D4

AIRSPACE AND AIRCRAFT RELATED NOISE

AIR QUALITY AND GREENHOUSE GAS EMISSIONS

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GLOSSARY

Units	
$\mu g/m^3$	Microgram per cubic metre
t	metric tonne
Nomenclature	
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalents
NO_2	Nitrogen dioxide
N_2o	Nitrous Oxide
NO_x	Oxides of nitrogen
O_3	Ozone
PM	Particulate matter
$PM_{2.5}$ and PM_{10}	Particulate matter with an aerodynamic diameter less than 2.5 or 10 micrometres, respectively
SO_2	Sulfur dioxide
THC	Total hydrocarbons
VOC	Volatile organic compounds

4.1
INTRODUCTION

This chapter presents the air quality and greenhouse gas assessment of aircraft operations associated with the Project. The chapter describes methodologies, input information, quantifies potential emissions from aircraft operations, dispersion modelling configurations and assesses predicted ground-level concentrations of air pollutants against regulatory objectives.

The potential impacts on air quality due to aircraft operations related to the Project were considered for current and predicted future air traffic levels. The existing air quality in the region was described in terms of ambient air quality monitoring data that has been collected by the Department of Environment and Heritage Protection (DEHP). Existing emissions to air associated with industry in the area and current Sunshine Coast Airport (SCA) operations have also been used to characterise existing air quality.

A greenhouse gas assessment of aircraft operations is also presented in this chapter. Estimates were made of current emission levels as well as emissions based on forecast air traffic levels. Greenhouse gas emissions from aircraft operations are under the direct control of individual airlines and as such fall under the Scope 3 carbon accounting category.

4.2
METHODOLOGY AND ASSUMPTIONS

This section describes the process that was used to estimate existing and future emissions of air pollutants including greenhouse gases (GHGs) from aircraft activities associated with the Project. The estimation methods are described initially along with the sources of input data before the assumptions and limitations of the analysis are outlined.

4.2.1 Methodology

The emission of air pollutants including greenhouse gases from aircraft associated with the Project is dependent upon the number and type of aircraft movements. The methodologies used to estimate the existing air quality, aircraft movements and the subsequent estimation of emissions are presented in the following sections.

4.2.1.1 Existing air quality

Data from the DEHP monitoring network was analysed to provide an indication of ambient background levels of air pollutants in the region. Potential sources of air pollutants in the region were identified including industries that report to the National Pollutant Inventory (NPI) in the region. More detail is provided in Chapter B16 – Air Quality and GHG Emissions.

4.2.1.2 Aircraft movements

For the purposes of this chapter one aircraft movement is defined as either an arrival or a departure. Aircraft movements for the present (2012) and future scenarios (2020, 2030 and 2040) were taken from forecasts made by Leading Edge Aviation Planning Professionals (LEAPP, 2012).

In the LEAPP report, movements were reported for commercial aircraft, general aviation fixed wing and helicopters operating out of SCA for 2012 and forecast for 2020, 2030, 2040 and 2050. **Table 4.2a** shows the annual movements for 2012 and the forecast scenarios. This data was used as the basis for emissions estimation in this assessment.

Detailed flight data for SCA over the period November 2011 to April 2012 were supplied by Airservices Australia's (Airservices) Safety and Assurance Group. Aircraft were classified into commercial, general aviation and helicopters categories, to align with the LEAPP report forecasts. This data was used to develop a distribution of typical aircraft operating out of SCA that was combined with the LEAPP forecast movements for use in calculating emissions. **Appendix D4:A** shows the number of recorded flights and classification of each into the commercial, general aviation and helicopter categories.

4.2.1.3 Emissions estimation

Air quality

Aircraft have the potential to impact on air quality through the emission of pollutants associated with the combustion of fuel. The most important air pollutants are carbon monoxide (CO), oxides of nitrogen (NO_X), sulfur dioxide (SO_2) particulate matter (PM) and to a lesser extent, volatile organic compounds (VOCs). Emissions of these pollutants from aircraft operating out of SCA were estimated using the movement information described above and the emission factors contained in the Emissions and Dispersion Modelling System (EDMS) (FAA, 2010).

EDMS was originally developed in the mid-1980s for the Federal Aviation Administration Office of Environment and Energy, Washington, DC, to assess the potential air quality impacts of airport and military airbase emission sources. It is specifically engineered for the aviation community, and can be used to calculate emissions and model the dispersion of these emissions using site-specific meteorological data. EDMS version 5.1.3, released in November 2010, was used in this assessment.

Emissions can be calculated for aircraft, auxiliary power units, ground support equipment and vehicles and stationary sources. Emission factors for aircraft engines are sourced from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank. Emissions take into account the different engine operations during start-up, taxiing, takeoff, climb out and approach. EDMS was used to calculate the emissions associated with each aircraft in the vicinity of the SCA (up to 3,000 feet).

EDMS contains emission factors for particulate matter for ICAO certified engines only. For other engine types, particulate matter emissions were calculated using Airports Council International (ACI) emission factors from the Airport Carbon and Emissions Reporting Tool (ACERT) (Simpson, 2012). The non-ICAO aircraft and corresponding ACERT emission factors used are detailed in **Appendix D4:A**.

The detailed flight data supplied by Airservices was input into EDMS to generate annual emission rates. The total emission rates were then scaled according to the annual movements forecast in the LEAPP report.

VOC emissions due to aircraft refuelling, which are not calculated by EDMS, and the fuel storage facility were also calculated using emission factors from the NPI.

Greenhouse gas

The climate impact of air travel is a combination of the combustion of aircraft fuel causing GHG emissions and additional effects parameterised by the aircraft Radiative Forcing Index (RFI, see **Section 4.2.2.4** for more details). **Table 4.2b** presents the emission factors used in this assessment in terms of the emissions attributed to a single passenger on an aircraft for each kilometre of travel. These factors do not take into account the RFI.

Detailed information is available on the estimated fuel consumption for the Landing/Take-Off (LTO) cycle for individual aircraft. For this study, fuel consumption for the LTO cycle for individual aircraft types was sourced in the first instance from the IPCC (2006) then from the ACERT v1.0 'Do-it-yourself airport greenhouse gas emissions inventory

Table 4.2a: Annual movements, 2012 and forecast to 2040

Flight type	2012	2020	2030	2040
Commercial	5,559	8,900	13,660	18,210
General Aviation	25,168	29,370	35,630	35,630
Helicopter	60,302	70,390	85,390	85,390

Table 4.2b: Emission factors for whole flights on a per passenger kilometre basis

Distance category for flights	Minimum distance (km)	Maximum distance (km)	Emission factor kg $CO_{2\text{-}e}$ per passenger km	Source
Domestic haul	0	400	0.219	MoE BC, 2012
Short haul	401	1,000	0.200	Defra, 2012
Medium haul	1,001	3,700	0.110	Defra, 2012
Long haul	3,701	N/A	0.130	Defra, 2012
Helicopter	N/A	N/A	0.447	MoE BC, 2012

Table 4.2c: NGA factors for aviation fuel consumption

Fuel combusted	**Energy (GJ/kL)**	**Emission factor (kg CO_2-e/GJ)**		
		CO_2	**CH_4**	**N_2O**
Aviation gasoline for use as a fuel in an aircraft	33.1	66.3	0.04	0.7
Kerosene for use as fuel in an aircraft	36.8	68.9	0.01	0.7

Table 4.2d: Origin/destination based GHG emission factors

Origin / destination	**Distance (km)**	**No. passengers (average)**	**GHG emissions for single trip**	
			LTO CO_2-e (t)	**Flight CO_2-e (t)**
Domestic				
Sydney	832	128	2.50	21.2
Melbourne	1450	126	2.51	20.1
Brisbane	85	33	0.81	1.6
Other	600	27	0.63	3.2
Local	0	11	0.81	0.8
Asian				
China	7,210[a]	262	10.29	245.6
Asia	5,690[a]	262	10.29	193.8

a *Average distance to origin/destination*

tool' (Simpson et al., 2012). Where information for a specific aircraft type was unavailable, it was matched as closely as possible to an available IPCC or ACERT type (details are presented in **Appendix D4:A**).

The greatest volume of fuel used by aircraft operating out of SCA is in the form of kerosene (jet fuel) used in jet and turboprop engines. Smaller, general aviation aircraft such as single engine Cessnas have piston engines that use aviation gasoline (avgas). The Australian Government publishes emission factors for these fuel types as part of the Australian National Greenhouse Accounts (NGA) factors (Commonwealth of Australia, 2013). **Table 4.2c** presents the factors for energy and individual GHG emissions (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)).

Drawing on the six month detailed flight movement data, specific origin/destination GHG emission factors for flight emissions and LTO emissions were calculated to use as a basis for forecasting future emissions. **Table 4.2d** presents these factors. GHG emissions were divided equally between the origin and destination airports. For the majority of flights this meant that SCA was assigned half the GHG emissions. In some cases, predominantly training flights, SCA was both origin and destination and therefore was assigned the entire GHG emissions for those trips.

Note that Sydney has been classified as short haul (between 400 and 1,000 kilometres) whereas Melbourne has been classified as medium haul (between 1,000 and 3,700 kilometres). Due to the different emission factors, the total flight emissions for Sydney and Melbourne are similar, despite Melbourne's relatively greater distance.

Figure 4.2a presents a proportional breakdown of aircraft type for routes based on the detailed six-month flight records for November 2011 to April 2012 and including aircraft that made ten or more trips during this period. The 'Other' group of destinations is dominated by regional places including Clermont, Theodore, Gold Coast, Townsville, Toowoomba and Middlemount. Much of this traffic serves Fly In Fly Out resources sector activity. **Figure 4.2a** shows that trips to Sydney and Melbourne are made by A320 and B737 jetliners, while trips to Brisbane and regional destinations are nearly exclusively served by turboprops.

4.2.1.4 Dispersion modelling

The site-specific meteorological data for this study was generated by coupling The Air Pollution Model (TAPM), a prognostic mesoscale model developed by CSIRO, to CALMET, a diagnostic model. The coupled TAPM/CALMET modelling system was developed by Katestone to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale

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Figure 4.2a: Composition of commercial aircraft by number of movements grouped by origin/destination (excluding aircraft with less than 10 movements)

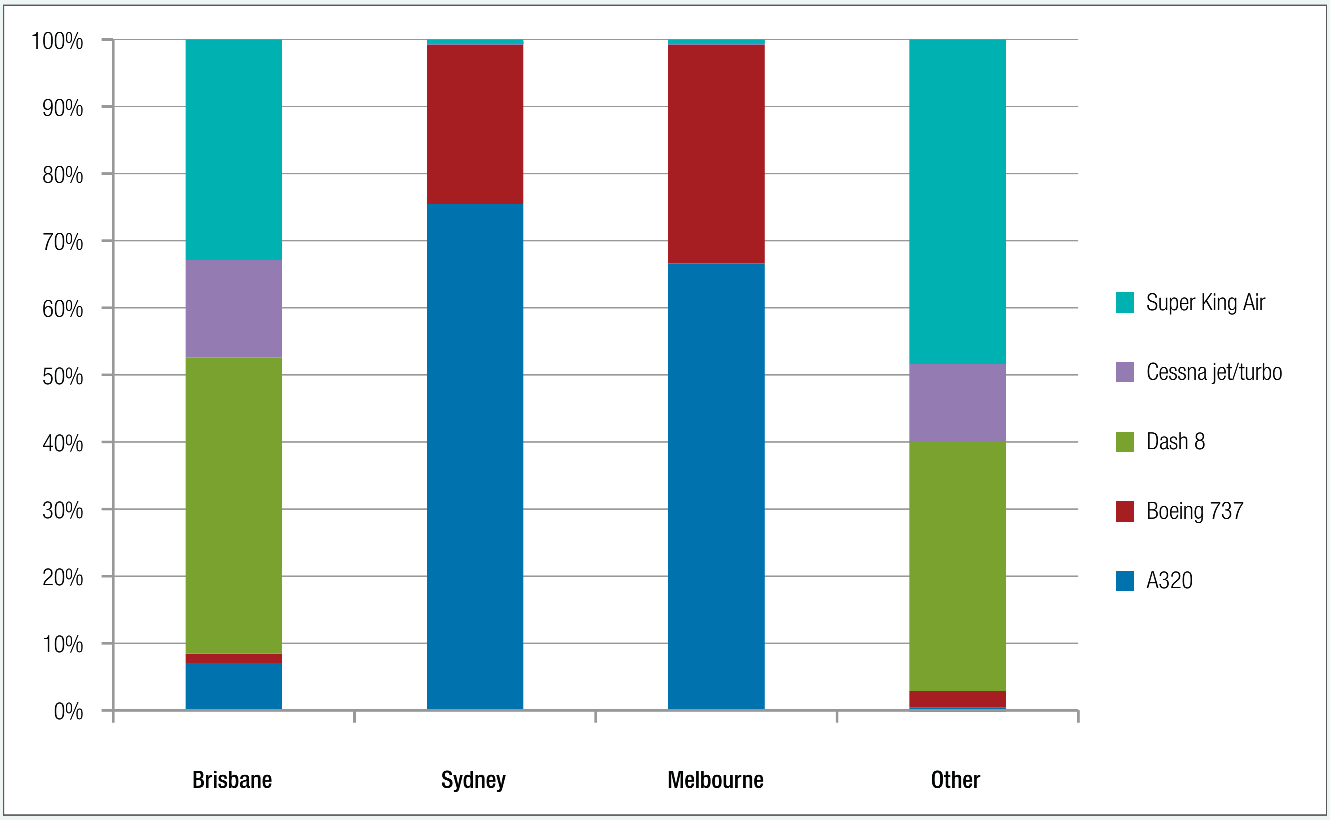
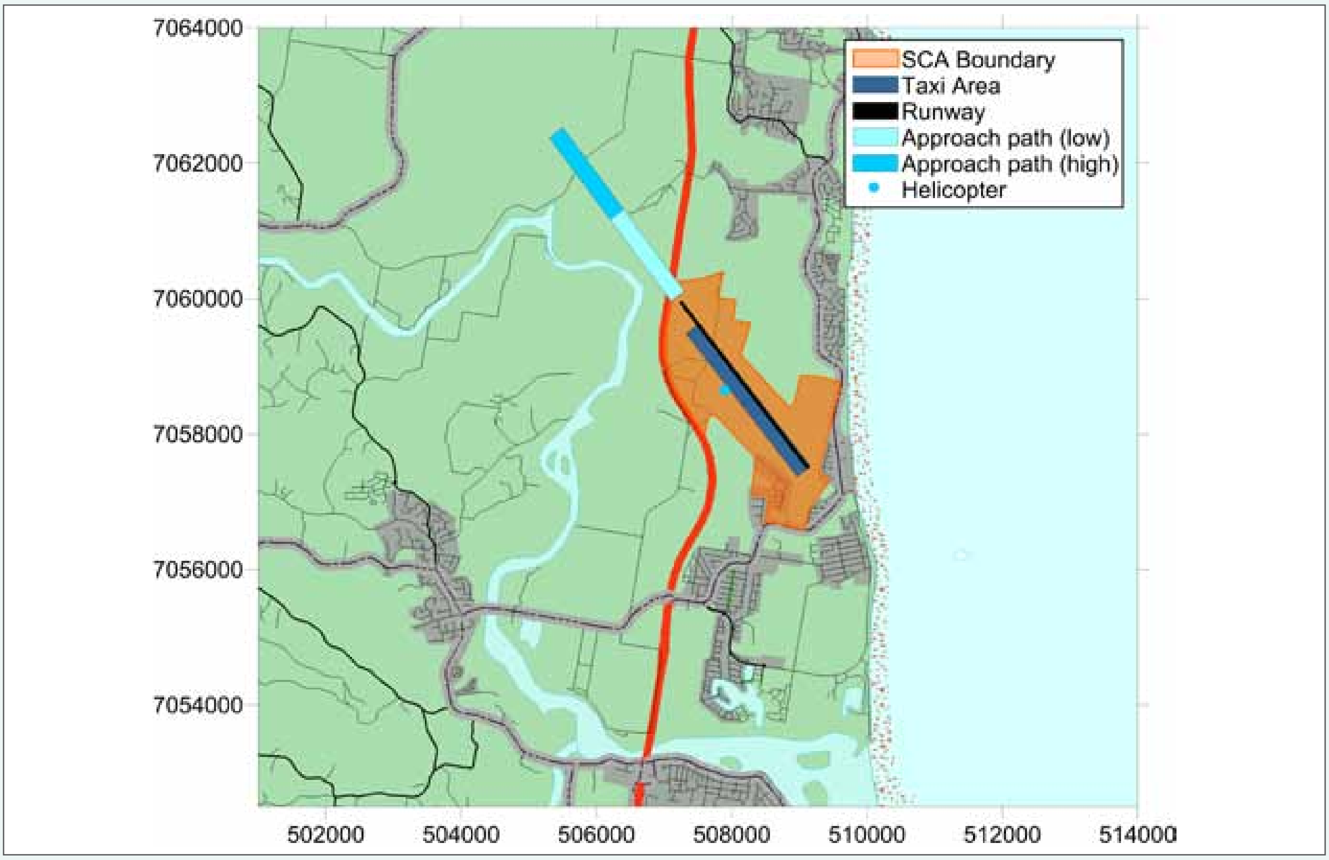


Figure 4.2b: Modelled source locations



meteorology for input into pollutant dispersion models, in this case CALPUFF v6.267. Details of the TAPM, CALMET and CALPUFF setups are provided in Chapter B16 – Air Quality and GHG Emissions – **Appendix B16:A**.

To assess the potential maximum impact of the Project on local air quality, the 2040 scenario was modelled using CALPUFF. The model was used to predict ground-level concentrations of the main pollutants emitted by aircraft associated with operations of the Project. The emission rates were calculated as described above and input into the model using the following approach:

- Emissions were subdivided into taxi, takeoff and approach/climbout sections
- The aircraft taxi emissions were assigned to the taxi and runway areas
- The aircraft takeoff emissions were assigned to the new runway area
- The approach/climbout emissions were assigned to areas, 100 m and 250 m above ground, stretching 3 km in total past the western end of the runway
- Helicopter emissions were assigned to a range of heights

Sources are located as shown in **Figure 4.2b** and full model setups are provided in **Appendix D4:B**.

The busy day scenario in Chapter A2 was used to generate an activity profile for a worst-case day. **Figure 4.2c** shows the profile in terms of the percentage of a day's emissions that was attributed to each hour for the 2040 scenario. As can be seen in the profile, no aircraft activity occurs at the airport at night between 10pm and 6am, and there are two main peaks of activity, between 12pm and 1pm and between 7pm and 8pm. The dispersion modelling for emissions from the aircraft exhaust, and VOC emissions due to aircraft refuelling took this activity profile into account. VOC emissions from filling the on-site fuel storage tanks were modelled with a constant emission rate as fuelling times will be variable, potentially occurring throughout the day and night.

4.2.2 Assumptions and technical limitations

The following sections describe the assumptions that have been made in performing the air quality and greenhouse gas assessments.

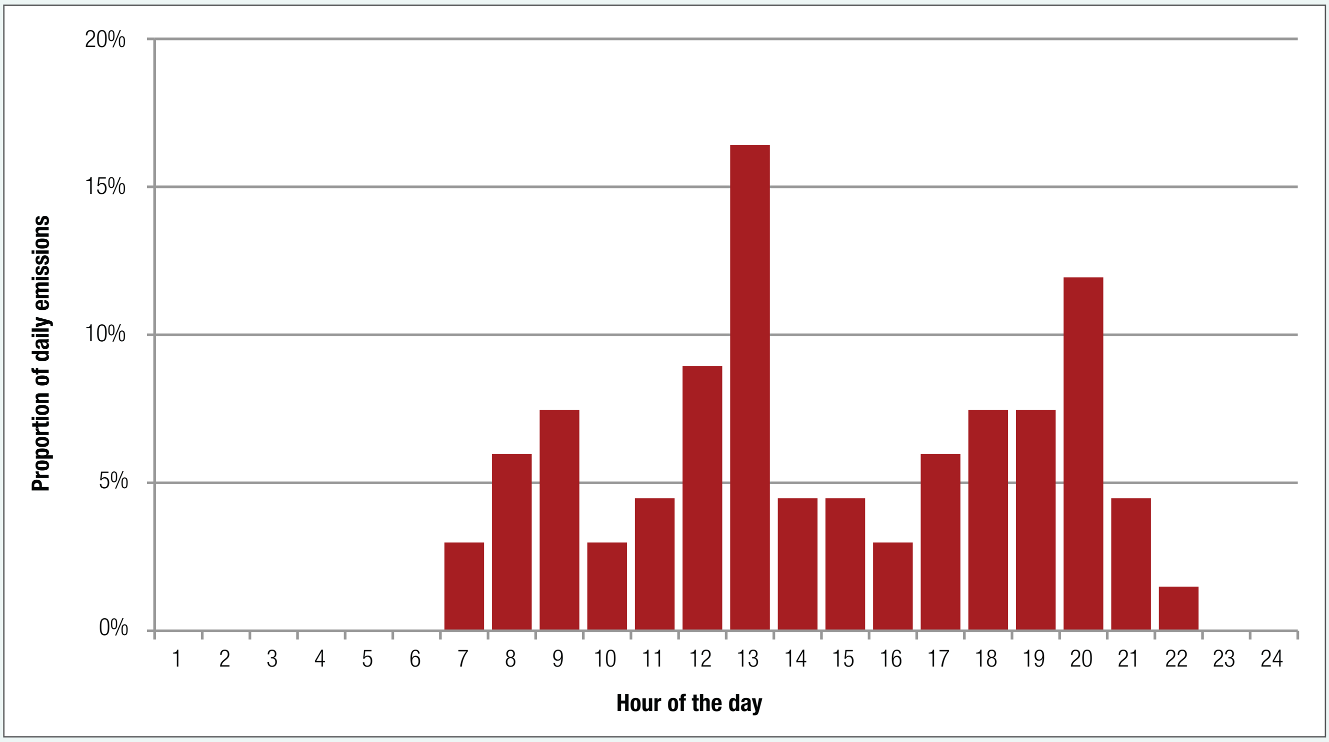
4.2.2.1 Existing air quality

Aircraft emissions for the 2040 scenario were compared to estimates of current aircraft emissions and current industry emissions reported to the NPI. No attempt was made to predict the changes in industrial emissions between now and 2040.

4.2.2.2 Aircraft movements

Aircraft movements calculated for each year were assumed to be equivalent to the movements in the six months of data supplied by Airservices, scaled according to the total annual movements supplied by LEAPP for each aircraft category (Commercial, General Aviation or Helicopter). All fixed wing aircraft with a capacity greater than 10 passengers were classified as commercial, with the remaining flights classified as either helicopters or general aviation. Radar records may not contain all incoming and outgoing aircraft due to data recording or coverage issues; however, it was assumed that the dataset contained a representative sample of aircraft

Figure 4.2c: Worst case daily activity profile for 2040



using SCA. This data was not used to determine total flight numbers, only the typical proportions of aircraft within each category.

About 88 per cent of the aircraft listed in the supplied data were entered into the EDMS. The remaining 12 per cent included aircraft types that used the airport once a month or less, and aircraft models that could not be found within the EDMS.

As older aircraft are replaced, it is expected that improvements in engine technology will lead to reductions in emissions. However, as the reduction in emissions cannot be quantified at this point, no additional plane types were introduced into EDMS. Therefore, the emissions profile of the future fleet was assumed to be the same as the current profile. This approach will lead to an overestimate of future emissions.

Where multiple engine types were available for an aircraft in the EDMS database, the default engine type was selected whenever possible. In situations where this was not possible, the engine type for an aircraft was selected from the range of possible options.

Ground support equipment and auxiliary power units were not included in the estimation of emissions from aircraft activities; however Chapter B16 includes an assessment of this equipment.

VOC emissions from ground support equipment and auxilliary power units are negligible compared to other VOC emission sources and have not been assessed further.

All flights were assumed to fit into the busy day scenario activity profile. This approach does not take into account a possible increase in unscheduled and light aircraft movements that may occur during periods of lower commercial demand. This will overestimate emissions during the peak hours, and therefore provide a conservative estimate of short-term impacts.

EDMS calculates emissions to a height of 3,000 ft, based on the assumption that this is the size of the mixing height.

4.2.2.3 Emissions

Air quality

Emission rates of PM_{10} and $PM_{2.5}$ were assumed to be equivalent to total particulates. Particulate matter emitted from aircraft can be classified into a number of groups, depending on the size of the particles. PM_{10} is defined as all particulate matter with an aerodynamic diameter of 10 µm or less. $PM_{2.5}$ is similarly defined as all particulate matter with an aerodynamic diameter of 2.5 µm or less and is a subset of PM_{10}. Combustion particles, such as those emitted by aircraft, are generally made up predominantly of particles falling into the $PM_{2.5}$ category. This assessment has assumed that all emitted particulate matter is both $PM_{2.5}$ and PM_{10} and, hence, will overestimate the potential impacts associated with emissions of particulate matter.

Greenhouse gas emissions

Emissions of GHGs from aircraft can be assigned to an airport in a number of different ways. Typically, only those emissions associated with the LTO phase are assigned as Scope 3 emissions. However, as SCRC is interested in understanding the full impact of the Project on emissions of GHG, emissions from the whole of the flight have also been accounted for in this assessment.

Greenhouse gas emissions attributed to aircraft operations are based on the number of passengers and the distance travelled. The basis for estimating commercial GHG emissions was the table of passenger-kilometre emission factors provided in **Table 4.2b**. As explained in **Section 4.2.1.3**, the use of passenger-kilometre factors required the estimation of passenger numbers and distances travelled. Passenger numbers were based on the normal seating configurations of aircraft together with average passenger number statistics. Distances were based on generalised origins/destinations, namely: Sydney, Melbourne, Brisbane, Other and Local (including training flights) – as well as ‘China’ and ‘Asia’ added for future international flights.

Emissions estimates for future air travel required an assumption about the distance travelled by passengers to new destinations. Due to the difficulty in quantifying the distance travelled by future passengers on trips to Asia, a simplified assumption was made based on a selection of several locations. These locations were generally based on present day air traffic from the Brisbane Airport (Brisbane Airport Corporation, 2012; p. 22). **Table 4.2e** summarises the assumptions made on distances travelled to destinations to China and other locations in Asia. It was further assumed that the trips to China and Asia would be made by Boeing 747 carrying 262 passengers.

Table 4.2e: Basis for approximating distances to future Asian destinations from SCA

Nominal destination	Real destinations	Distance
China	Hong Kong	6,860
	Guangzhou	6,980
	Beijing	8,320
	Taipei	6,680
	Average	7,210
Asia	Bangkok	7,420
	Kuala Lumpur	6,450
	Singapore	6,100
	Denpasar, Bali	4,460
	Manila	5,730
	Port Moresby	2,010
	Seoul	7,640
	Average	5,690

The passenger-kilometre emission factors were based on individual passengers and statistics for average occupancy of aircraft on various routes (ICAO, 2012). To use these factors for movements of whole aircraft one needs to know aircraft occupancy. **Table 4.2f** shows the average occupancies for routes relevant to SCA. This GHG assessment used the average of these, 74 per cent, to determine passenger numbers from the total passenger capacities of individual aircraft (see **Appendix D4:A**, Table A1). However, emission predictions are very sensitive to occupancy for low passenger capacity aircraft. Therefore, all aircraft with seating for less than 20 passengers were assumed to be full for the purposes of emissions calculation.

Table 4.2f: ICAO passenger load factors for select relevant routes with narrow body jets (2010 data) (ICAO, 2012, p. 12)

Route	Load factor
Local Asia	69%
North & Mid Pacific	78%
South Pacific	75%
Average	74%

The composition of commercial air traffic between SCA and the main current destinations varies considerably. This has an effect on reported GHG emissions due to the differing aircraft types used, the relatively greater influence of the LTO in shorter flights and the distance 'bands' adopted for per-passenger-kilometre emission factors.

Training flights may not necessarily reach the height assumed in the LTO fuel consumption calculations; however, the full LTO cycle was conservatively applied to all flights.

Using two approaches to estimate emissions – LTO fuel consumption and passenger kilometre factors – gave rise to some inconsistencies, notably in short distance flights where the overall flight emissions tended to be underestimated. LTO emissions are inevitable and can be determined with more certainty than the whole of flight emissions. This study assumed that the LTO fuel consumption emission factors were a better estimate than the passenger kilometre factors.

Actual LTO emissions are logically less than the whole flight emissions. Information was available on the proportion of a total flight's fuel consumption that would comprise the LTO fuel consumption for certain flight distances (European Environment Agency, 2001). A 231 kilometre (125 nautical mile) flight in a Boeing 737 was selected as a reference point, where LTO fuel consumption comprised 51 per cent. For flights where the LTO fraction of GHG emissions was greater than 51 per cent of overall flight emissions a correction was applied to increase flight emissions to an amount where the LTO proportion would comprise 51 per cent of flight emissions. The correction was applied to records where:

- They were not local flights (departing and arriving at SCA, where flight emissions were assumed equal to LTO emissions)
- The distance was less than or equal to 231 kilometres
- The LTO emissions were higher than 51 per cent of flight emissions.

Emissions of total VOCs due to the fuel storage facility and aircraft refuelling activities were calculated based on the busy day scenario activity profile and emission factors for airport activities based on data for Melbourne Airport (DEWHA, 2008). The emission factor for Avgas was used for all aircraft movements. This provides a conservative assessment, as jet kerosene has negligible evaporative emissions (Alamo Area Council of Governments, 2012). EDMS speciates aircraft emissions into a range of VOCs. Those VOCs with air quality criteria in the Air EPP were modelled. EDMS can also be used to calculate speciated VOC emissions from fuel storage. While the more conservative NPI emission factors were used to calculate fuel storage emissions, the speciation from EDMS was used to calculate emissions of individual VOCs from fuel storage and aircraft refuelling.

4.2.2.4 Radiative Forcing Index

Estimates of the GHG emissions from the combustion of fuel in aviation do not account for other climate effects in the upper atmosphere, linked to the emissions of nitrogen oxides, particles and water vapour (Commission for Integrated Transport, 2007, p. 19). The science on how much warming is caused by aviation emissions at high altitudes is much more uncertain than GHG emissions due to fuel burning. Also, the upper-atmosphere effects are much more short-term than the warming impact of CO_2 that continues for hundreds of years.

The IPCC (1999) estimated that the total climate change impact of aviation emissions to 2050 would be 2.7 times the CO_2 impact. There are suggestions that this could be lowered to 1.9; however, all estimates in this area have wide bands of uncertainty (Commission for Integrated Transport, 2007). The RFI is an extension of the concept of radiative forcing and is the total radiative forcing of a process with respect to that of its CO_2-e emissions.

The delay in gaining international agreement about the application of the RFI for aircraft climate impacts arises from the complexity of the issues and the challenges with inter-jurisdictional management of trans-boundary pollution. Nonetheless, given the international policy and diplomatic focus on climate change mitigation, it is probable that agreement will be reached.

At that point, the emissions officially attributed to aviation and airports may increase drastically. This will be especially challenging where emissions trading schemes or carbon taxes are used to incentivise mitigation of GHG emissions.

This assessment has included estimates with the RFI of 2.7 from IPCC, clearly indicated and separated from the official estimate of emissions for use in the EIS.

4.2.2.5 Dispersion modelling

Individual flight paths have not been modelled, instead emissions have been assigned to area sources that represent a conservative estimate of emission locations to ensure that the potential impacts are not underestimated. The approach/climbout aircraft emissions were compressed into the areas modelled, which were lower and closer to the airport than is likely to occur in practice. This ensured that a conservative assessment was made taking into account the possibility of aircraft with lower approaches as well as the majority of emissions coming from the earlier part of an aircraft's ascent.

Predictions of ground-level concentrations of NO_2 were based on the assumption that 30 per cent of the NO_X emitted to the atmosphere is either emitted as NO_2 or converted to NO_2 within the region. This is expected to be a conservative assumption within approximately 10 km of the airport.

VOC emissions from the fuel storage facility and aircraft refuelling were modelled as volume sources. The aircraft refuelling was modelled in a location with closest proximity to sensitive receptors to provide a conservative estimate.

4.3
POLICY CONTEXT AND LEGISLATIVE FRAMEWORK

4.3.1 Environmental Protection (Air) Policy

The *Environmental Protection Act 1994* (EP Act) provides the framework for the management of the air environment in Queensland. The legislation applies to government, industry and individuals and provides a mechanism for the delegation of responsibility to other government departments and local government and provides all government departments with a mechanism to incorporate environmental factors into decision-making.

The EP Act gives the Minister of DEHP the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The Environmental Protection (Air) Policy (Air EPP) was made under the EP Act and was gazetted in 1997; the Air EPP was revised in 2008 and came into force on 1 January 2009.

The objective of the Air EPP is:

> *....to identify the environmental values of the air environment to be enhanced or protected and to achieve the objective of the Environmental Protection Act 1994, i.e. ecologically sustainable development.*

The environmental values to be enhanced or protected under the Air EPP are the qualities of the environment that are conducive to:

- Human health and wellbeing
- Protecting health and biodiversity of ecosystems
- Protecting the aesthetics of the environment, including the appearance of building structures and other property.

DEHP must consider the requirements of the Air EPP when it decides an application for an environmental authority, amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the Air EPP specifies air quality indicators and objectives for Queensland.

4.3.2 National Environment Protection Measure

The National Environment Protection Council defines national ambient air quality standards and goals in consultation, and with agreement from, all state governments. These were first published in 1998 in the National Environment Protection (Ambient Air Quality) Measure (NEPM(Air)). Compliance with the NEPM(Air) standards is assessed via ambient air quality monitoring undertaken at locations prescribed by the NEPM(Air) and that are representative of large urban populations. The goal of the NEPM(Air) is for the ambient air quality standards to be achieved at these monitoring stations within ten years of commencement, i.e. from 2008. The Air EPP has adopted the NEPM(Air) goals as air quality objectives.

4.3.3 Relevant ambient air quality objectives for the Project

The air quality objectives specified in Schedule 1 of the Air EPP and the NEPM(Air), relevant to the air quality assessment of the SCA are presented in **Table 4.3a**. This list represents the air pollutants with the greatest potential for impact; other pollutants may be emitted by aircraft, but will have a lower potential for impact.

4.3.4 Greenhouse gas scopes

The process for accounting for greenhouse gas emissions involves dividing emissions among three 'scopes' to assign responsibility for emissions and manage potential double-counting. The Australian Government Clean Energy Regulator defines two emission categories for calculating greenhouse gas emissions in legislation. These are as follows:

- Direct emissions, including:
    1. Scope 1 emissions:

       In relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.

Table 4.3a: Relevant ambient air quality objectives used in Queensland (Air EPP)

Indicator	Averaging Period	Objective ($\mu g/m^3$)	Environmental value
Particulate matter (as $PM_{2.5}$)[a]	24-hour	25	Health and wellbeing
	Annual	8	
Particulate matter (as PM_{10})[b,c]	24-hour	50	Health and wellbeing
Nitrogen dioxide (NO_2)	1-hour	250	Health and wellbeing
	Annual	62	
	Annual	33	Health and biodiversity of ecosystems
Sulfur dioxide (SO_2)	1-hour	570	Health and wellbeing
	24-hour	230	
	Annual	57	
	Annual	32	Protecting agriculture
	Annual	22	Health and biodiversity for ecosystems (for forests and natural vegetation)
Carbon monoxide (CO)	8-hour	11,000	Health and wellbeing
Xylenes (total)	24-hour	1200	Health and wellbeing

a $PM_{2.5}$ are particles that have aerodynamic diameters that are less than 2.5 μm
b PM_{10} are particles that have aerodynamic diameters that are less than 10 μm
c Five exceedences allowed per year

- Indirect emissions, including:

  2. Scope 2 emissions:

     In relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by a facility but that do not form part of the facility.

A third emission category is defined under the Greenhouse Gas Protocol (WBCSD, 2009) for calculating greenhouse gas emissions that are a consequence of the activities of a facility but occur from sources owned or controlled by another organisation. This category is termed Scope 3 emissions and covers sources such as:

- Aircraft emissions
- Employee business travel
- Transportation of products, materials and waste
- Outsourced activities, contract manufacturing and franchises
- Emissions from waste that are released in locations owned or controlled by another company
- Emissions from the use and end-of-life phases of products and services produced by the reporting facility
- Employees commuting to and from work
- Production of imported materials.

4.3.5 Australian international commitments

The following discussion of Australia's global commitments to respond to climate change is derived from information published by the Commonwealth Department of Environment (DoE) on its website (DoE, 2013).

The United Nations Framework Convention on Climate Change (UNFCCC) provides the basis for global action 'to protect the climate system for present and future generations'. Australia ratified the Convention in 1992. The Convention entered into force in 1994 after a requisite 50 countries had ratified it. There are now 193 Parties to the UNFCCC – almost all of the members of the United Nations.

Parties to the Convention have agreed to work towards stabilising 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.

Under the convention, Australia is committed to:

- Submitting a national inventory of emissions and removals of greenhouse gases
- Implementing national programs to mitigate climate change and adapt to its impacts
- Conducting research related to the climate system and promoting relevant technologies
- Raising public awareness about climate change
- Submitting comprehensive National Communications (i.e. reports).

The Kyoto Protocol is an international agreement created under the UNFCCC in Kyoto, Japan in 1997. Australia's ratification of the protocol came into effect on 11 March 2008. The protocol aims to reduce the collective greenhouse gas emissions of developed country parties by at least five per cent below 1990 levels during 2008 to 2012 – referred to as the first commitment period. Australia has had a target for emissions of 108 per cent of estimated emissions for 1990 or 591.5 Mt CO_2-e.

At the United Nations climate change negotiations in Durban, South Africa in 2011, Parties to the Kyoto Protocol decided to establish a second commitment period from 1 January 2013. On 9 November 2012, the Australian Government announced its intention to join a second commitment period under the Kyoto Protocol, and confirmed its participation in the second commitment period at the Doha Conference of the Parties in late 2012. All countries that are party to the UNFCCC are negotiating a new global agreement that is intended to have legally binding commitments for all major emitters. This agreement is due for finalisation by 2015 and to come into effect in 2020.

4.3.6 Obligations for aircraft emissions

Under the UNFCCC domestic aviation emissions are counted as part of country targets while emissions associated with international travel are handled by the ICAO, the United Nations agency that serves as the forum for cooperation in all fields of civil aviation. Under UNFCCC rules, a flight segment is designated as 'domestic' if it takes off and lands in Australia and 'international' if it arrives from or departs to a foreign country. This is also the basis for Australia's reporting under the Kyoto Protocol (Department of Infrastructure and Transport, 2012a).

The ICAO has proposed global aspirational goals for international aviation of two per cent annual fuel efficiency improvements until 2050. The 190 ICAO member states also resolved to strive to keep global net carbon emissions from international aviation at the same level from 2020 onwards (i.e. carbon neutral growth). Australia was part of this resolution. For 2011, emissions from domestic and international aviation activity in Australia accounted for 8.00 and 8.93 Mt CO_2-e (Department of Infrastructure and Transport, 2012a).

4.3.7 Regulation of GHG emissions

The Sunshine Coast Council (SCC) must report greenhouse and energy data annually to the Australian Government under the National Greenhouse and Energy Reporting Act 2007 and regulations. However, SCC would not be responsible for reporting Scope 3 emissions due to aircraft movements. Aircraft operators have responsibility for reporting these emissions.

The Australian Government introduced a carbon pricing mechanism that puts a price on carbon from 1 July 2012 until 1 July 2014. The repeal of Clean Energy Act 2011 that established the carbon price is currently under consideration, the Clean Energy Act and associated legislation is expected to be abolished coinciding with the 2014/2015 National Greenhouse and Energy Reporting period. 'Direct Action' is the government's new approach to reducing carbon emissions to meet Australia's commitments under the second period of the Kyoto Protocol, although the details of this policy and scheme are still under consideration.

Based on existing legislation from 1 July 2012 to 1 July 2014 the carbon price will apply to emissions from Australian domestic aviation and is expected to provide incentives for reducing associated carbon emissions. For 2012-2013 the increase in the cost of aviation fuel relating to the excise was approximately six cents per litre, this equates to an 8 per cent increase in fuel costs based on a jet fuel price of $120 per barrel. Indicatively at a carbon price of $23 per tonne CO_2-e, Australia's domestic aviation emissions for 2010-11 would have required a cost recovery of approximately $3.40 per passenger.

4.4
EXISTING CONDITIONS

This section describes current air quality in the region before presenting the estimated emissions from the existing air traffic using SCA.

4.4.1 Existing air quality

Air quality in the area is monitored by DEHP at Mountain Creek, approximately 10 km to the south of the airport. **Table 4.4a** presents a summary of the PM_{10} concentrations measured at Mountain Creek, as well as the number of recorded exceedances and the circumstances leading to them. Five exceedances of the objective are allowed per year. **Table 4.4b** presents a summary of NO_2 and PM_{10} concentrations measured at Mountain Creek, including the 75th percentile value, which is a good indication of typical ambient background concentrations.

This analysis of ambient air quality monitoring at Mountain Creek shows that the air quality objectives are rarely exceeded except during regional events such as dust storms are associated with elevated levels of particulate matter. Inference from this data suggests that concentrations of dust, NO_2 and ozone in the region around the SCA will generally be low; however, exceedances of the Air EPP objectives for particular matter may occur on occasion due to natural events.

Industrial activities that emit air pollutants in the area that currently report to the NPI are shown in **Table 4.4c**. It can be seen from the table that quarries and landfills make up the largest number of reporting industries in the area. Reported emissions of all pollutants from individual facilities cover a range of several orders of magnitude.

Table 4.4a: Concentrations of 24-hour average PM_{10} measured at the DEHP Mountain Creek ambient air quality monitoring station

Year	Maximum concentration (µg/m³)	6th highest concentration (µg/m³)	Number of exceedances	Circumstances during periods of exceedance
2003	69	35.8	1	Dust storms
2004	66.6	35	1	Construction works nearby
2005	62.9	30.1	2	Dust storms
2006	39.8	28.9	0	-
2007	41.9	31.9	0	-
2008	56.3	36	1	Wind-blown dust
2009	863.8	69	8	Major dust storms
2010	33.7	23.9	0	-
2011	49.5	28.4	0	
Air quality objective:		50 µg/m³		

Table 4.4b: Concentrations of NO_2 and PM_{10} measured at the DEHP Mountain Creek ambient air quality monitoring station

	NO_2 concentration (µg/m³)			PM_{10} (µg/m³)	
Year	Maximum 1 hour average	75th percentile 1hour average	Annual average	6th highest	75th percentile 24-hour average
2003	62.0	32.0	9.4	35.8	18.2
2004	77.1	37.6	9.4	35.0	17.7
2005	60.2	30.1	9.4	30.1	17.1
2006	65.8	30.1	9.4	28.9	17.1
2007	63.9	28.2	7.5	31.9	17.3
2008	56.4	30.1	7.5	36.0	17.9
2009	56.4	28.2	7.5	69.0	19.2
2010	54.5	30.1	9.4	23.9	15.4
2011	60.2	Not reported	7.5	28.4	15.7
Air quality objective	250	-	62, 33	50	-

Table 4.4c: NPI reported emissions for 2011/2012 from facilities within a 40km radius of the SCA (kg, Air Total)

Industry Type	Facility Name	CO	NO_2	SO_2	PM_{10}	$PM_{2.5}$	Distance from airport (km)
Production of hot-mix asphalt	Bli Bli	2,305	1,563	133	27,072	6,119	11
Quarrying; sand and gravel production; extraction of rock, crushing, screening	Bli Bli quarry	8,197	16,436	10	43,298	1,186	11
	Sunrock quarry	10,164	21,380	13	31,408	1,506	38
	Hanson Glasshouse Mtns Quarry	6,881	12,888	1,299	19,253	918	38
	Boral Quarries Coolum	3,502	9,864	6	25,259	862	10
	Boral Quarries Moy Pocket	27,618	39,375	40	42,699	4,720	36
Landfill and municipal waste	Buderim Landfill	680	523	113	224	213	9
	Coolum Landfill	42	-	-	-	-	9
	Eumundi Landfill	3	-	-	-	-	19
	Kenilworth Landfill	1	-	-	-	-	37
	Nambour Landfill	232	-	-	-	-	11
	Woombye Landfill	12	-	-	-	-	14
	Caloundra Landfill	248	-	-	-	-	21
Food Processing, Confectionary and Processed Ginger Products	Ginger Factory	410	2,392	189	130	70	14
Sawmilling	Peachester Sawmilling Company Pty Ltd	2,448	894	102	1,944	1,644	34
Protein rendering	Sunland Proteins	4,491	9,881	27,307	11,857	4,132	26
Maximum from a single facility (kg/year)		27,618	39,375	27,307	43,298	6,119	
Total reported emissions (kg/year)		67,235	115,195	29,213	203,143	21,370	

4.4.2 Existing emissions of criteria air pollutants from SCA

The estimated emissions of criteria air pollutants (CO, NO_x, SO_2 and PM_{10}) from aircraft operating out of the airport during 2012 are presented in **Table 4.4d**. Commercial flights are shown to be the primary source of NO_2 and SO_2, while helicopters are the primary source of CO and PM_{10} emissions. When compared to industries that report to the NPI ( ), the SCA is of a similar magnitude to other large industries in the area for emissions of NO_2 and PM_{10}. Emissions of CO from the airport are significantly larger than emissions reported to NPI by any industries in the region; however, the NPI does not include motor vehicle traffic, which is also major source of CO, NO_x and PM_{10}.

Table 4.4d: Estimated emissions to air from aircraft operations at SCA in 2012

	Emissions due to existing activities (kg/year)				
Activity	**CO**	**NO_x**	**SO_2**	**PM_{10}**	**VOC**
Commercial flights	33,507	20,286	2,150	505	12,792
General aviation	122,367	2,567	607	3,756	35,927
Helicopters	221,078	1,755	658	37,598	40,563
Fuel storage and refuelling	-	-	-	-	9,467
TOTAL	376,952	24,609	3,414	41,859	98,748

4.4.3 Existing GHG emissions

Table 4.4e shows the estimated GHG emissions for 2012 according to different flight types. The table indicates that commercial flights are the most significant contributors to GHG emissions, particularly when flight emissions are considered.

Table 4.4e: Summary of total predicted GHG emissions from aircraft movements during 2012 (t CO_2-e)

Type of operations	**LTO emissions**	**Flight emissions**
Commercial	6,190	49,670
General aviation	2,030	3,820
Helicopter	3,620	7,170
TOTAL	11,840	60,660

Table 4.4f shows the movements of commercial flights according to destination and the associated GHG emissions estimates. The table shows that flights to Sydney and Melbourne make up the majority of movements and an even greater majority of the GHG emissions.

Table 4.4f: Summary of commercial aircraft movements and GHG emissions during 2012

	Aircraft movements		**GHG emissions (t CO_2-e)**	
Origin/ Destination	**Number**	**%**	**LTO**	**Flight**
Sydney	2,747	49%	3,440	29,190
Melbourne	1,932	35%	2,430	19,450
Brisbane	389	7%	170	340
Other	458	8%	130	670
Local	32	1%	10	10
TOTAL	5,559	100%	6,190	49,670

4.5
DESCRIPTION OF SIGNIFICANCE CRITERIA

Table 4.5a presents the significance criteria used in this chapter to assess the potential impacts of emissions to air from aircraft associated with the Project. A level of significance (negligible to very high) were assigned to each air pollutant assessed based on a calculated Air Quality Index (AQI) score. The AQI was calculated using the following equation:

AQI = pollutant concentration / pollutant standard x 100

The AQI calculation is used by the DEHP to interpret current air quality levels across Queensland. Using the AQI calculation, DEHP determines the current state of each air quality monitoring station, ranging from very good (low AQI) to hazardous (high AQI).

For each air pollutant assessed from aircraft associated with the Project, an AQI score was calculated and a level of significance assigned based on the relevant AQI range presented in **Table 4.5a**. The impact assessment conducted combined the impact significance with the likelihood of impact to determine the potential risk (see **Table 4.6c**).

Table 4.5a: Impact significance criteria: emissions from aircraft

Air Quality Index (AQI) Score	**Equivalent EHP AQI rating**	**Impact Significance/ Consequence**
150 +	Very poor – Hazardous	Very High
100 – 149	Poor	High
67 – 99	Fair	Moderate
34 – 66	Good	Minor
0 – 33	Very good	Negligible

GHG emissions from aircraft are out of the direct control of SCA and therefore fall under Scope 3 for carbon accounting. Therefore, significance criteria were not applied to GHG emissions from aircraft. Scope 1 and 2 emissions are covered in Chapter B16 – Air Quality and GHG Emissions.

4.6

ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

4.6.1 Air quality

4.6.1.1 Emissions due to forecast aircraft movements

Table 4.6a summarises the estimated emissions to air from aircraft movements forecast through to 2040. **Figure 4.6a** shows the projected growth in emissions from key pollutants indexed to 2012 levels. The contribution of commercial, general aviation and helicopters is shown. The results indicate the following:

- Driven primarily by the growth in commercial flights, emissions of NO_X were predicted to grow most significantly out to 2040, to almost three times higher than current levels
- Emissions of CO and PM were found to grow also, but at a slower rate. Emissions in 2040 were predicted to be around 1.5 times greater than current emissions
- PM emissions were dominated by helicopter activities, which were predicted to plateau towards 2040
- The worst-case emissions scenario was found to be 2040.

Table 4.6a: Estimated emissions to air from existing and forecast aircraft operations at SCA

	Emissions due to forecast activities (kg/year)				
Year	**CO**	**NO_x**	**SO_2**	**PM**	**VOC**
2012	376,952	24,609	3,414	41,859	98,748
2020	454,504	37,523	4,918	49,079	121,054
2030	568,624	55,969	7,073	59,798	153,739
2040	596,050	72,573	8,832	60,211	164,682

4.6.1.2 Dispersion modelling results

The worst-case emissions scenario (2040) was modelled to assess compliance with the EPP Air. **Table 4.6b** presents the maximum ground-level concentrations predicted to occur outside of the SCA boundary due to aircraft operations. The predicted concentration of xylenes is presented as this was the VOC with the greatest potential impact relative to its air quality objective. The results indicate that all air pollutants were predicted to be below the air quality objective. The maximum significance level was found to be minor, due to the 1-hour average concentration of NO_2. All other pollutants were predicted to have a negligible impact. The low predicted cone=centrations of VOCs indicates that odor impacts are unlikely to occur.

Figure 4.6a: Predicted aircraft emissions of combustion pollutants for current and forecast scenarios

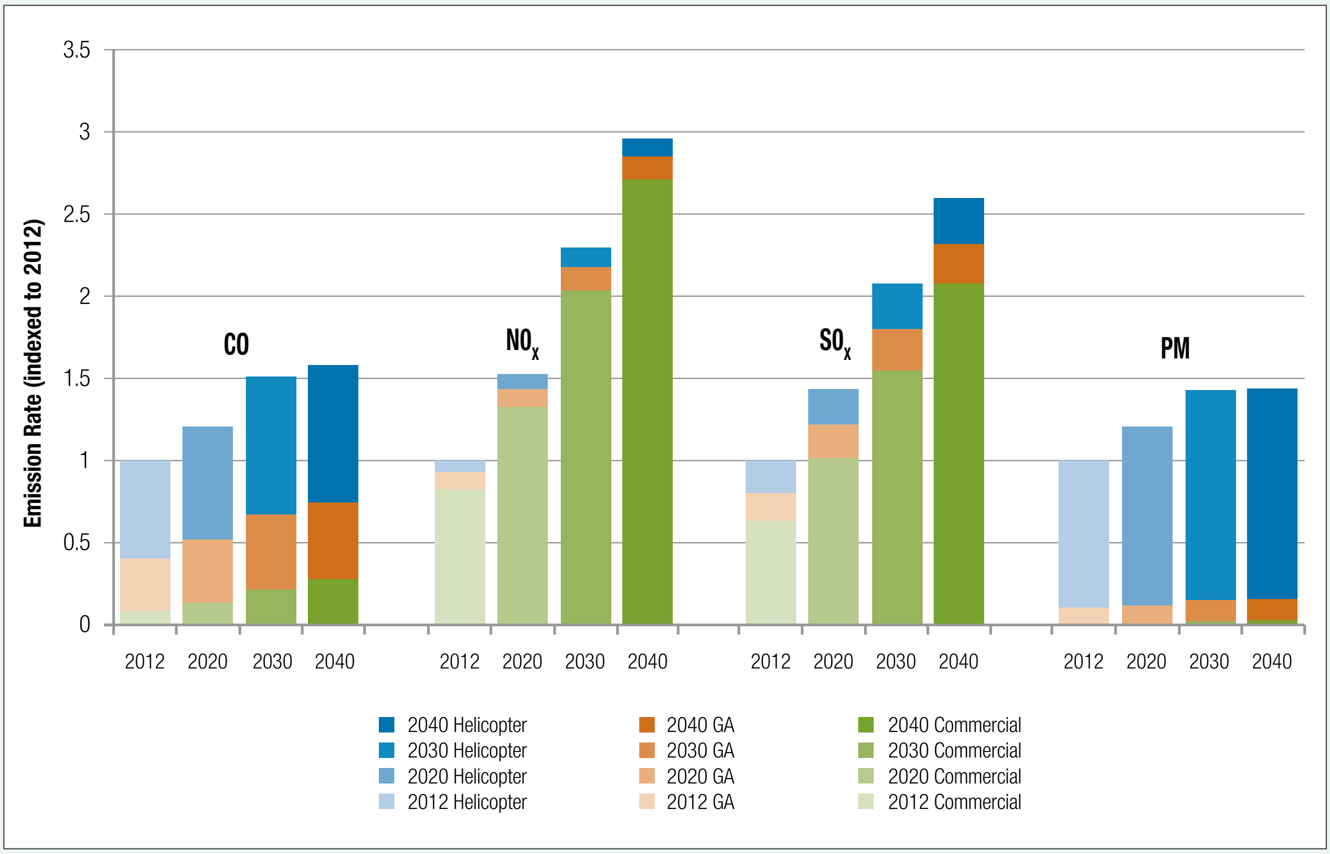


Table 4.6b: Predicted off-site impacts

Pollutant	Averaging Period	Maximum offsite (μg/m^3)	Objective (μg/m^3)	Significance criteria
CO	8 hour	674	11,000	Negligible
NO_2	1-hour	110	250	Minor
	Annual	0.97	62 – Health 33 – Ecosystems	Negligible
SO_2	1-hour	39	570	Negligible
	24-hour	5.2	230	Negligible
	Annual	0.33	57 – Health 22 – Ecosystems	Negligible
PM_{10}	24-hour	8.3	50	Negligible
$PM_{2.5}$	24-hour	8.3	25	Negligible
	Annual	0.37	8	Negligible
Xylenes (total)	24-hour	7.9	1200	Negligible

The predicted distributions of maximum 1-hour average NO_2, the pollutant of highest significance, is presented in **Figure 4.6b** as a contour plot. The figure shows contours of the maximum 1-hour average NO_2 concentration predicted to occur at any time during the modelled year. These contour plots indicate that the highest ground-level concentrations are likely to occur to the north-west and south-east. All other pollutants are well below the relevant air quality objectives at all sensitive areas.

Figure 4.6b: Maximum 1-hour average concentration of NO_2 (objective 250 μg/m^3)

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Table 4.6c summarises the outcomes of the air quality impact assessment in terms of the risk rating associated with aircraft emissions. The table shows that the predicted risk associated with air pollutants with the potential to affect human health was, at worst, low. The risk associated with impacts to ecosystems was found to be negligible.

4.6.2 Greenhouse gas

4.6.2.1 Greenhouse gas emissions

Table 4.6d presents the distance-based forecasts of aircraft movements for 2020, 2030 and 2040.

Table 4.6e provides the complete carbon footprint for aircraft movements in 2012, and for future years 2020, 2030 and 2040. The predicted GHG emissions from aircraft movements in 2040 with the airport expansion is 420,960 tonnes CO_2-e (scope 3).

Figure 4.6c and **Figure 4.6d** present the footprint data in column charts to highlight the relative contributions to GHG emissions of general aviation, helicopter and commercial aircraft movements. General aviation makes a minor contribution to emissions in 2012 and its relative contribution is predicted to diminish further in future years. However, the contribution of helicopters to emissions is distinct in 2012. If the SCA intends to focus on managing LTO emissions as part of its Scope 3, rather than flight emissions, then helicopter activity will remain a consideration. Including flight emissions (Figure 4.6d), rather than just LTO, increases total emissions and decreases the relative significance of helicopter and general aviation.

Table 4.6c: Impact assessment table: Air quality

	Initial assessment with mitigation inherent in the Preliminary Design in place			
Primary impacting processes	**Mitigation Inherent in the Design**	**Significance of impact**	**Likelihood of impact**	**Risk rating**
Pollutant concentrations related to human health impacts	None	Minor	Possible	Low
Pollutant concentrations related to ecosystem impacts	None	Negligible	Possible	Negligible

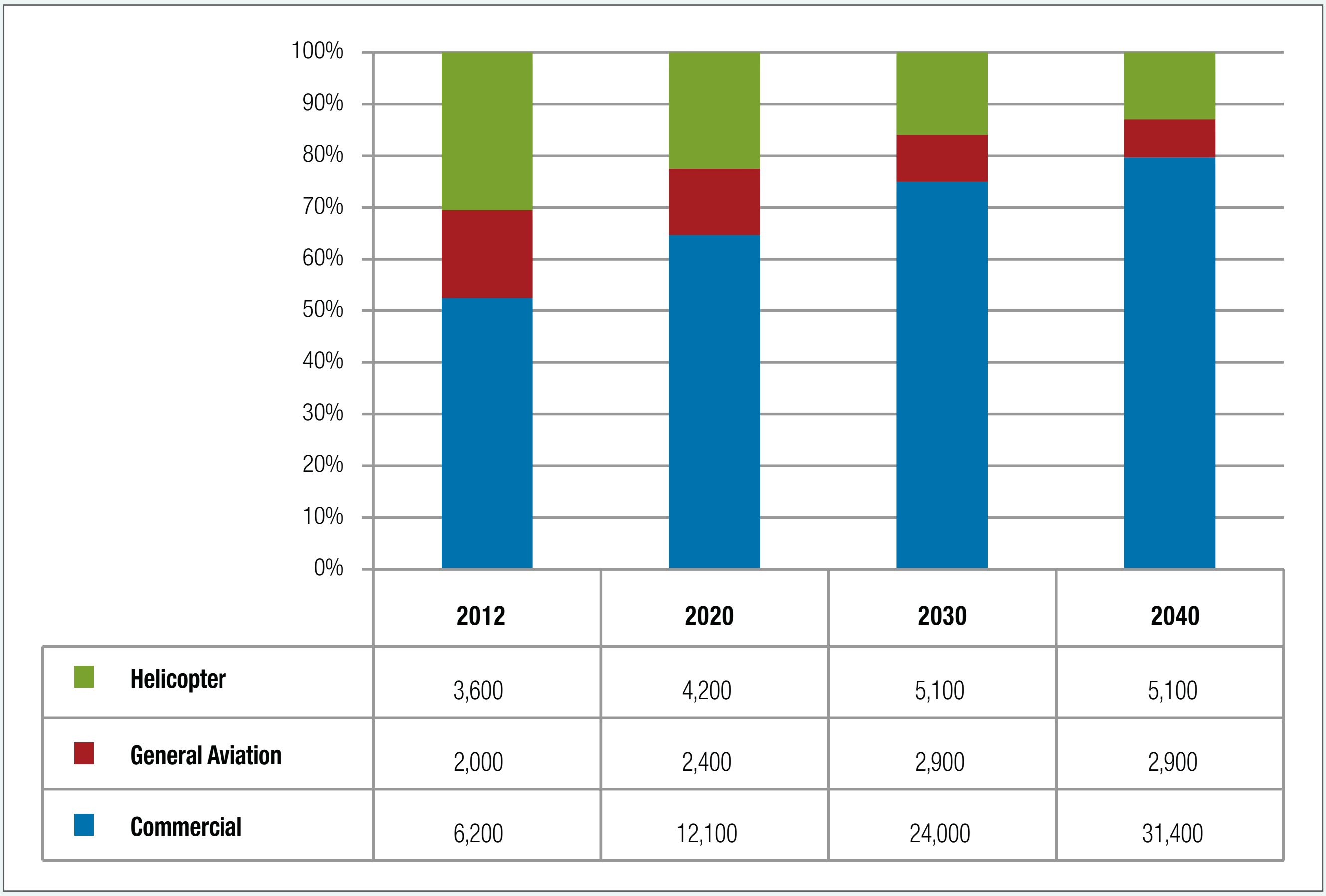
Table 4.6d: Predicted number of commercial flight movements

Origin/ Destination2	2012		2020		2030		2040	
	Movements	**%**	**Movements**	**%**	**Movements**	**%**	**Movements**	**%**
Domestic								
Sydney	2,747	49%	4,132	46%	5,671	42%	7,636	42%
Melbourne	1,932	35%	2,906	33%	3,989	29%	5,371	29%
Brisbane	389	7%	585	7%	803	6%	1,081	6%
Other	458	8%	689	8%	946	7%	1,273	7%
Local	32	1%	48	1%	66	<1%	89	<1%
Subtotal	5,559	100%	8,361	94%	11,474	84%	15,451	85%
Asia								
China	0	0%	539	6%	1,093	8%	1,104	6%
Asia	0	0%	0	0%	1,093	8%	1,655	9%
Subtotal	0	0%	539	6%	2,186	16%	2,759	15%
TOTAL	5,559	100%	8,900	100%	13,660	100%	18,210	100%

Table 4.6e: Summary of total predicted GHG emissions from aircraft movements (t CO_2-e)

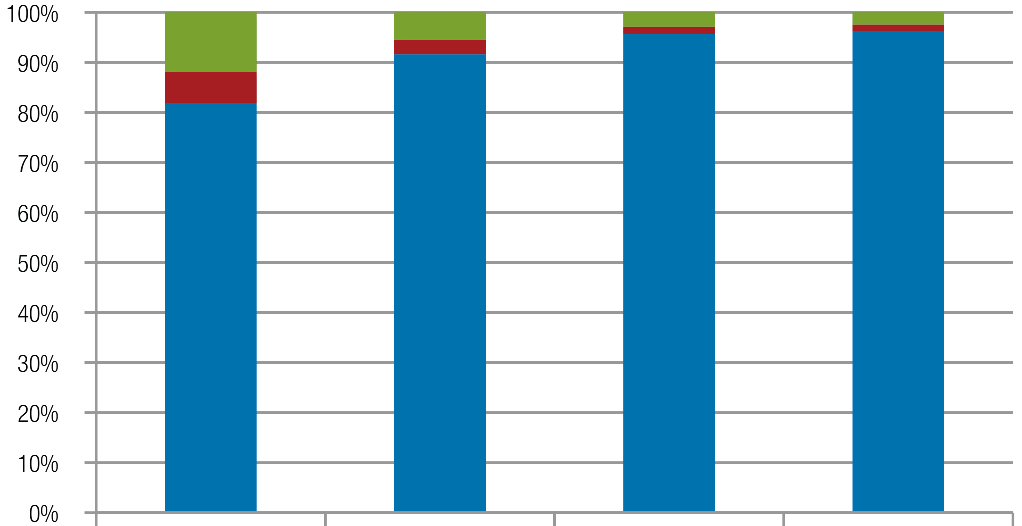
Type of operations	2012	2020	2030	2040
LTO emissions:				
Commercial	6,190	12,080	24,020	31,390
General aviation	2,030	2,370	2,880	2,880
Helicopter	3,620	4,230	5,130	5,130
Total	11,840	18,680	32,030	39,400
Flight emissions:				
Commercial	49,670	140,930	342,590	405,410
General aviation	3,820	4,450	5,400	5,400
Helicopter	7,170	8,370	10,150	10,150
Total (for use in EIS)	60,660	153,750	358,140	420,960
Flight emissions with RFI applied:				
TOTAL	150,000	390,000	940,000	1,110,000

Figure 4.6c: LTO GHG emissions (t CO_2-e) for all aircraft movements to/from SCA (rounded)



	2012	2020	2030	2040
🟩 **Helicopter**	3,600	4,200	5,100	5,100
🟥 **General Aviation**	2,000	2,400	2,900	2,900
🟦 **Commercial**	6,200	12,100	24,000	31,400

Figure 4.6d: Flight GHG emissions (t CO_{2-e}) for all aircraft movements to/from SCA (rounded)



	2012	2020	2030	2040
🟩 **Helicopter**	7,200	8,400	10,200	10,200
🟥 **General Aviation**	3,800	4,500	5,400	5,400
🟦 **Commercial**	49,700	140,900	342,600	405,400

This study has estimated the LTO and GHG emissions for a range of origin/destination points in 2012, 2020, 2030 and 2040 for commercial flights only. **Table 4.6f** compiles the results of this estimation. In 2012, a carbon footprint of the airport would include 6,190 tonnes per year CO_2-e in scope 3 to account for the LTO emissions from commercial flights. If the footprint instead included flight emissions, Scope 3 emissions for aircraft movements would be 49,670 t/y for commercial flights. By 2040, with the airport expansion, the LTO emissions would grow to 31,390 t/y. The flight emissions would grow substantially more to 405,410 t/y due to the greater distances travelled to Asia and China. For the purposes of the EIS, the adopted estimate is 405,410 t/y for commercial flight emissions.

Figure 4.6e and **Figure 4.6f** provide a comparative breakdown of LTO and flight GHG emissions by origin/destination. Brisbane, 'other' and local are inconsequential in either LTO or flight emissions. The China and Asia flights are distinct from 2020 onwards for LTO emissions due to the high LTO fuel consumption by wide body jets, but even more so for flight emissions due to the longer distances. By 2040, Asia and China flights contribute 46 per cent of LTO emissions and 66 per cent of commercial flight emissions.

The bubble chart at **Figure 4.6g** illustrates the vast difference in aircraft movement GHG emissions depending on the choice that is made to assign emissions to the airport. The chart plots three concentric circles for 2012 and each forecast year. The area of each circle represents emissions, respectively for: LTO; flight; and flight with RFI applied. The vertical axis for the centres of the circles represents the level of flight emissions. The common practice is to assign only LTO emissions to Scope 3 for an airport. This would make total emissions in 2040 91 per cent less than assigning flight emissions to the airport (as adopted here for the purposes of this EIS). As discussed in **Section 4.2.2.4**, it is not yet established practice to apply the RFI. However, were this to become an established practice, and if that factor were to remain 2.7, the total emissions attributed to the airport accounting for flight emission with the RFI factor applied, would obviously be far higher.

Emissions from commercial aviation comprised the majority of flight GHG emissions in 2012 and the projections for future years indicate that this would increase. Nonetheless, this study estimated that a significant proportion of LTO emissions would be from helicopter activity, while increasing long-distance commercial air traffic from SCA to China and Asia was predicted to drive future increases in emissions.

Table 4.6f: Estimated GHG emissions of commercial flights (t CO_2-e)

Origin/ Destination	2012		2020		2030		2040	
	LTO	**Flight**	**LTO**	**Flight**	**LTO**	**Flight**	**LTO**	**Flight**
Domestic								
Sydney	3,440	29,190	5,170	43,900	7,090	60,250	9,550	81,130
Melbourne	2,430	19,450	3,660	29,260	5,020	40,150	6,760	54,070
Brisbane	170	340	260	510	360	700	480	940
Other	130	670	200	1,020	280	1,390	370	1,880
Local	10	10	20	20	30	30	40	40
Subtotal	6,190	49,670	9,300	74,700	12,770	102,520	17,190	138,050
Asia								
China	0	0	2,780	66,230	5,620	134,180	5,680	106,940
Asia	0	0	0	0	5,620	105,890	8,520	160,410
Subtotal	0	0	2,780	66,230	11,250	240,070	14,200	267,360
TOTAL	6,190	49,670	12,080	140,930	24,020	342,590	31,390	405,410

Figure 4.6e: LTO GHG emissions for commercial flights to/from SCA

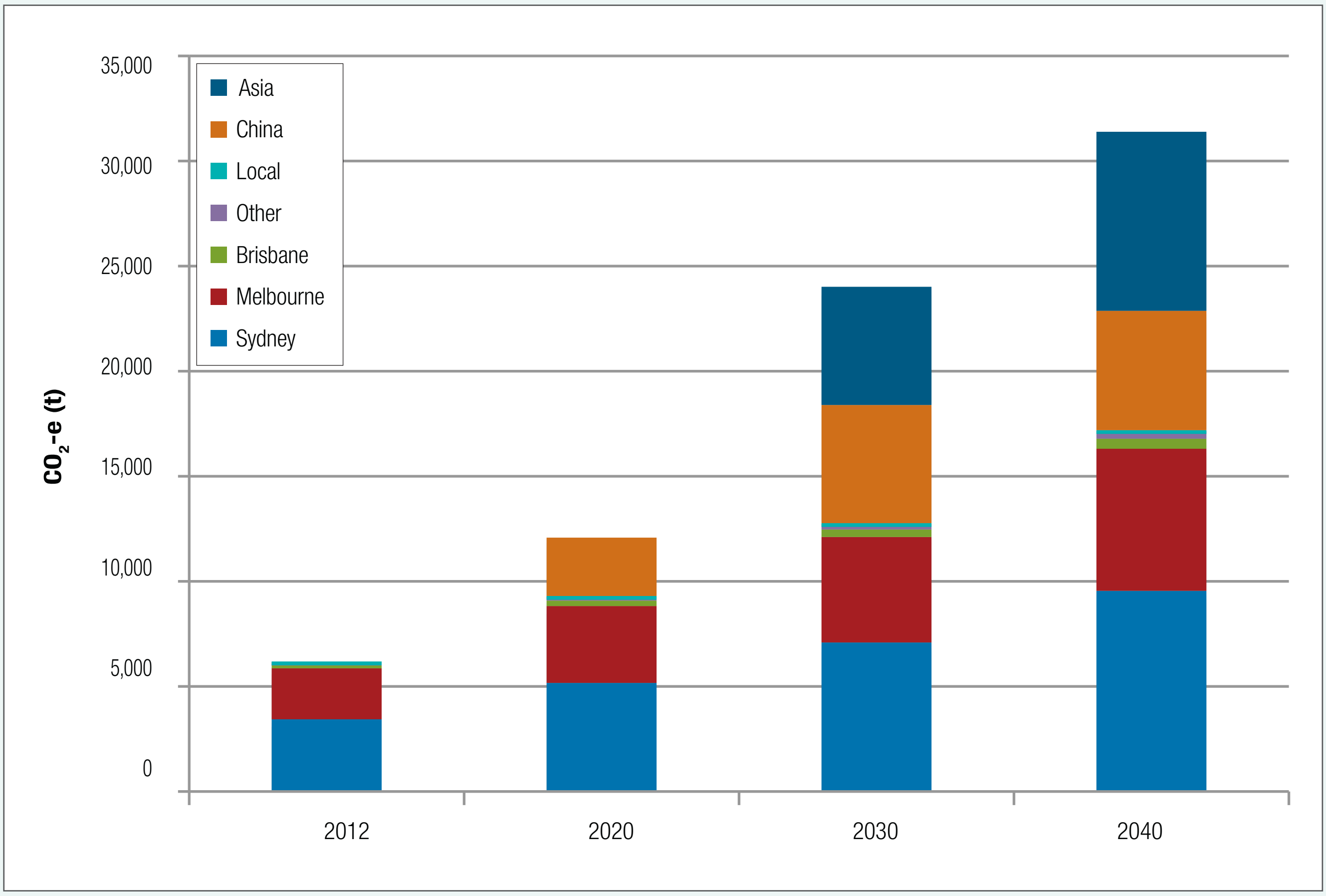


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Figure 4.6f: Flight GHG emissions for commercial flights to/from SCA

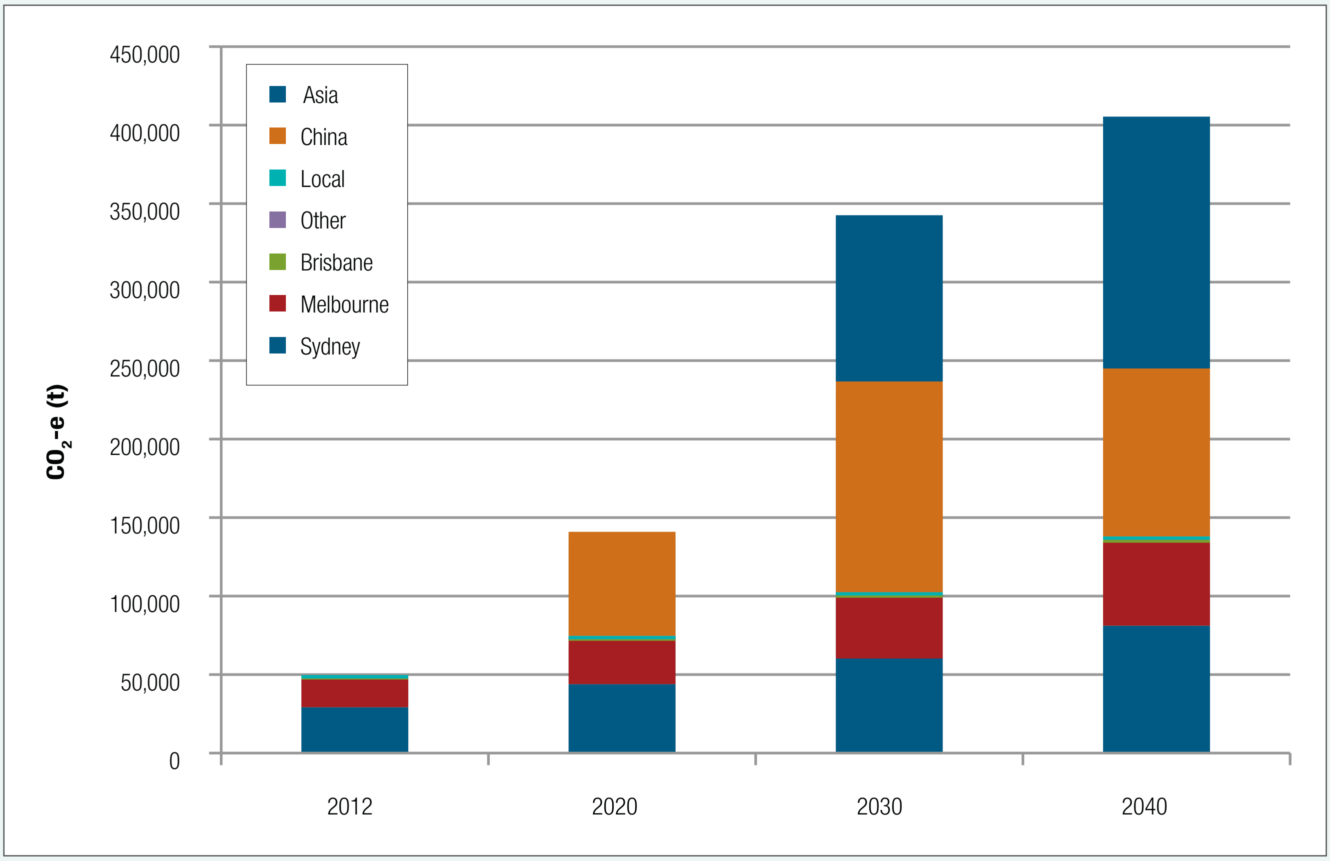
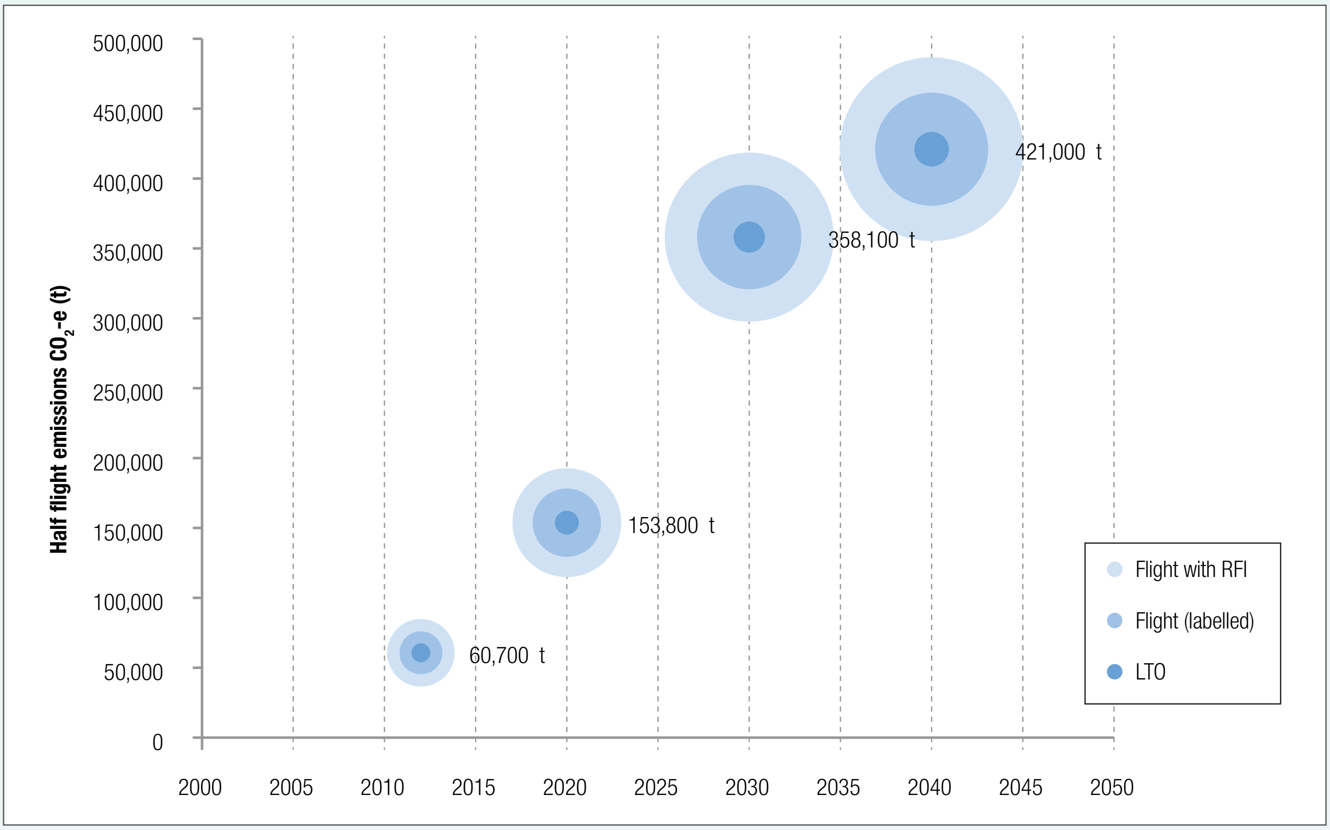


Figure 4.6g: Total GHG emissions from aircraft movements distinguishing LTO, flight and RFI. Labels show flight emissions attributed to SCA (rounded). The step increase in flight emissions is due to the introduction of services to Asia



4.6.2.2 Contribution to GHG emissions

Since GHG emissions do not have a local impact, it is conventional to assess projects by estimating the distinct contribution that a project may make to emissions from a UNFCCC participating nation or sector. **Table 4.6g** presents the flight emissions from the SCA alongside projected Australian emissions and emissions from Australia's domestic aviation sector. (Note that international aviation is presently not assigned to nations under the Kyoto Protocol.) The Australian Government has reported that annual GHG emissions from transport have increased by 3.2 per cent over the year to June 2012. The primary drivers of this annual increase included the consumption of aviation turbine fuel in civil aviation. The past five years have seen a 20.5 per cent increase in aviation turbine fuel consumption (DCCEE, 2012c). **Table 4.6g** shows that the contribution of SCA to Australia's national emissions would be small. Domestic air emissions from SCA (assuming SCA takes responsibility for half of all flight emissions to/from the airport) will be stable at approximately one per cent into the future.

4.6.3 Mitigation

The air quality assessment has shown a low risk of impacts from aircraft emissions and GHG emissions from aircraft fall outside of the direct control of SCA.

Whilst there are a number of available options to minimise emissions of air pollutants or GHGs, many of these are out of the control of SCA.

IPCC analysis indicates that annual improvements in aircraft fuel efficiency in general are projected to be 1-2 per cent, which will be overshadowed by an expected 5 per cent traffic growth in the sector. The estimated annual growth in GHG emissions taking these factors into account is forecast as 3-4 per cent. Greater opportunity lies in the optimisation of aircraft operations, including the LTO phase. The IPCC Fourth Assessment Report (Barker et al, 2007) estimated that air traffic emissions can be reduced by 6-12 per cent through:

- Minimising taxiing time
- Flying at optimal cruise altitudes
- Flying minimum-distance great circle routes, taking into account prevailing winds
- Minimising or eliminating holding and stacking around airports.

Recent estimates indicate that fuel accounts for 20 per cent of operating costs for a modern airline (Kahn, et al, 2007). Although there are currently no fuel efficiency standards for aviation, fuel efficiency has primarily been addressed from a cost management basis with the indirect effect of reducing GHG emissions. The cost of fossil fuels will continue to be the most significant driver for technological developments for the foreseeable future. Once technological development and efficiency improvements are exhausted the remaining emissions can be targeted through utilisation of sustainable biofuels or offsetting.

In general aircraft emissions can be reduced in one of four ways:

- Fleet renewal with more fuel efficient aircraft
- Aircraft retrofit for improved efficiency
- Operational streamlining to reduce fuel consumption

Table 4.6g: Projected GHG emissions from SCA compared with Australian and aviation sector emissions

Parameter	2012	2020	2030
Australia national emissions			
Domestic emissions, with carbon price and Carbon Farming Initiative (kt CO_2-e)[1]	571,600[2]	637,410	630,970
SCA projected flight emissions (kt CO_2-e)	61	153.8	358.1
Percentage contribution of SCA	0.011%	0.024%	0.057%
Australian domestic aviation emissions			
Australian domestic aviation sector emissions with a carbon price (kt CO_2-e)[3]	6,770	8,130	11,850
SCA projected flight emissions, domestic[4] aviation only (kt CO_2-e)	60.7	87.5	118.1
Percentage contribution of SCA	0.90%	1.08%	1.00%

1 DCCEE, 2012d

2 Linear interpolation between 2011 quarterly update and 2013 projection

3 DCCEE, 2012e

4 General aviation, helicopter and commercial flights with 'China' and 'Asia' excluded

- Fuel substitution with less carbon intensive alternatives (e.g. biofuels), however this may not reduce emissions of other pollutants.

Many of the above mentioned activities would predominantly occur in the LTO phase and fall under operational streamlining. They can be broadly considered under three categories:

- Departing
- Approaching
- Ground movements.

SCA has a very limited ability to influence emissions from aircraft movements.

The main mitigation measure that SCA is able to implement is Continuous Descent Approaches (CDA). CDA requires the aircraft to descend at a steady and continuous decline to landing. Whereas, conventionally aircraft approach an airport in a stair-step fashion, throttling down and requesting permission to descend to each new (lower) altitude.

SCA has implemented ‘Required Navigation Performance (RNP) procedures to allow shorter approach paths and CDAs on the existing Runway 18/36 and RNP procedures are proposed for the new 13/36 runway. Over the life of the project it is anticipated that most jet aircraft will adopt the new technology. Use of RNP tracks has benefits of reducing flight miles and hence air emissions.

4.7
CONCLUSION

This chapter presents the results of an air quality and greenhouse gas assessment of the potential emissions from aircraft operations associated with the Project.

The potential impacts on air quality due to aircraft operations related to the Project were considered for current and predicted air traffic levels. The maximum significance level was found to be minor, due to the 1-hour average concentration of NO_2. All other pollutants were found to have a negligible potential for impact.

A greenhouse gas assessment of aircraft operations was also presented in this chapter. Estimates were made of current emission levels as well as emissions based on forecast air traffic levels. Greenhouse gas emissions from aircraft operations are under the direct control of individual airlines and as such fall under the Scope 3 carbon accounting category.

Table 4.7a summarises the risk rating determined by the assessment. As the risk is low or negligible, no further mitigation strategies are required, although options for minimising impacts are discussed in the chapter.

Table 4.7a: Impact assessment table: Air quality

Potential Impacts	Risk rating
Pollutant concentrations related to human health impacts	Low
Pollutant concentrations related to ecosystem impacts	Negligible

4.8
REFERENCES

Australian Government, Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008, Emission Estimation Technique Manual for Airports Version 2.0.

Alamo Area Council of Governments, 2012, Proposed Planning Process for the Emission Inventory, Technical Proposal.

Leading Edge Aviation Planning Professionals (LEAPP), 2012. Long-term forecasts of aviation activity at Sunshine Coast Airport for 2013-2050, Draft Report, Unpublished.

Federal Aviation Administration (FAA), 2010. Emissions and Dispersion Modeling System (EDMS), v5.1.3, http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/edms_model/

Simpson, A, Sankey, S, Oh, X, Fleuti, E, McGill, R, Barrett, A, Norton, C, Qian, D, Yu, C, 2012. The Airport Carbon and Emission Reporting Tool (ACERT), Airports Council International [Online] http://www.aci.aero/About-ACI/Priorities/Environment-and-ACERT/ACERT, Accessed December 2012.

Ministry of Environment, British Columbia (MoE BC), 2012. 2012 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions Including Guidance for Public Sector Organizations, Local Government and Community Emissions, Ministry of Environment, Victoria BC.

Department of Environment (DoE), 2013. Various web pages describing UNFCCC and Kyoto Protocol [Online] http://climatechange.gov.au/international/international-negotiations and http://climatechange.gov.au/international/negotiations/history-negotiations

Department for Environment, Food and Rural Affairs (Defra), 2012. 2012 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting, Produced by AEA for the Department of Energy and Climate Change (DECC) and Defra, Version 1.0, 28/5/2012 [Online] http://www.defra.gov.uk/publications/2012/05/30/pb13773-2012-ghg-conversion/, Accessed December 2012.

Commonwealth of Australia, 2013. Australian National Greenhouse Accounts (NGA) factors.

Department of Infrastructure and Transport, 2012a, Managing the Carbon Footprint of Australian Aviation, Department of Infrastructure and Transport, Canberra.

ICAO 2011, Airport Air Quality Manual, International Civil Aviation Organization, Montreal

Barker T., I. Bashmakov, L. Bernstein, J. E. Bogner, P. R. Bosch, R. Dave, O. R. Davidson, B. S. Fisher, S. Gupta, K. Halsnæs,G.J. Heij, S. Kahn Ribeiro, S. Kobayashi, M. D. Levine, D. L. Martino, O. Masera, B. Metz, L. A. Meyer, G.-J. Nabuurs, A. Najam, N. Nakicenovic, H. -H. Rogner, J. Roy, J. Sathaye, R. Schock, P. Shukla, R. E. H. Sims, P. Smith, D. A. Tirpak, D. Urge-Vorsatz, D. Zhou, 2007: Technical Summary. In: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer (eds)],Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou, 2007: Transport and its infrastructure. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Synergy Consultants et al, 2007

Sustainable Aviation, 2010, Aircraft on the Ground CO_2 Reduction Programme, Airport Operators Association (UK) [Online] http://www.aoa.org.uk/documents/Aircraft%20on%20the%20Ground%20.pdf, Accessed 21/01/13.

C&S Companies, KB Environmental Sciences and Synergy Consultants, 2009a. San Diego County Regional Airport Authority Air Quality Management Plan – Analysis of Ground-based Aircraft Movement Greenhouse Gases, San Diego, San Diego County Regional Airport Authority.

C&S Companies, KB Environmental Sciences and Synergy Consultants, 2009b. San Diego International Airport Air Quality Management Plan Analysis of Potential Air Emission Reduction, San Diego, San Diego County Regional Airport Authority.

Unique, 2009. Fixed Energy Systems for Aircraft at Zurich Airport, Unique Environmental Services and Technical Facility Management, Zurich [Online] http://www.zurich-airport.com/Portaldata/2/Resources/documents_unternehmen/umwelt_und_laerm/Technical_Report_Aircraft_Fixed_Ground_Power_Systems_2009.pdf, Accessed 23/01/13.

Helsinki Airport, 2012, Helsinki Airport on the leading edge of green landings [Online article] http://www.helsinki-vantaa.fi/more-information/Helsinki-Airport-in-brief/greenlandings Accessed January 2013

Copenhagen Airport, 2009, Green take-offs at Copenhagen Airport reduce CO_2 emissions by 32,000 tonnes (Online article, 8 September 2009) [Online] http://www.cph.dk/CPH/UK/Newsroom/News/2009/Green+take+offs.htm, Accessed Jan 2013.

IATA, 2009, A global approach to reducing aviation emissions, First stop: carbon-neutral growth from 2020, International Air Transport Association [Online] http://www.iata.org/SiteCollectionDocuments/Documents/Global_Approach_Reducing_Emissions_251109web.pdf