WAGGA WAGGA
SPECIAL ACTIVATION PRECINCT

FINAL DRAFT MASTER PLAN REPORT C.4.1

PLANNING CONSIDERATIONS FOR
AIR, NOISE AND ODOUR

Department of Planning, Industry & Environment

13 July 2020

Job Number 19040948

Prepared by

Todoroski Air Sciences Pty Ltd

Suite 2B, 14 Glen Street

Eastwood, NSW 2122

Phone: (02) 9874 2123

Fax: (02) 9874 2125

Email: info@airsciences.com.au

WAGGA WAGGA SPECIAL ACTIVATION PRECINCT

PLANNING CONSIDERATIONS FOR AIR, NOISE AND ODOUR

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	04/11/2019	D Kjellberg, P Henschke & A Todoroski	A Todoroski
DRAFT - 002	20/11/2019	D Kjellberg, P Henschke & A Todoroski	A Todoroski
DRAFT - 003	12/06/2020	D Kjellberg & A Todoroski	A Todoroski
DRAFT - 004	29/06/2020	D Kjellberg & A Todoroski	A Todoroski
FINAL - 001	13/07/2020	A Todoroski	

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Todoroski Air Sciences has prepared this report for the Wagga Wagga Special Activation Precinct (SAP). The report presents an analysis of the concept scenarios prepared for the Wagga Wagga SAP.

This report incorporates the following aspects:

- A background and description of the aims of the SAP;
- A review of the existing meteorology and air quality environment around the SAP site;
- A description of the modelling methodology and approach used to assess potential air, odour and noise impacts;
- Presentation and discussion of the baseline analysis prepared for the SAP; and,
- Presentation of the predicted results for the analysis of the concept scenarios and model findings.

2 PROJECT BACKGROUND

2.1 Local setting

The SAP investigations are focussed on examining the areas in the vicinity of the existing industrial estate at Bomen, approximately 7 kilometres (km) northeast of the Wagga Wagga city centre. The investigation area consists of a mixture of commercial/ industrial operations, some residential areas and vacant rural land.

Figure 2-1 presents the SAP approximate investigation area. For this study, we have considered an area larger than the SAP approximate investigation area, as there would be existing and potential future residential receptors outside of the SAP approximate investigation area that warrant consideration.

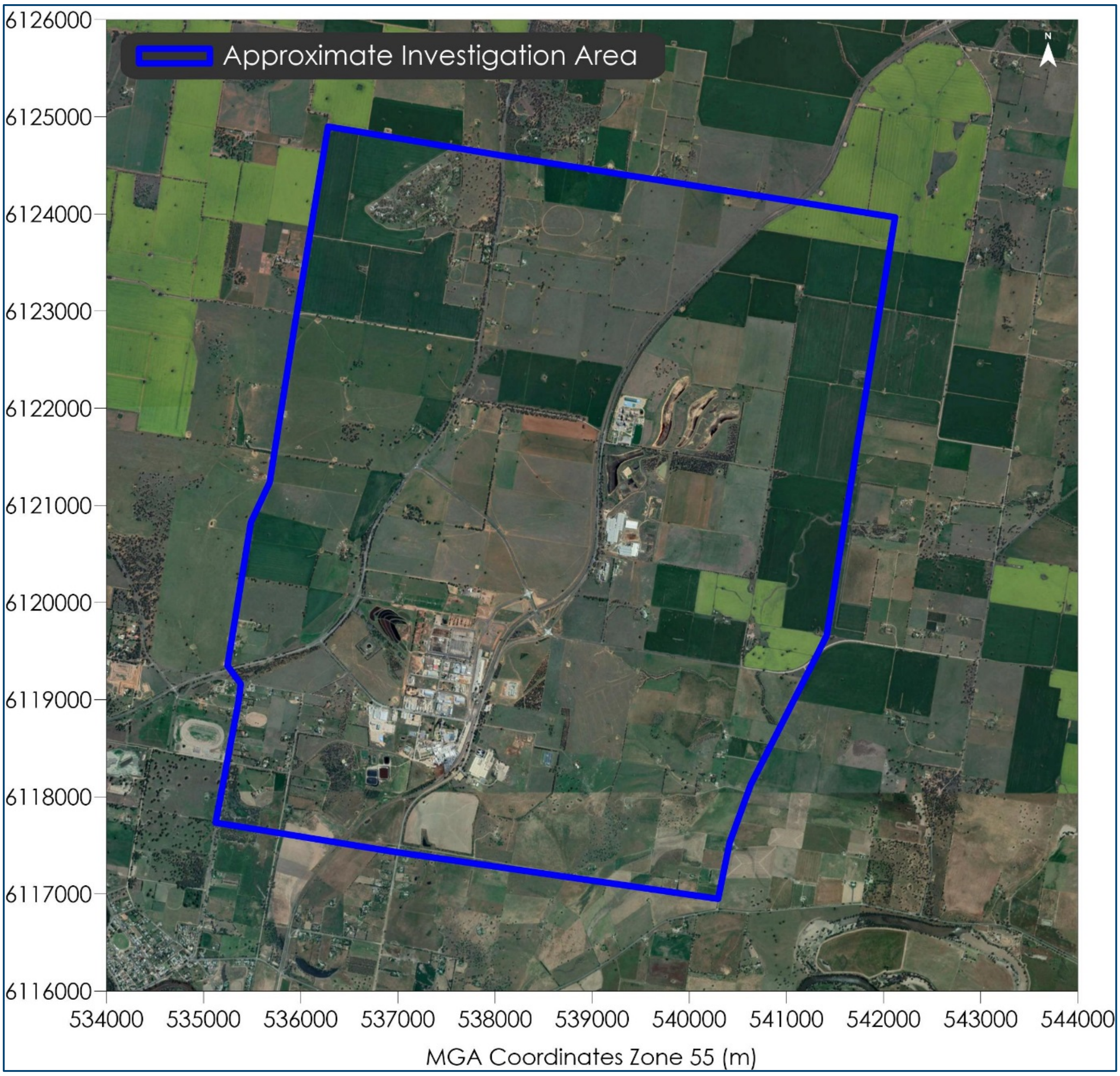

Figure 2-1: SAP approximate investigation area

Figure 2-2 presents a representative three dimensional visualisation of the terrain features surrounding the SAP area. The local topography is gently undulating and a rail-line runs diagonally from the southwest to northeast of the SAP investigation area, generally along a ridge. There is a valley to the east and west of the ridge.

Figure 2-2 also presents the location of buildings/ structures in and around the SAP area. The colour shading indicates the current zoning classification of the structure.

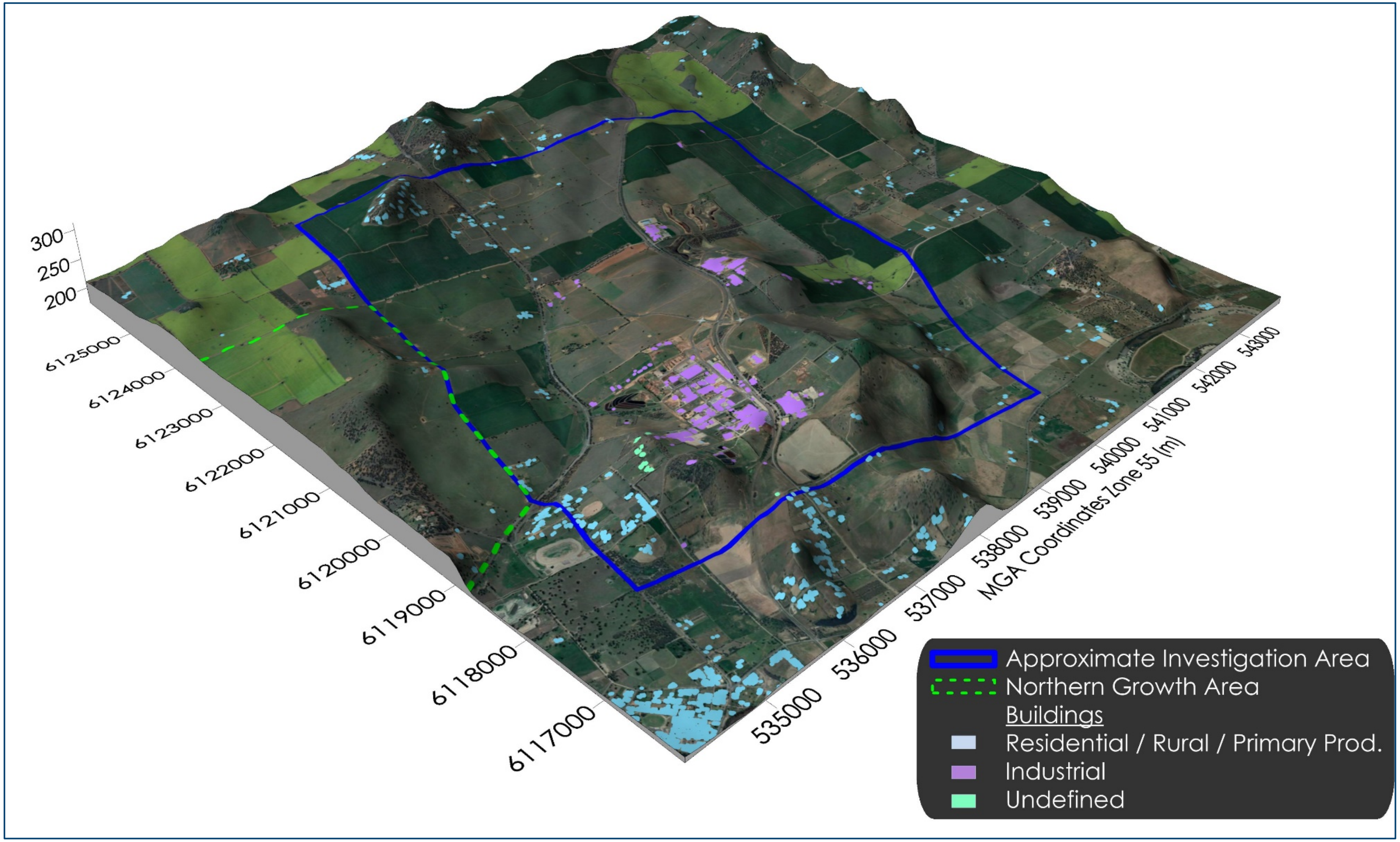

Figure 2-2: Representative visualisation of the local topography surrounding the Project

2.2 Existing industries

The operations identified within the SAP area are set out in **Table 2-1** and **Figure 2-3**. The key pollutants with most scope to exceed criteria are also shown, and the industries with potential to cause impacts above EPA criteria outside of the industrial area are highlighted in light blue shading.

The modelling results for these existing industries are set out in **Section 5**. The modelled scenarios provide a risk analysis associated with all existing emissions relevant to assessing the potential relative impacts on receptors outside the Project area at present.

The modelling analysis defines the existing industries within the industrial area where normal operations have most potential to cause air quality impacts at existing receptor locations outside of the industrial area, and also defines the extent of the corresponding impacted areas outside the industrial area.

Further iterative modelling will be needed as part of the SAP master planning process in order to evaluate the impact that would arise from a larger number of industrial operations in the SAP area. Some indicate results can be taken from previous similar works completed for Wagga Wagga City Council.

Table 2-1: Existing Industries

Company	Industry	Key substance emitted	Potential for impact beyond industrial area	Map identification number
Enirgi Power Storage	Lead acid battery recycling	PM_{10}, lead, SO_2, SO_3, metals	Y	1
Riverina Oil and Bio Energy	Vegetable oil refining plant	H_2S, VOCs, NO_2, SO_2, odour	Y	2
Wagga Wagga City Council	Bomen Industrial Sewage Treatment Facility	Odour	Y	3
Heinz	Food processing	Odour	Y	4
Teys (previously Cargill)	Meat processing	Odour, NO_2	Y	5
Southern Oil	Oil re-refinery	NO_2, H_2S, dioxins and furans, PM_{10}, SO_3, SO_2, metals	Y	6
Wagga Wagga City Council	Livestock marketing centre	Odour, PM_{10}	Y	7
Fulton Hogan (previously Pioneer Road Service)	Asphalt plant	Odour and VOCs, NO_2	Y	8
Caltex depot	Fuel storage and distribution	VOCs	N	9
Rodneys Transport	Freight and grain storage (and other storage)	PM_{10}	N	10
SUEZ (previously SITA)	Waste removal and resource recovery	Odour	N	11
Austrak	Concrete works	PM_{10}	N	12
Vinidex	Plastic pipe manufacturing	VOCs and NO_2	N	13
Southern steel	Steel distribution	-	N	14
Unknown	LPG supplier	VOCs	N	15
Nufarm	Agricultural products	-	N	16

Company	Industry	Key substance emitted	Potential for impact beyond industrial area	Map identification number
Truck art	Automotive and spray painting	VOCs	N	17
Great southern electrical	Power solutions	-	N	18
AG n VET Services	Agricultural products	-	N	19
Hutcheon and Pearce (TECSight)	Agricultural vehicles	-	N	20
Baked Enamel	Coloured glass	NO_2, VOCs	N	21
Ladex Construction Group	Construction	-	N	22
Proway	Cattle yard fabrication	Welding fume	N	23
Riverina Engineering	Engineering	Welding fume	N	24
Southwest Trailers	Trailers	Welding fume	N	25
Essential Energy	Power distribution	-	N	26
Steel Supplies	Steel distribution	-	N	27
Bomen Hot Spot Café	Café	-	N	28
Bidgebong Wines	Wine	Odour	N	29
Dickson Trailers	Vehicles for animal and agricultural product transport	Welding fume	N	31
Points Direct	Agricultural vehicles	-	N	32
Leghorn Industries	Manufacturing chicken sheds	Welding fume	N	33
Land Transport	Storage and distribution	PM_{10}	N	34
Riverina Scrap Metal Processing	Scrap metal	Welding/oxy fume, dust	N	35
CHEP	Pallets	-	N	36
Vetafarms	Pet food	-	N	37
Bomen Produce Company	Stock feeds	-	N	38
BOC limited	Gas and welding equipment	VOCs	N	39
Bomen Substation	Power distribution	-	N	40
The Big Steel	Steel distribution	Welding fume	N	41
AWH	Wool distribution	-	N	42
Option Agparts	Agricultural vehicles	-	N	43

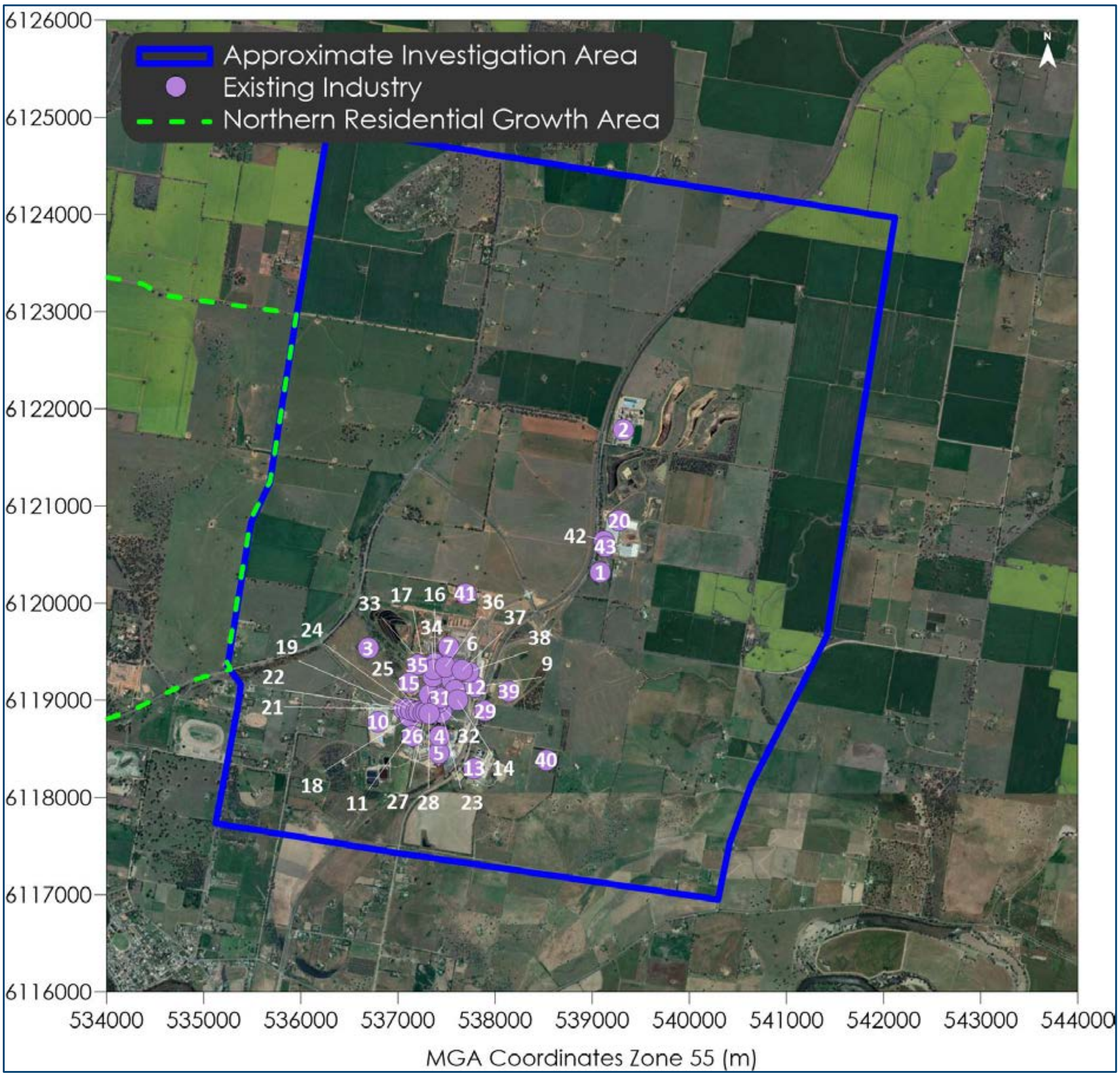

Figure 2-3: Existing industries

2.2.1 Existing industries noise limits

A number of industries within the SAP have been issued Environmental Protection Licences (EPL) which include noise limits. The EPLs and relevant noise limits for industries identified within the SAP are presented in **Table 2-2**.

Table 2-2: Existing industries EPL noise limits

Facility	EPL No.	Noise Limits (dBA)			
Austrak	20452	General			
BOC	13141	General			
Fulton Hogan	12948	General			
Heinz	1361	NL			
Rodneys Transport	13199	General			
Wagga Livestock	11351	NL			
Wagga STF	393	NL			
		Day 7am-6pm Mon-Fri 7am-1pm Sat	**Evening** 6pm-10pm Mon-Fri	**All Other Times**	
		L_{A10} (15 min)	L_{A10} (15 min)	L_{A10} (15 min)	
Enirgi	12878	37	36	35	
Southern Oil	11408	55	45	40	
		L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{Aeq} (15 min)	
Tasco	12395	50	40	35	
		Day 7am-6pm Mon-Sat 8am-6pm Sun & Pub. Hol.	**Evening** 6pm-10pm	**Night** 10pm-7am Mon-Sat 10pm-8am Sun & Pub. Hol.	
		L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{A1} (1 min)
Riverina Oils	13097	35	35	35	45
Teys	2262	37	37	35	45

General – Facility must not exceed limits outlined in NSW Industrial Noise Policy (**NSW EPA, 2017**)
NL – (Not listed) No noise requirements listed for the facility

The limiting criteria for an individual operation would be 35 dB(A) LAeq (15min) at night time, coupled with a L_{A1} (1 min) sleep disturbance criterion.

For this assessment we need to consider the effect of all industries operating at night, thus the limiting criteria will be the amenity criteria of 40 dB(A) LAeq (15min) at night time, coupled with a L_{A1} (1 min) sleep disturbance criterion applicable to any individual operation.

3 EXISTING ENVIRONMENT

This section describes the existing environment including the climate, ambient air quality and background noise levels in the area surrounding the SAP.

3.1 Local climatic conditions

Long-term climatic data from the Bureau of Meteorology (BoM) weather station at Wagga Wagga Aeronautical Meteorological Office (AMO) (Site No. 072150) were used to characterise the local climate in the proximity of the Project. The Wagga Wagga AMO is located approximately 9.5km southeast of the Project.

Table 3-1 and **Figure 3-1** present a summary of data from the Wagga Wagga AMO collected over an approximate 60 to 78 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 31.9 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 2.8°C.

Rainfall exhibits variability across the year. The data indicate that October is the wettest month with an average rainfall of 56.4 millimetres (mm) over 6.9 days and April is the driest month with an average rainfall of 39.7mm over 4.8 days.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 52 per cent (%) in January to 88% in July. Mean 3pm humidity levels range from 29% in January to 65% in July.

There is little spread in the wind speeds between the 9am and 3pm conditions. Mean 9am wind speeds range from 6.5 kilometres per hour (km/h) in June to 13.1km/h in January. Mean 3pm wind speeds range from 10.7km/h in June to 17.7km/h December.

Table 3-1: Monthly climate statistics summary – Wagga Wagga AMO

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	31.9	31.0	27.7	22.6	17.4	13.9	12.8	14.5	17.7	21.7	25.9	29.5	22.2
Mean min. temp. (°C)	16.4	16.4	13.5	9.2	5.9	3.7	2.8	3.5	5.1	7.8	10.9	13.9	9.1
Rainfall													
Rainfall (mm)	40.5	40.2	44.6	39.7	50.6	50.4	54.4	50.7	49.2	56.4	46.3	46.6	571.5
No. of rain days (≥1mm)	4.0	4.0	4.0	4.8	6.2	7.4	9.1	8.8	7.1	6.9	5.5	4.6	72.4
9am conditions													
Mean temp. (°C)	22.5	21.7	19.0	14.6	10.0	7.0	5.9	7.8	10.9	14.8	17.9	21.0	14.4
Mean R.H. (%)	52	57	61	69	82	87	88	83	77	67	59	52	70
Mean W.S. (km/h)	13.1	12.2	10.5	8.7	7.2	6.5	6.8	8.7	10.2	11.4	12.7	13.0	10.1
3pm conditions													
Mean temp. (°C)	30.1	29.3	26.5	21.6	16.6	13.2	12.0	13.7	16.7	20.2	24.3	27.8	21.0
Mean R.H. (%)	29	33	35	43	56	64	65	59	54	46	36	30	46
Mean W.S. (km/h)	16.3	13.8	13.2	12.4	11.6	10.7	11.8	14.3	15.2	15.9	17.3	17.7	14.2

Source: **Bureau of Meteorology, 2019 (accessed July 2019)**

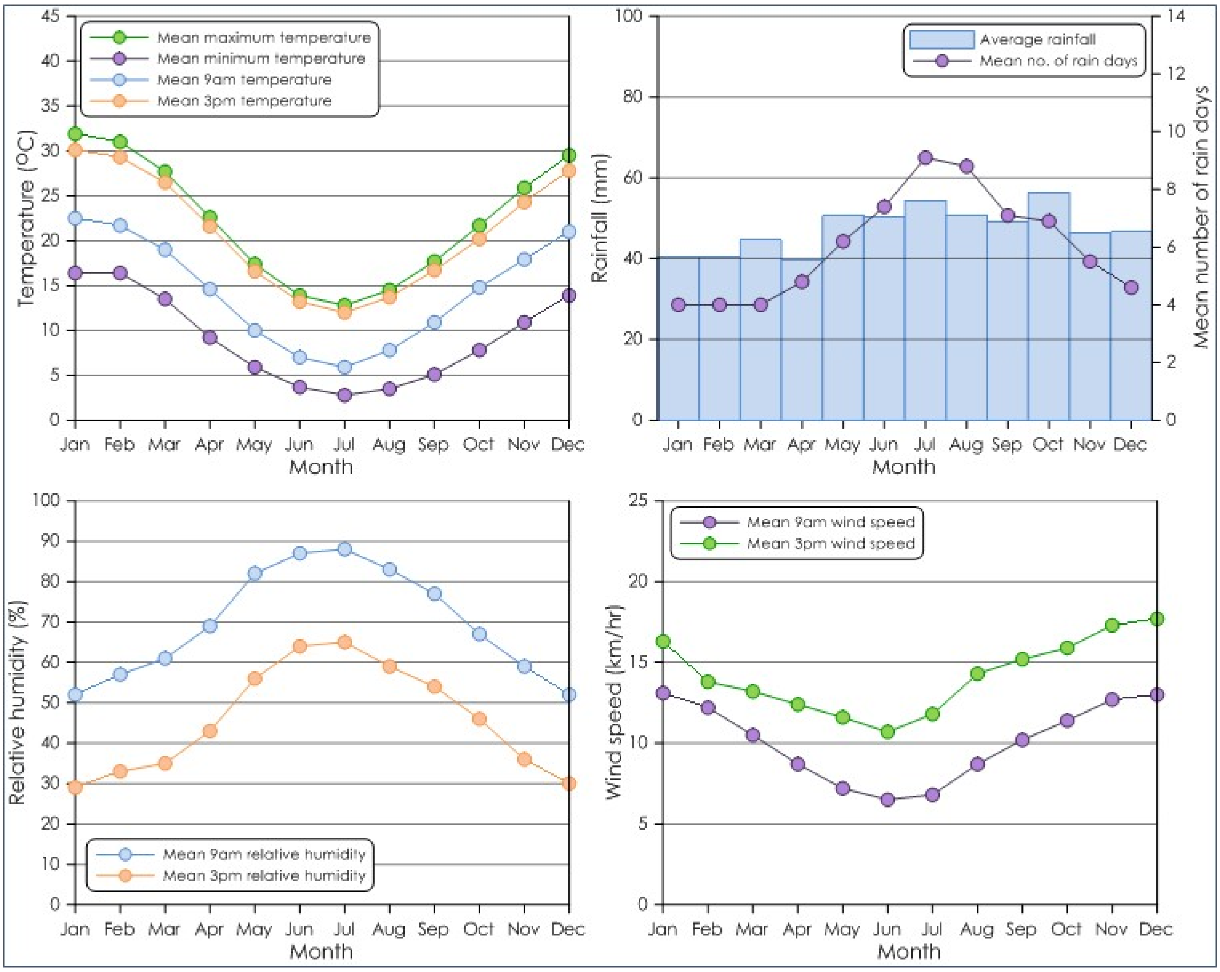

Figure 3-1: Monthly climate statistics summary – Wagga Wagga AMO

3.2 Local meteorological conditions

The Wagga Wagga AMO has been used to represent local meteorological conditions that would be experienced at the Project site. The Wagga Wagga AMO is located approximately 9.5km southeast of the Project. Annual and seasonal windroses prepared from data collected for the 2016-2018 calendar years are presented in **Figure 3-2**.

The windroses indicate that on an annual basis winds are predominately from the east and east-northeast. The wind distributions during all seasonal are generally similar to the annual. In winter there are fewer winds from the east-northeast and wind speeds from the east-northeast to east-southeast are lower than in other seasons.

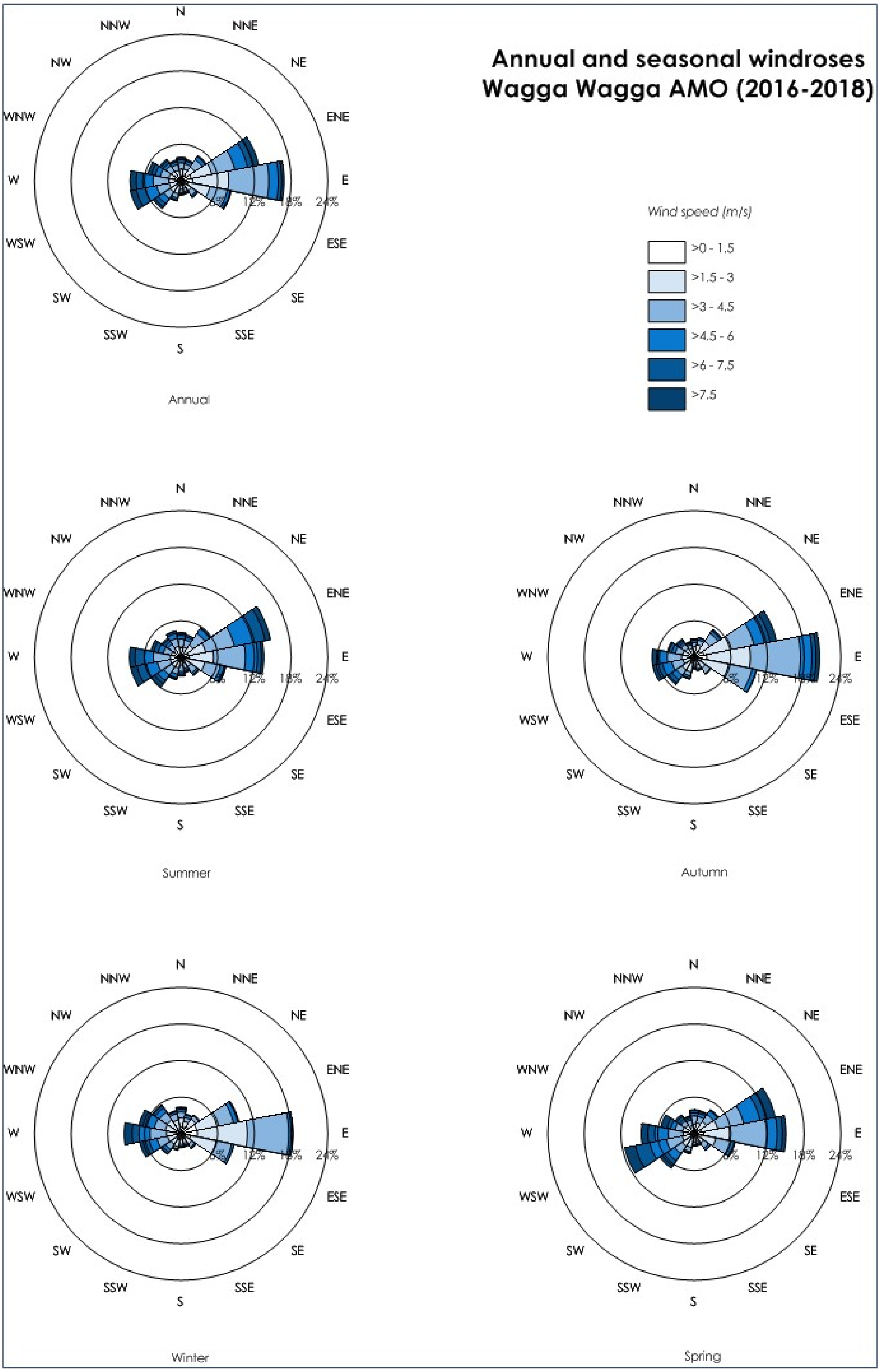

Figure 3-2: Annual and seasonal windroses for Wagga Wagga AMO (2016-2018)

3.3 Ambient air quality

The main sources of air pollutants in the residential area surrounding the SAP include emissions from local anthropogenic activities (such as motor vehicle exhaust and domestic wood heaters), industrial activities and agricultural activities.

Ambient air quality monitoring data at the SAP are not available. Therefore, the available data from the nearest air quality monitors operated by the NSW Office of Environment and Heritage (OEH) were used to quantify the existing background level for assessed pollutants at the Project site.

These include the Wagga Wagga and Wagga Wagga North monitoring stations which are located within approximately 4.5km. Note that the Wagga Wagga monitoring station was decommissioned in October 2011 and the Wagga Wagga North station was commissioned in July 2011.

3.3.1 PM_{10} monitoring

The available PM_{10} monitoring data from the nearest air quality monitors operated by the NSW OEH have been reviewed and are summarised in **Table 3-2**. Recorded 24-hour average PM_{10} concentrations are presented graphically in **Figure 3-3**.

A review of **Table 3-2** indicates that the annual average PM_{10} concentrations at Wagga Wagga were below the applicable criterion at the time of 30µg/m^3 but were often above the current criterion of 25µg/m^3. The annual average PM_{10} concentration at Wagga Wagga North exceeded the applicable criterion in 2018. The data indicate a seasonal trend with higher levels occurring in the summer months and lower levels occurring in the winter.

The maximum 24-hour average PM_{10} concentrations recorded at the Wagga Wagga and Wagga Wagga North stations exceed the relevant criterion of 50µg/m^3 many times during the review period.

The cause of the relatively large number of elevated dust days was not examined in detail as part of this study as it would not be related to any activity in the SAP, rather it appears to be related to rainfall/ drought conditions, and possibly previous stubble burning activities.

Table 3-2: Summary of PM_{10} levels from NSW OEH monitoring (μg/m³)

Year	Annual average			Year	Maximum 24-hour average			Year	No. days above standard	
	Wagga Wagga	Wagga Wagga Nth	NEPM Standard		Wagga Wagga	Wagga Wagga Nth	NEPM Standard		Wagga Wagga	Wagga Wagga Nth
2001	-	-	25*	2001	**69.6**	-	50	2001	2	-
2002	**29.2**	-	25*	2002	**193.2**	-	50	2002	34	-
2003	**27.7**	-	25*	2003	**970**	-	50	2003	21	-
2004	**25.7**	-	25*	2004	**109**	-	50	2004	28	-
2005	24.6	-	25*	2005	**161.9**	-	50	2005	27	-
2006	**29.2**	-	25*	2006	**188.3**	-	50	2006	37	-
2007	**26.1**	-	25*	2007	**110.3**	-	50	2007	34	-
2008	24.9	-	25*	2008	**294.9**	-	50	2008	23	-
2009	27.0	-	25*	2009	**297.4**	-	50	2009	21	-
2010	17.2	-	25*	2010	**64.9**	-	50	2010	6	-
2011	-	-	25*	2011	36.0	**56.3**	50	2011	0	1
2012	-	18.8	25*	2012	-	**67.2**	50	2012	-	1
2013	-	22.1	25*	2013	-	**110.7**	50	2013	-	15
2014	-	20.7	25*	2014	-	**88.2**	50	2014	-	13
2015	-	19.9	25*	2015	-	**145.1**	50	2015	-	7
2016	-	20.6	25*	2016	-	**114.7**	50	2016	-	16
2017	-	20.6	25*	2017	-	**171.6**	50	2017	-	10
2018	-	**27.4**	25*	2018	-	**127.2**	50	2018	-	34
2019#	-	-	25*	2019	-	**221.9**	50	2019	-	32

*The National Environment Protection Council (NEPC) varied the Ambient Air Quality National Environment Protection Measure (NEPM) on 4 February 2016 (NEPC, 2016) incorporating a change in the annual average standard for PM_{10} concentrations from 30μg/m³ to 25μg/m³.

#includes data until 26 July 2019.

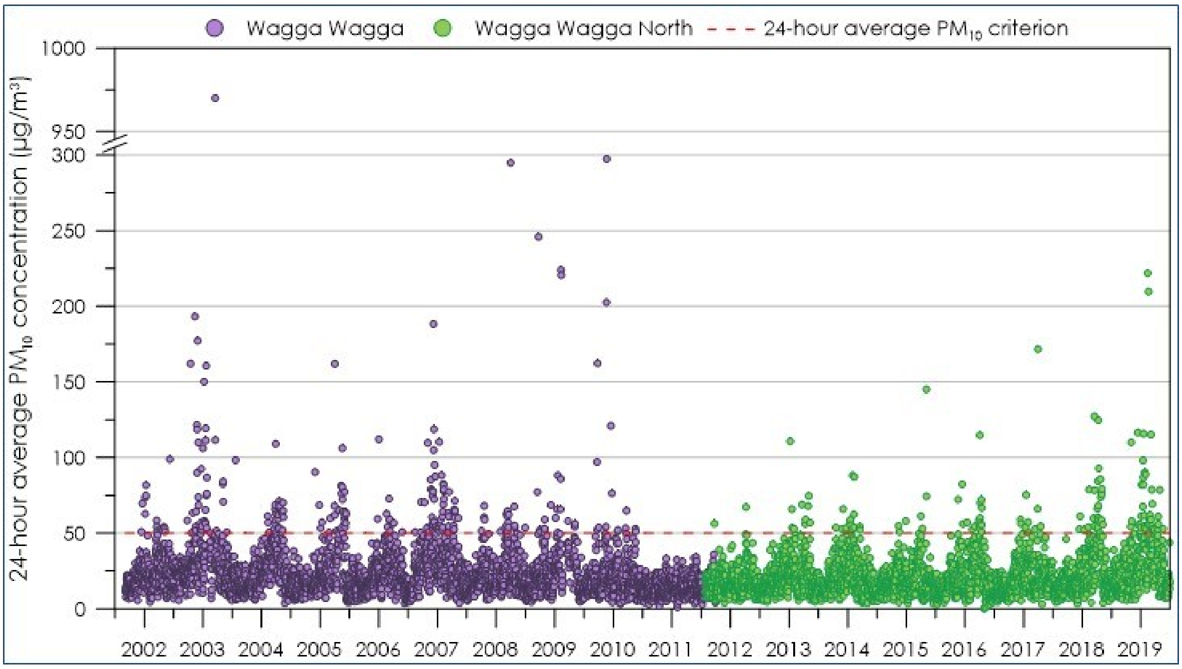

Figure 3-3: 24-hour average PM_{10} concentrations

3.3.2 $PM_{2.5}$ monitoring

A summary of the available $PM_{2.5}$ monitoring data from the NSW OEH monitoring stations is presented in **Table 3-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented graphically in **Figure 3-4**.

A review of **Table 3-3** indicates that the annual average $PM_{2.5}$ concentrations at Wagga Wagga North were above the relevant criterion of 8µg/m^3 for the 2012, 2017 and 2018 years.

The data indicate an inverse seasonal trend to PM_{10}, with lower levels occurring in the summer months and higher levels occurring in the winter, likely due to smoke form domestic wood heaters.

The maximum 24-hour average $PM_{2.5}$ concentrations recorded at the monitoring stations were found to exceed the relevant criterion of 25µg/m^3 at times during the review period.

Table 3-3: Summary of $PM_{2.5}$ levels from NSW OEH monitoring (µg/m^3)

Year	Annual average		Year	Maximum 24-hour average		Year	No. days above standard
	Wagga Wagga Nth	NEPM Standard		Wagga Wagga Nth	NEPM Standard		Wagga Wagga Nth
2011	-	8*	2011	15.4	25*	2011	0
2012	**8.7**	8*	2012	23.2	25*	2012	0
2013	7.9	8*	2013	**29.9**	25*	2013	3
2014	7.5	8*	2014	**27.6**	25*	2014	2
2015	7.6	8*	2015	24.2	25*	2015	0
2016	7.4	8*	2016	**28.1**	25*	2016	2
2017	**8.1**	8*	2017	**32.5**	25*	2017	4
2018	**8.4**	8*	2018	23.8	25*	2018	0
2019#	-	8*	2019	**30.8**	25*	2019	3

*The National Environment Protection Council (NEPC) varied the Ambient Air Quality National Environment Protection Measure (NEPM) on 4 February 2016 (**NEPC, 2016**) amending the status of the 'advisory reporting standards' to 'standards' for 24-hour and annual average $PM_{2.5}$ concentrations.
#includes data until 26 July 2019.

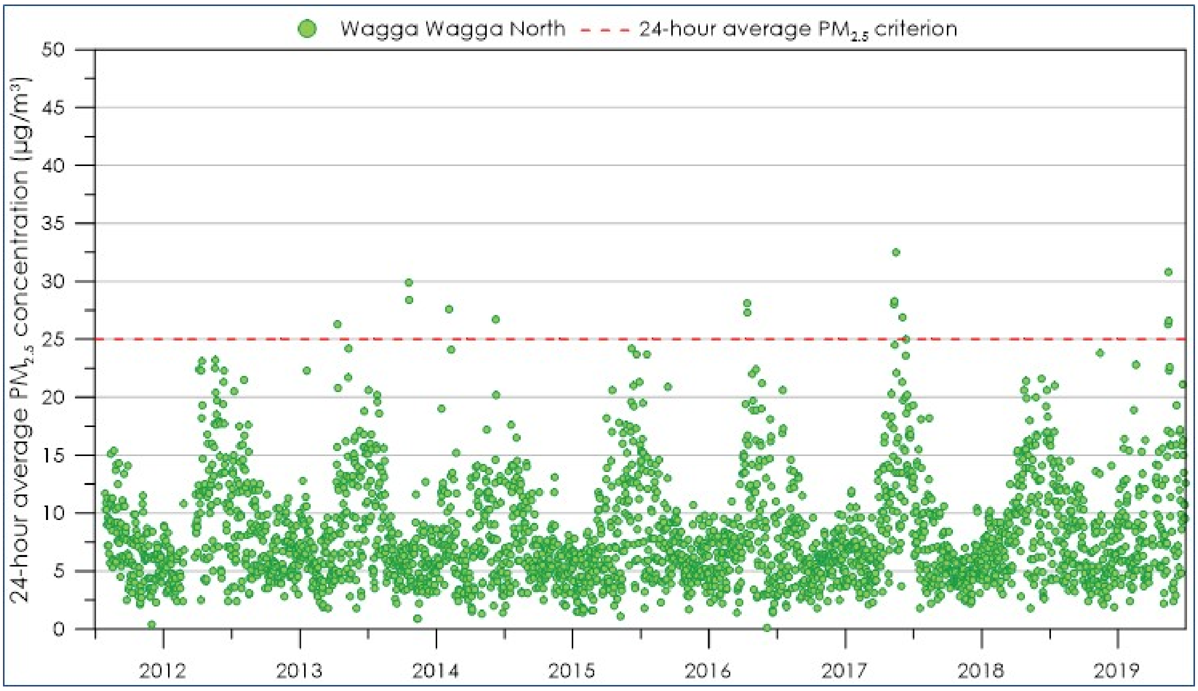

Figure 3-4: 24-hour average $PM_{2.5}$ concentrations

3.4 Existing Noise Levels

Noise monitoring has been conducted in the vicinity of the SAP to quantify the existing noise environment in the area. A review of the existing development reports indicate that unattended noise monitoring has been conducted for the following facilities/ developments:

- Noise Planning Assessment Industrial Land Study Bomen (**Atkins, 2008**);
- Teys Australia Bomen Beef Processing Facility (**CEE, 2015 & HLA, 2002**);
- Yammatree Family Trust Fairview Park Estate (**GHD, 2016**); and,
- Enirgi Power Storage (**GHD, 2018**).

The results of the monitoring are summarised in **Table 3-4**. The locations selected for the unattended noise measurements are presented in **Figure 3-5**.

Table 3-4: Summary of unattended noise measurement results (dBA)

Location	Background Level L_{A90}			Equivalent Continuous Level L_{Aeq}			Date	Source
	Day	Evening	Night	Day	Evening	Night		
Fairview 1	31	30	27	53	47	44	October 2014	GHD, 2016
Fairview 2	33	33	32	49	46	45	October 2014	GHD, 2016
Fairview 3	39	37	33	52	53	52	October 2014	GHD, 2016
Fairview 4	36	34	33	62	61	57	October 2014	GHD, 2016
Fairview 5	35	34	29	50	49	46	October 2014	GHD, 2016
Teys 1	32	33	30	52	47	48	May 2001	HLA, 2002
Murphy 1	36	33	37	54	53	48	October 2006	CEE, 2015
Murphy 2	34	37	34	43	42	40	October 2006	CEE, 2015
Atkins 1	38.2	38.1	35.1	51.3	50.4	47.9	October 2007	Atkins, 2008
Atkins 2	48.5	54.5	51	59.3	62.3	61.9	October 2007	Atkins, 2008

Location	Background Level L_{A90}			Equivalent Continuous Level L_{Aeq}			Date	Source
	Day	Evening	Night	Day	Evening	Night		
Atkins 3	35.3	32.1	28.6	48.7	44	43.8	October 2007	Atkins, 2008
Atkins 4	37.3	38.4	32.8	53.2	51.8	51.5	October 2007	Atkins, 2008
Enirgi 1	51	51	51	71	65	58	March 2017	GHD, 2018
Enirgi 2	33	27	21	43	53	32	March 2017	GHD, 2018

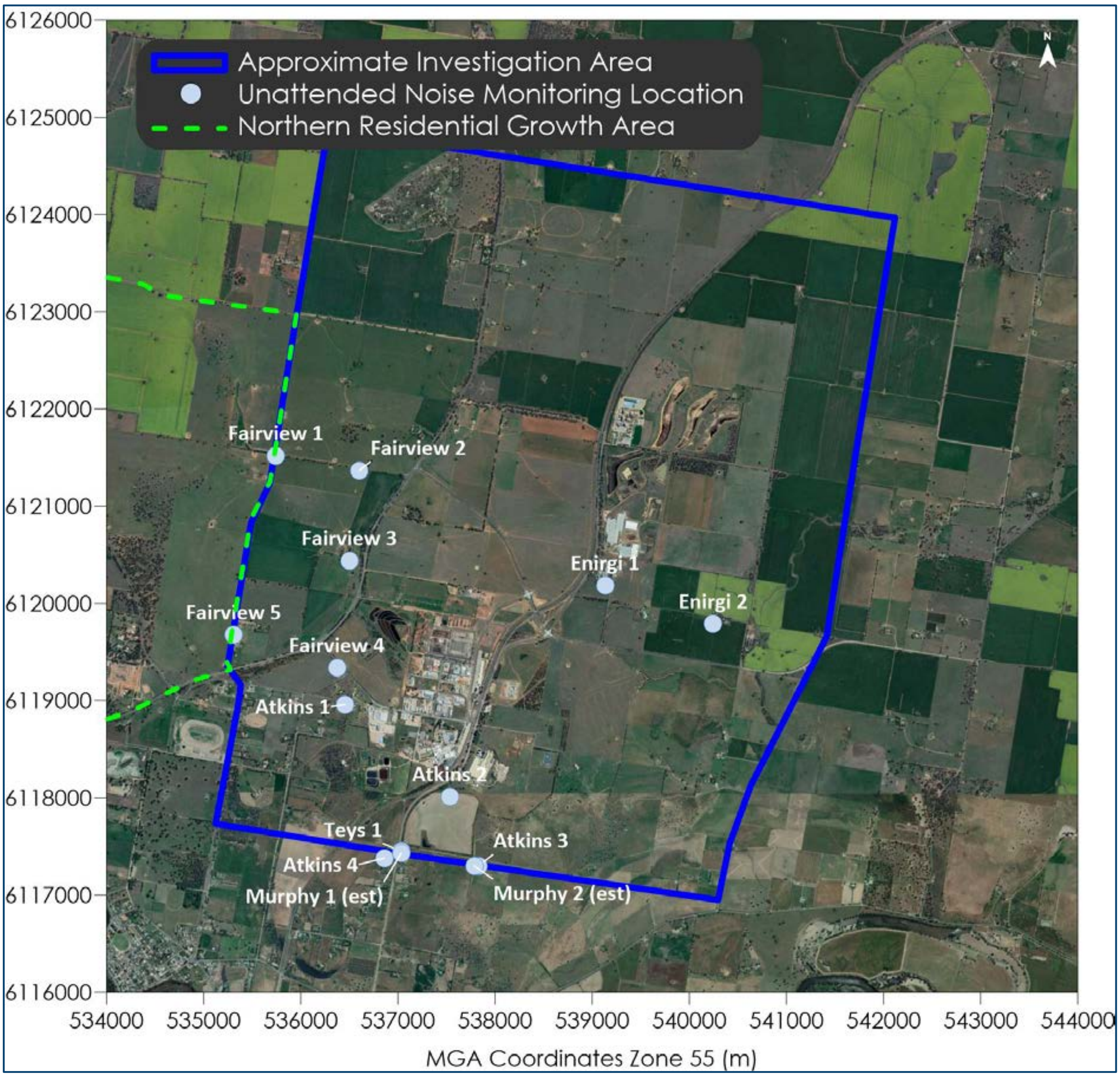

Figure 3-5: Unattended noise monitoring locations

3.5 Summary - existing air quality odour and noise environment

3.5.1 Air quality and odour

In general, there are elevated particulate levels in the Wagga Wagga area, with the particulate levels exceeding the EPA criteria relatively often. PM_{10} is most likely to be associated with the state of ground cover in the region (this is affected by rain/ drought conditions and agricultural activities). $PM_{2.5}$ is most likely impacted by residential wood heaters in the town in the cooler months, and historical stubble burning practices.

Site inspections of the industrial facilities in the SAP do not indicate any major sources of PM_{10} and $PM_{2.5}$ likely to make a large impact on the particulate levels experienced by the population.

The existing elevated background dust levels are above the recently tightened NSW EPA criteria for particulates in these locations, thus it will not be possible to design the SAP (or any industry, farm or other activity in the area) to meet these criteria. However, this is also the case in most areas of NSW.

It is advisable to pre-define how this situation would be dealt with in this locality. As a guide, for individual industrial projects in NSW, the approach taken in similar circumstances is that the proposed facility is require to meet best practice levels of emissions and to not lead to an unacceptable increase in pollution levels that may affect health. The same approach is applied to developments such as major state infrastructure projects, which in similar circumstances adopt health based criteria based on acceptable incremental increases in particulate levels.

The SAP process allows a standardised approach to be developed to minimise possible excessive additional dust impacts arising. However, as outlined above, there is a relatively low risk of any major levels of particle emissions to arise from either the existing or future development of the SAP.

Whilst there are no other monitoring data available, there is also no reason to consider that other pollutants such as NO_2 or SO_2 would be elevated in this locality. Levels in the Wagga Wagga region can reasonably be expected to be low, and would not constrain development of the SAP.

3.5.2 Noise

Overall, the existing noise levels show some limited areas near to existing industries to be near to acceptable noise levels. The results are consistent with expected noise levels in proximity to an industrial area, when considering the local environment and proximity to sources; for example, the measured noise levels very near to the Enirgi facility are consistent with noise levels within an industrial area, and levels near receptors in the vicinity of Teys/ Cartwrights Hill are near to noise criteria.

For this study, the baseline noise levels are not crucial inputs to the design of the proposed industrial area. This is because the proposed industrial area needs to be designed to meet the pre-defined cumulative amenity criteria, as set out in the NSW Noise Policy for Industry. These criteria are not based on the existing background level, rather they define the acceptable cumulative level for human wellbeing.

The existing noise levels could be an issue where they exceed the amenity criteria, but the measured data show that this is not the case in this location.

4 MODELLING METHODOLOGY

4.1 Introduction

The relationship between the permissible level of air pollution emissions from any source (e.g. Regulatory limit) and the permissible level at receptor (i.e. ground level or ambient air quality criteria set out in the NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (**EPA, 2016**)) was analysed to determine the limiting pollutants that will govern the findings of the air quality assessment. The limiting pollutants are those with the smallest ratio between the level that could be emitted (at the source) and the level permitted in the ambient air (at the receiver). This is the limiting pollutant ratio, as set in the applicable criteria.

For noise, we determined the difference between the sound energy released at the source and the applicable noise criteria at the receiver. This is the noise residual. The sound energy is derived for a typical array of noise sources in an industrial area, and the applicable night time criteria (assuming 24/7 operations) will govern noise residual (limiting case). For a 24/7 operation it is taken that the sound energy from the source is the same, but the criteria are less stringent thus when the night time criteria are met, the evening and daytime criteria are also met. (It noted that even if there happens to be more noise energy released from the source in the evening or daytime, the less stringent criteria almost always adequately than compensate for this).

The air pollutant levels (for any air pollutant) at the source are related to the level at the receiver by the degree of air dispersion or dilution of the pollutant as it travels from the source to the receptor. In a similar way, for noise, the sound energy at the source is related to the noise level at the receiver by the degree of noise attenuation between the source and receiver. Thus for air pollution we apply a ratio, division or multiplication calculations, and for noise we use subtraction or addition calculations, but otherwise the same big picture principles apply).

Air dispersion modelling was used to determine the dilution ratio between all potential sources and all receptors (the modelling method is detailed later). At any receptor where the air dilution ratio approaches the limiting pollutant ratio, there is a high risk of exceeding the criteria for the limiting pollutant i.e. a high risk of air quality impacts arising. Medium and low and risks are also defined according to the range source emissions that can be expected to arise from industrial sources, and/or for other pollutants.

Similarly, noise modelling was used to determine the noise attenuation between all potential sources and all receivers (the modelling is detailed later). Risks were assigned on the same basis as air, i.e. per the limiting criteria at the receiver, thus at any receiver where the noise attenuation approaches the noise residual, there is a high risk of exceeding the criteria and a high risk of noise impacts arising.

The modelled outputs are thus presented as risk levels to allow the risks from several pollutants, which may be dispersed differently (see later), but also noise to be compared on a like-for-like basis. The ability to make a valid comparison between all types of industries, air pollutants and noise pollutants is crucial for making good planning decisions.

The NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (**EPA, 2016**) define a range of criteria for many air pollutants. However, the pollutants can be categorised in simple terms according to how they are released. In general:

- Stacks will release; air toxics (such as metals, dioxins etc.) after capture and treatment, and common criteria pollutants (such as SO_2, NO_2 and fine particles) from a combustion process or a material handling process.

- The key fugitive emissions are dust and odour. These emissions may arise from wind erosion of an exposed site (dust), a pond (sewage, or process water odours), the openings of a building (paint fumes, dust, welding fumes etc.), or a land surface (manure, compost etc.).

How the pollutant is released is the key factor in determining the type of industry, and also the degree of dispersion between source and receiver.

In general, fugitive emissions result in most impact nearest the source and at ground level nearby, with less and less impacts as one moves further away. The spatial extent of the impact is generally governed by low wind conditions and inversions. In general, the greatest impacts tend to be confined to a valley

Noise, and especially noise at night-time is most affected by inversions and gradient winds, and is most similar to the fugitive sources. However noise propagation is significantly affected by barriers, thus the terrain is a significant factor. Like the fugitive sources, noise impacts can be confined within a valley (if the source is in the central part of the valley and the valley terrain is significant).

Unlike fugitive sources and noise, stacks are designed to disperse pollutant away from the ground. Emission released from stack will have their highest impacts on the surrounding elevated terrain, and often somewhat away from the source. Placing stacks at the bottom of a valley is generally counterproductive as taller, more costly stack will be needed to prevent impacts. On the other hand, whilst stack sources would ideally be placed atop ridges and hills, the types of industries that have stacks are generally large, and visually such industries can be an imposing eyesore (in the view of many).

Knowing the above, meant that the air dispersion modelling between source and receiver could be limited to stacks and fugitive sources. The limiting pollutant ratio for stack emissions was determined to be air toxics (Metals), and was odour for fugitive sources.

The air and noise modelling factors in the prevailing weather and terrain conditions for the specific locality.

For both the air and noise modelling, the modelling was “reverse engineered” such that the same risk profile could be applied to the sources as well as the receivers/ receptors. This was done so that it is possible to tell which sources cause the impact at receptors. Only high risk sources can cause high risk impacts. Removing either the high risk source or high risk impacted receptor (or both) eliminates the risk of impacts arising.

The modelling was then set up to allow this to be done quickly and to iteratively arrive at an optimal separation between source and receptor that would minimise impacts. Further refinement of the modelling was made to factor in low, medium and high amenity sectors to be developed, according to the types of industry that would emit low, medium or high levels of air pollution or noise.

Technical details of the modelling are set out in the next section.

4.2 Technical Detail of Air Dispersion and Noise Modelling Methodology

The air dispersion modelling approach applies the CALPUFF modelling suite, as per typical air quality assessment projects conducted by Todoroski Air Sciences. The approach used is described in detail in **Appendix A**, and is only summarised in this section.

The CALPUFF modelling suite was used for the dispersion modelling. The model was setup in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation**, **2011**).

4.2.1 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from The Air Pollution Model (TAPM) with surface observations. TAPM was applied to generate prognostic upper air data for use in CALMET, as detailed in **Appendix A**.

The 2016 calendar year is selected as the period for modelling.

4.2.2 Evaluation of Meteorological modelling

The outputs of the CALMET modelling was evaluated using visual analysis of the wind fields and extracted data and also through a statistical evaluation.

Figure 4-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields follow the terrain well and indicate that the modelling simulation produces realistic fine scale flow fields (such as terrain forced flows) in the surrounding areas.

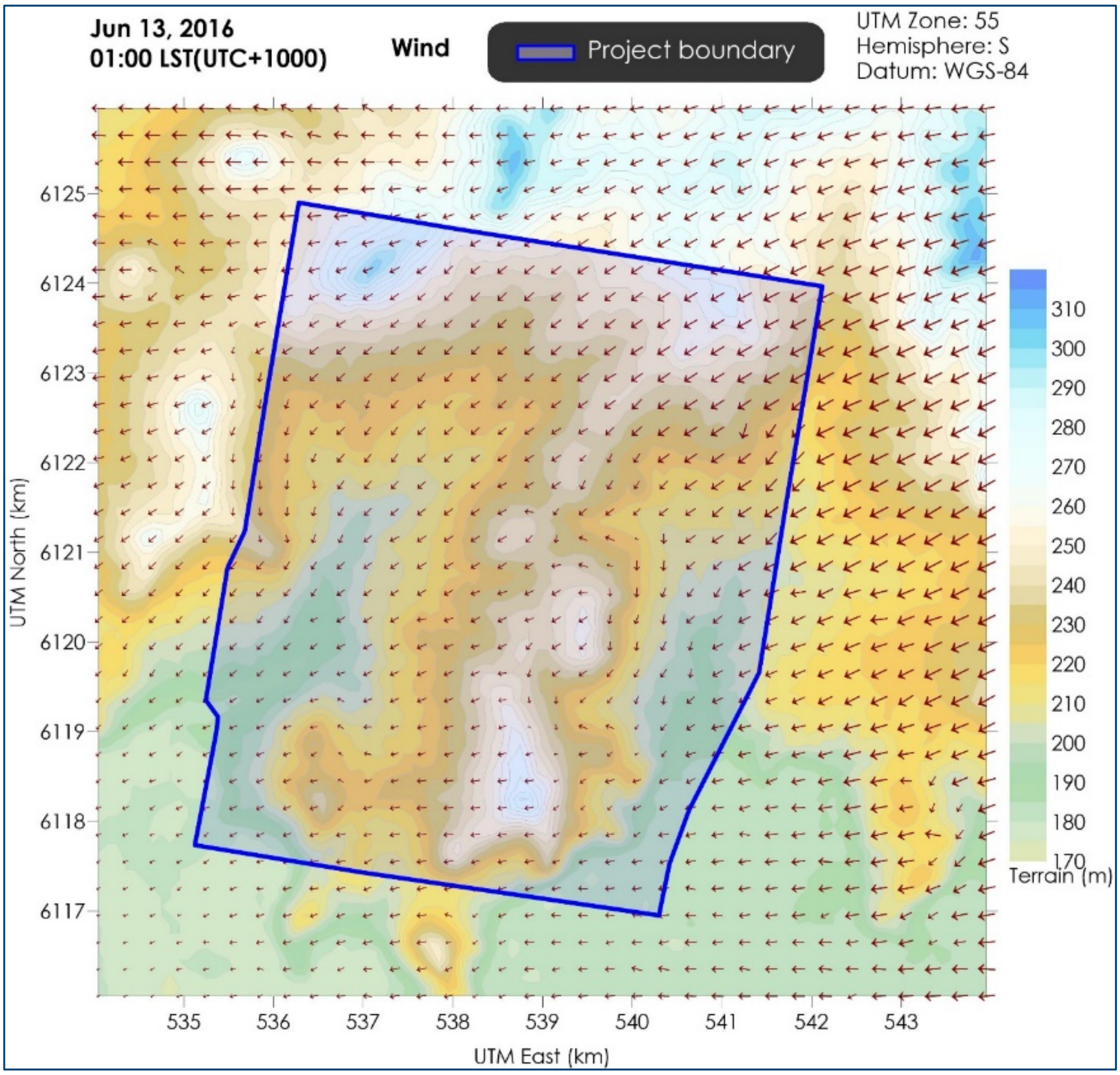

Figure 4-1: Example of the wind field for one of the 8,760 hours of the year that are modelled

CALMET generated meteorological data were extracted at a location within the CALMET domain and are analysed in **Appendix A.**

Overall the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. This is evident as the windroses based on the CALMET data also compare well with the windroses generated with the measured data, as presented in **Appendix A.**

The statistical evaluation of the data is also presented in **Appendix A** and shows that the data exhibit all of the expected traits commensurate with valid modelling results, suitable to represent the meteorology in the locality.

4.2.3 Dispersion modelling

The CALPUFF dispersion modelling is based on the emission of pollutants from sources within the meteorological modelling domain. The model was setup to include all existing and potential future source locations arranged in a grid within the SAP. The locations of all the modelled source locations are presented in **Figure 4-2**. For each modelled scenario, sources were toggled on or off depending on whether industrial emissions are to be expected from that location.

Each source was modelled separately as a point (stack) source and as a fugitive (volume) source with emission release parameters that would represent relatively standard sources associated with industrial activities. The point sources were setup to represent emissions from a stack with generalised flow parameters (e.g. exit velocity, temperature) and an emission point which is elevated above the ground. The volume sources represent diffuse, fugitive ground based sources which commonly include dust and odour emitting sources.

These sources were modelled over the entire year and are assumed to emit air emissions continuously using a unit emission rate. The emissions were modelled for only the key pollutants with scope to exceed EPA criteria. The different rates of emission of various key pollutants was accounted for, allowing source or receptors impact risk to be shown on a like-for-like basis, irrespective of the pollutant emitted.

Dispersion modelling impacts from the stack and volume sources were determined at the modelled receptor locations, as presented in **Figure 4-3**. Similarly to the sources, modelled receptors were switched on or off depending on whether "sensitive receptors" currently exist at the location in question, or are expected to be used for sensitive land uses in the future, e.g. dwellings, schools, hospitals, etc.

The area without any source or receptors is the buffer or separation area.

The dispersion modelling impacts are presented in two sets of risk contours, with the risk levels representing the likelihood any pollutant exceeding the relevant criteria at a receptor location. The first set of contours shows the risk of the modelled sources causing impacts at any of the receptors in the scenario (shown as shaded contours at the source locations). The second set of contours presents the risk of impacts occurring at the receptors from any of the sources in the scenario (shown as shaded contours at the receptor locations). The results are split in this way to show where the potential impacts would be, and where they would originate from.

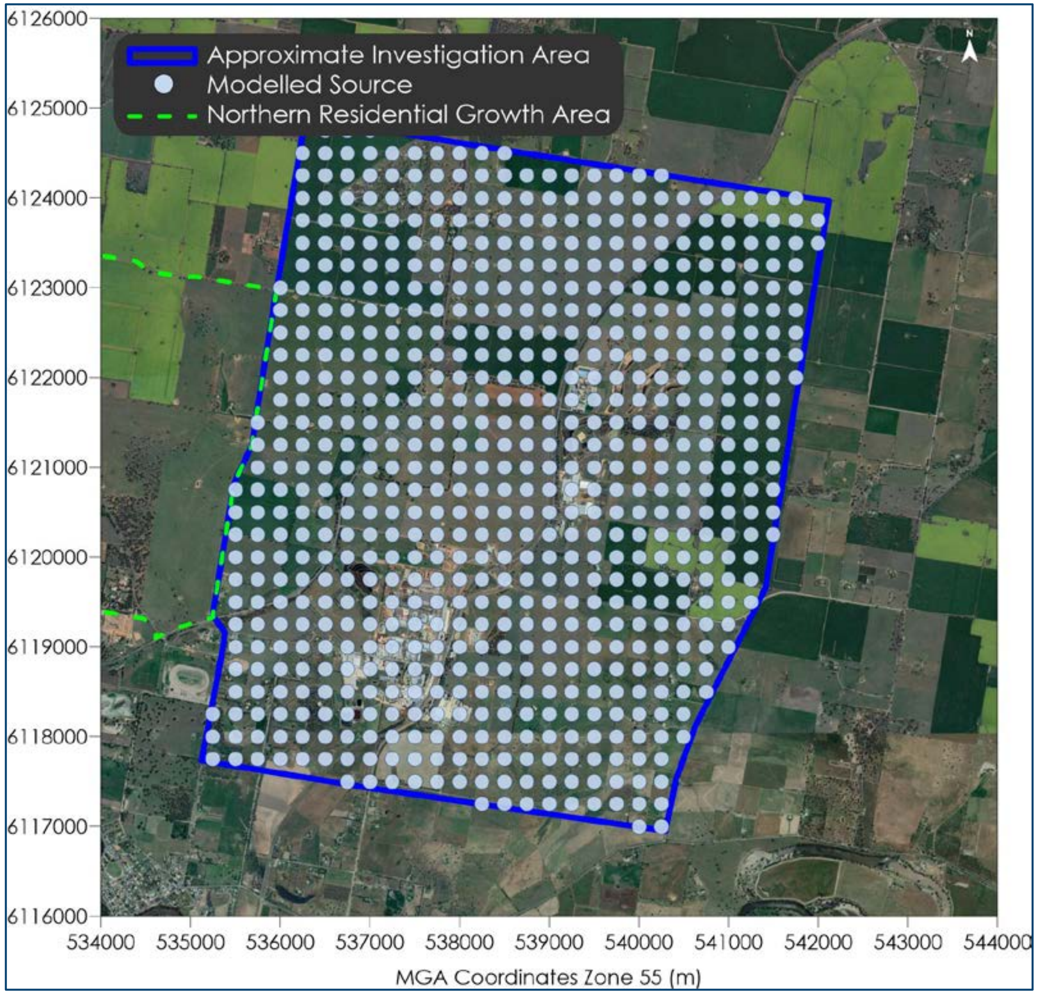

Figure 4-2: All modelled source locations

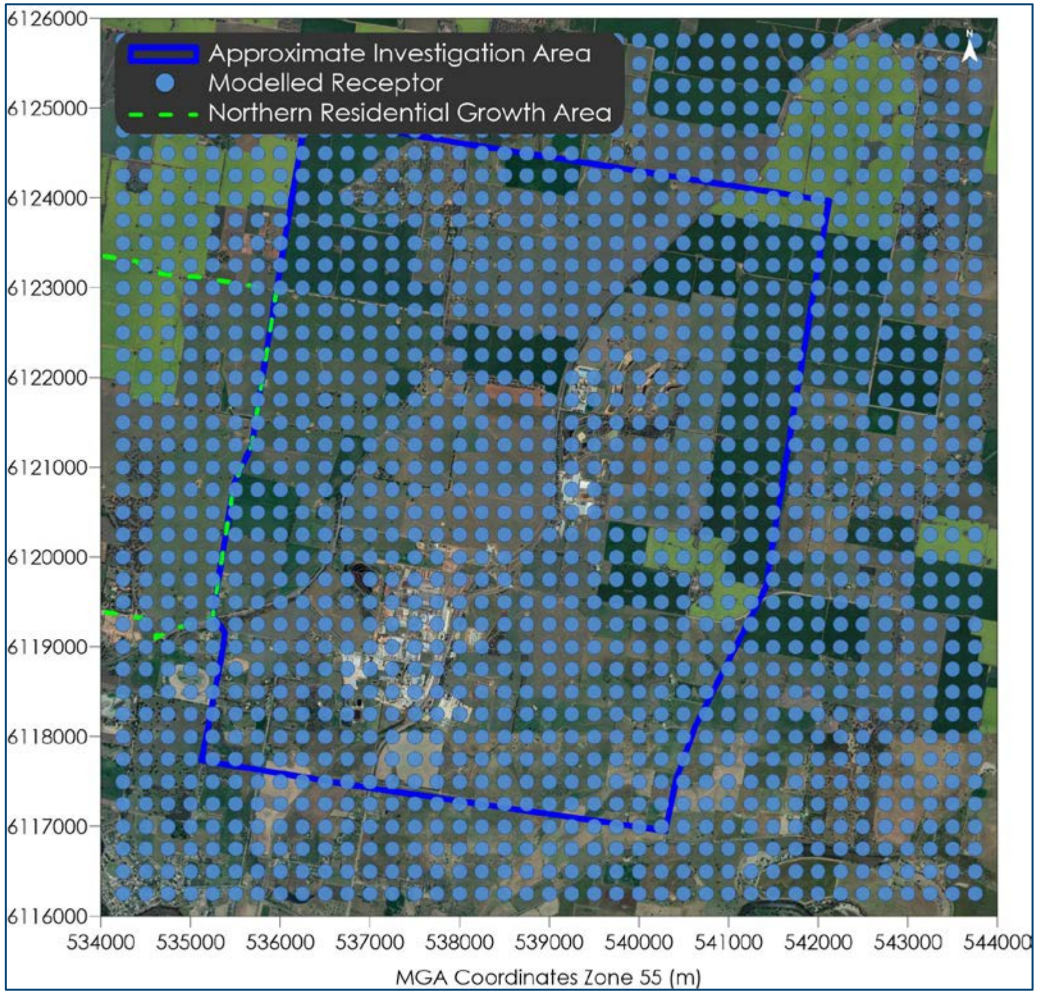

Figure 4-3: All modelled receptor locations

4.3 Noise modelling

Noise emissions were modelled in a similar manner to the air emissions with all existing and potential future industrial source locations arranged in a grid within the SAP. The same grid of sources and receptors were used between air and noise models for consistency between the models. The same terrain information was also applied in both models.

Noise sources were modelled using the ENM noise model under strong inversion conditions and generalised noise emissions profiles typical of industrial activities.

5 PART A - BASELINE ANALYSIS

The results for both the air dispersion and noise modelling for the baseline analysis were based on assessing impacts from the sources locations presented in **Figure 5-1** at the receptor locations as presented in **Figure 5-2**. Receptors were selected based on the locations of existing buildings as shown in the figure.

Receptors were also included in unoccupied areas at a similar distance from the existing industries to existing receptors as a means to represent an approximate (existing) initial buffer distance for consideration in the design of the industrial area.

However it should be noted that at the time of the initial baseline modelling, detailed information on which buildings were occupied was not known, and therefore their status as a 'sensitive receptor' (location at which impacts are to be assessed) could not be verified.

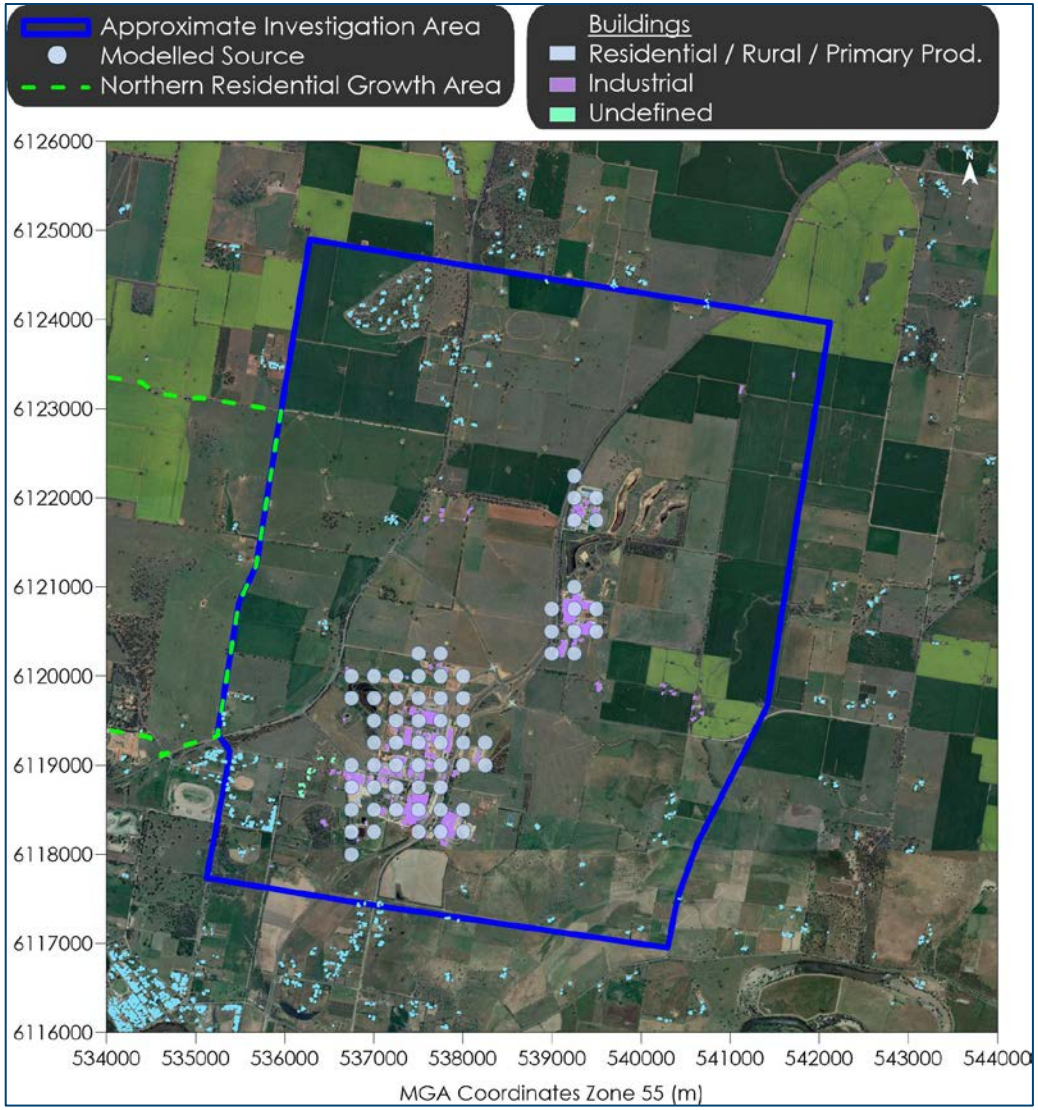

Figure 5-1: Modelled source locations - baseline analysis

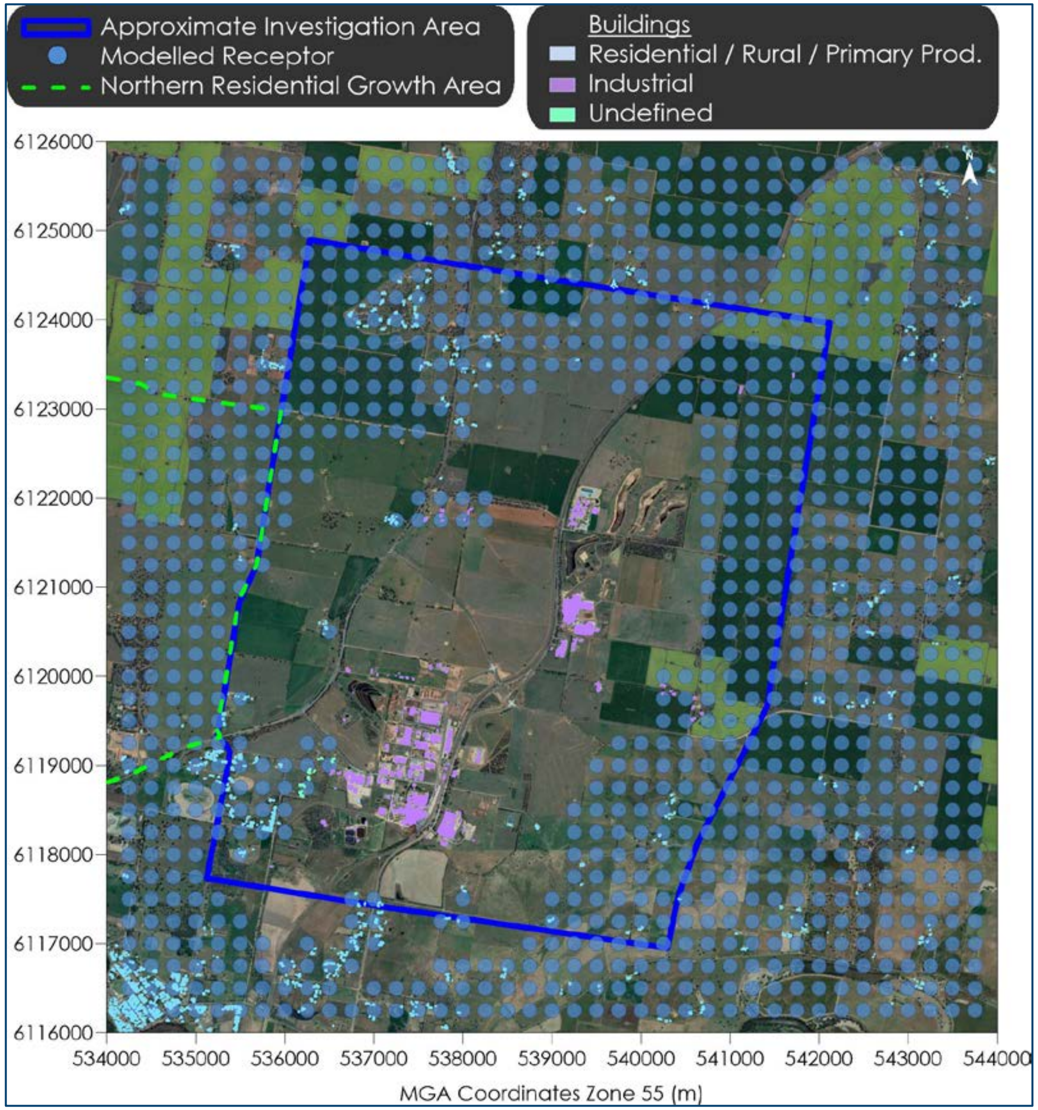

Figure 5-2: Modelled as receptor locations - baseline analysis

5.1 Modelling Results

The results of the analyses completed are presented in the following section. The air dispersion modelling results are plotted spatially in **Figure 5-3** to **Figure 5-6** and the noise modelling results are presented in **Figure 5-7** and **Figure 5-8**.

5.2 Analysis

The colour shading outside of the industrial area of the SAP (i.e. outside of the existing Bomen Industrial Estate BIE) shows the risk of potential impact upon existing or potential receptors. The colour shading inside the BIE shows the risk of an existing source causing impact upon the modelled receptors outside of the BIE.

Note that only existing sources are modelled, but the existing receptors and a grid of hypothetical receptors outside of an anticipated suitable setback buffer around the BIE are also modelled.

This modelling should be considered as a first-estimate of the necessary setback buffer, and will need iterative refinement based on feedback from other disciplines participating in the Master Planning.

Note that the green dotted line in the figures shows the Northern Residential Growth Area.

5.2.1 Air

Figure 5-3 presents (only) dispersion risk results for only volume sources and the corresponding result, but for only stack sources, is shown in **Figure 5-4**. The results in these figures only show the effects of the prevailing wind, terrain and air dispersion. The results are <u>not</u> dependent on the scale of emissions from each facility, which are considered in **Figure 5-5** and **Figure 5-6**. These latter figures show the effects of the prevailing wind, terrain and air dispersion <u>and</u> the scale of the emissions from the source.

In **Figure 5-3** and **Figure 5-4** the close proximity of existing receptors and sources dominates the risk profile, and masks the relatively lower risk of impact arising from other sources. This is less apparent in **Figure 5-5** and **Figure 5-6** which include consideration of the scale of the source.

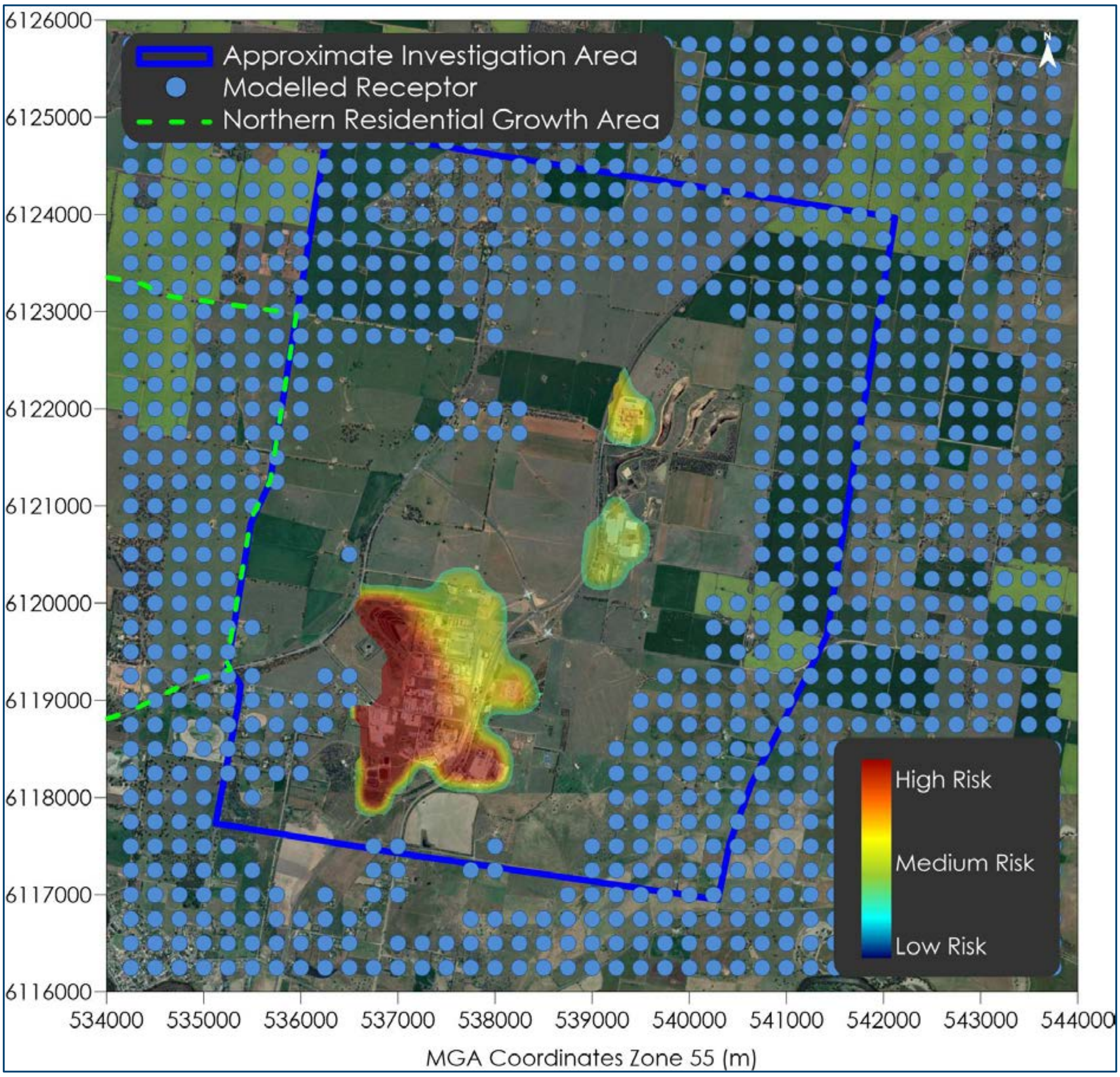

Figure 5-3: Predicted source risk areas for baseline analysis volume sources

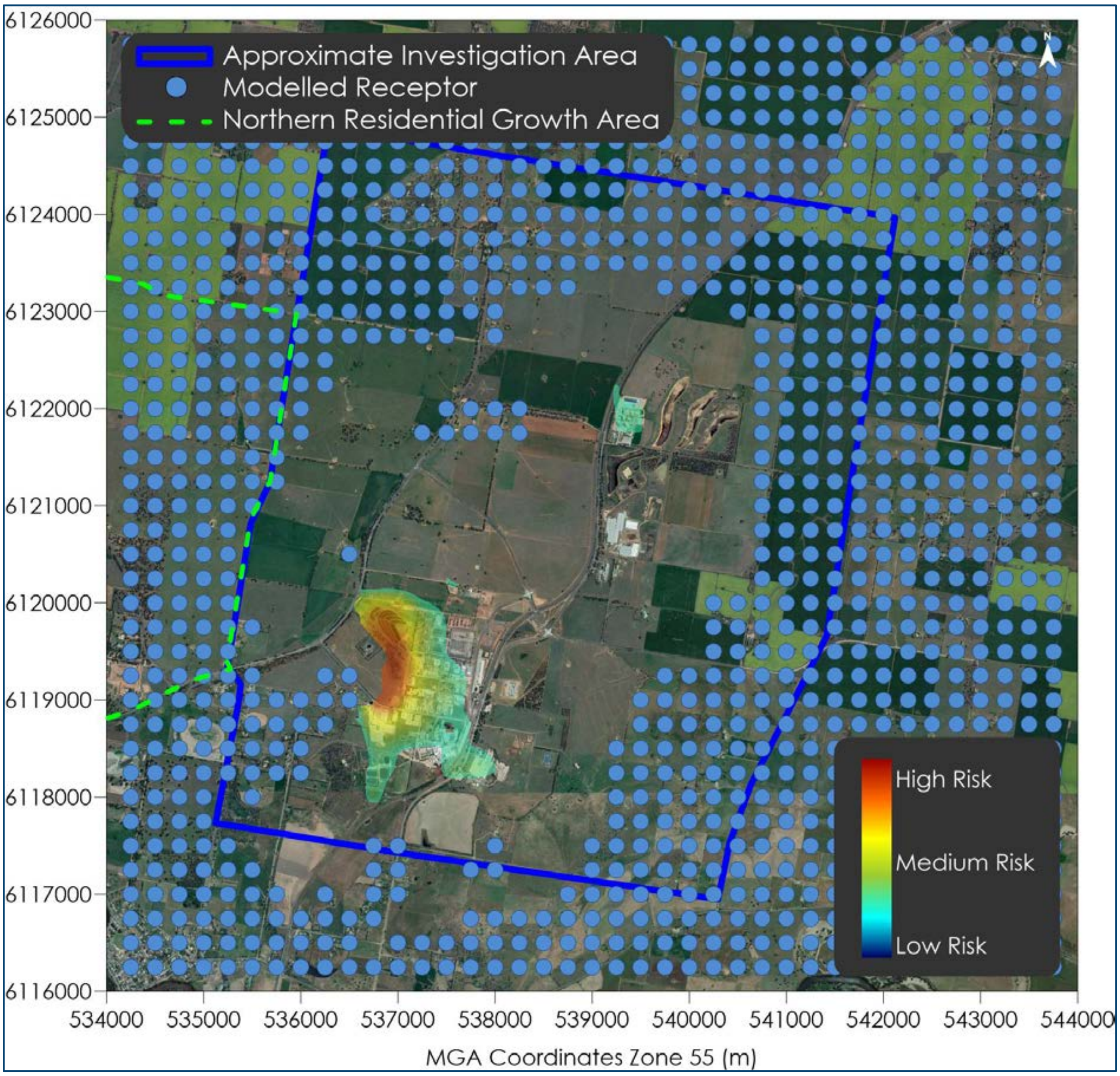

Figure 5-4: Predicted source risk areas for baseline analysis stack sources

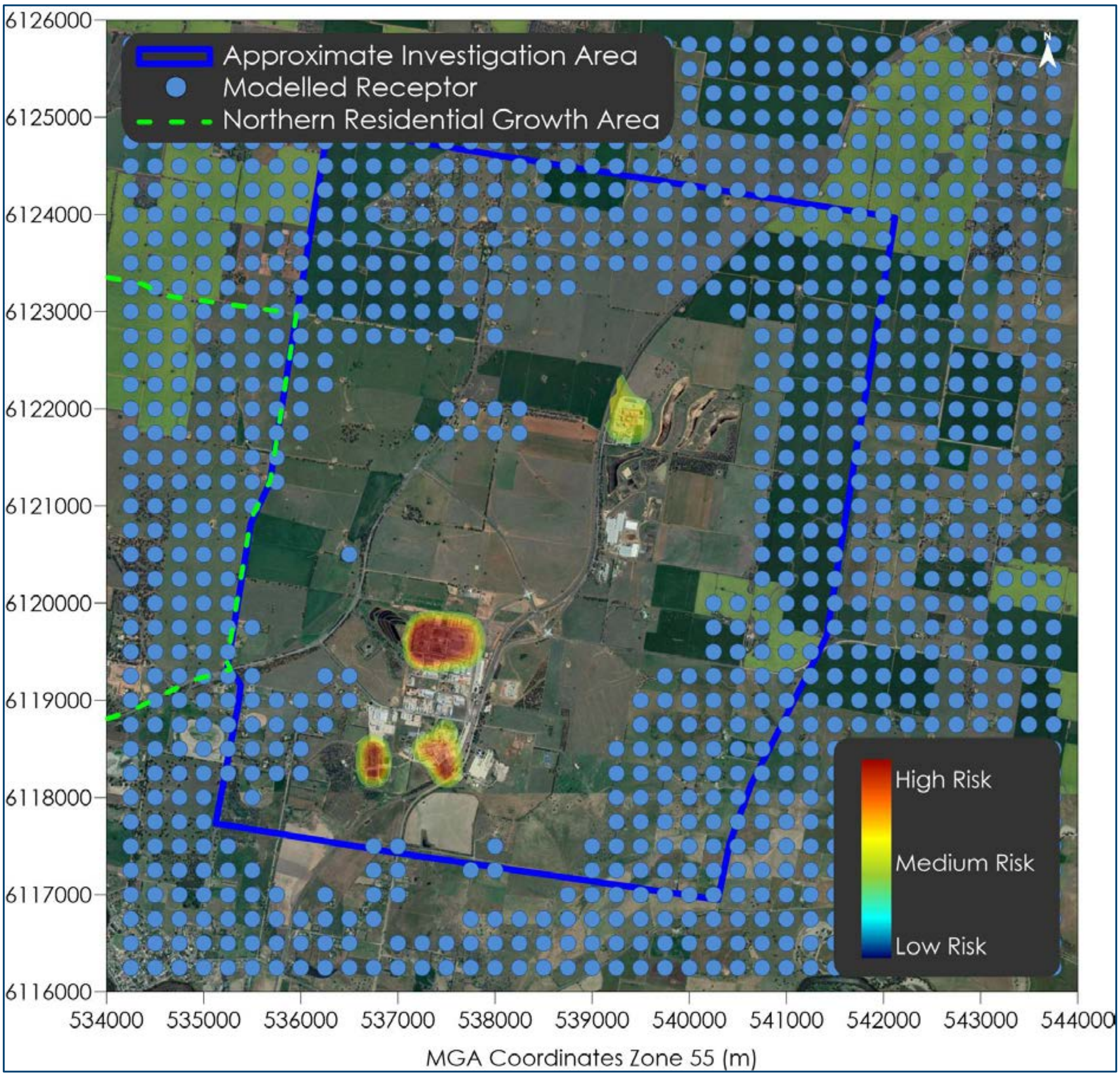

Figure 5-5: Predicted source risk areas for existing air and odour sources

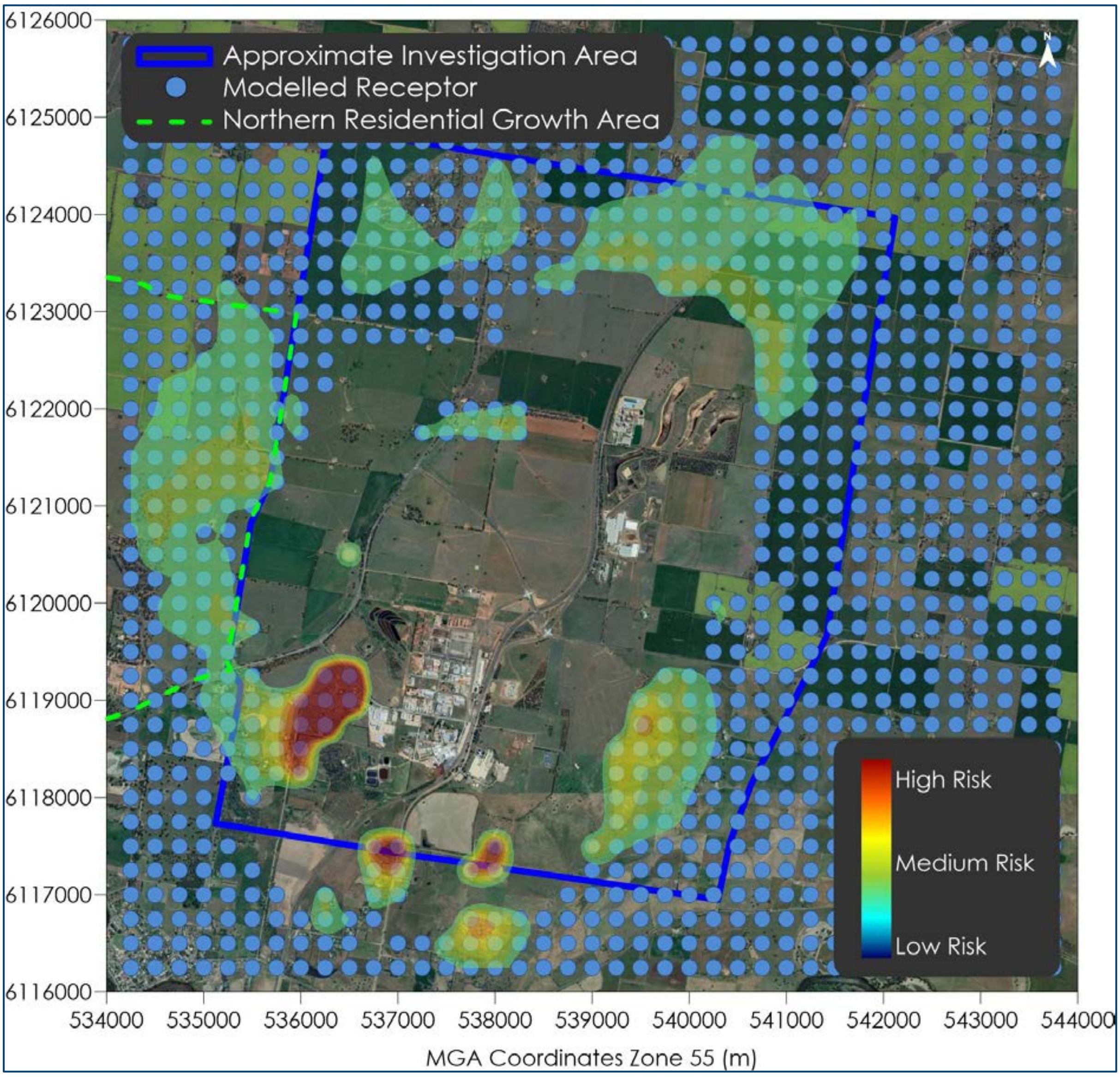

Figure 5-6: Predicted receptor risk areas due to air and odour emissions from existing sources

5.2.2 Noise

Figure 5-7 presents the source noise risk areas for existing noise sources. This figure identifies which noise sources pose the most risk of impacting an existing receptor.

Figure 5-8 presents the receptor noise risks due to the existing noise sources. This figure identifies which receptor locations are most impacted by existing noise sources.

The figures show that, similarly to the air dispersion modelling, the risk of potential impacts is highest toward the south-western region of the SAP where the close proximity of existing receptors and sources dominates the risk. However the relative risk levels for noise sources are generally lower than those of air (volume) sources for the areas with small separation distances.

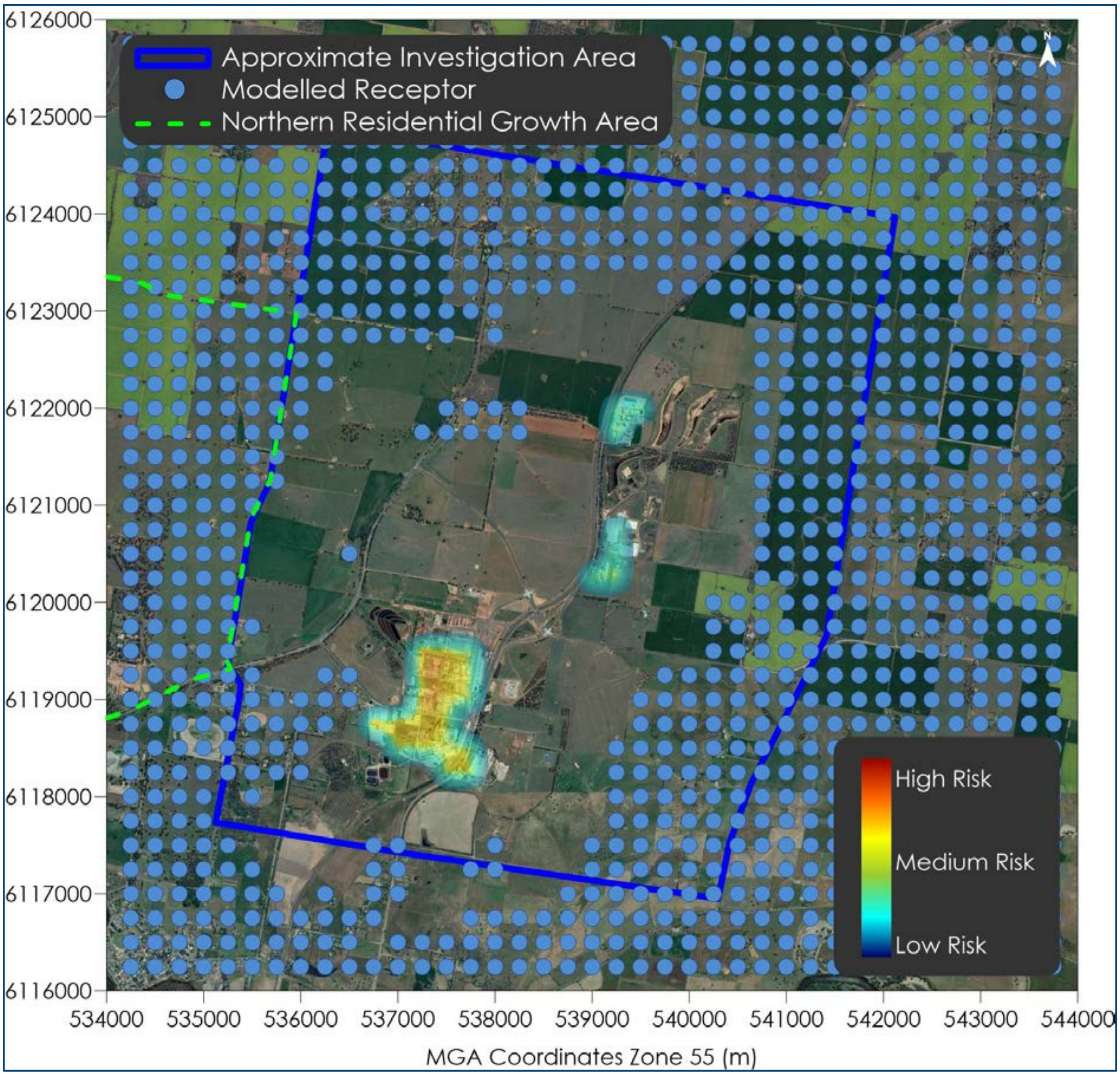

Figure 5-7: Predicted source risk areas for existing noise sources

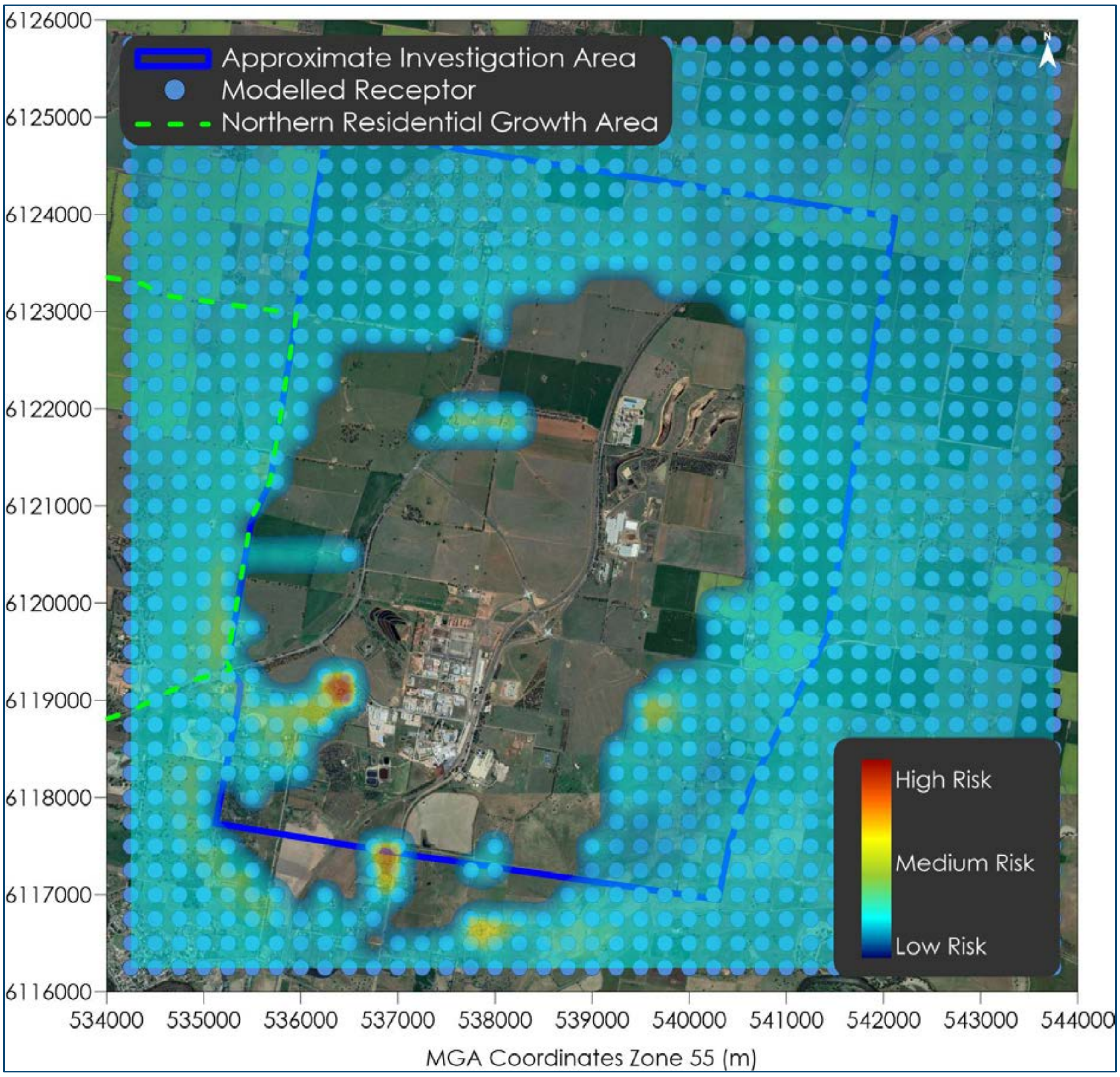

Figure 5-8: Predicted risk areas at receptors from existing noise sources

5.3 Discussion

The analysis shows that the existing constraints arise due to air quality and odour factors, rather than noise. Depending on the final design of the industrial area, and proximity to receptors, noise may become a more significant factor, and should be considered in the design and planning process.

The analysis shows a likely medium to high risk level of impact between existing industries and receptors in the Cartwrights Hill area (south and south west of the southern parts of the BIE). The impact, or land use conflict arises due to insufficient dispersion caused by the close proximity of the existing receptors to existing odorous industrial activities. This effect dominates the results, and masks the potential risk of impact that may otherwise be apparent between other sources and more distant receptors. The effect is lessened when the scale of the emissions is included in the considerations.

The analysis considered the potential development areas to the west of the SAP and found some low to medium risk of impacts due to existing industrial activities. This arises along a prominent ridge line in the area, and is predominantly due to emissions from existing stack sources of pollution.

Overall, based on this analysis, and previous work in the area, the following can be determined:

1. The most impacted receptors are shown with high risk (red) shading in **Figure 5-6**. The impact is driven by air quality and odour, much more so than noise. It is likely that there may be existing air quality or odour impacts or levels near to criteria at these locations.

2. To minimise or prevent impacts arising at these receptor locations, the areas shown with high risk (red) shading in **Figure 5-3** and **Figure 5-4** should not be further developed for low to medium amenity industries. High amenity industries (i.e. with little air or noise emissions) could be developed in the red shaded areas in these figures. However alternative options to this may be available, for example the areas shown with high risk (red) shading in **Figure 5-6** could be rezoned to high amenity industrial areas and transitioned from residential to high amenity industrial use, or the existing impact could be acknowledges via a Section 10.7 encumbrance on the land title of the affected properties, generally this may requires some form of agreement and compensation.

3. The appropriate setback or buffer area around the existing sources of emissions in the SAP can be approximated by the extent of the areas without any sources or receptors but including the existing and sources and "receptors" in a zone of medium to high risk of impact, as presented in **Figure 5-6.**

4. There is likely to be some low to medium risk of impacts arising in the potential development area to the west of the SAP, shown with a green dotted outline in **Figure 5-6**.

5. Impacts from the existing volume sources, such as ponds, land surfaces and fugitive emissions from buildings predominantly relate to odour emissions. Emissions from stacks include odour, but also toxic air pollutants. The volume sources tend to cause impacts near the source, and tend to pool in a valley. The stack sources tend to most impact the surrounding high points of the landscape (though impacts are generally relatively smaller due to greater distance).

6. The situation lends itself to the many potential planning approaches to better manage land use conflict. Some similar strategies include:

    a. Strategy 1:

        i. Confine the volume sources to a valley, but beware that the emissions will tend to be more concentrated during low wind speed and inversion conditions, and at such times may flow or drift down the valley causing impacts at relatively distant down-valley receptors.

        ii. Reserve the elevated land for industries with stack sources, as this means shorter stacks will be as effective in dispersing emissions, but be aware that such industries tend to be large, need large or tall plant, and may be visible from afar.

    b. Strategy 2, as per Strategy 1, but do not develop the lowest ground (apart from say wetlands or other such non-polluting uses). This can reduce impacts by spreading the emissions over a larger area (and requires a larger foot print and setback buffer).

    c. Strategy 3, as per Strategy 1 or 2, but introduce vegetation bands within the industrial area. Buffers nominally 50-100m wide generally along height contour lines that consist of dense, tall vegetation will add dispersion and dilution of fugitive or volume emissions, thus this strategy may not assist greatly if the sources present in the new industrial area are predominantly from stacks. This strategy is best compatible with minimising visual impacts, which in-turn assists to minimise community perception of any potential odour and noise impacts.

    d. Strategy 4, as per Strategy 1, 2 or 3, but minimise development on top of ridges. This strategy is most suitable for mitigating noise impacts, as elevated sources tend to cause most impact.

7. The strategies above are based on confining industrial development within the existing western valley, i.e. generally west of the rail line, this may limit access to the rail line and make the strategy unworkable.

8. It is anticipated that further residential expansion in the impacted areas would be prevented by introducing a setback buffer area. The planning authority may potentially apply Section 10.7 planning certificates to this land in order to clearly define that the land is within an impacted area, similar to land in a flood or bushfire risk area. Existing residential uses within the buffer area can be managed per Point 2.

5.4 Next steps

The modelling provided in this analysis identifies the existing conflicting receptor and source locations.

In the next iteration of the process, the modelling would not consider the existing most-impacted existing receptor/ source locations that are within a necessary setback buffer area (on the basis that the land use would alter), as done previously in similar work for Wagga wagga City Council (see **Appendix B**).

Ideally planners would use this modelling to specify the preferred extent of the industrial and residential land (or both) and the modelling can be refined to define the setback buffer needed to prevent impacts.

This is an iterative process, but must begin at some point, i.e. this analysis. The recommendations in this study are based on this analysis and also recent similar work. Please be sure to also refer to the earlier work at **Appendix B** which is based on a fully developed, large industrial area, and provides a good indication of the necessary buffers and also outlines the steps involved in obtaining these buffers.

6 PART B - CONCEPT SCENARIOS ANALYSIS

Three scenarios were shortlisted for analysis following the Short Enquiry by Design workshop. These scenarios include:

- Scenario 4 - A 'high growth' scenario featuring a central area for low amenity 'stack' industries, close the RiFL hub. A Byrne Road industry cluster develops, along with green corridors and a new area of high amenity tech and clean industries to the west of Olympic Highway.
- Scenario 5 – A 'compact' scenario focussed on developing land north and south of Merino Drive. A Commercial Gateway precinct is also included along Bomen Road.
- Scenario 7 – A 'high growth' scenario where development is directed north and north-east. It incorporates industry zoned land north-east of Byrnes Road and also new land along Olympic Highway. Additional rail terminals are included north of RiFL.

Each of the scenarios are tested using the approach outlined in **Section 4** to identify the areas at risk of potential impact upon existing or potential future receptors. Note the potential receptors included unoccupied areas at a similar distance from the existing industries (similar to the baseline analysis) or at the extent of the scenario design, which is the means used to identify the necessary buffer distance.

The dispersion risk results for air quality include both volume sources and stack sources combined showing a single prediction for the concept scenarios. The combined result shows the maximum risk of either air quality or odour issues arising at the receptor locations.

The modelled source and receptor arrangement for each of the scenarios is presented in **Figure 6-1** to **Figure 6-3**.

For each of the scenarios different amenity areas are assigned and represent low, medium or high potential for air, odour and noise emissions. The amenity areas are modelled as per the concept scenario, or per the optimised changes recommended to minimise likely land use conflict.

Recommended land use conflict minimisation options were determined on the basis of extensive iterative testing for each scenario. These options set out one or more recommended changes to each scenario and involve changes in the amenity zoning within the proposed industrial area, curtailment of the spatial extent of the proposed industrial areas, curtailment of existing residential use areas, curtailment of potential future residential uses (or in other words expansion of buffers), or a combination of any of these methods.

Note that the amenity zonings inherently limit the types of activities that can be conducted in specific areas. A more detailed description of the limitation would be provided for the final option chosen.

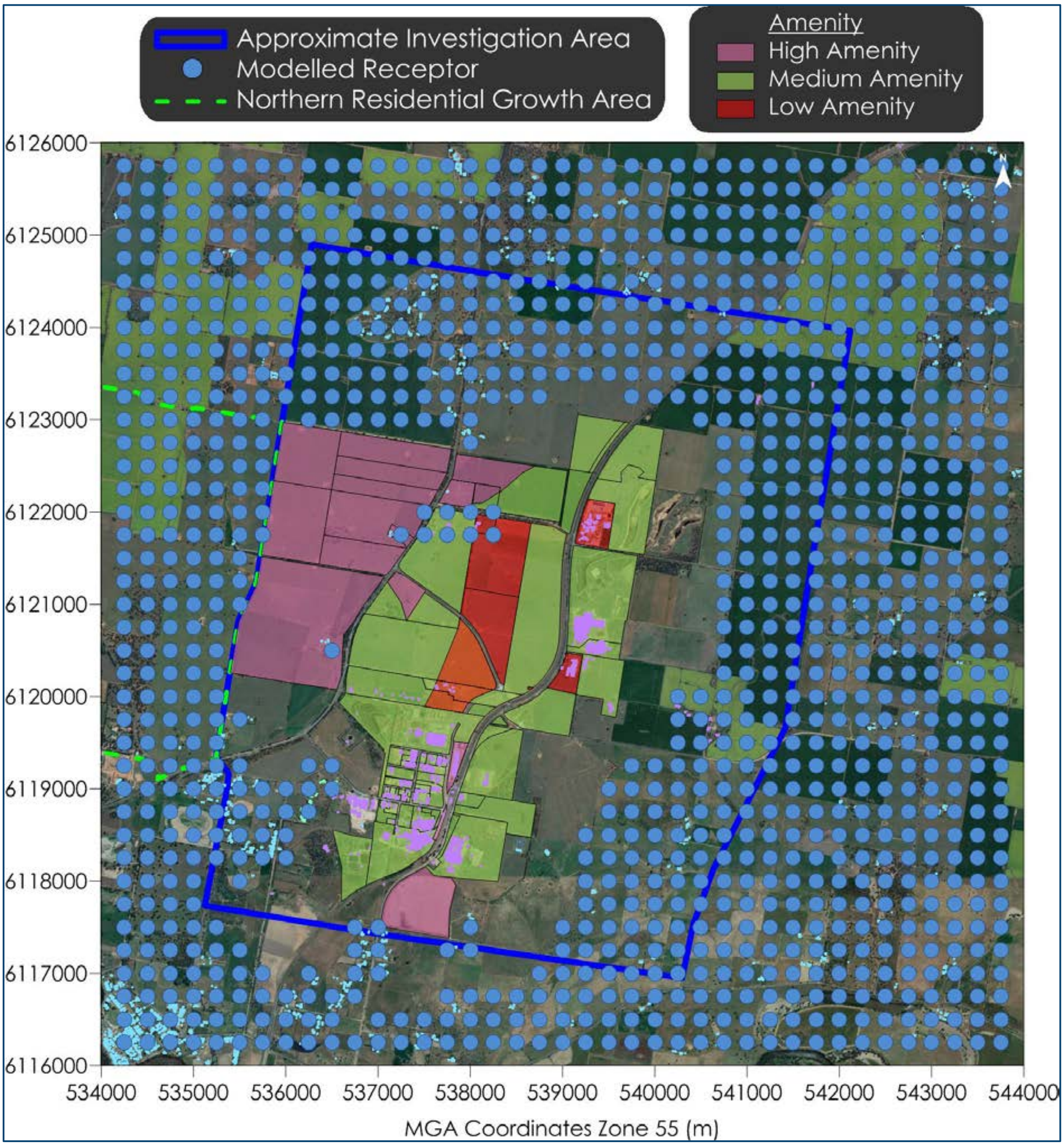

Figure 6-1: Scenario 4 – modelled source and receptor locations

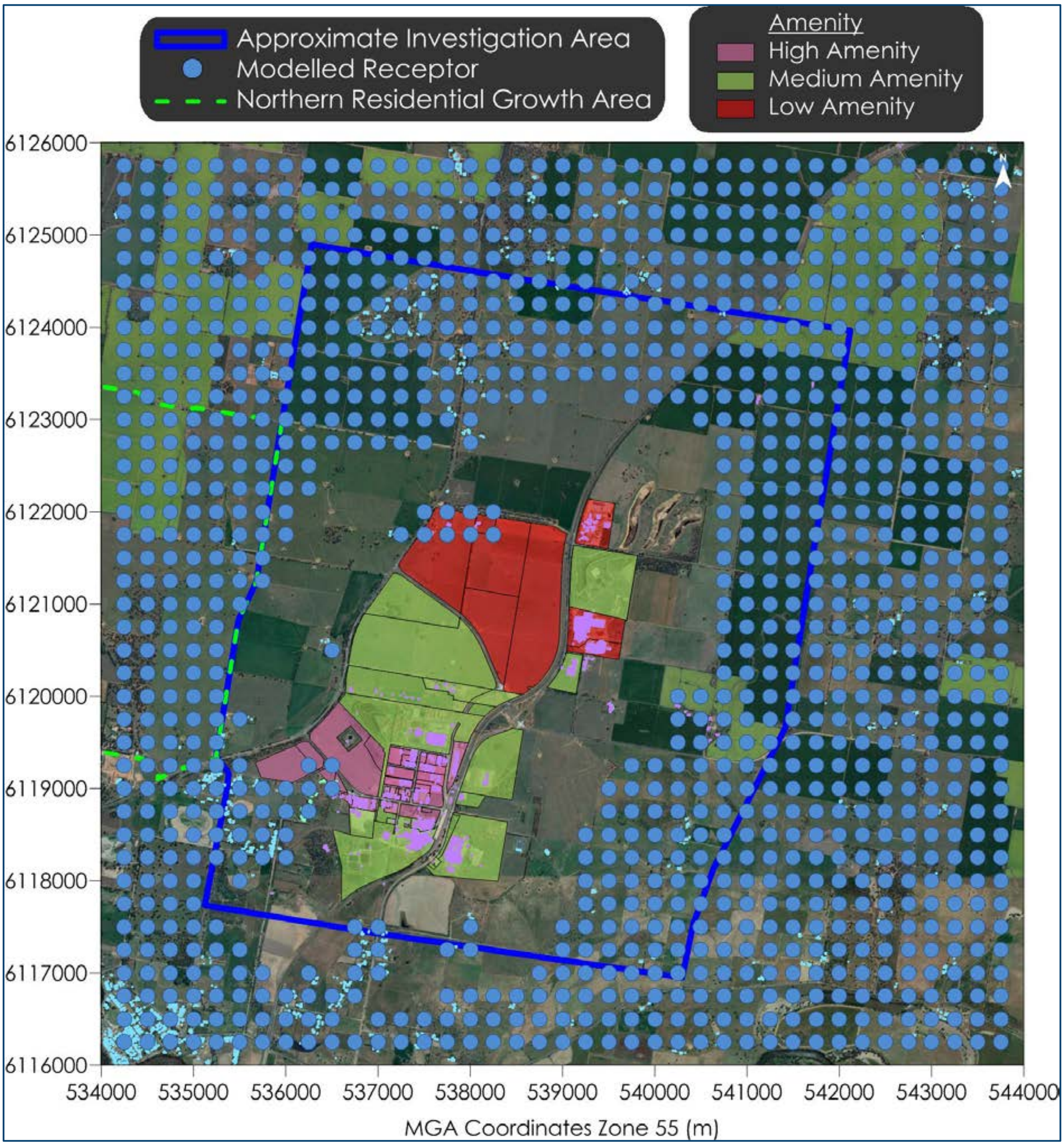

Figure 6-2: Scenario 5 – modelled source and receptor locations

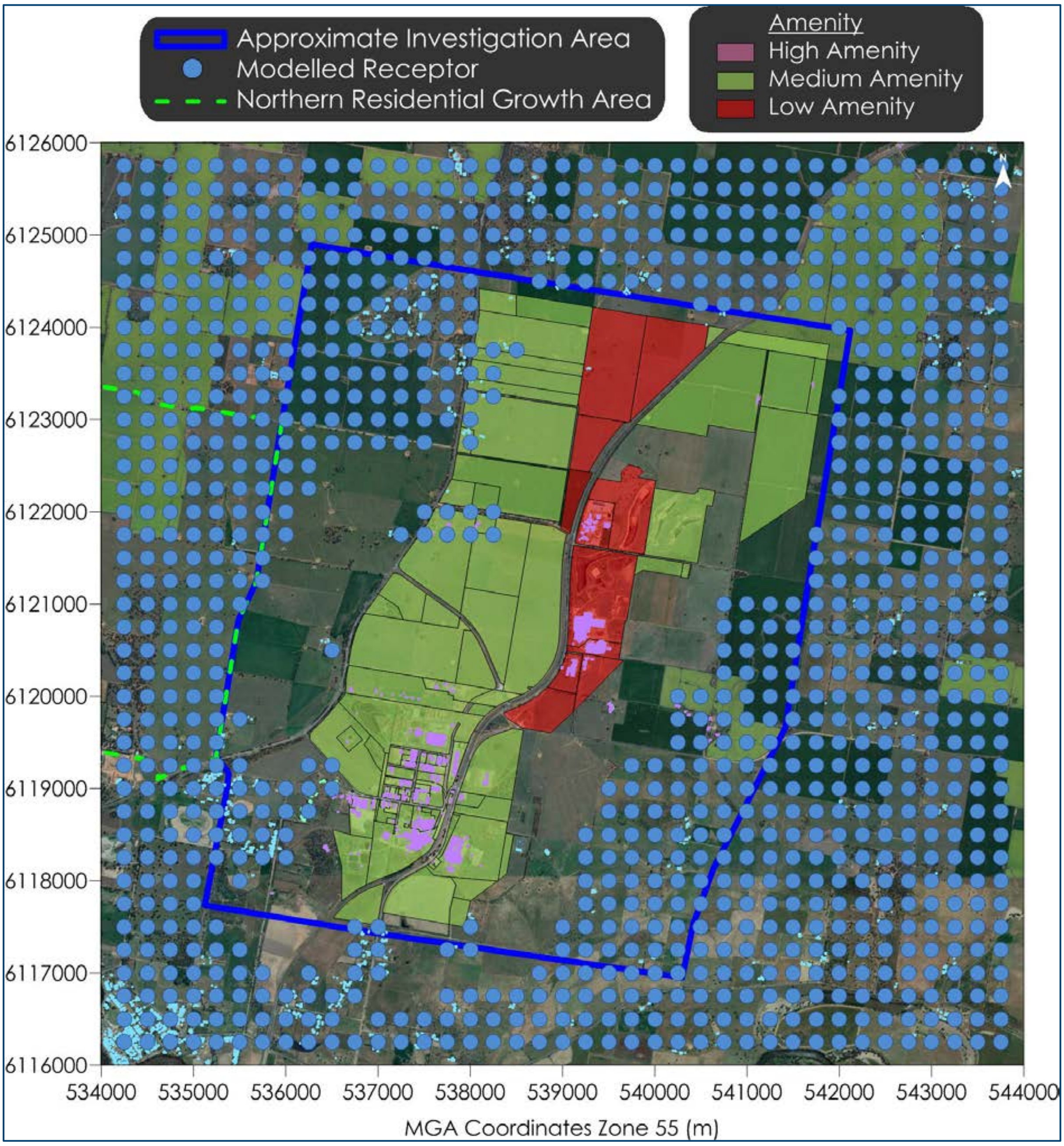

Figure 6-3: Scenario 7 – modelled source and receptor locations

6.1 Scenario 4

6.1.1 Concept constraints modelling – Scenario 4

This scenario proposes a large area of industrial land, generally extending to the west. There are low, medium and high amenity zones proposed, with the low amenity zones located centrally, furthest from dwellings not already on industrially zoned land. The scenario has some significant constraints which appear to be manageable by curtailing the extent of the industrial land and by re-zoning the most impacted dwellings.

Strategies to minimise the potential land use constraints are considered in **Section 6.1.2**

6.1.1.1 Air and odour

Figure 6-4 and **Figure 6-5** present the potential constraints due to air and odour emissions at the receptors and source locations, respectively, for Scenario 4.

Figure 6-4 shows that relatively few dwellings (in red shading) have a large constraining effect on the potential industrial area, which is shown with red shading in **Figure 6-5**. Note that **Figure 6-4** also shows that there is a potential to impact the rural land in the northern parts of the SAP where there are presently no dwellings.

Strategies to minimise the potential land use constraints shown in **Figure 6-4** to **Figure 6-5** are considered in **Section 6.1.2**.

6.1.1.2 Noise

Figure 6-6 and **Figure 6-7** present the potential constraints due to noise emissions at the receptors and source locations, respectively, for Scenario 4.

Figure 6-6 shows that there is scope for land and some limited numbers of dwellings to the west and north to be impacted by noise. Dwellings within the proposed industrial areas would be severely impacted by noise. **Figure 6-7** shows that the existing dwellings and potential dwellings on adjacent land would pose significant constraints on the potential industrial area, as is shown with red shading in this figure.

Strategies to minimise the potential land use constraints shown in **Figure 6-6** and **Figure 6-7** are considered in **Section 6.1.2**.

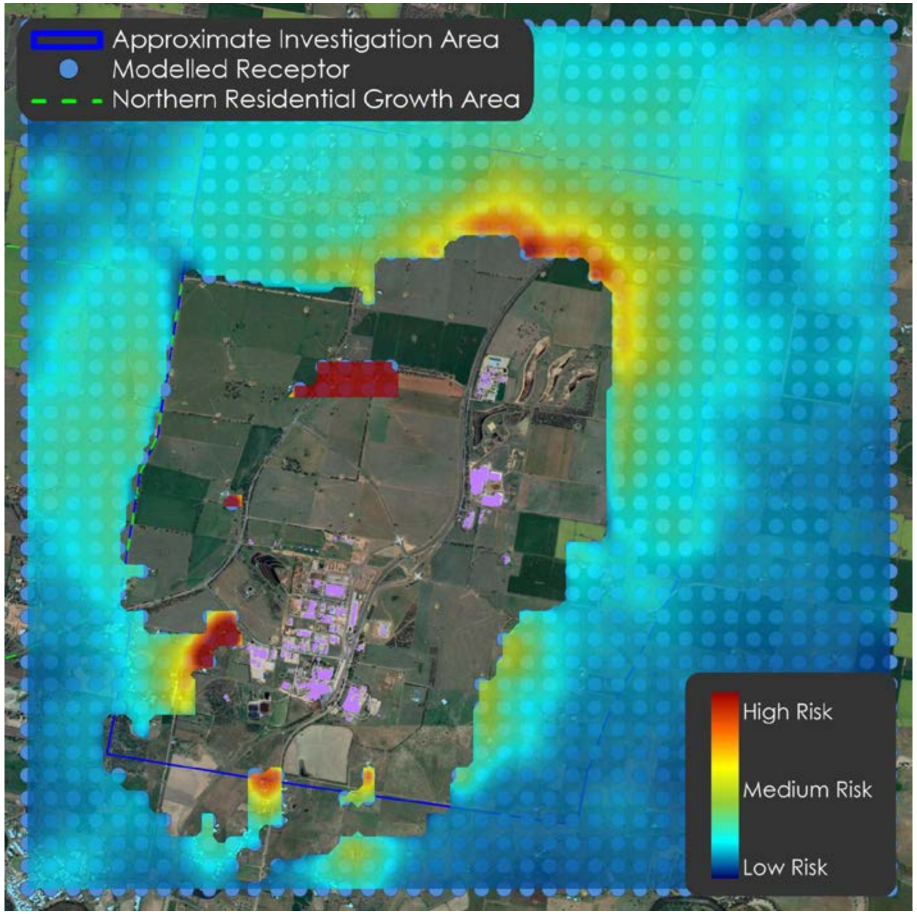

Figure 6-4: Predicted receptor risk areas due to air and odour emissions from Scenario 4

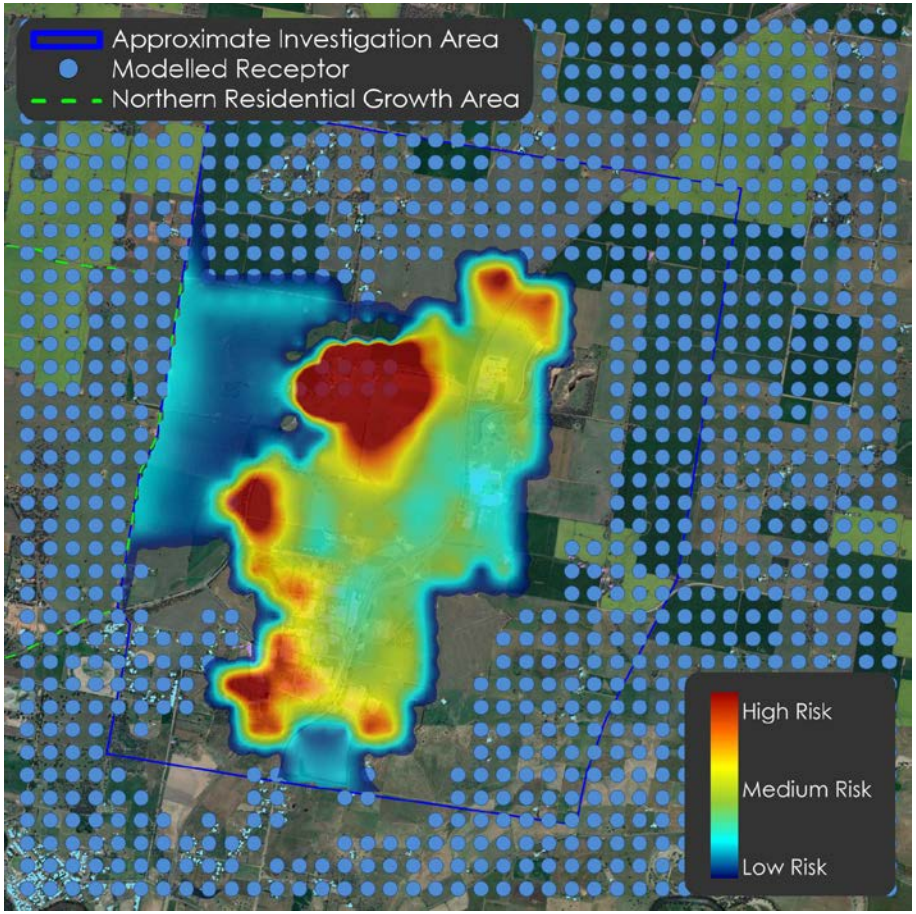

Figure 6-5: Predicted source risk areas due to air and odour emissions from Scenario 4

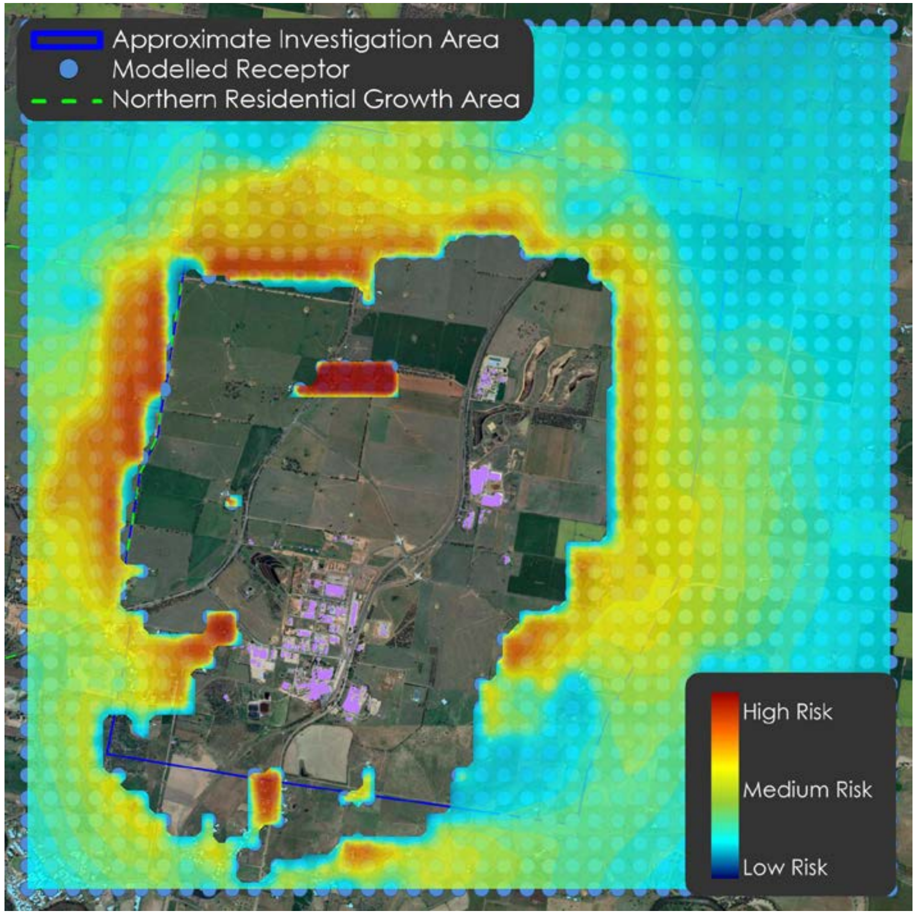

Figure 6-6: Predicted receptor risk areas due to noise emissions from Scenario 4

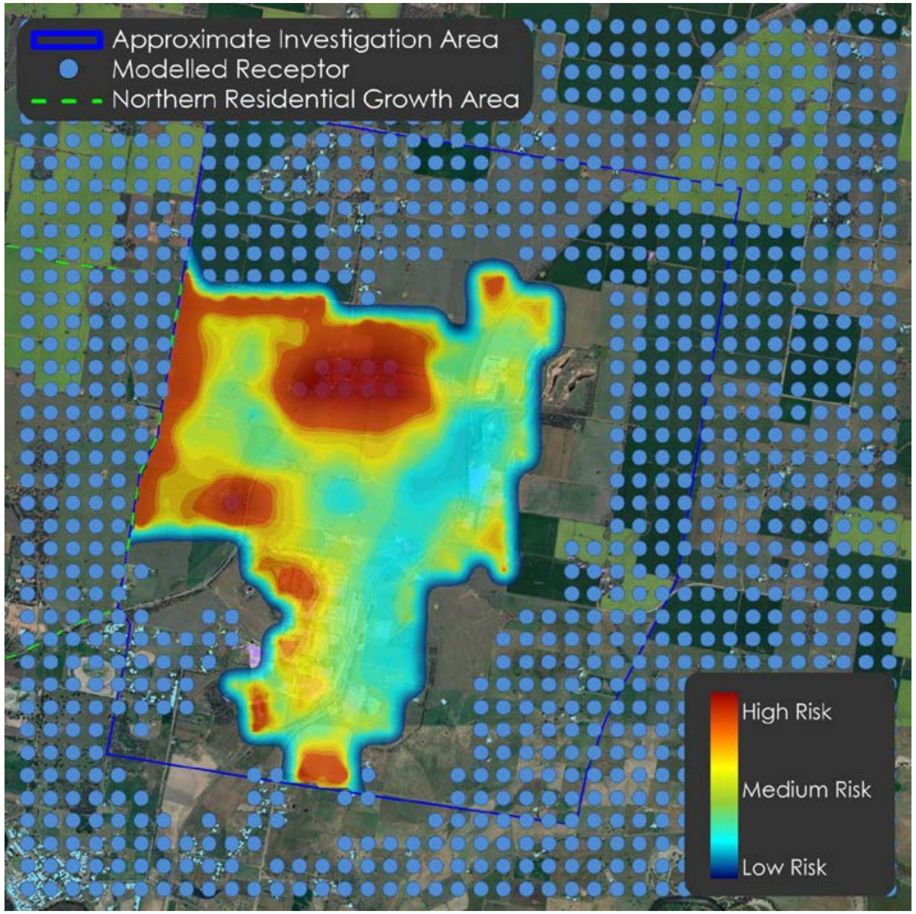

Figure 6-7: Predicted source risk areas due to noise emissions from Scenario 4

6.1.2 Concept scenario optimisation for air, odour and noise – Scenario 4

Figure 6-8 outlines the optimisation measures recommended for Scenario 4.

The existing residential dwellings within the proposed industrial zone have been rezoned (i.e. making them non-sensitive receptors in terms of air, odour and noise). This includes the cluster of dwellings in the middle of the SAP (west of Riverina Oils), the individual dwellings to the west of the highway, a cluster of dwellings located to the southwest of the Bomen industrial Estate , and several dwellings located on the southern boundary of the SAP investigation area. (Please note that these existing residential dwellings have been rezoned in all optimisation scenarios.)

To prevent new land use conflicts arising, the following changes were made to Scenario 4. These are the optimal changes needed to maximise future industrial and residential coexistence. The optimisation process involved modelling dozens of modifications to the scenario.

- The existing dwellings and potential future dwelling receptor locations which were rezoned are shown as blue spots in **Figure 6-8**. The orange spots show the dwelling and potential future dwelling receptors.
- The proposed high amenity zone to the west is curtailed along the western edge and northern edge.
- The proposed high amenity zone to the south is curtailed along the southern edge.

With these changes, potential air, odour and noise land use conflicts can be minimised for Scenario 4, as shown in **Figure 6-9** to **Figure 6-12**.

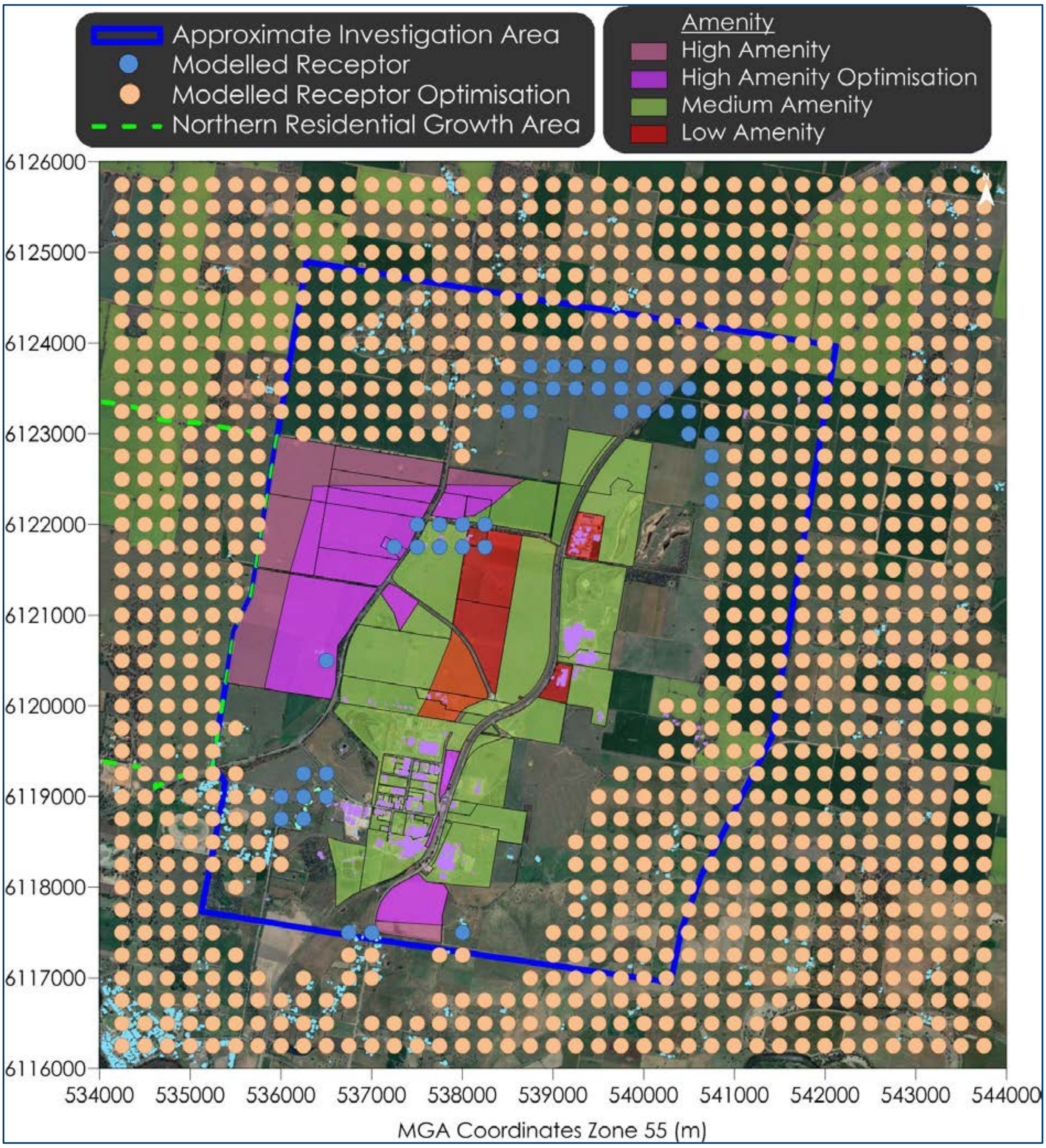

Figure 6-8: Optimisation features – Scenario 4

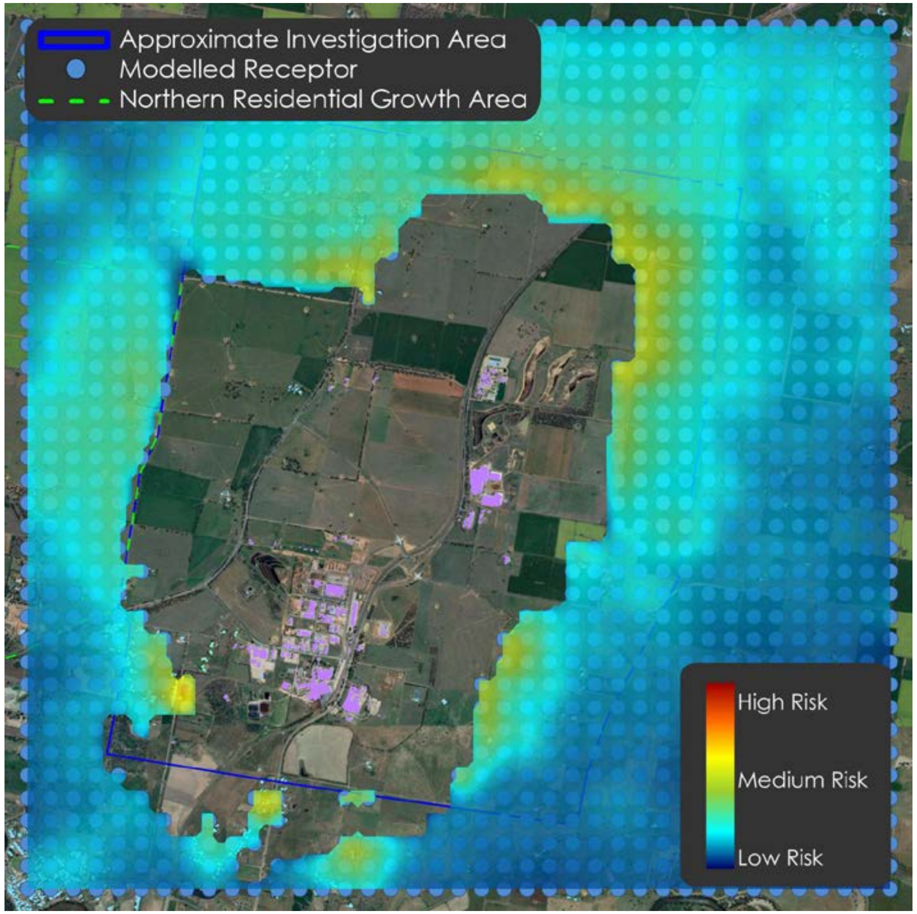

Figure 6-9: Predicted receptor risk areas due to air and odour emissions from Scenario 4

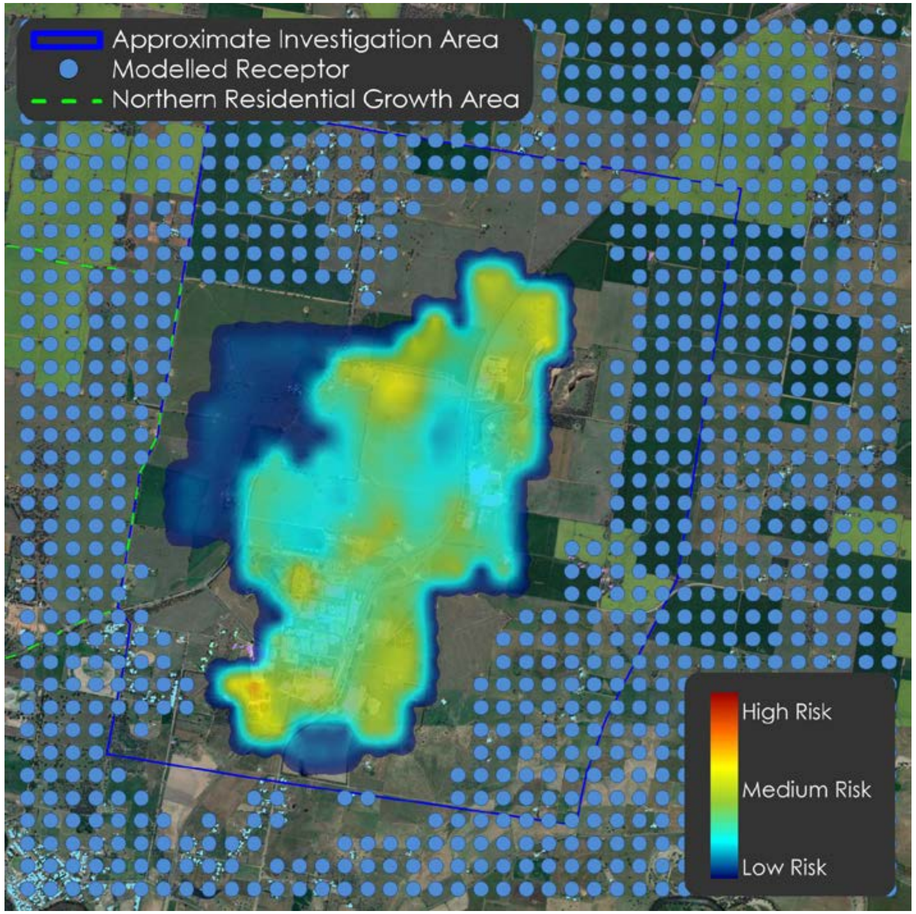

Figure 6-10: Predicted source risk areas due to air and odour emissions from Scenario 4

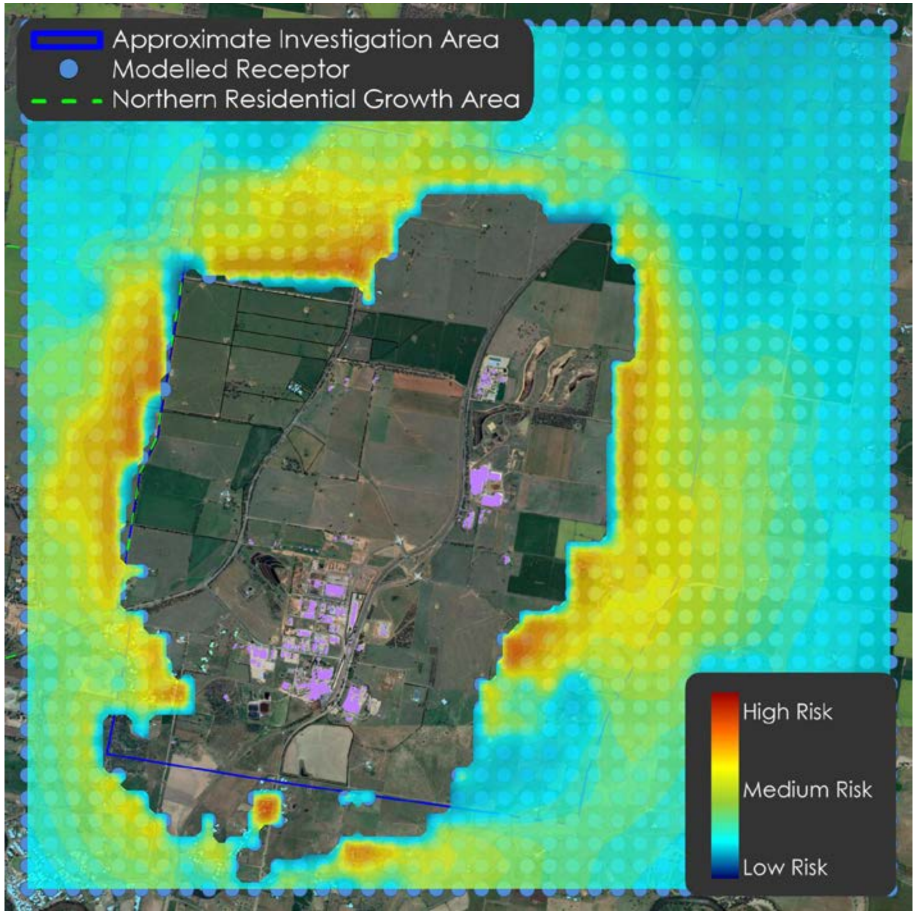

Figure 6-11: Predicted receptor risk areas due to noise emissions from Scenario 4

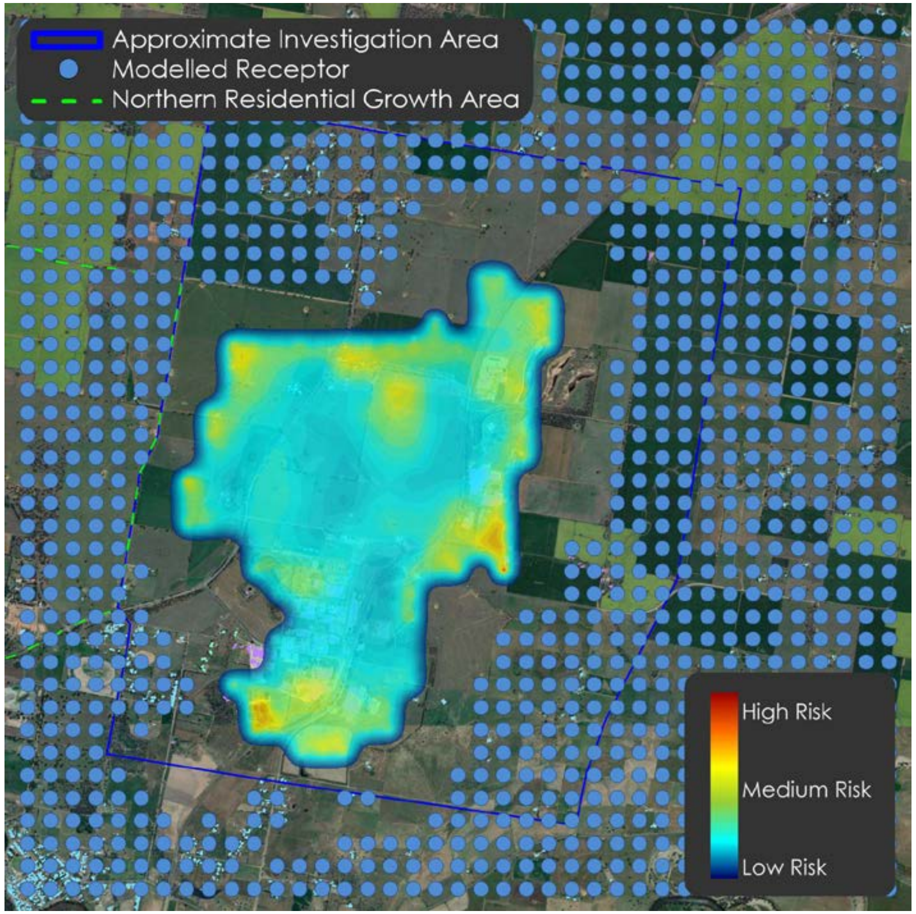

Figure 6-12: Predicted source risk areas due to noise emissions from Scenario 4

6.2 Scenario 5

6.2.1 Concept constraints modelling – Scenario 5

This scenario is interesting as it has zoned the existing industrial activities in the Bomen Industrial Estate as high amenity land, whereas there is currently medium to low amenity activity on this land. The industrial area is also relatively smaller than in the other scenarios, and overall, Scenario 5 has relatively the least constraints in regard to air, odour and noise.

If it is possible to transition the existing industrial activities to high amenity industrial activities, and if the allocated land is sufficient for future needs, this scenario has good scope to be successful.

Strategies to minimise the potential land use constraints are considered in **Section 6.2.2**.

6.2.1.1 Air and odour

Figure 6-18 and **Figure 6-19** present the potential constraints due to air and odour emissions at the receptors and source locations, respectively, for Scenario 5.

Figure 6-18 shows that relatively few dwellings (in red shading) have a large constraining effect on the potential industrial area, which is shown with red shading in **Figure 6-19**. Note that **Figure 6-18** also shows that there would be only limited potential to impact the rural land in the northern parts of the SAP where there are presently no dwellings.

Strategies to minimise the potential land use constraints shown in **Figure 6-18** to **Figure 6-19** are considered in **Section 6.2.2**.

6.2.1.2 Noise

Figure 6-20 and **Figure 6-21** present the potential constraints due to noise emissions at the receptors and source locations, respectively, for Scenario 5.

Figure 6-20 shows that there is medium scope for land and some limited numbers of dwellings to the north, west and east to be impacted by noise. Dwellings within the proposed industrial areas would be severely impacted by noise. **Figure 6-21** shows that the existing dwellings and potential dwellings on adjacent land would pose significant constraints on the potential industrial area, as is shown with red shading in this figure.

Strategies to minimise the potential land use constraints shown in **Figure 6-20** and **Figure 6-21** are considered in **Section 6.2.2**.

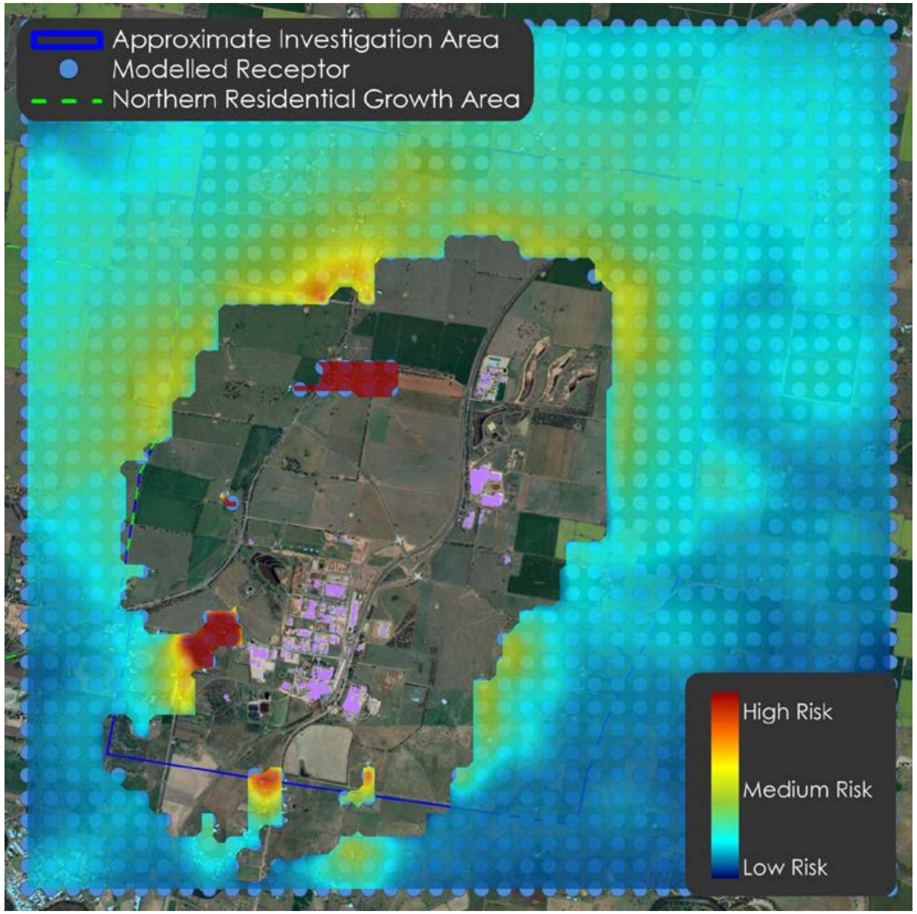

Figure 6-13: Predicted receptor risk areas due to air and odour emissions from Scenario 5

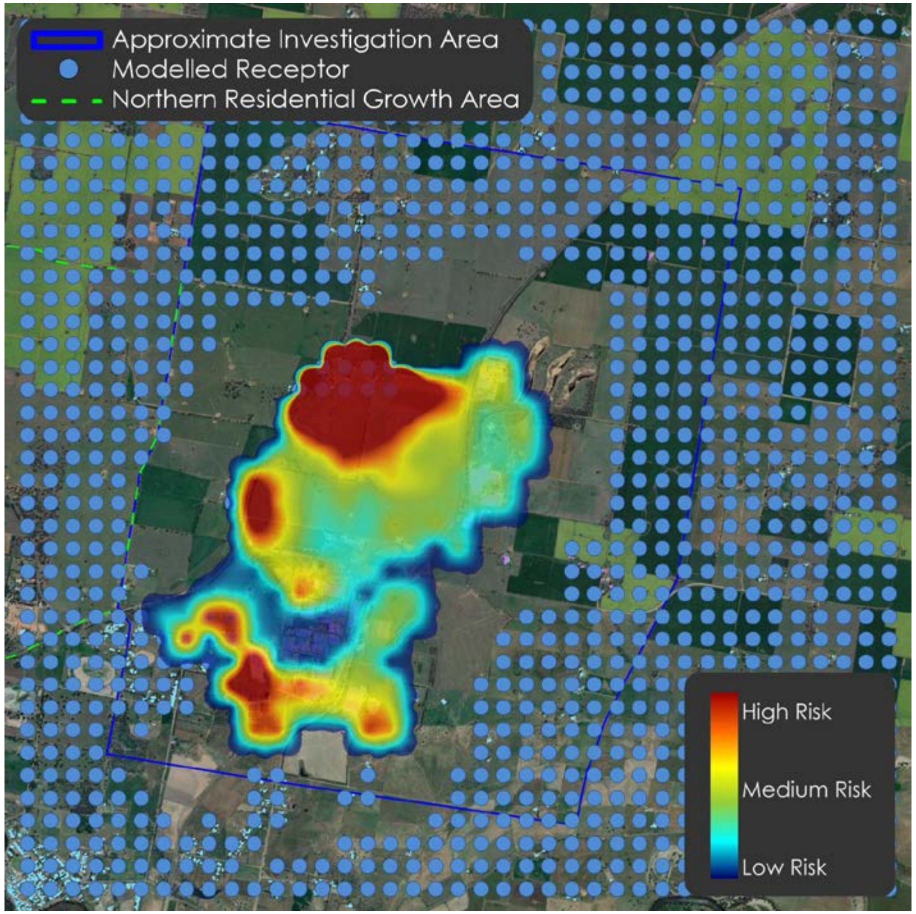

Figure 6-14: Predicted source risk areas due to air and odour emissions from Scenario 5

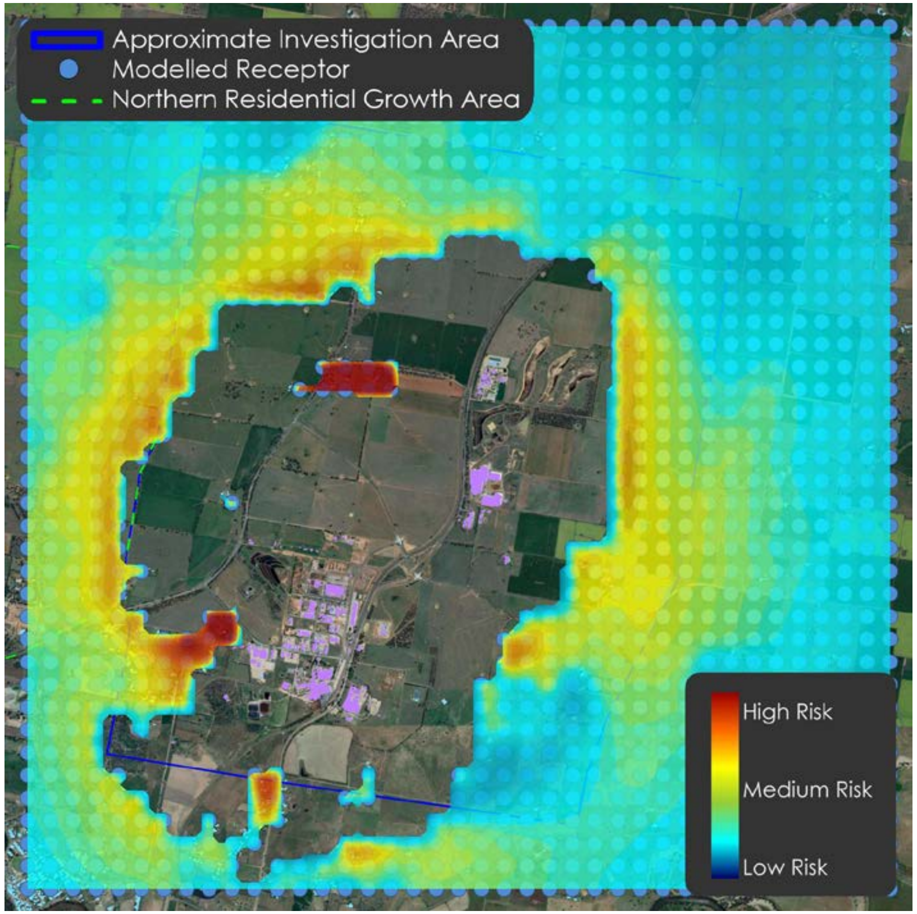

Figure 6-15: Predicted receptor risk areas due to noise emissions from Scenario 5

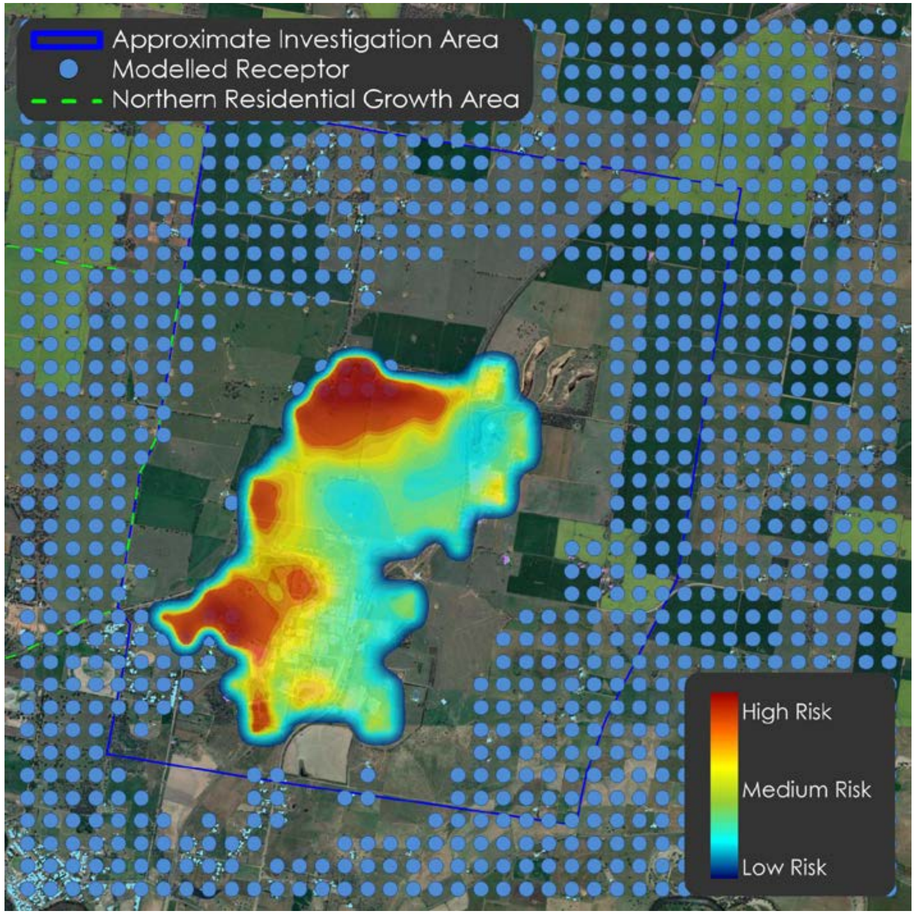

Figure 6-16: Predicted source risk areas due to noise emissions from Scenario 5

6.2.2 Concept scenario optimisation for air, odour and noise – Scenario 5

Figure 6-17 outlines the optimisation measures recommended for Scenario 5.

The existing residential dwellings within the proposed industrial zone have been rezoned (i.e. making them non-sensitive receptors in terms of air, odour and noise). This includes the cluster of dwellings in the middle of the SAP (west of Riverina Oils), the individual dwellings to the west of the highway, a cluster of dwellings located to the southwest of the Bomen Industrial Estate, and several dwellings located on the southern boundary of the SAP investigation area. (Please note that these existing residential dwellings have been rezoned in all optimisation scenarios.)

To prevent new land use conflicts arising, the following changes were made to Scenario 5. These are the optimal changes needed to maximise future industrial and residential coexistence. The optimisation process involved modelling dozens of modifications to the scenario.

- The existing dwellings and potential future dwelling receptor locations that were rezoned are shown as blue spots in **Figure 6-17**. The orange spots show dwellings and potential future dwelling receptors that were modelled.
- The proposed high amenity zone to the south west is curtailed along the western edge

With these changes, potential air, odour and noise land use conflicts can be minimised for Scenario 5, as shown in **Figure 6-18** to **Figure 6-21**.

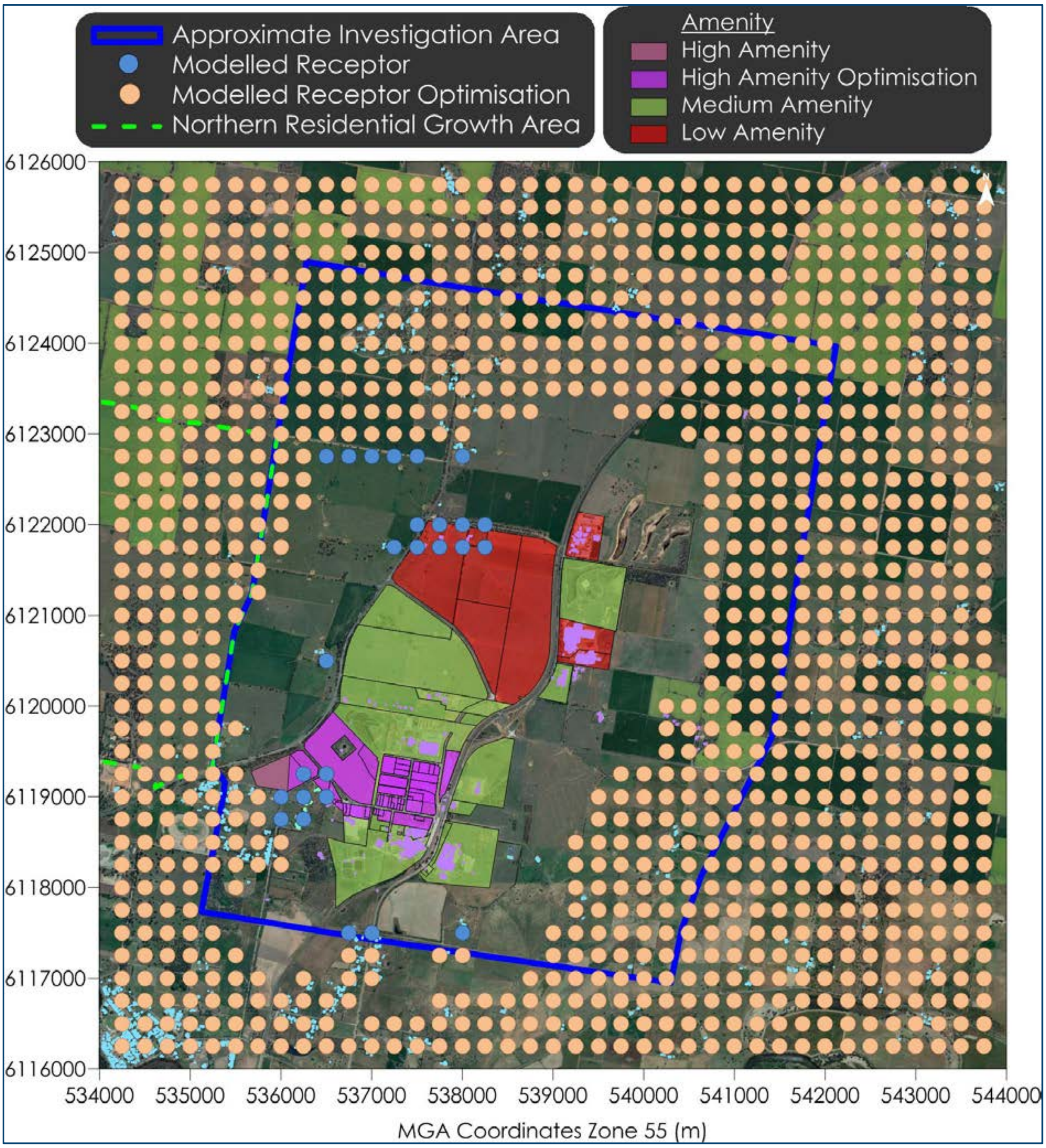

Figure 6-17: Optimisation features – Scenario 5

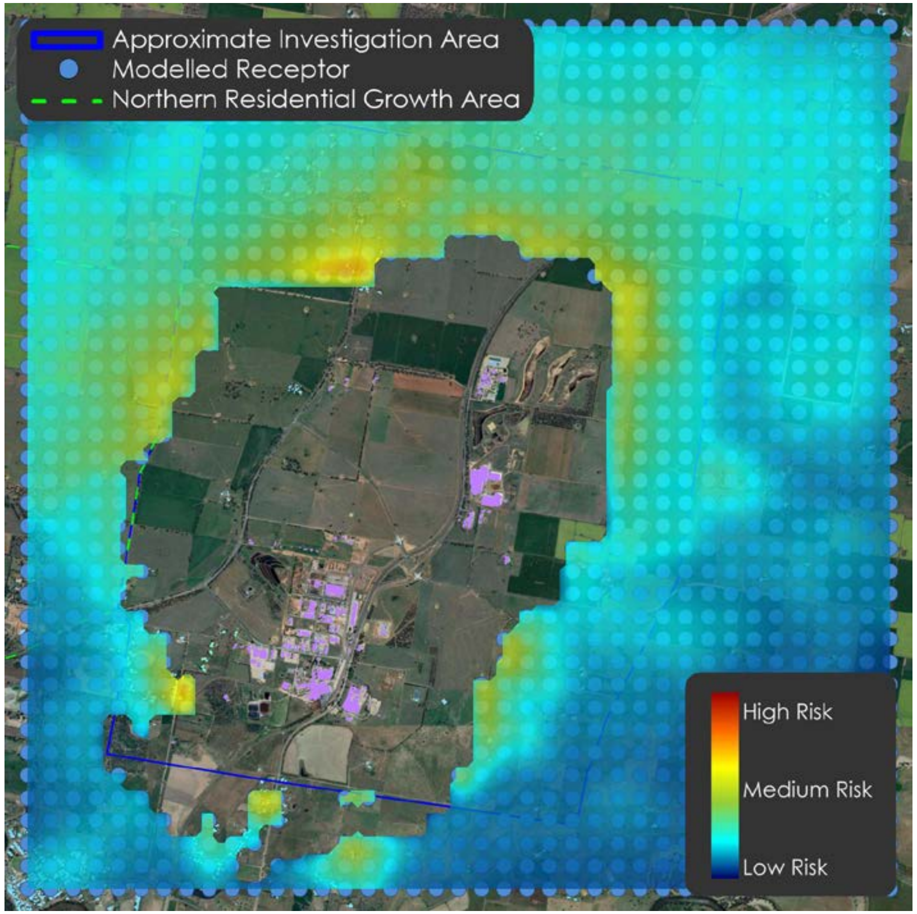

Figure 6-18: Predicted receptor risk areas due to air and odour emissions from Scenario 5

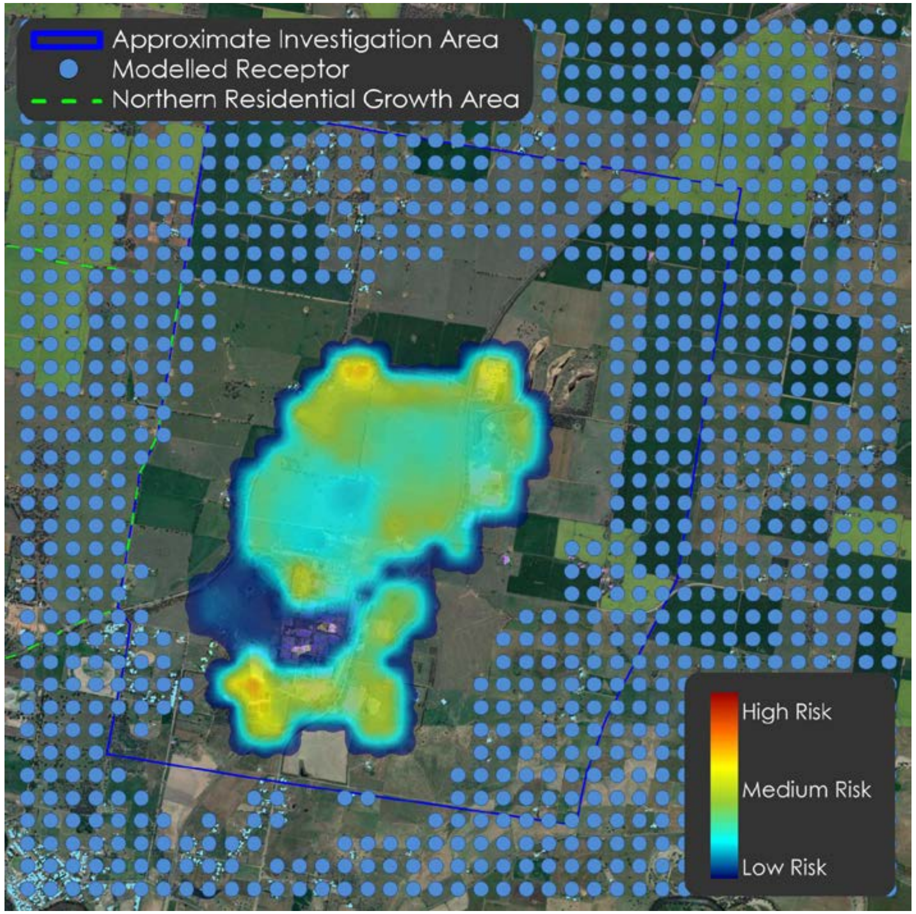

Figure 6-19: Predicted source risk areas due to air and odour emissions from Scenario 5

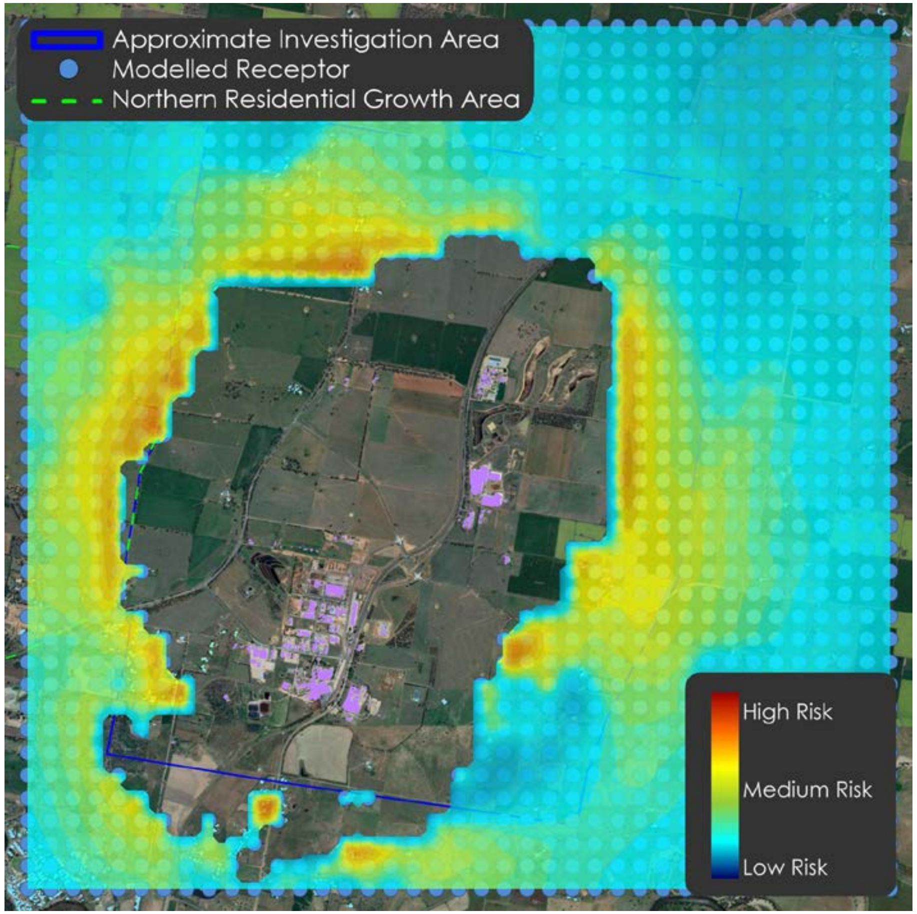

Figure 6-20: Predicted receptor risk areas due to noise emissions from Scenario 5

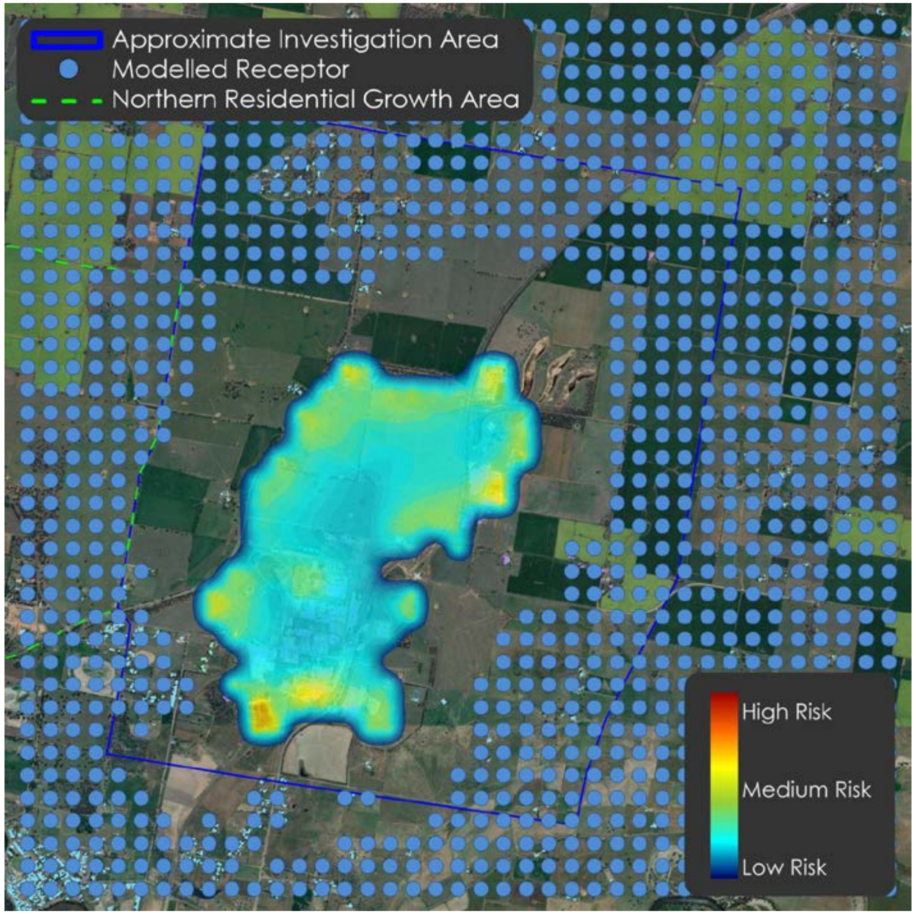

Figure 6-21: Predicted source risk areas due to noise emissions from Scenario 5

6.3 Scenario 7

6.3.1 Concept constraints modelling – Scenario 7

This scenario has a relatively large extent of industrial land, spreading generally northwards, and along the rail line. The scenario does not propose high amenity land, and is perhaps the most ambitious extension of the indusial area relative to the other scenarios.

The proposed industrial land to the northwest overlaps areas with many dwellings. It is not feasible to manage this land use conflict other than by curtailing the extent of the industrial land, or via a combination of industrial curtailment and re-zoning of some of the nearest dwellings.

Strategies to minimise the potential land use constraints are considered in **Section 6.3.2**.

6.3.1.1 Air and odour

Figure 6-22 and **Figure 6-23** present the potential constraints due to air and odour emissions at the receptors and source locations, respectively, for Scenario 7.

Figure 6-22 shows that a significant number of existing dwellings (in red shading) have a large constraining effect on the potential industrial area, as shown with red shading in **Figure 6-23**. Note that **Figure 6-22** also shows that there would large potential to impact many dwellings and rural land in the northern parts of the SAP.

Strategies to minimise the potential land use constraints shown in **Figure 6-22** to **Figure 6-23** are considered in **Section 6.3.2**.

6.3.1.2 Noise

Figure 6-24 and **Figure 6-25** present the potential constraints due to noise emissions at the receptors and source locations, respectively, for Scenario 7.

Figure 6-24 shows that there is a high scope for land and significant numbers of dwellings to the north to be severely impacted by noise. Dwellings within the proposed industrial areas would also be severely impacted by noise. **Figure 6-25** shows that the many existing dwellings and potential dwellings on adjacent land would pose significant constraints on the potential industrial area, as is shown with red shading in this figure.

Strategies to minimise the potential land use constraints shown in **Figure 6-24** and **Figure 6-25** are considered in **Section 6.2.2**

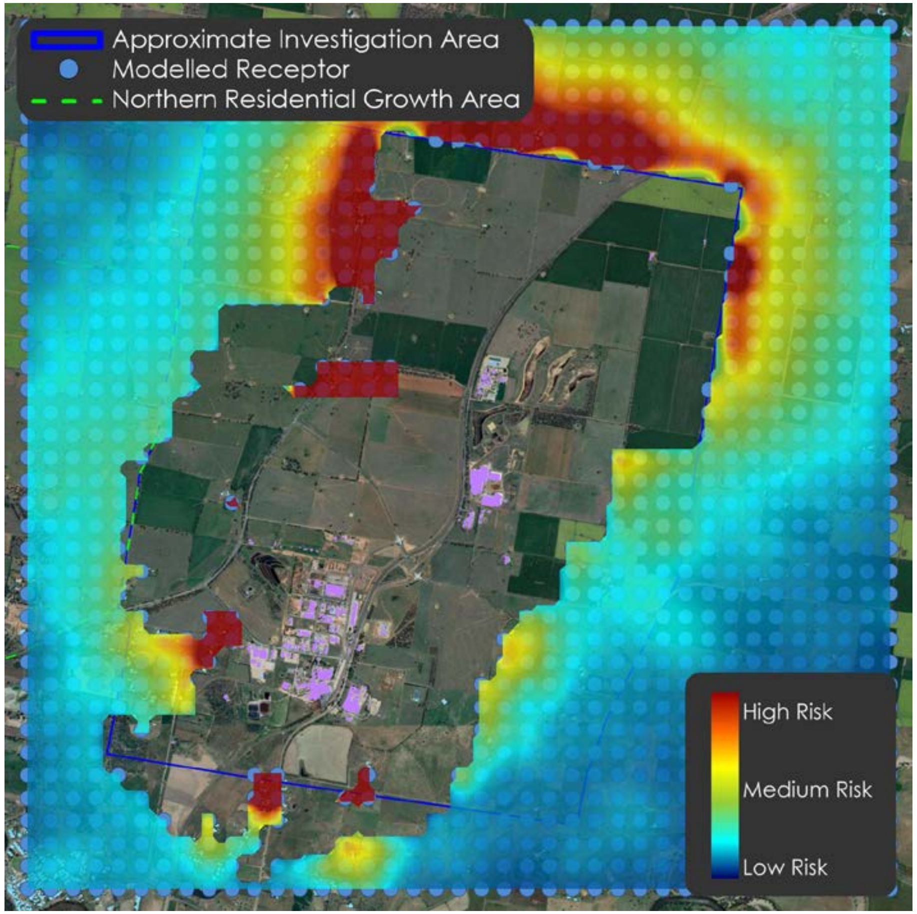

Figure 6-22: Predicted receptor risk areas due to air and odour emissions from Scenario 7

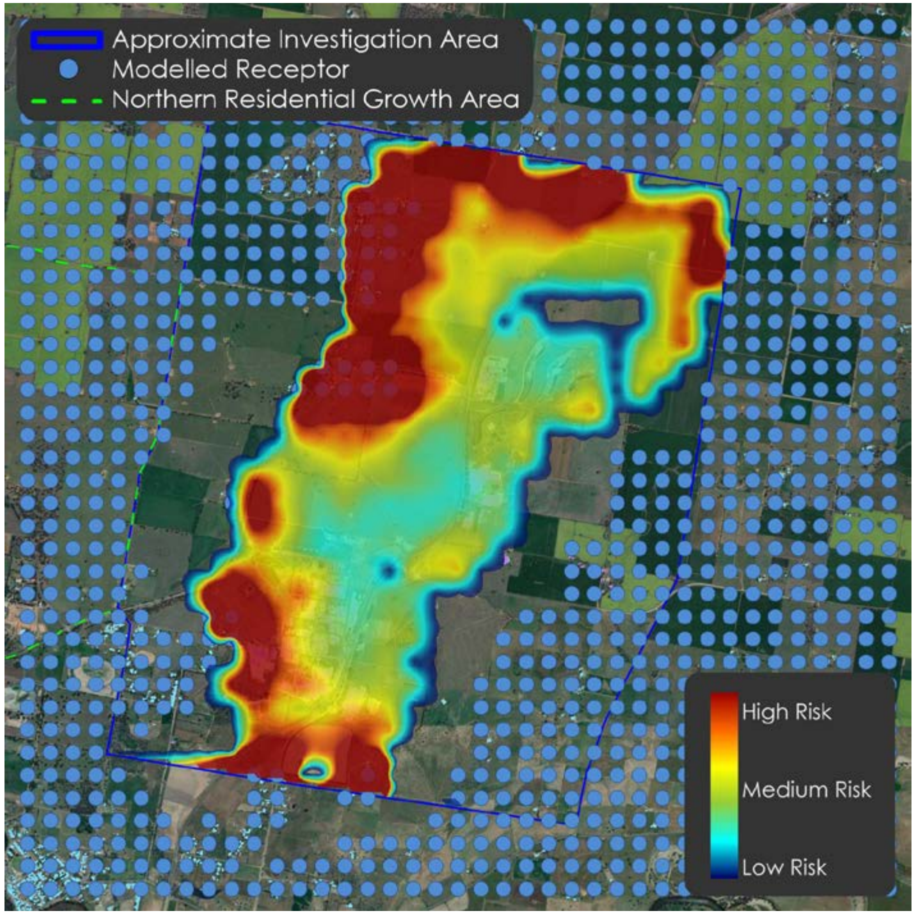

Figure 6-23: Predicted source risk areas due to air and odour emissions from Scenario 7

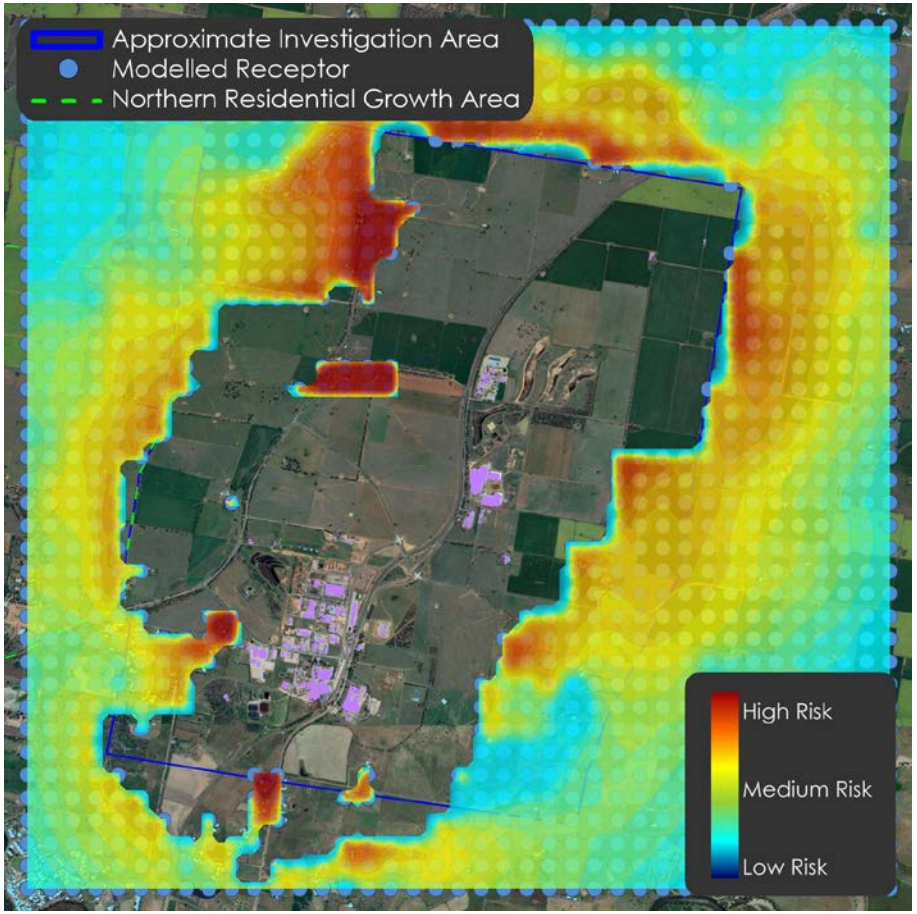

Figure 6-24: Predicted receptor risk areas due to noise emissions from Scenario 7

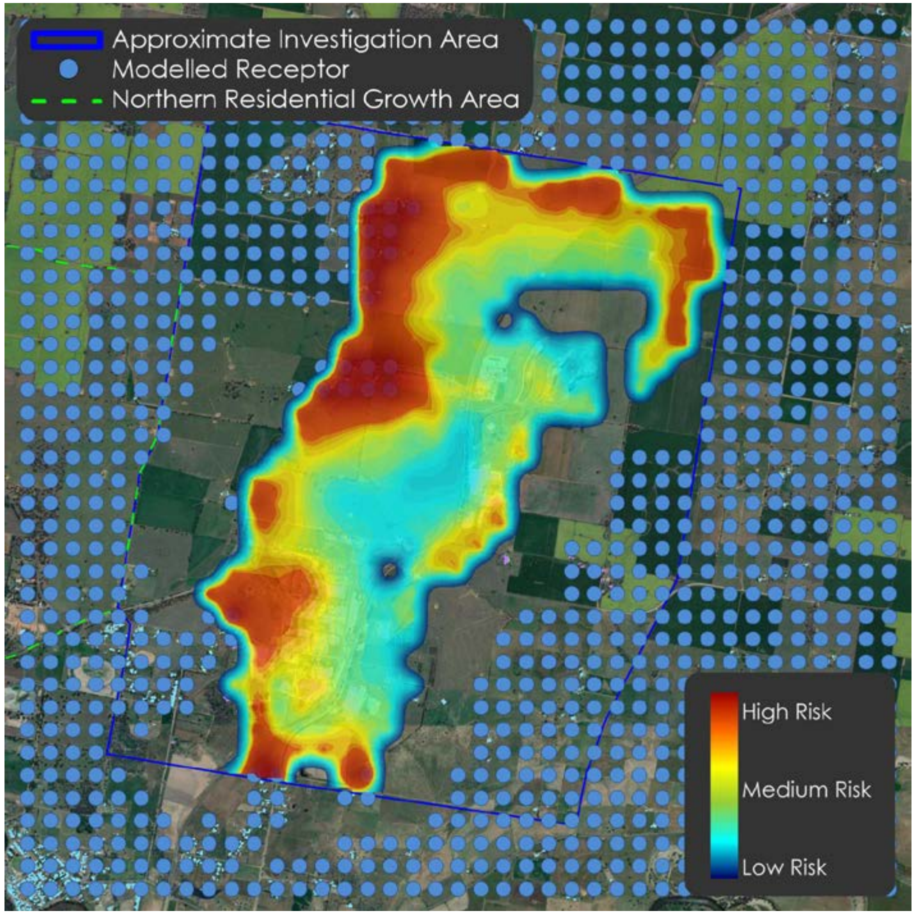

Figure 6-25: Predicted source risk areas due to noise emissions from Scenario 7

6.3.2 Concept scenario optimisation for air, odour and noise – Scenario 7

Figure 6-26 and **Figure 6-27** outline two distinct options for the recommended optimisation measures for Scenario 7.

The existing residential dwellings within the proposed industrial zone have been rezoned (i.e. making them non-sensitive receptors in terms of air, odour and noise). This includes the cluster of dwellings in the middle of the SAP (west of Riverina Oils), the individual dwellings to the west of the highway, a cluster of dwellings located to the southwest of the Bomen Industrial Estate, and several dwellings located on the southern boundary of the SAP investigation area. (Please note that these existing residential dwellings have been rezoned in all optimisation scenarios.)

To prevent new land use conflicts arising, the following changes were made to Scenario 7. These are the optimal changes needed to maximise future industrial and residential coexistence. The optimisation process involved modelling dozens of modifications to the scenario.

For the option per **Figure 6-26**;

- The existing dwellings and potential future dwelling receptor locations which were rezoned are shown as blue spots in **Figure 6-26**. The orange spots show the dwelling and potential future dwelling receptors. Note that a significant number of dwellings along the fringes of Brucedale are re-zoned.
- The proposed medium amenity zone is curtailed along the north-western, northern and north eastern edges, and to a small extend along the southernmost edge.
- The northern most (approx.) third of the low amenity zone is altered as follows:
    - o the northern most part is omitted altogether (changed from low amenity zone to a buffer, without activity); and,
    - o the remaining part is re-zoned to medium amenity use.

With these changes, potential air, odour and noise land use conflicts can be minimised for Scenario 7, as shown in **Figure 6-28** to **Figure 6-31**.

For the option per **Figure 6-27**;

- The existing dwellings and potential future dwelling receptor locations that were rezoned are shown as blue spots in **Figure 6-27**. The orange spots show the dwelling and potential future dwelling receptors. Note that a significant number of dwellings along the fringes of Brucedale are re-zoned, along with dwellings and land north of the SAP investigation area.
- The proposed medium amenity zone is curtailed along the north-western and north-eastern edges, and to a small extend along the southernmost edge.

With these changes, potential air, odour and noise land use conflicts can be minimised for Scenario 7, as shown in **Figure 6-32** to **Figure 6-35**.

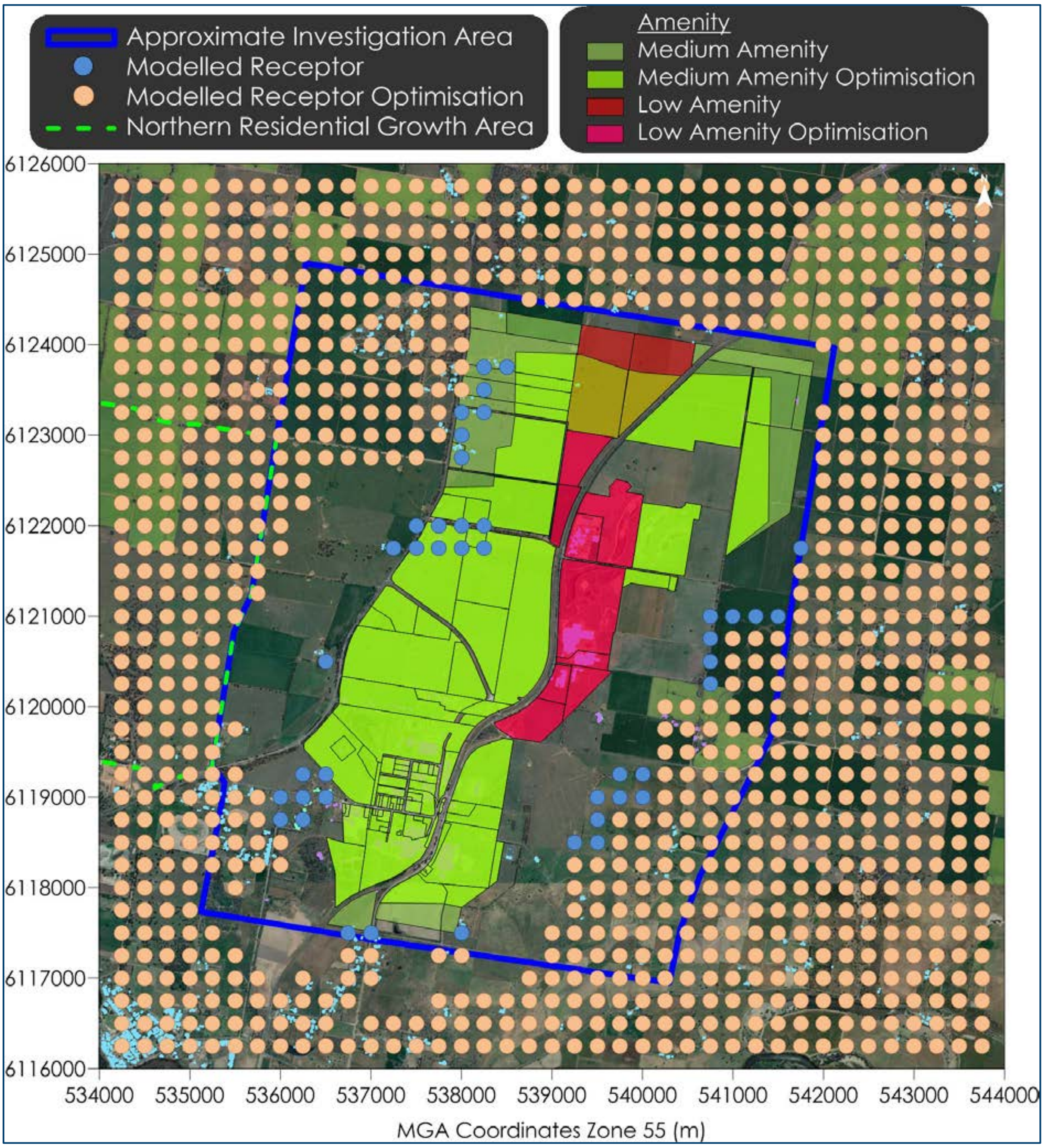

Figure 6-26: Optimisation features – Scenario 7

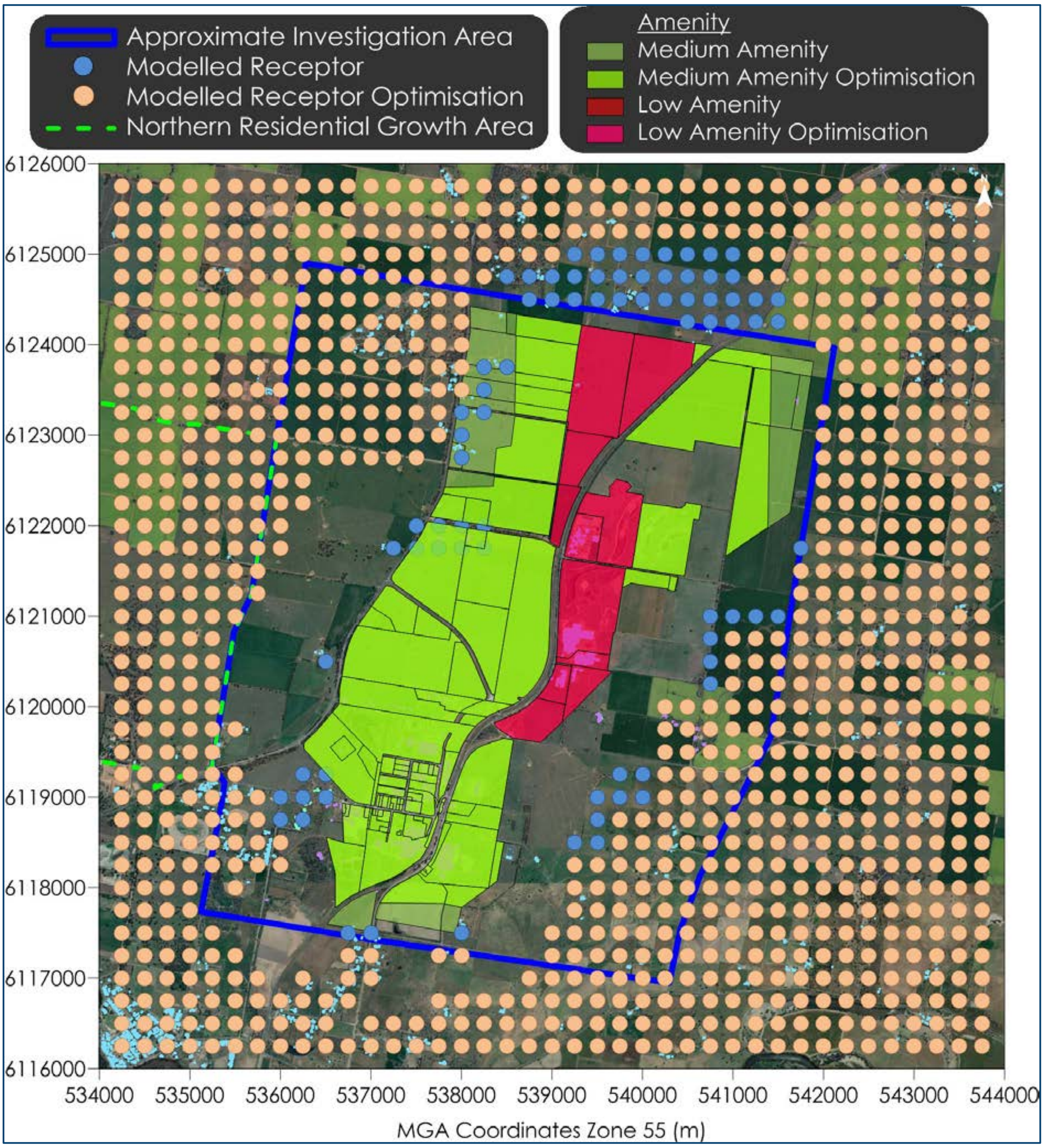

Figure 6-27: Optimisation features – Scenario 7

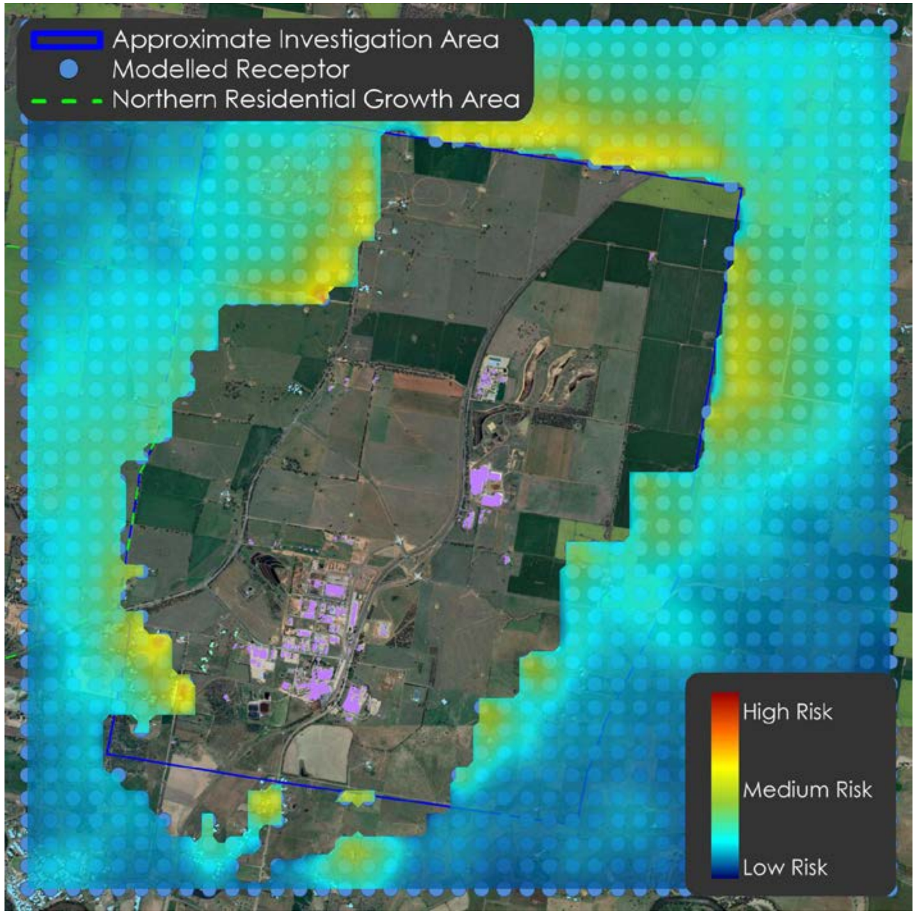

Figure 6-28: Predicted receptor risk areas due to air and odour emissions from Scenario 7

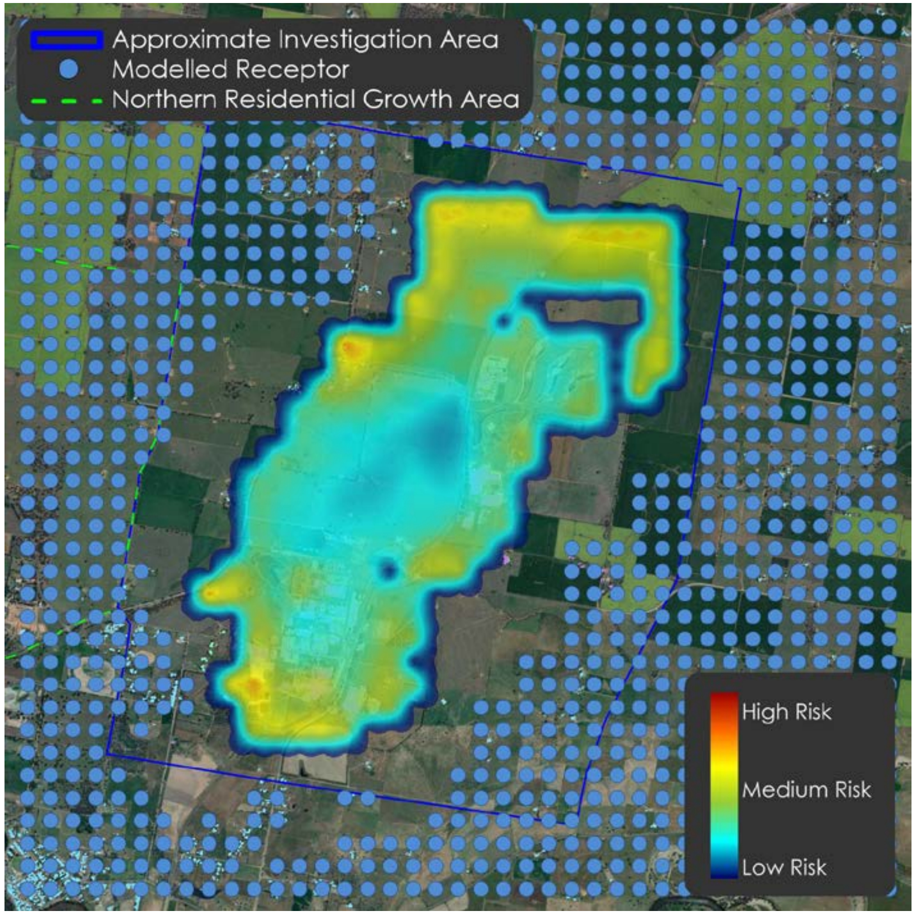

Figure 6-29: Predicted source risk areas due to air and odour emissions from Scenario 7

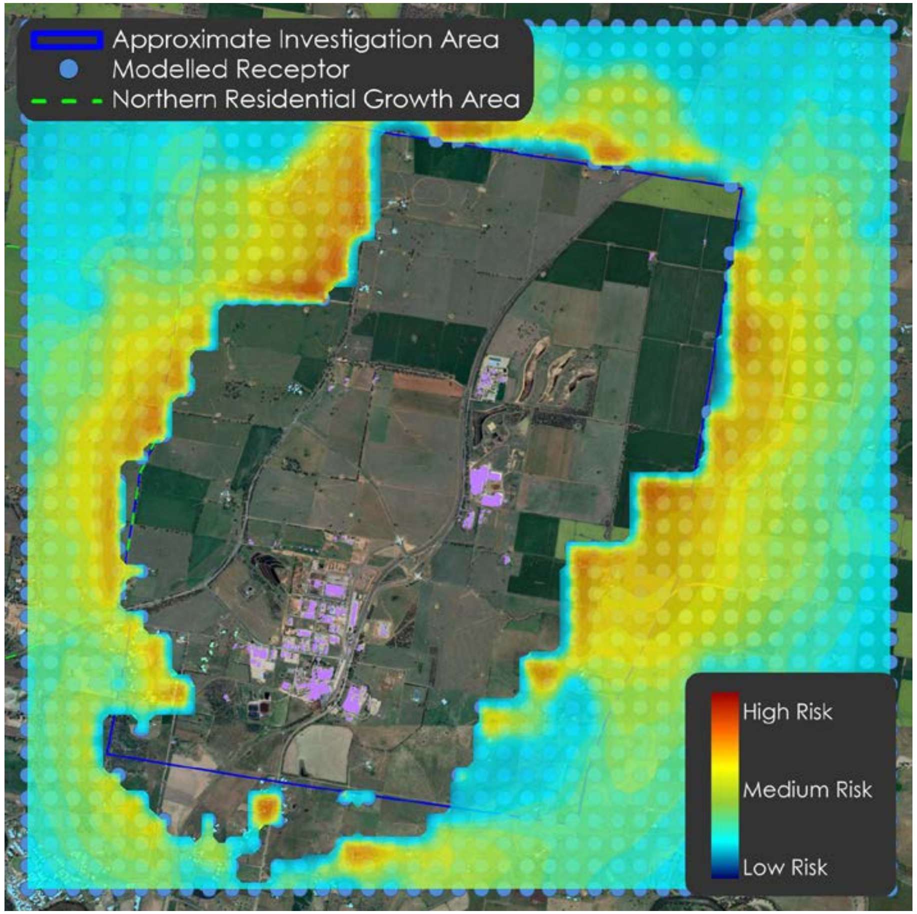

Figure 6-30: Predicted receptor risk areas due to noise emissions from Scenario 7

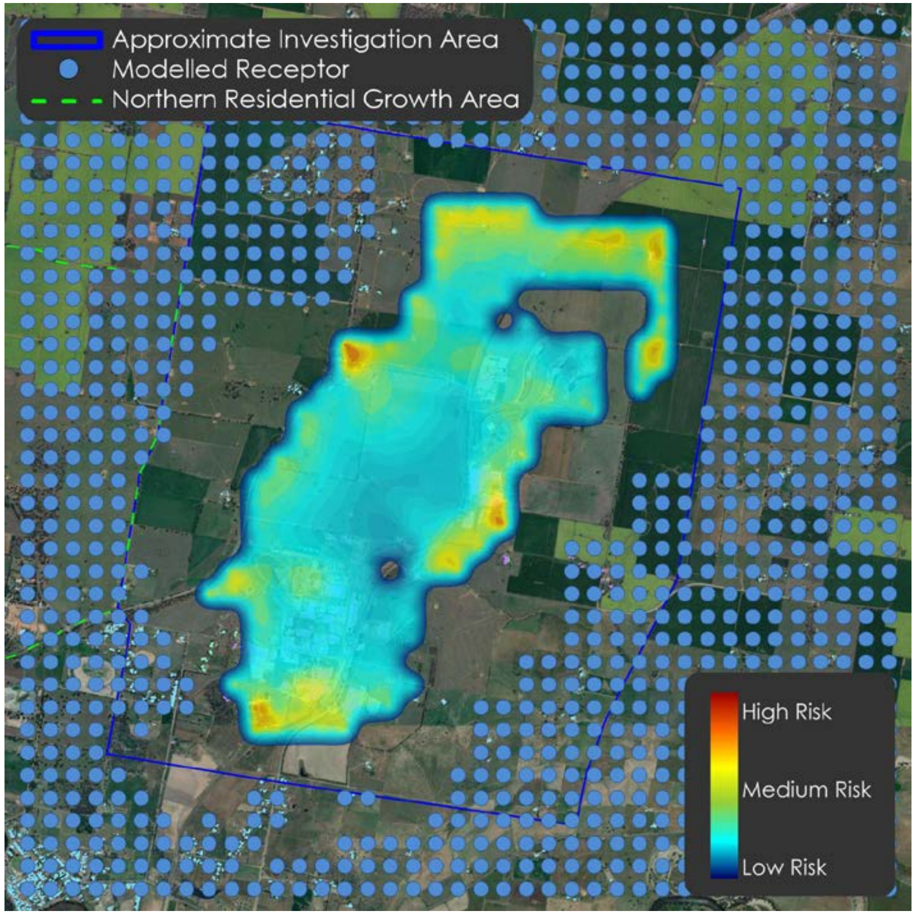

Figure 6-31: Predicted source risk areas due to noise emissions from Scenario 7

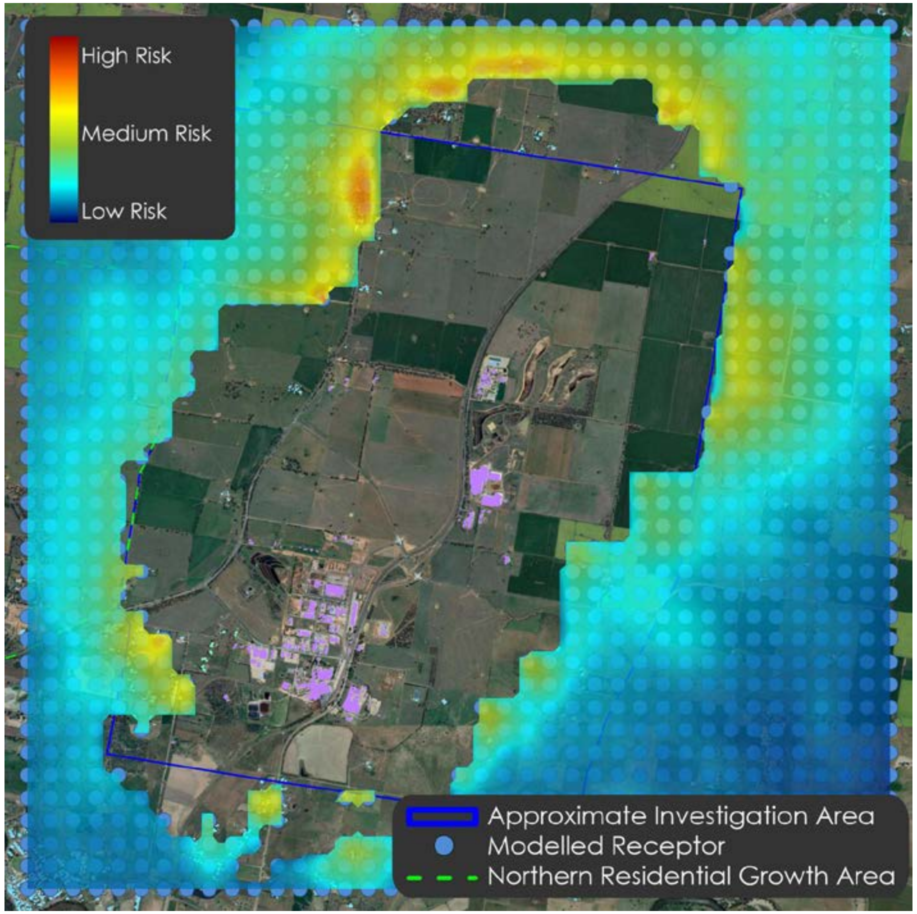

Figure 6-32: Predicted receptor risk areas due to air and odour emissions from Scenario 7

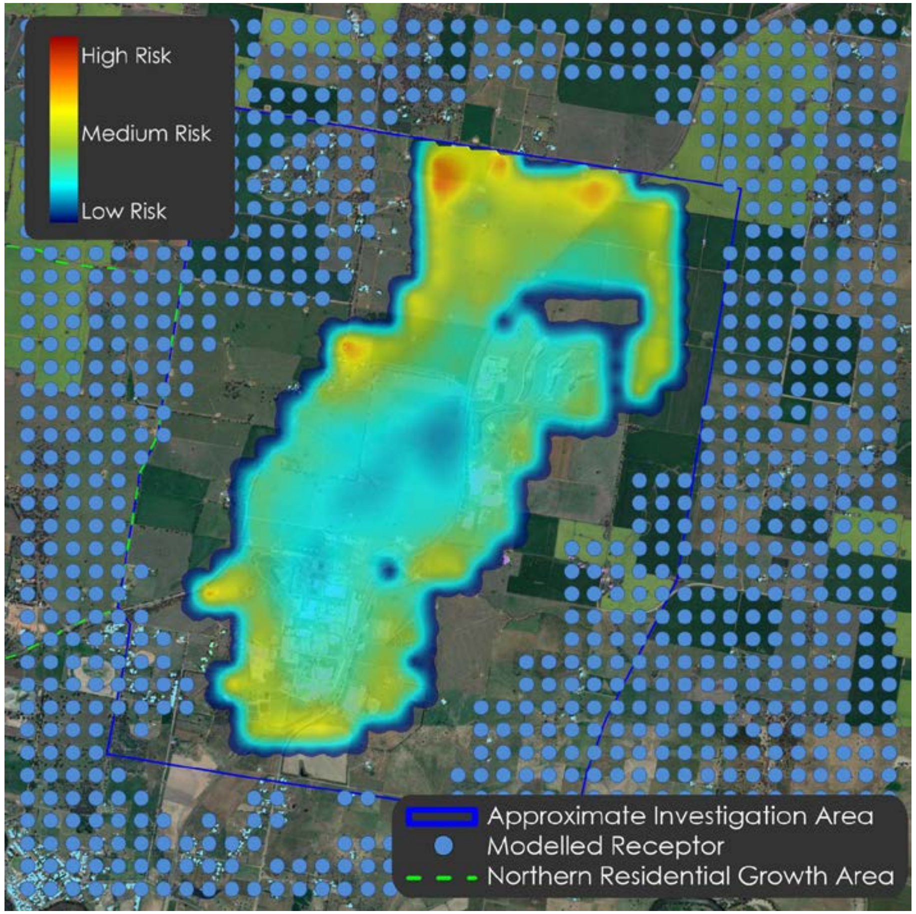

Figure 6-33: Predicted source risk areas due to air and odour emissions from Scenario 7

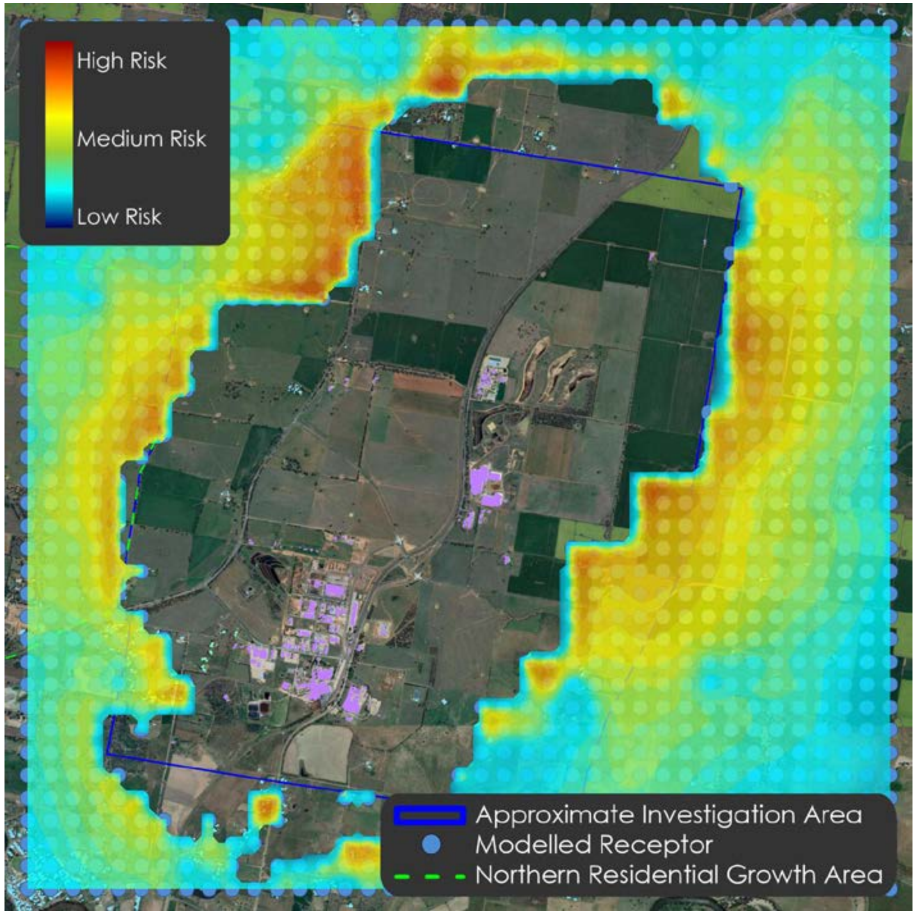

Figure 6-34: Predicted receptor risk areas due to noise emissions from Scenario 7

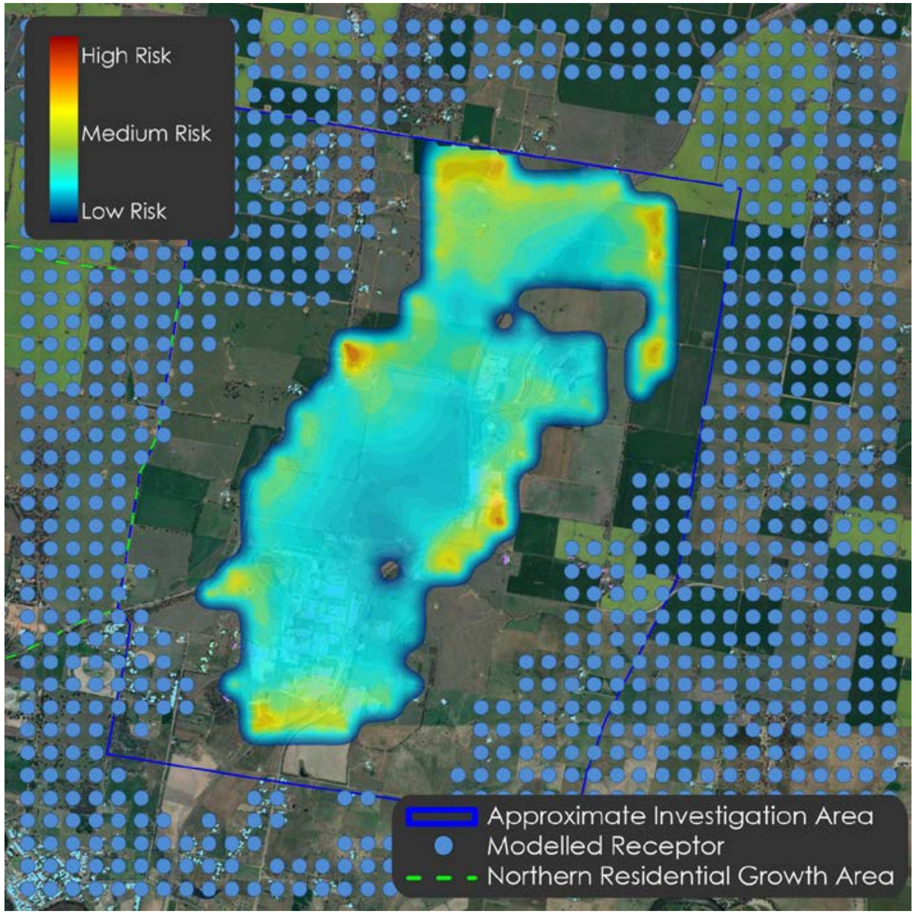

Figure 6-35: Predicted source risk areas due to noise emissions from Scenario 7

6.4 Summary of concept scenario testing

The analysis testing of the three concept scenarios indicate that only Scenario 5 has low scope to generate potential air, odour or noise impacts without any significant changes. However this scenario inherently makes a significant change by re-zoning the existing industrial area at Bomen to a high amenity use. Notably, this inherent change does not resolve the existing potential for land use conflict in the south western part of the SAP investigation area, however it does minimise the spatial extent of the land use conflict.

The existing potential for land use conflict in the south western part of the SAP investigation area arises as the existing industry and dwellings are too close. In practice, this issue affects all of the scenarios, and whatever solution is chosen, it would appear to be applicable to any of the scenarios. Thus if it is feasible to re-zone the existing industrial area at Bomen to a high amenity use as inherent in Scenario 5, this could also be an option for Scenario 4 and Scenario 7. If this approach is not an option, the recommended options for Scenario 4 and 7 are also generally applicable. These options involve curtailing existing residential use in the problematic areas in combination with restrictions on the extent of the industrial land use.

The testing for Scenario 7 indicates large scale curtailment of industrial and residential land use in the northern areas is necessary. In effect, this shrinks the industrial extent of Scenario 7 to be closer to that represented by Scenario 4. For Scenario 5, a similar, though less extensive curtailment is also necessary in the north western areas.

The question arises therefore as to just how much industrial land is required. If Scenario 4 provides sufficient land, it is the best option (there may need to be some refinement of the inherent re-zoning of the existing industrial uses). However, if more land is necessary, there needs to be closer examination of Scenario 4 relative to Scenario 7.

In this regard, Scenario 4 poses significantly less curtailment of existing residential use. However this scenario moves activity westwards, and has large high amenity areas in that direction, whereas Scenario 7 contains significantly more medium amenity industrial land, and is closer to the rail line. If deciding between Scenario 4 and 7, the answers to the following questions should also be considered:

- is there enough medium amenity industrial land in Scenario 4 (relative to Scenario 7)? If so, Scenario 4 is preferable in terms of air, odour and noise effects.
- is there a long term need for industrial land along the rail line (Scenario 7), rather than straddling the highway (Scenario 4). If so, does this preference outweigh the greater risk of air, odour and noise impacts at existing receptors associated with Scenario 7 (relative to less risks with Scenario 4).

6.4.1 Concept scenario options – concluding comments

The three concept scenarios developed for the Wagga Wagga SAP were tested using the approach outlined in **Section 6**.

The recommended optimal changes needed to maximise future industrial and residential coexistence and the key considerations that may affect the choice of one concept scenario over another are outlined in the discussion.

This study has also assessed the baseline impact risk of the existing emission sources located within the SAP, identified several areas of land use conflict due to insufficient separation between residences and emission sources and also identified a necessary setback buffer to ameliorate these impacts, as shown in **Figure 5-6**.

The key findings and some suggested means to minimise or prevent potential impacts associated with the baseline analysis are set out in **Section 5.3.**

7 PART C.4.1 – PLANNING CONSIDERATIONS FOR AIR, NOISE AND ODOUR – FINAL OPTION

Of the three shortlisted scenarios from the Short Enquiry by Design workshop, Scenario 7, a 'high growth' scenario where development is directed north and northeast was chosen for the development of the SAP.

This scenario incorporates industry zoned land northeast of Byrnes Road and also new land along Olympic Highway. Additional rail terminals are included north of RiFL.

Planning considerations to minimise or control land use conflicts for air, odour and noise are set out in this section.

7.1 Results

The initial approach considered for planning controls in the SAP industrial area were to classify various types of development into low, medium and high amenity activities, according to scale, throughput and other such limitations.

This was considered unsuitable for planning purposes, particularly in this case where some existing operations appear to operate with emissions near to compliance criteria at existing receptors. Thus the approach was revised to provide numerical criteria applicable to the land. This is only possible for noise and odour given that there is a limiting criterion for an emission (noise or odour), whereas for air, there are many criteria for many pollutants which apply at various locations and averaging periods. As such, only preferences or guidance can be provided for air emissions.

The planning considerations for the final master planning per Part C.4.1 are set out below. The key consideration in making the revised assessment is that there are no sensitive receptors within the precinct boundary, meaning that any existing receptors within the precinct boundary may become part of the buffer zone or may otherwise be re-zoned. All other applicable assumptions remain unchanged.

As before, the objective of the modelling and assessment task is to define the maximum extent of emissions from within the industrial area that do not cause impacts, in this case outside of the precinct boundary. It can be seen in the noise and odour figures that the buffer line extends out to the edges of the precinct boundary. The corresponding noise and odour emissions from any part of the industrial area which would reach the outer extent of the buffer area are also identified.

For air, only general good practice guidance can be provided.

7.1.1 Noise

Figure 7-1 shows the results for noise. The left hand side of the figure shows sound power levels as 1dB contour lines within the SAP industrial area. The right hand side shows the noise level outside of the SAP area.

The contour lines within the industrial area represent the maximum attenuated sound power level per hectare (i.e. noise that can leave the site, per hectare).

The following formula can be used to convert the contour line value crossing the middle of a specific lot into that lots' permitted sound power level based on the lot size. Per the formula, bigger lots get more sound power, smaller lots get less.

Equation 1: $PWL(lot) = PWL(ha) + 10\log(A/10{,}000)$, where:

PWL(lot)	= Allowed attenuated sound power level per lot, dB(A)
PWL(ha)	= Sound power level of contour line crossing middle of the lot (OK to use a decimal if between lines);
A	= Lot area in square metres

Upon subdivision, this sound power (PWL(lot)) can be set as a property right for the lot, perhaps as part of a Section 10.7 Notice attached to the property, and/ or as part of the total tally of lot sound power within a database or electronic register/ tool for managing the approval of developments in the industrial area.

From a regulatory view point, measuring PWL(lot) at the site is more swift, direct and reliable than measuring the intrusive noise level at receivers, especially for a lot within a large industrial area where it can be very hard to determine which source/ lot/ operation is causing the noise at the receiver.

From an application/ assessments/ approval point of view, this pre-set allowance for the lot's sound power level reduces the work a noise consultant may need to do, saving time and money. It may however prompt some operators to design the plant to pollute up to the limit so to speak. However, this occurs currently, but at least per this approach the PWL(lot) is easily measurable and so potential transgressions can be swiftly and efficiently regulated.

The right hand side of **Figure 7-1**, shows the sound pressure levels outside of the industrial area.

As per the Noise Policy for Industry (**NSW EPA, 2017**), the limiting criterion is the amenity criterion of 40dB(A) which is a 9-hour average noise level over the night time period (10pm to 7am) and applies to the cumulative noise of all industrial noise sources, whereas the intrusive criteria is 35dB(A) and applies to each individual site. As the noise sources in the industrial area will be a mix of constant sources (e.g. fan or transformer that is always on) and intermittently noisy sources such as vehicles and mobile plant, and other batch activities, many sources will only make noise intermittently over 9 hours. Thus the measured cumulative 9-hour noise level will be less than the maximum measured 15-minute level (from all sources) in that same 9-hour period.

The sound power limits above correspond with all lots operating at the individual intrusive noise limit for each lot which is set at 35dB, LAeq(15min) to protect the amenity of the nearest receptor outside of the SAP boundary (the large rectangular area), and both limits are commensurate with the industrial area meeting the cumulative noise amenity level of 40dB, LAeq(9hr).

The pink line **Figure 7-1** represents the required buffer area which is equally the 35dB, LAeq(15min) individual site intrusive criteria compliance boundary line (or the location of the nearest sensitive receptors at which the intrusive criteria apply) and also the cumulative noise amenity level extent for 40dB, LAeq(9hr).

The land within the buffer line is not suitable for residential use. It is recommended that suitable strategies to prevent any new residential use and ideally to also progressively reduce any existing residential use in the buffer area over time should be developed.

The required buffer line extends outside of the precinct boundary in a small area to the southwest. It is recommended to adjust the precinct boundary as shown by the dashed line in the figure. This is because of excessive potential land-use conflict in this small area which cannot be reasonably resolved whilst also maintaining a viable precinct.

Examples of actual source sound power levels per hectare are shown in **Appendix C**. The data indicate that all likely industrial noise sources can fit within the specified sound power level allowances in the industrial area, except in some limited locations near to receptors or the precinct boundary where only low noise sources should be permitted.

7.1.2 Noise mitigation options

As for any operation in NSW, as a minimum, general or commonly used noise mitigation is expected for industries in the industrial area that have potential to release noise emissions.

The industrial area and buffer within the precinct boundary is designed such that industries incorporating general levels of control should be able to operate within the industrial precinct without causing impacts. But there are limitations, for example a facility that would have high levels of noise emissions may need to have extra noise mitigation if it chooses to locate near to the edge of the estate near receptors. Such a location is better suited to an operation that has noise emissions within the specified allowance as it is unlikely to need extra abatement.

The left hand side of **Figure 7-1** provides an allowance per hectare for potential noise emissions. This can be used as part of the approvals process, where a proposed development with less emissions per hectare than the allowance for the proposed lot would be suitable. The figure also serves to help potential new industries to identify the more suitable lots where, depending on their emissions, the facility can reasonably expect to be able to operate without causing impacts (outside of the precinct boundary) or to require extra noise controls.

General mitigation options for industries to manage noise emissions would vary depending on the nature of the source and the effectiveness of potential mitigation options need to be considered in each case. Some examples of general noise mitigation measures include:

- Mitigation at the source;
    - Selection of equipment – select equipment with low sound power levels when purchasing new equipment or substituting equipment.
    - Modifying equipment – silencers, mufflers and dampeners may be retrofitted to existing equipment to reduce noise emissions.
    - Operational time – consider adjusting operating times for when equipment is in use.
    - Implementing quiet work practices – using equipment in ways to minimise noise, this includes reducing throttle setting and turning off equipment when not being used.

  - Maintain equipment – regularly inspect and maintain equipment to ensure it is in good working order.
  - Limit equipment use – reduce the amount of equipment operating simultaneously, avoid clustering of equipment.
- Mitigation along the path between source and receiver;
  - Barriers – construct barriers between source and receiver.
  - Direction – orient noise emissions away from receiver.
  - Distance – provide as much distance as possible between source and receiver.
- Mitigation at the receiver;
  - Barriers – construct barriers at the receiver.
  - Architectural treatments – treatment options will vary depending on the level of noise at the receiver.
- Planning controls;
  - Limit intensification of residential development within areas near to 35dBA impact area (i.e. approximately within the 32dBA contour of right-hand side of **Figure 7-1**). As the population density increases, the proportion of sensitive individuals is also likely to increase, indicating that allowing increased residential intensification in these areas would result in a higher risk of noise impacts upon sensitive individuals. This also allows for a margin of error for differences between the modelled results and the actual emissions output from future industries (a 3dBA difference equates to doubling/halving the noise source emissions).

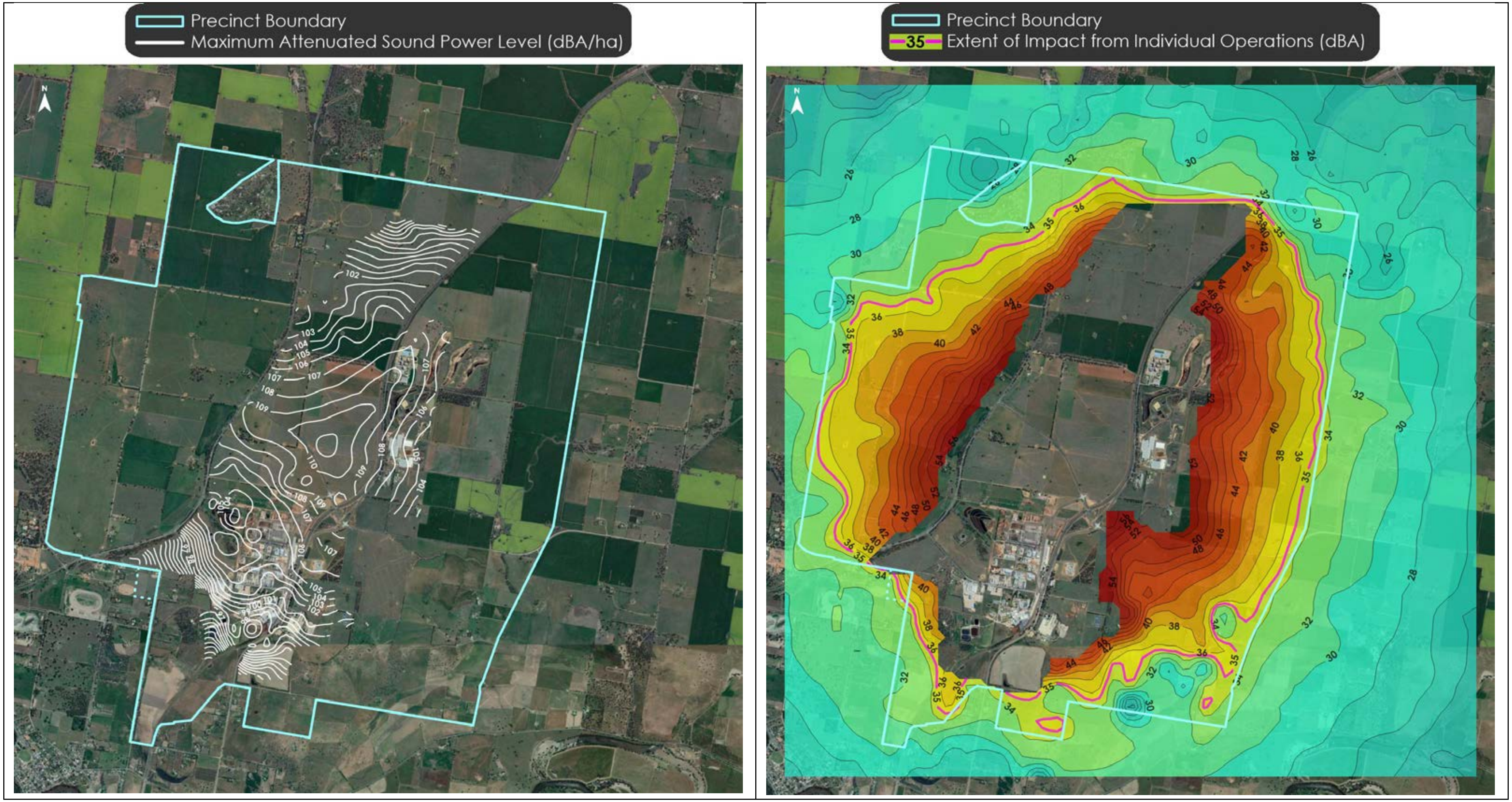

Figure 7-1: Source sound power level per Ha (left) and received sound pressure level (right) due to noise emissions from the industrial area

7.1.3 Odour

Figure 7-2 presents the results for odour. The left hand side of the figure shows the odour emission rate per hectare for sources of odour in the industrial area and the right hand side shows the recieved odour level outside of the industrial area.

Referring to the left hand side of **Figure 7-2**, the contour lines within the industrial area represent the maximum attenuated odour emission rate ($OU.m^3/s/ha$) (i.e. rate of release of odour that can leave the site, per second per hectare).

This converts linearly to any lot's odour emission allowance. For example, if the lot is half a hectare, it can emit odour at half the rate of the contour line level passing through the middle of the lot. If the lot area is two hectares it can emit double the contour line level.

Like noise, this odour emission rate allowance can be set as a property right for the lot, perhaps as part of any a Section 10.7 Notice attached to the property.

Referring to the right hand side of **Figure 7-2**, the pink line represents the required odour buffer area.

The required buffer line extends outside of the precinct boundary in a small area to the southwest. It is recommended to adjust the precinct boundary as shown by the dashed line in the figure. This is because of excessive potential land-use conflict in this small area which cannot be reasonably resolved whilst also maintaining a viable precinct.

Examples of actual source odour emission rates levels per hectare are shown in **Appendix C**. The data indicate that a range of likely industrial odour sources can fit per the specified odour emission rate allowances in the industrial area provided that care is taken in the approval process for industries near to receptors or the precinct boundary where only low odour sources should be permitted.

For example, the results indicate that the odour allowance is approximately 4,000 OU/ha near the existing Teys abattoir and the emissions from the operation are presently approximately 3,800 OU/ha, giving little "headspace" for additional odour in this locality depending on the exact lot size and proximity to the precinct boundary.

7.1.4 Odour mitigation options

As for any operation in NSW, as a minimum general or commonly used pollution controls are expected for industries in the industrial area which have potential to release air emissions.

The industrial area and buffer within the precinct boundary is designed such that industries incorporating general levels of control should be able to operate within the industrial precinct without causing impacts. But there are limitations, for example a facility that would have high levels of odour emissions may need to have extra odour mitigation if it chooses to locate near to the edge of the estate near receptors. Such a location is better suited to an operation that has odour emissions within the specified allowance as it is unlikely to need extra abatement.

The left hand side of **Figure 7-2** provides an allowance per hectare for potential odour emissions. This can be used as part of the approvals process where a proposed development with less emissions per hectare than the allowance for the proposed lot would be suitable. The figure also serves to help potential new industries to identify the more suitable lots where depending on their emissions, the facility can reasonably expect to be able to operate without causing impacts (outside of the precinct boundary) or to require extra pollution controls.

General mitigation options for industries to manage odour emissions would vary depending on the nature of the source and the effectiveness of potential mitigation options need to be considered in each case. Some examples of general odour mitigation options include:

- Mitigation at the source;
  - Handling of malodourous material within enclosed building or within a closed system. Aim to minimise exposure of material and prevent odour emissions into the environment.
  - Capture and ventilation of odour emissions at the source (e.g. hooding and extraction, negative pressure enclosures, etc.).
  - Exhaust odour emissions via a stack to allow for adequate dispersion.
  - Treatment of odour emissions before release (e.g. biofilter, carbon filter, thermal oxidiser, ozone reactors, etc.).
  - Regular cleaning of work space, clean up any spills.
  - Routine preventative maintenance on equipment.
  - Reduce amount of odorous material stored and handled at site.
  - Regular inspection of work place areas to identify odour.
  - Build continuous dense landscaping (bunds and vegetation) along odour source boundaries to assist in odour dispersion from the odour source. Provide guidance and training to on-site personnel to assist identification of problematic odour sources at the site and taking proactive action.
  - Position the most odorous sources as far away as possible from receivers (the odour allowance will be higher there also).
  - Establish incident or complaint management system to assist with identifying odour sources and take preventative measures.
- Mitigation at the receiver may only provide small benefits but is appropriate for new dwellings outside of the precinct boundary;
  - Orientate buildings to provide adequate air flow around the building and design buildings to encourage air flow in a particular direction. (This can be aided by block size and shapes and understanding of prevailing wind flows). Avoid construction of dead end courtyards or long narrow spaces perpendicular to the prevailing winds where air can lay dormant and stagnate;

  - Design buildings so living spaces do not face odorous sources and position any air conditioning and ventilation intakes away from the odour source.

- Planning controls;

  - Limit intensification of residential development within areas near to 2OU impact area (i.e. approximately within 1OU contour of right-hand side of **Figure 7-2**). As the population density increases, the proportion of sensitive individuals is also likely to increase, indicating that allowing increased residential intensification in these areas would result in a higher risk of odour impacts upon sensitive individuals. This also allows for a margin of error for differences between the modelled results and the actual emissions output from future industries.

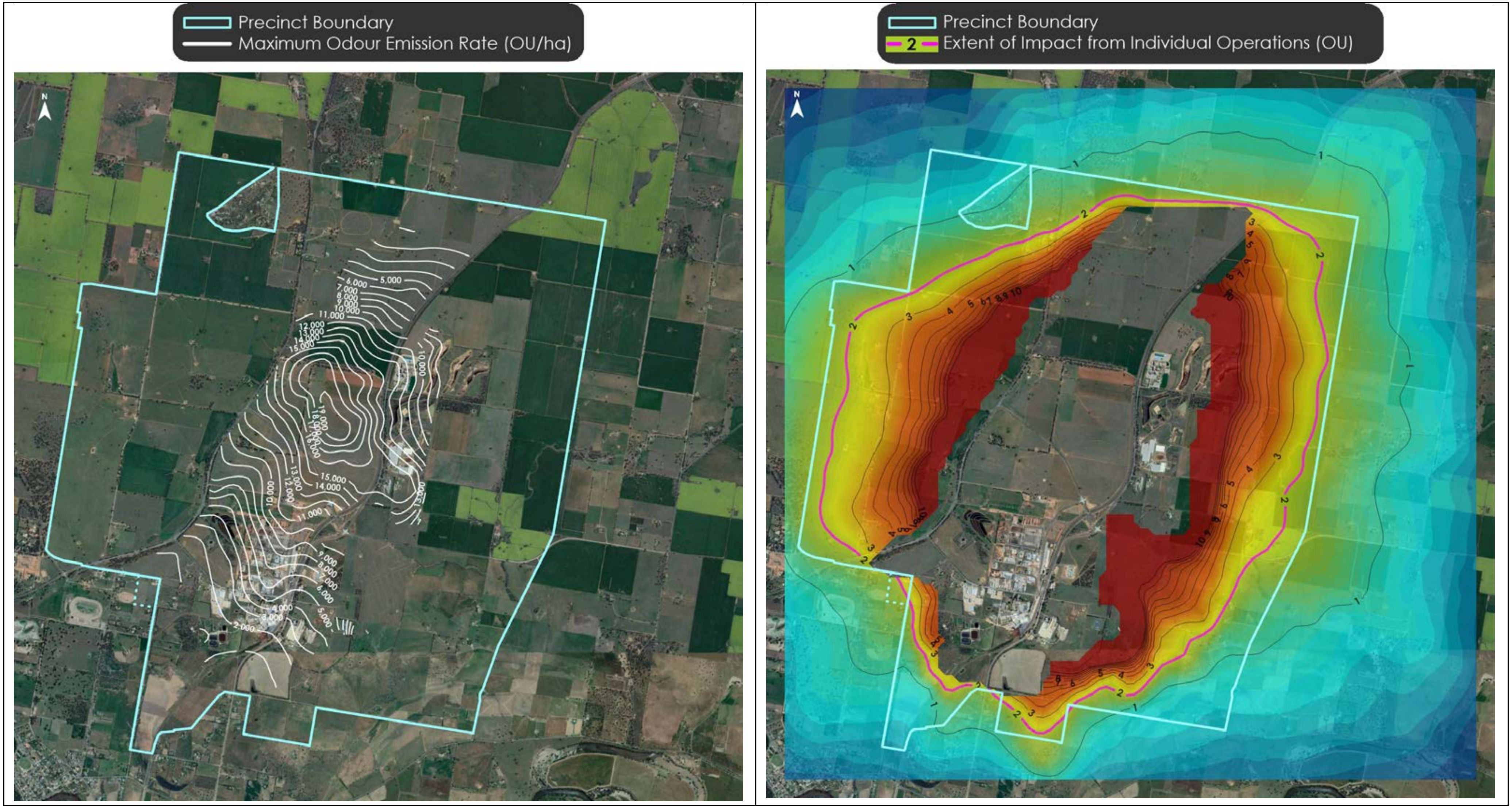

Figure 7-2: Source odour emissions rate per Ha (left) and received odour (right) due to odour emissions from the industrial area

7.1.5 Air

For air emisions, it is not possible to ascribe a maximum quantity of emissions per hectare, given that there may be hundereds of different types of air emissions each with differing criteria averaging periods or locations for compliance.

For air, the approach taken is to accept that all air toxic emissions must be minimised to the maximum practicable extent, as set out in Section 7.2.1 of the EPA Approved Methods (**EPA, 2017**). Previous work identified that for fugitive air emissions, odour is the most limiting emission affecting potential compliance. As fugitive emissions will arise from area or volume sources, their zone of potential impact is considered as part of the odour assessment (see 7.1.3). Thus stack emissions are considered in more detail here.

Stacks have the potential to cause most impact at locations where the dispelled plume may reach the ground. For stacks, this is most likely to arise in elevated locations in the surrounding terrain but may also occur nearby due to plume down wash effects. As the earlier work has shown it is prefereable to locate stacks in more elevated areas. This however is not mandatory as it is feasible for an applicant to simply specify a taller, higher velocity or higher temperature stack that has better dispersion and can perform equally well in a low lying area than a less highly performing stack in an elevated area.

Figure 7-3 shows the results for a generic source of air emissions represented by a typical industrial boiler stack modelled per earlier stack modelling and assumptions. The figure shows no constraints beyond those for noise and odour.

The left side of **Figure 7-3** shows the concentration of NO_X emissions within the industrial area which can be emitted from the stack (mg/m^3) that would meet an NO_2 concentration at receivers of 95 µg/m^3, which when combined with an assumed background level of 85 µg/m^3 at 100% conversion of NO_x to NO_2, is a little below the proposed new NEPM limit for 1-hour averge NO_2. This concentration is also shown in the left hand side of the figure as the pink buffer line.

The required buffer line extends outside of the precinct boundary in a small area to the southwest. It is recommended to adjust the precinct boundary as shown by the dashed line in the figure. This is because of excessive potential land-use conflict in this small area which cannot be reasonably resolved whilst also maintaining a viable precinct.

Note that there are two equally applicable limits/ criteria for a stack; the emissions concentration limits which apply to emissions in the stack (as set out in the POEO Clean Air Regulation); and, the ambient or ground level concentration limits which apply at a receptor (as set out in (**EPA, 2017**)). An orange contour line is drawn within the industrial area corresponding to the POEO Clean Air Regulation limit for a boiler (350mg/m^3) and a green line for levels approximately 150% above this. Note that the levels shown within the industial area are the in-stack concentrations which would cause an exceedance of the ambient criteria at receptors. Hence where the level shown in the industrial area is greater than POEO Regulation limit for a stack, this means more emissions than is lawful for the stack would need to be emitted in order to exceed the criteria at a receptor. (It does not mean that more than the lawful level of stack emissions are proposed in this industrial area).

The right hand side of **Figure 7-3** shows generalised guidance for locating industries with stacks. The general preferences shown cannot be used in planning documents other than for general guidance. The figures aim to assist applicants to identify locations within the industrial area where installing a stack will be less costly (preferrred locations) and also guide approval bodies as to the level of scrutiny warranted for applications with a stack, for example a stack with higher specifications may be needed in the zone between the "preferred" and "not preferred areas" for stacks and a high level of regulatory scrutiny would be needed for approval of stack applications in the "not preferred" for stack area.

7.1.6 Air mitigation options

As for any operation in NSW, as a minimum, general or commonly used pollution controls and mitigation is expected for industries in the industrial area which have potential to release air emissions.

The industrial area and buffer within the precinct boundary is designed such that industries incorporating general levels of control should be able to operate within the industrial area without causing impacts. But there are limitations, for example a facility that would have high levels of air emissions may need to have extra pollution controls if it chooses to locate near to the edge of the estate near receptors. Such a location is better suited to an operation that does not require a stack to manage pollution.

The right hand side of **Figure 7-3** provides a guide for new industries to help identify the more suitable lots where, depending on the type of industry and emissions, the facility can reasonably expect to be able to operate without causing impacts (outside of the precinct boundary) or requiring extra pollution controls.

General mitigation options for industries to manage air emissions from stacks include:

- Mitigation at the source;
  - Increase stack height to allow for additional dilution.
  - Increase stack velocity to promote dispersion.
  - Increase stack temperature to promote dispersion of exhaust gases.
  - Treatment of air emissions before release (e.g. carbon filter, thermal oxidiser, Bag filter etc.).
  - Maintain equipment – regularly inspect and maintain equipment to ensure it is in good working order.

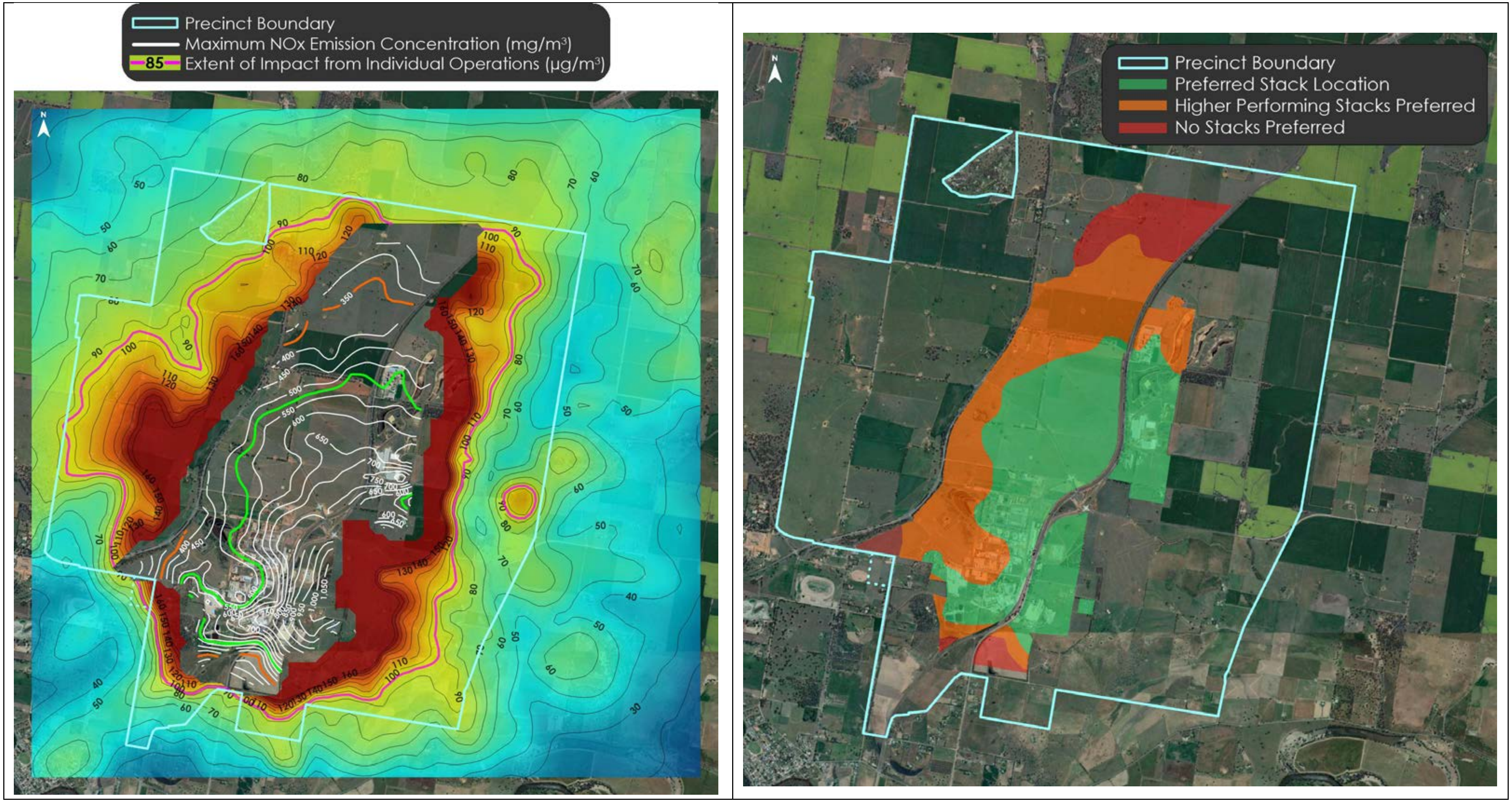

Figure 7-3: Example of Air emissions rate per stack (left) and received air pollutant concentrations (right) due to NO_x emissions from the industrial area

8 REQUIRED BUFFER AREA

The buffer area shown in **Figure 8-1** represents the consolidated noise, odour and air buffer area needed to manage land use conflicts between the industial area and existing receptors outside of the precinct boundary.

As can be seen the buffer comes close to the edges of the precinct boundary, however it is wrong to interpret the buffer as just that needed for the maximum extension of the industial area. For example, there are also parallel limitations on the amount of emissions that can be generated from any lot within the industrial area so as to limit the spatial extent of individual and cumulative impacts from industry. The required buffer area and the allotment of noise and odour emissions go hand –in-hand and cannot be seperated; both are necesessary to manage potential land use concflicts.

The buffer extends beyond the precinct boundary in a small area to the southwest. As excessive potential land-use conflict in this small area cannot be reasonably resolved whilst also maintaining a viable precinct, it is recommended to adjust the precinct boundary as shown by the dashed blue line in the figure.

The land within the required buffer area is not suitable for residential use. As detalied further in **Section 8.1** it is recommended that suitable strategies to prevent any new residential use and ideally to also progressively reduce any existing residential use in the buffer area over time be developed.

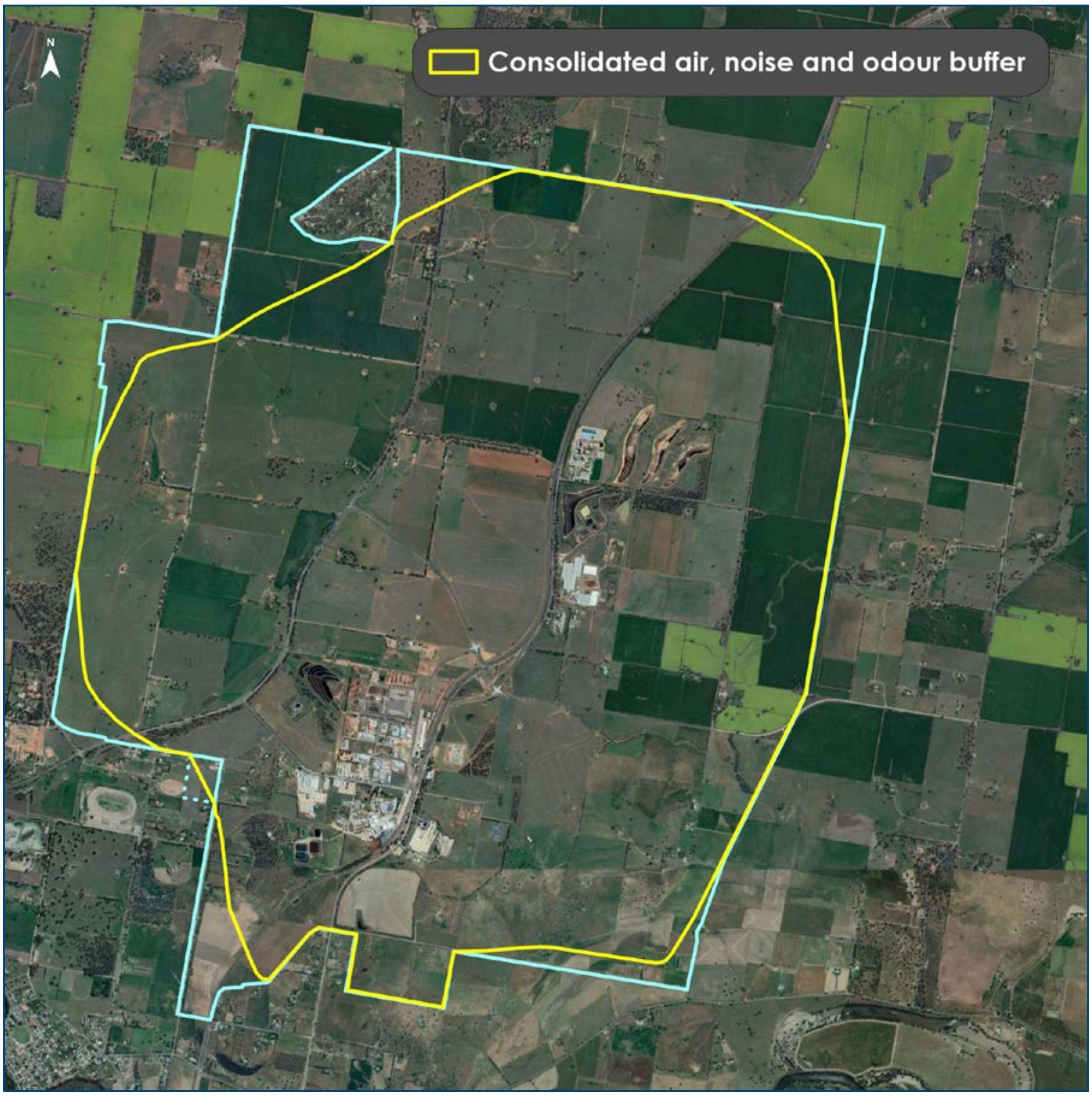

Figure 8-1: Required Buffer Area

8.1 Dwellings within the precinct and required buffer area

There area a number of existing dwellings within the precinct boundary and the required buffer area.

These dwellings are identified in the figure in **Appendix D**, along with a table showing the likely level of noise and odour impact which may arise at each receptor. Note that the impact shown is that for any individual industrial activity.

Thus for example for noise, the criteria for evaluating the scale of potential impacts at these dwellings would be 35 dB(A) (not the cumulative criterion). In general, noise impacts within 3dB(A) above the criterion may be considered acceptable in an existing situation such as this but impacts more than 5dB(A) above the criterion are significant, and generally are considered unacceptable. It is important to note that the impacts presented in this report are for all possible future industrial development being in place and emitting emissions per the allotment level for each parcel of land area. Due to this any actual impacts may not arise for a long time in the future or may not occur at all if a quiet industry (i.e. 5 to 10 or more dB(A) below the noise allotment) locates near to the receptor.

8.2 Residential areas adjacent to the Precinct

As the population density of a location increases, the proportion of sensitive individuals in the area will also increase, in turn increasing the risks of sensitive individuals being adversely impacted by odour and noise. Due to the range in sensitivity to impacts in the population, greater residential use or intensification would be problematic if it occurs in the locations closest to the minimum required buffer area where future impacts may be near to guideline levels.

In addition to the required minimum buffer area shown in **Figure 8-1**, it is recommended to minimise or limit further residential intesification in areas close to the required buffer area. This is necessary to ensure that the projected impacts are not excaebated in the future by residential creep (increased numbers of residential dwellings close to industrial sources).

The majority of land at the edges of the buffer area in **Figure 8-1** is unlikely to be developed for significant additional residential uses. The land that may be within the potential Northern Growth Area to the west of the Precinct will need to be planned and designed to ensure adequate amenity can be achieved in this area. To the south of the Precinct, there are two areas where further subdivision and residential may be permissible under the current planning controls. These areas have been studied in more detail.

The green dashed line shown in **Figure 8-2** is approximately consistent with the 32dBA and 1OU contours presented in the figure (as shown also in **Figure 7-1** and **Figure 7-2** respectively). These levels provide suitable margins relative to the range of adverse impact preceived by sensitive individuals, and thus provide sufficient leeway to significantly reduce the risk of sensitive individuals being impacted. The levels are also sufficient to account for the range of potential differences between the modelled results and the actual emissions output from future industries.

It is noted that odour criteria are calculated as a function of population density and therefore it would be considered good planning practice to not increase population density where impacts may be close to the potential future criteria.

For the areas located outside of the Precinct but within the green line shown in **Figure 7.1** and **Figure 7.2**, it is recommended that the existing planning controls be reviewed, with a view to limiting further residential development in these areas.

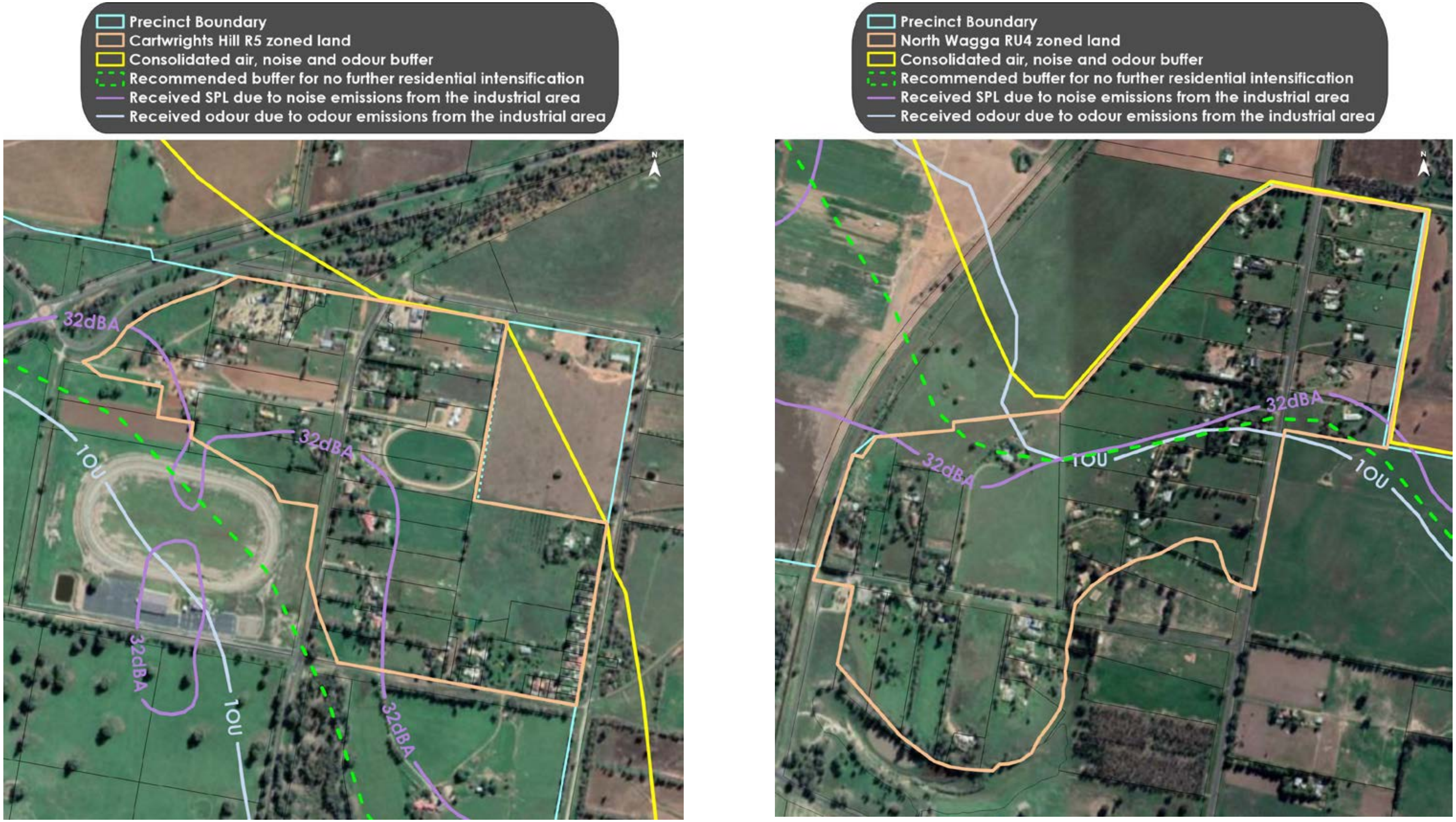

Figure 8-2: Recommended buffer for minimising residential intensification

9 SUGGESTED MONITORING FRAMEWORK

Monitoring can conducted to ensure air, odour and noise impacts are managed within criteria.

A potentially suitable monitoring framework is set out below. The framework is based on establishing a number of unattended monitoring stations at locations along the SAP boundary that are representative of receiver locations and areas between industrial activity and receivers. The monitoring stations would be capable of measuring ambient air quality and noise levels.

Recommended ambient air quality monitoring parameters are summarised in **Table 9-1**. The suggested monitor locations are set out in **Appendix D**.

Table 9-1: Recommended ambient air quality monitoring

Parameter	Averaging period	Criteria	Monitoring method
$PM_{2.5}$	24 hour average	25µg/m³	Continuous real-time monitor
	Annual average	8µg/m³	
PM_{10}	24 hour average	50µg/m³	Continuous real-time monitor
	Annual average	25µg/m³	
NO_2	1 hour average	246µg/m³	Continuous real-time monitor
	Annual average	62µg/m³	
SO_2	1 hour average	570µg/m³	Continuous real-time monitor
	24 hour average	228µg/m³	
	Annual average	60µg/m³	
CO	1 hour average	30mg/m³	Continuous real-time monitor
	Annual average	10mg/m³	
Noise	15 Minute average	40 dB, LAeq.	Continuous real-time monitor
Meteorological	5,10 and 15-minute	n. A.-	Refer to separate table in **Appendix D**.

Annual monitoring reports should be conducted to assess the trends in pollutant and noise levels over time as a means of evaluating the overall performance of the SAP compared with relevant guidelines.

The suggested monitor type for this are any of the semi-portable, solar powered units, in the price range of $50,000 to $80,000 each. These units allow scope to progressively re-locate the monitor as more industry is developed or to re-locate it away from areas that become unsuitable over time (e.g. a livestock dust bathing wallow forms nearby, or nearby trees grow and begin to generate excessive pollens which interfere with readings).

This type of monitoring however is not suitable for direct compliance assessment of noise and odour emissions because there are no instruments which can do this reliably at present. (However, it is noted that progress is being made with directional noise monitors).

Expert attended monitoring is thus necessary for any compliance assessment of noise and odour emissions.

9.1.1 Noise – attended

The framework for the SAP allows for more efficient monitoring at the source as opposed to the current regulatory framework where conducting an assessment at a receiver can make it difficult or impossible to isolate the noise contribution from a specific operation. However, where cumulative levels are within criteria at a receiver, there is no pressing need to conduct compliance monitoring at the source(s). The unattended continuous monitors serve to identify trends and the need for any attended monitoring.

Thus it is suggested that initially four, quarterly attended noise surveys are carried out over a 12 month period, thereafter followed by annual surveys. Where the continuous monitoring indicates increasing noise levels at or above the cumulative criteria of 40 dB(A), more frequent attended monitoring may be warranted to identify the issue and determine what (if any) action may be needed.

Attended measurement of noise should be conducted at the edge of the precinct boundary near receptors to evaluate whether the noise is due to industry or other sources such as traffic or insects etc. This should also be done at selected operations (e.g. on-site or at the site boundary) to determine the total site sound power level and compare it with the allowance for the specific parcel of land.

9.1.2 Odour – attended

As for noise, attended measurement of odour should be conducted at the edge of the precinct boundary near receptors to evaluate whether there is odour present due to industry or other sources. An odour survey based on the German/ European field olfactometry methods should be conducted over a sufficient number of days to ensure likely worst case weather conditions are considered.

Odour sampling of sources at a site can also be conducted (however this is relatively involved and requires operator co-operation) to determine the total site odour emission rate and compare this with the allowance for the specific parcel of land.

9.1.3 Air - attended

Routine stack testing is suitable for compliance assessment of specific industries, as would normally be done. The pollutants measured and their sampling frequency should be based on the normal evaluation of likely risk and consequence for the specific operation. This is exactly per the existing framework used to manage air quality from industrial activities.

We suggest however that for the SAP, monitoring of air pollutants for the purpose of trend analysis be conducted as per **Section 9**. This can be used to identify any significant change in industrial emissions, For example, should there be some plant failure, the continuous monitors are likely to identify any significant increase in pollutants and would alert industries and the regulator that there may be a problem which requires attention (rather than waiting for the next stack test).

9.2 Other potential management systems

It is possible, but does not appear necessary, to utilise predictive or real-time systems for management of dust, odour and air emissions. These systems are best suited to industries that have capacity and discretion to conduct activities at the least impacting times or to cease or delay certain activities; for example a blast at a mine, or batching of hot-mix or asphalt products, maintenance of odorous plant, turning of windrows, etc. This would only appear to apply to a limited number of industries in this area and thus such emissions may be reasonably managed by reference to normal, widely available weather forecasts and real-time data from a weather station.

This highlights the need to install a weather station in the SAP area. It is suggested to locate the weather station centrally in the industrial area or near to it, preferably on more elevated ground and away from any tall trees, buildings etc. that may obstruct wind flows. The appropriate siting and instrument specifications are set out in the table in **Appendix D**. The approximate cost to install a suitable weather station would be $24,000 to $28,000.

10 CONCLUSIONS

The study found that it is possible to recommend appropriate noise and odour allocations per lot area, that if followed, would limit scope for individual and cumulative noise and odour impacts outside of the nominal precinct boundary (or more precisely the specified buffer zone area).

Appropriate allocations for both noise (sound power) and odour (odour emission rate) per hectare have been made in this study. These allocations can be applied in planning instruments and used in the approvals process for any new and expanded industries.

However, it was not viable to make specific allowances for air emissions, given that there can be hundreds of different air pollutants with hundreds of different criteria. However, some guidence is provided in this regard to assist both applicants and approval bodies in minimising impacts and cost burdens on new and expanded industries.

Monitoring can be used check on and maintain complaince with air, odour and noise criteria. Suggestions for a suitable framework are set out in this report. The framework comprises four unattended monitors and a weather station and is augmented with periodic attended monitoring.

The frame work uses the unattended monitoring for trend analysis only. This means that relatively low-cost solar powered instruments can be used. Due to this, the instruments can be re-located relatively easily and can thus respond to any increases in industrial uses or varying site conditions.

The allotment of appropriate noise and odour emissions per lot area, means that direct attended measurements of noise and odour can be made at a site to evaluate compliance, similarly to how stack testing may be done for stack sources. Presently, odour and noise impacts due to a single operation are generally evaluated at a receptor, which in some cases can be dificult or near to impossible to do reliably. The regulatory framework does however permit alternative standards (as proposed here) and in this case it means that compliance can be measured accurately, in a short time and under a very wide ranage of weather conditions and times, making complaince evaluation for both operators and regulators more efficient and reliable. The proposed approach for the SAP is expected to provide more certainty to operators, regulators and the community alike and also provide a framework for managing total cumulative impacts and a more rapid means to identify any problematic operations.

The allotment of noise and odour emissions goes hand-in-hand with the required buffer area. The required buffer area is necessary for industry to be able to operate without causing undue impact on receivers. The land within the required buffer area is therefore not suitable for residential use. It is recommended to develop sutable strategies to prevent any new residential use and ideally to also progressively reduce any existing residential use in the buffer area over time. The report provides information to assist in developing such strategies.

11 REFERENCES

Acoustic Logic (2018)

"585-649 Mamre Road, Orchard Hills Operational Noise Assessment – Lot 7 (Snack Brands)", prepared by Acoustic Logic July 2018

Atkins (2008)

"Noise Planning Assessment Industrial Land Study Bomen, Wagga Wagga" Prepared by Atkins Acoustics and Associates Pty Ltd. on behalf of Willana Associates, February 2008.

CEE (2015)

"Environmental Assessment Biofilter Teys Australia Bomen Beef Processing Facility", Prepared by Claus Environmental Engineering on behalf of Teys Australia, October 2015.

HLA (2002)

"Bomen Abattoir Expansion Proposal Environmental Impact Statement", Prepared by HLA Envirosciences Pty Limited on behalf of Cargill Foods Australia, July 2002.

GHD (2016)

"Yammatree Family Trust Fairview Park Estate Noise Impact Assessment", Prepared by GHD on behalf of Yammatree Family Trust, March 2016.

GHD (2018)

"Enirgi Power Storage Recycling Consolidation Project Environmental Impact Statement Appendix H Noise Impact Assessment", Prepared by GHD, July 2018.

Katestone Environmental (2014)

"Rutherford Odour Investigation – Part 2 – Modelling Program", prepared for NSW Environmental Protection Authority by Katestone Environmental, February 2014.

NSW EPA (2016)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, December 2016.

NSW EPA (2017)

"Noise Policy for Industry", NSW Environment Protection Authority, October 2017.

Renzo Tonin & Associates (2018)

"Asics Facility, Darling Street, Sydney Business Park, Marsden Park", prepared for Sydney Business Park by Renzo Tonin & Associates, March 2018.

SLR (2018)

"Enfield Intermodal Logistics Centre Noise and Vibration Impact Assessment MOD 14", prepared for Goodman Property Services (Aust) Pty Limited by SLR, January 2018.

SLR (2018)

"Oakdale South Estate Lot 5A DHL DA Noise Impact Assessment", prepared for Goodman Property Services (Aust) Pty Limited by SLR, May 2018.

Todoroski Air Sciences (2016)

"Air Quality Assessment Organic Waste Processing and Composting Facility, Howlong NSW", prepared for Cleanaway Waste Management by Todoroski Air Sciences, November 2016.

Todoroski Air Sciences (2019)

"Air Quality Impact Assessment Advanced Organics Recycling Facility, Tamworth NSW", prepared for Tamworth Regional Council by Todoroski Air Sciences, September 2019.

The Odour Unit (2001)

"Odour Assessment and Control Study Wagga Wagga Abattoir", prepared for Cargill Foods Australia by the Odour Unit, August 2001

TRC Environmental Corporation (2011)

"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

Wilkinson Murray (2016)

"MPE Stage 2 Noise & Vibration Impact Assessment", prepared for Arcadis by Wilkinson Murray, December 2016.

Wilkinson Murray (2017)

"Botany Concrete Batching Plant Upgrade Noise and Vibration Impact Assessment", prepared for Element Environment by Wilkinson Murray, November 2017.

12 GLOSSARY

ABL	Assessment background level. The single-figure background level representing each assessment period: day, evening and night (that is, three assessment background levels are determined for each 24-hour period of the monitoring period).
Background levels	Existing concentration of pollutants in the ambient air.
CALPUFF	A multi-layer, multi-species, non-steady state Gaussian puff dispersion model that is able to simulate the effects of time- and space-varying meteorological conditions on pollutant transport.
dB	Decibel. A measure of sound level. The decibel is a logarithmic way of describing a ratio. The ratio may be power, sound pressure, voltage, intensity or other parameters. In the case of sound pressure, it is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure squared to a reference sound pressure squared.
dBA	A-weighted decibel. Unit used to measure 'A-weighted' sound pressure levels. A-weighting is an adjustment made to sound-level measurement to approximate the response of the human ear.
Diffuse source	Activities that are generally dominated by fugitive area or volume-source emissions, which can be relatively difficult to control.
Dispersion modelling	Modelling by computer to mathematically simulate the effect on plume dispersion under varying atmospheric conditions; used to calculate spatial and temporal fields of concentrations and particle deposition due to emissions from various source types.
ENM	Environmental noise model
EPL	Environmental protection licence
H_2S	Hydrogen sulfide
Incremental impact	The impact due to an emission source (or group of sources) in isolation, i.e. without including background levels.
L_{A1}	The A-weighted noise level which is exceeded for 1% of the sampling period.
L_{A10}	The A-weighted noise level which is exceeded for 10% of the sampling period.
L_{A90}	The A-weighted noise level which is exceeded for 90% of the sampling period.
L_{Aeq}	The equivalent continuous A-weighted sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment.

µg	Mass in micrograms.
m^3	Volume in cubic metres.
NO_2	Nitrogen dioxide.
NO_x	Oxides of nitrogen, including NO and NO_2.
PM_{10}	Particulate matter less than 10 µm in aerodynamic equivalent diameter.
$PM_{2.5}$	Particulate matter less than 2.5 µm in aerodynamic equivalent diameter.
Point source	Source of emissions, generally a stack. Emissions can generally be relatively easily controlled by using waste reduction, waste minimisation and cleaner production principles or conventional emission control equipment
SAP	Wagga Wagga Special Activation Precinct
Sensitive receptor	A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.
SO_2	Sulfur dioxide
SO_3	Sulfur trioxide
Stack	A vertical pipe used to vent pollutants from a process
TAPM	CSRIO's PC-based, 3-D prognostic model for air pollution studies.
Total impact	The total impact of an emission source (or group of sources) and existing ambient levels of a pollutant; i.e. the total impact is equal to background levels plus the incremental impact.
VOCs	Volatile organic compounds

Appendix A
Dispersion Modelling Approach

Dispersion Modelling approach

Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach.

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The CALPUFF model is an advanced "puff" model that can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three dimensional, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation (TRC)**, **2011**).

Modelling methodology

Modelling was undertaken using a combination of The Air Pollution Model (TAPM) and the CALPUFF Modelling System. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for 3D simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a 3D gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the 3D meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

Meteorological modelling

TAPM was applied to the available data to generate a 3D upper air data file for use in CALMET. The centre of analysis for TAPM was 35deg3min south and 147deg24.5min east. The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

The CALMET domain was run on a 10 x 10km area with 0.1km grid resolution. The available meteorological data for the 2016 calendar year from two surrounding meteorological monitoring sites were included in this run. **Table A-1** outlines the parameters used from each station.

Table A-1: Surface observation stations

Weather stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Wagga Wagga AMO (BoM) (Station No. 072150)	✓	✓	✓	✓	✓	✓	✓
Wagga Wagga Nth (NSW OEH)	✓	✓			✓	✓	✓

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = station level pressure

Local land use and detailed topographical information was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as seen in **Figure A-1**.

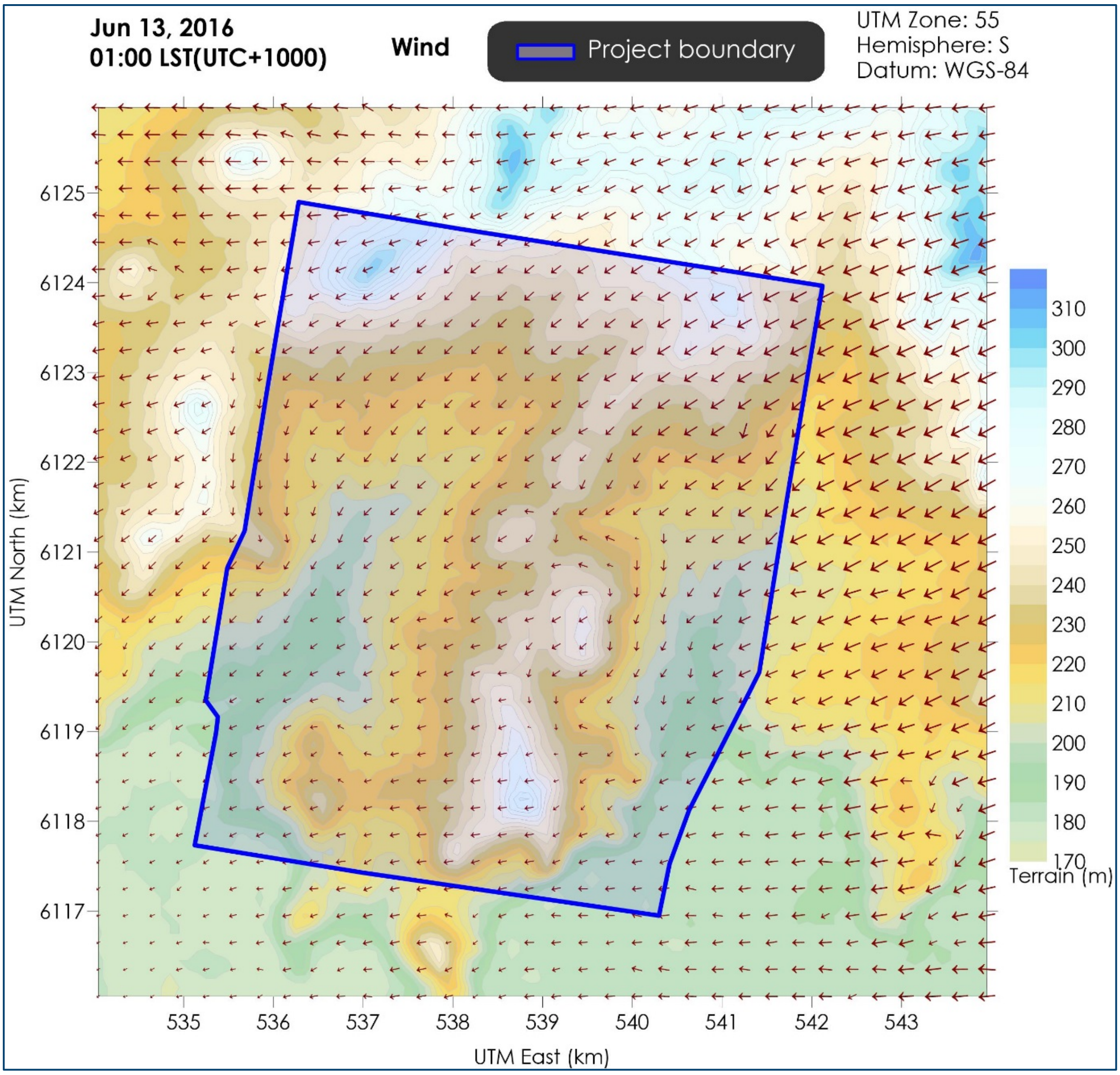

Figure A-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure A-2** and **Figure A-3**.

Figure A-2 presents the annual and seasonal windroses from the CALMET data. On an annual basis, winds tend to flow on a northeast and north-northeast to west-northwest and west-southwest axis. The wind distributions in summer consist of winds from the east and east-northeast and the southwest and west-southwest sectors. The autumn distribution is dominated by winds from the northeast. The most frequent winds in winter come from the west-northwest and west. In spring, the winds are predominantly from the west-southwest.

Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. **Figure A-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.

Figure A-2: Annual and seasonal windroses from CALMET (cell ref 5050)

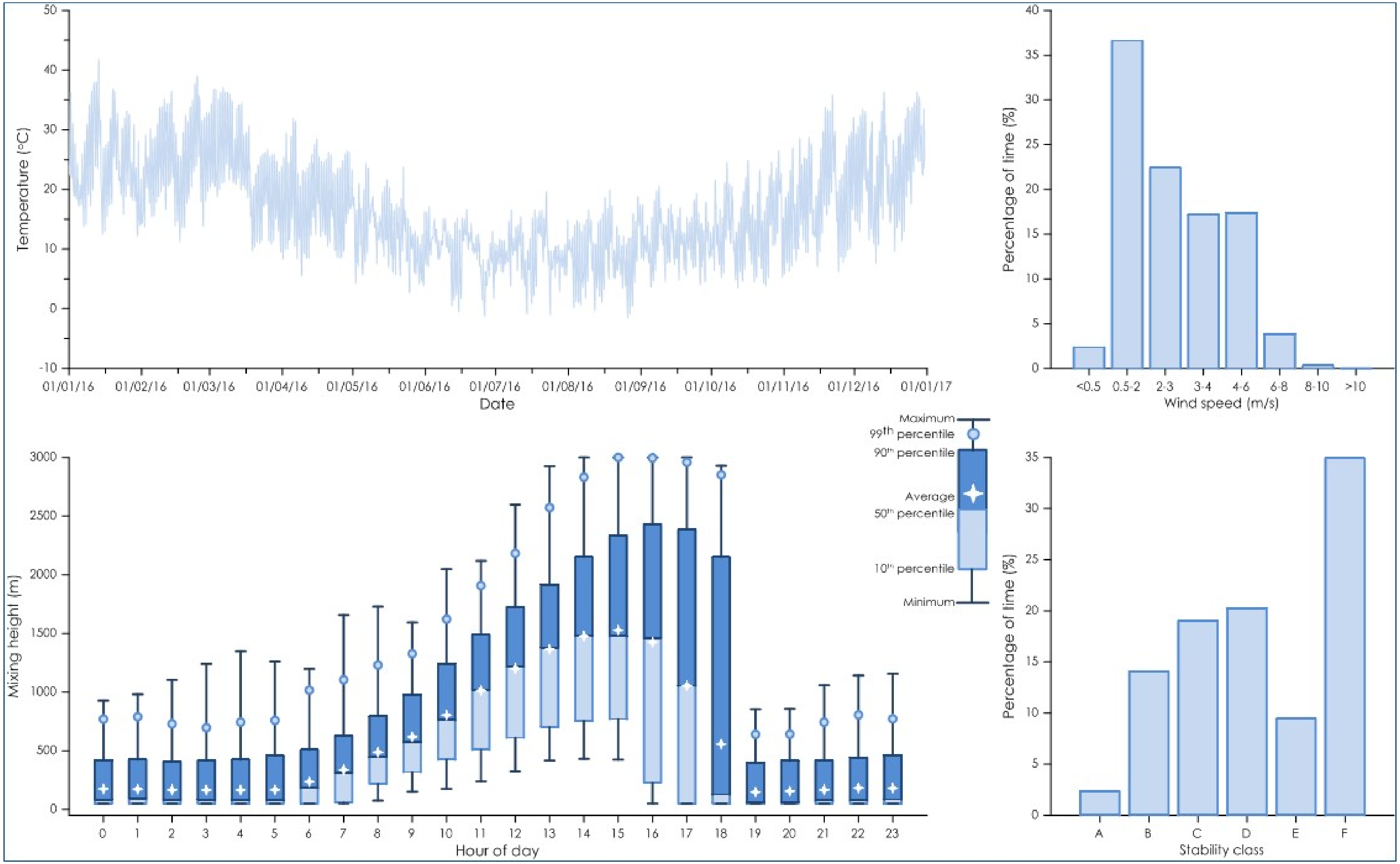

Figure A-3: Meteorological analysis CALMET (cell ref 5050)

Appendix B

Previous Bomen Industrial Estate Modelling Results

Previous Bomen Industrial Estate modelling

Each source was modelled separately as a stack source and as a volume source with emission release parameters that would represent relatively standard sources associated with industrial activities.

These sources were modelled over the entire year and are assumed to emit air emissions continuously using a unit odour emission rate. The emissions were modelled for only the key pollutants with scope to exceed EPA criteria. A relative scaling was made to account for differences between pollutants, allowing risk to be shown on a like-for like basis, irrespective of the pollutant emitted.

Figure B-1 presents the modelled source and receptors locations.

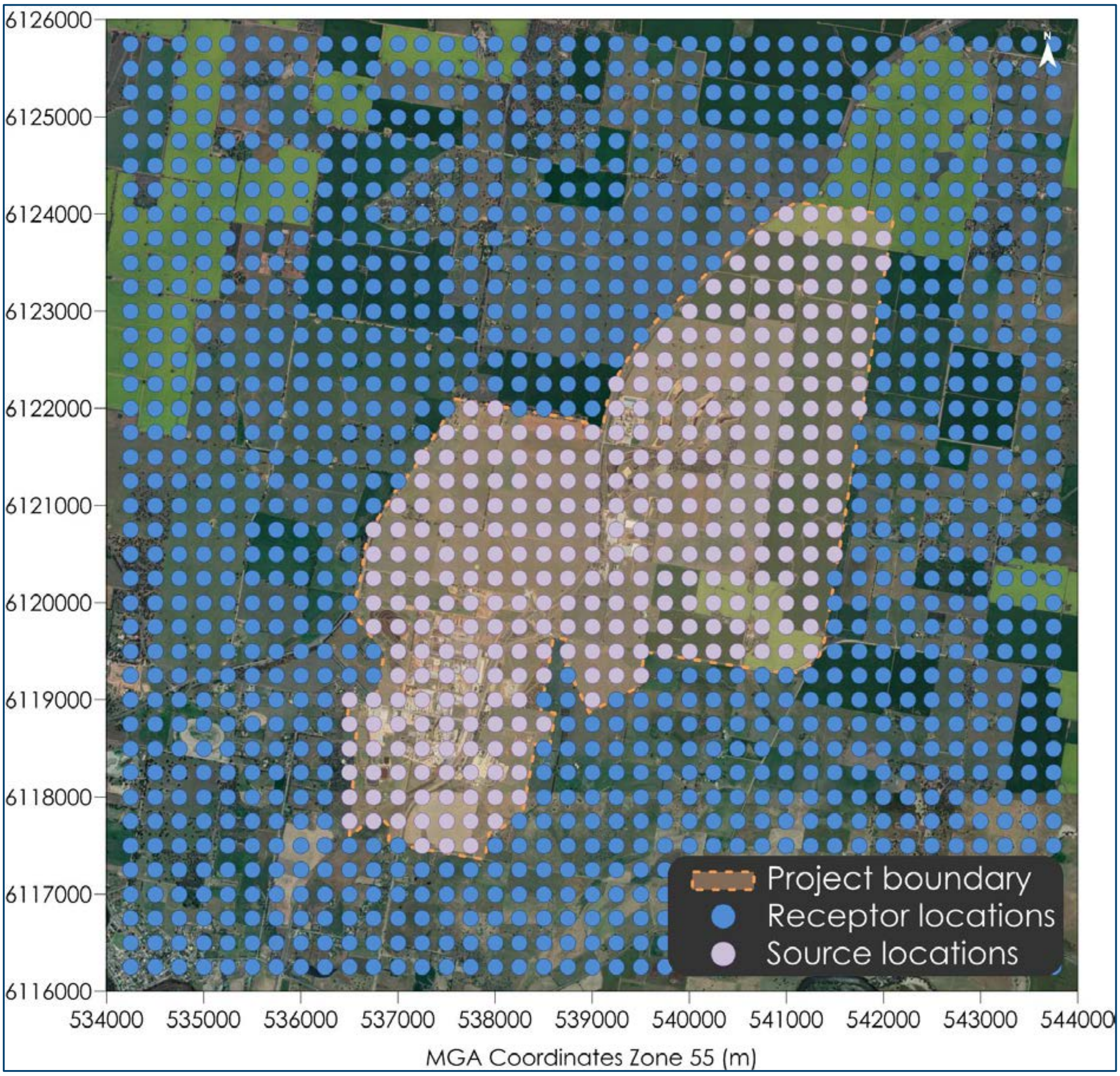

Figure B-1: Modelling setup

Dispersion Modelling Results

The results of the analyses completed are presented in the following section. The results are plotted spatially in **Figure B-2** to **Figure B-8**. The figures present the 99th percentile 1-hour average result for each source. The colour shading outside of the BIE shows the risk of potential impact upon receptors, and the colour shading inside the BIE shows the risk of a source causing impact upon receptors outside of the BIE. The modelling work allowed the development of a setback buffer area, within which receptors were removed, reducing the risk of land use conflict. Its aim was to have no areas of medium or high risk of impact inside and outside the BIE.

Figure B-2 presents the results for only volume sources and, as expected shows that potential future residential areas located along the boundary of the BIE would have the greatest potential for air quality and odour risk impacts from sources inside the BIE. (Note that noise impacts would be within those for air quality). As expected, the results also show that industrial sources closer to the BIE boundary have most risk of causing impact outside the boundary.

The corresponding result, but for only stack sources, is shown in **Figure B-4**. Relative to the volume sources, the stack sources result in a different spatial risk profile, due to the additional dispersion which arises via stacks. Whilst impacting the nearest receptors along the BIE boundary, the stack sources also have additional impact upon the areas of elevated terrain near the BIE.

To minimise potential impacts, an initial setback distance from the BIE was introduced into the modelling to evaluate the amelioration it would provide in potential impacts, and hence future land use conflicts. It was considered that development of potential high density residential land use concurrent with high impacting industry in the north eastern parts of the study area was unlikely, at least in the near future, thus a medium risk of impacts was considered appropriate. The effect of the initial setback buffer for mitigating impacts due only to the volume sources is shown in **Figure B-3**.

Due to the greater impacts caused by stack sources upon elevated terrain in the surrounding areas, this initial setback was too small to mitigate impacts from stack sources.

Two potential scenarios are considered which include: consideration of high-risk locations within the BIE and amending the initial setback buffer to cover the impact caused by stack sources.

Figure B-7 presents an initial setback buffer for mitigating impacts due only to the stack sources similar to the initial setback buffer for volume sources. Some parts of the industrial area would be high-risk locations at which to operate the types of industries which require a significant stack, thus suggested stack exclusion areas within the industrial area were modelled. These areas would be better suited for warehousing and other such low polluting activities. **Figure B-8** presents the effect of a suggested "no stack zone" within the BIE and relative to **Figure B-7**, shows a significant reduction in the risk of impacts in the elevated locations in the surrounding area.

The initial setback buffer for the volume sources was extended to cover the additional areas of moderate and high impact due to typical stack sources, as shown in **Figure B-7** and shows the reduction in the risk of impacts in the elevated locations in the surrounding areas.

Both scenarios indicate suitable options to mitigate impacts due to potential stack sources within the BIE.

Based on this analysis, the future planning of the BIE should consider adopting a similar set-back buffer for new residential receptors, allowing the existing industrial areas to be developed reasonably, without undue impact.

Please note that there is some "waviness" in the setback line due to the regular grid pattern in the modelling. A refined setback line to remove such waviness, and which is amenable for use in planning instruments was developed. **Figure B-8** presents the final recommended planning setback or buffer line. Minor changes to this line (e.g. changing the setback distance by approximately 10%), for example to make it better align with roads, intersections, easements, ridgelines, creeks etc. would be reasonable.

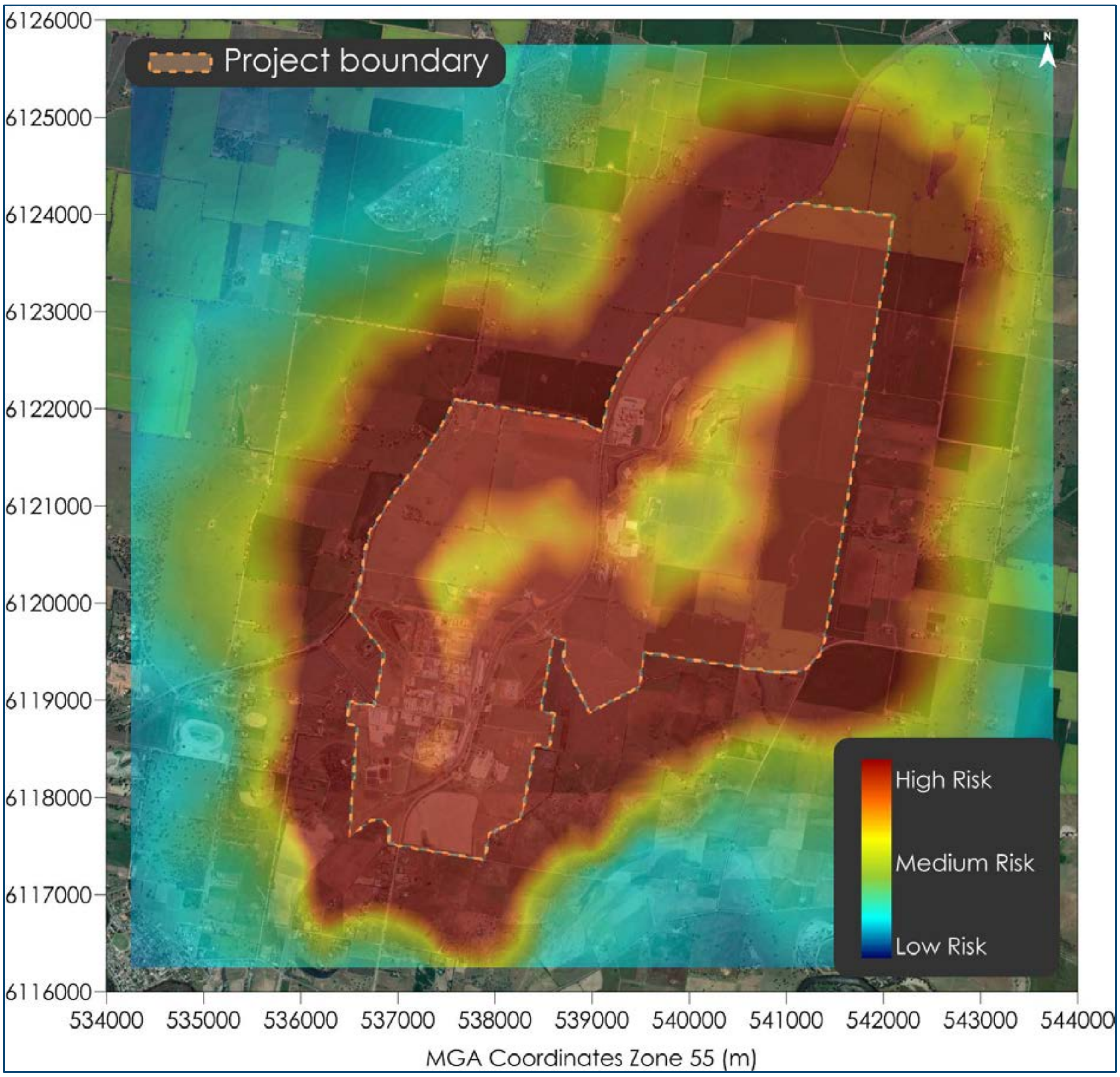

Figure B-2: Predicted risk areas for volume sources (all receptors at ground level, no setback)

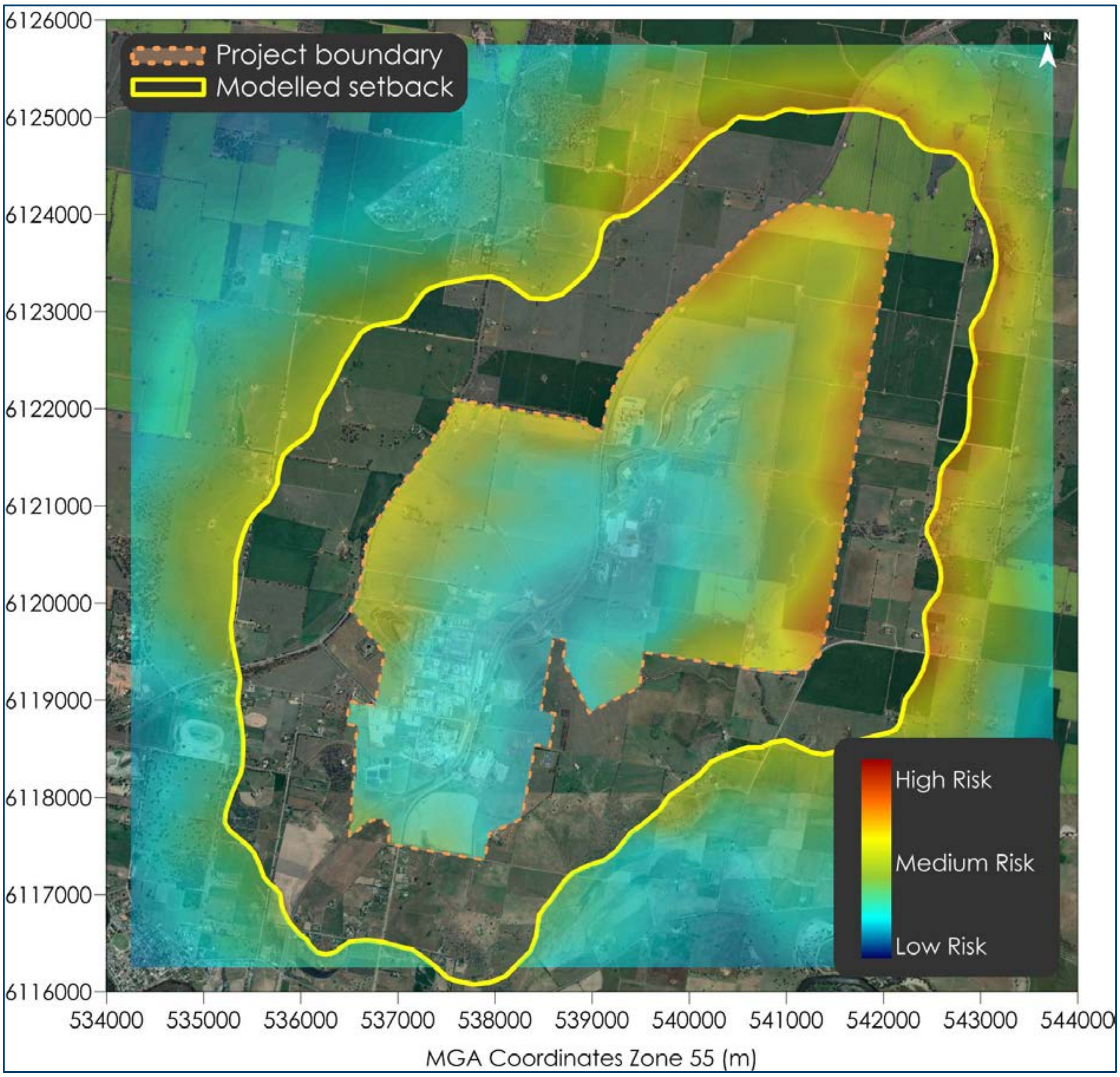

Figure B-3: Predicted risk areas for volume sources (setback receptors at ground level)

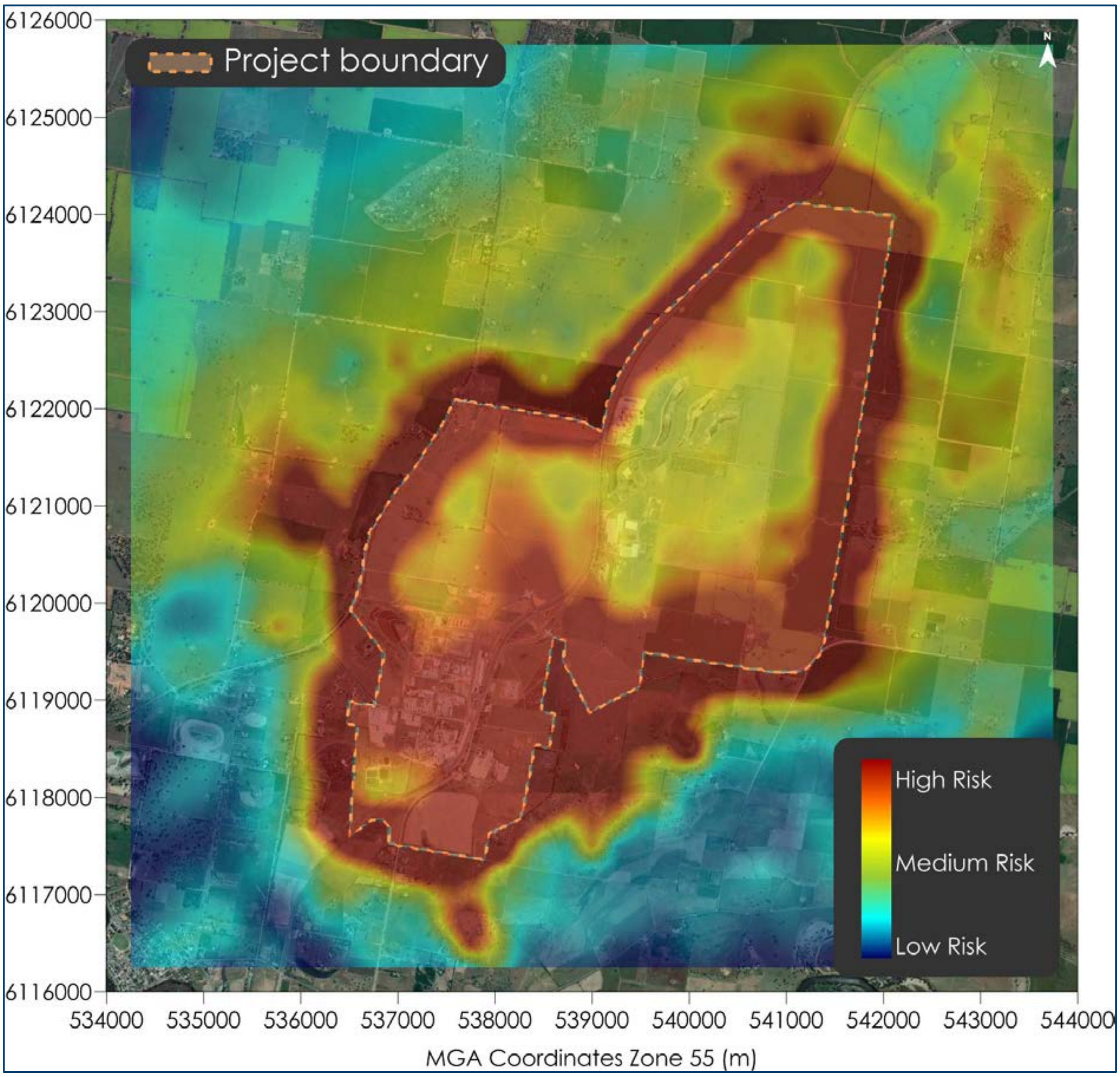

Figure B-4: Predicted risk areas for stack sources (all receptors at ground level, no setback)

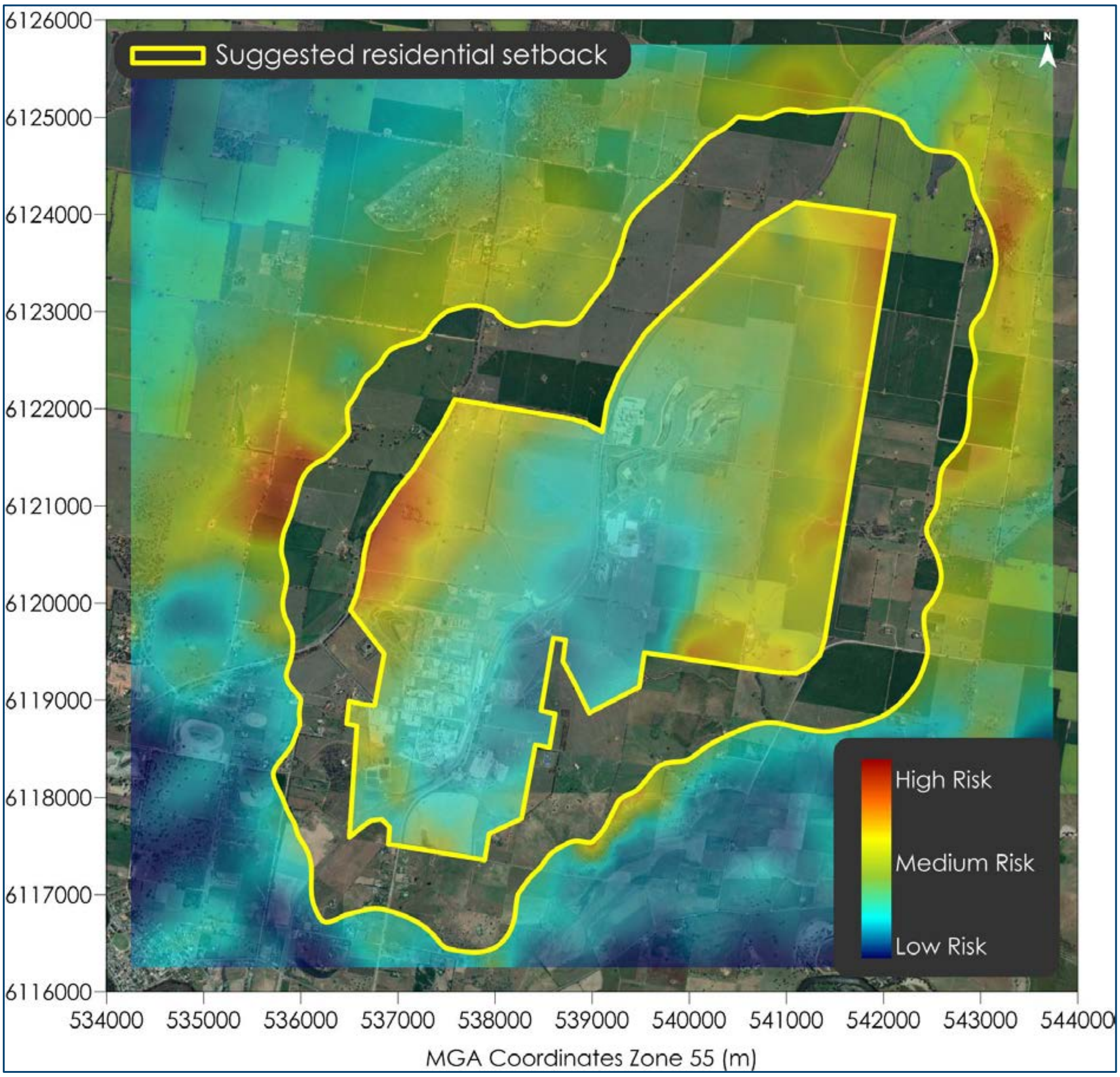

Figure B-5: Predicted risk areas for stack sources (setback receptors at ground level)

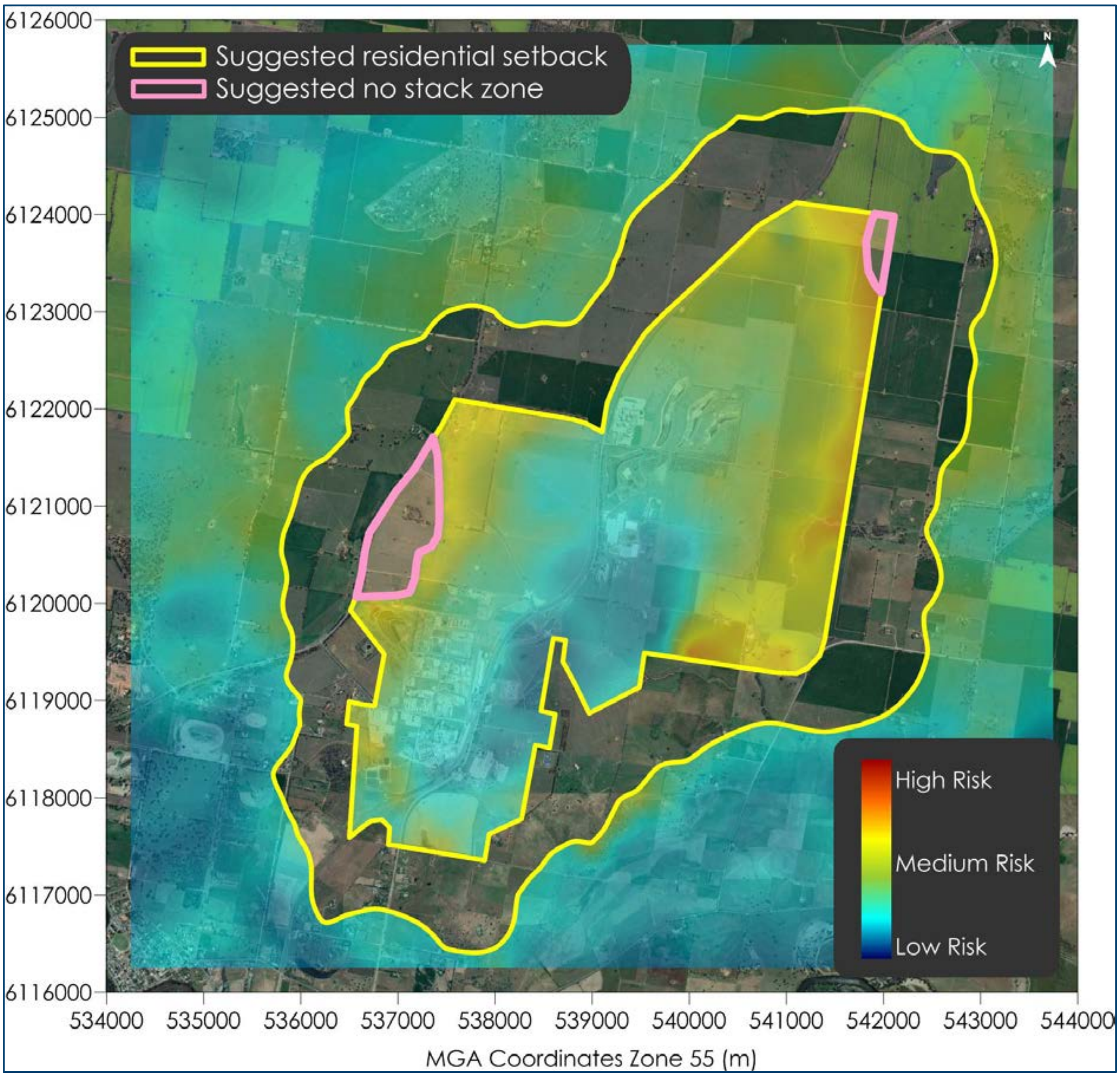

Figure B-6: Predicted risk areas for stack sources (setback receptors at ground level and no stack zone)

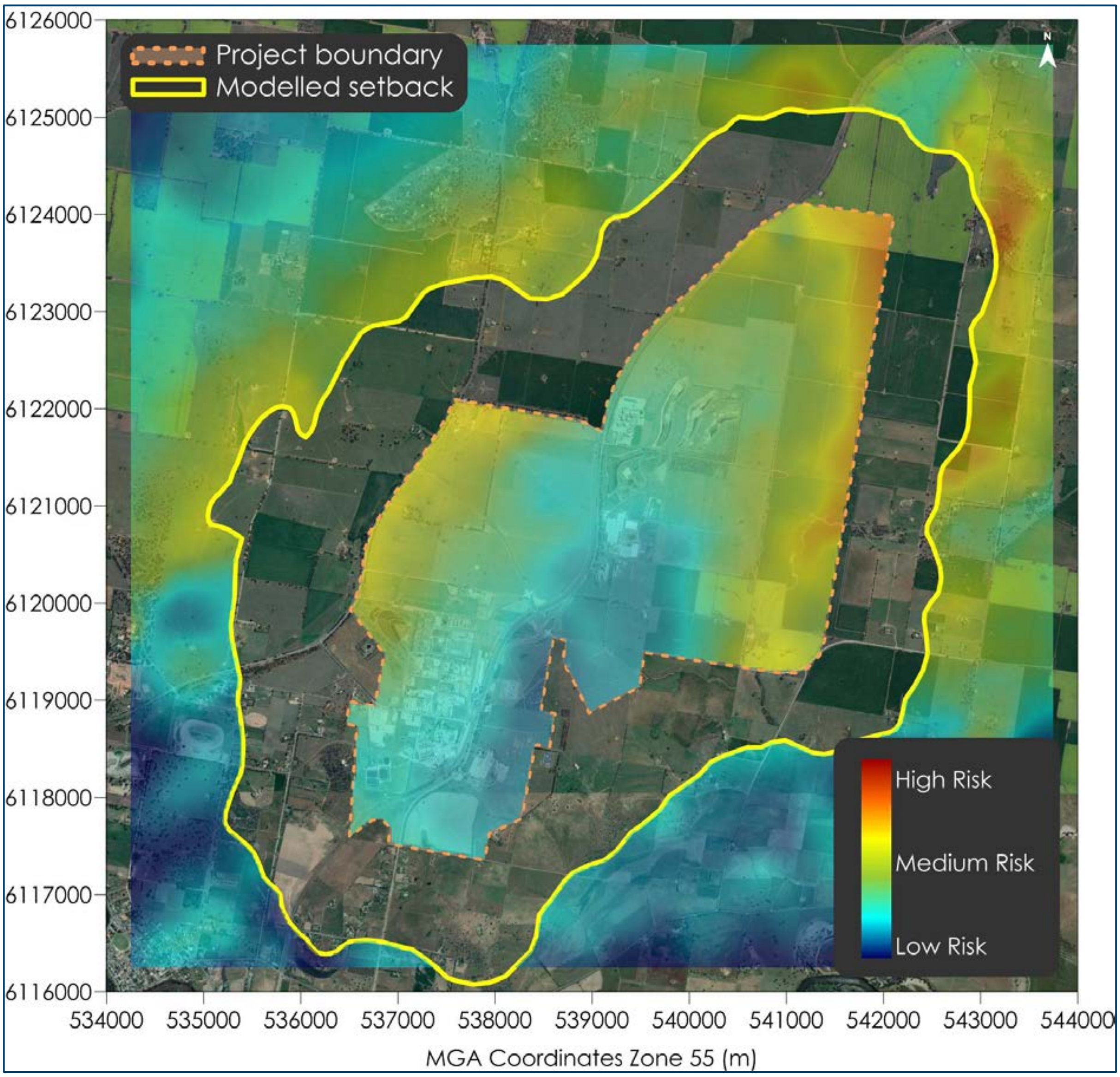

Figure B-7: Predicted risk areas for stack sources (setback receptors at ground level)

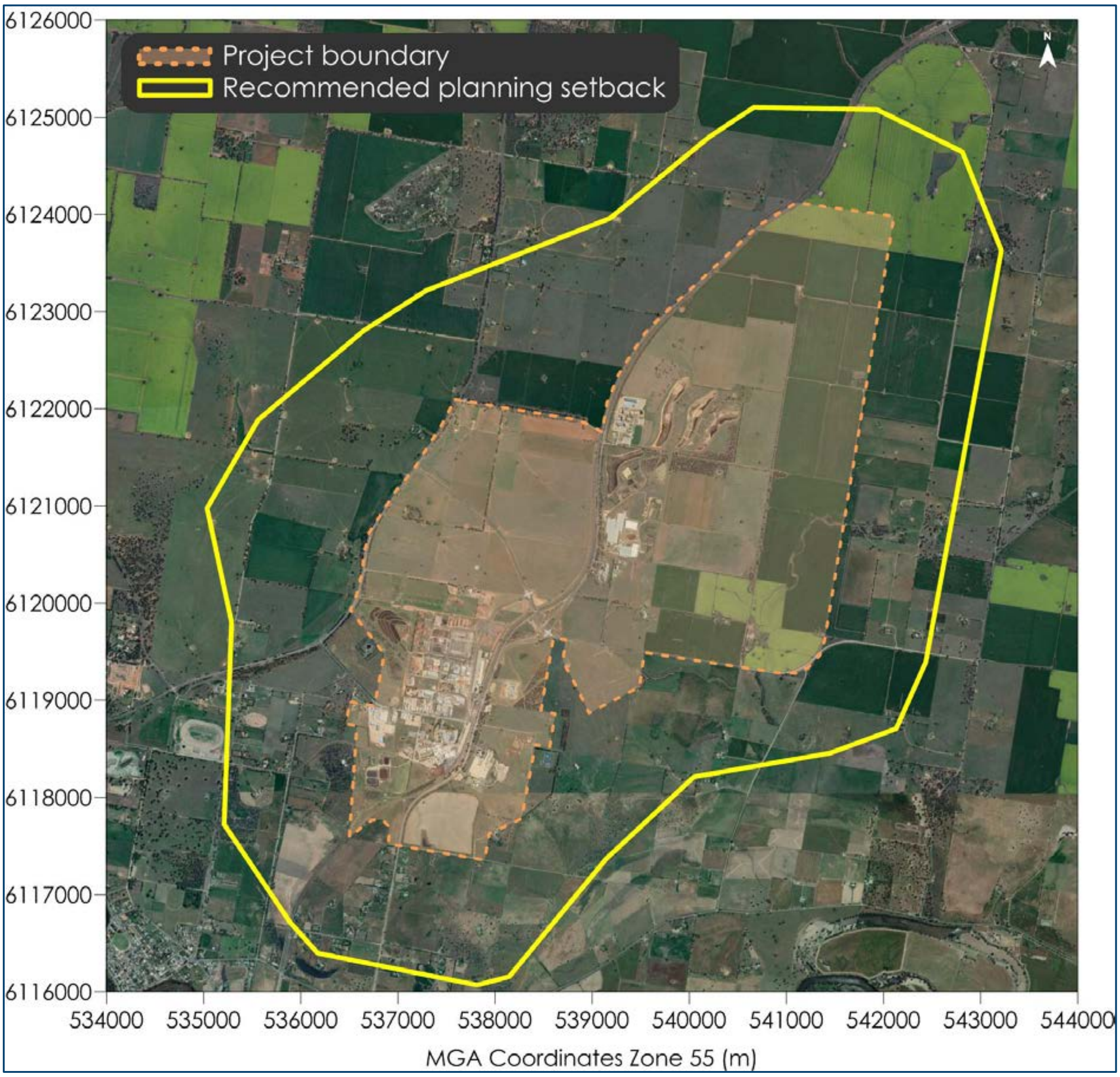

Figure B-8: Recommended planning setback for the BIE

Appendix C

Examples of sound Power and odour emission rates per hectare for industries

Sound power levels per hectare for various industries are shown in the table below.

Table C-1: Sound power levels per hectare for various industries

Enirgi Battery Recycling (GHD, 2018)	PWL (dB(A))
Air compressor	106
Boiler	102
Casting machine	98
Centrifuge	95
Condenser	109
Crystalliser/pump	94
Forklift	99
Furnace	105
Furnace	118
Hammer mill chute	110
Hot air generator	93
Salt sib stack fan	107
Scrubber stack fan	98
Stack fan	101
Tanker	88
Vibrating screen	107
Water cooler	93
Bagger	83
Classifier	81
Friction dryer	83
Plastics granulator	85
Waste tank with loading hopper	82
Total	**120**
Area (ha)	51
PWL/ha	**103**
Riverina Oils and BioEnergy (Heggies, 2010)	**PWL (dB(A))**
Bucket elevator (grains silos to crushing unit)	93
Crushing unit	110
Extraction plant	110
Refinery	104
Front End Loader (Meal Storage Shed)	102
Product Truck loading	99
Product Truck loading	99
Product Truck manoeuvre	99
Product Truck manoeuvre	99
Induced Draft Fans	96
Induced Draft Fans	96
Induced Draft Fans	96
Total	**115**
Area (ha)	16
PWL/ha	103
Moorebank Precinct East - Stage 2 (Wilkinson Murray, 2016)	**PWL (dB(A))**
Reach stacker	106
Truck idling	95
Truck travelling at 10km	103
Locomotive idling	100
Locomotive travelling at 10km	106
Locomotive Shifter	95

Car travelling at 40km	91
Truck idling	95
Truck travelling at 10km	103
Truck travelling at 40km	106
Total	**113**
Area (ha)	80
PWL/ha	**94**
Enfield Intermodal (SLR, 2018)	**PWL (dB(A))**
Large truck	102
Small truck	102
Truck idling	97
Reach stacker	106
Metal clangs	84
Commercial power washer	94
Forklifts	99
Train idling	100
Slow moving train	100
Train refuelling	97
Air condenser unit	60
Exhaust fan	62
Total	**111**
Area (ha)	34
PWL/ha	**95**
Botany CBP (Wilkinson Murray, 2017)	**PWL (dB(A))**
Agitator trucks	98
Aggregate truck unloading	99
Cement tanker unloading	104
Underground hopper	100
Silo bin and hopper	99
Total	**107**
Area (ha)	0.5
PWL/ha	**111**
Queanbeyan Transfer Station (Wilkinson Murray, 2014)	**PWL (dB(A))**
Truck movement	95
Truck movement	95
Truck movement	95
Light vehicle movement	91
Light vehicle movement	91
Light vehicle movement	91
Light vehicle movement	91
Light vehicle movement	91
Light vehicle movement	91
Transfer station	85
Total	**102**
Area (ha)	1.5
PWL/ha	**101**
Asics Facility (Renzo Tonin, 2018)	**PWL (dB(A))**
Warehouse	75
Semi/ B double movement	106
Semi/ B double idling	95
Forklift	90
Total	**106**

Area (ha)	5
PWL/ha	**99**
Lot 7 (Snack Brands) (Acoustic Logic, 2018)	**PWL (dB(A))**
Warehouse	75
Semi/ B double movement	105
Semi/ B double movement	105
Forklift	94
Total	**108**
Area (ha)	46
PWL/ha	**92**
Lot 5A DHL (SLR, 2018)	**PWL (dB(A))**
Heavy vehicle	103
Heavy vehicle	103
Forklift	93
Forklift	93
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Light vehicle	96
Total	**110**
Area (ha)	5
PWL/ha	**103**

The following table presents odour emission rates per hectare for various industries.

Table C-2: Odour emission rates per hectare for various industries

Industry	Source	TOER	Area (ha)	Estimated OER/Ha
Atlantic Pacific Foods	Katestone Environmental (2014)	143,000	4.1	34,878
Australian Waste Oil Refineries	Katestone Environmental (2014)	6,400	1.6	4,129
Biodiesel Industries Australia	Katestone Environmental (2014)	535	0.2	2,229
National Ceramic Industries Australia	Katestone Environmental (2014)	35,000	15.0	2,333
Transpacific Refineries	Katestone Environmental (2014)	8,360	5.7	1,467
Treloar	Katestone Environmental (2014)	577	1.9	304
Wax Converters Textiles	Katestone Environmental (2014)	26,900	2.0	13,450
Tamworth Compost Facility	Todoroski Air Sciences (2019)	60,138	8.0	7,527
Howlong Compost Facility	Todoroski Air Sciences (2016)	17,631	8.7	2,027
Cootamundra Waste Management Facility	Todoroski Air Sciences (2019)	28,087	5.4	5,170
Cootamundra Waste Water Treatment Facility	Todoroski Air Sciences (2019)	13,937	3.2	4,421
Howlong Landfill	Todoroski Air Sciences (2016)	4,740	3.9	1,215
Howlong Sewage Treatment Facility	Todoroski Air Sciences (2016)	18,110	24.0	755
Cargill Abattoir	The Odour Unit (2001)	191,500	50.0	3,830

Appendix D

Location of dwellings within Precinct boundary and indicative compliance monitoring sites

Figure D-1: Location of dwellings within the Precinct boundary

Table D-1: Location, noise and odour effects for dwellings within the Precinct boundary

x (m)	y (m)	ID	Type	Noise level (dBA)	Odour concentration (OU)
538244	6123809	1	Dwelling	40.1	3.2
538288	6123493	5	Dwelling	47.3	8.4
540367	6119797	22	Dwelling	43.9	3.8
540277	6118427	28	Dwelling	31.7	1.6
540012	6117180	32	Dwelling	34.8	0.7
540749	6124151	40	Dwelling	34.2	1.8
539354	6117877	46	Dwelling	33.0	2.6
535947	6119010	80	Dwelling	39.9	2.5
536406	6119080	110	Dwelling	-	-
537629	6120111	119	Dwelling	-	-
536532	6119041	131	Dwelling	-	-
536173	6118696	132	Dwelling	38.5	3.5
536276	6118944	134	Dwelling	-	-
535925	6118351	137	Dwelling	33.7	1.6
535848	6117862	148	Dwelling	31.9	1.1
536616	6118916	153	Dwelling	-	-
535313	6119571	156	Dwelling	39.3	2.8
536204	6118777	200	Dwelling	39.4	3.2
540355	6118606	257	Dwelling	34.7	1.8
540680	6119582	270	Dwelling	39.9	2.3
536464	6120535	297	Dwelling	-	-
537769	6123116	304	Dwelling	44.4	11.6
538144	6123262	307	Dwelling	47.3	13.4
537928	6123603	310	Dwelling	37.2	3.2
539011	6117275	348	Dwelling	22.8	1.1
537966	6122882	349	Dwelling	-	-
539524	6119870	369	Dwelling	-	-
535560	6119765	459	Dwelling	42.2	3.6
536542	6118938	483	Dwelling	-	-
536721	6120059	573	Dwelling	-	-

- Denotes a dwelling within or too close to the industrial area to permit a reasonable prediction of impacts to be made.

Figure D-2: Indicative monitoring locations