D2

VOLUME D: AIRSPACE

Background to Airspace Architecture

D2 Background to Airspace Architecture

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2.1 Introduction

The Brisbane Airport New Parallel Runway (NPR) project involves construction of a new runway 3,600 m long and 2,000 m to the west of the existing main runway. As part of the project, the existing cross runway would be strengthened and converted into a taxiway.

This project would result in changes to the pattern of aircraft noise around Brisbane Airport, due to required alterations to aircraft flight paths and airport operating modes. The changes would result in lower noise impacts in some areas, and higher noise impacts in others. In addition, projected future growth in air traffic will result in increased numbers of operations at the airport, with or without the NPR project, although this will be mitigated to some extent by the introduction of new, quieter aircraft and improvements in air traffic navigation technology and procedures.

This Chapter provides background information on the issues and concepts that relate to airspace operations to assist the reader in understanding the noise impacts associated with the NPR. Outlining an explanation of these factors at the outset provides the basis for the discussions regarding flight paths and noise implications that follow in Chapters D3, D4 and D5.

Airspace operations at Brisbane Airport are influenced by a range of factors. These include daily, weekly and seasonal variations in weather, and in the number of aircraft arriving and departing, as well as their points of origin or destination. Longer term factors like growth in total traffic volumes and the introduction of new aircraft or new technologies also affect operations. It is important to understand how each factor can influence how an aircraft may be directed to operate on a given day. The following factors play an important role in airspace operations and are discussed in detail in the sections below:

- Weather;
- Aircraft flight paths;
- Airport operating hours;
- Volume of aircraft traffic;
- Air Traffic Control procedures;
- Modes of operation (different combinations of runway direction and operating rules); and
- Mode capacity (the maximum number of aircraft per hour which can be processed in a particular mode).

This Chapter also provides a summary of the ways in which aircraft noise can be described, and introduces measures of aircraft noise exposure which are used in subsequent sections to describe and compare noise impacts under various scenarios.

2.2 Weather

Weather patterns heavily influence airport operations on an hourly, daily and seasonal basis. There are a number of ways weather affects aircraft operations. They are as follows:

- Wind direction and speed, which dictate the direction of the operating (duty) runways (i.e. the direction from which aircraft can land or take-off);
- Whether it is raining or not (wet or dry). Different operating rules are invoked if the runway is wet; and
- Visibility due to fog or height of the cloud base. This determines whether certain flight paths and operating rules are used or not.

2.2.1 Wind Direction

As a general aviation rule, the safest and most efficient way for aircraft to operate is for all departures and arrivals to be conducted into the wind. A runway can be used in two directions, so wind direction is important to an airport for three main reasons:

1. It influences the selection of the alignment of the runways when they are originally built;
2. It affects the direction in which the runways will be used for arrivals and departures at any given time; and
3. If the conditions are too dangerous the airport will be closed.

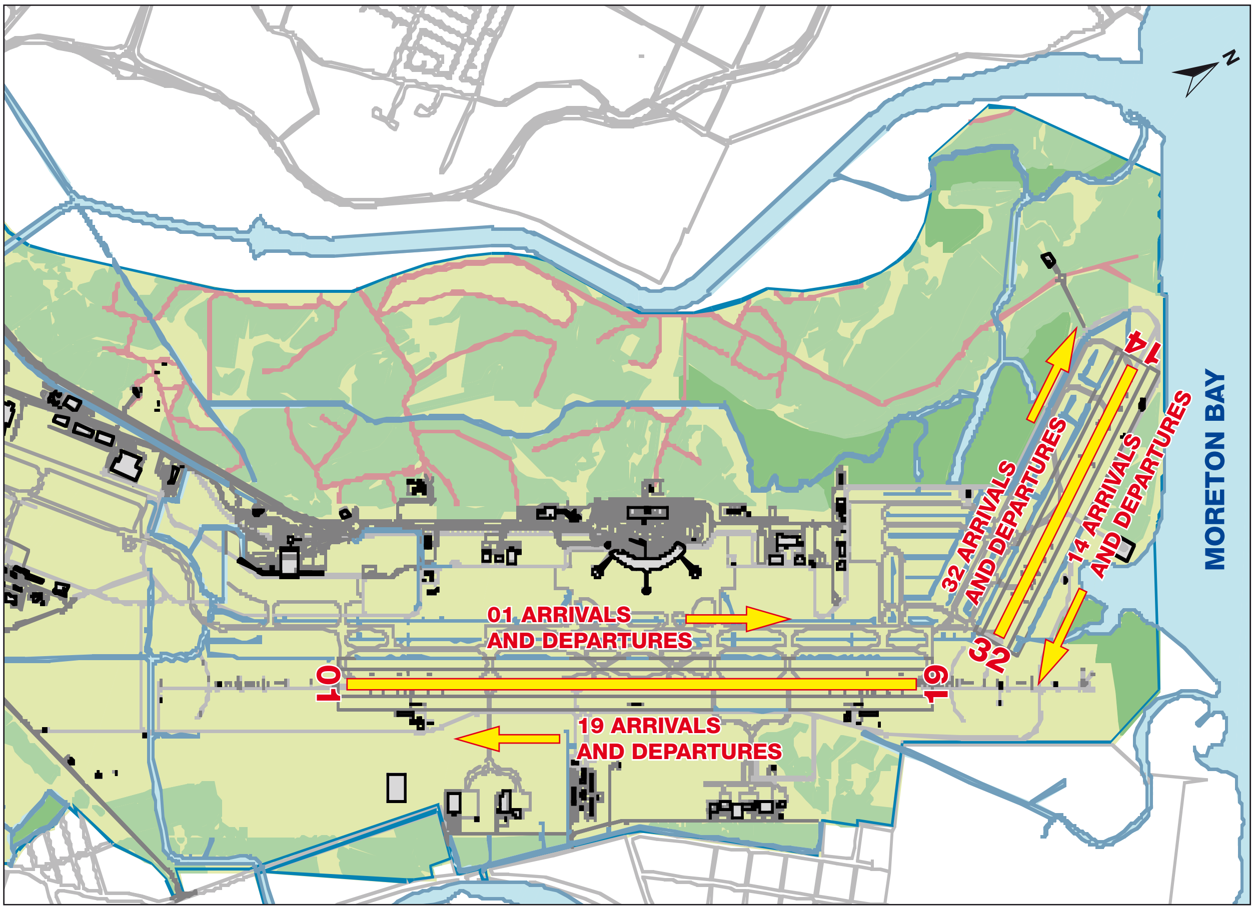
At Brisbane Airport, meteorological information has been collected for many years by both the Bureau of Meteorology and Airservices Australia (AsA). Consequently, wind speed and direction is well understood. Chapters D4, D5 and D6 provide additional detailed discussions of relevant weather conditions at Brisbane Airport.

In summary, the wind patterns at Brisbane Airport are characterised by distinct seasonal patterns. In summer the winds at the Airport are predominantly north to north-easterly or south-easterly, while in winter they are predominantly from a south to south-westerly direction. This generally north-south pattern of winds would have been an important consideration for the current alignment of the existing airport runways and proposed NPR.

Runways can operate in both directions. As noted previously, Brisbane's main runway is positioned in a north-south alignment, such that arrivals on the main runway can land from the south over Brisbane and departures take off to the north over Moreton Bay or vice versa. The current runway layout is shown in **Figure 2.2a**.

The modes of runway operation are discussed in more detail in section D2.7. In summary, when wind is from a northerly direction (typical summer conditions) the 01 runway direction is used with aircraft arriving from the south over Brisbane and taking off to the north over Moreton Bay. Conversely, when the wind is from a southerly direction (typical winter conditions) the runway is used in the 19 direction with aircraft arriving from the north over Moreton Bay and taking off to the south over Brisbane.

Figure 2.2a: *Existing Runway Configuration 2005.*



Note: Runways are generally numbered according to the magnetic direction in which they point, rounded to the nearest ten degrees and then divided by ten. Each digit is pronounced separately for clarity in radio communications. For example, at Brisbane Runway Zero One (01) would be aligned in roughly a 10-degree direction (i.e. close to magnetic north), and Runway One Nine (19) would be used for a runway with a 190-degree alignment (i.e. close to magnetic south).

2.2.2 Wind Speed

Wind at an airport is most commonly described in its crosswind and downwind components. The crosswind component of wind is the vector component of wind that blows perpendicular (at right angles) to the runway it refers to. The downwind component is the vector component of wind that blows parallel (in line) with the runway it refers to. By way of example, the crosswind and downwind components on the main runway 01/19 for a 25 knot north-easterly is shown in **Figure 2.2b**. Under these conditions the downwind component is 20.5 knots and the crosswind component is 14.3 knots and the main operating (duty) runway would be runway 01.

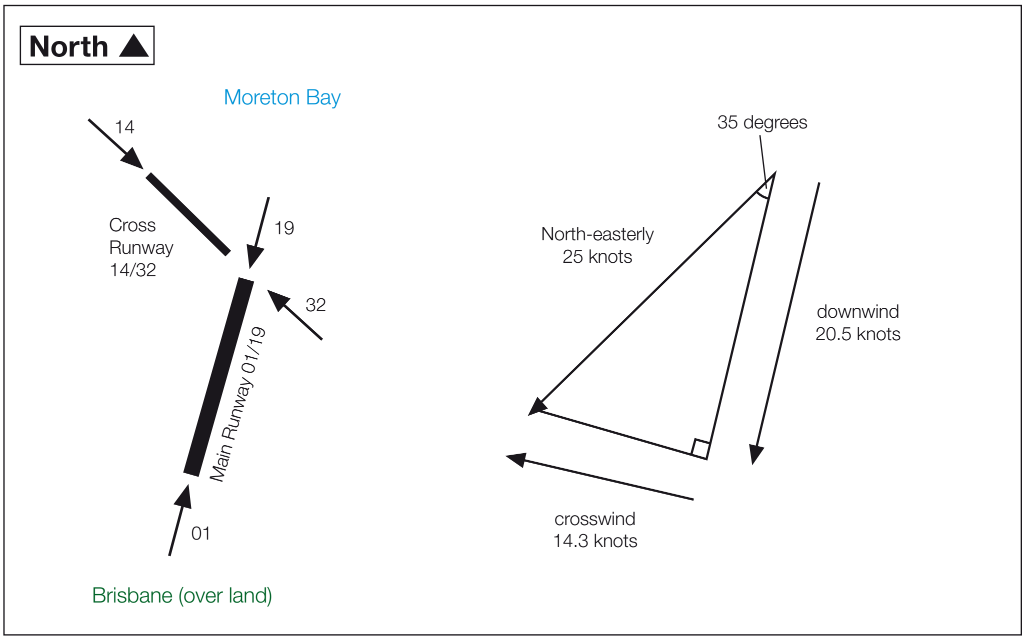
Wind speed is important because in low downwind speed conditions – typically less than 5 knots (~10 km/hr), aircraft may be able to safely land and take-off even with the wind blowing from behind, referred to as a tail wind.

At Brisbane Airport wind speeds fluctuate widely, but generally winds are stronger during daylight hours and in the early evenings. As the ground temperature cools, local wind speeds generally are observed to decrease. This is important when determining the use of a particular runway direction or mode of operation (see section D2.7). For example, noise over residential areas of Brisbane is minimised when both arrivals and departures take place over Moreton Bay, but this is possible only when wind conditions allow operations in both a northerly (01) and a southerly (19) direction.

2.2.3 Rain

The operating rules for aircraft change if it has been raining (even very lightly) and the runway is considered ‘wet’ rather than ‘dry’. With a ‘wet’ runway, safety considerations generally dictate that no tailwind is allowed for any operations, and this restricts the potential to apply certain Noise Abatement Procedures, as explained in more detail in section D2.7.

Figure 2.2b: *Crosswind and Downwind on Runway 01/19 for a 25 Knot North-Easterly.*



2.2.4 Visibility

Good weather, clear skies and little or no cloud cover presents the optimum conditions for aircraft operations. When weather conditions are not good and the human eye cannot be relied upon for visual cues to avoid terrain obstacles or other aircraft, or see the runway, pilots are required to fly either on a different flight path or with different flight rules.

In controlled airspace like that surrounding Brisbane Airport, Air Traffic Control (ATC) determines, based on the presenting weather conditions, whether 'visual' or 'instrument' conditions apply and hence whether instrument or visual flight rules apply. The standards for triggering when instrument over visual conditions apply are set by the recognised international body ICAO and is prescribed in relevant AsA publications to which all pilots and airlines refer. The determination for instrument or visual conditions at Brisbane Airport is monitored continuously by ATC and set accordingly.

2.3 Flight Paths

Flight paths are the highways in the sky. They are three-dimensional tracks that provide pilots with the signposting to allow them to safely fly between destinations and to land and take-off from airports. Ideally, aircraft fly by the most direct route and at the optimum altitude for reasons of economy and efficiency of flight operations. However, it is not always possible for aircraft to fly optimum routes because of safety considerations, the competing demands of other airspace users, and noise abatement considerations.

In order to achieve safe segregation of aircraft, and being mindful of the noise effects on the community, aircraft depart and arrive at Brisbane Airport according to a set of flight path procedures known as Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs). SIDs and STARs have specified directional and height limits which pilots are required to observe when flying into and out of a destination.

SIDs and STARs have been developed on the basis of minimising as far as possible the noise impacts associated with aircraft operations.

All SIDs and STARs which relate to Brisbane Airport are published as part of Airservices Australia's Aeronautical Information Package (AIP) and are contained in the Departure and Approach Procedures (DAP East) available at http://www.airservicesaustralia.com/publications/aip.ais. They are also discussed in more detail in Chapter D3.

While flight paths are often depicted as single lines on a map, it is not possible for all aircraft following a particular flight path to fly precisely along the same line. In practice, individual flight paths tend to occur within flight corridors that can be a number of kilometres wide. The SIDs and STARs are followed most closely under 'instrument' weather conditions. Under 'visual' conditions aircraft may be given alternative instructions, known as 'vectoring', which may allow the aircraft to shortcut the SID or STAR to achieve more efficient sequencing of aircraft arrivals and departures. In addition, variation in wind conditions affects the exact flight path followed. For example, wind affects the rate at which departing aircraft climb, and hence the point at which a turn may be executed.

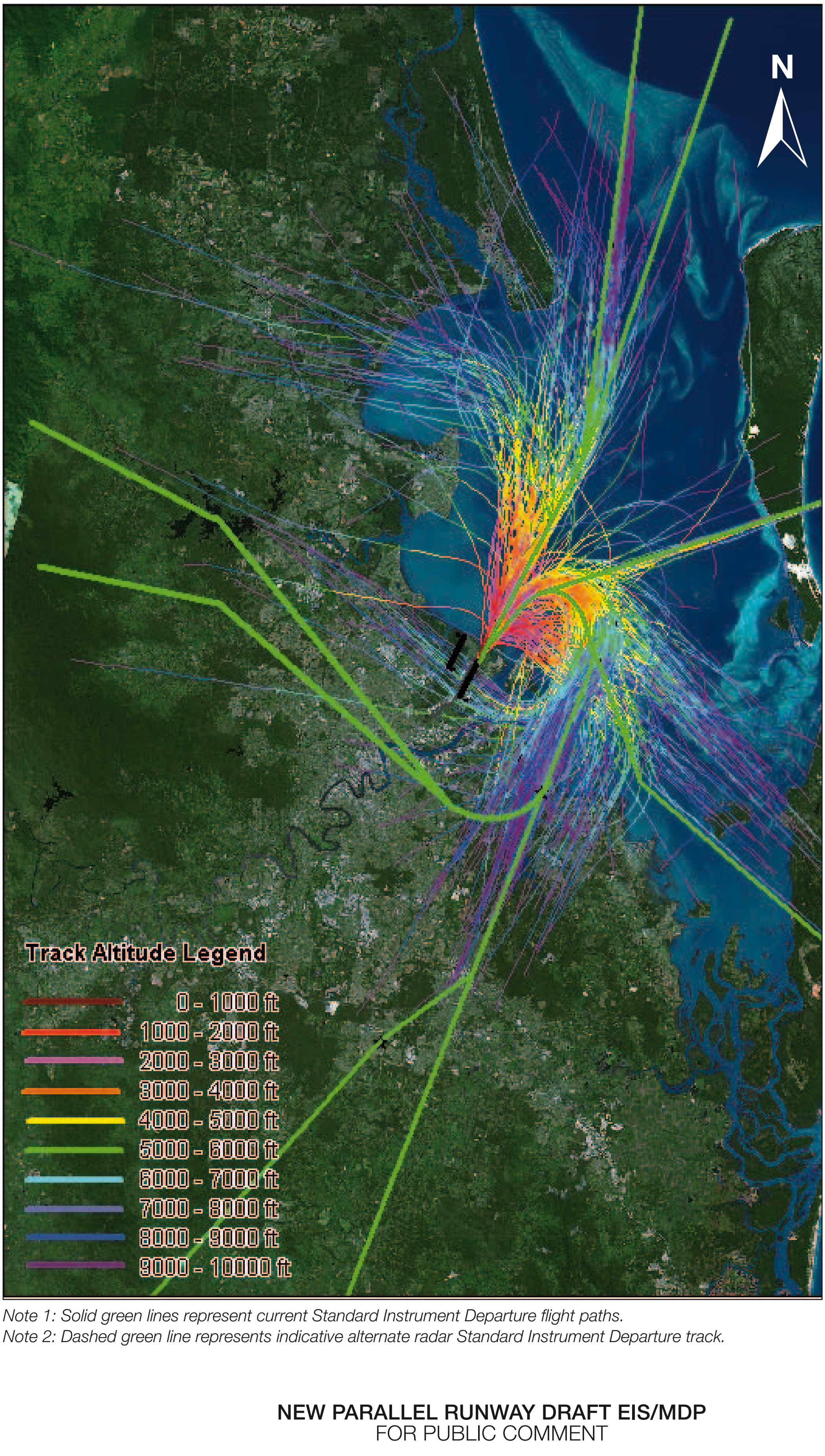
Figures 2.3a to **2.3d** show typical individual flight tracks for jet aircraft arriving and departing on runway 01 and runway 19 at Brisbane Airport, recorded during the month of January 2005. The altitude of the aircraft is represented in the figures by coloured bands.

The plotted flight tracks were provided by Airservices Australia's Noise and Flight Path Monitoring System (NFPMS) installed at Brisbane. The NFPMS records flight paths to 30 nautical miles from the airport, for aircraft at or below an altitude of 10,000 ft above ground level or mean sea level.

Movements and noise data recorded by the NFPMS at Brisbane Airport since July 2000 can be found on the Airservices Australia website at: http://www.airservices.gov.au/reports/nfpms/nfpmsbrisbane.asp

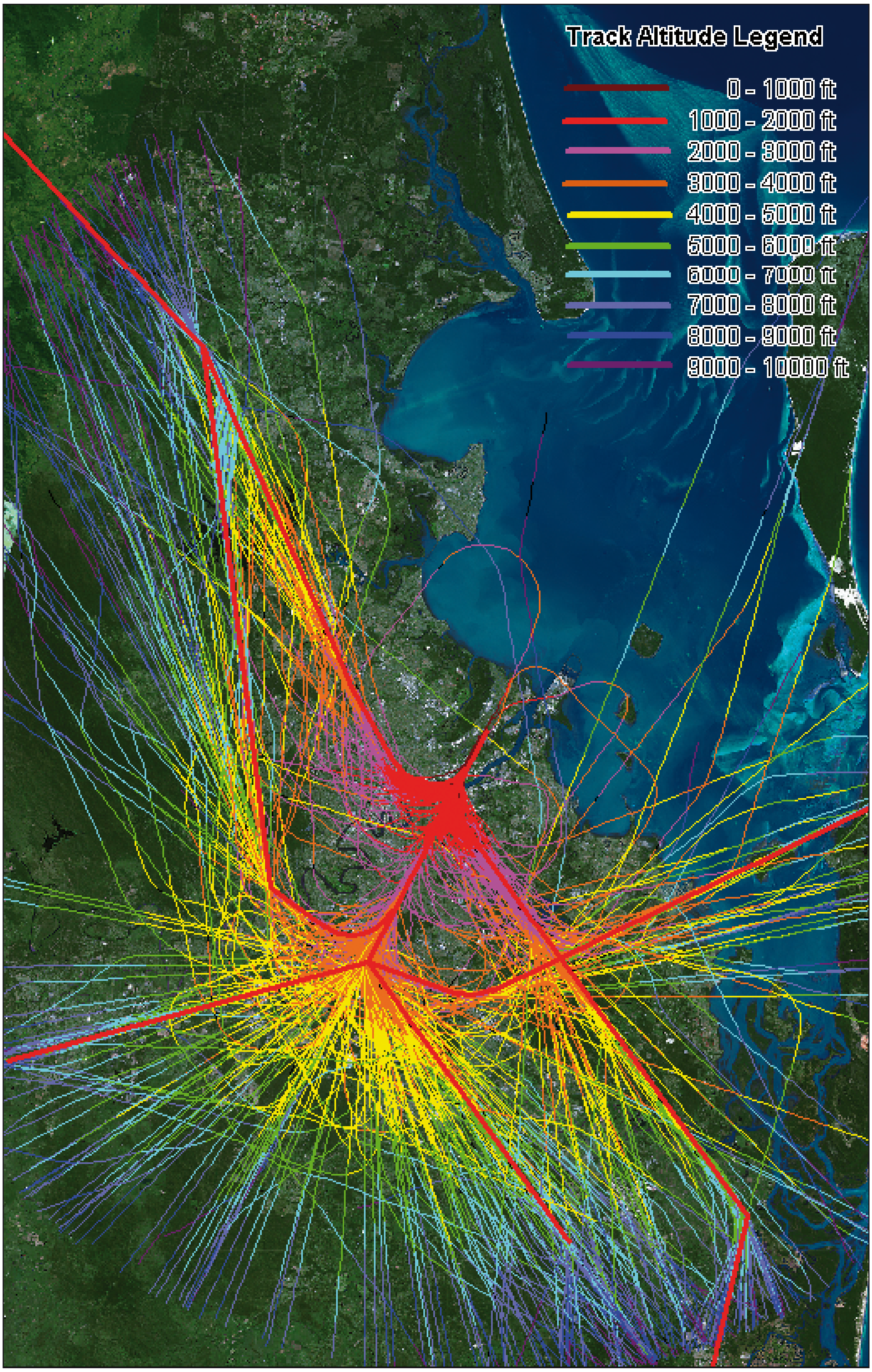
The SIDs and STARs are shown on **Figures 2.3a** to **2.3d** as a bold green line and bold red lines respectively. The flight track divergence from the nominal track for both arrivals and departures is evident in the **Figures 2.3a** to **2.3d**, which is due to meteorological conditions, requirements for aircraft separation, visual vectoring of aircraft and other variable factors such as individual aircraft performance characteristics.

Figure 2.3a: *Runway 01 Jet Aircraft Departures January 2005.*



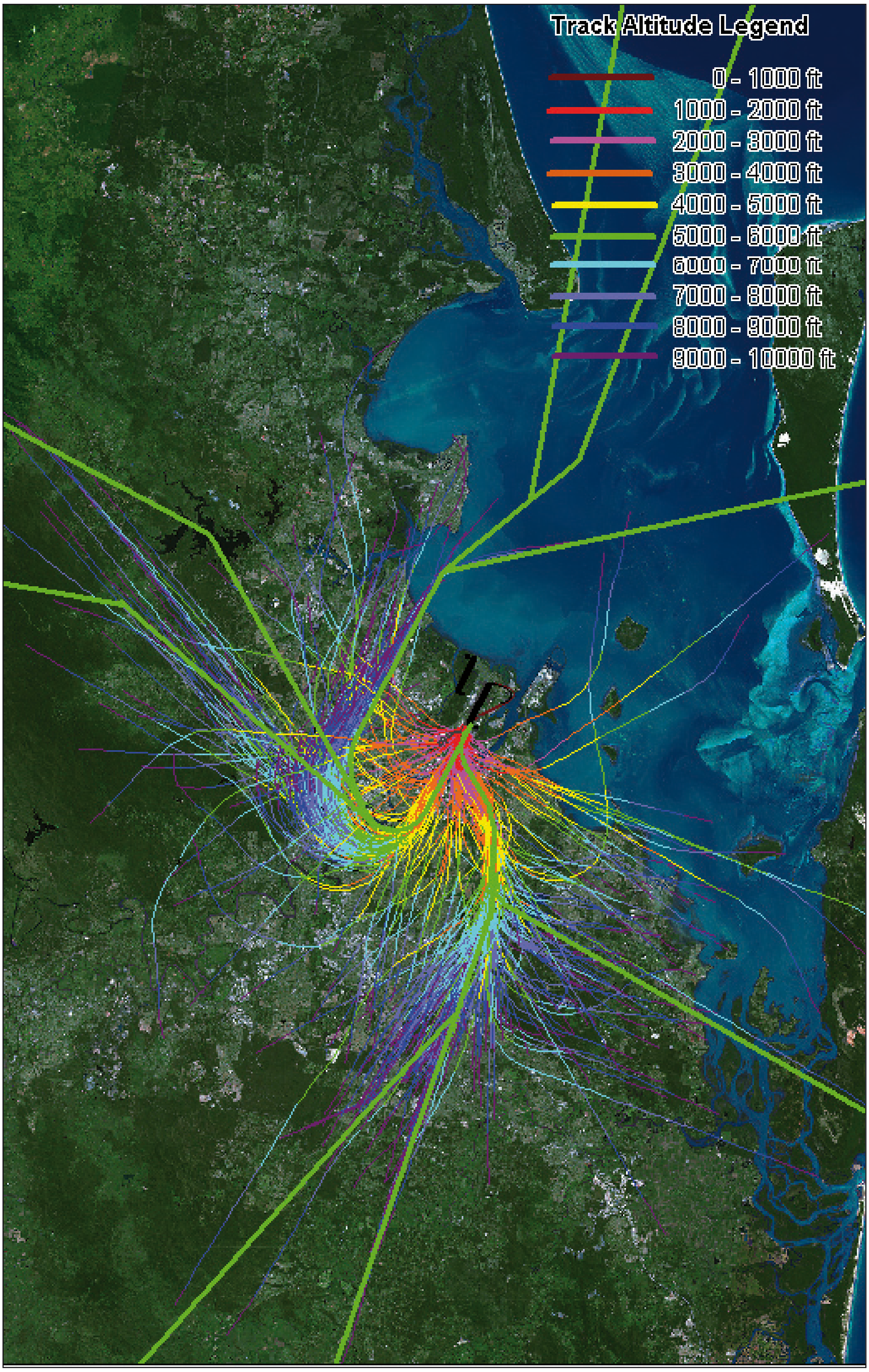
Note 1: Solid green lines represent current Standard Instrument Departure flight paths.
Note 2: Dashed green line represents indicative alternate radar Standard Instrument Departure track.

Figure 2.3b: *Runway 01 Jet Aircraft Arrivals January 2005.*



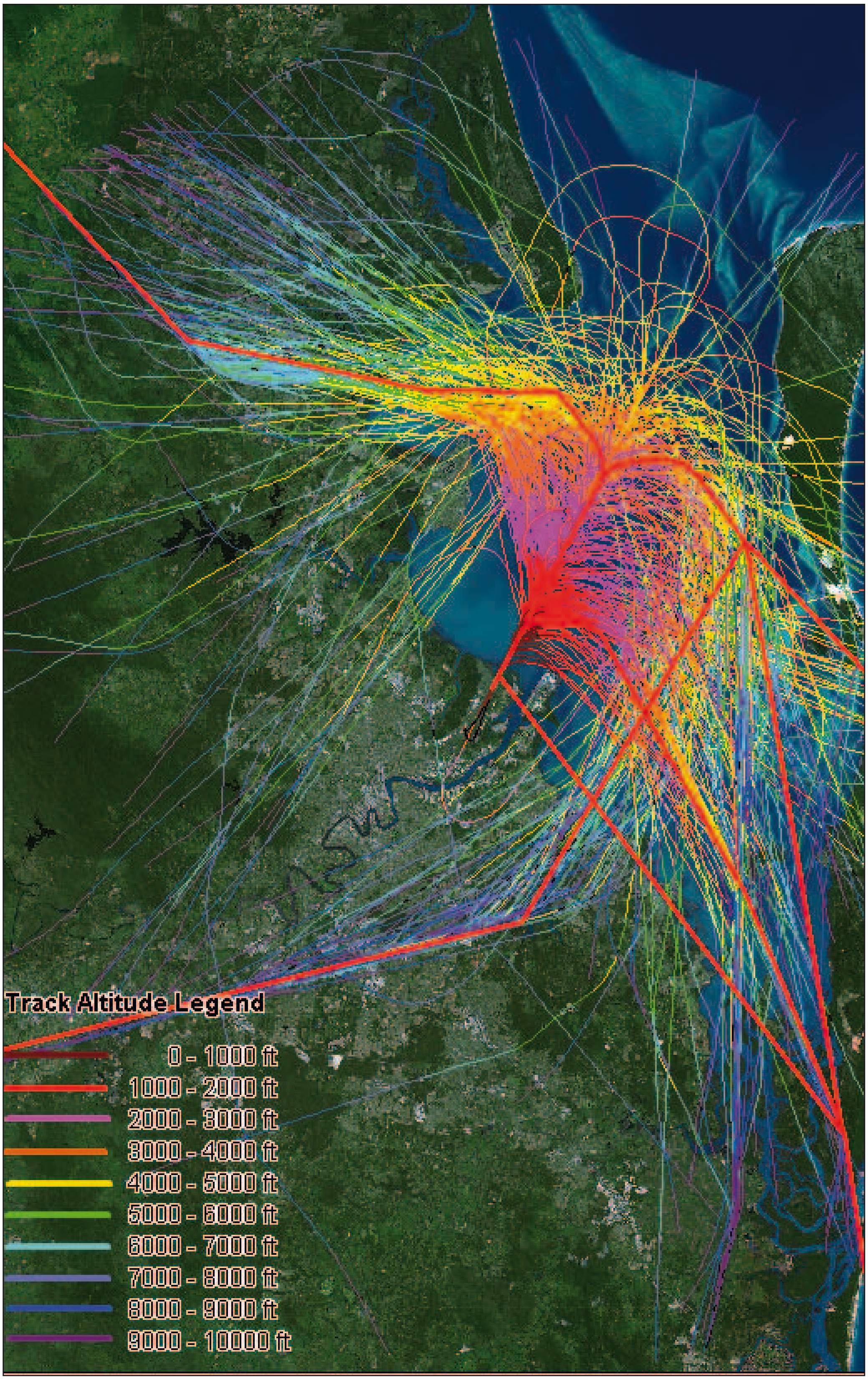
Note: Solid red lines represent current Standard Arrival Route flight paths.

Figure 2.3c: *Runway 19 Jet Aircraft Departures January 2005.*



Note: Solid green lines represent current Standard Instrument Departure flight paths.

Figure 2.3d: *Runway 19 Jet Aircraft Arrivals January 2005.*



Note: Solid red line represents current Standard Arrival Route flight paths.

2.4 Airport Operating Hours

Brisbane Airport operates 24 hours a day, 7 days a week, which is critical for the commercial viability of the Airport as well the sustained economic growth of Brisbane and South East Queensland.

It is important that 24 hour operations are maintained to assist in the:

- Scheduling difficulties associated with different time zones of destination and origin ports of departing and arriving aircraft. This is especially the case with many international flights;
- The management of efficient domestic operations that are affected by time differences between Queensland and other States for several months each year as a result of daylight saving;
- Provision of vital regional overnight financial and commercial services; and
- Expeditious delivery of local high value perishable goods for the export market.

24 hour operations also provide a commercial and tourism advantage to Brisbane and South East Queensland for international operations over some interstate airports.

2.5 Volume of Aircraft Traffic

Noise levels heard on the ground are based on a number of factors which among others include the type of aircraft, the height at which it might be flying, the manoeuvres it might be making (e.g. turning, powering up or down) or the weather. Another factor of major importance is the number of times the noise is heard during an hour or over the day. As the volume of air traffic increases, the airport noise footprint is likely to increase, unless there are improvements in aircraft technology to reduce aircraft noise.

The number of aircraft arriving and departing varies throughout the day and between days and months. Typically, the daily profile of aircraft movements includes periods of concentrated demand which are referred to as the peaks or peak periods. These are generally in the 7am to 9am and 5pm to 7pm periods in weekdays reflecting high domestic commuter demand, similar to what occurs on the road network. Refer to Volume A, Chapter A2 for details of aircraft and passenger demand forecasts and specifically section A2.5 for further details on daily profiles.

The various operating modes and procedures have specific capacities (the number of aircraft that can land or take off) that are generally determined by operational safety considerations. The number of aircraft that need to arrive or depart at any one time will therefore affect which operational modes can be selected. For instance, 'Reciprocal' mode operations limit jet aircraft movements to over the Bay (and not over the city) with the benefit of limiting residential areas overflown by aircraft. However, this mode of operation has a much reduced capacity that restricts operations to the night period only.

As discussed earlier in this Chapter, weather also has a significant effect on when the different operating modes can be used. Using the above example of 'Reciprocal' mode operations, it may be possible to operate the mode for capacity reasons, due to sufficiently low demand, but weather conditions may prevent the mode from being adopted for safety reasons.

Additionally, other operational factors also limit when certain operating modes can be implemented. For instance, the volume of air traffic movements occurring at any one time may require a certain mode of operation for ATC to efficiently manage arriving and departing aircraft.

ATC procedures are discussed in the following section 2.6 and existing runway operating modes are discussed in more detail in section D2.7. Proposed runway operating modes for the NPR are discussed in Chapter D5 and D10.

2.6 Air Traffic Control Procedures for Brisbane Airport

ATC procedures are the specific operating procedures or rules that apply to each flight. These rules differ for differing operational circumstances, which include weather, time of the day, the number of aircraft presenting for arrival or departure (also known as 'traffic demand') and pilot capability or familiarity with local conditions.

Each airport in Australia has a set of air traffic control procedures which pertain to its operations. These are contained in AsA publications which are kept updated with copies available in every aircraft cockpit that flies in Australia. These include the following:

- SIDS and STARS – refer to Chapter D3 for existing and proposed flight paths for Brisbane;
- Weather criteria for visual and instrument landings;
- Nominating duty runways;
- Separation of arriving and departing aircraft; and
- Noise abatement procedures.

Procedures specific to Brisbane Airport are discussed in the following sections.

2.6.1 Weather Criteria for Visual or Instrument Landings

The weather criteria, currently used at Brisbane Airport, which determine whether an Instrument or Visual Approach will be prescribed, are as follows:

- Where the majority of cloud cover is below 2,500 ft above ground level and the visibility is 5,000 m or less – an Instrument Approach will be nominated on the computerised automatic terminal information service (CATIS); or
- Where the majority of cloud cover is above 2,500 ft above ground level and the visibility is 5,000 m or more – a Visual Approach may be nominated.

2.6.2 Nominating Duty Runways

The duty runway refers to the operating direction of the runway. For example, on the main runway when landings are from the south over Brisbane and departures are to the north over Moreton Bay the duty runway is runway 01. In nominating a duty runway or runways there are specific weather, operational and noise abatement provisions that must be adhered to. **Figure 2.6a** is an extract from Airservices Australia's Aeronautical Information Publication (AIP), AIP ENR 1.1.4.5, which details certain conditions that must be considered in nominating a runway or set of runways for operations at an airport in Australia.

Figure 2.6a: *Extracts of Section 4.5 of AsA AIP ENR 1.1.4.5.*

4.5 Nomination of Runways

ATC will nominate the runway, preferred runway or take-off direction. Where noise abatement procedures are in force, the provisions of DAP NAP must be applied. ATC will not nominate a particular runway for use if an alternative runway is available, when:

a. for runways that are completely dry:
   (1) the crosswind component, including gusts, exceeds 20KT;
   (2) the downwind component, including gusts, exceeds 5KT.

b. for runways that are not completely dry:
   (1) the crosswind component, including gusts, exceeds 20KT;
   (2) there is a downwind component.

Note: Notwithstanding the limitations detailed above, location specific crosswind/downwind limitations may be detailed in AIP DAP East/West NAP

Note: DAP is Departure and Approach Procedures and NAP is Noise Abatement Procedures.

2.6.3 Sequencing of Arriving Aircraft

Different aircraft, depending on their size and weight, require different distances between each other to allow for wake turbulence effects from departing or arriving aircraft. The capacity of the runway system is determined by the sequencing rates for the arriving and departing aircraft. The minimum time separation for sequencing (spacing) of arriving aircraft is shown in **Table 2.6a**. The table indicates how capacity is reduced as a result of bad weather conditions and poor visibility.

Departing aircraft are typically dispatched between the arriving aircraft, where they are held short of the runway on the taxiway until the last arriving aircraft has landed and cleared the runway.

When there is one departure immediately after another, the second aircraft is given clearance to take-off once the preceding aircraft has reached 600 ft altitude and/or commenced a turn. This separation may increase in the case of smaller aircraft following larger aircraft due to wake turbulence.

The 2.5 minute minimum separation for visual and Instrument Meteorological Conditions (IMC) approaches equates to a maximum of 25 arrivals per hour, whereas the 5 minute minimum separation for low visibility operations equates to a maximum of 13 arrivals per hour. This illustrates that low visibility conditions significantly reduce the airport capacity.

2.6.4 Noise Abatement Procedures (NAP)

The Noise Abatement Procedures (NAP) incorporated into air traffic management for Brisbane Airport have essentially tried to direct as much air traffic departing or landing at Brisbane Airport over water or to reduce as far as possible in the noise sensitive part of the flight, air traffic over other areas of Brisbane. The NAPs indicate:

- The preferred runways to be used for take-offs and landings; and
- The preferred flight paths for arriving and departing aircraft.

At Brisbane Airport the current DAP 107 Aerodrome & Procedure Charts designate specific NAP for some approaches and departures, which stipulate either preferred runways and/or preferred flight paths. These procedures can be found at: http://www.airservicesaustralia.com/publications/current/dap/AeroProcChartsTOC.htm#B

Preferred Runways

The preferred runways, as detailed in the NAPs for Brisbane, provide for landings and take-offs to be over Moreton Bay, (that is landings on runway 19 and take-offs from runway 01), whenever possible. Currently, this 'nose-to-nose' mode of operation (known technically as 'reciprocal operations') is utilised predominantly at night when, typically,

Table 2.6a: Minimum Current ATC Time Separation for Sequencing of Arrivals.

Condition	Minutes
Visual Meteorological Conditions (VMC) – Visual Approaches.	2.5
Instrument Meteorological Conditions (IMC) - Instrument approach due to the amount of cloud cover or height AGL then a Visual Approach.	2.5
IMC - full Instrument Landing System (ILS) conditions where the visual criteria for visual flight cannot be met.	3.0
Low visibility operations – where the visibility is less than 1,200 metres.	5.0

meteorological and demand conditions suit its application. Over recent years this has resulted in about 90 percent of all operations at night (between the hours of 10pm and 6am) being directed over Moreton Bay.

Unfortunately, nose-to-nose operations become unsustainable in all but light traffic demand circumstances due to the long intervals required to ensure safe aircraft separation standards. So when nose-to-nose operations are not sustainable due to traffic demand or weather conditions, preference is given to 01 direction operations. This means departures occur over Moreton Bay and arrivals over Brisbane.

Preferred Flight Paths

NAPs for Brisbane also specify preferred flight paths which facilitate maximum use of over-water tracks for the noise sensitive parts of the flight (i.e. take-offs and landings below 3,000 ft). They also specify additional requirements for minimum altitudes (3,000 ft by day and 5,000 ft by night for jets) for those portions of flights that must be carried out over land. In cases where it is not possible to avoid take-off or final approach over land, procedures are specified to minimise noise effects.

Climb and Descent Procedures

Aircraft climb and descent profiles have a bearing on noise levels on the ground. As a general rule, the higher the aircraft climbs, the lower the noise impact at ground level. Aircraft height on climb can vary considerably as it can be affected by a number of factors including:

- Aircraft weight (which can fluctuate with passenger, cargo and fuel loads);
- Air pressure, density and temperature;
- Wind speed and direction;
- Aircraft performance and configuration;
- Aircraft speed and bank angle of turns; and
- Climb gradient specified in the SID being flown (climb gradient is specified to achieve obstacle clearance).

In addition to affecting climb rate these factors may also affect the point on the runway where the aircraft actually takes-off and therefore affect the height of the aircraft at a given point. At Brisbane, climb procedures are stipulated as part of the NAPs when departures from the main runway occur over land (i.e. take-offs from runway 19). Climb procedures refer to different combinations of power/thrust settings and flap retraction at specific heights to minimise noise exposure on the ground.

In the later stages of descent and on final approach to land at Brisbane Airport, aircraft generally maintain the worldwide standard constant descent rate of three degrees to the horizontal. This means that the height of the aircraft on approach will be fairly consistent over a given point. As a rough guide, an aircraft on a three degree descent profile will be about 50 m high for every 1,000 m it is from touchdown.

Flight management coordination of aircraft flying from other nearby airports or helicopters staging from hospital, rescue or other bases also has an effect on flight path management for Brisbane Airport in certain circumstances.

2.6.5 Approach Requirements

At Brisbane Airport the AIP may specifically designate types of approaches to be carried out by certain types of aircraft. As an example, an extract from the AIP is reproduced in **Figure 2.6b** for certain approach requirements.

Figure 2.6b: *Extracts of Section 11.5 of AsA AIP ENR 1.1.4.5.*

11.5.2 In addition to the requirements of para 11.5.1, with the exception of Australian and New Zealand operators and aircraft conducting independent visual approaches at Sydney, HEAVY jet aircraft will only be assigned a visual approach when:

a. specifically requested by the pilot, and the pilot has reported the landing runway in sight; or
b. the straight-in approach aid is unserviceable.

11.5.3 In the case of sub-para 11.5.2b. above, the aircraft will be:

a. radar vectored to intercept final no closer than 8NM from the runway threshold, at an altitude not less than 2,500FT Above Aerodrome Level (AAL); and
b. assigned a straight-in visual approach when:
(1) established on final or on a heading to intercept final course at an angle of not more than 30 degrees; and
(2) visual glideslope guidance (VASIS/PAPI) is available; and
(3) the pilot has reported the landing runway in sight.

Note 1: HEAVY jet aircraft are classified as wide body international aircraft.
Note 2: VASIS and PAPI are navigational aids.

2.7 Runway Modes of Operation

2.7.1 Current Operating Modes

Currently Brisbane Airport operates mainly in one of the three modes described below and shown in **Figure 2.7a**. The mode used is dependent on weather conditions on any given day. They are:

- '01' mode, in which jet aircraft arrive from the south and depart to the north on the main runway, with a very small number of operations, generally by light aircraft, on the cross runway in the north-westerly ('32') direction;
- '19' mode, in which jet aircraft arrive from the north and depart to the south on the main runway, with a significant number of operations, generally by light aircraft, on the cross runway in the south-easterly ('14') direction; and
- 'Reciprocal' mode, in which all jet aircraft depart to the north and arrive from the north on the main runway, with some non-jet movements on the cross runway – that is, all operations occur over Moreton Bay.

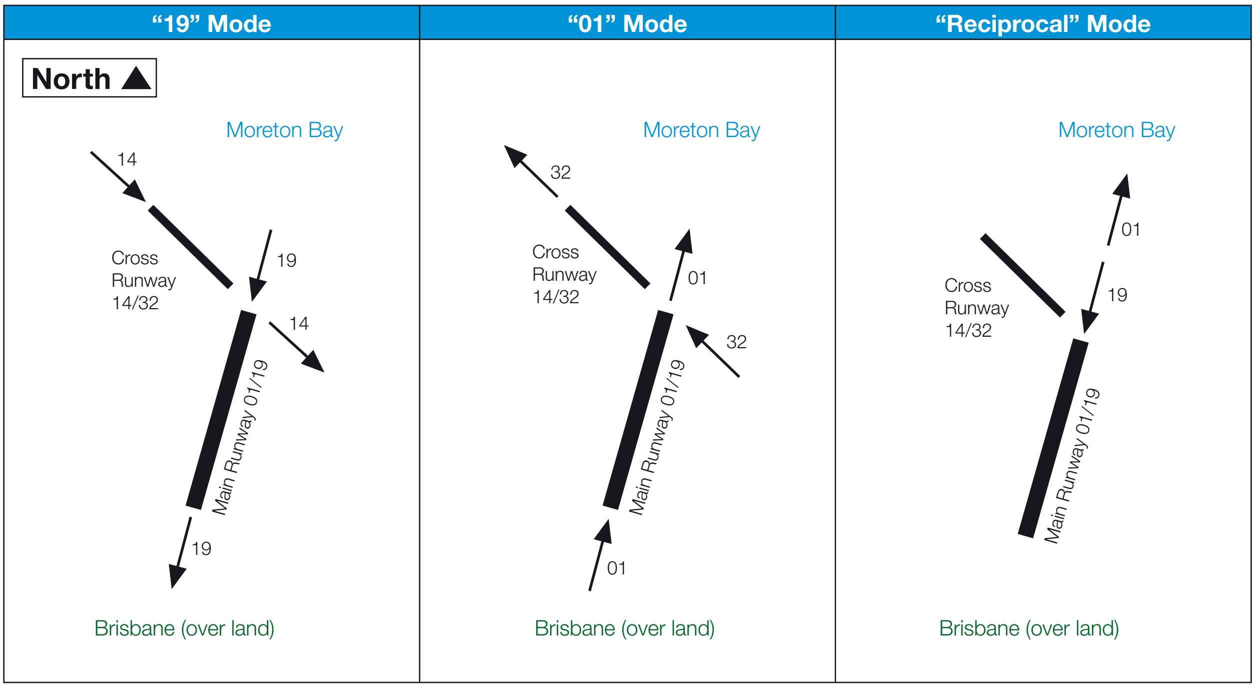
2.7.2 Mode Capacity

Each mode is available only under certain weather conditions, and has a capacity limit related to the number of presenting arrivals and departures in a given time period. For '01' and '19' modes, the meteorological restrictions are:

- With a dry runway, all aircraft operations are restricted to a maximum downwind component of 5 knots, and a maximum crosswind component of 20 knots; and
- With a wet runway, no downwind component is allowed, and a maximum crosswind component of 20 knots.

The uppermost capacity limit for these modes for a single peak hour is estimated at 59 total movements. This capacity of 59 movements per hour is based on advice from Airservices Australia for optimised operations to maximise rates of arrivals and departures, however, it is not sustainable for more than the one hour. Volume A, Chapter A2 provides further details on the current runway capacity.

Figure 2.7a: *Existing Runway System and Modes.*



The capacity limit of 59 movements per hour is higher than the current number of presenting aircraft operations in any time period for Brisbane Airport. That is, each mode can, in principle, be used at any time, provided they are allowed by meteorological conditions.

The 'Reciprocal' mode is a low capacity 'nose-to-nose' mode only used for noise abatement at night between the hours of 10.00pm and 6.00am. This means aircraft can land from the north and take off to the north over Moreton Bay. This mode can be used when:

- The downwind component of the wind is less than 10 knots (~18 km/hr);
- The runway is dry; and
- The total number of aircraft movements is less than 12 per hour.

The nose-to-nose operation means the sequencing of each arrival or departure movement is dependent on the successful completion of the previous departure or arrival movement and vice versa, which significantly reduces the runway capacity for this mode. When the weather conditions or traffic numbers preclude the use of this mode, the airport will switch to either the '01' or '19' mode for jet aircraft but non-jet aircraft will use runway 14 or runway 32 as the next preference.

Currently at Brisbane Airport during the day and evening periods, jet movements are split equally over Moreton Bay and over the Brisbane city and suburbs, with approximately 50 percent each way. About 10 percent to 15 percent of total movements occur on runway 14/32, and nearly all of these movements are smaller non-jet aircraft.

However, at night typically 80 percent (summer) to 90 percent (winter) of the total movements arrive or depart over Moreton Bay, with a corresponding reduction of movements over the city and suburbs. This is a result of the low number of aircraft movements (typically less than eight movements per hour) at night combined with Brisbane's favourable weather, which allows the use of the preferred 'Reciprocal' runway operating mode as described above.

Movements at Brisbane Airport since July 2000 have been reported quarterly by Airservices Australia and can be found on the Airservices website at http://www.airservices.gov.au/reports/nfpms/nfpmsbrisbane.asp

2.7.3 Rules for Mode Selection – 'Active' versus 'Passive'

At all times, where more than one of the above operating modes is available on the basis of both meteorological and capacity constraints, the mode to be used is selected in the following order of preference:

1. 'Reciprocal' (10pm to 6am only);
2. '01' mode; and
3. '19' mode.

During the day period, the current procedure for changing modes at Brisbane is best described as 'passive'. That is, if the Airport is currently operating in '19' mode and '01' mode becomes available, a change to '01' mode is not necessarily implemented immediately. In general, a change to a higher-priority mode is implemented only if the current mode becomes unavailable, or will clearly become unavailable in a short time. A change of operating mode is implemented by ATC and the time it takes to implement is dependent on the volume of air traffic at the time.

In the night period, on the other hand, a change to 'Reciprocal' mode is implemented on an 'active' basis. If '01' or '19' mode is currently being used, and 'Reciprocal' mode becomes available, then a change to 'Reciprocal' mode is implemented as soon as possible.

2.8 Noise Descriptors

There are a number of different ways to describe aircraft noise, each being useful for a different purpose. The most important are described in the following sections.

2.8.1 ANEF and ANEC Contours

ANEF (Australian Noise Exposure Forecast) Contours

Due to the legislative requirement for all regulated airports in Australia to produce an ANEF and local planning agencies reliance on ANEF contours to be used in planning decisions, it is the most commonly used descriptor in Australia. ANEF contours are produced using computer modelling techniques adapted for Australian conditions from the US Federal Aviation Administration Integrated Noise Model (INM). The ANEF was designed to be used as a land use planning tool to assist town planning agencies in stopping noise sensitive land uses such as residential housing, schools and nursing homes encroaching too close to airports. ANEF is a computer generated forecast based on:

- The expected aircraft movement numbers;
- The types of aircraft;
- The daily distribution by time period of arrivals and departures; and
- The configuration of the runways.

The ANEF contours do not refer to normal decibel levels but are the result of 'averaged annual day' data inputs. ANEF contours also incorporate noise frequencies the human ear finds most annoying in addition to the actual noise emitted from aircraft which is termed the effective perceived noise level in decibels (EPNdB). ANEF contours also consider the cumulative nature of noise exposure in addition to weighting night time operations to incorporate people's increased sensitivity to noise at night.

The ANEF unit was developed on the basis of social survey data, and is relatively well correlated with the proportion of people who would describe themselves as 'seriously affected' by the noise. However, its definition is complex, and as a single-number index it does not provide the level of information to adequately describe noise impacts. In addition, it is not used outside Australia, and is therefore not generally used in describing the findings of overseas research, such as that described in the Health Impact Assessment in Chapter D7.

An 'ANEF chart' is a set of land use planning contours for a specific airport that has been formally endorsed for technical accuracy by Airservices Australia, after a period of public consultation. The production of an ANEF chart for all major airports is a requirement of the *Airports Act 1996*. Contours which are calculated using the same methods, but which have not been formally endorsed, are known as Australian Noise Exposure Concept (ANEC) contours.

A detailed technical explanation of the ANEF is contained in the Airservices Australia publication "The Australian Noise Exposure Forecast System and Associated Land Use Compatibility Advice for Areas in the Vicinity of Airports" (2002), in addition to an explanation in Appendix A of the Australian Standard AS2021–2000.

Australian Standard 2021 provides guidance on the acceptability of various areas for certain types of development, in terms of the ANEF level in the area. For example, residential development is considered 'acceptable' in areas with ANEF lower than 20, 'conditionally acceptable' in areas with ANEF between 20 and 25, and 'unacceptable' in areas with ANEF greater than 25. In 'conditionally acceptable' areas the Standard recommends that new buildings should incorporate acoustic treatment to achieve specified internal noise levels. **Table 2.8** details the types of buildings (as established by AS2021-2000) considered acceptable to be located within different ANEF zones.

ANEC (Australian Noise Exposure Concept) Contours

ANEC contours for various future airport options are presented in this report largely because the final ANEF contours will have an impact on future land use planning around the airport, and hence represent a particular form of noise impact. The relationship between ANEF values and proportion of people 'seriously affected' by the noise, as shown in **Figure 2.8a** is nevertheless instructive.

2.8.2 N70 Contours

Over the last ten years, a system of describing aircraft noise has been developed by the Department of Transport and Regional Services (DOTARS) through industry and community consultation, which is oriented toward providing information in a form that can be more readily understood by the community. The information is presented in terms of a number of descriptors intended to provide sufficient detail to allow

Table 2.8: Building Land Use Compatibility Advice for Areas in the Vicinity of Airports.
(To be read in conjunction with AS2021-2000: Acoustics – Aircraft noise intrusion – Building Siting and Construction).

Building Type	ANEF Zone of Site		
	Acceptable	Conditional	Unacceptable
House, home, unit, flat, caravan park	Less than 20 (Note 1)	20 to 25 (Note 2)	Greater than 25
Hotel, motel, hostel	Less than 25	25 to 30	Greater than 30
School, university	Less than 20 (Note 1)	20 to 25 (Note 2)	Greater than 25
Hospital, nursing home	Less than 20 (Note 1)	20 to 25	Greater than 25
Public Building	Less than 20 (Note 1)	20 to 30	Greater than 30
Commercial Building	Less than 25	25 to 35	Greater than 35
Light Industrial	Less than 30	30 to 40	Greater than 40
Other Industrial	Acceptable in all ANEF zones		

Note 1: The actual location of the 20 ANEF is difficult to define accurately, mainly because of variations in aircraft flight paths. Because of this, the procedures in Clause 2.3.2 of the Standard may be followed for building sites outside but near the 20 ANEF contour.

Note 2: Within the 20 to 25 ANEF, some people may find that the land is not compatible with residential or educational uses. Land use authorities may consider that the incorporation of noise control features in the construction of residences or schools is appropriate.

members of the public to more readily relate the likely impact of aircraft noise to their personal experience of aircraft noise.

This system is described in the discussion paper 'Expanding Ways to Describe and Assess Aircraft Noise' published in 2000 by DOTARS. The most commonly used noise descriptor in this system is N70, which represents the number of aircraft fly-over noise events exceeding 70 decibels (dBA) for a given time interval (e.g. per day 6am to 6pm; per night – 10pm to 6am) at a given location.

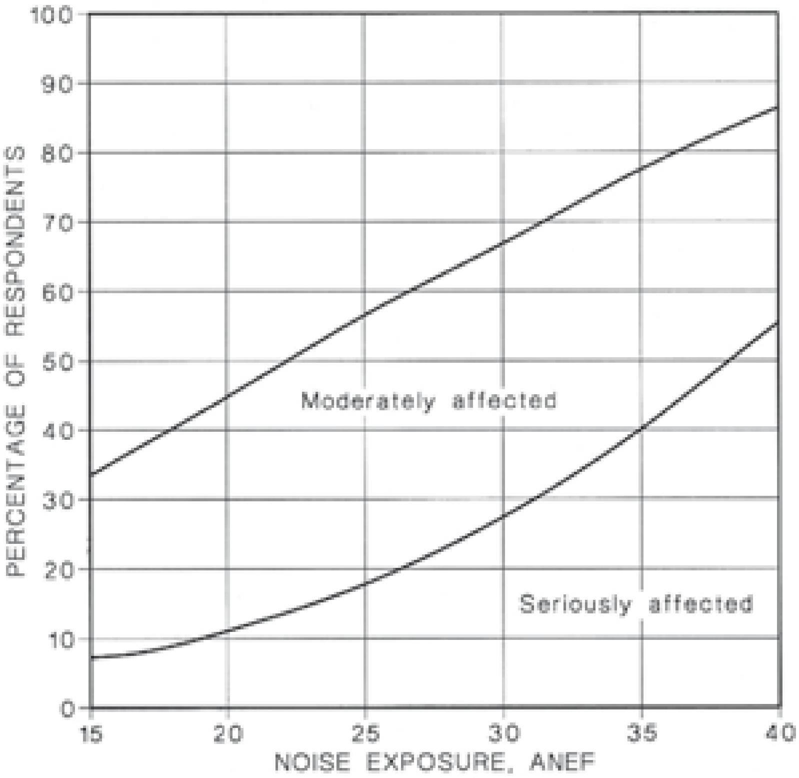
A noise level of 70dBA outside a building would generally result in an internal noise level of approximately 60dBA, if windows are open to a normal extent. This noise level is sufficient to disturb conversation, in that speakers would generally be forced to raise their voices to be understood, or some words may be missed in speech from a television or radio. If external windows are closed, such effects would typically be experienced inside when an external noise level is approximately 80dBA, whereas if the listener is outside they would be experienced at a level of approximately 60dBA.

N70 contours can be calculated for different periods, indicating the average number of events experienced per day in that period. In assessing the noise impacts of the NPR, N70 contours have been developed for 12 separate periods, representing combinations of:

- Day (6am-6pm), Evening (6pm-10pm) or Night (10pm-6am);
- Weekday or Weekend; and
- Summer (representing the 'northern hemisphere winter' airline scheduling period) or Winter (representing the 'northern hemisphere summer' period).

The 'night' period definition was selected as it corresponds with times when certain airport operating procedures, such as reciprocal operations, are possible (see section 2.7). Reported N70 values for the 'night' period are directly responsive

Figure 2.8a: *Relationship Between ANEF and Proportion of People 'Seriously Affected' by Aircraft Noise (from Australian Standard 2021).*



NOTE: This graph was derived from the National Acoustic Laboratories Report No. 88.

to changes in those procedures, and allow for comparison between different options in terms of their impact on noise in the 10pm-6am period.

N70s for the NPR are provided and described in Chapter D5.

2.8.3 Flight Path Movement Charts and Respite Charts

Another indication of the extent and nature of aircraft exposure for various scenarios can be obtained by considering diagrams that are generally termed ‘flight path movement charts’. These show numbers of operations occurring within flight corridors or ‘flight zones’ – broad areas containing a significant number of aircraft tracks.

Flight path movement charts (or ‘flight zone’ diagrams) indicate the predicted number of aircraft operations within each zone, in addition to other information, and have proved to be helpful to the public in understanding and assessing changes in airport operations and aircraft movements.

An associated measure of aircraft noise exposure is ‘respite’. This is the proportion of days or defined periods when there are no aircraft operations within a flight zone. This has been found to be a useful indicator in areas where noise exposure is highly variable, generally due to different modes of operation arising from variability in weather conditions.

All the above indicators of noise impact are included in the present report, although due to the number of scenarios and time periods involved, some indicators are presented only for the more important or relevant cases.

Flight Path Movement Charts for the NPR are provided and described in Chapter D5.

2.8.4 Single Event Contours

Whereas flight path movement charts indicate the numbers of aircraft operations over an area, but not their noise level, single-event noise contours indicate the noise level resulting from a single operation of a specific aircraft type on a specific track. They typically show contours representing the maximum noise level reached during the operation considered in dBA.

Single Event Contours for the NPR are provided and described in Chapter D5.