Appendix 7-2: Airside Air Quality Modelling Methodology

Appendix 7-2 Airside Air Quality Modelling Methodology

Introduction

The impact of airside traffic emissions on nearby air quality sensitive receptors has been predicted using the Aviation Environmental Design Tool (AEDT) v4a, designed by the United States Federal Aviation Administration, Office of Environment and Energy (FAA-AEE). The software was designed to predict impacts from noise, emissions, and fuel consumptions through different stages of flight.

Methodology

Changes in atmospheric pollutant concentrations at sensitive receptors in the vicinity of the Dublin Airport Site have been assessed in line with the methodology set out in the ICAO Airport Air Quality Manual[1]. The manual details the approach for conducting an assessment of airport operations, including the use of dispersion modelling of current and future aircraft movements and associated ground side equipment operations.

Aviation Environmental Design Tool

AEDT is a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality consequences. AEDT is a comprehensive tool that provides information to FAA stakeholders on each of these specific environmental impacts.

AEDT is designed to model individual studies ranging in scope from a single flight at an airport to scenarios at the regional, national, and global levels. It is therefore considered appropriate for use for the purpose of this EIAR. AEDT uses geographic information system (GIS) and relational database technology and is actively used by the U.S. government for domestic aviation system planning as well as domestic and international aviation environmental policy analysis.

The model scenarios include emissions of:

- Oxides of nitrogen (NO_x);
- PM_{10};
- $PM_{2.5}$; and
- Total Hydrocarbons (THC) (for the assessment of odour, based on research undertaken at Copenhagen Airport[2]).

The following aircraft forecast scenarios have been provided by Mott MacDonald on behalf of daa:

- 2025 Schedule 2: Current Operation – actual operations from 22nd August 2025;
- 2029 Schedule 4: Permitted Operation – a modelled scenario including a ‘night-quota scheme’, single runway operations between 12am and 6am, and a 32 mppa cap; and
- 2029 Schedule 3: Proposed Operation – a modelled scenario including a ‘night-quota scheme’, single runway operations between 12am and 6am, and a 40 mppa cap.

The scenarios considered in this assessment and how the aircraft forecasts align with them are described below. The Principal Assessment includes the North Runway Relevant Action (NRRA):

- 2029 Permitted Operation – this scenario includes a capacity of 32 mppa and is representative of the 2029 future receiving environment and uses Schedule 4 data.
- 2029 Proposed Operation – this scenario includes a passenger throughput capacity of 40 mppa. This scenario uses Schedule 3 modelled data.

[1] ICAO (2023) Doc 9889, Airport Air Quality Manual, Third Edition 2023
[2] Morten Winther, Uffe Kousgaard, Arne Oxbøl (2006), Calculation of odour emissions from aircraft engines at Copenhagen Airport, Science of the Total Environment, 2006 Jul 31;366(1):218-32.

Aircraft and Airside Equipment

Aircraft and Airside Emissions Inventory

The model incorporates two databases (Airport and Fleet) based on real-world data of airport operations using published aircraft data and equipment use. The databases contain the geographic and source information for airport and equipment elements necessary to populate required parameters in the underlying environmental models, including aerodynamic parameters, exhaust emission and structural coefficients for aircraft, Ground Support Equipment (GSE) emissions, external reference codes from standard aviation sources, runway and helipad data, and historical meteorological values.

The airport database comprises of a global set of airport-specific data using standard FAA, International Civil Aviation Organization (ICAO), and International Air Transport Association (IATA) aircraft and airframe codes.

The Fleet database comprises of data for all available equipment, both aircraft and non-aircraft, used in the performance, emissions, and noise environmental models.

Sources – Airport

Airport emissions have been modelled using an approximation of the airport layout, including runways, taxiways and terminals. The airport layout has been based on aerial photography and maps to determine the layout for the model. The layout has assumed that commercial and cargo flights each have a dedicated apron in front of the terminal buildings, with separate aprons used for Terminal 1, Terminal 2, and cargo flights.

It has been assumed that all taxi routes to or from a runway begin or stop at the start or end of each runway, with aircraft using the remainder of the runway to taxi to or from the appropriate terminal, following landing or before take-off. Separate taxiways have been modelled to connect each runway end to all aprons. The use of the shorter taxi routes that are possible, using the aircraft access roads that run at intervals along the length of each runway, have not been accounted for in the assessment. It has been assumed that aircraft from all aprons use a direct taxi route to and from the start or end of each runway.

The Principal Assessment includes single runway usage during overnight hours (as defined by the scenarios listed in above in *Aviation Environmental Design Tool*). Single runway usage has been inputted into the model for the Permitted Operation and Proposed Operation. For further details regarding runway assignment, see *Determination of Air Traffic Movements* below.

Arrival and departure tracks were provided by daa. Several tracks were provided to account for variations in aircraft size. All aircraft have been assumed to use the same arrival/departure track from each runway end.

Arrival/departure tracks have been manually inputted into the model up to a distance of 2 km from the runway end based on tracks provided by daa. The AEDT software then extends the inputted arrival tracks for a further 100 nautical miles (nmi) to complete the emissions calculations. This ensures that all aircraft emissions that occur below 1,000m are accounted for in the assessment.

All modelled scenarios use the same runway parameters and GSE for each aircraft for arrival and departure.

Sources – Fleet

The AEDT Fleet database contains tables that store aircraft and non-aircraft equipment related information for use by the AEDT system.

The AEDT Fleet database contains over 3,000 aircraft (airframe/engine combinations) and approximately 350 non-aircraft emissions sources (ground support equipment, stationary power and fuel equipment, and auxiliary power units).

The AEDT Fleet database contains aircraft modelling parameters specific to the four aircraft representations used to evaluate the environmental impacts of interest in AEDT. These four models are:

1. ICAO Engine Emissions Databank (EDB).
2. ICAO Aircraft Noise and Performance Database (ANP).
3. EUROCONTROL Base of Aircraft Data Family 3.

4. EUROCONTROL Base of Aircraft Data Family 4.

The set of system provided non-aircraft equipment is available for assignment to operations in two ways, either as stand-alone operations or associated with (and therefore proportional to) aircraft operations.

Emissions Data for Modelled Sources

Aircraft Movement Data

Operational airside data was provided by Mott MacDonald on behalf of daa. Forecasts were provided for a 'busy day' schedule, which contained a schedule of air traffic movements (ATM) including details of aircraft type, distance travelled and departure/arrival airport. Schedules were provided individually for the Current Operation, Permitted Operation and Proposed Operation.

The 'busy day' schedules of ATMs form the basis of the data used to complete the modelling of pollutant emissions from aircraft, and the associated emissions from aircraft and GSE.

With regards to Auxiliary Power Unit (APU) use, it has been confirmed by daa that fixed electrical ground power (FEGP) was to be deployed at all contact stands by 2025 and remote stands by 2030. This is in accordance with Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure[3]. Table 1 lists the APU usage data provided by daa, based on conditions in 2025. This data has been applied to emissions calculations for the airlines and aircraft listed in that table. APUs have been assumed to run for fifteen minutes for all operations for these airlines and aircraft. Airlines and aircraft that have longer APU run durations represent a small number of ATM and the use of these durations would significantly overestimate the emissions from the APUs. It is also assumed that airlines not included in Table 1 utilise the FEGP provision instead of APU use. As no contact stands are present within the apron dedicated for cargo flights, APU usage has been applied to all modelled cargo flights.

Table 1: Auxiliary Power Unit usage at Dublin Airport

Airline	Aircraft	APU Duration (minutes)
Signature Aviation	Fleet Average Arrival/Departure	30
Universal Aviation	Fleet Average Arrival/Departure	45
Aer Lingus	800	10
Aer Lingus	8200	15
Air France KLM	Fleet Average Departure	10
Air France KLM	Fleet Average Arrival	5
Turkish Airlines	A321	5
Turkish Airlines	A330	7
BCT	Fleet Average Arrival/Departure	15
ASL Airlines	Fleet Average Arrival/Departure	15
Etihad	787-9	15
Etihad	787-10	15
Etihad	B777	15
Etihad	A350-1000	15
Average		**15.50**

Notes:
Data has not been provided separately for arrivals/departures unless stated otherwise.

[3] The European Parliament and the Council of the European Union (2023). Regulation EU) 2023/1804 if the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU.

To provide a more conservative approach, it has been assumed that the 'busy day' schedule applies to all days of the week (i.e. Monday to Sunday). In reality, less aircraft movements are expected on certain days of the week and therefore the number of aircraft movements may be lower than that which has been modelled.

The number of aircraft movements per year has been determined by multiplying the total number of aircraft movements within each 'busy day' schedule by the number of days in the year. The number of annual operations for each aircraft type within each scenario is outlined in Table 2 and Table 3. Equipment codes were also assigned to all aircraft within the model, which were used by AEDT to assign an associated engine to each aircraft. For 59 aircraft, more than one equipment code was available within the BADA database. In the model, one equipment code has been used for all operations of each aircraft type. The single equipment code with the highest emission coefficients for NOx through all stages of the LTO was chosen for these aircraft. This is a precautionary approach, with NOx emissions for all ATMs assumed to be the maximum possible for that aircraft. The engine codes are also outlined in Table 2 and Table 3.

Table 2: Modelled ATMs – Schedule 2

Aircraft	IATA Code	Engine Code	Number of ATM/year	
			Arrivals	Departures
Airbus A321-100 Series	32B	3IA008	1460	1460
Boeing 767-300 ER Freighter	76V	12PW102	365	365
Boeing 737-300 Series Freighter	76Y	1CM007	1095	730
Airbus A320neo	32N	01P20CM130	10950	10220
Boeing 777-200-ER	772	10PW099	1460	1095
Boeing 787-8 Dreamliner	788	02P23RR127	730	1095
Boeing 787-9 Dreamliner	789	02P23RR135	2190	2190
Airbus A220-300	223	16PW111	1460	1460
Embraer ERJ135-ER	ER3	6AL012	365	365
Bombardier Challenger 600	CCJ	1TL001	730	365
Bombardier Challenger 650	Z33	07P05GE220	365	0
Airbus A319-100 Series	319	6CM044	1460	1095
Embraer ERJ190	E90	8GE119	2190	2555
Airbus A321neo	32Q	01P20CM132	8030	8395
Airbus A320-200 Series	320	1IA001	23360	24090
Boeing 737-8	7M8	01P20CM140	25185	25550
Boeing 757-200 Series Freighter	75F	3RR034	365	365
Boeing 767-300 Series	76W	10PW098	730	730
Airbus A330-300 Series	333	2RR023	4015	4380
Airbus A330-200 Series	332	4PW067	1095	1095
Boeing 737-800 Series	73H	3CM034	13870	14965
ATR 72-200	AT7	PW127A	13870	13870
Boeing 777-300 ER	77W	07P27GE240	1095	1095
Bombardier Challenger 3500	CL5	01P14HN011	1095	730
Boeing 737-800 Series	7S8	3CM034	19710	19345
Boeing 737-800 Series	73K	3CM034	1095	1095
Airbus A320-200 Series	32A	1IA001	1460	1460
Embraer ERJ195-E2	295	04P20PW203	1460	1460
Boeing 737-700 Series	73W	8CM051	365	365
Airbus A320neo	32X	01P20CM130	730	730
Airbus A321-200 Series	321	2CM013	730	730

Aircraft	IATA Code	Engine Code	Number of ATM/year	
			Arrivals	Departures
Embraer ERJ145-EP	ER4	6AL006	365	365
Bombardier Global Express	Z06	4BR004	365	365
Cessna 680-A Citation Latitude	Z22	7PW078	365	365
Airbus A330-300 Series	SFF	2RR023	365	365
Boeing 777-200-LR	77L	07P27GE240	365	365
Cessna 560 Citation Excel	Z30	PW530	365	730
Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	Z39	4BR004	365	0
Gulfstream G-5 Gulfstream 5 / G-5SP Gulfstream G500	Z25	4BR004	365	0
Cessna CitationJet CJ/CJ1 (Cessna 525)	CJ2	1PW035	365	365
Bombardier Global 5000	X11	01P04BR013	730	365
Gulfstream IV-SP	GJ4	1RR019	365	365
Cessna 560 Citation Excel	Z15	PW530	730	365
Gulfstream G280	G28	01P11HN012	365	0
Boeing 757-200 Series Freighter	75V	3RR034	365	365
Embraer ERJ195	E95	10GE133	730	730
Boeing 757-300 Series	75W	3RR034	1095	1095
Airbus A330-900N Series (Neo)	ET6	04P24RR146	365	0
Pilatus PC-24	PL4	1PW038	0	365
Embraer 1000	E9L	11GE147	0	365
ATR 72-600	ATF	PW127	365	365
Bombardier CRJ-1000	CRK	07P27GE224	365	365
		Total ATM/year	**151840**	**151110**

Table 3: Modelled ATMs – Schedule 3

Aircraft	IATA Code	Engine Code	Number of ATM/year	
			Arrivals	Departures
Boeing 737-8	7M8	01P20CM140	43800	45625
Airbus A321-200 Series	321	2CM013	1460	1460
Boeing 787-9 Dreamliner	789	02P23RR135	4745	4745
Boeing 737-800 Series	73K	3CM034	1095	1095
Airbus A320neo	32N	01P20CM130	18250	18250
Boeing 787-8 Dreamliner	788	02P23RR127	2920	2920
Boeing 737-400 Series	734	1CM007	1095	1095
Boeing 777-300 ER	77W	07P27GE240	365	365
Airbus A350-900 series	359	07P27RR153	365	365
Airbus A320neo	32X	01P20CM130	365	365
Airbus A220-300	223	16PW111	2555	2555
Airbus A321neo	32Q	01P20CM132	16060	14965
Boeing 737-300 Series Freighter	76Y	1CM007	730	365
Embraer ERJ190	E90	8GE119	4015	4015
Airbus A320-200 Series	320	1IA001	16425	16790

Aircraft	IATA Code	Engine Code	Number of ATM/year	
			Arrivals	Departures
Boeing 737-400 Series	73P	1CM007	365	730
Airbus A330-900N Series (Neo)	339	04P24RR146	1825	1825
ATR 72-200	AT7	PW127A	10585	10950
Boeing 757-200 Series Freighter	75V	3RR034	365	365
Cessna 441 Conquest II	CNT	TPE10	365	365
Airbus A330-300 Series	333	2RR023	3650	3650
Boeing 767-300 ER Freighter	76V	12PW102	1095	1095
Boeing 777-300 ER	779	07P27GE240	1095	1095
Boeing 737-800 Series	7S8	3CM034	6570	7665
Boeing 737-800 Series	73H	3CM034	12045	10950
Saab 340-B-Plus	SF3	CT79B	730	730
Airbus A300F4-600 Series	ABY	5GE085	365	365
Airbus A320-200 Series	32A	1IA001	1095	1095
Embraer ERJ195-E2	295	04P20PW203	730	730
Boeing 737-700 Series	7M7	8CM051	365	365
Airbus A319-100 Series	319	6CM044	365	365
Embraer ERJ145-EP	ER4	6AL006	730	730
BAE Jetstream 32	J32	TPE12	365	365
Boeing 737-300 Series	733	1CM007	730	365
Boeing 747-100SR	744	1PW030	0	365
Boeing 737-9	7M9	01P20CM140	365	365
Airbus A330-200 Series	332	4PW067	730	365
Boeing 737-800 Series	738	3CM034	730	730
Embraer ERJ195	E95	10GE133	1095	730
Boeing 767-400	764	3GE058	365	365
		Total ATM/year	**160965**	**161695**

A ‘stage number’ was determined for each ATM based on the distance between Dublin Airport and the arrival/departure airport. Table 4 outlines the trip lengths associated with each stage number, as described in the AEDT v4a User Manual[4].

Table 4: ATM Stage Numbers

Stage Number	Trip Length (nmi)
1	0 to 500
2	500 to 1000
3	1000 to 1500
4	1500 to 2500
5	2500 to 3500
6	3500 to 4500
7	4500 to 5500
8	5500 to 6500
9	6500 to 11000

[4] U.S Department of Transportation and Federal Aviation Administration (2026). Aviation Environmental Design Tool (AEDT) Version 4a User Manual. Available at: https://aedt.faa.gov/Documents/AEDT4a_UserManual.pdf

Stage Number	Trip Length (nmi)
M	Maximum range at maximum take-off weight

Source: AEDT 4a User Manual, Page 138[4]

The stage number is used within the AEDT software to determine the procedural profile of the ATM. Procedural profiles are provided within the AEDT database and include information regarding thrust, climb rate (ft/min) and airspeed (kt) at different stages of take-off or approach. These procedural profiles are used to determine the LTO for each ATM. The stage numbers are used to determine the fuel levels required for the ATM and, consequently, overall weight of the aircraft. All arrivals are assumed by AEDT to have a stage number of 1.

'STANDARD' procedural profiles have been used for all ATMs within the model to provide a more conservative approach. These procedural profiles assume a power setting of 100% during take-off, 85% during climb-out (maximum climb thrust), 30% during approach and 7% while idling, as outlined in Table D-2 of the ICAO Air Quality Manual[1].

Emissions from engine start-up have been calculated using AEDT for all ATMs.

Terminal Assignment

ATMs have been assigned to the appropriate terminal based on information provided by Mott MacDonald on behalf of daa. Information was compiled regarding the use of terminals by each airline.

All flights which have been marked as 'Cargo/Mail' in the forecasted schedules have been assigned to a separate cargo terminal (T-F).

Details regarding the terminal used by each airline is provided in Table 5 and Table 6. The majority of airlines operate all ATM from one terminal. The following exception to this is in Schedule 2, where Etihad Airways departures have been assigned to Terminal 1, whilst Etihad Airways arrivals have been assigned to Terminal 2.

Table 5: Terminal Assignments for Airlines – Schedule 2

Airline	Airline Code	Terminal
Aegean Airlines	A3	T-1
Aer Lingus	EI	T-2
Air Canada	AC	T-1
Air Charters Europe	AGR	T-1
Air France	AF	T-1
Air Nostrum	YW	T-1
Air Transat	TS	T-1
Alliance Executive Jets Ltd	ALE	T-1
American Airlines	AA	T-2
Blue Islands	SI	T-1
British Airways	BA	T-2
Delta Air Lines	DL	T-2
DHL	DHK	T-1
Egypt Air	MS	T-1
Emirates	EK	T-2
Ethiopian Airlines	ET	T-1
ETIHAD AIRWAYS	EY	Arrivals at Terminal 2, Departures at Terminal 1
EUROPEAN AIR TRANSPORT NV	QY	T-1
Eurowings	EW	T-1
FedEx	FX	T-1

Airline	Airline Code	Terminal
Finnair	AY	T-1
FlyOne	5F	T-1
Hisky	H4	T-1
Iberia	I2	T-2
Icelandair	FI	T-1
JetBlue	B6	T-2
KLM	KL	T-1
Loganair	LM	T-1
Lufthansa	LH	T-1
Lufthansa City Airlines	VL	T-1
Luxair	LG	T-1
NetJets	NJE	T-1
Norwegian	D8	T-1
Norwegian	DY	T-1
Nyx Air	OJ	T-1
Pegasus Airlines	PC	T-1
Qatar Airways	QR	T-1
Ryanair	FR	T-1
SAS	SK	T-1
SIGNATURE AIRCRAFT CHARTER	SIG	T-1
SunExpress	XQ	T-1
Swiss	LX	T-1
Tap Air Portugal	TP	T-1
TMA Cargo	T2	T-1
TRANSAVIA FRANCE	TO	T-1
TUI Fly Netherlands	OR	T-1
TURKISH AIRLINES	TK	T-1
United Airlines	UA	T-2
Universal Airways	UVA	T-1
UPS Airlines	5X	T-1
Vueling	VY	T-2
Westjet	WS	T-1
Zimex Aviation	XM	T-1

Note: ATMs which have been given a 'Cargo/Mail' category have been assigned to the cargo terminal (T-F) as opposed to the terminal listed above.

Table 6:Terminal Assignments for Airlines – Schedule 3

Airline	Airline Code	Terminal
AEG	AEG	T-1
Aegean Airlines	A3	T-1
Aer Lingus	EI	T-2

Airline	Airline Code	Terminal
Aeroflot	SU	T-1
Air Baltic	BT	T-1
Air Canada	AC	T-1
Air France	AF	T-1
Air Moldova	9U	T-1
Air Transat	TSC	T-1
American Airlines	AA	T-2
ARKIA ISRAELI AIRLINES	IZ	T-1
BA CITYFLYER	CJ	T-1
Blue Air	0B	T-1
Blue Islands	SI	T-1
BLUEBIRD CARGO LTD	BBD	T-1
British Airways	BA	T-1
CC	CC	T-1
Cello Aviation	CLJ	T-1
Delta Air Lines	DL	T-2
DHL	D0	T-1
Eastern Airways	T3	T-1
Emerald Airlines	EA	T-2
Emirates	EK	T-2
Ethiopian Airlines	ET	T-1
ETIHAD AIRWAYS	EY	T-1
EUROPEAN AIR TRANSPORT NV	QY	T-1
Eurowings	EW	T-1
FedEx	FX	T-1
Finnair	AY	T-1
FLYBE LTD	BE	T-1
FlyOne	5F	T-1
Hainan Airlines	HU	T-1
Hisky	H4	T-1
Iberia	I2	T-1
Icelandair	FI	T-1
INDIGO	6E	T-1
JetBlue	B6	T-2
KLM	KL	T-1
Loganair	LM	T-1
LOT POLISH AIRLINES	LO	T-1
Lufthansa	LH	T-1
Luxair	LG	T-1
Norwegian	D8	T-1

Airline	Airline Code	Terminal
Nyx Air	OJ	T-1
PLAY Airlines	OG	T-1
Qatar Airways	QR	T-1
RVL AVIATION	REV	T-1
Ryanair	FR	T-1
Ryanair	OE	T-1
Ryanair	PNX	T-1
Ryanair	RK	T-1
RYANAIR	AZ	T-1
SAS	SK	T-1
SIGNATURE AIRCRAFT CHARTER	SIG	T-1
Smartlynx Airlines	6Y	T-1
SOUTHWEST	WN	T-2
Stobart	RE	T-1
SUNWING	SWG	T-1
Swiss	LX	T-1
Tap Air Portugal	TP	T-1
TNT AIRWAYS	3V	T-1
TRANSAVIA FRANCE	TO	T-1
TUI	TOM	T-1
TURKISH AIRLINES	TK	T-1
United Airlines	UA	T-2
UPS	UPS	T-1
Vueling	VY	T-1
Westjet	WS	T-1
Zimex Aviation	XM	T-1

Note: ATMs which have been given a 'Cargo/Mail' category have been assigned to the cargo terminal (T-F) as opposed to the terminal listed above.

Table 7: Terminal Assignments for Airlines – Schedule 4

Airline	Airline Code	Terminal
AEG	*AEG*	*T-1*
Aegean Airlines	*A3*	*T-1*
Aer Lingus	*EI*	*T-1*
Aeroflot	*SU*	*T-1*
Air Baltic	*BT*	*T-1*
Air Canada	*AC*	*T-1*
Air France	*AF*	*T-1*
Air Moldova	*9U*	*T-1*

Air Transat	*TSC*	*T-1*
American Airlines	*AA*	*T-1*
Blue Air	*0B*	*T-1*
Blue Islands	*SI*	*T-1*
BLUEBIRD CARGO LTD	*BBD*	*T-2*
British Airways	*BA*	*T-2*
CC	*CC*	*T-1*
Cello Aviation	*CLJ*	*T-1*
Delta Air Lines	*DL*	*T-1*
DHL	*D0*	*T-2*
Eastern Airways	*T3*	*T-1*
Emerald Airlines	*EA*	*T-2*
Emirates	*EK*	*T-1*
Ethiopian Airlines	*ET*	*T-1*
ETIHAD AIRWAYS	*EY*	*T-2*
EUROPEAN AIR TRANSPORT NV	*QY*	*T-1*
Eurowings	*EW*	*T-1*
FedEx	*FX*	*T-1*
Finnair	*AY*	*T-1*
FLYBE LTD	*BE*	*T-1*
FlyOne	*5F*	*T-1*
Hisky	*H4*	*T-1*
Iberia	*I2*	*T-1*
Icelandair	*FI*	*T-1*
JetBlue	*B6*	*T-1*
KLM	*KL*	*T-1*
Loganair	*LM*	*T-1*
LOT POLISH AIRLINES	*LO*	*T-1*

Lufthansa	*LH*	*T-2*
Luxair	*LG*	*T-1*
Norwegian	*D8*	*T-1*
Nyx Air	*OJ*	*T-1*
PLAY Airlines	*OG*	*T-1*
Qatar Airways	*QR*	*T-1*
RVL AVIATION	*REV*	*T-1*
Ryanair	*FR*	*T-1*
Ryanair	*OE*	*T-1*
Ryanair	*PNX*	*T-1*
Ryanair	*RK*	*T-1*
SAS	*SK*	*T-1*
SIGNATURE AIRCRAFT CHARTER	*SIG*	*T-1*
Smartlynx Airlines	*6Y*	*T-1*
Stobart	*RE*	*T-1*
SUNWING	*SWG*	*T-1*
Swiss	*LX*	*T-1*
Tap Air Portugal	*TP*	*T-1*
TNT AIRWAYS	*3V*	*T-1*
TRANSAVIA FRANCE	*TO*	*T-2*
TUI	*TOM*	*T-1*
TURKISH AIRLINES	*TK*	*T-1*
United Airlines	*UA*	*T-1*
UPS	*UPS*	*T-1*
Vueling	*VY*	*T-1*
Westjet	*WS*	*T-1*
Zimex Aviation	*XM*	*T-1*

Determination of Air Traffic Movements

AEDT enables two ways of entering ATM into the model:

- They can be inputted by specifying the departure/arrival time, runway end, and departure/arrival track; or
- The number of ATM associated with each type of aircraft and stage number can be inputted, along with information regarding departure/arrival capacity and capacity profiles based on different time periods. Restrictions on runway usage can be inputted into AEDT to allow for the model to assign a runway based on meteorological conditions and time of day. This information is used by AEDT to produce a 'pseudo-schedule' of annual ATMs which is used to calculate emissions.

Emissions have been modelled by enabling AEDT to produce a pseudo-schedule as opposed to specifying flight times, runway ends and tracks. The appropriate runway end for arrivals/departures strongly depends on the meteorological conditions at the time of the operation. Manually assigning ATMs to runway ends and tracks is likely to result in the assignment of a runway end or track that is inappropriate for the meteorological conditions at that time. Therefore, enabling AEDT to generate a schedule based on number of ATMs, capacity profiles and runway restrictions was considered to be more appropriate for this assessment.

Runway assignment has been based on wind direction for each hour within the meteorological data used within the model (see **Error! Reference source not found.**). The following runway assignments have been made:

- For easterly winds (0° to 180°) – aircraft will arrive at runway end N10L or 10R. This is split on a 50/50 basis and the assignment of ATM to each runway end was determined through the AEDT software. All aircraft will depart from runway 10R;
- For westerly winds (180° to 360°) – aircraft will depart from either runway N28R or 28L. This is split on a 50/50 basis and assignment of ATM to each runway end was determined through the AEDT software. All aircraft will arrive at runway 28L;
- The cross-runway (16-34) has not been considered within the model. This runway is only used in certain conditions (i.e. strong cross-winds) and therefore is in use for a small proportion of time. The use of this runway is considered to have a negligible effect on air quality and therefore has not been considered in this assessment.

Single runway operating hours have also been inputted into the model where appropriate.

Average taxi times were provided by daa for arrivals and departures. A taxi time of 7 minutes and 38 seconds was applied to all arriving aircraft, and a taxi time of 14 minutes and 52 seconds was applied to all departing aircraft.

To generate a pseudo-schedule, AEDT requires a maximum number of arrivals and departures per hour to be inputted into the model. It has been assumed that the number of arrivals and departures per hour cannot exceed the maximum number of arrivals or departures per hour outlined within the 'busy day' schedule for each assessment scenario.

AEDT also requires capacity profiles to be included. These profiles are required for quarter-hourly, daily, and monthly movements. The profiles are inputted into the model as weighted proportions of the maximum number of movements. A weighting of '1' corresponds to the maximum number of movements within the specified time-period. AEDT uses these weighted profiles and the number of ATMs to produce schedules for each day of the year using the 'delay and sequencing model'. The 'delay and sequencing model', which is built into AEDT, allows for taxi emissions to be determined and will account for the queueing of aircraft while awaiting departure.

The quarter-hourly capacity profiles have been determined using the 'busy day' schedules provided for each scenario. The maximum number of quarter-hourly movements was determined and used to produce weightings of the number of movements in each quarter-hour of the day. The maximum number of movements per quarter-hour for these profiles is based on the maximum number of movements within a quarter-hour between these two periods.

For the daily capacity profiles, it has been assumed that a 'busy day' schedule applies for all days of the week (Monday - Sunday). Therefore, the maximum weighting of '1' has been given to all days of the week. This provides a more conservative approach as in reality less aircraft movements and less queuing are expected on certain days of the week and therefore the number of aircraft movements may be lower than that which has been modelled.

Monthly capacity profiles have been based on the 2023 statistics published by the Department for Transport[5]. Monthly weightings were not applied to commercial movements, however, due to the consistency in cargo movements across all months of the year. A weighting of '1' was applied to all months for cargo movements.

Charts showing the operational quarter-hourly and monthly capacity profiles can be found in Plate 1, Plate 2, Plate 3**Error! Reference source not found.** and Plate 4.

[5] Department for Transport (2023) State Airport Aviation Statistics. Available at: https://www.gov.ie/en/collection/0e1fd9-department-of-transport-aviation-statistics-snapshot/

Plate 1: Quarter-Hourly Capacity Profile – Schedule 2

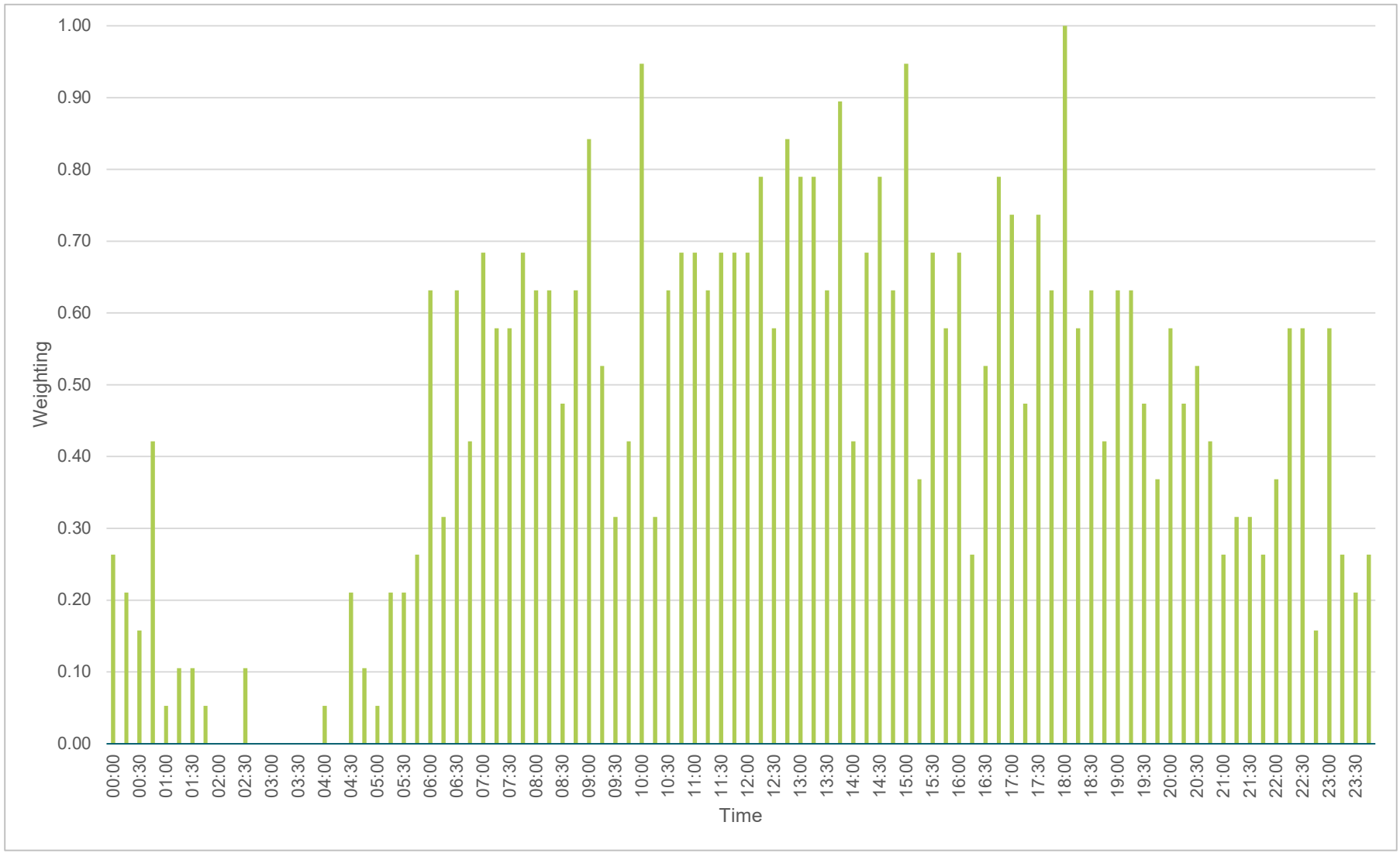


Plate 2: Quarter-Hourly Capacity Profile – Schedule 3

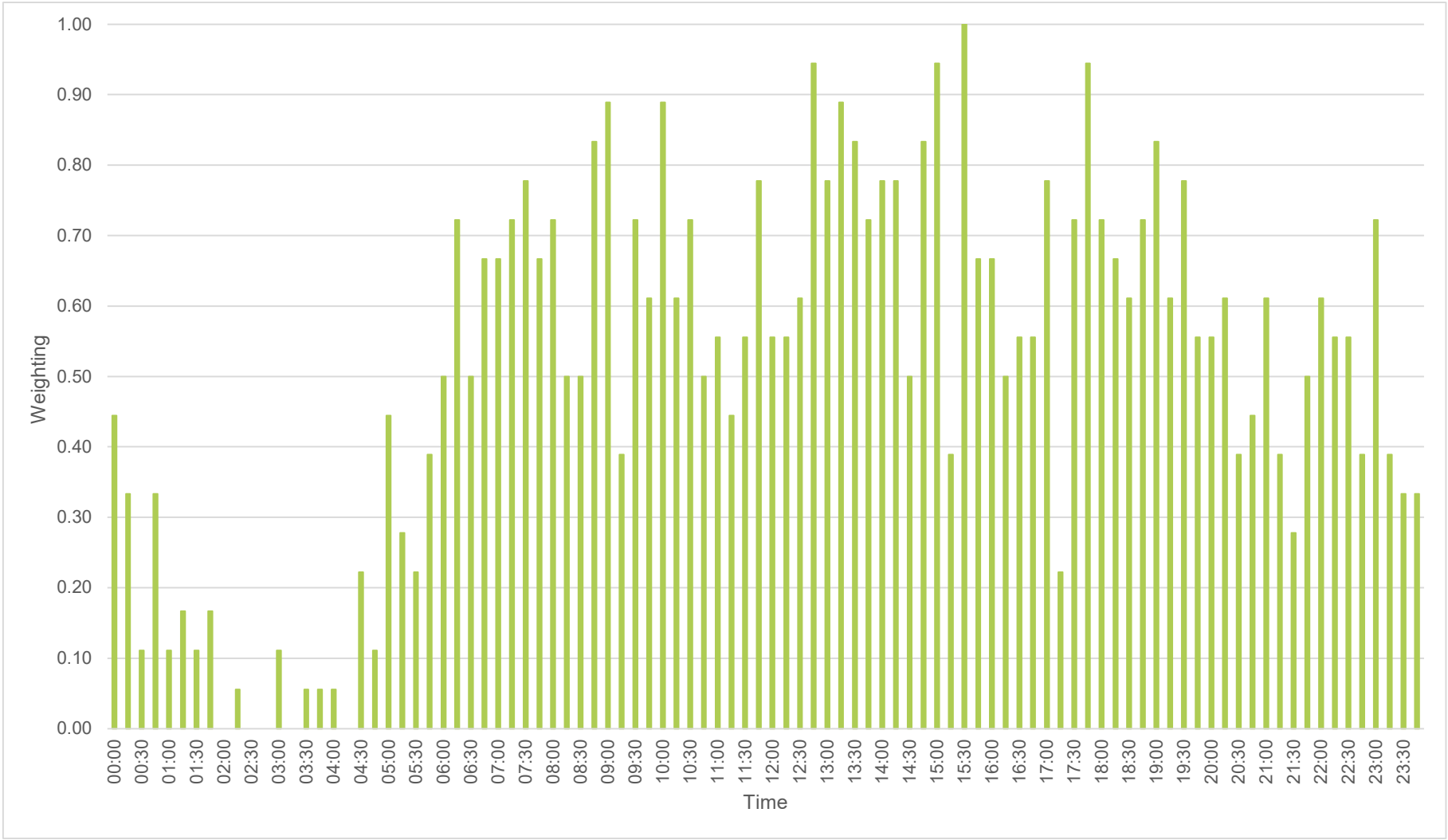


Plate 3:Quarter-Hourly Capacity Profile – Schedule 4

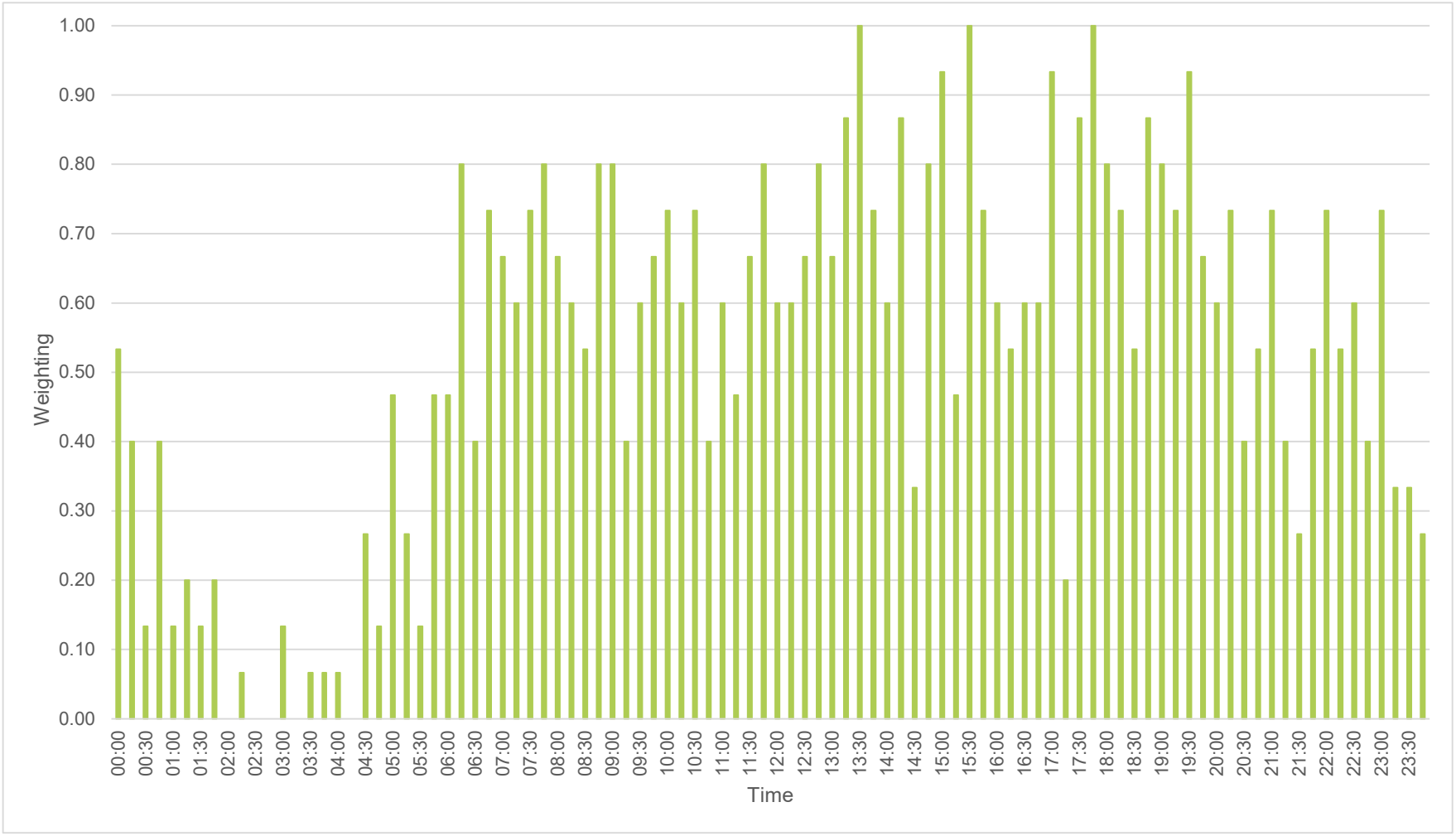
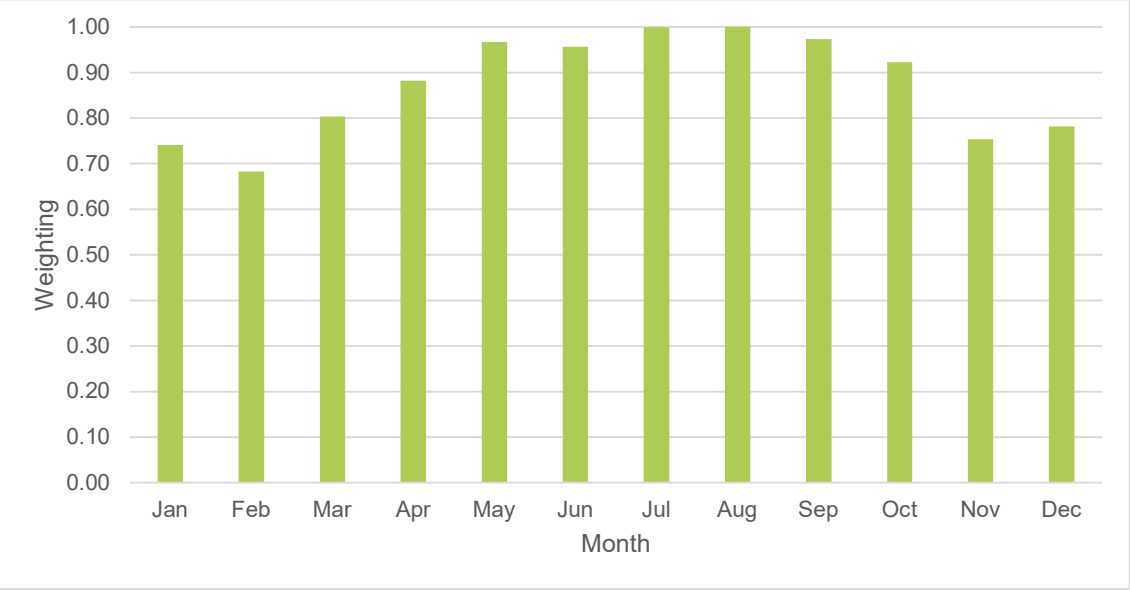


Plate 4: Monthly Capacity Profile – All Scenarios



Aircraft Emissions Data

Aircraft emissions data has been extracted from the 'ICAO Engine Emissions Databank'[6] dataset for the selected representative aircraft directly in the model.

Emissions data is based on the most recent data for emissions per aircraft (and GSE) as of 2026. Assuming emissions per aircraft (and GSE) in 2025 for scenarios in 2029 is a precautionary approach, as it means that the assessment does not account for the improving emissions technology of the evolving aircraft fleet.

Brake and Tyre Wear

PM_{10} and $PM_{2.5}$ emissions from the wear and tear of brakes and tyres on aircraft have been calculated based on methodology outlined by Curran (2006)[7]. The equations below were used to calculate PM_{10} and $PM_{2.5}$ emissions from arriving aircraft. Emissions from departing aircraft were assumed to be zero, as the wear and tear on brakes and tyres can be considered to be negligible for departures. The maximum take-off weight (MTOW) was determined for each aircraft using the BADA 4 database within AEDT. The Equation 2 assumes that 10% of PM_{10} becomes suspended.

$PM_{2.5}$ emissions are assumed to be 40% of PM_{10} emissions from brake wear, and 70% of PM_{10} emissions from tyre wear.

Equation 1. Brake Wear- PM_{10} (Kg per LTO) = $2.53 \times 10^{-7} \times MTOW$

Equation 2. Tyre Wear- PM_{10} (Kg per LTO) = $(2.23 \times 10^{-6} \times MTOW - 0.0874) \times 0.1$

PM_{10} and $PM_{2.5}$ emissions were distributed across the north and south runways. For the north runway, this was confined to the section of the runway west of the crosswind runway, where aircraft are most likely to touch-down. For the south runway, the whole runway was modelled as aircraft can arrive/depart from both sides of the runway. Emissions were modelled within AEDT and were inputted in the form of an hourly emissions source, including VOC emissions in grams per second per metres squared ($g/m^2/s$).

Ground Support Equipment Data

GSE information was utilised from the AEDT software database. AEDT stores information regarding the standard GSE associated with each type of aircraft.

[6] International Civil Aviation Organisation (2023). Engine Emissions Databank.
[7] Curran, R. (2006). Method for estimating particulate emissions from aircraft brakes and tyres.

Each aircraft was assigned a 'code' based on its wingspan. The criteria for each type of aircraft are outlined within the ICAO Aerodrome Reference Code[8] and is shown in Table 8

Table 8: ICAO Aerodrome Reference Code

Code	Wingspan
A	< 15m
B	15m but < 24m
C	24m but <36m
D	36m but <52m
E	52m but <65m
F	65m but <80m

Source: Skybray, ICAO Aerodrome Reference Code[8]

One aircraft of each type was chosen, and the associated GSE were determined using the AEDT database. It has been assumed that the GSEs associated with the chosen aircraft from each aircraft code is used for all aircraft of that same code.

In the absence of site-specific information on GSE and to provide a precautionary assessment, all GSE have been modelled as diesel or gasoline-fuelled, depending on the options available within AEDT. No electric GSE equipment has been assumed for any scenario.

The operation duration for all GSEs was estimated using standard information from AEDT. The durations outlined in AEDT have been rounded to the nearest 5 minutes. The modelled GSEs for each type of aircraft and their associated operating duration is outlined in Table 9, Table 10, Table 11, Table 12 and Table 13.

Table 9: Ground Support Equipment - Type A Aircraft

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - Stewart & Stevenson TUG MC - Aircraft Tractor	86	0.8	5
Diesel - F750, Dukes Transportation Services, DART 3000 to 6000 gallon - Fuel Truck	175	0.25	20
Diesel - TLD - Ground Power Unit	0	0.75	30

Table 10: Ground Support Equipment - Type B Aircraft

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - Stewart & Stevenson TUG MC - Aircraft Tractor	86	0.8	5
Diesel - Stewart & Stevenson TUG MA 50 - Baggage Tractor	71	0.55	10
Diesel - Stewart & Stevenson TUG 660 - Belt Loader	71	0.5	15
Diesel - Hi-Way / TUG 660 chasis - Catering Truck	71	0.53	5
Diesel - F750, Dukes Transportation Services, DART 3000 to 6000 gallon - Fuel Truck	175	0.25	20
Diesel - TLD 1410 - Lavatory Truck	56	0.25	10
Diesel - F250 / F350 - Service Truck	235	0.2	10

Table 11: Ground Support Equipment - Type C Aircraft

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - None - Air Conditioner	0	0.75	25
Diesel - ACE 180 - Air Start	425	0.9	10
Diesel - Stewart & Stevenson TUG GT-35, Douglas TBL-180 - Aircraft Tractor	88	0.8	10

[8] Skybrary (2023). ICAO Aerodrome Reference Code. Available at: ICAO Aerodrome Reference Code | SKYbrary Aviation Safety

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - Stewart & Stevenson TUG MA 50 - Baggage Tractor	71	0.55	30
Diesel - Stewart & Stevenson TUG 660 - Belt Loader	71	0.5	20
Diesel - Hi-Way F650 - Cabin Service Truck	210	0.53	20
Diesel - Hi-Way F650 - Catering Truck	210	0.53	5
Diesel - F250 / F350 - Hydrant Truck	235	0.7	20
Diesel - TLD 1410 - Lavatory Truck	56	0.25	10
Diesel - F250 / F350 - Service Truck	235	0.2	10
Gasoline - Gate Service - Water Service	0	0.2	15

Table 12: Ground Support Equipment - Type D Aircraft

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - ACE 180 - Air Start	425	0.9	10
Diesel - Stewart & Stevenson TUG GT-50H - Aircraft Tractor	190	0.8	10
Diesel - Stewart & Stevenson TUG MA 50 - Baggage Tractor	71	0.55	60
Diesel - Stewart & Stevenson TUG 660 - Belt Loader	71	0.5	20
Diesel - FMC Commander 15 - Cargo Loader	80	0.5	40
Diesel - FMC Commander 30 - Cargo Loader	133	0.5	50
Diesel - Toyota 5,000 lb - Fork Lift	55	0.3	10
Diesel - Dukes Transportation Services / DART 8000 to 10,000 gallon - Fuel Truck	300	0.25	20
Diesel - Wollard TLS-770 / F350 - Lavatory Truck	235	0.25	10
Diesel - F250 / F350 - Service Truck	235	0.2	10
Gasoline - Gate Service - Water Service	0	0.2	15

Table 13: Ground Support Equipment - Type E Aircraft

GSE Equipment (Fuel Type and Description)	Horsepower	Load Factor	Duration (minutes)
Diesel - None - Air Conditioner	0	0.75	25
Diesel - ACE 180 - Air Start	425	0.9	10
Diesel - Stewart & Stevenson TUG T-750 - Aircraft Tractor	475	0.8	10
Diesel - Stewart & Stevenson TUG MA 50 - Baggage Tractor	71	0.55	60
Diesel - Stewart & Stevenson TUG 660 - Belt Loader	71	0.5	20
Diesel - Hi-Way F650 - Cabin Service Truck	210	0.53	20
Diesel - FMC Commander 15 - Cargo Loader	80	0.5	40
Diesel - Hi-Way F650 - Catering Truck	210	0.53	10
Diesel - F250 / F350 - Hydrant Truck	235	0.7	20
Diesel - Wollard TLS-770 / F350 - Lavatory Truck	235	0.25	10
Diesel - F250 / F350 - Service Truck	235	0.2	10
Gasoline - Gate Service - Water Service	0	0.2	15

Fuel Farm

Volatile Organic Compound (VOC) emissions from the fuel farm at Dublin Airport have been calculated in AEDT using fuel farm data provided by daa. The AEDT software allows for emissions from fuel tanks to be modelled alongside aircraft emissions.

It was confirmed by daa that there are three vertical storage tanks which hold Jet A1 (aviation kerosene) fuel. Each tank was confirmed to be 20 m in diameter and 16.1 m in height.

Table 14 outlines the fuel tank parameters inputted into the AEDT model. All three tanks have been modelled with the same parameters. Sigma Z0 denotes the vertical concentration distribution of the emissions plume at the source. This has been assumed to be 0 m as the floating roof would inhibit any vertical momentum the emissions plume. Sigma Y0 denotes the horizontal distribution of the emissions plume at the source. The AERMOD User Guide published by the United States Environmental Protection Agency[9] states that Sigma Y0 for single volume sources is calculated using the length of side divided by 4.3.

Table 14: Fuel Tank Model Parameters

Tank Type	Release Height (m)	Sigma Z0 (m)	Sigma Y0 (m)	Diameter (m)
Internal Floating Roof - Uncontrolled	16.1	0	4.6	20

Table 15 outlines the annual throughput of jet fuel for each scenario. Fuel usage of each aircraft was calculated using the schedules provided by Mott MacDonald on behalf of daa, using the expected stage length and the fuel usage for this distance taken from the AEDT database.

Table 15: Fuel Tank Annual Throughput (kL)

Tank	Location (x,y)	Annual Throughput of Fuel per Fuel Tank (kL)
Schedule 2 – 36.4 mppa		
Fuel Tank 1	717480, 742922	516,255.36
Fuel Tank 2	717467, 742893	516,255.36
Fuel Tank 3	717453, 742863	516,255.36
Schedule 3 – 40 mppa		
Fuel Tank 1	717480, 742922	583,600.57
Fuel Tank 2	717467, 742893	583,600.57
Fuel Tank 3	717453, 742863	583,600.57
Schedule 4 – 32 mppa		
Fuel Tank 1	717480, 742922	464,341.00
Fuel Tank 2	717467, 742893	464,341.00
Fuel Tank 3	717453, 742863	464,341.00

It was assumed that the total fuel used across the airport for each scenario was evenly distributed across the three fuel tanks. The use of fuel tank followed the same capacity profiles as the commercial aircraft movements, with summer movements being more active than winter months.

Odour

There is currently no standard approach for assessment of odour impacts associated with aircraft operations. A general approach to modelling odour impacts was undertaken at Copenhagen Airport[2]. The study assumed a linear relationship between odour and hydrocarbon (HC) emissions, and which were quantified from actual fuel flow and engine emissions from aircraft engines.

It was determined from the study that the majority of odour emissions occurred when an aircraft has lower thrust settings. The calculation of odour concentrations from aircraft within this assessment has been calculated using an emission factor of 57 odour units (OU_E) per milligramme of HC for all aircraft operations. This emission factor has been applied to all to hydrocarbon and VOC outputs. The study undertaken at Copenhagen Airport identified that the emission factor of 57 OUE/mgHC was within a range of 23 OUE/mgHC to 110 OUE/mgHC. Sensitivity calculations have been undertaken to assess the odour impacts using the full range of odour emission factors. The results of these calculations are presented in Appendix 7-4.

[9] United States Environmental Protection Agency (EPA). User's Guide for the AMS/EPA Regulatory Model (AERMOD).

VOC emissions from the fuel farm at Dublin Airport were calculated within the AEDT model and were quantified using the total amount of fuel used by aircraft in each scenario.

In addition to odour impacts from all stages of the LTO, odour impacts from the refuelling of aircraft was calculated using methodology from the ICAO manual[1]. VOC emissions were calculated using the Equation 1 outlined below. Only emissions from departure operations were calculated as aircraft within arrival operations are refuelled at their departure airport. It was assumed all refuelling would occur via hydrants as opposed to fuel trucks in the assessment years. Dublin Airport currently have hydrant systems installed at Pier 1[10] and Pier 4[11], with plans to extend the hydrant system to Pier 2 and Pier 3[12]. It is assumed that the hydrant system will be implemented at Pier 2 and Pier 3 by the Principal Assessment year of 2029.

Equation 3. Emissions [g VOC] = $\Sigma_{\text{fuel types}}$ (($\text{fuel}_{\text{hydrant delivered}}$ [kg] + 2 × $\text{fuel}_{\text{tanker delivered}}$ [kg]) × emission factor [g/kg])

An emission factor of 0.01 gVOC/kg fuel was used to determine VOC emissions. This emission factor is based on a study undertaken in Zurich and is outlined in Table 3-A2-6 of the ICAO manual[1].

VOC emissions were calculated for each terminal and were distributed across the whole apron. Emissions were modelled within AERMOD and were inputted in the form of an hourly emissions source, including VOC emissions in grams per second per metres squared (g/m^2/s).

AEDT Model

Dispersion Model Setup

General model settings used for the dispersion modelling are presented in Table 16 and discussed in more detail below.

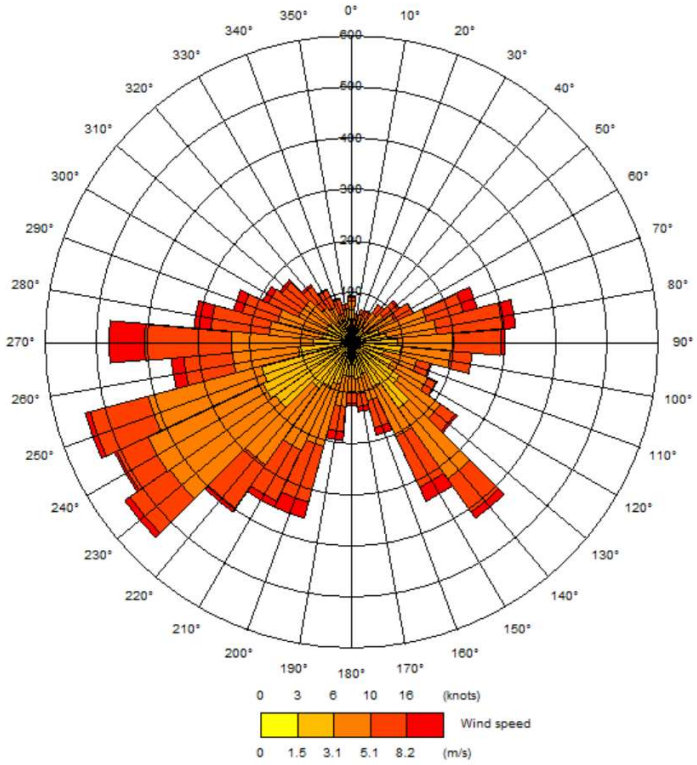
Table 16: General AEDT Input Parameters

Variables	AEDT Input
Latitude	53.4
Surface roughness at source (m)	0.025
Surface Roughness at met site (m)	0.025
Terrain types	No Terrain used; model area is assumed to be flat
Pollutants	NO_X, PM_{10}, $PM_{2.5}$, SO_2, VOCs, CO, THCs
Emission Factors	Emission factors for aircraft based on AEDT database
Meteorological data	1 year (2025) hourly sequential data from Dublin Airport (see **Error! Reference source not found.**)
Emission profiles	Profiles of aircraft LTO cycles applied to both day and night-time flights
Receptors	Selected human health sensitive and nature conservation sensitive receptors
Model output	Long-term annual mean and short-term hourly mean NO_X and SO_2 concentrationsLong-term annual mean and short-term 24 hour mean PM_{10} concentrations Long term VOC and THC concentrations

[10] Clare Civil (2019) Fuel Hydrant Loop Installation Project – Pier 1 Dublin Airport. Available at: https://www.clarecivil.ie/projects/detail/fuel-hydrant-loop-installation-dublin-airport.html#:~:text=This%20project%20formed%20part%20of,Pier%201%20at%20Dublin%20Airport.
[11] daa (2018) Dublin Airport's New Fuel Farm Opens. Available at: https://www.dublinairport.com/latest-news/2019/05/31/dublin-airport%27s-new-fuel-farm-opens#:~:text=The%20fuel%20hydrant%20system%2C%20which,a%20pit%20in%20the%20ground.
[12] Commission for Aviation Regulation (2019). Maximum Level of Airport Charges at Dublin Airport 2020-2024, Draft Determination.

Meteorological Data

Plate 5: 2025 Wind Rose Plot for Dublin Airport



AERMOD meteorological files are required for emissions dispersion in AEDT. This includes the input of surface air data and upper air data. AERMET v12 (AERMOD Meteorological Preprocessor)[13] was used to process meteorological data into AERMOD format from available data sources.

Meteorological data for Dublin Airport in 2025 was available in ADMS format. The processing tool within AERMOD was utilised to convert this data into a SAMSON format, which was inputted into AERMET to generate surface air data in the appropriate format.

No upper-air sounding data was available for Dublin Airport in any recent years, an upper-air sounding from Castor Bay in 2025 was considered to be representative of locations on the east coast of Ireland and was used in this assessment. Upper air[14][illegible]. This was input into AERMET to generate upper air data in the correct format.

Receptor Locations

The AEDT model predicts the airside emissions contribution to pollutant concentrations at selected air quality receptors sensitive to effects on human health and ecology.

The receptors considered in the assessment have been selected based on their proximity to the airport and the airside emission sources modelled, and/or proximity to a road affected by the Proposed Order and the landside road traffic emissions source.

The selected receptors considered in this assessment are listed in Tables 3 and 4 of Appendix 7-1. Not all potential receptors are included in the assessment. Instead, those that are included are representative of other potential receptors in their vicinity. Receptors have been chosen to capture the worst-case impact from each emission source modelled.

[13] US Environmental Protection Agency (2023) User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Available at: https://gaftp.epa.gov/Air/aqmg/SCRAM/models/met/aermet/aermet_userguide.pdf
[14] National Oceanic and Atmospheric Administration and Global Systems Laboratory (2022). NOAA/GSL Radiosonde Database. Available at: https://ruc.noaa.gov/raobs/

Background Concentrations

The background pollutant concentration data used in this assessment is described and presented in Table 5 and 6 of Appendix 7-1.

NO_x to NO_2 Conversion

NO_X to NO_2 conversion for Principal Assessment is informed by DEFRA's NO_X to NO_2 calculator[15], a tool recommended for the conversion of NO_X to NO_2 in Transport Infrastructure Ireland (TII) guidance[16]. The TII guidance recommends that the Armagh, Banbridge and Craigavon District Council area is used to represent NO_X and O_3 conditions in Ireland. In addition to this, a study published by the UK National Atmospheric Emission Inventory[17] considered the NO and NO_2 fraction of airside emissions factors based on an emissions inventory at Heathrow Airport. In the study, conversion factors were calculated for all stages of the LTO, with a recommended NO:NO_2 fraction of 85:15. A primary NO_2 fraction of 0.15 was manually assigned within the NO_X to NO_2 calculator.

Results

Total pollutant concentrations and deposition rates for each scenario modelled are presented in Appendix 7-3. The results presented for the pollutants NO_2, PM_{10}, $PM_{2.5}$, NO_X and nitrogen deposition are the combined contribution from airside and landside sources. Total pollutant concentrations are the contribution from one of or both of the airside and landside sources of emissions, plus the background contribution.

[15] Department for Food, Environment and Rural Affairs (2020), NOx to NO2 Calculator v8.1
[16] TII (2022), Air Quality Assessment of Specified Infrastructure Projects – Overarching Technical Document, PE-ENV-01106
[17] UK National Atmospheric Emissions Inventory (NAEI), 2012. Primary NO_2 Emission Factors for Aviation and Other Transport Sources. https://naei.energysecurity.gov.uk/sites/default/files/2024-05/3_9_324_136262_primary_no2_emission_factors_for_aviation_and_other_transport_sources_2010naei_v1.pdf