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The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement / Commonwealth Draft Environmental Impact Statement

Appendix P – Technical working paper: Air Quality

June 2017

The Northern Road Upgrade – Mersey Road to Glenmore Parkway

Prepared for Roads and Maritime Services by Jacobs Australia

Air Quality Assessment

Final

15 May 2017

JACOBS

The Northern Road Upgrade Mersey Road to Glenmore Parkway

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Contents

Executive summary

Introduction and purpose of this report

As a part of the Western Sydney Infrastructure Plan, the NSW Roads and Maritime Services is seeking approval to upgrade around 16km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park.

This document provides an assessment of potential air quality impacts associated with the construction and operational phases of this project. Consistent with the *Secretary's Environmental Assessment Requirements (Application number SSI 7127)* the Commonwealth EIS Guidelines, the objectives of this assessment were to:

- Identify potential air quality impacts associated with the construction and operational phases of the project
- Develop suitable mitigation measures to prevent the generation of dust during construction and to manage potential impacts during operation, as required.

Impacts were assessed with reference to the following guidelines:

- *Approved Methods for Modelling and Assessment of Air pollutants in NSW* (Approved methods), (NSW Department of Environment and Conservation, 2005)
- *Variation to the National Environment Protection (Ambient Air Quality) Measure*, (National Environment Protection Council, 2016).

Assessment overview and key findings

To determine potential impacts to local and regional air quality during construction a qualitative, risk-based assessment was undertaken which identified that dust mitigation measures are required for the following activities:

- Establishment and operation of construction compound sites and storage facilities
- Vegetation clearing, grubbing and removal
- Stripping, stockpiling and management of topsoil and unsuitable materials
- Bulk earthworks including placement and compaction of sub-base course and base course
- Road widening, realignment and intersection upgrade activities.

The qualitative risk assessment indicates that management and mitigation measures are required to reduce the potential for cumulative dust impacts from concurrent construction activities associated with the project and the Western Sydney Airport site at receivers surrounding the airport site.

Impacts to air quality at surrounding receivers as a result of the operation of the proposed upgrade were evaluated by quantitative modelling, using the Roads and Maritime *Tool for Roadside Air Quality* (TRAQ) CALINE-based dispersion model. Predictions from this assessment indicate that for the timeframes assessed, any changes in local air quality at surrounding receivers will be small and within the existing range of air quality variations within the area.

Conclusions and next steps

To manage potential impacts during construction, several mitigation and management measures were recommended including appropriate work practices and scheduling, consultation/co-ordination of works around the Western Sydney Airport site with the airport contractor(s), equipment selection, monitoring and preventative controls; and residual ratings were calculated. 'Moderate' risk ratings remained for several phases of construction indicating that careful management of emissions to air will be required during these particular periods of construction. It was recommended that these measures were incorporated into a Construction Environmental Management Plan (CEMP).

Regarding operations, impacts associated with the project were predicted to be minimal and not materially different from the relevant 'Do minimum' impacts, as well as being within relevant assessment criteria (with the exception of annually-averaged $PM_{2.5}$ concentrations which were a result of existing, elevated background concentrations) at surrounding receivers. Post-construction traffic monitoring was recommended to verify that traffic volumes and characteristics are not materially different from the forecast numbers assessed.

1. Introduction

1.1 Project background

Roads and Maritime is seeking approval to upgrade 16km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project). The project generally comprises the following key features:

- A six-lane divided road between Mersey Road, Bringelly and Bradley Street, Glenmore Park (two general traffic lanes and a kerbside bus lane in each direction). The wide central median would allow for an additional travel lane in each direction in the future, if required
- An eight-lane divided road between Bradley Street, Glenmore Park and about 100 m south of Glenmore Parkway, Glenmore Park (three general traffic lanes and a kerbside bus lane in each direction separated by a median)
- About eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham, to realign the section of The Northern Road that currently bisects the Western Sydney Airport site and to bypasses Luddenham
- About eight kilometres of upgraded and widened road between the existing Elizabeth Drive, Luddenham and about 100 m south of Glenmore Parkway, Glenmore Park
- Closure of the existing The Northern Road through the Western Sydney Airport site
- Tie-in works with the following projects:
    - The Northern Road Upgrade, between Peter Brock Drive, Oran Park and Mersey Road, Bringelly (to the south)
    - The Northern Road Upgrade, between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (to the north)
- New intersections including:
    - A traffic light intersection connecting the existing The Northern Road at the southern boundary of the Western Sydney Airport, incorporating a dedicated u-turn facility on the western side
    - A traffic light intersection for service vehicles accessing the Western Sydney Airport, incorporating 160 m of new road connecting to the planned airport boundary
    - A traffic light intersection connecting the realigned The Northern Road with the existing The Northern Road (west of the new alignment) south of Luddenham
    - A ‘give way’ controlled intersection (that is, no traffic lights) connecting the realigned The Northern Road with Eaton Road (east of the new alignment, left in, left out only)
    - A four-way traffic light intersection formed from the realigned Elizabeth Drive, the realigned The Northern Road and the existing The Northern Road, north of Luddenham
    - A traffic light intersection at the Defence Establishment Orchard Hills entrance, incorporating a u-turn facility
- New traffic lights at four existing intersections:
    - Littlefields Road, Luddenham
    - Kings Hill Road, Mulgoa
    - Chain-O-Ponds Road, Mulgoa
    - Bradley Street, Glenmore Park incorporating a u-turn facility
- Modified intersection arrangements at:
    - Dwyer Road, Bringelly (left in, left out only)

  - Existing Elizabeth Drive, Luddenham (left out only)
  - Gates Road, Luddenham (left in only)
  - Longview Road, Luddenham (left in, left out only)
  - Grover Crescent south, Mulgoa (left in only)
  - Grover Crescent north, Mulgoa (left out only)
- Dedicated u-turn facilities at:
  - The existing The Northern Road at Luddenham, south-west of Elizabeth Drive
  - The existing Elizabeth Drive, Luddenham around 800 m east of The Northern Road
  - Chain-O-Ponds Road, Mulgoa
- Twin bridges over Adams Road, Luddenham
- Local road changes and upgrades, including:
  - Closure of Vicar Park Lane, east of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, west of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, east of the realigned The Northern Road, Luddenham
  - Elizabeth Drive cul-de-sac, about 300 m east of The Northern Road with a connection to the realigned Elizabeth Drive, Luddenham
  - Extension of Littlefields Road, east of The Northern Road, Mulgoa
  - A new roundabout on the Littlefields Road extension, Mulgoa
  - A new service road between the Littlefields Road roundabout and Gates Road, including a ‘give way’ controlled intersection (that is, no traffic lights) at Gates Road, Luddenham
  - Extension of Vineyard Road, Mulgoa between Longview Road and Kings Hill Road
  - A new roundabout on the Vineyard Road extension at Kings Hill Road, Mulgoa
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road where required
- The upgrading of drainage infrastructure
- Operational ancillary facilities including:
  - Heavy vehicle inspection bays for both northbound and southbound traffic, adjacent to Grover Crescent, Mulgoa and Longview Road, Mulgoa respectively
  - An incident response facility on the south-western corner of the proposed four-way traffic light intersection at Elizabeth Drive, Luddenham
- New traffic management facilities including variable message signs (VMS)
- Roadside furniture and street lighting
- The relocation of utilities and services
- Changes to property access along The Northern Road (generally left in, left out only)
- Establishment and use of temporary ancillary facilities and access tracks during construction
- Property adjustments as required
- Clearance of undetonated explosive ordinance (UXO) within the Defence Establishment Orchard Hills as required.

The upgrade of The Northern Road is part of the Western Sydney Infrastructure Plan (WSIP). The WSIP involves major road and transport linkages that will capitalise on the economic gains from developing the Western Sydney Airport site at Badgerys Creek whilst boosting the local economy and liveability of western Sydney.

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Roads and Maritime Services (Roads and Maritime) to undertake an assessment of the potential environmental impacts of the project, and prepare an Environmental Impact Statement (EIS) in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act) that adequately addresses the *Secretary's Environmental Assessment Requirements (Application number SSI 7127)* (SEARs), as well as the guidance for preparing an EIS presented in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This document presents the results of an air quality assessment for the project.

1.2 Location of project area

The Northern Road is about 45km west of the Sydney central business district and traverses the local government areas of Penrith in the north and Liverpool in the south.

The Northern Road is a key north–south road between Narellan and Richmond, connecting the North West and South West Priority Growth Area. The corridor intersects with a number of regional motorways, arterial and collector roads such as (north to south) Richmond Road, Great Western Highway, M4 Motorway, Elizabeth Drive, Bringelly Road, and Camden Valley Way.

South of Glenmore Parkway, the project area is surrounded by rural residential zoned land as well as pastures and grasslands. Land to the east of The Northern Road in this section is occupied by the Commonwealth Defence Establishment Orchard Hills. Further south, The Northern Road passes through the village of Luddenham (including a small number of residential and commercial properties), before continuing through agricultural grasslands to its junction with Mersey Road. South of Mersey Road, Luddenham is the northern extent of The Northern Road Upgrade, Peter Brock Drive to Mersey Road).

A seven kilometre section of the existing The Northern Road alignment bisects the Western Sydney Airport site south-east of the Luddenham town centre.

1.3 Aim and scope of assessment

The purpose of this report is to provide an assessment of potential air quality impacts associated with the construction and operational phases of the project. This report is intended to support the EIS being prepared to assess the overall environmental impacts associated with the project.

In achieving this purpose, the main objectives of this assessment were to:

- Identify potential air quality impacts associated with the construction and operational phases of the project
- Develop suitable mitigation measures to prevent the generation of dust during construction and to manage potential impacts during operation, as required
- Describe all features of the natural environment which may be affected by the action, including air quality.

These objectives are consistent with the requirements for air quality outlined in the *Secretary's Environmental Assessment Requirements (Application number SSI 7127)*, issued 28 July 2015 and the guidance for preparing an EIS outlined in the EPBC Act. These specific requirements and where they are addressed in this document are outlined below in **Table 1-1**

Table 1-1 SEAR and EPBC Act air quality assessment requirements

Legislation / statute	Requirement	Where addressed in this paper
Secretary's Environmental Assessment Requirements (Application number SSI 7127)	During the preparation of the EIS, you must assess project impacts to air quality. This includes: • potential for impacts on local and regional air quality, including sensitive receivers; and • details of the proposed mitigation measures to prevent the generation and emission of dust.	**Sections 6** and **8** **Section 7**
Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999	The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: • description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: - Natural and physical resources, including air. Impacts to the environment (as defined in section 528) should include but not be limited to the following: • changes to air quality during construction and operation (including consideration of seasonal and meteorological variations that influence local air quality).	**Sections 5** and **6** **Sections 5** and **6**

2. Methodology

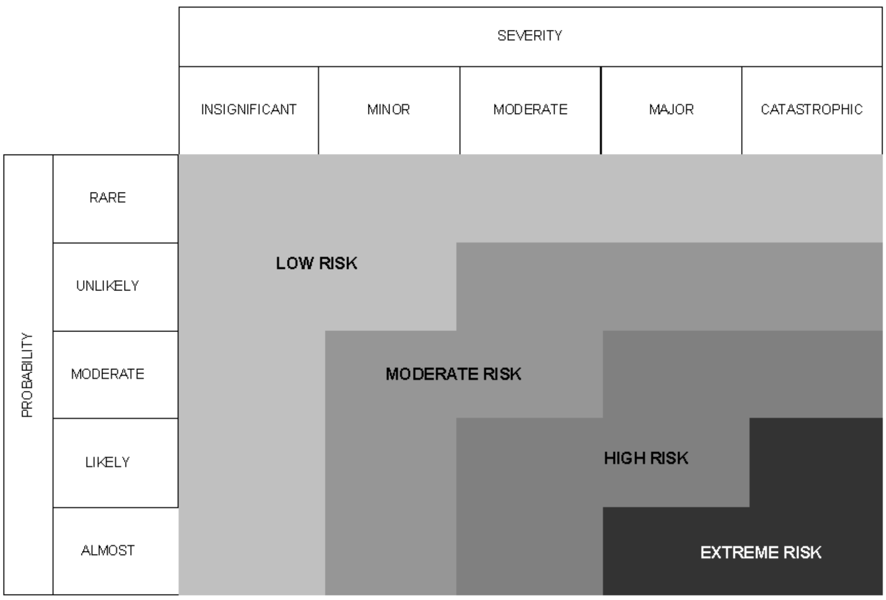
This section of the report describes the methods applied in this study to assess potential air quality impacts during construction and operational phases of the project.

2.1 Construction impacts review

During construction, the primary risk to local air quality is the generation of dust. That is, particulate matter in the form of total suspended solids (TSP), particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM_{10}) and particulate matter with an equivalent aerodynamic diameter less than 2.5 microns ($PM_{2.5}$). Airborne particulate matter has the potential to cause adverse health or nuisance impacts if not properly managed.

To identify and appropriately manage the generation of dust emissions during construction, a risk-based qualitative assessment method was applied. This approach is summarised below in **Table 2-1**.

Table 2-1 Methodology for assessment of air quality impacts during construction

<table>
<tr><th>Task</th><th>Methodology</th></tr>
<tr><td>Identification of local receivers, prevailing meteorological and ambient air quality conditions</td><td>Publically available imagery was reviewed to determine the location of nearby receivers in relation to the project study area.
To characterise prevailing weather conditions, long-term climate data including temperature, rainfall, wind speed and direction data were reviewed from the nearest monitoring station operated by the Bureau of Meteorology (BoM) at Penrith Lakes (station number 67113).
Background air quality conditions around the project were estimated from data collected at the nearest NSW Office of Environment and Heritage (OEH) ambient air quality monitoring stations located at St Marys, Bringelly, Prospect and Liverpool.</td></tr>
<tr><td>Determination of initial risk ratings for each phase of construction</td><td>Potential air quality impacts were qualitatively assessed for each phase of construction associated with the project. The likelihood (probability) and consequence (severity) of activities resulting in air quality impacts were evaluated to develop initial risk ratings. This was completed using Environmental risk management procedure ILC-ES-TP0-416, (NSW Roads and Traffic Authority, October 2006) shown below.

</td></tr>
</table>

<table>
<tr><th>Task</th><th>Methodology</th></tr>
<tr><td></td><td>
Figure 2-1 Environmental risk evaluation matrix (RTA, 2006)
<table>
<tr><th>Descriptor</th><th>Description</th><th>Example *</th></tr>
<tr><td>Rare</td><td>The event may occur only in extreme circumstances</td><td>Practically impossible</td></tr>
<tr><td>Unlikely</td><td>The event could occur at some time</td><td>"I've heard of it happening…"happens every five years</td></tr>
<tr><td>Moderate</td><td>The event should occur at some time</td><td>"it has happened before…"happens annually</td></tr>
<tr><td>Likely</td><td>The event will probably happen</td><td>Happens monthly</td></tr>
<tr><td>Almost certain</td><td>The event is expected to occur in most circumstances</td><td>"it's a common occurrence…"happens weekly or more often</td></tr>
</table>
Figure 2-2 Method for determining likelihood (probability), (RTA, 2006)
<table>
<tr><th>Descriptor</th><th>Description</th></tr>
<tr><td>Insignificant</td><td>No injuries, no adverse social or environmental impact. No real impact on the community, low financial loss.</td></tr>
<tr><td>Minor</td><td>On-site release immediately contained, medium financial loss, contained in a small area.</td></tr>
<tr><td>Moderate</td><td>Minor reversible impact on environment. On-site release contained with outside assistance, measurable adverse environmental or social impact, will result in annoyance or nuisance to community, high financial loss.</td></tr>
<tr><td>Major</td><td>Major reversible impact on environment. Loss of production capacity, off site release with no detrimental effects, major financial loss</td></tr>
<tr><td>Catastrophic</td><td>Major, widespread irreversible impact on environment</td></tr>
</table>
Figure 2-3 Method for determining consequence (severity), (RTA, 2006)
Factors including the intensity and duration of activities, relative location in relation to surrounding sensitive receivers, existing air quality and prevailing meteorological conditions were considered to develop likelihood and consequence ratings, and resulting initial risk ratings for each phase of construction.
</td></tr>
<tr><td>Develop mitigation measures and recalculate residual risks.</td><td>Following the initial assessment, air quality mitigation measures were recommended, where necessary, to minimise and mitigate phases of construction where 'moderate risks' or higher were estimated. Residual risk ratings were calculated based on the application of recommended management measures and safeguards. The extent of residual risks to air quality determined at a local scale was used to inform potential impacts at a broader regional level.</td></tr>
</table>

2.2 Operational impacts review

Potential impacts to air quality during the operational phase of the project are generally associated with motor vehicle emissions arising from changes in the volumes of motor vehicles, model of travel (such as free flow of congested and proximity to sensitive receptors. Key pollutants associated with exhaust fumes include carbon monoxide (CO), nitrogen dioxide (NO_2) and particulate matter (as PM_{10} and $PM_{2.5}$), as well as volatile organic compounds (VOCs).

To evaluate potential operational air quality impacts, a quantitative assessment approach was applied using the Roads and Maritime *Tool for Roadside Air Quality* (TRAQ) prediction model. TRAQ, which uses the CALINE4 air dispersion model for predicting air pollutant concentrations near roadways, was used to develop models for the following assessment scenarios:

- Scenario 1: Do minimum, year of opening (2021)

- Scenario 2: Proposed upgrade, year of opening (2021)
- Scenario 3: Do minimum, future year (2031)
- Scenario 4: Proposed upgrade, future year (2031).

It is noted that the 'Do minimum' scenarios 1 and 3 relate to a scenario whereby The Northern Road is realigned along the proposed upgrade route, with a single lane in each direction. This alignment has been selected for the assessment as the Western Sydney Airport site is proposed to traverse the existing alignment of The Northern Road between Adams Road and Badgerys Creek.

Modelling considered concept upgrade arrangements, measured and forecast traffic data (volumes, composition and speeds), and worst case meteorological conditions (that is, wind speed of 1 m/s, atmospheric stability Class F, and 15 degrees Celsius). Environment Protection Authority (EPA) vehicle fleet exhaust emission factors for 2021 and 2026 were used for the 2021 and 2031 scenarios respectively.

Predicted roadside operational contributions were added to background concentrations and compared to EPA ambient air quality assessment criteria. These criteria are discussed in **Section 4**. The relative difference in predicted impacts between each scenario was also assessed. Mitigation measures were recommended, as required, to manage any identified operational impacts.

As for construction, predicted impacts at a local level were used to inform potential operational impacts at a wider regional scale.

2.3 Cumulative impacts review

The Western Sydney Airport site is located directly east of the proposed upgrade route between Mersey Road, Luddenham and Adams Road, Luddenham. As outlined in the *Western Sydney Airport Environmental Impact Statement,* construction may commence as early as 2016, with airport operations to commence in the mid-2020s. If these timings for project commencement at the Western Sydney Airport site take place then it is likely that there will be some overlap between phases of construction of this particular portion of the proposed upgrade of The Northern Road and the Western Sydney Airport.

Construction of the Project is also likely to coincide with other phases of The Northern Road upgrade including:

- The Northern Road Upgrade, Old Northern Road Narellan to Peter Brock Drive, Oran Park (Stage 1)
- The Northern Road Upgrade, Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2)
- The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, Penrith.

Cumulative impacts during construction have been considered using the same qualitative, risk-based approach described above.

There is also the potential for cumulative operational air quality impacts at receivers around the Western Sydney Airport site once operations commence. These impacts have been considered with reference to the findings presented in the *Western Sydney Airport Environmental Impact Statement Volume 4 Appendix F1 Local air quality and greenhouse gas,* (Pacific Environment Limited, 2016).

3. Policy setting

In NSW, emissions to air are controlled by the *Protection of the Environment Operations Act 1997* (POEO Act) and the following regulations:

- *Protection of the Environment Operations (Clean Air) Regulation 2010*
- *Protection of the Environment Operations (General) Regulation 2009, Part 5.4 Air pollution.*

The *Approved Methods for Modelling and Assessment of Air Pollutants in NSW (Approved methods),* (NSW Environment Protection Authority, 2016) provides methods for modelling and assessing emissions to air in NSW.

4. Criteria

Relevant assessment criteria for the project from the *Approved methods* for the primary pollutants associated with the construction and operational phases of the project identified above are presented below in **Table 4-1**. Column four displays the original source for criteria adopted in the *Approved methods*.

Table 4-1 Air quality impact assessment criteria (DEC, 2005)

Pollutant	Averaging time	Criteria	Source
Particulate matter (PM_{10})	24 hours	50 µg/m^3	DoE, 2016
	Annual	30 µg/m^3	DoE, 2016
Particulate matter ($PM_{2.5}$)	24 hours	25 µg/m^3	DoE, 2016
	Annual	8 µg/m^3	DoE, 2016
Total suspended solids (TSP)	Annual	90 µg/m^3	NHMRC, 1996
Deposited dust	Annual (maximum increase)	2 g/m^2/month	NERDDC, 1988
	Annual (maximum total)	4 g/m^2/month	NERDDC, 1988
Carbon monoxide (CO)	15 minutes	100 mg/m^3	WHO, 2000
	1 hour	30 mg/m^3	WHO, 2000
	8 hours	10 mg/m^3	NEPC, 1998
Nitrogen dioxide (NO_2)	1 hour	246 µg/m^3	NEPC, 1998
	Annual	62 µg/m^3	NEPC, 1998
Volatile organic compounds (VOCs) as benzene	1 hour	29 µg/m^3	GoV, 2001

The intent of each of these criteria as described at their original source from which they were adopted in the *Approved methods* have been summarised below.

- Particulate matter (PM_{10} and $PM_{2.5}$): Part 2, Clause 5 of the *National Environment Protection (Ambient Air Quality) Measure – as amended,* (Department of the Environment, 2016) states that the desired outcome of the measure is 'ambient air quality that allows for the adequate protection of human health and well-being'.
- Total suspended solids (TSP): The now rescinded *Ambient Air Quality Goals Recommended by the National Health and Medical Research Council*, (National Health and Medical Research Council, 1996) states that 'at these levels [the criterion above in Table 4-1] there still may be some people who will experience respiratory symptoms' but that the intent of this criteria is the protection of human health for the broader majority of the population.
- Carbon monoxide (CO): The criteria for CO adopted from the *WHO Air Quality Guidelines for Europe, 2nd Edition*, (World Health Organisation, 2000) are intended to preserve a COHb (Carbon monoxide haemoglobin oxygen carrying capacity of the blood) safe level of 2.5% for a 'normal subject' engaging in light or moderate exercise. Exposures to concentrations above these levels for the periods specified were stated to result in adverse health effects.
- Nitrogen dioxide (NO_2): The same objective is stated for NO_2 in the *Ambient Air – National Environment Protection Measure for Ambient Air Quality,* (National Environment Protection Council, 1998); namely to provide 'adequate protection of human health and well-being'. Guidance regarding NO_2 exposure is detailed in the World Health Organisation, 2000 guideline which indicates that a 1 hour averaged criteria of 200 µg/m^3 includes a 50 per cent 'safety margin' and that it was only when short-term exposures were greater than 400 µg/m^3 that there was 'evidence to suggest possible small effects in function of asthmatics'.

- Volatile organic compounds (VOCs): This criterion is adopted from guidance presented in *State Environment Protection Policy (Air Quality Management) No. S 240,* (Government of Victoria, 2001). Part II Schedule A of the guideline describes how this criterion includes a factor of safety of 40, given the high toxicity and potential health effects arising from exposure to such substances.

As such it can generally be concluded that exposure up to and at the criteria specified in Table 4-1 may result in some health effects for some individuals. Exposures above these criteria broadly results in an increase in frequency of adverse health effects amongst a population, though the extent of this relationship varies between pollutants and exposures times.

The criteria in Table 4-1 relate to the 100th percentile (99.9th percentile for benzene), total cumulative concentration of pollutants in the air and not just contributions from project-specific sources. As such, ambient pollutant concentrations determined below in **Section 5.2** must also be considered when evaluating against these criteria.

5. Existing environment

5.1 Meteorology

The nearest weather station with long-term historical records operated by the Bureau of Meteorology (BoM) is the Penrith Lakes Automatic Weather Station (AWS) (station number 67113). This station is located approximately 8.5km to the northwest of the northern end of the Project. **Table 5-1** displays long-term temperature and rainfall averages recorded at this station from its date of commission in 1995 to present (April 2016).

Table 5-1 Long-term temperature and rainfall data from BoM Penrith Lakes AWS

Month	Mean maximum temperature (°C)	Mean minimum temperature (°C)	Mean rainfall (mm)	Mean number of rain days (> 1 mm)
January	30.7	18.5	100.8	7.6
February	29.4	18.5	121.4	7.8
March	27.5	16.6	69.2	7.5
April	24.4	13.1	53.1	5.8
May	21.0	9.3	40.4	4.7
June	18.1	6.9	52.4	5.7
July	17.7	5.4	29.8	4.2
August	19.9	6.2	30.6	3.6
September	23.3	9.4	31.2	4.7
October	25.9	12.1	53.4	5.3
November	27.3	15.0	85.7	8.0
December	29.2	16.9	62.4	7.0
Annual	**24.5**	**12.3**	**728.1**	**71.9**

These data indicate that the area around the project experiences warm and wet summers with mean daily maximum temperature of between 29 and 31 degrees Celsius. Months through winter and the beginning of spring are the coldest and driest periods of the year with average monthly rainfall from July to September of around 30 mm per month.

To determine prevailing wind conditions around the project area, annual and seasonal wind roses were generated from data collected in the years 2013, 2014 and 2015. These are displayed below in **Figure 5-1**, **Figure 5-2** and **Figure 5-3** for 2013, 2014 and 2015 respectively. Annual and seasonal wind roses are generally consistent from each of the three years, with winds blowing from the southwest most common during all times of the year. Calm conditions (i.e. wind speeds less than 0.5m per second) were most common in autumn and winter; occurring around 20 per cent of the time during these seasons.

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Figure 5-1 2013 Annual and seasonal wind roses for Penrith Lakes AWS

Figure 5-2 2014 Annual and seasonal wind roses for Penrith Lakes AWS

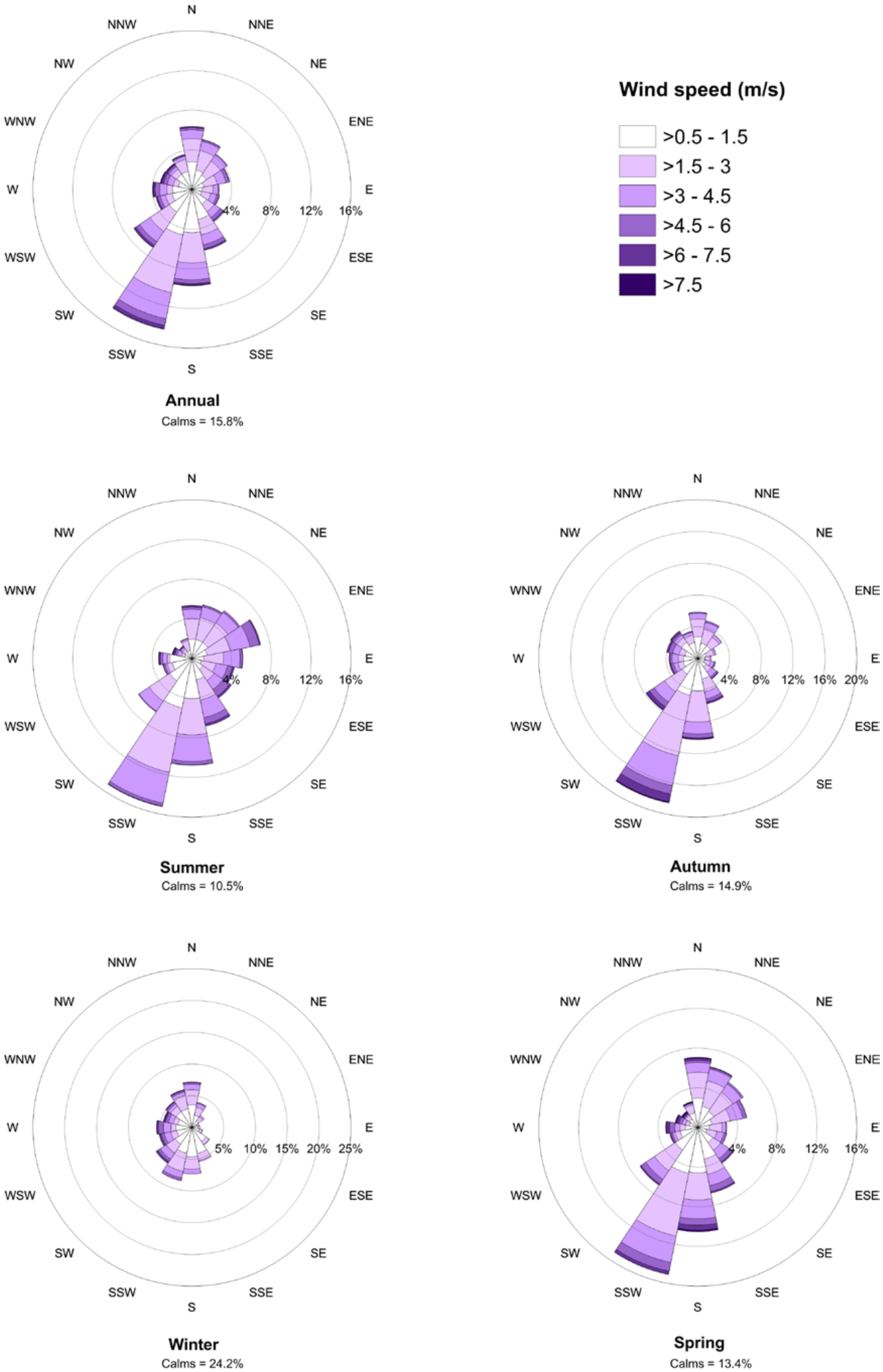

Figure 5-3 2015 Annual and seasonal wind roses for Penrith Lakes AWS

5.2 Ambient air quality

5.2.1 Air quality index

The NSW Office of Environment and Heritage (OEH) developed a metric known as the 'air quality index' (AQI). The purpose of the AQI is to provide an indication of the overall air quality by considering pollutant data measurements for ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and PM_{10}, as well as visibility against criteria presented in the *Variation to the National Environment Protection (Ambient Air Quality) Measure* and OEH standard for visibility. These readings are converted to a single overall value, known as the AQI using the formula:

$$AQI\ pollutant = \frac{Pollutant\ data\ reading}{Standard} \times 100$$

Table 5-2 provides a scale for relating AQI values to a qualitative indication of individual and relative air quality.

Table 5-2 AQI value classifications, (http://www.environment.nsw.gov.au/aqms/aqi.htm)

AQI value	Resulting classification
0 to 33	Very good
34 to 66	Good
67 to 99	Fair
100 to 149	Poor
150 to 199	Very poor
Greater than 200	Hazardous

Statistics generated from daily AQI values calculated at the nearest OEH air quality monitoring (St Marys – northern portion of the project, Bringelly – southern portion) are presented below in **Table 5-3**. These statistics indicate that daily AQI values are generally 'good' with occasional days of 'poor' air quality or worse, usually driven by particulate matter concentrations.

Table 5-3 St Marys AQI value statistics

Period	St Marys AQI value statistics			Bringelly AQI value statistics		
	Annual daily average	95^{th} percentile of daily values	Annual daily maximum	Annual daily average	95^{th} percentile of daily values	Annual daily maximum
2013	57	105	670	53	92	1274
2014	50	88	272	48	82	263
2015	45	79	220	47	77	225

5.2.2 Background concentrations

The OEH operates a state wide air quality monitoring network which provides information on current and historical air quality. The network includes 15 air quality stations around the greater Sydney region. The nearest stations in relation to the project are located at St Marys (approximately seven kilometres to the northeast), Bringelly (approximately five kilometres to the east) and Prospect (20km to the east). Noting their relative proximity, measurements at St Marys are considered to be most representative of background air quality conditions around the northern portion of the project area, and measurements from Bringelly for areas south of Elizabeth Drive (M12). The primary pollutants of concern during construction and operations, as identified in **Section 2**, are NO_2, CO and particulate matter. Concentrations of CO and $PM_{2.5}$ are not measured at this station. Both CO and $PM_{2.5}$ are measured at Prospect, although measurement of $PM_{2.5}$ only commenced in December 2014.

$PM_{2.5}$ data from 2013 and 2014 are available at Liverpool (approximately 19km to the east). As such, ambient concentrations for CO and $PM_{2.5}$ have been considered for this assessment from the stations at Prospect and Liverpool, with NO_2 and PM_{10} concentrations adopted from St Marys.

Table 5-4 Summary of pollutants measured at nearby OEH monitoring stations

OEH air quality monitoring station	Location	Nitrogen dioxide (NO_2)	Carbon monoxide (CO)	Particulate matter PM_{10}	Particulate matter $PM_{2.5}$
St Marys	Mamre Road	✓		✓	
Bringelly	Ramsay Road	✓		✓	
Prospect	William Lawson Park	✓	✓	✓	✓#
Liverpool	Rose St	✓	✓	✓	✓

$PM_{2.5}$ data only available at Prospect for 2015.

A summary of the ambient concentrations of PM_{10}, $PM_{2.5}$, NO_2 and CO measured at these four stations from 2013 to 2015 is shown below in **Table 5-5**.

Table 5-5 Summary of ambient pollutant concentrations measured from 2013 to 2015 at St Marys, Bringelly, Prospect and Liverpool

Station	Year	PM_{10} µg/m^3			$PM_{2.5}$ µg/m^3			NO_2 µg/m^3		CO mg/m^3
		100th %ile 24 hour	95th %ile 24 hour	Annual	100th %ile 24 hour	95th %ile 24 hour	Annual	100th %ile 1 hour	Annual	100th %ile 8 hour
St Marys	2013	93	33	16	-	-	-	76	11	-
	2014	45	28	18	-	-	-	64	8	-
	2015	53	27	15	-	-	-	66	8	-
Bringelly	2013	97	30	17	-	-	-	76	9	-
	2014	43	29	17	-	-	-	51	9	-
	2015	57	28	16	-	-	-	55	8	-
Prospect	2013	82	33	19	-	-	-	101	22	1.8
	2014	44	30	18	-	-	-	96	21	1.5
	2015	69	30	18	30	16	8	109	22	1.7
Liverpool	2013	99	37	21	74	19	9	115	23	2.4
	2014	41	33	19	24	16	9	90	21	2.5
	2015	69	31	19	32	17	9	123	20	2.1

Considering the results presented in **Table 5-5** against the assessment criteria established in **Section 4**, the following observations were made:

- 100th percentile (maximum) 24 hour-averaged PM10 background concentrations were found to exceed the criterion of 50 µg/m^3 at all four monitoring locations in 2013 and 2015, but were below this criterion in 2014. 95th percentile values of 24 hour-averaged concentrations ranged from 27 to 37 µg/m^3, with the highest values recorded at Liverpool
- Annually averaged PM_{10} background concentrations ranged from 15 to 21 µg/m^3 across the four sites for the three years considered (2013 to 2015), with the highest annual average concentrations recorded at Liverpool. These levels range from 15 to 9 µg/m^3 below the assessment criterion (30 µg/m^3)

- 100th percentile (maximum) 24 hour-averaged $PM_{2.5}$ background concentrations measured at Prospect (2015) and Liverpool (2013 to 2015) exceeded the criterion of 25 µg/m^3, but 95th percentile 24 hour-averaged $PM_{2.5}$ concentrations were below this value, ranging from 16 to 19 µg/m^3
- Annually averaged $PM_{2.5}$ background concentrations were measured to already exceed the assessment criterion of 8 µg/m^3
- 100th percentile 1 hour averaged NO_2 background concentrations were measured to be well below the assessment criterion (246 µg/m^3) at all of the four measurement sites and all of the three year's considered. Annually averaged NO2 background concentrations were also well below the annual criterion of 62 µg/m^3 with the highest concentration of 23 µg/m^3 recorded at Liverpool in 2013
- 100th percentile 8 hour-averaged CO2 concentrations measured at Prospect and Liverpool were found to be well below the assessment criterion (10 µg/m^3).

VOCs are not presently measured at any OEH air quality monitoring stations. As outlined in the *Western Sydney Airport Environmental Impact Statement Volume 4 Appendix F1 Local air quality and greenhouse gas,* (Pacific Environment Limited, October 2016); two historical studies have previously been completed by the NSW EPA to investigate baseline concentrations of air toxics:

- Air Toxics Monitoring Program (ATMP) involving the collection of 24 hour-averaged measurements at the Sydney CBD, Rozelle, St Marys and Blacktown from 1996 to 2001
- Ambient Air Quality Monitoring and Fuel Quality Testing Project (AAQMFQTP) where 24 hour-averaged measurements were collected from October 2008 to October 2009 at Turrella and Rozelle.

During the ATMP study, annual and 24 hour-averaged benzene concentrations of 1.4 µg/m^3 and 4.2 µg/m^3 were measured at St Marys respectively. Annual benzene concentrations of 1.4 µg/m^3 were measured at Turrella during the AAQMFQTP study.

Considering the monitoring data presented above, the following concentrations were adopted for the purpose of this assessment to characterise local and regional background air quality conditions. It is noted that the 1 hour averaged CO and VOC (as benzene) background concentrations have been approximated using the formula provided in the *AUSPLUME Gaussian Plume Dispersion Model Technical User Manual,* (Victorian Environment Protection Authority 2000) for estimating sub-hourly concentrations from hourly data. The formula was modified to estimate the 1 hour concentration from the available 8 hour and 24 hour averaged data respectively.

Table 5-6 Adopted pollutant background concentrations

Pollutant	Averaging time	Adopted background concentration (100th percentile)
PM_{10}	24 hour	29.4 µg/m^3 – North of Elizabeth Drive (M12) 29.0 µg/m^3 – South of Elizabeth Drive (M12)
	Annual	15.9 µg/m^3 – North of Elizabeth Drive (M12) 16.5 µg/m^3 – South of Elizabeth Drive (M12)
$PM_{2.5}$	24 hour	16.8 µg/m^3
	Annual	8.7 µg/m^3
NO_2	1 hour	68.4 µg/m^3 – North of Elizabeth Drive (M12) 60.9 µg/m^3 – South of Elizabeth Drive (M12)
	Annual	9.0 µg/m^3 – North of Elizabeth Drive (M12)

Pollutant	Averaging time	Adopted background concentration (100th percentile)
		8.7 µg/m³ – South of Elizabeth Drive (M12)
CO	1 hour	2.5 mg/m³
	8 hour	1.7 mg/m³
Volatile organic compounds (VOCs) as benzene	1 hour	2.6 µg/m³

5.3 Nearby receivers

Land-use around the proposed upgrade of The Northern Road, is low-density residential at the northern extent and rural/residential land, generally south of Orchard Hills. Approximate distances to the nearest receiver and typical distances to receivers along each segment of the proposed upgrade route as considered in the operational assessment (**Section 6.2**) are summarised in **Table 5-7**. The closest properties are about 20m from the proposed roadway.

Table 5-7 Summary of surrounding receivers

Segment	Description	Nearest and typical distances to surrounding receivers (m)
Segment 1	The Northern Road between Glenmore Parkway and Bradley Street (contains Commonwealth land)	Nearest: Approx. 50 m Typical: More than 100 m
Segment 2	The Northern Road between Bradley Street and Chain-O-Ponds Road (contains Commonwealth land)	Nearest: Approx. 20 m Typical: 50 to 100 m
Segment 3	The Northern Road between Chain-O-Ponds Road and Kings Hill Road (contains Commonwealth land)	Nearest: Approx. 20 m Typical: Approx. 50 m
Segment 4	The Northern Road between Kings Hill Road and Littlefields Road (contains Commonwealth land)	Nearest: Approx. 20 m Typical: Approx. 40 m
Segment 5	The Northern Road between Littlefields Road and Elizabeth Drive (M12)	Nearest: Approx. 40 m Typical: More than 50 m
Segment 6	The Northern Road between Elizabeth Drive (M12) and Park Road (former Northern Road)	Nearest: Approx. 100 m Typical: Approx. 100 m
Segment 7	The Northern Road between Park Road (former Northern Road) and Western Sydney Airport access	Nearest: More than 100 m Typical: More than 100 m
Segment 8	The Northern road south of Western Sydney Airport access	Nearest: Approx. 50 m Typical: Approx. 100 m

Potential impacts at these receivers were used to evaluate impacts from the Project at a local scale.

6. Potential impacts

6.1 Construction

Potential air quality impacts during construction were evaluated using the risk-based approach outlined in **Section 2.1**. Mitigation measures were recommended based on the estimated initial, unmitigated risk level, with residual risk levels calculated for each phase of construction as outlined in the construction methodology section of the EIS. The phases of construction were considered as follows:

- Early works including installation of construction signage and environmental controls, ground surveys, geotechnical and soil investigations, dilapidation and building surveys, protection of utilities and vegetation clearance
- Construction ancillary facilities including stockpiling areas (establishment and construction operations)
- Earthworks
- Traffic management and access
- Road widening and road-realignment works including ripping and re-compaction of subgrade, placement and compaction of subbase materials, demolition of kerbs, other road elements and structures
- Intersection works
- Construction of bridges and underpasses
- Drainage works including the installation of pavement drainage features and facilities used to drain and conveyor water from the road, open channels to protect the road embankments, extension/upgrade of existing culverts, spill basins and swales
- Pavement construction including the placement of select material, placement compaction and finishing of concrete and asphalt to form pavements
- Relocation of utilities and services
- Finishing works including line marking, installation of road signage and furnishings including street lighting, landscaping and demobilisation from site.

The assessment is presented below in **Table 6-1**.

As expected, phases involving the handling, disturbance and management of materials were determined to have the highest potential to generate impacts during construction. Though a potential for temporal residual impacts were predicted at a local scale during construction, they are not expected to be of an extent which would constitute a risk to regional air quality during the works.

Table 6-1 Construction air quality risk assessment

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Early works including installation of construction signage and environmental controls, ground surveys, geotechnical and soil investigations, dilapidation and building surveys and protection of utilities	• Generation and emission to air including dust and products of combustion (from equipment operations).	Minor	Unlikely	Low	• Inspecting the plant/equipment prior to commencement of works on site. • Conduct routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.	Rare	Unlikely	Low

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Establishment and operation of construction compound sites and storage facilities.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces.	Moderate	Likely	High	• Installation of perimeter screening around long-term compound sites. • Impose low speeds limits around compound sites to limit the generation of dust from vehicle movements. • Apply wheel-wash or rumble grid facilities at access points to limit the tracking of materials beyond the site boundary. • Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation. • Regularly water stockpiles. • Wherever possible and practical, limit the amount of materials stockpiled around the site. • Select compound sites which maximise the separation distance from surrounding receivers. • Select stockpiling locations at areas within compound sites which allow the greatest separation from surrounding receivers. • Reduce or halt stockpiling activities during inclement weather conditions	Moderate	Moderate	Moderate

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Early works - Vegetation clearing, grubbing and removal.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces.	Moderate	Likely	High	• Inspecting the plant/equipment prior to commencement of works on site. • Conduct routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently. • Avoid dry conditions where winds are blowing in the direction from the vegetation clearance area towards nearby receivers. • Install dust monitoring devices to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • Water cleared areas as required to minimise the potential for windborne dust.	Moderate	Moderate	Moderate

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Earthworks - Stripping, stockpiling and management of topsoil and unsuitable materials.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces and stockpiled materials.	Moderate	Likely	High	• Installation of perimeter screening around long-term stockpiling locations. • Regularly water stockpiles. • Wherever possible and practical, limit the amount of materials stockpiled around the site. • Ensure that all loads are covered when materials are being hauled to and from site. • Clean loose materials and debris from the tailgate of vehicles unloading materials to stockpiles prior to departure from site. • Position stockpiling areas as far as possible from surrounding receivers. • Limit stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers. • Install dust monitoring devices to quantify dust levels and determine whether control measures are adequate or whether further actions are required.	Moderate	Moderate	Moderate

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Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Road widening and re-alignment works, intersection works - Excavation and preparation of subgrade.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces. • Dust and debris arising from haulage of materials. • Odours arising from uncovered contaminated and/or hazardous materials.	Moderate	Moderate	Moderate	• Regular water exposed and disturbed areas especially during inclement weather conditions. • Wherever possible, minimise the extent of disturbed and exposed surfaces, and restore as soon as possible. • Ensure that all loads are covered and any loose materials/debris is removed before departure from site. • Apply wheel-wash or rumble grid facilities as appropriate to removal loose material and prevent the tracking of spoil debris onto local roads. • Apply odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works. • Wherever possible, stage subgrade preparation activities to limit the overall level of impact during this phase or work. • Install dust monitoring devices to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers.	Moderate	Moderate	Moderate

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Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Road widening and re-alignment works, intersection works - Placement and compaction of sub-base course and base course.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces. • Dust and debris arising from haulage of materials.	Moderate	Likely	High	• Regular watering of exposed and disturbed areas especially during inclement weather conditions. • Wherever possible, stage subgrade preparation activities to limit the overall level of impact during this phase or work. • Install dust monitoring devices to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers. • Ensure that all loads are covered and any loose materials/debris is removed before departure from site. • Abide by road speed limits. • Apply wheel-wash or rumble grid facilities as appropriate to removal loose material and prevent the tracking of spoil debris onto local roads.	Moderate	Moderate	Moderate

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Pavement construction – development of pavement and median.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Windborne dust emanating from disturbed/exposed surfaces. • Dust and debris arising from haulage of materials.	Moderate	Moderate	Moderate	• Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers. • Ensure that all loads are covered and any loose materials/debris is removed before departure from site. • Abide by road speed limits.	Minor	Unlikely	Low
Drainage and utilities works.	• Generation and emission to air including dust and products of combustion (from equipment operations). • Odours arising from uncovered contaminated and/or hazardous materials.	Minor	Unlikely	Low	• Regular watering of exposed and disturbed areas especially during inclement weather conditions. • Application of odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.	Minor	Unlikely	Low
Bridge preparation and installation activities.	• Generation and emission to air including dust and products of combustion (from equipment operations).	Minor	Unlikely	Low	• Ensure that any material exposed areas associated with these works are secured during project shutdown periods to prevent any dust emanating over the drivers using Adams Road and Elizabeth Drive (M12).	Minor	Rare	Low

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Installation of permanent traffic control signals and road furnishings; line marking and street lights.	• Generation and emission to air including dust and products of combustion (from equipment operations).	Insignificant	Rare	Low	• No measures expected to be required to effectively manage the low level of risk associated with these phases of construction.	Insignificant	Rare	Low
Landscaping and demobilisation from the site.	• Windborne dust emanating from disturbed/exposed surfaces.	Minor	Moderate	Moderate	• Stage work to ensure that finished areas are revegetated as soon as possible. • Regularly maintain and water revegetation areas to aid the establishment of adequate vegetation cover.	Minor	Unlikely	Low
Any phase of construction undertaken south of Elizabeth Drive (M12) completed con-current with construction activities at the Western Sydney Airport	• Generation and emission to air including dust and products of combustion (from equipment operations).	Moderate	Likely	High	• Develop construction program in consultation with the contractor(s) developing the western Sydney airport site. Maintain consultation through the course of both projects to plan activities in a manner which limits potential air quality-related impacts. • Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time. • Stop activities if dust is observed to be emanating from the airport site which could affect receivers which may also be affected by activities associated with the project.	Moderate	Moderate	Moderate

Phase of construction	Potential impacts	Initial risk rating			Recommended mitigation measures	Residual risk rating		
		Consequence	Likelihood	Risk Rating		Consequence	Likelihood	Risk Rating
Any Project construction activities undertaken at the same time as construction activities associated with other stages of The Northern Road upgrade.	• Generation and emission to air including dust and products of combustion (from equipment operations).	Moderate	Likely	High	• Develop construction program in consultation with the other stages of The Northern Road to plan activities in a manner which limits potential air quality-related impacts. • Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time and in similar locations to avoid cumulative impacts at relevant receivers • Stop activities if dust is observed to be emanating from beyond the project boundary of other stages of The Northern Road which could affect receivers which may also be affected by activities associated with the project.	Moderate	Moderate	Moderate

6.2 Operations

Operational air quality impacts were predicted for the following four assessment scenarios using the TRAQ dispersion model, as described in **Section 2.2**.

- Scenario 1: Do minimum, year of opening (2021)
- Scenario 2: Proposed upgrade, year of opening (2021)
- Scenario 3: Do minimum, future year (2031)
- Scenario 4: Proposed upgrade, future year (2031).

Predictions for each scenario where made along the eight segments listed below, where traffic conditions change as a result of intersections with other arterial roadways, or major street.

- Segment 1: The Northern Road between Glenmore Parkway and Bradley Street (contains Commonwealth land)
- Segment 2: The Northern Road between Bradley Street and Chain-O-Ponds Road (contains Commonwealth land)
- Segment 3: The Northern Road between Chain-O-Ponds Road and Kings Hill Road (contains Commonwealth land)
- Segment 4: The Northern Road between Kings Hill Road and Littlefields Road (contains Commonwealth land)
- Segment 5: The Northern Road between Littlefields Road and Elizabeth Drive (M12)
- Segment 6: The Northern Road between Elizabeth Drive (M12) and Park Road
- Segment 7: The Northern Road between Park Road and Western Sydney Airport site access
- Segment 8: The Northern road south of Western Sydney Airport site access.

Predicted concentrations for each pollutant of potential concern and each relevant averaging period are displayed below for each segment of scenarios one to four. Results are presented at distances representing the nearest and typical receivers from the project for each segment as presented above in **Table 6-1**.

Tables 6-2 to **6-10** provide results for each pollutant and averaging time as summarised in the following bullets:

- **Table 6-2:** Incremental and cumulative results for 24 hour-averaged PM_{10}
- **Table 6-3:**Incremental and cumulative results for annually-averaged PM_{10}
- **Table 6-4:** Incremental and cumulative results for 24 hour-averaged $PM_{2.5}$
- **Table 6-5:** Incremental and cumulative results for annually-averaged $PM_{2.5}$
- **Table 6-6:** Incremental and cumulative results for 1 hour-averaged NO_2
- **Table 6-7:** Incremental and cumulative results for annually-averaged NO_2
- **Table 6-8:** Incremental and cumulative results for 1 hour-averaged CO
- **Table 6-9:** Incremental and cumulative results for 8 hour-averaged CO
- **Table 6-10:** Incremental and cumulative results for 1 hour-averaged VOCs.

For ease of understanding, levels predicted in excess of criteria, as established in **Section 4**, have been displayed in **bolded** font.

Table 6-2 Background, incremental and cumulative 24 hour-averaged PM_{10} results vs 50 µg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	29.4	1.8	31.2	29.4	2.3	31.7	29.4	1.7	31.1	29.4	2.2	31.6
	Typical (>100m)		1.2	30.6		1.5	30.9		1.2	30.6		1.4	30.8
2	Nearest (20m)		2.2	31.6		2.6	32		2.3	31.7		3.8	33.2
	Typical (50m)		1.3	30.7		1.7	31.1		1.5	30.9		2.4	31.8
3	Nearest (20m)		2	31.4		2.5	31.9		2.3	31.7		3.5	32.9
	Typical (50m)		1.2	30.6		1.6	31		1.4	30.8		2.2	31.6
4	Nearest (20m)		1.9	31.3		2.2	31.6		2	31.4		3.3	32.7
	Typical (50m)		1.2	30.6		1.4	30.8		1.2	30.6		2.1	31.5
5	Nearest (50m)		1.2	30.6		1.4	30.8		1.2	30.6		2.2	31.6
	Typical (50m)		1.2	30.6		1.4	30.8		1.2	30.6		2.2	31.6
6	Nearest (100m)	29.0	0.8	29.8	29.0	0.8	29.8	29.0	0.5	29.5	29.0	1.1	30.1
	Typical (>100m)		0.5	29.5		0.8	29.8		0.3	29.3		0.9	29.9
7	Nearest(>100m)		0.7	29.7		0.7	29.7		0.4	29.4		1.1	30.1
	Typical (>100m)		0.4	29.4		0.7	29.7		0.3	29.3		1	30
8	Nearest (50m)		1.1	30.1		1.2	30.2		0.9	29.9		1.6	30.6
	Typical (100m)		0.7	29.7		0.8	29.8		0.6	29.6		1	30

Table 6-3 Background, incremental and cumulative annually-averaged PM_{10} results vs 30 µg/m^3 criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	15.9	0.7	16.6	15.9	0.9	16.8	15.9	0.7	16.6	15.9	1.2	17.1
	Typical (>100m)		0.5	16.4		0.6	16.5		0.4	16.3		0.8	16.7
2	Nearest (20m)		0.8	16.7		1.1	17		0.9	16.8		1.5	17.4
	Typical (50m)		0.5	16.4		0.7	16.6		0.6	16.5		1	16.9
3	Nearest (20m)		0.8	16.7		1	16.9		0.9	16.8		1.4	17.3
	Typical (50m)		0.5	16.4		0.6	16.5		0.6	16.5		0.8	16.7
4	Nearest (20m)		0.7	16.6		0.9	16.8		0.8	16.7		1.4	17.3
	Typical (50m)		0.5	16.4		0.5	16.4		0.4	16.3		0.9	16.8
5	Nearest (50m)		0.5	16.4		0.6	16.5		0.5	16.4		0.8	16.7
	Typical (50m)		0.5	16.4		0.6	16.5		0.5	16.4		0.8	16.7
6	Nearest (100m)	16.5	0.4	16.9	16.5	0.4	16.9	16.5	0.2	16.7	16.5	0.4	16.9
	Typical (>100m)		0.2	16.7		0.4	16.9		0.2	16.7		0.4	16.9
7	Nearest(>100m)		0.3	16.8		0.3	16.8		0.2	16.7		0.4	16.9
	Typical (>100m)		0.2	16.7		0.3	16.8		0.1	16.6		0.4	16.9
8	Nearest (50m)		0.4	16.9		0.5	17		0.4	16.9		0.7	17.2
	Typical (100m)		0.3	16.817		0.3	16.8		0.3	16.8		0.4	16.9

Table 6-4 Background, incremental and cumulative 24 hour-averaged $PM_{2.5}$ results vs 25 µg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	16.8	1.8	18.6	16.8	2.3	19.1	16.8	1.7	18.5	16.8	2.2	19
	Typical (>100m)		1.2	18		1.5	18.3		1.2	18		1.4	18.2
2	Nearest (20m)		2.2	19		2.6	19.4		2.3	19.1		3.8	20.6
	Typical (50m)		1.3	18.1		1.7	18.5		1.5	18.3		2.4	19.2
3	Nearest (20m)		2	18.8		2.5	19.3		2.3	19.1		3.5	20.3
	Typical (50m)		1.2	18		1.6	18.4		1.4	18.2		2.2	19
4	Nearest (20m)		1.9	18.7		2.2	19		2	18.8		3.3	20.1
	Typical (50m)		1.2	18		1.4	18.2		1.2	18		2.1	18.9
5	Nearest (50m)		1.2	18		1.4	18.2		1.2	18		2.2	19
	Typical (50m)		1.2	18		1.4	18.2		1.2	18		2.2	19
6	Nearest (100m)		0.8	17.6		0.8	17.6		0.5	17.3		1.1	17.9
	Typical (>100m)		0.5	17.3		0.8	17.6		0.3	17.1		0.9	17.7
7	Nearest(>100m)		0.7	17.5		0.7	17.5		0.4	17.2		1.1	17.9
	Typical (>100m)		0.4	17.2		0.7	17.5		0.3	17.1		1	17.8
8	Nearest (50m)		1.1	17.9		1.2	18		0.9	17.7		1.6	18.4
	Typical (100m)		0.7	17.5		0.8	17.6		0.6	17.4		1	17.8

Table 6-5 Background, incremental and cumulative annually-averaged $PM_{2.5}$ results vs 8 µg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	8.7	0.7	**9.4**	8.7	0.9	**9.6**	8.7	0.7	**9.4**	8.7	1.2	**9.9**
	Typical (>100m)		0.5	**9.2**		0.6	**9.3**		0.4	**9.1**		0.8	**9.5**
2	Nearest (20m)		0.8	**9.5**		1.1	**9.8**		0.9	**9.6**		1.5	**10.2**
	Typical (50m)		0.5	**9.2**		0.7	**9.4**		0.6	**9.3**		1	**9.7**
3	Nearest (20m)		0.8	**9.5**		1	**9.7**		0.9	**9.6**		1.4	**10.1**
	Typical (50m)		0.5	**9.2**		0.6	**9.3**		0.6	**9.3**		0.8	**9.5**
4	Nearest (20m)		0.7	**9.4**		0.9	**9.6**		0.8	**9.5**		1.4	**10.1**
	Typical (50m)		0.5	**9.2**		0.5	**9.2**		0.4	**9.1**		0.9	**9.6**
5	Nearest (50m)		0.5	**9.2**		0.6	**9.3**		0.5	**9.2**		0.8	**9.5**
	Typical (50m)		0.5	**9.2**		0.6	**9.3**		0.5	**9.2**		0.8	**9.5**
6	Nearest (100m)		0.4	**9.1**		0.4	**9.1**		0.2	**8.9**		0.4	**9.1**
	Typical (>100m)		0.2	**8.9**		0.4	**9.1**		0.2	**8.9**		0.4	**9.1**
7	Nearest(>100m)		0.3	**9**		0.3	**9**		0.2	**8.9**		0.4	**9.1**
	Typical (>100m)		0.2	**8.9**		0.3	**9**		0.1	**8.8**		0.4	**9.1**
8	Nearest (50m)		0.4	**9.1**		0.5	**9.2**		0.4	**9.1**		0.7	**9.4**
	Typical (100m)		0.3	**9**		0.3	**9**		0.3	**9**		0.4	**9.1**

Table 6-6 Background, incremental and cumulative 1 hour-averaged NO_2 results vs 246 µg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	68.4	8.3	76.7	68.4	10.6	79	68.4	6	74.4	68.4	10.4	78.8
	Typical(>100m)		5.6	74		7.2	75.6		4	72.4		7	75.4
2	Nearest (20m)		9	77.4		10.9	79.3		7.3	75.7		11.7	80.1
	Typical (50m)		5.5	73.9		6.8	75.2		4.5	72.9		7.4	75.8
3	Nearest (20m)		7.8	76.2		9.5	77.9		6.5	74.9		10.1	78.5
	Typical (50m)		4.8	73.2		5.9	74.3		4	72.4		6.3	74.7
4	Nearest (20m)		6.7	75.1		7.9	76.3		5.3	73.7		8.9	77.3
	Typical (50m)		4.1	72.5		4.9	73.3		3.2	71.6		5.6	74
5	Nearest (50m)		4.5	72.9		5.2	73.6		3.5	71.9		6.1	74.5
	Typical (50m)		4.5	72.9		5.2	73.6		3.5	71.9		6.1	74.5
6	Nearest (100m)	60.9	2.9	63.8	60.9	2.9	63.8	60.9	1.4	62.3	60.9	3.1	64
	Typical(>100m)		1.9	62.8		2.6	63.5		0.9	61.8		2.4	63.3
7	Nearest(>100m)		2.3	63.2		3	63.9		1.3	62.2		3.1	64
	Typical (>100m)		1.4	62.3		3	63.9		0.9	61.8		3.1	64
8	Nearest (50m)		3.8	64.7		4.5	65.4		2.5	63.4		4.2	65.1
	Typical (100m)		2.6	63.5		3.1	64		1.7	62.6		2.8	63.7

Table 6-7 Background, incremental and cumulative annually-averaged NO_2 results vs 62 µg/m^3 criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	9	1.6	10.6	9	2.1	11.1	9	1.2	10.2	9	2	11
	Typical (>100m)		0.9	9.9		1.5	10.5		0.8	9.8		1.4	10.4
2	Nearest (20m)		1.8	10.8		2.2	11.2		1.5	10.5		2.3	11.3
	Typical (50m)		1.1	10.1		1.3	10.3		0.9	9.9		1.5	10.5
3	Nearest (20m)		1.5	10.5		1.9	10.9		1.3	10.3		2	11
	Typical (50m)		1	10		1.1	10.1		0.8	9.8		1	10
4	Nearest (20m)		1.4	10.4		1.6	10.6		1	10		1.8	10.8
	Typical (50m)		0.8	9.8		0.9	9.9		0.6	9.6		1.1	10.1
5	Nearest (50m)		0.9	9.9		1.1	10.1		0.7	9.7		1.2	10.2
	Typical (50m)		0.9	9.9		1.1	10.1		0.7	9.7		1.2	10.2
6	Nearest (100m)	8.7	0.6	9.3	8.7	0.6	9.3	8.7	0.3	9	8.7	0.6	9.3
	Typical (>100m)		0.4	9.1		0.5	9.2		0.2	8.9		0.5	9.2
7	Nearest(>100m)		0.5	9.2		0.6	9.3		0.3	9		0.6	9.3
	Typical (>100m)		0.3	9		0.6	9.3		0.2	8.9		0.6	9.3
8	Nearest (50m)		0.7	9.4		0.9	9.6		0.5	9.2		0.9	9.6
	Typical (100m)		0.5	9.2		0.6	9.3		0.3	9		0.5	9.2

Table 6-8 Background, incremental and cumulative 1 hour-averaged CO results vs 30 mg/m3 criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	2.5	0.4	2.9	2.5	0.5	3	2.5	0.4	2.9	2.5	0.6	3.1
	Typical (>100m)		0.2	2.7		0.4	2.9		0.2	2.7		0.4	2.9
2	Nearest (20m)		0.3	2.8		0.4	2.9		0.4	2.9		0.6	3.1
	Typical (50m)		0.2	2.7		0.2	2.7		0.2	2.7		0.4	2.9
3	Nearest (20m)		0.2	2.7		0.3	2.8		0.2	2.7		0.4	2.9
	Typical (50m)		0.2	2.7		0.2	2.7		0.2	2.7		0.2	2.7
4	Nearest (20m)		0.2	2.7		0.2	2.7		0.2	2.7		0.2	2.7
	Typical (50m)		0.1	2.6		0.2	2.7		0.1	2.6		0.2	2.7
5	Nearest (50m)		0.1	2.6		0.2	2.7		0.2	2.7		0.2	2.7
	Typical (50m)		0.1	2.6		0.2	2.7		0.2	2.7		0.2	2.7
6	Nearest (100m)		0	2.5		0	2.5		0	2.5		0.2	2.7
	Typical (>100m)		0	2.5		0	2.5		0	2.5		0	2.5
7	Nearest (>100m)		0	2.5		0.1	2.6		0	2.5		0.2	2.7
	Typical (>100m)		0	2.5		0	2.5		0	2.5		0.2	2.7
8	Nearest (50m)		0	2.5		0.2	2.7		0.1	2.6		0.2	2.7
	Typical (100m)		0	2.5		0	2.5		0	2.5		0.2	2.7

Table 6-9 Background, incremental and cumulative 8 hour-averaged CO results vs 10 mg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)		0.3	2		0.4	2.1		0.2	1.9		0.4	2.1
	Typical (>100m)		0.2	1.9		0.2	1.9		0.2	1.9		0.3	2
2	Nearest (20m)		0.2	1.9		0.3	2		0.2	1.9		0.4	2.1
	Typical (50m)		0.2	1.9		0.2	1.9		0.2	1.9		0.2	1.9
3	Nearest (20m)		0.2	1.9		0.2	1.9		0.2	1.9		0.2	1.9
	Typical (50m)		0.1	1.8		0.2	1.9		0.1	1.8		0.2	1.9
4	Nearest (20m)		0.1	1.8		0.2	1.9		0.2	1.9		0.2	1.9
	Typical (50m)		0	1.7		0	1.7		0	1.7		0.2	1.9
5	Nearest (50m)	1.7	0	1.7	1.7	0.1	1.8	1.7	0	1.7	1.7	0.2	1.9
	Typical (50m)		0	1.7		0.1	1.8		0	1.7		0.2	1.9
6	Nearest (100m)		0	1.7		0	1.7		0	1.7		0	1.7
	Typical (>100m)		0	1.7		0	1.7		0	1.7		0	1.7
7	Nearest (>100m)		0	1.7		0	1.7		0	1.7		0.2	1.9
	Typical (>100m)		0	1.7		0	1.7		0	1.7		0.2	1.9
8	Nearest (50m)		0	1.7		0.1	1.8		0	1.7		0.2	1.9
	Typical (100m)		0	1.7		0	1.7		0	1.7		0	1.7

Table 6-10 Background, incremental and cumulative 1 hour-averaged VOC results vs 29 mg/m³ criterion

Segment	Receiver	Scenario 1 – Do minimum (2021)			Scenario 2 – Proposed upgrade (2021)			Scenario 3 – Do minimum (2031)			Scenario 4 – Proposed upgrade (2031)		
		Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative	Background	Road contribution	Cumulative
1	Nearest (50m)	2.6	0.2	2.8	2.6	0.2	2.8	2.6	0.2	2.8	2.6	0.2	2.8
	Typical (>100m)		0.2	2.8		0.2	2.8		0.2	2.8		0.2	2.8
2	Nearest (20m)		0.2	2.8		0.2	2.8		0.2	2.8		0.4	3
	Typical (50m)		0.2	2.8		0.2	2.8		0.2	2.8		0.2	2.8
3	Nearest (20m)		0.2	2.8		0.2	2.8		0.2	2.8		0.4	3
	Typical (50m)		0.2	2.8		0.2	2.8		0.2	2.8		0.2	2.8
4	Nearest (20m)		0.2	2.8		0.2	2.8		0.2	2.8		0.4	3
	Typical (50m)		0.1	2.7		0.2	2.8		0.2	2.8		0.2	2.8
5	Nearest (50m)		0.2	2.8		0.2	2.8		0.2	2.8		0.2	2.8
	Typical (50m)		0.2	2.8		0.2	2.8		0.2	2.8		0.2	2.8
6	Nearest (100m)		0	2.6		0	2.6		0	2.6		0.1	2.7
	Typical (>100m)		0	2.6		0	2.6		0	2.6		0	2.6
7	Nearest (>100m)		0	2.6		0	2.6		0	2.6		0	2.6
	Typical (>100m)		0	2.6		0	2.6		0	2.6		0	2.6
8	Nearest (50m)		0.1	2.7		0.2	2.8		0.1	2.7		0.2	2.8
	Typical (100m)		0	2.6		0	2.6		0	2.6		0.1	2.7

6.2.1 Discussion of operational results

Considering the predicted concentrations of exhaust emissions from the four scenarios in relation to the nearest and typical setback distances from the proposed upgrade alignment (refer to **Table 5-7**), the following conclusions have been made:

- Criteria for PM_{10}, NO_2, CO, VOCs and 24 hour-averaged $PM_{2.5}$ are expected to be met at surrounding nearby receivers for all four assessment scenarios, therefore the intent of each of the criteria in terms of managing health impacts to nearby receivers is expected to be achieved (refer to criteria in Section 4)
- The $PM_{2.5}$ annual criterion was predicted to be exceeded along each segment for each assessment scenario. This is a result of the adopted annual $PM_{2.5}$ background concentration (8.7 µg/m^3) already exceeding the 8 µg/m^3 criterion. However, comparisons between the predicted concentrations for the do minimum and proposed upgrade options were similar, indicating that the upgrade will not materially change annually averaged roadside $PM_{2.5}$ concentrations from conditions if the 'do minimum' option was to be implemented.

As such, for the year of opening (2021) and design year (2031) time frames assessed and based on the presently available data, the proposed upgrade is not expected to result in unacceptable concentrations at surrounding receivers. Noting this, impacts at a wider regional scale resulting from the project were also similarly assessed to be minimal.

6.2.2 Discussion of cumulative operational impacts

The Western Sydney Airport site is proposed to be developed at Badgerys Creek directly east of the proposed upgrade route between Adams Road, Luddenham and Badgerys Creek waterway. As presented in the *Western Sydney Airport Environmental Impact Statement Volume 4 Appendix F1 Local air quality and greenhouse gas,* (Pacific Environment Limited, 2016), emissions of pollutants to air from airport operations (most notably NO_2) are predicted to contribute to overall concentrations at surrounding nearby receivers. The potential for cumulative impacts between the roadway emissions and airport emissions is most likely to occur at a small number of receivers located along Adams Road, east of the proposed upgrade route. This is because of the prevailing wind conditions which are from the southwest. Contributions from The Northern Road would be minimal at these locations noting that they are more than 100m from the proposed alignment. Cumulative concentrations at these locations are therefore likely to be below the assessment criteria.

When winds blow from the southeast, which are generally uncommon but occur most frequently during summer, there is also the potential for short-term cumulative impacts at receivers located around Luddenham. As above, considering the distance to these receivers from the alignment of the proposed upgrade, contributions to overall concentrations at these locations would again be minimal, and resulting overall concentrations are likely to be below criteria.

There is also the potential for cumulative operational impacts associated with the other stages of The Northern Road upgrade. These impacts are expected to be minimal noting that the area of influence of operational air quality emissions is small, and that each stage is adjoining; mostly affecting different receivers.

7. Environmental management measures

7.1 Expected environmental outcomes

Project specific environmental safeguards and management measures identified in **Table 7-1** have been developed with the aim of minimising or mitigating, as far as practical, the potential air quality impacts described in this working paper.

Broadly the expected environmental outcomes of the environmental management measures are to:

- Minimise and manage potential air quality / dust impacts from the construction of the project
- Control dust and exhaust emissions of plant and equipment from construction activities
- Minimise adverse impacts on existing air quality
- Achieve particulate concentrations from construction activities that meet guideline values
- Ensure compliance with the relevant legislation requirements and conditions of approval
- Implement feasible and reasonable air quality control measures with the aim of constructing the project in a manner that minimises dust emissions from the site
- Minimise and manage any complaints from the community or stakeholders.

7.2 Expected effectiveness

Roads and Maritime have experience managing potential air quality impacts associated with the construction and operational phases of large-scale road development projects. As such, the environmental management measures outlined above are expected to be effective.

As noted above, it is expected that these recommendations, along with relevant requirements from project approvals, best practice guidelines and applicable legislation would be developed into CEMP and OEMP documents prepared to manage the relevant phases of the project. As like on other similar projects, it is expected that routine auditing of the effectiveness of the implementation of the CEMP and OEMP requirements would be routinely undertaken to ensure that management measures remain adequate and fit for purpose.

7.3 Safeguards and management measures

The following safeguards and management measures have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works which are described above in **Section 6**. These measures should be incorporated into relevant Construction Environmental Management Plans (CEMPs) during construction and Operational Environmental Management Plans (OEMPs) during operations.

Table 7-1 Recommended safeguards and management measures

Impact	Environmental safeguard	Responsibility	Timing
Excessive exhaust emissions arising from plant and equipment	Ensure that plant and equipment operates in a proper and efficient manner by: • Inspecting the plant/equipment prior to commencement of works on site. • Conduct routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.	Construction Contractor	Prior to and routinely during construction.
Dust generation and emissions arising from	• Installation of perimeter screening around compound sites.	Construction Contractor	During construction

Impact	Environmental safeguard	Responsibility	Timing
compound and stockpiling locations	• Impose low speeds limits around compound sites to limit the generation of dust from vehicle movements. • Apply wheel-wash or rumble grid facilities at access points to limit the tracking of materials beyond the site boundary. • Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation. • Regularly water stockpiles and limit the amount of materials stockpiled around the site. • Position stockpiling areas as far as possible from surrounding receivers. • Limit stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers. • Consultation will be carried out consistent with the draft Community Involvement Framework in relation to air quality near ancillary sites and relevant incident management process during construction.		
Dust generation and emissions arising from materials haulage	• Impose low speeds limits across all site haulage routes. • Ensure that all loads are covered when materials are being hauled to and from site. • Wherever possible, position internal haulage routes away from surrounding receivers.	Construction Contractor	During construction
Dust generation and emissions arising from earthwork, vegetation clearance, bridge and pavement construction activities.	• Regular watering of exposed and disturbed areas especially during inclement weather conditions. • Wherever possible, minimise the extent of disturbed and exposed surfaces, and restore as soon as possible. • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers. • Ensure that any material exposed areas are secured during project	Construction Contractor	During construction

Impact	Environmental safeguard	Responsibility	Timing
	shutdown periods to prevent any dust emanating over adjacent roads.		
Odours arising from uncovered contaminated and/or hazardous materials.	• Application of odour suppression agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.	Construction Contractor	During construction
Windborne dust emanating from non-vegetated surfaces	• Stage work to ensure that finished areas are revegetated as soon as possible. • Regularly maintain and water revegetation areas to aid the establishment of adequate vegetation cover.	Construction Contractor	During construction
Dust emissions emanating beyond the project area	• Install depositional dust gauges to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • These gauges should be installed at regular intervals along the project alignment at representative receiver locations. Gauges should also be installed around major construction compound and stockpiling locations.	Construction Contractor	During construction
Cumulative dust impacts arising from con-current construction of the proposed upgrade and the Western Sydney Airport	• Develop construction program in consultation with the contractor(s) developing the Western Sydney Airport site. Maintain consultation through the course of both projects to plan activities in a manner which limits potential air quality-related impacts. • Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time. • Stop activities if dust is observed to be emanating from the airport site which could affect receivers which may also be affected by activities associated with the project.	Construction Contractor, western Sydney airport Contractor(s)	Prior to and during construction
Roadside air quality during operations	• Post-construction traffic measurements should be collected to verify that traffic volumes and characteristics are not materially different from the forecast numbers considered in this assessment. • Where material differences are	Roads and Maritime Services	Post-construction

Impact	Environmental safeguard	Responsibility	Timing
	identified, further assessment should be completed to confirm that the level of impacts remain consistent with the predictions of this study.		

8. Residual impacts

8.1 Local scale

Residual impacts are the potential impacts which may remain even after the environmental management measures outlined above have been implemented. Residual impacts associated with key phases of construction are described in detail using the ‘residual risk rating’ metric above in **Table 6-1** and range from low to medium in magnitude at a local scale.

Regarding operations, since air quality impacts were predicted to be minor, and the project was not predicted to result in air quality concentrations exceeding relevant criteria at surrounding receivers (excepting $PM_{2.5}$ which is already exceeded as a result of elevated background levels), no specific environmental management measures were recommended beyond post-opening verification monitoring. Though the project is not expected to result in unacceptable air quality concentrations at surrounding receivers during operations, concentrations were predicted to marginally increase relative to the ‘Do minimum’ option. Relative concentrations would also increase markedly along the portion of the project which takes a new route from the existing road around Luddenham, which was previously mostly unaffected by road-related emissions.

8.2 Regional scale

Residual emissions to air during construction will be temporal and are unlikely to be of a magnitude which would be of significance at a regional scale.

Regarding operations; noting the low level of impacts generally predicted at a local scale, it is not expected that the project would result in any significant changes to regional air quality. Even in the instance of $PM_{2.5}$; though the project may further elevate concentrations above the annually averaged criterion of 8 µg/m^3 locally, this effect becomes comparable to the ‘do minimum’ option at around 200m from the alignment and as such would not result in any material changes at a regional scale.

The regional significance of emissions to air of greenhouse gases has been considered separately as part of the Greenhouse Gas and Climate Change Risk Assessment Technical Papers.

9. Conclusion

An assessment was completed to evaluate potential air quality impacts associated with the construction and operational phases of a proposed upgrade of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park.

To determine potential impacts to air quality during construction a qualitative, risk-based assessment was undertaken which identified that dust mitigation measures are required to limit the potential for dust impacts at a local scale during the following activities:

- Establishment and operation of construction compound sites and storage facilities
- Vegetation clearing, grubbing and removal
- Stripping, stockpiling and management of topsoil and unsuitable materials
- Bulk earthworks including placement and compaction of sub-base course and base course
- Road widening, realignment and intersection upgrade activities.

Residual local impacts during construction were not of an extent which would constitute a risk to regional air quality.

A variety of different mitigation and management measures were recommended including appropriate work practices and scheduling, consultation/co-ordination of works around the Western Sydney Airport site and other stages of The Northern Road upgrade to limit any localised cumulative impacts, equipment selection, monitoring and preventative controls; and residual ratings were calculated. 'Moderate' risk ratings remained for several phases of construction including those above, indicating that careful management of emissions to air will be required during these particular periods of construction.

Impacts to air quality at surrounding receivers as a result of the operation of the proposed upgrade were evaluated by quantitative modelling, using the TRAQ CALINE-based dispersion model. Predictions from this assessment indicate that for the timeframes assessed, any changes in local air quality at surrounding receivers will be small and within the existing range of air quality variations within the area. At a regional scale, impacts associated with operations were assessed to be of minimal significance.

Post-construction traffic monitoring was recommended to verify that traffic volumes and characteristics are not materially different from the forecast numbers assessed.

10. References

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