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DUBLIN AIRPORT NORTH RUNWAY

NOISE INFORMATION FOR THE REGULATION 598/2014 (Aircraft Noise Regulation) ASSESSMENT

Report to

daa plc
Old Central Terminal Building
Dublin Airport
Co Dublin
Ireland

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REVISION HISTORY

Revision	Details
1.0	Working Draft issued for client comment.
2.0	Draft issued for client comment.
3.0	Final version.

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1.0 INTRODUCTION

daa plc intends to apply for permission for a proposed development comprising the taking of a 'relevant action' only within the meaning of Section 34C of the Planning and Development Act 2000, as amended, at Dublin Airport, Co. Dublin.

The proposed relevant action relates to the night-time use of the runway system at Dublin Airport. It involves the amendment of the operating restriction set out in condition no. 3(d) and the replacement of the operating restriction in condition no. 5 of the North Runway Planning Permission (Fingal County Council Reg. Ref. No. F04A/1755; ABP Ref. No.: PL06F.217429), as well as the introduction of new noise mitigation measures. Conditions no. 3(d) and 5 have not yet come into effect or operation, as the construction of the North Runway is ongoing.

Regulation (EU) No 598/2014[1] of the European Parliament and of the Council of 16 April 2014 (Aircraft Noise Regulation) under Article 5 requires that member states shall ensure that the Balanced Approach is adopted in respect of aircraft noise management at those airports where a noise problem has been identified.

In Ireland, The Aircraft Noise (Dublin Airport) Regulation Act of 2019 (Aircraft Noise Regulation Act of 2019; or the Act) implements the Aircraft Noise Regulation for the purpose of regulating aircraft noise related to aircraft movements at Dublin Airport. The Act established the Aircraft Noise Competent Authority (ANCA) as a separate unit with Fingal County Council. To that end, the Act requires that ANCA determine if a noise problem exists at Dublin Airport. If this is the case they shall ensure that a Noise Abatement Objective (NAO) for the airport is defined. This then allows the measures available to reduce the noise impact to be identified with reference to achieving the NAO, and the likely cost-effectiveness of the noise mitigation measures to be thoroughly evaluated through the use of Cost Effectiveness Analysis (CEA).

At this time ANCA have not determined whether a noise problem exists at Dublin Airport and therefore, at present, a NAO has not been defined. In order to provide the necessary supporting documentation to allow ANCA to carry out their assessment, daa have developed a candidate NAO (cNAO) to provide a basis for assessment of the proposed aircraft noise mitigation measures being proposed as part of this application and to allow it to carry out a CEA.

Under the Aircraft Noise Regulation Act of 2019, a CEA is required when assessing multiple noise reduction measures. Effectiveness is based on the degree of noise exposure reduction that a

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[1] REGULATION (EU) No 598/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Union airports within a Balanced Approach and repealing Directive 2002/30/EC https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014R0598

measure can provide compared to a baseline noise exposure level. Cost-effectiveness is determined by dividing the cost to implement the measure by the change in baseline noise exposure levels resulting from the measure.

This report contains the noise information, and the details of its derivation, that has been used in the Cost Effectiveness Assessment (CEA) undertaken by RICONDO. Section 2.0 details the operating restrictions and noise controls currently in place at Dublin Airport.

Section 3.0 discusses the candidate Noise Abatement Objective (cNAO) developed for Dublin Airport and the noise metrics considered in the CEA, with Section 4.0 detailing the scenarios that are considered.

Section 5.0 introduces the noise modelling methodology used and the population and demographics assessment methodology. The resulting information is introduced in Section 6.0.

A glossary of acoustic terminology is contained in Appendix 1.

Appendix 2 gives details on noise modelling methodology including that used in relation to population and demographics.

Appendix 3 contains the resulting noise contour plots. The numerical results are contained in a completed version of the draft template which was provided by the Aircraft Noise Competent Authority (ANCA) (Doc Ref: ANCA Reporting Template v2.0 – Completed).

2.0 DUBLIN AIRPORT OPERATING RESTRICTIONS AND NOISE CONTROLS

2.1 From Planning Permissions

The operating restrictions of direct relevance to this CEA are set out in condition no. 3(d) and condition no. 5 of the North Runway Planning Permission (Fingal County Council Reg. Ref. No. F04A/1755; ABP Ref. No.: PL06F.217429), as it is their potential amendment and removal respectively that is the subject of the 'relevant action'. These two conditions have not yet come into effect or operation as the construction of the North Runway is ongoing.

Condition 3(d) and the exceptions at the end of Condition 3 state the following:

'3(d). Runway 10L-28R shall not be used for take-off or landing between 2300 hours and 0700 hours.

except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports.'

Condition 5 states the following:

'5. *On completion of construction of the runway hereby permitted, the average number of night time aircraft movements at the airport shall not exceed 65/night (between 2300 hours and 0700 hours) when measured over the 92 day modelling period as set out in the reply to the further information request received by An Bord Pleanála on the 5th day of March, 2007.'*

Separate to the North Runway Planning Permission, condition no. 3 of the Terminal 2 Planning Permission (Fingal County Council Reg. Ref. No. F04A/1755; ABP Ref. No. PL06F.220670) and condition no. 2 of the Terminal 1 Extension Planning Permission (Fingal County Council Reg. Ref. No. F06A/1843; ABP Ref. No. PL06F.223469) provide that the combined capacity of Terminal 1 and Terminal 2 together shall not exceed 32 million passengers per annum. However, the proposed relevant action does not relate to or seek any amendment of permitted annual passenger capacity of the Terminals at Dublin Airport.

2.2 Noise Action Plan (NAP)

Under the Environmental Noise Regulations 2006 (the 'Regulations'), Statutory Instrument 140 of 2006, Fingal County Council (FCC) is the designated Action Planning Authority with responsibility for preparing a Noise Action Plan for Dublin Airport. These Regulations give effect to the European Union (EU) Directive 2002/49/EC relating to the assessment and management of environmental noise.

The current Noise Action Plan (NAP)[2] for Dublin Airport details in Section 5 the existing noise management framework at Dublin Airport. This considers the six areas listed below, the first four of which are the principal elements of the Balanced Approach which is introduced in Section 3.0:

- Reduction of Noise at Source: where the NAP notes there has been an improvement in the percentage of aircraft meeting quieter standards.
- Land use planning: which is the responsibility of FCC and in response they have been preparing a Dublin Airport Local Area Plan and associated noise zones.
- Noise abatement operating procedures: which the NAP notes include the preferential runway usage, the noise preferential routes, and the environmental noise corridors which aircraft must adhere to on arrival and departure to minimise noise impact. The

[2] Fingal County Council: Noise Action Plan for Dublin Airport 2019 – 2023: December 2018 https://maps.fingalcoco.ie/media/NAP%20Final.pdf

operation of a Continuous Decent Approach (CDA) is also noted. CDA reduces the noise experienced on the ground by reducing the overall thrust required during the initial descent and keeps aircraft at higher altitudes for longer. The NAP discussion on operating procedures, which include the rules on how aircraft should perform take-off climbs, states that Dublin Airport requires compliance with a take-off climb profile, which is based on noise abatement departure climb guidance contained in an ICAO document (Doc 8168 Vol 1).

- Operating restrictions: where the NAP states that at present, there are no operating restrictions at Dublin Airport in its current form. Although this relates to the situation prior to the completion of the North Runway when the associated Conditions no. 3(d) and 5 have not yet come into effect or operation.
- Monitoring and community engagement: where the NAP states how Fingal County Council and Dublin Airport participate in regular meetings with the Dublin Airport Environment Working Group (DAEWG), Community Liaison Group (CLG) and the Dublin Airport Stakeholders Forum (DASF). The Dublin airport community engagement programme is also introduced. This comprises newsletters and various programmes that support the local community in the form of initiatives and funds, with further information in the Noise and Flight Track Monitoring Reports which are published on the Dublin Airport website.
- Home Sound Insulation Programme (HSIP): which the NAP notes this was launched by the airport in 2017 to address the existing impact of the Airport on those most affected by aircraft noise. HSIP is voluntary to households which qualify by being located within the 2016 63dB $L_{Aeq,16hr}$ noise contour, and is broadly based on the voluntary Residential Noise Insulation Scheme required under consent for the Airport's North Runway.

Considering the existing noise situation at Dublin Airport a range of proposed actions are proposed which are envisaged to take place over the duration of the Noise Action Plan. These are detailed in Section 7 of the Noise Action Plan and include continuing to work to encourage the operation of quieter aircraft, keeping under review land use policies and monitoring encroachment, and further reporting including the enhancement of the Noise and Flight Track Monitoring system.

2.3 Competent Authority Overview

Fingal County Council is the Competent Authority for aircraft noise regulation at Dublin Airport under the Aircraft Noise (Dublin Airport) Regulation Act 2019. The Aircraft Noise Competent Authority (ANCA) was established by Fingal County Council in 2019.

ANCA prepared a report titled Aircraft Noise Mitigation at Dublin Airport[3]. This contains a section titled *Noise Management and Mitigation at Dublin Airport* which repeats many of the measures given in the NAP such as the preferential runway usage, the noise preferential routes, and Noise Abatement Departure Procedure (NADP) on how aircraft should perform take-off climbs.

2.4 ANCA Reporting Template

ANCA issued to daa a draft reporting template to be completed as part of the Relevant Action application.

The template contains information such as the scenarios considered, the associated noise information, and the management measures in place under each of them.

These are separated out under the headings of reduction of noise at source, land-use planning and management, noise abatement operating procedures, operating restrictions, and financial instruments. The first four of these are the first four principal elements of the NAP noise management framework.

For most of the scenarios the entries summarise the current measures, with the exception of the preferential runway usage which varies as described in Section 4.0, and the extent of the noise insulation programmes.

The completed reporting template has the document reference: ANCA Reporting Template v2.0 – Completed.

3.0 NOISE ELEMENT OF COST EFFECTIVENESS ASSESSMENT

3.1 NOISE ABATEMENT OBJECTIVE FOR DUBLIN AIRPORT

As detailed in the ANCA report titled Aircraft Noise Mitigation at Dublin Airport, the Balanced Approach to aircraft noise management is an internationally agreed approach to managing noise at large airports. Noise reduction is explored through four principal elements with the objective to address noise problems in the most cost-effective manner, and only apply operating restrictions as a last resort measure.

[3] Aircraft Noise Competent Authority: Aircraft Noise Mitigation at Dublin Airport: Overview of Current Systems and Practices: September 2020 https://www.fingal.ie/sites/default/files/2020-08/an_overview_of_aircraft_noise_mitigation_at_dublin_airport_2020.pdf

The Balanced Approach to Aircraft Noise Management

The Balanced Approach to aircraft noise management was developed by the International Civil Aviation Organisation (ICAO). It is an internationally agreed approach to managing noise at large airports. It consists of identifying whether a noise problem exists at an airport and then analysing the various measures available to reduce noise.

Noise reduction is explored through four principal elements, namely, reduction at source, land use planning and management, noise abatement operational procedures and operating restrictions.

The objective is to address noise problems in the most cost-effective manner.

The reduction of noise at source relies on the development and uptake of progressively quieter aircraft. Advances in aircraft design have resulted in the introduction of quieter aircraft. However, providing incentives for airlines and airports to bring forward quieter aircraft types is also an important factor to encourage uptake and reduce noise at airports.

Non-operational noise mitigation measures relate to land-use planning and management. This can include measures such as zoning and noise insulation schemes.

A noise abatement operational procedure is a measure that limits or improves the noise climate at an airport without restricting aircraft access. An operating restriction is a noise-related action that limits access to or reduces the operational capacity of an airport. Operating restrictions are only to be applied as a last resort measure.

Regulation (EU) No 598/2014 under Article 5 requires that member states shall ensure that the Balanced Approach is adopted in respect of aircraft noise management at those airports where a noise problem has been identified. To that end, they shall ensure that the Noise Abatement Objective (NAO) for that airport is defined. This then allows the measures available to reduce the noise impact to be identified, and the likely cost-effectiveness of the noise mitigation measures to be thoroughly evaluated.

At this time ANCA have not determined whether a noise problem exists at Dublin Airport and therefore, at present, a NAO has not been defined. If one is to be set in due course by the Aircraft Noise Competent Authority (ANCA) it is likely to contain a summary objective and details of how the NAO will be measured. For the purposes of this application a candidate NAO (cNAO) was developed which has the following summary objective “To limit and reduce the adverse effects of long-term exposure to aircraft noise, including health and quality of life, so that long-term noise exposure, particularly at night, does not exceed the situation in 2018. This should be achieved through the application of the Balanced Approach”. The reason that 2018 was chosen as the baseline year is that the Noise Action Plan and Local Area Plan for Dublin Airport suggest that a noise problem at night might be emerging in the period up to 2018.

This cNAO relates to the adverse effects of aircraft noise rather than simply the amount of noise, meaning that the distribution of noise over areas with lower populations is likely to be considered beneficial even if the amount of noise is the same or potentially greater.

It also highlights the particular importance of the situation at night. This is consistent with people's extra sensitivity to noise during the evening and night, and the nature of the application being considered which seeks to change the controls on activity at night.

The criterion is for the effects to not exceed a baseline, which could be a past or future year. Several options are available, the first being the recent activity at the airport, for example the 2018 situation or the 2019 situation. Another option is the situation that was consented when the North Runway was given permission.

There is also reference in the cNAO to the Balanced Approach, as summarised above, and so this has influenced the scenarios that are considered by the CEA and are set out in Section 4.0.

For the purposes of the CEA undertaken to date the project team and daa has developed a NAO based on the above summary objective, with the baseline taken as the 2018 Situation, although corresponding noise information on the 2019 Situation has also been prepared. This has been considered in terms of the air noise from the airport, the noise from airborne aircraft and aircraft on the runways, which is the main source of noise from the airport and is the source that has been modelled in response to the requirements of EU Directive 2002/49/EC[4].

3.2 Measurement of the NAO

Regulation (EU) No 598/2014 under Annex 1 requires that air traffic noise impact will be described, at least, in terms of noise indicators L_{den} and L_{night} which are defined and calculated in accordance with Annex I to Directive 2002/49/EC. The CEA undertaken has used the parameters of L_{den} and L_{night} so defined.

Three additional noise indicators have also been computed, these are L_{day} and $L_{evening}$ which are defined in Directive 2002/49/EC, and their combination which is the $L_{Aeq\ 16hr}$ for an annual period. While these all have an objective basis, and so could be used in CEA according to Regulation (EU) No 598/2014, they do not have corresponding information relating to their effects, and so are just for information.

The consideration of effects has involved the determination of the number of people 'highly sleep disturbed' and 'highly annoyed'. The latter has been done in accordance with the

[4] DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 June 2002 relating to the assessment and management of environmental noise https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0049&from=EN

approach recommended by the World Health Organisation Environmental Guidelines 2018 (WHO 2018)[5] as endorsed by the European Commission through Directive 2002/367[6], and has taken into account the noise exposure from 45 dB L_{den} and 40 dB L_{night} as appropriate. It is aircraft noise above these levels that WHO 2018 states are associated with adverse health effects.

Also determined are the number of people exposed to given noise levels. These comprise:

- 55 dB L_{den} where WHO 2018 reports evidence of an effect on reading skills and oral comprehension in children,
- 65 dB L_{den} at which WHO 2018 reports an association between those exposed and those considering themselves highly annoyed of 45.5 %. Such a noise level is also comparable with the level of 63 dB $L_{Aeq,16h}$ widely used in the UK for eligibility for acoustic insulation, following Government guidance, and is also used for eligibility at Dublin under the North Runway Permission,
- 50 dB L_{night} which is described as the desirable level in the Noise Action Plan for Dublin Airport 2019 – 2023[7],
- 55 dB L_{night} which the WHO Night Noise Guidelines 2009 (NNG 2009)[8] described as the threshold at which "Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed".

Given the nature of the development being considered, the results found greater changes for the L_{night} parameter and the number of people highly sleep disturbed, so these became the primary focus.

3.3 Significant Effects under the Scenarios

In addition to considering the overall effect, consideration has also been given to the significance of the change under the various options considered from the baseline. This

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[5] World Health Organisation Regional Office for Europe ENVIRONMENTAL NOISE GUIDELINES for the European Region 2018 https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/environmental-noise-guidelines-for-the-european-region-2018

[6] COMMISSION DIRECTIVE (EU) 2020/367 of 4 March 2020 amending Annex III to Directive 2002/49/EC of the European Parliament and of the Council as regards the establishment of assessment methods for harmful effects of environmental noise https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020L0367&from=EN

[7] Fingal County Council Noise Action Plan for Dublin Airport 2019 - 2023 - December 2018 https://www.fingal.ie/sites/default/files/2019-04/NAP%20Final.pdf

[8] World Health Organisation Europe NIGHT NOISE GUIDELINES FOR EUROPE - 2009 https://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

considers both the resulting noise levels and the changes in noise levels. A consequence of this approach is that it puts emphasis on those newly affected, as they will experience the greatest changes, when considering the overall number significantly adversely affected.

The consideration of significant effects follows the approach of the technical chapter in the Environmental Impact Assessment Report (EIAR) also being prepared for the application. There the classification and significance of effects is evaluated with reference to definitive standards, accepted criteria and legislation where available. This is supplemented by professional opinion and professional judgement.

The EPA Draft Guidelines[9] advises that adherence to a systematic method of description can be of considerable assistance and includes in a Table 3.3 relevant terms that can be used to consistently describe specific effects. In terms of describing the significance of effects the terms range from imperceptible to profound, and they have been used here.

For the L_{den} and L_{night} noise indicators the significance of effect has been determined by separately rating both the absolute noise levels and the change in noise level as set out below. The individual ratings are then combined to determine the significance of any effects.

The absolute noise values and associated impact criteria for residential receptors that have been developed are given in Table 1. They commence with a negligible band which applies to noise levels that lie below a low threshold, specifically 45 dB L_{den} and 40 dB L_{night}, as WHO 2018 states that aircraft noise above these levels is associated with adverse health effects. The subsequent bands are defined by values that are required to be reported under Directive 2002/49/EC.

Taking L_{den}, the value of 55 dB is where WHO 2018 reports evidence of an effect on reading skills and oral comprehension in children. This value is also comparable to the level of 54 dB $L_{Aeq,16h}$ which is now used in the UK as marking the approximate onset of significant community annoyance. The value of 55 dB L_{den} has therefore been assigned to medium impact, as it relates to the start of these effects.

Taking the value of 65 dB L_{den}, this is where WHO 2018 reports an association between those exposed and those considering themselves highly annoyed of 45.5 %. Such a noise level is also comparable with the level of 63 dB $L_{Aeq,16h}$ widely used in the UK for eligibility for acoustic insulation, following Government guidance, and is also used for eligibility at Dublin under the North Runway Permission. The value of 65 dB L_{den} has therefore been assigned to the start of a high impact.

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[9] Environmental Protection Agency GUIDELINES ON THE INFORMATION TO BE CONTAINED IN ENVIRONMENTAL IMPACT ASSESSMENT REPORTS DRAFT AUGUST 2017 https://www.epa.ie/pubs/advice/ea/EPA%20EIAR%20Guidelines.pdf

For the night period the value of 45 dB L_{night} has been assigned to low impact. This follows from the approach in the UK where the Government proposed the value as the Lowest Observed Adverse Effect Level[10], and this received broad support.

As noted earlier, the level of 50 dB L_{night} is described as the desirable level in the Noise Action Plan for Dublin Airport 2019 – 2023. This value has therefore been assigned to the level above which medium impact arises.

The higher level of 55 dB L_{night} has been assigned to the level above which high impact arises. This follows from the WHO Night Noise Guidelines 2009 (NNG 2009) which describe it as the threshold at which "Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed". The noise level is also comparable with the level of 55 dB $L_{Aeq,8h}$ commonly used at airports in the UK for eligibility for sound insulation schemes.

Table 1: Noise Impact Criteria (absolute) – residential

Scale Description	Annual dB L_{den}	Annual dB L_{night}
Negligible	<45	<40
Very Low	45 – 49.9	40 – 44.9
Low	50 – 54.9	45 – 49.9
Medium	55 – 64.9	50 – 54.9
High	65 – 69.9	55 – 59.9
Very High	≥70	≥60

The scale to be used to assess the change in noise level is given in Table 2. The thresholds are derived from the difference contour bands recommended in CAP1616a[11]. A semantic scale of this type, following the format of examples given in the Institute of Environmental Management and Assessment guidelines, has been applied in previous air noise assessments and accepted in Public Inquiries for airport developments in the UK and Ireland, for example the application for

[10] DfT Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace – October 2017
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918784/consultation-response-on-uk-airspace-policy-web.pdf
[11] UK Civil Aviation Authority Airspace Change: Environmental requirements technical annex CAP 1616a
https://publicapps.caa.co.uk/docs/33/CAP1616A%20Environmental%20requirements%20technical%20annex%20second%20edition.pdf

the North Runway at Dublin Airport. The same approach was followed in the Heathrow 3rd Runway Preliminary Environmental Impact Report (PEIR)[12].

Table 2: Noise Impact Criteria (relative)

Scale Description	Change in noise level, dB(A)
Negligible	0 – 0.9
Very Low	1 – 1-9
Low	2 – 2.9
Medium	3 – 5.9
High	6 – 8.9
Very High	≥9

The effect of a change in noise level tends to increase with the absolute level of noise experienced at a receptor. If, for example, the night-time noise level at a dwelling were to change from 45 dB to 50 dB L_{night}, the overall effect for the occupants would be less than if the night-time noise level were to increase by the same amount from 55 dB to 60 dB L_{night}.

There is no clearly accepted method of how to rate the magnitude of the effect of a change in the absolute air noise level and the associated change in noise level. Some guidance however has been provided in the UK's National Planning Practice Guidance (NPPG) which states:

"In cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise may result in a significant adverse effect occurring even though little or no change in behaviour would be likely to occur."

The magnitude of an effect from changing between one scenario and another (e.g. baseline to future with the Relevant Action) has been established by considering both the absolute noise level in the higher of the two scenarios and the relative change in noise level that occurs at a given receptor.

Table 3 shows how the absolute and relative impacts are interpreted into magnitude of effect. This considers the criteria presented above, other guidance and professional judgement. The effect rating scale is taken from the EPA Draft EIAR Guidelines.

[12] Heathrow Expansion PRELIMINARY ENVIRONMENTAL INFORMATION REPORT Volume 1, Chapter 17 Noise and vibration https://assets.heathrowconsultation.com/wp-content/uploads/sites/5/2019/06/19-Volume-1-PEIR-Chapter-17-Noise-and-vibration.pdf

Table 3: **Summary of magnitude of effect – noise**

Absolute Noise Level Rating	*Change in Noise Level Rating*					
	Negligible	*Very Low*	*Low*	*Medium*	*High*	*Very High*
Negligible	Imperceptible	Imperceptible	Imperceptible	Not Significant	Slight	Moderate
Very Low	Imperceptible	Imperceptible	Not Significant	Slight	Moderate	Significant
Low	Imperceptible	Not Significant	Slight	Moderate	Significant	Significant
Medium	Not Significant	Slight	Moderate	Significant	Significant	Very Significant
High	Slight	Moderate	Significant	Significant	Very Significant	Profound
Very High	Moderate	Significant	Significant	Very Significant	Profound	Profound

A potential significant effect (adverse or beneficial) would be considered to arise if in Table 3 the magnitude of the effect was rated as significant or higher.

4.0 SCENARIOS CONSIDERED

The proposed relevant action relates to the night-time use of the runway system at Dublin Airport, both in terms of the runway(s) used, and the level of activity. These coupled with the requirements of the Balanced Approach, which are to explore noise reduction through four principal elements with the objective to address noise problems in the most cost-effective manner, and only apply operating restrictions as a last resort measure, have led to the future scenarios considered. Specifically, the considered future scenarios differ only the measures that apply on or are due to activity at night. They also do not include additional controls or restrictions unless they appear necessary.

Under the Aircraft Noise (Dublin Airport) Regulation Act 2019 ('the Act', S.I. No. 12 of 2019) for which ANCA is the Competent Authority, ANCA has defined:

- a 'situation' to represent the historic, current and future noise conditions that would prevail in the absence of development or changes to the existing consents.
- a 'forecast without new measures' to represent the situation which would prevail as a result of development proposals but without any noise-related action. This should be representative of an unconstrained / unrestrictive operation.
- a 'forecast including additional measures' to represent the noise conditions that would arise from any development proposals inclusive of specific or combinations of noise mitigation measures.

The scenarios considered therefore include a set for 'situations' that have either occurred, those in 2018 and 2019, or will occur in the future, in 2022 and 2025, with no changes to the existing consents.

There is also a 'forecast without new measures' scenario, for 2025, which considers the situation as a result of the development proposals but without any noise-related action. This considers a future with the North Runway operating without Conditions 3(d) and 5 in place.

The final set of scenarios are for forecasts including additional measures. The initial set of these to be developed consider the situation without Condition 5 in place, as it is the most onerous of the operating restrictions, and with alternatives to Condition 3 (d). In effect this sought to see if the unconstrained forecast activity could be accommodated with the use of preferential runways while meeting the candidate Noise Abatement Objective (NAO).

The results of the analysis by Ricondo found that this cNAO could be met under several of these scenarios, with limited additional measures to those already in place, in particular additional noise insulation programmes.

While operating procedures such as continuous climb and Low Power/Low Drag approaches were considered, they were not taken forward to assessment. This is largely due to the IAA ANSP having control over the design and assessment of the airspace, which consequently influences the procedures used. So, while airspace improvements are anticipated as part of the European Airspace Modernisation Programme, because modifying procedures is not directly within the control of the daa and the forthcoming modernisation of procedures, these types of measures were not further considered.

The scenarios considered are listed in Table 4 with a description of the runway use. In this it should be noted that:

- South Runway is the existing main runway which is aligned approximately east west
- Cross runway is the existing runway aligned approximate north-west south-east
- 10R refers to movements on the South Runway heading in an easterly direction
- 28L refers to movements on the South Runway heading in a westerly direction
- 10L refers to movements on the North Runway heading in an easterly direction
- 28R refers to movements on the North Runway heading in a westerly direction

Table 4: Scenarios Considered by CEA

Scenario Type	Scenario Description	Runway Use Description
Situation	2018 Situation	South Runway preferred. Cross runway used for capacity and when wind dictates
Situation	2019 Situation	South Runway preferred. Cross runway used for capacity and when wind dictates
Situation	2022 Forecast Situation Scenario 01	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - South Runway only
Forecast including additional measures	2022 Forecast with Runway use Scenario 02	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - South Runway preferred 00:00-06:00. Otherwise as day.
Situation	2025 Forecast Situation Scenario 01	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - South Runway only
Forecast including additional measures	2025 Forecast with Runway use Scenario 02	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - South Runway preferred 00:00-06:00. Otherwise as day.
Forecast including additional measures	2025 Forecast with Runway use Scenario 03	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - same as day
Forecast including additional measures	2025 Forecast with Runway use Scenario 04	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - 10L and 28L preferred for departures, 10R and 28R preferred for arrivals (i.e. opposite to day). Cross runway only used when wind dictates
Forecast including additional measures	2025 Forecast with Runway use Scenario 05	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - alternate between Runway use Scenarios 03 and 04
Forecast without new measures	2025 Forecast without any measures Scenario 06	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - no restrictions. Departures modelled as using north or south runway depending on destination. Arrivals modelled as 50/50 split between runways unless runway capacity exceeded
Forecast including additional measures	2025 Forecast with Runway use Scenario 07	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - departures modelled as using north or south runway depending on destination. Arrivals modelled as per day unless runway capacity exceeded
Forecast including additional measures	2025 Forecast with Runway use Scenario 08	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - departures modelled as per day. Arrivals modelled as 50/50 split between runways unless runway capacity exceeded
Forecast including additional measures	2025 Forecast with Runway use Scenario 09	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - North Runway preferred 00:00-06:00. Otherwise as day.
Forecast including additional measures	2025 Forecast with Runway use Scenario 10	Day - 10R and 28R preferred for departures, 10L and 28L preferred for arrivals. Cross runway only used when wind dictates Night - alternate between Runway use Scenarios 02 and 09

For all of the future scenarios except those which are of the Situation type, the measures in place are those currently in place with the addition of a noise insulation programme with eligibility based on 55 dB L_{night}. A noise quota is also proposed for these scenarios to control the total noise at night.

5.0 NOISE MODELLING, POPULATION AND DEMOGRAPHICS ASSESSMENT METHODOLOGY

The noise modelling methodology utilises a noise model, the Federal Aviation Authority Aviation Environmental Design Tool (AEDT) version 2d SP2, which is compliant with *ECAC.CEAC Doc 29 4th Edition Report on Standard Method of Computing Noise Contours around Civil Airports* and with *EU Commission Directive 2015/996 Establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*. The model has been used with past movement data provided by daa and forecast movement information provided by Mott MacDonald.

Existing dwelling data has been acquired from GeoDirectory. An assessment of permitted but not yet built dwellings has been carried out. Population data has been estimated using the average dwelling occupancy by small area. This has been obtained for 2016 based on Census data from the Central Statistics Office. An assessment of zoned land has also been undertaken which identified a number of areas designated for residential use. For those not contained in the existing or permitted dwellings an average density of 35 dwellings per hectare and 3 people per dwelling has been assumed.

Further details of the noise modelling and population and demographics assessment methodology are contained in Appendix 2.

6.0 NOISE INFORMATION

The completed dataset for the scenarios is contained in the document reference: ANCA Reporting Template v2.0 – Completed. Figures 01 to 28 in Appendix 3 contains the noise contour plots for the L_{den} and L_{night} noise indicators. Figures 29 to 34 in Appendix 3 contains the noise contour plots for selected scenarios and show the residential land use.

Nick Williams	**David Charles**
for Bickerdike Allen Partners LLP	**Partner**

APPENDIX 1
GLOSSARY OF ACOUSTIC AND AVIATION TERMS

Sound

Sound is a form of energy that is transmitted away from its source through a medium such as air by longitudinal pressure waves. The human ear can detect the small changes in pressure associated with sound and this manifests as the sense of hearing.

The Decibel, dB

The decibel (dB) is the unit used to describe the magnitude of sound. It is a logarithmic ratio between a measured level and a reference level, typically sound pressure level against a reference pressure level of 20 µPa.

The decibel scale effectively compresses a wide range of values to a more manageable range of numbers; the threshold of hearing occurs at approximately 0 dB (corresponding to the reference value of 20 µPa) and the threshold of pain is around 120 dB (corresponding to a value of 20 Pa).

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in Watts (W). The sound power level L_w is expressed in decibels, referenced to 10-12 Watts.

Frequency, Hz

Frequency is equivalent to musical pitch. It is the rate of vibration of the air molecules that transmit the sound and is measured as the number of cycles per second or Hertz (Hz).

The human ear is sensitive to sound in the range 20 Hz to 20 kHz. This frequency range is normally divided up into discrete bands for engineering use. The most common are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is further divided into three. The bands are named by their centre frequency value.

A-weighting

The sensitivity of the human ear is frequency dependent. Mid-frequency sound tends to be perceived as louder than very low- or high-frequency sound even when the decibel values are equal. Sound levels are therefore often frequency weighted to give an overall single figure value in dB(A) that accounts for the response of the human ear at different frequencies.

Ambient Noise

Ambient noise, usually expressed using the $L_{Aeq,T}$ metric, is commonly understood to include all sound at any particular site over a defined period of time, regardless of whether the sound is actually defined as noise.

Background Noise

Background noise, usually expressed using the $L_{A90,T}$ metric, is the steady sound attributable to less prominent and mostly distant sound sources above which clearly identifiable specific noise sources intrude.

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. Sound energy is radiated out in all directions and spreads over the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, for each doubling of distance from a point source the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber, or plasterboard, they are reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. Although this reduction is limited by diffraction of the sound around the edges of the screen, it can still provide valuable noise attenuation. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land immediately beyond by around 10 dB. The best results are obtained when a screen is situated close to the source or close to the receiver.

Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradients are variable and difficult to predict.

Noise Metrics

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

$L_{Aeq,T}$

$L_{Aeq,T}$, or the equivalent continuous A-weighted sound pressure level, is the most widely used noise metric. It is an energy average and is defined as the level of a notional sound which would deliver the same A-weighted sound energy as the actual variable sound over a defined period of time, T.

$L_{Aeq,16h}$ and $L_{Aeq,8h}$ are commonly used to describe the daytime period (07:00 to 23:00) and night-time period (23:00 to 07:00) respectively. In the context of aircraft noise, these are typically averaged over the summer period (92 days from June 16th to September 15th inclusive) and are referred to as the summer day and summer night values.

L_{den}

L_{den}, or the day-evening-night noise indicator, is a long-term average (usually annual in the context of aircraft noise) 24 hour $L_{Aeq,T}$ value where a 10 dB penalty is applied to noise at night and a 5 dB penalty is applied to noise in the evening. It is defined by the following formula:

$$L_{den} = 10 \times Log\left(\frac{12}{24} \times 10^{\left(\frac{L_{day}}{10}\right)} + \frac{4}{24} \times 10^{\left(\frac{L_{eve}+5}{10}\right)} + \frac{8}{24} \times 10^{\left(\frac{L_{night}+10}{10}\right)}\right)$$

Where:

L_{day} is the A-weighted long-term average sound level for the 12 hour daytime period (07:00 to 19:00),

L_{eve} is the A-weighted long-term average sound level for the 4 hour evening period (19:00 to 23:00), and

L_{night} is the A-weighted long-term average sound level for the 8 hour night-time period (23:00 to 07:00).

Aviation Terms

ANCA

ANCA, the Aircraft Noise Competent Authority, is the body responsible for ensuring that noise generated by aircraft activity at Dublin Airport is assessed in accordance with EU and Irish legislation.

FAA

The Federal Aviation Administration (FAA) is the regulatory body for civil aviation in the United States. The FAA produces AEDT, the industry standard modelling software for aircraft noise.

AEDT

The Aviation Environmental Design Tool (AEDT) is the industry standard software for the evaluation of aircraft noise in the vicinity of airports based on aircraft type, operation, route, flight profile and terrain.

NMT

A noise monitoring terminal (NMT) is a fixed or mobile station with the appropriate instrumentation to measure aircraft noise in the vicinity of an airport on a long-term basis.

NFTMS

A noise and flight track monitoring system (NFTMS) comprises a network of NMTs that record and correlate noise data with individual flights by use of other airport logged flight telemetry, such as radar data.

Start of roll

The position on a runway where aircraft commence their take-off procedure.

Runway arrival threshold

The beginning of the portion of the runway usable for landing.

APPENDIX 2

NOISE MODELLING, POPULATION AND DEMOGRAPHICS ASSESSMENT METHODOLOGY

A2.1 DETAILED NOISE MODELLING METHODOLOGY

This section describes the modelling methodology for the air noise predictions. It firstly details the scenarios that have been considered and presents summaries of the aircraft movements. It then sets out the methodology and the assumptions used in the prediction of airborne aircraft noise levels and the production of noise contours. The methodology used to assess the number of people and dwellings within the contours in described in Section A2.2.

Scenarios Considered

The scenarios considered fall into seven groups; these are:

- 2018 Situation
- 2019 Situation
- 2022 Forecast Situation
- 2022 Forecast with Runway use
- 2025 Forecast Situation
- 2025 Forecast with Runway use
- 2025 Forecast without any measures

The 2018 Situation scenario is based on the aircraft movements which occurred during 2018. The 2019 Situation scenario is based on the aircraft movements which occurred during 2019. The Forecast Situation scenarios are based on the forecast aircraft movements with the conditions attached to the North Runway Permission, i.e. with no use of the North Runway at night and aircraft movements limited to 65/night. The Forecast with Runway use and Forecast without any measures scenarios are based on the forecast aircraft movements with the North Runway Permission conditions removed.

Due to the profound impact on the aviation industry worldwide of the Covid-19 pandemic, activity is now forecast to reach 32 mppa by 2025, so the presence of Condition 3 of the Terminal 2 Permission (which limits Dublin Airport to 32 mppa) has no effect.

Aircraft Movements

The annual day, evening and night movements and summer day and night movements are given in the tables below by aircraft type for each of these scenarios. Aircraft types with a small number of movements have been grouped under “Other”.

Table A2.1: 2018 Situation Movements

Aircraft Type	*2018 Situation Movements*				
	Annual			*92-Day Summer*	
	Day 07h-19h	*Evening 19h-23h*	*Night 23h-07h*	*Day/ 07h-23h*	*Night 23h-07h*
Airbus A306	214	337	487	130	127
Airbus A319	2,991	924	160	1,061	12
Airbus A320	41,542	10,156	6,015	14,270	2,293
Airbus A320neo	30	4	8	0	0
Airbus A321	5,596	537	948	2,023	377
Airbus A321neo	0	0	0	0	0
Airbus A330	9,519	396	2,059	3,098	584
Airbus A330neo	0	0	0	0	0
Airbus A350	135	2	105	60	45
ATR 42	2,327	272	1	672	1
ATR 72	14,142	2,432	1,098	4,626	322
BAe 146/Avro RJ	4,314	963	354	1,472	126
Boeing 737-400	254	567	611	268	151
Boeing 737-700	1,420	289	286	468	63
Boeing 737-800	55,616	17,096	10,838	19,517	3,250
Boeing 737 MAX	1,625	77	392	508	140
Boeing 757	2,702	35	879	1,084	236
Boeing 767	1,088	472	491	457	137
Boeing 777	1,508	591	973	570	285
Boeing 777X	0	0	0	0	0
Boeing 787	1,554	160	898	597	194
Bombardier CS300	484	2	0	144	0
Bombardier Dash 8	2,858	1,321	15	1,147	3
Embraer E190/195	4,737	1,669	182	1,534	95
Other	9,423	2,061	1,096	3,408	314
Total	**164,079**	**40,363**	**27,896**	**57,114**	**8,755**

Table A2.2: 2019 Situation Movements

Aircraft Type	2019 Situation Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day/ 07h-23h	Night 23h-07h
Airbus A306	162	301	377	463	377
Airbus A319	3,159	911	370	4,070	370
Airbus A320	41,840	10,109	6,796	51,949	6,796
Airbus A320neo	1,000	119	13	1,119	13
Airbus A321	5,461	907	1,086	6,368	1,086
Airbus A321neo	619	87	158	706	158
Airbus A330	8,905	40	2,031	8,945	2,031
Airbus A330neo	0	0	0	0	0
Airbus A350	214	0	220	214	220
ATR 42	14,398	2,481	1,089	16,879	1,089
ATR 72	4,280	767	207	5,047	207
BAe 146/Avro RJ	196	547	527	743	527
Boeing 737-400	1,001	298	104	1,299	104
Boeing 737-700	58,447	18,855	12,136	77,302	12,136
Boeing 737-800	251	6	103	257	103
Boeing 737 MAX	2,939	23	528	2,962	528
Boeing 757	1,845	541	693	2,386	693
Boeing 767	1,536	587	1,121	2,123	1,121
Boeing 777	0	0	0	0	0
Boeing 777X	2,576	63	947	2,639	947
Boeing 787	1,030	5	3	1,035	3
Bombardier CS300	2,355	921	6	3,276	6
Bombardier Dash 8	4,323	940	275	5,263	275
Embraer E190/195	10	0	0	10	0
Other	11,384	2,243	530	13,627	530
Total	**167,931**	**40,751**	**29,320**	**208,682**	**29,320**

Table A2.3: 2022 Forecast Situation Movements

Aircraft Type	2022 Forecast Situation Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	325	325	650	180	180
Airbus A319	3,249	975	650	1,172	180
Airbus A320	41,266	10,723	6,824	14,426	1,893
Airbus A320neo	1,625	975	0	721	0
Airbus A321	5,849	0	650	1,623	180
Airbus A321neo	650	0	0	180	0
Airbus A330	11,373	0	975	3,156	270
Airbus A330neo	0	0	0	0	0
Airbus A350	0	0	0	0	0
ATR 42	2,275	325	0	721	0
ATR 72	15,272	2,275	650	4,869	180
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	0	1,625	975	451	270
Boeing 737-700	975	325	325	361	90
Boeing 737-800	55,563	19,496	8,123	20,827	2,254
Boeing 737 MAX	650	0	0	180	0
Boeing 757	1,300	0	0	361	0
Boeing 767	0	325	325	90	90
Boeing 777	325	650	325	270	90
Boeing 777X	0	0	0	0	0
Boeing 787	3,249	0	650	902	180
Bombardier CS300	1,950	0	0	541	0
Bombardier Dash 8	1,950	650	0	721	0
Embraer E190/195	7,473	1,950	0	2,615	0
Other	4,224	1,625	0	1,623	0
Total	**159,540**	**42,241**	**21,120**	**55,989**	**5,860**

Table A2.4: 2022 Forecast with Runway use Movements

Aircraft Type	*2022 Forecast with Runway use Movements*				
	Annual			*92-Day Summer*	
	Day 07h-19h	*Evening 19h-23h*	*Night 23h-07h*	*Day 07h-23h*	*Night 23h-07h*
Airbus A306	325	0	975	90	270
Airbus A319	3,249	650	975	1,082	270
Airbus A320	41,591	11,048	9,423	14,606	2,615
Airbus A320neo	1,625	975	0	721	0
Airbus A321	5,849	0	650	1,623	180
Airbus A321neo	1,300	0	650	361	180
Airbus A330	11,697	0	1,950	3,246	541
Airbus A330neo	0	0	0	0	0
Airbus A350	0	0	0	0	0
ATR 42	2,275	325	0	721	0
ATR 72	15,272	2,275	650	4,869	180
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	0	1,625	975	451	270
Boeing 737-700	975	325	325	361	90
Boeing 737-800	53,613	19,171	10,398	20,196	2,885
Boeing 737 MAX	650	0	0	180	0
Boeing 757	1,300	0	0	361	0
Boeing 767	0	325	325	90	90
Boeing 777	0	650	650	180	180
Boeing 777X	0	0	0	0	0
Boeing 787	2,599	0	1,300	721	361
Bombardier CS300	1,950	0	0	541	0
Bombardier Dash 8	1,950	650	0	721	0
Embraer E190/195	7,148	1,950	325	2,524	90
Other	4,224	1,625	0	1,623	0
Total	**157,591**	**41,591**	**29,569**	**55,268**	**8,205**

Table A2.5: 2025 Forecast Situation Movements

Aircraft Type	2025 Forecast Situation Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	325	325	651	180	180
Airbus A319	1,952	976	651	811	180
Airbus A320	40,023	9,762	6,508	13,794	1,803
Airbus A320neo	7,484	1,952	976	2,615	270
Airbus A321	3,254	0	0	902	0
Airbus A321neo	2,278	0	325	631	90
Airbus A330	11,063	0	651	3,065	180
Airbus A330neo	0	0	0	0	0
Airbus A350	651	0	0	180	0
ATR 42	2,278	325	0	721	0
ATR 72	15,293	2,278	651	4,869	180
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	0	1,627	976	451	270
Boeing 737-700	2,929	1,302	325	1,172	90
Boeing 737-800	51,737	15,619	8,135	18,663	2,254
Boeing 737 MAX	7,809	4,555	0	3,426	0
Boeing 757	0	0	0	0	0
Boeing 767	0	325	325	90	90
Boeing 777	976	0	325	270	90
Boeing 777X	0	651	0	180	0
Boeing 787	6,508	0	651	1,803	180
Bombardier CS300	1,952	0	0	541	0
Bombardier Dash 8	1,952	651	0	721	0
Embraer E190/195	6,182	976	0	1,984	0
Other	4,230	1,627	0	1,623	0
Total	**168,878**	**42,952**	**21,150**	**58,694**	**5,860**

Table A2.6: 2025 Forecast with Runway use and Forecast without any measures Movements

Aircraft Type	2025 Forecast with Runway use and Forecast without any measures Movements				
	Annual			92-Day Summer	
	Day 07h-19h	Evening 19h-23h	Night 23h-07h	Day 07h-23h	Night 23h-07h
Airbus A306	325	0	976	90	270
Airbus A319	1,952	651	976	721	270
Airbus A320	40,349	10,087	9,111	13,975	2,524
Airbus A320neo	7,484	1,952	976	2,615	270
Airbus A321	3,254	0	0	902	0
Airbus A321neo	2,603	0	1,302	721	361
Airbus A330	11,714	0	1,302	3,246	361
Airbus A330neo	0	0	0	0	0
Airbus A350	325	0	325	90	90
ATR 42	2,278	325	0	721	0
ATR 72	15,293	2,278	651	4,869	180
BAe 146/Avro RJ	0	0	0	0	0
Boeing 737-400	0	1,627	976	451	270
Boeing 737-700	2,929	1,302	325	1,172	90
Boeing 737-800	49,785	15,293	10,413	18,032	2,885
Boeing 737 MAX	8,460	4,555	651	3,606	180
Boeing 757	0	0	0	0	0
Boeing 767	0	325	325	90	90
Boeing 777	651	0	651	180	180
Boeing 777X	0	651	0	180	0
Boeing 787	5,857	0	1,302	1,623	361
Bombardier CS300	1,952	0	0	541	0
Bombardier Dash 8	1,952	651	0	721	0
Embraer E190/195	5,857	976	325	1,893	90
Other	4,230	1,627	651	1,623	180
Total	**167,251**	**42,301**	**31,238**	**58,063**	**8,655**

Noise Modelling Software

The noise modelling utilises the Federal Aviation Authority Aviation Environmental Design Tool (AEDT) version 2d SP2, which is compliant with *ECAC.CEAC Doc 29 4th Edition Report on Standard Method of Computing Noise Contours around Civil Airports* and with *EU Commission Directive 2015/996 Establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*. This was the latest version of the software when the assessment work began.

The AEDT software evaluates aircraft noise in the vicinity of airports using flight track information, aircraft fleet mix, aircraft profiles and terrain. The AEDT software is used to produce noise exposure contours as well as predict noise levels at specific user-defined sites. For Dublin Airport the input data has comprised:

- physical details of the airport, both current and future,
- the topography of the surrounding area,
- the aircraft movements themselves,
- the routes flown by the aircraft movements,
- the procedures used by the aircraft movements,
- dwelling, population and community building data.

Study Area

The study area is based on the largest extent of likely impacts due to air noise, i.e. the lowest value noise contours assessed for each metric. The extents of the study are contained within an area that extends 53 km to the west, 49 km to the east, 32 km to the north and 20 km to the south of the centre of the existing main runway at Dublin Airport. Figure A2.1 shows the study area.

AEDT Study

The AEDT default weather settings for Dublin Airport and all-soft ground lateral attenuation have been used. The directivity effects of aircraft bank angle have been allowed for in accordance with EU Directive 2015/996.

Terrain data has been acquired for the study area. This was provided by emapsite in the form of a Digital Terrain Model dataset and has been incorporated within the noise model.

Airport Layout

The current airfield layout including runways and taxiways is shown on the AIP Ireland Aerodrome Chart[13]. This information has been used with a construction drawing for the North Runway supplied by daa to locate the Dublin Airport runways in the model.

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[13] EIDW AD 2.24-1, dated 28 March 2019, http://iaip.iaa.ie/iaip/IAIP_Frame_CD.htm

Aircraft Movements

The AEDT software includes noise information for many common aircraft types, but it does not include every aircraft type. Therefore, the actual and forecast aircraft types need to be mapped to aircraft types in the AEDT software. For most aircraft, substitutions are proposed by the AEDT software or the ANP database[14] where a similar alternative aircraft type is used to model the actual type. For larger aircraft this generally does not involve a change but for the smaller aircraft, and in particular the general aviation aircraft, some substitutions occur. Where the AEDT and ANP databases have no guidance, an aircraft type has been assigned based on the aircraft size and engine details.

This is in accordance with EU Directive 2015/996 which states that "The ANP database provided in Appendix I covers most existing aircraft types. For aircraft types or variants for which data are not currently listed, they can best be represented by data for other, normally similar, aircraft that are listed."

Helicopters and military aircraft have been excluded from this assessment as they perform less than 1% of the aircraft movements at Dublin Airport and therefore do not materially contribute to the noise contours. They have historically been excluded from aircraft noise contours produced for Dublin Airport.

This is in accordance with EU Directive 2015/996 which states "Where noise generating activities associated with airport operations do not contribute materially to the overall population exposure to aircraft noise and associated noise contours, they may be excluded. These activities include: helicopters, taxiing, engine testing and use of auxiliary power-units."

Runway Usage

The runway usage for the 2018 Situation has been obtained from the individual aircraft movement data for the relevant year. A summary of the overall runway split for the 2018 annual period is given in Table A2.7.

Table A2.7: 2018 Annual Runway Usage

Runway	Arrivals	Departures
10	23.3%	24.1%
28	72.2%	71.4%
16	3.8%	2.4%
34	0.6%	2.1%

[14] Aircraft Noise and Performance Database, https://www.aircraftnoisemodel.org

The runway usage for the 2019 Situation has been obtained from the individual aircraft movement data for the relevant year. A summary of the overall runway split for the 2019 annual period is given in Table A2.8.

Table A2.8: 2019 Annual Runway Usage

Runway	Arrivals	Departures
10	21.1%	20.8%
28	77.9%	76.7%
16	0.8%	0.3%
34	0.2%	2.2%

Once the North Runway is operational the cross runway (16/34) will continue to be used, however only for essential use (e.g. when there are strong crosswinds) as stated in Condition 4 of the North Runway Permission. Specifically, for the purposes of noise modelling the future usage of the cross runway is assumed to be 1% of aircraft movements, with the remaining 99% of movements on the two main runways. 0.75% of aircraft movements are forecast to use Runway 16 with the remaining 0.25% on Runway 34.

The modelled future runway usage over a given year is summarised in Table 13B-9 below, based on the average runway usage over the last 10 years and allowing for the expected reduction in cross runway usage.

Table 13B-9: Future Runway Usage

Runway	Arrivals	Departures
10L/10R	29%	29%
28L/28R	70%	70%
16	0.75%	0.75%
34	0.25%	0.25%

Once the North Runway is operational Dublin Airport will operate during the daytime (07:00 – 23:00) in accordance with Conditions 3a-3c per the mode of operation Option 7b, as detailed in the Environmental Impact Statement Addendum, Section 16 as received by the planning authority on the 9th day of August, 2005. This provides that:

a. “the parallel runways (10R-28L and 10L-28R) shall be used in preference to the cross runway, 16-34,

b. when winds are westerly, Runway 28L shall be preferred for arriving aircraft. Either Runway 28L or 28R shall be used for departing aircraft as determined by air traffic control,

c. when winds are easterly, either Runway 10L or 10R as determined by air traffic control shall be preferred for arriving aircraft. Runway 10R shall be preferred for departing aircraft,

   except in cases of safety, maintenance considerations, exceptional air traffic conditions, adverse weather, technical faults in air traffic control systems or declared emergencies at other airports."

In practice it is expected that, unless capacity requires mixed mode, the runways will operate in segregated mode during the daytime with arrivals using either Runway 10L or Runway 28L and departures using either Runway 10R or Runway 28R depending on wind direction.

Any movements by Code F aircraft are an exception to this, as they will always use the North Runway. It is also proposed that departures by Category A & B aircraft heading south during westerly operations will use the South Runway, and those heading north during easterly operations will use the North Runway.

A method of determining mixed mode runway usage on the main runways (North and South) for modelling purposes has been developed. The modelled runway usage has been determined on an hourly basis.

Most of the time the runways will operate in segregated mode, i.e. one runway for all arrivals, the other for all departures. However, there will be occasions during peak hours when runways will need to operate in some degree of mixed mode, i.e. both runways used simultaneously for arrivals and/or departures. The change from segregated to mixed mode and back to segregated mode will be determined by air traffic control (ATC) and once changed to a particular mode the airport is likely to operate in that mode for at least two hours.

The method assumes activity switches from segregated mode to mixed mode where activity is such that any of the three following single runway capacity limits are exceeded:

i. More than 35 arrivals in one hour.
ii. More than 44 departures in one hour.
iii. More than 48 movements (combined arrivals and departures) on one runway in one hour.

In mixed mode, where each individual runway handles both arrivals and departures, departures will operate using the compass departure principle. This means that if a departure is using a route that turns to the north then the North Runway will be used, and conversely if it is using a route that turns to the south, the South Runway will be used.

For westerly operations when in mixed mode as few arrivals as possible will use 28R, while not exceeding the single runway capacity limit of 48 combined arrivals and departures on runway 28L. For easterly operations when in mixed mode as few arrivals as possible will use 10R, while not exceeding the single runway capacity limit of 48 combined arrivals and departures on runway 10L.

When using the North Runway most aircraft will not use the full length on departure, and instead join the runway from the 1st intermediate taxiway. The exceptions are Code E and Code F aircraft, which will typically use the full runway length. All departures on the existing South Runway are assumed to use the full runway length.

During the night-time period (23:00 – 07:00) for the Forecast Situation scenarios the south runway is the permitted runway. For the 2022 Forecast with Runway use scenario the south runway was the preferred runway in the core night period (00:00-06:00). Between 23:00 and 00:00 and between 06:00-07:00 the runway usage followed the same principles as in the daytime, i.e. Option 7b.

A number of 2025 Forecast with Runway use scenarios were considered in addition to the 2025 Forecast without any measures scenario. For these a variety of uses to the runways at night were investigated.

The resulting runway usage by hour for each scenario, on a typical busy day for both easterly and westerly operations is shown in Table A2.10 and Table A2.11 respectively. For the night-time period further information is given for the 2025 Forecast with Runway use scenarios in addition to the 2025 Forecast without any measures scenario in Table A2.12 and Table A2.13.

Table A2.10: Typical Busy Day Runway Usage By Hour – Westerly Operations

Hour	2022 Forecast Situation		2022 Forecast with Runway use		2025 Forecast Situation		2025 Forecast with Runway use / Forecast without any measures	
	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)
00:00-00:59	10	0	12	0	10	0	12 in total	
01:00-01:59	4	0	5	0	4	0	6 in total	
02:00-02:59	4	0	3	0	4	0	4 in total	
03:00-03:59	1	0	1	0	1	0	1 in total	
04:00-04:59	5	0	9	0	5	0	9 in total	
05:00-05:59	6	0	8	0	6	0	8 in total	
06:00-06:59	17	0	3	30	17	0	35 in total	
07:00-07:59	37	27	11	38	42	27	15	38
08:00-08:59	26	8	23	11	27	8	24	12
09:00-09:59	19	16	18	19	23	18	22	21
10:00-10:59	23	15	24	15	23	19	24	19
11:00-11:59	21	18	20	19	22	19	21	20
12:00-12:59	24	22	23	21	24	23	23	22
13:00-13:59	15	21	18	22	17	22	20	23
14:00-14:59	27	19	24	22	27	24	24	27
15:00-15:59	11	16	13	18	11	17	13	20
16:00-16:59	24	23	23	23	24	23	23	23
17:00-17:59	17	22	20	19	17	22	20	19
18:00-18:59	24	16	22	19	24	16	22	19
19:00-19:59	18	23	18	25	19	23	19	25
20:00-20:59	12	17	12	15	12	18	12	16
21:00-21:59	17	10	17	9	17	10	17	9
22:00-22:59	26	7	25	7	26	7	25	7
23:00-23:59	18	0	19	1	18	0	21 in total	

Table A2.11: Typical Busy Day Runway Usage By Hour – Easterly Operations

Hour	2022 Forecast Situation		2022 Forecast with Runway use		2025 Forecast Situation		2025 Forecast with Runway use / Forecast without any measures	
	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)
00:00-00:59	10	0	12	0	10	0	12 in total	
01:00-01:59	4	0	5	0	4	0	6 in total	
02:00-02:59	4	0	3	0	4	0	4 in total	
03:00-03:59	1	0	1	0	1	0	1 in total	
04:00-04:59	5	0	9	0	5	0	9 in total	
05:00-05:59	6	0	8	0	6	0	8 in total	
06:00-06:59	17	0	30	3	17	0	35 in total	
07:00-07:59	24	40	34	15	24	45	34	19
08:00-08:59	6	28	12	22	6	29	13	23
09:00-09:59	14	21	17	20	16	25	19	24
10:00-10:59	11	27	11	28	15	27	15	28
11:00-11:59	20	19	21	18	20	21	21	20
12:00-12:59	24	22	23	21	25	22	24	21
13:00-13:59	18	18	19	21	19	20	20	23
14:00-14:59	19	27	23	23	23	28	27	24
15:00-15:59	15	12	16	15	16	12	18	15
16:00-16:59	23	24	23	23	23	24	23	23
17:00-17:59	22	17	19	20	22	17	19	20
18:00-18:59	14	26	17	24	14	26	17	24
19:00-19:59	21	20	23	20	21	21	23	21
20:00-20:59	17	12	15	12	18	12	16	12
21:00-21:59	11	16	10	16	11	16	10	16
22:00-22:59	7	26	7	25	7	26	7	25
23:00-23:59	18	0	1	19	18	0	21 in total	

Table A2.12: Typical Busy Day Runway Usage By Night Hour – 2025 Westerly Operations

Hour	Forecast with Runway use Scenario 02		Forecast with Runway use Scenario 03		Forecast with Runway use Scenario 04		Forecast with Runway use Scenario 05	
	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)
00:00-00:59	12	0	10	2	2	10	6	6
01:00-01:59	6	0	5	1	1	5	3	3
02:00-02:59	4	0	3	1	0	4	1.5	2.5
03:00-03:59	1	0	1	0	0	1	0.5	0.5
04:00-04:59	9	0	8	1	0	9	4	5
05:00-05:59	8	0	5	3	3	5	4	4
06:00-06:59	5	30	5	30	30	5	17.5	17.5
23:00-23:59	20	1	20	1	1	20	10.5	10.5
Hour	Forecast without any measures Scenario 06		Forecast with Runway use Scenario 07		Forecast with Runway use Scenario 08		Forecast with Runway use Scenario 09	
	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)	28L (South)	28R (North)
00:00-00:59	5	7	10	2	5	7	0	12
01:00-01:59	2.5	3.5	5	1	2.5	3.5	0	6
02:00-02:59	1.5	2.5	3	1	1.5	2.5	0	4
03:00-03:59	0.5	0.5	1	0	0.5	0.5	0	1
04:00-04:59	4	5	8	1	4	5	0	9
05:00-05:59	3.5	4.5	6	2	2.5	5.5	0	8
06:00-06:59	20.5	14.5	23	12	2.5	32.5	5	30
23:00-23:59	10	11	20	1	10	11	20	1

Table A2.13: Typical Busy Day Runway Usage By Night Hour – 2025 Easterly Operations

Hour	Forecast with Runway use Scenario 02		Forecast with Runway use Scenario 03		Forecast with Runway use Scenario 04		Forecast with Runway use Scenario 05	
	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)
00:00-00:59	12	0	2	10	10	2	6	6
01:00-01:59	6	0	1	5	5	1	3	3
02:00-02:59	4	0	0	4	3	1	1.5	2.5
03:00-03:59	1	0	0	1	1	0	0.5	0.5
04:00-04:59	9	0	0	9	8	1	4	5
05:00-05:59	8	0	3	5	5	3	4	4
06:00-06:59	30	5	30	5	5	30	17.5	17.5
23:00-23:59	1	20	1	20	20	1	10.5	10.5

Hour	Forecast without any measures Scenario 06		Forecast with Runway use Scenario 07		Forecast with Runway use Scenario 08		Forecast with Runway use Scenario 09	
	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)	10R (South)	10L (North)
00:00-00:59	5	7	0	12	7	5	0	12
01:00-01:59	2.5	3.5	0	6	3.5	2.5	0	6
02:00-02:59	1.5	2.5	0	4	1.5	2.5	0	4
03:00-03:59	0.5	0.5	0	1	0.5	0.5	0	1
04:00-04:59	4	5	0	9	4	5	0	9
05:00-05:59	3.5	4.5	1	7	5.5	2.5	0	8
06:00-06:59	20.5	14.5	18	17	32.5	2.5	30	5
23:00-23:59	10	11	0	21	11	10	1	20

Flight Routes

Flight routes refer to the ground tracks followed by aircraft. In practice every aircraft follows a slightly different route, depending on the weather conditions and aircraft characteristics. For modelling purposes, it is typically considered sufficient to model each distinct route using what is known as a backbone track, as well as a number of sub-tracks either side of the backbone tracks to represent the variation in actual routes flown.

This approach is in accordance with EU Directive 2015/996 which states that "It is common practice to treat the data for a single route as a sample from a single population; i.e. to be represented by one backbone track and one set of dispersed subtracks."

This approach has the benefit of reducing the complexity of the noise model without significantly affecting its accuracy, as well as enabling the current and future operations to be modelled on the same basis.

Flight Roues – Current Situation

For the cross runway straight arrival routes have been used with a set of modelled departure routes for Category A & B and Category C & D aircraft, which have been developed based on the published SIDs.

For the main runway, based on an analysis of radar data in 2018, approaching aircraft are generally lined up with the extended centreline of the runway at least 17 km from the runway threshold. Consequently, the main runway approach routes have been modelled as straight out to this point. Before this point arrivals are modelled using 7 routes which cover the broad swathe of directions that the arriving aircraft approach from. Flights have been equally distributed between the 7 routes. The modelled current arrival routes are shown in pink on Figure A2.2.

For departures on the current main runway (10/28), that will be known as 10R/28L in the future, the current routes used vary with aircraft type and destination.

Category A & B aircraft, which are predominantly turboprops such as the ATR 72, are not required by the IAA to remain within the existing environmental corridors to the same extent as the larger jet aircraft types. They therefore commonly turn off the extended runway centreline to the north or south shortly after the end of the runway. A review of radar tracks for recent activity has resulted in a set of routes for these aircraft types shown in red on Figure A2.2.

Currently the airport has a total of 11 Standard Instrument Departure (SID) routes for westerly operations and 10 for easterly operations, although in both cases a number are initially the same until after they have left the study area. Given this similarity, for noise modelling purposes a set of seven initial departure routes have been created from the western end and four initial departure routes from the eastern end. Table A2.14 shows which route has been used to model each SID and gives the initial direction of the routes.

Table A2.14: Departure Routes Used to Model SIDs

SID	Modelled Route		Initial Direction
	Westerly Operations	Easterly Operations	
BAMLI	ROTEV	ROTEV	North
BEPAN	NEPOD	NEPOD	South
DEXEN	DEXEN	DEXEN	East
INKUR	INKUR	ROTEV	West
LIFFY	LIFFY	LIFFY	East
OLONO	NEPOD	NEPOD	South
PELIG[1]	PELIG	-	West
PESIT	NEPOD	NEPOD	South
NEVRI	ROTEV	ROTEV	North
ROTEV	ROTEV	ROTEV	North
SUROX	SUROX	ROTEV	North

[1] Westerly Operations Only

For Category C & D aircraft, which are jet engined aircraft, these routes have been supplemented for departures to the west by routes that turn earlier, although not as early as Category A & B aircraft routes. This assumption originally arose from a detailed review of 2010 radar data and has been confirmed as remaining appropriate by a review of recent radar data. These reviews found that many of the Category C & D on runway 28 actually performed their initial turn earlier than described by the SIDs. This is because after reaching an altitude of 3000 ft, they are vectored off by ATC. Two additional 'Early Turn' routes were therefore created for each route with initial turns to the north, south, or east, i.e. the ROTEV, NEPOD, LIFFY and DEXEN routes. Traffic has been distributed equally between the three turning points, i.e. the two early turns and the SID, for each route.

The modelled current Category C & D routes are shown in blue on Figure A2.2.

Flight Routes – North Runway Airport Layout

Due to the expected reduction in the use of the cross runway in the future, the areas exposed to the minimum noise levels of interest do not reach the point where aircraft turn off the extended runway centreline. Straight arrival and departure routes have therefore been used for the cross runway in the interests of reducing the complexity of the model.

Arrival routes for the existing South Runway have been modelled as the same as the current routes. Arrival routes have been created for the North Runway which replicate those for the South Runway. The modelled arrival routes based on the future North Runway airport layout are shown on Figures A2.3 and A2.4.

Once the North Runway is in use Category A & B aircraft will continue to turn off the extended runway centreline shortly after the end of the runway, however they will not be allowed to turn across the other runway, i.e. they cannot turn north off the south runway and vice versa. A new set of departure routes has therefore been developed for Category A & B aircraft. From the southern runway this replicates the current routes, but with no turns to the north. For the North Runway the routes have been designed to replicate the current routes as closely as possible but with no turns to the south as shown in Figures A2.3 and A2.4.

For Category C & D aircraft a number of the modelled routes have been used to represent more than one of the SIDs, so combining the traffic on some of the SIDs onto a single modelled route. The departure routes to the west are supplemented by early turn routes, similar to the current routes.

In order to achieve a safe minimum separation between departures and arrivals performing a go around and based on public consultation a subsequent detailed safety assessment by the Air Traffic Service Provider a course divergence of at least 30° is required. As the runways are parallel this necessitated an early turn by departures from the North Runway.

An analysis was undertaken to determine the best initial turn angles taking into account the resulting noise, and the local community was consulted on the options. The analysis concluded that that for departures to the west there were limited differences between the various turn angle options, but an initial turn of 15° or 30° to the north was favourable in terms of the overall numbers of sensitive receptors under the flight path. This was supplemented with a 75° initial turn for departures heading to the north or west off North Runway in westerly departures. For departures to the east an initial turn of 15° to the north was the most favourable option. The public consultation resulted in the 15°/75° divergence to the west off North Runway and 15° to the east going forward for further analysis.

The subsequent detailed airspace design indicated that 30° was required when departing off North Runway to the west in order to allow for safety requirements associated with potential missed approaches/ go arounds. The final set of divergence was therefore selected to be 30° and 75° to the west and 15° to the east. .

A set of departure routes from the North Runway was then developed that replicated the current routes as closely as possible, while allowing for these initial turns. The result is routes with an early turn to the north. When heading east all of the routes turn 15° at 1.06nm from the end of the runway. When heading to the west the routes to DEXEN, INKUR, NEPOD, PELIG and SUROX turn 30°, while those to ABBEY and ROTEV turn 75°, all at 1.18nm from the end of the runway.

The departures on the South Runway continue along the extended runway centreline before turning.

The modelled current Category C & D routes are shown in blue on Figures A2.3 and A2.4.

This approach is in accordance with EU Directive 2015/996 which states that "In many cases is not possible to model flight paths on the basis of radar data — because the necessary resources are not available or because the scenario is a future one for which there are no relevant radar data. In the absence of radar data, or when its use is inappropriate, it is necessary to estimate the flight paths on the basis of operational guidance material".

Dispersion

Aircraft on departure are allocated a route to follow. In practice, this route is not followed precisely by all aircraft allocated to this route. The actual pattern of departing aircraft is dispersed about the route's centreline. The degree of dispersion is normally a function of the distance travelled by an aircraft along the route after take-off and also on the form of the route.

When considering many departures, it is commonly found that the spread of aircraft approximates to a "normal distribution" pattern, the shape or spread of which will vary with distance along the route. A simplified mathematical model can be adopted to represent a normal distribution of events, based on standard deviations. EU Directive 2015/996 advises the use of seven "dispersed" tracks associated with each departure route, these comprise the Centreline of each route and the three Sub Tracks either side.

The allocation of movements to each track for this assessment was as follows:

- 28.2% of departures along the Centreline;
- 22.2% of departures along each of the two inner Sub Tracks either side of the Centreline and offset by a distance of 0.71 standard deviation;
- 10.6% of departures along each of the 2nd pair of Sub Tracks either side of the Centreline and offset by a distance of 1.43 standard deviation;
- 3.1% of departures along each of the two outer Sub Tracks either side of the Centreline and offset by a distance of 2.14 standard deviations.

This dispersion model has been applied with a departure offset profile, which comprises the standard deviations of the magnitude of the dispersion for lengths of straight and curved track. These have been determined from a detailed analysis of radar tracks for operations in 2016 at Dublin. Operations in 2018 have been reviewed and found to follow a similar distribution.

Route Usage

The actual aircraft movement logs for years that have already occurred provide destination airports for each departure movement. This has been combined with an assessment that has been carried out of which departure route is used for each destination which utilise the direction it is from Dublin.

The forecasts for future years generally include departure route information for each movement, which has been used. Where departure route information is not available, a departure route has been assigned based on the destination airport.

Flight Profiles

Arrival Profiles

The standard arrival profiles for many of the aircraft in the AEDT database include level sections. An analysis of radar data found these do not occur at Dublin, therefore 3 degree continuous descent approach profiles have been created and used for all aircraft types.

Departure Profiles

For the most common aircraft, based on confidential information provided by airlines, custom "USER" profiles have been created that more closely replicate the procedures used by aircraft departing from Dublin Airport. These profiles broadly replicate NADP2 procedures with a lower initial thrust than maximum on takeoff.

The AEDT departure profiles for many of the aircraft in the AEDT database finish at 10,000 ft. To allow predictions over the whole of the study area these profiles have been extended to 30,000 ft or for certain aircraft the maximum altitude AEDT calculates to be achievable for the particular aircraft type. These user-defined profiles have been denoted "30KFT".

This approach is in line with EU Directive 2015/996 which advises that "Caution must be exercised before adopting default procedural steps provided in the ANP database (customarily assumed when actual procedures are not known). These are standardised procedures that are widely followed but which may or may not be used by operators in particular cases".

Stage Lengths

For departure movements the AEDT software offers a number of flight profiles for most aircraft types, and in particular for the larger aircraft types. These relate to different departure weights which are greatly affected by the length of the flight, and consequently the fuel load. In the AEDT software this is referred to as the stage length and is in increments of 500 nm up to 1,500 nm and then in increments of 1,000 nm. The AEDT software assumes all aircraft take off with a full passenger load irrespective of stage length. As the stage length increases the aircraft has to depart with greater fuel and so its flight profile is slightly lower than when a shorter stage length is flown.

For some of the aircraft types, in particular the smaller aircraft, only one stage length is available in the AEDT software. For the remainder a stage length was chosen based on the distance to the destination airport.

This approach complies with EU Directive 2015/996 which states that "Vertical dispersion is usually represented satisfactorily by accounting for the effects of varying aircraft weights on the vertical profiles."

AEDT Validation

Results from the Dublin Airport Noise and Track Keeping (NTK) system have been used for noise validation purposes. Specifically, the results from Noise Monitoring Terminals (NMTs) 1, 2 and 20 between January and December 2018 have been used.

The noise levels from the monitors are automatically correlated with aircraft movements using the radar track keeping system and the average determined by aircraft type and operation. A number of parameters are measured by the system, for this validation the Sound Exposure Level (SEL) of the individual aircraft movements has been used.

To take into account the measured levels the AEDT software has been used to predict the level at the NMT locations using the recommended AEDT aircraft type. This has been compared to the measured averages for the aircraft types when separately arriving and departing. Where the differences between the measured and predicted results were found to be significant then adjustments were made to the modelling to minimise differences. This was done by adjusting the AEDT NPD data for the modelled aircraft types so that the movement-weighted average modelled noise levels at the NMTs matched the measured level noise level.

Seventeen aircraft have had modifications made to their arrival and departure noise assumptions. The modifications are detailed in Table A2.15 below.

Table A2.15: Modifications to AEDT Default Assumptions

Aircraft Type	Arrivals		Departures		
	AEDT Type	Adjustment (dB)	AEDT Type	Profile	Adjustment (dB)
A306	A300-622R	-3.1	A300-622R	30KFT	+0.6
A319	A319-131	-1.4	A319-131	30KFT	+0.9
A320	A320-211	-0.7	A320-211	USER	-1.3
A320neo	A320-211	-2.0	A320-211	USER	-3.2
A321	A321-232	-0.4	A321-232	USER	-0.5
A332	A330-301	-1.3	A330-301	30KFT	-1.1
A333	A330-301	-1.1	A330-301	30KFT	-0.8
ATR72	SD330	+1.5	SD330	30KFT [2]	+0.1[3]
B734	737400	+0.4	737400	30KFT	-0.1
B738	737800	-2.7	737800	USER	-1.2
B738MAX	7878max	-3.0	7378max	USER	-1.5
B752	757RR	-0.4	757RR	30KFT	-2.3
B772	777200	+0.2	777200	30KFT	+1.5
B773	777300	-0.8	777300	30KFT	-2.4
B787	7878R	-0.3	7878R	30KFT	+0.1
E190	EMB190	-0.8	EMB190	30KFT	+0.5
RJ85	BAE146	-3.3	BAE146	30KFT [2]	-1.6
DH4[1]	SD330	0	DHC6	30KFT [2]	0

[1] The DH4 type was not validated due to insufficient results. The modelled AEDT types are based on BAP's experience of this aircraft at other airports where it operates more frequently, as the default AEDT suggested type of DHC830 typically leads to significant under-prediction of noise levels.

[2] Maximum altitude limited to AEDT calculated max for the AEDT type.

[3] This aircraft does not routinely depart over NMT20 as it turns before reaching it, validation has therefore been based solely on measured results from NMTs 1 & 2.

These modifications achieve a better correlation between predicted and measured noise at the airport, resulting in differences between predicted and measured levels of less than 1 dB at each of the three NMTs. The exception is the RJ85 which has a difference between modelled noise levels and measured noise levels at NMT20 of more than 2 dB. For this aircraft NMT20 correlates fewer departures than NMT2. It is possible that NMT20 is only recording the loudest departures by this aircraft, resulting in an average measured level that is not representative.

This is in line with EU Directive 2015/996, which requires that "All input values affecting the emission level of a source, including the position of the source, shall be determined with at least the accuracy corresponding to an uncertainty of ± 2dB(A) in the emission level of the source".

Performance of Modernised Aircraft Types

The degree of expected improvement in noise levels for the recently introduced and future aircraft types in the forecasts which are not contained within the AEDT model are given below in Table A2.16 for arrivals and departures. The expected improvement in noise levels is based on a comparison with either the current generation aircraft that is being directly replaced, or the most similar aircraft type available in AEDT.

The expected changes in noise levels are based on the differences in average certification noise levels between the current and modernised aircraft types from the *EASA Approved Noise Levels database*[15] where available. For aircraft whose certification noise levels were not available the assumptions have been based on the assumptions used by the ERCD for the Airports Commission (2014)[16].

Table A2.16: Expected Change in Noise Levels between Current and Modernised Aircraft Types

Current Aircraft Type	Modernised Aircraft Type	Expected Change in Noise Levels between Current and Modernised Aircraft Types (dB)	
		Arrival	Departure
737700	Bombardier CS300	-3.4	-4.3
Airbus A321	Airbus A321neo	-2.4	-5.4
Airbus A321	Airbus A321LR[1]	-2.4	-5.4
Airbus A330-300	Airbus A330-900neo	-1.1	-4.8
Airbus A330-300	Airbus A350-900	-3.0	-7.5
Boeing 777-300	Boeing 777X[2]	-0.8	-3.8
Embraer E190	Embraer E190-E2	-1.9	-6.2

[1] Based on A321neo certification noise levels
[2] Based on ERCD assumptions

15 https://www.easa.europa.eu/easa-and-you/environment/easa-certification-noise-levels
16 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389579/noise_methodology_addendum.pdf

A2.2 DETAILED POPULATION AND DEMOGRAPHICS ASSESSMENT METHODOLOGY

Dwelling data has been acquired from GeoDirectory for 2019 Q2, which was the latest available dataset when the assessment work began.

An assessment of not yet built dwellings, which have already been granted planning permission, has been carried out. This has utilised information on permitted developments provided by Tom Phillips and Associates (TPA) which has been compared to the data from GeoDirectory, as a number of the developments are progressing on site. This resulted in a separate permitted dwellings database.

Population data has been estimated using the average dwelling occupancy by small area. This has been obtained for 2016 based on Census data from the Central Statistics Office[17]. It has then been determined into which of the small areas each of the dwellings falls, based upon which they have been assigned the average dwelling occupancy for the area. This approach is in line with that used for the last round of Noise Mapping.

An assessment of zoned land has also been undertaken. This identified a number of areas which are designated for residential use. Some of these already contain existing or permitted dwellings and so are included in those datasets. The remaining areas have been assumed to have future developments with an average density of 35 dwellings per hectare and 3 people per dwelling. The dwelling density is based on a recent planning history search for the various sites and relevant local area plans. 3 people per dwelling is a conservative estimate based on the 2016 Census data, which found an average occupancy of a little under 3 people per dwelling for the study area.

Each dwelling and community building has been included in the AEDT model as a receptor. A representative set of receptors has been created for each permitted development and zoned land area based on site plans and other publicly available information. Noise levels have been predicted at each of these receptor locations.

[17] http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=EP008

APPENDIX 3

NOISE CONTOUR PLOTS

A3.1 NOISE CONTOUR PLOTS

The following noise contour plots are included below:

Bickerdike Allen Partners
Architecture Acoustics Technology

<u>Noise Contours and Residential Use</u>