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14/5/2020

S U M M A R Y

181 Chapel Street Rezoning

1. Proposed future bedrooms in buffer zone meet AS/NZS 2107:2016 standard for recommended design noise levels in bedrooms.
2. 300 Hz tone barely audible when future bedroom window open and this attracts a tonal penalty of + 1.7 dB(A).
3. With the tonal adjustment, bedroom still meets the requirements of AS/NZS 2107:2016.
4. 100 Hz hum is due to transformer laminations vibrating at twice the mains frequency, but this tone is barely audible and masked by other noises such as breeze in trees and traffic.
5. Daytime noise is dominated by traffic which masks the transformer hum. Nighttime transformer hum may be inaudible in the bedrooms with the windows closed and barely audible when the window is 200 mm open for ventilation. The hum at low level, is heard occasionally during still weather and no traffic flow.
6. The noise levels meet the Tasmanian guidelines and Australian Standards.
7. The proposed subdivision enjoys lower night time substation noise levels compared to the residents adjacent to the substation gate at Albion Street.
8. Approval for the subdivision is recommended as regards noise.

CLIENT Mr Chris Hazel

BRIEF: Measure and analyse the noise in the proposed subdivision according to the Tasmanian DPIWE "Noise Measurements Procedures Manual (July 2004) and evaluate whether future proposed dwellings comply with the requirements of the Tasmania Environment Protection Policy (Noise) 2009, the requirements of AS/NZS 2107:2016 (Acoustics-Recommended design sound levels and reverberation times for building interiors) and AS 1055:2018.

INTRODUCTION:

Concern has been expressed by Tas Networks in relation to noise associated with a nearby substation and the transmission lines.

We conducted noise measurements at the site during the day and night on various dates in February 2020 and at night on 8/4/2020 and for comparison, at the entrance to the sub station near 12 and 13 Albion Street.

This is the main report, supported by data presented in accompanying appendices sent earlier.

Using the measured noise levels, adjusted for tonal components emanating from the sub station transformers, the future bedrooms within the buffer zone were assessed in accordance with AS/NZS 2107:2016 'Acoustics – Recommended design sound levels and reverberation times for building interiors'.

The standard AS/NZS 2107:2016 recommends in Table 1, for houses and apartments in inner city areas or near major roads, the following satisfactory and maximum design noise levels in rooms:

Design noise level	Leq (dBA)	
	Satisfactory	Maximum
Sleeping areas	35	40
Living areas	35	45
Work areas	35	45

The Tasmanian Environment Protection Policy (Noise) 2009 document lists in Table 1, 'Acoustic environment indicator levels', the following:

1.Outdoor living areas Moderate annoyance, daytime and evening if 16 h Leq = 50 dB(A)
2.Outside bedrooms Sleep disturbance, window open (outdoor values) 8 h Leq = 45 dB(A)
3.Inside bedrooms, Sleep disturbance, night-time 8 h Leq = 30 dB(A)

Noise annoyance depends on the following factors:

- the ambient noise level
- the new noise level
- whether the noise has tonal components
- whether the noise has impulsive components
- the low frequency content
- the time of the day or night the noise occurs
- how often it occurs and its degree of predictability
- whether the noise is regretfully caused, mindlessly created or inflicted as an act of aggression

RESULTS:

Noise Levels:

The noise measurements were conducted during the week and week ends under suitable weather conditions, that is, no rain and light or no wind.

The main results are shown on pages A 5, A 6 and A 12 to A 15 in appendix A.

For example, consider the night time (1:08 h) measurement at location 2 (page A 6).

L_{10} is the noise level exceeded for 10 % of the sampling time. For example, L_{10} = 32.8dB(A) means that for 1.5 minutes out of the 15 minute sample, the noise level was 32.8 dB(A) or higher. L_{10} gives the approximate average of the higher noise levels encountered. It is used as a metric in traffic noise studies.

From pages A 5 and A 6, the mean night time (2200 h onwards) noise level is L10 = 35.4 dB(A) with a sample deviation = 3.1 dB(A)

L90 is the noise level exceeded for 90 % of the sampling time. L90 = 30.5 dB(A) means that for 13.5 minutes out of the 15 minutes, the noise level was 30.5 dB(A) or more. It is a good descriptor of the base or background noise level.

At night time, at location 2, we measured a mean L90 = 30.3 dB(A) with a sample standard deviation of 0.75 dB(A). As the measurements were done in February, we assume that this mean background noise level corresponds to a summer sub-station load. The conditions were calm to moderately calm as shown on page A 4. Hence the night time background L90 noise levels at location 1 and 2 were partly due to the continuous transformer lamination hum.

Leq is the A weighted equivalent noise level. A fluctuating noise having an Leq = 32.3 dB(A) has the same acoustic energy as a steady noise of 32.3 dB(A).

The mean night time Leq = 35.6 dB(A) with a sample standard deviation of 4.4 dB dB(A).

Spectral analysis:

Subjectively, the 100 Hz transformer lamination hum associated with sub stations was barely audible in between traffic events and breeze in the trees. However, there was a higher pitched tone that was somewhat more audible.

The 1/3 octave spectral analysis indicated this tone to be in the 315 Hz band as shown, for example, on page A 12, location 2 at 0:25 h. The tone is present (see page A 14, 1:08h and page A 15, 0:10 h) but not continuously.

A 1/12 octave analysis (see page B 3, top spectra) indicated the tone to be 302 Hz whereas at the entrance to the sub station, at location 3, the spectral content indicated harmonics of 100 Hz, 150 Hz, 200 Hz and 300 Hz as expected. Why only the 300 Hz tone at location 2 and not the other harmonics? Is the 300 Hz feature, the ripple voltage due to full wave rectification of the 3 phase 50 Hz power lines that somehow gets converted into an acoustic signal?

We constructed a theoretical polar plot of the 4 large in line transformers at the sub station, as shown in appendix C. The polar plot shows areas where the pure tone sound waves from the 4 transformers reinforce and cancel. The polar plots indicate that the 100 Hz major lobes miss the proposed subdivision as shown on page C 2 but the 300 Hz lobes do reside at location 1 and 2 as shown on the overlay on page C 3.

The polar plot does not take into account reflections from nearby reflecting surfaces.
Tonality adjustment:

Page D 2 contains the tonal adjustment based on AS 1055:2018.

The tonal adjustment = 0.25 (band exceedance) + 2.75. So, for example, for the location 2, 0:25 h column, the measured noise level is Leq = 33.3 dB(A) and the adjusted for the 315 Hz tone or the rating level is 35 dB(A). The difference is 35 – 33.3 = 1.7 dB(A).

The mean difference of the four 15 minute samples obtained around midnight is 1.6 dB(A) with a sample standard deviation of 0.49 dB(A).

The night time mean adjusted noise level is therefore Leq = 35.6 + 1.6 = 37.2 dB(A).

Ideally we should design the building elements (in this case mainly the windows) for the end of life of the building, that is, for the noise climate likely to illuminate the building in say 40 years time. However, traffic flow predictions beyond 15 to 20 years are unreliable. There may be more electric vehicles, there may be quieter road surfaces, the mix of cars and trucks may alter and the substation load may even decrease as more people seek alternative energy.

TRANSFORMERS:

The sound power level of a transformer is according to AS/NZS 60076.19: 2009 (Power transformers, Part 10: Determination of sound levels) related to the MVA as follows:
(See Annex ZA, page 29 and Annex ZZ, page 32)

Standard Maximum $L_{wa} = 66 + 14 \log (MVA)$

Our measurements were conducted during the summer. If we assume that the winter load is 50 % greater than the summer load, then the noise level will increase in winter by:

$= 14 \log 1.5 = 2.46$ or say 2.5 dB(A).

Hence the winter night time noise level is Leq $= 37.2 + 2.5 = 39.7$ dB(A)

This winter night time increase of sub station transformer noise by 2.5 dB(A) is a slight increase barely noticeable. . A 1 dB(A) increase is a marginal increase in noise. An increase in noise of 1 dB can be detected in a laboratory condition by a trained listener with good hearing. A 3 dB increase is a just noticeable increase in noise, that is, 50 % of the public perceive it as an increase in noise while the other 50 % don't perceive an increase in noise level. It is a point of indifference where we can't make up our mind as to whether an increase occurred or not. Also, the increase occurs over a long period of time and therefore subjectively undetectable. A 5 dB(A) increase in noise is noticeable.

Hence to this 39.7 dB(A) we add 2.5 dB(A) to take into account the 'façade effect', that is, the noise travels past the measuring microphone, reflects off the facede and back again into the measuring microphone 1 m away. This applies to incoherent sounds. The transformer hum is a coherent sound and this requirement may not apply. We will include it as a 'safety factor'. Hence the level outside a bedroom is likely to be 39.7 + 2.5 = 42.2 dB(A).

This meets the Environment Protection Policy (Noise) 2009 of 45 dB(A) at night as in their Table 1.

Research conducted by N.L. Carter, P. Ingham and K. Tran in relation to traffic noise, indicated that the mean indoor/outdoor attenuation using the metric Leq, was 17.05 dB(A) with windows slightly open for ventilation and 21.5 dB(A) with the windows closed.("Overnight Traffic Measurements In Bedrooms and Outdoors – Pennant Hills Road, Sydney – Comparisons With Criteria For Sleep" Acoustics Australia Vol 20, No 2, page52).

So with a transformer hum outside a bedroom at 42.2 dB(A) and a window attenuation of 17 dB. The noise in the bedroom is likely to be 42.2 – 17 = 25.2 dB(A) and this meets the requirements of AS/NZS 2107:2016 for bedrooms near minor roads.

100 Hz STANDING WAVES IN BEDROOMS:"

A wave length belonging to 100 Hz which fits exactly between two opposite surfaces in a bedroom is an axial mode and there is some acoustic merit in avoiding if possible, dimensions of 3.42 metres. This assumes a bedroom night time temperature of about 20 degrees C.

Most building materials come in lengths of multiples of 300 mm for example1200 mm, 2400 mm and so on so 3.4 m dimension is easily avoided by builders who want to reduce material wastage.

CONCLUSION:

The noise levels attributed to the sub-station and shown in the appendices are all below the recommended noise levels of AS/NZS 2107:2016 and the Environment Protection Policy (Noise) 2009 regarding bedrooms and outdoor living areas.

The substation noise levels at the proposed subdivision are lower than the noise levels experienced by the residents living near the entrance gate to the substation in Albion Street.

The proposed subdivision is acceptable as relates to noise and approval is recommended.

Pearu Terts

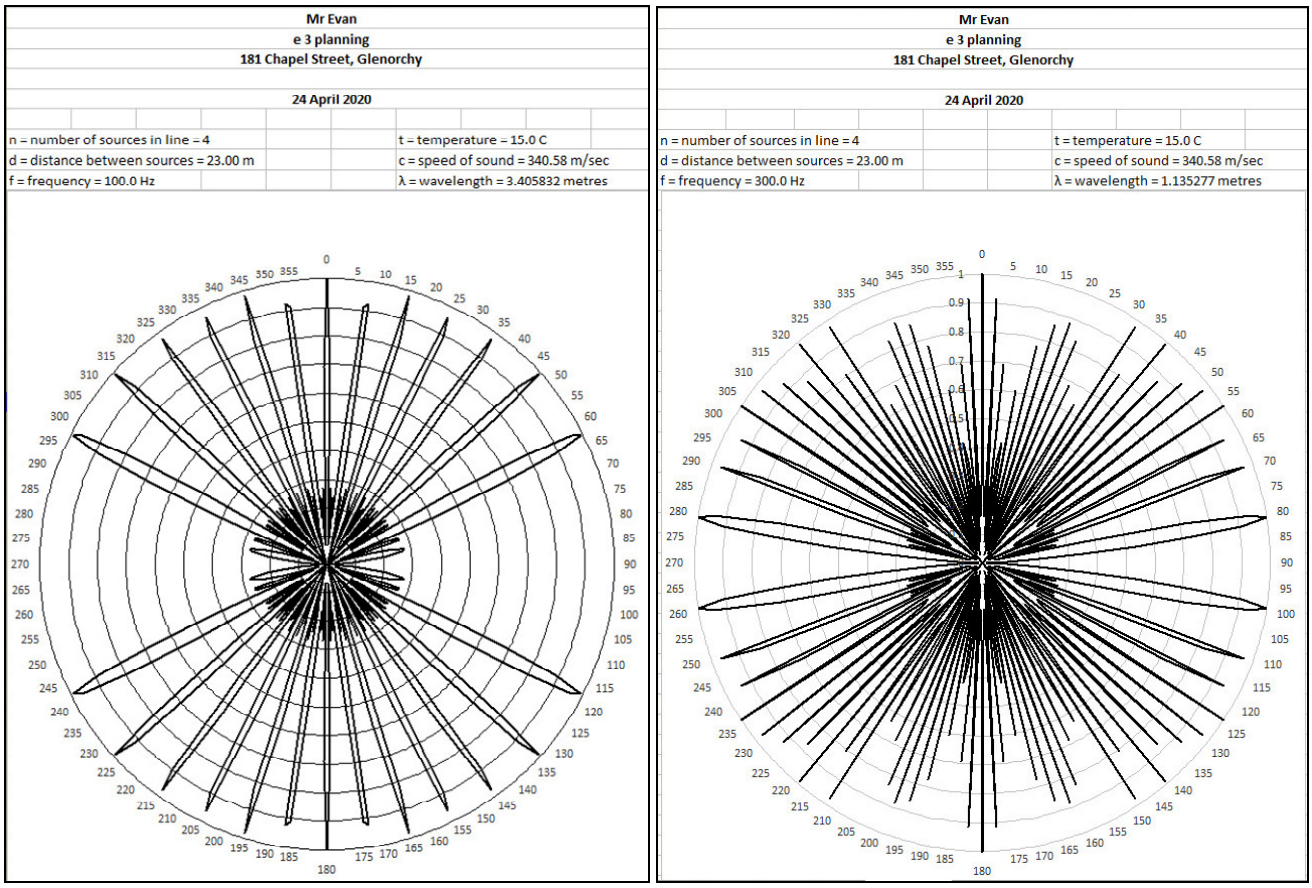
181 Chapel St residential subdivision project, Glenorchy
Supplementary report: Polar pattern distribution of substation tonal noise, April 2020
Appendix C to be read in conjunction with main report

General

The vacant site at 181 Chapel St is a long block which lies alongside the street, overlain in the middle by high voltage transmission lines originating from the Albion St substation. Existing residential neighbours surround the area, many of which lie in closer proximity to the substation than any of the proposal lots the client site.

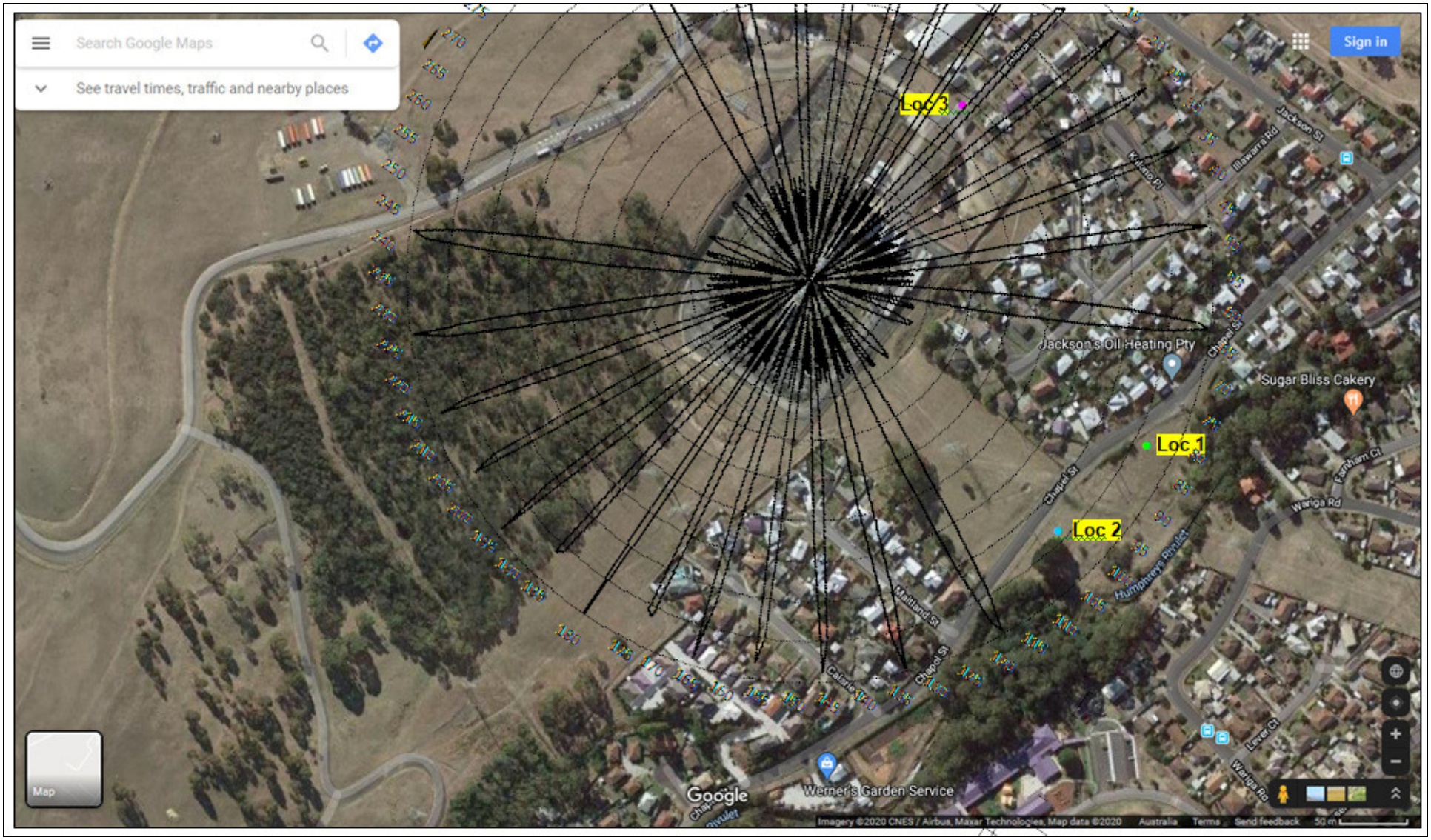
This report describes prediction of substation tonal noise emission distribution using modelling.
Airphoto interpretation indicates there are 4 transformers in line and 23 m apart along a bearing of 34°. The air temperature was taken as 15℃. Note the patterns are for free field and do not account for reflections or refraction around houses etc.

Polar distribution of 100 Hz and 300 Hz tones for 4 transformers in line 23 m apart

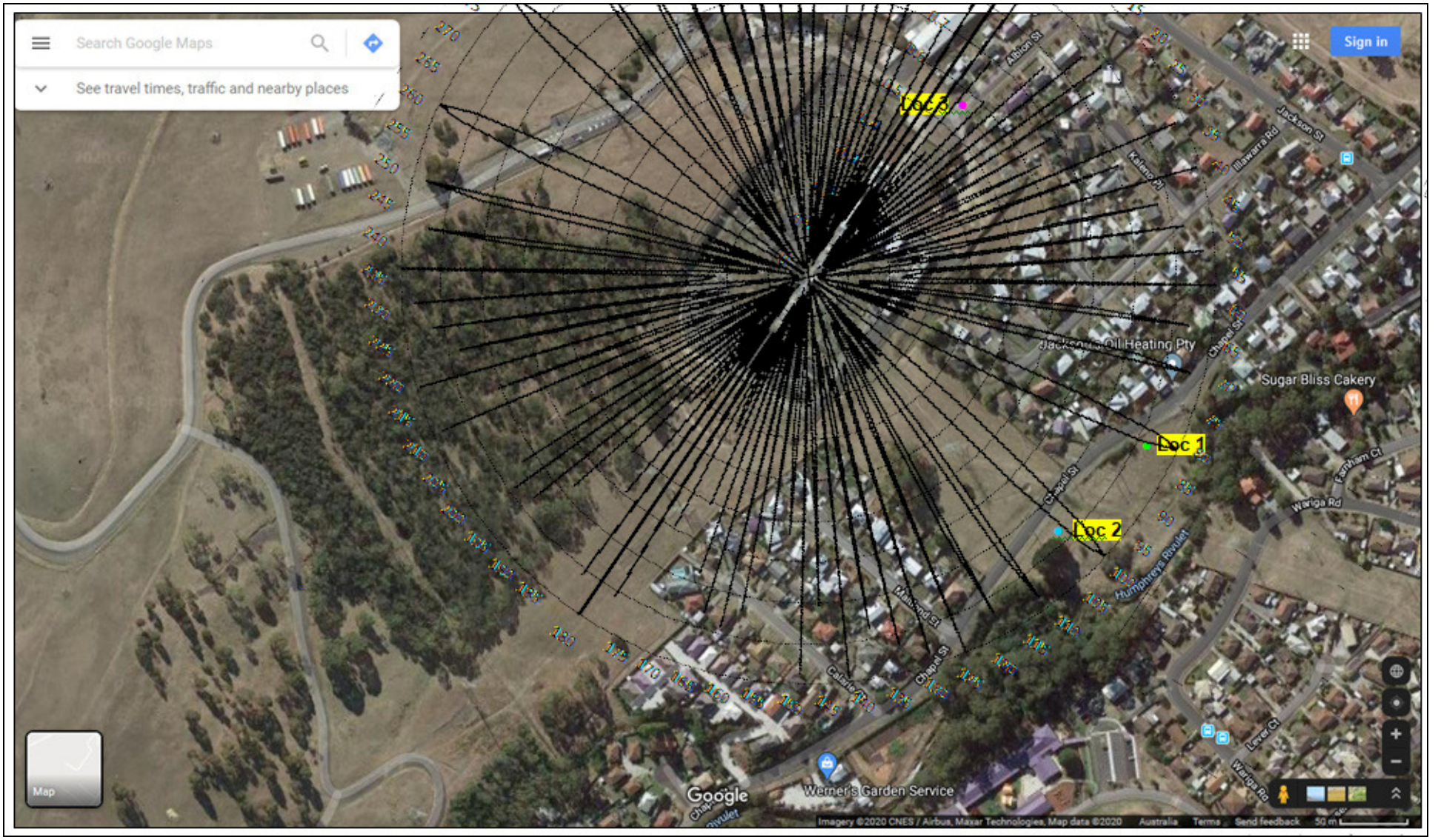


[Last revised 27/4/2020]

Polar pattern of 100 Hz tone airphoto overlay



Polar pattern of 300 Hz tone airphoto overlay



181 Chapel St residential subdivision project, Glenorchy
Field report for site visits February 2020
Appendix A to be read in conjunction with main report

General

The vacant site at 181 Chapel St is a long block which lies alongside the street, overlain in the middle by high voltage transmission lines originating from the Albion St substation. Existing residential neighbours surround the area, many of which lie in closer proximity to the substation than any of the proposal lots the client site. This report describes the findings of ambient noise monitoring and observations from several site visits at both day and night times, 14-20 February 2020.

Instruments used

- Brűel & Kjær Sound Level Calibrator Type 4230 s/n 1169836, Laboratory Certified Sept 2019;
- Norsonic Precision Sound Level Meter Nor131, s/n 1312829, Laboratory Certified Sept 2019;
- Weather Instruments (Aneroid barometer, Zeal Wet/Dry bulb Psychrometer, Suunto KB-14/360R compass, Kaindl Windmaster 2 wind speed meter);
- 100 m fiberglass tape

Location definitions

The locations for measurements were defined and described as follows:

Designation	Definition/comments
Loc 1	Proposal Lot 5, opposite 184 Chapel St, nearby Aurora Pole #39 (106210) 10 m setback from front boundary, microphone at 1.3 m height
Loc 2	Proposal Lot 3, at a point 30 m southwest of Aurora Pole #40 (106212) 12 m setback from front boundary, microphone at 1.3 m height
Loc 3	By Tas Networks substation entry gate, near 12 & 13 Albion St, microphone at 1.3 m height

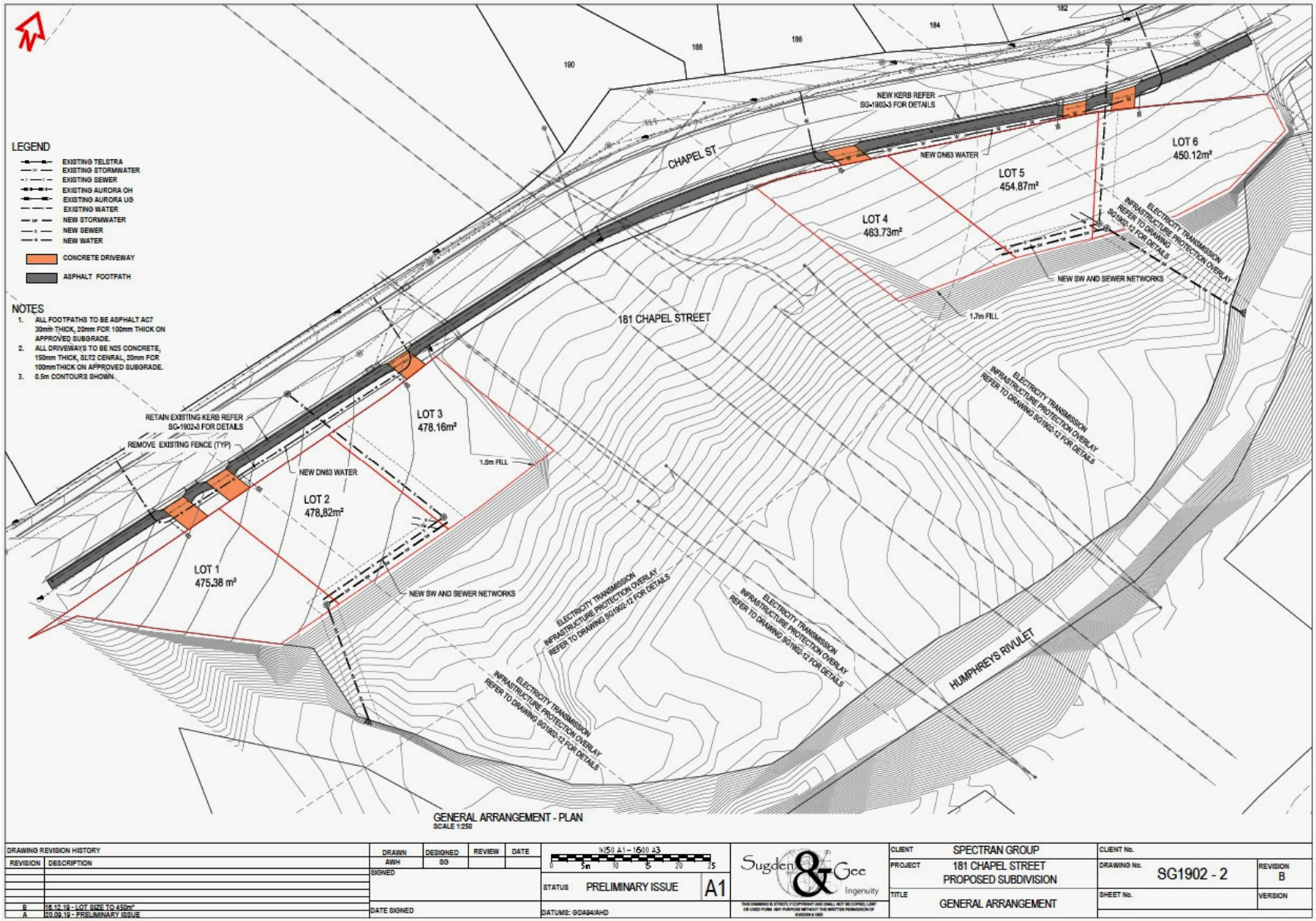
Aerial photo and plan are on the following pages.

[Last revised 11/4/2020]

Airphoto showing the study site and locale

Locations shown to good approximation. Image sourced from Google 21/2/2020, note 50 m scale bar and correct compass orientation.

Proposal site plan



Plan as sourced from client 13/2/2020, not to original scale and skewed compass orientation

Weather observations

Conditions were suitable for noise measurements, details shown below

Date	14/02/2020	16/02/2020	16/02/2020	16/02/2020	18/02/2020	18/02/2020	18/02/2020	19/02/2020	20/02/2020
Location	Loc 2	Loc 2	Loc 1	Loc 2	Loc 2	Loc 2	Loc 2	Loc 2	Loc 2
Time	22:00	0:20	15:55	19:00	1:50	17:00	22:45	19:05	0:15
Temp ℃	22	20.5	18	14.5	11.5	19	-	14	13
Relative Humidity %	82	77	45	62	75	59.0	-	52	61
Pressure hPa	1008	1009	1017	1019	1010	1010.0	1011	1013	1013
Wind speed average m/s	<0.5	<0.5	1.8	0.7	1.3	1.0	1.1	1.5	0.8
Wind speed maximum m/s	<1	<1	3.7	1.2	1.5	2.7	1.4	2.1	1.2
Wind direction	NE	NW	SE	Variable	SW	E	SW	E	Variable
Cloud cover x/8	5	5	1	4	0	8	8	-	6

Noise descriptions

For each location, ambient noise by source noted during the site visit is listed (in descending order of significance by loudness, noticeability, duration and incidence):

Location 1 and 2

- Traffic including occasional truck or motorbike, 50 km/h zone
- Birds including crows, gulls, plover
- Dogs
- Breeze in trees
- Background hum of substation, particularly tones at 100 Hz and 315 Hz
- Crickets

Location 3

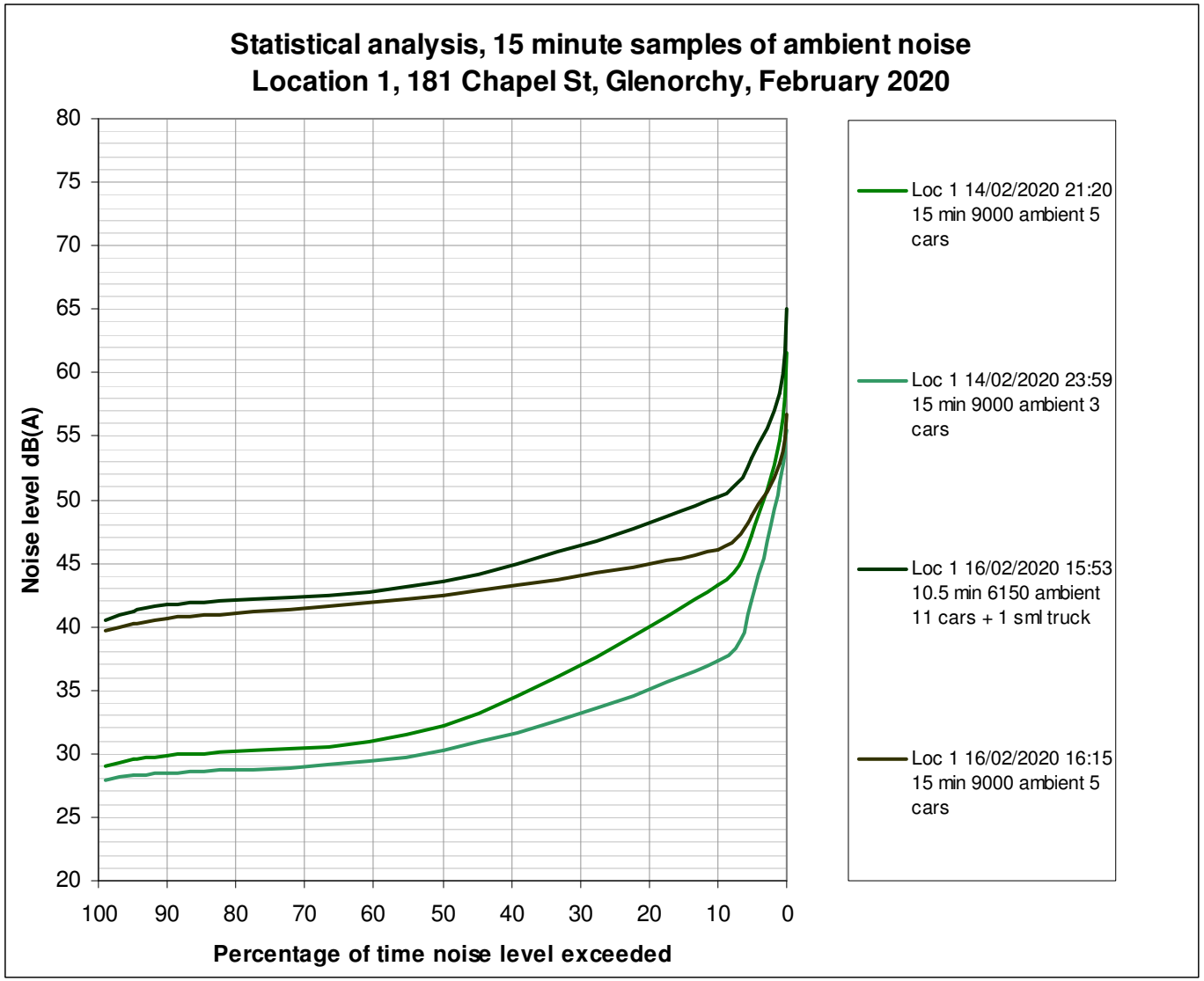
- Traffic including occasional truck or motorbike, 50 km/h zone
- Background hum of substation, numerous tones present
- Birds including crows, gulls, plover
- Dogs

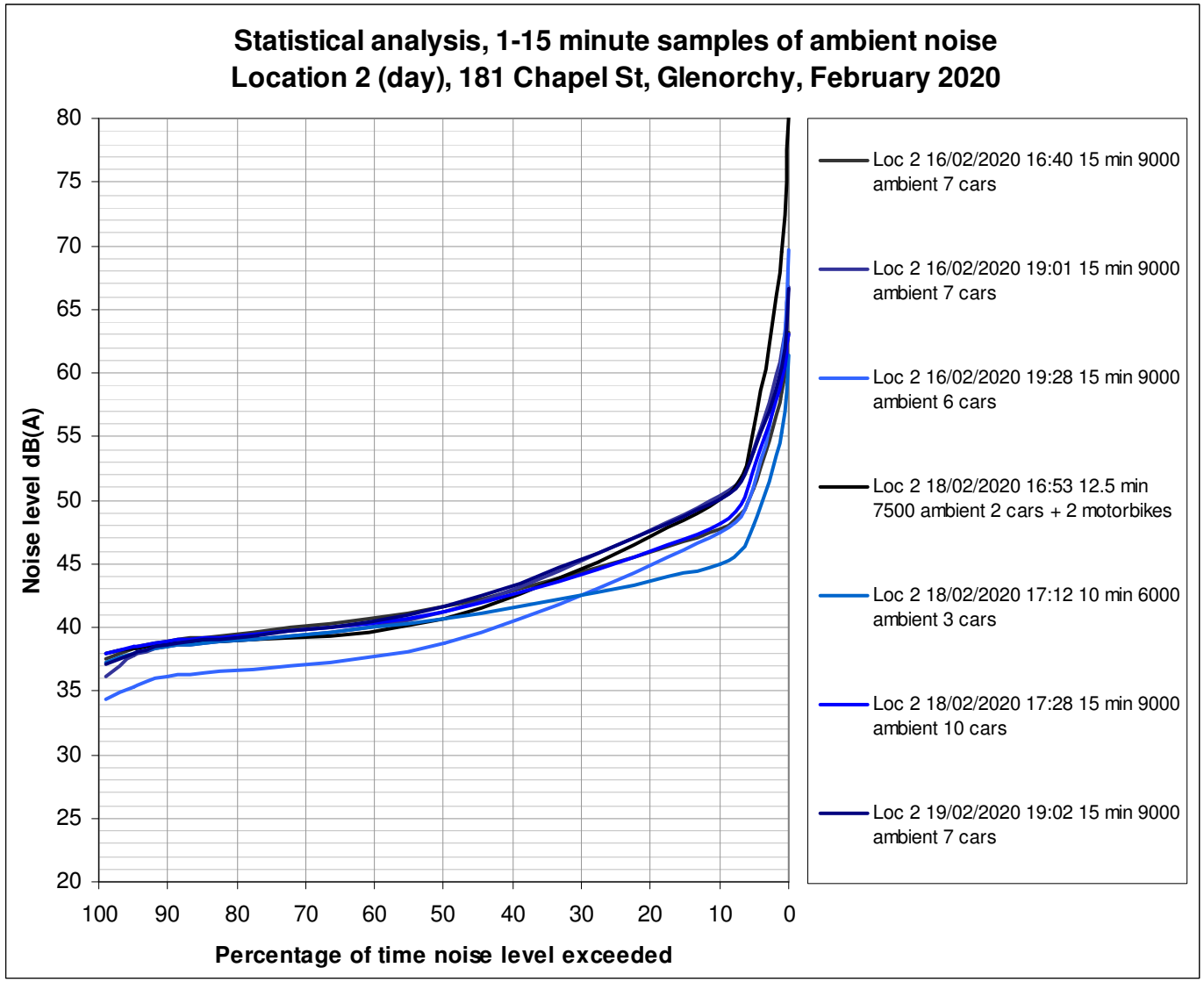
Statistical analysis of 1-15 minute samples of ambient noise dB(A), 14-16/2/2020

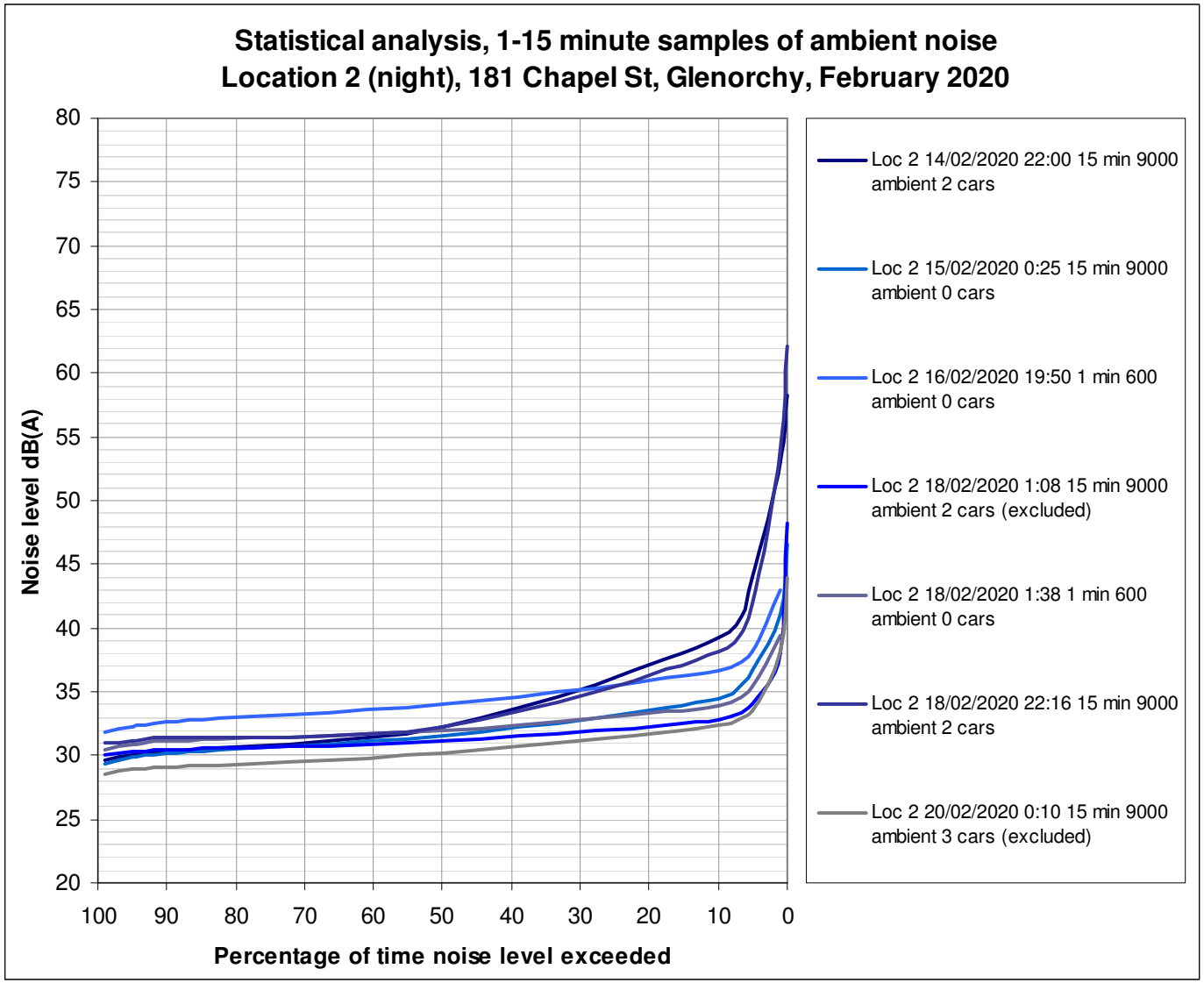
Location	Loc 1	Loc 2	Loc 1	Loc 2	Loc 1	Loc 1	Loc 2	Loc 2	Loc 2	Loc 2
Date	14/02/2020	14/02/2020	14/02/2020	15/02/2020	16/02/2020	16/02/2020	16/02/2020	16/02/2020	16/02/2020	16/02/2020
Time	21:20	22:00	23:59	0:25	15:53	16:15	16:40	19:01	19:28	19:50
Duration	15 min	15 min	15 min	15 min	10.5 min	15 min	15 min	15 min	15 min	1 min
Samples	9000	9000	9000	9000	6150	9000	9000	9000	9000	600
Note	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient
Comment	5 cars	2 cars	3 cars	0 cars	11 cars + 1 sml truck	5 cars	7 cars	7 cars	6 cars	0 cars
Lmax	63.3	59.0	58.3	59.1	66.5	58.1	64.3	-	-	-
L0.1	61.6	58.2	55.5	46.6	65	56.7	63.2	66.8	69.7	-
L1	54.6	53	51.3	41	58.4	52.9	58.5	61.6	61	43
L5	47.2	43.9	42.1	36.7	53.2	48.7	50.9	54	51.1	38.2
L10	43.3	39.2	37.3	34.5	50.2	46.1	47.7	50.3	47.5	36.6
L50	32.2	32.2	30.2	31.5	43.5	42.5	41.7	41.2	38.8	34
L90	29.9	30.3	28.5	30.2	41.7	40.7	38.9	38.5	36.1	32.7
L95	29.5	30	28.3	29.9	41.2	40.3	38.4	37.8	35.3	32.3
L99	29	29.7	27.9	29.3	40.5	39.7	37.5	36.1	34.3	31.8
Lmin	28.2	28.8	27.4	28.7	39.3	38.5	36.2	-	-	-
Leq A	42.0	39.8	37.9	33.3	47.8	44.3	46.3	49.0	48.7	35.2

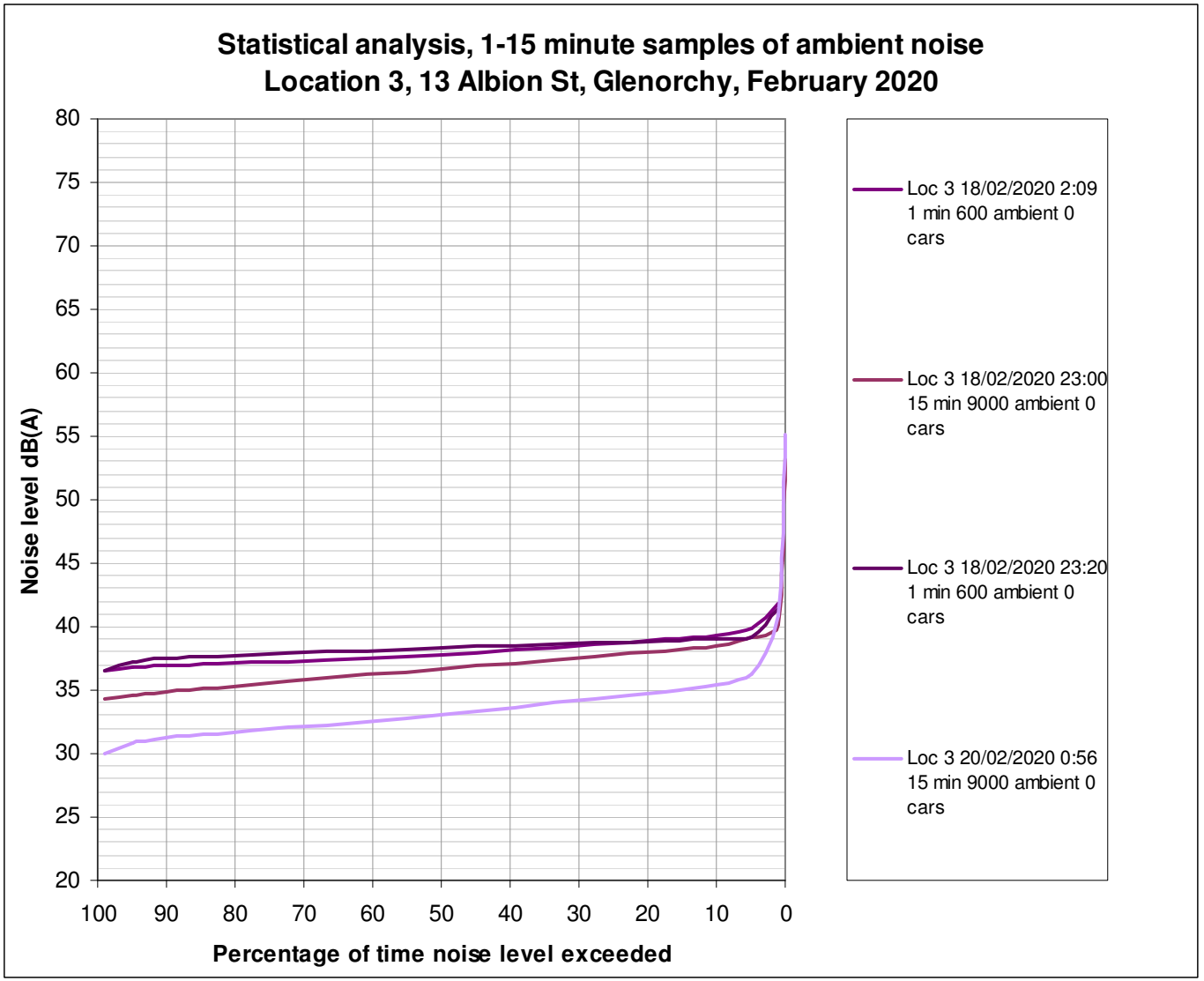
Statistical analysis of 1-15 minute samples of ambient noise dB(A), 18-20/2/2020

Location	Loc 2	Loc 2	Loc 3	Loc 2	Loc 2	Loc 2	Loc 2	Loc 3	Loc 3	Loc 2	Loc 2	Loc 3
Date	18/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020	18/02/2020	19/02/2020	20/02/2020	20/02/2020
Time	1:08	1:38	2:09	16:53	17:12	17:28	22:16	23:00	23:20	19:02	0:10	0:56
Duration	15 min	1 min	1 min	12.5 min	10 min	15 min	15 min	15 min	1 min	15 min	15 min	15 min
Samples	9000	600	600	7500	6000	9000	9000	9000	600	9000	9000	9000
Note	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient
Comment	2 cars (excluded)	0 cars	0 cars	2 cars + 2 motorbikes	3 cars	10 cars	2 cars	0 cars	0 cars	7 cars	3 cars (excluded)	0 cars
Lmax	-	-	-	-	-	64.2	62.8	58.0	44.8	72.1	48.7	72.5
L0.1	48.2	-	-	80.1	61.4	63.0	62.1	53.2	-	66.6	44.0	55.2
L1	38.0	39.4	41.8	69.5	55.3	59.4	54.0	40.2	41.4	60.4	38.2	40.8
L5	34.0	35.4	39.8	55.6	48.0	52.4	41.9	39.1	39.2	53.8	33.5	36.3
L10	32.8	33.9	39.3	50.1	45.0	48.2	38.1	38.5	39.0	50.1	32.4	35.4
L50	31.2	32.0	37.8	40.7	40.7	41.3	32.2	36.7	38.4	41.7	30.2	33.1
L90	30.5	31.1	37.0	38.8	38.5	38.9	31.4	34.9	37.5	38.6	29.1	31.3
L95	30.3	30.9	36.8	38.4	38.0	38.5	31.2	34.6	37.2	38.0	28.9	30.9
L99	30.0	30.5	36.5	37.9	37.3	37.9	31.0	34.3	36.5	37.1	28.6	30.0
Lmin	-	-	-	-	-	36.8	30.3	33.7	36.3	36.4	28.1	29.1
Leq A	32.3	32.8	38.1	57.0	44.4	46.9	40.7	37.3	38.4	48.5	31.2	37.7

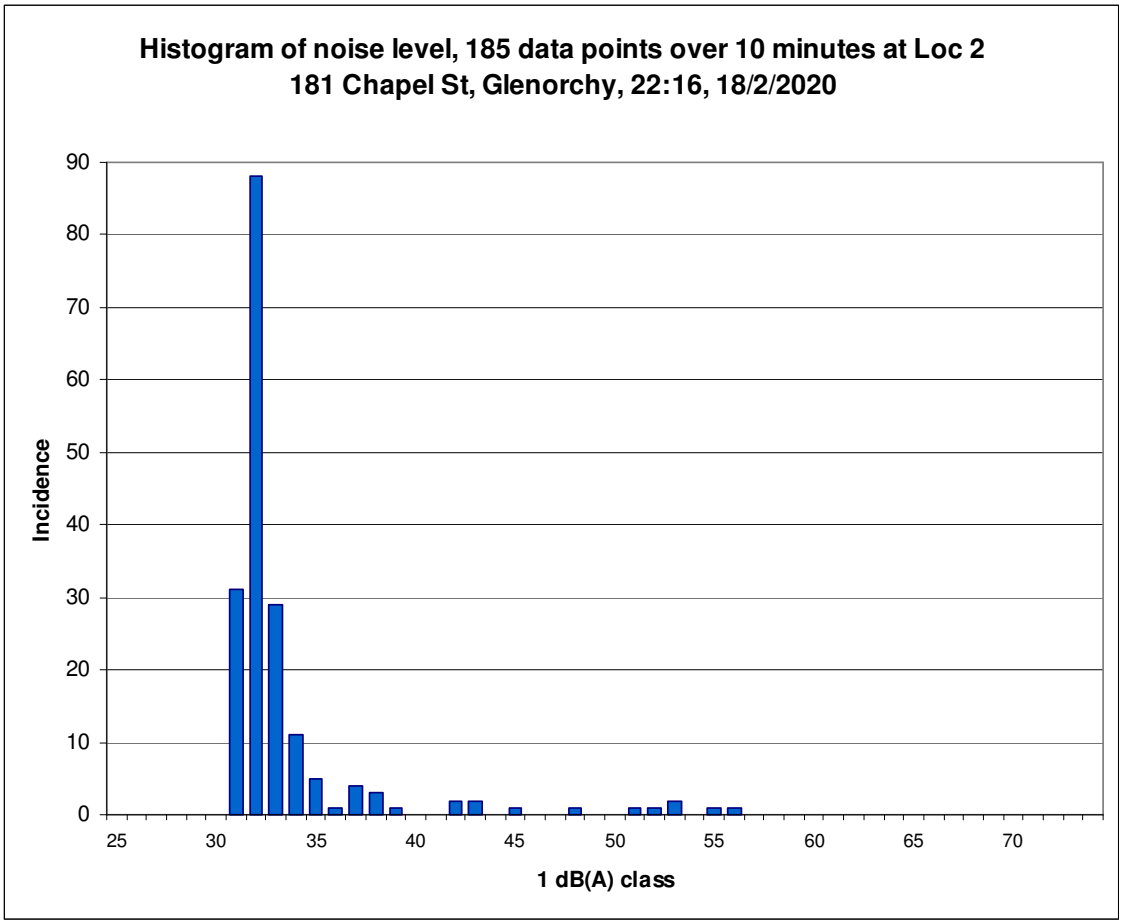


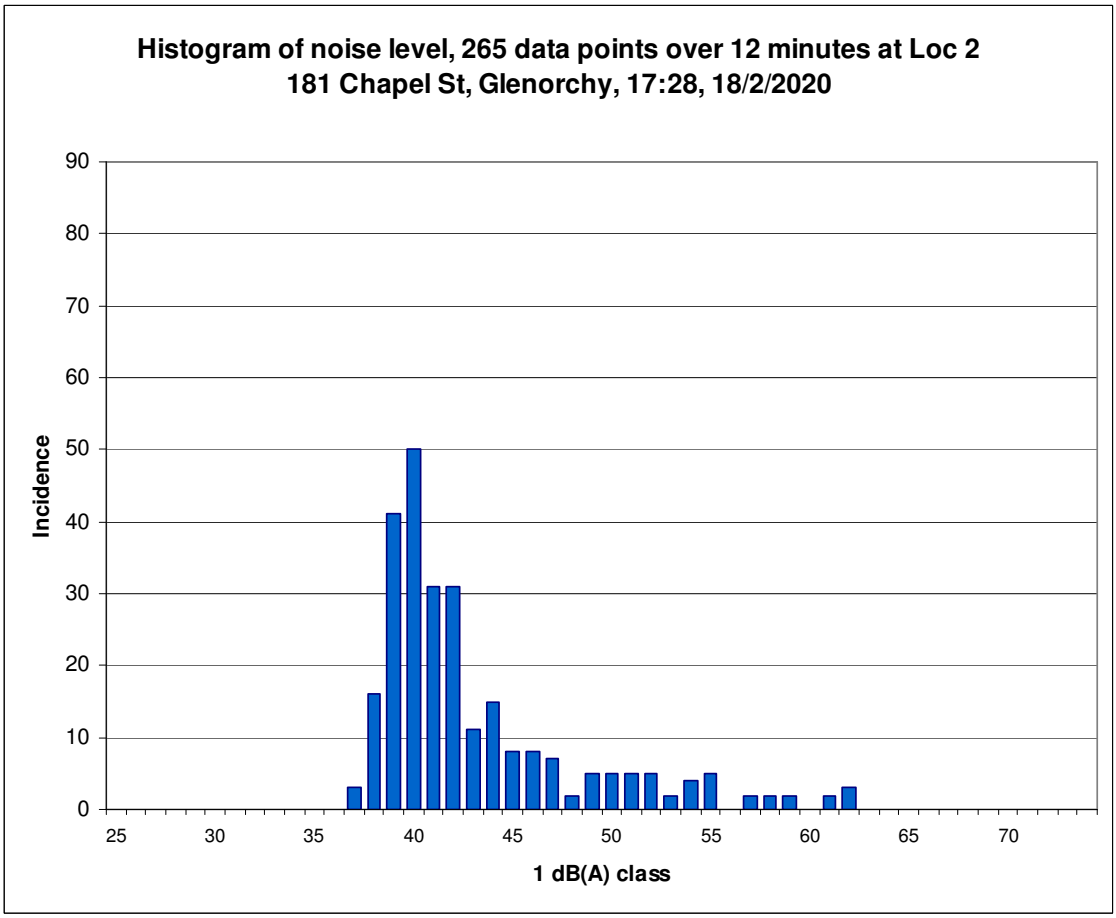






Example histograms: distribution of noise at Location 2 during night and day





Spectral analysis (thirds/octaves) of measurements 14-15/2/2020

Location	Loc 1		Loc 2		Loc 1		Loc 2	
Date	14/02/2020		14/02/2020		14/02/2020		15/02/2020	
Time	21:20		22:00		23:59		0:25	
Duration	15 min		15 min		15 min		15 min	
Comment	5 cars		2 cars		3 cars		0 cars	
Measure	Leq	L90	Leq	L90	Leq	L90	Leq	L90
Third octave Hz 25	39.1	29.3	39.7	27.7	35.2	23.9	32.9	25.0
32	39.2	28.1	36.8	26.7	34.6	22.7	32.8	24.1
40	38.1	30.0	38.5	28.2	36.1	25.9	34.2	24.9
50	39.6	29.7	43.5	30.4	42.5	25.5	34.9	25.1
63	39.3	27.7	38.5	27.7	41.7	23.0	34.4	23.7
80	39.2	28.0	36.5	28.1	33.0	24.1	37.5	26.9
100	39.4	27.7	37.0	30.8	33.5	23.3	34.8	30.6
125	34.7	23.5	33.5	23.8	30.6	19.9	27.7	21.3
160	32.9	20.0	31.8	20.7	29.4	-	23.4	19.9
200	32.3	19.9	30.9	19.9	28.1	-	20.4	-
250	32.0	19.9	31.2	-	27.1	-	21.3	19.9
315	30.8	21.1	29.1	-	26.8	-	32.4	28.6
400	31.6	20.0	24.8	-	24.4	-	20.7	19.8
500	32.6	20.0	29.2	-	26.2	-	22.3	-
630	32.7	19.9	28.1	-	26.7	-	22.2	-
800	34.6	-	31.6	-	28.4	-	21.3	-
1k	35.2	-	32.9	-	31.1	-	21.1	-
1.25k	33.1	-	31.6	-	30.1	-	20.2	-
1.6k	31.2	-	29.3	-	28.1	-	20.3	-
2k	28.9	-	27.8	-	25.0	-	21.8	-
2.5k	25.9	-	26.1	-	23.7	-	20.5	-
3.15k	24.3	-	23.7	-	22.2	-	20.5	-
4k	23.7	-	21.2	-	20.1	-	19.6	-
5k	21.5	-	18.9	-	18.9	-	18.9	-
6.3k	19.9	-	16.7	-	17.8	-	18.3	-
8k	19.6	-	18.8	-	18.6	-	21.8	-
10k	16.2	-	13.4	-	17.1	-	16.1	-
Octave Hz 31.5	43.6	34.0	43.3	32.3	40.1	29.1	38.1	29.5
63	44.1	33.3	45.3	33.7	45.4	29.1	40.6	30.2
125	41.3	29.6	39.4	31.9	36.3	24.9	35.8	31.4
250	36.5	25.1	35.3	-	32.1	-	33.0	29.2
500	37.1	-	32.5	-	30.6	-	26.6	-
1k	39.2	-	36.8	-	34.8	-	25.7	-
2k	34.0	-	32.7	-	30.8	-	25.7	-
4k	28.1	-	26.5	-	25.4	-	24.5	-
8k	23.6	-	21.6	-	22.6	-	24.1	-
Overall A	42.0	29.9	39.8	30.3	37.9	28.5	33.3	30.2
C	48.6	39.8	48.1	39.9	46.8	35.7	44.1	38.8

Note: L90 spectral analysis measurement floor is 19.8 dB (thirds) and 24.9 (octaves)

Spectral analysis (thirds/octaves) of measurements 16/2/2020

Location	Loc 1		Loc 1		Loc 2		Loc 2		Loc 2		Loc 2	
Date	16/02/2020		16/02/2020		16/02/2020		16/02/2020		16/02/2020		16/02/2020	
Time	15:53		16:15		16:40		19:01		19:28		19:50	
Duration	10.5 min		15 min		15 min		15 min		15 min		1 min	
Comment	11 cars + 1 sml truck		5 cars		7 cars		7 cars		6 cars		0 cars	
Measure	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90
Third octave Hz 25	61.7	40.3	60.5	39.3	63.0	45.9	45.5	320	48.8	33.6	41.1	34.9
32	59.6	39.2	58.5	37.5	61.3	43.7	44.3	31.8	45.8	33.5	37.3	30.9
40	57.3	38.9	55.9	35.6	59.5	41.7	42.9	31.0	45.0	31.5	34.6	29.9
50	55.7	36.5	53.0	37.4	58.7	40.3	41.2	31.3	48.9	31.1	35.9	30.2
63	51.8	36.1	50.0	36.3	54.3	39.0	42.1	30.9	62.2	30.9	39.1	29.5
80	52.5	34.8	47.7	34.6	51.3	38.0	42.4	30.2	52.8	30.6	35.6	31.2
100	59.5	32.6	44.9	33.1	51.8	37.2	42.5	34.9	45.4	35.1	38.4	36.6
125	44.8	29.5	43.0	30.9	46.4	33.9	40.3	27.7	54.6	28.1	31.6	26.8
160	43.4	26.0	39.6	27.9	44.3	30.8	39.6	25.1	48.3	25.0	30.1	23.6
200	41.7	24.3	36.4	26.6	42.0	28.2	40.5	23.5	53.3	23.4	25.3	21.8
250	38.9	25.2	35.3	26.9	40.4	26.1	38.9	20.3	41.5	20.6	24.1	19.9
315	35.9	26.8	33.5	27.2	36.3	26.3	35.2	23.4	35.0	23.2	25.9	21.9
400	35.4	27.3	32.9	27.7	34.8	26.6	34.9	22.3	32.5	22.4	24.4	20.5
500	36.1	27.9	33.5	28.1	35.4	28.0	38.1	24.2	34.2	24.5	25.8	22.3
630	36.5	27.9	33.2	27.4	36.1	28.2	38.4	24.8	34.1	25.7	25.6	22.2
800	37.1	27.4	33.1	27.1	37.8	28.2	40.0	25.1	36.7	26.3	26.0	22.5
1k	37.4	27.2	33.2	27.0	38.2	27.6	40.0	24.7	37.3	26.0	25.5	22.7
1.25k	36.8	26.5	31.5	26.2	36.6	26.5	38.6	24.6	36.8	24.8	25.6	22.3
1.6k	33.8	24.7	30.2	24.5	33.5	24.8	37.6	23.5	38.2	23.5	23.7	20.4
2k	33.2	23.2	30.6	23.2	31.3	23.4	38.6	28.4	36.5	23.6	22.6	19.9
2.5k	28.9	22.4	29.2	21.7	29.8	22.4	39.4	31.2	33.6	23.1	22.5	-
3.15k	31.9	21.4	29.2	20.8	29.1	21.4	36.1	20.6	30.8	19.9	22.2	-
4k	33.2	21.2	28.1	20.0	27.6	20.1	33.3	19.9	27.1	-	21.7	-
5k	31.0	19.9	27.1	19.9	25.4	19.8	31.6	-	23.4	-	18.9	-
6.3k	25.8	19.9	25.8	19.9	23.2	19.8	30.7	-	22.6	-	17.0	-
8k	40.4	39	39.8	37.8	33.7	31.5	26.5	-	19.0	-	15.3	-
10k	34.7	31.9	32.8	29.1	27.1	25.3	21.1	-	16.2	-	12.3	-
Octave Hz 31.5	64.7	44.3	63.5	42.5	66.3	48.9	49.1	36.4	51.6	37.7	43.3	37.2
63	58.5	40.6	55.5	41.0	60.6	44.0	46.7	35.6	62.9	35.6	41.9	35.1
125	59.7	34.9	47.8	35.9	53.5	39.5	45.8	36.0	55.9	36.2	39.7	37.2
250	44.2	30.3	40.0	31.7	44.9	31.7	43.5	27.4	53.6	27.3	29.9	26.1
500	40.8	32.5	38.0	32.5	40.2	32.4	42.2	28.7	38.4	29.2	30.1	26.5
1k	41.9	31.8	37.4	31.6	42.4	32.3	44.4	29.6	41.7	30.5	30.5	27.3
2k	37.2	28.3	34.8	28.1	36.6	28.4	43.4	33.5	41.3	28.2	27.7	-
4k	36.9	25.7	33.0	25.0	32.4	25.3	38.8	-	32.9	-	25.9	-
8k	41.6	39.8	40.7	38.4	34.9	32.7	32.4	-	24.8	-	20.0	-
Overall A	47.8	41.7	44.3	40.7	46.3	38.9	49.0	38.5	48.7	36.1	35.2	32.7
C	66.7	49.0	64.6	48.5	67.5	53.5	53.9	44.4	63.8	44.7	45.7	43.0

Note: L90 spectral analysis measurement floor is 19.8 dB (thirds) and 24.9 (octaves)

Spectral analysis (thirds/octaves) of measurements 18/2/2020

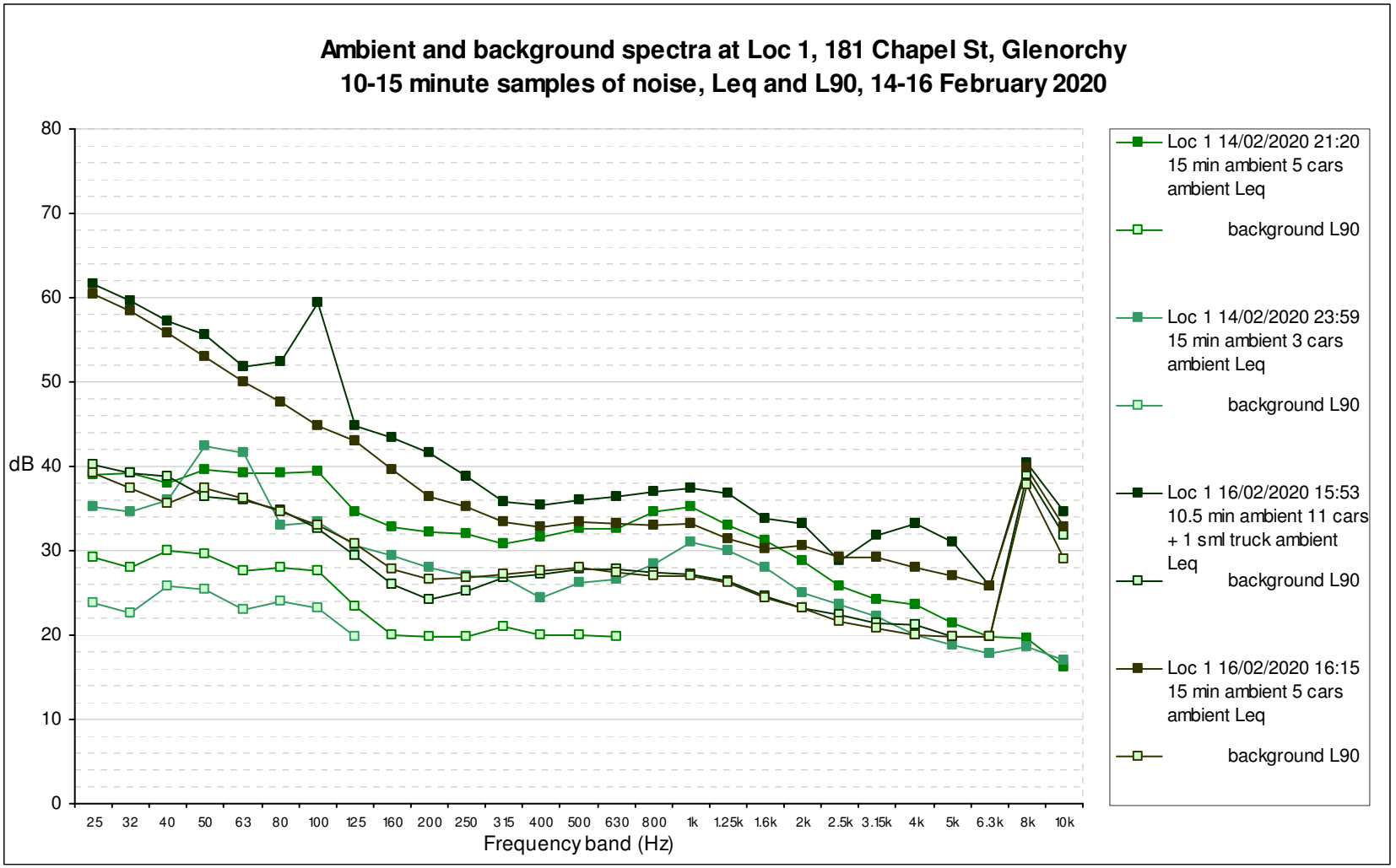
Location	Loc 2		Loc 2		Loc 3		Loc 2		Loc 2		Loc 2	
Date	18/02/2020		18/02/2020		18/02/2020		18/02/2020		18/02/2020		18/02/2020	
Time	1:08		1:38		2:09		16:53		17:12		17:28	
Duration	15 min		1 min		1 min		12.5 min		10 min		15 min	
Comment	2 cars (excluded)		0 cars		0 cars		2 cars + 2 motorbikes		3 cars		10 cars	
Measure	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90
Third octave Hz 25	33.5	27.7	34.0	30.9	43.5	40.3	60.9	43.0	62.7	38.8	62.8	40.9
32	32.3	27.1	34.4	31.4	39.3	36.5	60.0	42.1	58.8	38.0	58.5	39.5
40	30.5	26.0	32.9	29.1	46.4	44.9	58.8	40.7	56.0	37.5	55.8	38.0
50	33.0	28.8	32.5	29.2	40.8	36.9	57.2	39.5	53.3	36.9	57.2	38.5
63	31.1	26.1	33.0	29.8	39.9	37.7	58.9	37.9	51.0	35.6	56.5	37.7
80	29.5	25.9	32.0	28.4	44.7	43.1	58.3	37.0	47.4	35.6	51.5	37.0
100	35.7	33.6	36.4	34.3	46.0	43.1	59.1	38.7	45.4	36.0	47.2	37.5
125	26.5	23.0	30.4	26.0	36.7	33.7	59.1	33.4	43.7	31.5	47.9	32.9
160	23.0	20.2	28.9	25.7	32.3	30.4	57.1	30.6	43.1	29.4	47.8	29.9
200	20.7	19.8	24.0	20.7	38.7	35.3	56.9	27.9	37.8	27.1	44.2	27.1
250	20.1	19.8	22.3	20.1	30.4	28.8	52.0	24.7	35.3	25.6	40.0	25.6
315	30.3	27.4	30.5	28.6	36.7	34.2	52.3	25.8	34.2	26.7	37.4	27.5
400	19.2	19.8	20.1	19.8	25.5	22.8	49.8	26.5	33.2	27.4	36.1	27.4
500	20.1	-	22.7	19.9	26.9	20.8	46.7	28.4	33.4	28.8	36.5	28.8
630	21.3	-	27.1	20.9	22.6	20.2	44.3	28.9	34.0	29.2	37.0	29.3
800	22.0	-	23.8	22.1	23.6	21.4	42.9	29.2	34.9	29.0	38.7	29.1
1k	21.4	-	22.6	20.9	24.5	21.8	43.5	28.8	35.3	28.6	38.8	29.0
1.25k	20.5	-	20.9	19.9	24.9	20.9	44.4	27.4	34.1	27.4	36.6	27.8
1.6k	20.8	-	20.1	-	22.5	19.8	44.9	25.9	32.3	25.9	34.6	26.3
2k	21.9	-	21.2	-	22.5	19.8	44.7	24.1	31.5	25.3	32.0	24.7
2.5k	19.8	-	18.9	-	26.6	25.0	45.2	22.2	31.5	23.0	30.7	23.0
3.15k	20.1	-	16.3	-	29.2	27.5	43.6	20.6	30.3	22.0	29.2	21.9
4k	18.1	-	14.6	-	21.0	20.1	42.1	19.9	29.1	21.3	28.0	21.1
5k	16.6	-	13.4	-	20.9	20.2	41.4	-	27.7	19.9	26.6	19.9
6.3k	15.5	-	12.3	-	21.1	20.3	38.0	19.8	27.1	19.9	24.9	19.9
8k	15.4	-	11.4	-	20.1	19.8	36.7	29.5	31.4	28.6	30.8	27.0
10k	13.7	-	10.2	-	16.3	-	31.3	19.8	24.2	19.9	23.3	19.8
Octave Hz 31.5	37.0	31.8	38.6	35.3	48.7	46.6	64.8	46.8	64.8	42.9	64.8	44.4
63	36.2	31.9	37.3	33.9	47.1	44.9	63.0	43.0	56.0	40.8	60.5	42.5
125	36.4	34.1	38.0	35.4	46.6	43.8	63.3	40.3	49.0	38.0	52.4	39.3
250	31.1	28.7	31.9	29.8	41.2	38.3	59.1	31.1	40.8	31.3	46.2	31.6
500	25.1	-	29.0	25.0	30.1	26.2	52.3	32.8	38.3	33.3	41.3	33.3
1k	26.1	-	27.4	25.8	29.1	26.2	48.4	33.3	39.6	33.2	42.9	33.4
2k	25.7	-	24.9	-	29.1	27.1	49.7	29.1	36.6	29.7	37.5	29.6
4k	23.3	-	19.7	-	30.3	28.9	47.2	-	33.9	25.9	32.8	25.8
8k	19.7	-	16.2	-	24.4	-	40.9	30.3	33.3	29.6	32.4	28.4
Overall A	32.3	30.5	32.8	31.1	38.1	37.0	57.0	38.8	44.4	38.5	46.9	38.9
C	42.2	40.1	42.5	41.4	51.9	50.9	69.2	51.1	68.1	48.8	68.2	49.9

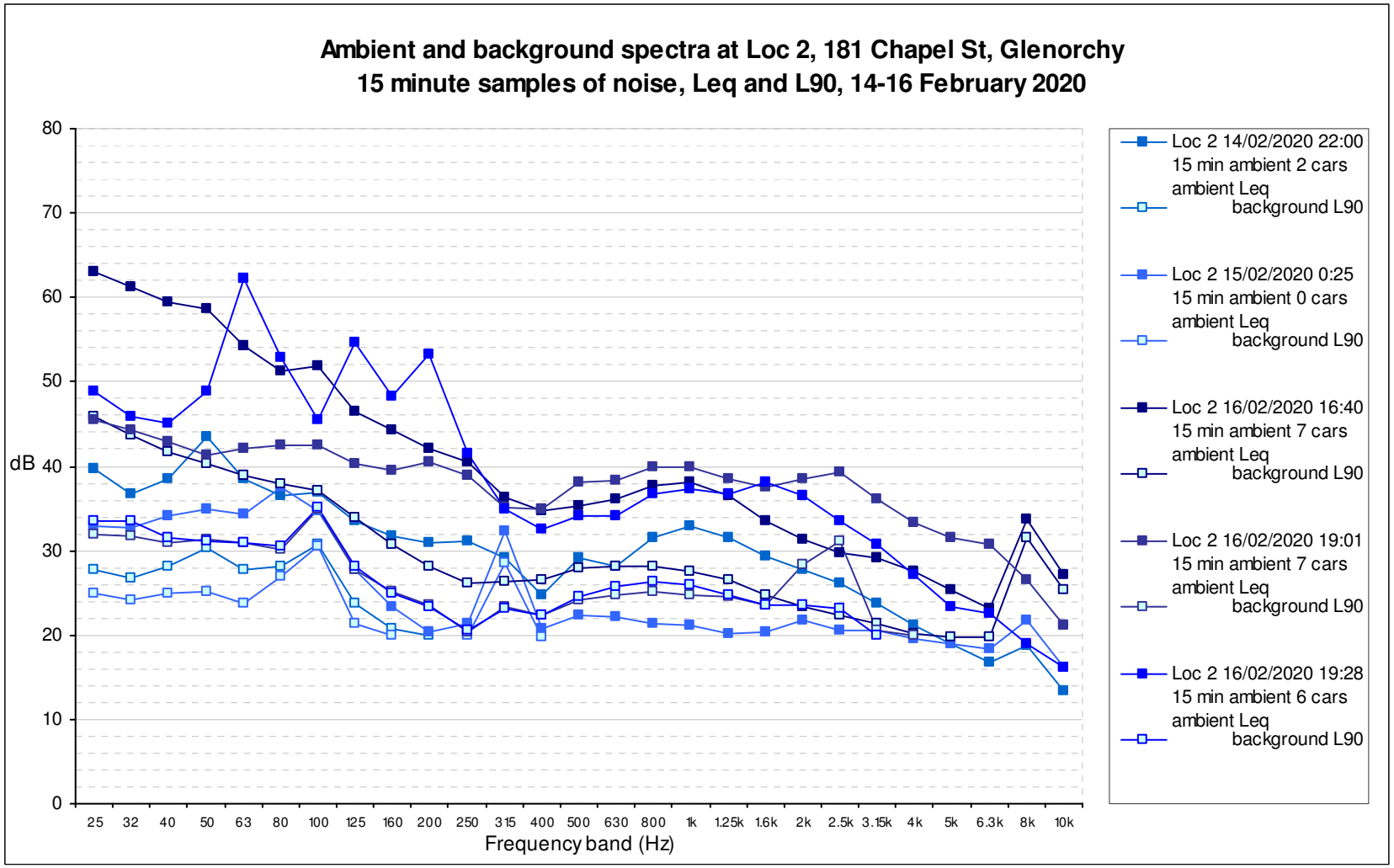
Note: L90 spectral analysis measurement floor is 19.8 dB (thirds) and 24.9 (octaves)

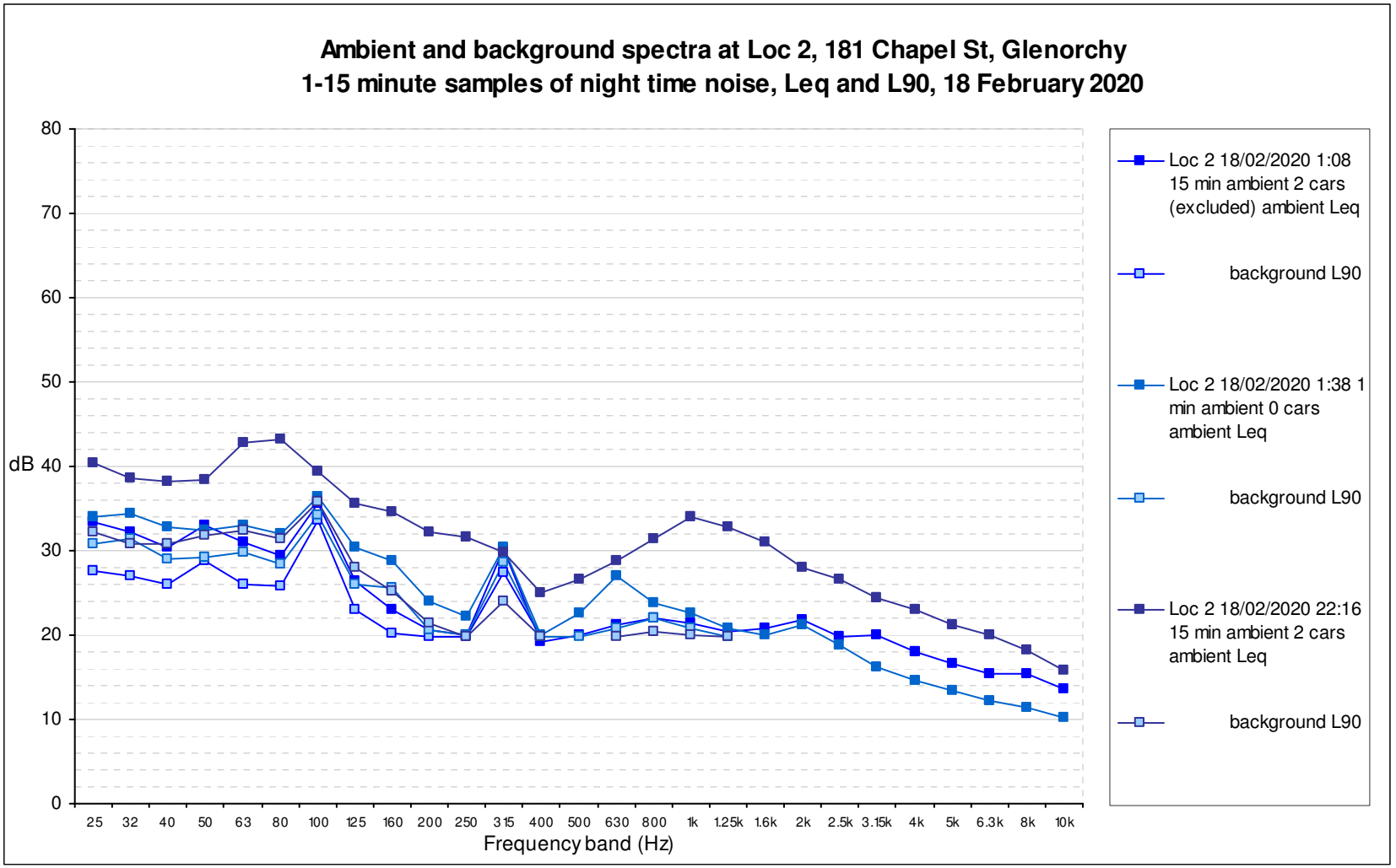
Spectral analysis (thirds/octaves) of measurements 18-20/2/2020

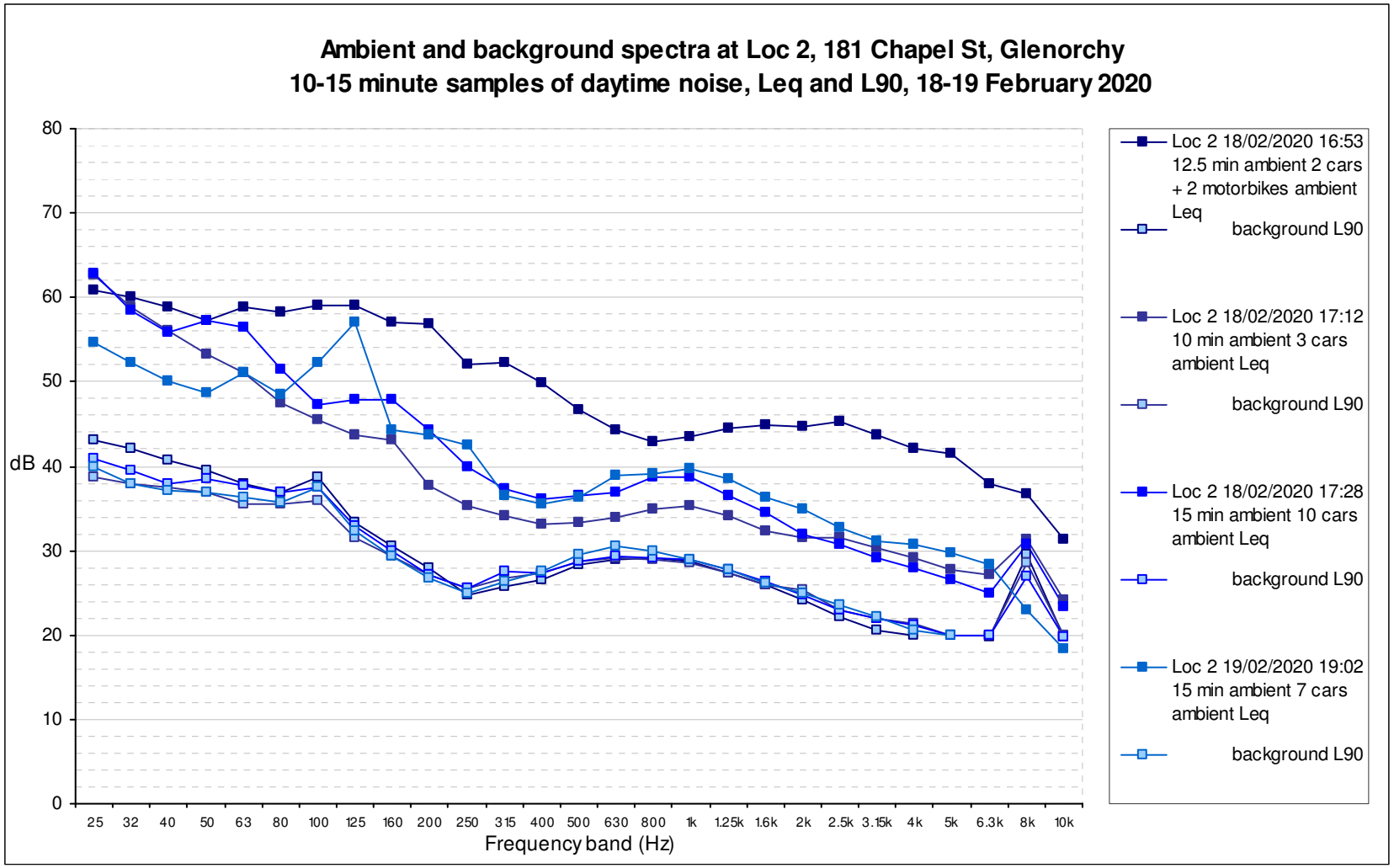
Location	Loc 2		Loc 3		Loc 3		Loc 2		Loc 2		Loc 3	
Date	18/02/2020		18/02/2020		18/02/2020		19/02/2020		20/02/2020		20/02/2020	
Time	22:16		23:00		23:20		19:02		0:10		0:56	
Duration	15 min		15 min		1 min		15 min		15 min		15 min	
Comment	2 cars		0 cars		0 cars		7 cars		3 cars (excluded)		0 cars	
Measure	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90	Leq	L90
Third octave Hz 25	40.5	32.2	44.6	39.0	43.7	39.6	54.6	40.0	36.6	25.1	45.6	40.8
32	38.6	30.9	40.3	33.2	38.6	35.2	52.3	38.0	33.9	25.9	40.1	33.4
40	38.3	30.9	43.4	40.3	43.7	41.1	50.1	37.2	32.6	27.5	44.3	42.0
50	38.4	31.9	41.4	37.9	42.8	39.0	48.7	36.9	31.7	27.0	39.3	36.0
63	42.9	32.5	39.7	36.9	41.8	38.5	51.0	36.4	27.2	22.3	36.6	34.4
80	43.3	31.4	43.4	41.3	43.6	41.4	48.5	35.7	26.2	23.0	42.6	41.1
100	39.5	35.8	40.2	36.4	40.6	37.7	52.2	37.5	36.0	34.0	36.6	33.8
125	35.6	28.1	35.6	33.0	36.8	34.1	57.1	32.3	23.6	21.0	32.7	30.2
160	34.6	25.3	34.5	31.5	35.1	32.7	44.3	29.3	20.5	19.8	34.5	30.0
200	32.2	21.5	38.5	29.5	32.5	30.3	43.6	26.8	18.9	-	31.2	26.4
250	31.7	19.9	28.7	24.8	28.1	25.9	42.4	25.0	19.6	19.8	28.6	25.4
315	29.8	24.0	32.0	25.9	31.5	25.6	36.5	26.4	31.2	25.8	35.1	28.7
400	25.1	19.8	30.1	23.0	26.4	24.0	35.5	27.5	18.3	19.8	23.3	20.1
500	26.6	-	23.9	21.7	25.6	23.8	36.4	29.6	19.4	-	20.8	19.9
630	28.9	19.9	20.8	19.8	22.9	20.5	38.9	30.5	19.0	-	19.6	-
800	31.4	20.5	21.4	-	23.6	20.9	39.2	30.0	19.4	-	20.2	-
1k	34.1	20.0	21.4	-	23.5	20.9	39.7	29.0	19.6	-	19.5	-
1.25k	32.8	19.9	21.0	-	23.5	21.4	38.6	27.8	19.7	-	19.5	-
1.6k	31.0	-	20.9	-	23.8	21.8	36.4	26.2	20.0	-	19.2	-
2k	28.0	-	24.8	-	24.7	22.9	34.9	24.9	20.0	-	22.2	-
2.5k	26.6	-	24.4	-	26.1	24.6	32.7	23.6	18.4	-	26.1	-
3.15k	24.5	-	26.3	-	27.4	25.9	31.1	22.2	18.0	-	30.5	-
4k	23.1	-	25.5	-	27.8	26.3	30.8	20.6	16.3	-	29.6	-
5k	21.3	-	25.4	-	28.4	26.8	29.7	19.9	16.0	-	27.2	-
6.3k	20.0	-	26.1	-	29.0	27.7	28.3	-	14.9	-	20.6	-
8k	18.3	-	23.7	-	26.6	25.3	22.9	-	14.4	-	16.6	-
10k	15.8	-	20.9	-	23.7	22.7	18.3	-	12.7	-	13.7	-
Octave Hz 31.5	44.0	36.1	47.9	43.2	47.3	44.0	57.5	43.3	39.5	31.1	48.7	44.8
63	46.8	36.7	46.5	43.9	47.6	44.6	54.3	41.1	33.8	29.4	45.0	42.9
125	41.9	36.8	42.3	38.9	42.9	40.1	58.5	39.1	36.4	34.4	39.7	36.5
250	36.1	26.9	39.7	32.0	35.8	32.6	46.5	30.9	31.7	26.8	37.2	31.8
500	31.9	-	31.4	26.5	30.0	27.8	42.0	34.1	23.7	-	26.3	-
1k	37.7	24.9	26.0	-	28.3	25.8	44.0	33.8	24.3	-	24.5	-
2k	33.7	-	28.5	-	29.7	28.0	39.7	29.8	24.3	-	28.2	-
4k	27.9	-	30.5	-	32.7	31.1	35.3	25.8	21.6	-	34.1	-
8k	23.1	-	28.8	-	31.7	30.5	29.7	-	18.9	-	22.6	-
Overall A	40.7	31.4	37.3	34.9	38.4	37.5	48.5	38.6	31.2	29.1	37.7	31.3
C	50.0	43.4	50.9	48.3	50.7	50.5	62.1	49.3	44.0	39.1	50.7	48.6

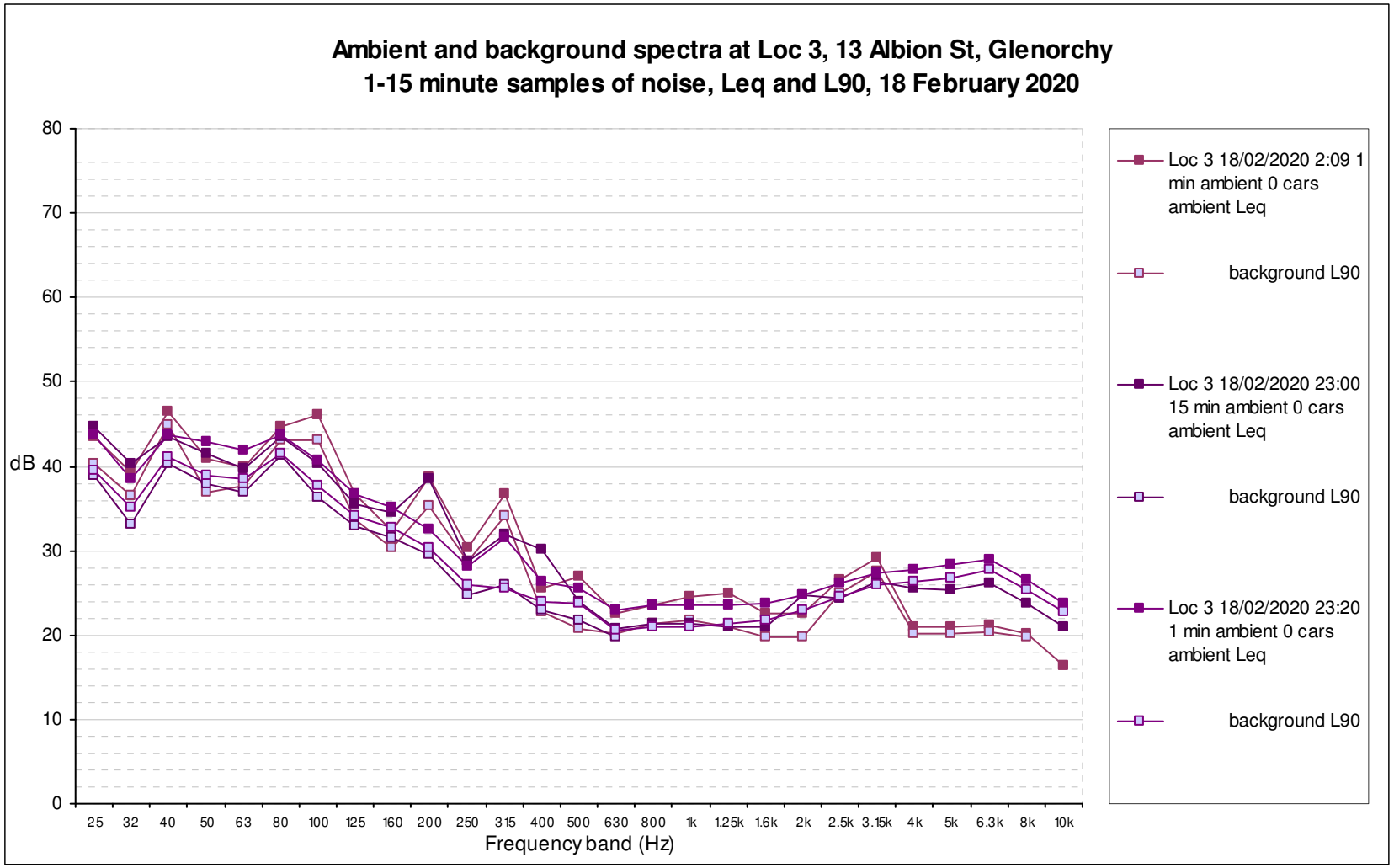
Note: L90 spectral analysis measurement floor is 19.8 dB (thirds) and 24.9 (octaves)

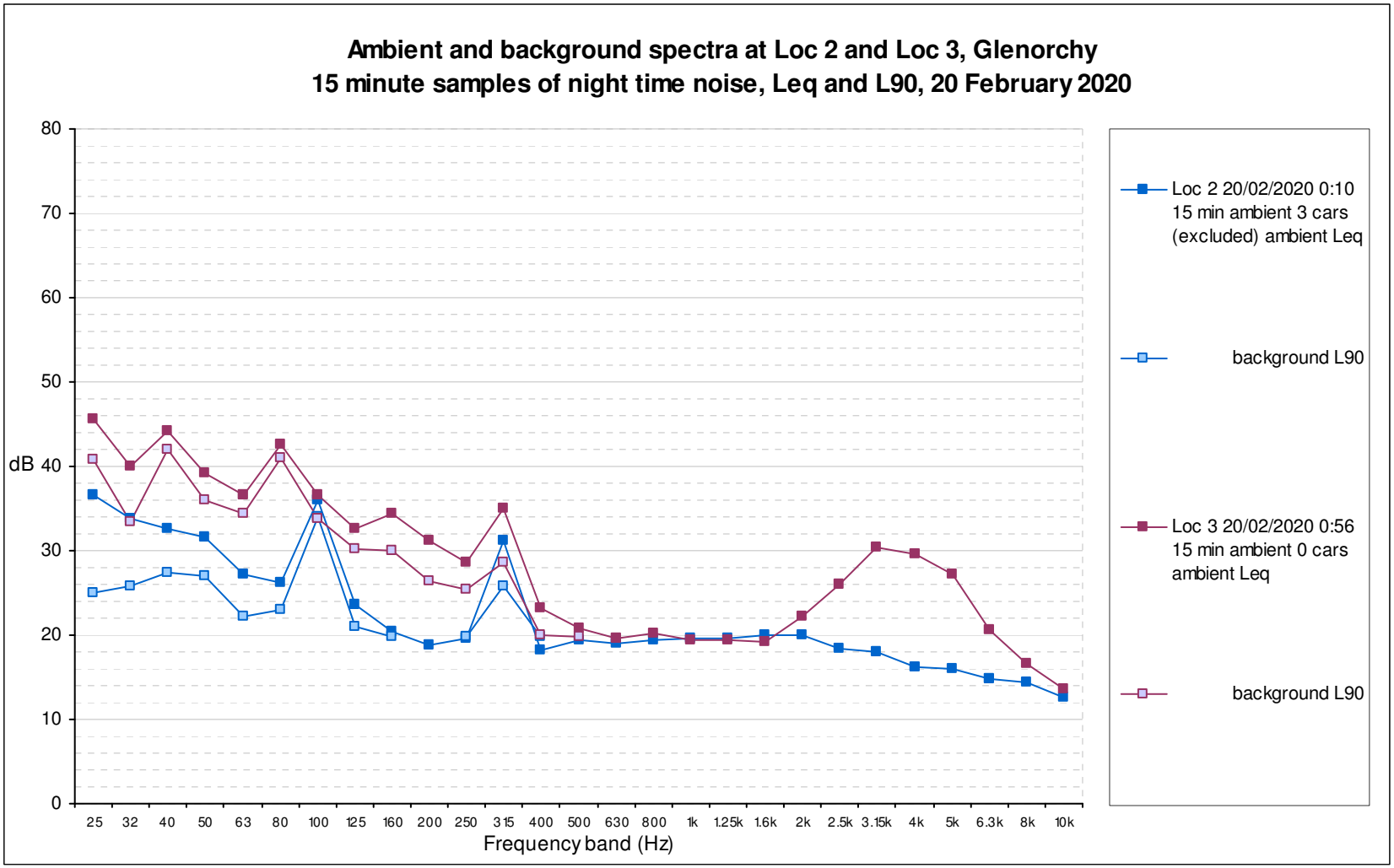




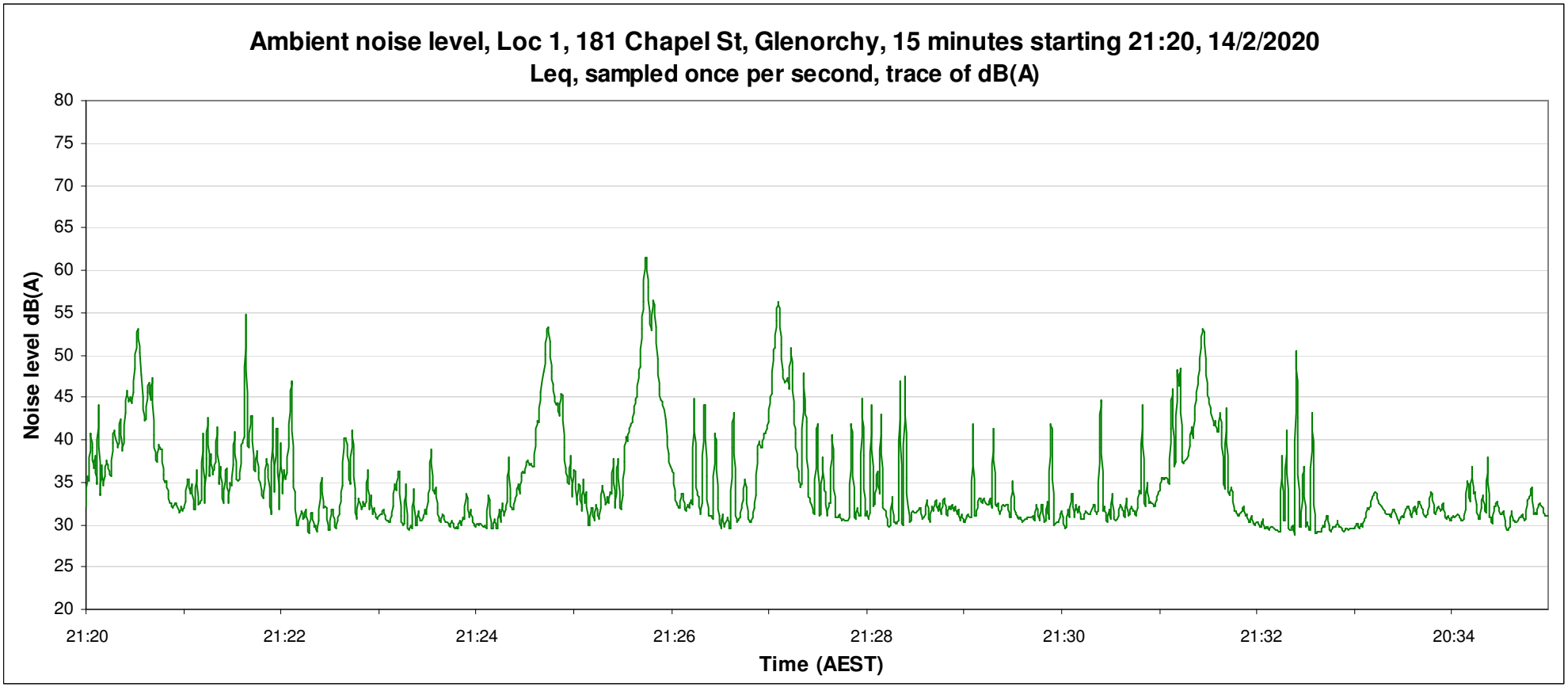






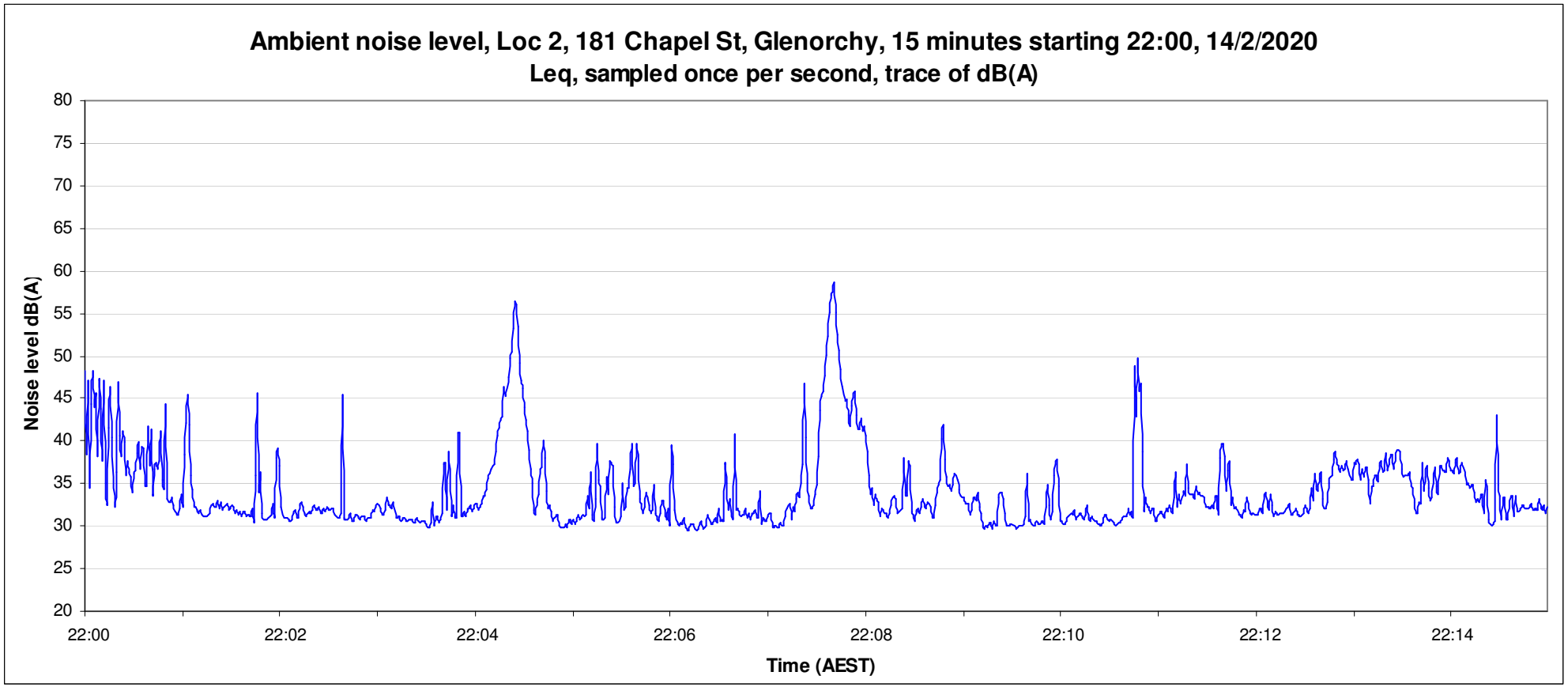


Example trace of 15 minute evening ambient noise level measurement



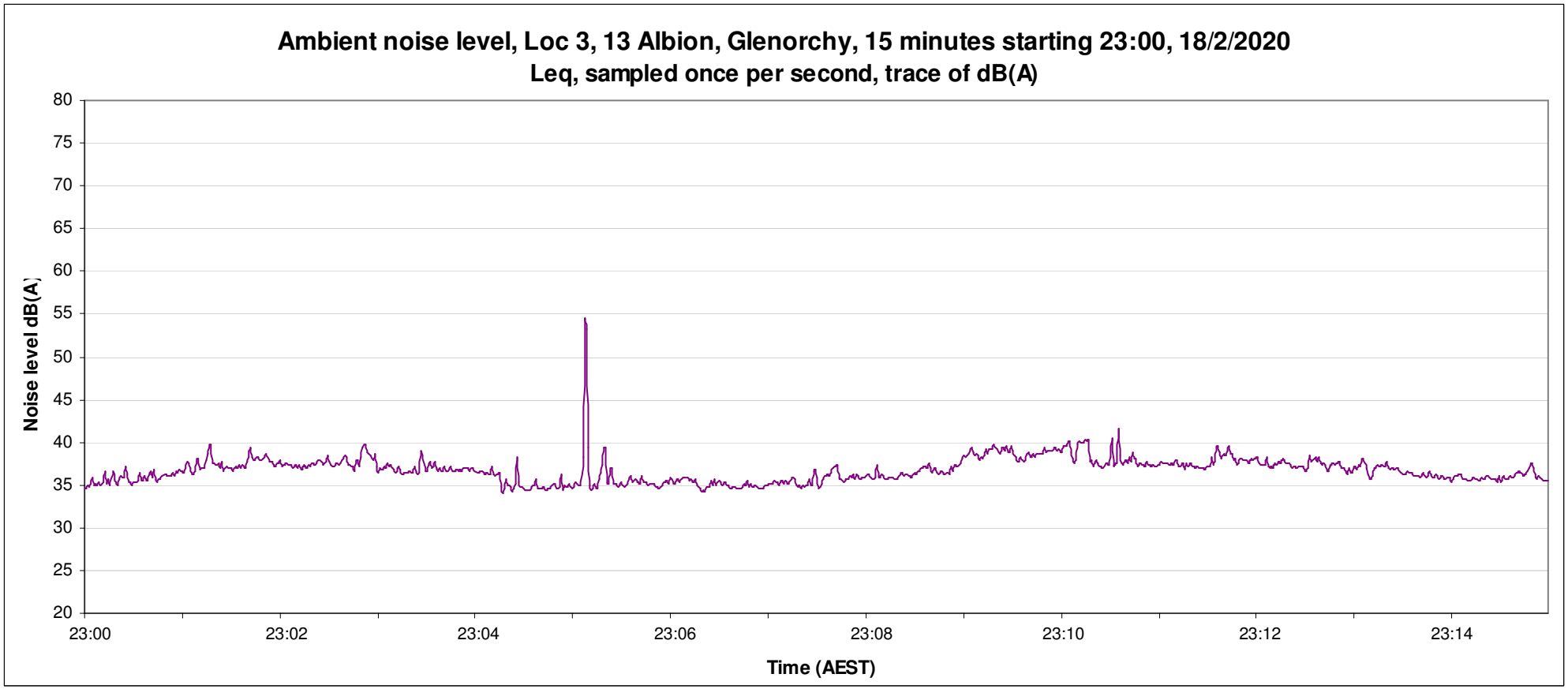
Traffic events dominate the noise at Location 1, with additional spikes from birds and dogs.
Relatively flat baseline from background hum

Example trace of 15 minute evening ambient noise level measurement



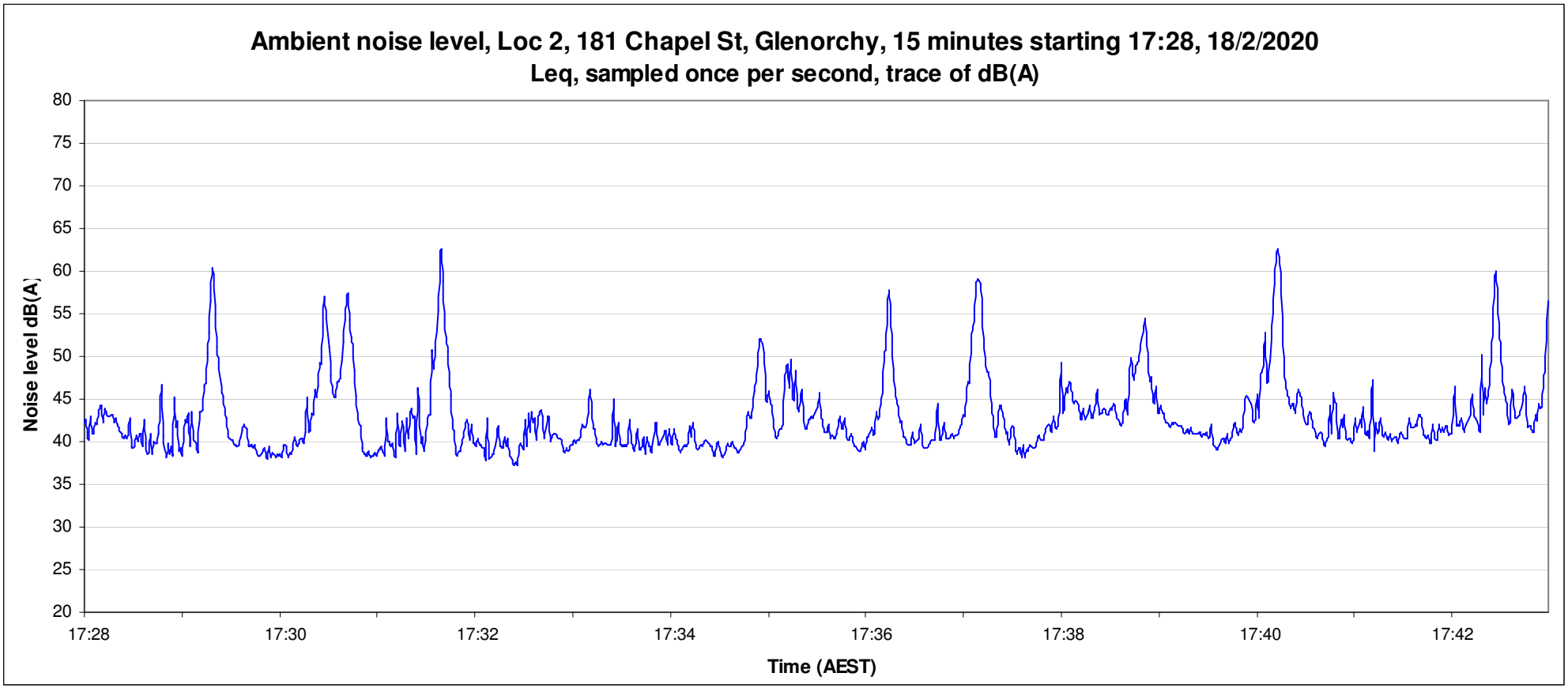
Traffic events dominate the noise at Location 2, with additional spikes from birds and dogs.
Relatively flat baseline from background hum

Example trace of 15 minute evening ambient noise level measurement



Occasional spikes from birds and dogs.
Undulating flat baseline from background hum of substation

Example trace of 15 minute ambient daytime noise level measurement



Traffic events dominate the noise, with additional spikes from birds and dogs.
Raised background due to complex assemblage of neighbourhood activity

181 Chapel St residential subdivision project, Glenorchy
Field report for site visit April 2020
Appendix B to be read in conjunction with main report

General

The vacant site at 181 Chapel St is a long block which lies alongside the street, overlain in the middle by high voltage transmission lines originating from the Albion St substation. Existing residential neighbours surround the area, many of which lie in closer proximity to the substation than any of the proposal lots the client site. This report describes the findings of ambient noise monitoring and observations from the supplementary site visit at night time, 8th April 2020.

Instruments used

- Brűel & Kjær Sound Level Calibrator Type 4230 s/n 1169836, Laboratory Certified Sept 2019;
- Norsonic Precision Sound Level Meter Nor131, s/n 1312829, Laboratory Certified Sept 2019;
- iPhone4 with AudioTools App, Studio Six Digital;
- Weather Instruments (Aneroid barometer, Zeal Wet/Dry bulb Psychrometer, Suunto KB-14/360R compass, Kaindl Windmaster 2 wind speed meter);
- 100 m fiberglass tape

Location definitions

The locations for measurements were defined and described as follows:

Designation	Definition/comments
Loc 2	Proposal Lot 3, at a point 30 m southwest of Aurora Pole #40 (106212) 12 m setback from front boundary, microphone at 1.3 m height
Loc 3	By Tas Networks substation entry gate, near 12 & 13 Albion St, microphone at 1.3 m height

Aerial photo and plan are previously shown in Appendix A.

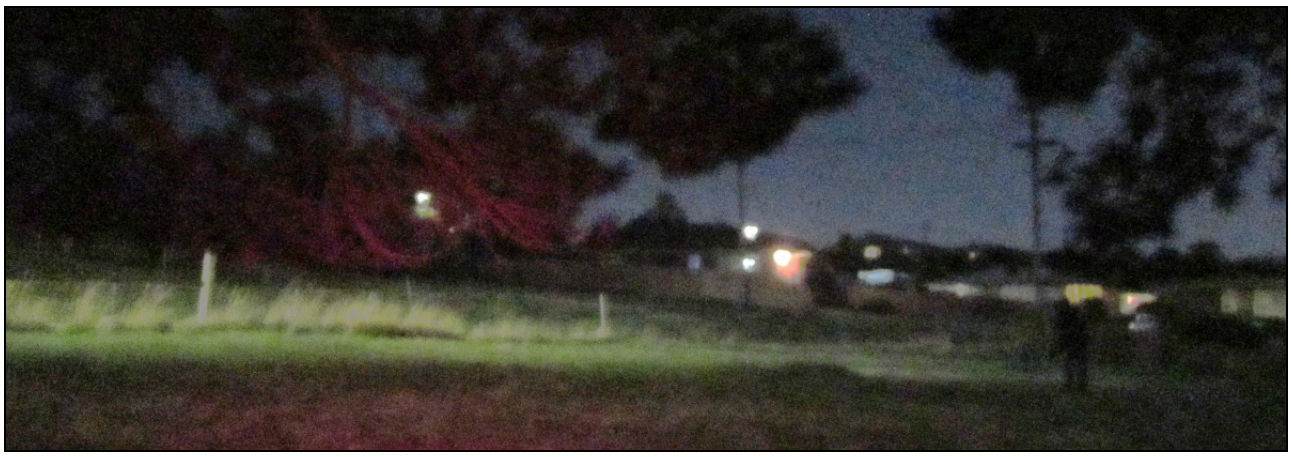
Weather observations

Conditions were suitable for noise measurements, details shown alongside.

Weather observations	
Date	8/4/2020
Location	Loc 2
Time	21:45
Temp ℃	12.5
Relative Humidity %	94
Pressure hPa	1026
Wind speed average m/s	1.5
Wind speed maximum m/s	2.2
Wind direction	WSW
Cloud cover x/8	0

[Last revised 11/4/2020]

Photograph



Monitoring ambient noise levels at Location 2, 8/4/2020

Noise descriptions

For each location, ambient noise by source noted during the site visit is listed (in descending order of significance by loudness, noticeability, duration and incidence):

Location 2

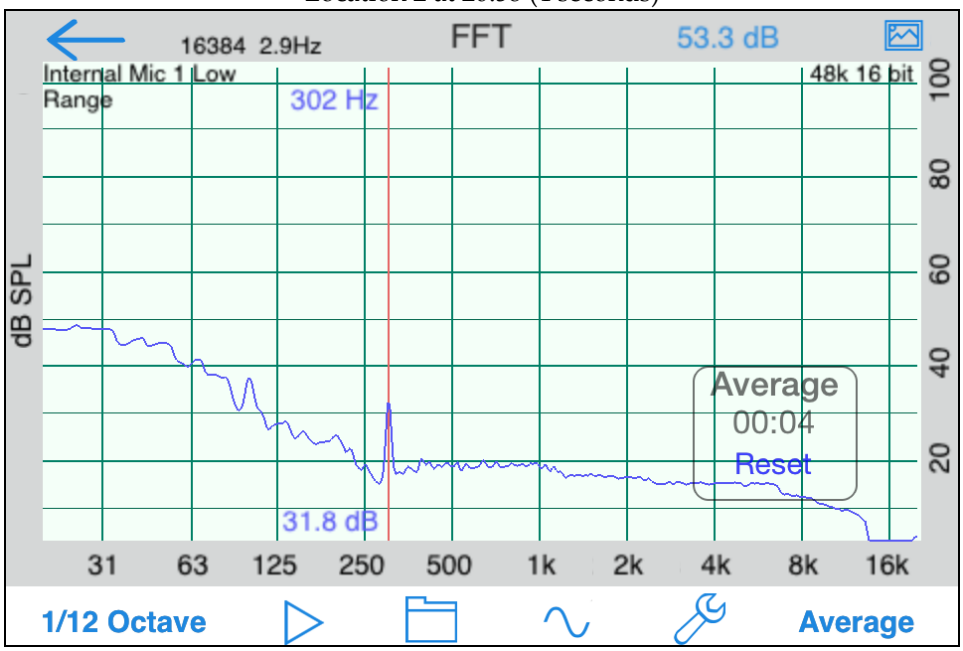
- Traffic including cars and motorbike, 50 km/h zone
- Birds including plovers
- Background hum of substation, particularly tones at 100 Hz and 315 Hz
- Humphreys Rivulet water flowing nearby
- Dogs

Location 3

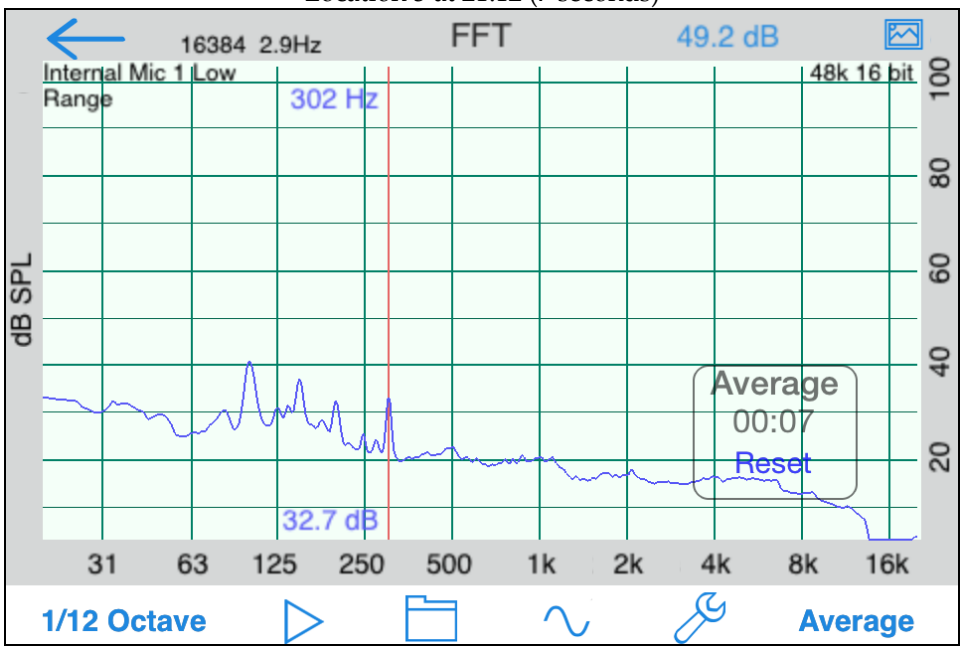
- Background hum of substation, numerous tones present
- Birds including plover
- Neighbour voices
- Dogs

FFT spectral analysis of background samples

Location 2 at 20:58 (4 seconds)



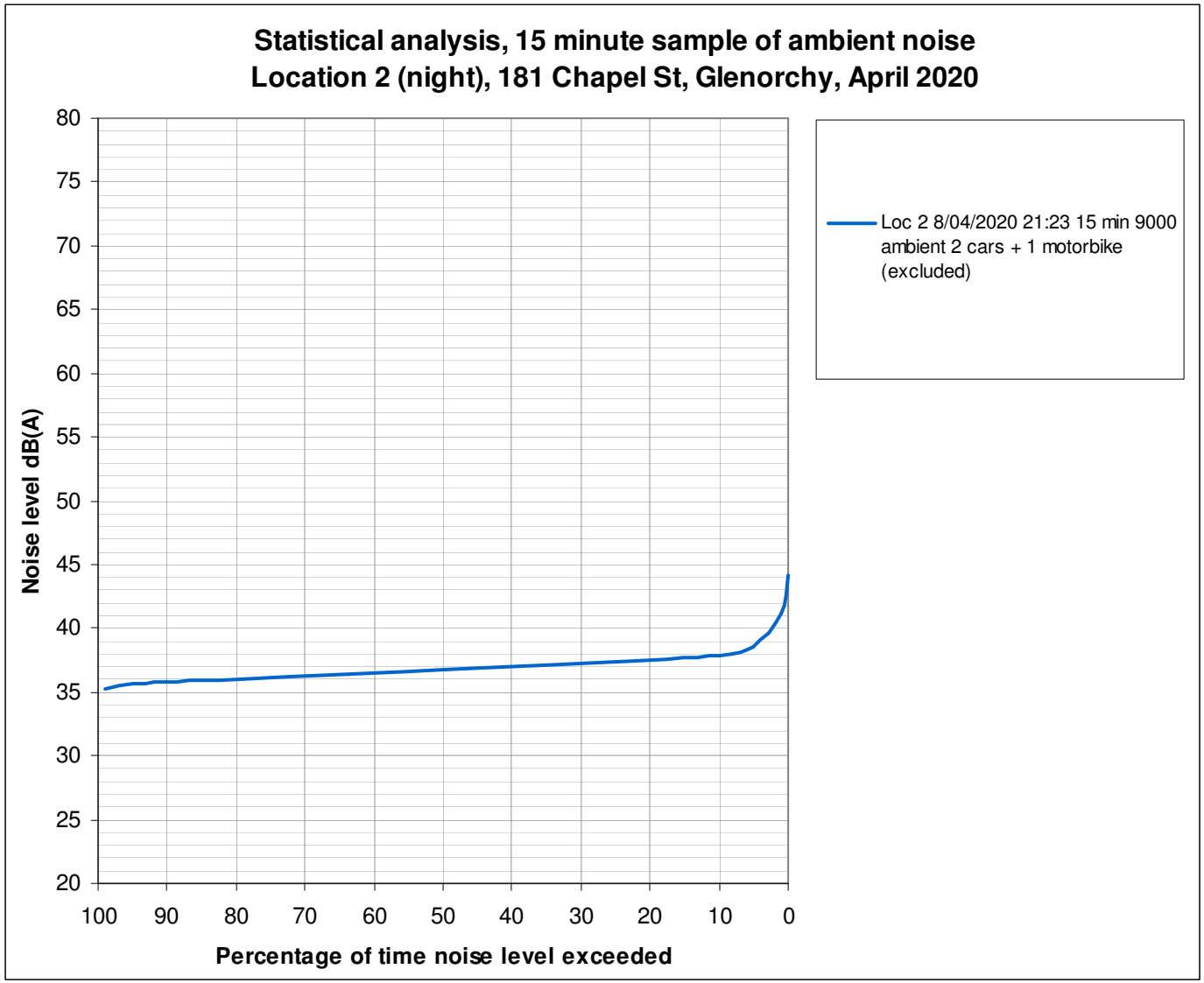
Location 3 at 21:12 (7 seconds)



Analysis by fine tuning measured the most audible tone at 301 Hz

Statistical analysis of 15 minute sample of ambient noise dB(A), 8/4/2020

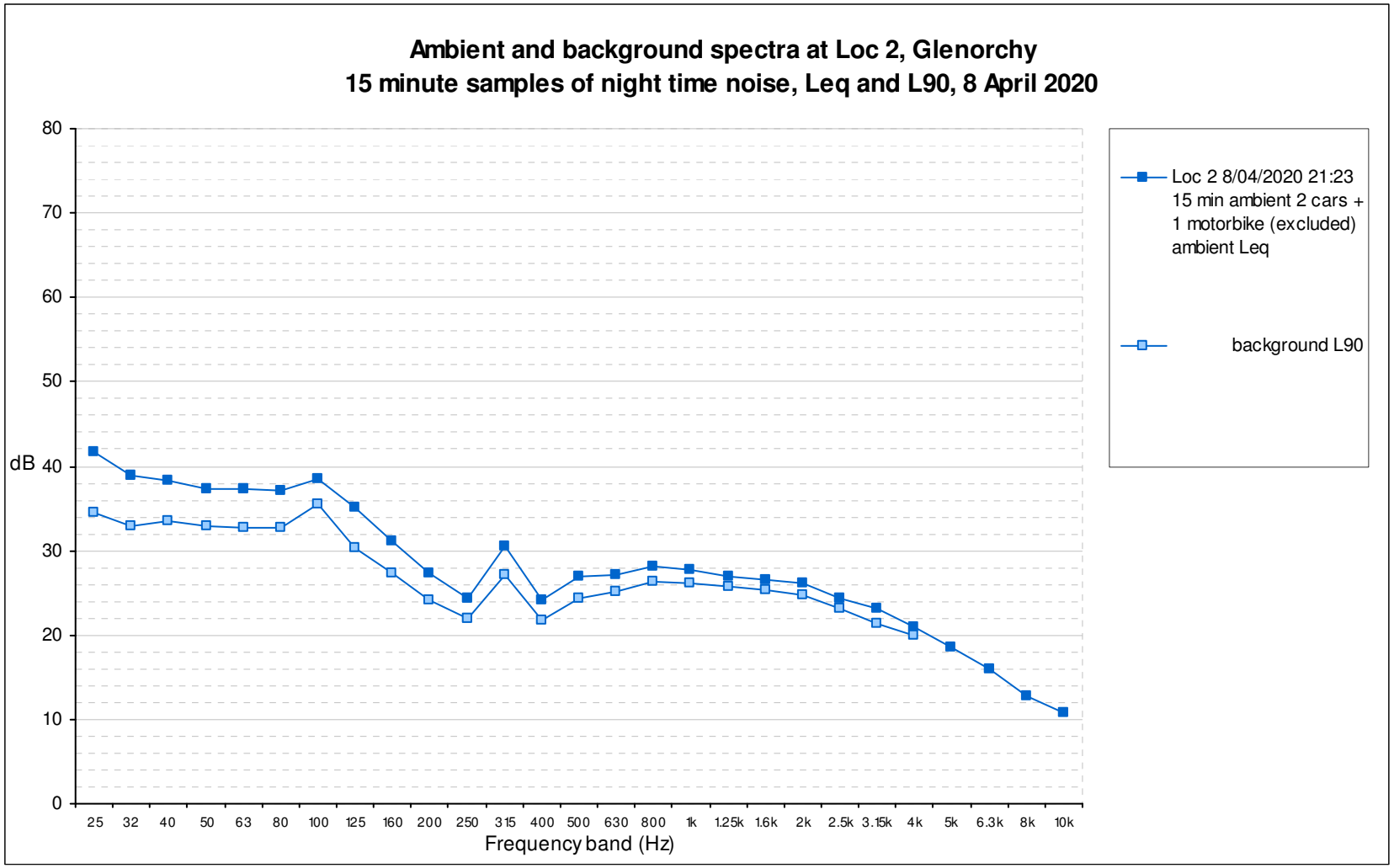
Location	Loc 2
Date	8/04/2020
Time	21:23
Duration	15 min
Samples	9000
Note	ambient
Comment	2 cars + 1 motorbike (excluded)
Lmax	48.3
L0.1	44.2
L1	41.1
L5	38.5
L10	37.9
L50	36.7
L90	35.8
L95	35.6
L99	35.2
Lmin	34.3
Leq A	37.0



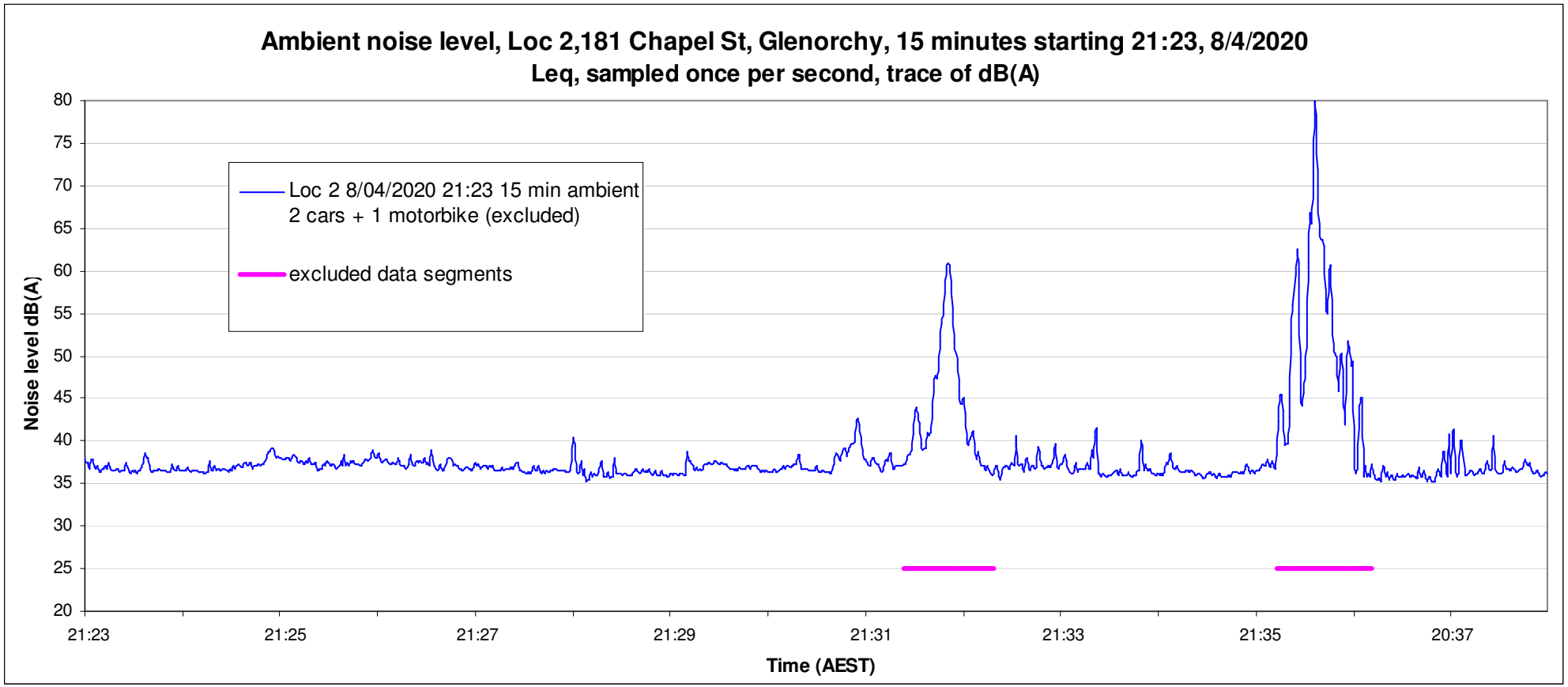
Spectral analysis (thirds/octaves) of measurement 8/4/2020

Location	Loc 2	
Date	8/04/2020	
Time	21:23	
Duration	15 min	
Comment	2 cars + 1 motorbike (excluded)	
Measure	Leq	L90
Third octave Hz 25	41.6	34.6
32	39.0	32.9
40	38.3	33.6
50	37.3	32.9
63	37.4	32.7
80	37.1	32.8
100	38.6	35.6
125	35.2	30.4
160	31.2	27.4
200	27.3	24.1
250	24.3	22.0
315	30.5	27.2
400	24.1	21.8
500	27.0	24.3
630	27.1	25.1
800	28.1	26.4
1k	27.8	26.1
1.25k	26.9	25.7
1.6k	26.6	25.3
2k	26.2	24.7
2.5k	24.4	23.1
3.15k	23.2	21.3
4k	20.9	19.9
5k	18.5	-
6.3k	15.9	-
8k	12.7	-
10k	10.7	-
Octave Hz 31.5	44.6	38.5
63	42.0	37.6
125	40.7	37.2
250	32.9	29.7
500	31.0	28.7
1k	32.4	30.8
2k	30.6	29.2
4k	26.1	-
8k	18.4	-
Overall A	37.0	35.8
C	49.0	45.7

Note: L90 spectral analysis measurement floor is 19.8 dB (thirds) and 24.9 (octaves)



Trace of 15 minute evening ambient noise level measurement



Traffic events (particularly a motorbike) dominated the noise at Location 2, with additional spikes from plovers in particular.
The relatively flat baseline arises from continuous background substation hum and rivulet noise.
The data exclusion periods extended the total measurement duration to 17.6 minutes, the latter part including 2nd car not shown in this 15 minute plot.

181 Chapel St residential subdivision project, Glenorchy
Additional report: Corrections of selected data for 315 Hz tonality, April 2020
Appendix D to be read in conjunction with main report

General

The vacant site at 181 Chapel St is a long block which lies alongside the street, overlain in the middle by high voltage transmission lines originating from the Albion St substation. Existing residential neighbours surround the area, many of which lie in closer proximity to the substation than any of the proposal lots the client site.

This report uses a 315 Hz penalty/tonal correction applied to selected data from Appendix A, according to the adjustment protocol in AS 1055:2018.

Reference

Colin Tickell (2019) AAS, Acoustic Proceedings 2019, AS 1055: 2018 Revision
https://www.acoustics.asn.au/conference_proceedings/AAS2019/papers/p17.pdf
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[Last revised 30/4/2020

Table of corrections

Location	Loc 2			Loc 2			Loc 2			Loc 3			Loc 2			Loc 3		
Date	15/02/2020			18/02/2020			18/02/2020			18/02/2020			20/02/2020			20/02/2020		
Time	0:25			1:08			1:38			2:09			0:10			0:56		
Duration	15 min			15 min			1 min			1 min			15 min			15 min		
Measure	ambient			ambient			ambient			ambient			ambient			ambient		
Traffic	0 cars			2 cars (excluded)			0 cars			0 cars			3 cars (excluded)			0 cars		
Data	raw	A wt	adjust	raw	A wt	adjust	raw	A wt	adjust	raw	A wt	adjust	raw	A wt	adjust	raw	A wt	adjust
Measurement	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq
Thirds Hz 25	32.9	-11.8	32.9	33.5	-11.2	33.5	34.0	-10.7	34.0	43.5	-1.2	43.5	36.6	-8.1	36.6	45.6	0.9	45.6
32	32.8	-6.6	32.8	32.3	-7.1	32.3	34.4	-5.0	34.4	39.3	-0.1	39.3	33.9	-5.5	33.9	40.1	0.7	40.1
40	34.2	-0.4	34.2	30.5	-4.1	30.5	32.9	-1.7	32.9	46.4	11.8	46.4	32.6	-2.0	32.6	44.3	9.7	44.3
50	34.9	4.7	34.9	33.0	2.8	33.0	32.5	2.3	32.5	40.8	10.6	40.8	31.7	1.5	31.7	39.3	9.1	39.3
63	34.4	8.2	34.4	31.1	4.9	31.1	33.0	6.8	33.0	39.9	13.7	39.9	27.2	1.0	27.2	36.6	10.4	36.6
80	37.5	15.0	37.5	29.5	7.0	29.5	32.0	9.5	32.0	44.7	22.2	44.7	26.2	3.7	26.2	42.6	20.1	42.6
100	34.8	15.7	34.8	35.7	16.6	35.7	36.4	17.3	36.4	46.0	26.9	46.0	36.0	16.9	36.0	36.6	17.5	36.6
125	27.7	11.6	27.7	26.5	10.4	26.5	30.4	14.3	30.4	36.7	20.6	36.7	23.6	7.5	23.6	32.7	16.6	32.7
160	23.4	10.0	23.4	23.0	9.6	23.0	28.9	15.5	28.9	32.3	18.9	32.3	20.5	7.1	20.5	34.5	21.1	34.5
200	20.4	9.5	20.4	20.7	9.8	20.7	24.0	13.1	24.0	38.7	27.8	38.7	18.9	8.0	18.9	31.2	20.3	31.2
250	21.3	12.7	21.3	20.1	11.5	20.1	22.3	13.7	22.3	30.4	21.8	30.4	19.6	11.0	19.6	28.6	20.0	28.6
315	32.4	25.8	38.0	30.3	23.7	35.7	30.5	23.9	35.6	36.7	30.1	41.7	31.2	24.6	37.0	35.1	28.5	40.2
400	20.7	15.9	20.7	19.2	14.4	19.2	20.1	15.3	20.1	25.5	20.7	25.5	18.3	13.5	18.3	23.3	18.5	23.3
500	22.3	19.1	22.3	20.1	16.9	20.1	22.7	19.5	22.7	26.9	23.7	26.9	19.4	16.2	19.4	20.8	17.6	20.8
630	22.2	20.3	22.2	21.3	19.4	21.3	27.1	25.2	27.1	22.6	20.7	22.6	19.0	17.1	19.0	19.6	17.7	19.6
800	21.3	20.5	21.3	22.0	21.2	22.0	23.8	23.0	23.8	23.6	22.8	23.6	19.4	18.6	19.4	20.2	19.4	20.2
1k	21.1	21.1	21.1	21.4	21.4	21.4	22.6	22.6	22.6	24.5	24.5	24.5	19.6	19.6	19.6	19.5	19.5	19.5
1.25k	20.2	20.8	20.2	20.5	21.1	20.5	20.9	21.5	20.9	24.9	25.5	24.9	19.7	20.3	19.7	19.5	20.1	19.5
1.6k	20.3	21.3	20.3	20.8	21.8	20.8	20.1	21.1	20.1	22.5	23.5	22.5	20.0	21.0	20.0	19.2	20.2	19.2
2k	21.8	23.0	21.8	21.9	23.1	21.9	21.2	22.4	21.2	22.5	23.7	22.5	20.0	21.2	20.0	22.2	23.4	22.2
2.5k	20.5	21.8	20.5	19.8	21.1	19.8	18.9	20.2	18.9	26.6	27.9	26.6	18.4	19.7	18.4	26.1	27.4	26.1
3.15k	20.5	21.7	20.5	20.1	21.3	20.1	16.3	17.5	16.3	29.2	30.4	29.2	18.0	19.2	18.0	30.5	31.7	30.5
4k	19.6	20.6	19.6	18.1	19.1	18.1	14.6	15.6	14.6	21.0	22.0	21.0	16.3	17.3	16.3	29.6	30.6	29.6
5k	18.9	19.4	18.9	16.6	17.1	16.6	13.4	13.9	13.4	20.9	21.4	20.9	16.0	16.5	16.0	27.2	27.7	27.2
6.3k	18.3	18.3	18.3	15.5	15.5	15.5	12.3	12.3	12.3	21.1	21.1	21.1	14.9	14.9	14.9	20.6	20.6	20.6
8k	21.8	20.8	21.8	15.4	14.4	15.4	11.4	10.4	11.4	20.1	19.1	20.1	14.4	13.4	14.4	16.6	15.6	16.6
10k	16.1	14.1	16.1	13.7	11.7	13.7	10.2	8.2	10.2	16.3	14.3	16.3	12.7	10.7	12.7	13.7	11.7	13.7
Measured A	33.3			32.3			32.8			38.1			31.2			37.7		
C	44.1			42.2			42.5			51.9			44.0			50.7		
Derived Oct 31.5	38.1	0.8	38.1	37.0	-1.8	37.0	38.6	0.3	38.6	48.7	12.3	48.7	39.5	0.3	39.5	48.7	10.7	48.7
63	40.6	16.1	40.6	36.2	10.0	36.2	37.3	11.9	37.3	47.1	23.0	47.1	33.8	7.0	33.8	45.0	20.8	45.0
125	35.8	17.9	35.8	36.4	18.2	36.4	38.0	20.6	38.0	46.6	28.3	46.6	36.4	17.8	36.4	39.7	23.6	39.7
250	33.0	26.1	38.2	31.1	24.1	35.9	31.9	24.6	36.1	41.2	32.5	43.7	31.7	24.9	37.1	37.2	29.6	41.0
500	26.6	23.6	26.6	25.1	22.1	25.1	29.0	26.6	29.0	30.1	26.7	30.1	23.7	20.6	23.7	26.3	22.7	26.3
1k	25.7	25.6	25.7	26.1	26.0	26.1	27.4	27.2	27.4	29.1	29.2	29.1	24.3	24.3	24.3	24.5	24.4	24.5
2k	25.7	26.9	25.7	25.7	26.9	25.7	24.9	26.1	24.9	29.1	30.3	29.1	24.3	25.5	24.3	28.2	29.4	28.2
4k	24.5	25.4	24.5	23.3	24.3	23.3	19.7	20.7	19.7	30.3	31.4	30.3	21.6	22.6	21.6	34.1	35.1	34.1
8k	24.1	23.3	24.1	19.7	18.9	19.7	16.2	15.4	16.2	24.4	23.7	24.4	18.9	18.1	18.9	22.6	22.2	22.6
Derived A	33.0	32.4	34.1	32.2	31.8	33.0	32.7	31.7	33.4	38.4	36.6	39.1	31.1	30.4	32.4	37.5	37.6	38.2
C	42.9	32.9	43.9	41.1	32.1	41.9	42.4	32.8	43.0	51.5	37.9	51.8	41.2	31.1	42.3	49.0	37.2	49.4

Highlighted figures indicate measured and derived corrected dB(A) values after 315 Hz total adjustment