12. Air quality and greenhouse gases

The air quality and greenhouse gas assessment included a review of climatic data obtained from the airport site and an analysis of ambient air quality from data collected from monitoring stations in the vicinity of the airport site. Air quality impacts associated with the construction of the proposed airport (particularly construction dust) were modelled as were emissions and air quality impacts associated with the operation of the proposed airport. Other air quality parameters that were assessed included odour (from aircraft exhaust and the on-site waste water treatment plant), regional air quality impacts (ozone) and greenhouse gas emissions.

Construction would result in dust emissions generated during both the bulk earthworks and the aviation infrastructure works and the asphalt batching plant would generate some odour during construction. The results of the air dispersion modelling show that the predicted dust impacts during construction would be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant is also predicted to be below the relevant criteria at all sensitive residential receptors and would be largely contained within the airport site.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide (NO2), particulate matter (as PM_{10} and $PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2) and air toxics. There would also be odour emissions from exhaust and from the on-site wastewater treatment plant. The highest off-site concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and northeast of the proposed airport. Airport traffic on surrounding road infrastructure was found to be a significant contributor to off-site ground level concentrations, particularly for those receptors located close to proposed roadways. Despite this, there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. The exception was the maximum (99.9th percentile) one hour concentration of formaldehyde with an exceedance shown at an on-site receptor. This exceedance is principally governed by the contribution from external roads as opposed to activities at the airport itself. Predicted off-site odour concentrations were expected to be below detection limits for both aircraft exhaust emissions and odours from the on-site wastewater treatment plant.

Only marginal ozone impacts would result from the operation of the Stage 1 development. These emissions would be managed using best available techniques and/or emission offsets.

Greenhouse gas emissions from the Stage 1 development have been estimated to comprise 0.11 Mt CO2-e/annum, with the majority of emissions associated with the consumption of purchased electricity. The Scope 1, Scope 2 and Scope 3 greenhouse gas emissions estimated for the proposed Stage 1 development would represent approximately 0.1 per cent of Australia’s projected 2030 transport-related greenhouse gas emission inventory. For this reason, it can be concluded that the greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the Stage 1 development. In particular, a dust management plan would be developed and implemented to address potential impacts from dust generated during construction. Air quality monitoring would also be undertaken at the airport site during operations. Even though greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, a number of mitigation measures would also be implemented during operations to reduce these emissions.

In acknowledgement that the National Environment Protection Council is currently in the process of revising its criteria for particles, updated air quality modelling would be undertaken and documented in the Final EIS.

12.1. Introduction

This chapter provides a review of the local and regional air quality impacts of the proposed airport. This chapter draws on a comprehensive local air quality and greenhouse gas assessment (included as Appendix F1 in Volume 4) and a regional air quality assessment (included as Appendix F2 in Volume 4).

For the purpose of the assessment, local air quality was defined as being within a five kilometre radius of the airport site and regional air quality refers to the wider Sydney basin. Regional air quality considers the formation of secondary pollutants (such as ozone (O_3) through photochemical reactions from primary emissions from the proposed airport.

The potential impacts of the proposed Stage 1 development on local and regional air quality and the anticipated greenhouse gas emissions from the construction and operation of the Stage 1 development are considered and appropriate mitigation and management measures have been identified to reduce potential impacts.

The local air quality and greenhouse gas assessment and the regional air quality assessment have been prepared in consultation with the Australian Government Department of the Environment and has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines).

12.2. Methodology

The assessment of air quality and greenhouse gases included a review of climatic data obtained from the airport site and an analysis of ambient air quality based on data collected from monitoring stations in the vicinity of the airport site. Air quality impacts associated with the construction and operation of the proposed airport were modelled using representative sensitive receivers located in the vicinity of the airport site. Other air quality parameters assessed include odour (from aircraft exhaust and the on-site wastewater treatment plant), regional air quality impacts (ozone) and greenhouse gas emissions. The potential for impacts arising from the proposed airport to be exacerbated by climate change was considered as part of the assessment.

12.2.1. Meteorology and existing air quality

Climatic data (wind speed and direction, temperature, rainfall and humidity) was obtained from the automatic weather station operated by the Bureau of Meteorology at the airport site. Data measured over the past five years (2010–14) were used to characterise the prevailing weather conditions at the airport site.

Air quality monitoring data collected between 2005 and 2014 from the NSW Office of Environment and Heritage (OEH) monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond were used to describe the existing air quality in the vicinity of Badgerys Creek.

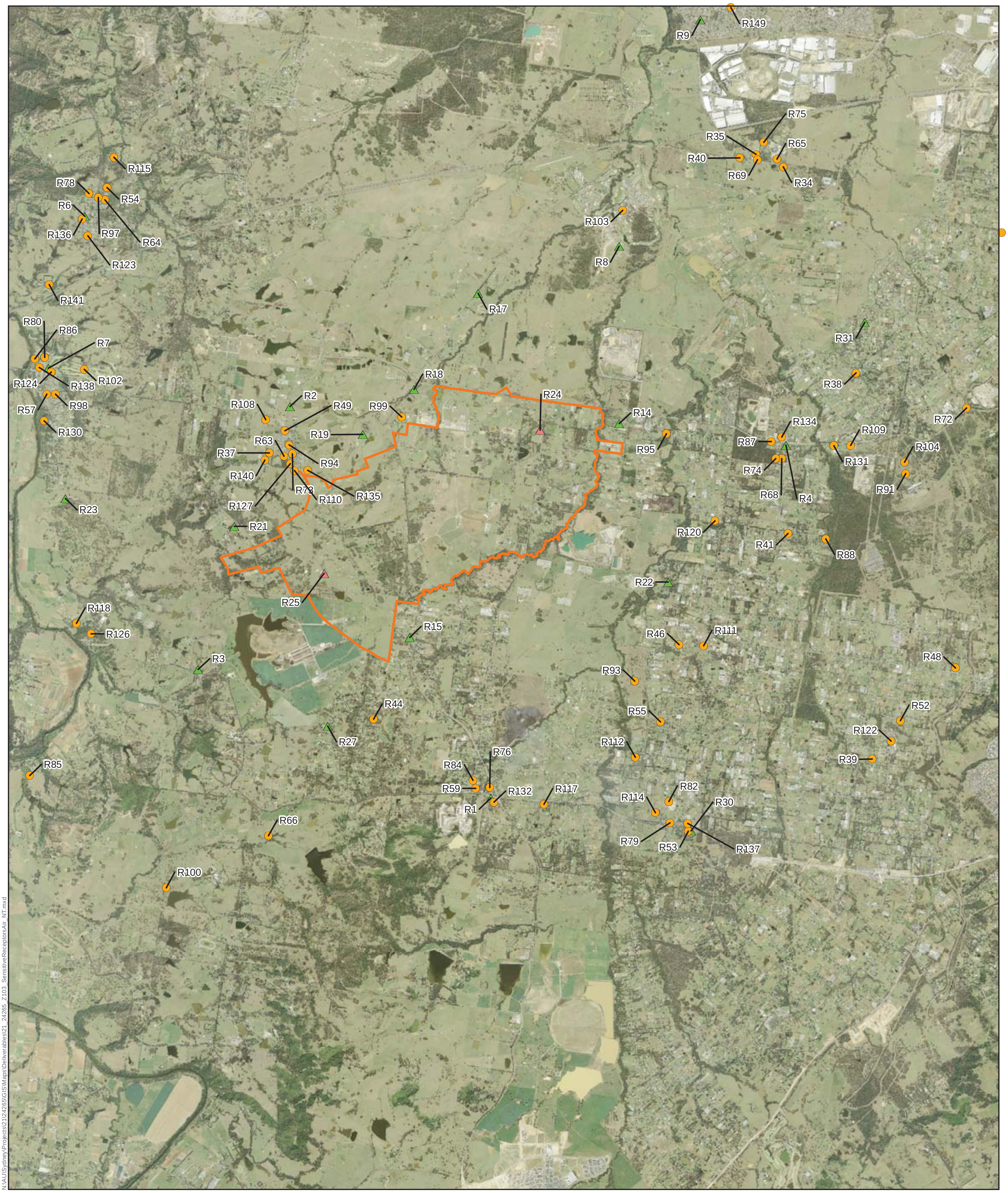
12.2.2. Sensitive receptors

It is standard practice in air quality assessments to estimate pollutant concentrations at discrete locations which are considered to be broadly representative of exposure in the area of interest. The concentrations at these locations are then compared with the relevant air quality assessment criteria in the legislation (refer to Section 12.3). The locations are known as ‘receptors’. Receptors should reflect locations where the general public is likely to have access on a regular basis as well as sensitive locations where people are likely to work or reside. Examples of sensitive receptors include schools, day care centres and hospitals.

The airport site is located in an area with a high density of sensitive receptors. To assess each individual receptor was not practicable. Therefore, a series of receptors were selected on the basis that they would be representative of residential suburbs and individual residences close to the airport site. In addition, a number of community receptors, such as schools, churches, shopping centres and recreational areas, were also identified within the local area. On-site receptors were selected to evaluate the potential exposures of airport staff and passengers.

A total of 152 sensitive receptors were identified. The approach taken for this assessment was to identify a sub-set of receptors to represent individual residences and clusters of residences located within approximately five kilometres of the airport site. This subset included 18 residential receptors, two on-site receptors and 75 community receptors. On-site receptors were selected to evaluate the potential exposures of airport staff and passengers at the facility, noting that airport terminal staff are likely to have a much longer exposure. The on-site receptors have been assessed during operations only as during construction the relevant uses for assessment would not yet exist. The locations of the receptors are shown in Figure 12–1.

The regional model was run using three dimensional nested grids to determine impacts over the Sydney basin and the broader NSW Greater Metropolitan encompassing Newcastle, Wollongong and Lithgow with 25 vertical levels up to 8,000 metres.



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LEGEND

▭ Airport site
● Community
▲ Residential
▲ Airport site

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Figure 12-1 - Location of sensitive receptors in the vicinity of the airport site

12.2.3. Construction

A quantitative assessment of construction impacts was undertaken using the United States Environmental Protection Agency (USEPA) dispersion model AERMOD (USEPA 2004). A detailed description of the model configuration and meteorological file is provided in Appendix F1.

Construction of the Stage 1 development would result in dust emissions generated during both the bulk earthworks and the aviation infrastructure works. Total suspended particulate, PM_{10} and $PM_{2.5}$ emission rates were calculated using emission factors developed both locally and from the USEPA (1995). Key emission sources during bulk earthworks include the operation of dozers, vehicle haulage on unpaved roads, grading of roads and scrapers loading and transporting topsoil for rehabilitation. Hauling of gravel and subgrade material and the movement of cement and asphalt trucks will be the primary emission sources during the aviation infrastructure works. There would also be diesel particulate matter emissions (comprising $PM_{2.5}$ only) from the on-site equipment as well as odour emissions from the asphalt plant.

It is acknowledged that some construction activities would overlap. To provide a conservative basis for assessment, the worst case emissions scenario was identified for the bulk earthworks and the construction of aviation infrastructure.

12.2.4. Operation

The proposed airport has the potential to generate emissions in the form of nitrogen dioxide, particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide, sulfur dioxide, air toxics, odour and greenhouse gases. These emissions have the ability to affect human health, reduce amenity and contribute to climate change.

Modelling of emissions and air pollution associated with the proposed airport was undertaken using the United States Federal Aviation Administration (FAA) Emissions and Dispersion Modelling System (EDMS) (Version 5.1.4 from June 2013). The EDMS is a combined emissions and dispersion model used for assessing air quality at civilian airports and military air bases. It has been used for several recent airport assessments in Australia including at Sydney Airport and Adelaide Airport.

The operational air quality assessment has adopted the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (DEC 2005) as the primary basis of the impact assessment and in some cases other relevant legislation and guidelines including the draft NEPM-AAQ (refer to Section 12.3).

The detailed methodology for the assessment is presented in Appendix F1 in Volume 4. A brief description of the air quality modelling is provided later in this section. An overview of the air quality assessment is provided in Figure 12–2.

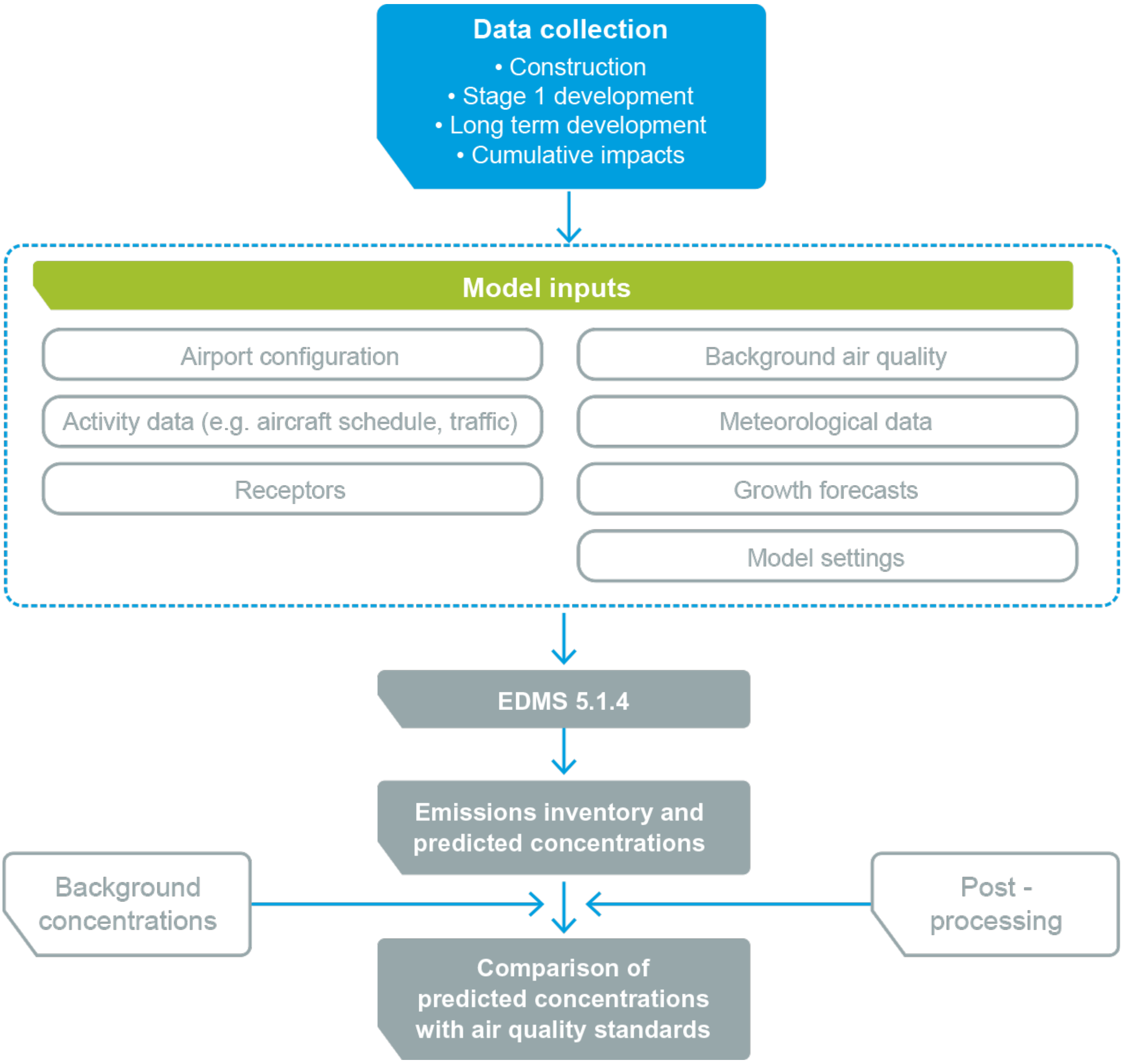


Figure 12–2 – Overview of air quality assessment

Emissions inventories and dispersion model predictions for the proposed Stage 1 and long term developments were obtained using EDMS based on activity data and growth projections for all emission sources. The types of activity that result in atmospheric emissions at airports are identified in the relevant DoE National Pollutant Inventory (NPI) emission estimation technique manual (DEWHA, 2008). These activities (which generate emissions through either combustion or evaporation) are listed in Table 12–1.

Table 12–1 – Summary of activities generating atmospheric emissions at the airport

NPI source type		Description
Emissions directly from aircraft	Aircraft main engine	Main engines of aircraft ranging from start-up to shut-down.
	Auxiliary power unit	Auxiliary power unit located on-board aircraft providing electricity and pre-conditioned air while on the ground and bleed air for main engine start.
Aircraft handling emissions	Ground support equipment	Ground support equipment necessary to handle the aircraft during the turnaround at the stand, including ground power units, air climate units, aircraft tugs, conveyor belts, passenger stairs, fork lifts, tractors, cargo loaders, etc.
	Airside traffic	Service vehicle and machinery traffic, including sweepers, trucks (catering, fuel, sewage), cars, vans, buses etc. that circulate on service roads within the airport perimeter and typically within the restricted area.
	Aircraft refuelling	Evaporation through aircraft fuel tanks (vents) and from fuel trucks or pipeline systems during fuelling operations.
Stationary/ infrastructure sources	Power/heat generating plant	Facilities that produce energy for the airport infrastructure, namely boiler houses, heating/cooling plants, co-generators.
	Emergency power generator	Diesel or other generators for emergency operations (e.g. for buildings or for runway lights).
	Aircraft maintenance	All activities and facilities for maintenance of aircraft, i.e. washing, cleaning, paint shop, engine test beds, etc.
	Airport maintenance	All activities and facilities for maintenance of airport facilities, including cleaning operations.
	Fuel	Fuel storage, distribution and handling.
	Construction and demolition activities	All construction and demolition activities involved in airport operation and development, including the resurfacing of roads and runways.
	Fire training	Activities for fire training with different fuels (e.g. kerosene, butane, propane, wood).
	Wastewater treatment	All activities and facilities for the collection, storage and treatment of wastewater on-site.
Landside traffic	Vehicle traffic	Cars, vans, trucks, buses, motorbikes etc. associated with the proposed airport on access roads, drop-off areas and parking lots. Emissions include tailpipe and evaporative releases.

EDMS incorporates a comprehensive database of emission factors for aircraft engines, ground support equipment, auxiliary power units, vehicles and stationary sources. The emission factors are taken from a range of sources, including the International Civil Aviation Organization, the FAA and the USEPA.

The pollutants currently included in the EDMS emission calculations are:

- carbon dioxide (CO_2);
- carbon monoxide (CO);
- nitrogen oxides (NO_x)
- sulfur oxides (SO_x)

- particulate matter ($PM_{2.5}$ and PM_{10});
- total hydrocarbons (THC);
- non-methane hydrocarbons (NMHC);
- volatile organic compounds (VOC);
- total organic gases (TOG); and
- 394 speciated organic gases (including benzene, toluene, xylenes and formaldehyde).

Model post-processing was undertaken to determine the relative contribution of nitrogen dioxide to nitrogen oxides, sulfur dioxide to sulfur oxides and volatile organic compounds speciation.

The EDMS dispersion analysis undertaken in this assessment uses AERMOD (USEPA 2004). Detailed spatial information on aircraft movements, other emission sources (for example, engine testing and auxiliary power units), the proposed airport layout, and meteorological data were employed within EDMS to determine the proposed airport's contribution to concentrations of criteria pollutants at discrete receptor locations and across the model domain.

Aircraft movements are calculated in EDMS using the schedule, gate locations, runway locations and the taxi paths between the gates and runways. For this assessment, gates were allocated in groups and more than 30 different taxiway sections were entered utilising the proposed runway system.

Emissions from vehicles on roadways are calculated in EDMS and include terminal traffic and external roadways. The terminal traffic comprises traffic that would be travelling to and from the airport and accounts for vehicles using parking facilities or vehicles dropping off or collecting passengers. The traffic emissions from the external roads included all roadways outside of the proposed airport site, extending as far north as the M4 and as far east as the M7. Future emissions from the proposed M12 roadways were also included.

The results from the dispersion modelling were then used in combination with the data on existing air quality (used to define background concentrations) to determine the likely impact of airport operations.

12.2.5. Cumulative impacts

There is potential for cumulative impacts during the operation of the proposed airport. For the purpose of this assessment cumulative impacts are defined as 'existing' (background) air quality, combined with the airport activities within the airport site (incremental) for each development stage and other projects which are current or reasonably foreseeable at the time of this project and would give rise to combined impacts. For the Stage 1 development, cumulative impacts would be the emissions from the proposed airport operating with the single runway and the external roadways combined with background pollutant measurements from other sources. For the long term development, this would also be the case except that the proposed airport's emissions would comprise emissions from the airport operating with both runways at full capacity.

Within the Western Sydney airshed, there are a number of other industrial emitters with the potential to affect local air quality. These include:

- major roadways (for example, M4 and M7);
- Camden Airport;
- Bankstown Airport;
- the Elizabeth Drive landfill facility;
- Boral Bricks Bringelly;
- Erskine Park Quarry;
- the Western Sydney Service Centre (metal manufacturing); and
- the Western Sydney Employment Area.

With the exception of the major roadways, the sources are all located at a sufficient distance from the airport site that potential cumulative impacts at the local scale are considered negligible. The adopted background air quality values would effectively account for potential emissions from these other sources.

To address the potential cumulative impacts of the proposed airport in combination with the major roadways, emissions from both sources were included in the modelling.

There would be potential cumulative emissions from operation of the proposed Stage 1 development in combination with the construction activities pertaining to the long term development. It is anticipated that dust emissions generated during construction of the second runway would be effectively managed. This assumption is supported by the fact that there are significant safety issues associated with dust generation in the vicinity of an operational airport that would be of much greater risk (and so receive more careful management) than conventional nuisance dust issues from other construction activities. The additional combustion emissions from on-site equipment during the long term development construction activities are also assumed to be insignificant in comparison to the emissions from the airport in isolation and on that basis, have not been considered further in this chapter.

Regional ozone impacts were also considered in terms of cumulative emissions within the Sydney basin.

12.2.6. Odour

12.2.6.1. Odour from aircraft exhaust

Studies by Winther et al. (2005) established that, at the point of emission, there is a relationship of 57 odour units (OU) per milligram per cubic metre of total organic compounds released by aircraft. This relationship has been referenced within other local air quality assessments recently published, such as the assessment for London Luton Airport (Air Quality Consultants 2012).

This approach (mass emission of TOC multiplied by 57 to establish the OU emission rate) has been adopted within the current assessment. Total organic compound emissions were quantified by EDMS from aircraft operations in start-up mode in combination with total organic compound emissions from auxiliary power units and ground support equipment. These total organic compound emissions were then scaled accordingly to represent odour emission rates in OU/s.

Subsequently, odour impacts of the proposed airport were assessed referencing an odour detection threshold (one OU) corresponding to 34 milligrams per cubic metre of total organic compounds. This relationship was based on odour measurements conducted by the CSIRO in 1997 at Sydney Airport (PPK 1997), and effectively provides an odour performance criterion for nearby sensitive receptors in terms of total organic compounds.

12.2.6.2. Odour from the on-site wastewater treatment plant

To characterise the potential odour impacts of the on-site wastewater treatment plant, odour sampling was completed at two similar wastewater treatment plant facilities located at Pitt Town and central Sydney. The purpose of the monitoring was to characterise the odour from these existing facilities and to use the data to derive odour emission rates for use in the dispersion modelling. The odour emissions used in this assessment are provided in Table 12–2.

Table 12–2 – Adopted waste water treatment plant odour monitoring inputs

Sample	Odour concentration (OU)	Specific odour emission rate (OU m/s)
MBR tank – membrane chamber	1,970	0.68
MBR tank – aerobic chamber	3,620	1.19
MBR tank – anoxic chamber	4,310	1.42
Activated carbon filter outlet (treated air)	3,320	n/a

12.2.6.3. Regional air quality (ozone)

Ozone air quality impacts were evaluated using the Comprehensive Air Quality Model with extensions (CAMx) Version 6.2 developed by Rambol Environ (ENVIRON 2015). CAMx is a three-dimensional, gridded, atmospheric dispersion model with photochemistry that allows for assessments of gaseous and particulate air pollution (for example, ozone, $PM_{2.5}$, PM_{10} and air toxics) over spatial scales ranging from suburban to continental. CAMx was used to assess ozone impacts in the Sydney Greater Metropolitan Region in a study for the NSW Environmental Protection Authority (EPA) to develop the tiered assessment procedure for ozone (ENVIRON 2011). CAMx is used around the world and is one of two models used by the USEPA to develop air quality regulations for ozone and particulate matter (USEPA 2011).

CAMx requires meteorological input data for: wind, temperature, pressure, vertical diffusivity, water vapour, clouds, rainfall and layer interface height. CSIRO's three-dimensional meteorological and air pollution model 'The Air Pollution Model' (TAPM) was used to simulate meteorology within the study area. Surface observation data from numerous meteorological stations located in the Sydney region were used for calibration and a statistical evaluation shows good correlation for wind speed and temperature with reasonably low bias and error.

The ozone modelling assessment considered emissions data for the following scenarios:

- 2008 base case for model evaluation;
- 2030 future base case for comparison with future airport operations;
- 2030 airport case for Stage 1 development emissions; and
- 2063 airport case for long term airport emissions (refer to Chapter 32 of Volume 3).

The 2008 base case scenario was used to assess model performance, by comparing predicted ozone concentrations against ambient monitoring data for the same period. Scatter plots presented for the evaluation demonstrated that modelled-observed data pairs are clustered around the 1:1 line, showing that the model tends to correctly predict ozone variability. The model exhibits little bias at Bringelly and St Marys, with the normalised mean bias less than two per cent for one hour ozone and less than seven per cent for four hour ozone.

To assess the impact from the addition of airport emissions, a number of days were selected for detailed analysis. Twelve days with high observed ozone (one hour ozone concentrations greater than 70 parts per billion and four hour ozone concentrations greater than 65 parts per billion) and good model performance (bias within plus or minus 15 per cent in peak values) were selected for analysis. Historical dates in January and February 2009 were selected to represent the meteorological conditions that have historically led to peak ozone formation and which the model has effectively captured for peak ozone formation with the addition of future emissions.

12.2.7. Greenhouse gases

Quantification of greenhouse gas emissions (in tonnes of carbon dioxide equivalent (t CO_2-e)) associated with each greenhouse gas source was made in accordance with the *Greenhouse Gas Protocol* (WRI & WBCSD 2004), the Intergovernmental Panel on Climate Change (IPCC) and the Australian Government greenhouse gas accounting/classification systems.

The greenhouse gas assessment is guided by the *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations). These describe the detailed requirements for reporting under the *National Greenhouse and Energy Reporting Act 2007* (Cth) (NGER Act). Calculations are consistent with the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (the “NGER Measurement Determination”).

To streamline the quantification process, greenhouse gas emissions were calculated within the EDMS model used for the local air quality assessment. Any deviations in the calculation approaches between the NGER Technical Guidelines and the EDMS model are acknowledged and their material impact quantified.

Greenhouse gas emission calculations are generally of the form:

$$\mathrm{Emission_i} = \mathrm{Activity\ data} \times \mathrm{EF_i}$$

Where:

$Emission_i$ = Estimated emissions of greenhouse gas $_i$ (t CO_2-e)

$Activity\ data$ = Basis of emission estimate (for example, amount of fuel combusted for energy generation) (generally in gigajoules for fuel combustion)

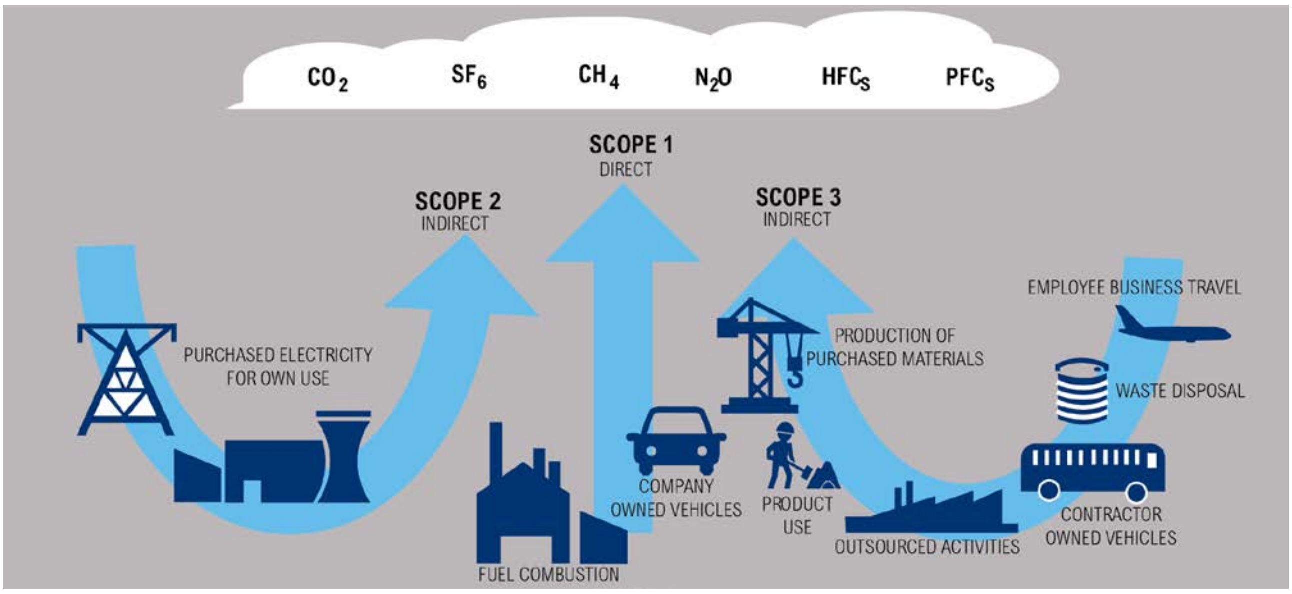
EF_i = Emission factor for greenhouse gas $_i$ (t CO_2-e/activity)

Greenhouse gas emissions were estimated based upon the methods outlined in the following documents:

- the *Greenhouse Gas Protocol* (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) 2004);
- the *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2015 (No.2)* (DoE 2015a) produced from the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (DCCEE 2008); and
- *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia* (DoE, 2014a).

The *Greenhouse Gas Protocol* establishes an international standard for accounting and reporting greenhouse gas emissions (WRI & WBCSD 2004). The Protocol has been adopted by the International Organization for Standardization, endorsed by greenhouse gas initiatives (such as the Carbon Disclosure Project) and is compatible with existing greenhouse gas trading schemes.

Under this Protocol, three emissions “scopes” (Scope 1, Scope 2 and Scope 3) are defined for greenhouse gas accounting and reporting purposes. This terminology has been adopted in Australian greenhouse gas reporting and measurement methods and has been employed in this assessment. Scope 1 emissions are direct greenhouse emissions from sources owned or controlled by the reporting entity such as airport owned vehicles and equipment. Scope 2 emissions are indirect greenhouse gas emissions from the generation of purchased energy by the proposed airport. Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but arise from sources not owned or controlled by that entity such as the activities of individual airlines (that is, aircraft movements). A visual representation of Scope 1, 2 and 3 emissions is presented in Figure 12–3.



Source: WRI & WBCSD 2004.

Figure 12–3 – Overview of the three scopes and emissions sources across a reporting entity

12.3. Air quality criteria

Gaseous pollutants and particulate matter performance criteria

Legislation, guidelines and standards governing air pollutant emissions and ambient air quality have been introduced at the Commonwealth and State government levels. Legislation, guidelines and other standards which have been considered for this assessment are summarised in Table 12–3.

Regulated air pollutants are divided into ‘criteria’ pollutants and ‘air toxics’. Criteria pollutants tend to be ubiquitous and emitted in relatively large quantities, and their health effects have been studied in some detail. Air toxics are gaseous or particulate organic pollutants that are present in the air in low concentrations and have characteristics hazardous to human, plant or animal life. The health effects and main sources of pollutants investigated in the local air quality and greenhouse gas assessment are summarised in Appendix F1.

Table 12–3 – Emissions and air quality legislation

Legislating body	Legislation/measures	Summary
Ambient air quality		
Australian Government	*Airports Act 1996*	Promotes the sound development of civil aviation in Australia. It contains an obligation on airport lessee companies to develop a master plan every five years including a detailed environmental strategy which is required to address amongst other things continuous improvement in the environmental consequences of activities at the airport; progressive reduction in extant pollution at the airport and development and adoption of a comprehensive environmental management system for the proposed airport that maintains consistency with relevant Australian and international standards. The Airports Act also contains a number of offences related to pollution at airports. An Airport Plan is required to authorise the construction and operation of the Stage 1 development.
	Airports (Environment Protection) Regulations 1997	Imposes a general duty to prevent or minimise environmental pollution once an airport lease is granted. Promotes improved environmental management practices at airports. Includes provisions setting out definitions, acceptable limits and objectives for air quality, as well as monitoring and reporting requirements.
	Air Navigation (Aircraft Engine Emissions) Regulations /Chicago Convention Annex 16	The regulations make it an offence to fly certain aircraft if they do not meet relevant emissions standards including the standards set out in Annex 16 to the Chicago Convention.
	National Environment Protection (Ambient Air Quality) Measure (NEPM-AAQ)	Sets the national health-based air quality standards for six air pollutants (carbon monoxide, nitrogen dioxide, sulfur doxide, lead, ozone and PM_{10}) and includes advisory reporting standards for $PM_{2.5}$.
	National Environment Protection (Air Toxics) Measure (Air Toxics NEPM)	Sets a nationally consistent approach to monitoring (by reference to ‘investigation levels’) for five air toxics: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). These are not compliance standards but are for use in assessing the significance of the monitored levels of air toxics with respect to the protection of human health.

Legislating body	Legislation/measures	Summary
NSW Government	*Protection of the Environment Operations Act 1997* (POEO Act), and the Protection of the Environment Operations (General) Regulation 2009	The POEO Act provides a range of controls with regard to air quality including requirements to maintain plant and equipment in proper and efficient condition and to operate plant and equipment in a proper and efficient manner. This includes the means of processing, handling, moving, storage and disposal of materials.
Emissions of air quality criteria pollutants		
Australian Government	National Environment Protection (National Pollutant Inventory) Measure	The primary goals are to: (a) collect a broad base of information on emissions and transfers of substances and (b) disseminate information to all sectors of the community. This NEPM covers a variety of air pollutants.
NSW Government	*Protection of the Environment Operations Act* (2007) (POEO Act) and Protection of the Environment Operations (Clean Air) Regulation (2010) (Clean Air Regulation)	The object of the POEO Act is to achieve the protection, restoration and enhancement of the quality of the NSW environment having regard to the need to maintain ecologically sustainable development. The Clean Air Regulation prescribe standards for certain groups of plant and premises to regulate industry's air emissions and impose requirements on the control, storage and transport of volatile organic liquids.
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW	This policy document lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. It is referred to in Part 5: Air impurities from emitted activities and plant of the Clean Air Regulation. It also prescribes the air pollutants and averaging periods that an airport's emissions are to be assessed against.
Emissions of greenhouse gases		
Australian Government	*National Greenhouse and Energy Reporting Act (2007)*	An airport lessee company (ALC) is required to register and report its operational greenhouse gas emissions attributable to the activities over which it has operational control. This is because it is expected that its emissions will exceed relevant thresholds. This may also apply to the construction contractor and other contractors or users of the airport (e.g. airlines).
Ozone-depleting substances		
Australian Government	*Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995	This Act and these Regulations impose controls on the manufacture, import, export and management of substances that deplete ozone in the atmosphere including CFCs 11, 12, 113, 114 and halons 1211, 1301 and 2402.
NSW Government	*Ozone Protection Act 1989*	This Act regulates or prohibits the manufacture, sale, distribution, conveyance, storage, possession and use of ozone-depleting substances in NSW.

The air quality criteria adopted for use in the air quality assessment are principally those defined in the NSW Approved Methods (DEC 2005). The Approved Methods take account of various pollutant criteria and averaging periods from multiple sources, including the Commonwealth's National Environment Protection (Ambient Air Quality) Measure (NEPM-AAQ). In some cases, the Approved Methods mirror the NEPM-AAQ. In other cases, where no similar criteria are stated in the Approved Methods, criteria outlined in the NEPM-AAQ have been adopted in this study. Examples of the latter are average annual PM_{10} and $PM_{2.5}$. A summary of the adopted air quality assessment criteria and their source is provided in Table 12–4. In each case, where several performance criteria are available, the more stringent criterion has been used.

Table 12–4 – Air quality criteria applicable to the airport

Pollutant	Criterion(a)	Averaging period	Source(b)
Carbon monoxide (CO)	87 ppm or 100 mg/m3	15 minutes	NSW EPA
	25 ppm or 30 mg/m3	1 hour	NSW EPA
	9 ppm or 10 mg/m3	8 hours	NSW EPA, AEPR (b)
Nitrogen dioxide (NO$_2$)	16 pphm or 320 µg/m3	1 hour	AEPR
	12 pphm or 246 µg/m3	1 hour	NSW EPA
	3 pphm or 62 µg/m3	1 year	NSW EPA
Total suspended particulate matter (TSP)	90 µg/m3	1 year	NSW EPA, AEPR
Particulate matter < 10 µm (PM$_{10}$)	50 µg/m3	24 hours(c)	NSW EPA
	30 µg/m3	1 year	NSW EPA
Particulate matter < 2.5 µm (PM$_{2.5}$)	25 µg/m3	24 hours	NEPM-AAQ advisory reporting standard
	8 µg/m3	1 year	NEPM-AAQ advisory reporting standard
Deposited dust – Incremental	2 g/m2/month	Annual	NERDDC
Deposited dust – Cumulative	4 g/m2/month	Annual	NERDDC
Lead (Pb)	1.5 ppm	3 months	AEPR
	0.5 µg/m3	1 year	NSW EPA
Photochemical oxidants (as ozone (O$_3$))	0.10 ppm or 210 µg/m3	1 hour	NSW EPA(d), AEPR
	0.08 ppm or 170 µg/m3	4 hours	NSW EPA(e), AEPR
Sulfur dioxide (SO$_2$)	25 pphm or 710 µg/m3	10 minutes	NSW EPA(f), AEPR
	20 pphm or 570 µg/m3	1 hour	NSW EPA, AEPR
	8 pphm or 228 µg/m3	1 day	NSW EPA
	2 pphm or 60 µg/m3	1 year	NSW EPA, AEPR
Benzene	0.009 ppm or 29 µg/m3	99.9th one hour max	NSW EPA
Toluene	0.09 ppm or 360 µg/m3	99.9th one hour max	NSW EPA
Xylene	0.004 ppm or 180 µg/m3	99.9th one hour max	NSW EPA
Formaldehyde	0.18 ppm or 20 µg/m3	99.9th one hour max	NSW EPA
Benzo[a]pyrene	0.4 µg/m3	99.9th one hour max	NSW EPA

Notes:

(a) ppm = parts per million; pphm = parts per hundred million; µg/m^3 = micrograms per cubic metre; mg/m^3 = milligrams per cubic metre

(b) NSW EPA = NSW EPA 'Approved Methods'; AEPR = *Airports (Environment Protection) Regulations 1997*

(c) Up to 5 exceedances allowed per year in NEPM-AAQ

(d) Given as 214 µg/m^3 in Approved Methods

(e) Given as 171 µg/m^3 in Approved Methods

(f) Given as 712 µg/m^3 in Approved Methods

It is noted that in 2014, the National Environment Protection Council released an Impact Statement and draft variation to the AAQ NEPM in relation to the standards for airborne particles. The NSW EPA, which has managed the NEPM variation, has subsequently requested NSW Cabinet approval for a number of changes to the particle standards. It is understood that Australian Environment Ministers have agreed to finalise their consideration of the draft variation to the NEPM-AAQ by the end of 2015. These changes may be subsequently adopted by the NSW EPA into an update to the NSW Approved Methods.

In consideration of potential future changes to the air quality standards for particulates, the Department will seek further guidance from the National Environment Protection Council during exhibition of the draft EIS and revise the modelling and assessment of local air quality in accordance with any revised criteria proposed in the draft NEPM.

In recognition of the potential health problems arising from exposure to air toxics, 'investigation levels' have been set for five pollutants in ambient air under the *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM). These investigation levels are listed in Table 12–5**.**

Table 12–5 – Advisory standard air toxic investigation levels applicable to the airport

Pollutant	Criterion[a]		Averaging period	Source
Benzene	0.003	ppm	1 year(d)	Air Toxics NEPM, investigation levels
PAHs[b] (as B[a]P)[c]	0.3	ng/m^3	1 year[d]	Air Toxics NEPM, investigation levels
Formaldehyde	0.04	ppm	24 hours	Air Toxics NEPM, investigation levels
Toluene	1.0	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.1	ppm	1 year[d]	
Xylenes	0.25	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.20	ppm	1 year[d]	

Notes:

(a) ng/m^3 – nanograms per cubic metre

(b) PAH – polycyclic aromatic hydrocarbons

(c) B[a]P – benzo[a]pyrene, the most widely studied PAH and used as an indicator compound

(d) Arithmetic mean of concentrations of 24 hour monitoring results

12.3.1.1. Odour performance criteria

The Approved Methods also include ground-level concentration criteria for complex mixtures of odorous air pollutants, taking account of population density in a given area. Table 12–6 lists the odour criteria to be exceeded not more than one per cent of the time, across different population densities. The airport site falls within an urban area, so a criterion of two OU applies.

Table 12–6 –Odour performance criteria for the assessment of odour

Population of affected community	Criterion for complex mixtures of odorous air pollutants 99th percentile (OU)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

12.3.1.2. Greenhouse gases

The NGER Act establishes a mandatory obligation on corporations which exceed defined thresholds to report greenhouse gas emissions, energy consumption and other related information.

Corporate and facility reporting thresholds for greenhouse gas emissions and energy consumption are provided in Table 12–7. Emissions are measured in terms of tonnes of carbon dioxide equivalent which is a value representing the normalisation of different types of greenhouse gases to their equivalent global warming potential of carbon dioxide.

Table 12–7 –NGER reporting thresholds

Corporate threshold		Facility threshold	
Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)	Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)
50	200	25	100

Source: DCCEE, 2007.

As the proposed airport (once operational) is anticipated to have combined Scope 1 and Scope 2 emissions greater than 25 kilotonnes carbon dioxide equivalent in a financial year, emissions are expected to be required to be reported under the NGER scheme.

If a corporation has operational control over facilities whose greenhouse gas emissions or energy use in a given reporting year:

- individually exceed the relevant facilities threshold; or
- when combined with other facilities under the corporation’s operational control, exceed the relevant corporate thresholds, that corporation must report its greenhouse gas emissions or energy use (as the case may be) for that year under the NGER Act.

This definition may encompass the ALC, a construction company, various other contractors and airlines. A preliminary assessment of greenhouse emissions and energy use for the Stage 1 development is presented in Section 12.7.

12.3.1.3. Regional air quality (ozone)

The National Environment Protection Measures (NEPM) for ambient air quality standards for ozone are summarised in Table 12–8 and expressed as parts per million by volume. The NEPM standards are identical to the impact assessment criteria prescribed by the NSW EPA in the Approved Methods, although the impact assessment criteria are expressed as parts per hundred million and in micrograms per cubic metre of air (refer to Table 12–9). The NEPM standard, like the NSW EPA criteria, also allows for the goal to be exceeded for one day a year.

Table 12–8 – National standards for ozone (NEPM)

Averaging period	Maximum concentration	Maximum allowable exceedances
1 hour	0.10 ppm	1 day a year
4 hours	0.08 ppm	1 day a year

Table 12–9 – Impact Assessment criteria for ozone (NSW EPA)

Averaging period	Concentration	
	pphm	µg/m^{3}a
1 hour	10	214
4 hours	8	171

The ambient ozone monitoring data and ozone modelling results presented in this chapter use parts per billion as the preferred reporting unit. A concentration of 100 parts per billion for one hour ozone is equivalent to the NEPM standard of 0.10 parts per million and the NSW EPA criterion of 10 parts per hundred million, while a concentration of 80 parts per billion for four hour ozone is equivalent to the NEPM standard of 0.08 parts per million and the EPA criterion of eight parts per hundred million.

Ozone standards for vegetation are not prescribed by the NSW EPA, however under the Queensland Environment Protection (Air) Policy 2008 (EPP (Air)), air quality objectives are listed for both human health and ecosystems damage. The EPP (Air) adopts the NEPM health based standards referenced in Table 12–8.

12.4. Existing environment

This section describes the meteorological conditions (wind speed and direction, temperature, rainfall and humidity) at the airport site. The existing, ambient air quality in the vicinity of the airport site is also described.

12.4.1. Meteorology

Air quality is influenced by meteorological conditions. Wind speed, wind direction, temperature and relative humidity all affect the potential dispersion and transport of emissions and are basic input requirements for dispersion modelling.

Climatic data was reviewed for five consecutive years (2010-14). Summary statistics are provided in Appendix F1. These data were used to describe the local meteorology at Badgerys Creek.

12.4.1.1. Wind speed and direction

The average wind speed across the five year period was 2.6 metres per second. The percentage of winds less than 0.5 metres per second across the period was nine per cent.

An analysis of the climatic data suggests that there is no strong relationship between the time of year and the monthly average wind speed, although the monthly average wind speeds are generally less during autumn as shown on Figure 12–4. There is little variation in average wind speed between years. The highest average wind speed of 2.9 metres per second was recorded in 2010 and the lowest average wind speed of 2.5 metres per second was recorded in 2012.

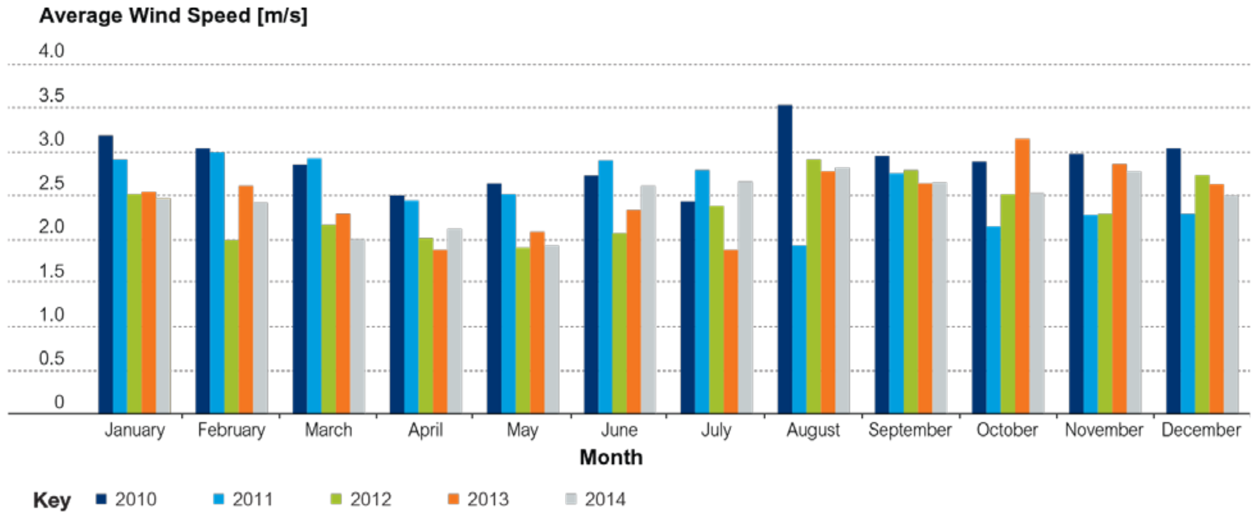


Figure 12–4 – Monthly average wind speed at Badgerys Creek (2010-2014)

Annual and seasonal wind roses for the years 2010-14 are presented in Appendix F1. Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – north, north-north-east, north-east, etc. The bar at the top of each wind rose diagram represents northerly winds, and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the width of the bar corresponds to wind speed categories, the narrowest representing the lightest winds.

On an annual basis, the predominant winds at Badgerys Creek originate from the south-west, followed by the south-south-west and north. Very few winds originate from the north-west. The prevailing winds vary across the seasons with the characteristic south-westerly wind less prominent during summer where winds from the north-east become more frequent. During winter, the majority of winds originate from the south-west. There is a consistent seasonal pattern across all years.

12.4.1.2. Temperature, rainfall and humidity

There is a strong seasonal variation in temperature at Badgerys Creek. The annual average temperature between 2010 and 2014 was 17 degrees Celsius. On average, January was the hottest month, with an average monthly temperature of 23 degrees Celsius and maximum of 45 degrees Celsius. June and July were the coldest months for the five year period, with average temperatures of 11 degrees Celsius and 10 degrees Celsius, respectively. The minimum temperatures for these months were -2 degrees Celsius and -1 degrees Celsius, respectively.

Total annual rainfall data measured over the 2010-14 period indicates an annual average total rainfall of 814 millimetres. The wettest year was 2013 with 912 millimetres of rainfall. The driest year was 2014 with 693 millimetres of rainfall. The rainfall data collected at Badgerys Creek indicate that February is the wettest month, with an average rainfall of 114 millimetres while July is the driest month, with an average rainfall of 30 millimetres. The average monthly rainfall for all years was 68 millimetres.

The annual average relative humidity reading at Badgerys Creek was 73 per cent. The month with the highest relative humidity on average was June, with an average of 79 per cent. The months with the lowest relative humidity were September and October.

12.4.1.3. Vertical profile

Measurements of the vertical profile of the lower atmosphere are made daily at Sydney Airport. No other regular measurements of this kind are made within the Sydney region. The wind speed and wind direction measurements are made using a radiosonde, typically up to 7,000 metres above ground level. The vertical profile measurements of wind speed between 2010 and 2014 are shown in Figure 12–5.

The measurements of wind speed indicate that in the lower few hundred metres of the atmosphere, the wind speeds are generally relatively low, up to eight metres per second. Layers of high wind speeds are observed between 800 metres and 1,000 metres and again between 3,500 metres and 4,500 metres. The highest observed wind speed was 116 metres per second.

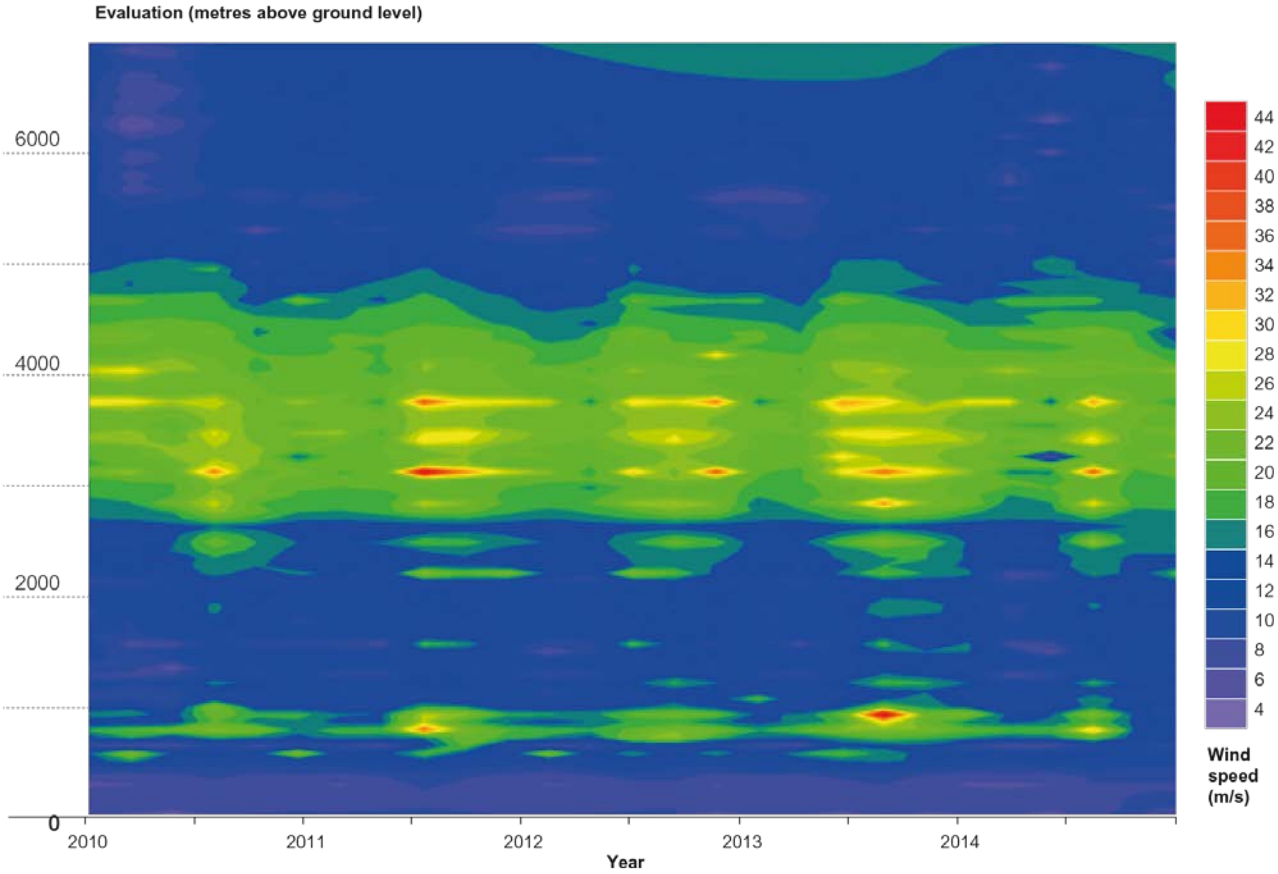


Figure 12–5 – Vertical profile of wind speed at Sydney Airport (2010-14)

12.4.2. Local ambient air quality

To assess the potential impacts of the proposed airport against the relevant air quality assessment criteria described in Section 12.3, it is necessary to have information on existing concentrations of pollutants for the study area so that the cumulative (ambient conditions plus project incremental emissions) impact may be evaluated.

Air quality monitoring data collected between 2005 and 2014 from the OEH monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond was used to describe the existing air quality in Badgerys Creek. The data was compared with the criteria given in Table 12–4 and Table 12–5.

A summary of the available air quality data is provided below with further information provided in Appendix F1. Generally, air quality for the local area is good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires. Uncontrolled combustion events such as bushfires will influence regional observations of PM_{10} and $PM_{2.5}$, and to a lesser extent, nitrogen oxides.

12.4.2.1. Nitrogen dioxide (NO_2)

The main oxides of nitrogen present in the atmosphere are nitric oxide, nitrogen dioxide and nitrous oxide. The major human activity which generates oxides of nitrogen is fuel combustion, especially in motor vehicles. Oxides of nitrogen form in the air when fuel is burnt at high temperatures. This is mostly in the form of nitric oxide with usually less than 10 per cent in the form of nitrogen dioxide. Once emitted, nitric oxide combines with oxygen ('oxidises') to form nitrogen dioxide, especially in warm sunny conditions. These oxides of nitrogen may remain in the atmosphere for several days, during this time chemical processes may generate nitric acid, and nitrates and nitrites as particles. These oxides of nitrogen play a major role in the chemical reactions that generate photochemical smog (OEH 2014a).

Data for nitrogen dioxide were obtained from the monitoring station at Bringelly. The data is presented in Table 12–10. There were no exceedances of the nitrogen dioxide one hour average criteria of 246 micrograms per cubic metre (the one hour maximum concentration ranged between 51 micrograms per cubic metre and 92 micrograms per cubic metre). There were also no exceedances of the annual average criteria of 62 micrograms per cubic metre (the annual average concentrations ranged between 9 micrograms per cubic metre and 13 micrograms per cubic metre).

Analysis of the data shows a clear downward trend in nitrogen dioxide concentrations most substantially between 2006 and 2009 and then again after 2012. In addition, there is a strong seasonal influence on nitrogen dioxide concentrations, peaking during the winter months. This trend is attributed to the more stable atmospheric conditions during winter that leads to reduced dispersion as well as the limited photochemical processes that react with nitrogen dioxide during the summer months.

Further analysis of the data shows that the greatest concentrations of nitrogen dioxide originate from the east and are associated with the key local nitrogen oxides sources, such as vehicle emissions from the M7 which is located to the east of the Bringelly monitoring station.

Table 12–10 – Maximum one hour and annual average nitrogen dioxide concentrations at Bringelly

Year	One hour maximum ($\mu g/m^3$)	Annual average ($\mu g/m^3$)	Exceedances of one hour standard (days per year)
EPA criterion	*246*	*62*	*n/a*
2005	92	13	No exceedances
2006	82	13	No exceedances
2007	90	12	No exceedances
2008	68	10	No exceedances
2009	70	9	No exceedances
2010	76	12	No exceedances
2011	60	10	No exceedances
2012	78	11	No exceedances
2013	76	10	No exceedances
2014	51	10	No exceedances

12.4.2.2. Particulate matter

Particulate matter is solid or liquid particles that are suspended in air that may reduce visual amenity or adversely impact health. It is measured as PM_{10} (particles less than 10 micrometres in diameter) and $PM_{2.5}$ (particles less than 2.5 micrometres in diameter). Examples of particles in the air include dust, smoke, plant spores, bacteria and salt. Particulate matter may be a primary pollutant, such as smoke particles, or a secondary pollutant formed from the chemical reaction of gaseous pollutants. Human activities resulting in particulate matter in the air include mining; burning of fossil fuels; transportation; agricultural and hazard reduction burning; the use of incinerators; and the use of solid fuel for cooking and heating (OEH 2014a).

Data for PM_{10} was obtained from the monitoring station at Bringelly. The data are presented in Table 12–11. The maximum concentrations of 24 hour average PM_{10} have been fairly constant over the last 10 years, generally ranging between 40 micrograms per cubic metre and 97 micrograms per cubic metre (the exception is 2009, where elevated 24 hour average PM_{10} concentrations were measured on a number of occasions as a result of a series of dust storms). There have been several exceedances of the 24 hour average criterion of 50 micrograms per cubic metre. Aside from 2009, the annual average concentrations appear to be generally decreasing with no exceedances of the criterion of 30 micrograms per cubic metre (the annual average concentrations ranged between 25 micrograms per cubic metre and 15 micrograms per cubic metre).

Further analysis of the data suggests that the greatest concentrations originate from the north-west, and to a lesser extent, from the east, west and south-east. The dominant north-west source is likely to be a function of natural events such as bushfires and dust storms that tend to be associated with the hot dry prevailing winds originating from this direction. To the east and south-west are the densely populated precincts of Liverpool and Campbelltown which encompass a multitude of potential particulate matter sources.

Table 12–11 –Maximum 24 hour and annual average PM_{10} concentrations at Bringelly

Year	24 hour maximum (µg/m³)	Annual average (µg/m³)	No. of exceedances of 24 hour standard
EPA criterion	*50*	*30*	*n/a*
2005	55	19	2
2006	72	20	3
2007	51	18	1
2008	63	16	1
2009	1,684	25	6
2010	41	15	No exceedances
2011	86	16	2
2012	40	16	No exceedances
2013	97	17	3
2014	43	17	No exceedances

Data for $PM_{2.5}$ was obtained from the monitoring station at Liverpool and Richmond. The data are presented in Table 12–12. The data indicates that $PM_{2.5}$ concentrations are higher at Liverpool than Richmond, with combustion emissions from urbanisation anticipated to be a major source of the measured differences. There are a number of days across the monitoring period where the 24 hour average measurements are above the NEPM goal of 25 micrograms per cubic metre. As with the PM_{10} monitoring data, the dust storms from 2009 have also been captured in the data set, recording up to 268 micrograms per cubic metre at Liverpool.

Table 12–12 – Maximum 24 hour and annual average $PM_{2.5}$ concentrations at Liverpool and Richmond

Year	24 hour max (µg/m³)		Annual average (µg/m³)		No. of exceedances of 24 hour standard	
	Liverpool	Richmond	Liverpool	Richmond	Liverpool	Richmond
NEPM advisory goal	*25*		*8*		*n/a*	
2005	31	23	8	6	2	0
2006	48	78	9	6	3	1
2007	23	21 (a)	7	6 (a)	0	0
2008	32	18	6	7	1	0
2009	268	149	8	6	5	2
2010	22	21	6	4	0	0
2011	38	43	6	5	2	2
2012	25	117	9	5	0	2
2013	74	83	9	8	2	14
2014	24	25	9	7	0	0

Notes: (a) Less than 75% data retrieval for year

12.4.2.3. Carbon monoxide (CO)

Carbon monoxide is an odourless, colourless gas produced by incomplete oxidation (burning). As well as wildfires, carbon monoxide is produced naturally by oxidation of the oceans and organic decomposition. In cities, the motor vehicle is by far the largest human source, although any combustion process may produce it (OEH 2014a).

Data for carbon monoxide was obtained from the monitoring station at Macarthur and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data is presented in Table 12–13. The one hour maximum concentrations of carbon monoxide show a reasonably stable trend through the years with a slight decrease after 2006. The eight hour maximum concentrations also show a slight decrease that occurred after 2007. There have been no exceedances of one hour or eight hour carbon monoxide criteria at Macarthur.

Table 12–13 – Minute, one hour and eight hour average carbon monoxide concentrations at Macarthur and Campbelltown West

Year	15 minute maximum (mg/m^3)		One hour maximum (mg/m^3)		Eight hour maximum (mg/m^3)	
	Macarthur	Campbelltown West	Macarthur	Campbelltown West	Macarthur	Campbelltown West
EPA criterion	*100*	*100*	*30*	*30*	*10*	*10*
2005	-	-	2.3 (a)	-	1.2 (a)	-
2006	-	-	2.5	-	2.3	-
2007	-	-	2.4	-	2.2	-
2008	-	-	1.5	-	1.1	-
2009	-	-	1.6	-	0.9	-
2010	-	-	2.0	-	1.1	-
2011	-	-	2.1	-	1.3	-
2012	-	-	1.1 (a)	1.1 (a)	0.8 (a)	0.8 (a)
2013	-	-	-	10.5	-	8.6
2014	-	2.1	-	1.5	-	1.2

Notes: (a) Less than 75 per cent data retrieval for year

12.4.2.4. Sulfur dioxide (SO_2)

Sulfur dioxide in the atmosphere arises from both natural and human activities. Natural processes which release sulfur compounds include decomposition and combustion of organic matter; spray from the sea; and volcanic eruptions. The main human activities producing sulfur dioxide are the smelting of mineral ores containing sulfur and the combustion of fossil fuels (OEH 2014a).

Data for sulfur dioxide were obtained from the monitoring station at Bringelly and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data is presented in Table 12–14. There have been fluctuating one hour maximum concentrations of sulfur dioxide over the past 10 years. In 2007 and 2008, one hour maximum concentrations of sulfur dioxide rose by 50 per cent from the 2006 level. Concentrations decreased during 2010 and 2011 and subsequently rose again in 2011. The 24 hour concentrations follow a similar trend to the one hour maximums with a significant drop in 2010 and subsequent increase in 2011. Annual average sulfur dioxide concentrations appear to have decreased from 2010 to 2011 but then increased again in 2012 and 2013. There have been no exceedances of the criteria for any of the required averaging periods.

Further analysis of the data suggests that the greatest concentrations of sulfur dioxide originate from the east, and are most likely associated with vehicle emissions and industry located in this direction.

Table 12–14 – Maximum 15-minute, one hour, eight hour and annual average sulfur dioxide concentrations at Bringelly and Campbelltown West

Year	10 minute maximum ($\mu g/m^3$)	One hour maximum ($\mu g/m^3$)		24 hour maximum ($\mu g/m^3$)		Annual average ($\mu g/m^3$)	
	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West
EPA criterion	*712*	*570*	*570*	*228*	*228*	*60*	*60*
2004	-	43	-	6.8	-	0.6	-
2005	-	26	-	7.5	-	0.7	-
2006	-	26	-	6.3	-	1.0	-
2007	-	49	-	8.2	-	1.2	-
2008	-	54	-	7.5	-	0.3	-
2009	-	34	-	9.2	-	-0.8	-
2010	-	23	-	5.7	-	0.7	-
2011	-	31	-	5.2	-	0.3	-
2012	-	43	23 (a)	5.1	5.7 (a)	0.5	1.4 (a)
2013	-	31	26	7.0	6.8	0.7	1.3
2014 (b)	80(c)	26	34	8.5	9.9	0.7	1.2

Notes: (a) Less than 75 per cent data retrieval for year.

(b) Calibration issue with instrument between January and May 2014. The data have been included for completeness.

(c) High resolution data was available for Campbelltown West only.

12.4.2.5. Air toxics

Air toxics include benzene, dioxins, lead and other metals. Major sources of these toxics include motor vehicle exhaust and some commercial and industrial processes. Knowledge of the health effects of air toxics is far from complete, but studies are showing that very small amounts of air toxics may present a risk to human health and the environment (OEH 2014a).

Continuous monitoring of air toxics is not measured as part of the OEH air quality monitoring network or under any other program at present. However, between 1996 and 2001, the NSW Environment Protection Authority (EPA) (then Department of Environment and Conservation (DEC)) conducted the Air Toxics Monitoring Project which investigated concentrations of the NEPM air toxics (benzene, toluene, xylene and polyaromatic hydrocarbons such as benzo[a]pyrene) for 24 hour periods at numerous locations across Sydney and NSW (DEC 2004a, DEC 2004b). In addition, the Ambient Air Quality Monitoring and Fuel Quality Testing Project collected 24 hour concentrations of formaldehyde at Rozelle and Turella for a one year period from October 2008 to October 2009. The results of this monitoring have been published as part of the EPA's *Current Air Quality in New South Wales* technical paper (DECCW 2010).

The Air Toxics Monitoring Project found ambient concentrations of most tested substances were well below international ambient air quality goals at the time. The Ambient Air Quality Monitoring and Fuel Quality Testing Project also found low concentrations of all chemical pollutants, with many observations below the detection limit of the method.

12.4.2.6. Ozone (O_3)

Near the ground, ozone is a colourless, gaseous secondary pollutant. It is formed by chemical reactions between reactive organic gases and oxides of nitrogen in the presence of sunlight. Ozone is one of the irritant secondary pollutants in photochemical smog and is often used as a measure of it (OEH 2014a).

Data for ozone in the vicinity of the airport site was obtained from the monitoring station at Bringelly. The data are presented in Table 12–15 and further analysis of regional ozone is presented in Section 12.4.5. There have been multiple exceedances of both the one hour maximum criteria of 214 micrograms per cubic metre and the four hour maximum criteria of 171 micrograms per cubic metre over the past 10 years. The one hour maximum concentrations ranged between 188 micrograms per cubic metre and 268 micrograms per cubic metre and the four hour maximum concentrations ranged between 149 micrograms per cubic metre and 235 micrograms per cubic metre.

Ozone concentrations vary based on the time of day and also time of year, with peak ozone concentrations occurring in the mid-afternoon and also during the summer months. The seasonal variability is associated with the availability of sunlight, with the increase in sunlight in the summer months driving the photochemical activity that generates ozone.

Table 12–15 – Maximum one hour and four hour average ozone concentrations at Bringelly

Year	One hour maximum ($\mu g/m^3$)	Four hour maximum ($\mu g/m^3$)	Exceedances of one hour standard (days per year)	Exceedances of four hour standard (days per year)
EPA criterion (NEPM goal)	*214*	*171*	*(1)*	*(1)*
2005	261	235	8	5
2006	240	218	6	3
2007	255	219	10	5
2008	199	155	0	0
2009	257	232	7	3
2010	223	179	2	1
2011	268	226	5	2
2012	188	149	0	0
2013	231	207	3	1
2014	265	237	4	3

12.4.3. Odour

The airport site is mostly isolated from other industry that has the potential to be odorous. The exception is the poultry industry with a number of broiler and egg-laying farms in the vicinity, particularly to the east of the airport site. Multiple sources of odour are typically only treated cumulatively when similar in character and, as such, consideration of background odour has not been included as part of this assessment.

12.4.4. Adopted local background concentrations

The background concentrations adopted for the local air quality assessment are presented in Table 12–16.

Table 12–16 – Summary of assumed background concentrations

Pollutant	Averaging period	Year	Value used for background		Location
Carbon monoxide (CO)	15 minutes	2014	2.1	mg/m^3	Campbelltown West
	One hour	2014	1.5	mg/m^3	Campbelltown West
	Eight hours	2014	1.2	mg/m^3	Campbelltown West
Nitrogen dioxide (NO_2)	One hour	2014	Varying	-	Bringelly
	One year	2014	10	µg/m^3	Bringelly
Particulate matter < 10 µm (PM_{10})	24 hours	2014	Varying	-	Bringelly
	One year	2014	17	µg/m^3	Bringelly
Particulate matter < 2.5 µm ($PM_{2.5}$)	24 hours	2014	Varying		Bringelly (b)
	One year	2014	7	µg/m^3	Bringelly (b)
Deposited dust	One year	n/a	2	g/m^2/month	n/a
Sulfur dioxide (SO_2)	10 minutes	2014	80	µg/m^3	Campbelltown West
	One hour	2014	34	µg/m^3	Campbelltown West
	24 hours	2014	9.9	µg/m^3	Campbelltown West
	One year	2014	1.2	µg/m^3	Campbelltown West
Benzene	One year	2008-09	1.0	µg/m^3	Rozelle
Toluene(a)	24 hours	2008-09	15.3	µg/m^3	Rozelle
	One year	2008-09	3.7	µg/m^3	Rozelle
Xylenes (a)	24 hours	2008-09	16.6	µg/m^3	Rozelle
	One year	2008-09	2.4	µg/m^3	Rozelle
Formaldehyde	24 hours	2008-09	4.3	µg/m^3	Rozelle
B[a]p	One year	2008-09	0.2	ng/m^3	Blacktown

Notes: (a) 24 hour average value has been pro-rated based on the 1996-2001 data from Table 4-10 in Appendix F1.
(b) Based on 2014 $PM_{2.5}$ / PM_{10} ratio of 0.31 at Liverpool and Richmond.

12.4.5. Regional air quality (ozone)

Regional air quality considers the formation of secondary pollutants (such as ozone (O_3)) through photochemical reactions from primary emissions of precursor gases including nitrogen oxides, volatile organic compounds and carbon monoxide.

Regional ozone is affected both by local formation and the transport of ozone and its precursor gases from upwind areas. As a secondary pollutant, ozone concentrations are generally more regionally homogeneous than concentrations of primary pollutants (USEPA 2013).

Meteorology and seasonality also play an important role in ozone formation. Peak ozone concentrations in Sydney tend to occur in the afternoon and during summer months due to the availability of sunlight and higher temperatures.

Elevated ground-level ozone concentrations are also associated with slow moving high pressure systems during the warmer seasons, associated with generally cloudless skies, light winds and the development of stable conditions near the surface that reduce the vertical mixing of the precursor gases. The combination of reduced mixing and light winds minimises the dispersal of pollutants, allowing their concentrations to build up (USEPA 2014).

There are a range of precursor gas emission sources which contribute to regional ozone generation. Sources include industrial, commercial, off-road mobile and on-road mobile emissions together with biogenic sources such as emission of volatile organic compounds from areas of existing vegetation such as the Blue Mountains.

The relationship between ozone formation and emissions of precursor gases is not linear, for example nitrogen oxides emissions can lead to both formation and destruction of ozone, depending on the local quantities of nitrogen oxides, volatile organic compounds and sunlight (USEPA 2014).

The NSW EPA tiered procedure for ozone assessment requires classification of areas of Sydney as “attainment” or “non-attainment”, based on meeting or exceeding an “acceptance limit” expressed as 82 per cent of the NEPM goal (NEPC 2007).

Ozone is currently measured at 15 Sydney monitoring sites, operated by the OEH. The maximum one hour and four hour average ozone concentrations for the most recent five years of monitoring data at these sites are presented in Table 12–17 and Table 12–18. The average across the five years is taken and the maximum five year average is compared against the acceptance limits of 82 parts per billion (one hour) and 65.2 parts per billion (four hour). It is clear from the analysis that all areas of the Sydney region are currently classified as non-attainment.

Table 12–17 – Classification of ozone nonattainment based on one hour average ozone concentrations

Station	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	84	73	66	75	66	73
Rozelle	73	93	69	73	67	75
Lindfield	82	86	73	81	85	81
Chullora	83	114	80	105	79	92
Earlwood	85	99	82	101	69	87
Maximum five year average – Sydney central-east (nonattainment)						92
Richmond	89	116	85	95	90	95
St Marys	95	136	85	110	100	105
Vineyard	90	94	80	105	112	96
Prospect	104	126	80	111	103	105
Maximum five year average – Sydney north-west (nonattainment)						105
Liverpool	91	103	79	117	103	99
Bringelly	104	125	88	108	124	110
Bargo	110	126	91	95	105	105
Macarthur	119	131				
Oakdale	99	126	89	95	110	104
Campbelltown west				94	124	
Camden				110	123	
Maximum five year average – Sydney south-west (nonattainment)						110

Table 12–18 – Classification of ozone nonattainment based on four hour average ozone concentrations

Station	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	77	69	63	67	61	67
Rozelle	67	80	54	63	60	65
Lindfield	79	84	71	74	75	77
Chullora	72	96	68	94	73	81
Earlwood	74	88	68	82	65	75
Maximum – Sydney central-east (nonattainment)						**81**
Richmond	82	88	70	76	73	78
St Marys	83	121	72	101	85	92
Vineyard	79	75	70	90	75	78
Prospect	97	114	73	104	97	97
Maximum – Sydney north-west (nonattainment)						**97**
Liverpool	81	95	71	110	87	89
Bringelly	89	118	72	102	113	99
Bargo	86	98	83	82	93	88
Macarthur	103	122				
Oakdale	88	98	81	81	88	87
Campbelltown west				82	111	
Camden				90	110	
Maximum – Sydney south-west (nonattainment)						**99**

All areas of the Sydney region are currently classified as non-attainment, meaning they are not meeting an ‘acceptance limit’ expressed as 82 per cent of the NEPM standards (ENVIRON 2011). Exceedances of the ambient ozone standards in Sydney are generally limited to the summer months (December to February). In some years, exceedances occur in the months of October, November and March, however outside the core summer periods, exceedances often coincide with bushfires events (for example November 2009 and October 2013).

A review of the most recent 10 years of monitoring data reveals exceedances of the one hour and four hour ozone standard in eight of the previous 10 years at Bringelly. Analysis of long term trends indicates that there is some evidence of decreasing monthly maximum ozone concentrations at Bringelly, near the airport site, as well as in other areas of Sydney.

12.5. Assessment of impacts during construction

12.5.1. Overview

Construction of the proposed Stage 1 development would result in dust emissions being generated during both the bulk earthworks and the aviation infrastructure works. Dust emissions during the bulk earthworks would result from:

- dozers;
- scrapers;
- the loading and unloading of material;
- hauling on paved and unpaved roads;
- wind erosion; and
- grading.

Dust emissions during the aviation infrastructure works would be generated by:

- the working crew (similar to the equipment used during bulk earthworks);
- the asphalt plant; and
- the concrete batching plant.

In addition to the above, there would also be diesel particulate matter emissions (comprising $PM_{2.5}$ only) from the on-site equipment as well as odour emissions from the asphalt plant.

This section describes the results of the air dispersion modelling for the construction of the Stage 1 development. The concentrations of PM_{10}, $PM_{2.5}$, dust deposition and odour were determined for 18 residential receptors and 75 community receptors in the vicinity of the airport site. Only the residential receptors are discussed below as they were considered representative of the community receptors. The tabulated results for all receptors, including the community receptors, are provided in Appendix F1.

Contour plots for each of the pollutants and relevant averaging periods are also provided in Appendix F1.

12.5.2. Bulk earthworks

Table 12–19 presents a summary of the maximum 24 hour average and annual average particulate matter and dust deposition concentrations due to the on-site construction activities. Table 12–20 summarises the cumulative results including other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1.
The results show that the predicted dust impacts during the bulk earthworks would be below the air quality assessment criteria for each of the reported air quality parameters both incrementally as a result of the project and cumulatively when assessed with background concentrations and modelled inputs of other projects.

The contour plots show the spatial extent of particulate matter and the predicted concentrations across the local area (refer to Appendix F1). While the predicted concentrations remain low at all off-site residential receptors, the nature of the plume spread for the 24 hour and annual averaging periods is highest to the north-east and south-west of the airport site, consistent with the prevailing winds measured at Badgerys Creek (refer to Section 12.4.1).

Table 12–19 – Predicted incremental particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*2*
R1	Bringelly	1.0	0.1	0.4	<0.1	1 x10^{-5}
R2	Luddenham	2.1	0.3	0.5	0.1	7 x10^{-5}
R3	Greendale, Greendale Road	2.7	0.1	1.4	0.1	2 x10^{-5}
R4	Kemps Creek	1.3	0.1	0.8	<0.1	2 x10^{-5}
R6	Mulgoa	0.4	0.1	0.2	<0.1	1 x10^{-5}
R7	Wallacia	0.6	0.1	0.3	<0.1	1 x10^{-5}
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	2.0	0.3	0.7	0.1	5 x10^{-5}
R14	Badgerys Creek, Lawson Road	4.8	0.6	2.0	0.2	1 x10^{-4}
R15	Greendale, Mersey Road	3.3	0.4	1.2	0.1	5 x10^{-5}
R17	Luddenham Road	2.2	0.3	0.6	0.1	6 x10^{-5}
R18	Corner of Adams and Elizabeth Drive	6.5	1.0	1.8	0.2	2 x10^{-4}
R19	Corner of Adams and Anton Road	7.2	0.9	2.1	0.2	2 x10^{-4}
R21	Corner of Willowdene Avenue and Vicar Park Lane	2.9	0.5	0.7	0.1	1 x10^{-4}
R22	Rossmore, Victor Avenue	1.4	0.1	0.7	<0.1	2 x10^{-5}
R23	Wallacia, Greendale Road	0.8	0.1	0.3	<0.1	2 x10^{-5}
R27	Greendale, Dwyer Road	1.2	0.2	0.4	<0.1	3 x10^{-5}
R30	Rossmore residential	0.7	0.1	0.3	<0.1	7 x10^{-6}
R31	Mount Vernon residential	1.8	0.1	1.0	<0.1	2 x10^{-5}

Table 12–20 – Predicted cumulative particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*30*	*25*	*8*	*4*
R1	Bringelly	43.0	17.1	13.5	7.0	2.0
R2	Luddenham	42.7	17.3	13.3	7.1	2.0
R3	Greendale, Greendale Road	42.7	17.1	13.3	7.1	2.0
R4	Kemps Creek	42.6	17.1	13.3	7.0	2.0
R6	Mulgoa	42.6	17.1	13.3	7.0	2.0
R7	Wallacia	42.6	17.1	13.3	7.0	2.0
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	43.4	17.3	13.5	7.1	2.0
R14	Badgerys Creek, Lawson Road	43.0	17.6	13.4	7.2	2.0
R15	Greendale, Mersey Rd	44.6	17.4	14.0	7.1	2.0
R17	Luddenham Road	44.2	17.3	13.7	7.1	2.0
R18	Corner Adams and Elizabeth Drive	44.2	18.0	13.7	7.2	2.0
R19	Corner of Adams and Anton Road	43.9	17.9	13.6	7.2	2.0
R21	Corner of Willowdene Avenue and Vicar Park Lane	42.9	17.5	13.4	7.1	2.0
R22	Rossmore, Victor Avenue	42.7	17.1	13.3	7.0	2.0
R23	Wallacia, Greendale Road	42.6	17.1	13.3	7.0	2.0
R27	Greendale, Dwyer Road	43.0	17.2	13.4	7.0	2.0
R30	Rossmore residential	42.7	17.1	13.4	7.0	2.0
R31	Mt Vernon residential	42.6	17.1	13.3	7.0	2.0

12.5.3. Aviation infrastructure works

Table 12–21 presents a summary of the maximum 24 hour average and annual average particulate matter and dust deposition concentrations at each of the 20 residential receptors, due to the aviation infrastructure works. Table 12–22 summarises the results cumulatively with other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1.

The results show that the predicted dust impacts during the aviation infrastructure works are forecast to be below the air quality assessment criteria for each of the reported air quality parameters both incrementally as a result of the project and cumulatively when assessed with the background concentrations and modelled inputs of other projects.

The contour plots show a similar trend to those described for the bulk earthworks, with maximum off-site concentrations predicted to the north-east and south-west of the airport site (refer to Appendix F1).

Table 12–21 – Predicted incremental results during aviation infrastructure works

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*2*
R1	Bringelly	2.7	0.2	2.3	0.2	7 x10^{-6}
R2	Luddenham	2.7	0.4	2.4	0.3	4 x10^{-5}
R3	Greendale, Greendale Road	8.0	0.3	5.4	0.2	2 x10^{-5}
R4	Kemps Creek	11.0	0.2	2.8	0.2	1 x10^{-5}
R6	Mulgoa	1.3	0.1	0.7	0.1	7 x10^{-6}
R7	Wallacia	1.7	0.1	0.9	0.1	1 x10^{-5}
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	4.0	0.4	3.3	0.3	2 x10^{-5}
R14	Badgerys Creek, Lawson Road	25.4	1.2	6.6	0.7	5 x10^{-5}
R15	Greendale, Mersey Road	7.3	0.6	5.9	0.5	3 x10^{-5}
R17	Luddenham Road	5.3	0.4	2.4	0.3	3 x10^{-5}
R18	Corner of Adams and Elizabeth Drive	11.0	1.1	7.8	1.0	1 x10^{-4}
R19	Corner of Adams and Anton Road	8.7	1.1	7.0	1.1	1 x10^{-4}
R21	Corner of Willowdene Avenue and Vicar Park Lane	4.6	0.7	3.9	0.7	1 x10^{-4}
R22	Rossmore, Victor Avenue	6.6	0.3	2.2	0.2	1 x10^{-5}
R23	Wallacia, Greendale Road	2.1	0.2	1.2	0.2	1 x10^{-5}
R27	Greendale, Dwyer Road	2.6	0.2	2.9	0.2	2 x10^{-5}
R30	Rossmore residential	2.3	0.1	1.5	0.1	4 x10^{-6}
R31	Mt Vernon residential	5.9	0.2	2.9	0.2	1 x10^{-5}

Table 12–22 – Predicted cumulative results during aviation infrastructure works

Receptor	Receptor description	PM$_{10}$ (µg/m^3)		PM$_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*30*	*25*	*8*	*4*
R1	Bringelly	45	17	14	7	2
R2	Luddenham	43	17	13	7	2
R3	Greendale, Greendale Road	43	17	13	7	2
R4	Kemps Creek	43	17	13	7	2
R6	Mulgoa	43	17	13	7	2
R7	Wallacia	43	17	13	7	2
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	47	17	14	7	2
R14	Badgerys Creek, Lawson Road,	50	18	14	8	2
R15	Greendale, Mersey Road	46	18	17	8	2
R17	Luddenham Road	44	17	15	7	2
R18	Corner of Adams and Elizabeth Drive	45	18	15	8	2
R19	Corner of Adams and Anton Road	44	18	15	8	2
R21	Corner of Willowdene Avenue and Vicar Park Lane	43	18	14	8	2
R22	Rossmore, Victor Avenue	43	17	13	7	2
R23	Wallacia, Greendale Road	43	17	13	7	2
R27	Greendale, Dwyer Road	43	17	14	7	2
R30	Rossmore residential	43	17	14	7	2
R31	Mt Vernon residential	43	17	13	7	2

12.5.4. Asphalt batching plant

The 99th percentile one hour odour predictions for emissions from the asphalt batching plant are presented in Table 12–23. Odour from the asphalt plant would be below the relevant criteria at all sensitive residential receptors. The contour plot shows that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1). The two OU contour (the adopted impact assessment criterion) spreads outside of the airport site a relatively short distance to the north. This area is currently unoccupied and, therefore, there would be no adverse odour impacts to sensitive receptors from the asphalt batching plant.

Table 12–23 – Predicted 99th percentile odour concentration from asphalt batching plant

Receptor	Receptor description	One hour 99th percentile odour (OU)
Assessment criteria		*2*
R1	Bringelly	<0.1
R2	Luddenham	<0.1
R3	Greendale, Greendale Road	<0.1
R4	Kemps Creek	0.1
R6	Mulgoa	<0.1
R7	Wallacia	<0.1
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	0.3
R14	Badgerys Creek, Lawson Road	1.7
R15	Greendale, Mersey Road	0.1
R17	Luddenham Road	0.4
R18	Corner of Adams and Elizabeth Drive	0.5
R19	Corner of Adams and Anton Road	0.1
R21	Corner of Willowdene Avenue and Vicar Park Lane	<0.1
R22	Rossmore, Victor Avenue	0.2
R23	Wallacia, Greendale Road	<0.1
R27	Greendale, Dwyer Road	<0.1
R30	Rossmore residential	<0.1
R31	Mt Vernon residential	0.2

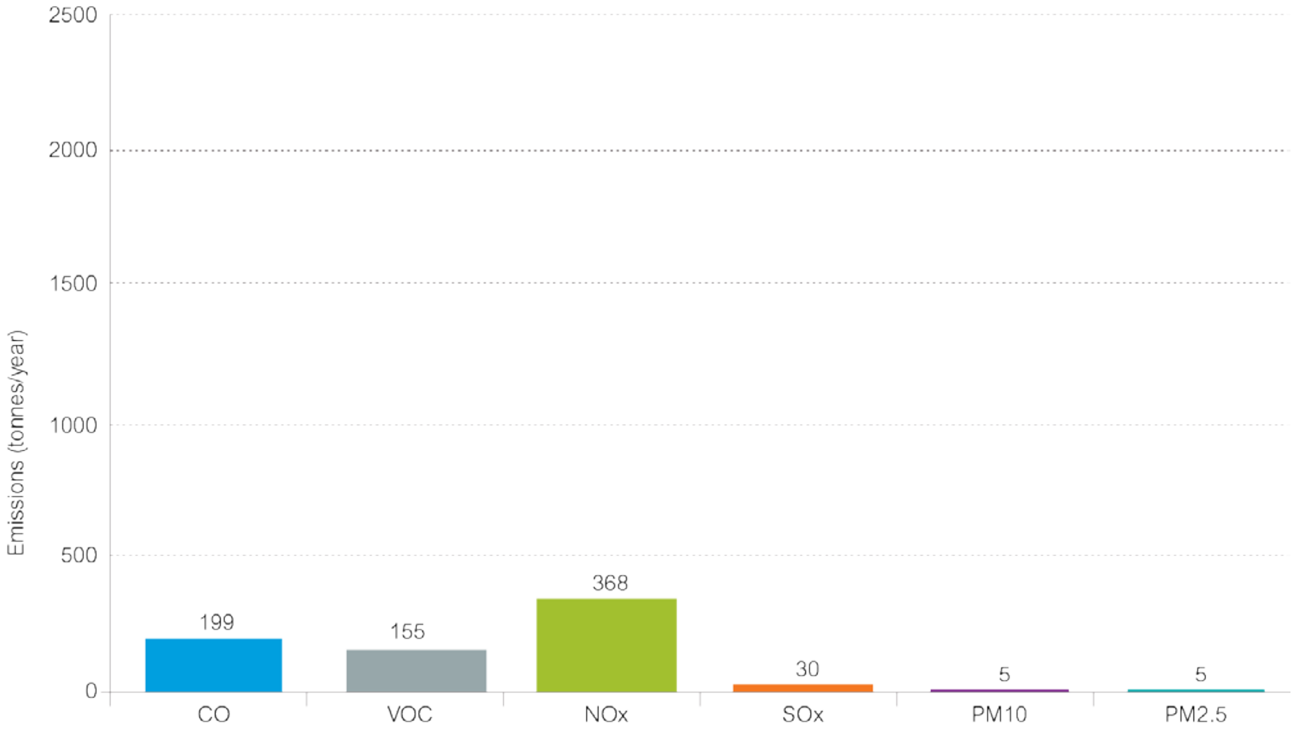
12.6. Assessment of impacts during operation

This section describes the results of the emission calculations and air dispersion modelling for the operation of the proposed Stage 1 development.

12.6.1. Emissions

The emissions of criteria pollutants from the Stage 1 development are presented in Figure 12–6. Incremental emissions are generated by sources associated with the airport operations alone including emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative emissions include the respective airport sources in addition to emissions from vehicles on external roadways, as characterised within the surface transport and access technical report (refer to Chapter 15 and Appendix J in Volume 4).

AIRPORT EMISSIONS (INCREMENTAL)



AIRPORT AND EXTERNAL ROAD EMISSIONS (CUMULATIVE)

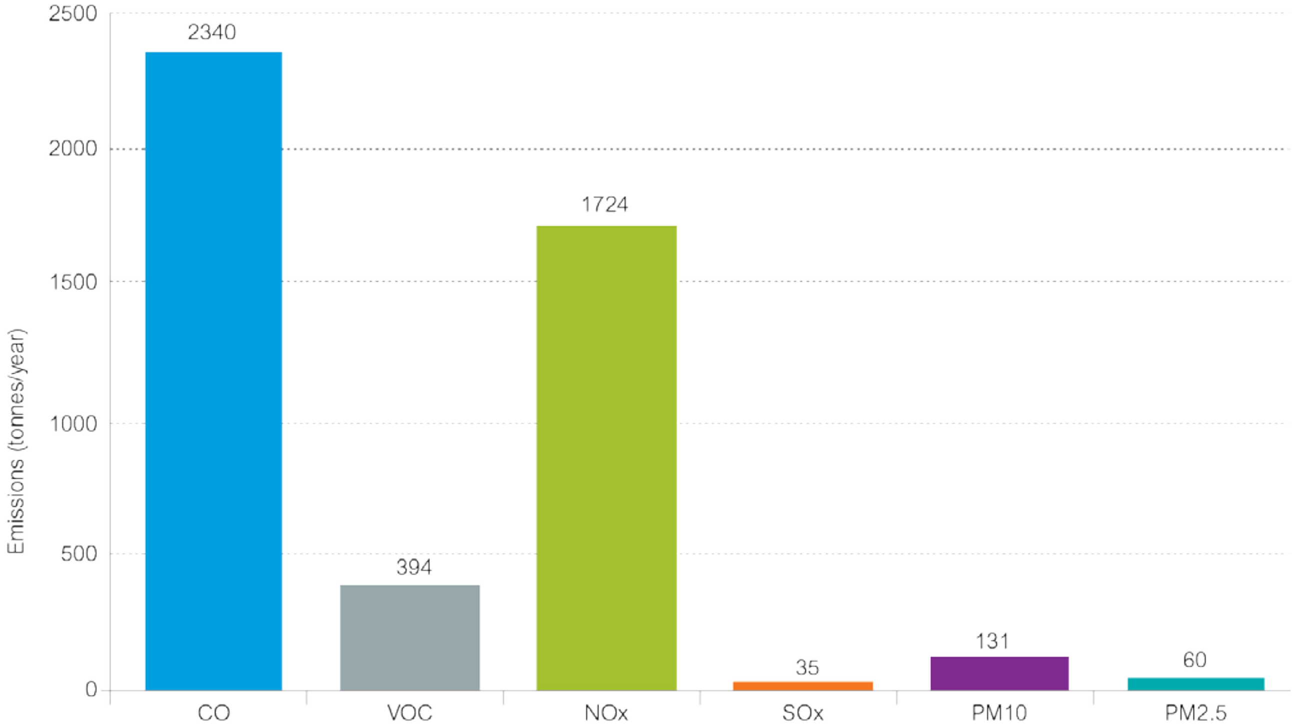


Figure 12–6 – Total estimated emissions for criteria pollutants

The emission inventory for the Stage 1 development is presented by source type in Table 12–24. The percentage contribution of each source is shown alongside the emission value. Emission totals have been provided with and without the cumulative contributions from external roadways. The external roadways are estimated to be the largest source of emissions during the Stage 1 development, as shown on Figure 12–7. This is attributed to the extent of the road network, the number of vehicles using the road network and the associated emissions that have been included in the modelling (refer to Appendix F1). Review of the incremental emissions (that is, those emissions from within the airport site only) shows the emissions from aircraft engines are the most significant source.

Emissions from auxiliary power units, ground support equipment, parking facilities and terminal traffic were also significant emission sources. In the case of carbon monoxide, the largest single source was ground support equipment (24 per cent), while for nitrogen oxides, auxiliary power units were the next largest source (five per cent). Stationary sources, in particular fuel tanks, are a significant contributor to volatile organic compounds emissions. Evaporative losses from jet fuel at the on-site fuel farm is calculated to account for over 99 per cent of losses compared with those from diesel and petroleum, reflecting this fuel source’s volatility.

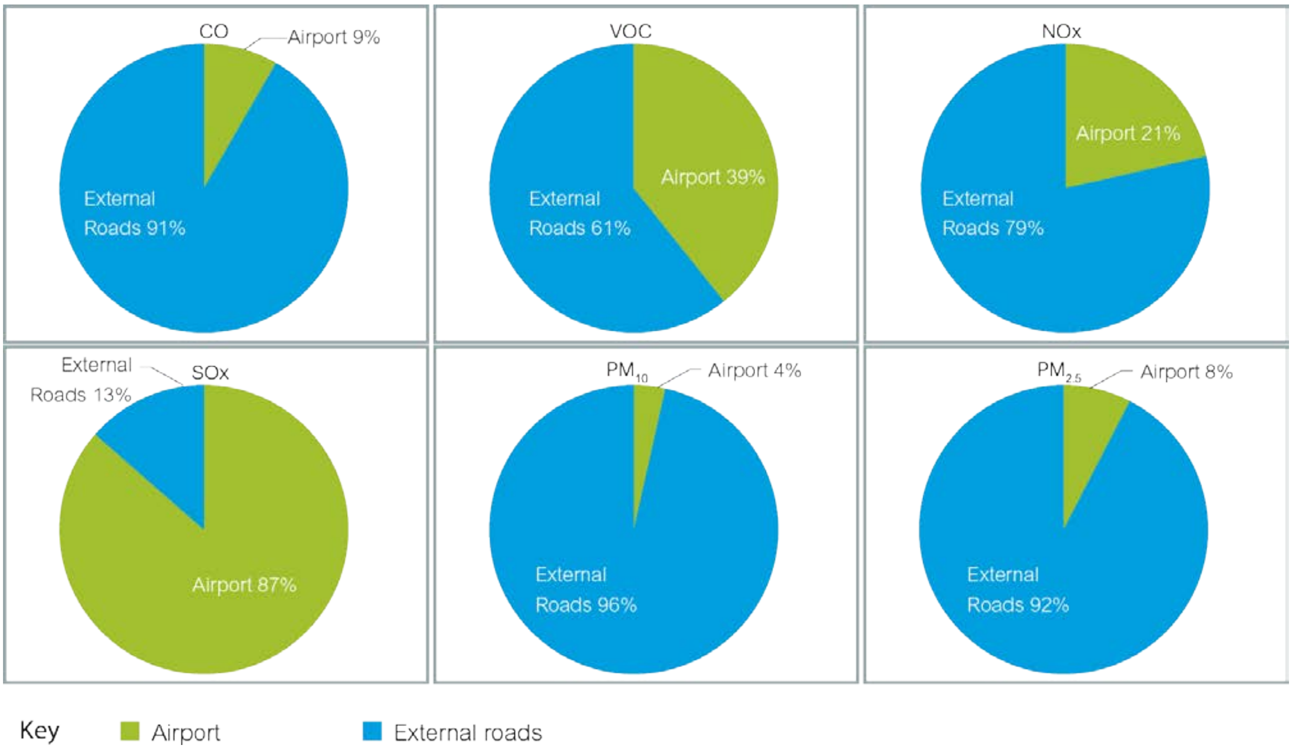
When the cumulative contributions from the external roadways in the study area are considered, they account for an estimated 97 per cent of PM_{10}, 93 per cent of $PM_{2.5}$ and 79 per cent of nitrogen oxides emissions with the remaining emissions comprising those from the proposed airport.

Table 12–24 – Airport emission inventory for criteria pollutants

Category	Emissions (tonnes per year)											
	CO		VOC		NOx		SO_2		PM_{10}		$PM_{2.5}$	
Aircraft engines	126.5	64%	26.5	17%	335.9	91%	23.3	77%	1.8	39%	1.8	39%
Ground support equipment	48.6	24%	2.0	1%	4.5	1%	0.5	2%	0.3	6%	0.3	6%
Auxiliary power units	4.7	2%	0.5	0%	17.3	5%	1.6	5%	1.1	23%	1.1	23%
Parking facilities	9.4	5%	1.0	1%	0.4	0%	0.0	0%	0.0	1%	0.0	0%
Terminal traffic	4.9	2%	0.5	0%	1.2	0%	0.0	0%	0.2	4%	0.1	2%
Stationary sources	2.4	1%	62.0	40%	4.4	1%	4.7	16%	0.3	7%	0.3	7%
Boilers	1.9	1%	0.1	0%	2.4	1%	0.0	0%	0.2	4%	0.2	4%
Engine tests	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Fuel tanks	-	-	54.5	35%	-	-	-	-	-	-	-	-
Generators	0.4	0%	0.1	0%	2.0	1%	0.1	0%	0.1	3%	0.1	3%
Paint and Solvent	-	-	7.2	5%	-	-	-	-	-	-	-	-
Training Fires	0.0	0%	0.1	0%	0.0	0%	0.0	0%	0.7	15%	0.7	15%
Total (airport)	199	100%	155	100%	368	100%	30	100%	5	100%	5	100%
External roadways	2131	91%	238	72%	1353	79%	4.7	13%	126	96%	54.9	92%
Airport	199	9%	155	28%	368	21%	30	87%	5	4%	5	8%
Total including external roadways	2,331	100%	331	100%	1,717	100%	30	100%	130	100%	59	100%

Notes: (a) Includes contribution from airport traffic on roadways outside the airport site.

CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides, SO_2 = Sulfur dioxide, PM_{10} and $PM_{2.5}$ = Particulate matter



Notes: CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides, SO_x = Sulfur oxides, PM_{10} and $PM_{2.5}$ = Particulate matter

Figure 12–7 – Estimated airport and external roads emissions as a percentage of total modelled for criteria pollutants

Forecast emissions from the proposed airport have also been considered in the context of the Sydney airshed. Projected emissions data for the Sydney airshed were prepared by the NSW EPA (2012) for the years 2016, 2021, 2026, 2031 and 2036. The projected emissions for 2031 have been compared with the total emissions from the proposed airport and are shown in Table 12–25. As the Sydney airshed forecast emissions are not available for 2030, it has been assumed that they will be the same as 2031. The emissions from the airport represent up to 0.7 per cent of the total anthropogenic emissions of nitrogen oxides within the Sydney airshed.

Table 12–25 – Forecast Sydney airshed emissions compared with forecast airport emissions

Pollutant	Forecast Sydney airshed emissions in 2031 (tonnes/year)	Forecast airport emissions in 2030 (tonnes/year)	Forecast airport emissions compared with Sydney airshed in 2030 (%)
CO	166,802	199	0.1%
VOC	98,369	155	0.2%
NOx	51,452	368	0.7%
SO_2	18,522	30	0.2%
PM_{10}	10,446	5	<0.1%
$PM_{2.5}$	12,834	5	<0.1%

Source: Forecast 2031 Sydney Airshed emissions from EPA 2012a.
Note: Forecast airport emissions do not include contributions from external roadways. CO = Carbon monoxide, VOC = Volatile organic compounds, NOx = Nitrogen oxides, SO_2 = Sulfur dioxide, PM_{10} and PM2.5 = Particulate matter

12.6.2. Dispersion modelling results

The concentrations of the criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, PM_{10}, $PM_{2.5}$ and volatile organic compounds) were determined for residential, on-site and community receptors in the local area. As the residential receptors are generally located in the similar areas as the community receptors, only the residential and on-site receptors are discussed below. The results for all receptors, including the community receptors, are provided in Appendix F1.

Contour plots that show the spatial distribution of each pollutant are provided in Appendix F1.

The incremental emissions comprise emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative predictions include the respective airport sources and emissions from the external roadways and background contributions.

12.6.2.1. Nitrogen dioxide (NO_2)

The dispersion modelling results for maximum one hour and annual average nitrogen dioxide are presented in Table 12–26. The results of the dispersion modelling show predicted nitrogen dioxide concentrations to be below the air quality assessment criteria at all residential receptors when considering the airport both in isolation (incremental) and combined with the external roadways and background sources (cumulative).

The maximum one hour nitrogen dioxide concentration is predicted to occur at receptor R3, located to the south-west of the airport site. The incremental and cumulative contributions are predicted to be 60 per cent and 70 per cent of the air quality assessment criteria of 320 micrograms per cubic metre. The cumulative contributions from external roadways are shown to have negligible effects for some receptors and greater effects for others such as R22 at Rossmore.

Table 12–26 – Predicted incremental and cumulative NO_2 concentrations

Receptor	Receptor description	Airport (µg/m3)		Cumulative (µg/m3)	
		One hour	Annual	One hour	Annual
Assessment criteria		*320*	*62*	*320*	*62*
R1	Bringelly	84	11	139	18
R2	Luddenham	91	13	91	15
R3	Greendale, Greendale Road	194	12	227	14
R4	Kemps Creek	76	11	160	25
R6	Mulgoa	84	12	90	14
R7	Wallacia	90	11	92	13
R8	Twin Creeks, corner Twin Creeks Drive & Humewood Place	86	13	105	19
R14	Badgerys Creek, Lawson Road	147	13	160	22
R15	Greendale, Mersey Road	130	13	138	17
R17	Luddenham Road	96	13	115	18
R18	Corner Adams and Elizabeth Drive	107	17	110	22
R19	Corner Adams and Anton Road	111	19	121	23
R21	Corner Willowdene Avenue and Vicar Park Lane	171	13	179	16
R22	Rossmore, Victor Avenue	68	11	145	17
R23	Wallacia, Greendale Road	87	11	101	13
R24	Badgerys Creek 1 NE	166	18	169	25
R25	Badgerys Creek 2 SW	104	12	108	16
R27	Greendale, Dwyer Road	80	11	86	12
R30	Rossmore residential	66	11	131	20
R31	Mt Vernon residential	142	12	143	19

12.6.2.2. Particulate matter (PM_{10})

The dispersion modelling results for maximum 24 hour average and annual average PM_{10} are presented in Table 12–27. The results of the dispersion modelling show predicted PM_{10} concentrations to be below the air quality assessment criteria at all residential receptors. For both averaging periods, the background PM_{10} contributes more than half of the respective criterion.

The contour plots show that the contribution from roadways plays a significant role in the ground level concentrations of PM_{10} (refer to Appendix F1).

Table 12–27 – Predicted incremental and cumulative PM_{10} concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*50*	*30*
R1	Bringelly	0.5	<0.1	7.8	1.1	44	18
R2	Luddenham	0.5	<0.1	2.0	0.3	43	17
R3	Greendale, Greendale Road	1.0	<0.1	3.3	0.2	43	17
R4	Kemps Creek	0.6	<0.1	15.8	1.7	46	19
R6	Mulgoa	0.5	<0.1	1.9	0.2	43	17
R7	Wallacia	0.4	<0.1	2.0	0.2	43	17
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	3.8	0.6	44	18
R14	Badgerys Creek, Lawson Road	1.5	0.1	7.1	1.1	44	18
R15	Greendale, Mersey Road	1.1	0.1	2.5	0.5	44	18
R17	Luddenham Road	0.7	<0.1	3.5	0.6	43	18
R18	Corner Adams and Elizabeth Drive	0.7	0.1	3.7	0.7	44	18
R19	Corner Adams and Anton Road	2.0	0.2	3.0	0.6	44	18
R21	Corner Willowdene Avenue and Vicar Park Lane	0.9	<0.1	3.3	0.4	43	17
R22	Rossmore, Victor Avenue	0.9	<0.1	4.5	0.6	44	18
R23	Wallacia, Greendale Road	0.6	<0.1	3.0	0.2	43	17
R24	Badgerys Creek 1 NE	4.1	0.4	6.0	1.2	44	18
R25	Badgerys Creek 2 SW	0.6	<0.1	2.8	0.6	43	18
R27	Greendale, Dwyer Road	0.1	<0.1	1.7	0.2	43	17
R30	Rossmore residential	0.3	<0.1	7.5	1.4	45	18
R31	Mt Vernon residential	0.9	<0.1	5.6	0.6	43	18

12.6.2.3. Particulate matter ($PM_{2.5}$)

The dispersion modelling results for maximum 24 hour average and annual average $PM_{2.5}$ are presented in Table 12–28. The dispersion modelling shows predicted $PM_{2.5}$ concentrations to be below the air quality assessment criteria at all residential receptors. For both averaging periods, the background is anticipated to contribute more than half of the respective criterion.

As with PM_{10}, the contour plots show the contribution from roadways plays a significant role in the ground level concentrations of $PM_{2.5}$ (refer to Appendix F1).

Table 12–28 – Predicted incremental and cumulative $PM_{2.5}$ concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*25*	*8*
R1	Bringelly	0.5	<0.1	3.6	0.5	14	8
R2	Luddenham	0.5	<0.1	1.0	0.2	14	7
R3	Greendale, Greendale Road	1.0	<0.1	2.0	0.1	13	7
R4	Kemps Creek	0.6	<0.1	6.5	0.8	15	8
R6	Mulgoa	0.5	<0.1	1.0	0.1	13	7
R7	Wallacia	0.4	<0.1	0.9	0.1	13	7
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	1.6	0.3	14	7
R14	Badgerys Creek, Lawson Road	1.4	0.1	4.0	0.6	14	8
R15	Greendale, Mersey Road	1.0	0.1	1.4	0.3	14	7
R17	Luddenham Road	0.7	<0.1	1.5	0.3	14	7
R18	Corner Adams and Elizabeth Drive	0.7	0.1	1.8	0.4	14	7
R19	Corner Adams and Anton Road	1.9	0.2	2.4	0.4	14	7
R21	Corner Willowdene Avenue and Vicar Park Lane	0.8	<0.1	1.5	0.2	14	7
R22	Rossmore, Victor Avenue	0.9	<0.1	2.0	0.3	14	7
R23	Wallacia, Greendale Road	0.6	<0.1	1.3	0.1	13	7
R24	Badgerys Creek 1 NE	3.9	0.3	4.3	0.7	14	8
R25	Badgerys Creek 2 SW	0.6	<0.1	1.3	0.3	13	7
R27	Greendale, Dwyer Road	0.1	<0.1	0.7	0.1	13	7
R30	Rossmore residential	0.3	<0.1	3.5	0.7	14	8
R31	Mt Vernon residential	0.9	<0.1	2.2	0.3	14	7

12.6.2.4. Carbon monoxide (CO)

The dispersion modelling results for maximum 15-minute, one hour and eight hour carbon monoxide are presented in Table 12–29. The results of the dispersion modelling show predicted carbon monoxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

The contour plots show higher concentrations centred over the proposed airport and along roadways (refer to Appendix F1).

Table 12–29 –Predicted incremental and cumulative CO concentrations

Receptor	Receptor description	Airport (µg/m3)			Airport + external roadways (µg/m3)			Cumulative – Airport + external roadways + existing background (µg/m3)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*	*100*	*30*	*10*
R1	Bringelly	0.6	0.4	0.1	3.2	2.4	0.3	5.3	3.9	1.5
R2	Luddenham	0.5	0.4	0.1	0.5	0.4	0.1	2.6	1.9	1.3
R3	Greendale, Greendale Road	0.9	0.7	0.1	1.6	1.2	0.2	3.7	2.7	1.4
R4	Kemps Creek	0.7	0.5	0.1	2.0	1.5	0.5	4.1	3.0	1.7
R6	Mulgoa	0.7	0.5	0.1	0.9	0.7	0.1	3.0	2.2	1.3
R7	Wallacia	0.3	0.2	0.0	0.9	0.7	0.1	3.0	2.2	1.3
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.9	0.7	0.1	1.5	1.1	0.2	3.6	2.6	1.4
R14	Badgerys Creek, Lawson Road	1.8	1.4	0.2	3.1	2.3	0.3	5.2	3.8	1.5
R15	Greendale, Mersey Road	1.1	0.8	0.2	1.4	1.0	0.2	3.5	2.5	1.4
R17	Luddenham Road	0.5	0.4	0.1	1.1	0.8	0.2	3.2	2.3	1.4
R18	Corner Adams and Elizabeth Drive	0.7	0.5	0.1	1.8	1.4	0.2	3.9	2.9	1.4
R19	Corner Adams and Anton Road	2.3	1.7	0.3	2.4	1.8	0.3	4.5	3.3	1.5
R21	Corner Willowdene Avenue and Vicar Park Lane	1.1	0.8	0.2	1.7	1.3	0.2	3.8	2.8	1.4
R22	Rossmore, Victor Avenue	1.0	0.8	0.1	1.1	0.9	0.2	3.2	2.4	1.4

Receptor	Receptor description	Airport (µg/m3)			Airport + external roadways (µg/m3)			Cumulative – Airport + external roadways + existing background (µg/m3)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
R23	Wallacia, Greendale Road	0.4	0.3	0.1	0.7	0.5	0.1	2.8	2.0	1.3
R24	Badgerys Creek 1 NE	3.1	2.3	0.5	3.1	2.3	0.5	5.2	3.8	1.7
R25	Badgerys Creek 2 SW	0.5	0.4	0.1	1.0	0.8	0.1	3.1	2.3	1.3
R27	Greendale, Dwyer Road	0.2	0.1	0.0	0.3	0.2	0.1	2.4	1.7	1.3
R30	Rossmore residential	0.4	0.3	0.1	2.6	1.9	0.4	4.7	3.4	1.6
R31	Mt Vernon residential	0.8	0.6	0.1	0.9	0.6	0.2	3.0	2.1	1.4

12.6.2.5. Sulfur dioxide (SO_2)

The dispersion modelling results for maximum 10-minute, one hour, 24 hour and annual average sulfur dioxide, are presented in Table 12–30 (10-minute and one hour averaging periods) and Table 12–31 (24 hour and annual averaging periods). The results of the dispersion modelling show predicted sulfur dioxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

The contour plots show higher concentrations in the north and north-east of the airport site, consistent with the annual prevailing winds (refer to Appendix F1).

Table 12–30 –Predicted incremental and cumulative maximum 10 minute and one hour sulfur dioxide concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		10-min	1-hour	10-min	1-hour	10-min	1-hour
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*700*	*570*
R1	Bringelly	28	19	29	19	109	53
R2	Luddenham	18	12	19	12	99	46
R3	Greendale, Greendale Road	63	42	65	43	145	77
R4	Kemps Creek	24	16	24	16	104	50
R6	Mulgoa	122	81	122	81	202	115
R7	Wallacia	66	44	66	44	146	78
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	64	42	64	43	144	77
R14	Badgerys Creek, Lawson Road	85	56	86	57	166	91
R15	Greendale, Mersey Road	49	32	49	32	129	66
R17	Luddenham Road	133	88	133	88	213	122
R18	Corner Adams and Elizabeth Drive	39	26	41	27	121	61
R19	Corner Adams and Anton Road	102	67	102	68	182	102
R21	Corner Willowdene Avenue and Vicar Park Lane	51	34	52	34	132	68
R22	Rossmore, Victor Avenue	25	16	25	16	105	50
R23	Wallacia, Greendale Road	83	55	84	56	164	90
R24	Badgerys Creek 1 NE	87	57	87	57	167	91
R25	Badgerys Creek 2 SW	84	56	85	56	165	90
R27	Greendale, Dwyer Road	16	11	16	11	96	45
R30	Rossmore residential	24	16	24	16	104	50
R31	Mt Vernon residential	90	59	90	59	170	93

Table 12–31 – Predicted incremental and cumulative maximum 24 hour and annual average SO_2 concentrations

Receptor	Receptor description	Airport (µg/m3)		Airport + external roadways (µg/m3)		Cumulative – Airport + external roadways + existing background (µg/m3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*228*	*60*
R1	Bringelly	1.8	0.1	2.0	0.1	11.9	1.3
R2	Luddenham	1.4	0.2	1.4	0.2	11.3	1.4
R3	Greendale, Greendale Road	4.6	0.2	4.7	0.2	14.6	1.4
R4	Kemps Creek	2.2	0.1	2.3	0.1	12.2	1.3
R6	Mulgoa	2.4	0.1	2.4	0.1	12.3	1.3
R7	Wallacia	1.5	0.1	1.5	0.1	11.4	1.3
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	2.2	0.2	2.2	0.3	12.1	1.5
R14	Badgerys Creek, Lawson Road	4.6	0.3	4.9	0.3	14.8	1.5
R15	Greendale, Mersey Road	3.9	0.3	3.9	0.3	13.8	1.5
R17	Luddenham Road	2.7	0.2	2.8	0.2	12.7	1.4
R18	Corner Adams and Elizabeth Drive	2.5	0.6	2.5	0.6	12.4	1.8
R19	Corner Adams and Anton Road	4.4	0.8	4.5	0.8	14.4	2.0
R21	Corner Willowdene Avenue and Vicar Park Lane	3.8	0.2	3.8	0.2	13.7	1.4
R22	Rossmore, Victor Avenue	2.4	0.1	2.5	0.1	12.4	1.3
R23	Wallacia, Greendale Road	2.8	0.1	2.9	0.1	12.8	1.3
R24	Badgerys Creek 1 NE	7.4	0.7	7.4	0.7	17.3	1.9
R25	Badgerys Creek 2 SW	2.2	0.1	2.2	0.2	12.1	1.4
R27	Greendale, Dwyer Road	0.6	0.1	0.7	0.1	10.6	1.3
R30	Rossmore residential	1.7	0.1	1.9	0.1	11.8	1.3
R31	Mt Vernon residential	4.2	0.1	4.3	0.2	14.2	1.4

12.6.2.6. Air toxics

The dispersion modelling results for the four air toxics evaluated in this assessment (benzene, toluene, xylene and formaldehyde) are presented in Table 12–32 (99.9th percentile), Table 12–33 (24 hour averaging period) and Table 12–34 (annual averaging period). The results of the dispersion modelling show the predicted concentrations of air toxics to be well below the air quality assessment criteria for the 99.9th percentile. The exception was formaldehyde with an exceedance shown at on-site receptor R24 (highlighted in bold text in Table 12–32).

The 24 hour and annual average concentrations of benzene, toluene and xylenes were predicted to be orders of magnitude lower than the air quality assessment criteria. The concentration of formaldehyde was also less than 20 per cent of the investigation level (refer to Table 12–32 and Table 12–33).

Table 12–32 –Predicted incremental and cumulative 99.9th percentile one hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m^3)				Airport + external roadways (µg/m^3)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
Assessment criteria		*29*	*360*	*180*	*20*	*29*	*360*	*180*	*20*
R1	Bringelly	0.1	<0.1	<0.1	0.7	2.0	0.8	0.5	14.9
R2	Luddenham	0.2	0.1	0.1	1.5	1.3	0.5	0.3	9.3
R3	Greendale, Greendale Road	0.2	0.1	<0.1	1.2	1.2	0.5	0.3	8.8
R4	Kemps Creek	0.1	<0.1	<0.1	0.9	2.3	0.9	0.6	17.1
R6	Mulgoa	0.1	<0.1	<0.1	0.7	0.8	0.3	0.2	5.6
R7	Wallacia	0.1	<0.1	<0.1	0.7	0.6	0.2	0.2	4.3
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.1	<0.1	<0.1	0.8	1.0	0.4	0.3	7.4
R14	Badgerys Creek, Lawson Road	0.3	0.1	0.1	2.2	1.3	0.5	0.3	9.3
R15	Greendale, Mersey Road	0.3	0.1	0.1	1.8	1.5	0.6	0.4	11.0
R17	Luddenham Road	0.1	0.1	<0.1	1.0	0.9	0.3	0.2	6.2
R18	Corner Adams and Elizabeth Drive	0.2	0.1	<0.1	1.4	1.3	0.5	0.4	9.8
R19	Corner Adams and Anton Road	0.4	0.1	0.1	2.6	2.2	0.8	0.6	16.1
R21	Corner Willowdene Avenue and Vicar Park Lane	0.2	0.1	0.1	1.5	1.1	0.4	0.3	8.1

Receptor	Receptor description	Airport (µg/m^3)				Airport + external roadways (µg/m^3)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
R22	Rossmore, Victor Avenue	0.2	0.1	<0.1	1.1	0.8	0.3	0.2	5.8
R23	Wallacia, Greendale Road	0.1	<0.1	<0.1	0.9	0.6	0.2	0.2	4.6
R24	Badgerys Creek 1 NE	0.6	0.2	0.2	4.2	3.1	1.2	0.8	22.6
R25	Badgerys Creek 2 SW	0.3	0.1	0.1	2.0	1.8	0.7	0.5	13.5
R27	Greendale, Dwyer Road	0.1	0.1	<0.1	1.0	0.9	0.4	0.2	6.8
R30	Rossmore residential	0.1	<0.1	<0.1	0.5	1.6	0.6	0.4	11.8
R31	Mt Vernon residential	0.2	0.1	0.1	1.4	1.0	0.4	0.3	7.0

Table 12–33 – Predicted incremental and cumulative 24 hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m^3)			Airport + external roadways (µg/m^3)			Cumulative – Airport + external roadways + existing background (µg/m^3)		
		Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde
Assessment criteria		*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*
R1	Bringelly	<0.1	<0.1	0.9	0.1	0.1	2.1	15.4	16.7	6.4
R2	Luddenham	0.1	0.1	1.6	0.1	0.1	1.5	15.4	16.7	5.8
R3	Greendale, Greendale Road	0.1	0.1	1.5	0.1	0.1	1.6	15.4	16.7	5.9
R4	Kemps Creek	0.1	<0.1	1.1	0.2	0.1	3.4	15.5	16.7	7.7
R6	Mulgoa	<0.1	<0.1	0.8	0.1	<0.1	1.0	15.4	16.6	5.3
R7	Wallacia	<0.1	<0.1	0.8	<0.1	<0.1	0.9	15.3	16.6	5.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<0.1	<0.1	0.8	0.1	<0.1	1.2	15.4	16.6	5.5
R14	Badgerys Creek, Lawson Road	0.1	0.1	2.4	0.1	0.1	2.7	15.4	16.7	7.0
R15	Greendale, Mersey	0.1	0.1	2.0	0.1	0.1	1.8	15.4	16.7	6.1

Receptor	Receptor description	Airport (µg/m^3)			Airport + external roadways (µg/m^3)			Cumulative – Airport + external roadways + existing background (µg/m^3)		
		Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde
	Road									
R17	Luddenham Road	0.1	<0.1	1.1	0.1	<0.1	1.1	15.4	16.6	5.4
R18	Corner Adams and Elizabeth Drive	0.1	0.1	1.5	0.1	0.1	1.4	15.4	16.7	5.7
R19	Corner Adams and Anton Road	0.1	0.1	2.7	0.2	0.1	3.0	15.5	16.7	7.3
R21	Corner Willowdene Avenue and Vicar Park Lane	0.1	0.1	1.7	0.1	0.1	1.5	15.4	16.7	5.8
R22	Rossmore, Victor Avenue	0.1	<0.1	1.2	0.1	0.1	1.4	15.4	16.7	5.7
R23	Wallacia, Greendale Road	0.1	<0.1	1.1	0.1	<0.1	1.1	15.4	16.6	5.4
R24	Badgerys Creek 1 NE	0.2	0.2	4.6	0.3	0.2	5.1	15.6	16.8	9.4
R25	Badgerys Creek 2 SW	0.1	0.1	2.1	0.1	0.1	2.4	15.4	16.7	6.7
R27	Greendale, Dwyer Road	0.1	<0.1	1.0	0.1	<0.1	1.3	15.4	16.6	5.6
R30	Rossmore residential	<0.1	<0.1	0.5	0.1	0.1	2.4	15.4	16.7	6.7
R31	Mt Vernon residential	0.1	0.1	1.4	0.1	0.1	1.5	15.4	16.7	5.8

Table 12–34 – Predicted incremental and cumulative annual average air toxic concentrations

Receptor	Receptor description	Airport (µg/m^3)			Airport + external roadways (µg/m^3)			Cumulative – Airport + external roadways + existing background (µg/m^3)		
		Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde
Assessment criteria		*10*	*406*	*935*	*10*	*406*	*935*	*10*	*406*	*935*
R1	Bringelly	0.01	<0.01	<0.01	0.02	0.01	1.0	3.7	2.4	6.4
R2	Luddenham	0.02	0.01	0.01	0.01	0.01	1.0	3.7	2.4	5.8
R3	Greendale, Greendale Road	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.9
R4	Kemps Creek	0.01	<0.01	<0.01	0.03	0.02	1.1	3.7	2.4	7.7
R6	Mulgoa	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.3
R7	Wallacia	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.5
R14	Badgerys Creek, Lawson Road	0.02	0.01	<0.01	0.02	0.02	1.1	3.7	2.4	7.0
R15	Greendale, Mersey Road	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	6.1
R17	Luddenham Road	0.01	0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.4
R18	Corner Adams and Elizabeth Drive	0.03	0.01	0.01	0.02	0.01	1.1	3.7	2.4	5.7
R19	Corner Adams and Anton Road	0.04	0.02	0.01	0.02	0.02	1.1	3.7	2.4	7.3
R21	Corner Willowdene Avenue and Vicar Park Lane	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.8
R22	Rossmore, Victor Avenue	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.7
R23	Wallacia, Greendale Road	<0.01	<0.01	<0.01	<0.01	<0.01	1.0	3.7	2.4	5.4
R24	Badgerys Creek 1 NE	0.06	0.02	0.02	0.04	0.03	1.1	3.7	2.4	9.4
R25	Badgerys Creek 2 SW	0.02	0.01	<0.01	0.02	0.01	1.0	3.7	2.4	6.7

Receptor	Receptor description	Airport (µg/m³)			Airport + external roadways (µg/m³)			Cumulative – Airport + external roadways + existing background (µg/m³)		
		Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde
R27	Greendale, Dwyer Road	0.01	<0.01	<0.01	0.01	<0.01	1.0	3.7	2.4	5.6
R30	Rossmore residential	<0.01	<0.01	<0.01	0.02	0.02	1.1	3.7	2.4	6.7
R31	Mt Vernon residential	0.01	<0.01	<0.01	0.01	0.01	1.0	3.7	2.4	5.8

12.6.3. Odour

12.6.3.1. Aircraft exhaust

The modelling results for the 99th percentile one hour odour emissions from aircraft exhaust are presented in Table 12–35. The modelling shows predicted odour concentrations to be below the threshold detection level of one OU at all but one of the residential receptors. At R24, the predicted odour concentration is one OU, indicating when a receptor is located in this area, they may detect odour from aircraft exhausts. This is, however, less than the NSW EPA odour performance criterion of two OU.

The contour plots show that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1).

Table 12–35 – Predicted 99th percentile odour concentrations from aircraft exhaust

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1
R18	Corner Adams and Elizabeth Drive	1
R19	Corner Adams and Anton Road	1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.3.2. Wastewater treatment plant

The modelling results for the 99th percentile one hour odour emissions from the on-site wastewater treatment plant are presented in Table 12–36. The modelling shows predicted odour concentrations to be below the threshold detection level of one OU at all residential receptors.

The contour plots show that the highest odour concentrations would be largely limited to within the airport site (refer to Appendix F1).

Table 12–36 – Predicted 99th percentile odour concentrations from wastewater treatment plant

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1
R18	Corner Adams and Elizabeth Drive	<1
R19	Corner Adams and Anton Road	<1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	<1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.4. Fuel jettisoning

As discussed in Chapter 7, fuel jettisoning is extremely rare worldwide and generally only occurs during an emergency, as a safety precaution when a plane must land prematurely. In Australia, there are specific protocols in place to regulate fuel jettisoning in accordance with the Air Navigation (Fuel Spillage) Regulations 1999. For example, pilots must obtain authority from air traffic control before jettisoning fuel and must receive instruction on where the operation is to be performed. Fuel jettisoning is required to occur in an area nominated by air traffic control in clear air at 6,000 feet (approximately 2,000 metres) above ground level such that all fuel is vaporised before reaching the ground. Reasonable precautions must be taken to promote the safety of persons and property in the air and on the ground.

Due to improvements in fuel efficiency and lightweight aircraft material, the amount of fuel jettisoned from aircraft in emergency situations has decreased substantially, with this trend anticipated to continue. As fuel efficiency, technology and airspace management continue to improve, volumes of fuel required to be carried on planes will steadily decline in the future. Major Australian airlines already have goals in place to implement these improvements. Qantas, for example, is currently aiming to improve its fuel efficiency by 1.5 per cent per year until 2020 (Department of Resources, Energy and Tourism 2013). The Qantas Group Fuel Optimisation Program also has strategies in place to reduce travel distance and unnecessary aircraft weight. These strategies will help to reduce the volume of fuel carried by aircraft and reduce the amount of fuel released in event of an emergency.

The effects of fuel jettisoning on local air quality would be limited due to the inability of many aircraft to perform fuel dumps, the rapid vaporisation and wide dispersion of jettisoned fuel, the strict guidelines on fuel jettison altitudes and locations and the anticipated reduction in events and volumes in the future. For these reasons, fuel dumping is not considered likely to have a significant immediate or future impact on local air quality or human health.

12.6.5. Regional air quality

International studies have shown that emissions from airport operations are small when viewed in the context of regional emissions inventories (Ratliff et al. 2009). This is supported by data presented in the *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales* (EPA 2012) which shows that emissions from existing airport operations in Sydney are less than three per cent of total emissions for the Sydney region.

The daily maximum predicted one hour ozone concentrations are presented in Table 12–37. Results are presented as peak concentrations for the 2030 future base case (no airport), the 2030 airport Case (airport emissions plus 2030 future base case) and the largest difference in daily maximums (the 2030 airport case – 2030 future base case). The largest difference represents the maximum change in daily maximum ozone concentration, as a result of the additional emissions from the airport.

Table 12–37 – Maximum daily predicted one hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	149.1	149.1	0.4
07/01/2009	129.8	129.8	5.5
14/01/2009	106.6	106.6	1.3
29/01/2009	124.1	124.1	0.3
30/01/2009	107.4	107.4	0.6
31/01/2009	109.4	109.4	0.6
04/02/2009	103.8	103.8	1.1
05/02/2009	119.6	119.6	0.3
06/02/2009	112.5	112.5	0.8
07/02/2009	133.7	133.7	0.3
08/02/2009	148.6	148.6	0.6
20/02/2009	98.3	98.3	1.0

The results of the regional air quality analysis show that for each day of analysis, the peak predicted one hour ozone concentrations were unchanged between the 2030 future base case and the 2030 airport case. This is because the predicted ozone concentrations from the proposed airport occur in different locations to where ozone peaks occur. Both the 2030 future base case and the 2030 airport case were above the NEPM criterion of 100 parts per billion for all but one day of analysis.

To provide context, the predicted peak ozone concentrations presented in Table 12–37 can be compared with measured peak one hour ozone concentrations at Bringelly. During 2014, there were two days when the maximum daily one hour ozone concentration was above the NEPM standard, with a peak concentration of 124 parts per billion measured in November 2014. It is noted that the modelled peak values are expected to be higher than observed peak values because monitoring networks never achieve full coverage of an airshed. In other words, modelling can predict higher peak ozone for areas not covered by monitoring networks.

The largest difference in daily maximum one hour ozone concentration, from the addition of airport emissions, was 5.5 parts per billion, however the second highest was significantly lower at 1.3parts per billion. This highlights that reliance on a single model result (for example, focussing on the largest ozone change) could accentuate the influence of uncertainties in the model's input data or model formulation. Therefore, the average of the 2nd to 4th highest ozone change (1.1 parts per billion) is used to describe ozone impacts. This approach is similar to the use of a 99th percentile to describe maximum ozone impacts. When compared to the maximum allowable increment level of one part per billion, prescribed by the NSW tiered procedure for ozone assessment, a marginal impact is predicted from the 2030 airport case.

The peak predicted four hour ozone concentration were unchanged between the 2030 airport case and the 2030 future base case on ten days and increased on two days, by a maximum of 0.1 parts per billion as shown in Table 12–38

Table 12–38 – Maximum daily predicted four hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	126.2	126.3	0.3
07/01/2009	115.3	115.4	2.4
14/01/2009	98.7	98.8	0.7
29/01/2009	95.9	95.9	0.5
30/01/2009	78.2	78.2	0.6
31/01/2009	99.9	99.9	0.5
04/02/2009	97.3	97.3	0.7
05/02/2009	108.7	108.7	0.4
06/02/2009	92.4	92.4	0.4
07/02/2009	121.0	121.0	0.6
08/02/2009	129.9	129.9	0.6
20/02/2009	83.9	84.0	1.2

The highest change in daily maximum four hour ozone concentration, from the addition of airport emissions, was 2.4 parts per billion, while the second highest was 1.2 parts per billion. The average of the 2nd to 4th highest change in daily maximum four hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one part per billion.

Locations of ozone differences between the 2030 airport case and the 2030 base case – that is, ozone due to airport emissions –are shown in the spatial plots of the daily maximum predicted one hour and four hour ozone concentrations (refer to Appendix F2 in Volume 4). Decreases in daily maximum ozone occur only in the vicinity of the airport for the 2030 airport case and are attributable to ozone suppression by nitrogen oxides emissions. Increases in ozone occur downwind of the airport site which, on most days, is to the south.

12.7. Greenhouse gas assessment

Consensus within the scientific community is that anthropogenic (man-made) activities, including aviation, increase atmospheric concentrations of greenhouse gases which lead to climate change. The IPCC estimated in 2007 that aviation accounts for two per cent of global carbon dioxide emissions. However, with airline travel becoming more popular in Australia and around the world, this contribution could reach five per cent by 2050 (SACL 2014).

This section presents the results of the greenhouse gas assessment which quantifies the greenhouse gas emissions (in tonnes of carbon dioxide equivalent (tCO_2-e)) for construction and the Scope 1, Scope 2 and Scope 3 emissions associated with the operation of the Stage 1 development.

12.7.1. Construction emission estimates

Greenhouse gas emissions generated during construction of the proposed Stage 1 development are presented in Table 12–39. The two main sources of greenhouse gas emissions would be the operation of construction equipment and vegetation clearing. A conservative approach was applied when calculating the emissions. For example, it was assumed that the equipment used during construction of the aviation infrastructure would use as much fuel as the equipment used during the bulk earthworks. It was also assumed that construction equipment would be used for six working days a week. Public holidays and bad weather were also factored into the calculations. In addition, it was assumed that 50 per cent of the vegetation cleared was carbon and that 3.67 tonnes of carbon dioxide equivalent is generated per tonne of carbon cleared (AGO 1999, 2000, 2002 and 2003).

Table 12–39 – Summary of greenhouse gas emissions during construction

Scope	Source	Fuel type	Quantity	Units	Emissions (t CO_2-e)
1	Equipment	Transport diesel oil	162	ML	286
1	Vegetation clearing	N/A	39	kt	71,565
				Total	71,851

12.7.2. Operations emission estimates

Greenhouse gas emissions forecast to be generated during operation of the proposed Stage 1 development are presented in Table 12–40. As shown in Table 12–40, electricity consumption would account for the vast majority of greenhouse gas emissions (83 per cent). Electricity is a Scope 2 emission. Scope 1 emissions would account for the remaining 17 percent of greenhouse gas emissions from the airport site. Within the Scope 1 emissions, greenhouse gas emissions from auxiliary power units would be the greatest source of emissions.

Table 12–40 – Summary of estimated annual Scope 1 and 2 greenhouse gas emissions

Scope	Source	Fuel type	Annual quantity	Units	Annual emissions (t CO_2-e)
1	Ground support equipment	Transport diesel oil	0.85	ML	2,292
		Transport gasoline	2	ML	4,776
1	Auxiliary power unit	Stationary gasoline (jet fuel)	5	ML	10,975
1	Boilers	Stationary natural gas	1,489,809	m^3	3,005
1	Generators	Stationary diesel oil	0.04	ML	113
1	Fire training	Stationary Kerosene (jet fuel)	0.01	ML	14
1	Wastewater treatment plant	N/A	1,935	ML	1204
1	Fugitive emissions	Transport gasoline (jet fuel)	985	ML	104
1	Fugitive emissions	Transport diesel oil	0.85	ML	0.1
1	Fugitive emissions	Transport gasoline	2	ML	0.2
2	Electricity	N/A	124,392,000	kWh	106,977
				TOTAL	129,462

Note: Fuel Type reflects the categories in DoE (2014b)
Assumptions made within the greenhouse gas calculations are provided within Appendix F1.
Emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

As mentioned in Section 12.2.7, it is not commonplace to report Scope 3 emissions due to the potential of double counting greenhouse gas emissions. Nevertheless, as they are considered significant for the proposed airport, the most probable primary contributor (jet fuel) has been quantified in Table 12–41. It must be noted that this assessment accounts for the greenhouse gas emissions being emitted during the entire flight of departing planes only. This method assumes the arriving planes' emissions are accounted for by the airport from which the planes departed. This method is common overseas and has been recommended by the Airport Cooperative Research Program (ACRP) (ACRP 2009).

Table 12–41 – Summary of estimated annual Scope 3 greenhouse gas emissions

Scope	Source	Fuel type	Annual quantity	Annual emissions (t CO_2-e)
3	In flight aviation fuel	Transport gasoline (jet fuel)	986	2,524,504

Note: Emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

Table 12–42 compares the Stage 1 development's estimated greenhouse gas emissions to NSW's total anthropogenic emissions in 2011–12. It concludes that the Stage 1 development would contribute to less than 0.1 per cent of NSW's total emissions for 2011–12.

Table 12–42 – Comparison of greenhouse gas emissions

Location	Source coverage	Reference year	Emissions Mt CO_2-e
Western Sydney Airport (Stage 1 development)	Scope 1 and 2	2030	0.13
NSW	Total	2011-12	154.7

Source: DoE (2014) and CER (2015).

Table 12–43 summarises Australia's current and forecast sectoral breakdown of greenhouse gas emissions. As aviation is considered a part of 'transport' it can be concluded that the Stage 1 development would account for approximately 0.1 per cent of the total 'transport' greenhouse gas emissions throughout Australia.

Table 12–43 – Australian sectoral breakdown of 2014-15 projection results to 2029-30

Sector	2013-14 Mt CO_2-e	2029-30 Mt CO_2-e
Electricity	180	224
Direct combustion	93	129
Transport	92	115
Fugitives	41	68
Industrial processes	32	39
Agriculture	82	92
Waste	13	16
Land use, land use change and forestry	14	41
Total	548	724

Source: DoE (2015)

12.8. Mitigation and management measures

Mitigation and management measures proposed to minimise the impacts on local and regional air quality are listed in Table 12–44. Measures to reduce greenhouse gas emissions during the operation of the proposed airport are also listed in Table 12–44. These measures would be incorporated into the environmental management plan for the proposed airport.

Table 12–44 – Mitigation and management measures (air quality and greenhouse gases)

ID	Issue	Mitigation/management measure	Timing
12.1	Dust management Plan	A dust management plan would be developed prior to construction of the proposed airport as part of the construction environmental management framework. The plan would collate measures to mitigate and manage potential impacts on air quality. The plan should include standard measures such as watering of exposed surfaces and covering of stockpiled material. The plan may also include monitoring of dust deposition, dust flux, real time PM_{10} continuous monitoring and/or visual inspections.	Pre-Construction
12.2	Community engagement	Develop and implement a stakeholder communications plan that specifically addresses construction and includes community engagement before work commences on-site.	Pre-Construction
12.3		Display the name and contact details of person(s) accountable for environmental management at the airport site boundary.	Construction
12.4	Dust management	Record all dust and air quality complaints, identify cause(s), and record the response to the complaint, including any further mitigation measures taken.	Construction
12.5		Make the complaints log available to the relevant authority when asked.	Construction
12.6		Record in a log book any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation.	Construction
12.7		Carry out regular site inspections to monitor compliance with the dust management plan, record inspection results, and make an inspection log available to the relevant authority when asked.	Construction
12.8		Increase the frequency of site inspections by the person accountable for air quality and dust issues on-site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Construction
12.9		Determine dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations in consultation with the relevant authorities. Where possible commence baseline monitoring at least three months before work commences on site or before work on a construction phase commences.	Pre-Construction
12.10		Avoid site runoff of water or mud. This will reduce the potential for track-out dust emissions.	Construction
12.11	Vehicle and equipment emissions	Vehicle operators would be required to switch off engines when not in use.	Construction
12.12		Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Construction
12.13		Appropriate vehicle speeds on sealed and unsealed roads would be considered as part of the dust management plan.	Construction
12.14		Produce a construction logistics plan to manage the sustainable delivery of goods and materials.	Pre-Construction

ID	Issue	Mitigation/management measure	Timing
12.15		Prepare a travel plan that supports and encourages sustainable travel for construction workers (public transport, cycling, walking, and car-sharing).	Construction
12.16		Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays.	Construction
12.17		Adequate water would be made available on the site for effective dust and particulate matter suppression and mitigation, using non-potable water where possible and appropriate.	Construction
12.18		Use enclosed chutes and conveyors and covered skips.	Construction
12.19		Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment. Use fine water sprays on such equipment wherever appropriate.	Construction
12.20		Equipment would be readily available on-site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	Construction
12.21	Demolition	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible), to provide a screen against dust.	Construction
12.22		Ensure effective water suppression methods are used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Construction
12.23		Avoid use of explosive blasting in demolition building works, using appropriate manual or mechanical alternatives.	Construction
12.24		Bag and remove any biological debris or damp down such material before demolition.	Construction
12.25	Earthworks	Re-vegetate earthworks and exposed areas or soil stockpiles to stabilise surfaces as soon as practicable.	Construction
12.26		Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Construction
12.27		Minimise exposed areas as far as is practical.	Construction
12.28	Aviation Infrastructure	Avoid scrabbling (roughening of concrete surfaces) if possible.	Construction
12.29		Sand and other aggregates would be stored in bunded areas and not allowed to dry out, unless required for particular processes. If so, appropriate additional control measures would be in place.	Construction
12.30		Bulk cement and other fine powder materials would be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Construction
12.31		Seal and appropriately store bags of any fine powder materials to prevent dust generation.	Construction
12.32	Track out dust	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper to be continuously in use.	Construction
12.33		Avoid dry sweeping of large areas.	Construction
12.34		Vehicles should be covered to prevent escape of material during transport.	Construction
12.35		Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Construction

ID	Issue	Mitigation/management measure	Timing
12.36		Record all inspections of haul routes and any subsequent action in a site log book.	Construction
12.37		Hard surfaced haul routes would be regularly cleaned and damped down with fixed or mobile sprinkler systems or mobile water bowsers.	Construction
12.38		Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Construction
12.39		An adequate area of hard surfaced road between the wheel wash facility and the site exit would be provided, wherever site size and layout permits.	Construction
12.40		Site access points would be located as far as practicable from sensitive receptors.	Construction
12.41	Greenhouse gases – Scope 2 emissions	Consideration will be given to designing, constructing and operating the Stage 1 development to achieve the following where appropriate: • 5 Star Green Star – Design & As Built; • 5 Star NABERS Office Energy Rating; and • 4 Star Green Star – Performance	Pre-construction
12.42	Demolition	Avoid use of explosive blasting in demolition works, using appropriate manual or mechanical alternatives.	Construction
12.43	Earthworks	Minimise exposed areas as far as practical.	Construction
12.44	Management of air quality and odour	Develop and implement an operational air quality and odour management plan for the proposed airport.	Operation
12.45	Air quality monitoring	Install an air quality monitoring station at the airport site to monitor NO_x, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs.	Pre-operation Operation
12.46		Conduct ambient air quality monitoring prior to operation to record baseline air quality conditions prior to operation activities.	Pre-operation
12.47	Emissions	Consider best available techniques to reduce the potential for ground level ozone formation, which may include: • replacing conventionally fuelled ground support equipment with electric or hydrogen powered belt loaders, pushback tractors, bag tugs, and cargo loaders; • using remote ground power for remote aircraft parking positions; • installing co-generation or tri-generation in-lieu of traditional gas fired boilers or solar hot water systems to replace gas fired boilers; • avoiding certain activities, such as training fires, maintenance (spray painting) during the ozone seasons; • using underground fuel hydrant systems and/or vapour recovery systems for refuelling and fuel storage; and • promoting the use of public transport to the airport.	Operation
12.48	Greenhouse gases – Scope 1 emissions	Support alternatively fuelled and ‘modernised’ ground support equipment – including compressed natural gas, hydrogen, electric, compressed air and hybrid vehicles.	Operation

ID	Issue	Mitigation/management measure	Timing
12.49		Educate ground support equipment drivers in techniques to conserve fuel and implement a no-idling policy	Operation
12.50		Design runways, taxiways, gates and terminals to minimise aircraft and ground support equipment travel distances where practical.	Operation
12.51		Aircraft management procedures would consider the reduction of fuel use as far as practical.	Operation
12.52		Reduce the use of auxiliary power units by using fixed electrical ground power and preconditioned air supply to aircraft where possible.	Operation
12.53		Specify high efficiency power, heating and cooling plants.	Operation
12.54		Make use of renewable energy sources where practical for the generation, use or purchase of electricity, heating and cooling.	Operation
12.55	Greenhouse gases – Scope 3 emissions	Consider the use of high capacity public transport to and from the proposed airport as part of the ground transport plan. Support the use of the low emission vehicles to and from the proposed airport, including the provision of recharging stations.	Operation
12.56		Develop an integrated solid waste management plan to implement waste saving initiatives such as composting and recycling.	Operation
12.57		Install tenant energy sub-metering systems.	Operation

12.9. Conclusion

Construction of the proposed Stage 1 development would generate dust emissions during both the bulk earthworks and the aviation infrastructure works. The asphalt batching plant would also generate some odour during construction. The results of the air dispersion modelling show that the dust impacts during construction are expected to be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant would also be below the relevant criteria at all sensitive residential receptors and largely contained within the airport site. Some odour may be detected outside of the airport boundary to the north, however, this area is currently unoccupied and, as such, there would be no impacts on sensitive receptors.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide, PM_{10}, $PM_{2.5}$, carbon monoxide, sulfur dioxide and air toxics. There would also be odour emissions from exhaust and from the on-site wastewater treatment plant. The highest off-site concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and north-east of the proposed airport. This is anticipated to be a function of the prevalence of south-westerly winds and the proximity of these receptors to activities at the proposed airport. Airport traffic on surrounding road infrastructure was found to be a significant contributor to predicted off-site ground level concentrations, particularly for those receptors located close to proposed roadways. Despite this, there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. The exception was the 99.9th percentile one hour maximum for formaldehyde with an exceedance shown at an on-site receptor. Predicted off-site odour concentrations were below odour detection limits for both aircraft exhaust emissions and odours from the on-site wastewater treatment plant.

The local effects of fuel jettisoning at the airport site would be limited due to the inability of many aircraft to jettison fuel, the quick vaporisation and dispersion of aircraft fuel, the strict guidelines on fuel dumping altitudes and locations, and the anticipated reduction in fuel dumping events and volumes in the future. For these reasons, fuel jettisoning is not considered likely to have a significant future impact on local air quality or human health.

The maximum predicted one hour ozone concentration remained unchanged following the implementation of the airport and four hour ozone concentrations increased by a maximum of 0.1 parts per billion. Both predicted base case and the long term development were generally above the NEPM criteria. The average change in daily maximum four hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one parts per billion.

Greenhouse gas emissions from the Stage 1 development have been estimated to comprise 0.11 Mt CO_2-e/annum, with the majority of emissions associated with purchased electricity. The Scope 1, Scope 2 and Scope 3 greenhouse gas emissions estimated for the proposed Stage 1 development represent approximately 0.1 per cent of Australia’s projected 2030 transport-related greenhouse gas emission inventory. For this reason, it can be concluded the greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, however a number of mitigation measures have been suggested to reduce these emissions.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the proposed Stage 1 development. In particular, a dust management plan would be developed and implemented to address potential impacts from dust generated during construction. Air quality monitoring would also be undertaken at the airport site during operations. Even through greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, a number of mitigation measures would also be implemented during operations to reduce these emissions.