SOUTH CREEK WEST

Air Quality Impact Assessment
Belmore Road Precinct (Precinct 2)

Prepared for:

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BASIS OF REPORT

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1 Introduction

In March 2021, SLR Consulting Australia Pty Ltd (SLR) prepared a Stage 1 Air Quality Impact Assessment (AQIA) for the rezoning of Northwest Precinct (Precinct 2 – the Site) within the South Creek West Land Release Area (SCWLRA) in southwest Sydney, NSW.

The AQIA concluded that some adverse air quality impacts may be experienced along the eastern boundary of the Site associated with particulate emissions from the existing Bringelly Brickworks (the Facility) located at 60 Greendale Rd, Bringelly and recommended a dispersion modelling study for the Facility using recent activity data and latest modelling software in line with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (from here after 'the Approved Methods').

In December 2021, Camden Council (the Council) requested additional information regarding the planning proposal for the Site, as follows:

> *12. Air Quality Assessment*
>
> *a) Bringelly Brickworks – As per the conclusions of the Stage 1 Air Quality Assessment prepared by SLR, it is requested that a dispersion modelling study is conducted in relation to the existing Bringelly Brickworks to understand the suitability of proposed land uses, particularly on the western side of the precinct, and any potential impacts on the ILP.*

This report provides a detailed quantitative assessment of the potential air quality impacts of the Bringelly Brickworks operations on the Site.

This assessment has been prepared with consideration of the following policies and guidelines:

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2017) (the Approved Methods)
- Protection of the Environment Operations Act 1997 (NSW Parliament, 1997)
- Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW Parliament, 2010)

The Approved Methods outlines the requirements for conducting an air quality impact assessment as follows (also indicated are the relevant sections of this report where the requirements are met):

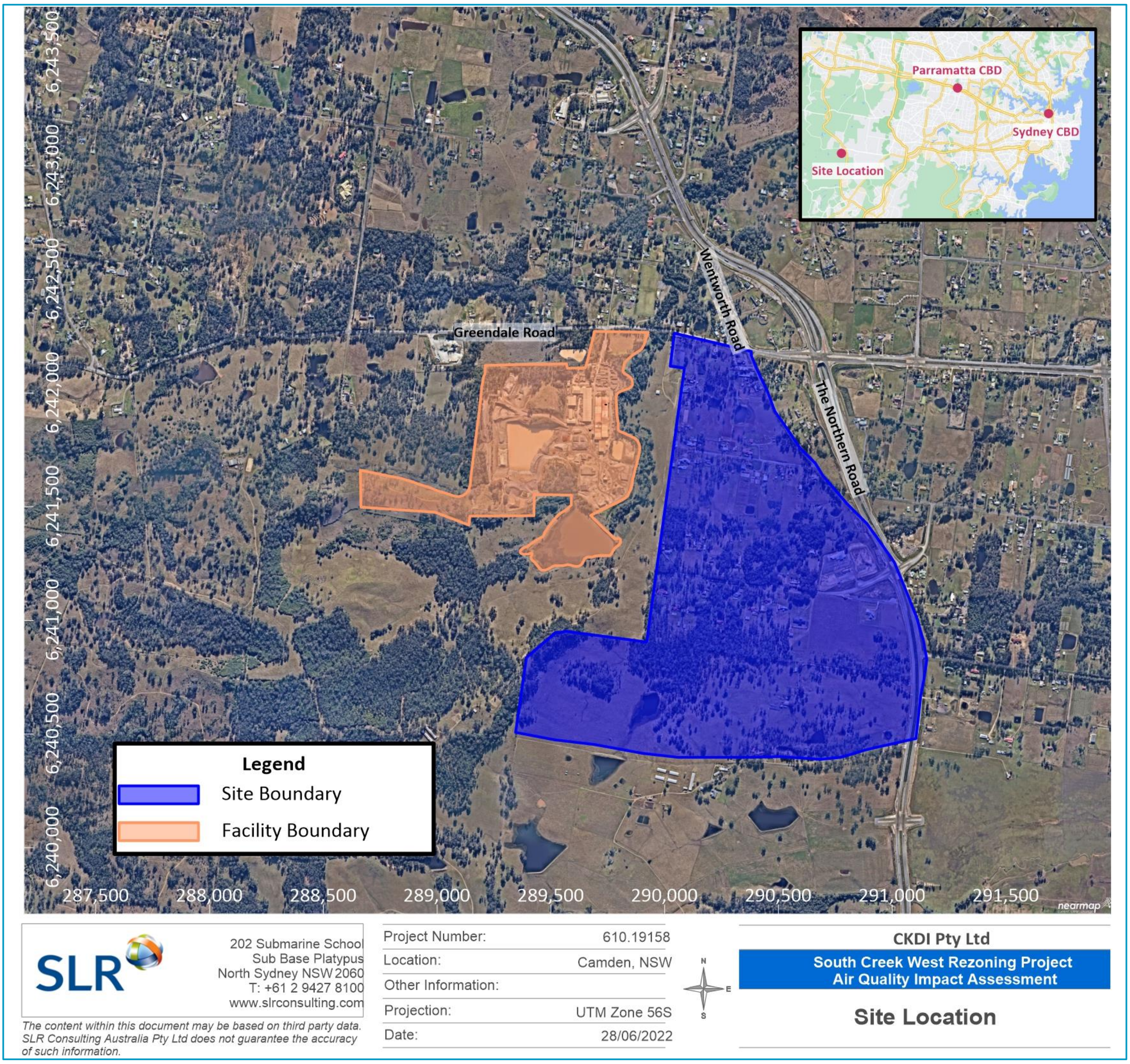
- Description of sensitive receptor locations and local topographic features (**Section 2.3** and **Section 2.5** respectively)
- Establishment of air quality assessment criteria (**Section 3.2**)
- Description of existing air quality environment (**Section 4**)
- Compilation of a comprehensive emissions inventory for the proposed activities (**Section 5**)
- Analysis of climate and dispersion meteorology for the region (**Section 6.2.4**)
- Completion of atmospheric dispersion modelling and analysis of results (**Section 6.3**)
- Preparation of an air quality impact assessment report comprising the above.

2 Project Overview

2.1 Site Location

The Site is located in Bringelly within the Camden Local Government Area (LGA), with access from the Northern Road and Greendale Road, and future access roads from the proposed Lowes Creek Maryland (LCM) Precinct. The Site location is shown in **Figure 1**.

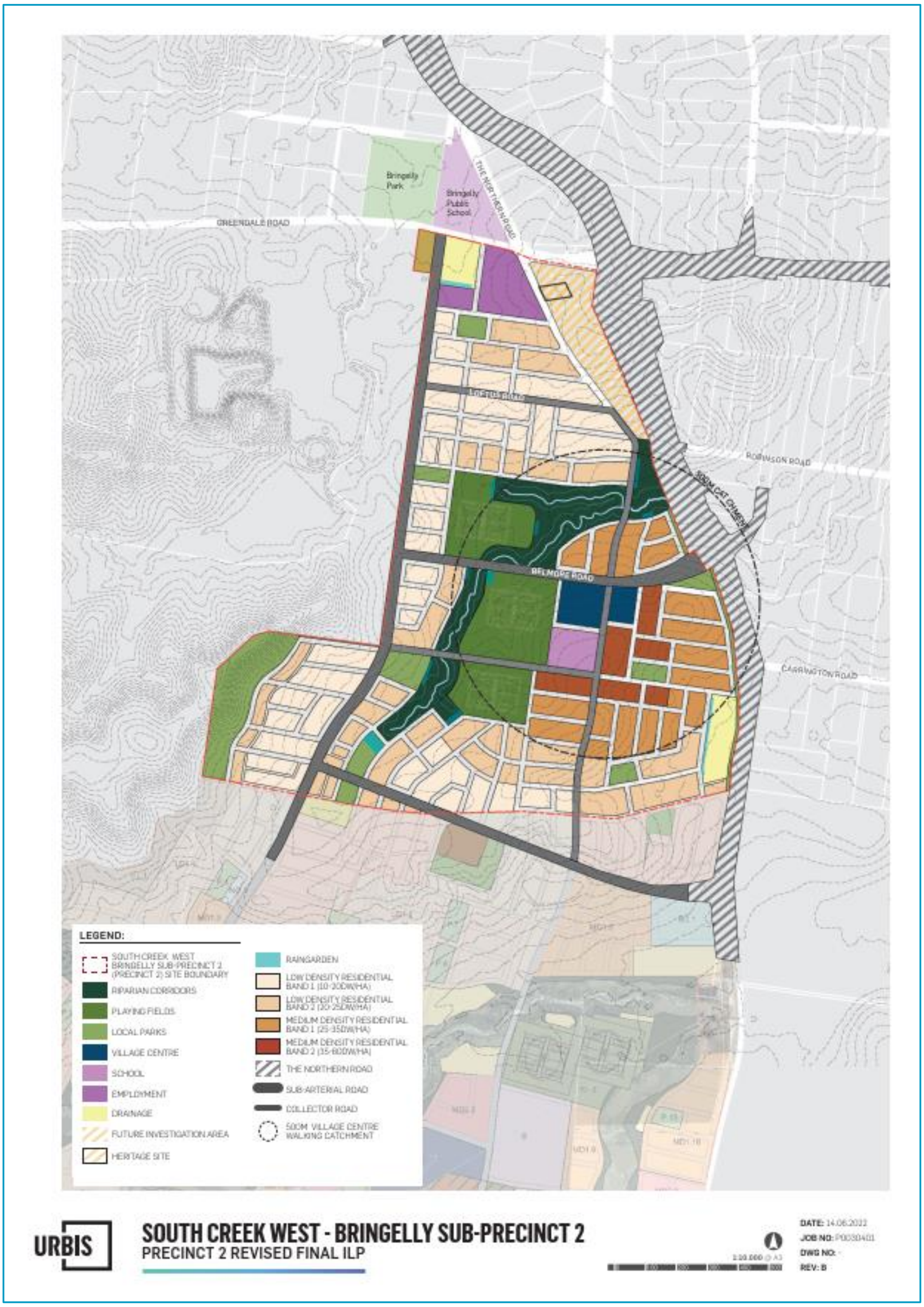
Figure 1 Site Location



2.2 Indicative Layout Plan

The land uses within Precinct 2 will include residential, riparian, playing fields, local parks, school, local centre, employment and drainage. An Indicative Layout Plan (ILP) is shown in **Figure 2**. The final ILP will be determined following further development of the design.

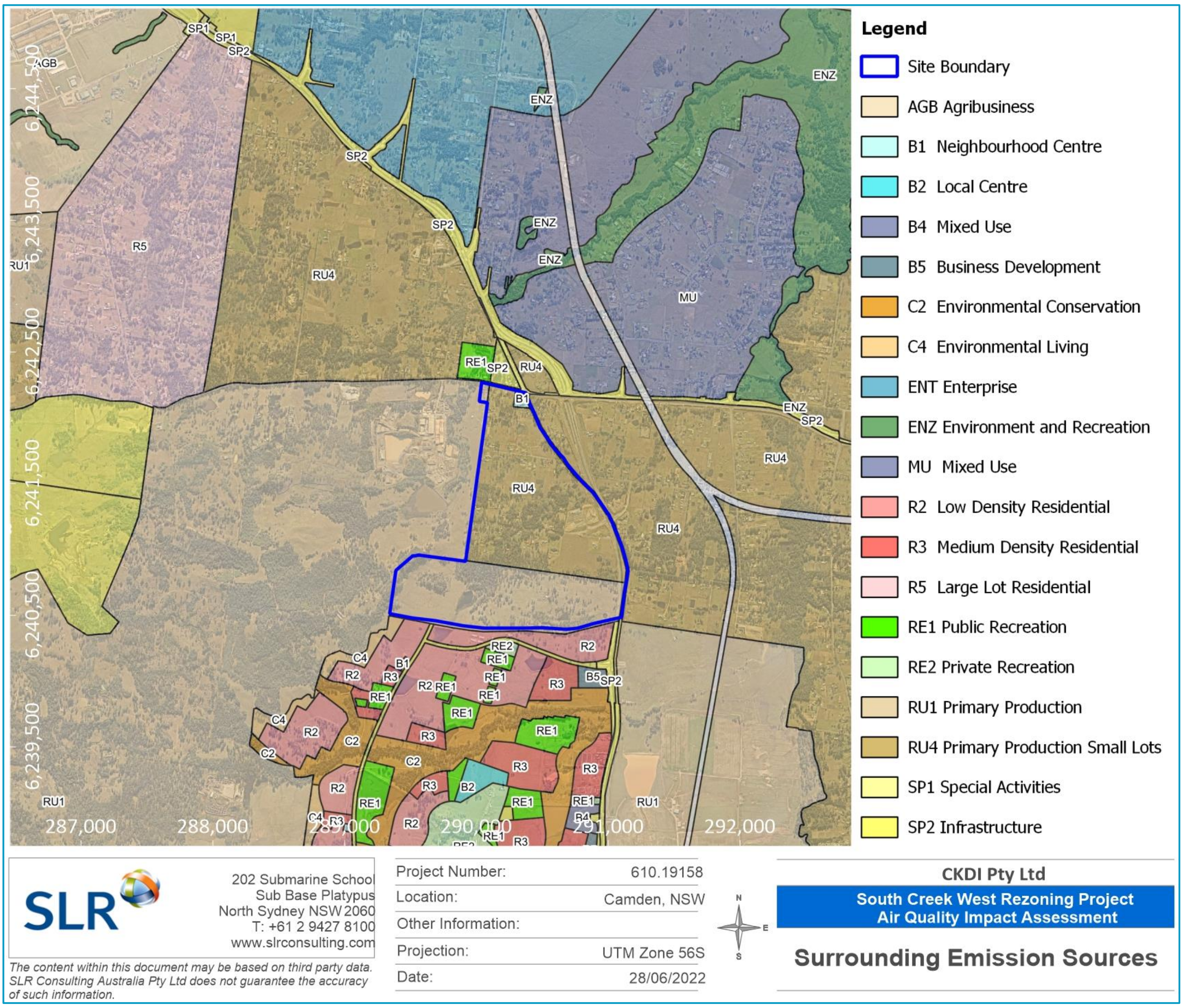
Figure 2 Indicative Site Layout – Precinct 2



2.3 Surrounding Land Use

As per the State Environmental Planning Policy (Biodiversity and Conservation) 2021 and Camden Local Environmental Plan (LEP) 2010, the northern part of the Site and the areas immediately to its east are zoned as RU4 (Primary Production Small Lots) while the southern and western part of the Site are zoned as RU1 (Primary Production) as shown in **Figure 3**.

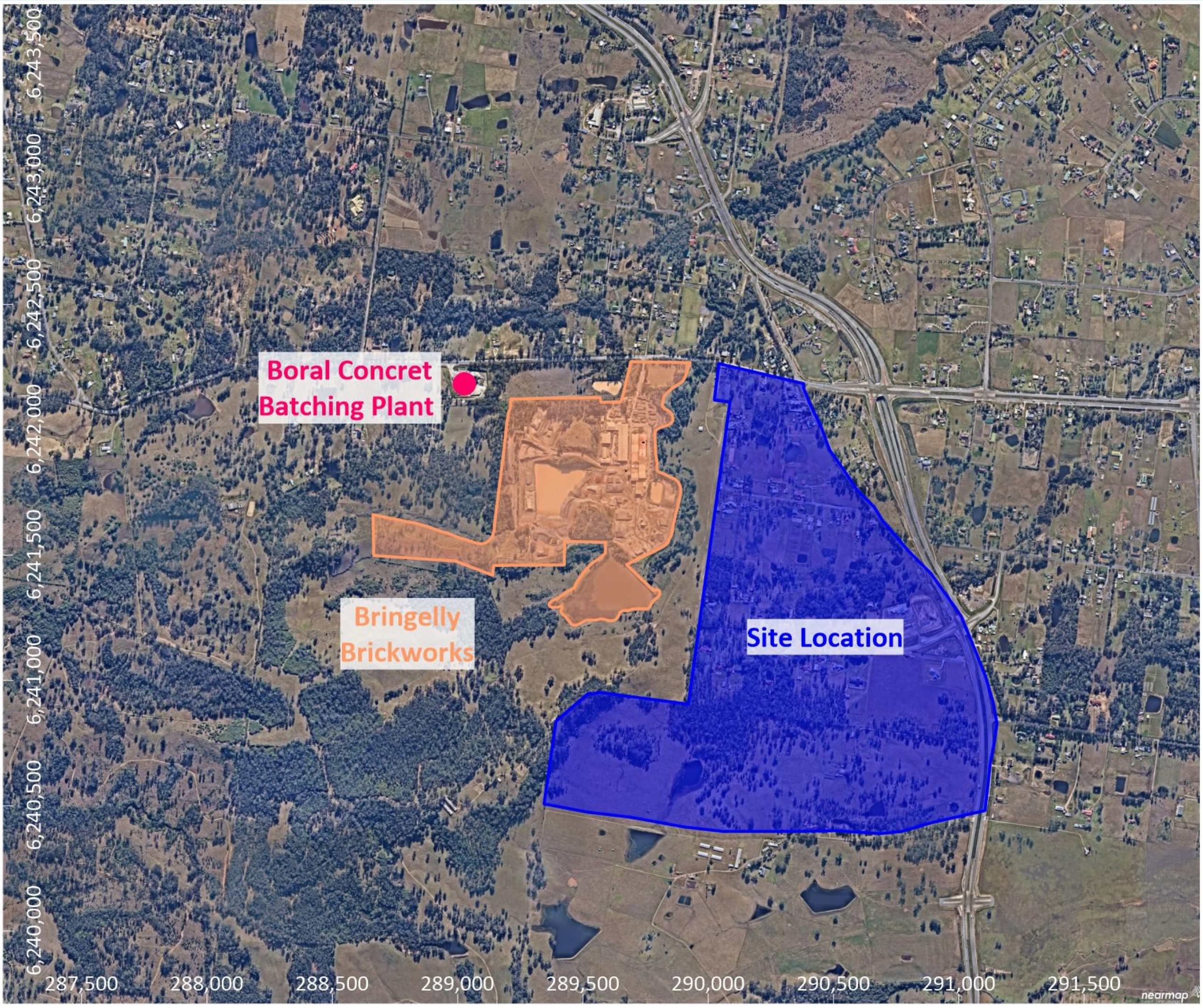
Figure 3 Surrounding Land Uses



2.4 Neighbouring Industries

Sources of emissions to air in the vicinity of the Site with the potential to give rise to cumulative impacts were reviewed based on Environment Protection Licences (EPLs) and the National Pollutant Inventory (NPI) database. No NPI facilities have been identified within the 3 km radius, and the only identified sources other than Bringelly Brickworks based on a desktop review, is the Boral concrete batching plant located approximately 500 m northwest of the Bringelly Brickworks as shown in **Figure 4**.

Figure 4 Neighbouring Emission Sources



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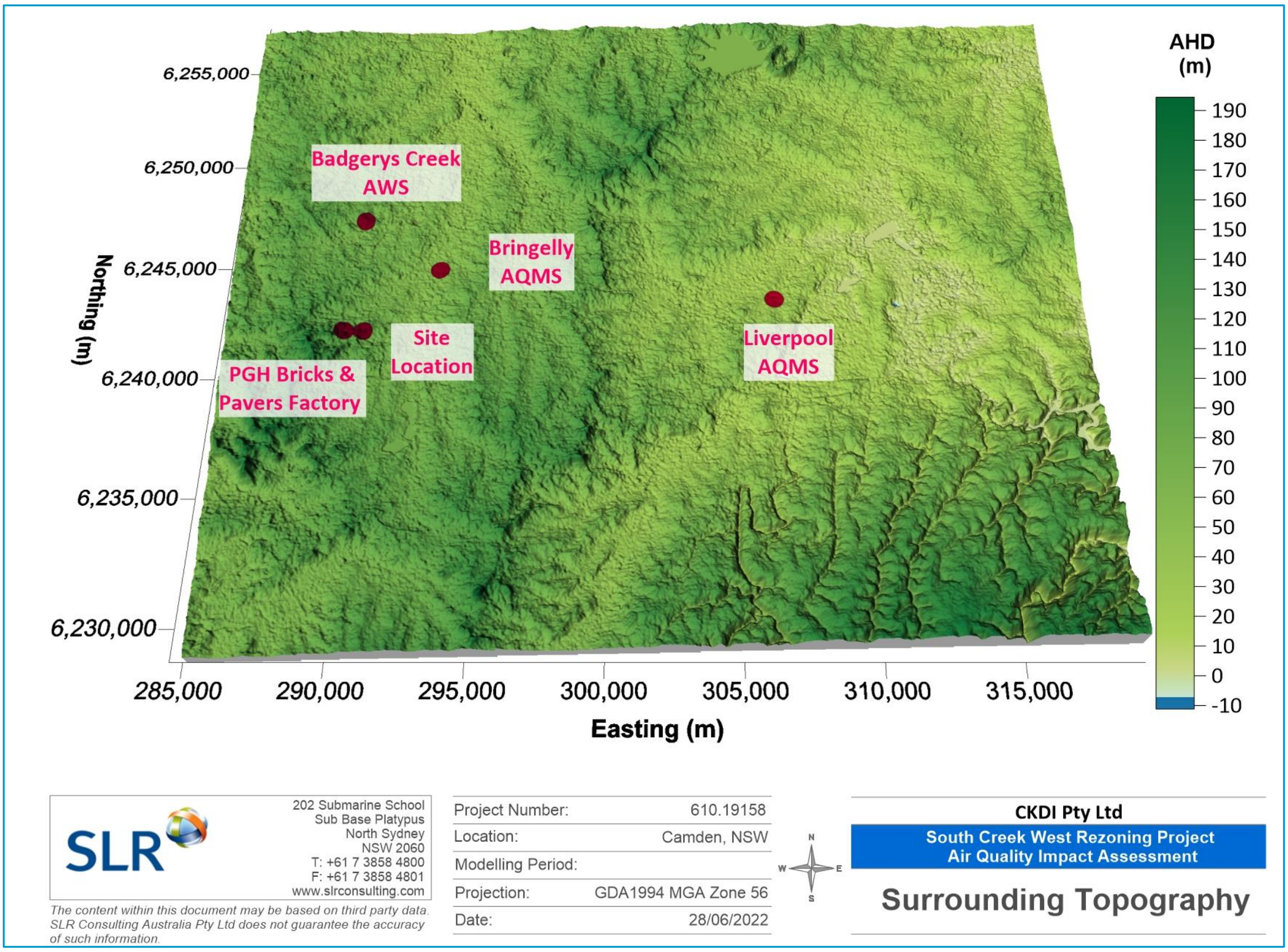
	Location: Camden, NSW	South Creek West Rezoning Project Air Quality Impact Assessment
	Other Information:	
	Projection: UTM Zone 56S	Surrounding Emission Sources
The content within this document may be based on third party data. SLR Consulting Australia Pty Ltd does not guarantee the accuracy of such information.	Date: 28/06/2022	

2.5 Local Topography

Topography is important in air quality studies as local atmospheric dispersion can be influenced by night-time katabatic (downhill) drainage flows from elevated terrain or channelling effects in valleys or gullies.

A three-dimensional representation of the region surrounding the Site is given in **Figure 5**. The topography in the vicinity of the Site is relatively flat and ranges from an approximate elevation of 80 metres (m) to 100 m Australian Height Datum (AHD).

Figure 5 Topography of the Area Surrounding the Site



3 Regulatory Requirements

3.1 Relevant Legislation, Policy, and Guidance

The following air quality policy and guidance documents have been referenced within this assessment and have been used to identify the relevant air quality criteria (see **Section 3.2**).

3.1.1 Protection of the Environment Operations Act 1997 & Amendment Act 2011

The Protection of the Environment Operations (POEO) Act 1997 and Amendment Act 2011 are a key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA) which enables the Government to establish instruments for setting environmental standards, goals, protocols and guidelines.

The following sections of the POEO Act are of general relevance to the Project:

- Section 117 of the POEO Act states that the wilful or negligent release of ozone depleting substances such as chlorofluorocarbons (CFCs) to the atmosphere carries the highest of all penalties under NSW environmental law.
- Section 124 and 125 of the POEO Act state that any plant located at a premise should be maintained in an efficient condition and operated in a proper and efficient manner to reduce the potential for air pollution.
- Section 126 of the POEO Act requires that materials are managed in a proper and efficient manner to prevent air pollution.
- Section 128 of the POEO Act states:
  - The occupier of a premises must not carry on any activity or operate any plant in or on the premises in such a manner to cause or permit the emission at any point specified in or determined in accordance with the regulation of air impurities in excess of [the standard of concentration and/or the rate] prescribed by the regulations in respect of any such activity or any such plant.
  - Where neither such a standard nor rate has been so prescribed, the occupier of any premises must carry on activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.
- Section 129 of the POEO Act states that odours generated by operational activities should not be detectable beyond the site boundary.
- Section 133 of the POEO Act states that the EPA may prohibit the burning of fires in the open or burning of waste in an incinerator. These activities are illegal in most local Council areas.

Changes under the POEO Amendment Act 2011 include that the owner of a premises, the employer or any person carrying on the activity which causes a pollution incident is to *immediately* notify the relevant authorities when material harm to the environment is caused or threatened.

3.1.2 Protection of the Environment Operations (Clean Air) Regulation 2021

The POEO (Clean Air) Regulation 2021 (the Regulation) is the core regulatory instrument for air quality issues in NSW. In relation to industry, the Regulation:

- sets maximum limits on emissions from activities and plant for a number of substances;

- deals with the transport and storage of volatile organic liquids;
- restricts the use of high sulphur liquid fuel; and
- imposes operational requirements for certain afterburners, flares, vapour recovery units and other treatment plant.

Part 5 of the POEO (Clean Air) Regulation 2021 (the Regulation) also deals with emissions of air impurities from activities and plant, and sets maximum limits on emissions for a number of substances including those anticipated at the Facility as noted in **Table 1** and **Table 2**. The standards of concentrations prescribed by Part 5, Division 3 do not apply to plant during start up and shutdown periods, however such emissions are still subject to the requirements of Section 128 (2) of the POEO Act in relation to the prevention and minimisation of air pollution.

Part 6 of the Regulation outlines the control of VOCs and the requirement for any fuel burning equipment or industrial plant to be fitted with control equipment. Exemptions exist where approved by the EPA.

Table 1 Schedule 2 Standards of concentration for scheduled premises— Ceramic works (Group 6[1])

Air impurity	Activity	Concentration[2]
Solid particles (Total)	Any kiln or dryer	50 mg/m^3
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any kiln or dryer	500 mg/m^3
Fluorine (F2), or any compound containing fluorine, as total fluoride (HF equivalent)	Any kiln or dryer	50 mg/m^3
Hydrogen chloride (HCl)	Any activity, other than the manufacture of glazed terracotta roofing tiles	100 mg/m^3
Type 1 substances and Type 2 substances (in aggregate)	Any kiln or dryer fired on a non-standard fuel	1 mg/m^3
Smoke	Any dryer Any kiln used for firing dark red or dark brown face bricks formed by dry press brick machines	Ringelmann 3 or 60% opacity

Note 1 Group 6: afterburners and other thermal treatment plant, flares and vapour recovery units and other non-thermal treatment plant.
Note 2 Reference conditions are: Dry, 273 K, 101.3 kPa for any activity.

Table 2 Schedule 4 Standards of concentration for scheduled premises—general activities and plant (Group 6[1])

Air impurity	Activity	Concentration[2]
Solid particles (Total)	Any activity or plant (except as listed below)	50 mg/m^3
	Any crushing, grinding, separating or materials handling activity	20 mg/m^3
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any activity or plant (except boilers, gas turbines and stationary reciprocating internal combustion engines listed below)	350 mg/m^3
Sulfuric acid mist (H_2SO_4) or sulphur trioxide (SO_3) or both, as SO_3 equivalent	Any activity or plant	100 mg/m^3
Hydrogen sulphide (H_2S) (see also clause 42)	Any activity or plant	5 mg/m^3
Fluorine (F_2) and any compound containing fluorine, as total fluoride (HF equivalent)	Any activity or plant, other than the manufacture of aluminium from alumina	50 mg/m^3
Chlorine (Cl_2)	Any activity or plant	200 mg/m^3
Hydrogen chloride (HCl)	Any activity, other than the manufacture of glazed terracotta roofing tiles	100 mg/m^3
Type 1 substances and Type 2 substances (in aggregate)	Any activity or plant	1 mg/m^3
Cadmium (Cd) or mercury (Hg) individually	Any activity or plant	0.2 mg/m^3
Dioxins or furans	Any activity or plant using a non-standard fuel that contains precursors of dioxin or furan formation	0.1 ng/m^3
	Incinerator that processes waste	0.1 ng/m^3
Volatile organic compounds (VOCs), as n-propane	Any activity or plant involving combustion (except as listed below)	40 mg/m^3 VOCs or 125 mg/m^3 CO

Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	Ringelmann 1 or 20% opacity

Note 1 Group 6: afterburners and other thermal treatment plant, flares and vapour recovery units and other non-thermal treatment plant.

Note 2 Reference conditions are: Dry, 273 K, 101.3 kPa for any activity.

3.1.3 NSW Environment Protection Authority Air Quality Policy and Guidance

The Approved Methods lists the statutory methods for modelling and assessing air pollutants from stationary sources and specifies criteria which reflect the environmental outcomes adopted by the EPA. The Approved Methods are referred to in the POEO (Clean Air) Regulation 2002 for assessment of impacts of air pollutants.

The air quality criteria set out in the Approved Methods relevant to this assessment are reproduced and discussed in **Section 3.2**.

3.2 Relevant Air Quality Criteria

Ambient air quality criteria for the identified pollutants of concern are prescribed by Section 7.1 of the Approved Methods. The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW and are considered to be appropriate for the setting. Those relevant to the identified emission sources at the Site are discussed below.

It is noted that the criteria outlined in the sections below present the current ambient air quality criteria adopted by the NSW Government, which are based on the standards set out in the National Environment Protection (Ambient Air Quality) Measure (the AAQ NEPM). On 15 April 2021, The National Environmental Protection Council agreed to vary the AAQ NEPM and on 18 May 2021 the ambient air standards for NO_2 and SO_2 were amended. These changes to the standards for NO_2 and SO_2 include:

- NO_2:
  - The 1-hour standard for NO_2 has been reduced to 164 ug/m^3 ppb (previously 246 ug/m^3).
  - The annual standard for NO_2 has been reduced to 31 ug/m^3 (previously 62 ug/m^3).
  - The form of both the 1-hour and annual NO_2 standards are as maximum values with no allowable exceedances.
- SO_2:
  - The 1-hour standard for SO_2 has been reduced to 285 ug/m^3 (previously 570 ug/m^3).
  - The 24-hour standard for SO_2 has been reduced to 20 ppb (previously 80 ppb).
  - The form of both the revised 1-hour and 24-hour SO_2 standards are as maximum values with no allowable exceedances.

It is not yet known if or when the Approved Methods will be amended to reflect the recent changes to the AAQ NEPM and therefore this AQIA considers the NO_2 and SO_2 ambient air quality criteria as published in the Approved Methods and those in the current AAQ NEPM. The AQIA air quality criteria for the pollutants of concern during the operational phase of the Project as outlined in the Approved Methods are provided below. Predictive modelling output is generally in the form of mass concentrations (mass of pollutant per volume of air) and therefore in this context it is preferable to present these criteria as mass concentrations for consistency.

3.2.1 Suspended Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed as total suspended particulate (TSP).

The annual impact assessment criterion for TSP recommended by the NSW EPA is 90 µg/m^3. The TSP impact assessment criterion was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

PM_{10} (Particulate Matter < 10 µm) and $PM_{2.5}$ (Particulate Matter < 2.5 µm) are considered important pollutants due to their ability to penetrate into the respiratory system. In case of $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The impact assessment criteria specified within the Approved Methods for suspended particulate matter are provided in **Table 3**.

Table 3 Impact Assessment Criteria for Suspended Particulate Matter

Pollutant	Averaging Period	Criterion
TSP	Annual	90 µg/m^3
PM_{10}	24-hour	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24-hour	25 µg/m^3
	Annual	8 µg/m^3

3.2.2 Carbon Monoxide

CO is an odourless, colourless gas formed from the incomplete burning of fuels. CO bonds to the haemoglobin in the blood and reduces the oxygen carrying capacity of red blood cells, thus decreasing the oxygen supply to the tissues and organs, in particular the heart and the brain.

CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow. The highest concentrations are found at the kerbside, with concentrations decreasing rapidly with increasing distance from the road.

The impact assessment criteria specified within the Approved Methods for CO are provided in **Table 4**.

Table 4 Impact Assessment Criteria for Carbon Monoxide (CO)

Pollutant	Averaging Period	Criterion
CO	15-minutes	87 ppm (100 mg/m^3)
	1-hour	25 ppm (30 mg/m^3)
	8-hour	9 ppm (10 mg/m^3)

Note: ppm = parts per million

3.2.3 Oxides of Nitrogen

Oxides of nitrogen (NO_X) is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry NO_X generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2).

NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to form NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. Long term exposure to NO_2 can lead to lung disease.

NO will be converted to NO_2 in the atmosphere after being emitted. The impact assessment criteria specified within the Approved Methods for NO_2 are provided in **Table 5**.

Table 5 Impact Assessment Criteria for Nitrogen Dioxide (NO_2)

Pollutant	Averaging Period	Criterion
NO_2	1-hour	12 pphm (246 µg/m^3)
	Annual	3 pphm (62 µg/m^3)

Note: pphm = parts per hundred million

3.2.4 Sulphur Dioxide

SO_2 is a colourless, pungent gas with an irritating smell. When present in sufficiently high concentrations, exposure to SO_2 can lead to impacts on the upper airways in humans (i.e. the noise and throat irritation). SO_2 can also mix with water vapour to form sulphuric acid (acid rain) which can damage vegetation, soil quality and corrode materials.

Main sources of SO_2 in the air are industries that process materials containing sulphur (e.g. wood pulping, paper manufacturing, metal refining and smelting, textile bleaching, wineries etc.). SO_2 is also present in motor vehicle emissions, however since Australian fuels are relatively low in sulphur, high ambient concentrations are not common.

The impact assessment criteria specified within the Approved Methods for SO_2 are provided in **Table 6**.

Table 6 Impact Assessment Criteria for Sulphur Dioxide (SO_2)

Pollutant	Averaging Period	Criteria
SO_2	10-minutes	25 pphm (712 µg/m^3)
	1-hour	20 pphm (570 µg/m^3)
	24-hour	8 pphm (228 µg/m^3)
	Annual	2 pphm (60 µg/m^3)

Note: pphm = parts per hundred million

3.2.5 Hydrogen Fluoride

Hydrogen fluoride (HF) is the most prevalent gaseous fluoride and the most reactive form in which fluorine exists in the environment. It is a colourless, pungent, acrid gas at room temperature. HF is extremely toxic and can cause severe respiratory damage or skin burns at elevated concentrations. It is used in the petroleum, chemical, and plastics industries and the primary sources of HF emissions are the industries that manufacture it or use it in production.

Table 7 Impact Assessment Criteria for Hydrogen Fluoride

Pollutant	Averaging Period	Criteria*
Hydrogen fluoride	90 days	0.5 µg/m^3
	30 days	0.84 µg/m^3
	7 days	1.7 µg/m^3
	24 hours	2.9 µg/m^3

3.2.6 Individual Air Toxics

Section 7.2 of the Approved Methods lists impact assessment criteria for principal and individual toxic air pollutants, defined on the basis that they are carcinogenic, mutagenic, teratogenic, highly toxic or persistent in the environment. The impact assessment criteria for principal and individual air toxics relevant to handling and recycling of e-waste are presented in **Table 8**.

The impact assessment criteria for individual air toxics are required to be applied at and beyond the boundary of the facility (i.e. regardless of the distance to the nearest sensitive receptor). Background levels (i.e. cumulative impacts) are not required to be considered as these pollutants are not generally found in significant concentrations in ambient air in NSW.

Table 8 NSW EPA Assessment Criteria for Relevant Air Toxics

Pollutant	Averaging Period	Concentration (mg/m^3)
Acetone	1-hour	22
Arsenic & compounds	1-hour	0.00009
Benzene	1-hour	0.029
Beryllium & compounds	1-hour	0.000004
Carbon disulphide	1-hour	0.07
Chlorin	1-hour	0.05
Chloroethane	1-hour	48
Ethylbenzene	1-hour	8
Hydrogen chloride	1-hour	140
Manganese & compounds	1-hour	0.018
Mercury (organic)[a]	1-hour	0.00018
Phenol [b]	1 hour	0.02
Styrene [b]	1 hour	0.12
Tetrachloroethane	1 hour	3.5
Toluene [b]	1 hour	0.36
Xylenes [b]	1 hour	0.19

[a] As a conservative approach all mercury emissions from the Facility as assessed against the organic criterion

[b] Criteria relates to odour impacts

4 Background Air Quality

4.1 Regional Air Quality

Air quality monitoring is performed by the NSW Department of Planning and Environment (DPE) at a number of monitoring stations across NSW. The closest station with data for the last five years is the Bringelly Air Quality Monitoring Station (AQMS), located approximately 4 km to the northeast of the Site. The following air pollutants are monitored at this station:

- Oxides of nitrogen (NO, NO_2 and NO_x)
- Sulfur dioxide (SO_2)
- Fine particles as $PM_{2.5}$
- Fine particles as PM_{10}

Since Carbon Monoxide (CO) is not monitored at the Bringelly AQMS, data recorded by the Camden AQMS located approximately 11 km south of the site is obtained for the purpose of this assessment.

A summary of the monitored pollutant concentrations for the last five years (2017-2021) is presented in **Table 9** and the data are presented graphically in **Figure 6** to **Figure 10**.

Table 9 Summary of Air Quality Monitoring Data at Bringelly and Camden AQMS (2017-2021)

Pollutant	PM_{10}		$PM_{2.5}$		NO_2		CO	SO_2	
Averaging Period	Maximum 24-hour	Annual	Maximum 24-hour	Annual	Maximum 1-hour	Annual	Maximum 1-hour	Maximum 1-hour	Annual
Units	µg/m³	µg/m³	µg/m³	µg/m³	pphm	pphm	ppm	pphm	pphm
2017	83.7 (6)	19.8	55.7 (2)	7.5	3.6	0.5	2.2	0.9	0.03
2018	92.9 (8)	21.2	55.6 (4)	8.0	3.6	0.6	1.5	1.1	0.04
2019	134.0 (24)	23.6	178.0 (27)	11.3	3.4	0.5	3.5	2.8	0.05
2020	241.8 (11)	18.3	78.1 (12)	8.5	3.0	0.3	4.9	2.2	0.05
2021	69.0 (1)	15.3	57.4 (3)	7.2	2.4	0.3	2.7	0.9	0.04
Criterion	**50**	**25**	**25**	**8**	**12**	**3**	**25**	**20**	**2**

#numbers in brackets represent number of exceedances of relevant criteria recorded each year

A significant number of exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criterion were recorded by the Bringelly AQMS in 2019 and 2020. A review of the available compliance monitoring reports indicates that these exceedances were primarily due to exceptional events such as bushfires, dust storms or hazard reduction burns. Elevated PM_{10} and $PM_{2.5}$ concentrations were recorded along the east coast of Australia in late 2019 and early 2020 during a major bushfire event.

Exceedances of the annual average $PM_{2.5}$ criterion were also recorded for the years 2019 and 2020; these exceedances were primarily due to the above-mentioned bush fires which impacted much of the state in late 2019 and early 2020.

Figure 6 Measured Daily Maximum 1-Hour Average NO_2 Concentrations at Bringelly AQMS (2017-2021)

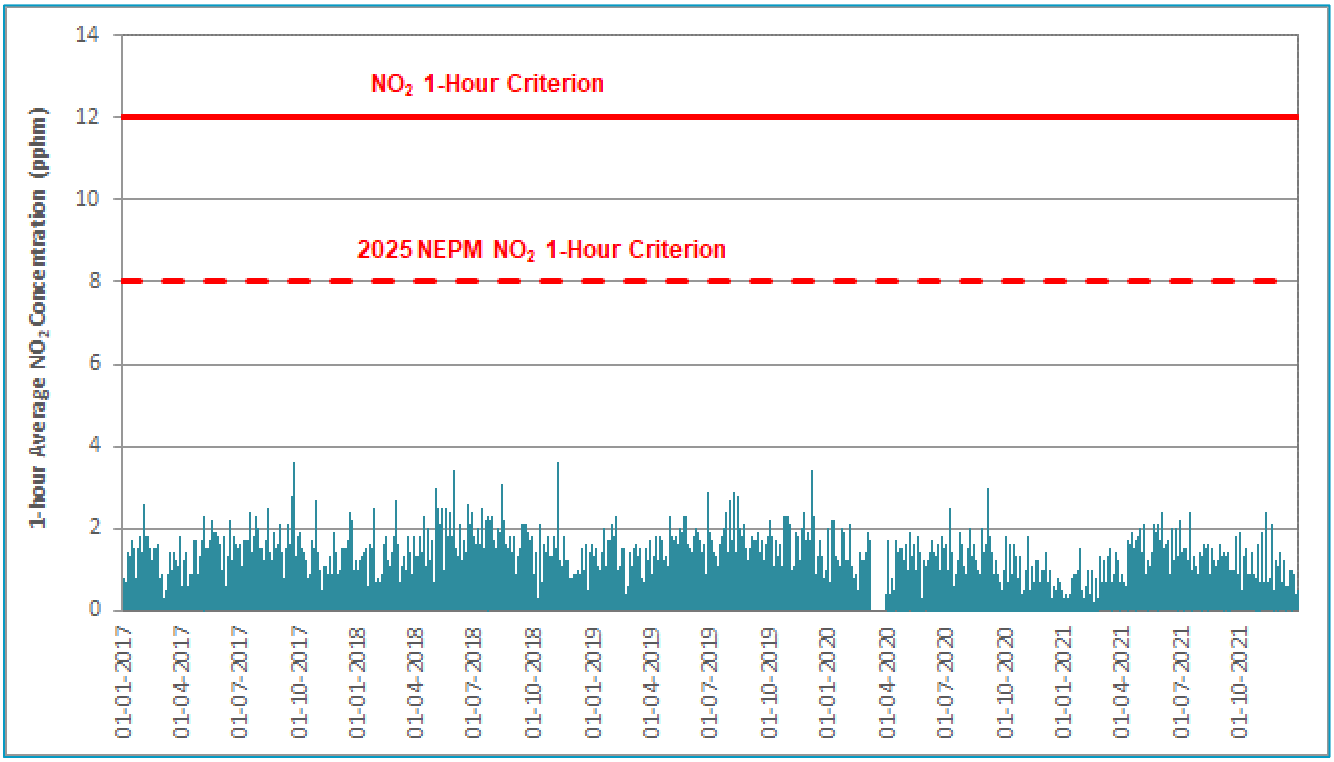


Figure 7 Measured Daily Maximum 1-Hour Average CO Concentrations at Camden AQMS (2017-2021)

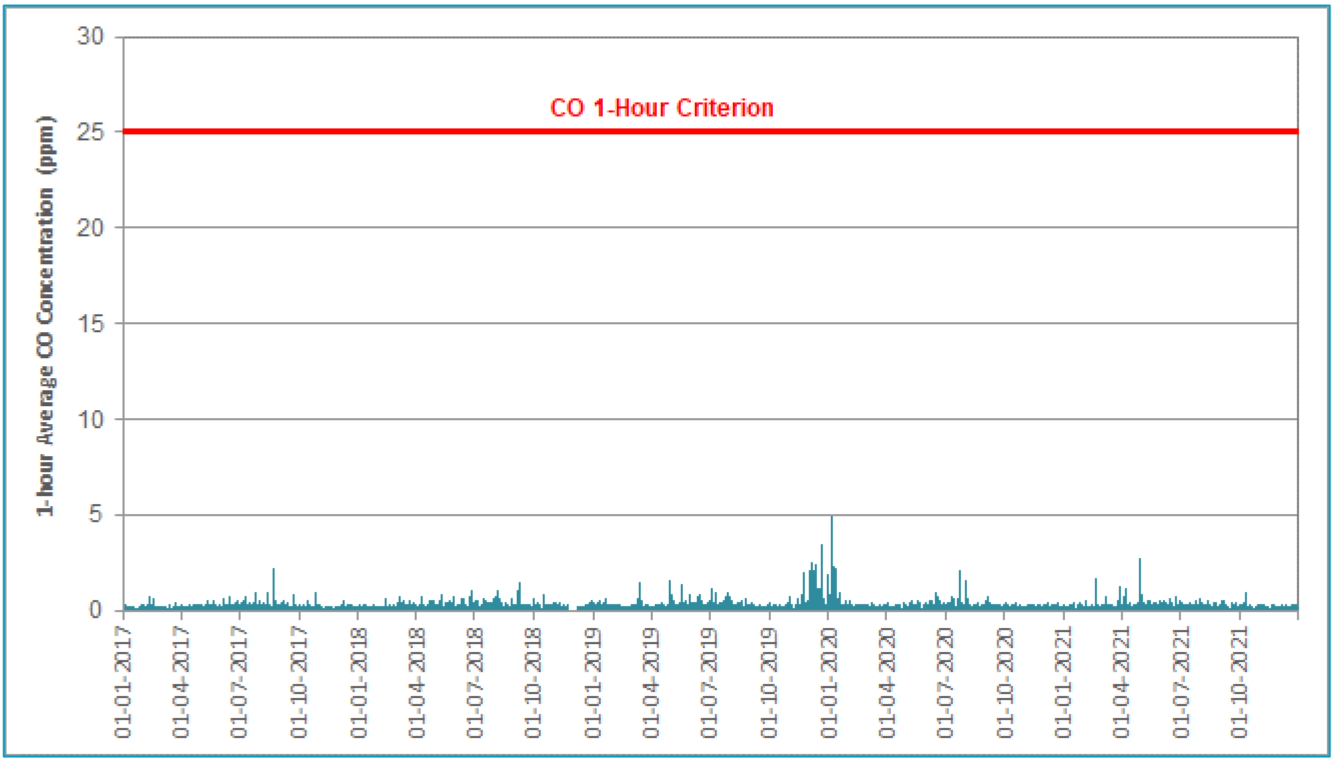


Figure 8 Measured Daily Maximum 1-Hour Average SO_2 Concentrations at Bringelly AQMS (2017-2021)

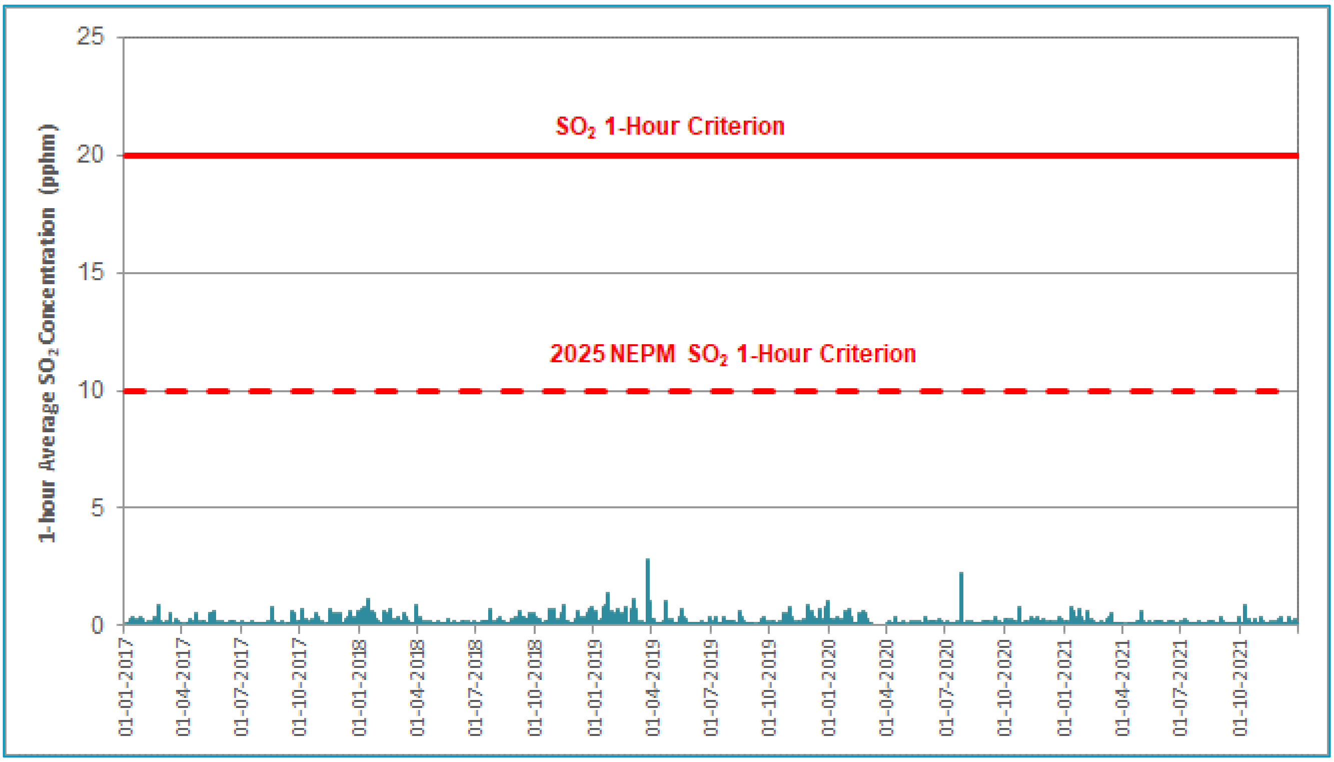


Figure 9 Measured 24-Hour Average PM_{10} Concentrations at Bringelly AQMS (2017-2021)

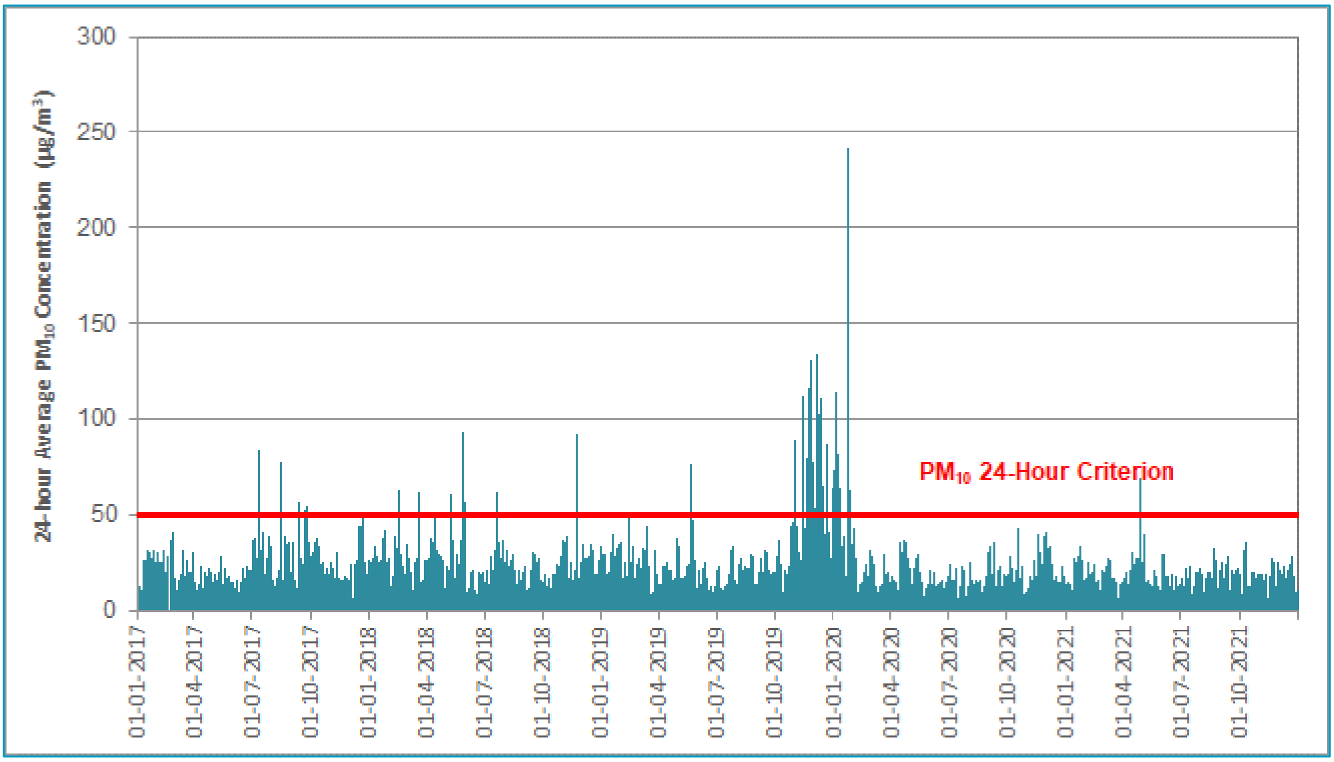
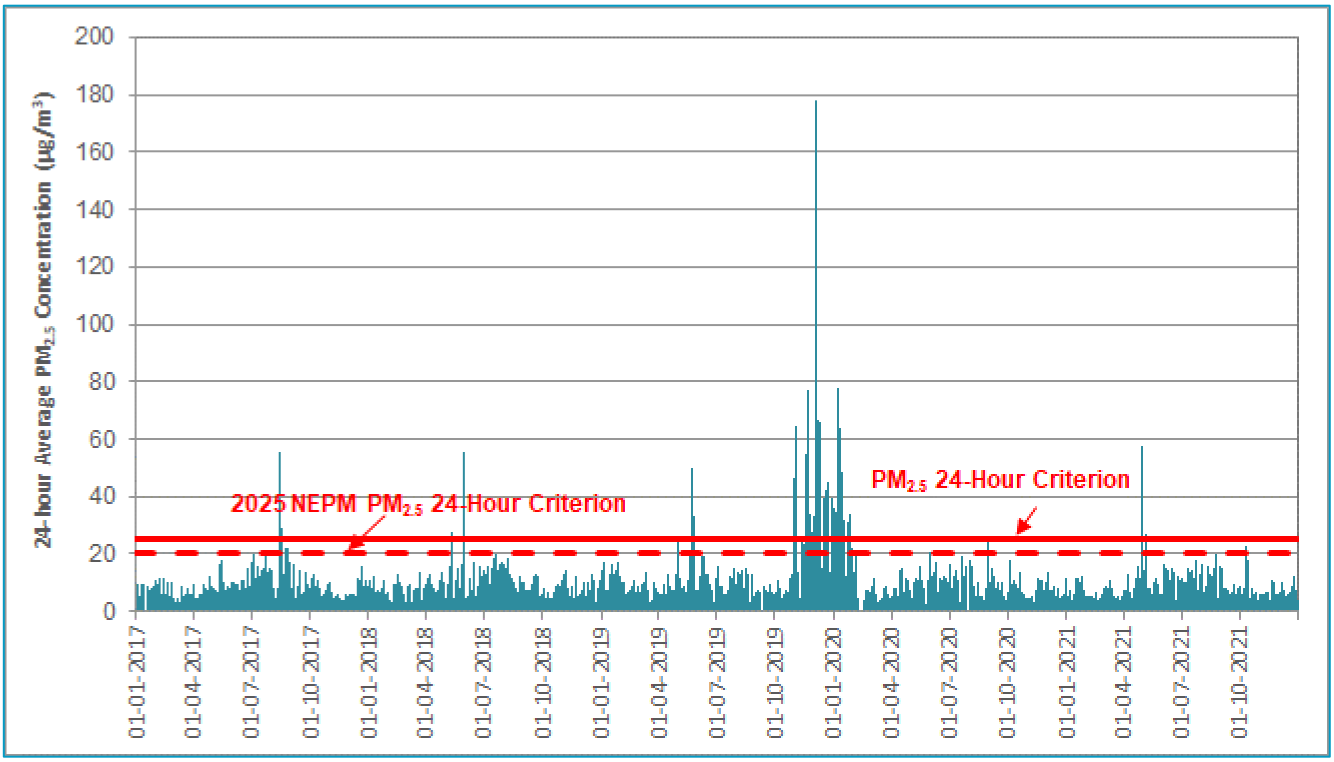


Figure 10 Measured 24-Hour Average $PM_{2.5}$ Concentrations at Bringelly AQMS (2017-2021)



4.2 Local Air Pollutant Sources and Types

As mentioned in **Section 2.4**, the two local air emission sources that are identified with potential to have air quality impacts on the Site are Bringelly Brickworks and Boral Concrete. The following sections outline further details of the potential contaminants that may be emitted from these sources. It is noted that no significant source of odours has been identified and as such odour emissions have not been considered further by this assessment.

4.2.1 Bringelly Brickworks

The potential sources of air emissions associated with the proposed activities at Bringelly Brickworks have been identified as follows:

- emissions from dryer stacks and kiln stack; and
- dust emissions from quarrying.

Stack Emissions

Firing of bricks in kilns leads to emissions of hydrogen fluoride (HF), hydrogen chloride (HCl), NO_x, CO, particulate matters (PM_{10} and $PM_{2.5}$), oxides of sulphur (SO_x), some VOC's and metals. NOx, CO and fine particulates are mainly combustion products while the other emissions originates from the firing of bricks. The sulphur content of natural gas is very low, so the SO_x emissions would arise predominantly from the heating of the bricks. The location of the kiln stack and the two dryer stacks are shown in **Figure 11**.

Figure 11 Stack Locations at Bringelly Brickworks

Particulate Emissions from Quarrying Operations

Although some particulate matters will be emitted from the exhaust stack, most of the particulates generated at the Bringelly Brickworks will arise from the quarry operations, the transport of material to stockpiles and subsequent crushing and preparation for use in the manufacturing building. The location of fugitive emission sources at Bringelly Brickworks are shown in **Figure 12**.

In May 2013, Wilkinson Murray Pty Ltd (Wilkinson Murray , 2013) prepared an air quality assessment for the clay/shale extraction and manufacturing processes and air quality associated with fixed and mobile mechanical plant and vehicle movements within Bringelly Brickworks.

Figure 12 Location of Fugitive Emission Sources at Bringelly Brickworks

Source: (Wilkinson Murray , 2013)

The Bringelly Brickworks produces bricks principally for the housing market and comprises of a gas-fired kiln and dryers housed in the largest of the existing buildings with exhaust stacks. Bricks are dried, fired and then removed by forklift to a holding yard. A clay shale quarry lies to the south and west of the Brickworks and material from this pit is extracted and used in the manufacture of the bricks.

The Bringelly Facility is currently approved under Modification 1 (MOD 1) of the State Significant Development (SSD) 5684 to:

- extract 200,000 tonnes per annum of clay/shale;
- import 321,000 tonnes per annum of raw material; and
- produce 263,500 tonnes of bricks per annum.

In August 2021, an application for Modification 2 to the SSD 5684 was submitted to Department of Industry and Environment (DIE) to:

- extract 350,000 tonnes per annum of clay/shale;
- import 350,000 tonnes per annum of raw material; and
- produce 330,000 tonnes of bricks per annum.

4.2.2 Boral Concrete Batching Plant

In April 2016, Ramboll Environ prepared an AQIA for Boral Concrete Batching Plant (Ramboll Environ Australia, 2016) for the production of up to 125,000 tonnes per annum of concrete. The site layout for the Boral Concrete Batching Plant is shown in **Figure 13**. Based on available information, the site is likely to generate fugitive particulate emissions. The site is also likely to generate product of combustions mainly associated with the onsite stationary/mobile equipment.

Figure 13 Site Layout of Boral Concrete Batching Plant

Source: Ramboll Environ 2016

5 Emissions Estimation

5.1 Bringelly Brickworks

5.1.1 Stack Sources

Stack parameters used in dispersion modelling were obtained from the previously completed air quality assessment by Wilkinson Murray (Wilkinson Murray , 2013) and are reproduced in **Table 10**.

Table 10 Stack Parameters Used in Dispersion Modelling

Stack Parameters	Unit	Model Input		
		Kiln Stack	Dryer Stack 1	Dryer Stack 2
Easting	m	289,744	289,739	289,672
Northing	m	6,241,949	6,241,950	6,241,836
Height	m	17.5	13.0	13.0
Stack diameter	m	1.5	1.4	1.4
Exit Velocity	m/s	13	5.6	6.55
Exit Temperature	°C	436.5	319	308.5

Emissions of other air toxics are also likely to arise from the kiln operations. VOC's and metals identified in the 2013 air quality assessment have also been adopted for this assessment. The emission rates used for the modelling for the kiln stack and the dryer stacks are summarised in **Table 11**.

Table 11 Stack Emissions Data Used for Modelling

Parameter	Emissions (g/s)		
	Kiln	Dryer Stack 1	Dryer Stack 2
TSP	0.3383	0.0198	0.0289
PM_{10}	0.2805	0.0148	0.0198
Total fluoride	0.198	0.0006	0.0009
HCl	0.5858	0.0005	0.0007
SO_3	0.0588	0.0012	0.014
SO_2	1.8975	0.0011	0.0158
NO_2	1.2540	0.0602	0.0734
CO	1.8068	0.0652	0.0619
Acetone	0.0071	-	-
Benzene	0.012	-	-
Carbon disulphide	0.00018	-	-
Chlorine	0.00543	-	-
Chloroethane	0.00196	-	-
Ethylbenzene	0.00018	-	-

Parameter	Emissions (g/s)		
	Kiln	Dryer Stack 1	Dryer Stack 2
Xylene	0.00052	-	-
Phenol	0.00036	-	-
Styrene	0.00008355	-	-
Tetrachloroethane	0.0000117	-	-
Toluene	0.00668	-	-
Arsenic	0.00013	-	-
Beryllium	0.000001754	-	-
Manganese	0.0543	-	-
Mercury	0.0000313	-	-

Source: Wilkinson Murray 2013

5.1.2 Fugitive Sources

The emission rates associated with the dust generating activities at Bringelly Brickworks (including how much material is moved, how far it is moved and so on) was adopted from the Wilkinson Murray report (2013). Estimated emission amounts for each activity are presented in **Table 12**. It is noted that the emission rates were estimated based on the extraction of 200,000 tpa clay/shale and production of 263,500 tpa of bricks.

In light of the latest modification (MOD 2), it is appropriate to scale these emissions accordingly. Therefore, as a conservative measure the modelled results have been scaled based on the ratio of proposed extraction rate (350,000 tpa of bricks) compared to those assessed (200,000 tpa).

Also, based on the movement of the extraction areas, there stages were assessed. As part of this current modelling assessment, the worst stage (ie Stage 3) emission rates have been adopted.

Table 12 Dust Emission Inventory – Bringelly Brickworks

Activity	TSP	PM_{10}	$PM_{2.5}$
	Stage 3	Stage 3	Stage 3
Topsoil removal by scraper	1,160	580	116
Scraper travelling	1,496	748	150
Scraper unloading	800	400	80
Dozers ripping	1,463	732	146
Loading Clay/Shale in pit	21	11	2
Hauling Clay/Shale to stockpile	8,141	4,071	814
Unloading Clay/Shale at stockpile	21	11	2
Grading roads	492	246	49
Hauling material onsite (paved road)	4,394	2,197	439
Unloading material to stockpile	10	5	1
Loading box feeder (FEL)	31	16	3
Crushing	178	89	18

Activity	TSP	PM10	PM2.5
	Stage 3	Stage 3	Stage 3
Plant feed conveyor	58	29	6
Wind erosion – Exposed area	544	272	54
Wind erosion – Stockpile area	238	119	24
Total	**19,047**	**9,524**	**1,905**
Total Modelled	**33,332**	**16,667**	**3,334**

Source: Wilkinson Murray 2013

5.2 Boral Concrete Batching Plant

Air emissions associated with the Boral Concrete Batching Plant (CBP) would primarily comprise of fugitive particulate matter releases. Potential sources of emission were identified as follows:

- Handling of aggregate and sand at storage bins and within the CBP;
- Transferring cement and cement supplement into silos from delivery trucks;
- CBP conveying and loading to agitator trucks;
- Wheel-generated dust from trucks and front end loader (FEL) movements across paved surfaces; and
- Wind erosion from material storage bins and adjacent paved surfaces.

Ramboll Environ prepared a quantitative air quality impact assessment for this operation in 2016 (Ramboll Environ Australia, 2016). Modelling results presented in this report showed that potential impact at the proposed site (Precinct 2) would be negligible. Given this, detailed modelling for this site was not warranted and has not been considered further in this study.

6 Dispersion Modelling Settings

6.1 Model Selection

Emissions from the proposed operations have been modelled using a combination of the TAPM, CALMET and CALPUFF models. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods. It is noted that building wake affect were also included in the model.

6.2 Meteorological Modelling

6.2.1 Selection of Representative Year for Meteorological Modelling

In order to determine a representative meteorological year, five years of meteorological data (2017-2021) from the nearest BoM station located at Badgerys Creek (Station ID 67108), approximately 5.0 km north of the Site were reviewed and analysed. Specifically, the following parameters were analysed:

- Frequency and distribution of the predominant wind directions;
- Wind speed;
- Temperature; and
- Relative humidity.

Based on this analysis, 2021 calendar year was selected as a representative year for this study (Refer to **Appendix A**).

6.2.2 TAPM

The TAPM prognostic model, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to generate the upper air data required for CALMET modelling.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate one full year of hourly meteorological observations at user-defined levels within the atmosphere.

Additionally, the TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values.

The TAPM model may assimilate actual local wind observations so that they can be used to optimise the output. Wind speed and direction observations recorded by the following BoM stations were used to realign the predicted solution towards the observed values:

- Badgerys Creek AWS (Station ID 67108, approximately 5 km north of the Site)
- Camden Airport AWS (Station ID 68192, approximately 11 km southwest of the Site)
- Horsley Park Equestrian Centre AWS (Station ID 67119, approximately 16 km northeast of the Site)
- Bankstown Airport AWS (Station ID 66137, approximately 24 km east of the Site)
- Penrith Lakes AWS (Station ID 67113, approximately 25 km north of the Site)
- Canterbury Racecourse AWS (Station ID 66194, approximately 36 km northeast of the Site)

Table 13 details the parameters used in the TAPM meteorological modelling for this assessment.

Table 13 Meteorological Parameters Used for this Study - TAPM

TAPM (v 4.0)	
Number of grids (spacing)	5 (30 km, 10 km, 3 km, 1 km, and 300 m)
Number of grid points	30 x 30 x 35
Year of analysis	2021
Centre of analysis	288,994 m E 6,241,039 m S
Data assimilation	Badgerys Creek Aws, Camden Airport AWS, Horsley Park Equestrian Centre AWS, Bankstown Airport AWS, Penrith Lakes AWS, Canterbury Racecourse AWS

6.2.3 CALMET

CALMET is a meteorological model that develops hourly wind and other meteorological fields on a three-dimensional gridded modelling domain that are required as inputs to the CALPUFF dispersion model. Associated two dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, sea breeze, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final hourly varying wind field thus reflects the influences of local topography and land uses.

CALMET modelling was run in no observation mode for a 7.5 km × 7.5 km domain with a resolution of 100 m. The TAPM-generated three-dimensional meteorological data were used as the 'initial-guess wind' field and local topography and land use information were used to refine the wind field predetermined by the TAPM. **Table 14** details the parameters used in the meteorological modelling to drive the CALMET model.

Table 14 Meteorological Modelling Parameters – CALMET

Parameter	Model Domain
Meteorological grid	7.5 km × 7.5 km
Meteorological grid resolution	100 m
Initial guess filed	3D output from TAPM model (1 km horizontal resolution)

6.2.4 Meteorological Data Used in Modelling

To provide a summary of the meteorological conditions predicted at the site using the methodology described in **Section 6.2**, a single-point, ground-level meteorological dataset was 'extracted' from the 3-dimensional dataset at the Site and is presented in this section.

Wind Speed and Direction

Annual and seasonal wind patterns predicted by CALMET for 2021 calendar year is presented as wind roses in **Figure 14** and **Figure 15** respectively and a wind speed distribution plot in **Figure 16.** The wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from north). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus, it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

The annual wind rose predicted by CALMET for 2021 indicates that winds blow evenly from all directions at the site with the exception from north-western quadrant. Calm wind conditions were predicted to occur 5.7% of the time during 2021.

The seasonal wind roses indicate that typically:

- In spring, winds blowing from the north-eastern and south-western quadrants are predicted to be predominant. Calm winds are predicted to occur approximately 5.1% of the time during spring.
- In summer, wind blow evenly from all directions except for a low frequency from the north-western quadrant. Calm winds are predicted to occur 3.6% of the time during summer.
- In autumn and winter, winds from the south-western are predicted to be predominant with a low frequency of winds predicted to be blowing from north-western quadrant during autumn and south-eastern quadrant during winter. Calm winds are predicted to occur 6.3% of the time during autumn and 7.6% during winter.

Figure 14 CALMET-Predicted Annual Wind Roses for the Site (2021)

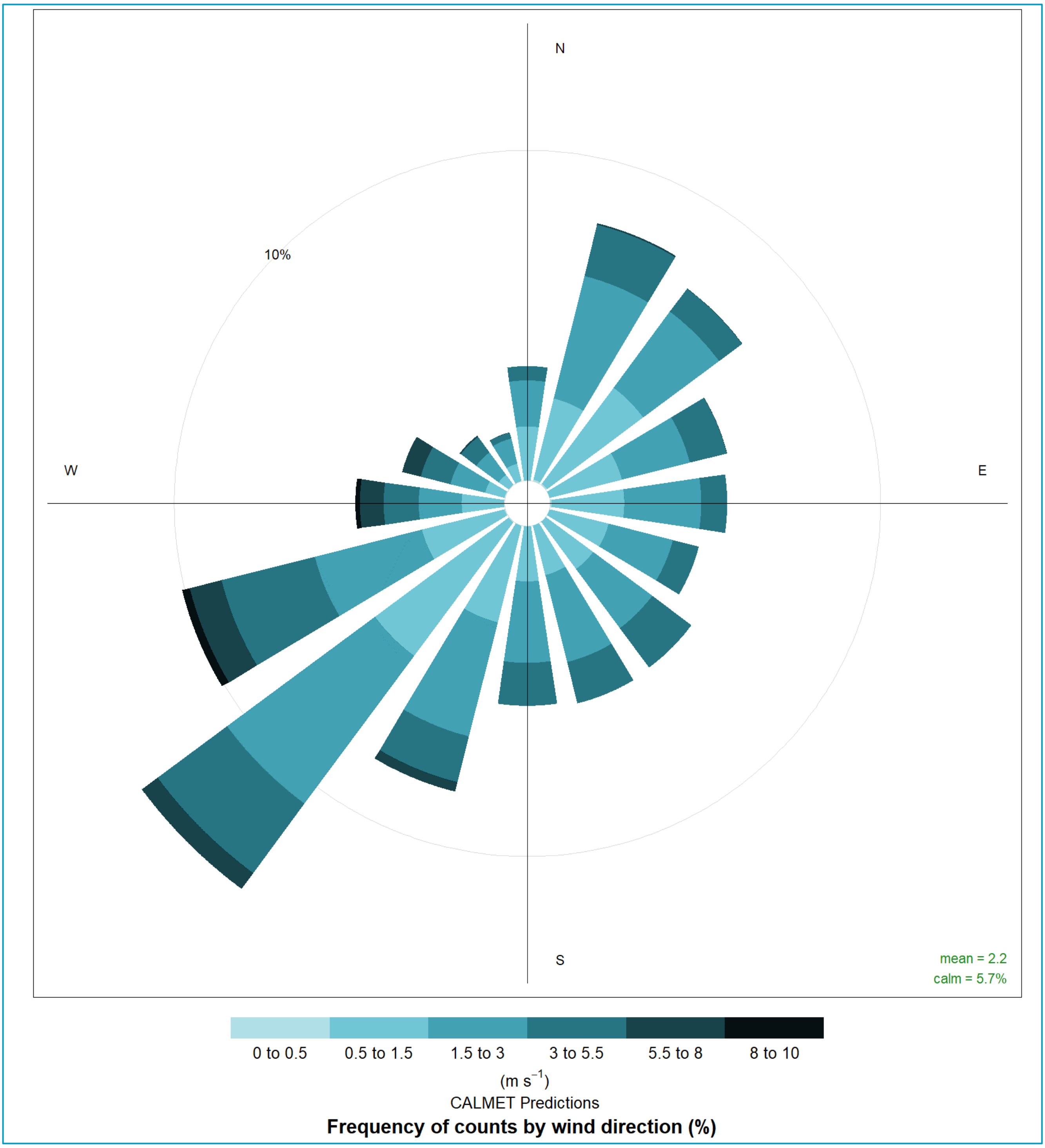


Figure 15 CALMET-Predicted Seasonal Wind Roses for the Site (2021)

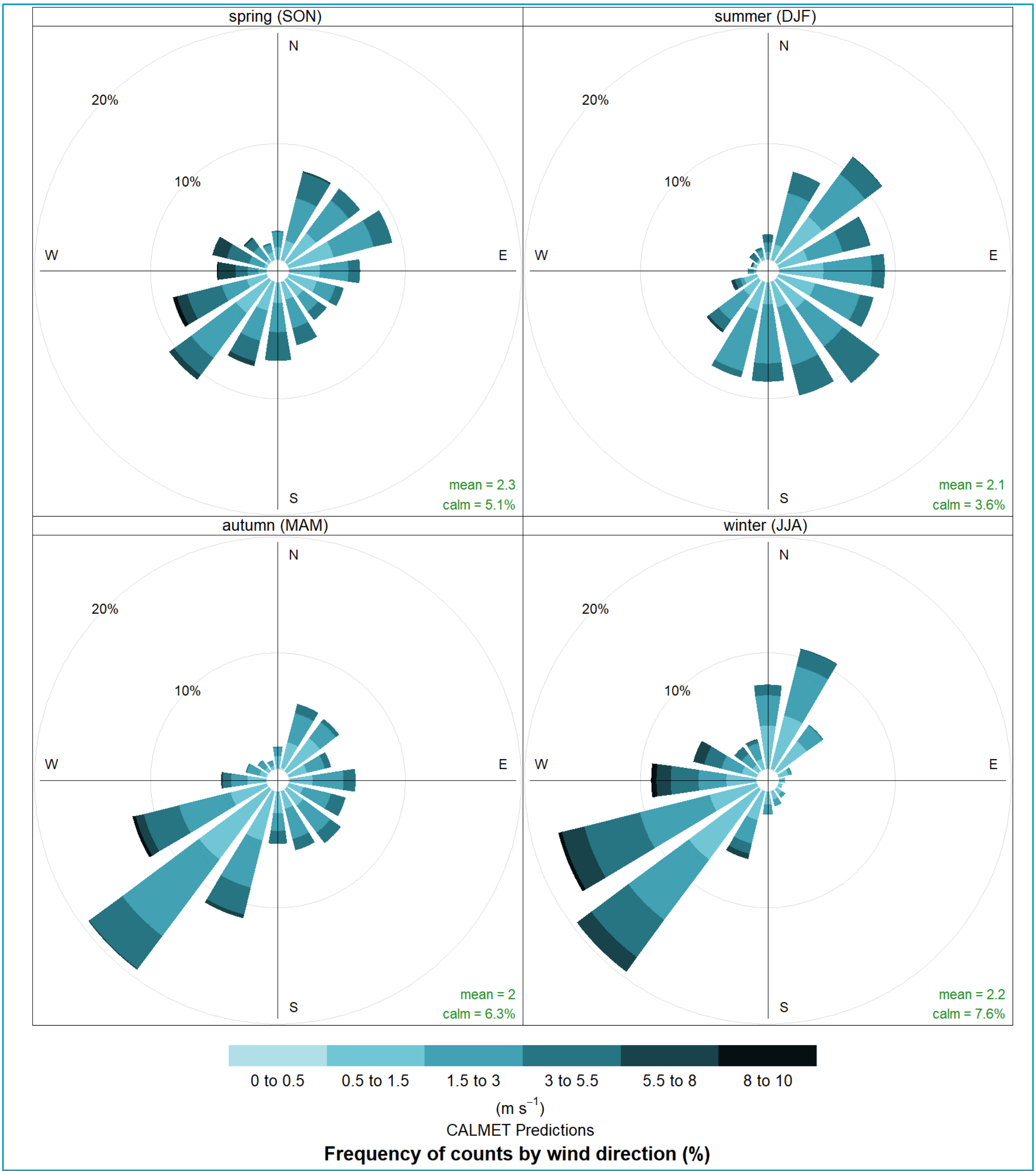
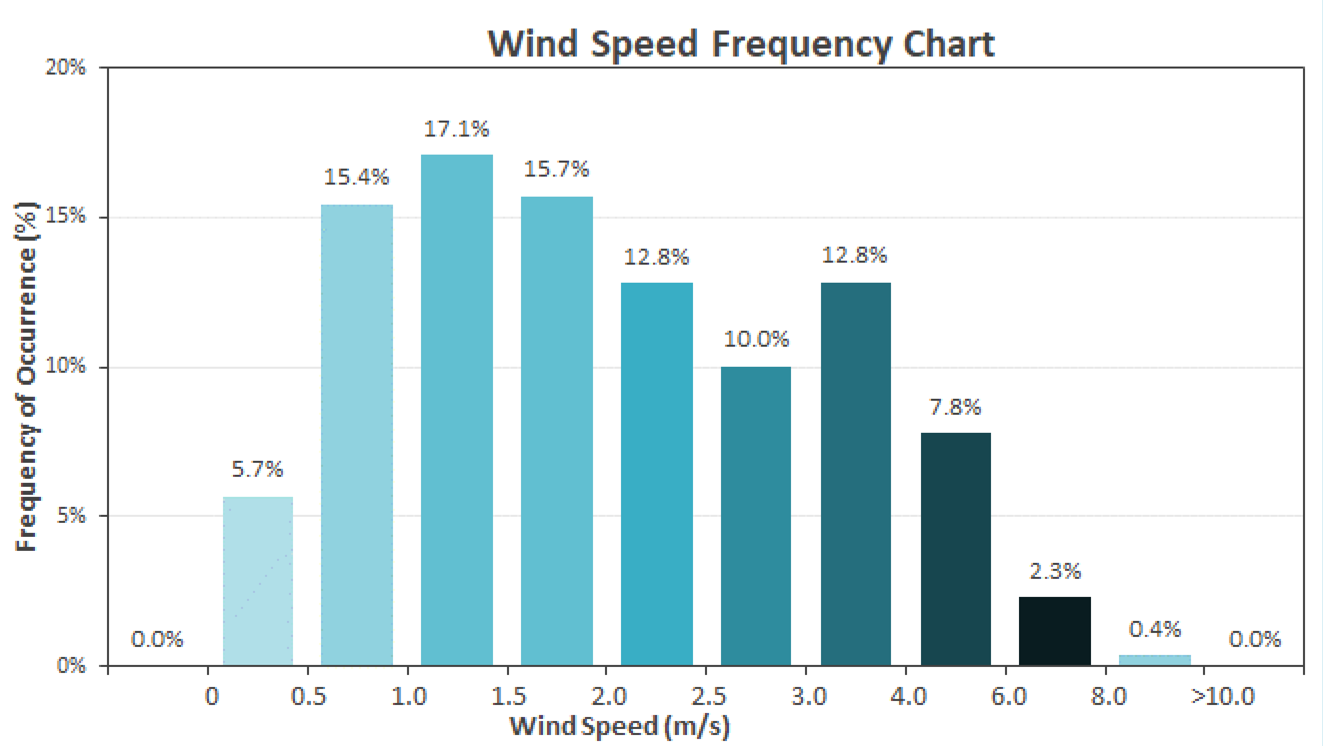


Figure 16 Annual Wind Speed Frequencies at the Site (CALMET Predictions, 2021)



Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner (PGT) assignment scheme identifies six stability classes, A to F, to categorise the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

The meteorological conditions defining each PGT stability class are shown in **Table 15**.

Table 15 Meteorological Conditions Defining PGT Stability Classes

Surface Wind Speed (m/s)	Daytime Insolation			Night-Time Conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

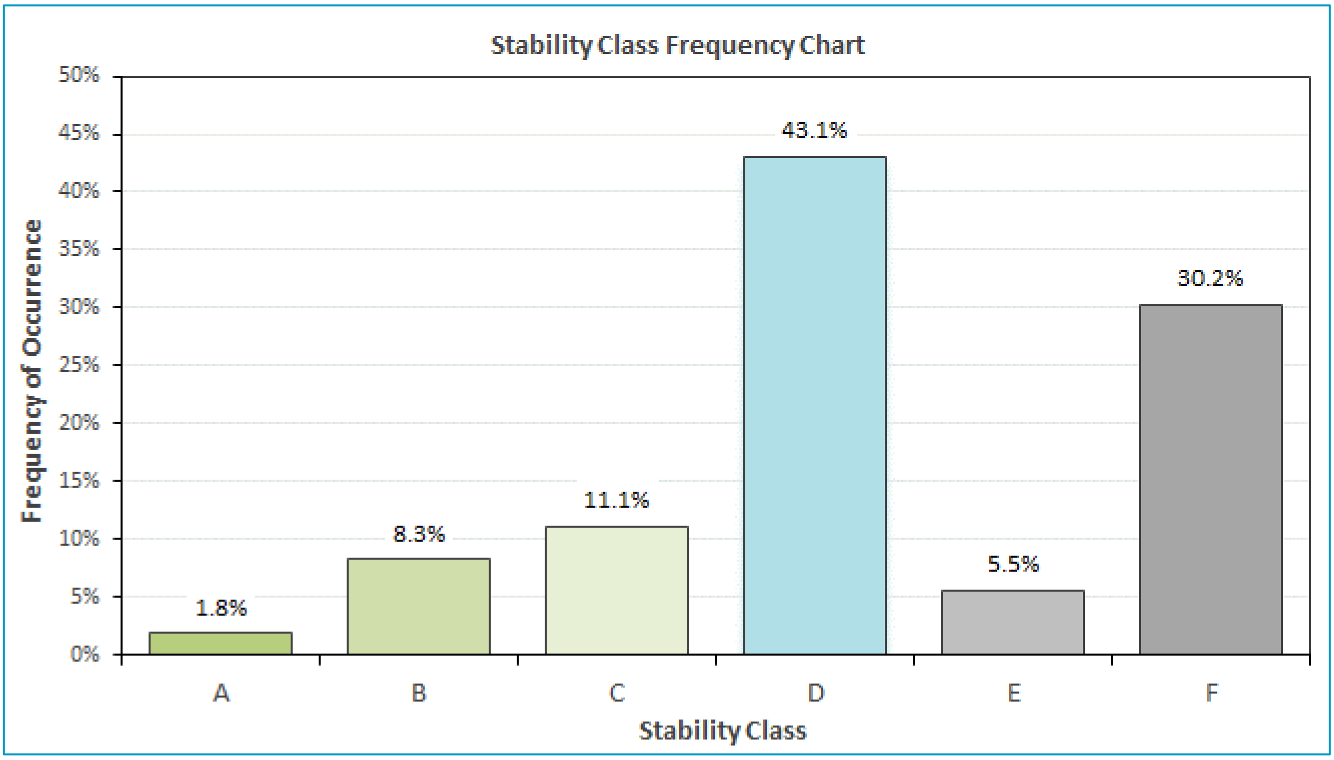
Source: (NOAA, 2018)

Notes:

1. Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter.
2. Night refers to the period from 1 hour before sunset to 1 hour after sunrise.
3. The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

The frequency of each stability class predicted by CALMET, extracted at the Site, during the modelling period is presented in **Figure 17**. The results indicate a high frequency of conditions typical to Stability Class D (Neutral) and Stability Class F (Very Stable), with a low frequency of very unstable conditions (Stability Class A). Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing. Stability Class F is indicative of stable night time conditions, which will inhibit pollutant dispersion resulting in higher pollutant concentrations at ground level at surrounding areas.

Figure 17 Predicted Stability Class Frequencies at the Site (CALMET predictions, 2021)

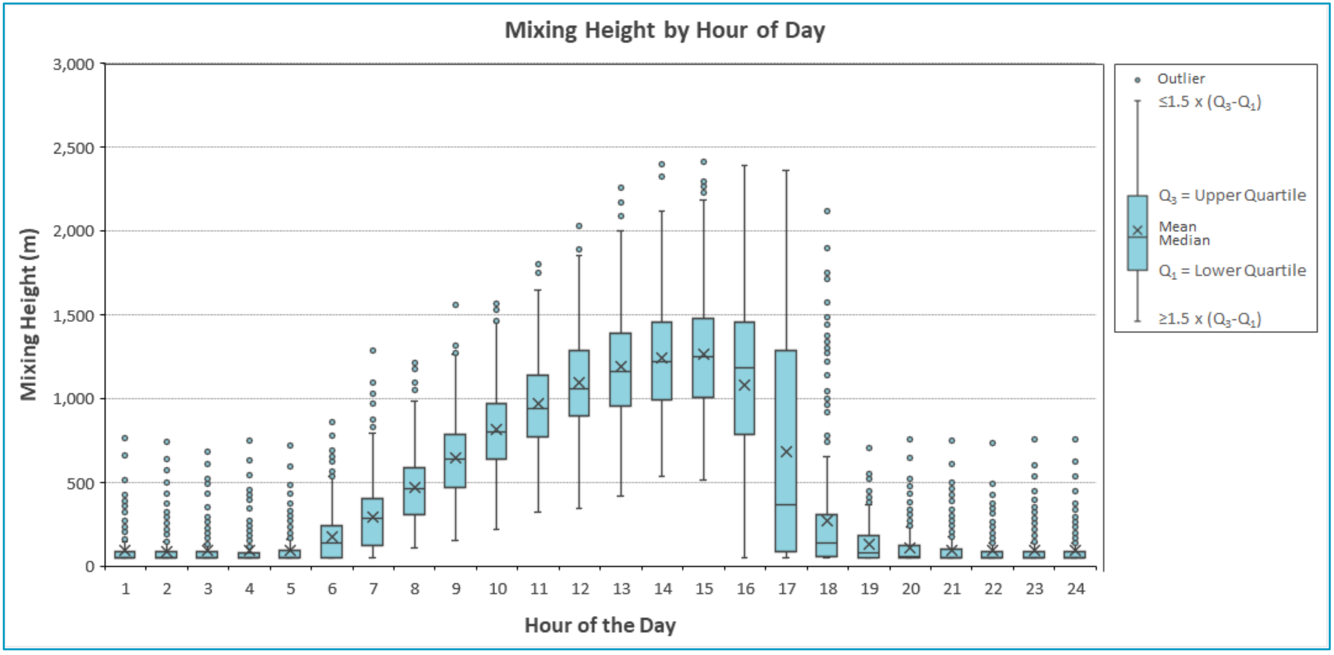


Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Site during the 2021 modelling period are illustrated in **Figure 18**.

As will be expected, an increase in mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

Figure 18 Predicted Mixing Heights at the Site (CALMET predictions, 2021)



6.3 Dispersion Modelling

6.3.1 CALPUFF Model Parameters and Options

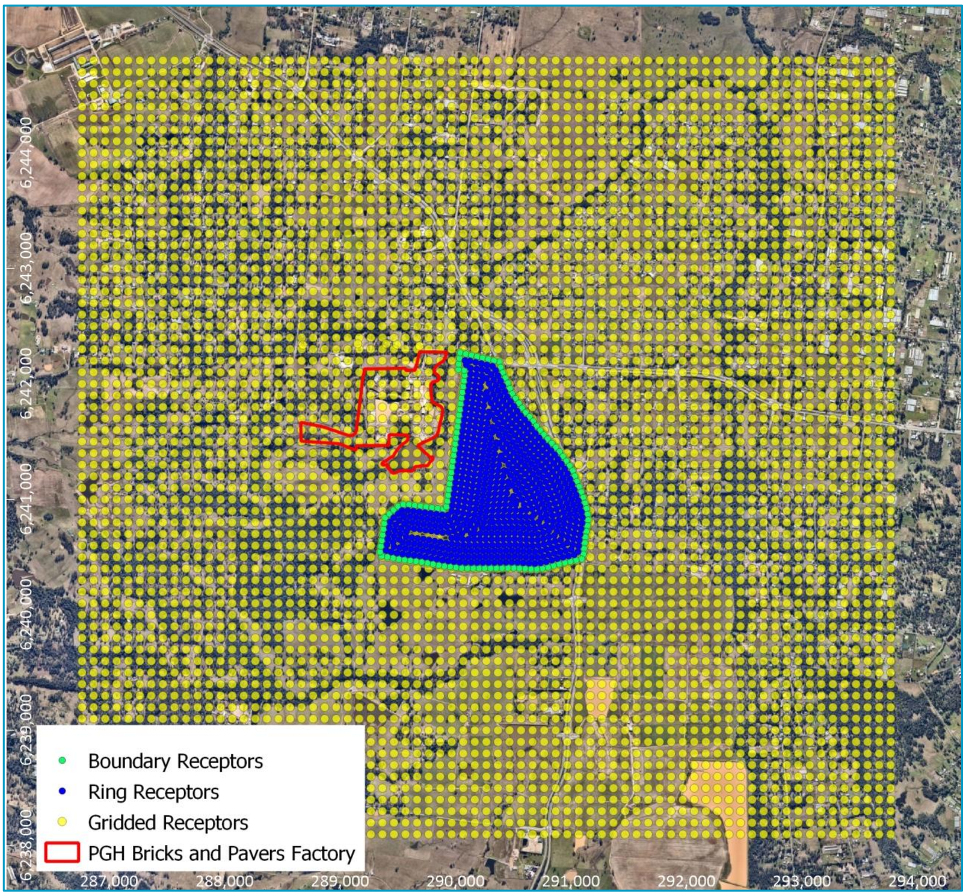
A summary of CALPUFF modelling options and parameters used for this assessment is provided in **Table 16**. The location of the modelled gridded receptors and the Site boundary ring receptors is illustrated in **Figure 19**. It is noted that the Site boundary ring receptors were included to appropriately capture impacts for individual toxic pollutants beyond the boundary.

Table 16 Model Parameters

Parameter	Option
Calculation Type	Concentration
Plume Rise Method	Briggs
Building Downwash	BPIP-PRIME
Gridded Receptors	7.5 km x 7.5 km with 100 m resolution; 0 m AGL centred on Site
Gridded Receptor Spacing	100 m
Site Boundary Ring Receptors	50 m spacing up to approximately 5200 m

AGL Above ground level

Figure 19 Modelled Receptors



6.3.2 Building Downwash

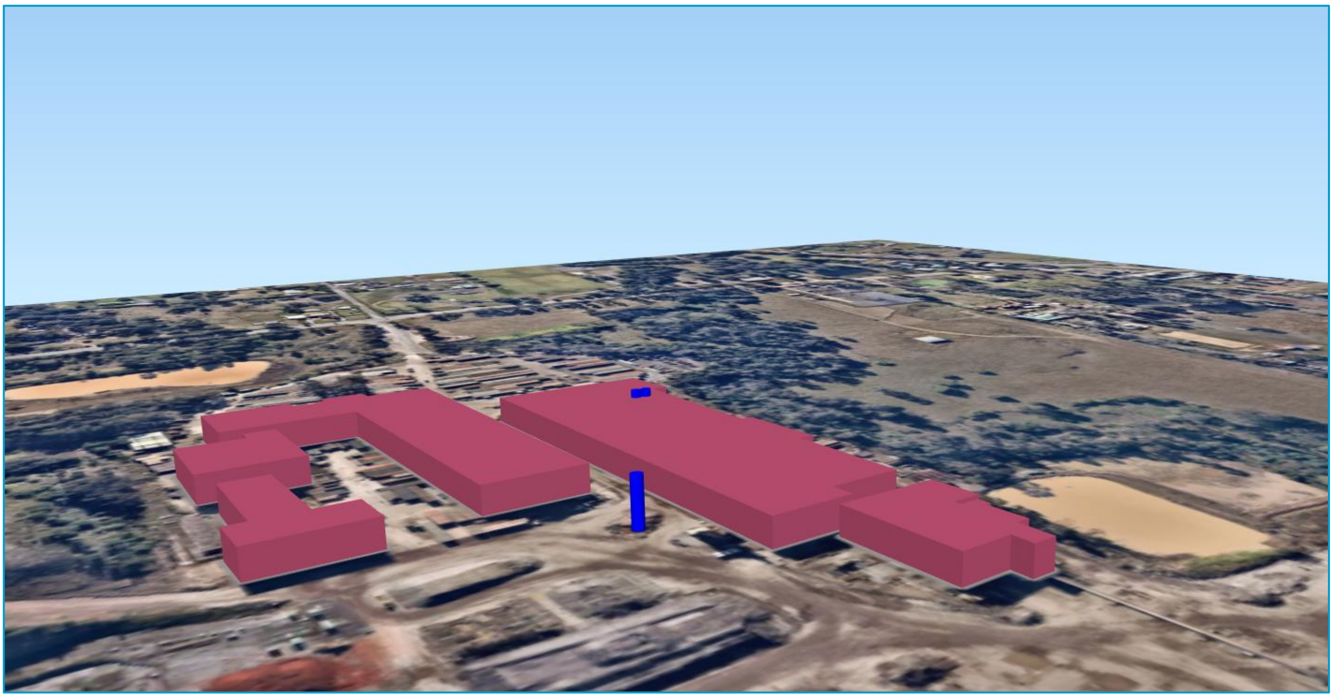
Building downwash is a phenomenon caused by structures near to pollutant emission sources influencing atmospheric turbulence. Airflow is rapidly mixed to the ground as frictional forces and pressure gradients cause stagnations and eddies to develop in the wake of buildings downwind of elevated sources.

The USEPA has established a Good Engineering Practice (GEP) stack height which is defined as the '*height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutants in the immediate vicinity of the source as a result of atmospheric downwash, eddies or wakes which may be created by the source itself, nearby structures or nearby terrain obstacles*' (USEPA, 1985). The definition of GEP stack height is the building height plus 1.5 times the lesser of the building height or projected building width.

CALPUFF contains the *Prime* algorithm which was used to predict building downwash effects. Influencing building dimensions were calculated using the USEPA's Building Profile Input Program (BPIP).

For modelling purposes, Bringelly Brickworks and neighbouring industrial buildings were included in the modelling to account for potential building wakes effect. The relative locations of the sources and buildings are illustrated in **Figure 20**.

Figure 20 Modelled Sources and Buildings



6.3.3 NO_x to NO_2 conversion

NO_x emitted from combustion processes mainly consist of NO with a small portion (approximately 10%) of NO_2. In the atmosphere however, NO emitted from the source oxidises to NO_2 in the presence of ozone (O_3) and sunlight as it travels further from the source. The rate of oxidation depends on a number of parameters including the ambient O_3 concentration. The Approved Methods lists a few methods that can be applied to take account the oxidation of NO to NO_2 in estimating downwind NO_2 concentrations at receptor locations.

However, as a conservative measure Method 1 (100% conversion) has been adopted for this assessment. This method is usually used as a screening level assessment and assumes 100% conversion of NO to NO_2 before the plume arrives at the receptor location. Use of this method can significantly over-predict NO_2 concentrations at nearfield receptors. Given the low regional background concentrations (see **Section 4.1**), the Method 1 (100% conversion) is adopted for this assessment.

6.3.4 Conversion of Averaging Times

For pollutants with short-term (sub-hourly) air quality impact assessment criteria, in the absence of specific guidance in the Approved methods, the short-term impacts have been estimated using the formula cited in the *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* (EPAV, 2013) as follows:

$$C_t = C(t_0) \times ({}^{t_0}/_{t})^{0.2}$$

Where

C_t = concentration for the longer time-averaging period

C_0 = concentration for the shorter time-averaging period

t_0 = longer averaging time

t = shorter averaging time

7 Dispersion Modelling Results

7.1 Particulates as PM_{10}

Table 17 present maximum 24-hour and annual average incremental and cumulative PM_{10} concentrations. As can be seen, the exceedances of the 24-hour average criterion are predicted on all boundaries, however western boundary is the worst impacted boundary.

Table 17 Maximum Predicted PM_{10} Concentrations at the Site Boundaries

Receptors	Incremental PM_{10}		Cumulative PM_{10}	
	24-hour	Annual	24-hour	Annual
	ug/m³		ug/m³	
Maximum on Northern Boundary	11.0	1.4	70.9	16.4
Maximum on Eastern Boundary	9.1	0.7	69.1	15.8
Maximum on Southern Boundary	6.5	0.3	69.0	15.3
Maximum on Western Boundary	14.2	1.3	69.3	16.4
Criteria			**50**	**25**

Daily varying background concentrations were adopted from the Bringelly AQMS for contemporaneous analysis of the cumulative assessment. In accordance with the Approved Methods, a contemporaneous analysis of the maximum predicted concentrations at the worst impacted receptor on the western boundary was performed and is presented in **Table 18**.

This analysis predicted no exceedances of the relevant 24-hour average criterion of 50 µg/m³ when predicted incremental impacts associated with the Bringelly Brickworks are high. Predicted exceedances are mainly associated with high background levels (caused by regional events such as bushfire) on these days with minimal (<1% of the criterion) incremental impact from the local sources.

Table 18 Summary of 24 hours Average PM_{10} Contemporaneous Analysis

Date	PM_{10} 24-Hour Average (µg/m³)			Date	PM_{10} 24-Hour Average (µg/m³)		
	Highest Background	Proposal Site Increment	Total		Background	Highest Proposal Site Increment	Total
27/04/2021	69.0	0.3	69.3	4/07/2021	6.7	14.2	20.9
3/05/2021	39.9	0.7	40.6	6/06/2021	16.2	13.6	29.8
9/10/2021	36.1	0.0	36.1	3/07/2021	13.2	10.1	23.3
23/01/2021	33.5	0.3	33.8	19/07/2021	11.1	10.0	21.1
21/08/2021	32.2	7.2	39.4	4/05/2021	30.5	9.4	39.9
8/10/2021	31.1	0.2	31.3	27/06/2021	10.1	9.1	19.2
7/10/2021	31.0	1.2	32.2	13/06/2021	12.0	9.1	21.1
4/05/2021	30.5	9.4	39.9	1/08/2021	14.4	9.1	23.5
14/04/2021	30.4	0.8	31.2	6/07/2021	14.4	8.5	22.9

Date	PM_{10} 24-Hour Average (µg/m³)			Date	PM_{10} 24-Hour Average (µg/m³)		
	Highest Background	Proposal Site Increment	Total		Background	Highest Proposal Site Increment	Total
2/06/2021	29.7	4.1	33.8	9/06/2021	6.0	7.8	13.8

Contour plots of the predicted incremental increase in 24-hour and annual average PM_{10} concentrations for Bringelly Brickworks are presented in **Appendix B**.

7.2 Particulates as $PM_{2.5}$

Table 19 present maximum 24-hour and annual average incremental and cumulative $PM_{2.5}$ concentrations. Similar to PM_{10}, the exceedances of the 24-hour average criterion are predicted at all boundaries, with western boundary is the worst impacted.

Table 19 Maximum Predicted $PM_{2.5}$ Concentrations at the Site Boundaries

Receptors	Incremental $PM_{2.5}$		Cumulative $PM_{2.5}$	
	24-hour	Annual	24-hour	Annual
	ug/m³		ug/m³	
Maximum on Northern Boundary	3.1	0.4	58.0	7.6
Maximum on Eastern Boundary	2.2	0.2	57.4	7.4
Maximum on Southern Boundary	1.5	0.1	57.4	7.3
Maximum on Western Boundary	3.3	0.4	57.5	7.6
Criteria			**25**	**8**

Daily varying background concentrations were adopted from the Bringelly AQMS for contemporaneous analysis of the cumulative assessment. In accordance with the Approved Methods, a contemporaneous analysis of the maximum predicted concentrations at the worst impacted receptor on the western boundary was performed and is presented in **Table 20**.

This analysis shows no exceedances of the relevant 24-hour average criterion of 25 µg/m³ when predicted incremental impacts associated with the Bringelly Brickworks are high. Predicted exceedances are mainly associated with high background levels (caused by regional events such as bushfire) on these days with minimal (<1% of the criterion) incremental impact from the local sources.

Table 20 Summary of 24 hours Average $PM_{2.5}$ Contemporaneous Analysis

Date	$PM_{2.5}$ 24-Hour Average (µg/m³)			Date	$PM_{2.5}$ 24-Hour Average (µg/m³)		
	Highest Background	Proposal Site Increment	Total		Background	Highest Proposal Site Increment	Total
27/04/2021	57.4	0.1	57.5	4/07/2021	5.8	3.3	9.1
4/05/2021	27.3	2.1	29.4	6/06/2021	15.2	3.0	18.2
3/05/2021	25.7	0.2	25.9	1/08/2021	9.3	2.6	11.9

Date	$PM_{2.5}$ 24-Hour Average (µg/m³)			Date	$PM_{2.5}$ 24-Hour Average (µg/m³)		
	Highest Background	Proposal Site Increment	Total		Background	Highest Proposal Site Increment	Total
9/10/2021	22.8	0.0	22.8	18/07/2021	4.4	2.5	6.9
21/08/2021	19.7	1.7	21.4	13/06/2021	12.1	2.5	14.6
23/07/2021	18.0	0.0	18.0	19/07/2021	9.4	2.5	11.9
10/10/2021	17.6	0.6	18.2	18/06/2021	6.9	2.4	9.3
28/04/2021	17.0	0.1	17.1	3/07/2021	9.6	2.4	12.0
29/04/2021	16.6	0.3	16.9	4/08/2021	3.0	2.3	5.3
29/04/2021	16.6	0.3	16.9	5/10/2021	4.7	2.3	7.0

Contour plots of the predicted incremental increase in 24-hour and annual average $PM_{2.5}$ concentrations for Bringelly Brickworks are presented in **Appendix B**.

7.3 Particles as TSP

Table 21 presents the incremental and cumulative annual average TSP concentrations predicted at each of the Site boundaries.

Table 21 Predicted Incremental and Cumulative Annual Average TSP Concentrations

Receptors	Annual Average TSP Concentrations (µg/m³)		
	Regional Background	Incremental Impact	Cumulative Impact
Maximum on Northern Boundary	30.1	2.2	32.3
Maximum on Eastern Boundary	30.1	1.1	31.2
Maximum on Southern Boundary	30.1	0.4	30.5
Maximum on Western Boundary	30.1	2.1	32.2
Criterion			**90**

Table 21 indicate that the predicted cumulative concentrations at all the boundaries are well below the annual average TSP criterion of 90 µg/m³. Contour plots of the predicted incremental increase in annual average TSP concentrations for Bringelly Brickworks are presented in **Appendix B**.

7.4 Dust Deposition

Table 22 presents the incremental and cumulative annual average dust deposition rates predicted at each of the Site boundaries.

Table 22 Predicted Annual Average Dust Deposition Rates

Receptors	Annual Average Dust Deposition Rate ($g/m^2/month$)		
	Regional Background	Incremental Impact	Cumulative Impact
Maximum on Northern Boundary	2.0	<0.1	<2.1
Maximum on Eastern Boundary	2.0	<0.1	<2.1
Maximum on Southern Boundary	2.0	<0.1	<2.1
Maximum on Western Boundary	2.0	0.1	2.1
Criterion			**4**

Table 22 indicates that the predicted incremental and cumulative annual average dust deposition rates at both receptors are well below the criterion of 2 $g/m^2/month$ (incremental increase in dust deposition) and below 4 $g/m^2/month$ (cumulative dust deposition).

Contour plots of the predicted incremental increase annual average dust deposition rates for Bringelly Brickworks are presented in **Appendix B**.

7.5 CO

Table 23 presents the maximum incremental and cumulative 15-minute, 1-hour and 8-hour average CO concentrations predicted at the Site Boundaries. Due to the insignificant incremental increase of CO predicted at the Site boundaries, exceedances of the relevant CO criteria at the site is highly unlikely.

Contour plots of the predicted incremental increase in 15-minute, 1-hour and 8-hour average CO concentrations are presented in **Appendix B**.

Table 23 Predicted CO Concentrations at the Site Boundaries

Receptors	Incremental CO			Cumulative CO		
	15-minute	1-hour	8-hour	15-minute	1-hour	8-hour
	mg/m^3			mg/m^3		
Maximum on Northern Boundary	0.04	0.03	0.03	4.1	3.1	1.8
Maximum on Eastern Boundary	0.04	0.03	0.02	4.1	3.1	1.7
Maximum on Southern Boundary	0.03	0.02	0.01	4.1	3.1	1.7
Maximum on Western Boundary	0.08	0.06	0.03	4.2	3.2	1.8
Criteria				**100**	**30**	**10**

1 The 1-hour average CO concentrations predicted by the modelling were converted to 15-minute averages using the power law formula.

2 The 1-hour average CO concentrations are compared with 8-hour average CO criterion as a conservative approach

7.6 NO_2

Table 24 presents the incremental and cumulative maximum 1-hour and annual average NO_2 concentrations predicted at the Site Boundaries. Given low incremental impacts predicted by the model, exceedances of the maximum 1-hour and annual average NO_2 criteria were not observed. As noted in **Section 6.3.3**, this assessment has conservatively assumed 100% conversion of NO to NO_2.

Contour plots of the predicted incremental increase in maximum 1-hour and annual average NO_2 concentrations are presented in **Appendix B**.

Table 24 Predicted NO_2 Concentrations at the Site Boundaries

Receptors	Incremental NO_2		Cumulative NO_2	
	1-hour	Annual	1-hour	Annual
	ug/m³		ug/m³	
Maximum on Northern Boundary	24.4	0.9	69.5	7.4
Maximum on Eastern Boundary	19.4	0.5	64.5	7.0
Maximum on Southern Boundary	13.8	0.2	58.9	6.7
Maximum on Western Boundary	39.7	1.2	84.9	7.7
Criteria			**246**	**62**

7.7 SO_2

Table 25 presents the maximum incremental 10-minute, 1-hour, 24-hour, and annual average SO_2 concentrations predicted at the Site Boundaries. No exceedances of the relevant SO_2 criteria due to the operation of the Facility are predicted.

Contour plots of the predicted incremental increase in 10-minute average, 1-hour average, 24-hour average, and annual average SO_2 concentrations are presented in **Appendix B**.

Table 25 Predicted SO_2 Concentrations at the Site Boundaries

Receptors	Incremental SO_2				Cumulative SO_2			
	10-minute	1-hour	24-hour	Annual	10-minute	1-hour	8-hour	Annual
	ug/m³				ug/m³			
Maximum on Northern Boundary	46.5	32.5	15.6	0.9	80.3	56.1	20.8	1.9
Maximum on Eastern Boundary	39.9	27.9	7.4	0.6	73.6	51.4	12.7	1.6
Maximum on Southern Boundary	27.4	19.2	4.3	0.2	61.2	42.7	9.6	1.2
Maximum on Western Boundary	85.9	60.0	18.1	1.3	119.6	83.6	23.4	2.3
Criteria					**712**	**570**	**228**	**60**

* The 1-hour average SO2 concentrations predicted by the modelling were converted to 10-minute averages using the power law formula

7.8 Hydrogen Fluoride

Table 26 presents the maximum incremental 24-hour average HF concentrations predicted at the Site Boundaries. Given the insignificant incremental increase of HF predicted at these receptors, exceedances of the relevant HF criteria due to the operation of the Facility are considered unlikely. Contour plots of the predicted incremental increase in 24-hour average HF concentrations are presented in **Appendix B**.

Table 26 Predicted HF Concentrations at the Site Boundaries

Receptors	Incremental HF 24-hour ug/m³
Maximum on Northern Boundary	1.6
Maximum on Eastern Boundary	0.8
Maximum on Southern Boundary	0.5
Maximum on Western Boundary	1.9
Criteria	**2.9**

7.9 Individual Toxic Air Pollutants

Table 27 and **Table 28** present the 99.9th percentile incremental 1-hour average concentrations for all modelled toxic air pollutants. Model predictions show that all pollutants in this category comply with the relevant criteria at all modelled locations within the Site boundary.

Due to the very low concentrations of other air toxics predicted by the modelling, concentration contour plots have not been presented for other air toxic pollutants. As the predicted downwind concentrations are proportional to the mass emission rate, the distribution of 1-hour average pollutant concentrations for other air toxics will show the similar plume distribution as that presented in **Figure 21** for HCl, albeit at lower levels proportional to the relative emission rates.

Table 27 Predicted 99.9th Percentile 1-hour Average Incremental Impacts for Metals and Type 1 & Type 2 Substances at and Beyond the Site Boundary

Receptors	99.9th Percentile 1-Hour Average Concentrations (µg/m³)			
	Arsenic & compounds	Beryllium & compounds	Manganese & compounds	Mercury (organic)
Maximum on Northern Boundary	0.002	0.00003	0.2	0.0005
Maximum on Eastern Boundary	0.001	0.00002	0.1	0.0003
Maximum on Southern Boundary	0.001	0.00001	0.1	0.0002
Maximum on Western Boundary	0.002	0.00003	0.2	0.0005
Percentage of Criterion	**2.5%**	**0.7%**	**1.1%**	**0.3%**
Criteria	**0.09**	**0.004**	**18**	**0.18**

Figure 21 Contour Plot of 99.9th Percentile HCl Concentrations

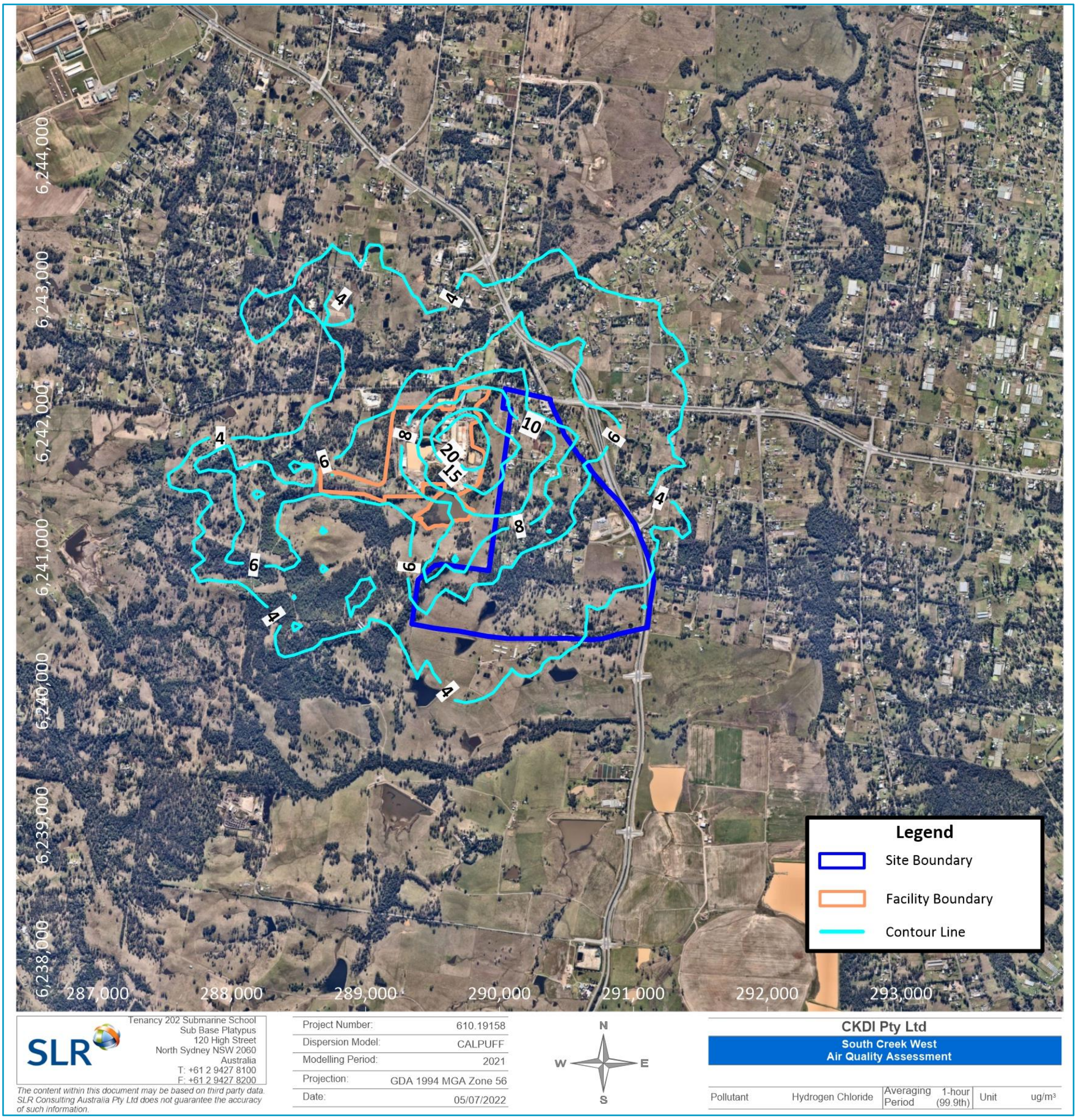


Table 28 Predicted 99.9th Percentile 1-hour Average Incremental Impacts for HCl and VOCs at and Beyond the Site Boundary

Receptors	99.9th Percentile 1-Hour Average Concentrations (µg/m³)										
	Acetone	Benzene	Carbon disulfide	Chlorine	Chloro-ethane	Ethylbenzene	HCl	Styrene	Tetra-chloroethane	Toluene	Xylenes
Maximum on Northern Boundary	0.1	0.2	0.2	0.2	0.2	0.2	10.0	0.2	0.05	0.1	0.2
Maximum on Eastern Boundary	0.1	0.1	0.1	0.1	0.1	0.1	8.6	0.1	0.03	0.1	0.1
Maximum on Southern Boundary	<0.1	0.1	0.1	0.1	0.1	0.1	5.9	0.1	0.01	<0.1	0.1
Maximum on Western Boundary	0.1	0.2	0.2	0.2	0.2	0.2	18.5	0.2	0.07	0.1	0.2
Percentage of Criterion	**0.0%**	**0.7%**	**0.3%**	**0.4%**	**0.0%**	**0.0%**	**13.2%**	**0.2%**	**0.0%**	**0.0%**	**0.1%**
Criteria	**22000**	**29**	**70**	**50**	**48000**	**8000**	**140**	**120**	**3500**	**360**	**190**

8 Conclusions

SLR has been commissioned by CKDI Pty Ltd to prepare an AQIA for the rezoning of the Northwest Precinct (Precinct 2 – the Site) within the South Creek West Land Release Area (SCWLRA) in southwest Sydney, NSW.

The purpose of this report is to assess the potential air quality impacts associated with operations within the existing Bringelly Brickworks, and comparison of predicted off-site pollutant concentrations against the most recent state and national air quality criteria.

Emission estimation and dispersion modelling was conducted to predict potential air quality impacts associated with the Bringelly Brickworks operations on the Site. Emission rates of these pollutants were obtained from AQIA for Bringelly Brickworks prepared by Wilkinson Murray (Wilkinson Murray , 2013), and scaled to reflect the latest modification application (MOD 2) to extract up to 350,000 tpa of clay/shale. The modelling was performed using the CALPUFF model and site-representative, 3-dimensional meteorological data generated using a combination of TAPM/CALMET models for the 2021 calendar year.

To enable an assessment of potential cumulative air quality impacts, regional background PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2 concentrations were established based on monitoring data collected by the Bringelly and Camden AQMSs operated by the NSW DES for the 2021 calendar year.

The dispersion modelling study predicted that the off-site long term particulate concentrations and annual average dust deposition rates would be below the respective NSW EPA criteria, however exceedances of 24-hour average PM_{10} and 24-hour average $PM_{2.5}$ concentrations were predicted on a number of days. A detailed review of the maximum predicted 24-hour average concentrations at the site boundary showed that:

- The predicted exceedances of the 24-hour average PM_{10} criterion occur on days of existing high backgrounds (> 50 µg/m³) caused due to exceptional weather events (eg bushfires). The incremental impact of Bringelly Brickworks on these days are negligible. No exceedances were predicted on days with high incremental contribution at the Site.
- The predicted exceedances of the 24-hour average $PM_{2.5}$ criterion showed similar pattern with exceedances predicted on days with high background levels (> 25 µg/m³) caused by the exceptional weather events (eg bushfires). The incremental impact of Bringelly Brickworks on these days is negligible. No exceedances were predicted on days with high incremental contribution at the Site.

Given above, it is concluded that the existing Bringelly Brickworks operation of is highly unlikely to cause any additional exceedances of the 24-hour average PM_{10} and $PM_{2.5}$ criterion at the South West Creek Precinct 2.

No exceedances of other pollutants including product of combustion were predicted by the model within the proposed site boundary.

Based on the results of this assessment, it is concluded that the air quality impacts do not represent a constraint to this Development application.

9 References

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APPENDIX A

Selection of Representative Meteorological Year

Meteorological data collected over the period 2017-2021 at Badgerys Creek AWS (Station #67108), located approximately 5.0 km to the north of the Site, was analysed to select a representative year for dispersion modelling. The analysis showed that data collected during the 2021 calendar year are in reasonably good agreement with 5-year averages and was therefore selected for use in this assessment.

Data collected by the Parkes Airport AWS from 2017-2021 is summarised in **Figure A1** to **Figure A3**. Examination of the data indicates the following:

- **Figure A1** indicates relatively similar wind direction frequencies for all years analysed;
- **Figure A2** indicates that 2019 and 2021 exhibit wind speeds that are closest to the 5-year average; and
- **Figure A3** shows that temperatures in 2018 and 2021 most closely reflect the 5-year average.

Figure A1 Frequency of Winds at Badgerys Creek AWS for 2017-2021

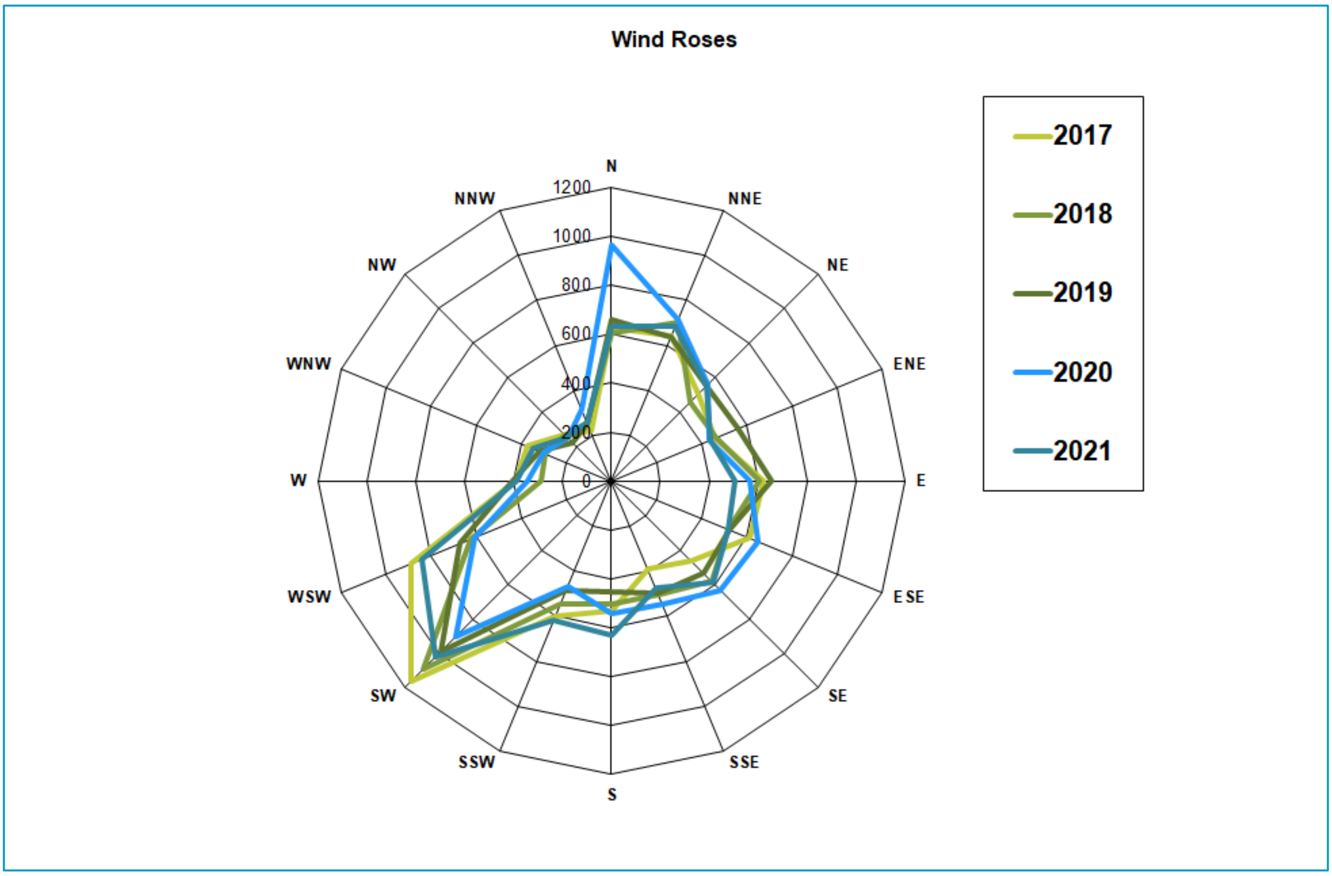


Figure A2 Monthly Average Wind Speed at Badgerys Creek AWS for 2017-2021

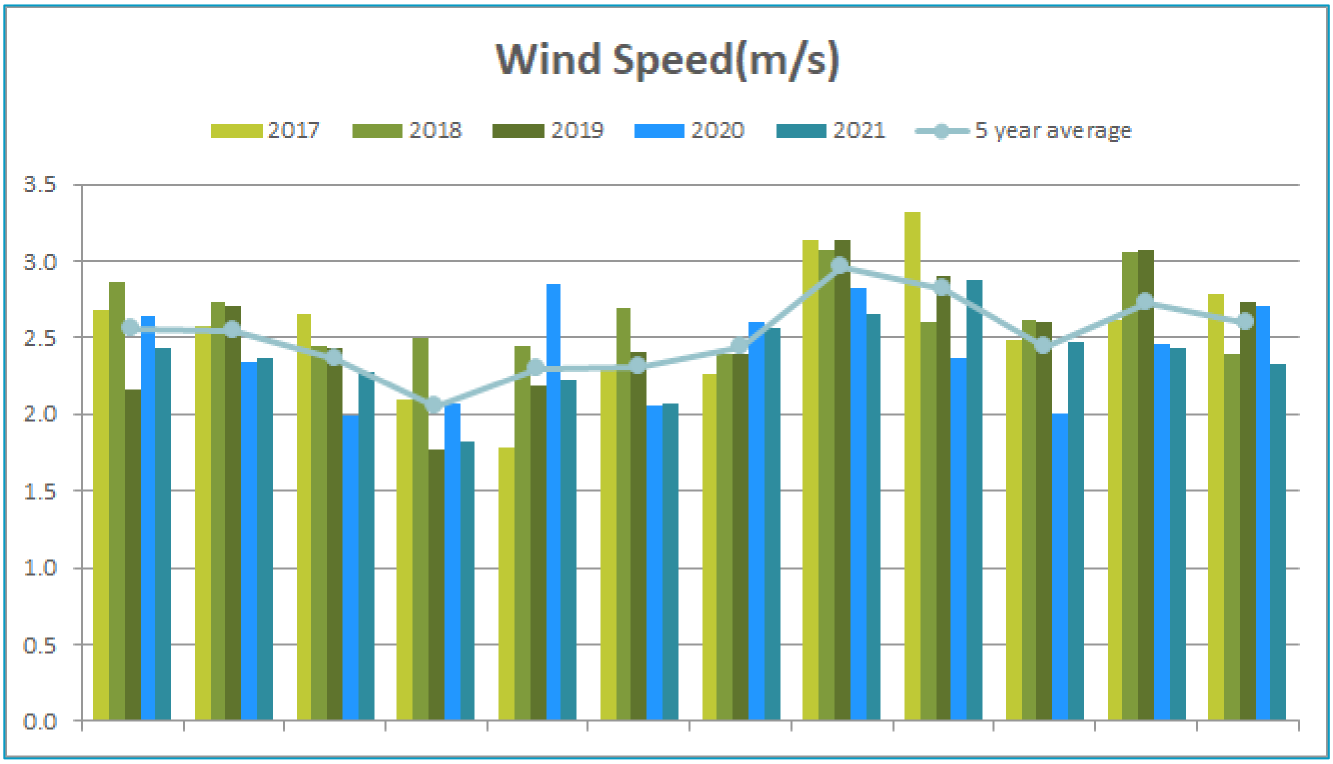
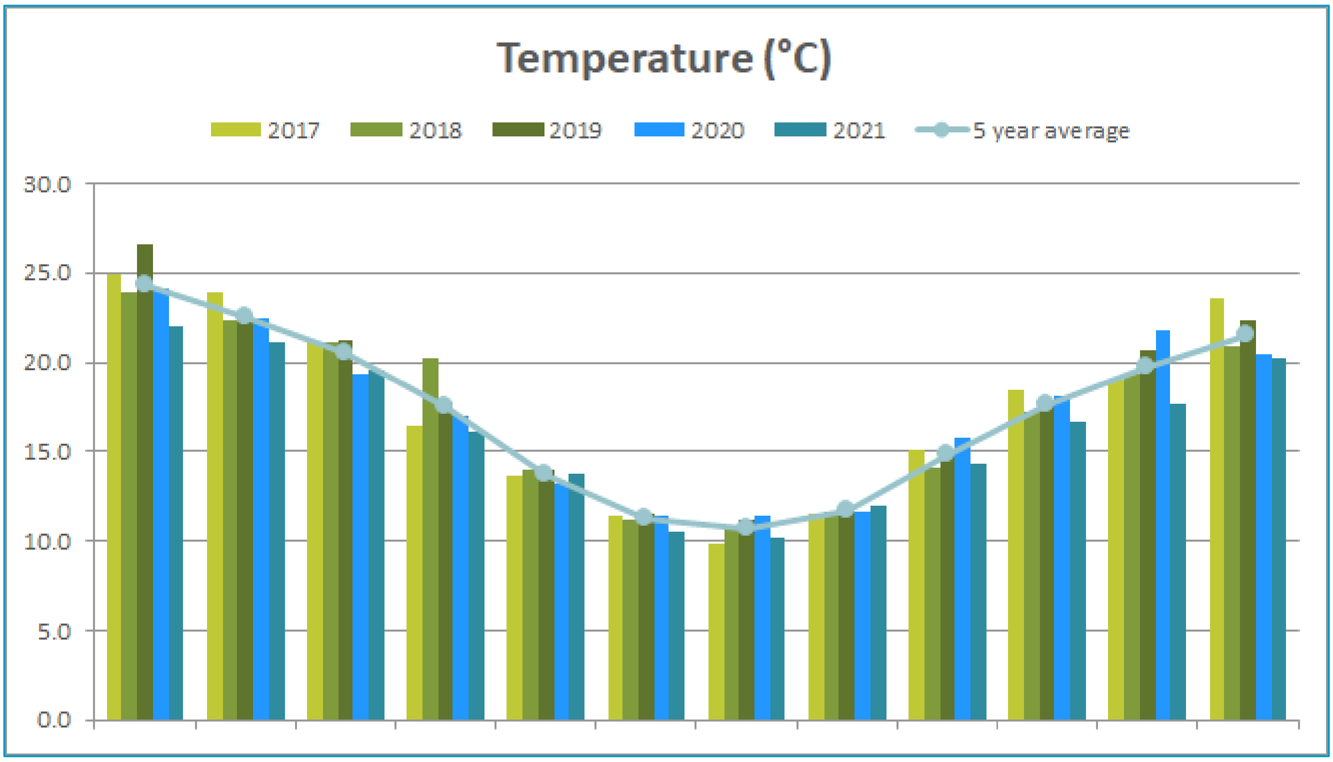


Figure A3 Monthly Average Temperature at Badgerys Creek AWS for 2017-2021



APPENDIX B

Isopleth Plots

Figure B-1 Predicted 24-Hour Average Incremental PM_{10} Isopleth Plot

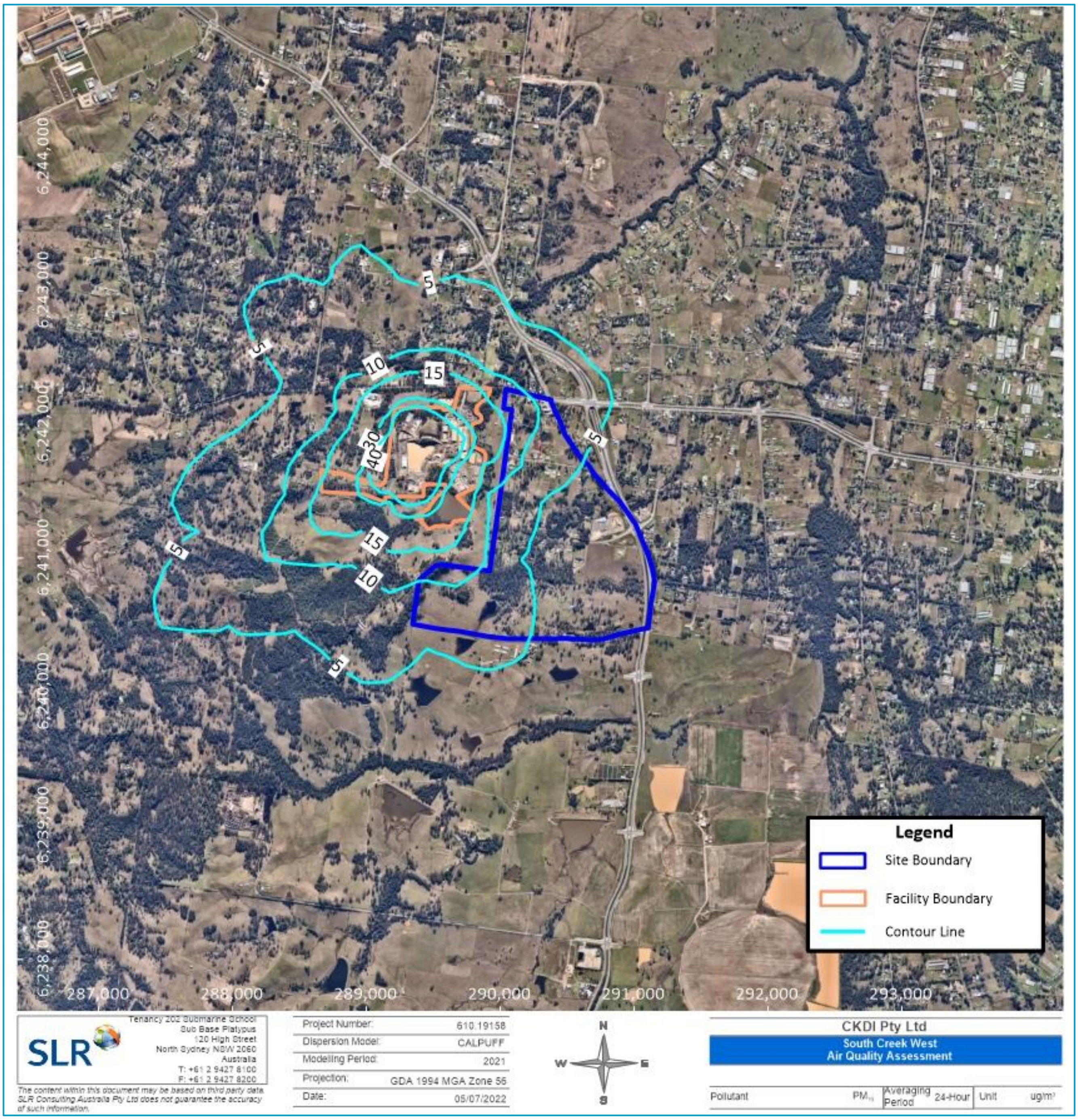


Figure B-2 Predicted Annual Average Incremental PM_{10} Isopleth Plot

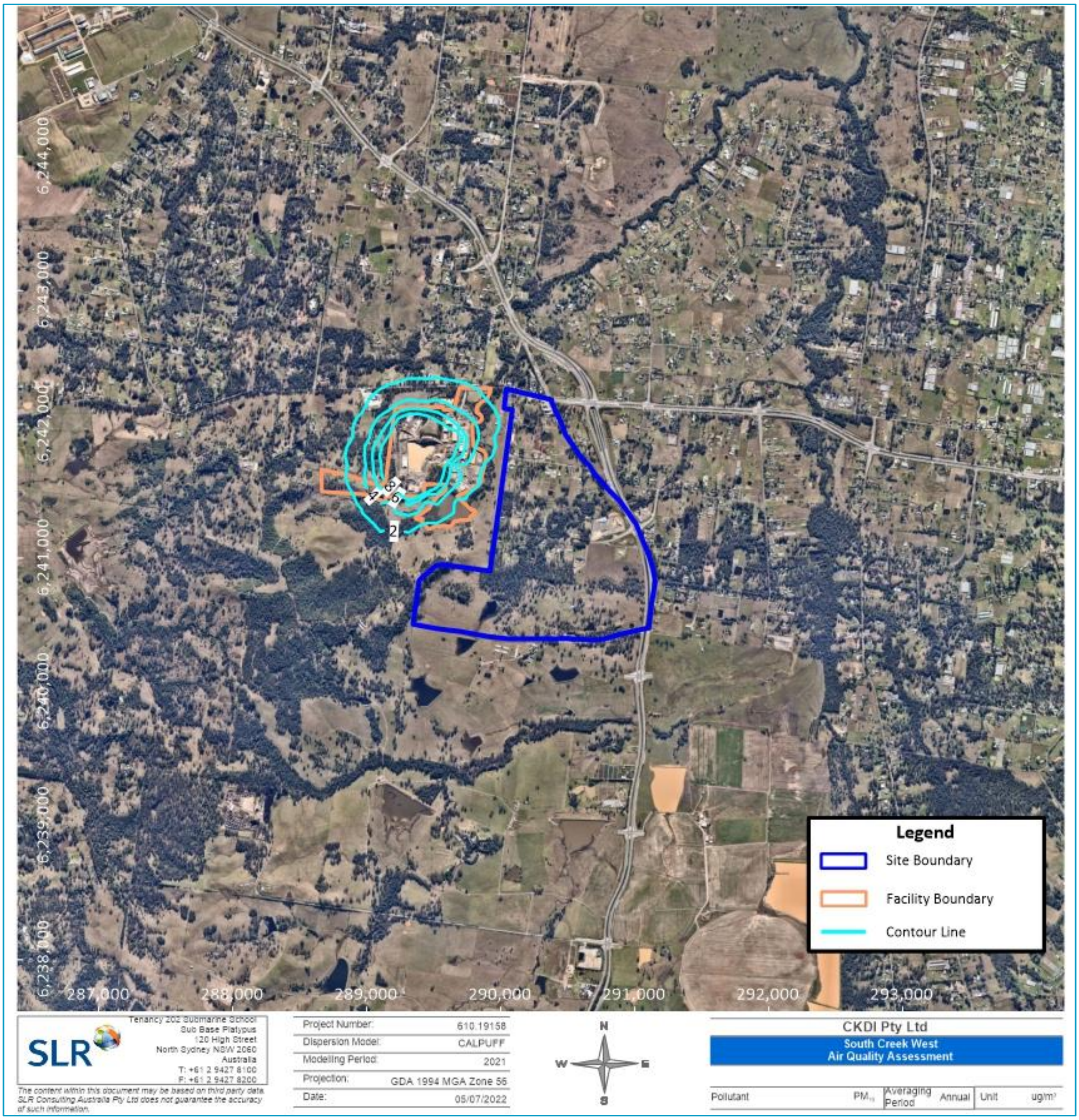


Figure B-3 Predicted Annual Average Incremental TSP Isopleth Plot

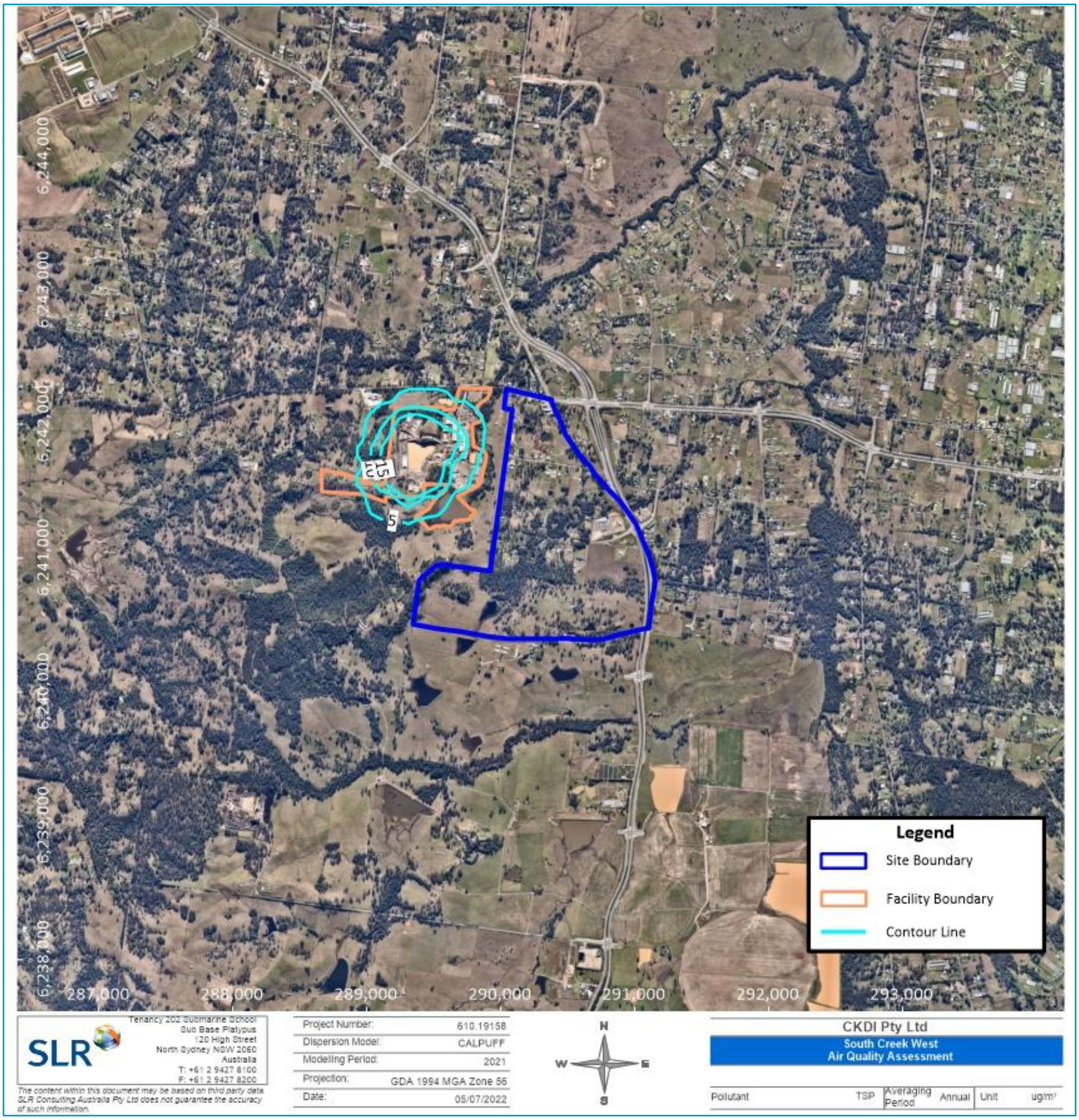


Figure B-4 Predicted Annual Average Incremental Dust Isopleth Plot

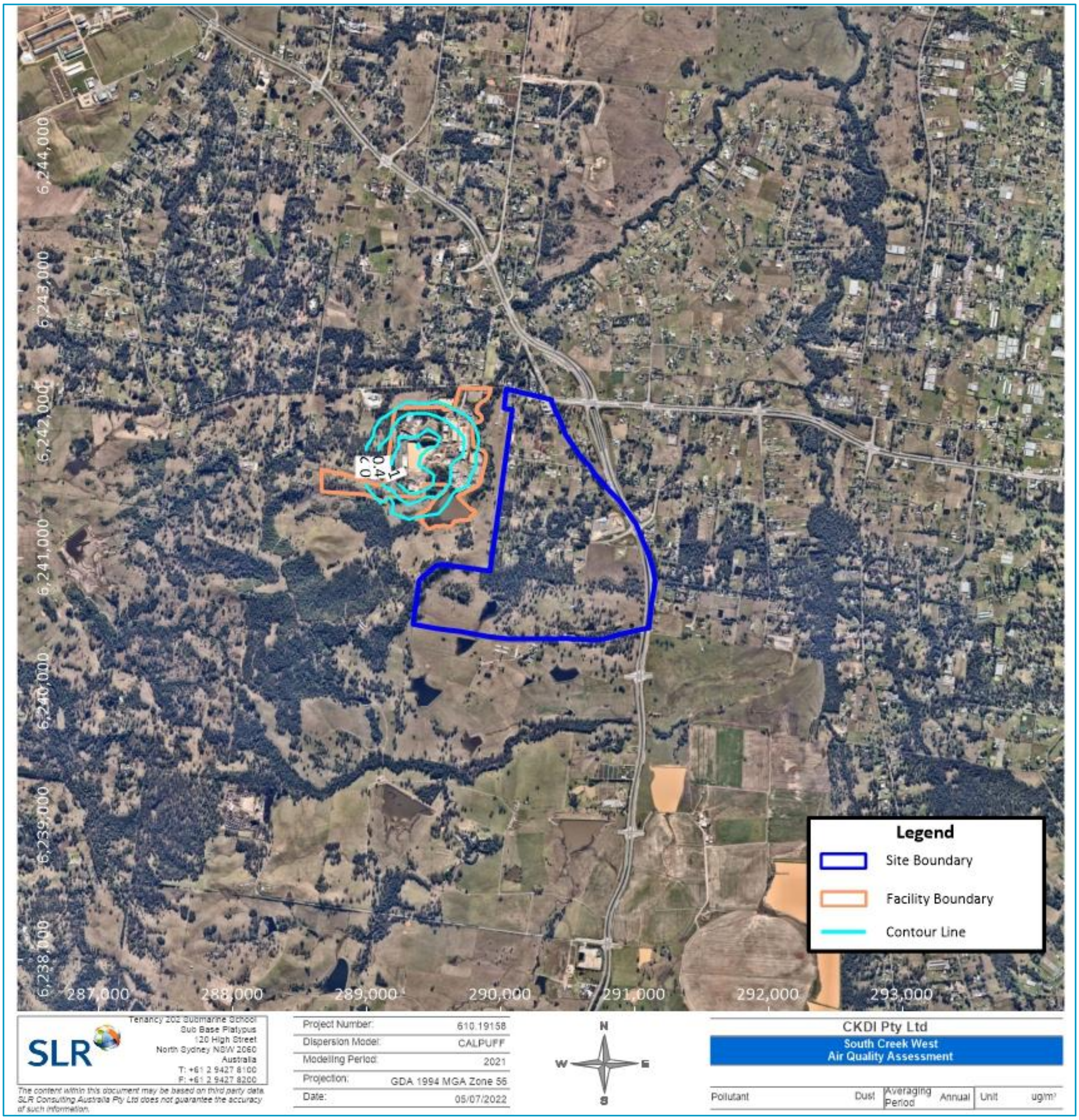


Figure B-5 Predicted 24-Hour Average Incremental $PM_{2.5}$ Isopleth Plot

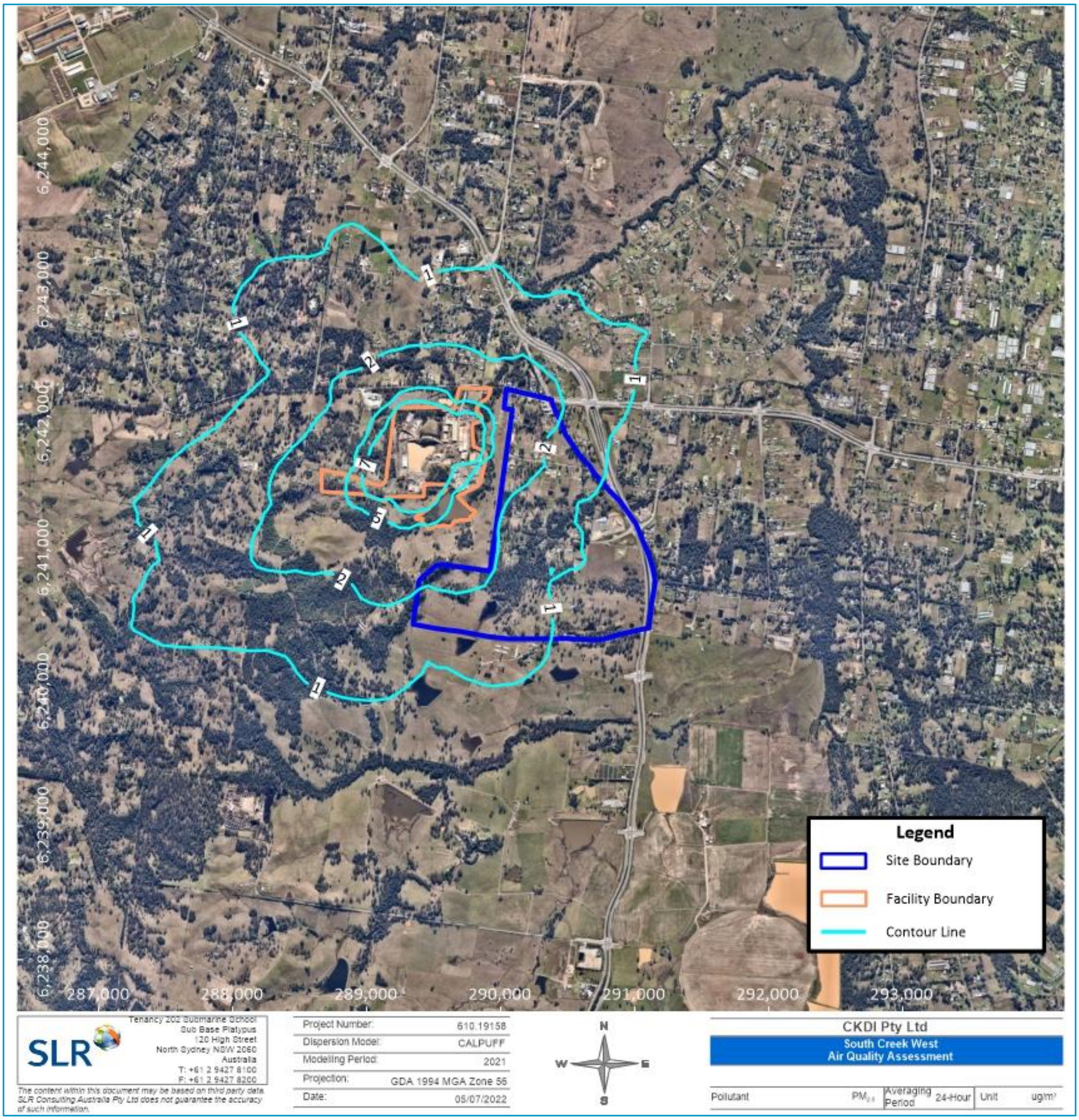


Figure B-6 Predicted Annual Average Incremental $PM_{2.5}$ Isopleth Plot

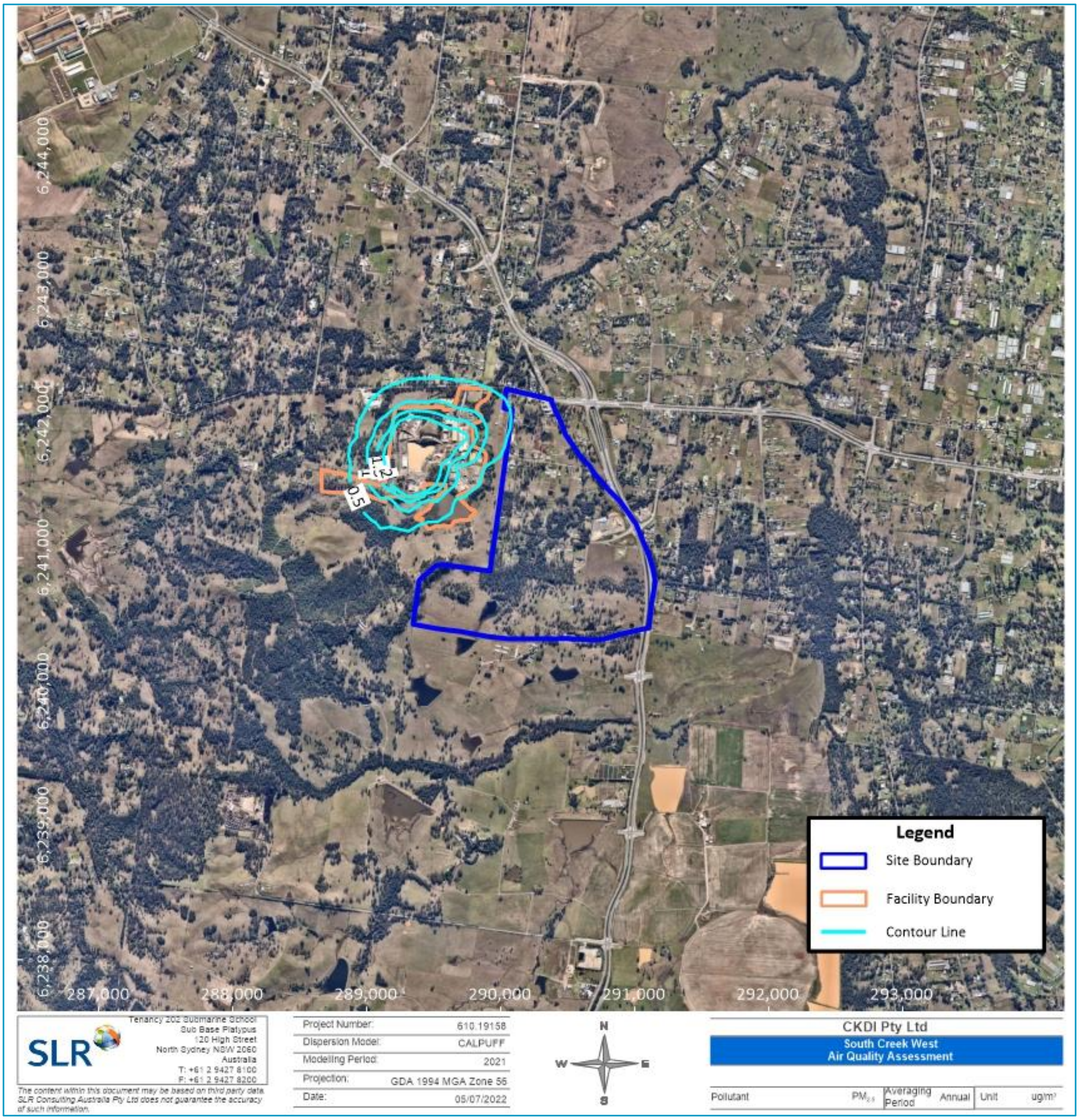


Figure B-7 Predicted 15-minute Average Incremental CO Isopleth Plot

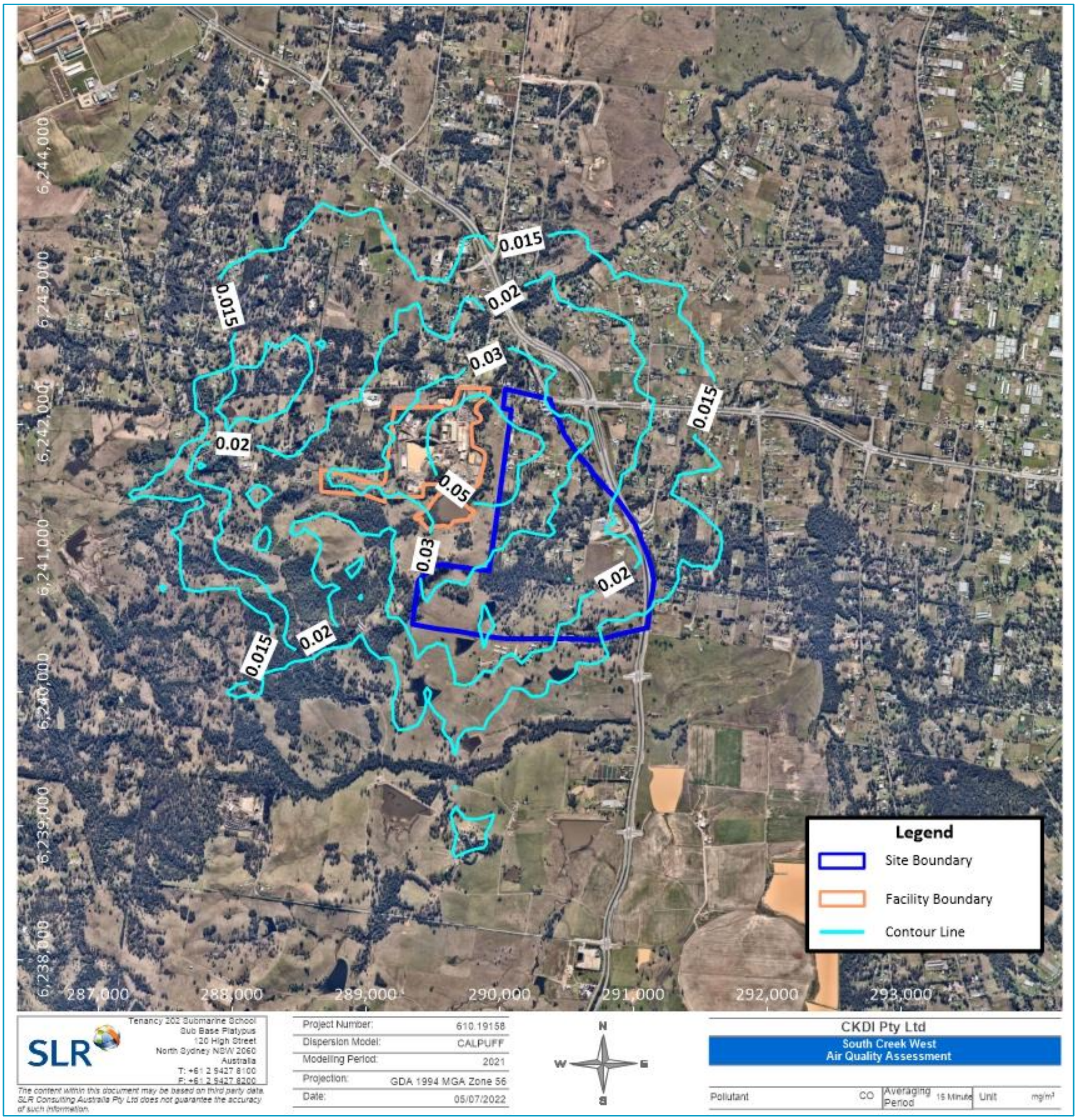


Figure B-8 Predicted 1-Hour Average Incremental CO Isopleth Plot

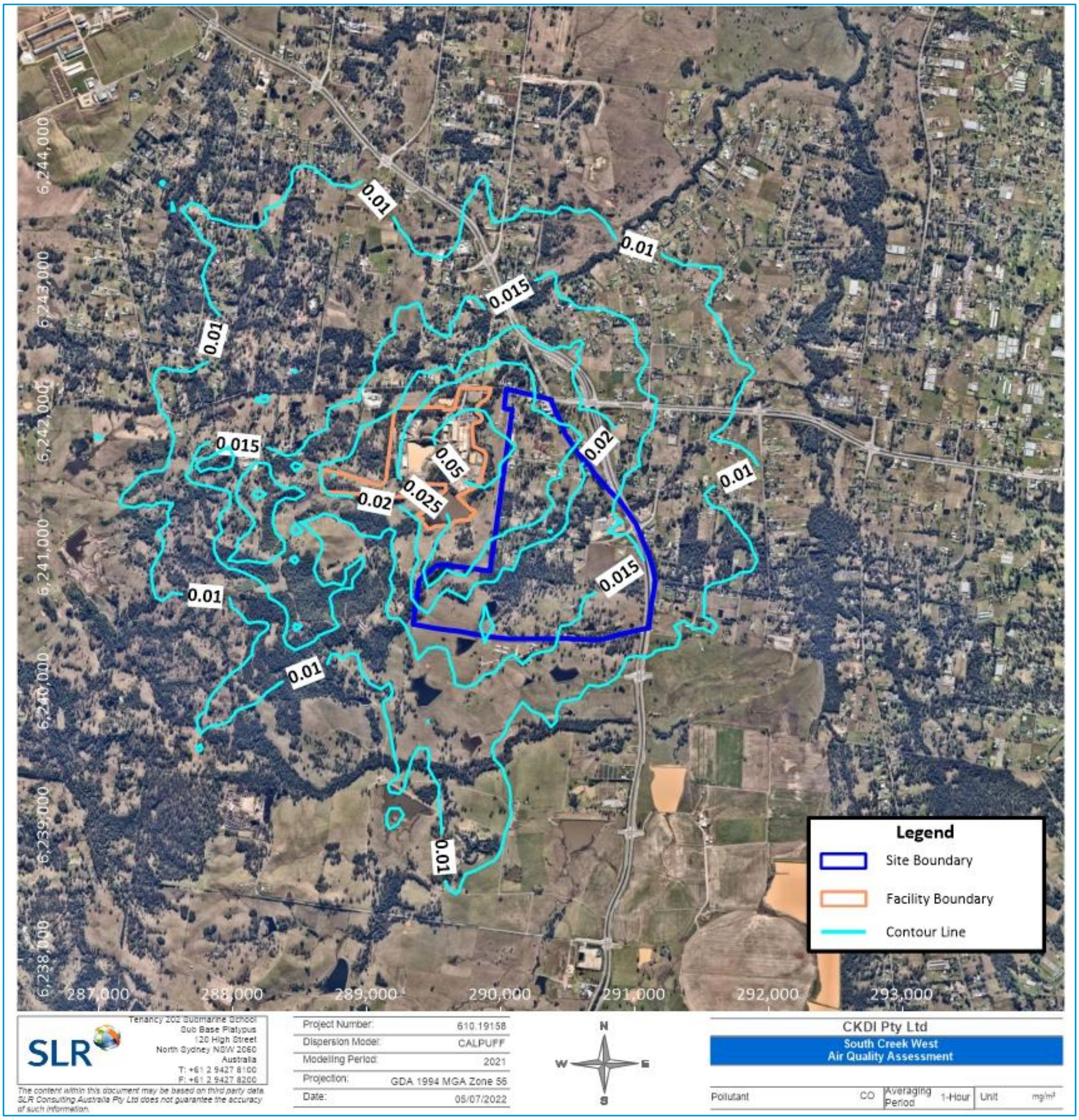


Figure B-9 Predicted 8-Hour Average Incremental CO Isopleth Plot

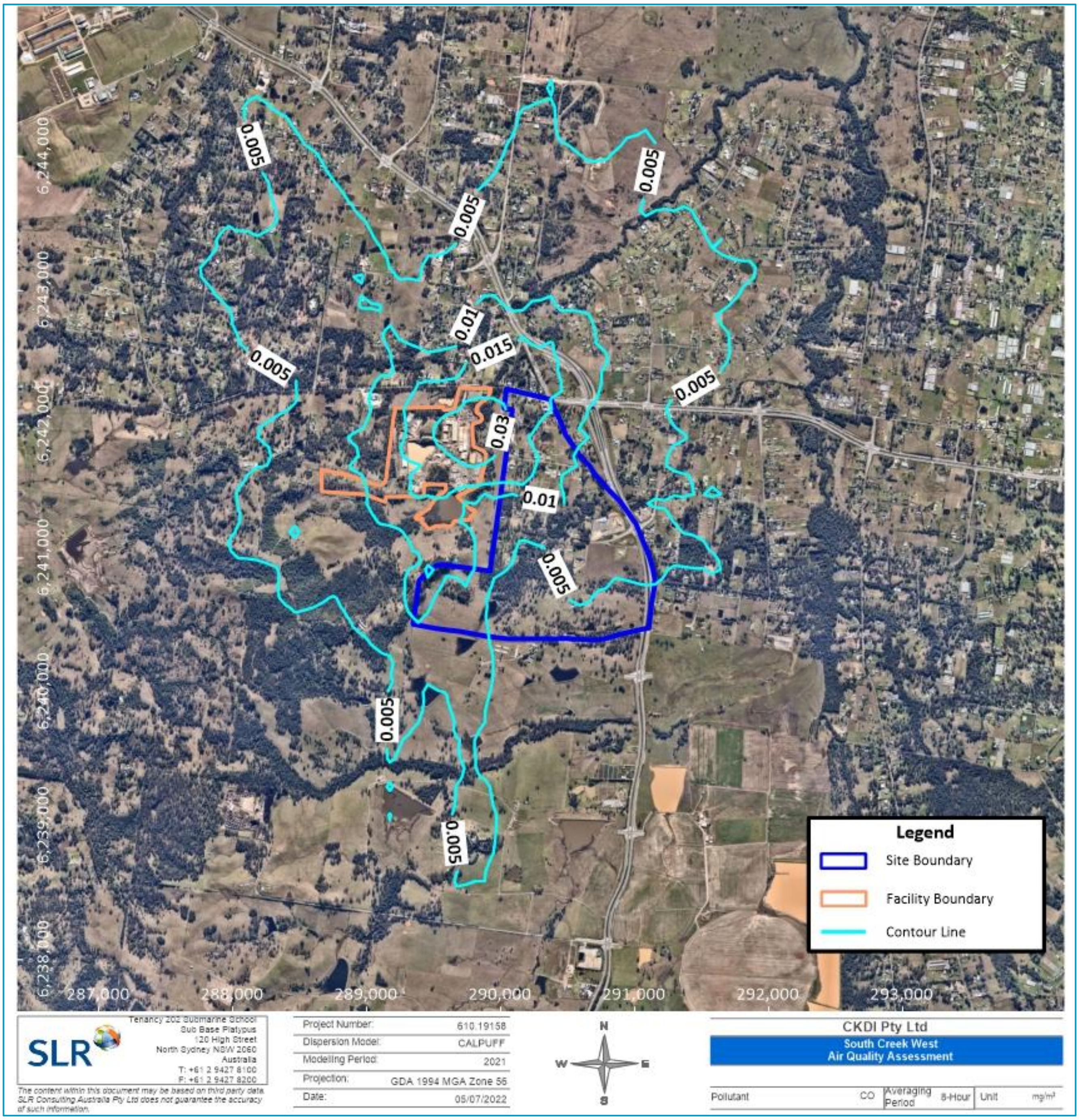


Figure B-10 Predicted 1-Hour Average Incremental NO_2 Isopleth Plot

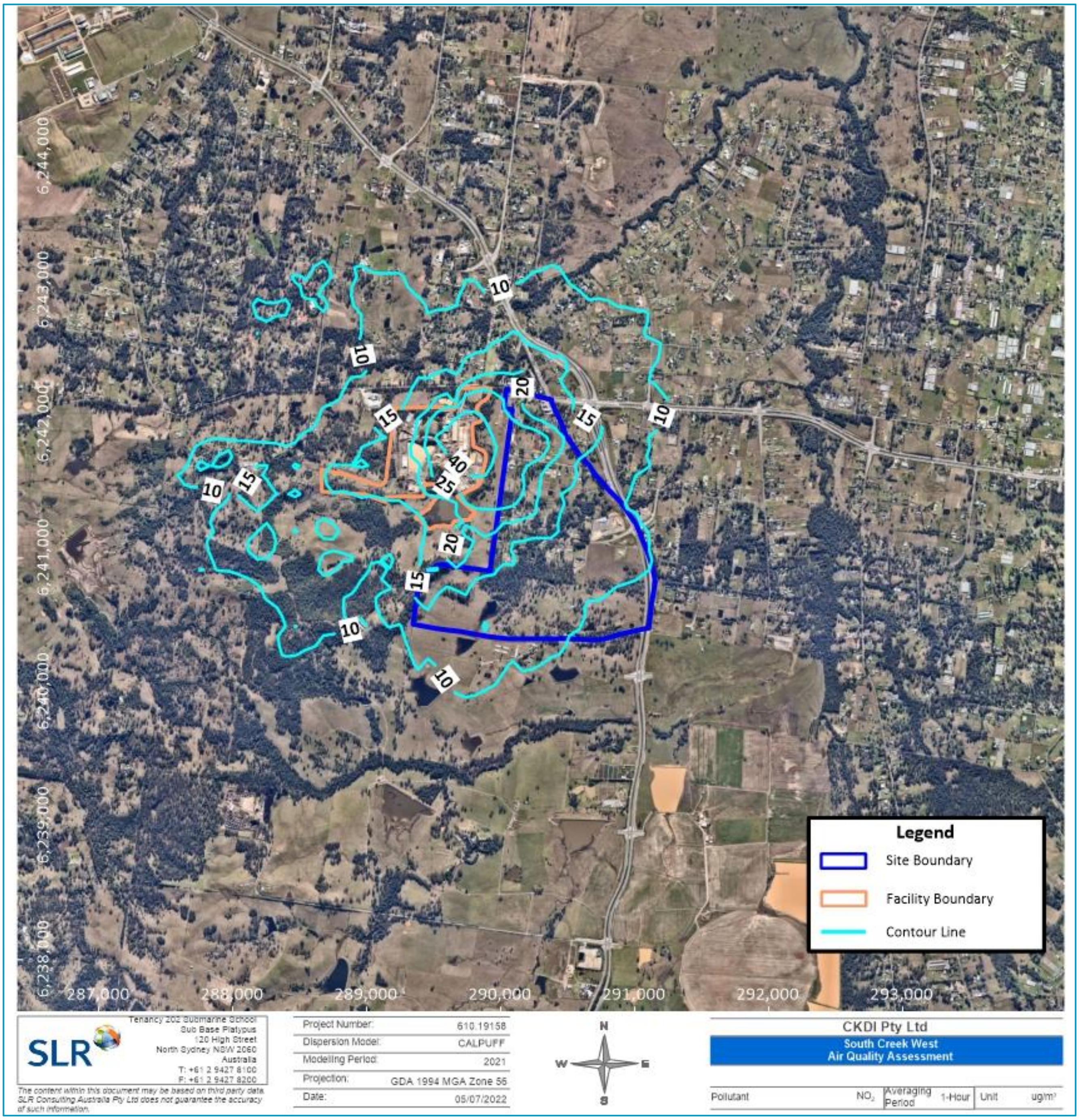


Figure D-11 Predicted Annual Average Incremental NO_2 Isopleth Plot

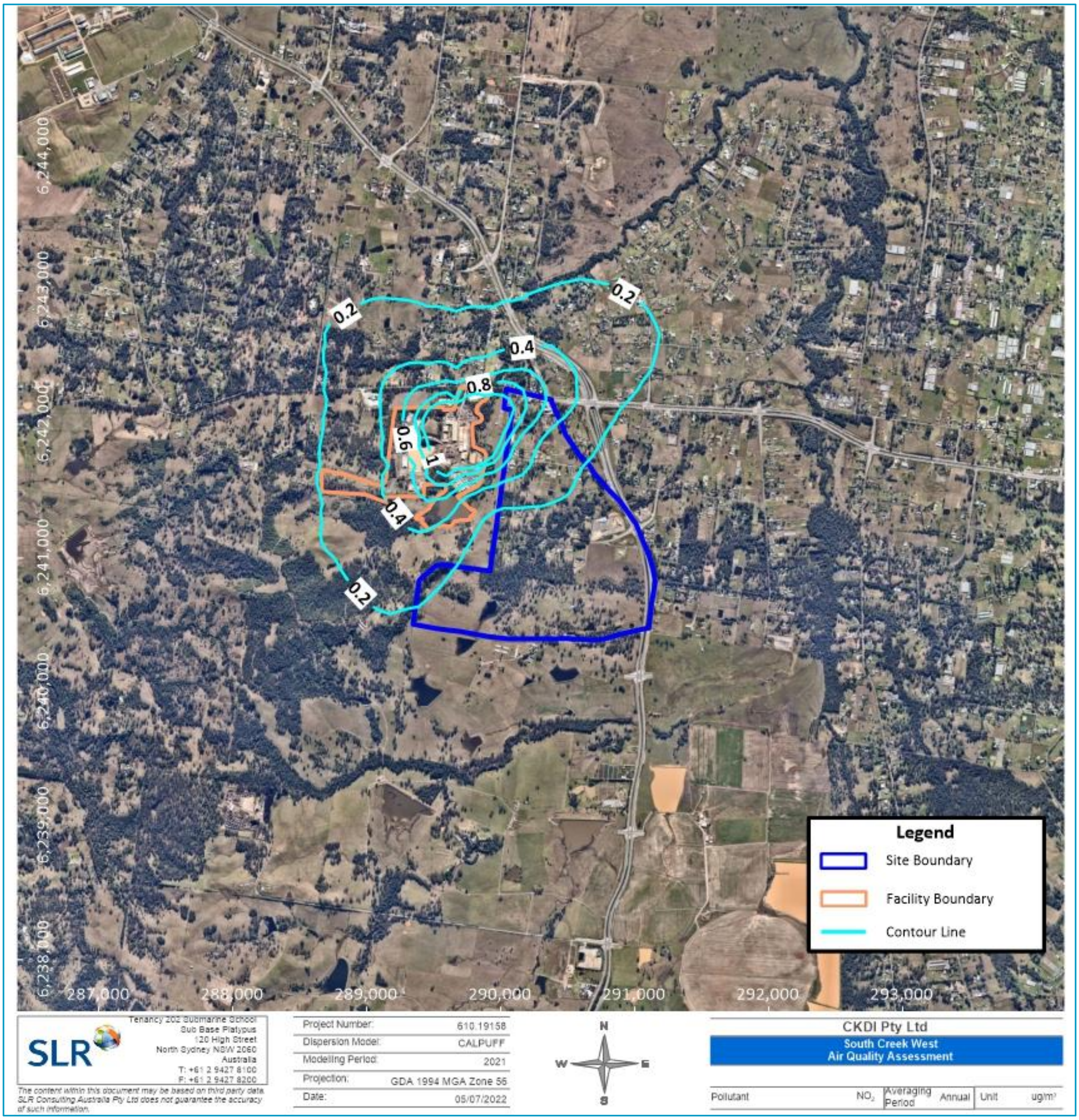


Figure D-12 Predicted 10-minute Average Incremental SO_2 Isopleth Plot

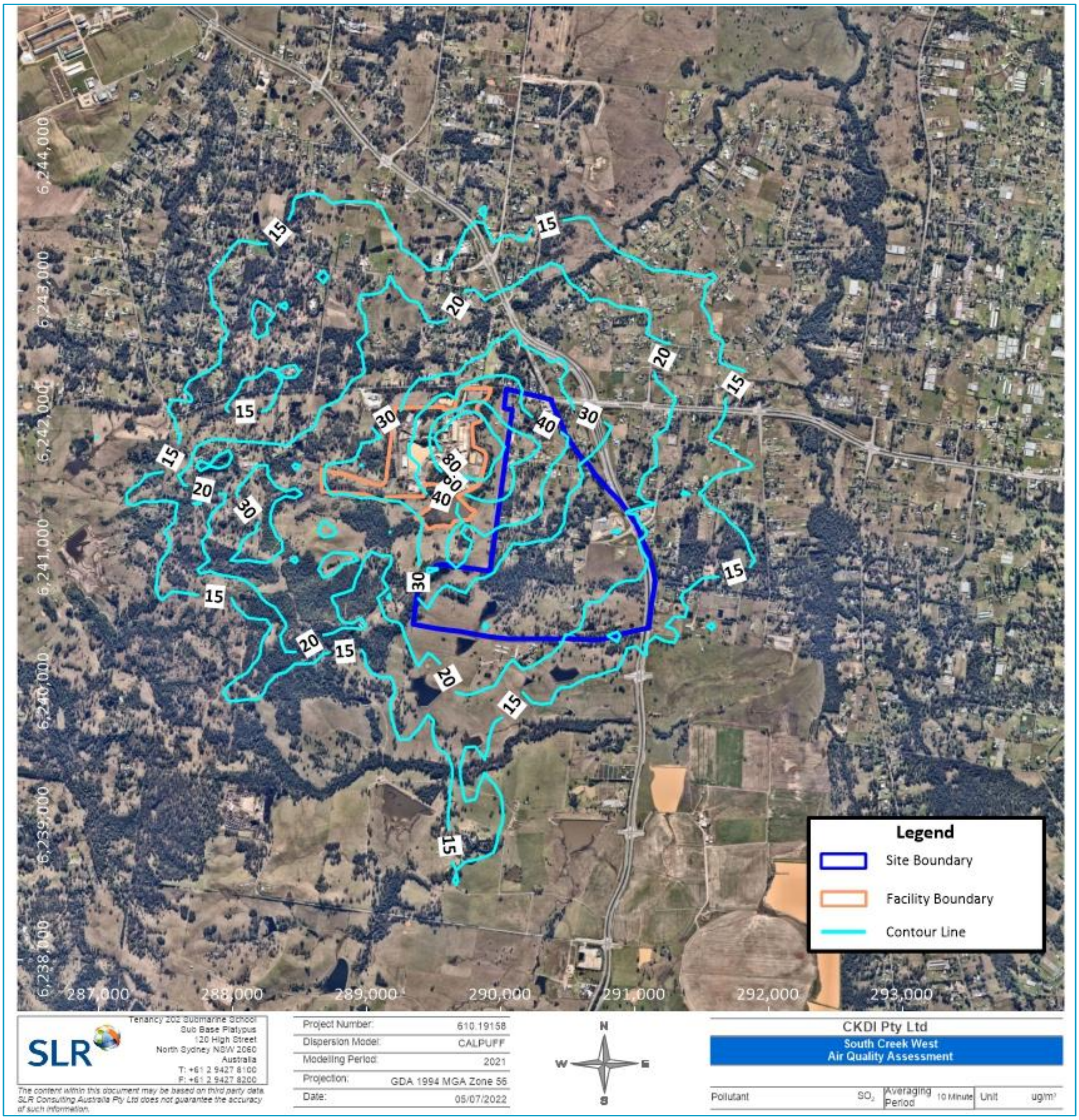


Figure D-13 Predicted 1-Hour Average Incremental SO_2 Isopleth Plot

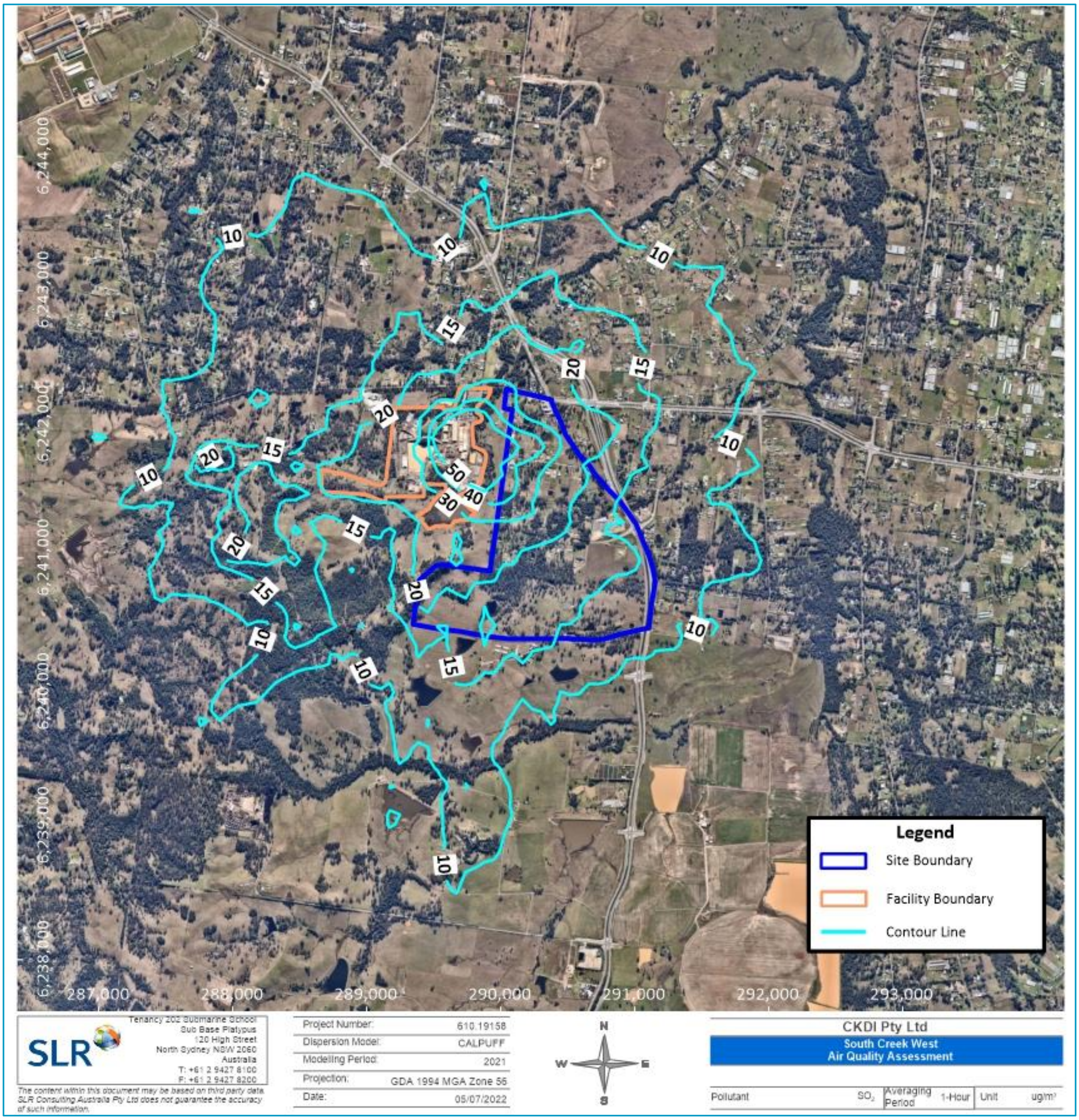


Figure D-14 Predicted 24-Hour Average Incremental SO_2 Isopleth Plot

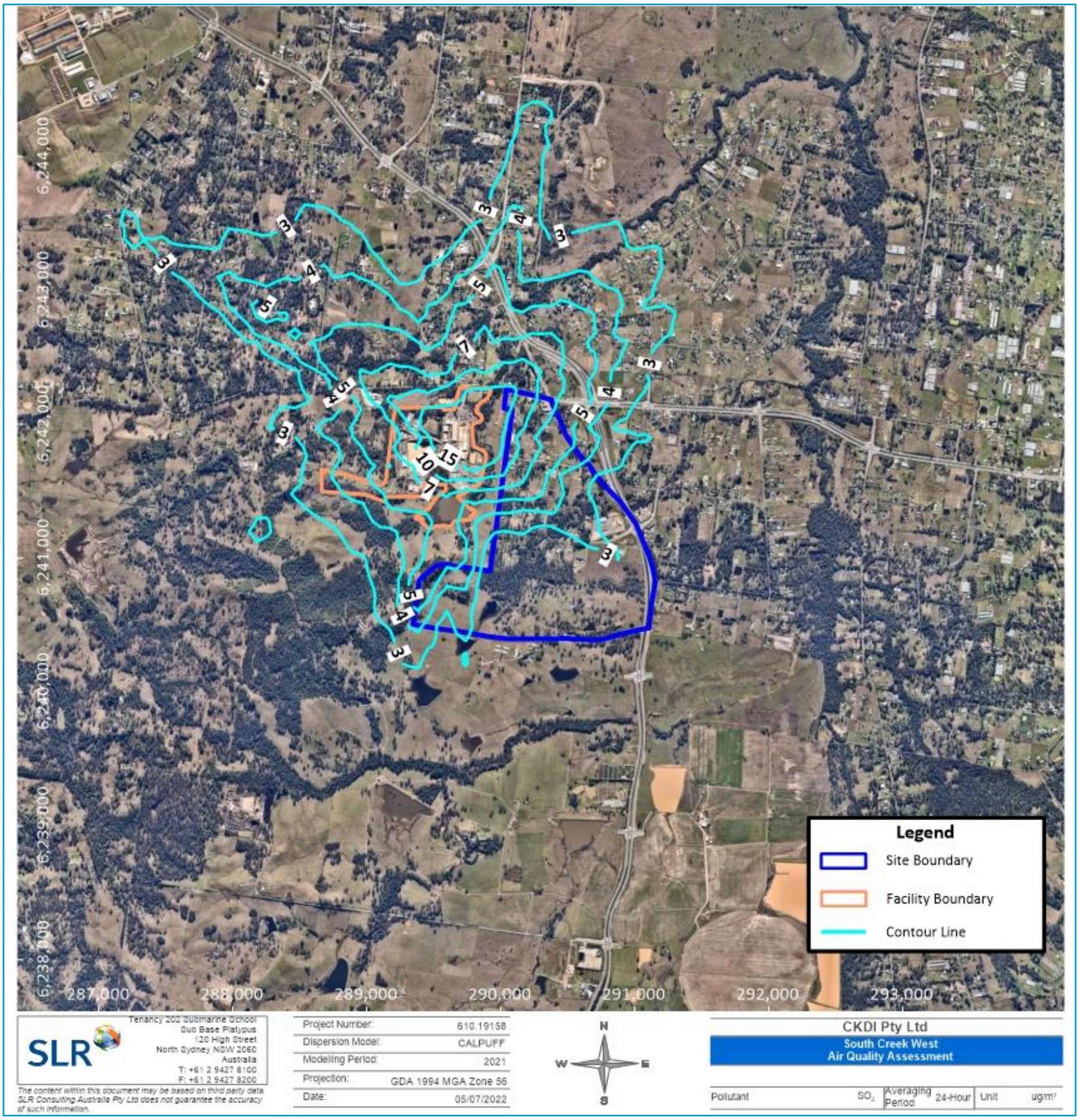


Figure D-15 Predicted Annual Average Incremental SO_2 Isopleth Plot

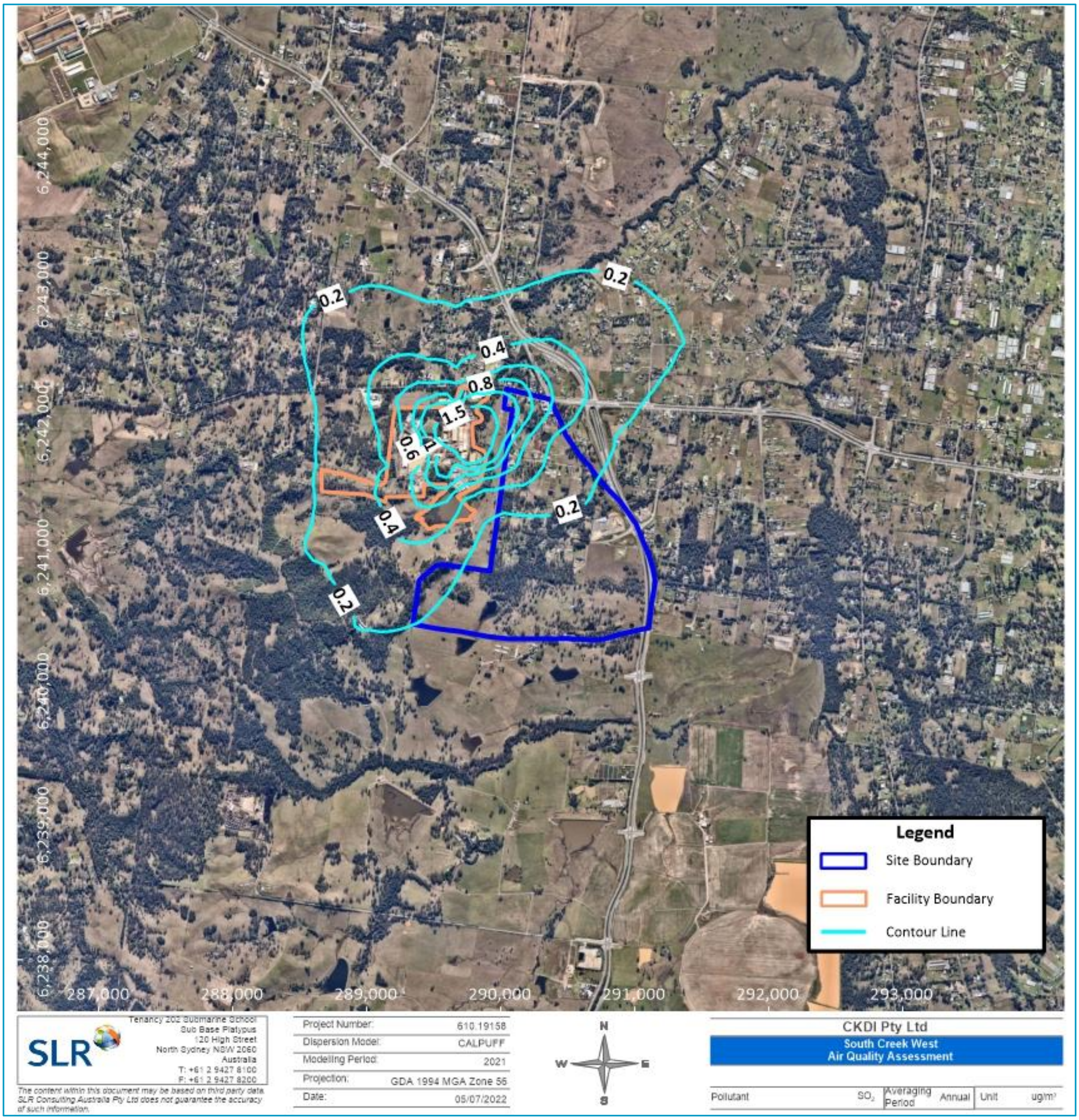
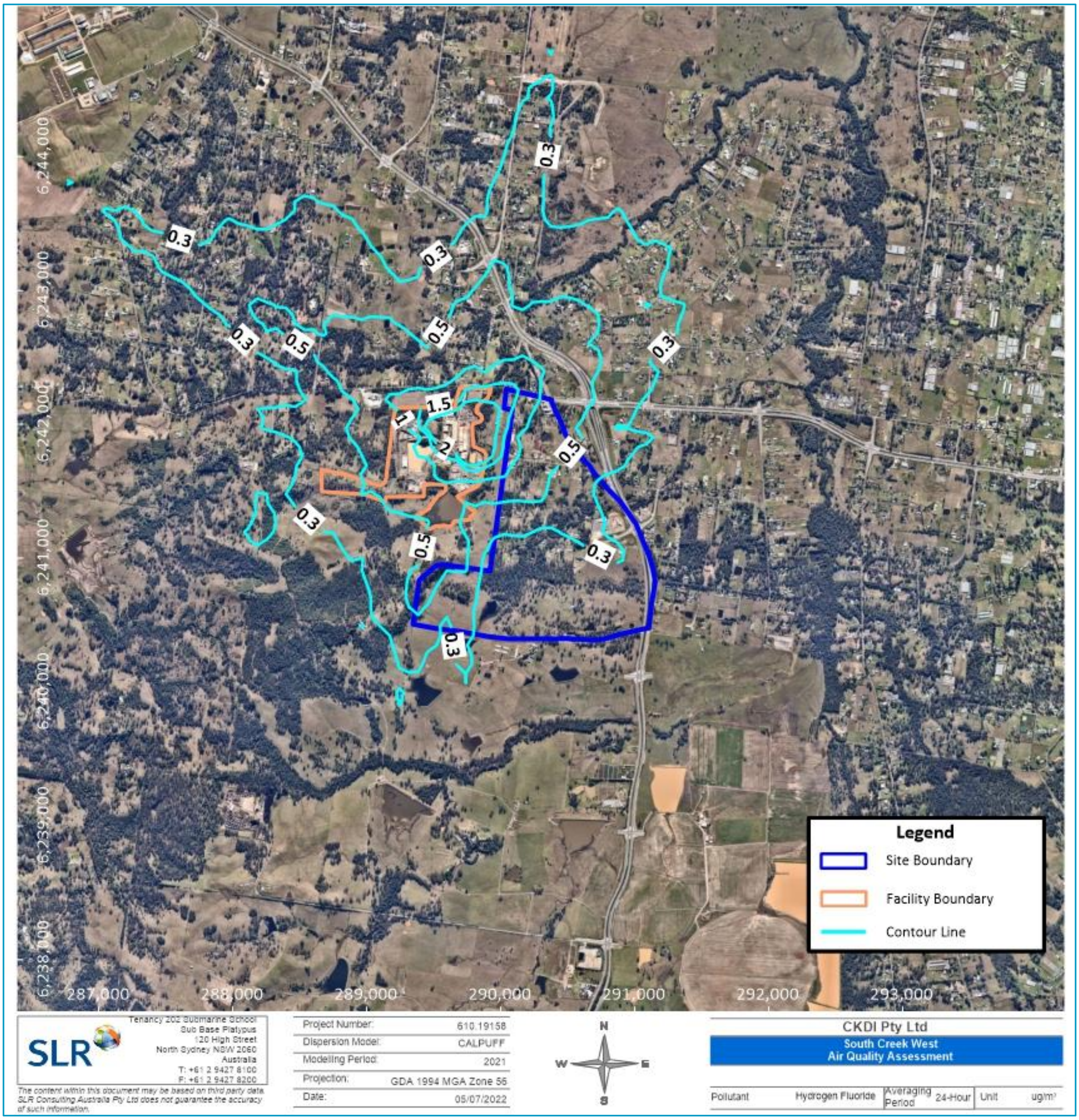


Figure D-16 Predicted 24-Hour Average Incremental Hydrogen Fluoride Isopleth Plot



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