BRISBANE AIRPORT

WELLINGTON POINT AND THORNLANDS SHORT-TERM NOISE MONITORING

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PREPARED FOR

BRISBANE AIRPORT CORPORATION PTY LTD
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GLOSSARY OF TERMS

L_{Amax}	The maximum noise level over a sample period is the maximum level measured during the sample period. For aircraft noise, the maximum noise level is measured using slow response.
N-above	'Number-above', or 'N-above', describe the number of aircraft noise events that exceed a particular noise threshold. The most common 'N-above' are N70 and N60, describing the number of events above 70 dB(A) and 60 dB(A) respectively.
RNP-AR	Required Navigation Performance Authorisation Required (RNP-AR) is a precision arrival or departure procedure which uses satellite navigation. RNP-AR is typically developed to provide a shortened arrival procedure (as is the case at Brisbane Airport).
ILS	Instrument Landing System is a radio navigation system. ILS is typically available in most weather conditions, including poor conditions that may prohibit some other navigation methods. ILS require a long, straight arrival path.
CNE	Correlated Noise Events (CNE) are events recorded in the noise monitoring data that are correlated with a simultaneous aircraft operation nearby, for which valid air traffic surveillance data has also been collected.
AHD	The Australian Height Datum (AHD) is the official national vertical datum for Australia.

AIRCRAFT TYPES AND ABBREVIATIONS

717-200	Boeing 712-200 (narrow body jet)
737-300	Boeing 737-300 (narrow body jet)
737-400	Boeing 737-400 (narrow body jet)
737-700	Boeing 737-700 (narrow body jet)
737-800	Boeing 737–800 (narrow body jet)
777-300ER	Boeing 777-300ER (wide body jet)
787-10	Boeing 787-10 (wide body jet)
A320-200	Airbus A320-200 (narrow body jet)
A321-200	Airbus A321-200 (narrow body jet)
A350-900	Airbus A350-900 (wide body jet)
A350-1000	Airbus A350-1000 (wide body jet)
A380-800	Airbus A380-800 (wide body jet)
B463	British Aerospace BAe-146-300 (narrow body jet)
E190	Embraer E190-100 (narrow body jet)
F100	Focker 100 (narrow body jet)
F70	Focker 70 (narrow body jet)
DH8D	DeHavilland Dash 8 (turbo propeller)
SF34	Saab 340 (turbo propeller)
SW4	Swearingen Metroliner (turbo propeller)
C441	Cessna 441 Conquest II (turbo propeller)
AW139	AgustaWestland AW139 (helicopter)

1 INTRODUCTION

Brisbane Airport operates a north-south oriented parallel runway system. The system comprises the legacy runway, Runways 01R/19L, and the new runway, Runways 01L/19R.

Brisbane Airport Corporation (BAC), in cooperation with Airservices Australia (Airservices) engaged Envirosuite to undertake short-term noise monitoring in Wellington Point and Thornlands in response to community enquiries regarding aircraft noise. SoundIN Pty Ltd (SoundIN) has been engaged by BAC to review and analyse the results of that noise monitoring. This report details the results of that analysis.

Short-term noise monitoring is periodically undertaken by BAC at locations surrounding the airport based on community feedback. This short-term noise monitoring augments the permanent Noise and Flight Path Monitoring System (NFPMS) operated by Airservices.

The short-term monitoring detailed in this report was undertaken for the purposes of:

- Recording the aircraft noise levels at three locations in the Wellington Point and Thornlands are from aircraft arriving and departing from Brisbane Airport; and
- Recording the relative altitude of aircraft overflying those areas; and
- Facilitating an investigation into noise and flight path data affecting the area.

Brisbane Airport and the noise monitoring sites are indicated in **Figure 1-1**.

Figure 1-1 Site Locality

2 NOISE MONITORING DESCRIPTION

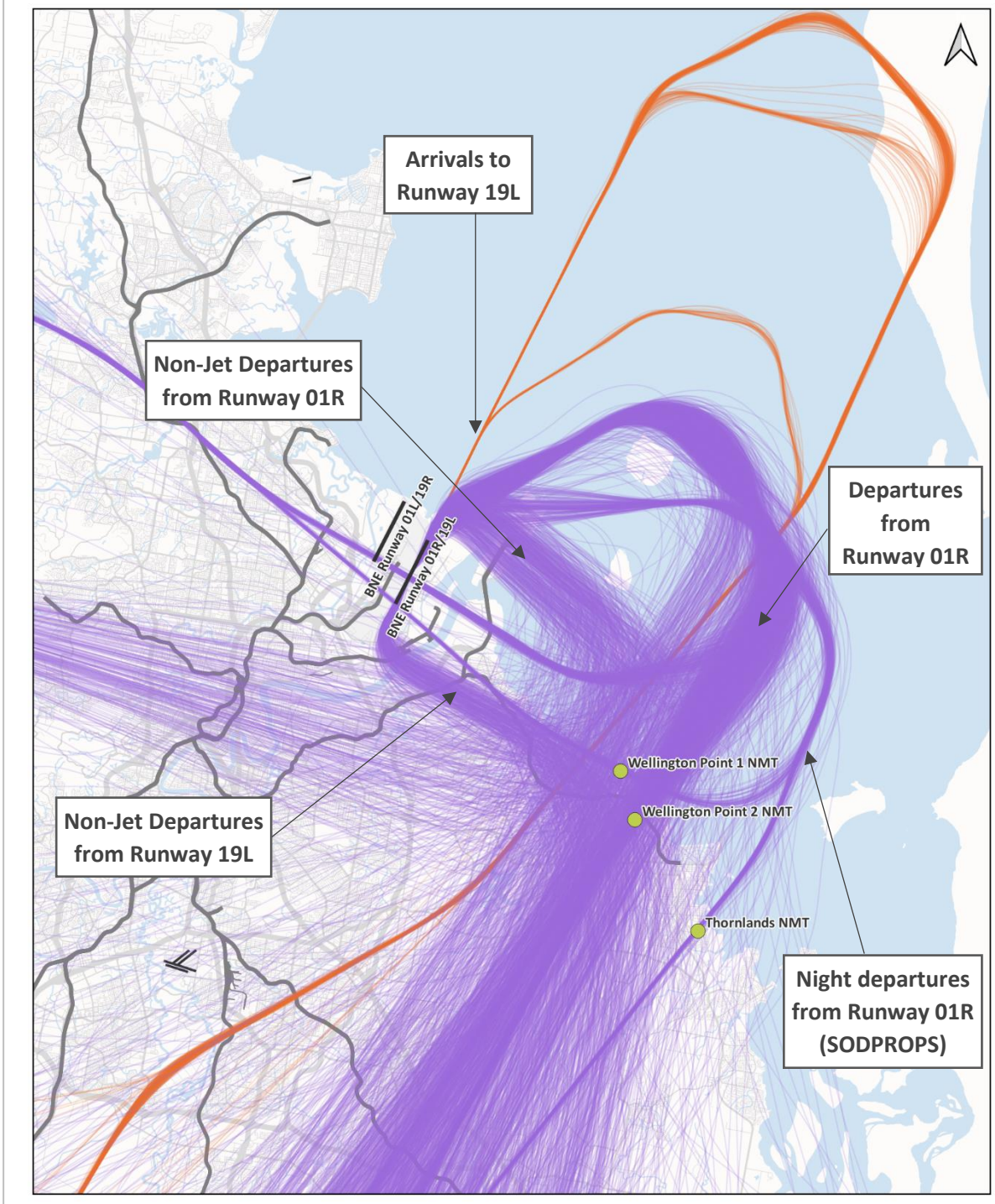
2.1 Details of the Short-Term Noise Monitor Deployment

The following details of the noise monitor deployments are pertinent.

- Monitoring was undertaken at the three locations indicated in **Figure 2-1**.
- Monitoring was undertaken between 13 January 2023 and 30 April 2023. “Wellington Point 1” NMT was installed and operational at various times during this period. Interruptions were caused by various issues affecting the operation of the equipment. “Wellington Point 1” NMT collected data for a total of 64 days during the various deployments, equating to approximately 9 weeks of data. “Wellington Point 2” and “Thornlands” NMTs were deployed continuously between 20 January 2023 and 21 April 2023 (13 weeks), with only two, one-hour service interruptions in this period.
- The duration of this monitoring (9-13 weeks) is considered sufficient to collect a representative sample of operations from Brisbane Airport, including variations in operating modes, aircraft flown, and weather conditions.
- The NMTs were installed at elevations between 20-26 metres AHD (“Wellington Point 1” 20 m, “Wellington Point 2” 26 m, “Thornlands” 22 m).
- The monitors captured both arrival and departure operations.
- Operations in the area include arrivals and departures to and from the legacy runway during the day, evening and night (arrivals onto Runway 19L and departures from Runway 01R).
- At night, distinct flight paths are available from the legacy runway (departures from Runway 01R) during the use of “Simultaneous Opposite Direction Parallel Runway Operations” (SODPROPS).
- Non-jet departures off Runway 19L and Runway 01R pass through the area.
- The short-term noise monitoring consisted of noise monitor terminals equipped with AU-2000 Outdoor Smart Microphone. The microphones were verified in conformance with IEC 61672-1 before the deployment.
- Self-calibration checks on the noise monitor terminals occurred daily on time, and the monitors remained within the calibration range throughout the deployment period.

Figure 2-1 demonstrates the location of the noise monitoring sites with respect to the various flight paths.

Figure 2-1 Noise Monitoring Sites and Flight Paths



Note: Locations of features are indicative only and are shown solely to demonstrate features pertinent to the noise assessment.

2.2 Aircraft Noise Event Detection

Noise events exceeding a defined threshold were automatically identified by the noise monitoring terminals and noise level data saved. Events which were correlated with a simultaneous aircraft operation nearby were automatically identified as aircraft noise events. These events are described as correlated noise events (CNE). The noise level data and aircraft operation data for these events were subsequently associated and saved for post-processing and analysis.

To permit the correlation of aircraft events with measured noise events, a three-dimensional cylinder-like capture zone at each deployment site was established in the processing software. The capture zone was defined by a circular radius 3,000 m, projected 4,267 m (14,000 ft) up from the monitor site. The capture zones are shown in **Figure 2-2**.

The capture zones include the various flight paths described in section 2.1 – i.e. day, evening and night departures from Runway 01R; night-time SODPROPS departures from Runway 01R; day, evening and night arrivals onto Runway 19L; and non-jet departures from Runway 19L and Runway 01R.

The automated noise monitoring system requires several criteria to be met in order to classify an aircraft noise event. These criteria relate to the validity of recorded noise level and air traffic control (ATC) surveillance data, the proximity of aircraft (i.e. within the relevant capture zone) and that the noise level, duration and rise and fall accords with that of an aircraft noise event.

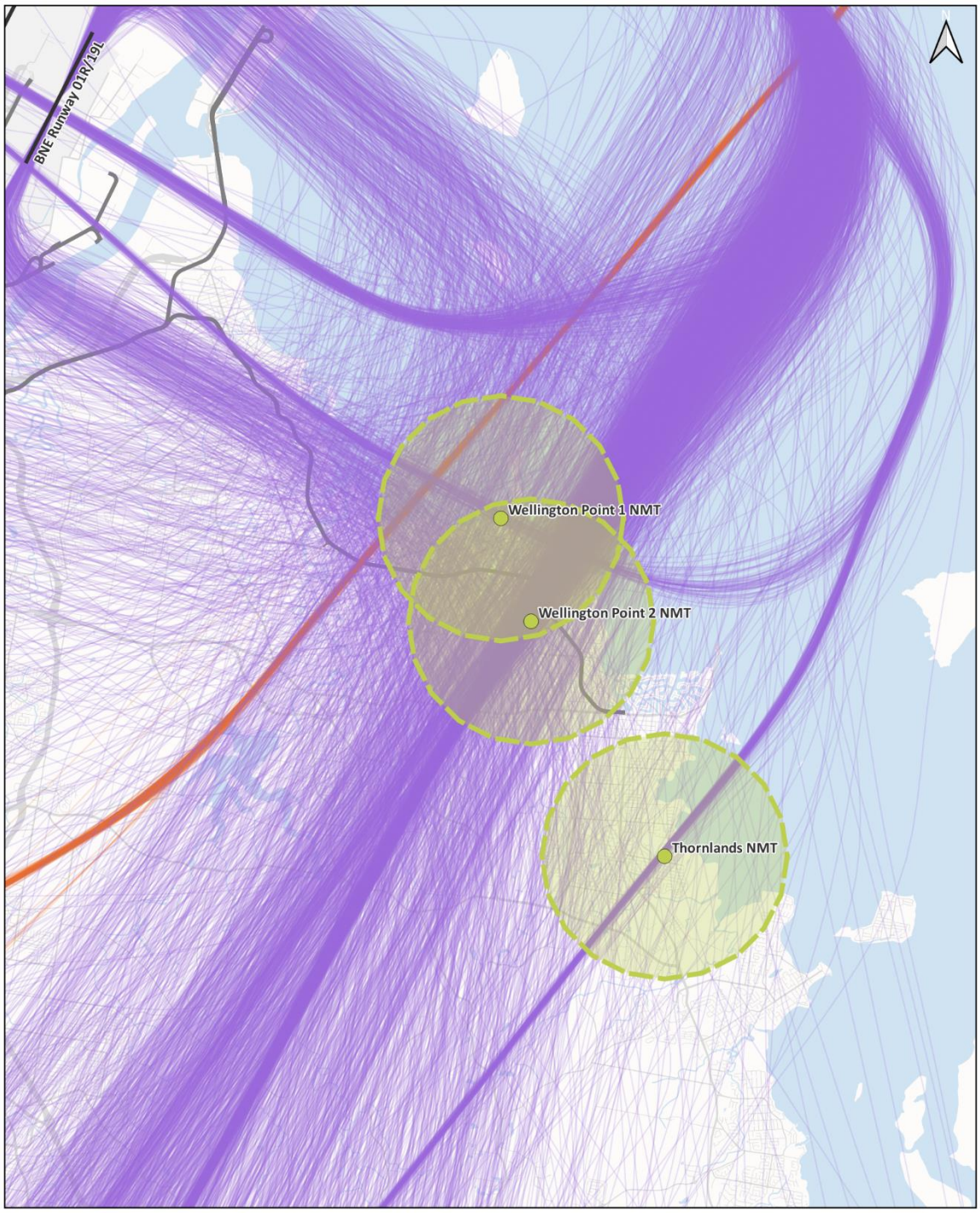
In this way, the system is able to automatically eliminate most extraneous noise events. However, it is possible that some aircraft noise events are not recorded. Most often these are due to the absence of valid ATC surveillance data, or due to the aircraft noise levels being insufficient to satisfy the defined thresholds for noise level and duration.

The noise detection thresholds applied for the monitoring described are described in **Table 2-1**. Noise detection thresholds were established for each noise monitor based on the measured background noise levels at each.

Table 2-1 Noise Detection Thresholds

Wellington Point 1	Wellington Point 2	Thornlands
12 midnight – 5 am = 42 dBA	12 midnight – 5 am = 43 dBA	12 midnight – 5 am = 41 dBA
5 am – 9 am = 51 dBA	5 am – 7 pm = 54 dBA	5 am – 9 am = 49 dBA
9 am – 8 pm = 52 dBA	7 pm – 10 pm = 50 dBA	9 am – 8 pm = 51 dBA
8 pm – 12 midnight = 42 dBA	10 pm – 12 midnight = 50 dBA	8 pm – 12 midnight = 45 dBA

Figure 2-2 Capture Zones



3 NOISE MONITORING RESULTS

This section of the report presents the noise monitoring results for each of the sites.

A summary of the data is presented separately for departures and arrivals, with some examination of the prominent aircraft affecting each site.

To better understand the various flight paths / track groups impacting an area, an analysis of operations and noise levels for prominent track groups is included.

The number of CNE in each track group is far lower than the total operations for the track group. This is due to one of two things: many operations in the track group may have failed to meet the various criteria for a CNE (e.g., noise thresholds were not met at a time when the aircraft was in the spatial extents of the capture zone; see section 2.2); or, many operations in the data contained identifiers that were unable to be matched with spatial data, which was obtained separately. Therefore, the examination of individual track groups should be considered in context; i.e., noise data assigned to a track group is likely a subset of the total operations in that group and, though that subset is likely to contain a similar distribution to the larger population, some statistical descriptors may be skewed by the limited population of the subset.

A comparison of monitoring results between the sites is presented in section 4.

3.1 Wellington Point 1 NMT

3.1.1 Correlated Aircraft Departure Operations

Table 3-1 presents a summary of the correlated aircraft departure noise events at the Wellington Point 1 site.

Table 3-1 Summary of Correlated Aircraft Departure Noise Events at Wellington Point 1

Aircraft [1]	Number of CNE	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [2] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [3] - feet	10th Percentile Slant Distance [3,4] - feet
737-800	409	57.3	60.6	3.1	11630	9963
DH8D	123	57.6	61.3	2.6	7762	5706
SF34	60	58.3	61.5	3.1	6912	5245
A320-200	49	55.6	60.0	3.8	11510	9532
SW4	49	57.6	61.5	2.9	7309	5167
E190-100	29	56.1	58.4	3.6	11285	10313
F100	17	57.7	65.6	4.5	10892	9638
A350-900	16	51.4	52.9	2.9	10839	10330
C441	15	58.0	62.3	3.0	7544	5155
737-700	14	56.1	58.0	3.3	12724	11709
All Jet	**594**	**56.8**	**60.3**	**3.6**	**11482**	**9791**
All Turboprop	**265**	**57.8**	**61.8**	**2.9**	**7433**	**5325**

Note:
1. Presentation of individual aircraft types in **Table 3-1** is limited to the ten aircraft types with the most correlated departure events.
2. The 90th percentile L_{Amax} presents the loudest 10% of events.
3. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
4. The 10th percentile slant distance presents the nearest 10% of events.

The following can be observed from the noise monitoring results.

- The most numerous aircraft demonstrate similar average noise levels around 55-58 dB(A).
- Narrow body jets are most prevalent (737-800, F100, F70, A320-200 and others not shown), representing 63% of the total correlated aircraft departures for fixed-wing aircraft.
- Wide body jets (A350-900 and others not shown) represent only 5% of the total correlated departures for fixed-wing aircraft.
- Turboprop aircraft (DH8D, SF34, SW4, C441 and others not shown), represent 30% of the total correlated aircraft arrivals for fixed-wing aircraft.

- All aircraft exhibit some variation in L_{Amax}; demonstrated by the standard deviation of L_{Amax} and the difference between the 90th percentile and average. For most aircraft, the 90th percentile L_{Amax} is approximately 3-4 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among most aircraft of a similar type. The average slant distance for most jets is approximately 11,000 ft.
- The 10th percentile slant distance (i.e. lowest 10%) ranges between 500 ft and 2,400 ft lower than the mean across the presented aircraft.
- The SF34 is the lowest (by average) and loudest (by average) of the presented aircraft.
- The F100 is the loudest aircraft by 90th percentile L_{Amax}. Given the difference between the average and 90th percentile L_{Amax} for this aircraft, and noting that there is no corresponding difference in the average and 10th percentile slant distances, it must be considered that some of the higher noise levels reported for this aircraft may be erroneous. With a total CNE of 17, only 2 such events would need to be included in the analysis in order to impact the 90th percentile.
- Turboprop aircraft (DH8D, SF34, SW4 and C441) are notably lower than most jet aircraft. Measured L_{Amax} noise levels from turboprops are similar to jet aircraft.
- The A350-900 is distinctly quieter than other jet aircraft. We note that this is among the newest generation of jet aircraft operating at Brisbane Airport.

Table 3-2 presents a summary of prominent departure track groups affecting the Wellington Point 1 NMT. The track groups are shown in **Figure 3-1**.

Table 3-2 Summary of Prominent Departure Track Groups Affecting Wellington Point 1

Track Group [1]	Num. of Ops [2]	Num. of CNE [3]	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [4] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [5] - feet	10th Percentile Slant Distance [5,6] - feet
01R : D : J : 5	4614	390	56.9	60.5	3.6	11654	10013
01R : D : J : 13	66	30	53.5	59.0	4.0	10409	8986
01R : D : P : 10	200	34	57.5	60.3	2.9	7385	5559
19L : D : P : 8	232	90	58.0	62.4	2.9	7325	5422

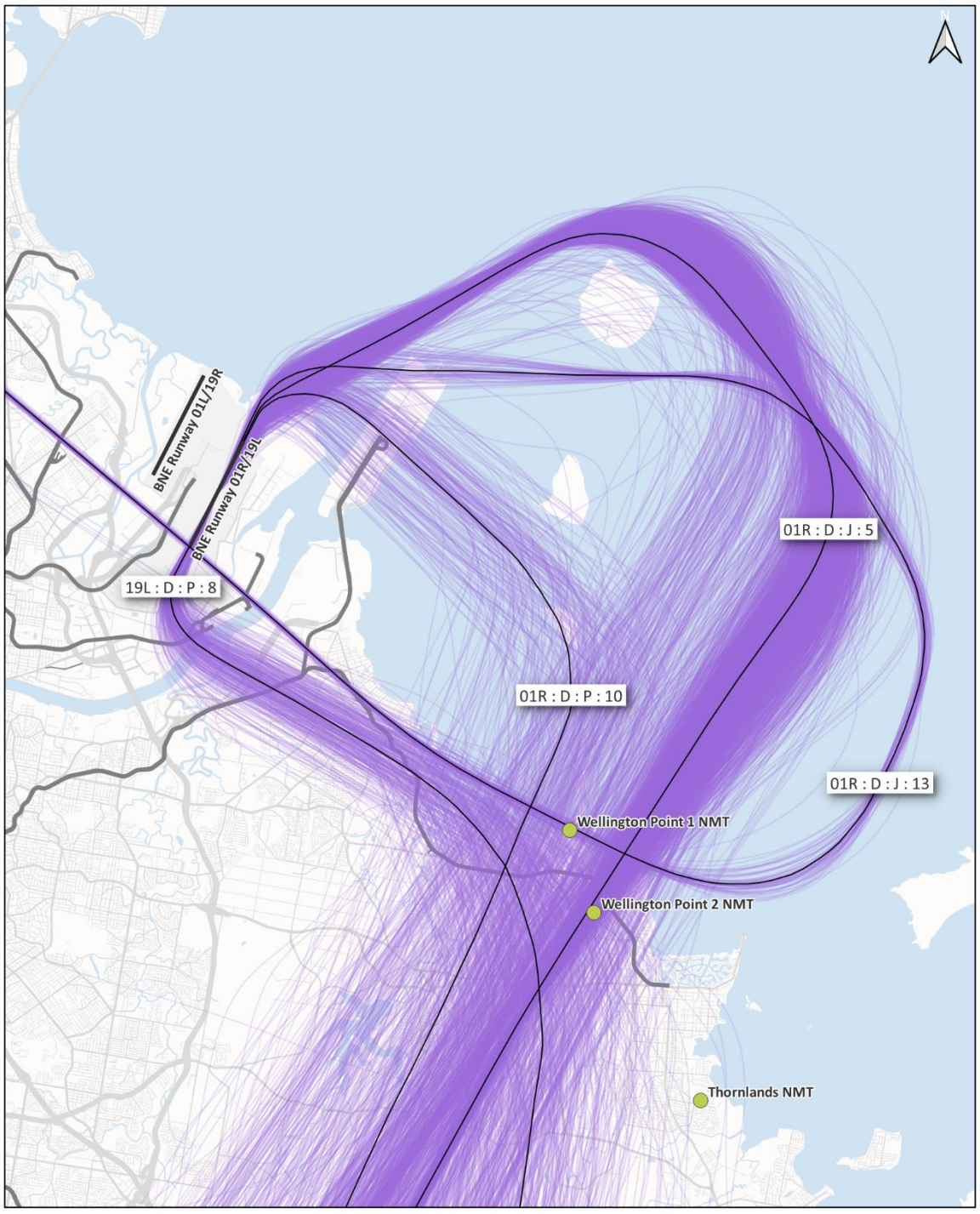
Note:
1. The track group is described by the naming convention "RUNWAY : OPERATION : AC TYPE : NUMBER"
2. The number of operations in the period is presented for the full period 1 January 2023 to 30 April 2023. This period exceeds the short-term noise monitoring period.
3. The number of CNE is substantially lower than the total number of operations. This is due to many operations not fulfilling the requirements for correlation (see section 2.2).
4. The 90th percentile L_{Amax} presents the loudest 10% of events.
5. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
6. The 10th percentile slant distance presents the nearest 10% of events.

Of the prominent track groups, it is noteworthy that all but "01R : D : J : 13" are available during the day, evening and night. "01R : D : J : 13" is available only during SODPROPS operations. Thus, this is a preferred departure flight path at night when operational conditions permit (i.e., acceptable weather conditions and sufficiently low demand to permit the safe use of SODPROPS).

All prominent track groups yield similar average L_{Amax} noise levels, except for "01R : D : J : 13"; which is 3-4 dBA quieter. The 90th percentile L_{Amax} and slant distances (both average and lowest 10th percentile) for "01R : D : J : 13" are not distinctly different to "01R : D : J : 5". Noting this, it is considered likely that the lower average L_{Amax} noise level of "01R : D : J : 13" is due to the fleet operating on this flight path. We note that 43% of CNE on "01R : D : J : 13" are from the newest generation of aircraft operating at Brisbane Airport (A350-900, A350-1000 and 787-10; this fleet mix is representative of the total operations on this track group).

As with the aircraft summaries presented above, track groups containing turboprops exhibit distinctly lower slant distances. L_{Amax} from these track groups are similar to jet track groups, though marginally louder.

Figure 3-1 Prominent Departure Track Groups Affecting Wellington Point 1



3.1.2 Correlated Aircraft Arrival Operations

Table 3-3 presents a summary of the correlated aircraft arrival noise events at the Wellington Point 1 site.

Table 3-3 Summary of Correlated Aircraft Arrival Noise Events at Wellington Point 1

Aircraft [1]	Number of CNE	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [2] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [3] - feet	10th Percentile Slant Distance [3,4] - feet
737-800	66	54.8	60.7	4.6	9082	8504
A320-200	14	55.3	61.2	5.9	8980	7526
All Jet	**91**	54.9	61.0	4.8	8994	8036

Note: 1. Presentation of individual aircraft types in **Table 3-3** is limited to the aircraft types with more than ten correlated arrival events.
5. The 90th percentile L_{Amax} presents the loudest 10% of events.
6. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
7. The 10th percentile slant distance presents the nearest 10% of events.

The following can be observed from the noise monitoring results.

- The most numerous aircraft demonstrate similar average noise levels around 55 dB(A).
- Both the presented aircraft are narrow body jets.
- All aircraft exhibit some variation in L_{Amax}; demonstrated by the standard deviation of L_{Amax} and the difference between the 90th percentile and average. For both presented aircraft, the 90th percentile L_{Amax} is approximately 6 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among the presented aircraft. The average slant distance for is approximately 9,000 ft.
- The 10th percentile slant distance (i.e. lowest 10%) for the 737-800 is approximately 500 ft lower than the mean, whereas the A320-200 10th percentile slant distance is approximately 1,500 ft lower than the mean.

3.1.3 Daily Distribution of Correlated Noise Events

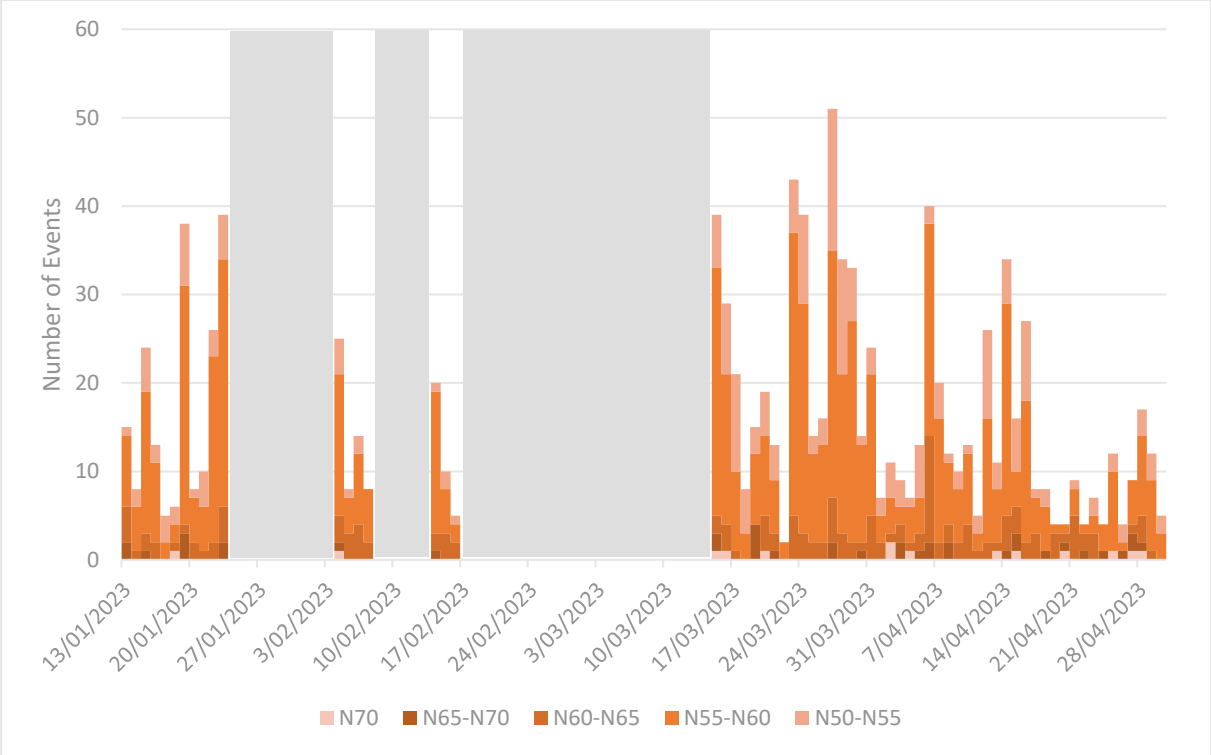
Figure 3-2 presents the number of events within various noise thresholds for each day of the monitoring. The number of events above a noise level threshold is denoted 'number-above' or 'N-above' and is typically expressed in the form N70 (i.e. number of events above 70 dB(A)).

Note that the NMT was offline for three periods, which are indicated by grey blocks in the **Figure 3-2**.

The following is noted from **Figure 3-2** and statistical analysis of the daily N-above values.

- The number of correlated noise events can be seen to vary significantly from day to day. This is likely largely due to different wind conditions requiring Brisbane Airport to utilise different operating modes (i.e. runway directions). Varying traffic numbers and schedules from day to day are also a likely contributing factor.
- The maximum N60 measured was 15 and the average was 3.0. Aircraft noise events above 70 dBA were infrequently observed; the maximum N70 was two and the average was 0.2.
- On most days, the largest proportion of measured aircraft noise events were in the range 55-60 dBA. This accords with the data presented in the previous sections.

Figure 3-2 N-above Distribution During the Monitoring



3.2 Wellington Point 2 NMT

3.2.1 Correlated Aircraft Departure Operations

Table 3-4 presents a summary of the correlated aircraft departure noise events at the Wellington Point 2 site.

Table 3-4 Summary of Correlated Aircraft Departure Noise Events at Wellington Point 2

Aircraft [1]	Number of CNE	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [2] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [3] - feet	10th Percentile Slant Distance [3,4] - feet
737-800	1205	58.4	62.0	3.0	10802	9384
A320-200	70	56.9	62.9	4.7	10495	8896
E190-100	66	56.6	62.4	4.1	10445	9488
DH8D	62	59.3	64.1	3.3	7253	4970
F100	45	58.4	61.1	2.3	9489	8630
SW4	42	60.5	64.0	2.5	6820	5171
A321-200	40	53.4	56.7	2.1	11425	9903
SF34	32	60.1	63.6	2.8	6911	5436
737-400	27	56.3	57.2	1.5	11318	10564
737-700	24	56.8	59.4	3.3	11990	10817
All Jet	**1565**	**57.9**	**61.9**	**3.3**	**10777**	**9301**
All Turboprop	**157**	**59.8**	**64.0**	**2.9**	**7108**	**5102**

Note: 1. Presentation of individual aircraft types in **Table 3-4** is limited to the ten aircraft types with the most correlated departure events.
2. The 90th percentile L_{Amax} presents the loudest 10% of events.
3. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
4. The 10th percentile slant distance presents the nearest 10% of events.

The following can be observed from the noise monitoring results.

- The most numerous aircraft demonstrate similar average noise levels around 56-58 dB(A).
- Narrow body jets are most prevalent (737-800, A320-200, E190-100, F100, A321-200, 737-400, 737-300, and others not shown), representing 88% of the total correlated aircraft departures for fixed-wing aircraft. 69% of all fixed-wing correlated departures are 737-800.
- Wide body jets (none shown) represent only 2% of the total correlated departures for fixed-wing aircraft.
- Turboprop aircraft (DH8D, SW4, SF34 and others not shown) represent 9% of the total correlated aircraft departures for fixed-wing aircraft.
- All aircraft exhibit some variation in L_{Amax}; demonstrated by the standard deviation of L_{Amax} and the difference between the 90th percentile and average. For most aircraft, the 90th percentile L_{Amax} is approximately 3-4 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among most aircraft of a similar type. The average slant distance for most jets is approximately 11,000 ft.
- The 10th percentile slant distance (i.e. lowest 10%) ranges between 800 ft and 2,300 ft lower than the mean across the presented aircraft.
- The SW4 is the lowest (by average) and loudest (by average) aircraft. The DH8D is exhibited the loudest 90th percentile L_{Amax} and correspondingly had the lowest 10th percentile slant distance.
- Turboprop aircraft (SF34 and DH8D) are notably lower than most jet aircraft. Measured L_{Amax} noise levels from turboprops appear to be slightly higher than jet aircraft (by average and 90th percentile).
- It is noteworthy that 737-400, 737-300 are typically operated as freight aircraft, most often at night.

Table 3-5 presents a summary of prominent departure track groups affecting the Wellington Point 2 NMT. The track groups are shown in **Figure 3-3**.

Table 3-5 Summary of Prominent Departure Track Groups Affecting Wellington Point 2

Track Group [1]	Num. of Ops [2]	Num. of CNE [3]	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [4] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [5] - feet	10th Percentile Slant Distance [5,6] - feet
01R : D : J : 5	4614	1289	57.9	61.8	3.3	10780	9337
01R : D : J : 13	66	16	56.4	60.1	4.7	11759	10906
19L : D : P : 8	322	77	60.2	64.2	3.0	6931	4975

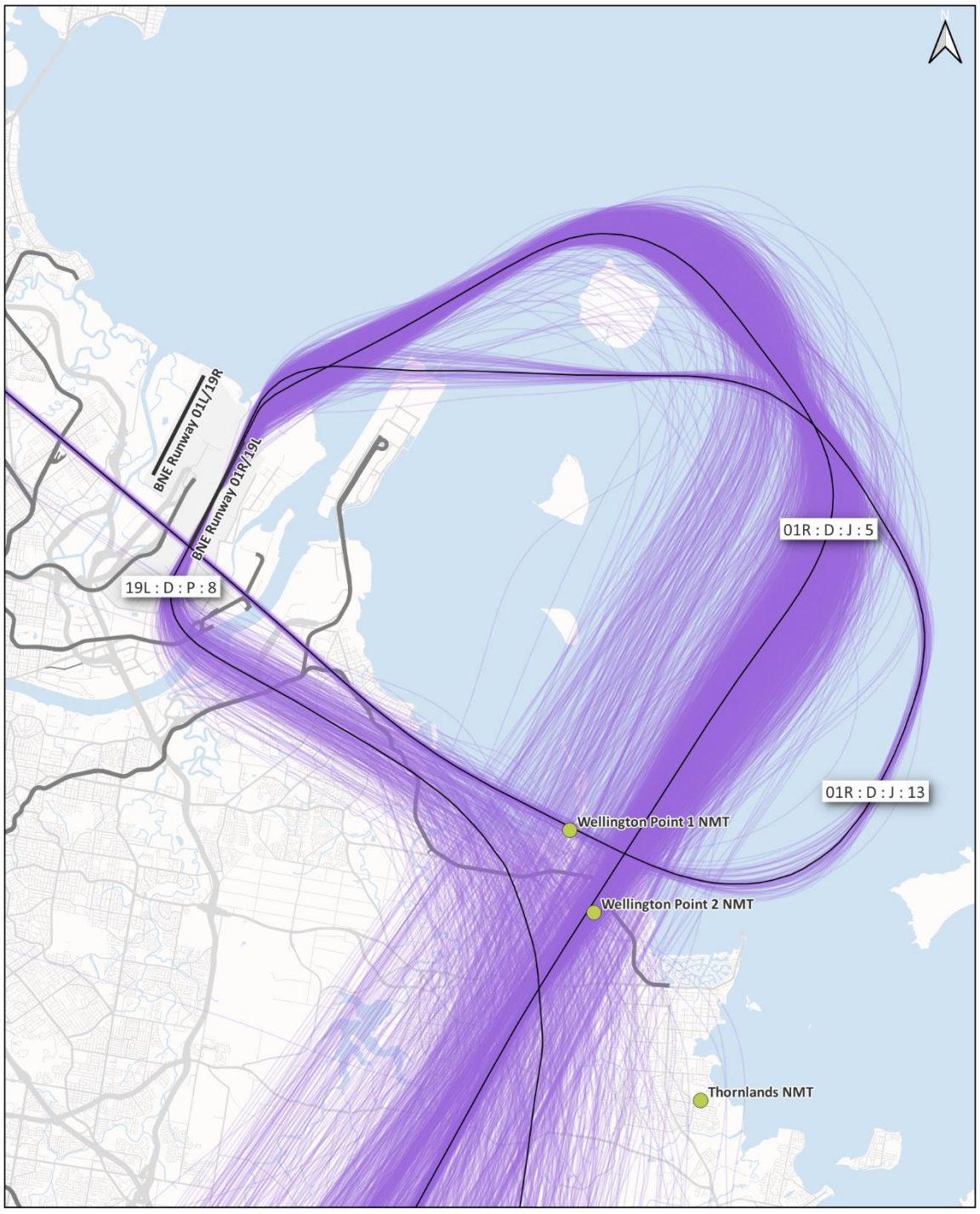
Note:
1. The track group is described by the naming convention "RUNWAY : OPERATION : AC TYPE : NUMBER"
2. The number of operations in the period is presented for the full period 1 January 2023 to 30 April 2023. This period exceeds the short-term noise monitoring period.
3. The number of CNE is substantially lower than the total number of operations. This is due to many operations not fulfilling the requirements for correlation (see section 2.2).
4. The 90th percentile L_{Amax} presents the loudest 10% of events.
5. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
6. The 10th percentile slant distance presents the nearest 10% of events.

Of the prominent track groups, it is noteworthy that all but "01R : D : J : 13" are available during the day, evening and night. "01R : D : J : 13" is available only during SODPROPS operations. Thus, this is a preferred departure flight path at night when operational conditions permit (i.e., acceptable weather conditions and sufficiently low demand to permit the safe use of SODPROPS).

"01R : D : J : 13" exhibited the quietest L_{Amax} (by average and 90th percentile). Again, this is likely due to the prevalence of modern aircraft in the fleet operating on this track group.

As with the aircraft summaries presented above, track groups containing turboprops exhibit distinctly lower slant distances. L_{Amax} from these track groups are marginally louder than jet track groups.

Figure 3-3 Prominent Departure Track Groups Affecting Wellington Point 2



WELLINGTON POINT SHORT-TERM NOISE MONITORING

FLIGHT PATHS

0 2 4 6 8 km

LEGEND

Arrivals
Departures
Median of track group
[RWY : OP : AC TYPE : #]

Note: Locations of features are indicative only and are shown solely to demonstrate features pertinent to the noise assessment.

3.2.2 Correlated Aircraft Arrival Operations

Arrivals do not regularly pass near the Wellington Point 2 site. Consequently, very few correlated aircraft arrival noise events were recorded.

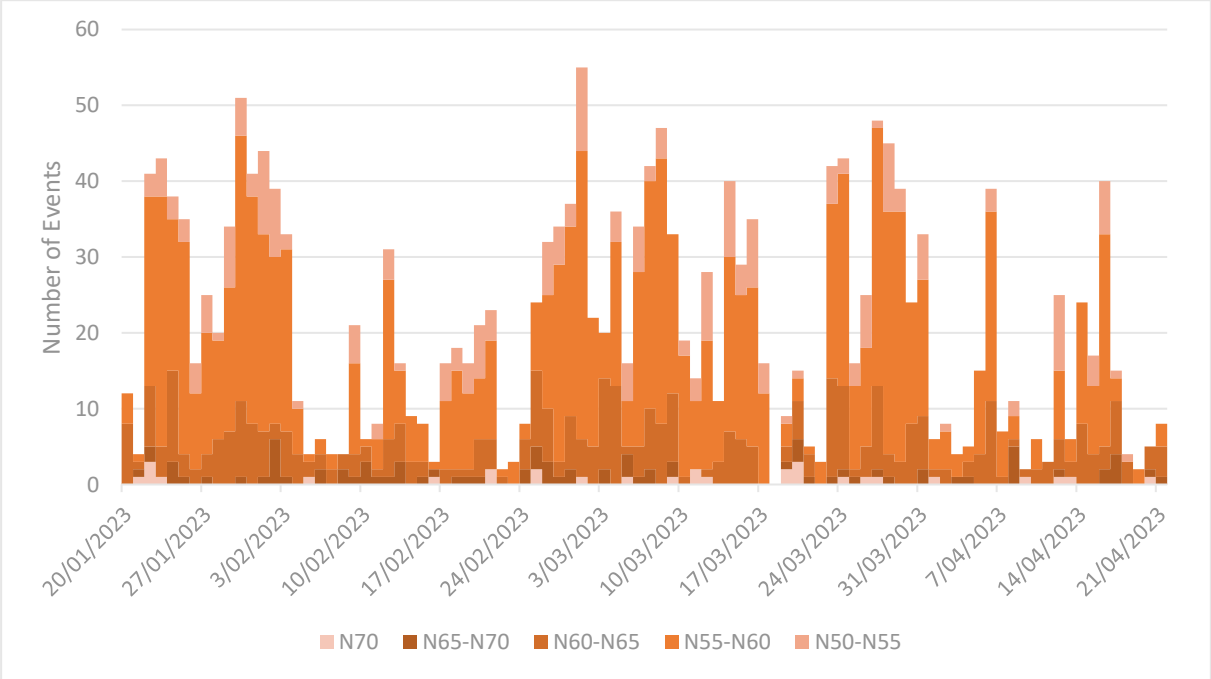
3.2.3 Daily Distribution of Correlated Noise Events

Figure 3-2 presents the number of events within various noise thresholds for each day of the monitoring. The number of events above a noise level threshold is denoted 'number-above' or 'N-above' and is typically expressed in the form N70 (i.e. number of events above 70 dB(A)).

The following is noted from **Figure 3-2** and statistical analysis of the daily N-above values.

- The number of correlated noise events can be seen to vary significantly from day to day. This is likely largely due to different wind conditions requiring Brisbane Airport to utilise different operating modes (i.e. runway directions). Varying traffic numbers and schedules from day to day are also a likely contributing factor.
- The maximum N60 measured was 15 and the average was 4.6. Aircraft noise events above 70 dBA were infrequently observed; the maximum N70 was three and the average was 0.3.
- On most days, the largest proportion of measured aircraft noise events were in the range 55-60 dBA. This accords with the data presented in the previous sections.

Figure 3-4 N-above Distribution During the Monitoring



3.3 Thornlands NMT

3.3.1 Correlated Aircraft Departure Operations

Table 3-6 presents a summary of the correlated aircraft departure noise events at the Thornlands site.

Table 3-6 Summary of Correlated Aircraft Departure Noise Events at Thornlands

Aircraft [1]	Number of CNE	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [2] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [3] - feet	10th Percentile Slant Distance [3,4] - feet
737-800	45	56.0	58.7	2.9	11844	10234
DH8D	17	57.0	58.7	1.9	9105	6951
A320-200	12	56.8	62.9	4.9	9947	8060
B463	8	49.2	51.5	1.9	9783	9197
737-400	8	56.2	58.5	1.9	10709	9347
737-300	8	54.9	57.6	2.8	11164	9330
A321-200	6	52.6	55.6	2.7	11335	9677
SF34	6	57.3	59.8	2.5	7304	5838
All Jet	**99**	**55.4**	**59.2**	**3.9**	**11107**	**9068**
All Turboprop	**31**	**57.2**	**59.6**	**2.7**	**8461**	**5755**

Note: 1. Presentation of individual aircraft types in **Table 3-6** is limited to the aircraft types with more than five correlated departure events.
7. The 90th percentile L_{Amax} presents the loudest 10% of events.
8. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
9. The 10th percentile slant distance presents the nearest 10% of events.

The following can be observed from the noise monitoring results.

- The most numerous aircraft demonstrate similar average noise levels around 53-57 dB(A).
- Narrow body jets are most prevalent (737-800, A320-200, B463, 737-400, 737-300, A321-200, and others not shown), representing 68% of the total correlated aircraft departures for fixed-wing aircraft.
- Wide body jets are also prevalent (none shown), represent 5% (7 CNE) of the total correlated departures for fixed-wing aircraft.

- Turboprop aircraft (DH8D, SF34, and others not shown), represent 23% of the total correlated aircraft departures for fixed-wing aircraft.
- All aircraft exhibit some variation in L_{Amax}; demonstrated by the standard deviation of L_{Amax} and the difference between the 90th percentile and average. For most aircraft, the 90th percentile L_{Amax} is approximately 2-3 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among most aircraft of a similar type. The average slant distance for most jets is approximately 11,000 ft.
- The 10th percentile slant distance (i.e. lowest 10%) ranges between 600 ft and 2,200 ft lower than the mean across the presented aircraft.
- The SF34 is the lowest (by average and 10th percentile) and loudest (by average) aircraft.
- Turboprop aircraft (SF34 and DH8D) are notably lower than most jet aircraft. Measured L_{Amax} noise levels from turboprops are similar to jet aircraft, though marginally higher on average.
- It is noteworthy that B463, 737-400, 737-300 are typically operated as freight aircraft, most often at night.

Table 3-7 presents a summary of prominent departure track groups affecting the Thornlands NMT. The track groups are shown in **Figure 3-5**.

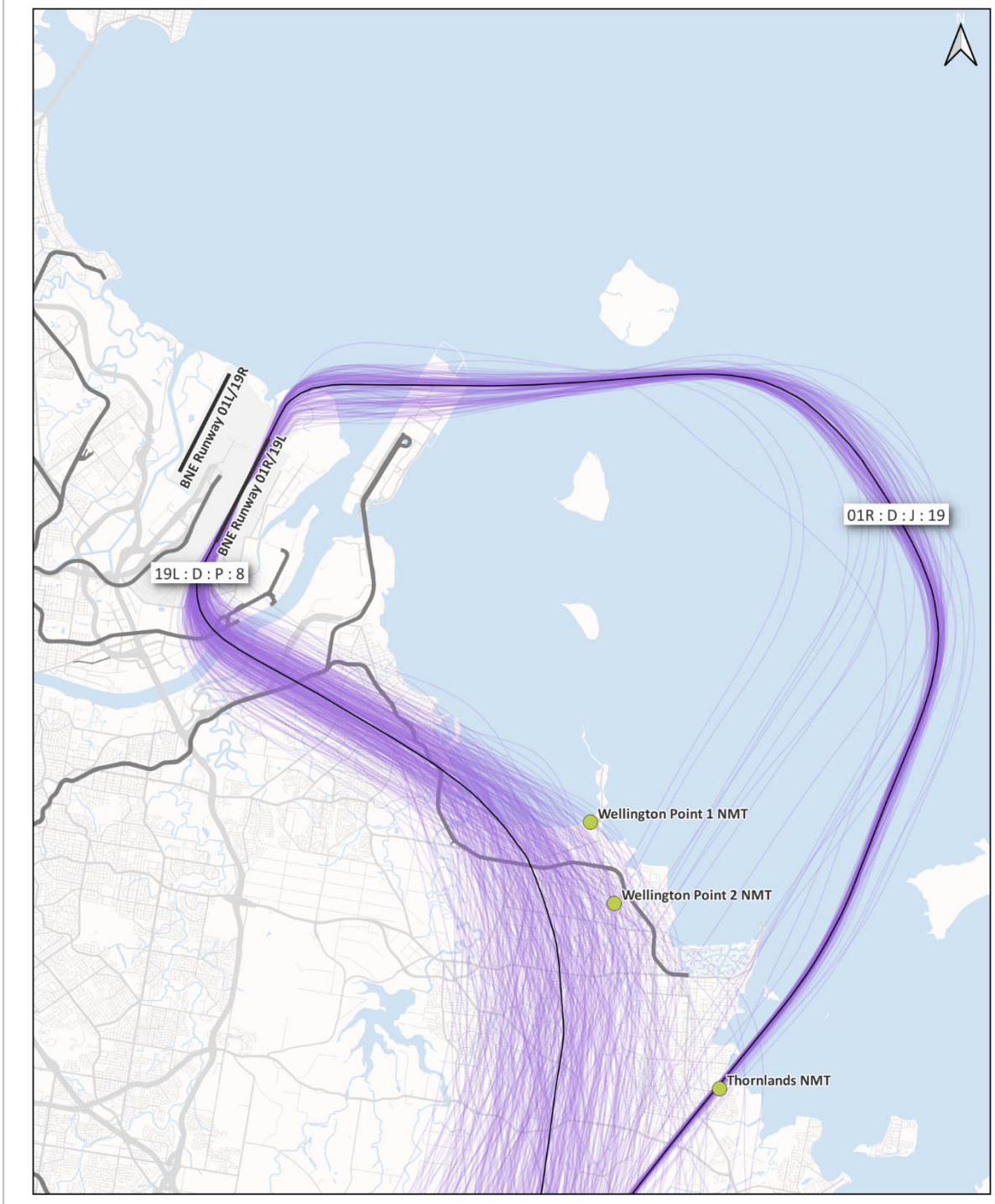
Table 3-7 Summary of Prominent Departure Track Groups Affecting Thornlands

Track Group [1]	Num. of Ops [2]	Num. of CNE [3]	Average L_{Amax} - dB(A)	90th Percentile L_{Amax} [4] - dB(A)	Standard Deviation of L_{Amax}	Average Slant Distance [5] - feet	10th Percentile Slant Distance [5,6] - feet
01R : D : J : 19	137	43	53.5	57.0	2.7	11605	10114
19L : D : P : 8	322	11	56.9	58.7	1.6	8695	6358

Note:
1. The track group is described by the naming convention "RUNWAY : OPERATION : AC TYPE : NUMBER"
2. The number of operations in the period is presented for the full period 1 January 2023 to 30 April 2023. This period exceeds the short-term noise monitoring period.
3. The number of CNE is substantially lower than the total number of operations. This is due to many operations not fulfilling the requirements for correlation (see section 2.2).
4. The 90th percentile L_{Amax} presents the loudest 10% of events.
5. Slant distance is the nearest three-dimensional distance from the aircraft to the noise monitoring terminal.
6. The 10th percentile slant distance presents the nearest 10% of events.

Of the prominent track groups, it is noteworthy that “19L : D : P : 8” is available during the day, evening and night. “01R : D : J : 19” is available only during SODPROPS operations. Thus, this is a preferred departure flight path at night when operational conditions permit (i.e., acceptable weather conditions and sufficiently low demand to permit the safe use of SODPROPS).

Figure 3-5 Prominent Departure Track Groups Affecting Thornlands



3.3.2 Correlated Aircraft Arrival Operations

Arrivals do not regularly pass near the Thornlands site. Consequently, very few correlated aircraft arrival noise events were recorded.

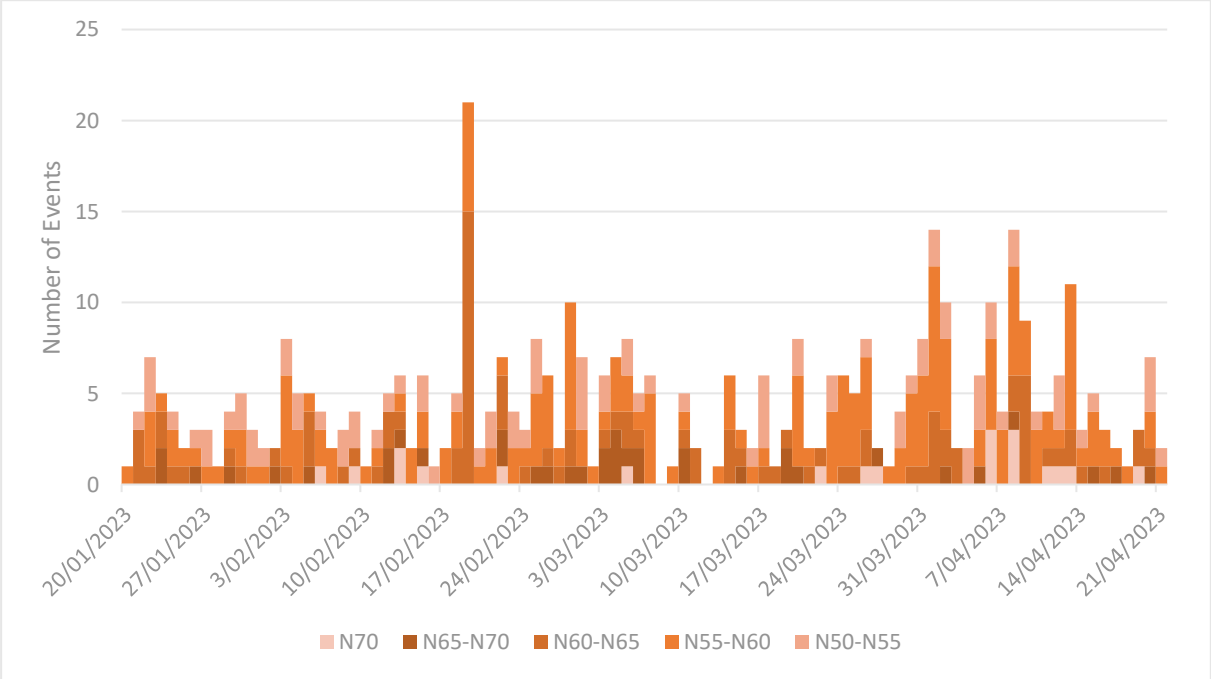
3.3.3 Daily Distribution of Correlated Noise Events

Figure 3-2 presents the number of events within various noise thresholds for each day of the monitoring. The number of events above a noise level threshold is denoted 'number-above' or 'N-above' and is typically expressed in the form N70 (i.e. number of events above 70 dB(A)).

The following is noted from **Figure 3-2** and statistical analysis of the daily N-above values.

- The number of correlated noise events can be seen to vary significantly from day to day. This is likely largely due to different wind conditions requiring Brisbane Airport to utilise different operating modes (i.e. runway directions). Varying traffic numbers and schedules from day to day are also a likely contributing factor.
- The maximum N60 measured was 15 and the average was 1.4. Aircraft noise events above 70 dBA were infrequently observed; the maximum N70 was three and the average was 0.2.
- On most days, the largest proportion of measured aircraft noise events were in the range 55-60 dBA. This accords with the data presented in the previous sections.

Figure 3-6 N-above Distribution During the Monitoring



4 COMPARISON BETWEEN SITES

One of the objectives of the short-term noise monitoring was to facilitate a comparison of measured noise levels across the three NMTs.

In general, the sites are impacted by different operations more, or less, based on the proximity to the aircraft to the monitoring site. Relatively few aircraft operations produced CNEs at multiple NMTs (, referred to as mutually correlated noise events, 360 between Wellington Point 1 and Wellington Point 2, less than 25 between Thornlands and either of the other two NMTs).

Noting this, it is more useful to consider the results of the most impactful track groups at each site, and compare these impacts.

"01R : D : J : 5" impacts both Wellington Point 1 and Wellington Point 2 NMTs. Average and 90th percentile L_{Amax} noise levels for are similar, though both average and 90th percentile L_{Amax} at Wellington Point 1 are approximately 1 dB quieter. Wellington Point 2 recorded 1289 CNE for this track group, whereas Wellington Point 1 recorded only 390. Examining the location of this track group (**Figure 3-1** and **Figure 3-3**), it is evident that more operations pass over the Wellington Point 2 site. Considering this, it is probable that the greater proportion of CNEs at Wellington Point 2 is due to the closer proximity and consequently higher noise levels (criteria for a CNE were likely achieved less frequently at Wellington Point 1 NMT).

"01R : D : J : 13" is a SODPROPS (preferred night-time flight path) impacting both Wellington Point 1 and Wellington Point 2 NMTs. It is noted that the Wellington Point 1 NMT is located directly under track group "01R : D : J : 13", whereas Wellington Point 2 NMT is approximately 2 km south of the median for this track group. Overall, 30 CNE from track group "01R : D : J : 13" were measured at Wellington Point 1, compared to 16 such events for Wellington Point 2 NMT.

Only five operations on "01R : D : J : 13" were mutually correlated at both NMTs. The average L_{Amax} difference for these five mutually correlated noise events was negligible (0.1 dB).

The average L_{Amax} from track group "01R : D : J : 13" was approximately 3 dB quieter at Wellington Point 1. However, the 90th percentile L_{Amax} was only 1.1 dB quieter.

Noting the difference in the number of CNE at each NMT, and the relative location of each NMT to the flight path, it must be considered that the difference in average and 90th percentile L_{Amax} noise levels between the two NMTs could be misleading. It is possible that a number of operations were not correlated at the Wellington Point 2 NMT on the basis of not having achieved the necessary noise thresholds. If this were the case, the average and 90th percentile statistical descriptors of the LAmax would be biased toward the loudest events, having presumably not captures many quieter events.

The Thornlands NMT is not similarly affected by any common track groups to the other NMTs. However, track group "01R : D : J : 19" directly overflies the Thornlands NMT and is similar to "01R : D : J : 13" – a SODPROPS departure track. 43 CNE were recorded at the Thornlands NMT from

"01R : D : J : 19", which is comparable to the 30 CNE recorded for "01R : D : J : 13" at the Wellington Point 1 NMT.

The average L_{Amax} at Thornlands NMT and Wellington Point 1 NMT, for each of the respective SODPROPS tracks, is the same – 53.5 dBA. The 90th percentile L_{Amax} is 2.0 dB quieter at Thornlands. The 10th percentile slant distance approximately 1,000 feet lower at Wellington Point 1.

The difference in 10th percentile slant distance does not account for the difference in 90th percentile L_{Amax}. It does, however, elude to the most likely cause; the fleet operating on "01R : D : J : 19" is almost exclusively narrow body jets whereas the fleet operating on "01R : D : J : 13" includes a large proportion of wide body jets. Despite the prevalence of new generation aircraft in the "01R : D : J : 13" fleet – such as A350-900, which are among the quietest jet aircraft operating at Brisbane Airport – the contribution of other wide body jets is likely responsible for the higher observed 90th percentile L_{Amax} at Wellington Point 1 NMT.

5 CONCLUSION

SoundIN has undertaken an analysis of short-term aircraft noise monitoring at three sites in Wellington Point and Thornlands.

The following observations have been made in our analysis.

Departure Aircraft Events at the Wellington Point 1 Site

- Average noise levels for departures were similar amongst the most prolific aircraft – approximately 55-58 dB(A).
- All aircraft exhibited some variation in L_{Amax}; meaning that even for like operations, the noise level on the ground can be expected to vary from flight to flight. For most aircraft, the 90th percentile L_{Amax} (i.e. the 10th loudest out of every 100 events) is approximately 3-4 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among most aircraft of a similar type. The most prolific aircraft had an average slant distance of approximately 11,000 ft.
- Flight paths / track groups affecting the area include jet departures from Runway 01R, non-jet departures from both Runway 01R and Runway 19L and jet departures during SODPROPS (preferred night-time mode) off Runway 01R.

Arrival Aircraft Events at the Wellington Point 1 Site

- Arrival noise events were far less prevalent than departures.
- Average noise levels for arrivals were similar amongst the most prolific aircraft – approximately 55 dB(A).
- All aircraft exhibited some variation in L_{Amax}; meaning that even for like operations, the noise level on the ground can be expected to vary from flight to flight. For most aircraft, the 90th percentile L_{Amax} is approximately 6 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among the presented aircraft. The average slant distance for is approximately 9,000 ft.

Daily Distribution of Correlated Noise Events at the Wellington Point 1 Site

- The number of correlated noise events varies significantly from day to day.
- The majority of aircraft noise events produced a maximum noise level in the range 55-60 dB(A).

- Aircraft noise events above 60 dB(A) are infrequent, with an average of 1.4 per day.
- Very few aircraft noise events above 70 dB(A) were measured, with a maximum of three events on any day and an average of 0.2 per day.

Departure Aircraft Events at the Wellington Point 2 Site

- Average noise levels for departures were similar amongst the most prolific aircraft – approximately 56-58 dB(A).
- All aircraft exhibited some variation in L_{Amax}; meaning that even for like operations, the noise level on the ground can be expected to vary from flight to flight. For most aircraft, the 90th percentile L_{Amax} (i.e. the 10th loudest out of every 100 events) is approximately 3-4 dB higher than the average L_{Amax}.
- Slant distances and altitudes are consistent among most aircraft of a similar type. The most prolific aircraft had an average slant distance of approximately 11,000 ft.
- Flight paths / track groups affecting the area include jet departures from Runway 01R, non-jet departures from both Runway 01R and Runway 19L and jet departures during SODPROPS (preferred night-time mode) off Runway 01R (though these are approximately 2km north of the site).

Arrival Aircraft Events at the Wellington Point 2 Site

- Arrivals do not regularly pass near the Wellington Point 2 site. Consequently, very few correlated aircraft arrival noise events were recorded.

Daily Distribution of Correlated Noise Events at the Wellington Point 2 Site

- The number of correlated noise events varies significantly from day to day.
- The majority of aircraft noise events produced a maximum noise level in the range 55-60 dB(A).
- Aircraft noise events above 60 dB(A) are infrequent, with an average of 4.6 per day.
- Very few aircraft noise events above 70 dB(A) were measured, with a maximum of three events on any day and an average of 0.3 per day.

Departure Aircraft Events at the Thornlands Site

- Average noise levels for departures were similar amongst the most prolific aircraft – approximately 53-57 dB(A).
- All aircraft exhibited some variation in L_{Amax}; meaning that even for like operations, the noise

level on the ground can be expected to vary from flight to flight. For most aircraft, the 90th percentile L_{Amax} (i.e. the 10th loudest out of every 100 events) is approximately 2-3 dB higher than the average L_{Amax}.

- Slant distances and altitudes are consistent among most aircraft of a similar type. The most prolific aircraft had an average slant distance of approximately 11,000 ft.

- Flight paths / track groups affecting the area include jet departures from Runway 01R, non-jet departures from both Runway 01R and Runway 19L and jet departures during SODPROPS (preferred night-time mode) off Runway 01R.

Arrival Aircraft Events at the Thornlands Site

- Arrivals do not regularly pass near the Thornlands site. Consequently, very few correlated aircraft arrival noise events were recorded.

Daily Distribution of Correlated Noise Events at the Thornlands Site

- The number of correlated noise events varies significantly from day to day.
- The majority of aircraft noise events produced a maximum noise level in the range 55-60 dB(A).
- Aircraft noise events above 60 dB(A) are infrequent, with an average of 4.6 per day.
- Very few aircraft noise events above 70 dB(A) were measured, with a maximum of three events on any day and an average of 0.2 per day.

Comparison of Between Noise Monitoring Sites

- In general, each of the sites is affected more, or less, by different operations and flight paths.
- For track groups affecting more than one site, there are typically few mutually correlated noise events and the proportion of correlated noise events generally differs greatly. This supports the view that different operations and flight paths affect each NMT differently.
- Each of the sites is affected by SODPROP departure tracks (i.e., tracks that would be used during the preferred night-time operating mode). Noise level differences were observed, though the different proportion of correlated noise events makes drawing robust conclusions from this data difficult.
- It is noteworthy that the fleet operating on the SODPROPS track group overlying the Thornlands NMT (“01R : D : J : 19”) is almost exclusively narrow body jets. Conversely, the SODPROPS track group overflying the Wellington Point 1 NMT (“01R : D : J : 13”) comprises a fleet having a large proportion of wide body jets. In general, wide body jets would be expected to produce higher noise levels. However, of the wide body jets operating on “01R : D : J : 13”, a large proportion of

them are among the newest generation of jet aircraft operating at Brisbane Airport. Many of these aircraft can produce lower noise levels than older generation narrow body jets. (e.g., A350-900 is among the quietest jet aircraft operating at Brisbane Airport).

APPENDIX A

TRACK GROUP REPORTS