HERRING STORER ACOUSTICS

AUSTRALIAN GARNET PTY LTD

LUCKY BAY GARNET MINE PROJECT
COMMISSIONING

ENVIRONMENTAL NOISE ASSESSMENT

APRIL 2024

OUR REFERENCE: 31331-2-23207

[redacted]

DOCUMENT CONTROL PAGE

COMMISSIONING
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FOR

AUSTRALIAN GARNET PTY LTD

[redacted]

[redacted]

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A	Monitored Noise Levels

1.0 INTRODUCTION

Herring Storer Acoustics was commissioned by Australian Garnet Pty Ltd to undertake noise measurements relating to noise emissions from the recently constructed mine site in Luck Bay, Western Australia.

Works approval W6214/2019/1 was granted for the Lucky Bay mine site in April 2021. As a part of the approval and subsequent supporting Noise Management Plan, a post commissioning acoustic assessment has been undertaken.

Noise level measurements of the processing plant and mining operations have been undertaken in both near and far field locations. The resultant noise levels have been assessed for compliance against the criteria contained in the *Environmental Protection (Noise) Regulations 1997.*

Additionally, the results of the commissioning noise level measurements have been used to calibrate the predictive noise model used for the works approval application. This allows for modelling of noise emissions for the worst-case possible noise propagation conditions.

For information, a locality plan of the extent of the mine site is shown in Figure 1.1.

FIGURE 1.1 – AUSTRALIAN GARNET LUCKY BAY OPERATIONS

2.0 ACOUSTIC CRITERIA

The criteria used is in accordance with the *Environmental Protection (Noise) Regulations 1997.* These regulations stipulate maximum allowable external noise levels. For residential or noise sensitive premises, this is determined by the calculation of an influencing factor. The influencing factor is calculated for the usage of land within the two circles, having radii of 100m and 450m from the premises of concern. For commercial and industrial premises, the assigned noise levels are fixed for all hours, as listed in Table 2.1.

TABLE 2.1 – ASSIGNED OUTDOOR NOISE LEVELS

Type of premises receiving noise	Time of day	Assigned level (dB)		
		$L_{A\,10}$	$L_{A\,1}$	$L_{A\,max}$
Noise sensitive premises: highly sensitive area (i.e within 15m of a dwelling)	0700 to 1900 hours Monday to Saturday	45 + IF	55 + IF	65 + IF
	0900 to 1900 hours Sunday and public holidays	40 + IF	50 + IF	65 + IF
	1900 to 2200 hours all days	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + IF	45 + IF	55 + IF
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90

Note: The L_{A10} noise level is the noise that is exceeded for 10% of the time.
The L_{A1} noise level is the noise that is exceeded for 1% of the time.
The L_{Amax} noise level is the maximum noise level recorded.
IF = Influencing Factor

It is a requirement that noise from the site be free of annoying characteristics (tonality, modulation and impulsiveness) at other premises, defined as per Regulation 9.

Where the above characteristics are present and cannot be practicably removed, the following adjustments are made to the measured or predicted level at other premises.

TABLE 2.2 – ADJUSTMENTS FOR ANNOYING CHARACTERISTICS WHEN MUSIC IS NOT PRESENT

Where tonality is present	Where modulation is present	Where impulsiveness is present
+ 5 dB	+ 5 dB	+ 10 dB

The influencing factor at the noise sensitive premises has been determined as being zero for the nearest receptors, as they are in a rural area and not within 450m of the mine site.

3.0 METHODOLOGY/MEASURED NOISE LEVELS

To determine the noise that is received from the Australian Garnet operations, noise measurements were carried out during a site visit from the 3rd to the 10th of July 2023.

Two forms of noise level measurements were carried out, namely continuous and short term observed measurements.

3.1 CONTINUOUS NOISE LEVEL MEASUREMENTS

To measure the noise emissions from the operating mine site, noise monitors, capable of continuous noise level measurement were utilised.

Two noise monitoring campaigns were undertaken. For the first campaign, three noise monitors (Svan307A) were deployed on Monday 3rd July 2023 and measured noise levels through to the 10th July 2024 (approximately 1 week).

The first noise monitor was located at the highest noise area identified during the site visit, being the active mining area where the loader, trommel (screen) and generation systems were positioned. This monitor captured continuous noise levels and provided a baseline for comparison to the other far field monitors.

The other two monitoring units were placed towards the east, being the nearest noise sensitive residence, and to the south, being towards the Lucky Bay campgrounds.

Figure 3.1 details the locations of the monitors, and Figure 3.2 shows them in situ.

FIGURE 3.1 - CONTINOUS MONITORING LOCATIONS

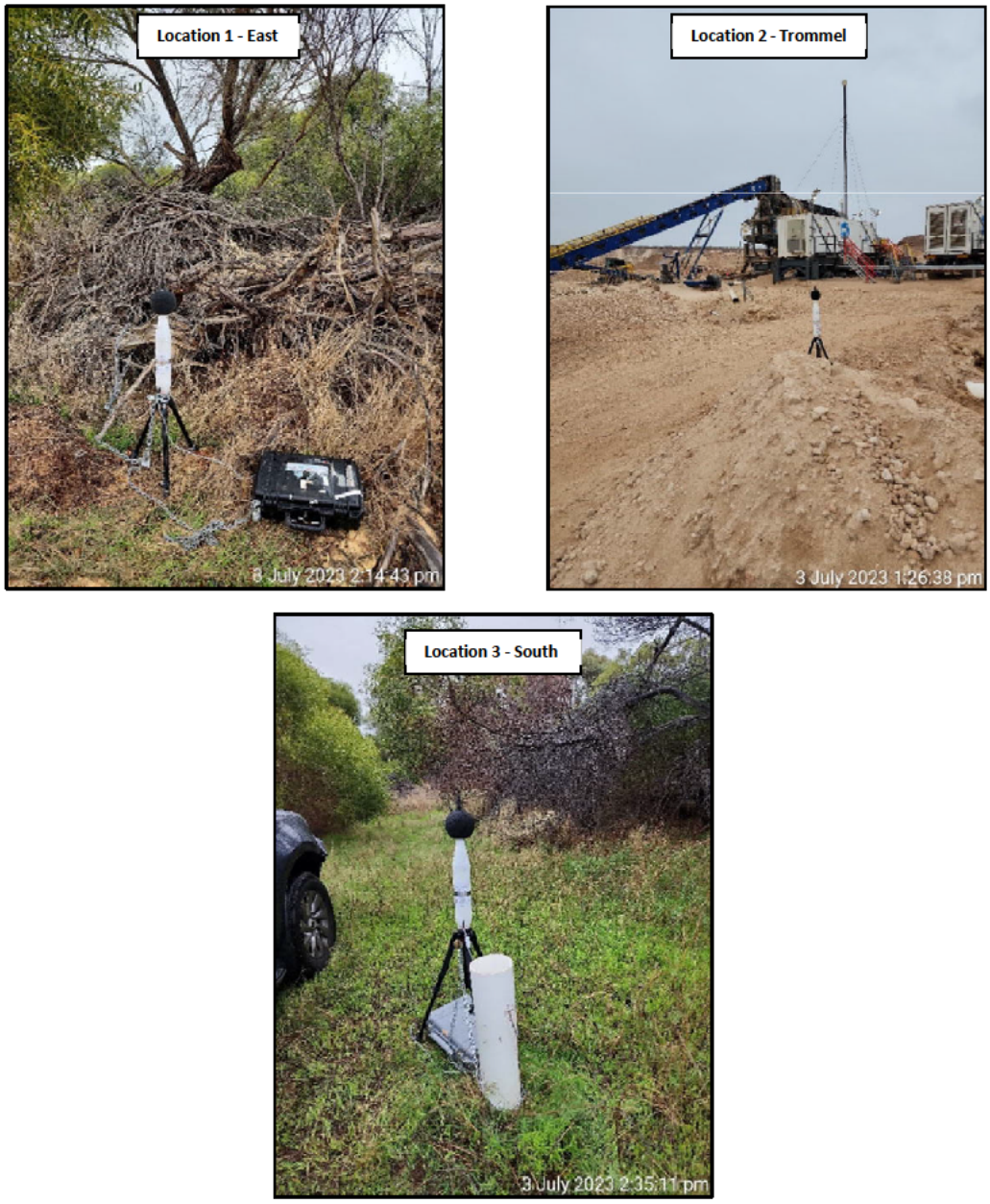


FIGURE 3.2 - MONITORS IN SITU

For the second noise monitoring campaign the locations of the noise monitors were changed to better represent the noise levels at the nearest noise sensitive premise.

Continuous noise monitoring has been undertaken from August 2023 (to current) at the site in three locations, with two being different location from that previous used. The updated continuous monitoring locations are as below in Figure 3.3 and include a comparable location for the residence to the east. It is noted that authority to monitor at the residence was not given, hence a logger at near to equal distance was used. For information the monitoring locations are as follows:

TABLE 3.1 – MONITORING SUMMARY

Assessment Report	Monitoring Period	Monitoring Location
31331-1-23207	17th May to 1st June 2023	Trommel Logger
		Laydown Logger
		South Logger
31331-2-23207	24th August 2023 to 1st March 2024	Hill West Logger
		Laydown Logger
		Residence Logger

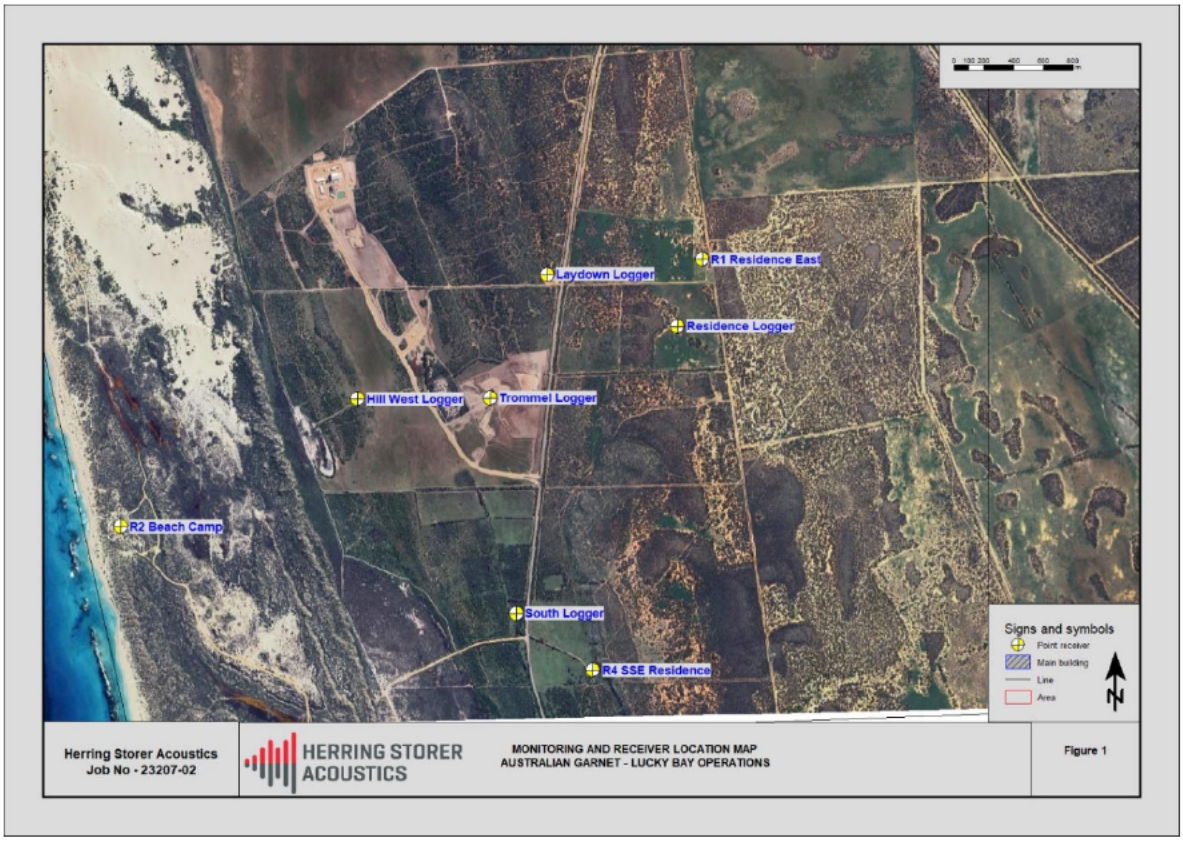


FIGURE 3.3 – PREVIOUS AND UPDATED MONITORING LOCATION MAP

The analysis included monthly monitoring data from August 2023 to February 2024.

3.2 OBSERVED HANDHELD NOISE LEVEL MEASUREMENTS

During the site visit on the 3rd and 4th July 2023, short term, observed noise level measurements were conducted.

Two types of measurements were carried out, firstly nearfield noise level measurements of the main process operating and mining areas, and far field noise levels measurements of the overall mine noise emissions.

Measurements in at the far field locations were conducted at 05:00 on Tuesday 4th July 2023 as this was a clear weather period with south-westerly winds. Observations were taken over a one hour period, with measurements conducted short term (between traffic movements) over a representative period of 15 minutes.

Confirmation noise level measurement was conducted at this location as winds at the time were in the general direction of interest. It was used for confirmation of the predicted noise levels, however, did not form the basis of the actual assessable noise level.

Measurement locations of the main processing plant are shown in Figure 3.4, with the other measurement locations for the mine site shown in Figure 3.5.

FIGURE 3.4 – MAIN PROCESSING PLANT – NOISE MEASUREMENT LOCATIONS

FIGURE 3.5 – MINESITE – NOISE MEASUREMENT LOCATIONS

4.0 MONITORED AMBIENT NOISE

For information purposes, the ambient noise monitoring conducted prior to the construction of the project has been included. The purpose of this inclusion is to relate current noise levels to those measured prior to the project being in place.

As per the "Draft Guidelines on Environmental Noise for Prescribed Premises" (released in May 2016), continuous noise monitoring has been conducted to establish the ambient noise levels. The monitoring location was on the southern boundary of the development, near to the residential receivers in this direction. Monitoring commenced on the 17 May and continued through till the 2nd June 2022. Figure 4.1 contains a map of the monitoring location, with Figure 4.2 showing pictures of the monitor in situ.

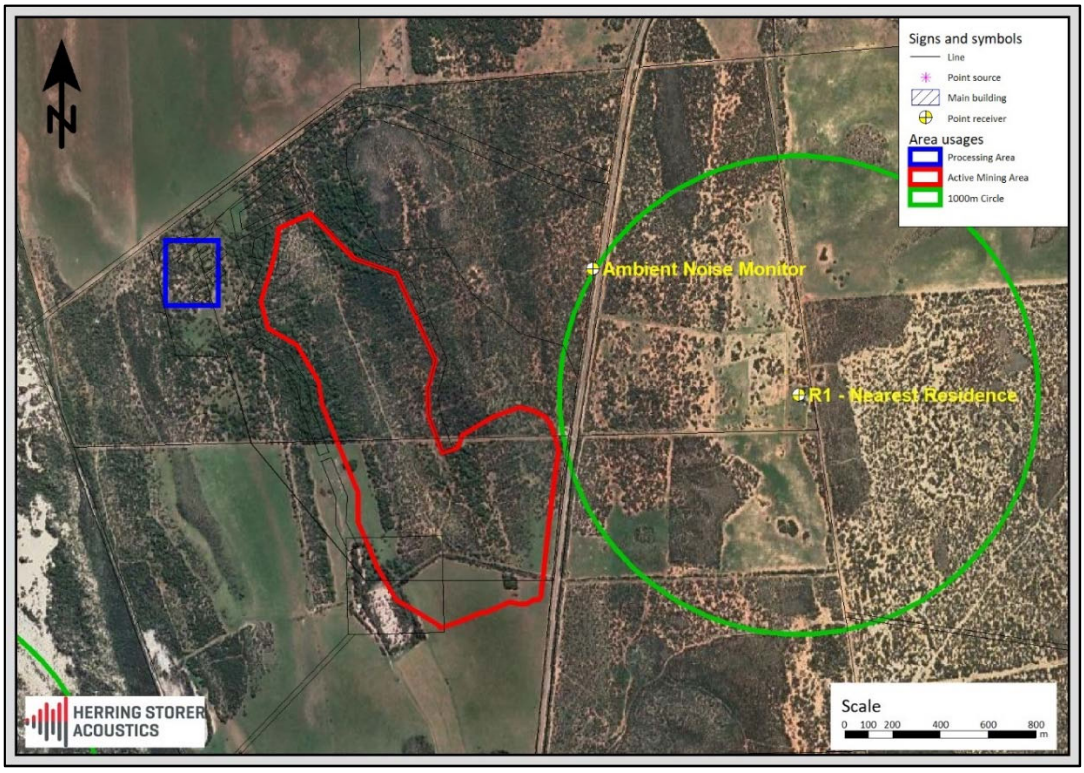


FIGURE 4.1 – MONITORING LOCATION

FIGURE 4.2 – MONITORING PICTURES – IN SITU

Noise monitoring results are summarised graphically below in Figure 4.3.

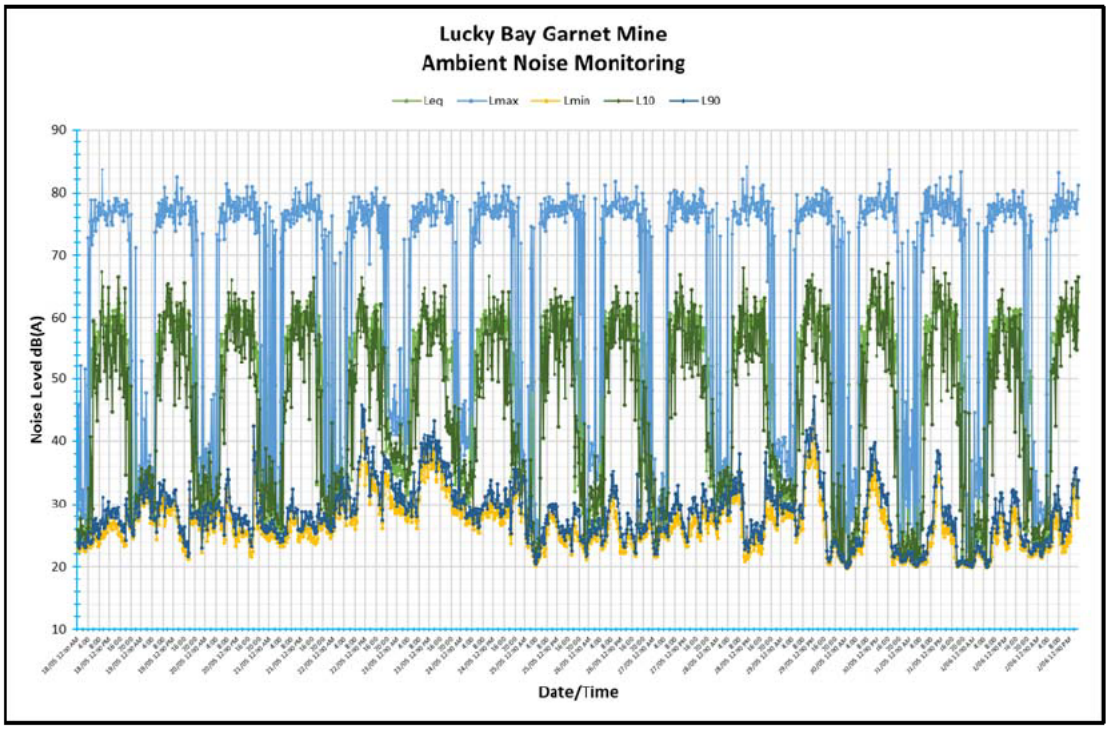


FIGURE 4.3 – MONITORED NOISE LEVELS

For informational purposes, a summary of the average noise level for each daily regulatory time period is shown in Table 4.1.

Weather data for the monitoring period was sourced via the Bureau of Meteorology web site for the Geraldton Airport. Where appropriate, noise level data was excluded due to the influence of heavy rain.

TABLE 4.1 – SUMMARY NOISE LEVELS

Day / Date	Time Period			Comment
	Day 0700 to 1900	Evening 1900 to 2200	Night 2200 to 0700	
Tuesday, 17 May 2022	61	50	51	
Wednesday, 18 May 2022	59	50	45	Rain
Thursday, 19 May 2022	60	48	50	
Friday, 20 May 2022	60	51	50	
Saturday, 21 May 2022	60	48	49	
Sunday, 22 May 2022	59	49	50	
Monday, 23 May 2022	60	50	52	Rain
Tuesday, 24 May 2022	60	49	51	Rain
Wednesday, 25 May 2022	60	52	52	Rain
Thursday, 26 May 2022	60	51	52	
Friday, 27 May 2022	60	50	53	
Saturday, 28 May 2022	60	48	49	
Sunday, 29 May 2022	60	50	45	
Monday, 30 May 2022	61	51	49	
Tuesday, 31 May 2022	61	50	51	
Wednesday, 1 June 2022	59	50	49	
Average (Good Days)	**60**	**50**	**50**	

5.0 RESULTS

5.1 OBSERVED HANDHELD NOISE LEVEL MEASUREMENTS

A summary of the noise levels for the observed measurements is shown in Table 5.1. It is noted that the plant and trommel was in a steady operational state throughout the measurement period.

TABLE 5.1 – MEASURED NOISE LEVELS

Measurement Location	L_{A10} (dB(A))	Comment
Process Plant Loc 1	83	Normal Operation
Process Plant Loc 2	72	Normal Operation
Process Plant Loc 3	72	Normal Operation
Process Plant Loc 4	74	Normal Operation
Process Plant Loc 5	73	Normal Operation
Process Plant Loc 6	74	Normal Operation
Process Plant Loc 7	71	Normal Operation
Process Plant Loc 8	68	Normal Operation
Process Plant Loc 9	66	Normal Operation
Process Plant Loc 10	59	Normal Operation
Process Plant Loc 11	58	Normal Operation
Process Plant Loc 12	58	Normal Operation
Process Plant Loc 13	61	Normal Operation
Process Plant Loc 14	66	Normal Operation
Process Plant Loc 15	68	Normal Operation
Process Plant Loc 16	75	Normal Operation
Process Plant Loc 17	70	Normal Operation
Booster Pad Generator Loc 18	74	Steady State Operation
Trommel Loc 19	81	Loaded with FEL
Measurement Loc A	36	Plant / Trommel audible in background – low level
Aust garnet Entrance Gate Loc B	44	Operating Not Audible

5.2 CONTINUOUS NOISE LEVEL MEASUREMENTS

Additional to the above observed measurement, the continuous monitored noise levels were also analysed. The individual statistical noise levels for each location are contained graphically in Appendix A with the summarised comparison contained further.

For each month, a period of ideal noise propagation conditions, namely winds below 5m/sec and from the westerly quadrant have been identified. For these periods, the daily noise levels have been analysed for overall noise levels, and the third octave band data comparison included. An example this is shown below in Figures 5.1 to 5.3, with the entire period included in Appendix A.

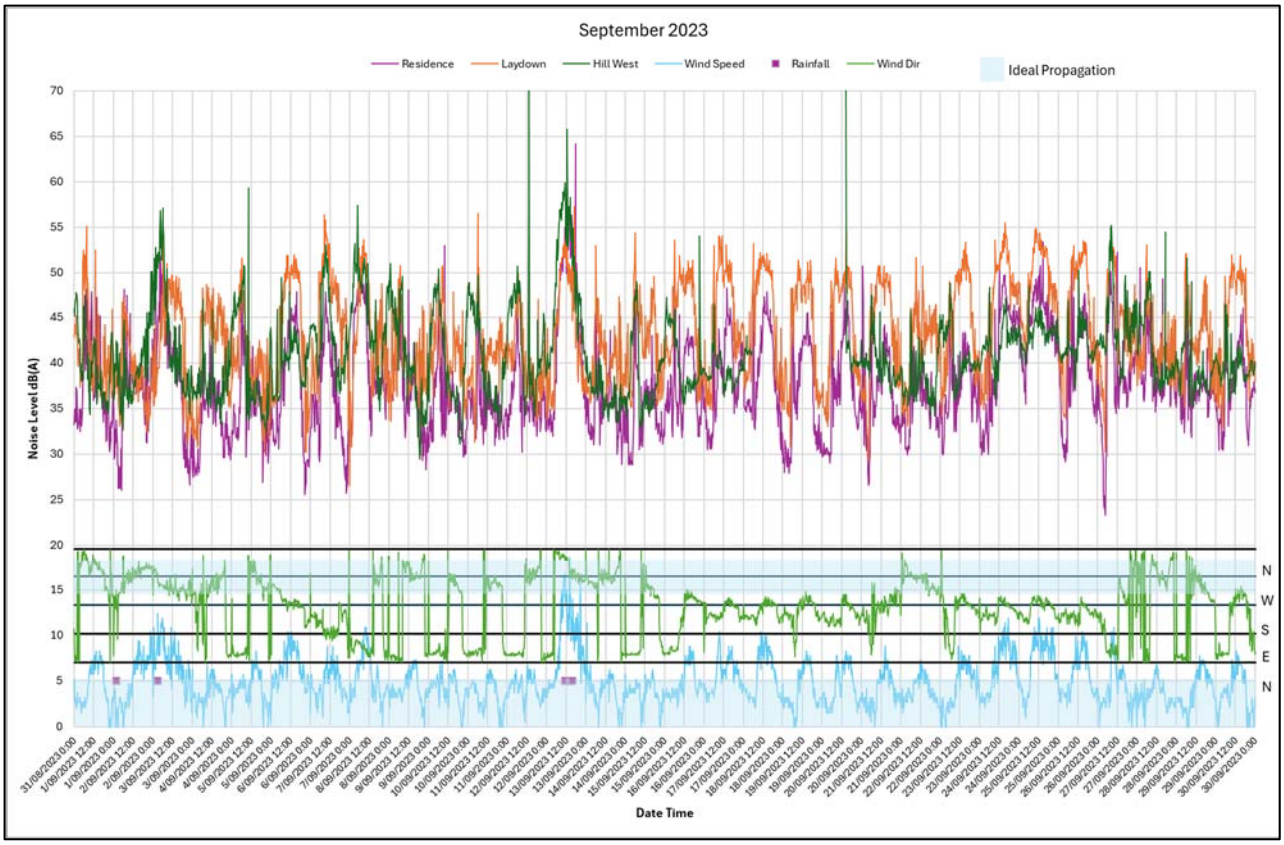


FIGURE 5.1 – MONITORED NOISE LEVEL COMPARISON – SEPTEMBER 2023

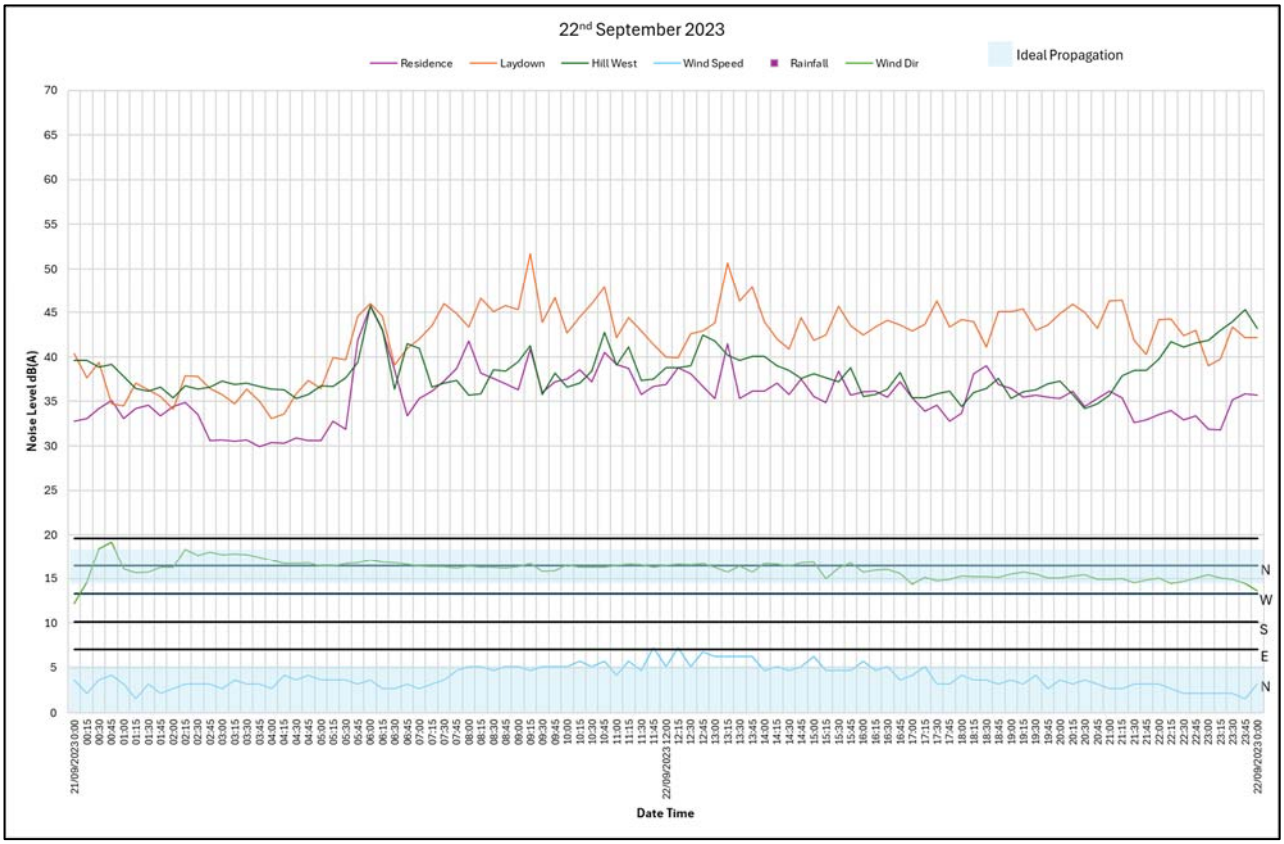


FIGURE 5.2 – PERIOD OF IDEAL NOISE PROPAGATION – 22nd SEPTEMBER 2023

FIGURE 5.3 – THIRD OCTAVE BAND COMPARISON - 22ND SEPTEMBER 9:30AM

6.0 PREDICTIVE NOISE MODELLING

The noise modelling has been calibrated to the site measurements conducted i.e. nearfield noise levels for the processing plant, booster pumps and trommel.

Noise levels were predicted using the acoustic software SoundPlan for worst case wind conditions as per the DER 'Draft Guideline on Environmental Noise for Prescribed Premises (May 2021)' for day operation.

It is noted that 'worst case' wind conditions refer to conditions where there is a temperature inversion in conjunction with light winds in the direction from noise source to receiver, resulting in effective sound propagation to receiver locations. For the case of light westerly winds, temperature inversions are unlikely due to the warm air from the ocean.

The 'SoundPlan' software implements the CONCAWE algorithm, which has been used in this assessment.

Topographical data used for the above algorithm has been based on the proposed extraction area, as provided by the client. For the surrounding area, general ground RL's are imported into the model via Google Earth.

The sound power levels used in the acoustic modelling are calculated based on measured noise levels from this current assessment.

Based on the operations undertaken, the following three scenarios have been modelled:

Scenario 1 – Night Operations - Processing Plant, Booster Pumps and Trommel;
Scenario 2 – Day Operations – Mining Operations; and
Scenario 3 – Day Operations - All sources (Processing and Mining).

Resultant noise levels for the modelling are as per Table 6.2.

TABLE 6.1 – PREDICTED NOISE LEVELS AT MONITORING LOCATIONS

Operating Condition	Monitoring Location	Noise Level dB(A)
Scenario 1 – Night Operations- Processing Plant, Booster Pumps and Trommel	Hill West Logger	38
	Laydown Logger	30
	Residence Logger	29
Scenario 2 – Day Operations – Mining Operations	Hill West Logger	40
	Laydown Logger	48
	Residence Logger	37
Scenario 3 – Day Operations -All sources (Processing and Mining)	Hill West Logger	42
	Laydown Logger	48
	Residence Logger	37

When comparing the monitored noise levels for periods of ideal propagation (as per figure 5.2), it can be seen that there is a good correlation between the monitored noise levels and the calculated noise levels for the operations noise emissions from Scenario 3.

7.0 ASSESSMENT

Analysis of day and night operations for both the monitored noise levels, and the predicted noise levels under worst case conditions has been undertaken. The summarised predicted noise levels for the worst case noise propagation conditions are shown in Table 7.1 below. It is noted that analysis of the monitored noise levels correlated for periods of ideal propagation, and the noise levels given the distance and levels are not tonal, as confirmed by third octave band analysis of the monitored noise levels (East Residence equivalent logger).

TABLE 7.1 – PREDICTED NOISE LEVELS AT NOISE SENSITIVE LOCATIONS

Operating Condition	Location	Noise Level dB(A)
Scenario 1 – Night Operations- Processing Plant, Booster Pumps and Trommel	R1 Residence East	29
	R2 Beach Camp	28
	R3 NW Residence	16
	R4 SSE Residence	23
Scenario 2 – Day Operations – Mining Operations	R1 Residence East	35
	R2 Beach Camp	29
	R3 NW Residence	1
	R4 SSE Residence	34
Scenario 3 – Day Operations -All sources (Processing and Mining)	R1 Residence East	35
	R2 Beach Camp	31
	R3 NW Residence	15
	R4 SSE Residence	34

The measured noise level conducted at 05:00 hours at the eastern measurement location A was an L_{A10} of 36 dB(A). This noise levels contained all operations for the Australian Garnet mine site which included the main processing plant, generators and pumps and the active mining area being the loader and trommel / generators.

The closest noise emission to the measurement location A (active mining area), was approximately 900m away. The nearest noise sensitive premise was a further 1000m from the measurement location. The expected distance attenuation given the distance to the residence would be a further reduction of around 6 dB(A) from that measured.

Weather conditions at the time of the measurement were calm to light south-westerly winds and cold (approx. 4 degrees Celsius), hence providing good noise propagation from the mine site to the measurement location.

Therefore, based on calculation, the noise level at the nearest noise sensitive residence would be 30 dB(A) which is a conservative assessment as there would likely be greater attenuation due to ground effect and other conditions than a distance attenuation only. This correlates to the predicted noise level for this receiver of 29 dB(A).

Day time confirmation measurements at the same location were inconclusive as the observed noise levels were due to ambient noise, hence measurement of the mining / processing operations was difficult to measure.

As the measurement conditions encompassed all aspects of the operating mine, the resultant noise level represents the current mining operations.

Given the assessable noise level of 29 dB(A), the Australian Garnet operations would comply for all time periods.

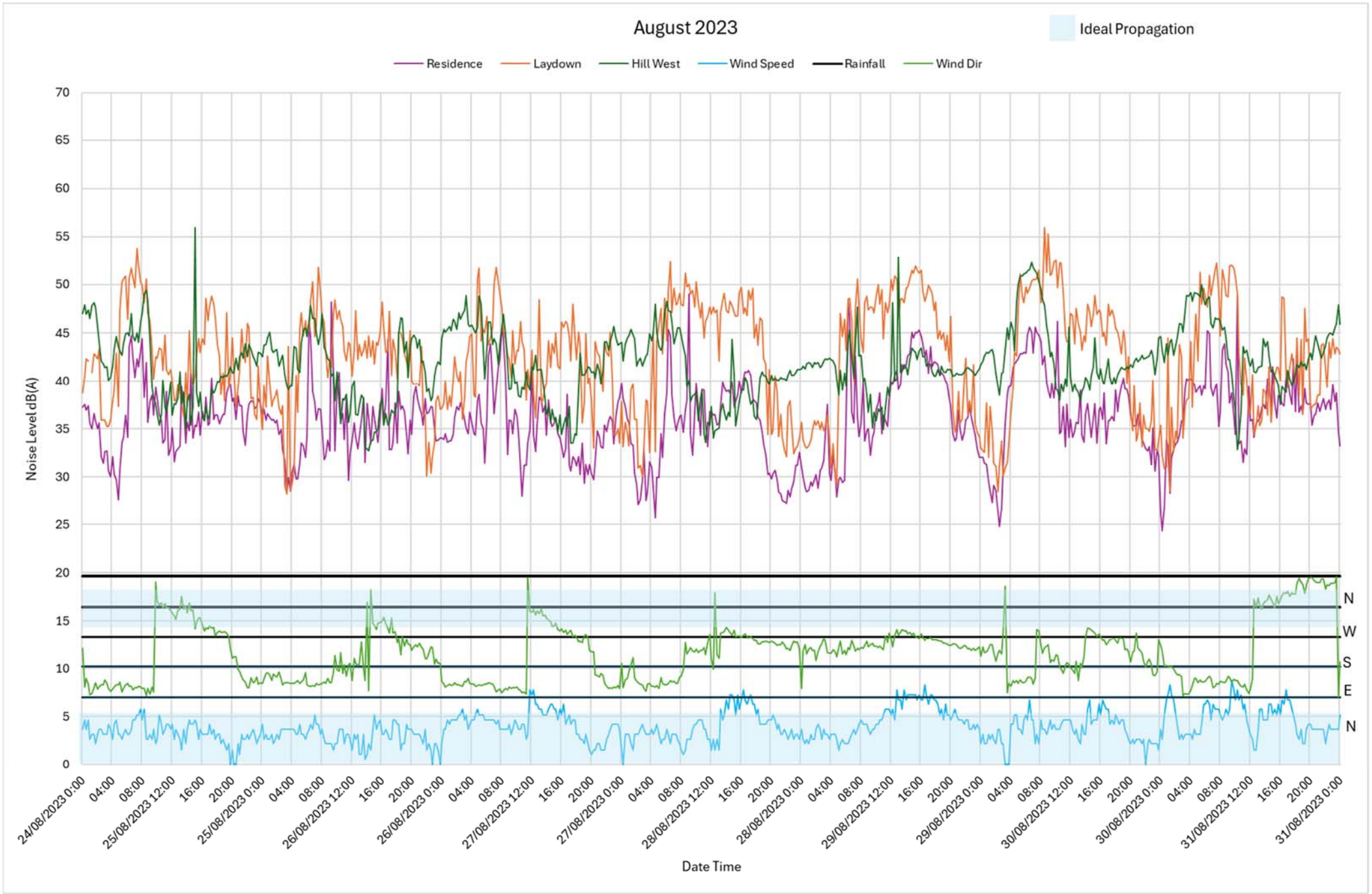
8.0 CONCLUSION

Assessment of the Australian Garnet noise levels show that compliance is achieved for all operating conditions for day and night periods.

Whilst it has been identified that there could be a potential exceedance for future operations, based on the progression of the mine, the implementation of noise management via the monitoring of noise propagation (weather conditions) is implemented into the noise management plan.

It is noted, the acoustic assessments for the works approval application allowed for tonality, which increased the assessable noise levels by 5 dB. The monitored noise levels show that the noise received at the noise sensitive premises does not contain annoying characteristics, hence the acoustic assessment was conservative by allowing the tonal penalty.

APPENDIX A


August 2023
Ideal Propagation
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
24/08/2023 0:00
04:00
08:00
25/08/2023 12:00
16:00
20:00
25/08/2023 0:00
04:00
08:00
26/08/2023 12:00
16:00
20:00
26/08/2023 0:00
04:00
08:00
27/08/2023 12:00
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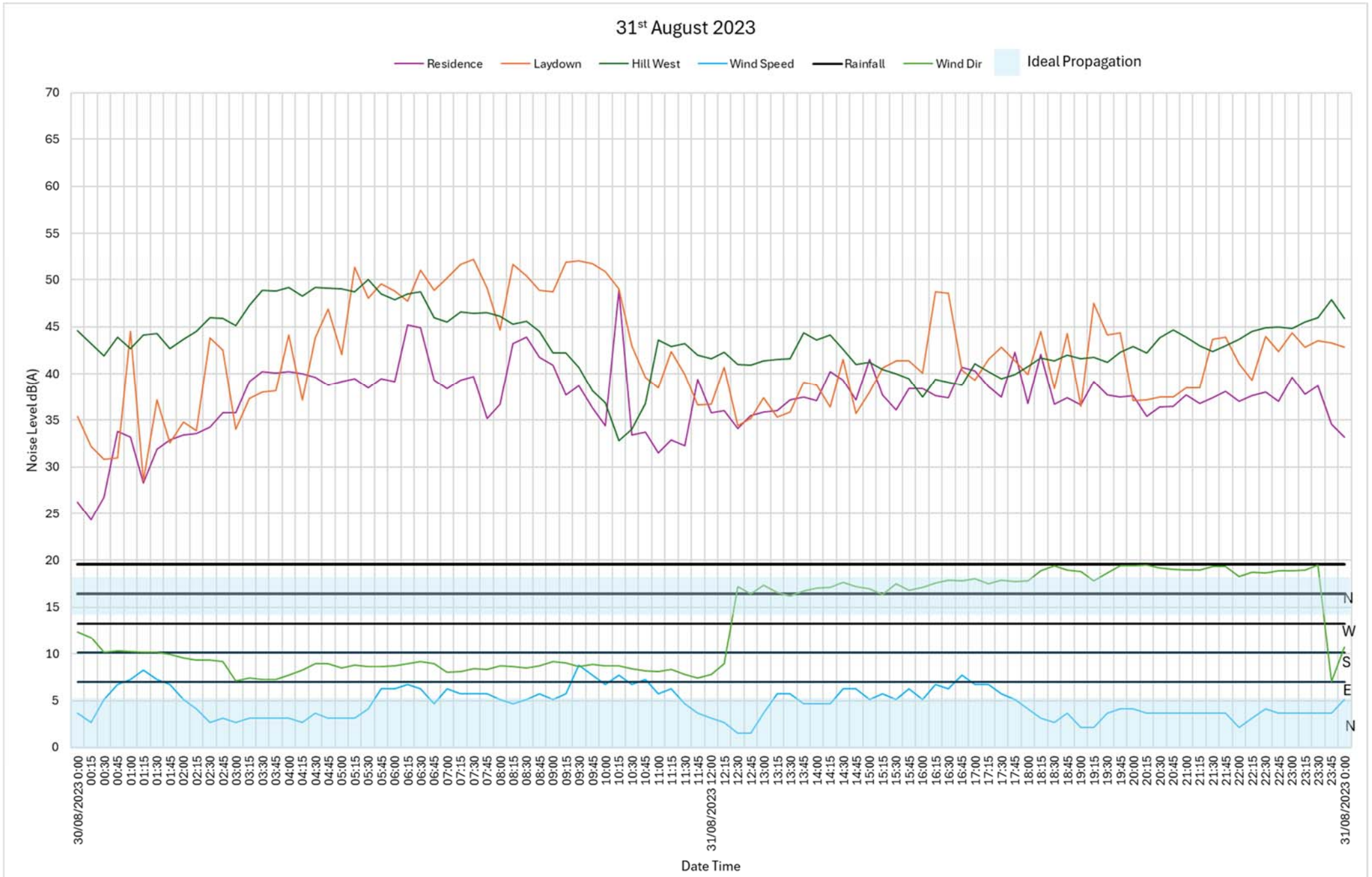
Date Time


31st August 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
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31/08/2023 12:00
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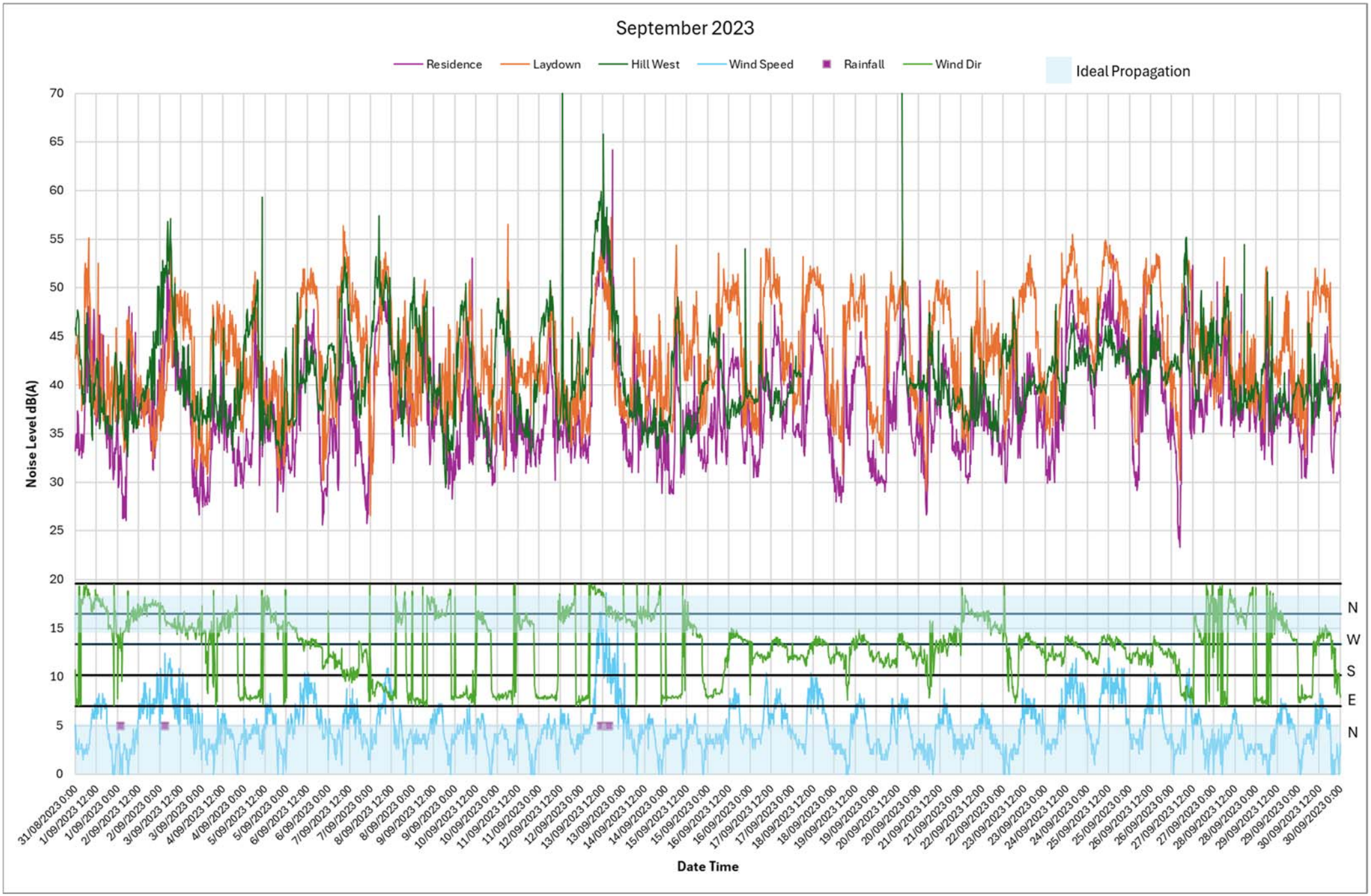
Date Time


September 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
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50
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40
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30
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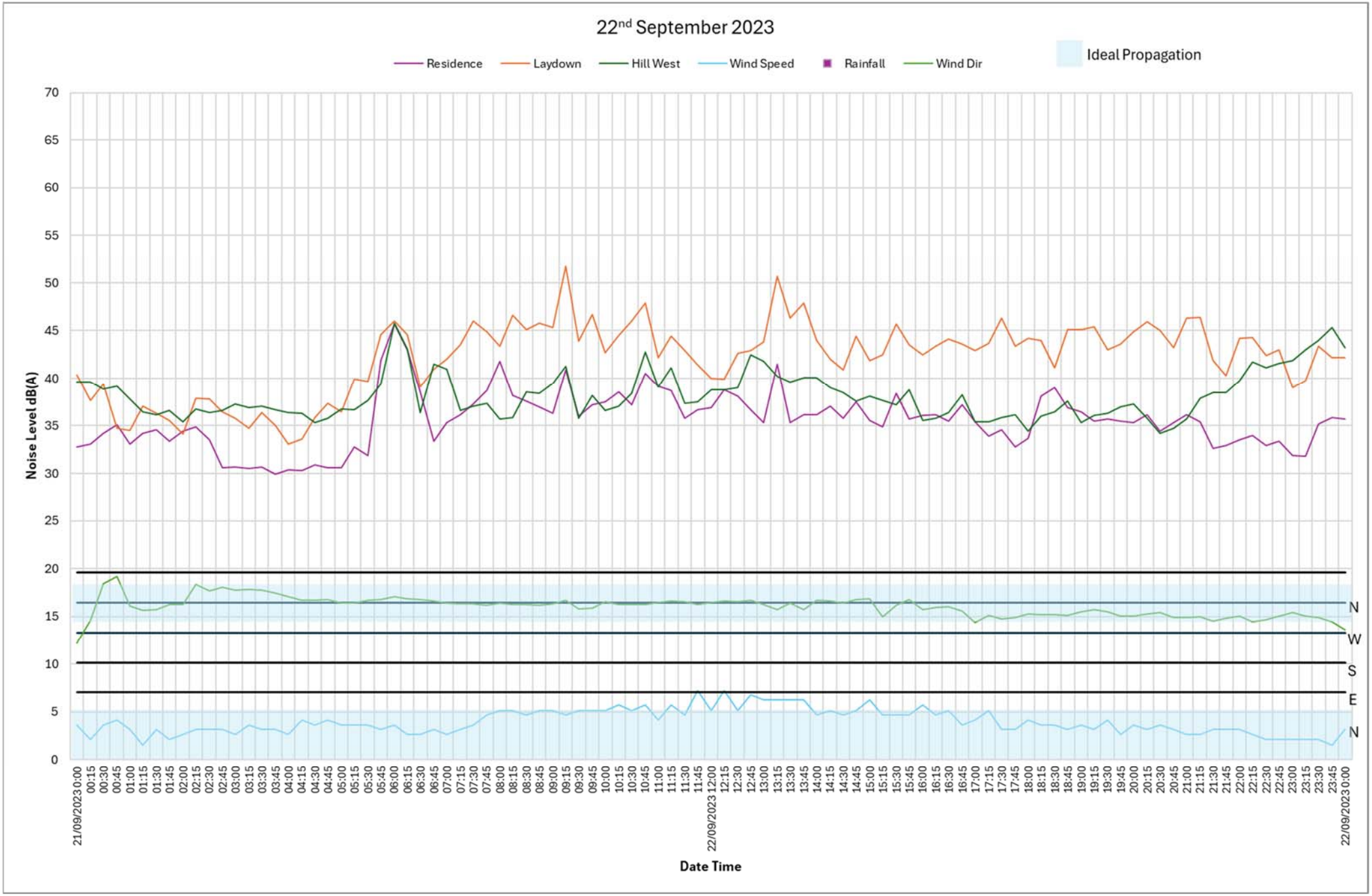
22nd September 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
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21/09/2023 0:00
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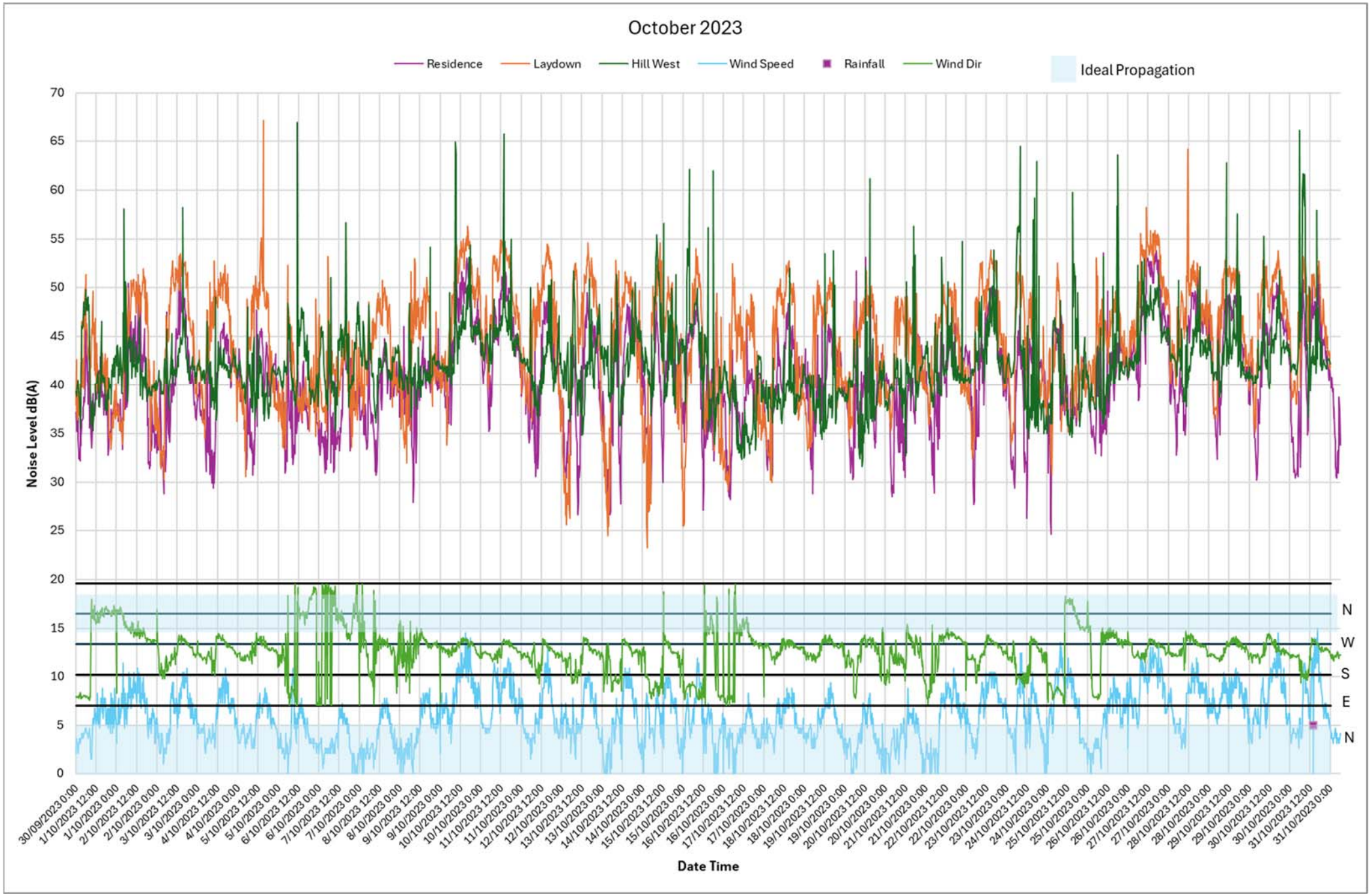
Date Time


October 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
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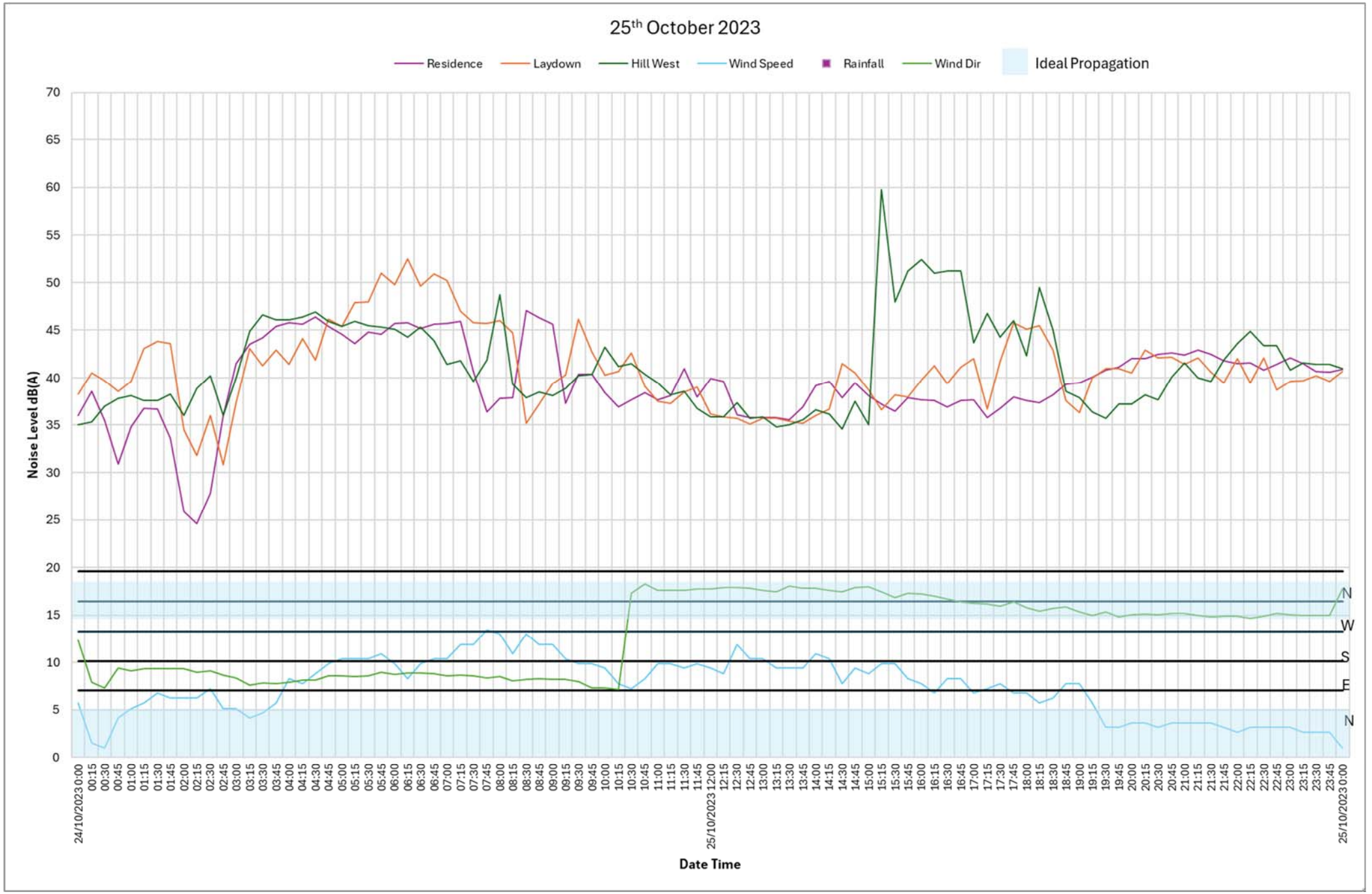
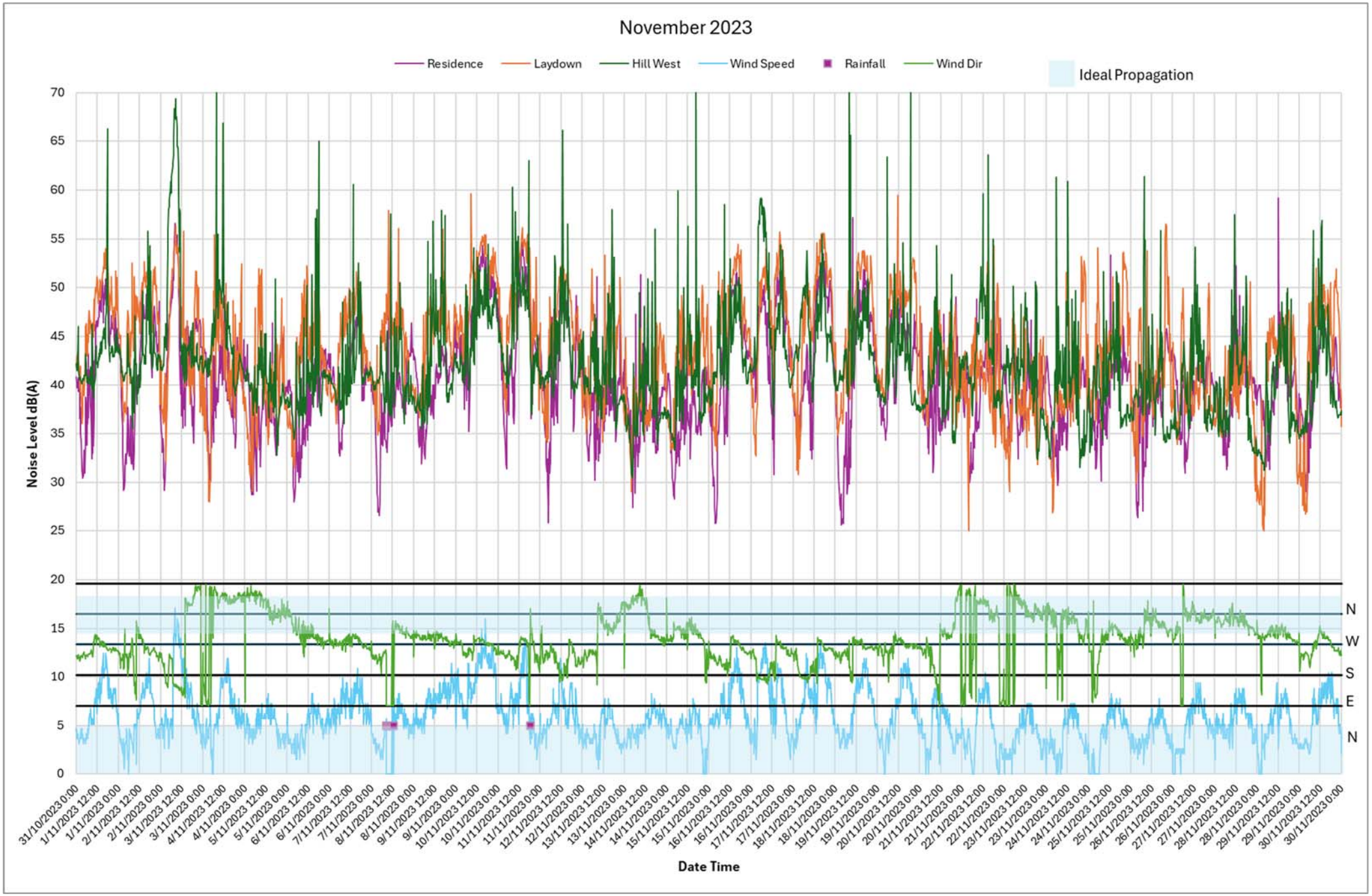
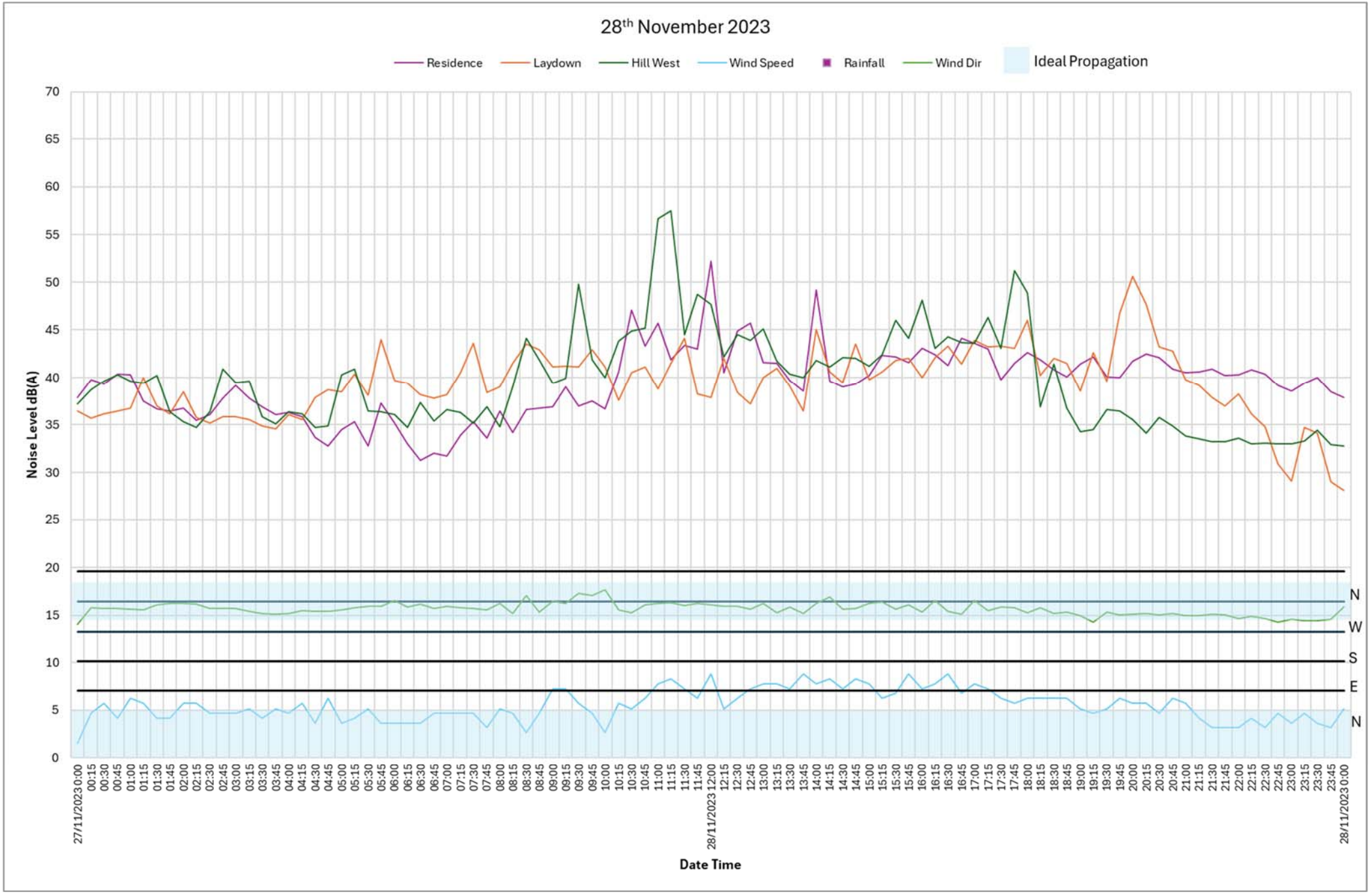
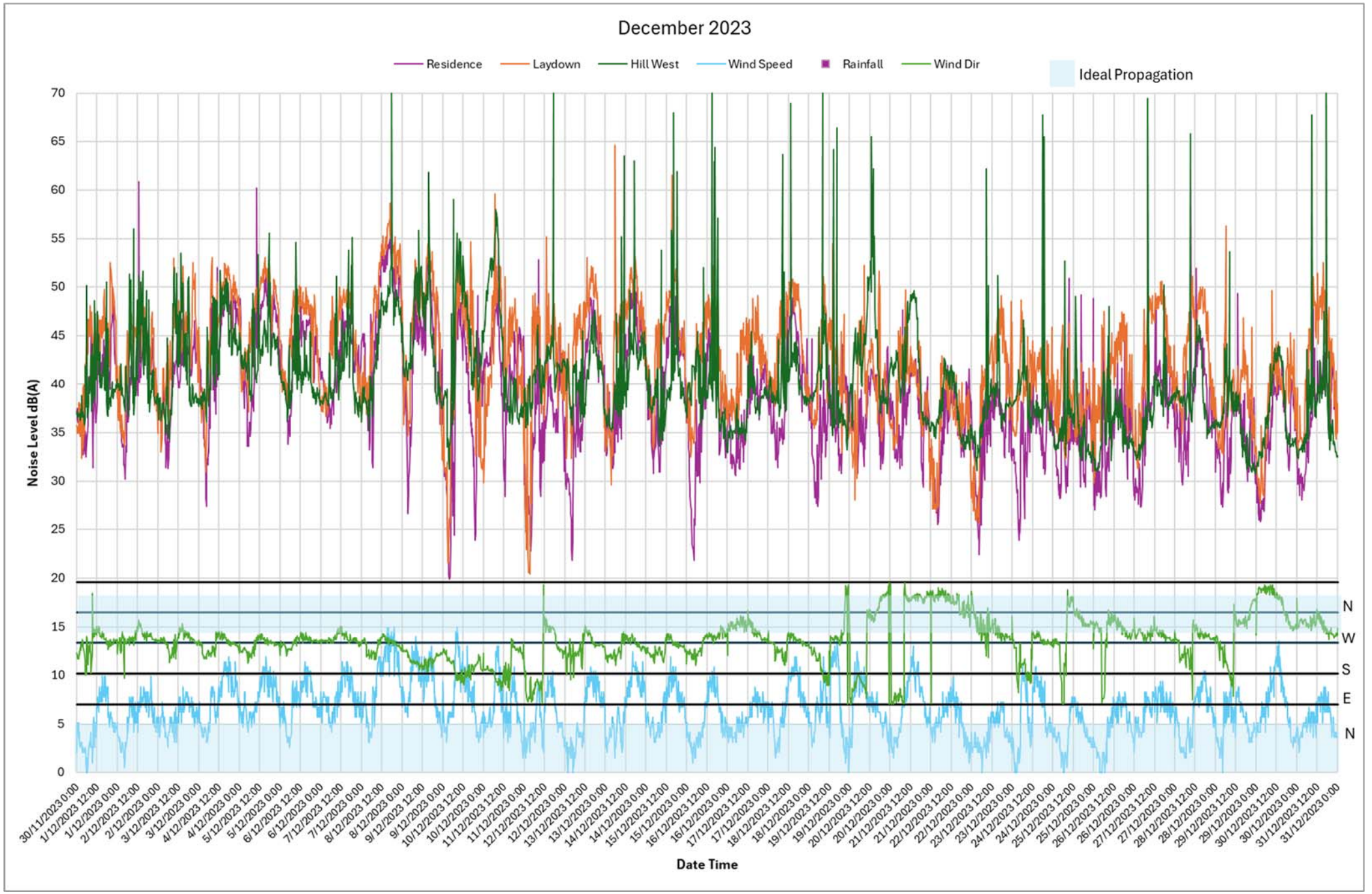
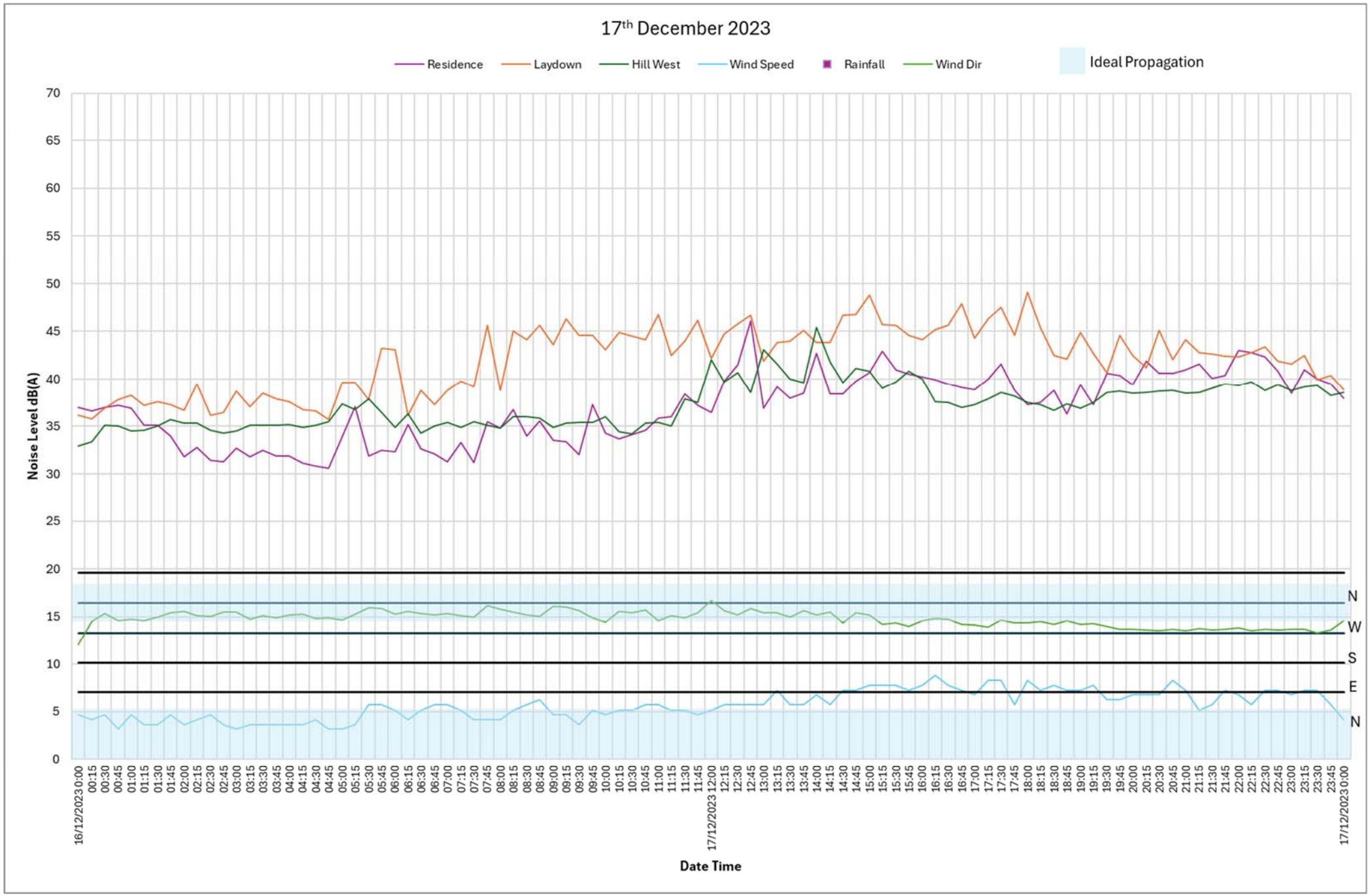
25/10/2023 12:00
25/10/2023 0:00
26/10/2023 12:00
26/10/2023 0:00
27/10/2023 12:00
27/10/2023 0:00
28/10/2023 12:00
28/10/2023 0:00
29/10/2023 12:00
29/10/2023 0:00
30/10/2023 12:00
30/10/2023 0:00
31/10/2023 12:00
31/10/2023 0:00
Date Time

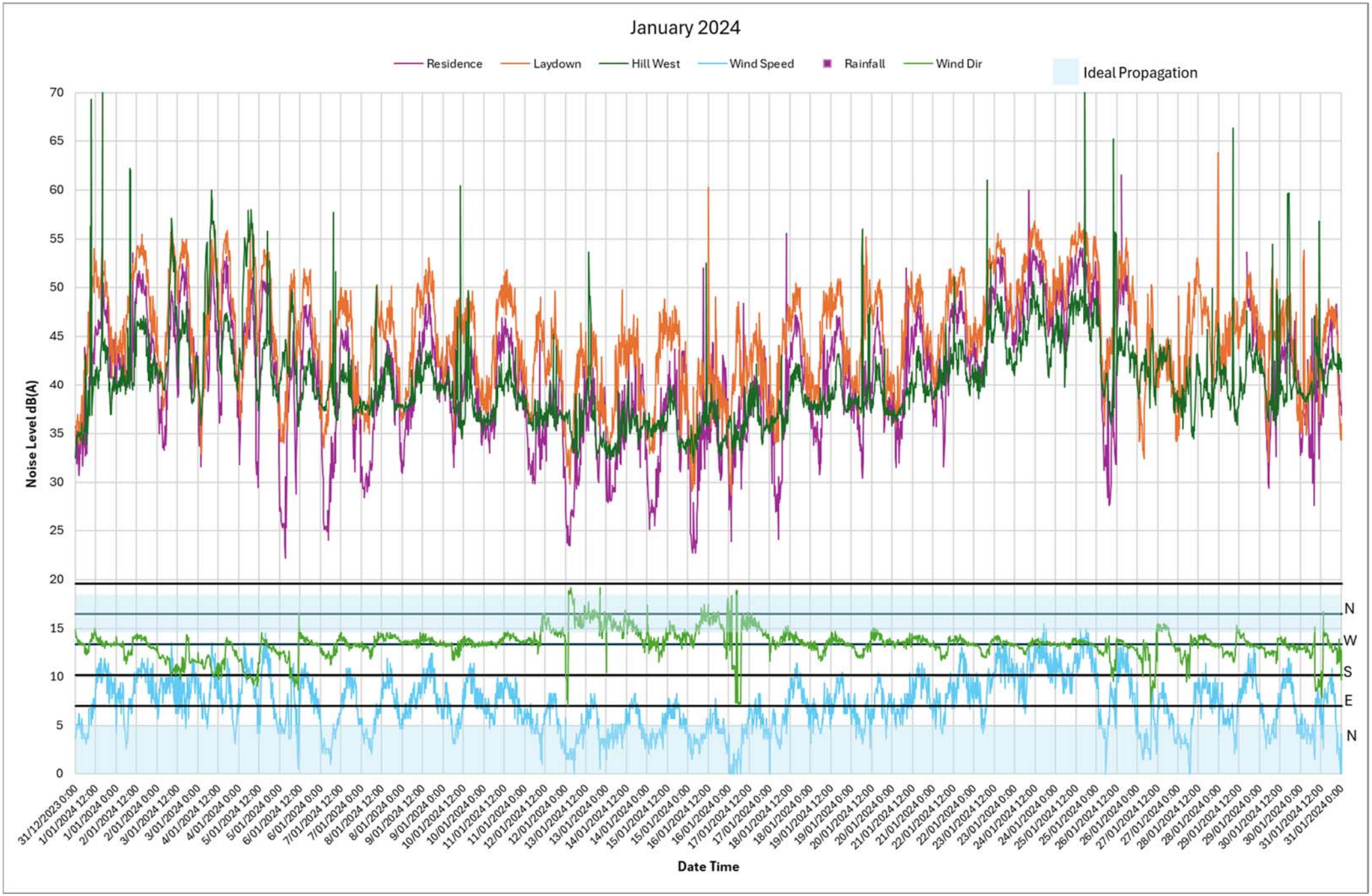

25th October 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
24/10/2023 0:00
25/10/2023 12:00
25/10/2023 0:00
Date Time

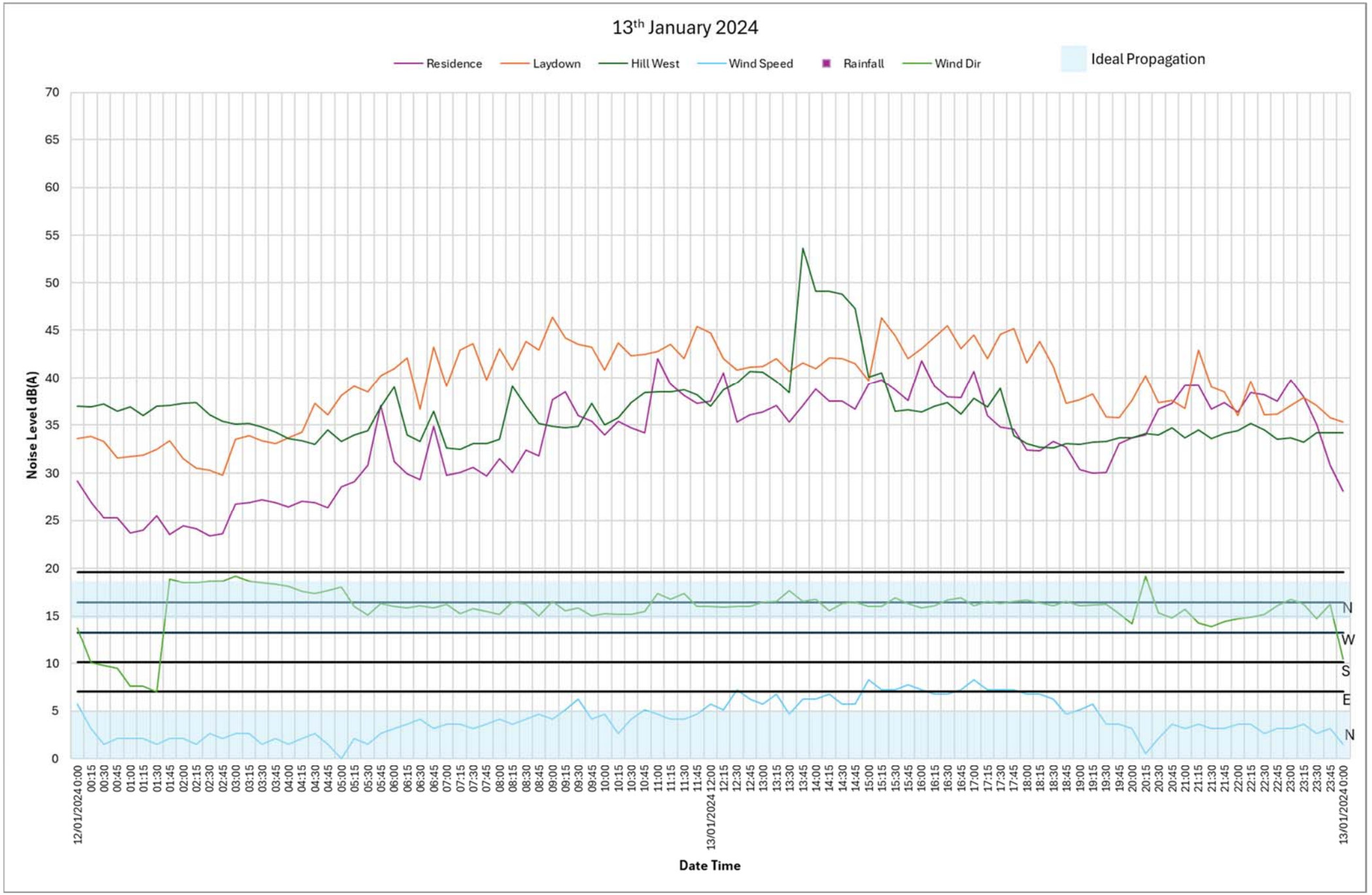

November 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
31/10/2023 0:00
1/11/2023 12:00
1/11/2023 0:00
2/11/2023 12:00
2/11/2023 0:00
3/11/2023 12:00
3/11/2023 0:00
4/11/2023 12:00
4/11/2023 0:00
5/11/2023 12:00
5/11/2023 0:00
6/11/2023 12:00
6/11/2023 0:00
7/11/2023 12:00
7/11/2023 0:00
8/11/2023 12:00
8/11/2023 0:00
9/11/2023 12:00
9/11/2023 0:00
10/11/2023 12:00
10/11/2023 0:00
11/11/2023 12:00
11/11/2023 0:00
12/11/2023 12:00
12/11/2023 0:00
13/11/2023 12:00
13/11/2023 0:00
14/11/2023 12:00
14/11/2023 0:00
15/11/2023 12:00
15/11/2023 0:00
16/11/2023 12:00
16/11/2023 0:00
17/11/2023 12:00
17/11/2023 0:00
18/11/2023 12:00
18/11/2023 0:00
19/11/2023 12:00
19/11/2023 0:00
20/11/2023 12:00
20/11/2023 0:00
21/11/2023 12:00
21/11/2023 0:00
22/11/2023 12:00
22/11/2023 0:00
23/11/2023 12:00
23/11/2023 0:00
24/11/2023 12:00
24/11/2023 0:00
25/11/2023 12:00
25/11/2023 0:00
26/11/2023 12:00
26/11/2023 0:00
27/11/2023 12:00
27/11/2023 0:00
28/11/2023 12:00
28/11/2023 0:00
29/11/2023 12:00
29/11/2023 0:00
30/11/2023 12:00
30/11/2023 0:00
Date Time

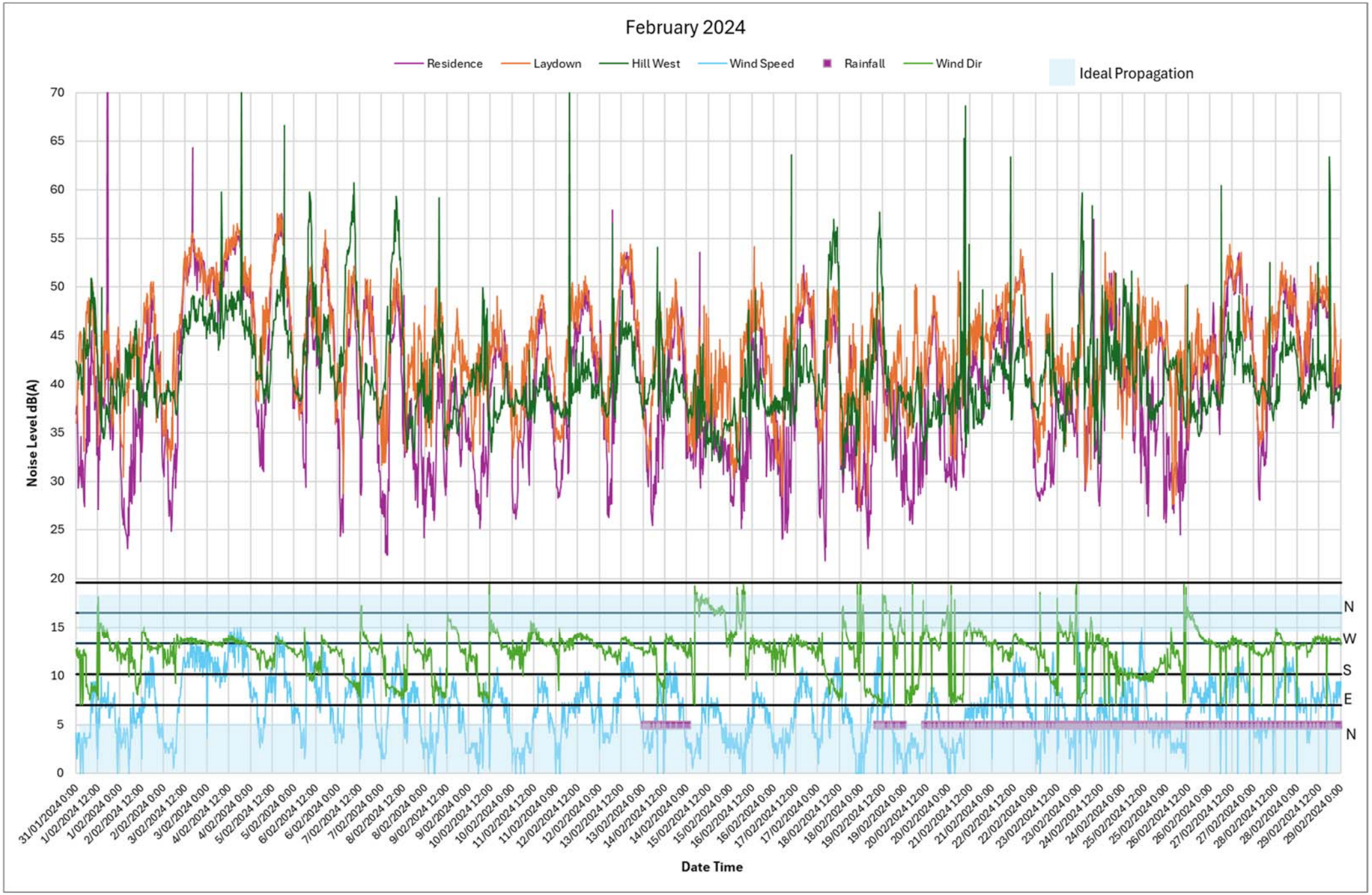

28th November 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
27/11/2023 0:00
28/11/2023 12:00
28/11/2023 0:00
Date Time

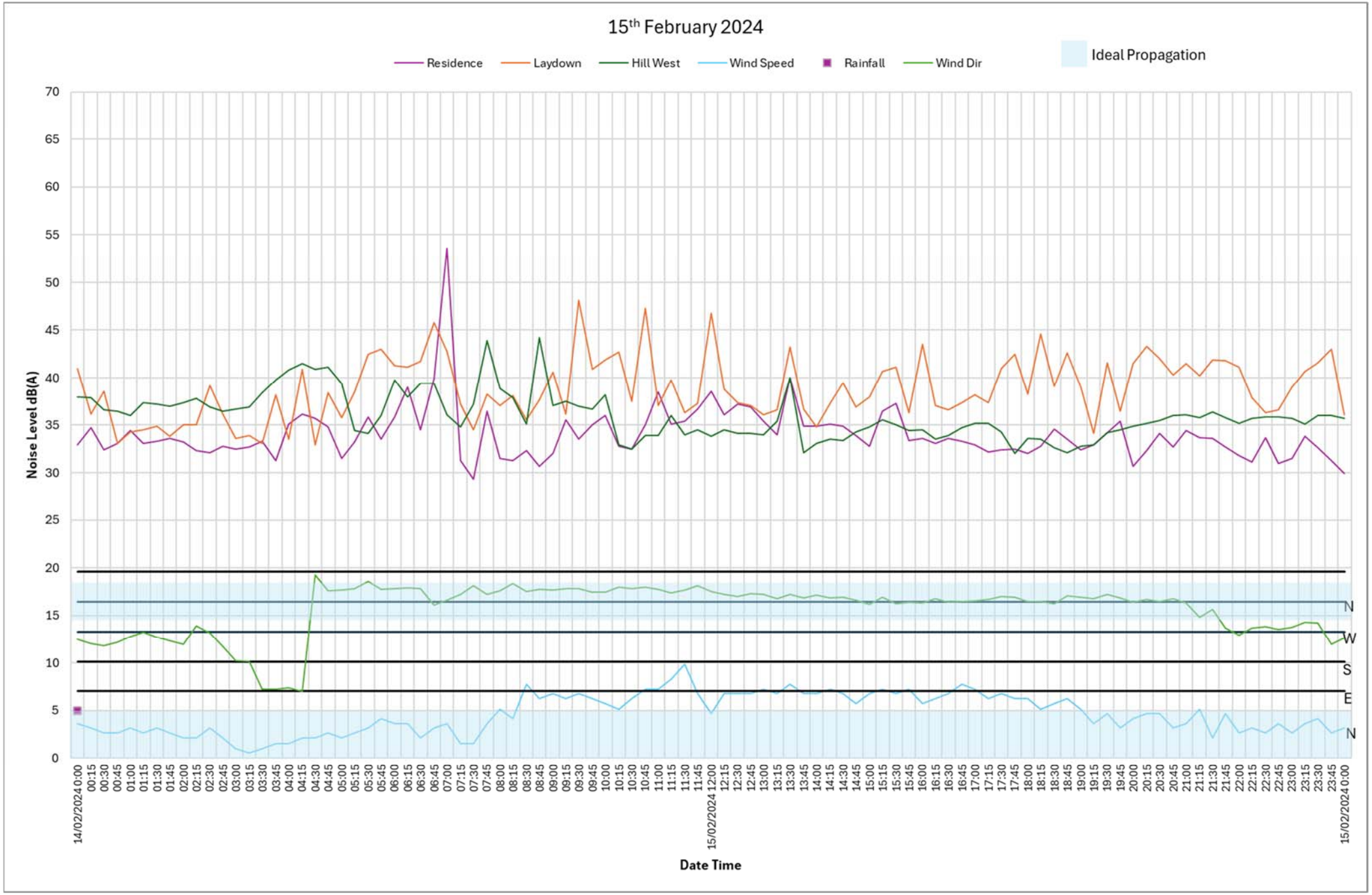

December 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
Date Time

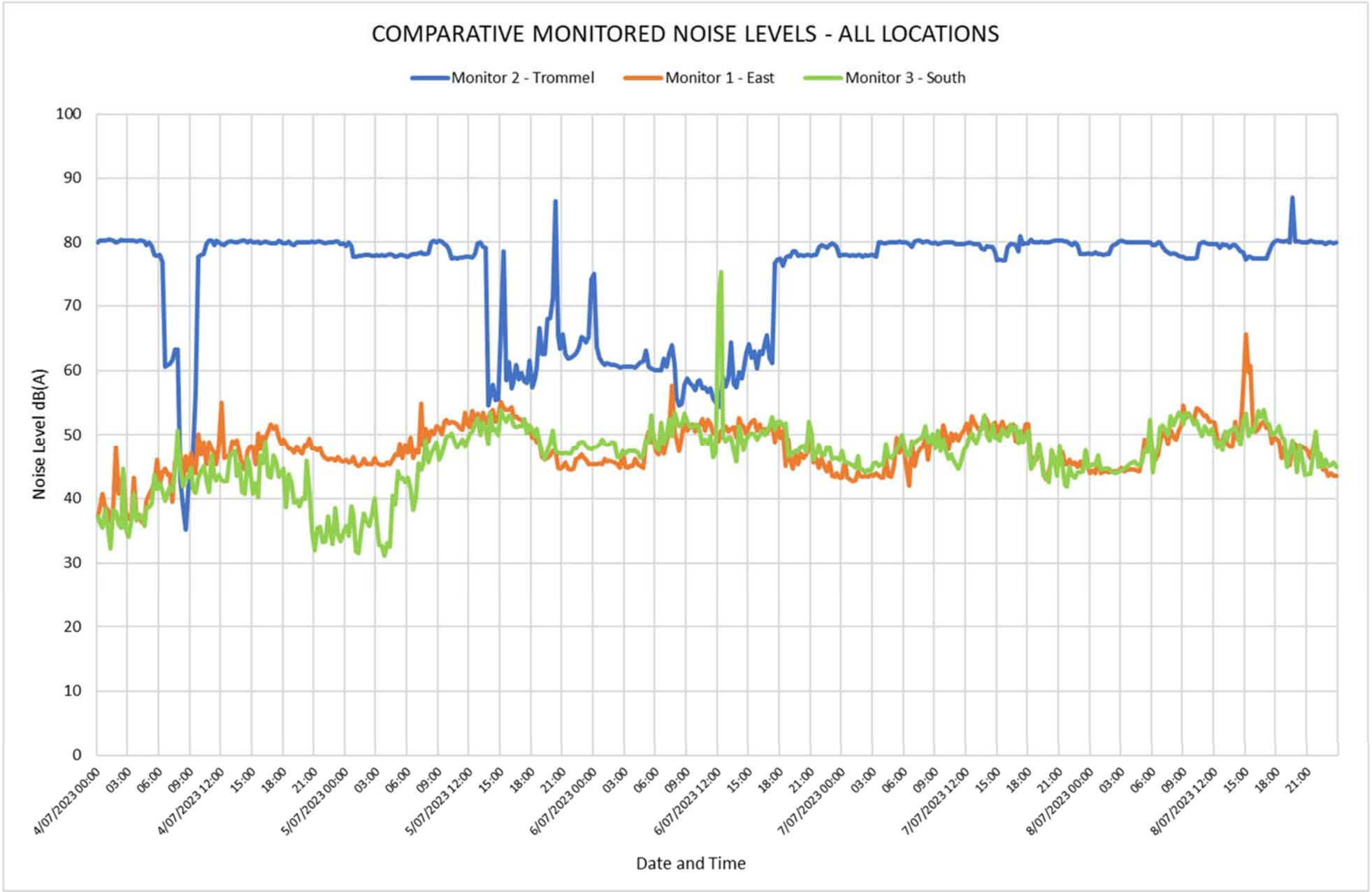

17th December 2023
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
16/12/2023 0:00
17/12/2023 12:00
17/12/2023 0:00
Date Time


January 2024
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
Date Time


13th January 2024
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
12/01/2024 0:00
13/01/2024 12:00
13/01/2024 0:00
Date Time


February 2024
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
Date Time
N
W
S
E
N


15th February 2024
Residence
Laydown
Hill West
Wind Speed
Rainfall
Wind Dir
Ideal Propagation
Noise Level dB(A)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
N
W
S
E
N
14/02/2024 0:00
15/02/2024 12:00
15/02/2024 0:00
Date Time


COMPARATIVE MONITORED NOISE LEVELS - ALL LOCATIONS
Monitor 2 - Trommel
Monitor 1 - East
Monitor 3 - South
Noise Level dB(A)
100
90
80
70
60
50
40
30
20
10
0
4/07/2023 00:00
03:00
06:00
09:00
4/07/2023 12:00
15:00
18:00
21:00
5/07/2023 00:00
03:00
06:00
09:00
5/07/2023 12:00
15:00
18:00
21:00
6/07/2023 00:00
03:00
06:00
09:00
6/07/2023 12:00
15:00
18:00
21:00
7/07/2023 00:00
03:00
06:00
09:00
7/07/2023 12:00
15:00
18:00
21:00
8/07/2023 00:00
03:00
06:00
09:00
8/07/2023 12:00
15:00
18:00
21:00
Date and Time