D4

VOLUME D: AIRSPACE

Aircraft Noise Modelling Methodology

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Aircraft Noise Modelling Methodology

4.1 Introduction

This Chapter provides a description of the modelling process used to undertake the aircraft noise impact assessment for this project. Model inputs including aircraft types and noise levels, aircraft flight paths and meteorological data are presented. Procedures used to validate these data are also described. Results of the aircraft noise impact assessment are presented in Chapter D5.

4.1.1 Overview of Modelling Process

The object of the noise modelling process is to calculate values of the noise descriptors listed in section D2.8 for current Airport operations, and to predict values for all relevant future scenarios. The noise descriptors indicate the extent of noise impacts, and can be directly compared when considering the costs and benefits of various alternative noise abatement strategies.

As discussed in sections D2.1 to D2.7, a wide range of factors affect the potential noise impact from Airport operations at Brisbane Airport, and hence a complex modelling process is required to take all these factors into account. **Figure 4.1** shows the process in diagramatic form.

For each operational scenario modelled, a set of airport operating modes is defined, together with 'selection rules' defining the conditions under which each mode would be selected by Air Traffic Control. The rules take account of weather conditions, the number of departures and arrivals occurring at the time, and the 'priority' assigned to each mode – generally a reflection of the desirability of that mode in terms of noise abatement. 'Active' or 'passive' control of mode selection can be assumed (see section D2.7.3).

A detailed schedule of predicted 'busy day' Airport operations is used, together with historical weather data, to determine the pattern of mode usage which would result for a typical busy day in the assumed scenario. (Refer to section D2.5.1 for details on the characteristics and the development of the 'busy day' profiles used in the noise modelling). Aircraft operating in these modes are then assigned to tracks according to the runway in use, the type of aircraft and the location of the airport of origin or destination. Finally, a pre-calculated 'noise map' gives the pattern of noise exposure for each aircraft type on each of these tracks. The 'noise maps' for each operation are summed or combined in various ways to produce the descriptors of overall noise exposure listed in section D2.7.

The fundamental inputs to this process are:

- Airport operating schedules, including both the numbers and times of aircraft operations and the aircraft types which would operate in a future year;
- The selection of operating mode which includes consideration of:
  - Meteorological data; and
  - Air traffic management rules;
- Aircraft flight paths, including the track followed on the ground and the height of the aircraft at various points; and
- Noise levels produced by the various aircraft types performing standard arrival and departure operations.

Each of these inputs is discussed in the following sections.

4.1.2 The Integrated Noise Model (INM)

The INM (Integrated Noise Model) aircraft noise prediction program, produced by the US Federal Aviation Administration, was used to produce 'noise maps' for each of the 20 aircraft types considered in this study on each of the existing Airport flight paths and each of the proposed NPR flight paths. INM Version 6.1 was used, as this was the latest available version at the time of performing the calculations. (Version 6.2 has since been released, but trial calculations indicate that the difference in predicted noise levels between the versions is negligible.)

Parameters used in the calculations are:

- Temperature 20° C (mean temperature recorded at Brisbane Airport over all times and all months);
- Atmospheric pressure 1013 hecto pascals (hPa); and
- Average headwind 5 knots (mean headwind calculated for all existing departures at Brisbane Airport).

Predicted noise levels are not very sensitive to any of the above parameters – for example, reducing the temperature to 10° C, increasing atmospheric pressure to 1028 hPa or reducing the average headwind to zero, all result in a change of less than 1 decibel (dB) in the calculated noise level from typical operations.

The INM model does not allow for calculation of the effect of atmospheric conditions such as wind and temperature inversions on sound propagation. These factors are known to have a strong influence on noise generated at ground level. However, for sources that are significantly elevated, such as an aircraft in flight, their influence on sound propagation is much lower, and has not been as thoroughly studied.

In many cases, the major impact of adverse wind and temperature gradient conditions on noise from ground level sources comes through the removal of intervening barriers. This can result in significant enhancement of noise at the receiver location. However, this effect is not relevant for noise from a source such as an aircraft in flight.

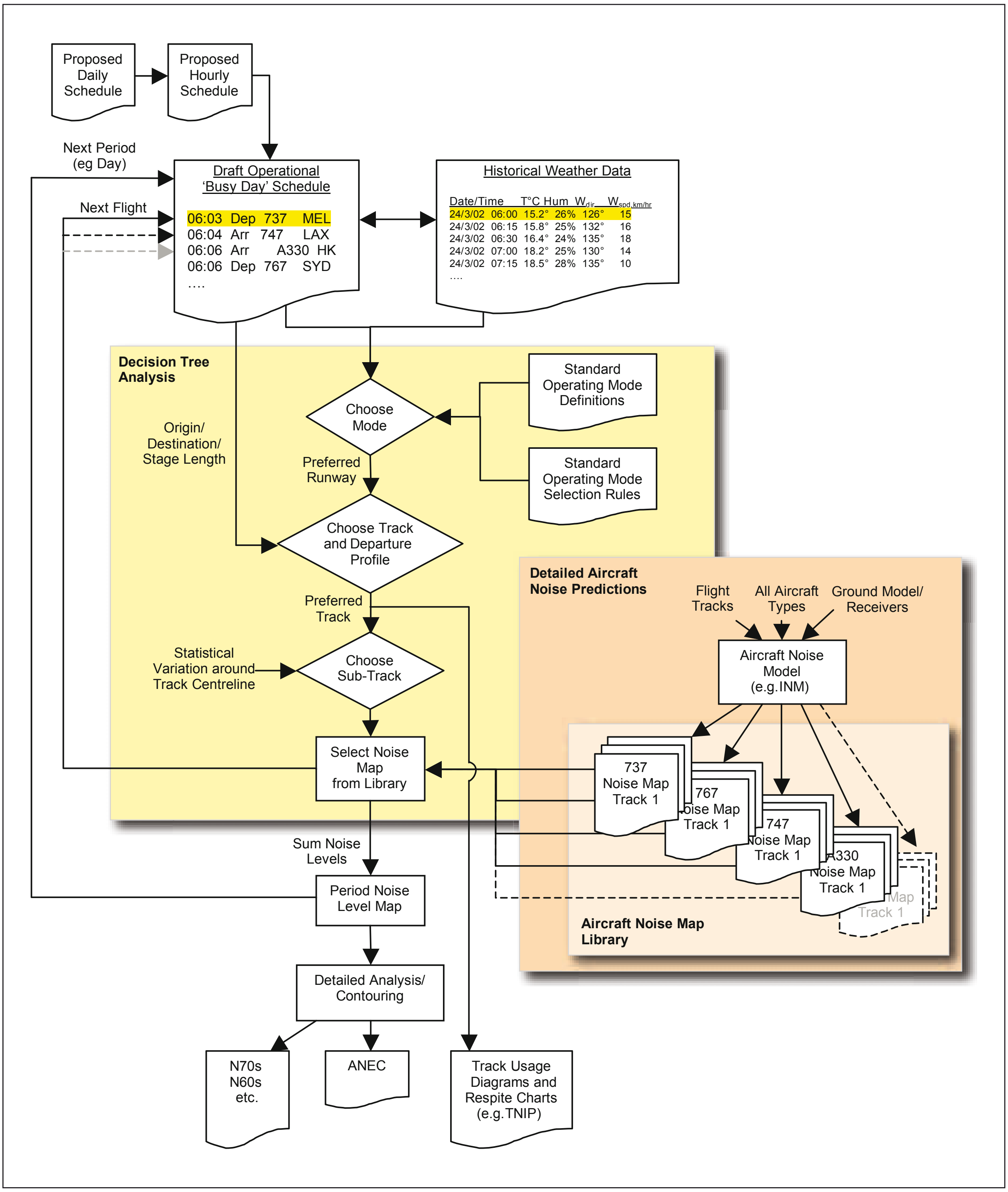
Standard noise prediction algorithms which calculate the effect of meteorological conditions on sound propagation, such as ENM (Environmental Noise Model) and CONCAWE, have not been validated in modelling an elevated source, and are generally based on data from sources close to the ground. For prediction of noise from ground-level sources such as reverse thrusts and taxiing, the ENM prediction program is used, as described in Chapter D5.

INM's 'standard' height-vs-distance profiles were generally used in calculations (see section 4.4.1 for details). Departures by most aircraft types are defined for several 'stage lengths', representing different distances to the destination, and hence different assumed fuel loads. Noise levels on departure were calculated for all possible stage lengths for each aircraft type.

For each aircraft type and each track, custom-designed software was used to control INM's operation, calculating noise levels at each point on an initial grid of size of 0.1 Nm x 0.1 Nm (~185 m x 185 m), covering the area of interest. For graphics and TNIP presentation to a grid size of 0.25 Nm x 0.25 Nm (~500 m x 500 m) is used.

Two noise units were calculated – the maximum noise level during the overflight in dBA, which is used in calculating N70 values, and the Effective Perceived Noise Level (EPNL) which is used in calculating the Australian Noise Exposure Concept (ANEC). These constitute the 'noise maps' used in modelling of airport operating scenarios.

Figure 4.1: *Detailed Noise Prediction Methodology.*



4.2 Current and Future Aircraft Movements

4.2.1 Flight Frequency, Number and Type

Aircraft operations for future years were determined by Tourism Futures International (TFI). Based on historical data and detailed analysis for future aircraft movements, busy day profiles and detailed schedules for the years 2005, 2008, 2015 and 2035 were constructed for use in the noise modelling. (Refer to section D2.5 for further discussion regarding development of the predictive aircraft schedules).

In future years, the capacity limits of the current modes effectively constrain the growth of the Airport with the existing runway layout. Projections of future demand indicate that by around 2013 the number of movements would exceed the capacity of the existing runway layout in peak hours. Between 2013 and 2015, these small predicted capacity exceedances could be managed by scheduling controls, and would have negligible impact on-airport operations. After 2015, the peak hour demand would begin to cause unacceptable delays and restrict future Airport growth.

4.2.1.1 Aircraft Types

Projections of aircraft movements for future years were provided by TFI in terms of the classes of aircraft type shown in **Table 4.1**. Each class has been represented by one or a number of aircraft types for use in the standard INM aircraft noise modelling program, and **Table 4.1** also shows the INM types used for each aircraft class.

The aircraft types were selected to be representative of the aircraft currently using Brisbane Airport, and have also been used to represent future aircraft types. The noise emission characteristics of future aircraft types are not known, but it can be reasonably assumed that they will not be higher than those of current equivalent types, and in general they are expected to be lower. For example, Qantas has made a commitment that by 2015 its Boeing 767 fleet will be replaced with the Boeing 787, which is expected to be significantly quieter. (Refer to section 5.8 for more information on the trending to quieter aircraft).

Hence, the present procedure of representing future aircraft types by current aircraft types is considered conservative.

Within the current aircraft fleet operating at Brisbane Airport, it can be expected that older-generation aircraft will be phased out over time and replaced by newer-generation aircraft. The assumed schedule for this replacement is shown in **Table 4.2a**.

Table 4.1: Aircraft Types Modelled.

Aircraft Class	Types In Model
A380	A340
Large Wide-Body	74720B; 747400, 777300
Medium Wide-Body	777200; A330; A340
Small Wide-Body	767300; 777200
Large Narrow-Body	737400; 737800;A320
Small Narrow-Body	737300; 737700
Regional Jet	BAE300; F10065; 717200, LEAR35
Freight B727	727EM2
Freight B737	737300; 737700
Freight BAe146	BAE300; F10065
Large Turbo-Prop	DHC830
Medium Turbo-Prop	DHC830
Small Turbo-Prop	DHC6
Small RPT	CNA441
General Aviation	CNA441

4.2.2 Daily and Seasonal Variations

Projections of aircraft movements for future years were also provided by TFI for a typical busy summer and winter weekday and weekend, as detailed in Chapter A2. For each year of interest, these provide separate predictions for each of four scenarios, namely:

- Summer Weekday (representing the 'northern hemisphere winter' airline scheduling period);
- Summer Weekend (representing the 'northern hemisphere winter' airline scheduling period);
- Winter Weekday (representing the 'northern hemisphere summer' airline scheduling period); and
- Winter Weekend (representing the 'northern hemisphere summer' airline scheduling period).

For each of these scenarios, the predictions provide numbers of aircraft arrivals and departures, by aircraft class (**Table 4.1**) and origin or destination, for each 15 minute period of the day. **Figures 4.2a** to **4.2d** show predicted total aircraft movements per hour for each scenario and each year.

Each representative busy day has been broken down for modelling purposes into the following periods of the day:

- Day 6am to 6pm;
- Evening 6pm to 10pm; and
- Night 10pm to 6am.

The majority of movements at Brisbane Airport occur during the day and this pattern is forecast to remain the same at 2015 and 2035. The most significant difference between the summer and winter periods is due to the fact that Queensland does not adopt daylight saving in summer, resulting in additional movements in the noise sensitive 5am – 6am night time period.

In 2035, projections of future movement numbers in the 'no build' case are restricted to ensure that the capacity of the existing runway system is not exceeded.

Table 4.2a: Aircraft Classes and Proportions.

Aircraft Class	INM Type	Year 2005	2008	2015	2035	Comments
A380	A340	--	--	100%	100%	A340 has been assumed based on a noise footprint provided by Airbus claiming that A380 noise levels will be similar to those from the A340-300.
Large Wide-Body (350 to 450 PAX)	74720B 747400 777300	38% 62% 0%	20% 70% 10%	5% 50% 45%	0% 10% 90%	The 777-300 is Large Wide-Body (about 380 PAX). BAC believes based on recent trends that aircraft of this type will dominate in this class as 747s are phased out and replaced. The 777-300 is considered most representative INM type by 2035.
Medium Wide-Body (280 to 350 PAX)	777200 A330 A340	49% 48% 3%	50% 45% 5%	50% 30% 20%	100% 0% 0%	The 787 is being introduced in 2008 and by 2035 this class will be represented by aircraft like the B787-9. Boeing claims this will be much quieter than all current aircraft in this class, so the 777-200, being the quietest INM aircraft is used to represent all aircraft in 2035.
Small Wide-Body (200 to 280 PAX)	767300 777200	100% 0%	80% 20%	15% 85%	0% 100%	777-200 is intended as substitute for the quieter 787-800 and A350 aircraft that will replace the 767-300 but for which there is no noise certification data yet.
Large Narrow-Body (150 to 200 PAX)	737400 737800 A320	35% 64% 1%	25% 60% 15%	10% 70% 20%	0% 20% 80%	Qantas will only have 737-800s and 900s in future and it is likely Virgin will also move mainly to large 'New Generation Narrow-Body'. It is likely most Large Narrow-Body aircraft in 2035 will be quieter, so these are best represented by an A320 noise profile.
Small Narrow-Body (100 to 150 PAX)	737300 737700	44% 56%	30% 70%	0% 100%	- -	'Old Generation' 737 Narrow-Body assumed to be phased out by 2015 when probably the only domestic 737-700 aircraft will be Virgin Blue. By 2035 this aircraft class is expected to be overtaken by Large Narrow-Body.
Regional Jet (50 to 120 PAX)	717200 BAE300 F10065 LEAR35	60% 22% 10% 8%	65% 20% 50% 5%	85% 0% 10% 5%	95% 0% 0% 5%	The 717-200 was operated by Jet Star in 2005. It is assumed that by 2035 most regional jets will be represented by this type aircraft noise profile or better.
Freight B727	727EM2	100%	-	-	-	There will be no 727s by 2008. They are to be replaced by 737-300 or equivalent.
Freight B737	737300 737700	100% 0%	100% 0%	50% 50%	0% 100%	By 2035 it is expected 737-700 or equivalent will largely replace 737-300.
Freight BAe146	BAE300 F10065	100% 0%	100% 0%	60% 40%	0% 100%	It is anticipated that by 2035 freighters in this class will have a noise profile similar to F100-65 or better.
Large Turbo-Prop (50 to 100 PAX)	DHC830	100%	100%	100%	100%	Also intended to represent the Q400.
Medium Turbo-Prop (20 to 50 PAX)	DHC830	100%	100%	100%	100%	Also intended to include the SF340.
Small Turbo-Prop (<20 PAX)	DHC6	100%	100%	100%	100%	
Small Regular Public Transport (RPT)	CNA441	100%	100%	100%	0%	
General Aviation	CNA441	100%	100%	100%	100%	

Figure 4.2a: *Aircraft Movements Per Hour – Winter Weekday.*

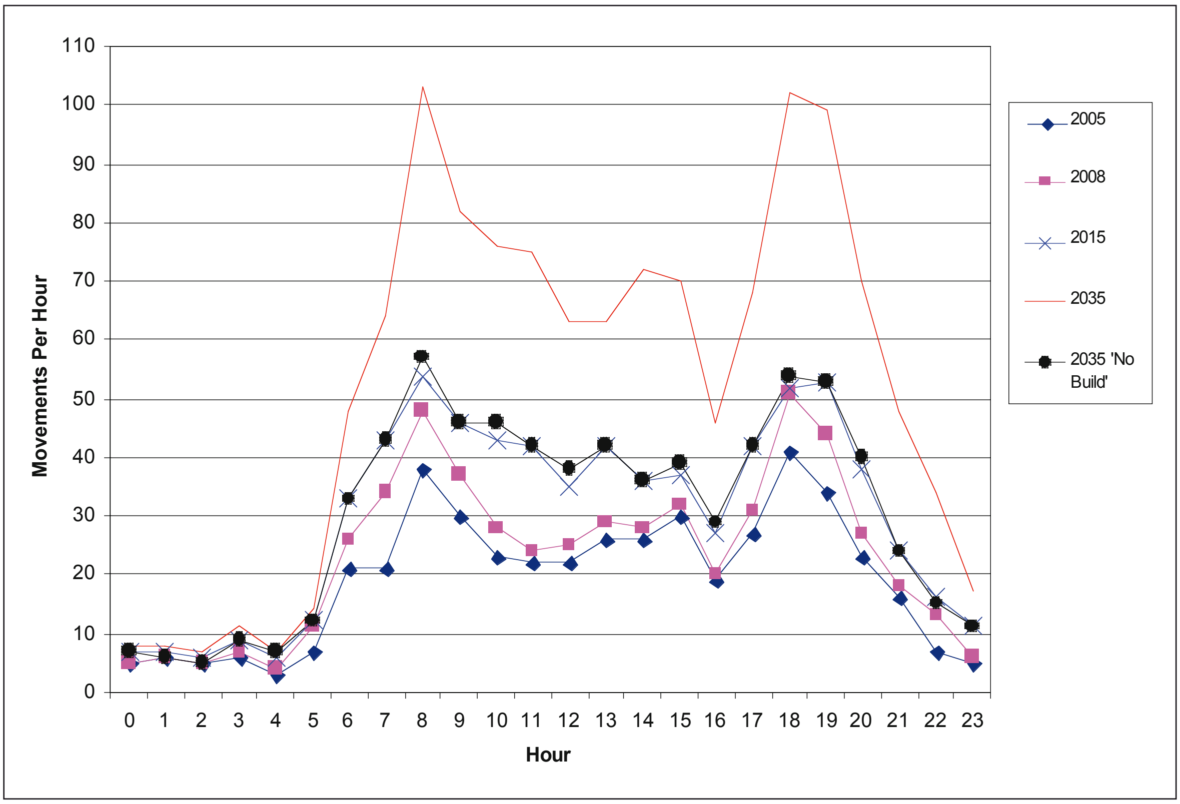


Figure 4.2b: *Aircraft Movements Per Hour – Summer Weekday.*

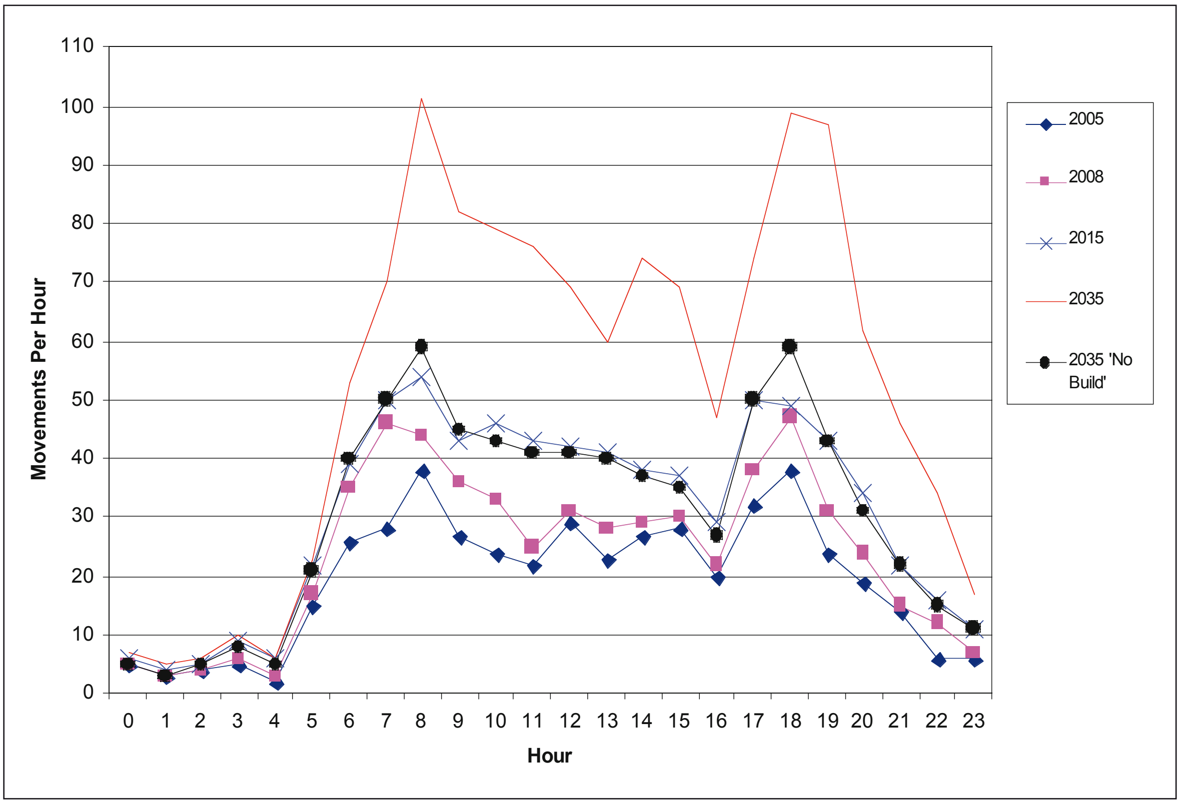


Figure 4.2c: *Aircraft Movements Per Hour – Winter Weekend.*

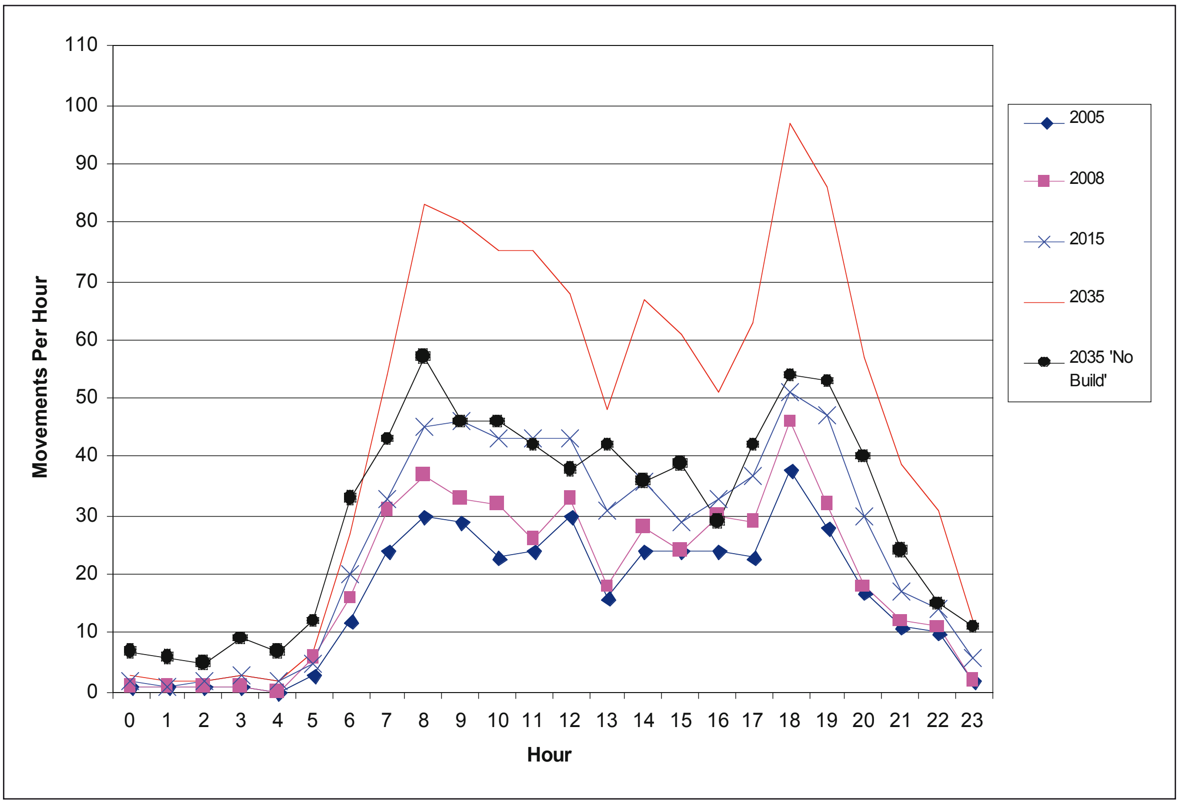


Figure 4.2d: *Aircraft Movements Per Hour – Summer Weekend.*

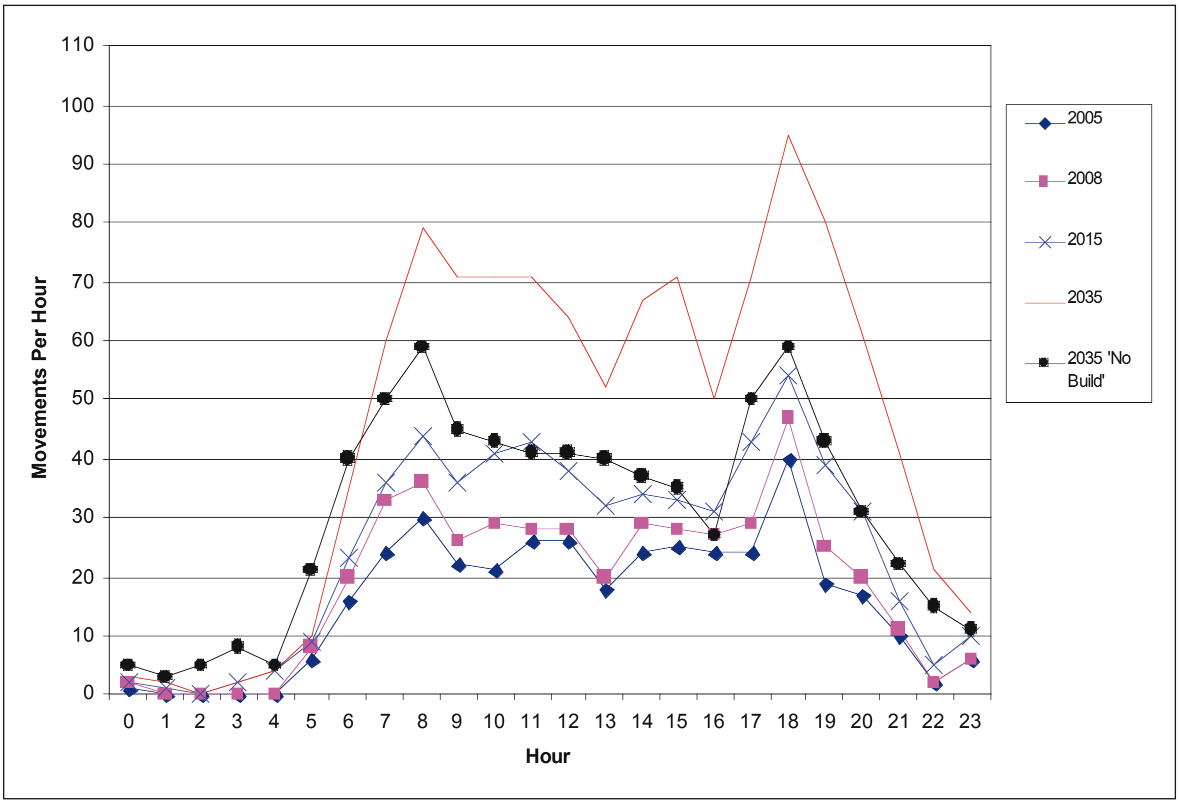


Figure 4.2e shows the number of movements per day in the TFI predictions, broken down by INM aircraft type. In 2015, the assumed fleet mix is dominated by aircraft equivalent to 737-800. However, by 2035, aircraft with noise emissions equivalent to (or better than) A320 and 777-200 aircraft would be the dominant source of noise impact.

The movement numbers in **Figures 4.2a** to **4.2d** represent 'typical busy days', and are appropriate for use in calculation of N70 and similar noise descriptors. However, ANEC values are defined in terms of annual average aircraft movements rather than a 'typical busy day'. **Table 4.2b** shows the relationship between predicted annual average movements, as described in section A2.4, and movements calculated on the basis of the mean of the four scenarios shown above. In calculating ANEC values, the number of aircraft movements in a future year was based on the mean of the four scenarios above, reduced by the factors shown in **Table 4.2b**. This difference is assumed to apply consistently to all aircraft types and times of day.

Figure 4.2e: *Aircraft Movements Per Day (Average Between Scenarios) By INM Aircraft Type.*

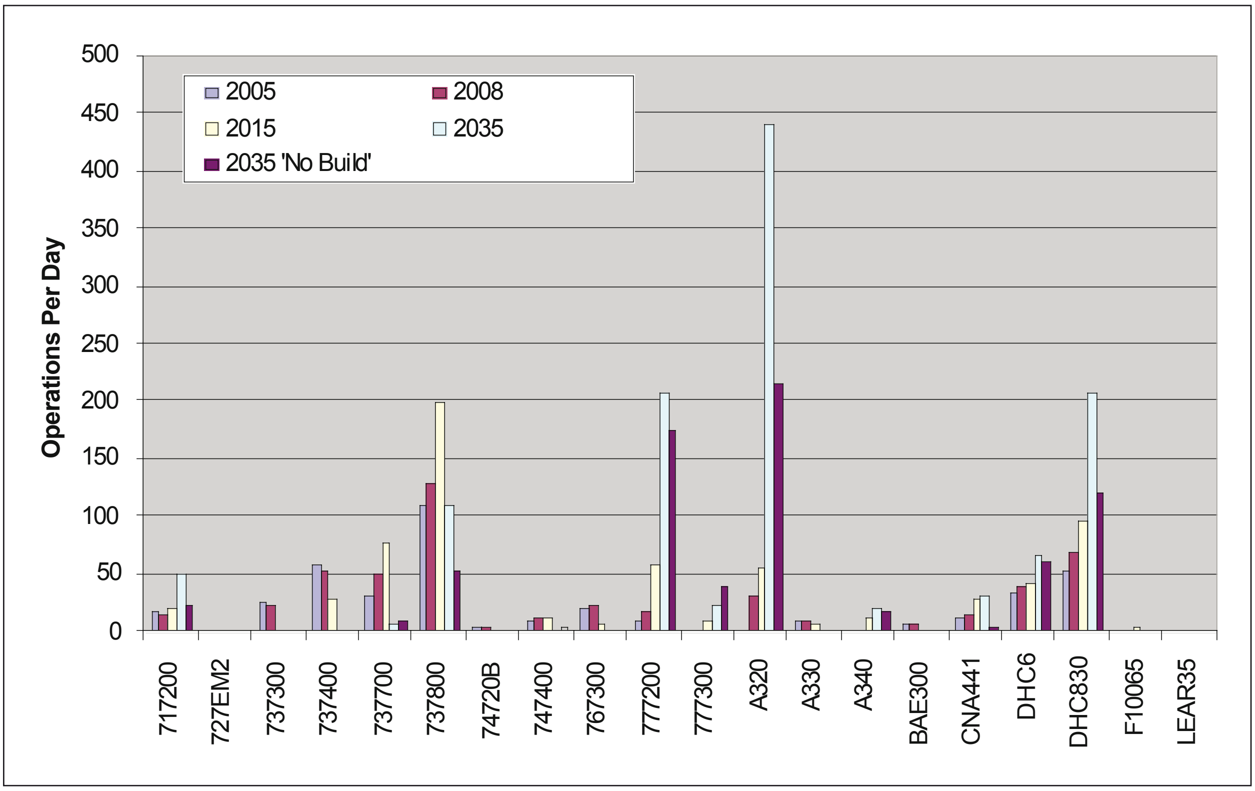


Table 4.2b: Comparison of Future Average Annual and 'Busy' Day Movements.

Year Scenario	Annual Average Movements	Annualised 'Busy Day' Movements	Average as Proportion of 'Busy Day'
2015	227,000	245,100	92.6%
2035	393,000	429,700	91.5%
2035 'No Build'	256,000	268,600	95.3%

4.2.3 Aircraft Ports of Origin and Departure Destinations

The description of origin and destination in the TFI data is provided in terms of 'Direction' and 'Route'. These were assigned to specific airports as shown in **Table 4.2c**, which in turn allows movements to be assigned to tracks, and to stage lengths for departures as discussed in sections 4.5 and 4.4 respectively.

Table 4.2c: Assignment of 'Direction' and 'Route' in TFI Data to Airports.

Direction	Route	Airport Name
Dom_North	Domestic GA	Townsville
Dom_North	NT	Darwin
Dom_North	Qld Regional	Townsville
Dom_South	Adelaide	Adelaide
Dom_South	Domestic GA	Coffs Harbour
Dom_South	Melbourne	Melbourne
Dom_South	Other South Domestic	Canberra
Dom_South	Sydney	Sydney
Dom_West	NT	Alice Springs
Dom_West	Perth	Perth
Int_East	Americas	Los Angeles
Int_East	Pacific Islands	Nadi
Int_East	Trans Tasman	Auckland
Int_North	NE Asia	Tokyo Narita
Int_North	SE Asia	Singapore Changi
Int_North	SE Asia/Mid East	Bangkok
Other	Domestic GA	Archerfield
Other	QLD Regional	Mount Isa

4.3 Mode Selection Methodology

The modes of operation considered for the NPR include:

1. Simultaneous Opposite Direction Parallel Runway Operations (SODPROPS);
2. Dependant Opposite Direction Parallel Runway Operations (DODPROPS) (in night hours 10pm to 6am only);
3. 01 mixed parallel; and
4. 19 mixed parallel.

Refer to section D3.3 for a full discussion of modes of operation.

As discussed in section D2.7, the operating mode in use at any given time depends on the following factors:

- The weather (wind speed and direction, wet or dry condition, and visibility conditions);
- The number of aircraft operating to and from the airport; and
- The rules which apply to a decision to change from one mode to another.

The following sections discuss the meteorological data which have been utilised in the modelling process; limits on the number of aircraft for safe operation in each mode; and the rules which the air traffic controllers apply for deciding when to change from one mode to another.

4.3.1 Meteorological Data and Analysis

The mode of operation of the airport depends strongly on meteorological conditions. Air traffic control select the runway direction depending on the wind direction and speed, runway conditions and visibility conditions. The following is a discussion of how historical meteorological conditions were analysed to provide a basis for determining how weather may affect air traffic operations in the future scenarios being studied.

4.3.1.1 Data Inputs

Meteorological data were available from the Bureau of Meteorology (BOM) site on the Airport for the period 11 October 1995 to 8 December 2005 (approximately 10 years). This data gives mean wind speed, maximum wind gust and mean wind direction over the 10 minutes before the time of the reading. Data are generally recorded every 30 minutes, but are sometimes recorded more often, and sometimes less. For analysis, the data were regularised to give values every 15 minutes, corresponding to the nearest actual recorded data point. Gaps in data are 1.7 percent, with the maximum gap being 5 days. Gaps are not concentrated in any day or season.

In addition, data recorded by the Computer Automated Terminal Information System (CATIS) used by the Airport were also available for the period August 1998 to June 2005, although data recorded before June 2000 were not recorded in a consistent format, and were not used in the present analysis. The CATIS system records meteorological conditions only when a change occurs which is significant from the point of view of the current Airport operations (for example, when the operating mode is changed), and records may be spaced up to several hours apart. However, the CATIS data indicate directly whether visual or instrument conditions apply at any time, and hence can be combined with the Bureau of Meteorology (BOM) data to provide comprehensive information on meteorological conditions.

4.3.1.2 Data Validation

A preliminary analysis compared wind speeds as recorded by CATIS (which are the speeds used directly by Air Traffic Control (ATC) personnel in determining the airport operating mode) with speeds recorded in the BOM data. The comparison was made by selecting the wind speed from BOM data which corresponds to the recording time for each CATIS record. Three measures of wind speed were derived from the BOM data – mean speed over the previous 10 minutes, maximum gust speed over the previous 10 minutes, and the average of these. **Table 4.3** shows the comparison.

From **Table 4.3**, it can be concluded that wind speeds as recorded in the BOM data are sufficiently well correlated with the actual speeds used in determining airport operating mode that they can be used in a predictive model. The best correlation with CATIS wind speeds is derived by using the mean speed recorded in BOM data.

From these two data sets, a combined set was created indicating for each 15 minute period from July 2000 to June 2005:

- Wind speed and direction; and
- Whether meteorological conditions were visual or instrument.

In the model the meteorological rules set maximum cross-wind and down-wind components for all relevant runways (refer to section D2.2 for definition of cross-wind and down-wind). In general, under dry runway conditions the maximum allowable cross wind component is 20 knots (kts) and the maximum allowable downwind component is 5 kts. Specific rules apply for some particular modes as described in Chapter D5.

The model applies these rules to determine the availability of operating modes for each 15 minute period in the 5 year time frame.

This forms part of the selection process to determine which mode would be used under a given future scenario.

Table 4.3: Comparison of Wind Speed Data from BOM and CATIS Records.

Value to be Measured	Assessment Parameter	Basis for Wind Speed Data in BOM Records		
		Mean Over 10 mins	Max. gust over 10 mins	Average of Mean and Gust Values
Wind Speed, kts	Mean (BOM – CATIS)	- 0.3	3.9	1.3
Wind Component in the 01 Direction, kts	Mean (BOM – CATIS)	- 0.95	- 1.15	- 1.05
	Standard Deviation of (BOM – CATIS)	3.3	4.6	3.8
Is the wind component in the 01 direction > 5 kts?	Percent Agreement	89%	85%	87%
Is the wind component in the 19 direction > 5 kts?	Percent Agreement	91%	90%	90%

4.3.2 Number of Aircraft Presenting

Selection of a mode of operation also depends on whether that mode can safely manage the number of aircraft presenting for arrival and departure. For example, the over-bay operation modes are limited to the following numbers of aircraft operations:

- Reciprocal (Single Runway)
  12 movements (total) per hour
  (only available at night – 10pm to 6am);
- DODPROPS
  20 movements (10 arrivals and 10 departures) per hour; only available at night – 10pm to 6am – after opening of NPR;
- SODPROPS
  55 movements (25 arrivals and 30 departures) per hour; available after opening of NPR whenever all other conditions are fulfilled.

Details of constraints for each mode are provided in Chapter D5.

4.3.3 Mode Selection Hierarchy

The hierarchy for mode selection is based on giving highest priority to over-bay operations. When over-bay operations are not possible, priority is given to the mode which results in the minimum amount of noise nuisance. The mode selection hierarchy therefore is as follows:

Selection 1:	SODPROPS.
Selection 2:	DODPROPS (only allowed in night hours 10pm – 6am).
Selection 3:	01 or 19 parallel depending on the outcomes of the modelling process.

Determination of when 01 or 19 parallel mode is selected is dependent on the outcomes of the modelling and is discussed in Chapter D5.

4.3.4 Mode Switching Decision for Modelling

Air Traffic Control monitor weather conditions and the number of presenting aircraft as discussed above and make decisions on whether to change from one mode to another. The rules which apply to current operations at Brisbane Airport are discussed in section D2.6.3. They essentially describe Brisbane as a passively managed Airport during the day and evening periods, 6am to 10pm, and an actively managed Airport for noise abatement purposes in the night hours from 10pm to 6am.

Following discussion and agreement with current air traffic control management personnel, the following rules, considered practical and plausible, have been applied for ‘active’ operation of the new runway for noise modelling purposes during the day and evening periods:

- If one mode is in use but a higher-priority mode becomes available, a change would be made only after the higher-priority mode **has been available** for at least 45 minutes, and **will be available** for at least another 60 minutes. This is plausible given the weather information available to ATC personnel.
- If a higher-priority mode is not available or cannot yet be selected under the above rule, and the current mode remains available, retain the current mode.
- If the current mode is unavailable, change immediately to the highest-priority mode that will be available for at least 60 minutes.

At night, due to noise sensitivity and very low movement rates, the modelling assumes the over-bay modes SODPROPS or DODPROPS have been actively used for each flight if the weather dictates that these modes are available.

4.4 Validation of Aircraft Noise Levels

4.4.1 Height Versus Distance Profiles

The INM program that is used for calculation of aircraft noise levels has 'standard' height-vs-distance profiles for all aircraft types on approach and departure. On departure, different profiles are assigned for different 'stage lengths', representing the distance to the airport of destination. These 'standard' profiles were compared with actual recorded height-vs-distance profiles for aircraft flight operations in July 2003, January and June 2004 and January 2005. (The data set is described in more detail in section 4.5.)

Figures 4.4a and **4.4b** show the median, and upper and lower 10 percent bounds, for the height of an aircraft approaching runway 19 from the south and the north respectively. Heights are reasonably correlated with the standard INM profile, especially in the more important area below approximately 4,000 ft.

Figures 4.4c and **4.4d** show similar profiles for a typical departure of a B737-300 aircraft on Stage 2 departures to the south and north respectively. Here there is more divergence from the 'standard' profile, with actual profiles being lower than the 'standard', but once again at heights less than approximately 4,000 ft the agreement is good.

For any of the profiles shown, the difference in height between the median profile and the 'standard' profile would result in a maximum difference of approximately 2 dBA in noise level. Such differences can also arise from other factors, notably differences between actual and nominal thrust settings. Given this, it was determined that rather than adjust the 'standard' INM height-vs-distance profiles, it would be preferable to adjust the predicted noise level for each aircraft type, based on a comparison between predicted and measured noise levels. This process is described in the following section.

An exception is the case of arrivals by 777-200 aircraft, where the 'standard' approach profile includes a very long section in which the aircraft is 'held' at 3,000 ft. This is not considered realistic for approaches to Brisbane Airport, either currently or with the NPR, and an alternative profile was defined including a continuous descent at the standard angle of 3° to the ground.

4.4.2 Comparison of Aircraft Noise Levels – Model vs Actual

Airservices Australia's Noise and Flight Path Monitoring System (NFPMS) includes five noise monitors located around the Airport as shown in **Figure 4.4e**. These record maximum noise levels from all detectable aircraft overflights. Times of recorded events are correlated with information from radar tracks to identify the aircraft type and other information. Data from this system were obtained for all events recorded between July 2003 and June 2005, and recorded noise levels were compared with INM predictions.

Of the five NFPMS monitors, monitor 3 is intended to detect noise from aircraft using the cross runway, while monitors 4 and 5 are located under flight paths that are less commonly used than monitors 1 and 2. Monitors 1 and 2 provide the largest number of detected correlated aircraft noise events, and are most suitable for analysis of recorded noise levels.

As shown in **Figure 4.4e**, monitors 1 and 2 are both located beneath departure flight paths, while monitor 1 is also located beneath a flight path for arrivals. For aircraft which are detected by those monitors, variation in the actual flight track used would result in a variation of less than 2 dBA in the recorded noise level. In practice, recorded noise levels were compared with calculated levels for a track which is directly over the monitor.

Figure 4.4f compares measured and predicted maximum noise levels for aircraft arrivals, as measured at monitor 1. The figure shows all aircraft types for which sufficient data were available that the standard error of the mean is less than approximately 1 dBA. The agreement is considered reasonable, with the difference between measured and predicted levels being within 2 dBA for most aircraft types, except the measured levels for the 777-200, which were about 4 dBA higher than predicted levels.

Figure 4.4a: Height-vs-Distance Profile for All Arrivals on Runway 19 from the South.

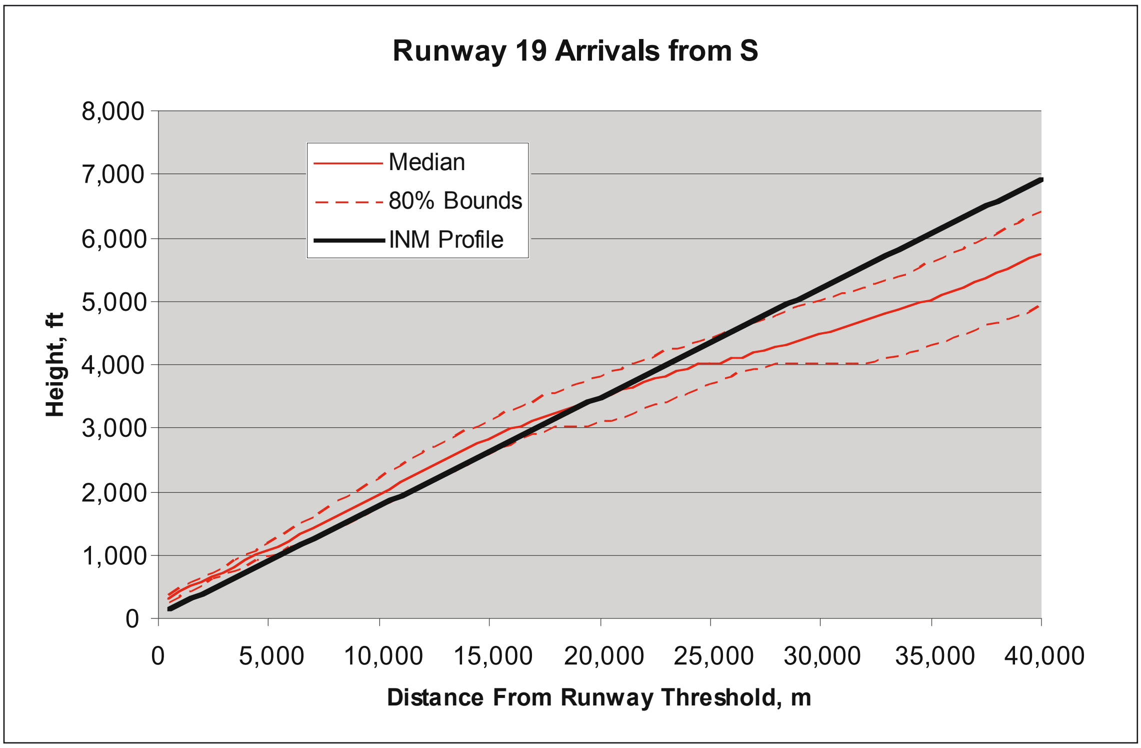


Figure 4.4b: Height-vs-Distance Profile for All Arrivals on Runway 19 from the North.

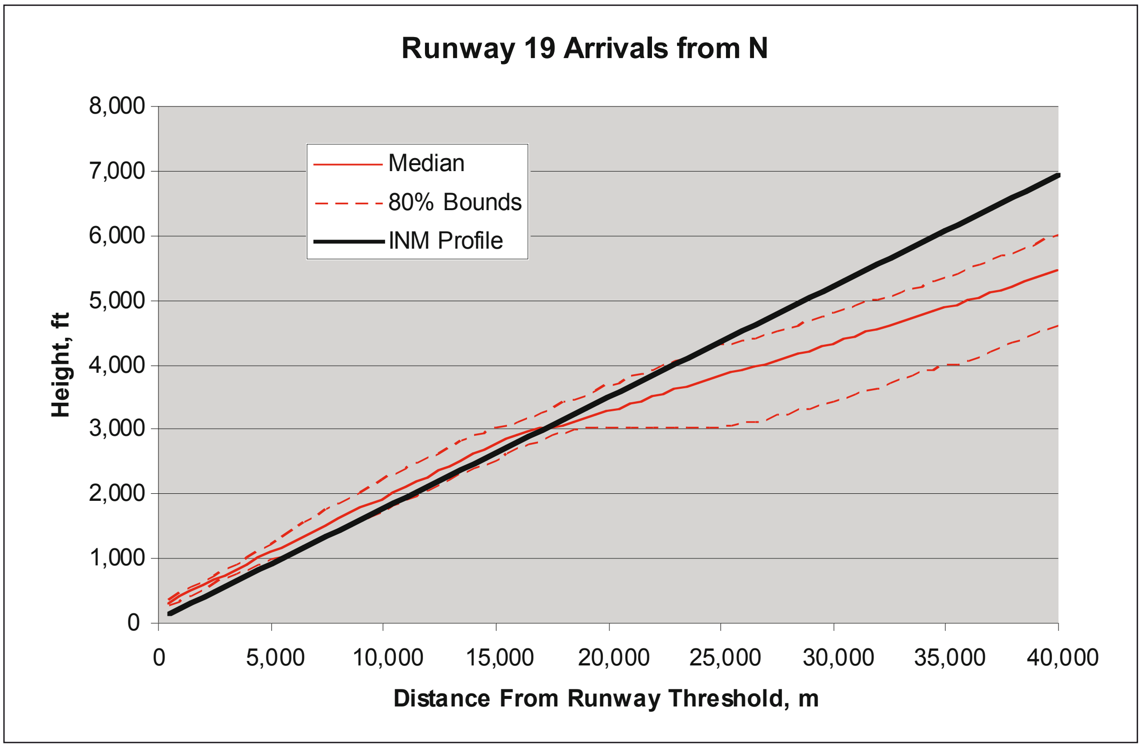


Figure 4.4c: *Height-vs-Distance Profile, 737-300 Stage 2 Departures on Runway 19 to the South.*

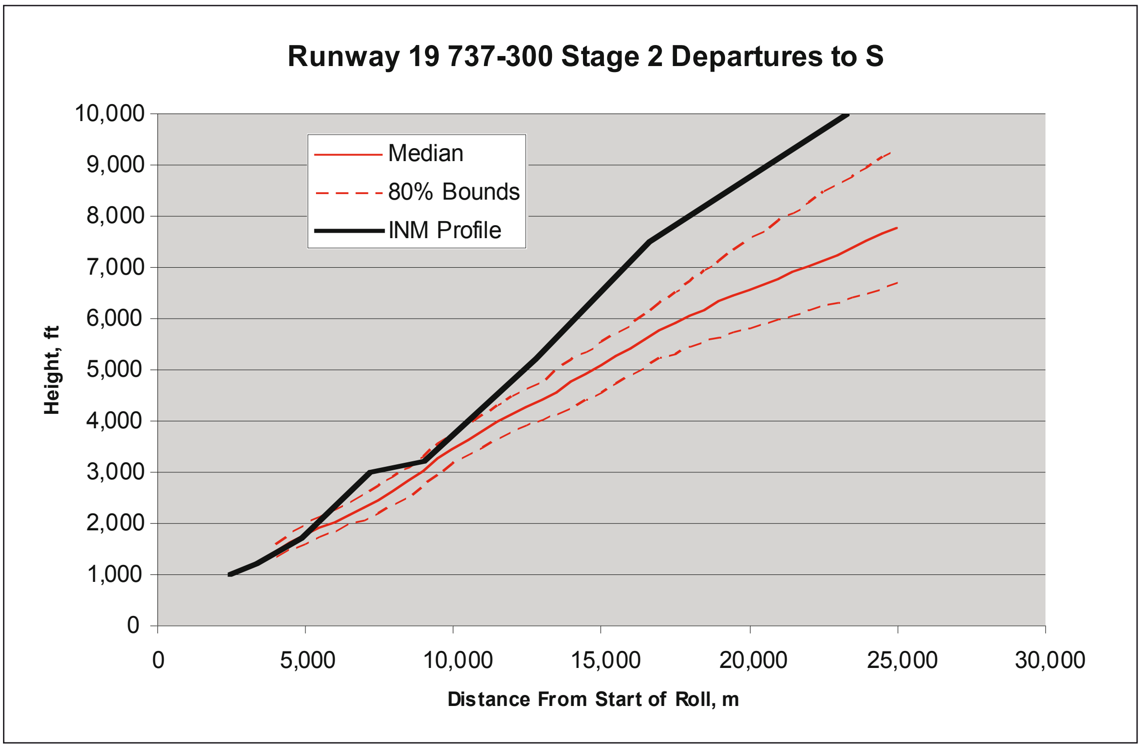


Figure 4.4d: *Height-vs-Distance Profile, 737-300 Stage 2 Departures on Runway 19 to the North.*

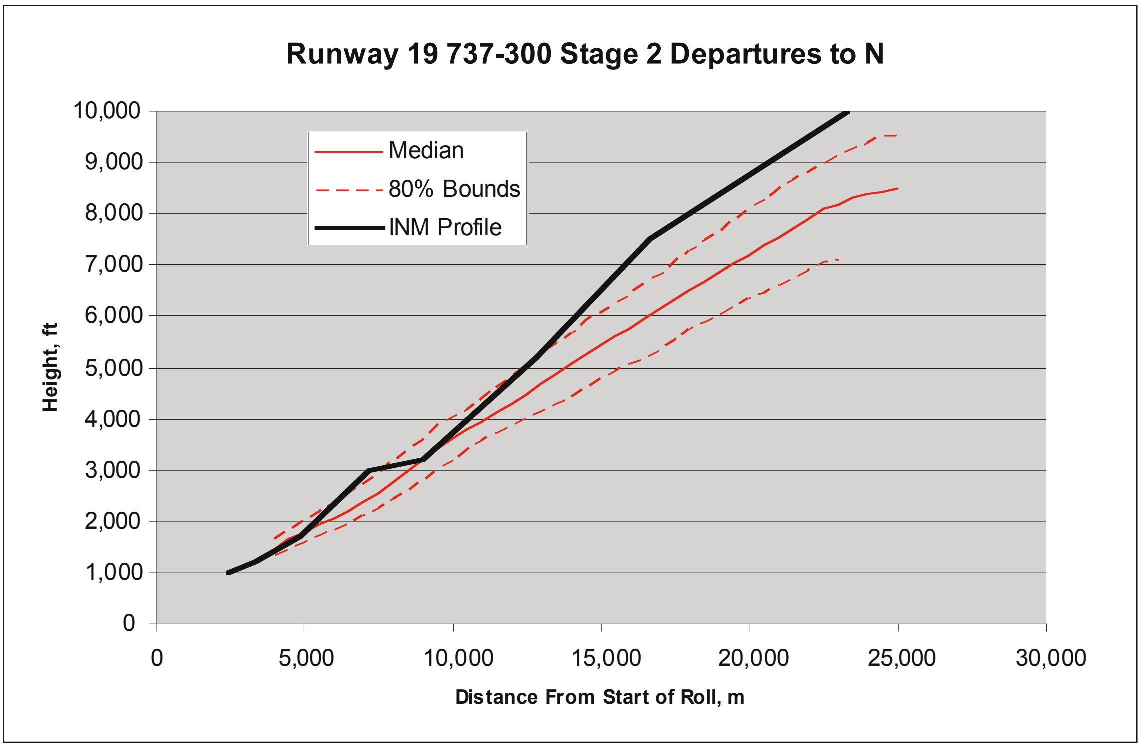


Figure 4.4e: *Location of Airservices Australia's Noise and Flight Path Monitors, and Departure Flight Tracks to the South.*

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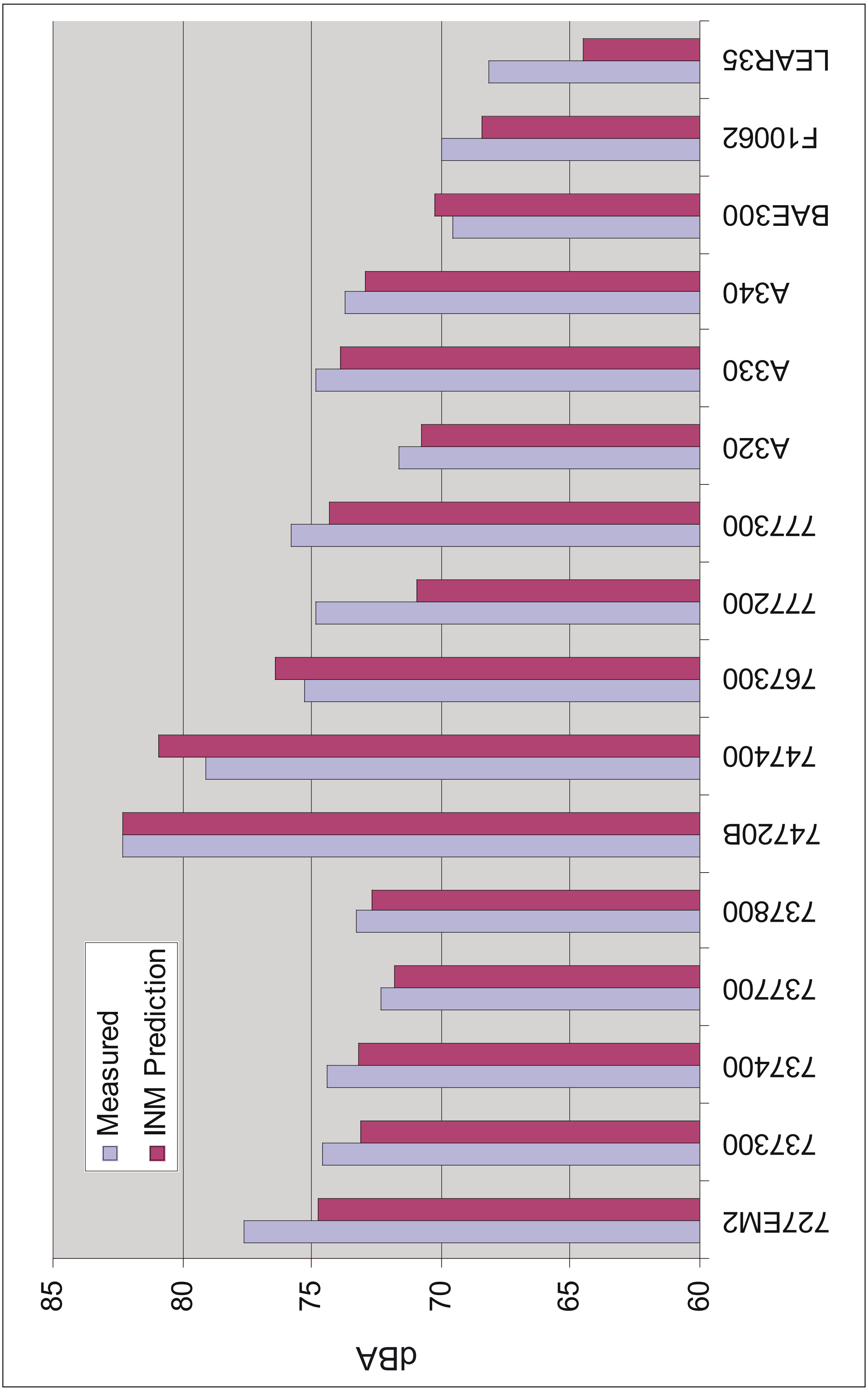


Figure 4.4f: *Aircraft Arrivals, Monitor 1 – Mean Measured Maximum Noise Level, dBA and Predicted Value from INM.*

Figures 4.4g and **4.4h** show a similar comparison for aircraft departures, as recorded at monitors 1 and 2 respectively. Here there is a notable under-prediction of noise levels from a number of important aircraft types, in particular all 737 types, 777 types and the A330. The differences between measured and predicted levels are quite consistent between monitors 1 and 2.

Assessment of aircraft height-vs-distance profiles, as discussed in section 4.4.1, indicates that although these aircraft tend to be lower than assumed in the 'standard' INM profile, this would not result in noise level differences of the size shown in **Figures 4.4g** and **4.4h**. It is assumed that the measured noise level differences are related to the use of greater thrust than is assumed in the INM 'standard' departure profile or other procedures specific to departures at Brisbane Airport by these aircraft.

To account for the measured differences, corrections were included in all calculated noise levels for departures, representing the difference between the mean measured levels and INM predictions as shown in **Figures 4.4g** and **4.4h**. These corrections are shown in **Table 4.4**.

The corrections in **Table 4.4** are applied in calculating noise levels for years 2005–2015. In 2035, the aircraft types included in modelling are intended to be representative of future types which may operate at that time, and which would have noise signatures similar to those of existing aircraft. The factors causing increased noise levels on departure for certain specific current aircraft types would not necessarily apply for these future types, and hence the inclusion of corrections based on measured noise levels from current types is not considered appropriate.

In addition, corrections were not included in calculating ANEC contours. These contours are relevant for land use planning purposes, and are intended to be representative of ANEF contours that would be endorsed for land use planning by Airservices Australia. To ensure consistency between airports, Airservices Australia currently requires that endorsed ANEF contours be produced directly from the INM program.

Table 4.4: Corrections to Calculated Noise Levels from Aircraft on Departure.

INM Aircraft Type	Stage Length	Correction, dB
737300	1	6
737300	2	6
737300	3	5
737300	4	2
737400	1	6
737400	2	5
737400	3	5
737400	4	3
737700	1	2
737700	2	2
737700	3	2
737700	4	0
737800	1	2
737800	2	1
737800	3	1
737800	4	1
777200	1	5
777200	2	5
777200	3	5
777200	4	5
777200	5	5
777200	6	3
777200	7	3
A330	1	4
A330	2	4
A330	3	4
A330	4	4
A330	5	4
A330	6	4
LEAR35	1	2

Figure 4.4g: *Aircraft Departures, Monitor 1 – Mean Measured Maximum Noise Level, dBA and Predicted Value from INM.*

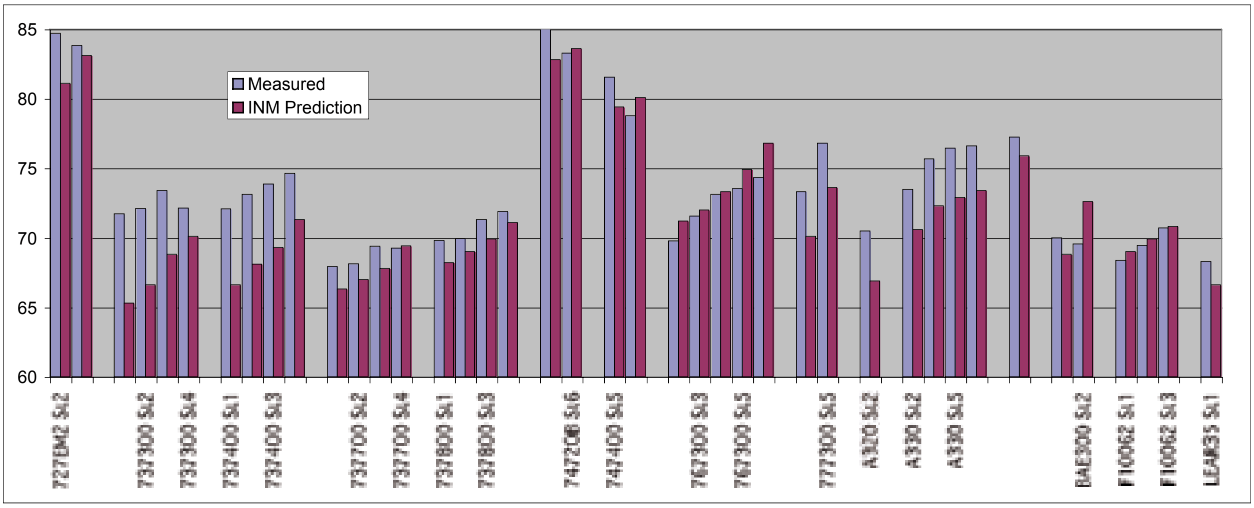
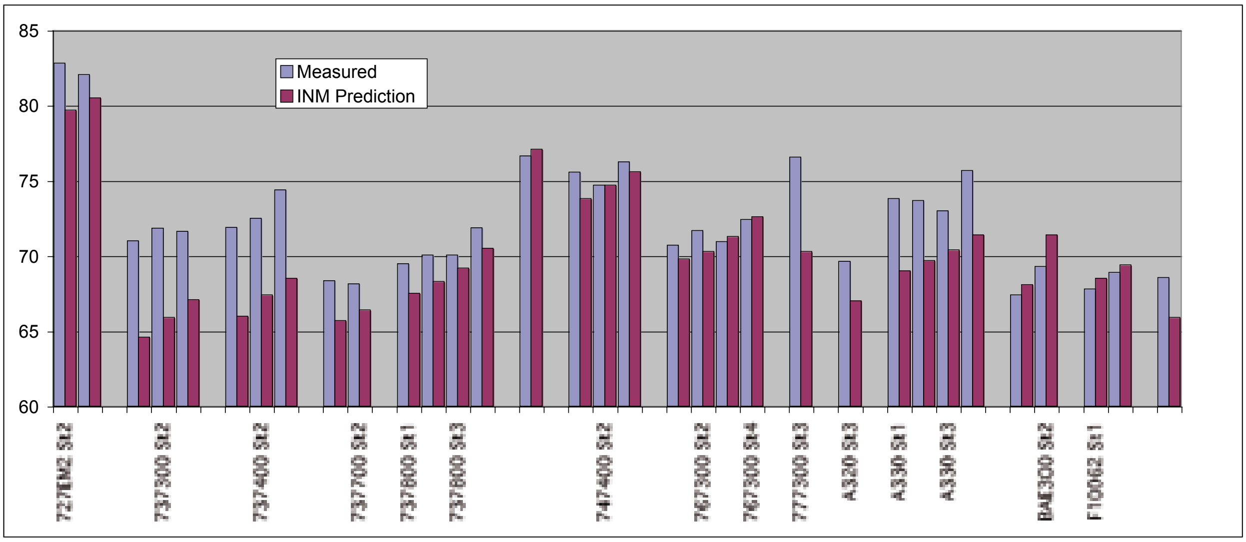


Figure 4.4h: *Aircraft Departures, Monitor 2 – Mean Measured Maximum Noise Level, dBA and Predicted Value from INM.*



4.5 Determination of Flight Tracks for Noise Modelling

In this report the usual convention is applied in distinguishing between an aircraft 'flight path', which represents a three-dimensional trace of an aircraft's position while performing an operation, and a 'flight track', which represents a two-dimensional projection of the flight path onto the ground surface. This section considers flight tracks. The height-vs-distance profile of aircraft performing these operations is considered separately in section 4.4.1.

Aircraft arriving at and departing from an airport nominally follow one of a number of Standard Arrival Routes (STARs) or Standard Instrument Departure Routes (SIDs). However, as previously discussed in section D2.3 actual tracks diverge from these nominal tracks due to meteorological conditions, requirements for aircraft separation, and other variable factors.

The approach outlined in this Chapter has been developed to simulate as accurately as possible the current and anticipated future movements of aircraft, based on the current spread of tracks around the nominal STARs and SIDs. It is important to note, however, that this is a snapshot of a 'best-fit' approximation only for both current and future movements. While this approach is considered reasonable for the modelling assessment, the actual distribution of aircraft around a nominal track will vary from day to day, week to week and month to month.

Existing aircraft flight tracks were determined by analysis of all flight tracks recorded by Airservices Australia's Noise and Flight Path Monitoring System (NFPMS) over four separate months: July 2003, January and July 2004, and January 2005. These were chosen to allow comparison of tracks used in different seasons. However, preliminary analysis indicated no systematic differences between the tracks flown by aircraft in these four months (although the number of aircraft using different tracks, of course, varied), and hence in the analysis presented below data from all months are aggregated.

The purpose of this analysis is to identify tracks that are associated with specific types of aircraft operations, allowing the total number of operations on the various tracks to be predicted for future years. Aircraft operations were classified by:

- Aircraft category (jet or non-jet);
- Operation (arrival or departure);
- Airport operating mode;
- For arrivals – visual or instrument conditions; and
- Direction of the airport of origin or destination. This was generally divided into five categories – NE (bearing 0-100° from Brisbane Airport); SE (bearing 100-160°); S (bearing 160-230°); W (bearing 230-295°); and N (bearing 295-360°). However, for some types of operation alternative angle ranges were used to give a better clustering of actual tracks.

The analysis process is illustrated in **Figures 4.5a** to **4.5c**. Tracks for all aircraft operations in a particular category, as defined above, are plotted, as in **Figure 4.5a**. **Figure 4.5a** shows jet arrivals in the 01 direction in visual conditions from the south. In many cases, as in this Figure, the tracks clearly fall into at least two separate groups. The groups represent two STARs, either of which may be followed by aircraft arriving from the given direction. Aircraft from exactly the same airport may arrive on either of these STARs, depending on operational conditions at the time. In this case, even though there are visual conditions, in order to manage the number of aircraft, some were sent along the visual STAR (the grouping closer to the coast shown in red on **Figure 4.5b**) and some were directed to use the instrument STAR (the grouping further away from the coast shown in black on **Figure 4.5b**).

Tracks were assigned to one or other of the groups according to their proximity to the central 'spine' of each group, as shown in **Figure 4.5b**.

For each group, a set of nominal tracks was then determined, representing the centre of each group, and the dispersion of tracks within the group.

Generally five nominal tracks were assigned for each group:

- A central track, representing 30 percent of all tracks;
- Tracks on either side of the centre, each representing 22 percent of all tracks; and
- Outlying tracks on either side, each representing 13 percent of all tracks.

In some cases where there were very few recorded tracks, only three or, rarely, only one nominal track was identified.

The locations of these nominal tracks were determined directly from the recorded tracks, using custom-designed software. **Figure 4.5c** shows typical results, indicating the nominal tracks for each of the two groups shown in **Figure 4.5b**.

In this way, if aircraft operations are categorised as described above they can be assigned on a proportional basis first to a group, using the proportion of actual operations in each group, and then to nominal tracks.

The process described above was repeated for all combinations of aircraft type, operation, airport operating mode, visual/instrument conditions and directions. This results in a total of 571 nominal tracks and sub-tracks describing existing operations at Brisbane Airport. These are shown in Appendix 4A**.**

4.6 Overall Calculation Procedures

For each airport operating scenario considered, an airport operating mode was assigned for each 15 minutes over a five year period, taking account of:

- The set of possible operating modes, and their priority as described in section 4.3.3;
- Whether each mode is available under the current weather conditions, using the meteorological data set described in section 4.3.1;
- Whether each mode is available given the number of presenting arrivals and departures for the relevant scenario, as described in section 4.3.2; and
- Whether a change to a higher-priority mode would be undertaken under the assumed rules for mode selection, as described in section 4.3.4.

Aircraft operations occurring in that 15 minute period are then assigned to tracks according to the direction of the airport of origin or destination, and whether conditions are visual or instrument. Operations on each track can then be used to determine measures of overall noise exposure, using the calculated noise levels described in section 4.4.

4.7 Transparent Noise Information Package (TNIP)

The Department of Transport and Regional Services (DOTARS) has developed the Transparent Noise Information Package (TNIP), which is a suite of software applications, to enable information on aircraft movements and noise to be rapidly produced for individual airports and to establish a transparent link between what is described in reports and what a member of the public actually experiences.

TNIP has been developed over the past ten years through extensive community consultation as a result of the special circumstances surrounding Sydney Airport and are the outcome of the Sydney community's response to the conventional and limited approach to providing information on aircraft noise at that time.

Experience has shown that describing aircraft noise in terms of where aircraft fly, the times and numbers of overflights and the loudness of individual noise events is likely to give a person a good feel for aircraft noise exposure patterns. Previously, information of this type has not been readily available and aircraft noise has commonly been described using noise contours that combine and average out the various noise components.

In what is a first for any new runway impact study in Australia, BAC has taken the TNIP software and tailored it for the NPR Project to provide the community, in as user friendly a manner as possible, access to the aircraft noise and flight path information used to prepare the aircraft noise assessment presented in Chapter D5 in this Volume of the Draft EIS/MDP. The TNIP software also allows the user to independently verify the noise exposure patterns described in the Draft EIS/MDP without special expertise or equipment.

The TNIP software is provided on an auto-starting CD-ROM application compatible with most computers and is preloaded with all the data from which the flight paths and N70 contours, that appear in the Draft EIS/MDP and Noise and Flight Path Information Booklet, have been drawn.

Once the files are loaded, the user is presented with a screen showing Brisbane Airport and surrounding suburbs and a number of drop-down menus. By selecting from the menus either individually, or in groups, components such as N70 contours are generated over the map.

Demonstrations on the use of TNIP will be provided at the NPR Community Information Centres during the public engagement period. For further details, contact the NPR Information Freecall Line on 1800 737 075.

A complete explanation and history of TNIP can be found on the DOTARS website at:
http://www.dotars.gov.au/aviation/environmental/transparent_noise/tnip.aspx

Figure 4.5a: Jet Arrival Tracks – '01' Mode, Visual Conditions, S Direction.

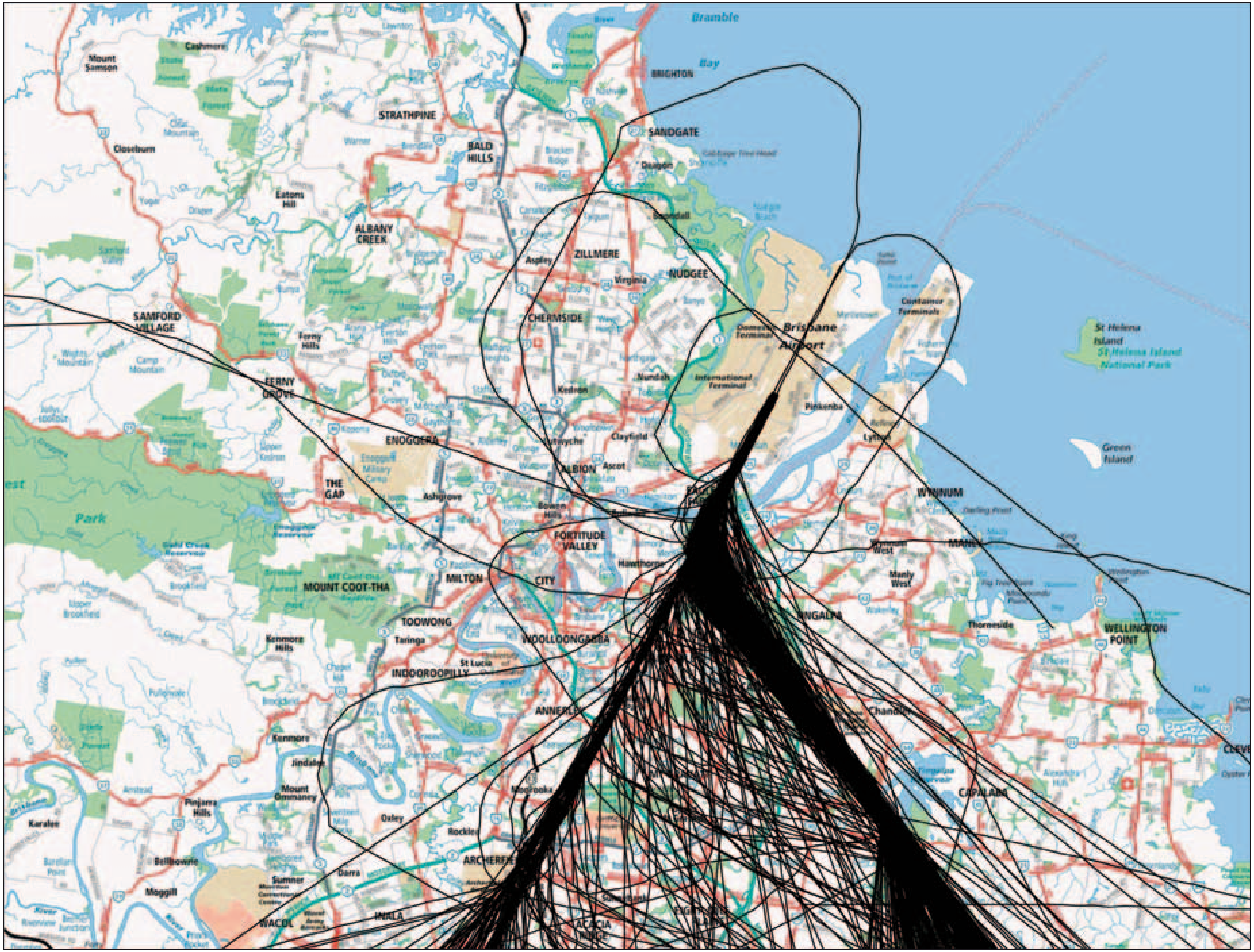


Figure 4.5b: *Classification of Tracks in* ***Figure 4.5a*** *into Two Groups.*

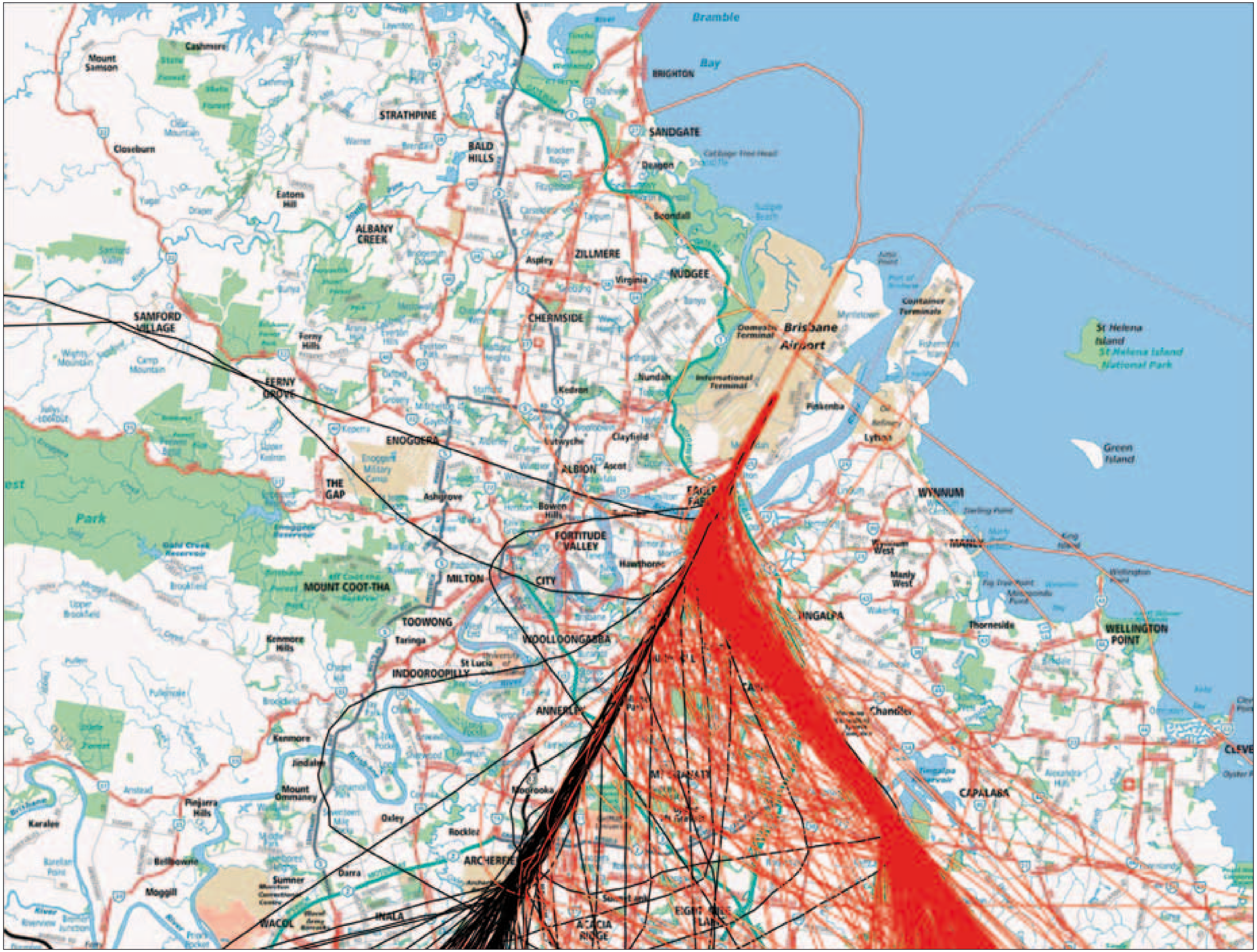
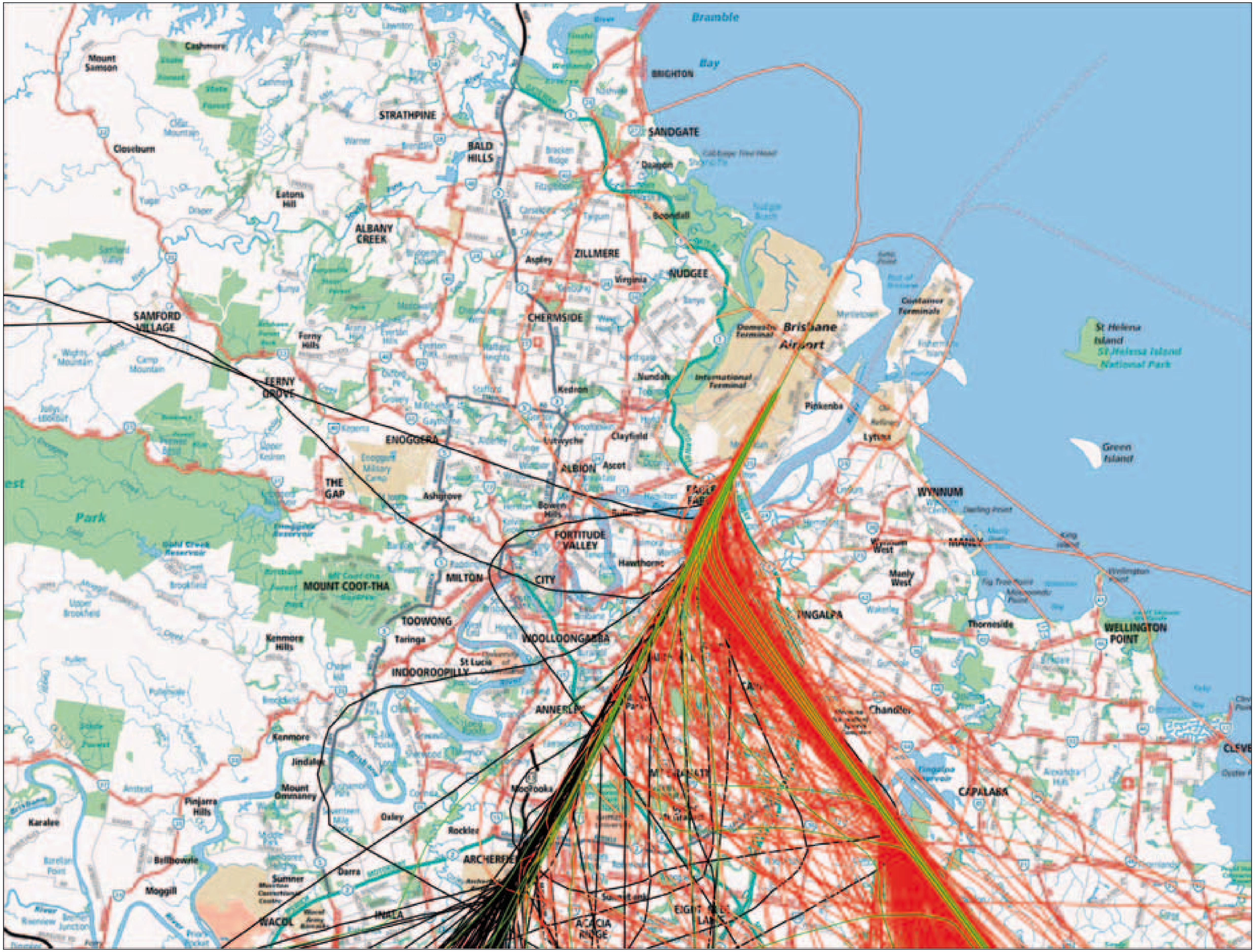


Figure 4.5c: *Construction of Representative Tracks for Each of the Two Groups Shown in* ***Figure 4.5b****.*



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