Music Noise Investigation

5 WESTON AVENUE, FISHER SOUTH 3152

Final Report – 1727 -01

NoiseNet Operations Pty Ltd ABN: 26 624 212 175		Customer Name:	Fisher City Council
noisenet.com.au		Report Number:	1727-01
P: 1800 266 479		Issue Date:	22/08/2022
Customer Ref No.:	1855638	Monitoring Type:	Single Monitor
Property Type:	Residential House		
Property Address:	5 WESTON AVENUE, FISHER SOUTH 3152		
Property Code:	3152_1727	Report Issue:	Final Report
Compiled By:	Jake Donovan-Parker	Reviewed By	Stuart Clough

1 OBJECTIVE

NoiseNet was commissioned by Fisher Ciy Council to investigate suspected intrusive music noise from 90 Streeton Lane, Fisher South 3152 (referred to as the Target Property). This report will refer to music noise but this category will also include talking as they are similar sounds and generally associated together.

To facilitate the investigation, unattended noise monitoring was conducted using proprietary NoiseNet technology, with the gathered data analysed using specialised techniques to ascertain;

1) Instances of audible music noise at the monitoring position
2) The date and time when 1) occurs, and
3) The frequency and durations of 1), and
4) The direction of arrival of 1).
5) The intensity (dB(A)) of 1).

Results of the analysis are compared to relevant criteria and legislation for the job locality, and conclusions drawn as to periods of criteria exceedance.

2 SITE CONTEXT AND MONITORING LOCATION

2.1 SITE DESCRIPTION

The target property, 90 Streeton Lane, Fisher South 3152, is located in a primarily residential area. Music noise from a nearby commercial property (the target property) has been reported as a nuisance and impacting the complainant's property (5 Weston Avenue, Fisher South 3152). See Figure 1 for details.

To gather data and recordings of music noise impacting the complainant property, a noise monitor was installed at 5 Weston Avenue, Fisher South 3152, located north of the target address. For further details on the monitoring location, refer to Figure 1 and Section 2.2.

2.2 NOISE MONITORING

A NoiseNet Pinpoint smart noise monitor (S/N: 5214) was installed on a pergola support beam on the south east corner of 5 Weston Avenue, Fisher South 3152, approximately 1.5 metres above ground level and 10 metres the target property (refer to Figure 1 and Figure 2).

The monitoring position was chosen to allow clear measurement of music noise as it affects external habitable areas, while minimising the impact of other noise sources in the area which include general residential noise. The positioning of the monitor did not allow for a clear line of sight to the target property as the line of sight was blocked by a wooden fence and retaining wall. Notwithstanding this, the angular capability of the noise monitor was still able to be utlisied to determine the direction of arival of the music noise.

The noise monitor recorded noise between 2:15 pm on the 7th of July 2022 and 12:05 pm on the 20th of July 2022, and was calibrated prior to shipment to the installing authority to ensure accuracy (decibel level and date/time) before installation. Data from this period has been used to confirm directional sources.

A noise diary was also provided by the complainant which outlined 6 periods where the complainant believed there was intrusive noise. These periods were reported to start between 5:03 pm and 6:17 pm and last up 8h:06m.

Refer to Section A.1 and A.2 for further information regarding NoiseNet noise monitoring equipment.

Where possible, the unattended noise monitoring was conducted in accordance with *Department of Environment and Heritage Protection EM1107* and *AS1055:1997* guidelines[1].

[1] The guidelines focus on methodology ensuring accurate measures of sound level in decibels (dB). As the criteria and methodology used in this report are based on noise classification, audibility and duration, a number of recommendations (particularly concerning reflecting surfaces and weather considerations) are disregarded in favour of a more representative monitoring location.

Figure 1 - Target property, surrounding residents and noise monitoring location.

Figure 2 - Noise monitor location, in situ.

3 CRITERIA

Noise from indoor venues is managed in Fisher City Council under The Environmental Protection Act 2017, Division 2 part 167, which details criteria for nuisance noise from residential properties as follows:

1. A person must not--

- *(a) emit an unreasonable noise from residential premises; or*
- *(b) permit an unreasonable noise to be emitted from residential premises.*

Noise from indoor venues in Fisher City Council is also managed under The Public Health and Wellbeing Act, Part 6 Division 1 part 167 Section 61, which details criteria for nuisance noise from a residential property as follows:

1. A person must not--

- *(a) cause a nuisance*; or*
- *(b) knowingly allow or suffer a nuisance* to exist on, or emanate from, any land owned or occupied by that person.*

**Where noise or emissions are defined as a nuisance excluding noise arising from or constituted by any noise or emission from a wind turbine at a wind energy facility.*

4 ANALYSIS METHODOLOGY

The NoiseNet PinPoint noise monitor gathers data, (audio recordings and A weighted decibel levels) via a calibrated certified microphone, which is analysed in a number of steps to give insights on the timing and duration of audible music noise.

The same steps are used to analyse data gathered from a directional microphone array on the PinPoint noise monitor to give insights on the direction of arrival of music noise. Full details of the noise monitor can be found in Section A.1 and A.2.

4.1 MUSIC NOISE IDENTIFICATION

To efficiently analyse the large amount of data gathered by the monitor, automated tools are utilised to reduce and largely remove the amount of listening required by human operators. The aim of these tools is to identify, with accuracy, times when music, bass or talking noise is recorded by the noise monitor. Each step of the identification process is described in Sections 4.1.1 to 4.1.3.

4.1.1 AUTOMATED NOISE EVENT DETECTION

The background noise level LA_{90} is determined over a rolling time window, and is used to establish a baseline for significant and insignificant noises. If a given four seconds has a noise level significantly above the background level, a ‘noise event’ is deemed to have occurred. Each of these noise events are extracted as a recorded ‘snippet’, which contain only the most significant and impactful noises.

Examples of noises which would likely be disregarded as background noise are air-conditioning/mechanical plant, crickets and distant traffic. Foreground sounds likely to be extracted as snippets include close proximity dog barking, bird calls or other impulsive and loud noises.

4.1.2 AUTOMATED SPECTRAL FINGERPRINT ANALYSIS

Each snippet is then automatically classified as either containing “music, bass or talking” or “non music, bass or talking”, by comparing the spectral “fingerprint” of the snippet in question and a database of spectral fingerprints from many different noise sources. The comparison and classification method are conducted using various machine learning algorithms and techniques, which groups snippets into the closest matching category.

Due to the similarities between talking and music noise the two are difficult to differentiate by our AI and so these sounds are placed in the same singular category.

Refer to Section A.3 for further details.

4.1.3 MANUAL VERIFICATION

A manual verification step is introduced to ensure the automated steps are achieving sufficient accuracy. Operators are given a randomised selection of 4 second audio snippets, observing the spectral fingerprint and listening to the audio. The operator then assigns an appropriate category to the snippet, which is compared to the category the automated processes had assigned. In this way, the amount of false positive and false negative identifications of music noises is quantified.

If accuracy is deemed insufficient, the operator tagged data is fed back into the system, allowing the automated detection of music noise to be improved for a particular situation. For example, the system may initially tend to provide “false alarms” on dog noises, perhaps falsely identifying dog noise as music noise. The operator correctly identifies the dog noise, and the system is retrained, and re-run, providing a more accurate classification of different noises. The manual verification, re-classification, and re-analyse step can be performed as many times as deemed necessary to obtain the most accurate result possible.

4.2 DETERMINATION OF PARTY/TALKING NOISE DURATION

For this analysis, automated tools and processes are used to determine the duration of music, bass and/or talking noises measured by the monitor. Due to the continuous nature of music, bass and talking noise; for all snippets categorised as containing music, bass and/or talking 4 seconds (the entire length of the snippet) is added to the duration tally for that relevant hour or half-hour period.

4.3 DIRECTIONAL DATA PRESENTATION

When displaying results from the directional analysis, data points are plotted on a polar chart, which allows for visualisation of both azimuth and elevation of the noise source in the one chart. An example of the polar chart is given in Figure 3, wherein the blue data point occurs at an angle of approximately 50 degrees azimuthal angle and 60 degrees elevation angle and the red data point occurs at an angle of approximately 225 degrees azimuthal angle and 15 degrees elevation angle. Sources with low elevation angle occur towards the outer edges of the plot, and sources with higher elevation angles appear closer to the centre of the plot. If we imagine the sound direction of arrival being plotted on the surface of a sphere, at the appropriate azimuth and elevation angles, the polar plot is the equivalent of looking directly down on that sphere from above. A limitation of the noise monitor is that noise cannot be determined as occurring uniquely above or below – i.e an elevation angle of 45 degrees may indicate a direction of arrival of 45 degrees above the horizontal, or 45 degrees below the horizontal.

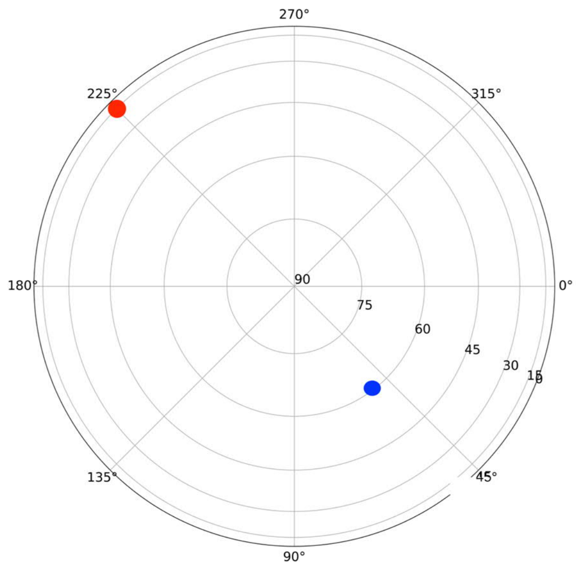


Figure 3 –Example polar chart. The blue data point occurs at an angle of approximately 50 degrees azimuthal angle and 60 degrees elevation angle. The red data point occurs at an angle of approximately 225 degrees azimuthal angle and 15 degrees elevation angle.

Directional data may also be presented on the polar chart as a heat map, with different colours indicating the amount of noise arriving from a certain azimuthal angle. For example, the heatmap in Figure 4 shows that most noise originated from the 75-90 degree direction, and the second most noise coming from the 180-200 degree direction. Blue/Purple colours indicate directions were little/noise noise was observed. Information regarding elevation angle is typically discarded when generating and interpreting these plots.

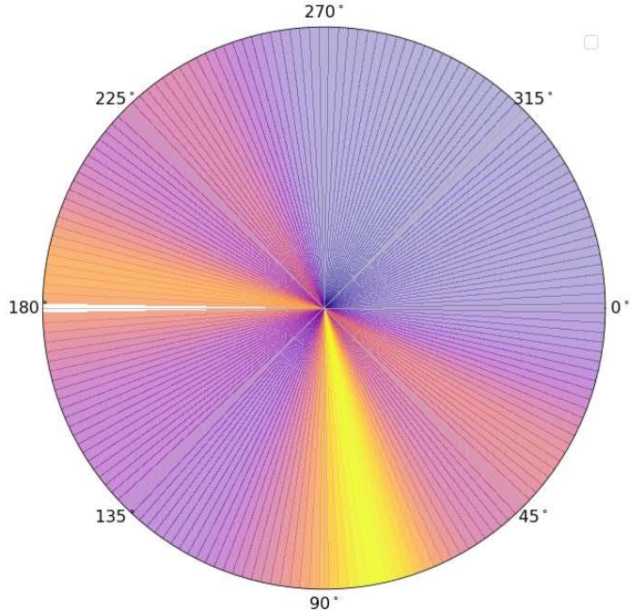


Figure 4 - Example heat map (not related to this job). The most noise is measured in the 75-90 degree azimuthal direction, with the second most measured in the 180-200 degree direction.

Heat maps may be displayed with the underlying data points plotted as well, to give additional insight into the dataset. Since the directional noise monitor provides information on the direction of arrival, the actual noise source may be located at any physical location which is in the same direction (we generally cannot resolve the distance to the noise source. As such, care must be taken on interpreting any polar charts overlaid on physical floorplans or photographs, because noise sources are not necessarily located at locations denoted on the image. All care and explanation will be given where such images are presented.

4.4 DETERMINATION OF MUSIC NOISE SEVERITY AND DIRECTION OF ARRIVAL

After durations of Music noise are identified with sufficient accuracy, we selected the four periods with the highest durations are selected for more in-depth analysis including the directional analysis. The following method was implemented to determine the relative impact of the music noise for each of these periods:

1) We calculated the L10 and L90 averaged over 3 minute windows across the entire period identified with music noise, including a 30-60 min section of audio either side of the period of high music noise.
2) The L10 was selected to measure the noise energy of the music noise as it is a better representation of the noise impact of music due to its impulsive nature.
3) The L90 will be used to measure the background noise level as it is generally sufficient to capture the background level when there is very little noise activity. L90 can be affected by continual music noise where there is little variation in the volume, or for continuous sounds (like mechanical noise from HVAC) so it is not always representative of the actual background noise.
4) The relative impact of the music noise is the difference between 2) and 3).

While NoiseNet and our technology has the ability to extract directional “beamformed audio” from the microphone array, the quality of the audio from this process is lower than that of the certified microphone, this decline in quality can affect the accuracy of detection. For this job we have utilised the following approach to determine the relative direction of arrival of the music noise during the course of the monitoring:

a) NoiseNet's AI will be applied to the certified audio and then time-matched to the directional audio which allows for a predicted category to be assigned to the directional audio. The sections of audio this is applied to are sections where the music noise is the predominant noise contributor with few other competing noises.
b) A random sample of directional snippets categorised in step a) are then manually verified to determine the accuracy of the predictions in the prior step.
c) Once the accuracy is satisfactory directional data from all snippets within the time periods described in a) are used to create a heatmap as outline in Section 4.3.

This approach means that not all captured audio is sampled for direction, we attempt as much as possible to ensure that the sample is clean and appropriately representative of the nuisance in question.

4.5 ACCURACY

Under ideal circumstances, our methods can very reliably distinguish music noise from other general noise events such as birds, dogs, gates/doors opening and closing and objects falling. However, every job presents an entirely unique acoustic environment, with music and other noises that have never been classified by our system before. Even though every job is held to rigorous internal quality assurances, the automation techniques used can never be 100% accurate, and the possibility of false positive and false negative music identification exists. This means that quoted results may differ from actual durations of music noise occurring at the property.

Accuracy of direction of arrival is typically around 7 degrees variation in azimuthal accuracy, and variations in elevation angle are approximately 5-7 degrees at low angles, and 10 -15 degrees at higher elevations. Accuracy of the directional device may also be affected by the number of simultaneous noise sources, and the effect of reflections and reverberation of sound within enclosed spaces.

The accuracy of directional readings are further complicated by the nature of recognising a primary sound versus potential secondary noise sources. Our directional system locks on to up to the four loudest noise sources at any one time.

When a directional result is triggered, it is based on the triggering of a noise event above a pre-set threshold of intensity. We then extract an audio snippet of up to the first four seconds of that recording, which utilises beam-forming to maximise the volume from that direction and to partially filter out sounds from other directions.

Due to imperfections in beam-forming and the potential for multiple different noises to be captured within the audio snippet, it is possible music noise may be detected in a sample that has been triggered by a different noise source (e.g. a bird). In this case the tracking algorithm is already looking in a particular direction and when it hears the music the direction provided is likely to be incorrect. We will call these detections 'ghost' detections, or results, as well as instances where detections where we detect music noise both in the correct direction as well as in a direction that is not correct. It is also possible to get ghost detections where there is an appreciable echo/reflection off a hard surface, meaning music noise may be "detected" both in the correct location and off the reflected surface.

These ghost results mean that the directional data will result in significant scatter, where detected noises can on occasions be shown in places that do not make sense for that noise source. For this reason we use the heatmap approach where we measure the density of a specific noise type relative to the directions. The heatmaps will focus on results where there is a consistent source direction and de-emphasise the more random events where 2 noise sources occur concurrently or when reflections are detected. As a result, all decisions around source noise should be based primarily on the heatmaps, recognising that these are a measure of probability of a particular noise emanating from a particular location. Individual “points” of noise cannot by themselves be used to prove the presence or absence of a noise in a particular location, although they can sometimes be used to provide additional context to the results.

The direction of arrival detected by the directional microphone array could be different to the actual bearing to the noise source due to diffractions around objects such as fences and trees, small human errors in the placement of the microphone array in the noise monitor and how level the supporting structure is that the noise monitor was attached/placed on.

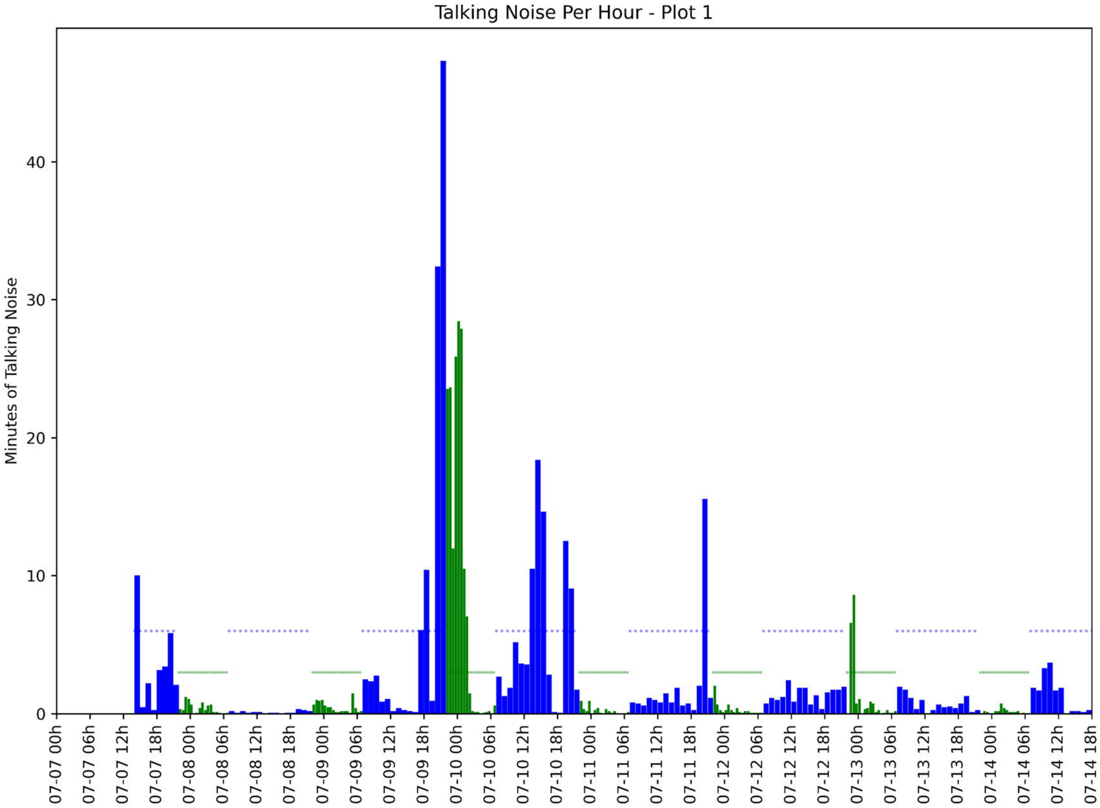
Due to the MEMS microphones in use on the directional microphone array and the relatively small span of the directional array (~70 mm), the directional data will tend to focus on noises that are in the mid- to high-frequency ranges.

We encourage independent verification checks and result validation from complainants and/or council staff, particularly in the event of borderline exceedances cases or likely legal action. Having corroborating information to back up our findings and to provide further context and interpretation to our results will build a much stronger case than just relying on our data alone.

5 RESULTS

Using the methods described in Section 4.1, instances of music noise were successfully extracted and identified from data gathered by the noise monitor over the monitoring period.

The logic in Section 4.2 was then applied to find the total duration of music noise, with results shown in Figure 8. Table 1 shows the same durations for the day time (7am-10pm) and night time (10pm-7am) periods respectively, with solid red cells indicating periods with more than 40 or 20 minutes of music noise during the day or night time periods, respectively, and other colours indicating an implied level of nuisance in line with these limits.



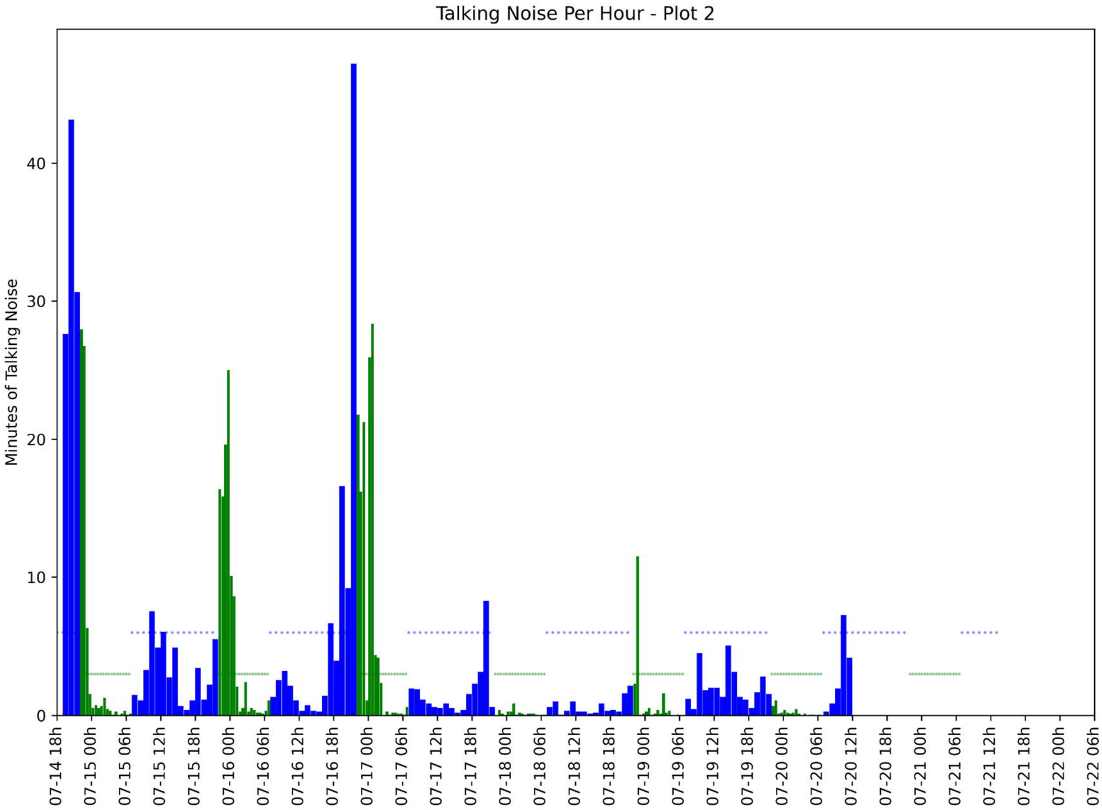


Figure 5 - Total duration (minutes) of music noise per hour (blue, 7am-10pm) or half-hour (green, 10pm-7am).

Max of Value	Date													
Period Commencing	07/07/22	08/07/22	09/07/22	10/07/22	11/07/22	12/07/22	13/07/22	14/07/22	15/07/22	16/07/22	17/07/22	18/07/22	19/07/22	20/07/22
00:00		0:40	0:36	28:26	0:00	0:16	1:05	0:00	0:32	10:05	25:56	0:16	0:16	0:24
00:30		0:00	0:28	27:53	0:16	0:40	0:00	0:12	0:44	8:36	28:22	0:16	0:32	0:12
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01:30		0:24	0:16	7:03	0:04	0:08	0:24	0:44	0:40	0:16	4:10	0:04	0:08	0:12
02:00		0:48	0:08	1:29	0:00	0:24	0:52	0:24	1:17	0:32	2:21	0:12	0:24	0:28
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03:00		0:36	0:12	0:08	0:12	0:04	0:08	0:08	0:20	0:16	0:16	0:04	1:37	0:00
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04:30		0:08	0:04	0:04	0:00	0:04	0:04	0:12	0:00	0:12	0:12	0:08	0:00	0:04
05:00		0:04	1:29	0:08	0:00	0:04	0:16	0:00	0:08	0:12	0:08	0:04	0:00	0:04
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06:00		0:00	0:08	0:00	0:00	0:04	0:04	0:00	0:04	0:20	0:04	0:04	0:00	0:04
06:30		0:04	0:12	0:36	0:08	0:04	0:12	0:00	0:08	1:05	0:36	0:04	0:00	0:00
07:00		0:12	2:29	2:41	0:48	0:44	1:57	1:53	1:29	1:21	1:57	0:36	1:13	0:16
08:00		0:04	2:21	1:17	0:44	1:09	1:45	1:41	1:05	2:33	1:53	1:00	0:28	0:52
09:00		0:12	2:45	1:53	0:36	1:00	1:09	3:18	3:18	3:14	1:09	0:04	4:30	1:57
10:00		0:04	0:52	5:10	1:09	1:13	0:20	3:42	7:32	2:09	0:52	0:20	1:49	7:15
11:00		0:08	1:05	3:38	1:00	2:25	1:00	1:41	4:54	1:05	0:36	1:00	2:01	4:10
12:00		0:08	0:12	3:34	0:48	0:52	0:00	1:53	6:03	0:20	0:32	0:16	2:01	0:00
13:00		0:00	0:24	10:29	1:29	1:53	0:16	0:00	2:45	0:44	0:52	0:16	1:21	
14:00	10:01	0:04	0:16	18:25	0:48	1:53	0:40	0:12	4:54	0:20	0:32	0:08	5:02	
15:00	0:28	0:04	0:12	14:39	1:53	0:40	0:28	0:12	0:40	0:16	0:12	0:12	3:10	
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18:00	3:10	0:04	10:25	0:04	0:16	1:33	0:44	0:00	3:26	3:58	2:17	0:24	0:32	
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20:00	5:51	0:16	32:23	9:04	15:35	1:45	0:08	43:09	2:13	9:12	8:16	1:37	2:49	
21:00	2:05	0:12	47:19	1:45	1:09	1:57	0:16	30:39	5:31	47:10	0:36	2:09	1:33	
22:00	0:20	0:40	23:31	0:56	2:01	0:00	0:00	27:57	16:24	21:46	0:00	2:17	0:40	
22:30	0:16	1:00	23:39	0:20	0:40	6:35	0:12	26:45	15:52	16:12	0:24	11:29	1:05	
23:00	1:13	0:56	11:58	0:12	0:16	8:36	0:08	6:19	19:37	21:14	0:08	0:04	0:08	
23:30	1:05	1:00	25:52	0:56	0:08	0:44	0:00	1:33	25:00	1:05	0:00	0:08	0:12	
Day Exceedances	0	0	1	0	0	0	0	1	0	1	0	0	0	0
Night Exceedances	0	0	3	2	0	0	0	2	1	2	2	0	0	0
Total Exceedances	0	0	4	2	0	0	0	3	1	3	2	0	0	0

Table 1 – Minutes:Seconds of music noise per hour between 7am and 10pm, and per half hour between for 10pm and 7am, for each monitored day. Time of day represents the start of the 60 or 30 minute period (e.g 7am-8am), with red cells indicating exceedance of the 40 minute day or 20 minute thresholds.

Using the methods described in Section 4.1, the direction of the music noises from the data gathered by the directional monitor were successfully identified over the monitoring period.

The accuracy of the detected direction of arrival of sound is dependent on the path the sound takes from the source to the noise monitor. The resolved direction may be influenced by confounding factors such as reflections, barriers and obstacles or simultaneous noise sources. As such, directional results should be interpreted from a statistical standpoint, with the direction of individual noise events considered carefully.

Additionally, in reference to Section 4.3, the reader is reminded that the location where individual data points lie on the satellite imagery is inconsequential, and do not represent an absolute location of the noise source.

Figure 6 displays a heat map supplemented with a scatter plot of AI predicted music noise from across the four periods with highest music noise (which are also four of the periods the complainant outlined in their noise diary). The clustering of data points at low elevation angles (towards the outer edge of the polar chart) indicates that music noise is impinging on the noise monitor from either a similar altitude, from reasonably large separation distances, or diffracting over obstructing obstacles similar to the height of the monitor (such as fences or buildings).

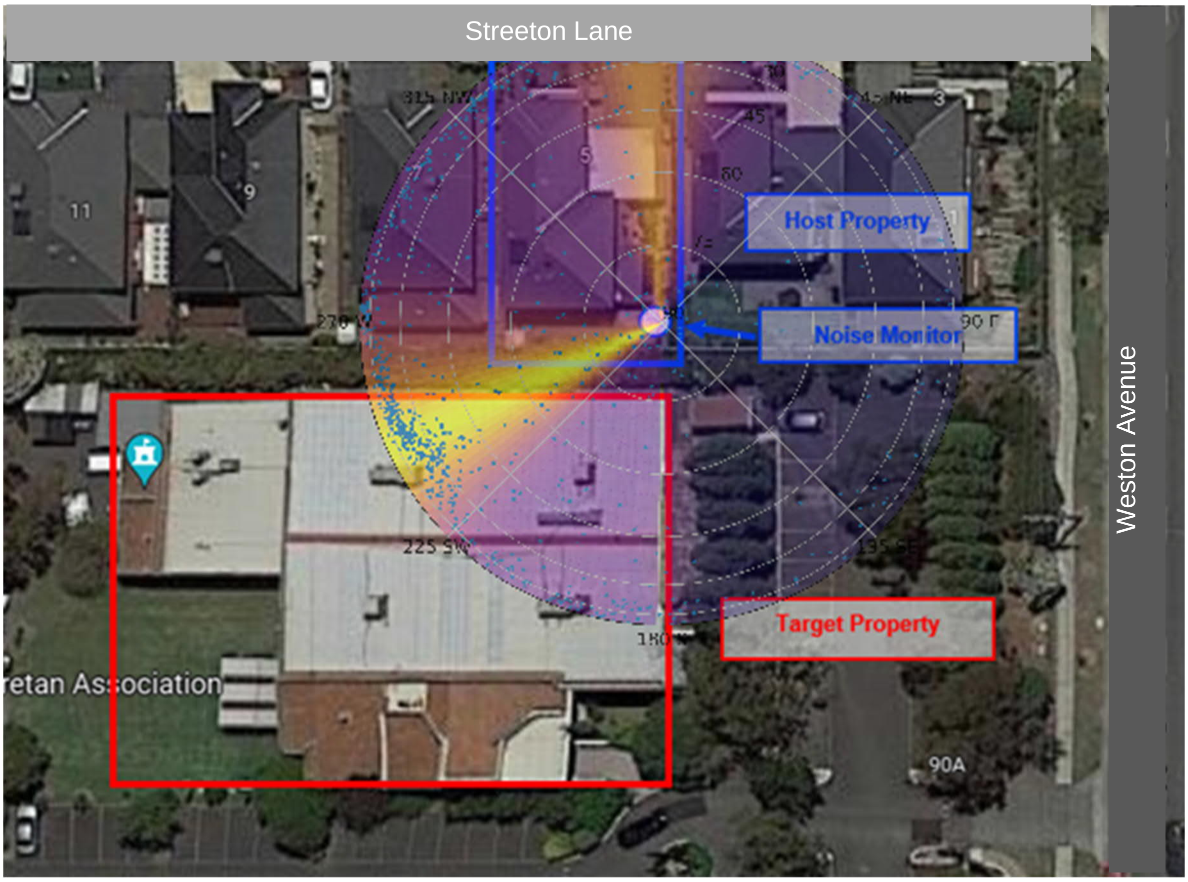

Figure 6 - Overlay heat map and scatter plot of AI predicted music noises from across the four periods of highest music noise.

Using the methods described in Section 4.4, 4 sections of audio were selected to evaluate the relative impact of the music noise. A spectrogram and dB(A) plot were generated for each of these sections and the dB(A) plots were annotated using the colour coding key in Figure 7. The sections of audio are presented in Figure 8 through to Figure 11 with the x-axis in these plots describing the time as mm-dd hh. 2 snippets of audio from each section of the three periods has been provided along with this report.

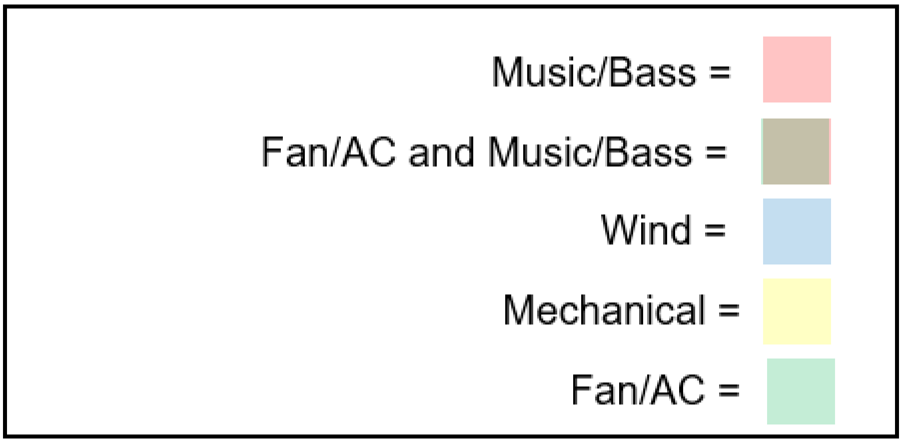

Figure 7 – Colour coding key used for annotating the dB(A) plots in Figure 8 through to Figure 10.

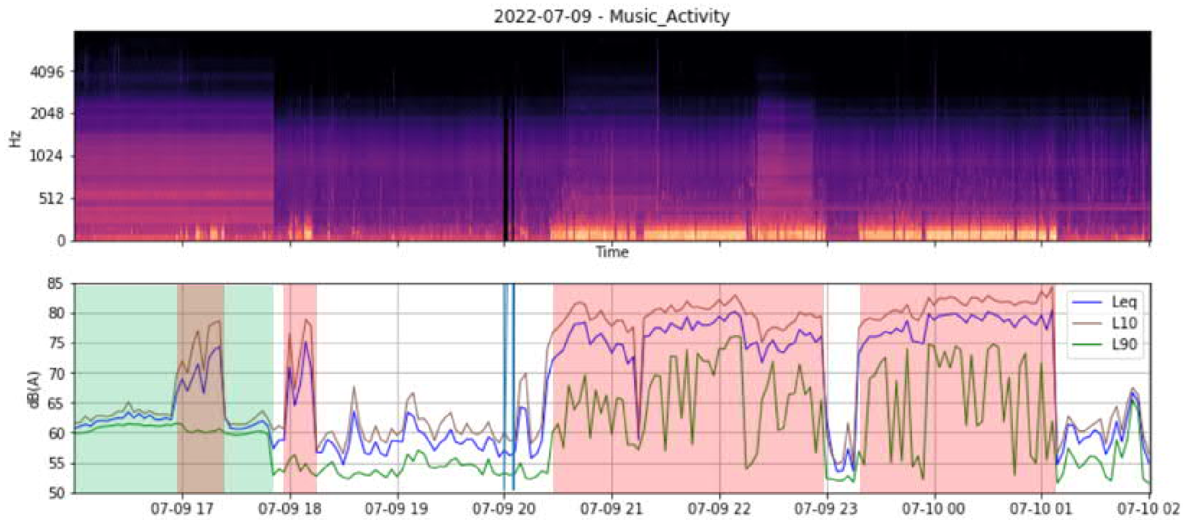

Figure 8 – Spectrogram and annotated dB(A) plot for the period between 4:00 pm 9/7/22 and 2:00 am 10/8/22.

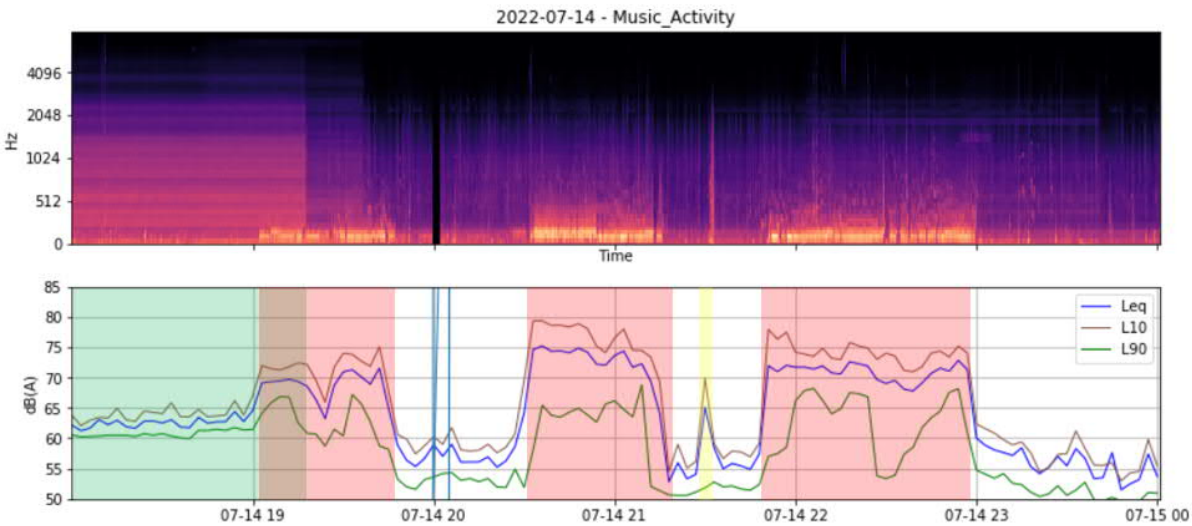

Figure 9 - Spectrogram and annotated dB(A) plot for the period between 6:00 pm and midnight 14/7/2022.

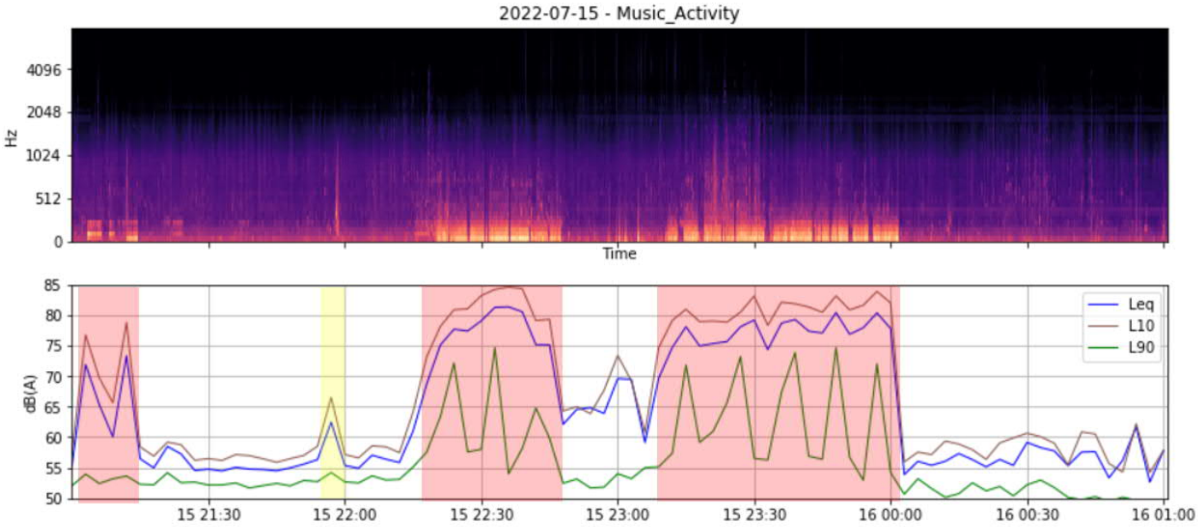

Figure 10 - Spectrogram and annotated dB(A) plot for the period between 9:00 pm 15/7/22 and 1:00 am 16/7/2022.

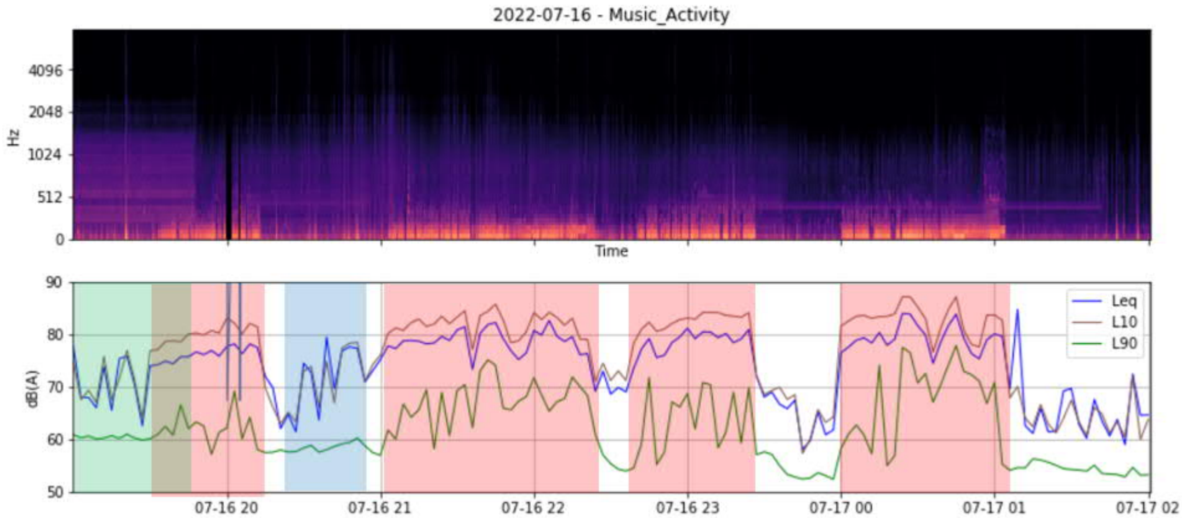

Figure 11 - Spectrogram and annotated dB(A) plot for the period between 7:00 pm 16/7/22 and 2:00 am 17/7/2022.

6 FINDINGS

The monitoring at 5 Weston Avenue, Fisher South 3152 confirmed that the noise environemnt was significantly affected by music noise during most of the times reported by the complainant. The days with the most consistent high energy music noise were 9th, 14th, 15th and 16th of July 2022 which started between 5:00 and 5:30 pm and went to as late as 1:00 am the next morning.

In regards to the two other days outlined by the complainants (8/7/22 and 10/7/22) there was either no music detected or the music was quieter/less consistent than the four days chosen for in depth analysis. The stronger acoustic signal improves the accuracy of directional data so we have focussed the analysis on these 3 days.

Figure 5 and Table 1 show very consistent durations of music noise during the four periods of consistent high energy music noise outlined in the paragraph above.

It should be noted that our detections systems are measuring a consolidated acoustic pattern that includes periods with amplified music as well as periods with talking or yelling. All of these noise types will show up as positive detections. In assessing the severity of these different potential sub-types, we believe that the sub-type of the source is not particularly material and that the decibel readings of the noise at the times the noise is detected is the most relevant indicator of likely nuisance.

From the directional data analysed and displayed in Figure 6, it is shown that the detected music noise is predominantly coming from southwest of the noise monitor which points at the target property (perhaps towards an opening where the noise escapes from the target property). The other direction of interest on the heatmap is pointing north which is likely caused by false positives coming from within the host property and/or noise reflections.

Date	9-10/2/22	14/7/22	15-16/7/22	16-17/7/22
Period	4pm to 2am	6pm to midnight	9pm to 1am	7pm to 2am
Background	55	53	53	58
LMax (averaged)	84	80	85	87
L10 (averaged)	81	75	80	83

Figure 12 – Spectrogram and annotated dB(A) plot for the period between 4:00 pm 9/7/22 and 2:00 am 10/8/22.

When it came to the severity or intensity of the music being played, the certified noise monitor was able to clearly show the impact of the reported nuisance. Figure 8 shows that the dB(A) is raised from 55 to a maximum of 84 and average L10 of 81 dB(A) by the music being played when compared to the background noise level. Figure 9 shows that the dB(A) is raised from 53 to a maximum of 80 and averageL10 of 75 dB(A) by the music being played when compared to the background noise level. Figure 10 shows that the dB(A) is raised from 53 to a maximum of 85 and average L10 of 80 dB(A) by the music being played when compared to the background noise level. Figure 11Figure 10 shows that the dB(A) is raised from 58 to a maximum of 87 and average L10 of 83 dB(A) by the music being played when compared to the background noise level. It should be noted that the night of 16/7/22 had significant amounts of wind that contributed to the raised background level in Figure 11.

When considering all the examples provided it is concluded that the music and or talking noise raises the noise energy level by 22-32 dB(A) above the background noise level. The music is clearly audible and has clear potential to be disruptive to the complainant property and others in the nearby area.

7 CONCLUSION

A NoiseNet noise monitor was installed at 5 Weston Avenue, Fisher South 3152, to investigate potential nuisance amplified music at 90 Streeton Lane, Fisher South 3152. Analysis of recordings and data gathered by the monitor identified 4 instances of prolonged, consistent amplified music noise at levels significantly above background noise over the course of 13 days of monitoring.

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