Advanced Environmental Dynamics

Specialist Consultants

Northshore Hamilton Urban Development Area

Air Quality Constraints Assessment and Update

Project # 951003

Prepared for:

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Executive Summary

This report presents the methodology and findings of an update of the Airshed Constraints Assessment of the Northshore Hamilton Urban Development Area (UDA) undertaken by Advanced Environmental Dynamics (AED) during 2012, on behalf of the (former) Urban Land Development Authority (now known as Economic Development Queensland (EDQ)). The 2012 study was updated in September 2014 to include the latest available industry-specific information in order to verify that the findings of the 2012 were representative of current air quality constraints within the local airshed.

In summary the 2014 re-assessment of air quality constraints associated with air emissions from industrial facilities within the UDA, has concluded that the findings of the original study are in general both current and robust. Capital improvements and the down-turn in the economy since undertaking the industry surveys in 2012, attributing to the conservatism of the conclusions drawn during the initial study.

Both the 2012 and 2014 study consisted of two primary components. The first component involved a series of site visits and the development of (updated) facility-specific emissions inventories for a number of local industries that were identified as potentially being associated with air emissions. A pollutant risk ranking exercise was conducted to determine those pollutants that were most likely to exceed the relevant health-related ambient air quality criteria. The second component of the study involved dispersion modelling of those facilities for which an emissions inventory had been developed during the first stage of the assessment with key pollutants identified by the risk assessment.

Air Quality Constraints Map

The findings of the first study combined with the learnings from the dispersion modelling have led to the development of an air quality constraints map for the Northshore Hamilton UDA (Figure A) subject to the building heights specified in Figure B.

Figure A: Air Quality Constraints Map for the Northshore Hamilton UDA.

Figure B: Proposed Number of Stories for Future Development within the NSH UDA.

It is additionally noted that the area in the northern portion of the UDA that contains the Puma Energy and BP bulk fuel storage facilities as well as the Kingsford Smith Drive Caltex service station is constrained by benzene (refer to the UDA properties indicated by the black square in Figure C). The air quality constraints map presented in Figure A is based on the inclusion of the Vic EPA criterion for the 3-minute average concentration for benzene. Although the Queensland EPP(Air) includes only an annual average objective for benzene, we have included the Vic EPA criterion in recognition of the uncertainties of the constraints assessment due to the limited information that is publically available for the BP bulk fuel storage facilities particularly with respect to peak concentrations of benzene on short-term averages. For comparison, an air quality constraints map is included as Figure C which is based on the Queensland EPP(Air) objective for the annual average concentration of benzene.

The relative level of conservatism in the predicted impacts of benzene in this portion of the UDA may be verified through the implementation of an ambient air monitoring program with the results of the ambient air monitoring program used to refine the constraints map in this area.

Figure C: Air Quality Constraints Map (Based on Qld EPP(Air) Objective for Benzene). The most affect UDA properties indicated by the black square.

Interpretation of the Air Quality Constraints Map

It is important to note that the blue shaded areas of Figure A and Figure C do not represent areas of 'acceptable' and/or 'unacceptable' air quality. Instead, the shaded areas highlight locations which may be constrained by potential impacts associated with the respective industry(ies), with the level of constraint increasing with decreasing distance to the industrial facility.

Thus, not all development activities are necessarily excluded from locations within the shaded areas. The nature and extent of acceptable activities and/or the level of additional mitigation that may need to be considered when designing the development will vary throughout the UDA. For example, locations within some constrained areas may not be ideally suited to a residential development or the development of day and/or aged care. However, shorter-term activities such as dog parks, recreational activities, vehicle parking, and/or an office complex with climate control may be suitable. It is advisable that each development application within the shaded areas should be considered on a case-by-case basis. Some guidance is provided in Section 3.2.7 and Table 9.

It is also important to note that although the Air Quality Constraints Assessment has considered the potential for amenity-related impacts (such as that due to odour), the focus of the assessment has been on the constraints associated with the potential for adverse human health-related impacts as assessed against ambient air quality objectives.

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Abbreviations

AED	Advanced Environmental Dynamics Pty Ltd
Air NEPM	National Environment Protection Measure for Ambient Air Quality
Air toxics NEPM	Air Toxics National Environment Protection Measure
AQ	Air quality
AQCA	Air quality constraints assessment
BCC	Brisbane City Council
BoM	Australian Bureau of Meteorology
CALMET	California Meteorological Model
CALPUFF	California Plume Dispersion Model
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Department of Environment and Heritage Protection
EDQ	Economic Development Queensland
EPA	Environmental Protection Agency
EPP(Air)	Environmental Protection (Air) Policy 2008
GLC	Ground level concentrations
NEPM	National Environment Protection Measure
NPI	National Pollutant Inventory
NPI EETM	National Pollutant Inventory Emissions Estimation Techniques Manual
NSH	Northshore Hamilton
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PAH	Polycyclic aromatic hydrocarbons
PM_{10}	Particulate matter less than 10 micrometres in diameter
$PM_{2.5}$	Particulate matter less than 2.5 micrometres in diameter
QLD	Queensland
SO_2	Sulphur dioxide
TAPM	The Air Pollution Model
TOC	Total organic compounds
TSP	Total suspend particulates
TVOC	Total volatile organic compounds

UDA	Urban development area
ULDA	Urban Land Development Authority
US EPA	United States Environmental Protection Agency
Vic	Victorian Government
VOC	Volatile organic compounds

Units

°C	Degrees Celsius
µg/m^3	Micrograms per cubic metre
m	Metres
m^3	Cubic metres
OU	Odour units

1. Introduction

In 2012, Advanced Environmental Dynamics Pty Ltd (AED) was commissioned by the Urban Land Development Authority (ULDA) to undertake an air quality constraints assessment (AQCA) of the Northshore Hamilton (NSH) Urban Development Area (UDA).

In August 2014, AED was commissioned by joint venture partners Alceon Group Pty Ltd (Alceon) and Economic Development Queensland (EDQ) to revisit the initial study and update the findings of the study (if required) in consideration of additional information that may have become available since the completion of the 2012 assessment.

This report provides a brief summary of the methodology and findings of the air quality constraints assessment and presents the updated constraints map for the Northshore Hamilton UDA.

The technical details of the assessments are included in the supporting appendices. The reader is directed to these appendices for additional information pertaining to the methodology and findings of the assessments.

Specifically, this report and supporting technical appendices summarises the findings of the two primary components of the (2012 and 2014) study:

- The first component involved a series of site visits and the development of facility-specific emissions inventories (where deemed necessary) for the thirteen local facilities that were identified in previous studies as potentially being associated with air emissions. This study also included undertaking an air pollutant risk ranking of emissions from each of the assessed facilities to determine in order of priority those identified pollutants that were most likely to exceed the relevant ambient air quality criteria.
- The second component involved dispersion modelling of those facilities for which an emissions inventory had been developed. The findings of the first component combined with the learnings from the dispersion modelling have led to the development of an air quality constraints map for the Northshore Hamilton UDA.

1.1 Changes to the 2012 Report based on the 2014 Findings

The 2014 update of the initial study undertaken by AED 2012 included the following:

- Site visits to:
  - Boral Whinstanes asphalt plant;
  - Boral Whinstanes concrete batching plant;
  - BCC Eagle Farm asphalt plant;
  - CP Plating;

  - GrainCorp (formerly Pacific terminals) wet bulk storage; and
  - Puma Energy (formerly Neumanns) bulk fuel storage facility. (Note that access to this facility was not able to be obtained during the 2012 study.)
- Updating of industry questionnaires developed in 2012.
- Updating of NPI information for:
  - Boral Whinstanes asphalt plant;
  - BCC Eagle Farm asphalt plant;
  - Puma Energy bulk fuel storage; and
  - BP bulk fuel storage.
- Updating the site-specific emissions inventories for:
  - Boral Whinstanes asphalt plant;
  - Boral Whinstanes concrete batching plant;
  - BCC Eagle Farm asphalt plant;
  - Puma Energy bulk fuel storage; and
  - BP bulk fuel storage.

  (Note that the differences between the 2012 and 2014 site-based emissions inventories are highlighted in the corresponding emissions table in the relevant technical appendix.)
- Updating the risk assessment for:
  - Boral Whinstanes asphalt plant;
  - BCC Eagle Farm asphalt plant;
  - Puma Energy bulk fuel storage; and
  - BP bulk fuel storage.
- Modelling or remodelling of emission sources associated with:
  - Boral Whinstanes asphalt plant;
  - Boral Whinstanes concrete batching plant;
  - BCC Eagle Farm asphalt plant; and
  - Puma Energy bulk fuel storage.
- Processing of facility results and/or cumulative results for all modelled facilities and all modelled pollutants.
- Reviewing the constraints map developed for the UDA.
- Updating this technical report and supporting appendices.

Note that the following were **not** updated as part of the 2014 review:

- Site-specific meteorology developed for the study region. The initial study considered 5 years of meteorology. This was considered sufficient for the purposes of this assessment.
- Estimates of background levels of pollutants. Background levels developed during the 2012 were considered sufficient for the purposes of this assessment.

1.2 Study Background

The Northshore Hamilton Urban Development Area (UDA) covers 304-hectares of land on the Brisbane River at Northshore Hamilton, located six kilometres from the Brisbane CBD (Figure 1). The Northshore Hamilton UDA includes the land between Kingsford Smith Drive and the Brisbane River, extending from Bretts Wharf in the west to the Gateway Motorway in the east. The Northshore Hamilton UDA is five kilometres from the Brisbane Airport.

As part of the Northshore Hamilton UDA Development Scheme (ULDA, 2009), the Northshore Hamilton area will be transformed from an industrial area to a vibrant riverside mixed-use community with the transition to more public-friendly and usable spaces.

Figure 1: Location of the Northshore Hamilton UDA relative to the Brisbane CBD and Brisbane Airport.

(Source: Google)

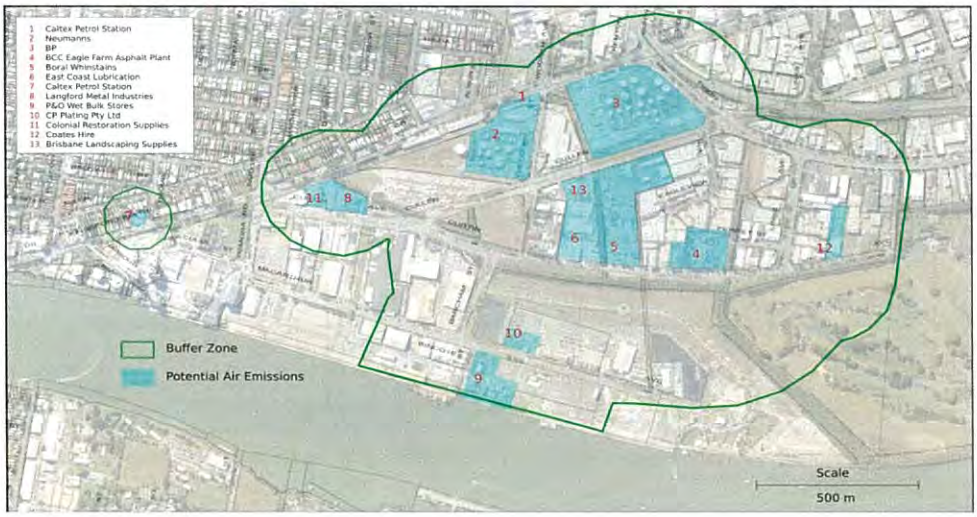
The Northshore Hamilton UDA is understood to have a complex history of industrial and commercial uses and is currently subject to a number of potential impacts arising from emissions of air pollutants both within the UDA and as a result of its locale within the broader urban environment. Previous studies (e.g. ASK (2006), ANE (2011)) had identified a total of thirteen local facilities that were considered to be potential sources of air pollutants. These included:

1. Caltex Station (Kingsford Smith Drive)
2. Puma Energy (formerly Neumann) bulk fuel storage facility
3. BP bulk fuel storage facility
4. BCC Eagle Farm
5. Boral Whinstanes
6. East Coast Lubrication
7. Caltex Station (Hercules Street)
8. Langford Metal Industries
9. Pacific Terminals wet bulk storage
10. CP Plating
11. Colonial Restoration Supplies
12. Coates Hire
13. Brisbane Landscaping Supplies

The ANE (2011) study based the development of buffer zones on regulatory guidelines for specific industries (Table 1). The final buffer zone for the Northshore Hamilton UDA excluded development in all areas within the green line indicated in (Figure 2). It is noted that the exclusion zone covers nearly the entirety of the Northshore Hamilton UDA.

Although these guidelines for buffer distances can be very helpful when developing potential separation distances between certain activities, they are general in nature and do not take into account site-specific information such as (for example) the nature and extent of air emissions controls that may be in use and the scale of the facility such as throughput, hours of operation, etc.

Figure 2: Previously Identified Air Emission Sources – Northshore Hamilton UDA.



(Source: ANE, 2011)

Table 1: Regulatory Buffer Zones and Those Previously Adopted for the NSH UDA (Adapted from ANE, 2011).

Number	Facility	Victorian EPA[1] (m)	WA EPA[2] (m)	SA EPA[3] (m)	UDA Buffer distance[4] (m)
1	Caltex Service Station Kingsford Smith Drive	-	50 (daytime/evening) 100 (24 hr)	-	100
2	Puma Energy Fuel Storage Facility	100 (floating) 300 (Fixed)	300-500 (fixed) 200-1000 (floating)	500	300
3	BP Fuel Storage Facility	100 (floating) 300 (Fixed)	300-500 (fixed) 200-1000 (floating)	500	300
4	BCC Eagle Farm Asphalt Plant	500 (bitumen batching plant)	1000 (asphalt)	1000	500
5a	Boral Whinstanes Asphalt Plant	500 (bitumen batching plant)	1000 (asphalt)	1000 (asphalt)	500
5b	Boral Whinstanes	100 (concrete batching plant)	300 – 500 (concrete)	200 (Concrete)	500

Number	Facility	Victorian EPA[1] (m)	WA EPA[2] (m)	SA EPA[3] (m)	UDA Buffer distance[4] (m)
	Concrete Batching Plant				
6	East Coast Lubrication	-	300 – 1000 (chemical production)	500 (chemical production)	300
7	Caltex Service station Hercules Street	-	50 (daytime/evening) 100 (24 hr)	-	100
8	Langford Metal Industries	500 (sheet metal products)	200	100 (surface coating < 10 kg powder/day)	200
9a	Pacific Terminals Wet Bulk Storage	-	-	300 (bulk shipping)	300
9b	P&O Dry Bulk Storage	-	-	300 (bulk shipping)	300
10	CP Plating	500 (sheet metal products)	500 (metal finishing), 200 (metal coating), 200-500 (boiler)	100 (chromium plating), 100 (surface coating < 10 kg powder/day)	200
11	Colonial Restoration Supplies	100 (joinery only)	100 – 300	100 (<4000 m^3/year)	150
12	Coates Hire	500 (printing and coating with heated oven)	200	100 – 300	200
13	Brisbane Landscape Supplies	-	100 (nurseries)	-	100

Notes:

(1) Victorian Environment Protection Agency, Recommended Buffer Distances for Industrial Residual Air Emissions, AQ 2/86, July 1990.

(2) Western Australia Environment Protection Authority, Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) Separation Distances between Industrial and Sensitive Land Uses , June 2005.

(3) South Australian Environment Protection Authority, Guidelines for Separation Distances, December 2007.

(4) Air Quality Assessment, Northshore Hamilton – Additional Advise, Tasks 2 and 3, Air Noise Environment Pty Ltd, 9th September 2011.

1.3 Study Motivation and Overview

In order to inform Alceon & EDQ as to the appropriateness (or otherwise) of the use of the adopted buffer zones, AED has undertaken an air quality constraints assessment which has included a series of site visits, a pollutant risk ranking assessment and dispersion modelling.

Information collected during the site visits combined with publically available information was used to develop estimates for the emissions inventories for a number of the facilities. These included (and are limited to):

- Caltex petrol station (Kingsford Smith Drive)
- Caltex petrol station (Hercules Street truck refuelling centre)
- BP bulk fuel storage;

- Puma Energy (formerly Neumann) bulk fuel storage;
- BCC Eagle Farm asphalt plant;
- Boral Whinstanes asphalt plant
- Boral Whinstanes concrete batching plant; and
- CP Plating Pty Ltd.

These facilities were then modelled using the dispersion model CALPUFF based on five years of hourly meteorology that was developed for the study area using a combination of the meteorological models The Air Pollution Model (TAPM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the US EPA approved CALMET (Section 2.4).

1.4 Study Limitations

In general, the accuracy of an air quality assessment relies heavily on the reliability and thoroughness of the information that is made available for the purposes of the study.

Unfortunately, in the case of a local or regional airshed study the facilities that are necessarily assessed are often reluctant to provide what is considered to be commercially sensitive information for use in the assessment. However such information is crucial when attempting to undertake detailed emissions calculations and accurate dispersion modelling.

The NSH UDA air quality constraints assessment has also relied heavily on publically available information combined with information obtained during the site visits and information that has been provided directly by the owners/operators of the facilities.

A detailed discussion of the nature and extent of the limitations of the study is presented in Appendix A. In summary, limitations of the Northshore Hamilton UDA air quality constraints assessment include those associated with (but may not be limited to):

- The accuracy, completeness and representativeness of data sets used as inputs into the assessment such as information provided by the client, third party information and information that is publically available.
- The estimation of emissions associated with the facilities based on publicly available information, information provided by the facilities and/or the use of emission factors.
- The dispersion modelling methodology and the use of numerical tools to simulate physical systems and the presentation of model results including the use of contour plots.

Due to the nature of the study undertaken, AED is unable to conduct a detailed assessment of the quality, accuracy, completeness or representativeness of the third party information that has been provided and/or collected for the purposes of this assessment. Should any of the information not be accurate, the conclusions of this study may be affected.

2. Air Quality Constraints Assessment Methodology

This section presents an overview of the methodology used to develop the air quality constraints map and includes a brief discussion of:

- The development of the facility-specific emissions inventories;
- The identification of relevant air quality criteria;
- The results of the pollutant risk ranking; and
- The pollutant dispersion modelling methodology.

Details of the assessment are presented in the supporting technical appendices.

2.1 Facility-Specific Pollutant Emission Inventories

Emission inventories for key pollutants were developed for the eight facilities and pollutants summarised in Table 2. The details of the development of the emissions inventories and the assumptions applied are presented in the supporting appendices and were based on a combination of (where available):

- Annual air emissions for the previous six years as reported to the National Pollutant Inventory (NPI);
- Conditions outlined in the site licences;
- Results from stack/point source emissions testing;
- Published emission factors (NPI EETM);
- Site-specific information provided by the owners/operators of the facilities; and
- Previous air quality assessments undertaken in the area.

Table 2: Facilities and Pollutants for which Emission Rates were Estimated.

Number	Facility Description	Pollutants	Sources of information
1	Caltex petrol station (Kingsford Smith Drive)	• Benzene • Toluene • Styrene	Site visit and Note (1)
2	Puma Energy bulk fuel storage	• Benzene • Cyclohexane • Ethanol • Ethylbenzene • n-Hexane • Isoproylbenzene (Cumene) • Lead • Toluene • Xylenes • Total volatile organic compounds	Site visit, site licence, NPI, information provided by Puma Energy.

Number	Facility Description	Pollutants	Sources of information
3	BP bulk fuel storage	• Benzene • Carbon monoxide • Cyclohexane • Ethanol • Ethylbenzene • n-Hexane • Isoproylbenzene (cumene) • Particulates as PM_{10} • Particulates as $PM_{2.5}$ • Styrene • Sulphur dioxide • Toluene • Xylenes • Total volatile organic compounds	Site licence, NPI
4	BCC Eagle Farm asphalt plant	• Arsenic • Benzene • Benzo(a)pyrene • Beryllium • Cadmium • Carbon monoxide • Chromium • Copper • Formaldehyde • N-hexane • Hydrogen sulphide • Lead • Manganese • Mercury • Nickel • Oxides of nitrogen • PAHs • Particulates as PM_{10} • Particulates as $PM_{2.5}$ • Sulphur dioxide • Sulphuric acid • Total suspended particulates • Total volatile organic compounds • Odour	Site licence, site visit, NPI, information provided by BCC, stack testing results, NPI EETM
5a	Boral Whinstanes asphalt plant	• Arsenic • Benzo(a)pyrene • Beryllium • Cadmium • Carbon monoxide • Chromium • Copper • Fluoride • Lead • Manganese • Mercury • Nickel • Oxides of nitrogen • PAHs • Particulates as PM_{10} • Particulates as $PM_{2.5}$ • Sulphur dioxide • Total suspended particulates • Total volatile organic compounds • Odour	Site licence, site visit, NPI, stack testing results, information provided by Boral, NPI EETM
5b	Boral Whinstanes concrete batching plant	• Particulates as PM_{10} • Particulates as $PM_{2.5}$	Site licence, site visit, NPI, information provided by Boral
7	Caltex petrol station (Hercules Street)	• Benzene • Toluene • Styrene	Site visit and Note (1)

Number	Facility Description	Pollutants	Sources of information
10	CP Plating	• Sulphuric acid • Zinc	Site visit, site licence, information provided by CP Plating.

Notes: (1): Vipac (2009), Hamilton Harbour Development - Air quality assessment, Document No. 70Q-09-0204-TRP-760016-2, 6 August 2009

2.2 Regulatory Criteria

The regulatory criteria used for the pollutant risk ranking against which results of the dispersion modelling have been compared are summarised in Table 3 and have been sourced from national and state legislation:

- Australian Government (2003): Ambient Air Quality National Environment Protection Measure (Ambient Air NEPM).
- Australian Government (2004): Air Toxics National Environment Protection Measure (Air Toxics NEPM).
- Queensland Government (2009): *Environmental Protection Act 1994 Environmental Protection (Air) Policy 2008*. Reprinted as in force on 1 January 2009.
- Queensland Government: *Guideline. Odour impact Assessment from Developments.*
- Victorian EPA (2001): *Victorian Government Gazette*, No. 240 Friday 21 December 2001.

(Note that although the following table includes health, amenity and vegetation-related criteria, this assessment has focused primarily on the demonstration of compliance or otherwise with health-related ambient air criteria.)

Table 3: Regulatory Standards, Goals and Objectives.

Pollutant	Averaging Period	Environmental Value	Value[(1)]	Unit	Source
Arsenic	3 minute	carcinogen	0.19	µg/m^3	Vic EPA
	annual	health	0.006	µg/m^3	Qld EPP(Air)
Benzene	3 minute	carcinogen	58	µg/m^3	Vic EPA
	annual	health	10	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Benzo(a)pyrene	3 minute	carcinogen	0.80	µg/m^3	Vic EPA
	annual	health	0.0003	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Beryllium	3 minute	carcinogen	0.01	µg/m^3	Vic EPA
Cadmium	3 minute	carcinogen	0.04	µg/m^3	Vic EPA
	annual	health	0.005	µg/m^3	Qld EPP(Air)
Carbon monoxide	1 hour	toxicity	31,250	µg/m^3	Vic EPA
	8 hour	health	11,250	µg/m^3	Qld EPP(Air) & Air NEPM
	8 hour	health	11,250	µg/m^3	Vic EPA
Chromium	3 minute	toxicity	19	µg/m^3	Vic EPA
	3 minute	carcinogen	0.19	µg/m^3	Vic EPA

Pollutant	Averaging Period	Environmental Value	Value[1]	Unit	Source
Copper	3 minute	toxicity	7.31	µg/m^3	Vic EPA
	3 minute	toxicity	36.02	µg/m^3	Vic EPA
Cyclohexane	3 minute	toxicity	38,203	µg/m^3	Vic EPA
Ethanol	3 minute	odour	4,148	µg/m^3	Vic EPA
	3 minute	toxicity	68,439	µg/m^3	Vic EPA
Ethylbenzene	3 minute	toxicity	15,827	µg/m^3	Vic EPA
Fluoride	24 hour	ecosystems (non-protected)	2.9	µg/m^3	Qld EPP(Air)
	24 hour	agriculture	1.5	µg/m^3	Qld EPP(Air)
	24 hour	bioaccumulation	3.17	µg/m^3	Vic EPA
	7 day	bioaccumulation	1.86	µg/m^3	Vic EPA
	30 day	ecosystems (non-protected)	0.84	µg/m^3	Qld EPP(Air)
	30 day	agriculture	0.4	µg/m^3	Qld EPP(Air)
	90 day	ecosystems (non-protected)	0.5	µg/m^3	Qld EPP(Air)
	90 day	ecosystems (protected)	0.1	µg/m^3	Qld EPP(Air)
	90 day	agriculture	0.25	µg/m^3	Qld EPP(Air)
	90 day	bioaccumulation	0.55	µg/m^3	Vic EPA
Hexane, n-	3 minute	toxicity	6,440	µg/m^3	Vic EPA
Hydrogen sulphide	3 minute	odour	0.15	µg/m^3	Vic EPA
	3 minute	toxicity	513	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	7.5	µg/m^3	Qld EPP(Air)
	24 hour	health	160	µg/m^3	Qld EPP(Air)
Isopropylbenzene (Cumene)	3 minute	odour	42.6	µg/m^3	Vic EPA
	3 minute	toxicity	8100	µg/m^3	Vic EPA
Lead	1 hour	toxicity	3.27	µg/m^3	Vic EPA
	annual	health	0.5	µg/m^3	Qld EPP(Air)
Magnesium	3 minute	toxicity	360	µg/m^3	Vic EPA
Manganese	3 minute	toxicity	36	µg/m^3	Vic EPA
	annual	health	0.16	µg/m^3	Qld EPP(Air)
Mercury	3 minute	bioaccumulation	0.36	µg/m^3	Vic EPA
	3 minute	bioaccumulation	3.60	µg/m^3	Vic EPA
Nickel	3 minute	carcinogen	0.36	µg/m^3	Vic EPA
	annual	health	0.02	µg/m^3	Qld EPP(Air)
Nitrogen oxides (as nitrogen dioxide)	1 hour	health	250	µg/m^3	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	207	µg/m^3	Vic EPA
	annual	health	62	µg/m^3	Qld EPP(Air) & Air NEPM
	annual	ecosystems	33	µg/m^3	Qld EPP(Air)
Odour	1-hour	amenity	2.5[2]	OU	Queensland DEHP
PM10	1 hour	toxicity	87	µg/m^3	Vic EPA
	24 hour	health	50[3]	µg/m^3	Qld EPP(Air) & Air NEPM
PM2.5	1 hour	toxicity	55	µg/m^3	Vic EPA
	24 hour	health	25	µg/m^3	Qld EPP(Air) & Air NEPM (advisory)

Pollutant	Averaging Period	Environmental Value	Value[(1)]	Unit	Source
	annual	health	8	µg/m^3	Qld EPP(Air)
Styrene	3 minute	odour	229	µg/m^3	Vic EPA
	3 minute	toxicity	7,608	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	75	µg/m^3	Qld EPP(Air)
	7 day	health	280	µg/m^3	Qld EPP(Air)
Sulphur Dioxide	1 hour	health	570	µg/m^3	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	485	µg/m^3	Vic EPA
	24 hour	health	172	µg/m^3	Qld EPP(Air) & Air NEPM
	annual	health	57	µg/m^3	Air NEPM
	annual	health	57	µg/m^3	Qld EPP(Air)
	annual	agriculture	31	µg/m^3	Qld EPP(Air)
	annual	ecosystems	21	µg/m^3	Qld EPP(Air)
Sulphuric Acid	3-minute	toxicity	36	µg/m^3	Vic EPA
Toluene	3 minute	odour	697	µg/m^3	Vic EPA
	3 minute	toxicity	13,120	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	1,066	µg/m^3	Qld EPP(Air)
	24 hour	health	4,100	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
	annual	health	410	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
TSP	3 minute	amenity	360	µg/m^3	Vic EPA
	annual	health	90	µg/m^3	Qld EPP(Air)
Xylenes (Total)	3 minute	odour	382	µg/m^3	Vic EPA
	3 minute	toxicity	12,443	µg/m^3	Vic EPA
	24 hour	health	1,200	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
	annual	health	950	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Zinc	3 minute	toxicity	36	µg/m^3	Vic EPA (zinc chloride fume)
	3 minute	toxicity	186	µg/m^3	Vic EPA (zinc oxide fume)

Notes:
(1): At 0°C.
(2): Based on the 99.5th percentile.
(3): Five exceedences per year allowed.

2.3 Pollutant Risk Ranking

Based on the results of a pollutant risk ranking exercise (presented in detail in the supporting appendices), the top three pollutants from each of the facilities for which emissions have been estimated are as summarised in Table 4.

Due to the different dilution potential of the various emission sources within each facility (e.g. stack versus fugitive sources) as well as between different facilities (e.g. stack sources compared to breathing of fuel storage tanks) a direct comparison of the relative risk between pollutant emissions from the various facilities is not able to be undertaken.

Table 4: Pollutant Risk Ranking by Facility and Source Type based on Health-related Criteria

Number	Facility	Rank 1	Rank 2	Rank 3
1	Caltex Service Station (Kingsford Smith Drive)	Benzene	Toluene	Styrene
2	Puma Energy fuel storage facility	Benzene	Lead	Toluene
3	BP fuel storage facility (fugitives)	Benzene	Toluene	Xylenes (Total)
3	BP fuel storage facility (boiler stack)	$PM_{2.5}$	SO_2	NO_x
4	BCC asphalt plant (fugitive)	NO_x	$PM_{2.5}$	PM_{10}
4	BCC asphalt plant (stack)	NO_x	$PM_{2.5}$	SO_2
5a	Boral asphalt facility (fugitive)	NO_x		
5a	Boral asphalt facility (stack)	$PM_{2.5}$	PM_{10}	TSP
5b	Boral concrete batching facility	$PM_{2.5}$	PM_{10}	-
7	Caltex Service Station (Hercules St)	Benzene	Toluene	Styrene
10	CP Plating	Sulphuric acid	Zinc	-

2.4 Dispersion Modelling

Based on the results of the pollutant risk ranking, dispersion modelling was undertaken for each of the following pollutants:

- Odour and hydrogen sulphide;
- TSP, PM_{10} and $PM_{2.5}$;
- Oxides of nitrogen and sulphur dioxide;
- Benzene and toluene;
- Lead and zinc;
- Sulphuric acid; and
- Benzo(a)pyrene

As noted in Section 1.1, pollutant dispersion modelling was undertaken using the regulatory approved model CALPUFF. A total of five years of meteorology was developed for the study region using a combination of the meteorological models TAPM and CALMET. The details of the development of the meteorology are presented in Appendix I. The details of the dispersion modelling and the assumptions that were applied are presented for each of the relevant facilities in the corresponding appendices.

In general, due to the relative uncertainty in the accuracy and reliability of available information, a conservative approach has been adopted. For example, due to lack of information relating to each of the individual storage tanks from the BP bulk fuel storage facilities, all pollutant emissions for this facility have been allocated to tanks that lie on the permitter of the facilities in order to obtain worst-case off-site impacts.

2.5 Cumulative Impact Assessment

The results of the dispersion modelling have been used to develop contour plots based on cumulative impacts of emissions from the modelled facilities for each of the pollutants noted in Section 2.4. Contour plots are presented in Appendix L.

Results of the cumulative assessment have identified particulate matter and benzene as the key pollutants that drive air quality constraints within the local airshed.

2.6 Assessment of Other Identified Facilities

A number of industrial facilities that had previously been identified (Section 1.1) as potentially being associated with emissions of air pollutants were not explicitly modelled. The approach used to assess air quality constraints associated with these facilities is summarised in Table 5.

For those facilities associated with spray painting and/or powder coating, a buffer zone of 75m or 100m was selected depending on the extent to which information pertaining to site-based air quality controls was available.

Table 5: Assessment Methodology for Facilities that were not Explicitly Modelled.

Number	Facility Description	Comments	Approach
6	East Coast Lubrication	Site visit conducted. Storage of closed containers only. Minimal risk of air emissions.	No air quality constraints were identified.
8	Langford Metal Industries	Site visit conducted. Powder coating considered to be main activity contributing to potential air quality constraints.	Insufficient information to quantify emissions. Buffer zone of 100 meters has been adopted.
9	Pacific Terminal wet bulk storage.	Site visit conducted. Some combustion of fuel on site for heating of stored materials to liquid state in preparation for transport. Odour was identified as the most likely air quality constraint though no odour issues were identified.	Based on the magnitude of the operations and the materials stored on site, no air quality constraints were identified.
10	CP Plating	Although emissions from the plating operations has been explicitly considered, insufficient information was provided in relation to the surface coating operations to quantify emissions from this activity.	Insufficient information to quantify emissions from metal coating operations thus for this activity. Based on the mitigation measures implemented on site and the location of the ventilation a buffer zone of 75 meters has been adopted.

Number	Facility Description	Comments	Approach
11	Colonial Restoration Supplies	Discussions were held with property owners but not directly with operators. The scale of the previous operations has been significantly reduced with operations currently occupying less than half of the original building size. Future plans for the facility are unknown. Adjacent to Langford Metals powder coating activities. No dust issues were identified. Wood dryer located at the southern boundary of the property adjacent to the driveway entrance.	Insufficient information to quantify emissions. Buffer zone of 100 meters has been adopted.
12	Coates Hire	Discussions were held with site manager. Welding is conducted on site. Spray painting is conducted on site and the spray painting booth is soon to be upgraded. Limited information provided.	Insufficient information to quantify emissions. Buffer zone of 100 meters has been adopted.
13	Brisbane Landscaping Supplies	Has relocated.	No air quality constraints identified.

2.7 Background Levels of Pollutants

In theory, background levels of pollutants are the concentrations that would occur in the absence of all anthropogenic emission sources. In practice, 'background' levels for air quality typically refer to the concentration of pollutants that would occur in the absence of any emission sources that are explicitly accounted for in the dispersion modelling.

Estimates of background levels are typically developed using ambient air monitoring data at locations that are considered to be representative of the background environment of the study area. In practice, the practicalities and limitations associated with the establishment of an ambient air monitoring stations means that they are rarely sited at optimal locations.

Additionally, although the Victorian EPA recommend the use of the 70th percentile as an estimate for the background level, in reality the actual background level will be spatially and temporally varying as the emission rate of pollutants from natural sources are often functions of a number of factors including for example, frequency of rain, wind speed, atmospheric stability etc.

In the absence of the local industrial facilities that are being considered explicitly in this assessment, the local air quality of Northshore Hamilton UDA is influenced by the larger

urban environment in which it is located and includes significant transport corridors such as Kingsford Smith Drive and the Gateway Motorway located to the east.

For this assessment, and with limitations in the data set as noted above, data from the Queensland Government's Wynnum and Springwood ambient air quality monitoring locations has been used to estimate background levels of particulate matter, sulphur dioxide, nitrogen dioxide, benzene and toluene. Adopted background levels are summarised in Table 6 . Monitoring data for other pollutants were not available.

These background levels were considered when developing the air quality constraints map presented in Section 3.1.

Table 6: Estimate of Background Levels (µg/m^3).

Pollutant	Averaging Period	Background Levels	Source
Benzene	3 minute	-	Springwood
	24 hour	5.5(1)	Springwood
	Annual	3.8(2)	Springwood
Nitrogen dioxide	1 hour	22.6(3)	Wynnum
	Annual	17.8(4)	Wynnum
$PM_{2.5}$	24 hour	6.0(6)	Wynnum
	Annual	5.7(7)	Wynnum
PM_{10}	24 hour	19.9(5)	Wynnum
Sulphur dioxide	1 hour	5.7(8)	Wynnum
	24 hour	5.4(9)	Wynnum
	Annual	4.8(10)	Wynnum
Toluene	3 minute	-	Springwood
	30 minute	-	Springwood
	24 hour	14.4(11)	Springwood
	Annual	7.0(12)	Springwood

Notes:

(1) Based on the 70th percentile of the monthly 24-hour maximums for 2011.
(2) Based on annual average for 2011.
(3) Based on the maximum 70th percentile of the 1-hour averages for 2008, 2009, 2010, 2011.
(4) Based on the maximum of annual average for 2008, 2009, 2010, 2011.
(5) Based on maximum 70th percentile of the 24-hour averages for 2005, 2006, 2007, 2008, 2009, 2010, 2011.
(6) Based on maximum 70th percentile of the 24-hour averages for 2009, 2010, 2011.
(7) Based on the maximum of annual average for 2009, 2010, 2011.
(8) Based on maximum 70th percentile of the 1-hour averages for 2008, 2009, 2010, 2011.
(9) Based on maximum 70th percentile of the 24-hour averages for 2008, 2009, 2010, 2011.
(10) Based on the maximum of annual average for 2008, 2009, 2010, 2011.
(11) Based on the 70th percentile of the monthly 24-hour maximums for 2011.
(12) Based on annual average for 2011.

3. Results of the Air Quality Constraints Assessment

The air quality constraints map that has been developed for the Northshore Hamilton UDA is presented in Section 3.1 and is followed by a series of discussions pertaining to its interpretation and limitations including:

- The relative conservatism of the applied air quality constraints assessment methodology;
- Other emission sources that may impact on local air quality;
- The interpretation of air quality constraints based on the adopted ambient air criteria;
- The robustness of the constraints map presented in Section 3.1; and
- Comments pertaining to land use and potential land use restrictions.

This chapter concludes with a number of recommendations based on the findings and learnings of the air quality constraints assessment.

3.1 The Northshore Hamilton UDA Air Quality Constraints Map

Presented in Figure 3 is the air quality constraints map for the Northshore Hamilton UDA that has been developed based on the air quality constraints assessment methodology outlined in Section 2 and supporting appendices.

Within each of the areas indicated by the blue shaded regions (or buffer zones), air quality objectives may not be met at all times. The large constrained area covering the northern section of the UDA is constrained by emissions of benzene from the Puma Energy fuel storage facility, the BP facility and the Caltex service station on Kingsford Smith Drive as assessed against Victorian EPA ambient air criteria for the 3-minute average concentration of benzene.

Figure 3: Air Quality Constraints Map for the Northshore Hamilton UDA.

3.1.1 Interpretation of the Air Quality Constraints Map

It is important to note that the blue shaded areas of Figure 3 do not represent areas of 'acceptable' and/or 'unacceptable' air quality. Instead, the shaded areas highlight locations within the UDA which may be constrained by potential impacts associated with the respective industry(ies) with the level of constraint increasing with decreasing distance to the industrial facility.

Thus, not all development activities are necessarily excluded from locations within the shaded areas. The nature and extent of acceptable activities and/or the level of additional mitigation that may need to be considered when designing the development will vary throughout the UDA. For example, locations within some constrained areas may not be ideally suited to a residential development or the development of day and/or aged care. However, shorter-term activities such as dog parks, recreational activities, vehicle parking, and/or an office complex with climate control may be suitable. It is advisable that each development application within the shaded areas should be considered on a case-by-case basis. Some guidance is provided in Section 3.2.7 and Table 9.

The relative level of conservatism in the predicted impacts associated with these shaded area may be verified through the implementation of an ambient air monitoring program with the results of the ambient air monitoring program used to refine the constraints map in the area of interest.

3.2 Discussion

3.2.1 Summary of Air Quality Constraints

Presented in Table 7 is a summary of the key drivers used to develop the air quality constraints map presented in Figure 3 for each facility for which a constraint or potential constraint has been identified.

Table 7: Summary of Air Quality Constraints and Key Drivers.

Number	Facility	Key Drivers for Buffer Zone	Comments
1, 2, 3	Caltex Service Station Kingsford Smith Drive, Puma Energy Fuel Storage Facility, BP Fuel Storage Facility	• Benzene • Vic EPA (3-minute average, toxicity)	• No significant air quality constraints north of Curtin Avenue based on compliance with Qld EPP(Air) objectives.
4, 5a	BCC Eagle Farm Asphalt Plant, Boral Whinstanes Asphalt Plant	• Potential for nuisance dust • Potential for odour.	• Based on a combination of results from the dispersion modelling, background levels, and information obtained during site visits. • Dust – medium risk

Number	Facility	Key Drivers for Buffer Zone	Comments
			• Odour – low risk
5b	Boral Whinstanes Concrete Batching Plant	• Potential for nuisance dust	• Based on background levels, and information obtained during site visits. • Dust – low risk
7	Caltex Service Station Hercules Street	• Benzene • Vic EPA (3-minute average, toxicity)	• No significant air quality constraints based on compliance with Qld EPP(Air) objectives.
8	Langford Metal Industries	• VOCs (spray painting/powder coating) • Particulates (spray painting/powder coating)	• Minimal information available. • Regulatory buffer zones used. • Based on the age of the facility, we recommend emissions testing be conducted if regulatory buffer zone is to be reviewed.
10	CP Plating	• Heavy metals (electroplating) • Sulphuric acid (electroplating) • VOCs (spray painting/powder coating) • Particulates (spray painting/powder coating)	• Good information was made available in relation to electroplating activities • Minimal information available in relation to powder coating/spray painting. • Regulatory buffer zones used for spray painting/powder coating. • Based on the age of the facility, we recommend emissions testing be undertaken if regulatory buffer zone is to be reviewed.
11	Colonial Restoration Supplies	• VOCs (wood heating)	• Minimal information available. • Adapted regulatory buffer zones. • Recommend emissions testing if regulatory buffer zone is to be reviewed.
12	Coates Hire	• VOCs (spray painting/powder coating) • Particulates (spray painting/powder coating)	• Minimal information available in relation to powder coating/spray painting. • Regulatory buffer zones used for spray painting/powder coating. • A new spray painting booth is to be installed. • Based on the age of the spray booth (if a new one is installed), an air quality assessment may have been undertaken in support of the DA application. Thus we recommend that site-specific information and/or licence conditions (if available) and/or modelling results from a recent study (if available) be obtained if regulatory buffer zone is to be reviewed.

3.2.2 Air Quality Constraints Assessment Methodology

Although there are a number of uncertainties associated with the accuracy and representativeness of the emissions inventories developed for the local industries, in general, we believe that a conservative approach has been adopted in order to provide confidence in the constraints map developed for the Northshore Hamilton UDA.

Generic buffer zones of 75 m or 100 m for spray painting/powder coating activities have taken into account site-specific information as was made available for this study. It is noted that none of the facilities that were not explicitly modelled, are required to report to the National Pollutant Inventory.

3.2.3 Other Local Emission Sources of Key Pollutants

Other potentially significant local emission sources that have not been explicitly modelled include the local road network (which is a source of oxides of nitrogen, particulates, benzene) and local road construction activities (which is a source of particulates). Vehicle traffic on both Kingsford Smith Drive as well as heavy vehicle traffic on Curtin Avenue will have an impact on local air quality. As the quality of the local road network improves, wheel generated dust from unpaved areas and the shoulders of trafficked areas within the UDA should be accompanied by a reduction in locally-generated nuisance dust.

3.2.4 Ambient Air Criteria

Criteria adopted in this assessment have considered both Federal and State legislation. In order to assess a wider range of air pollutants, ambient air criteria from both Queensland and Victoria have been considered.

Typically air quality assessments would incorporate ambient air quality criteria from other jurisdictions only for pollutants not included in the relevant State legislation. Of particular note to this study, the air quality constraints assessment has considered ambient air criteria for benzene as summarised in Table 8.

Table 8: Adopted Ambient Air Criteria for Benzene.

Pollutant	Averaging Period	Environmental Value	Value[(1)]	Unit	Source
Benzene	3 minute	carcinogen	58	$\mu g/m^3$	Vic EPA
	annual	health	10	$\mu g/m^3$	Qld EPP(Air) & Air Toxics NEPM

Notes:
(1): At 0°C.

As noted previously, the area in the northern portion of the UDA that contains the Puma Energy and BP bulk fuel storage facilities as well as the Kingsford Smith Drive Caltex service station is constrained by benzene. The air quality constraints map presented in Figure 3 is

based on the inclusion of the Vic EPA criterion for the 3-minute average concentration for benzene.

Although the Queensland EPP(Air) includes only an annual average objective for benzene, we have included the Vic EPA criterion in recognition of the uncertainties of the constraints assessment due to the limited information that is publically available for the BP bulk fuel storage facilities particularly with respect to peak concentrations of benzene on short-term averages.

For comparison, an air quality constraints map is included as Figure 4 which is based on the Queensland EPP(Air) objective for the annual average concentration of benzene and excludes the Vic EPA criterion for the 3-minute average.

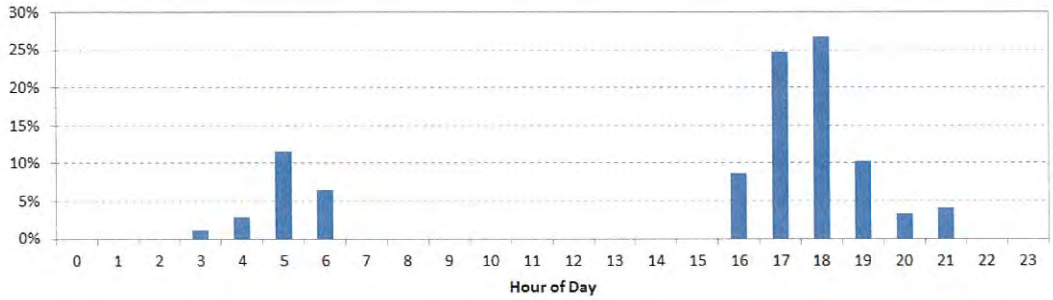
Figure 4: Air Quality Constraints Map (Based on Qld EPP(Air) Objective for Benzene).

Based on the results of the dispersion modelling, the Victorian EPA criterion for the 3-minute average ground-level concentration of benzene is predicted to be exceeded approximately 0.55% of the time or approximately 48 hours per year at a location representative of the UDA development area to the north of Curtin Avenue (grey area, Figure 5). Presented in Figure 6 is a plot of the fraction of those exceedences that are predicted to occur as a function of the hour of the day. These results highlight the early morning and the early evening as the highest-risk time of day when combined with worst-case meteorology. No exceedences are predicted between 07:00 and 15:59.

Figure 5: Development Areas North of Curtin Avenue.

(Source: Adapted from information provided by the ULDA)

Figure 6: Hour of Day When Exceedences of the Vic EPA 3-Minute Criterion for Benzene are Predicted to Occur within the grey areas of Figure 5.



3.2.5 Air Quality Constraints associated with Building Heights for New Developments

Due to the elevated emission sources associated with BP fuel storage facility, BCC asphalt plant and Boral asphalt plant, AED has undertaken a comparison of ambient air criteria and predicted pollutant concentrations at ground level (i.e. at a height of 1.5 m), and at 3 meter intervals to a height of 37.5 m (which approximately corresponds to a twelve story building). This assessment of the variation in pollutant concentration with height was undertaken in order to assess any potential building height constraints on future development as a result of air quality.

Based on the results of the dispersion modelling and the number of stories for future development depicted in Figure 7, no additional air quality constraints were identified. Thus the air quality constraints map presented in Section 3.1 is applicable for building development in accordance with the number of stories specified in Figure 7.

Figure 7: Proposed Number of Stories for Future Development within the NSH UDA.

(Source: Adapted from information provided by the ULDA)

3.2.6 Robustness of the Air Quality Constraints Map

AED understands that Alceon's current focus for development in the near future is on the portion of the UDA that is located south of Curtin Avenue and bounded by the Brisbane River.

The absence of significant air emission sources in the southern portion of the UDA combined with the detailed information relating to activities at the Pacific Terminals wet bulk storage facility, CP Plating, BCC asphalt plant, as well as the Boral Whinstanes asphalt and concrete batching facility, has provided confidence in the findings of the air quality constraints assessment that specifically relates to this section of the UDA.

For reasons outlined in previous sections, there is less certainty around the relative conservatism of the constraints mapping to the north of Curtin Avenue. Although site-specific information was available for the Puma Energy facility, detailed site-specific information for the BP fuel facility would be required if the relative conservatism of the constraints mapping in this part of the UDA is to be quantified further.

3.2.7 Comments in Relation to Land Use and Land Use Restrictions

The following comments are noted (in no particular order):

- To minimise the risk of adverse health impacts due to the exposure of sensitive members of the public to elevated levels of pollutants (that may still meet regulatory requirements), we would advise against the development of day care and/or aged care facilities to the north of Curtin Avenue until such time as the magnitude and frequency of potentially elevated levels of benzene from the storage facility and particulates from vehicle traffic on Kingsford Smith Drive has been quantified (for example by direct measurement of ambient air quality levels), or as per the requirement of the regulating authorities.
- South of Curtin Avenue, we conservatively recommend that day care and/or aged care facilities not be located within 200 m of the BCC asphalt plant, Boral Whinstanes facility, CP Plating or as per the requirement of the regulating authorities.
- We conservatively advise that within Precinct 8A, future eating facilities be located facing the southern portion of the precinct (i.e. facing Macarthur Avenue as opposed to the Mangroves) in order to minimise the risk of odour or nuisance dust impacts from the asphalt facilities.
- It has also been noted that impacts from wheel generated dust from traffic along Curtin Avenue has not been explicitly assessed. We understand that improvements to road infrastructure will occur as time progresses. It is further highlighted that nuisance dust may occur within Precinct 8A as a result of wheel-generated dust and wind-blown dust from exposed areas along Curtin Avenue until such time as this stretch of roadway is upgraded and off-road parking on the southern side of Curtin Avenue is restricted to

sealed areas only. Until such time as this occurs, limiting out-door eating areas to facing the southern portion of Precinct 8A will also reduce the potential for nuisance dust impacts.

- It is noted that the constraints map presented in Section 3.1 is considered applicable subject to the building height limitations presented in Section 3.2.5.

Presented in Table 9 is a summary of the proposed land uses and/or land use restrictions associated with each of the buffer zones identified in Table 7.

Note that the recommended land uses are illustrative and may not be exhaustive.

Table 9: Summary of Potential Land Uses.

Number	Facility	Potential Land Uses within the UDA	Comments and/or Potential Restrictions[1]
1, 2, 3	Caltex Service Station Kingsford Smith Drive, Puma Energy Fuel Storage Facility, BP Fuel Storage Facility	North of Curtin Avenue: • Offices with fixed windows and air conditioning. • Eating areas. • Parkland areas with limited seating. • Dog Park. • Parking areas. South of Curtin Avenue • Unrestricted [1],[2]	Potential restrictions for areas north of Curtin Avenue (Figure 5) if Vic EPA criterion is to be complied with: e.g. • Eating areas to be restricted to indoor only or outdoor during the daytime only. • No lighting of dog park. Note that the aim of the proposed additional constraints is to discourage outdoor activities during highest risk times of day until such time as ambient air monitoring has been able to quantify the relative conservatism of the dispersion modelling.
4, 5a, 5b	BCC Eagle Farm Asphalt Plant, Boral Whinstanes Asphalt Plant, Boral Whinstanes Concrete Batching Plant	Within buffer zone: • Industry uses that are not adversely impacted by dust. • Offices with fixed windows and air conditioning.	Outside buffer zones: • Within Precinct 8A outdoor eating areas be oriented facing Macarthur Avenue to maximise distance to facilities. • Else unrestricted [1],[2]
7	Caltex Service station Hercules Street	• Unrestricted [1],[2]	
8	Langford Metal Industries	Within buffer zone: • Industrial uses that do not rely on natural ventilation and have limited prolonged outdoor activity. Outside Buffer zone: • Unrestricted [1],[2]	Due to the age of the facility and the scale of operations, it is recommended that a reduction in the proposed buffer zone associated with spray painting/powder coating activities requires emissions testing.

Number	Facility	Potential Land Uses within the UDA	Comments and/or Potential Restrictions[1]
10	CP Plating	Within buffer zone: • Industrial uses that do not rely on natural ventilation and have limited prolonged outdoor activity. Outside Buffer zone: • Unrestricted [1],[2]	Due to the age of the facility, it is recommended that a reduction in the proposed buffer zone associated with spray painting/powder coating activities requires emissions testing.
11	Colonial Restoration Supplies	Within buffer zone: • Industrial uses that do not rely on natural ventilation and have limited prolonged outdoor activity. Outside Buffer zone: • Unrestricted [1],[2]	Due to the age of the facility and the uncertainty associated with the scale of activities, it is recommended that a reduction in the proposed buffer zone associated with wood drying activities requires emissions testing.
12	Coates Hire	Within buffer zone: • Industrial uses that do not rely on natural ventilation and have limited prolonged outdoor activity. Outside Buffer zone: • Unrestricted [1],[2]	Due to the uncertainty pertaining to the scale of operations, it is recommended that a reduction in the proposed buffer zone associated with spray painting/powder coating activities requires consideration of additional site-specific information.

Notes:

(1) Day care/aged care be restricted to a distance not less than 200 m from all identified facilities or as per regulatory requirements.

(2) Based on building height restrictions as indicated in Section 3.2.5.

3.3 Additional Recommendations

Based on the findings of the air quality constraints assessment, AED recommends that consideration be given to the following:

- As noted in Section 3.2.4, a wider range of ambient air criteria has been used for this assessment than is typically applied for an air quality assessment in Queensland with both Queensland EPP(Air) and Victorian EPA criteria considered for the same pollutant. As the constraints indicated in the northern section of the UDA are driven by the Victorian EPA criteria for the 3-minute average ground level concentration of benzene, these constraints are conservative when compared with those indicated by Queensland EPP(Air) criteria in isolation. Should a refinement of the constraints map in the northern portion of the UDA be considered, the relative level of conservatism may be verified

through the implementation of an ambient air monitoring program with the results of the ambient air monitoring program used to refine the constraints map in this area.

- More detailed consideration should also be given to the impact of vehicle emissions from Kingsford Smith if future development is proposed adjacent to this roadway.

4. Summary

AED has undertaken an air quality constraints assessment of the Northshore Hamilton UDA on behalf of Alceon and Economic Development Queensland (EDQ, formerly the Urban Land Development Authority).

The study has considered the impact on air quality of the emission of a total of 28 pollutants (plus odour) from 13 local industrial facilities.

An air quality constraints map has been developed based on:

- Comparison of the results from pollutant dispersion modelling with health-related ambient air quality criteria;
- Estimates of background levels of some pollutants based on monitoring data; and
- The consideration of industry-related regulator prescribed buffer zones.

The predicted air quality constraints potentially limit permanent development north of Curtin Avenue until such time as additional information can be obtained showing that the current assessment is overly conservative in this part of the UDA. The relative level of conservatism in the predicted impacts in this area may be verified through the implementation of an ambient air monitoring program with the results used to refine the constraints map in this area.

To the south of Curtin Avenue, air quality constraints are limited to small areas (of approximately 100 m radius) around a limited number of facilities.

The air quality constraints map is considered conservative and is limited to the building height restrictions provided by the ULDA in 2012.

Note that due to the nature of the study undertaken, AED is unable to conduct a detailed assessment of the quality, accuracy, completeness or representativeness of the third party information that has been provided and/or collected for the purposes of this assessment. Should any of the information not be accurate, the conclusions of this study may be affected.

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APPENDICES

Contents

Tables

Figures

Abbreviations

AED	Advanced Environmental Dynamics Pty Ltd
AERMET	American Meteorological Society/Environmental Protection Agency Regulatory Model Meteorological Pre-processor
Air NEPM	National Environment Protection Measure for Ambient Air Quality
Air toxics NEPM	Air Toxics National Environment Protection Measure
AQ	Air quality
AQCA	Air quality constraints assessment
B(a)P	Benzo(a)pyrene
BCC	Brisbane City Council
BoM	Australian Bureau of Meteorology
BP	British Petroleum Plc
CALMET	California Meteorological Model
CALPUFF	California Plume Dispersion Model
CO	Carbon monoxide
CP Plating	C.P. Plating Pty Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Department of Environment and Heritage Protection
EPA	Environmental Protection Agency
EPP(Air)	Environmental Protection (Air) Policy 2008
GLC	Ground level concentrations
GMT	Greenwich Mean Time
NEPM	National Environment Protection Measure
NOAA	National Oceanic and Atmospheric Administration
NPI	National Pollutant Inventory
NPI EETM	National Pollutant Inventory Emissions Estimation Techniques Manual
NSH	Northshore Hamilton
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
P&O	The Peninsular and Oriental Steam Navigation Company
PAH	Polycyclic aromatic hydrocarbons
PM_{10}	Particulate matter less than 10 micrometres in diameter
$PM_{2.5}$	Particulate matter less than 2.5 micrometres in diameter
QLD	Queensland
SO_2	Sulphur dioxide

SRTM	Shuttle Radar Topography Mission
TOC	Total organic compounds
TSP	Total suspend particulates
TAPM	The Air Pollution Model
UDA	Urban development area
ULDA	Urban Land Development Authority
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
Vic	Victorian Government
Vic EPA	Victorian Government Environment Protection Authority
VOC	Volatile organic compounds

Units

%	Percentage
°C	Degrees Celsius
µg/m^3	Micrograms per cubic metre
g/s	Grams per second
kg	Kilogram
l	Litre
m	Metres
m3	Cubic metres
mg/s	Milligrams per second
OU	Odour units

Appendix A Assessment Limitations

This section outlines the limitations associated with the air quality constraints assessment. These include limitations associated with:

- The data sets used as inputs into the assessment such as information provided by the client, third party information and information that is publically available.
- The estimation of emissions associated with the each of the facilities.
- The modelling methodology and the use of numerical tools to simulate physical systems.
- The presentation of results including the use of contour plots.

A.1.1 Limitations Associated with the Information used as Inputs into the Assessment

Limitations associated with information used as inputs into this air quality constraints assessment include (but may not be limited to) the following:

a) The completeness, accuracy and representativeness of information pertaining to the individual facilities:

- Detailed site-specific information was not available for the following facility:
  - BP bulk fuel storage.
- Limited information was available for the following facilities:
  - Caltex service station (Kingsford Smith Drive);
  - Caltex service station (Hercules Street);
  - Langford Metals;
  - Coates Hire;
  - East Coast Lubrication; and
  - P&O Dry Storage.
- Detailed site-specific information was available for the following facilities:
  - Puma Energy bulk fuel storage;
  - BCC asphalt plant;
  - Boral asphalt plant
  - Boral concrete batching facility;
  - CP Plating; and
  - Pacific Terminal wet bulk storage.

b) Publically available information including:

- NPI annual emissions reporting;
- NPI Emissions Estimation Techniques Manuals;
- Licence conditions; and
- Reports outlining air quality assessments undertaken by other consultancies.

c) Information provided by the Client.

d) The accuracy and representativeness of third-party supplied data sets used in the development of the meteorological wind fields including (but not limited to):

- Land use data from the default TAPM V4.0.5 database which consists of Australian vegetation and soil type data on a longitude/latitude grid at 3-minute grid spacing (approximately 5 km) provided by CSIRO Wildlife and Ecology;
- Terrain data from the default TAPM V4.0.5 database which is derived from Australian terrain height data on a longitude/latitude grid at 9-second grid spacing (approximately 0.3 km) from Geoscience Australia;
- Terrain data for CALMET (Scire, 2000a) from the Shuttle Radar Topography Mission (SRTM) dataset at 3 arc second downloaded from TRC website (SRTM, 2000);
- Regulatory supplied meteorological data.

A.1.2 Limitations Associated with the Emissions Estimation

Uncertainty in the estimated emissions inventories arise from limitations which include (but may not be limited to):

a) The use of emission factor formulas which are based on a limited number of samples at facilities for which representativeness in relation to the facilities considered in this study is not able to be assessed.

b) The lack of site-specific data for a number of the facilities as outlined in Section A.1.1.

A.1.3 Limitations Associated with the Modelling Methodology

With respect to the modelling methodology the following limitations are noted:

a) The use of numerical models to represent a physical system requires that the set of governing equations be approximated by a set of discrete equations which is then solved using numerical algorithms. In general, the more complicated the physical system, the more approximations are required in order to solve the system using numerical techniques. These approximations or parameterisations include for example, the representation of sub-grid scale physical processes. Inevitably there is a trade-off between computational speed and the numerical grid size which governs the resolution of

the model output. Each dispersion model will represent and/or approximate physical processes differently with often a range of technical options available to the user perhaps even for the same physical process. As the use of different parameterisations may lead to significantly different results, it is important that careful consideration be given to the sensitivity of the results to the technical options and/or inputs chosen.

b) In general, when conducting an air quality assessment a conservative methodology is adopted where inputs are biased towards the higher end of the anticipated range of values. This approach has evolved in part due to the uncertainties associated with the representativeness of the model inputs and in part due to the difficulties in verifying the accuracy of the model output. In general, if the results of the assessment based on a conservative approach do not highlight the potential for significant adverse impacts from a given project, then the requirement to refine the level of conservatism that has been adopted may not be warranted. However, should potential issues be suggested, a review and refinement of the conservative assumptions that have been incorporated in the assessment should be considered. Following the changes in the EPP(Air) that came into enforcement on 1 January 2009, there has been an increasing pressure on those undertaking air quality assessments to reduce the level of conservatism that is incorporated into the modelling methodology, this must be balanced however by the level of uncertainty and the representativeness of the model inputs on timescales as suggested by the relevant ambient air quality objectives.

c) Although very important, model validation and/or calibration is rarely undertaken due to the complexity of the physical system that is being modelled as well as the timeframes and costs associated with the collection of data at a temporal and spatial resolution required to undertake a statistically meaningful study. Thus at best, the model output should be used as a guide to highlight potential air quality issues, provide valuable input into the development of ambient air monitoring programs, and to highlight to the proponent the level of mitigation that may be required in order to protect environmental values.

A.1.4 Limitations Associated with the Presentation of Results

The presentation of results using contour plots necessarily involves the interpolation of the model output onto a grid for the purposes of visualisation. The uncertainty in the location of the contours presented is a function of the resolution of the presentation grid.

The reader is thus advised that there will be some inherent uncertainty in the boundary of the buffer zones developed due to model accuracies and grid resolution.

Appendix B Summary of Pollutants & Criteria Considered as Part of the Air Quality Constraints Assessment

B.1 Pollutants

Presented in the following table are the emission sources considered as part of the air quality constraints assessment.

Table 1: Pollutants Considered in the Air Quality Constraints Assessment.

Pollutants	Pollutants
Arsenic	Magnesium
Benzene	Manganese
Benzo(a)pyrene	Mercury
Beryllium	Nickel
Cadmium	Nitrogen oxides (as nitrogen dioxide)
Carbon monoxide	Odour
Chromium	PM10
Copper	PM2.5
Cyclohexane	Styrene
Ethanol	Sulphur Dioxide
Ethylbenzene	Sulphuric Acid
Fluoride	Toluene
Hexane, n-	TSP
Hydrogen sulphide	Total volatile organic compounds
Isopropylbenzene (cumene)	Xylenes (Total)
Lead	Zinc

B.2 Regulatory Criteria

The regulatory criteria used for the pollutant risk ranking against which results of the dispersion modelling have been compared are summarised in Table 2 and have been sourced from national and state legislation:

- Australian Government (2003): Ambient Air Quality National Environment Protection Measure (Ambient Air NEPM).
- Australian Government (2004): Air Toxics National Environment Protection Measure (Air Toxics NEPM).
- Queensland Government (2009): *Environmental Protection Act 1994 Environmental Protection (Air) Policy 2008*. Reprinted as in force on 1 January 2009.
- Queensland Government: *Guideline. Odour impact Assessment from Developments.*

- Victorian EPA (2001): *Victorian Government Gazette*, No. 240 Friday 21 December 2001.

Table 2: Regulatory Standards, Goals and Objectives.

Pollutant	Averaging Period	Environmental Value	Value[1]	Unit	Source
Arsenic	3 minute	carcinogen	0.19	µg/m^3	Vic EPA
	annual	health	0.006	µg/m^3	Qld EPP(Air)
Benzene	3 minute	carcinogen	58	µg/m^3	Vic EPA
	annual	health	10	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Benzo(a)pyrene	3 minute	carcinogen	0.80	µg/m^3	Vic EPA
	annual	health	0.0003	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Beryllium	3 minute	carcinogen	0.01	µg/m^3	Vic EPA
Cadmium	3 minute	carcinogen	0.04	µg/m^3	Vic EPA
	annual	health	0.005	µg/m^3	Qld EPP(Air)
Carbon monoxide	1 hour	toxicity	31,250	µg/m^3	Vic EPA
	8 hour	health	11,250	µg/m^3	Qld EPP(Air) & Air NEPM
	8 hour	health	11,250	µg/m^3	Vic EPA
Chromium	3 minute	toxicity	19	µg/m^3	Vic EPA
	3 minute	carcinogen	0.19	µg/m^3	Vic EPA
Copper	3 minute	toxicity	7.31	µg/m^3	Vic EPA
	3 minute	toxicity	36.02	µg/m^3	Vic EPA
Cyclohexane	3 minute	toxicity	38,203	µg/m^3	Vic EPA
Ethanol	3 minute	odour	4,148	µg/m^3	Vic EPA
	3 minute	toxicity	68,439	µg/m^3	Vic EPA
Ethylbenzene	3 minute	toxicity	15,827	µg/m^3	Vic EPA
Fluoride	24 hour	ecosystems (non-protected)	2.9	µg/m^3	Qld EPP(Air)
	24 hour	agriculture	1.5	µg/m^3	Qld EPP(Air)
	24 hour	bioaccumulation	3.17	µg/m^3	Vic EPA
	7 day	bioaccumulation	1.86	µg/m^3	Vic EPA
	30 day	ecosystems (non-protected)	0.84	µg/m^3	Qld EPP(Air)
	30 day	agriculture	0.4	µg/m^3	Qld EPP(Air)

Pollutant	Averaging Period	Environmental Value	Value[1]	Unit	Source
	90 day	ecosystems (non-protected)	0.5	µg/m^3	Qld EPP(Air)
	90 day	ecosystems (protected)	0.1	µg/m^3	Qld EPP(Air)
	90 day	agriculture	0.25	µg/m^3	Qld EPP(Air)
	90 day	bioaccumulation	0.55	µg/m^3	Vic EPA
Hexane, n-	3 minute	toxicity	6,440	µg/m^3	Vic EPA
Hydrogen sulphide	3 minute	odour	0.15	µg/m^3	Vic EPA
	3 minute	toxicity	513	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	7.5	µg/m^3	Qld EPP(Air)
	24 hour	health	160	µg/m^3	Qld EPP(Air)
Isopropylbenzene (Cumene)	3 minute	odour	42.6	µg/m^3	Vic EPA
	3 minute	toxicity	8100	µg/m^3	Vic EPA
Lead	1 hour	toxicity	3.27	µg/m^3	Vic EPA
	annual	health	0.5	µg/m^3	Qld EPP(Air)
Magnesium	3 minute	toxicity	360	µg/m^3	Vic EPA
Manganese	3 minute	toxicity	36	µg/m^3	Vic EPA
	annual	health	0.16	µg/m^3	Qld EPP(Air)
Mercury	3 minute	bioaccumulation	0.36	µg/m^3	Vic EPA
	3 minute	bioaccumulation	3.60	µg/m^3	Vic EPA
Nickel	3 minute	carcinogen	0.36	µg/m^3	Vic EPA
	annual	health	0.02	µg/m^3	Qld EPP(Air)
Nitrogen oxides (as nitrogen dioxide)	1 hour	health	250	µg/m^3	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	207	µg/m^3	Vic EPA
	annual	health	62	µg/m^3	Qld EPP(Air) & Air NEPM
	annual	ecosystems	33	µg/m^3	Qld EPP(Air)
Odour	1-hour	amenity	2.5[2]	OU	Queensland DEHP
PM10	1 hour	toxicity	87	µg/m^3	Vic EPA
	24 hour	health	50[3]	µg/m^3	Qld EPP(Air) & Air NEPM
PM2.5	1 hour	toxicity	55	µg/m^3	Vic EPA
	24 hour	health	25	µg/m^3	Qld EPP(Air) & Air NEPM (advisory)
	annual	health	8	µg/m^3	Qld EPP(Air)
Styrene	3 minute	odour	229	µg/m^3	Vic EPA

Pollutant	Averaging Period	Environmental Value	Value[1]	Unit	Source
	3 minute	toxicity	7,608	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	75	µg/m^3	Qld EPP(Air)
	7 day	health	280	µg/m^3	Qld EPP(Air)
Sulphur Dioxide	1 hour	health	570	µg/m^3	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	485	µg/m^3	Vic EPA
	24 hour	health	172	µg/m^3	Qld EPP(Air) & Air NEPM
	annual	health	57	µg/m^3	Air NEPM
	annual	health	57	µg/m^3	Qld EPP(Air)
	annual	agriculture	31	µg/m^3	Qld EPP(Air)
	annual	ecosystems	21	µg/m^3	Qld EPP(Air)
Sulphuric Acid	3-minute	toxicity	36	µg/m^3	Vic EPA
Toluene	3 minute	odour	697	µg/m^3	Vic EPA
	3 minute	toxicity	13,120	µg/m^3	Vic EPA
	30 minute	aesthetics of the environment	1,066	µg/m^3	Qld EPP(Air)
	24 hour	health	4,100	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
	annual	health	410	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
TSP	3 minute	amenity	360	µg/m^3	Vic EPA
	annual	health	90	µg/m^3	Qld EPP(Air)
Xylenes (Total)	3 minute	odour	382	µg/m^3	Vic EPA
	3 minute	toxicity	12,443	µg/m^3	Vic EPA
	24 hour	health	1,200	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
	annual	health	950	µg/m^3	Qld EPP(Air) & Air Toxics NEPM
Zinc	3 minute	toxicity	36	µg/m^3	Vic EPA (zinc chloride fume)
	3 minute	toxicity	186	µg/m^3	Vic EPA (zinc oxide fume)

Notes:

(1): At 0°C.

(2): Based on the 99.5th percentile.

(3): Five exceedences per year allowed.

B.3 Pollutant Risk Ranking

In developing a pollutant risk ranking for the facilities for which a site based emissions inventory has been developed, namely:

- Puma Energy bulk fuel storage facility;
- BP fuel storage facility;
- BCC asphalt plant;
- Boral asphalt plant;
- Boral concrete batching plant;
- CP Plating;
- Caltex service station (Kingsford Smith Drive); and
- Caltex service station (Hercules Street).

the following is noted:

- For comparison against ambient air quality criteria (Table 2), in the case of pollutants for which there are multiple criteria, in general, the strictest criterion has been selected.
- A comparison of pollutant risk assumes that all pollutants are emitted from like-sources, i.e. sources that have common characteristics such as release height, exit velocity, stack diameters, exhaust temperature, etc.
- The methodology adopted for this assessment does not allow for a comparison of the relative risk associated with different emission source types, e.g. stack source emissions compared to fugitive emissions. (Note that AED has developed a methodology that does allow for a comparison of dissimilar source types but based on the findings of this assessment, the application of the more complex methodology was not considered warranted.)
- The pollutant risk ranking provides some guideline as to which pollutants to prioritise for the dispersion modelling component of the assessment.
- In general, the results of a pollutant risk ranking exercise are dependent on the regulatory criteria that are adopted for a given study.

B.3.1 An Example of the Application of the Risk Ranking Methodology

Consider the emission of three pollutants (A, B, and C) from a single emissions source (for example an exhaust stack) for which it is assumed that the emission rate of each of the three pollutants is as summarised in Table 3.

Step (1): The relevant ambient air criteria are reviewed (for example those listed in Table 2) and the strictest ambient air quality criterion for each of the three pollutants that has been adopted for the purposes of the pollutant ranking exercise is identified and listed in Table 3.

Step (2): For each pollutant, the emission rate is divided by the adopted ambient air quality criteria. It is noted that the units of the emission rate and the ambient air criteria may be different as long as all emission rates, and all criteria, have the same units. For example, pollutant C with an emission rate of 1 mg/s and adopted air quality criterion of 0.1 $\mu g/m^3$ has an associated risk of (1.0/0.1 = 10). A similar calculation is undertaken for the other pollutants.

Step (3): Next, each risk value in the table is divided by the maximum risk (in this case 10), in order to obtain a relative risk for each pollutant. The highest risk pollutant will have a value of 1. All other relative risks will be less than 1.

Step (4): The pollutants are ranked in order from highest to lowest risk. It is noted that the relative risk column in the table provides an indication of the relative likelihood of an exceedence of one pollutant compared with the highest risk pollutant. With reference to Table 3, the pollutant that is most likely to exceed ambient air criteria is pollutant C (relative risk score of 1). Based on a relative risk of 0.1, pollutant A is second most likely to exceed ambient air criteria, but is 10 times (or an order of magnitude) less likely to exceed than pollutant C. Pollutant B is 100 times (or two orders of magnitude) less likely to exceed its relevant ambient air criterion than pollutant C and has a pollutant risk ranking of 3.

Table 3: Example – Pollutant Risk Ranking for a Generic Facility.

Substance	Emission Rate (mg/s)	Air Quality Value	Risk	Relative Risk	Pollutant Ranking
Pollutant C	1	0.1	10	1	1
Pollutant A	10	10	1.0	0.1	2
Pollutant B	0.1	1	0.1	0.01	3

Appendix C Facility #2: Puma Energy Fuel Storage Facility

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the Puma Energy fuel storage facility.

Detailed facility information was provided by Puma Energy for use in this assessment but has not been included due to its commercial sensitivity

Figure 1: Facility Map - Puma Energy Bulk Fuel Storage.

C.1 Facility Details

Table 4: Facility Details - Puma Energy Fuel Storage Facility.

Property	Description
Address	37 Theodore Street, Whinstanes QLD, 4007
Lot and Plan	Lot 1093: Plan SL8401 Lot 451: Plan SL6925 Lot 593: Plan SL2981
Aspect of Development	ERA 11(b) Crude oil storing or petroleum storing – storing crude oil or petroleum product in tanks or containers having a combined storage capacity of 500 000 litres or more.

C.2 Licence conditions

Table 5: Licence Conditions Relevant to Air Quality: EPA Permit Number: IPCE00686607.

Condition	Description
Nuisance	
(PA1)	The release of noxious or offensive odours or any other noxious or offensive airborne contaminants resulting from the activity must not cause a nuisance at any nuisance sensitive or commercial place.
(PA2)	When requested by the administering authority, emissions monitoring to the atmosphere must be undertaken to investigate any complaint of environmental nuisance caused by noxious or offensive odours and/or any other noxious or offensive airborne contaminants, and the results notified within 14 days to the administering authority following completion of monitoring.
(PA3)	The method of measurement and reporting of the emissions monitoring required in accordance with condition PA2 must comply with the latest edition of the Environmental Protection Agency's Air Quality Sampling Manual.
Release of Contaminants to the Atmosphere	
(PA4)	The release of contaminants to the atmosphere from point sources must only occur from point sources which are listed in Table 1 and Table 2 of this development approval.
(PA5)	Contaminants resulting from the operation of the sources described in Table 1 and Table 2 must only be released to the atmosphere from those release points specified in Table 1 and Table 2 of this development approval.
Total Hydrocarbon Releases to Air	
(PA6)	The operator of the ERA to which this approval relates must determine the total mass of hydrocarbon contaminants released from the approved place to the atmosphere each year. Note: Where possible hydrocarbons must be grouped according to photochemically reactive functional groups.
(PA7)	The determination of the total mass of hydrocarbon contaminants released to the atmosphere annually must include all point source and non-point source releases
Reporting of Total Hydrocarbon Releases to Air	
(PA8)	A report of the total mass of hydrocarbon contaminants released to the atmosphere for the preceding 12 month period must be included in each annual return and include, but not be limited to: (i) Total mass of hydrocarbons released (ii) The percentage increase or decrease in the contaminant releases and (iii) The ratio of total mass quantity of point source releases to non-point source releases

Table 6: Table 1 - Vent Release Points: EPA Permit Number: IPCE00686607.

Release Point Number	Description
1	Truck filling gantry vent
2	Truck filling gantry vent
3	Truck filling gantry vent
4	Truck filling gantry vent
5	Truck filling gantry vent
6	Groundwater Remediation Air Stripper vent pipes

Table 7: Table 2 – Petroleum product storage tanks: EPA Permit Number: IPCE00686607.

Tank Identification/ Release Point	Storage Method	Packaging Group	Design Capacity (L)
121	AG – Above Ground	PG11	1,214,973
123	AG – Above Ground	PG11	2,774,068
267	AG – Above Ground	PG11	20,500
2166	AG – Above Ground	PG11	109,939
7927	AG – Above Ground	PG11	703,359
7928	AG – Above Ground	PG11	627,851
7944	AG – Above Ground	PG11	17,111,177
15780	AG – Above Ground	PG11	114,048
21	AG – Above Ground	C1	40700
22	AG – Above Ground	C1	40700
23	AG – Above Ground	C1	40700
24	AG – Above Ground	C1	40200
25	AG – Above Ground	C1	40900
26	AG – Above Ground	C1	40900
27	AG – Above Ground	C1	68800
27b	AG – Above Ground	C2	40900
28	AG – Above Ground	C1	6800
28b	AG – Above Ground	C2	68,000
29	AG – Above Ground	C1	2,300
100	AG – Above Ground	C1	4,340,955
122	AG – Above Ground	C1	3,627,005
358	AG – Above Ground	C1	7,800,970
385	AG – Above Ground	C1	8,857,990
441	AG – Above Ground	C1	1,031,138
442	AG – Above Ground	C1	1,030,375
443	AG – Above Ground	C1	1,042,345
444	AG – Above Ground	C1	1,040,548
445	AG – Above Ground	C1	460,610
7945	AG – Above Ground	C1	3,742,176
15713	AG – Above Ground	C1	3,739,157
Truckstop	AG – Above Ground	C1	108,000
Separator	AG – Above Ground	C1	10,000
15781	AG – Above Ground	C1	53,280

C.3 NPI Reports for the Puma Energy Storage Facility

Presented in the following tables are the previous six years of NPI reports for the Puma Energy facility.

Table 8: 2012/2013 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	750	750	0.0
Cumene (isopropylbenzene)	224	224	0.0
Cyclohexane	626	626	0.0
Ethanol	5224	5224	0.0
Ethylbenzene	244	244	0.0
n-Hexane	2147	2147	0.0
Toluene (methylbenzene)	1506	1506	0.0
Total Volatile Organic Compounds	175209	175209	0.0
Xylenes (individual or mixed isomers)	985	985	0.0

Table 9: 2011/2012 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	880	880	0.0
Cumene (isopropylbenzene)	226	226	0.0
Cyclohexane	750	750	0.0
Ethanol	7296	7296	0.0
Ethylbenzene	271	271	0.0
n-Hexane	2604	2604	0.0
Toluene (methylbenzene)	1709	1709	0.0
Total Volatile Organic Compounds	204774	204774	0.0
Xylenes (individual or mixed isomers)	1079	1079	0.0

Table 10: 2010/2011 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	845.4	845.4	0.0
Cumene (isopropylbenzene)	254.4	254.4	0.0
Cyclohexane	703.2	703.2	0.0
Ethanol	7715.8	7715.8	0.0
Ethylbenzene	283.9	283.9	0.0
n-Hexane	2402.6	2402.6	0.0
Toluene (methylbenzene)	1681.9	1681.9	0.0
Total Volatile Organic Compounds	189959	189959	0.0
Xylenes (individual or mixed isomers)	1147.6	1147.6	0.0

Table 11: 2009/2010 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	1627.5	1627.5	0.0
Cumene (isopropylbenzene)	314.1	314.1	0.0
Cyclohexane	1397.7	1397.7	0.0
Ethanol	16402.8	16402.8	0.0
Ethylbenzene	430.8	430.8	0.0
n-Hexane	4981.5	4981.5	0.0
Toluene (methylbenzene)	3020.2	3020.2	0.0
Total Volatile Organic Compounds	390205.4	390205.4	0.0
Xylenes (individual or mixed isomers)	1686.1	1686.1	0.0

Table 12: 2008/2009 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	3408.6	3408.6	0.0
Cumene (isopropylbenzene)	114.5	114.5	0.0
Cyclohexane	3168.3	3168.3	0.0
Ethanol	16633.5	16633.5	0.0
Ethylbenzene	653.8	653.8	0.0
n-Hexane	11763.3	11763.3	0.0
Toluene (methylbenzene)	5992.8	5992.8	0.0
Total Volatile Organic Compounds	942210.8	942210.8	0.0
Xylenes (individual or mixed isomers)	2405.6	2405.6	0.0

Table 13: 2007/2008 NPI Report - Puma Energy Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	1525	1525	0.0
Cumene (isopropylbenzene)	210	210	0.0
Cyclohexane	1374	1374	0.0
Ethanol	10610	10610	0.0
Ethylbenzene	311	311	0.0
Lead & compounds	1	1	0.0
n-Hexane	5040	5040	0.0
Toluene (methylbenzene)	2642	2642	0.0
Total Volatile Organic Compounds	153169	153169	0.0
Xylenes (individual or mixed isomers)	1114	1114	0.0

C.4 Site-Based Emissions Inventory

A site-based emissions inventory was developed using information based on 2013/2014 annual throughputs and inconsideration of the NPI data presented in Section C.3.

The use of an annual emission rate for the pollutants for which short-term averaging period ambient air criteria exists (such as the Vic EPA 3-minute average criterion for benzene), may be considered to be representative of emission rates in practice, only if the activities that generate the emissions occur on a continuous basis and are not driven by short-term batch processes.

For the case of emissions of volatile organic compounds from the Puma Energy bulk fuel storage facility, the key source of emissions will be associated with tank breathing, emptying and refuelling.

Site-specific information was provided by the facility and the emissions inventory was developed based on a combination of site-specific and publically available information.

Presented in Table 14 is a summary of the site-based emissions inventory that has been adopted for use in the air quality constraints assessment.

Table 14: Emissions Inventory of the Puma Energy Facility (mg/s).

Substance	2014	2012	% Difference
Benzene	1.08E+02	1.08E+02	0%
Cumene (Isopropylbenzene)	1.09E+01	9.96E+00	9%
Cyclohexane	1.00E+02	1.00E+02	0%
Ethylbenzene	2.07E+01	2.07E+01	0%
n-Hexane	3.73E+02	3.73E+02	0%
Lead & compounds	1.39E-01	3.17E-02	338%
Toluene (methylbenzene)	1.90E+02	1.90E+02	0%
Xylenes (individual or mixed isomers)	7.63E+01	7.63E+01	0%
Ethanol	5.27E+02	5.27E+02	0%
Total Volatile Organic Compounds	2.99E+04	2.99E+04	0%

C.4.1 Pollutant Risk Ranking

A pollutant risk ranking exercise (refer to Section B.3) was undertaken based on the emissions inventory developed in Section C.4.

Results of the pollutant ranking exercise highlights benzene as the highest risk pollutant followed by the pollutants toluene and lead.

Table 15: Pollutant Risk Ranking for the Puma Energy Bulk Fuel Storage Facility.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Benzene	annual	health	Qld EPP(Air)	1.00E+01	1.08E+02	1.000	1
Ethanol	3 minute	toxicity	Vic EPA	6.84E+04	5.27E+02	0.001	6
Ethylbenzene	3 minute	toxicity	Vic EPA	1.58E+04	2.07E+01	0.000	8
Hexane, n-	3 minute	toxicity	Vic EPA	6.44E+03	3.73E+02	0.005	5
Isopropylbenzene	3 minute	toxicity	Vic EPA	8.84E+03	1.02E+01	0.000	9
Lead	annual	health	Qld EPP(Air)	5.00E-01	7.66E-02	0.014	3
Toluene	annual	health	Qld EPP(Air)	4.10E+02	1.90E+02	0.043	2
Xylenes (Total)	annual	health	Qld EPP(Air)	9.50E+02	7.63E+01	0.007	4
Cyclohexane	3-minute	toxicity	Vic EPA	3.82E+04	1.00E+02	0.000	7

C.5 Dispersion Modelling

Dispersion modelling of the Puma Energy facility was undertaken for five years of meteorology (Appendix KK) for the emission rates developed in Section C.4 based on the following assumptions:

- All tank-related annual total emissions were distributed amongst 15 locations and assumed to be generated from point sources corresponding to the tank breathing. In the absence of additional information, the emissions exhaust temperature was assumed to correspond to ambient air temperature (i.e. neutrally buoyant) with an exit velocity of 0.01 m/s. Emissions associated with truck refuelling at the gantry were assumed associated with fugitive emissions.

C.5.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix D Facility #3: BP Fuel Storage Facility

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the BP fuel storage facility.

Additional information was not provided by BP for use in this assessment.

Figure 2: Facility Map - BP Bulk Fuel Storage.

D.1 Facility Details

Table 16: Facility Details - BP Fuel Storage Facility.

Property	Description
Address	701 Kingsford Smith Drive, Whinstanes QLD 4007
Lot and Plan	Lot 613 on SL1931
Aspect of Development	ERA 11(b) Crude oil storing or petroleum storing – storing crude oil or petroleum product in tanks or containers having a combined storage capacity of 500 000 litres or more.

D.2 Licence conditions

Table 17: Licence Conditions Relevant to Air Quality: EPA Permit Number: ENDC00545506/SR115.

Condition	Description
Schedule B - Air	
Release of Contaminants to the Atmosphere	
(B1)	The release of contaminants from a point source must only occur from a point source which is identified in the application for development approval, or listed in Table 1 of the air schedule of this development approval.
(B2)	Contaminants resulting from the operation of the sources described in Table 1 of the air schedule must only be released to the atmosphere from the release point specified in Table 1 of the air schedule.
(B3)	Contaminants released from each point source specified in Table 1 of the air schedule must be directed vertically upwards without any impedance or hindrance.
(B4)	Contaminants must be released to the atmosphere from a release point at a height not less than the corresponding height stated for that release point in Table 1 of the air schedule.
(B5)	Contaminants must be released to the atmosphere from a release point at a vertical velocity not less than the corresponding vertical velocity stated for that release point in Table 1 of the air schedule.
(B6)	Contaminants must be released to the atmosphere from a release point at a temperature not less than the corresponding temperature stated for that release point in Table 1 of the air schedule.
(B7)	Contaminants must not be release to the atmosphere from a release point at a mass emission rate as measured at a monitoring point specified in Schedule H, in excess of that state in Table 2 of the air schedule.
Fuel Burning	
(B8)	The maximum average quantity of fuel burned per hour must not exceed 110 kilograms (based on total consumption for eight hour operation).
(B9)	The sulphur content of any fuel burned in industrial fuel burning equipment is not to exceed 3.0 percent by weight.
(B10)	The fuel which may be burnt in industrial fuel burning equipment is fuel oil.
Schedule H - Self-Monitoring and Reporting	
(H9)	The operator of the ERA to which this approval relates must conduct and keep records of a monitoring program of contaminant releases to the atmosphere at the release points, frequency, and for the parameters specified in Schedule H Table 1 and which complies with the following: (a) All determinations must be performed by a person or body registered by the National Association of Testing Authorities (NATA) or the New Zealand Testing Laboratory Registration Council (TELARC). (b) Monitoring provisions for the release points listed in Schedule H Table 1 must comply with the Australian Standard AS4323.1-1995 "Stationary source emissions: Method 1: Selection of sampling provisions". (c) The following tests must be performed for each required determination specified in Table 1: (i) gas velocity and volume flow rate; (ii) temperature; and (iii) water vapour concentration. (d) where practicable samples taken must be representative of the contaminants discharged when

	emissions are expected to be normal. (e) during the sampling period the following additional information must be gathered: (i) fuel in use and fuel usage rate; (ii) production throughput (k/hour); and (iii) percentage in mass and in volume used of the design capacity.
Records	
(H10)	Any record of the results of the monitoring of contaminant releases to the atmosphere made in accordance with the above condition must not be disposed of within ten (10) years of the date the record was made.
Total Hydrocarbon Releases to Air	
(H11)	The operator of the ERA to which this approval relates must determine by measurement or estimation the total mass of hydrocarbons released from the approved place to the atmosphere each year. Note: Where possible hydrocarbons must be grouped according to photochemically reactive functional groups.
(H12)	The determination of the total mass of contaminants released to the atmosphere annually must include all point source and non-point source releases.
Reporting of Total Contaminant Releases to Air	
(H13)	A report on the total mass of contaminants released to the atmosphere for the preceding 12 month period must be included in each annual return and include, but not be limited to; (i) Total mass of hydrocarbons released; (ii) the percentage increase or decrease in the contaminant releases compared to the previous 12 months; (iii) the ratio of total mass quantity of point source releases to non-point source releases.
(H14)	Every five (5) years, provide a complete report of the monitoring plus the percentage increase or decrease in the contaminant release from the release point indicated in the Schedule B – Table 1.

Table 18: Schedule B – Table 1. EPA Permit Number: ENDC00545506/SR115.

Release Point Number	Source Description	Minim Average Flue Gas Velocity (metres/second)	Minim Average Flue Gas Temperature (Celsius)	Minimum Release Height (metres above ground level)
A1	Boiler	6	150	24.38

Table 19: Schedule B – Table 2. EPA Permit Number: ENDC00545506/SR115.

Contaminant / Release limit units	Release point number / Release Limit
	A1
Sulphur Oxides (as SO2) (grams/sec)	1.264
Nitrogen Oxides (as NO2) (grams/sec)	0.166
Carbon Monoxide (grams/sec)	0.232
Total Organic Carbon (grams/sec)	0.0008
Particulates (grams/sec)	0.075

Table 20: Schedule H – Table 1 Required Release Point Determinations. EPA Permit Number: ENDC00545506/SR115.

Release Point Numbers	Determination Required	Frequency
A1	Sulphur Oxides (as SO2)	Not less than once every five years
A1	Nitrogen Oxides (as NO2)	Not less than once every five years
A1	Carbon Monoxide	Not less than once every five years
A1	Total Organic Carbon	Not less than once every five years
A1	Particulates (as PM10 and as total suspended)	Not less than once every five years

D.3 NPI Reports for the BP Whinstanes Fuel Storage Facility

Presented in the following tables are the previous six years of NPI reports for the BP fuel storage facility.

Table 21: 2012/2013 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	668.9	668.9	0.0
Cumene (Isopropylbenzene)	21.6	21.6	0.0
Cyclohexane	1008.6	1008.6	0.0
Ethanol	550.9	550.9	0.0
Ethylbenzene	227.3	227.3	0.0
n-Hexane	1950.4	1950.4	0.0
Styrene (ethenylbenzene)	2.2	2.2	0.0
Toluene (methylbenzene)	2695.1	2695.1	0.0
Total Volatile Organic Compounds	242130.0	242130.0	0.0
Xylenes (individual or mixed isomers)	1131.2	1131.2	0.0

Table 22: 2011/2012 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	596.5	596.5	0.0
Cumene (Isopropylbenzene)	19.3	19.3	0.0
Cyclohexane	886.4	886.4	0.0
Ethanol	300.7	300.7	0.0
Ethylbenzene	203.7	203.7	0.0
n-Hexane	1697.0	1697.0	0.0
Styrene (ethenylbenzene)	1.9	1.9	0.0
Toluene (methylbenzene)	2401.7	2401.7	0.0
Total Volatile Organic Compounds	213360.0	213360.0	0.0
Xylenes (individual or mixed isomers)	1006.7	1006.7	0.0

Table 23: 2010/2011 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	633.3	633.3	0.0
Cumene (Isopropylbenzene)	20.1	20.1	0.0
Cyclohexane	942.8	942.8	0.0
Ethanol	819.7	819.7	0.0
Ethylbenzene	217.8	217.8	0.0
n-Hexane	1807.4	1807.4	0.0
Styrene (ethenylbenzene)	1.97	1.97	0.0
Toluene (methylbenzene)	2563.1	2563.1	0.0
Total Volatile Organic Compounds	227883	227883	0.0
Xylenes (individual or mixed isomers)	1077.2	1077.2	0.0

Table 24: 2009/2010 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	665.8	665.8	0.0
Cumene (isopropylbenzene)	19.5	19.5	0.0
Cyclohexane	987.0	987.0	0.0
Ethanol	768.1	768.1	0.0
Ethylbenzene	224.1	224.1	0.0
n-Hexane	1902.0	1902.0	0.0
Styrene (ethenylbenzene)	1.94	1.94	0.0
Toluene (methylbenzene)	2686.9	2686.9	0.0
Total Volatile Organic Compounds	240714	240714	0.0
Xylenes (individual or mixed isomers)	1097.1	1097.1	0.0

Table 25: 2008/2009 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	622.6	622.6	0.0
Cumene (isopropylbenzene)	15.2	15.2	0.0
Cyclohexane	909.0	909.0	0.0
Ethanol	396.6	396.6	0.0
Ethylbenzene	200.3	200.3	0.0
n-Hexane	1767.6	1767.6	0.0
Styrene (ethenylbenzene)	1.57	1.57	0.0
Toluene (methylbenzene)	2491.5	2491.5	0.0
Total Volatile Organic Compounds	226116	226116	0.0
Xylenes (individual or mixed isomers)	955.9	955.9	0.0

Table 26: 2007/2008 NPI Report - BP Fuel Storage Facility.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Benzene	654.3	654.3	0.0
Cumene (isopropylbenzene)	16.7	16.7	0.0
Cyclohexane	964.6	964.6	0.0
Ethanol	302.4	302.4	0.0
Ethylbenzene	211.7	211.7	0.0
n-Hexane	1885.8	1885.8	0.0
Styrene (ethenylbenzene)	1.75	1.75	0.0
Toluene (methylbenzene)	2613.5	2613.5	0.0
Total Volatile Organic Compounds	238096	238096	0.0
Xylenes (individual or mixed isomers)	654.3	654.3	0.0

D.4 Site-Based Emissions Inventory

A site-based emissions inventory was developed using a combination of the maximum annual emissions for each of the previous four years of NPI reporting presented in Section D.3 and site licence conditions that apply to the stack for the on-site boiler (Section D.2).

The use of an annual emission rate for the NPI-reported pollutants for which short-term averaging period ambient air criteria exists, may be considered to be representative of emission rates in practice, if the activities that generate the emissions occur on a continuous basis and are not driven by short-term batch processes.

For the case of emissions of volatile organic compounds from the BP bulk fuel storage facility, the key source of emissions will be associated with tank breathing, emptying and refuelling. Additionally, the consumption of fuel by the boiler has the potential to release pollutants into the atmosphere.

Additional site-specific information was not provided by the facility thus the emissions inventory was developed solely using publically available information. In particular, information pertaining to the following was not available for this study:

- The frequency of ship unloading/loading and the time it takes for ship unloading/loading;
- Type of fuels stored and the annual throughput of fuels per fuel type;
- Type of fuel tanks (floating roof, etc.);
- Method of emptying of fuel tanks (i.e. to trucks, ships, etc., using vapour recovery etc.), frequency of emptying, rate of emptying.
- Hours of operation of the boiler.

Presented in Table 27 is a summary of the emissions inventories adopted for the BP facility.

Table 27: Emissions Inventory for the BP Fuel Storage Facility.

Substance	2014		2012		% Difference	
	Fugitive	Point	Fugitive	Point	Fugitive	Point
Benzene	2.12E+01	-	2.11E+01	-	0%	0%
Carbon Monoxide	-	2.32E+02	-	2.32E+02	0%	0%
Cumene (isopropylbenzene)	6.85E-01	-	6.37E-01	-	8%	0%
Cyclohexane	3.20E+01	-	3.13E+01	-	2%	0%
Ethanol	2.60E+01	-	2.60E+01	-	0%	0%
Ethylbenzene	7.21E+00	-	7.10E+00	-	1%	0%
n-Hexane	6.18E+01	-	6.03E+01	-	3%	0%
Nitrogen oxides	-	1.66E+02	-	1.66E+02	0%	0%
PM10	-	7.50E+01	-	7.50E+01	0%	0%
PM2.5	-	7.50E+01	-	7.50E+01	0%	0%
Styrene (ethenylbenzene)	6.94E-02	-	6.25E-02	-	11%	0%
Sulphur dioxide	-	1.26E+03	-	1.26E+03	0%	0%
Toluene (methylbenzene)	8.55E+01	-	8.52E+01	-	0%	0%
Total Volatile Organic Compounds	7.68E+03	-	7.63E+03	-	1%	0%
Xylenes (individual or mixed isomers)	3.59E+01	-	3.48E+01	-	3%	0%

D.4.1 Pollutant Risk Ranking

A pollutant risk ranking exercise (refer to Section B.3) was undertaken based on the emissions inventories developed in Section D.4.

As noted in Section B.3, the methodology adopted, strictly speaking only applies to emissions of pollutants from emission sources of identical (or very similar) source characteristics. Thus for the BP fuel storage facility, two pollutant risk ranking exercises were undertaken: one for fugitive emissions and one for point source emissions (i.e. the boiler stack)

Results of the pollutant ranking exercise for fugitive emission sources highlights benzene as the highest risk pollutant, followed by toluene and total xylenes.

Table 28: Pollutant Risk Ranking – Fugitive Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Benzene	annual	health	Qld EPP(Air)	1.00E+01	2.11E+01	1.000	1
Hexane, n-	3 minute	toxicity	Vic EPA	6.44E+03	6.18E+01	0.005	4
Toluene	annual	health	Qld EPP(Air)	4.10E+02	8.55E+01	0.099	2
Xylenes (Total)	annual	health	Qld EPP(Air)	9.50E+02	3.59E+01	0.018	3
Cyclohexane	3-minute	toxicity	Vic EPA	3.82E+04	3.20E+01	0.000	5

Results of the pollutant ranking exercise for the boiler stack, highlights particulate matter as $PM_{2.5}$ as the highest risk pollutant, followed by sulphur dioxide and oxides of nitrogen.

Table 29: Pollutant Risk Ranking – Boiler (Point Source) Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Carbon monoxide	8 hour	health	Qld EPP(Air)	1.13E+04	2.32E+02	0.002	5
Oxides of nitrogen	annual	health	Air NEPM	6.20E+01	1.66E+02	0.286	3
PM10	24 hour	health	Air NEPM	5.00E+01	7.50E+01	0.160	4
PM2.5	annual	advisory	Air NEPM	8.00E+00	7.50E+01	1.000	1
Sulfur dioxide	24 hour	health	Qld EPP(Air)	1.72E+02	1.26E+03	0.784	2

D.5 Dispersion Modelling

Dispersion modelling of the BP facility was undertaken using five years of meteorology (Appendix KK) for the emission rates developed in Section D.4 based on the following assumptions:

- All emissions were distributed at tank locations on the perimeter of the facility and assumed to be generated from point sources corresponding to the tank breathing vents. This conservative assumption was applied due to the limited facility-specific information that was available for this study. This conservative approach to the distribution of emissions will lead to the prediction of worst-case off-site impacts when compared to emissions that are distributed throughout the facility.
- In the absence of additional information, the emissions exhaust temperature for the tanks was assumed to correspond to ambient air temperature (i.e. neutrally buoyant) with an exit velocity of 0.01 m/s.

D.5.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix NK. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix E Facility #4: BCC Eagle Farm Asphalt Plant

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the BCC Eagle Farm asphalt plant.

Detailed facility information was provided by BCC for use in this assessment but has not been included due to its commercial sensitivity. It is additionally noted that two stack testing results were provided.

Figure 3: Facility Map - BCC Eagle Farm Asphalt Plant.

E.1 Facility Details

Table 30: Facility Details - BCC Eagle Farm Asphalt Plant.

Property	Description
Address	260 Curtin Avenue West, Eagle Farm QLD 4009
Lot and Plan	Lot 1 Plan RP852694 Lot 796 Plan SL320
Aspect of Development	ERA 59 – Asphalt manufacturing – manufacturing asphalt ERA 17 – Fuel burning – any process involving the use of fuel burning equipment (including, for example, a standby power generator) that is capable of burning (whether alone or in total) 500 kg or more of fuel in an hour.

E.2 Licence conditions

Table 31: Licence Conditions Relevant to Air Quality: EPA Permit Number: ENDC00628707.

Condition	Description
Schedule B - Air	
Release of Contaminants to the Atmosphere	
(B1)	The release of contaminants from a point source must only occur from a point source which is identified in the application for development approval, or listed in Table 1 of the air schedule of this development approval.
(B2)	Contaminants resulting from the operation of the sources described in Table 1 of the air schedule must only be released to the atmosphere from the release point specified in Table 1 of the air schedule.
(B3)	Contaminants released from each release point specified in Table 1 of the air schedule must be directed vertically upwards without any impedance or hindrance.
(B4)	Contaminants must be released to the atmosphere from a release point at a height not less than the corresponding height stated for that release point in Table 1 of the air schedule.
(B5)	Contaminants must not be release to the atmosphere from a release point at a concentration, as measured at a monitoring point specified in Schedule H, in excess of that state in Table 2 of the air schedule.
Fuel Burning	
(B6)	The fuel which may be burnt in industrial fuel burning equipment is natural gas
Fabric Filter Dust Collector (FFDC)	
(B7)	All contaminants arising from the operation of the asphalt plant's rotary drum mixer and the filler silos must be treated in a fabric filter dust collector prior to release to the atmosphere at release point A1.
(B8)	An electric interlock must prevent the filling of either filler silos unless Fabric Filter Dust Collector fan is operating.
(B9)	Except for the production of "Precoated Aggregate" the fabric filter dust collector serving the rotary drum mixer must operate at all times when the rotary drum mixer is in use.
(B10)	Except as provided by condition B9, an electric interlock must prevent the operation of the rotary drum mixer unless the Fabric Filter Dust Collector fan is operating.
(B11)	A device which is capable of detecting filter medium breakthrough must be installed in the outlet of the Fabric Filter Dust Collector.
(B12)	An audible and visual two stage alarm system must warn the operator-in-charge of the Fabric Filter Dust Collector serving the rotary drum mixer of the possibility that filter medium breakthrough has occurred.
(B13)	An electrical interlock must commence the safe shut down of the rotary drum mixer served by the Fabric Filter Dust Collector not more than one (1) minute after activation of the high-high" alarm.
(B14)	Replacement bags for all Fabric Filter Dust Collector must be held on site at all times.
(B15)	In the event that any replacement bags for the Fabric Filter Dust Collector are utilised then the stockpile of replacement bags must be replenished to the required quantity as soon as practicable.
(B16)	All collected material removed from the Fabric Filter Dust Collector must be removed and disposed of in a manner that will not cause the release of contaminants to the atmosphere or to waters.
Dust Control	
(B17)	For the purpose of avoiding any release of dust or particulate matter from the approved place

	which could cause an environmental nuisance, the following measures must be taken: (i) Stockpiles must be maintained using all reasonable and practicable measures to minimise the release of wind-blown dust or particulate matter to the atmosphere. Reasonable and practicable measures may include, but are not limited to, anemometer switching systems which trigger operation of effective water spray systems during winds likely to generate such release; use of approved dust suppressants; shielding and storage in bunkers; and revegetation of disturbed areas; and (ii) Trafficable areas must be maintained using all reasonable and practicable measures to minimise the release of windblown dust or traffic generated dust to the atmosphere. Reasonable and practicable measures may include, but are not limited to, sealing with bitumen or other suitable material; keeping surface clean; use of water sprays; adoption and adherence to speed limits; use of approved dust suppressants; and wind breaks; and (iii) Raw material preparation plant and external transfer conveyers must be operated and maintained using all reasonable and practicable measures to minimise the release of wind-blown dust or particulate matter to the atmosphere. Reasonable and practicable measures may include, but are not limited to, transfer of materials in a moist state; enclosure or sealing of conveyers; use of water sprays at transfer points; shielding; and wind breaks.
Schedule H - Self-Monitoring and Reporting	
Monitoring of Contaminant Releases to the Atmosphere	
(H10)	The registered operator of this approval must conduct a monitoring program of contaminant release to the atmosphere at the release points, frequency, and for the parameters specified in Schedule H – table 1 and which complies with following: (a) All determinations must be performed by a person or body registered by the National Association of Testing Authorities (NATA) or the New Zealand Testing Laboratory Registration Council (TELARC). (b) Monitoring provisions for the release points listed in Schedule H Table 1 must comply with the Australian Standard AS4323.1-1995 "Stationary source emissions: Method 1: Selection of sampling provisions". (c) The following tests must be performed for each required determination specified in Table 1: (i) gas velocity and volume flow rate; (ii) temperature; and (iii) water vapour concentration. (d) where practicable samples taken must be representative of the contaminants discharged when emissions are expected to be maximum; (e) during the sampling period the following additional information must be gathered: (i) production rate; (ii)equipment operating; and (iii) product made.
(H11)	Records must be kept of the results of all monitoring of release of contaminants to the atmosphere for a period of at least five (5) years.
Total Hydrocarbon Releases to Air	
(H12)	The registered operator of this approval relates must determine by measurement or estimation the total mass of hydrocarbons released from the approved place to the atmosphere each year. Note: Where possible hydrocarbons must be grouped according to photochemically reactive functional groups.
(H13)	The determination of the total mass of contaminants released to the atmosphere annually must

	include all point source and non-point source releases.
(H14)	By 1 November 1997 the registered operator of this approval must submit a report detailing the methods used to determine the total mass quantity of contaminants released to the atmosphere.
Reporting of Total Contaminant Releases to Air	
(H15)	A report on the total mass of contaminants released to the atmosphere for the preceding 12 month period must be included in each annual return and include, but not be limited to; (i) Total mass of hydrocarbons released; (ii) the percentage increase or decrease in the contaminant releases compared to the previous 12 months; (iii) the ratio of total mass quantity of point source releases to non-point source releases.

Table 32: Schedule B – Table 1. EPA Permit Number: ENDC00628707.

Release Point Number	Source Description	Minimum Release Height (metres)	Minim Efflux Velocity (metres/second)
A1	Rotary Drum Mixer Stack	27.3	14 (at maximum production capacity)
A2	Heater No. 1 Stack	4	Not specified
A3	Heater No. 2 Stack	4	Not specified

Table 33: Schedule B – Table 2. EPA Permit Number: ENDC00628707.

Release Point Number	Contaminant	Release Limit	Release Limit Units
A1	CO	1.0	g/m^3
	SO3	0.1	g/m^3
	H2S	0.005	g/m^3
	NOx	0.35	g/m^3
	Particulates	0.05	g/m^3

Table 34: Schedule H – Table 1. EPA Permit Number: ENDC00628707.

Required Release Point Determinations		
Determination Required	**Release Point Numbers**	**Frequency**
mass rate (g/min) and concentration (mg/m^3) of nitrogen oxides	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of sulphur dioxide	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of hydrogen sulphide	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of carbon monoxide	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of nitrogen oxides	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter

mass rate (g/min) and concentration (mg/m^3) of carbon dioxide	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of oxygen	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of TOC	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter
mass rate (g/min) and concentration (mg/m^3) of Particulates	A1	Within 6 months of the date of issue of this approval and at intervals of not more than annually thereafter

E.3 NPI Reports for the BCC Eagle Farm Asphalt Facility

Presented in the following tables are the previous six years of NPI reports for the BCC asphalt plant.

Table 35: 2012/2013 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.16	0.00	0.16
Beryllium & compounds	0.00	0.00	0.00
Cadmium & compounds	0.07	0.00	0.07
Carbon monoxide	75115.00	303.00	74812.00
Chromium (III) compounds	0.89	0.00	0.89
Chromium (VI) compounds	0.90	0.00	0.90
Copper & compounds	0.93	0.00	0.93
Fluoride compounds	0.00	0.00	0.00
Lead & compounds	0.51	0.00	0.51
Mercury & compounds	0.00	0.00	0.00
Nickel & compounds	2.20	0.00	2.20
Oxides of Nitrogen	7362.00	985.00	6377.00
Particulate Matter 10.0 um	2147.00	90.00	2057.00
Particulate Matter 2.5 um	83.00	83.00	0.00
Polycyclic aromatic hydrocarbons (BaPeq)	22.05	0.05	22.00
Sulphur dioxide	2070.63	0.63	2070.00
Total Volatile Organic Compounds	7149.00	570.00	6579.00
Xylenes (individual or mixed isomers)	60.00	0.00	60.00
Zinc and compounds	6.30	0.00	6.30
Benzene	179.00	0.00	179.00
Formaldehyde (methyl aldehyde)	560.00	22.00	538.00
n-Hexane	5149.00	0.00	5149.00
Hydrogen sulfide	175.00	0.00	175.00
Manganese & compounds	1.60	0.00	1.60
Polychlorinated dioxins and furans (TEQ)	0.00	0.00	0.00
Toluene (methylbenzene)	30.00	0.00	30.00

Table 36: 2011/2012 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.11	0.00	0.11
Beryllium & compounds	0.04	0.00	0.04
Cadmium & compounds	0.14	0.00	0.14
Carbon monoxide	22257.71	1357.71	20900.00
Chromium (III) compounds	1.51	0.00	1.51
Chromium (VI) compounds	1.65	0.00	1.65
Copper & compounds	0.61	0.00	0.61
Fluoride compounds	0.00	0.00	0.00
Lead & compounds	0.12	0.00	0.12
Mercury & compounds	0.08	0.00	0.08
Nickel & compounds	0.71	0.00	0.71
Oxides of Nitrogen	8521.50	4413.50	4108.00
Particulate Matter 10.0 um	1380.95	403.95	977.00
Particulate Matter 2.5 um	371.78	371.78	0.00
Polycyclic aromatic hydrocarbons (BaPeq)	21.23	0.23	21.00
Sulphur dioxide	2351.80	2.80	2349.00
Total Volatile Organic Compounds	3015.70	594.70	2421.00

Table 37: 2010/2011 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.11	0.0	0.11
Beryllium & compounds	0.04	0.0	0.04
Cadmium & compounds	0.13	0.0	0.13
Carbon monoxide	119041.9	1545.9	117496.0
Chromium (III) compounds	1.44	0.0	1.44
Chromium (VI) compounds	1.56	0.0	1.56
Copper & compounds	0.57	0.0	0.57
Fluoride compounds	0.00	0.00	0.0
Lead & compounds	0.12	0.0	0.12
Mercury & compounds	0.07	0.0	0.07
Nickel & compounds	0.67	0.0	0.67
Oxides of Nitrogen	8905.4	5025.4	3880.0
Particulate Matter 10.0 um	1524.0	460.0	1064.0
Particulate Matter 2.5 um	423.3	423.3	0.0
Polycyclic aromatic hydrocarbons (BaPeq)	20.3	0.26	20.1
Sulphur dioxide	4539.2	3.2	4536.0
Total Volatile Organic Compounds	2972.2	677.2	2295.0

Table 38: 2009/2010 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.11	0.0	0.11
Beryllium & compounds	0.04	0.0	0.04
Cadmium & compounds	0.14	0.0	0.14
Carbon monoxide	257091.9	1545.9	255546.0
Chromium (III) compounds	1.47	0.0	1.47
Chromium (VI) compounds	1.60	0.0	1.60
Copper & compounds	0.59	0.0	0.59
Fluoride compounds	0.0	0.0	0.0
Lead & compounds	0.12	0.0	0.12
Mercury & compounds	0.07	0.0	0.07
Nickel & compounds	0.68	0.0	0.68
Oxides of Nitrogen	8936.4	5025.4	3911.0
Particulate Matter 10.0 um	1848.0	460.0	1388.0
Particulate Matter 2.5 um	423.3	423.3	0.0
Polycyclic aromatic hydrocarbons (BaPeq)	20.8	0.26	20.5
Sulphur dioxide	5147.2	3.19	5144.0
Total Volatile Organic Compounds	1498.2	677.2	821.0

Table 39: 2008/2009 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.11	0.0	0.11
Beryllium & compounds	0.04	0.0	0.04
Cadmium & compounds	0.14	0.0	0.14
Carbon monoxide	30525.0	0.0	30525.0
Chromium (III) compounds	1.55	0.0	1.55
Chromium (VI) compounds	1.68	0.0	1.68
Copper & compounds	0.62	0.0	0.62
Lead & compounds	0.13	0.0	0.13
Mercury & compounds	0.08	0.0	0.08
Nickel & compounds	0.72	0.0	0.72
Oxides of Nitrogen	4420.0	0.0	4420.0
Particulate Matter 10.0 um	1621.0	0.0	1621.0
Polycyclic aromatic hydrocarbons (BaPeq)	21.7	0.0	21.7
Sulphur dioxide	11933.0	0.0	11933.0
Total Volatile Organic Compounds	177.0	0.0	177.0

Table 40: 2007/2008 NPI Report - BCC Eagle Farm Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Arsenic & compounds	0.12	0.0	0.12
Beryllium & compounds	0.04	0.0	0.04
Cadmium & compounds	0.15	0.0	0.15
Carbon monoxide	15469.0	0.0	15469.0
Chromium (III) compounds	1.64	0.0	1.64
Chromium (VI) compounds	1.79	0.0	1.79
Copper & compounds	0.66	0.0	0.66
Lead & compounds	0.13	0.0	0.13
Mercury & compounds	0.08	0.0	0.08
Nickel & compounds	0.77	0.0	0.77
Oxides of Nitrogen	4375.0	0.0	4375.0
Particulate Matter 10.0 um	2656.0	0.0	2656.0
Polycyclic aromatic hydrocarbons (BaPeq)	23.0	0.0	23.0
Sulphur dioxide	9375.0	0.0	9375.0
Total Volatile Organic Compounds	3438.0	0.0	3438.0

E.4 Site-Based Emissions Inventory

A site-based emissions inventory was developed using a combination of the maximum annual emissions for each of the previous six years of NPI reporting presented in Section E.3, stack sampling data and site licence conditions (Section E.2).

For the case of emissions of pollutants from the BCC asphalt plant, the key sources of emissions will be associated with fugitive and point sources.

Detailed site-specific information was provided by the facility and thus the emissions inventory was developed using a combination of publically available and site-specific information.

Presented in Table 41 is a summary of the emissions inventory adopted for the BCC facility.

Table 41: Emissions Inventory for the BCC Asphalt Facility.

Substance	2014		2012		% Difference	
	Fugitive (mg/s)	Point (mg/s)	Fugitive (mg/s)	Point (mg/s)	Fugitive	Point
Arsenic & compounds	-	6.76E-03	-	5.09E-03	0%	33%
Beryllium & compounds	-	1.70E-03	-	1.70E-03	0%	0%
Cadmium & compounds	-	6.47E-03	-	6.47E-03	0%	0%
Carbon monoxide	6.54E+01	1.72E+04	6.54E+01	1.10E+04	0%	56%
Chromium (III) compounds	-	6.94E-02	--	6.94E-02	0%	0%
Chromium (VI) compounds	-	7.55E-02	-	7.55E-02	0%	0%
Copper & compounds	-	3.93E-02	-	2.77E-02	0%	42%
Fluoride compounds	-	-	-	-	0%	0%

Substance	2014		2012		% Difference	
	Fugitive (mg/s)	Point (mg/s)	Fugitive (mg/s)	Point (mg/s)	Fugitive	Point
Lead & compounds	-	2.16E-02	-	1.33E-02	0%	62%
Mercury & compounds	-	3.55E-03	-	4.98E-03	0%	-29%
Nickel & compounds	-	9.30E-02	-	3.24E-02	0%	187%
Oxides of Nitrogen	2.12E+02	6.01E+03	2.12E+02	3.85E+03	0%	56%
Particulate Matter 10.0 um	3.89E+01	1.12E+02	1.94E+01	1.12E+02	100%	0%
Particulate Matter 2.5 um	1.79E+01	8.42E+01	1.79E+01	8.42E+01	0%	0%
Polycyclic aromatic hydrocarbons (B[a]Peq)	1.12E-02	9.71E-01	1.12E-02	9.71E-01	0%	0%
Sulfur dioxide	1.35E-01	1.72E+03	1.35E-01	1.10E+03	0%	56%
Total Volatile Organic Compounds	2.86E+01	2.78E+02	2.86E+01	1.45E+02	0%	91%
Hydrogen Sulphide H2S	-	4.22E+01	-	-	0%	New
Sulpuric acid	-	8.59E+01	-	5.50E+01	0%	56%
Total particulates	-	8.59E+02	-	5.50E+02	0%	56%
Xylenes (individual or mixed isomers)	-	2.54E+00	-	-	0%	New
Zinc and compounds	-	2.66E-01	-	-	0%	New
Benzene	-	7.57E+00	-	-	0%	New
Formaldehyde (methyl aldehyde)	9.30E-01	2.27E+01	-	-	New	New
n-Hexane	-	2.18E+02	-	-	0%	New
Manganese & compounds	-	6.76E-02	-	-	0%	New
Polychlorinated dioxins and furans (TEQ)	-	-	-	-	0%	0%
Toluene (methylbenzene)	-	1.27E+00	-	-	0%	New
Odour[(1)]	2.29E+03	2.63E+04	1.27E+03	1.68E+04	81%	56%

Notes: (1): in units of odour units x cubic meters per second (OU m^3/s).

E.4.1 Pollutant Risk Ranking

A pollutant risk ranking exercise (refer to Section B.3) was undertaken based on the emissions inventories developed in Section E.4.

As noted in Section B.3, the methodology adopted, strictly speaking only applies to emissions of pollutants from emission sources of identical (or very similar) source characteristics. Thus for the BCC asphalt plant, two pollutant risk ranking exercises were undertaken: one for fugitive emissions and one for point source emissions.

Results of the pollutant ranking exercise for fugitive emission sources highlights oxides of nitrogen, particulate matter as $PM_{2.5}$ and particulate matter as PM_{10} as the three highest risk pollutants.

Table 42: Pollutant Risk Ranking – Fugitive Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Benzo(a)pyrene	annual	health	Qld EPP(Air)	3.00E-04	6.75E-07	0.001	7
Carbon monoxide	8 hour	health	Qld EPP(Air)	1.13E+04	6.54E+01	0.002	5
Formaldehyde	3 minute	carcinogen	Vic EPA	4.37E+01	9.30E-01	0.006	4
Nitrogen oxides	annual	health	Air NEPM	6.20E+01	2.12E+02	1.000	1
PM_{10}	24 hour	health	Air NEPM	5.00E+01	3.89E+01	0.227	3
$PM_{2.5}$	annual	advisory	Air NEPM	8.00E+00	1.79E+01	0.653	2
Sulfur dioxide	annual	health	Air NEPM	5.70E+01	1.35E-01	0.001	6

Results of the pollutant ranking exercise for the point source emissions highlights oxides of nitrogen, particulate matter as $PM_{2.5}$ and sulphur dioxide as the three highest risk pollutants.

Table 43: Pollutant Risk Ranking – Point Source Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Arsenic	annual	health	Qld EPP(Air)	6.00E-03	6.76E-03	0.012	10
Benzene	annual	health	Qld EPP(Air)	1.00E+01	7.57E+00	0.008	12
Benzo(a)pyrene	annual	health	Qld EPP(Air)	3.00E-04	5.96E-05	0.002	17
Beryllium	3 minute	carcinogen	Vic EPA	1.00E-02	1.70E-03	0.002	16
Cadmium	annual	health	Qld EPP(Air)	5.00E-03	6.50E-03	0.013	9
Carbon monoxide	8 hour	health	Qld EPP(Air)	1.13E+04	1.72E+04	0.016	8
Chromium	3 minute	carcinogen	Vic EPA	1.90E-01	1.45E-01	0.008	11
Copper	3 minute	toxicity	Vic EPA	7.31E+00	3.93E-02	0.000	22
Formaldehyde	3 minute	carcinogen	Vic EPA	4.40E+01	2.27E+01	0.005	13
Hexane, n-	3 minute	toxicity	Vic EPA	6.44E+03	2.18E+02	0.000	19
Hydrogen sulfide	24 hour	health	Qld EPP(Air)	1.60E+02	4.22E+01	0.003	15
Lead	annual	health	Qld EPP(Air)	5.00E-01	2.16E-02	0.000	18
Manganese	annual	health	Qld EPP(Air)	1.60E-01	6.76E-02	0.004	14
Mercury	3 minute	bioaccumulation	Vic EPA	3.60E-01	5.00E-03	0.000	20
Nickel	annual	health	Qld EPP(Air)	2.00E-02	9.30E-02	0.048	6
Nitrogen oxides	annual	health	Air NEPM	6.20E+01	6.01E+03	1.000	1
PM_{10}	24 hour	health	Air NEPM	5.00E+01	8.59E+02	0.177	4
$PM_{2.5}$	annual	advisory	Air NEPM	8.00E+00	6.44E+02	0.830	2
Sulfur dioxide	annual	agriculture	Qld EPP(Air)	3.10E+01	1.72E+03	0.565	3
Toluene	annual	health	Qld EPP(Air)	4.10E+02	1.27E+00	0.000	23
TSP	annual	health	Qld EPP(Air)	9.00E+01	8.59E+02	0.098	5
Xylenes (Total)	annual	health	Qld EPP(Air)	9.50E+02	2.54E+00	0.000	24
Zinc	3 minute	toxicity	Vic EPA	3.60E+01	2.66E-01	0.000	21
Sulphuric Acid	3-minute	toxicity	Vic EPA	3.60E+01	8.59E+01	0.025	7

E.5 Dispersion Modelling

Dispersion modelling of the BCC asphalt facility for fugitive and point sources was undertaken using five years of meteorology (Appendix KK) for the emission rates developed in Section E.4.

E.5.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix NK. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix F Facility #5: Boral Whinstanes Asphalt Plant

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the Boral Whinstanes asphalt plant.

Detailed and comprehensive facility information was provided by Boral for use in this assessment but has not been included due to its commercial sensitivity.

Figure 4: Facility Map - Boral Whinstanes Asphalt Plant.

F.1 Facility Details

Table 44: Facility Details - Boral Whinstanes Asphalt Plant.

Property	Description
Address	Cullen Avenue West, WHINSTANES QLD 4007
Lot and Plan	Lot 25 Plan RP857071
Aspect of Development	ERA 6 Asphalt manufacturing Threshold (b) – manufacturing in a year 1000t or more of asphalt ERA 21 Motor Vehicle Workshop Operations – operating a workshop on a commercial

	basis or in the course of carrying on a commercial enterprise involving maintaining mechanical components, engine cooling radiators or body panels; spray-painting body panels; and detailing or washing relating to motor vehicles ERA 8 (3a) Chemical Storage – for storing 10 m3 to 500 m3 of chemicals of C1 and C2 combustible liquids under AS 1940 or Dangerous Goods Class 3

F.2 Licence conditions

Table 45: Licence Conditions Relevant to Air Quality: EPA Permit Number: IPDE01331609.

Condition	Description
Agency Interest: Air	
A1	Odour management plan The development approval holder must develop and implement the odour management plan. This plan must be prepared to ensure that odour does not cause a nuisance at any nuisance sensitive place. (a) Objectives/targets for what is intended to be achieved; (b) Management strategies for the overall approach to be taken to meet/maintain the stated objectives/targets; (c) Management strategies to minimise odour at the source(s); (d) Tasks/actions required to implement the nominated strategies, including any necessary approval applications and consultations; (e) Performance indicators against which the level of achievement of the stated objectives/targets will be measured; (f) Monitoring of odour at the source(s); (g) Frequency/deadline or time frame in which each of the tasks/actions is to be carried out and/or completed; (h) Responsible person/organisation for carrying out each task/action; (i) Reporting and review arrangements (including any auditing) for each task: how often; and to whom; and (j) Corrective actions to be undertaken if the stated objectives/targets are not being met or maintained, including who is responsible for taking required actions. Corrective actions may include end of pipe engineering improvements.
Odour Nuisance	
A2	Notwithstanding any other condition of this approval, the release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the activity must not cause any environmental nuisance at any nuisance sensitive place.
The release of contaminants to the atmosphere	
A3	The release of contaminants to the atmosphere from a point source must only occur from those release points identified in Table 'I and must be directed vertically upwards without any impedance or hindrance.
A4	Contaminants must be released to the atmosphere from a release point at a height and a flow rate not less than the corresponding height and velocity stated for that release point in Table 1.
A5	Contaminants must not be released to the atmosphere from a release point at a mass emission rate/concentration, as measured at a monitoring point, in excess of that stated in Table 1 and monitored not less frequently than Table 2.

Monitoring of Contaminant Releases to the Atmosphere	
A6	The holder of this approval must conduct and keep records of a monitoring program of contaminant releases to the atmosphere at the release points, frequency. and for the parameter specified in Table 2 and which complies with the following: (a) Monitoring provision for the release points listed in Table 2 must comply with the Australian Standard AS 4323.1 ~ 1995 "Stationary source emissions Method 1: Selection of sampling provisions". (b) All determinations of contaminant releases to the atmosphere must be made in accordance with methods prescribed in the most recent version of the Environmental Protection Agency's Air Quality Sampling Manual. If monitoring requirements for specific contaminants are not described in the Environmental Protection Agency's Air Quality Sampling Manual, monitoring protocols must be in accordance with; (i) for odour, Australian and New Zealand Standard ASINZS 4323.3:2001, Stationary source emissions - Determination of odour concentration by dynamic olfactometry; and (ii) for other contaminants, a method as approved by New South Wales DEC/EPA, Victorian EPA or United States EPA. (c) The following tests must be performed for each required determination specified in Table 2: (i) gas velocity and volume flow rate; (ii) temperature and oxygen content; (iii) water vapour concentration (d) Where practicable samples taken must be representative of the contaminants discharged when emissions are expected to be at maximum rates. (e) During the sampling period the following additional information must be gathered: (i) plant throughput rate at the time of sampling; (ii) fuel type and consumption rate; (iii) any atypical factors that may influence odour and particulates emissions; (iv) the odour and particulates treatment system operating, system status and rate; and (v) reference to the actual test methods and accuracy.
Fuel Burning	
A7	The only fuels which are to be used in industrial fuel burning equipment are gas and distillate.
Scrubber	
A8	Effluent gases, dust and vapours from the dryer must be effectively collected by the extraction systems serving the plant and must be treated by a Baghouse to effectively minimize the release of air pollutants and ensure compliance with this development approval.
A9	All contaminants (exhaust gases) arising from the operation of the asphalt plant's rotary drum drier must be treated by a baghouse prior to release to the atmosphere at release point RP1.
A10	All collected material removed from a scrubber must be recycled, or removed and disposed of to a facility that can lawfully accept such wastes.
Dust Nuisance	
A11	The release of dust and/or particulate matter resulting from the ERA must not cause an environmental nuisance at any nuisance sensitive or commercial place.
A12	Dust and particulate matter must not exceed any of the following levels when measured at any nuisance sensitive place: (a) Dust deposition of 120 milligrams per square metre per day over a 30-days averaging period, when DEHP Condition Boral Submission monitored in accordance with Australian Standard AS 3580.101 of 2003 (or more recent editions); OR

	(b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (μm) (PM10) suspended in the atmosphere of: (i) 50 micrograms per cubic metre (with five one day exceedences allowed in any one year period. These 5 days exceedences per year are based on the natural events such as bushfires and dust storm); (ii) Within the General Industry / Business Enterprise Park 150 micrograms per cubic metre. when monitored in accordance with: (a) Australian Standard AS 3580.9.6 of 2003 (or more recent editions) 'Ambient air - particulate matter - Determination of suspended particulate PM10 high-volume sampler with size-selective inlet — Gravimetric method'; or (b) Any alternative method of monitoring PM10 which may be permitted by the 'Air Quality Sampling Manual' as published from time to time by the administering authority.
A13	When requested by the administering authority, dust and particulate monitoring must be undertaken to investigate any complaint of environmental nuisance caused by dust and/or particulate matter, and the results notified within 14 business days to the administering authority following completion of monitoring. Monitoring must be carried out at a place(s) relevant to the potentially affected dust sensitive place and at upwind control sites and must include: (a) for a complaint alleging dust nuisance, dust deposition; and (b) for a complaint alleging adverse health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (μm) (PM10) suspended in the atmosphere over a 24hr averaging time.
General Dust Control	
A14	For the purpose of avoiding any release of dust or particulate matter from the approved place which could cause an environmental nuisance, the following measures must be taken: (a) stockpiles must be maintained using all reasonable and practicable measures to minimise the release of wind-blown dust or particulate matter to the atmosphere. Reasonable and practicable measures may include, but are not limited to, anemometer switching systems which trigger operation of effective water spray systems during winds likely to generate such releases; use of approved dust suppressants; shielding and storage in bunkers; and (b) Trafficable areas must be maintained using all reasonable and practicable measures to minimise the release of windblown dust or traffic generated dust to the atmosphere. Reasonable and practicable measures may include, but are not limited to, sealing with bitumen or other suitable material; keeping surfaces clean; use of water sprays; adoption and adherence to speed limits (less than 15 kph); use of approved dust suppressants; and wind breaks; and (c) Raw material preparation plants and external transfer conveyors must be operated and maintained using all reasonable and practicable measures to minimise the release of wind-blown dust or particulate matter to the atmosphere. Reasonable and practicable measures may include, but are not limited to, transfer of materials in a moist state; enclosure or sealing of conveyors; use of water sprays at transfer points; shielding; and wind breaks.
Dust Control – Aggregate and Sand Transport Trucks	
A15	The registered operator must take all reasonable and practicable measures necessary to prevent spillage and/or loss of particulate matter and windblown dust from trucks used for transporting aggregates and sand to the approved place. Reasonable and practicable measures may include but are not limited to: (a) wetting down the load prior to transport; (b) having the entire load covered with a tarpaulin or similar material prior to departure to the

	approved place, and (c) clearing of spillage from side rails, tail gates and draw bars of trucks prior to departure to the approved place.
Dust Control – Filler (Fly Ash and Lime) Transport Trucks	
A16	The registered operator must take all reasonable and practicable measures necessary to prevent spillage and/or loss of particulate matter and windblown dust from trucks used for transporting 'fly ash and lime' to the approved place. Reasonable and practicable measures may include but are not limited to the use of pneumatic tankers.
Dust and Odour Control – Asphalt Transport Trucks	
A17	The registered operator must take all reasonable and practicable measures necessary to prevent spillage and/or loss and/or odour of particulate matter and asphalt from trucks used for transporting 'asphalt' from the approved place. Reasonable and practicable measures may include but are not limited to the use of fabric load covers. Any spilled material must be cleaned up as quickly as possible.
Dust Control – Loading, Transfer and Unloading of Materials	
A18	The registered operator must take all reasonable and practicable measures necessary to minimise the release of windblown dust and particulate matter emission to the atmosphere during the loading, transfer and unloading of materials. Reasonable and practicable measures may include but are not limited to; (a) Use of water sprays at transfer points. (b) Use of shielding and windbreaks. (c) Transfer of material in a moist state. (d) Use of dust collection and treatment systems.
Odour complaint investigation and monitoring	
A19	When requested by the administering authority, monitoring must be undertaken to investigate any complaint of environmental nuisance caused by a release to the atmosphere from a release point at the site, and the results thereof notified to the administering authority within 14 business days following completion of monitoring.
A20	If the administering authority requests monitoring to determine contaminant releases to the atmosphere, all monitoring must be performed by an independent person or body possessing appropriate experience and qualifications to perform the required measurements. Odour stack monitoring must be conducted in accordance with Australian and New Zealand Standard AS/NZS 4323.3:2001, Stationary source emissions - Determination of odour concentration by dynamic olfactometry; and for any other odorant gases, a method as approved by Queensland, New South Wales or Victorian Environmental Departments.
A21	If monitoring indicates that environmental nuisance is caused or threatened by odour release from the activities, then the registered operator must: (a) advise the administering authority of planned odour abatement measures; and (b) as soon as practicable implement odour abatement measures such that the release of odour from the activity will not result in further environmental nuisance.
A22	The ducting and extraction systems that transfer odorous gases and vapours from one location to another must be constructed, operated and maintained so that no leakage of odorous gases and vapours to the atmosphere occurs from these sources.
A23	Gases and vapours from the bitumen tanks must be effectively collected and efficiently treated using activated carbon filter (or technology of a proven greater efficiency) to minimise the concentration of noxious and/or offensive gases and odours prior to any release to the atmosphere.

A24	The activated carbon filter(s), the bitumen tanks and other source equipment; and control device must be maintain as specified in manufacturer's specifications and in a manner to prevent or minimise the release of contaminants to the atmosphere. A carbon filter maintenance procedure must be prepared and implemented in accordance with the manufactures operating instructions/specifications.
A25	The activated carbon filter must be replaced when it saturated with the VOCs and efficiency is reduced below the manufacturers' specifications.

Table 46: Agency Interest Air - Table 1. EPA Permit Number: IPDE01331609.

Contaminants Release to Air				
Release Point Number	**Minimum Release Height (metres)**	**Minimum velocity (m/s)**	**Contaminant release**	**Maximum release limit**
RP1 – Baghouse Filter Stack	18.3	20	Total Solid Particulates	150 mg/Nm^3 (dry)
			Particulate Matter < 10 microns (PM10)	135 mg/Nm^3 (dry)
			Carbon Monoxide (CO)	150 mg/Nm^3 (dry)
			Oxides of Nitrogen (NO_X)	50 mg/Nm^3 (dry) at 15% O_2
			Volatile Organic Compounds (VOC)	150 mg/Nm^3 (dry) at 15% O_2
			Odour	1600 ou (wet)
			Smoke	Ringelmann 1 except for 5 minutes after initial start-up where Ringelmann 3 is allowed.

Note 1: The above total heavy metal limit is for the total of lead, cadmium, mercury, chromium, arsenic, nickel and beryllium.
Note 2: The above smoke limit does not include the release of clean water vapour.

Table 47: Agency Interest Air - Table 2. EPA Permit Number: IPDE01331609.

Required Release Point Determination		
Determination Required	**Release Point Numbers**	**Frequency**
Smoke	RP1-Baghouse Filter Stack	Visually inspected hourly and recorded if the maximum release limit in Table 1 is exceeded.
Total Solid Particulates	RP1-Baghouse Filter Stack	RP1 must be monitored within three months of commencement of this development approval and then annually thereafter (see note 1)
Particulate Matter < 10 microns (PM10)		
Carbon Monoxide (CO)		
Oxides of Nitrogen (NO_X)		
Volatile Organic Compounds (VOC)		
Odour		

Note 1: Within three months of commencement this development approval, the holder of this development approval must conduct air emission monitoring to demonstrate compliance with air emissions limits listed in Table 1.

F.3 NPI Reports for the Boral Whinstanes Asphalt Plant

Presented in the following tables are the previous six years of NPI reports for the Boral Whinstanes asphalt plant.

Table 48: 2012/2013 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	23370.8	267.8	23103.0
Fluoride compounds	2.7	2.7	0.0
Oxides of Nitrogen	2621.6	854.9	1766.7
Particulate Matter 10.0 um	4430.7	3098.9	1331.8
Particulate Matter 2.5 um	66.0	66.0	0.0
Polycyclic aromatic hydrocarbons (B[a]Peq)	0.0	0.0	0.0
Sulphur dioxide	340.3	0.5	339.8
Total Volatile Organic Compounds	1091.8	113.3	978.5
Zinc and compounds	1.26	0.80	0.46
Chromium (III) compounds	1.12	1.06	0.06
Copper & compounds	24.9	0.5	24.5
Manganese & compounds	8.64	7.96	0.68
Mercury & compounds	0.03	0.00	0.03
Nickel & compounds	1.08	0.80	0.29

Table 49: 2011/2012 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	35108.9	386.9	34722.0
Fluoride compounds	0.0	0.0	0.0
Oxides of Nitrogen	3944.7	1289.5	2655.2
Particulate Matter 10.0 um	138.2	118.2	20.0
Particulate Matter 2.5 um	106.4	106.4	
Polycyclic aromatic hydrocarbons (B[a]Peq)	12.9	0.1	12.9
Sulphur dioxide	102.9	0.8	102.1
Total Volatile Organic Compounds	466.0	171.9	294.1

Table 50: 2010/2011 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	35919.8	598.8	35321
Fluoride compounds	0.0237	0.0	0.0237
Oxides of Nitrogen	4696.8	1995.8	2701
Particulate Matter 10.0 um	202.9	182.9	20
Particulate Matter 2.5 um	164.7	164.7	0.0
Polycyclic aromatic hydrocarbons (B[a]Peq)	13.1	0.103	13
Sulphur dioxide	520.3	1.25	519.0
Total Volatile Organic Compounds	565.1	266.1	299.0

Table 51: 2009/2010 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	35007	484	34523
Fluoride compounds	0.023		0.023
Oxides of Nitrogen	4252	1612	2640
Particulate Matter 10.0 um	168	148	20
Particulate Matter 2.5 um	133	133	
Polycyclic aromatic hydrocarbons (B[a]Peq)	13.08	0.083	13
Sulphur dioxide	509.0	1.0	508.0
Total Volatile Organic Compounds	507	215	292

Table 52: 2008/2009 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	31889	440	31449
Fluoride compounds	0.021		0.021
Oxides of Nitrogen	3870	1465	2405
Particulate Matter 10.0 um	152.3	134.3	18
Particulate Matter 2.5 um	120.9	120.9	
Polycyclic aromatic hydrocarbons (B[a]Peq)	12.08	0.076	12
Sulphur dioxide	462.9	0.916	462
Total Volatile Organic Compounds	461.4	195.4	266

Table 53: 2007/2008 NPI Report - Boral Whinstanes Asphalt Plant.

Substance	Air Total (kg)	Air Fugitive (kg)	Air Point (kg)
Carbon monoxide	22279	238	22041
Fluoride compounds	0.0148		0.0148
Oxides of Nitrogen	2477	792	1685
Particulate Matter 10.0 um	85.3	72.6	12.7
Particulate Matter 2.5 um	65.3	65.3	
Polycyclic aromatic hydrocarbons (B[a]Peq)	8.21	0.04	8.17
Sulphur dioxide	324.5	0.495	324
Total Volatile Organic Compounds	292.3	105.6	186.7

F.4 Site-Based Emissions Inventory

A site-based emissions inventory was developed using a combination of the maximum annual emissions for each of the previous four years of NPI reporting presented in Section F.3, site licence conditions (Section F.2) and stack testing results.

For the case of emissions of pollutants from the Boral asphalt plant, the key sources of emissions will be associated with fugitive and point sources.

Detailed site-specific information was provided by Boral. Thus the emissions inventory was developed using a combination of publically available and site-specific information.

Presented in Table 27 is a summary of the emissions inventory adopted for the Boral asphalt plant.

Table 54: Emissions Inventory for the Boral Asphalt Plant.

Substance	2014		2012		% Difference	
	Fugitive (mg/s)	Stack (mg/s)	Fugitive (mg/s)	Stack (mg/s)	Fugitive	Stack
Carbon monoxide	2.76E+01	1.63E+03	2.76E+01	1.63E+03	0%	0%
Fluoride compounds	1.25E-01	1.09E-03	-	1.09E-03	New	0%
Hydrochloric acid	-	-	-	-	0%	0%
Oxides of Nitrogen	9.19E+01	3.35E+02	9.19E+01	3.35E+02	0%	0%
Particulate Matter 10.0 um	4.91E+01	9.03E+02	8.42E+00	9.03E+02	483%	0%
Particulate Matter 2.5 um	7.58E+00	6.77E+02	7.58E+00	6.77E+02	0%	0%
Polycyclic aromatic hydrocarbons (B[a]Peq)	4.75E-03	5.98E-01	4.75E-03	5.98E-01	0%	0%
Sulfur dioxide	5.74E-02	2.39E+01	5.74E-02	2.39E+01	0%	0%
Total Volatile Organic Compounds	1.22E+01	1.00E+03	1.22E+01	1.00E+03	0%	0%
TSP	-	1.00E+03	-	1.00E+03	0%	0%
Arsenic	-	4.11E-02	-	2.08E-02	0%	97%
Beryllium	-	3.08E-03	-	3.92E-04	0%	686%
Cadmium	-	6.18E-03	-	6.18E-03	0%	0%
Chromium	-	1.38E-01	-	1.38E-01	0%	0%
Lead	-	4.33E-02	-	3.43E-02	0%	26%
Nickel	-	7.85E-02	-	7.85E-02	0%	0%
Mercury	-	1.54E-02	-	1.28E-02	0%	20%
Odour[(1)]	4.97E+03	1.71E+04	4.97E+03	1.71E+04	0%	0%
Zinc and compounds	-	5.79E-02	-	-	0%	New
Chromium (III) compounds	-	5.16E-02	-	-	0%	New
Manganese & compounds	-	3.98E-01	-	-	0%	New

Notes: (1): in units of odour units x cubic meters per second (OU m^3/s).

F.4.1 Pollutant Risk Ranking

A pollutant risk ranking exercise (refer to Section B.3) was undertaken based on the emissions inventories developed in Section F.4.

As noted in Section B.3, the methodology adopted, strictly speaking only applies to emissions of pollutants from emission sources of identical (or very similar) source characteristics. Thus for the Boral asphalt plant, two pollutant risk ranking exercises were undertaken: one for fugitive emissions and one for point source emissions.

Results of the pollutant ranking exercise for fugitive emission sources highlights oxides of nitrogen, particulate matter as $PM_{2.5}$ and particulate matter as PM_{10} as the three highest risk pollutants.

Table 55: Pollutant Risk Ranking – Fugitive Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Benzo(a)pyrene	annual	health	Qld EPP(Air)	3.00E-04	2.88E-07	0.001	7
Carbon monoxide	8 hour	health	Qld EPP(Air)	1.13E+04	2.76E+01	0.002	5
Fluoride	90 day	bioaccumulation	Vic EPA	5.46E-01	1.25E-01	0.154	4
Nitrogen oxides	annual	health	Air NEPM	6.20E+01	9.19E+01	1.000	1
PM_{10}	24 hour	health	Air NEPM	5.00E+01	4.91E+01	0.663	2
$PM_{2.5}$	annual	advisory	Air NEPM	8.00E+00	7.58E+00	0.640	3
Sulfur dioxide	annual	health	Air NEPM	5.70E+01	6.00E-02	0.001	6

Results of the pollutant ranking exercise for point source emissions highlights particulate matter as $PM_{2.5}$, particulate matter as PM_{10}, and TSP as the three highest risk pollutants.

Table 56: Pollutant Risk Ranking – Point Source Emissions.

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Arsenic	annual	health	Qld EPP(Air)	6.00E-03	4.11E-02	0.081	4
Benzo(a)pyrene	annual	health	Qld EPP(Air)	3.00E-04	3.67E-05	0.001	14
Beryllium	3 minute	carcinogen	Vic EPA	7.64E-03	3.08E-03	0.005	11
Cadmium	annual	health	Qld EPP(Air)	5.00E-03	6.18E-03	0.015	8
Carbon monoxide	8 hour	health	Qld EPP(Air)	1.13E+04	1.63E+03	0.002	13
Chromium	3 minute	carcinogen	Vic EPA	1.86E-01	1.38E-01	0.009	9
Copper	3 minute	toxicity	Vic EPA	7.31E+00	1.15E+00	0.002	12
Fluoride	90 day	bioaccumulation	Vic EPA	5.46E-01	1.09E-03	0.000	17
Lead	annual	health	Qld EPP(Air)	5.00E-01	4.33E-02	0.001	15
Manganese	annual	health	Qld EPP(Air)	1.60E-01	3.98E-01	0.029	7
Mercury	3 minute	bioaccumulation	Vic EPA	3.60E-01	1.54E-02	0.001	16
Nickel	annual	health	Qld EPP(Air)	2.00E-02	7.85E-02	0.046	6

Substance	Averaging Period	Environmental Value	Source	Criteria (mg/s)	Emission Rate (mg/s)	Relative Risk	Risk Ranking
Nitrogen oxides	annual	health	Air NEPM	6.20E+01	3.35E+02	0.064	5
PM_{10}	24 hour	health	Air NEPM	5.00E+01	9.03E+02	0.213	2
$PM_{2.5}$	annual	advisory	Air NEPM	8.00E+00	6.77E+02	1.000	1
Sulfur dioxide	annual	health	Air NEPM	5.70E+01	2.39E+01	0.005	10
TSP	annual	health	Qld EPP(Air)	9.00E+01	1.00E+03	0.132	3
Zinc	3 minute	toxicity	Vic EPA	3.60E+01	5.79E-02	0.000	18

F.5 Dispersion Modelling

Dispersion modelling of the Boral asphalt facility for fugitive and point sources was undertaken using five years of meteorology (Appendix KK) for the emission rates developed in Section E.4.

F.5.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix G Facility #5: Boral Whinstanes Concrete Batching Plant

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the Boral Whinstanes concrete batching plant.

Detailed and comprehensive facility information was provided by Boral for use in this assessment but has not been included due to its commercial sensitivity.

Figure 5: Facility Map - Boral Whinstanes Concrete Batching Plant.

G.1 Facility Details

Table 57: Facility Details - Boral Whinstanes Concrete Batching Plant.

Property	Description
Address	208 Curtin Avenue West, Eagle Farm QLD 4009
Lot and Plan	Lot 25 Plan RP857071
Aspect of Development	ERA 62 Concrete Batching – Producing concrete or a concrete product by mixing cement, sand, rock, aggregate or similar materials in works (including mobile works) having a design production capacity of more than 100 t per year

G.2 Licence conditions

Table 58: Licence Conditions Relevant to Air Quality: EPA Permit Number: SR0431DA.

Condition	Description
Schedule B - Air	
Release of Contaminants to the Atmosphere	
(B1)	The release of contaminants to the atmosphere must only occur from those release points identified in Schedule B – Table 1.
(B2)	Contaminants must not be released to the atmosphere from a release point at a flow rate and a concentration in excess of that stated in Schedule B – Table 1
Dust Nuisance	
(B2-1)	The release of dust and/or particulate matter resulting from the activity must not cause an environmental nuisance at any dust sensitive place.
(B2-2)	Excedeence of any of the following levels when measured at any dust sensitive place is an environmental nuisance for the purposes of condition 82-1. - Dust deposition of 120 milligrams per square metre per day, when monitored in accordance with Australian Standard AS 3580.10 of 1991 ; OR - A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (PM10) suspended in the atmosphere of 150 micrograms per cubic metre over a 24 hour averaging time, at a dust sensitive place downwind of the site, when monitored in accordance with: - Australian Standard AS 3580.9.6'Ambient air - Particulate matter - Determination of suspended particulate PM10 high-volume sampler with size-selective inlet – Gravimetric method'; or - any alternative method of monitoring PM10 which may be permitted by the 'Air Quality Sampling Manual' as published from time to time by the administering authority.
(B2-3)	When requested by the Administering Authority, dust and particulate monitoring must be undertaken to investigate any complaint of environmental nuisance caused by dust and/or particulate matter, and the results notified within 14 days to the administering authority following completion of monitoring. Monitoring must be carried out at a place(s) relevant to the potentially affected dust sensitive place and at upwind control sites and must include: - for a complaint alleging dust nuisance, dust deposition; and - for a complaint alleging adverse health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (PM10) suspended in the atmosphere over a 24hr averaging time.

Table 59: Schedule B – Table 1. EPA Permit Number: SR0431DA.

Release Point Number	Contaminant	Concentration
Silo 1 – Filter Bag	Particulate matter	50 mg/m^3
Silo 2 – Filter Bag	Particulate matter	50 mg/m^3
Silo 3 – Filter Bag	Particulate matter	50 mg/m^3
Silo 4 – Filter Bag	Particulate matter	50 mg/m^3
Silo 5 – Filter Bag	Particulate matter	50 mg/m^3
Silo 6 – Filter Bag	Particulate matter	50 mg/m^3
Batching Plant Filter Bag	Particulate matter	50 mg/m^3

G.3 Site-Based Emissions Inventory

A site based emissions inventory was developed for fugitive emissions associated with material handling based on information obtained during the site-visit and estimates of fugitive emissions for the Boral asphalt facility as reported to NPI and used to develop its site-based emissions inventory (Section F.4)

Emission rates for particulate matter for fugitive emissions only were developed.

G.4 Dispersion Modelling

Dispersion modelling of the Boral concrete facility for fugitive emission sources was undertaken using five years of meteorology (Appendix KK) for the emission rates developed in Section E.4.

G.4.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix H Facility #10: CP Plating

This appendix summarises the publically available information used to assess the potential air quality constraints associated with activities associated with CP Plating Pty Ltd.

Detailed facility information was provided by CP Plating for use in this assessment but has not been included due to its commercial sensitivity.

Figure 6: Facility Map - CP Plating.

H.1 Facility Details

Table 60: Facility Details - CP Plating.

Property	Description
Address	222 Macarthur Ave, Hamilton, QLD, 4007
Lot and Plan	L.848 SL.4269 PAR TOOMBUL
Aspect of Development	Activity: 38 (21) – Surface Coating – coating, painting or powder coating, using in a year, the following quantity of surface coating materials – up to 100t

H.2 Licence conditions

Registration Certificate No. A003351377, effective date 24 June 2012, anniversary date: 23 June 2012.

No licence conditions related to air quality.

H.3 Development of Site-Based Emissions Inventory

A site-based emissions inventory was developed for emissions of zinc and sulphuric acid based on confidential information provided by CP Plating.

There was insufficient information provided to develop an emissions inventory in relation to spray painting/powder coating activities that occur on site. When assessing air quality constraints associated with these activities, a regulatory prescribed industry-related buffer zone approach was adopted.

H.4 Dispersion Modelling

Dispersion modelling of fugitive emissions sources associated with activities at CP Plating was undertaken using five years of meteorology (Appendix KK) for the emission rates developed as part of Section E.4.

H.4.1 Results of the Dispersion Modelling

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix I Caltex Service Stations

This appendix summarises the publically available information used to assess the potential air quality constraints associated with the Caltex service stations located on Kingsford Smith Drive and Hercules Street.

Publically available information was used for the purposes of assessing the potential constraints associated with these facilities.

These facilities were assessed in an air quality assessment undertaken by Vipac (2009) in support of the Hamilton Harbour Development. Information contained in Vipac (2009) combined with emission factors from the NPI EETM (2012b) *Emission Estimation Technique Manual for Aggregated Emissions from Service Stations, National Pollution Inventory version 1.0* were used to develop an emissions inventory for each of the two facilities.

I.1 Facility # 1 Caltex Petrol Station Kingsford Smith Drive

This section presents information and constraints associated with the Caltex service station located on Kingsford Smith Drive, in close proximity to the Puma Energy and BP bulk fuel storage facilities.

Figure 7: Facility Map - Caltex Petrol Station Kingsford Smith Drive.

Table 61: Facility Details - Caltex Petrol Station Kingsford Smith Drive.

Property	Description
Address	647 Kingsford Smith Drive, Eagle Farm QLD 4009
Lot and Plan	Lot 1030 on SL6844, Parish of Toombul
Aspect of Development	Material change of use – Development permit ERA 11 – Petroleum storage (capacity more than 10,000 L and less than 500,000L)

I.1.1 Licence conditions

Table 62: Licence Conditions Relevant to Air Quality: Council File Reference DRS/USE/H05-922483.

Condition	Description
Standard Conditions	
Release of Contaminants to the Atmosphere	
1	Unless otherwise specified in this approval, the emissions to air from the site must not cause concentrations of air pollutants at or beyond the boundary of the site to exceed either: • The Standards and Goals specified in Schedule 2 of the National Environment Protection Measure - Ambient Air Quality; or • The Air Quality Indicators specified in Schedule 1 of Queensland Environmental Protection (Air) Policy 1997; or • The Air Quality Objectives and Indicators specified in Schedules B, C and D of the Victorian State Environment Protection Policy (The Air Environment). Where the above listed documents specify different Air Quality Indicators, Standards, or Goals for a particular air pollutant, the most stringent must be used. Unless otherwise specified, the impact of the site emissions on ambient air quality at or beyond the boundary of the site may be determined by either monitoring or modelling. *GUIDELINE* *This condition is imposed where air quality may be affected as a result of the development.*
2	The holder of this environmental authority must not release odour and visible contaminants, including dust, smoke, fumes and aerosols to the environment which causes an environmental nuisance.
16	Loading, unloading and refuelling activities are to be limited to between the hours of 4.30 am - 9.00 pm Monday to Friday and 6:00 am - 8:00pm Saturday to Sunday.
PETROLEUM PRODUCT STORAGE	
29	This approval only permits the storage of the following materials and quantities: • 1x42,000 L u/tank of ULP, • 1x22,500 L u/tank of ULP; • 1x22,500 L u/tank of Vortex, • 1x18,500 L u/tank of Vortex; • 1x13,500 L u/tank of Vortex; and • 1x42,000 L u/tank of Diesel.
30	Where motor spirit is to be transferred from a delivery tank to an underground fuel tank, the underground tank shall be fitted with the following equipment: (a) a coupling on the fill pipe that makes a liquid-tight connection with the transfer hose on the delivery tank (b) a vapour transfer system through which vapours displaced by the transfer of liquids into the tank are returned to the delivery tank being unloaded by means of: a vapour return line of vapour-tight construction that has an internal diameter of not less than 65% of the minimum internal diameter of the fill pipe; and a coupling on the vapour return line that makes a vapour-tight connection with the relevant fitting on the vapour return hose connected to the delivery tank. (when vapour recovery system is installed) (c) a spring loaded vapour return adaptor, which closes when the hose is disconnected,

	shall be installed in the top of the riser (when vapour recovery system is installed) (d) the vapour recovery point shall be located within 2 metres of the respective fill point. (when vapour recovery system is installed) (e) mixing of product is prevented in piping common to more than one tank. (f) in the case of a tank that is gravity filled, an overfill protection device system shall be provided. This device shall stop the flow of into the tank before there is insufficient space in that tank to receive the contents of the transfer hose on the delivery tank.
32	(i) Stage 1 vapour recovery shall be installed on all tanks used for the storage of motor spirits on this site (within 3 years from the date of this approval). Only tanks which are equipped with vapour recovery shall be used for the storage of motor spirit. (Tanks which currently store distillate cannot be used for the storage of motor spirit unless the tank is equipped with vapour recovery). (iii) Establish, implement, maintain and review procedures for the operation and maintenance of vapour recovery systems in accordance with the manufacturer's specifications. (iii) The owner/occupier of UPS System must not allow transfer of motor spirit from a delivery vehicle to underground tanks unless the delivery vehicle is fitted with vapour recovery equipment and the equipment operated in an efficient manner when transferring motor spirit from delivery vehicle to an UPS system.

I.1.2 Emissions Inventory

Parameters used to develop the emissions inventory for the Kingsford Smith Drive Caltex service station are summarised in Table 63.

Table 63: Parameters used to Develop the Emissions Inventory.

Parameter	Value	Units
Daily throughput	31,200	Litres
Peak hour throughput	3,000	Litres per hour

Based on the emission factors volatile organic compounds associated with tank refilling, tank breathing, spillage and vehicle refuelling included in the NPI EETM (2012b), emission rates of benzene, toluene and styrene were developed and are summarised in Table 64.

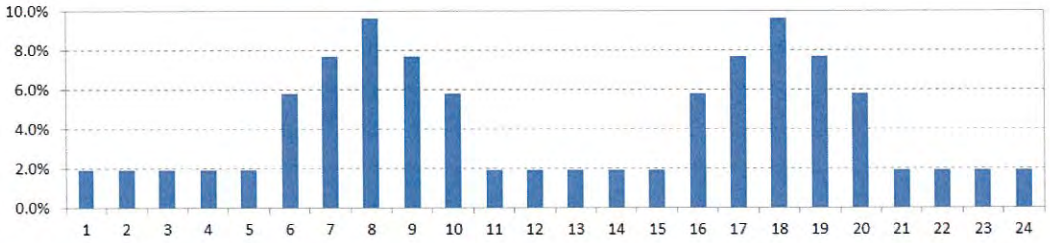
Results from a pollutant risk ranking highlights benzene as the highest risk pollutant followed by toluene and styrene.

Table 64: Emissions Inventory for the Kingsford Smith Drive Caltex Service Station (2012 & 2014)

Substance	Fugitive Emission Rate (mg/s)	Pollutant Risk Ranking
Benzene	20.9	1
Styrene	0.1	3
Toluene	5.28	2

Figure 8 presents the assumed distribution of the daily demand on an hourly basis to account for peak and off peak hours that has been used in the dispersion modelling.

Figure 8: Assumed Hourly Demand based on Percentage of Daily Total - Caltex Petrol Station Kingsford Smith Drive.



I.1.3 Dispersion Modelling and Results

Dispersion modelling for fugitive emissions sources associated with this facility was undertaken using five years of meteorology (Appendix KK).

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

I.2 Facility #7: Caltex Petrol Station Hercules Street

This section presents information used to assess potential air quality constraints associated with activities at the Caltex truck refuelling station located at 18 Hercules Street, Hamilton.

Figure 9: Facility Map - Caltex Petrol Station Hercules Street.

I.2.1 Site Licence

A site licence was not provided for this facility.

I.2.2 Emissions Inventory

Parameters used to develop the emissions inventory for the Caltex service station on Hercules Street are summarised in Table 63.

Table 65: Parameters used to Develop the Emissions Inventory.

Parameter	Value	Units
Daily throughput	2,600	Litres
Peak hour throughput	250	Litres per hour

Based on the emission factors volatile organic compounds associated with tank refilling, tank breathing, spillage and vehicle refuelling included in the NPI EETM (2012b), *Emission Estimation Technique Manual for Aggregated Emissions from Service Stations, National Pollution Inventory version 1.0*, emission rates of benzene, toluene and styrene were developed and are summarised in Table 66.

Results from a pollutant risk ranking highlights benzene as the highest risk pollutant followed by toluene and styrene.

Table 66: Emissions Inventory for the Hercules Street Drive Caltex Service Station (2012 & 2014)

Substance	Fugitive Emission Rate (mg/s)	Pollutant Risk Ranking
Benzene	3.54	1
Styrene	0.01	3
Toluene	4.02	2

I.2.3 Dispersion Modelling

Dispersion modelling for fugitive emissions sources associated with this facility was undertaken using five years of meteorology (Appendix KK).

The results of the dispersion modelling are presented as cumulative contour plots in Appendix N. Results for the individual facilities have not been presented.

The results of the dispersion modelling and estimates of background levels of pollutants have been considered when developing the air quality constraints map for the Northshore Hamilton UDA.

Appendix J Other Facilities

This appendix summarises the publically available information used to assess the potential air quality constraints associated with facilities not discussed in other appendices.

In general, limited information was available. What information has been used to assess possible constraints associated with these facilities is outlined in the following sections.

J.1 Facility #6: East Coast Lubrication

East Coast Lubrication is located at 184 Curtin Avenue West, Eagle Farm, Qld, 4009. The facility was established at the current premises in 2010. Prior to East Coast Lubrication, the premise was occupied by Castrol and used as production and storage facility.

Current operations at East Coast Lubrication involve receiving, storing and distribution of C2 Lubricants.

Figure 10: Facility Map - East Coast Lubrication.

This facility does not report to NPI and no significant emission sources related to air quality were identified during site visit on 31 August 2012.

Thus this facility was not considered further.

J.2 Facility #8: Langford Metal Industries

This section presents publically available information used to assess the potential for air quality constraints as a result of activities conducted by Langford Metal Industries.

Table 67: Facility Details - Langford Metal Industries.

Property	Description
Address	24 Curtin Avenue West, Eagle farm ,QLD, 4009
Lot and Plan	
Aspect of Development	Activity: 38 (2a) – Surface Coating – coating, painting or powder coating, using in a year, the following quantity of surface coating materials – up to 100t Activity: 17 – Abrasive Blasting

Figure 11: Facility Map - Langford Metal Industries.

This facility does not report to the NPI.

A number of activities related to metal works are undertaken on-site. Based on the findings of a site-visit, no significant air quality issues relating to these activities were identified.

In relation to on-site spray painting and/or powder coating activities that occur on-site, there was insufficient information provided to develop a detailed site-specific emissions inventory. Therefore, when assessing air quality constraints associated with these activities, a regulatory prescribed industry-related buffer zone approach was adopted.

J.3 Facility #9: Pacific Terminals Wet Bulk Storage

This section outlines publically available information that was used to assess possible air quality constraints associated with activities at the Pacific Terminal wet bulk storage facility.

A site visit was undertaken and detailed site information was provided for the facility by Pacific Terminals.

Figure 12: Facility Map - Pacific Terminals Wet Bulk Storage.

Table 68: Facility Details - Pacific Terminals Wet Bulk Storage.

Property	Description
Address	Macarthur avenue, Hamilton, QLD 4009
Lot and Plan	
Aspect of Development	ENRE:00733207 (ERA 50 Bulk material handling threshold 2 – loading or unloading 100t or more bulk materials in a day)

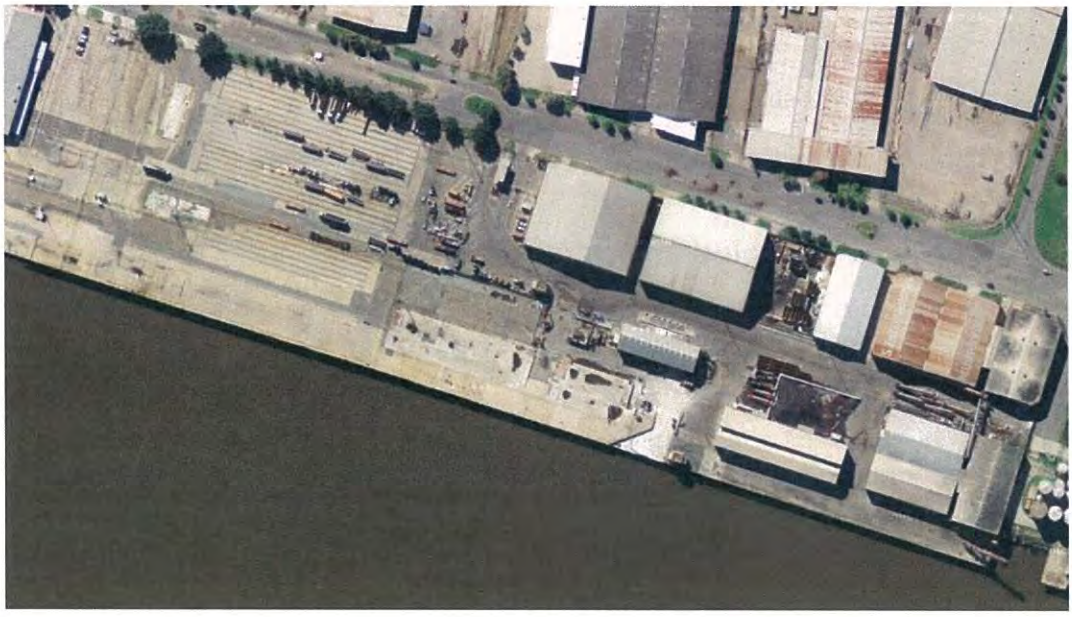
Based on the information provided, no significant air quality issues were identified.

This facility was not considered further.

J.4 Facility #9: P&O Dry Bulk Storage

This section outlines publically available information that was used to assess possible air quality constraints associated with activities at the P&O Dry Bulk Storage facility.

Figure 13: Facility Map – P&O Dry Bulk Storage.



J.4.1 Facility Details

Table 69: Facility Details - P&O Dry Bulk Storage.

Property	Description
Address	221 Macarthur avenue, Hamilton QLD 4009
Lot and Plan	Portion 859, part of SL4540, County od Stanley, Parish of Toombul
Aspect of Development	ERA 74 – Stockpiling, loading or unloading goods in bulk- commercial loading, unloading or stockpiling materials or good, in association with an activity mentioned in item 71. Using a crane, conveyer, pump or other similar way oat at a rate of more than 100 t per day.

J.4.2 Site Licence

Table 70: Licence Conditions Relevant to Air Quality: IPDE00815707.

Condition	Description
Schedule B - Air	
Release of Contaminants to the Atmosphere	
Fuel Burning	
B1	The fuel which may be burned in industrial fuel burning equipment is natural gas
Noxious or Offensive Odour	

B2	Notwithstanding any other conditions of this environmental authority no release of contaminants from the licensed place is to cause a noxious or offensive odour beyond the boundaries of the licensed place.
Dust Control	
B3	All sealed traffic areas must be cleaned as necessary to minimise the release of dust and particulate matter to the atmosphere

Based on publically available information, no significant air quality issues were identified.

This facility was not considered further.

J.5 Facility #11: Colonial Restoration Supplies

This section outlines publically available information that was used to assess possible air quality constraints associated with activities at Colonial Restoration Supplies which is located at 20 Curtin Avenue West, Eagle Farm.

Figure 14: Facility Map - Colonial Restoration Supplies.

A site licence was not made available for this assessment.

AED understands that a wood dryer is used as part of site operations. The wood dryer is located on the southern portion of the facility near Curtin Avenue West.

There was insufficient information provided to develop an emissions inventory in relation to these wood drying activities. Therefore when assessing air quality constraints associated with these activities, a regulatory prescribed industry-related buffer zone approach was adopted.

J.6 Facility #12: Coates Hire

This section outlines publically available information that was used to assess possible air quality constraints associated with activities at the Coates Hire facility which is located at 340 Curtin Avenue, Eagle Farm.

Figure 15: Facility Map - Coates Hire.

A site licence was not made available for this assessment.

AED understands that spray painting and/or powder coating activities are conducted as part of site operations.

There was insufficient information provided to develop an emissions inventory in relation to spray painting and/or powder coating activities. Thus when assessing air quality constraints associated with these activities, a regulatory prescribed industry-related buffer zone approach was adopted.

J.7 Facility #13: Brisbane Landscape Supplies

Brisbane Landscape supplies has relocated and therefore this facility was not considered further.

Appendix K Technical Details of the Meteorological Model

Dispersion modelling typically requires a meteorological dataset representative of the project region consisting of observations on an hourly basis. The required inputs consist of parameters like wind speed, wind direction, temperature, atmospheric stability and mixing height. In general, meteorological observations recorded by weather stations (BoM, DEHP or client operated) include hourly wind speed, wind direction, temperature, rainfall and humidity. However additional parameters like atmospheric stability class and mixing height are difficult to measure and are often generated through the use of meteorological models.

This appendix provides the technical details of the development of the meteorology that is used to drive the pollutant dispersion model. In total, five years of representative meteorology has been developed for use in the air quality constraints assessment.

K.1 TAPM

TAPM (version 4.0.4) developed by CSIRO (Commonwealth Scientific and Industrial Research Organisation) was used to develop the initial phase of three-dimensional meteorology for the larger study region. In general, output from TAPM includes (but is not be limited to) wind speed, wind direction, temperature, water vapour, cloud, rain, mixing height, and atmospheric stability. TAPM includes the option to assimilate local observations (of wind speed and wind direction) in order to nudge the predicted solution towards the observed records. Local observations within the neighbourhood of the project site were available from BoM and DEHP monitoring stations. However as only the upper air data of TAPM is used in CALMET, the data assimilation functionality of TAPM was not used. Instead the surface observations were used in the next step of meteorological modelling (CALMET). Technical details of the model equations, parameterisations and numerical methods are described in the Hurley (2008). Details of the TAPM configuration are summarised in Table 71.

Table 71: TAPM Configuration.

Parameter	Units	Value
Years modelled	-	2006, 2007, 2008, 2009, 2010
Grid centre	Lat, Long	-27.44167, 153.0833
Local centre coordinates	UTM zone 56 (m)	508235, 6964642
Number of nested grids	-	4
Grid dimensions (nx, ny)	-	31,31
Number of vertical grid levels (nz)	-	25
Outermost (Grid 1) spacing (dx, dy)	Km	30,30
Third Innermost (Grid 2) spacing (dx, dy)	Km	10,10
Second Innermost (Grid 3) spacing (dx, dy)	Km	3,3

Parameter	Units	Value
Innermost (Grid 4) spacing (dx, dy)	Km	1,1
Local hour	-	GMT + 10.2
Local Met Assimilation	-	No
Surface vegetation database	-	Default database at 3-minute grid spacing
Terrain database	-	Default database at 9-second grid spacing

K.2 CALMET

CALMET (version 6.0) was used to simulate meteorological conditions in the vicinity of Hamilton Northshore. CALMET is a diagnostic three dimensional meteorological pre-processor for the CALPUFF modelling system (developed by Earth Tech, Inc.).

Prognostic output from TAPM was used as upper air data for input (above c. 1000 m) into the CALMET model. Using high resolution geophysical datasets and surface observational data, CALMET then develops the higher resolution flow fields to include (in general) the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation as well as differential heating and surface roughness associated with variations in land use categories across the modelling domain.

Two resolution CALMET grids were developed in order to derive high resolution meteorological fields at 50 m resolution which was used as input into the CALPUFF dispersion model. The domain size and grid resolution of these CALMET are specified in Table 72 and the extent of the CALMET domains is shown in Figure 16.

Table 72: CALMET Domain Specifications.

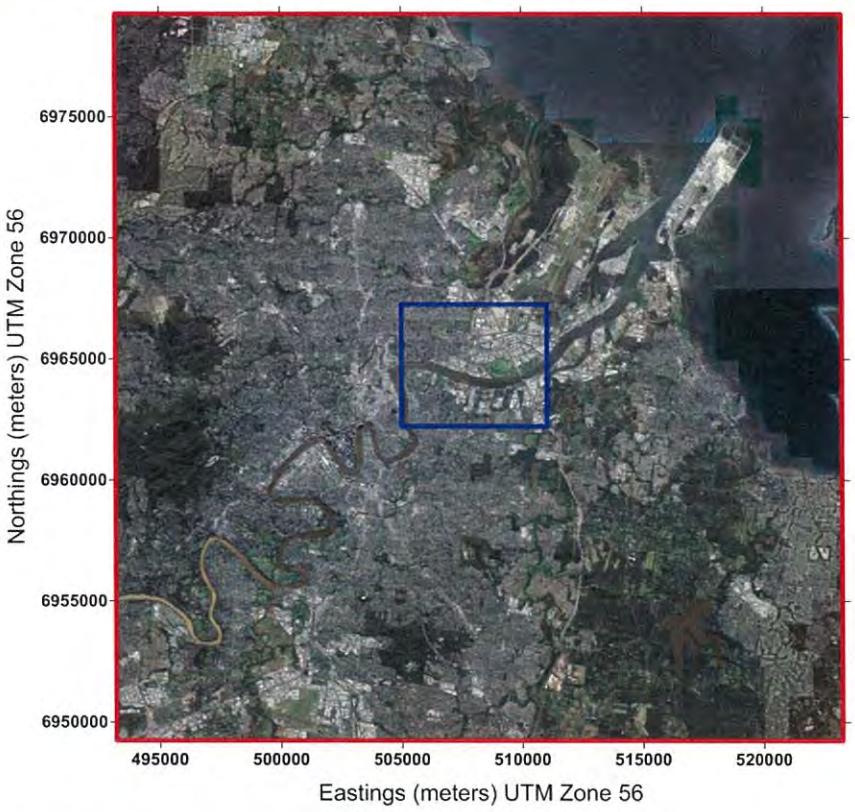
CALMET Grid Resolution	Domain Size (X, Y)	Number of Nodes in X and Y	Grid Spacing (m)
500 m	30 km x 30 km	61 x 61	500 x 500
50 m	6 km x 5 km	121 x 101	50 x 50

The development of each of the two CALMET grids requires input datasets along with the control file where the CALMET run parameters are specified. These input datasets include:

- Geophysical data
- Upper air meteorological data
- Surface meteorological data

The inputs to CALMET models for the above mentioned datasets for the set of two CALMET models are discussed in detail in the following sections.

Figure 16: Areal Extent of CALMET Domains (red 30km x 30km, blue 6km x 5km).



K.2.1 The CALMET Model at 500 m Resolution.

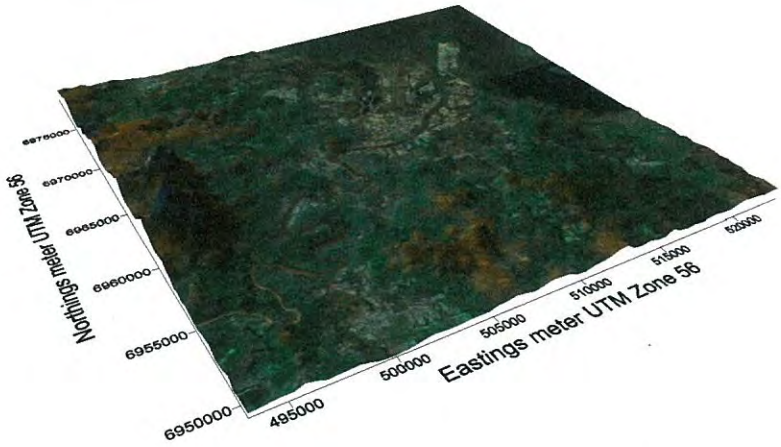
Geophysical dataset

The Geophysical dataset contain terrain and land use information for the modelling domain. Traditionally, TAPM generated terrain information and land use data are used as an input in CALMET. However TAPM datasets are coarser than other publically available datasets and hence these datasets were replaced by high resolution datasets as input for CALMET.

For this assessment, the terrain for the 500 m resolution CALMET grid was extracted from 3-arc second (90m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000. (Downloaded from USGS website)

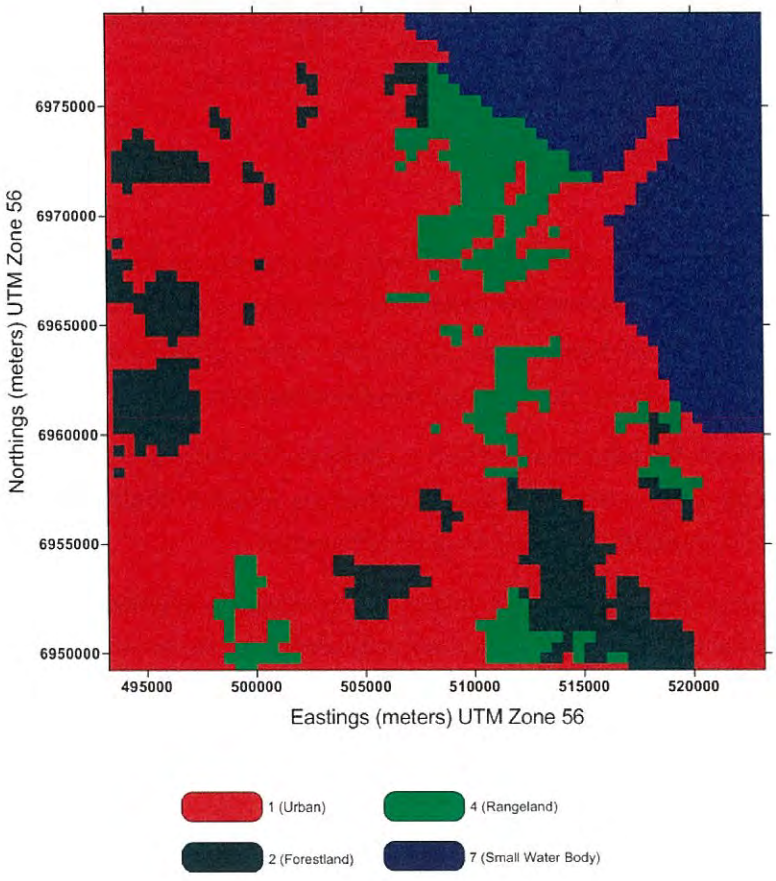
A three-dimensional view of the terrain data at 500 m resolution overlayed over the base map is shown in Figure 17. The figure highlights the relatively flat terrain along the coastline and surrounding area with the elevation increasing inland towards western and southern boundary of the modelling domain.

Figure 17: Terrain - CALMET 500 m Resolution.



The land use or land cover data for the modelling domain as shown in Figure 18 was manually generated based on aerial images from Google earth.

Figure 18: Land Use - CALMET 500 m Resolution.



The Geotechnical parameters for the user defined land use classification were adopted from a combination of closest CALMET and AERMET land use categories. User defined land use classification and geotechnical parameters used in CALMET are shown in figures below.

Figure 19: Geotechnical Parameters for User Defined CALMET Land Use Classification.

CALMET User defined Category	ESA category	Aermet Category	Surface roughness (a)	Bowen ratio (a)	Albedo (a)	Soil heat flux parameter (b)	Anthropogenic heat flux (b)	Leaf Area Index (b)
1	17 Artificial surfaces and associated areas (Urban areas >50%)	Low intensity residential	0.54	0.8	0.16	0.25 (Calmet – Urban)	0	0.2 (Calmet – Urban)
2	3 Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)	Mixed Forest	1.3	0.3	0.14	0.15 (Calmet – Forestland)	0	6 (modified from Calmet – Forestland, 7)
	5 Open (15-40%) broadleaved deciduous forest/woodland (>5m)							
3	9 Mosaic forest or shrubland (50-70%) / grassland (20-50%)	Shrubland (Non-arid)	0.3	1	0.18	0.15 (Calmet – Forestland)	0	4.5 (average of modified Calmet forestland (above) and agriland un-irrigated)
	10 Mosaic grassland (50-70%) / forest or shrubland (20-50%)							
	11 Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)							
	12 Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)							
	2 Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)							
4	13 Sparse (<15%) vegetation	Grassland / Herbaceous	0.1	0.8	0.18	0.15 (Calmet – Rangeland)	0	0.5 (Calmet – Rangeland)
5	1 Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)	Small grains	0.15	0.5	0.2	0.15 (Calmet – Agri land irrigated)	0	3 (Calmet – Agri land irrigated)
	0 Rainfed croplands							
6	------------------------------	Quarries/strip mine/gravel	0.3	1.5	0.2	0.15 (Calmet –Barren)	0	0.05 (Calmet –Barren)
7	Water Bodies	Open water	0.001	0.1	0.1	1 (Calmet –small water body)	0	0 (Calmet –small water body)
8		Bare rock /sand/clay non-arid	0.05	1.5	0.2	0.15 (Calmet – Barren)	0.0	0.05 (Calmet – Barren)

(a) EPA (2008), *AERSURFACE User's Guide*, developed by the Air Quality Modelling Group, USEPA office of Air Quality Planning and Standards.
(b) CALPUFF version 6, USER guide.

Upper air dataset

Upper air data was extracted from TAPM output for the innermost 9 points as shown by red circles in Figure 20. The circumference of the circle represent the influence of that particular upper air data (radius of influence 6 km) and the centre of the circle (not shown in figure) represents the location of the data. Coordinates of these upper air locations are presented in Table 74.

Figure 20: Location of Upper Air Data Extracted from TAPM - CALMET 500 m Resolution.

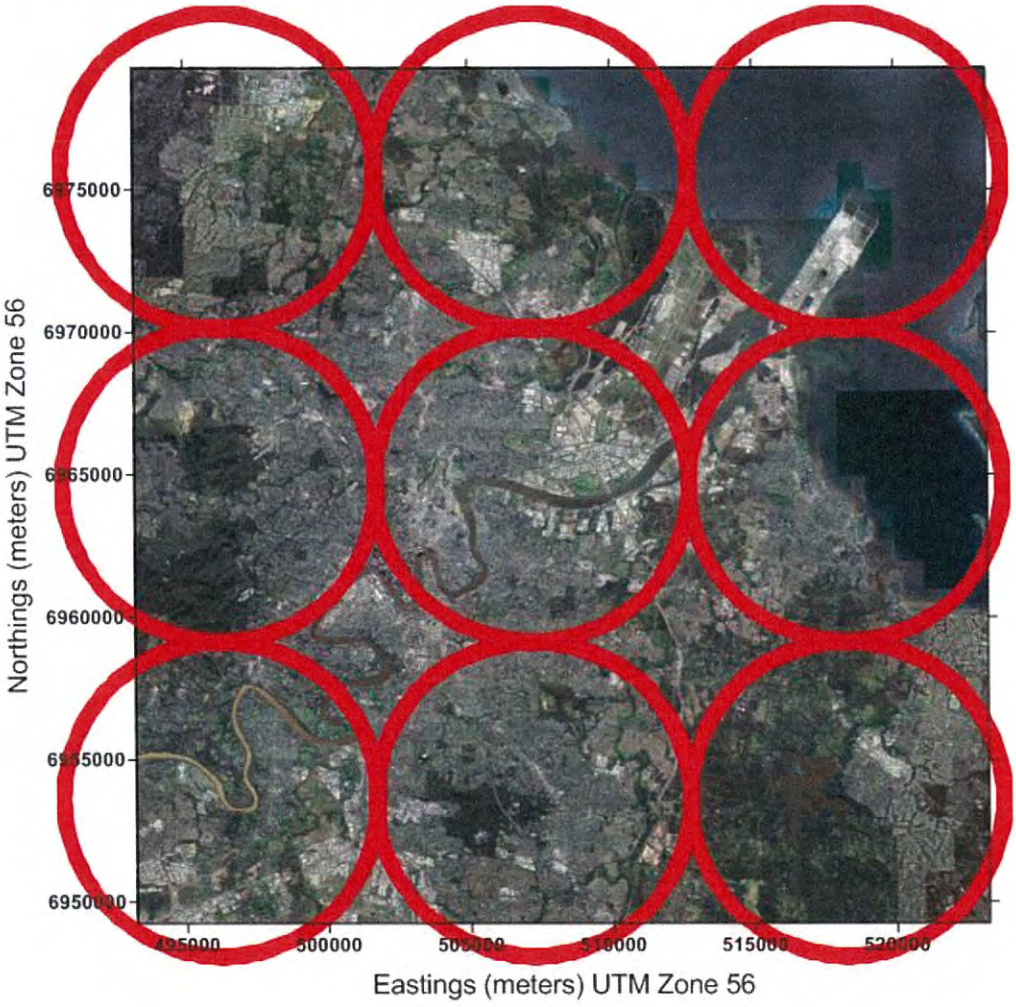


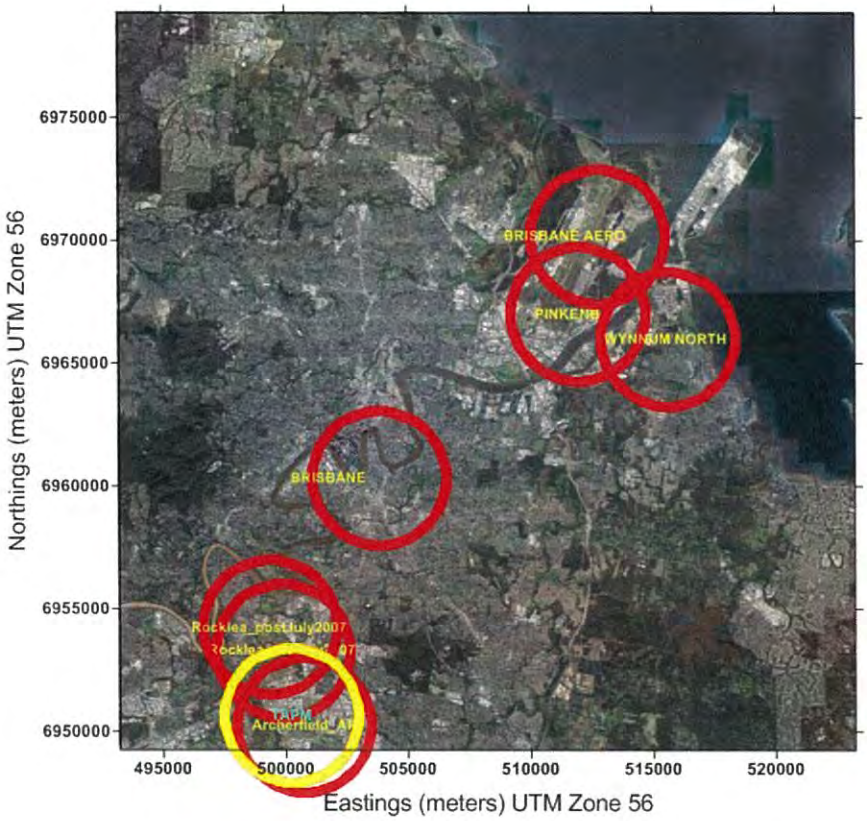
Table 73: Coordinates of Upper Air Data Extracted From TAPM - CALMET 500 m Resolution.

Station Name	ID	Source	Easting(km)	Northing (Km)
US1	22201	TAPM	496.235	6964.642
US2	22202	TAPM	507.235	6964.642
US3	22203	TAPM	518.235	6964.642
US4	22204	TAPM	496.235	6953.642
US5	22205	TAPM	507.235	6953.642
US6	22206	TAPM	518.235	6953.642
US7	22207	TAPM	496.235	6975.642
US8	22208	TAPM	507.235	6975.642
US9	22209	TAPM	518.235	6975.642

Surface observations dataset

Surface observations from monitoring stations operated by BoM and DEHP were collated and used as input in CALMET. The following figure illustrates the location of these observation stations. The radius of the red circles represents the applied radius of influence (3 km) for that particular surface station and centre of the circle represent the location of the surface observations.

Figure 21: Location of Surface Stations - CALMET 500 m Resolution.



Assimilation of surface observations in CALMET requires that at least one station has a non-missing value for wind speed and wind direction for each hour of simulation. Values of wind speed and wind direction from the TAPM generated surface station location (yellow ring, southwest corner of the modelling domain) were only used in the absence of observational data from at least one of the other monitoring locations. Coordinates and source of these surface stations used as input into CALMET are presented in Table 74.

Table 74: Coordinates of Surface Data - CALMET 500 m Resolution.

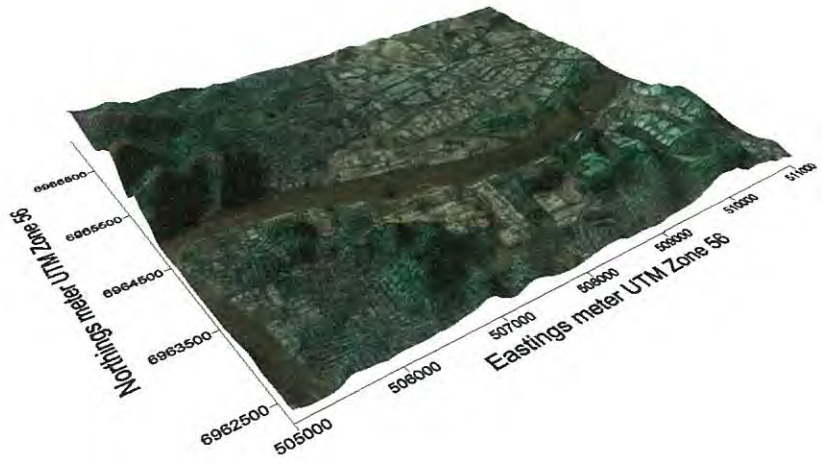
Station Name	ID	Easting (km)	Northing (Km)	Station Name	Source
SS1	11100	500.235	6950.642	TAPM	TAPM
SS2	11101	499.8716	6953.298	Rocklea_preJuly2007	DEHP
SS3	11102	499.3483	6954.218	Rocklea_postJuly2007	DEHP
SS4	11103	500.7699	6950.241	Archerfield AP	BoM
SS5	11104	511.9403	6966.983	Pinkenba	DEHP
SS6	11105	515.6259	6965.971	Wynnum North	DEHP
SS7	11106	503.8429	6960.309	Brisbane	BoM
SS8	11107	512.7739	6970.173	Brisbane Aero	BoM

K.2.2 The CALMET Model at 50 m Resolution.

Geophysical dataset

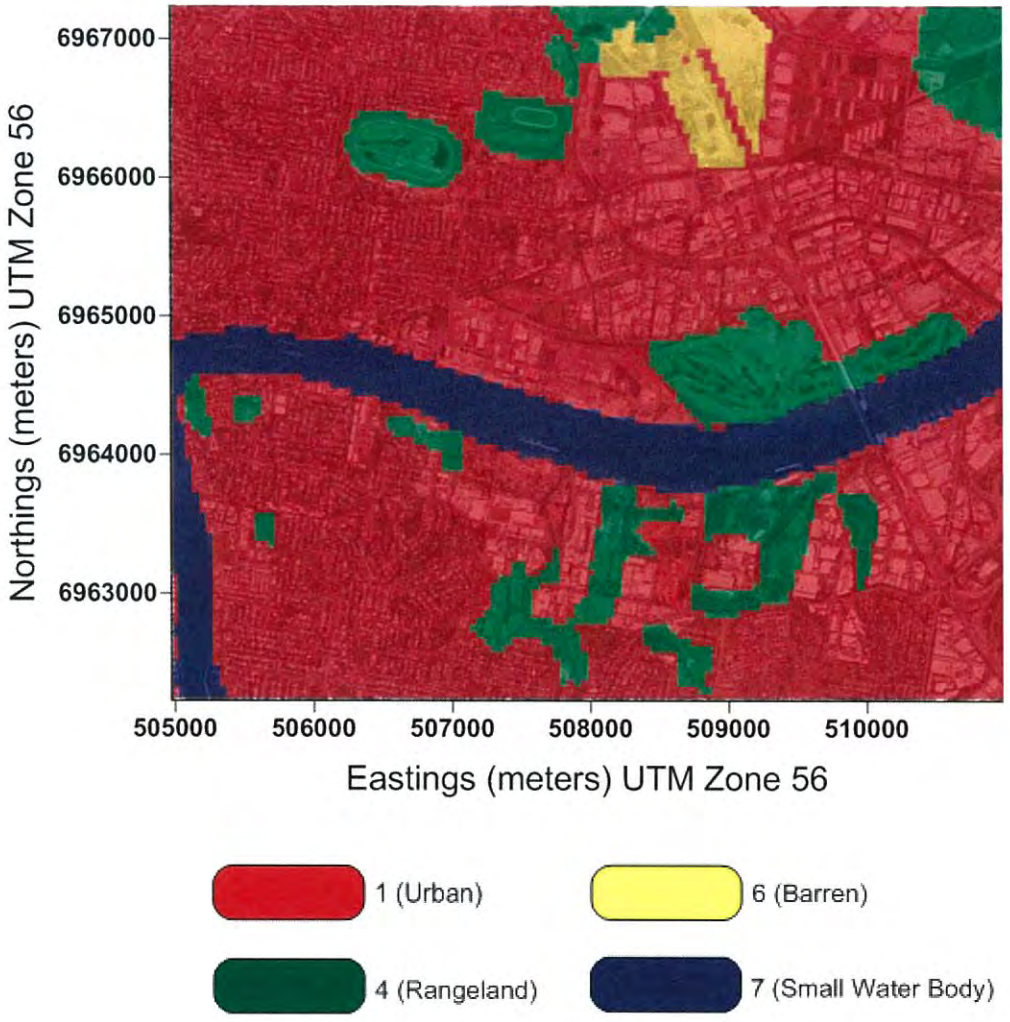
The terrain for the 50 m resolution CALMET grid was extracted from 3-arc second (90m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000 (downloaded from USGS website). A three-dimensional view of the terrain data at 50m resolution overlayed over the base map is shown in Figure 22. The figure highlights the relatively flat terrain on northern and eastern side of Brisbane River, with elevation rising on southern and western side of Brisbane River.

Figure 22: Terrain - CALMET 50 m Resolution.



Land use or land cover data for the modelling domain was generated manually by comparing with aerial imagery. The Geotechnical parameters for the user defined land use classification were adopted from a combination of closest CALMET and AERMET land use categories. User defined land use classification and geotechnical parameters used in CALMET are shown in Figure 19.

Figure 23: Land Use - CALMET 50 m Resolution.



Upper air dataset

Upper air data was extracted from TAPM output for the innermost grid at 1 point as shown by red circle in Figure 24. The radius of the circle represents the radius of influence of the upper air data (3 km) and the centre of the circle represents the location of the data. Coordinates of this upper air station are presented in Table 75.

Table 75: Coordinates of Upper Air Data Extracted from TAPM - CALMET 50 m Resolution.

Station Name	ID	Source	Easting(km)	Northing (Km)
US1	22201	TAPM	508.235	6964.642

Surface observations dataset

Surface observations from monitoring stations operated by BoM and DEHP operated monitoring sites were collated and used as input into the 500 m resolution CALMET model. From the output of CALMET 500 m model, surface data sets were extracted at 5 locations and were assimilated as input to CALMET 50 m model. One TAPM surface datasets was also assimilated into the model to ensure that the input data set did not contain any missing hours. Data from TAPM was only used in the absence of observational data from at least one of the other surface datasets from CALMET 500 m model.

Illustrated in Figure 24 are the locations of the upper air and surface stations in reference to the CALMET modelling domain.

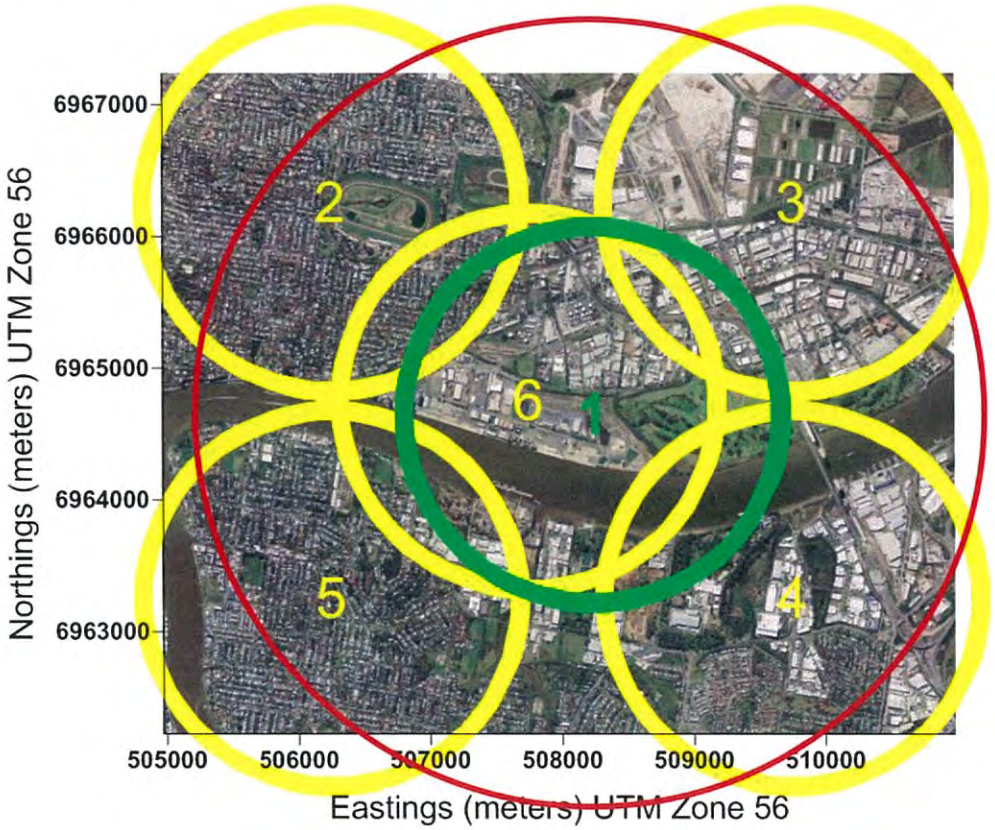
- Red Circle – Upper air data from TAPM
- Yellow Circle – Surface data from CALMET – 500 m resolution
- Green Circle - Surface data from TAPM innermost grid (only used if data from no other stations are available for the hour)

The radius of the yellow and green circles represents the area of influence (radius 1.5 km) for that particular surface station and centre of the circle represents the location of the surface observations. Coordinates and source of these surface stations are presented in Table 76.

Table 76: Coordinates of Surface Data - CALMET 50 m Resolution.

Station Name	ID	Easting(km)	Northing (Km)	Anemometer Height (m)	Source
SS1	11100	508.235	6964.642	10	TAPM innermost Grid
SS2	11101	506.25	6966.25	10	CALMET – 500 m resolution
SS3	11102	509.75	6966.25	10	CALMET – 500 m resolution
SS4	11103	509.75	6963.25	10	CALMET – 500 m resolution
SS5	11104	506.25	6963.25	10	CALMET – 500 m resolution
SS6	11105	507.75	6964.75	10	CALMET – 500 m resolution

Figure 24: Location of Surface and Upper Air Data - CALMET 50 m Resolution.



Appendix L Existing Meteorological Environment

L.1 Wind Speed and Direction

The wind rose generated from five years of wind data recorded at DEHP operated Pinkenba monitoring station for the five-year period (2006 through 2010) is presented in Figure 25. The wind bins in wind rose are matched to approximate Beaufort Wind Scale (NOAA) as shown in Figure 26. Figure 25 shows calm to light air predominantly from southwest directions followed by light air to light breeze from south east directions. Some low frequency light air to light breeze winds from observed from west, north and east directions.

Figure 25: Wind Rose – Pinkenba Monitoring Station (2006 through 2010).

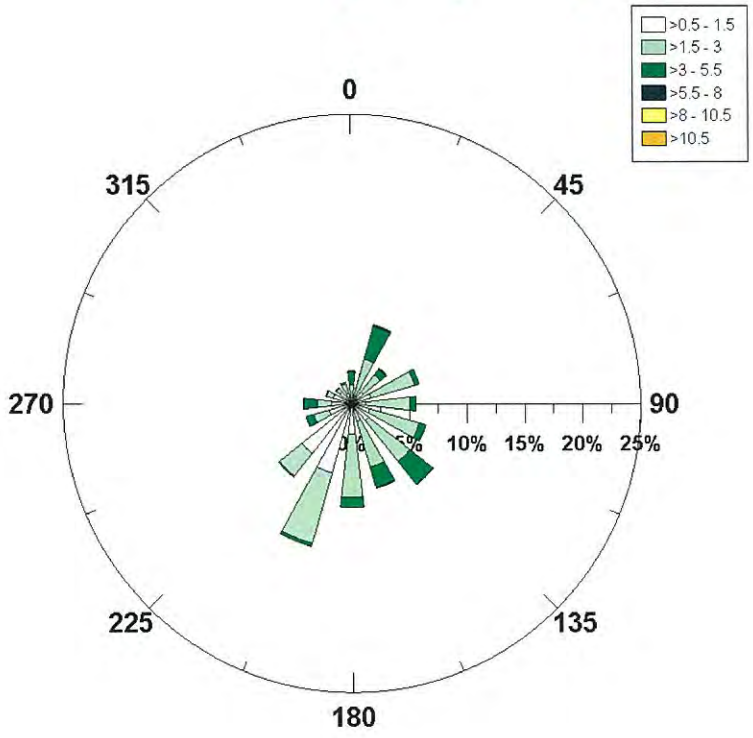
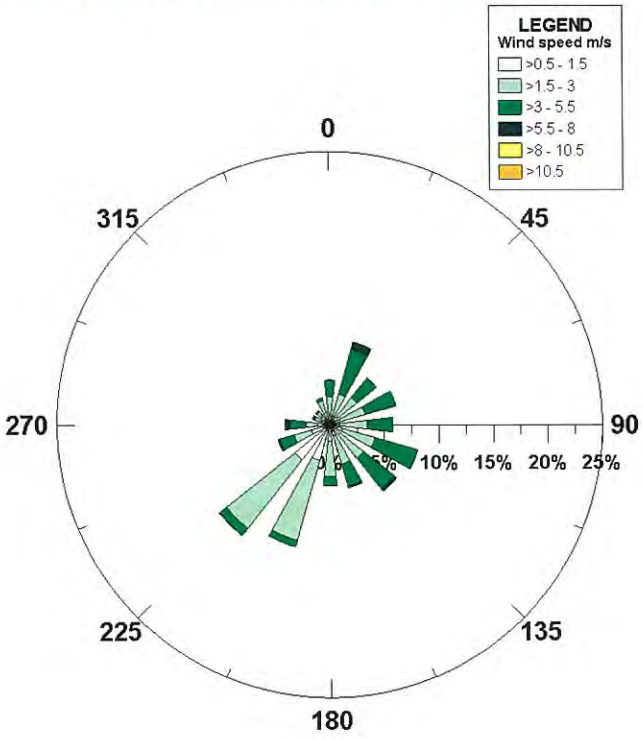


Figure 26: The Beaufort Wind Scale.

Force	Description	Observation	km/hour
0	Calm	Smoke rises vertically	< 1
1	Light air	Direction of wind shown by smoke drift, but not wind vanes	1 - 5
2	Light breeze	Wind felt on face; leaves rustle, ordinary vane moved by wind	6 - 11
3	Gentle breeze	Leaves and small twigs in constant motion	12 - 19
4	Moderate breeze	Raises dust and loose paper; small branches are moved	20 - 29
5	Fresh breeze	Small trees in leaf begin to sway, small branches are moved	30 - 39
6	Strong breeze	Large branches in motion; umbrellas used with difficulty	40 - 50
7	Near gale	Whole trees in motion; inconvenience felt when walking against wind	51 - 61
8	Gale	Twigs break off trees; progress generally impeded	62 - 74
9	Strong gale	Slight structural damage occurs (chimney pots and slates removed)	75 - 87
10	Storm	Trees uprooted; considerable structural damage occurs	88 - 101

Surface observation data from Pinkenba as well as other BoM and DEHP operated monitoring stations were assimilated in meteorological models to simulate site specific meteorology. The wind rose generated from such five years of CALMET simulated data for the five-year period is presented in Figure 27. A comparison of wind rose from Pinkenba monitoring station to CALMET simulated wind data shows quite similarity in terms of wind direction, however CALMET predicts comparatively higher wind speeds than that observed at Pinkenba monitoring station. Figure 27 shows mainly light breeze predominantly from southwest direction followed by light breeze to gentle breeze from southeast and northeast direction. Similar to Pinkenba monitoring station low frequency gentle breeze are predicted by CALMET from west and north directions.

Figure 27: Wind Rose - Project Site (CALMET, 2006 through 2010).



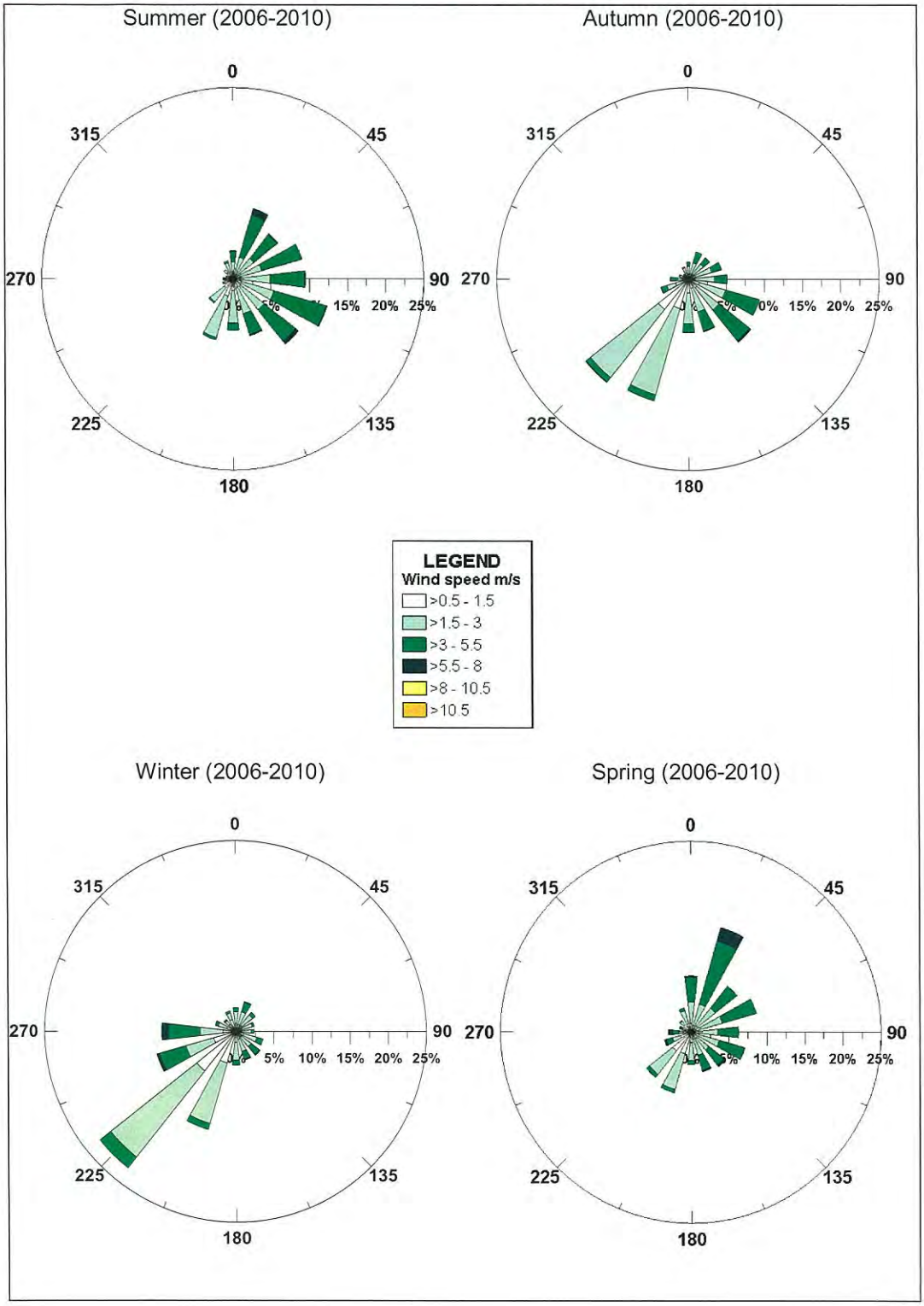
Seasonal variability's predicted by simulated CALMET modelling are shown in Figure 28. Summer is characterised mainly by gentle breeze from north through to southeast direction, some light air from east through to southwest direction and light breeze to gentle breeze from northeast direction.

Autumn is characterised by light breeze from southwest direction, followed by light breeze to gentle breeze from southeast direction.

Winter winds are characterised by calm to light air and light breeze from southwest direction followed by light to gentle breeze from west direction.

Spring winds are characterised by gentle to moderate breeze from northeast direction followed by some low frequency gentle breeze from north and east direction. Some low frequency light breeze is also predicted from southwest direction.

Figure 28: Seasonal Wind Rose - Project Site (CALMET, 2006 through 2010).



L.2 Stability Class

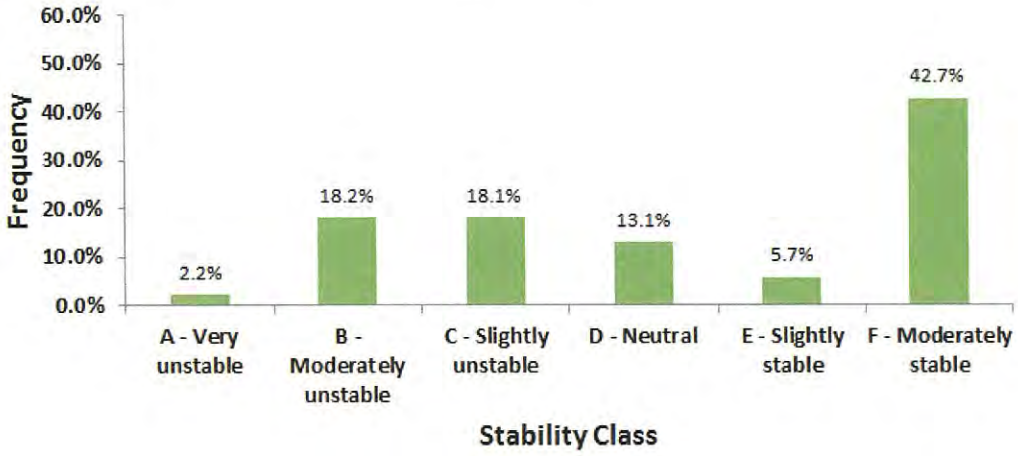
Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead it must be inferred from available data, either measured or numerically simulated.

The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data for five years (2006 through to 2010) is presented in Figure 29. Stability class F is predicted to occur most frequently (42.7%), indicating that the dominant conditions are moderately to very stable, with very little lateral and vertical diffusion.

The frequency of strongly convective (unstable) conditions at the study area, represented by stability class A, is relatively low at 2% of hours during the five years simulated. This category requires strong sunlight and low wind speeds through the day, and is characterised by vertical movement of air.

Figure 29: Frequency of Stability Class - Project Site (CALMET, 2006 – 2010).

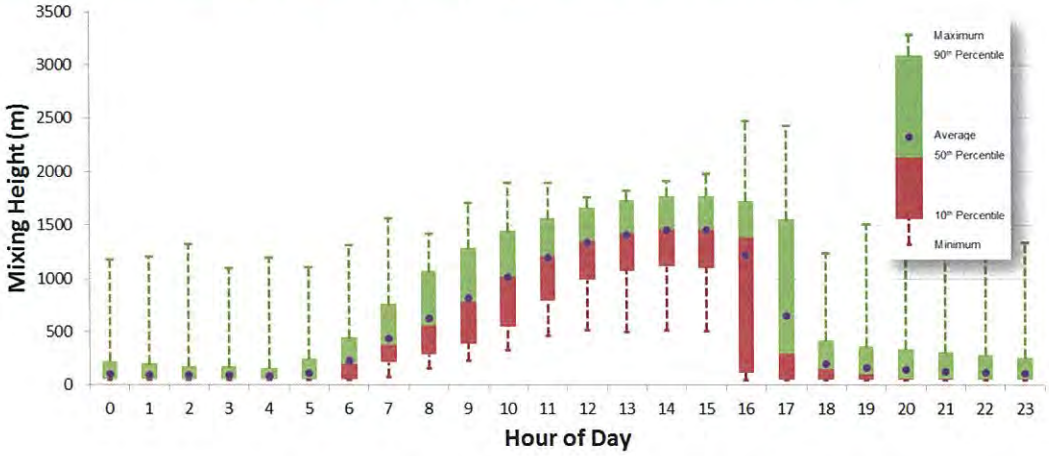


L.3 Mixing Height

The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that is not able to be measured directly. Numerically simulated hourly mixing height data are presented in Figure 30 for the five-year period of 2006 through to 2010. Figure 30 shows the mixing height as a function of the hour of the day at the location of the study area. The graph represents the typical growth of the boundary layer, whereby the mixing height is generally lowest during the night and into the early morning and highest during the late afternoon.

The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low mixing heights typically translate to stagnant air with little vertical motion, while high mixing heights allow vertical mixing and good dispersion of pollutants.

Figure 30: Mixing Height by Time of Day - Project Site (CALMET, 2006 – 2010).



Appendix M Dispersion Model - CALPUFF

Dust dispersion modelling was undertaken using the US EPA approved CALPUFF model for five years of meteorological conditions at 50 m resolution wind fields developed using CALMET. General run control parameters and technical options that were selected are presented in Table 77. Defaults were used for all other options.

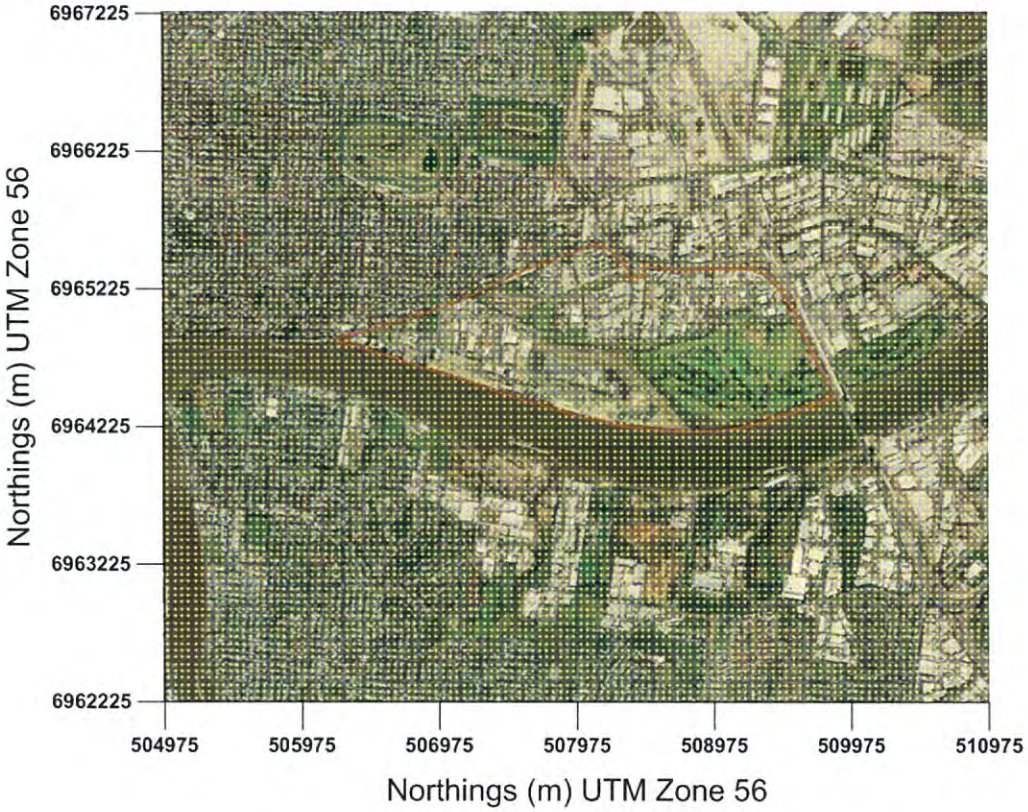
Table 77: CALPUFF Configuration.

Parameter	Units	Value
CALPUFF version	-	V6.263
Years modelled	-	2006, 2007, 2008, 2009, 2010
No. X grid cells (NX)	-	121
No. Y grid cells (NY)	-	610
Grid spacing (DGRIDKM)	km	0.05
X coordinate (XORIGKM)	km	504.975
Y coordinate (YORIGKM)	km	6962.225
No. of vertical layers (NZ)	-	10
UTC time zone (XBTZ)	Hours	UTC+1000
Method used to compute dispersion coefficient (MDISP)	-	2 (internally calculated sigma v, sigma w using micrometeorology)
Computational grid size and resolution	-	Identical to CALMET grid
Gridded receptors used (LSAMP)		False
Discrete receptors modelled	-	999
Discrete receptors height above ground	m	1.5, 3.5, 7.5, 10.5, 13.5, 16.5, 19.5, 22.5, 25.5, 28.5, 31.5, 34.5, 37.5
Wet deposition		False
Dry deposition		True for fugitive PM10, False for other pollutants

M.1 CALPUFF Computational Grid

Computational grid for the CALPUFF dispersion modelling was set identical to CALMET meteorological grid. This 6 km x 5 km grid will extend approximately 2 km in all directions beyond the ULDA area of interest. The additional buffer distance allows for the consideration of puff trajectory recirculation. Yellow markers (Figure 31) shows the fine resolution (50 m) grid nodes selected for CALMET and CALPUFF computational grid.

Figure 31: CALPUFF Computational Grid.



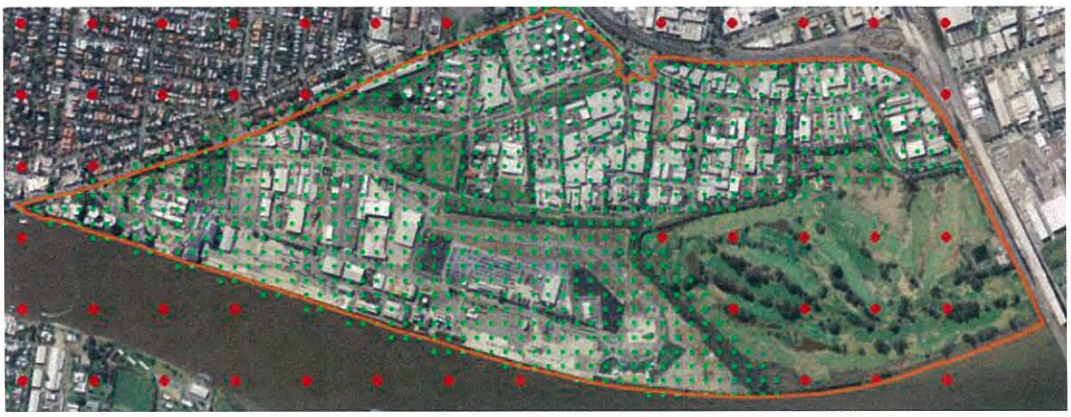
M.2 Discrete Receptor Grid

CALPUFF Dispersion model was set to predict concentrations of modelled pollutants at 999 discrete receptors in the vicinity of study area. Contour plots showing the predicted impacts on regional scale were generated based on results at these discrete receptors.

The location of the discrete receptors is shown in Figure 32. To generate high resolution contour plots within the ULDA area of interest, closely spaced receptors at 50 m separation distance (green markers) were included in the dispersion model. Red markers represent receptors at 250 m spacing.

A total of 13 levels (1 ground + 12 storeys) were included in dispersion modelling to predict impacts at ground level and elevated receptor locations. Ground level receptors were modelled at 1.5 m height above ground. The heights of the elevated receptors were included in Table 77.

Figure 32: CALPUFF Discrete Receptor Grid.



M.3 Project Receptors

A total of 26 sensitive receptors of interest to the Project were provided by ULDA as shown by yellow outlines in Figure 33 Figure 34. Digits at centre of each yellow outline (Figure 35) represent the number of storeys associated with each receptor. Impacts at each of these receptors were predicted by blanking the concentration grid outside the yellow outlines to provide the maximum impact at each receptor.

Figure 33: ULDA Receptors.

Figure 34: ULDA Receptors.

Figure 35: Number of Storeys for ULDA Receptors.

Appendix N Contour Plots of Cumulative Impacts

N.1 Odour

This section presents the cumulative contour plots for the 99.5th percentile, 1-hour average concentration of odour from all relevant sources.

Table 78: Regulatory Criteria Relevant to Odour.

Pollutant	Averaging Period	Environmental Value	Value (OU)	Source
Odour	99.5th percentile 1-hour	amenity	2.5	Queensland DEHP

Figure 36: The 99.5th Percentile 1-Hour Average Ground Level Concentration of Odour.

Scenario: Cumulative Impacts		**Sources included:** BCC asphalt plant, Boral asphalt plant	
Pollutant:	Odour	**Averaging Period:**	1-hour
Background level:	none	**Rank:**	99.5th Percentile
Project Goal:	Qld DEHP 2.5 OU	**Contour level(s):**	0.25, 0.5, 1.0, and 2.5 OU
Legend: Cyan: 2.5 OU, Yellow: 0.25, 0.5 and 1.0 OU			

N.2 Particulate Matter

This section presents the cumulative contour plots for particulate matter as TSP, PM_{10} and $PM_{2.5}$ from all relevant sources. Note that background levels have not been included in the contour plots. However these have been considered when developing the air quality constraints maps that have been produced for the Northshore Hamilton UDA.

Table 79: Ambient Air Criteria Relevant to Particulate Matter.

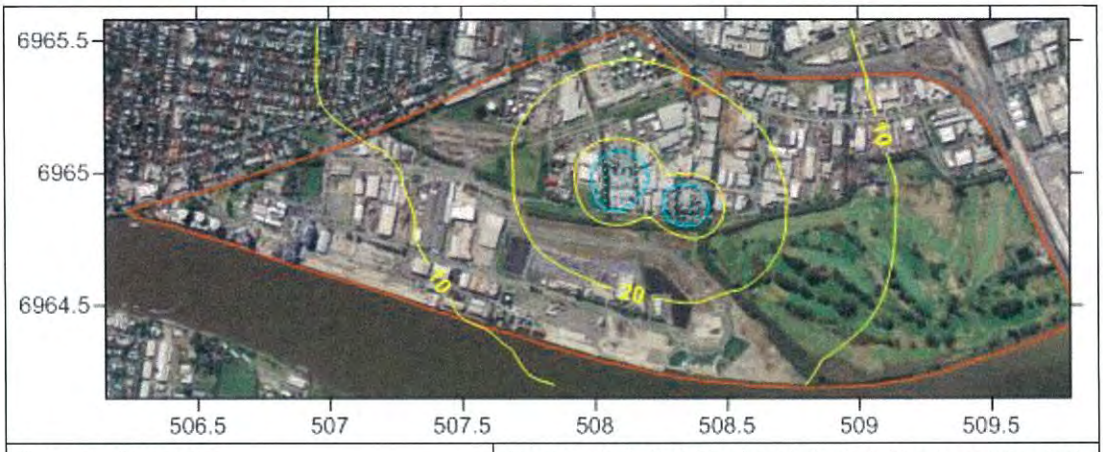
Pollutant	Averaging Period	Environmental Value	Value[(1)] (µg/m^3)	Source
TSP	annual	health	90	Qld EPP(Air)
PM10	1 hour	toxicity	87	Vic EPA
	24 hour	health	50	Qld EPP(Air) & Air NEPM
PM2.5	1 hour	toxicity	55	Vic EPA
	24 hour	health	25	Qld EPP(Air) & Air NEPM (advisory)
	annual	health	8	Qld EPP(Air)

Note: (1) At 0°C

Figure 37: The Annual Average Ground Level Concentration of TSP.

Scenario: Cumulative		**Sources included:** BCC asphalt plant, Boral asphalt plant	
Pollutant:	TSP	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Not applicable
Project Goal:	Qld EPP(Air) 90 µg/m^3	**Contour level(s):**	0.5, 1, 2 and 90 µg/m^3
Legend: Cyan: 90 µg/m^3 , Yellow: 0.5, 1, and 2 µg/m^3			

Figure 38: The 99.9th percentile 1-Hour Average Ground Level Concentration of PM_{10}.

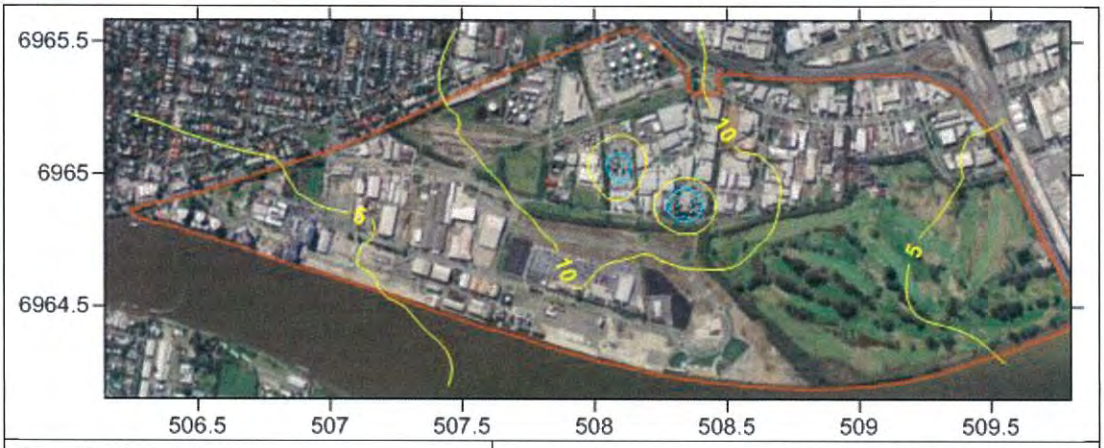


Scenario: Cumulative		**Sources included:** Boral asphalt plant, Boral concrete plant, BCC asphalt plant, BP	
Pollutant:	PM10	**Averaging Period:**	1-hour
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 87 µg/m^3	**Contour level(s):**	10, 20, 50, 87 µg/m^3
Legend: Cyan: 87 µg/m^3 , Yellow: 10, 20, and 50 µg/m^3			

Figure 39: The Maximum 24-Hour Average Ground Level Concentration of PM_{10}.

Scenario: Cumulative		**Sources included:** Boral asphalt plant, Boral concrete plant, BCC asphalt plant, BP	
Pollutant:	PM10	**Averaging Period:**	24-hour
Background level:	Not included	**Rank:**	Maximum
Project Goal:	Qld EPP(Air) 50 µg/m^3	**Contour level(s):**	5, 10, 25 and 50 µg/m^3
Legend: Cyan: 50 µg/m^3 , Yellow: 5, 10 and 25 µg/m^3			

Figure 40: The 99.9th percentile 1-Hour Average Ground Level Concentration of $PM_{2.5}$.

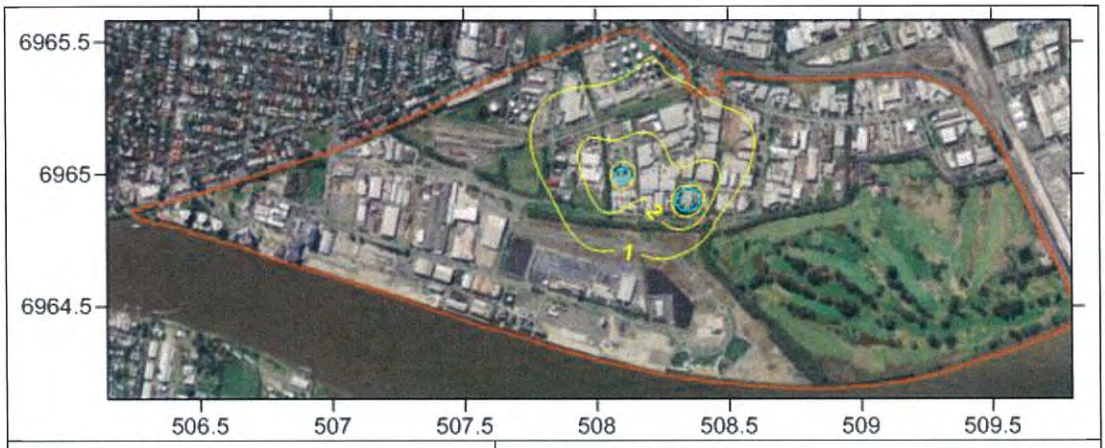


Scenario: Cumulative		**Sources included:** Boral asphalt plant, Boral concrete plant, BCC asphalt plant, BP	
Pollutant:	PM2.5	**Averaging Period:**	1-hour
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 55 µg/m^3	**Contour level(s):**	5, 10, 25 and 55 µg/m^3
Legend: Cyan: 55 µg/m^3 , Yellow: 5, 10 and 25 µg/m^3			

Figure 41: The Maximum 24-Hour Average Ground Level Concentration of $PM_{2.5}$.

Scenario: Cumulative		**Sources included:** Boral asphalt plant, Boral concrete plant, BCC asphalt plant, BP	
Pollutant:	PM2.5	**Averaging Period:**	24-hour
Background level:	Not included	**Rank:**	Maximum
Project Goal:	Qld EPP(Air) 25 µg/m^3	**Contour level(s):**	3, 5, 10, 15 and 25 µg/m^3
Legend: Cyan: 25 µg/m^3 , Yellow: 3, 5, 10 and 15 µg/m^3			

Figure 42: The Annual Average Ground Level Concentration of $PM_{2.5}$.



Scenario: Cumulative		**Sources included:** Boral asphalt plant, Boral concrete plant, BCC asphalt plant, BP	
Pollutant:	PM2.5	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Not applicable
Project Goal:	Qld EPP(Air) 8 µg/m^3	**Contour level(s):**	1, 2, 5, and 8 µg/m^3
Legend: Cyan: 8 µg/m^3 , Yellow: 1, 2, and 5 µg/m^3			

N.3 Sulphur Dioxide

This section presents the cumulative contour plots for sulphur dioxide from all relevant sources. Note that background levels have not been included in the contour plots. However these have been considered when developing the air quality constraints maps that have been produced for the Northshore Hamilton UDA.

Table 80: Ambient Air Criteria Relevant to Sulphur Dioxide.

Pollutant	Averaging Period	Environmental Value	Value[(1)] (µg/m^3)	Source
Sulphur Dioxide	1 hour	health	570	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	485	Vic EPA
	24 hour	health	172	Qld EPP(Air) & Air NEPM
	annual	health	57	Qld EPP(Air) & Air NEPM
	annual	agriculture	31	Qld EPP(Air)
	annual	ecosystems	21	Qld EPP(Air)

Note: (1) At 0°C

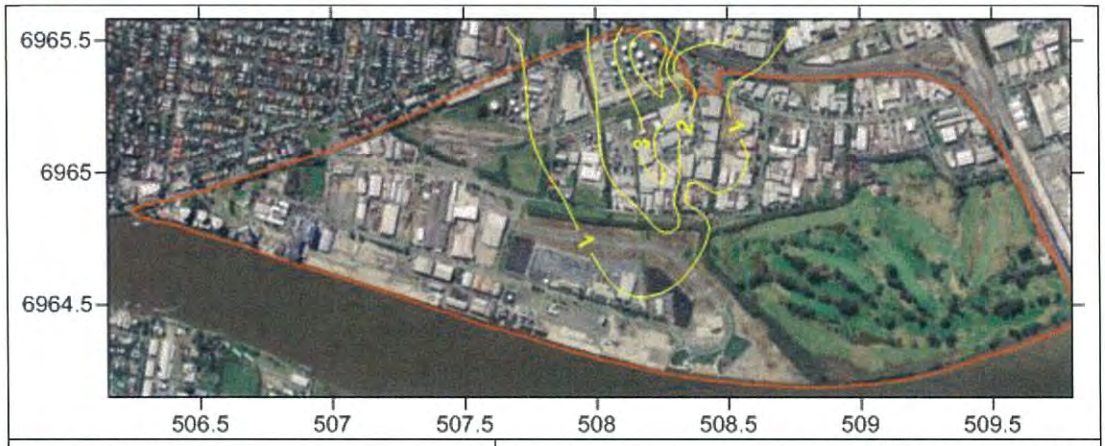
Figure 43: The 99.9th Percentile 1-Hour Average Ground Level Concentration of Sulphur Dioxide.

Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant, BP	
Pollutant:	Sulphur Dioxide	**Averaging Period:**	1-hour
Background level:	Not included	**Rank:**	99.9th Percentile
Project Goal:	Qld EPP(Air) 570 µg/m^3 Vic EPA 485 µg/m^3	**Contour level(s):**	15, 30, 45, 60, 75, and 485 µg/m^3
Legend: Cyan: 485 µg/m^3 , Yellow: 15, 30, 45, 60 and 75 µg/m^3			

Figure 44: The Maximum 24-Hour Average Ground Level Concentration of Sulphur Dioxide.

Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant, BP	
Pollutant:	Sulphur dioxide	**Averaging Period:**	24-hour
Background level:	Not included	**Rank:**	Maximum
Project Goal:	Qld EPP(Air) 172 µg/m^3	**Contour level(s):**	5, 10, 15, 20 and 172 µg/m^3
Legend: Cyan: 172 µg/m^3 , Yellow: 5, 10, 15 and 20 µg/m^3			

Figure 45: The Annual Average Ground Level Concentration of Sulphur Dioxide.



Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant, BP	
Pollutant:	Sulphur Dioxide	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Not applicable
Project Goal:	Qld EPP(Air) 57 µg/m^3 (h) Qld EPP(Air) 21 µg/m^3 (e)	**Contour level(s):**	1, 2, 3, 4, 21 and 57 µg/m^3
Legend: Cyan: 57 µg/m^3 , Green: 21 µg/m^3, Yellow: 1, 2, 3 and 4 µg/m^3			

N.4 Benzo(a)pyrene as an Indicator for PAHs

This section presents the cumulative contour plots for benzo(a)pyrene from all relevant sources.

Table 81: Ambient Air Criteria Relevant to Benzo(a)pyrene.

Pollutant	Averaging Period	Environmental Value	Value[(1)] ($\mu g/m^3$)	Source
Benzo(a)pyrene	3 minute	carcinogen	0.80	Vic EPA
	annual	health	0.0003	Qld EPP(Air) & Air NEPM

Note: (1) At 0°C

Figure 46: The 99.9th Percentile 3-Minute Average Ground Level Concentration of B(a)P.

Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant	
Pollutant:	Benzo(a)pyrene	**Averaging Period:**	3-Minute
Background level:	Not included	**Rank:**	99.9th Percentile
Project Goal:	Vic EPA 0.8 $\mu g/m^3$	**Contour level(s):**	0.0025, 0.005, 0.01 and 0.8 $\mu g/m^3$
Legend: Cyan: 0.8 $\mu g/m^3$, Yellow: 0.0025, 0.005, and 0.01 $\mu g/m^3$			

Figure 47: The Annual Average Ground-Level Concentration of B(a)P).

Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant	
Pollutant:	Benzo(a)pyrene	**Averaging Period:**	Annual Average
Background level:	Not included	**Rank:**	N/A
Project Goal:	Qld EPP(Air) 0.0003 µg/m^3	**Contour level(s):**	0.0001, 0.0002 and 0.0003 µg/m^3
Legend: Cyan: 0.0003 µg/m^3 , Yellow: 0.0001 and 0.0002 µg/m^3			

N.5 Volatile Organic Compounds

This section presents the cumulative contour plots for benzene and toluene from all relevant sources. Note that background levels have not been included in the contour plots. However these have been considered when developing the air quality constraints maps that have been produced for the Northshore Hamilton UDA.

Table 82: Ambient Air Criteria Relevant to Modelled VOCs.

Pollutant	Averaging Period	Environmental Value	Value[(1)]	Source
Benzene	3 minute	carcinogen	58	Vic EPA
	annual	health	10	Qld EPP(Air) & Air Toxics NEPM
Toluene	3 minute	odour	697	Vic EPA
	3 minute	toxicity	13,120	Vic EPA
	30 minute	aesthetics of the environment	1,100	Qld EPP(Air)
	24 hour	health	4,100	Qld EPP(Air) & Air Toxics NEPM
	annual	health	410	Qld EPP(Air) & Air Toxics NEPM

Note: (1) At 0°C

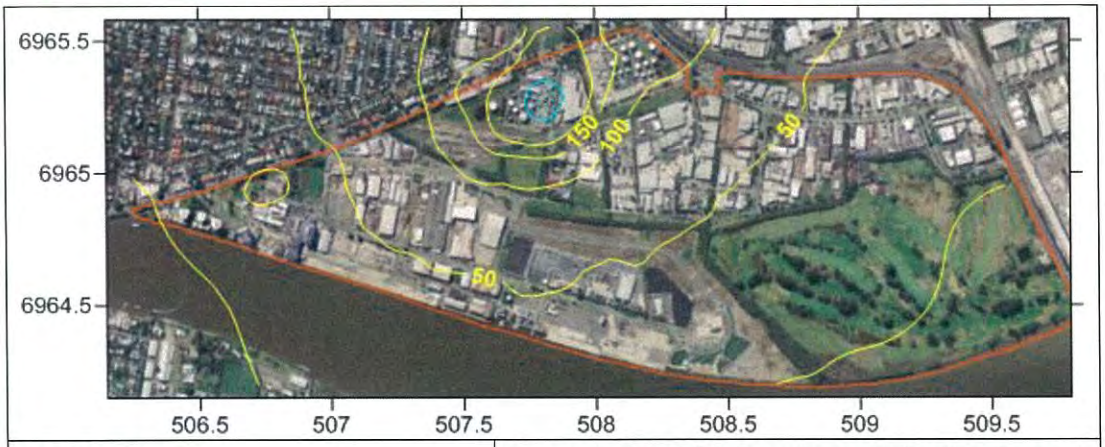
Figure 48: The 99.9th Percentile 3-Minute Average Ground Level Concentration of Benzene.

Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Benzene	**Averaging Period:**	3-Minute
Background level:	Not included	**Rank:**	99.9th Percentile
Project Goal:	Vic EPA 58 µg/m^3	**Contour level(s):**	20, 30, 40 and 58 µg/m^3
Legend: Cyan: 58 µg/m^3 , Yellow: 20, 30 and 40 µg/m^3			

Figure 49: The Annual Average Ground-Level Concentration of Benzene.

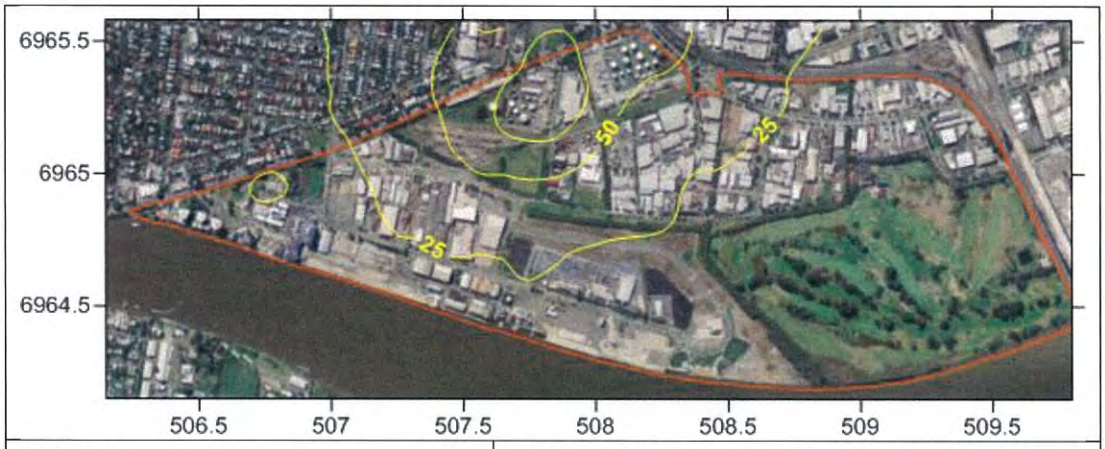
Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Benzene	**Averaging Period:**	Annual Average
Background level:	Not included	**Rank:**	N/A
Project Goal:	Qld EPP(Air) 10 µg/m^3	**Contour level(s):**	1, 2, 4, 7 and 10 µg/m^3
Legend: Cyan: 10 µg/m^3 , Yellow: 1, 2, 4 and 7 µg/m^3			

Figure 50: The 99.9th Percentile 3-Minute Average Ground-Level Concentration of Toluene.



Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Toluene	**Averaging Period:**	3-minute
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 697 µg/m^3	**Contour level(s):**	50, 100, 150, 250 and 697 µg/m^3
Legend: Cyan: 697 µg/m^3 , Yellow: 50, 100, 150 and 250 µg/m^3			

Figure 51: The 99.9th Percentile 30-Minute Average Ground-Level Concentration of Toluene.

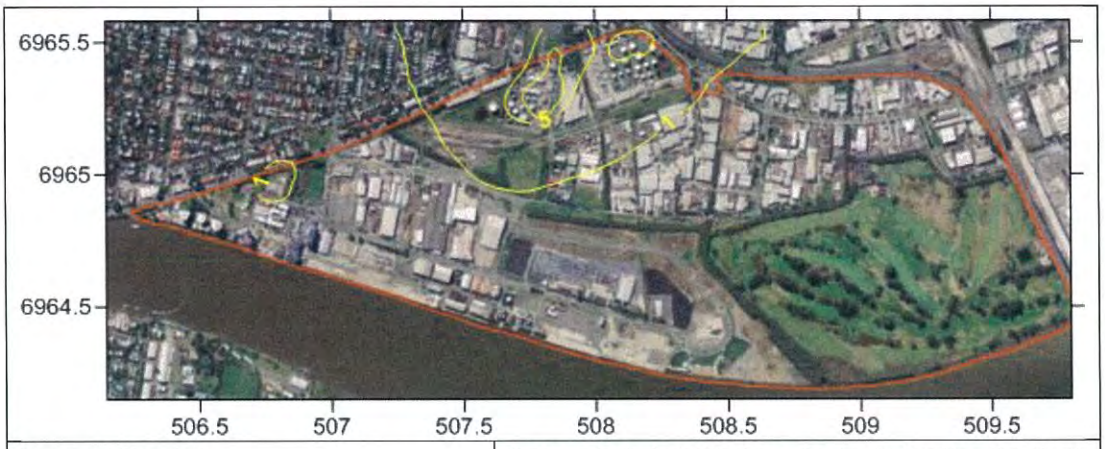


Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Toluene	**Averaging Period:**	30-minute
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Qld EPP(Air) 1,066 µg/m^3	**Contour level(s):**	25, 50, 100 and 1,066µg/m^3
Legend: Cyan: 1,066 µg/m^3 , Yellow: 25, 50 and 100 µg/m^3			

Figure 52: The Maximum 24-Hour Average Ground-Level Concentration of Toluene.

Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Toluene	**Averaging Period:**	24-hour
Background level:	Not included	**Rank:**	Maximum
Project Goal:	Qld EPP(Air) 4,100 µg/m^3	**Contour level(s):**	5, 10, 20, 30, and 4,100 µg/m^3
Legend: Cyan: 4,100 µg/m^3 , Yellow: 5, 10, 20 and 30 µg/m^3			

Figure 53: The Annual Average Ground-Level Concentration of Toluene.



Scenario: Cumulative		**Sources included:** BP, Puma Energy, Caltex Hercules street, Caltex Kingsford Smith drive, BCC asphalt plant	
Pollutant:	Toluene	**Averaging Period:**	Annual Average
Background level:	Not included	**Rank:**	N/A
Project Goal:	Qld EPP(Air) 410 µg/m^3	**Contour level(s):**	1, 5, 10, and 410 µg/m^3
Legend: Cyan: 410 µg/m^3 , Yellow: 1, 5 and 10 µg/m^3			

N.6 Heavy Metals

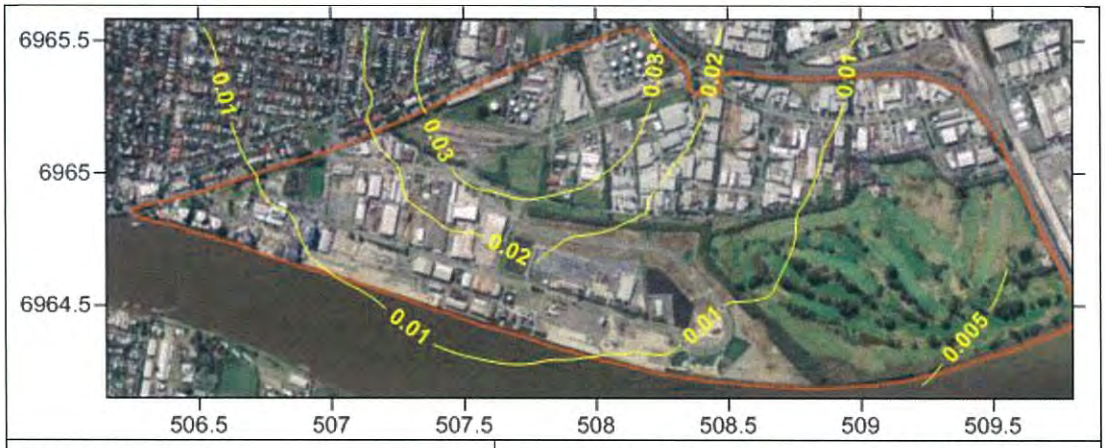
This section presents the cumulative contour plots for lead and zinc from all relevant sources.

Table 83: Ambient Air Criteria Relevant to Heavy Metals.

Pollutant	Averaging Period	Environmental Value	Value[(1)] (µg/m^3)	Source
Lead	1 hour	toxicity	3.27	Vic EPA
	annual	health	0.5	Qld EPP(Air) & Air NEPM
Zinc	3 minute	toxicity	36	Vic EPA (zinc chloride fume)
	3 minute	toxicity	186	Vic EPA (zinc oxide fume)

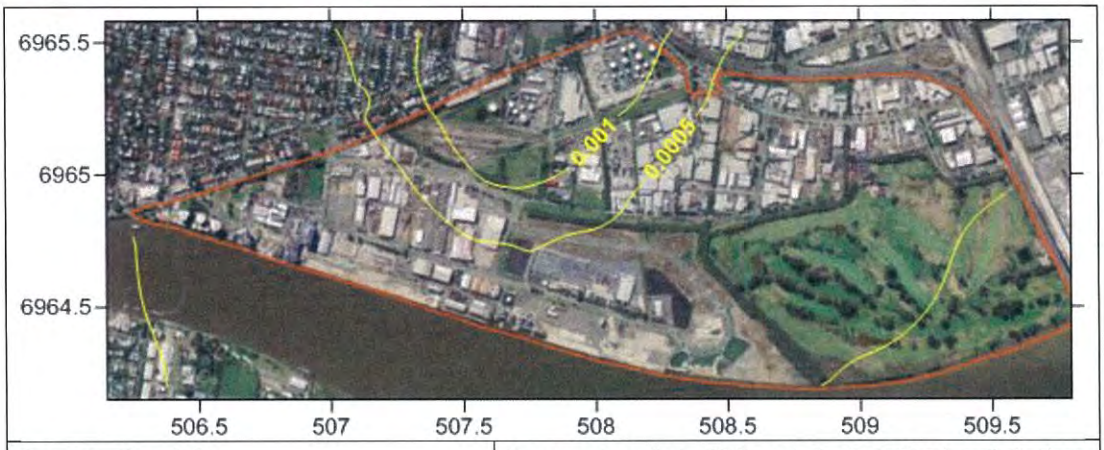
Note: (1) At 0°C

Figure 54: The 99.9th Percentile 1-Hour Average Ground Level Concentration of Lead.



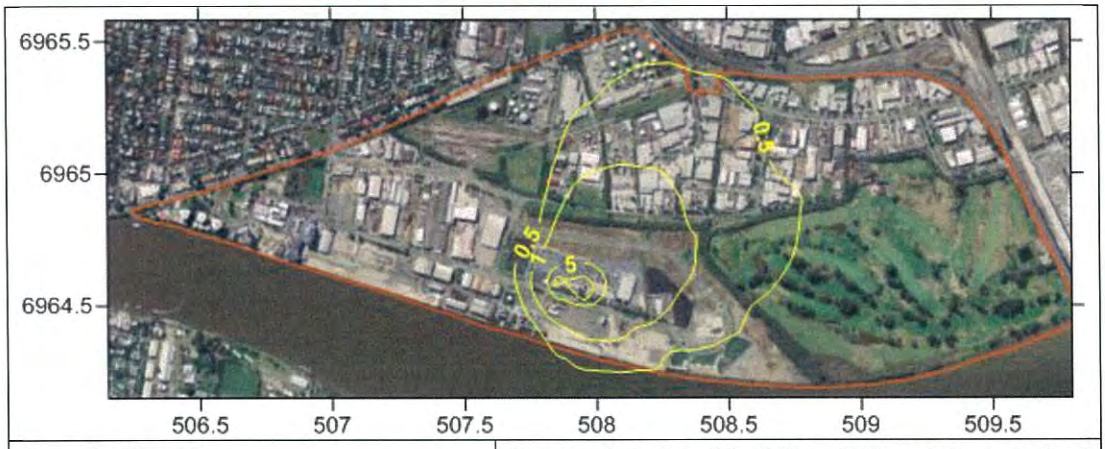
Scenario: Cumulative		**Sources included:** BCC asphalt plant, Boral asphalt plant, Puma Energy	
Pollutant:	Lead	**Averaging Period:**	1-hour
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 3.27 µg/m^3	**Contour level(s):**	0.005, 0.01, 0.02, 0.03 and 3.27 µg/m^3
Legend: Cyan: 3.27 µg/m^3 , Yellow: 0.003, 0.004, 0.006 and 0.01 µg/m^3			

Figure 55: The Annual Average Ground Level Concentration of Lead.



Scenario: Cumulative		**Sources included:** BCC asphalt plant, Boral asphalt plant, Puma Energy	
Pollutant:	Lead	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Not applicable
Project Goal:	Qld EPP(Air) 0.5 µg/m^3	**Contour level(s):**	0.0001, 0.0005, 0.001, and 0.5 µg/m^3
Legend: Cyan: 0.5 µg/m^3 , Yellow: 0.0001, 0.005, and 0.001 µg/m^3			

Figure 56: The 99.9th Percentile 3-Minute Average Ground-Level Concentration of Zinc.



Scenario: Cumulative		**Sources included:** CP Plating, BCC asphalt plant, Boral asphalt plant	
Pollutant:	Zinc	**Averaging Period:**	3-minute
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 36 µg/m^3	**Contour level(s):**	0.5, 1, 5, 10, and 36 µg/m^3
Legend: Cyan: 36 µg/m^3 , Yellow: 0.5, 1, 5, and 10 µg/m^3			

N.7 Oxides of Nitrogen

This section presents the cumulative contour plots for oxides of nitrogen from all relevant sources. Note that background levels have not been included in the contour plots. However these have been considered when developing the air quality constraints maps that have been produced for the Northshore Hamilton UDA.

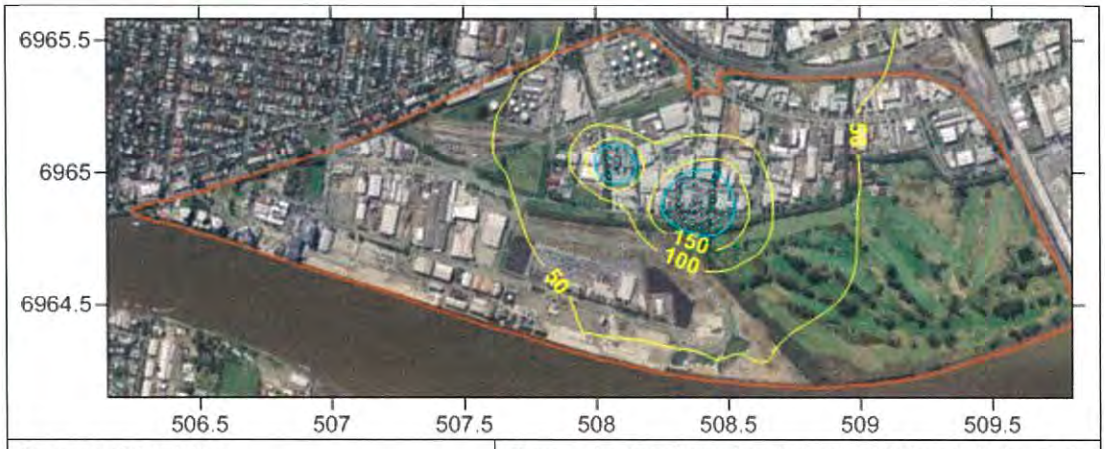
It is also noted, that a conservative approach has been adopted whereby all oxides of nitrogen are assumed to be in the form of nitrogen dioxide. In practice the conversion of released oxides of nitrogen to nitrogen dioxide occurs with distance from the emission source(s). As the dispersion models are typically not run using chemical transformation options, for these types of assessments a percentage conversion is assumed of approximately 20% for the shorter averaging periods and in close proximity to the source(s). Data from the DEHP's Wynumm monitoring location suggests an approximate ratio of 25% of NOx as NO_2 based on the maximum 1-hour average concentrations (2008, 2009, 2010 and 2011), with a ratio of 58.6% of NOx as NO_2 based on the maximum of the annual averages for this same period.

Table 84: Ambient Air Criteria Relevant to Oxides of Nitrogen.

Pollutant	Averaging Period	Environmental Value	Value[(1)] (µg/m^3)	Source
Nitrogen Dioxide	1 hour	health	250	Qld EPP(Air) & Air NEPM
	1 hour	toxicity	207	Vic EPA
	annual	health	62	Qld EPP(Air) & Air NEPM
	annual	ecosystems	33	Qld EPP(Air)

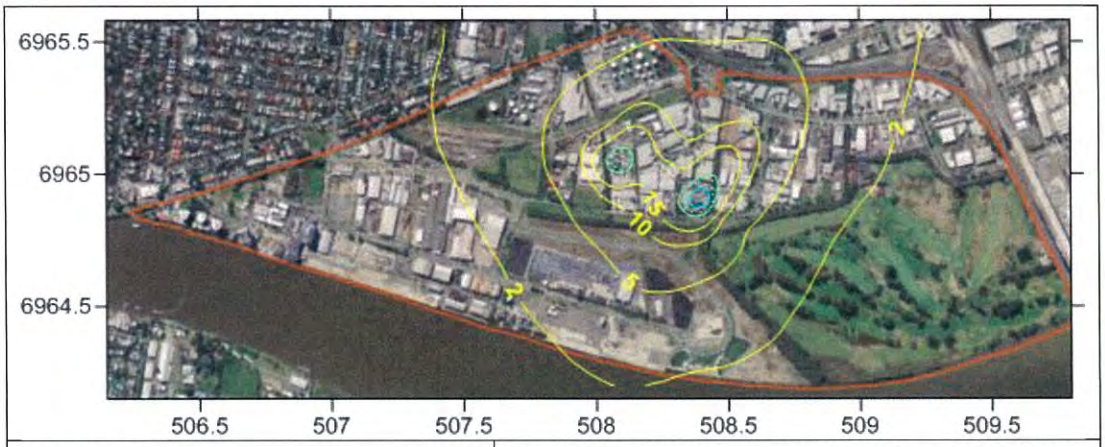
Note: (1) At 0°C

Figure 57: The 99.9th Percentile 1-Hour Average Ground Level Concentration of Nitrogen Dioxide.



Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant, BP	
Pollutant:	Nitrogen Dioxide	**Averaging Period:**	1-hour
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 207 µg/m^3	**Contour level(s):**	50, 100, 150 and 207 µg/m^3
Legend: Cyan: 207 µg/m^3 , Yellow: 50, 100 and 150 µg/m^3			

Figure 58: The Annual Average Ground Level Concentration of Nitrogen Dioxide.



Scenario: Cumulative		**Sources included:** Boral asphalt plant, BCC asphalt plant, BP	
Pollutant:	Nitrogen Dioxide	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Not applicable
Project Goal:	Qld EPP(Air) 62 µg/m^3 (h) Qld EPP(Air) 33 µg/m^3 (e)	**Contour level(s):**	2, 5, 10, 15, 33 and 62 µg/m^3
Legend: Cyan: 62 µg/m^3 , Green: 33 µg/m^3, Yellow: 2, 5,10 and 15 µg/m^3			

N.8 Sulphuric Acid

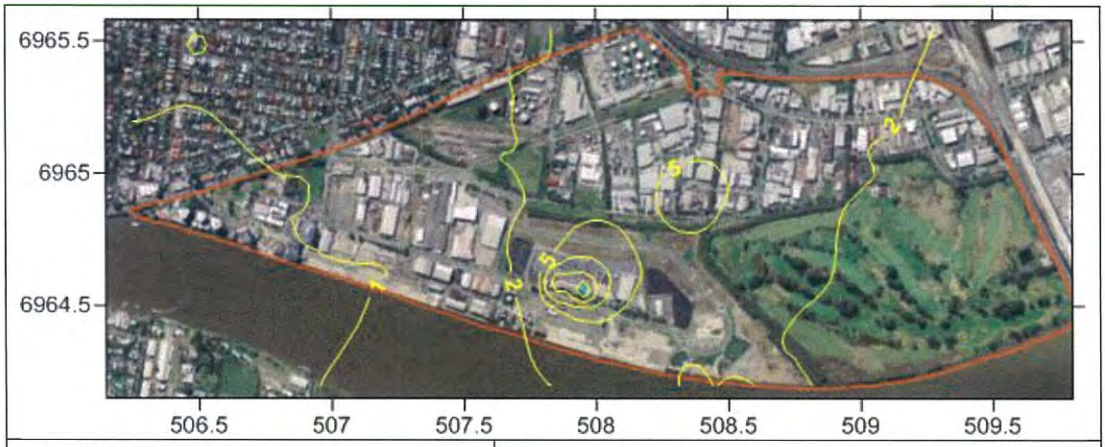
This section presents the cumulative contour plots for sulphuric acid from all relevant sources.

Table 85: Ambient Air Criteria Relevant to Sulphuric Acid.

Pollutant	Averaging Period	Environmental Value	Value[(1)] ($\mu g/m^3$)	Source
Sulphuric Acid	3 minute	toxicity	36	Vic EPA

Note: (1) At 0°C

Figure 59: The 99.9th Percentile 3-Minute Average Ground-Level Concentration of Sulphuric Acid.



Scenario: Cumulative		**Sources included:** BCC asphalt plant, CP plating	
Pollutant:	Sulphuric Acid	**Averaging Period:**	3-minute
Background level:	Not included	**Rank:**	99.9th percentile
Project Goal:	Vic EPA 36 $\mu g/m^3$	**Contour level(s):**	1, 1.5, 2, 5, 10 and 36 $\mu g/m^3$
Legend: Cyan: 36 $\mu g/m^3$, Yellow: 1, 1.5, 2, 5 and 10 $\mu g/m^3$			

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