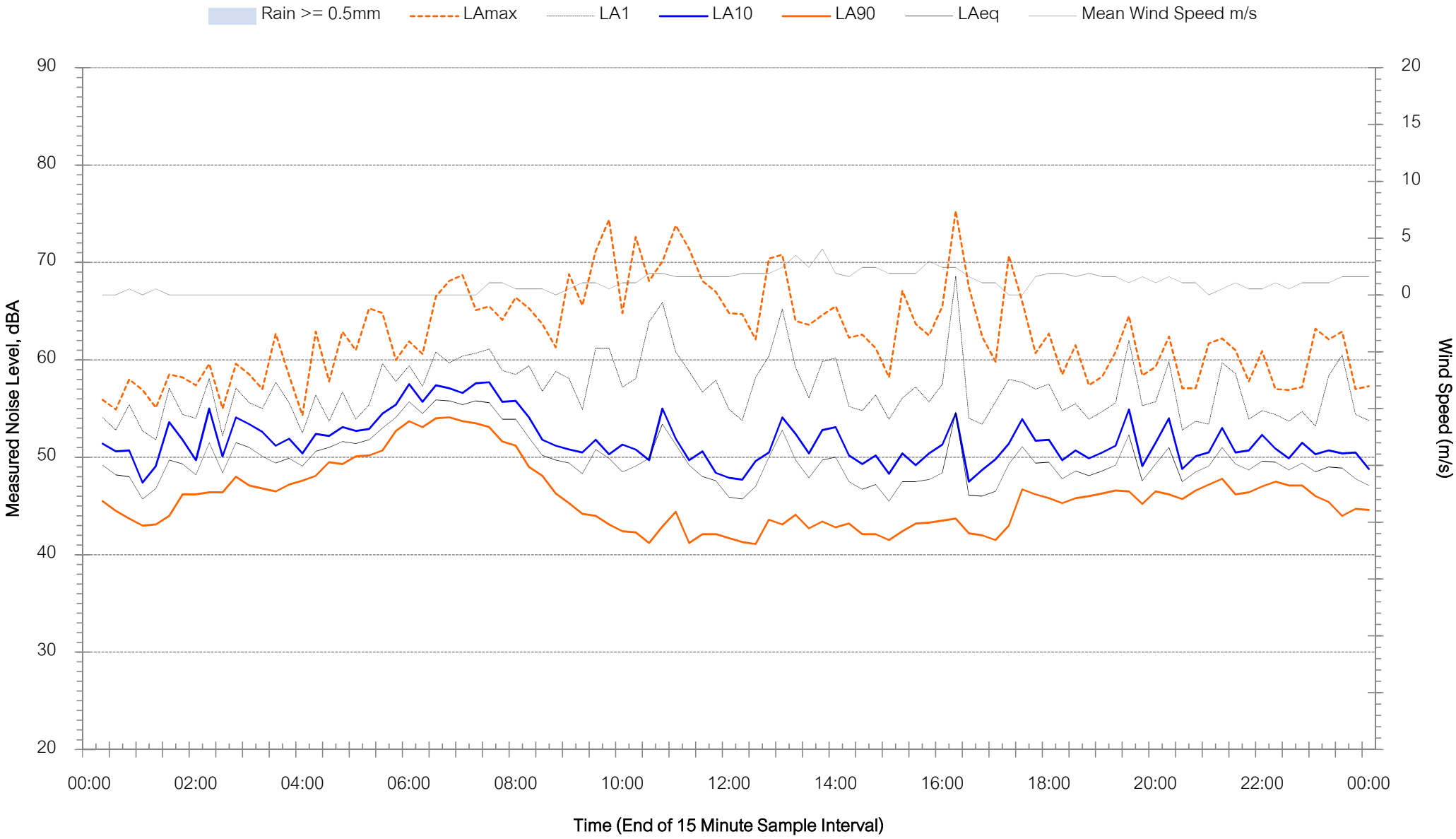
Background Noise Levels

Location - N3 - Wednesday 8 May 2019



Background Noise Levels

Location - N3 - Thursday 9 May 2019

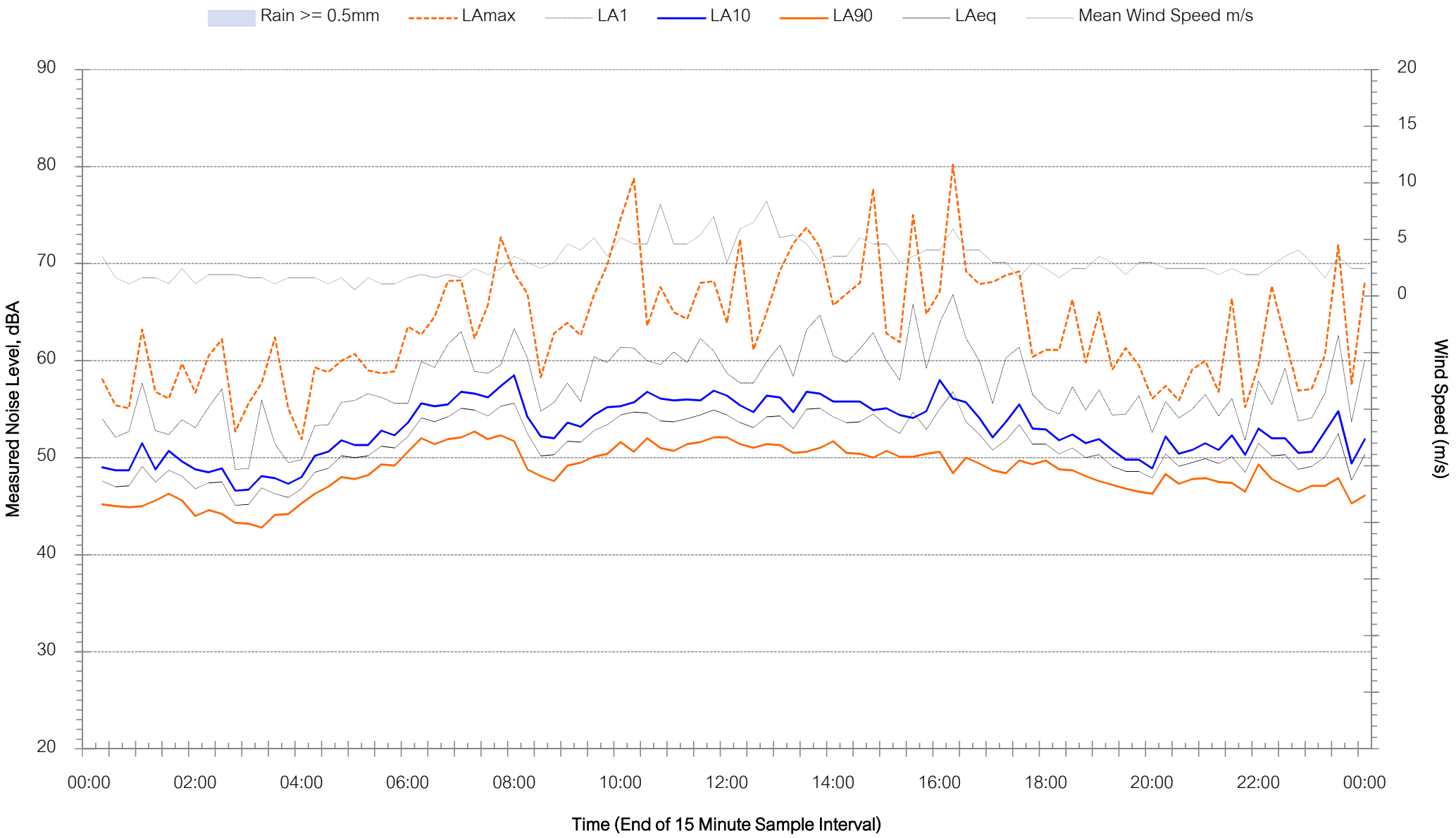


Background Noise Levels

Location - N3 - Friday 10 May 2019

Background Noise Levels

Location - N3 - Saturday 11 May 2019

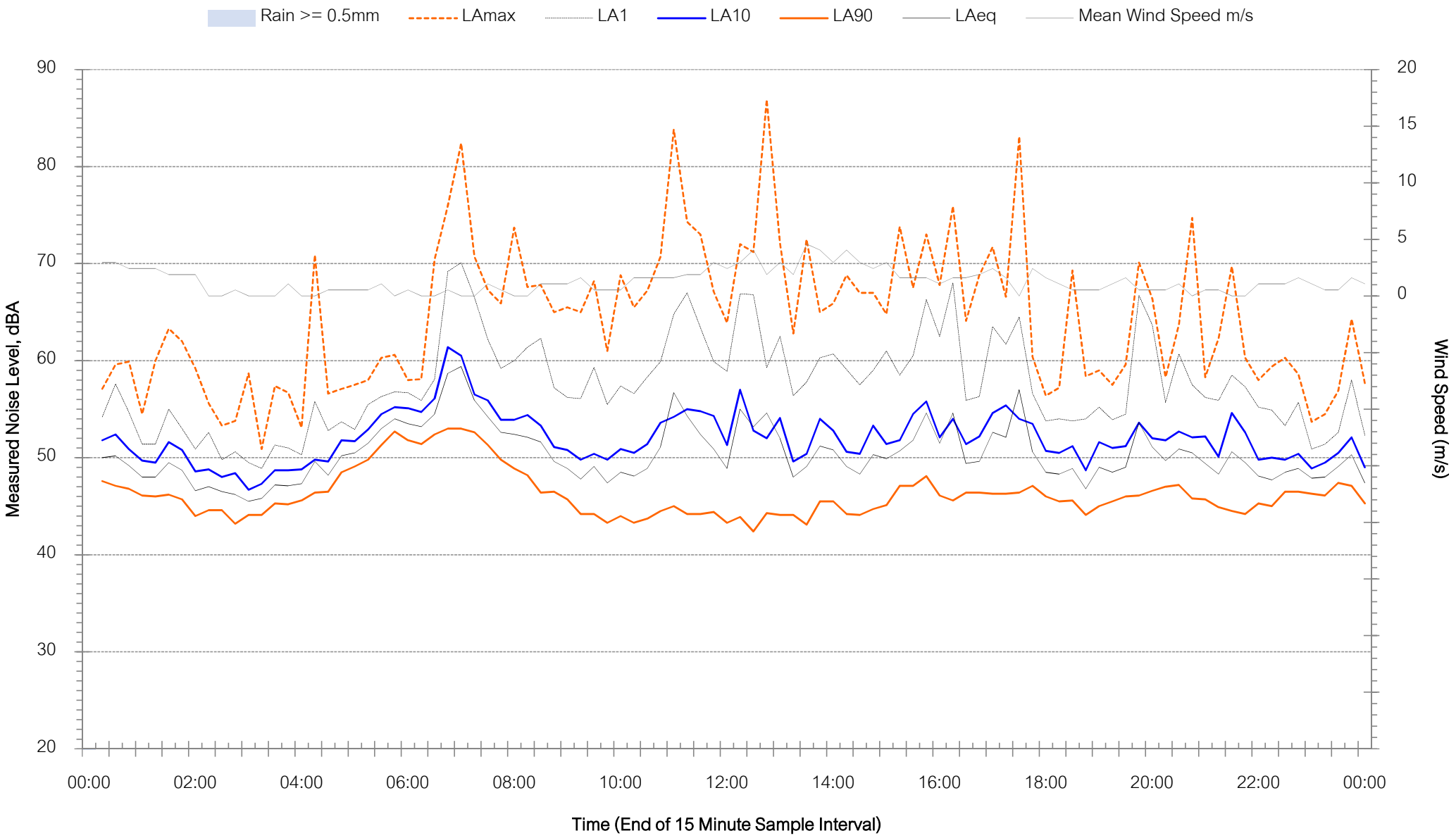


Background Noise Levels

Location - N3 - Sunday 12 May 2019

Background Noise Levels

Location - N3 - Monday 13 May 2019



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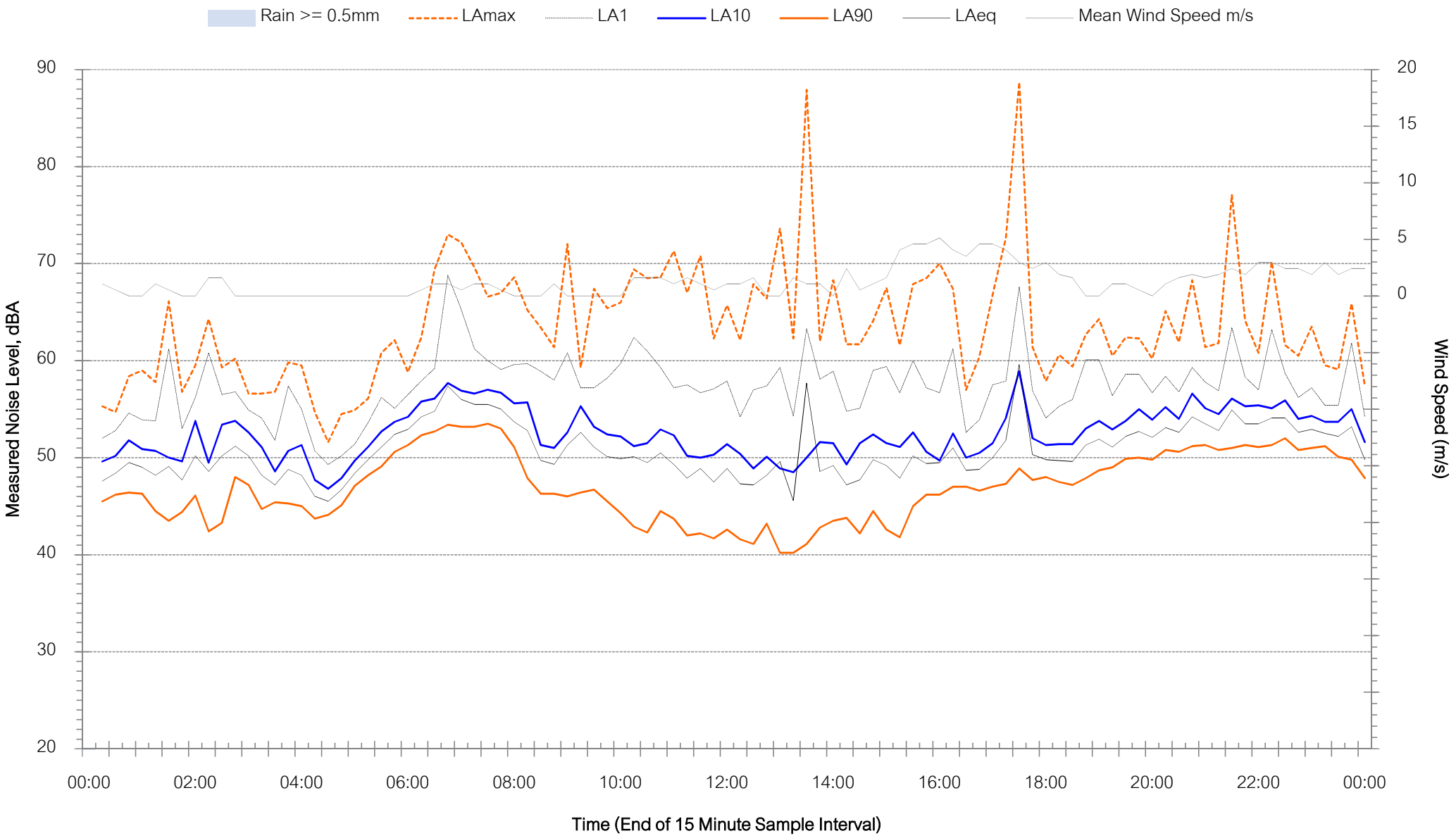

Background Noise Levels

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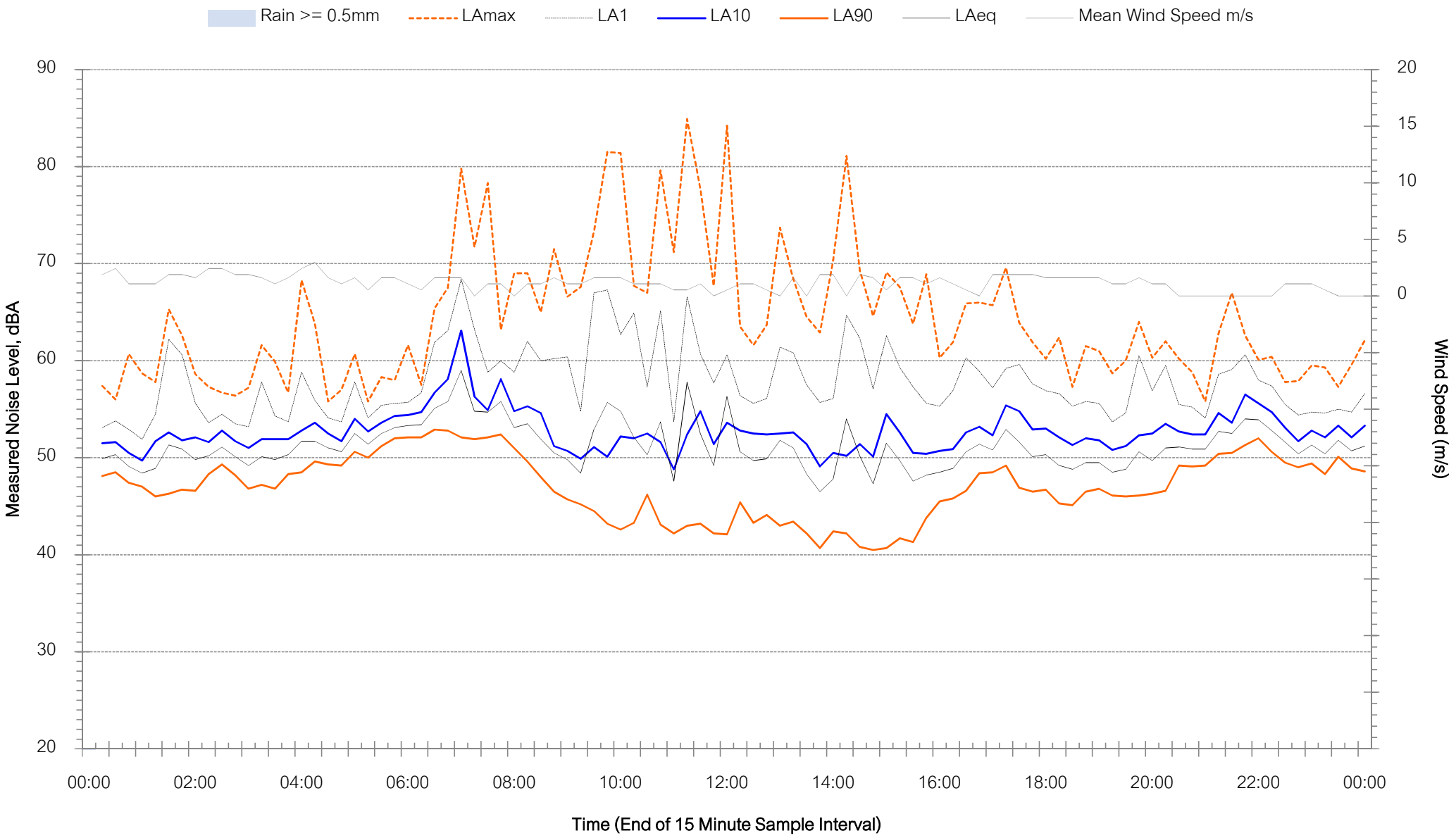
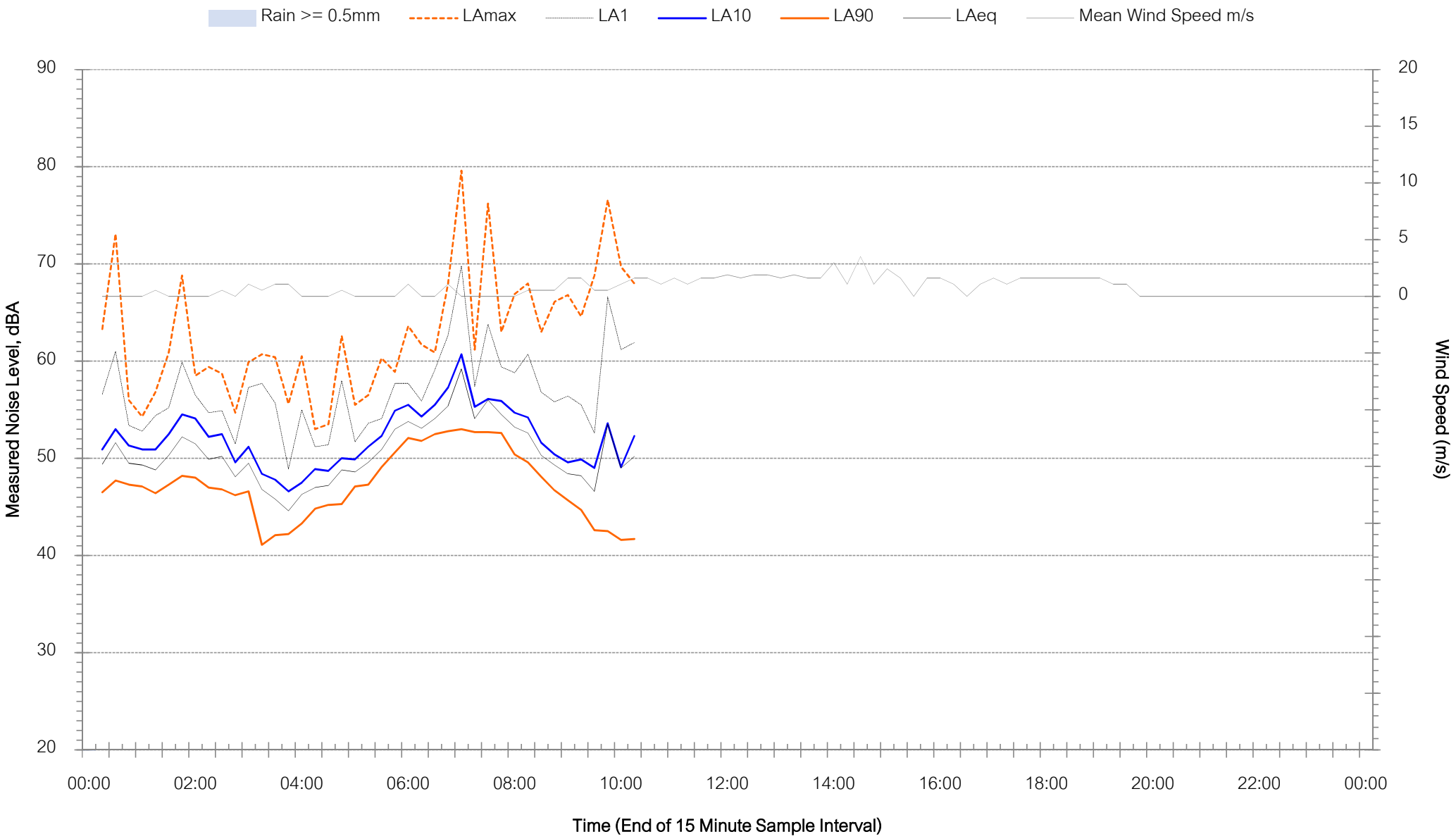


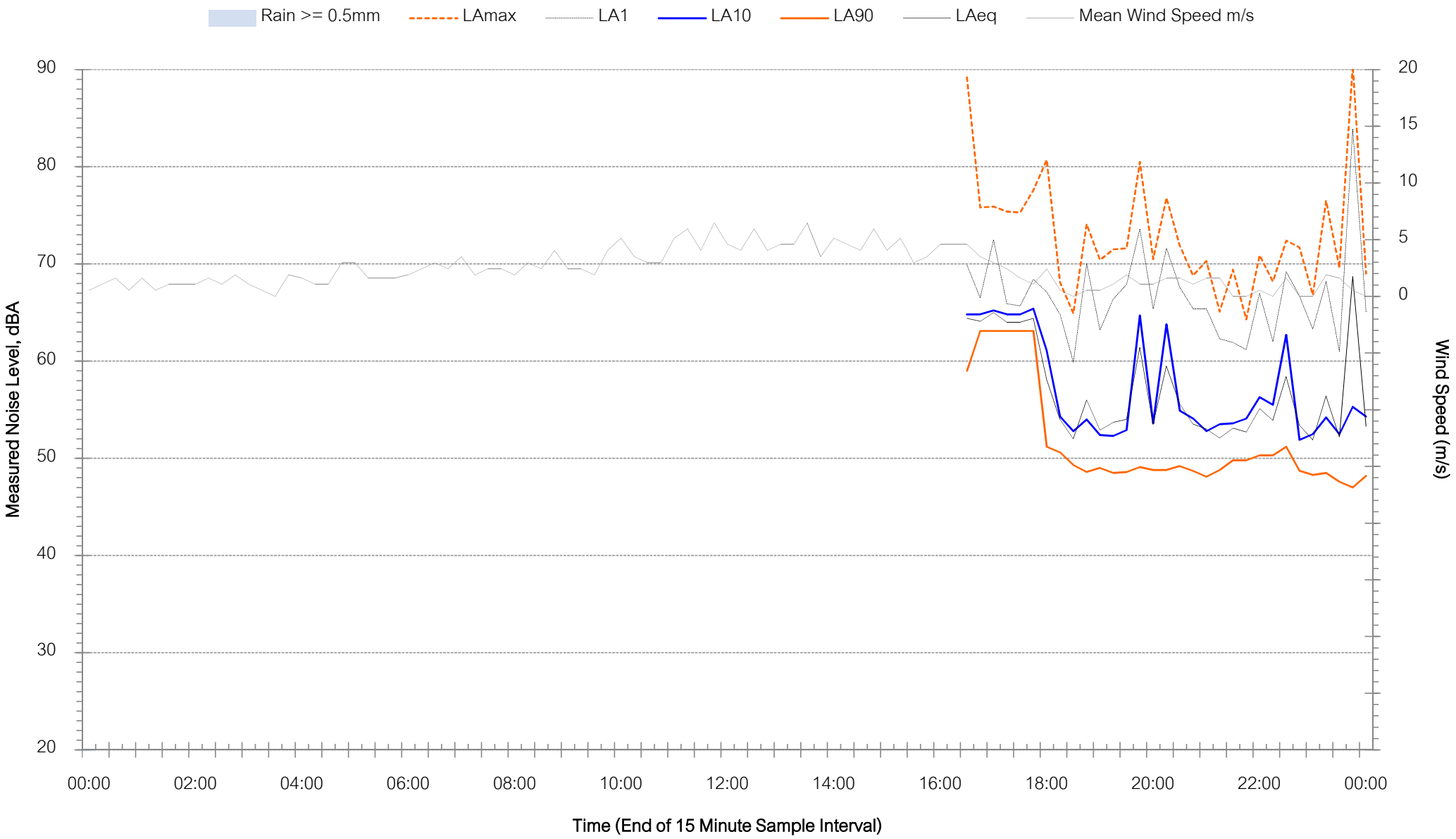
Background Noise Levels

Location - N3 - Thursday 16 May 2019



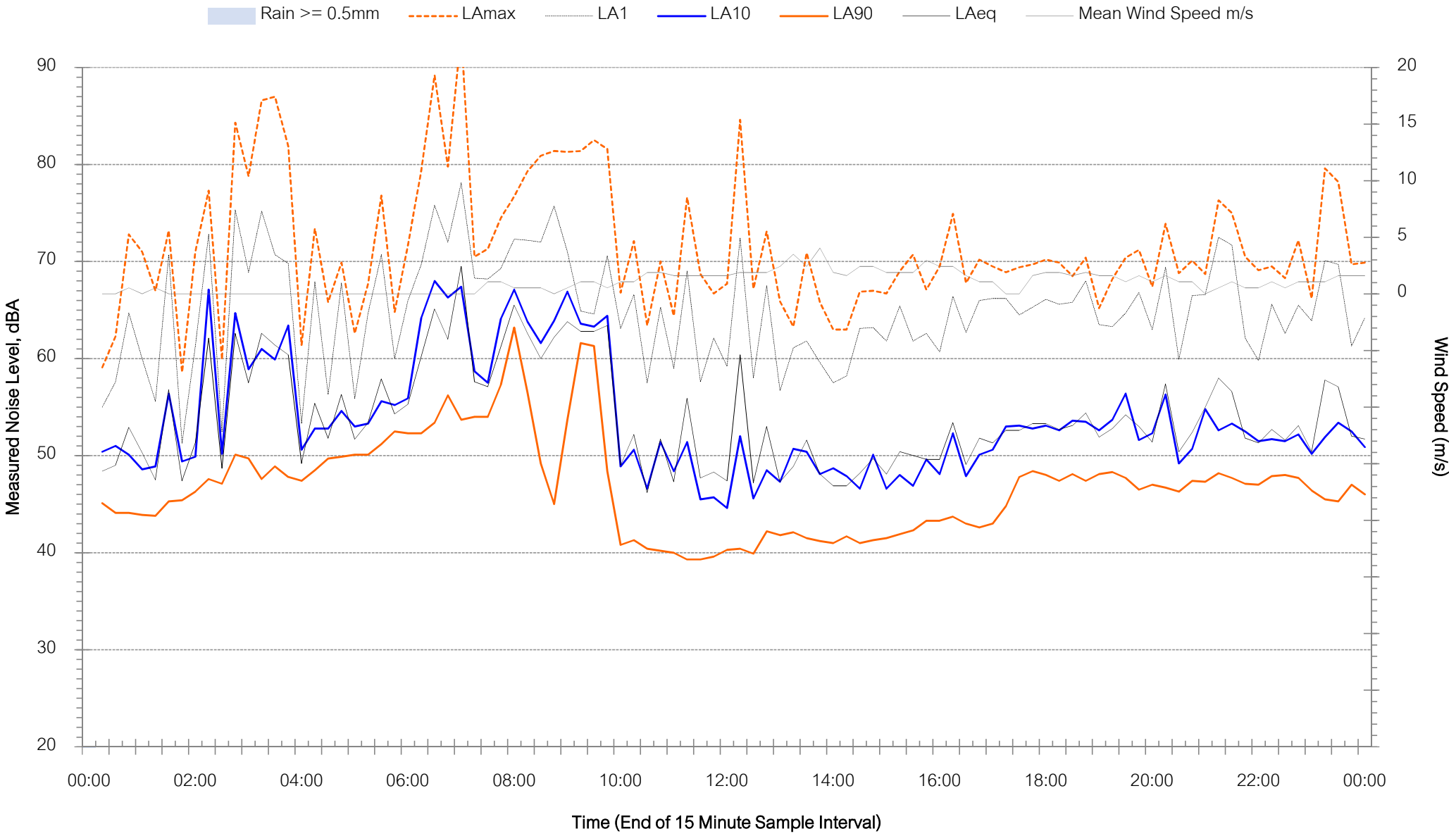
Background Noise Levels

Location - N4 - Wednesday 8 May 2019



Background Noise Levels

Location - N4 - Thursday 9 May 2019

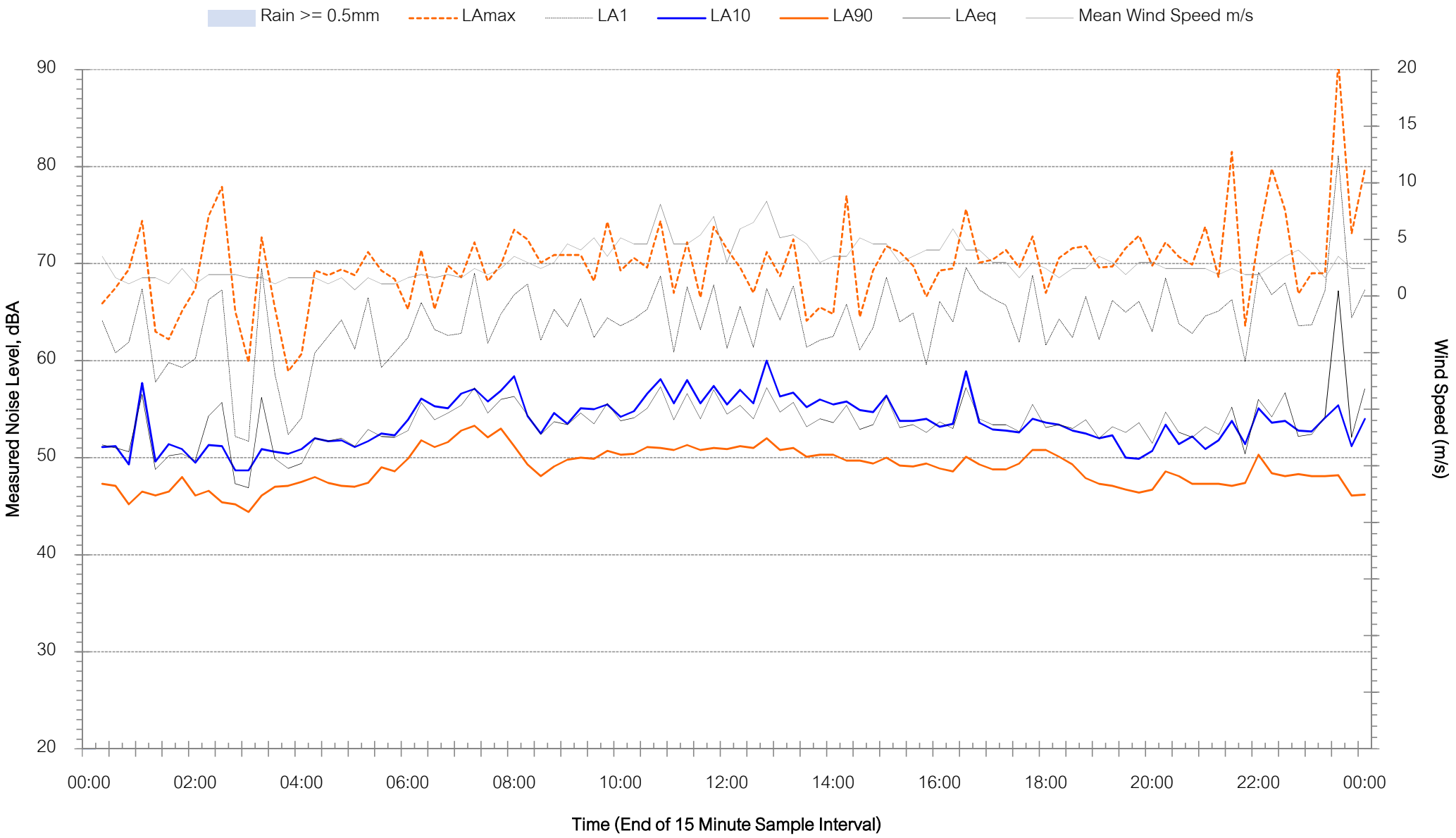


Background Noise Levels

Location - N4 - Friday 10 May 2019

Background Noise Levels

Location - N4 - Saturday 11 May 2019

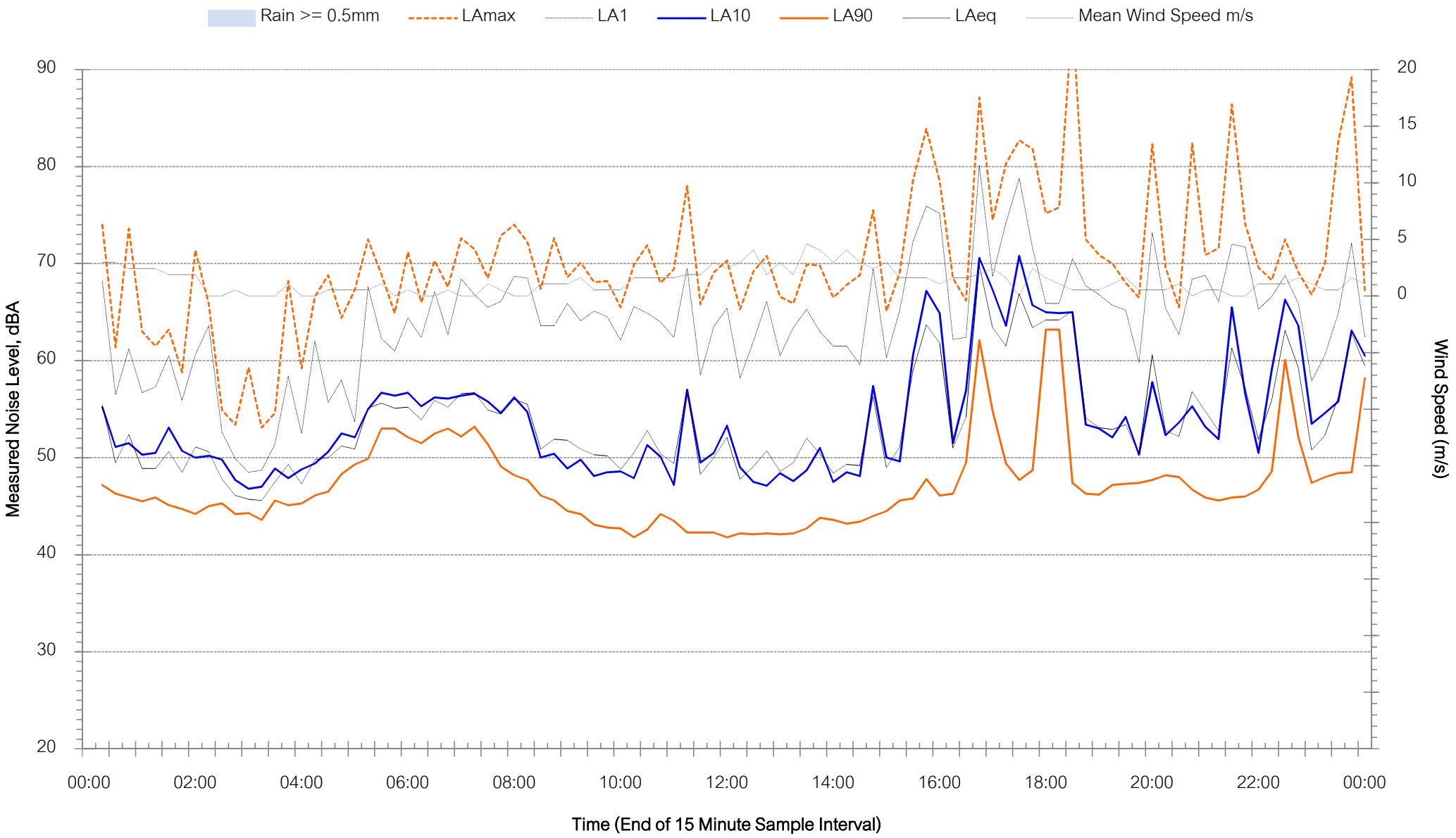


Background Noise Levels

Location - N4 - Sunday 12 May 2019

Background Noise Levels

Location - N4 - Monday 13 May 2019

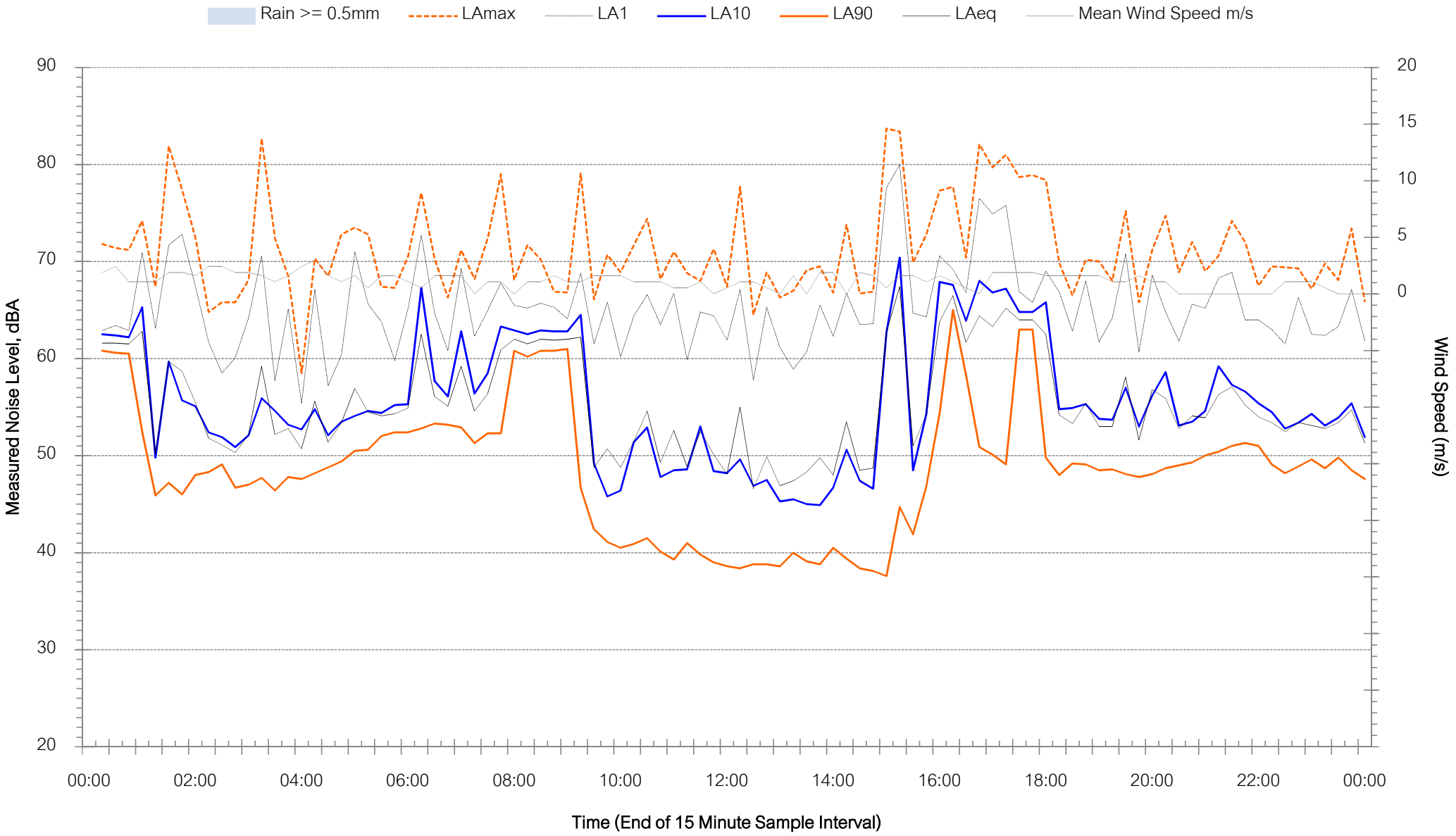


Background Noise Levels

Location - N4 - Tuesday 14 May 2019

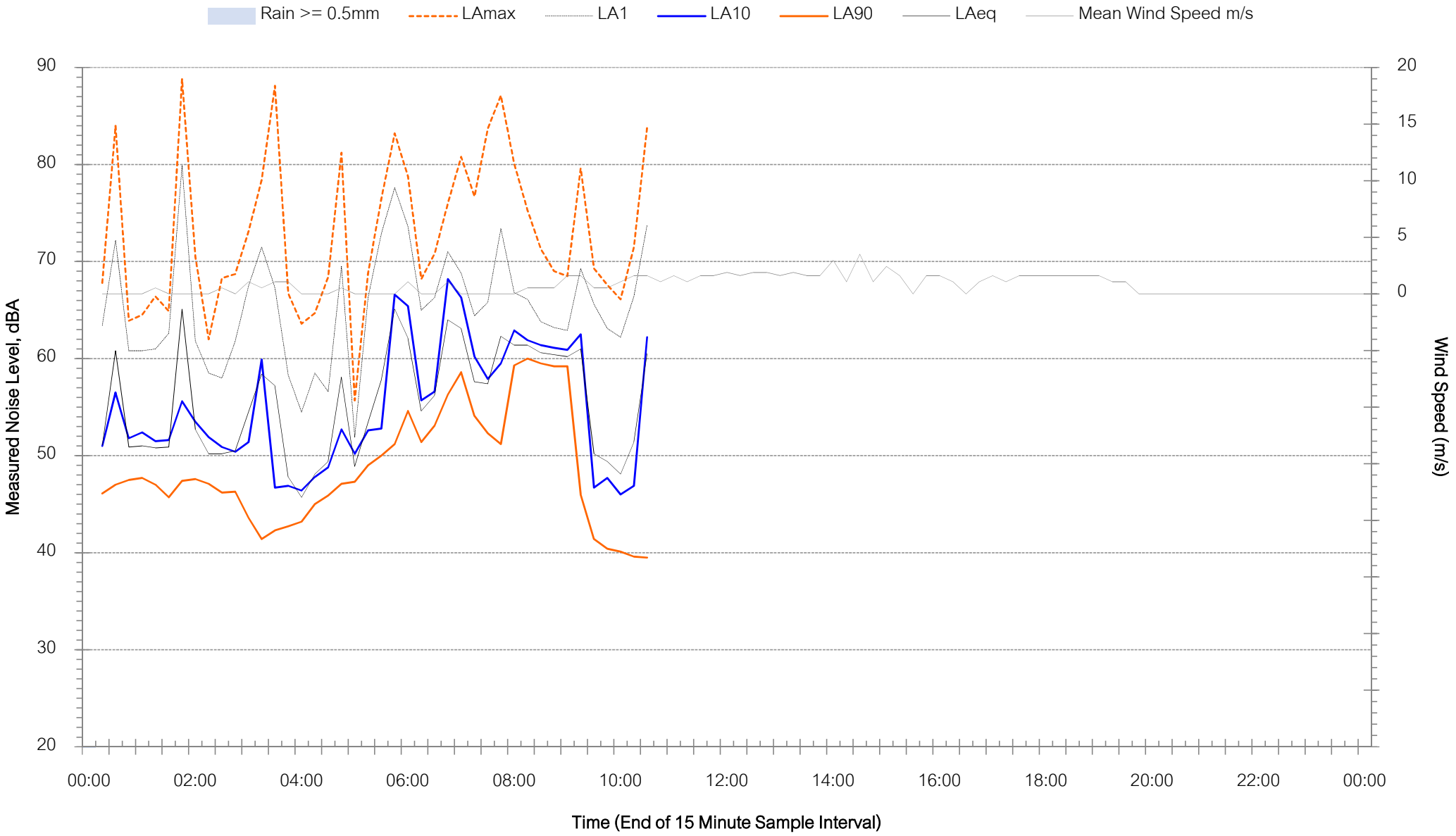
Background Noise Levels

Location - N4 - Wednesday 15 May 2019



Background Noise Levels

Location - N4 - Thursday 16 May 2019



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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 3 Ending September 2019.

Prepared for: Holcim (Australia) Pty Ltd
July 2019
MAC180611-01RP5

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Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 3 Ending September 2019

Prepared for: Holcim (Australia) Pty Ltd

Prepared by: Muller Acoustic Consulting Pty Ltd
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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
MAC180611-01RP5	Final	30 July 2019	Robin Heaton		Rod Linnett	

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APPENDIX A – GLOSSARY OF TERMS

APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending September 2019 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS/NZS IEC 61672.1:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

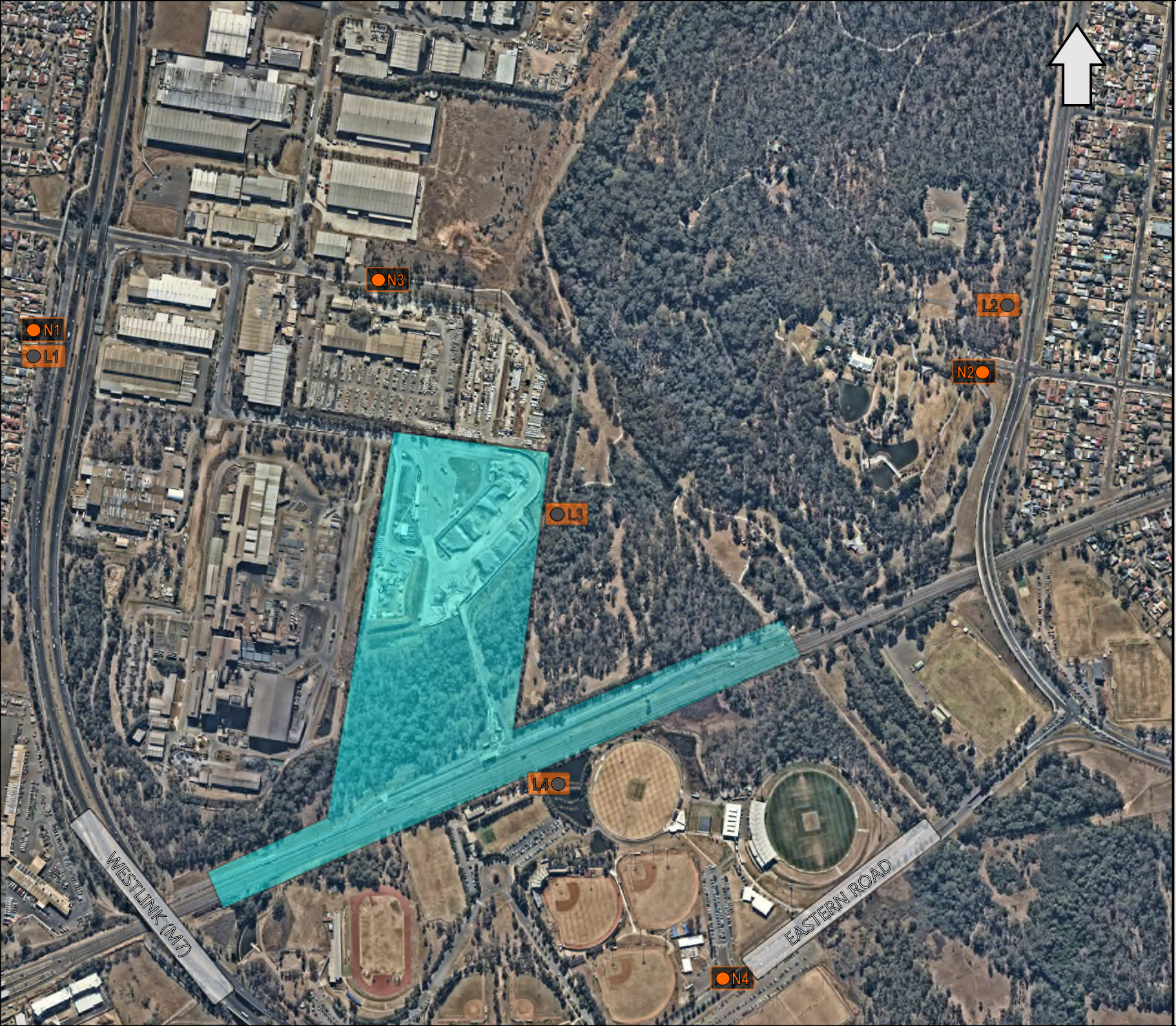

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY	
N1	MONITORING LOCATION
L1	LOGGER LOCATION
	SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Tuesday 9 July 2019 and Wednesday 10 July 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019 Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for more than seven days in general accordance with the procedures described AS 1055:2018 and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977 and 957 noise analysers from Tuesday 9 July 2019 to Friday 19 July 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1.2019. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/07/2019	16:53 (Day)	74	59	54	WD: SW WS: 1.0m/s Rain: Nil	Traffic 50-74 Birds 53-59 Dogs Barking 54-56 Aircraft 50-54 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<44
09/07/2019	21:44 (Evening)	69	53	48	WD: W WS: 0.1m/s Rain: Nil	Traffic 40 -58 Car Tyre Squeal 65-69 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<38
09/07/2019	23:22 (Night)	61	49	45	WD: SW WS: 0.1m/s Rain: Nil	Traffic 46-52 Truck Brakes 55-61 Sirens 45-54 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<35
RDC $L_{A1(1min)}$ Contribution						<40

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
10/07/2019	07:50 (Day)	69	59	55	WD: W WS: 0.1 m/s Rain: Nil	Birds 59-69 Traffic 58-64 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<40
09/07/2019	21:06 (Evening)	71	55	51	WD: W WS: 0.1m/s Rain: Nil	Traffic 52-64 Car Exhaust 71 Aircraft 53 Trains 52 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<39
09/07/2019	22:39 (Night)	62	52	49	WD: W WS: 0.1m/s Rain: Nil	Traffic 50-62 Truck Reverse Alarms 48-49 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<39
RDC $L_{A1(1min)}$ Contribution						<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
10/07/2019	08:18 (Day)	83	62	54	WD: W WS: 0.1m/s Rain: Nil	Passing Trucks 75-83 Council Works in Park 55-57 Birds 54-60 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<44
09/07/2019	21:25 (Evening)	64	54	51	WD: SW WS: 0.1m/s Rain: Nil	Other Industrial Noise 40-64 Traffic 46-50 Sirens 40 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<41
09/07/2019	23:01 (Night)	68	57	52	WD: SW WS: 0.1m/s Rain: Nil	Other Industrial Noise 52-68 Aircraft 54-64 Insects 43-46 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<42

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
09/07/2019	17:31 (Day)	64	54	52	WD: W WS: 0.1m/s Rain: Nil	Commuter Trains 58-64 Traffic 50-55 Birds 59 RDC Loader 40-48
		RDC $L_{Aeq(15min)}$ Contribution				<42
09/07/2019	20:40 (Evening)	64	54	51	WD: SE WS: 1m/s Rain: Nil	Steel Mill 52-55 Birds 60-64 Traffic 52-55 Commuter Trains 54-58 General Sports Noise 56 RDC Reverse alarms 45
		RDC $L_{Aeq(15min)}$ Contribution				<41
09/07/2019	22:17 (Night)	77	64	53	WD: W WS: 0.1m/s Rain: Nil	Passing traffic 65-77 Other Industrial Noise 52-55 Commuter Train 59-61 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<43

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq(period)}$[2]	Measured Background Noise Level (LA_{90}) dB RBL [2]
L1 (N1 Station Street)	Day	57	50
	Evening	53	45
	Night	53	41
L2 (N2 Knox Road)	Day	59	50
	Evening	57	49
	Night	56	41
L3 (N3 Nurragingy Reserve)	Day	57	49
	Evening	50	45
	Night	52	44
L4 (N4 Olympic Park)	Day	62	48
	Evening	62	48
	Night	62	47

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<44	44	✓
N2	<40	40	✓
N3	<44	50 (When in use)	✓
N4	<42	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<38	44	✓
N2	<39	39	✓
N3	<41	50 (When in use)	✓
N4	<41	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution		RDC Noise Criteria		Compliant
	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$	
N1	<35	<40	39	53	✓
N2	<39	<45	39	53	✓
N3	<42	N/A	50 (When in use)	N/A	✓
N4	<43	N/A	55 (When in use)	N/A	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three attended measurements conducted on Tuesday 9 July 2019, satisfying the relevant noise limits. Extraneous noise sources included traffic, local residential noise, and aircraft noise.

6.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during theday, evening and night attended measurements conducted on Tuesday 9 July 2019 and Wednesday 10 July 2019, satisfying the relevant noise limits for this location. Extraneous sources measured include traffic birds and aircraft noise.

6.3 Discussion of Results - Location N3

Attended measurements on Tuesday 9 July 2019 and Wednesday 10 July 2019 identified that RDC noise was inaudible during the daytime, evening and night measurements, which satisfied the relevant noise criteria for this location. Extraneous sources audible during the attended surveys included traffic, aircraft noise, birds and other industrial noise which generally masked RDC noise. For the evening and night assessment periods, it is noted the receiver was not “in use”, hence criteria are referenced for completeness.

6.4 Discussion of Results - Location N4

RDC noise emissions were audible during the day, evening measurements on Tuesday 9 July 2019, however remained below the applicable noise criteria. Night time measurements remained inaudible at the N4 monitoring location on Tuesday 9 July 2019. It is noted that the sports centre was not in use during the night period and criteria are referenced for completeness. Extraneous noise sources included birds, traffic, train pass-bys, other industrial noise and aircraft noise all audible throughout attended measurements at this location.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 3, ending September 2019.

Unattended noise monitoring was completed between Tuesday 9 July 2019 and Friday 19 July 2019 at four representative monitoring locations.

Attended noise monitoring was conducted on Tuesday 9 July 2019 and Wednesday 10 July 2019. The assessment has identified that noise emissions generated by RDC were generally inaudible throughout the attended monitoring, with all measurements satisfying the relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

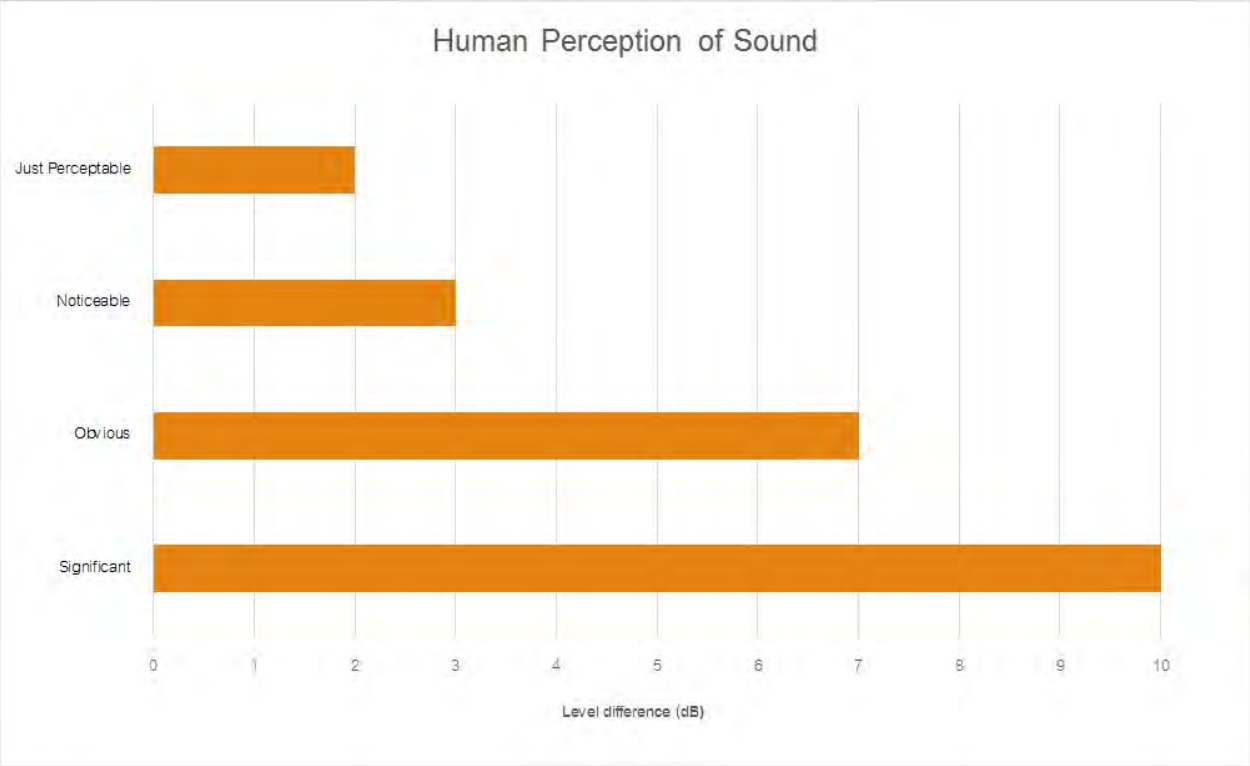
Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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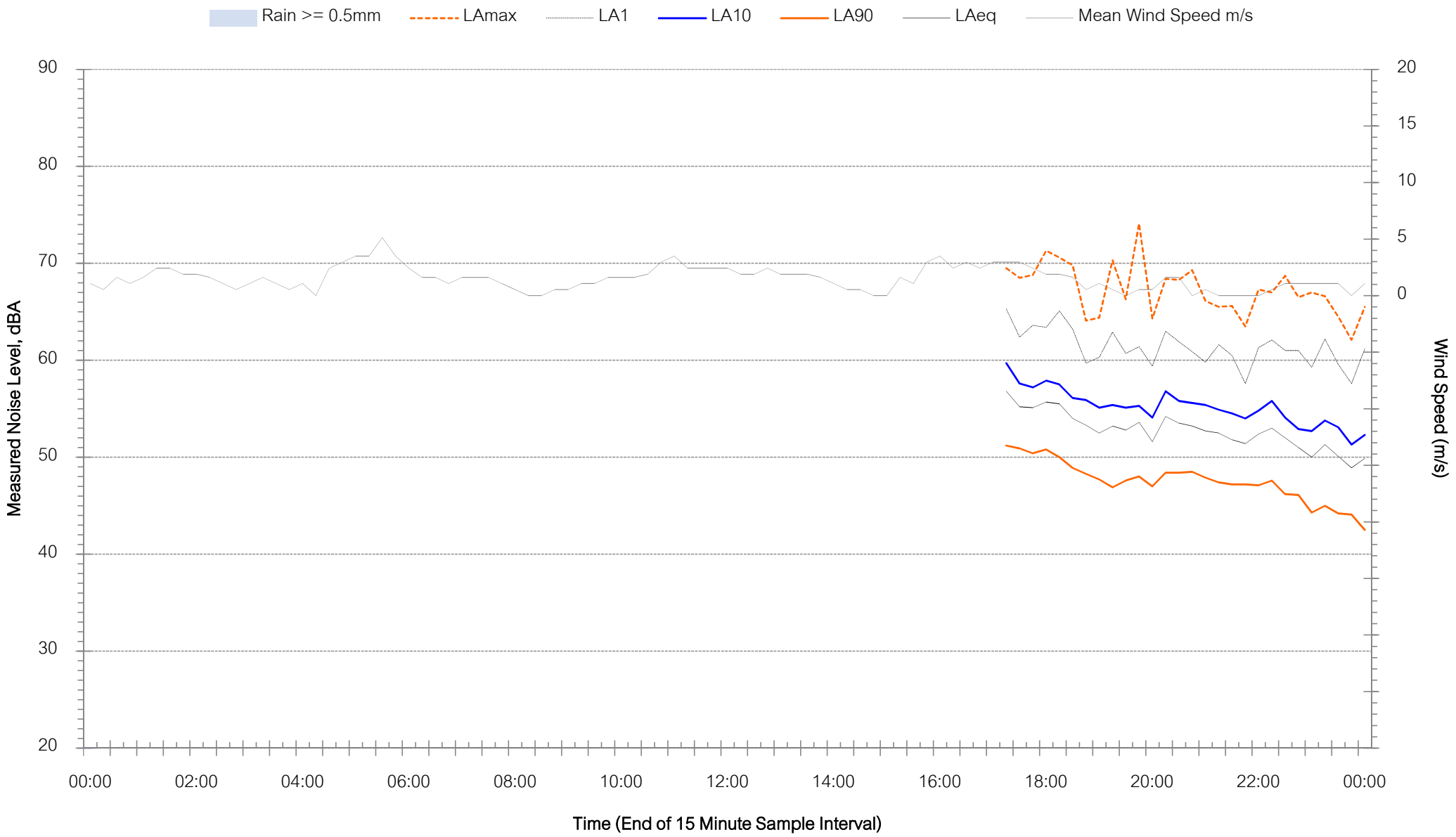
Appendix B – Unattended Noise Monitoring Charts

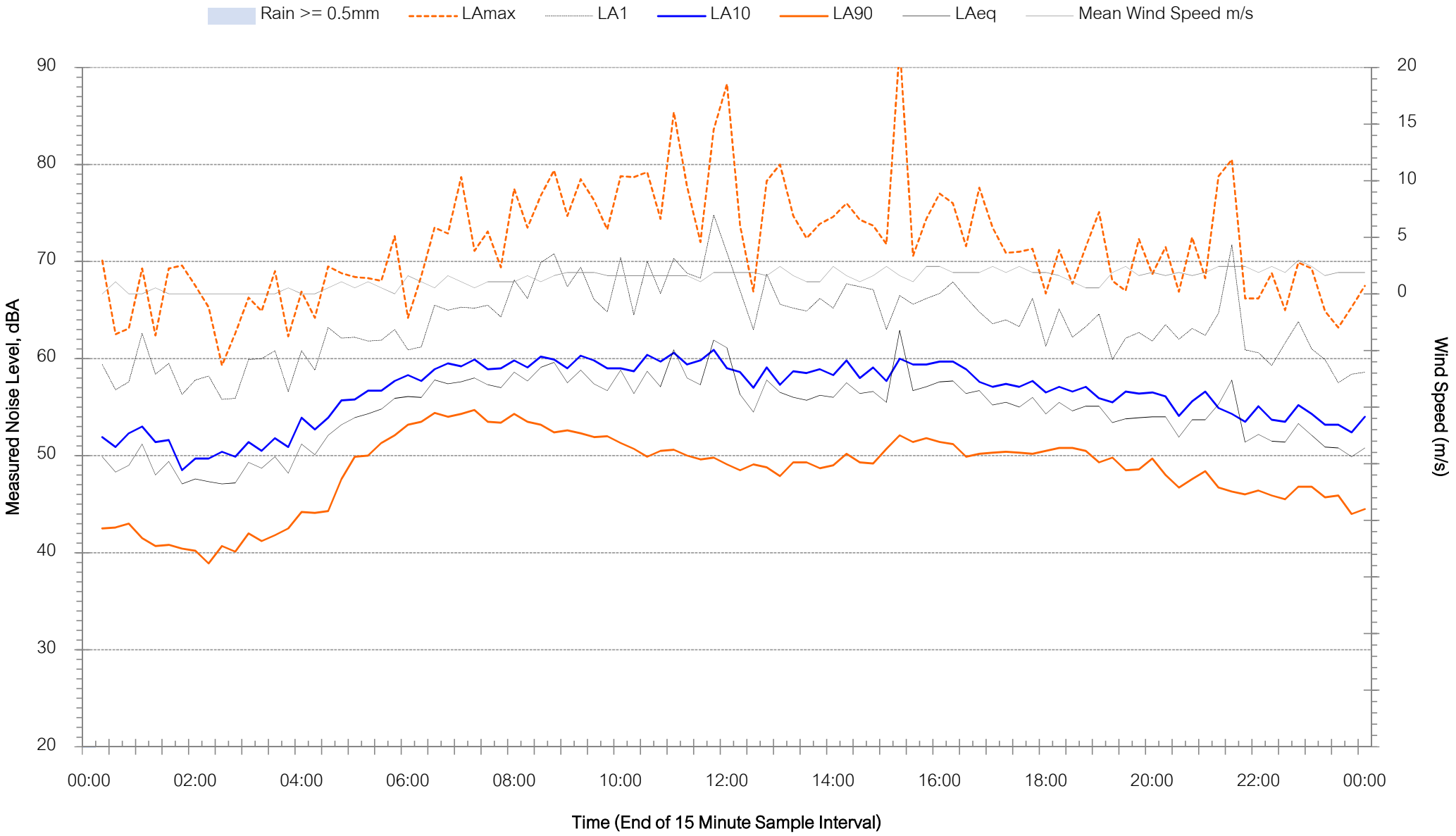
Background Noise Levels

Location N1 - Tuesday 9 July 2019



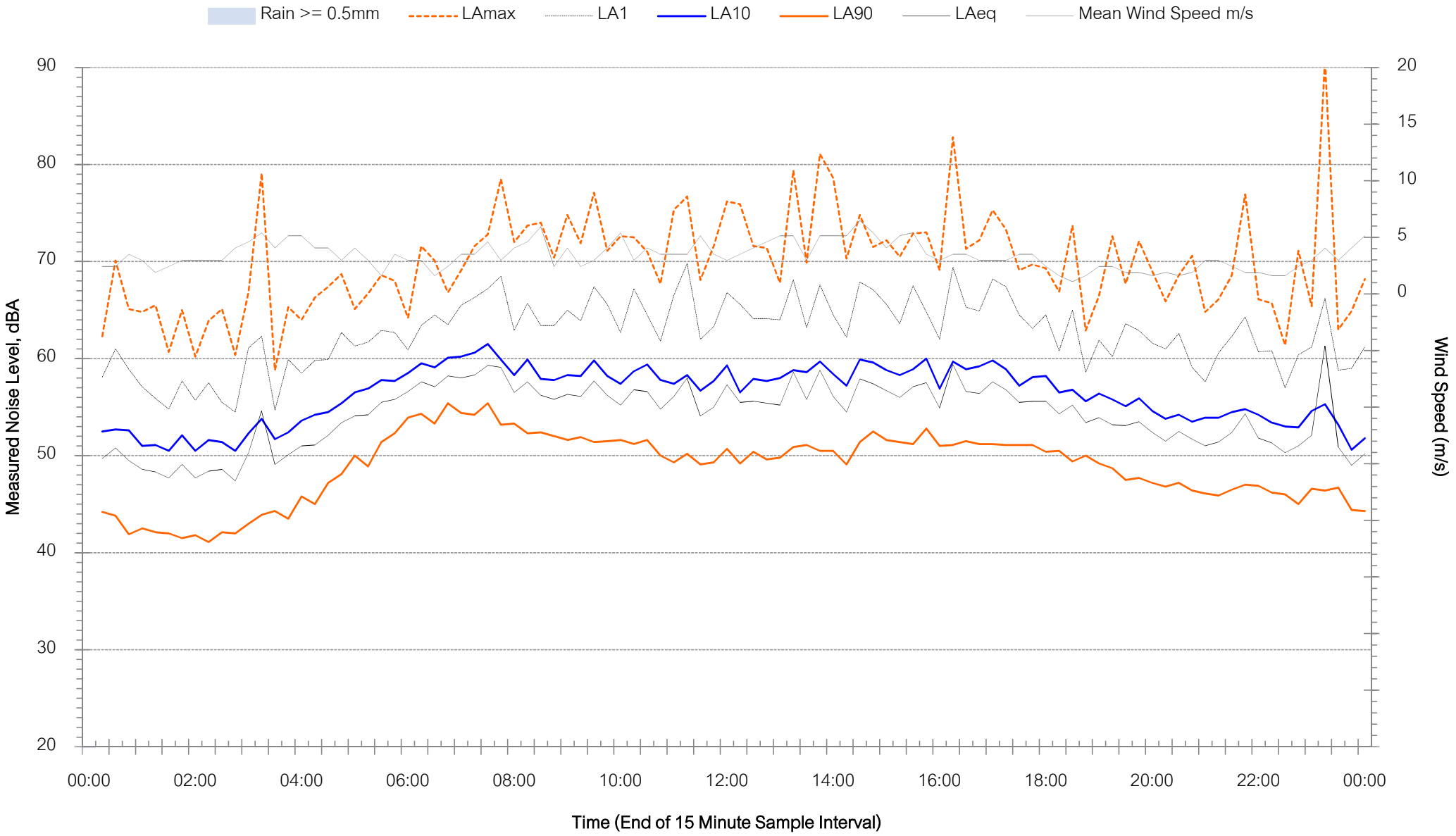
Background Noise Levels

Location N1 - Wednesday 10 July 2019



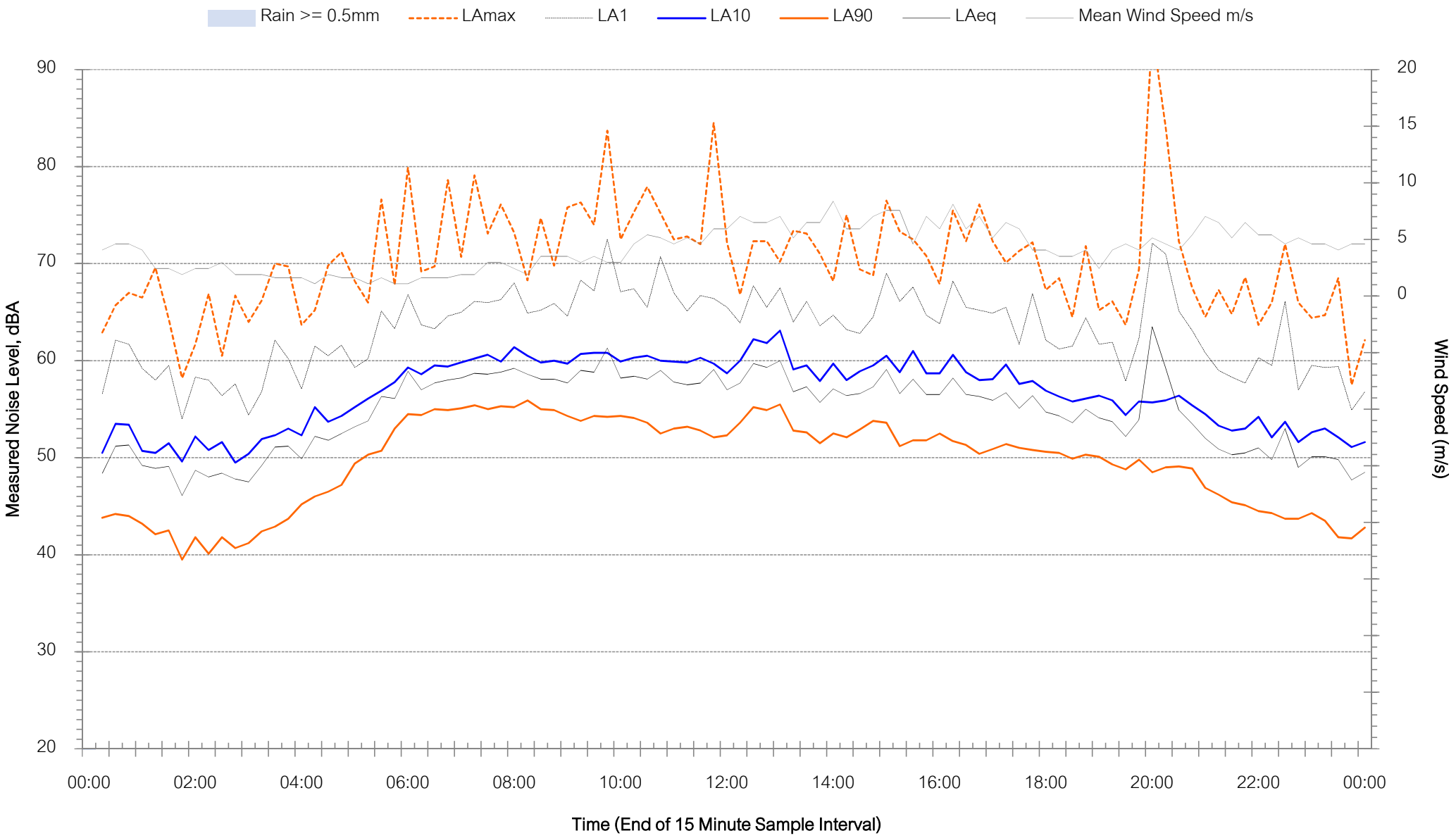
Background Noise Levels

Location N1 - Thursday 11 July 2019



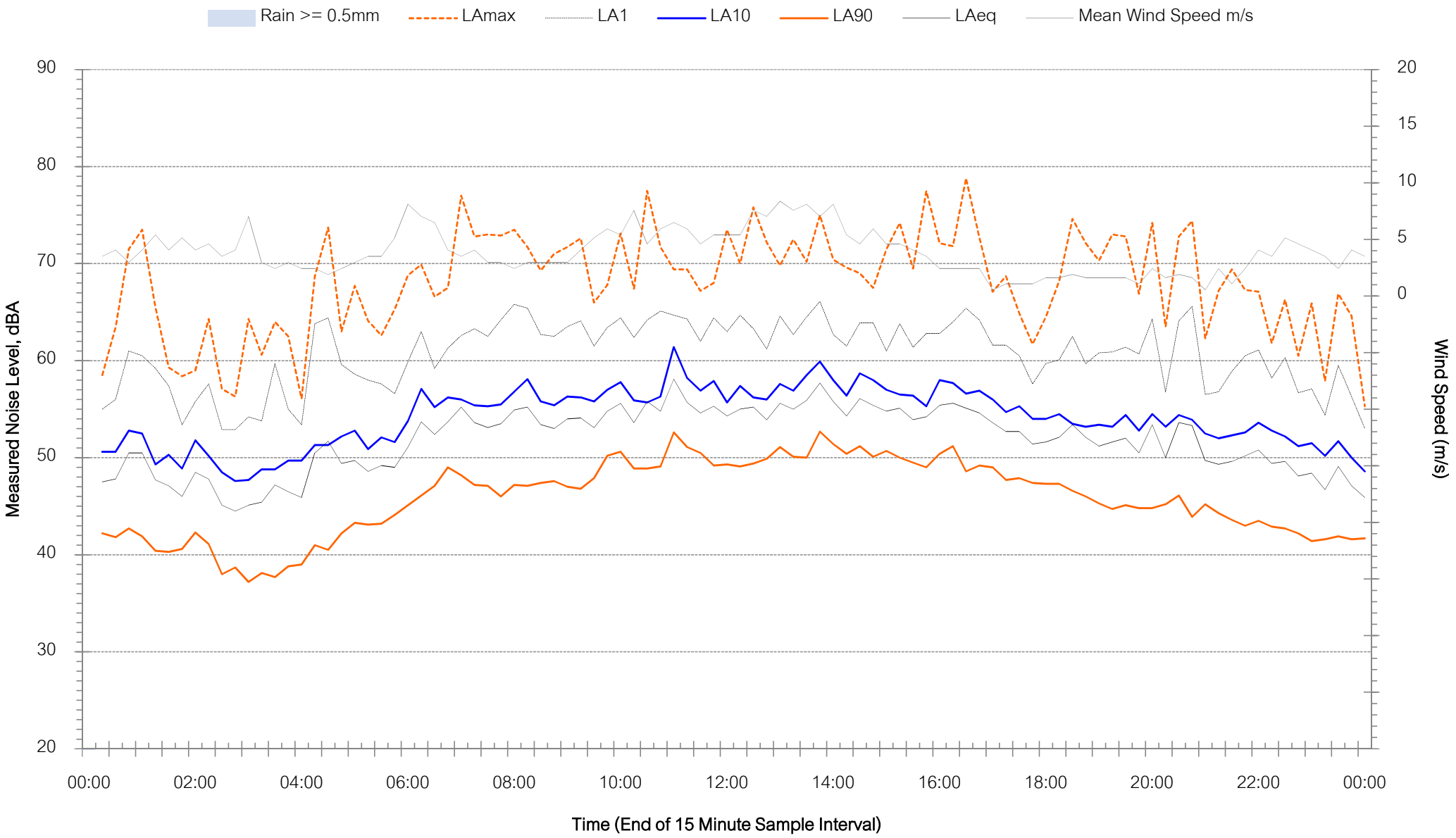
Background Noise Levels

Location N1 - Friday 12 July 2019



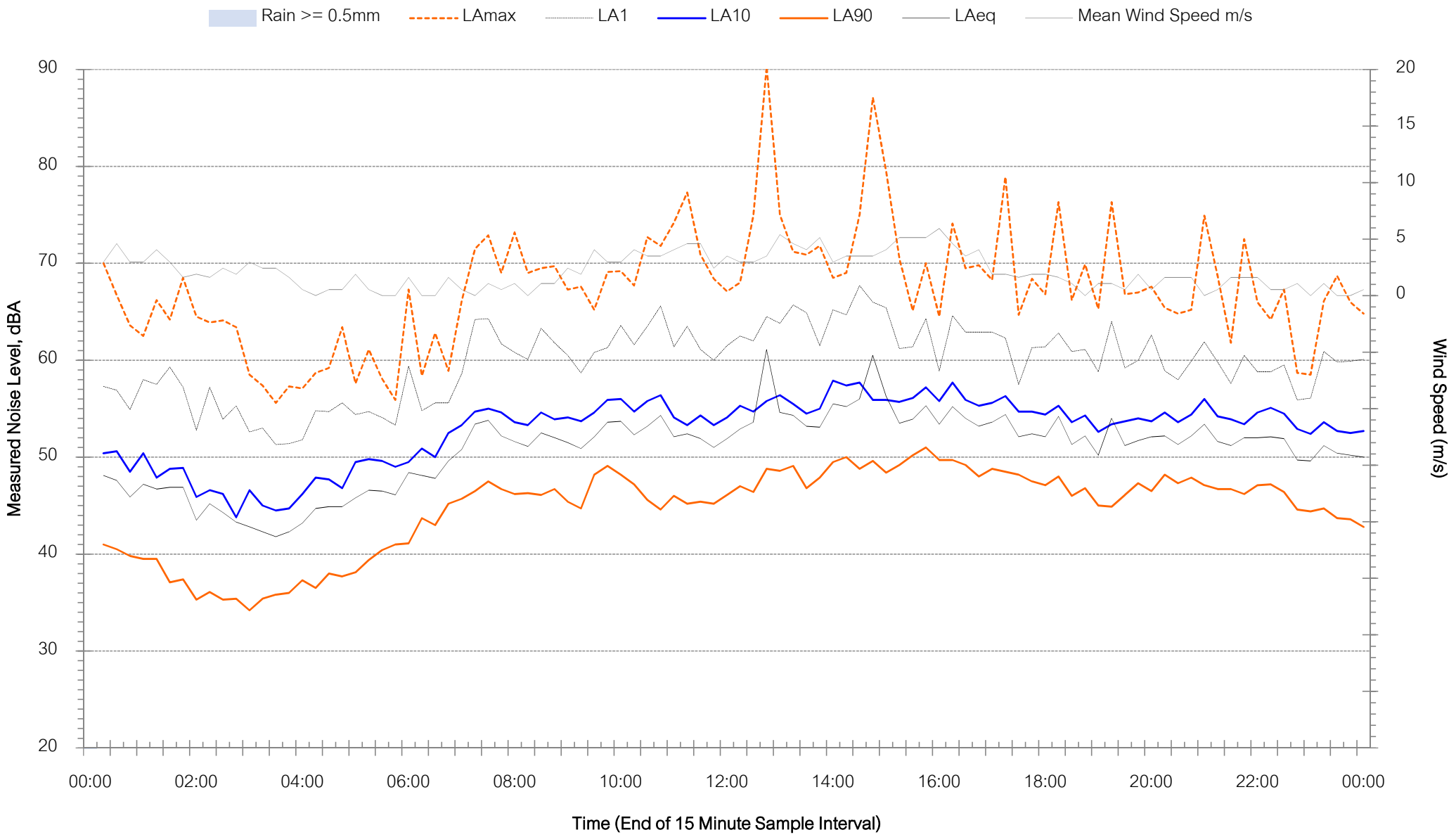
Background Noise Levels

Location N1 - Saturday 13 July 2019



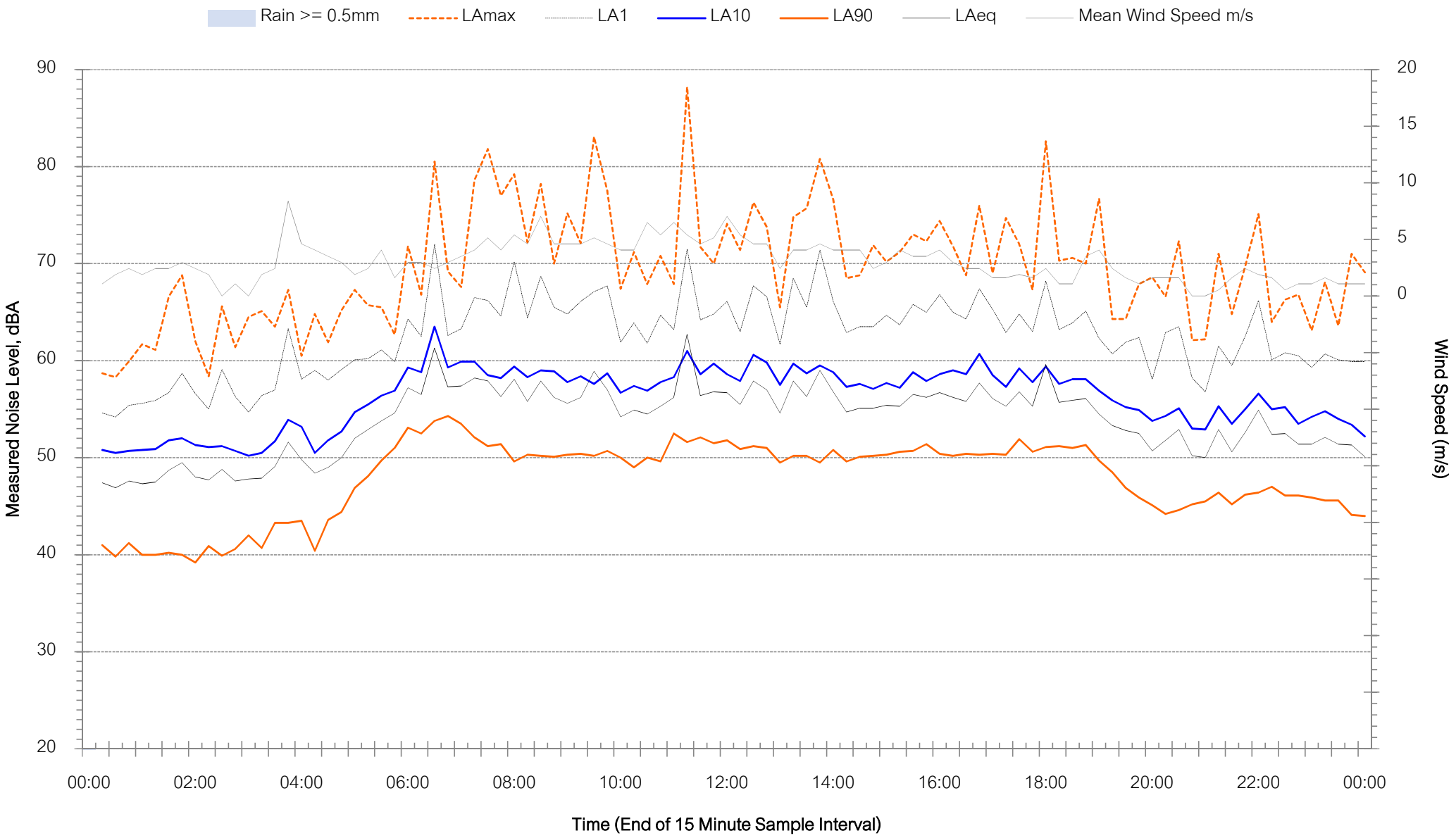
Background Noise Levels

Location N1 - Sunday 14 July 2019



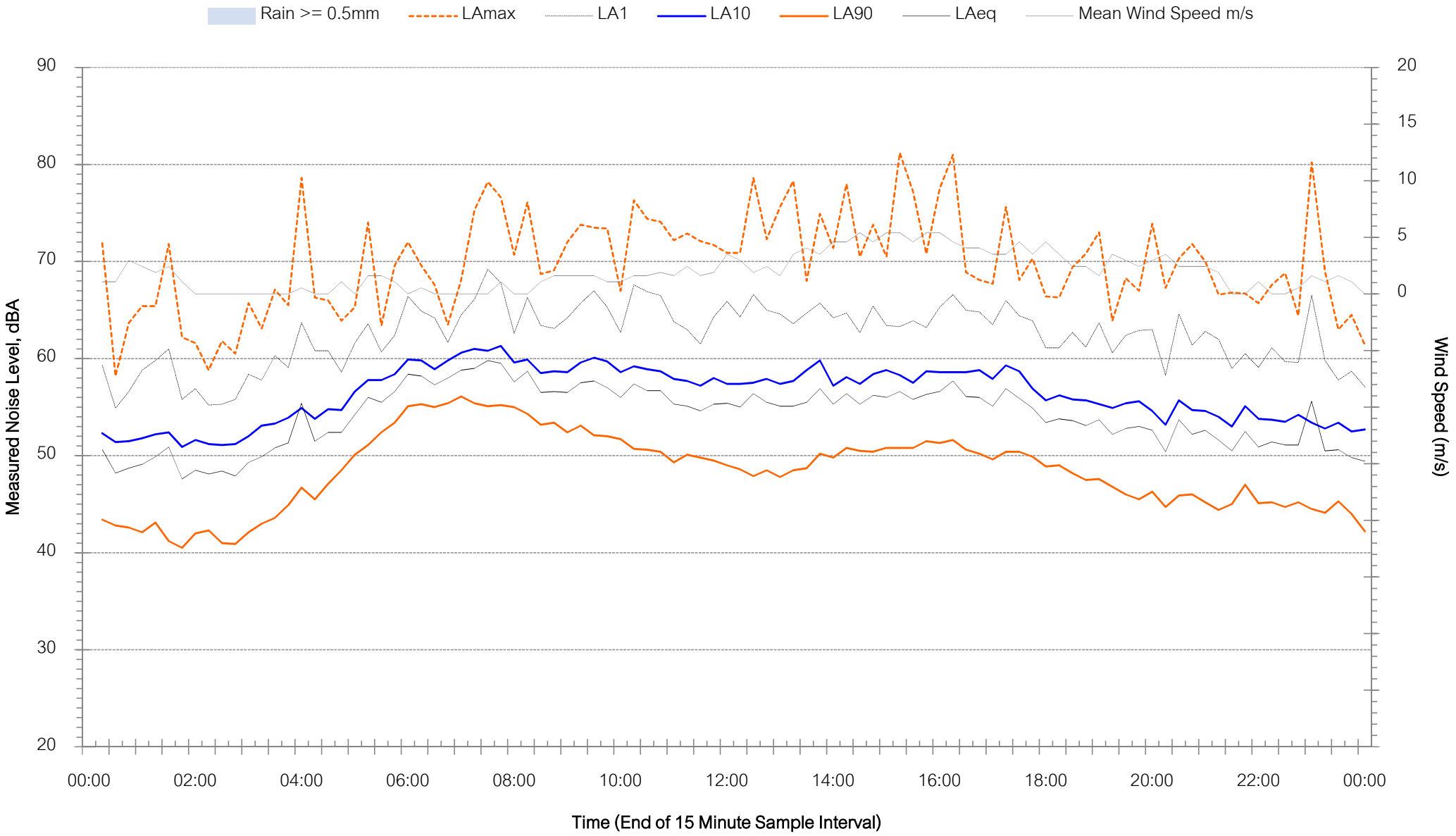
Background Noise Levels

Location N1 - Monday 15 July 2019



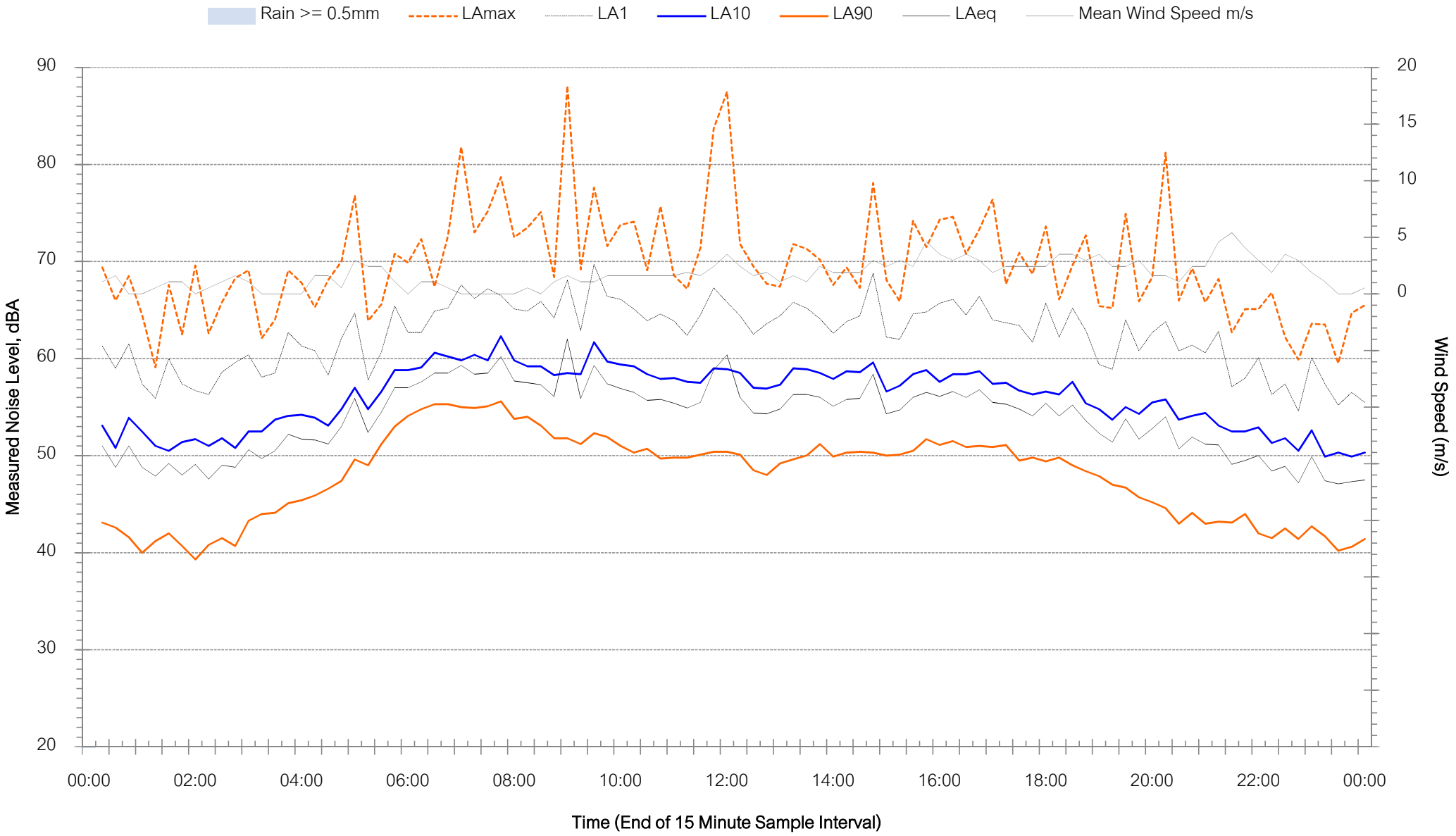
Background Noise Levels

Location N1 - Tuesday 16 July 2019



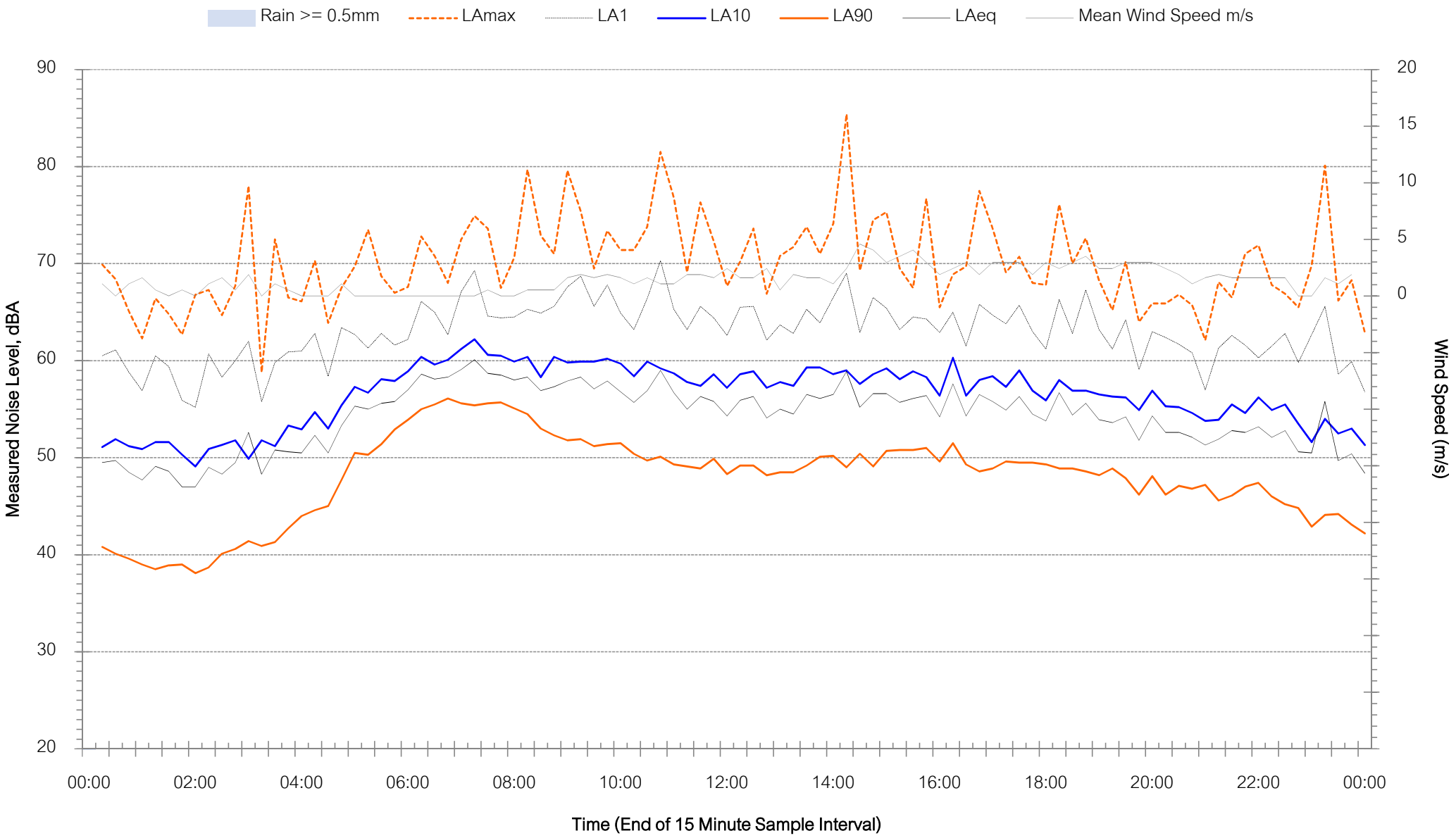
Background Noise Levels

Location N1 - Wednesday 17 July 2019



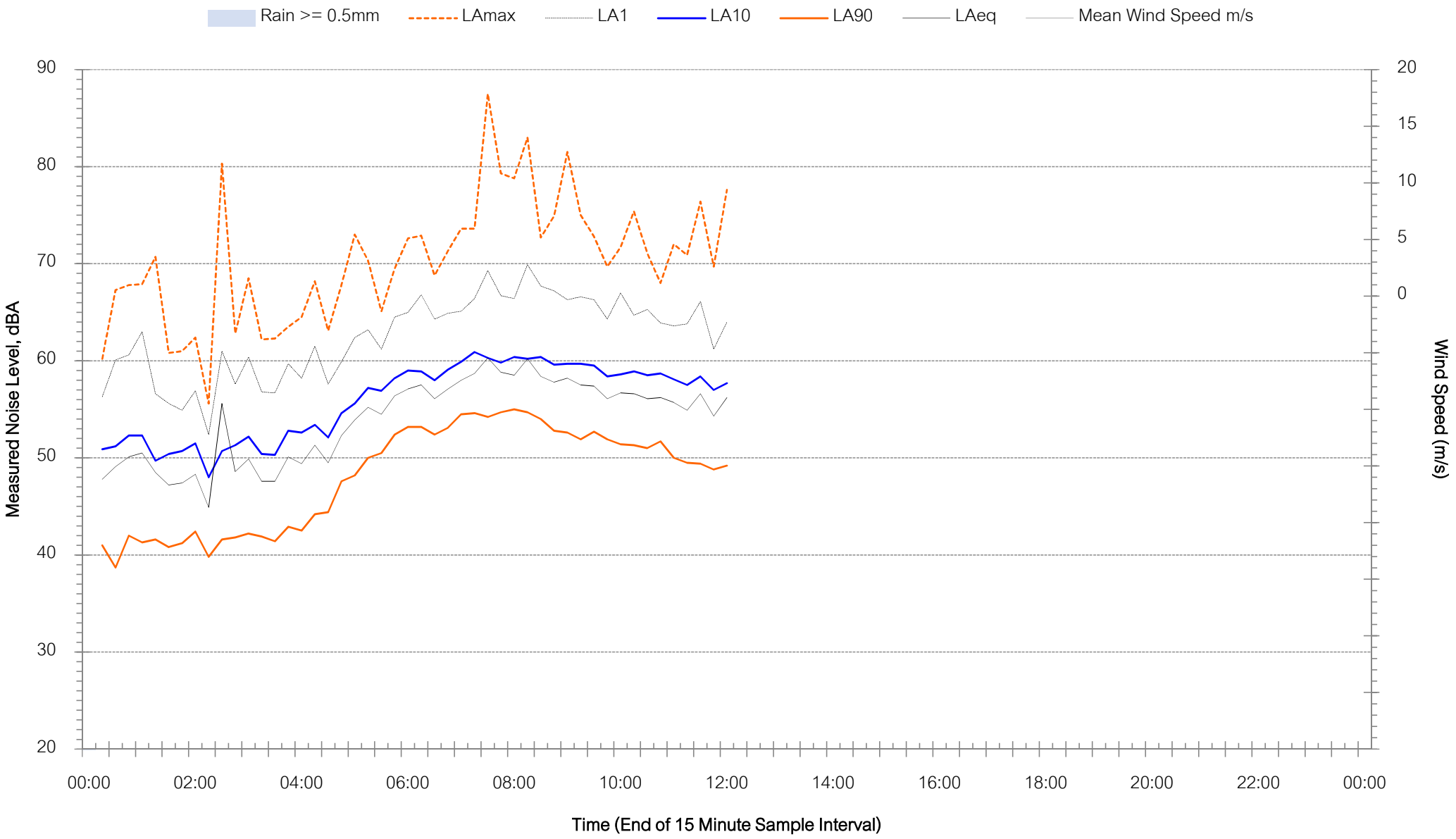
Background Noise Levels

Location N1 - Thursday 18 July 2019



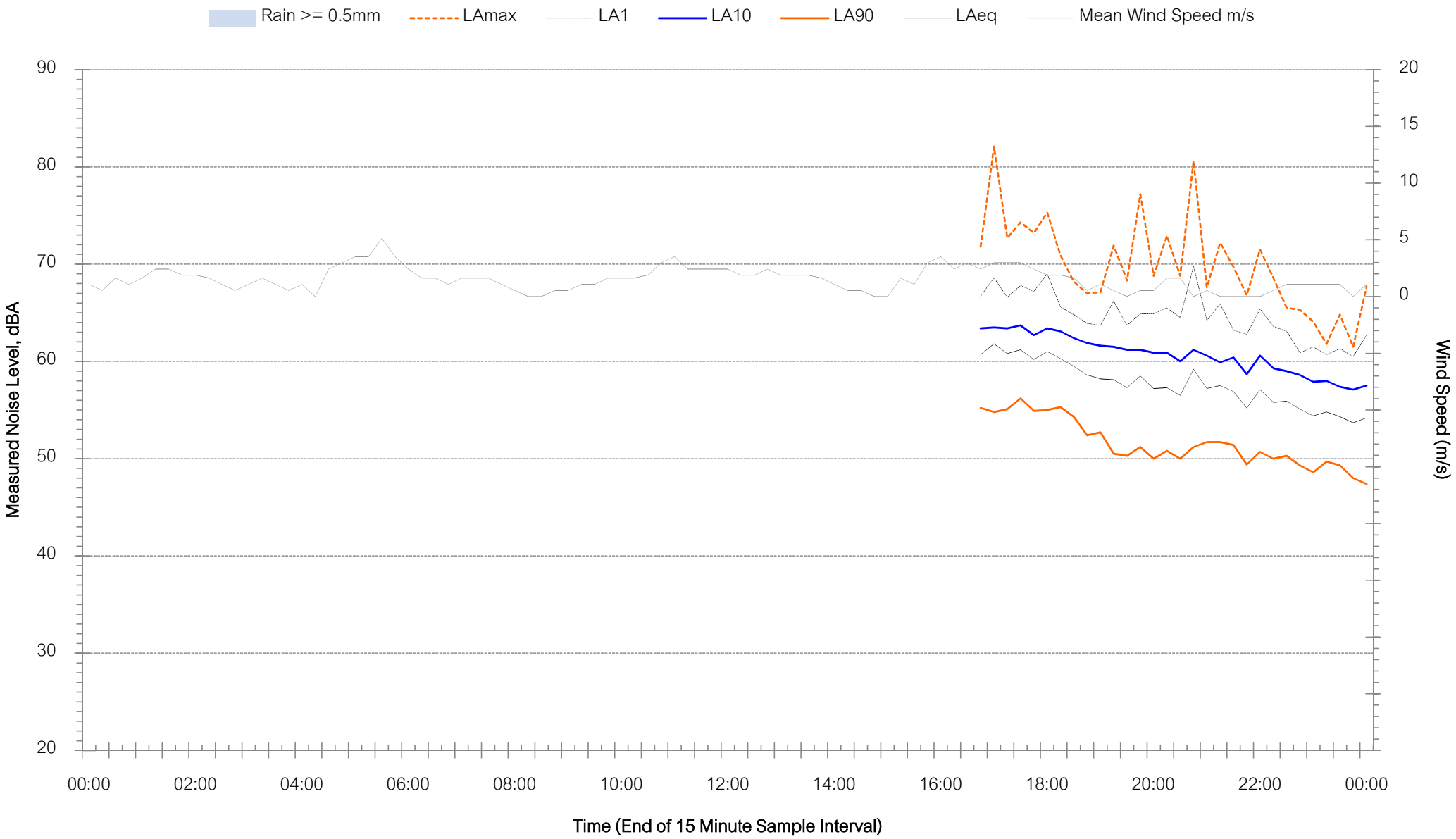
Background Noise Levels

Location N1 - Friday 19 July 2019



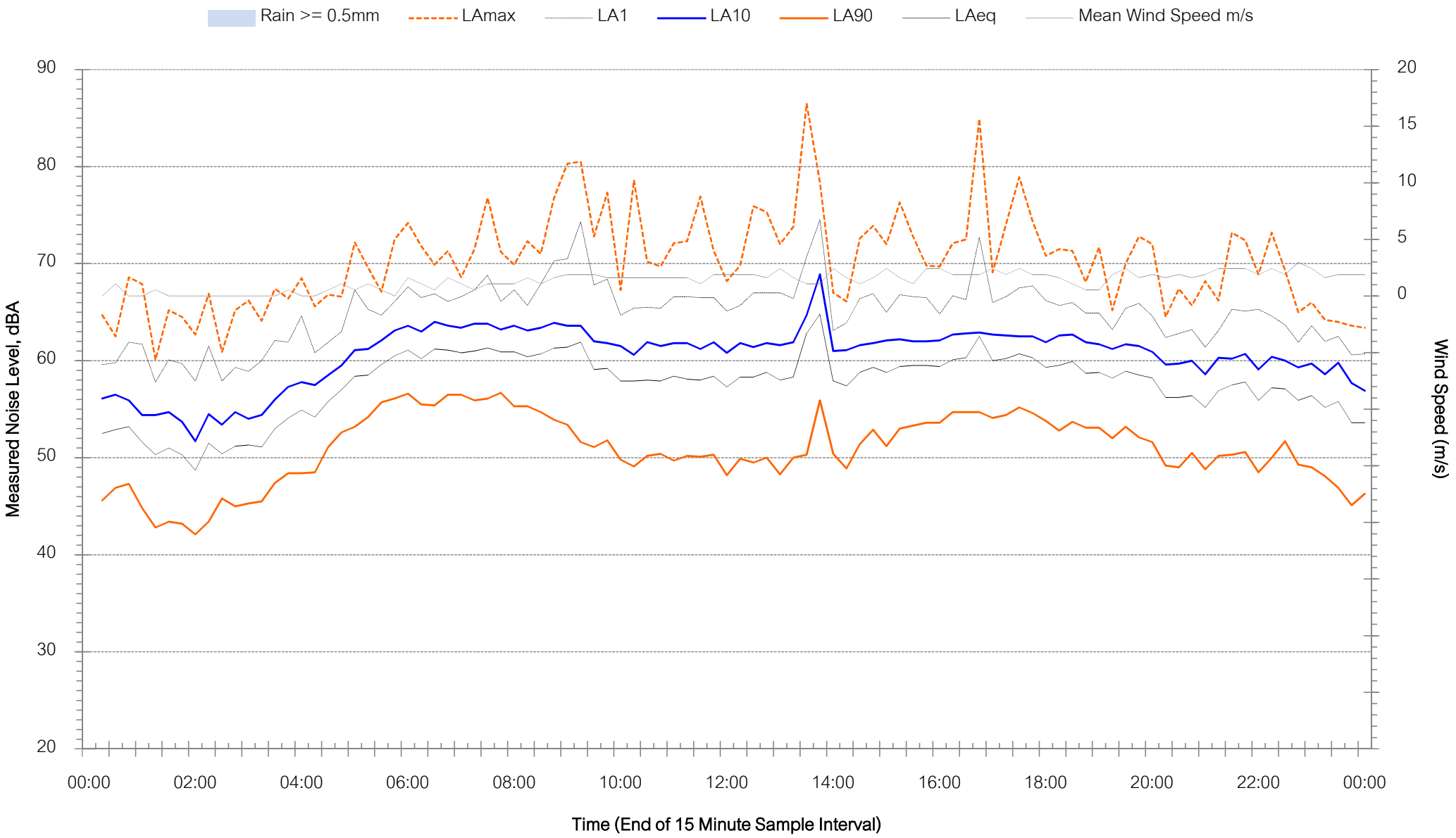
Background Noise Levels

Location N2 - Tuesday 9 July 2019



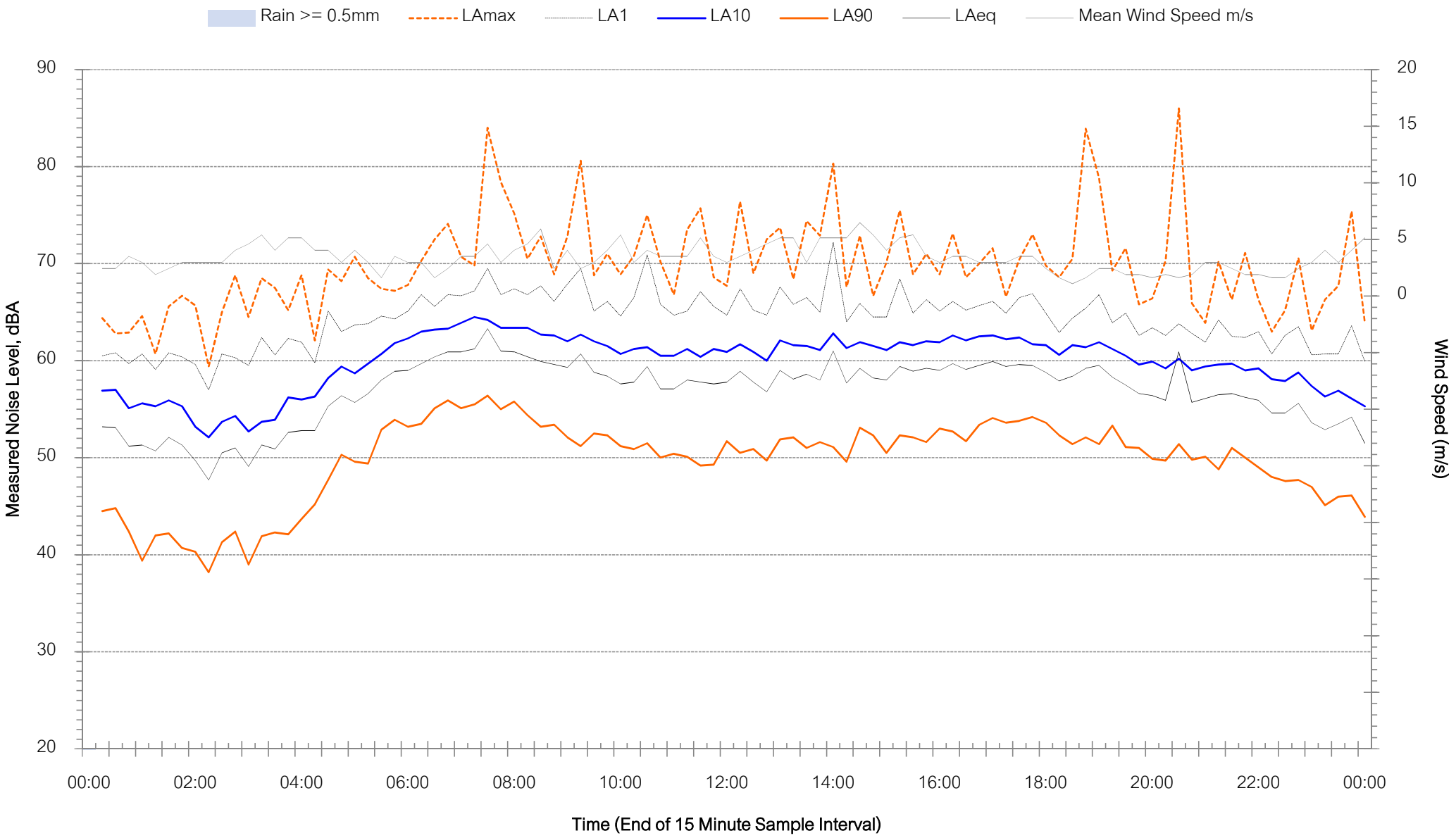
Background Noise Levels

Location N2 - Wednesday 10 July 2019



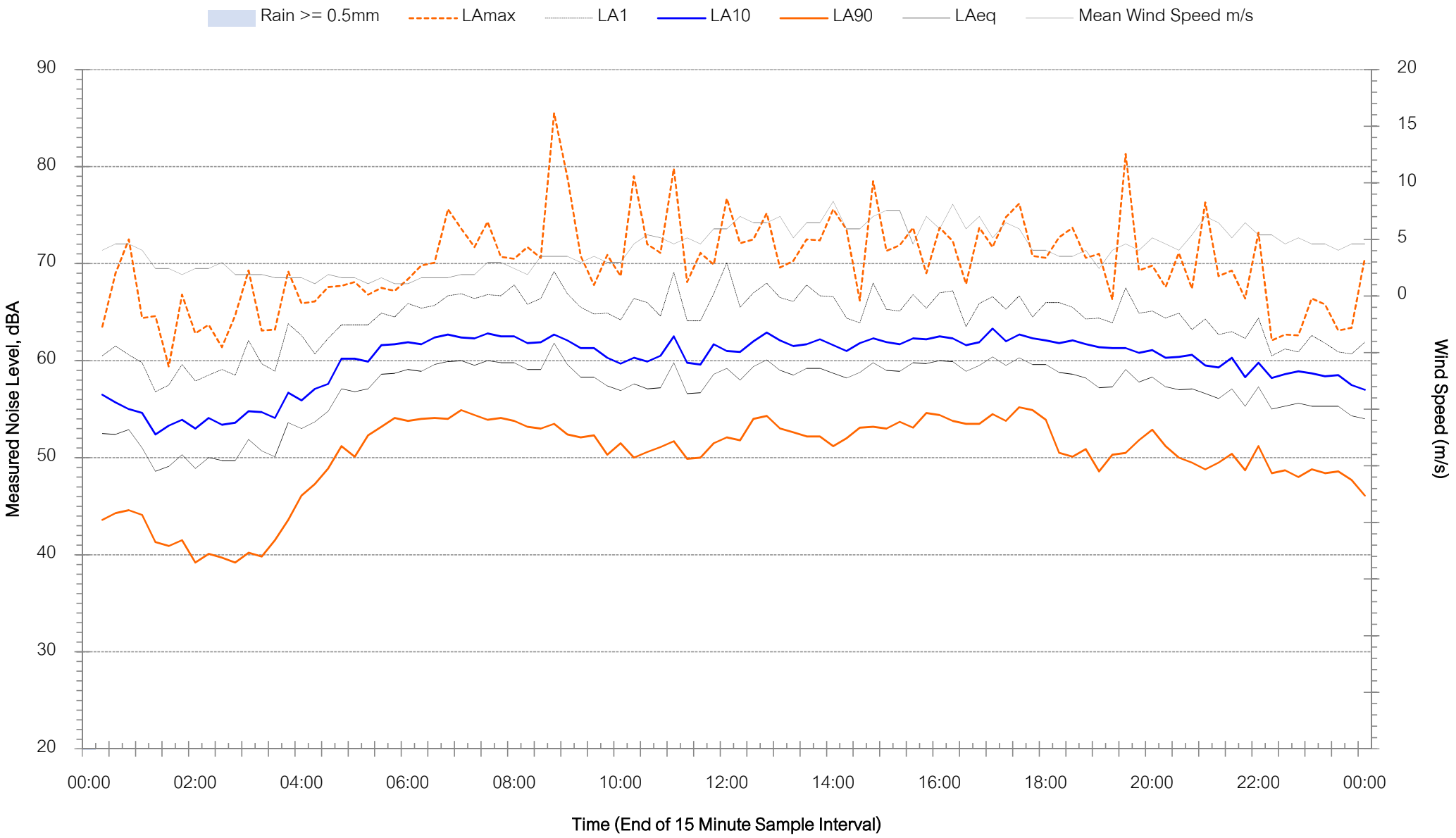
Background Noise Levels

Location N2 - Thursday 11 July 2019



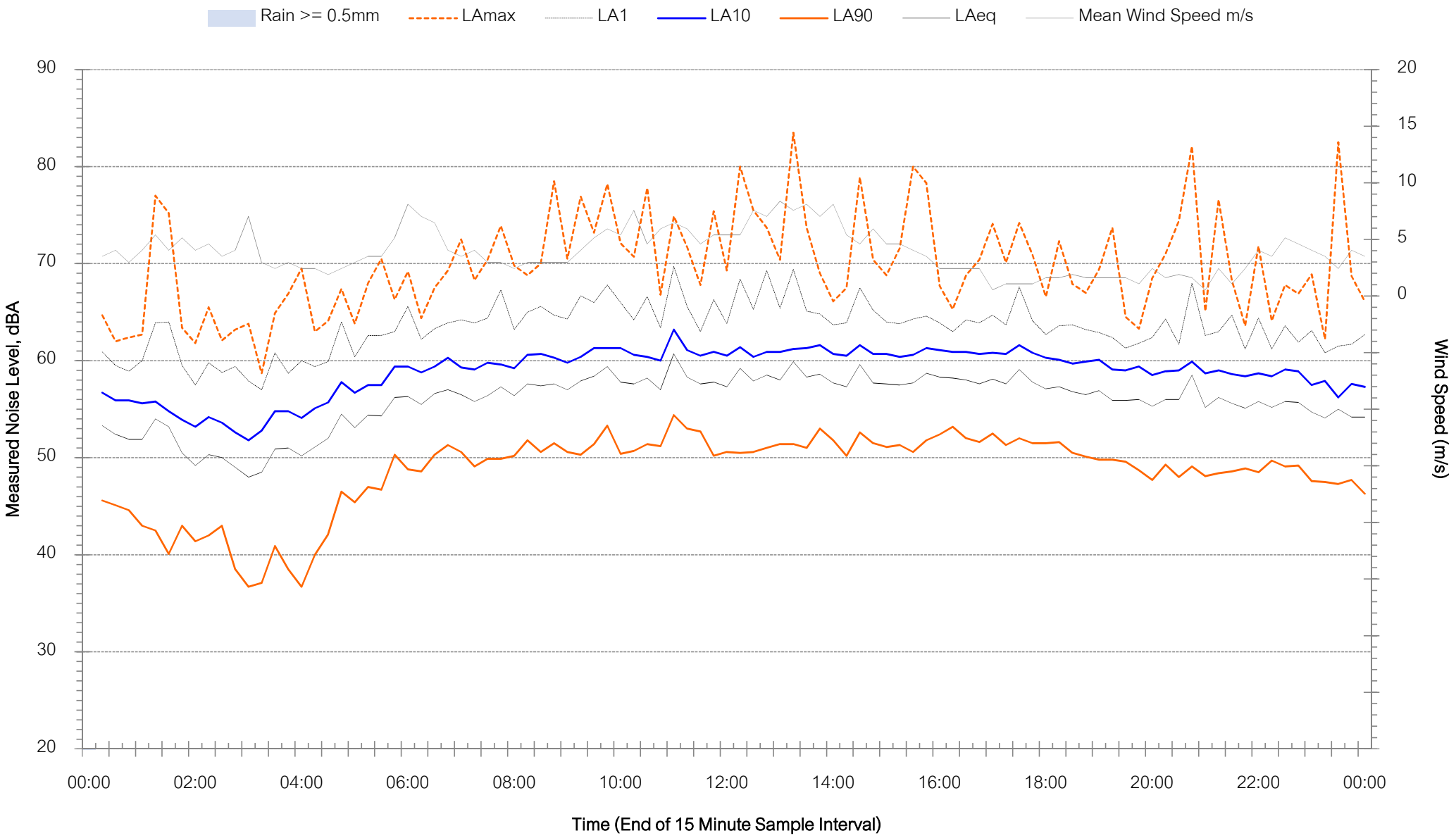
Background Noise Levels

Location N2 - Friday 12 July 2019



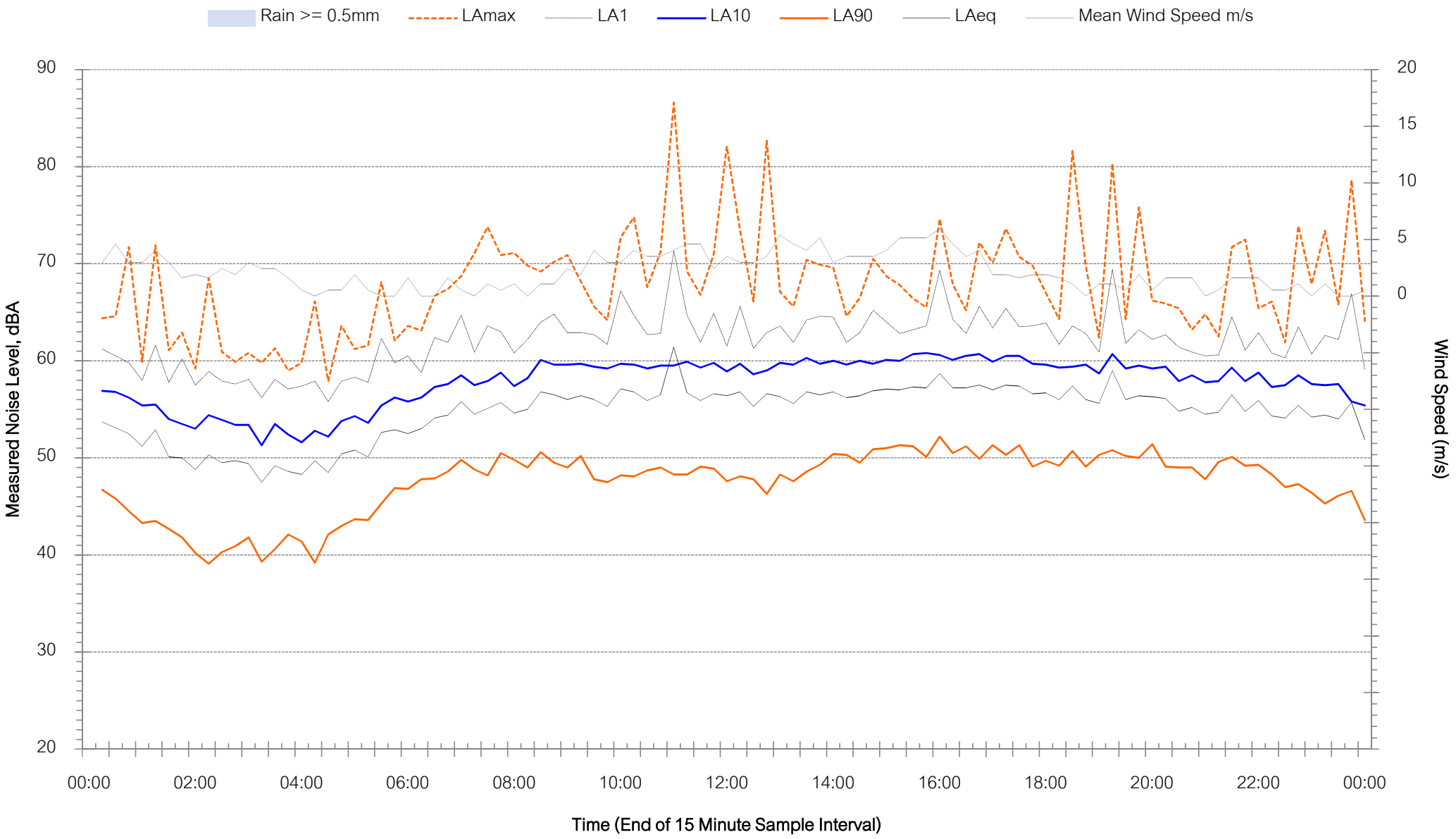
Background Noise Levels

Location N2 - Saturday 13 July 2019



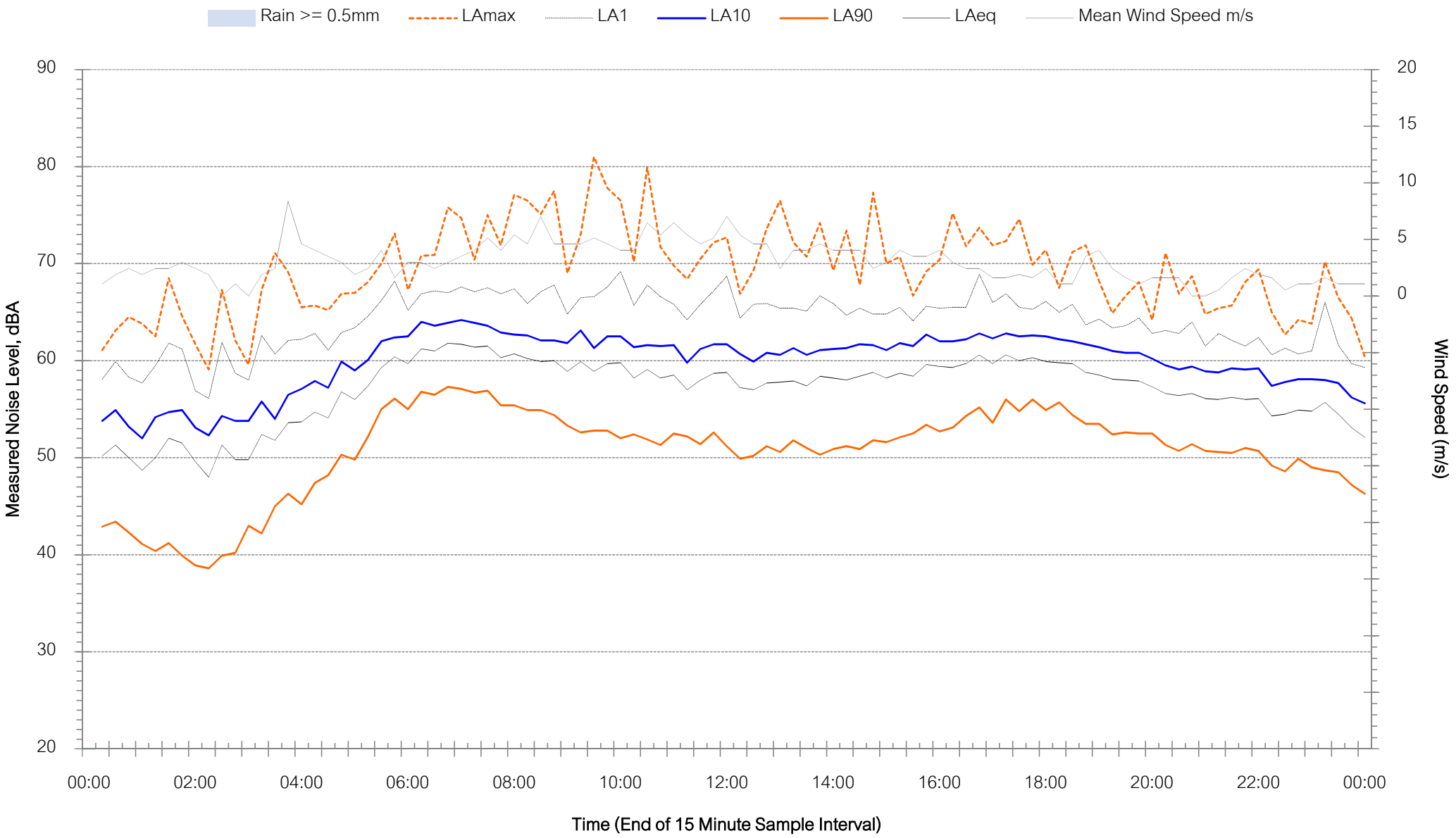
Background Noise Levels

Location N2 - Sunday 14 July 2019



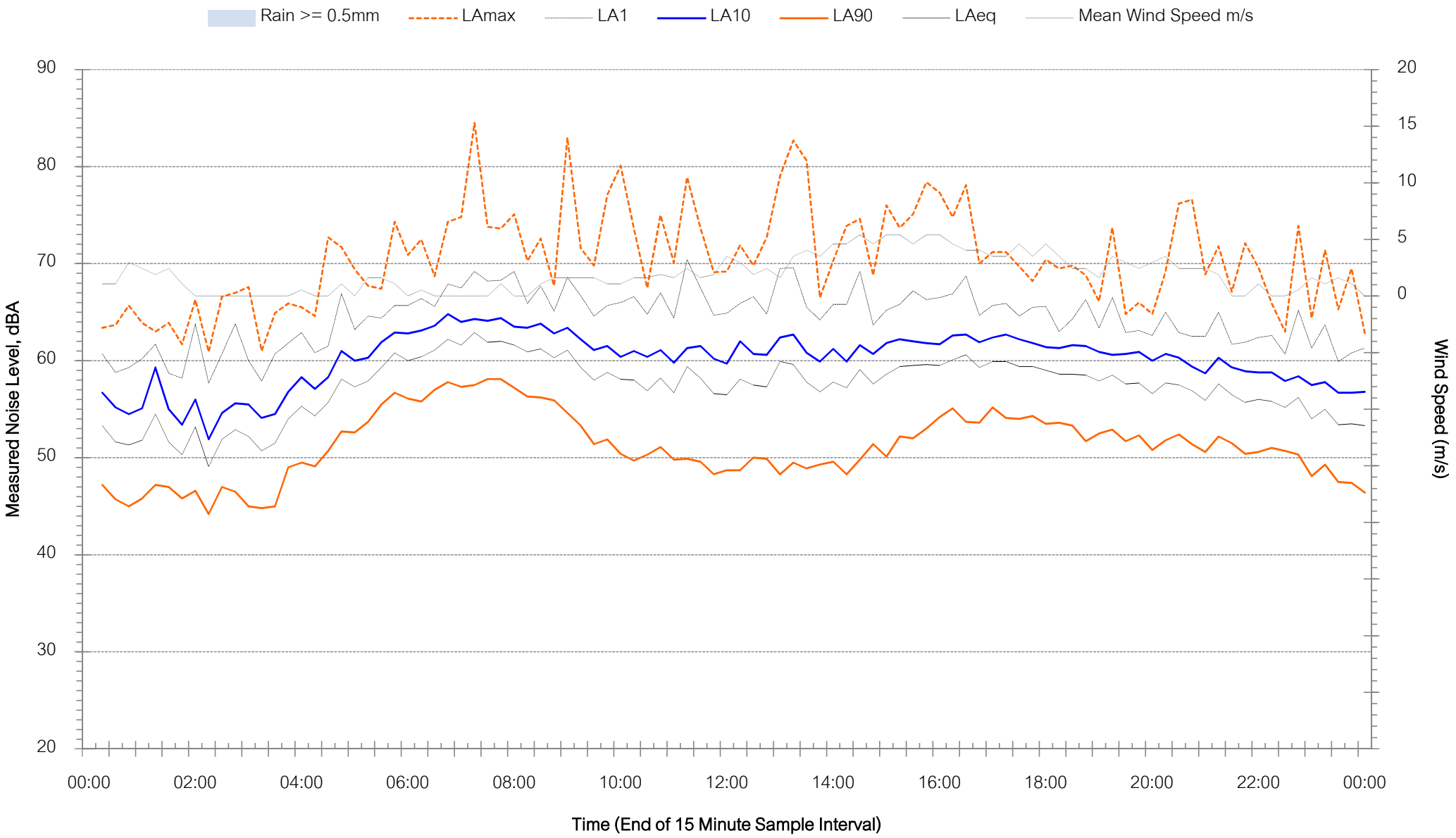
Background Noise Levels

Location N2 - Monday 15 July 2019



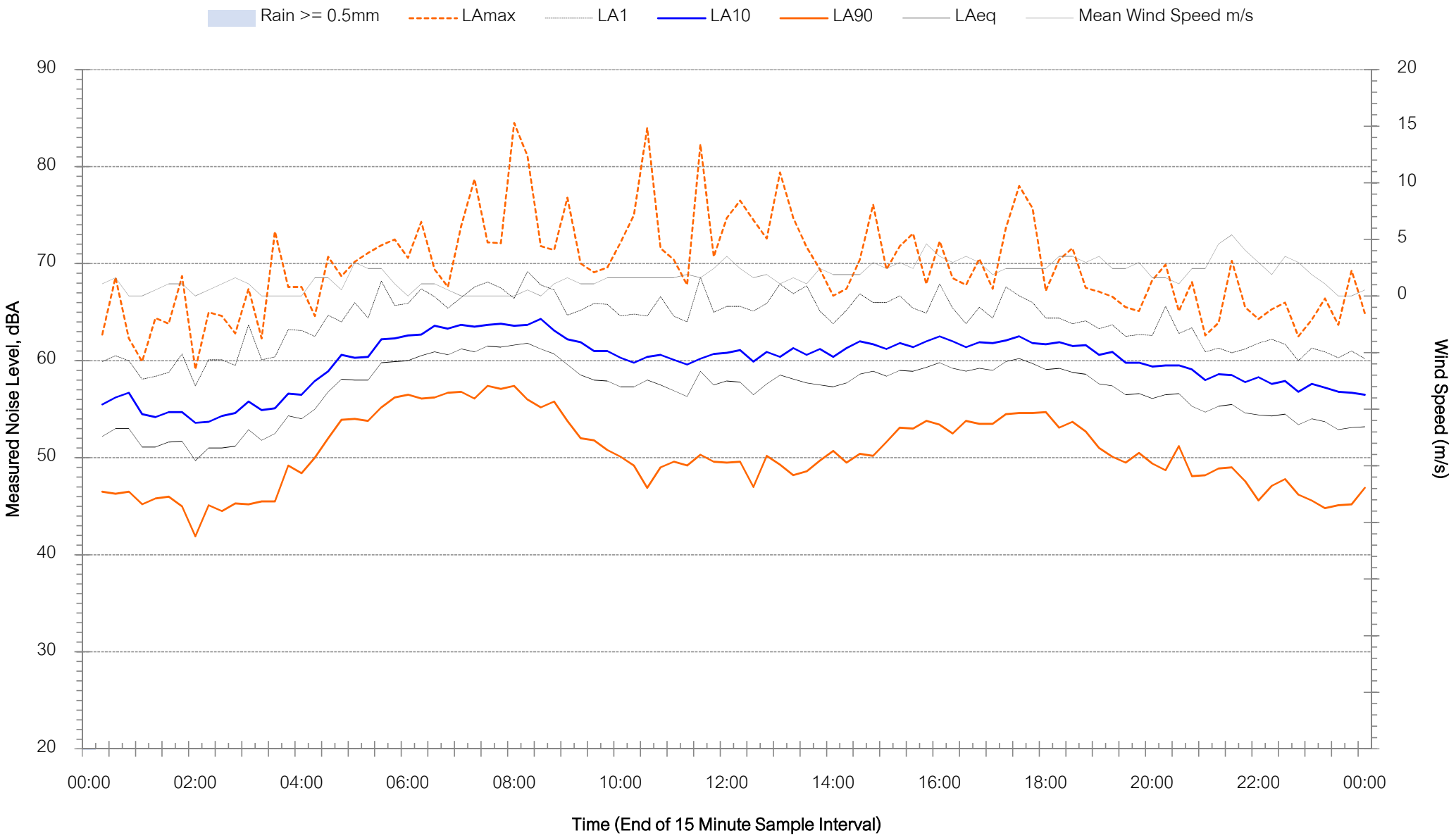
Background Noise Levels

Location N2 - Tuesday 16 July 2019



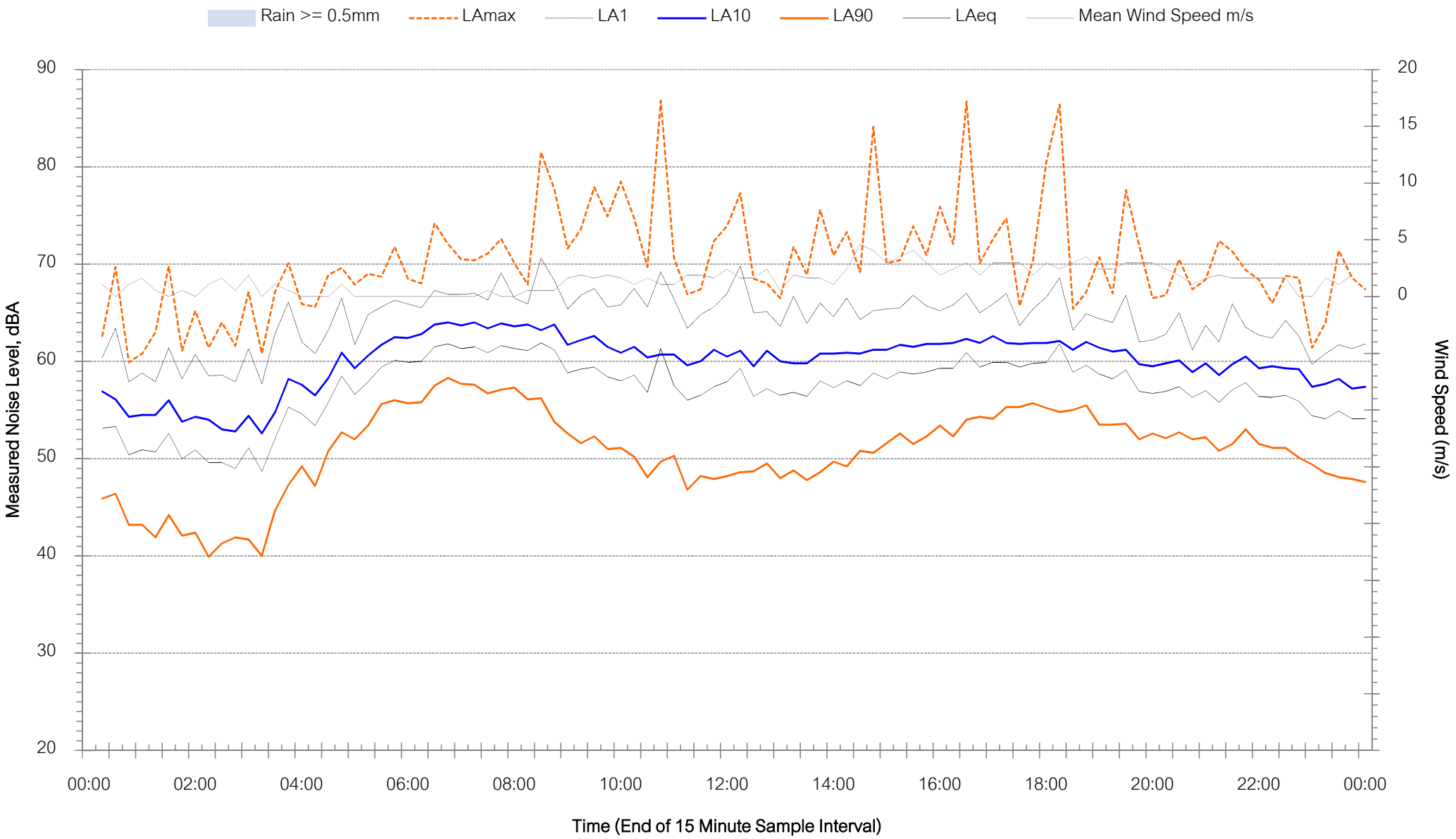
Background Noise Levels

Location N2 - Wednesday 17 July 2019



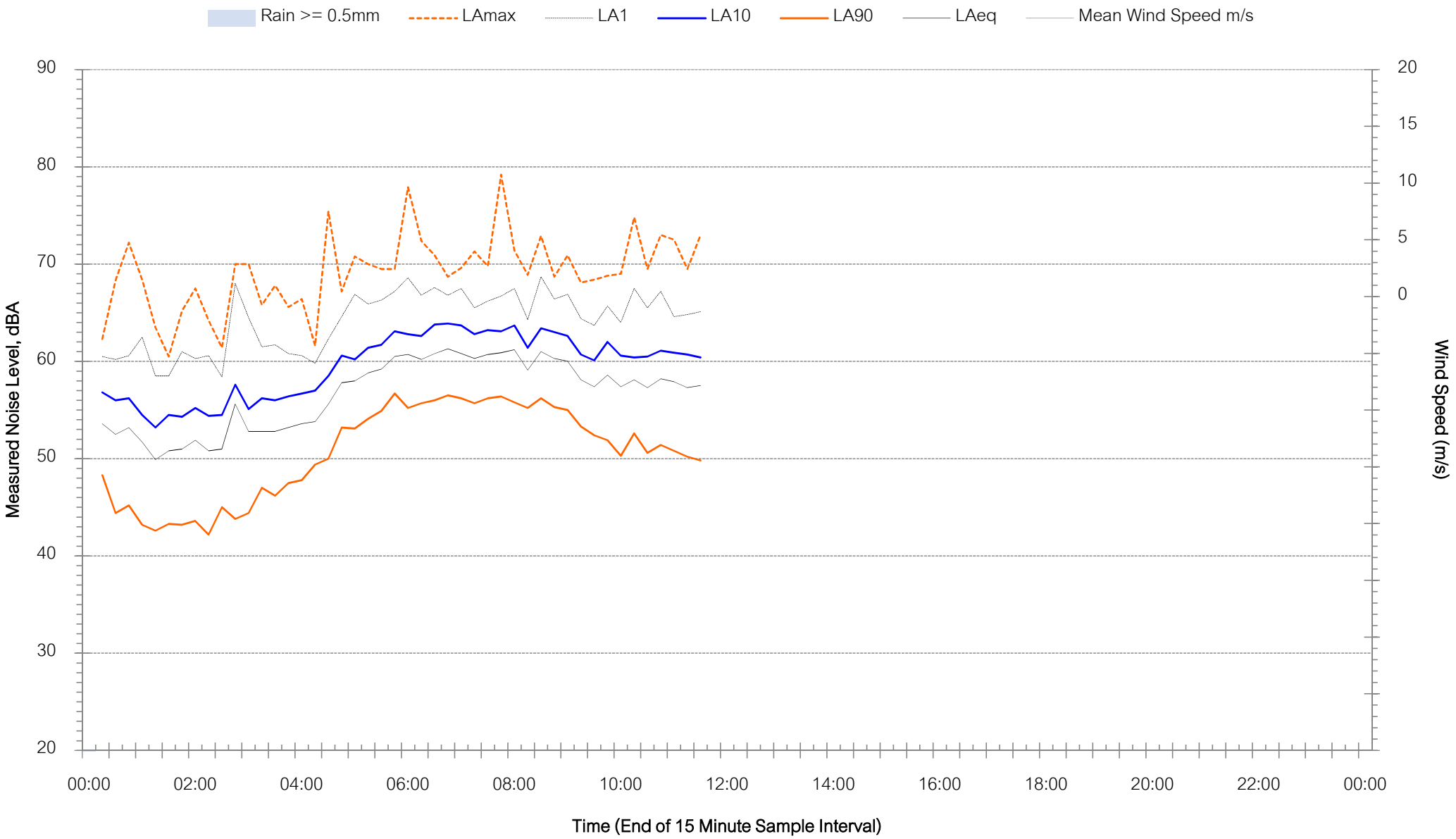
Background Noise Levels

Location N2 - Thursday 18 July 2019



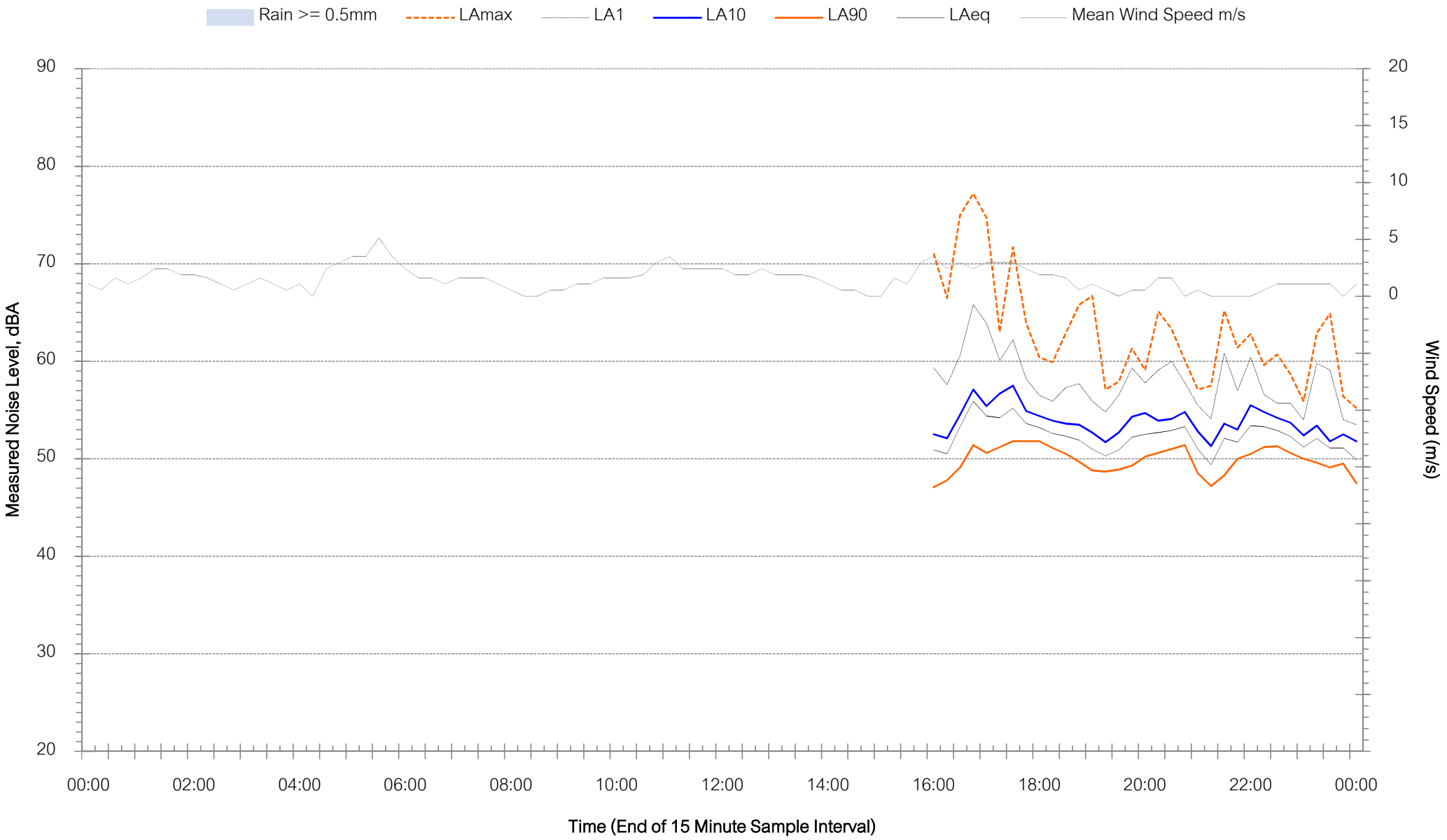
Background Noise Levels

Location N2 - Friday 19 July 2019



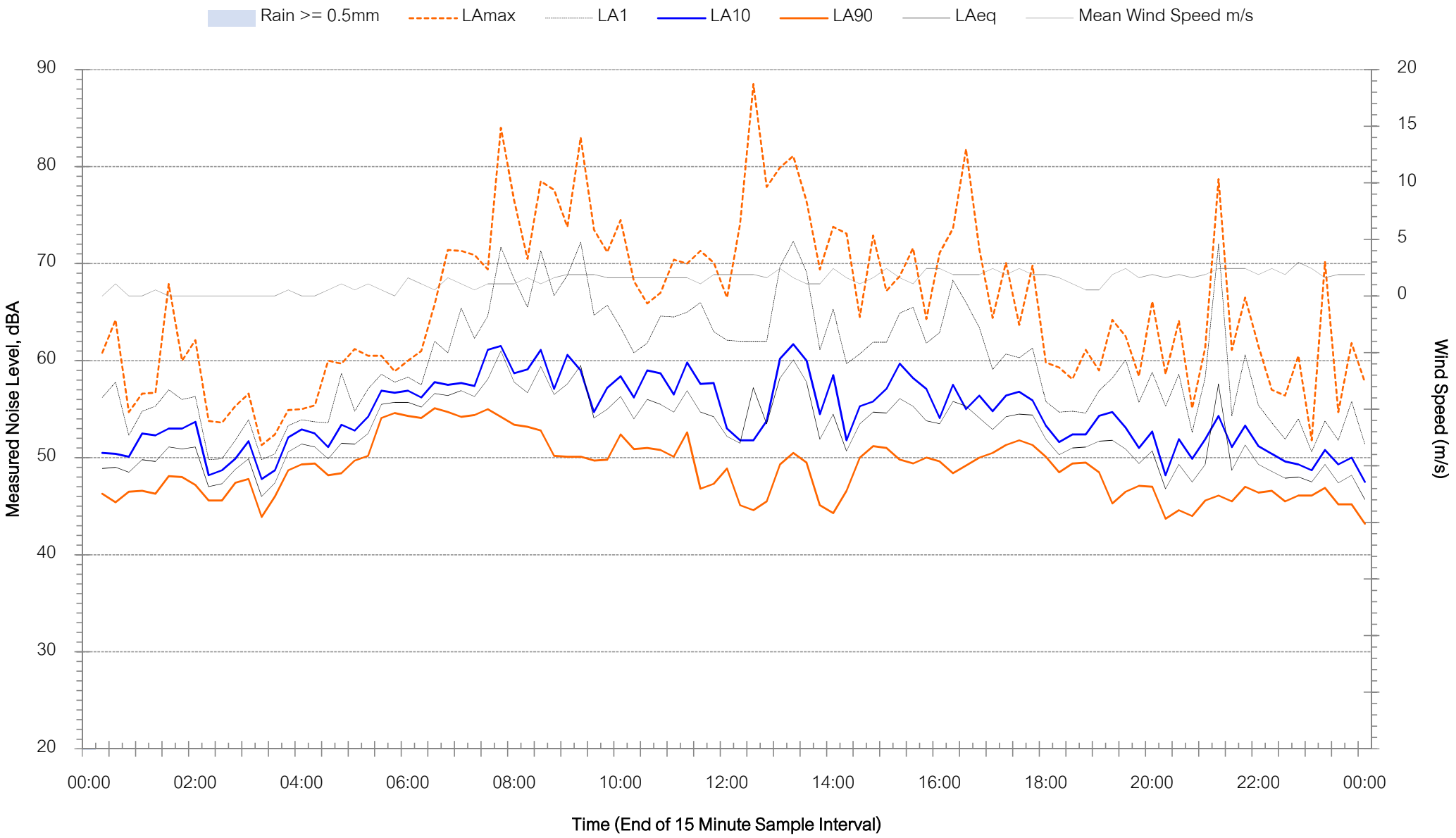
Background Noise Levels

Location - N3 - Tuesday 9 July 2019



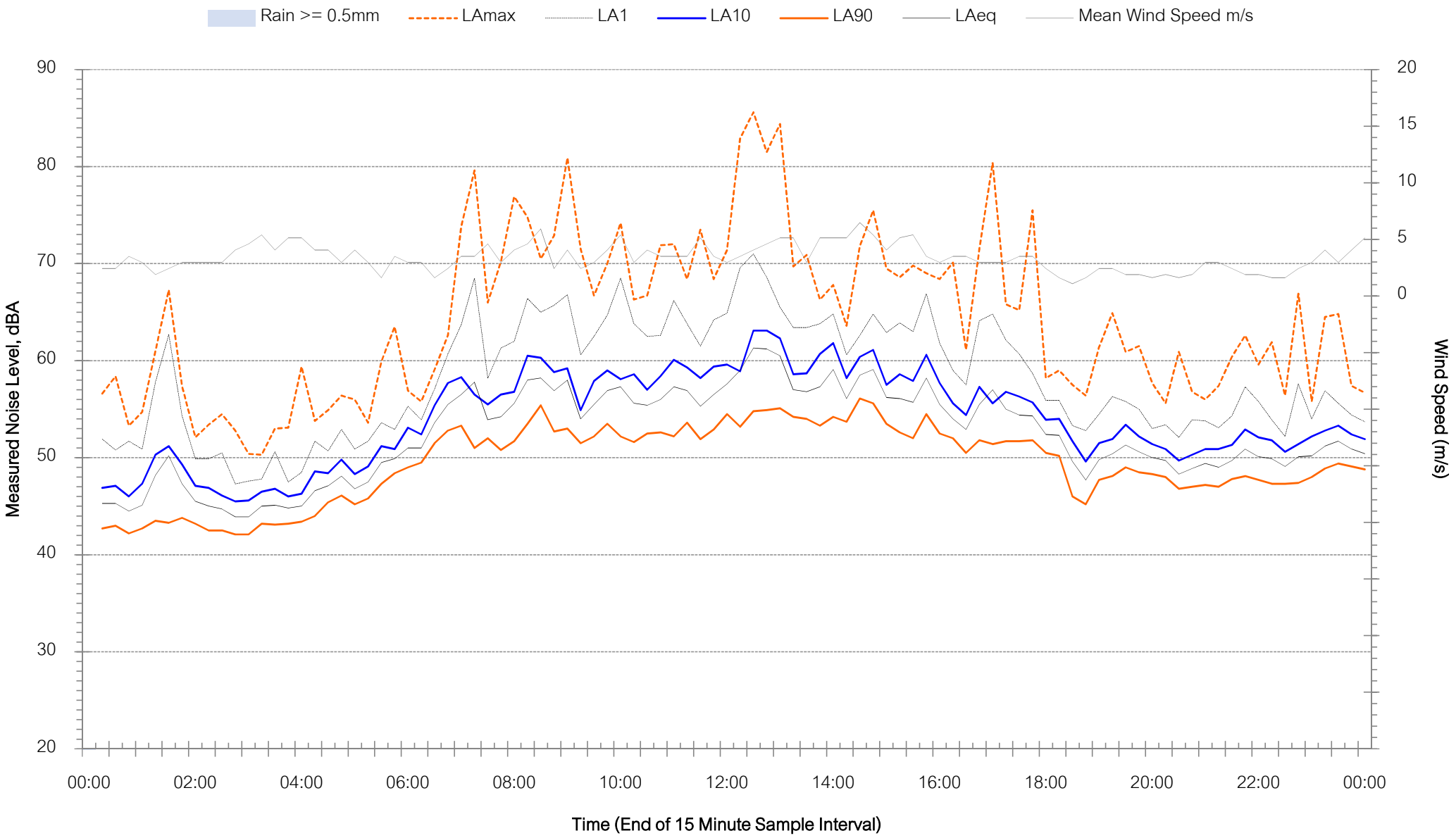
Background Noise Levels

Location - N3 - Wednesday 10 July 2019



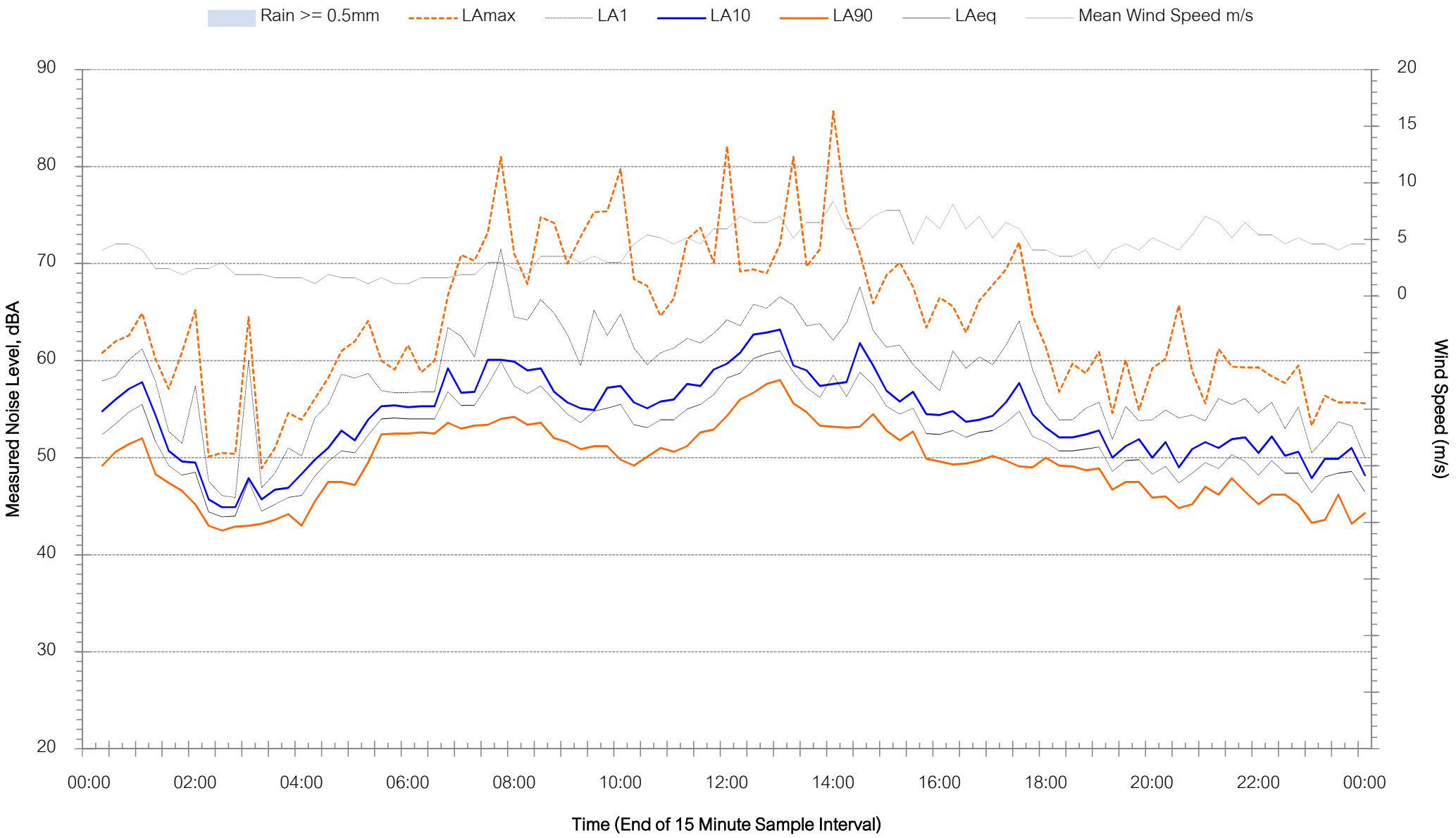
Background Noise Levels

Location - N3 - Thursday 11 July 2019



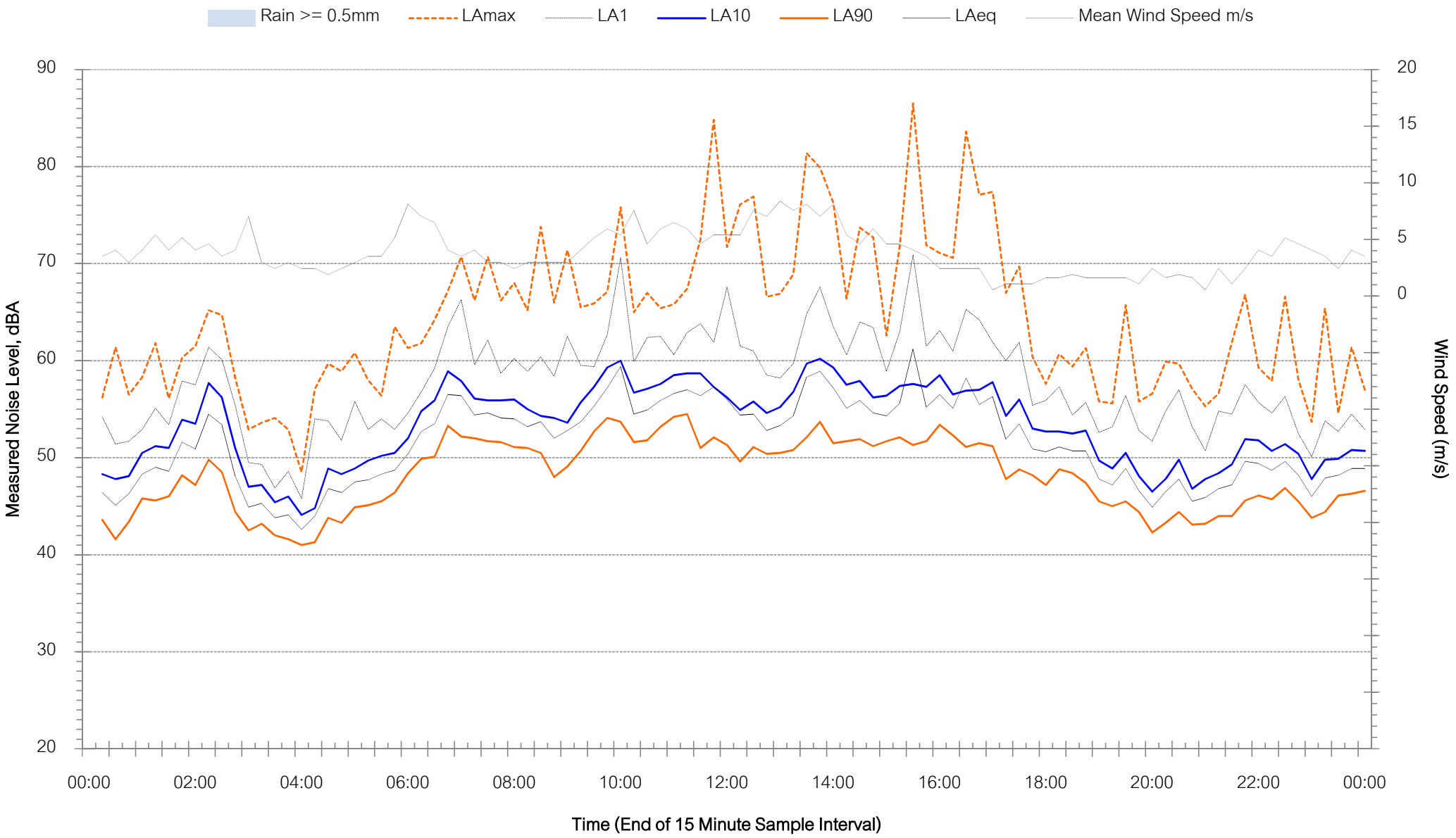
Background Noise Levels

Location - N3 - Friday 12 July 2019



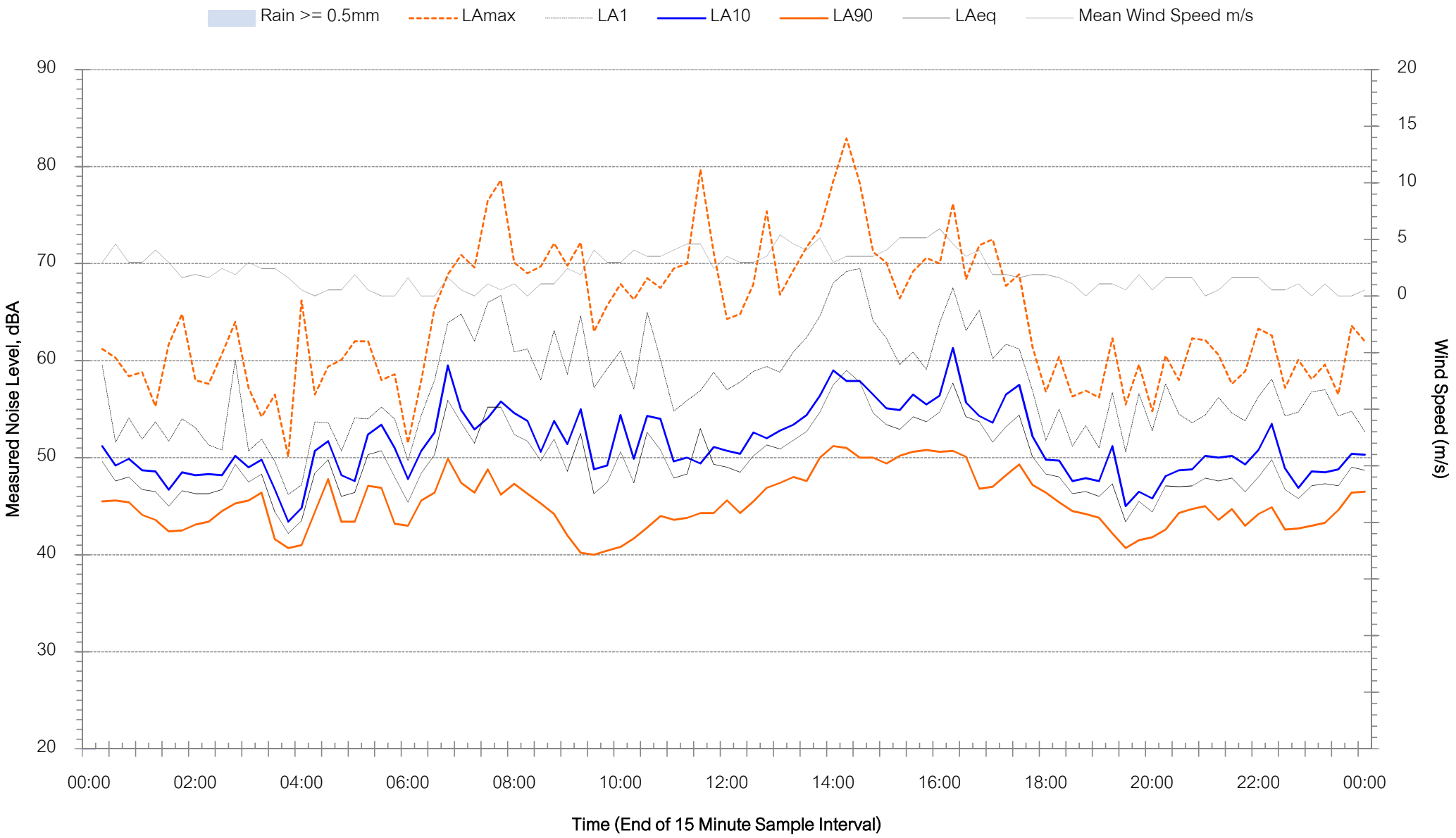
Background Noise Levels

Location - N3 - Saturday 13 July 2019



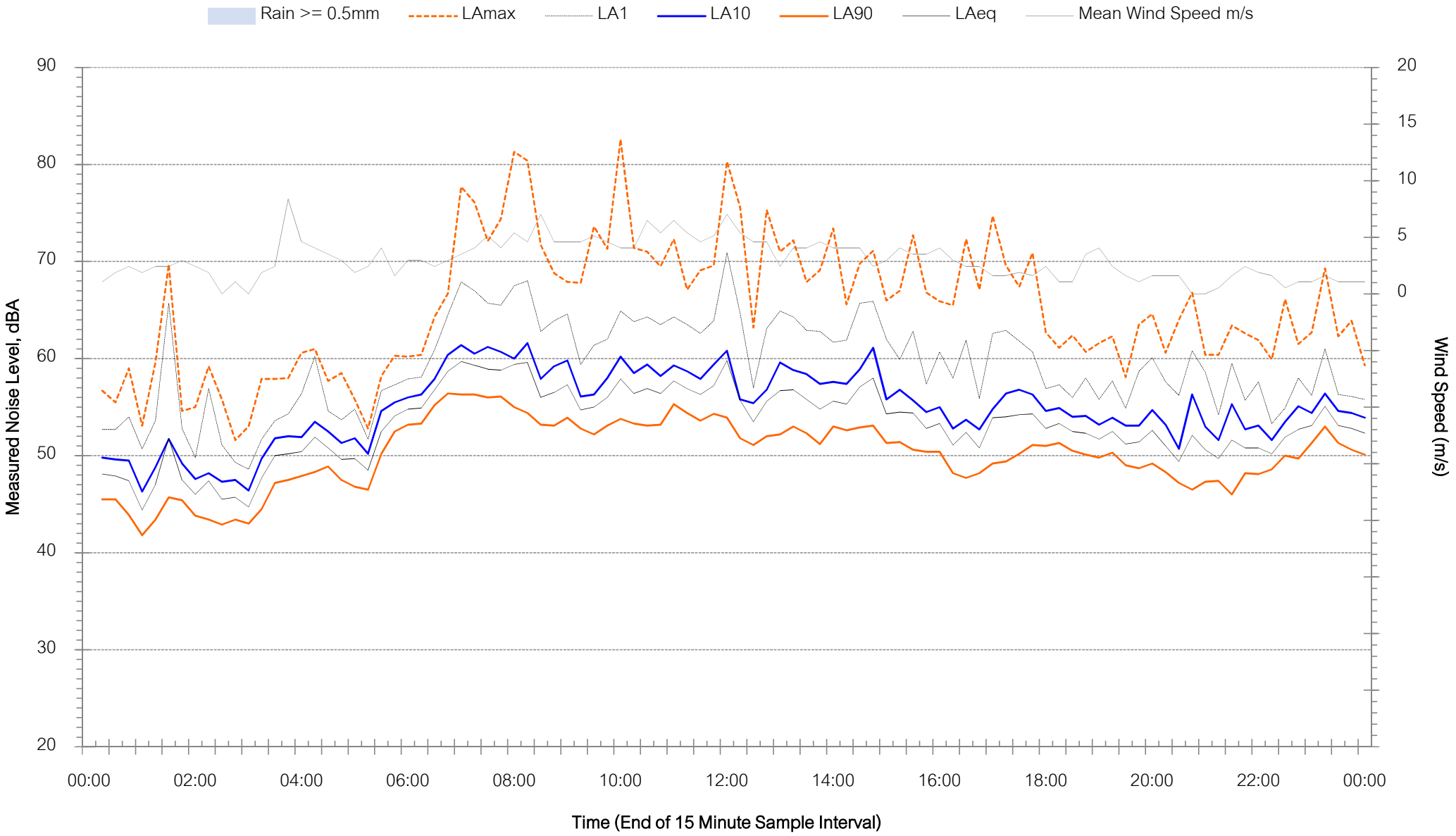
Background Noise Levels

Location - N3 - Sunday 14 July 2019



Background Noise Levels

Location - N3 - Monday 15 July 2019

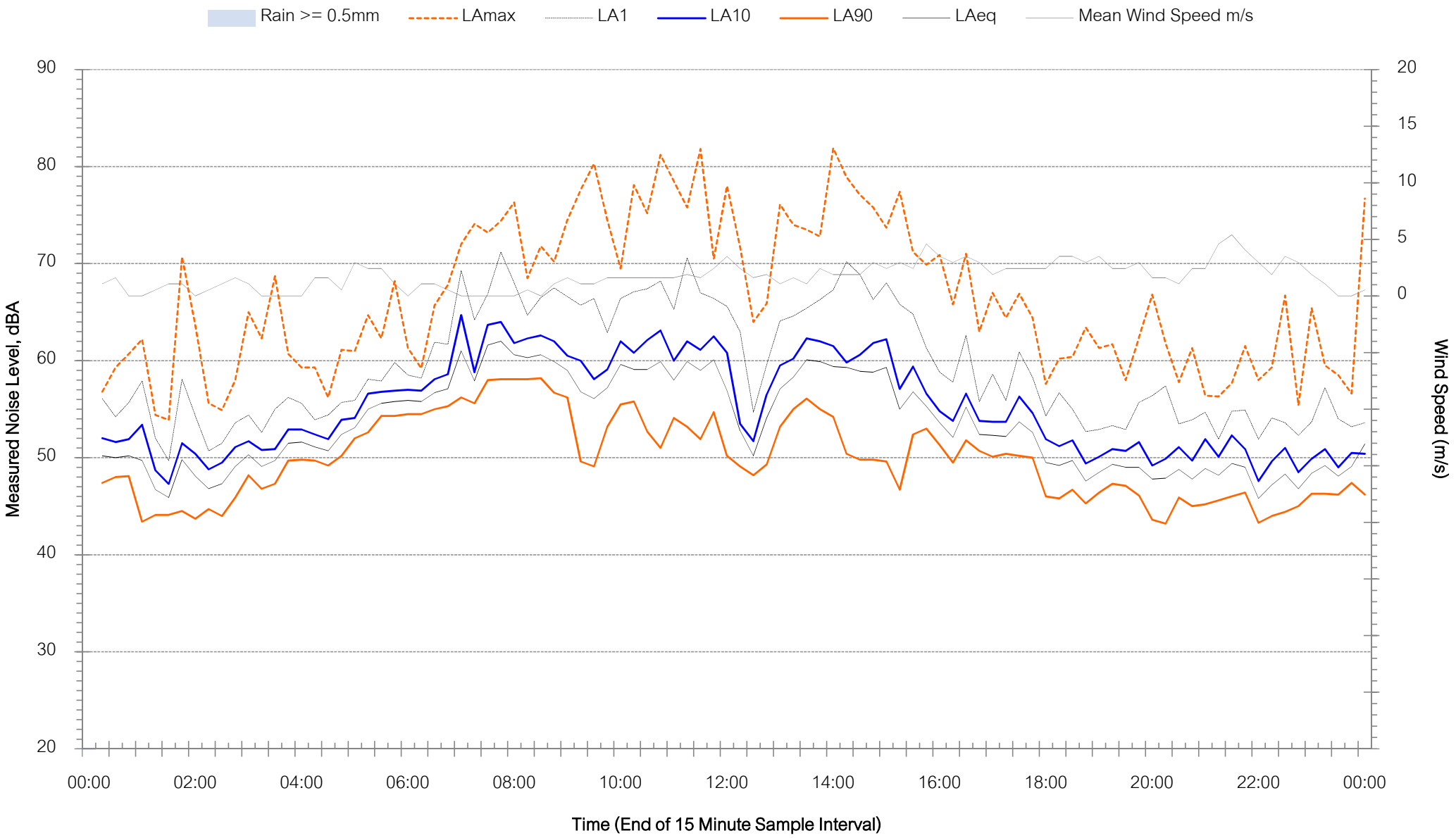


Background Noise Levels

Location - N3 - Tuesday 16 July 2019

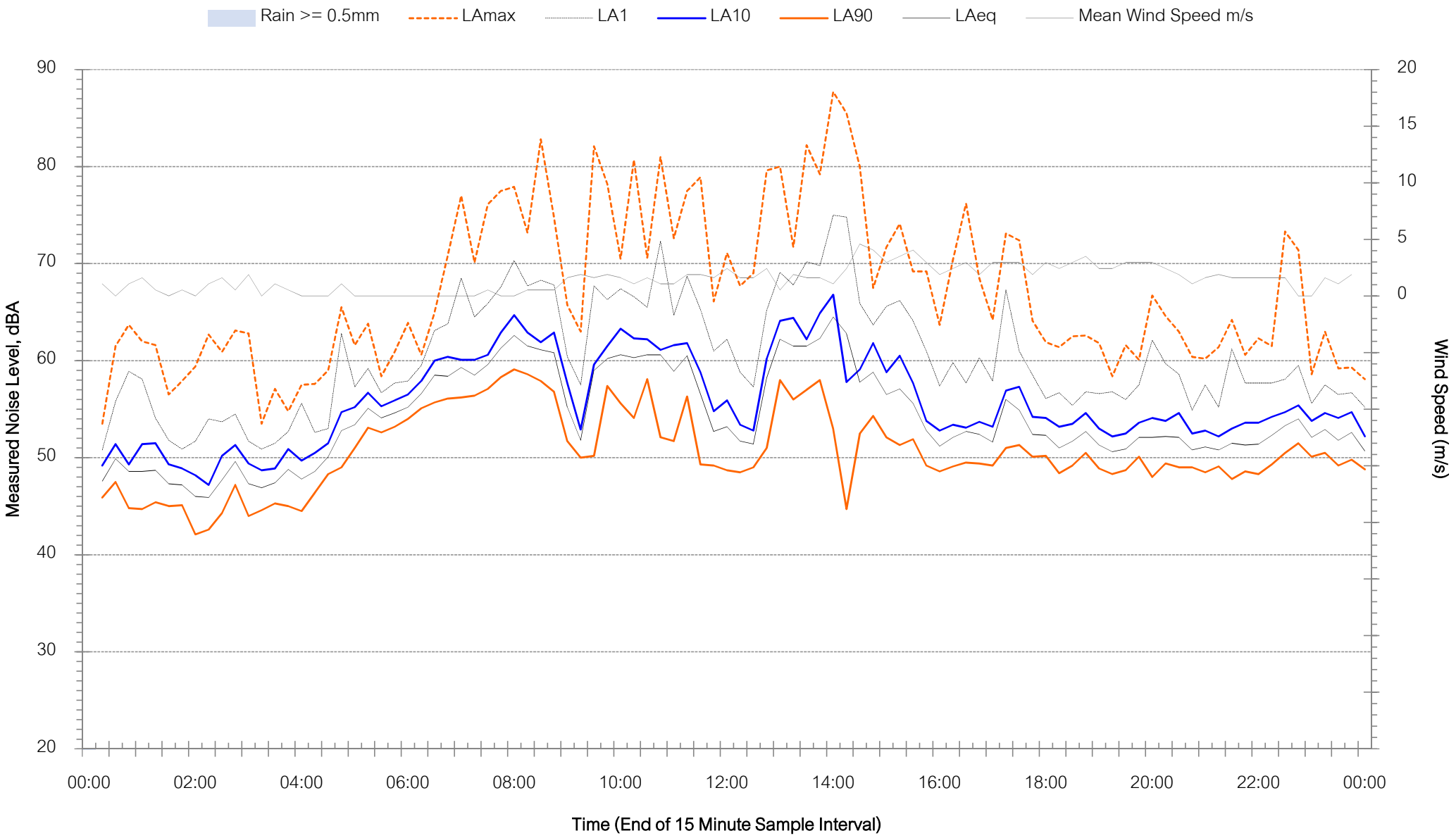
Background Noise Levels

Location - N3 - Wednesday 17 July 2019



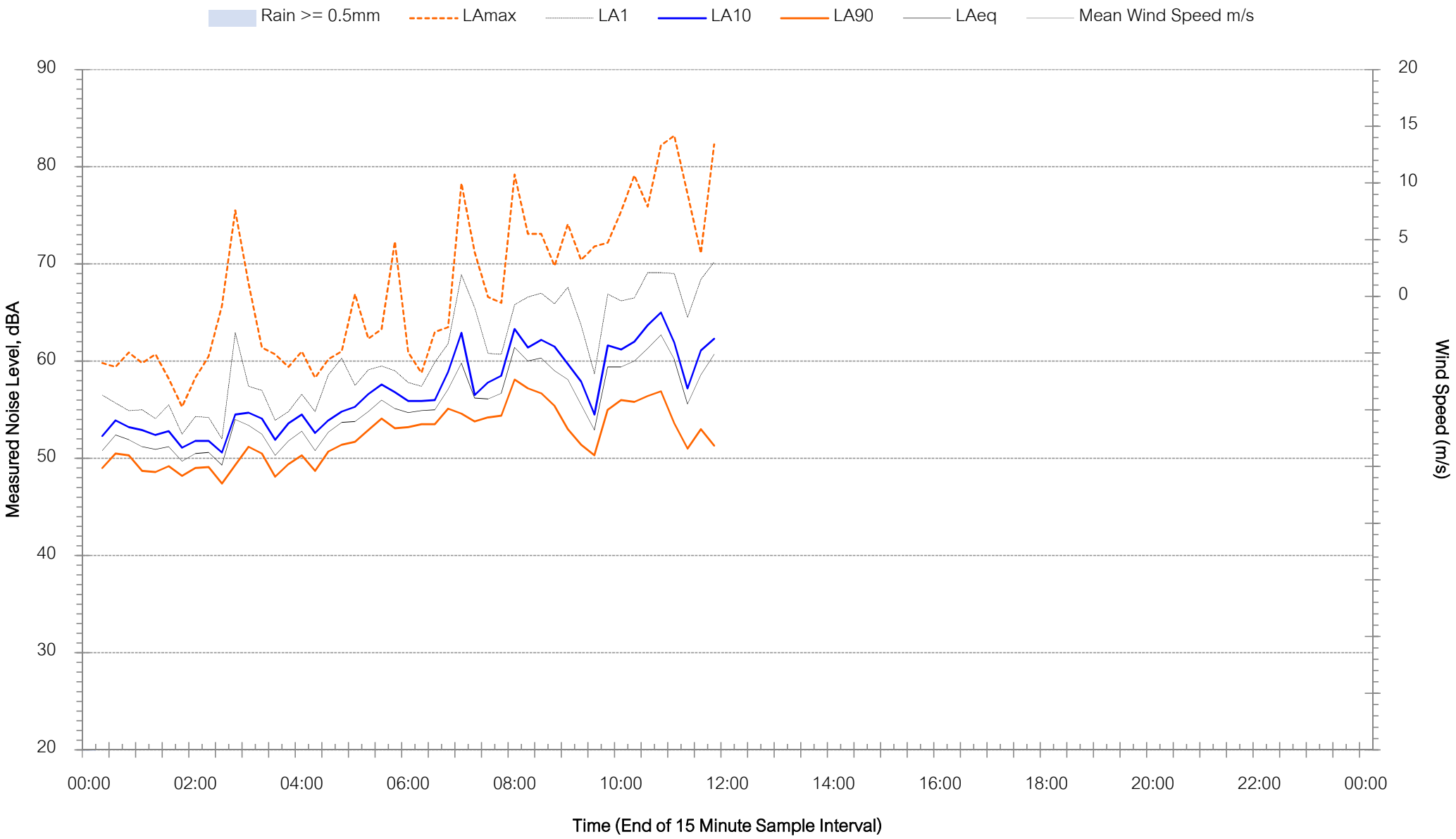
Background Noise Levels

Location - N3 - Thursday 18 July 2019



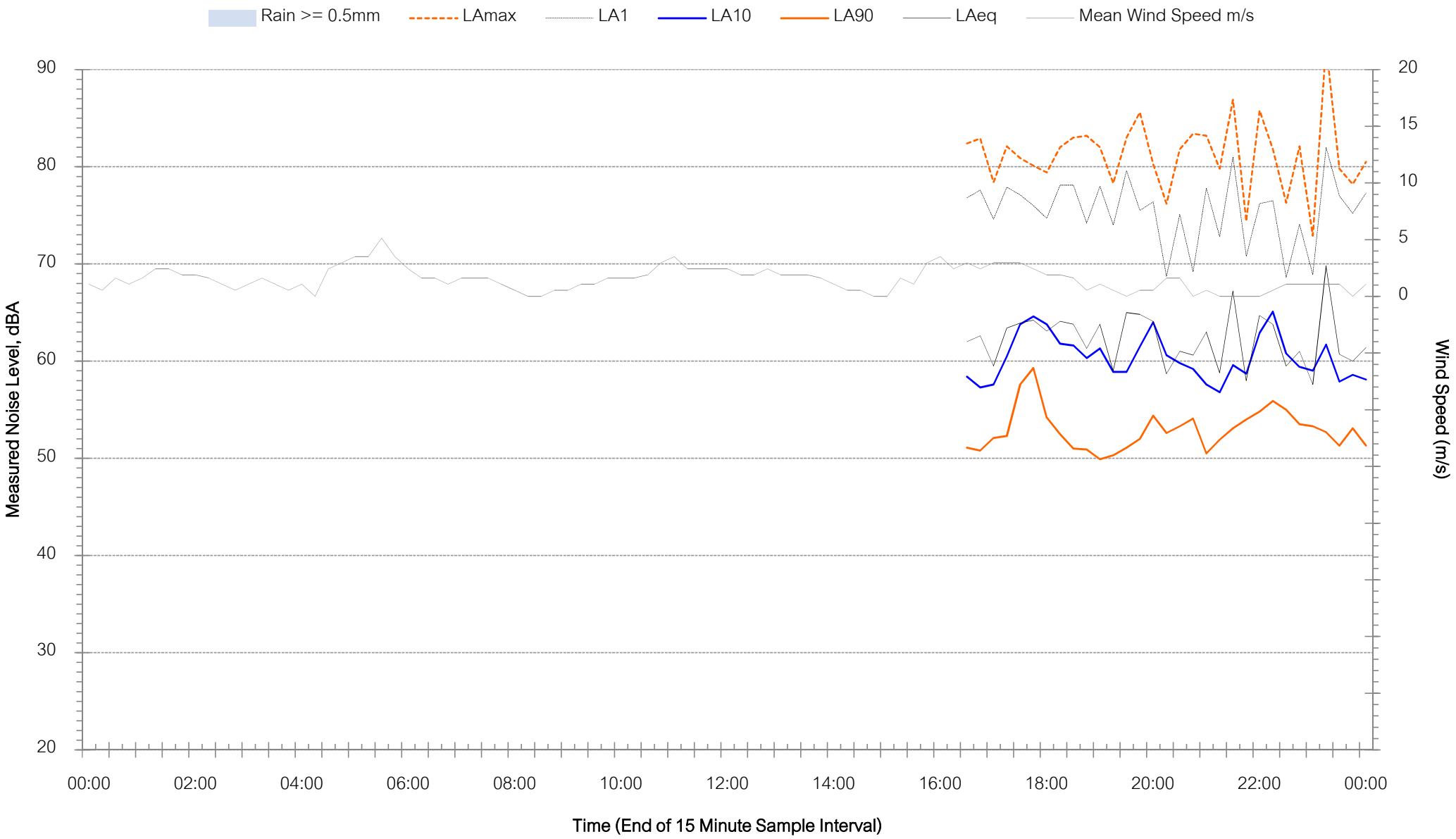
Background Noise Levels

Location - N3 - Friday 19 July 2019



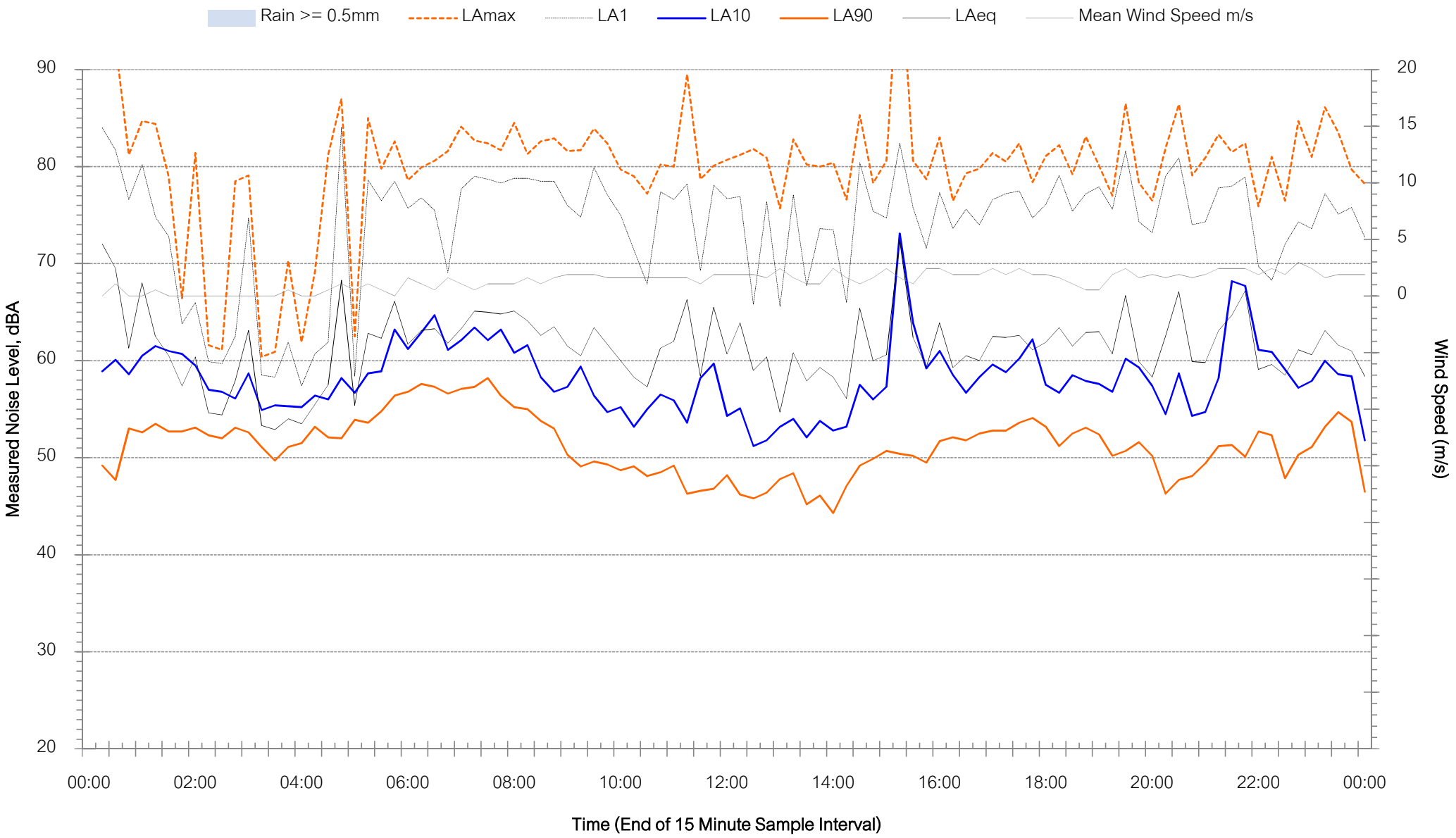
Background Noise Levels

Location N4 - Tuesday 9 July 2019



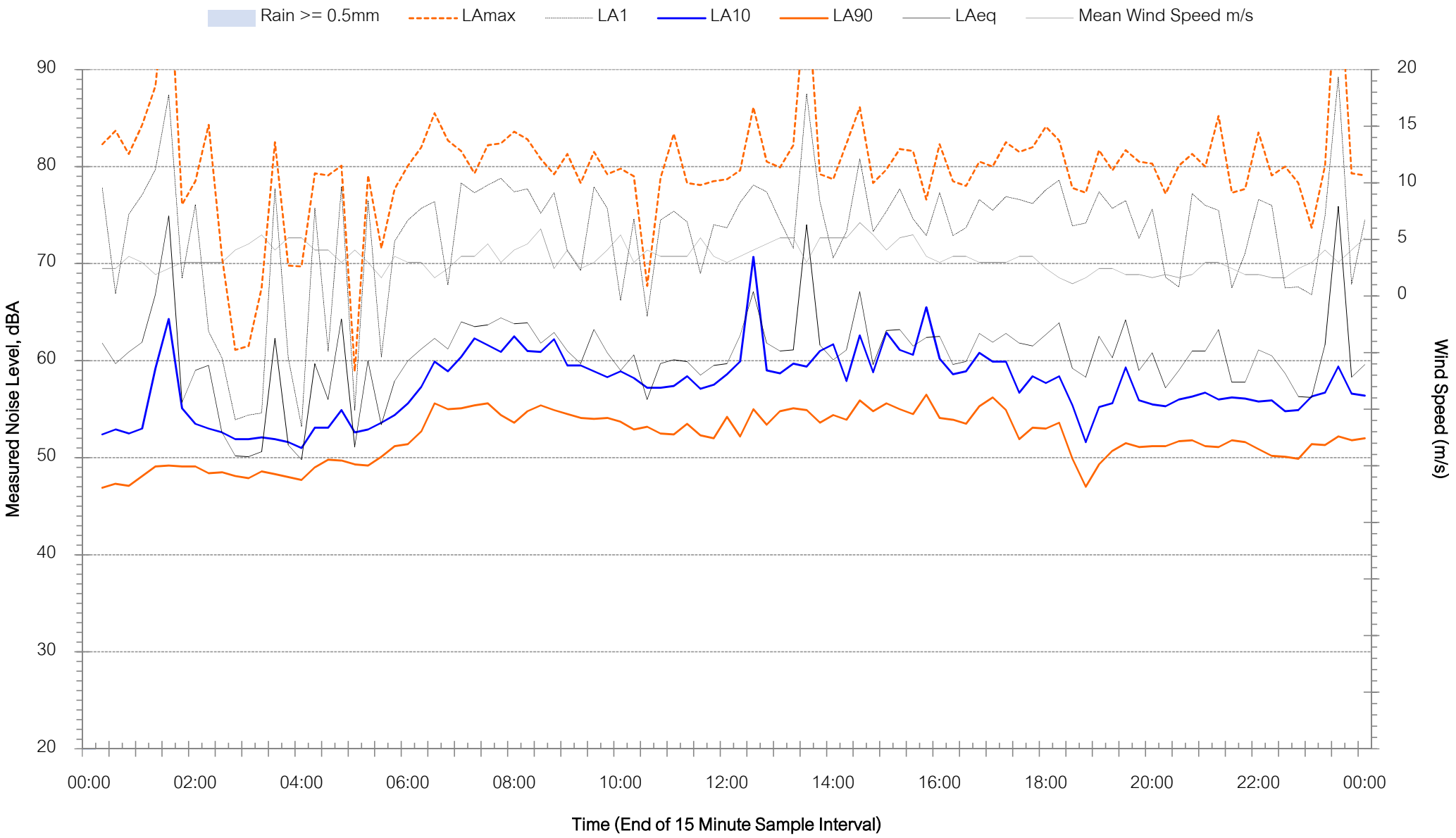
Background Noise Levels

Location N4 - Wednesday 10 July 2019



Background Noise Levels

Location N4 - Thursday 11 July 2019

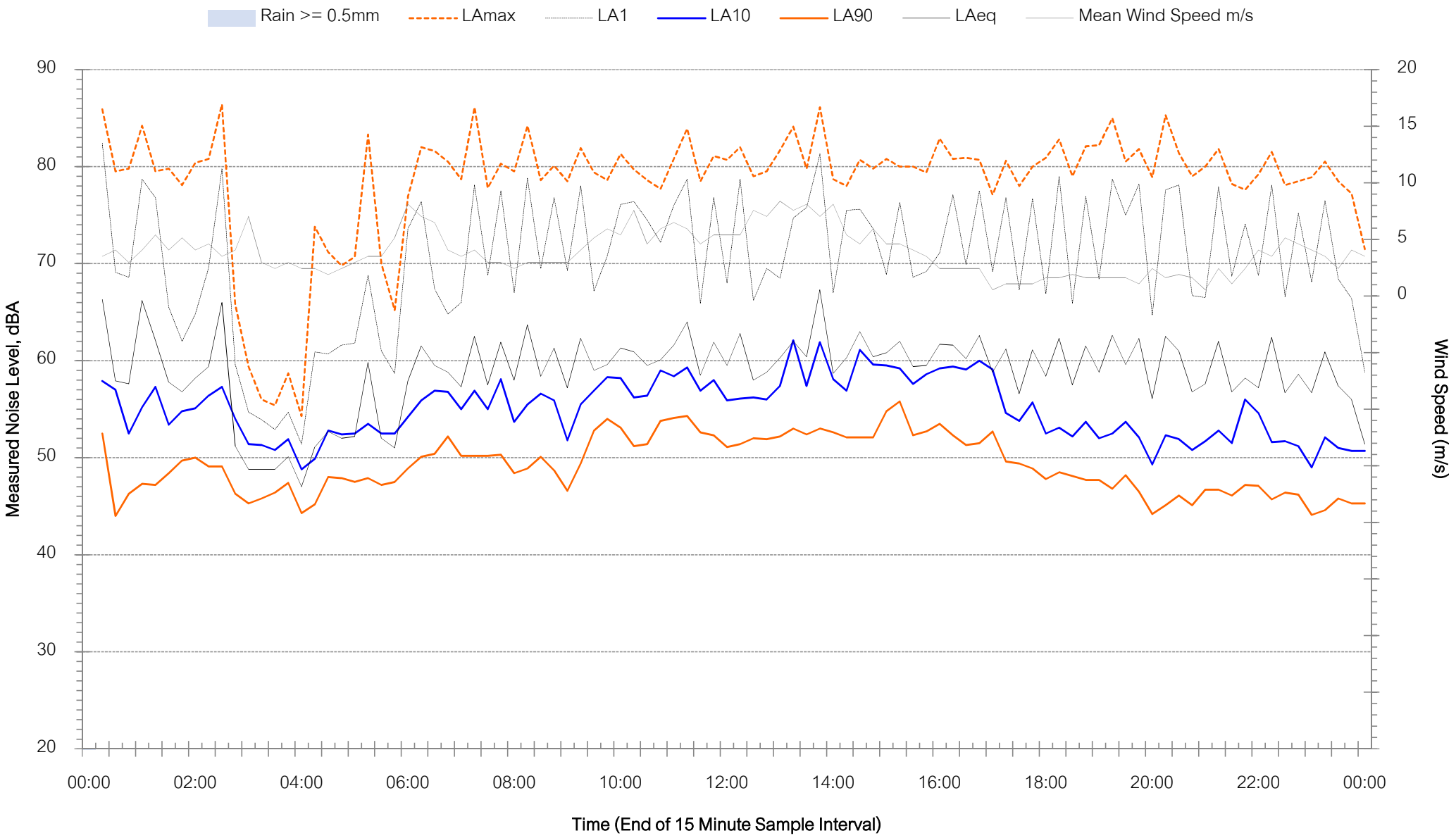


Background Noise Levels

Location N4 - Friday 12 July 2019

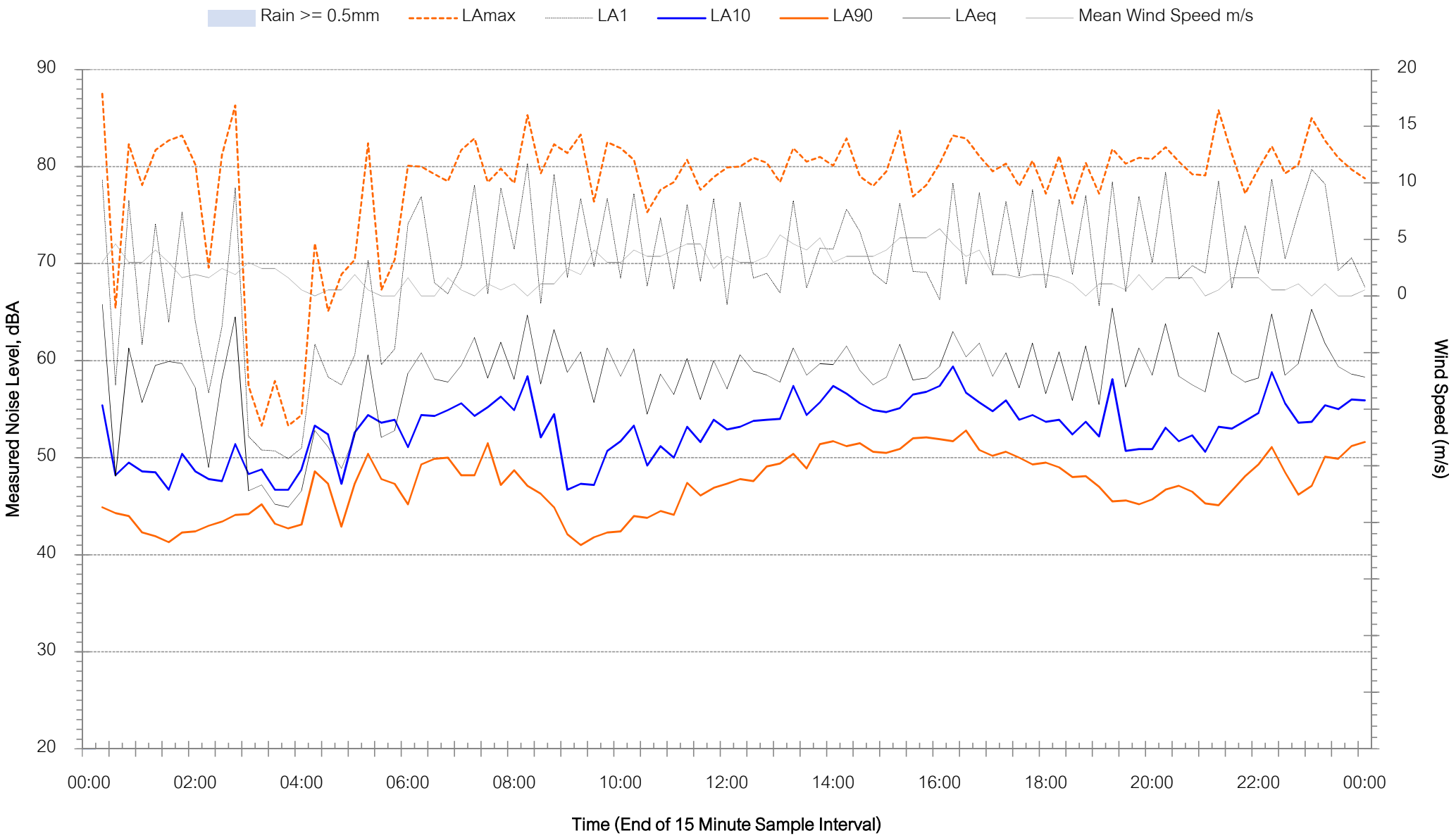
Background Noise Levels

Location N4 - Saturday 13 July 2019



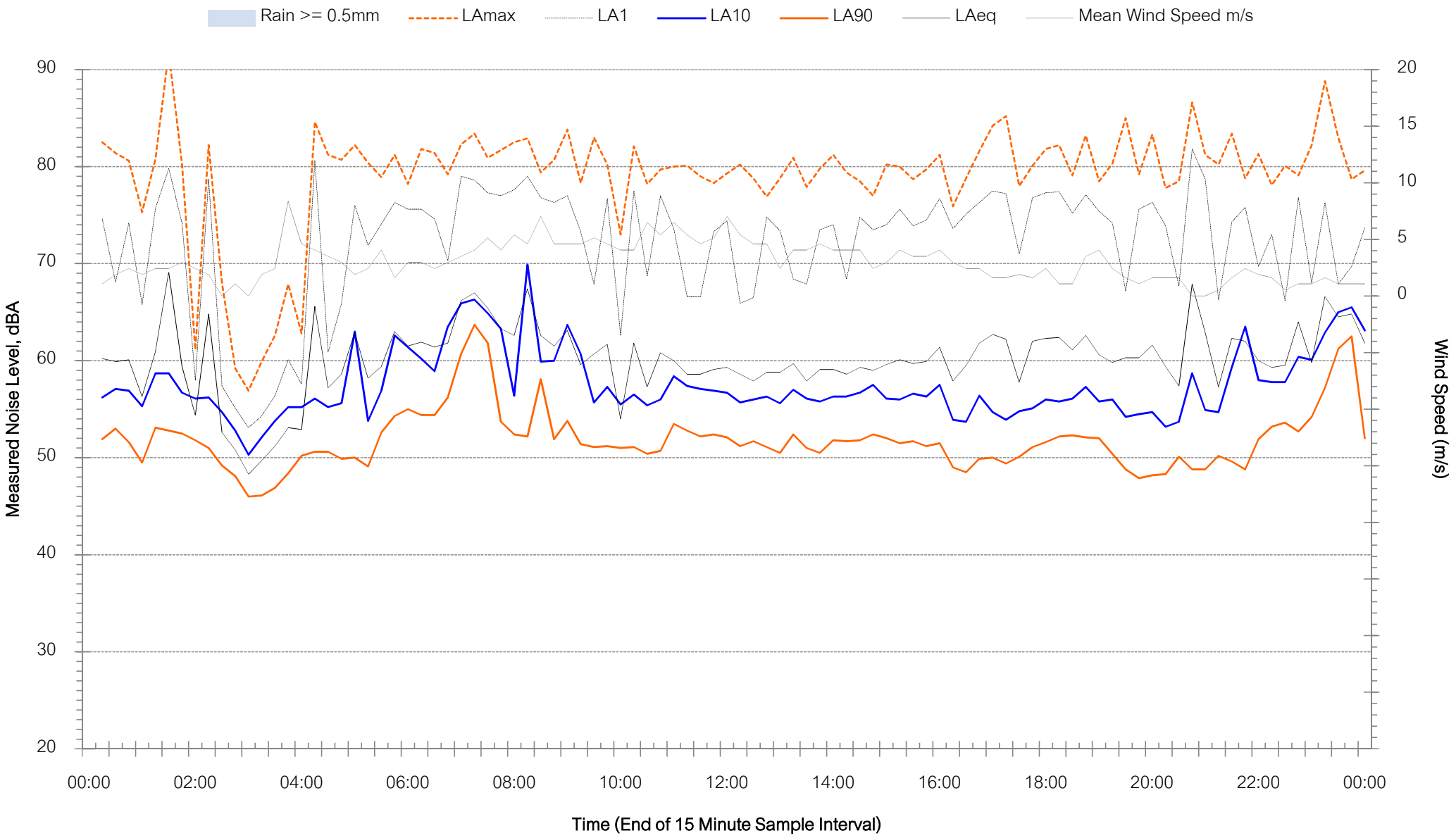
Background Noise Levels

Location N4 - Sunday 14 July 2019



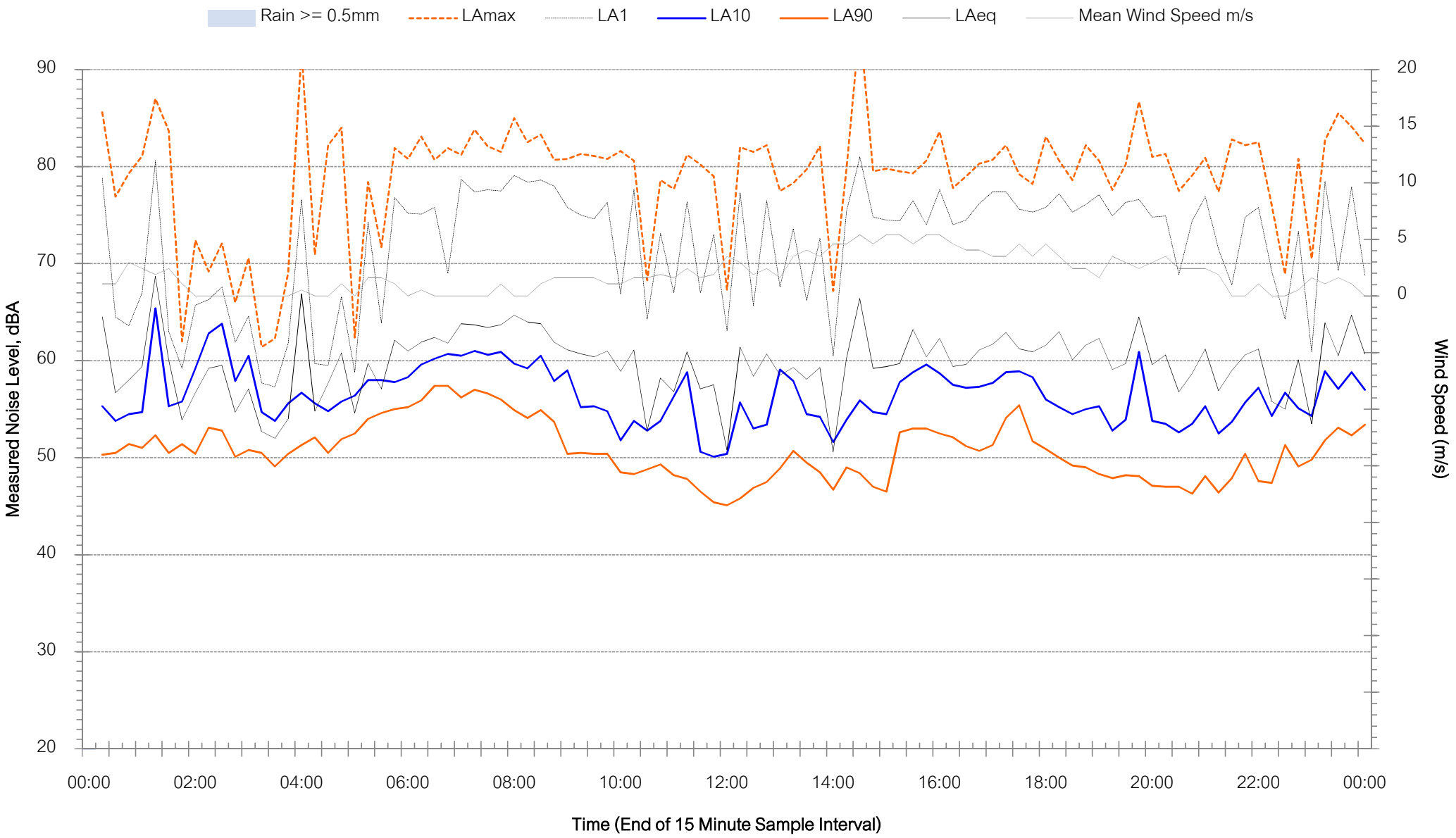
Background Noise Levels

Location N4 - Monday 15 July 2019



Background Noise Levels

Location N4 - Tuesday 16 July 2019



Background Noise Levels

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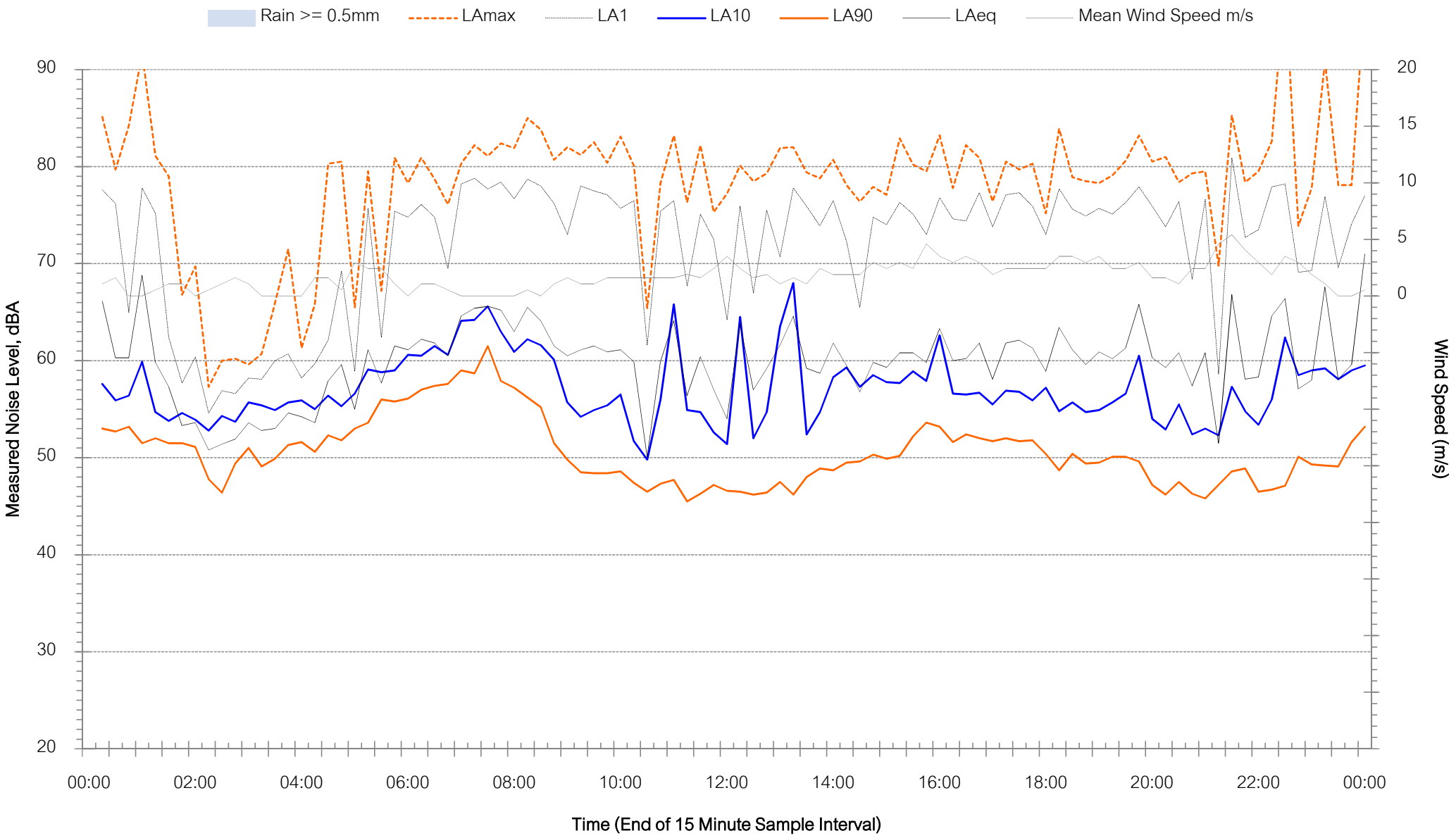
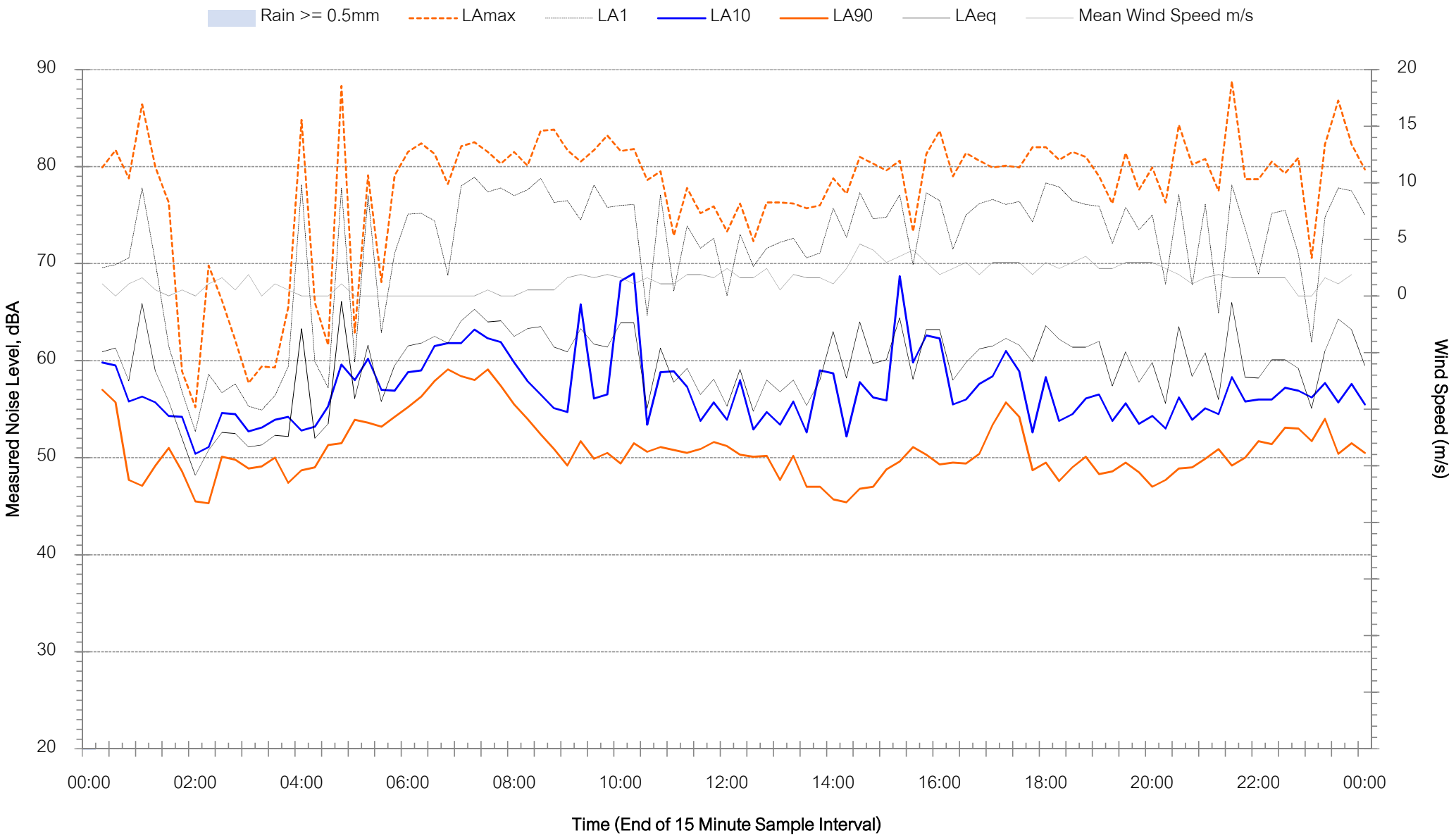


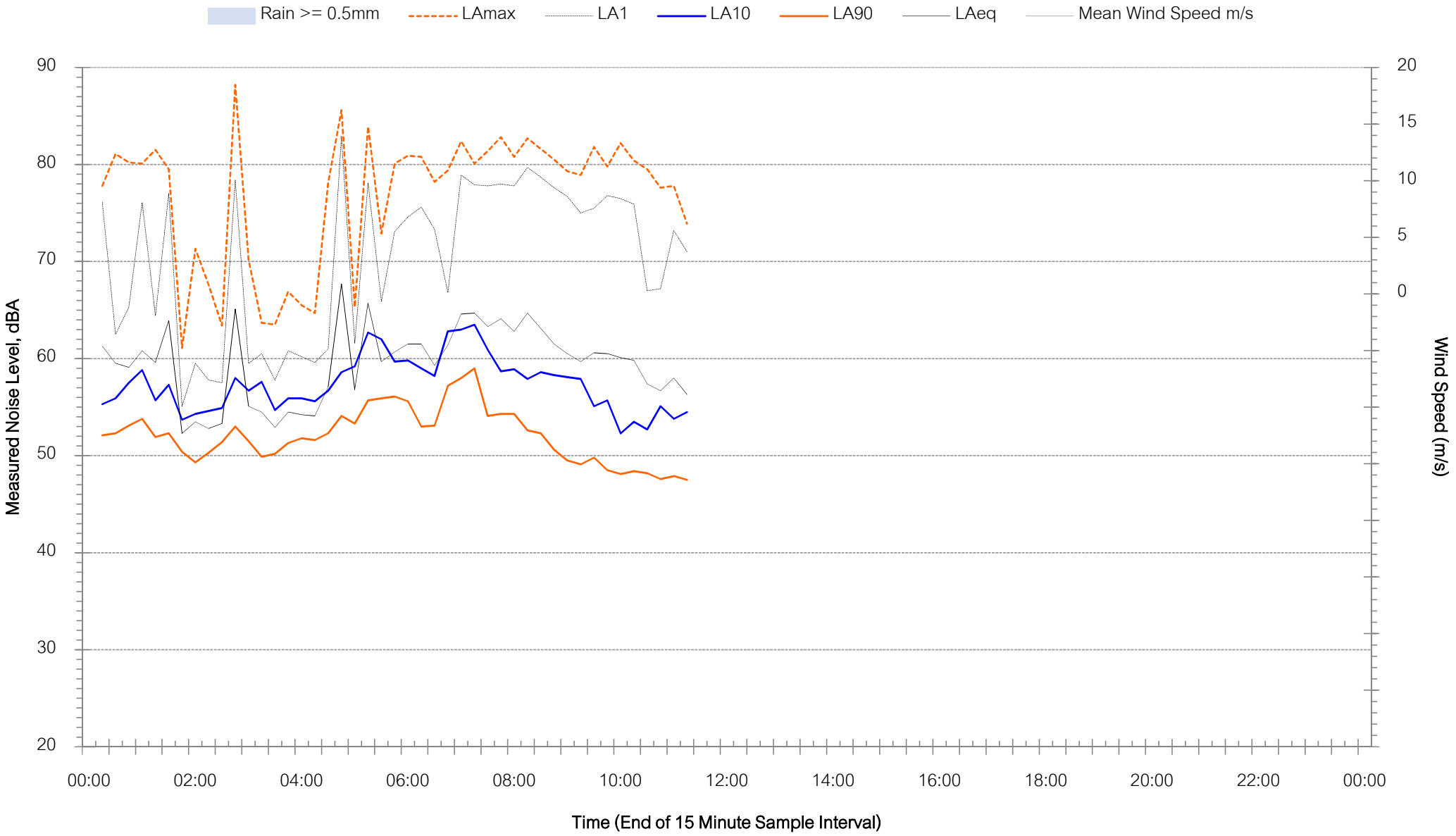
Background Noise Levels

Location N4 - Thursday 18 July 2019



Background Noise Levels

Location N4 - Friday 19 July 2019



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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 4 Ending December 2019.

Prepared for: Holcim (Australia) Pty Ltd
October 2019
MAC180611-01RP6

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Document Information

Noise Monitoring Assessment

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Quarter 4 Ending December 2019

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending December 2019 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS/NZS IEC 61672.1:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

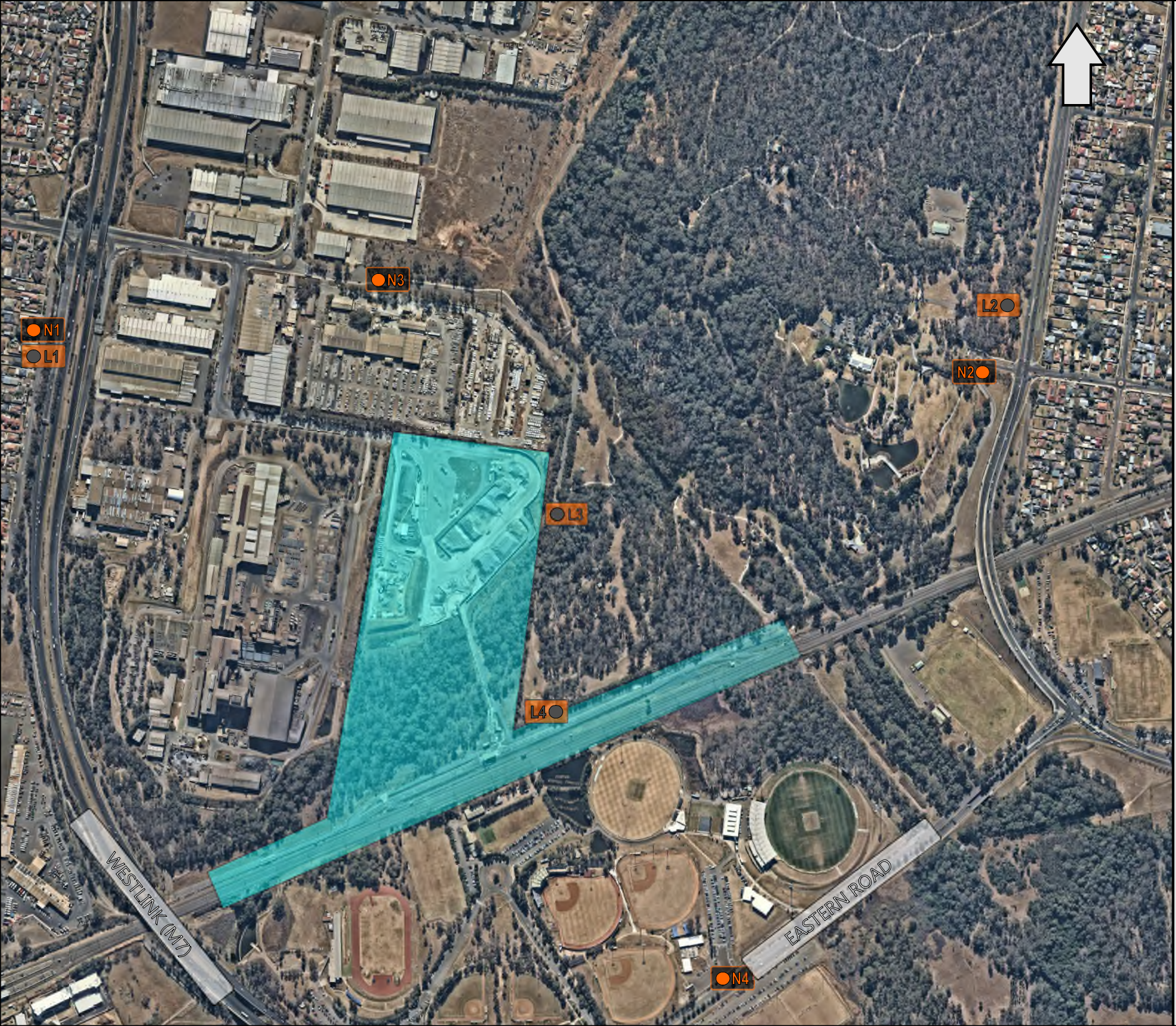

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

N1	MONITORING LOCATION
L1	LOGGER LOCATION
	SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Tuesday 1 October 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019 Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15 minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for a minimum of seven days in general accordance with the procedures described AS 1055:2018 and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977 noise analysers from Tuesday 1 October 2019 to Thursday 10 October 2019. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1.2019. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
01/10/2019	13:17 (Day)	82	58	52	WD: SW WS: 1m/s Rain: Nil	Pedestrians <49 Traffic 49-82 Birds <49 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<42
01/10/2019	18:19 (Evening)	78	56	50	WD: E WS: 0.1m/s Rain: Nil	Local residential noise <54 Traffic 44-77 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<40
01/10/2019	22:13 (Night)	63	54	53	WD: E WS: 0.1m/s Rain: Nil	Traffic dominant 39-63 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<39
RDC $L_{A1(1min)}$ Contribution						<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
01/10/2019	14:34 (Day)	74	62	52	WD: SW WS: 0.1m/s Rain: Nil	Traffic 54-70 Birds <54 Aircraft <62 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<42
01/10/2019	19:09 (Evening)	66	54	48	WD: E WS: 0.1m/s Rain: Nil	Aircraft 52-58 Traffic 46-58 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<38
01/10/2019	22:56 (Night)	65	52	46	WD: E WS: 0.1m/s Rain: Nil	Traffic 44-65 Birds <44 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<36
RDC $L_{A1(1min)}$ Contribution						<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
01/10/2019	13:43 (Day)	65	52	48	WD: SW WS: 0.5m/s Rain: Nil	Traffic 52-63 Birds 51-59 Industrial hum 48-50 Wind in trees <49 Train 52-55 Aircraft 49-54 RDC audible 48
		RDC $L_{Aeq(15min)}$ Contribution				<48
01/10/2019	18:43 (Evening)	66	57	54	WD: E WS: 0.1m/s Rain: Nil	RDC Industrial hum 53-55 Traffic 53-60 Aircraft 52-58 RDC audible 50-53
		RDC $L_{Aeq(15min)}$ Contribution				<50
01/10/2019	22:33 (Night)	63	54	53	WD: E WS: 0.1m/s Rain: Nil	RDC Industrial hum 49-52 Aircraft <54 Traffic 54-61 RDC audible 49-50
		RDC $L_{Aeq(15min)}$ Contribution				<49

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
01/10/2019	14:08 (Day)	69	55	45	WD: SW WS: 0.5m/s Rain: Nil	Birds 48-52 Industrial hum 43-45 Traffic 43-64 Train 52-63 RDC audible 43
		RDC $L_{Aeq(15min)}$ Contribution				<45
01/10/2019	19:31 (Evening)	76	64	53	WD: E WS: 0.1m/s Rain: Nil	Traffic 48-71 Insects <43 Aircraft 56-58 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<43
01/10/2019	23:15 (Night)	76	61	50	WD: E WS: 0.1m/s Rain: Nil	Traffic 39-71 Birds 39-60 Insects <40 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq(period)}$[2]	Measured Background Noise Level (LA_{90}) dB RBL [2]
L1 (N1 Station Street)	Day	56	49
	Evening	53	42
	Night	51	35
L2 (N2 Knox Road)	Day	57	48
	Evening	56	48
	Night	54	41
L3 (N3 Nurragingy Reserve)	Day	54	43
	Evening	49	42
	Night	51	43
L4 (N4 Olympic Park)	Day	59	42
	Evening	56	43
	Night	58	44

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Noise Compliance Assessment

The compliance assessment summary for each monitoring location N1 to N4 are presented in **Table 7** to **Table 9** for each assessment period.

Table 7 Daytime Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<42	44	✓
N2	<42	40	✓
N3	<48	50 (When in use)	✓
N4	<45	55 (When in use)	✓

Note: Day - the period from 7am to 6pm Monday to Saturday, or 8am to 6pm on Sundays and public holidays.

Table 8 Evening Noise Compliance Assessment

Receiver No.	RDC Noise Contribution	RDC Noise Criteria	Compliant
	dB $L_{Aeq(15min)}$	dB $L_{Aeq(15min)}$	
N1	<40	44	✓
N2	<38	39	✓
N3	<50	50 (When in use)	✓
N4	<43	55 (When in use)	✓

Note: Evening - the period from 6pm to 10pm.

Table 9 Night Time Noise Compliance Assessment

Receiver No.	RDC Noise Contribution		RDC Noise Criteria		Compliant
	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$	dB $L_{Aeq(15min)}$	dB $L_{A1(1min)}$	
N1	<39	<45	39	53	✓
N2	<36	<45	39	53	✓
N3	<49	N/A	50 (When in use)	N/A	✓
N4	<40	N/A	55 (When in use)	N/A	✓

Note: Night - the period from 10pm to 7am Monday to Saturday, or 10pm to 8am on Sundays and public holidays.

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6 Discussion

6.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three attended measurements conducted on Tuesday 1 October 2019, satisfying the relevant noise limits. Extraneous noise sources included pedestrians, birds and local residential noise, with ambient noise levels dominated by traffic noise.

6.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during the day, evening and night attended measurements conducted on Tuesday 1 October 2019, satisfying the relevant noise limits for this location. Extraneous sources measured include traffic, birds and aircraft noise.

6.3 Discussion of Results - Location N3

Attended measurements on Tuesday 1 October 2019 identified that RDC noise was audible during the daytime, evening and night measurements. RDC emissions ranged from <48dBA to <53BA which satisfied the relevant noise criteria for this location. Extraneous sources audible during the attended surveys included traffic, birds, wind in trees, train pass-by and aircraft noise which generally masked RDC noise. For the evening and night periods, it is noted the receiver was not “in use” and hence criteria are referenced for completeness.

6.4 Discussion of Results - Location N4

RDC noise emissions were audible during the day measurement on Tuesday 1 October 2019, however remained below the applicable noise criteria. Evening and night time measurements remained inaudible at the N4 monitoring location on Tuesday 1 October 2019. It is noted that the sports centre was not in use during the night period and criteria are referenced for completeness. Extraneous noise sources included birds, traffic, train pass-by, insects and aircraft noise all audible throughout attended measurements at this location.

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7 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 4, ending December 2019.

Unattended noise monitoring was completed between Tuesday 1 October 2019 and Thursday 10 October 2019 at four representative monitoring locations.

Attended noise monitoring was conducted on Tuesday 1 October 2019. The assessment has identified that noise emissions generated by RDC were inaudible at the nearest residential receivers during the attended monitoring, with all measurements satisfying the relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

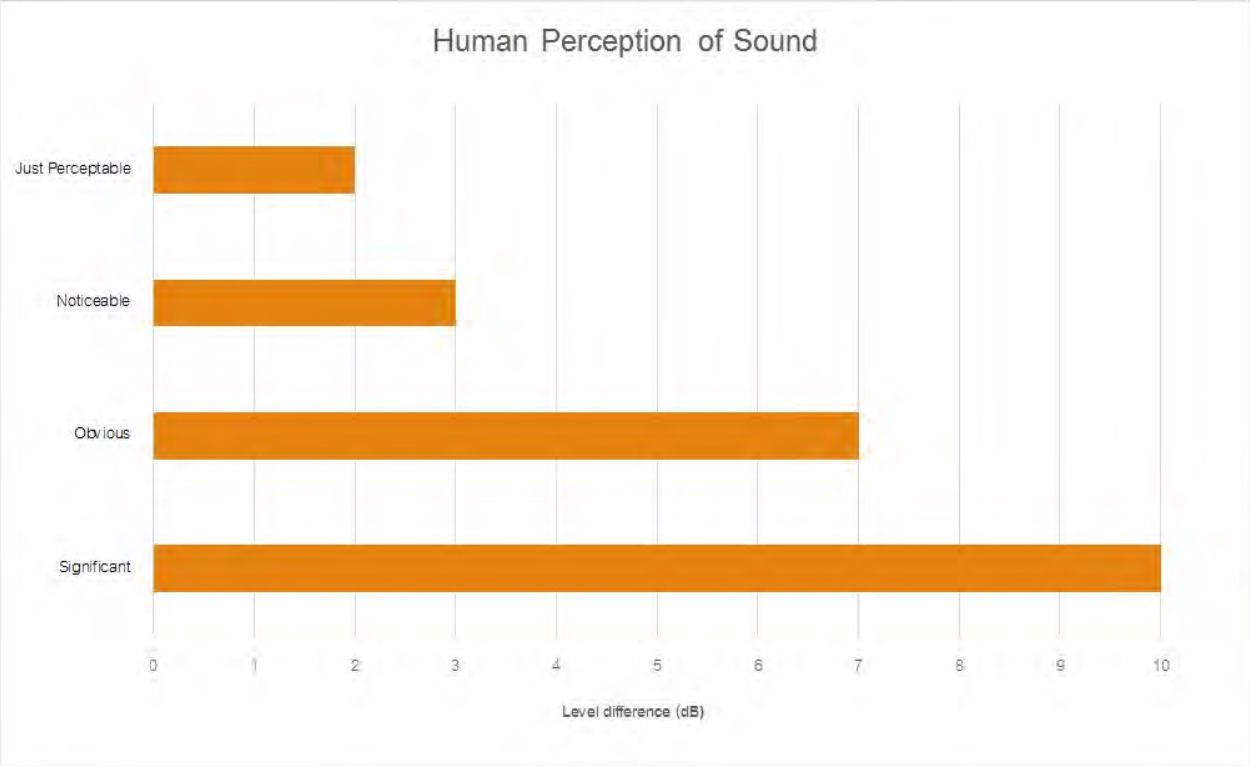
Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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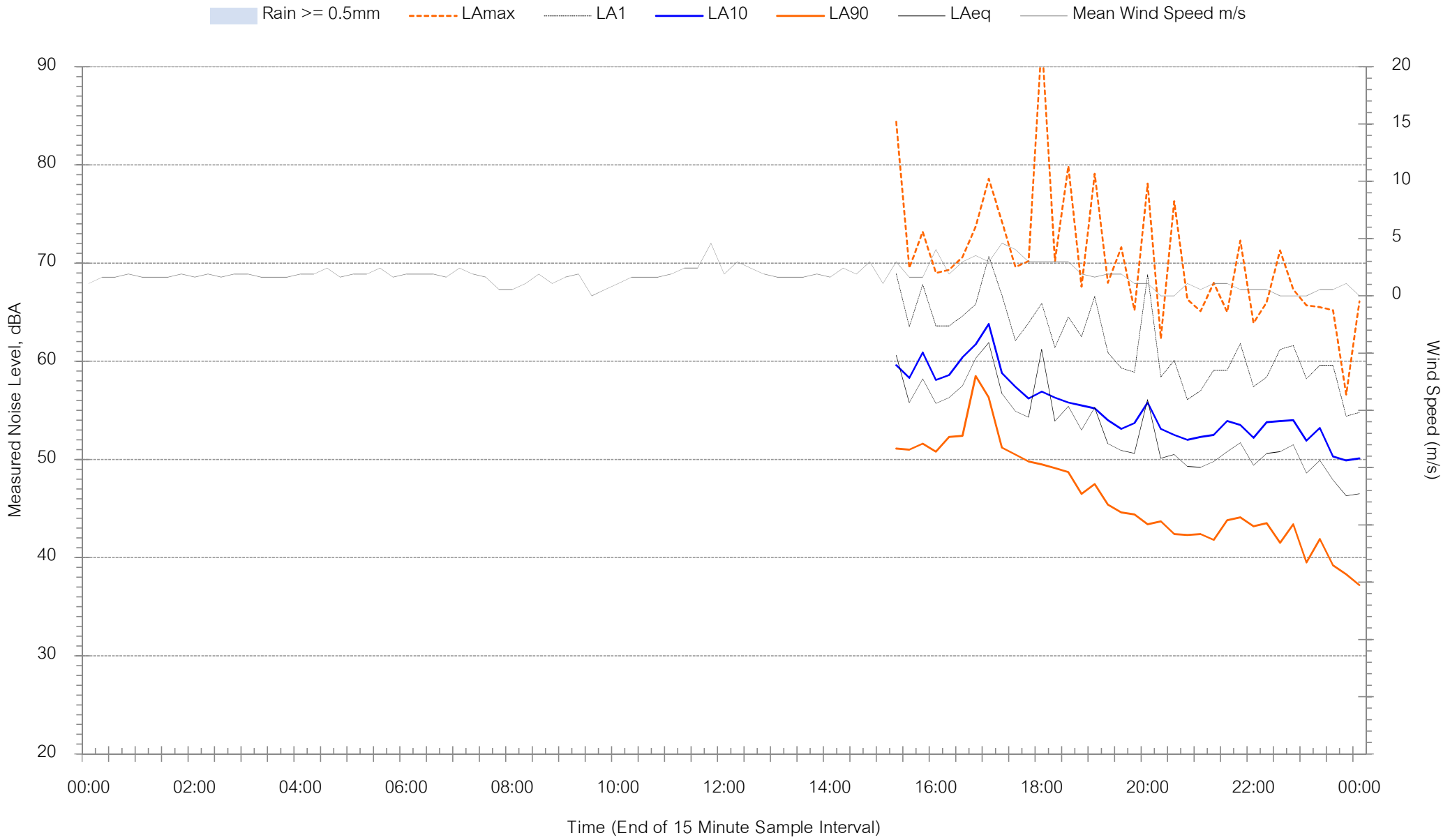
Appendix B – Unattended Noise Monitoring Charts

Background Noise Levels

N1 - Tuesday 1 October 2019



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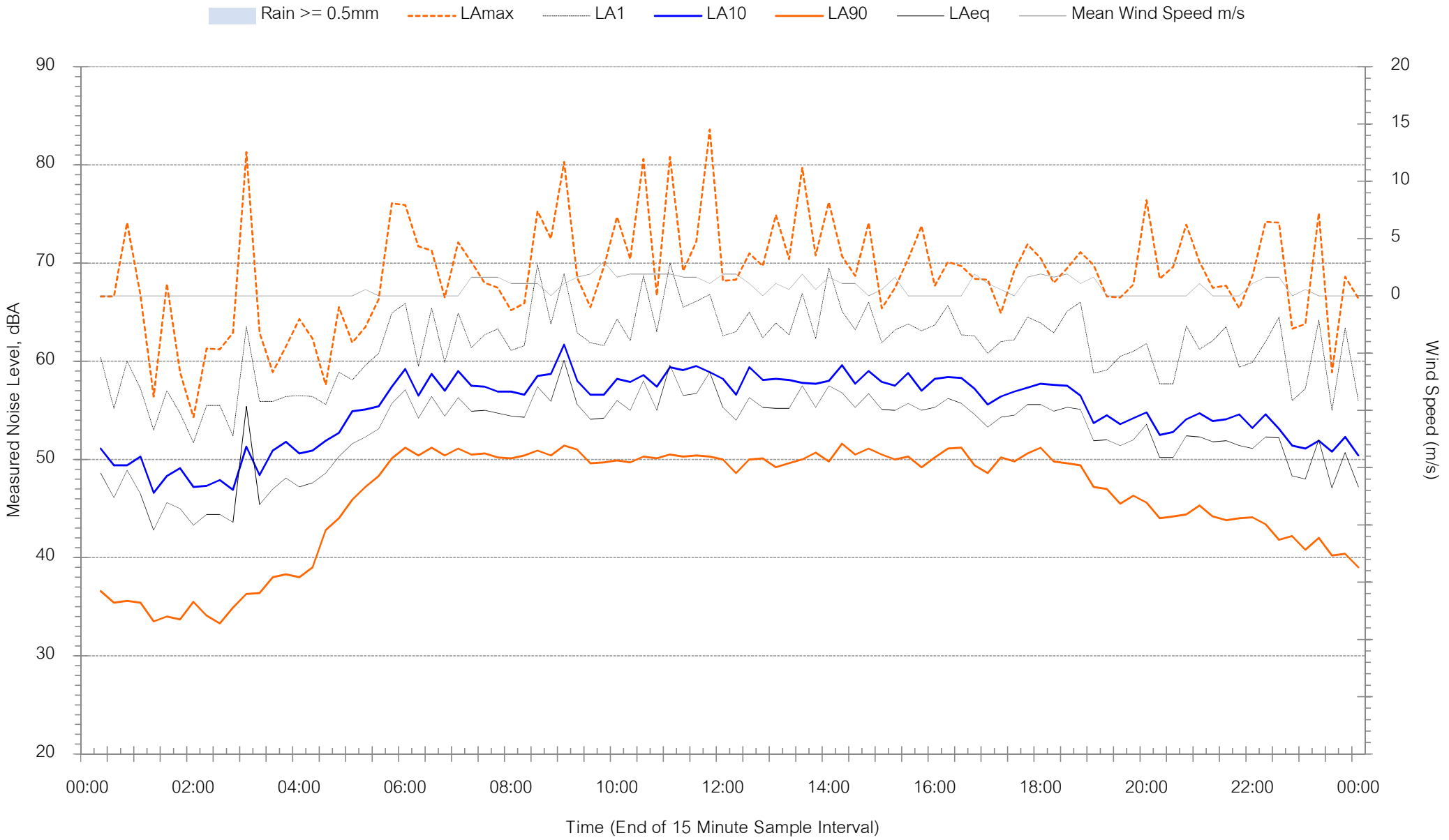

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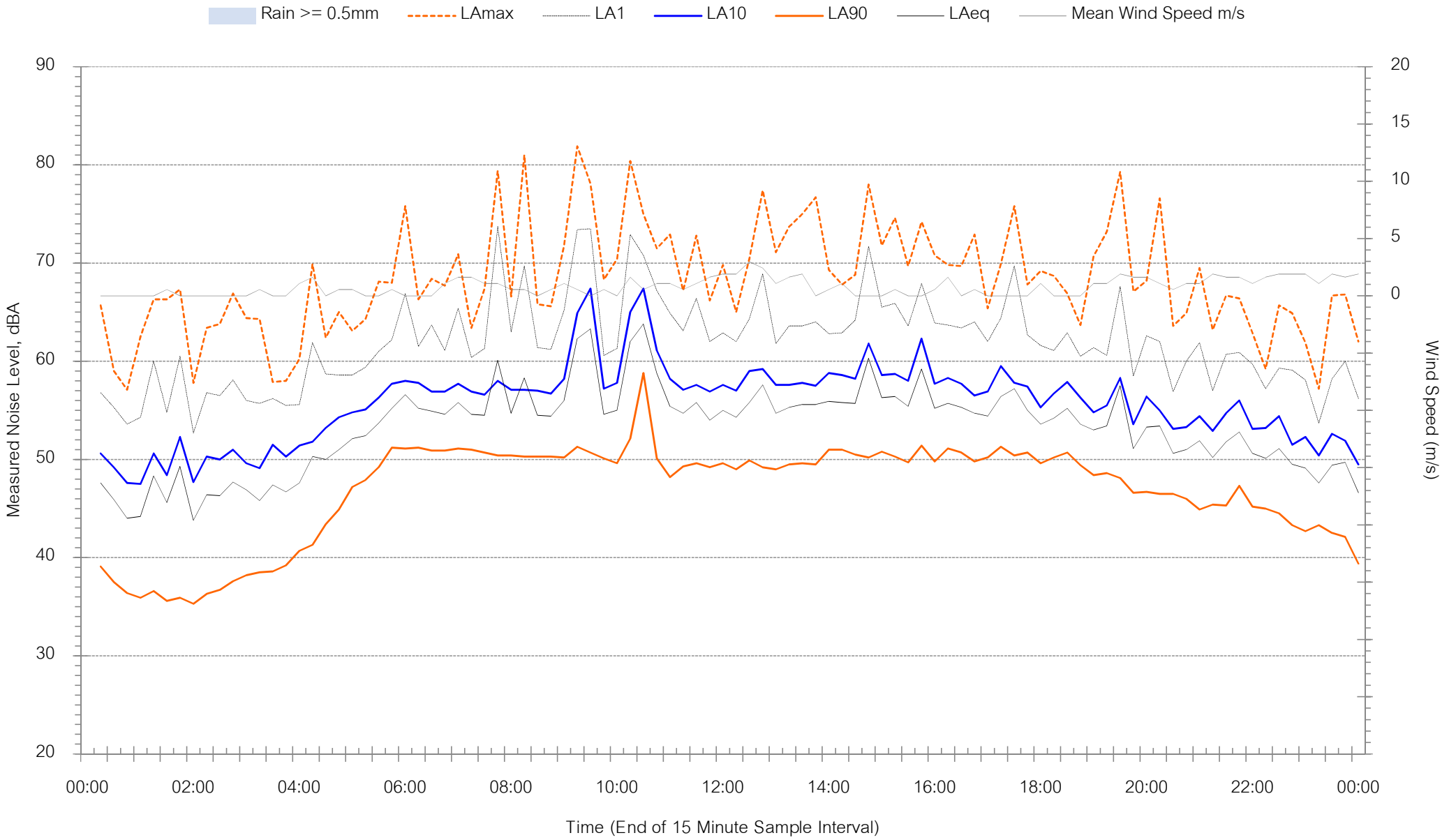

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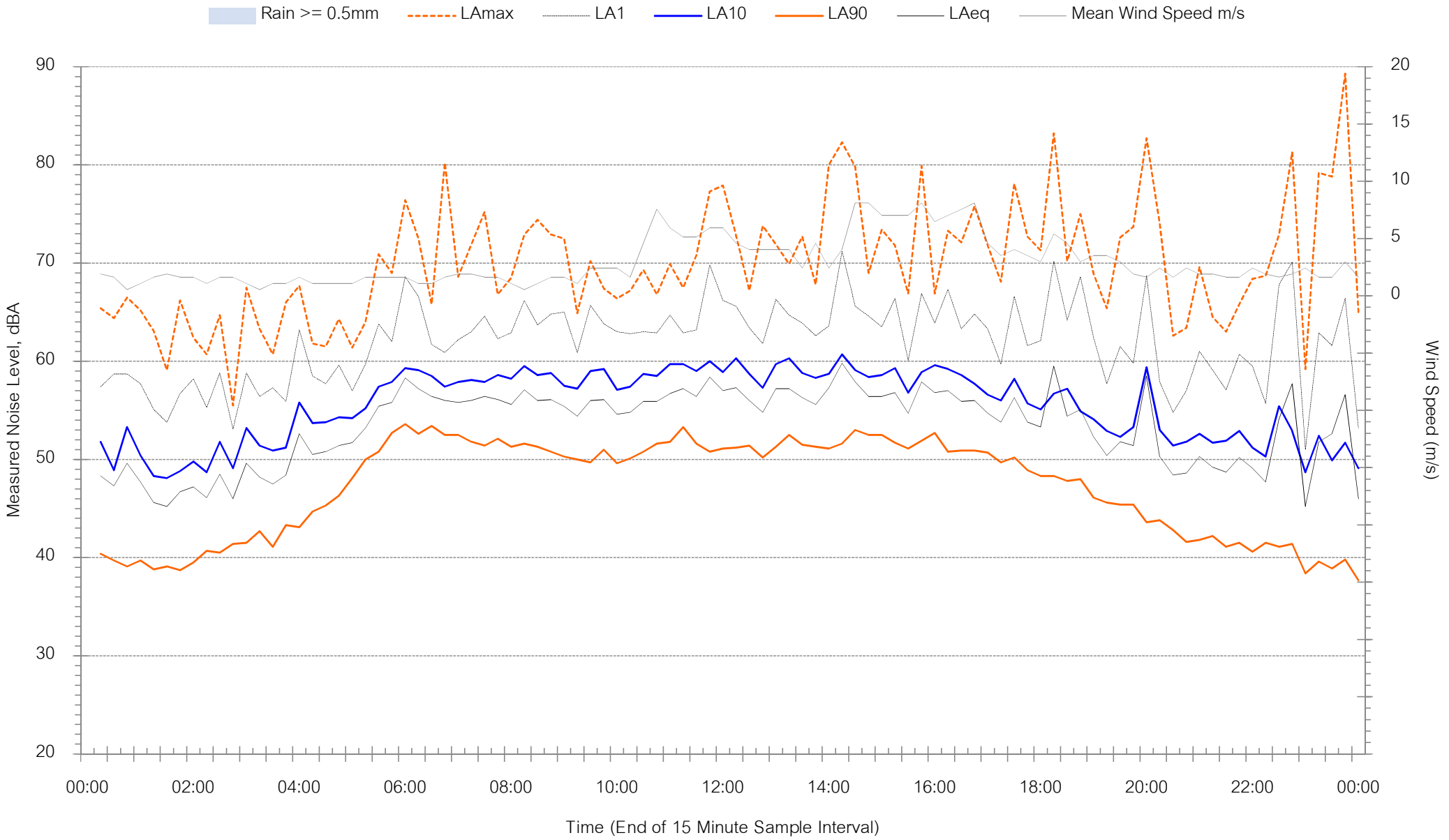

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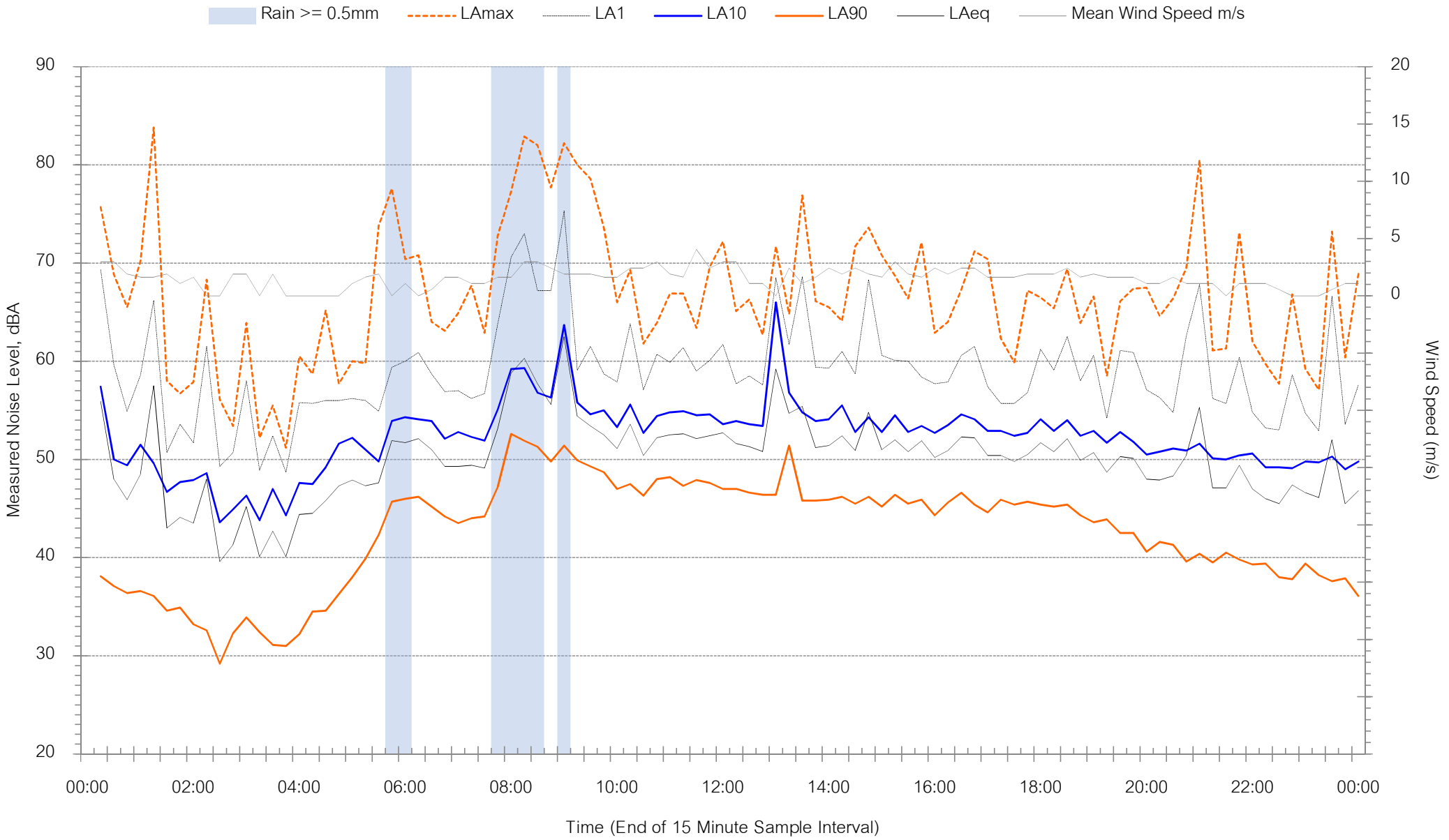

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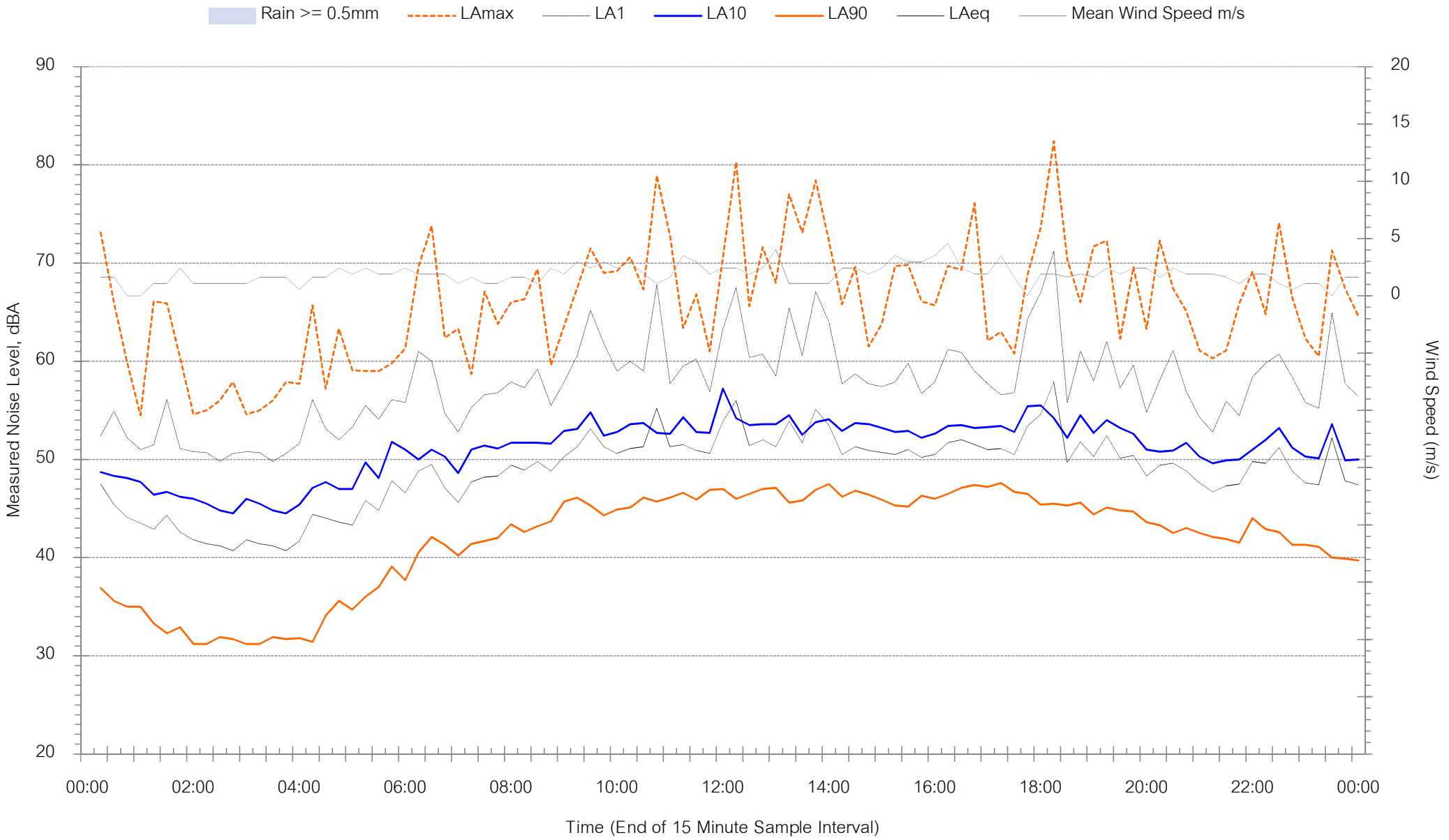

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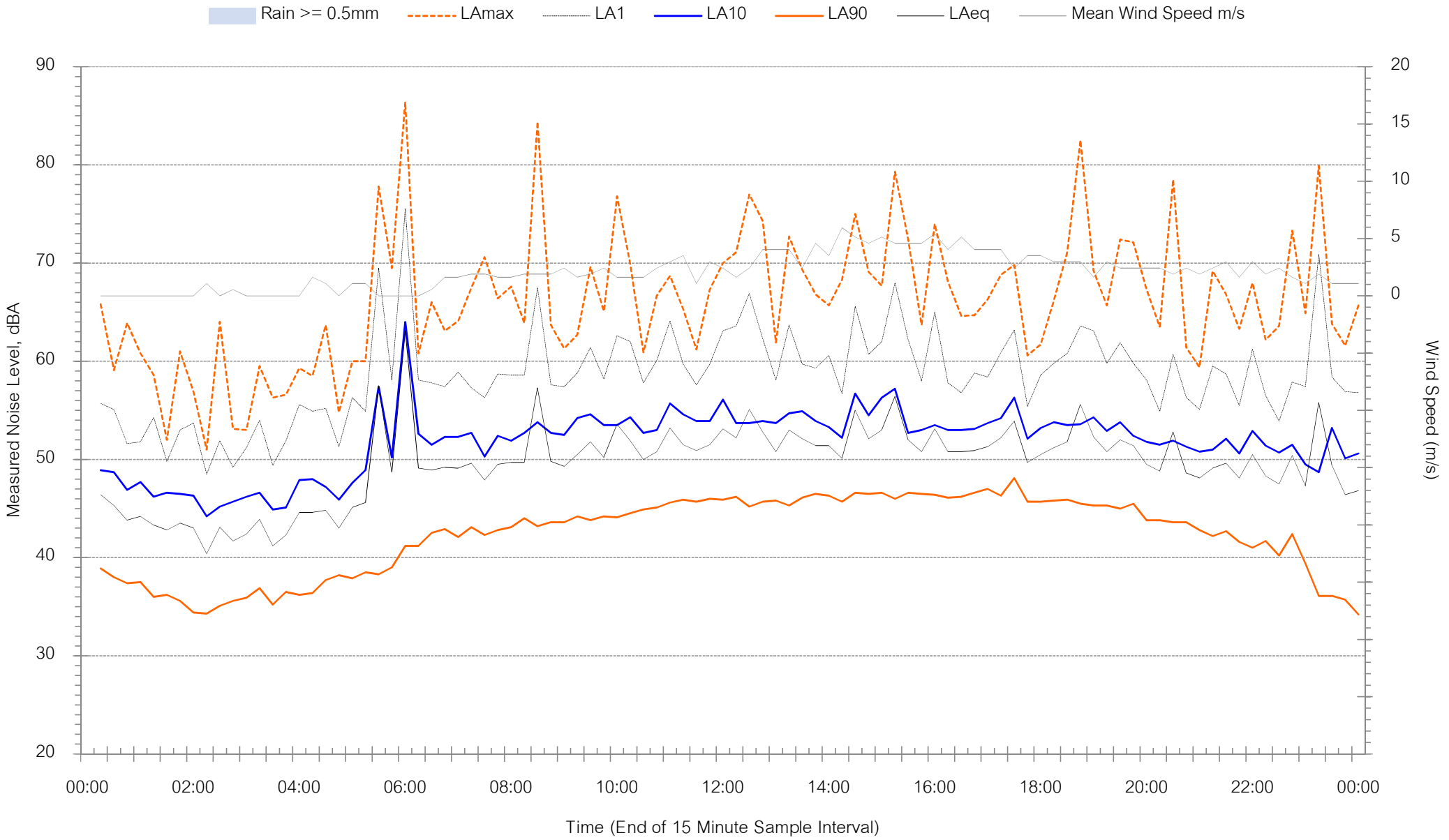

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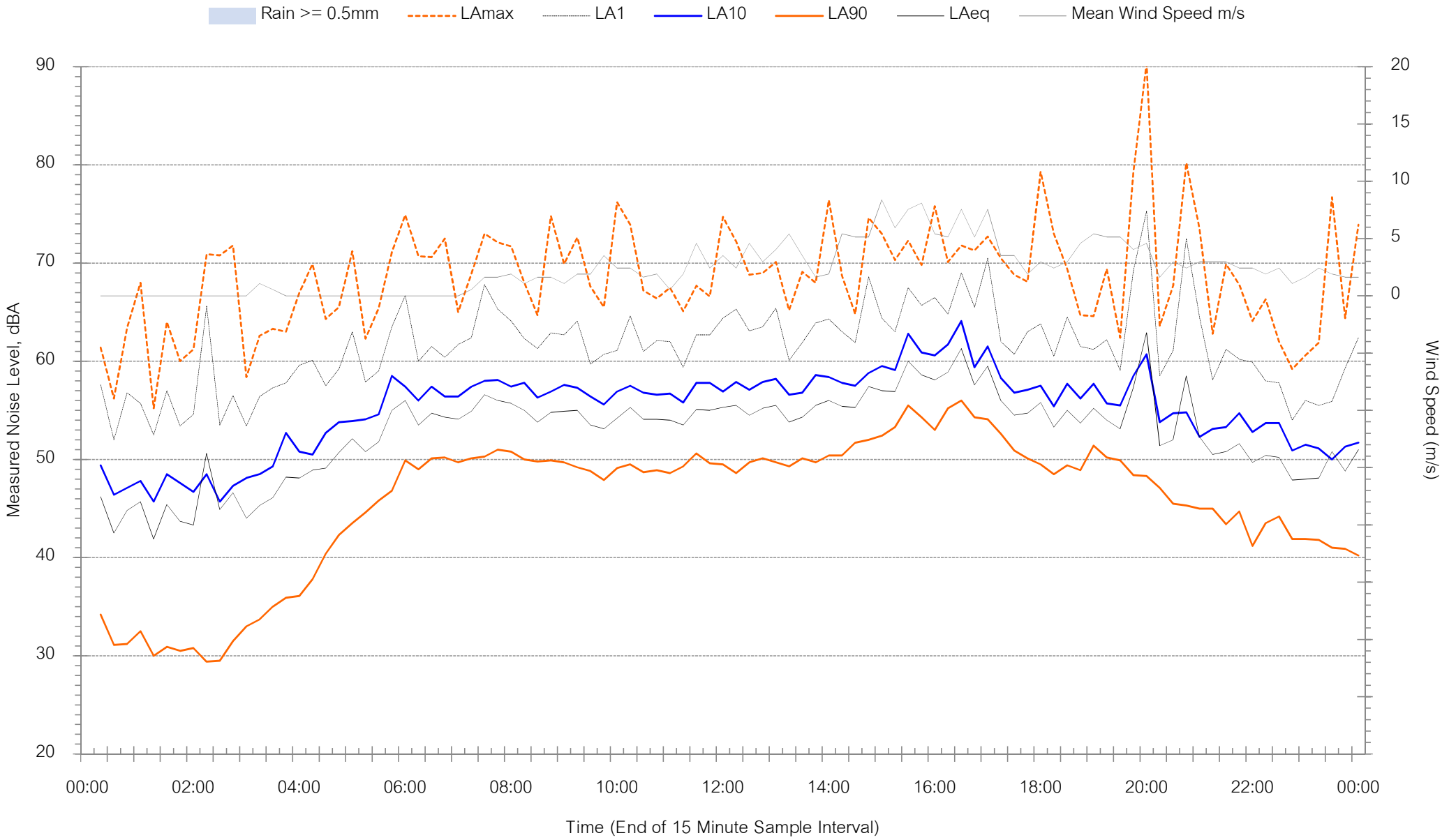

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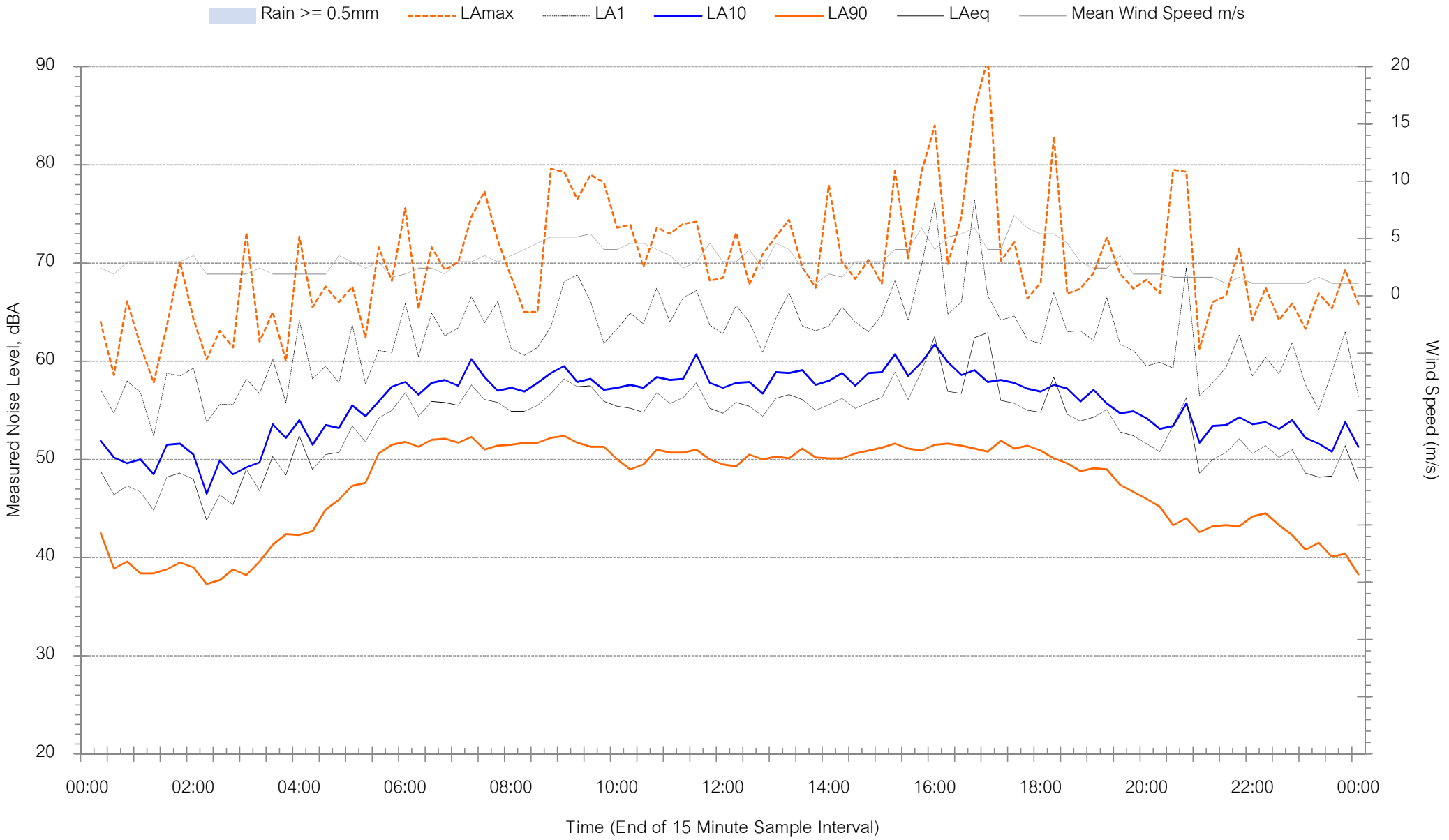

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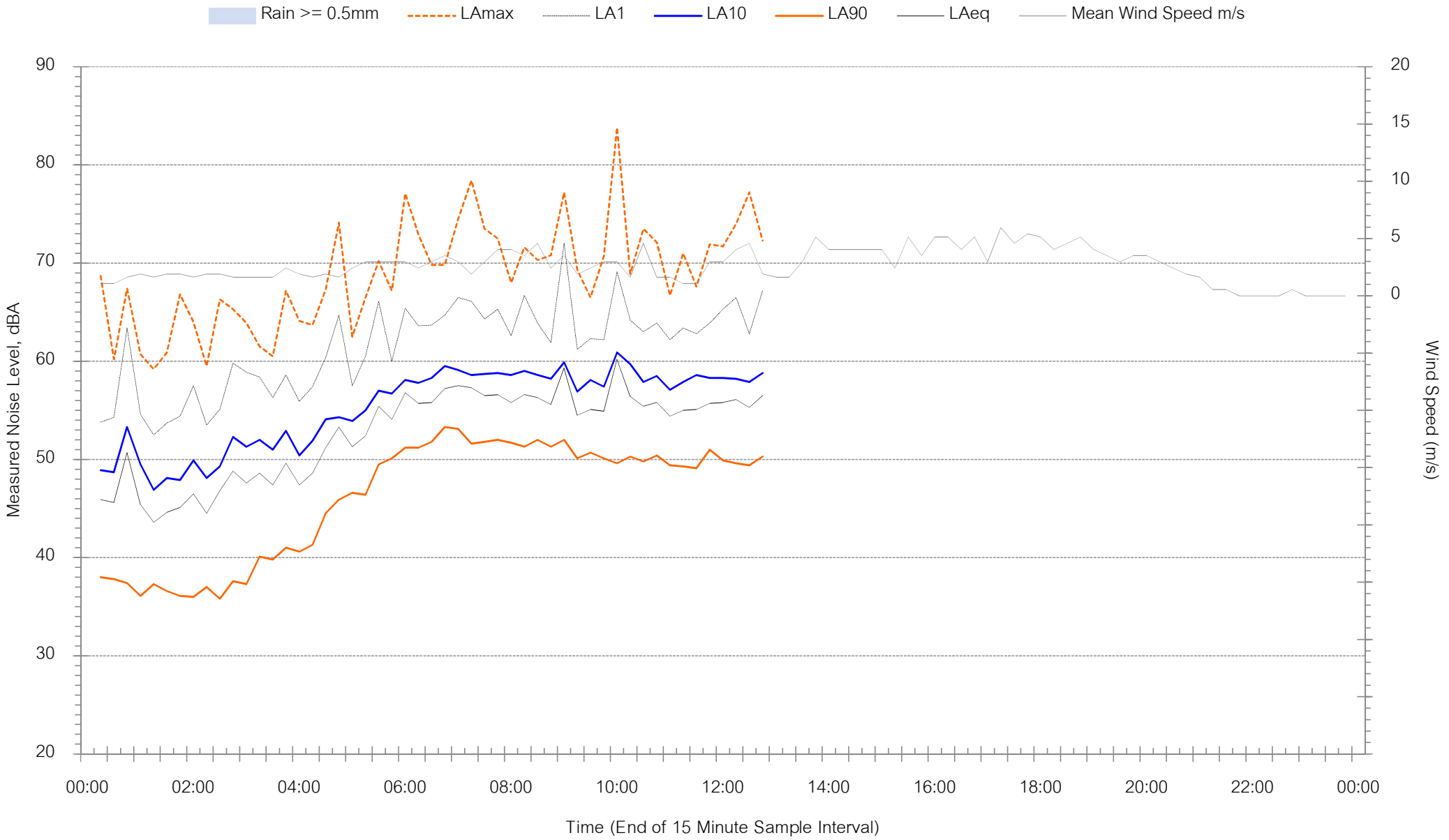

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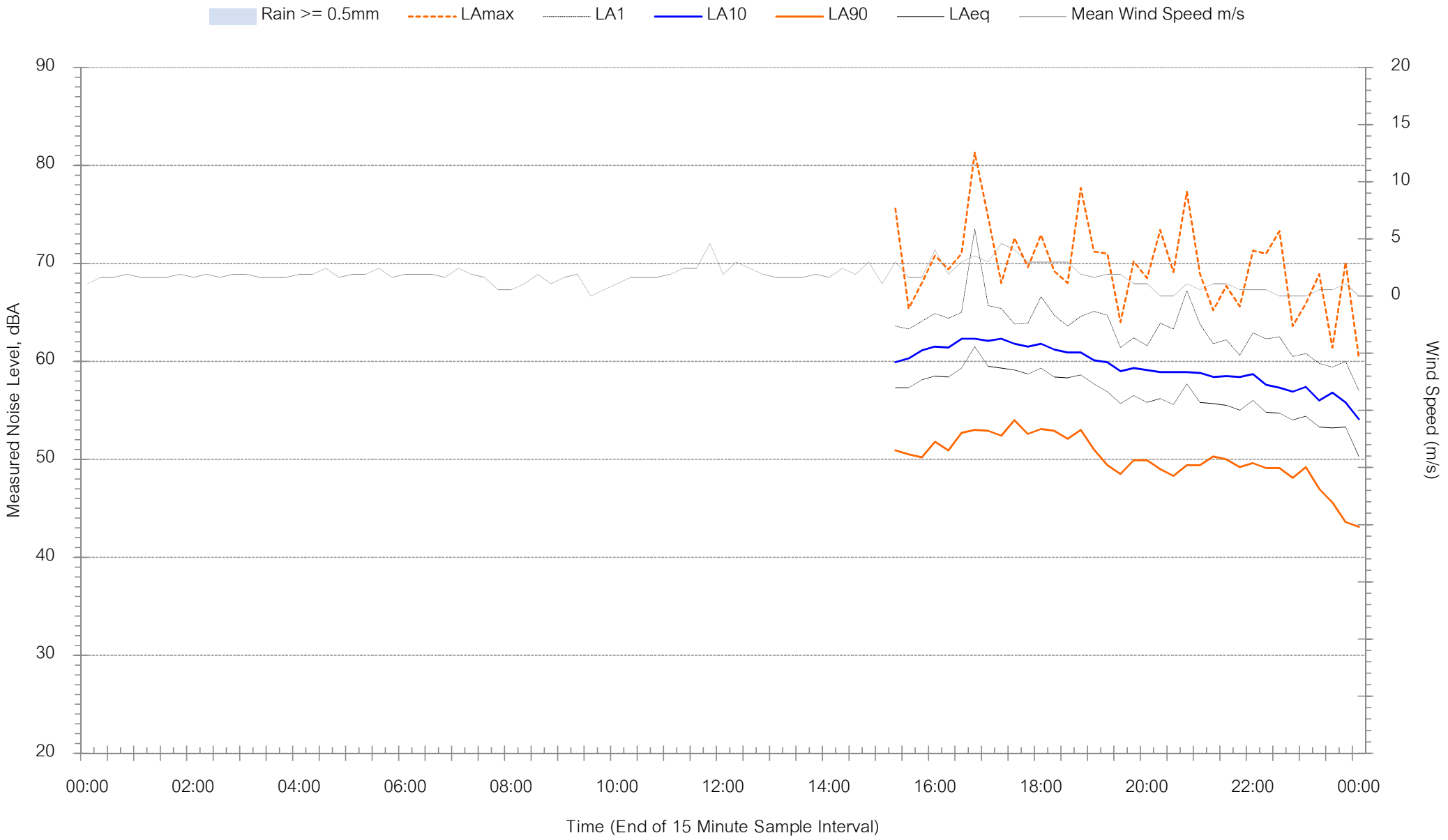

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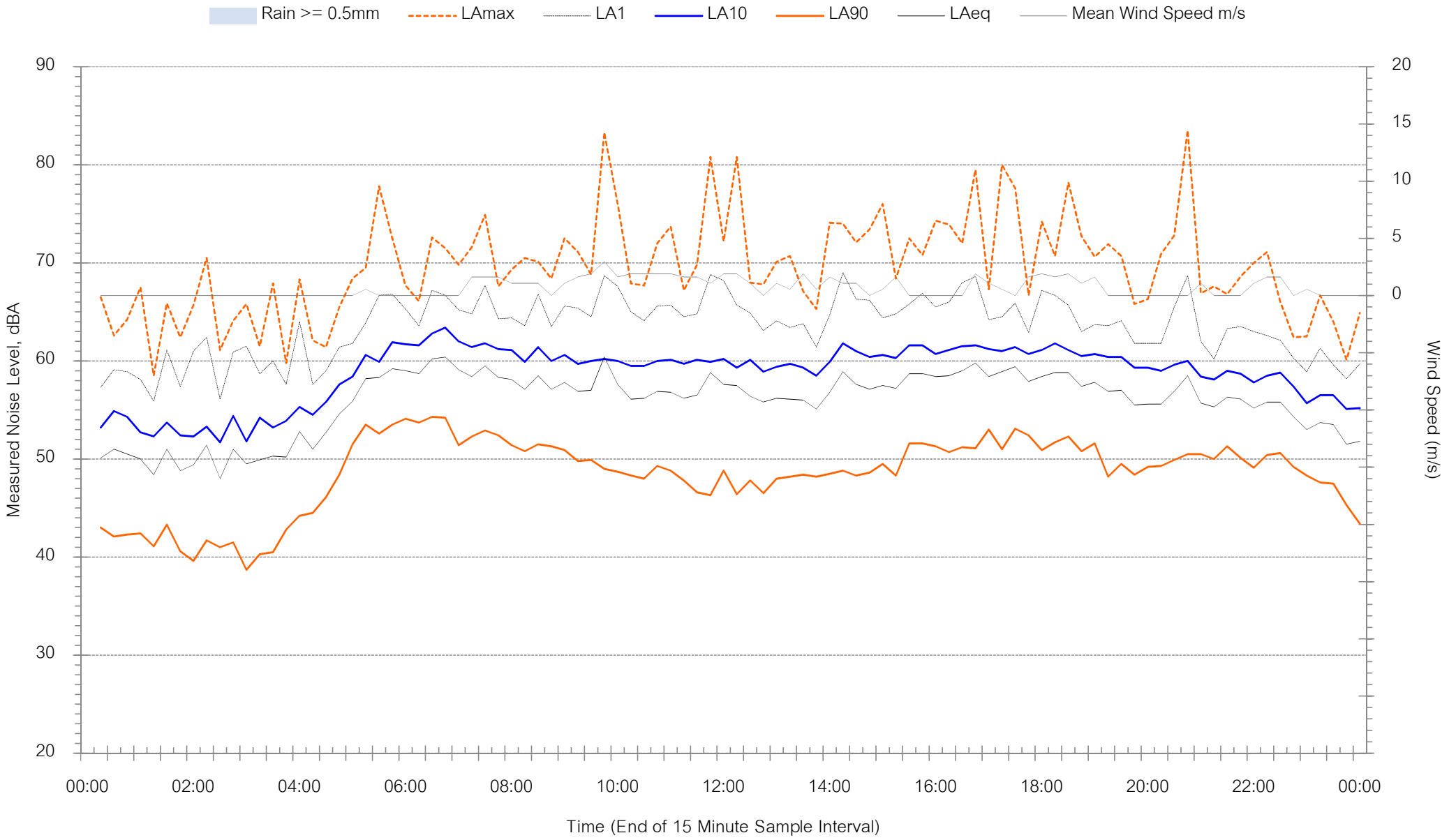

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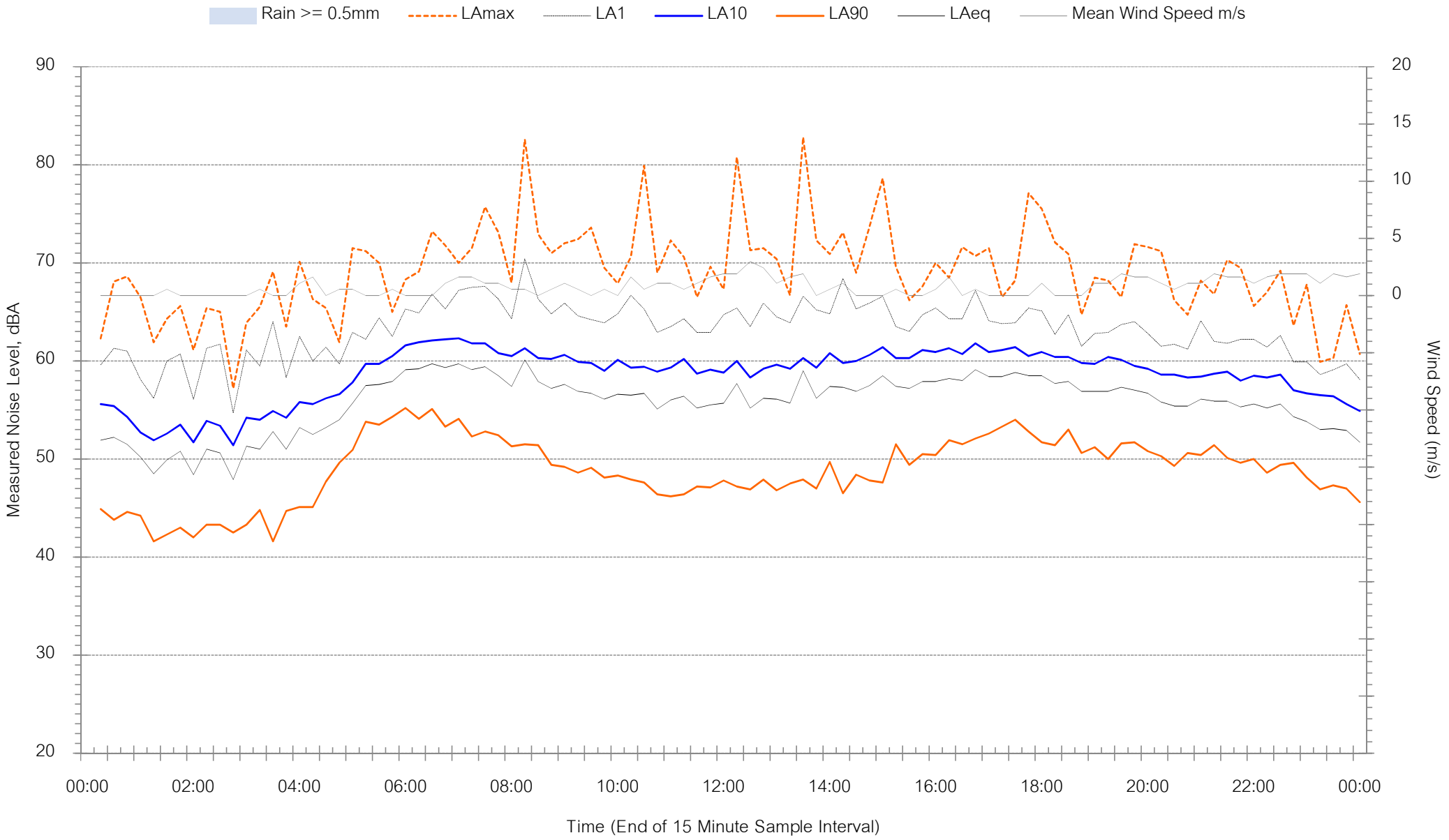

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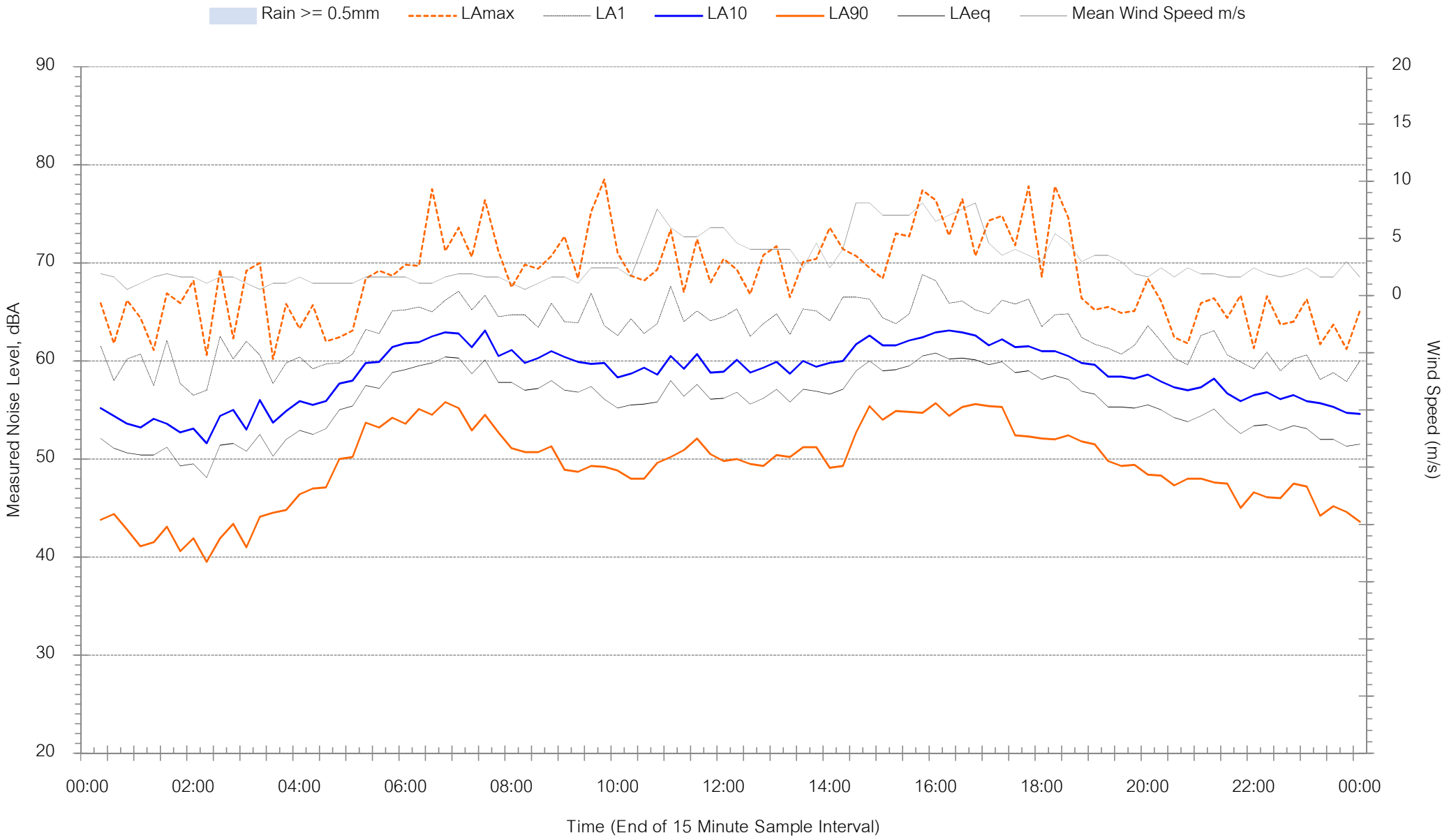

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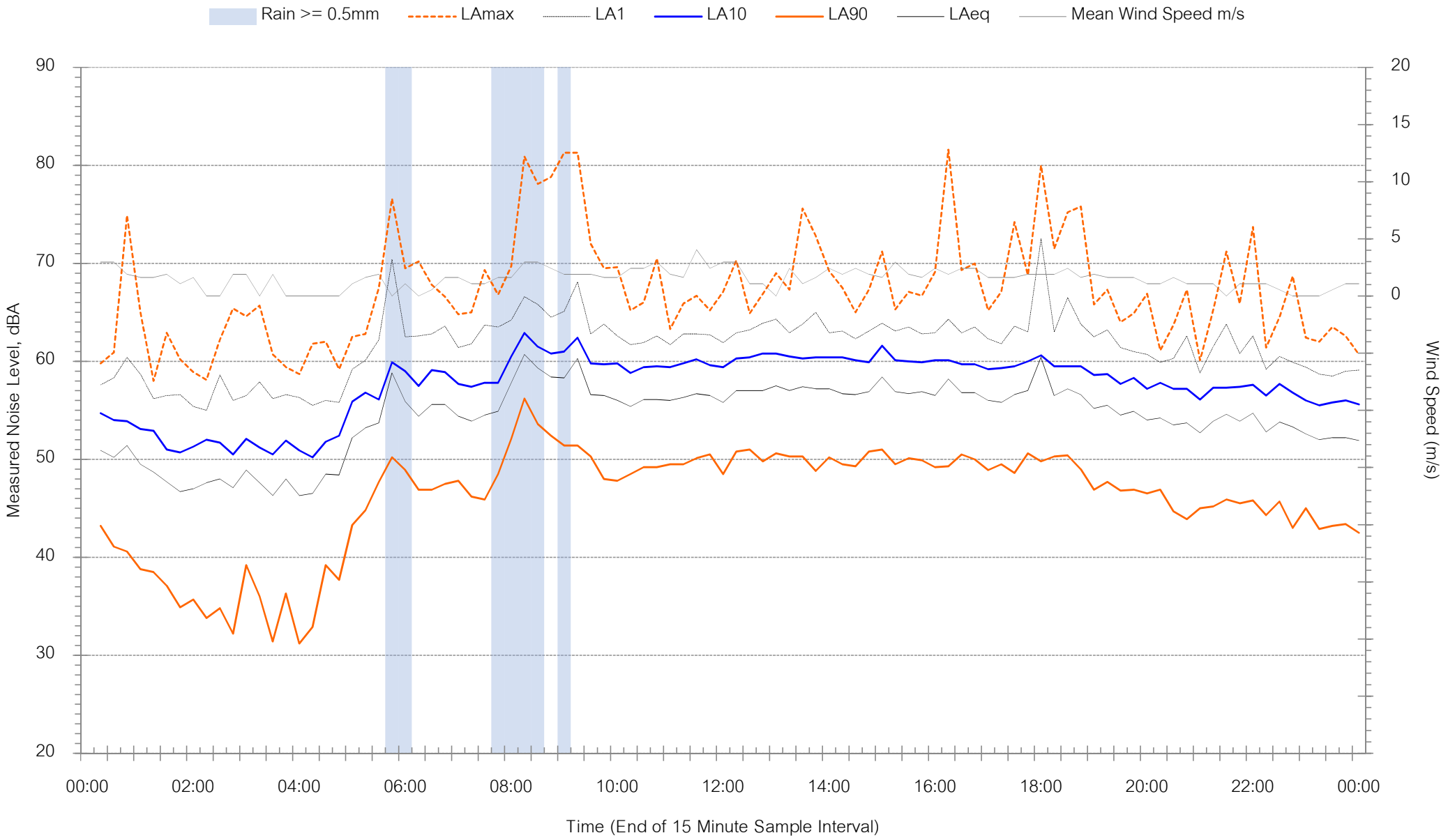

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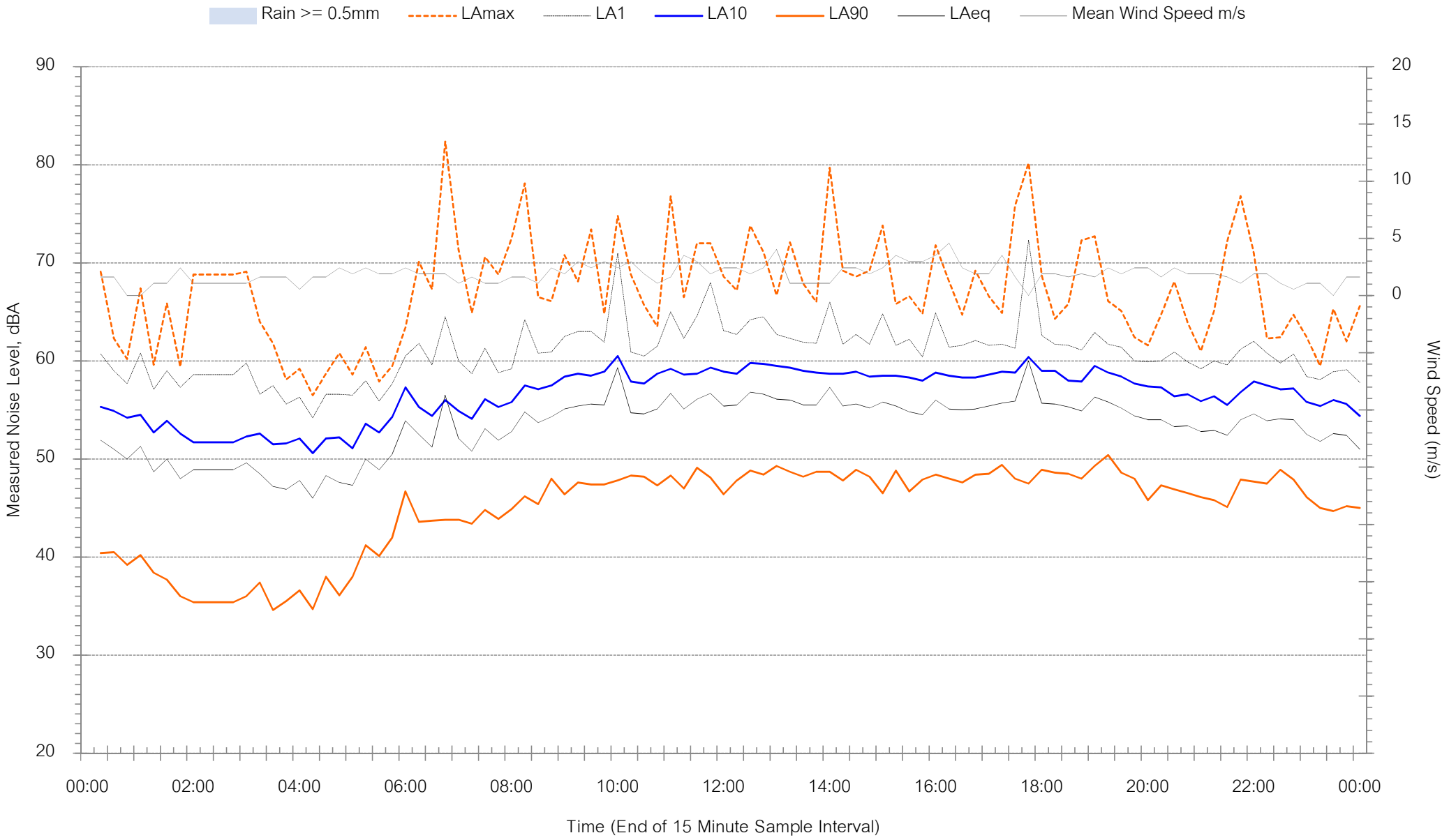

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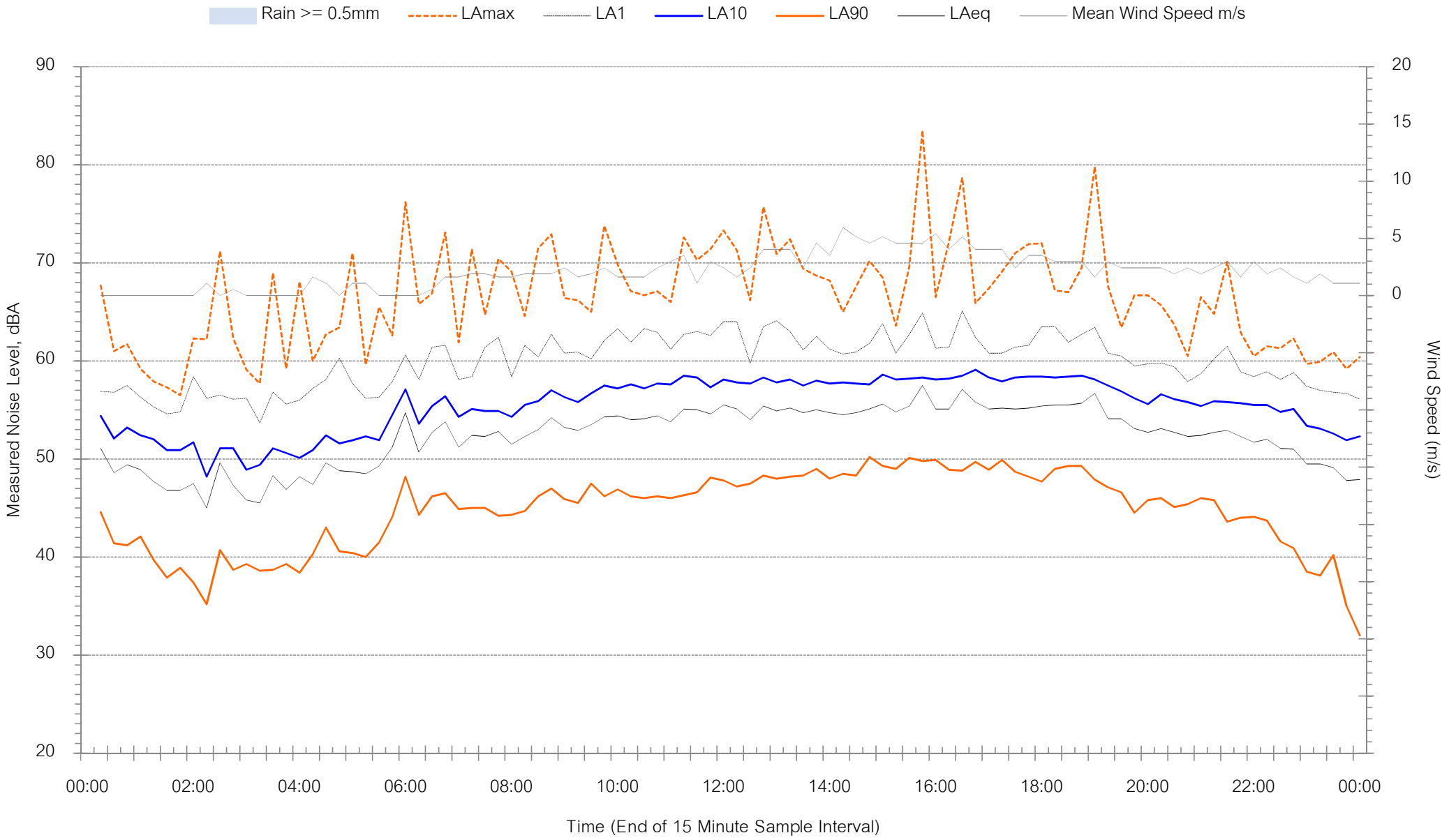

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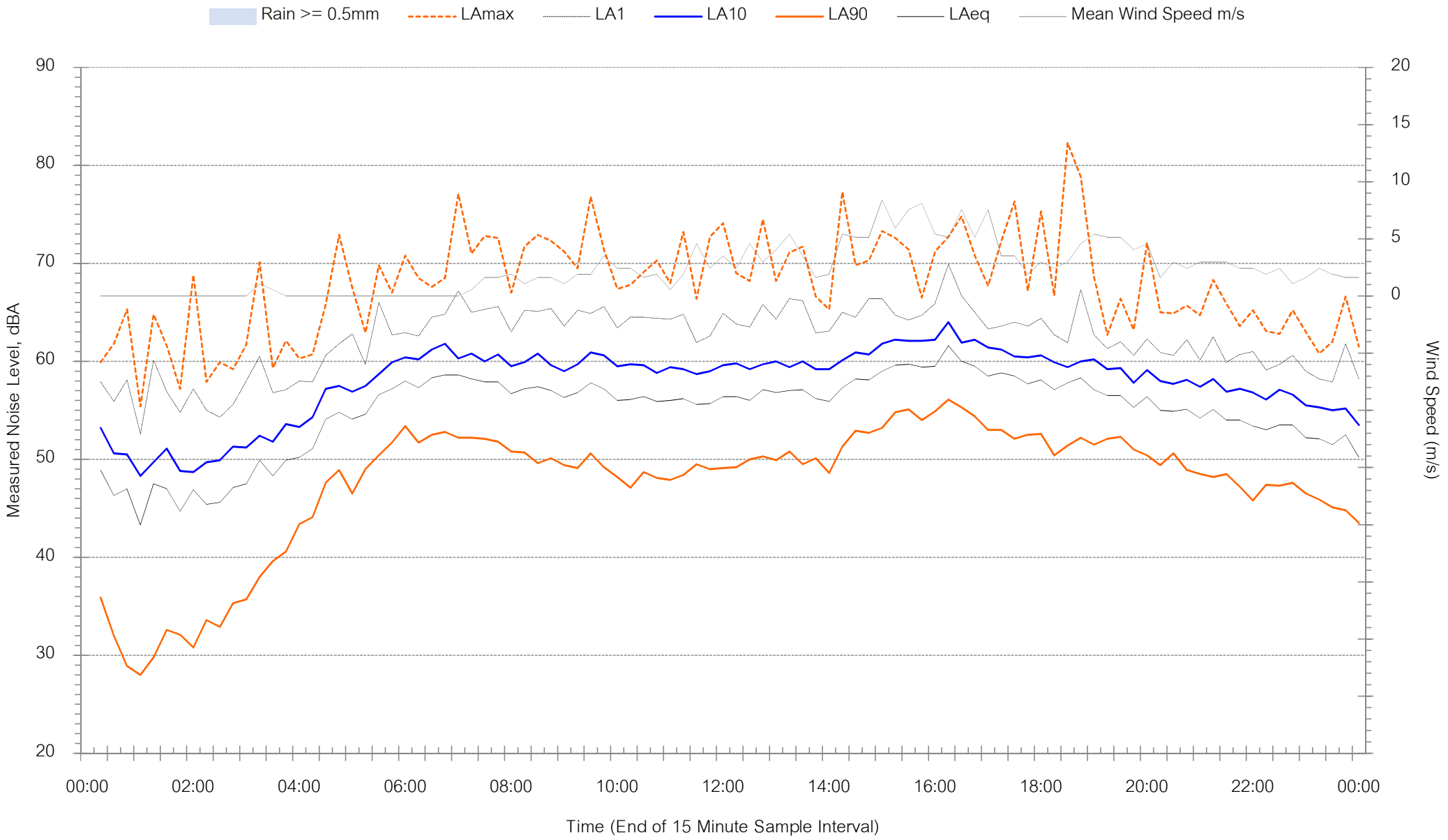

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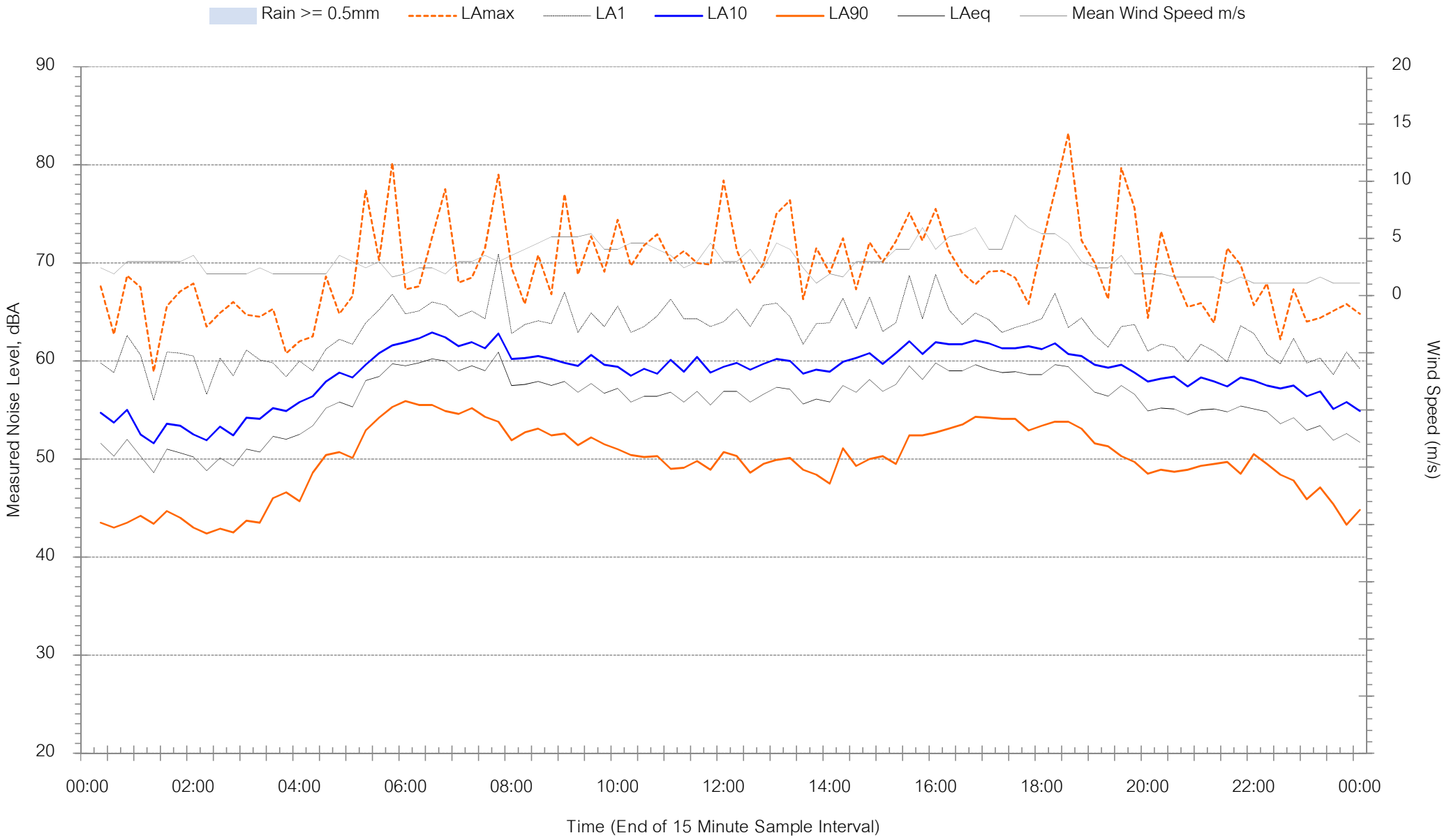

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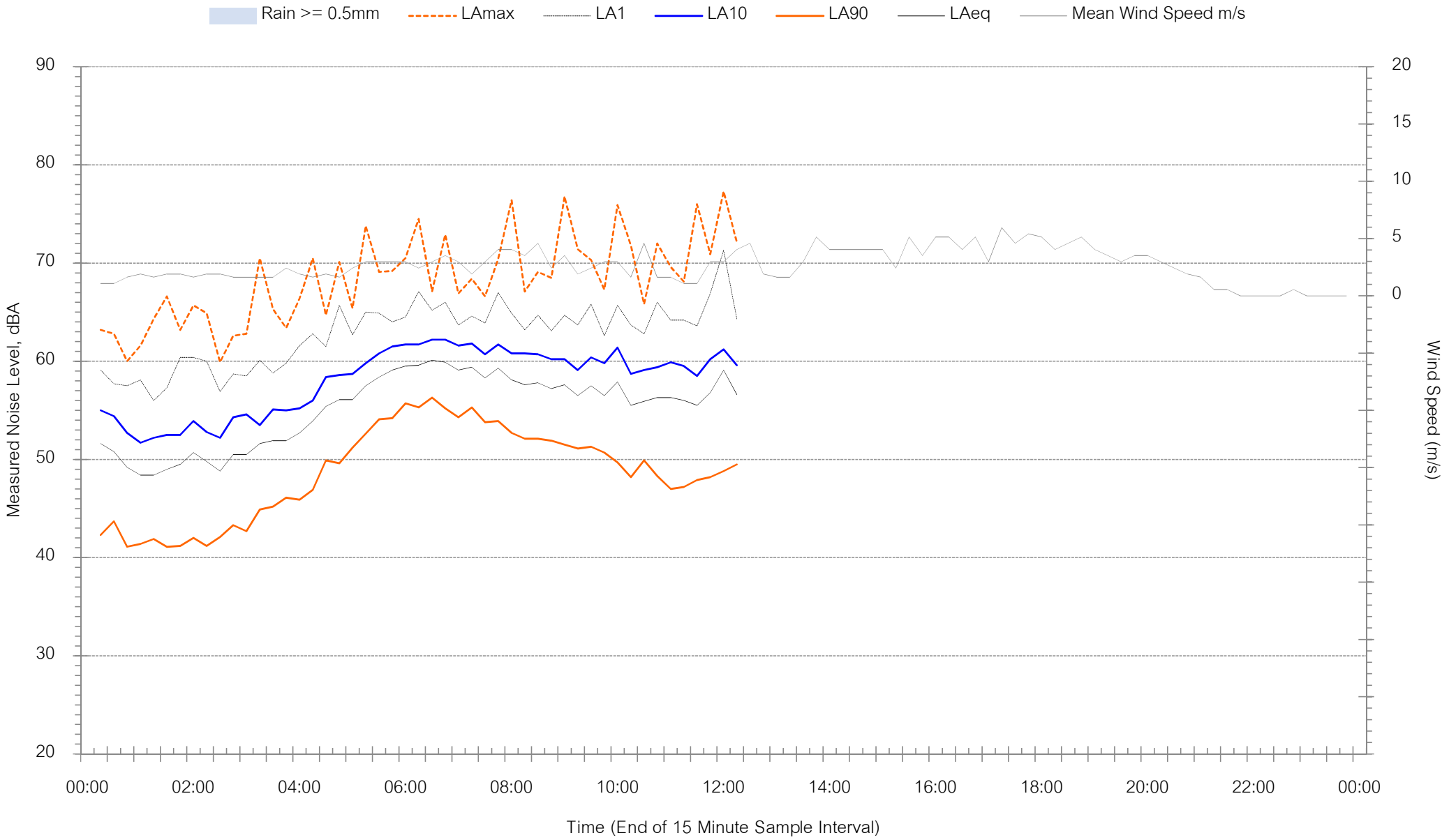

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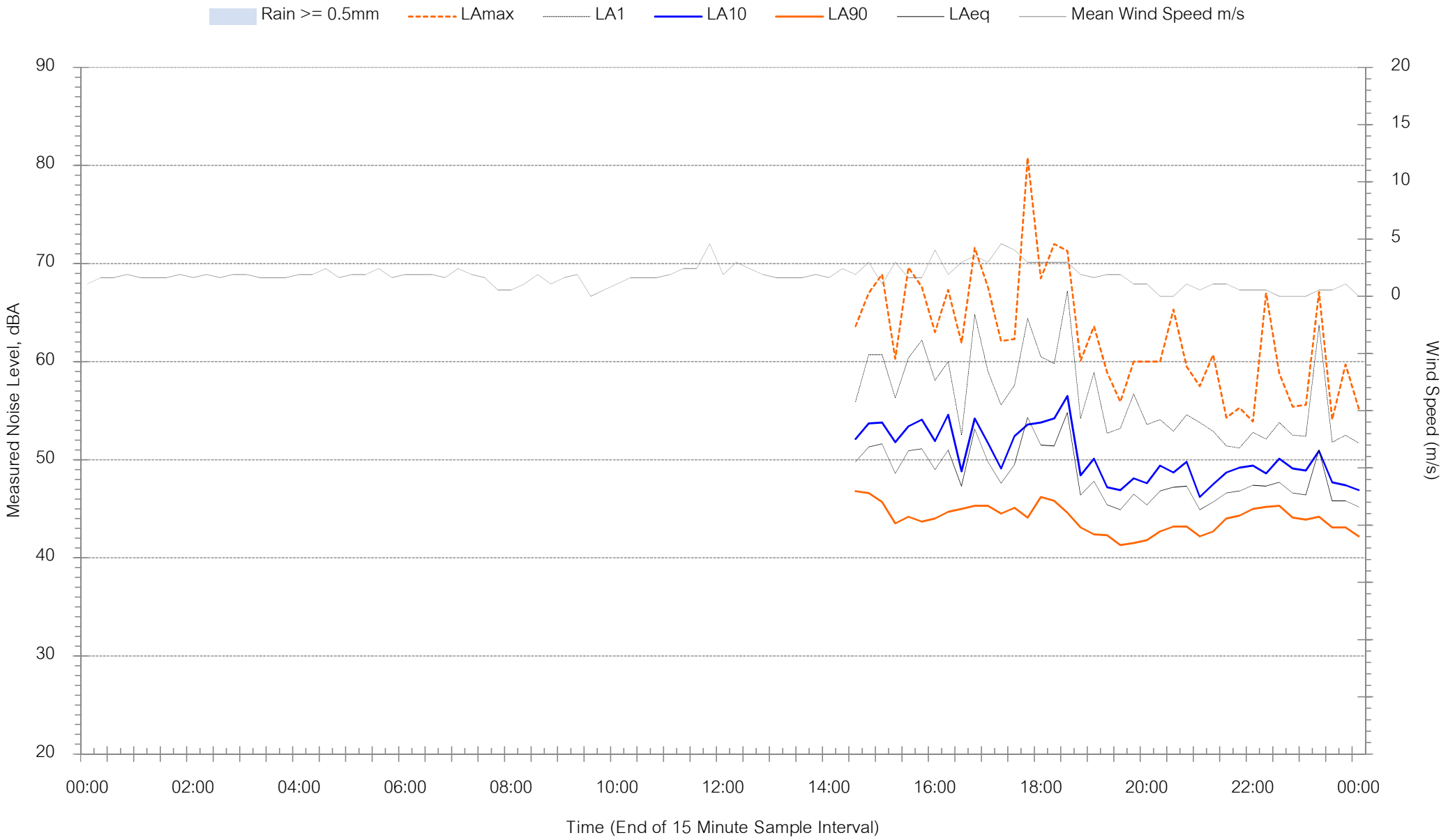

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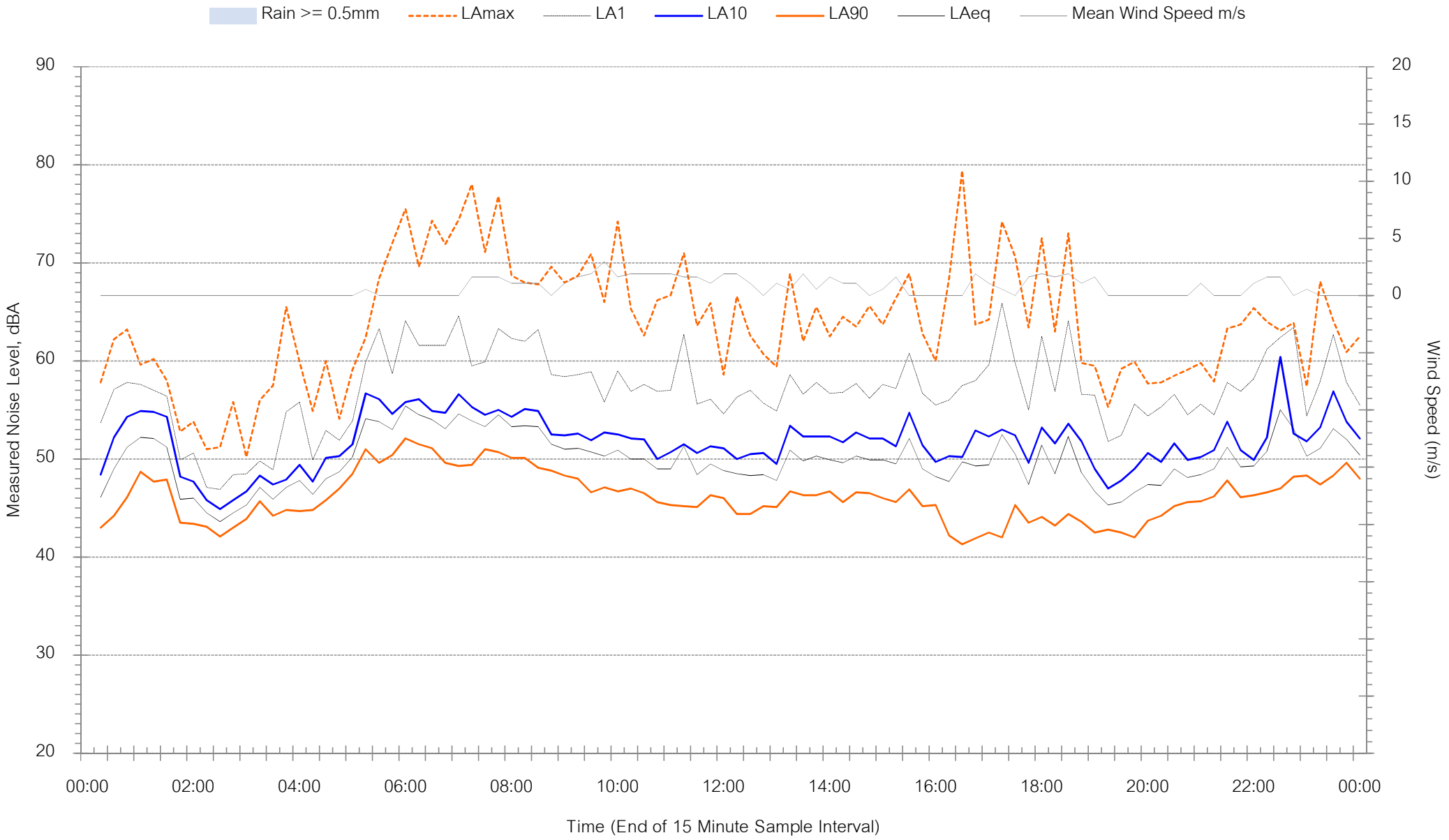

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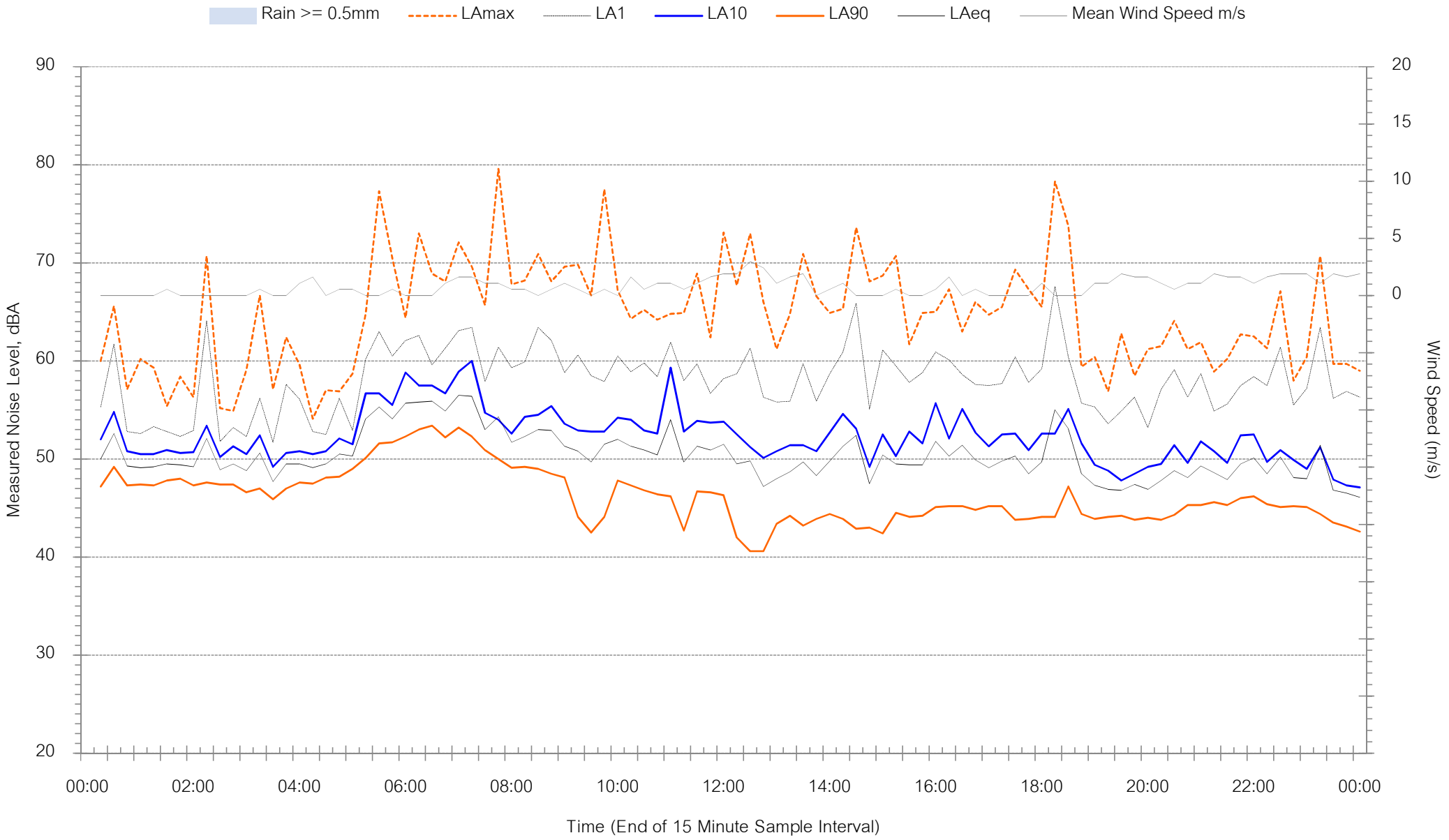

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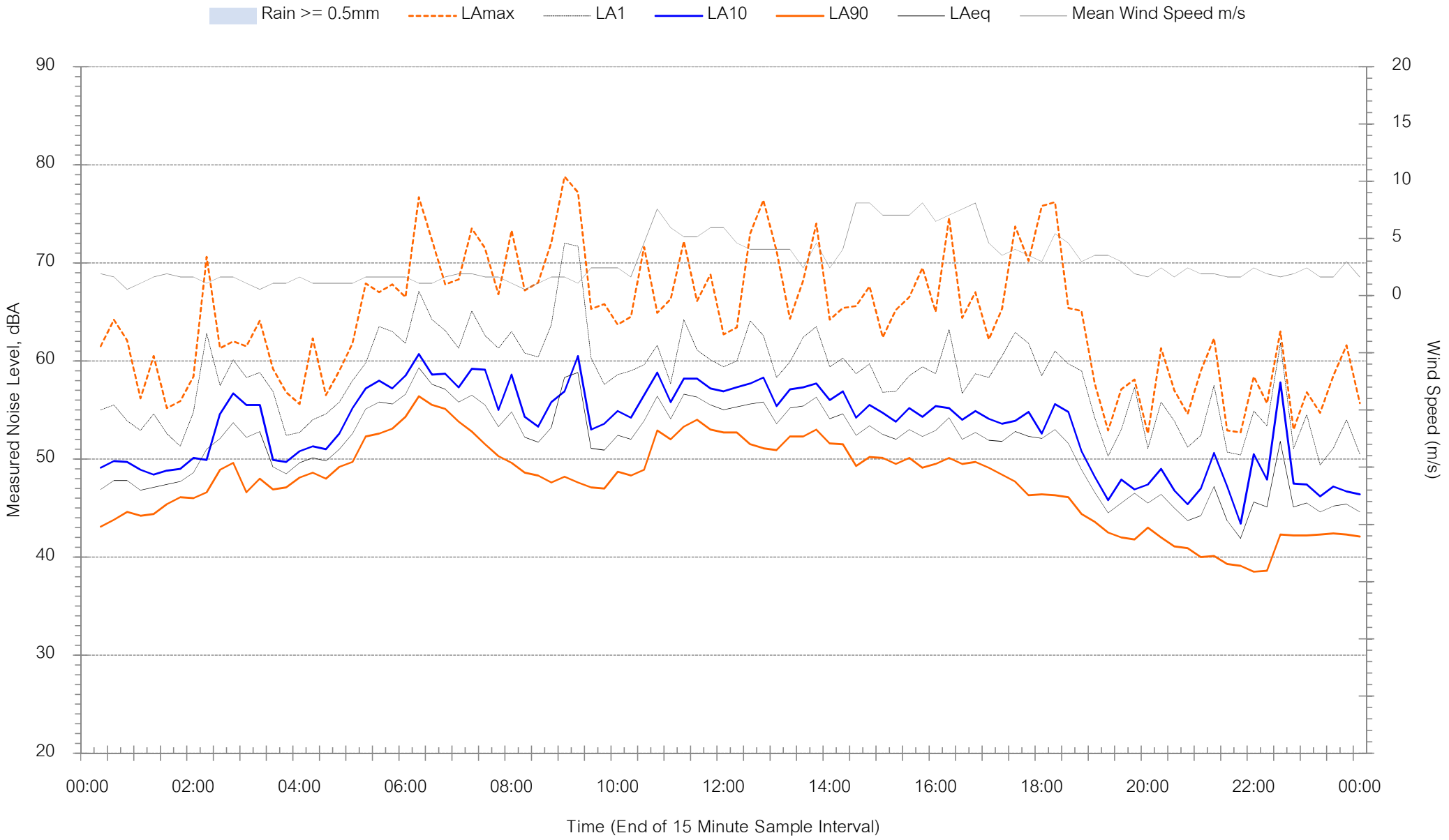

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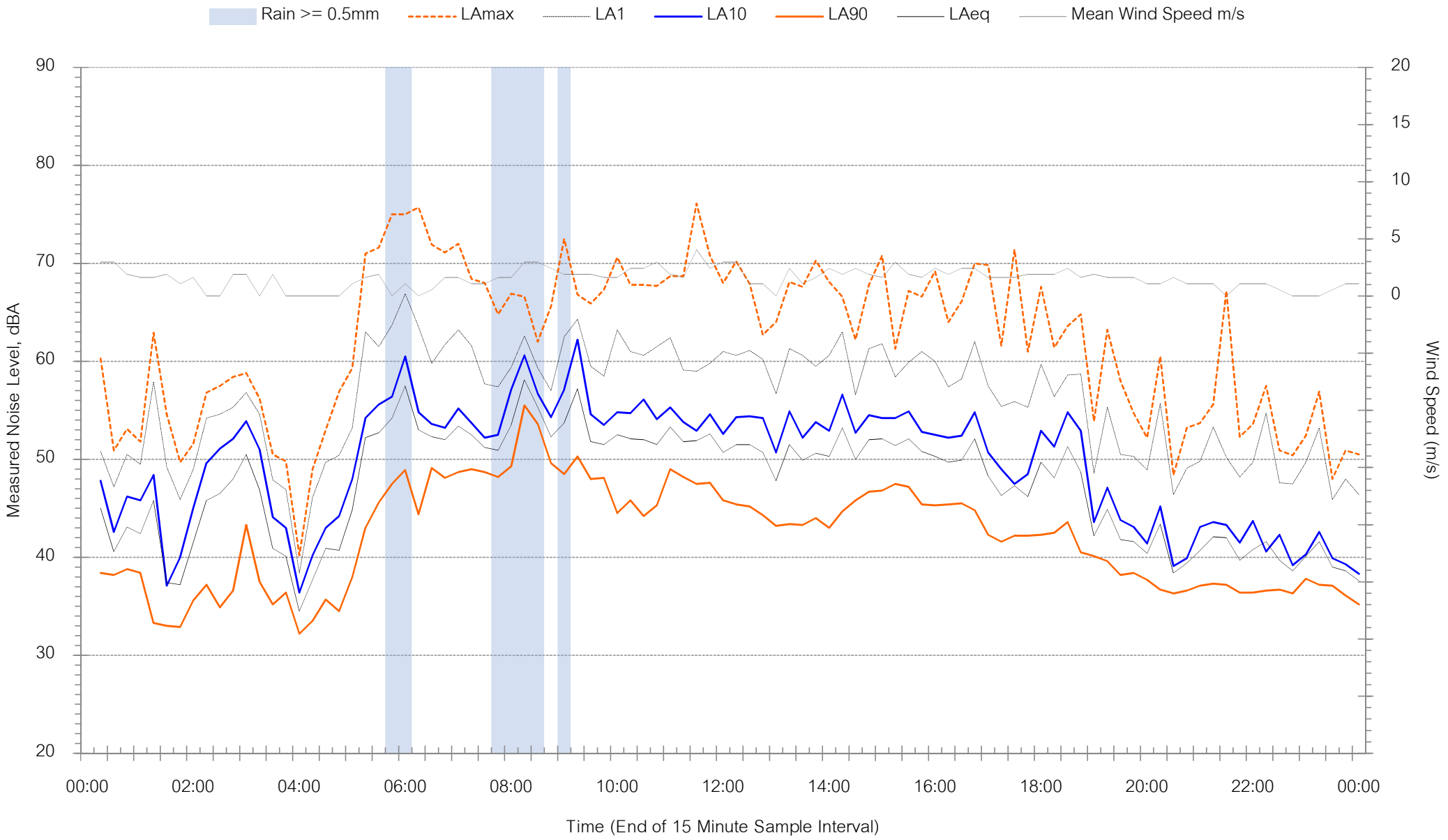

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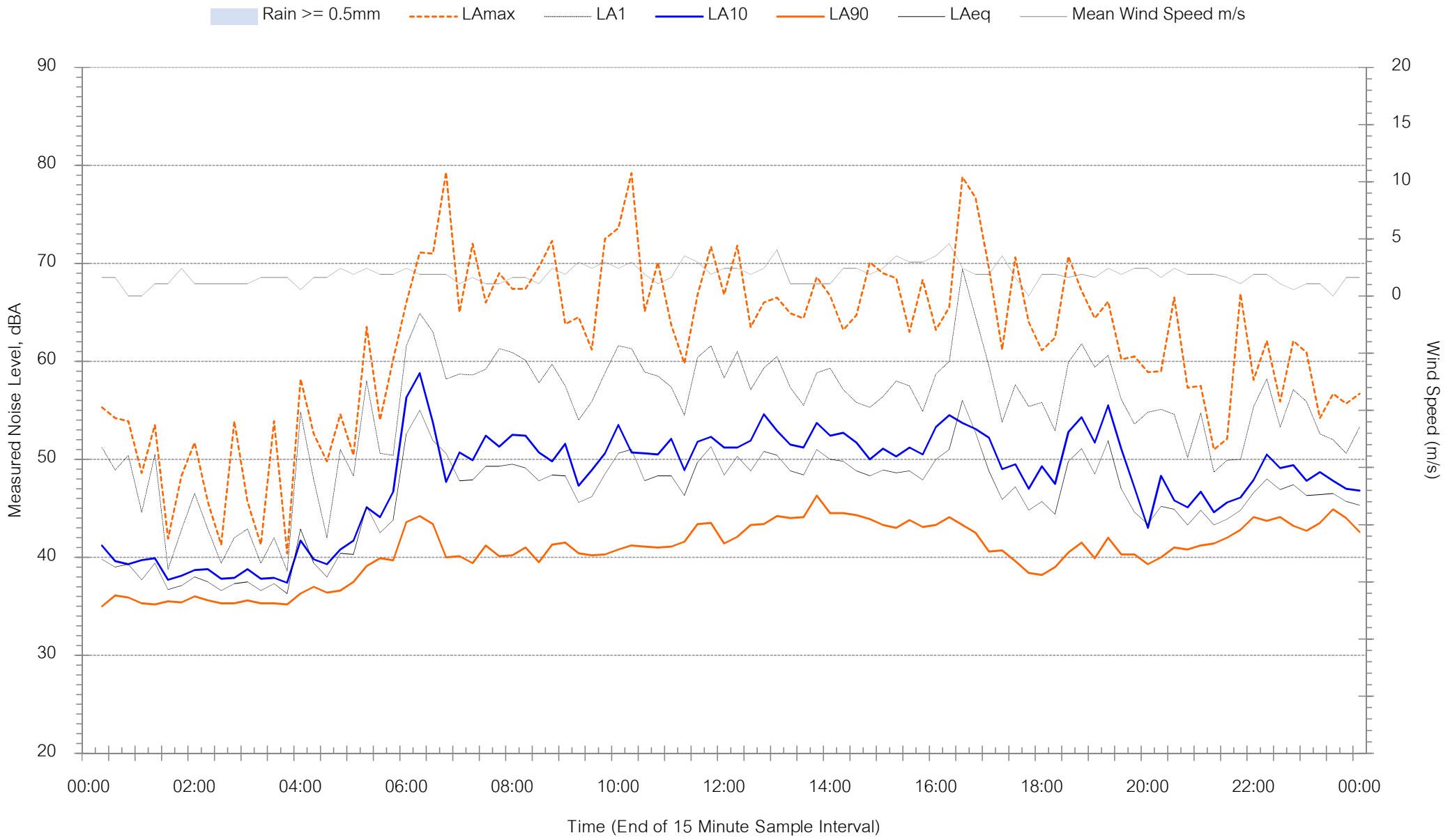

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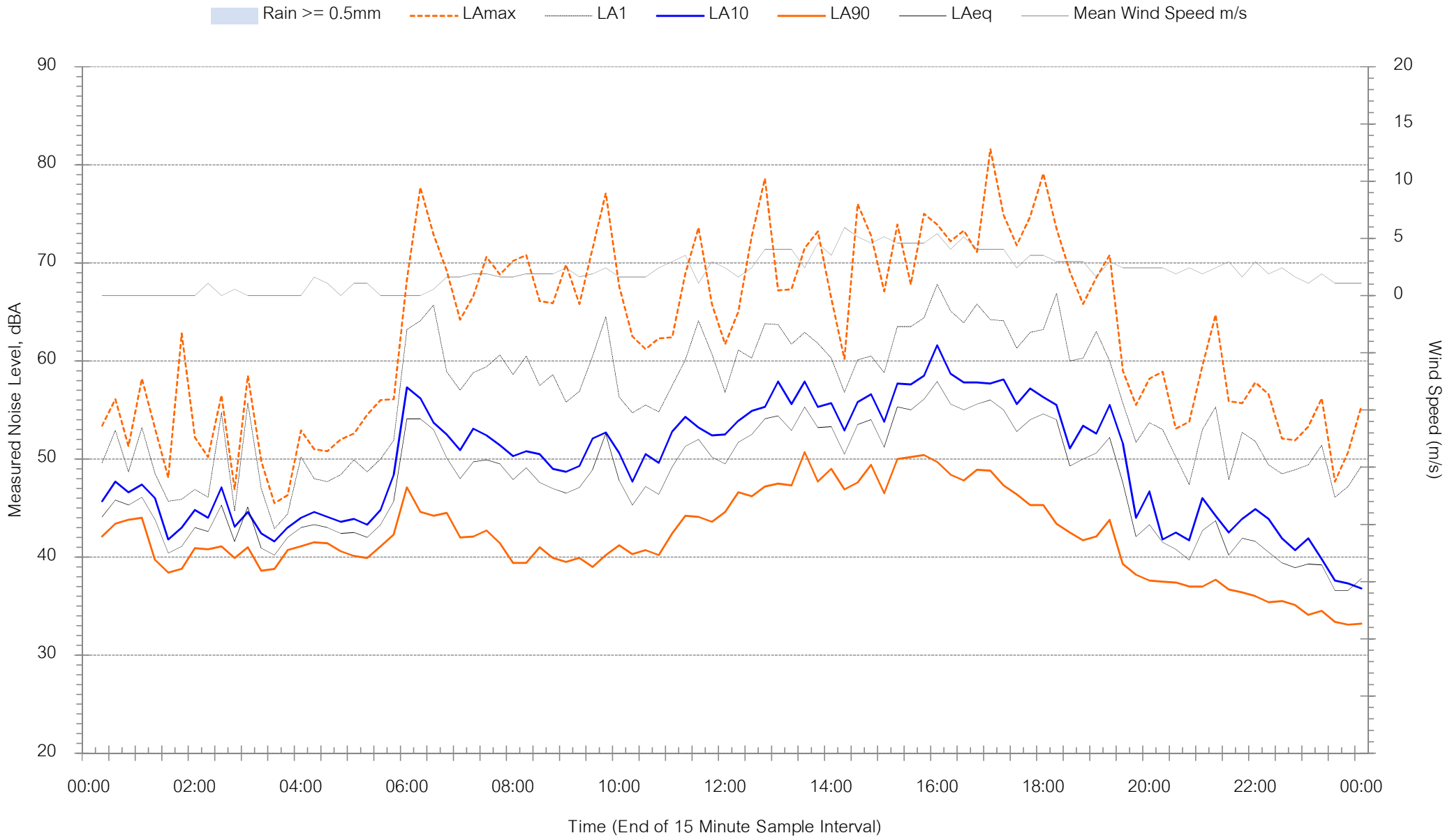

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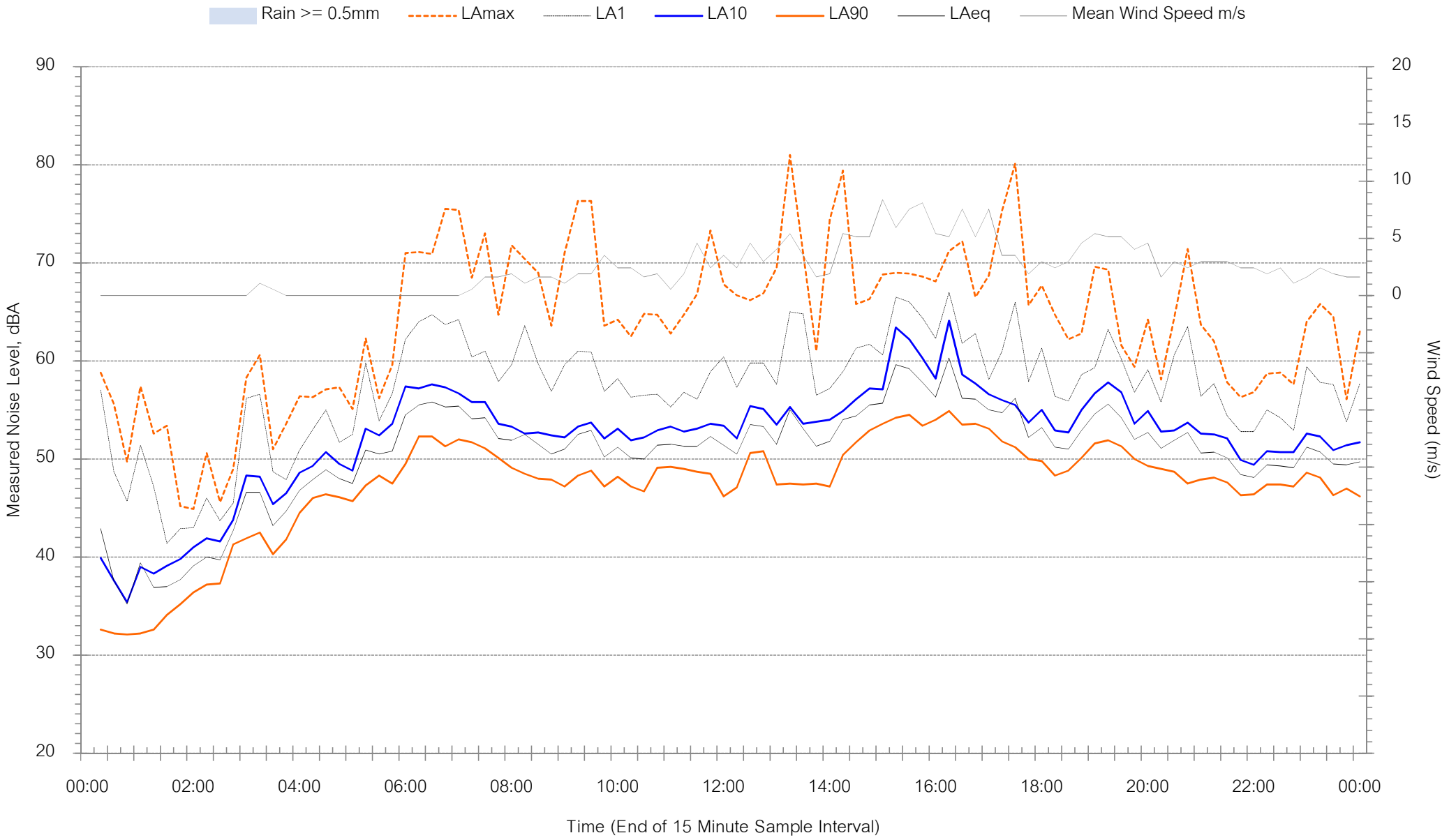

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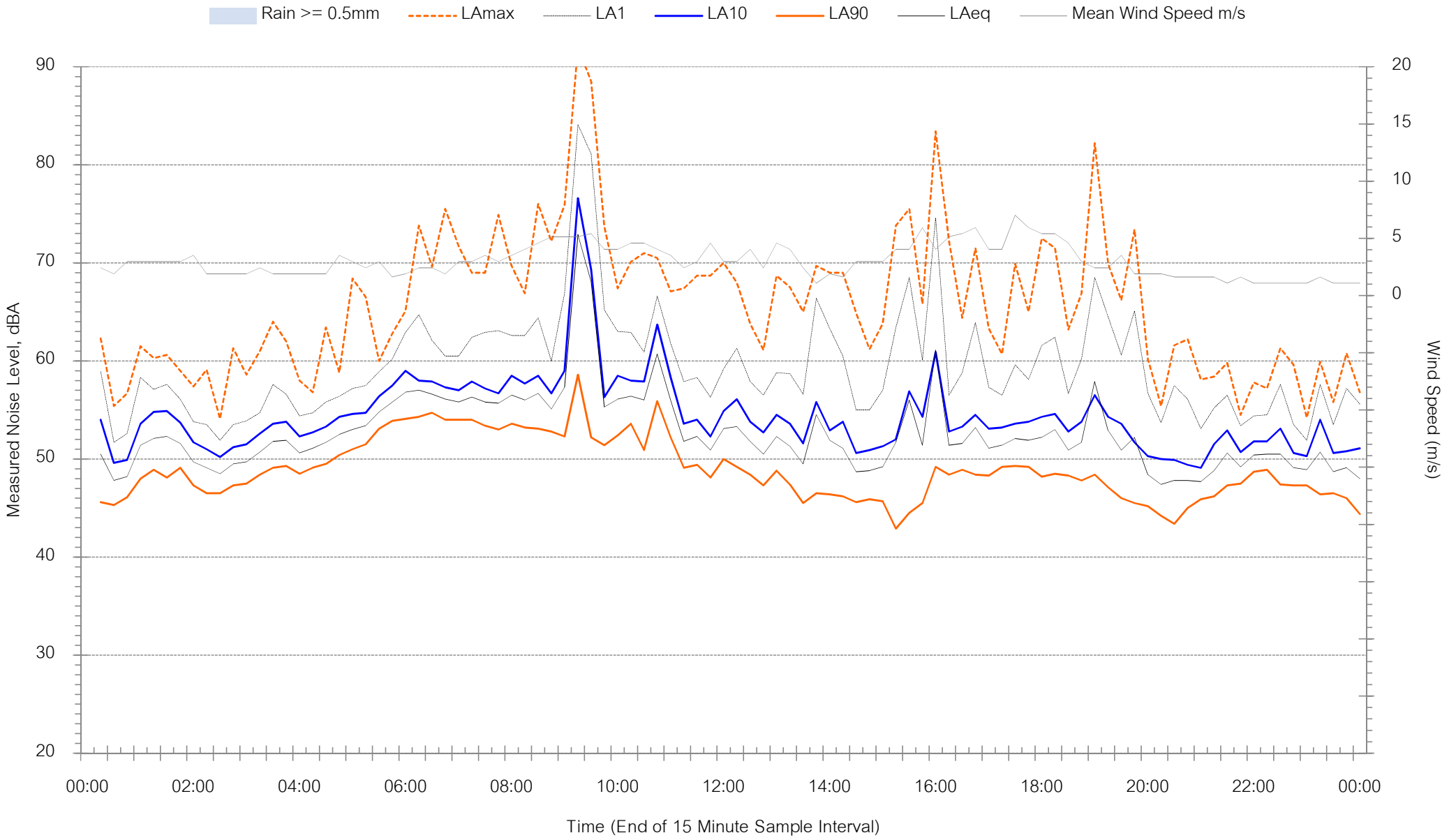

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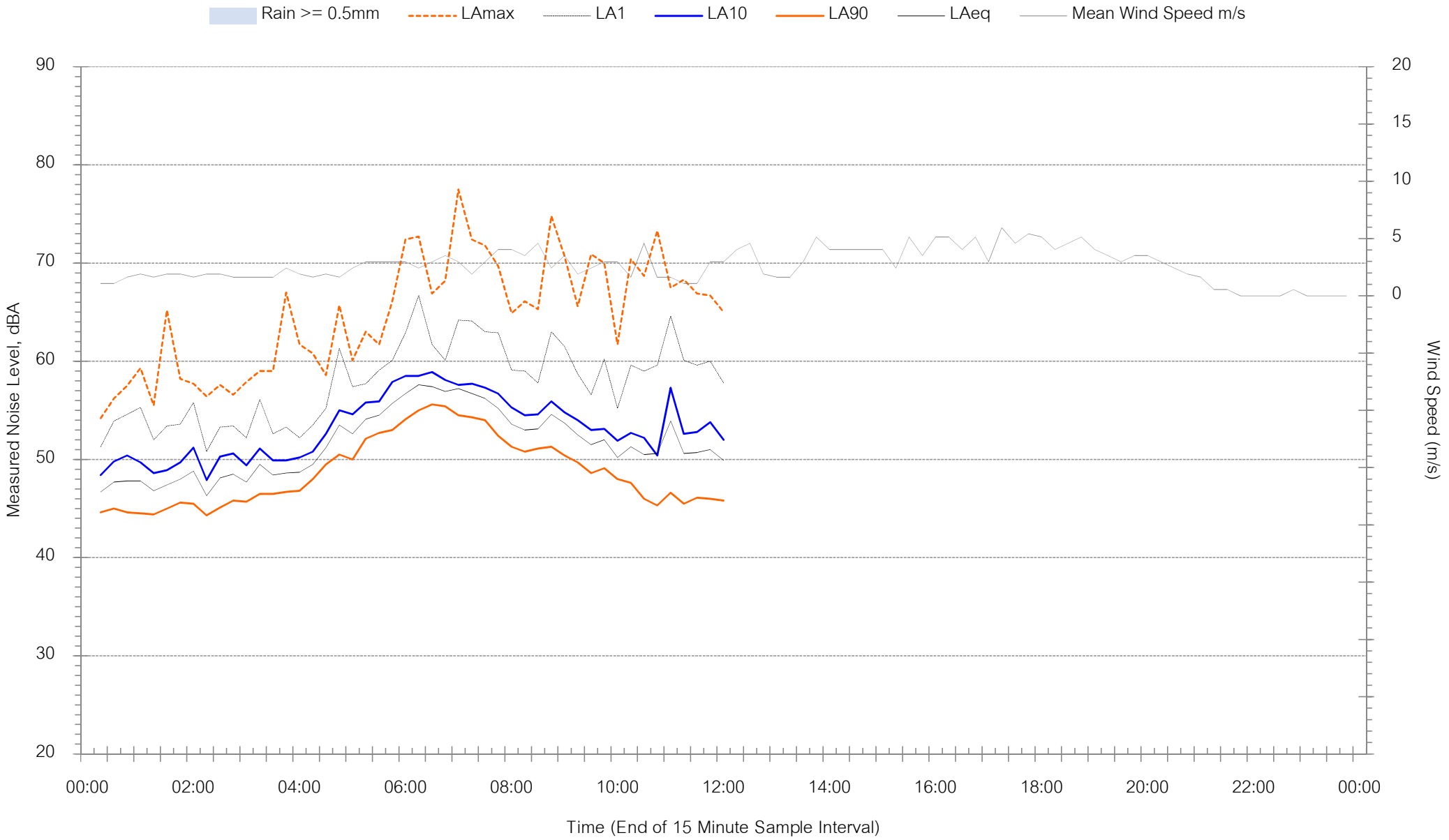

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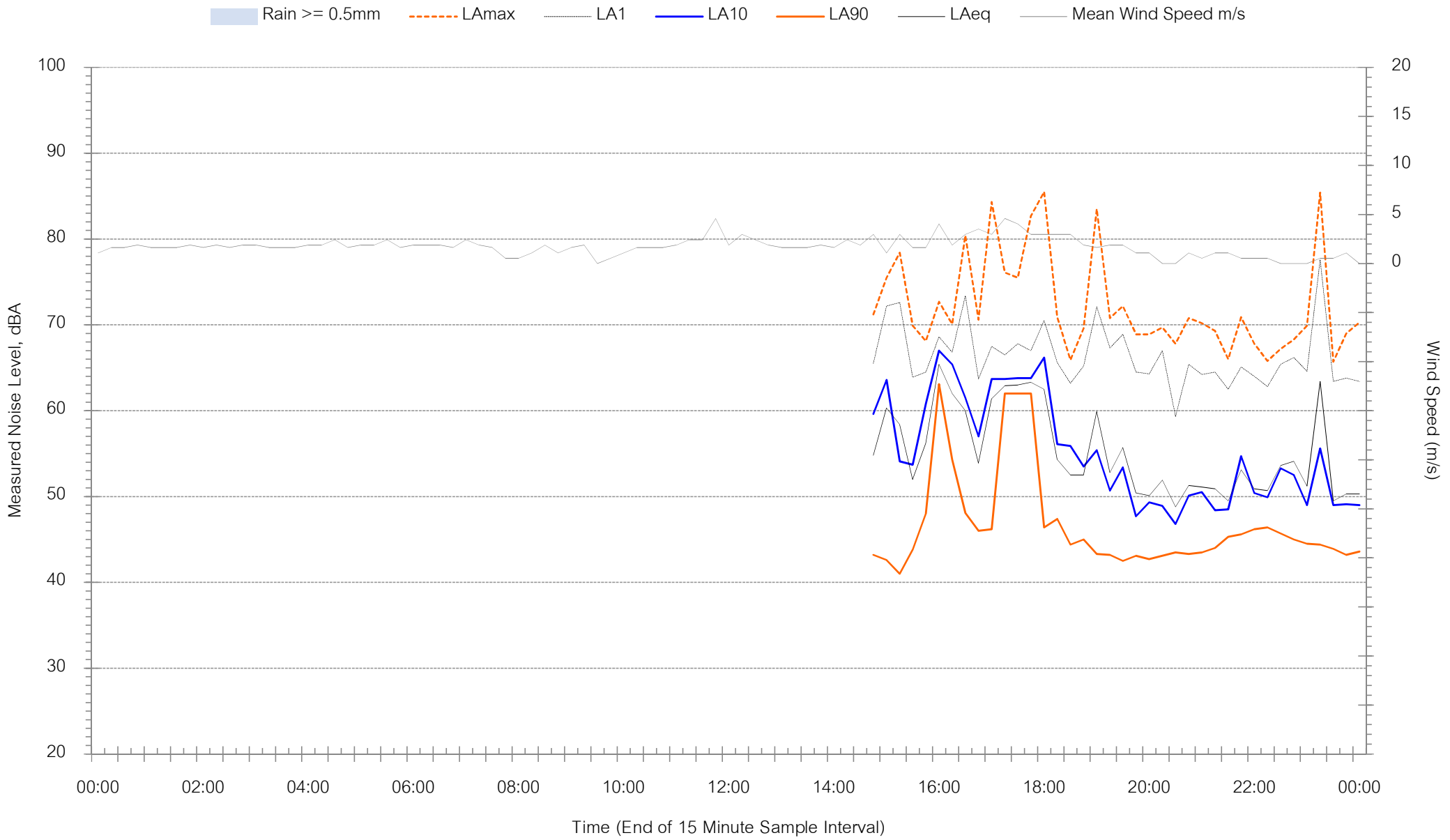

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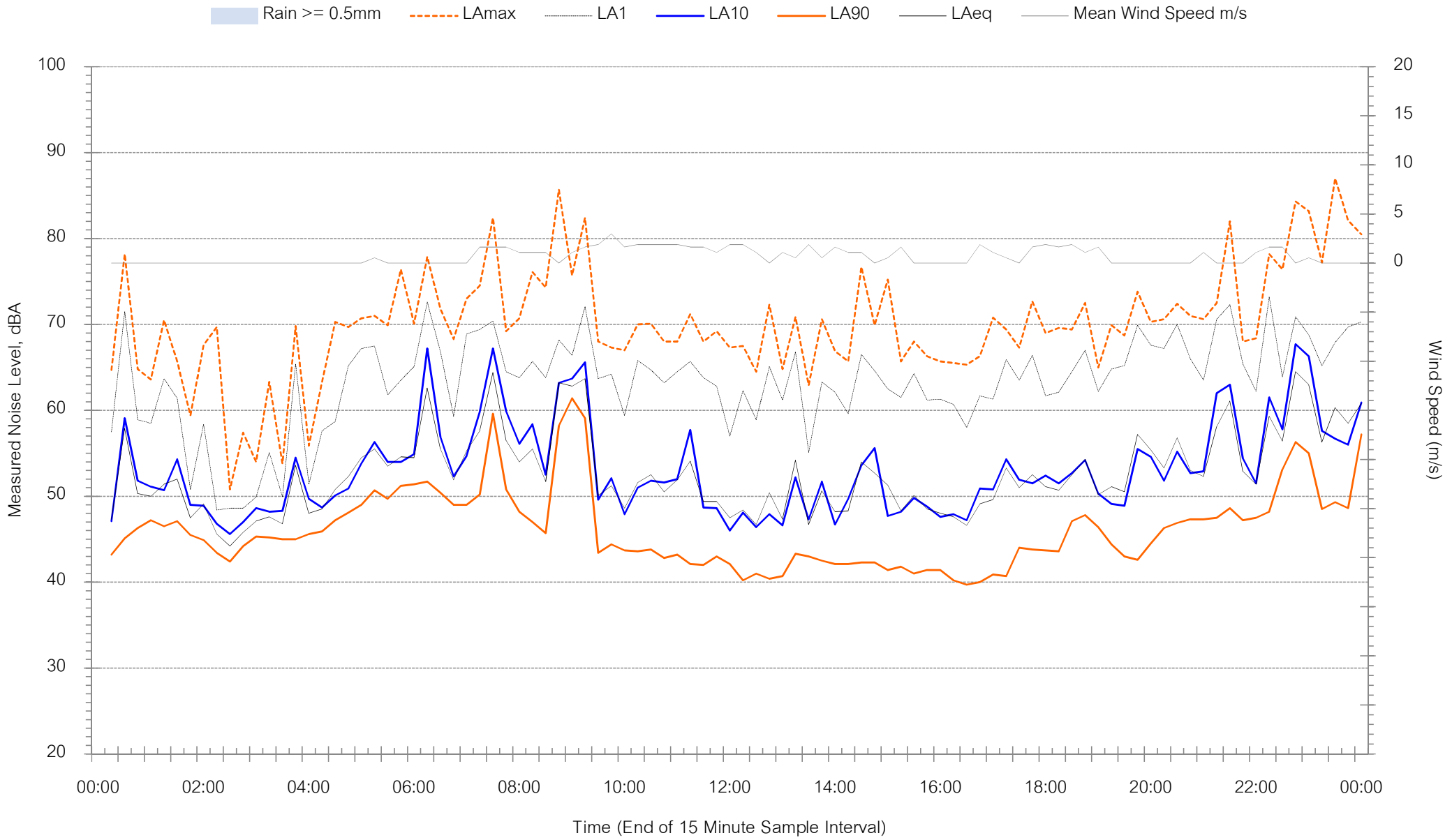

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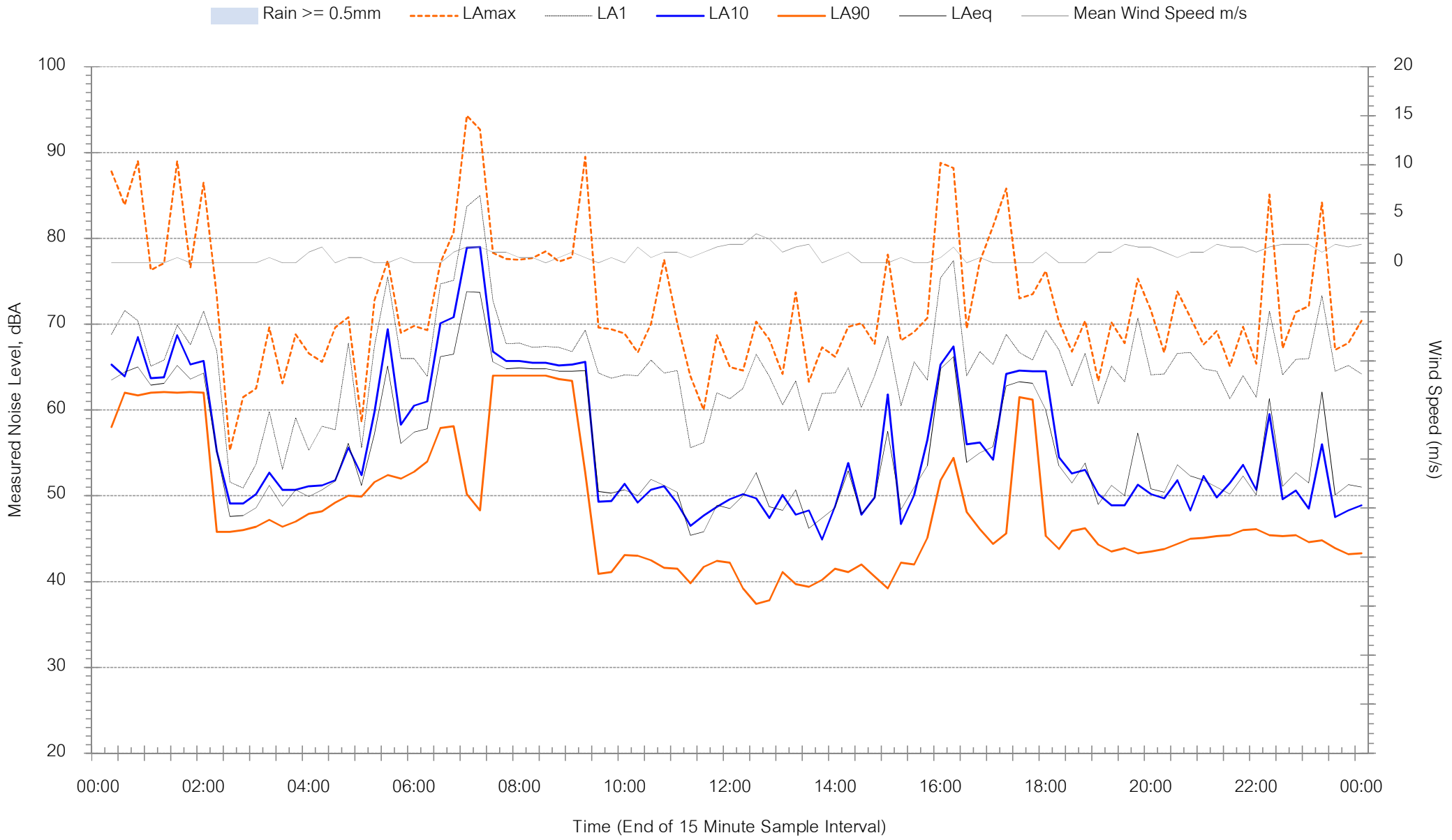

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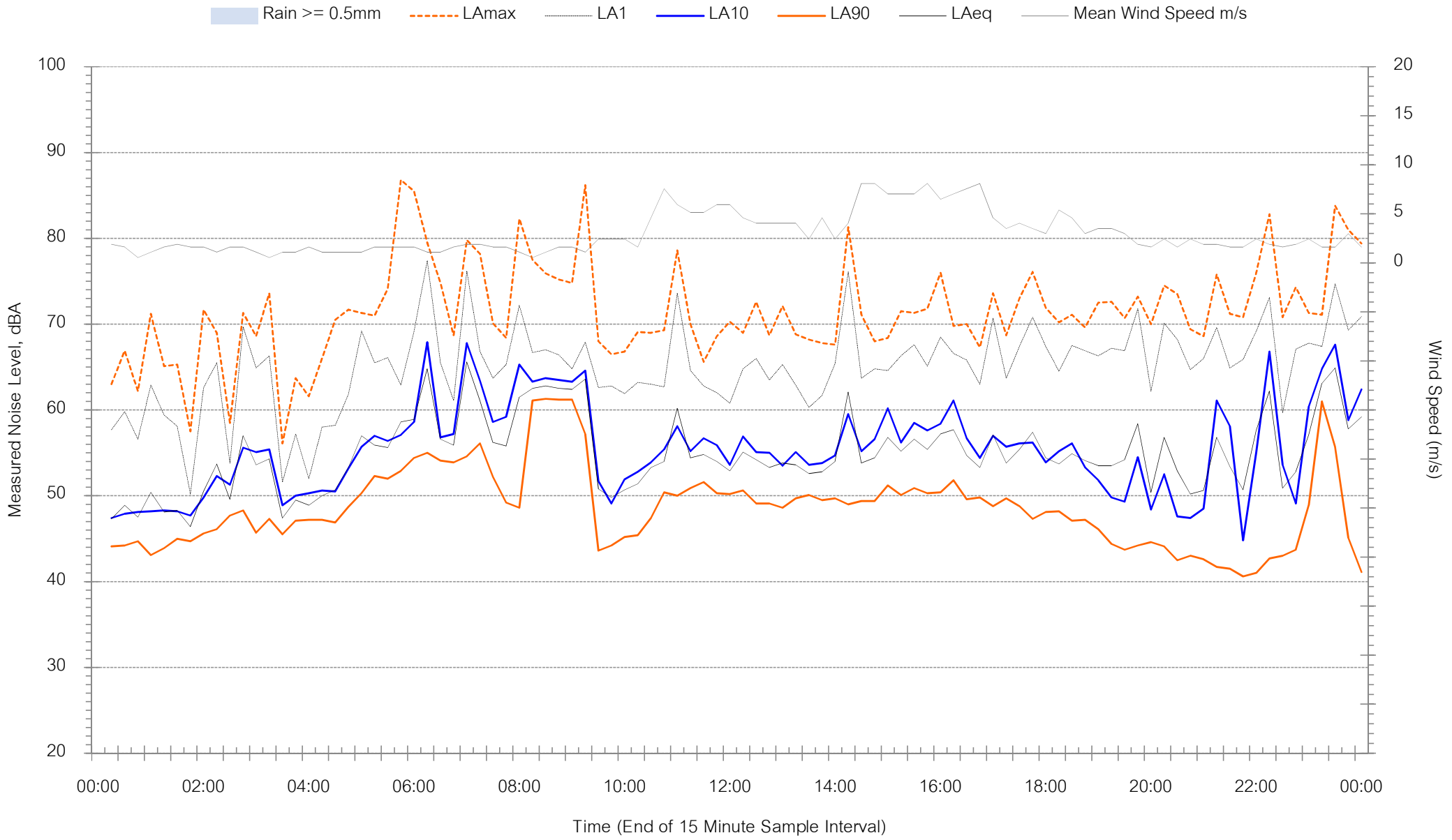

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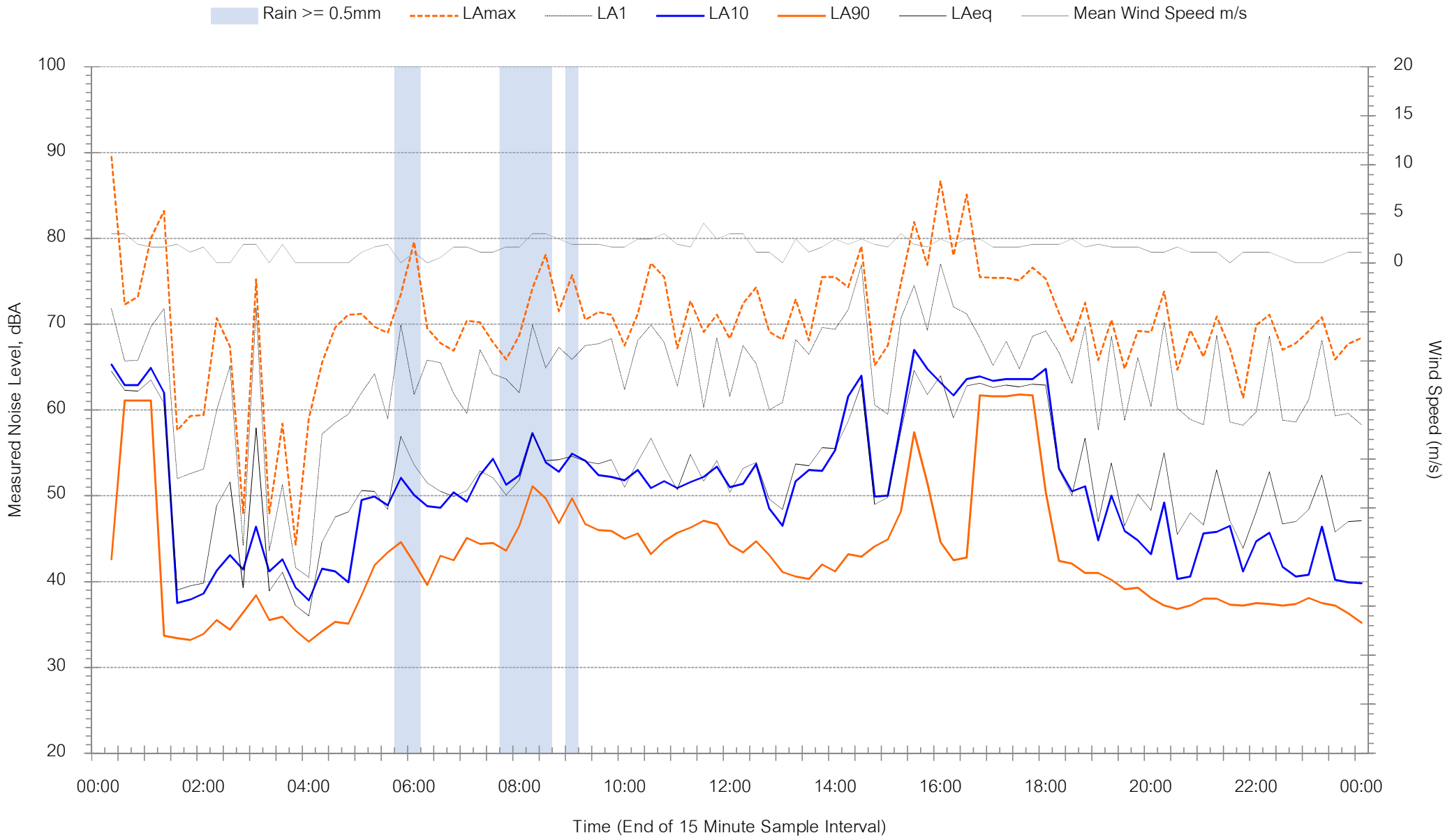

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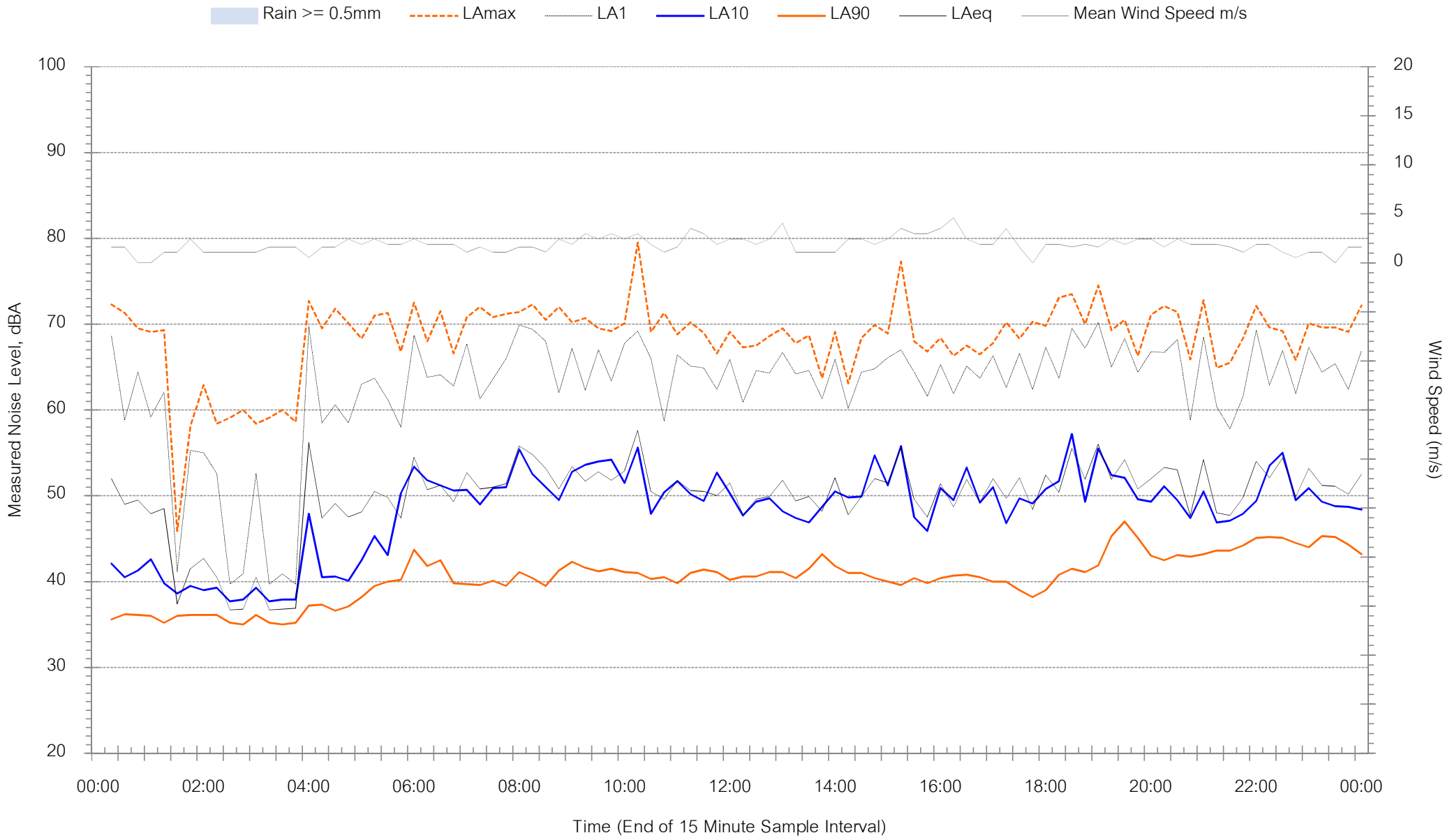

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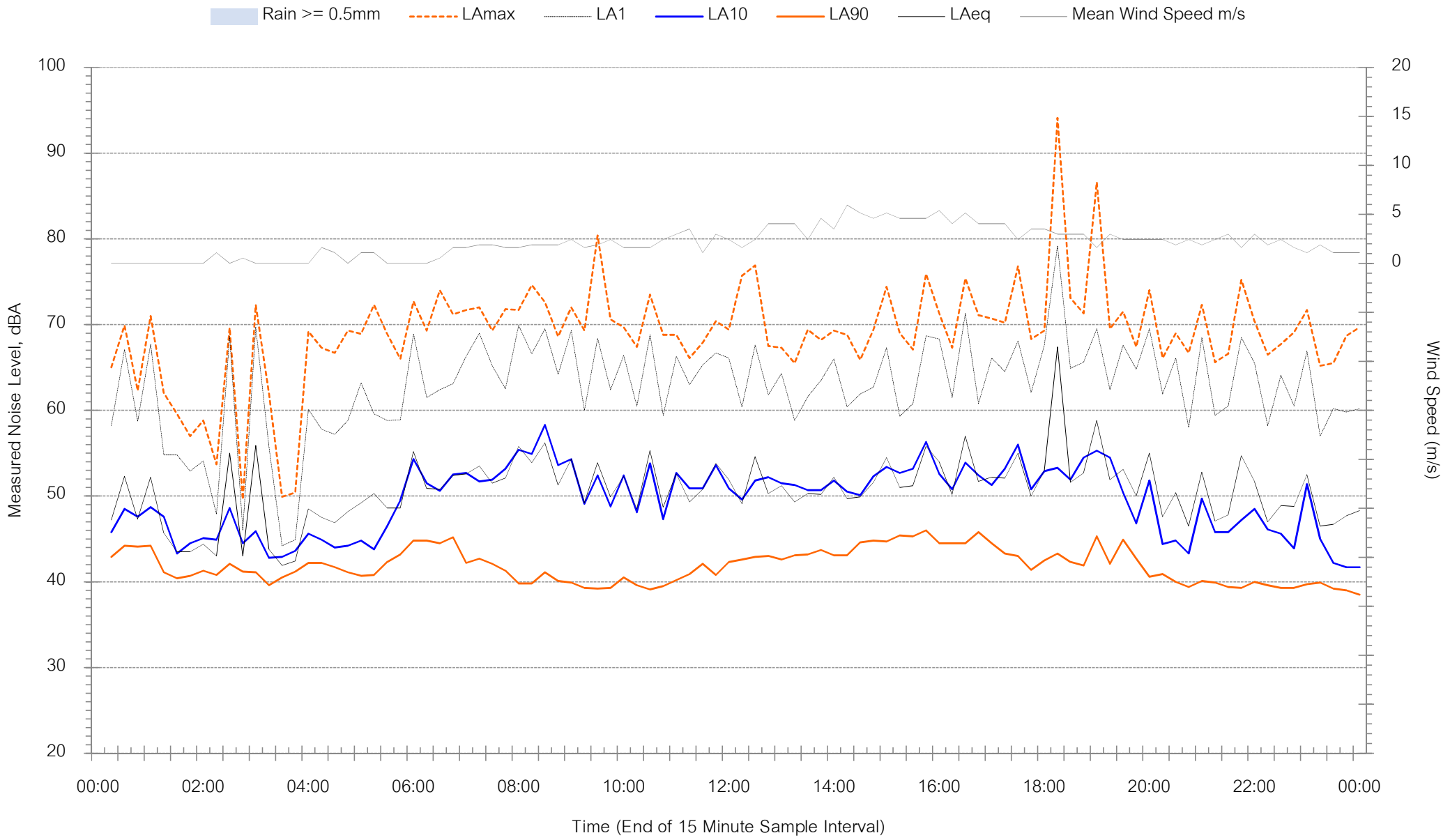

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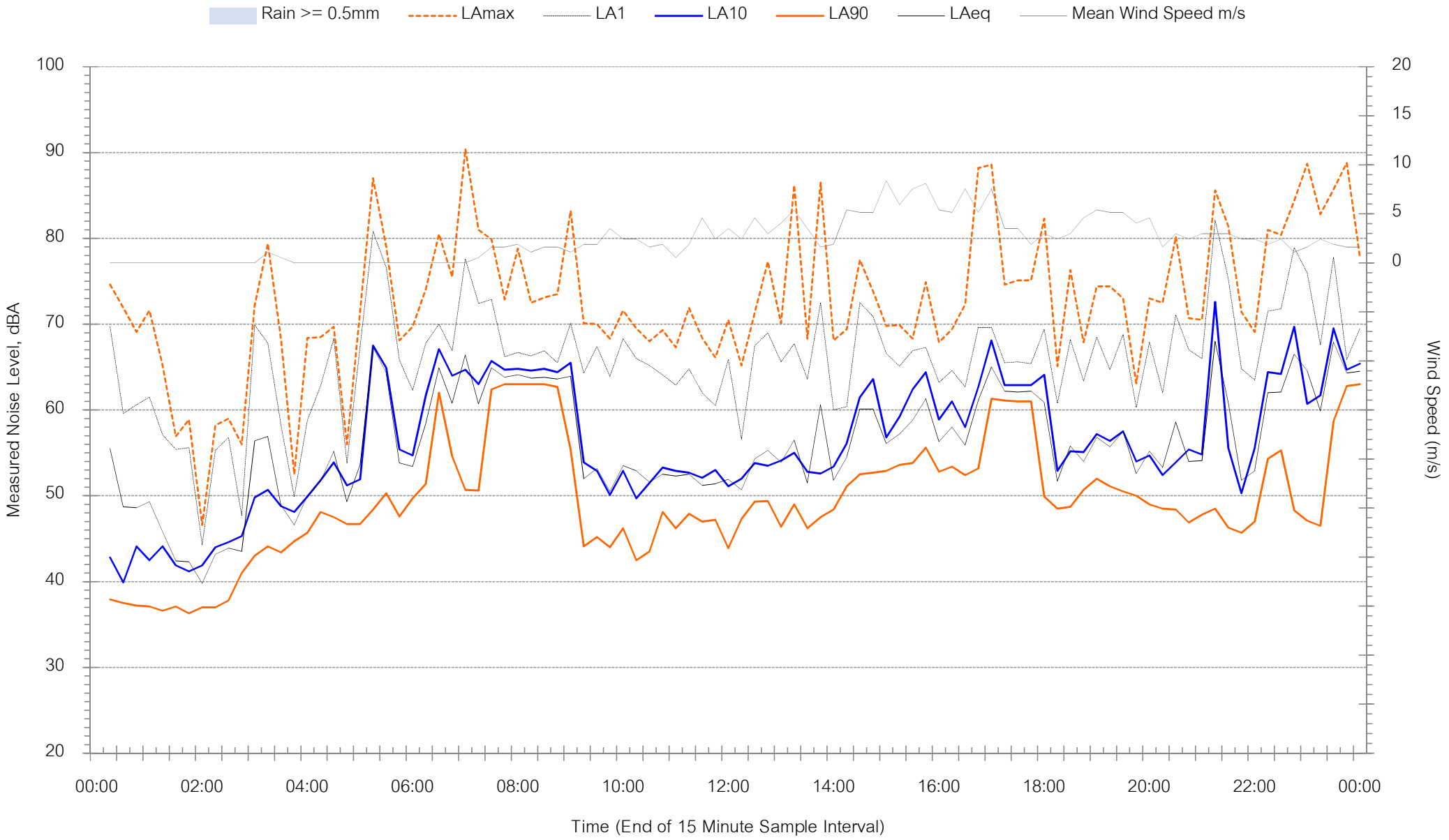

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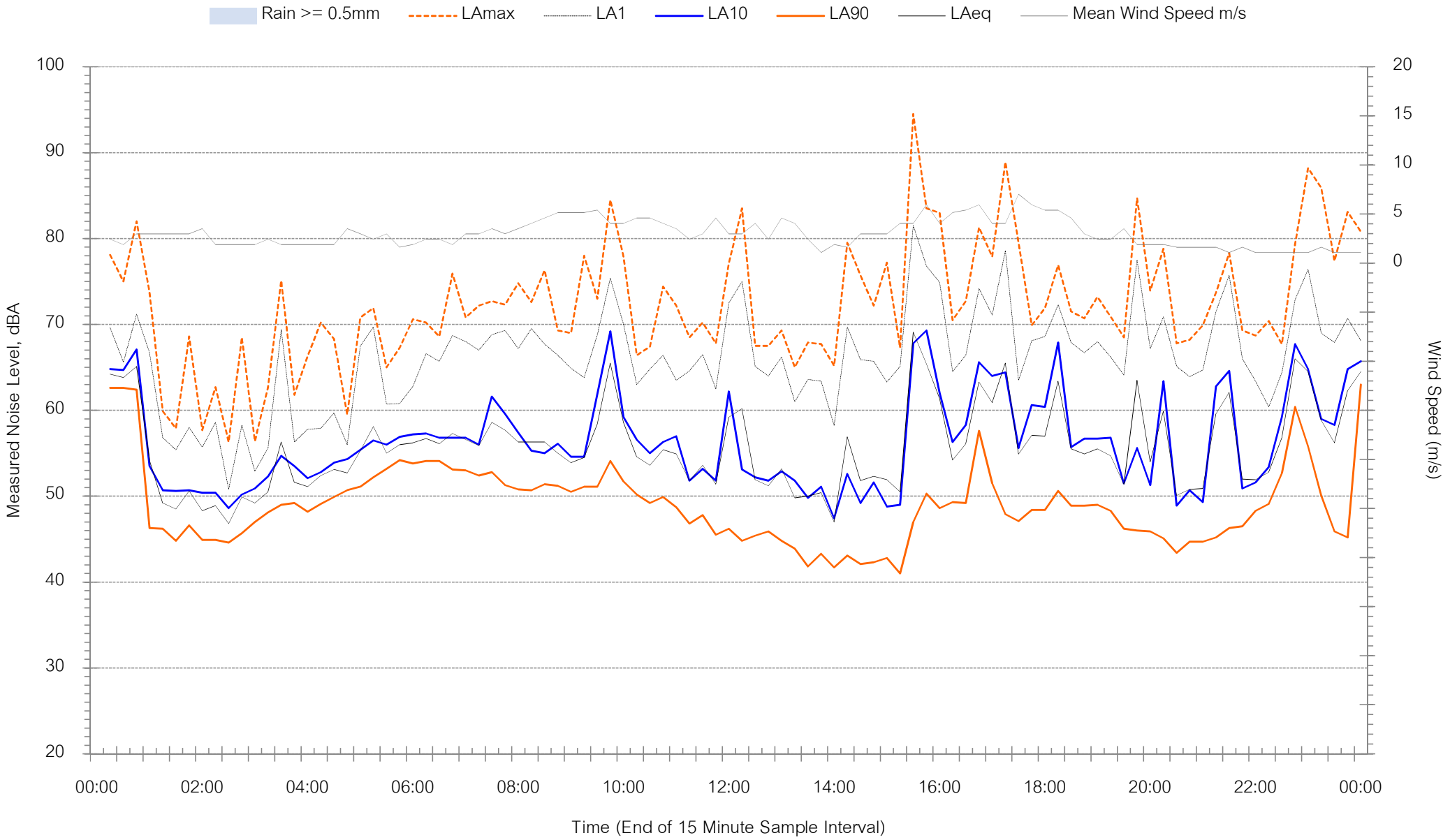

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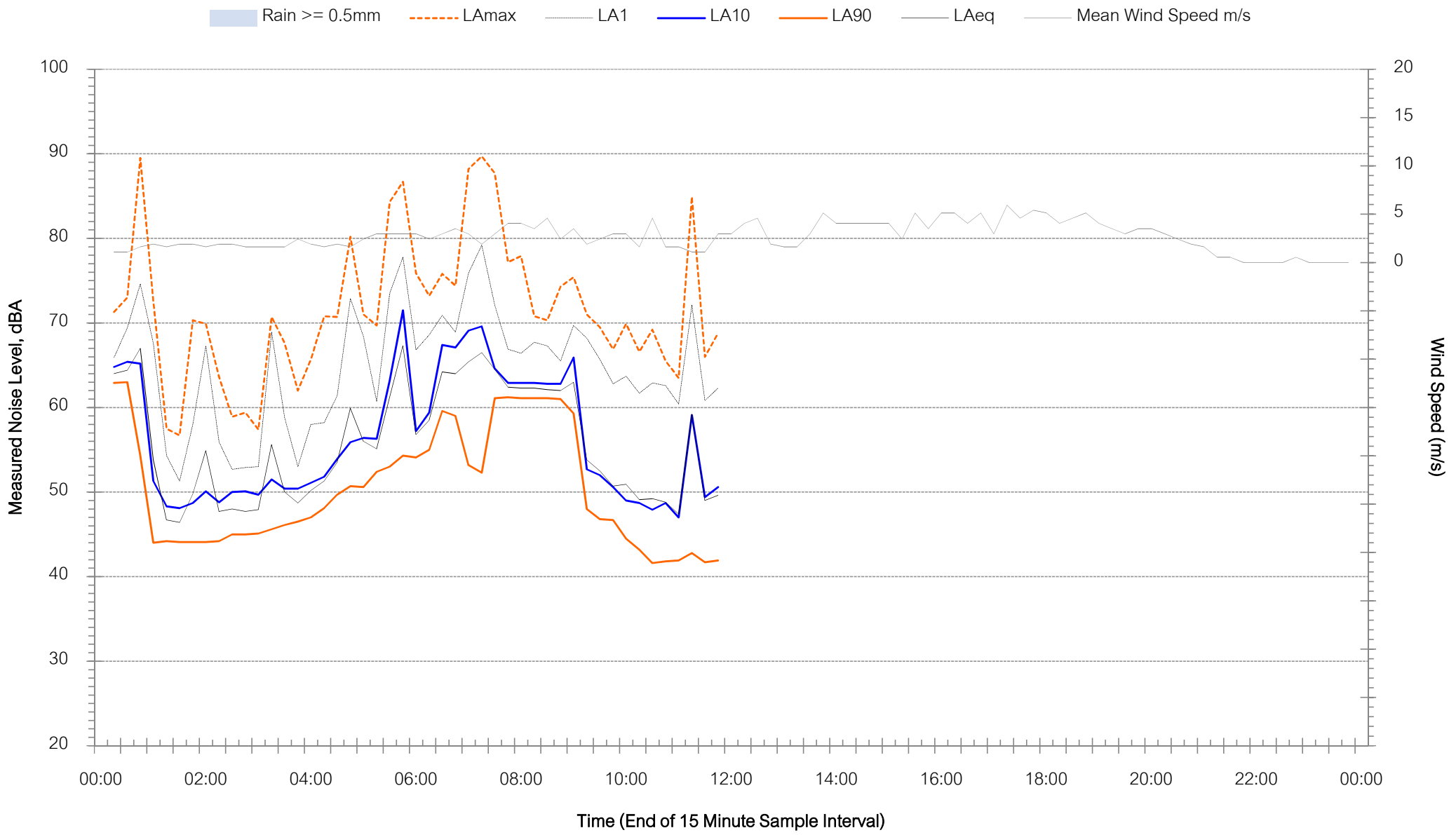

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Muller Acoustic Consulting

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 1 Ending March 2020.

Prepared for: Holcim (Australia) Pty Ltd
January 2020
MAC180611-01RP7

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Muller Acoustic Consulting

Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 1 Ending March 2020

Prepared for: Holcim (Australia) Pty Ltd

Prepared by: Muller Acoustic Consulting Pty Ltd
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Document ID	Status	Date	Prepared By	Signed	Reviewed By	Signed
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APPENDIX A – GLOSSARY OF TERMS

APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending March 2020 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS/NZS IEC 61672.1:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

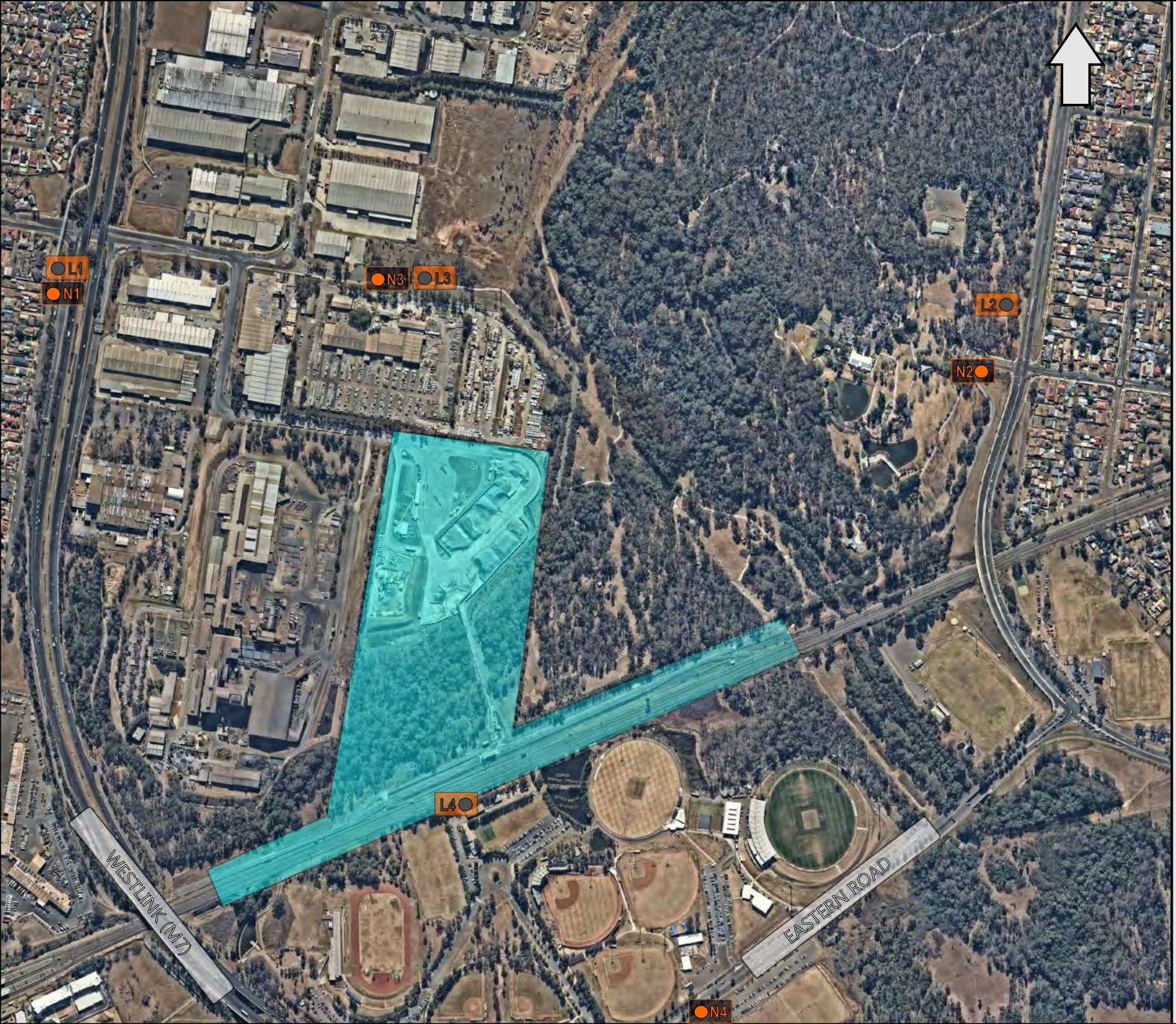

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

- N1 MONITORING LOCATION
- L1 LOGGER LOCATION
- SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Wednesday 8 January 2020. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019 Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15-minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for a minimum of seven days in general accordance with the procedures described AS 1055:2018 and the RDC Consolidated Consent. Noise measurements were carried out using Svantek Type 1, 977 noise analysers from Wednesday 8 January 2020 to Friday 17 January 2020. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1.2019. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/01/2020	13:33 (Day)	80	61	52	WD: E WS: 1m/s Rain: Nil	Traffic 48-80 Birds 58-67 Local residential noise <58 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<42
08/01/2020	20:01 (Evening)	70	53	47	WD: E WS: 0.5m/s Rain: Nil	Birds 48-60 Traffic 46-70 Local residential noise <47 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<37
08/01/2020	22:19 (Night)	68	51	43	WD: E WS: 1m/s Rain: Nil	Traffic 46-68 Local residential noise 46-51 Insects <46 Wind <46 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<33
RDC $L_{A1(1min)}$ Contribution						<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/01/2020	14:07 (Day)	81	64	53	WD: E WS: 2m/s Rain: Nil	Traffic 44-81 Birds 49-57 Wind <57 Aircraft 48-56 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<40
08/01/2020	20:45 (Evening)	65	56	53	WD: E WS: 0.5m/s Rain: Nil	Insects 53-56 Traffic 54-65 Train 48-54 Birds <54 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<39
08/01/2020	22:43 (Night)	62	53	47	WD: SE WS: 1m/s Rain: Nil	Traffic 46-62 Insects <46 Train 46-52 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<37
RDC $L_{A1(1min)}$ Contribution						<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/01/2020	14:30 (Day)	77	58	53	WD: E WS: 2m/s Rain: Nil	Traffic 49-60 Wind 52-58 Birds 48-56 Insects <48 Aircraft 48-54 Industrial noise 50-77 Holcim loader <50
RDC $L_{Aeq(15min)}$ Contribution						<50
08/01/2020	20:21 (Evening)	72	53	47	WD: E WS: 1m/s Rain: Nil	Industrial noise 46-49 Birds 46-51 Traffic 48-72 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<37
08/01/2020	22:00 (Night)	60	49	47	WD: E WS: 1m/s Rain: Nil	Industrial noise 46-48 Aircraft 46-56 Wind <46 Traffic <46 Car Horn 60 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<37

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
08/01/2020	15:17 (Day)	63	52	50	WD: E WS: 2m/s Rain: Nil	Wind 50-58 Birds 48-63 Traffic 46-54 Train 48-54 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40
08/01/2020	21:08 (Evening)	78	66	53	WD: E WS: 0.1m/s Rain: Nil	Local residential noise <58 Traffic 48-78 Insects <48 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<38
08/01/2020	23:08 (Night)	86	64	49	WD: E WS: 1m/s Rain: Nil	Traffic 48-86 Aircraft 46-49 Insects <49 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<39

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq(period)}$[2]	Measured Background Noise Level (LA_{90}) dB RBL[2]
L1 (N1 Station Street)	Day	61	46
	Evening	69	41
	Night	51	34
L2 (N2 Knox Road)	Day	57	48
	Evening	57	46
	Night	53	36
L3 (N3 Nurragingy Reserve)	Day	54	47
	Evening	52	45
	Night	51	44
L4 (N4 Olympic Park)	Day	62	43
	Evening	62	40
	Night	60	38

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Discussion

5.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all three attended measurements conducted on Wednesday 8 January 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous noise sources included birds, local residential noise, insects and wind in trees, with ambient noise levels dominated by traffic noise.

5.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during the day, evening and night attended measurements conducted on Wednesday 8 January 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous sources measured include traffic, birds, wind in trees, aircraft, train and insects.

5.3 Discussion of Results - Location N3

Attended measurements on Wednesday 8 January 2020 identified that RDC noise was audible during the daytime measurements, with evening and night measurements inaudible. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous sources audible during the attended surveys included traffic, wind in trees, birds, insects, aircraft and industrial noise which generally masked RDC noise. For the evening and night periods, it is noted the receiver was not in use and hence criteria are referenced for completeness.

5.4 Discussion of Results - Location N4

RDC noise emissions inaudible during the day, evening and night measurements on Wednesday 8 January 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. It is noted that the sports centre was not in use during the night period and criteria are referenced for completeness. Extraneous noise sources included wind in trees, birds, traffic, train, local residential noise, insects and aircraft noise all audible throughout the attended measurements at this location.

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6 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 1, ending March 2020.

Unattended noise monitoring was completed between Wednesday 8 January 2020 and Friday 17 January 2020 at four representative monitoring locations.

Attended noise monitoring was conducted on Wednesday 8 January 2020. The assessment has identified that noise emissions generated by RDC were inaudible at the nearest residential receivers during the attended monitoring, with all measurements satisfying the relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

Table A1 provides a number of technical terms have been used in this report.

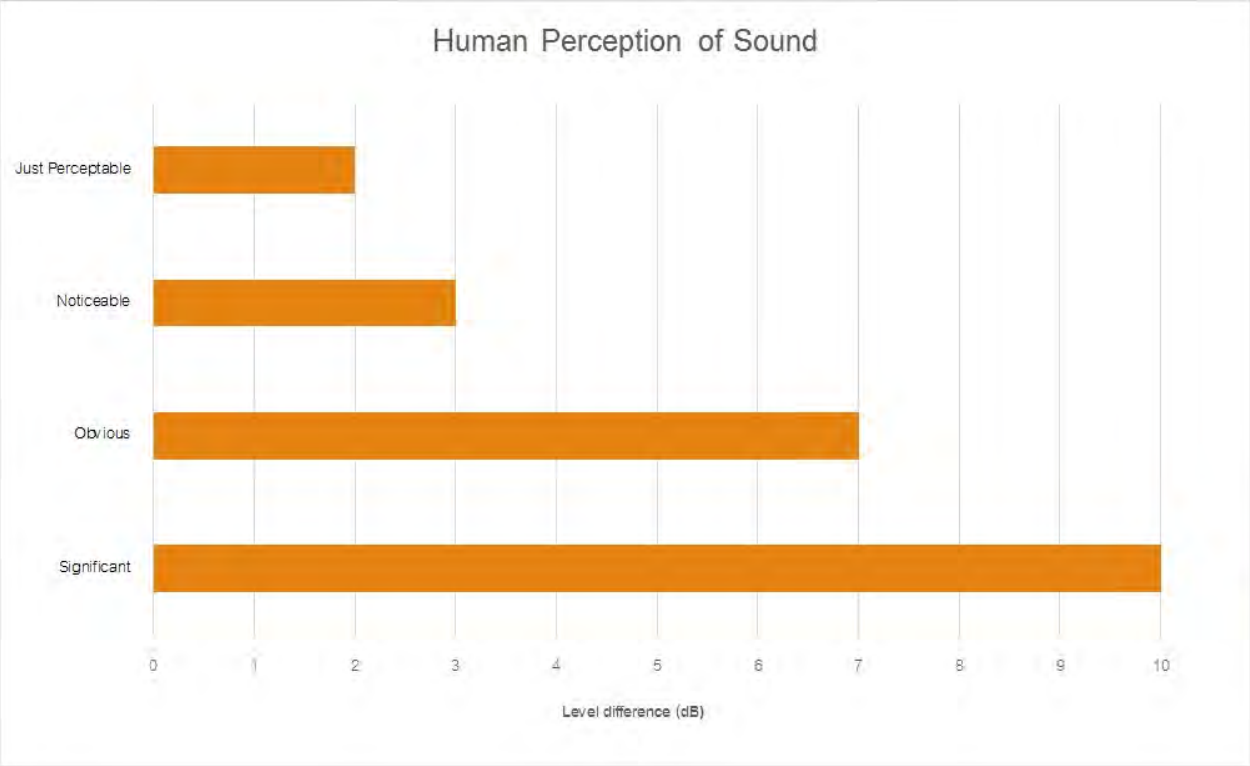
Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA

Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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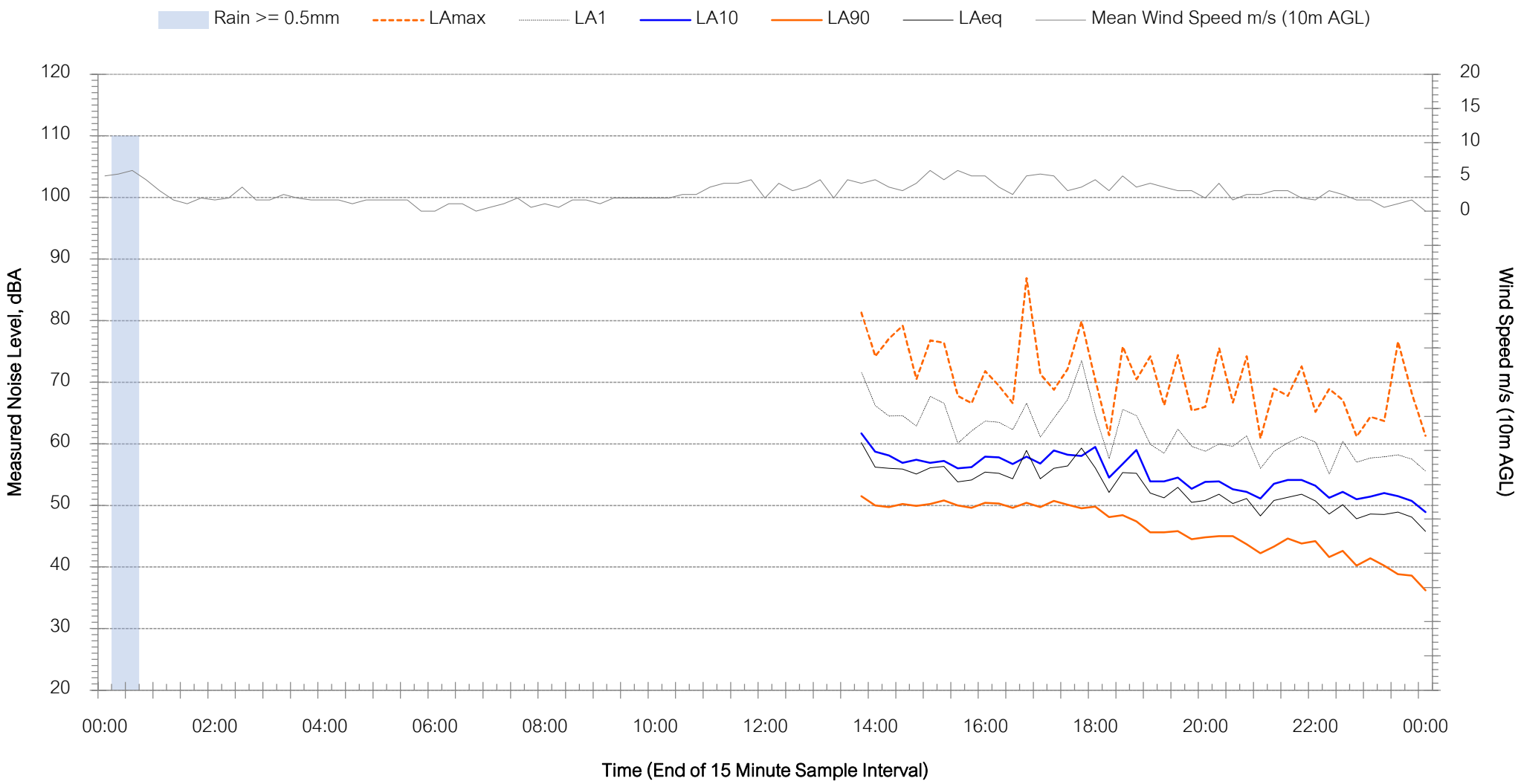
Appendix B – Unattended Noise Monitoring Charts

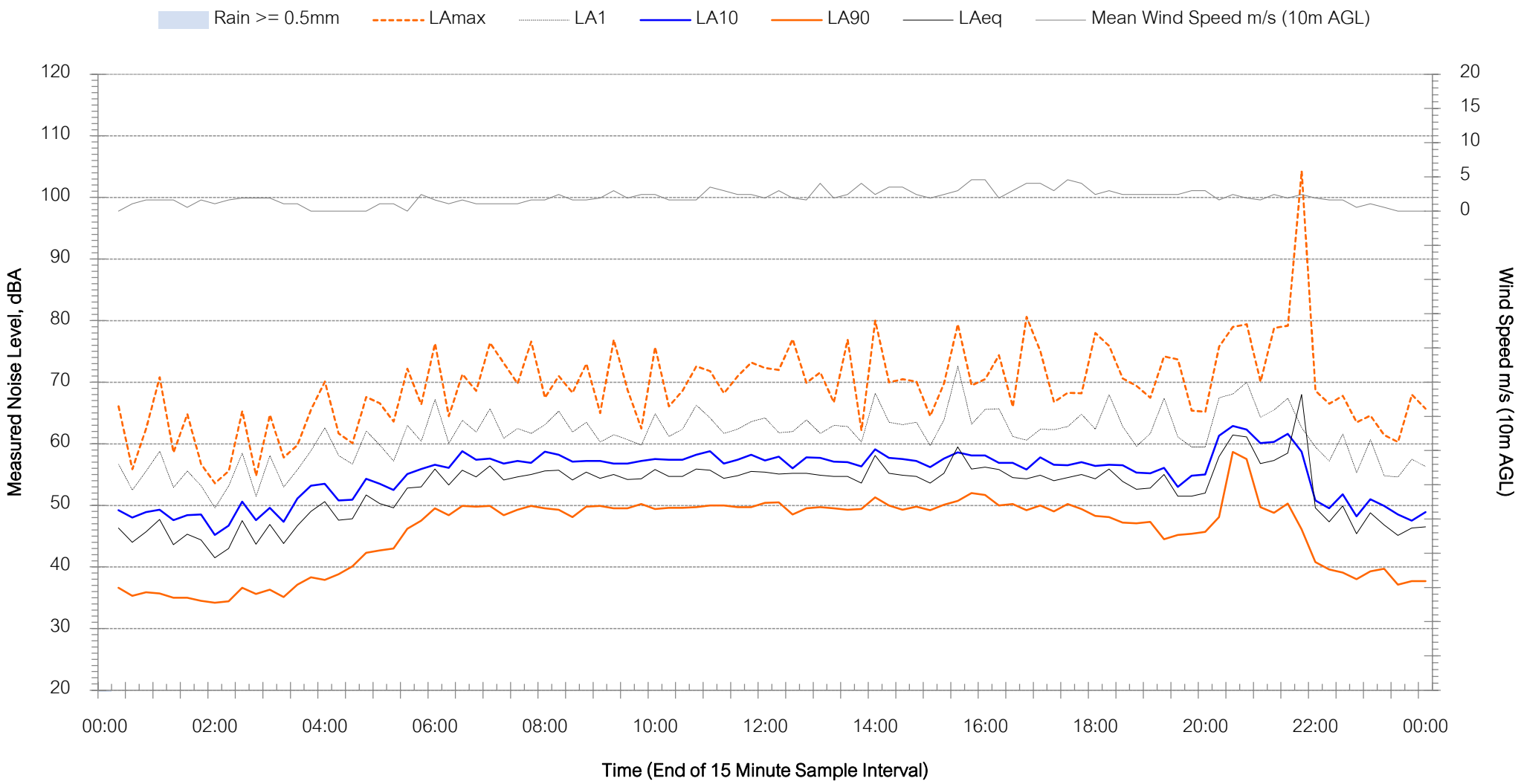
Background Noise Levels

N1 - Wednesday 8 January 2020



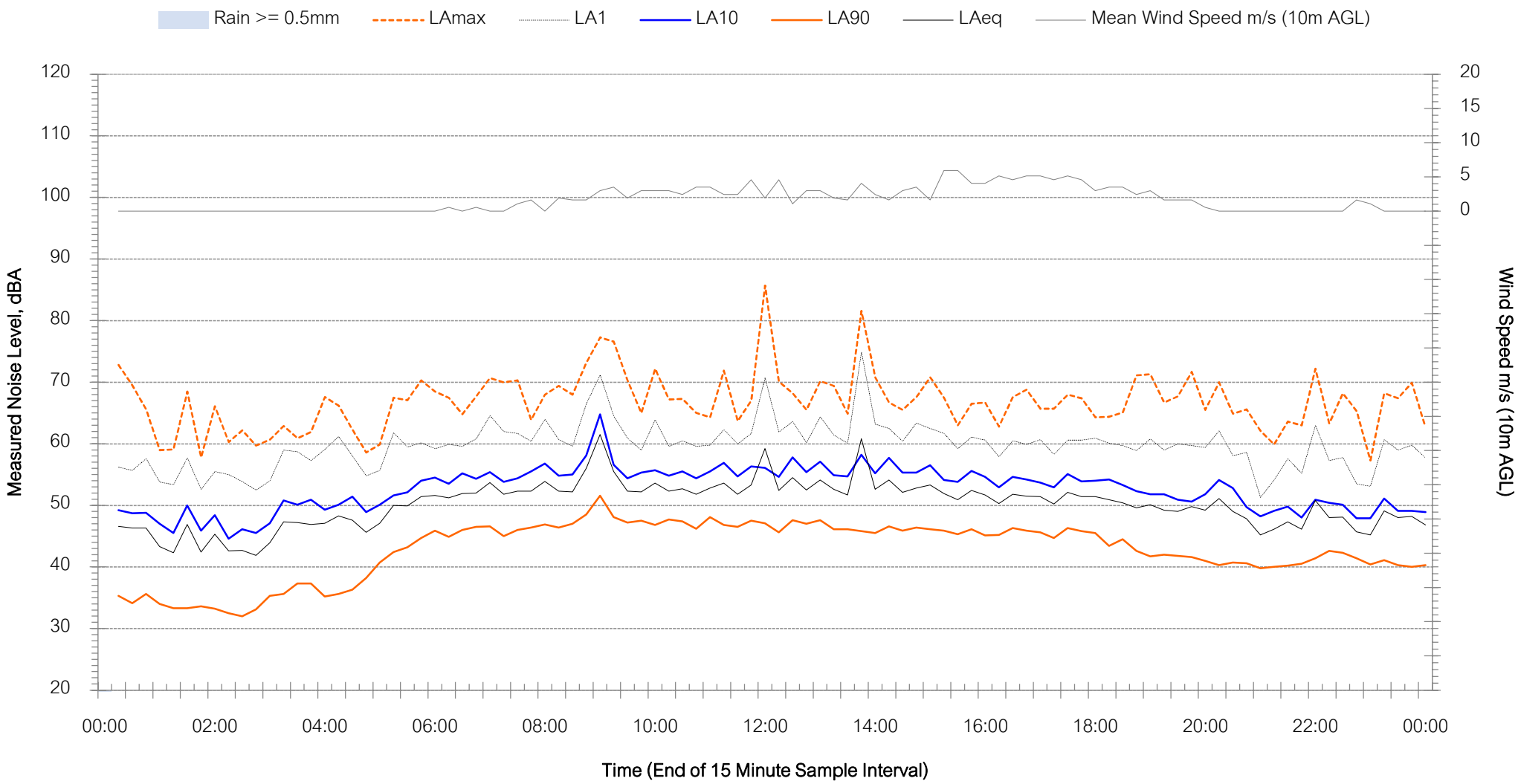
Background Noise Levels

N1 - Thursday 9 January 2020



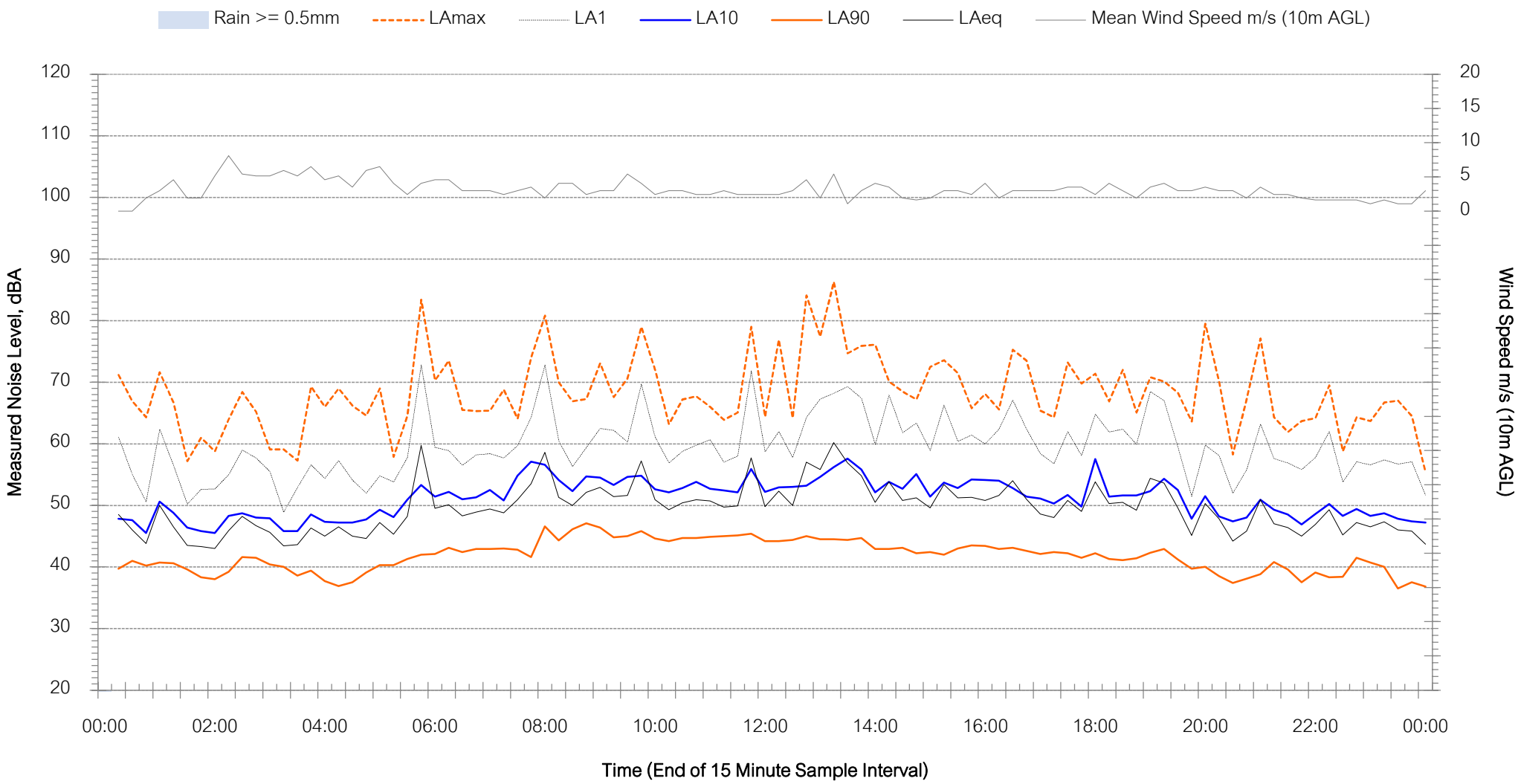
Background Noise Levels

N1 - Friday 10 January 2020



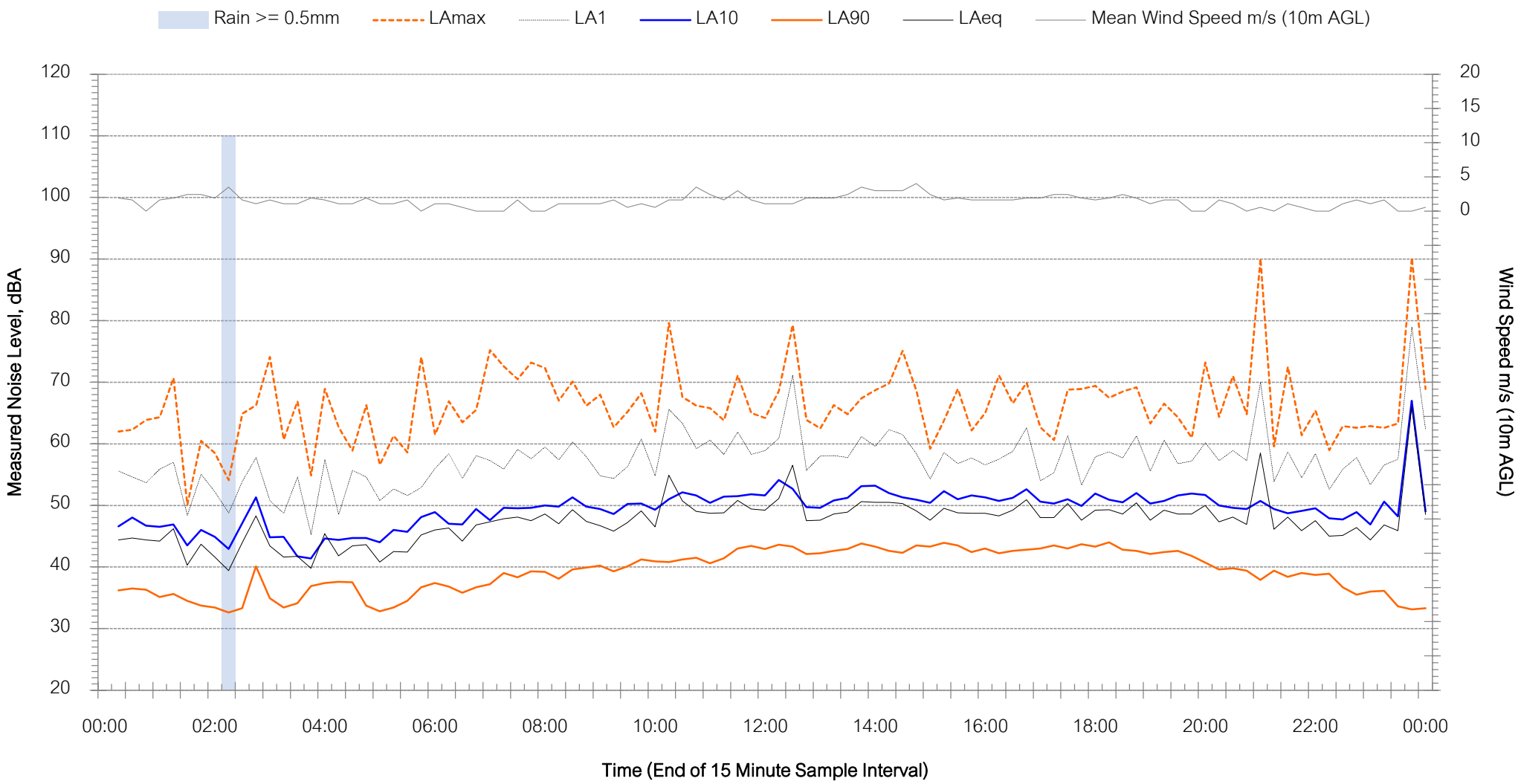
Background Noise Levels

N1 - Saturday 11 January 2020



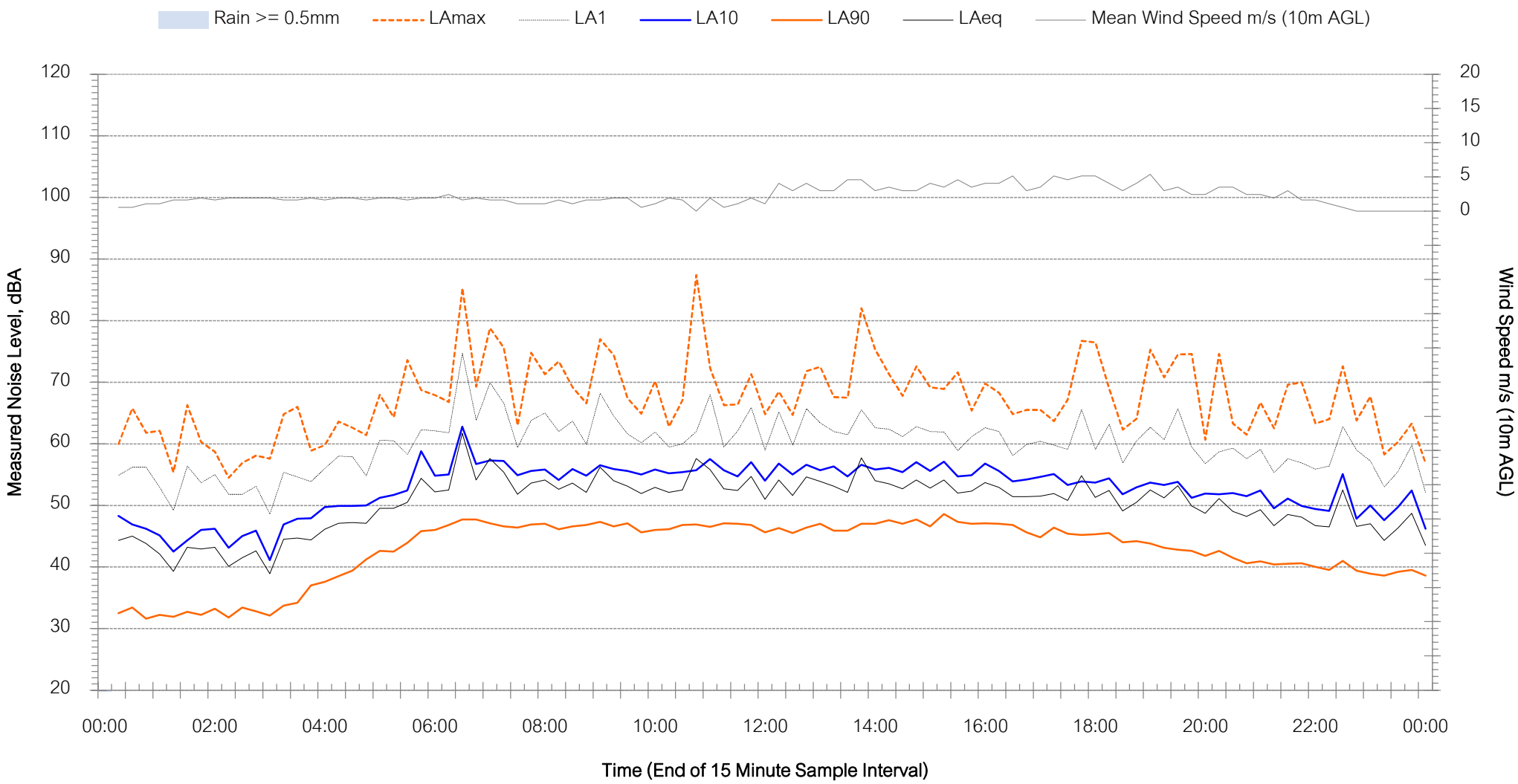
Background Noise Levels

N1 - Sunday 12 January 2020



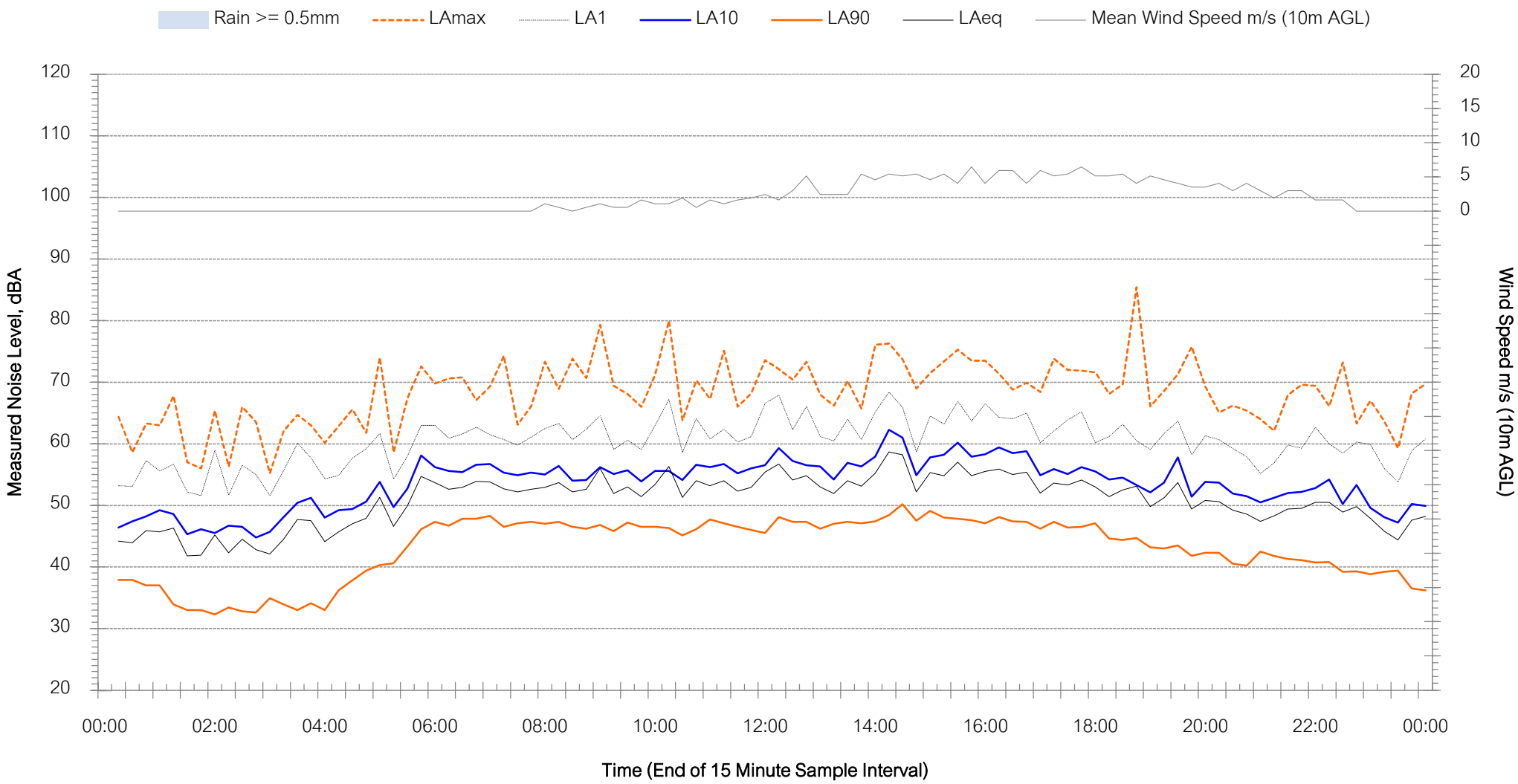
Background Noise Levels

N1 - Monday 13 January 2020



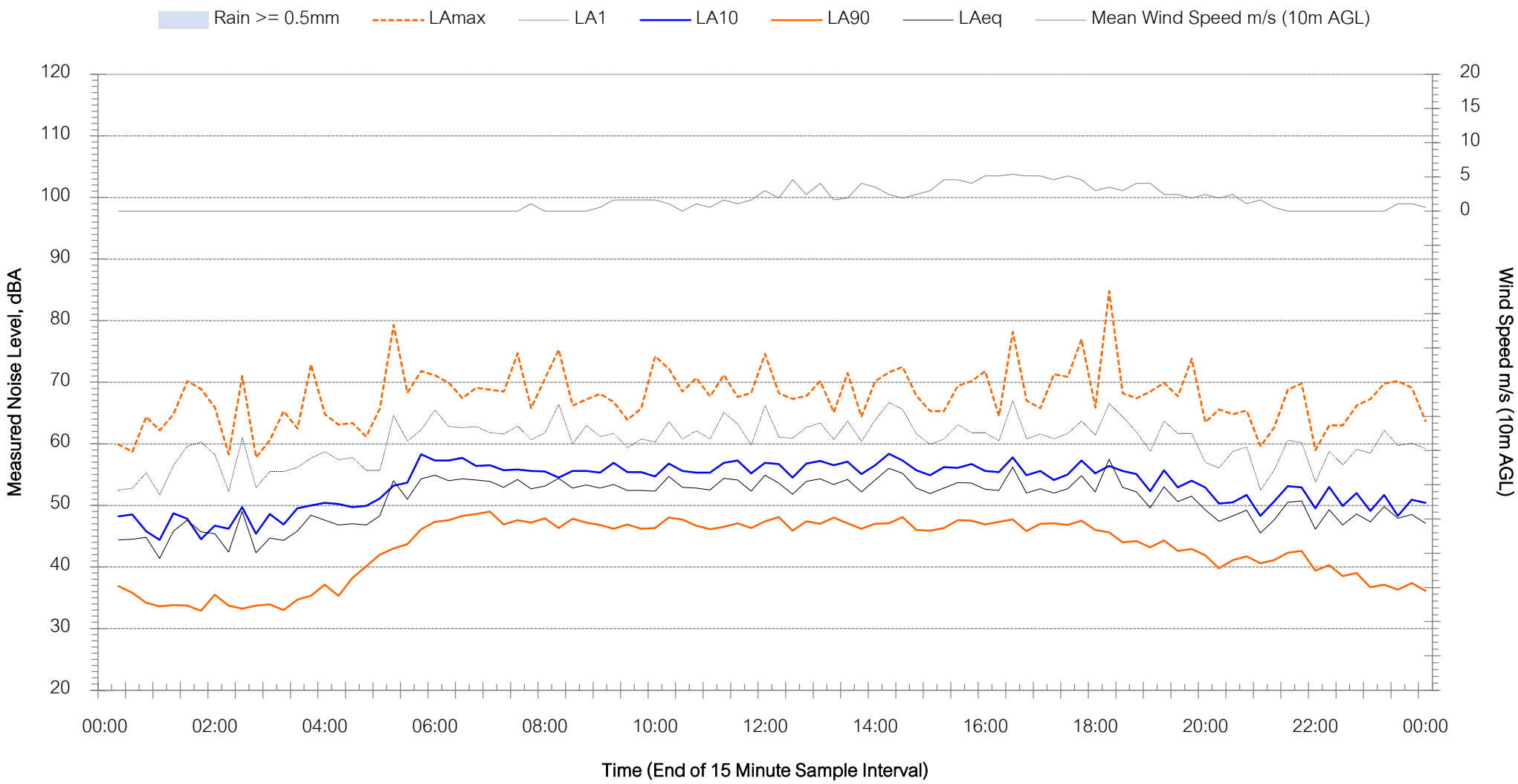
Background Noise Levels

N1 - Tuesday 14 January 2020



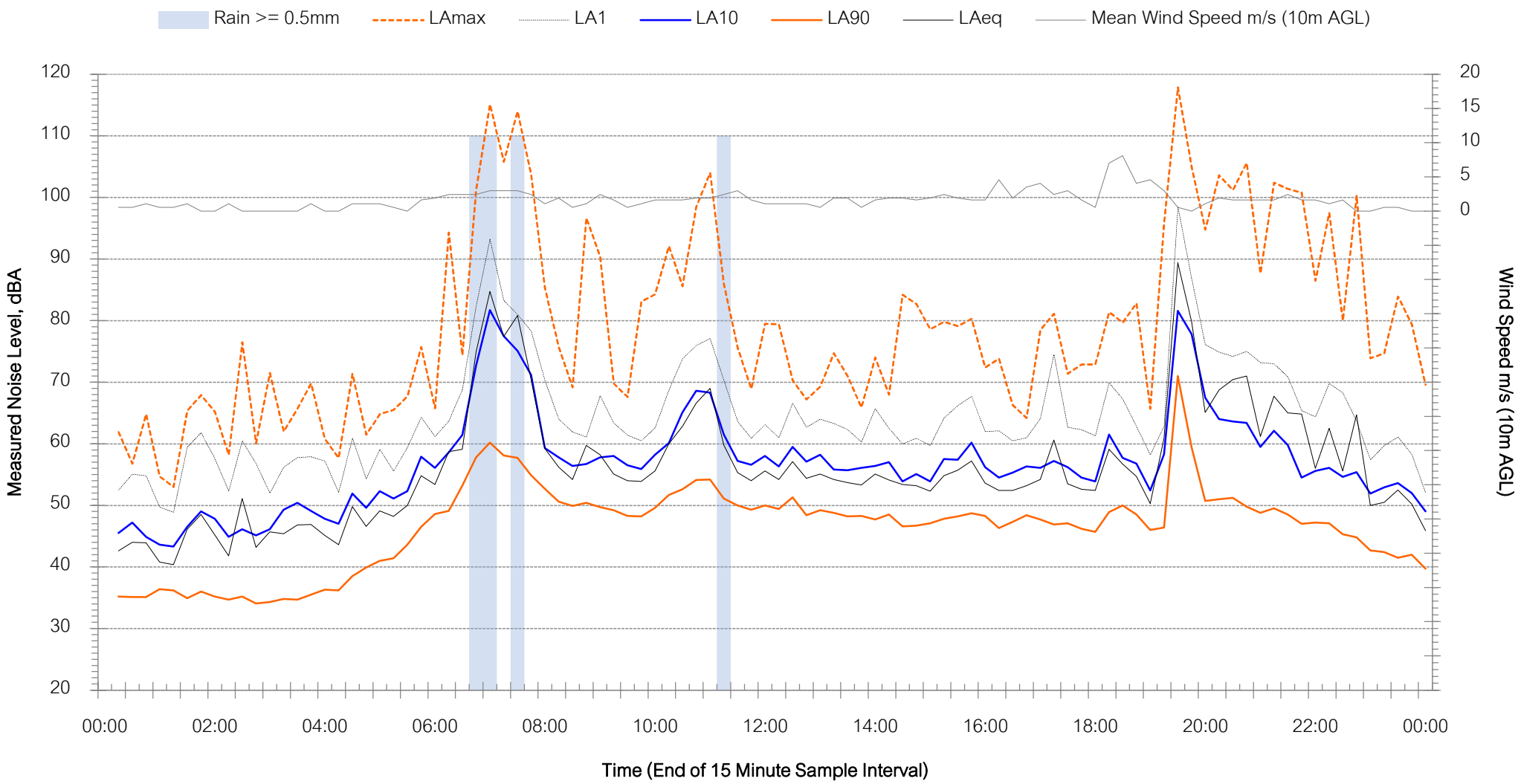
Background Noise Levels

N1 - Wednesday 15 January 2020



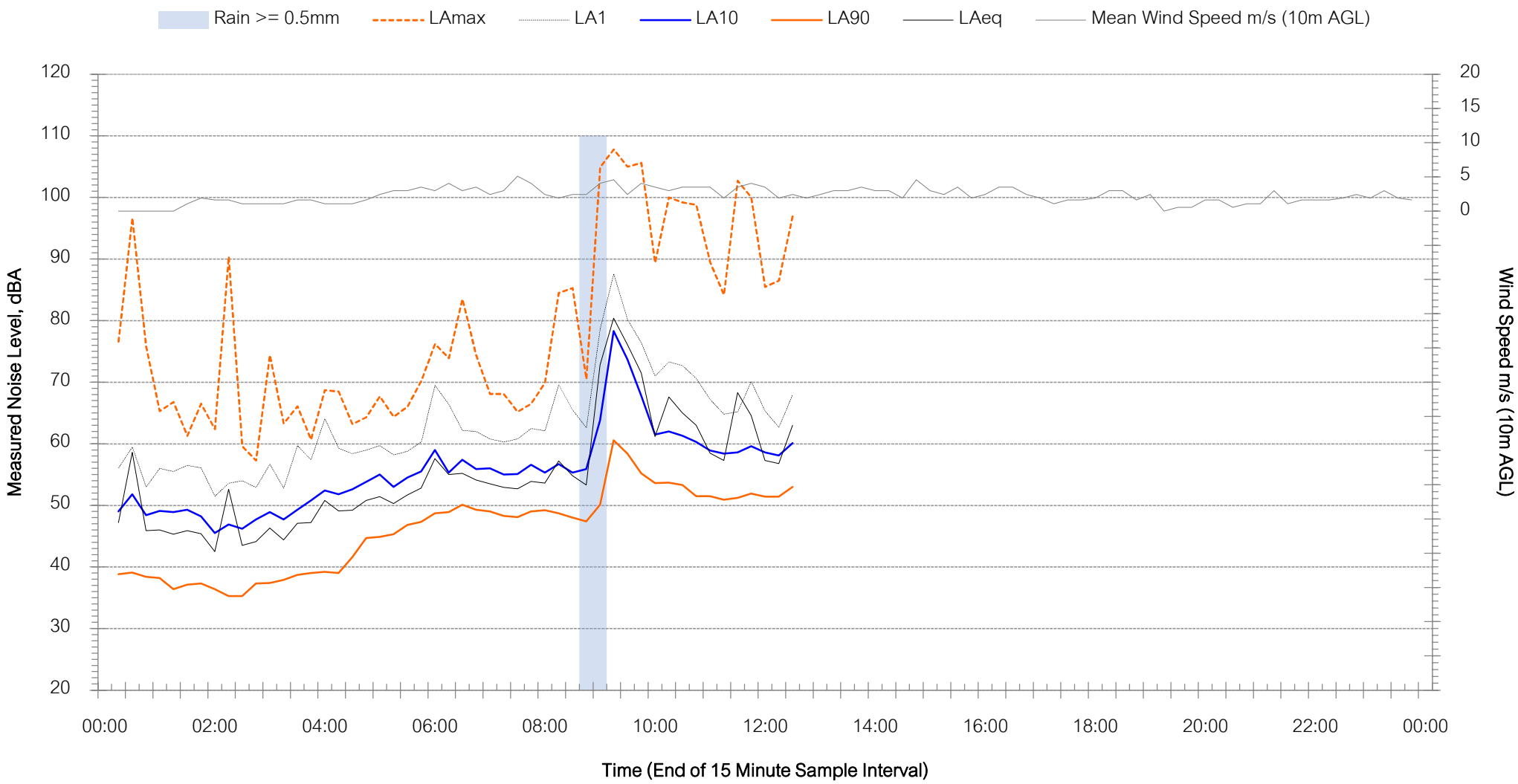
Background Noise Levels

N1 - Thursday 16 January 2020



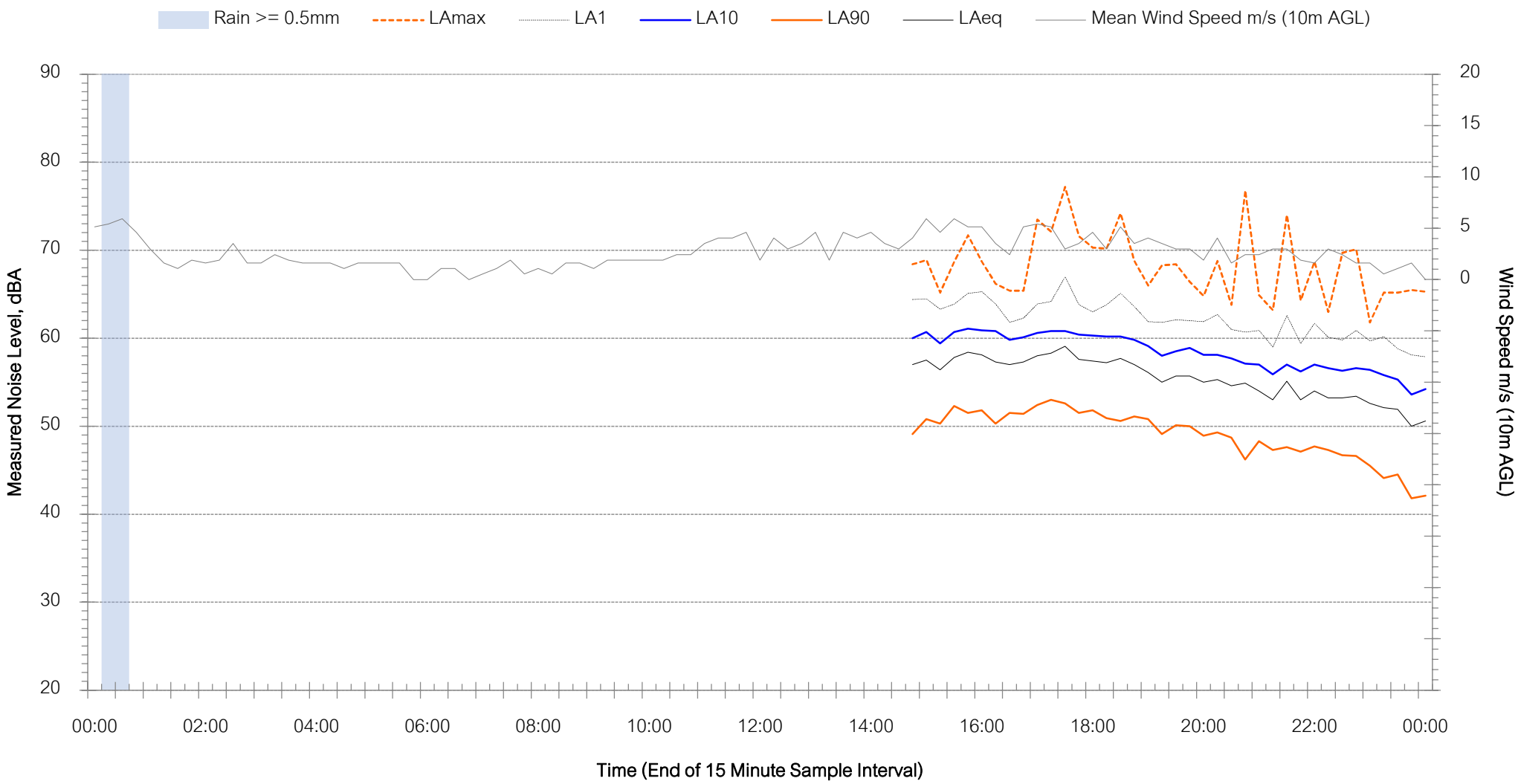
Background Noise Levels

N1 - Friday 17 January 2020



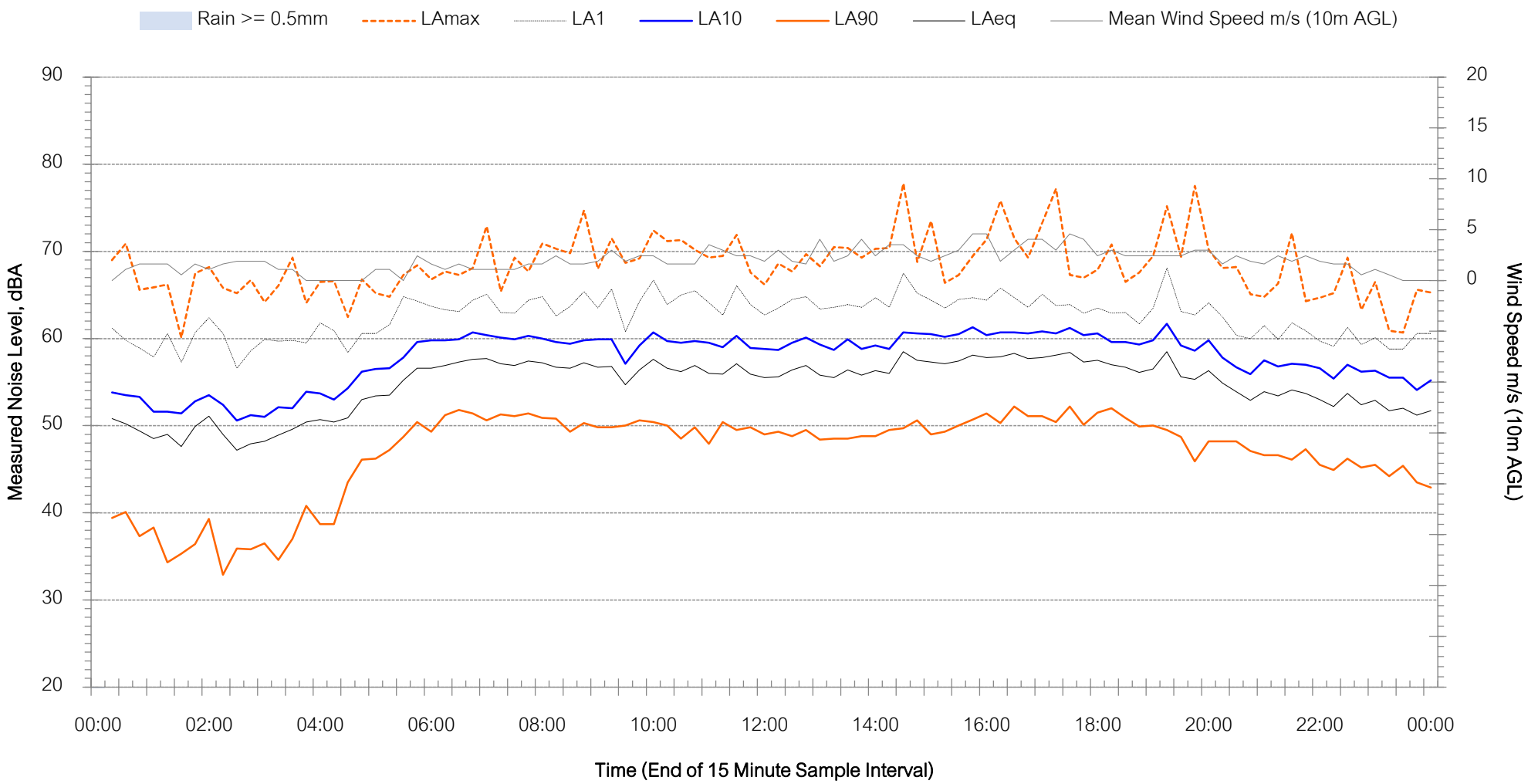
Background Noise Levels

N2 - Wednesday 8 January 2020



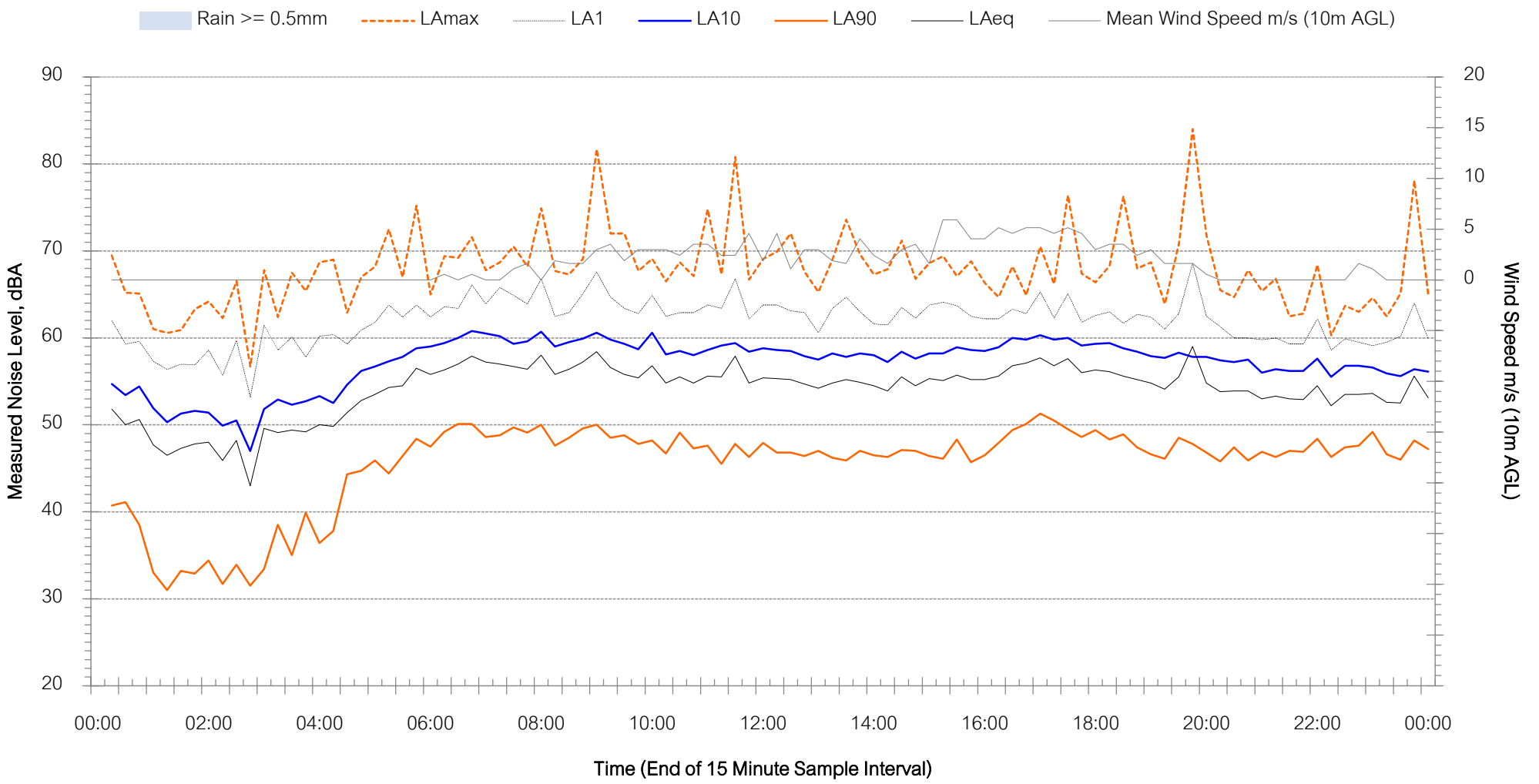
Background Noise Levels

N2 - Thursday 9 January 2020



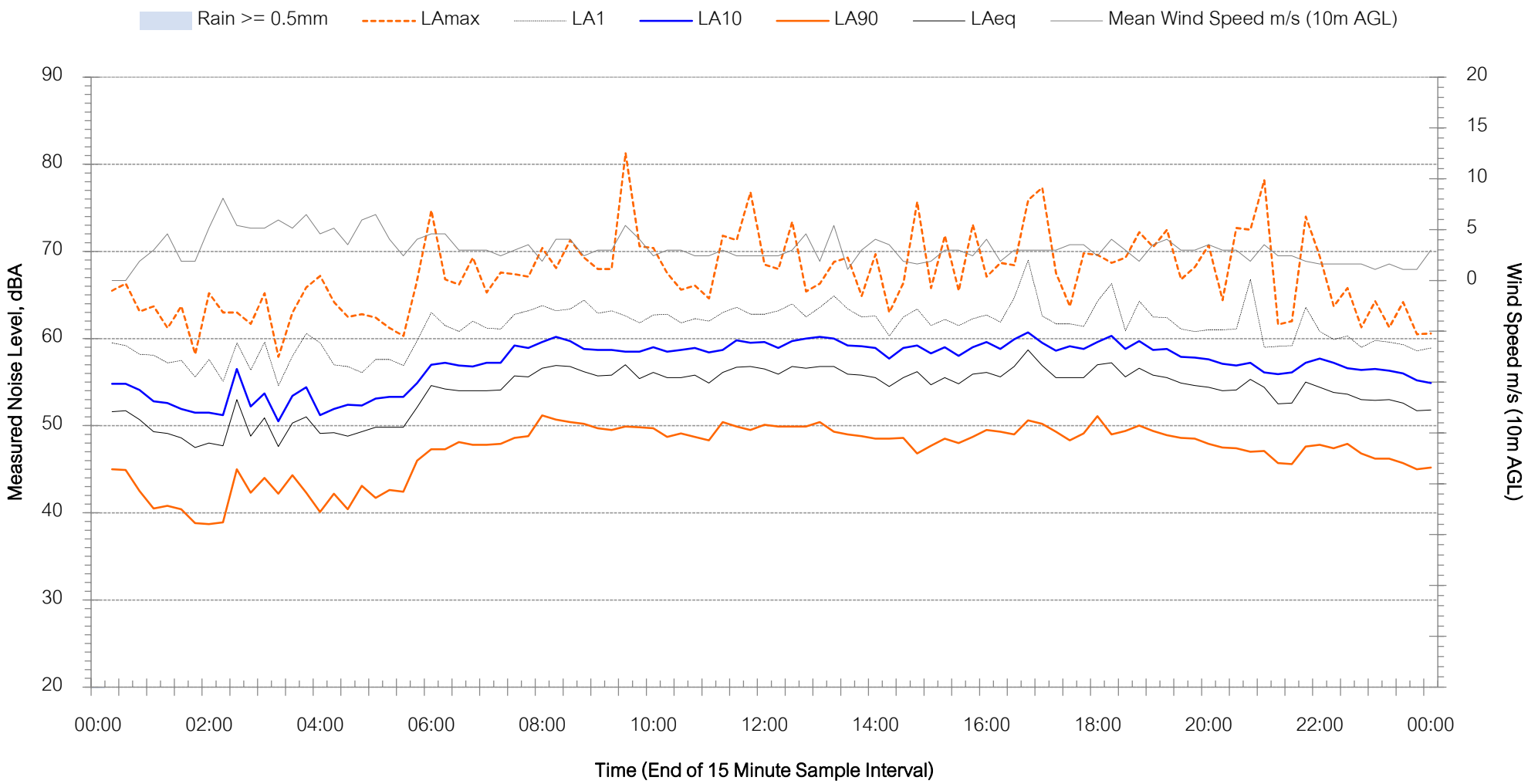
Background Noise Levels

N2 - Friday 10 January 2020



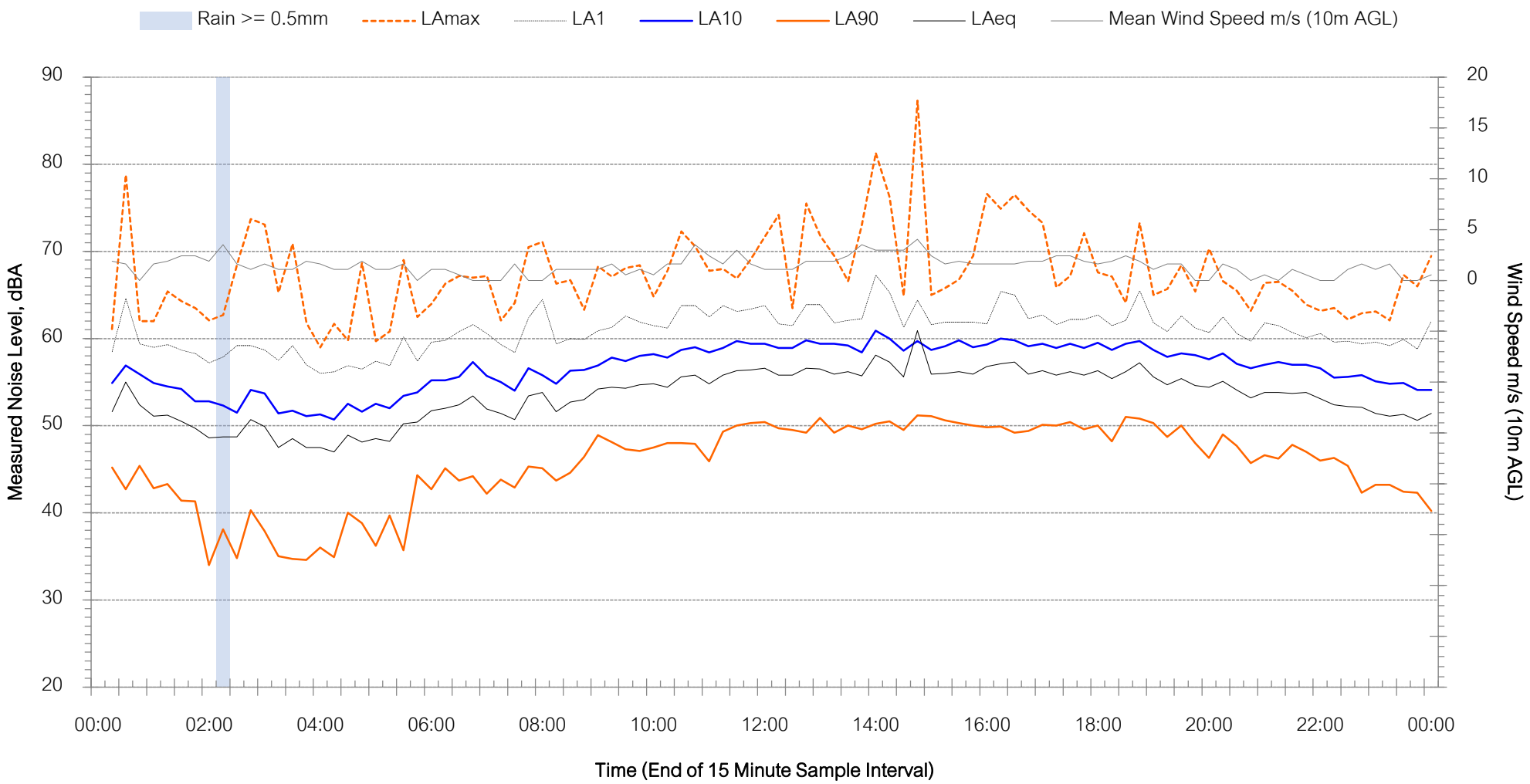
Background Noise Levels

N2 - Saturday 11 January 2020



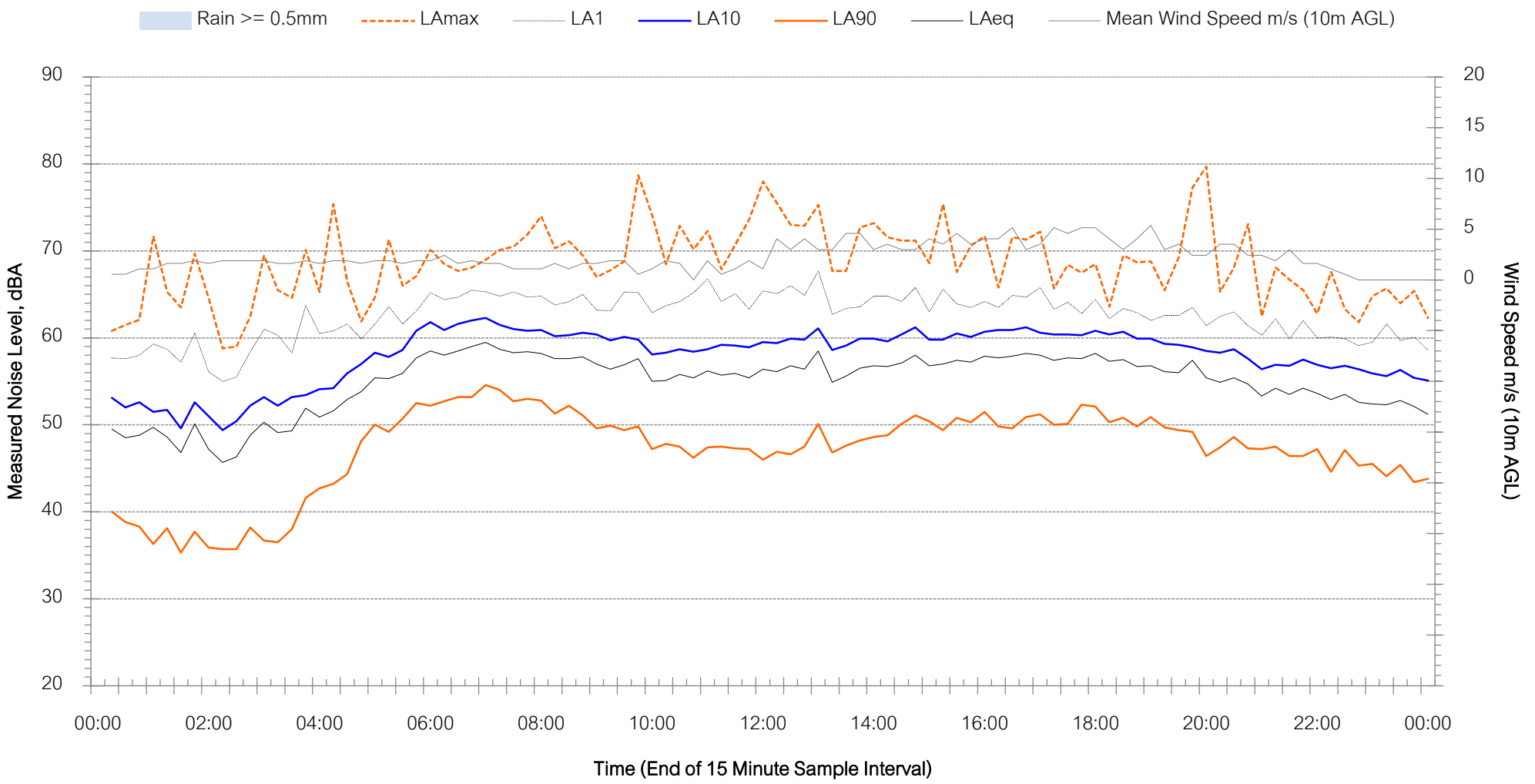
Background Noise Levels

N2 - Sunday 12 January 2020



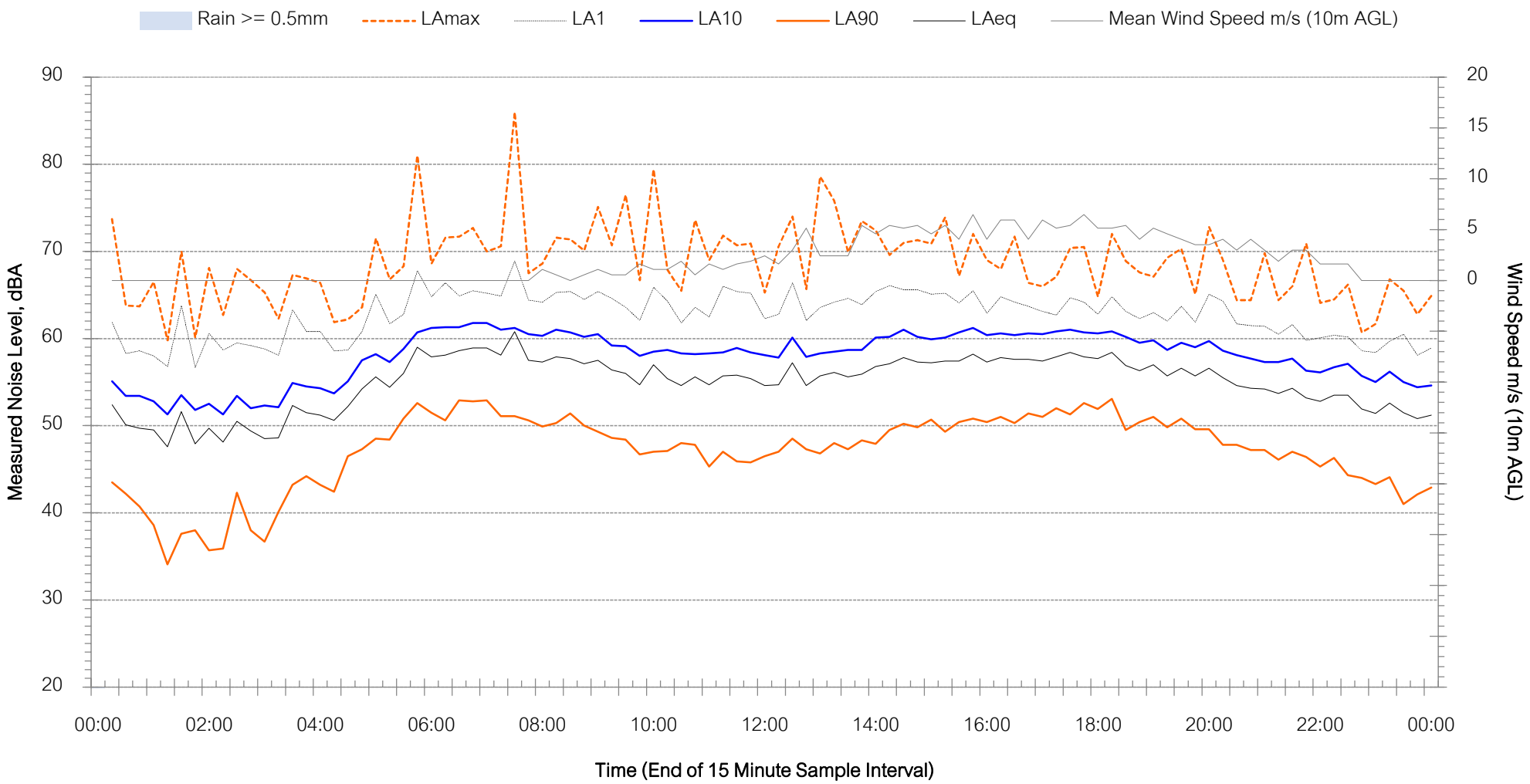
Background Noise Levels

N2 - Monday 13 January 2020



Background Noise Levels

N2 - Tuesday 14 January 2020

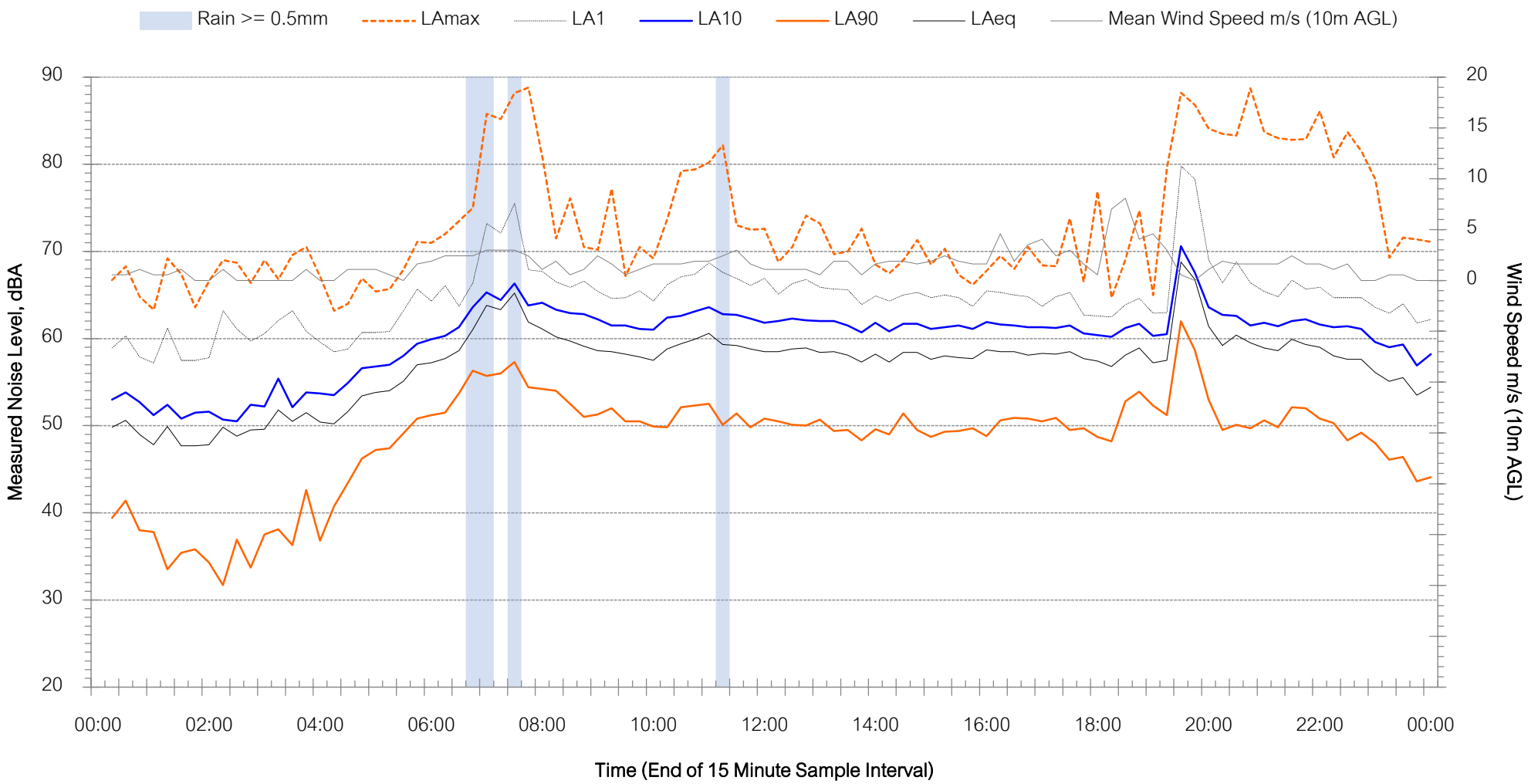


Background Noise Levels

N2 - Wednesday 15 January 2020

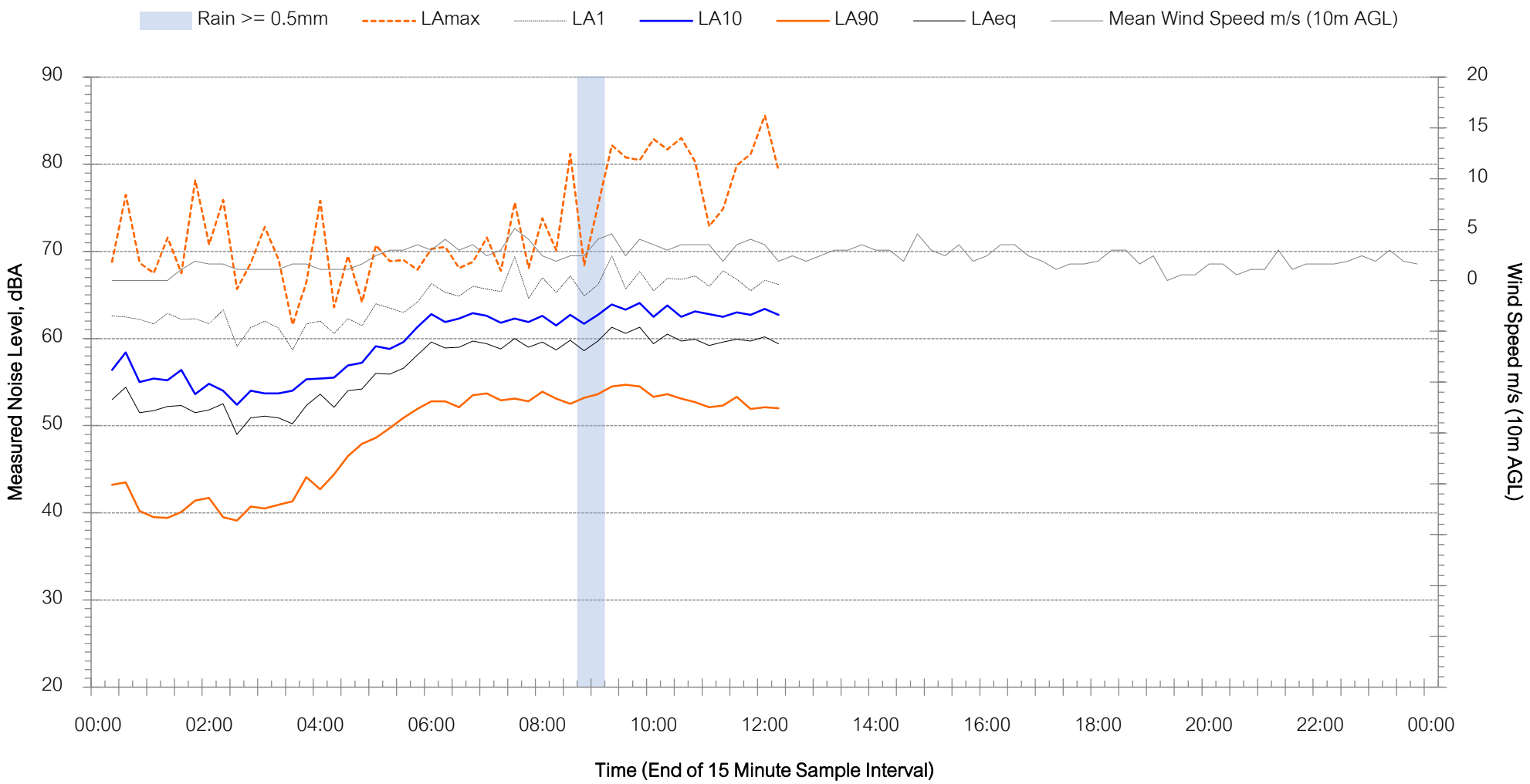
Background Noise Levels

N2 - Thursday 16 January 2020



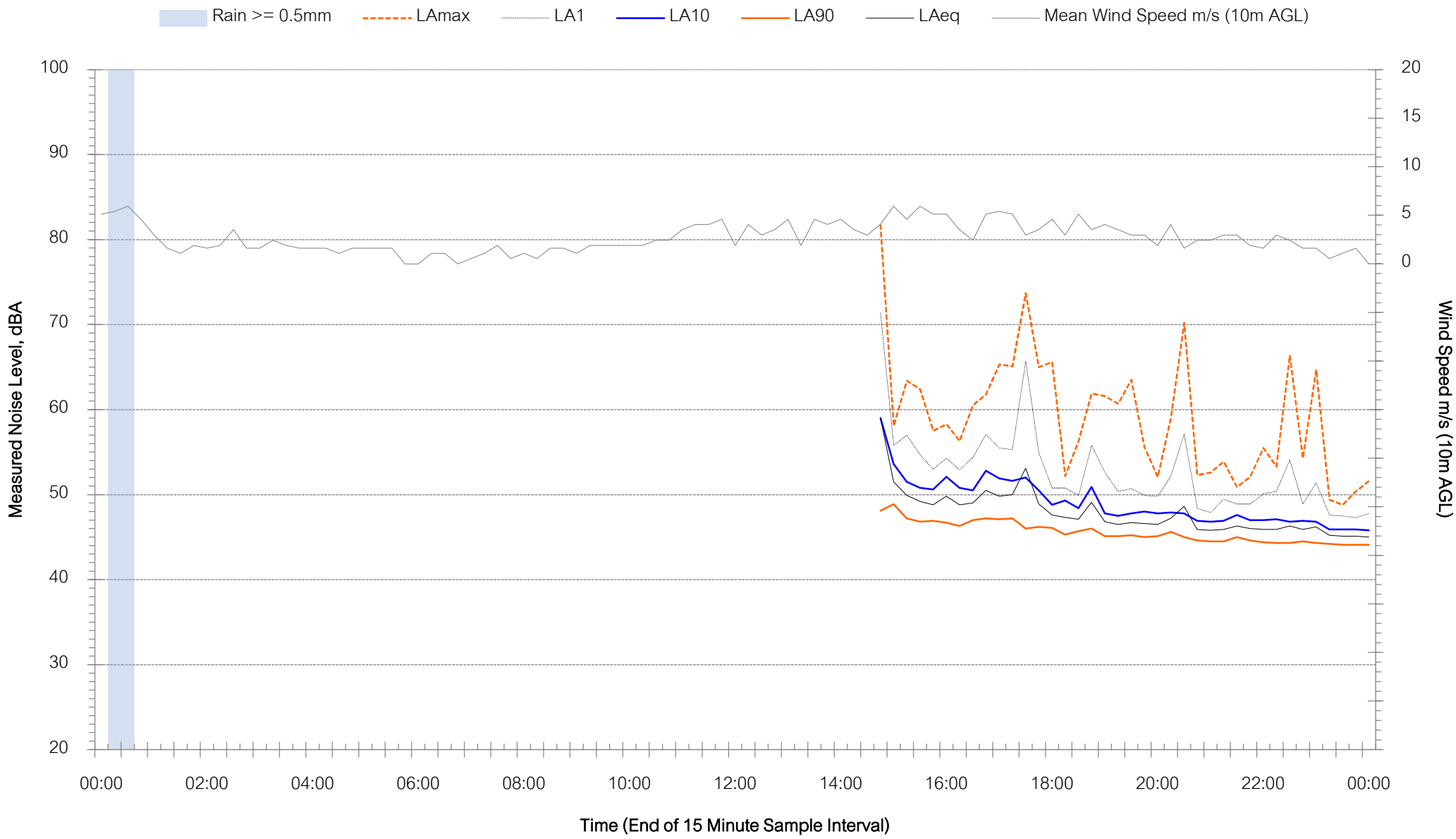
Background Noise Levels

N2 - Friday 17 January 2020



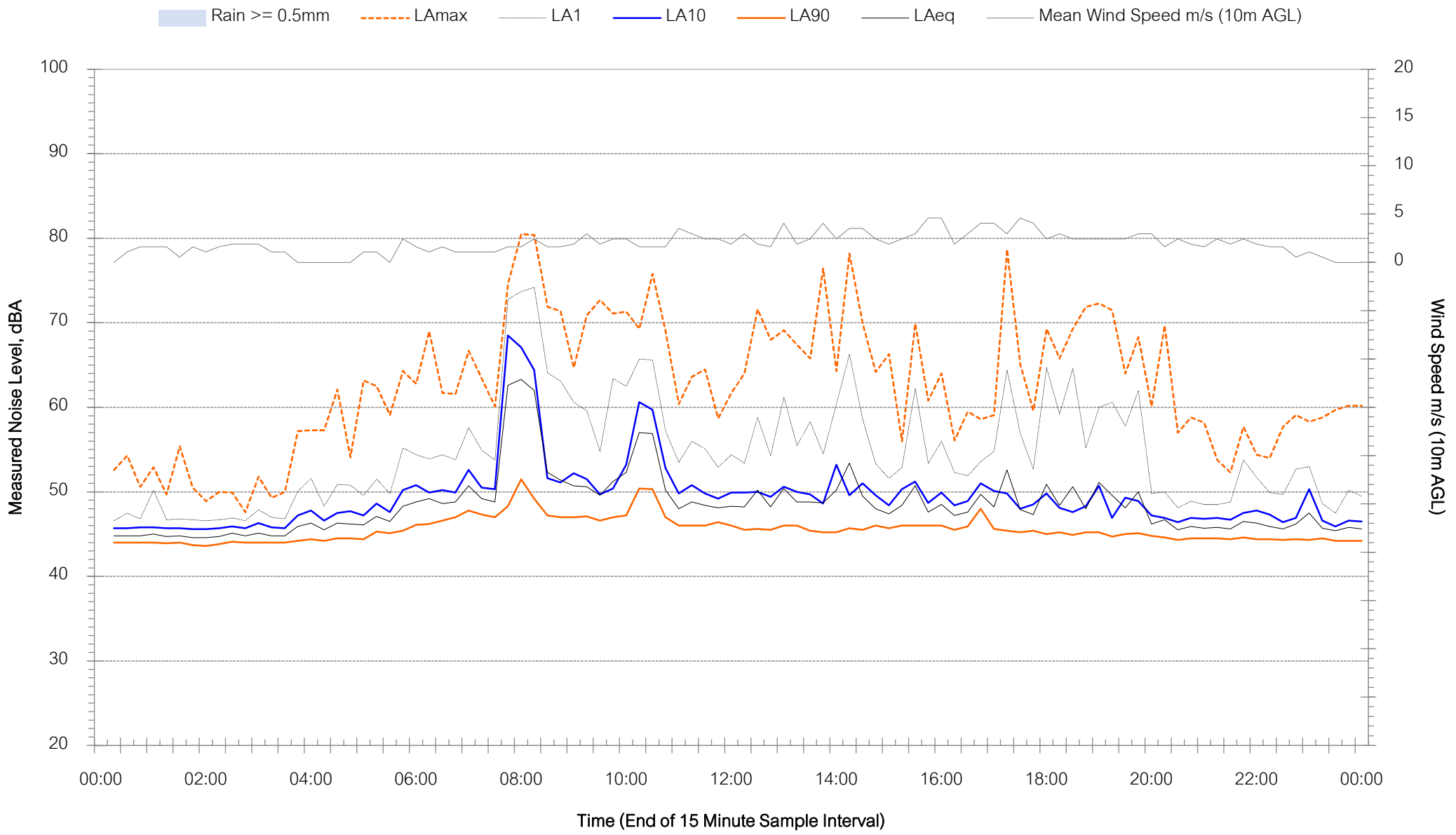
Background Noise Levels

N3 - Wednesday 8 January 2020



Background Noise Levels

N3 - Thursday 9 January 2020



Background Noise Levels

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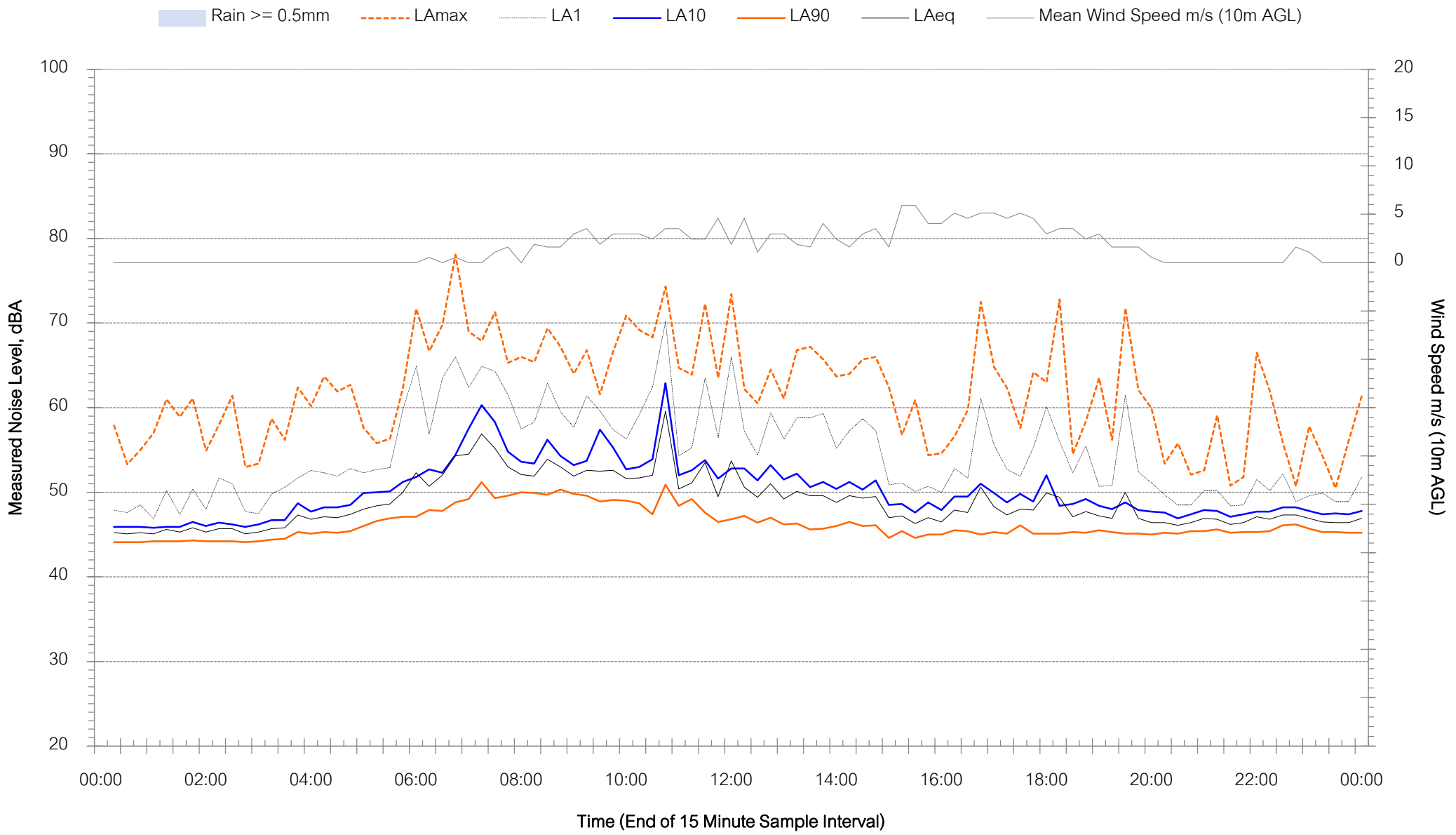
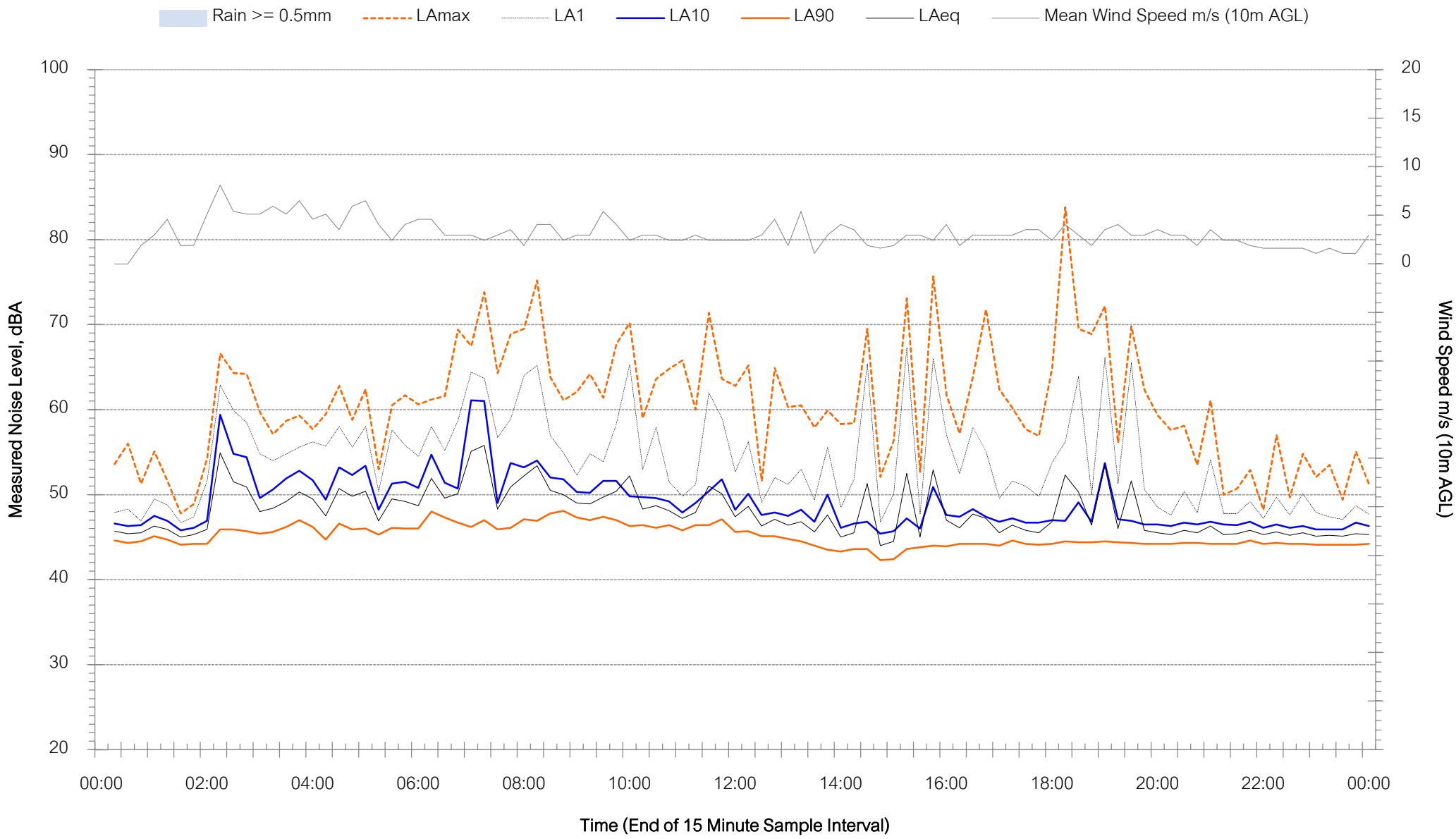


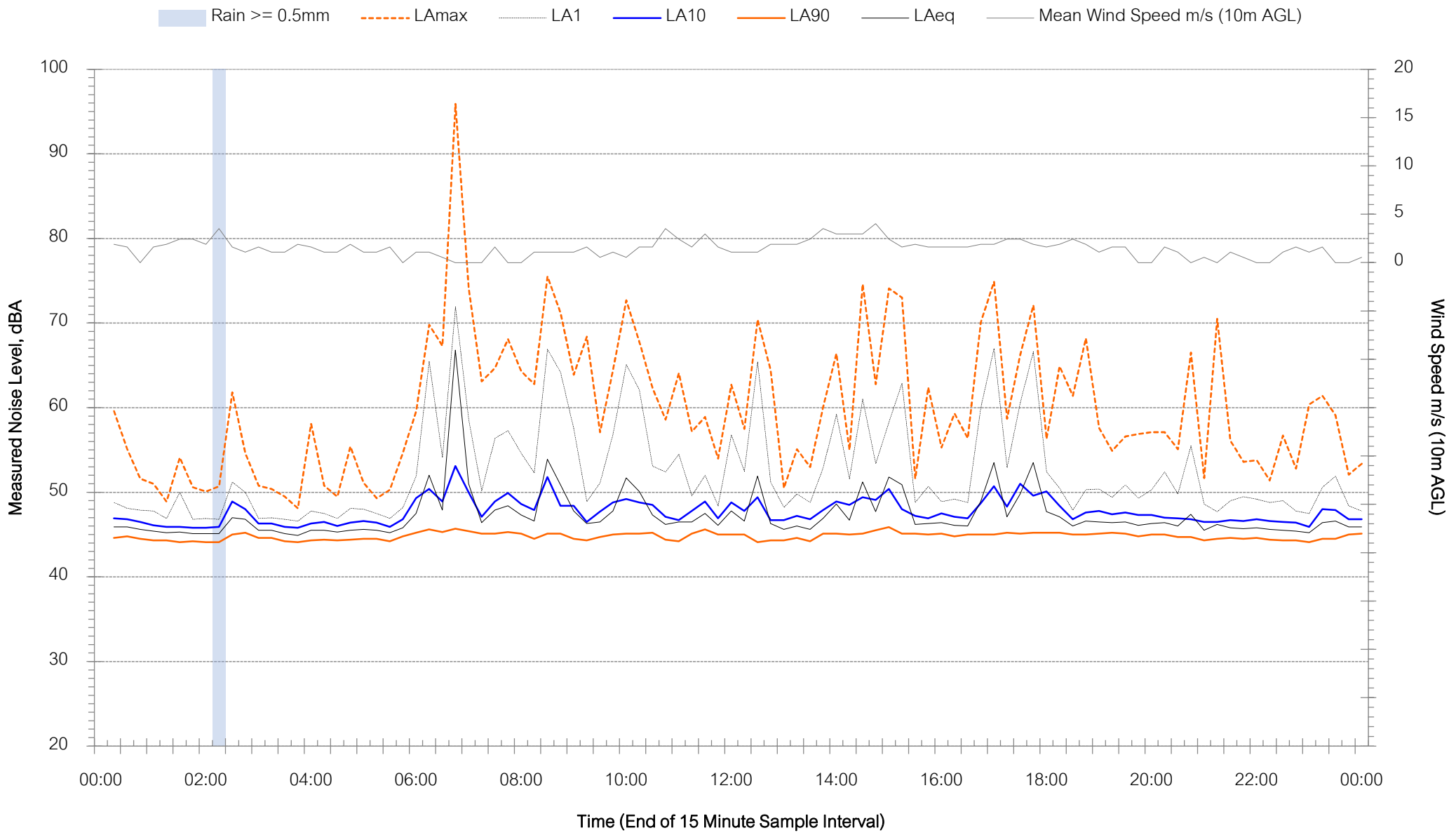
Background Noise Levels

N3 - Saturday 11 January 2020



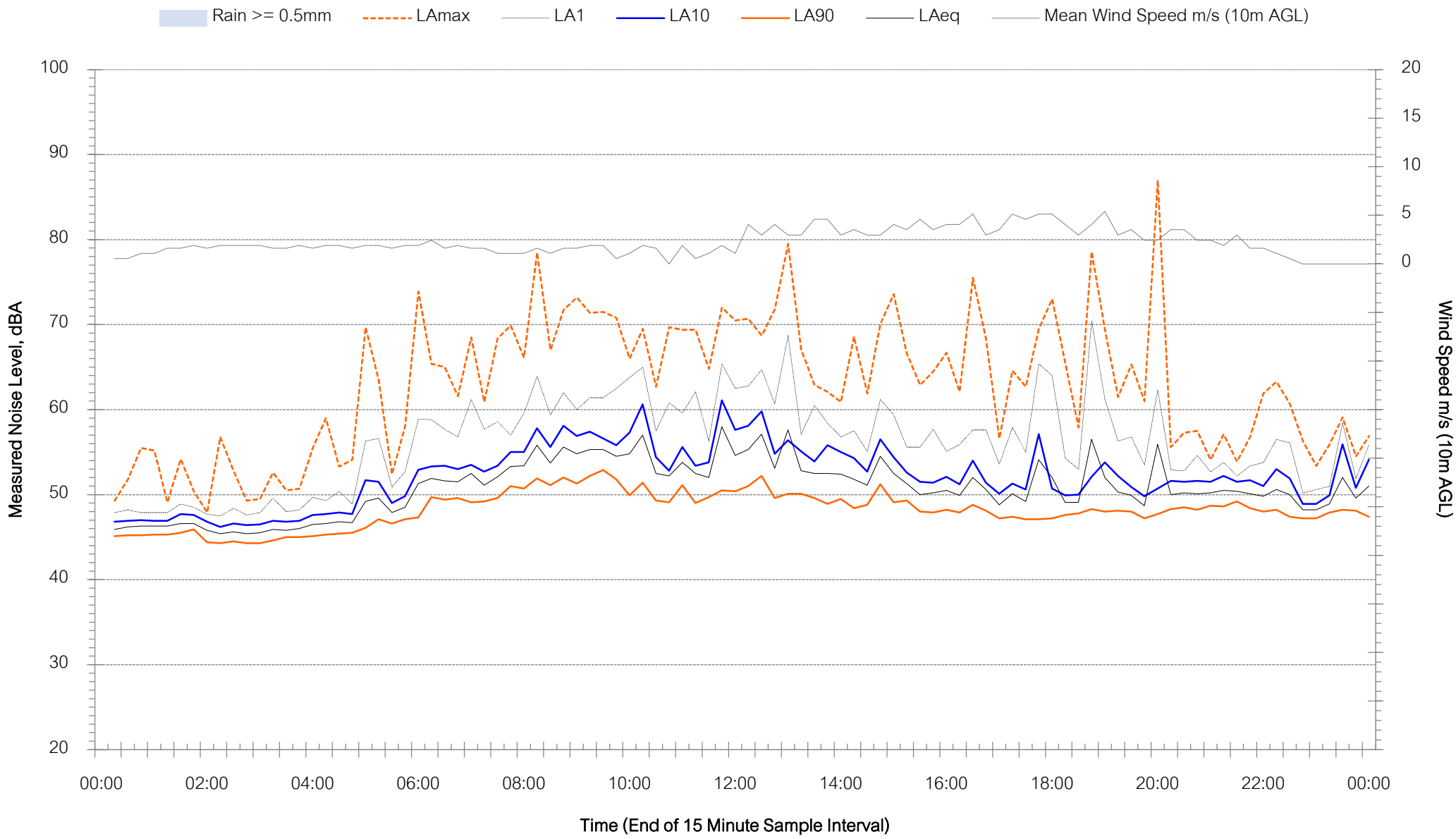
Background Noise Levels

N3 - Sunday 12 January 2020



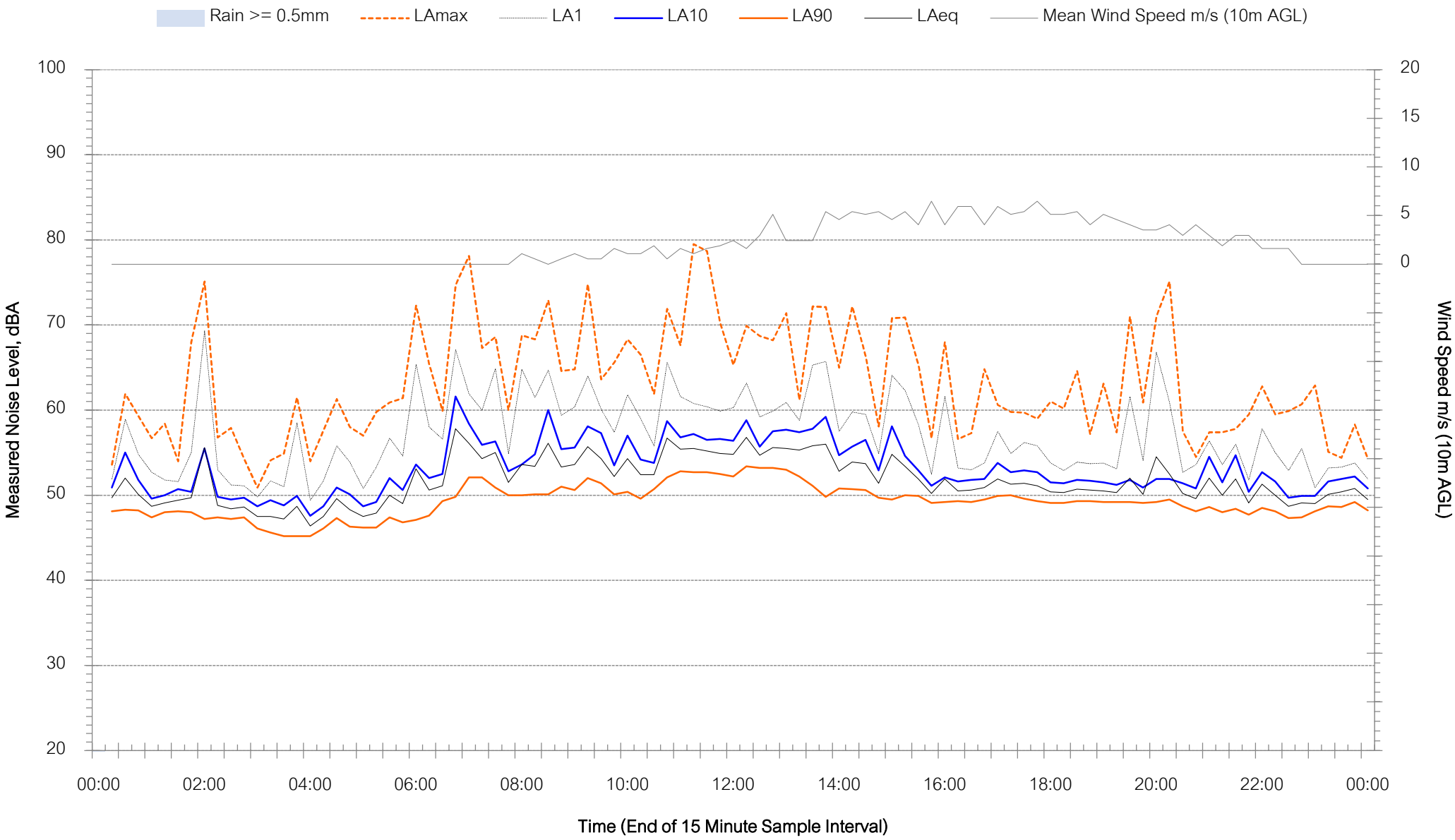
Background Noise Levels

N3 - Monday 13 January 2020



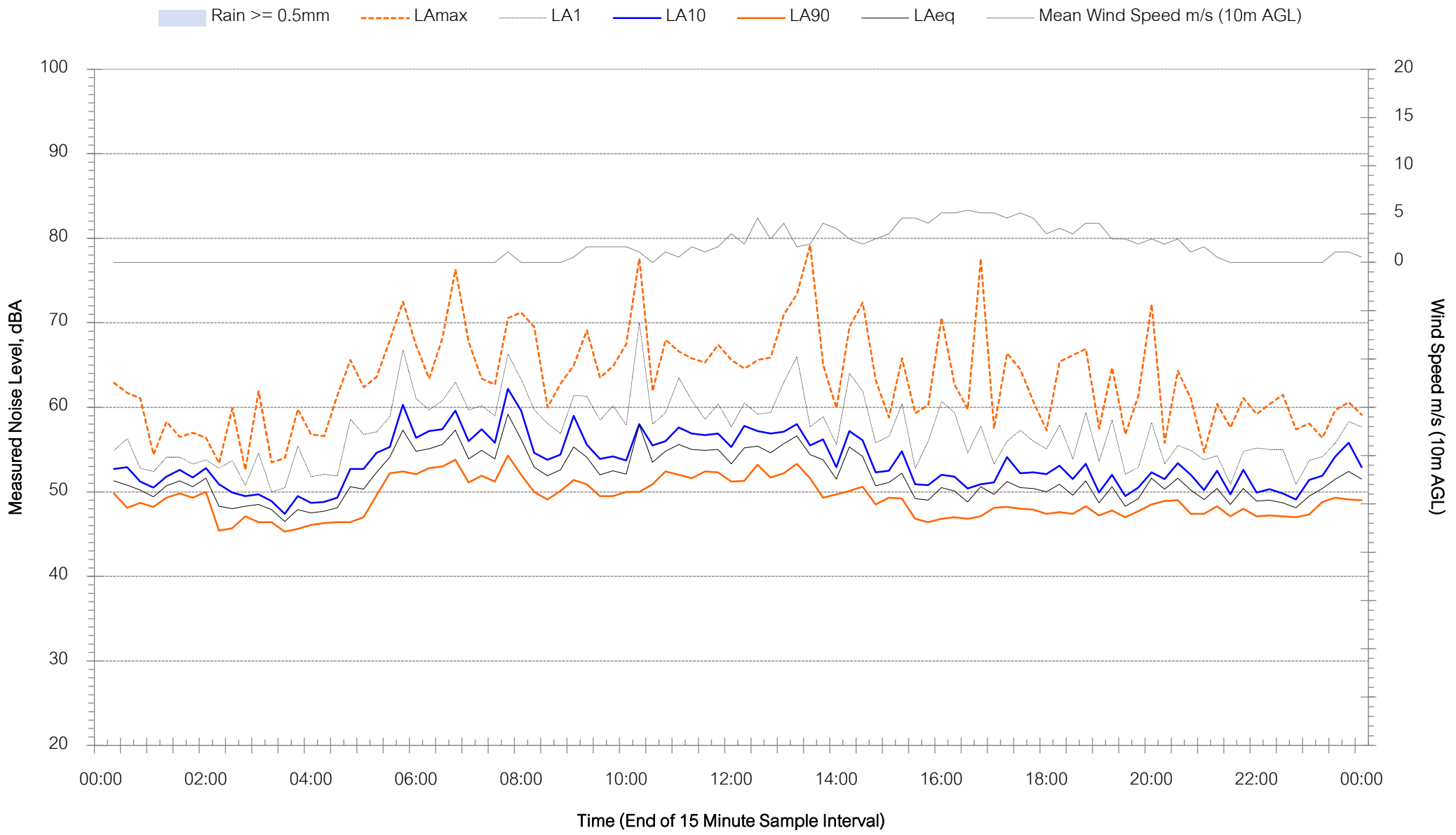
Background Noise Levels

N3 - Tuesday 14 January 2020



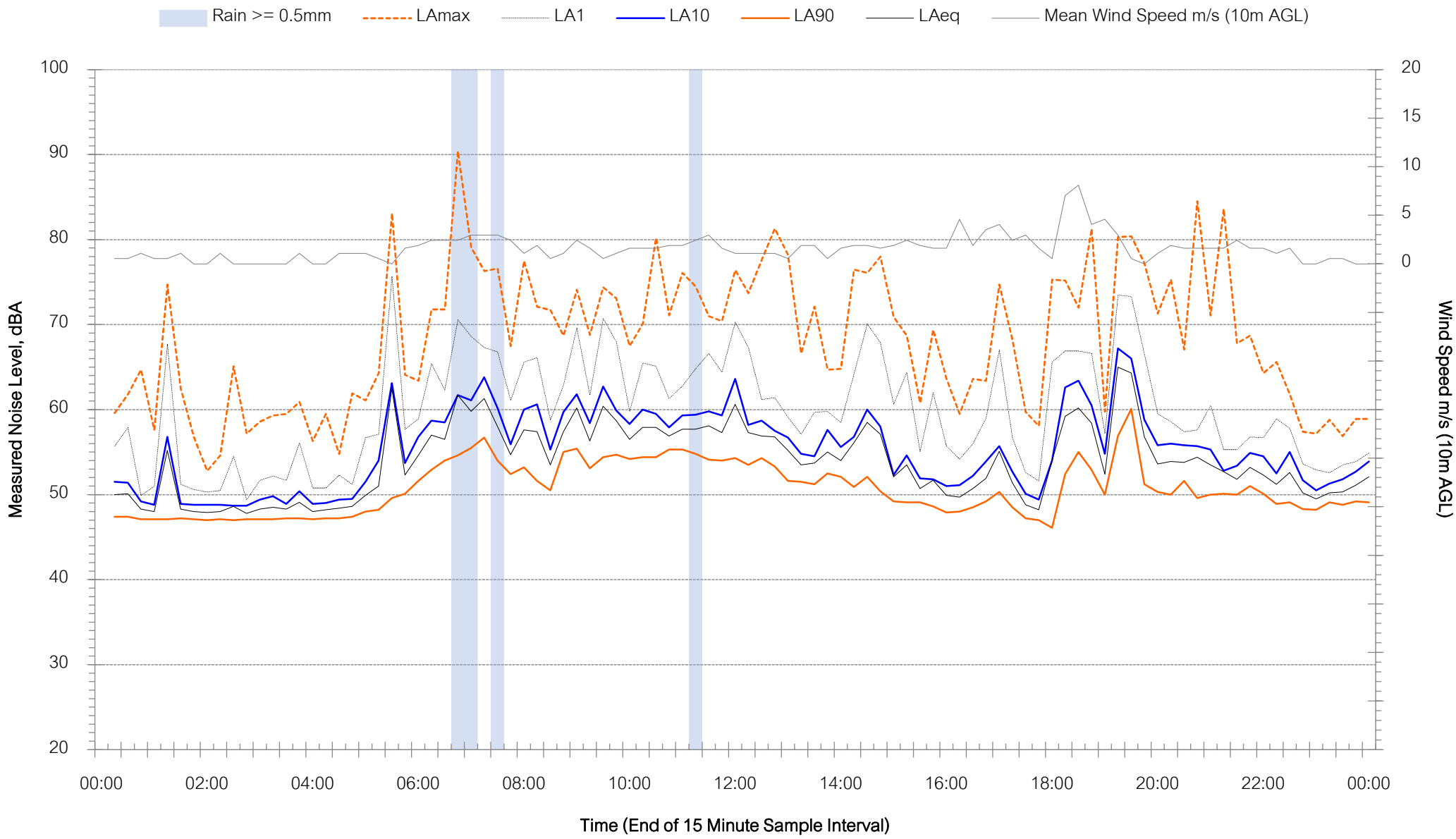
Background Noise Levels

N3 - Wednesday 15 January 2020



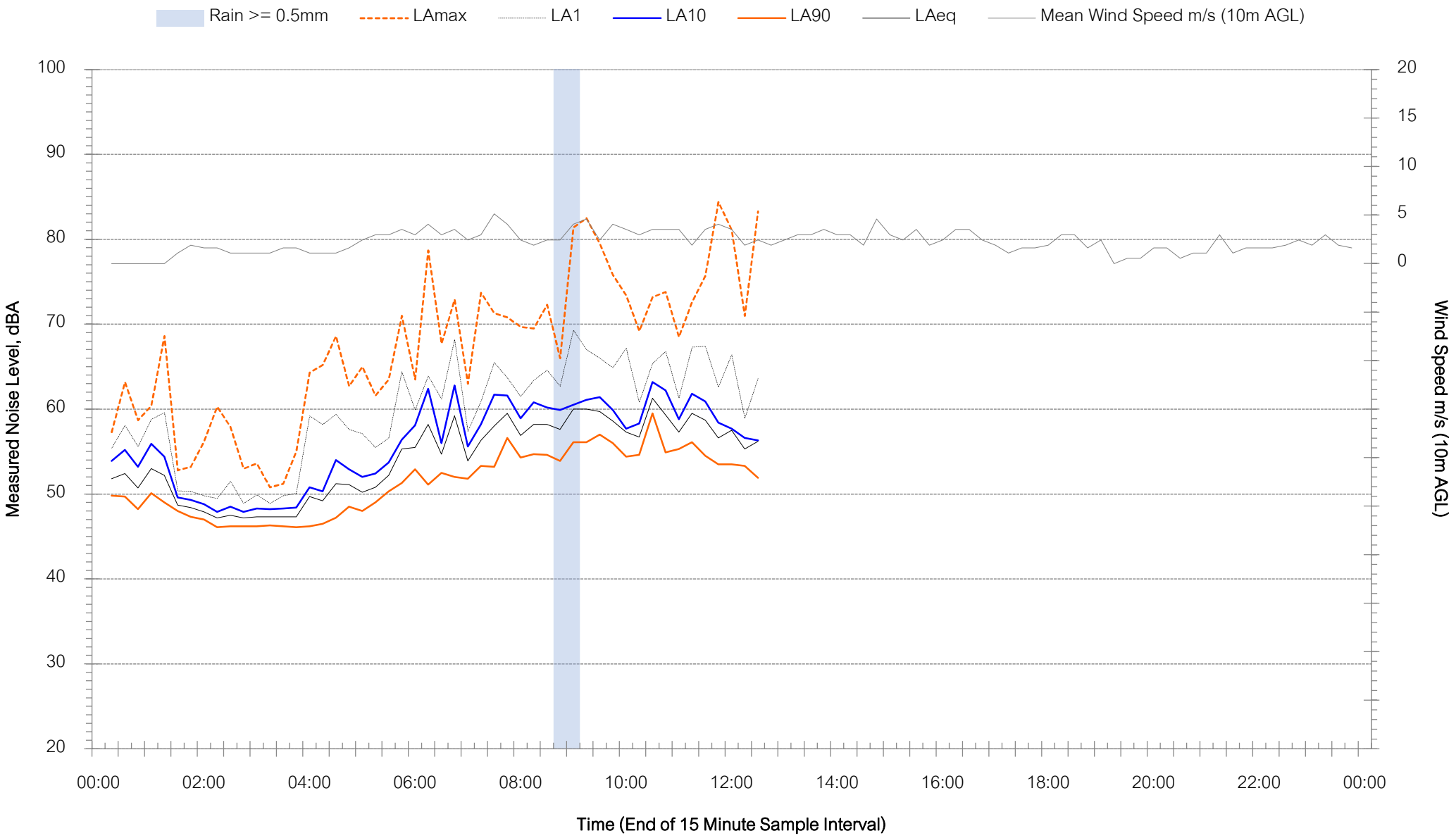
Background Noise Levels

N3 - Thursday 16 January 2020



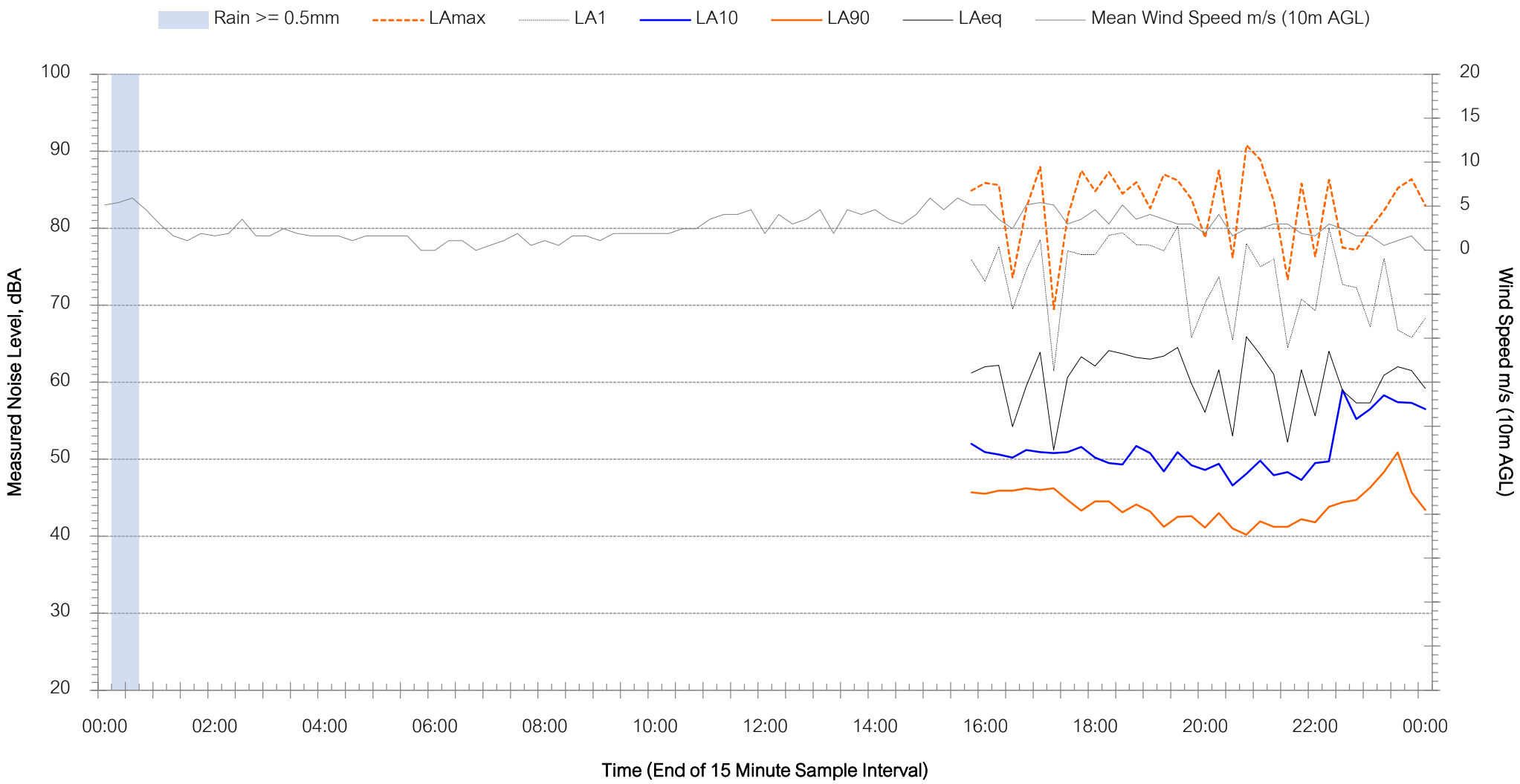
Background Noise Levels

N3 - Friday 17 January 2020



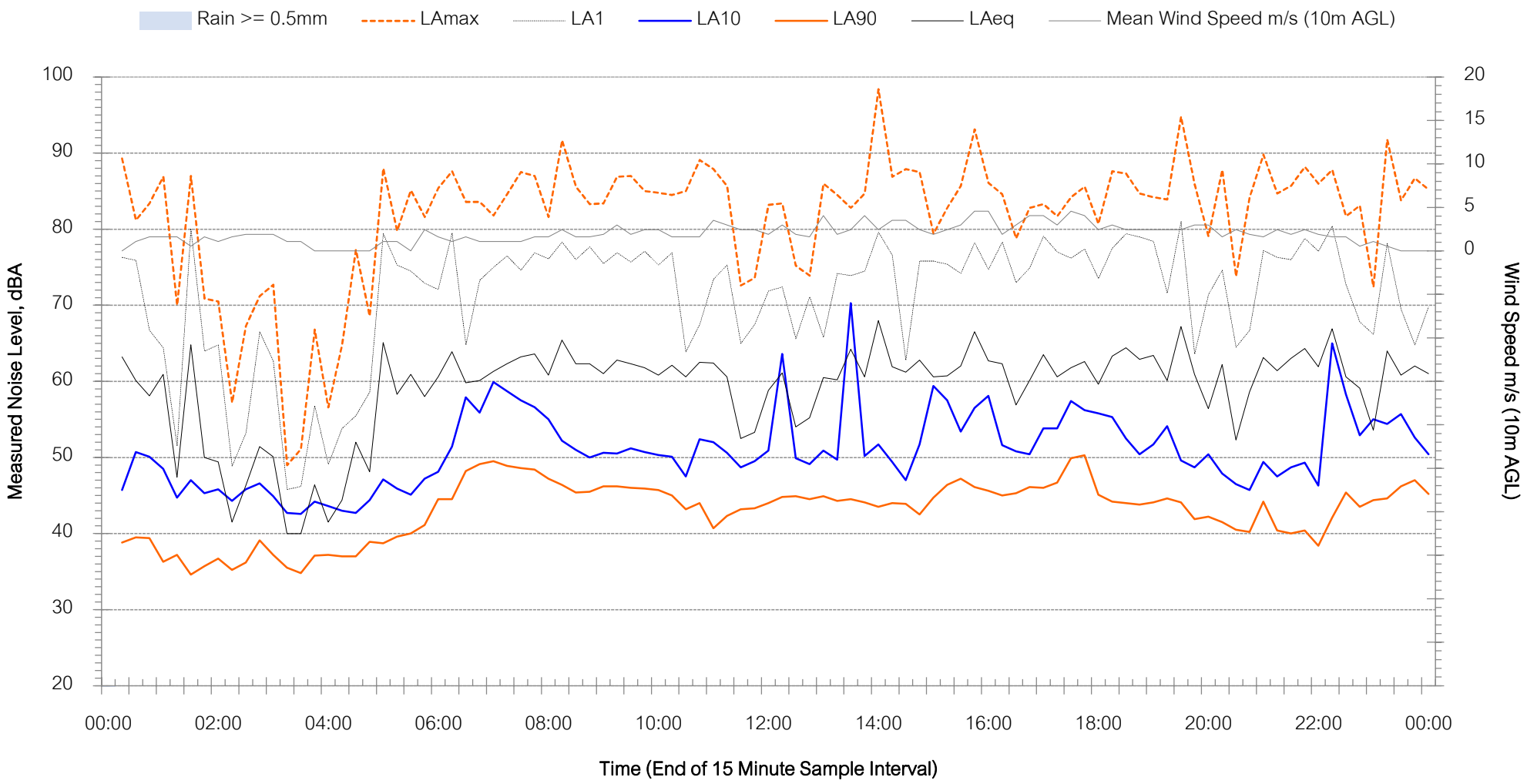
Background Noise Levels

N4 - Wednesday 8 January 2020



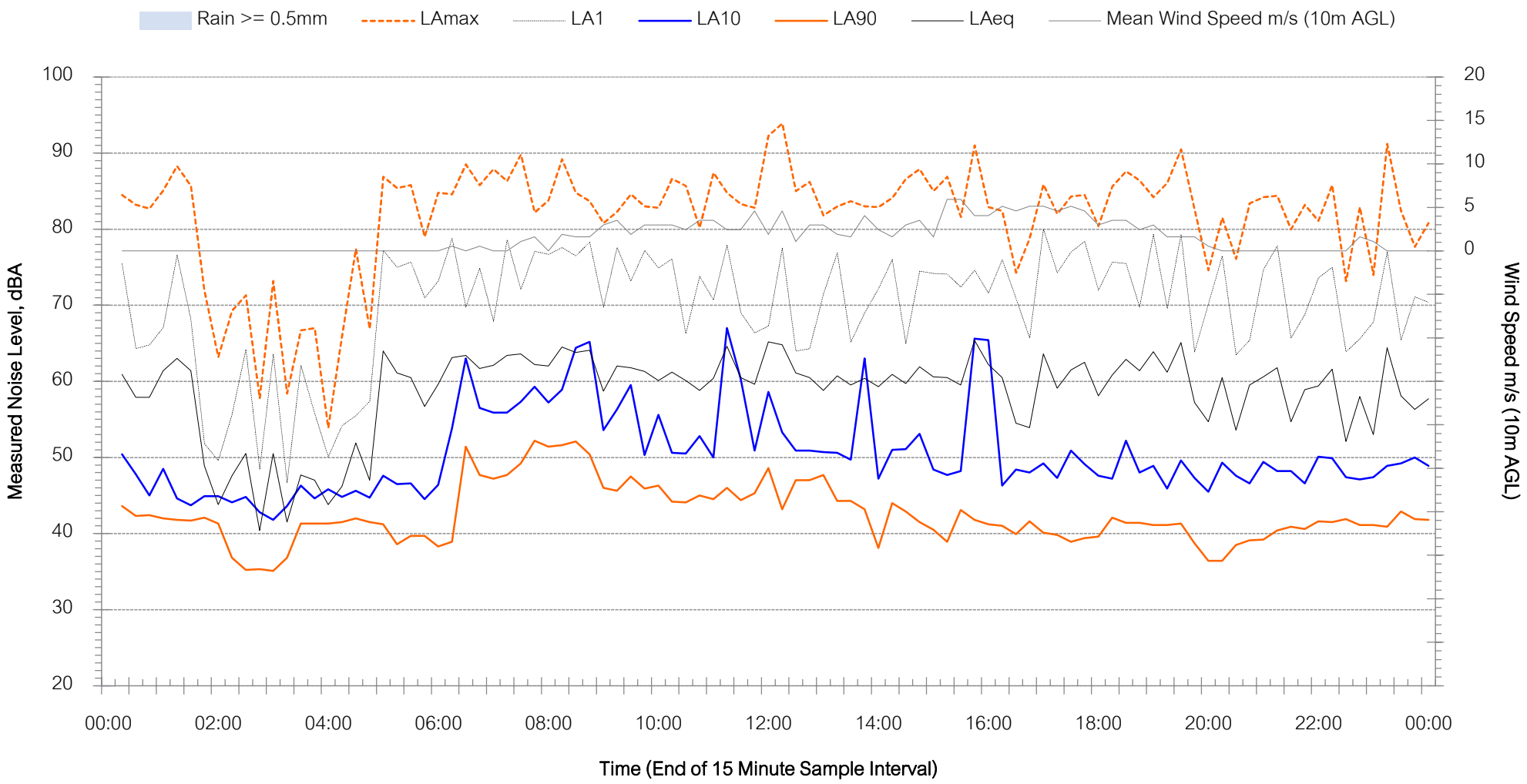
Background Noise Levels

N4 - Thursday 9 January 2020



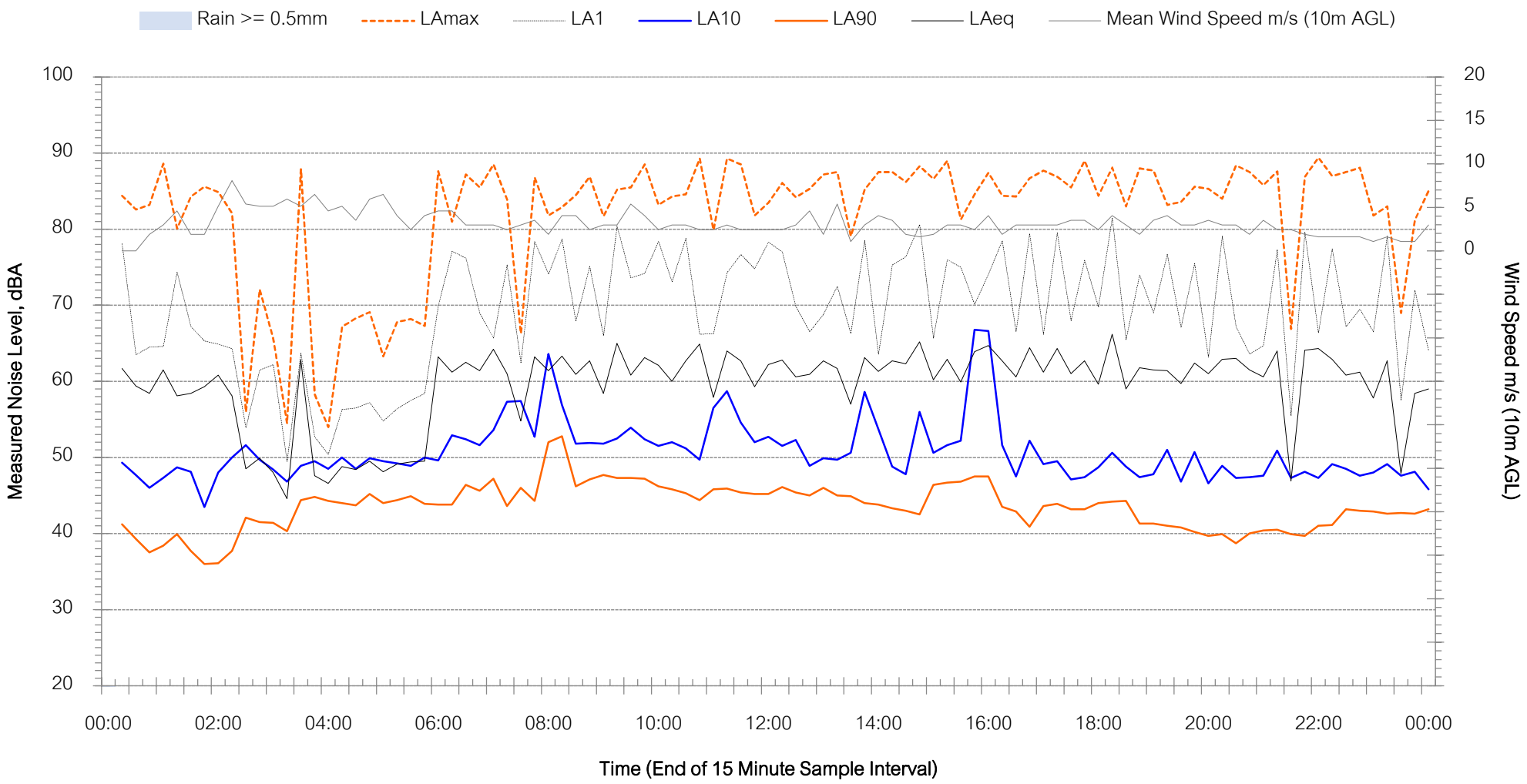
Background Noise Levels

N4 - Friday 10 January 2020



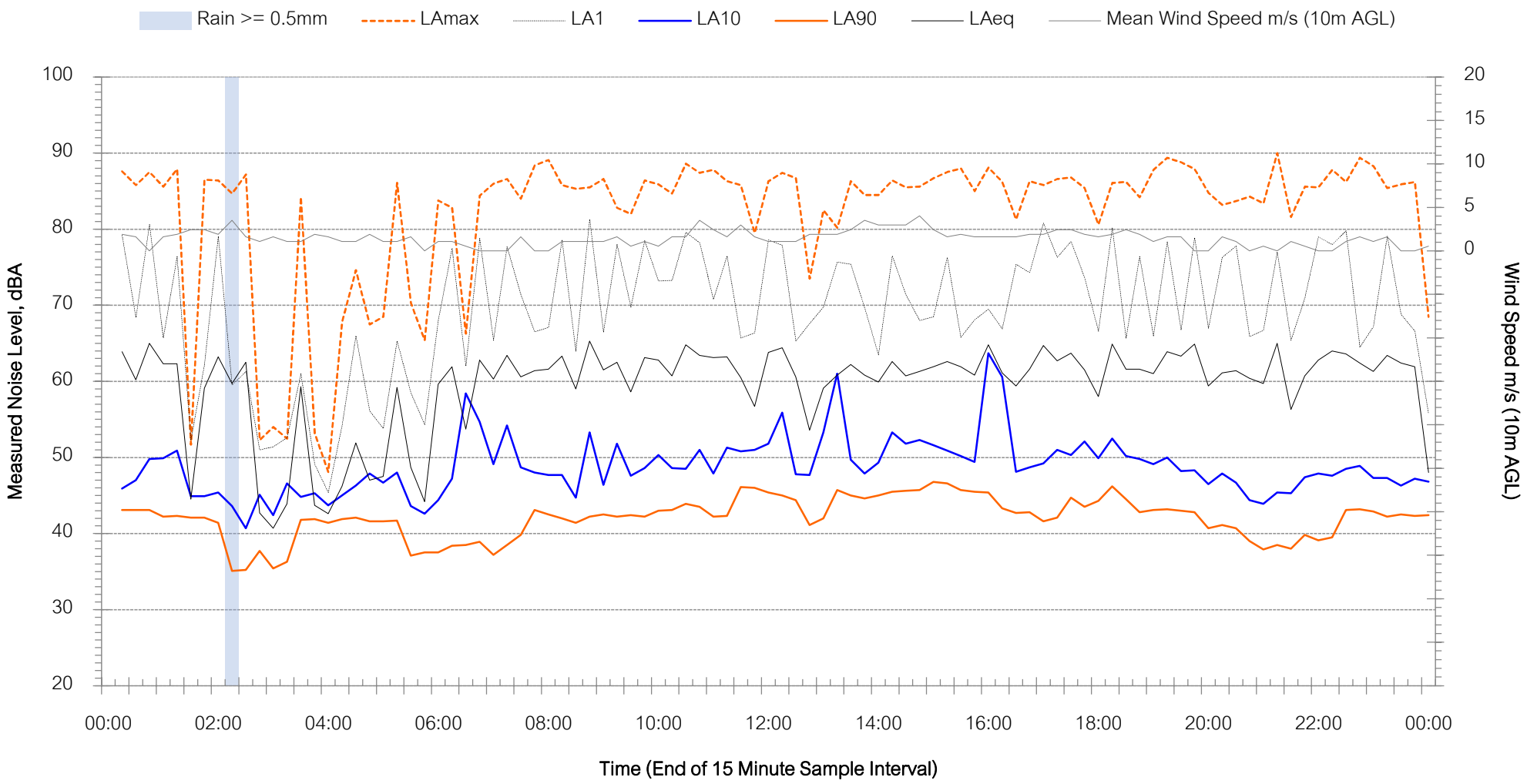
Background Noise Levels

N4 - Saturday 11 January 2020



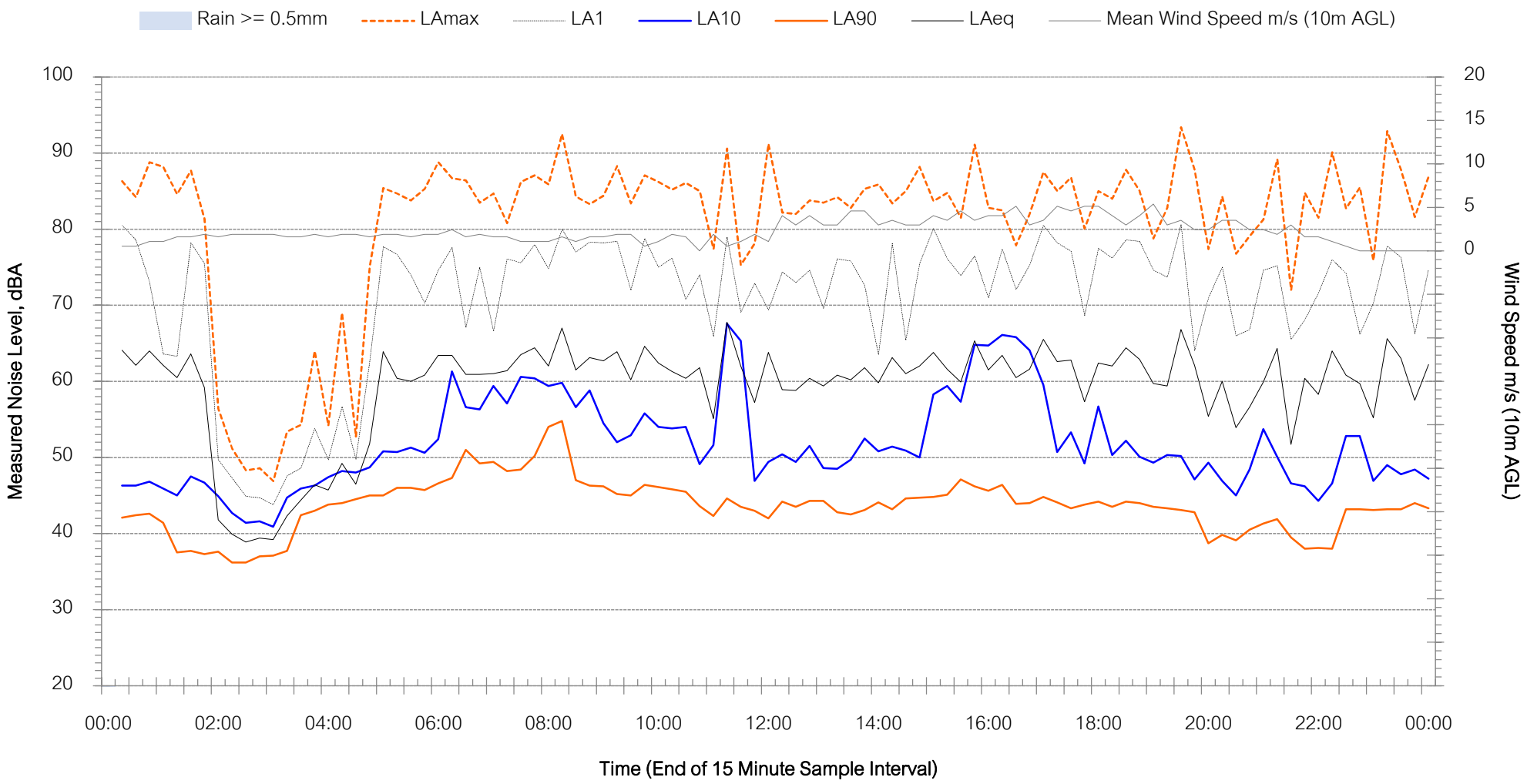
Background Noise Levels

N4 - Sunday 12 January 2020



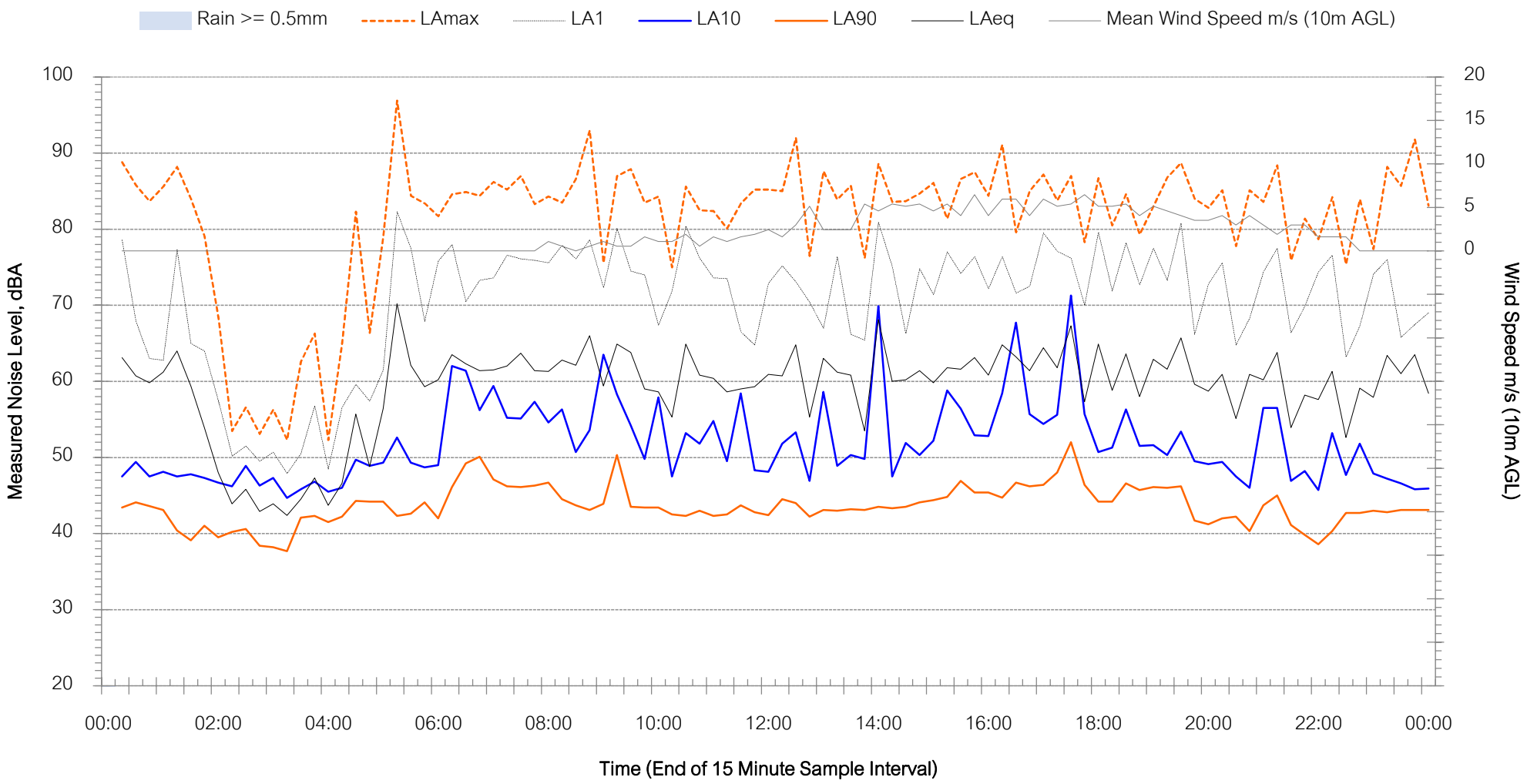
Background Noise Levels

N4 - Monday 13 January 2020



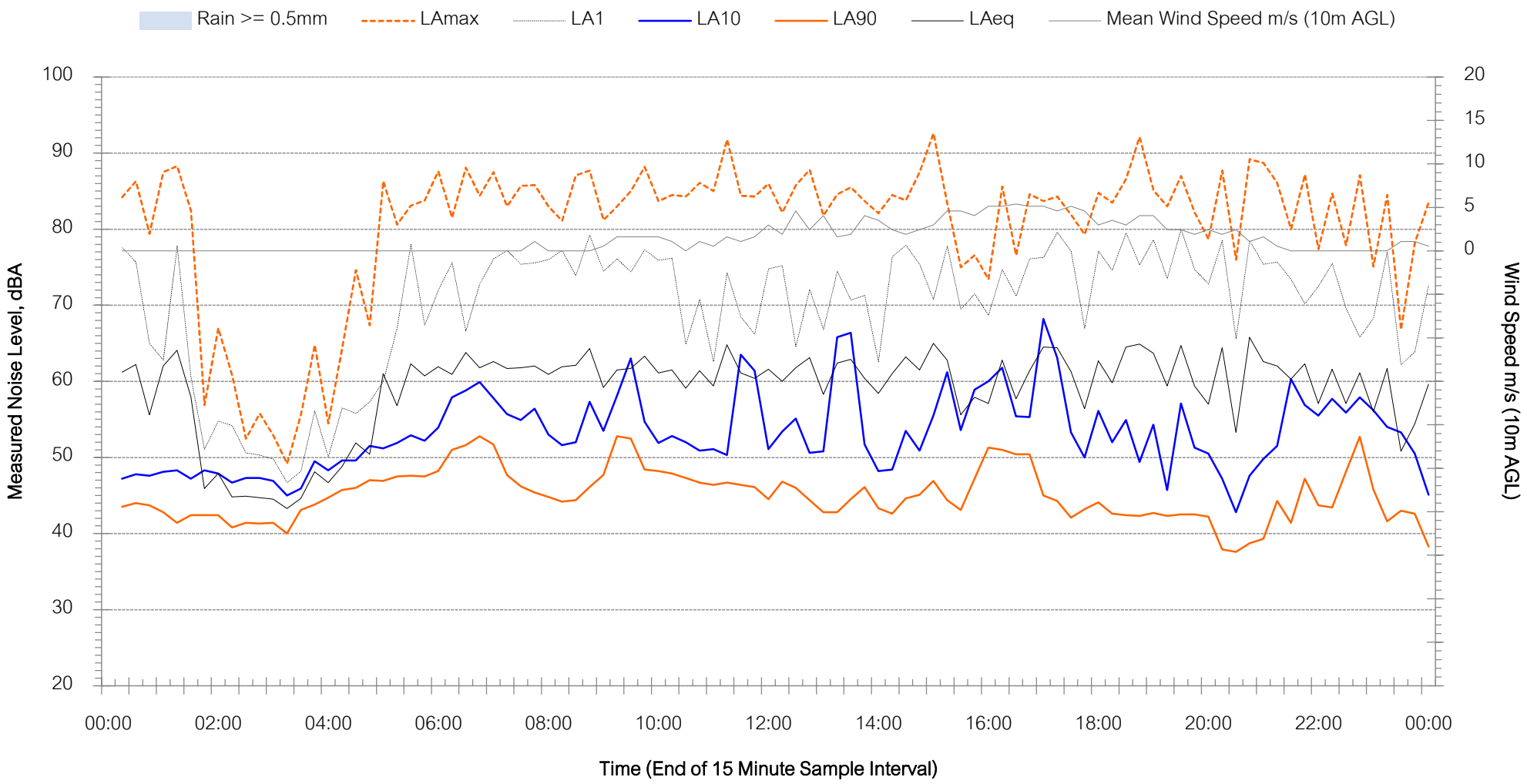
Background Noise Levels

N4 - Tuesday 14 January 2020



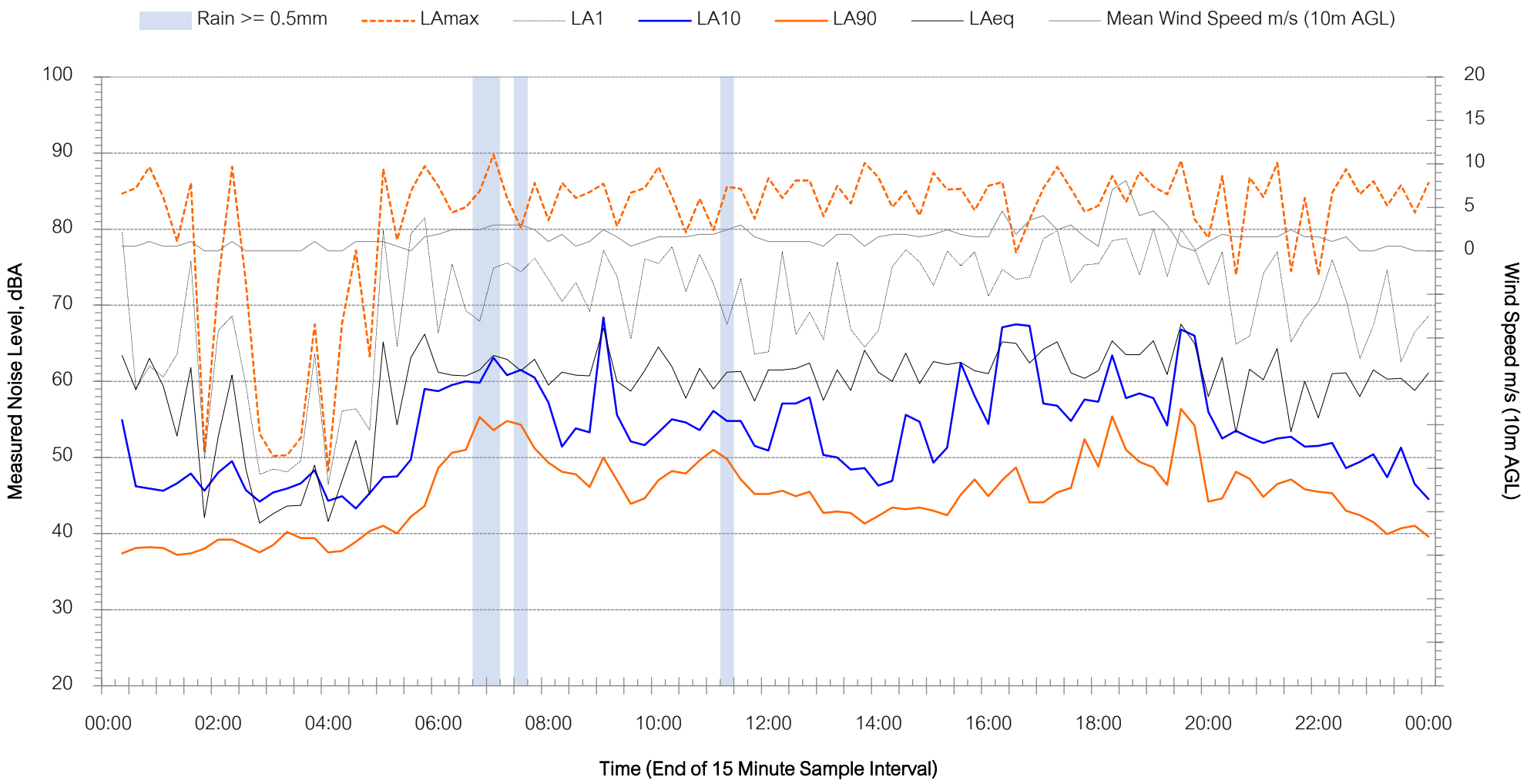
Background Noise Levels

N4 - Wednesday 15 January 2020



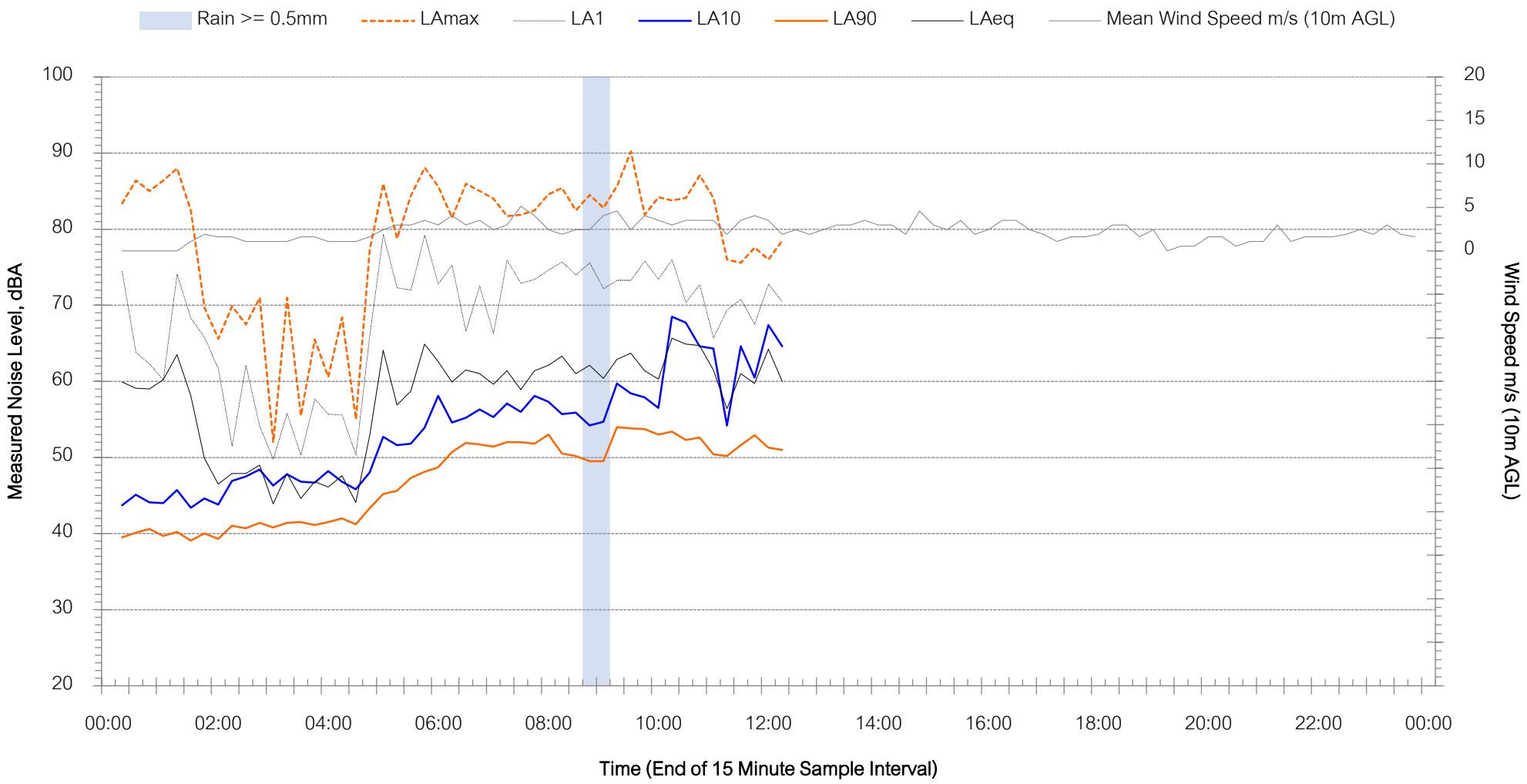
Background Noise Levels

N4 - Thursday 16 January 2020



Background Noise Levels

N4 - Friday 17 January 2020



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Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW
Quarter 2 Ending June 2020.

Prepared for: Holcim (Australia) Pty Ltd
April 2020
MAC180611-01RP8

MAC
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Document Information

Noise Monitoring Assessment

Rooty Hill Distribution Centre, Rooty Hill, NSW

Quarter 2 Ending June 2020

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APPENDIX A – GLOSSARY OF TERMS

APPENDIX B – UNATTENDED NOISE MONITORING CHARTS

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1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Holcim (Australia) Pty Ltd (Holcim) to complete a Noise Monitoring Assessment (NMA) for the Holcim Regional Distribution Centre (RDC), at Rooty Hill, NSW.

This assessment has been undertaken at four representative monitoring locations for the Quarterly period ending June 2020 as part of the Noise Monitoring Program (NMP) to address conditions outlined in the Development Consent.

The assessment has been conducted in accordance with the following documents:

- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPI), 2017;
- Rooty Hill RDC Operational Noise Management Plan (NMP), 2015;
- Rooty Hill, Consolidated Consent, 2017 (Mod 2);
- Australian Standard AS 1055:2018 - Acoustics - Description and Measurement of Environmental Noise; and
- Australian Standard AS/NZS IEC 61672.1:2019 (AS 61672) – Electro Acoustics - Sound Level Meters Specifications Monitoring;

A glossary of terms, definitions and abbreviations used in this report is provided in **Appendix A**.

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2 Noise Criteria

The noise criteria for each receiver location are outlined in the NMP and consolidated consent for the RDC are presented in **Table 1**.

Table 1 Noise Criteria, dBA

Location	Monitoring Location	Morning Shoulder[1,2]	Day[1,2]	Evening[1,2]	Night[1,2]	
		$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{Aeq(15min)}$	$L_{A1(1min)}$
Any residences in Station Street	N1	39	44	44	39	53
Any residences in Coughlan Crescent	N2	40	40	39	39	53
Any residences in Mavis Street	N1/N4	35	35	35	35	53
Nurragingy Reserve	N3	When Reserve is in use – 50dB, L_{Aeq}				
Colebee Centre	N3	When the Centre is in use – 50dB, L_{Aeq}				
Blacktown Olympic Park (Active recreation areas)	N4	When active recreational areas of the Park are in use – 55dB, L_{Aeq}				

Note 1: Noise criteria adopted from NMP.

Note 2: Morning shoulder 6am-7am Monday to Saturday and 6am-8am Sundays and public holidays; Day 7am-6pm Monday to Saturday and 8am-6pm Sundays and public holidays; Evening 6pm-10pm Monday to Sunday; Night 10pm-7am Monday to Saturday and 10pm-8am Sunday.

The RDC is located at Rooty Hill, NSW approximately 1km east of the railway station and town centre. Receivers in the locality surrounding the RDC are primarily industrial, recreational and urban residential. The RDC is bounded by the railway line to the south, industry to the west and recreational areas to the east. The residential areas potentially affected by noise from the operation are to the east, beyond the Nurragingy Reserve in Doonside, NSW (Crawford Street and Knox Road); and to the west, beyond industrial zones and the M7 Motorway in Station Street, Rooty Hill, NSW. Road traffic from the M7 Motorway is a dominant noise source in the area along with urban hum and railway noise.

Monitoring locations were selected in accordance with the NMP and are representative of the nearest noise sensitive receivers to the RDC.

The operational compliance monitoring locations with respect to the RDC are presented in the locality plan shown in **Figure 1** and **Table 1** along with the relevant noise criteria for each location.

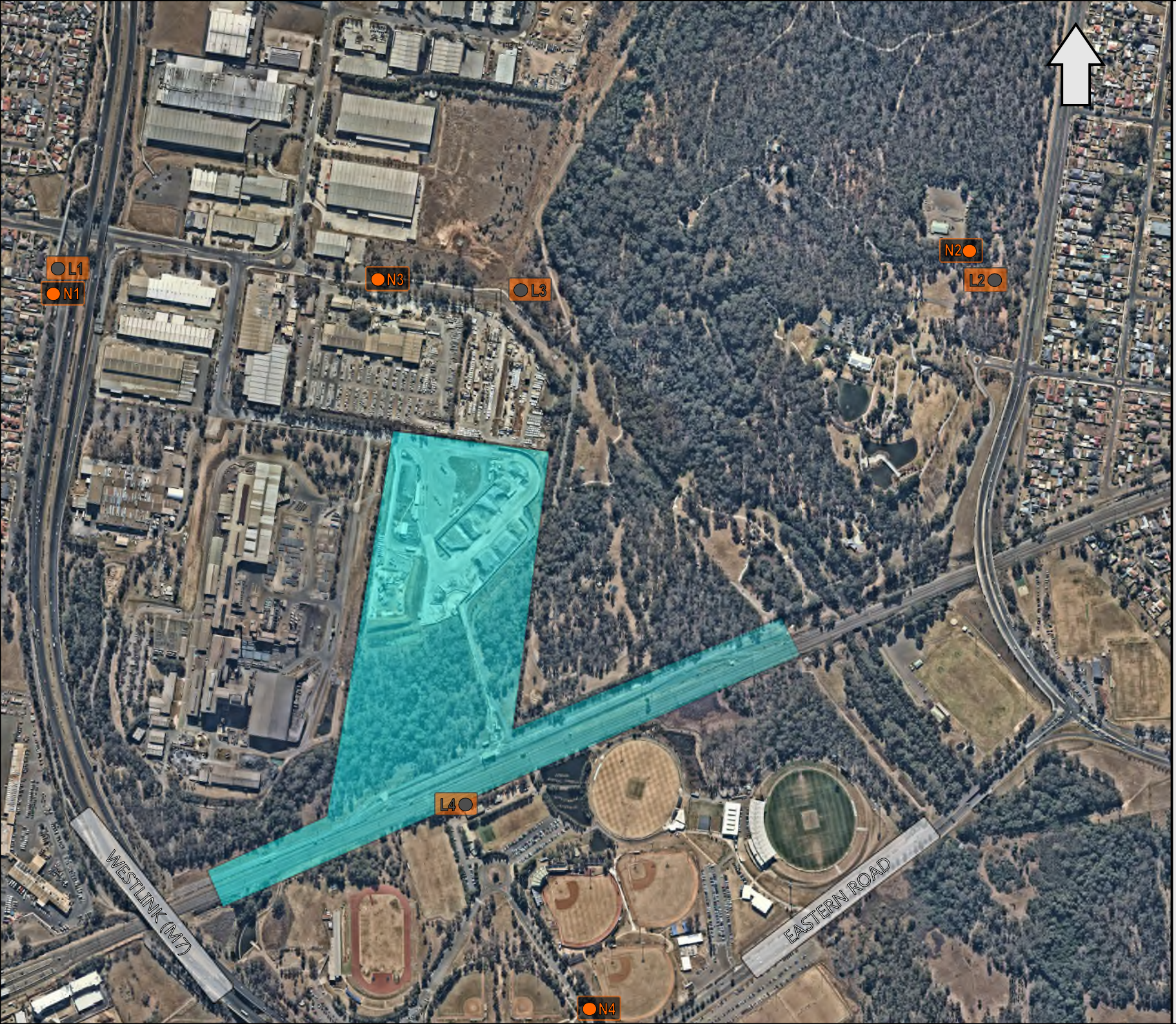

FIGURE 1

LOCALITY PLAN

REF: MAC180611-01

0 300m

KEY

- N1 MONITORING LOCATION
- L1 LOGGER LOCATION
- SITE LOCATION

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*Imagery Source : nearmaps

3 Methodology

Noise monitoring consisted of attended and unattended monitoring during the daytime, evening and night time periods.

3.1 Attended Noise Monitoring

Attended noise monitoring was conducted in general accordance with the procedures described in Australian Standard AS 1055:2018 and the RDC Consolidated Consent. The measurements were carried out using a Svantek Type 1, 971 noise analyser on Tuesday 14 April 2020 and Wednesday 15 April 2020. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019 Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA.

Attended noise monitoring was conducted for 15-minutes in duration during the daytime, evening and night time periods over one day. Where possible, throughout each measurement the operator(s) quantified the contribution of each significant noise source.

Extraneous noise sources were excluded from the analysis to determine the $LA_{eq(15min)}$ RDC noise contribution for comparison against the relevant criteria. Where the RDC was inaudible, the RDC contribution is estimated to be at least 10dB below the ambient noise level.

3.2 Unattended Noise Monitoring

The unattended noise monitoring was conducted at locations N1 – N4 for a minimum of seven days in general accordance with the procedures described AS 1055:2018 and the RDC Consolidated Consent. Noise measurements were carried out using Type 1 Svantek 977 and Svantek 957 noise analysers from Tuesday 14 April 2020 to Wednesday 22 April 2020. The acoustic instrumentation used carries current NATA calibration and complies with AS/NZS IEC 61672.1:2019. Calibration of all instrumentation was checked prior to and following measurements. Drift in calibration did not exceed ±0.5dBA. **Appendix B** presents the noise monitoring charts for the assessment period.

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4 Results

4.1 Attended Noise Monitoring Results

4.1.1 Attended Assessment Results - Location N1

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N1 for the NMA are presented in **Table 2**.

Table 2 Operator-Attended Noise Survey Results – Location N1

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
15/04/2020	09:13 (Day)	70	56	50	WD: N WS: 0.5m/s Rain: Nil	Traffic 40-70 Birds 40-68 People 43-54 Residential noise 45-52 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<40
14/04/2020	19:48 (Evening)	78	50	44	WD: SE WS: 0.5m/s Rain: Nil	Insects <40 Traffic 40-60 People 40-78 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
14/04/2020	22:01 (Night)	68	51	43	WD: NE WS: <0.1m/s Rain: Nil	Traffic 37-68 Roadworks 37-48 Insects <35 Residential Noise 39-53 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<35
		RDC $L_{A1(1min)}$ Contribution				<50

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.2 Attended Assessment Results - Location N2

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N2 for the NMA are presented in **Table 3**.

Table 3 Operator-Attended Noise Survey Results – Location N2

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
15/04/2020	10:22 (Day)	70	56	48	WD: N WS: 0.5m/s Rain: Nil	Traffic 37-70 Residential Noise 38-46 Birds 37-54 Distant Construction 37-45 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<38
14/04/2020	21:02 (Evening)	66	54	45	WD: E WS: <0.1m/s Rain: Nil	Traffic 35-62 Aircraft 35-63 Train 43-66 Insects <30 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<35
14/04/2020	23:10 (Night)	61	51	44	WD: E WS: <0.1m/s Rain: Nil	Traffic 35-61 Train 38-45 Insects <35 Industrial noise <38 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<35
RDC $L_{A1(1min)}$ Contribution						<50

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.3 Attended Assessment Results - Location N3

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N3 for the NMA are presented in **Table 4**.

Table 4 Operator-Attended Noise Survey Results – Location N3

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
15/04/2020	09:34 (Day)	75	59	55	WD: NW WS: 0.5m/s Rain: Nil	Industrial Noise 49-75 Traffic 49-64 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<45
14/04/2020	20:13 (Evening)	61	53	50	WD: NE WS: <0.1m/s Rain: Nil	Industrial Noise 46-61 Traffic 46-56 Aircraft <46 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<45
14/04/2020	22:24 (Night)	65	50	46	WD: E WS: <0.1m/s Rain: Nil	Traffic 42-65 Industrial Noise 42-56 Aircraft 42-50 Insects <35 RDC Inaudible
RDC $L_{Aeq(15min)}$ Contribution						<40

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.1.4 Attended Assessment Results - Location N4

The monitored noise level contributions and observed meteorological conditions for each assessment period at location N4 for the NMA are presented in **Table 5**.

Table 5 Operator-Attended Noise Survey Results – Location N4

Date	Time (hrs)	Descriptor (dBA re 20 µPa)			Meteorology	Description and SPL, dBA
		L_{Amax}	L_{Aeq}	L_{A90}		
15/04/2020	10:00 (Day)	77	61	52	WD: NW WS: 0.5m/s Rain: Nil	Ground Maintenance 50-67 Train 50-66 Birds 44-56 Traffic 44-77 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45
14/04/2020	20:40 (Evening)	79	65	52	WD: E WS: <0.1m/s Rain: Nil	Traffic 47-79 Aircraft <44-47 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45
14/04/2020	22:49 (Night)	82	63	50	WD: E WS: <0.1m/s Rain: Nil	Traffic 41-75 Trains 35-50 Security Patrol 45-82 RDC Inaudible
		RDC $L_{Aeq(15min)}$ Contribution				<45

Note: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

4.2 Unattended Noise Monitoring Results

The summary (RBL and overall LA_{eq}), noise levels recorded during unattended noise monitoring are presented in **Table 6**.

Table 6 Unattended Noise Monitoring Summary

Monitoring Location	Period[1]	Measured dB $LA_{eq(period)}$[2]	Measured Background Noise Level (LA_{90}) dB RBL[2]
L1 (N1 Station Street)	Day	56	49
	Evening	54	42
	Night	52	38
L2 (N2 Knox Road)	Day	57	48
	Evening	54	46
	Night	54	40
L3 (N3 Nurragingy Reserve)	Day	49	42
	Evening	47	44
	Night	49	42
L4 (N4 Olympic Park)	Day	60	44
	Evening	60	45
	Night	61	45

Note 1: Day - the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays; Evening - the period from 6pm to 10pm; Night - the remaining periods.

Note 2: Calculated from one week of monitoring data and determined using the long term methodology for each period as per Fact Sheet A of the NPI (2017).

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5 Discussion

5.1 Discussion of Results - Location N1

RDC noise emissions were inaudible during all attended measurements conducted on Tuesday 14 April 2020 and Wednesday 15 April 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous noise sources included birds, local residential noise, insects, roadworks and people passing with ambient noise levels dominated by traffic noise.

5.2 Discussion of Results - Location N2

RDC noise emissions were inaudible during all attended measurements conducted on Tuesday 14 April 2020 and Wednesday 15 April 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous sources measured include traffic, birds, industrial noise, construction noise, residential noise, aircraft, trains and insects.

5.3 Discussion of Results - Location N3

Due to park closure by government regulations for COVID-19, attended measurements for this quarter were conducted at an alternative location, at the park gates end of Woodstock Avenue. RDC noise emissions were inaudible during all measurements conducted on Tuesday 14 April 2020 and Wednesday 15 April 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. Extraneous sources audible during the attended surveys included traffic, aircraft, insects and industrial noise which generally masked RDC noise. It is noted the receiver was not in use at the time of the measurements and hence criteria are referenced for completeness.

5.4 Discussion of Results - Location N4

RDC noise emissions were inaudible during all measurements on Tuesday 14 April 2020 and Wednesday 15 April 2020. RDC noise contributions were estimated to satisfy the relevant noise criteria for all periods. It is noted that the sports centre was not in use during the evening or night periods and criteria are referenced for completeness. Extraneous noise sources included ground maintenance, lawn mowing, security patrols, birds, traffic and trains.

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6 Conclusion

Muller Acoustic Consulting Pty Ltd (MAC) has completed a Noise Monitoring Assessment (NMA) on behalf of Holcim (Australia) Pty Ltd for the Regional Distribution Centre (RDC), at Rooty Hill, NSW. The assessment was completed to assess compliance against relevant noise criteria for Quarter 2, ending June 2020.

Unattended noise monitoring was completed between Tuesday 14 April 2020 and Wednesday 22 April 2020 at four representative monitoring locations.

Attended noise monitoring was conducted on Tuesday 14 April 2020 and Wednesday 15 April 2020. The assessment has identified that noise emissions generated by RDC were inaudible at the nearest residential receivers during the attended monitoring, with all measurements satisfying the relevant noise criteria at all assessed residential receivers.

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Appendix A – Glossary of Terms

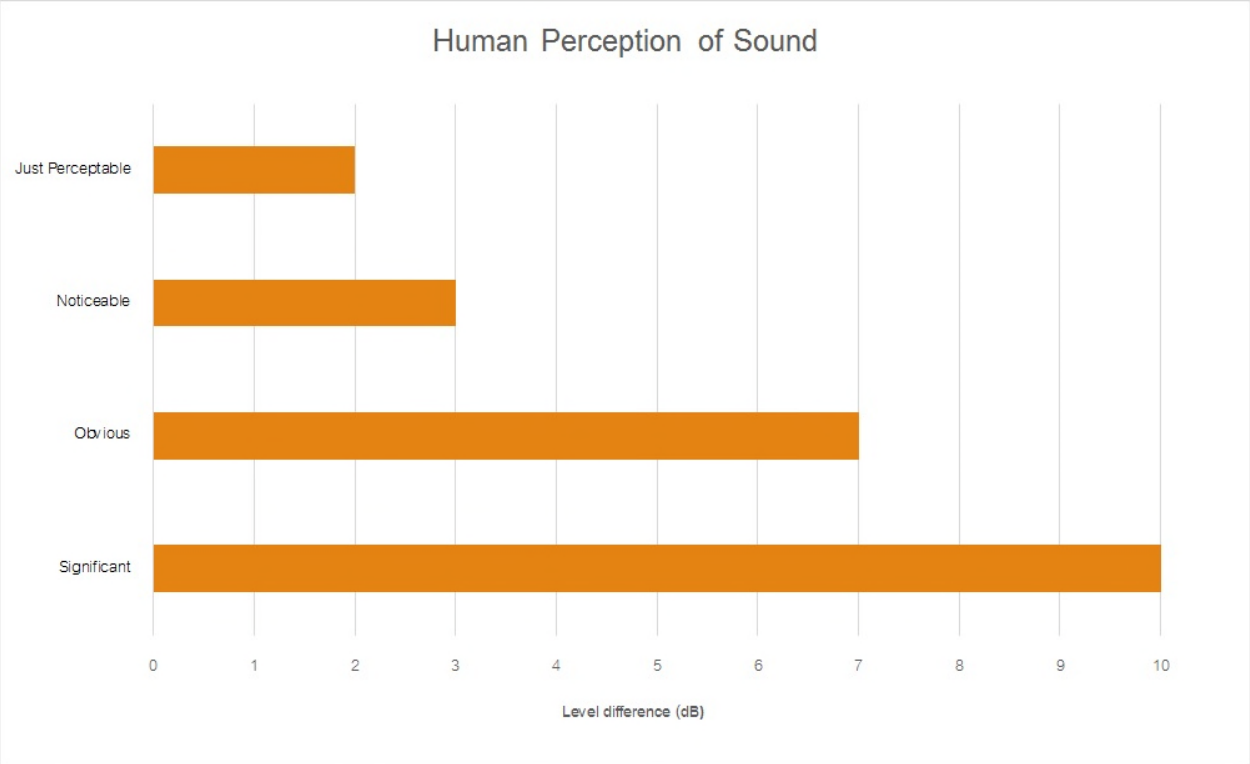
Table A1 provides a number of technical terms have been used in this report.

Table A1 Glossary of Terms	
Term	Description
1/3 Octave	Single octave bands divided into three parts
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment Background Level (ABL) is defined in the NPI as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured LA90 statistical noise levels.
Adverse Weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dBA	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
LA10	A noise level which is exceeded 10 % of the time. It is approximately equivalent to the average of maximum noise levels.
LA90	Commonly referred to as the background noise, this is the level exceeded 90 % of the time.
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period.
LAmax	The maximum root mean squared (rms) sound pressure level received at the microphone during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single figure background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the ABL's.
Sound power level (LW)	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental location of the source and is independent of the surrounding environment. Or a measure of the energy emitted from a source as sound and is given by: = 10.log10 (W/Wo) Where: W is the sound power in watts and Wo is the sound reference power at 10-12 watts.

Table A2 provides a list of common noise sources and their typical sound level.

Table A2 Common Noise Sources and Their Typical Sound Pressure Levels (SPL), dBA	
Source	Typical Sound Level
Threshold of pain	140
Jet engine	130
Hydraulic hammer	120
Chainsaw	110
Industrial workshop	100
Lawn-mower (operator position)	90
Heavy traffic (footpath)	80
Elevated speech	70
Typical conversation	60
Ambient suburban environment	40
Ambient rural environment	30
Bedroom (night with windows closed)	20
Threshold of hearing	0

Figure A1 – Human Perception of Sound



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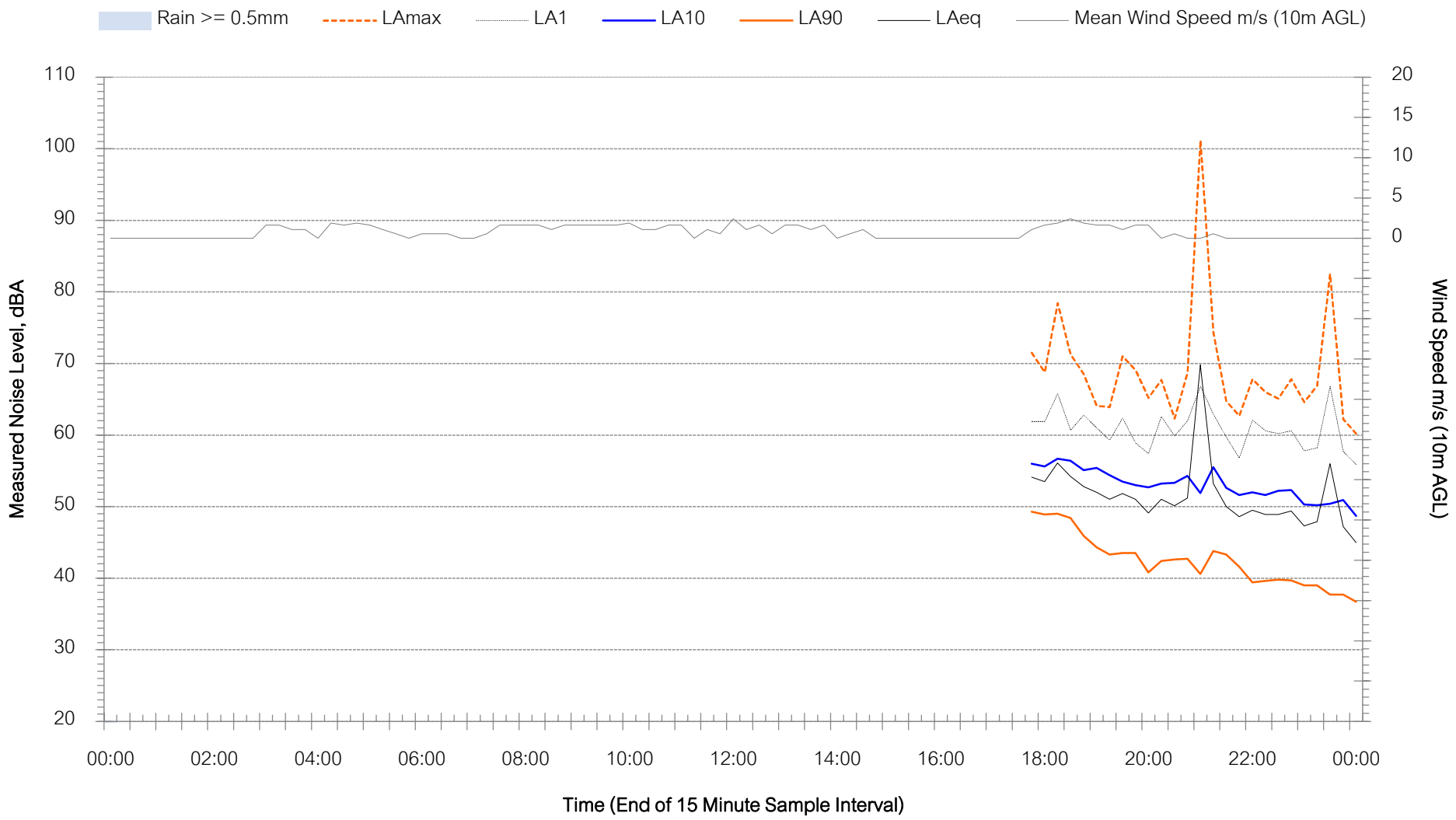
Appendix B – Unattended Noise Monitoring Charts

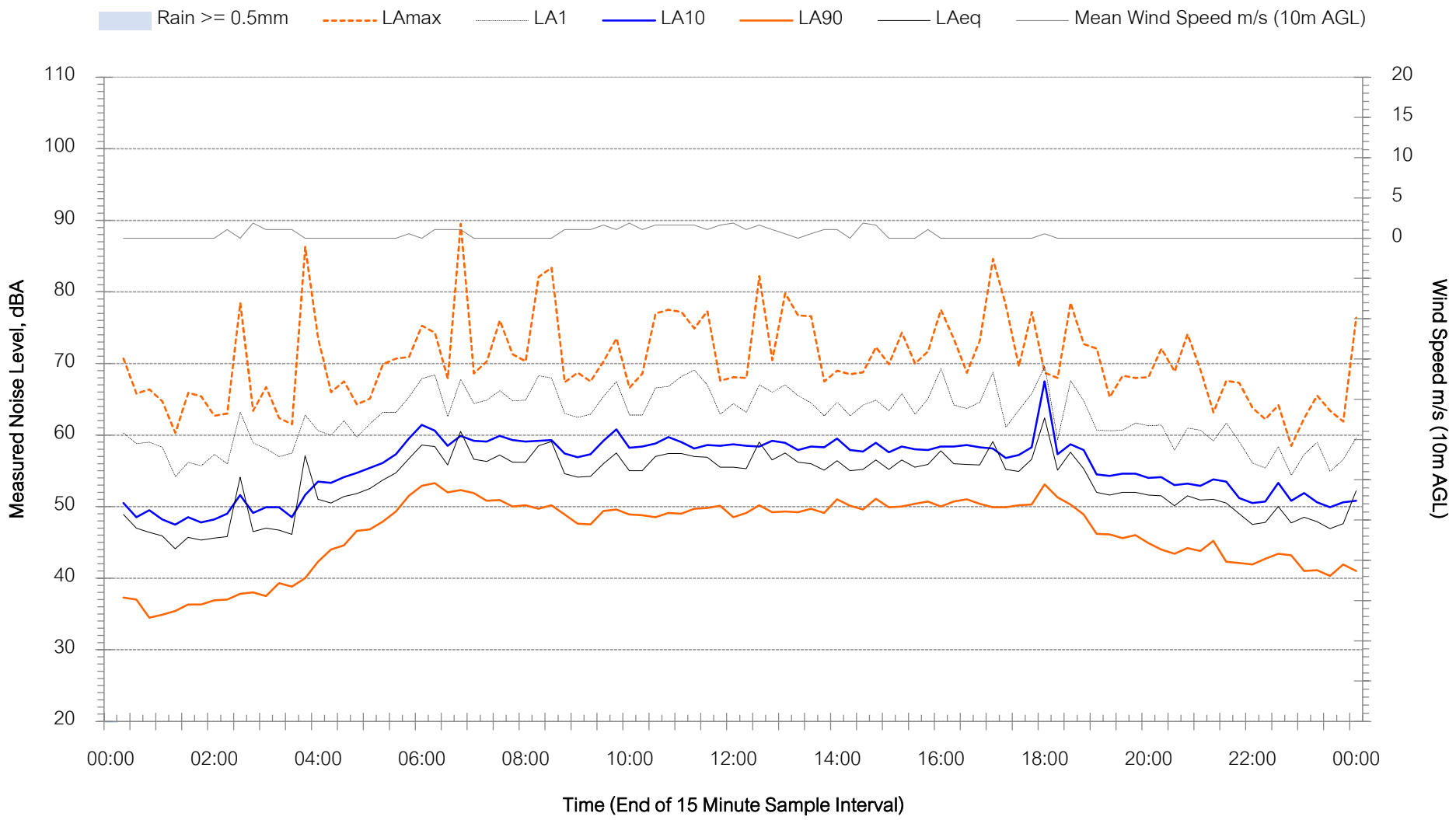
Background Noise Levels

N1 - Tuesday 14 April 2020



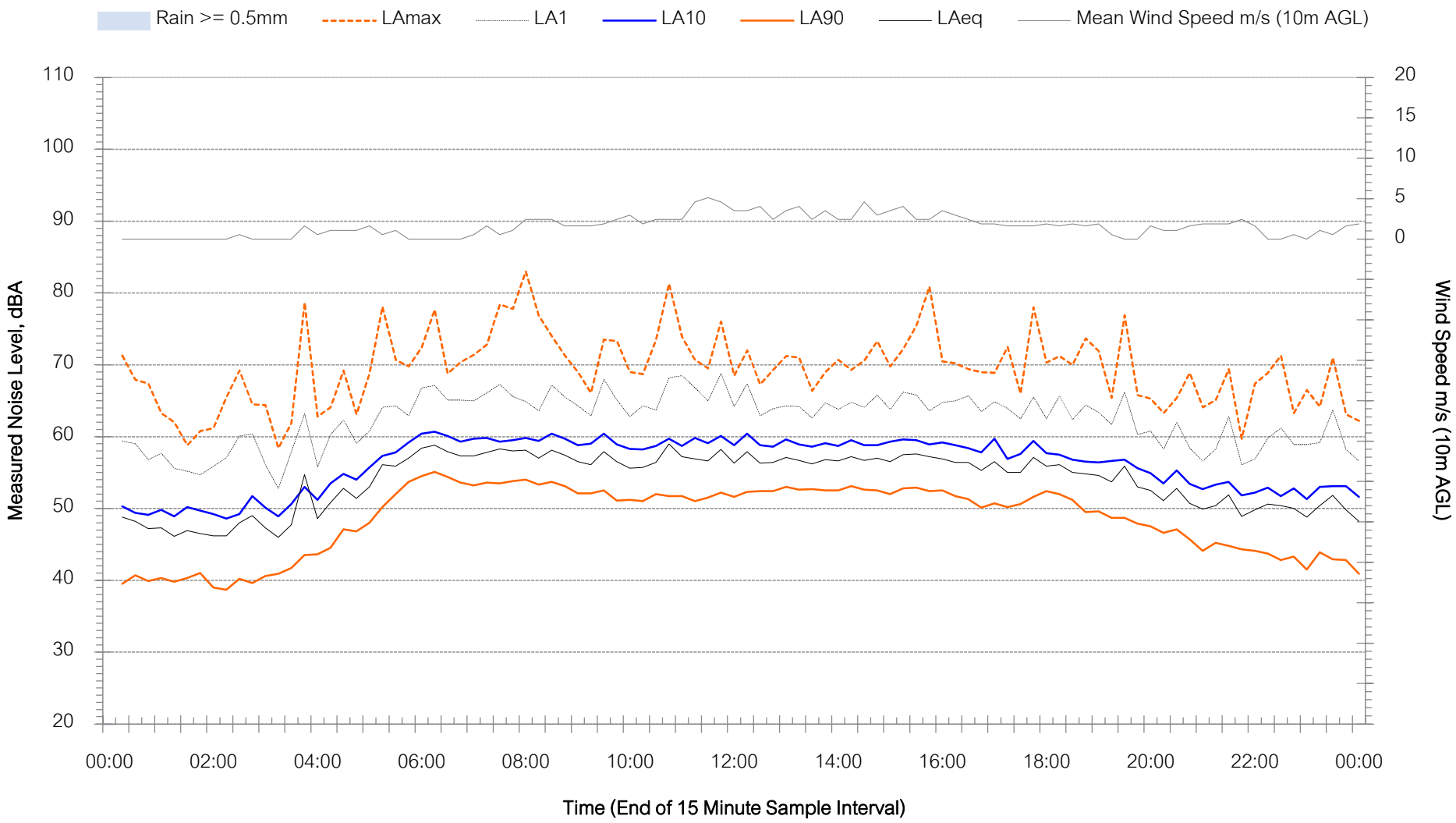
Background Noise Levels

N1 - Wednesday 15 April 2020



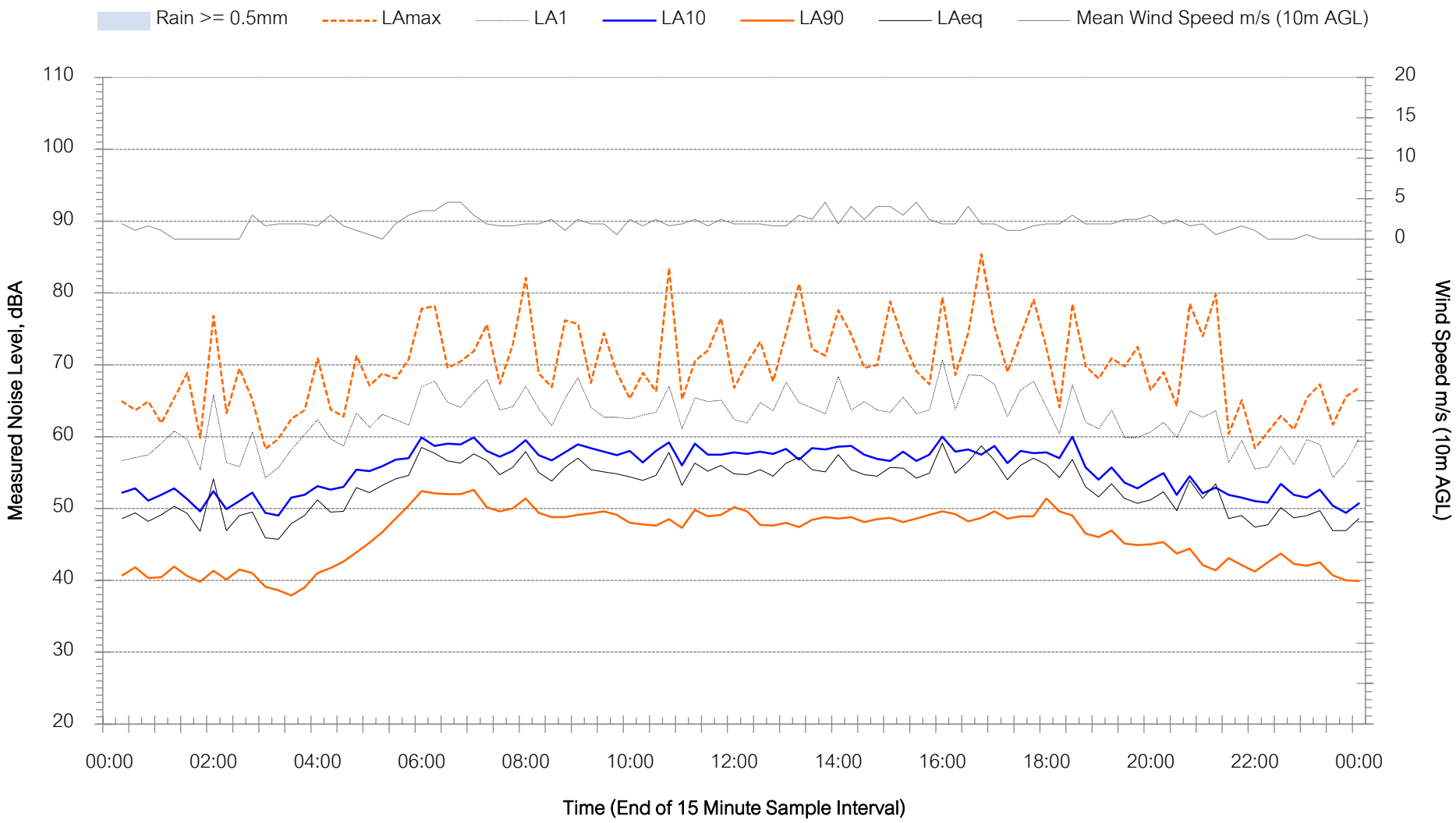
Background Noise Levels

N1 - Thursday 16 April 2020



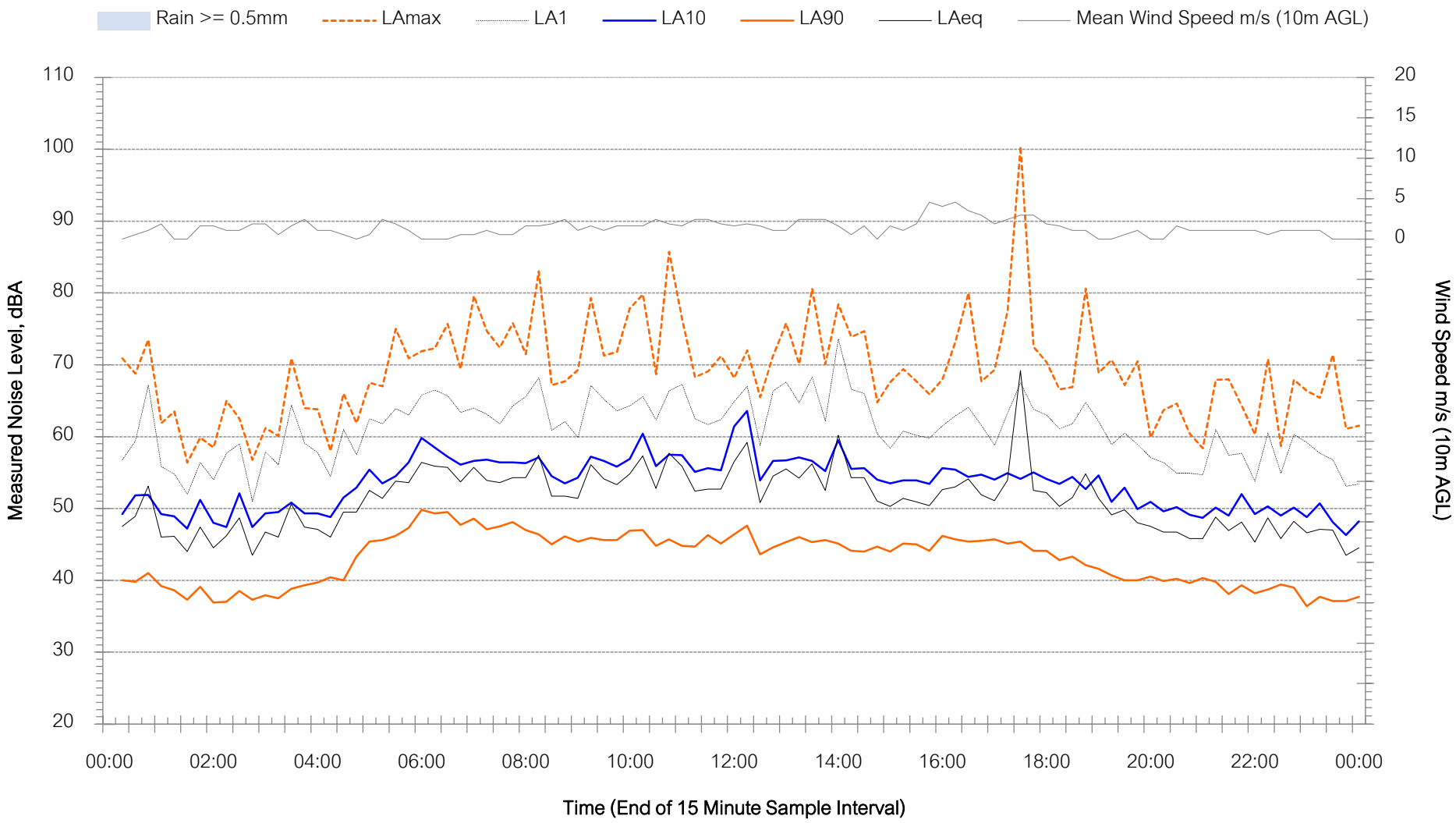
Background Noise Levels

N1 - Friday 17 April 2020



Background Noise Levels

N1 - Saturday 18 April 2020



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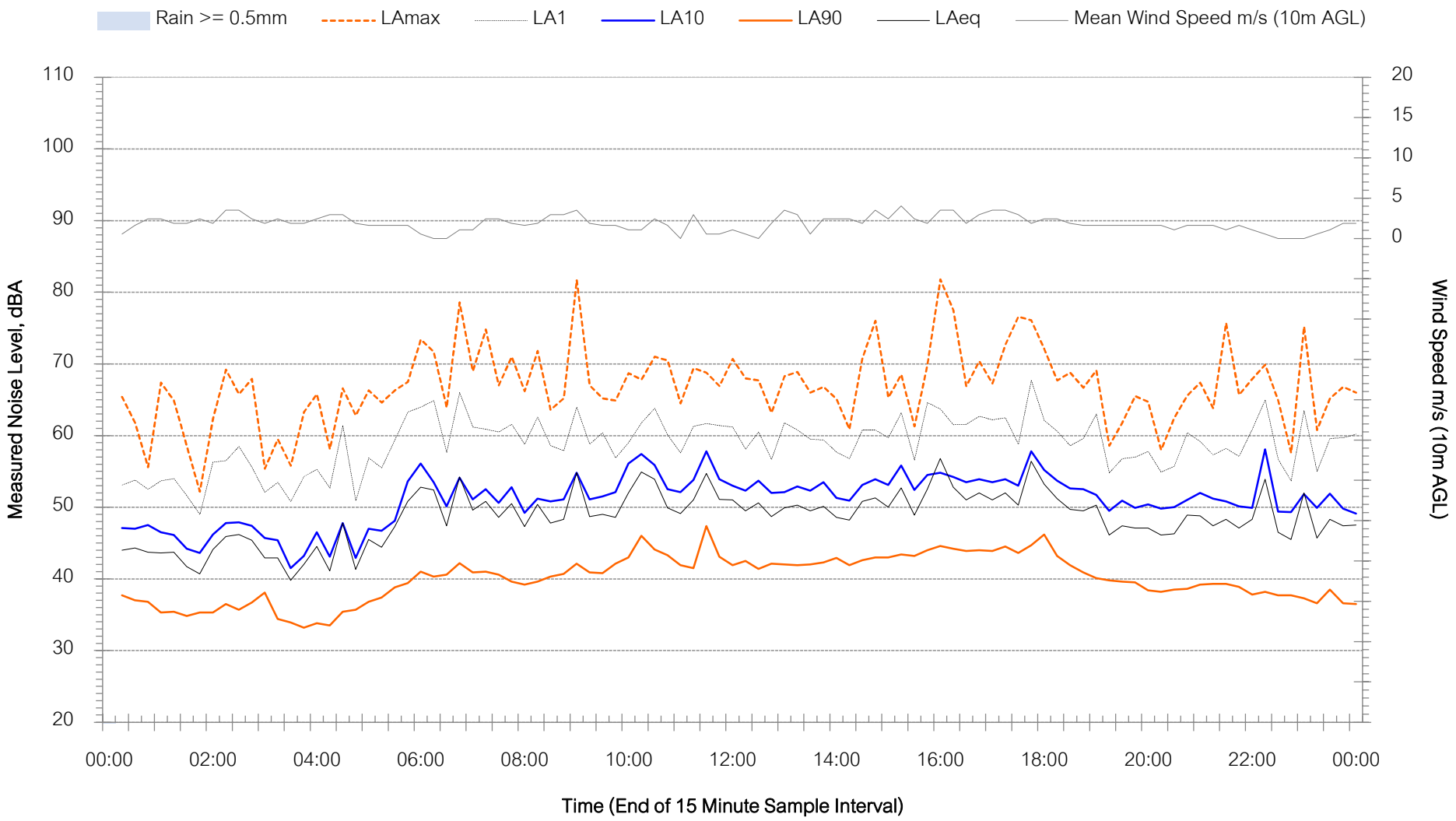

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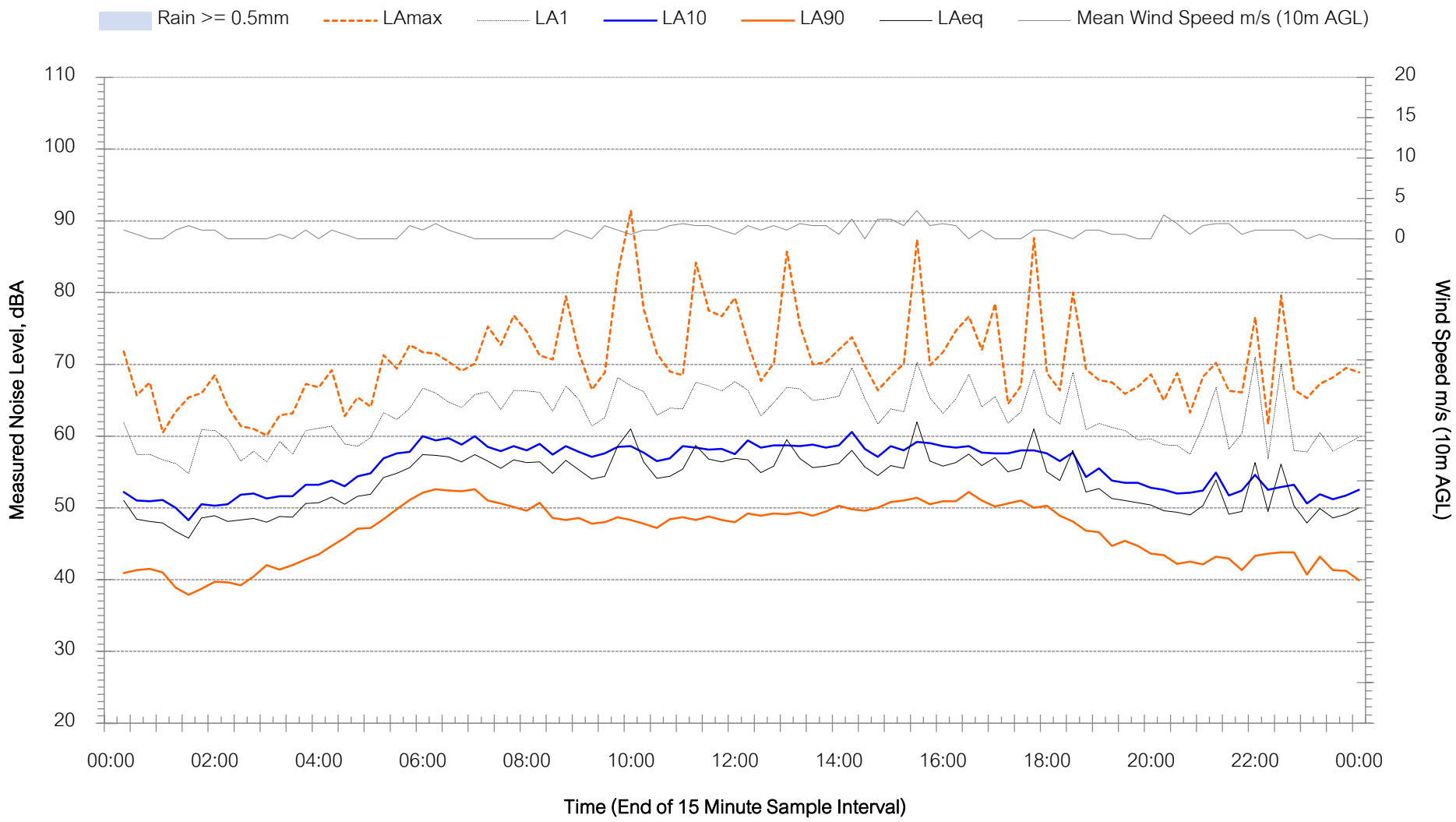

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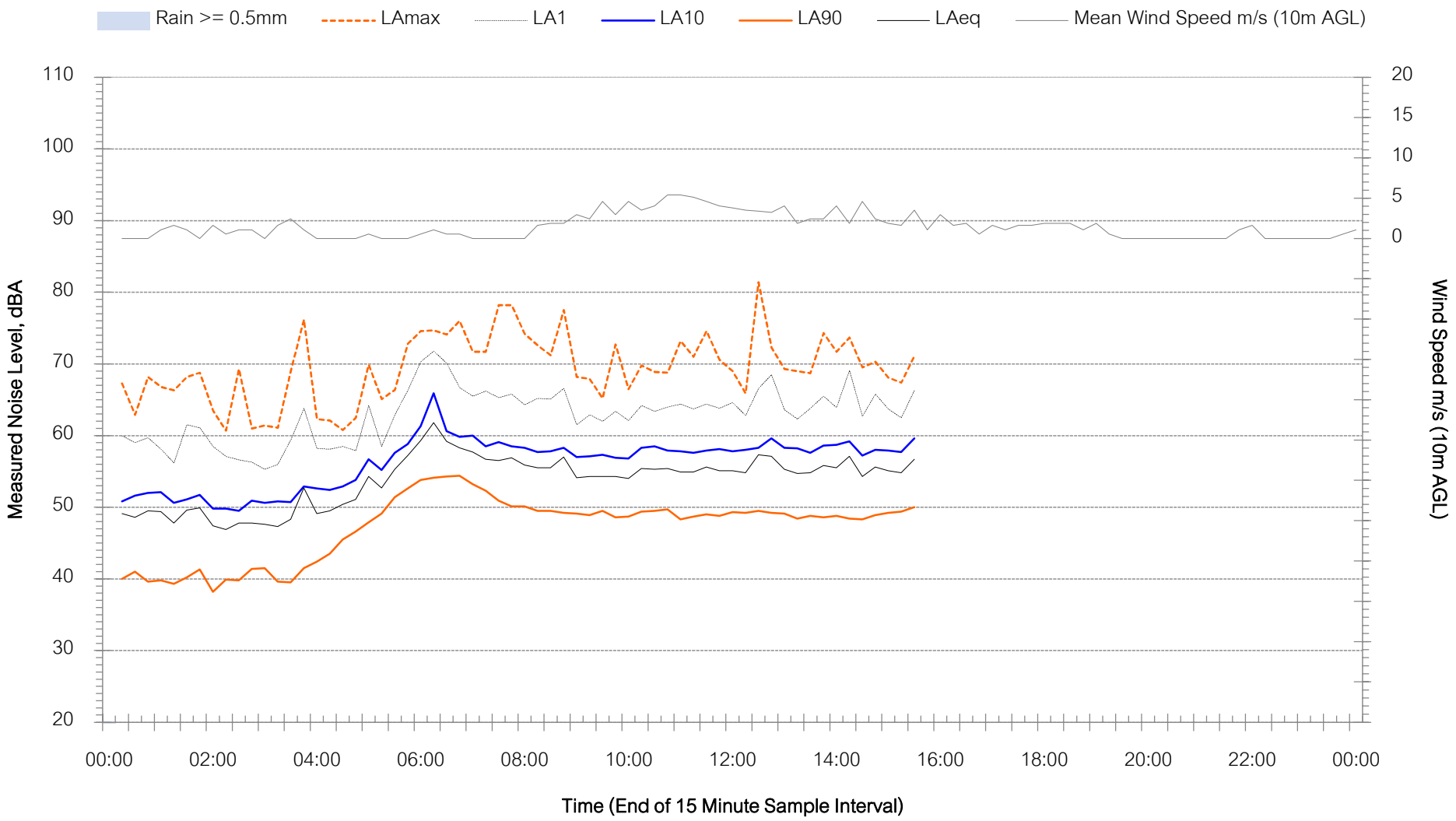

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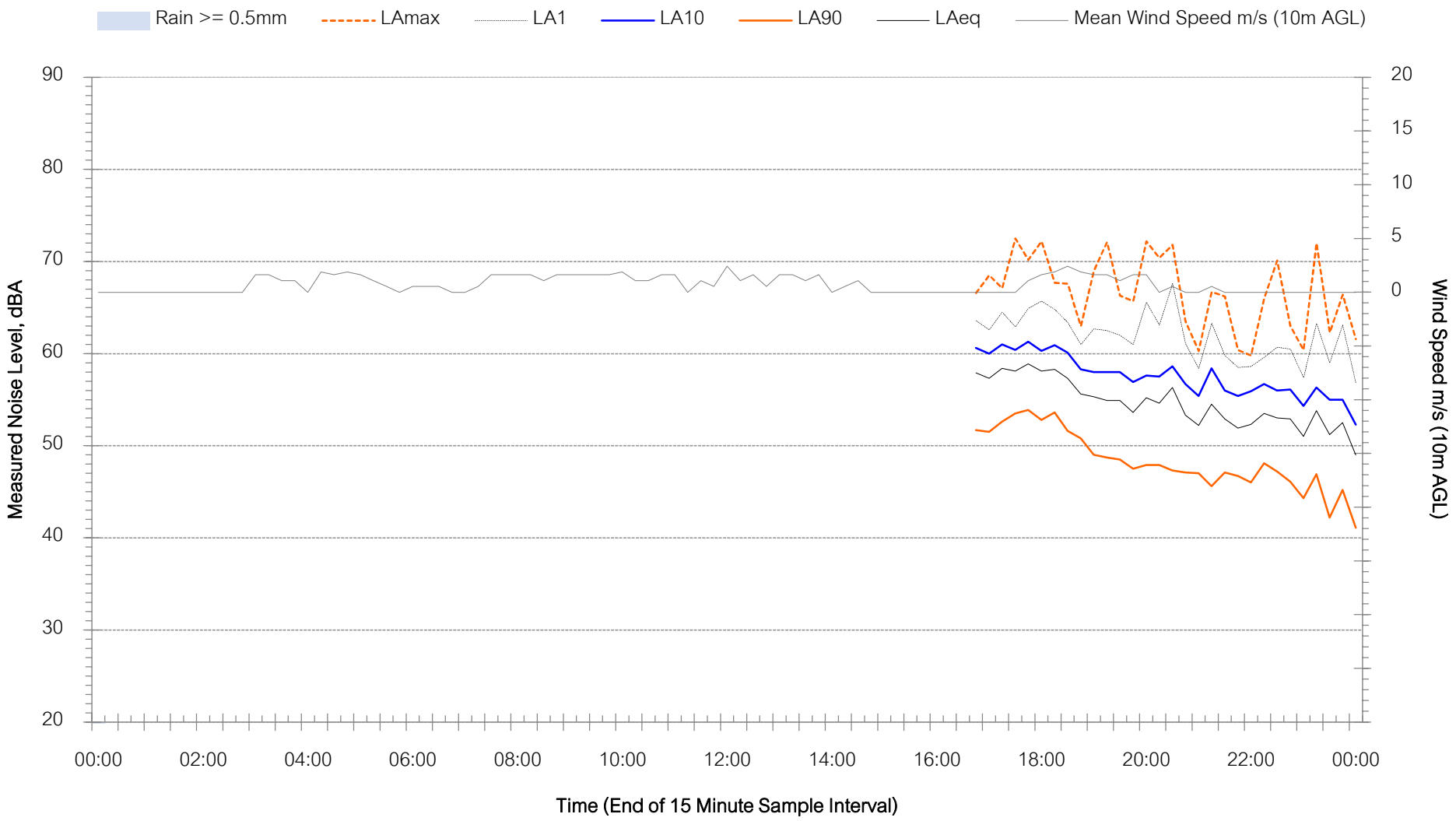

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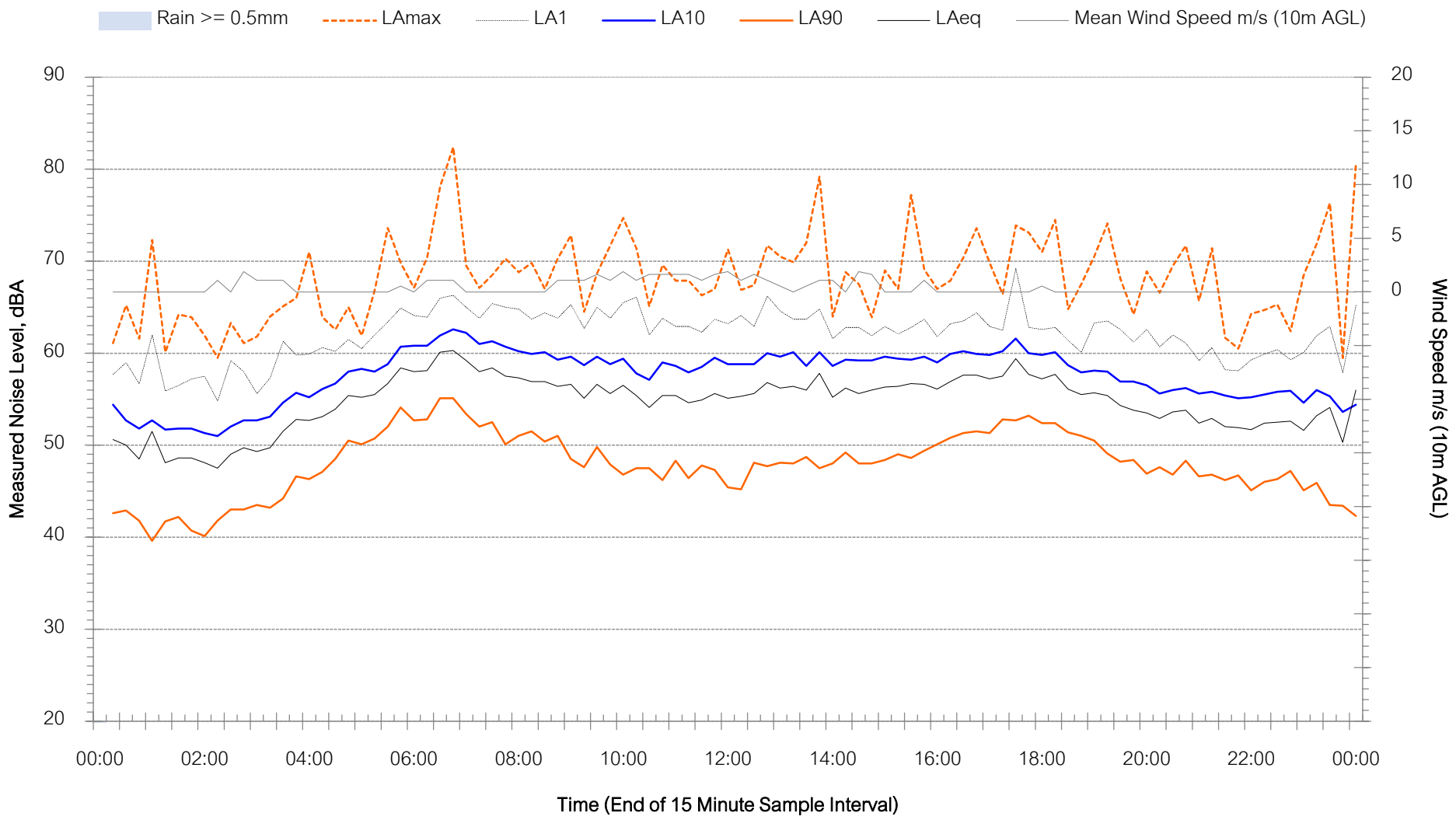

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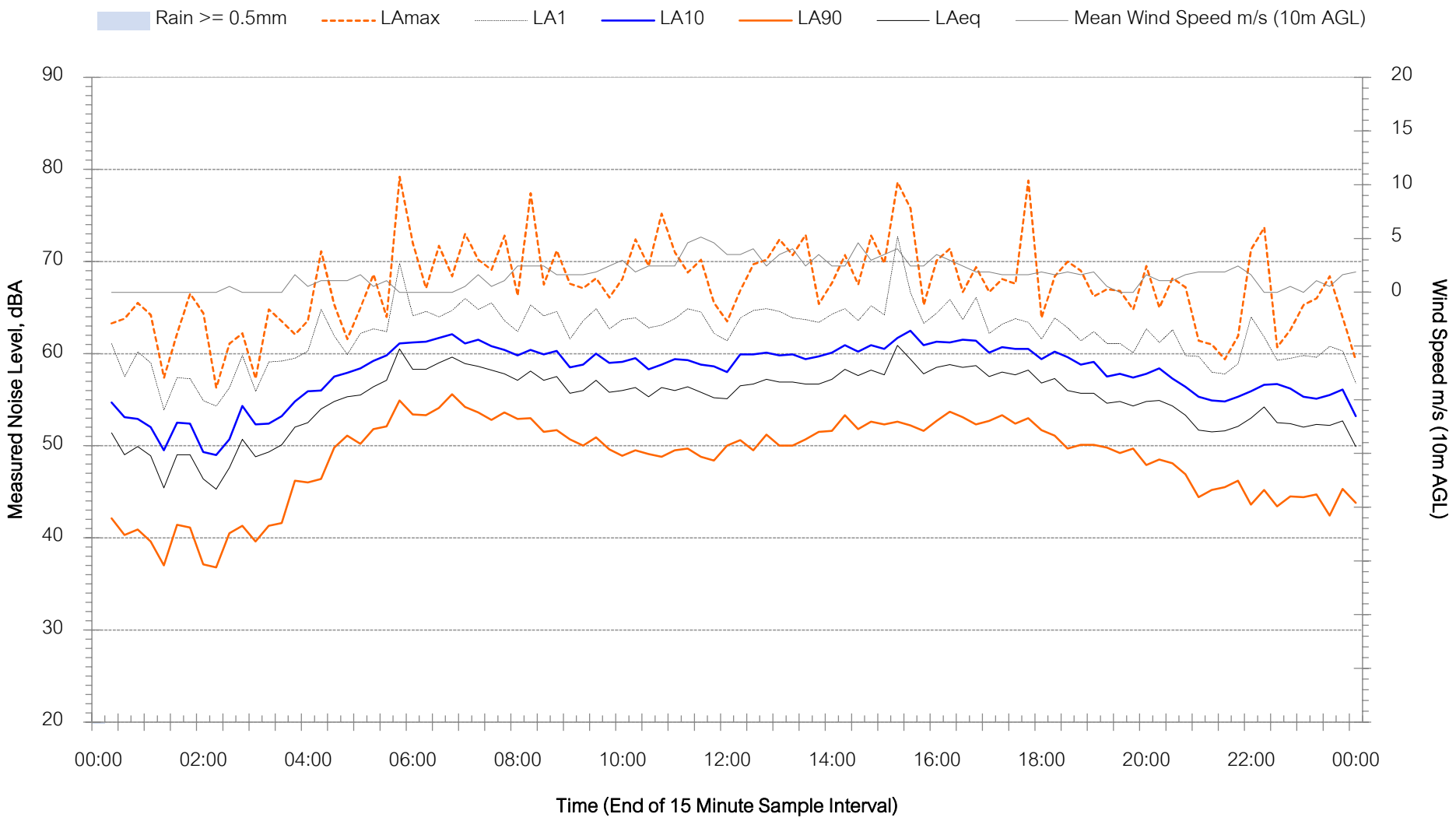

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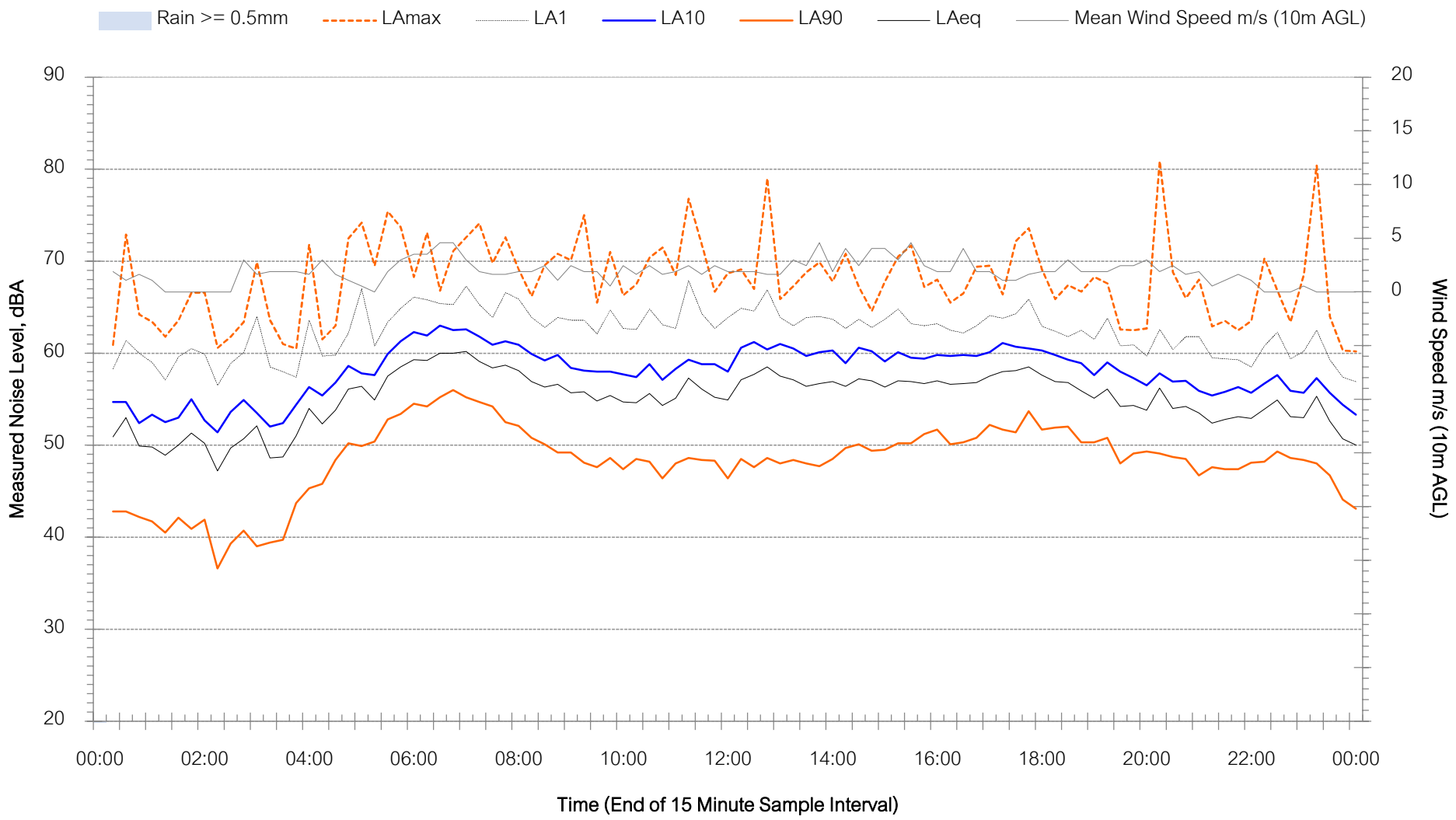

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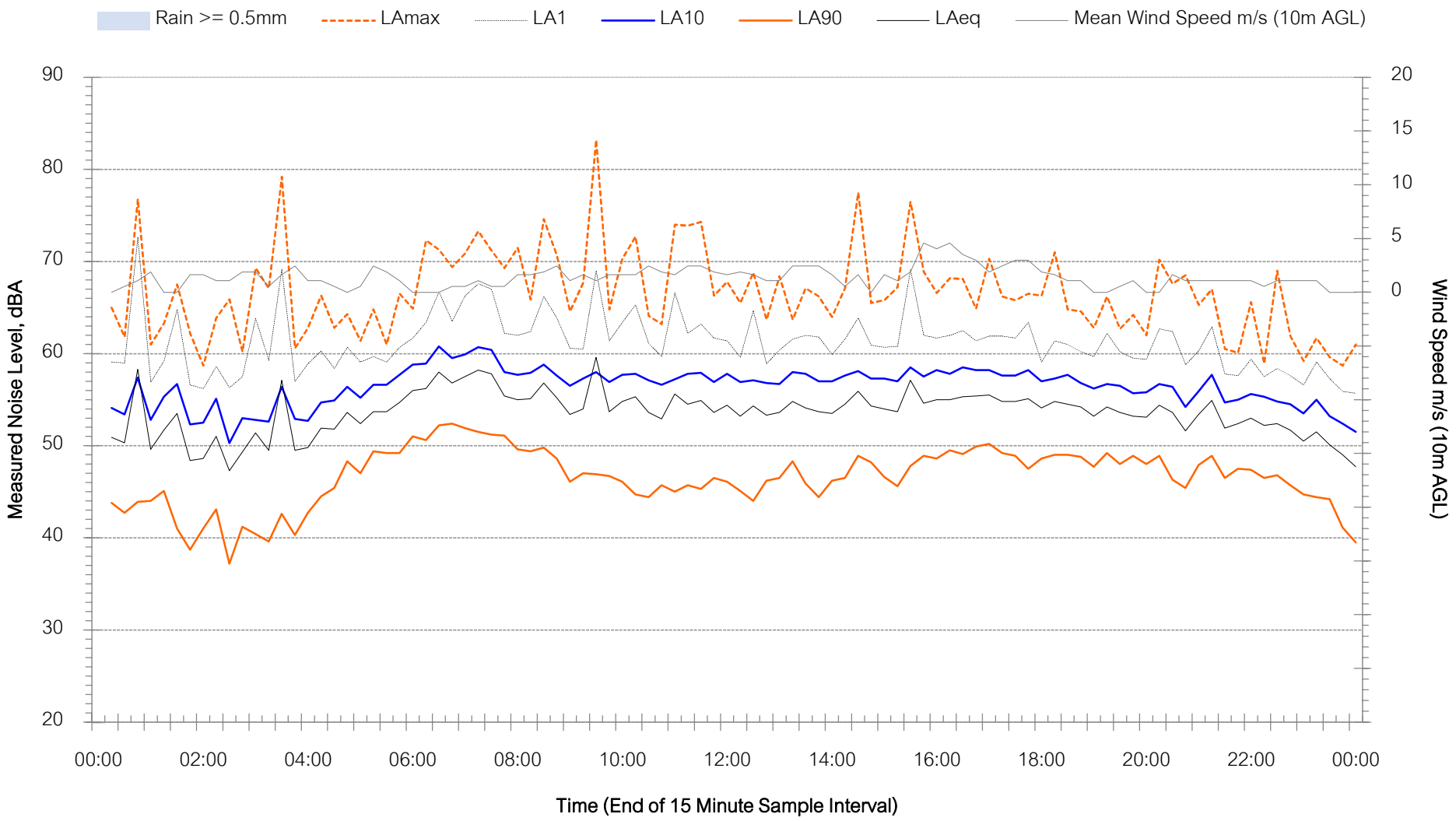

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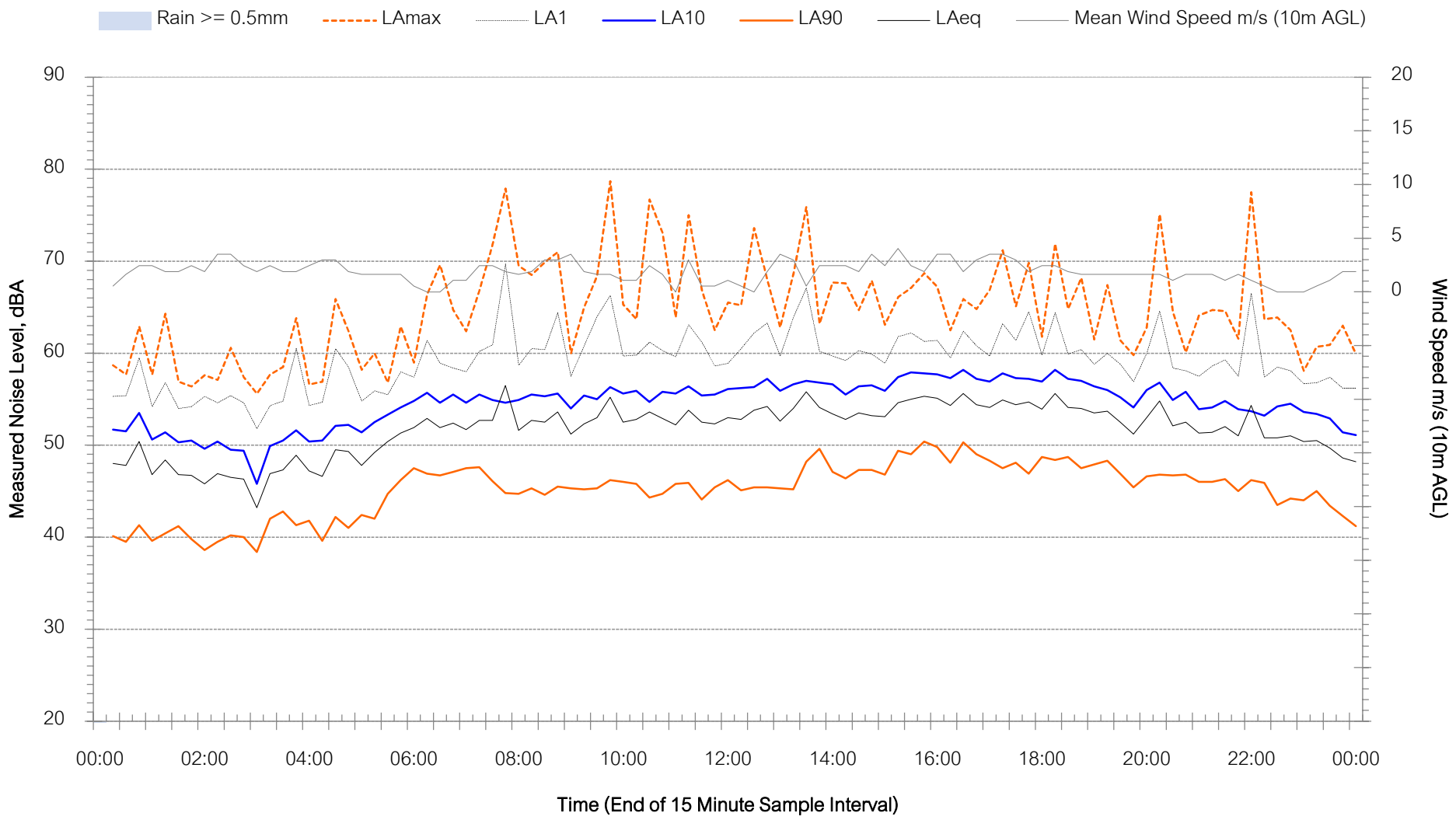

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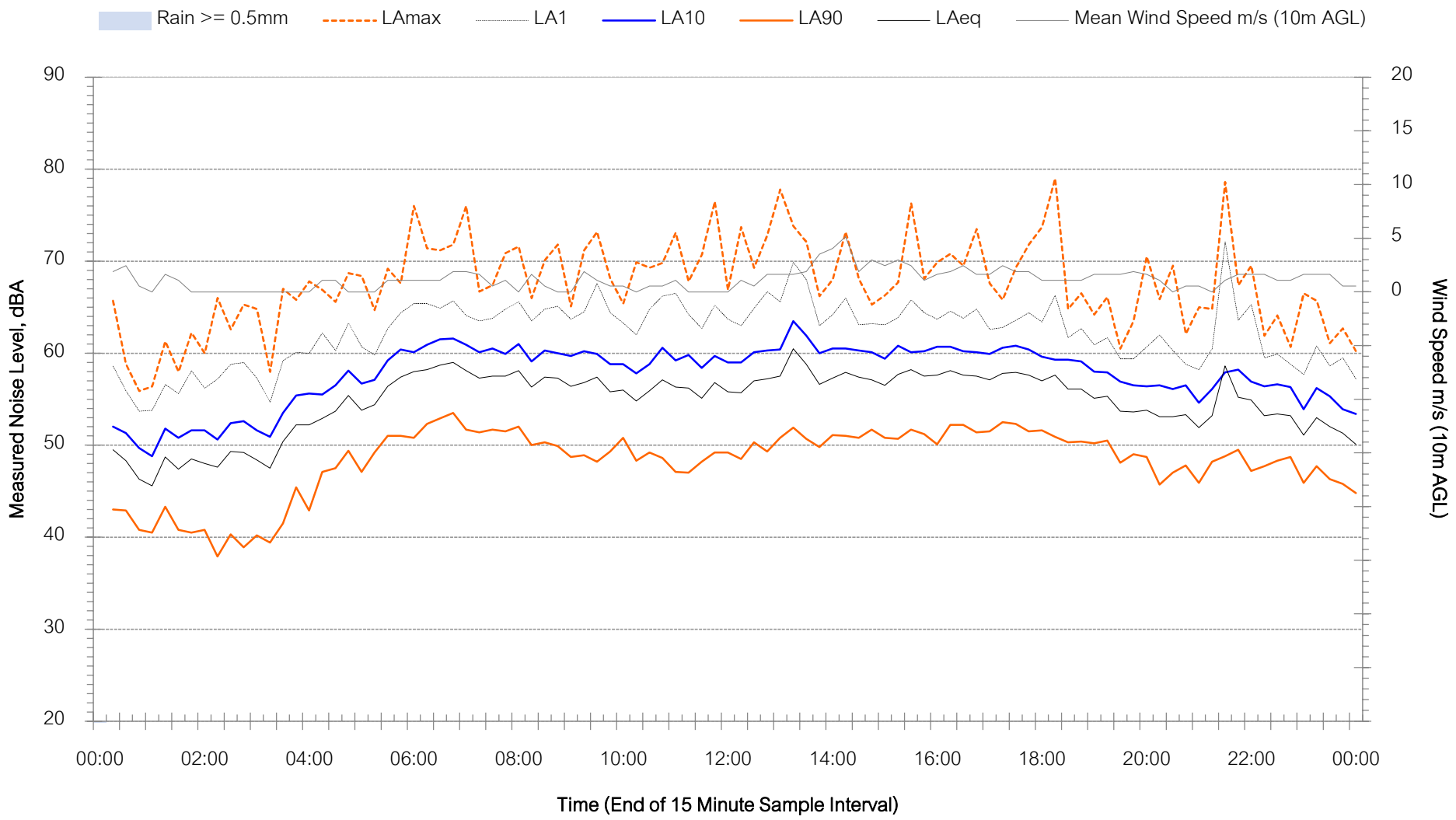

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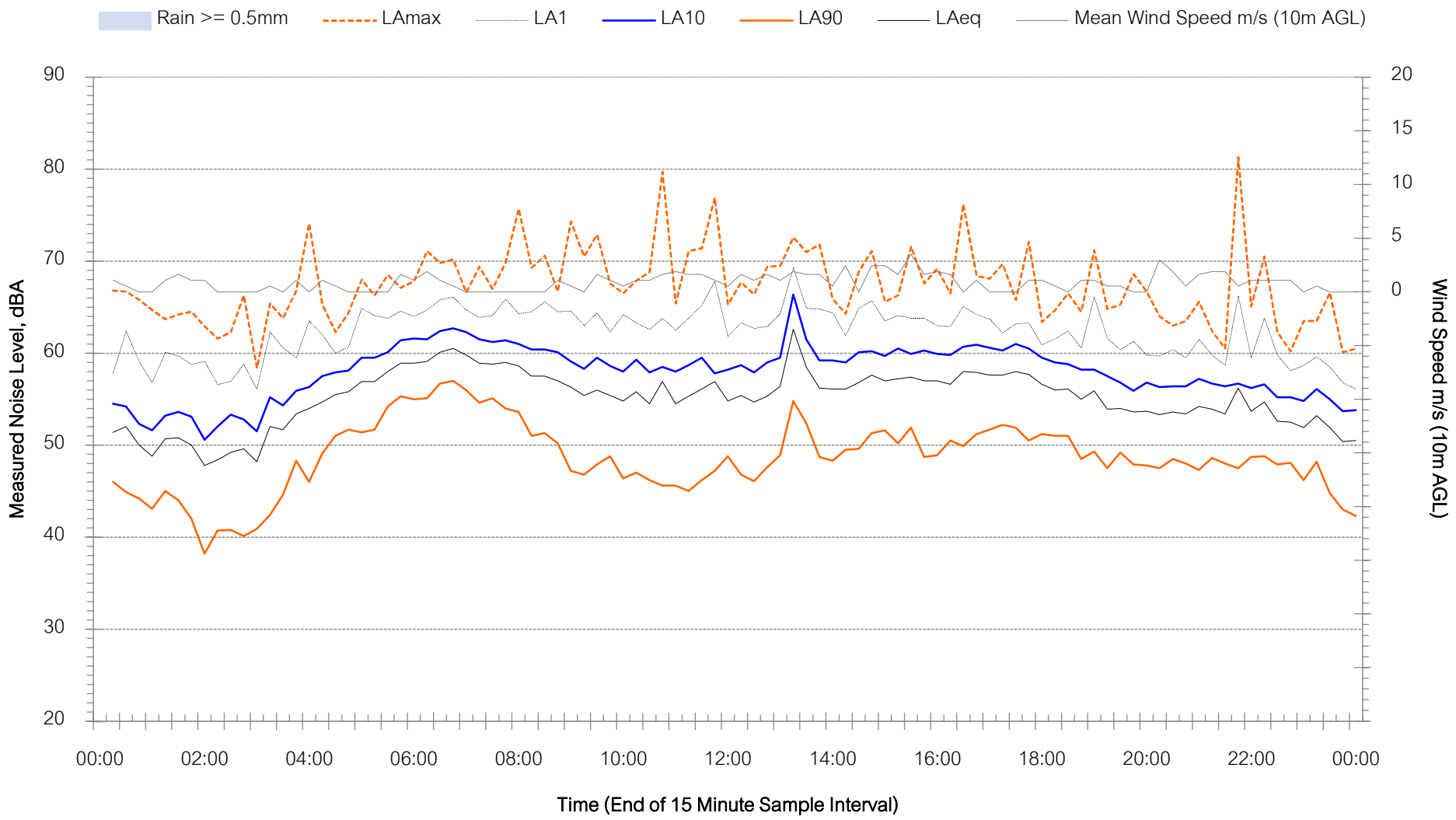

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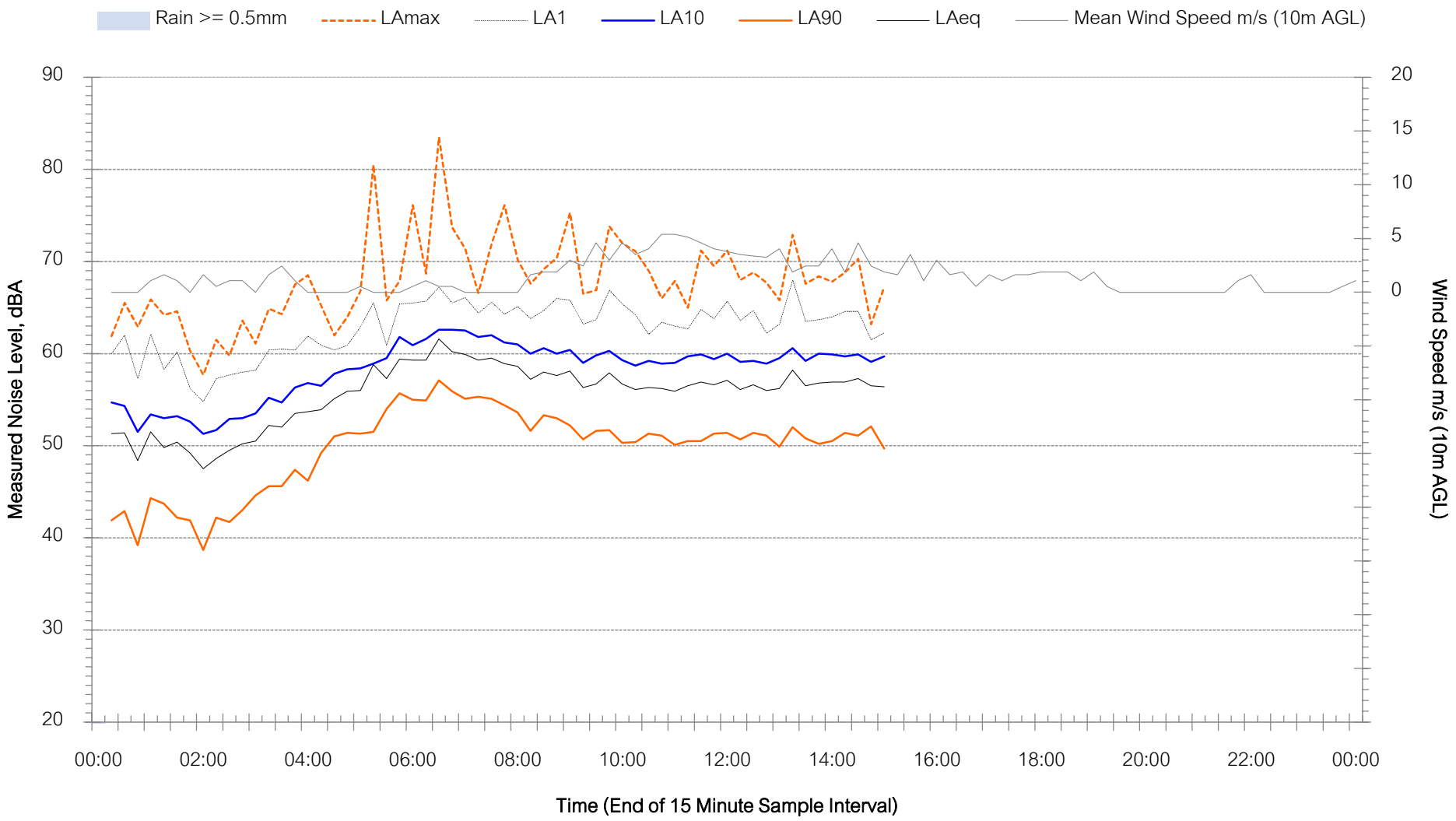

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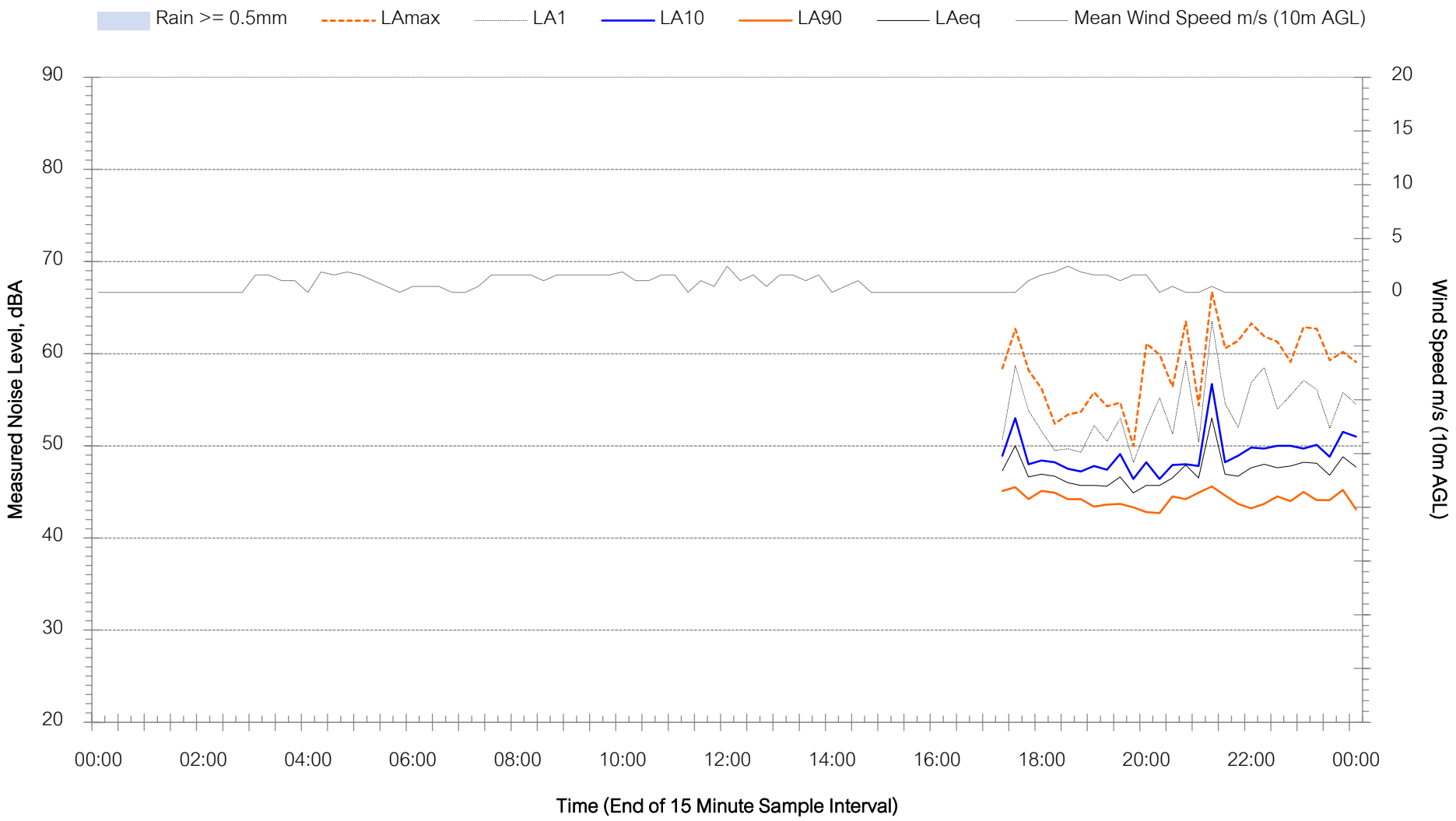

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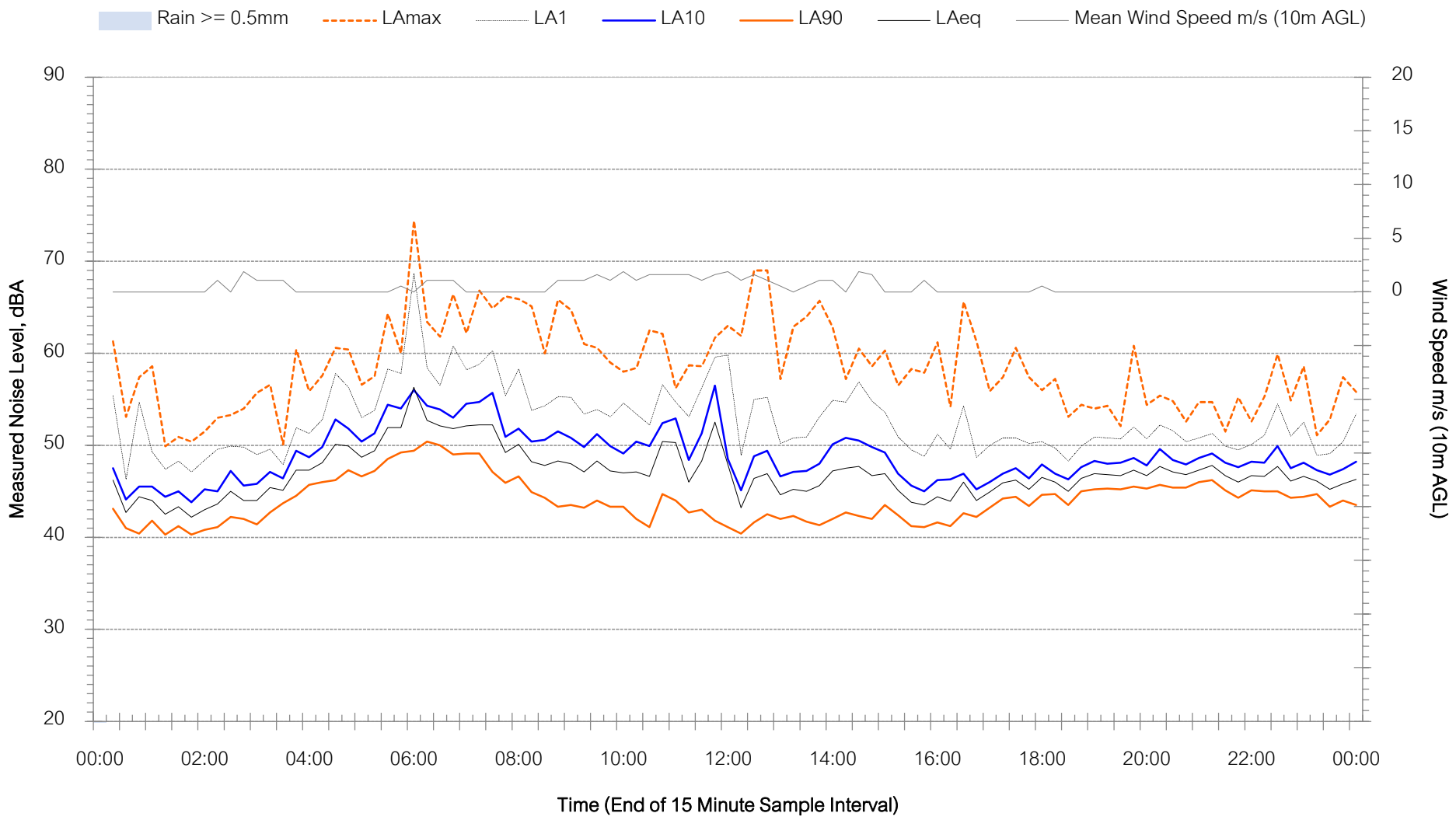

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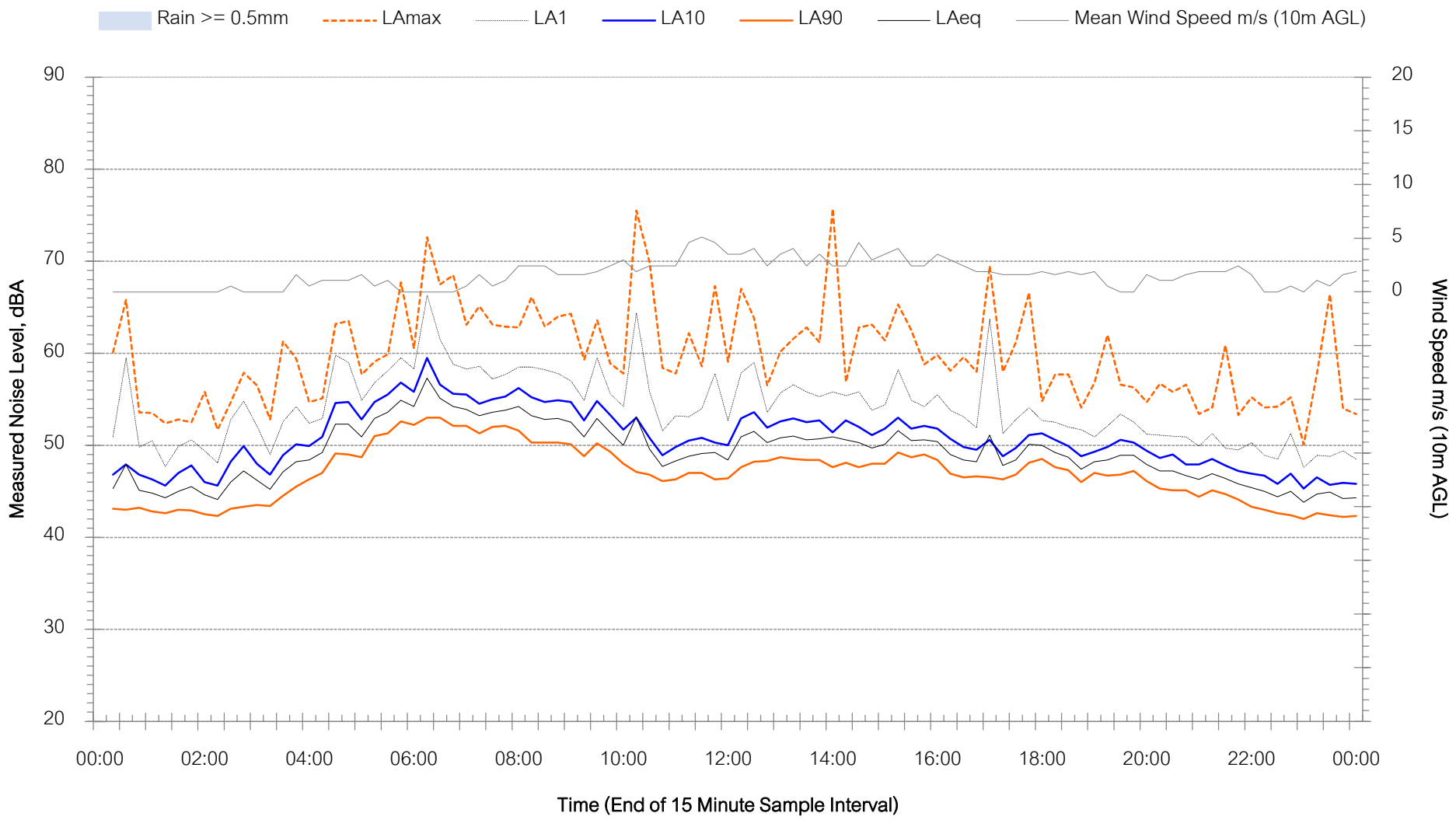

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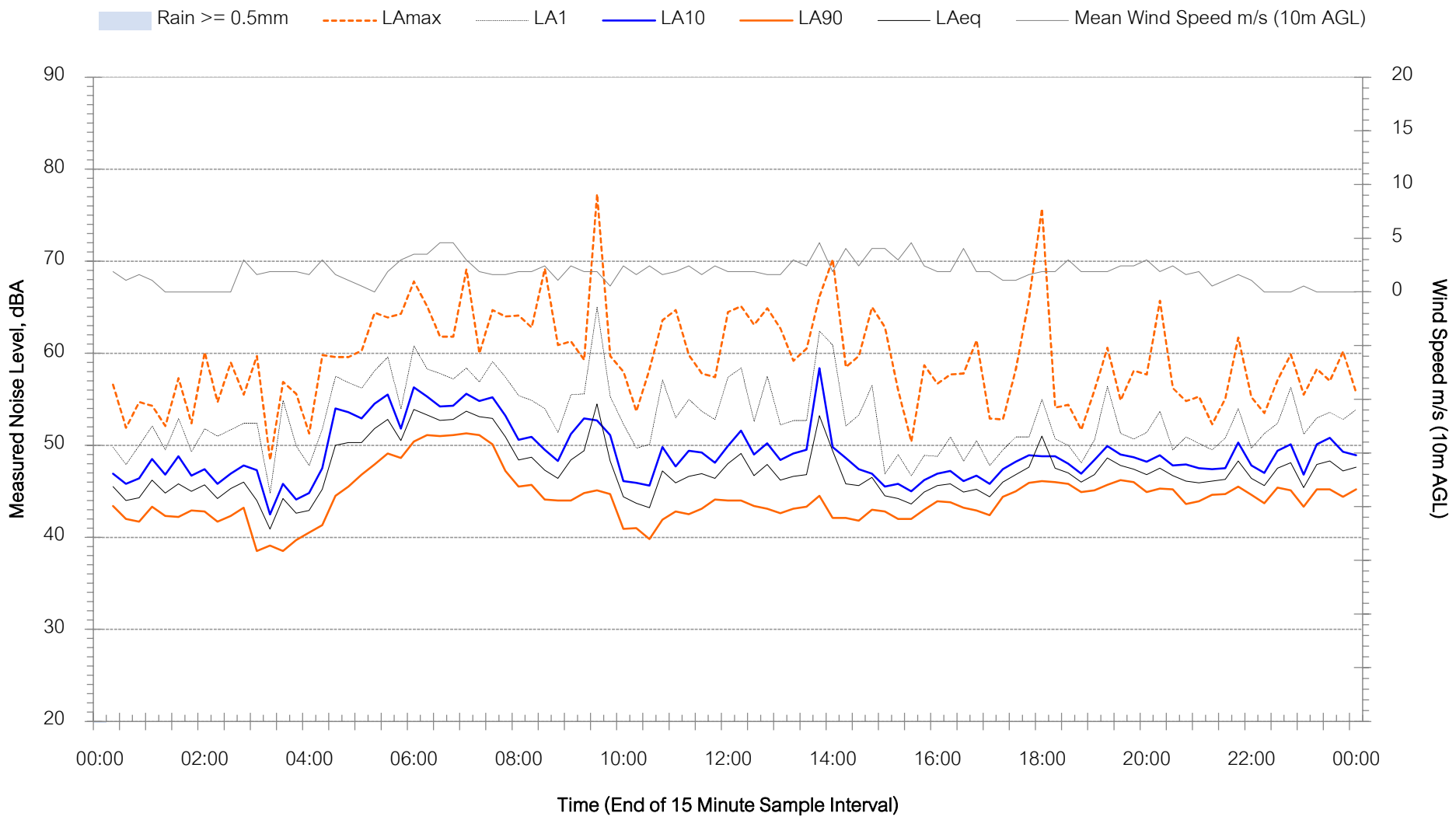

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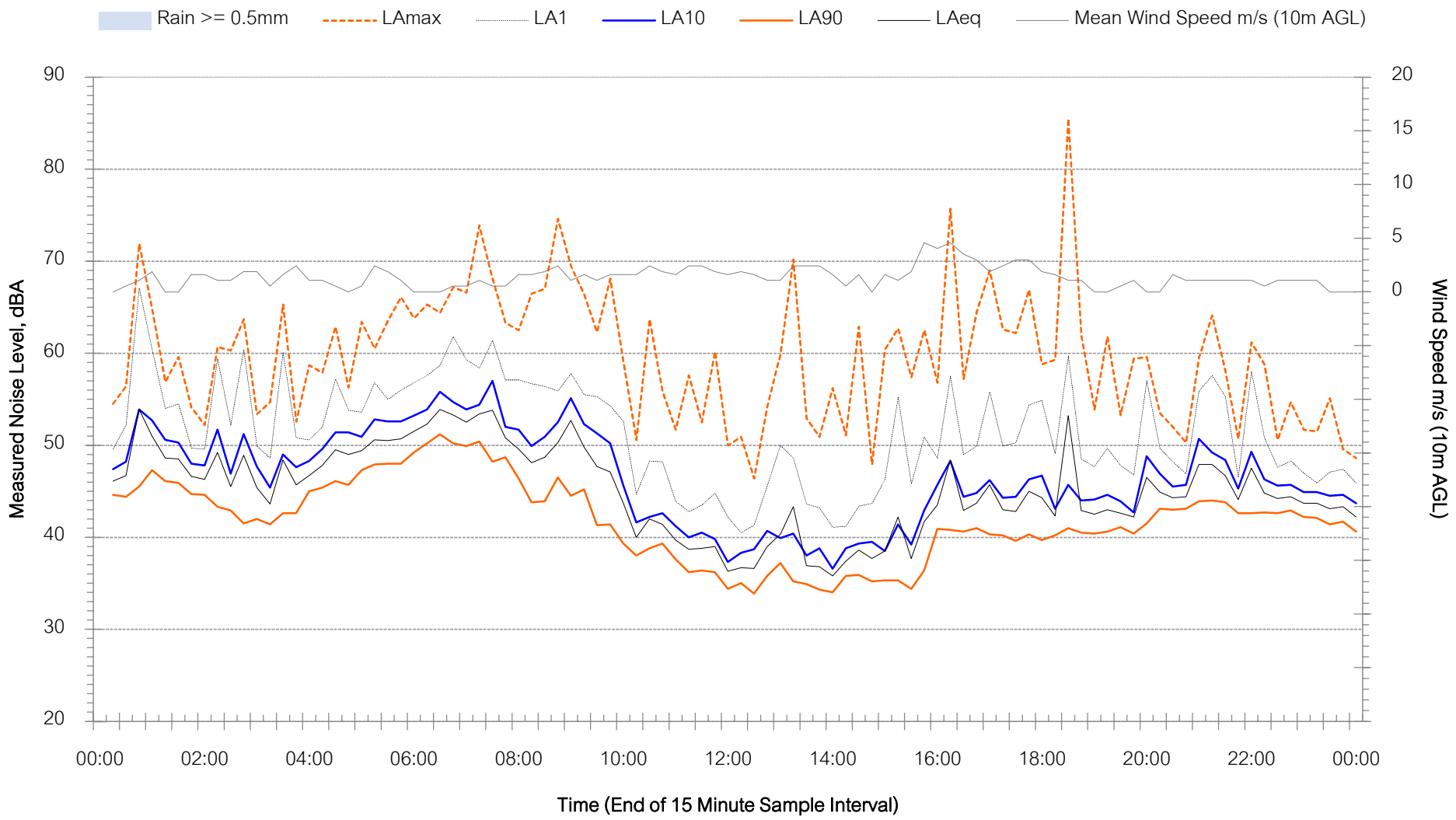

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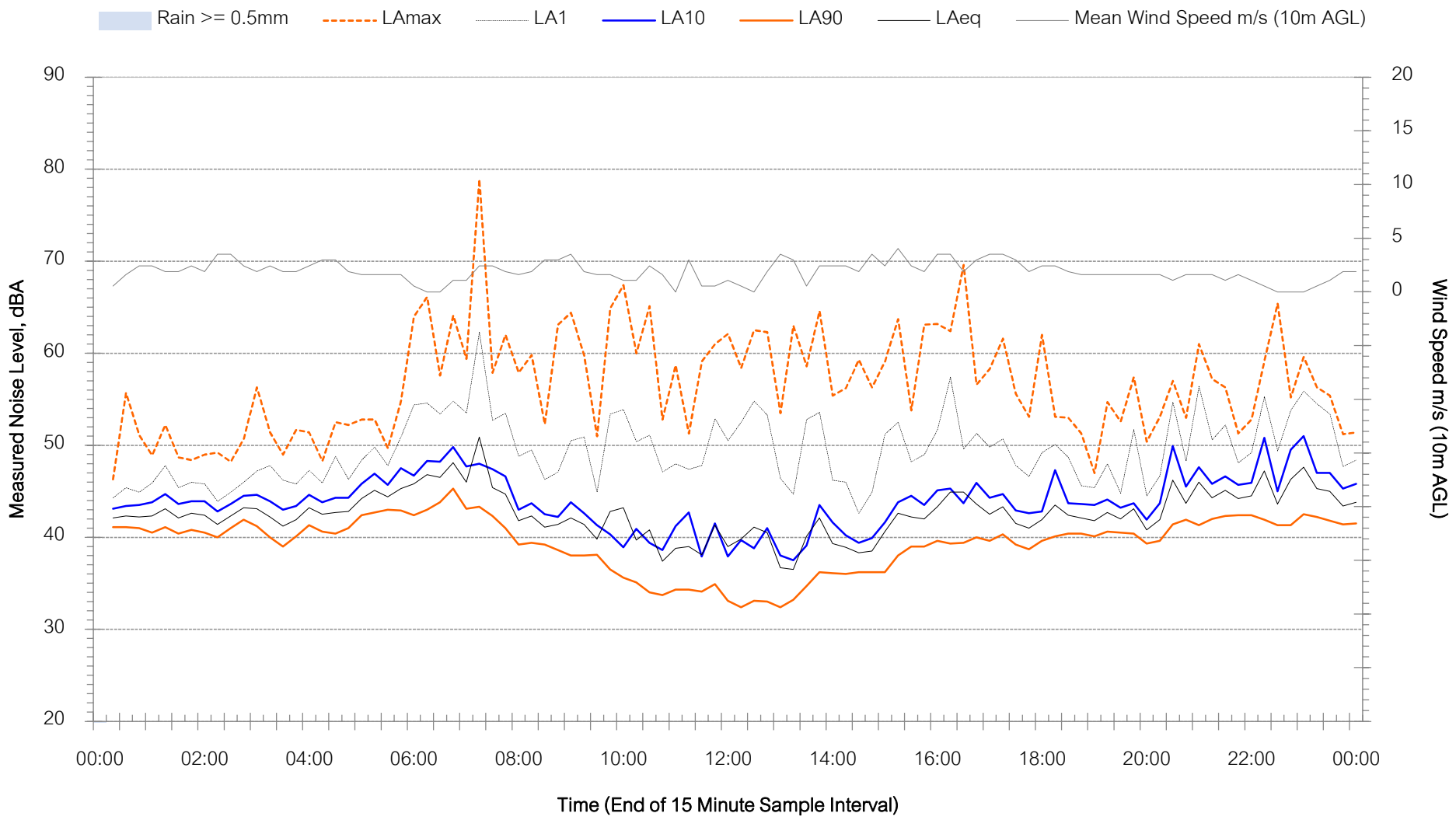

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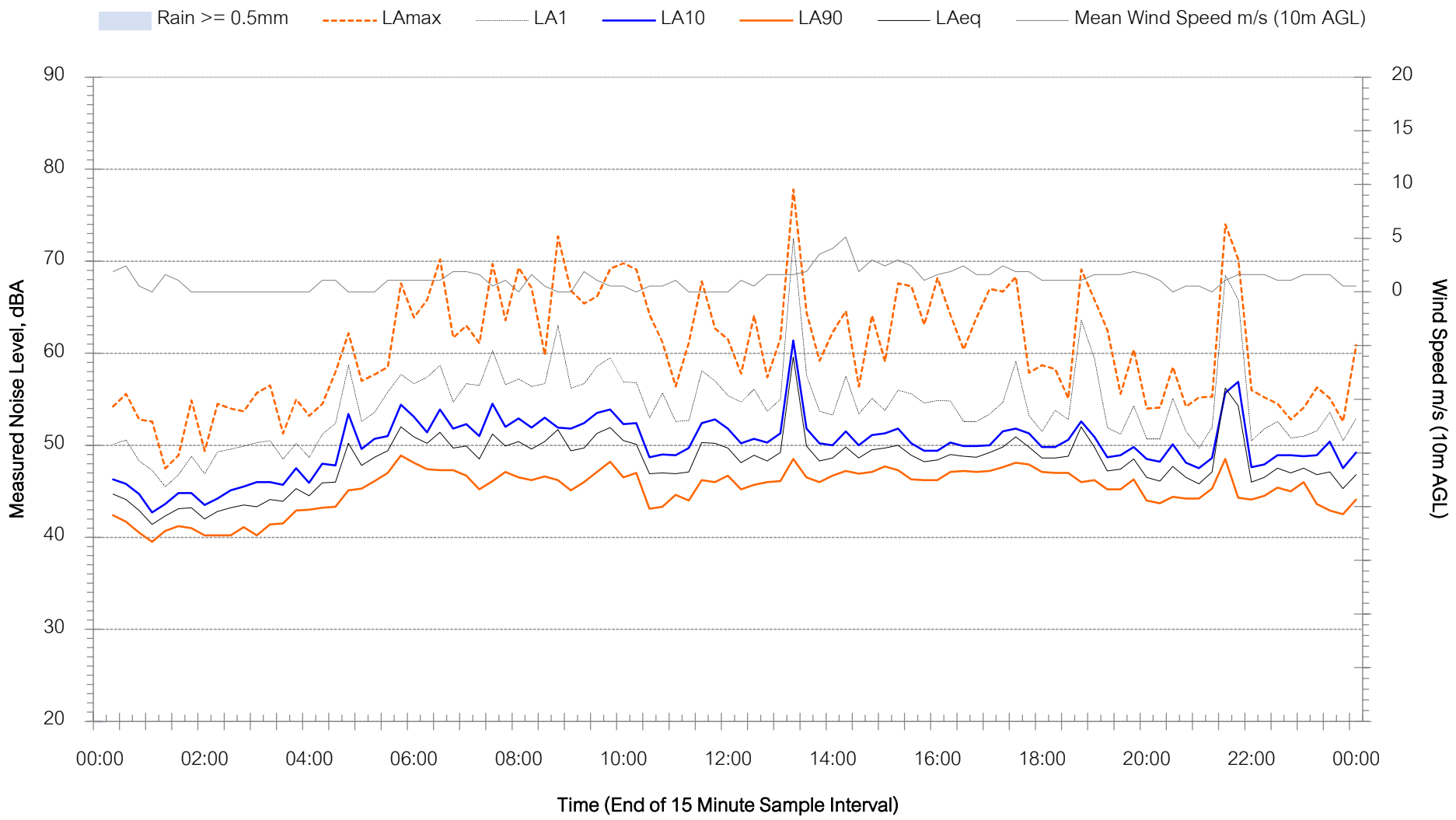

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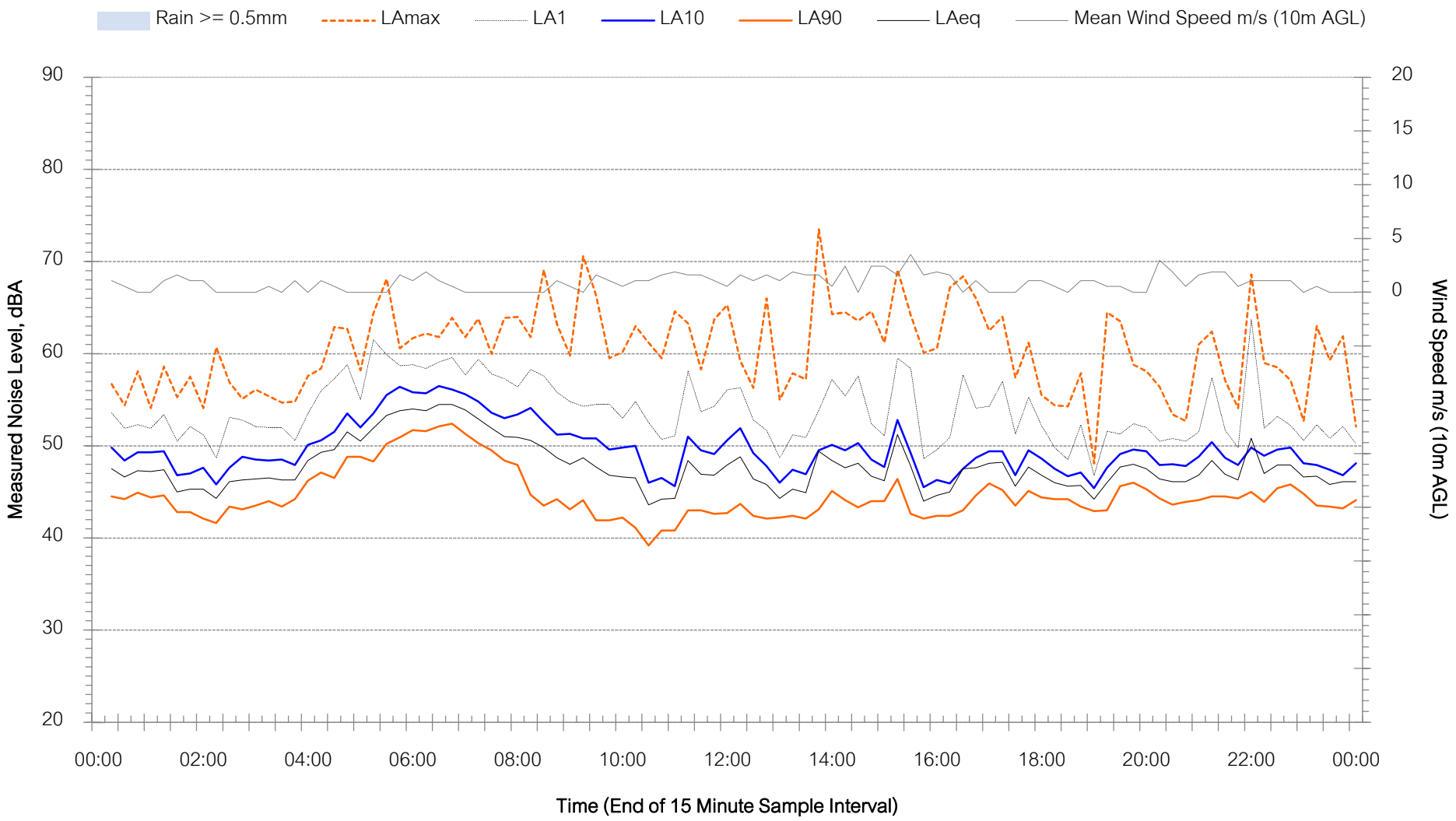

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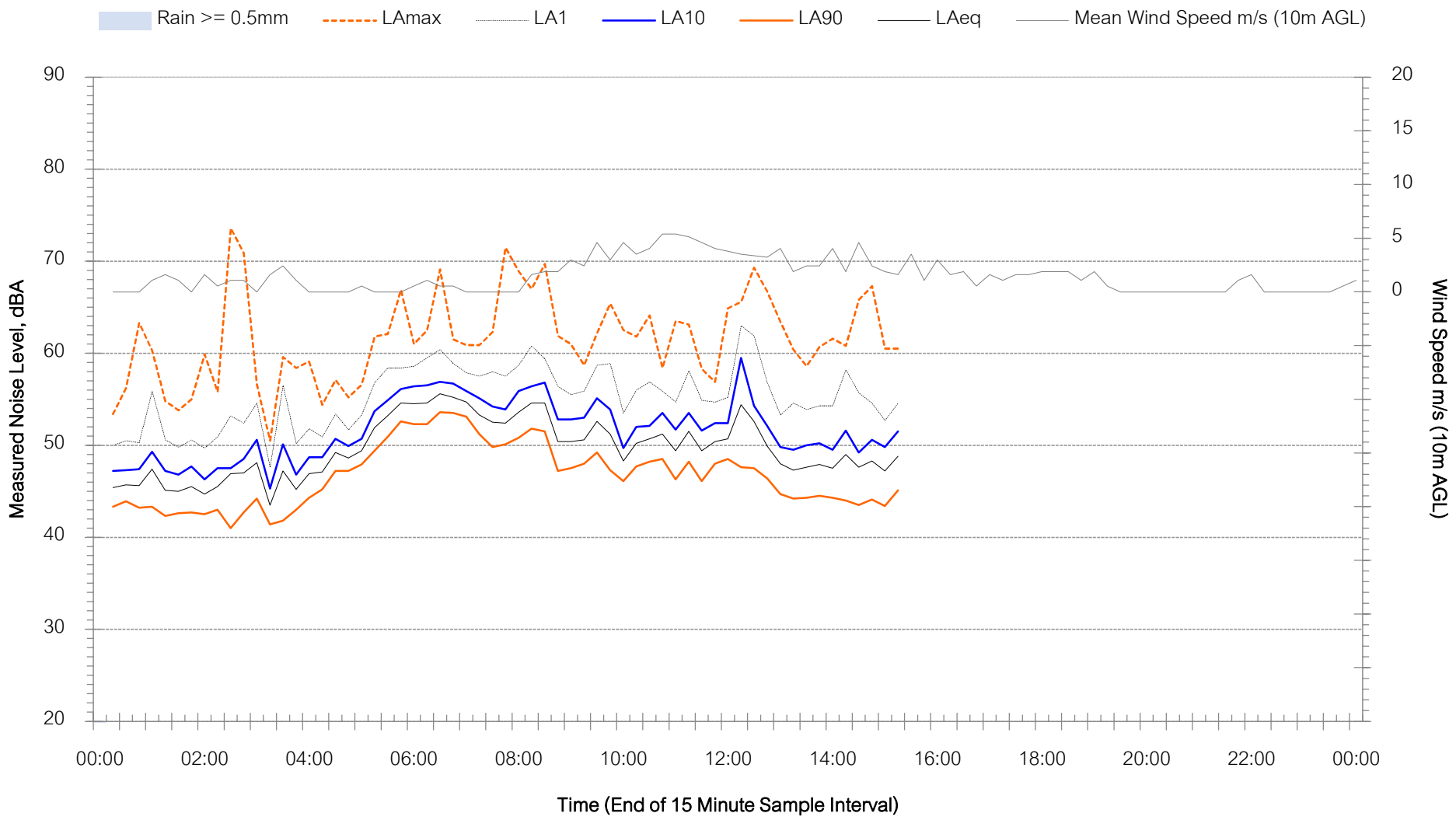

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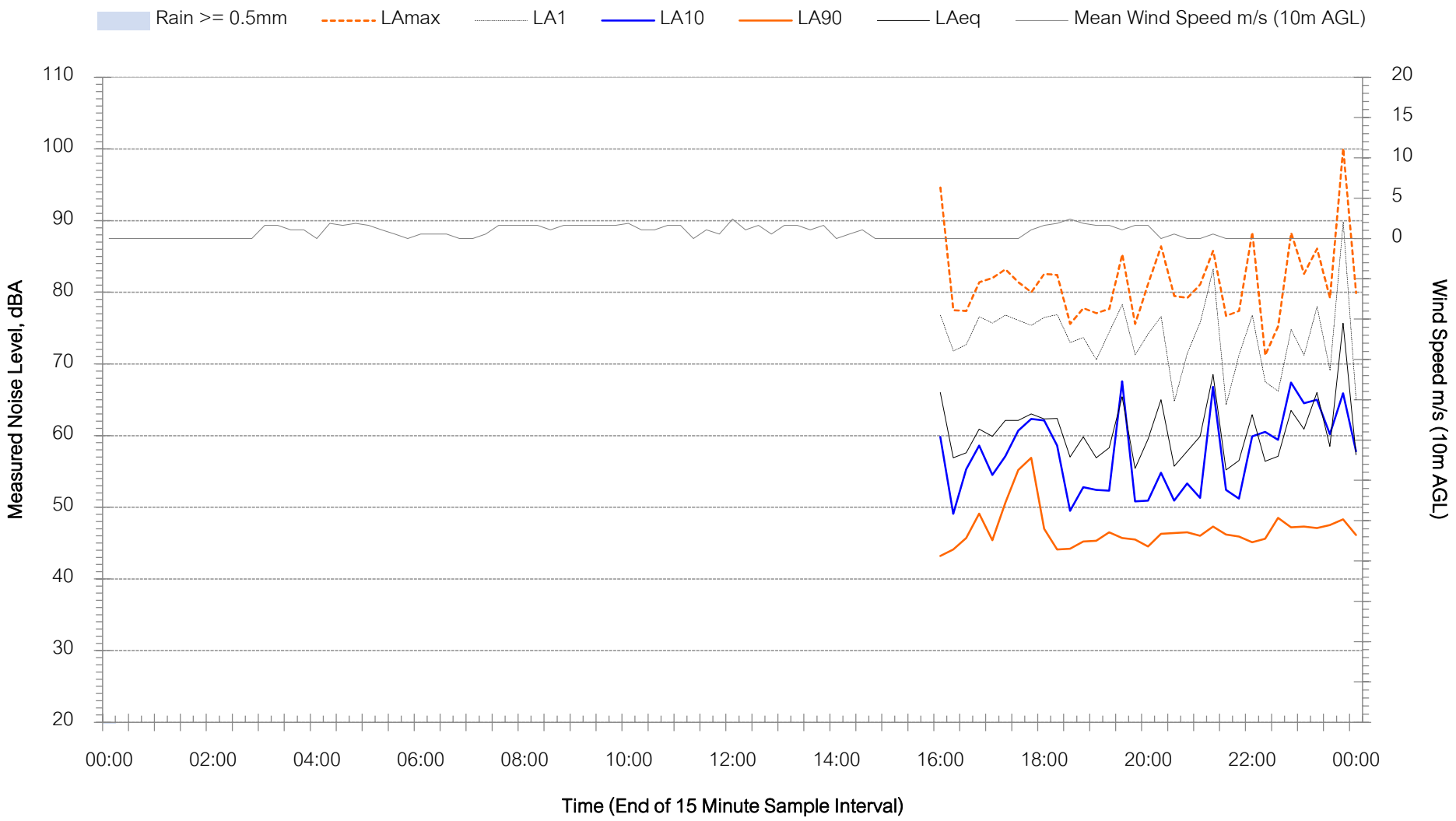

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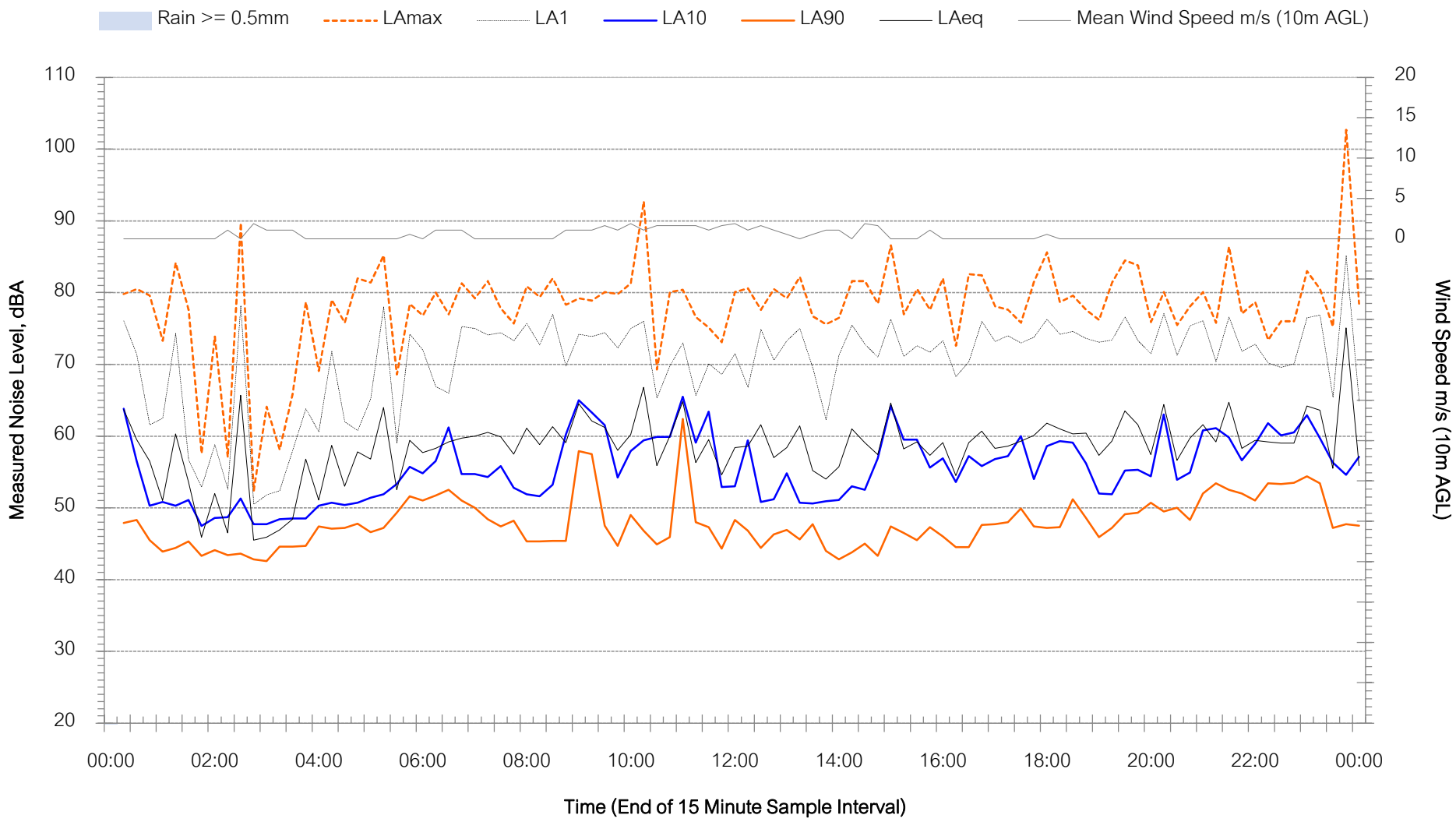

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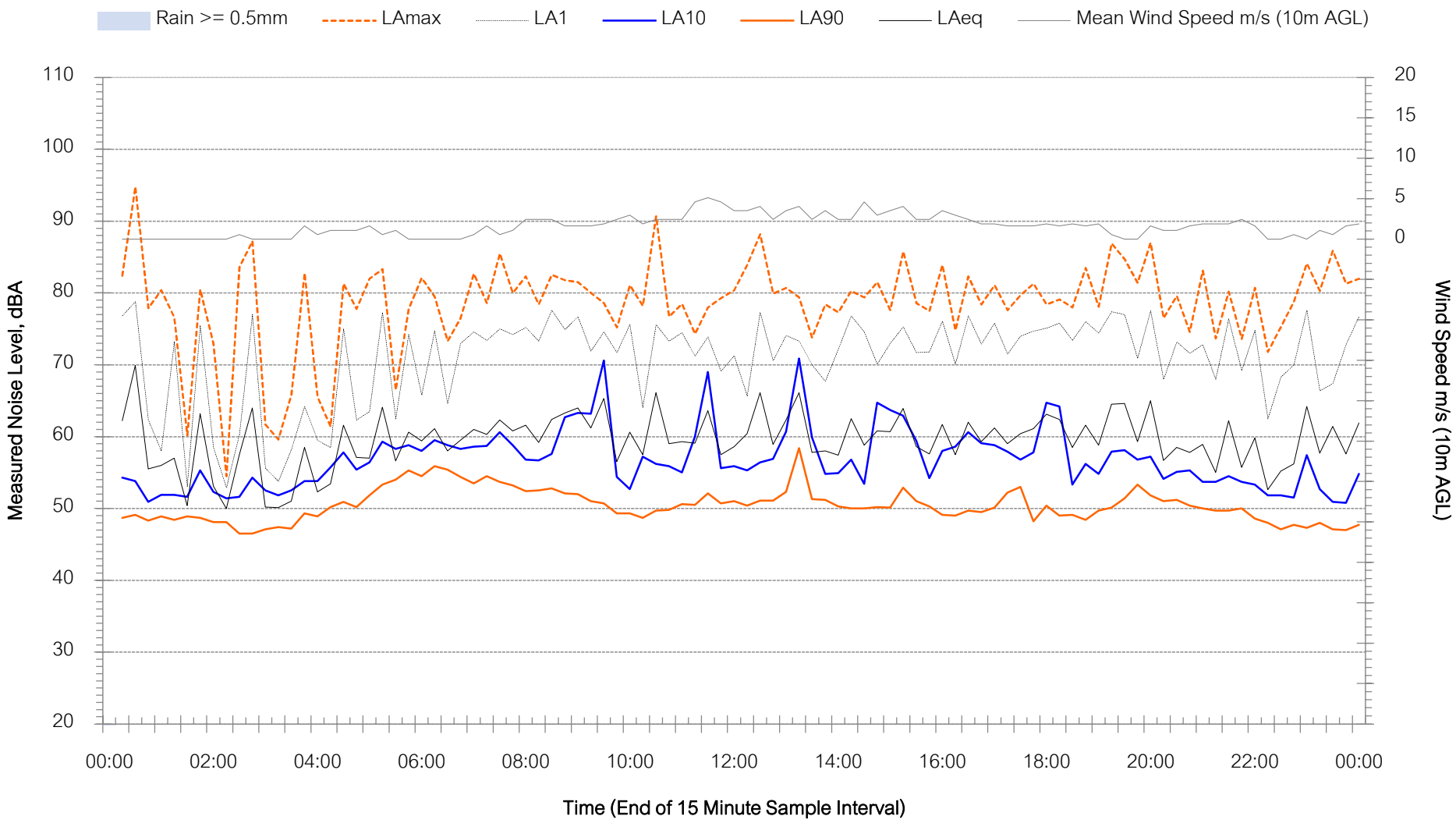

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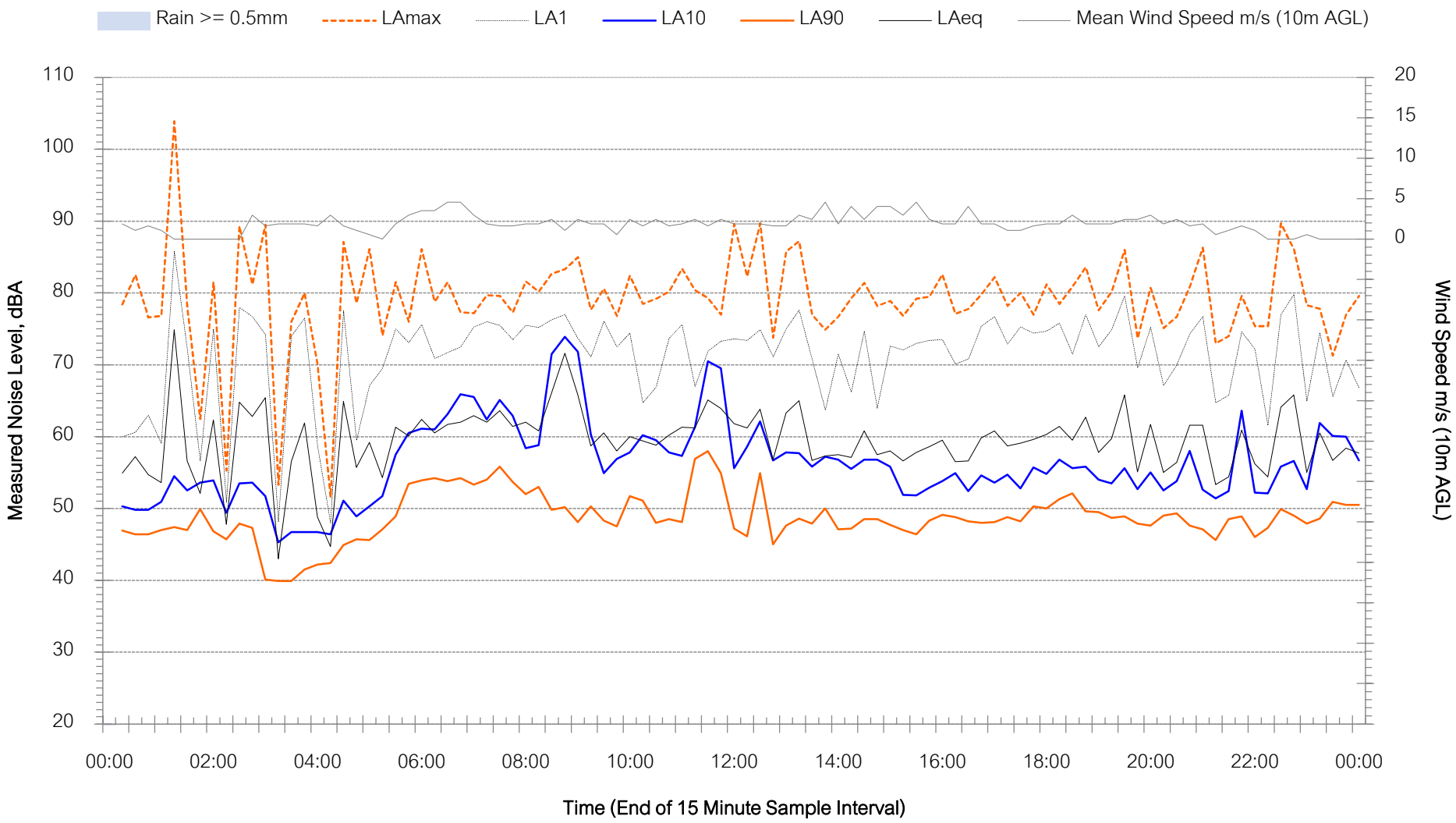

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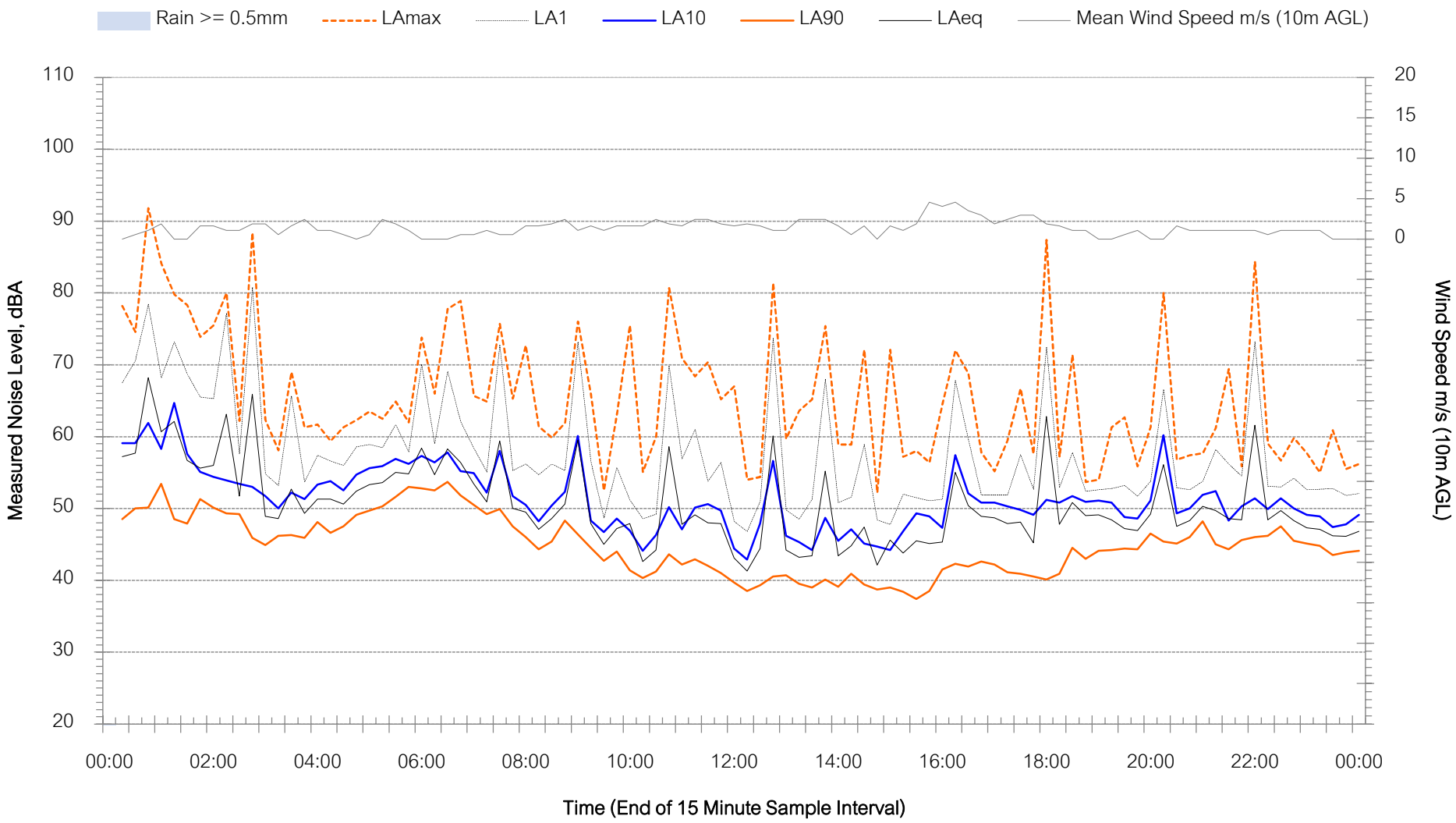

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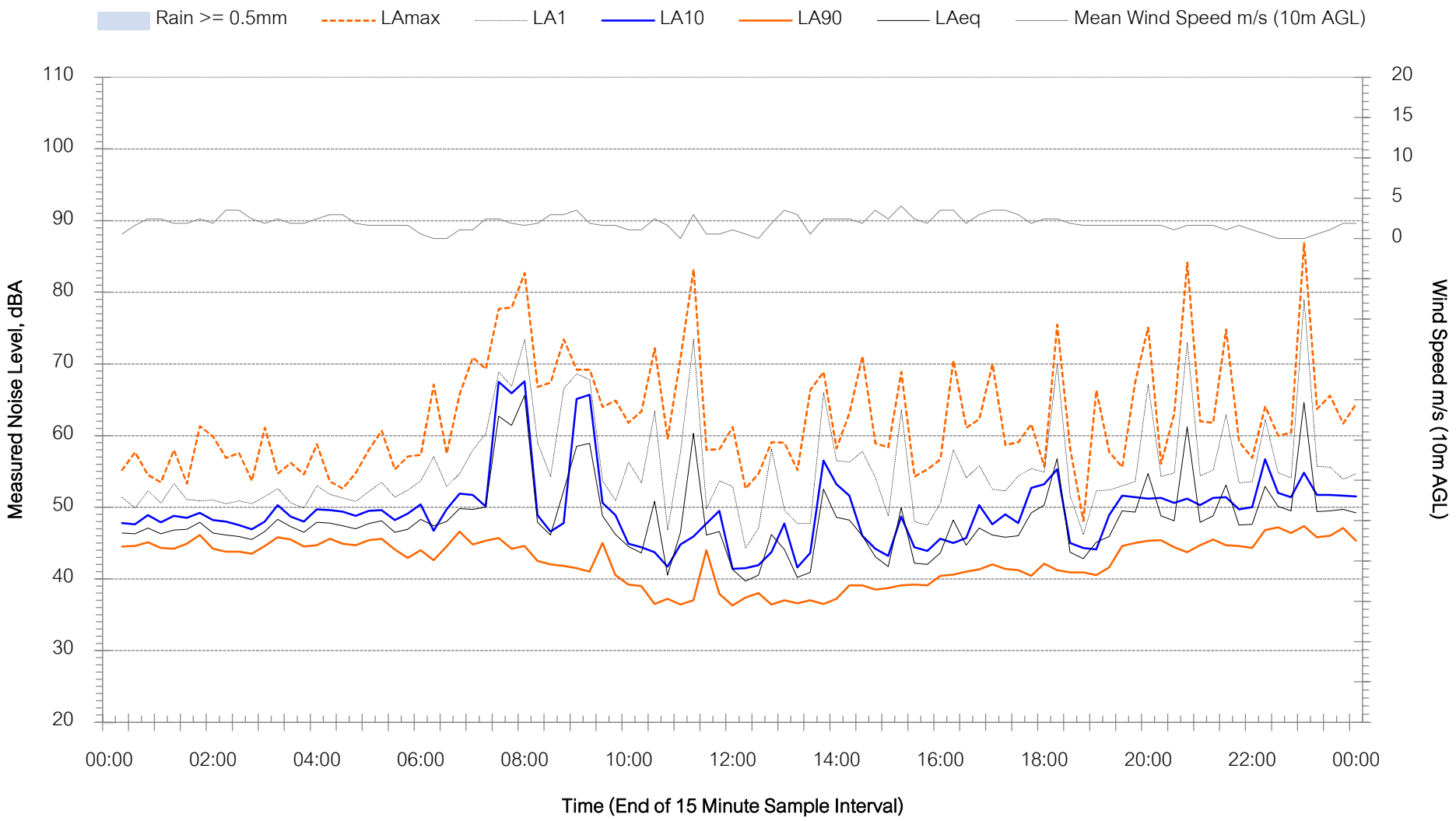

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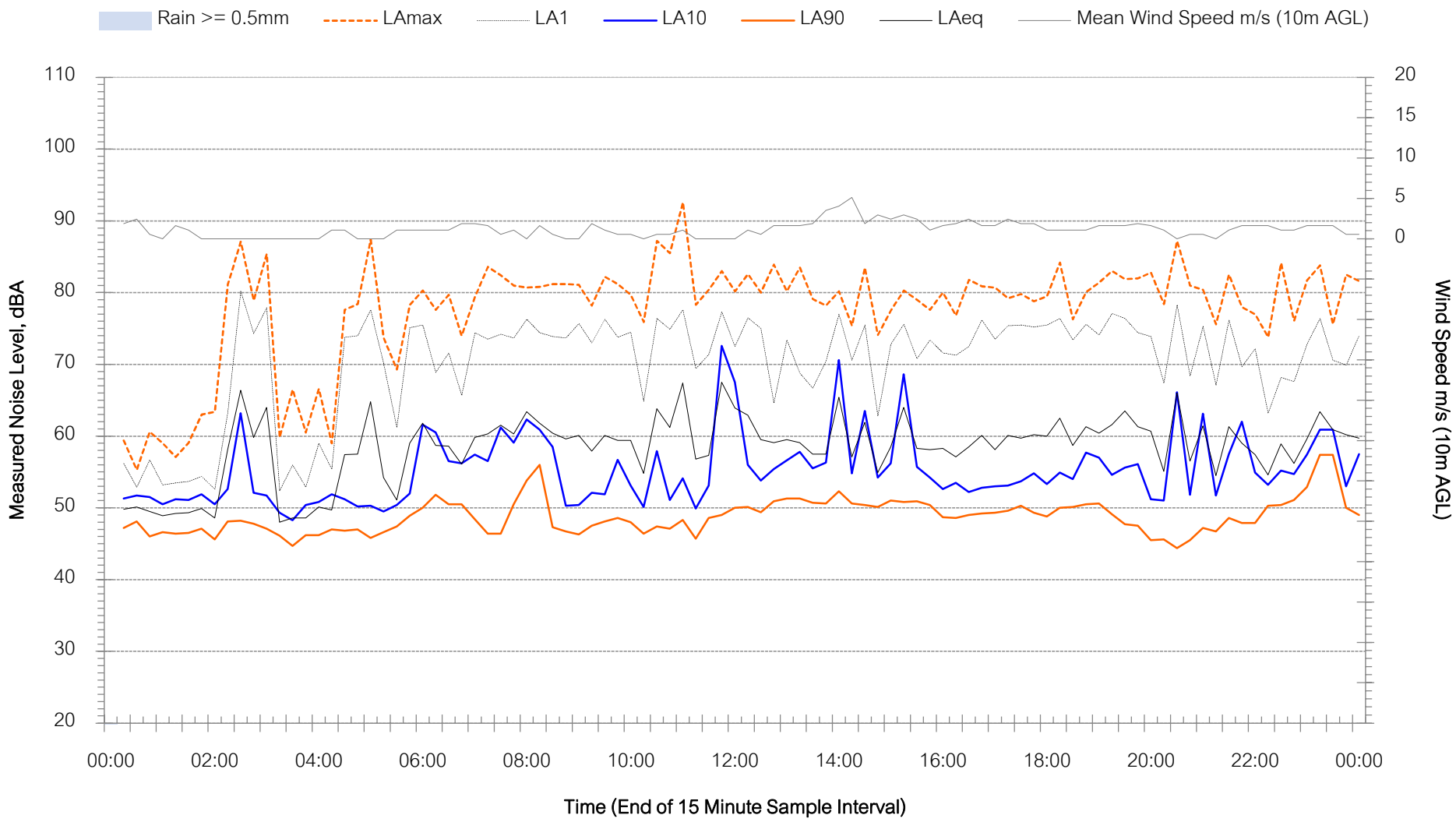

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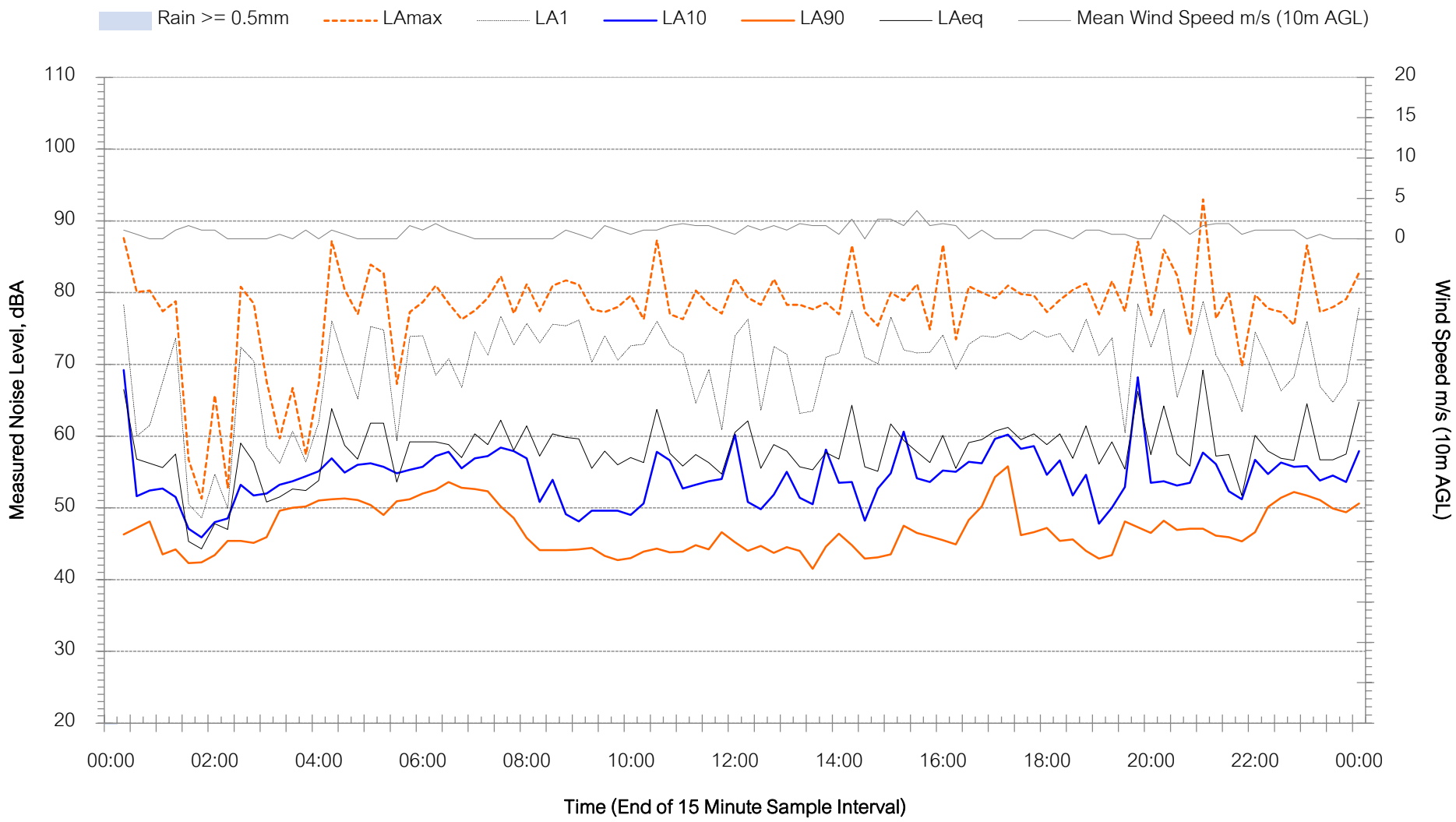

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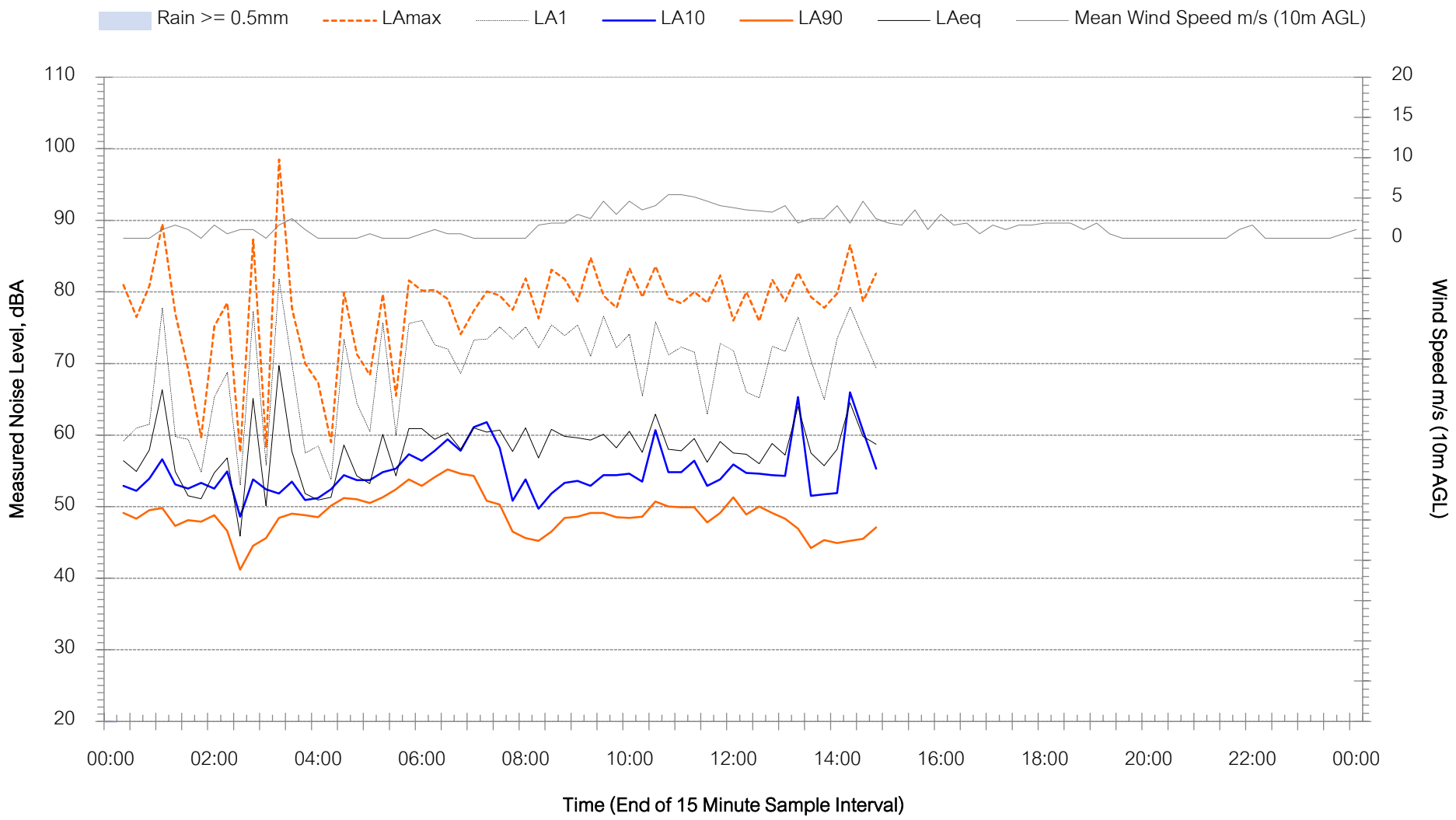

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Appendix 2 – Water Quality and Aquatic Ecology Reports by Niche Environment and Heritage

niche
Environment and Heritage

Holcim Regional Distribution Centre, Rooty Hill NSW

Aquatic ecology monitoring –Visual assessment

Prepared for Holcim

September 2018

Document control

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Project office:	Wollongong
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Project Manager:	Matthew Russell
Authors:	Matthew Russell
Internal review:	Sian Griffiths
Document status:	Final
Local Government Area:	Hills Shire

Document revision status

Author	Revision number	Internal review	Date issued
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Cover photograph: Eastern Creek

Stream health -Visual assessment

This report consists of the visual assessment of stream health of Agnes Creek and Eastern Creek as part of Holcim Regional Distribution Centre (RDC) aquatic ecology monitoring program required to meet condition 2.28 of the project approval. Visual monitoring of stream condition was conducted at six sites, four sites on Agnes Creek and two sites on Eastern Creek. Field survey was conducted on 22 August 2018 by Aquatic Ecologist Matthew Russell. The following pages detail the results of the stream health visual assessment and form the initial stage of the monitoring program. The next stage of the monitoring program will be undertaken in spring 2018 and include AUSRIVAS and visual assessment in accordance with condition 2.28 of RDC project approval.

Overall the streams were in reasonable condition. Despite some sites having exposed banks there was no evidence of active erosion. There was good native riparian vegetation coverage at all sites with the exception of AE6 upstream which is planted and highly modified. The sites within Holcim and downstream did have exotic weeds and rubbish however this was also observed at upstream sites. While the waterways are disturbed this is likely to be related to the overall anthropogenic impacts within the catchment and not directly related to activities at Holcim.

AE1: Agnes Creek

A: Upstream

B: Downstream

	Attribute	AE1
Riparian	Vegetation	The dominant tree species comprised of Swamp Oak (*Casuarina glauca*) and Broad leaf privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width (m)	2m
	Bank condition	Exposed banks but stable. No significant erosion.
	Substrate	Fine sediment, large woody debris and organic matter.
	Flow/depth	Low Flow/ 1m
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Fine scum on surface otherwise clear.
Comments		Weeds and rubbish present.

AE2: Agnes Creek

A: upstream

B: Downstream

	Attribute	AE2
Riparian	Vegetation	Dominant tree and shrub species was Swamp Oak (*Casurina glauca*). Dominant groundcover was Wandering Jew (*Tradescantia fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Low shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width (m)	1m
	Bank Condition	Stable and Vegetated
	Substrate	Silt, large woody debris and organic matter
	Flow/depth	Low flow/<0.5m
	Macrophytes/algae	Emergent macrophytes present –Bulrush (*Typha sp*.)
	Water quality observations	Some algae
Comments		Weeds and rubbish

AE3: Agnes Creek

A: Upstream

B: Downstream

	Attribute	AE3
Riparian	Vegetation	Dominant tree species was Swamp Oak (*C. glauca*). Dominant grass/herb species was Wandering Jew *T. fluminensis*
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum T. fluminensis*
Stream characteristics	Modal width (m)	3m
	Bank Condition	Stable, steep, exposed in sections however no visible erosion.
	Substrate	Fine sediment
	Flow/depth	Low flow/1 m
	Macrophytes/algae	Ribbon Weed (*Vallisneria sp.)*
	Water quality observations	Surface scum
Comments		

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included Swamp Oak (*C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant shrubs were *C. glauca* and Large-leaved Privet (*L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width (m)	5m
	Bank condition	Exposed banks but no active erosion
	Substrate	Fine sediment
	Flow/depth	Low/Moderate flow
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Turbid and surface scum
Comments		

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was Swamp Oak (*C. glauca*). Dominant grass/herb was Lomandra (*Lomandra .longifolia*) and Wandering Jew (*T. fluminensis*).
	Stream shading	Low
	Exotic vegetation	*T. fluminensis.*
Stream characteristics	Modal width (m)	5m
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris
	Flow/depth	Low/moderate flow m
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Turbid
Comments		Lots of large woody debris

AE6: Agnes Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Others include eucalypts and melaleuca species. Dominant groundcover was *Lomandra longifolia*.
	Stream shading	None
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width (m)	5m
	Bank condition	Sandstone revetment -no erosion
	Substrate	Fine sediment
	Flow/depth	No flow/Dry at sampling site
	Macrophytes/algae	Macrophytes present. *Typha sp*. occupied most of the stream.
	Water quality observations	Dry at site
Comments		Water sample taken upstream at weir. Planted riparian vegetation.

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Holcim Regional Distribution Centre
Rooty Hill NSW

Aquatic Ecology Monitoring

Prepared for Holcim | 20 May 2021

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Version	Author	Review	Status	Date
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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of bi-annual monitoring undertaken on 26 March 2019. Aquatic ecology monitoring and visual monitoring of stream condition was conducted at six sites: four sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sampling sites

A total of six sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). Four sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project).

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
AE2	Angus Creek downstream –near property boundary in Nurragingy Reserve.	-33.76563506	150.854665
AE3	Angus Creek upstream of Eastern Creek confluence in Nurragingy Reserve.	-33.76496807	150.8554235
AE4	Eastern Creek downstream of Angus Creek in Nurragingy Reserve	-33.76419362	150.8576059
AE5	Eastern Creek upstream of Angus Creek in Nurragingy Reserve	-33.76411307	150.8570044
AE6	Angus Creek upstream above railway.	-33.77017801	150.8499068

Figure 1: Location of sites

2.2 Field methods

The field survey was undertaken on 26 March 2019 by Aquatic Ecologist Matthew Russell and field assistant David Wilkinson. The field methods were consistent with standardised techniques for field sampling as prescribed by AUSRIVAS (Turak *et al*. 2000). The AUSRIVAS method of sampling both pools and riffles was modified for this program, as no suitable in-stream riffle features were present.

2.2.1 Visual assessment

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO)(% saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg CaCO3/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

2.2.3 Macroinvertebrates

Samples were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was undertaken to ensure the sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats were appropriately sampled. Segmented sampling was also employed where pool length was short and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted suspended fauna.

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used to identify fauna included:

- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera). Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002) The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia. CSIRO Publishing.
- Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW. Cooperative Research Centre for Freshwater Ecology. Albury NSW.
- Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports 12, 1-31.
- Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters. La Trobe University.
- Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Murray Darling Freshwater Research Centre.
- Online resource - http://www.mdfrc.org.au/bugguide/.

2.3 Data analysis

2.3.1 SIGNAL2 (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a, b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site. Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL2 score of the site.

Table 2: SIGNAL 2 grade and the level of pollution tolerance

SIGNAL grade	Pollution tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3: Guide to interpreting the SIGNAL2 scores

SIGNAL2 score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

3. Results

3.1 Rainfall

Sampling was conducted on the 26 March 2019. Antecedent rainfall since the start of the month was 144 millimetres (mm) (Figure 2). However most of the rain fell a two weeks prior to sampling with only 20 mm in the week before. The water level at the time of sampling was moderate and with visible flow.

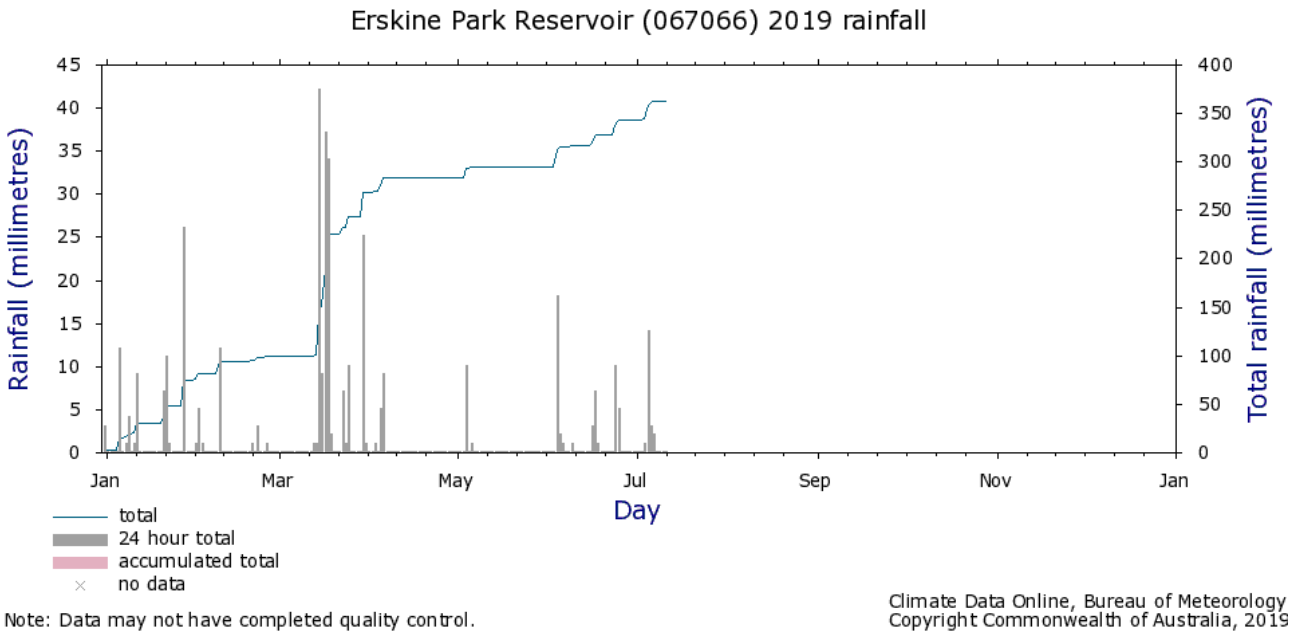

Figure 2: Rainfall January to July 2019.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. Overall the streams were in similar condition to quarterly surveys conducted in November 2018, however there was a slight decolourisation (opaque) adjacent to and downstream of the RDC (Site AE2 and AE3).

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 4. Electrical conductivity (EC) in Angus Creek was high at upstream site AE1 (2237 µS/cm), exceeding Default Trigger Values (DTVs). This was also observed further upstream at AE6 (2860 µS/cm). The remaining sites in Angus Creek and Eastern Creek had elevated EC but within ANZECC guidelines for lowland streams. Turbidity was below ANZECC guidelines at all sites, however there did appear to be a slight discolouration of the water at AE2 compared to upstream sites that could possibly indicate runoff from the RDC. Dissolved oxygen was below DTVs for all sites however this is common for small Western Sydney streams. The pH was within the DTVs at all sites. Alkalinity was highest at the upstream sites with lower values recorded downstream in Angus and Eastern Creeks.

Table 4: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH*	Alkalinity (mg CaCa3/L)
AE1	Angus Creek	14.32	**2237**	7.5	**16.9**	7.13	*230
AE2	Angus Creek	15.91	510	42.5	**59.8**	7.87	*89
AE3	Angus Creek	15.5	*520	11.5	**15**	7.4	*92
AE4	Eastern Creek	14.08	754	33.2	**41.9**	7.47	*92
AE5	Eastern Creek	14.34	755	47.2	**52.5**	7.86	*103
AE6	Angus Creek	14.53	**2820**	16.4	**69.8**	7.65	*268

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

* Laboratory results were used as field measurement and laboratory results were substantially different.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 5).

Table 5: Nutrients - laboratory results

Site	Stream	Total Phosphorous (P) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.08	0.5	0.06	0.4
AE2	Angus Creek	0.11	0.6	0.29	0.3
AE3	Angus Creek	0.04	0.6	0.27	0.3
AE4	Eastern Creek	0.1	0.8	0.06	0.7
AE5	Eastern Creek	0.07	0.5	0.1	0.4
AE6	Angus Creek	0.1	1.1	0.31	0.8

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

3.4 Macroinvertebrates – SIGNAL 2

SIGNAL2 results for the six sampled sites are provided in Table 6. Raw data is provided in Annex 2.

The number of taxa ranged from 8-13, with the most taxa observed in Angus Creek at the AE3 downstream site. The least taxa observed were in Angus Creek sites (AE1 and AE2) up and downstream of the RDC. The SIGNAL2 scores indicate that both creeks have a dominance of pollution-tolerant taxa, possibly indicating moderate to severe pollution (Table 3). Pollution sensitive taxa Leptoceridae was observed at Angus Creek site AE1 and Eastern Creek sites AE4 and AE5. The SIGNAL2 bi-plot (Figure 3), indicates that no sites have favourable habitat and all locations are exhibiting some form of pollution or natural stress. Downstream sites AE2 and AE3 in Angus Creek had a higher SIGNAL2 score than upstream site AE1 and AE6. Downstream Eastern Creek site AE4 was marginally lower than the upstream site AE5 (Table 6).

Table 6: Number of taxa and weighted SIGNAL2 scores

Site	Number of taxa	SIGNAL2 weighted scores
AE1	8	3.31
AE2	8	3.53
AE3	13	3.85
AE4	10	2.89
AE5	11	3.10
AE6	10	3.00

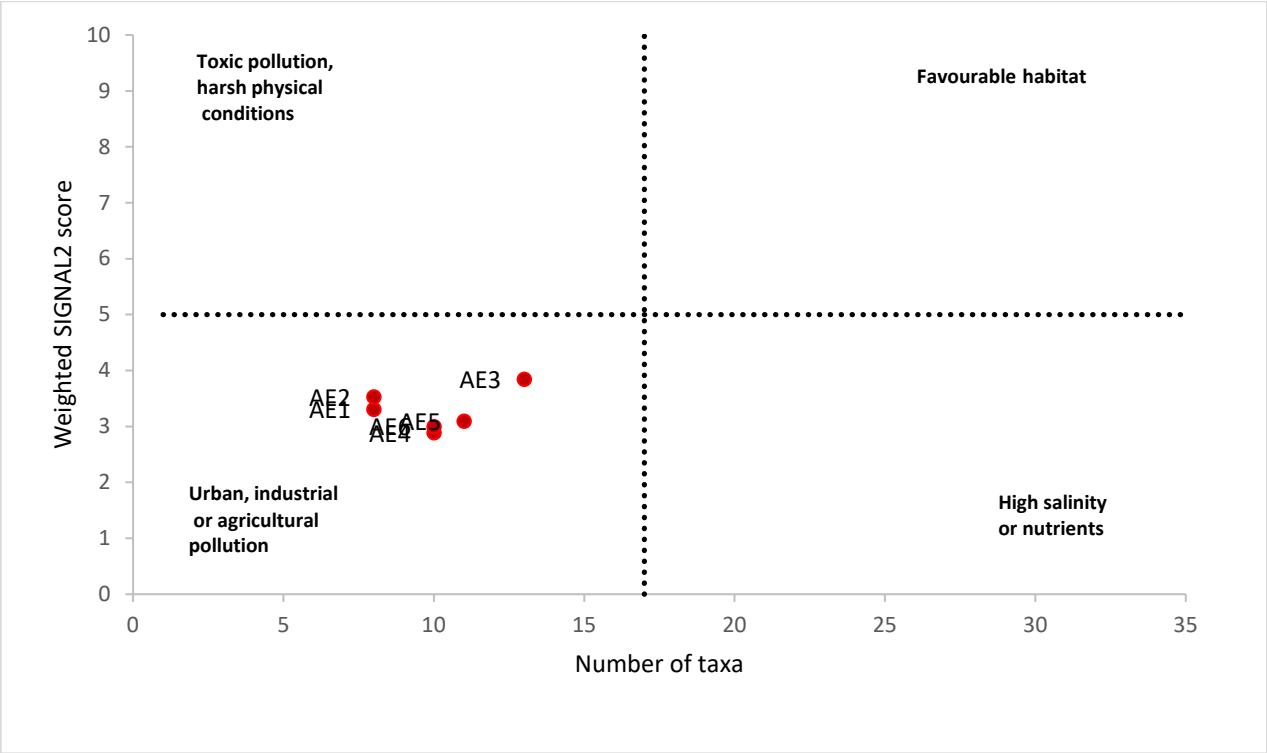

Figure 3: SIGNAL2 score and number of taxa bi-plot.

4. Discussion and Conclusion

Many urban streams are impacted by runoff, habitat degradation, stream modification and land use within the catchment. This appears to be similarly the case in Angus Creek and Eastern Creek with indicators of poor stream health associated with all of the monitoring sites. High electrical conductivity can affect aquatic invertebrates and EC concentration can be the result of several influences including groundwater, local geology, sediments, which can be exacerbated by anthropogenic disturbances or pollution. While the source is unclear it is evident that the elevated EC levels are originating upstream of the RDC and is not originating from the Holcim property. Visual observations identified a slight opaque discolouration at Site AE2 and AE3 downstream of the RDC (Annex 1), however turbidity was below ANZECC guidelines.

It is recommended that Holcim investigate and determine whether water is inadvertently leaving the RDC and entering into the creek.

Despite some lower SIGNAL2 scores recorded downstream of AE1, this is considered unlikely to be due to the RDC, particularly as downstream sites had a higher score than upstream sites. Furthermore there is a variety of upstream impacts and land use activities that are likely to affect the stream and, as such, the low scores observed are likely the result of a combination of natural and anthropogenic catchment stressors.

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Online resources

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Exposed banks but stable. No significant erosion.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low Flow/ ~1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water
Comments		Weeds and rubbish present. Exotic fish *Gambusia holbrooki* present.

AE2: Angus Creek

A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Stable and vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/<1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Some algae; water slightly opaque in colour.
Comments		Weeds and rubbish. Exotic fish *Gambusia holbrooki* present.

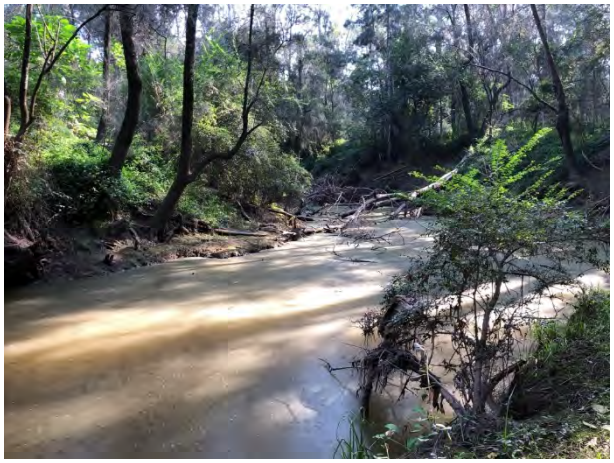
AE3: Angus Creek downstream

A: Upstream

B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections however no visible erosion.
	Substrate	Fine sediment
	Flow/depth	Low flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water opaque in colour.
Comments		Exotic fish *G. holbrooki* present.

AE4: Eastern Creek downstream



A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Exposed banks but no active erosion.
	Substrate	Fine sediment
	Flow/depth	Low-moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid and surface scum.
Comments		Exotic fish *G. holbrooki* present.

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Low-moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid
Comments		Lots of large woody debris. Exotic fish *G. holbrooki* present.

AE6: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6 UPSTREAM
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Others species present included eucalypt and melaleuca species. Dominant groundcover was *L. longifolia*.
	Stream shading	Low
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width	4 metres
	Bank condition	Sandstone revetment -no erosion.
	Substrate	Fine sediment and boulders.
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha* sp. occupied most of the stream. Algae present.
	Water quality observations	Low water level but clear
Comments		Planted riparian vegetation. Exotic fish *Gambusia holbrooki* present.

Annex 2 Macroinvertebrate data – Mach 2019

SITE	AE1	AE2	AE3	AE4	AE5	AE6
Glossophionidae	0	1	0	1	1	1
Turbellaria	2	0	2	0	2	0
Hydrobiidae	4	4	4	0	4	4
Oligochaeta	2	0	2	2	2	2
Isopoda	0	0	0	0	0	2
Hydrophilidae	0	0	2	0	0	0
Hydraenidae	0	0	2	0	0	0
Stratiomiyidae	0	0	0	2	0	0
Tanypodinae	0	0	4	4	0	4
Orthocladiinae	0	0	7	0	0	0
Chironominae	0	0	3	3	3	3
Corixidae	2	0	2	2	0	0
Coenagrionidae	2	2	2	2	2	2
Diphlebiidae	6	0	0	0	0	0
Isostictidae	0	0	0	3	3	3
Megapodagrionidae	0	5	5	0	0	0
Hemicorduliidae	5	5	5	0	5	0
Libellulidae	0	4	0	0	4	4
Leptoceridae	0	6	6	6	6	0

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Holcim Regional Distribution Centre, Rooty Hill NSW

Aquatic ecology monitoring –Visual assessment

Prepared for Holcim

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Cover photograph: Eastern Creek

Stream health -Visual assessment

This report consists of the visual assessment of stream health of Agnes Creek and Eastern Creek as part of Holcim Regional Distribution Centre (RDC) aquatic ecology monitoring program required to meet condition 2.28 of the project approval. Visual monitoring of stream condition was conducted at six sites, four sites on Agnes Creek and two sites on Eastern Creek. Field survey was conducted on 26 February 2019 by Aquatic Ecologist Matthew Russell. The following pages detail the results of the stream health visual assessment and form the initial stage of the monitoring program. The next stage of the monitoring program will be undertaken in autumn 2018 and include AUSRIVAS and visual assessment in accordance with condition 2.28 of RDC project approval.

Overall the streams were in reasonable condition. Agnes Creek had very clear water compared to sampling in spring 2018, however Easter Creek sites were visually more turbid. Despite some sites having exposed banks there was no evidence of active erosion. There was good native riparian vegetation coverage at all sites with the exception of AE6 upstream which is planted and highly modified. The sites within Holcim and downstream did have exotic weeds and rubbish however this was also observed at upstream sites. While the waterways are disturbed this is likely to be related to the overall anthropogenic impacts within the catchment and not directly related to activities at Holcim.

AE1: Agnes Creek

A: Upstream

B: Downstream

	Attribute	AE1
Riparian	Vegetation	The dominant tree species comprised of Swamp Oak (*Casurina glauca*) and Broad leaf privet (*Ligustrum lucidum*). Dominant grass/herb species is Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L.lucidum and T.fluminensis*
Stream characteristics	Modal width (m)	2m
	Bank condition	Banks exposed, no significant signs of erosion
	Substrate	Fine sediment
	Flow/depth	Low Flow /1m
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Very clear
Comments		Some rubbish.

AE2: Agnes Creek

A: upstream

B: Downstream

	Attribute	AE2
Riparian	Vegetation	Dominant tree and shrub species was Swamp Oak (*Casurina glauca*). Dominant groundcover was Wandering Jew (*Tradescantia fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width (m)	2m
	Bank Condition	Stable and Vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/1m
	Macrophytes/algae	Macrophytes present –*Potomogoton crispus*, *Typha sp*., *Vallisneria sp*. and *Cyprus sp*.
	Water quality observations	Filamentous algae
Comments		Weeds and rubbish.

AE3: Agnes Creek

A: Upstream

B: Downstream

	Attribute	AE3
Riparian	Vegetation	Dominant tree species was Swamp Oak (*C. glauca*). Dominant grass/herb species was Wandering Jew *T. fluminensis*
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum T. fluminensis*
Stream characteristics	Modal width (m)	4m
	Bank Condition	Stable, steep, exposed in sections however no visible erosion.
	Substrate	Fine sediment
	Flow/depth	Low flow/1 m
	Macrophytes/algae	*Vallisneria sp.* and *Cyprus sp.*
	Water quality observations	Surface scum/clear
Comments		Anoxic smell/dead animal smell.

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included Swamp Oak (*C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant shrubs were *C. glauca* and Large-leaved Privet (*L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width (m)	7m
	Bank condition	Exposed banks but no active erosion
	Substrate	Fine sediment
	Flow/depth	Low/Moderate flow
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Turbid
Comments		

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was Swamp Oak (*C. glauca*). Dominant grass/herb was Lomandra (*Lomandra .longifolia*) and Wandering Jew (*T. fluminensis*).
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis.*
Stream characteristics	Modal width (m)	5m
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris
	Flow/depth	Low/moderate flow >1m
	Macrophytes/algae	*Perscaria dicipens*
	Water quality observations	Turbid
Comments		Lots of large woody debris.

AE6: Agnes Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Others include eucalypts and melaleuca species. Dominant groundcover was *Lomandra longifolia*.
	Stream shading	Low
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width (m)	4m
	Bank condition	Sandstone revetment -no erosion
	Substrate	Fine sediment and boulders
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha sp*. occupied most of the stream. Algae Present
	Water quality observations	Low
Comments		Water sample taken upstream at weir. Planted riparian vegetation.

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Aquatic Ecology Monitoring

Prepared for Holcim | 2 September 2019

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Document control

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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of quarterly monitoring undertaken on 21 August 2019. Water quality monitoring and visual monitoring of stream condition was conducted at six sites: four sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sites

A total of six sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). Four sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project).

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
AE2	Angus Creek downstream –near property boundary in Nurragingy Reserve.	-33.76563506	150.854665
AE3	Angus Creek upstream of Eastern Creek confluence in Nurragingy Reserve.	-33.76496807	150.8554235
AE4	Eastern Creek downstream of Angus Creek in Nurragingy Reserve	-33.76419362	150.8576059
AE5	Eastern Creek upstream of Angus Creek in Nurragingy Reserve	-33.76411307	150.8570044
AE6	Angus Creek upstream above railway.	-33.77017801	150.8499068

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Location of sites

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Figure 1

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2.2 Field methods

The field survey was undertaken on 21 August 2019 by Ecologist David Wilkinson. The field methods were consistent with standardised techniques for field monitoring.

2.2.1 Visual assessment

A description of aquatic habitat was produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO)(% saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

3. Results

3.1 Rainfall

Sampling was conducted on the 21 August 2019. Antecedent rainfall since the start of the month was 0 millimetres (mm) (Figure 2). However the most recent of the rain fell a one month prior to sampling with 0 mm in the week before. The water level at the time of sampling was low-moderate and with no visible flow.

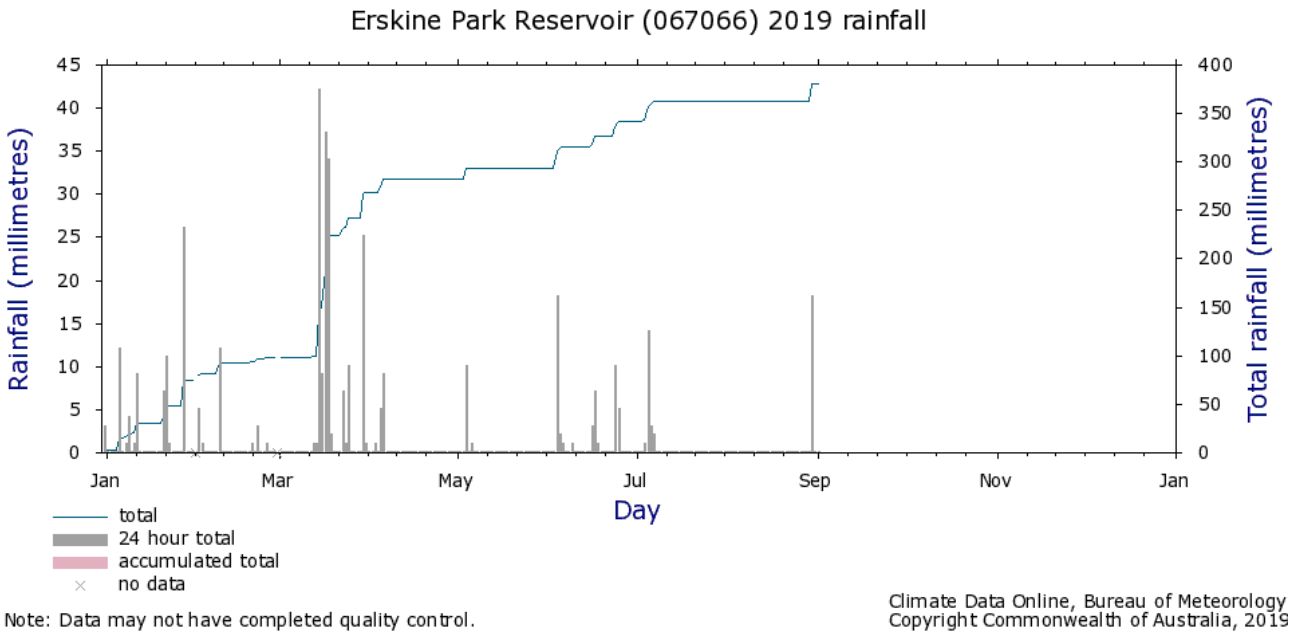

Figure 2: Rainfall January to August 2019.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. Overall the streams were in similar condition to quarterly surveys conducted in February 2019, however there was a decolourisation (opaque) adjacent to and downstream of the RDC (Site AE2 and AE3) (Annex 1).

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 2. Electrical conductivity (EC) in Angus Creek was high at upstream site AE1 (2084 µS/cm), however not exceeding Default Trigger Values (DTVs). This was also observed further upstream at AE6 (3143 µS/cm), which did exceed the DTVs. The remaining sites in Angus Creek and Eastern Creek had elevated EC but within ANZECC guidelines for lowland streams. Turbidity was below ANZECC guidelines at all sites except for AE2 (110.9NTU), however there did appear to be discolouration of the water at AE2 and AE3 compared to upstream sites that could possibly indicate runoff from the RDC. Dissolved oxygen was below DTVs for all sites however this is common for small Western Sydney streams. The pH was within the DTVs at all sites except AE1 which had a reading of 8.12 pH. Alkalinity was highest at the upstream sites with lower values recorded downstream in Angus and Eastern Creeks (Table 2).

Table 2: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH	Alkalinity (mg $CaCO_3$/L)
AE1	Angus Creek	8.98	2084	13.5	**24.1**	**8.12**	200
AE2	Angus Creek	11.86	402	**110.9**	**44.4**	7.96	60
AE3	Angus Creek	10.90	411	34.9	**28.6**	7.04	60
AE4	Eastern Creek	9.31	435	48.3	**45.1**	7.44	60
AE5	Eastern Creek	9.76	425	31.8	**47.2**	6.60	60
AE6	Angus Creek	9.02	**3143**	5.3	**42.9**	7.30	220

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 3).

Table 3: Nutrients - laboratory results

Site	Stream	Total Phosphorous (P) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.04	0.4	0.03	0.4
AE2	Angus Creek	0.02	1.1	0.51	0.6
AE3	Angus Creek	0.07	1.3	0.59	0.7
AE4	Eastern Creek	0.04	0.5	0.11	0.4
AE5	Eastern Creek	0.03	0.4	0.11	0.3
AE6	Angus Creek	0.01	0.6	0.25	0.3

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

4. Discussion and Conclusion

Many urban streams are impacted by runoff, habitat degradation, stream modification and land use within the catchment. This appears to be similarly the case in Angus Creek and Eastern Creek with indicators of poor stream health associated with all of the monitoring sites. High electrical conductivity can affect aquatic ecology and EC concentration can be the result of several influences including groundwater, local geology, sediments, which can be exacerbated by anthropogenic disturbances or pollution. While the source is unclear it is evident that the elevated EC levels are originating upstream of the RDC and is not originating from the Holcim property. Visual observations identified a slight opaque discolouration at Site AE2 and AE3 downstream of the RDC (Annex 1), however turbidity was below ANZECC guidelines at AE3, but was above the guidelines at AE2 (110.9NTU).

It is recommended that Holcim investigate and determine whether water is inadvertently leaving the RDC and entering into the creek.

References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.

Turak E., Waddell N. and Johnstone G. (2000) NSW AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation.

Online resources

http://ausrivas.ewater.com.au/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Exposed banks but stable. No significant erosion.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low Flow/ ~1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water/Slight slime film on surface
Comments		Weeds and rubbish present. Exotic fish *Gambusia holbrooki* observed

AE2: Angus Creek

A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Stable and vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/<1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Some algae; water opaque in colour.
Comments		Weeds and rubbish. Exotic fish *Gambusia holbrooki* observed

AE3: Angus Creek downstream

A: Upstream

B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections however no significant erosion.
	Substrate	Fine sediment
	Flow/depth	Low flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water opaque in colour.
Comments		Exotic fish *G. holbrooki* observed. Significant amount of rubbish present

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Exposed banks but no active erosion.
	Substrate	Fine sediment
	Flow/depth	Low-moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid and surface scum.
Comments		Rubbish. Exotic fish *G. holbrooki* observed

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Low-moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid
Comments		Lots of large woody debris. Exotic fish *G. holbrooki* observed

AE6: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6 UPSTREAM
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Others species present included eucalypt and melaleuca species. Dominant groundcover was *L. longifolia*.
	Stream shading	Low
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width	4 metres
	Bank condition	Sandstone revetment -no erosion.
	Substrate	Fine sediment and boulders.
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha* sp. occupied most of the stream. Algae present.
	Water quality observations	Low water level but clear
Comments		Lots of rubbish. Planted riparian vegetation. Exotic fish *Gambusia holbrooki* present.

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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of bi-annual monitoring undertaken on 6 November 2019. Aquatic ecology monitoring and visual monitoring of stream condition was conducted at six sites: four sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sampling sites

A total of six sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). Four sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project).

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
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Location of sites

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Figure 1

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2.2 Field methods

The field survey was undertaken on 6 November 2019 by Senior Aquatic Ecologist Matthew Russell and Aquatic Ecologist David Wilkinson. The field methods were consistent with standardised techniques for field sampling as prescribed by AUSRIVAS (Turak *et al*. 2000). The AUSRIVAS method of sampling both pools and riffles were modified for this program, as no suitable in-stream riffle features were present.

2.2.1 Visual assessment

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO)(% saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

2.2.3 Macroinvertebrates

Samples were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was undertaken to ensure the sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats were appropriately sampled. Segmented sampling was also employed where pool length was short, and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted suspended fauna.

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used to identify fauna included:

- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera). Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002) The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia. CSIRO Publishing.
- Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW. Cooperative Research Centre for Freshwater Ecology. Albury NSW.
- Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports 12, 1-31.
- Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters. La Trobe University.
- Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Murray Darling Freshwater Research Centre.
- Online resource - http://www.mdfrc.org.au/bugguide/.

2.3 Data analysis

2.3.1 SIGNAL2 (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a, b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site. Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL2 score of the site.

Table 2: SIGNAL 2 grade and the level of pollution tolerance

SIGNAL grade	Pollution tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3: Guide to interpreting the SIGNAL2 scores

SIGNAL2 score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

3. Results

3.1 Rainfall

Sampling was conducted on the 6 November 2019. Antecedent rainfall since the start of the month was 17 millimetres (mm) (Figure 2), two days prior to sampling. A total 39 mm was recorded in October. The water level at the time of sampling was moderate but with no visible flow.

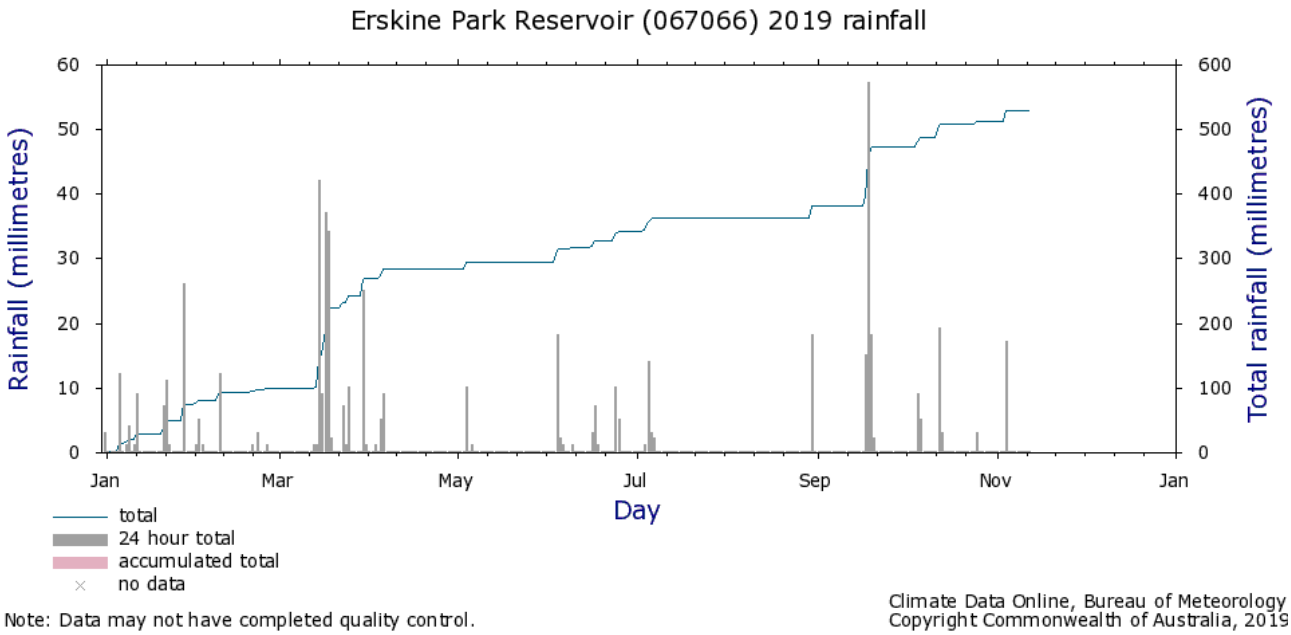

Figure 2: Rainfall January to November 2019.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. Overall the streams were in slightly better condition compared to quarterly visual surveys conducted in August 2019. The slight decolourisation (opaque) adjacent to and downstream of the RDC (Site AE2 and AE3) present in August was not present during this sampling period.

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 4. Electrical conductivity (EC) at all sites were within the ANZECC Default Trigger values (DTVs). The remaining sites in Angus Creek and Eastern Creek had relatively consistent EC with AE6 having the highest at 557µS/cm but still within ANZECC guidelines. Turbidity was below ANZECC DTVs at all sites, the discolouration that had been noted previously (August 2019) was not observed during this sampling period. Dissolved oxygen was below DTVs for all sites however this is common for small Western Sydney streams. The pH was within the DTVs at all sites. Alkalinity was highest at the upstream sites with lower values recorded downstream in Angus and Eastern Creeks.

Table 4: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH*	Alkalinity (mg $CaCo_3$/L)
AE1	Angus Creek	16.46	342	6.1	**22.6**	6.51	120
AE2	Angus Creek	16.9	253	8.6	**34.9**	7.05	80
AE3	Angus Creek	16.81	220	6.6	**36.5**	7.32	80
AE4	Eastern Creek	17.41	318	16.9	**65.6**	7.13	60
AE5	Eastern Creek	17.48	311	19.09	**51.6**	7.25	80
AE6	Angus Creek	18.01	557	5.1	**47.9**	7.06	100

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 5).

Table 5: Nutrients - laboratory results

Site	Stream	Total Phosphorous (TP) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.12	0.6	<0.01	0.6
AE2	Angus Creek	0.08	0.3	<0.01	0.3
AE3	Angus Creek	0.07	0.4	<0.01	0.4
AE4	Eastern Creek	0.1	0.7	0.13	0.6
AE5	Eastern Creek	0.1	0.6	0.12	0.5
AE6	Angus Creek	0.13	0.6	<0.01	0.6

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

3.4 Macroinvertebrates – SIGNAL 2

SIGNAL2 results for the six sampled sites are provided in Table 6. Raw data is provided in Annex 2.

The number of taxa ranged from 7-15, with the most taxa observed in Angus Creek at the AE4 downstream site. The least taxa observed were in Angus Creek site AE6. The SIGNAL2 scores indicate that the creek has a dominance of pollution-tolerant taxa, possibly indicating moderate to severe pollution (Table 3). The SIGNAL2 bi-plot (Figure 3), indicates that no sites have favourable habitat and all locations are exhibiting some form of pollution or natural stress. Downstream site AE2 and AE3 in Angus Creek had a higher SIGNAL2 score than upstream sites AE1 and AE6. Downstream Eastern Creek site AE4 was slightly lower than the upstream site AE5 (Table 6).

Table 6: Number of taxa and weighted SIGNAL2 scores

Site	Number of taxa	SIGNAL2 weighted scores
AE1	12	1.56
AE2	11	3.18
AE3	10	3.13
AE4	15	3.35
AE5	10	3.57
AE6	7	2.78

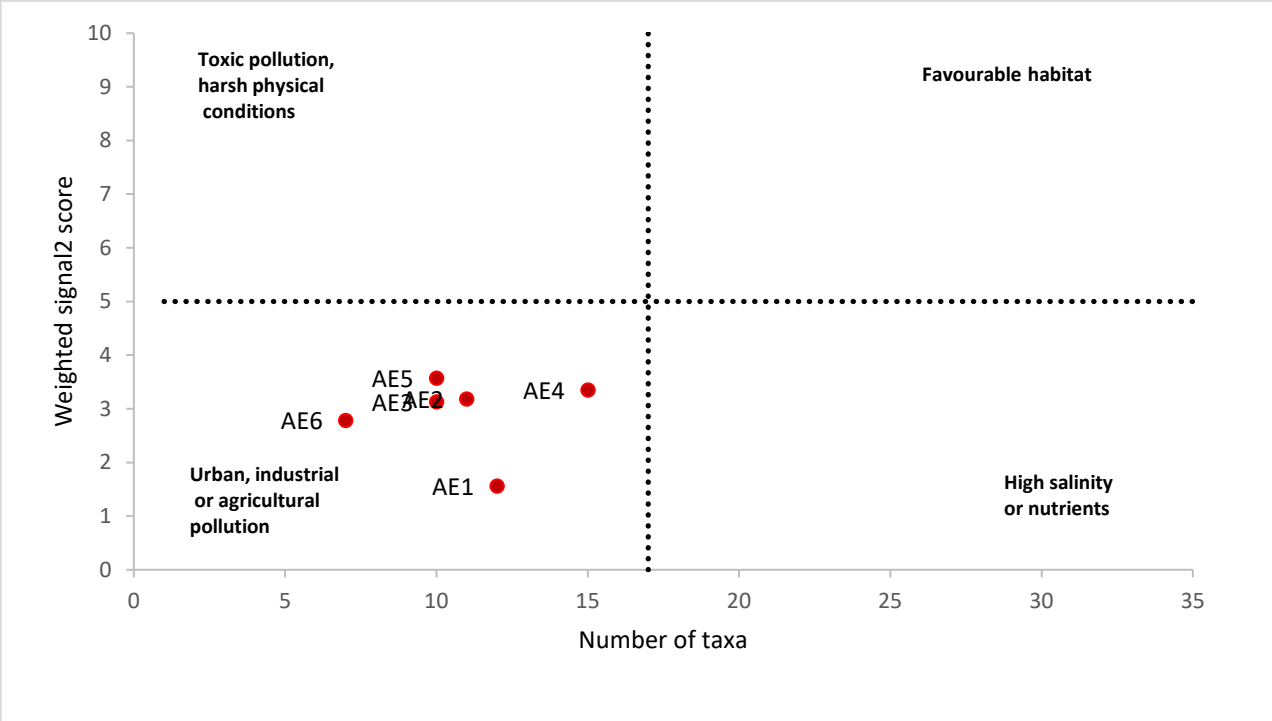

Figure 3: SIGNAL2 score and number of taxa bi-plot.

4. Discussion and Conclusion

With the exception of dissolved oxygen, all physiochemical parameters and nutrients analytes were with ANZECC DTVs. August visual monitoring identified a slight opaque discolouration at Site AE2 and AE3 downstream of the RDC, however this spring monitoring period the water was observed to be clear and had low turbidity.

Low SIGNAL2 scores were recorded at sites AE1 and AE6, however these are considered unlikely to be due to the RDC particularly as downstream sites had a higher score than upstream sites. Furthermore, there is a variety of upstream impacts and land use activities that are likely to affect the stream and, as such, the low scores observed are likely the result of a combination of natural and anthropogenic catchment stressors.

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Online resources

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Exposed banks but stable. No significant erosion.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low Flow/ ~1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water
Comments		Weeds and rubbish present. Exotic fish *Gambusia holbrooki* present.

AE2: Angus Creek

A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Stable and well vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/<1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Some algae
Comments		Weeds and rubbish. Exotic fish *Gambusia holbrooki* present.

AE3: Angus Creek downstream

A: Upstream

B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections however no visible erosion.
	Substrate	Fine sediment
	Flow/depth	Low flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water clear, some algae present
Comments		Exotic fish *G. holbrooki* present.

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Exposed banks but no active erosion.
	Substrate	Fine sediment
	Flow/depth	Low-moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Slightly turbid and surface scum.
Comments		Exotic fish *G. holbrooki* present.

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Low-moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Slightly turbid
Comments		Lots of large woody debris and plastic based rubbish. Exotic fish *G. holbrooki* present.

AE6: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6 UPSTREAM
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Other species present included eucalypt and melaleuca species. Dominant groundcover was *L. longifolia*.
	Stream shading	Low
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width	4 metres
	Bank condition	Sandstone revetment -no erosion.
	Substrate	Fine sediment and boulders.
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha* sp. occupied most of the stream. Algae present.
	Water quality observations	Low water level but clear
Comments		Planted riparian vegetation. Schools of exotic fish, *Gambusia holbrooki* present.

Annex 2 Macroinvertebrate data – November 2019

SITE	AE1	AE2	AE3	AE4	AE5	AE6
Glossophionidae	3	2	7	3	2	1
Turbellaria				1		2
Hydrobiidae	23	17	30		1	13
Pyralidae		1				
Planorbidae				2		
Physidae	1			1		1
Oligochaeta	2	5	6		2	2
Acarina	1			1		
Ceinidae	2					
Hydrophilidae						1
Dixidae				1		
Simuliidae						
Stratiomiyidae		1			1	
Culicidae						
Ceratopogonidae						
Tanypodinae	3		2		1	
Orthocladiinae						
Chironominae	40		4	82	53	37
Baetidae				2		
Veliidae				3		
Corixidae	1					
Notonectidae		1				
Pleidae				1		
Coenagrionidae	3	5	3	4	5	
Diphlebiidae		1				
Isostictidae			3	10	8	
Megapodagrionidae		1				
Aeshnidae			1			
Hemicorduliidae	1	2	8	1		
Libellulidae	1	1	1			
Ecnomidae					1	
Leptoceridae				53	20	
Micronectidae				12		
gambusia		1	1	1		

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Document control

Project number	Client	Project manager	LGA
4099	Holcim	Matthew Russell	Hills Shire

Version	Author	Review	Status	Date
D1	David Wilkinson	Matthew Russell	Draft	20/08/2020
Rev1	Matthew Russell			

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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of quarterly monitoring undertaken on 17 August 2020. Water quality monitoring and visual monitoring of stream condition was conducted at six sites: four sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sites

A total of six sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). Four sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project).

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
AE2	Angus Creek downstream –near property boundary in Nurragingy Reserve.	-33.76563506	150.854665
AE3	Angus Creek upstream of Eastern Creek confluence in Nurragingy Reserve.	-33.76496807	150.8554235
AE4	Eastern Creek downstream of Angus Creek in Nurragingy Reserve	-33.76419362	150.8576059
AE5	Eastern Creek upstream of Angus Creek in Nurragingy Reserve	-33.76411307	150.8570044
AE6	Angus Creek upstream above railway.	-33.77017801	150.8499068

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0 150
m
GDA 1994 MGA Zone 56

Location of sites

Holcim Regional Distribution Centre - Aquatic Monitoring

Niche PM: Matthew Russell
Niche Proj. #: 4099
Client: Holcim

Figure 1

sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017

Drawn by: GIS_user File: T:\spatial\projects\a4000\a4099_AgnesCreek\Mapsv\report\4099_Figure_1.mxd Last updated: 12/20/2018 12:21:20 PM

2.2 Field methods

The field survey was undertaken on 17 August 2020 by Ecologist David Wilkinson. The field methods were consistent with standardised techniques for field monitoring.

2.2.1 Visual assessment

A description of aquatic habitat was produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO)(% saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

3. Results

3.1 Rainfall

Sampling was conducted on the 17 August 2020. Antecedent rainfall since the start of the month was 58 millimetres (mm) (Figure 2). The most recent of the rain fell two days prior to sampling with a reading of 8mm while the highest rain fall was recorded on the 10th August 2020 with 34mm recorded at Erskine Park Reservoir gauge. The water level at the time of sampling was moderate and with a visible flow.

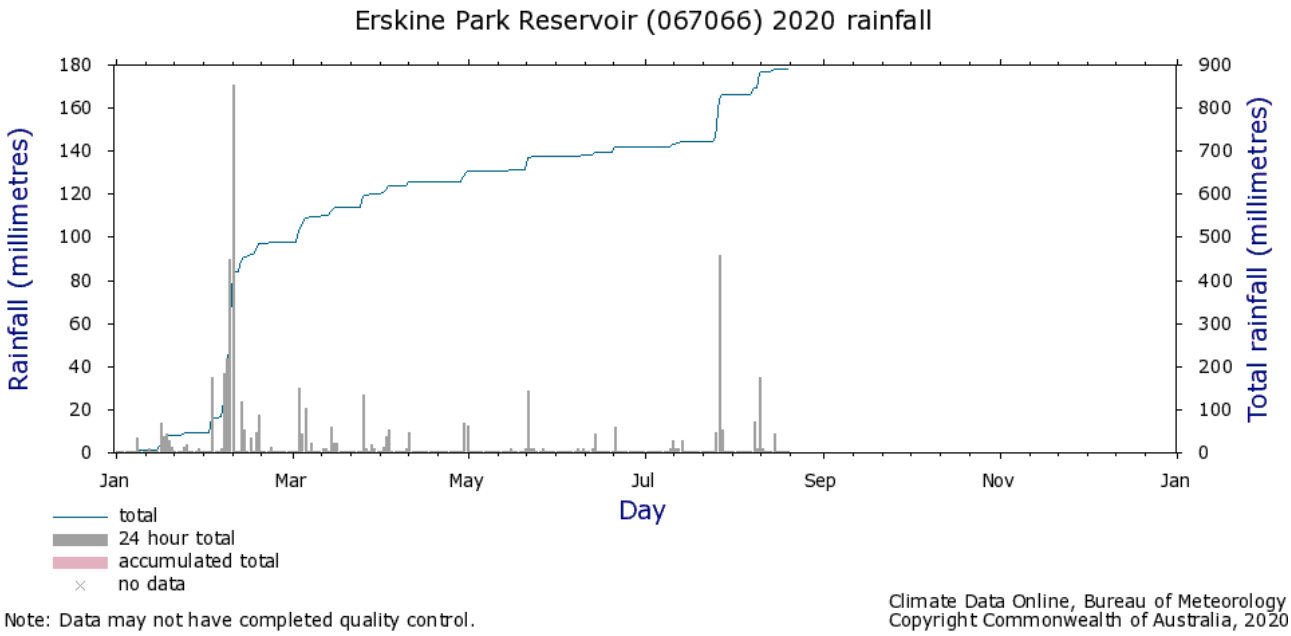

Figure 2: Rainfall January to August 2020.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. The riparian vegetation damage noted in February 20 (Niche 2020) caused by a flood event has recovered and the vegetation is now thickly covering the banks edges at sites AE1 and AE2. The banks of sites AE4 and AE5 are still exhibiting signs of erosion and riparian vegetation stripping due to the flood events in February and the recent rain in the month of August. The overall water level of the creeks was still moderate with strong flow at the time of sampling (17 August 2020). The water at all sites apart from AE2 and AE6 were visibly discoloured with sites AE4 and AE5 being the worst. At all sites, it was noted that there was a large amount of plastic based waste that had been deposited from recent and past high flows.

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 2. Although elevated, Electrical conductivity (EC) at all sites in Angus Creek and Eastern Creek similar to past monitoring periods of low to moderate flow, ranging from 721 µS/cm (AE4) to 1483 µS/cm (AE6). All readings from the six sites were within ANZECC guidelines for lowland streams. Turbidity was below ANZECC guidelines at all sites within Angus Creek. However, both the Eastern Creek sites (AE4 and AE5) were above the trigger values as with previous periods, with readings of 71.5 NTU and 84.5NTU respectively. Dissolved oxygen (DO) was below DTVs for all sites, the system was observed to have a low active flow at the time of sampling. However, the sites being below the DTVs for DO is common for small Western Sydney streams and has been observed throughout the monitoring program. The pH was within the DTVs at all sites ranging from 7.44 – 7.79. Alkalinity was

highest in the Angus Creek system with values ranging from 340 (AE6) to 260 (AE3) while the values for Eastern Creek were lower with both sites having a value of 120 (Table 2).

Table 2: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH	Alkalinity (mg $CaCO_3$/L)
AE1	Angus Creek	12.32	1226	24.3	**70.4**	7.79	280
AE2	Angus Creek	12.75	1229	11.5	**68.3**	7.7	300
AE3	Angus Creek	12.75	1236	8.3	**68.9**	7.71	260
AE4	Eastern Creek	12.53	721	**71.5**	**79.8**	7.46	120
AE5	Eastern Creek	12.42	724	**84.5**	**78.9**	7.44	120
AE6	Angus Creek	12.66	1483	3.7	**76.6**	7.87	340

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 3).

Table 3: Nutrients - laboratory results

Site	Stream	Total Phosphorous (P) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.04	1.6	1.19	0.4
AE2	Angus Creek	0.07	1.8	1.1	0.7
AE3	Angus Creek	0.07	1.7	1.1	0.6
AE4	Eastern Creek	0.16	1.9	1.1	0.8
AE5	Eastern Creek	0.16	2.7	1.37	1.3
AE6	Angus Creek	0.03	1.9	1.5	0.4

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

4. Discussion and Conclusion

Many streams that occur within urban areas are impacted by runoff, habitat degradation, stream modification and land use within the catchment. This appears to be similarly the case in Angus Creek and Eastern Creek with indicators of poor stream health associated with all the monitoring sites. Turbidity was elevated in Eastern Creek, which has been observed over several monitoring occasion and considered with in background levels for this system. Angus Creek was with ANZECC guidelines indicating that there has been no suspended solid runoff from the Holcim site. Electrical conductivity has previously been lower than usual (Niche Feb 2020) due to a high flow event diluting the concentration of salts, however this monitoring period the conductivity of both systems had returned to its usual levels observed during previous monitoring periods of low-moderate flow. Visual observations identified a slight amount of erosion of the bank in Angus Creek that has been caused by the recent heavy rain event, along with an increase in organic debris and rubbish consisting of plastics and other anthropogenic debris in the creek system. The rubbish and other plastic based debris are not believed to have originated from the RDC and has likely been transported from the catchment upstream. The riparian vegetation damage observed in recent monitoring has recovered since February 2020 high flow event with vegetation re-established on the banks of Angus Creek.

References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.

Turak E., Waddell N. and Johnstone G. (2000) NSW AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation.

Online resources

http://ausrivas.ewater.com.au/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Exposed banks but stable. Slight erosion.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low-Moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water, some floating scum
Comments		High levels of rubbish and debris

AE2: Angus Creek

A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Soft, bank vegetation stripped away in sections
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low-Moderate flow/>1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Clear, moderate flow
Comments		Weeds and rubbish. Riparian vegetation and bank eroded by water flow and deer tracks

AE3: Angus Creek downstream

A: Upstream

B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections however no significant erosion.
	Substrate	Fine sediment
	Flow/depth	Low- Moderate flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water slightly brown in colour/clear
Comments		Significant amount of rubbish present. Flood debris high on bank and on foot bridge

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Bank is soft and shallow holes in bank full of water
	Substrate	Fine sediment
	Flow/depth	Moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid and significant rubbish present
Comments		Rubbish, significant amount of debris. Water erosion channels caused by water flowing out of bank

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed, very soft
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Turbid
Comments		Significant amount of large woody debris/plastics/picnic table present in creek

AE6: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE6 UPSTREAM
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was *Acacia sp*. Others species present included eucalypt and melaleuca species. Dominant groundcover was *L. longifolia*.
	Stream shading	Low
	Exotic vegetation	Exotic grasses and herbs.
Stream characteristics	Modal width	4 metres
	Bank condition	Sandstone revetment -no erosion. Slight scalping of riparian vegetation above stone.
	Substrate	Fine sediment and boulders.
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha* sp. occupied most of the stream. Algae present.
	Water quality observations	Low- level but clear
Comments		Lots of rubbish. Planted riparian vegetation. Exotic fish *Gambusia holbrooki* present.

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Aquatic Ecology Monitoring

Prepared for Holcim | 17 June 2020

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Document control

Project number	Client	Project manager	LGA
4099	Holcim	Matthew Russell	Hills Shire

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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of bi-annual Macroinvertebrate monitoring undertaken on 29th May 2020. Aquatic ecology monitoring and visual monitoring of stream condition was conducted at five sites: three sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sampling sites

A total of five sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). three sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project). Site AE6 could not be reached during this monitoring period due to works being conducted at the entrance of the site.

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
AE2	Angus Creek downstream –near property boundary in Nurragingy Reserve.	-33.76563506	150.854665
AE3	Angus Creek upstream of Eastern Creek confluence in Nurragingy Reserve.	-33.76496807	150.8554235
AE4	Eastern Creek downstream of Angus Creek in Nurragingy Reserve	-33.76419362	150.8576059
AE5	Eastern Creek upstream of Angus Creek in Nurragingy Reserve	-33.76411307	150.8570044
AE6	Angus Creek upstream above railway.	-33.77017801	150.8499068

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0 150
m
GDA 1994 MGA Zone 56

Location of sites

Holcim Regional Distribution Centre - Aquatic Monitoring

Niche PM: Matthew Russell
Niche Proj. #: 4099
Client: Holcim

Figure 1

sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017

Drawn by: GIS_user File: T:\spatial\projects\a4000\a4099_AgnesCreek\Mapsv\report\4099_Figure_1.mxd Last updated: 12/20/2018 12:21:20 PM

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2.2 Field methods

The field survey was undertaken on 29th May 2020 by Aquatic Ecologist David Wilkinson and Christie Chapman. The field methods were consistent with standardised techniques for field sampling as prescribed by AUSRIVAS (Turak *et al*. 2000). The AUSRIVAS method of sampling both pools and riffles were modified for this program, as no suitable in-stream riffle features were present.

2.2.1 Visual assessment

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO % saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

2.2.3 Macroinvertebrates

Samples were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was undertaken to ensure the sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats were appropriately sampled. Segmented sampling was also employed where pool length was short, and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted suspended fauna.

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used to identify fauna included:

- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera). Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002) The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia. CSIRO Publishing.
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- Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Murray Darling Freshwater Research Centre.
- Online resource - http://www.mdfrc.org.au/bugguide/.

2.3 Data analysis

2.3.1 SIGNAL2 (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a, b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site. Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL2 score of the site.

Table 2: SIGNAL 2 grade and the level of pollution tolerance

SIGNAL grade	Pollution tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3: Guide to interpreting the SIGNAL2 scores

SIGNAL2 score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

3. Results

3.1 Rainfall

Sampling was conducted on the 29th May 2020. Antecedent rainfall since the start of the month was 45 millimetres (mm) (Figure 2). With 32mm within a week prior to sampling. A total 45 mm was recorded in October. The water level at the time of sampling was moderate but with no visible flow.

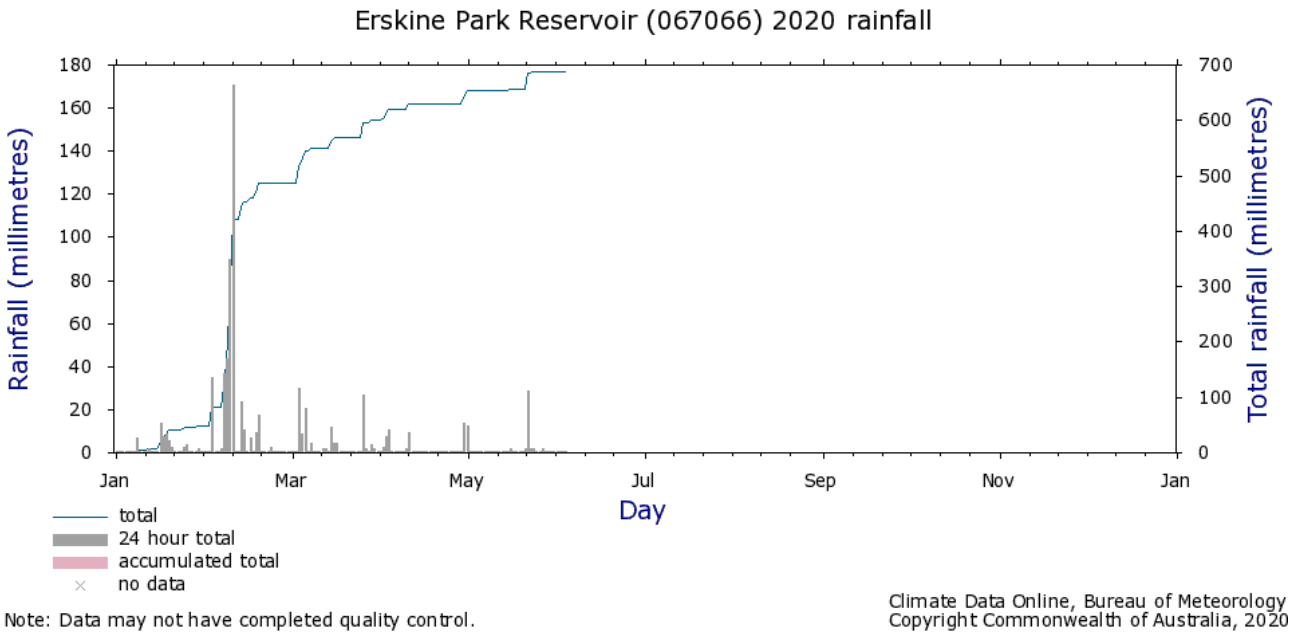

Figure 2: Rainfall January to May 2020.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. Overall the streams were in good condition compared to some previous quarterly visual surveys. The banks of Angus Creek and Eastern Creek have been slightly affected by erosion from rainfall events in February 2020. The previous survey observed that the system had received bank-full flooding events which had removed some material from the banks. Site AE6 could not be sampled as the sports ground from which it is accessed was closed because of COVID 19.

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 4. Electrical conductivity (EC) at all sites were within the ANZECC Default Trigger values (DTVs). The remaining sites in Angus Creek and Eastern Creek had relatively consistent EC with AE1 having the highest at 1009 µS/cm but still within ANZECC guidelines. The other Angus Creek Sites both had values at least 200 µS/cm above the Eastern Creek Sites. Turbidity was below ANZECC DTVs at all sites, except for the Eastern Creek Sites. Both AE4 and AE5 had turbidity values of 622NTU. Dissolved oxygen was below DTVs for all sites however this is common for small Western Sydney streams. The pH was within the DTVs at all sites. Alkalinity was highest at the upstream sites with lower values recorded downstream in Angus and Eastern Creeks.

Table 4: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH*	Alkalinity (mg $CaCo_3$/L)
AE1	Angus Creek	14.1	1009	6.8	**58.3**	7.33	80
AE2	Angus Creek	13.87	897	2.3	**53.7**	7.32	80
AE3	Angus Creek	13.84	874	8.8	**49.7**	7.42	60
AE4	Eastern Creek	13.35	622	**622**	**75.8**	7.16	40
AE5	Eastern Creek	13.33	622	**622**	**76.8**	7.32	60
AE6	Angus* Creek	-	-	-	-	-	-

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

*Not sampled.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 5).

Table 5: Nutrients - laboratory results

Site	Stream	Total Phosphorous (TP) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.03	1	0.41	0.6
AE2	Angus Creek	0.02	0.6	0.38	0.2
AE3	Angus Creek	0.04	0.7	0.37	0.3
AE4	Eastern Creek	0.13	1.2	0.43	0.8
AE5	Eastern Creek	0.19	1.5	0.43	1.1
AE6	Angus Creek*	-	-	-	-

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

*Not sampled.

3.4 Macroinvertebrates – SIGNAL 2

SIGNAL2 results for the six sampled sites are provided in Table 6. Raw data is provided in Annex 2.

The number of taxa ranged from 8-10, with the most taxa (10) observed in Angus Creek at the AE1, AE2 and AE3 sites. The least taxa (8) observed were in Eastern Creek site AE4. The SIGNAL2 scores indicate that the creek has a dominance of pollution-tolerant taxa, possibly indicating moderate to severe pollution (Table 3). Only one pollution sensitive macroinvertebrate family, Caddisfly Leptoceridae, was observed. This family was at all sites excluding the upstream Site AE1.

The SIGNAL2 bi-plot (Figure 3), indicates that no sites have favourable habitat and all locations are exhibiting some form of pollution or natural stress. Downstream site AE2 and AE3 in Angus Creek had a higher SIGNAL2 score than upstream site AE1. Downstream Eastern Creek site AE4 was slightly lower than the upstream site AE5 (Table 6).

Table 6: Number of taxa and weighted SIGNAL2 scores

Site	Number of taxa	SIGNAL2 weighted scores
AE1	10	2.5
AE2	10	3
AE3	10	3.38
AE4	8	3.48
AE5	9	3.83
AE6*	-	-

*Not sampled.

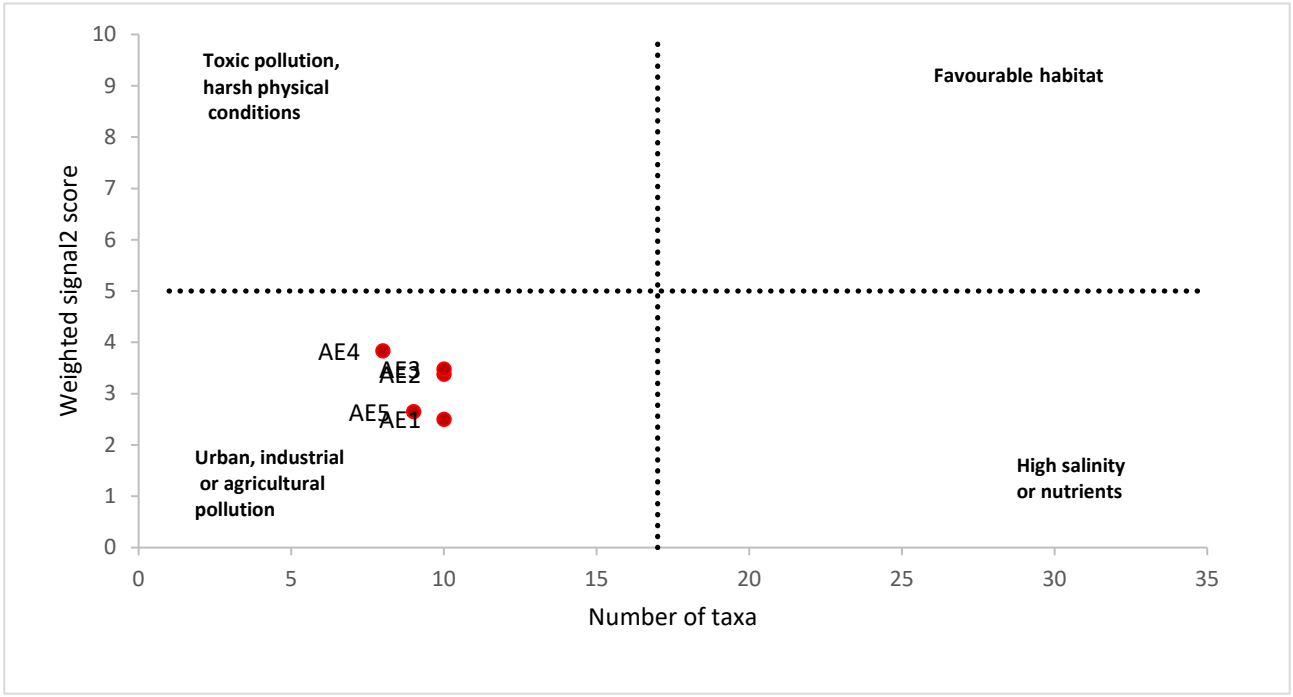

Figure 3: SIGNAL2 score and number of taxa bi-plot.

4. Discussion and Conclusion

With the exception of dissolved oxygen at all sites and turbidity in Eastern Creek, all physiochemical parameters and nutrients analytes were with ANZECC DTVs for all of the five sites surveyed this monitoring period. The water at the time of monitoring was clear, with little to no turbidity observed within Angus Creek but with very high turbidity observed in the Eastern Creek system. Both Creeks have shown slight levels of bank erosion and instability from heavy rainfall events this year with flood debris being located high above the bank-full flow margins, however the riparian vegetation has recovered since February 2020 visual inspection. It is expected that recovery of riparian vegetation will help to restabilise the banks.

Low SIGNAL2 scores (<3) were recorded at all sites however downstream sites had a higher score than upstream sites as well as pollution sensitive family macorainvertebrate family that was not observed at the upstream site. Considering this it is unlikely that the RDC is affecting stream ecology. Furthermore, there is a variety of upstream impacts and land use activities that are likely to affect the stream and, as such, the low scores observed are likely the result of a combination of natural and anthropogenic catchment stressors, which is common place for intercity stream systems of this nature. Overall, the two streams appear to be in reasonable health for an urban waterway. There are no physiochemical or ecological evidence suggesting that the RDC is affecting the downstream environment. .

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Online resources

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Exposed banks but stable. Slight erosion of lower bank.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low Flow/ ~1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water
Comments		Weeds and rubbish present. Exotic fish *Gambusia holbrooki* present.

AE2: Angus Creek

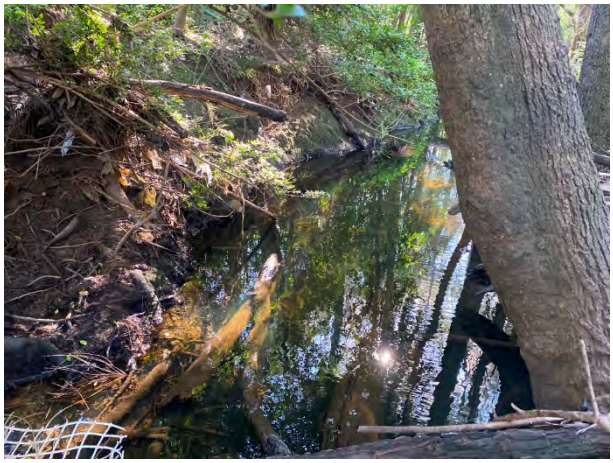
A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Stable and lightly vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/<1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Clear water
Comments		Weeds and rubbish. Exotic fish *Gambusia holbrooki* present. Significant deer activity on banks and in riparian zone

AE3: Angus Creek downstream

A: Upstream



B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections, slight visible erosion.
	Substrate	Fine sediment, organic matter
	Flow/depth	Low flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water clear
Comments		Exotic fish *G. holbrooki* present, large amount of plastic rubbish

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Exposed banks, erosion present since last visit
	Substrate	Fine sediment
	Flow/depth	Low-moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Very turbid/slight milky colouration
Comments		Exotic fish *G. holbrooki* present. Significant amount of rubbish in system

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Low-moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Very turbid
Comments		Lots of large woody debris and plastic based rubbish. Evidence of flood debris (picnic table in Angus Creek) Exotic fish *G. holbrooki* present.

Annex 2 Macroinvertebrate data – May 2020

SITE	AE1	AE2	AE3	AE4	AE5	AE6
Glossophionidae	16	3	-	2	2	-
Hydrobiidae	10	8	6	1	3	-
Physidae	2	-	-	-	-	-
Oligochaeta	1	23	5	-	1	-
Acarina	-	-	1	-	-	-
Ostracoda	4	2	7	1	4	-
Hydrophilidae	1	-	-	-	-	-
Scirtidae	-	-	-	-	1	-
Simuliidae	-	12	2	-	-	-
Stratiomiyidae	2	2	-	1	-	-
Chironominae	6	4	11	-	14	-
Notonectidae	-	-	4	-	1	-
Coenagrionidae	8	1	10	2	-	-
Gomphidae	-	1	1	1	-	-
Leptoceridae	-	2	1	12	2	-
Micronectidae	2	-	-	4	12	-

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Offset strategy and assessment (NSW, QLD, Commonwealth)
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Holcim Regional Distribution Centre
Rooty Hill NSW

Aquatic Ecology Monitoring

Prepared for Holcim | 2 December 2020

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Document control

Project number	Client	Project manager	LGA
4099	Holcim	Matthew Russell	Hills Shire

Version	Author	Review	Status	Date
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R0	David Wilkinson	Matthew Russell	Review	02/12/2020

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1. Introduction

1.1 Background

This document reports on results of the visual and stream health assessment of Angus Creek and Eastern Creek as part of the Holcim Regional Distribution Centre (RDC) (the Project) aquatic ecology monitoring program (hereafter referred to as the monitoring program). The monitoring program, including quarterly visual monitoring, bi-annual aquatic survey and reporting, is required under condition 2.28 of the Project approval.

The aim of the monitoring program is to compare downstream sites to upstream sites and determine whether the RDC is affecting stream health adjacent to or downstream of the Project.

This report presents the results of bi-annual Macroinvertebrate monitoring undertaken on 19th November 2020. Aquatic ecology monitoring and visual monitoring of stream condition was conducted at Six sites: four sites on Angus Creek and two sites on Eastern Creek.

2. Methods

2.1 Location of sampling sites

A total of six sites were sampled on Angus Creek and Eastern Creek (Figure 1, Table 1). four sites were located on Angus Creek (two upstream and two downstream of the Project) and two sites were located on Eastern Creek (one upstream and one downstream of the Project).

Table 1: Survey sites

Site name	Location	Latitude	Longitude
AE1	Angus Creek upstream near property boundary	-33.76798576	150.8516665
AE2	Angus Creek downstream –near property boundary in Nurragingy Reserve.	-33.76563506	150.854665
AE3	Angus Creek upstream of Eastern Creek confluence in Nurragingy Reserve.	-33.76496807	150.8554235
AE4	Eastern Creek downstream of Angus Creek in Nurragingy Reserve	-33.76419362	150.8576059
AE5	Eastern Creek upstream of Angus Creek in Nurragingy Reserve	-33.76411307	150.8570044
AE6	Angus Creek upstream above railway.	-33.77017801	150.8499068

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0 150
m
GDA 1994 MGA Zone 56

Location of sites

Holcim Regional Distribution Centre - Aquatic Monitoring

Niche PM: Matthew Russell
Niche Proj. #: 4099
Client: Holcim

Figure 1

sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017

Drawn by: GIS_user File: T:\spatial\projects\a4000\a4099_AgnesCreek\Mapsv\report\4099_Figure_1.mxd Last updated: 12/20/2018 12:21:20 PM

v2.0

2.2 Field methods

The field survey was undertaken on 19th November 2020 by Aquatic Ecologist David Wilkinson. The field methods were consistent with standardised techniques for field sampling as prescribed by AUSRIVAS (Turak *et al*. 2000). The AUSRIVAS method of sampling both pools and riffles were modified for this program, as no suitable in-stream riffle features were present.

2.2.1 Visual assessment

A description of aquatic habitat was also produced using the AUSRIVAS proforma. The survey is a rapid visual assessment used to describe the habitat based on the following parameters:

- Geomorphology
- Channel diversity
- Bank stability
- Riparian vegetation and adjacent land use
- Water quality
- Macrophytes
- Local impacts and land use practices.

2.2.2 Water quality

Physio-chemical field measurements

Surface water quality was measured in situ using a Yeokal 611 water quality probe at each site. The following variables were recorded:

- Temperature (°C)
- Conductivity (µS/cm)
- pH
- Dissolved oxygen (DO % saturation and mg/L)
- Turbidity (NTU).

Alkalinity (mg $CaCO_3$/L) was measured with a standard titration kit. Water quality data were compared with the ANZECC (2000) default trigger values (DTVs) of physical and chemical stressors for protection of slightly upland aquatic ecosystems in South-Eastern Australia.

Water sampling

Water samples were taken at each location and sent to ALS laboratories to test for Total Phosphorus (TP), Total Nitrogen (TN) (Nitrogen Oxides (NOx) +Total Kjeldahl Nitrogen (TKN)). The results were compared with ANZECC (2000) DTVs for TP, TN and NOx.

2.2.3 Macroinvertebrates

Samples were collected from pool edges for a length of 10 metres, either as a continuous line or in disconnected segments. Sampling in segments was undertaken to ensure the sub-habitats such as macrophyte beds, bank overhangs, submerged branches and root mats were appropriately sampled. Segmented sampling was also employed where pool length was short, and it was logistically difficult to sample in a continuous line (e.g. in-stream logs). A 250 µm dip net was drawn through the water with short sweeps towards the bank to dislodge benthic fauna while scraping submerged rocks and debris, sides of the stream bank and the bed substrate. Further sweeps in the water column targeted suspended fauna.

Each sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps, pipettes and or paint brushes. Each tray was picked for a minimum period of 40 minutes, after which they were picked at 10 minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals, in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% ethanol.

Laboratory methods-invertebrate identification

Macroinvertebrate samples were identified to family level with the exception of Oligochaeta (to class), Polychaeta (to class), Ostracoda (to subclass), Nematoda (to phylum), Nemertea (to phylum), Acarina (to order) and Chironomidae (to subfamily). Keys used to identify fauna included:

- Dean, J., Rosalind, M., St Clair, M., and Cartwright, D. (2004) Identification keys to Australian families and genera of caddis-fly larvae (Trichoptera). Cooperative Research Centre for Freshwater Ecology.
- Gooderham, J. and Tsyrlin, E. (2002) The Waterbug Book: A guide to the Freshwater Macroinvertebrates of Temperate Australia. CSIRO Publishing.
- Hawking and Theischinger (1999) A guide to the identification of larvae of Australian families and to the identification of ecology of larvae from NSW. Cooperative Research Centre for Freshwater Ecology. Albury NSW.
- Madden, C. (2010) Key to genera of Australian Chironomidae. Museum Victoria Science Reports 12, 1-31.
- Madden, C. (2011) Draft identification key to families of Diptera larvae of Australian inland waters. La Trobe University.
- Smith, B. (1996) Identification keys to the families and genera of bivalve and gastropod molluscs found in Australian inland waters. Murray Darling Freshwater Research Centre.
- Online resource - http://www.mdfrc.org.au/bugguide/.

2.3 Data analysis

2.3.1 SIGNAL2 (Stream Invertebrate Grade Number Average Level) scores

The revised SIGNAL2 biotic index developed by Chessman (2003a, b) was used to determine the "environmental quality" of sites. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their response to a range of environmental conditions (Table 2). The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. A weighted SIGNAL2 score was also calculated (see Chessman 2003b). The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site. Table 3 provides a broad guide for interpreting the health of the site according to the SIGNAL2 score of the site.

Table 2: SIGNAL 2 grade and the level of pollution tolerance

SIGNAL grade	Pollution tolerance
10-8	Indicates a greater sensitivity to pollution
7-5	Indicates a sensitivity to pollution
4-3	Indicates a tolerance to pollution
2-1	Indicates a greater tolerance to pollution

Table 3: Guide to interpreting the SIGNAL2 scores

SIGNAL2 score	Habitat quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

*Note that SIGNAL2 scores are indicative only and that pollution does not refer to just anthropogenic pollution. Environmental stress may result in poor water quality occurring naturally in waterways. Low family richness and the occurrence of pollution tolerant invertebrates can give a low SIGNAL score even when they are in natural condition.

3. Results

3.1 Rainfall

Sampling was conducted on the 19 November 2020. Antecedent rainfall since the start of the month was 37 millimetres (mm) (Figure 2). With only 8mm falling within a week prior to sampling. The water level of both Eastern Creek and Angus Creek at the time of sampling was low to moderate and with no visible flow.

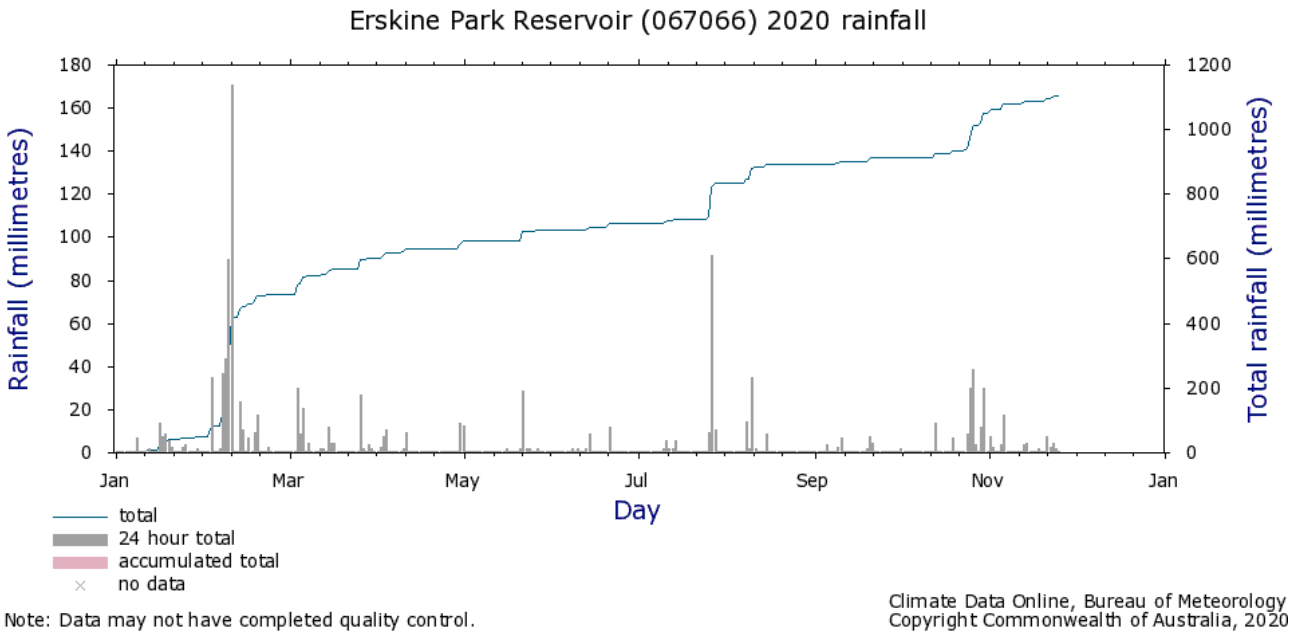

Figure 2: Rainfall January to May 2020.

3.2 Visual observations

Results of the visual survey including photographs of each site are provided in Annex 1. Overall, the streams were in moderate condition but improved compared to some previous quarterly visual surveys. The banks of Angus Creek have been revegetated heavily after being scoured during the February 2020 heavy rainfall events. Eastern Creek still appears to be suffering from erosion of its banks as they are still exposed and unvegetated. The previous survey observed that the system had received overbank flooding events which had removed some material from the banks. All sites had large quantities of plastics and other rubbish in the system and on the banks.

3.3 Water quality

3.3.1 Physio-chemical

Field physio-chemical water quality results are shown in Table 4. Electrical conductivity (EC) at all sites were elevated, but within the ANZECC Default Trigger values (DTVs). The sites in Angus Creek and Eastern Creek had relatively consistent EC, with AE1 having the highest at 1684 µS/cm but still within ANZECC guidelines. Eastern Creek upstream had significantly lower EC than Angus Creek (AE4 611 µS/cm) While Eastern Creek Downstream had a much higher EC once mixed with Angus Creek (AE5 1211 µS/cm). Turbidity was below ANZECC DTVs at all sites, except for the Eastern Creek Site AE4 which had reading of 70.6 NTU. Dissolved oxygen was below DTVs for all sites however this is common for small Western Sydney streams. The pH was within the DTVs at all sites. Alkalinity was consistent in Angus Creeks upstream sites (AE6, AE1 and AE2) with it lowering slightly downstream (AE3). While the two Eastern Creek sites had the same reading.

Table 4: Field physio chemical water quality results

Site	Stream	Temp (C°)	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (% sat)	pH*	Alkalinity (mg $CaCo_3$/L)
AE1	Angus Creek	18.94	1684	16.4	**33.7**	7.65	300
AE2	Angus Creek	18.92	1368	6.4	**41.9**	7.51	300
AE3	Angus Creek	18.77	1365	7	**37.5**	7.35	260
AE4	Eastern Creek	19.94	611	**70.6**	**47.5**	7.56	200
AE5	Eastern Creek	19.19	1211	17.5	**22.1**	7.54	200
AE6	Angus Creek	19.66	1453	8.2	**75.7**	7.82	300

ANZECC default trigger levels (DTVs) for lowland streams: Electrical conductivity (125-2200 µS/cm), Turbidity (6-50 NTU), pH (6.5-8), Dissolved Oxygen (80-110%). Text in bold indicate those variables that exceed the default trigger values.

3.3.2 Nutrients

Total Nitrogen, Total Phosphorus and Nitrogen Oxides were within ANZECC guidelines for lowland streams (Table 5).

Table 5: Nutrients - laboratory results

Site	Stream	Total Phosphorous (TP) (mg/L)	Total Nitrogen TN (TKN + NOx) (mg/L)	Nitrogen Oxides (NOx) (mg/L)	Total Kjeldahl Nitrogen (TKN) (mg/L)
AE1	Angus Creek	0.05	0.7	0.12	06
AE2	Angus Creek	0.04	0.5	0.07	0.4
AE3	Angus Creek	0.05	0.4	0.04	0.4
AE4	Eastern Creek	0.16	1.2	0.03	1.2
AE5	Eastern Creek	0.18	1.3	0.02	1.3
AE6	Angus Creek	0.06	1.2	0.6	0.6

ANZECC default trigger levels (DTVs) for lowland streams: TP (50mg/L), TN (500 mg/L), NOx (20 mg/L). Text in bold indicate those variables that exceed the default trigger values.

3.4 Macroinvertebrates – SIGNAL 2

SIGNAL2 results for the six sampled sites are provided in Table 6. Raw data is provided in Annex 2.

The number of taxa ranged from 4-11, with the most taxa (11) observed in Angus Creek site AE2 and Eastern Creek Site AE4. The least taxa (4) observed was in Angus Creek site AE6. The SIGNAL2 scores indicate that the creek has a dominance of pollution-tolerant taxa, possibly indicating moderate to severe pollution (Table 3). Only two pollution sensitive macroinvertebrate families, Caddisfly Leptoceridae (SIGNAL 6) and Mites, Acarina (SIGNAL 6), were observed. Leptoceridae were only present at the Eastern Creek sites (AE4 and AE5). While Acarina were only present at AE2 and AE5.

The SIGNAL2 bi-plot (Figure 3), indicates that no sites have favourable habitat and all locations are exhibiting some form of pollution or natural stress. Downstream Angus Creek site AE2 had the highest SIGNAL2 score, with both the upstream sites and downstream sites having lower scores (Table 6).

Table 6: Number of taxa and weighted SIGNAL2 scores

Site	Number of taxa	SIGNAL2 weighted scores
AE1	7	2.7
AE2	11	3.4
AE3	7	2.6
AE4	11	3.0
AE5	8	2.7
AE6	4	3.1

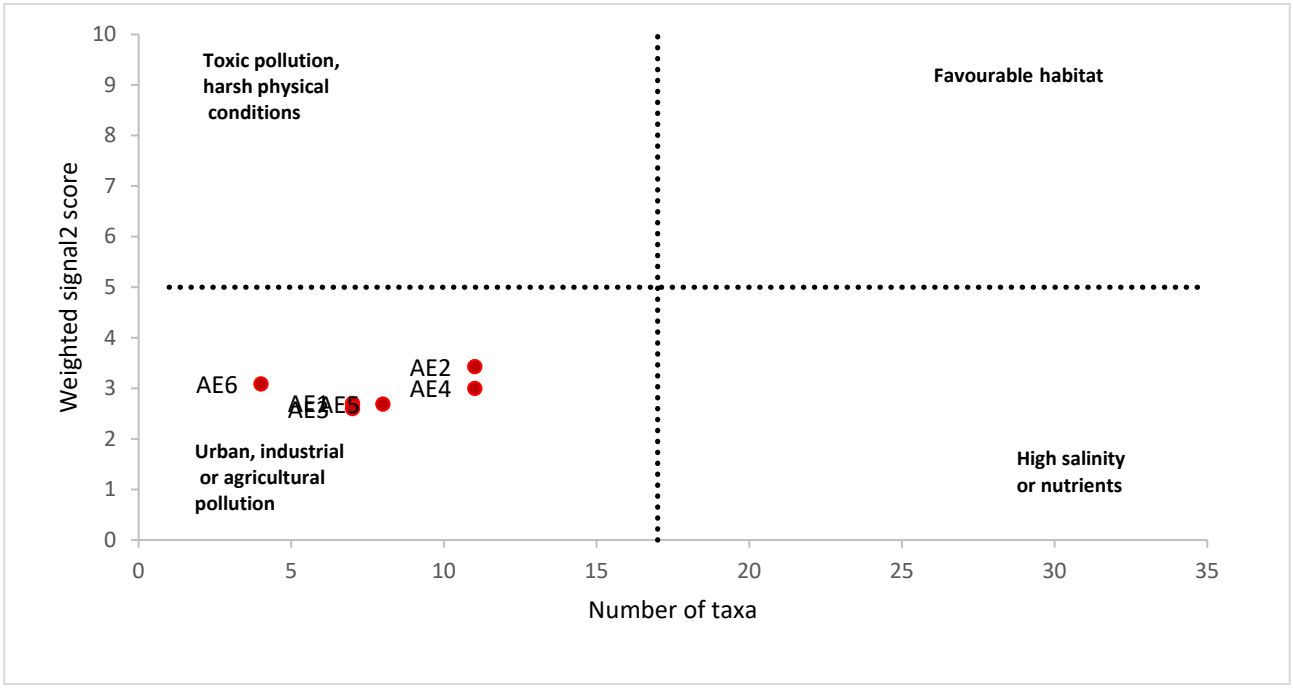

Figure 3: SIGNAL2 score and number of taxa bi-plot.

4. Discussion and Conclusion

With the exception of dissolved oxygen at all sites and turbidity in Eastern Creek, all physiochemical parameters and nutrients analytes were within ANZECC DTVs for all of the six sites surveyed this monitoring period. The water at the time of monitoring was clear, with little to no turbidity observed within Angus Creek but with elevated turbidity observed in the Eastern Creek system. Both Creeks have shown slight levels of bank regrowth and improved bank stability from heavy rainfall events early this year, with Angus Creek showing a high level of regrowth of the riparian vegetation.

Low SIGNAL2 scores (~3) were recorded at all sites however downstream sites mostly had lower scores than upstream sites Additionally, pollution sensitive family macroinvertebrate (Leptoceridae) was only found at the Eastern Creek sites. However, this does not necessarily imply any impact from the RDC and could be related prior high flows or natural variability in a highly disturbed watercourse. Considering the SIGNAL2 scores and the poor water quality and stream health upstream (AE6), it is unlikely that the RDC is affecting stream ecology. Furthermore, there is a variety of upstream impacts and land use activities that are likely to affect the stream and, as such, the low scores observed are likely the result of a combination of natural and anthropogenic catchment stressors, which is common place for intercity stream systems of this nature. There are no physiochemical or ecological evidence suggesting that the RDC is affecting the downstream environment.

References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) National water quality management strategy and assessment guidelines: Australian and New Zealand guidelines for fresh and marine water quality ANZECC/ARMCANZ.

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Turak E., Waddell N. and Johnstone G. (2000) NSW AUSRIVAS Sampling and Processing Manual. Department of Environment and Conservation.

Online resources

http://ausrivas.ewater.com.au/

http://www.mdfrc.org.au/bugguide/

AE1: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE1 UPSTREAM
Riparian	Vegetation	The dominant tree species comprised Swamp Oak (*Casuarina glauca*) and Broad-leaf Privet (*Ligustrum lucidum*). Groundcover was dominated by Wandering Jew (*Tradescantia fluminensis*).
	Stream shading	Moderate shading
	Exotic vegetation	*L. lucidum and T. fluminensis*
Stream characteristics	Modal width	3 metres
	Bank condition	Slightly vegetated banks and stable. Slight erosion of lower bank.
	Substrate	Fine sediments; silt, sand and gravel, large woody debris and organic matter.
	Flow/depth	Low Flow/ ~1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Clear water
Comments		Weeds and rubbish present.

AE2: Angus Creek

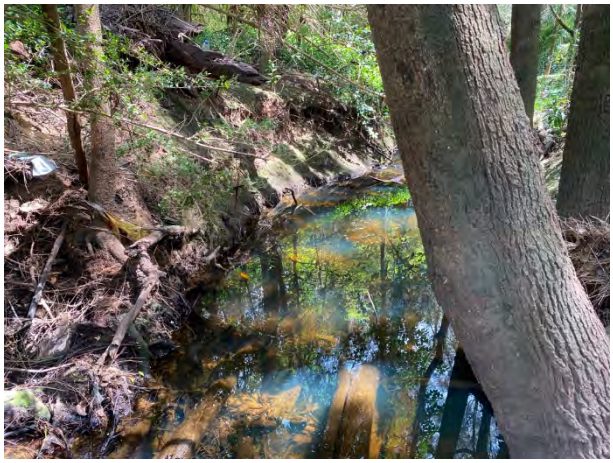
A: upstream

B: Downstream

	Attribute	AE2 DOWNSTREAM
Riparian	Vegetation	Dominant tree species included (*C. glauca*). Dominant groundcover was (*T. fluminensis*) and mixture of exotic and native grasses and herbs.
	Stream shading	Moderate shading
	Exotic vegetation	*T. fluminensis* and other groundcover species.
Stream characteristics	Modal width	2 metres
	Bank Condition	Stable and lightly vegetated
	Substrate	Silt and boulder, large woody debris and organic matter
	Flow/depth	Low flow/<1 metre
	Macrophytes/algae	Emergent macrophytes present – Bulrush (*Typha* sp.), *Cyprus* sp. *Potamogeton crispus*
	Water quality observations	Clear water
Comments		Weeds and rubbish. Significant deer activity on banks and in riparian zone

AE3: Angus Creek downstream

A: Upstream



B: Downstream

	Attribute	AE3 DOWNSTREAM
Riparian	Vegetation	Dominant tree species was *C. glauca*). Dominant grass/herb species was Wandering Jew (*T. fluminensis)*
	Stream shading	Moderate shading
	Exotic vegetation	*L. Lucidum*, *T. fluminensis*
Stream characteristics	Modal width	4 metres
	Bank Condition	Stable, steep, exposed in sections, slight visible erosion.
	Substrate	Fine sediment, organic matter
	Flow/depth	Low flow/~1 metre
	Macrophytes/algae	Ribbon Weed (*Vallisneria* sp.*)*
	Water quality observations	Water clear
Comments		Large amount of plastic rubbish

AE4: Eastern Creek downstream

A: Upstream

B: Downstream

	Attribute	AE4 DOWNSTREAM
Riparian	Vegetation	Dominant canopy species included *C. glauca*) and Prickly-leaved Tea Tree (*Melaleuca styphelioides*). Dominant mid-storey species were *C. glauca L. lucidum*). Dominant groundcover was the exotic *T. fluminensis*
	Stream shading	Moderate
	Exotic vegetation	*L. lucidum* and *T. fluminensis*
Stream characteristics	Modal width	7 metres
	Bank condition	Exposed banks, erosion present since last visit
	Substrate	Fine sediment
	Flow/depth	Low-moderate flow/ >1m
	Macrophytes/algae	Macrophytes not present
	Water quality observations	Very turbid/slight milky colouration
Comments		European Carp present. Significant amount of rubbish in system

AE 5: Eastern Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Dominant overstorey species was *C. glauca*. Dominant grass/herb was Lomandra (*Lomandra longifolia*) and groundcover *T. fluminensis.*
	Stream shading	Moderate
	Exotic vegetation	*T. fluminensis*
Stream characteristics	Modal width	5 metres
	Bank condition	Exposed but stable. No active erosion present.
	Substrate	Fine sediment and large woody debris.
	Flow/depth	Low-moderate flow/ >1 metre
	Macrophytes/algae	Macrophytes not present.
	Water quality observations	Very turbid
Comments		Lots of large woody debris and plastic based rubbish. Evidence of flood debris (picnic table in Angus Creek) European Carp present.

AE 6: Angus Creek upstream

A: Upstream

B: Downstream

	Attribute	AE5 UPSTREAM
Riparian	Vegetation	Riparian vegetation was planted. Dominant tree species was Acacia sp present included eucalypt and melaleuca species. Dominant longifolia. Others species groundcover was L longifolia
	Stream shading	Low
	Exotic vegetation	*Exotic grasses and herbs*
Stream characteristics	Modal width	4 metres
	Bank condition	Sandstone revetment – no erosion
	Substrate	Fine sediment and boulders
	Flow/depth	Low flow and depth
	Macrophytes/algae	Macrophytes present. *Typha* sp. Occupied most of the stream. Algae present
	Water quality observations	Low water level but clear
Comments		Lots of rubbish. Planted riparian vegetation. Exotic fish *Gambusia holbrooki* present

Annex 2 Macroinvertebrate data – November 2020

SITE	AE1	AE2	AE3	AE4	AE5	AE6
Glossophionidae		1	1	1		1
Hydrobiidae	35	35	9	4	2	12
Planorbidae	2					
Physidae	12	1	1			
Oligochaeta	8		31			
Acarina		2			1	
Atyidae				3		
Elmidae				1		
Hydrophilidae		2			1	
Simuliidae		3	1			
Stratiomiyidae		1			1	
Chironominae	30	5	3	8	10	50
Baetidae				1		
Gerridae				3		
Corixidae				33	16	1
Coenagrionidae			5	7	4	
Aeshnidae		1				
Gomphidae	1	1		3		
Leptoceridae				34	1	
Tricladia	8	1				

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Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)

Appendix 3 – Bushland Regeneration Report 2018-2020 by Toolijooa Environmental Restoration

Toolijooa Environmental Restoration

Holcim Australia - Rooty Hill Distribution Centre

Bushland Regeneration Report

2018 – 2020

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1. Summary of Works

Zone	Type of Work	Weed Type	Work Description
JANUARY 2018			
1	Maintenance	Vine	• *Anredera cordifolia* was spot sprayed (using 0.5% Grazon Extra®) on the eastern side of the creek line to control further spread down the creek into established areas.
		Woody	• Woody weeds were sprayed (using 0.5% Grazon Extra®) along the eastern side of the creek line, adjacent to the vehicle bridge. Spraying was the selected treatment due to erosion concerns. Species targeted included *Erythrina x sykesii*, *Ligustrum lucidum*, and *Morus alba*.
	Other	N/A	• All plantings watered in
Depot	Maintenance	Herbaceous	• Herbaceous was hand weeded around recent plantings before being carefully spot sprayed (using 0.6% Starane® Advanced, 1% Roundup Biactive®) through the planting bed adjacent to the office buildings and carparks, from within and around plantings to control seed development through summer. Herbaceous weeds were also sprayed adjacent to the loader parking bay. Species targeted included *Aster subulatus, Conyza spp., Cyperus eragrostis, Cynodon dactylon, Echinochloa crus-galli, Paspalum dilatatum, Setaria* sp., *Solanum nigrum, Sonchus oleraceus* and *Verbena bonariensis*. • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®) along the rails in the eastern section of the access road, around the rail gates (Micks instructions), the unloading buildings (including conveyer belt) and along the outside of the fence line adjacent to Zone 3 (western), moving towards the M7, to control further growth in the summer period and seed production/dispersal. Targeted species included *Anagallis arvensis, Avena* sp., *Bidens pilosa, Chloris gayana, Conyza* spp., *Cortaderia selloana, Cynodon dactylon, Digitaria ciliaris, Echinochloa crus-galli, Foeniculum vulgare, Lactuca serriola, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Pennisetum clandestinum, Setaria* sp., *Sida rhombifolia, Solanum nigrum, Sonchus oleraceus,* and *Verbena bonariensis*.

Zone	Type of Work	Weed Type	Work Description
			• Herbaceous were slashed from around the service box on the southern side of the rail lines, along the road edge from the conveyer belt heading towards the M7 and also around the main entrance gates off Kellogg Rd. These areas were targeted because they are high traffic areas for snakes and pedestrian safety is of concern. Species targeted included *Bidens pilosa, Chloris gayana, Cynodon dactylon, Foeniculum vulgare, Paspalum dilatatum, Pennisetum clandestinum* and *Verbena bonariensis*. • Vegetation was slashed back along the central sound wall to control over growing grasses which allows for a cleaner path for workers to use. • *Conyza* spp. and *Lactuca* sp. were hand weeded from within the planting bed adjacent to the sales yard and access road. • Vegetation was slashed back along the walkways between the office and workshop, and carpark inclusive, to control vegetation from growing further on the pathway, hindering Holcim staff. All pathways were cleaned off using a leaf blower. • Slashed *Medicago sativa* along Snake Alley to inhibit habitat for snakes and to control further flowering/seeding. Sprayed edges (using 2% Roundup Biactive®) along the walkway and both sides of the sediment fence to inhibit further expansion and control seed development/dispersal, targeting *Conyza* spp. and *Medicago sativa*.
FEBRUARY 2018			
1	Maintenance	Herbaceous	• Herbaceous was hand weeded from within and around the recent plantings along the eastern fence line to control further growth and seed production. Species targeted included *Bidens pilosa, Conyza* spp., *Panicum maximum, Paspalum dilatatum, Setaria* sp., *Sonchus oleraceus,* and *Verbena bonariensis*.
Depot	Maintenance	Herbaceous	• Slashed herbaceous along the access road way from the bridge moving towards the eastern sound wall, pushing back 3m (where possible) to eliminate habitat for snake activity. Native plantings and grasses were avoided. Species targeted included *Bidens pilosa, Chloris gayana, Cynodon dactylon, Echinochloa crus-galli, Sonchus oleraceus,* and

Zone	Type of Work	Weed Type	Work Description
			Verbena bonariensis.
			• Grasses were slashed behind the eastern sound wall to the Hume entrance and along the northern fence line to maintain aesthetic appearances and control further seed development. *Chloris gayana* was the target species. • *Typha orientalis* seed heads were removed and collected from patches underneath conveyer belt, drainage line adjacent to the access road and on the east and western side of the unloader building to control further seed and clogging of drainage lines. *T. orientalis* was also cut back underneath the conveyer belt and the drainage lines to stop further seed development this season.
MARCH 2018			
1	Maintenance	Herbaceous	• Herbaceous weeds were slashed through the zone on the western side of the conveyer belt, where previous works have occurred, to control further growth and seed development/spread into high resilient areas. Species targeted included *Aster subulatus, Bidens pilosa, Conyza spp., Onopordum acanthium, Sida rhombifolia, Solanum capsicoides, Solanum pseudocapsicum,* and *Sonchus oleraceus*.
		Woody	• Emerging *Ligustrum sinense* were slashed through the open section on the western side of the conveyer belt, to control growth and to be treated in future visits
3	Maintenance	Herbaceous	• Herbaceous was slashed within the planting bed, and along the road edges on the eastern side of the access road, to control further seed/plant development. Care was taken in between plantings to avoid any damage. Species targeted included *Bidens pilosa, Chloris gayana, Conyza spp., Cynodon dactylon, Paspalum dilatatum, Setaria sp.* and *Verbena bonariensis*.
Depot	Maintenance	Herbaceous	• Continued removal of *Typha orientalis* through the western drainage line, which was previously left due to snake sighting. • Hand weeding and mattock removal of herbaceous weeds and large exotic grass clumps along the road edges of the western drainage line, to control further seed development. Species targeted included *Aster subulatus, Chloris gayana, Conyza spp., Echinochloa crus-galli, Eragrostis*

Zone	Type of Work	Weed Type	Work Description
			curvula and *Verbena bonariensis.* • Exotic grasses were slashed opposite the rail crossing, along the western access road. Species slashed included *Chloris gayana* and *Cynodon dactylon.* • *Juncus acutus* was hand weeded from within the eastern drainage line and adjacent to the drainage under the rails. • Slashed herbaceous weeds through the eastern drainage line (once *C. glauca* were cleared) to control growth and site aesthetics. Species targeted included *Aster subulatus, Bidens pilosa, Conyza* spp., *Chloris gayana* and *Echinochloa crus-galli.*
		Woody	• Stem treated *Casuarina glauca* along the eastern drainage line from the unloader building to the drainage under rail tracks.
APRIL 2018			
Depot	Maintenance	Herbaceous	• Hand weeded herbaceous through the planting bed behind the offices, where *Aster subulatus* was a primary target. Time was taken to ensure no further seed dispersal was possible, by cutting and painting larger seeding stems instead of hand pulling. Cleared emerging weeds from around past plantings. Larger grasses were also hand weeded from around plantings and groundcovers. Species targeted included: *Aster subulatus, Conyza* sp., *Senecio madagascariensis,* and *Sonchus oleraceus.* • Spot sprayed herbaceous (using 2% Roundup Biactive®) through the planting bed behind the offices, around the workshop, road edges around refuelling station, along the western wall of the concrete plant and along the access road behind the sales yard sound wall to the conveyer belt. Species targeted included: *Aster subulatus, Bidens pilosa, Chloris gayana, Conyza* spp., *Cynodon dactylon, Digitaria ciliaris, Eragrostis curvula, Euphorbia peplus, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus,* and *Solanum nigrum.* • Hand weeded through the planting bed adjacent to the sales yard and access road entrance. Targeted species included *Bidens pilosa,*

Zone	Type of Work	Weed Type	Work Description
			Echinochloa crus-galli, and *Sonchus oleraceus.* • Brush cut adjacent to the main gates, along the top slope of the northern fence line, along the centre sound wall (adjacent to water cart fill station), along the access road (from sound wall to bridge) and in the western corner (adjacent to the M7), to control growth and further inhibit seed production and dispersal. Targeted species included *Bidens pilosa, Conyza* spp., *Chloris gayana, Cynodon dactylon, Eragrostis curvula, Paspalum dilatatum, Sonchus oleraceus,* and *Verbena bonariensis.* • Slashed and sprayed along Snake Alley, along the walk way and against the concrete barriers (using 2% Roundup Biactive®). This included along the sediment fence on both sides. Species targeted included *Conyza* spp., *Medicago sativa,* and *Sonchus oleraceus*.
MAY 2018			
3	Maintenance	Herbaceous	• Exotic grasses were slashed and sprayed (using 1.5% Roundup Biactive®) along the fence line adjacent to the access road (eastern section) and also adjacent to Zone 2 (western) behind the created planting bed. Species targeted included: *Chloris gayana, Paspalum dilatatum, Paspalum urvillei,* and *Setaria* sp.
Depot	Maintenance	Herbaceous	• Herbaceous was spot sprayed (using 1.5% Roundup Biactive®) along all access roads (from sales yard to unloader building), along both sides of the conveyer belt, around the unloader building and walkways, around all conveyer belt buildings, along the road edges to western corner (M7) including rail line at western corner and also through the eastern drainage line (where are was previously cleared of woody weeds and slashed to control *Typha orientalis*). Spraying was also conducted along the central sound wall adjacent to the truck yard. Target species included *Andropogon virginicus, Aster subulatus, Bidens pilosa, Chloris gayana, Chloris virgata, Conyza spp., Cynodon dactylon, Eragrostis curvula, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Setaria sp. Sonchus oleraceus, Taraxacum officinale,* and *Verbena bonariensis*. • Herbaceous weeds were spot sprayed (using 1/5% Roundup Biactive®) along the back sides of all stock

Zone	Type of Work	Weed Type	Work Description
			piles, bays, and along the entrance road to sales yard, to control weed growth and ensure no materials end up inside the product. Species targeted include; *Andropogon virginicus, Chloris gayana, Conyza* spp., *Onopordum acanthium, Phytolacca octandra, Senecio pterophorus, Setaria* sp., *Solanum capsicoides, Solanum nigrum,* and *Sonchus oleraceus*. • *Pennisetum setaceum* were mattock removed from behind the stock piles. All seeds were bagged and disposed of accordingly. • *Medicago sativa* was slashed down from Snake Alley, from the refuelling station to the end of the sales yard, to ground level to stop further growth and flowering/seeding.
		Woody	• *Casuarina glauca* and *Eucalyptus* spp. trees were removed from within and behind the stock piles, surrounding bays, and entrance road into the sales yard.
JULY 2018			
1	Maintenance	Herbaceous	• Herbaceous weeds were slashed from within the recent planting bed in the south-eastern corner of the zone, adjacent to the eastern fence line, to control and inhibit further weed growth and seed development/dispersal. Species targeted included; *Bidens pilosa, Conyza* spp., *Sida rhombifolia,* and *Sonchus oleraceus.* • *Solanum pseudocapsicum* (large) were stem treated and fruits collected in the south western side of the creek line, to inhibit seed being eaten by birds and spread further. • Herbaceous weeds were spot sprayed (using 0.9% Starane® Advanced + 1g/10L Associate®) throughout the south western side of the creek line from the conveyor belt to the western fence line, controlling growth and seed development within resilient areas. Species targeted included; *Bidens pilosa, Conyza* spp., *Onopordum acanthium, Senecio pterophorus, Sida rhombifolia, Solanum nigrum, Solanum pseudocapsicum,* and *Tradescantia fluminensis.* • Herbaceous weeds were spot sprayed (using 0.9% Starane® Advanced + 1g/10L Associate®) on the

Zone	Type of Work	Weed Type	Work Description
			north eastern side of the creek line from the conveyor belt to the retention dam. Species targeted included; *Bidens pilosa, Onopordum acanthium, Senecio madagascariensis,* and *Sida rhombifolia.*
		Vine	• Exotic vines were spot sprayed (using 0.9% Starane® Advanced + 1g/10L Associate®) throughout the south western and north western sides of the creek line, with a focus on *Asparagus asparagoides*. Other species targeted included; *Acetosa sagittata, Anredera cordifolia, Araujia sericifera*.
		Woody	• Re-emerging woody weeds were stem treated on the south-western side of the creek line, to inhibit further growth in resilient areas. Species targeted included: *Melia azedarach, Ricinus communis,* and *Solanum mauritianum*.
2a	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.9% Starane® Advanced + 1g/10L Associate®) through the zone, with a focus on the western fence line, to control growth. Species targeted included *Onopordum acanthium* and *Senecio madagascariensis*.
		Vine	• Asparagus asparagoides was heavily targeted by means of spot spraying (using 0.9% Starane® Advanced + 1g/10L Associate®) within the zone, to control growth and flowering.
2b	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.9% Starane® Advanced + 1g/10L Associate®) in the south western side of the creek line, with a focus on the western boundary fence line, to control and inhibit further growth and seed dispersal. Species targeted included; *Bidens pilosa, Onopordum acanthium,* and *Solanum pseudocapsicum*. • *Bryophyllum delagoense* was targeted by spot spraying (using 0.9% Starane® Advanced + 1g/10L Associate®) in the south western section of the zone, adjacent to the conveyer belt. • *Eragrostis curvula* was mattock removed in the south eastern side of the creek line, adjacent to the *Grevillea juniperina* stands.
		Vine	• *Asparagus asparagoides* was heavily targeted by means of mattock removal on the south eastern side of the creek line, through established shrubs

Zone	Type of Work	Weed Type	Work Description
			and expanding groundcovers.
3	Maintenance	Herbaceous	• Herbaceous weeds were sprayed along the northern border of the zone adjacent to Zone 2b, to control growth and further spread into the existing planting bed. Species targeted included: *Onopordum acanthium, Plantago lanceolata,* and *Senecio pterophorus*.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were slashed around the main front gates, along the northern fence line (adjacent to Hume gate), behind the eastern sound wall to the access road to rails and along the northern section of the retention basin (near Snake Alley). Species targeted included; *Bidens pilosa, Chloris gayana, Cynodon dactylon, Eragrostis curvula, Pennisetum clandestinum, Sonchus oleraceus,* and *Verbena bonariensis.* • Herbaceous weeds and exotic grasses were spot sprayed (using 1.5% Roundup Biactive®) along Snake Alley, behind the eastern sound wall (along the wall itself and along the drainage line), along the northern fence line, along the access road to the bridge, underneath the bridge on the southern side and around the fuel station, to control and inhibit further growth and seed development. Species targeted included; *Bidens pilosa, Brassica* spp., *Chloris gayana., Conyza* spp., *Eragrostis curvula, Medicago sativa, Senecio madagascariensis* • *Cortaderia selloana* was de-seeded then sprayed (using 1.5% Roundup Biactive®) along the northern fence line, behind the sound wall, to control further growth. • Tall seeding herbaceous weeds were hand weeded through the main planting bed behind the office building, to control further development and seed dispersal. Species targeted included *Onopordum acanthium* and *Sonchus oleraceus.* • Herbaceous was spot sprayed (using 0.9% Starane® Advanced) through the planting bed behind the office, including around the workshop. Species targeted included; *Anagallis arvensis, Aster sp., Conyza sp., Modiola caroliniana, Onopordum acanthium, Senecio madagascariensis,* and *Sonchus oleraceus.*

Zone	Type of Work	Weed Type	Work Description
			• *Pennisetum setaceum* were mattock removed from behind the office building. All seeds were bagged and disposed of accordingly. • *Cynodon dactylon* was slashed back from around plantings within the planting bed, adjacent to the footpath to the workshop. • Over-hanging vegetation was cut back along the footpath to the workshop, allowing for an uninterrupted walk. Path way cleaned off by use of a blower.
AUGUST 2018			
2b	Maintenance	Herbaceous	• *Chlorophytum comosum* was spot sprayed (using 1.5% Roundup Biactive®) adjacent to parking bay past the bridge, to control further growth and eliminate from within the bushland.
		Vine	• Further continued to remove *Asparagus asparagoides* by means of mattock removal on the south eastern side of the creek line, through established shrubs and expanding groundcovers.
Depot	Maintenance	Herbaceous	• Exotic grasses were slashed around both retention basins to control further seed dispersal and allow native grasses and shrubs to expand. Targeted species included: *Chloris gayana, Cynodon dactylon,* and *Eragrostis curvula.* • Herbaceous weeds were spot sprayed (using 1% Roundup Biactive®) along the western wall behind the concrete plant, behind truck parking and along the bunds surrounding the plant and Snake Alley. Species targeted include; *Anagallis arvensis, Aster subulatus, Bidens pilosa, Brassica* sp., *Chloris gayana, Conyza* spp., *Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Paspalum urvillei, Senecio madagascariensis, Sonchus oleraceus,* and *Verbena bonariensis.*
		Woody	• *Casuarina glauca* was removed from the eastern basin edges and drainage edges to allow the established shrubs to expand and not be out competed. • *Acacia saligna* was stem treated on the lower section of the bund, adjacent to Snake Alley.

Zone	Type of Work	Weed Type	Work Description
SEPTEMBER 2018			
Depot	Maintenance	Herbaceous	• Exotic grasses and herbaceous weeds were slashed along the northern entrance kerb (lower slope) to eastern sound wall, around the main gates and water valves, along the side road to the concrete plant and on top of the western bund to inhibit further growth and seed development/dispersal. Species targeted included: *Chloris gayana, Cynodon dactylon, Eragrostis curvula, Lolium rigidum, Paspalum dilatatum, Setaria* sp., *Sonchus oleraceus,* and *Verbena bonariensis.* • Herbaceous was hand weeded through the planting beds adjacent to the office building and carpark, to control seed development and also from around plantings as to not be accidentally sprayed. Species targeted included: *Conyza* sp., *Lactuca serriola, Solanum nigrum,* and *Sonchus oleraceus.* • Herbaceous weeds were sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) through the planting beds surrounding the office building, lunch rooms, workshop, road edges (all depot), along the western bund (all sides), around the main gates and water valves, along the central sound wall and pugmill, behind the eastern sound wall (from the access road to Hume), through the planting bed at the start of the access road, behind the first stockpile adjacent to access road, the whole access road including around the conveyer belt (both sides and underneath), electrical buildings, unloader building, along the rail lines and pathways (adjacent to the drainage lines and rails). Targeted species included; *Anagallis arvensis, Bidens pilosa, Brassica* sp., *Chloris gayana, Conyza* sp., *Cynodon dactylon, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Tall/large *Onopordum acanthium* were stem treated across the concrete plant bund (on all sides) to inhibit further growth and seed development/dispersal.

Zone	Type of Work	Weed Type	Work Description
		Woody	• Emerging native shrubs/trees were stem treated along the pathway adjacent to the drainage lines and rail lines, to inhibit further growth and interference to train and rail staff. Species targeted included *Casuarina glauca* and *Melaleuca decora*.
	Other	N/A	• Rubbish was collected across the whole depot including along all road edges and especially around the main gates.
OCTOBER 2018			
1	Maintenance	Herbaceous	• *Pennisetum clandestinum* was slashed below the concrete wall/conveyer belt, to allow for easier spraying in November and to allow native groundcovers/shrubs the potential to grow and expand. • Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®) adjacent to the bridge and creek line in the southeast section of the zone, to control further growth and further seed development. Species targeted included; *Bidens pilosa, Brassica* sp., *Conyza* spp., *Galium aparine, Lactuca serriola, Medicago* sp., *Sonchus oleraceus,* and *Solanum nigrum*
		Vine	• *Araujia sericifera* were hand weeded through the northeast section of the zone, to inhibit further growth through established shrubs.
		Woody	• *Grevillea robusta* was drilled within the southwest section of the zone adjacent to the conveyer belt and drainage line. • Juvenile *Ligustrum sinense* was slashed below the concrete wall/conveyer belt, to control growth.
2b	Maintenance	Herbaceous	• Isolated *Chloris gayana* and *Paspalum dilatatum* was spot sprayed (using 2% Roundup Biactive®) through the grassland to inhibit further growth through native grasses. • Herbaceous weeds were spot sprayed (using 1g/10L Associate® + 0.6% Starane Advanced®) through the planting bed adjacent to the eastern fence line, to inhibit further growth and to control further seeding potential. Species targeted included; *Brassica* sp., *Conyza* sp., *Onopordum acanthium,* and *Verbena bonariensis.*

Zone	Type of Work	Weed Type	Work Description
3	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®; 2% Roundup Biactive®) through the planting bed in the eastern section, to inhibit further growth and seed development/dispersal, this also includes around recent plantings. Species targeted included; *Conyza* spp., *Medicago* sp., *Onopordum acanthium, Plantago lanceolata,* and *Sonchus oleraceus.* • Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®; 2% Roundup Biactive®) along the fence line and access road to the western fence line, to inhibit further growth and seed development within high resilient areas. Species targeted included; *Bidens pilosa, Conyza* spp., *Onopordum acanthium, Sonchus oleraceus,* and *Solanum nigrum.* • *Cortaderia selloana* and *Juncus acutus* were mattock removed from within the planting bed in the southern section of the zone, to inhibit growth and further seed development.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were slashed through Snake Alley and the lower slope of the concrete bund. Sprayed (using 2% Roundup Biactive®) to ensure no growth of *Medicago sativa* and to also ensure no snakes are within the vegetation adjacent to the pedestrian walkway. Other species treated included *Conyza* sp. • Herbaceous weeds were sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) through the planting beds surrounding the office building, lunch rooms, workshop, road edges (all depot), along the western bund (all sides), around the main gates and water valves, along the central sound wall and pugmill, through the planting bed at the start of the access road, the whole access road including around the conveyer belt (both sides and underneath), electrical buildings, unloader building, along the rail lines and pathways (adjacent to the drainage lines and rails) also in the western corner adjacent to the M7, especially along the road edges. Targeted species included; *Anagallis arvensis, Bidens pilosa, Brassica* sp., *Chloris gayana, Conyza* sp., *Cynodon dactylon, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia,*

Zone	Type of Work	Weed Type	Work Description
			Senecio madagascariensis, Setaria sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis*. • Exotic grasses were slashed in the western corner adjacent to the M7 to control growth and to inhibit snake activity in the area during warmer weather conditions. Species targeted included, *Chloris gayana* and *Eragrostis curvula* • *Juncus acutus* was removed through the drainage line on the southern side of the rail line, with all seed removed and bagged. • Large *Cortaderia selloana* and *Onopordum acanthium* were removed from within the planting bed adjacent to the eastern access road, to inhibit further growth and seed development.
		Woody	• *Casuarina glauca* was removed along the rail line/drainage line from the unloader building moving east to the exit gates, to control growth and expansion onto the rail line and also inhibit any structural damage caused by the root system. • *Casuarina glauca* was also removed through the planting bed adjacent to the eastern access road, to allow for existing shrubs and canopy to grow and expand in the planting bed
NOVEMBER 2018			
All	Other	N/A	• Conducted a plant survey across previously revegetated areas.
Depot	Maintenance	Herbaceous	• Herbaceous weeds along Snake Alley were re-sprayed (using 1.5% Roundup Biactive) to ensure no growth of *Medicago sativa* and to also ensure no snakes are within the vegetation adjacent to the pedestrian walkway. The lower slope of the Concrete bund was also slashed to control exotic grasses and herbaceous weed growth, to the sediment fence. Species slashed included, Conyza sp., *Hypericum perforatum,* and *Medicago sativa.* • Herbaceous weeds were sprayed (using 1.5% Roundup Biactive®) along the pathway from the office building to the workshop, road edges (surrounding the fuel container), along the central sound wall (especially around the loader parking), through the drainage lines (rocks) leading from the

Zone	Type of Work	Weed Type	Work Description
			concrete plant into the western retention basin, the access road (from the sales yard to the bridge) and underneath the bridge on the eastern side, to inhibit further development of seed and possible seed dispersal. The lower section of the eastern retention basin was also sprayed on the slope and rocks adjacent to the access road bridge. Targeted species included: *Anagallis arvensis, Bidens pilosa, Chloris gayana, Conyza* sp., *Cynodon dactylon, Echinochloa crus-galli, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Exotic grasses and herbaceous weeds were slashed surrounding both retention basins to control growth of weeds along the road edges and to inhibit snake activity in high pedestrian areas (especially the eastern basin). Species targeted included: *Chloris gayana, Conyza* spp., *Eragrostis curvula, Echinochloa crus-galli, Hypericum perforatum, Medicago sativa, Onopordum acanthium, Paspalum dilatatum, Solanum nigrum,* and *Sonchus oleraceus.* • Follow up on *Juncus acutus* was undertaken through the drainage line behind the unloader building moving east. • Exotic grasses were heavily targeted within the western drainage line adjacent to the rails, as well as tall herbaceous weeds, to inhibit further growth within the drainage line and allow for aquatic species growth. Species targeted included *Chloris gayana, Conyza* spp., *Cortaderia selloana, Eragrostis curvula, Lactuca serriola, Paspalum dilatatum, Sonchus oleraceus,* and *Verbena bonariensis*.
		Woody	• *Casuarina glauca* was removed along the rail line/drainage line from the unloader building moving west to the crossing gates, to control growth and expansion onto the rail line and also inhibit any structural damage caused by the root system.
DECEMBER 2018			
1	Maintenance	Herbaceous	• Exotic grasses were sprayed throughout the western

Zone	Type of Work	Weed Type	Work Description
			side of the zone, from within and around areas of high resilience, to control further growth and seed dispersal within the area. Species targeted included *Eragrostis curvula* and *Paspalum dilatatum*. • Herbaceous weeds were slashed within the eastern side of the zone, adjacent to the creek line, to control herbaceous growth and inhibit further seed development/dispersal within the area. Species targeted included: *Bidens pilosa, Onopordum acanthium, Sida rhombifolia, Sonchus oleraceus,* and *Verbena bonariensis*. • Herbaceous weeds were slashed within and around the planting bed, in the SE section of the zone, adjacent to the eastern fence line, to control growth and allow for further plant development. Species targeted included *Setaria* sp. and *Verbena bonariensis*.
		Vine	• *Araujia sericifera* was stem treated on the western side of the conveyer belt, from within existing shrubs and canopy, to control further growth and flowering.
2a	Maintenance	Herbaceous	• Herbaceous weeds were sprayed within the zone, from within areas of high resilience, to control further growth and seed development/dispersal within the area, and to allow for groundcover expansion where available. Species targeted included: *Chloris gayana, Eragrostis curvula,* and *Paspalum dilatatum*
2b	Maintenance	Herbaceous	• *Paspalum dilatatum* was reduced by mattock removal adjacent to the back access road parking bay, within areas of high resilience and native groundcovers. • Herbaceous weeds were slashed along the eastern fence line, adjacent to Nurragingy Reserve, moving north into Zone 1. Species targeted included: *Paspalum dilatatum*, *Setaria* sp., *Sida rhombifolia,* and *Verbena bonariensis.*
3	Maintenance	Herbaceous	• Exotic grasses and herbaceous weeds were slashed within and around the planting bed, adjacent to the access road and Nurragingy Reserve. Species targeted included; *Cynodon dactylon, Paspalum dilatatum, Setaria* sp., and *Verbena bonariensis.*
Depot	Maintenance	Herbaceous	• Herbaceous weeds were re-sprayed (using 1.5% Roundup Biactive®) and slashed along the

Zone	Type of Work	Weed Type	Work Description
			pedestrian walkway and Snake Alley. Species treated included *Conyza* sp., and *Portulaca olearacea*. • Herbaceous weeds were sprayed (using 1.5% Roundup Biactive®; 0.6% Starane® Advanced) along the pathway from the office building to the workshop, through the office building planting beds, office carpark, western concrete wall (behind the concrete plant), western bund along the side road, road edges (surrounding the fuel container), back access road to unloader buildings, surrounding the unloader buildings, through the planting bed along the eastern access road and in the western corner along the road to M7, to inhibit growth and seed development/dispersal. Targeted species included; *Anagallis arvensis, Bidens pilosa, Chloris gayana, Conyza* sp., *Cynodon dactylon, Echinochloa crus-galli, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Herbaceous weeds and exotic grasses were hand weeded surrounding the electrical boxes, from underneath existing shrubs and within sprawling groundcovers. Species targeted included: *Aster* sp., *Ehrharta erecta,* and *Tragopogon porrifolius*. • *Pennisetum setaceum* was mattock removed from within the office planting bed, in various locations to inhibit seed dispersal. • Slashed the northern fence line from the main gates, including behind the eastern sound wall to the back access road. Species targeted included: *Bidens pilosa, Brassica* spp., *Chloris gayana, Cynodon dactylon, Eragrostis curvula, Sida rhombifolia,* and *Sonchus oleraceus.* • Exotic grasses were slashed in the M7 corner of the access road, to control growth along road edges and inhibit snake activity in the area. Species targeted included *Chloris gayana*, and *Eragrostis curvula*. • *Typha orientalis* and other herbaceous weeds were slashed within the eastern drainage line, adjacent to the rail lines, to inhibit growth and seed

Zone	Type of Work	Weed Type	Work Description
			development. Other species targeted included; *Aster* sp., *Conyza* sp., and *Verbena bonariensis*.
		Woody	• *Casuarina glauca* was stem treated within the office planting bed, adjacent to the southern exit and walk way.
JANUARY 2019			
1	Maintenance	Woody	• Woody weeds were sprayed (using 0.5% Grazon Extra®) along the creek line, adjacent to the bridge on both sides, to control growth and seed development. Species targeted included: *Casuarina glauca, Cestrum parqui, Erythrina x sykesii, Ligustrum lucidum,* and *Senna pendula*.
3	Maintenance	Woody	• Overhanging branches were trimmed back adjacent to the front gates and main road, especially surrounding the water valves and on the curve, to improve visibility for drivers.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) along the pathway from the office building to the workshop, through the office building planting beds, office carpark, western concrete wall (behind the concrete plant), road edges (surrounding the fuel container), and along the central sound wall from the pugmill to loader parking, to inhibit growth and seed development/dispersal and allow clear pathways. Targeted species included: *Anagallis arvensis, Bidens pilosa, Chloris gayana, Conyza* sp., *Cynodon dactylon, Echinochloa crus-galli, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Herbaceous weeds and exotic grasses were hand weeded within the planting beds surrounding the main office buildings, from within and around established shrubs and plantings to allow for a follow up spray to be conducted. Species targeted included: *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chloris gayana, Conyza* sp., *Digitaria ciliaris, Echinochloa crus-galli, Lactuca serriola, Paspalum dilatatum, Senecio madagascariensis, Setaria* sp., and *Sonchus oleraceus*. • Vegetation along the northern fence line was slashed from the main gates, to control growth and seed development. Other areas slashed included surrounding the air quality control monitor in the

Zone	Type of Work	Weed Type	Work Description
			centre of the depot and along the central sound wall from pugmill to loader parking. Species targeted included: *Bidens pilosa, Brassica* spp., *Chloris gayana, Cynodon dactylon, Eragrostis curvula, Sida rhombifolia,* and *Sonchus oleraceus*. • *Cynodon dactylon* patches were slashed to the ground within the planting bed surrounding the main office. • Pathways from the main office to the workshop and lunch room were trimmed and cleared of all debris. • Exotic grasses and herbaceous weeds were slashed on the front edges of the retention basins, to inhibit snake activity near pedestrian areas, and also behind the eastern sound wall, especially in the southern areas where access has become overgrown. Species targeted included: *Bidens pilosa, Chloris gayana, Cynodon dactylon, Eragrostis curvula, Paspalum dilatatum,* and *Solanum capsicoides*. • Overgrown vegetation was slashed through the eastern drainage line to inhibit seed development. Species targeted included *Echinochloa crus-galli* and *Typha orientalis*. • Herbaceous weeds and exotic grasses were sprayed (using 2% Roundup Biactive® or 0.6% Starane Advanced®) along the access road from the sales yard to the rail line, including around/underneath the conveyor belt and surrounding buildings. Additionally, the eastern and western drainage line was also sprayed along the footpath edge to control weed growth and seed development. Species targeted included; *Aster* sp., *Conyza* spp., *Echinochloa crus-galli, Lactuca serriola, Solanum capsicoides, Solanum nigrum,* and *Sonchus oleraceus*. • Herbaceous weed and grasses were sprayed (using 2% Roundup Biactive®) at the train exit gates, adjacent to the site boundaries, to inhibit growth around gates which can impede gate movement. Species targeted included: *Bidens pilosa, Paspalum dilatatum,* and *Pennisetum clandestinum*.
		Woody	• Overhanging branches were cut back off the access road, behind the sales yard sound wall, to improve traffic flow.

Zone	Type of Work	Weed Type	Work Description
FEBRUARY 2019			
2b	Maintenance	Herbaceous	• *Arundo donax* removal began along the eastern fence line to create passage ways along the fence and to inhibit further spread into high resilient areas.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were sprayed (using 1.5% Roundup Biactive) between the pedestrian walkway and sediment fence of Snake Alley. Species treated included *Conyza* sp. and *Portulaca olearacea*. • Herbaceous weeds were sprayed (using 1.5% Roundup Biactive®; 0.6% Starane® Advanced) along the pathway from the office building to the workshop, through the office building planting beds, office carpark, road edges (surrounding the fuel container), along the central sound wall from the pugmill to loader parking, around the air filter adjacent to the truck parking and along the road edges from Hume to the main gates, to inhibit growth and seed development/dispersal, and allow clear pathways for workers to use with ease. Targeted species included; *Anagallis arvensis, Aster* sp.*, Bidens pilosa, Chloris gayana, Conyza sp., Cynodon dactylon, Echinochloa crus-galli, Ehrharta erecta, Eragrostis curvula, Lactuca serriola, Lolium rigidum, Medicago sativa, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp.*, Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Pathways from the main office to the workshop and lunch room were trimmed and pathways cleaned of all debris. • Herbaceous weed and grasses were sprayed (using 1.5% Roundup Biactive®) through the planting bed at the start of the access road, to main a clear space for upcoming plantings. Herbaceous weeds were also sprayed along the access road edges to the bridge to inhibit growth of developing species. Species targeted included: *Conyza* spp., *Cyperus rotundus, Melinis repens, Modiola caroliniana, Paspalum dilatatum,* and *Setaria* sp. • Herbaceous weeds were spot sprayed using 0.6% Starane® Advanced) adjacent to the creek line to inhibit further growth and seed development within the area. Species targeted included: *Amaranthus*

Zone	Type of Work	Weed Type	Work Description
			sp., Bidens pilosa, Onopordum acanthium, Solanum nigrum, and *Sonchus oleraceus.* • Herbaceous weeds and exotic grasses were sprayed (using 1.5 % Roundup Biactive®) from the eastern end of the rails to the unloader building, to control weed density and growth through the drainage line, and to eliminate habitat for snake activity. Species targeted included; *Chloris gayana, Conyza spp., Cynodon dactylon, Echinochloa crus-galli, Paspalum dilatatum, Typha orientalis,* and *Verbena bonariensis.*
		Woody	• Canopy trees were removed within the planting bed at the start of the access road, in accordance to the Structural Audit conducted on the depot, as to not cause damage to the sound wall as the roots develop.
MARCH 2019			
1	Maintenance	Herbaceous	• Herbaceous weeds and exotic grasses were slashed within and surrounding the planting bed, to inhibit further growth and seed development, and allow for plantings to grow further. Species targeted included: *Bidens pilosa, Paspalum dilatatum, Sida rhombifolia*, and *Sonchus oleraceus*. • Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®) within the south-western side of the area, with a focus adjacent to the creek line and through resilient areas. Species targeted included: *Bidens pilosa, Brassica* sp., *Conyza* spp., *Onopordum acanthium, Sida rhombifolia, Sonchus oleraceus,* and *Verbena bonariensis*.
		Woody	• *Arundo donax* was stem treated in the northern section of the zone, adjacent to the eastern fence line from within the planting bed, to inhibit further growth and allow for native plant growth.
2b	Maintenance	Herbaceous	• *Paspalum dilatatum* was heavily targeted by means of mattock removal through the grassland adjacent to the access road and eastern fence line; from within areas of high resilience to inhibit further seed development/dispersal and allow for groundcover expansion of native species. *Chloris gayana* was also targeted on the front edges. • Herbaceous weeds from within native groundcovers were also hand weeded to inhibit growth and seed

Zone	Type of Work	Weed Type	Work Description
			development. Species targeted included: *Bidens pilosa, Solanum pseudocapsicum,* and *Sonchus oleraceus.* • *Bryophyllum delagoense* was sprayed using 0.6% Starane Advanced®) within the south-western side of the area, through shrubs to inhibit further growth and seeding.
3	Maintenance	Herbaceous	• Herbaceous weeds and exotic grasses were slashed in the south-eastern corner planting bed, adjacent to the access road, to improve depot aesthetics and to inhibit further weed growth surrounding plantings. Species targeted included: *Chloris gayana, Paspalum dilatatum*, and *Verbena bonariensis.* • Herbaceous weeds and exotic grasses were spot sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) on the south-western side, through the open area and adjacent to the road edges to inhibit further growth and allow for native species expansion. Species targeted included; *Chloris gayana, Cynodon dactylon, Eragrostis curvula, Euphorbia spp., Paspalum dilatatum,* and *Sonchus oleraceus.*
Depot	Maintenance	Herbaceous	• Herbaceous weeds were sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) surrounding the main entrance gates, along the concrete plant western wall, surrounding the workshop and adjoining pathways, pathway to the concrete plant and fuel containers, to ensure no further growth and improve depot aesthetics for CEO visit. Targeted species included: *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chloris gayana, Conyza sp., Cynodon dactylon, Echinochloa crus-galli, Lolium rigidum, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis.* • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®; 0.6% Starane Advanced®) along both sides of the conveyer belt, surrounding the unloader buildings, and along the access road, to inhibit growth and seed development and improve depot aesthetics. Species targeted included; *Conyza* spp., *Brassica* spp., *Chloris gayana, Echinochloa crus-galli, Setaria* sp., and

Zone	Type of Work	Weed Type	Work Description
			Sonchus oleraceus.
		Vine	• Passiflora suberosa was spot sprayed (using 2% Roundup Biactive®) at the main entrance gates to inhibit further growth on fence line or sign poles.
APRIL 2019			
1	Maintenance	Herbaceous	• Herbaceous weeds were slashed throughout the eastern section of the zone, north and south of the creek line, and also on the western section southwest of the creek line, to manage growth of herbaceous weeds and control further seed development and dispersal in the area. All regrowth will be sprayed during May. Species targeted included; *Bidens pilosa, Conyza* spp., *Ochna serrulata, Paspalum dilatatum, Pavonia hastata, Senecio madagascariensis, Sida rhombifolia, Solanum nigrum, Solanum pseudocapsicum, Solanum capsicoides,* and *Verbena bonariensis*.
		Woody	• Woody weeds were slashed throughout the zone, to control growth and seed development. All regrowth is to be sprayed throughout May. Species targeted included: *Erythrina crista-galli, Ligustrum lucidum, Ligustrum sinense,* and *Solanum mauritianum*.
2b	Maintenance	Herbaceous	• Herbaceous weeds were slashed through the zone in the eastern and western sections, to manage growth of exotic weeds and control further seed development and dispersal within the area. All regrowth within the slashed sections will be sprayed in May. Species targeted included; *Bidens pilosa, Conyza* spp., *Paspalum dilatatum, Pavonia hastata, Senecio madagascariensis, Sida rhombifolia, Solanum nigrum, Solanum pseudocapsicum, Solanum capsicoides,* and *Verbena bonariensis*. • Exotic grasses were slashed surrounding areas of native resilience within the south western section of the zone, to help promote native growth and expansion. Species targeted included *Eragrostis curvula* and *Paspalum dilatatum*.
3	Maintenance	Herbaceous	• *Chloris* spp. was slashed in the western section adjacent to the conveyor belt and along the border of Zone 2, to inhibit further growth and seed dispersal. • Vegetation was slashed back along the front edge of the zone, adjacent to the access road, to stop

Zone	Type of Work	Weed Type	Work Description
			the encroachment of vegetation onto the road.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were sprayed (using 0.6% Starane Advanced®) between the pedestrian walk way and sediment fence to the shed of Snake Alley. Species treated included *Conyza* sp. and *Medicago sativa*. • Herbaceous weeds were sprayed (using 1% Roundup Biactive®; 0.6% Starane Advanced®) surrounding the main entrance gates, surrounding the workshop and adjoining pathways, along the top and eastern sides of the western bund adjacent to the road edge, and along the central sound wall and loader parking, to ensure no further growth and improve depot aesthetics. Targeted species included; *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chloris gayana, Conyza* sp., *Cynodon dactylon, Echinochloa crus-galli, Lolium rigidum, Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Sida rhombifolia, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Plantago lanceolata,* and *Verbena bonariensis*. • Herbaceous weeds and exotic grasses were slashed along the northern fence line and slope, from the main entrance gates to the side gate, to control further seed development and growth, thus improving depot aesthetics. Species targeted included; *Chloris gayana, Eragrostis curvula, Paspalum dilatatum,* and *Verbena bonariensis*. • Herbaceous weeds and exotic grasses were hand weeded and spot sprayed (using 1% Roundup Biactive®; 0.6% Starane Advanced®) through the main planting bed surrounding the office buildings, to control further seed dispersal and growth through areas of resilience. Species targeted included; *Aster* sp., *Bidens pilosa, Chloris gayana, Conyza* spp., *Digitaria ciliaris, Euphorbia* spp., *Modiola caroliniana, Paspalum dilatatum, Pennisetum clandestinum, Solanum nigrum,* and *Sonchus oleraceus*.
		Vine	• *Vicia* sp. was spot sprayed through the planting beds surrounding the main office building.
MAY 2019			
1	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed using 0.6% Starane Advanced® where previously slashed,

Zone	Type of Work	Weed Type	Work Description
			throughout the eastern section of the zone, and also on the western side, south of the creek line, to manage growth of herbaceous weeds and control further seed development and dispersal in the area. Targeted included: *Bidens pilosa, Conyza* spp., *Ochna serrulata, Paspalum dilatatum, Pavonia hastata, Senecio madagascariensis, Sida rhombifolia, Solanum nigrum, Solanum pseudocapsicum, Solanum capsicoides,* and *Verbena bonariensis.*
2b	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed using 0.6% Starane Advanced® where previously slashed, through the zone in the eastern and western sections, to manage growth of exotic weeds and control further seed development and dispersal within the area. Target species included *Bidens pilosa, Bryophyllum delagoense, Conyza* spp., *Paspalum dilatatum, Pavonia hastata, Senecio madagascariensis, Sida rhombifolia, Solanum nigrum, Solanum pseudocapsicum, Solanum capsicoides,* and *Verbena bonariensis*.
		Vine	• *Anredera cordifolia, Asparagus asparagoides*, and *Passiflora suberosa* were spot sprayed through the eastern and western sections of the zone, to control further growth into shrubs and canopy species.
3	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed along the front edge and along the border of Zone 2, to inhibit further growth through high resilient areas. Species targeted included *Onopordum acanthium* and *Sonchus oleraceus*. • *Chloris* spp. was slashed in the eastern section adjacent to the access road, to inhibit further growth and seed dispersal.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were sprayed through the planting bed adjacent to the sales yard and access road, along the entire access road, through the drainage line (eastern), surrounding all unloader buildings, conveyor belt, and through the drainage line on the southern side of the rails, to ensure no further growth and improve depot aesthetics. Targeted species included; *Anagallis arvensis, Andropogon virginicus, Aster* sp., *Bidens pilosa, Chloris gayana, Chloris virgata, Conyza* sp., *Cortaderia selloana, Cynodon dactylon, Echinochloa crus-galli, Eragrostis curvula, Melinis repens, Modiola caroliniana, Onopordum*

Zone	Type of Work	Weed Type	Work Description
			acanthium, Paspalum dilatatum, Plantago lanceolata, Sida rhombifolia, Senecio madagascariensis, Setaria sp., *Sonchus oleraceus*, and *Verbena bonariensis*. • *Chloris gayana* was slashed from the southern sound wall to the bridge adjacent to the access road to control growth and improve depot aesthetics. • Exotic grasses were slashed and sprayed in the western corner, to control further growth. Area to be maintained as low grassland from now on. Species targeted included *Chloris gayana, Cynodon dactylon,* and *Eragrostis curvula*.
		Vine	• *Araujia sericifera* was sprayed using 2% Roundup Biactive® + 1g/10L Associate® along the southern fence line, to eliminate growth. Stems are located within the City Rails property.
		Woody	• Woody weeds were spot sprayed using 1% Grazon Extra® along the southern boundary fence lines and adjacent to the western drainage line, to inhibit seed dispersal within the bushland and surrounding areas. Species targeted included, *Casuarina glauca, Erythrina x sykesii, Melaleuca* spp., *Morus alba*, and *Rubus* sp. • Removed shrubs blocking signage within the carpark.
JUNE 2019			
Depot	Maintenance	Herbaceous	• Tall/seeding herbaceous weeds were hand weeded through the planting bed surrounding the office building and carpark to inhibit further seed development and dispersal through the area. Species targeted included: *Aster* sp., *Chloris gayana, Conyza* spp., *Melinis repens, Pennisetum clandestinum, Pennisetum setaceum,* and *Sonchus oleraceus.* • Herbaceous weeds and exotic grasses were spot sprayed (using 0.8% Starane Advanced®; 1.5% Roundup Biactive®) through the planting beds surrounding the office building and carpark, adjacent to the front gate and hydrant boosters, road edges, surrounding the workshop, refuelling container, Snake Alley, concrete plant walkways and surrounding the loader parking area, to inhibit further growth and seed development and also

Zone	Type of Work	Weed Type	Work Description
			improve depot aesthetics. Species targeted included: *Anagallis arvensis, Aster* sp., *Bidens pilosa, Bromus catharticus, Conyza* spp., *Echinochloa crus-galli, Medicago sativa, Onopordum acanthium, Paspalum dilatatum, Plantago lanceolata, Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus*, and *Trifolium repens*.
		Woody	• Removed branches surrounding electrical boxes adjacent to the carpark to allow maintenance access for contractors.
JULY 2019			
1	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®; 1.5% Roundup Biactive®) throughout the northeast, northwest and southeast sections of the zone, to inhibit further growth and seed development. Species targeted included; *Asparagus aethiopicus, Bidens pilosa, Chloris gayana, Conyza* spp., *Brassica* spp., *Eragrostis curvula, Galium aparine, Onopordum acanthium, Paspalum dilatatum, Plectranthus* spp., *Rubus sp., Senecio madagascariensis, Senecio pterophorus, Solanum capsicoides, Solanum nigrum, Solanum pseudocapsicum, Verbena bonariensis*.
		Vine	• Exotic vines were spot sprayed (using 0.6% Starane Advanced®) through the northeast and northwest sections of the zone, to inhibit further growth and seed development/dispersal. Species targeted included; *Araujia sericifera, Asparagus asparagoides, Passiflora suberosa, Solanum seaforthianum.*
		Woody	• Juvenile woody weeds were spot sprayed (using 0.5% Grazon Extra®) through the northeast and northwest section of the zone, to inhibit further growth and seeding potential. Species targeted included; *Cestrum parqui, Ligustrum lucidum, Ligustrum sinense, Ochna serrulata, Olea europaea subsp. cuspidata, Ricinus communis, Senna pendula,* and *Solanum mauritianum*.
2a	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®; 1.5% Roundup Biactive®) through the grassland and adjacent to the creek line within the eastern side of the site, to inhibit further growth and seed development. Species targeted included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Brassica* spp., *Eragrostis curvula,*

Zone	Type of Work	Weed Type	Work Description
			Paspalum dilatatum, Solanum nigrum, Solanum pseudocapsicum, Verbena bonariensis.
		Woody	• Juvenile woody weeds were spot sprayed (using 0.5% Grazon Extra®) through the area, to inhibit further growth and seeding potential. Species targeted included; *Ligustrum lucidum, Ligustrum sinense, Olea europaea subsp. cuspidata.*
2b	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.6% Starane Advanced®) through the grassland and adjacent to the creek line within the eastern side of the site, to inhibit further growth and seed development. Species targeted included; *Bidens pilosa, Conyza* spp., *Brassica* spp., *Onopordum acanthium, Solanum nigrum, Solanum pseudocapsicum, Tradescantia fluminensis, Verbena bonariensis.*
		Woody	• *Arundo donax* was further reduced along the eastern fence line, within and surrounding plantings, to inhibit further growth in the area.
Depot	Maintenance	Herbaceous	• Exotic grasses and herbaceous weeds were slashed surrounding both retention basins and behind the eastern sound wall to inhibit further growth and seed development/dispersal, and to improve site aesthetics accordingly. Targeted species included; *Bidens pilosa, Chloris gayana, Cynodon dactylon, Eragrostis curvula, Onopordum acanthium, Sida rhombifolia, Solanum nigrum, Verbena bonariensis*. • Herbaceous weeds and exotic grasses were spot sprayed (using 1.5% Roundup Biactive®) along the access road from the sales yard to bridge, through the planting bed adjacent to the sales yard, underneath the conveyor belt, western access road (adjacent to the road and bridge), to inhibit further weed growth and inhibit further seed development and also improve depot aesthetics. Species targeted included; *Aster* sp., *Bidens pilosa, Brassica* sp., *Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula, Lactuca serriola, Lolium perenne, Medicago sativa, Medicago* spp., *Onopordum acanthium, Paspalum dilatatum, Plantago lanceolata, Rumex* sp., *Senecio madagascariensis, Setaria* sp., *Sonchus oleraceus, Trifolium repens, Verbena bonariensis.* • Herbaceous weeds were spot sprayed (using 1.5% Roundup Biactive®) across and on top of the

Zone	Type of Work	Weed Type	Work Description
			concrete bund, with a focus on *Onopordum acanthium*, especially large and near-flowering specimens. *Paspalum dilatatum* was also targeted.
AUGUST 2019			
1	Maintenance	Herbaceous	• *Asparagus aethiopicus* was spot sprayed (using 0.75% Grazon Extra® + 1g/10L Associate®) through the north-eastern section of the zone, through remnant areas, to inhibit further growth and seed development.
		Vine	• Exotic vines were skirted and spot sprayed (using 0.75% Grazon Extra® + 1g/10L Associate®) within the north-eastern section of the zone, with a focus on *Araujia sericifera* and *Jasminum polyanthum*, to inhibit further growth through existing shrubs and canopy. • Exotic vines were heavily targeted by means of stem treatment through the north-west, north east, south-west and south-east sections of the zone, with a detailed focus within the north-east where vines were denser, within existing shrubs. Species targeted included; *Araujia sericifera, Passiflora subpeltata* and *Solanum seaforthianum*.
2a	Maintenance	Herbaceous	• *Chloris gayana* was heavily slashed in the north-western corner of the zone, to inhibit further growth through remnant areas and further seed development/dispersal. Follow up will be conducted in the area upon regrowth.
		Vine	• Isolated *Araujia sericifera* was stem treated within the open section of the zone, to inhibit further growth.
2b	Maintenance	Herbaceous	• *Arundo donax* was further reduced along the eastern fence line, within and surrounding plantings, to inhibit further growth in the area.
3	Maintenance	Herbaceous	• *Cynodon dactylon* and *Pennisetum clandestinum* were slashed along the access road, surrounding plantings and groundcovers, on the eastern side to inhibit growth through plantings. Follow up works will be conducted within the area upon regrowth. • Large *Onopordum acanthium* were stem treated through the revegetation bed on the western side, to inhibit further growth and seed development.
		Woody	• Continued reduction of *Casuarina glauca* within the revegetation bed along the western side, to limit growth and allow for further canopy and shrub

Zone	Type of Work	Weed Type	Work Description
			development.
SEPTEMBER 2019			
Depot	Maintenance	Herbaceous	• Herbaceous weeds were hand weeded through the planting beds surrounding the office buildings, concrete bund and along the western bund adjacent to the access road to inhibit further flower development seed dispersal. Species targeted included *Onopordum acanthium, Pennisetum setaceum* and *Sonchus oleraceus. Onopordum acanthium* was also stem treated within existing shrubs. • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®; 0.8% Starane Advanced®) through the planting bed surrounding the office building, across the western bund, road edges of the carpark and depot, surrounding the workshop and fuel containers, across the northern slope (lower) and surrounding the central sound wall including the loader parking bay. Species targeted included, *Aster* sp, *Chloris gayana, Conyza* spp., *Echinochloa crus-galli, Medicago* sp., *Onopordum acanthium, Paspalum dilatatum, Pennisetum setaceum, Poa annua, Senecio madagascariensis, Sonchus oleraceus, Verbena bonariensis.* • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®) from behind the stockpiles within the sales yard and stacker bay, to inhibit growth and seed spread into materials and surrounding areas. Species targeted included; *Melinis repens, Onopordum acanthium, Pennisetum setaceum, Solanum nigrum, Solanum sisymbriifolium,* and *Sonchus oleraceus.* • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®) across Snake Alley and through the planting bed at the top of the back access road, to control growth and seed development/dispersal in the area. Targeted species included; *Aster* sp., *Conyza* spp., *Medicago sativa, Paspalum dilatatum, Sonchus oleraceus*.
		Vine	• *Vicia* sp. was heavily spot sprayed (using 0.8% Starane Advanced®) throughout the planting bed surrounding the office buildings, to inhibit further growth and seed development.
OCTOBER 2019			

Zone	Type of Work	Weed Type	Work Description
1	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.9% Starane Advanced®) through the south-western section of the zone with a focus adjacent to the creek line and within developing groundcovers, to inhibit further growth and seed development and dispersal. Species targeted included; *Conyza* spp., *Onopordum acanthium, Solanum nigrum, Tradescantia fluminensis, Verbena bonariensis*.
2b	Maintenance	Vine	• *Asparagus asparagoides* and *Passiflora suberosa* were removed/treated adjacent to the conveyor belt within the south-western section of the zone, to inhibit further growth and fruit production.
3	Maintenance	Vine	• An isolated patch of *Vinca major* was spot sprayed (using 0.5% Grazon Extra®) within the south-western section of the zone, to inhibit further spreading and flowering within areas of high resilience. • *Asparagus asparagoides* and *Passiflora suberosa* were removed/treated adjacent to the conveyor belt within the south-western section of the zone, to inhibit further growth and fruit production.
		Woody	• *Ligustrum sinense* was spot sprayed (using 0.5% Grazon Extra®) on an isolated patch within the south-western section of the zone, to inhibit growth within existing shrubs.
Depot	Maintenance	Herbaceous	• *Pennisetum setaceum* was hand weeded adjacent to the main office building to inhibit flowering and further seed development/spread. • Herbaceous weeds were spot sprayed (using 1.5% Roundup Biactive®) along all access roads from the sales yard to the M7 and eastern access road, through the three drainage lines, surrounding all buildings (unloader, electrical etc.), along both sides of the conveyor belt, planting bed at the top of the access road, along all rail ballasts and on the southern side of the rails, to inhibit further growth and seed development, and improve depot aesthetics. Species targeted included, *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chloris gayana, Conyza* spp., *Cyclospermum leptophyllum, Cynodon dactylon, Echinochloa crus-galli, Hypochaeris radicata, Lactuca serriola, Medicago sp., Onopordum acanthium, Paspalum dilatatum, Senecio madagascariensis, Sonchus oleraceus, Typha orientalis,* and *Verbena bonariensis.*

Zone	Type of Work	Weed Type	Work Description
NOVEMBER 2019			
Depot	Maintenance	Herbaceous	• Re-emerged *Pennisetum setaceum* was hand weeded adjacent to the main office building to inhibit further seed development/spread. • Tall herbaceous weeds were hand weeded through the office planting beds, to control growth and flowering/seeding potential. Species targeted included; *Aster* sp., *Conyza* spp., and *Sonchus oleraceus*. • Herbaceous weeds were spot sprayed (using 1.5% Roundup Biactive®, 0.8% Starane Advanced®) through the office planting beds, surrounding the weighbridge, adjacent to the front gate, surrounding the watercart re-filling station, along the central sound wall and unloader parking, surrounding the workshop and fuel cell, pathways leading to the concrete plant (including old pathways) and Snake Alley, to improve depot aesthetics and control further weed growth and seed development. Targeted species included; *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chenopodium album, Chloris gayana, Conyza* spp., *Cyclospermum leptophyllum, Cynodon dactylon, Hypochaeris radicata, Lactuca serriola, Medicago sativa, Medicago* sp., *Onopordum acanthium, Paspalum dilatatum, Sonchus oleraceus, Verbena bonariensis.*
	Other	N/A	• • Rubbish was collected along the road edges of the access road from the sales yard to unloader building, including along the western side of the conveyor belt.
DECEMBER 2019			
Depot	Maintenance	Herbaceous	• Isolated *Pennisetum setaceum* was hand weeded adjacent to the main office building to inhibit further seed development/spread. • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®, 0.9% Starane Advanced®) through the office planting beds, surrounding the weighbridge, front gate, surrounding the watercart re-filling station, along the central sound wall and loader parking, surrounding the workshop and fuel cell, pathways leading to the concrete plant (including old pathways), Snake Alley, plant bed adjacent to sales yard, access road edges,

Zone	Type of Work	Weed Type	Work Description
			adjacent to conveyor belt and electrical buildings, eastern drainage line and walk way, and western drainage line and walkway, to improve depot aesthetics and control further weed growth and seed development. Targeted species included; *Anagallis arvensis, Aster* sp., *Bidens pilosa, Chenopodium album, Chloris gayana, Conyza* spp., *Cyclospermum leptophyllum, Cynodon dactylon, Echinochloa crus-galli, Eleusine indica, Hypochaeris radicata, Lactuca serriola, Medicago* spp., *Onopordum acanthium, Paspalum dilatatum, Pennisetum clandestinum, Senecio madagascariensis, Solanum nigrum, Solanum sisymbriifolium, Sonchus oleraceus, Typha orientalis,* and *Verbena bonariensis.*
JANUARY 2020			
1	Maintenance	Herbaceous	• Isolated herbaceous weeds were stem treated within the north-eastern and south-eastern sections of the zone, to inhibit growth and further seeding potential. Species targeted included, *Solanum pseudocapsicum, Solanum sisymbriifolium*.
		Vine	• *Asparagus officinalis* was stem treated through the north-eastern, north-western and south-western sections of the zone to inhibit further fruit development and spreading into high resilient areas. • *Passiflora suberosa* were stem treated within the north-eastern, south-eastern and south-western sections of the zone, to inhibit growth and further inhibit fruiting. • Isolated *Araujia sericifera* were stem treated within the north-western section of the zone, firstly treated adjacent to the conveyer belt and secondly along the western fence line near the creek, to inhibit further growth into canopy layers.
		Woody	• *Grevillia robusta* were drilled within the north-eastern section of the zone, to further inhibit fruiting and germination within the area. • *Lycium ferocissimum* was stem treated in the north-eastern section of the zone, right adjacent to the fence line, from within native shrubs, to inhibit further growth and seeding potential. In addition, *Ligustrum sinense* was also stem treated adjacent to *L. ferocissimum*.

Zone	Type of Work	Weed Type	Work Description
			• *Olea europaea* subsp. *cuspidata* were stem treated in the north-eastern section of the zone, adjacent to the eastern sound wall and *Casuarina glauca* stands, as to inhibit further growth within the area. Additionally, a large specimen along the fence line was drilled. • Isolated *Lantana camara* was stem treated within the north-western section of the zone, to inhibit further growth and spread through native shrubs. • Large *Erythrina x sykesii* was drilled in the north-eastern and north-western sections of the zone, due to the fact they were non-flowering and on the creek banks. Additionally, smaller specimens were stem treated through the area to inhibit further growth and flowering.
2a	Maintenance	Vine	• *Asparagus officinalis* was stem treated through the area to inhibit further fruit development and spreading into high resilient areas. • Isolated *Araujia sericifera* was also stem treated within the area to inhibit establishment within the bushland, especially along the eastern fence line.
2b	Maintenance	Vine	• *Asparagus officinalis* was stem treated through the area to inhibit further fruit development and spreading into high resilient areas.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were spot sprayed (using 0.8% Starane® Advanced + 1g/L Associate®) through the access road planting bed adjacent to the sales yard, to inhibit further growth and seeding development. • Herbaceous weeds were sprayed (using 1.5% Roundup Biactive®) along the access road to the bridge and additionally behind the eastern sound wall to HUME, including surrounding their gates and access road section, to inhibit growth and seeding potential. Species targeted included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Cynodon dactylon, Paspalum dilatatum, Typha orientalis,* and *Verbena bonariensis.* • Exotic grasses were slashed surrounding the northern section of the eastern retention basin, along the access road guard rails, to improve area aesthetics and control further seeing potential. Species targeted included; *Chloris gayana*, *Conyza* spp.,

Zone	Type of Work	Weed Type	Work Description
			Eragrostis curvula.
FEBRUARY 2020			
1	Maintenance	Herbaceous	• Emerging herbaceous weeds were spot sprayed (using 0.8% Starane® Advanced) within the south-eastern section of the zone, through the previous plantings, to inhibit further growth after recent rain falls. Species targeted included; *Bidens pilosa, Brassica* sp., *Bryophyllum delagoense, Conyza* spp., *Onopordum acanthium, Senecio madagascariensis, Solanum nigrum, Solanum pseudocapsicum, Verbena bonariensis.*
		Vine	• *Passiflora suberosa* was stem treated adjacent to the creek line to inhibit further growth in the south-eastern side of the zone. • *Vinca major* was spot sprayed (using 0.5% Grazon Extra®) in the south-eastern section of the zone, adjacent to the creek line, to inhibit further growth.
		Woody	• *Privet lucidum* and *Senna pendula* was stem treated along the eastern fence line within the south-eastern side of the zone, to inhibit further seeding and dispersal.
2b	Maintenance	Herbaceous	• Emerging herbaceous weeds were spot sprayed (using 0.8% Starane® Advanced) within the south-eastern section of the zone, through the previous plantings, to inhibit further growth after recent rain falls. Species targeted included; *Bidens pilosa, Brassica* sp., *Bryophyllum delagoense, Conyza* spp., *Onopordum acanthium, Senecio madagascariensis, Solanum nigrum, Solanum pseudocapsicum, Verbena bonariensis.* • *Bryophyllum delagoense* was hand weeded along the eastern fence line from within native shrubs to inhibit growth and further spreading within the area. • Mattock removed *Agapanthus* sp. from within high resilient areas on the eastern side of the zone, adjacent to the access road, to inhibit further development.
		Vine	• *Asparagus officinalis* was stem treated through the area, on both sides of the conveyer belt, to inhibit further fruit development and spreading into high resilient areas.

Zone	Type of Work	Weed Type	Work Description
			• *Araujia sericifera* and *Asparagus asparagoides* were stem treated/mattock removed from within areas of resilience within the south-eastern section of the zone, to control growth through shrubs.
Depot	Maintenance	Herbaceous	• Herbaceous weeds were hand weeded through the office planting beds to inhibit further flower and seed development/dispersal through within the area. Species targeted included; *Aster* sp., *Conyza* spp., *Pennisetum setaceum, Sonchus oleraceus.* • Herbaceous weeds were sprayed (using 1.5% Roundup Biactive®; 0.8% Starrane Advance®) along the central sound wall and loader parking area, surrounding the workshop and buildings, through the office planting beds, snake alley pathway, surrounding the fuel cell and walkways to the concrete plant and along the lower section of the northern slope from the main gates to HUME, to control further growth and seed development/dispersal. Species targeted included; *Aster* sp., *Bidens pilosa, Chloris gayana, Chloris virgata, Conyza* spp., *Cynodon dactylon, Echinochloa crus-galli, Euphorbia* sp., *Melinis repens, Onopordum acanthium, Paspalum dilatatum, Pennisetum clandestinum, Setaria* sp., *Sonchus oleraceus.* • Exotic grasses were slashed along the northern slope and adjacent to the main road leading to the sales yard, to improve site ascetics and control growth of exotic grasses. Species included; *Chloris gayana, Cynodon dactylon, Eragrostis curvula*. • Snake alley was slashed to control further growth and seeding development, with a focus on *Conyza* spp. Follow up spraying will be undertaken in future visits. • Spot sprayed (using 1.5% Roundup Biactive®) the remaining section of the access road from the unloader building to M7 western corner, with additional works carried out along the walkways adjacent to the rail line (both sides) and through the planting bed along the eastern access road, to control growth and seed development/dispersal. Species targeted included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula, Panicum maximum, Paspalum dilatatum, Pennisetum clandestinum, Typha orientalis, Verbena*

Zone	Type of Work	Weed Type	Work Description
			bonariensis.
MARCH 2019			
1	Maintenance	Vine	• Exotic vines were stem treated/mattock removed through the north-eastern section of the site to control growth and seed development. Growth has been exponential after recent rain and warm weather. Species targeted included; *Araujia sericifera, Asparagus asparagoides* and *Passiflora suberosa.*
Depot	Maintenance	Herbaceous	• Exotic grasses were slashed on the southern side of the bridge along the back access road to inhibit seed development and improve site aesthetics, with works continuing along the fence line towards the train line. Species targeted included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Cynodon dactylon, Paspalum dilatatum* and *Sonchus oleraceus.* • Snake alley was slashed and sprayed (using 1.5% Roundup Biactive®) to control growth and seed development, and to improve the area aesthetics. Targeted species in the area included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Cynodon dactylon, Echinochloa crus-galli, Paspalum dilatatum, Solanum sisymbriifolium* and *Sonchus oleraceus.* • Herbaceous weeds were heavily targeted by means of spot spraying (using1.5% Roundup Bi-active® | 0.6% Starane® Advanced), surrounding all unloader buildings, along both sides of the conveyor belt, access road edges, along the ballast edges of the rails (north and south sides), eastern drainage line, western walkway, access road planting bed to inhibit weed growth and seed development. Species targeted included; *Bidens pilosa, Chloris gayana, Conyza* spp., *Euphorbia* spp., *Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Seteria* sp., *Sida rhombifolia, Solanum nigrum, Solanum sisymbriifolium* and *Sonchus oleraceus.*
MAY 2020			
Depot	Maintenance	Herbaceous	• Tall/seeding herbaceous weeds were hand weeded through the planting bed surrounding the main office buildings to inhibit further seed development and dispersal within the area. Target species included: *Aster* sp., *Bidens pilosa, Pennisetum*

Zone	Type of Work	Weed Type	Work Description
			setaceum, and *Sonchus oleraceus.* • Herbaceous weeds were spot sprayed (using 1.5% Roundup Biactive® and 0.8% Starane® Advanced) through the planting beds surrounding the main office buildings including; surrounding the workshop, main gates, fuel cell, surrounding the concrete plant (pathway and truck parking), loader parking, central sound wall, access road planting bed, conveyer belt and electrical buildings adjacent to unloader building, to inhibit growth and seeding potential, and also improving depot aesthetics. Target species included: *Anagallis arvensis, Aster* sp., *Bidens pilosa, Bromus catharticus, Chloris gayana, Chloris virgata, Conyza* spp., *Cynodon dactylon, Cyperus rotundus, Echinochloa crus-galli, Euphorbia* sp., *Lactuca serriola, Malva* sp., *Medicago* sp., *Onopordum acanthium, Paspalum dilatatum, Plantago lanceolata, Senecio madagascariensis, Sonchus oleraceus,* and *Trifolium repens*. • Snake alley was sprayed (using 1.5% Roundup Biactive®) to control further growth and seeding development, and to improve the area aesthetics. Targeted species in the area included: *Conyza* spp., *Euphorbia* spp., *Medicago sativa,* and *Sonchus oleraceus.*
JULY 2020			
1	Maintenance	Herbaceous	• Herbaceous weeds were slashed throughout the zone within the south-east and north-west (adjacent to the conveyer belt) sections of the bushland to inhibit further seed development and growth. Species targeted included: *Avena* sp., *Bidens pilosa, Bromus catharticus, Conyza* spp., *Onopordum acanthium, Paspalum dilatatum, Senecio madagascariensis, Sida rhombifolia, Solanum nigrum,* and *Sonchus oleraceus*. • Herbaceous weeds were spot sprayed (using 0.6% Starane® Advanced + 1g/10L Associate®) through all sections of the zone to inhibit further growth and seed development/dispersal within the area. Species targeted included: *Bidens pilosa, Bryophyllum delagoense, Onopordum acanthium, Plantago lanceolata, Senecio madagascariensis, Solanum nigrum, Solanum sisymbriifolium, Sonchus oleraceus,* and *Tradescantia fluminensis.*
		Vine	• Exotic vines were spot sprayed (using 0.6% Starane®

Zone	Type of Work	Weed Type	Work Description
			Advanced + 1g/10L Associate®) through all sections of the zone to inhibit further growth and seed development. Species targeted included *Araujia sericifera, Asparagus asparagoides,* and *Passiflora suberosa*. • *Vinca major* was spot sprayed (using 0.5% Grazon Extra®) within the south-west section of the zone, adjacent to the creek line, to inhibit further growth and spreading within high resilient areas.
		Woody	• *Ligustrum sinense* was slashed within the north-west section adjacent to the conveyer belt to inhibit further growth and re-growth will be sprayed in the following visits. • Emerging and developing woody weeds were spot sprayed (using 0.5% Grazon Extra®) through the south-west section of the zone to inhibit further growth and flowering/seeding potential. Targeted species included: *Cestrum parqui, Ligustrum sinense, Olea europaea* subsp. *cuspidata, Senna pendula,* and *Solanum mauritianum*.
2b	Maintenance	Herbaceous	• Herbaceous weeds were slashed throughout the zone within the south-east section of the bushland to inhibit further seed development and growth. Species targeted included: *Bidens pilosa, Sida rhombifolia,* and *Solanum nigrum*. • Herbaceous weeds were spot sprayed (using 0.25% Starane® Advanced + 1g/10L Associate®) through all sections of the zone to inhibit further growth and seed development/dispersal within the area. Targeted species included: *Bidens pilosa, Onopordum acanthium, Plantago lanceolata, Senecio madagascariensis, Solanum nigrum, Solanum sisymbriifolium, Sonchus oleraceus,* and *Tradescantia fluminensis*.
		Vine	• *Vinca major* was spot sprayed in the south-west section adjacent to the creek line to inhibit further growth and spreading into high resilient areas.
AUGUST 2020			
Depot	Maintenance	Herbaceous	• Hand weeded herbaceous through the office planting beds to maintain aesthetics and inhibit further seed development and dispersal within the area. Targeted species included: *Aster* sp., *Bidens pilosa, Conyza* spp., *Onopordum acanthium,*

Zone	Type of Work	Weed Type	Work Description
			Pennisetum setaceum, and *Sonchus oleraceus*. • Herbaceous weeds were spot sprayed (using 2% Roundup Biactive®) | 0.3% Fireball®) through and surrounding all office planting beds, along the northern bund road edge, western bund road edge, surrounding the main gate and hydrant valves, surrounding the workshop and fuel container, along the central sound wall and loader parking bay, along the snake alley walk way, behind the concrete truck parking bay, within the central section (recently cleared and covered within material) and through the access road planting bed, to inhibit growth and further seed development within the area. Targeted species included: *Aster* sp., *Bidens pilosa, Brassica* sp., *Bromus catharticus, Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula, Lactuca serriola, Medicago sp., Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Plantago lanceolata, Senecio madagascariensis,* and *Sonchus oleraceus*. • Exotic grasses and herbaceous weeds were slashed along the northern bund from the main entrance gate to HUME back gate, including along the road edges to maintain aesthetics and inhibit weed growth. Species targeted included: *Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula,* and *Sonchus oleraceus.* • The grassland within the office planting bed was mowed down to maintain aesthetics and reduce habitat for snakes in the upcoming warmer weather.
NOVEMBER 2020			
Depot	Maintenance	Herbaceous	• Hand weeded herbaceous through the office planting beds to maintain aesthetics and inhibit further seed development and dispersal within the area. Target species included: *Aster* sp., *Conyza* spp*., Onopordum acanthium, Pennisetum setaceum,* and *Sonchus oleraceus*. • Herbaceous weeds were spot sprayed (using 1.5% Roundup Biactive®) | 0.6% Starane® Advanced) through and surrounding all office planting beds, along the northern bund road edge, western bund road edge, surrounding the main gate and hydrant valves, surrounding the workshop and fuel container, along the central sound wall and loader

Zone	Type of Work	Weed Type	Work Description
			parking bay, the central section (recently cleared and covered within material), to inhibit growth and further seed development within the area. Targeted species included: *Aster* sp., *Bidens pilosa, Brassica* sp., *Bromus catharticus, Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula, Lactuca serriola, Medicago sp., Modiola caroliniana, Onopordum acanthium, Paspalum dilatatum, Plantago lanceolata, Senecio madagascariensis,* and *Sonchus oleraceus*. • Exotic grasses and herbaceous weeds were slashed along the northern bund from the main entrance gate to HUME back gate, including along the road edges to maintain aesthetics and inhibit weed growth. Species targeted included: *Chloris gayana, Conyza* spp., *Cynodon dactylon, Eragrostis curvula,* and *Sonchus oleraceus*. • Snake Alley was slashed and pathway was spot sprayed from the fuel cell to retention basin to inhibit further growth and seed development/dispersal, and importantly, to keep vegetation down to inhibit snake activity in the area. • The grassland within the office planting bed was mowed down to maintain aesthetics and inhibit habitat for snakes in the upcoming warmer weather.
DECEMBER 2020			
1	Maintenance	Herbaceous	• Tall/flowering *Onopordum acanthium* were de-seeded and stem treated through the SE, NE and NW sections of the zone to inhibit further growth and flowering potential through high resilient areas.
		Vine	• *Araujia sericifera* and *Passiflora suberosa* were heavily targeted by means of stem treating and hand weeding, through the bushland, especially through the SE, NE, and NW sections of the zone, to inhibit further growth and flowering/seeding potential within the area. In addition, *Asparagus asparagoides* and *Solanum seaforthianum* were also treated within the NE section.
		Woody	• *Lantana camara* was stem treated within the NE section of the zone, to control further growth and seeding potential through high resilient and established shrubs. • Re-emerging woody weeds were spot sprayed

Zone	Type of Work	Weed Type	Work Description
			(using 1g/10L Associate® + Pulse®) through the NW section of the zone, especially adjacent to the conveyer belt, and including along the creek line adjacent to the vehicle bridge, to control further growth through cleared sections. Species targeted included: *Erythrina crista-galli, Ligustrum lucidum, Ligustrum sinense, Morus a*lba, and *Senna pendula*.
2b	Maintenance	Vine	• *Araujia sericifera* was stem treated` through the SE section of the zone, to inhibit further growth and seeding potential.
Depot	Maintenance	Herbaceous	• Snake Alley was spot sprayed (using 1.5% Roundup Biactive®) to maintain a dead zone and inhibit snake activity along pathways. Species targeted included: *Chloris gayana, Conyza* spp., *Echinochloa crus-galli,* and *Paspalum dilatatum.*

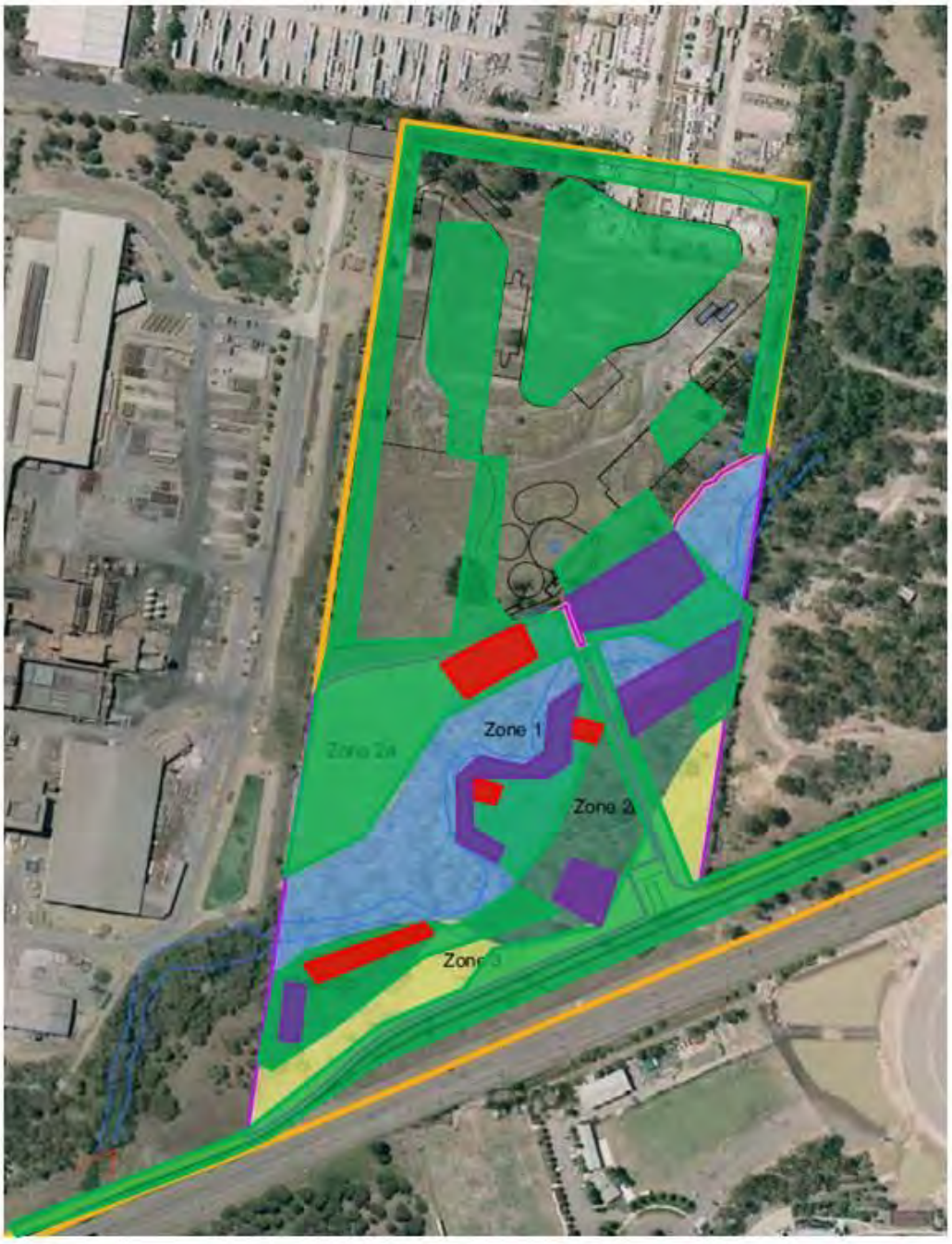
Note:

- All spraying utilised a 1% solution of 'Roundup Biactive®' unless stated otherwise.
- All cut/scrape and painting and drill and stem injecting was done using neat 'Roundup Biactive®'.

2. Revegetation

No revegetation has occurred since 2017. Previously revegetated beds were maintained for weedy encroachment, and monitored for planting health throughout the contract period.

3. Works Undertaken Mapping



Holcim Rooty Hill Distribution Centre

2018 - 2020

Toolijooa environmental restoration

Source: Sinclair Knight Mertz

N

Not to Scale

Species of Major Weeds Treated

Herbaceous: *Bidens pilosa, Chloris gayana, Conyza* sp., *Cynodon dactylon, Eragrostis curvula, Medicago sativa, Onopordum acanthium, Paspalum dilatatum, Senecio madagascariensis, Solanum* spp., *Sonchus oleraceus, Typha orientalis, Verbena bonariensis*	
Vine: *Araujia sericifera, Asparagus asparagoides, Passiflora suberosa*	
Woody: *Lantana camara, Ligustrum* spp., *Olea europaea* subsp. *cuspidata, Senna pendula*	

4. Recommendations

Bushland

- Continue maintenance of previously revegetated areas and monitor for planting health.
- Push back vine and woody weeds throughout Zones 1 and 2, focusing on *Ligustrum* spp. and *Asparagus aethiopicus.*

Landscape

- Allocate more hours/visits for general upkeep of Depot area and Snake Alley to maintain access and aesthetics.
- Continue removal of native trees and shrubs (*Casuarina glauca*) to reduce encroachment onto the rail line and prevent any structural damage caused by emerging root system