CAMELLIA-ROSEHILL PLACE STRATEGY

AIR AND ODOUR IMPLEMENTATION REPORT

Department of Planning& Environment

7 July 2022

Job Number 21041267

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Camellia-Rosehill
Place Strategy
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DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	28/06/2021	P Henschke	D Kjellberg + WSP
DRAFT - 002	30/06/2021	P Henschke	
DRAFT - 003	03/09/2021	P Henschke	
DRAFT - 004	10/09/2021	P Henschke	WSP + Golder
FINAL - 001	10/09/2021	A Todoroski	
FINAL - 002	15/11/2021	P Henschke	WSP + Golder
FINAL - 003	13/12/2021	P Henschke	WSP + Golder
FINAL - 004	29/04/2022	P Henschke	
FINAL - 005	06/06/2022	P Henschke	WSP + Golder
FINAL - 006	07/07/2022	P Henschke	

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EXECUTIVE SUMMARY

This report presents the findings of the air and odour impacts assessment for the Camellia-Rosehill Place Strategy and Master Plan.

The Master Plan developed for the Camellia-Rosehill Precinct includes new residential areas to the northwest, improved connections and continued employment growth to the east with a transition zone proposed to facilitate an intensification of employment uses within the urban light services, light industry and manufacturing sectors.

The air and odour baseline analysis identified a mix of industries located within and surrounding the Camellia-Rosehill Precinct which include waste management and recycling, asphalt and bitumen production, concrete batching, fuel storage and other operations. The analysis shows a likely medium to high-risk level of impact between existing industries and receptors in the area to the northeast and east of the Camellia-Rosehill Precinct due to the relatively close proximity of sources to receptors.

Air dispersion modelling with the CALPUFF modelling suite was utilised to test the Master Plan. Air emissions sources representing general industrial activities were positioned to represent any location within the Camellia-Rosehill Precinct where potential air emissions can occur. These sources were assumed to emit air emissions continuously with different rates of emission of various key pollutants accounted for, allowing source or receptors impact risk to be shown on a like-for-like basis, irrespective of the pollutant emitted.

The air dispersion modelling results of the Master Plan indicates that potential high-risk areas are identified on the eastern portion of the Camellia-Rosehill Precinct with the adjacent areas across the Parramatta and Duck River. The residential and mixed use areas to the northwest indicates low potential for air quality risk as the adjoining transition zone includes high amenity industries which acts as a buffer from the heavy industrial activity to the east.

Detailed air quality modelling was conducted for the Sydney Water Pumping Station 067 to identify the extent of potential odour impacts and determine a potential buffer distance for this activity. The modelling predictions indicate the facility has minimal impact at ground level, with maximum impacts occurring above the facility that extend to approximately 100 metres from the source. It is noted that Sydney Water intends to undertake further review and upgrades to SPS067, the impacts of which may be positive but are not modelled in this report. The Department advises that it will continue to consult with Sydney Water to investigate measures to mitigate odour impacts.

Based on the analysis, high-risk areas would not be suitable for those industrial uses that generate a significant amount of air emissions. The modelling results are used to develop appropriate allocations for air and odour emissions applicable to the land within the Camellia-Rosehill Precinct. This allows industries to understand which parcels of land are best suited for their operations and understand the level of air quality control required depending on the activity and the location within the Camellia-Rosehill Precinct.

Figure ES-1 presents an example of this showing the allocated odour emission rate per hectare for sources of odour in the industrial area. The contour lines within the industrial area represent the maximum attenuated odour emission rate per second per hectare and shows that areas central to the industrial area have a higher allocation of odour and would be best suited for odorous industries. This however does not exclude these industries locating in other areas of the Camellia-Rosehill Precinct if the odour emissions can be managed to the allocated levels, achieved through additional odour controls.

It is recommended that planning controls be investigated taking into account the findings of this report to ensure that land use conflicts are avoided and adequate amenity for residential and other sensitive land uses.

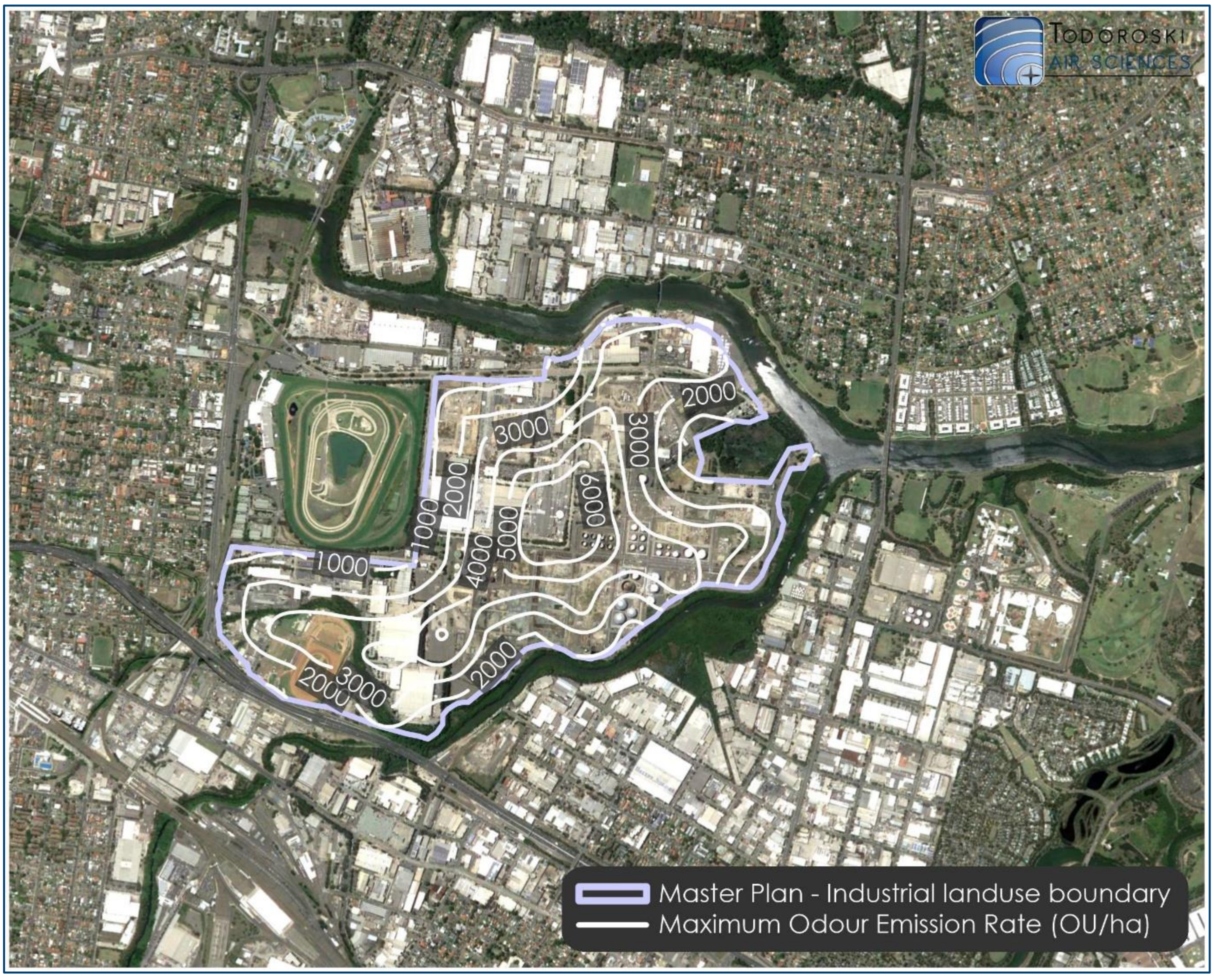

Figure ES-1: Source odour emissions rate per hectare from the industrial area

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GLOSSARY

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
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
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
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
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
VOCs	Volatile organic compounds

1 INTRODUCTION

New South Wales Department of Planning and Environment (DPE), in collaboration with City of Parramatta Council (Council), industry, the community and State agencies is leading the development of the Camellia-Rosehill Place Strategy (the Place Strategy) and Master Plan for the Camellia–Rosehill Precinct (the Precinct).

The Precinct is shown in **Figure 1-1** and is defined by Parramatta River to the north, Duck River to the east, the M4 Motorway to the south and James Ruse Drive to the west, all of which form physical boundaries to the Precinct.

Figure 1-1: Camellia-Rosehill Precinct

The Precinct is presently dominated by industrial activity, with large amounts of land also allocated to Rosehill Gardens Racecourse and stabling yards for Parramatta Light Rail and Sydney Metro. Its industrial legacy means that soils are heavily contaminated across most of the precinct.

The Place Strategy and Master Plan has been prepared for the whole Precinct and draws on the substantial body of previous investigations, including ongoing collaboration with industry, the community and state agencies.

The overarching objective of the Place Strategy is to provide an integrated 20-year vision, which recognises the strategic attributes of the Precinct, guides future land use and infrastructure investment decisions and which can be delivered with the support of State and local agencies.

DPE has engaged Todoroski Air Sciences to deliver technical air quality and odour studies for the Environmental Package, with the following scope of work:

- Identify and characterise all potential sources of air emissions due to the range of industrial and commercial activity within the Precinct and the existing ambient air quality levels;
- Conduct air dispersion modelling of all potential sources of air emissions to help predict any potential air quality impacts on the future development of the Precinct; and,
- Explore air quality mitigation measures that can be applied to prevent and mange any risks associated with air quality.

An Enquiry by Design (EbD) process was undertaken to inform the preparation of the Place Strategy. The EbD was an interactive process which explored a number of Master Plan options for Camellia-Rosehill which could deliver the vision for the Precinct and resulted in a draft Master Plan which was the subject of public consultation as part of the Camellia-Rosehill Directions Paper. The draft Master Plan was further refined following exhibition of the Directions Paper and consideration of the submission received.

The draft place strategy was publicly exhibited on 17 December 2021 until 4 March 2022. The draft Master Plan was further refined following exhibition of the draft place strategy and consideration of the submissions received. Refer to the DPE's finalisation report for further information.

1.1 Overview

The objective of the Camellia-Rosehill Place Strategy is to provide an integrated 20-year vision which recognises the strategic attributes of the Precinct, guides future land use and infrastructure investment decisions and which can be delivered with the support of State and local agencies.

Through the development of the Place Strategy there is the potential for activation of the Parramatta River Duck River foreshore and for capitalising on investment in Parramatta Light Rail and synergies with Rosehill Racecourse, leading to opportunities for a variety of additional development outcomes including urban services, innovation industries, a Town Centre and residential development.

This sees the Camellia-Rosehill Precinct as an important industry and employment hub which supports essential city building functions and will continue to do so. It will be supplemented by a Town Centre, greening of the precinct and supplementary land uses to support local urban services, entertainment, and recreational activity. The historical and cultural significance of the precinct to First Nations Peoples will be recognised while strengthening its position as an employment hub and economics corridor with improved transport connectivity and utilities support services.

The environmental aspects of the precinct are improved with an integrated strategy for the remediation of contaminated lands, the progressive reclaiming of foreshore lands for public access and use and aiming to become a net zero precinct by 2040 supported through circular economy industries and embedded renewable energy networks. Recycled water will support greening of the precinct as well as the surrounding areas, which will in turn improve amenity and reduce urban heat island effects and likely see an improvement to air quality in the precinct and the surrounding area.

The Camellia-Rosehill Vision is outlined in **Section 1.2**.

The Place Strategy is underpinned by the Master Plan and several technical studies. This Air and Odour Implementation Report forms part of this.

The purpose of this report is to present the findings on the environmental air quality and odour testing associated with the Master Plan that were developed to understand the potential constraints and provide solutions and recommendations.

1.2 Camellia-Rosehill Vision

Camellia-Rosehill has an important strategic role as an industry and employment hub within the Greater Parramatta and Olympic Peninsula (GPOP) Economic Corridor. By 2041, the precinct will be enhanced with service and circular economy industries and new recreational and entertainment facilities, all enabled by better transport access via light rail, active transport and road connections.

A well-designed town centre next to the light rail stop will be the focus of community activity.

A new urban services precinct and retention of heavy industrial land will ensure Camellia-Rosehill fulfils its potential to be an employment powerhouse.

New homes and jobs will be close to public transport supported by new quality public spaces including public open spaces, public facilities, high quality street infrastructure, and walking and cycling paths.

Key environmental features such as Parramatta River, Duck River and their wetlands will be protected and enhanced. Camellia's rich heritage will be preserved, celebrated and promoted.

Country and culture will be valued and respected with the renewal guided by Aboriginal people.

The precinct will be net zero ready and set a new standard for environmental sustainability with embedded renewable energy networks, integrated remediation and water management strategies, and circular economy industries.

Recycled water will be connected to all residences, businesses and public spaces and will support the integrated network of green infrastructure.

Camellia will be a showcase of recovery and restoration – a place of economic prosperity but also a place where people love to live, work and enjoy.

1.3 Local setting

The Camellia-Rosehill Precinct is located approximately 1.5 kilometres (km) east of Parramatta Central Business District (CBD) and approximately 16.5km west of the Sydney CBD. The precinct covers an area of approximately 321 hectares (ha) and is bounded by Parramatta River to the north, Duck River to the east, the M4 motorway to the south and James Ruse Drive to the west. Key features of the Camellia-Rosehill Precinct include the existing industrial uses and the Rosehill Racecourse.

Key sensitive receptor locations include the Rydalmere residential area to the northeast, the Rosehill residential area to the west, the Parramatta residential area to the northwest, a childcare centre located at 1C Grand Avenue, Rosehill and a residential property located between Grand Avenue North and Grand Avenue. A University of Western Sydney campus is located to the northwest and the Rydalmere and Silverwater industrial areas located to the north and south.

Figure 1-2 presents the Camellia-Rosehill Precinct and location of the key areas.

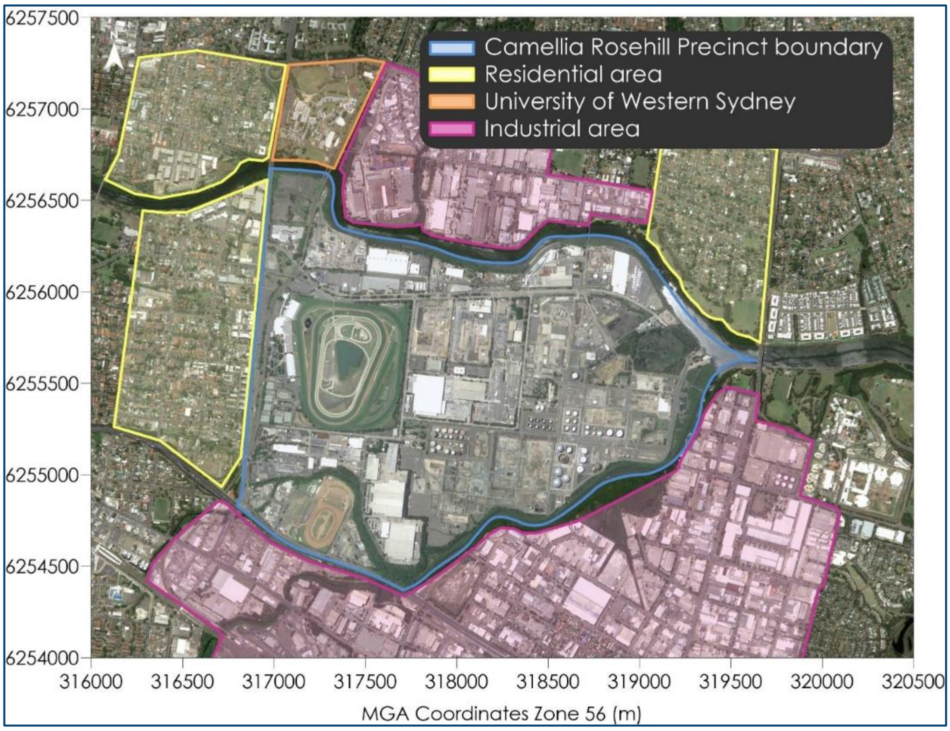

Figure 1-2: Local setting

1.4 Camellia-Rosehill Master Plan

The Master Plan is shown in **Figure 1-3** and forms the basis of the Place Strategy. Key features of the Master Plan include:

- Provision for approximately 10,000 dwellings within a Town Centre serviced by light rail.
- Provision for approximately 15,400 jobs.
- A new primary school and primary and secondary high school.
- District open space facilities.
- Introduction of a new entertainment precinct and an urban services area.
- Initiatives to Care for Country and continued protection of heritage listed sites.
- Retention of the existing state heritage sewerage pumping station (SPS) 067 within the town centre.

- Measures to mitigate land use conflicts and risks including buffers and setbacks from existing fuel pipelines and between the existing sewerage pumping station and future surrounding residential uses.
- Access to the Parramatta River, Duck River and Duck Creek foreshores and potentially the wetland.
- New transport infrastructure including a local road network, potential bus services, additional connections into and out of the precinct, and opportunities to integrate Parramatta Light Rail Stage 2.
- An extensive active transport network.
- A comprehensive remediation strategy.
- A sustainability strategy and integrated water cycle management strategy.

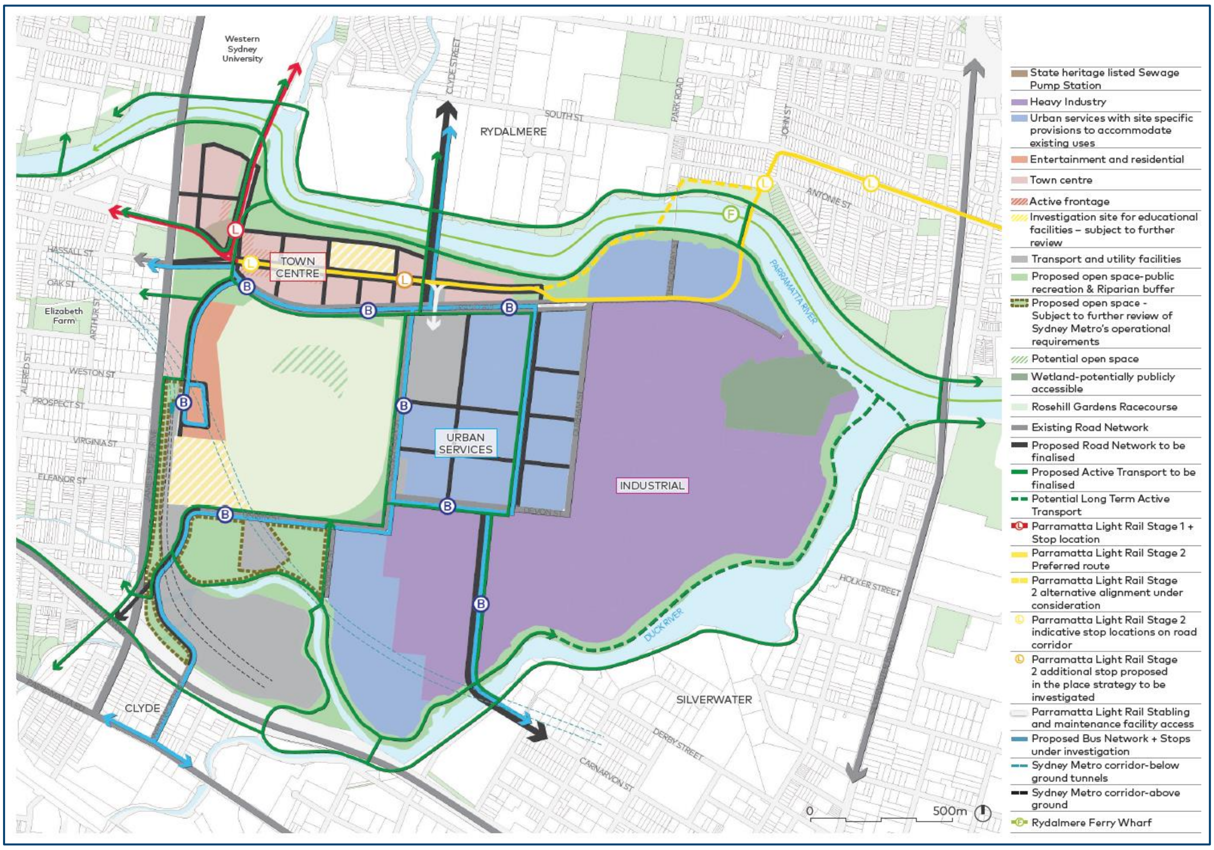

Figure 1-3:Camellia-Rosehill Master Plan

2 BASELINE ANALYSIS

2.1 Existing conditions

In general, there are elevated particulate levels in the area surrounding the Camellia-Rosehill Precinct, with the particulate levels exceeding the NSW Environment Protection Authority (EPA) criteria relatively often. Short-term (24-hour average) PM_{10} is most likely to be associated with wider regional influences which often affect the entire Sydney region such as the state of ground cover (this is affected by rain/ drought conditions and agricultural activities). Short-term $PM_{2.5}$ is also most likely impacted by wider regional influences such as bushfire and hazard reduction burns and influenced by local anthropogenic sources such as residential wood heaters, motor vehicle emissions and regional industrial emissions (e.g., electricity generation).

The industrial facilities identified in the Camellia-Rosehill Precinct 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 wider population.

The annual average background dust levels are typically below the NSW EPA criteria for PM_{10}, however are above for $PM_{2.5}$ and thus it will be difficult to design the Camellia-Rosehill Precinct to meet these criteria. This is also the case in most urban areas of NSW.

It is generally expected that industries should meet EPA criteria, and hence that the design of the Camellia-Rosehill Precinct should be such as to enable these criteria to be met. However, regional bushfire and dust events will govern any degree of compliance, and in the future are almost certain to result in exceedances, as occurs across most of NSW.

Other pollutants such as NO_2, SO_2 and CO are not shown to be elevated in this region, however O_3 levels are shown to be close to, or at times, above the NSW EPA criteria. The atmospheric levels of NOx and VOCs in the atmosphere lead to the formation of O_3 and continuing growth in the sources of NOx and VOCs will exacerbate this. Industries (and sources such as motor vehicle exhaust) need to consider the means to control these emissions and consider the use of modern new plant which generate lower emissions, limiting the extent of any impacts.

Odour emissions are a key constraint for the Camellia-Rosehill Precinct development and have shown in the past to be an issue. There may be a need for the development process to consider if it is necessary to allocate buffers between some industries to minimise scope for harm on other sites, consider if existing industries need to achieve best practice operating conditions and/ or recognise that some industries are no longer compatible with the vision of the precinct and need to consider re-locating.

2.2 Existing industries

Existing industries identified within and surrounding the Camellia-Rosehill Precinct are set out in **Table 2-1** and **Figure 2-1**. These operations include a mix of industries such as waste management and recycling, asphalt and bitumen production, concrete batching, fuel storage and other operations.

The existing impacts of these industries on surrounding residential receptors needs to be considered as well as potential future residential and other sensitive land uses within the Camellia-Rosehill Precinct.

The Camellia-Rosehill Precinct has a history of use by a range of industrial purposes and industries with potential to contaminate the land. A range of contaminants are present across the Precinct, including asbestos, heavy metals, total petroleum hydrocarbons and total polycyclic hydrocarbons. During remediation/ earthworks there is potential for air quality impacts to arise which can constrain development.

Table 2-1: Existing Industries

Company	Industry	Key substance emitted	Map identification number
Sydney Water	Sewerage pumping station 067	Odour	1
Mauri ANZ Camellia	Yeast manufacture	Odour, CO, NOx, Dust, SO2 and VOCs	2
CSR Bricks & Roofing (Monier)	Brick and tile manufacture	Dust	3
Rosehill Garden Soil	Soil distribution	Dust	4
Boral Plasterboard Camellia	Plaster, plasterboard and cornice manufacturing	Odour, CO, NOx, Dust, SO2 and VOCs	5
Earth Power	Hazardous waste treatment or disposal service	Odour, CO, NOx, Dust, SO2 and VOCs	6
Concrete Recyclers	Resource recovery	Dust	7
Camellia Waste Facility	Materials Recycling Facility (non-putrescible)	Dust and Odour	8
Emoleum Road Services (SAMI Bitumen)	bitumen and emulsion facility + Reclaimed asphalt pavement (RAP) facility	VOCs and Odour	9
Hymix	Concrete batching	Dust	10
KLF Holdings	Building material recycling	Dust	11
James Hardie Rosehill	Fibre cement manufacturing and distribution	Odour, CO, NOx, Dust, SO2 and VOCs	12
Viva Energy Parramatta Terminal	Hydrocarbon storage and distribution	VOCs and Odour	13
Downer Sustainable Road Resource Centre	Asphalt production, bitumen storage, RAP, Reconomy	Odour, CO, NOx, Dust, SO2 and VOCs	14
Hytec	Concrete batching	Dust	15
Downer EDi	Asphalt production, bitumen storage, RAP	Odour, CO, NOx, Dust, SO2 and VOCs	16
Rheem Rydalmere	Manufacture of Electric, Gas, Solar and Heat Pump Hot Water Heaters	Dust, VOCs and Toxics	17
Lubrizol International	Chemical Storage - Lubricant additives. Group A Waste Generation. Petroleum Works - Oil Blending and Storage	Dust, VOCs and Toxics	18
Bluestar Web Silverwater	Multi Channel Printing and communication	CO, NOx, Dust, SO2 and VOCs	19
Daniels Heath	Biomedical waste treatment by incineration or chemical treatment	Odour, Dust, VOCs and Toxics	20
Clyde Transfer Station	Waste transfer activities	Dust and Odour	21
Bingo	Waste transfer activities	Dust and Odour	22
MET Recycling	Building material recycling	Dust	23
Gunlake	Concrete batching	Dust	24
Hanson	Concrete batching	Dust	25

Company	Industry	Key substance emitted	Map identification number
Parramatta Light Rail Stabling and Maintenance Facility	Public Transit – legacy VCH containment treatment system	Volatile Chlorinated Hydrocarbons (VCH)	26

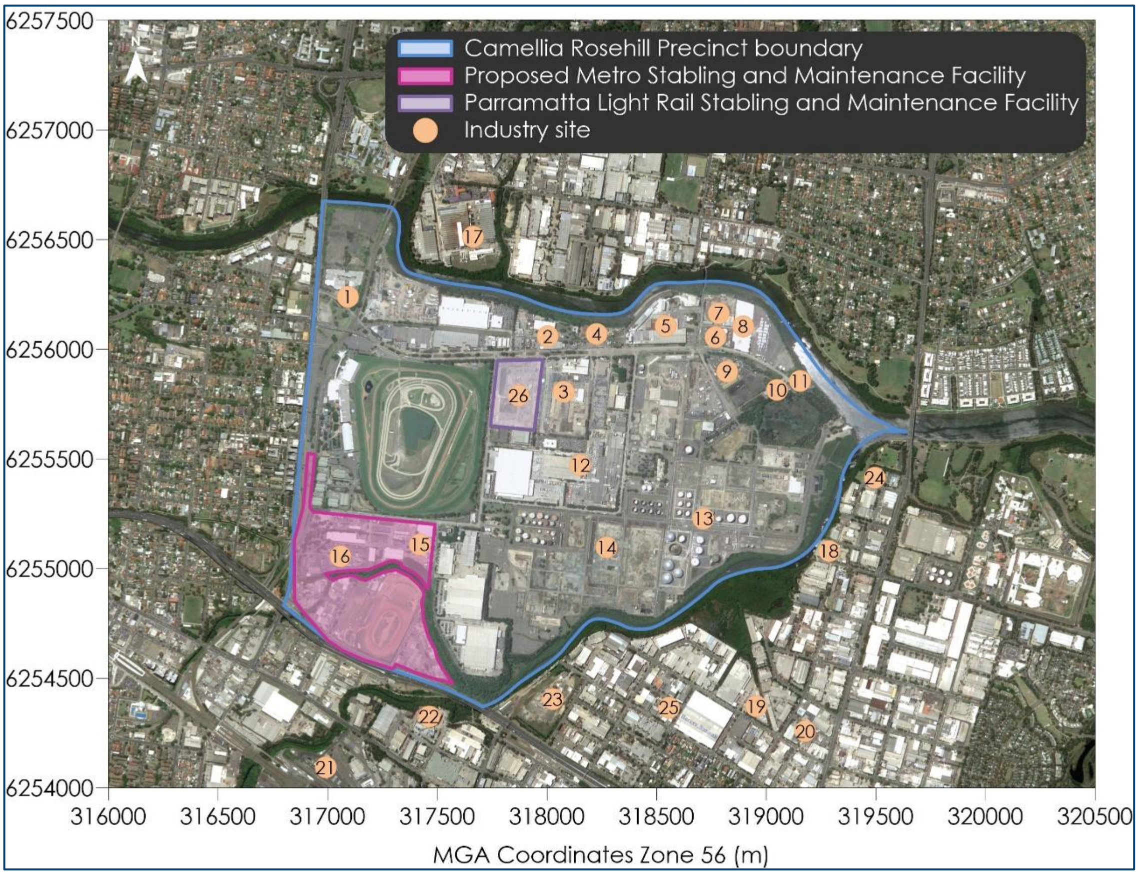

Figure 2-1: Existing industries

2.3 Odour complaints

There are several existing industries within the Camellia-Rosehill Precinct that have the potential to generate odour emissions and there has been a history of odour complaints in relation to these activities. Odour complaints received by the NSW EPA for the area surrounding the Camellia-Rosehill Precinct (and likely associated with industries located within and surrounding the Camellia-Rosehill Precinct) from 2016 to 2020 have been analysed.

The number of odour complaints received by suburb location is presented graphically in **Figure 2-2**. The nature of the odour complainant is either a resident, local worker or transient. The figure shows the greatest number of odour complaints received by suburb were in Silverwater and Camellia followed by Rydalmere with most complaints associated with industries located in the Camellia-Rosehill Precinct.

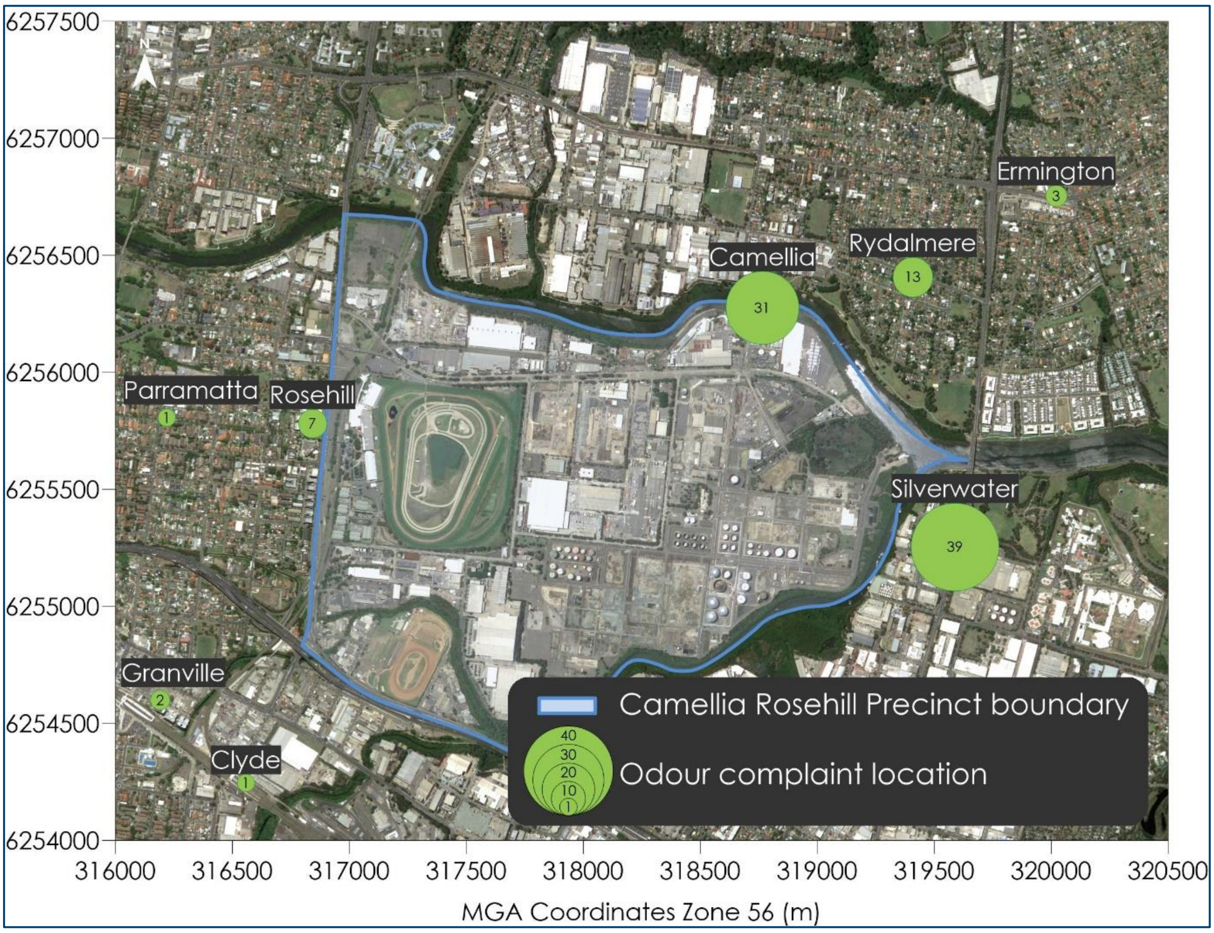

Figure 2-2: Odour complaint locations

2.4 Constraints and Opportunities

2.4.1 Constraints

The baseline analysis indicates a likely medium to high-risk level of impact between existing industries and receptors in the area to the northeast and east of the Camellia-Rosehill Precinct. The impact, or land use conflict, arises due to the relatively close proximity of these existing receptors to existing industrial activities. Any future residential development within the Camellia-Rosehill Precinct would likely be a high-risk level due to existing industrial activities and need to consider a staged development to allow for the transition.

Overall, the following can be determined:

- The most impacted receptors are driven by odour followed by dust and other air pollutants. It is likely that there may be existing air quality or odour impacts or levels near to criteria at these locations.
- To minimise or prevent future impacts arising at these receptor locations, the Master Plan will identify the most suitable locations for industries within the Camellia-Rosehill Precinct such that land use conflict is avoided.

- 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 to the source, and tend to concentrate in low-lying areas and would drift along waterways such as the Parramatta River and Duck River. The stack sources tend to most impact the surrounding high points of the landscape (though impacts are generally relatively smaller due to greater distance). High rise development artificially increases the landscape and increases the risk of impacts occurring at height.

2.4.2 Opportunities

The following opportunities aim to manage potential land use conflicts and enable industries to operate without undue compliance burden while at the same time provide residents with adequate amenity and health protection.

- Co-locate high impact industrial uses to minimise buffer requirements.
- Delineating a suitable buffer between existing and future residences and any major new industrial developments.
- The future residences within the Camellia-Rosehill Precinct may also limit the potential for major industrial development nearby, but the necessary buffer can be determined by the modelling assessment.
- Introduce vegetation bands within the industrial area. Buffers nominally 50-100m wide which consist of dense, tall vegetation will promote dispersion and dilution of fugitive or volume emissions. This strategy is best compatible with minimising visual impacts, which in-turn assists to minimise community perception of any potential odour impacts.

3 AIR QUALITY MODELLING METHODOLOGY

3.1 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 New South Wales (NSW) Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**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.

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. 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 risks are also defined according to the range of source emissions that can be expected to arise from industrial sources, and/or for other pollutants.

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

The NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**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 (including VOCs). 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 (waste material, 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.

Unlike fugitive sources, stacks are designed to disperse pollutant away from the ground. Emissions 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 stacks will be needed to prevent impacts on higher ground. A similar situation arises with a residential tower where receptors are level with the stack release point.

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

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

The air 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 factor in low, medium and high amenity use, according to the types of industry that would emit low, medium or high levels of air pollution and was applied to the scenarios for testing.

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

3.2 Technical detail

For this study 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**).

3.2.1 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 simulates "puffs" of material emitted from modelled sources, influenced by 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.

3.2.2 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 33deg49min south and 151deg2min 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 2018 calendar year from the Bureau of Meteorology (BoM) Sydney Olympic Park Automatic Weather Station (AWS) (Station No. 066212) and NSW DPE weather stations at Parramatta North, Chullora, Prospect and Macquarie Park were included in this run. The 2018 calendar period was selected as the year for the dispersion modelling based on an analysis of long-term meteorological data trends as outlined in **Appendix A**.

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 3-1**.

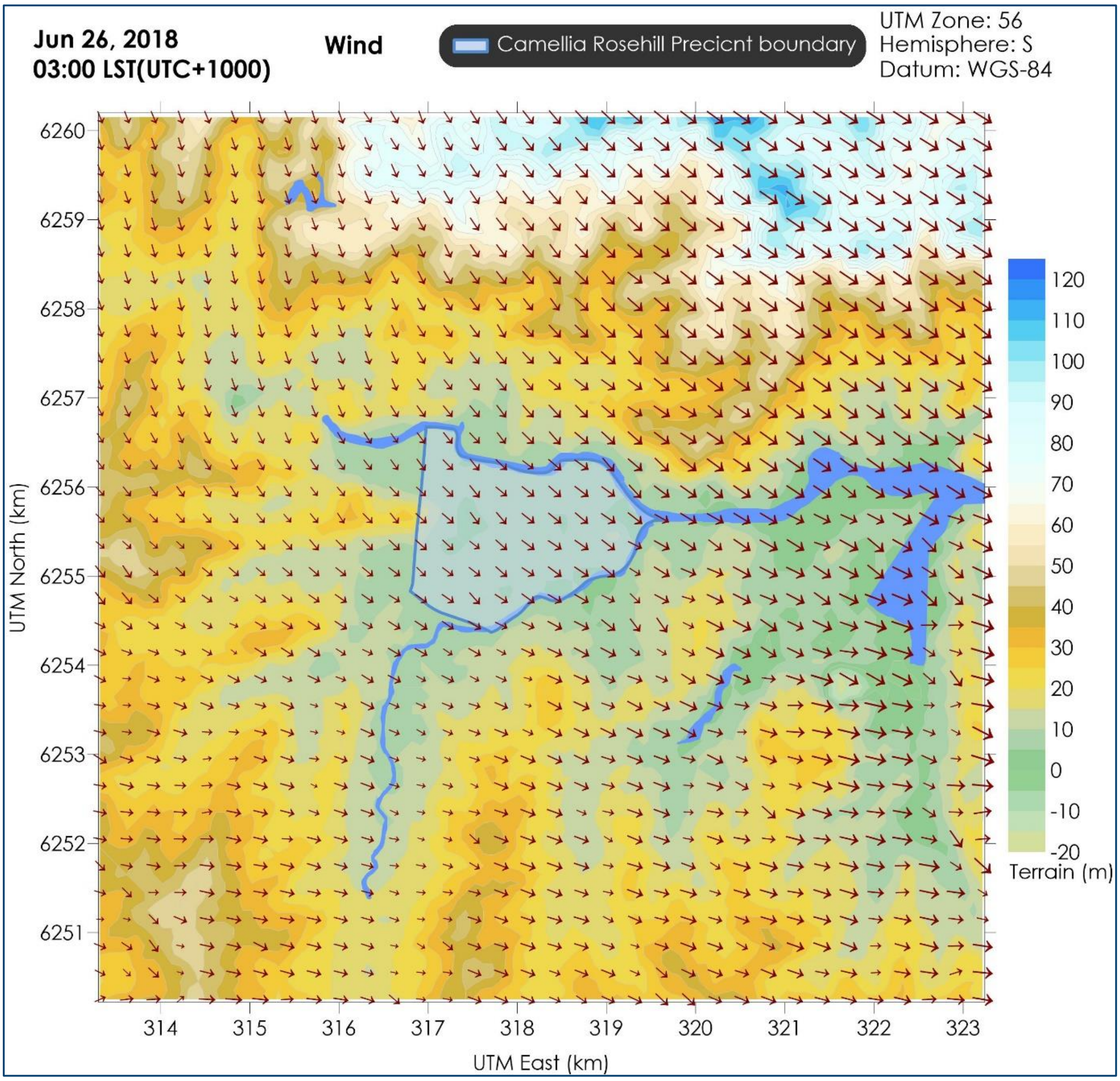

Figure 3-1: Representative snapshot of wind field

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

Figure 3-2 presents the annual and seasonal windroses from the CALMET data. On an annual basis, winds tend to flow on a north-northwest and northwest to south-southeast and east axis. The wind distribution in summer indicates wind predominantly from the east-northeast and east. The autumn distribution is similar to the annual distribution with wind from the north-northwest most frequent. During winter, winds predominantly from the north-northwest and northwest. The spring windrose shows varied winds from all directions.

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 3-3** 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.

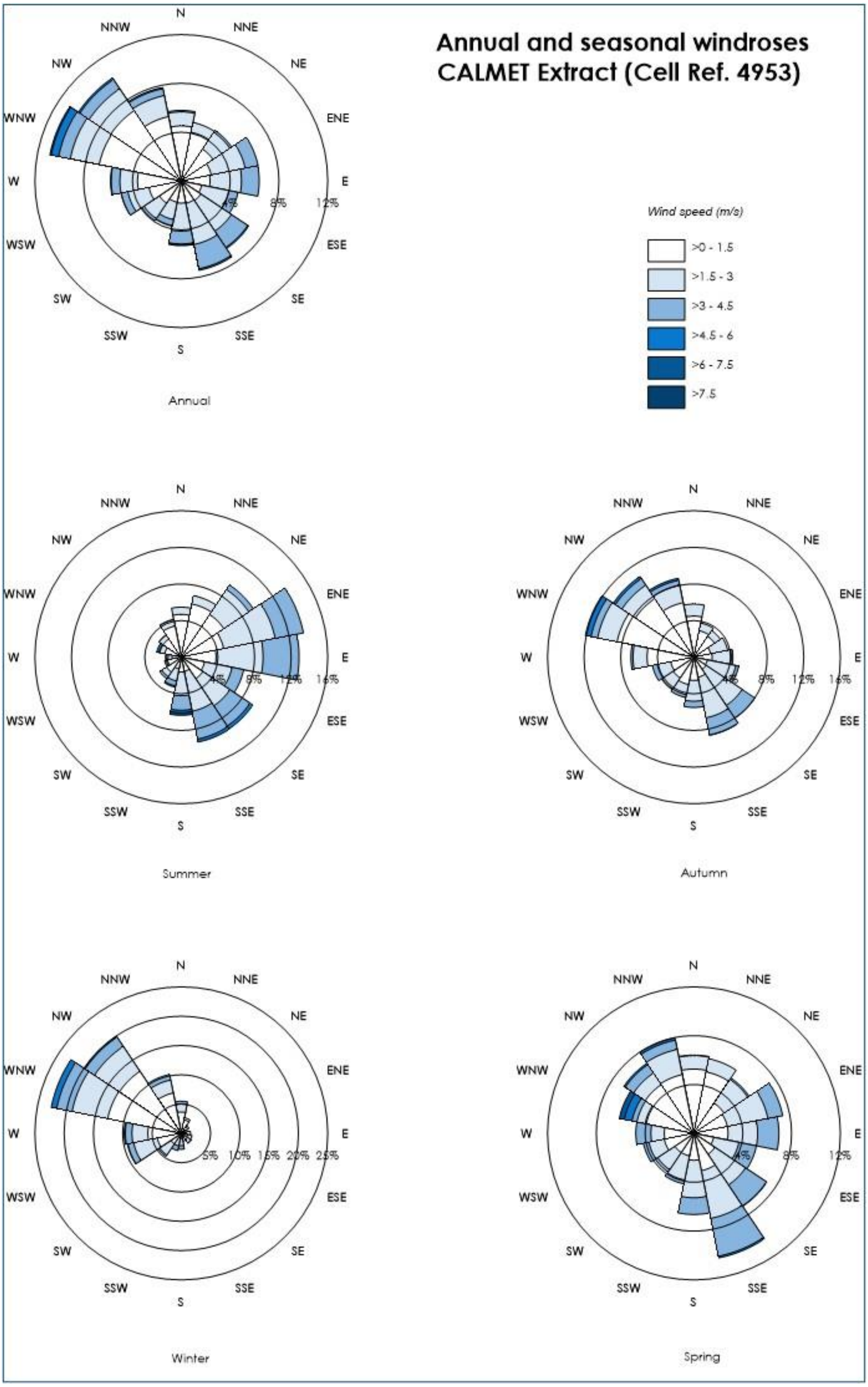

Figure 3-2: Annual and seasonal windroses from CALMET (cell ref 4953)

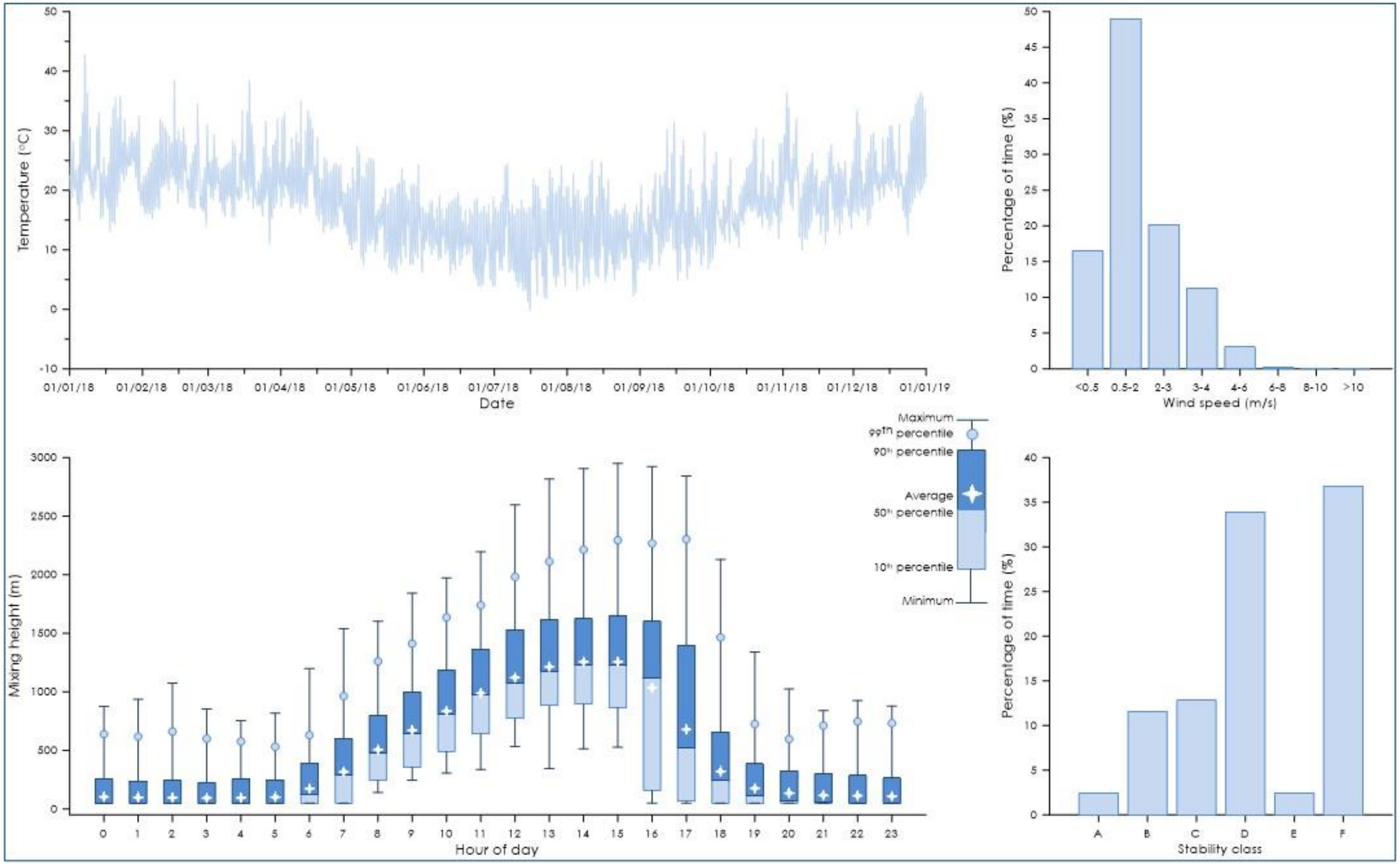

Figure 3-3: Meteorological analysis CALMET (cell ref 4953)

3.2.3 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 Camellia-Rosehill Precinct. The locations of all the modelled air and odour source locations are presented in **Figure 3-4**.

The sources represent any location within the Camellia-Rosehill Precinct where potential air emissions can occur. 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 were 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 3-5**. The receptor locations assessed would include any existing or potential future sensitive receptors located within and beyond the Camellia-Rosehill Precinct boundary.

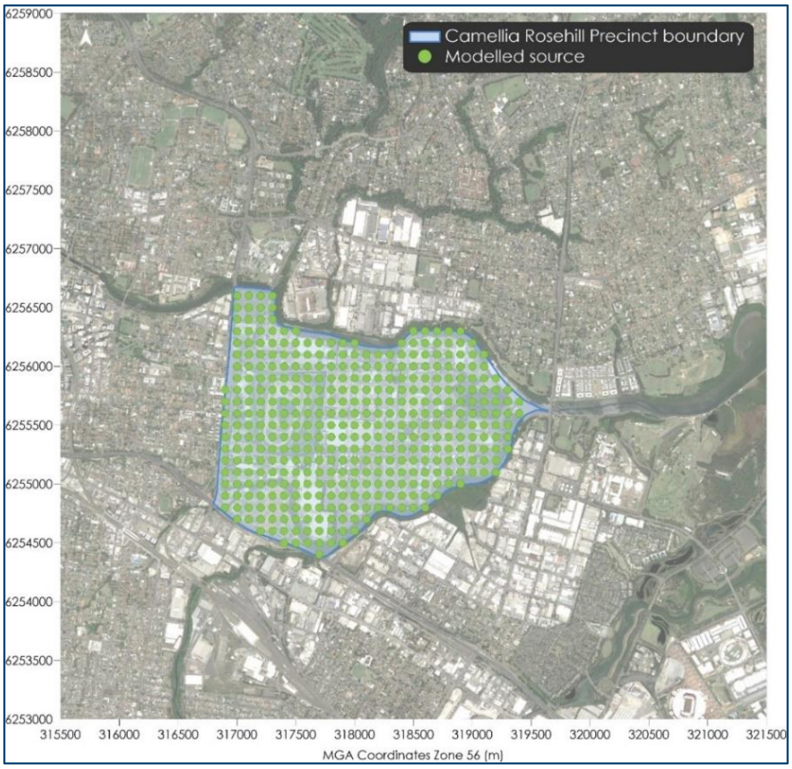

Figure 3-4: Modelled source locations

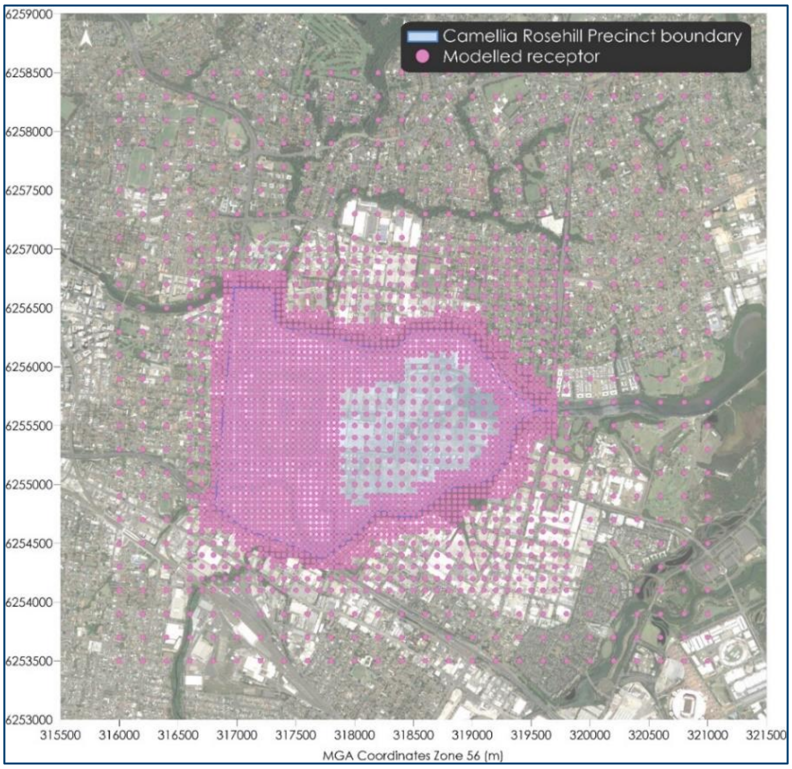

Figure 3-5: Modelled receptor locations

3.3 Scenario testing

The Master Plan described in **Section 1.4** was tested using the approach outlined in the previous section to identify the areas at risk of potential impact upon existing or potential future receptors and associated land-use conflict.

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

Different amenity areas are assigned to the land-uses and represent low, medium or high potential for air and odour emissions. The amenity areas factor in the types of industry and activities that may occur and the different rates of air emission. Key pollutants are accounted for by determining which precincts have a lower/higher scale of amenity, allowing source or receptors impact risk to be shown on a like-for-like basis, irrespective of the pollutant emitted. For example, the land-uses likely to have a greater dust and/or odour impact are considered a low amenity area. The amenity area for the Master Plan is presented in **Figure 3-6**.

The proposed residential land-uses are included as potential sensitive receptor areas. Areas including public recreation, open spaces, the Rosehill Racecourse, wetland, waterway (i.e. Parramatta River and Duck River) and foreshore are treated as a potential buffer for the industrial sources within the Camellia-Rosehill Precinct for the purposes of the scenario testing. We note that people would not normally be present in these locations for extended periods (and have a less likelihood of experiencing impact relative to a residential location) and would also have a different level of expectation with regards to potential impact (i.e. a higher level of comfort and repose would be expected for a residential location). The aim of the scenario testing is to inform the development of the Master Plan by highlighting potential areas of risk in the proposed zoning with regards to potential air and odour land use conflicts associated with residential and industrial uses. Further detailed assessment of the potential air and odour impacts associated with the available industrial land is presented in **Section 5**.

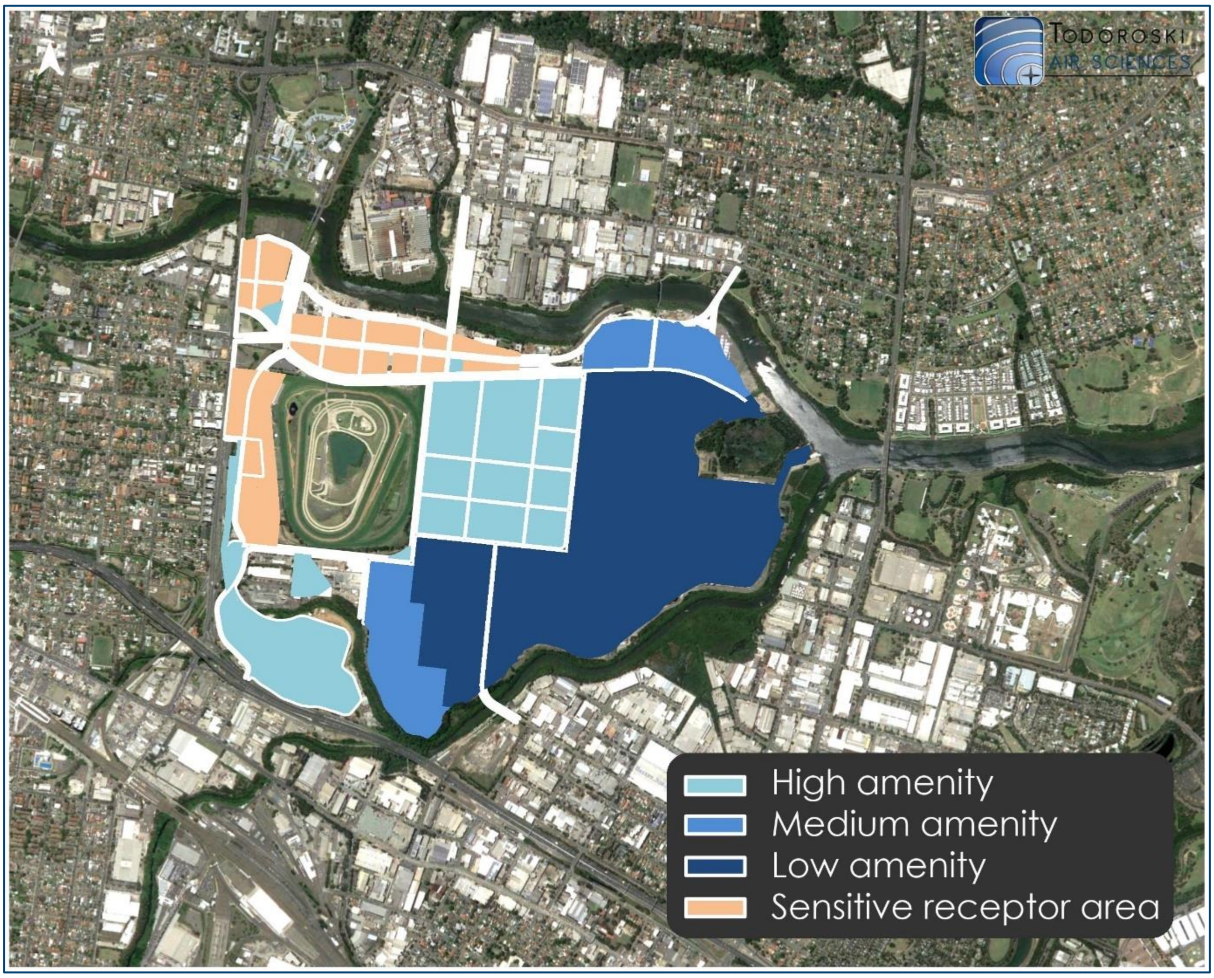

Figure 3-6: Master Plan – amenity area

3.4 Assumptions and limitations

The assumptions and limitations used in the testing of the scenario include:

- Existing industrial receptors outside of the Camellia-Rosehill Precinct boundary are assumed to be sensitive receptor areas.
- Sources were assumed to be high/medium/low amenity based on the potential future land use and their likelihood to emit low, medium or high levels of air and odour pollution. For example, a low emitting industry in high amenity area may include warehousing and distribution with only trucks and forklifts as the main air pollution sources. A high emitting industry in a low

amenity area may include industrial manufacturing or waste processing with fixed air pollution sources.

- Sources were modelled over the entire year and are assumed to emit air emissions continuously using a unit emission rate over the entire area. For this assessment is has been assumed that all sources operate 24/7.
- Industrial movement has been accounted for within each amenity area, however the movement of vehicles (such as via road) into and out of the Camellia-Rosehill Precinct are not specifically included. These are seen as transient sources and assessed differently to fixed industrial sources.
- Public recreation, open spaces, the Rosehill Racecourse, wetland, waterway (i.e. Parramatta River and Duck River) and foreshore areas are treated as a potential buffer for the industrial sources for the purposes of the scenario testing.

4 ANALYSIS OF MODELLING RESULTS

4.1 Master Plan testing

Figure 4-1 presents the potential constraints due to air and odour emissions at the receptors and source locations, respectively, for the Master Plan.

Figure 4-1 shows that potential high-risk areas are identified on the eastern portion of the Camellia-Rosehill Precinct with the low amenity area as it interacts with the industrial areas across the Parramatta and Duck rivers, namely the Rydalmere and Silverwater industrial areas (refer to **Figure 1-2**). The modelling results reflect the current situation with regards to the highest number of odour complaints received for the suburbs of Silverwater, Camellia and Rydalmere.

The industrial areas outside of the Camellia-Rosehill Precinct (the Rydalmere and Silverwater industrial areas) have been assumed to be a sensitive receptor area. This is due to the potential future land uses of these areas beyond the control of the Camellia-Rosehill Place Strategy and the possibility that they could allow for other sensitive land uses (e.g. childcare centre or children's play centres). However, if there were certainty that these areas would remain industrial and not affected by industrial air and odour emissions, this would reduce the potential risk for activity within the Camellia-Rosehill Precinct. An example of this is presented in **Figure 4-2** with the surrounding industrial areas not considered a sensitive receptor area. It can be seen that the risk areas within the Camellia-Rosehill Precinct have significantly reduced.

The Sydney Water Pumping Station 067 shows medium to low risk of impact at ground level with higher impacts expected at height due to the nature of the source, further detail on the modelling is discussed in the following section.

The residential and mixed-use area in the northwest of the Camellia-Rosehill Precinct indicates medium to low risk from the adjoining industrial areas. The adjoining industrial area would comprise of urban services which are characterised as having low potential for air and odour emissions. This industrial area acts as a suitable buffer to the more heavy industrial uses located further to the east.

The Master Plan includes residential development to the north of the Camellia-Rosehill Precinct that would be close to potential future heavy industrial uses. We note the modelling for the Master Plan testing is conservative as it assumes (in the future) all the available industrial land is occupied by industry and is continuously emitting air emissions. However, the future land use / industry may not have any air emissions at all and there would not be any risk of impact. The modelling therefore presents a "worst case scenario". There is potential for some minor risk to occur in this area and to alleviate the potential risk associated in this location, the Master Plan includes converting a portion of the land closest to the industrial land to recreational uses to act as a buffer. Future industry nearby needs to also recognise the residential land and apply appropriate air mitigation and controls to minimise impacts in these areas. This location may not be suitable for industry that emit significant air emissions.

Careful consideration of staging of development and operating industries will be required. An investigation into the potential allocations for air and odour of the available industrial land is presented later in the report which can be used a guide for future industry to identify suitable and unsuitable areas for development.

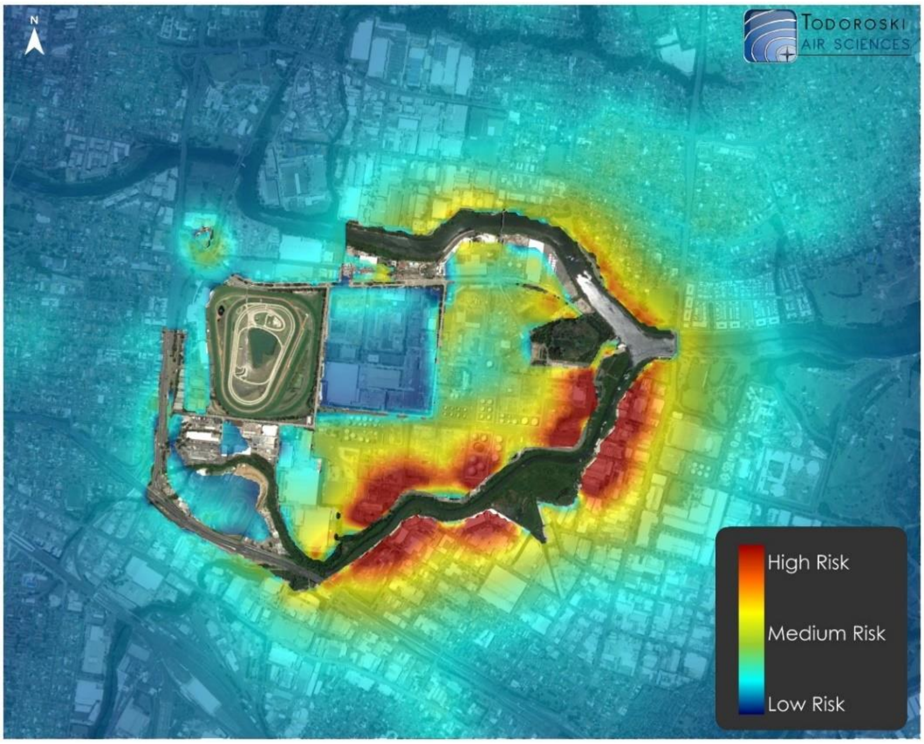

Figure 4-1: Modelling results for Master Plan

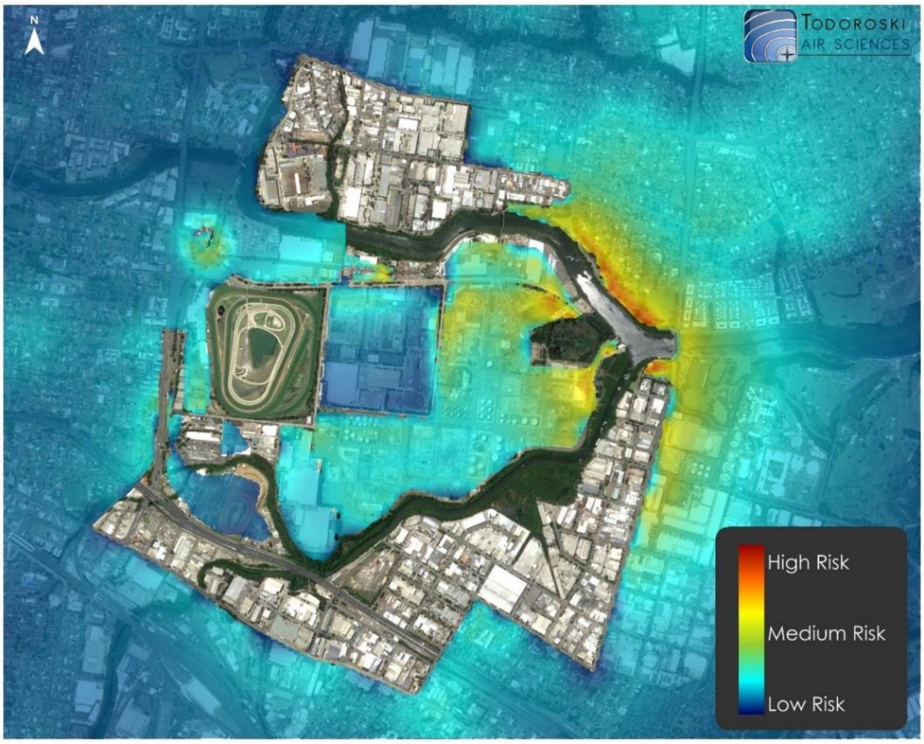

Figure 4-2: Modelling results for Master Plan with surrounding industrial areas not considered a sensitive receptor area

4.2 Modelling of Sydney Water Pumping Station 067

Detailed air quality modelling has been conducted for the Sydney Water Pumping Station 067 (SPS 067) within the Camellia-Rosehill Precinct to identify the extent of potential odour impacts and determine a potential buffer distance required for any new residential properties.

Sydney Water have indicated that the existing Odour Control Unit (OCU) at SPS 067 will be replaced with a new OCU consisting of activated carbon and bio-trickling filter to reduce the amount of odour generated, with a new stack to assist with the dispersion of odour from this source. Sydney Water have indicated that the proposed OCU may be positioned to the northeast of the existing facility at the site. It is noted that this may not be the optimum location to mitigate surrounding odour impacts. The Department will continue to consult with Sydney Water to investigate measures to mitigate odour impacts from SPS 067.

Odour modelling is based on the expected odour emission from the proposed OCU based on information provided by Sydney Water. The stack parameters for the modelled point source are outlined in **Table 4-1**.

Table 4-1: Modelled stack parameters for proposed OCU

Parameter	Value	Units
Stack height	16	m
Stack diameter	0.55	m
Temperature	20	ºC
Exit velocity	15	m/s
Flow rate	3.5	m^3/s
Odour concentration	500	OU
Emission rate	1,750	$OU.m^3/s$

The modelled source location for the proposed OCU is shown in **Figure 4-3**. The model included consideration of potential 'building' wake effects on air dispersion that arise due to the effect of winds passing over the buildings surrounding the site.

Figure 4-3: Proposed OCU stack location

Figure 4-4 shows the predicted area of impact for the SPS 067 at various heights above the ground. The modelling predictions for the SPS 067 indicate the facility has minimal impact at ground level with higher impact occurring at height. The modelling results for varying heights of ranging from ground level to 48m above ground level with the approximate buffer distance are shown in **Table 4-2**.

Table 4-2: Summary of approximate buffer distances for SPS 067 at varying heights

Height (m)	Approximate buffer distance based on modelling predictions (m)
0	0
20	35
24	100
32	80
40	70
48	60

Potential options to reduce the extent odour impacts from SPS 067 include improving the dispersion of odour emissions from the OCU stack by increasing the stack height and exit velocity and improving the control efficiency of the OCU by increasing the capacity or duplicating the filters of the OCU to further reduce the odour emissions generated.

The zone of impact associated with SPS 067 can also be optimised on the site by relocating the OCU stack away from the nearest potential future residential dwellings (e.g. relocate to the southernmost corner of the lot). Further detailed assessment is required to identify the most optimal the location of the OCU stack.

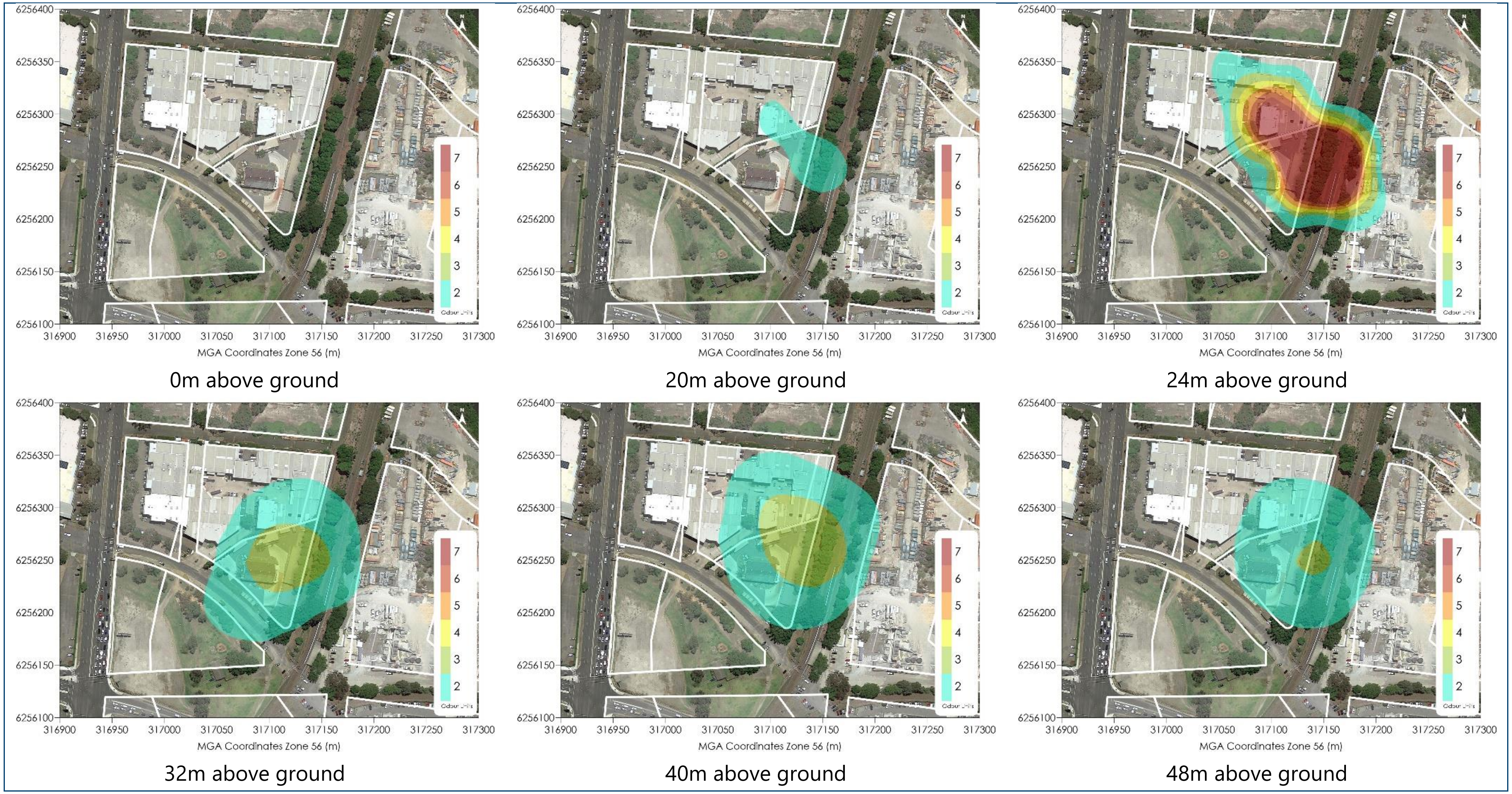

Figure 4-4: Modelling results for SPS 067 – Nose-response odour levels at various heights

5 ALLOCATIONS FOR AIR AND ODOUR

Allocations for air and odour emissions and impacts have been developed for the available land within the Camellia-Rosehill Precinct. The objective is to define the maximum extent of air and odour emissions from within the industrial area that do not cause impacts, in this case outside of the industrial use areas boundary.

The allocations provide an indication on the extent of air and odour emissions for future industries and the suitable locations within the industrial zoned areas to maximise the beneficial use within the Camellia-Rosehill Precinct.

The key consideration in making the allocations is that there are no sensitive receptors within the industrial use areas of the Camellia-Rosehill Precinct. The proposed residential and sensitive use areas (i.e. public school) are outside of the industrial land use area and have been considered as sensitive along with public recreation, open spaces, the Rosehill Racecourse. The wetland, waterway (i.e. Parramatta River and Duck River) and foreshore are not considered as sensitive areas.

5.1 Odour

Figure 5-1 presents the odour emission rate per hectare for sources of odour in the industrial area. 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). The maximum attenuated odour emission rate for an industry can be estimated from odour measurements taken at the source of an existing/ similar facility and from odour measurements presented in available literature studies. 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.

The map shows that areas central to the industrial area have a higher allocation of odour and would be best suited for odorous industries. This however does not exclude these industries locating in other areas of the precinct as long as the odour emissions can be managed to the allocated levels. Some industries would need to consider additional odour controls to ensure they meet the allowable odour levels for the location.

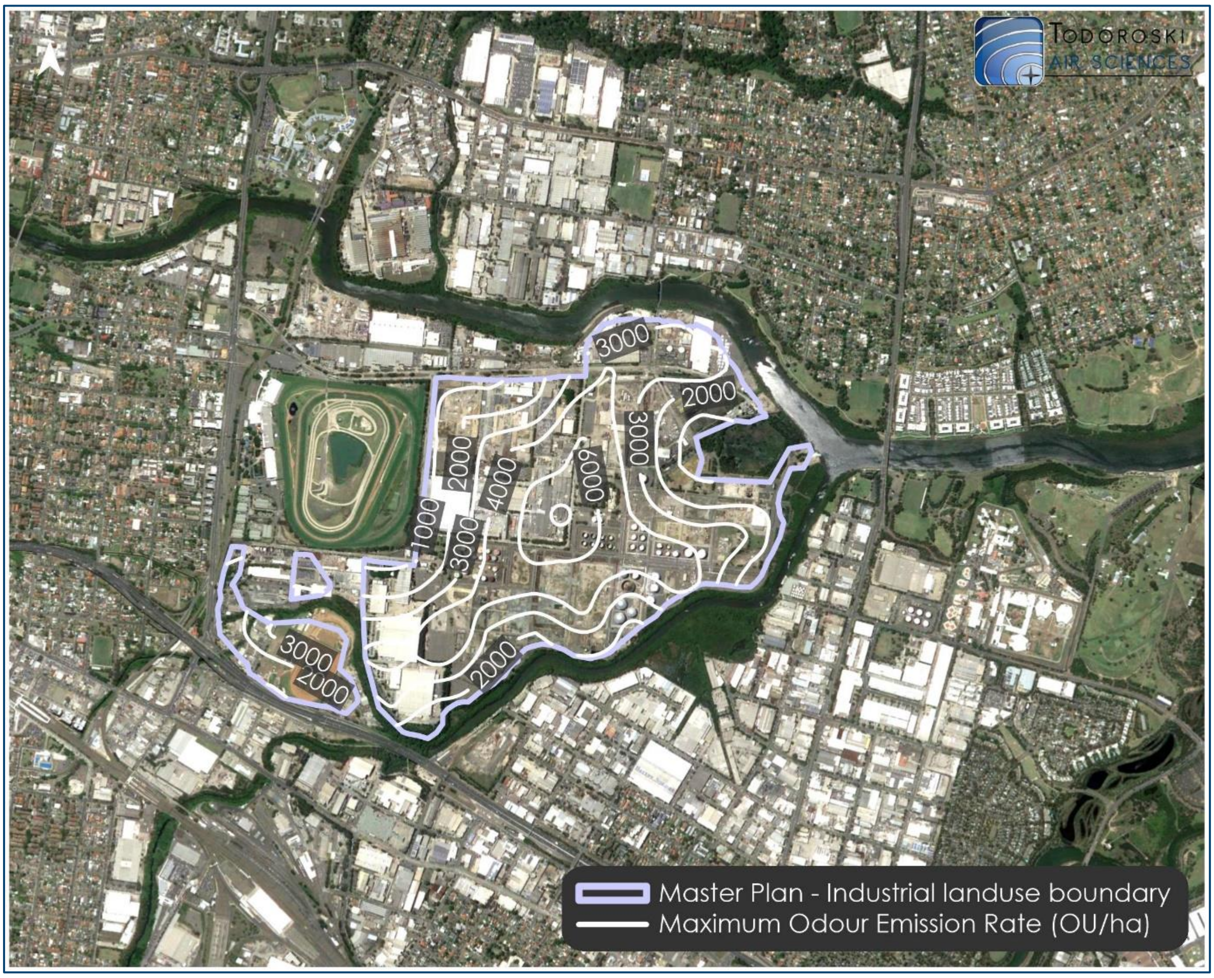

Figure 5-1: Source odour emissions rate per Ha (left) from the industrial area

Figure 5-2 presents the predicted odour impacts beyond the Camellia-Rosehill Precinct. As per the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW EPA, 2016**) the most stringent 2 OU NSW criteria applicable to densely populated urban areas has been applied at the sensitive land use areas. The results show the 2 OU would be met at these locations.

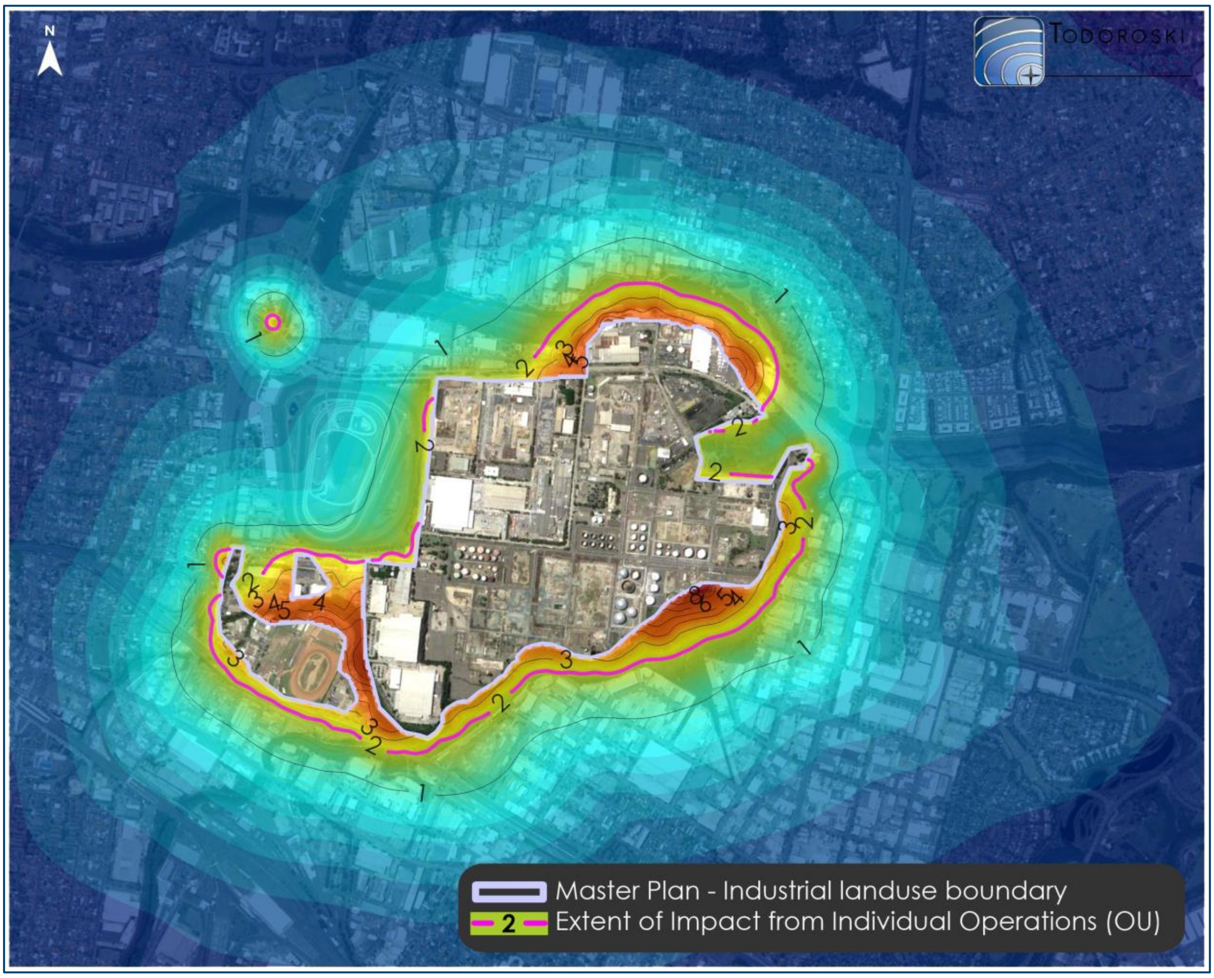

Figure 5-2: Received odour due to odour emissions from the industrial area

5.2 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 Camellia-Rosehill Precinct is designed such that industries incorporating general levels of control should be able to operate within the industrial precinct without causing impacts. However, 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 precinct near receptors. Such a location is better suited to an operation which has odour emissions within the specified allowance as it is unlikely to need extra abatement.

Figure 5-1 provides an allowance per hectare for potential odour emissions. This can be used for 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 and inspection to identify odour.
  - Routine preventative maintenance on equipment.
  - 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;
  - 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.

5.3 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. 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.

Figure 5-3 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 $\mu g/m^3$, which when combined with an assumed background level of 85 $\mu g/m^3$ at 100% conversion of NO_x to NO_2.

Figure 5-3: Air emission concentration per stack from the industrial area

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**)). We see that the POEO Clean Air Regulation limit for a boiler, 350mg/m^3, would not met within the industrial area and in order to meet the ground level concentration limits at the receptor locations the stack concetrations would need to be approxmialety 300mg/m^3 or less.

Figure 5-4 presents the predicted NO_X impacts beyond the Camellia-Rosehill Precinct and shows the predicted levels would comply with the relevant impact assessment criterion at the sensitive land use areas.

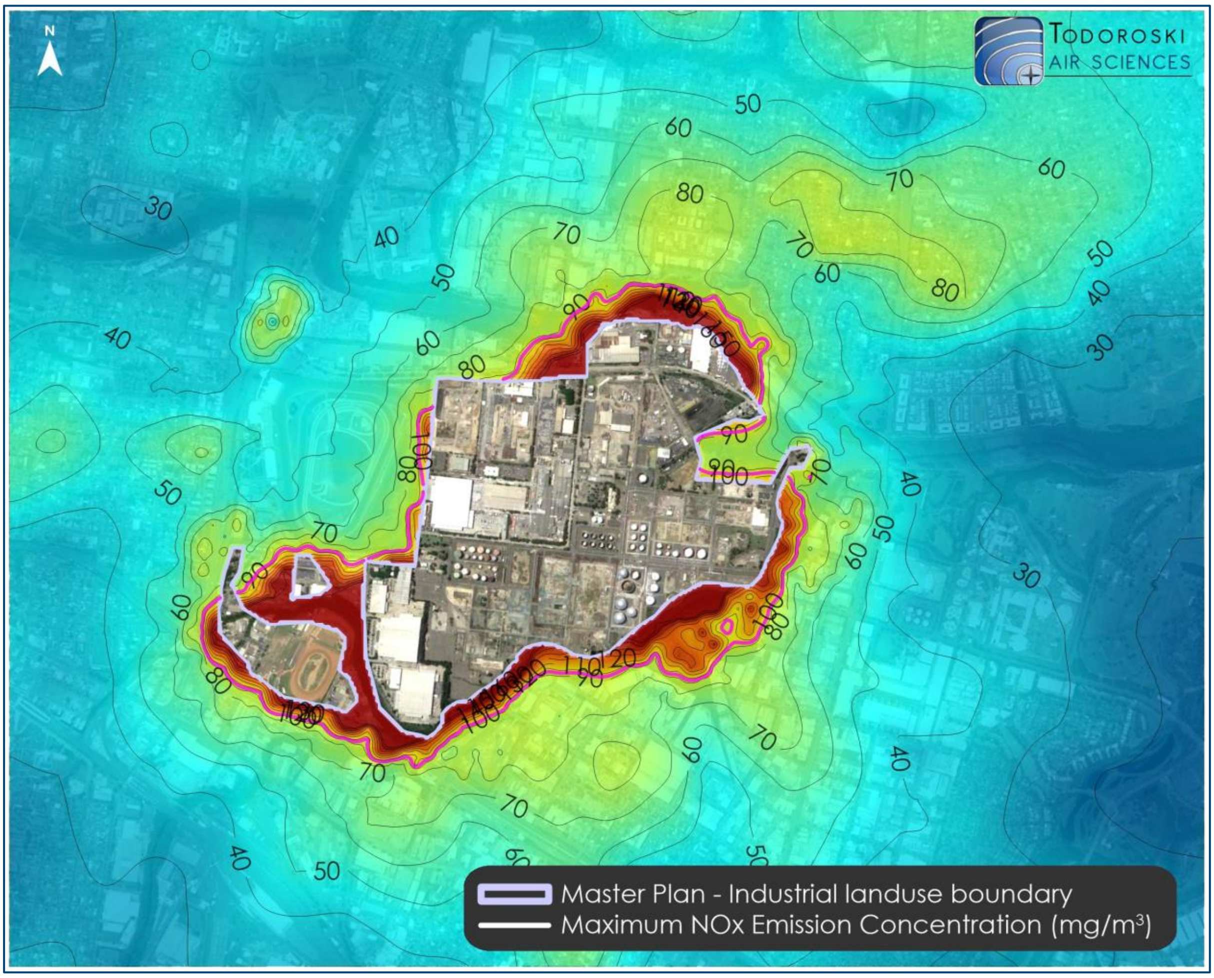

Figure 5-4: Received air pollutant concentrations due to NO_x emissions from the industrial area

5.4 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 Camellia-Rosehill 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.

Specific stack parameters will be tailored to the requirements of the industry it services and should be designed with consideration of good engineering practice.

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.

5.5 Locating industry within the Camellia-Rosehill Precinct

The approach presents a numerical criterion applicable to the land within the Camellia-Rosehill Precinct to minimise or control land use conflict associated with the proposed development of the land and maximise the beneficial use within the Camellia-Rosehill Precinct.

For example, **Figure 5-1** and **Figure 5-3** show the allotment within the industrial area with the highest levels occurring towards the central part of the precinct and lowest levels near the boundary. This can be used for 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). Industry locating near to the edge of the precinct, closer to receptors, may need to consider extra abatement or may require extra pollution controls. Such a location is better suited to an operation with low air and odour emissions.

5.6 Potential impacts at sensitive areas

The modelling results demonstrate that, if industries operate within the allocation for odour and air concentrations, compliance with the relevant impact assessment criteria can be achieved at the sensitive land uses areas. These include the proposed school sites and open space areas within the Camellia-Rosehill Precinct.

It is noted that some of the existing operations within the Camellia-Rosehill Precinct may not comply with the allocation for odour and air concentrations asssoicated with the proposed Master Plan. In order for these allocations to be met, a plan will be developed and ongoing consultation with these operations would be required to discuss how current odour and air emission can be mitigated to meet the future Master Plan requirements and minimise the potential for land use conflict.

6 CONCLUSIONS AND RECOMMENDATIONS

This analysis of the Master Plan indicates that there is scope to generate potential air and odour impacts depending on the position of the land use with regard to adjoining land uses and sensitive receptor areas. The possibility for land use conflict arises when potential land uses and sensitive receptor areas are located too closely. A suitable buffer is achieved with transitional uses between the low amenity land uses and the sensitive receptor areas within the Camellia-Rosehill Precinct.

Odour modelling of SPS 067 indicates the facility has minimal potential for odour impact at ground level and at 24m above ground, the impacts extend to approximately 100m from the source and a buffer should be considered for this source to the proposed residential areas. Given that Sydney Water upgrades to SPS 067 remain unresolved, it is prudent that further modelling be conducted prior to rezoning or lodging of any development applications in proximity to SPS 067, to enable an updated consideration of buffer setbacks that may be required. The Department will continue to consult with Sydney Water to investigate measures to mitigate odour impacts.

Appropriate allocations for odour (odour emission rate) per hectare and air concentrations across the Camellia-Rosehill Precinct is provided in this regard to positioning industries with these emissions to minimise impacts and cost burdens on new industries. The information can 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 no sensitive receptor area) or to require any extra odour controls.

It is recommended that planning controls be investigated as part of any future rezoning to ensure that land use conflicts are avoided and adequate amenity for residential and other sensitive land uses.

7 REFERENCES

Cox et al. (2021)

"DRAFT Camellia-Rosehill Place Strategy Package A Integrated Master Plan Workshop Outcomes Report", prepared by Cox, Oculus, Cred Consulting, Savills, Kinesis, Narla Environmental, The Fulcrum Agency, Dominic Steele Consulting Archaeology and Hector Abrahams Architects, June 2021.

NSW EPA (2016)

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

TRC (2011)

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

Appendix A

Selection of meteorological year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Sydney Olympic Park AWS weather station, is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2015 to 2019 was analysed against the available measured wind speed, wind direction, temperature and relative humidity. The analysis indicates that 2018 dataset is closest to the mean for wind speed, 2017 is closest for wind direction, temperature and relative humidity. On the basis of a score weighting analysis, 2018 was found to be most representative.

Table A-1: Statistical analysis results for Sydney Olympic Park AWS

Year	Wind speed	Wind direction	Temperature	Relative humidity	Score
2015	2.81	0.65	0.73	1.26	8.89
2016	2.43	0.68	0.69	1.12	8.02
2017	2.27	0.65	0.67	1.06	7.56
2018	2.19	0.66	0.70	1.13	7.53
2019	2.67	0.66	0.69	1.11	8.46

Figure B-1 shows the frequency distributions for wind speed, wind direction, temperature and relative humidity for the 2018 year compared with the mean of the 2015 to 2019 data set. The 2018 year data appear to be reasonably well aligned with the mean data.

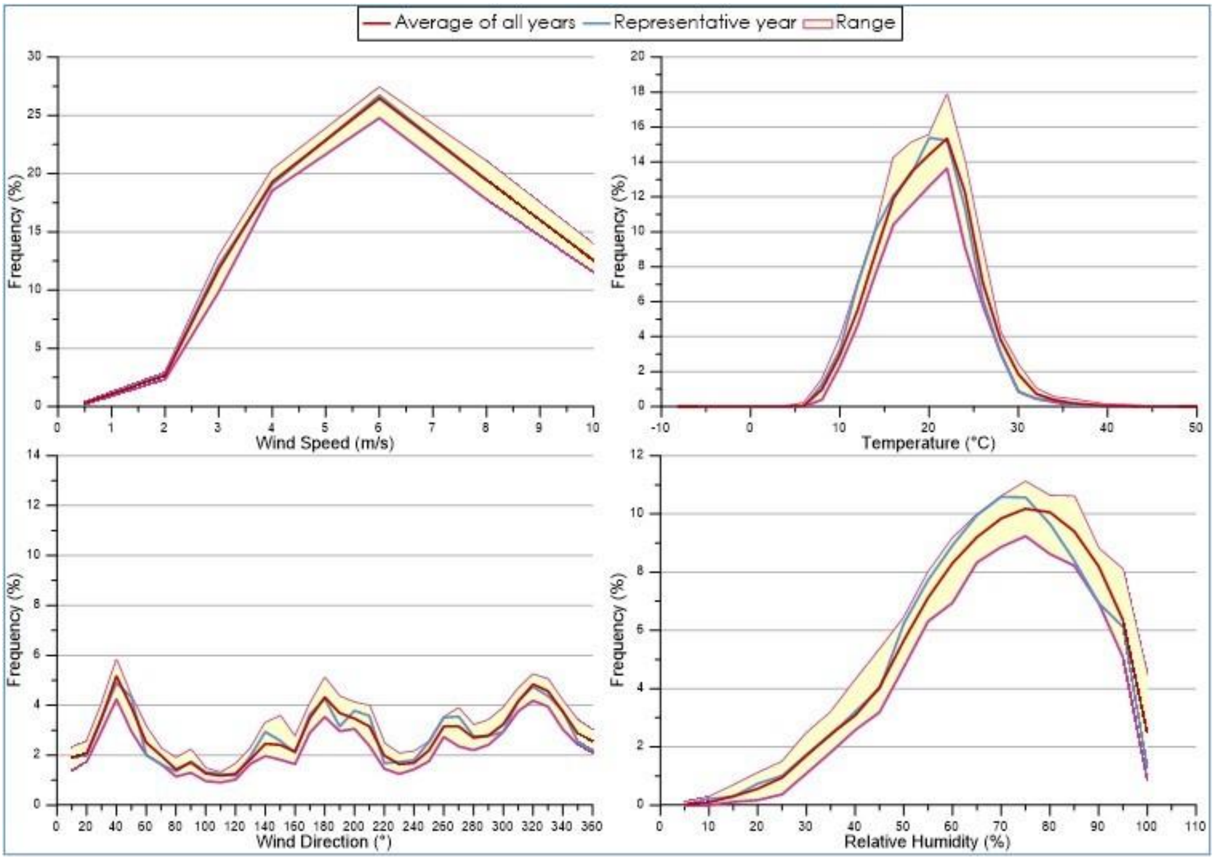

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity