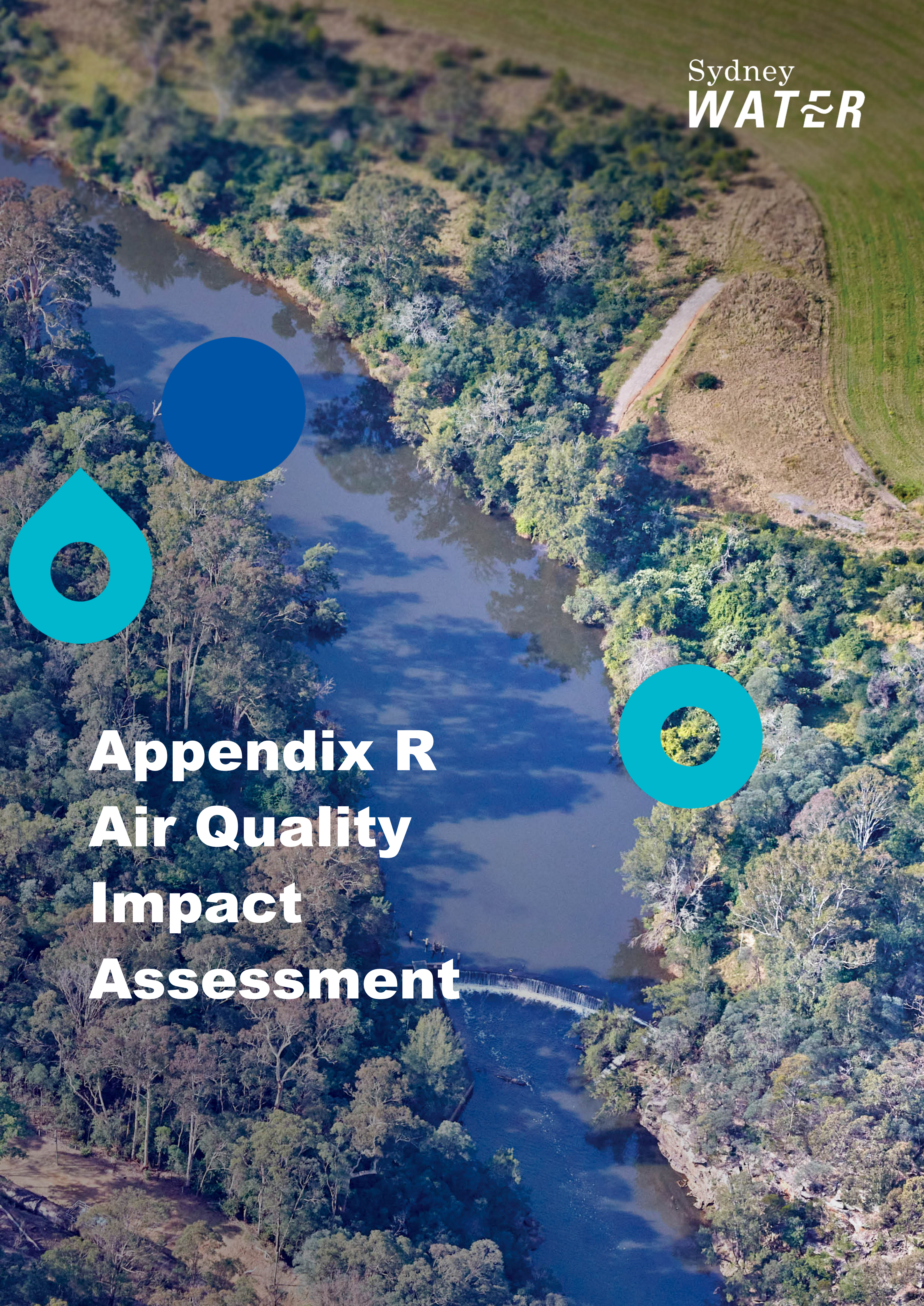

Sydney WATER

Appendix R Air Quality Impact Assessment

Upper South Creek Advanced Water Recycling Centre

Air Quality Impact Assessment

Final | Revision 1

15 June 2021

Sydney Water

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Upper South Creek Advanced Water Recycling Centre

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D2R0	11/09/20	Draft report following SWC review	SL	SL	SWC	PH
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Acronyms and definitions

Abbreviation	Definition
AC	Activated carbon
BoM	Bureau of Meteorology
BTF	Bio-trickling filter
CALMET	Meteorological model for the CALPUFF air dispersion model
CALPUFF	Computer-based air dispersion model
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DPIE	Department of Planning, Industry and Environment
EPA	NSW Environment Protection Authority
EPL	Environmental Protection Licence
Jacobs	Jacobs Group (Australia) Pty Limited
ML/d	Megalitres per day
NEPM	National Environment Protection Measure
NEPC	National Environmental Protection Council of Australia
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPI	National Pollutant Inventory
OEH	Office of Environment and Heritage, now part of the Department of Planning, Industry and Environment
OCU	Odour Control Unit
OU	Odour units
$PM_{2.5}$	Particulate matter with equivalent aerodynamic diameters less than 2.5 microns
PM_{10}	Particulate matter with equivalent aerodynamic diameters less than 10 microns
POEO Act	*Protection of the Environment Operations (POEO) Act 1997*
SEARs	Secretary’s Environmental Assessment Requirements
SOER	Specific odour emission rate
TAPM	The Air Pollution Model – a meteorological and air dispersion model developed by CSIRO
TOER	Total odour emission rate
TSP	Total Suspended Particulate matter

Executive Summary

This report provides an assessment of the potential air quality impacts of the Upper South Creek Advanced Water Recycling Centre, a proposal for new wastewater infrastructure to service growth in Western Sydney (the project).

The purpose of this air quality impact assessment is to form part of an Environmental Impact Statement being prepared by Sydney Water to accompany an application for approval under the State Significant Infrastructure provisions of Part 5 of the NSW *Environmental Planning and Assessment Act 1979.* The assessment has been undertaken to address the *Secretary's Environmental Assessment Requirements* and was carried out in accordance with the requirements of the NSW Environment Protection Authority. The report includes a detailed assessment of the Advanced Water Recycling Centre (AWRC) treating up to 50 megalitres per day (ML/d). The report also includes a high-level assessment of the project treating up to 100 ML/d at its ultimate capacity, to be built and operated in future stages.

In summary, the assessment identified the key air quality issues, characterised the existing air quality and meteorological environment, quantified project emissions and used an air dispersion model to predict the impact of the project on local air quality. The key potential air quality issues were identified as:

- Dust during construction of all proposed infrastructure;
- Odour from the AWRC during operation; and
- Emissions from cogeneration engines at the AWRC during operation.

A detailed review of the existing environment was carried out and the following conclusions were made:

- The prevailing winds in the area are from the south-southwest and north-northwest, a pattern that is common for Western Sydney and which reflects the influence of the Blue Mountains to the west.
- Air quality monitoring has shown that many locations near the project have experienced at least one day above the applicable criterion for particulate matter (as PM_{10}) in the past five years. Annual average particulate matter concentrations generally increased from 2017 onwards and also exceeded the applicable criterion in 2019 at some locations. These results were heavily influenced by dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019). Concentrations of another key indicator of air quality, nitrogen dioxide (NO_2), were reviewed and found to be below their relevant criteria.

The main conclusions of the assessment are:

- Dust impacts during construction can be minimised to acceptable levels with appropriate environmental safeguards. These safeguards will be documented in a Construction Environmental Management Plan and implemented during the construction phase.
- Odour impacts of the AWRC are expected to be at acceptable levels based on model results which showed compliance with the applicable assessment criteria at the nearest sensitive receptors. This conclusion was reached using conservative assumptions in relation to biosolids loadout times and odour control unit operation. Therefore, the predicted odour impacts of the AWRC would represent the potential worst-case impacts. The modelling also indicated that operating the AWRC at 100 ML/d is also not expected to cause adverse odour impacts. Some odour may be detected from time-to-time on parkland located within the site boundary however this impact has been determined as low risk given that the parkland would be for passive recreation where there would be relatively few people present for short durations.
- Emissions from the cogeneration engines are not expected to result in any adverse air quality impacts for both 50 and 100 ML/d scenarios.

Finally, it was noted that the proposed odour control measures are consistent with best practice for odour management at wastewater treatment plants.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts of the project in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

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1. Introduction

Sydney Water is planning to build and operate new wastewater infrastructure to service the South West and Western Sydney Aerotropolis Growth Areas. The proposed development will include a wastewater treatment plant in Western Sydney, known as the Upper South Creek Advanced Water Recycling Centre. Together, this Water Recycling Centre and the associated treated water and brine pipelines, will be known as the ‘project’.

The purpose of the assessment is to form part of an Environmental Impact Statement (EIS) to accompany an application for approval under the State Significant Infrastructure provisions of Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

The air quality impact assessment has been carried out in accordance with relevant guidelines published by the NSW Environment Protection Authority (EPA), namely, the “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW” (EPA, 2016) (hereafter referred to as the “Approved Methods”).

The main objectives of this assessment were to:

- Identify potential air quality issues;
- Quantify existing and potential air quality impacts; and
- Identify suitable air quality management measures, as appropriate, to minimise impacts.

The Secretary’s Environmental Assessment Requirements (SEARs) for the project were issued by the Department of Planning, Industry and Environment (DPIE) and identify the specific requirements to be addressed by the project EIS. This assessment has been prepared in accordance with the SEARs, as well as relevant governmental assessment requirements, guidelines and policies. **Table 1** lists the matters relevant to this assessment and where they are addressed in this report.

Table 1 Relevant matters raised in the SEARs

Requirement	Section(s) where addressed
Air quality – including: - An air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines. - The Proponent must ensure the AQIA also includes the following: a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation (2010); b) a cumulative local and regional air quality impact assessment, including consideration of the impacts associated with cogeneration of energy	This report, in particular: - Section 3 identifies the key air quality issues - Section 4 discusses the applicability of the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation (2010), with emission limits presented in Section 6 - Section 8 provides an assessment of the potential construction and operational air quality impacts in accordance with the EPA guidelines, including potential impacts cogeneration of energy. Impacts during construction have been determined by a qualitative review of activities and impacts during operation have been determined by modelling.

2. Project Description

An overview of the location of the proposed infrastructure is provided in **Figure 1**. Further details of each component of the project are provided below.

Advanced Water Recycling Centre

- a wastewater treatment plant with the capacity to treat up to 50 ML of wastewater per day, with ultimate capacity of up to 100 ML per day
- the Advanced Water Recycling Centre will produce:
  - high-quality treated water suitable for a range of uses including recycling and environmental flows
  - renewable energy, including through the capturing of heat for cogeneration
  - biosolids suitable for beneficial reuse
  - brine, as a by-product of reverse osmosis treatment

Treated water pipelines

- a pipeline about 17 kilometres (km) long from the Advanced Water Recycling Centre to the Nepean River at Wallacia Weir, for the release of treated water
- infrastructure from the Advanced Water Recycling Centre to South Creek to release excess treated water and wet weather flows
- a pipeline about five kilometres long from the main treated water pipeline at Wallacia to a location between the Warragamba Dam and Warragamba Weir, to release high-quality treated water to the Warragamba River as environmental flows.

Brine pipeline

- a pipeline about 24 km long that transfers brine from the Advanced Water Recycling Centre to Lansdowne, in south-west Sydney, where it connects to Sydney Water's existing Malabar wastewater network

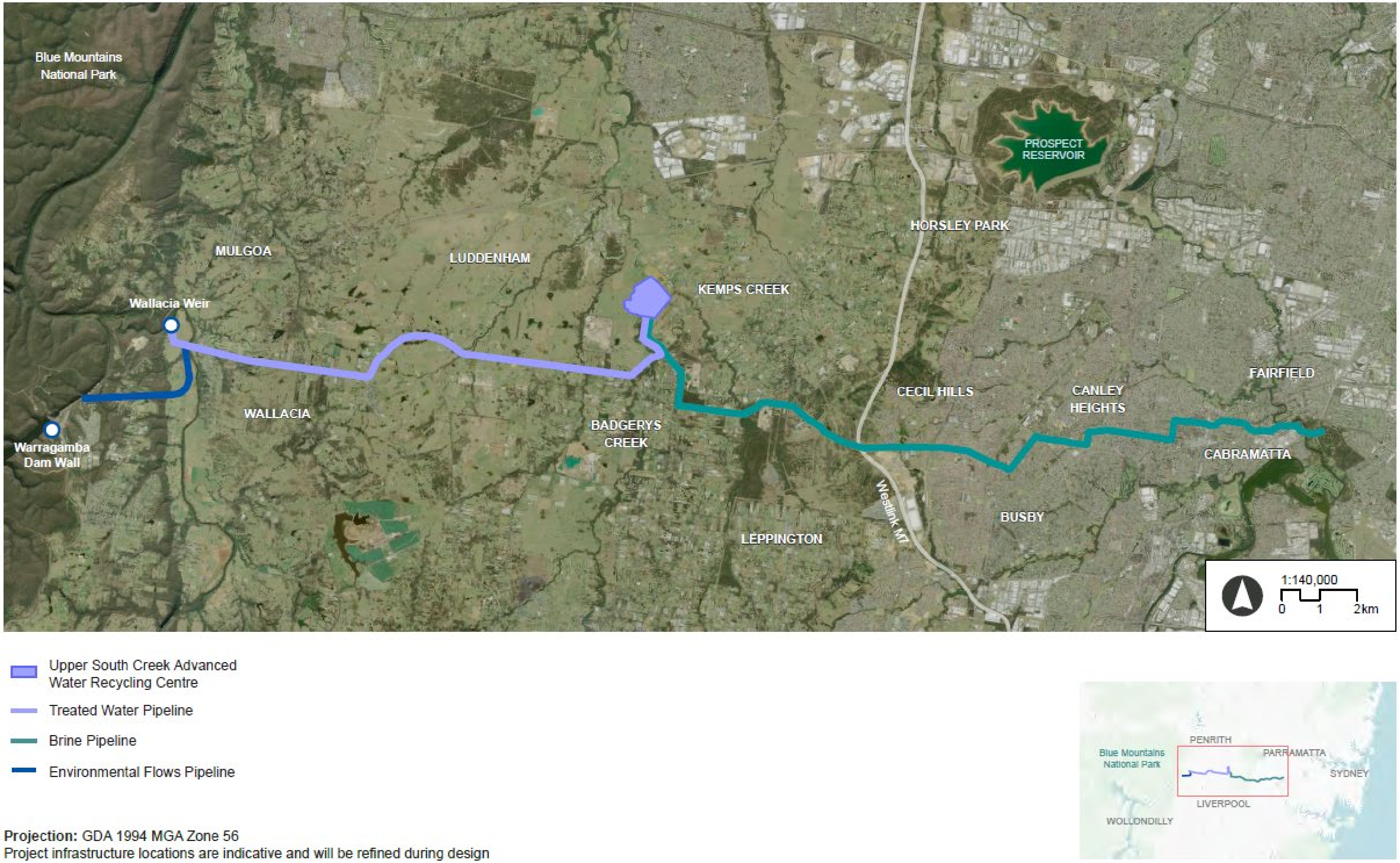
Sydney Water is planning to deliver the project in stages, with Stage 1 comprising:

- building and operating the Advanced Water Recycling Centre to treat an average dry weather flow of up to 50ML per day
- building all pipelines to their ultimate capacity, but only operating them to transport and release volumes produced by the Stage 1 Advanced Water Recycling Centre

Figure 2 shows the indicative AWRC layout, highlighting the key treatment processes and infrastructure. This layout forms the basis of the assessment but may change in detailed design.

The timing and scale of future stages will be phased to respond to drivers including population growth rate and the most efficient way for Sydney Water to optimise its wastewater systems.

A more detailed description of the project is provided in the EIS.



Projection: GDA 1994 MGA Zone 56
Project infrastructure locations are indicative and will be refined during design

Figure 1 Project overview

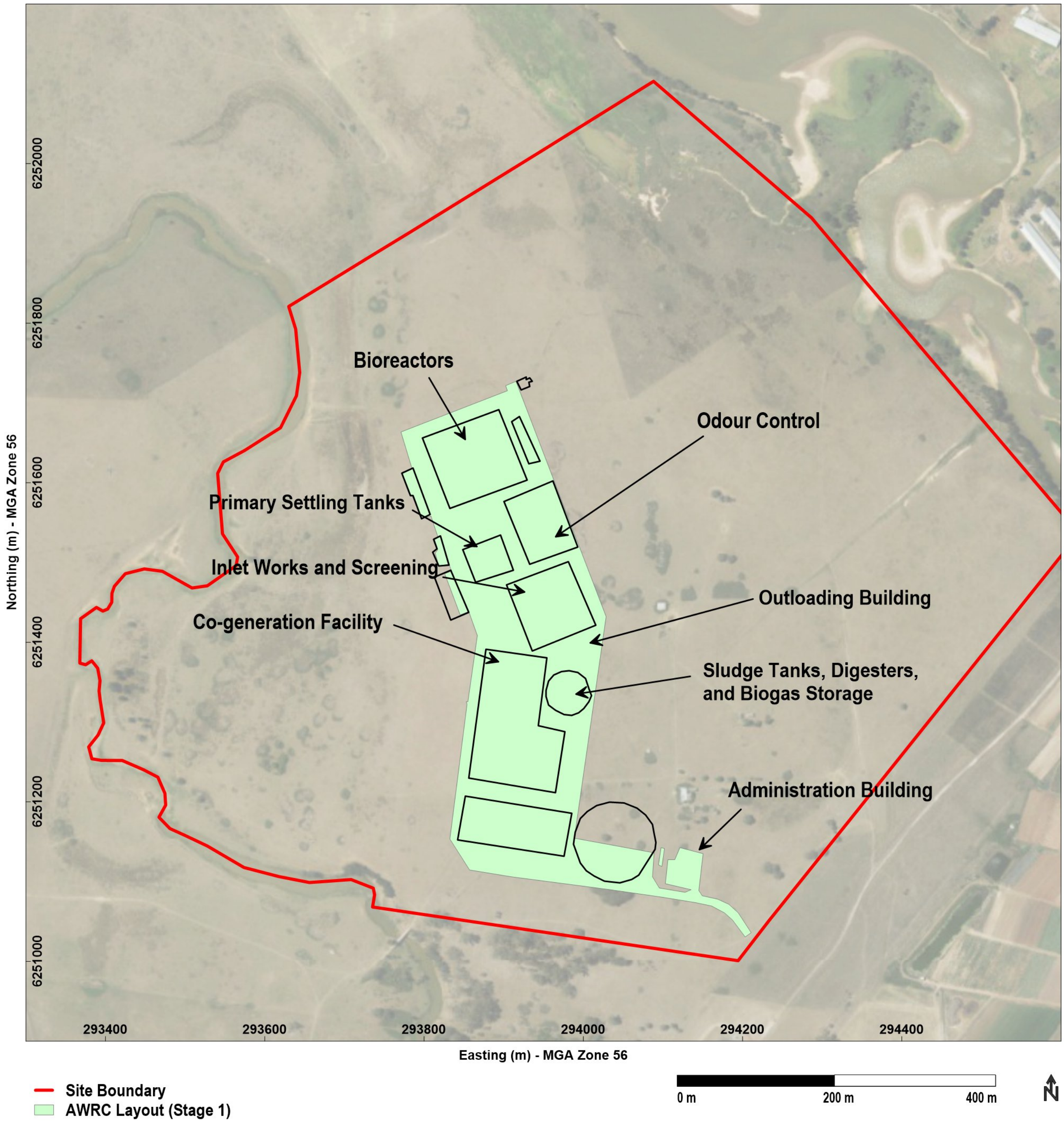


Figure 2 Indicative AWRC layout

3. Potential Air Quality Issues

Air quality issues can arise when emissions from an industry or activity lead to a deterioration in the ambient air quality. Potential air quality issues have been identified, considering the types of emissions to air and proximity of these emission sources to sensitive receptors.

Construction of the project could lead to emissions to air from a variety of activities including land clearing, earthworks, material handling, and material transport. Emissions may also arise from wind erosion of exposed areas. These construction-related emissions would mainly comprise of particulate matter in the form of:

- Total suspended particulates (TSP), typically where particles are less than 30 microns in equivalent aerodynamic diameter;
- Particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}); and
- Particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$).

There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter, and to a lesser extent sulphur dioxide (SO_2).

Operation of the project will involve processes associated with the removal of contaminants from the incoming wastewater. This wastewater will comprise of both household and some industrial wastewater. Physical, chemical, and biological processes will be used to remove contaminants and produce treated water. Solids will be treated before being dewatered and trucked offsite.

Odour may be generated from the liquid and solid waste streams with a progressive reduction in odour intensity expected through the treatment process. This odour will be most significantly associated with the AWRC and various odour treatment mechanisms will be in place to minimise emissions. Odour is not expected to be an issue for the treated water and brine pipelines due to the enclosed nature of this infrastructure.

Energy recovery will involve the combustion of biogas in cogeneration engines with the most significant emission being NO_x, including nitrogen dioxide (NO_2). NO_x is the key emission from cogeneration units with the potential for concentrations to approach legislative standards and NO_2 is linked to adverse health effects.

In summary, the potential air quality issues associated with the project have been identified:

- Dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) during construction of all infrastructure;
- Odour from the AWRC during operation; and
- Emissions from cogeneration engines at the AWRC during operation.

These issues are the focus of this assessment.

4. Air Quality Criteria

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of one or more substances known to cause health, nuisance and/or environmental effects, exceeds a certain level.

The project has been assessed against the air quality criteria set by the EPA as part of its Approved Methods (EPA, 2016). Most of the EPA criteria are drawn from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPMs) (NEPC, 1998). To measure compliance with ambient air quality criteria, the NSW Government has established a network of monitoring stations across NSW and up-to-date records are published on the DPIE air quality monitoring network website.

As noted in **Section 3**, the most significant emissions to air from the project will be:

- Dust (that is, particulate matter) during construction of all infrastructure;
- Odour from the AWRC during operation; and
- Emissions from cogeneration engines at the AWRC during operation.

There are various classifications of particulate matter, and the EPA has developed assessment criteria for TSP, PM_{10}, $PM_{2.5}$ and deposited dust. **Table 2** shows the EPA air quality assessment criteria. The criteria for TSP and deposited dust have been set to protect against nuisance amenity impacts while the criteria for PM_{10} and $PM_{2.5}$ have been set to protect against health impacts.

Table 2 EPA air quality assessment criteria for particulate matter

Substance	Averaging time	Criterion
Particulate matter (as TSP)	Annual	90 µg/m^3
Particulate matter (as PM_{10})	24-hour	50 µg/m^3
	Annual	25 µg/m^3
Particulate matter (as $PM_{2.5}$)	24-hour	25 µg/m^3
	Annual	8 µg/m^3
Deposited dust	Annual (maximum increase)	2 g/m^2/month
	Annual (maximum total)	4 g/m^2/month

Odour assessment criteria are used to assess the potential for air emissions to impact on local amenity. The EPA has set odour assessment criteria as part of their Approved Methods (EPA, 2016) with more specific guidance outlined in the "Technical framework Assessment and management of odour from stationary sources in NSW" (DEC, 2006). The relevant odour assessment criteria are shown in **Table 3**.

Table 3 EPA air quality assessment criteria for odour

Population of affected community	Criterion (odour units) (nose response time average, 99th percentile)
Single rural residence (≤~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (>2000) and/or schools and hospitals	2

The odour criteria are prescribed in odour units (OU), not to be exceeded more than 1% of the time, for different population densities. The differences between odour criteria are based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For example, in a densely populated area there will be a greater risk that some individuals within the community will find an odour unacceptable than in a sparsely populated area.

The criteria assume that 7 OU at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is more chance that sensitive individuals would be exposed. The criterion of 2 OU at the 99th percentile is considered to be acceptable for the whole population. Dispersion models typically predict down to a 1-hour averaging time, so correction to “nose-response” averaging times (of the order of 1 second) is required. This correction is further explained in **Section 6**. The EPA odour criteria are based on “nose-response” averaging times.

The National Pollutant Inventory (NPI, 2008) identifies a range of emissions from engines running on biogas including carbon monoxide, polycyclic aromatic hydrocarbons and sulfur dioxide however it is the NO_x which is the key emission from cogeneration units based on the potential for concentrations to approach standards listed in the *Protection of the Environment Operations (Clean Air) Regulation 2010.* **Table 4** shows the EPA criteria for NO_2; the component of NO_x that has been linked to adverse health effects.

Table 4 EPA air quality assessment criteria for nitrogen dioxide

Substance	Averaging time	Criterion
Nitrogen dioxide (NO_2)	1-hour	246 µg/m^3
	Annual	62 µg/m^3

The EPA criteria outlined above (that is, those in **Table 2**, **Table 3** and **Table 4**) apply to existing and potentially sensitive receptors, where the Approved Methods defines a sensitive receptor as *“a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area”*. This definition has also been interpreted as places of near-continuous occupation.

The *Protection of the Environment Operations (POEO) Act 1997 (POEO Act)* was enacted on the 1st July 1999 and has an objective to ensure consistency by bringing the key pollution statutes under a single act. The project requires an Environment Protection Licence (EPL) under the *POEO Act* during construction and operation.

The *POEO Act* introduces the concept of “offensive odours” and there are provisions that specifically relate to odour. It provides that EPA licensed facilities “must not cause or permit the emission of any offensive odours from the premises”. Any licensed facility may be required to meet conditions designed to avoid or control odour. In addition, it is an offence for any person to cause air pollution (which includes dust and odour) due to poor maintenance of plant or the poor handling of material. For licensed facilities these requirements will be enforced by the EPA.

Also relevant is the *Protection of the Environment Operations (Clean Air) Regulation 2010* which prescribes requirements including emission standards for domestic solid fuel heaters, control of burning, motor vehicle emissions and industrial emissions. This regulation is applicable to emissions from the proposed cogeneration unit.

5. Existing Environment

This section provides a description of the environmental characteristics in the area, including a review of the local meteorological and ambient air quality conditions. The review is primarily focussed on the area around the proposed AWRC but is also applicable to the areas around the associated treated water and brine pipelines. One of the objectives for this review was to develop an understanding of any existing air quality issues as well as the meteorological conditions which typically influence the local air quality conditions.

5.1 Local Setting

The project, and specifically the proposed AWRC, is located in a rural area of Western Sydney, approximately 40 km to the west of the Sydney central business district, and part of the Greater Western Sydney region. The AWRC site is set at an elevation of approximately 40 m above sea level within a natural depression that follows the alignment of South Creek and Badgerys Creek. **Figure 3** shows a pseudo three-dimensional representation of the local terrain.

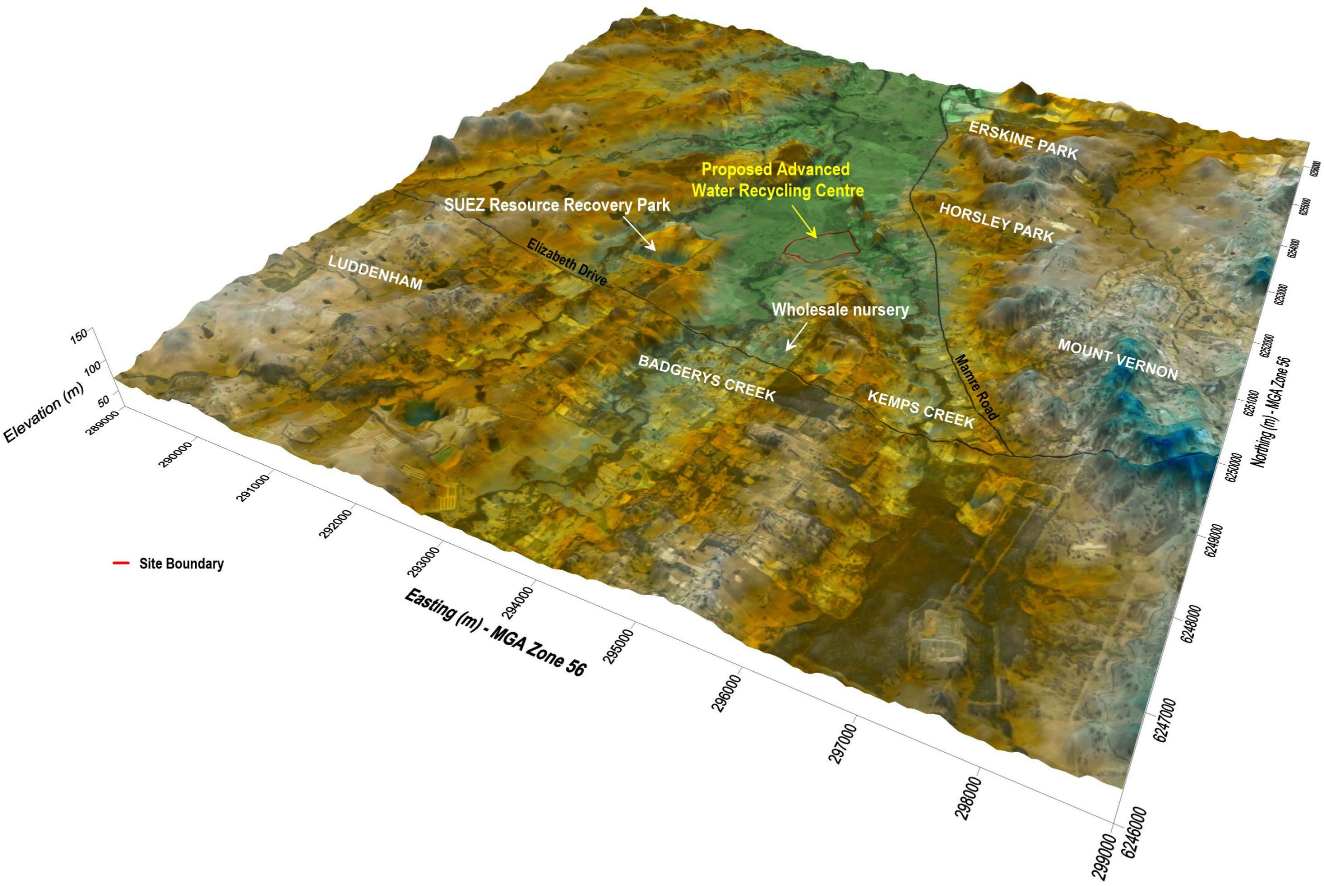


Figure 3 Pseudo three-dimensional representation of the local terrain

The area around the AWRC is largely rural residential. The key local industries and activities include:

- The SUEZ Resource Recovery Park which processes waste, approximately one kilometre (km) to the southwest;
- A wholesale nursery, approximately 1.5 km to the south;
- Chicken broiler / layer farms to the south, northeast and east; and
- The Western Sydney Airport, currently under development and approximately 7 km to the southwest.

From a potential cumulative impact perspective these industries do not generate odour that would be of a similar nature to those emissions from the AWRC. The SUEZ Resource Recovery Park may be a source of dust (and odour) however its contribution to air quality will already be represented in the monitoring data discussed in **Section 5.3**.

The nearest private residential properties are approximately 500 m to the south, southeast, east and northeast. The Twin Creeks residential development is located approximately 1.5 km to the northwest. There is also the potential for new dwellings to existing to the northwest of the AWRC. These are discussed in **Section 8**.

5.2 Meteorological Conditions

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature and atmospheric stability. For air quality assessments, a minimum of one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the model simulations.

The EPA has prescribed the minimum requirements for meteorological data that are to be used in dispersion modelling. These requirements are outlined in the Approved Methods (EPA, 2016) and state that at least one year of “site-specific” data should be used. If “site-specific” data are not available then “site-representative” data, correlated against at least five years of data, are acceptable. The meteorological data must also be at least 90 percent complete.

Meteorological monitoring is not carried out at the location of the proposed AWRC site, however there are several meteorological stations within 10 km of the site. The closest meteorological stations with publicly available data are located at Bringelly, Horsley Park, Liverpool, Prospect and St Marys. The Horsley Park station is operated by the Bureau of Meteorology with the other four stations operated by the DPIE. **Figure 4** shows the location of the meteorological stations and, based on the topography and proximity of these stations to the proposed AWRC, these stations would be classified as “site-representative” under the Approved Methods terminology.

Meteorological data from five recent years (2015 to 2019 inclusive) from the five identified monitoring stations have been analysed to identify a representative year for the modelling. Hourly records of wind speed and wind direction were examined. The process for identifying a representative meteorological year involved comparing wind patterns and statistics for each calendar year.

Figure 5 shows the annual wind patterns for each year from 2015 to 2019, based on data collected at St Marys, the closest meteorological station to the site. It can be seen from these wind-roses that the most common winds in the area are from the south-southwest and north-northwest. This pattern of winds is common for Western Sydney and reflects the influence of the north to south alignment of the Blue Mountains to the west. It is also clear from **Figure 5** that wind patterns were similar in all five years of data presented. This suggests that wind patterns do not vary significantly from year to year, and potentially the data from any of the years presented could be used as a representative year for modelling purposes.

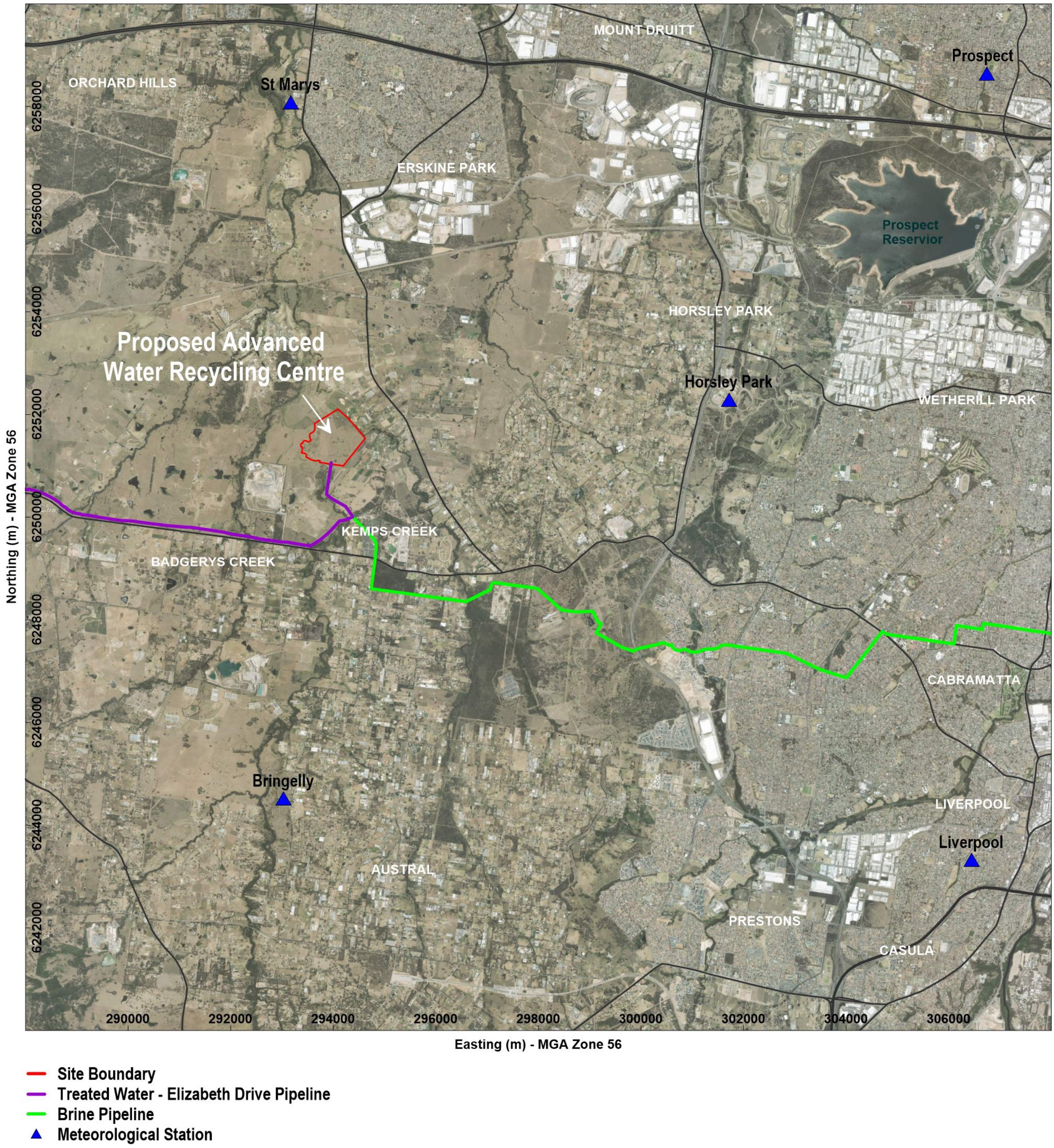


Figure 4 Location of nearest meteorological stations

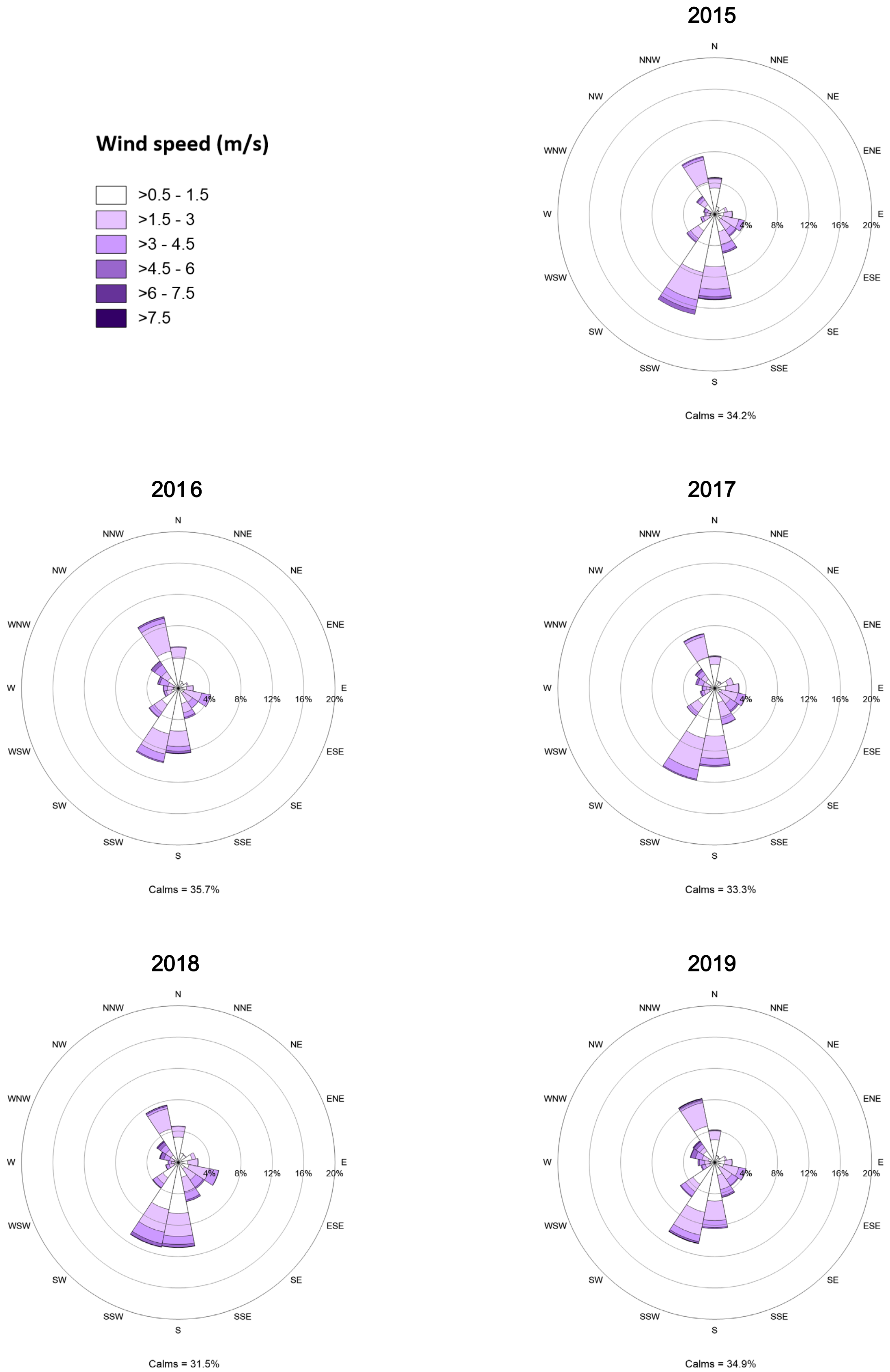


Figure 5 Annual wind-roses for data collected at the St Marys meteorological station

Figure 6 shows the wind speed data from each of the five meteorological stations. These data show that the average and maximum wind speeds exhibited similar ranges across all five years and for all five locations. Maximum wind speeds reached around 10 metres per second (m/s) as an hourly average and these winds were not isolated to any particular time of year.

The annual data statistics for the 2015 to 2019 years have been examined to assist with identifying a representative meteorological year. Table 5 shows the statistics.

Table 5 Annual statistics from meteorological data collected between 2015 and 2019

Year	Bringelly	Liverpool	Prospect	St Marys	Horsley Park
Percentage complete (%)					
2015	100	97	100	99	97
2016	99	99	100	97	97
2017	98	100	99	99	99
2018	99	98	99	98	99
2019	98	98	98	99	100
Mean wind speed (m/s)					
2015	1.4	1.9	1.7	1.3	2.0
2016	1.4	2.0	1.8	1.3	2.0
2017	1.4	1.9	1.8	1.3	2.2
2018	1.5	1.9	1.9	1.4	2.2
2019	1.4	1.8	1.8	1.3	2.1
Percentage of calms (<= 0.5 m/s)					
2015	29	12	14	33	21
2016	32	15	14	33	22
2017	30	15	14	33	20
2018	31	16	13	29	18
2019	33	17	15	35	20
Percentage of wind speeds >6 m/s					
2015	0.2	1.0	0.4	0.2	1.4
2016	0.4	1.9	1.1	0.2	1.5
2017	0.6	2.1	0.9	0.1	2.0
2018	0.8	2.2	1.2	0.5	2.8
2019	0.6	1.8	1.3	0.5	2.3

Over these five years the mean annual wind speed has ranged from 1.3 m/s at St Marys in 2019 to 2.2 m/s at Horsley Park in 2017 and 2018. The percentage of calms (that is, winds less than or equal to 0.5 m/s) has ranged from 13 to 35%. The similar trends and statistics for each year suggest that data from any of the years reviewed may be considered as representative for the purposes of modelling.

For this air quality assessment the 2019 calendar year has been selected as the meteorological modelling year, based on high data capture rate, meeting the EPA's requirement for a 90% complete dataset, and similar wind patterns to other years. Methods used for incorporating the 2019 data into the meteorological modelling (CALMET) and air dispersion modelling for the AWRC site (CALPUFF) are discussed in detail in **Section 7**. Annual and seasonal wind-roses from data collected by all meteorological stations for 2019 are provided in **Appendix A**.

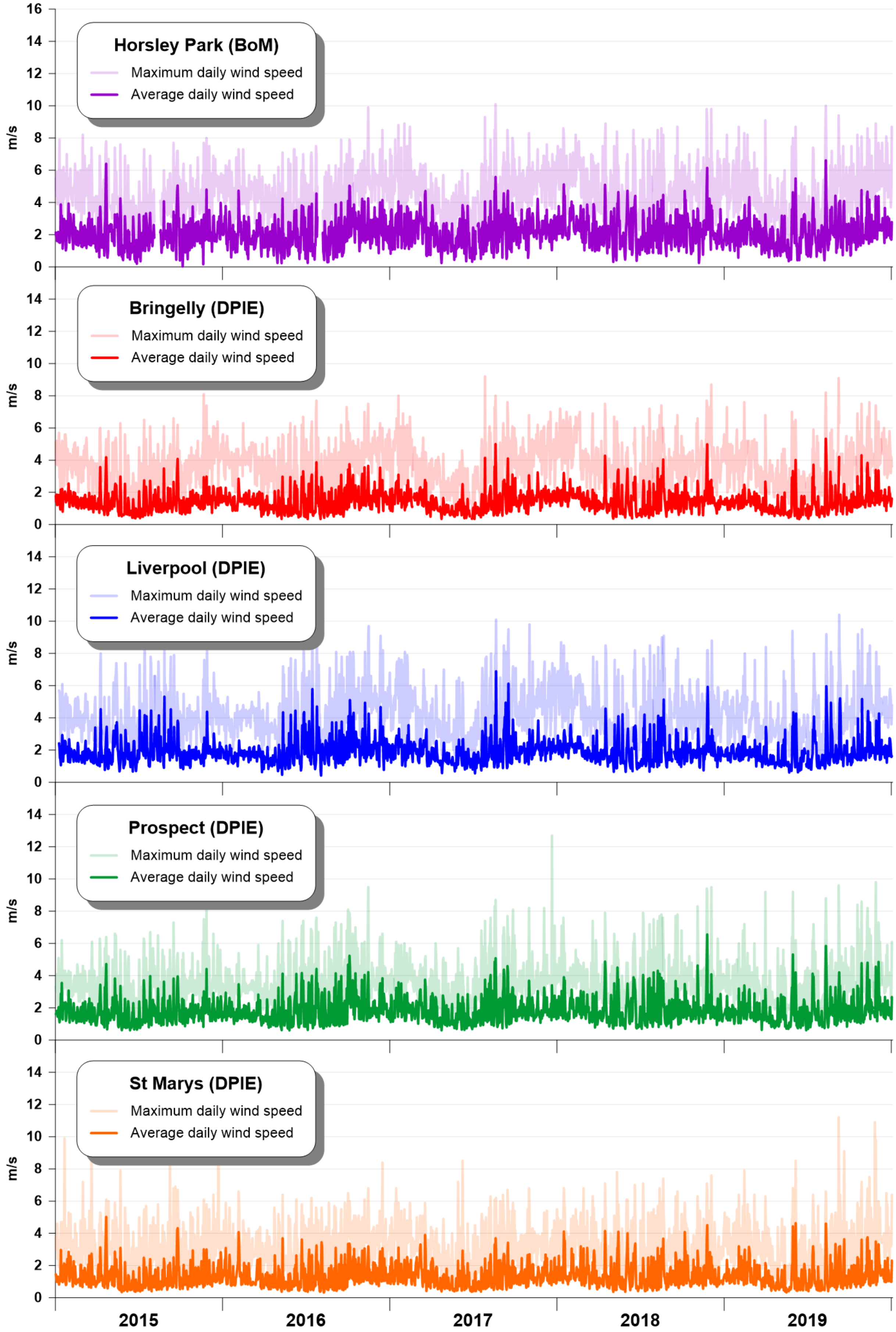


Figure 6 Wind speed data collected between 2015 and 2019

5.3 Air Quality Conditions

The most common indicators of air quality are those referred to as "criteria" air pollutants by the NEPC. Such pollutants include:

- Carbon monoxide (CO);
- Nitrogen dioxide (NO_2);
- Ozone (O_3);
- Sulfur dioxide (SO_2);
- Lead (Pb); and
- Particles (as PM_{10} and $PM_{2.5}$)

The DPIE has established a network of air quality monitoring stations across NSW with the closest monitoring stations to the area of interest located at Bringelly, Liverpool, Prospect and St Marys (**Figure 4**). Data from these stations have been examined and compared to relevant EPA criteria to understand the existing air quality conditions. The focus of this review was on PM_{10} and NO_2 since these pollutants have been identified as potential emissions from the project during construction and operation phases respectively.

Table 6 provides a summary of the measured PM_{10} concentrations near the project for the past five years, with shaded values indicating exceedances. These data show that PM_{10} concentrations have exceeded the 24-hour average criterion on at least one day in almost all years, at all locations, and that the number of exceedances increased in 2018 and 2019. One or more exceedances of the 24-hour average criterion per year is not uncommon for most DPIE monitored locations in NSW. Annual average PM_{10} concentrations exceeded the EPA's annual criterion in 2019 at Liverpool and Prospect.

In their "Annual Air Quality Statement 2018" the OEH (now DPIE) concluded that particle levels increased across the state due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH, 2019). Air quality conditions in the Sydney region were clearly influenced by the drought conditions in 2017 and 2018 and lower than average rainfall. In addition, late 2019 coincided with a period of unprecedented bushfires in Australia, predominantly across southeast Australia. The bushfires adversely affected air quality across many parts of NSW including Sydney and these events are reflected in the data presented in **Table 6**.

Table 6 Summary of measured PM_{10} concentrations near the project

Year	Bringelly	Liverpool	Prospect	St Marys	EPA criterion
Maximum 24-hour average PM_{10} (µg/m^3)					
2015	57	69	69	53	50
2016	62	69	110	100	
2017	84	74	61	50	
2018	93	102	113	101	
2019	134	179	183	160	
Number of days above 50 µg/m^3					
2015	1	1	1	1	-
2016	3	3	4	3	
2017	6	2	1	0	
2018	NA	13	8	NA	
2019	24	28	25	26	
Annual average PM_{10} (µg/m^3)					
2015	16	18	18	15	30
2016	17	20	19	16	

Year	Bringelly	Liverpool	Prospect	St Marys	EPA criterion
2017	20	21	19	16	25
2018	21	24	22	19	
2019	24	28	26	25	

Table 7 provides a summary of the measured NO_2 concentrations near the project for the past five years. These data show that NO_2 concentrations have not exceeded the relevant EPA criteria.

Table 7 Summary of measured NO_2 concentrations near the project

Year	Bringelly	Liverpool	Prospect	St Marys	EPA criterion
Maximum 1-hour average NO_2 (µg/m^3)					
2015	55	123	109	66	246
2016	62	96	109	86	
2017	74	131	123	76	
2018	74	127	105	76	
2019	70	103	101	68	
Annual average NO_2 (µg/m^3)					
2015	8	21	23	8	62
2016	NA	25	21	8	
2017	10	25	21	8	
2018	12	25	18	10	
2019	10	25	18	8	

6. Emissions to Air

Odours in domestic wastewater are caused by gases produced during the breakdown of organic matter. They are often the result of a mixture of volatile compounds, and over 100 compounds have been associated with odours at wastewater treatment plants.

Odour sensory methods, as opposed to analytical monitoring of individual compounds, are normally used to measure odours. Analytical monitoring of individual compounds is not usually practical, as odours are complex chemical mixtures. Odour sensory methods depend upon the olfactory response (sense of smell) of individuals who serve on evaluation panels.

Sensory response is measured using a dynamic olfactometer, which is a dilution device for the presentation of odours to a panel of observers. Using an olfactometer, a series of dilutions of an air sample from the odour source is presented to a panel of “sniffers”. The panel must indicate if there is a distinction between the sample and odour free air. The point at which only 50% of the panel can detect the smell is called the odour threshold. The number of times odorous air must be diluted with odour-free air in order for 50% of a selected panel of “sniffers” to detect a smell is related to the concentration of a particular odour, which is described in odour units. Hence 1 odour unit indicates that an equal volume of air is required to dilute a particular volume of odorous air to a level at which half the panel were able to detect the smell. This process, referred to as olfactometry, is used to quantify odour emissions from a particular source.

Sydney Water has developed an extensive database of odour emissions from all key wastewater treatment processes at almost all plants in their network. Emissions for modelling have been derived from historical site reviews and sampling programs and were measured using dynamic olfactometry according to the “Australian/New Zealand Standard: Stationary source emissions – Part 3: Determination of odour concentration by dynamic olfactometry (AS/NZS4323.3:2001)”.

The Sydney Water odour emissions database has been used to develop estimates of maximum emissions from the proposed AWRC. The wastewater treatment process will include:

- Inlet works for preliminary treatment;
- Primary, secondary and tertiary wastewater treatment;
- Advanced treatment including through reverse osmosis;
- Biosolids handling facilities;
- Cogeneration for heat and energy production;
- Odour control facilities;
- Infrastructure to South Creek for releases during wet weather; and
- Pumping stations to transfer treated water to the Nepean and Warragamba Rivers, and the brine to the Malabar wastewater system.

Emissions from many of the key odour generating sources (i.e. inlet, channels, wash presses, screens, outlet) will be ducted to the proposed odour control facility that will consist of biological tricking filters (BTF) and an activated carbon (AC) polishing scrubber. Treated air will be released via a stack. This arrangement is best practice for odour management.

The Sydney Water Standard for odour control units (OCU) specifies that odour concentrations in the exhaust air will not exceed 500 OU. Recent (2020) measurements at Sydney Water treatment plants with activated carbon technology have shown that concentrations below 500 OU are easily achieved. An odour concentration of 500 OU is therefore considered a conservative estimate of the odour concentration in air discharged from the OCU.

Table 8 shows the source and emission data, as used by the dispersion model, for the proposed AWRC. The main intent of the inventory is to capture the most significant emission sources that may influence off-site odour. Not every source will be captured. It is possible that there will be other sources of odour from time to time, such as leaks from covers and maintenance activities including cleaning. These potential sources are not expected to be significant enough to change odour impact outcomes but they will need to be managed and minimised during operations. The dominant odour sources, which will be most significant in determining the extent of impacts during normal operations, are expected to be the OCU and the biosolids loadout building.

Table 8 Estimated odour emissions (50 ML/d)

Source	Source type	Area (m^2)	Height (m)	Stack tip diam. (m)	Base elevation (m)	Temperature. (K)	Velocity (m/s)	Air flow (m^3/s)	Odour conc (OU)	SOER ($ou.m^3/m^2/s$)	TOER ($ou.m^3/s$)
Odour Control Unit	Point	-	15.0	1.5	40.0	293	15.0	26.0	500	-	13000
Bioreactor 1 and 2	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Bioreactor 3 and 4	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Membrane Tanks 1 and 2	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Membrane Tanks 3 and 4	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Biosolids Loadout Building	Volume	-	12.5	-	40.0	-	-	10.0	1680	-	16800
Cogeneration Engine	Point	-	6.0	0.4	40.0	699	12.3	1.6	1589	-	2463
										Total	**35,613**

Notes: SOER = Specific odour emission rate. TOER = Total odour emission rate.

Table 9 outlines the source of the estimated odour emission rates and other modelled parameters.

Table 9 Source of estimated odour emission rates and other modelled parameters.

Source	Documentation
Odour Control Unit	Concentration: 500 OU is upper value for other sites that have an OCU with carbon polishing, or feature carbon as the main treatment stage. Examples include: - North Head WWTP: BTF with AC polishing. Samples taken 25/2/20. - PARPS Re-lift Station (Adelaide): BTF with AC polishing: Based on 4 samples taken 09/01/2019 - Merrimac STP – BTF with AC polishing: Based on 42 samples taken ~2008 Picton WRP: BTF with AC polishing. Based on 18 samples taken between 11/08/2005 – 08/08/2006Temp: 293K = 20C. This is approximately ambient temperature. In winter, the air will be warmer than ambient, as the wastewater arrives at the plant slightly above ambient and the air will be warmer under odour control covers. Air flow: Air flow is based on the ventilation needs of covered processes and as per the design. Velocity: 15 m/s is a standard design velocity. The value is intended to be high enough to achieve good dispersion without unwanted phenomena (e.g. noise / whistling from stack, backpressure on fan, etc). Sealed and covered receival buildings address the risk of long receival times over long pumping length, especially in early development period.

Source	Documentation
Bioreactor 1 and 2	SOER: 0.5 is a default value for this source from Sydney Water Odour Emissions Database (short sludge age plant). Concentration is back-calculated from the SOER based on a flux hood with 5 L/min air sample rate. Assumed value of 0.5 is conservative as the AWRC would be a long sludge age plant.
Bioreactor 3 and 4	SOER: 0.5 is default value for this source from Sydney Water Odour Emissions Database (short sludge age plant). Concentration is back-calculated from the SOER based on a flux hood with 5 L/min air sample rate. Assumed value of 0.5 is conservative as the AWRC would be a long sludge age plant.
Membrane Tanks 1 and 2	SOER: 0.5 is default value for this source from Sydney Water Odour Emissions Database (short sludge age plant). Concentration is back-calculated from the SOER based on a flux hood with 5 L/min air sample rate. Assumed value of 0.5 is conservative as the AWRC would be a long sludge age plant.
Membrane Tanks 3 and 4	SOER: 0.5 is default value for this source from Sydney Water Odour Emissions Database (short sludge age plant). Concentration is back-calculated from the SOER based on a flux hood with 5 L/min air sample rate. Assumed value of 0.5 is conservative as the AWRC would be a long sludge age plant.
Biosolids Loadout Building	Concentration: 1,680 OU based on measurement data from the Malabar plant. Air flow: Based on nominal wind velocity and assumed openings in the building.
Cogeneration Engine	Concentration: 1589 OU: from North Head and as sampled in 2013. Temperature: From cogeneration unit at North Head. Air flow: From cogeneration unit at North Head. Based on a temperature of 699 K. Velocity: From cogeneration unit at North Head. Calculated from discharge air flow and stack diameter.

The odour emissions data have been multiplied by "peak-to-mean" factors to convert the model's one hour averaging time to a nose-response averaging time, which is in the order of one second. **Table 10** shows the peak-to-mean factors for each source based on the data prescribed by the EPA (2016).

Table 10 Peak-to-mean factors

Source	Peak-to-mean factors for each stability class					
	A	B	C	D	E	F
Odour Control Unit[1]	2.3	2.3	2.3	2.3	2.3	2.3
Bioreactor 1 and 2	2.5	2.5	2.5	2.5	2.3	2.3
Bioreactor 3 and 4	2.5	2.5	2.5	2.5	2.3	2.3
Membrane Tanks 1 and 2	2.5	2.5	2.5	2.5	2.3	2.3
Membrane Tanks 3 and 4	2.5	2.5	2.5	2.5	2.3	2.3
Biosolids Loadout Building	2.3	2.3	2.3	2.3	2.3	2.3
Cogeneration Engine[1]	2.3	2.3	2.3	2.3	2.3	2.3

[1] Determined to fall under the definition of "wake-affected point" from results of modelling with and without buildings. That is, the turbulence generated by wind over buildings will influence plume dispersion.

Operation of the cogeneration unit will result in the release of NO_x. The selected cogeneration unit will need to comply with the emission standards prescribed in the *Protection of the Environment Operations (Clean Air) Regulation 2010*. For NO_x, the relevant emission standard is 450 mg/Nm^3 for those activities operating on or after 1 September 2005 (referred to as "Group 6"). **Table 11** shows the modelled parameters for the cogeneration unit.

Table 11 Modelled parameters for the cogeneration unit

Parameter	Value	Reference
Easting (m)	293892	Determined by GIS and site layout
Northing (m)	6251372	Determined by GIS and site layout
Height (m)	6	Assumed minimum height
Stack tip diameter (m)	0.4	Sydney Water
Base elevation (m)	40	Determined by GIS and site layout
Flow rate (Am^3/s)	1.6	Sydney Water
Flow rate (Nm^3/s)	0.6	Sydney Water
Temperature (K)	699	Sydney Water
Velocity (m/s)	12.3	Calculated from flow rate
NO_x concentration (mg/Nm^3)	450	POEO Clean Air Regulation limit
NO_x mass emission rate (g/s)	0.27	Calculated from in-stack concentration

7. Approach to Assessment

7.1 Overview

This assessment has followed the Approved Methods (EPA, 2016) which specifies how assessments based on the use of air dispersion models should be undertaken. The Approved Methods include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

As previously stated, air emissions and odour from the pipelines is not expected during operation due to the enclosed nature of this infrastructure and handling of only treated water and brine. Potential impacts during construction have been assessed qualitatively by examining all proposed works and the proposed measures to manage emissions to air.

For operations, the CALPUFF computer-based air dispersion model has been used to predict ground-level concentrations due to the identified emission sources at the AWRC, and the model predictions have been compared with relevant air quality criteria. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions.

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model. The model comprises meteorological modelling as well as dispersion modelling, both of which are described below.

7.2 Meteorological Modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radiosondes or numerical models, such as the Commonwealth Scientific and Industrial Research Organisation’s (CSIRO’s) prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model. The modelling therefore simulates dispersion under a comprehensive range of meteorological conditions including temperature inversions.

The closest known meteorological station that collects suitable upper air data for CALMET is located at Sydney Airport, approximately 40 km to the east of the AWRC site. The necessary upper air data were therefore generated by TAPM, using influence from the surface observations at the Bringelly, Horsley Park, Liverpool, Prospect and St Marys meteorological stations. CALMET was then set up with five surface observation stations and five upper air stations (based on TAPM output for the location of each surface meteorological station). The meteorological modelling followed the guidance of TRC (2011) and adopted the “observations” mode.

Key model settings for TAPM are shown below in **Table 12**.

Table 12 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2019
Centre of analysis	Centre (33º51.5’ S, 150º46’ E)

Parameter	Value(s)
Terrain data source	30 m Shuttle Research Topography Mission (SRTM)
Land use data source	Default
Meteorological data assimilation	Bringelly, Horsley Park, Liverpool, Prospect and St Marys meteorological stations. Radius of influence = 10 km. Number of vertical levels for assimilation = 4

Table 13 lists the model settings and input data for CALMET.

Table 13 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	30 m SRTM
Land use data source(s)	Digitised from aerial imagery
Meteorological grid domain	20 km x 20 km
Meteorological grid resolution	0.2 km
Meteorological grid dimensions	100 x 100 x 9 grid points
Meteorological grid origin	288000 mE, 6240000 mN. MGA Zone 56
Surface meteorological stations	Bringelly: wind speed, wind direction, temperature and relative humidity Liverpool: wind speed, wind direction, temperature and relative humidity Prospect: wind speed, wind direction, temperature and relative humidity St Marys: wind speed, wind direction, temperature and relative humidity Horsley Park: wind speed, wind direction, temperature and relative humidity (TAPM for ceiling height, cloud cover, and air pressure)
Upper air meteorological stations	Upper air data files for the locations of the Bringelly, Liverpool, Prospect, St Marys and Horsley Park, derived by TAPM. Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8760 hours (1 Jan 2019 to 31 Dec 2019)
R1, R2	0.5, 1
RMAX1, RMAX2	5, 20
TERRAD	5

Terrain information was extracted from the NASA Shuttle Research Topography Mission database which has global coverage at approximately 30 m resolution. Higher resolution topographical data are not necessary in order to develop wind fields that reflect the influence of terrain and effects that are important for dispersion of emissions from the project to the sensitive receptor areas. Land use data, for the definitions in CALMET, were extracted from aerial imagery. **Figure 7** shows the model grid, land use and terrain information, as used by CALMET.

Figure 8 shows a snapshot of winds at 10 m above ground-level as simulated by the CALMET model under stable conditions.

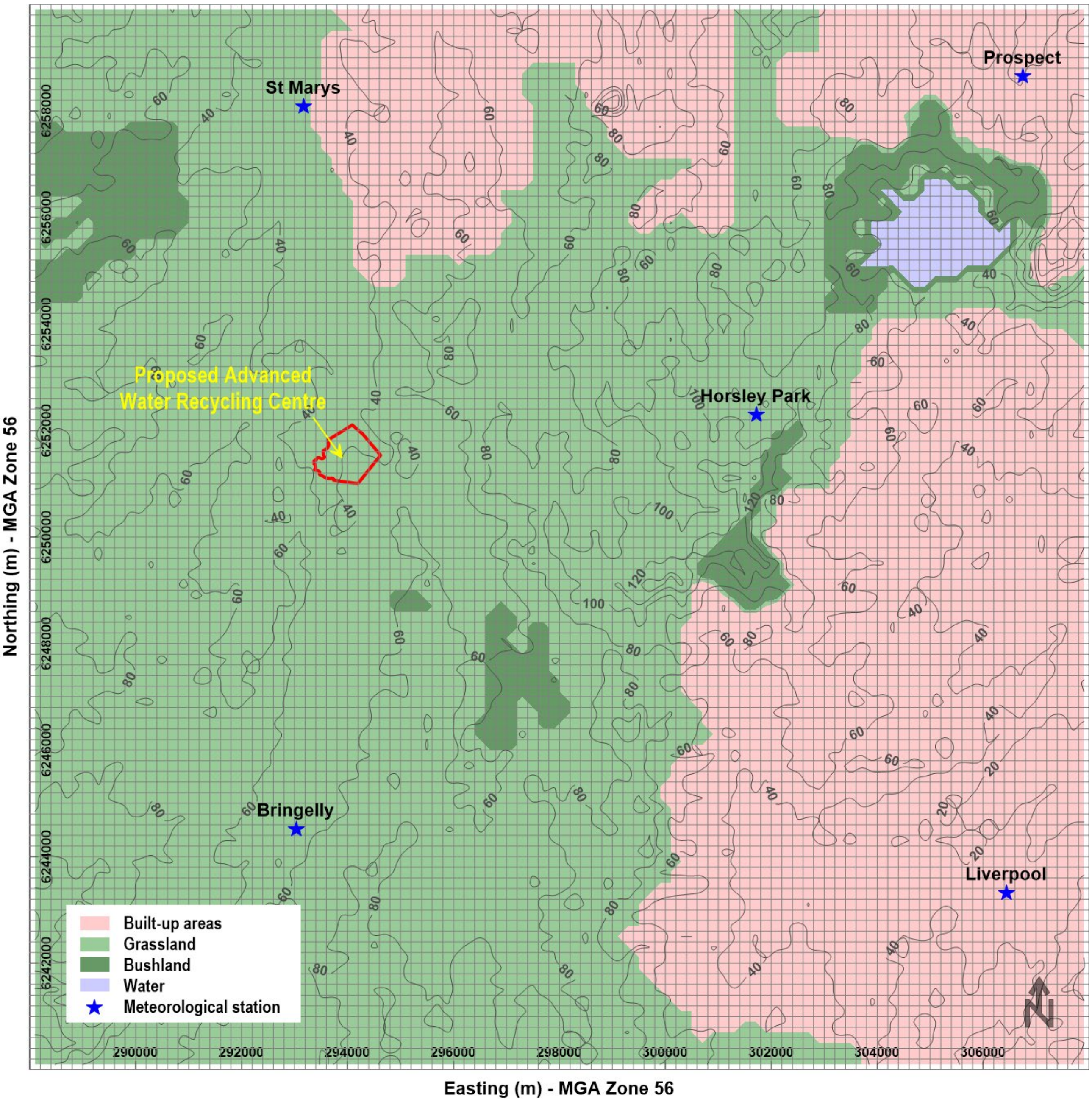


Figure 7 Model domain, grid, land use and terrain information

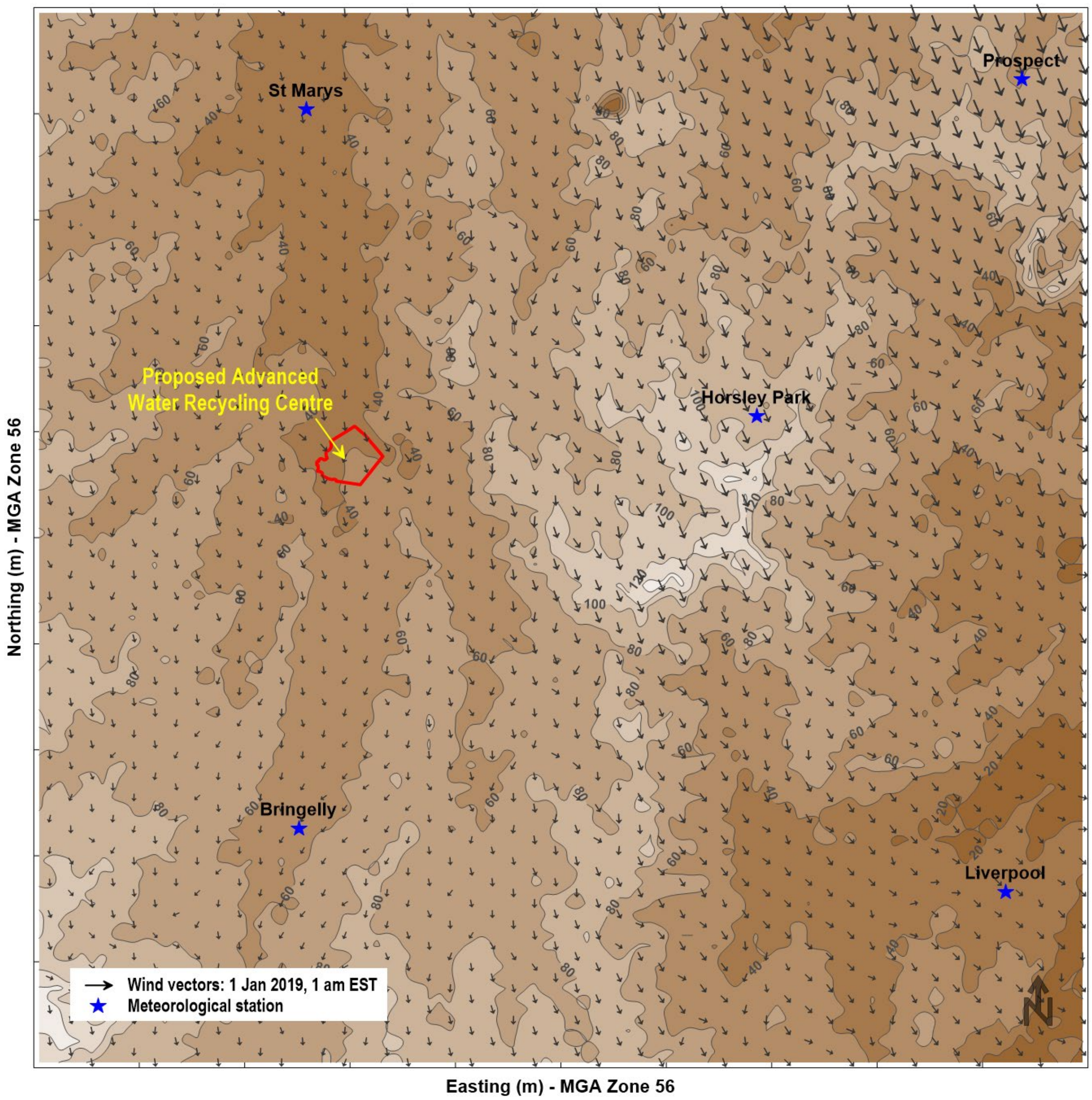


Figure 8 Example of CALMET simulated ground-level wind flows

7.3 Dispersion Modelling

Ground-level odour and NO_x concentrations due to the identified emission sources at the AWRC have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. CALPUFF is an air dispersion model which has been approved by the EPA for these types of assessments (EPA, 2016).

The modelling was performed using the emission estimates from **Section 6** and the meteorological information provided by the CALMET model, described in **Section 7.2**. Predictions were made at 1,551 discrete points (including sensitive receptors) to allow for contouring of results. The locations of the model receptors are shown in **Appendix B**.

Key model settings and inputs for CALPUFF are provided in **Table 14**.

Table 14 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
CALMET model domain	Grid cells: Easting 1-100, Northing 1-100
CALPUFF computational domain	Grid cells: Easting 1-100, Northing 1-100
Dry deposition	No
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Receptors	1551 discrete receptors. See **Appendix B**.

Figure 9 shows the modelled source locations. The AWRC was represented by a series of point, area and volume sources located according to the proposed site layout. **Figure 9** shows the location of the modelled sources. Emissions from all sources have been modelled at constant rates for every hour of the meteorological year, except for the biosolids loadout building where the potential emissions would only be likely between the hours of 7 am and 3 pm.

Odour and NO_x concentrations were predicted over an area of 6 km by 6 km and predictions at identified sensitive receptors were then compared with the EPA air quality criteria, previously discussed in **Section 4**. Contour plots have been created to show the spatial distribution of model predictions.

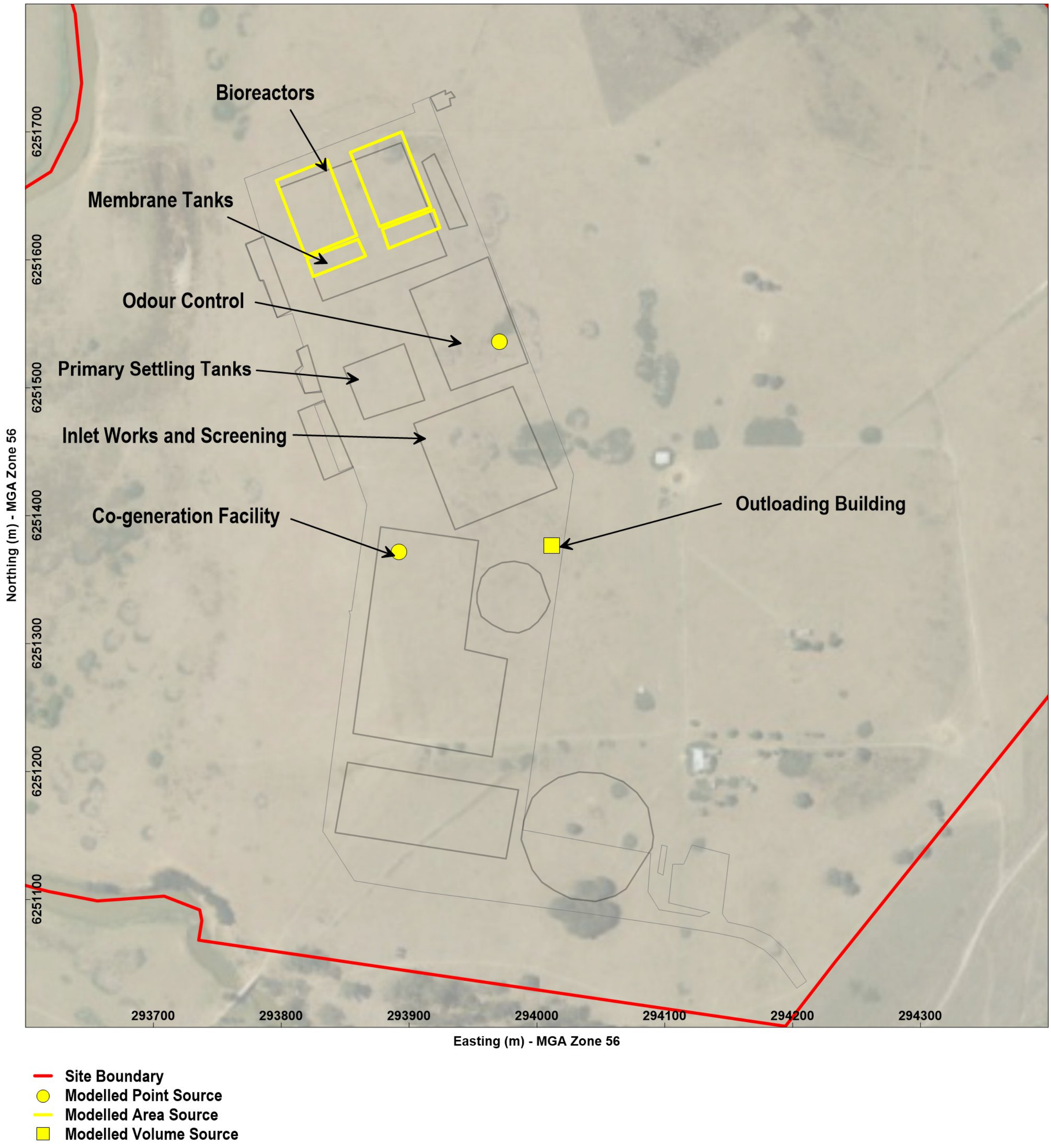


Figure 9 Modelled source locations (50 ML/d)

8. Air Quality Assessment

This section provides an assessment of the potential air quality issues of the project, as identified in **Section 3**.

8.1 Construction

The key air quality issue during construction will be dust. Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. Air quality impacts during construction would largely result from dust generated from work associated with land clearing, earthworks, material handling, and material transport required to develop the AWRC and associated pipelines.

Construction of the AWRC is anticipated to occur over approximately 36 months. Anticipated works are summarised as follows:

- Site establishment such as installation of environmental controls, roads, fencing, plant and equipment delivery, demolition of existing buildings and contamination management. These works are expected to take 2 months.
- Earthworks such as cut and fill, drainage works, excavation for detention basins and underground infrastructure, dewatering and waste disposal. These works are expected to take 15 months.
- Civil works including roads and stormwater infrastructure works. These works are expected to take 9 months.
- Structure construction such as construction of buildings, treatment works, storage tanks and process units. These works are expected to take 20 months.
- Mechanical and electrical installation such as utility connections. These works are expected to take 9 months.
- Commissioning such as equipment testing and discharging commissioning wastewater. This is expected to take 6 months.
- Landscaping and restoration, expected to take 3 months.

Construction of the pipelines is anticipated to occur over approximately 30 months. Anticipated works are summarised as follows:

- Site establishment such as installation of environmental controls, roads, site compounds fencing, and plant and equipment delivery. These works are expected to take 2 months.
- Earthworks and civil works such as excavation of trenches, dewatering, waste disposal, installation of pipelines and backfill. This is expected to take 24 months.
- Commissioning such as equipment testing and discharging commissioning wastewater. This is expected to take 3 months.
- Landscaping and restoration, expected to take 3 months.

Laydown areas for stockpiles, parking, pipes, equipment, turnaround points, temporary amenities etc. would be located to avoid community, and environmental constraints. Construction would typically occur between 7 am to 6 pm Monday to Friday and between 8 am and 12 pm on Saturday. Works outside of these standard hours may be needed, to minimise traffic impacts or if required by local Council or Transport for NSW approvals. Equipment is likely to include, but not be limited to excavators, loaders, dozers, scrapers, dump trucks, water carts, compactors, screens, piling rigs, and cranes. The number and type of equipment would vary depending on the development activity being undertaken.

The total amount of dust generated would depend on the quantities of material handled, silt and moisture content of the soil, the types of operations being carried out, exposed areas, frequency of water spraying and speed of machinery. The detailed approach to construction would depend on decisions made by the successful contractor(s), and changes to the construction methods and sequences that are expected to take place during the construction phase.

In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of weather conditions for the period in which work would be taking place in each location on the site. However, it will be important that exposed areas be stabilised as quickly as possible and that appropriate dust measures are implemented to keep dust impacts to a minimum.

Environmental safeguards will be documented in a Construction Environmental Management Plan (CEMP). Safeguards to minimise air quality impacts during construction will include:

- Maintaining equipment in good working order to comply with the clean air regulations of the *Protection of the Environment Operations Act 1997*, having appropriate exhaust pollution controls, and meeting Australian Standards for exhaust emissions.
- Switching off vehicles/machinery when not in use.
- Watering exposed areas using a non-potable water source, where possible.
- Covering exposed areas with tarpaulins or geotextile fabric, where possible.
- Modifying or ceasing work in windy conditions.
- Modifying site layout to maximise distance from sensitive receivers.
- Progressively stabilising the construction footprint (e.g. spray grass, rehabilitation as works progress along the alignment).
- Covering all transported waste.

Impacts to the existing land and productivity, and potential land use conflicts, has also been considered in the context of the proposed construction works. For example, dusts have the potential to cause physical impacts on vegetation with the effects depending on the characteristics of the dust, plant species and environmental conditions. Doley (2006) examined the physical effects of dust on vegetation and suggested that the most sensitive plant functions may be altered with dust loads in the order of 8 g/m^2 for dusts with medium diameters of 50 micrometres (µm). This dust load is higher than the EPA's criterion defining impacts to human amenity (4 g/m^2/month) so the management of impacts to human amenity should also minimise impacts to the existing land and productivity, thereby reducing land use conflicts.

8.2 Operation

The potential odour impacts of the AWRC operating at 50 ML/d have been quantified using dispersion modelling. **Figure 10** shows the predicted odour levels (in odour units) at the 99th percentile, corrected for nose response times and due to all identified sources. These results are considered conservative as they assume:

- Biosolids loadout emissions for all hours between 7 am and 3 pm, for every day of the year; and
- Emissions from the OCU at the expected upper limit (that is, 500 OU) for every hour of the year.

The results have been assessed by referencing the EPA odour impact assessment criteria from **Section 4**. As noted in **Table 3** of **Section 4** the EPA criteria are population based, that is, more stringent criteria are to be applied for higher population densities. The process for assessment of the results has been to determine the population predicted to detect over 2 OU and to identify the criterion from **Table 3** relating to that population.

Figure 10 shows that the 2 OU contours, at the 99th percentile, align approximately with the extent of the AWRC boundary and do not encroach on any existing or potential private sensitive receptors, residential areas or existing recreational areas. A project specific criterion higher than 2 OU is therefore justified on the basis of the low population density within the 2 OU contour. From **Figure 10** it has been estimated that there will be no more than a population of 125 within the extent of the 2 OU contour so, by **Table 3**, an appropriate project specific criterion would be at least 4 OU. **Figure 10** shows that the 4 OU contour is within the AWRC site boundary and does not extend to any existing or potential private sensitive receptors, residential areas or existing recreational areas. In addition, the 4 OU contour is not predicted to extend to the proposed alignment of the M12 Motorway which would be adjacent to the southern site boundary.

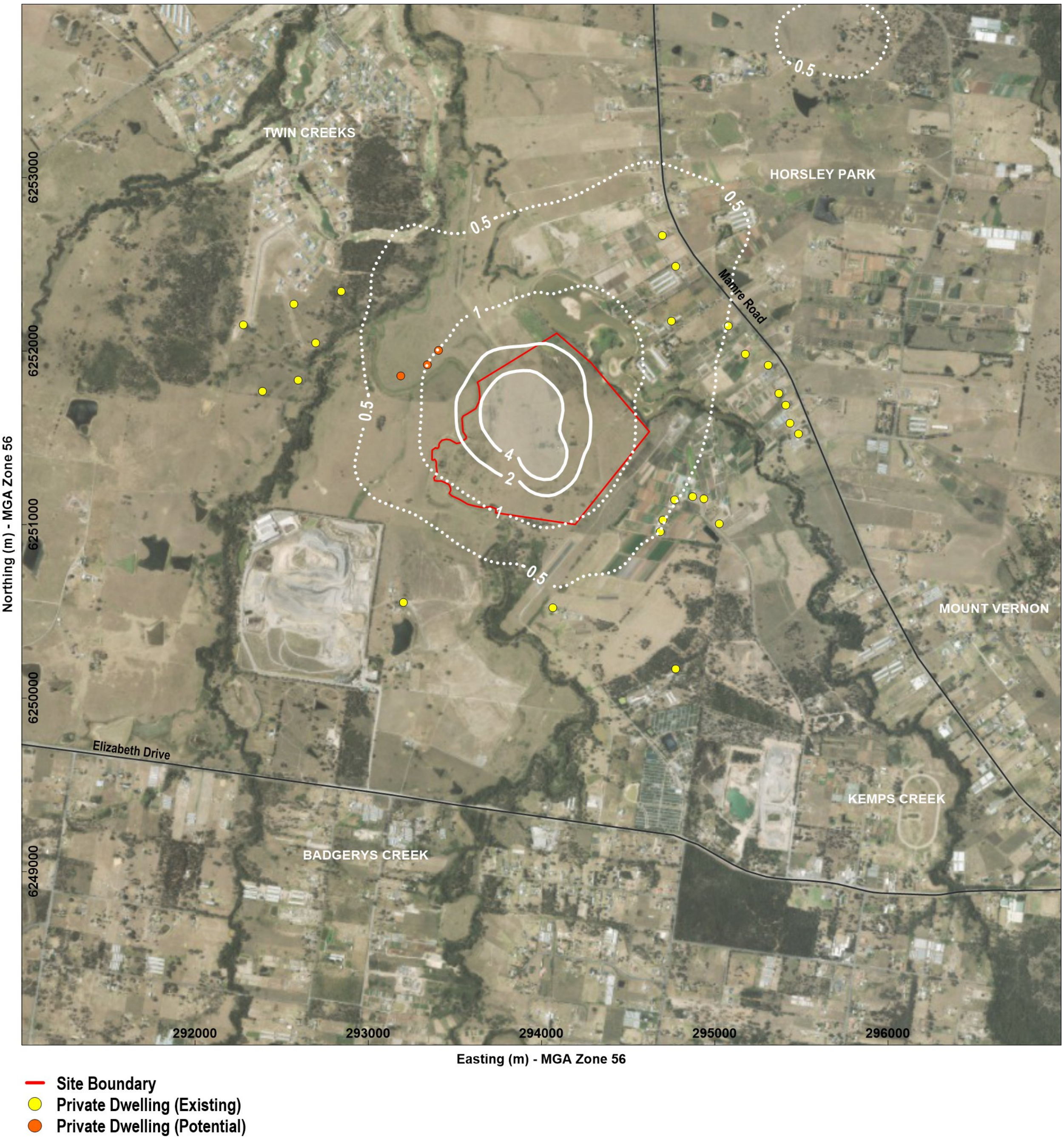


Figure 10 Predicted odour levels at the 99th percentile due to the AWRC (50 ML/d)

Dispersion modelling of odour has also been carried out for a conceptual future AWRC operating at 100 ML/d. These results (**Appendix C**) also indicate that the 4 OU contour will not extend to any existing or potential private sensitive receptors or residential areas. There is potential for the western side of the AWRC site to be opened up as parkland for transient recreational users however the infrequent use, low numbers of people and short durations mean that impacts would be unlikely. Therefore, the conceptual future AWRC is also not expected to cause adverse odour impacts. This outcome reflects a design that is consistent with best practice for odour management at wastewater treatment plants, that is, ducting and treatment in an odour control facility. The outcomes also indicate compliance with the POEO Act which states that the project “must not cause or permit the emission of any offensive odours from the premises”.

Figure 11 shows the predicted maximum 1-hour average NO_2 concentrations due to the AWRC operating at 50 ML/d. These results assume that 100% of the NO_x is NO_2 at the locations of maximum ground-level concentrations, a conservative assumption. In reality, NO_2 will only be in the order of 20% of the NO_x at the locations of maximum ground-level concentrations, based on data collected by the DPIE. At the nearest sensitive receptors, the predicted maximum 1-hour average NO_2 concentrations are less than 50 µg/m^3. With the addition of maximum background levels for the selected model year (103 µg/m^3 from **Table 7**) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion. The 143 µg/m^3 contour represents the EPA criterion assuming a maximum background level of 103 µg/m^3 and that 100% of the NO_x is NO_2. Doubling the predicting maximum 1-hour average NO_2 concentrations in **Figure 11**, as an indication of potential impacts for the AWRC at 100 ML/d, will also demonstrate compliance with the EPA's 246 µg/m^3 criterion at the nearest sensitive receptors. In addition, maximum contributions from the proposed M12 Motorway have been modelled at up to 8 µg/m^3 (Roads and Maritime, 2019). Cumulative impacts between the AWRC, M12 Motorway and maximum background levels will still demonstrate compliance with the EPA's 246 µg/m^3 criterion.

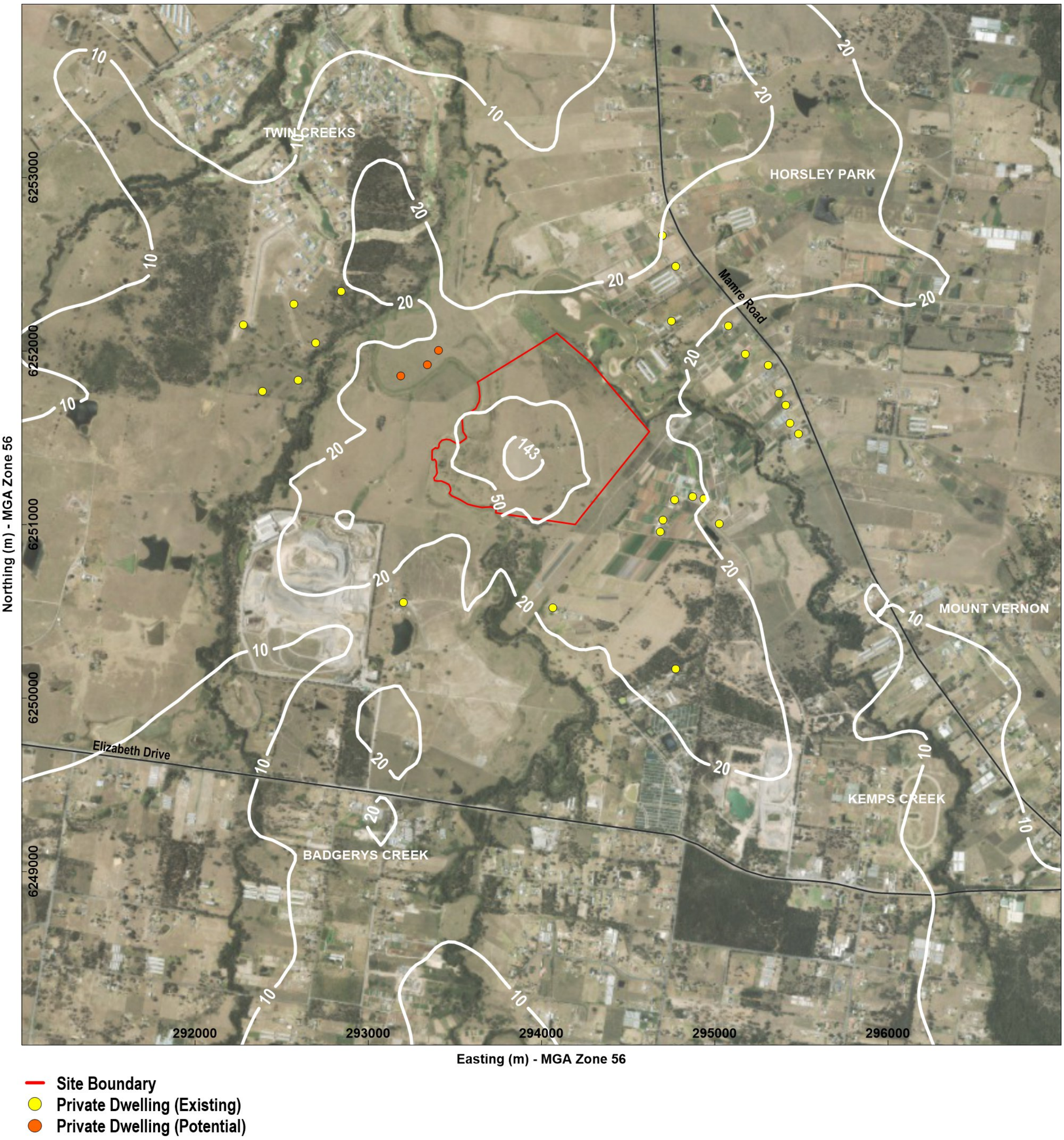


Figure 11 Predicted maximum 1-hour average NO_2 concentrations due to the cogeneration facility (50 ML/d)

Figure 12 shows the predicted annual average NO_2 concentrations due to the AWRC operating at 50 ML/d. These predictions also assume that 100% of the NO_x is NO_2. At the nearest sensitive receptors the predicted average NO_2 concentrations are less than 1 μg/m³. With the addition of background levels (i.e. 25 μg/m³ from **Table 7**) the results show compliance with the EPA's 62 μg/m³ criterion. Doubling the predicting annual average NO_2 concentrations in **Figure 12**, as an indication of potential impacts for the AWRC at 100 ML/d, will also demonstrate compliance with the EPA's 62 μg/m³ criterion at the nearest sensitive receptors. Annual contributions from the proposed M12 Motorway have been modelled at up to 2 μg/m³ (Roads and Maritime, 2019). Cumulative impacts between the AWRC, M12 Motorway and background levels will still demonstrate compliance with the EPA's 246 μg/m³ criterion.

Based on the model results it has therefore been inferred that the AWRC will not result in any adverse air quality impacts with respect to NO_2.

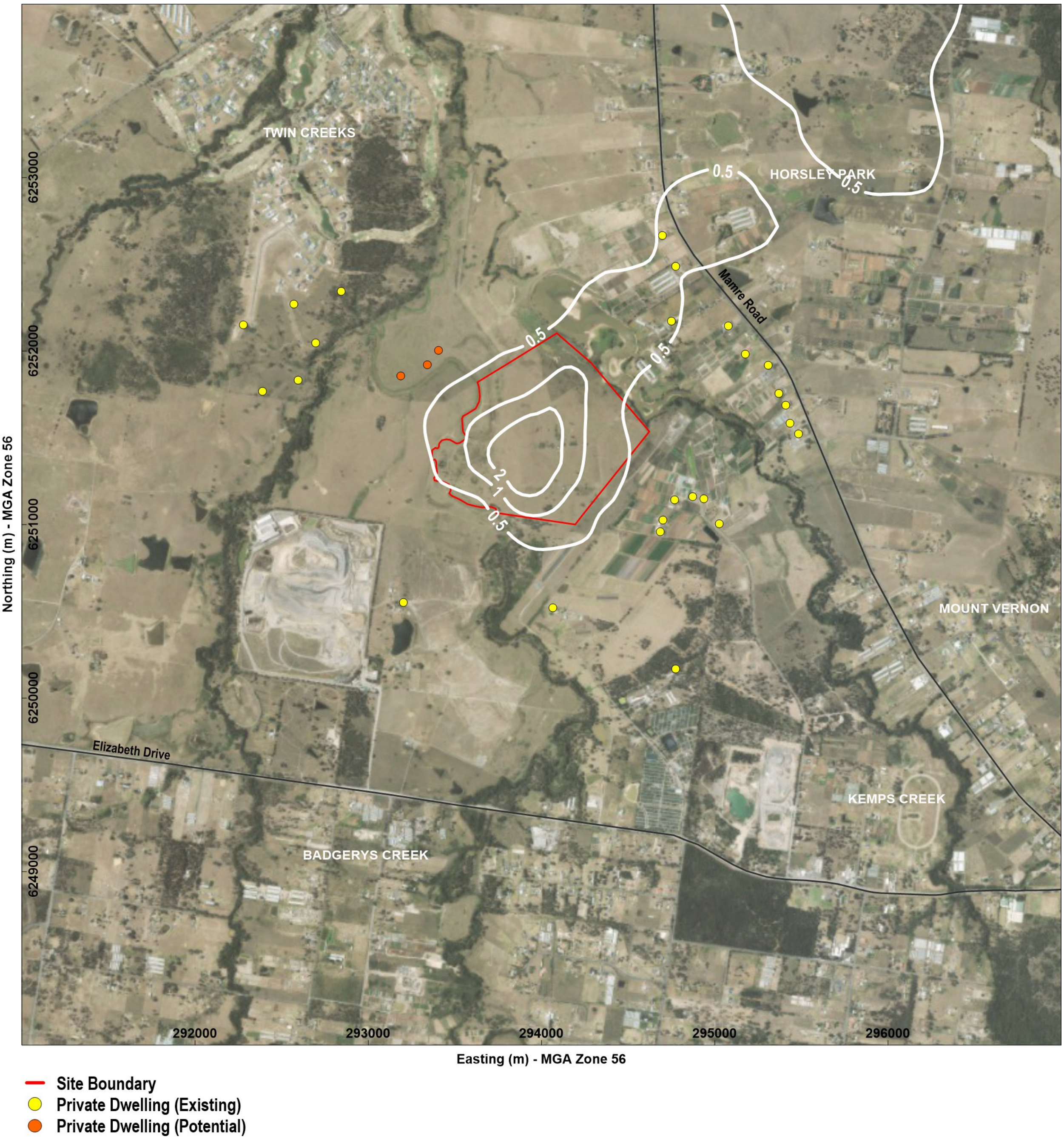


Figure 12 Predicted annual average NO_2 concentrations due to the cogeneration facility (50 ML/d)

9. Conclusions

This report has assessed the potential air quality impacts of the Upper South Creek Advanced Water Recycling Centre. In summary, the assessment identified the key air quality issues, characterised the existing air quality and meteorological environment, quantified project emissions and used an air dispersion model to predict the impact of the project on local air quality.

The key potential air quality issues were identified as:

- Dust during construction of all proposed infrastructure;
- Odour from the AWRC during operation; and
- Emissions from cogeneration engines at the AWRC during operation.

A detailed review of the existing environment was carried out and the following conclusions were made:

- The prevailing winds in the area are from the south-southwest and north-northwest, a pattern that is common for Western Sydney and which reflects the influence of the north to south alignment of the Blue Mountains to the west.
- Air quality monitoring has shown that, in terms of particulate matter (as PM_{10}), many locations near the project have experienced at least one day above the EPA's 24-hour criterion in the past five years. The averages generally increased from 2017 onwards and exceeded the EPA criterion in 2019 at some locations. These results were heavily influenced by dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019). Concentrations of another key indicator of air quality, NO_2, were reviewed and found to be below the relevant EPA criteria.

The main conclusions of the assessment were as follows:

- Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. However, appropriate environmental safeguards have been identified to minimise impacts. These safeguards will be documented in a Construction Environmental Management Plan and implemented during the construction phase.
- Odour impacts of the AWRC (at 50 ML/d) are expected to be at acceptable levels based on model results which showed compliance with the EPA assessment criteria at the nearest existing and potential private sensitive receptors or residential areas. This conclusion was reached using conservative assumptions in relation to biosolids loadout times and odour control unit operation. Therefore, the predicted odour impacts of the AWRC would represent the potential worst-case impacts. Dispersion modelling also indicated that the conceptual future AWRC, operating at 100 ML/d, is also not expected to cause adverse odour impacts. Some odour may be detected from time-to-time on parkland located within the site boundary however this impact has been determined as low risk given that the parkland would be for passive recreation where there would be relatively few people present for short durations.
- The cogeneration engines are not expected to result in any adverse air quality impacts for both 50 and 100 ML/d scenarios.

Finally, it was noted that emissions from many of the key odour generating sources will be ducted to the proposed odour control facility, treated and exhausted via a stack. This arrangement is consistent with best practice for odour management at wastewater treatment plants.

10. References

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Appendix A. Wind-Roses For All Meteorological Stations

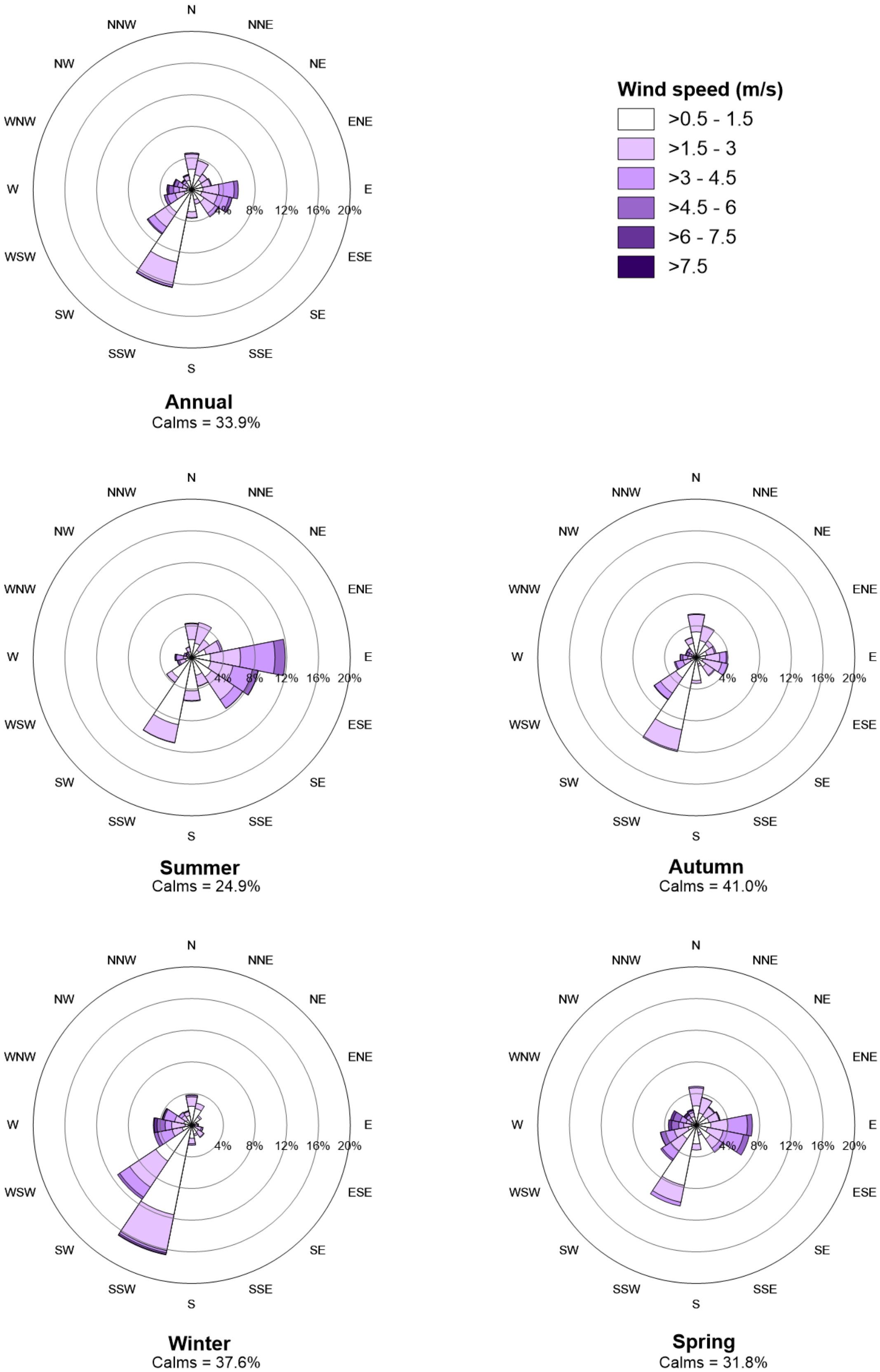

Figure B1 Annual and seasonal wind-roses for Bringelly (2019)

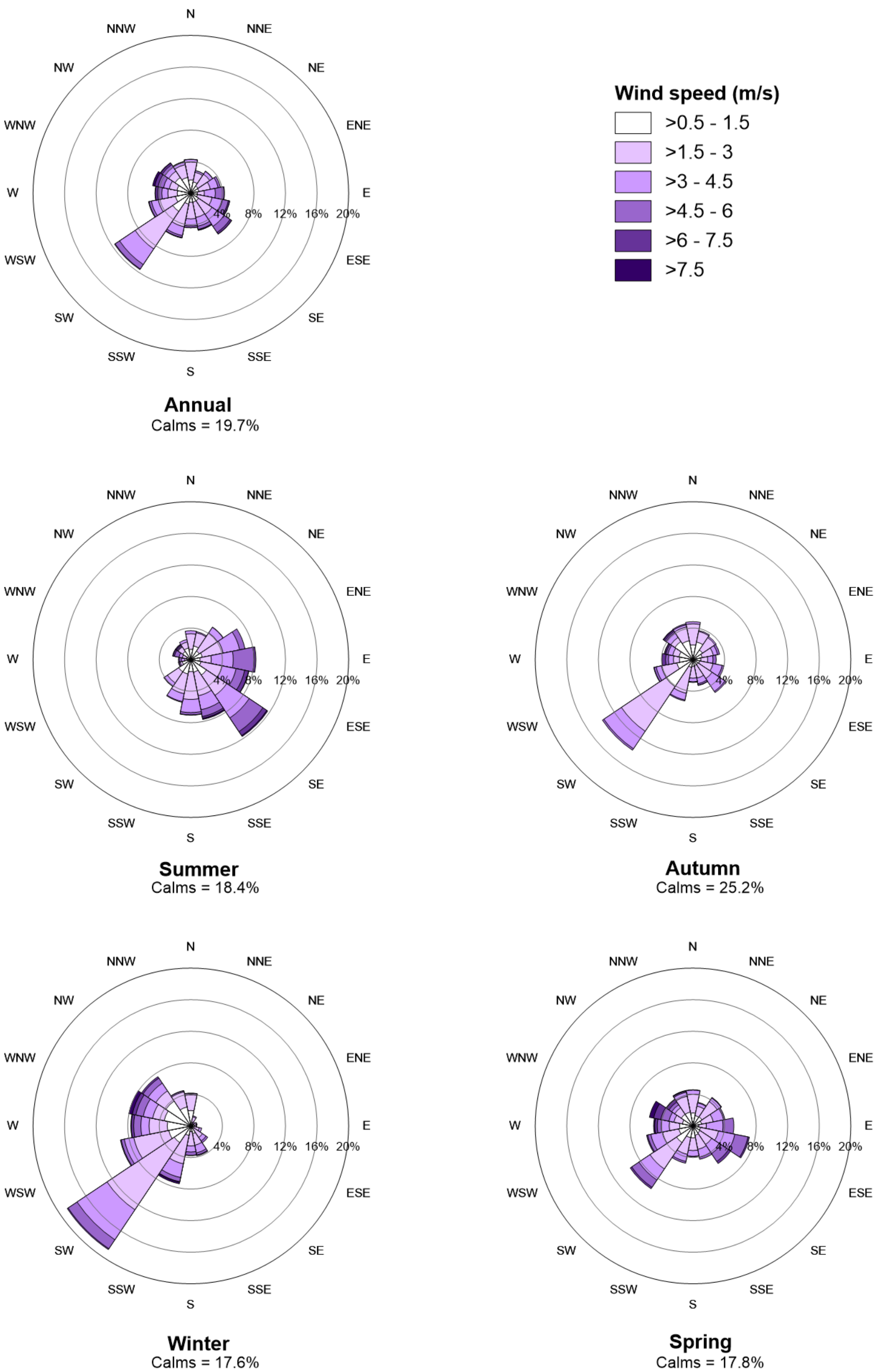

Figure B2 Annual and seasonal wind-roses for Horsley Park (2019)

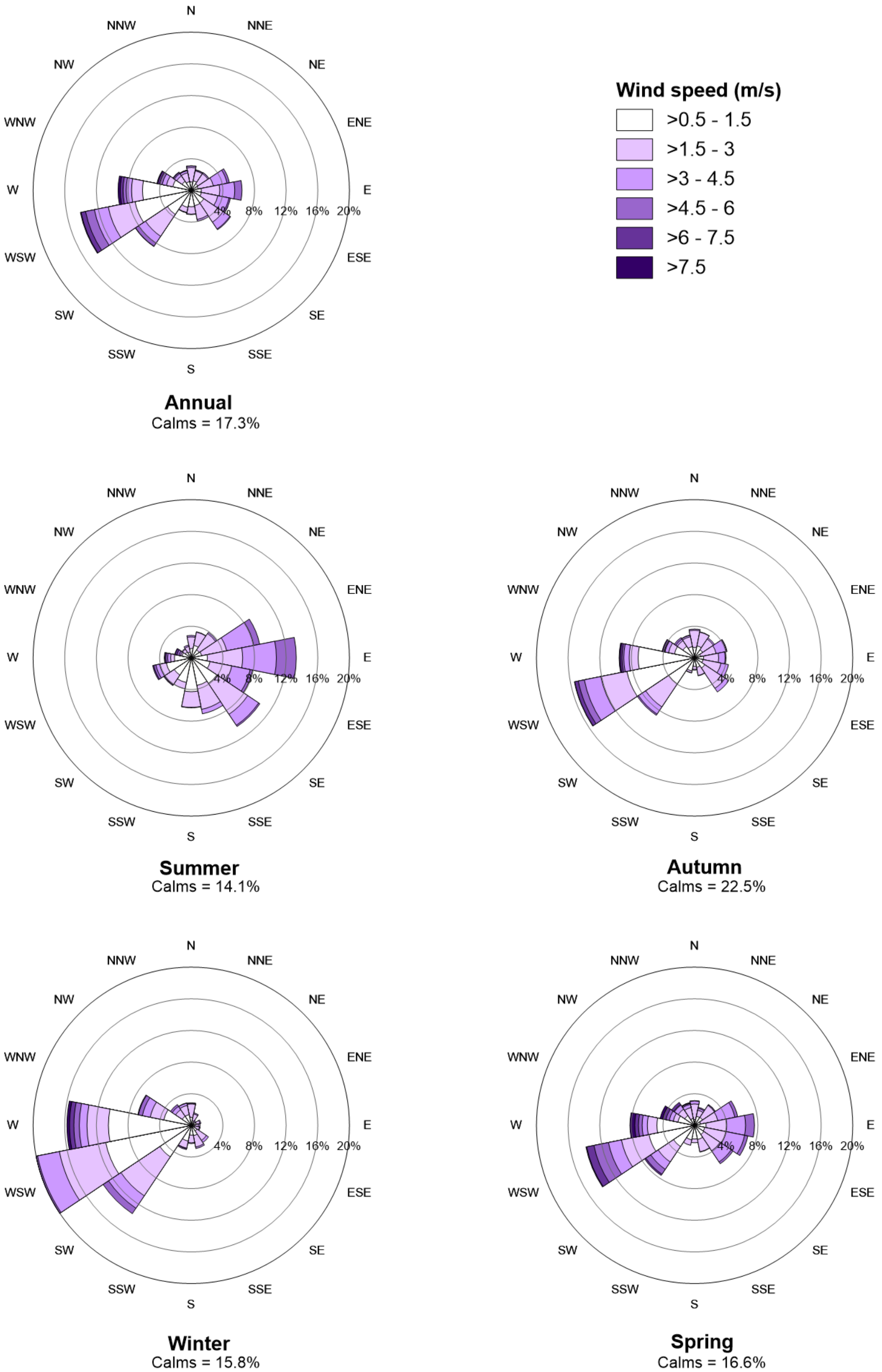

Figure B3 Annual and seasonal wind-roses for Liverpool (2019)

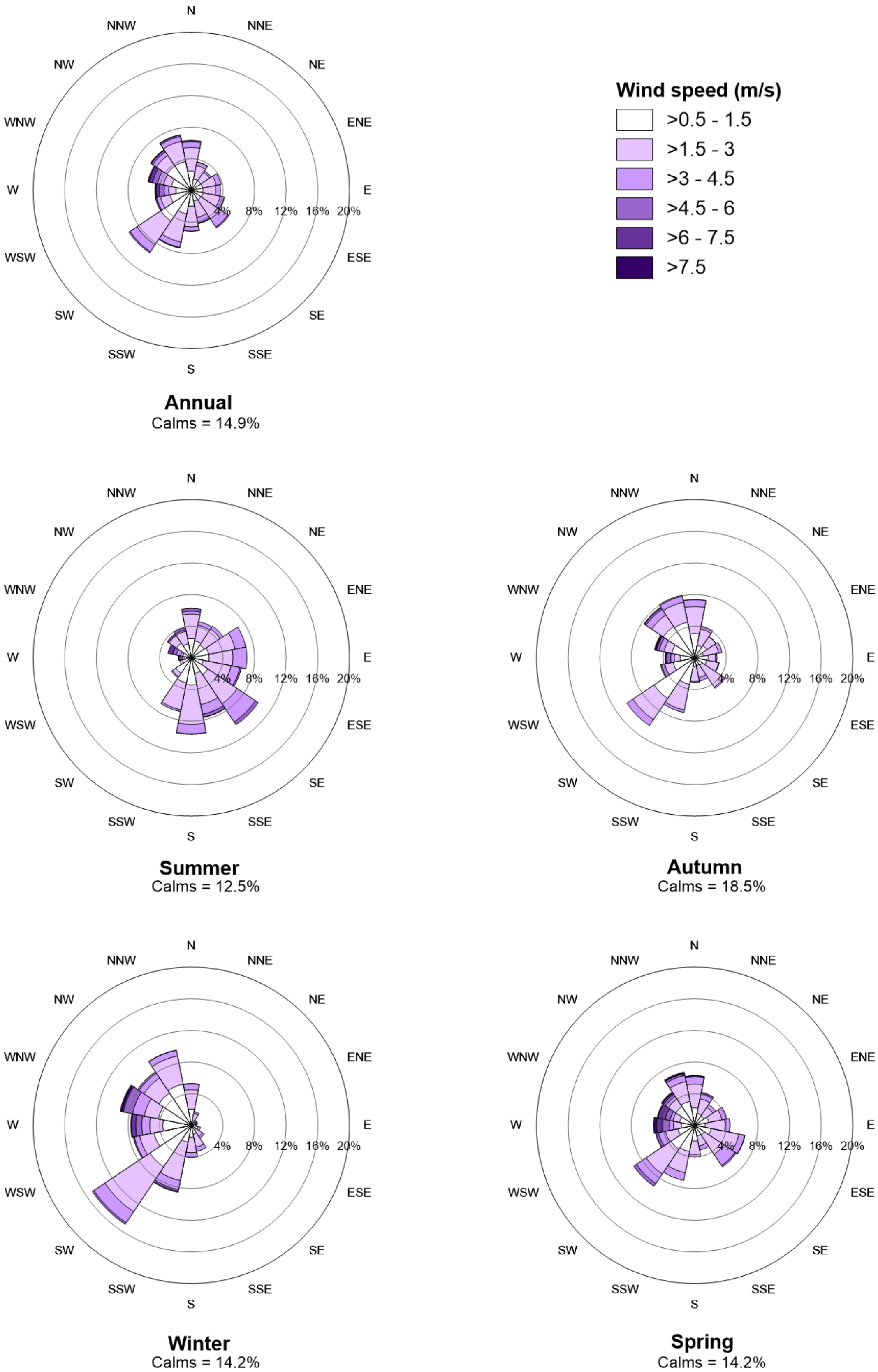

Figure B4 Annual and seasonal wind-roses for Prospect (2019)

Figure B5 Annual and seasonal wind-roses for St Marys (2019)

Appendix B. Model Receptors

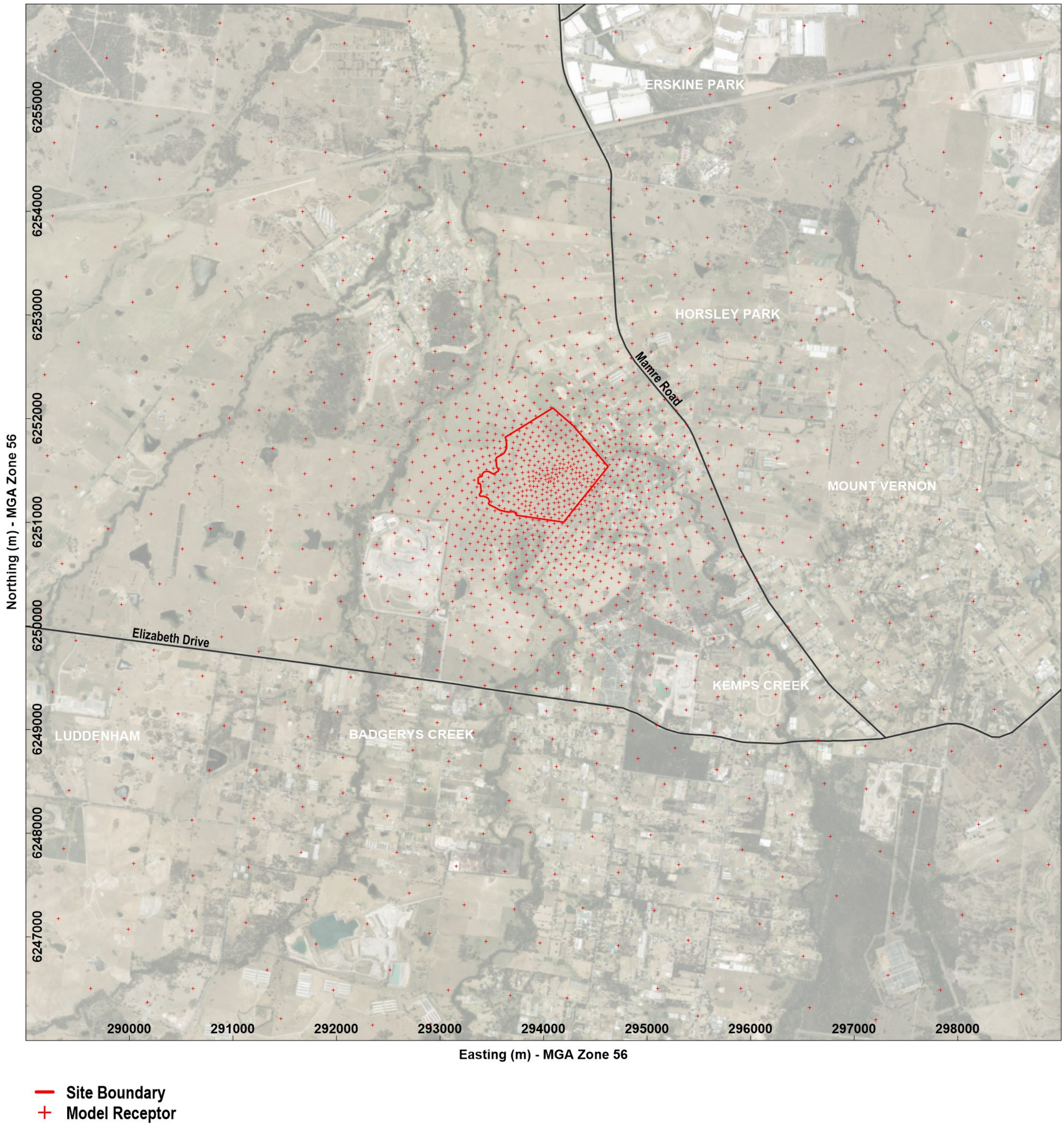

Figure C1 Model receptors

Appendix C. Indicative Results for 100 ML/d plant

Table D1 Estimated odour emissions (100 ML/d)

Source	Source type	Area (m^2)	Height (m)	Stack tip diam. (m)	Base elevation (m)	Temperature. (K)	Velocity (m/s)	Air flow (m^3/s)	Odour conc (OU)	SOER ($ou.m^3/m^2/s$)	TOER ($ou.m^3/s$)
Sources for 50 ML/d											
Odour Control Unit	Point	-	15.0	1.5	40.0	293	15.0	26.0	500	-	13000
Bioreactor 1 and 2	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Bioreactor 3 and 4	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Membrane Tanks 1 and 2	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Membrane Tanks 3 and 4	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Biosolids Loadout Building	Volume	-	12.5	-	40.0	-	-	10.0	1680	-	16800
Cogeneration Engine	Point	-	6.0	0.4	40.0	699	12.3	1.6	1589	-	2463
Additional sources for 100 ML/d											
Odour Control Unit	Point	-	15.0	1.5	40.0	293	15.0	26.0	500	-	13000
Bioreactor 1 and 2	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Bioreactor 3 and 4	Area	2700	2.0	-	40.0	-	-	-	754	0.5	1350
Membrane Tanks 1 and 2	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Membrane Tanks 3 and 4	Area	650	2.0	-	40.0	-	-	-	754	0.5	325
Biosolids Loadout Building	Volume	-	12.5	-	40.0	-	-	10.0	1680	-	16800
Cogeneration Engine	Point	-	6.0	0.4	40.0	699	12.3	1.6	1589	-	2463
										Total	**71,226**

Notes: SOER = Specific odour emission rate. TOER = Total odour emission rate.

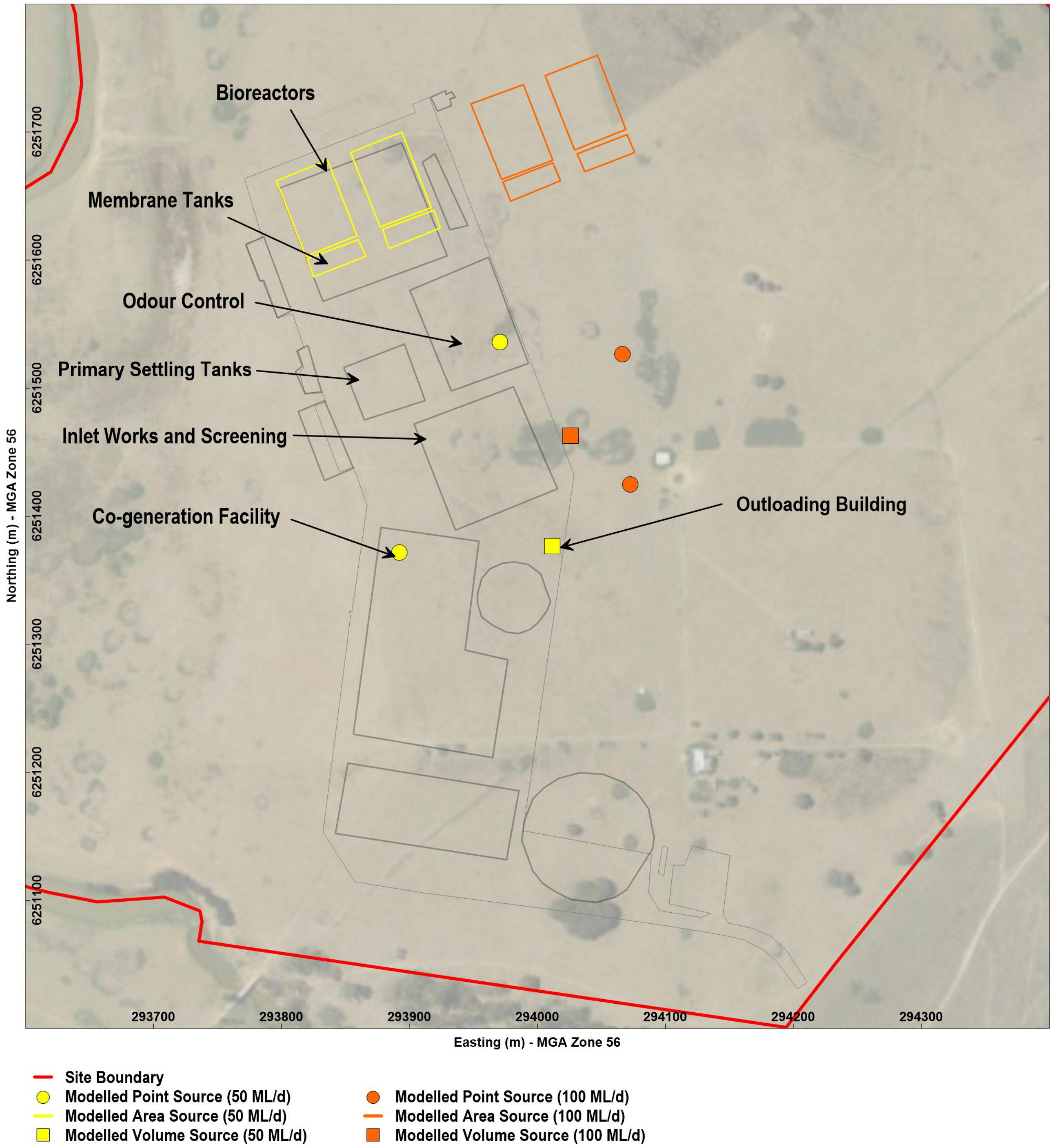

Figure D1 Modelled source locations (100 ML/d)

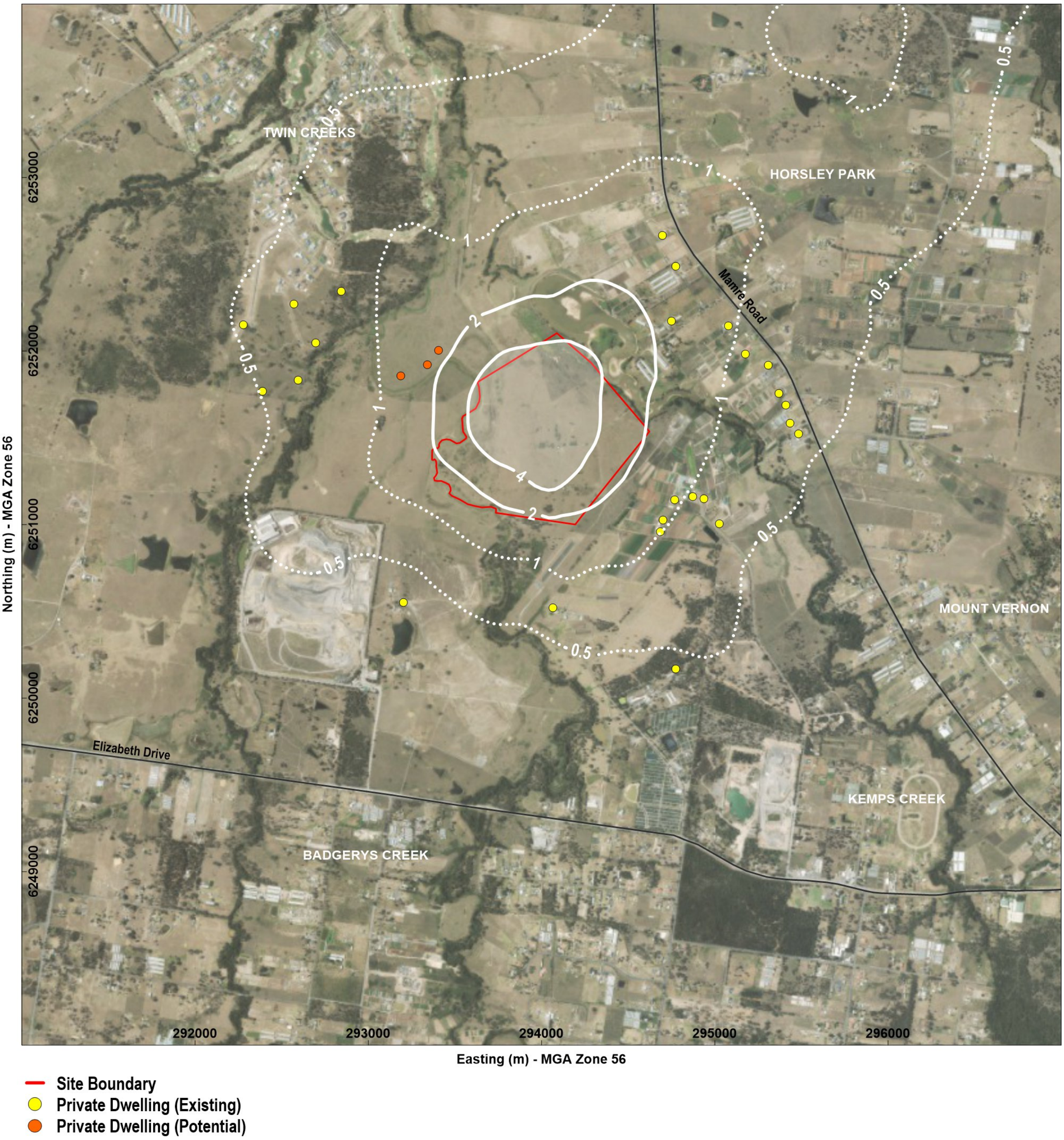

Figure D2 Predicted odour levels at the 99th percentile due to the AWRC (100 ML/d)