Prepared for
Besmaw Pty. Limited
ABN: 67 008 481 187

Air Quality Impact Assessment

Request for Planning Proposal: - 251, 260R, 278, and 280-282

12-Dec-2023
Kurnell Planning Proposal

Air Quality Impact Assessment

Request for Planning Proposal: - 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell.

Client: Besmaw Pty. Limited

ABN: 67 008 481 187

Prepared by

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Executive Summary

This Air Quality Impact Assessment (AQIA) report has been prepared by AECOM Australia Pty Ltd (AECOM) to accompany a proponent initiated Planning Proposal (Planning Proposal) in support of the proposed amendment to *State Environmental Planning Policy (Precincts—Central River City) 2021* (SEPP Precincts) and *Sutherland Shire Local Environmental Plan 2015* (SSLEP 2015).

The Planning Proposal aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument local environmental plan zones and enable additional uses to accommodate a diverse range of land uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell (the site). The Planning Proposal will establish a new mixed-use community encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

This report has been prepared to assess the air quality impacts from the proposed development following the initial Air Quality Impact Assessment report dated 12 February 2020 (AECOM 2020).

In March 2023 the proponent submitted a Scoping Proposal to Sutherland Shire Council to commence the formal Planning Proposal process, in accordance with the LEP Making Guidelines. The Scoping Proposal provided a comprehensive 'status update,' outlining the concept master plan, the intended development outcome, the proposed planning controls, and the environmental considerations which were to be further resolved.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to the DPE, State agencies, and several internal Council teams for review and comment. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas within the technical documentation.

Separate to the Scoping Proposal package, extensive and ongoing engagement with relevant State Agencies has occurred since November 2022, with the objective of clarifying and resolving any of the outstanding considerations.

The first AQIA prepared from the site (AECOM 2020) addressed the original key matters for consideration for the Planning Proposal described in the State Environmental Planning Policy (Kurnell Peninsula) 1989 Review, Scope of Works document dated September 2017. A copy of the original AQIA is provided in Appendix A. In response to the Scoping Proposal submitted to Sutherland Shire Council in March 2023, advice was received by DPE, EPA and Council on key focus areas to build on information provided in previous technical studies for the site including the AQIA 2020 report. Feedback received on the AQIA included:

- Department feedback and advice – Kurnell Scoping Proposal from DPE dated 10 August 2023
- Environment Protection Agency (EPA) feedback and advice provided on 8 June 2023 regarding setback distances and land use conflicts associated with the adjoining Breen Proposal. Upon review of the previous response revised feedback was provided by the EPA dated 18 August 2023.
- The Environmental Science Unit of Sutherland Shire Council on 6 June 2023.

The revised AQIA included a quantitative assessment of potential air quality impacts from vehicle emissions associated with the Planning Proposal on future sensitive receptors on Captain Cook Drive; and an assessment of reverse amenity impacts from dust and odour from the adjoining Breen proposed development.

The quantitative assessment of potential air quality impacts was undertaken using the GRAL dispersion model as requested by Sutherland Shire Council. Results of the dispersion modelling indicated:

- Predicted cumulative NO_2 and CO concentrations associated with the Planning Proposal modelled scenarios for 2029 and 2039 at sensitive receptors were well below the relevant EPA criteria for all averaging periods.
- Modelled dust emissions included emissions from vehicles on Captain Cook Drive with and without the proposal and the proposed modification to the adjoining Breen Facility. Results indicated:
  - Predicted cumulative maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations were found to exceed the EPA criteria for all modelled scenarios. This is largely attributed to elevated background

concentrations already exceeding the EPA criteria. There was one additional exceedance of the EPA criteria for the 'with project' scenario for 2036 for both PM_{10} and $PM_{2.5}$. Here the incremental contributions were relatively minor with the background concentration already approaching the criteria when the exceedance occurred.
- The predicted cumulative annual average PM_{10} and $PM_{2.5}$ concentrations were below the EPA criteria for all modelled scenarios.
- Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} and $PM_{2.5}$ concentrations (compared to vehicle emissions) at the worst affected sensitive receptor.

- Results from the modelling predict that both the maximum and 99th percentile odour concentrations are well below the EPA 1-hour 99th percentile odour criterion of 2 OU with no reverse amenity odour impacts anticipated from adjacent landfilling activities.

Based on the dispersion modelling results the proposed setback distance of the western most sensitive receptors within the Town Centre Precinct closest to the Breen Facility is considered adequate to minimise potential reverse amenity air quality and odour impacts from the Breen Proposal. Simialry the proposed setback distance of 70m from Captain Cook Drive for the nearest proposed receptors within the Town Centre Precinct and Quibray Bay Precinct are considered adequate provided the relevant planning and design considerations in accordance with the Guideline (DoP 2008) are met.

In addition to the quantitative assessment a qualitative impact assessment was undertaken for vehicle emissions on internal roads based on the Planning Proposal's potential to generate urban canyons which result in unfavourable dispersal conditions in built environments. A review of street aspect ratios based on proposed street widths and building set back distances and heights in the Master Plan found that, due to larger street widths and setback distances, street canyons would be of a low to mid-depth resulting in more acceptable dispersal conditions.

Reverse amenity impacts from air pollutants and odour were also assessed from a range of sources including the Cronulla WRRF, Ampol Fuel Terminal, Biogenic emissions from Mangroves and aircraft emissions from Sydney Airport. were also assessed qualitatively. A qualitative assessment of these sources concluded that all sources were unlikely to have a significant impact on the air or odour amenity of future receptors within the Planning Proposal Site.

Based on the above findings, provided identified planning and design considerations in this report are implemented to minimise potential air quality impacts and identified additional studies are undertaken at the development application stage no significant air quality impacts have been identified from the Planning Proposal.

1.0 Introduction

1.1 Overview

This Air Quality Impact Assessment (AQIA) report has been prepared by AECOM Australia Pty Ltd (AECOM) to accompany a proponent initiated Planning Proposal (Planning Proposal) in support of the proposed amendment to *State Environmental Planning Policy (Precincts—Central River City) 2021* (SEPP Precincts) and *Sutherland Shire Local Environmental Plan 2015* (SSLEP 2015).

The Planning Proposal aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument local environmental plan zones and enable additional uses to accommodate a diverse range of land uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell (the site). The Planning Proposal will establish a new mixed-use community encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

This report has been prepared to assess the air quality impacts from the proposed development following the initial Air Quality Impact Assessment report dated 12 February 2020 (AECOM 2020).

In March 2023 the proponent submitted a Scoping Proposal to Sutherland Shire Council to commence the formal Planning Proposal process, in accordance with the LEP Making Guidelines. The Scoping Proposal provided a comprehensive 'status update,' outlining the concept master plan, the intended development outcome, the proposed planning controls, and the environmental considerations which were to be further resolved.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to the DPE, State agencies, and several internal Council teams for review and comment. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas within the technical documentation.

Separate to the Scoping Proposal package, extensive and ongoing engagement with relevant State Agencies has occurred since November 2022, with the objective of clarifying and resolving any of the outstanding considerations.

Besmaw has engaged AECOM to prepare a the revised AQIA to address the feedback received from the DPE and state agencies and reflects the engagement undertaken to date.

1.2 Description of the site and locality

The land to which this planning proposal relates is 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell and is located within the Sutherland Shire Local Government Area (LGA).

The key features of the site are summarised in Table 1.

Table 1 Site Description

Feature	Lot 2 North	Lot 2 South	Lot 8	Lot 9
Street Address	251 Captain Cook Drive	280-282 Captain Cook Drive	278 Captain Cook Drive	260R Captain Cook Drive Kurnell
Legal Description	Lot 2 in DP1030269	Lot 2 in DP559922	Lot 8 in DP586986	Lot 9 DP 586986
Site Area	16ha	160ha	34.5ha	82m^2
	Total Area: Approximately 210.5 hectares			
Local Government Area	Sutherland Shire			

Figure 1 Site Aerial Image and Map

Source: Group GSA 2023

The location of the site is provided in Figure 1 and photos of the existing site are provided in Plate 1 to Plate 4.

Plate 1 Looking north across Lot 2 South, towards Quibray Bay with Boat Harbour in the foreground

Plate 2 Bate Bay looking south west, illustrating the revegetated dune in Lot 2 South

Plate 3 **Looking towards Bate Bay over Lot 2 South and Lot 8 (left)**

Plate 4 **Looking north to Quibray Bay over Lot 2 North and Captain Cook Drive in the foreground**

1.3 Purpose of this report

1.3.1 Government Department and Agency requirements

The first AQIA prepared from the site (AECOM 2020) addressed the original key matters for consideration for the Planning Proposal described in the State Environmental Planning Policy (Kurnell Peninsula) 1989 Review, Scope of Works document dated September 2017. A copy of the original AQIA is provided in Appendix A. In response to the Scoping Proposal submitted to Sutherland Shire Council in March 2023 advice was received by DPE, EPA and Council on key focus areas for previous technical studies for the site including the AQIA 2020 report. Feedback received on the AQIA included:

- Department feedback and advice – Kurnell Scoping Proposal from DPE dated 10 August 2023
- Environment Protection Agency (EPA) feedback and advice provided on 8 June 2023 regarding setback distances and land use conflicts associated with the adjoining Breen Proposal. Upon review of the previous response revised feedback was provided by the EPA dated 18 August 2023.
- The Environmental Science Unit of Sutherland Shire Council on 6 June 2023.

Both the original DPE key matters for consideration addressed in the AQIA 2020 and where they have been updated in this AQIA technical report together with the new department and agency comments following the Scoping Proposal are documented in Appendix B.

1.3.2 Project scope and objectives

The Purpose of this report is to revise the AQIA 2020 to accommodate department and agency comments listed in Section 1.3.1 and detailed in Appendix B following the Scoping Proposal submitted to Sutherland Shire Council in March 2023.The AQIA would be used to inform the master planning for the future development of the site, which will be the basis for future land use zones and development controls to guide long term development of the site and has been prepared in accordance with the following guidelines:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2022);
- *Technical Framework, Assessment and management of odour from stationary sources in NSW* (DEC 2006); and
- *Technical Notes, Assessment and management of odour from stationary sources in NSW* (DEC 2006a).
- Good Practice Guide for the assessment and management of air pollution from roadside transport proposals (CASANZ 2023)

The AQIA involved the analysis of air quality impacts associated with the Planning Proposal and included the following scope of work:

- Description of the Planning Proposal:
- Identification of relevant legislation, planning and guideline documents relevant this AQIA.
- Identification of relevant air quality, odour and landfill gas criteria.
- Description of the existing environment including local meteorology and climate, existing air quality and current and potential future air and odour emissions, terrain and land use.
- Identification of sensitive land uses within the study area.
- Undertaking an air and odour impact assessment for:
    - Future Land Use and Development Impacts including a qualitative assessment of construction impacts, land use and staging impacts and quantitative assessment of adjacent emissions from:
        - Vehicle emissions on Captain Cook Drive;
        - Reverse amenity impacts from the Proposed Breen Resources Proposal

  - Qualitative assessment of reverse amenity impacts from nearby potential sources of air pollutants or odour emissions.

- Provision of recommendations to inform the master planning for the future development including for project staging, minimising reverse amenity impacts, planning and design considerations, management practices and any future assessment requirements.

2.0 Proposed Development.

2.1 Site context

As discussed in Section 1.2 the site is located on 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell within the Sutherland Shire Local Government Area (LGA). This site is shown in Figure 2 and is bound by Captain Cook Drive to the north, industrial zoned land to the northeast (including the Sydney Water Desalination Plant), Kurnell Village and the Kurnell Ampol Fuel Terminal, Kamay Botany Bay National Park to the east, Bate Bay to the South[1] and Wanda Reserve to the west. The site is accessed by Captain Cook Drive, a major local east-west distributor road which links Kurnell village to Cronulla.

Figure 2 Kurnell Regional Context

Source: Group GSA 2023

[1] The property title of Lot 2 DP 1030269 extends down to the mean high water mark in Bate Bay.

2.2 Proposed land use precincts

The Master Plan comprises of four distinct development precincts as shown in Figure 3 including:

1. Town Centre
2. Bate Bay
3. Boat Harbour
4. Quibray Bay

Proposed land use categories are provided in Figure 4.

Figure 3 Precinct Locations

Source: Group GSA 2023

Figure 4 Proposed land use categories for precincts

Source: Group GSA 2023

2.3 Development Staging

A preliminary development program has been developed for the site and is expected to take 19 years, with final completion anticipated by 2044. A copy of the draft staging program has been provided below to provide context with regards to future development and potential changes to sensitive receptors discussed in this technical report.

Table 2 Preliminary project staging of Kurnell Master Plan

Precinct	Stage	Dwelling Yield	Construction Period (y)	Year of Completion
Quibray Precinct	1A	230	4	2029
Town Centre South	1B	919	7	2032
Town Centre North East	2	804	7	2036
Boat Harbour South	3A	0	2	2037
Boat Harbour North	3B	554	5	2038
Town Centre North West	4	303	3	2040
Bate Bay South	5A	571	5	2042
Bate Bay North	5B	480	6	2042

3.0 Air quality legislation and guidance documents

3.1 Legislation, regulations, and standards

The following provides a summary of the legislation, regulations, and standards relevant to the assessment of air quality impacts from the Kurnell Planning Proposal

3.1.1 State Environmental Planning Policy (Precincts – Central River City) 2021

In 2021 the *State Environmental Planning Policy (Precincts – Central River City) 2021* superseded the *State Environmental Planning Policy (Kurnell Peninsula) 1989* as part of DPE's initiative to consolidate SEPPs to simplify and consolidate the NSW planning system.

Chapter 5 of the SEPP relates specifically to the Kurnell Peninsula and aims to conserve the natural environment ensuring that development is managed in a sustainable manner and seeks to promote and encourage development consistent with the ecological and heritage values of the site. Environmental planning aims of the policy also include preservation of land of natural, environmental, historical, or cultural significance including the wetlands, to conserve the aquatic environment and its resources and to progressively phase out sand mining and facilitate rehabilitation of degraded lands.

The site is subject to the SEPP (Precincts – Central River City) and the land is currently zoned as follows in accordance with the SEPP:

Lot 2 North

- Zone No 6 (c) (Private Recreation Zone)

  The majority of land within Lot 2 North is covered by Zone No. 6 (c) with the exception to a small portion of coastal wetland that falls under *State Environmental Planning Policy (Resilience and Hazards) (NSW) 2021*

Lot 2 South

- Zone No. 4(a) (General Industrial Zone)

  Land over the eastern access corridor from Captain Cook Drive into the body of the lot is currently Zoned 4(a).

- Zone No. 6(b) (Public Recreation)

  Bate Bay foreshore is currently Zoned 6(b) for public recreation.

- Zone No. 7(b) (Special Development)

  The majority of land within Lot 2 South is zoned 7(b) and is largely attributed to sand mining activities.

- Part 9(a) (Regional Open Space)

  Land covered by the Boat Harbour is zoned Part 9(a).

The Planning Proposal aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument local environmental plan zones and enable additional uses to accommodate a diverse range of land uses at the site.

3.1.2 State Environmental Planning Policy (Transport and Infrastructure) 2021

The *State Environmental Planning Policy (Transport and Infrastructure) 2021* (Transport and Infrastructure SEPP) sets out the planning rules and controls for infrastructure in NSW including roads. The Transport and Infrastructure SEPP includes identifying environmental assessment procedures, assessment of impacts adjacent to development and consultation procedures.

Section 2.116 to Section 2.122 of the Transport and Infrastructure SEPP specifically deals with development in or adjacent to road corridors and road reservations. Section 1.119 explicitly covers development with frontage to a classified road. Under Section 2.119 (1)(b) the objective development with a frontage to a classified road must:

"…prevent or reduce the potential impact of traffic noise and vehicle emission on development adjacent to classified roads."

Furthermore, under Section 2.119 (2)(b) the consent authority must not grant consent to development on land that has a frontage to a classified road unless it has satisfied that:

"(a) where *practicable and safe, vehicular access to the land is provided by a road other than the classified road, and*

(b) the safety, efficiency and ongoing operation of the classified road will not be adversely affected by the development as a result of:

i. the design of the vehicular access to the land, or

ii. the emission of smoke or dust from the development, or

iii. the nature, volume or frequency of vehicles using the classified road to gain access to the land, and

(c) the development is of a type that is not sensitive to traffic noise or vehicle emissions, or is appropriately located and designed, or includes measures, to ameliorate potential traffic noise or vehicle emissions within the site of the development arising from the adjacent classified road."

Supporting documentation to the Transport and Infrastructure SEPP which guidance to the reduction of air quality impacts on sensitive adjacent development to roads as specified under Section 2.119 (1)(b) is discussed in Section 3.2.4.

3.1.3 Sutherland Shire Local Environmental Plan 2015

The *Sutherland Shire Local Environmental Plan (2015)* (LEP 2015) aims to make local planning provisions for the Sutherland Shire Local Government area in accordance with Section 33A of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act). Currently the LEP does not apply to land within the study area which is identified as a 'deferred matter' under Part 1 Clause 1.3(A) of the LEP 2015 and Section 59(3) of the EP&A Act 1979.

As part of the Planning Proposal the site is to be transitioned from the *State Environmental Planning Policy (Precincts – Central River City) 2021* to the Sutherland Shire Council LEP 2015.

3.1.4 Civil Aviation Safety Regulations 1998 (Cth)

The Civil Aviation Authority (CASA) are responsible for enforcing safety requirements stated in the *Civil Aviation Safety Regulations 1998 (Cth)* (CASR 1998) administered under the *Civil Aviation Act 1988 (Cth).* Aviation authorities have established that wind gusts with vertical velocity exceeding 4.3 metres per second (m/s) may cause damage to an aircraft airframe or otherwise upset an aircraft flying at low levels. Under Regulation 139.370 of the CASR 1998 and in accordance with the *Advisory Circular AC 139-5(1) Plume Rise Assessments* 2012 proponents of a facility where the vertical velocity of exhaust plumes exceed 4.3 m/s at an aerodrome Obstacle Limitation Surface (OLS), or at 110 m above the local ground anywhere else, must undertake plume rise modelling to assess the potential hazard to aircraft operations.

In March 2023 the 2012 *Circular AC 139-5(1)* was update to *Advisory Circular* AC 139.E-02v1.0 *Plume Rise Assessments 2023.* Previous ACs on this topic were predicated on the use of The Air Pollution Model (TAPM) for the detailed assessment of plume rises. The new AC adopts the use of the Exhaust Plume Analyzer to predict plume size and severity of flight impact created by a plume rise.

The Kurnell Peninsula is located directly under the flightpath for the main north-south runways at Sydney airport. The OLS for Sydney Airport at Lot 2 North and Lot 2 South as declared by the Commonwealth Department of Infrastructure and Regional Development on 20 March 2015 is set at between approximately 110 and 156 AHD. Existing site ground elevation range from approximately 0 to 10m in height (refer to Section 6.2.6).

3.1.5 National Environment Protection Council Act 1994 (Cth)

The *National Environment Protection Council Act 1994* (Cth) establishes and provides authority to the National Environment Protection Council (NEPC) to make National Environment Protection Measures (NEPMs) and to assess and report on their implementation and effectiveness in participating

jurisdictions. NEPMs are a special set of national objectives designed to assist in protecting or managing aspects of the environment. Regarding concentrations of air pollutants, there are two relevant NEPMs:

- National Environment Protection (Ambient Air Quality) Measure 2021 (AAQ NEPM)
- National Environment Protection (Air Toxics) Measure 2004 (Air Toxics NEPM).

The AAQ NEPM was designed to create a nationally consistent framework for monitoring and reporting on common ambient air pollutants. The Air Toxics NEPM provides a framework for monitoring, assessing, and reporting on ambient levels of air toxics, and was designed to collect information to facilitate the development of standards for ambient air toxics.

The AAQ NEPM sets the air quality standards for air pollutants examined in this report (NO, CO, PM_{10} and $PM_{2.5}$) and are consistent with the NSW EPA criteria adopted for this assessment (Section 4.1). In addition to the to the current standards, 24-hour and annual average $PM_{2.5}$ goals are proposed from 2025 and are lower than the current standards. The goal for particulates from 1 January 2025 will provide a framework for continuous improvement and facilitate a review of the $PM_{2.5}$ standard. The proposed $PM_{2.5}$ goals are considered relevant to the assessment of operational impacts from the proposal and proposed national environment protection goals for 2025 are provided in Section 4.2.

The *National Environment Protection Council Act 1994* (Cth) also administers the *National Environment Protection (National Pollutant Inventory) Measure 1998* which is used to collect a broad base of information on emissions, including emissions from all industry sectors, and reports and disseminates this information to the community in a useful as accessible form.

3.1.6 The Protection of the Environment Operations Act 1997 (NSW)

The Protection of the Environment Operations Act 1997 (NSW) (POEO Act) is the key piece of environment protection legislation administered by the EPA. The object of the POEO Act is to achieve the protection, restoration, and enhancement of the quality of the NSW environment.

The POEO Act provides a board allocation of environmental responsibilities between the NSW EPA, local councils, and other public authorities. The objects of the POEO Act relevant to air quality are:

- To protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development.
- To ensure that the community has access to relevant and meaningful information about pollution.
- To reduce risks to human health and prevent the degradation of the environment using mechanisms that promote the following:
    - Pollution prevention and cleaner production
    - The reduction to harmless levels of the discharge of substances likely to cause harm to the environment.
    - The making of progressive environmental improvements, including the reduction of pollution at source
    - The monitoring and reporting of environmental quality on a regular basis.
- To rationalise, simplify and strengthen the regulatory framework for environment protection.
- To improve the efficiency of administration of the environment protection legislation.

The POEO Act also allows for the provision of delegate legislation, including the Protection of the Environment Operations (Clean Air) Regulation 2021.

The POEO Act is supported by NSW EPA documents that provide methods for assessing and sampling air pollutants and includes the Approved methods for the modelling and assessment of air pollutants in NSW 2022 (referred to as the Approved Methods) discussed in Section 3.2.3.

3.1.7 Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)

The *Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)* (POEO Clean Air Regulation 2010) under the *Protection of the Environment Operations Act 1997 (NSW)* (POEO Act 1997) prescribes the requirements for a number of air pollutant generating activities in NSW. Requirements include domestic solid fuel heater certification, controlled burning, and installation of pollution control devices on certain motor vehicles, petrol supply standards, emission standards for industry groups and control storage and transport of volatile organic compounds.

3.1.8 POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016

Under the *POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016 (NSW)* all solid fuel heaters sold on or after 1 September 2019 must be certified by a body approved by the EPA and:

- Comply with:
  - AS/NZS 4012:2014 Domestic solid fuel burning appliances – Method for determination of power output and efficiency; and
  - AS/NZS 4013:2014 Domestic solid fuel burning appliances – Method for determination of flue gas emission.
- Have an overall average efficiency of at least 60 percent and a particulate emission factor of no more than 1.5g/kg (for heaters without catalytic combustors).

3.2 Guidance Documents

The following provides a summary of the relevant guidance documentation used to the assessment of air quality impacts from the Kurnell Planning Proposal

3.2.1 NSW Approved Methods for Modelling and Assessment

The Approved Methods for modelling (EPA 2022) under Part 5 of the POEO Clean Air Regulation 2010 provides the statutory methods for modelling and assessment from air emissions in NSW. The document outlines procedures for:

- Emissions inventories
- Meteorological data preparation
- Accounting for ambient air pollutant concentrations through cumulative impact assessments
- Dispersion modelling methodology
- Interpretation of modelling results
- Impact assessment criteria
- Modelling chemical transformation
- Procedures for developing site specific emission limits.

Under Section 2.1 of the Approved methods for modelling two levels of impact assessment are defined for dispersion modelling:

- Level 1: a screening level assessment using worst-case input data
- Level 2: a refined dispersion assessment using site specific input data.

A Level 2 assessment of operational impacts from the proposal has been undertaken in accordance with the Approved methods for modelling which is discussed further in Section 6.2. Interpretation of dispersion modelling results for the proposal involves comparing the predicted pollutant ground level concentrations with the impact assessment criteria in the Approved methods for modelling. The impact assessment criteria are presented in section 7.0.

3.2.2 Good Practice Guide

The *Good Practice Guide for the assessment and management of air pollution from roadside transport proposals* (CASANZ 2023) (GPG) recently released in February 2023, has been developed by the Clean Air Society of Australia and New Zealand (CASANZ) to support the assessment of air quality impacts from construction and operation of road proposals. The Guide sets the procedures to assess and mitigate potential air quality impacts from road proposals and established the minimum technical requirements for assessment of air quality impacts.

The GPG assessment framework determines the appropriate depth of assessment of construction and operation impacts from the proposal. The framework considers the scale and complexity of the proposal, the physical sensitivity of the local population and environment to air pollution, the potential for changes in air quality, and community concern about air quality. For operation a Stage 4 Detailed Assessment have been undertaken, which is discussed further in Section 6.2.

3.2.3 NSW Movement and Place Built Environment Indicators- Air Quality and Noise

The NSW Government Movement and Place Framework establishes a set of built environment performance indicators for evaluating the performance of projects. One of the performance indicators is for *Air Quality and Noise detailed in the Air Quality and Noise Comfort and Safety, Built Indicator Factsheet*.

The factsheet provides a semi-qualitative assessment of road traffic impacts considering the Average Annual Daily Traffic (AADT) and distance between the road kerb and sensitive receptors as shown in Figure 5. Predicted traffic numbers for the Proposal are discussed in Section 6.2.8.2, with design opening year and 10 years after opening for Captain Cook Drive to have an AADT of less than 20,000. A 90m development setback distance from Captain Cook Drive has also been included in the Master Plan for the Kurnell Planning Proposal. Based on the risk matrix shown in Figure 5, the air quality risk to sensitive receptors from vehicle emissions is low.

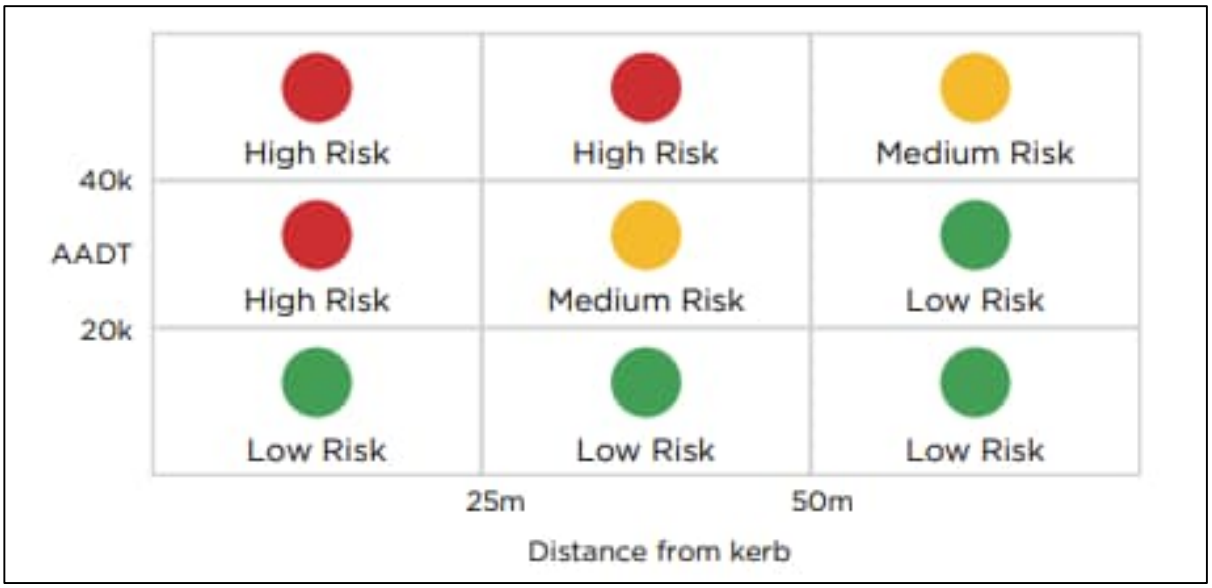


Figure 5 Air Quality Risk Matrix for the NSW Movement and Place Built Environment Indicator

Sutherland Shire Council under Item 59 of the *Internal Memorandum dated 6th June 2023 a referral response to the Besmaw Kurnell Scoping Proposal* have requested that to minimise impacts from vehicle emissions, the type and siting of buildings and range of mitigation measures employed shall be determined prior to development and be consistent with both the Air Quality Indicators fact sheet and the Development Near Rail and Corridors and Busy Roads Interim Guideline as described in Section 3.2.4. Planning and design considerations for the projects are discussed in Section 8.3.

A more comprehensive quantitative assessment of vehicle emissions has been undertaken in this report as detailed in Section 6.2 and Section 7.0. Therefore, no further consideration of the NSW Movement and Place indicators has been undertaken.

3.2.4 Development Near Rail Corridors and Busy Roads – Interim Guideline

The DPE's *Development Near Rail Corridors and Busy Roads – Interim Guideline* (DoP 2008) (the Guideline) supports the specific rail and road provisions of the Transport Infrastructure SEPP (see Section 3.1.2). The aim of the Guideline is to aid in reducing the health impacts of both noise and air quality impacts on sensitive adjacent development by assisting in the planning, design and assessment of development in or adjacent to rail corridors and busy roads. Under the guideline a busy road is defined as:

- Roads including freeways, tollways, transit ways and any other road with 20,000 AADT volume or more.
- Any other road with a high level of truck movements or bus traffic.

Section 4 of the Guideline provides consideration for how to identify the potential for vehicle exhausts to impact on development adjacent to roadways and how to address potential air quality issues from vehicle exhausts for development near busy roads at the design stage. Section 4.4 of the Guideline lists the triggers for when air quality should be a design consideration for developments and provides guidance on design considerations that may be considered to mitigate air quality impacts. These triggers and are provided in **Table 3**.

Table 3 Triggers for Air Quality as a Design Consideration (DoP 2008)

Trigger	Design Consideration (Y/N)	Comment
Within 10 metres of a congested collector road (traffic speeds of less than 40 km/hr at peak hour) or a road grade > 4% or heavy vehicle percentage flows > 5%,	No	• Level of Service (LoS) for Captain Cook Dr-Lindum Road intersection for 2018 rated A; good performance of intersection operating within capacity (ttpp 2019).
Within 20 metres of a freeway or main road (with more than 2500 vehicles per hour, moderate congestions levels of less than 5% idle time and average speeds of greater than 40 km/hr)	No	• Traffic volumes for 2018 at Captain Cook Dr-Lindum Road intersection are 969 VPH during AM peak and 928 during PM Peak (ttpp 2019) • Level of Service (LoS) for Captain Cook Dr-Lindum Road intersection for 2018 rated A; good performance of intersection operating within capacity (ttpp 2019).
Within 60 metres of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources)	Yes	• Site not located within 60m of any road tunnels, major intersections or overpasses. • Site located within 60m of a roundabout. • Site located adjacent to existing landfill and within 1km of Caltex Kurnell Fuel Terminal.
As considered necessary by the approval authority based on consideration of site constraints, and associated air quality issues	Yes	• DPE have specifically requested consideration in accordance with the Land Capability, Hazards and Air Quality Scope of Work documentation. • Design approaches are to minimise exposure to particle pollution next to major roads (e.g Captain Cook Drive) especially where road volumes are expected to increase.

Based on Table 3 development of the site would trigger the need to consider air quality impacts from vehicle emissions at the design stage of the development. A quantitative assessment of vehicle emissions is presented in Section 7.0 and design considerations in accordance with the guideline for future development at the site are provided in Section 8.2.

3.2.5 Environmental Guidelines, Solid Waste Landfills

The NSW EPA *Environmental Guidelines, Solid Waste Landfills* (EPA 2016) under *the Protection of the Environment Operations Act 1997 (NSW)* provide a set of minimum standards for the assessment of the operation and post-closure period for general solid waste and restricted solid waste landfills.

Development on or near closed (and operational) landfills can be a cause for concern due to the length of time required for waste to become physically, chemically, and biologically stable; with the potential for landfill to produce landfill gases many years after closure. Section 10.3 of the guideline's states that development on or near closed landfills should only be considered if the following conditions are met:

- The landfill should meet the EPA's stabilisation criteria for gas concentration levels (see Section 4.3). Gas criteria are particularly important for developments that create enclosed spaces where gas can accumulate or migrate (e.g buildings, basements, manholes, tunnels, service ducts, and stormwater and sewer pipes). These criteria may be less critical in the case of open developments such as sporting fields, golf courses and car parks.
- The risk of gas accumulation in any enclosed spaces within the development should be appropriately managed through design measures such as venting systems, sub-floor systems, gas barrier systems and other measures for managing sub-surface gas migration (see AQIA 2020); and
- Periodic methane monitoring should be conducted in all buildings and underground utilities (see (see AQIA 2020).

4.0 Assessment Criteria

4.1 Air Quality Criteria

Table 4 summarises the NSW EPA's impact assessment criteria for the pollutants included in the assessment. In general, these criteria relate to the total burden of air pollutants in the air and not just the air pollutants from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess impacts. A discussion of background levels in the study area is provided **in Section 5.3.3.**

Table 4 NSW EPA Air Quality Impact Assessment Criteria (EPA 2022)

Pollutant	Averaging Period	Criteria
Carbon monoxide (CO)	Maximum 1-hour average	30 mg/m^3
	Maximum 8-hour average	10 mg/m^3
Nitrogen dioxide (NO_2)	Maximum 1-hour average	164 μg/m^3
	Annual average	31 μg/m^3
Particulate matter (PM_{10})	Maximum 24-hour average	50 μg/m^3
	Annual average	25 μg/m^3
Particulate matter ($PM_{2.5}$)	Maximum 24-hour average	25 μg/m^3
	Annual average	8 μg/m^3
μg/m^3 = micrograms per cubic metre		

In addition to the adopted criteria in Table 4 predicted ground level $PM_{2.5}$ concentrations have been evaluated against the proposed $PM_{2.5}$ national environmental protection goals scheduled for 2025 provided in Table 5.

Table 5 NEPM proposed national environment protection goals scheduled for 2025.

Item	Pollutant	Averaging period	Goal	
			ppm	(μg/m^3)
7	Particles ≤ 2.5 micrometres in diameter ($PM_{2.5}$)	1 day	-	20
		Annual average	-	7
ppm = parts per million μg/m^3 = micrograms per cubic metre (under standard temperature and pressure).				

4.2 Odour Criteria

The perception of odour is based on an individual's response to chemical exposure. The odour threshold is the theoretical minimum concentration of a chemical that produces an olfactory response, which, in practice, is used to indicate whether an odour is detectable; the odour threshold defines 1 odour unit (1 OU) for each chemical. The threshold relates to odour detection and does not consider the recognition of an odours character.

The EPA's impact assessment criteria for complex mixtures of odours (EPA, 2022) were designed to consider the range of individual sensitivity to odours based on a statistical approach based on the size of the surrounding population. As population density increases, the proportion of sensitive individuals is also likely to increase; as such, areas with larger populations require more stringent criteria. The criteria are shown in Table 6.

Table 6 EPA Impact Assessment Criteria – Complex Odours

Population	Criteria (OU)*
Urban (≥ ~2000) and/or schools and hospitals	2
~ 500	3
~ 125	4
~ 30	5
~ 10	6
Single residence (≤ ~2)	7
*99th percentile nose response time	

The proposed site is bound by Quibray Bay to the north and Bate Bay to the South and east and west of the site is made of largely native vegetation including reserves and state parks and industrial areas. The nearest high density residential land is Kurnell Village located over 1km northeast of the site. The site itself is proposed for future high density residential commercial and recreational use and as such the most stringent odour assessment criterion of 2OU would be applicable to this area.

4.3 Land Fill Gas Stabilisation Criteria

Landfill gas has the potential to accumulate at dangerous levels in enclosed spaces at or near landfills. Landfill gas is primarily made up of methane and carbon dioxide and must not accumulate in buildings. Methane is explosive in the range of 5% to 15% volume/volume, and landfill gas can lead to asphyxiation in enclosed spaces. The threshold level for further investigation and corrective action is detection of methane at concentrations above 1% (volume/volume).

Development of buildings or structures near landfill sites (within 250m) are subject to the landfill gas stabilisation criteria listed under Section 10.2 of the EPA Environmental Guidelines (EPA 2016) (refer to Section 3.4.2). The criterion states that gas concentration levels in all perimeter gas wells have fallen to less than 1% methane (volume/volume) and less than 1.5% carbon dioxide (volume/volume) above the established natural background for a period of 24 months).

The guideline also states that the above criteria may be less critical in the case of open developments such as sporting fields, golf courses and car parks.

5.0 Existing Environment

5.1 Meteorology

Meteorology in the area surrounding the site is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale. Wind speed and direction are important variables in assessing potential air quality impacts, as they dictate the direction and distance air pollutant plumes travel. Wind speed and wind directional data from the Bureau of Meteorology (BoM) meteorological station at Kurnell (Station number 066043), approximately 2.5 km northeast from the site (at its closest point) has been used in this assessment. The BoM meteorological station at Kurnell only measures wind speed and wind direction as such this data has been supplemented by long term climate data for other meteorological parameters from the BoM Sydney Airport monitoring station and is discussed in Section 5.2.

Ten years of wind speed data from the BoM station at Kurnell were examined between 2013 and 2022. Annual wind roses for this period are shown in Figure 6. The average wind speed over the ten-year period was 5.8 m/s and was relatively consistent between years ranging from an annual average of 5.6 m/s in 2015 and an annual average of 5.9 m/s in 2018 and 2022. The occurrence of calm conditions where windspeeds were equal to or less than 5 m/s was relatively low occurring 1% of the time over the ten-year average. The annual average percentage of calms ranged from 0.4% in 2014 and 1.4% in 2017. The moderate average wind speeds recorded at Kurnell and low frequency of calm conditions indicates generally favourable dispersal conditions where air pollutants would disperse rapidly.

Wind direction also shown in Figure 6 is variable with a high frequency of winds from the northeast, south to south southwest and from the west to northwest. Predominant winds vary seasonally, and this is discussed further below. The annual wind distribution is relatively similar across all years between 2013 and 2022.

Monthly wind roses in Figure 7 from 2013 to 2022 shows that monthly average wind speeds vary between 5.0 in April to 6.1 m/s from November through to January. The occurrence of calms across the year is relatively low with an observed frequency ranging between 0.6% in August and 1.4% in January. The moderate average wind speeds and low percentage of calms indicates favourable dispersal conditions occur frequently throughout the year.

From October to March there is a high frequency of north-easterly winds, during this period winds from the south south-west also increase towards mid-summer to early autumn. Between April and September there is a higher frequency of winds from the west to southwest. This indicates that the site is more likely to be sensitive to air and odour emission sources west of the site during this period when winds are blowing towards the proposal area. As discussed above however moderate wind speeds and a low percentage of calms observed recently is likely to result in more rapid dispersion of air pollutants. This air and odour impacts are further examined quantitatively using dispersion modelling as discussed in Section 7.2

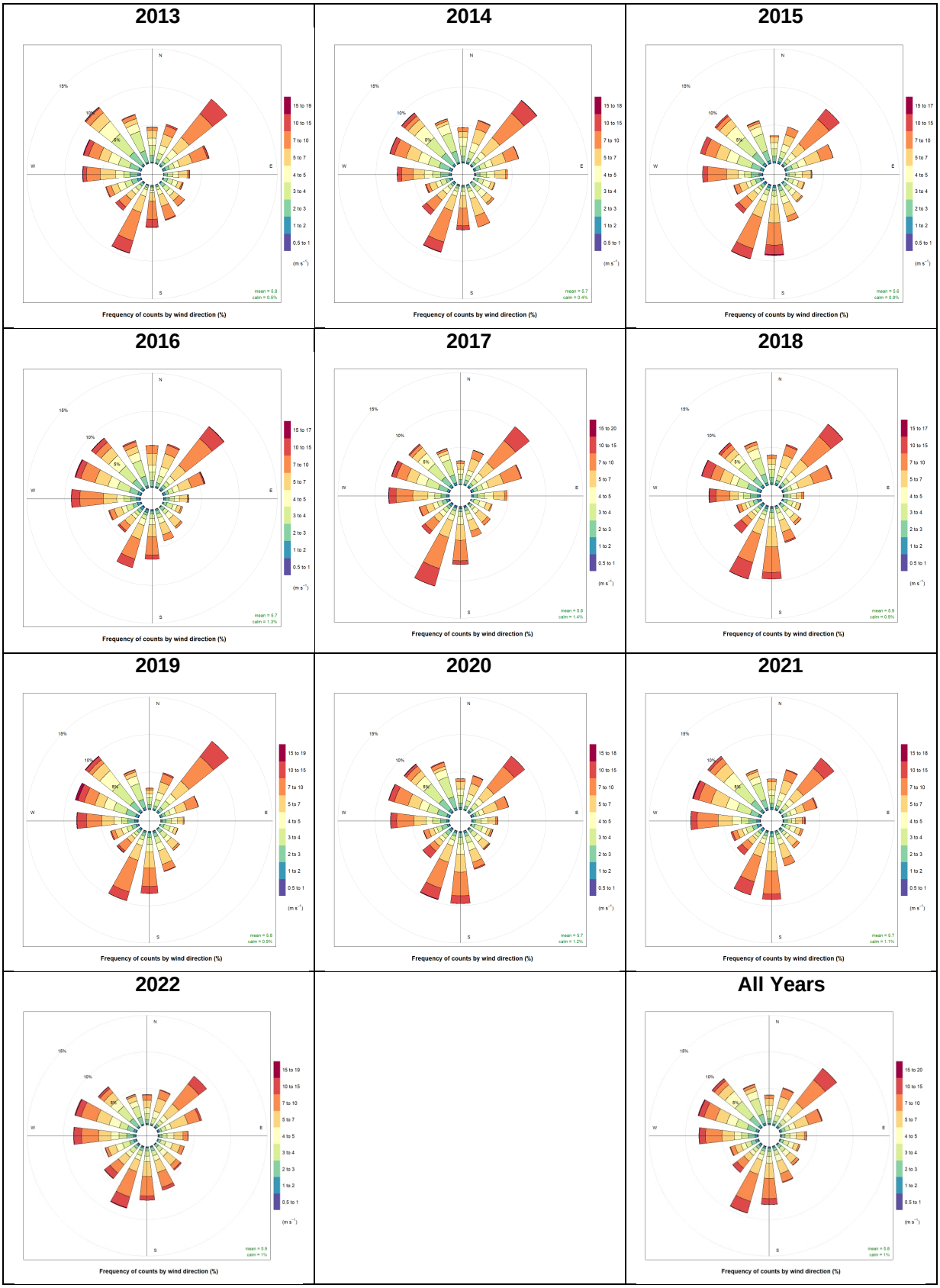


Figure 6 Annual wind roses at BoM Kurnell monitoring station from 2013 to 2022

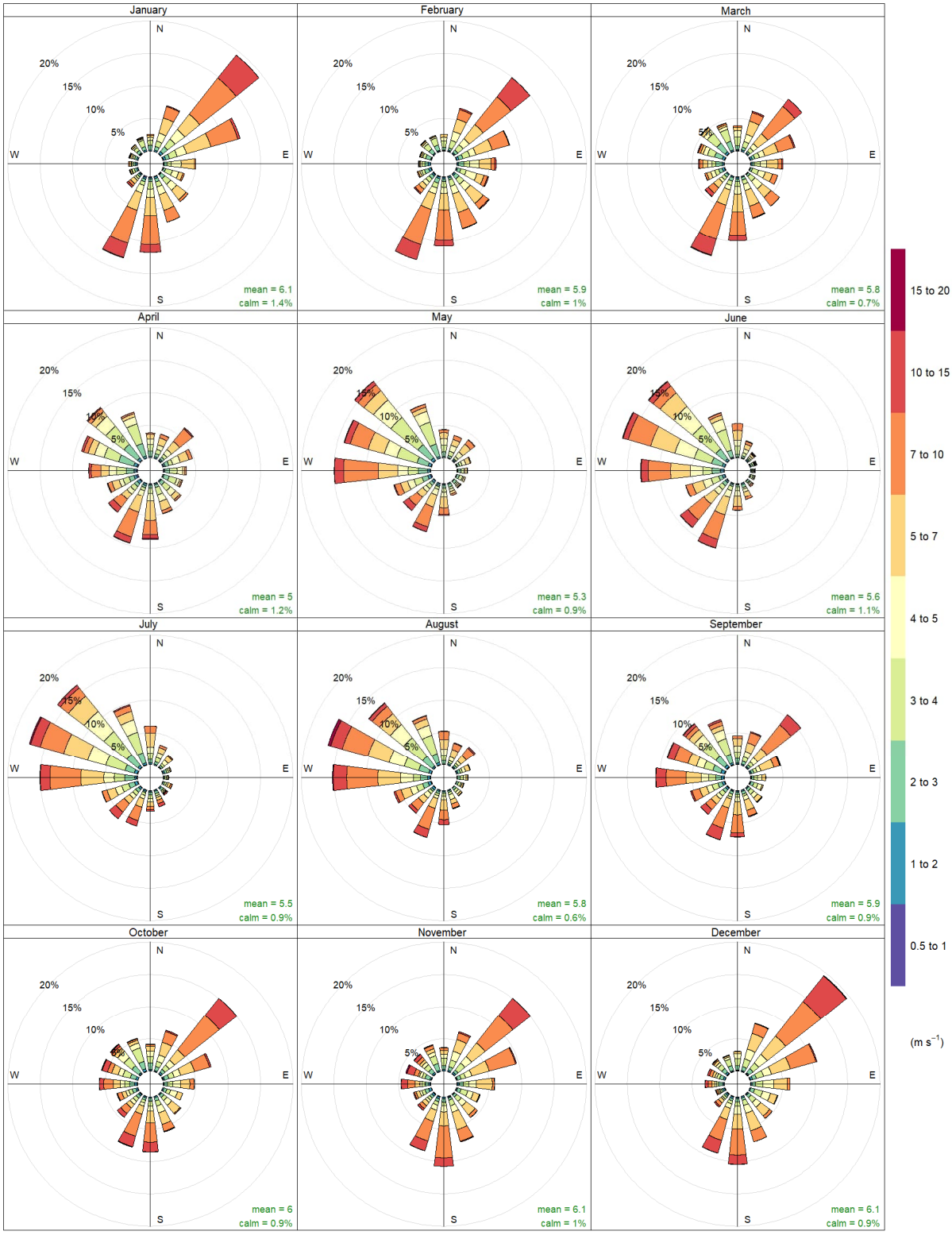


Figure 7 Average Monthly wind roses at BoM Kurnell monitoring station from 2013 to 2022

5.2 Local Climate

The BoM meteorological station at Sydney Airport records climate data for a range of meteorological parameters including, temperature, humidity, rainfall, wind speed and wind direction. A summary of the long-term data recorded at this station between 1939 and 2023 is shown in Table 7. Sydney Airport is located approximately 8.km north of the site and the data provides an indication of the regional climate of the area.

Table 7 Climate Summary, BOM Monitoring Station at Sydney Airport, 1939 to 2023

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	27	27	25	23	20	18	17	19	21	23	24	26	22
Mean minimum temperature (°C)	19	19	18	14	11	9	7	8	11	13	16	18	14
Mean rainfall (mm)	95	118	124	107	96	122	72	75	60	72	80	73	1090
Decile 5 (median) rainfall (mm)	72	87	91	81	78	99	52	48	47	48	66	63	1046
Mean number of days of rain ≥ 1 mm	8	9	10	9	8	9	7	7	7	8	8	8	96
Mean number of clear days	7	6	8	9	9	9	12	13	11	8	6	7	105
Mean number of cloudy days	13	12	12	11	11	11	9	8	8	11	12	12	129
Mean 9am temperature (°C)	22	22	21	18	15	12	11	13	16	18	20	22	17
Mean 9am relative humidity (%)	70	73	73	71	73	74	71	65	62	61	64	66	69
Mean 9am wind speed (km/h)	14	14	13	13	13	13	13	14	16	16	16	15	14
Mean 3pm temperature (°C)	25	25	24	22	19	17	16	17	19	21	22	24	21
Mean 3pm relative humidity (%)	60	63	61	59	58	57	52	49	51	54	56	58	57
Mean 3pm wind speed (km/h)	24	23	21	19	17	18	18	21	23	25	25	25	22

As shown in Table 7, the warmest temperatures occur during the summer months, with the highest average maximum temperature (27ºC) occurring in January and February. July is the coldest month, with a recorded average minimum temperature of 7ºC.

The site has an annual average rainfall of 1091mm occurring across an average of 94 days per year. March is the wettest month, with an average rainfall of 124 millimetres, while September is driest month with an average rainfall of 60 millimetres. Humidity follows a diurnal cycle, with higher humidity in the morning compared to the afternoon.

Average 9am and 3pm wind speeds in Table 7 show that wind speeds are generally higher in the afternoon compared to the morning with 9am and 3pm averages of 14km/h and 22 km/h respectively. The highest average wind speeds occurring in December (25 km/h).

5.3 Existing Air Quality

5.3.1 Potential sources of air pollution and odour

A review of the National Pollution Inventory (NPI) data base and EPA Environmental Protection Licence database identified the following existing potential sources of air emissions within Kurnell in Table 8. Table 8 provides a brief description of existing potential odour sources both onsite and offsite identified as part of the desktop review.

In addition to the potential sources identified in Table 8, Sutherland shire council in the Internal *Memorandum dated 6th June 2023 a referral response to the Besmaw Kurnell Scoping Proposal* requested consideration of potential odour impacts from mangroves and air emissions from aircraft within the site. These are discussed further in Section 7.6 and Section 7.7.

Finally in addition to the facilities listed in Table 8 and additional air emission sources raised by Sutherland shire council a key source of air emissions from Kurnell would be from vehicle emissions, specifically from Captain Cook Drive adjacent to Planning Proposal site as shown in Figure 2. Traffic data and vehicle emissions are discussed in Section 6.2.8.2.

Table 8 Potential Sources of Air Emissions

Source	Description	Pollutants	Address & Distance from Site	Comment
Onsite sources				
Sand Mining and Rehabilitation	Rehabilitation of sand quarry with virgin excavated natural material (VENM); and sand extraction, or separating activities	Particulates	Lot 2 South	Sand mining and rehabilitation works to cease as part of future proposed development of the site. However, there is the potential for rehabilitation works to coincide early stages of the Planning Proposal Development as is discussed in Section 8.2.
Kurnell Boarding Stables and Riding School	Small boarding stable facility and riding school.	Odour and particulates	Lot 2 North	The stable is a small facility and a site visit undertaken on 30 November 2017 indicated no significant source odour or dust from the stables. Operations would cease as part of the proposed future development (Stage 1A).
Nearby sources				
Cronulla Water Resource Recovery Facility	Primary, secondary and tertiary treatment of wastewater (EP 250,000, treating 53 million litres of wastewater a day) Cogeneration plant, capturing biogas from anerobic digestors to generate electricity.	Odour Nitrogen dioxide	Adjacent to Captain Cook Drive, approximate 1.8km west of the site.	Sufficient distance and vegetation in-between plant and site to provide buffering effect from potential odour impacts. Sufficient distance between cogeneration stack and site to allow dispersal of air pollutants
Kurnell Ampol Fuel Terminal	Fuel terminal	Volatile organic compounds (VOCs), particulates, odour	2 Solander Street, Kurnell, NSW	Sufficient distance and vegetation in-between plant and site to provide buffering effect from VOC and odour impacts
Breen Resources	Recovery of general waste and waste disposal by application to land	Particulates, odour and landfill gas (methane	Captain Cook Drive, Kurnell	Currently source of particulate, odour, and methane emissions.

Source	Description	Pollutants	Address & Distance from Site	Comment
Onsite sources				
		and carbon dioxide)		Proposed development on this site is discussed in Section 5.3.2[2]. Site may pose a potential source of landfill gas.

5.3.2 Potential changes to future air quality

Kurnell has traditionally been dominated by industrial land uses which have largely influenced local air quality. Recently a reduction in heavy industrial activities has been observed, shifting to a higher proportion of light industrial activities in the area, potentially improving local air quality. Changes in heavy industry include the conversion of the Ampol Kurnell Refinery (formerly Caltex) to a fuel terminal and the closure of the Continental Carbon Australia Plant. Further reductions in heavy industry activities are also anticipated with the winding down of sandmining on the site. For context changes to the region are summarised in Figure 8.

Figure 8 Kurnell site context

[2] It is noted that Breen Resources lodged a modification application for their site in February 2019 assessment of this proposal which was revised in 2022.

GreenHills Voluntary Planning Agreement

In 2010 the GreenHills Voluntary Planning Agreement (VPA) was proposed between Sutherland Shire Council, Breen Holdings and Frasers Property Australia (formerly Australand). Land covered by the VPA occupies approximately 124 ha on the Kurnell Peninsula, including the Landfill adjacent to the Site. A total of 91 hectares of land as part of the VPA has been dedicated to open space including the recently established skateboard park and playing fields. The continued development under the VPA would see the cessation of potential air quality impacts such as dust and odour from landfill activities and an increase in sensitive receptor density adjacent to the site.

Breen Resources Facility

In February 2019 Breen Resources (Breen) lodged a modification for development for the adjacent landfill site. The modification would involve relocating the existing waste facility (including plant and equipment) several hundred metres to the east on Lot 5 DP1158627. Site access would also be relocated from 330 Captain Cook Drive to the Lindum Road round-a-bout, east of the Marang Parkland Skate Park; and there would be a minor increase in the sites waste capacity. The proposed modification would result in the relocation existing sources of dust and vehicle emissions from the landfill site closer to Lot 2 North and Lot 2 South; prior to Breen's longer-term commitment to rehabilitate the site.

Since submission of the AQIA 2020 report, Breen have submitted a development application for a proposed resource management facility, parklands and continued landfilling on the residual parts of Lot 5 within their site. The master plan for the proposed Breen development is shown in Figure 9.

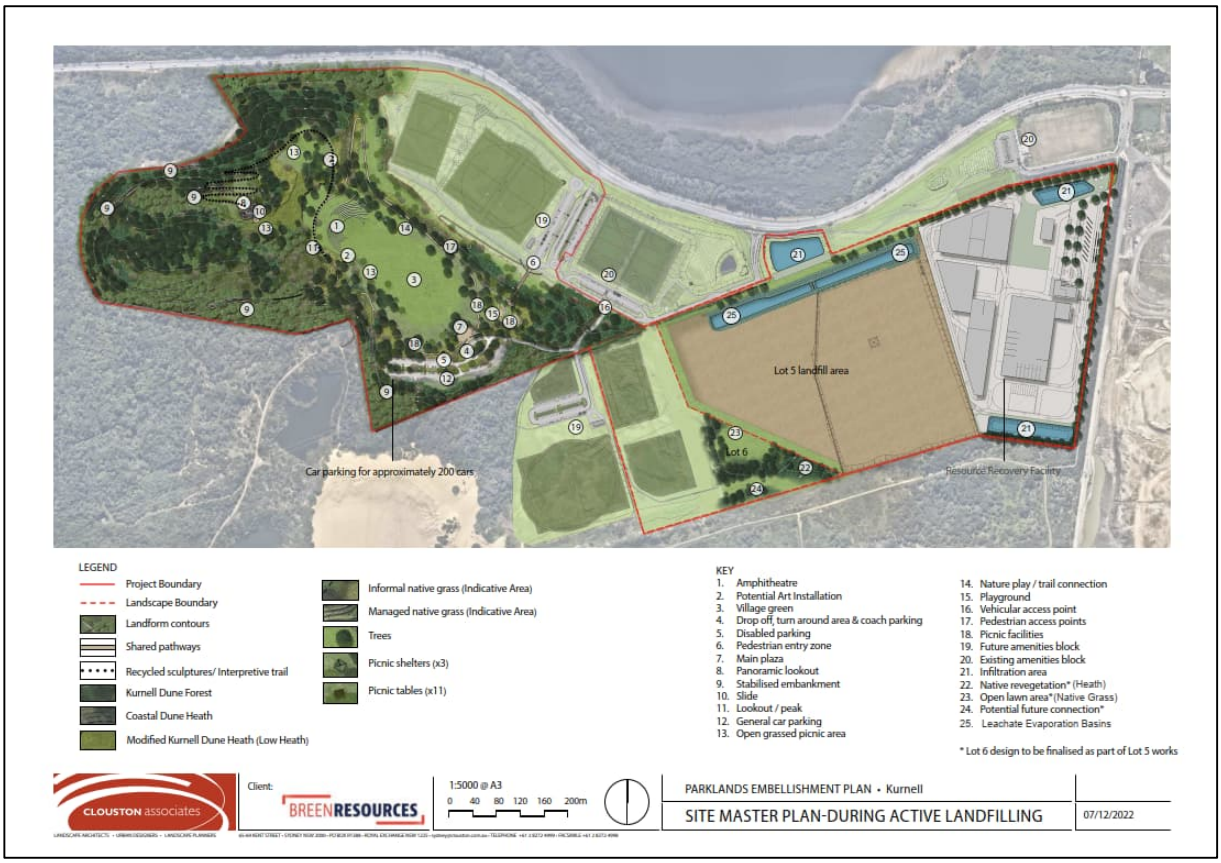


Figure 9 Revised Master Plan for Breen Resources During Active Landfilling

The Breen Air Quality Impact Assessment (Wilkinson Murray 2021) assessed the potential air quality impacts from the development using the air dispersion model AERMOD. A preliminary review of the results of the assessment found that for operation of the Breen Resources development:

- Maximum 24-Hour $PM_{2.5}$ project contribution within the proposed Town Precinct was predicted to be between 2-5µg/m^3.
- Maximum 24-Hour PM_{10} project contribution within the proposed Town Precinct was predicted to be approximately 20µg/m^3, and the predicted 2µg/m^3 concentration contour extends halfway across the Site.
- Predicted odour concentrations were less than 1 odour unit (OU) at the boundary of the Site; however, it is noted that assessment of potential odour impacts from green waste material at the resource recovery facility was not undertaken.

Agency submissions on the Breen Resources development application highlighted that predicted dust emissions from the development were unacceptable and additional mitigation was required. In the subsequent Response to Submissions report (Ethos Urban 2022) for the Breen Resource Recovery Facility, Breen Resources have committed to fully enclosing buildings, waste processing and receival areas of the resource management facility. Haulage roads would also be sealed. Quantitative assessment of the revised Breen Resources development including the mitigation commitments was not undertaken by Wilkinson Murray, but the proposed mitigation measures are likely to result in a significant reduction in off-site dust concentrations.

Correspondence from NSW EPA dated 18 August 2023 following a meeting held with Besmaw Urbis Pty Ltd on 2 August 2023 based on previous comments raised on the Proposal regarding potential land use conflicts between the Planning Proposal and the Breen Proposal in EPA Document DOC23/418068-3. EPA note that enclosure of Breen's proposed development coupled with the proposed staging of the Kurnell Planning proposal would substantially mitigate potential land use conflict risks the EPA previously identified. Regardless a quantitative assessment of potential reverse amenity impact (referred to as amenity impacts here out) have been assessed and are discussed in Section 6.2.8.1 and Section 7.0. It is highlighted that the nearest sensitive receptors within the Master Plan (within the proposed Town Precinct) have a separation distance to the nearest boundary of the Breen Resources development in the range of 100-144m. This separation distance is considered reasonable if the dust emission sources within the resource management facility are fully enclosed as described above. Further evaluation of reverse amenity impacts from the Breen Proposal are discussed in Section 7.2.

5.3.3 Air Quality Monitoring Data

The nearest EPA monitoring station is the Randwick air monitoring station, approximately 11km northeast of the Site. The monitoring station is located on the grounds of the Randwick Army Barracks on the corner of Avoca and Bundock Streets. The site itself lies within the eastern suburbs of Sydney and is largely surrounded by residential area.

A review of five years of monitoring data at Randwick has been undertaken between 2018 and 2022 for the following pollutants:

- Nitrogen Dioxide (NO_2)
- Particulate matter equal to or less than 10 microns in diameter (PM_{10});
- Particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$);

In addition to this monitoring data from Randwick has been supplemented by measured carbon dioxide (CO) concentrations at the EPA monitoring station at Roselle located approximately 18km to the north of the site.

Monitoring data for 2018 and 2022 is presented in Table 9 and is also presented graphically in Figure 10 to Figure 16. The monitoring data is summarised as follows:

- Both the 1-hour maximum and annual average NO_2 concentrations were well below the EPA criteria for all years. The highest 1-hour maximum of 95.3µg/m^3 occurred in 2019 and the highest annual average of 12.6 occurred in 2018 µg/m^3.
- The maximum 24-hour PM_{10} concentration was above the EPA criteria of 50 µg/m^3 in 2018, 2019 and 2020. Exceedances were attributed to extreme vents including bushfires and dust storms. Many exceedances occurred over 2019 and 2020 due to the black summer bushfires as shown in Figure 12. The maximum 24-hour PM_{10} concentrations for 2021 and 2022 were below the EPA criteria. Annual average PM_{10} concentrations were also below the criteria for all five examined years.
- The maximum 24-hour $PM_{2.5}$ concentration was above the EPA criteria of 25 µg/m^3 for all years with exception to 2022. Exceedances were generally attributed to extreme vents including bushfires and dust storms. Many exceedances occurred over 2019 and 2020 due to the black summer bushfires as shown in Figure 14. Annual average $PM_{2.5}$ concentrations were also below the EPA criteria of 8 µg/m^3 for all years with exception to 2019, but higher than the proposed NEPM goal of 7 µg/m^3 proposed for 2025 onward for 2018 and 2020.
- Maximum 1-hour concentrations for CO were well below the EPA criteria of 30,000 µg/m^3 for all years.

Based on a review of the monitoring data below background data for 2018 has been adopted for the assessment year. The year 2018 was chosen for the following reasons:

- The year corresponds to the chosen modelled meteorological year making it suitable for contemporaneous assessment of cumulative impacts.
- The years 2019 and 2020 are generally affected by the black summer bushfires and background concentrations are not considered representative of typical background concentrations. Both 2020 and 2021 data sets are also affected by COVID-19 and typically show lower annual average pollutant concentrations due to reduced vehicle emissions.
- Annual average dust concentrations in 2022 are significantly lower than other years and may be attributed to soil moisture conditions due to three consecutive years of higher-than-average annual rainfall and La Nina conditions. Therefore the 2018 data set is considered more conservative.

Table 9 Existing Air Quality at Randwick and Roselle (1 January 2018 to 31 December 2022) (DPE 2023)

Pollutant	Averaging Period	Concentration (µg/m^3)					Criterion (µg/m^3)
		2018	2019	2020	2021	2022	
Nitrogen dioxide (NO_2)	Maximum 1-hour	74.5	95.2	70.4	54.2	60.0	164
	Annual Average	12.6	12.3	9.3	9.6	11.9	31
Particulate matter (PM_{10})	Maximum 24-hour	93.1	128.1	135.9	37.3	37.3	50
	Annual Average	21.2	24.0	19.5	16.3	14.6	25
Particulate matter ($PM_{2.5}$)	Maximum 24-hour	31.9	95.8	111.9	31.8	13.9	25
	Annual Average	7.6	11.0	7.6	6.4	4.9	8
Carbon monoxide (CO)	Maximum 1-hour	1152	5928	3761	1705	1712	30,000

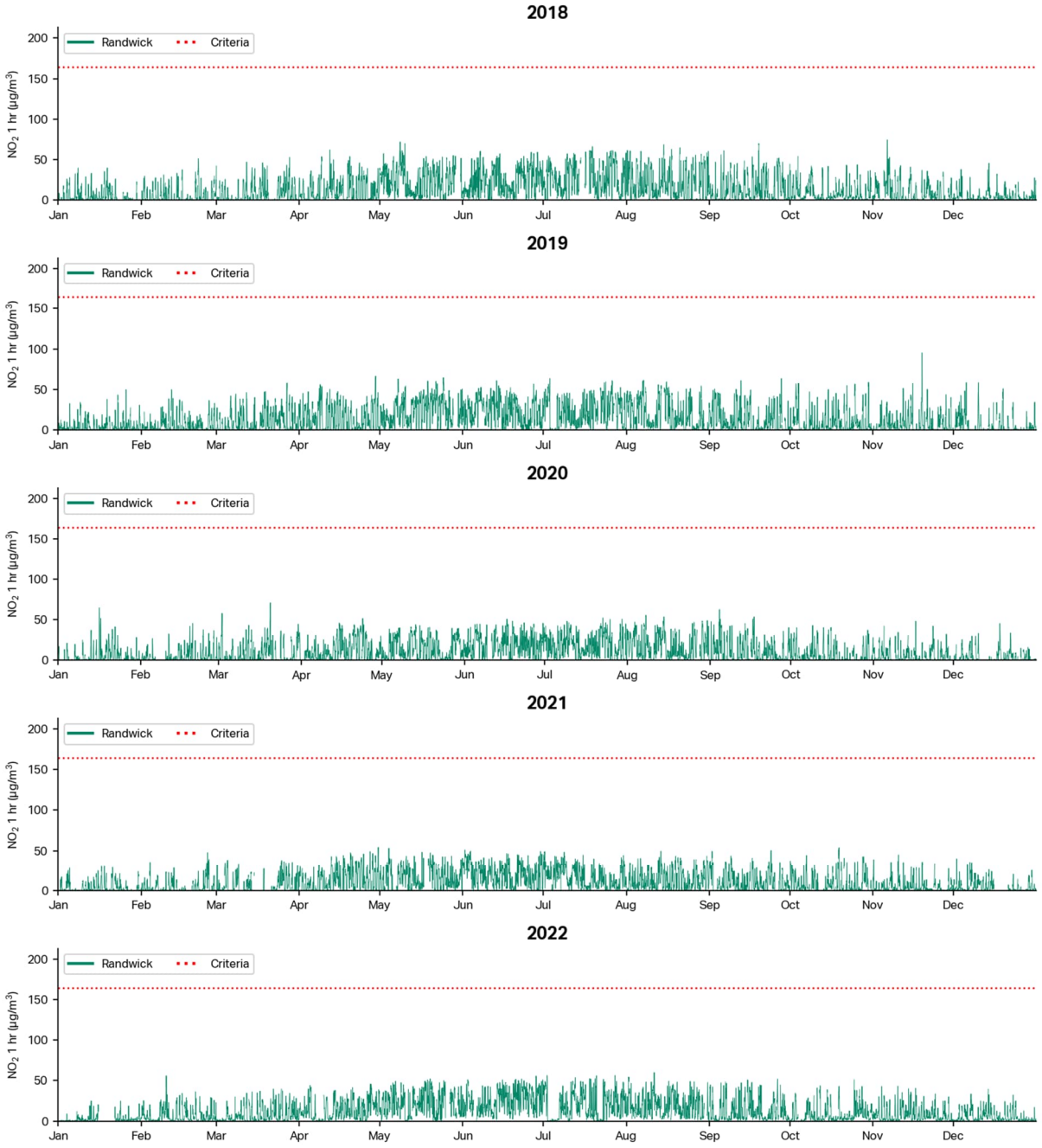


Figure 10 1-Hour NO_2 concentrations at Randwick EPA monitoring station between 2018 and 2022

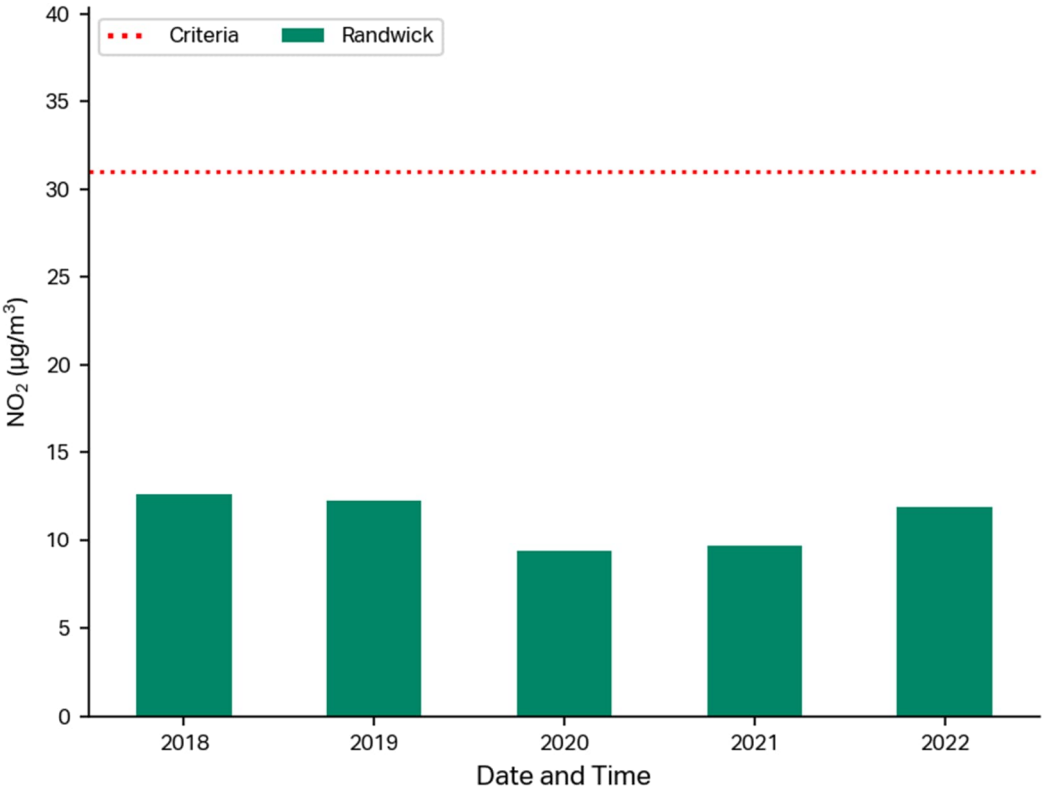


Figure 11 Annual average NO_2 concentrations at Randwick EPA monitoring station between 2018 and 2022.

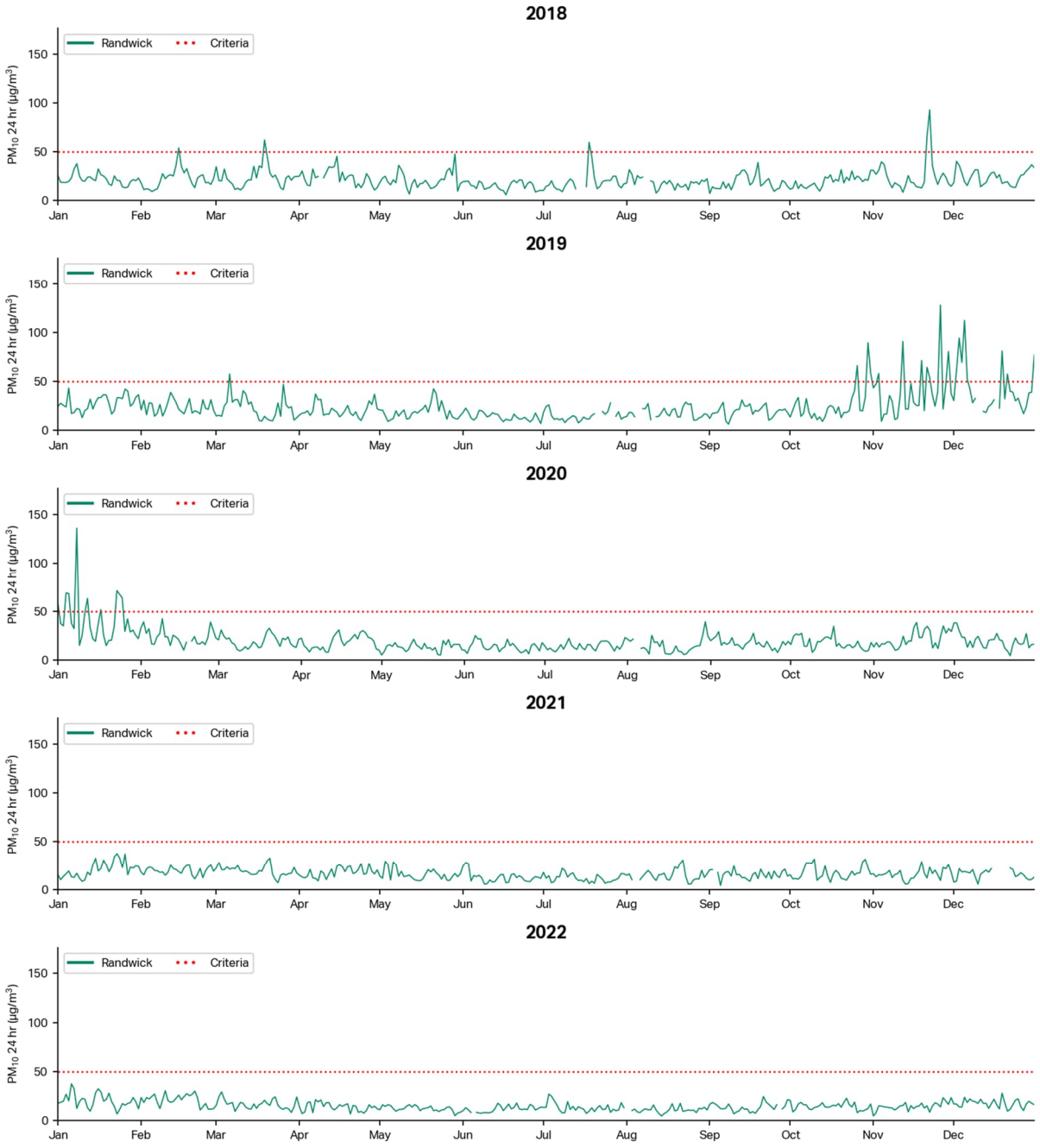


Figure 12 24 hour PM_{10} concentrations at Randwick EPA monitoring station between 2018 and 2022.

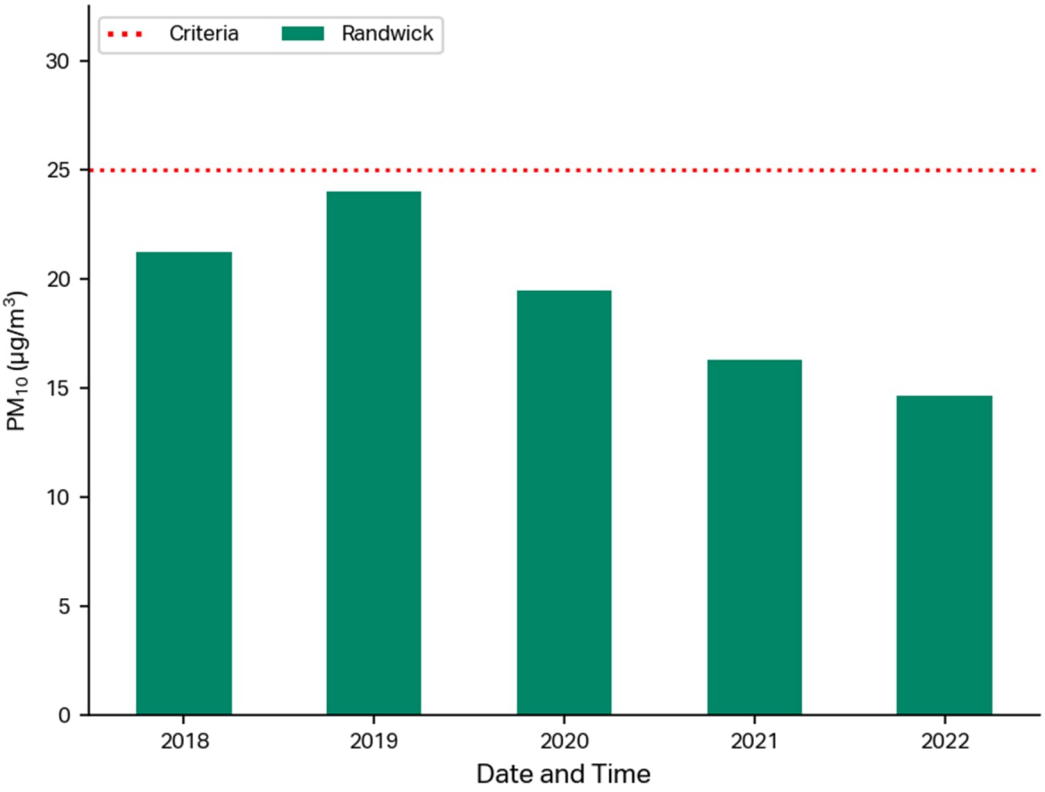


Figure 13 Annual average PM_{10} concentrations at Randwick EPA monitoring station between 2018 and 2022.

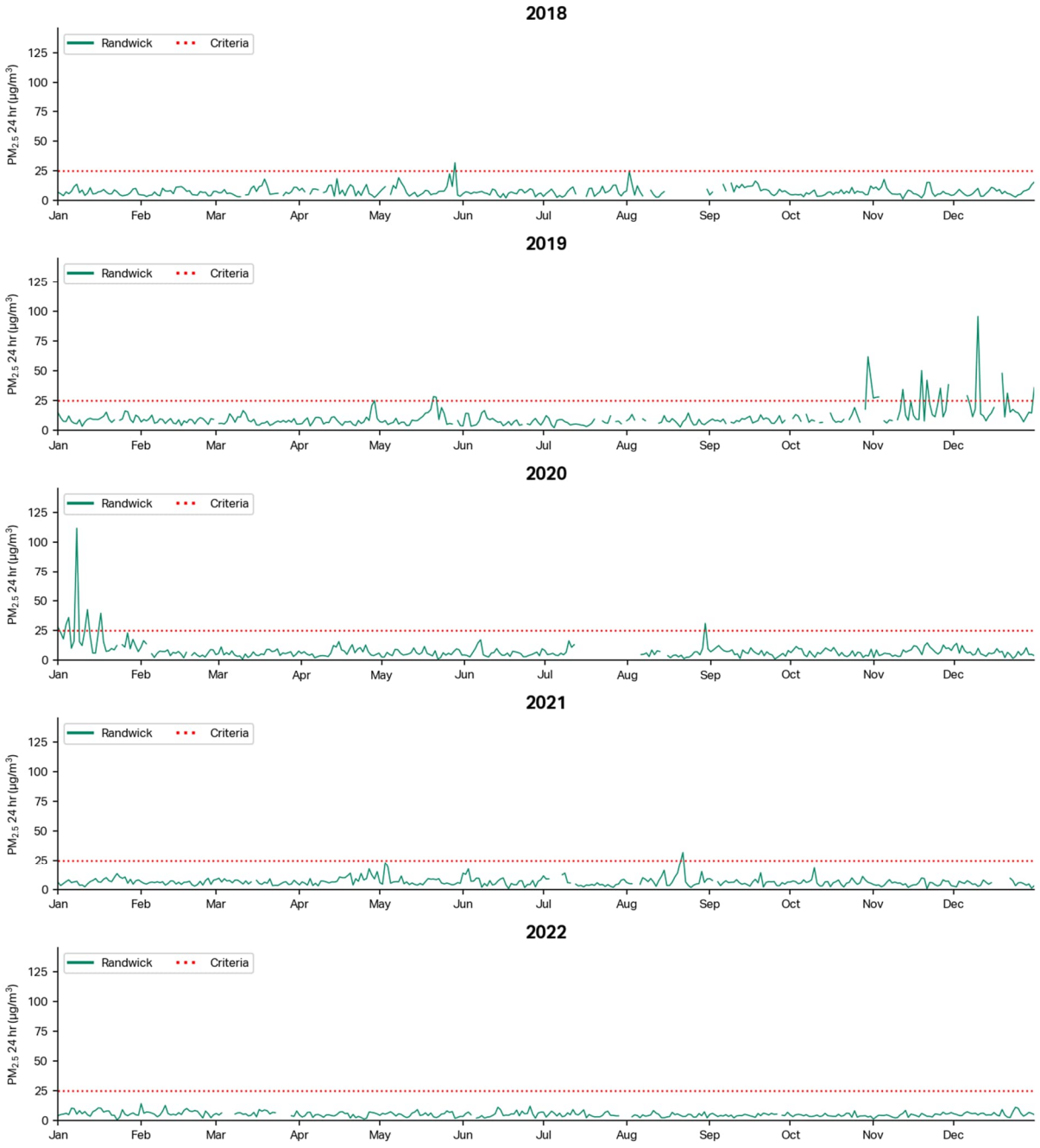


Figure 14 24 hour $PM_{2.5}$ concentrations at Randwick EPA monitoring station between 2018 and 2022.

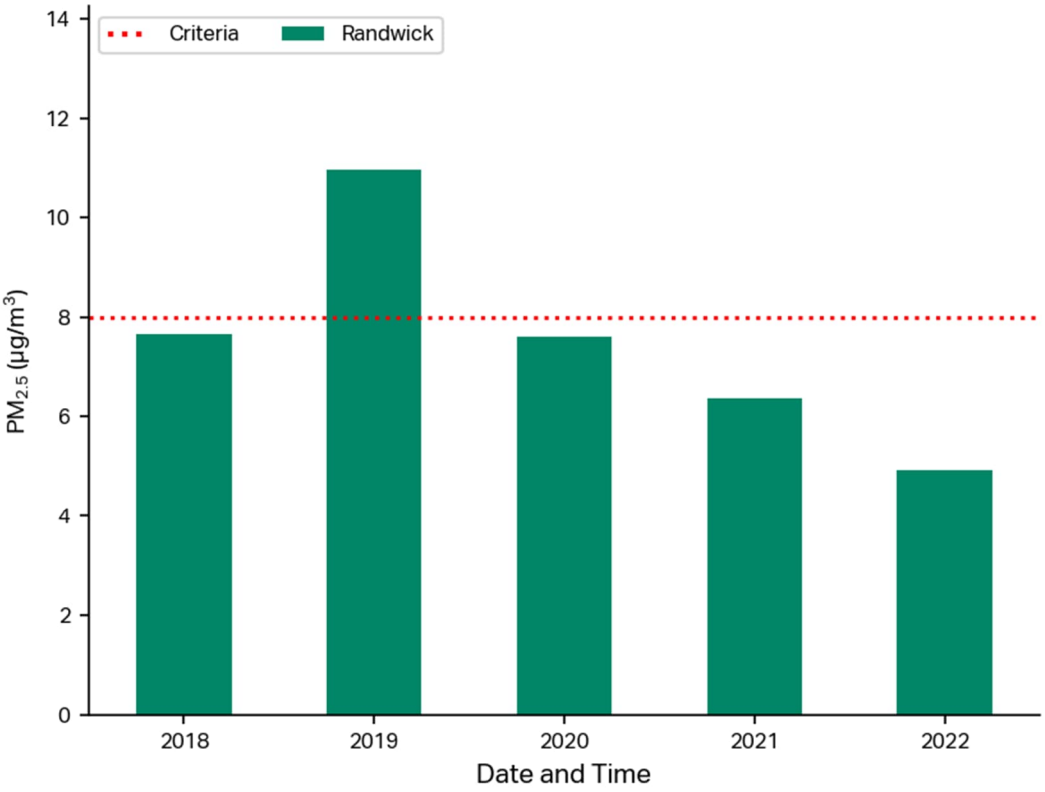


Figure 15 Annual average $PM_{2.5}$ concentrations at Randwick EPA monitoring station between 2018 and 2022.

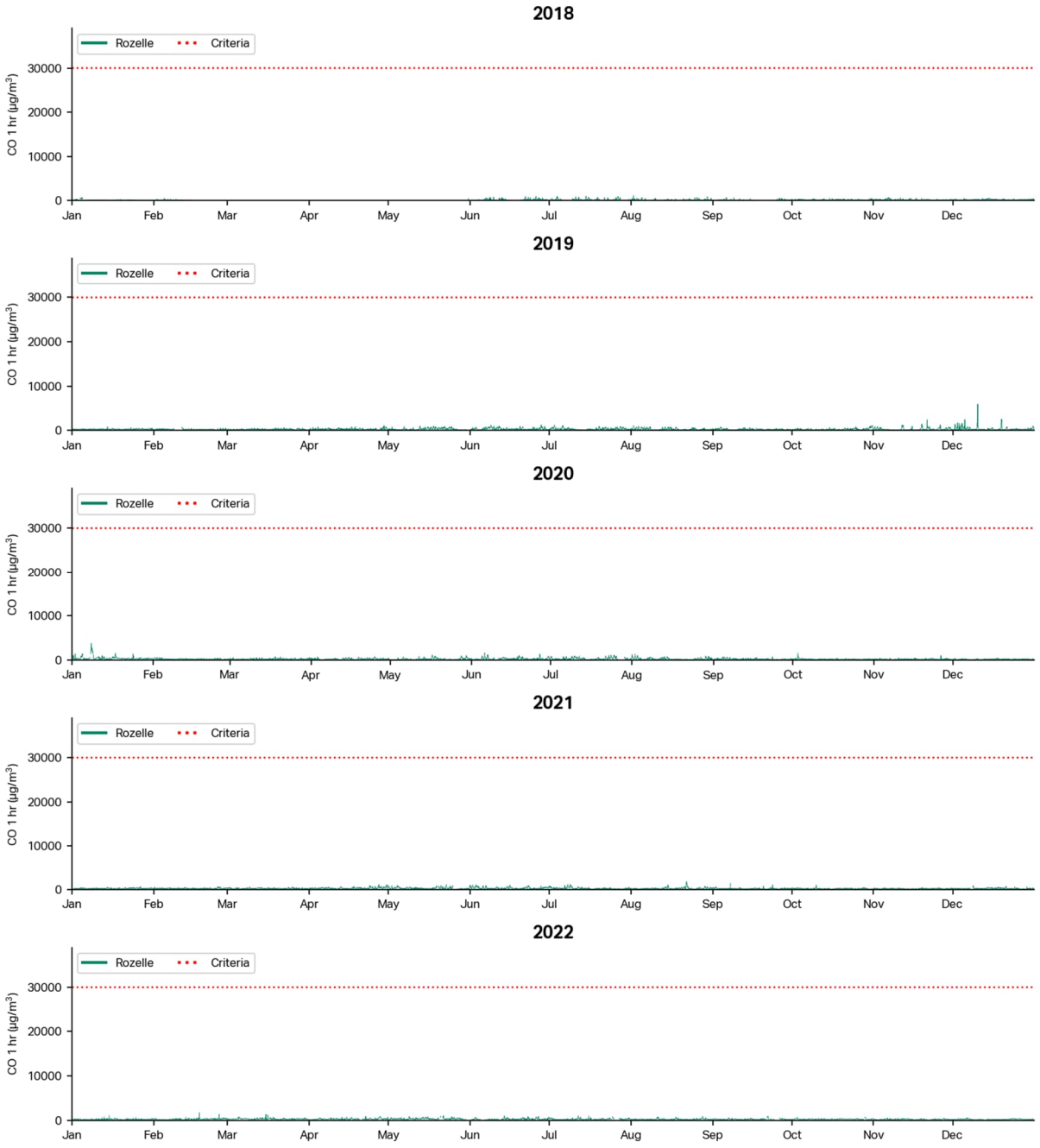


Figure 16 1 hour CO concentrations at Randwick EPA monitoring station between 2018 and 2022.

5.3.4 Landfill Gas Monitoring Data

Currently Consulting Earth Sciences (CES) undertake landfill gas monitoring quarterly at the Breen Resources landfill site collected from boreholes at the western end of the Landfill site (i.e. furthest away from Lot 2 South). The subsurface gas monitoring is required under Condition P1.1 of Breen Resources Environmental Protection Licence (No. 4608) (EPL). Three years of publicly available landfill gas quarterly monitoring data for methane undertaken by CES between July 2020 and October 2023 is summarised in Table 10**.** The data suggests that methane levels are currently below the assessment criterion (no data available for CO_2).

Table 10 Kurnell Landfill Sub Surface Gas Monitoring (CES 2020, CES 2021, CES 2022, CES 2023)

EPA ID	Well ID	MGA 56 Coordinates (m)		Initial CH_4 Well Concentration (%)			
				Initial		After Purging	
		Easting	Northing	Minimum	Maximum	Minimum	Maximum
Point 20	BH4A	331555	6233531	<0.1	0.4	<0.1	0.3
Point 22	BH8B	No Data	No Data	<0.1	0.4	<0.1	0.3
Point 23	BH12A	331166	6233700	<0.1	0.3	<0.1	0.3
Point 24	BH13A	331447	6233663	<0.1	0.3	<0.1	0.1
Point 25	BH18	330761	6233399	<0.1	0.5	<0.1	0.3
CH_4 Assessment Criterion (%)				**1.0**			

The Master Plan shows that proposed buildings within the Town Precinct (the closest precinct to the Breen Resources site) have a separation distance of 100-144m from the site boundary, with open space proposed between buildings within the Town Precinct and the western boundary of the Site which is adjacent to Breen Resources.

Landfill gas monitoring and an associated landfill gas risk assessment has not been undertaken as part of the revised AQIA. It is noted that under Section 10.2 of the EPA Environmental Guidelines (EPA 2016) development (unless open development such as a park) within 250m of existing or former landfill activities would need to comply with landfill gas criteria over a consecutive 24-month period to ensure that landfill gas has stabilised.

As discussed in the AQIA 2020, landfill gas monitoring may be required to demonstrate that the proposed 100-144m separation distance is adequate. The proposed staging plan for the Master Plan would likely allow sufficient time to undertake landfill gas monitoring prior to submission of a development application for the Town Precinct development stage. Timely initiation of landfill gas monitoring may be key to the approval of the Town Precinct.

Breen Resources is also required to undertake additional landfill gas monitoring as part of their proposed development and as such additional data for assessment may be available later prior to development of the Town Centre Precinct.

Recommendations for landfill gas monitoring are discussed in Section 8.0.

6.0 Assessment Methodology

6.1 Overview

The Air Quality Impact Assessment has been broken up in to two components used to inform the Kurnell Planning Proposal. The first component in Section 6.2.1 relates to the quantitative impact assessment of key potential air quality impacts using dispersion modelling. The second component relates to minor air quality impacts which are assessed qualitatively as described in Section 6.3

The assessment methodology has been developed address the following agency and department requirements:

- NSW EPA Referral Response letter (DOC23/418068-3) emailed to DPE on 18 August 2023 relating to the review of the Kurnell Peninsula Scoping Proposal
- DPE feedback and advice on the Kurnell Scoping Proposal on 10 August 2023 in the document titled *Pre-lodgement stage – Department of Planning and Environment Comments to Sutherland Shire Council*.
- Sutherland Shire Council, Environmental Science Unit (ESU) Internal Memorandum dated 6th June 2023 a referral response to the Besmaw Kurnell Scoping Proposal.

The assessment methodology should also be read in conjunction with Section 6.0 of the AQIA 2020 report (AECOM 2020) original DPE key matters for consideration. A copy of all agency and department comments is provided in refer to Appendix B.

6.2 Quantitative Assessment

A quantitative assessment was undertaken to assess the potential reverse amenity impacts due to the Breen Proposal and vehicle emissions from Captain Cook Drive on the Proposal site. The quantitative assessment was undertaken generally in accordance with the NSW EPA Approved Methods using the air dispersion model GRAL. The modelling methodology adopted for the study is discussed below.

6.2.1 Model Selection

Pollution dispersion for future developments is typically assessed using estimated pollutant emissions rates coupled with local environmental conditions and planned changes to the built environment. Characteristics of the emissions sources and the changes to the local environment need to be clearly understood to ensure that the dispersion model being used is suitable for the task. For the Breen development, complexity introduced by buildings, coastal topography and vegetation, neighbouring developments, and project-specific features have the potential to give rise to complex microscale air flows as wind pass through and around the future development.

Of the information required for an air quality impact assessment, the data that most influences the selection of a dispersion model is meteorology, with significant changes to the topography and built environment likely to result in changes to the flow of air and hence pollution dispersion. A dispersion model capable of assessing how the Breen development may affect microscale air flow and pollution dispersion in the near field is needed.

The common dispersion models used for complex modelling scenarios (AERMOD and CALPUFF) do not generally perform well within 100 m of a pollutant source, in highly complex terrain or around buildings or other barriers and therefore an alternative model is needed. The GRAL / GRAMM modelling suite can resolve wind flows for complex environments at a fine-scale resolution (down to 2m resolution). The Planning Proposal would likely result in changes to complex microscale air flows from changes to local topography and built form; making GRAL suitable to assess potential air quality impacts at the site.

GRAL is a Lagrangian Particle model developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria specifically to assess the dispersion of pollutants from roadways and tunnel portals (Oettl et al., 2002; Oettl et al., 2003; Oettl et al., 2005). GRAL has been extensively evaluated against experimental data from five different tunnel portals both in flat and complex terrain, with high and low traffic volumes, namely the Enrei, Hitachi and Ninomiya tunnels in

Japan (Oettl et al., 2003), and the Enrentalerbergtunnel in Austria (Oettl et al., 2002). GRAL has also been compared to other models (ADMS, LASAT, MUMO).

GRAL has been used for the assessment of surface road impact assessments and industrial development assessments in Australia since 2015 and has been accepted for use by NSW EPA through the NSW Chief Scientist, who has prepared a document outlining a study into the acceptability of GRAL for use in Australian conditions.

Given its suitability for this development and the acceptance of the GRAL model by NSW regulatory authorities, the GRAL model has been adopted for this assessment.

6.2.2 Model Scenarios

A total of five modelling scenarios were examined to assess the reverse amenity impacts from the adjoining Breen proposal and the impacts from vehicle emissions along Captain Cook Drive Modelling scenarios are summarised in Table 11 below with additional details provided in the emissions inventory section (Section 6.2.8).

Table 11 Modelled Scenarios

Scenario ID	Scenario Name	Description
Scenario 1a	Without proposal Opening year	• Captain Cook Drive assuming 2029 traffic volumes (which assumes no additional traffic generating developments) and the existing two-lane road configuration. • Breen Proposed Lot 5 landfill activities revised NRRF approved and operational (dust emissions).
Scenario 1b	Without proposal 10 years after opening	• Captain Cook Drive assuming 2039 traffic volumes (which assumes no additional traffic generating development) and existing two-lane configuration. • Breen Proposed Lot 5 landfill activities revised NRRF approved and operational (dust emissions).
Scenario 2a	With proposal Opening year	• Captain Cook Drive assuming 2029 traffic volumes (which assumes additional traffic generating development) and a proposed four-lane road configuration. • Breen Proposed Lot 5 landfill activities revised NRRF approved and operational (dust emissions).
Scenario 2b	With proposal 10 years after opening	• Captain Cook Drive assuming 2039 traffic volumes (which assumes additional traffic generating development) and proposed four-lane road configuration. • Breen Proposed Lot 5 landfill activities revised NRRF approved and operational (dust emissions).
Scenario 3	Breen Odour Impact	• Breen Proposed Lot 5 landfill activities revised NRRF approved and operational (odour emissions only).

6.2.3 GRAL/GRAMM Modelling Inputs

The GRAL / GRAMM model requires a range of data inputs that need to be defined prior to running the model. These data can be broadly separated into the following categories:

- Meteorological data.
- Terrain data.
- Land use data.
- Building data.
- Source data.

- Receptor locations.

A flow chart outlining the dispersion modelling process adopted for this assessment, including input and output data is presented in Figure 17. The dispersion modelling inputs used in this assessment have been described below. Dispersion model results have been discussed in Section 7.0

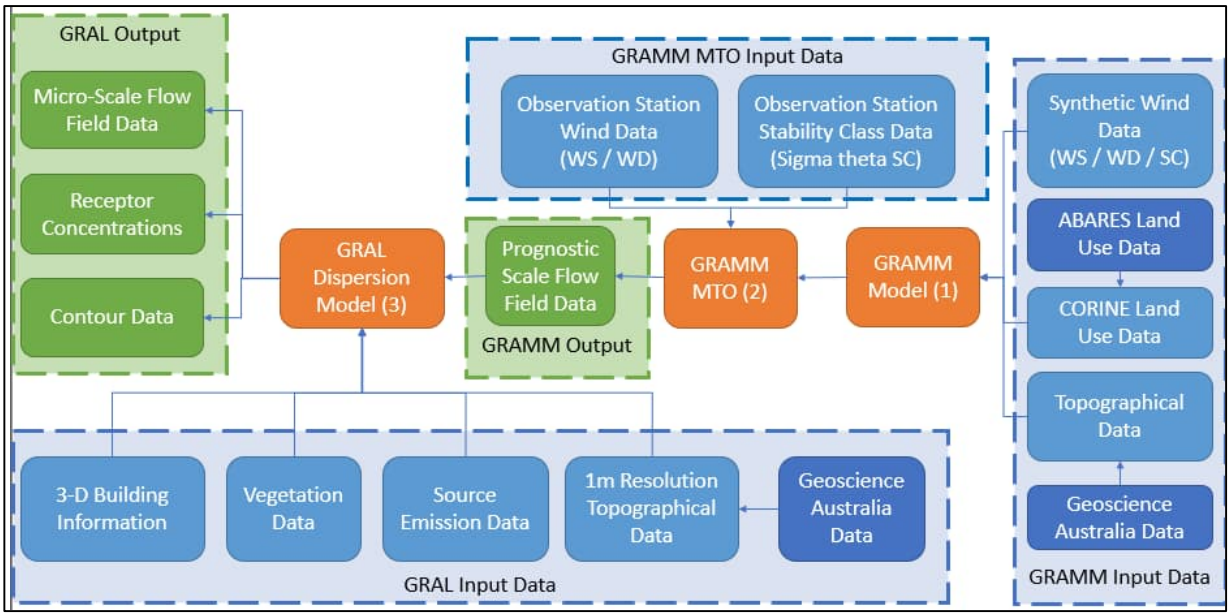


Figure 17 Modelling overview flow chart

6.2.4 Dispersion Meteorology

Dispersion meteorology refers to the data used by a dispersion model to dictate the direction of travel and degree of dispersion for a pollutant emitted from a source. Meteorological data for dispersion modelling builds upon the regional meteorology discussed above and converts the meteorological data into a form useful to GRAL. The analysis of the meteorological data also considers how representative the dispersion modelling meteorology is of the local conditions.

Meteorological data from the BoM Kurnell, Little Bay and Sydney Airport stations for 2018 was used along with detailed topographical information and land use data to produce a refined GRAMM meteorological data file for use in GRAL dispersion modelling. Justification for selection of the modelled year is provided in Appendix C and detailed GRAMM and GRAL settings have been provided in Section 6.2.10 and Section 6.2.11 respectively. A synthetic meteorology dataset was initially used to provide raw meteorological flow fields (3-dimensional field of wind conditions) for the Match to Observation (MTO) algorithm which in turn used Kurnell observational data to produce a refined meteorological data set.

The meteorological data produced by the MTO process was evaluated through an analysis of wind roses generated at the at the Kurnell, Little Bay, and Sydney Airport BoM monitoring station locations.

Analysis of the GRAMM and observed monitoring data show that the dispersion meteorology produced by GRAMM provides a good representation of the wind conditions expected at Kurnell and that the GRAMM data is acceptable for use in the assessment. Further analysis of the meteorological data is provided **in** Appendix C.

6.2.5 Terrain Data

Terrain data has been extracted for both the GRAMM and the GRAL meteorological data development from NSW Government Spatial Services Digital Elevations Models (DEMs) database. For the GRAMM domain a 1 m DEM data were used to create a 250m resolution wind field over the GRAMM domain. For GRAL, 1m DEM data were used by the GRAL model to provide high resolution wind fields of 2m within the modelling domain. Terrain data from the NSW Government Spatial Services DEMs database was modified for the Planning Proposal site to account for changes in existing terrain elevations. A 5m resolution DEM was provided by Urbis Pty Ltd and integrated into the land use data for use in GRAL.

The terrain data used by the GRAMM model to develop the regional wind fields; and higher resolution GRAL data are displayed in **Figure 18.** The figure also displays the proposed buildings from the Kurnell Masterplan and the proposed Breen facility and model domains for context.

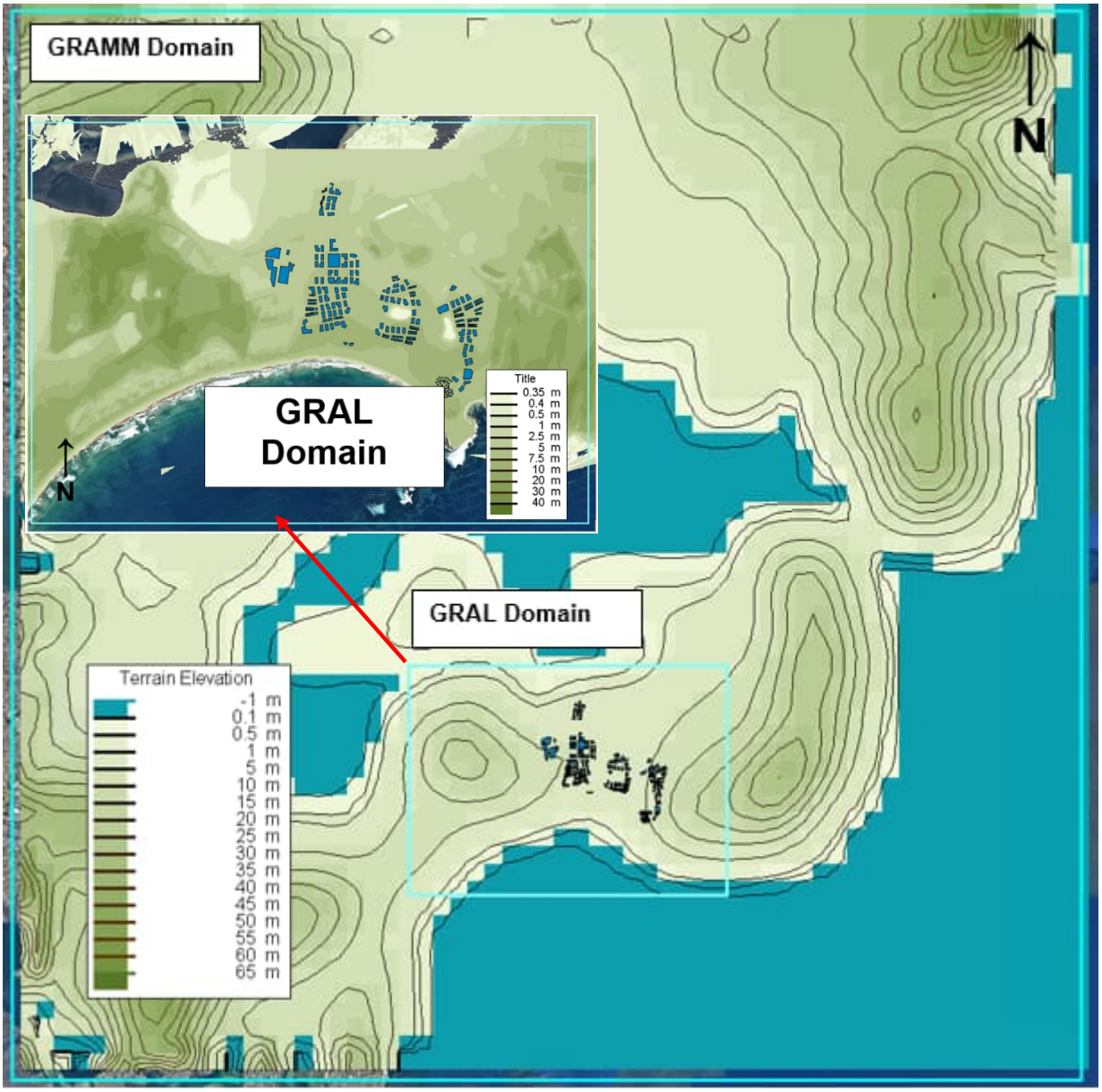


Figure 18 Terrain data used for GRAMM and GRAL

6.2.6 Land Use Data

Changes in land use can affect how air moves across the earth's surface with factors such as surface roughness, soil moisture, albedo (measure of the diffuse reflection of solar radiation), and heat conductivity all influencing wind speed and direction over the modelling domain.

The GRAMM model uses the CORINE land use scheme which outlines land uses according to 44 different categories. A more detailed description of the land use scheme used by GRAMM, the land use codes and the effects of the different settings is provided in the GRAMM documentation.

Data for use in the modelling was extracted using GIS techniques from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) "Catchment Scale Land Use of Australia", December 2018 version. Cross checks with recent satellite imagery showed a good match with the ABARES data across the modelling domains and surrounding areas.

6.2.7 Building Data

Accurate building data are critical to understanding the flow of air around the proposed buildings on the site and on the adjacent Breen development. Buildings need to be considered as part the air quality assessment to ensure the effect of the buildings on wind flow fields are appropriately considered. GRAL accepts building heights, ground elevation, building vertices, and roof area. Building data for the site Master Plan was supplied by Group GSA Pty Ltd. Both building data and vegetative screening for the revised proposed Breen NRRF plans by Triaxial Consulting in 2022 as part of the Response to Submissions for the Breen Proposal. The locations of buildings used in GRAL are presented graphically in Figure 18.

6.2.8 Emissions Inventory

Estimated air and odour emissions for the Breen facility and traffic emissions for Captain Cook Drive both with and without the Kurnell Planning Proposal are discussed in Section 6.2.8.1 and Section 6.2.8.2 respectively.

6.2.8.1 Breen Facility

Both dust and odour emissions from the site have been modelled from the Breen Proposal to assess the potential impacts on air and odour at the Kurnell Planning Proposal site.

Estimated dust emissions from both the Lot 5, B11 landfill activities and the NRRF have been sourced from the SoundIn (2022) *Breen Resources - Responses to Submissions Related to Air Quality* letter dated 17 November 2022 based on the revised NRRF facility. Emission factors for material handling were modified to reflect the annual average wind speed recorded at the BoM station at Kurnell as discussed in Section 5.1. All other values have been reproduced from the SoundIn 2022 letter.

The existing Breen resource facility is licenced to operate for 24 hours and proposed operating hours for the NRRF would also be 24 hours. As such dust emissions for PM_{10} and $PM_{2.5}$ have been modelled as continuous sources. Emission rates for all modelled sources are provided in Table 12. Haul roads have been modelled as line sources and all other sources have been modelled as volume sources. Dust emissions from Soil Recycling, Concrete Recycling and Light Waste Recycling Buildings have been modelled as multiple volume sources and entry/exit point roller doors for each of the buildings as per the revised NRRF site plans (Triaxial Consulting 2022).

Table 12 Dust emissions for resource recovers and landfilling activities at the Breen Facility

Activity	Sub Activity	Emissions (kg/h)		Source Type	No. Sources Modelled
		PM_{10}	$PM_{2.5}$		
Haul Roads	NRRF (Paved)	0.2052	0.0496	Line	2
	Landfill (Unpaved)	0.0051	0.0005	Line	1
Soil Recycling	Material Handling	0.0015	0.0002	Volume	7
	Processing	0.0188	0.0018	Volume	
	Wind Erosion	0.0080	0.0012	Volume	
Concrete Recycling	Material Handling	0.0008	0.0001	Volume	5
	Processing	0.0094	0.0009	Volume	
	Wind Erosion	0.0080	0.0012	Volume	
Light Waste Recycling	Material Handling	0.0011	0.0002	Volume	5
	Processing	0.0015	0.0002	Volume	
	Wind Erosion	0.0020	0.0003	Volume	
Landfill	Material handling	0.0027	0.0004	Volume	1
	Wind Erosion	0.0200	0.0030	Volume	

Odour emissions from landfill activities have been based on emissions reported in the Breen Resources AQIA (Wilkinson Murray 2021). Table 13 provides specific odour emission rates (SOER) sources of

odour emissions during landfilling activities including the active tipping area, daily cover, intermediate cover, and leachate ponds.

All odour emissions have been modelled as volume sources (classified as area sources in GRAL). The active daily tipping area was assumed to be covered at the end of each day with a 'daily cover' of approximately 150mm of virgin excavated material or approved daily cover material. Application of the daily cover to the active tipping face reduced the odour emissions from the active tipping area outside operational hours. Operational hours for the landfill are between 6am and 4pm on weekdays and 6:30am to 1:30pm on Saturdays. Odour emissions for the active tipping area were conservatively assumed to occur between 6am and 4pm every day and reduced daily cover emissions were assigned to this source between 4pm and 6am every day. Odour from intermediate cover and leachate ponds were modelled as a continuous source.

Table 13 Odour emissions for landfilling activities at the Breen Facility

Activity	SOER (OU.$m^3/m^2/s$)	Source Area (m^2)	Op Hrs per Year
Active tipping area	0.7	800	3650
Daily cover	0.4	800	5110
Intermediate cover	0.1	10000	8760
leachate ponds	0.2	8780	8760
Note: SOER stands for Specific Odour Emission Rate and is defined as is defined as the quantity of odour emitted per unit surface area per unit time (units: ou.$m^3/s/m^2$)			

6.2.8.2 External Traffic Emissions

Average annual daily traffic (AADT) and morning and afternoon peak vehicle numbers for Captain Cook Drive near Lindum Road have been provided by SCT Consulting based on values used within the Traffic Assessment (SCT Consulting 2023) for the Planning Proposal. Traffic numbers are provided in Table 14 and include forecast numbers with and without the planning proposal for the opening year 2029 (defined as the year of the proposed road widening of Captain Cook Drive from 2 to four lanes) and ten years after opening in 2039. Existing traffic numbers for 2023 have not been modelled for the assessment as the first stage of the development (and associated sensitive receptors) is not expected to be completed until 2029.

The following assumptions were made for forecast traffic numbers for Captain Cook Drive ((SCT Consulting 2023):

- The proportion of heavy vehicles has been maintained for forecast projections based on survey data collected in 2018.
- Opening year traffic forecasts (2029):
  - Adopts compound annual growth rates from previous modelling undertaken for the site.
  - Assumes only Stage 1A and Stage 2B (partial) of the Planning Proposal is operational as per Kurnell development program (refer to Section 2.3).
- Ten years after opening year traffic forecasts (2039):
  - Adopts compound annual growth rates from previous modelling undertaken for the site.
  - Assumes project delivery for Planning Proposal is fully completed and fully operational. This is a conservative estimate as project delivery is expected to include completion of Stage 3B, with partial delivery of Stage 4 and 5A and 5B has not commenced construction.

-

Table 14 Forecast vehicle numbers with and without the project for 2029 and 2039 (SRT Consulting 2023)

Modelled Scenario	Scenario Description	Modelled year	Speed limit (km/h)	Direction	Vehicle numbers			
					Daily Average	AM Peak Hour	PM Peak Hour	%HV
Scenario 1a	Without proposal Opening year	2029	80	Eastbound	6,215	470	355	5%
		2039	80	Westbound	5,745	380	520	1%
Scenario 1b	Without proposal 10 years after opening	2029	80	Eastbound	6,370	475	365	5%
		2039	80	Westbound	5,890	385	535	1%
Scenario 2a	With proposal Opening year	2029	80	Eastbound	7,540	525	565	5%
		2039	80	Westbound	7,035	570	590	1%
Scenario 2b	With proposal 10 years after opening	2029	80	Eastbound	16,790	865	1,945	5%
		2039	80	Westbound	15,665	1,680	1,085	1%

Projected AADT and morning and afternoon peak vehicle numbers for all modelled scenarios in Table 14 have been extrapolated using TfNSW Traffic Volume Viewer weekday 24 hour traffic profiles from Kingsway (Station ID 9824-PR) between 31 October 2022 and 31 October 2023. The Kingsway station is located 10m south of Sylvania Road, Miranda. Extrapolated 24-hour profiles are presented graphically in Figure 19 and Figure 20.

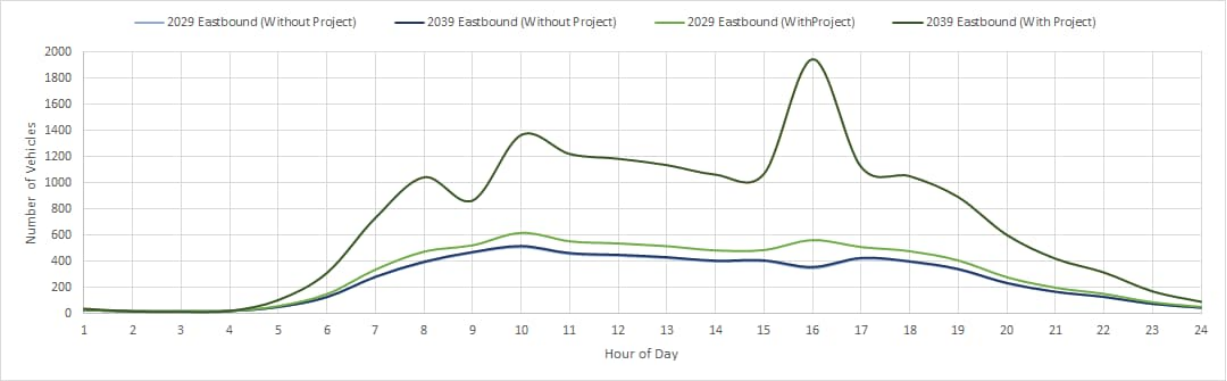


Figure 19 Extrapolated 24-hour traffic profiles for eastbound traffic

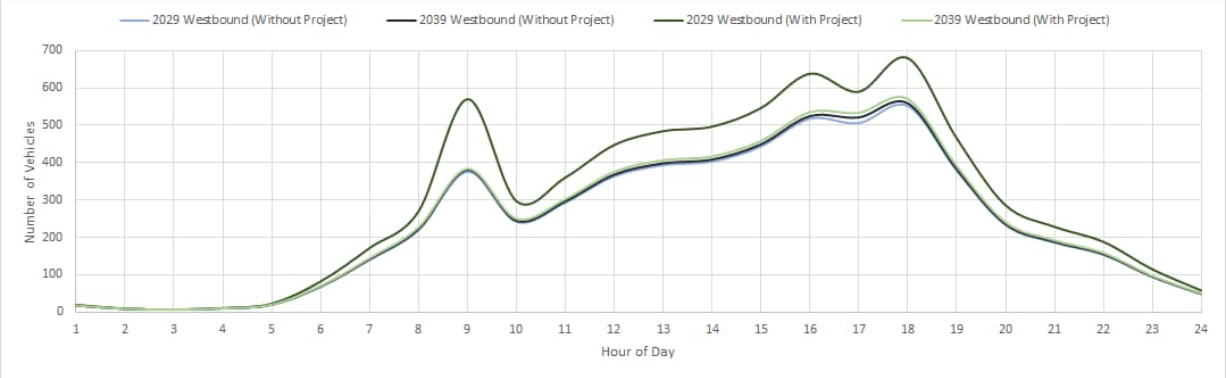


Figure 20 Extrapolated 24-hour traffic profiles for westbound traffic

Hot running base emission factors were obtained from the NSW Air Emissions Inventory (AEI) database for each pollutant as a starting point for calculating individual vehicle combustion emission rates. Base emission factors from the AEI are varied according to a range of parameters such as year of assessment, vehicle class, fuel and road type as follows:

- future years generally have lower emission rates due to the expectation of more stringent emissions regulations. Emissions have been conservatively modelled assuming emission factors from 2026 assigned to the 2029 modelled scenarios and 2036 emission factors assigned to 2039 modelled scenarios.
- vehicle class influences pollutant emissions through the characterisation of the fleet into groups defined by size, shape, mass, engine and fuel types. The effect of different vehicle classes on emissions are that smaller vehicles e.g., passenger cars, have lower emission factors and different pollutant mix than a larger vehicle class such as light commercial vehicles or heavy vehicle.
- different fuel types affect the mix of pollutants being emitted by a vehicle. As an example, diesel vehicles often have higher NO_X and particulate emission rates as compared with petrol vehicles, which can emit higher levels of VOC. Emission factors are specific for the fuel type of each vehicle class.
- road type effects the driving behaviours for different road types in NSW. Vehicles are generally most efficient when travelling on non-congested roads at a speed allowing the vehicles to operate at higher, more fuel-efficient gear ratios. Conversely, vehicles are least efficient when travelling on congested roads at low speeds. The AEI includes a methodology for correcting emission factors for speed relative to the road type base speed.

Cold start emissions were not considered for this project given the focus of the assessment on roadway operations where vehicles are assumed to be at operating temperature before entering Captain Cook Drive.

Evaporative emissions from vehicles were not considered given they are largely controlled by vehicle emissions control systems rendering the emissions insignificant in comparison to combustion emissions.

Greater uptake of alternate fuelled vehicles, in particular electric vehicles, will reduce the NSW vehicle fleet emissions into the future. The extent of this change is difficult to quantify given the variability in vehicle uptake therefore AEI does not include hybrid or electric vehicles. As internal combustion engine vehicles produce much higher pollutant emission rates than hybrid or electric vehicle emissions (due to fuel combustion) emission rate data omitting hybrid or electric vehicle uptake used to the modelled impacts would be conservative for the future years 2029 and 2039.

The NSW AEI does not include a methodology for calculating road grade effects on emissions, i.e., travelling up or down hill. Generally, travelling up hill will increase emissions whilst travelling downhill will decrease emissions. This increase and decrease with positive and negative grade are non-linear i.e., the increased emissions travelling up a hill are not the same as the reduction in emissions when the car is travelling down the hill with the same grade. While the road grade for Captain Cook Drive is mostly flat within the study area, grade correction factors were considered vital and where appropriate adopted from Permanent International Association of Road Congresses, (commonly known as the World Road Association) (PIARC) (2019) emissions factors and applied to the AEI hot running emission factors.

Non-exhaust emission data for PM_{10} and $PM_{2.5}$ were sourced from the NSW AEI and are added to the final hot running emission factor emission rates. As with tailpipe emission factors, non-exhaust emission factors are specific to vehicle class, fuel type and road type.

Finally, traffic volumes are combined with the vehicle emission factors. Individual vehicle class emission rates are multiplied by the fraction of the hourly traffic volume corresponding to that vehicle class for each hour of the day. All vehicle class emission rates for each road link were combined to determine the total emissions for each road link for each hour of the day. This data is combined to create a 24-hour emissions profile which is reflective of variable traffic flows influenced by peak, inter-peak and off-peak periods. A flowchart showing how the emission factor variables are combined in the emissions calculation process is presented below in Figure 6-21.

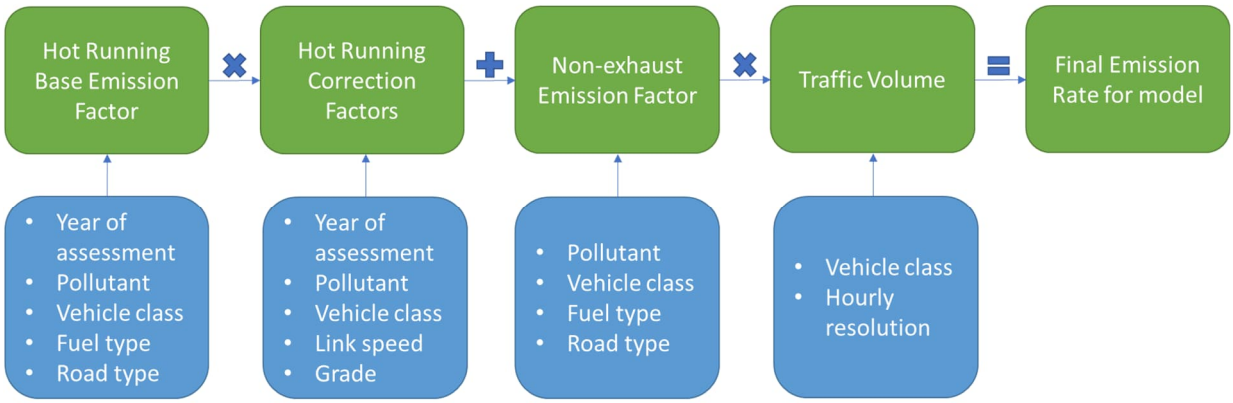


Figure 6-21 Vehicle emission calculation flowchart

6.2.9 Receptor Locations

A total of 17 discrete receptors were selected to assess the potential air quality impacts from the proposed development. Receptors are described in Table 15 and shown in Figure 22 and have been selected to represent potential worst case amenity impacts based on their proximity to both the western boundary adjoining the Breen Facility and immediately to the north and south of Captain Cook Drive.

Table 15 Location of Modelled Discrete Receptors

ID	Land use	Precinct	X (m)	Y (m)	Z (m)
1	Residential	Town Centre North	332591	6233454	2
2	Senior living	Town Centre North	332593	6233383	2
3	Senior living	Town Centre North	332591	6233323	2
4	Senior living	Town Centre North	332591	6233191	2
5	Senior living	Town Centre South	332541	6233125	2
6	Townhouse	Town Centre South	332548	6233062	2
7	Townhouse	Town Centre South	332535	6233023	2
8	Townhouse	Town Centre South	332531	6232993	2
9	Townhouse	Town Centre South	332520	6232956	2
10	Townhouse	Town Centre South	332494	6232840	2
11	Townhouse	Town Centre South	332481	6232771	2
12	Tourism	Town Centre South	332610	6233489	2
13	Tourism	Town Centre South	332660	6233491	2
14	School	Town Centre North	332740	6233536	2
15	Residential receptor	Town Centre North	332845	6233422	2
16	Residential receptor	Quibray Bay	332651	6233711	2
17	Residential receptor	Quibray Bay	332742	6233700	2

Figure 22 Location of discrete receptors

6.2.10 GRAMM Settings

GRAMM settings were selected based on available data, professional judgement and the settings outlined in the guidance document *Recommendations when using the GRAL / GRAMM modelling system* (Government of Styria, 2017). Settings for the GRAMM modelling run are presented in Table 16.

Table 16 GRAMM modelling domain parameters

Parameter	Value
Version	September 2022
Meteorological grid domain	15.5km x 15,5km
Horizontal grid resolution	250m
Reference grid coordinate (origin)	324500m, 6228500m (SW corner)
Vertical thickness of first layer	10m
Number of vertical layers	15
Vertical stretching factor	1.3
Relative layer height	1683m (Layer 15)

Parameter	Value
Surface meteorology coordinates	BoM Kurnell (334796 m 6235969 m)
	BoM Little Bay (338367 m 6238360 m)
	BoM Sydney Airport (331173 m 6242272 m)
Simulation length	1 Year (2018)
Number of synthetic wind speed categories	27
Synthetic wind speed categories	0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0, 16.0, 17.0, 18.0, 19.0m/s
Number of meteorological conditions[1]	1123
Maximum time step	10 seconds
Modelling time	3600 seconds
[1] Number of meteorological conditions reflects the number of individual wind conditions in the simulation period, i.e.: individual wind condition can occur multiple times within an 8760 hour timeseries, with statistics calculated from the 8760 hour timeseries of receptor concentrations.	

6.2.11 GRAL Settings

GRAL settings were selected based on available data and the settings outlined in the guidance document *Recommendations when using the GRAL / GRAMM modelling system* (Government of Styria, 2020). Settings for the GRAL modelling run are presented in Table 17.

Table 17 GRAL model settings

Parameter	Value
Version	22.03 Released September 2022
Flow field grid domain	1.15 km x 0.83 km
Lower left co-ordinate (UTM56S)	330250, 6231176
Model mode	Standard
Horizontal grid resolution	2.0 m
Vertical thickness of first layer	2.0 m
Number of vertical layers	40
Vertical stretching factor	1.0
Particles per second	300
Surface roughness	0.2 m
Roughness of building walls	0.01 m

6.2.12 NOx Conversion Methodology

Nitrogen oxides are produced in motor vehicle engines using fossil fuels and are formed during the oxidation of nitrogen when fuel is combusted. In this high-temperature environment, a variety of oxides are formed, including nitric oxide (NO) and nitrogen dioxide (NO_2).

One of the challenges of modelling NOx emissions is how to determine the amount of NO_2 at a receptor given that NO reacts (oxidises) in the atmosphere to form NO_2. Ozone is usually the chemical that is responsible for most of the oxidation, but other reactive atmospheric gases can also oxidise NO. GRAL assumes that the pollutants are inert, neutrally buoyant gases i.e., the model does not account for any

chemical transformations or dense gas effects. As such, the transformation of NOx to NO_2 needs to be done in the post-processing stage.

This assessment utilised the Ozone limiting methodology (OLM) from the Approved Methods for conversion of NOx to NO_2. This method uses both modelled NOx and background monitored Ozone to calculate NO_2 for each hour of the modelling predictions.

6.3 Qualitative Assessment

A qualitative assessment was undertaken to assess the potential air quality impacts from the internal traffic network within the Planning Proposal Site. Reverse amenity impacts were also assessed for nearby air emission sources including the Ampol Fuel terminal, aircraft movements from Sydney Airport and emissions from the cogeneration plant at Cronulla Water Resource Recovery Facility (WRRF). Odour amenity impacts were also qualitatively assessed from the WRRF, Ampol Fuel Terminal and onsite mangroves.

6.3.1 Internal Traffic Emissions

A review of the proposed setback distances for each Precinct and proposed building heights within the Master Plan has been undertaken to determine the potential for urban canyon effects on vehicle emissions from estimated aspect ratios. The potential for urban canyon effects was estimated using the proposed road reserve widths and setback distances in Table 18, and the aspect ratio classifications provided in Table 19.

Table 18 Proposed Road Reserve Width and Building Setback Distances

Precinct	Distance (m)		
	Road Reserve	Building Setback	Total
Residential Boulevard	23.2	6.0 (3.0m either side)	29.3
Residential Street	18.0	6.0 (3.0m either side)	24.0
High Street	16.6	6.0 (3.0m either side)	22.6
Main Street	30.0	6.0 (3.0m either side)	36.0

Table 19 also provides recommendations for the application of green infrastructure (GI). The strategic placement of GI such as open areas and vegetated areas as part of street scaping would need to be considered as part of the development. Placement of GI can be considered to manage roadside pollutant concentrations at the local scale. However, introduction of GI can either promote or disrupt the dispersion of air pollution by either exerting additional mechanical turbulence or decreasing turbulent kinetic energy. Within urban canyons trees have the potential to reduce wind speeds and reduce air exchange between the air above rooftops and within the canyon leading to the accumulation of pollutants inside the street canyon. For street canyons, the aspect ratio is critical to the appropriate GI form.

Table 19 Determination of Appropriate Green Infrastructure for Street Canyons Based on Aspect Ratio

Classification	Aspect Ratio	GI Recommendation
Deep Street Canyon	H/W ≥ 2	• Green walls only
Mid-Depth Street Canyon	H/W 0.5-2	• Green walls • Low-level vegetation (shrubs and low hedges)
Shallow Street Canyon	H/W ≥ 0.5	• Green walls • Low-level vegetation (shrubs and low hedges) • Small and open-crowned trees on the windward side of the canyon spaced broadly apart.
Source: Barwise & Kumar 2020		

A qualitative assessment of potential air quality impacts from vehicle emissions due to the potential to form urban canyons is provided in Section 7.3. Opportunities for street scaping without negatively impacting the dispersal of vehicle emissions due to the proposed wide road reserves is also discussed further in Section 8.0.

6.3.2 Cronulla Water Resource Recovery Facility

Assessment of potential amenity odour impacts on the Kurnell Planning Proposal site was undertaken in the AQIA 2020 report for the WRRF operated by Sydney Water. A review of the findings of the qualitative assessment provided in the AQIA 2020 report is provided in Section 7.4. Additionally, a review of annual NO_2 stack concertation monitoring data associated with the cogeneration plant operational at Cronulla WRRF since 2020 has been conducted.

The qualitative assessment of potential air quality and odour amenity impacts on the Kurnell Planning Proposal site from the Cronulla WRRF is provided in Section 6.3.2.

6.3.3 Ampol Fuel Terminal

A qualitative assessment of reverse amenity impacts from the Kurnell Ampol Fuel Terminal on the Kurnell Planning Proposal site was undertaken in the AQIA 2020 report in relation to both VOC fugitive emissions and odour emissions. A review of the findings of the qualitative assessment provided in the AQIA 2020 is provided in Section 7.5 together a qualitative assessment of additional VOC and odour studies conducted for the site by the NSW EPA in 2022 and The Odour Unit (TOU) Pty Ltd in 2023.

6.3.4 Mangroves

Sutherland Shire Council under Item 56 of the *Internal Memorandum dated 6th June 2023 a referral response to the Besmaw Kurnell Scoping Proposal* requests the consideration of potential odour impacts from mangroves and swamps. Specifically, land uses on site, in particular Lot 2 North must be situated so that any adverse impacts from exposure to odours are minimised; and consider the range of land use activities on site, population exposure and potential sensitive receptors.

To address the potential odour impacts from the site a qualitative impact assessment of potential odour impacts from mangroves on proposed future receptors is discussed in Section 7.6. The qualitative impact assessment reviews the proximity of sensitive receptors to existing mangroves on the site. Land use categories: closest to the existing mangroves are also examined to assess their potential sensitivity. In addition to this seasonal variation in odour emissions from mangroves; and local meteorological conditions that may increase potential for odour impacts at sensitive receptors are also discussed.

6.3.5 Sydney Airport

Sutherland Shire Council under Item 57 of the *Internal Memorandum dated 6th June 2023 a referral response to the Besmaw Kurnell Scoping Proposal* requests the consideration of air quality impacts from aircraft emissions. Specifically, Sutherland Shire Council require assessment of potential adverse air quality impacts from ongoing cumulative exposure from aircraft to be addressed due to the high number of aircraft movements, flying at low altitudes from Sydney Airport.

While the Kurnell Planning Proposal is sighted directly under the southern flight paths and obstacle limitation surface (OLS) for Sydney Airport; sufficient atmospheric mixing and dispersal of air emissions from aircraft is likely to occur at height above the site and ground level concentrations at the site from Sydney Airport are unlikely to be discernible from existing background concentrations. As such a qualitative assessment of air quality impacts from this source has been undertaken in Section 7.7.

To assess potential air quality impacts from Sydney Airport a review of DPE monitoring station pollutant data at Roselle and Randwick have been evaluated. Both stations are also situated under or close to Sydney Airport flight paths and OLS in Section 7.7. Compliance with ambient air quality criteria; and similarities to existing regional background concentrations at these stations infers that sensitive receptors under the direct flight path are unlikely to experience significant air quality impacts from aircraft movements.

7.0 Impact Assessment

7.1 Overview

The following sections provide an assessment of both predicted air quality impacts from the Proposal and potential existing and future amenity impacts on the Kurnell Planning Proposal. The assessment methodology of these impacts is described in Section 6.0 and can be grouped into both quantitative and qualitatively assessed impacts as follows:

A quantitative air quality assessment using the dispersion model GRAL was undertaken for:

- Reverse amenity impacts relating to dust and odour from proposed Landfill activities and operation of the proposed Resource Recycling Facility operated by Breen.
- Potential amenity impacts from Traffic Emissions along Captain Cook Drive

A qualitative assessment of:

- Amenity impacts associated with development near mangroves.
- Amenity impacts associated with potential for urban canyons within proposed internal road network.
- Reverse amenity impacts from aircraft emissions under Sydney Airport flight path.
- Reverse amenity impacts from odour and nitrous oxide emissions from operation of Cronulla Sewage Treatment Plant
- Reverse amenity impacts from air and odour emissions from the Kurnell Ampol Fuel Terminal

7.2 Modelling Results (Breen and Captain Cook Drive)

7.2.1 Air Quality

Table 20 provides a summary of the predicted incremental and cumulative air pollutant concentrations at the worst affected sensitive receptors for modelled Scenarios 1 to 4. All cumulative concentrations have been assessed contemporaneously using 2018 background data as reported in Section 5.3.2. A summary of the results is as follows:

- For NO_2:
  - Predicted maximum 1-hour and annual average cumulative impacts for all modelled scenarios were below the EPA criteria for all modelled scenarios at all receptors.
  - Maximum 1-hour contributions were higher for the with project scenarios due to higher volume of traffic but still well below the criteria when background concentrations are considered. Annual average incremental contributions for all scenarios are relatively small; with predicted concentrations of less than 1 µg/m^3.
  - A slight reduction in predicted maximum 1-hour and annual average concentrations is observed for the without project scenarios between 2029 and 2039. This is attributed to a reduction in emission rates, due to a higher proportion of the vehicle fleet in 2039 adhering to more stringent standards. For the with project scenarios this trend is obscured due to the increase in vehicle numbers between 2029 and 2039 with only partial completion of the Planning Proposal assumed for the 2029 scenario.
  - Concentration contours for 1-hour maximum and annual average NO_x concentrations for the with and without project scenarios are shown in Figure 23 and Figure 24 for 2039. The contours show that while the proposal would result in an increase in roadside NO_x emissions along Captain Cook Drive; predicted incremental NO_x concentrations are within 150 to 200 to the north 100 to 150 µg/m^3 to the south of Captain Cook Drive at the nearest receptors.
- For PM_{10}:

  - The predicted cumulative maximum 24-hour concentration exceeds the EPA criteria of 50µg/m^3 for all modelled scenarios. This is attributed to elevated background concentrations and is discussed further below.
  - The predicted cumulative annual average concentrations were below the EPA criteria of 20µg/m^3 for all modelled scenarios.
  - Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} concentrations (compared to vehicle emissions) at the worst affected sensitive receptor.
  - Incremental concentration contours for 24-hour maximum and annual average PM_{10} concentrations for the with and without project scenarios for 2039 are shown in Figure 25 and Figure 26. The contours show that the incremental contributions from Breen and Captain Cook Drive are below the EPA criteria.

- For $PM_{2.5}$:
  - The predicted cumulative maximum 24-hour concentration exceeds the EPA criteria of 25µg/m^3 for all modelled scenarios. This is attributed to elevated background concentrations and is discussed further below.
  - The predicted cumulative annual average concentrations of 7.1µg/m^3 were below the EPA criteria of 8µg/m^3 but slightly above the 2025 proposed NEPM goal of 7µg/m^3 for all modelled scenarios.
  - Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} concentrations (compared to vehicle emissions) at the worst affected sensitive receptor.
  - Incremental concentration contours for 24-hour maximum and annual average $PM_{2.5}$ concentrations for the with and without project scenarios for 2039 are shown in Figure 27 and Figure 28. The contours show that the incremental contributions from Breen and Captain Cook Drive are below the EPA criteria.

- For CO:
  - Both maximum 1-hour incremental and cumulative concentrations for all modelled scenarios were well below the EPA criteria.
  - Similar to the trend observed for NO_2 the without project scenarios show a reduction in predicted CO concentrations which is reflective of fleet changes due to higher uptake of vehicles with more stringent emission standards between 2029 and 2039. For the with project scenarios, this trend is obscured due to the increase in vehicle numbers between 2029 and 2039 with only partial completion of the Planning Proposal assumed for the 2029 scenario.

Table 20 Summary of predicted pollutant concentrations at worst affected sensitive receptors

Incremental Impacts						
Pollutant	Averaging Period	Concentration (µg/m³)				EPA Criteria (µg/m³)
		Without Project		With Project		
		2029	2039	2029	2039	
NO_2	Maximum 1-hour	48.7	30.5	62.6	67.3	164
	Annual average	0.5	0.3	0.5	0.7	31
PM_{10}	Maximum 1-hour	9.2	9.1	9.2	10.2	50
	Annual average	0.8	0.8	0.8	0.8	25
$PM_{2.5}$	Maximum 1-hour	3.3	3.3	3.3	3.4	25 (20)
	Annual average	0.2	0.2	0.2	0.2	8 (7)
CO	Maximum 1-hour	90.0	59.2	97.1	142.9	30,000
Cumulative Impacts						
Pollutant	Averaging Period	Concentration (µg/m³)				EPA Criteria (µg/m³)
		Without Project		With Project		
		2029	2039	2029	2039	
NO_2	Maximum 1-hour	75.1	74.9	75.5	75.9	164
	Annual average	12.3	12.1	12.3	12.5	31
PM_{10}	Maximum 1-hour	**94.5**	**94.5**	**94.5**	**94.5**	50
	Annual average	21.7	21.7	21.7	21.7	25
$PM_{2.5}$	Maximum 1-hour	**31.0**	**31.0**	**31.0**	**31.0**	25 (20)
	Annual average	7.1	7.1	7.1	7.1	8 (7)
CO	Maximum 1-hour	1153.0	1152.7	1153.1	1153.3	30,000

In accordance with the Approved Methods (EPA 2022) where predicted cumulative concentration exceeds the relevant criteria additional analysis must be provided to understand the contribution from a proposal in comparison to the background concentrations. As such further analysis of predicted maximum 24 hour PM_{10} and $PM_{2.5}$ concentrations for the 2039 with and without project scenarios.

Table 21 provides the predicted cumulative PM_{10} and $PM_{2.5}$ concentrations for 2036 modelled scenarios ranked by background. The table shows that at the worst affected receptor there are six exceedances of the maximum 24-hour PM_{10} criteria of 50 µg/m³ and two exceedances of the $PM_{2.5}$ µg/m³ criteria of 25. In all cases the background PM_{10} and $PM_{2.5}$ concentrations are significantly higher than the incremental contributions. There is only one additional exceedance predicted as a result of the proposal for PM_{10} predicted; where the incremental contribution for the with project in 0.2 µg/m³ higher than the without scenario. In this case the background contribution is also approaching the criteria at 47.8 µg/m³. Similarly there is one additional exceedance of the $PM_{2.5}$ criteria as a result of the proposal, where the background is approaching the criteria.

Table 21 Contemporaneous PM_{10} and $PM_{2.5}$ impact and background - days with highest background

Date	PM_{10} 24-hour average (µg/m^3)					
	Without Project 2039			With Project 2039		
	Background	Increment	Total	Background	Increment	Total
22/11/2018	**93.1**	2.5	**95.5**	**93.1**	2.5	**95.6**
21/11/2018	**65.9**	1.7	**67.6**	**65.9**	1.8	**67.7**
19/03/2018	**62.3**	1.1	**63.4**	**62.3**	1.3	**63.5**
18/07/2018	**59.8**	4.4	**64.2**	**59.8**	4.5	**64.4**
15/02/2018	**54.0**	0.1	**54.2**	**54.0**	0.3	**54.3**
29/05/2018	47.8	2.5	**50.4**	47.8	2.7	**50.5**
Date	**PM_{10} 24-hour average (µg/m^3)**					
	Without Project 2039			**With Project 2039**		
	Background	**Increment**	**Total**	**Background**	**Increment**	**Total**
29/05/2018	**30.6**	0.9	**31.5**	**30.6**	1.0	**31.6**
02/08/2018	24.8	1.2	**26.0**	24.8	1.3	**26.1**

Similarly, in Table 22 predicted exceedances of the 24 hour cumulative concentration for PM_{10} and $PM_{2.5}$ for the 2036 scenario ranked by incremental contribution (inclusive of Breen's proposed operations). The results show that at the worst affected receptor the highest 24 hour incremental contribution is 4.5µg/m^3 and 1.3 µg/m^3 for PM_{10} and $PM_{2.5}$ for the 'with project' scenario respectively. This is relatively low when compared to the background contributions and the incremental contribution for the project is only o.1 µg/m^3 higher than the without scenario for both PM_{10} and $PM_{2.5}$.

Table 22 Contemporaneous PM_{10} and $PM_{2.5}$ impact and background - days with highest incremental contribution

Date	PM_{10} 24-hour average (µg/m^3)					
	Without Project 2039			With Project 2039		
	Incremental	Background	Total	Incremental	Background	Total
18/07/2018	4.4	**59.8**	**64.2**	4.5	**59.8**	**64.4**
29/05/2018	2.5	47.8	**50.4**	2.7	47.8	**50.5**
22/11/2018	2.5	**93.1**	**95.5**	2.5	**93.1**	**95.6**
21/11/2018	1.7	**65.9**	**67.6**	1.8	**65.9**	**67.7**
19/03/2018	1.1	**62.3**	**63.4**	1.3	**62.3**	**63.5**
15/02/2018	0.1	**54.0**	**54.2**	0.3	**54.0**	**54.3**
Date	**PM_{10} 24-hour average (µg/m^3)**					
	Without Project 2039			**With Project 2039**		
	Incremental	**Background**	**Total**	**Incremental**	**Background**	**Total**
02/08/2018	1.2	24.8	**26.0**	1.3	24.8	**26.1**
29/05/2018	0.9	**30.6**	**31.5**	1.0	**30.6**	**31.6**

In summary the predicted pollutant contributions from the adjacent Breen Proposal and from vehicle emissions from Captain Cook Drive the proposal is unlikely to result in significant air quality impacts to proposed sensitive receptors from the Planning Proposal. While there are some exceedances of predicted cumulative concentrations for PM_{10} and $PM_{2.5}$ these are largely attributed to high background concentrations within the 2018 background air quality dataset used to conduct the contemporaneous

assessment. Based on the current Master Plan buffer distances between the Breen Facility and Captain Cook Drive are considered adequate. Additional planning and design considerations to further mitigate against potential air quality impacts are discussed in Section 8.3.

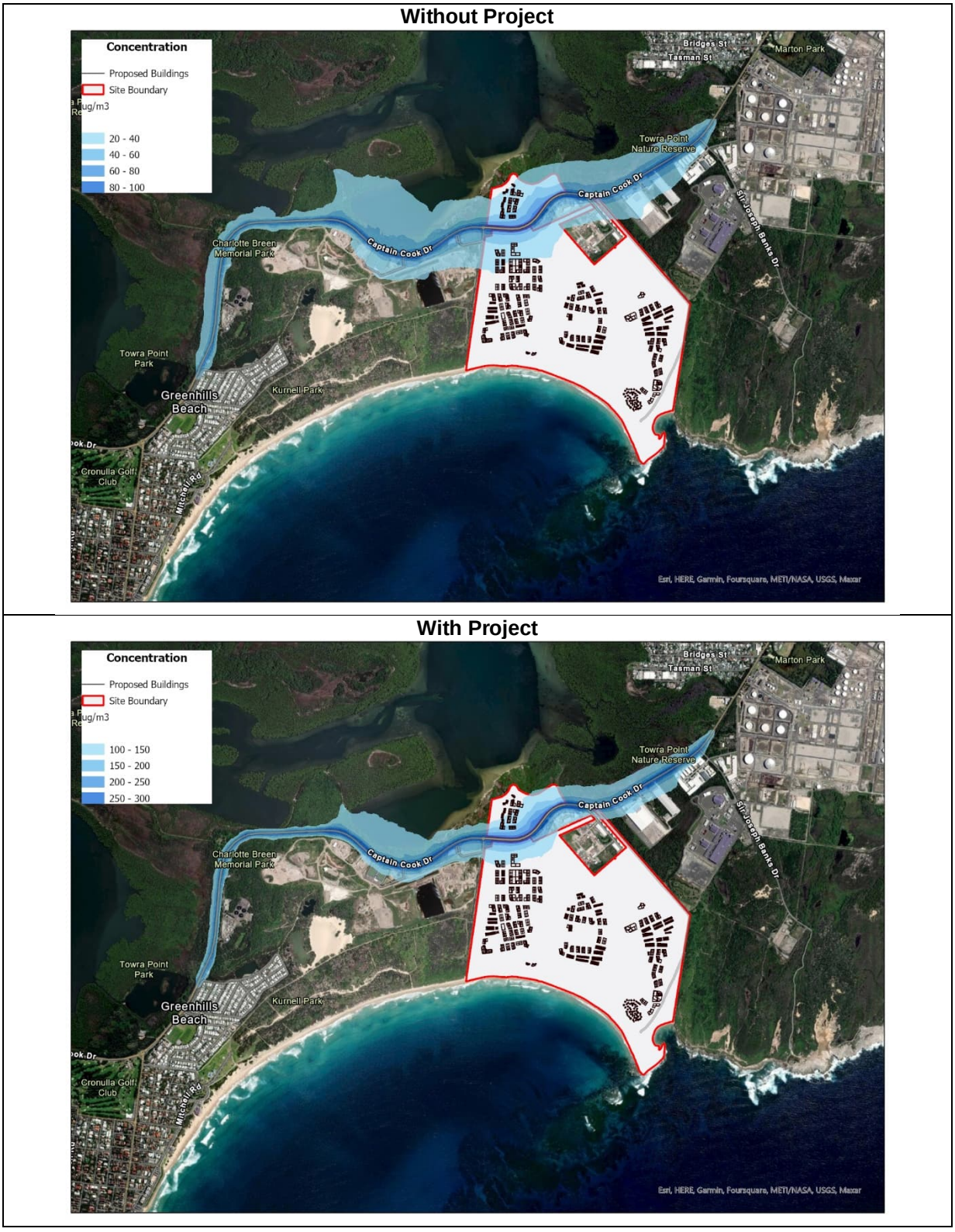
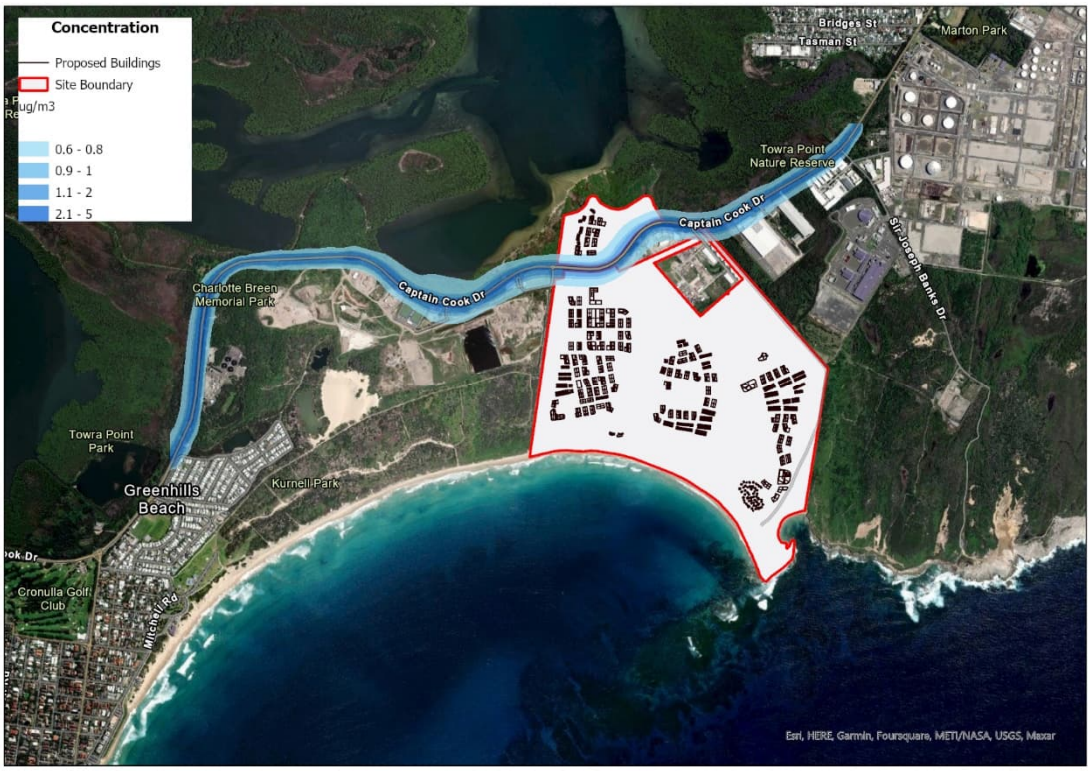


Figure 23 Predicted 1-hour Maximum NO_X contours for with and without project 2036 scenarios.

Without Project



With Project

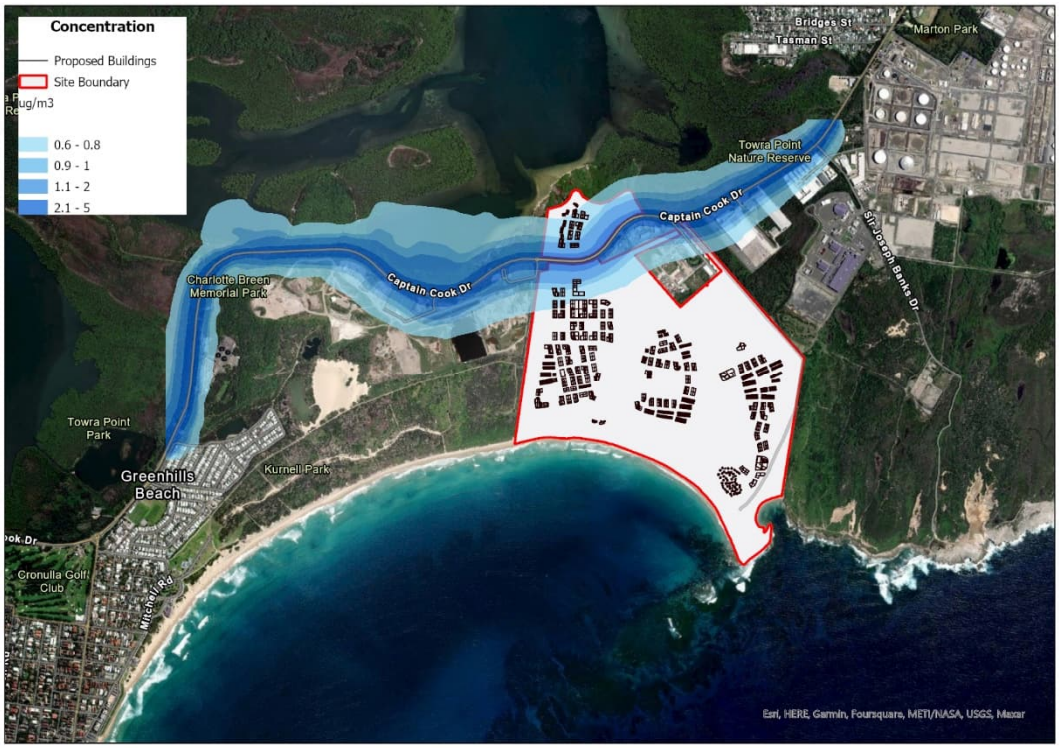
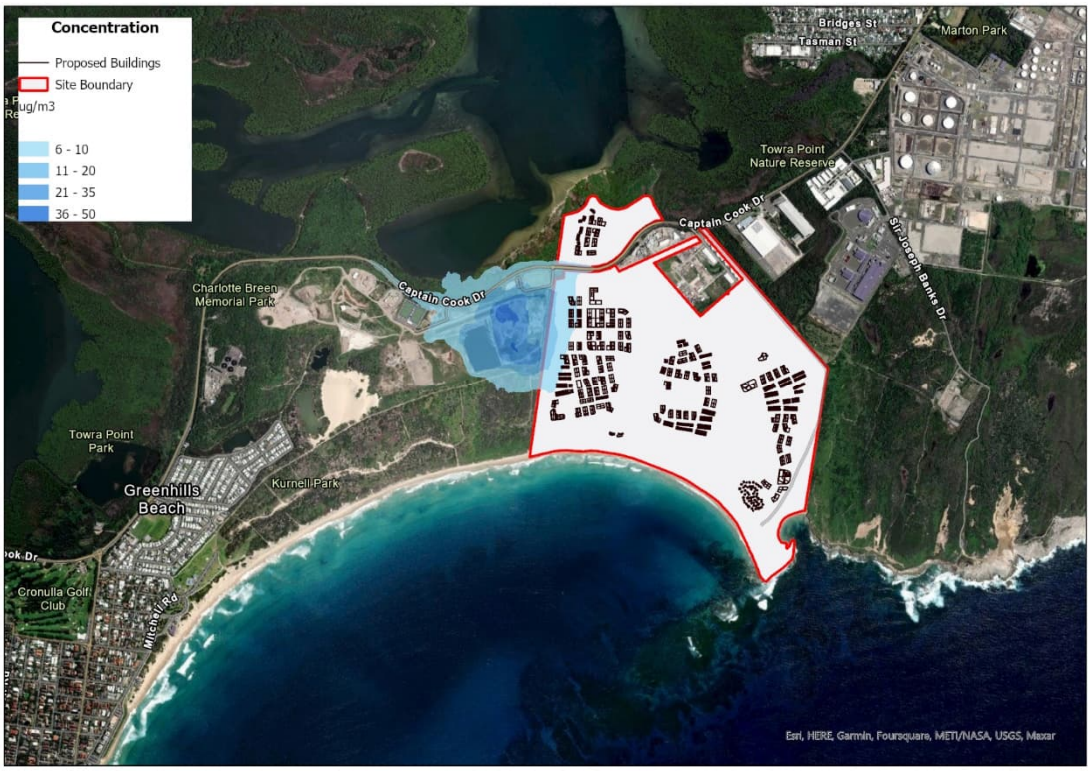


Figure 24 Predicted incremental annual average NO_X contours for with and without project 2036 scenarios.

Without Project



With Project

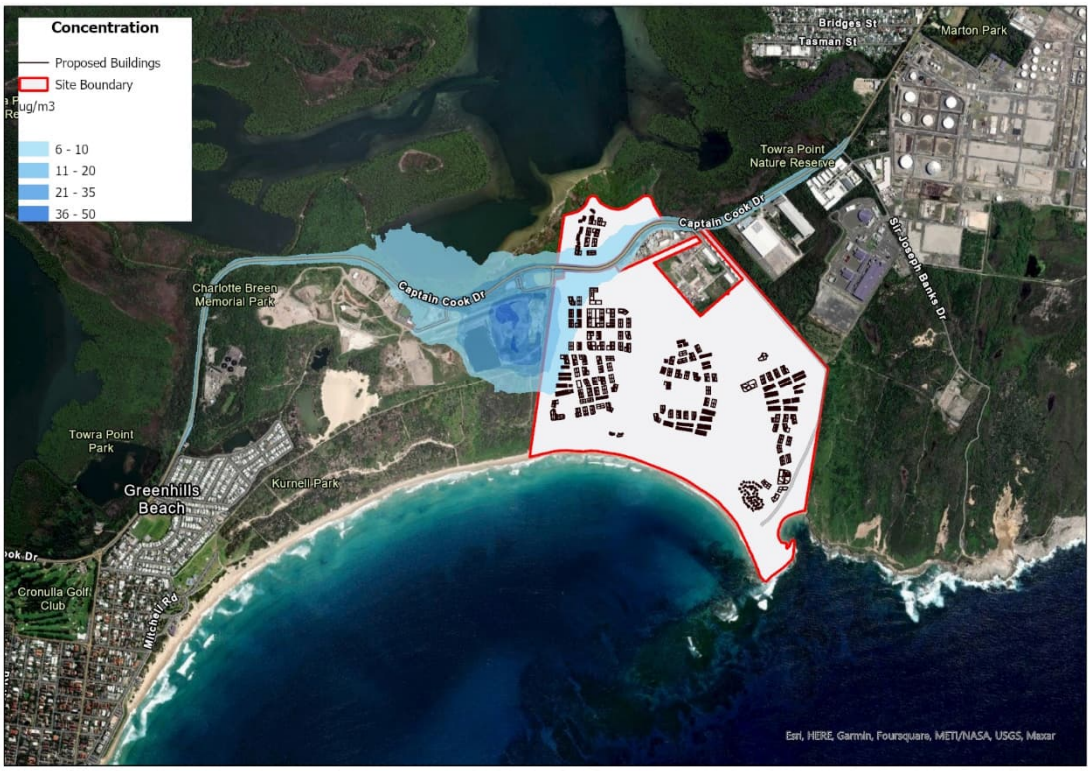
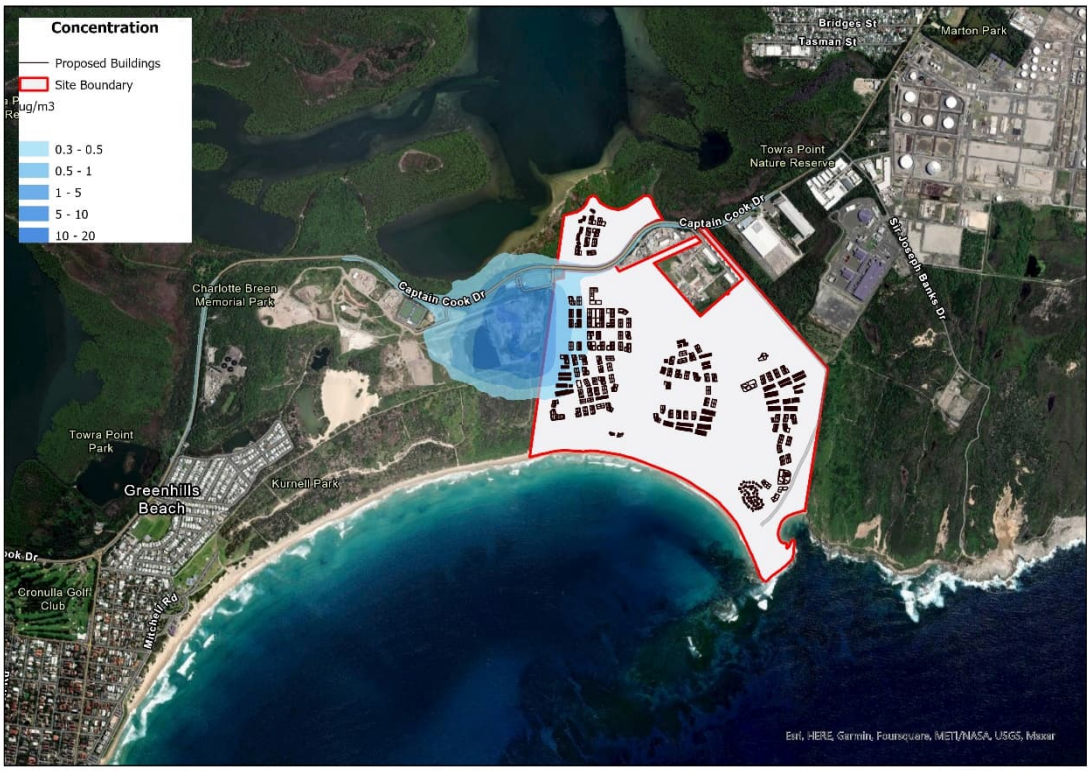


Figure 25 Predicted incremental 24 Hour Maximum PM_{10} contours for with and without project 2036 scenarios.

Without Project



With Project

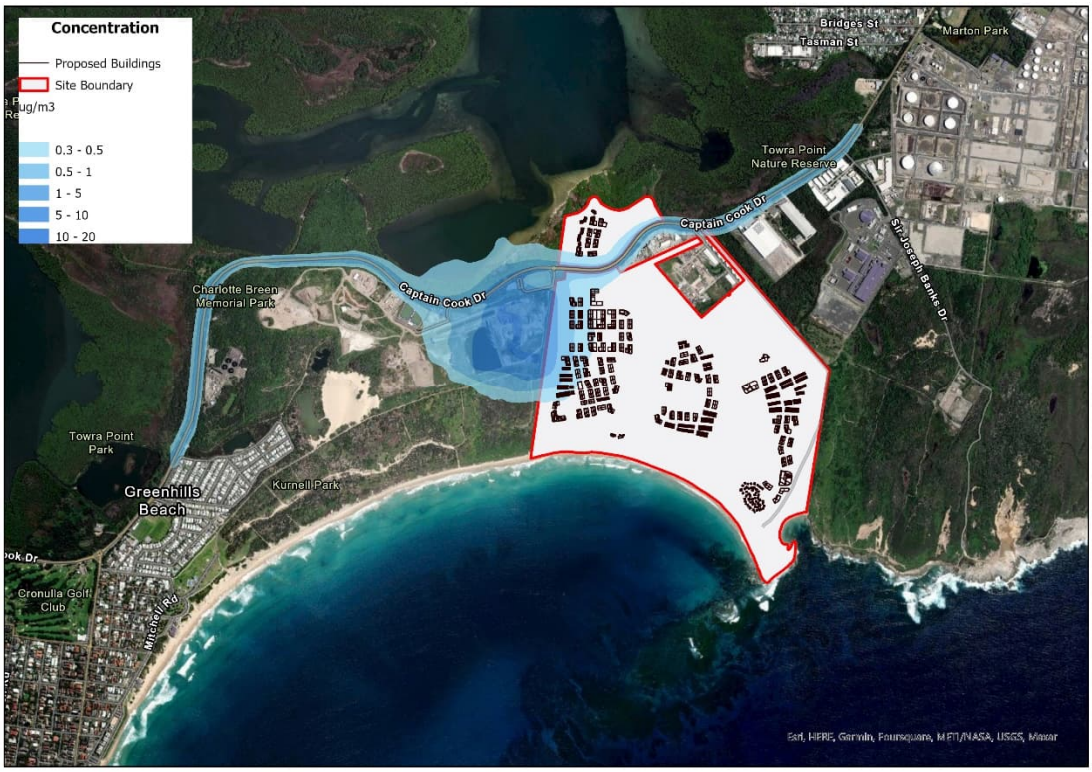
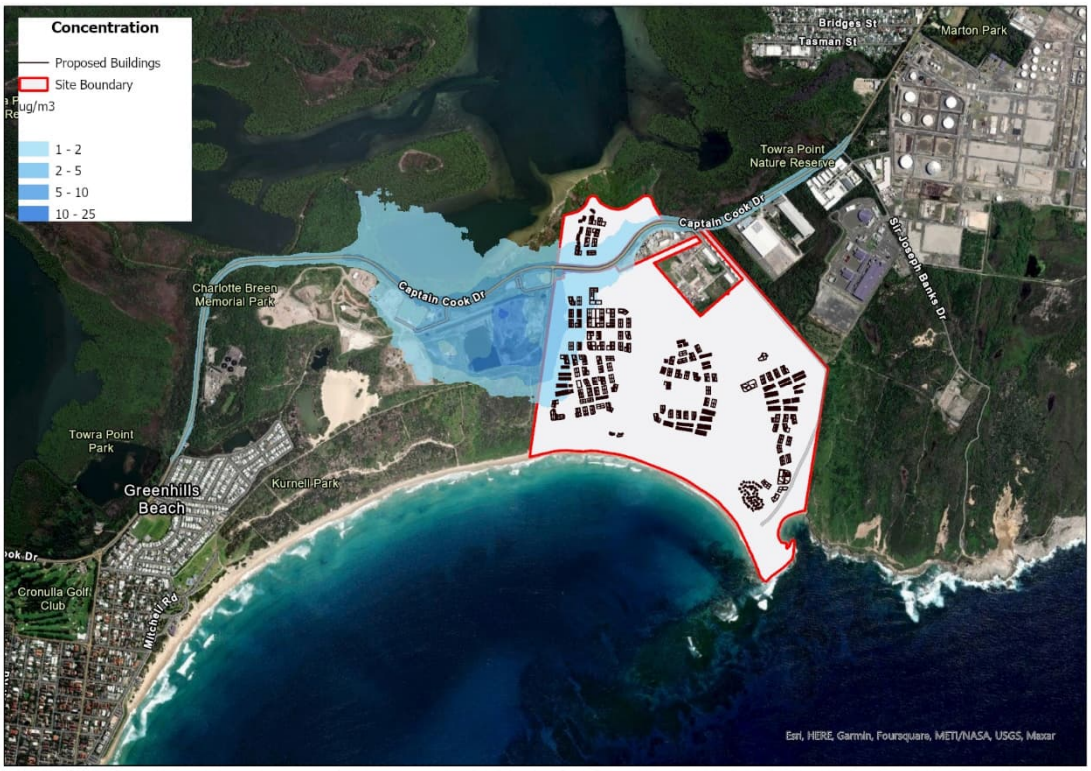


Figure 26 Predicted incremental annual average PM_{10} contours for with and without project 2036 scenarios.

Without Project



With Project

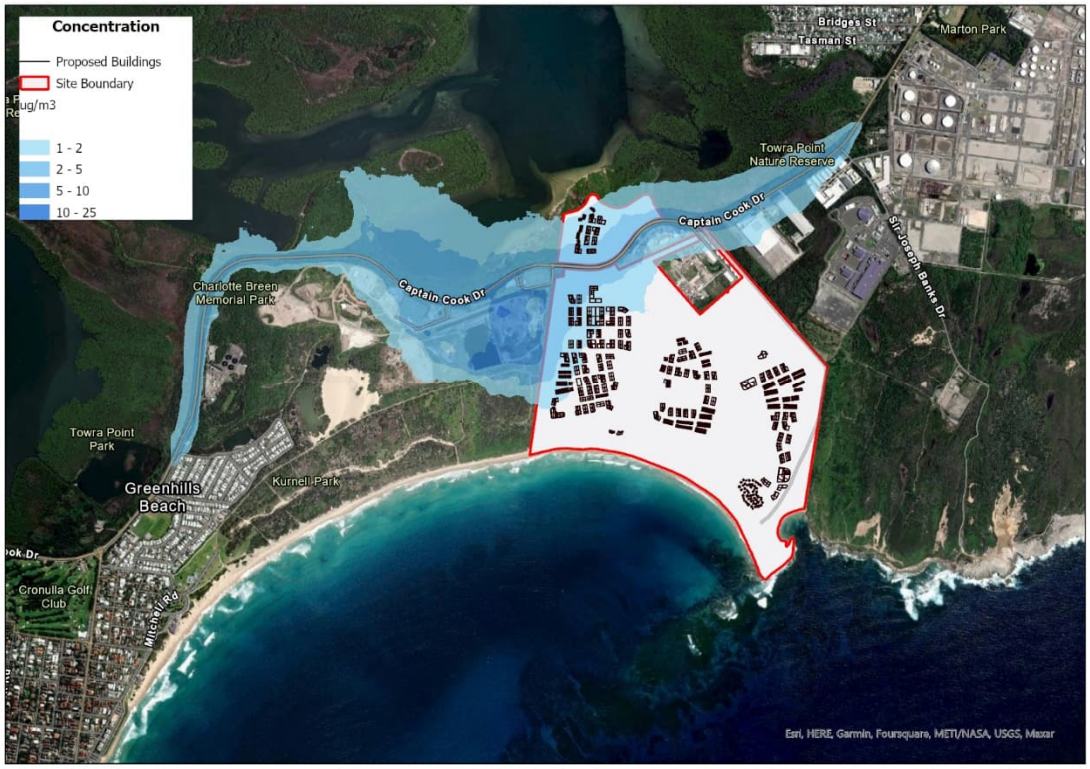
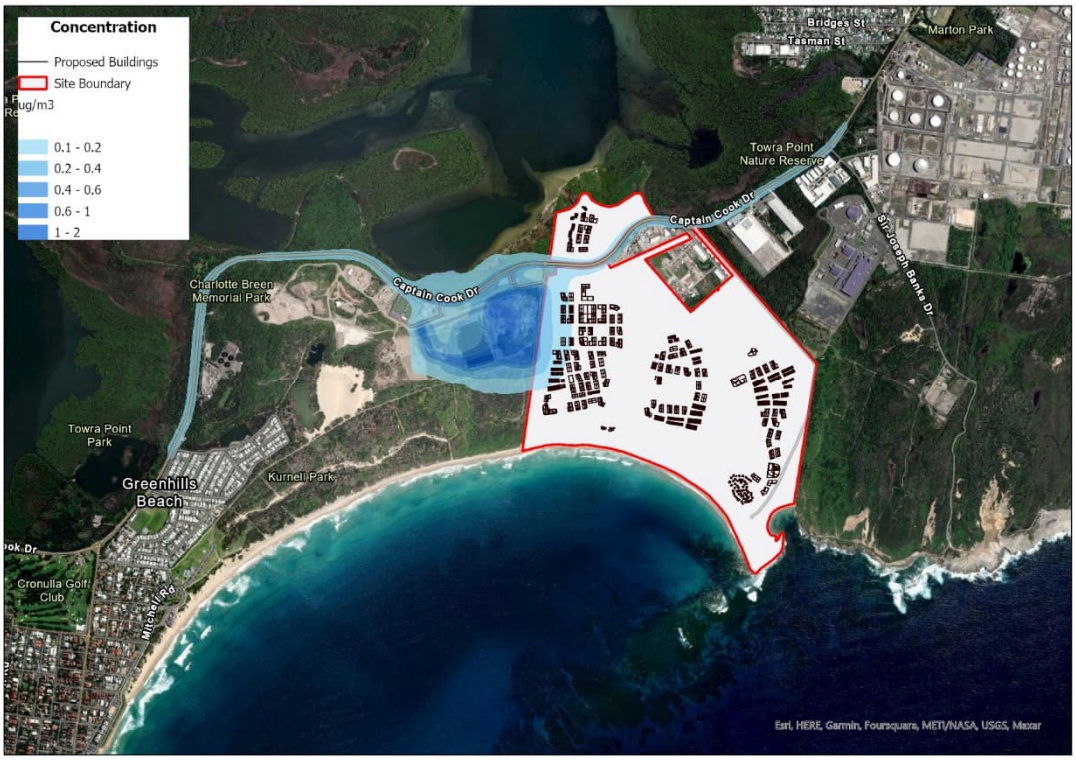


Figure 27 Predicted incremental 24 Hour Maximum $PM_{2.5}$ contours for with and without project 2036 scenarios.

Without Project



With Project

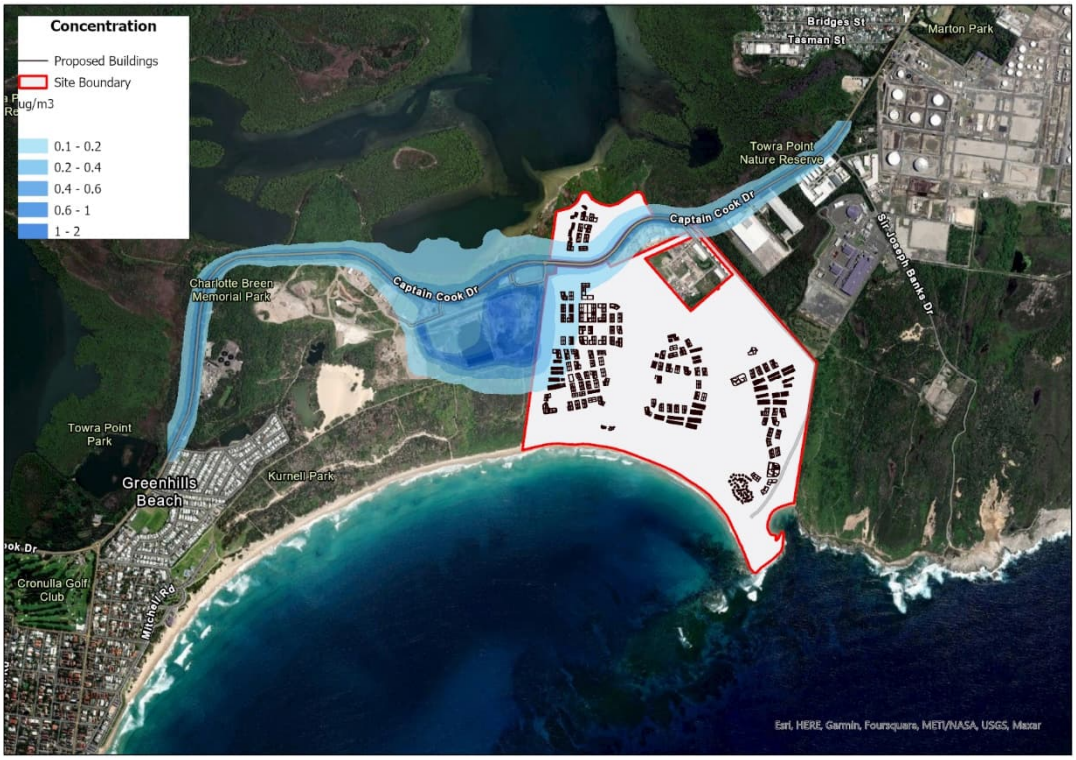


Figure 28 Predicted incremental annual average $PM_{2.5}$ contours for with and without project 2036 scenarios.

7.2.2 Odour

Predicted maximum and 99.9th percentile odour concentrations for sensitive receptors are provided in Table 23. Predicted 99th percentile values were predicted to be 0.1 OU at all receptors, which is also consistent with the findings of the Wilkenson Murray AQIA for the Breen site conducted in 2021. Predicted maximum 1-hour values were highest at sensitive receptors 2 and 3 which are located immediately west of the Breen Facility within the Town Centre Precinct. Results from the modelling predict that both the maximum and 99th percentile concentrations are well below the EPA 1-hour 99th percentile odour criterion of 2 OU therefore no significant reverse amenity odour impacts are anticipated from adjacent landfilling activities.

Table 23 Predicted 1-hour Maximum and 99th Percentile Odour Concentration (OU) at Sensitive Receptors

Receptor ID	1-hour Odour Concentration (OU)	
	Maximum	99th Percentile
1	0.4	0.1
2	0.5	0.1
3	0.5	0.1
4	0.3	0.1
5	0.4	0.1
6	0.3	0.1
7	0.3	0.1
8	0.3	0.1
9	0.4	0.1
10	0.2	0.1
11	0.2	0.1
12	0.4	0.1
13	0.3	0.1
14	0.2	0.1
15	0.2	0.1
16	0.3	0.1
17	0.2	0.1
Criteria		**2.0**

7.3 Internal Traffic Emissions

A review of the proposed setback distances for each Precinct and proposed building heights within the Master Plan has been undertaken to determine the potential for urban canyon effects on vehicle emissions from estimated aspect ratios. A summary of proposed road reserve widths and building setback distances and heights summarised from the Urban Desing Report (Group GSA 2023) are provided in Table 24 and Table 25 respectively.

Table 24 Proposed Road Reserve Width (Group GSA 2023)

Street Type	Road Reserve Distance (m)
Residential Boulevard	23.2
Residential Street	18.0
High Street	16.6
Main Street	30.0
Collector Street	22.4

Table 25 Proposed building types, set back distances, and building heights (Group GSA 2023)

Building Type	Building Setback	Approximate Building Height (m)
2-Storey Medium Density	4.5	7.4
4-Storey Medium Density Residential Flat	3	13.3
2-Storey Duplex	6	6.4
2-Storey Townhouse	3	6.4
6-Storey Town Centre Lot	3	20.5
8-Storey Town Centre Lot	3	26.9
10-Storey Town Centre Lot	3	33.3
12-Storey Town Centre Lot	3	39.7
6-Storey Apartment Building (Massoniette & Residential Flats)	3	19.7
8-Storey Building Apartment Building (Massoniette & Residential Flats)	3	26.1
10-Storey Building Apartment Building (Massoniette & Residential Flats)	3	32.5
6-Storey Apartment Building (Shop Top Residential Flats)	1.5	20.5
8-Storey Building Apartment Building (Shop Top Residential Flats)	1.5	26.9
10-Storey Building Apartment Building (Shop Top Residential Flats)	1.5	33.3
Note: Building height is estimated based on storey height for each building height listed in the Draft Urban Building Desing Report (2023)		

The potential for urban canyon effects was estimated using the proposed road reserve widths and setback distances Table 24 and Table 25 and the aspect ratio classifications provided in Table 19.

Table 26 Determination of Appropriate Green Infrastructure for Street Canyons Based on Aspect Ratio

Classification	Aspect Ratio	GI Recommendation
Deep Street Canyon	H/W ≥ 2	• Green walls only
Mid-Depth Street Canyon	H/W 0.5-2	• Green walls • Low-level vegetation (shrubs and low hedges)
Shallow Street Canyon	H/W ≥ 0.5	• Green walls • Low-level vegetation (shrubs and low hedges) • Small and open-crowned trees on the windward side of the canyon spaced broadly apart.
Source: Barwise & Kumar 2020		

A summary of estimated aspect ratios for each street type and proposed building type is provided in Table 27. A review of the Master Plan indicated that the proposed development provided adequate setback distances to avoid the formation of deep urban canyons, with all roads classified as either shallow or mid-depth urban canyons within each Precinct.

Table 19 also provides recommendations for the application of green infrastructure (GI). The strategic placement of GI such as open areas and vegetated areas as part of street scaping would need to be considered as part of the development and is discussed further in Section 8.3.3.

Table 27 Street canyon classification based on building and street type

Building Type	Street Classification Type				
	Residential Boulevard	Residential Street	High Street	Main Street	Collector Street
2-Storey Medium Density	Shallow	Shallow	Shallow	Shallow	Shallow
4-Storey Medium Density Residential Flat	Shallow	Mid-Depth	Mid-Depth	Shallow	Shallow
2-Storey Duplex	Shallow	Shallow	Shallow	Shallow	Shallow
2-Storey Townhouse	Shallow	Shallow	Shallow	Shallow	Shallow
6-Storey Town Centre Lot	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
8-Storey Town Centre Lot	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
10-Storey Town Centre Lot	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
12-Storey Town Centre Lot	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
6-Storey Apartment Building (Massoniette & Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
8-Storey Building Apartment Building (Massoniette & Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
10-Storey Building Apartment Building (Massoniette & Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
6-Storey Apartment Building (Shop Top Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
8-Storey Building Apartment Building (Shop Top Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth
10-Storey Building Apartment Building (Shop Top Residential Flats)	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth	Mid-Depth

7.4 Cronulla Water Resource Recovery Facility

The following subsections provide a qualitative assessment of amenity impacts in relation to both odour emissions from wastewater treatment and NO_X emissions from cogeneration at the Cronulla WRRF.

7.4.1 Odour

An assessment of odour amenity impacts from the Cronulla WWRF was previously undertaken as part of the AQIA 2020 report. The assessment included a review of an odour impact assessments undertaken by CH2Mhill on behalf of Sydney Water in 2011. The odour impact assessment was conducted as part of proposed upgrades to the WWRF as part of and odour and corrosion abatement project completed in 2015 aimed at significantly reducing the risk of occurs impacting on the surrounding community and improving the reliability and economic life of the plant.

In the Sydney Water 2011 odour assessment report odour impact from the Cronulla WWTP were assessed using the dispersion model CALPUFF in accordance with the NSW *Approved Methods*. Predicted modelling results indicated that the 1-hour the 99th percentile ground level odour concentration of 2 OU just slightly extended past the boundary of the Cronulla WWRF. The 2020 AQIA concluded that based on the separation distance of 1.8km between the Cronulla WWRF and the Proposed site no adverse amenity impacts were anticipated for future sensitive receptors at the Kurnell Planning Proposal site.

Since the AQIA 2020 report for the Proposal no new publicly available information relating to odour concentrations; or odour modelling is available. However, given the previous modelling results, the separation distance between odour sources at Cronulla WWRF and the Kurnell Planning Proposal site any fluctuation or changes to odour emissions at the WWRF are unlikely to result in significantly impacts to air amenity for future sensitive receptors.

7.4.2 Air Quality

The cogeneration plant at the Cronulla WRRF captures methane (biogas) from the anerobic digestors and uses it to power a combustion engine that drives an electrical generator. Air emissions from the cogeneration plant are emitted via a stack and is regulated under EPL 1728, which requires an annual monitoring event and reporting of NOx emissions. A stack concentration limit of 450mg/m^3 for NO_X is set under the EPL; which is consistent with the general activities and plant emission limit under Schedule 4 Standards of concertation for scheduled premises under the Protection of the Environment Operations (Clean Air) Regulation 2010, Schedule 4.

Annual monitoring results reported by Sydney Water between 2020 and 2023 are shown in **Table 28**.

Table 28 EPL (1728) NO_X monitoring data (EPA Point 18) for Co-generation stack (Sydney Water 2020-2023)

Sample Date	Number of Samples	NO_X concentration (mg/m^3)			EPL Licence Limit (mg/m^3)
		Minimum	Mean	Maximum	
10 August 2020	5	414	421	436	450
23 November 2020	4	277	288	295	
12 May 2022	4	438	446	450	
9 February 2023	3	388	414	428	

Table 28 shows that average NOx concentrations from the cogeneration stack are below the EPL licence limit for all monitoring events between 2020 and 2023. Similar maximum recorded NOx stack concentrations were generally below the licence limit of 450 µg/m^3 with exception to the maximum value recorded on 12 May 2022 which was at but not exceeding the concertation limit.

Given that NO_2 monitoring data between 2020 and 2023 for the cogeneration plant is compliant with the EPL limits; and there is sufficient separation distance between the Cronulla WRRF and the Kurnell Planning Proposal site no significant impacts on the air amenity of future receptors are anticipated.

7.5 Ampol Fuel Terminal

The following subsections provide an assessment of amenity impacts from air quality and odour emissions form the Ampol Fuel Terminal; formerly named the Caltex Kurnell Terminal as discussed in the AECOM 2020 AQIA.

Pollutants of interest from the fuel terminal would largely include volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, xylenes and n-hexane from fugitive air emissions associated with the volatilisation of hydrocarbon materials from fuels imported stored and exported onsite. Potential odour emissions from the Caltex Kurnell Terminal would be generated from both the volatilisation of hydrocarbons and small quantities of sulphurous compounds such as mercaptans and hydrogen sulphide present in fuels.

7.5.1 Air Quality

Assessment of potential reverse amenity impacts on the Kurnell Planning Proposal site were addressed in the 2020 AQIA. The 2020 AQIA reviewed an air quality assessment undertaken for the Kurnell Conversion Project undertaken by URS in 2013 used the dispersion model AUSPLUME to predict offsite ground level concentrations from the Kurnell Fuel Terminal. The results of the dispersion modelling predicted offsite 99.9th percentile 1 hour concentrations for benzene of less than 50 percent of the EPA criterion and for toluene, ethylbenzene, xylene, and n-hexane of less than 10 percent of the relevant EPA criterion. Therefore, VOC emissions from the Kurnell Ampol Fuel Terminal are unlikely to have any significant impact on future receptors at the site.

Supplementary to this assessment on the 22 April 2022 the NSW EPA conducted air quality monitoring around Kurnell using a photoionisation device (PID) to measure VOC emissions. A total of 20 ambient air monitoring samples were taken surrounding the fuel terminal and EPA reported that VOCs were not detected during the air monitoring around Kurnell (EPA 2022). As such no significant reverse amenity impacts were anticipated on the Kurnell Planning Proposal site.

7.5.2 Odour

Potential odour amenity impacts from the Ampol Fuel Terminal on the Kurnell Planning Proposal site were addressed in the 2020 AQIA. The 2020 AQIA reviewed information relating to potential odour impacts and odour complaints within the 2013 AQIA for the Kurnell Refinery Conversion Project (URS 2013) and for the Caltex odour reduction program (Caltex 2016). The 2020 AQIA report concluded that odour emissions from the Ampol Fuel Terminal at Kurnell are unlikely to have any significant impact on future receptors at the site.

More recently at the Kurnell Ampol Fuel Terminal a Sitewide Odour Study was conducted by The Odour Unit in 2023 (TOU 2023 cited by Ampol 2023). The study indicated there are several odour sources in Kurnell including the fuel terminal; however, the area also includes indigenous odour sources in the ambient environment including the National Parkland at Wetlands. Potential odour amenity impacts from mangroves is discussed further below in Section 7.6.

Odour sources specific to the fuel terminal identified in the Sitewide Odour Study indicated there are three key sources of odour emissions at the site. These include:

- Separator vents
- Fuel storage tanks (102, 103 and 104)
- Landfarming activities (soil remediation).

Additional odour mitigation (carbon filters) was installed on the separator vents in April 2023 and are currently monitored to determine their effectiveness as a long-term odour mitigation solution. A commitment to investigate other safeguards including installation of an air extraction system would be considered in the event odour impacts were continued to be observed.

Since the odour investigation Ampol have actioned measures that would reduce potential odour emissions associated with the fuel tanks including cleaning the oily water sewer downstream of the fuel storage tanks to improve drainage, trialling drain covers and freshwater flushing of drains (AMPOL 2023).

As of September 2023, landfarming activities were no longer occurring. Previously wet hydrocarbon sludge the source of the odour was dried out and exported offsite (AMPOL 2023a). The landfarm was decommissioned and is no longer considered a source of odour.

Based on the findings of the AQIA 2020 report and a review of reported outcomes of the Kurnell Ampol Fuel Terminal Sitewide Odour Study no significant odour amenity impacts are anticipated on the Kurnell Planning Proposal site.

7.6 Mangroves

The Kurnell Planning Proposal is located on a site containing and adjacent to mangroves as shown in Figure 29. As discussed in Section 6.3.4, Sutherland Shire Council have requested the consideration of potential odour impacts from mangroves on proposed sensitive receptors within the Kurnell Planning Proposal site.

Mangroves have the potential to produce biogenic odour emissions from the decomposition of organic material. As mangroves drop their seeds and other organic material, bacteria breakdown the organic matter producing biogenic sulphide gases including hydrogen sulphide which can be described as having a rotton-egg or sewage smell.

Odour impacts and the intensity of odour emissions from mangroves is highly variable and can fluctuate based on:

- Proximity of sensitive receptor to mangroves
- Time of year with period between May and November generally resulting in higher odour emissions
- Amount of organic matter produced; high yields of mangrove seeds result in higher rate of organic matter decomposition increasing sulphide gas produced.
- Meteorological and tidal conditions
    - Lower wind speeds and lower temperatures result in more stable atmospheric conditions which result in poorer dispersal of odorous compounds.
    - Higher rainfall can result in increased spread of organic matter which may decay further from the source.
    - High tide conditions can also increase the spread of organic matter.

The Masterplan includes an approximate 100m building development exclusion buffer proposed to surround protected wetlands on the site as shown in **Figure** 29. Proposed development is generally setback further than this buffer and proximity of nearby sensitive receptors is summarised as follows:

- For Lot 2 north, Quibray Bay Precinct mangroves lie to both the east and west of the precinct. The nearest sensitive receptors are:
    - Over 100m from the site boundary and mangroves to the west. Sensitive receptors at this location include both residential and seniors living accommodation.
    - Over 100m from mangroves to the east with the nearest proposed receptors are medium density residential properties.
- For Lot 2 South site mangrove lie along the northern border, south of Captain Cook Drive, and along the northeast border, west of the eastern access road. The nearest receptors include:
    - The proposed playing fields at the school within the northern section of the Town Centre Precinct; located within the 100m buffer zone. This is regarded a transient receptor where people are not expected to reside for long periods of time (8 hours per day or more). As such the odour sensitivity of this sensitive receptor is likely to be less significant than other land uses such as residential properties.
    - The Community Facility within the northern end of the Boat Harbour Precinct is just outside the 100m buffer zone.
    - Remaining land uses adjacent to the buffer zone are primarily zoned for environmental use or open parkland.

The proposed buffer zone around the wetlands (Wetland Proximity Area) and proposed proximity to sensitive receptors would help minimise potential odour impacts at sensitive receptors.

Furthermore, as discussed above, potential odour impacts from mangroves fluctuate, with the potential for odour impacts to occur generally higher for six months of the year between May and November and during unfavourable meteorological conditions. During this period prevalent winds (**Figure 7**) indicate most sensitive receptors would generally be upwind of the mangroves onsite. The exception to this is the period between September and November where north easterly winds are common and receptors within the Town Centre Precinct and Bate Bay Precinct are downwind of the wetlands. Regardless as discussed in **Section 5.1** local meteorological observations between 2013 and 2022 show moderate average wind speeds and a low frequency of calm conditions indicates generally favourable dispersal conditions where odour emissions are likely to disperse rapidly.

Following consideration of the separation distances between the wetlands and sensitive receptors; intermittent nature of the odour source and local meteorological conditions emissions from biogenic hydrogen sulphide from the decay of organic matter from mangroves within the wetlands is unlikely to result is significant odour amenity impacts on the proposed development.

Figure 29 Development Buffer Surrounding Mangroves.

Source: Group GSA 2023

7.7 Sydney Airport

The Kurnell Planning Proposal is located within the southern flight path and OLS from Sydney Airport; as shown within Figure 30. Sydney Airport is located within 5.5km to the north of the proposal site and development within the flight path zone has been restricted to migrate potential noise amenity impacts and is limited to a few sensitive receptors in the Boat Harbour Precinct including tourism and commercial facilities.

Figure 30 Location of Sydney Airport Flight Paths over Planning Proposal

Source: Group GSA 2023

As discussed in Section 6.3.5, Sutherland Shire Council have requested the consideration of potential air quality impacts from aircraft emissions on proposed sensitive receptors within the Kurnell Planning Proposal site. While the Kurnell Planning Proposal is sighted directly under the southern flight paths and OLS for Sydney Airport; sufficient atmospheric mixing and dispersal of air emissions from aircraft is likely to occur at height above the site. Incremental pollutant ground level concentrations at the site from aircraft emissions are unlikely to be discernible from existing background concentrations. Regardless an analysis of representative data from Randwick and Roselle DPE monitoring stations is disused below.

Both DPE Randwick and Roselle air quality monitoring stations are located under Sydney Airport flight paths; and Figure 31 shows the location of these stations; overlayed on Sydney Airports OLS map which is indicative of typical flight paths from the Airport. Monitoring data from both locations have been analysed to identify any potential air quality impacts that may also be loosely inferred for the proposed Kurnell Planning Proposal site. The DPE monitoring station at Earlwood which does not lie directly under a flight path has also been included for comparison. The year 2022 was chosen the most recent complete year that would be representative of typical operations at Sydney Airport. Previous years 2021

and 2020 would be considered a typical of airport operations due to international flight restrictions and reduced domestic travel during the COVID-19 pandemic.

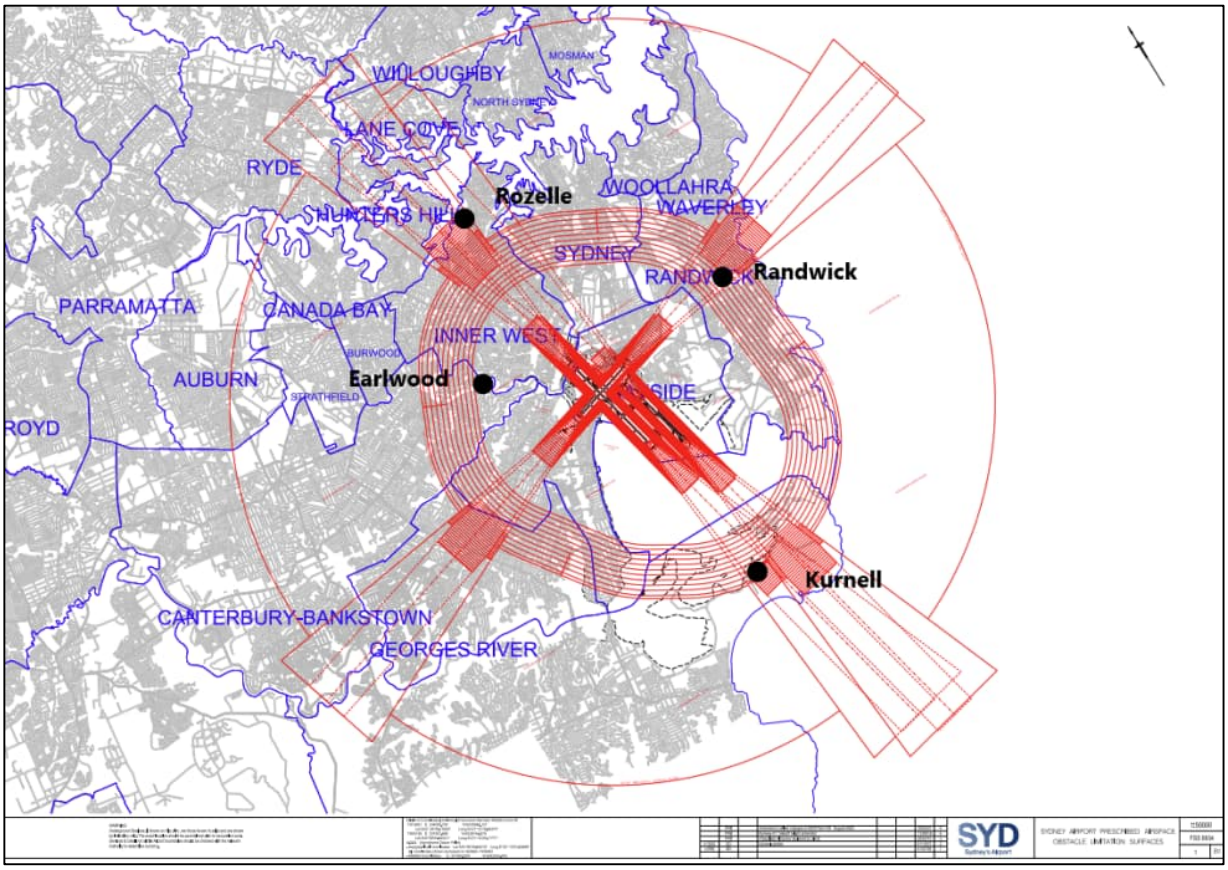


Figure 31 Location of Sydney Airport Obstacle Limitation Surfaces and DPE Monitoring Stations

Note: Obstacle Limitation Surface map for Sydney Airport has been obtained from: https://www.sydneyairport.com.au/

A comparison of monitoring data for 1-hour CO[3] and NO_2 concentrations and 24-hour PM_{10} and $PM_{2.5}$ concentrations at Randwick, Roselle and Randwick, which are the primary pollutants of combustion are shown in Figure 32 to Figure 35 below.

Comparison of the data shows that pollutant concentrations for CO, NO_2, PM_{10} and $PM_{2.5}$ across all three sites are below the relevant short term average EPA ambient air quality criteria for all three sites; including Randwick and Roselle which are underneath the Sydney Airport flight path. Both 1-hour concentrations for CO and NO_2, as well as 24 hour concentrations for particulates; and the annual average for all pollutants are similar between the Randwick and Roselle data and the Earlwood station data. From examination of the data that there is no significant difference in ambient air quality concentrations at Roselle and Randwick stations; that may be attributed to aircraft emissions above the existing regional background concentrations. Compliance with ambient air quality criteria; and similarities to existing regional background concentrations at these stations infers that sensitive receptors under the direct flight path at the Kurnell Planning Proposal site are unlikely to experience significant air quality impacts from aircraft movements.

[3] No CO data is available for the DPE station at Randwick; therefore Rozelle and Earlwood data only has been compared.

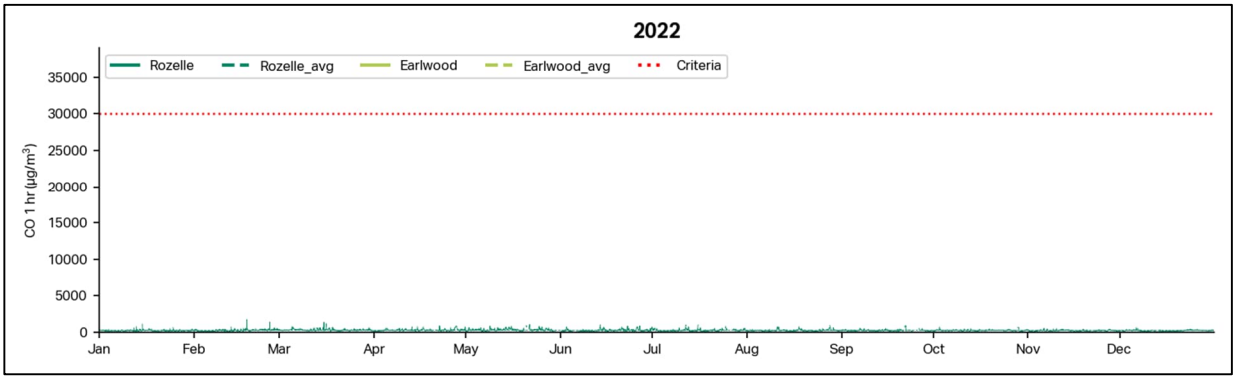


Figure 32 Comparison of 1-hour CO Concentrations at DPE Rozelle, Randwick and Earlwood stations for 2022

Note: DPE Monitoring Station

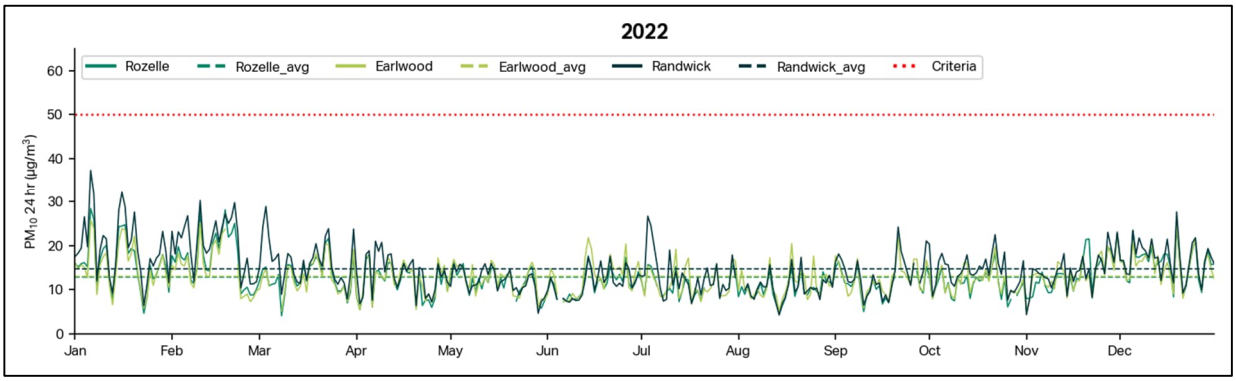


Figure 33 Comparison of 24-hour PM_{10} Concentrations at DPE Rozelle, Randwick and Earlwood stations for 2022

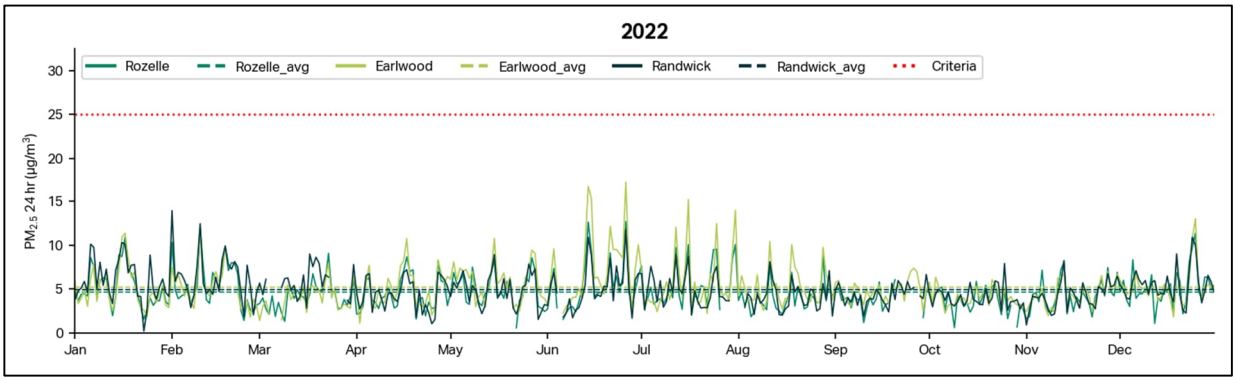


Figure 34 Comparison of 24-hour $PM_{2.5}$ Concentrations at DPE Rozelle, Randwick and Earlwood stations for 2022

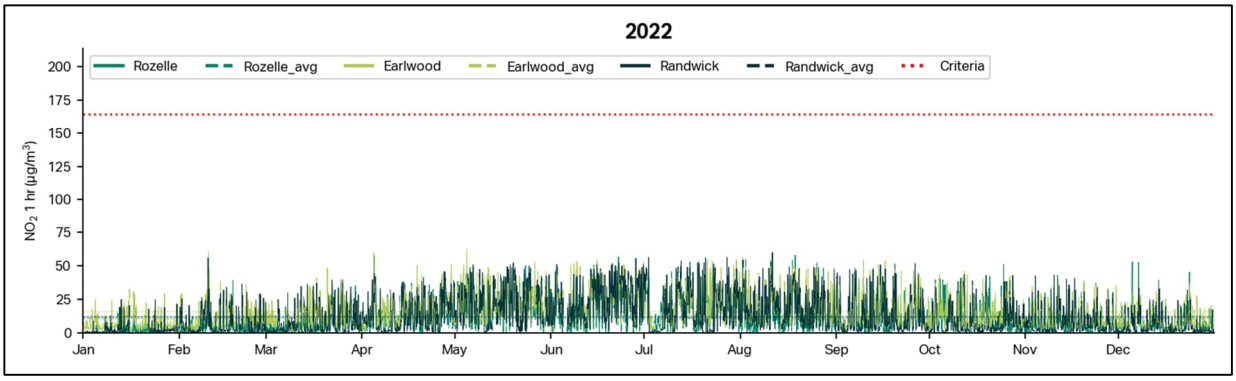


Figure 35 Comparison of 1-hour NO^2 Concentrations at DPE Rozelle, Randwick and Earlwood stations for 2022

7.8 Summary of Impact Assessment

A summary of the potential air quality and odour impacts associated with the Planning Proposal including reverse amenity impacts discussed in this section is summarised in Table 29.

Table 29 Summary of assessment of air quality impacts

Air Emission Source	
Breen facility	• Dispersion modelling of dust emissions from the Breen Proposal indicated that: - Predicted cumulative impacts maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations (inclusive of vehicle emissions from Captain Cook Drive) were found to exceed the EPA criteria for all modelled scenarios. This is largely attributed to elevated background concentrations already exceeding the EPA criteria. There was one additional exceedance of the EPA criteria for the with project scenario for 2036 for both PM_{10} and $PM_{2.5}$. Here the incremental contributions were relatively minor and the background concentration was already approaching the criteria. - The predicted cumulative annual average PM_{10} to $PM_{2.5}$ concentrations (inclusive of vehicle emissions from Captain Cook Drive were below the EPA criteria for all modelled scenarios. - Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} concentrations (compared to vehicle emissions) at the worst affected sensitive receptor. • Results from the modelling predict that both the maximum and 99th percentile odour concentrations are well below the EPA 1-hour 99th percentile odour criterion of 2 OU therefore no significant reverse amenity odour impacts are anticipated from adjacent landfilling activities. • Based on the dispersion modelling results the proposed setback distance of the western most sensitive receptors within the Town Centre Precinct is considered adequate to minimise potential air quality impacts from the Breen Proposal as a result of the Planning Proposal.
External traffic emissions	• Dispersion modelling for Captain Cook Drive results indicate that while the Planning Proposal would result in a potential increase in vehicle emissions: - Predicted cumulative impacts for with project scenarios for 2029 and 2039 for NO_2 and CO at sensitive receptors were well below the relevant EPA criteria for all pollutants. - Predicted cumulative maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations (inclusive of Breen operations) were found to exceed the EPA criteria for all modelled scenarios. This is largely attributed to elevated background concentrations already exceeding the EPA criteria. There was one additional exceedance of the EPA criteria for the with project scenario for 2036 for both PM_{10} and $PM_{2.5}$. Here the incremental contributions were relatively minor and the background concentration was already approaching the criteria. - The predicted cumulative annual average PM_{10} to $PM_{2.5}$ concentrations (inclusive of Breen operations) were below the EPA criteria for all modelled scenarios.

Air Emission Source	
	- Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} concentrations (compared to vehicle emissions) at the worst affected sensitive receptor. • Based on the dispersion modelling results the proposed 70m setback buffer from Captain Cook Drive is considered adequate to minimise potential air quality impacts from vehicle emissions as a result of the Planning Proposal.
Internal traffic emissions	• A review of the Master Plan indicated that the proposed development provided adequate setback distances to avoid the formation of deep urban canyons, with all roads classified as either shallow or mid-depth urban canyons within each Precinct. • The strategic placement of GI such as open areas and vegetated areas as part of street scaping would need to be considered as part of the development based on relevant street aspect ratios and is discussed further in Section 8.3.3.
Cronulla WRRF	• An assessment of odour amenity impact from the Cronulla WWRF was previously undertaken as part of the AQIA 2020 report which concluded based on a review of an odour impact assessment (CH2Mhill 2011) and a separation distance of 1.8m between the WWRF and the Planning Proposal no significant reverse odour amenity impacts are anticipated. No new publicly available information relating to odour concentrations; or odour modelling is available however any fluctuation or changes to odour emissions at the WWRF are unlikely to result in significantly impacts to air amenity for future sensitive receptors. • A cogeneration plant installed in 2020 onsite was reviewed to assess potential reverse air amenity impacts from NO_2 emissions. Monitoring data between 2020 and 2023 for the cogeneration plant was compliant with the EPL limits; and there is sufficient separation distance between the Cronulla WRRF and the Kurnell Planning Proposal site no significant impacts on the air amenity of future receptors are anticipated.
Ampol Fuel Terminal	• Assessment of potential reverse amenity impacts on the Kurnell Planning Proposal site were addressed in the 2020 AQIA. The 2020 AQIA concluded that potential VOC and odour emissions from the Ampol Fuel Terminal were unlikely to have any significant impact on future receptors at the site. • On 22 April 2022 the NSW EPA conducted VOC monitoring surrounding the fuel terminal and reported that VOCs at monitoring locations were not detected (EPA 2022). As such no significant reverse amenity impacts were anticipated on the Kurnell Planning Proposal site. • A Sitewide Odour Study was conducted by The Odour Unit in 2023 (TOU 2023 cited by Ampol 2023). Odour sources specific to the fuel terminal identified in the study included separator vents, fuel storage and landfarming activities. Additional mitigation and maintenance measures have since been implemented (and or being investigated) for both separator vents and fuel storage tanks and the landfarm has since been decommissioned. As such no significant reverse amenity impacts were anticipated on the Kurnell Planning Proposal site.

Air Emission Source	
Mangroves	• Following consideration of the separation distances between the wetlands and sensitive receptors; intermittent nature of the odour source and local meteorological conditions emissions from biogenic hydrogen sulphide from the decay of organic matter from mangroves within the wetlands is unlikely to result is significant odour amenity impacts on the proposed development.
Sydney Airport	• While the Kurnell Planning Proposal is sighted directly under the southern flight paths and OLS for Sydney Airport; sufficient atmospheric mixing and dispersal of air emissions from aircraft is likely to occur at height above the site. Incremental pollutant ground level concentrations at the site from aircraft emissions are unlikely to be discernible from existing background concentrations. • Compliance with ambient air quality criteria; and similarities to existing regional background concentrations at these stations infers that sensitive receptors under the direct flight path at the Kurnell Planning Proposal site are unlikely to experience significant air quality impacts from aircraft movements.

Provided the relevant planning and design considerations and additional assessment requirements listed in Section 8.0 are considered for future development applications the findings of the air quality impact assessment for the Kurnell Planning Proposal indicate there are no significant air quality or odour impacts as a result of the Planning Proposal, or reverse amenity impacts on the site from nearby air and odour emission sources.

8.0 Recommendations

8.1 Overview

The following section provided recommendations on potential air quality impact safeguards and management approaches for consideration at the master planning stage within the following areas:

- Project staging (Section 8.2);
- Planning and design considerations including development proximity to busy roads, use of wood heaters and open fireplaces and development under Sydney Airport OLS (Section 8.3); and
- Additional assessment requirements (Section 8.4).

8.2 Project Staging

As discussed in Section 2.3 construction of the Planning Proposal would take approximately 19 years to complete. The staging of the development is likely to influence short or intermediate term air quality impacts on existing and future sensitive receptors in the area. The duration of potential temporary impacts on nearby sensitive receptors can be influenced by strategic planning of the stages of development. Table 30 provided a list of staging recommendations to minimise potential air quality impacts associated with construction of the Site based on potential staging impacts.

Table 30 Staging Considerations for Development

Consideration	Comment
Cumulative Impacts	• Any construction work, particularly earthworks that coincide with either operation of the landfill and recovery centre prior to closure or construction activities associated with the Greenhill's VPA would need to consider cumulative dust impacts. • Onsite remediation activities are likely to coincide with construction activities associated with the Planning Proposal, particularly during the early stages of development. It is recommended that should construction works overlap with either onsite remediation or existing onsite operations: - A construction dust assessment should be undertaken to assess potential cumulative dust impacts at the development application stage. - Appropriate dust mitigation measures should be implemented in accordance with an Air Quality Construction Dust Management Plan to minimise potential cumulative impacts. • Assessment of construction dust impacts from overlapping construction stages should be considered for individual development applications.
Landfill and NRRF Operations	• Proposed staging of development for Town Centre North West (Stage 4) has been delayed to commence in 2027 with completion in 2040 and minimises cumulative construction dust risks and/or reverse amenity impacts during construction of the Breen Proposal.
Landfill Gas	• Proposed delayed staging of development for Town Centre North West (Stage 4) also allows for adequate time to undertake a minimum of two years of landfill gas monitoring adjacent to the Breen Facility. • Building and structure buffer distances applying to the landfill site may be imposed until the landfill site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Typically, this will be a period of about 30 years. Refer to **Section 8.3.2** for further detail.
Existing Sensitive Receptors	• Appropriate safeguard measures should be considered to minimise dust emissions from construction on any existing receptors. Based on the preliminary staging plan: - The Quibray Bay Precinct on Lot 2 North would be developed first (Stage 1A) and include closure and removal of Kurnell Boarding Stables and Riding School; eliminating potential construction dust risks to this receptor. - Early removal of the Boat Harbour cabins prior to construction and earth works as part of Boat Harbour North (Stage 3A) and Boat Harbour South (Stage 3B) to eliminate potential construction dust risks to this receptor.
Odour Impacts on Future	• Minor temporary odour impacts may be avoided if the Kurnell Boarding Stables and Riding School is closed prior to development and occupation of residential and commercial premises on Lot 2 South, immediately adjacent to Captain Cook Drive.

Consideration	Comment
Sensitive Receptors	• Preliminary staging as indicated in Section 2.3 shows Lot 2 North would be the first development stage (Stage 1A). Closure of the Kurnell Boarding stables and Riding School and subsequent development prior to development would ensure that environmental amenity and land use conflicts are minimised.

8.3 Planning and Design Considerations.

8.3.1 Development Adjacent Captain Cook Drive

Strategic planning should ensure that sensitive land use developments are sited to avoid or appropriately manage vehicle emissions from Captain Cook Drive at the site planning and building construction stages. Planning and design considerations to minimise exposure to vehicle emissions, are presented in Table 31. The planning and Design considerations in Table 31 are in line with the DPE's *Guideline* (DoP 2008) and supports the specific rail and road provisions of the Transport and Infrastructure SEPP as discussed in Section 3.1.2 and Section 3.2.4.

Table 31 Planning and Design Considerations for Development near Busy Roads

Consideration	Comment
Building Siting, Heights and Orientation	• Incorporating an appropriate separation distance between sensitive uses and the road using broad scale site planning principles such as building siting and orientation. The location of living areas, outdoor space and bedrooms and other sensitive uses (such as childcare centres, hospitals and senior living) should be as far away as practicable from the major source of air pollution. • Building heights adjacent to busy roads should be varied and interspersed with open areas to minimise the formation of urban canyons. Height aspect ratios based on proposed building heights and street widths in the Masterplan indicate urban canyons would be low to mid-depth; allowing for better dispersion. No deep urban canyons are proposed. • Where possible step back the upper stories of roadside buildings to increase dispersion of air pollutants and minimise cannoning effects of tall buildings close to the road. Allowances for upper level storey setbacks has been provided for buildings 6 stories or higher in the Master Plan • The Masterplan has allowed for a buffer zone of 70m from Captain Cook Drive. Each of the four neighbourhoods allow for graduated building heights; however taller buildings (up to 10-12 storeys) are situated along the proposed internal main roads.
Buffer zones	• The Master Plan proposes a minimum 70m noise buffer separation distance from Captain Cook Drive. This buffer would reduce the potential for air quality impacts at nearby sensitive receptors by allowing for better dispersal of vehicle emissions. • Examination of the Master Plan shows that the proposed separation distances for external roads include: - 72m to 93m separation distance for receptors located adjacent to Captain Cook Drive within the Quibray Bay Precinct. - The nearest proposed receptor within the Town Precinct adjacent to Captain Cook Drive is a school, which is considered a highly sensitive receptor. The separation distance from the school ranges from 72m for the proposed playing fields to 93m for the nearest proposed school building. • Dispersion modelling results suggest the proposed buffer separation distance of 70m is adequate
Childcare Centres and Schools	• Where new schools and childcare centres are being considered, the design should ensure that there is sufficient separation from busy roads to avoid adverse air quality impacts; particularly in the case of long day-care centres where young children and babies are subject to emissions from morning and afternoon peak traffic. Measures to avoid, reduce or mitigate against air quality impacts at any childcare centres include: - Where possible avoid siting childcare centres on Captain Cook Drive; - Courtyards or play areas should be protected from adverse air quality impacts by buildings; - Should a childcare centre front Captain Cook Drive layout should be considered to minimise air quality impacts such as orienting non-sensitive services like storage, bathrooms and car parking in areas subject to air pollution. • Proposed school is located on Lot 2 South adjacent to Captain Cook Drive, Site buildings are located outside the proposed 70m buffer zone. Layouts should be considered to minimise air quality impacts

Consideration	Comment
	such as orienting non-sensitive services like storage, bathrooms and carparking in areas subject to air pollution.
Landscaping	• Using vegetative screens, barriers or earth mounds where appropriate to assist in maintaining ambient air amenity. • Landscaping has the added benefit of improving aesthetics and minimising visual intrusion from an adjacent roadway. • The Masterplan provides allowance for vegetated buffer zones along roads; using both low scale planting and large shade trees. Allowance for green roofs on some buildings is also being considered which may result in potential air quality benefits. • Careful consideration of green infrastructure should be undertaken for mid-depth canyons as discussed further in Section 8.3.3.
Ventilation	• For ventilation of indoor areas, adjacent to Captain Cook Drive mechanical ventilation air inlet ports should be sited to maximise the distance from the road to reduce inflows of air pollutants • The location of open-able windows should be considered in the design of the development located adjacent to the roadway emission sources.
Senior Housing	• Senior housing should be located to ensure that vulnerable patients or the elderly are not placed in an area subject to adverse air quality impacts. • Master Plan indicated senior housing proposed does not front Captain Cook Drive. Layouts should be considered to minimise air quality impacts such as orienting non-sensitive services like storage, bathrooms and carparking in areas subject to air pollution on busy roads.

8.3.2 Development Adjacent Landfill

Landfill gas can accumulate in enclosed spaces in nearby buildings, basements, manholes, tunnels and service ducts as such any in accordance with the EPA Environmental Guidelines (EPA 2016); any buildings built within 250 metres of deposited waste must be designed not to accumulate landfill gas. The Master Plan shows that proposed buildings within the Town Precinct (the closest precinct to the Breen Resources site) have a separation distance of 100-144m from the site boundary, with open space proposed between buildings within the Town Precinct and the western boundary of the Site which is adjacent to Breen Resources.

Landfill gas monitoring and an associated landfill gas risk assessment has not been undertaken as part of this AQIA assessment. Under Section 10.2 of the EPA Environmental Guidelines (EPA 2016) development (unless open development such as a park) within 250m of existing or former landfill activities would need to comply with landfill gas criteria over a consecutive 24-month period to ensure that landfill gas has stabilised.

At this stage no changes to the Master Plan for the Site are recommended. However, it is critical to highlight that as discussed in the AQIA 2020, landfill gas monitoring may be required to demonstrate that the proposed 100-144m separation distance is adequate. The proposed staging plan for the Master Plan would likely allow sufficient time to undertake landfill gas monitoring prior to submission of a development application for the Town Precinct development stage. Timely initiation of landfill gas monitoring may be key to the approval of the Town Precinct.

8.3.3 Green Infrastructure

Placement of GI can be considered to manage roadside pollutant concentrations at the local scale. However, introduction of GI can either promote or disrupt the dispersion of air pollution by either exerting additional mechanical turbulence or decreasing turbulent kinetic energy. Within urban canyons trees have the potential to reduce wind speeds and reduce air exchange between the air above rooftops and within the canyon leading to the accumulation of pollutants inside the street canyon. For street canyons, the aspect ratio is critical to the appropriate GI form.

Based on the preliminary urban canyon classifications for internal roads in Section 6.3.1 (being either shallow or mid-depth urban canyons), there are several opportunities for street scaping without negatively impacting the dispersal of vehicle emissions due to the proposed wide road reserves. However, some street sections (in mid-depth canyons) would require strategic planting of low shrubs and hedges as opposed to taller trees to promote better air dispersion as shown in Table 26.

Table 32 Determination of Appropriate Green Infrastructure for Street Canyons Based on Aspect Ratio

Classification	Aspect Ratio	GI Recommendation
Deep Street Canyon	H/W ≥ 2	• Green walls only
Mid-Depth Street Canyon	H/W 0.5-2	• Green walls • Low-level vegetation (shrubs and low hedges)
Shallow Street Canyon	H/W ≥ 0.5	• Green walls • Low-level vegetation (shrubs and low hedges) • Small and open-crowned trees on the windward side of the canyon spaced broadly apart.
Source: Barwise & Kumar 2020		

8.3.4 Wood Heaters and Open Fire Places

Wood smoke is a significant contributor to atmospheric particulates, contributing approximately 28 percent of annual PM_{10} emissions and 47 percent of annual $PM_{2.5}$ emissions from the Sydney Region. As expected particulates from domestic solid fuel combustion is highest during the coldest months, with the highest contribution occurring in July, making up 57 and 75 percent of PM_{10} and $PM_{2.5}$ emissions in the Sydney Region. Given the existing high background concertation of PM_{10} and $PM_{2.5}$ in the region it is recommended that a ban on wood heaters be imposed on all future development within the site, as similarly imposed to the Canberra suburbs of Molonglo Valley, Dunlop and East O'Malley. Such a ban would aid in the protection of the public health of future residents. Should a ban not be imposed at a minimum wood heaters must comply with the requirements of the *POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016 (NSW)* as described in **Section 3.1.7**.

8.3.5 OLS Considerations

Should any proposed facility have an exhaust plume with a vertical velocity exceeding 4.3 m/s at the Sydney Airport OLS, a Plume Rise Assessment would be required to assess the potential hazard to aircraft operations in accordance with *Advisory Circular* AC 139.E-02v1.0 *Plume Rise Assessments 2023* (see **Section 3.1.7**).

Terrain height across the site varies, particularly with the dynamic nature of sand dunes, and is of low relief. Existing site ground elevation at the site are below 10 AHD and the OLS for Sydney Airport at Lot 2 North and Lot 2 South as declared by the Commonwealth Department of Infrastructure and Regional Development on 20 March 2015 is set at between approximately 110 and 156 AHD. Based on the above heights an exhaust plume with a vertical velocity exceeding 4.3 m/s would have to have a height of greater than 110 AHD to consider a potential hazard to aircraft operations

8.4 Assessment Requirements

Following changes to the SEPP (Kurnell Precincts) any proposed development within the site would require an environmental impacts assessment in accordance with the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). A component of the environmental assessment would involve identifying and assessing potential air quality impacts associated with development. Table 33 provided a brief outline of potential assessments that may be required for future development of the site, with regards to assessment of air quality impacts.

Table 33 Potential Future Assessment Requirements

Item	Requirements
Development Impacts	<u>Air Quality Impacts</u> Future development at the site would be required to assess the air quality impacts from each individual development. Cumulative assessment of air quality impacts on nearby sensitive receivers may also be required where proposed developments of a similar nature with regard to emission of air pollutants are proposed. The level of assessment for each development would be determined on a case by case basis. Where there is the potential for negligible or only minor air quality

Item	Requirements
	impacts from proposed industrial developments only a qualitative assessment may be required. Otherwise a quantitative assessment of potential air quality impacts will be required in accordance with the Protection of the Environment Operations Act 1997 (NSW) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2022)*. The Approved Methods lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW and can be used to predict whether emissions from a proposed development would comply with the EPA ambient air quality criteria. Proposed changes to Captain Cook Drive and associated vehicle numbers should be considered in accordance with the *Good Practice Guide for the assessment and management of air pollution from roadside transport proposals (CASANZ 2023)* <u>Odour Impacts</u> In addition to an assessment of air quality pollutants in accordance with the *Approved Method*s, any proposed development with the potential to generate offensive odour emissions should also be undertaken in accordance with the following documents: • *Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework* (DEC 2006a); and; • *Assessment and Management of Odour from Stationary Sources in NSW: Technical Notes* (DEC 2006b).
Construction Impacts	Assessment of construction air quality impacts would be required for development at the site including earthworks and any demolition works. The level of assessment would depend on the nature of the works and may involve: • A semi-quantitative assessment using the methodology outlined in the UK Institute of Air Quality Management (IAQM) document Guidance on the assessment of dust from demolition and construction; or • Quantitative assessment in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2022)*. The following items would need to consider as part of the construction impact assessment: • Potential impacts to existing sensitive receptors onsite including Boat Harbour Residents (prior to removal); • Potential cumulative and staging impacts associated with dust generating activities, including: - Earthworks, construction and/or demolition works that may coincide with existing dust generating activities onsite (prior to cessation) including sand mining and remediation works. - Cumulative impacts associated with construction works that may occur while the adjacent landfill and materials recovery facility is operational. - Cumulative impacts associated with nearby proposed develop or construction works such as road widening, or construction works under the Greenhills VPA. - Cumulative impacts associated with construction works that may occur in tandem with onsite remediation works and winding up of existing site operations. - In the event contaminated fill is discovered during excavation works appropriate safeguard measures would be required to prevent/minimise generation of airborne contaminants. A requirement of the construction impact assessment would be to identify best management practices for minimising construction dust and

Item	Requirements
	appropriate safeguard measures for combustion emissions to be incorporated into a Construction Air Quality Management Plan (CAQMP) prior to development. The following documentation should be considered when developing the CAQMP: • Mitigation measures listed within the AQIA for individual development applications within the Planning Proposal site. • *UK Institute of Air Quality Management (IAQM) document Guidance on the assessment of dust from demolition and construction* • *Good Practice Guide for the assessment and management of air pollution from roadside transport proposals (CASANZ 2023)* • Emission reduction strategies documented in the EPA's information report *Reducing Emissions from Non-road Diesel Engines* (Environ 2014) and at a minimum include: - Ensuring construction equipment are equipped with engines that conform with the highest available US, EU or equivalent national standards; - All diesel construction equipment uses fuel that conforms with the National Diesel Fuel Quality Standard; - Ensure all engines are correctly repaired and maintained; - Where possible improve engine performance by fitting with an anti-pollution control device; - Minimise engine idling times; - Locate plant and equipment away from sensitive populations and residential areas; restrict access to such areas to essential vehicles and machinery only and/or use lowest emissions equipment near these areas where possible; and - Where possible avoid use on onsite diesel or petrol generators by substituting mains electricity or battery powered equipment where possible.
Landfill Gas	Should the proposed development (or SEPP amendment that would have the effect of allowing development) encroaches into the recommended landfill buffer area (250m from landfill cell) an environmental audit should be conducted to assess the risk of harm to the proposed development posed by the potential offsite migration of landfill gas and amenity impacts resulting from the landfill. In the event a building or structure is located within the recommended buffer monitoring would be required in accordance with *NSW EPA Environmental Guidelines, Solid Waste Landfills* (EPA 2016). Building and structure buffer distances apply to closed landfill sites until the site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Typically, this will be a period of about 30 years. At least 24 months of monitoring may need to be undertaken at the site to determine if the site was suitable for enclosed development.
Vehicle Emissions	Proposed development, particularly multi story buildings adjacent to busy roads may require further assessment of vehicle emissions, where formation of urban canyons have the potential to impact receptors, particularly highly sensitive receptors such aged childcare, or aged care facilities. Air dispersion modelling using the lagrangian particle model GRAL developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria would be recommended at the development application stage if required.
Gas Efflux and Exhaust Plumes	Any future development with a gas efflux or exhaust plume which may have an average vertical velocity exceeding 4.3 m/s at the Sydney Airport OLS would be required to undertake a Plume Rise Assessment in accordance with the Advisory Circular AC 139.E-02v1.0 Plume Rise Assessments 2023 to assess the potential hazard to aircraft operations.

Item	Requirements
Wind Comfort Analysis	The existing annual average wind speed recorded at Kurnell BoM station over the ten-year period was 5.8 m/s is considered a moderate windspeed. Development of multistorey buildings as part of the Planning Proposal have the potential to create wind tunnels. Given the proposed utilisation of open space and outdoor dining areas it recommended that a pedestrian wind comfort assessment be undertaken for development applications for each Precinct or development stage.

9.0 Conclusion

AECOM have prepared an AQIA report to accompany Planning Proposal which proposes amendments to SEPP Precincts and SSLEP 2015 to accommodate a diverse range of land uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell. This report has been prepared to assess the air quality impacts from the proposed development following the initial Air Quality Impact Assessment report dated 12 February 2020 (AECOM 2020) and provides additional information to address DPE, EPA and Sutherland Shire Council following the Scoping Proposal issued by the Proponent in March 2023.

The revised AQIA included a quantitative assessment of potential air quality impacts from vehicle emissions associated with the Planning Proposal on future sensitive receptors on Captain Cook Drive; and to assess reverse amenity impacts from dust and odour from the adjoining Breen proposed development. To assess the impacts air dispersion modelling was undertaken using GRAL. Results of the dispersion modelling indicated:

- Predicted cumulative NO_2 and CO concentrations associated with the Planning Proposal modelled scenarios for 2029 and 2039 at sensitive receptors were well below the relevant EPA criteria for all averaging periods.
- Modelled dust emissions included emissions from vehicles on Captain Cook Drive with and without the proposal and the proposed modification to the adjoining Breen Facility. Results indicated:
  - Predicted cumulative maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations were found to exceed the EPA criteria for all modelled scenarios. This is largely attributed to elevated background concentrations already exceeding the EPA criteria. There was one additional exceedance of the EPA criteria for the 'with project' scenario for 2036 for both PM_{10} and $PM_{2.5}$. Here the incremental contributions were relatively minor with the background concentration already approaching the criteria when the exceedance occurred.
  - The predicted cumulative annual average PM_{10} and $PM_{2.5}$ concentrations were below the EPA criteria for all modelled scenarios.
  - Incremental maximum 24-hour and annual average contributions are relatively similar across all modelled scenarios indicating that dust from the Breen facility is the highest contributor to PM_{10} and $PM_{2.5}$ concentrations (compared to vehicle emissions) at the worst affected sensitive receptor.
- Results from the modelling predict that both the maximum and 99th percentile odour concentrations are well below the EPA 1-hour 99th percentile odour criterion of 2 OU with no reverse amenity odour impacts anticipated from adjacent landfilling activities.

Based on the dispersion modelling results the proposed setback distance of the western most sensitive receptors within the Town Centre Precinct closest to the Breen Facility is considered adequate to minimise potential reverse amenity air quality and odour impacts from the Breen Proposal. Simialry the proposed setback distance of 70m from Captain Cook Drive for the nearest proposed receptors within the Town Centre Precinct and Quibray Bay Precinct is considered adequate provided the relevant planning and design considerations in accordance with the Guideline (DoP 2008) are met.

In addition to the quantitative assessment a qualitative impact assessment was undertaken for vehicle emissions on internal roads based on the Planning Proposal's potential to generate urban canyons which result in unfavourable dispersal conditions in built environments. A review of street aspect ratios based on proposed street widths and building set back distances and heights in the Master Plan found that, due to larger street widths and setback distances, street canyons would be of a low to mid-depth resulting in better dispersal conditions.

Reverse amenity impacts from air pollutants and odour were also assessed from a range of sources including the Cronulla WRRF, Ampol Fuel Terminal, Biogenic emissions from Mangroves and aircraft emissions from Sydney Airport were also assessed qualitatively. A qualitative assessment of these sources concluded that all sources were unlikely to have a significant impact on the air or odour amenity of future receptors within the Planning Proposal Site.

Based on the above findings provided identified planning and design considerations identified in this report are implemented to minimise potential air quality impacts and additional studies identified are undertaken at the development application stage no significant air quality impacts have been identified from the Planning Proposal.

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Appendix A

Amendment of SEPP (Kurnell Peninsula) AQIA 2020

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Amendment of SEPP (Kurnell Peninsula) 1989

Air Quality Impact Assessment

Amendment of SEPP (Kurnell Peninsula) 1989

Amendment of SEPP (Kurnell Peninsula) 1989

Air Quality Impact Assessment

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Amendment of SEPP (Kurnell Peninsula) 1989

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Amendment of SEPP (Kurnell Peninsula) 1989

Table of Contents

Amendment of SEPP (Kurnell Peninsula) 1989

1.0 Introduction

1.1 Background

Besmaw, the landowner of 251 and 280-282 Captain Cook Drive, Kurnell Peninsula (the site) has initiated a Department of Planning and Environment (DPE) led process to review and amend State Environmental Planning Policy (Kurnell Peninsula) 1989 (SEPP Kurnell Peninsula) as it applies to the site.

The aim of the SEPP Kurnell Peninsula review process is to set the strategic land use framework for the site, within the context of the broader Kurnell Peninsula and South District. The review process commenced in June 2017, and a scope of works for technical studies was issued by the DPE on 25 September 2017 to inform the master planning process. The scope of works identified a number of technical studies be undertaken, including; biodiversity, bushfire, flooding and water cycle management, indigenous heritage, non-indigenous heritage, land capability, hazards and air quality, noise and vibration, traffic and transport and economic feasibility.

Besmaw have engaged AECOM Australia Pty Ltd (AECOM) to prepare an Air Quality Impact Assessment (AQIA) to address the DPE scope of works relating to air quality impacts. A copy of this DPE scope of works has been included in **Section 1.2.1** of this report. The findings of this report have informed the master planning process for the site.

1.2 Purpose of Report

1.2.1 Department of Planning and Environment Requirements

The AQIA for the proposed amendment of the SEPP (Kurnell Peninsula) 1989 has been prepared in accordance with the requirements of the Department of Planning Industry and Environment (DPIE) (formerly Department of Planning and Environment (DP&E)). Key matters for consideration in the AQIA are described in the State Environmental Planning Policy (Kurnell Peninsula) 1989 Review, Scope of Works document dated September 2017 and are shown in **Table 1** along with a reference to where the requirements are addressed in the report.

In addition to the key matters for consideration in the AQIA shown in **Table 1** the methodology for the AQIA was reviewed by DPIE, Sutherland Council and the Environment Protection Authority (EPA); with the proposed AQIA accepted by DPIE in July 2019[1].

Table 1 Department of Planning, Industry and Environment Requirements for Air Quality Impact Assessment.

Item	Section Addressed
Assessment should consider all potential air pollutants, including dust, complex mixtures of odours, individual odorous pollutants and air toxics	**Section 5.3.1** and **Section 6.0**.
The specific pollutants assessed must be selected based on a review of existing and potential emission sources in the vicinity of the proposed development	**Section 5.3.1**, **Section 5.3.2** and **Section 6.0**.
The information provided indicates potential for contaminated land and water, due to previous land uses. Air quality impacts associated with contamination and remediation activities must be evaluated	**Section 6.2.1**
A level 1 odour assessment as described in Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW (and accompanying technical notes) should be undertaken and identify any mitigation and management approaches including nominal separation distances.	**Section 6.3.2, Section 6.3.4** and **Section 7.3**
The Assessment should be undertaken with reference to: • Approved Methods for the modelling and Assessment of Air Pollutants in NSW • Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW; and • Development Near Rail Corridors and Busy Roads – Interim Guideline and the Infrastructure SEPP.	**Section 1.2.2**, **Section 3.4.1, Section 6.0** and **Section 7.4.1**
Prepare information that outlines the findings of the Air Quality Impact Assessment, including maps identifying those areas where urban development would encroach into the 'separation distance' between it and any odour producing activities;	**Section 6.0** and **Section 7.3**
Make specific recommendations on any mitigation approaches or measures including but not necessarily limited to staging development, separation distances to minimise exposure, architectural or building design treatments and transitional approaches. Consideration should be given to: • Design approaches to minimise exposure to particle pollution next to major roads (e.g Captain Cook Drive) especially where road volumes are expected to increase; • Restricted installation of the wood heaters and open fire places as wood heaters are a major contributing source of elevated particle levels in Sydney; and • Applying best management practices at the construction stage as diesel and gas powered equipment used in construction can cause air pollution.	**Section 7.2** to **Section 7.5.2**

[1] It is noted that based on the proposed buffer zone of 70 m from Captain Cook Drive air dispersion modelling of vehicle emissions was not undertaken as previously stated within methodology for the AQIA as accepted by DPIE in July 2019

1.2.2 Project Objectives and Scope

The Purpose of this report is to outline the findings of an AQIA into the proposed amendment of the SEPP (Kurnell Peninsula) 1989. The AQIA would be used to inform the master planning for the future development of the site, which will be the basis for future land use zones and development controls to guide long term development of the site. This report aims to address the requirements of the DP&E described in **Section 1.2.1** for the Project and has been prepared in accordance with the following guidelines:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2017);
- *Technical Framework, Assessment and management of odour from stationary sources in NSW* (DEC 2006); and
- *Technical Notes, Assessment and management of odour from stationary sources in NSW* (DEC 2006a).

The AQIA involved undertaking a qualitative assessment of the air quality impacts associated with the proposed SEPP amendment and included the following scope of work:

- Description of the proposed amendment of the SEPP (Kurnell Peninsula) 1989:
- Identification of relevant legislation, planning and guideline documents relevant this AQIA;
- Identification of relevant air quality, odour and landfill gas criteria;
- Description of the existing environment including local meteorology and climate, existing air quality and current and potential future air and odour emissions, terrain and landuse;
- Identification of sensitive land uses within the study area
- Undertake a qualitative air and odour impact assessment for:
    - Future Land Use and Development Impacts including a qualitative assessment of construction impacts, land use and staging impacts and a semi quantitative assessment of vehicle emissions;
    - Reverse amenity impacts from nearby potential sources of air pollutants or odour emissions;
- Provide recommendations to inform the master planning for the future development including; for project staging, separation distances, planning and design considerations, management practices and any future assessment requirements.

2.0 Project Description

2.1 Location

The site is comprised of two lots fronting Captain Cook Drive on the Kurnell Peninsula within the Sutherland Shire Local Government Area (LGA); Lot 2 North and Lot 2 South. Lot and Deposited Plan (DP) numbers along with a description of land use and current activities at each location are provided in **Table 2**. The location of the site is shown in **Figure 1** and site boundaries are shown in **Figure 2**.

The Site has a total area of approximately 176 hectares (ha). Lot 2 North, the smaller of the two lots has an area of approximately 16 ha and is bound by Quibray Bay to the north and north-east, Towra Point Nature Reserve to the west and Captain Cook Drive to the south. Lot 2 South has an area of approximately 160 ha. It is bound by Captain Cook Drive to the north, industrial zoned land to the northeast (including the Sydney Water Desalination Plant), Kurnell Village and the Caltex Oil Refinery, Kamay Botany Bay National Park to the east, Bate Bay to the South[2] and Wanda Reserve to the West.

The entire site is privately owned, including the foreshore area along Bate Bay and Boat Harbour. Potential future site land uses are discussed in further detail in **Section 2.2** and **Section 5.4.2**.

Table 2 Site Location and Existing Land Use Description

Lot Reference	Address	Lot and DP No.	Existing Land Use and Activities
Lot 2 North	251 Captain Cook Drive; Kurnell, NSW	Lot 2 DP 1030269	• Occupied in part by Kurnell Boarding Stables and Riding School • Contains a small area of wetlands listed under the *State Environmental Planning Policy No. 14 – Costal Wetlands* (SEPP 14): • The remaining land open space and does not contain any areas of significant vegetation or endangered ecological communities. • Besmaw is undertaking ongoing land management including weed eradication.
Lot 2 South	280-282 Captain Cook Drive; Kurnell, NSW	Lot 2 DP 559922	• Sand mining activities including: - Excavation of fine sands; - Backfilling with Virgin Excavated Natural Material (VENM); - Management of frontal dune system at Bate Bay: - Removal of Noxious weeds: - Planting endemic species to protect dunes; • Safety and security fencing; • Residential dwellings to the North of Boat Harbour (Boat Harbour Shacks) used for permanent and vacation accommodation;

[2] The property title of Lot 2 DP 1030269 extends down to the mean high water mark in Bate Bay.

Source: Imagery from Google Earth 2016

Figure 1 Site Location

Source: Imagery from Six Maps 2017

Figure 2 Lot 2 North and Lot 2 South

2.2 Proposed Amendment to SEPP (Kurnell Peninsula) 1989

As described in **Section 1.1,** in June 2017 Besmaw initiated a DP&E led process to review and amend State Environmental Planning Policy (Kurnell Peninsula) 1989 (SEPP Kurnell Peninsula) as it applies to the site (refer to **Section 2.1**). The aim of the SEPP Kurnell Peninsula review process is to set the strategic land use framework for the site, within the context of the broader Kurnell Peninsula and South District. The SEPP Amendment request seeks to:

- Apply new land use zones to be consistent with the *Standard Instrument Local Environmental Plans - Order 2006*
- Translate a range of presently permissible land uses through proposed zones and additional permitted uses;
- Simplify planning controls applying to the site;
- Facilitate the dedication of land for public open space purposes and recognise dedications that have already occurred and current open space reservations applying to the site;
- Establish a planning framework to facilitate opportunities and directions established under the deed of agreement;
- Facilitate the orderly and economic development of the site consistent with the emerging urban character of Kurnell Peninsula;
- Enable future incorporation of the new planning controls applying to the site within the *Sutherland Shire Local Environmental Plan 2015*

3.0 Legislation and Planning

3.1 NSW State Environmental Planning Policies (SEPPs)

The following subsections provide a description and discussion of the State Environmental Planning Policies (SEPPs) relevant to the Air Quality Impact Assessment.

3.1.1 State Environmental Planning Policy (Kurnell Peninsula) 1989 (NSW)

The *State Environmental Planning Policy (Kurnell Peninsula) 1989 (NSW)* (SEPP (Kurnell Peninsula)) applies to the land within the Shire of Sutherland, known as Kurnell Peninsula, and adjacent waterways. The aim of the SEPP (Kurnell Peninsula) is to conserve the natural environment ensuring that development is managed in a sustainable manner and to promote and encourage development consistent with the ecological and heritage values of the site. Environmental planning aims of the policy also include preservation of land of natural, environmental, historical or cultural significance including the wetlands, to conserve the aquatic environment and its resources and to progressively phase out sand mining and facilitate rehabilitation of degraded lands.

The site is subject to the SEPP (Kurnell Peninsula) and the land is currently zoned as follows in accordance with the SEPP:

Lot 2 North

- Zone No 6 (c) (Private Recreation Zone)

  The majority of land within Lot 2 North is covered by Zone No. 6(c) with the exception to a small portion of coastal wetland that falls under *State Environmental Planning Policy No. 14 (Coastal Wetlands) (NSW) 1985 (SEPP 14)*[3].

Lot 2 South

- Zone No. 4(a) (General Industrial Zone)

  Land over the eastern access corridor from Captain Cook Drive into the body of the lot is currently Zoned 4(a).

- Zone No. 6(b) (Public Recreation)

  Bate Bay foreshore is currently Zoned 6(b) for public recreation.

- Zone No. 7(b) (Special Development)

  The majority of land within Lot 2 South is zoned 7(b) and is largely attributed to sand mining activities.

- Part 9(a) (Regional Open Space)

  Land covered by the Boat Harbour is zoned Part 9(a).

Under Division 3 Clause 33 of the SEPP development for certain additional purposes is also allowed with the consent of Council. Proposed amendments to the SEPP (Kurnell Peninsula) are discussed in **Section 2.2** of this report and include updating land use zones to be consistent with the (*Standard Instrument Local Environmental Plans) Order 2006* and include dwelling houses as a permissible land use.

3.1.2 State Environmental Planning Policy (Infrastructure) 2007 (NSW)

The *State Environment Planning Policy (Infrastructure) 2007 (NSW)* (Infrastructure SEPP) is used to facilitate the effective delivery of infrastructure across NSW. This is achieved by improving regulatory certainty and efficiency, flexibility when locating infrastructure and services, use of government owed

[3] As part of DP&E and OEH Coastal Reforms, SEPP 14 (Coastal Wetlands) together with SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection) has been consolidated into the *Draft Coastal Management State Environment Planning Policy 2016 (NSW*).

land, identifying environmental assessment procedures, assessment of impacts adjacent to development and consultation procedures.

The policy includes specific planning provisions and development controls for 25 types of infrastructure works and facilities including Roads under Part 3 Division 17 of the Infrastructure SEPP. Part 3 Division 17, Subdivision 2, Clauses 98 to 104 specifically refers to development in or adjacent to road corridors and reservations. Clause 101 explicitly covers development with frontage to a classified road. Under Clause 101(1)(b) the objective development with a frontage to a classified road must:

> *"…prevent or reduce the potential impact of traffic noise and vehicle emission on development adjacent to classified roads."*

Furthermore, under Clause 101(2)(b) the consent authority must not grant consent to development on land that has a frontage to a classified road unless it has satisfied that:

> *"*(a) where *practicable and safe, vehicular access to the land is provided by a road other than the classified road, and*
>
> *(b) the safety, efficiency and ongoing operation of the classified road will not be adversely affected by the development as a result of:*
>
> *i. the design of the vehicular access to the land, or*
>
> *ii. the emission of smoke or dust from the development, or*
>
> *iii. the nature, volume or frequency of vehicles using the classified road to gain access to the land, and*
>
> *(c) the development is of a type that is not sensitive to traffic noise or vehicle emissions, or is appropriately located and designed, or includes measures, to ameliorate potential traffic noise or vehicle emissions within the site of the development arising from the adjacent classified road."*

Supporting documentation to the Infrastructure SEPP which guidance to the reduction of air quality impacts on sensitive adjacent development to roads as specified under Clause 101(1)(b) is discussed in **Section 3.4.1**

In addition to Clause 101, Clause 102 provides a classification for busy roads to which Division 17, Subdivision 2 applies (refer to **Section** Error! Reference source not found. for proposed changes to this clause). Under Clause 102(1) a applies to development of residential accommodation, places of public worship, hospitals and educational establishments or centre-based child care facilities adjacent to a road corridor with an annual average daily traffic volume of more than 20,000 vehicles.

While specifically related to general conditions of complying infrastructure development the following conditions applying to construction and demolition works under Clause 20C(8) under the Infrastructure SEPP are also essential in minimising dust emissions:

> *"(8C) Dirt, sand and other materials relating to the construction or other work compromised in the development and loaded onto any vehicles entering or leaving the site must be covered*
>
> *(8D) All vehicles, before leaving the site, must be cleaned of dirt, sand or other materials that have adhered during that construction or other work and could be tracked onto public roads."*

While Clause 20C(8) is not directly applicable to development adjacent to road corridors consideration should be given to the above mitigation measures and is discussed in **Section 7.4.1**.

3.2 Local Environmental Plan

The *Sutherland Shire Local Environmental Plan (2015)* (LEP 2015) aims to make local planning provisions for the Sutherland Shire Local Government area in accordance with Section 33A of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act). Currently the LEP does not apply to land within the study area which is identified as a 'deferred matter' under Part 1 Clause 1.3(A) of the LEP 2015 and Section 59(3) of the EP&A Act 1979.

Amendment of SEPP (Kurnell Peninsula) 1989

While the LEP 2015 currently does not apply to the site it is noted that the DPIE are continuously reviewing operational SEPPs to simplify the current planning system by removing duplicated, redundant and outdated planning controls. As part of this process planning provisions under existing SEPPs may be added to existing LEPs and as such there is the potential for provisions under the Kurnell Peninsula SEPP to be added to the LEP 2015 at a later date.

3.3 Commonwealth and NSW Regulations

3.3.1 Civil Aviation Safety Regulations 1998 (Cth)

The Civil Aviation Authority (CASA) are responsible for enforcing safety requirements stated in the *Civil Aviation Safety Regulations 1998 (Cth)* (CASR 1998) administered under the *Civil Aviation Act 1988 (Cth).* Aviation authorities have established that wind gusts with vertical velocity exceeding 4.3 metres per second (m/s) may cause damage to an aircraft airframe or otherwise upset an aircraft flying at low levels. Under Regulation 139.370 of the CASR 1998 and in accordance with the *Advisory Circular AC 139-5(1) Plume Rise Assessments* 2012 proponents of a facility where the vertical velocity of exhaust plumes exceed 4.3 m/s at an aerodrome Obstacle Limitation Surface (OLS), or at 110 m above the local ground anywhere else, must undertake plume rise modelling to assess the potential hazard to aircraft operations.

In January 2019 the 2012 *Circular AC 139-5(1)* was update to *Advisory Circular AC 139-5(v3.0) Plume Rise Assessments 2019.* This revision of the advisory circular amended the original 4.3 m/s benchmark velocity parameter to 6.1 m/s; which affords more leniency with regards to the vertical velocity of exhaust plumes at an OLS or 110m above ground level.

In December 2019 *Advisory Circular AC 139-5(v3.0) Plume Rise Assessments 2019* was placed under review. For the purpose of this assessment it is advised that the more conservative vertical velocity parameter of 4.3 m/s be adopted as the benchmark velocity.

The Kurnell Peninsula is located directly under the flightpath for the main north-south runways at Sydney airport. The OLS for Sydney Airport at Lot 2 North and Lot 2 South as declared by the Commonwealth Department of Infrastructure and Regional Development on 20 March 2015 is set at between approximately 110 and 156 AHD. Existing site ground elevation range from approximately 0 to 10m in height (refer to **Section 5.4.1**).

3.3.2 Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)

The *Protection of the Environment Operations (Clean Air) Regulation 2010 (NSW)* (POEO Clean Air Regulation 2010) under the *Protection of the Environment Operations Act 1997 (NSW)* (POEO Act 1997) prescribes the requirements for a number of air pollutant generating activities in NSW. Requirements include domestic solid fuel heater certification, controlled burning, and installation of pollution control devices on certain motor vehicles, petrol supply standards, emission standards for industry groups and control storage and transport of volatile organic compounds.

3.3.3 POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016

Under the *POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016 (NSW)* all solid fuel heaters sold on or after 1 September 2019 must be certified by a body approved by the EPA and:

- Comply with:
  - AS/NZS 4012:2014 Domestic solid fuel burning appliances – Method for determination of power output and efficiency; and
  - AS/NZS 4013:2014 Domestic solid fuel burning appliances – Method for determination of flue gas emission
- Have an overall average efficiency of at least 60 percent and a particulate emission factor of no more than 1.5g/kg (for heaters without catalytic combustors).

3.4 Development Guidelines

3.4.1 Development Near Rail Corridors and Busy Roads – Interim Guideline

The DP&E's *Development Near Rail Corridors and Busy Roads – Interim Guideline* (DoP 2008) (the Guideline) supports the specific rail and road provisions of the Infrastructure SEPP (see **Section 3.1.2**). The aim of the Guideline is to aid in reducing the health impacts of both noise and air quality impacts on sensitive adjacent development by assisting in the planning, design and assessment of development in or adjacent to rail corridors and busy roads. Under the guideline a busy road is defined as:

- Roads specified under Clause 102 of the Infrastructure SEPP including freeways, tollways, transit ways and any other road with 20,000 AADT volume or more;
- Any other road with a high level of truck movements or bus traffic.

Section 4 of the Guideline provides consideration for how to identify the potential for vehicle exhausts to impact on development adjacent to roadways and how to address potential air quality issues from vehicle exhausts for development near busy roads at the design stage. Section 4.4 of the Guideline lists the triggers for when air quality should be a design consideration for developments and provides guidance on design considerations that may be taken into account to mitigate air quality impacts. These triggers and are provided in **Table 3**.

Table 3 Triggers for Air Quality as a Design Consideration (DoP 2008)

Trigger	Design Consideration (Y/N)	Comment
Within 10 metres of a congested collector road (traffic speeds of less than 40 km/hr at peak hour) or a road grade > 4% or heavy vehicle percentage flows > 5%,	No	• Level of Service (LoS) for Captain Cook Dr-Lindum Road intersection for 2018 rated A; good performance of intersection operating within capacity (ttpp 2019).
Within 20 metres of a freeway or main road (with more than 2500 vehicles per hour, moderate congestions levels of less than 5% idle time and average speeds of greater than 40 km/hr)	No	• Traffic volumes for 2018 at Captain Cook Dr-Lindum Road intersection are 969 VPH during AM peak and 928 during PM Peak (ttpp 2019) • Level of Service (LoS) for Captain Cook Dr-Lindum Road intersection for 2018 rated A; good performance of intersection operating within capacity (ttpp 2019).
Within 60 metres of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources)	Yes	• Site not located within 60m of any road tunnels, major intersections or overpasses. • Site located within 60m of a roundabout. • Site located adjacent to existing landfill and within 1km of Caltex Kurnell Fuel Terminal.
As considered necessary by the approval authority based on consideration of site constraints, and associated air quality issues	Yes	• DPIE have specifically requested consideration in accordance with the Land Capability, Hazards and Air Quality Scope of Work documentation. • Design approaches are to minimise exposure to particle pollution next to major roads (e.g Captain Cook Drive) especially where road volumes are expected to increase.

Based on **Table 3** development of the site would trigger the need to consider air quality impacts from vehicle emissions at the design stage of the development. A qualitative assessment of vehicle emissions is presented in **Section 6.2.4** and design considerations in accordance with the guideline for future development at the site are provided in **Section 7.4.1**.

Amendment of SEPP (Kurnell Peninsula) 1989

3.4.2 Environmental Guidelines, Solid Waste Landfills

The NSW EPA *Environmental Guidelines, Solid Waste Landfills* (EPA 2016) under *the Protection of the Environment Operations Act 1997 (NSW)* provide a set of minimum standards for the assessment of the operation and post-closure period for general solid waste and restricted solid waste landfills.

Development on or near closed (and operational) landfills can be a cause for concern due to the length of time required for waste to become physically, chemically and biologically stable; with the potential for landfill to produce landfill gases many years after closure. Section 10.3 of the guidelines states that development on or near closed landfills should only be considered if the following conditions are met:

- The landfill should meet the EPA's stabilisation criteria for gas concentration levels (see **Section 4.3**). Gas criteria are particularly important for developments that create enclosed spaces where gas can accumulate or migrate (e.g buildings, basements, manholes, tunnels, service ducts, and stormwater and sewer pipes). These criteria may be less critical in the case of open developments such as sporting fields, golf courses and car parks.
- The risk of gas accumulation in any enclosed spaces within the development should be appropriately managed through design measures such as venting systems, sub-floor systems, gas barrier systems and other measures for managing sub-surface gas migration (see **Section 7.4.2**); and
- Periodic methane monitoring should be conducted in all buildings and underground utilities (see **Section 7.4.2**).

4.0 Air Quality Criteria

Potential sources of air pollutants of air pollutants from future, residential, commercial and recreational activities (refer to **Section 6.2**) at the site are likely to be limited and are currently unknown. As such assessment criteria discussed in the following subsections has been limited to odour impact assessment criteria (refer to **Section 4.1**) and the six pollutants monitored by the NSW EPA; Ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter equal to or less than 10 microns in diameter (PM_{10}) and particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$) (refer to **Section 4.2**). These pollutants were included in the *National Environmental Protection Measure (Ambient Air Quality)* (NEPC 1998) (NEPM) which established a set of standards for measurement and assessment of these pollutants. The objective of the Ambient Air Quality NEPM is to achieve ambient air quality that allows for the adequate protection of human health and wellbeing.

4.1 Odour Assessment Criteria

The perception of odour is based on an individual's response to chemical exposure. The odour threshold is the theoretical minimum concentration of a chemical that produces an olfactory response, which, in practice, is used to indicate whether an odour is detectable; the odour threshold defines 1 odour unit (1 OU) for each chemical. The threshold relates to odour detection and does not consider the recognition of an odours character.

The EPA's impact assessment criteria for complex mixtures of odours (EPA, 2017) were designed to take into account the ranges of individual sensitivity to odours based on a statistical approach based on the size of the surrounding population. As population density increases, the proportion of sensitive individuals is also likely to increase; as such, areas with larger populations require more stringent criteria. The criteria are shown in **Table 4**.

Table 4 EPA Impact Assessment Criteria – Complex Odours

Population	Criteria (OU)*
Urban (≥ ~2000) and/or schools and hospitals	2
~ 500	3
~ 125	4
~ 30	5
~ 10	6
Single residence (≤ ~2)	7
*99th percentile nose response time	

The proposed site is bound by Quibray Bay to the north and Bate Bay to the South and east and west of the site is made of largely native vegetation including reserves and state parks and industrial areas. The nearest high density residential land is Kurnell Village located over 1km north east of the site. The site itself is proposed for future high density residential commercial and recreational use and as such the most stringent odour assessment criterion of 2OU would be applicable to this area.

4.2 Air Quality Criteria

Table 5 summarises the NSW EPA's impact assessment criteria for the pollutants included in the assessment. In general, these criteria relate to the total burden of air pollutants in the air and not just the air pollutants from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess impacts. A discussion of background levels in the study area is provided in **Section 5.3.1**.

Table 5 NSW EPA Air Quality Impact Assessment Criteria (EPA 2017)

Pollutant	Averaging Period	Criteria
Ozone (O_3)	Maximum 1-hour	214 μg/m^3
	Maximum 4-hour	171 μg/m^3
Carbon monoxide (CO)	Maximum 1-hour average	30 mg/m^3
	Maximum 8-hour average	10 mg/m^3
Sulphur dioxide (SO_2)	Maximum 1-hour average	570 μg/m^3
	Maximum 24-hour average	228 μg/m^3
	Annual average	60 μg/m^3
Nitrogen dioxide (NO_2)	Maximum 1-hour average	246 μg/m^3
	Annual average	62 μg/m^3
Particulate matter (PM_{10})	Maximum 24-hour average	50 μg/m^3
	Annual average	25 μg/m^3
Particulate matter ($PM_{2.5}$)	Maximum 24-hour average	25 μg/m^3
	Annual average	8 μg/m^3
μg/m^3 = micrograms per cubic metre		

4.3 Landfill Gas Stabilisation Criteria

Landfill gas has the potential to accumulate at dangerous levels in enclosed spaces at or near landfills. Landfill gas is primarily made up of methane and carbon dioxide and must not accumulate in buildings. Methane is explosive in the range of 5% to 15% volume/volume, and landfill gas can lead to asphyxiation in enclosed spaces. The threshold level for further investigation and corrective action is detection of methane at concentrations above 1% (volume/volume).

Development of buildings or structures near landfill sites (within 250m) are subject to the landfill gas stabilisation criteria listed under Section 10.2 of the EPA Environmental Guidelines (EPA 2016) (refer to **Section 3.4.2**). The criterion states that gas concentration levels in all perimeter gas wells have fallen to less than 1% methane (volume/volume) and less than 1.5% carbon dioxide (volume/volume) above the established natural background for a period of 24 months).

The guideline also states that the above criteria may be less critical in the case of open developments such as sporting fields, golf courses and car parks.

5.0 Existing Environment

5.1 Meteorology

Meteorology in the area surrounding the site is affected by several factors such as terrain and land use. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale. Wind speed and direction are important variables in assessing potential air quality impacts, as they dictate the direction and distance air pollutant plumes travel. Wind speed and wind directional data from the Bureau of Meteorology (BoM) meteorological station at Kurnell (Station number 066043), approximately 2.5 km northeast from the site (at its closest point) has been used in this assessment. The BoM meteorological station at Kurnell only measures wind speed and wind direction as such this data has been supplemented by long term climate data for other meteorological parameters from the BoM Sydney Airport monitoring station and is discussed in **Section 5.2**.

Wind frequency distribution tables for the 2015 and 2016 BoM data are presented in **Table 6** and **Table 7**, while annual and seasonal wind roses for both years are shown in **Figure 3**. It can be seen from **Table 6**, **Table 7** and **Figure 3** that on an annual basis winds are frequent from the north east, south to south southwest and from the west to northwest. In 2015 there were a higher proportion of southerly winds, occurring 12 percent of the time as opposed to in 2016 where southerlies occurred 9 percent of the time and westerlies were the dominant wind occurring 11 percent of the time. For both years the annual average wind speed was found to be 5.7 m/s a moderate wind speed, which would aid in the dispersion of local air pollutants. Calms occurred for just over two percent of the time in 2015 and 2016.

Seasonally, the highest average wind speed for 2015 and 2016 occurs during spring. Wind direction between the two data sets slightly varies with 2015 having a higher occurrence of southerly winds and 2016 having a higher occurrence of 2016, the same trend is seen for autumn and is reflected in the annual data. Wind directional data for summer and winter is shown to be similar between the two datasets with a high proportion of south to south south-westerly and south easterly winds in summer and a high frequency of west to north westerly winds recorded in winter.

Table 6 Wind Speed Frequency Distribution of BoM 2015 data at Kurnell (%)

Wind Direction	Wind Speed Class (m/s)						
	0.5-2.1	2.1-3.6	3.6-5.7	5.7-8.8	8.8-11.1	≥11.1	Total
N	0.17	1.89	2.42	0.96	0.05	0.01	5.50
NNE	0.10	0.58	1.61	1.89	0.27	0.03	4.50
NE	0.10	0.64	1.61	3.62	2.25	0.79	9.01
ENE	0.23	0.68	1.64	3.03	0.25	0.01	5.84
E	0.14	0.84	2.26	1.22	0.08	0.00	4.54
ESE	0.06	0.53	1.36	0.58	0.02	0.00	2.55
SE	0.03	0.64	1.50	0.80	0.02	0.01	3.00
SSE	0.21	0.81	1.48	1.60	0.00	0.01	4.11
S	0.25	0.97	2.85	5.58	1.28	1.13	12.07
SSW	0.40	0.75	1.18	4.32	1.67	0.76	9.08
SW	0.23	0.57	1.16	1.69	0.40	0.48	4.53
WSW	0.32	0.86	1.07	0.99	0.21	0.03	3.48
W	0.31	1.87	2.67	3.61	1.07	0.53	10.06
WNW	0.17	1.75	2.56	1.63	0.59	0.26	6.96
NW	0.26	2.03	3.44	1.19	0.21	0.19	7.32
NNW	0.14	2.10	2.59	0.50	0.15	0.01	5.49
Sub-Total	3.12	17.52	31.40	33.21	8.52	4.27	98.04
Annual (Jan to Dec, 2015). Total periods = 8,760; Valid periods = 8,758; Calm wind periods = 170; Calm winds: 1.94 %							

Table 7 Wind Speed Frequency Distribution of BoM 2016 data at Kurnell (%)

Wind Direction	Wind Speed Class (m/s)						
	0.5-2.1	2.1-3.6	3.6-5.7	5.7-8.8	8.8-11.1	≥11.1	Total
N	3.58	0.39	0.14	0.00	0.00	0.00	4.11
NNE	1.96	0.34	0.14	0.00	0.00	0.00	2.44
NE	2.35	0.92	0.65	0.00	0.00	0.00	3.91
ENE	3.71	2.03	1.45	0.10	0.00	0.00	7.29
E	5.19	3.64	1.45	0.05	0.00	0.00	10.33
ESE	3.47	3.07	1.00	0.02	0.00	0.00	7.55
SE	2.90	2.69	1.42	0.15	0.00	0.00	7.15
SSE	2.94	2.29	1.12	0.08	0.00	0.00	6.43
S	1.36	1.74	1.25	0.05	0.00	0.00	4.40

Wind Direction	Wind Speed Class (m/s)						
	0.5-2.1	2.1-3.6	3.6-5.7	5.7-8.8	8.8-11.1	≥11.1	Total
SSW	3.11	1.29	0.60	0.10	0.00	0.00	5.11
SW	8.85	2.16	0.78	0.14	0.00	0.00	11.93
WSW	2.11	1.85	0.85	0.17	0.02	0.00	5.00
W	1.60	1.50	0.78	0.40	0.05	0.00	4.33
WNW	1.82	3.85	2.42	0.84	0.07	0.00	8.99
NW	2.85	1.66	1.75	0.48	0.00	0.00	6.74
NNW	1.39	0.45	0.26	0.02	0.00	0.00	2.12
Sub-Total	49.18	29.86	16.05	2.60	0.14	0.00	97.83
Annual (Jan to Dec, 2016). Total periods = 8,784; Valid periods = 8,774; Calm wind periods = 206; Calm winds: 2.35 %							

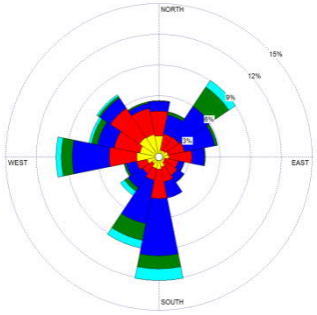
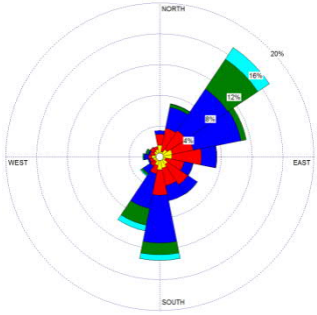
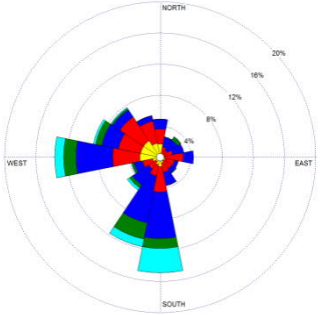
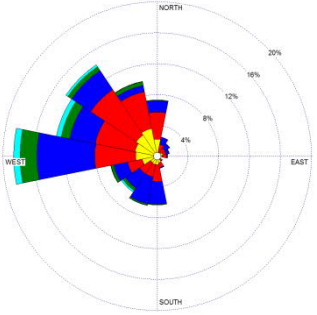
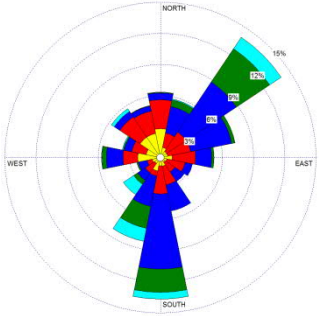
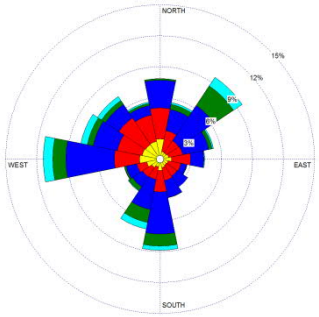
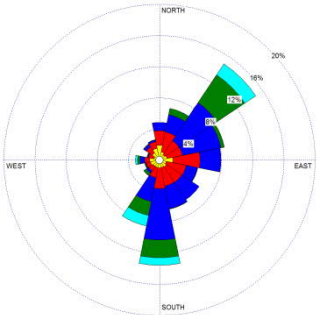
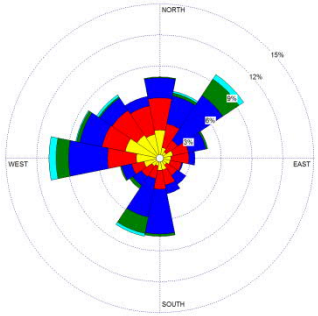
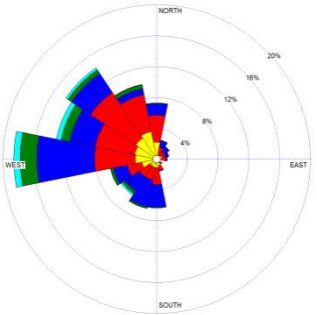
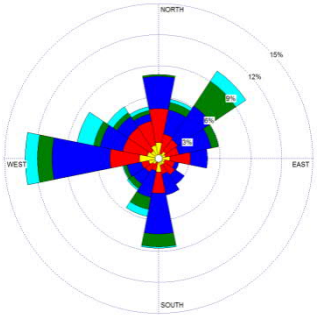
2015				
Annual	**Summer**	**Autumn**	**Winter**	**Spring**
				
Calms: 1.94%	Calms: 2.45%	Calms: 2.04%	Calms: 1.81%	Calms: 1.46%
2016				
Annual	**Summer**	**Autumn**	**Winter**	**Spring**
				
Calms: 2.35%	Calms: 2.60%	Calms: 1.85%	Calms: 2.19%	Calms: 2.71%

Figure 3 Annual and Seasonal Wind Roses at Kurnell BoM Station for 2014 and 2015.

5.2 Local Climate

The BoM meteorological station at Sydney Airport records climate data for a range of meteorological parameters including, temperature, humidity, rainfall, wind speed and wind direction. A summary of the long-term data recorded at this station between 1939 and 2017 is shown in **Table 8**. Sydney Airport is located approximately 8.km north of the site and the data provides an indication of the regional climate of the area.

Table 8 Climate Summary, BOM Monitoring Station at Sydney Airport, 1939 to 2017

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	27	27	25	23	20	18	17	18	21	23	24	26	22
Mean minimum temperature (°C)	19	19	18	14	11	9	7	8	11	13	16	18	14
Mean rainfall (mm)	95	112	117	109	97	124	70	77	60	70	80	74	1086
Decile 5 (median) rainfall (mm)	73	82	84	82	78	101	52	44	46	47	67	63	1046
Mean number of days of rain ≥ 1 mm	8	9	9	9	8	9	7	7	7	8	8	8	96
Mean number of clear days	7	6	8	9	9	9	12	13	11	8	6	7	105
Mean number of cloudy days	13	12	12	11	11	11	9	8	8	11	12	12	129
Mean 9am temperature (°C)	22	22	21	18	15	12	11	13	16	18	20	22	17
Mean 9am relative humidity (%)	70	73	73	71	73	74	71	65	62	61	64	66	69
Mean 9am wind speed (km/h)	14	14	13	13	13	13	13	14	16	16	16	15	14
Mean 3pm temperature (°C)	25	25	24	22	19	17	16	17	19	21	22	24	21
Mean 3pm relative humidity (%)	60	63	61	59	58	57	52	49	51	54	56	58	57
Mean 3pm wind speed (km/h)	24	23	21	19	17	18	18	21	23	25	25	25	22

As shown in **Table 8**, the warmest temperatures occur during the summer months, with the highest average maximum temperature (27ºC) occurring in January. July is the coldest month, with a recorded average minimum temperature of 17ºC.

The site has an annual average rainfall of 1086mm occurring across an average of 96 days per year. June is the wettest month, with an average rainfall of 124 millimetres, while July is driest month with an average rainfall of 60 millimetres. Humidity follows a diurnal cycle, with higher humidity in the morning compared to the afternoon.

Average 9am and 3pm wind speeds in **Table 8** show that wind speeds are generally higher in the afternoon compared to the morning with 9am and 3pm averages of 14km/h and 22 km/h respectively. The highest average wind speeds occurring in December (25 km/h).

5.3 Local Air Quality

5.3.1 Potential Sources of Odour and Air Pollutants

A review of the National Pollution Inventory (NPI) data base and EPA Environmental Protection Licence database identified the following existing potential sources of air emissions within Kurnell in **Table 9**. **Table 9** provides a brief description of existing potential odour sources both onsite and offsite.

Table 9 Potential Sources of Air Emissions

Source	Description	Pollutants	Address & Distance from Site	Comment
Onsite Sources				
Sand Mining and Rehabilitation	Rehabilitation of sand quarry with virgin excavated natural material (VENM); and sand extraction, crushing grinding or separating activities	Particulates	Lot 2 South	Sand mining and rehabilitation works to cease as part of future proposed development of the site.
Kurnell Boarding Stables and Riding School	Small boarding stable facility and riding school.	Odour and particulates	Lot 2 North	The stable is a small facility and a site visit undertaken on 30 November 2017 indicated no significant source odour or dust from the stables.
Nearby Sources				
Cronulla Sewage Treatment Plant	Primary, secondary and tertiary treatment of wastewater (EP 250,000, treating 53 million litres of wastewater a day)	Odour	Adjacent to Captain Cook Drive, approximate 1.8km west of the site.	Sufficient distance and vegetation in-between plant and site to provide buffering effect from potential odour impacts
Caltex Kurnell Terminal	Fuel terminal	Volatile organic compounds (VOCs), particulates, odour	2 Solander Street, Kurnell, NSW	Sufficient distance and vegetation in-between plant and site to provide buffering effect from VOC and odour impacts
Breen Resources	Recovery of general waste and waste disposal by application to land	Particulates, odour and landfill gas (methane and carbon dioxide)	Captain Cook Drive, Kurnell	Currently source of particulate, odour and methane emissions. Following site closure in site may still pose a potential source of landfill gas[4].

- [4] It is noted that Breen Resources lodged a modification application for their site in February 2019 assessment of this proposal has not been included in this report but is further discussed in Section 5.3.2 and Section 6.3.1.2.

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5.3.2 Potential Changes to Future Air Quality

Kurnell has traditionally been dominated by industrial uses which have largely influenced local air quality. Recently a reduction in heavy industrial activities has been observed, shifting to a higher proportion of light industrial activities in the area, potentially improving local air quality. Changes in heavy industry include the conversion of the Caltex Kurnell Refinery to a fuel terminal and the closure of the Continental Carbon Australia Plant. Further reductions in heavy industry activities are also anticipated with the winding down of sandmining on the site and landfill activities (Breen Holdings) to the west of the site.

In 2010 the GreenHills Voluntary Planning Agreement (VPA) was proposed between Sutherland Shire Council, Breen Holdings and Frasers Property Australia (formerly Australand). Land covered by the VPA occupies approximately 124 ha on the Kurnell Peninsula, including the Landfill adjacent to the Site. A total of 91 hectares of land as part of the VPA has been dedicated to open space including the recently established skateboard park and playing fields. The continued development under the VPA would see the cessation of potential air quality impacts such as dust and odour from landfill activities and an increase in sensitive receptor density adjacent to the site.

In February 2019 Breen Resources lodged a modification for development for the adjacent landfill site. The modification would involve relocating the existing waste facility (including plant and equipment) several hundred metres to the east on Lot 5 DP1158627. Site access would also be relocated from 330 Captain Cook Drive to the Lindum Road round-a-bout, east of the Marang Parkland Skate Park; and there would be a minor increase in the sites waste capacity. The proposed modification would result in the relocation existing sources of dust and vehicle emissions from the landfill site closer to Lot 2 North and Lot 2 South; prior to Breen's longer-term commitment to rehabilitate the site.

There is also the potential for future land use changes within Kurnell following the repeal of the SEPP (Kurnell Peninsula) and amalgamation of specified land use zones within the Sutherland Shire LEP 2015 which may impact on local air quality. An increase in high density residential and commercial land uses on the Peninsula may require adjacent land formerly zoned for general industrial use to be assigned a zone more compatible with surrounding land uses such as light industrial[5]. Furthermore, findings of the Economic Feasibility Study for the Project (Hill PDA 2018) indicate that industrial related employment within the LGA is declining and related employment is expected to decline over the next 30 years, which is likely to influence surrounding future land use.

5.3.1 Air Quality Monitoring Data

The nearest EPA monitoring station is the Randwick air monitoring station, approximately 11km northeast of the Site. The monitoring station is located on the grounds of the Randwick Army Barracks on the corner of Avoca and Bundock Streets. The site itself lies within the eastern suburbs of Sydney and is largely surrounded by residential area.

The Randwick air quality monitoring station was commissioned in 1995 and measures the following air pollutants:

- Ozone (O_3)
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Particulate matter equal to or less than 10 microns in diameter (PM_{10});
- Particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$);

A summary of the monitoring data from Randwick monitoring station for 2016 and 2017 is presented in **Table 10**. During the monitoring period one exceedance of the 24-hour PM_{10} criterion of 50 µg/m^3 occurred on 14 August 2017, with a recorded 24-hour average of 56 µg/m^3 (OEH 2018). The second highest 24-hour PM_{10} concentration recorded in 2017 was 46µg/m^3, which was below the EPA µg/m^3

[5] ***Light industry*** means an industry, not being a hazardous or offensive industry or involving use of a hazardous or offensive storage establishment, in which the processes carried on, the transportation involved or the machinery or materials used do not interfere with the amenity of the neighbourhood by reason of noise, vibration, smell, fumes, smoke, vapour, steam, soot, ash, dust, waste water, waste products, grit or oil, or otherwise.

criterion. Three exceedances of the 1 hour maximum ozone criterion also occurred in 2017, with the fourth highest 1 hour ozone concentration equal to the EPA criterion of 214 µg/m^3 (OEH 2018).

Recorded SO_2 and NO_x concentrations at Randwick were all within the OEH criterion for all averaging periods. Ground level 24 hour and annual average $PM_{2.5}$ concentrations for 2017 were also compliant with the relevant EPA criterion but data capture was limited between 31 March and 31 December 2017.

Table 10 Existing Air Quality at Randwick (1 January 2016 to 31 December 2017) (OEH 2018)

Pollutant	Averaging Period	Concentration (µg/m^3)		Criterion (µg/m^3)
		2016	2017	
Ozone (O_3)	Maximum 1-hour	212	248	214
	Maximum 4-hour	192.6	218.28	171
Sulphur dioxide (SO_2)	Maximum 1-hour	97	83	570
	Maximum 24-hour	10	22	228
	Annual Average	2	3	60
Nitrogen dioxide (NO_2)	Maximum 1-hour	90	84	246
	Annual Average	16	14	62
Particulate matter (PM_{10})	Maximum 24-hour	44	56	50
	Annual Average	18	19	25
Particulate matter ($PM_{2.5}$)	Maximum 24-hour	No Data	45*	50
	Annual Average	No Data	7*	25
* Only 70.5% Data capture for $PM_{2.5}$ at Randwick for 2017. No $PM_{2.5}$ data was recorded between 1 January 2016 and 29 March 2017.				

5.3.2 Landfill Gas Monitoring Data

Currently Consulting Earth Sciences (CES) undertake landfill gas monitoring quarterly at the Breen Resources landfill site collected from boreholes at the western end of the Landfill site (i.e. furthest away from Lot 2 South). The subsurface gas monitoring is required under Condition P1.1 of Breen Resources Environmental Protection Licence (No. 4608) (EPL). Twelve months of publically available landfill gas monitoring data for methane undertaken by CES between April 2017 and January 2018 is reproduced below in **Table 11** and a copy of the monitoring reports are included in **Appendix A**. The data suggests that for methane (no data available for CO_2) levels are currently below the assessment criterion.

Table 11 Kurnell Landfill Sub Surface Gas Monitoring (CES 2017, CES 2017a, CES 2017b CES 2018)

EPA ID	Well ID	MGA 56 Coordinates (m)		Initial CH_4 Well Concentration (%)							
				Initial				After Purging			
		Easting	Northing	Apr 2017	Jul 2017	Oct 2017	Jan 2018	Apr 2017	Jul 2017	Oct 2017	Jan 2018
Point 20	BH4A	331555	6233531	<0.1	<1	<0.1	<0.1	<0.1	<1	<0.1	<0.1
Point 22	BH8B	No Data	No Data	0.1	<1	<0.1	<0.1	<0.1	<1	<0.1	<0.1
Point 23	BH12 A	331166	6233700	<0.1	0.1	<0.1	<0.1	<0.1	<1	<0.1	<0.1

EPA ID	Well ID	MGA 56 Coordinates (m)		Initial CH_4 Well Concentration (%)							
				Initial				After Purging			
		Easting	Northing	Apr 2017	Jul 2017	Oct 2017	Jan 2018	Apr 2017	Jul 2017	Oct 2017	Jan 2018
Point 24	BH13A	331447	6233663	<0.1	<1	<0.1	<0.1	<0.1	<1	<0.1	<0.1
Point 25	BH18	330761	6233399	<0.1	<1	<0.1	<0.1	<0.1	<1	<0.1	<0.1
CH_4 Assessment Criterion (%)				**1.0**							

5.4 Terrain and Land Use

5.4.1 Terrain

Figure 4[6] shows a three dimensional representation of the local terrain. Terrain data were captured from NASA's Shuttle Radar Topography Mission (SRTM), which produces terrain information for the entire globe. For Australia, terrain data are available at approximately 30 m resolution (1-arc seconds). The terrain surrounding the site is relatively flat and low lying with elevations ranging between 0 and 30m AHD. The highest elevations in the surrounding area occur approximately 1km east of Lot 2 South on the Kurnell Peninsula and southwest of Little Bay. The Kurnell Peninsula is bound by Botany Bay to the North and Bate Bay to the South.

Terrain height across the site is of low relief but varies, particularly with the dynamic nature of sand dunes and existing sand mining and remediation. Site elevations range between approximately 0-10m AHD. Lot 2 North generally has an elevation of around 1-2m while Lot 2 South ranges from 1-10m. The final elevation of Lot 2 South prior to development would depend on the level of filling and compaction following decommissioning of sand mining activities.

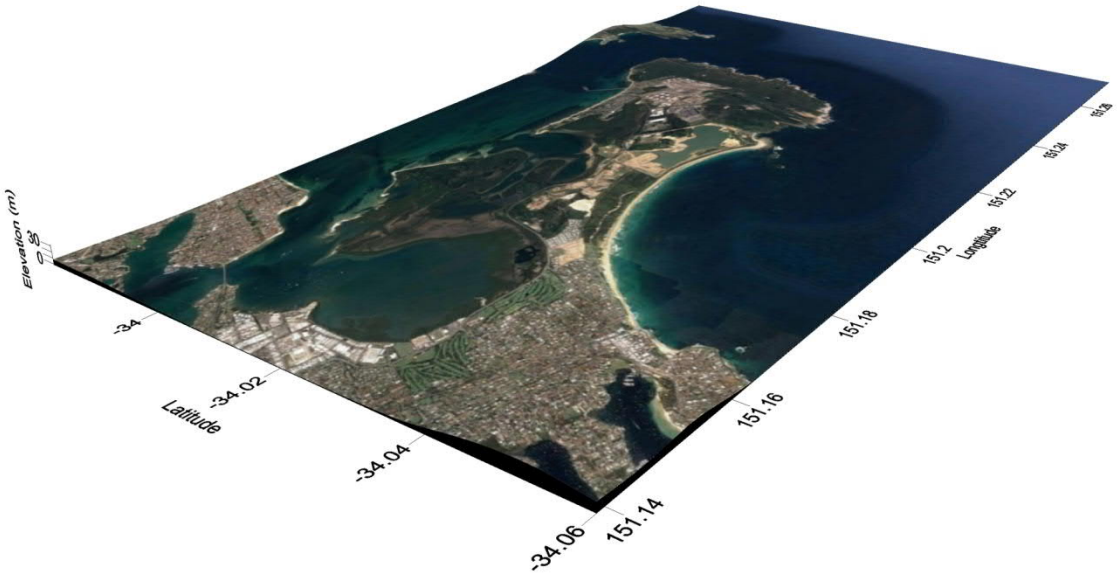

Figure 4 Terrain

5.4.2 Land Use

As discussed in **Section 2.1** the site is bound by is bound by Captain Cook Drive to the north, industrial zoned land to the northeast (including the Sydney Water Desalination Plant), Kurnell Village

[6] Due to relatively low relief of the study area, despite vertical exaggeration vertical features within the study area are generally too small to be identified.

and the Caltex Oil Refinery, Kamay Botony Bay National Park to the east, Bate Bay to the South[7] and Wanda Reserve and the Breen landfill and materials recovery centre to the west. Surrounding land uses are shown in **Figure 5**.

Potential future surrounding land uses with specific reference to potential sources of air emissions are discussed in **Section 5.3.2**.

Source: Imagery from Six Maps 2017

Figure 5 Existing Land Use Surrounding Lot 2 North and Lot 2 South

[7] The property title of Lot 2 DP 1030269 extends down to the mean high water mark in Bate Bay.

6.0 Impact Assessment

6.1 Overview

The Air Quality Impact Assessment has been broken up into two components used to inform the Master Planning for the site. The first component in **Section 6.2** relates to potential air quality impacts as a direct result of changes to land use and future development. The second component, **Section 6.2.4** provides a reverse amenity assessment of potential existing sources of air and odour emissions on potential future sensitive receptors at the Site.

6.2 Land Use and Future Development Impacts

The following subsections provide a qualitative impact assessment of the potential impacts from the Project and future development of the site. This includes construction impacts, temporary project staging impacts, land use changes and future development impacts on nearby sensitive receptors. A Level 1 Screening Assessment in accordance with the *NSW EPA Approved Methods* has also been undertaken to assess the potential impacts from increased vehicle emissions along Captain Cook Drive.

6.2.1 Construction Impacts

6.2.1.1 Earthworks

Earthworks associated with development of the site have the potential to generate dust emissions that may impact nearby sensitive receptors and existing receptors within the site such as the Kurnell Boarding Stables. Potential sources of dust emissions during earthmoving activities would include:

- Vegetation clearing and grubbing;
- Wheel generated dust,
- Materials handling,
- Excavation;
- Stockpiles;
- Hauling fill material;
- Wind generated dust from exposed surface areas.

Earthworks are likely to be more extensive on Lot 2 South which would require considerable levelling following cessation of sand mining activities. The magnitudes of dust impacts would be largely dependent on the quantity of cut/fill required and would likely require impact assessment. Remediation works at the site are currently being undertaken to assess the quantity of cut/fill required.

There is also the potential for air quality impacts associated with the excavation of contaminated fill and demolition works. On January 2018 Coffey Pty Ltd (Coffey) conducted a site investigation to assess potential for contamination on site the preliminary findings indicated that there is (Coffey 2018):

- Currently potentially contaminating activities and presence of suspected hazardous building materials;
- Evidence of current or former underground and aboveground fuel / chemical storage;
- Presence of wastes and uncontrolled fill material;
- Odours that may be indicative of site contamination

The study notes that currently potentially contaminating activities occur on Lot 2 South in association with sand extraction and land rehabilitation due to potential risk of accepting materials for reclamation activities; however this risk is mitigated through implementation of a Environmental Management Plan (EMP), Voluntary EPL and regularly conducted environmental performance assessments and auditing. Potentially contaminating activities are considered unlikely on Lot 2 North. Holistically the site is reasonable expected to be suitable for future residential development and unlikely to pose an

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unacceptable environmental risk (Coffey 2008), however in the event of contaminated material is uncovered during excavation works, appropriate mitigation measures would be required to reduce the risk of airborne contaminants.

Combustion emissions from mobile and stationary equipment used during earthworks also has the potential impact nearby sensitive receptors.

6.2.1.2 Building and Infrastructure

Potential impacts from the construction of buildings and installation of additional infrastructure would largely be from combustion emissions from stationary and mobile equipment. There is also the potential for dust generation from minor excavation works associated with installation of infrastructure.

6.2.2 Project Staging Impacts

The staging of the development is likely to influence short or intermediate term air quality impacts on existing and future sensitive receptors in the area. The duration of potential temporary impacts on nearby sensitive receptors can be influenced by strategic planning of the stages of development. Short- and long-term impacts that may have the potential to influence the staging of the development include:

- Potential cumulative impacts from dust and combustion emissions during site earthworks and construction activities that coincide with:
  - Any potential future construction activities associated with the Greenhill's VPA;
  - Existing landfill and resource recovery operations pre closure[8];
  - Any ongoing sand mining and remediation activities (i.e prior to closure);
- Any future development (and occupation) of the western portion of Lot 2 South, specifically the proposed Lot 2 South West Neighbourhood that would coincide with the continued operation of the landfill. Continued operation of the adjacent landfill (prior to closure) may impact on the air quality amenity of future proposed residential, commercial and community receptors. Specifically the neighbourhood may be impacted by dust emissions from landfill and resource recovery activities, particularly given the high frequency of westerly winds (see **Section 6.3.1.2** for other landfill related development impacts).
- Potential short term internal reverse amenity impacts associated with earthworks and construction on existing sensitive receptors including:
  - Kurnell Boarding Stables and Riding School; and
  - The Boat Harbour Cabins.

It is understood that these receptors would eventually be removed to make way for new development, potentially a business park. While still occupied dust, emissions generated from earthworks elsewhere on Lot 2 South during construction are likely to impact these sensitive receptors, particularly if the vegetated dunes that run in a north east to south west direction in front of the receptors which currently acts as a natural buffer were removed.

Potential air quality impacts associated with staging of the development would need to be assessed once the proposed development schedule has been finalised. Recommendations concerning potential impacts associated with staging are discussed in **Section 7.2**

6.2.3 Land Use Impacts

The proposed rezoning may have the potential to impact on local air quality based on future land use impacts. Currently the site is comprised of a number of activities which have the potential to generate air emissions including:

[8] At the time of writing existing landfill and resource operations were expected to cease in 2020; however in February 2020 the facility was still active and a modified development application lodged in February 2019 by Breen as discussed in Section 5.3.2 may result in extension in the life of the landfill site. The proposed modification has not been assessed as part of this report.

- Dust emissions from sand mining and remediation works including; material handling, dumping, loading, wind erosion from stockpiles and other exposed surfaces and wheel generated dust.
- Vehicle emissions from sand mining and rehabilitation works; and
- Potentially minor odour and dust emissions from Kurnell Boarding Stables and Riding School.

The SEPP amendment would result in the phasing out of existing sand mining and site rehabilitation activities and replacement with residential, commercial and recreational land uses which are generally less intensive land uses than mining activities on the local air shed. Cessation of existing sand mining and site rehabilitation activities may have the potential to improve local ambient air quality through the reduction of both particulate emissions from dust generating activities and combustion emissions (such as PM_{10}, $PM_{2.5}$, NO_2 and CO) from stationary and mobile plant equipment. It should be noted however that proposed changes in land use and associated development would generate traffic from on road vehicles and this is discussed further in **Section 6.2.4**.

The SEPP amendment and potential redevelopment of Lot 2 North proposed for residential and commercial use would result in the closure and removal of the Kurnell Boarding Stables and Riding School. Closure of the stables would result in the reduction of minor odour and dust emissions from the site.

Redevelopment of Lot 2 would include around 3800 dwellings and 600 Senior Living Dwellings. Development would be comprised of three neighbourhoods. The neighbourhood on Lot 2 North would be comprised primarily of senior living and retail and commercial facilities. The western neighbourhood on Lot 2 South would include luxury homes, medium to high density residential, hospitality, commercial and retail and community facilities. The final neighbourhood on the eastern side of Lot 2 South would include medium density residential, hospitality, eco-cabins and hotel, commercial and retail outlets and community facilities.

With the exception to solid fuel combustion from wood fired heaters and open fire places (see **Section 7.4.3**) air emissions from residential, recreational and commercial use are relatively minor with sources including lawn mowing, gaseous and liquid fuel combustion, aerosols and solvents and surface coatings.

Potential air quality impacts associated with the addition of road infrastructure and increased vehicle movements may result in increased vehicle emissions. This is further discussed in **Section 6.2.4**

6.2.4 Vehicle Emission Impacts

6.2.4.1 Existing Traffic Generation

Traffic data provided by Besmaw as stated in the Kurnell Peninsula Phase 1 Traffic Assessment (ttpp 2019) between 1 May 2017 and 30 April 2018 showed an average of 2,400 vehicle movements per day, or approximately 240 vehicles per hour (vph). Existing site traffic generation is generally comprised of landfill and sand trucks, employee and contractor light weight vehicles, and both light and heavy vehicles associated with the Kurnell Boarding Stables.

Predicted changes to onsite traffic generation are discussed in **Section 6.2.4.1**. The proposed SEPP amendment would result in a reduction of off-road vehicle emission impacts associated with the cessation mining activities (see **Section 6.2.3**), including emissions from fuel combustion, fluid evaporation, brake and tyre wear, and re-suspended road dust. Emissions reductions from motor vehicles would comprise mainly hydrocarbons, CO, NO_x and PM_{10}.

6.2.4.2 Future Traffic Generation

Change in land use would result in increased on road vehicle movements to and from the study area. The Phase 1 Traffic Assessment (ttpp) is expected to generate a net additional 2,164 vph during morning peak traffic and an additional 2,647 trips during the afternoon peak traffic.

The increase in daily traffic movements would result in an increase in motor vehicle emissions from fuel combustion, fluid evaporation, brake and tyre wear, and re-suspended road dust. Emissions from motor vehicles would comprise mainly hydrocarbons, CO, NO_x and PM_{10}. Traffic activity such as the number of vehicles, the fleet mix and vehicle speeds can directly influence the near roadside air pollutant concentrations. Vehicle emissions would vary based on the fleet mix or ratio of light to heavy vehicles, fuel type mix (for example, petrol and diesel), and the distribution of vehicles by age of

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manufacture. It should be noted that ground level concentrations of pollutants from vehicles adjacent to site would be influenced not only by emission levels but air circulation and set back distances. Dispersion of vehicle emissions is less affective when development along a road corridor is confined restricting airflow which would typically disperse and transport air pollutants from vehicles away from the source area. The degree to which pollutants disperse is influenced by the orientation and continuity of open spaces, their dimension and shape, topography and the layout of buildings surrounding the subject area. Urban canyons for example where a road is flanked by high density development on each site may channel prevent them from reaching road level depending on their shape, dimension and orientation. The more confined a space is by buildings, walls or embankments adjacent to or over a roadway, the less opportunity air pollutants have to disperse (DoP 2008).
The Masterplan Design Statement (PTW 2019) provides and indicative layout of the proposed development and internal road network. This includes three main streets which intersect Captain Cook Drive and a series of transverse secondary roads off each main street. One main street would provide access to the Lot 2 North neighbourhood, comprised of senior living, retail and commercial facilities, another providing access to Lot 2 South west neighbourhood; comprised of medium to high density residential, retail, commercial, hospitality and commercial facilities. The third main street would be located in the Lot 2 South east neighbourhood comprised on residential, commercial eco-tourism and community facilities; connecting with Captain Cook Drive via a loop.

The Masterplan Design Statement (PTW 2019) indicates a 70m buffer from development adjacent external roads Captain Cook Drive, and 50m buffer from Lindum Road; which is likely to provide a suitable setback distance for proposed sensitive receptors from vehicle emissions along these roads. As such quantitative assessment of vehicle emissions has not been undertaken, however design considerations for development adjacent to Captain Cook Drive has been further considered in **Section 7.3**.

6.3 Reverse Amenity Impacts

The following subsections provide a reverse amenity impact assessment for the proposed SEPP Amendment in relation to potential air quality and odour impacts. A reverse amenity assessment refers to the evaluation impacts on a proposed development from potential existing and future sources of air emissions and odour in the surrounding environment.

The proposed development introduces additional sensitive receptors to the receiving environment that have the potential impacted by existing air emission sources as identified in **Table 9**. As such updating the land use zones to be consistent with the *Standard Instrument Local Environmental Plans Order 2006* and planning for future development of the site requires consideration of the compatibility with adjoining current and future land uses. Siting and design of future residential, commercial and recreational development around existing activities will ensure the best outcomes with regards to air quality impacts. **Section 6.3.1**, **Section 6.3.2** and **Section 6.3.3** provide an assessment of air quality impacts from existing activities in the context of the SEPP amendment and **Section 6.3.4** identifies potential separation distances that may impact on future development of the site. The potential changes to future air amenity from outside sources are identified in **Section 5.3.2**.

6.3.1 Potential Air Quality Impacts

The following subsections provide a qualitative impact assessment of potential air pollutant emissions from nearby potential sources as identified in **Section 5.3.1** on future sensitive receptors within the Site.

6.3.1.1 Cronulla Wastewater Treatment Plant

No potential impacts to ambient air quality are anticipated at the site from the Cronulla Wastewater Treatment Plant. Potential odour impacts from WWTP are discussed in **Section 6.3.2.1**.

6.3.1.2 Breen Resources

Pollutants of interest from the Breen Resources land fill and waste recovery centre would include:

- Particulates (PM_{10} and $PM_{2.5}$) from dust generating activities including materials handling activities; wheel generated dust, stockpiling; daily cover activities, wind generated dust from stockpiles and exposed surfaces and processing of waste such as grinding and crushing;
- Combustion emissions from onsite mobile and stationary equipment mainly comprising of hydrocarbons, CO, NO_x and PM_{10}; and
- Landfill gas emissions produced as waste decays, broken down by microbes known as methanogens in a process called methanogenesis. Landfill gas is largely made up of methane and carbon dioxide; with trace amounts of VOCs largely making up the remainder of landfill gas emissions.

As noted in **Section 5.3.1** Breen Resources lodged a modification for development for the adjacent landfill site including relocation of the existing waste facility, site access and a minor increase in the sites waste capacity extending the life of the landfill facility. Additionally the Landfill was previously intended for closure in 2020 but as of February 2020 is still currently operational. Assessment of air quality impacts from ongoing operation of the landfill and the proposed modification has not been included in this report but would be required should the modified development application be approved.

Particulate and Combustion Impacts

Particulate and combustion emissions have the potential to impact on future sensitive receptors at the Site, however landfill activities are currently furthest removed from the site, located on the western portion of Breen Resources land, as such resource recovery activities adjacent to the site pose the greatest potential impact, particularly to future sensitive receptors on the western side of Lot 2 South, during the occurrence of westerly winds (see **Section 5.1**).

In light of potential impacts from dust generation activities and combustion emissions from mobile and stationary plant equipment these impacts are expected to reduce overtime with the winding down of landfill activities and closure as per the Greenhills VPA agreement (refer to **Section 5.3.2**). It is noted

however that the Breen Resource facility is currently still operational and preliminary staging noted in the Masterplan (PTW 2019) indicated Stage 1-4 of the redevelopment would occur on Lot 2 South west neighbourhood adjacent to Breen.

Landfill Gas Impacts

Landfill gas can accumulate in enclosed spaces in nearby buildings, basements, manholes, tunnels and service ducts and at certain concentrations can represent an explosive risk or act as an asphyxiant by displacing oxygen. Landfill gas can take up to 30 years to stabilise, post operation of a landfill and as such there is the potential for gas migration to occur offsite; including the Besmaw property. A review of the existing and previous revisions of the Breen Resources longest standing EPL (No. 4608) for the landfill site indicates that dating back to 2001 the facility has been used for disposal of inert waste or non-putrescible wastes, comprising mainly of mainly of demolition rubble, excavation spoil, asphalt and hard wastes. Though is likely to contain some biodegradable materials such as timber, paper and green waste and organic soils. It is this biodegradable material that produces landfill gas at inert waste landfill sites, but generally at lower rates than observed at putrescible waste landfills (EPA 2012a), and as **Table 11** shows existing landfill gas concentrations are below the EPA criterion. It should be noted however that while generally lower rates of landfill gas are observed at inert landfills, conditions for gas generation are not ideal landfill gas generation may persist for extended periods at low levels (EPA 2012a)

The active landfill on the Breen Resources site is at the western end of the site furthest from Lot 2 North and Lot 2 South, however historical records may indicate landfill cells closer to the eastern boundary of the site adjacent to Lot 2 North. A collection of satellite images of the landfill site dating between 1999 and 2017, where reviewed to examine the ongoing site activity and the landfill site and are provided in **Appendix A**. From the satellite imagery it appears that land immediately adjacent to the site appears to be predominantly used for stockpiling of waste materials prior to landfilling or reuse and potentially selected virgin excavated natural materials (VENM) and excavated natural materials (ENM) (Breen 2018). Based on satellite imagery the nearest visible landfill cell was not located on adjoining boundary of Lot 2 South but approximately 475m to the west of the Lot 2 South boundary (refer to **Figure 10** in **Appendix A**).

As further discussed later in **Section 6.3.4** in accordance with the EPA Environmental Guidelines any buildings built within 250 metres of deposited waste must be designed not to accumulate landfill gas. Assuming former a landfill cell on the eastern most boundary of the Breen Resources site as a 'worst case' scenario a portion of both Lot 2 North and Lot 2 South (see **Section 7.4.2**) may potentially be affected by offsite landfill gas migration. A preliminary review of landfill activity however suggests a buffer zone may not be required based on the following:

- A review of historical satellite imagery (see **Appendix A**) suggests that the nearest landfill cell is located approximately 475m to the west of the Lot 2 South boundary;
- Historical EPL records indicate that the site has only been used for inert waste (non-putrescible); and
- One year of landfill gas monitoring data shows subsurface methane gas concentrations near the active landfill face (see **Section 5.3.2**) are compliant with EPA landfill gas criterion.

Based on the above preliminary review unlikely that landfill gas impacts would occur within the Besmaw property, however further localised monitoring data may be required to address potential concerns as discussed in **Section 7.4.1**. The Masterplan also indicates a 50m buffer zone between Lindum Road and the south west neighbourhood on Lot 2 South would be established.

6.3.1.3 Caltex Kurnell Terminal

Pollutants of interest from the Caltex Kurnell Terminal would largely include volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, xylenes and n-hexane from fugitive air emissions associated with the volatilisation of hydrocarbon materials from fuels imported stored and exported onsite. Potential odour impacts from Caltex Kurnell Terminal are discussed in **Section 6.3.2.3**.

On 7 January 2014, development consent was granted by DP&E for the Kurnell Refinery Conversion Project by DP&E, which involved the progressive transition of the existing refinery to a finished product

terminal. In October 2014 the Kurnell Refinery was shut down which would have resulted in a significant reduction of air emissions from the facility into the local air shed. An air quality impact assessment for the Kurnell Conversion Project undertaken by URS in 2013 used the dispersion model AUSPLUME to predict offsite ground level concentrations from the Kurnell Fuel Terminal. The results of the dispersion modelling predicted offsite 99.9th percentile 1 hour concentrations for benzene of less than 50 percent of the EPA criterion and for toluene, ethylbenzene, xylene and n-hexane of less than 10 percent of the relevant EPA criterion. As such VOC emissions from the Caltex Kurnell Terminal are unlikely to have any significant impact on future receptors at the site.

6.3.2 Potential Odour Impacts

Land-use planning is a critical component in avoiding and managing odour impacts and potential conflicts that could arise from them. In accordance with the EPA *Technical Framework (and notes) Assessment and Management of Odour from Stationary Sources in NSW* (DEC 2006 and DEC 2006a) the following land use needs must be considered to minimise potential odour impacts and land use conflicts when a change in land use is proposed:

- Consideration of current land use and development trends as well as sustainable integrated planning principles;
- When changing the preferred land use in a particular area, consider any potential opportunities or constraints associated with existing development (such as odour emissions, transport, resource reuse and energy efficiency); and
- When rezoning is considered identify provisions for dealing with any potential conflict over land use.

The following subsections provide a qualitative impact assessment of potential odour emissions from nearby potential sources as identified in **Section 5.3.1** on future sensitive receptors within the Site.

6.3.2.1 Cronulla Wastewater Treatment Plant

In 2014 the Cronulla WWTP was upgraded and the existing Odour Treatment Facility (OTF) Augmented to reduce the risk of odours impacting the surrounding community and achieve a ‘no nuisance’ odour criteria of 2 Odour Units (OU), 99 percent of the time during normal operation. As part of the project a Review of Environmental Factors (REF) was completed including an Odour impact assessment undertaken by CH2Mhill on behalf of Sydney Water (Sydney Water 2011). Assessment of odour impacts were then further revised in July 2011 Cronulla Wastewater Treatment Plant Odour Management Project, Decisions Report (Sydney Water 2011).

Odour impact from the Cronulla WWTP were assessed using the dispersion model CALPUFF in accordance with the NSW *Approved Methods,* and a copy of the predicted 99th percentile 2OU contour plots are shown in **Figure 6**. It can be seen from **Figure 6** (Scenario 2 and Scenario 3) that operation of the upgraded WWTW and OTF with and without operation of Digester 2, that the 99th percentile 2OU criterion only slightly extends outside the Cronulla WWTP site boundary. As such given the separation distance (refer to **Section 6.3.4**) between the plant and the site, no adverse odour impacts are anticipated on the amenity of Lot 2 North and Lot 2 South.

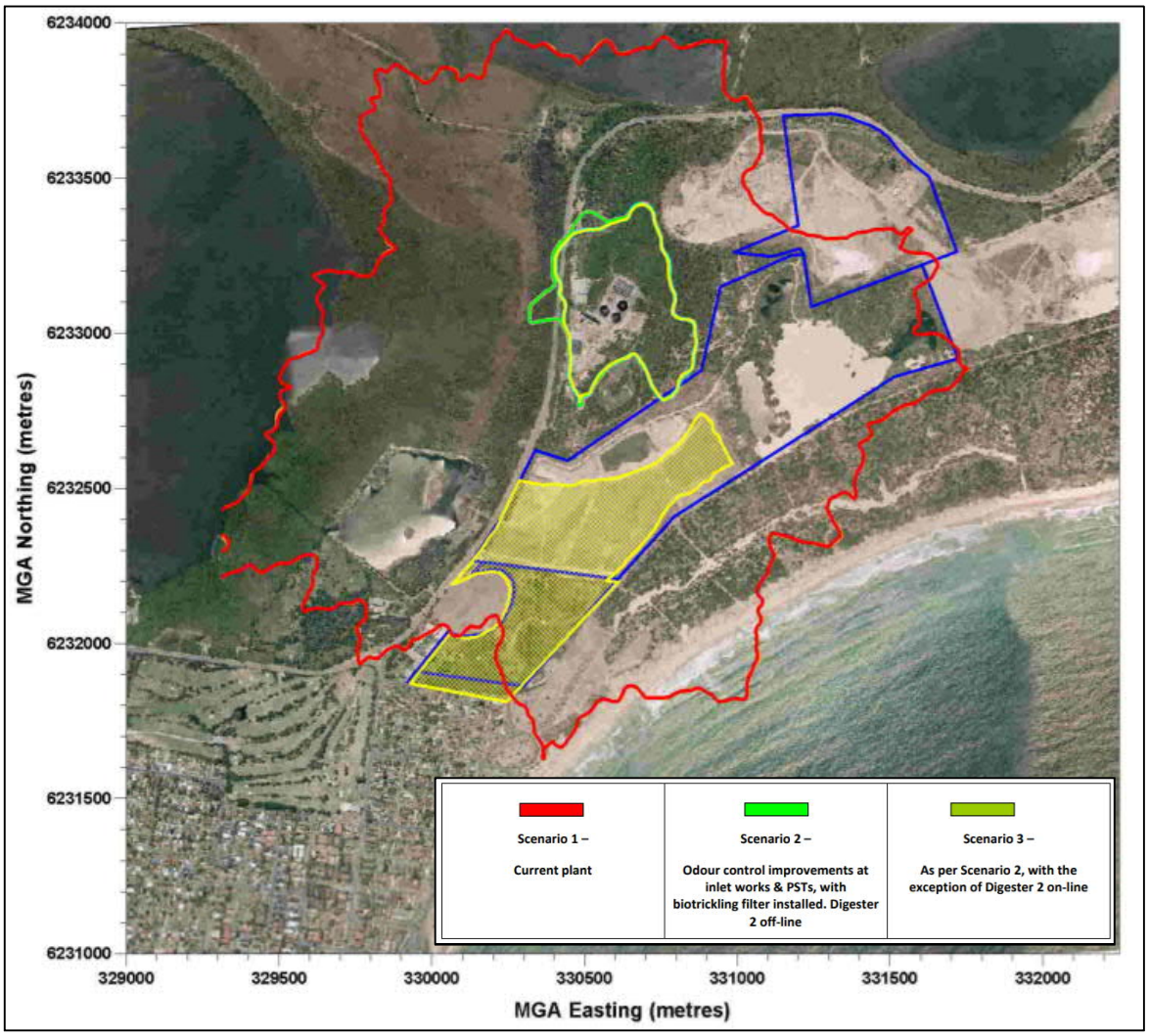

Figure 6 99th Percentile 2 OU Contours for Cronulla WWTP (Sydney Water 2011)

6.3.2.2 Breen Resources

The Breen Resources Landfill under the EPA Environmental Protection Licence (EPL) (No 4608) dated 31 March 2017 currently accepts only non-putrescible general waste. It does not accept putrescible waste such as food and garden waste which is largely responsible odour generation at landfill sites due to the breaking down of organic matter through anaerobic microbial processes, resulting in odorous compounds. Landfill gas from the site would largely be made up of methane and carbon dioxide which are both odourless.

Currently landfill activities which occur on the western portion of the Breen Resources site (furthest away from the Site) are currently winding down under the terms of the VPA between Breen Holdings, Sutherland Shire Council and Frasers Property Australia (refer to **Section 5.3.2**) and the landfill is due for closure in 2020 (LG Focus 2016). As such odour emissions from day to day landfill activities are expected to be negligible to any future receptors on Lot 2 North and Lot 2 south, and a reduction in any existing odour emissions would be observed following closure of the landfill site.

Approval of the development modification for Breen resources; relocating the existing waste facility, increasing the waste capacity and any associated delayed foreclosure of the landfill may result in additional impacts relating to dust and vehicle emissions to the site which would require further assessment.

6.3.2.3 Caltex Kurnell Terminal

Potential odour emissions from the Caltex Kurnell Terminal would be generated from both the volatilisation of hydrocarbons and small quantities of sulphurous compounds such as mercaptans and hydrogen sulphide present in fuels. The 2013 AQIA for the Kurnell Refinery Conversion Project (URS 2013) (refer to Section **6.3.1.3**) did not undertake a quantitative assessment of the project but stated there was likely to be a significant reduction in odour emissions following closure of the refinery. Additionally, in May 2014 Caltex completed an odour reduction program aimed at further preventing the emission of any offensive odours from the premises (Caltex 2016).

The 2013 AQIA notes that previously odour has been a key issue of community concern with Caltex typically receiving between 70 and 80 complaints per year (URS 2013). Based on the *Annual Review of Environmental Performance, Development Application SSD 5544* (Caltex 2015 and Caltex 2016) there has been a significant reduction in odour complaints since the conversion of the refinery to a finished product terminal. In 2015 and 2016, 21 and 15 air quality complaints (inclusive of odour complaints) were made through the Community Complaints Hotline. This reduction in odour complaints is likely attributed to the closure of the refinery which would have resulted in a considerable reduction in emission of odorous sulphur and VOC-based compounds. As such odour emissions from the Caltex Kurnell Terminal are unlikely to have any significant impact on future receptors at the site.

6.3.3 Internal Reverse Amenity Impacts

The Kurnell Boarding Stables and Riding School has the potential to generate odour emissions from manure decomposition and dust emissions from ground disturbance where horses are confined yards or stables. The stable is a small facility and a site visit undertaken on 30 November 2017 indicated no significant source odour or dust from the stables. It is however noted that horse establishments are generally best suited to rural areas with appropriate separation distances from residents and small holdings. Potential odour impacts from the stable are likely to be temporary and affected by the staging of development, should development of Lot 2 South occur prior to removal of the Kurnell Boarding Stables and Riding School the increased density and proximity of nearby sensitive receptors has the potential for neighbour disputes attributed to both odour and dust emissions.

Dust impacts from construction impacts on the existing boat harbour properties, prior to removal may also result in impacts to amenity and are discussed in **Section 6.2.2**.

6.3.4 Separation Distances

Table 12 provides a list of recommended separation distances between surrounding sources of air and odour emissions discussed in **Section 6.3.1** and **Section 6.3.2**. Separation distances have been calculated either by determining the distance from the activity source to the sensitive receptor boundary or more conservatively from the source boundary to sensitive receptor boundary (Site boundary) where guidelines stipulate.

In NSW generic separation distances between sources of air and odour emissions and sensitive receptors are not legislated and is determined on a case by case basis as such the following guidelines were reviewed in **Table 12**:

- NSW EPA's *Environmental Guidelines, Solid Waste Landfills*, Second Edition, 2016 (EPA 2016)
- VIC EPA's Recommended Separation Distances for Industrial Residual Air Emissions – Guideline (VIC EPA 2013)
- ACT Governments, *Draft separation Guidelines for Air Emissions* (ACT Government 2014)

Section 7.3 provides the adopted separation distances for the project based on those listed in **Table 12**. Where NSW guidelines are available these separation distances have been adopted. Where no NSW separation distances are available the most conservative buffer distance based on VIC EPA and ACT Government guidelines have been adopted.

The following information should be noted when reviewing **Table 12:**

- It should be noted however in the case of Caltex Kurnell Terminal the recommended buffer distance for fuel storage is considered to be unreliable[9] and has thus been excluded from; and
- Building and structure buffer distances apply to closed landfill sites until the site has stabilised to the point where the potential for subsurface gas migration has largely ceased (refer to **Section 4.3**). Typically, this will be a period of about 30 years.

Distances in **Table 13** have been calculated from the source boundary to the site boundary of the closest Lot (i.e Lot 2 North or Lot 2 South). It is also noted as part of the Master Plan, undeveloped Lot 8 DP 586986 (278 Captain Cook Drive); which has not been assessed as part of this development would be retained in its natural state and would remain a vegetative buffer to the east of the site. Separation distances from main external roads have also been included as part of the Masterplan including a 70m setback distance from Captain Cook Drive and a 50m set back distance from Lindum Road.

[9] The recommended ACT Government separation distance for petroleum storage is 1500m and is grossly over estimated and believed to be a 'typo' given that the guidelines provide a separation distance of only 500m for petroleum refining which produces more VOC and Odour emissions than fuel storage operations.

Table 12 Separation Distances

Source	Separation Distance Guidelines		Distance from Site (Boundary to Boundary)	Buffer Zone Onsite? (Y/N)
	Classification	**Buffer Distance**		
Cronulla Wastewater Treatment Plant	**NSW Guidelines** No guidance document. Individual Odour Assessment undertaken on case-by case basis. Alternative buffer zone guideline provided below	-	1800m	No
	ACT Government Guidelines Individual assessment recommended for mechanical/biological wastewater plants including aerated lagoons (EP >15,000).	-		
	VIC EPA Guidelines Mechanical/Biological Wastewater Treatment Plant, (Flow Rate > 5,000 L/day)	630m[a] (from activity boundary)		
Breen Resources	**NSW Guidelines** Landfill (Operational & Closure) No guidance document for materials recovery individual AQIA undertaken on case-by case basis. Alternative buffer zone guideline provided below	250m[c] (of deposited waste)	20m to boundary. 475m to nearest observed landfill cell.	Unlikely
	ACT Government Guidelines Materials Recovery Facility	300m (from activity boundary)		
	VIC EPA Guidelines Materials Recovery and Recycling Facility buffer zone applied on case by case basis.	-		
Caltex Kurnell Terminal	**NSW Guidelines** No guidance document. Individual AQIA undertaken on case-by case basis. Alternative buffer zone guidelines provided below	N/A	800m	No
	VIC EPA Guidelines Storage of Petroleum and Hydrocarbon Products (Storage Capacity > 2000t).	100-250m[d] (from activity boundary)		

a. Buffer distance calculated on EP of 250,000
b. Buffer distance based on Type 3 Landfill site – Solid Inert Waste/Non-putrescible. Buffer distance applies to buildings and structures used for sensitive or non-sensitive uses; change of use, infrastructure installation and installation of pipelines.
c. Landfill gas potential risks remain for at least 30 years post closure.
d. Buffer distance based on tank roof type (fixed or floating roof). Caltex has both so separation distances of 250m assumed.

7.0 Recommendations

7.1 Overview

The following section provided recommendations on potential air quality impact safeguards and management approaches for consideration at the master planning stage within the following areas:

- Project stagging (**Section 7.2**);
- Separation distances (**Section 7.3**);
- Planning and design considerations including development proximity to busy roads, use of wood heaters and open fire places and development under Sydney Airport OLS (**Section 7.4**);
- Best management practices (**Section 7.5**); and
- Additional assessment requirements (**Section 7.5.2**).

7.2 Project Staging

The staging of the development is likely to influence short or intermediate term air quality impacts on existing and future sensitive receptors in the area. The duration of potential temporary impacts on nearby sensitive receptors can be influenced by strategic planning of the stages of development. **Table 13** provided a list of staging recommendations to minimise potential air quality impacts associated with construction of the Site based on potential staging impacts identified in **Section 6.2.2**.

Table 13 Staging Considerations for Development

Consideration	Comment
Cumulative Impacts	• Any construction work, particularly earthworks that coincide with either operation of the landfill and recovery centre prior to closure or construction activities associated with the Greenhill's VPA would need to consider cumulative dust impacts. • Recommended that sand mining and remediation activities cease prior to any development construction on Lot 2 North or Lot 2 South to avoid potential cumulative impacts.
Landfill Operations	• Consider staging development and occupancy to minimise dust impacts on future residents. Of specific note staging of the Lot 2 South western neighbourhood prior to closure of landfill, where possible should avoid both cumulative impacts during construction and amenity impacts to future residence prior to closure of the landfill. • The proposed modification to the Breen Landfill site specifically relocation of the waste management area and associated activities on Lot 5 DP1158627 would also need to be taken into consideration if approved.
Landfill Gas	• Building and structure buffer distances applying to the landfill site may be imposed until the landfill site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Typically, this will be a period of about 30 years. Refer to **Section 7.4.2** for further detail.
Existing Sensitive Receptors	• Appropriate safeguard measures should be considered to minimise dust emissions from construction on the Kurnell Boarding Stables and Riding School and Boat Harbour cabins if still occupied at the time of construction; and • Early removal of Boat Harbour cabins, prior to earthworks is recommended.
Odour Impacts on Future Sensitive Receptors	• Minor temporary odour impacts may be avoided if the Kurnell Boarding Stables and Riding School is closed prior to development and occupation of residential and commercial premises on Lot 2 South, immediately adjacent to Captain Cook Drive.

7.3 Separation Distances

Separation distances between the Site and nearby sources of air and odour emissions have been defined by the reverse amenity assessment carried out in **Section 6.3.1** and **Section 6.3.2** and a review of separation distance guideline documents and NSW, VIC and ACT legislation described in **Section 6.3.4**.

Table 14 documents the potential separation distances required for the Cronulla WWTP, Breen Resources and Caltex Kurnell Fuel Terminal. Of these facilities only the Landfill and materials recovery facility operated by Breen Resources may require a potential onsite buffer zone.

Table 14 Potential Onsite Buffer Distances Required

Source	Potential Onsite Buffer Zone	Comment
Cronulla WWTP	None	WWTP is approximately 1800 from the site (boundary to boundary). Based on Victorian EPA Guidelines a mechanical/biological WWTP with an EP of 250,000 would require a buffer zone of 630m from the activity boundary, thus the site is over 1km further than the minimum separation distance required. Coupled with the vegetative buffer and predicted odour impacts from the facility detailed in **Section 6.3.2.1** sufficient separation exists between the plant and the site.
Breen Resources	Unlikely (refer to discussion below for further clarification)	The Breen Resources Landfill and Materials Recovery Facility lie approximately 20m west of the site. NSW EPA guidelines state that a 250m separation distance from deposited waste is required for operational and post operational of landfills. Assuming a landfill cell was located on the eastern most boundary of the Breen Resources site as a 'worst case' scenario a buffer zone of up to 230 metres may be required onsite. A review of satellite images of the landfill site dating between 1999 and 2019 however (see **Appendix A)** indicate that land immediately adjacent to the appears to be predominantly used for stockpiling of waste materials prior to landfilling or reuse and the nearest visible landfill cell was is approximately 475m to the west of the Lot 2 South boundary. As such coupled with existing landfill gas monitoring data indicating compliance with EPA landfill gas stabilisation criteria an onsite buffer zone may not be required. The ACT Government guideline for materials recovery facilities is 300m from the activity boundary, while Victorian separation distances are assessed on a case by case basis. Given the size of the facility and likely closure of the facility no buffer is recommended but consideration of impacts should development and occupation coincide with current operations (see **Section 7.2**) Additionally should the proposed modification to development lodged by Breen Resources be approved assessment of potential buffer zone would need to be reassessed. It is further noted that the Masterplan (PTW 2019) includes a 50m buffer zone from Lindum Road.
Caltex Kurnell Fuel Terminal	None	The fuel terminal is approximately 800m from the site (boundary to boundary). Based on Victorian EPA guidelines storage of petroleum and hydrocarbon products a separation distance of up to 250m depending on roof tank type (Caltex has both fixed and floating roofs). Thus site is over 0.5km further than the minimum separation distance required. Coupled with the vegetative buffer and predicted air quality and odour impacts detailed in **Section 6.3.1.3** and **Section 6.3.2.3** sufficient separation exists between the plant and the site.

As discussed in **Section 6.3.1.2** and Appendix A, historical satellite images indicate land immediately adjacent to the site appears to be predominantly used for stockpiling of waste materials and disposal of VENM and ENM. The nearest visible landfill cell is located approximately 475m to the west of the Lot 2 South boundary (refer to **Figure 10** in **Appendix A**), which is in excess of 200m from the EPA recommended separation distance of 250m. In addition the previous 12 months of landfill gas monitoring data and the active landfill face demonstrates compliance with the EPA criterion (see **Section 5.3.2** and Appendix A). As such it is unlikely that an onsite buffer zone be required for future land use planning.

Should a prior landfill cell be located on the eastern most boundary of the Breen Resources site; and/or subsurface landfill gas concentrations have the potential to exceed the EPA criterion at the Besmaw site boundary however a buffer zone of up to 230 metres may be required onsite. This buffer zone would impose potential restrictions on up to 15.4ha of Lot 2 South and 0.3 Ha of Lot 2 North for development, particularly those that would create enclosed spaces (refer to **Section 3.4.2** and **Section 7.4.2**)

7.4 Planning and Design Considerations;

7.4.1 Development Adjacent Captain Cook Drive

Strategic planning should ensure that sensitive land use developments are sited to avoid or appropriately manage vehicle emissions from Captain Cook Drive at the site planning and building construction stages. Planning and design considerations to minimise exposure to vehicle emissions, are presented in **Table 15**. The planning and Design considerations in **Table 15** are in line with the DP&E's *Guideline* (DoP 2008) and supports the specific rail and road provisions of the Infrastructure SEPP as discussed in **Section 3.1.2** and **Section 3.4.1**.

Table 15 Planning and Design Considerations for Development near Busy Roads

Consideration	Comment
Building Siting, Heights and Orientation	• Incorporating an appropriate separation distance between sensitive uses and the road using broad scale site planning principles such as building siting and orientation. The location of living areas, outdoor space and bedrooms and other sensitive uses (such as childcare centres, hospitals and senior living) should be as far away as practicable from the major source of air pollution • Building heights adjacent to busy roads should be varied and interspersed with open areas to minimise the formation of urban canyons; • Where possible step back the upper stories of roadside buildings to increase dispersion of air pollutants and minimise cannoning effects of tall buildings close to the road. • The Masterplan (PTW 2019) has allowed for a buffer zone of 70m from Captain Cook Drive and 50m from Lindum Road. Each of the three neighbourhoods allow for graduated building heights; however taller buildings (up to 10-12 storeys) are situated along the proposed internal main roads.
Childcare Centres	• Where new schools and childcare centres are being considered, the design should ensure that there is sufficient separation from busy roads to avoid adverse air quality impacts; particularly in the case of long day-care centres where young children and babies are subject to emissions from morning and afternoon peak traffic. Measures to avoid, reduce or mitigate against air quality impacts at any childcare centres include: - Where possible avoid siting childcare centres on Captain Cook Drive; - Courtyards or play areas should be protected from adverse air quality impacts by buildings; - Should a childcare centre front Captain Cook Drive layout should be considered to minimise air quality impacts such as orienting non-sensitive services like storage, bathrooms and car parking in areas subject to air pollution.
Hospitals	• Hospitals should be located to ensure that vulnerable patients or the elderly are not placed in an area subject to adverse air quality impacts. • A hospital would require effective ambulance access to Captain Cook Drive however modern hospitals are usually constructed so not to be sensitive to adverse air pollution as they are usually sealed buildings which have been designed to ensure internal conditions are suitable for patients. • Should a hospital is to be naturally ventilated with windows that open to balcony /outdoor areas, the site layout should ensure that the areas used by patients are suitable separated from busy roads or incorporate design features that mitigate air quality impacts to acceptable levels.
Landscaping	• Using vegetative screens, barriers or earth mounds where appropriate to assist in maintaining ambient air amenity. • Landscaping has the added benefit of improving aesthetics and minimising visual intrusion from an adjacent roadway. • The Masterplan provides allowance for vegetated buffer zones along roads; using both low scale planting and large shade trees. Allowance for green roofs on some buildings is also being considered which may result in potential air quality benefits.
Ventilation	• For ventilation of indoor areas, adjacent to Captain Cook Drive mechanical ventilation air inlet ports should be sited to maximise the distance from the road to reduce inflows of air pollutants • The location of open-able windows should be considered in the design of the development located adjacent to the roadway emission sources.
Senior Housing	• Senior housing should be located to ensure that vulnerable patients or the elderly are not placed in an area subject to adverse air quality impacts.

Consideration	Comment
	• Should senior housing front Captain Cook Drive layouts should be considered to minimise air quality impacts such as orienting non-sensitive services like storage, bathrooms and carparking in areas subject to air pollution. • The Masterplan (PTW 2019) allows for 600 senior living dwellings within Lot 2 North; which is separated by a 70m buffer zone from Captain Cook Drive.
Zoning	• Propose less sensitive land use for development that will front Captain Cook Drive such as open space or for commercial or retail use. Here buildings may act as a barrier that shields and protects highly sensitive areas from high-emission zones.

7.4.2 Development Adjacent Landfill

Landfill gas can accumulate in enclosed spaces in nearby buildings, basements, manholes, tunnels and service ducts as such any in accordance with the EPA Environmental Guidelines (EPA 2016) (see **Section 3.4.2**); any buildings built within 250 metres of deposited waste must be designed not to accumulate landfill gas. As discussed in **Section 7.3** a 250m buffer zone is considered worst case and is likely not applicable to any future development on the Besmaw site provided the closest landfill cell was located approximately 475m from the site boundary and subsurface methane gas concentrations are compliant with the EPA landfill gas stabilisation criteria, though additional monitoring may be required to satisfy any concerns raised by DP&E and EPA.

A review of the Masterplan (PTW 2019) indicates there is a 50m buffer zone between the proposed south western neighbourhood on Lot 2 South and Lindum Road which separates the project site and the Landfill.

For completeness the following design measures have been provide to mitigate against potential worst case impacts, should the site lie within 250m of a former landfill cell. Several options are available for gas control at nearby sensitive receptors including:

- Gasproof membranes beneath the building or enclosed space, and around underground services such as stormwater and sewer pipes, which can act as conduits for gas;
- Venting systems beneath the building or other void space, passive or fan assisted;
- Vertical barriers to control gas migration from the source or to prevent migration to the receptor site;
- Vertical venting trenches and wells, with passive or active extraction and venting to atmosphere;
- Sub-slab depressurisation systems (using fans or blowers) with venting to atmosphere;
- Building and sub-slab over pressurisation systems to stop gas migrating into the building monitoring systems and alarms; and
- Safe work procedures to manage risks that may be present in confined spaces such as manholes, tunnels and service ducts.

Land within 250 metres of existing or former landfill activities would need to comply with the landfill gas stabilisation criteria under Section 10.2 of the EPA Environmental Guidelines (EPA 2016) (see **Section 4.3**). For future development within a designated buffer zone a minimum of 24 months landfill gas monitoring, assuming the landfill gas is stabilised the site would be required. A Landfill Gas Risk assessment undertaken prior to development of buildings and services would also need to be undertaken to provide the responsible planning authorities with sufficient information to satisfy that the proposed new development or rezoning will not be adversely impacted by its proximity to the landfill site.

Alternatively, the affected parcel of land could be assigned for open development uses such as parks, golf course, other recreational uses or car parking. It is noted that immediately north of the site new open development as part of the Greenhills VPA has been approved with the construction of playing fields and a skate park, as such open development (eg, parks, carparks, golf course etc) may be more amenable as part of the development approval process. Its use as an open development would also be subject to demand in the area.

7.4.3 Wood Heaters and Open Fire Places

Wood smoke is a significant contributor to atmospheric particulates, contributing approximately 28 percent of annual PM_{10} emissions and 47 percent of annual $PM_{2.5}$ emissions from the Sydney Region. As expected particulates from domestic solid fuel combustion is highest during the coldest months, with the highest contribution occurring in July, making up 57 and 75 percent of PM_{10} and $PM_{2.5}$ emissions in the Sydney Region. Given the existing high background concertation of PM_{10} and $PM_{2.5}$ in the region it is recommended that a ban on wood heaters be imposed on all future development within the site, as similarly imposed to the Canberra suburbs of Molonglo Valley, Dunlop and East O'Malley. Such a ban would aid in the protection of the public health of future residents. Should a ban not be imposed at a minimum wood heaters must comply with the requirements of the *POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016 (NSW)* as described in **Section 3.3.2**.

7.4.4 OLS Considerations

Should any proposed facility have an exhaust plume with a vertical velocity exceeding 4.3 m/s at the Sydney Airport OLS, a Plume Rise Assessment would be required to assess the potential hazard to aircraft operations in accordance with *Advisory Circular AC 139-5(v.03) Plume Rise Assessments* (see **Section 3.3.2**). It should be noted that the Advisory Circular is currently under review; and any amendments would require due consideration.

Terrain height across the site varies, particularly with the dynamic nature of sand dunes, and is of low relief. Existing site ground elevation at the site are below 10 AHD and the OLS for Sydney Airport at Lot 2 North and Lot 2 South as declared by the Commonwealth Department of Infrastructure and Regional Development on 20 March 2015 is set at between approximately 110 and 156 AHD. Based on the above heights an exhaust plume with a vertical velocity exceeding 4.3 m/s would have to have a height of greater than 110 AHD to consider a potential hazard to aircraft operations

7.5 Management Practices

7.5.1 Construction Air Quality Management Plan

Following changes to the SEPP (Kurnell Peninsula) prior to construction work of any proposed development on the site a Construction Air Quality Management Plan (CAQMP) should be developed an include best management practices for minimising combustion emissions from diesel and gas powered mobile and stationary plant equipment. Consideration of emission reduction strategies documented in the EPA's information report *Reducing Emissions from Non-road Diesel Engines* (Environ 2014) should be considered in the CAQMP and at a minimum include:

- Ensuring construction equipment are equipped with engines that conform with the highest available US, EU or equivalent national standards;
- All diesel construction equipment uses fuel that conforms with the National Diesel Fuel Quality Standard;
- Ensure all engines are correctly repaired and maintained;
- Where possible improve engine performance by fitting with an anti-pollution control device;
- Minimise engine idling times;
- Locate plant and equipment away from sensitive populations and residential areas; restrict access to such areas to essential vehicles and machinery only and/or use lowest emissions equipment near these areas where possible; and
- Where possible avoid use on onsite diesel or petrol generators by substituting mains electricity or battery powered equipment where possible.

7.5.2 Stable Management

Preliminary staging as indicated in the Masterplan (PTW 2019) shows Lot 2 North would be the final development stage (Stage 8). Should development and occupation of residential and commercial premises on Lot 2 South adjacent to Captain Cook Drive occur prior to the closure of the Kurnell Boarding Stables and Riding School there is the potential for land use conflicts due to dust and odour

emissions (see **Section 6.3.3**). To ensure that environmental amenity and land use conflicts are minimised the following options are provided:

1. Closure of Kurnell Boarding Stables and Riding School prior to development and occupation of residential and commercial premises on Lot 2 South adjacent to Captain Cook Drive; or
2. Ensure effective management strategies and safeguard measures to mitigate offsite dust and odour impacts; should operation of the stable coincide with development and occupation of residential and commercial premises on Lot 2 South adjacent to Captain Cook Drive. Should the two activities coincide it is also recommended that the vegetative stand of trees or shrubs to the south of the stables on Lot 2 North remain temporarily to disperse odour before it reaches future sensitive receptors. This solution may be particularly useful when other odour-source controls are impractical or too costly and would have the added benefit of trees reducing offsite dust migration.

Amendment of SEPP (Kurnell Peninsula) 1989

7.6 Assessment Requirements

Following changes to the SEPP (Kurnell Peninsula) any proposed development within the site would require an environmental impacts assessment in accordance with the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act). A component of the environmental assessment would involve identifying and assessing potential air quality impacts associated with development. **Table 16** provided a brief outline of potential assessments that may be required for future development of the site, with regards to assessment of air quality impacts.

Table 16 Potential Future Assessment Requirements

Item	Requirements
Development Impacts	Air Quality Impacts Future development at the site would be required to assess the air quality impacts from each individual development. Cumulative assessment of air quality impacts on nearby sensitive receivers may also be required where proposed developments of a similar nature with regard to emission of air pollutants are proposed. The level of assessment for each development would be determined on a case by case basis. Where there is the potential for negligible or only minor air quality impacts from proposed industrial developments only a qualitative assessment may be required. Otherwise a quantitative assessment of potential air quality impacts will be required in accordance with the Protection of the Environment Operations Act 1997 (NSW) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005)*. The Approved Methods lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW and can be used to predict whether emissions from a proposed development would comply with the EPA ambient air quality criteria. Odour Impacts In addition to an assessment of air quality pollutants in accordance with the *Approved Method*s, any proposed development with the potential to generate offensive odour emissions should also be undertaken in accordance with the following documents: • *Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework* (DEC 2006a); and; • *Assessment and Management of Odour from Stationary Sources in NSW: Technical Notes* (DEC 2006b). Any development within close proximity to the Kurnell Boarding Stables and Riding School should consider potential odour impacts from the facility on future sensitive receptors. Specifically development on the north-western corner Lot 2 South which would be recurrently downwind of the stables as north easterly winds are frequent particular during the spring and summer months.
Construction Impacts	Assessment of construction air quality impacts would be required for development at the site including earthworks and any demolition works. The level of assessment would depend on the nature of the works and may involve: • A semi-quantitative assessment using the methodology outlined in the UK Institute of Air Quality Management (IAQM) document Guidance on the assessment of dust from demolition and construction; or • Quantitative assessment in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005)*. The following items would need to considered as part of the construction impact assessment: • Potential impacts to existing sensitive receptors onsite including the Kurnell Boarding Stables and Riding School and Boat Harbour Residents (prior to removal);

Item	Requirements
	• Potential cumulative and staging impacts associated with dust generating activities; including: - Earthworks, construction and/or demolition works that may coincide with existing dust generating activities onsite (prior to cessation) including sand mining and remediation works; - Cumulative impacts associated with construction works that may occur while the adjacent landfill and materials recovery facility is still operational. - Cumulative impacts associated with nearby proposed develop or construction works such as road widening, or construction works under the Greenhills VPA. - In the event contaminated fill is discovered during excavation works appropriate safeguard measures would be required to prevent/minimise generation of airborne contaminants.
Landfill Gas	Should the proposed development (or SEPP amendment that would have the effect of allowing development) encroaches into the recommended landfill buffer area (250m from landfill cell) an environmental audit should be conducted to assess the risk of harm to the proposed development posed by the potential offsite migration of landfill gas and amenity impacts resulting from the landfill. In the event that a building or structure is located within the recommended buffer monitoring would be required in accordance with *NSW EPA Environmental Guidelines, Solid Waste Landfills* (EPA 2016). Building and structure buffer distances apply to closed landfill sites until the site has stabilised to the point where the potential for subsurface gas migration has largely ceased. Typically, this will be a period of about 30 years. At least 24 months of monitoring may need to be undertaken at the site to determine if the site was suitable for enclosed development.
Vehicle Emissions	Proposed development, particularly multi story buildings adjacent to busy roads may require further assessment of vehicle emissions, where formation of urban canyons have the potential to impact receptors, particularly highly sensitive receptors such aged childcare, or aged care facilities. Air dispersion modelling using the lagrangian particle model GRAL developed at the Institute for Internal Combustion Engines and Thermodynamics, Technical University Graz, Austria would be recommended. The GRAL model has algorithms which effectively consider dispersion in low wind speed conditions and allows for very fine scale consideration of buildings to predict receptor concentrations at building facades both fronting and facing away from road corridors.
Gas Efflux and Exhaust Plumes	Any future development with a gas efflux or exhaust plume which may have an average vertical velocity exceeding 4.3 m/s at the Sydney Airport OLS would be required to undertake a Plume Rise Assessment in accordance with the *Advisory Circular AC 139-5(1) Plume Rise Assessments* to assess the potential hazard to aircraft operations. Any revisions to the *Advisory Circular AC 139-5(v3.0)* should also be taken into account should a plume assessment be required.
Breen Resources Modification	Breen Resources lodged a modification for development for the adjacent landfill site including relocation of the existing waste facility, site access and a minor increase in the sites waste capacity extending the life of the landfill facility beyond 2020. Assessment of air quality impacts from the proposed modification has not been included in this report but would be required should the modified development application be approved.

8.0 Conclusion

AECOM have prepared an AQIA to address the DP&E requirements on behalf of Besmaw in relation review and amend the *SEPP Kurnell Peninsula 1989 (NSW)* as it applies to 251 and 280-282 Captain Cook Drive, Kurnell Peninsula, NSW. The following report findings would be used to inform the master planning of the site:

- Implement strategic planning when considering staging of the development to:
  - Minimise cumulative impacts with existing and future dust generating activities;
  - Consider staging development and occupancy to minimise dust impacts on future residents on western portion of Lot 2 South prior to closure of landfill; and
  - Apply appropriate safeguard measures to reduce construction impacts on existing sensitive receptors onsite.
- Requirement of onsite buffer zone, to mitigate against landfill gas migration impacts is unlikely provided the closest landfill cell was located approximately 475m from the site boundary and subsurface methane gas concentrations are compliant with the EPA landfill gas stabilisation criteria, though additional monitoring may be required.
- Should former waste have been deposited on the eastern boundary of the landfill buffer distance of up to 230m (worst case) may be required on the eastern side of the site adjacent to the landfill placing restrictions on enclosed development where landfill gas may have the potential to accumulate. These restrictions may also potentially be avoided if compliance with landfill gas stabilisation criteria is demonstrated and additional design measures are employed for enclosed (built) development.
- No onsite buffer distance is required between the Cronulla WWTP and the Caltex Kurnell Terminal.
- A number of planning and design considerations should be taken into account including:
  - Development adjacent to Captain Cook Drive should be undertaken with due consideration to the DP&E's *Guideline*, especially with reference to siting of particularly sensitive land uses such as childcare centres and aged care facilities;
  - Any buildings built within 250 metres of deposited waste must be designed not to accumulate landfill gas;
  - At a minimum any wood heaters onsite must comply with the requirements of the *POEO (Clean Air) Amendment (Solid Fuel Heaters) Regulation 2016 (NSW)* but a site wide ban is preferred on all future development within the site to minimise particulate emissions;
  - Should any proposed facility have an exhaust plume with a vertical velocity exceeding 4.3 m/s at the Sydney Airport OLS, a Plume Rise Assessment would be required to assess the potential hazard to aircraft operations in accordance with *AC 139-5(1).*
- Development of suitable management practices:
  - Prepare a CAQMP to minimise emissions from mobile and stationary equipment in line with the EPA's report *Reducing Emissions from Non-road Diesel Engines* (Environ 2014);
  - Implement management strategies to minimise odour and dust impacts from Kurnell Boarding Stables and Riding School prior to closure on any adjacent sensitive receptors
- The following additional assessments have been identified that may be required prior to development:
  - AQIA of construction and operation impacts in accordance with the Approved Methods;
  - Landfill gas monitoring and landfill gas risk assessment;
  - Plume Rise Assessment for future development with an exhaust plume with an average vertical velocity exceeding 4.3 m/s

- Assessment of air quality impacts associated with proposed modification development application of the Breen Resource landfill and any associated extension to landfill operations prior to closure and remediation.

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Appendix A

Landfill Gas Monitoring

Appendix A Landfill Gas Monitoring

A copy of the landfill gas data monitoring undertaken by Consulting Earth Sciences (CES) for April 2017 to January 2018 in accordance with Condition P1.1 of Breen Resources Environmental Protection Licence (No. 4608) (EPL) for subsurface gas monitoring is provided below.

The monitoring data reports show both the location of EPL monitoring points 20 to 25 for subsurface gas monitoring and the monitoring results. The data suggests that for methane levels are currently below the EPA assessment criterion for landfill gas of 1% (volume/volume).

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Figure 1: Groundwater and Leachate Sampling Locations

CES Project ID:	Date:
CES070607-KLF	14/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Figure 2 Gas Monitoring Locations

CES Project ID:	Date:
CES070607-KLF	13/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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EPA License No.: 4608

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Kurnell Landfill Environmental Monitoring Locations

EPA ID No.	Monitoring Location	Easting	Northing
3	BH3A	331557.559	6233612.570
4	BH4A	331555.149	6233531.497
5	BH5A	331325.514	6233723.575
6	BH6A	331588.552	6233160.367
7	BH7A	331293.2	6233053.87
8	BH8A	331005.488	6233233.894
9	BH9C	331540.67	6233420.14
11	BH10A	331819.08	6233299.27
12	BH11A	331350.35	6233170.05
13	BH12A	331166.433	6233699.572
14	BH13A	331447.247	6233662.638
15	BH14	331997.150	6233370.046
16	BH15	332482.813	6233510.587
17	BH16	332149.279	6233032.038
18	BH17	331432.560	6233696.015
19	BH18	330761.63	6233399.46
26	BH19	331786.065	6233268.677
27	BH20	332200.120	6233439.830
28	BH22	332446.162	6233300.895
29	BH23	332254.027	6233075.673
30	BH24	331709.001	6232960.575
31	BH25	330974	6233693
1	LB02	331246	6233411

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Kurnell Landfill Quarterly Ground Water Analytical Results - April 2017

Monitoring Location:			BH3A	BH4A	BH5A	BH6A	BH7A	BH8A	BH9C	BH10	BH11A	BH12A	BH13A
Sample Id:			050717-JJ-BH3A	060717-JJ-BH4A	050717-JJ-BH5A	060717-JJ-BH6A	050717-JJ-BH7A	050717-JJ-BH8A	050717-JJ-BH9C	120417-JJ-19	110417-JJ-03	120417-JJ-18	120417-JJ-21
Laboratory Report Number:			170756	170846	170756	170846	170756	170756	170756	165224	165111	165224	165224
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab
Date Sampled:			05 Jul 17	06 Jul 17	05 Jul 17	06 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	12 Apr 17	11 Apr 17	12 Apr 17	12 Apr 17
Parameters	**PQL**	**Units**	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018
Standing Water Level	0.01	mBTOC	3.32	4.24	7.17	10.31	2.44	16.44	5.56	2.61	23.32	9.99	3.62
pH (field)	0.1	pH units	7.63	6.82	6.93	6.29	7.15	7.47	6.43	6.84	6.59	6.57	6.71
Electrical Conductivity (field)	1	µS/cm	922	1128	1585	1240	1040	708	1088	1341	1686	1880	1510
pH	0.1	pH units	7.9	6.8	7.3	6.6	7.4	7.7	7.1	6.9	7	7.1	7.3
Total Dissolved Solids	5	mg/L	640	840	950	540	630	400	520	880	1100	1100	960
Total Organic Carbon	1	mg/L	180	8	17	150	5	2	24	71	20	16	12
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	20	mg/L	41	41	120	39	32	48	30	55	140	190	99
Sulphate	5	mg/L	280	300	76	120	47	18	40	250	140	94	170
Ammonia as N	0.1	mg/L	1.6	0.016	8.8	0.037	0.01	<0.005	2.7	0.52	1.6	7.2	0.49
Sodium (Na)	0.03	mg/L	42	45	130	37	45	40	35	48	110	160	87
Potassium (I) Ion	0.03	mg/L	12	13	20	10	2.4	1.4	6.9	9	5.9	20	11
Calcium (II) Ion	0.03	mg/L	120	220	180	200	150	91	150	220	210	210	210
Magnesium (II) Ion	0.03	mg/L	17	13	28	22	26	8.8	11	20	40	27	22

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Ground Water Analytical Results - April 2017 (continued)

Sample Location:			BH14	BH15	BH16	BH17	BH18	BH19	BH20	BH22	BH23	BH24	BH25	LB2
Sample Id:			110417-JJ-06	110417-JJ-07	110417-JJ-10	110417-JJ-15	120417-JJ-16	110417-JJ-05	120417-JJ-20	110417-JJ-08	110417-JJ-09	110417-JJ-11	110417-JJ-13	-
Laboratory Report Number:			165111	165111	165111	165111	165224	165111	165224	165111	165111	165111	165111	-
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	Envirolab	-
Date Sampled:			11 Apr 17	11 Apr 17	11 Apr 17	11 Apr 17	12 Apr 17	11 Apr 17	12 Apr 17	11 Apr 17	11 Apr 17	11 Apr 17	11 Apr 17	11 Apr 17
Parameters	**PQL**	**Units**	1st quarter 2017/2018	1st quarter 2017/2018	1st Quarter 2017/2018	1st Quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018	1st quarter 2017/2018
Standing Water Level	0.01	mBTOC	1.93	4.33	0.7	5.26	26.88	3.12	1.4	2.42	2.52	12.44	7.2	nr
pH (field)	0.1	pH units	6.87	7.21	6.68	7.05	6.31	6.58	8.56	6.96	6.98	6.45	7.23	6.92
Electrical Conductivity (field)	1	µS/cm	1243	786	371	1002	1444	1377	501	839	599	496	1343	5840
pH	0.1	pH units	7	7.3	6.5	7.2	7.2	6.9	8	7.3	7.1	6.7	7.5	nt
Total Dissolved Solids	5	mg/L	800	490	180	580	940	930	280	450	380	300	710	nt
Total Organic Carbon	1	mg/L	97	5	6	6	6	67	9	12	10	21	5	nt
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	nt
Chloride	20	mg/L	75	34	63	47	76	30	48	52	26	25	170	nt
Sulphate	5	mg/L	130	36	11	130	120	280	60	65	17	27	8	nt
Ammonia as N	0.1	mg/L	0.25	0.13	0.016	0.21	0.018	0.005	0.01	3.8	0.11	<0.005	0.55	nt
Sodium (Na)	0.03	mg/L	83	26	45	45	61	40	36	54	25	15	150	nt
Potassium (I) Ion	0.03	mg/L	12	6.6	2.4	8.5	8.1	9.5	5.7	12	12	4.3	4.2	nt
Calcium (II) Ion	0.03	mg/L	240	110	22	160	210	260	44	99	89	89	150	nt
Magnesium (II) Ion	0.03	mg/L	39	21	5.6	17	31	26	7.4	13	8	7.8	19	nt

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Subsurface Gas Results - April 2017

EPA ID No.	Well ID	Initial well pressure above atmospheric (kPa)	Initial vent	Flow Rate L/hr	Initial well concentrations CH_4 (%)	Maximum vacuum on well (psi)	Recovery time (min)	Total volume purged (L)	Well concentrations following purging CH_4 (%)
20	BH4A	<1	Nil	0	<0.1	-20	<1	30	<0.1
22	BH8B	<1	Nil	0	0.1	-20	<1	30	<0.1
23	BH12A	<1	Nil	-	<0.1	-20	<1	30	<0.1
24	BH13A	<1	Nil	-	<0.1	-20	<1	30	<0.1
25	BH18	<1	Nil	-	<0.1	-20	<1	50	<0.1

BOLD Greater than the assessment criteria of 1.0 % CH_4

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Figure 1: Groundwater and Leachate Sampling Locations

CES Project ID:	Date:
CES070607-KLF	14/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Figure 2 Gas Monitoring Locations

CES Project ID:	Date:
CES070607-KLF	13/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Kurnell Landfill Environmental Monitoring Locations

EPA ID No.	Monitoring Location	Easting	Northing
3	BH3A	331557.559	6233612.570
4	BH4A	331555.149	6233531.497
5	BH5A	331325.514	6233723.575
6	BH6A	331588.552	6233160.367
7	BH7A	331293.2	6233053.87
8	BH8A	331005.488	6233233.894
9	BH9C	331540.67	6233420.14
11	BH10A	331819.08	6233299.27
12	BH11A	331350.35	6233170.05
13	BH12A	331166.433	6233699.572
14	BH13A	331447.247	6233662.638
15	BH14	331997.150	6233370.046
16	BH15	332482.813	6233510.587
17	BH16	332149.279	6233032.038
18	BH17	331432.560	6233696.015
19	BH18	330761.63	6233399.46
26	BH19	331786.065	6233268.677
27	BH20	332200.120	6233439.830
28	BH22	332446.162	6233300.895
29	BH23	332254.027	6233075.673
30	BH24	331709.001	6232960.575
31	BH25	330974	6233693
1	LB02	331246	6233411

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Kurnell Landfill Quarterly Ground Water Analytical Results - July 2017

Monitoring Location:			BH3A	BH4A	BH5A	BH6A	BH7A	BH8A	BH9C	BH10	BH11A	BH12A	BH13A
Sample Id:			050717-JJ-BH3A	060717-JJ-BH4A	050717-JJ-BH5A	060717-JJ-BH6A	050717-JJ-BH7A	050717-JJ-BH8A	050717-JJ-BH9C	050717-JJ-BH10B	050717-JJ-BH11A	060717-JJ-BH12A	060717-JJ-BH13A
Laboratory Report Number:			170756	170846	170756	170846	170756	170756	170756	170756	170756	170846	170846
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab
Date Sampled:			05 Jul 17	06 Jul 17	05 Jul 17	06 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	06 Jul 17	06 Jul 17
Parameters	**PQL**	**Units**	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018
Standing Water Level	0.01	mBTOC	3.32	4.24	7.17	10.31	2.44	16.44	5.56	3.8	23.34	10.02	3.78
pH (field)	0.1	pH units	7.63	6.82	6.93	6.29	7.15	7.47	6.43	7.1	6.75	6.95	7.47
Electrical Conductivity (field)	1	µS/cm	922	1128	1585	1240	1040	708	1088	1130	1853	2060	1086
pH	0.1	pH units	7.9	6.8	7.3	6.6	7.4	7.7	7.1	7.4	7.1	7	7.3
Total Dissolved Solids	5	mg/L	640	840	950	540	630	400	520	710	1100	990	650
Total Organic Carbon	1	mg/L	180	8	17	150	5	2	24	24	33	16	5
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	20	mg/L	41	41	120	39	32	48	30	44	140	140	72
Sulphate	5	mg/L	280	300	76	120	47	18	40	170	91	90	90
Ammonia as N	0.1	mg/L	1.6	0.016	8.8	0.037	0.01	<0.005	2.7	0.66	4.9	6.4	0.006
Sodium (Na)	0.03	mg/L	42	45	130	37	45	40	35	49	130	130	70
Potassium (I) Ion	0.03	mg/L	12	13	20	10	2.4	1.4	6.9	9.5	10	25	9.1
Calcium (II) Ion	0.03	mg/L	120	220	180	200	150	91	150	190	240	230	170
Magnesium (II) Ion	0.03	mg/L	17	13	28	22	26	8.8	11	17	49	26	15

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Ground Water Analytical Results - July 2017 (continued)

Sample Location:			BH14	BH15	BH16	BH17	BH18	BH19	BH20	BH22	BH23	BH24	BH25	LB2
Sample Id:			050717-JJ-BH14A	050717-JJ-BH15	050717-JJ-BH16	050717-JJ-BH17	060717-JJ-BH18	050717-JJ-BH19A	060717-JJ-BH20	050717-JJ-BH22	050717-JJ-BH23	050717-JJ-BH24	050717-JJ-BH25	-
Laboratory Report Number:			170756	170756	170756	170756	170846	170756	170846	170756	170756	170756	170756	-
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	Envirolab	-
Date Sampled:			05 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	06 Jul 17	05 Jul 17	06 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17	05 Jul 17
Parameters	**PQL**	**Units**	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018	2nd quarter 2017/2018
Standing Water Level	0.01	mBTOC	2.3	4.61	0.89	5.36	26.86	3.47	1.85	2.82	3.29	12.47	7.24	15.18
pH (field)	0.1	pH units	7.04	7.36	7.25	7.11	6.91	6.77	7.53	7.27	7.17	6.65	7.32	7.16
Electrical Conductivity (field)	1	µS/cm	1029	646	374	1039	1364	1412	455	698	512	433	1264	5350
pH	0.1	pH units	7.1	7.7	7	7.4	6.9	7.2	6.9	7.6	7.5	6.9	7.8	nt
Total Dissolved Solids	5	mg/L	660	390	220	690	820	1100	240	450	300	270	680	nt
Total Organic Carbon	1	mg/L	20	3	7	6	5	33	12	7	7	8	4	nt
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	nt
Chloride	20	mg/L	62	14	61	47	94	30	35	38	22	17	170	nt
Sulphate	5	mg/L	160	11	12	180	44	420	40	62	17	22	8	nt
Ammonia as N	0.1	mg/L	0.1	0.043	0.008	0.052	0.12	0.023	0.20	1.6	0.049	<0.005	0.64	nt
Sodium (Na)	0.03	mg/L	72	16	43	56	79	41	30	27	18	12	140	nt
Potassium (I) Ion	0.03	mg/L	8.9	7.3	3.3	10	6.2	8.5	7.6	8.1	9.7	4.4	3.8	nt
Calcium (II) Ion	0.03	mg/L	170	100	24	160	200	260	71	98	73	79	130	nt
Magnesium (II) Ion	0.03	mg/L	28	17	5.3	15	32	26	12	13	6.6	7.3	17	nt

NOTES:
nt = Not Tested

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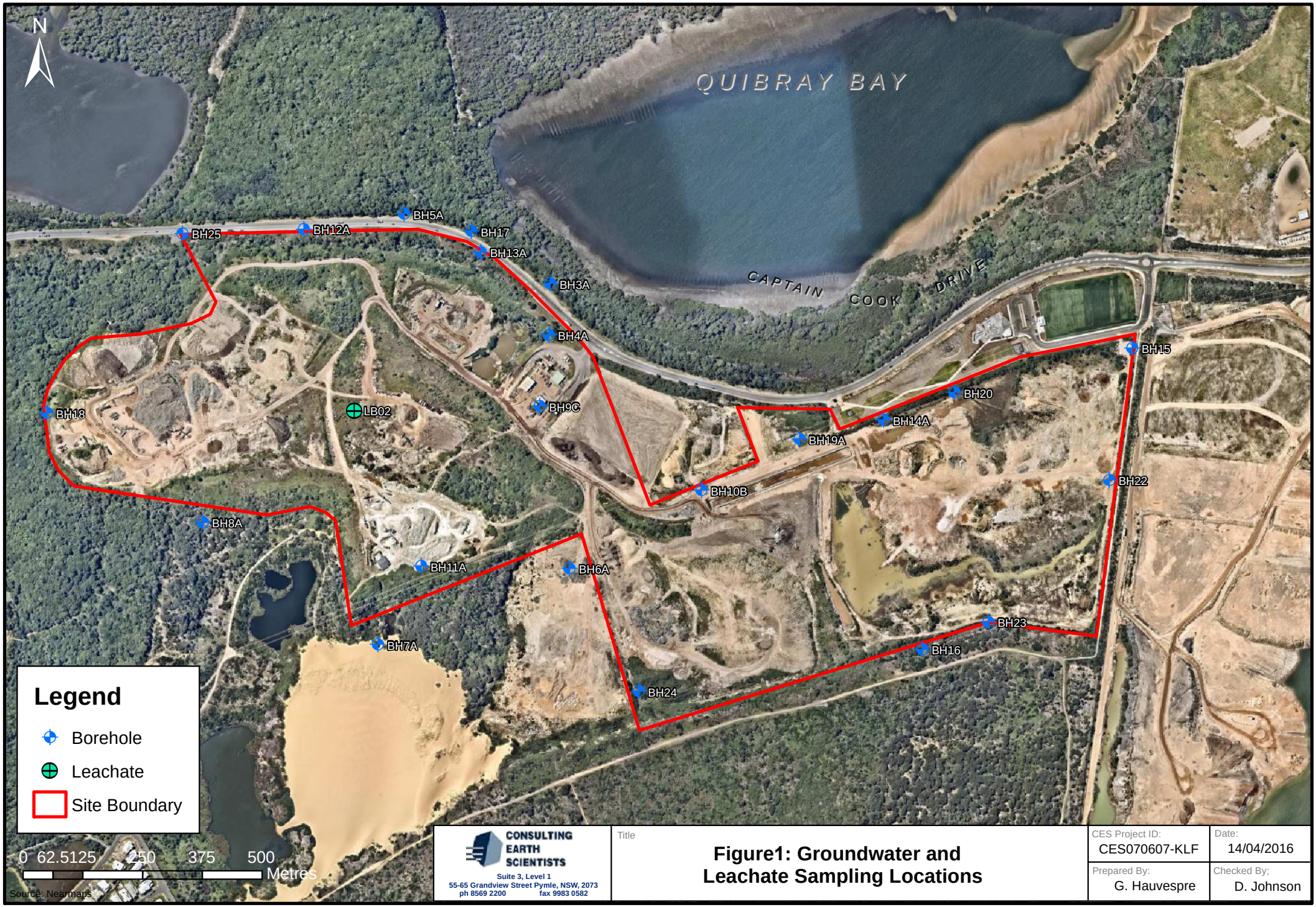
Kurnell Landfill Quarterly Subsurface Gas Results - July 2017

EPA ID No.	Well ID	Initial well pressure above atmospheric (kPa)	Initial vent	Flow Rate L/hr	Initial well concentrations CH_4 (%)	Maximum vacuum on well (psi)	Recovery time (min)	Total volume purged (L)	Well concentrations following purging CH_4 (%)
20	BH4A	<1	Nil	-0.2	<1	-18	<1	30	<1
22	BH8B	<1	Nil	-0.5	<1	-18	<1	30	<1
23	BH12A	<1	Nil	-0.5	0.1	-18	<1	30	<1
24	BH13A	<1	Nil	-0.5	<1	-18	<1	30	<1
25	BH18	<1	Nil	-0.4	<1	-18	<1	50	<1

BOLD Greater than the assessment criteria of 1.0 % CH_4



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Title

Figure1: Groundwater and Leachate Sampling Locations

CES Project ID:	Date:
CES070607-KLF	14/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Title

Figure 2 Gas Monitoring Locations

CES Project ID:	Date:
CES070607-KLF	13/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Kurnell Landfill Environmental Monitoring Locations

EPA ID No.	Monitoring Location	Easting	Northing
3	BH3A	331557.559	6233612.570
4	BH4A	331555.149	6233531.497
5	BH5A	331325.514	6233723.575
6	BH6A	331588.552	6233160.367
7	BH7A	331293.2	6233053.87
8	BH8A	331005.488	6233233.894
9	BH9C	331540.67	6233420.14
11	BH10A	331819.08	6233299.27
12	BH11A	331350.35	6233170.05
13	BH12A	331166.433	6233699.572
14	BH13A	331447.247	6233662.638
15	BH14	331997.150	6233370.046
16	BH15	332482.813	6233510.587
17	BH16	332149.279	6233032.038
18	BH17	331432.560	6233696.015
19	BH18	330761.63	6233399.46
26	BH19	331786.065	6233268.677
27	BH20	332200.120	6233439.830
28	BH22	332446.162	6233300.895
29	BH23	332254.027	6233075.673
30	BH24	331709.001	6232960.575
31	BH25	330974	6233693
1	LB02	331246	6233411

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Kurnell Landfill Quarterly Ground Water Analytical Results - October 2017

Monitoring Location:			BH3A	BH4A	BH5A	BH6A	BH7A	BH8A	BH9C	BH10	BH11A	BH12A	BH13A
Sample Id:			101017-JJ-BH3A	101017-JJ-BH4A	101017-JJ-BH5A	091017-JJ-BH6A	091017-JJ-BH7A	091017-JJ-BH8A	091017-JJ-BH9C	091017-JJ-BH10	091017-JJ-BH11A	101017-JJ-BH12A	101017-JJ-BH13A
Laboratory Report Number:			177358	177358	177358	177278	177278	177278	177278	177278	177278	177358	177358
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab
Date Sampled:			10 Oct 17	10 Oct 17	10 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	10 Oct 17	10 Oct 17
Parameters	**PQL**	**Units**	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018
Standing Water Level	0.01	mBTOC	3.3	4.3	7.31	10.57	2.53	17.5	5.78	2.89	23.61	10.19	3.87
pH (field)	0.1	pH units	7.59	6.2	6.82	6.44	7.23	7.43	6.84	7.06	6.78	6.93	6.89
Electrical Conductivity (field)	1	µS/cm	960	1119	1492	700	955	612	961	1041	1716	1525	1231
pH	0.1	pH units	7.8	7	7.2	6.5	7.3	7.5	7.2	7.2	7	7.2	7.3
Total Dissolved Solids	5	mg/L	560	780	870	160	240	360	270	710	400	1100	750
Total Organic Carbon	1	mg/L	5	8	16	73	5	3	29	25	19	16	7
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	20	mg/L	48	49	130	34	27	51	59	53	140	180	96
Sulphate	5	mg/L	320	280	78	72	48	16	53	160	78	120	93
Ammonia as N	0.1	mg/L	1.2	0.006	12	0.02	0.031	0.011	14	0.71	4.8	12	0.015
Sodium (Na)	0.03	mg/L	40	38	86	26	19	37	47	47	120	130	97
Potassium (I) Ion	0.03	mg/L	12	12	22	2.7	2.2	1.3	11	12	8	28	11
Calcium (II) Ion	0.03	mg/L	170	230	190	140	150	96	150	200	220	240	190
Magnesium (II) Ion	0.03	mg/L	20	15	25	12	26	9	13	20	47	38	18

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Ground Water Analytical Results - July 2017 (continued)

Sample Location:			BH14	BH15	BH16	BH17	BH18	BH19	BH20	BH22	BH23	BH24	BH25	LB2
Sample Id:			091017-JJ-BH14	091017-JJ-BH15	091017-JJ-BH16	101017-JJ-BH17	091017-JJ-BH18	091017-JJ-BH19A	091017-JJ-BH20	091017-JJ-22	091017-JJ-BH23	091017-JJ-BH24	101017-JJ-BH25	-
Laboratory Report Number:			177278	177278	177278	177358	177278	177278	177278	177278	177278	177278	177358	-
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	-
Date Sampled:			09 Oct 17	09 Oct 17	09 Oct 17	10 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	09 Oct 17	10 Oct 17	10 Oct 17
Parameters	**PQL**	**Units**	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018	3rd quarter 2017/2018
Standing Water Level	0.01	mBTOC	2.22	4.94	1.19	5.45	27.1	3.36	2.35	3.25	3.62	12.67	7.36	nt
pH (field)	0.1	pH units	6.84	7.34	7.39	6.93	6.88	6.85	7.34	7.31	7.3	6.5	7.19	6.93
Electrical Conductivity (field)	1	µS/cm	1531	745	370	1132	1448	1243	587	916	461	372	1132	1132
pH	0.1	pH units	6.8	7.5	6.9	7.3	6.8	6.9	7.4	7.6	7.5	6.6	7.6	nt
Total Dissolved Solids	5	mg/L	680	390	250	780	820	960	300	490	230	220	720	nt
Total Organic Carbon	1	mg/L	33	4	8	7	3	53	10	10	13	8	5	nt
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	nt
Chloride	20	mg/L	120	34	67	63	130	45	49	65	24	22	190	nt
Sulphate	5	mg/L	200	29	13	230	51	340	40	120	12	25	9	nt
Ammonia as N	0.1	mg/L	0.54	0.2	0.006	0.61	0.53	0.01	1.40	1.4	0.012	0.008	0.59	nt
Sodium (Na)	0.03	mg/L	120	28	46	44	98	46	41	55	16	15	130	nt
Potassium (I) Ion	0.03	mg/L	9.1	8.1	2.5	15	6.2	8.8	6.2	9.2	12	3.8	4.3	nt
Calcium (II) Ion	0.03	mg/L	220	120	29	210	190	250	85	110	71	63	170	nt
Magnesium (II) Ion	0.03	mg/L	40	21	5.6	19	32	24	9.6	18	7.7	5.3	20	nt

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Subsurface Gas Results - October 2017

EPA ID No.	Well ID	Initial well pressure above atmospheric (kPa)	Initial vent	Flow Rate L/hr	Initial well concentrations CH_4 (%)	Maximum vacuum on well (psi)	Recovery time (min)	Total volume purged (L)	Well concentrations following purging CH_4 (%)
20	BH4A	<0.1	Nil	1.3	<0.1	-18	<1	30	<0.1
22	BH8B	<0.1	Nil	0.9	<0.1	-18	<1	30	<0.1
23	BH12A	<0.1	Nil	1	<0.1	-18	<1	30	<0.1
24	BH13A	<0.1	Nil	1.2	<0.1	-18	<1	30	<0.1
25	BH18	<0.1	Nil	1.2	<0.1	-18	<1	50	<0.1

BOLD Greater than the assessment criteria of 1.0 % CH_4

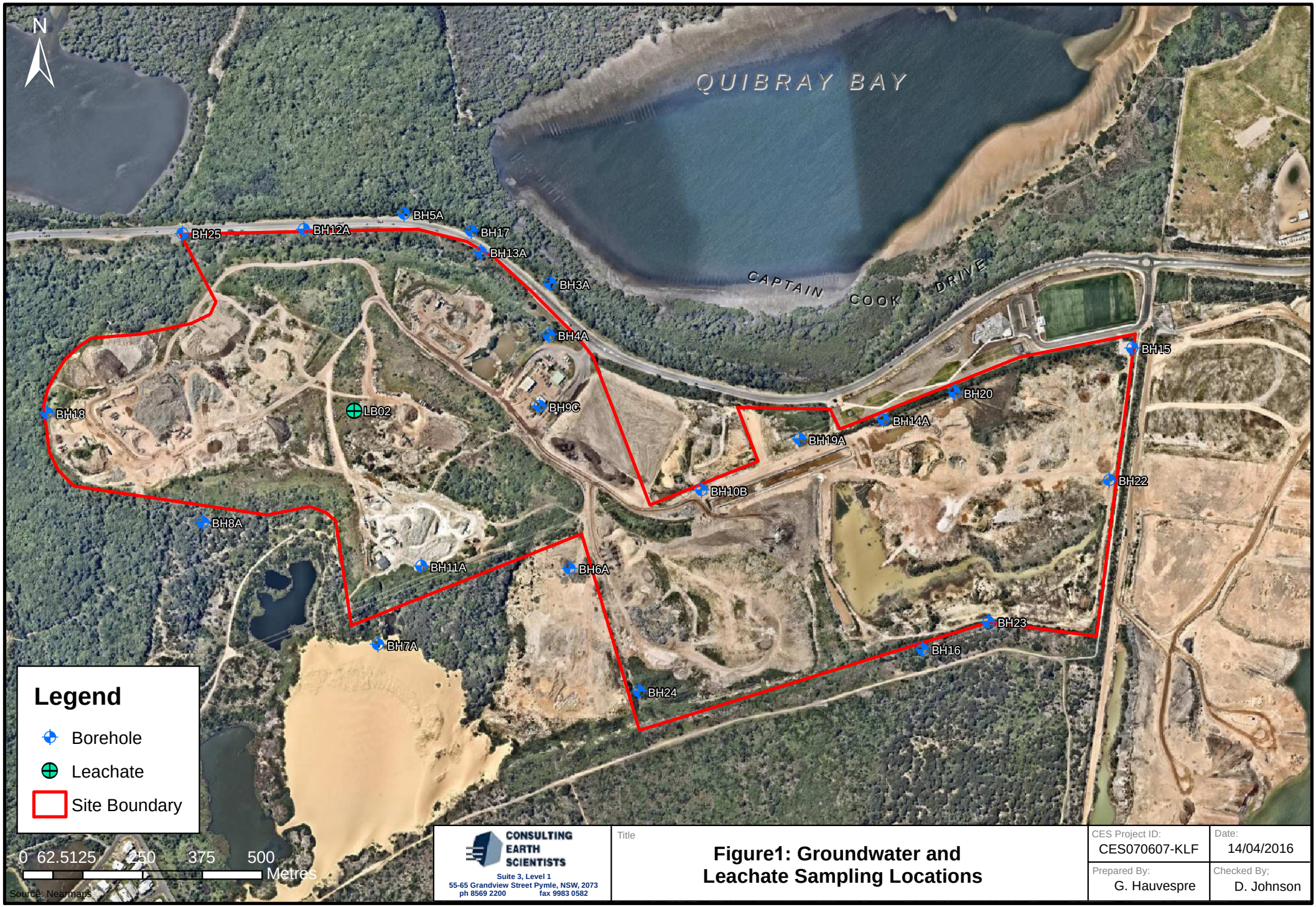

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Figure1: Groundwater and Leachate Sampling Locations

CES Project ID:	Date:
CES070607-KLF	14/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Title

Figure 2 Gas Monitoring Locations

CES Project ID:	Date:
CES070607-KLF	13/04/2016
Prepared By: G. Hauvespre	Checked By; D. Johnson

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Kurnell Landfill Environmental Monitoring Locations

EPA ID No.	Monitoring Location	Easting	Northing
3	BH3A	331557.559	6233612.570
4	BH4A	331555.149	6233531.497
5	BH5A	331325.514	6233723.575
6	BH6A	331588.552	6233160.367
7	BH7A	331293.2	6233053.87
8	BH8A	331005.488	6233233.894
9	BH9C	331540.67	6233420.14
11	BH10A	331819.08	6233299.27
12	BH11A	331350.35	6233170.05
13	BH12A	331166.433	6233699.572
14	BH13A	331447.247	6233662.638
15	BH14	331997.150	6233370.046
16	BH15	332482.813	6233510.587
17	BH16	332149.279	6233032.038
18	BH17	331432.560	6233696.015
19	BH18	330761.63	6233399.46
26	BH19	331786.065	6233268.677
27	BH20	332200.120	6233439.830
28	BH22	332446.162	6233300.895
29	BH23	332254.027	6233075.673
30	BH24	331709.001	6232960.575
31	BH25	330974	6233693
1	LB02	331246	6233411

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Kurnell Landfill Quarterly Ground Water Analytical Results - January 2018

Monitoring Location:			BH3A	BH4A	BH5A	BH6A	BH7A	BH8A	BH9C	BH10	BH11A	BH12A	BH13A
Sample Id:			160118-SI-BH3A	160118-SI-BH4A	160118-SI-BH5A	-	150116-SI-BH7A	150118-SI-BH8A	150118-SI-BH9C	150118-SI-BH10B	150118-SI-BH11A	160118-SI-BH12A	160118-SI-BH13A
Laboratory Report Number:			183384	183384	183384	-	183311	183311	183311	183311	183311	183384	183384
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab
Date Sampled:			16 Jan 18	16 Jan 18	16 Jan 18	15 Jan 18	15 Jan 18	15 Jan 18	15 Jan 18	15 Jan 18	15 Jan 18	16 Jan 18	16 Jan 18
Parameters	**PQL**	**Units**	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018
Standing Water Level	0.01	mBTOC	3.34	4.32	7.32	nt	2.9	16.89	5.87	3.01	23.78	10.23	3.8
pH (field)	0.1	pH units	7.73	6.66	6.85	nt	6.66	6.93	6.77	6.3	6.88	6.95	7.27
Electrical Conductivity (field)	1	µS/cm	841	959	1747	nt	857	532	1268	1006	1384	1707	1303
pH	0.1	pH units	7.6	7	7.2	nt	6.6	6.8	7	6.2	6.9	7.1	7.4
Total Dissolved Solids	5	mg/L	700	800	1100	nt	600	340	780	700	920	1200	890
Total Organic Carbon	1	mg/L	6	6	27	nt	4	8	44	34	11	17	10
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	nt	<5	<5	<5	<5	<5	<5	<5
Chloride	20	mg/L	46	43	170	nt	22	50	75	54	130	200	120
Sulphate	5	mg/L	310	350	91	nt	32	14	92	160	120	120	110
Ammonia as N	0.1	mg/L	1.2	<0.005	18	nt	0.018	<0.005	35	0.76	2.5	10	0.51
Sodium (Na)	0.03	mg/L	49	46	190	nt	23	33	74	48	110	170	190
Potassium (I) Ion	0.03	mg/L	11	12	37	nt	2.4	1	21	11	5.3	27	12
Calcium (II) Ion	0.03	mg/L	150	210	230	nt	170	91	190	200	190	220	190
Magnesium (II) Ion	0.03	mg/L	19	14	42	nt	28	8.6	22	19	35	46	22

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Ground Water Analytical Results - January 2018 (continued)

Sample Location:			BH14	BH15	BH16	BH17	BH18	BH19	BH20	BH22	BH23	BH24	BH25	LB2
Sample Id:			160118-SI-BH14A	160118-SI-BH15	160118-SI-BH16	160118-SI-BH17	160118-SI-BH18	160118-SI-BH19A	160118-SI-BH20	160118-SI-BH22	160118-SI-BH23	160118-SI-BH24	160118-SI-BH25	-
Laboratory Report Number:			183384	183384	183384	183384	183384	183384	183384	183384	183384	183384	183384	-
Laboratory:			EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	EnviroLab	-
Date Sampled:			16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18	16 Jan 18
Parameters	**PQL**	**Units**	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018	4th quarter 2017/2018
Standing Water Level	0.01	mBTOC	2.26	4.94	1.29	5.45	27.17	3.56	2.28	3.35	3.71	12.84	7.36	nt
pH (field)	0.1	pH units	6.7	6.86	5.83	7.14	6.45	6.58	6.55	7.02	6.5	7.18	7.27	nt
Electrical Conductivity (field)	1	µS/cm	1417	768	417	1049	1296	994	583	812	1858	336.8	1227	nt
pH	0.1	pH units	6.9	7.3	5.8	7.3	7	6.5	6.5	6.3	6.7	6.5	7.2	nt
Total Dissolved Solids	5	mg/L	950	560	250	780	820	860	430	660	1400	240	740	nt
Total Organic Carbon	1	mg/L	55	5	5	8	3	25	32	12	33	21	4	nt
Carbonate Alkalinity (CO3-2)	1	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	nt
Chloride	20	mg/L	98	54	76	62	120	45	46	79	260	22	190	nt
Sulphate	5	mg/L	190	64	13	210	55	300	65	170	380	28	9	nt
Ammonia as N	0.1	mg/L	0.87	0.46	0.013	1.7	0.61	0.008	0.89	2	0.008	<0.005	0.66	nt
Sodium (Na)	0.03	mg/L	160	50	60	68	100	50	37	76	260	17	170	nt
Potassium (I) Ion	0.03	mg/L	8.3	6	2.4	22	5.4	7.8	6.7	13	21	4.7	4.1	nt
Calcium (II) Ion	0.03	mg/L	220	130	44	200	200	220	110	130	270	72	150	nt
Magnesium (II) Ion	0.03	mg/L	42	26	5.8	19	33	25	14	21	34	8.3	20	nt

NOTES:
nt = Not Tested

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Kurnell Landfill Quarterly Subsurface Gas Results - January 2018

EPA ID No.	Well ID	Initial well pressure above atmospheric (kPa)	Initial vent	Flow Rate L/hr	Initial well concentrations CH_4 (%)	Maximum vacuum on well (psi)	Recovery time (min)	Total volume purged (L)	Well concentrations following purging CH_4 (%)
20	BH4A	<0.1	Nil	0.1	<0.1	-18	<1	30	<0.1
22	BH8B	<0.1	Nil	0.4	<0.1	-18	<1	30	<0.1
23	BH12A	<0.1	Nil	0.3	<0.1	-18	<1	30	<0.1
24	BH13A	<0.1	Nil	0.2	<0.1	-18	<1	30	<0.1
25	BH18	<0.1	Nil	0.6	<0.1	-18	<1	50	<0.1

BOLD Greater than the assessment criteria of 1.0 % CH_4

Appendix B

Landfill Satellite Images

Appendix B Landfill Satellite Images

A collection of Google Earth satellite images between December 1999 and April 2019 showing both the site and the adjacent landfill and materials recovery facility operated by Breen Resources is shown below.

Closer examination of site activity on the adjoining landfill is presented in **Figure 7** to **Figure 10**. From the satellite imagery it appears that sand extraction from the Breen Facility was ongoing in 2005 refer to **Figure 7**) and was filled in around 2009 (refer to **Figure 8**). Land immediately adjacent to the site appears to be predominantly used for stockpiling of waste materials and depositing VENM and ENM prior to landfilling or reuse (refer to **Figure 9**). The nearest visible landfill cell is not located on adjoining boundary of Lot 2 South but approximately 475m to the west of the Lot 2 South boundary and as such is greater than 250m buffer by the EPA Guidelines (refer to **Figure 10**).

Amendment of SEPP (Kurnell Peninsula) 1989

31 December 1999

31 December 2000

10 May 2005

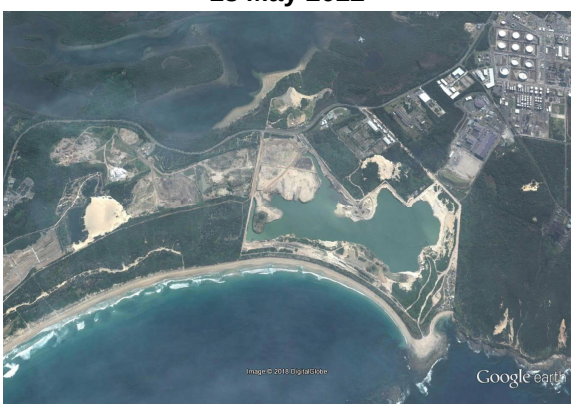
13 September 2005

20 January 2007

1 January 2009

20 October 2011

18 May 2012



9 September 2012

20 October 2012

24 November 2012

6 February 2013

2 April 2013

7 November 2013

13 November 2013

3 December 2013

1 January 2014

6 February 2014

5 May 2014

5 August 2014

2 November 2014

6 January 2015

16 February 2015

27 May 2015

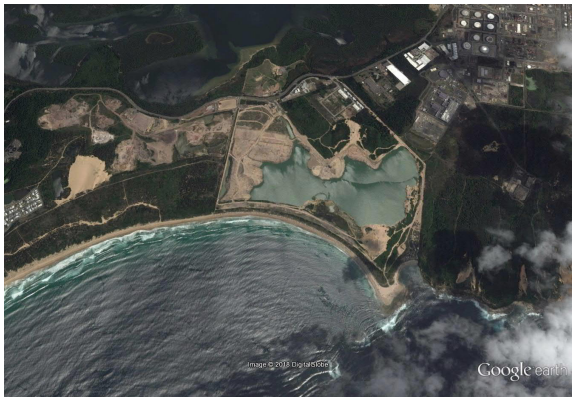
Amendment of SEPP (Kurnell Peninsula) 1989

23 June 2015

6 August 2015

16 October 2015

10 January 2016



23 March 2016

25 April 2016

3 May 2016

23 July 2016

1 October 2016

23 October 2016

19 February 2017

22 May 2017

23 August 2017

5 September 2017

12 March 2018

1 April 2019

Figure 7 Breen Resources Site Activity Adjacent to Lot 2 South on 13 September 2005

Figure 8 Breen Resources Site Activity Adjacent to Lot 2 South on 1 January 2009

Figure 9 Breen Resources Site Activity Adjacent to Lot 2 South on 2 April 2013

Figure 10 Breen Resources Site Activity Adjacent to Lot 2 South on 3 May 2016

Appendix B

Department and Agency Requirements

Appendix B Department and Agency Requirements

Overview

The following subsection provides a tabulated record of agency comments addressed in this report.

Department of Planning Requirements

The original AQIA (AECOM 2020) addressed the original key matters for consideration for the Planning Proposal described in the State Environmental Planning Policy (Kurnell Peninsula) 1989 Review, Scope of Works document dated September 2017. Key matters for consideration are shown in Table 34 along with a reference to where the requirements are addressed in the original AQIA 2020 report (included in Appendix A), and where relevant where these considerations have been updated in this technical report.

Table 34 Department of Planning requirements for Air Quality Impact Assessment.

Item	Section Addressed	
	AQIA 2020	AQIA 2023
Assessment should consider all potential air pollutants, including dust, complex mixtures of odours, individual odorous pollutants and air toxics	Section 5.3.1 and Section 6.0	Section 6.0 and Section 7.0
The specific pollutants assessed must be selected based on a review of existing and potential emission sources in the vicinity of the proposed development	Section 5.3.1, Section 5.3.2 and Section 6.0.	Section 5.3.1, Section 5.3.2 and Section 7.0
The information provided indicates potential for contaminated land and water, due to previous land uses. Air quality impacts associated with contamination and remediation activities must be evaluated	Section 6.2.1	Section 8.4
A level 1 odour assessment as described in Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW (and accompanying technical notes) should be undertaken and identify any mitigation and management approaches including nominal separation distances.	Section 6.3.2, Section 6.3.4 and Section 7.3	Section 7.2.2 (Level 3 Assessment) and Section 7.4.1, Section 7.5.2 and Section 7.6
The Assessment should be undertaken with reference to: • Approved Methods for the modelling and Assessment of Air Pollutants in NSW • Technical Framework – Assessment and Management of Odour from Stationary Sources in NSW; and • Development Near Rail Corridors and Busy Roads – Interim Guideline and the Infrastructure SEPP.	Section 1.2.2, Section 3.4.1, Section 6.0 and Section 7.4.1	Section 6.0, Section 7.0 and Section 8.3.1
Prepare information that outlines the findings of the Air Quality Impact Assessment, including maps identifying those areas where urban development would encroach into the 'separation distance' between it and any odour producing activities;	Section 6.0 and Section 7.3	Not applicable. Odour modelling discussed in Section 7.2.2
Make specific recommendations on any mitigation approaches or measures including but not necessarily limited to staging development, separation distances to minimise exposure, architectural or building design treatments and transitional approaches. Consideration should be given to: • Design approaches to minimise exposure to particle pollution next to major roads (e.g Captain Cook Drive) especially where road volumes are expected to increase;	Section 7.2 to Section 7.5.2	Section 8.0.

Item	Section Addressed	
	AQIA 2020	AQIA 2023
• Restricted installation of the wood heaters and open fire places as wood heaters are a major contributing source of elevated particle levels in Sydney; and • Applying best management practices at the construction stage as diesel and gas powered equipment used in construction can cause air pollution.		

In addition to the requirements dated September 2017, and following the lodgement of the Scoping Proposal for the site in May 2023 additional feedback was provided by DPE on the 10 August 2023. Assessment requirements relating to the AQIA are provided in Table 35 along with the with a reference to where the requirements are addressed in this report.

Table 35 DPE Feedback on Kurnell Scoping Proposal

Item	Section Addressed
The current Breen development's operational facility processes waste in the open and may present a risk of off-site air quality and noise impacts to the site. These issues were raised by nearby residents in response to the public exhibition of SSD-10412. Other issues raised included the existing heavy goods vehicle traffic on Captain Cook Drive leading to traffic congestion.	Section 6.0 and Section 7.0
The Department's Industry Assessments Team note that there is potential for air quality impacts on the site.	Section 6.0 and Section 7.0
The Response to Submissions Package for SSD-10412 included air quality advice. The advice was prepared on the basis that all material handling, stockpiling and processing for Breen SSD-10412 would occur within fully enclosed buildings and trafficable areas would be sealed.	Section 6.0 and Section 7.2
The Breen SSD-10412 RTS found that the enclosure of the development would result in approximately 50% reduction in off-site operational air quality impacts, from the EIS Air Quality Impacts, and compliance with air quality criteria at the sensitive receptors.	Section 6.0 and Section 7.2
The site and the proposed residential, seniors living and tourist accommodation uses were not included in the air quality monitoring as the possibility of these sensitive uses on the site is neither imminent or certain.	No air quality monitoring has been undertaken for this AQIA. AQIA of future proposed receptors provided in Section 7.2
The Air Quality Response in the Breen RTS shows (based on the Breen development being undertaken within enclosed buildings) that there will be: • exceedance by 0.2 ug/m^3 of the $PM_{2.5}$ concentration criteria (criteria 25 ug/m^3) in a 24 hour period at the hockey fields • exceedance by 0.77 ug/m^3 $PM_{2.5}$ concentration criteria concentration criteria (criteria 25 ug/m3) in a 24 hour period at the soccer fields • exceedance by 3.04 ug/m^3 of the PM_{10} concentration criteria (criteria 50 ug/m^3) in a 24 hour period at the soccer fields. Given the soccer fields are estimated to have exceedances in $PM_{2.5}$ and PM_{10} and are located near the site (located immediately west of the Breen site) – the Department notes that the site is also anticipated to experience the same exceedances.	Quantitaive assessment of modified Breen Proposal has been undertaken as described in Section 6.0 and Section 7.2
The Department notes that should Breen SSD-10412 proceed with all material handling, stockpiling and processing to occur outside of buildings and trafficable areas unsealed, this will further increase the anticipated exceedances on the site. It is recommended that prior to a request for a Gateway determination that the EPA be consulted in the preparation or revision of any Air Quality Impact Assessment or Noise Impact Assessment.	Quantitaive assessment of modified Breen Proposal has been undertaken as described

Item	Section Addressed
	in Section 6.0 and Section 7.2

Environmental Protection Authority Requirements

Feedback on the Scoping Proposal in May 2023 was also provided by EPA on 8 June 2023 regarding setback distances and land use conflicts associated with the adjoining Breen Proposal. Upon review of the previous response revised feedback was provided by the EPA dated 18 August 2023. Assessment requirements relating to the AQIA are provided in Table 36 along with the with a reference to where the requirements are addressed in this report.

Table 36 EPA Feedback on Kurnell Scoping Proposal

Date of Feedback	Item	Section Addressed
8 June 2023	The Scoping Proposal references an AECOM study (Amendment of SEPP (Kurnell Peninsula) 1989 – Air Quality Impact Assessment, 12 February 2020) that refers to the EPAs Environmental Guidelines for Solid Waste Landfills, 2016 (The Landfill Guidelines). The Landfill Guidelines draws from an older Department of Planning document for landfilling, NSW Department of Planning and Environment's EIS Practice Guideline: Landfilling, Table 1 (NSW Department of Urban Affairs and Planning, 1996. Both guidelines recommend a minimum 250 metre setback for a new landfill development from an existing sensitive land use. There is an important distinction between which land use is in place first. If a landfill moves near an existing residential development, it will be required to include appropriate management and mitigation measures. However, if a residential development is built closer to an existing landfill, which is the source of dust, odour and gas, a similar level of mitigation measures at the landfill cannot be planned and developed. The EPA does not use setback distances to determine if it can grant a licence nor to determine the potential impacts from a scheduled activity on a rezoning proposal. Instead, a thorough assessment would be required based on the specific risks from the activity. The EPA therefore recommends that setback distances alone are not used to determine the landform and boundary of the Besmaw site.	Quantitaive assessment of modified Breen Proposal has been undertaken as described in Section 6.0 and Section 7.2 Also see revised response dated 18 August 2023
	The EPA recommends that additional assessments be undertaken to determine the impact of dust, odour and landfill gas migration from the Besmaw site, and this information be used to determine the location of residences from the landfill site.	Quantitaive assessment of modified Breen Proposal has been undertaken as described in Section 6.0 and Section 7.2 Assessment of Landfill gas migration has not been assessed as part of this AQIA but is discussed in Section 5.3.4 and Section 8.3.2. Also see revised response dated 18 August 2023
	It is recommended that Besmaw be required to undertake further assessments of impacts from Breen, taking into account the SSD that is currently before DPE. The assessments should consider whether risk from dust, odour or landfill gas can be adequately managed, and	Quantitaive assessment of modified Breen Proposal has been undertaken as described in Section 6.0 and Section 7.2

Date of Feedback	Item	Section Addressed
	whether the proposed design and citing of the proposed residential development should be modified and/or staged to ensure these impacts can be adequately identified and managed.	Assessment of Landfill gas migration has not been assessed as part of this AQIA but is discussed in Section 5.3.4 and Section 8.3.2. Also see revised response dated 18 August 2023
18 August 2023	As that advice noted (8 June 2023), the EPA's primary concern regarding this proposal was the potential land use conflict between the Breen SSD-10412 and the Besmaw proposal. The EPA's concerns related to human health impacts from dust, odour and noise at the proposed Besmaw dwellings and the resulting regulatory burden on the EPA. However, the Response to Submissions document prepared by Ethos Urban (16 December 2022) states that Breen is willing to enclose their proposed development site. Further, Besmaw is considering staged development so the western portion of the mixed use development is completed at the end of the project. If these steps were taken, the land use conflict risks the EPA previously identified would be substantially mitigated. The attached advice on the Scoping Proposal was based on a scenario in which the Breen SSD proceeded with the original proposal (which did not include an enclosure) and the Besmaw site building residential dwellings on the western boundary of the development in a short time frame. There was a significant risk of dust, odour and noise complaints that were highlighted in our advice. The proposed staging of the Besmaw site, with the western portion of the site developed as the last stage, will allow Breen to complete the enclosure of the site prior to residential receivers being in close proximity to the Breen site. We note that this proposed staging of the Besmaw site was mentioned in the meeting on 2 August but does not yet form part of the Scoping Proposal. We would be broadly supportive of both of the above actions by Breen and Besmaw. However, we reiterate our previous advice that the Breen development may be subject to future complaint from the Besmaw site, and potential non-compliance under the POEO Act, if the controls at the Breen site are not implemented correctly.	Quantitaive assessment of modified Breen Proposal has been undertaken as described in Section 6.0 and Section 7.2

Sutherland Shire Council Requirements

Feedback on the Scoping Proposal in May 2023 was also provided by the Environmental Science Unit of Sutherland Shire Council on 6 June 2023. Assessment requirements relating to the AQIA are provided in Table 37 along with the with a reference to where the requirements are addressed in this report.

Table 37 Sutherland Shire Council requirements for Air Quality Impact Assessment.

Item		Section Addressed
56	Mangrove wetlands and swamps are essential to maintaining healthy aquatic ecosystems. Potential odour impacts from Mangrove wetlands and swamps however can occur. Land uses on the site – in particular Lot 2 North – must be situated so that any potential adverse impacts from exposure to odours are minimised. The degree of impact, separation distance and the siting of land uses be determined by an Air Quality Impact Assessment undertaken by a suitably qualified	Section 6.3.4 and Section 7.6

Item		Section Addressed
	air quality consultant. It shall include but not be limited to a range of land use activities on the site, population exposure and potential sensitive receptors.	
57	Aircraft, particularly those powered by jet engines, are emitters of air contaminants that include fine particulates $PM_{2.5}$, PM_{10}, soot, VOC's CO_2, NOx, and SO_2. These are emitted during flight and can have adverse impacts on human health and the environment. Though winds in this area will assist dispersion, there is concern that due to the continuous high concentration of flight movements over the site and low altitude of aircraft, the potential adverse impacts from ongoing and cumulative exposure to these air contaminants shall be determined and minimised. The degree of impact and application of appropriate ameliorative measures to minimise exposure and the risk of harm to human health, shall be applied appropriately to reflect proposed land use activity, population density and sensitive receptors on the site. This shall be determined as part of an Air Quality Impact Assessment undertaken by a suitably qualified air quality consultant.	Section 6.3.5 and Section 7.7
58	Motor vehicle traffic is a major source of air contaminants that can have adverse impacts on human and environmental health. Potential exposure to air contaminants from vehicles has been modelled for Captain Cook Drive, however potential exposure and health impacts from traffic using collector roads on site has not been determined. To ensure that impacts are minimised, especially as they reflect growth in traffic over time, air quality modelling using GRAL (or similar) or in accordance with the approved "Methods for modelling and Assessment of Air Pollutants in NSW", shall be undertaken to determine the degree of population exposure to emissions and separation from the pollution source required to minimise health risk. To ensure exposure to air contaminants is minimised for all land use activity that includes sensitive receptors, childcare centres, medical facilities, schools, play areas etc. shall not be located adjacent to a collector or major road. The creation of urban canyons and confinement of road and street spaces must be avoided**.**	Section, 6.2, Section 7.3, Section 7.2.1 and Section 7.3
59	To minimise impacts from air contaminant exposure generated by motor vehicles, the type and siting of buildings, and range of mitigation measures employed, shall be determined prior to development and consistent with guidelines such as the NSW DoP "Development Near Rail Corridors and Busy Roads – Interim Guideline", and "NSW Movement and Place BEI Factsheet – Air Quality and Noise".	Section 3.2 and Section 8.3.1
60	To help reduce the potential exposure of the residents and visitors to the site to air pollution generated by traffic, the site shall incorporate the principle of the 15-minute neighbourhood and 30-minute cities identified in the NSW Future Transport and by the NSW Greater Cities Commission to support and help reduce the need for motor vehicle trips.	Outside scope of this assessment see Traffic and Transport Assessment
61	Appropriate measures will be employed on site to minimise and mitigate pollutant exposure from for example, dusts and particulates generated by offsite and onsite land use activities, that include construction and land fill / recycling operations.	Section 8.0
62	Ongoing monitoring of Land Fill Gas shall be undertaken and included in the Air Quality Impact Assessment.	Landfill gas monitoring would require a minimum 2 year period and has not been undertaken as

Item		Section Addressed
		part of this AQIA but is discussed in Section 5.3.4 and Section 8.3.2.
63	Clear responsibilities for the ongoing management and application of air quality mitigation measures at the site must be identified.	Section 8.0
64	All potential air pollutants arising from construction activity on the site must be determined and appropriate mitigation measures applied to minimise exposure and risk to health of populations on the site.	Section 8.0
65	Wherever practical, vegetation that includes a mix of shrubs and trees shall be provided along all roads to help “filter” dusts and particulates, as well as provide improved amenity and reduce heat island impacts.	Section 8.3.1 and Section 8.3.3 as well as site Master Plan
66	Buildings on the site shall be designed and situated on the site to minimise exposure to air contaminants, this includes attention to the location and type of windows, mechanical ventilation systems, courtyards etc.	Section 8.3

Appendix C

Meteorological Analysis

Appendix C Meteorological Analysis

Meteorological Year Justification

As stated in Section **Error! Reference source not found.**, 2018 was selected as a representative year of meteorological data to use in the dispersion modelling.

The following points are considered when selecting a representative year of meteorological data to use in the dispersion modelling:

- The year selected is considered comparable to longer term trends, in terms of:
  - Southern Oscillation Index
  - Wind speed, wind direction and frequency of occurrence of calms
  - Temperature and rainfall
- Meteorological data availability is acceptable
- If a contemporaneous assessment is necessary, background air quality data is available for the same period as the meteorological data and representative of long term trends.

Southern Oscillation Index

Error! Reference source not found. shows the SOI data between 2011 and 2021. Three years (2011, 2015 and 2019) were strongly El Nino or La Nina. The remaining years had a neutral average SOI value.

Implications of strong El Nino or strong La Nina conditions on air quality are as follows:

- Strong El Nino conditions are commonly associated with hotter, dryer conditions which may result in higher wind conditions, higher background pollutant concentrations and better dispersion conditions associated with the stronger winds.
- Strong La Nina conditions are typically associate with wetter, cooler conditions which while they may result in poorer dispersion donations with lighter winds, wetter conditions often result in lower air pollutant levels due to higher rainfall levels.

Strong El Nino conditions are commonly associated with an SOI higher than +8 whereby La Nina conditions are associated with an SOI lower than -8.

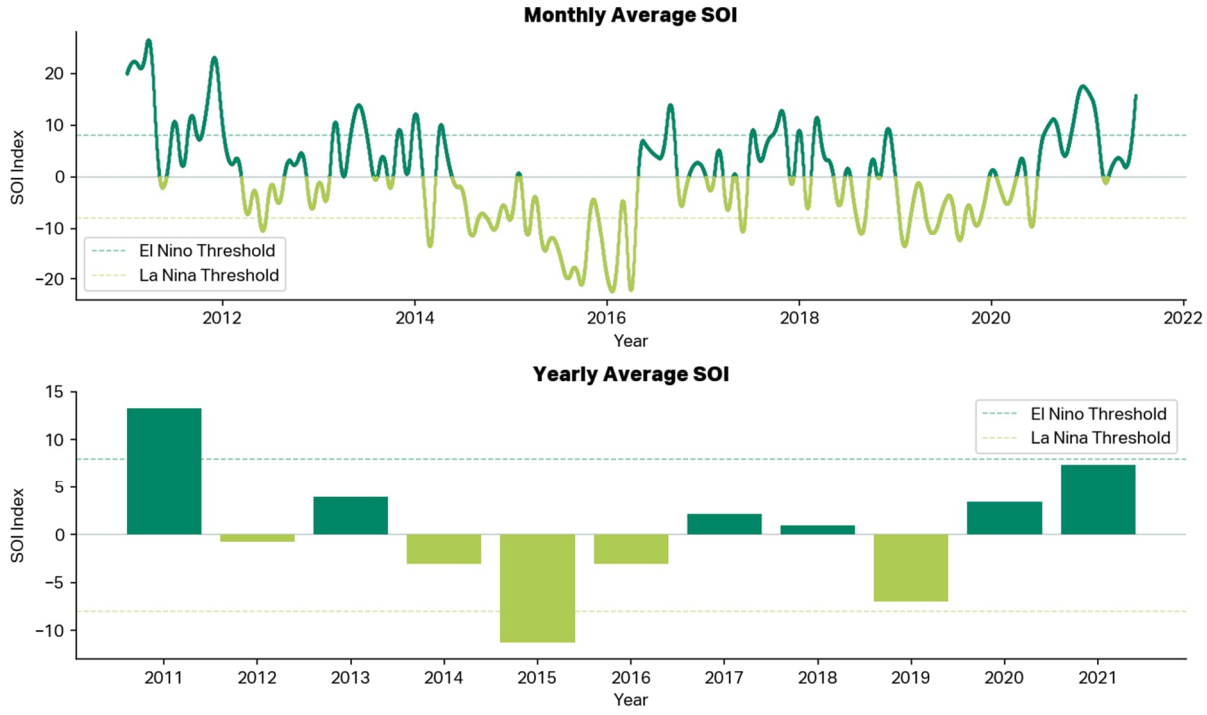
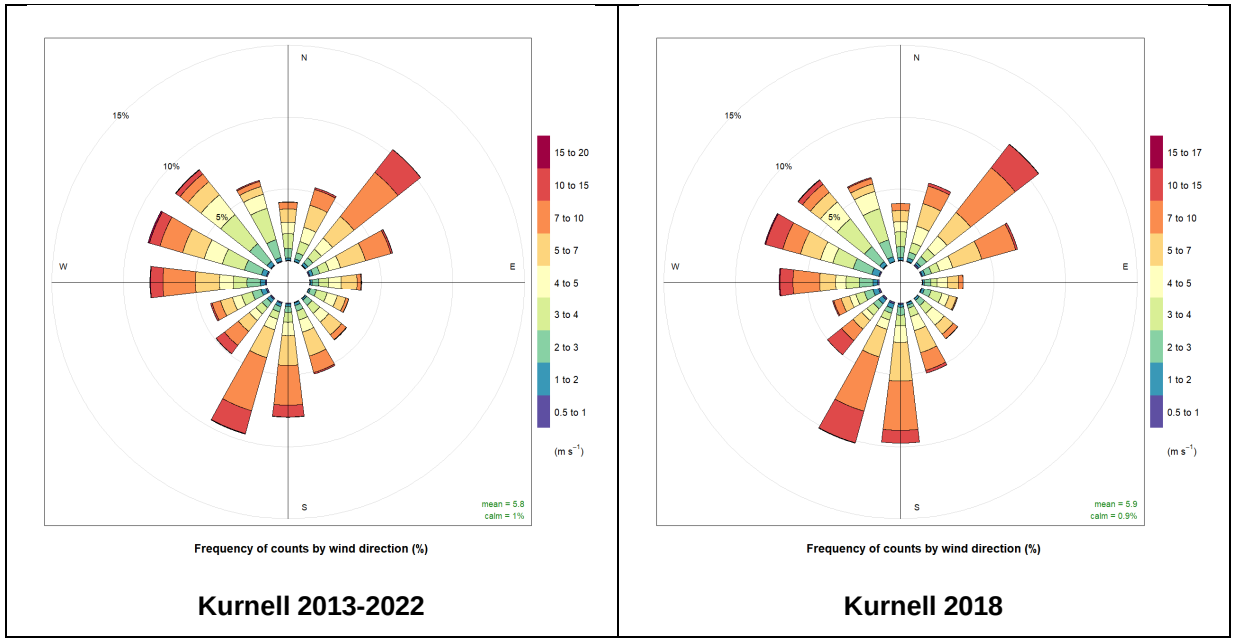


Figure 36 Southern Oscillation Index data from 2021 – 2021

Wind

Wind speed and wind direction data has been compared at the BoM Kurnell, Little Bay and Sydney Airport monitoring stations for a 10 year period (2013 – 2022) and 2018, which are presented as wind roses in Figure 37 below. The year 2018 compares well with the long term trends, showing a high frequency of northeast, southerly and north-westerly winds at each station; with a similar frequency distribution between 2018 and ten year average at individual stations. Moderate average wind speeds and a low percentage frequency of calm conditions were observed at all three sites over a ten year period. The 2018 annual average wind speeds and frequency of calms data was found to be similar to long term trends at each station, with only small differences which would not be expected to have a material impact to the assessment. Therefore, the 2018 wind data was acceptable for use in the dispersion modelling.



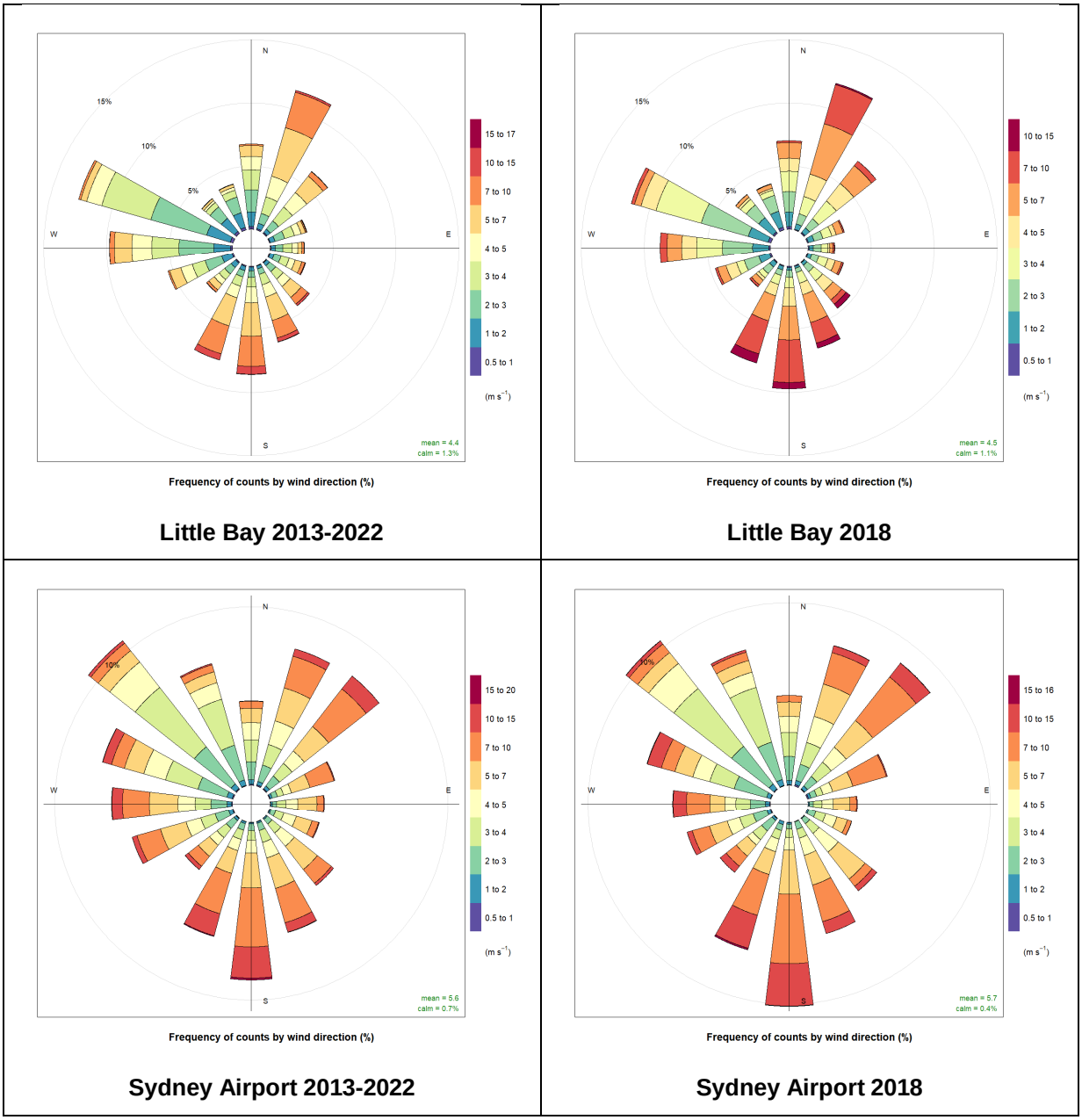


Figure 37 Comparison on 2018 and ten year average (2013 to 2022) BoM data at Kurnell, Little Bay and Sydney Airport

Temperature and rainfall

Temperature and rainfall data is not collected at Kurnell Station. The 2018 data from BoM Syndey Airport station has been compared to data collected over a ten year period between 2013 and 2022, which are presented below in **Figure 38**. The minimum and maximum temperatures for each month compare very closely showing 2022 was similar to the ten year trends with exception to a higher than average July temperature recorded for 2018. Rainfall was generally lower in 2018 than the ten year average, indicating it was a drier year than usual. This would not influence the results of the dispersion modelling as rainfall is not used as an input and no wet deposition modelling was undertaken. Therefore, the 2018 data was acceptable for use in the dispersion modelling.

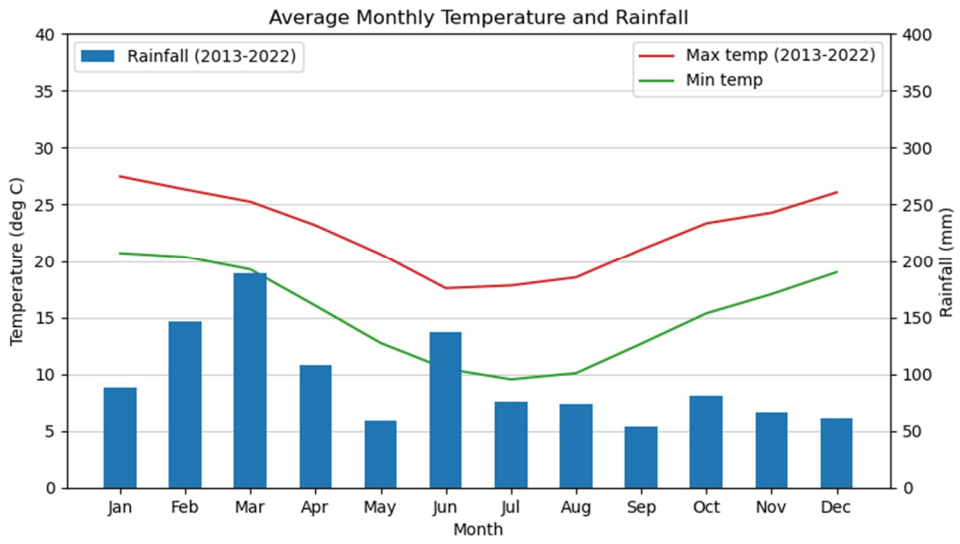
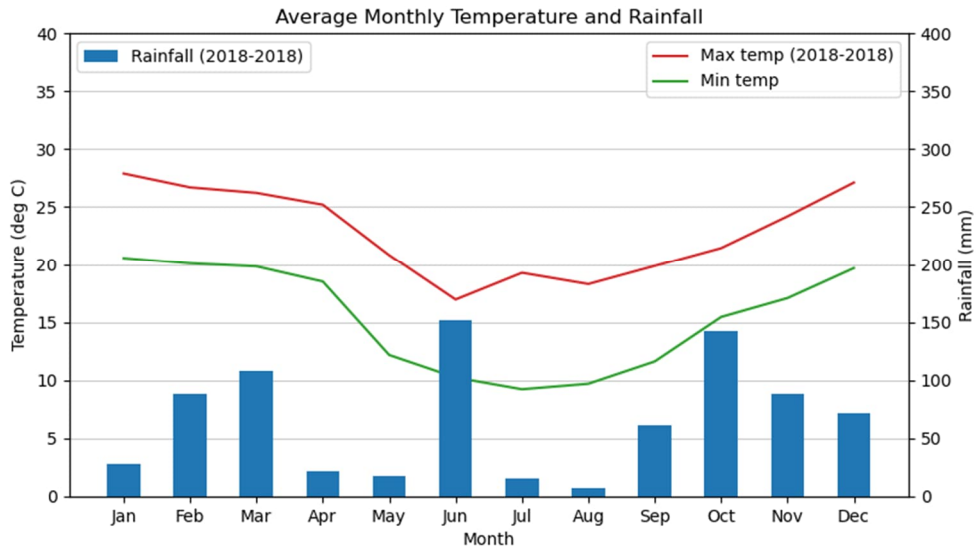
	**2013-2022**
	**2018**

Figure 38 BoM Sydney Airport temperature and rainfall

Data availability

Data availability for BoM Kurnell, Little Bay and Sydney Airport for 2018 is presented below in Figure 39, with green shading representing available data and white shading representing missing data. For the wind data, all three stations show good data capture rates throughout the year. The one exception to this is missing data at the Kurnell Station for a small period over April. Good data capture for both Little Bay and Sydney Airport is available however during this period. Therefore 2018 data was acceptable for use in the dispersion modelling.

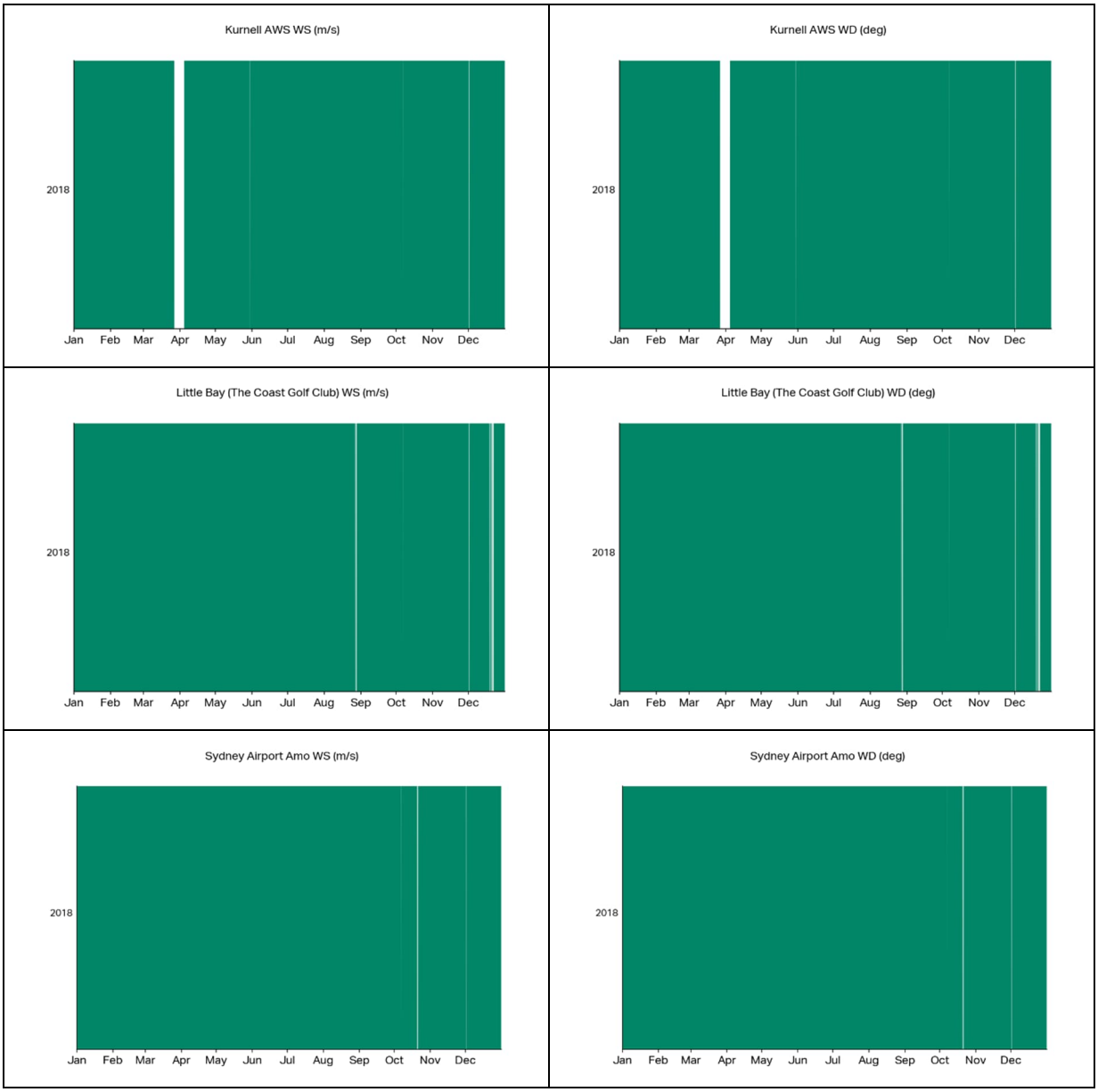


Figure 39 BoM Kurnell, Little Bay and Syndey Airport wind speed and wind direction missing data

Contemporaneous air quality concentration data

Background air quality data from EPA at Randwick and Rozelle was described in Section 5.3.3 in detail. Data quality and availability for 2018 was found to be acceptable for use in the contemporaneous assessment.

GRAMM Match to Observation Meteorological Analysis

Following the preliminary GRAMM modelling using the synthetic meteorological data, assessment of the possible observation stations and the identification of an observation station for the modelling domain (Mount Boyce), a meteorological data files for BoM stations at Kurnell, Little Bay and Sydney Airport for 2018 was developed in GRAMM meteorology input format and entered into the MTO function within GRAL. A time series of meteorological conditions best matching the surface station observations was generated from the MTO modelling run.

The MTO function can be adjusted using a weighting factor for each observation station allowing a more representative station within the domain to influence the MTO process more heavily at a given location. A weighting factor of 1 was assigned to each station.

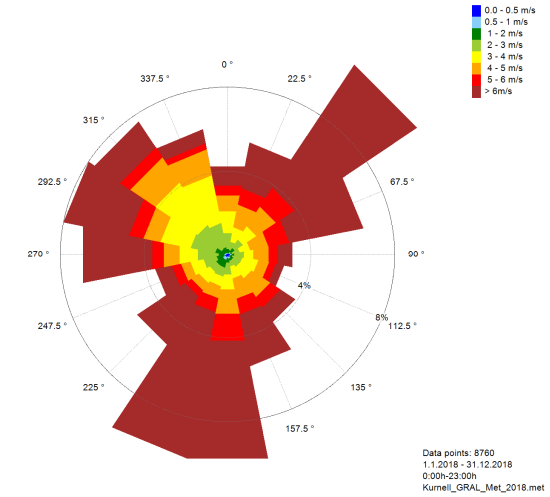
The MTO settings and the relevant vectoral and stability class error percentages calculated from the MTO run are shown below in Table 38. The vectorial error relates to the percentage of wind conditions that fit into a vectoral error percentile of 10, 20, 40 and 60 percent and a stability class error of 0 or ±1 classes (Oettl et al, 2021). In short, the higher the percentage of wind conditions that occur within a particular vectoral error band, the better the match that has occurred.

Table 38 Vectoral and Stability Class Error Percentage

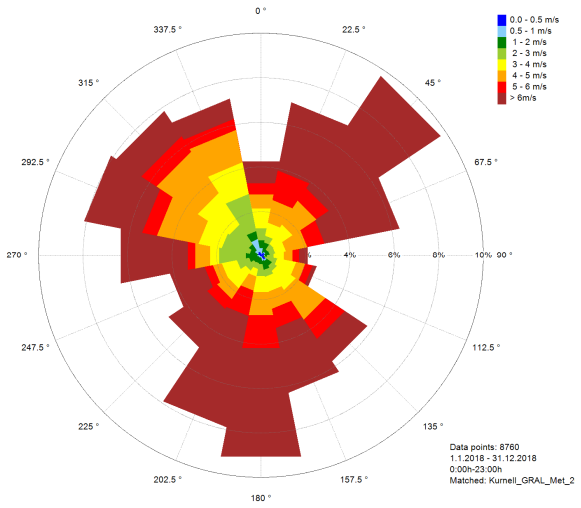
Station Name	Weighting Factor	Direction Factor	Auto Tuning Factor	Vectoral Error				Stability Class	
				10%	20%	40%	60%	0	1
Kurnell	1	1	1	42	75	90	94	71	96
Little Bay	1	1	1	17	38	68	84	51	78
Sydney Airport	1	1	1	27	55	86	93	58	82
Kurnell 334796, 6235969, 10 m elevation, Little Bay 338368, 6238360, 10 m elevation, Sydney Airport 331173, 6242273 10 m elevation									

The vectoral error match percentages shown above are acceptable and reflect a reasonable match for the GRAMM wind fields and the observation station location data.

Wind roses were plotted showing the differences between the observations at the Kurnell, Little Bay and Sydney Airport Bom stations for 2018 and the 2018 meteorology predicted by the GRAMM model at the location of each station within the modelling domain and are shown in Figure 40.



Kurnell BoM Measured Windrose (2018)



Kurnell GRAMM Windrose (2018)

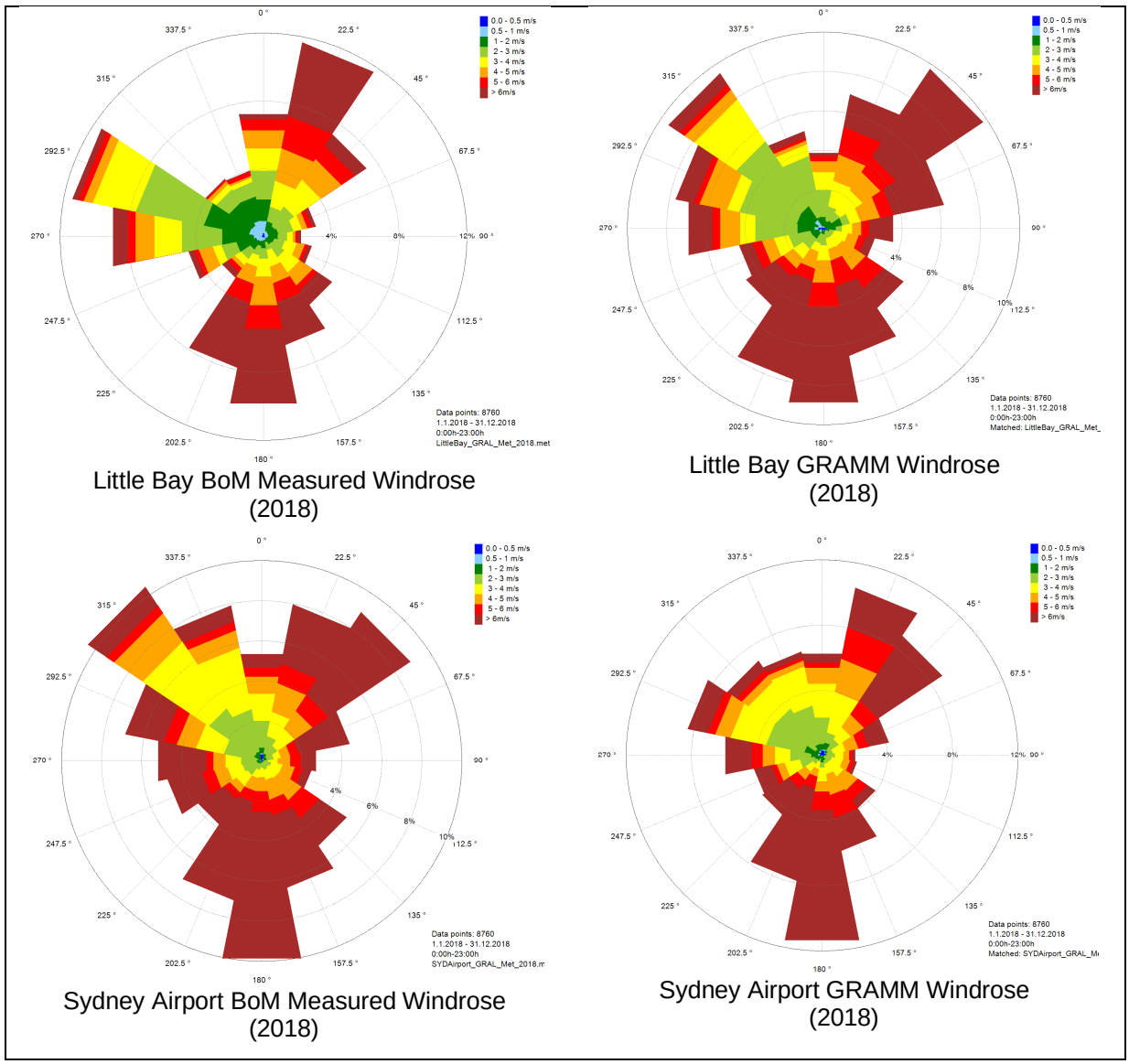


Figure 40 Comparison of BoM Observational and GRAMM 2018 data at Kurnell, Little Bay and Sydney Airport

These wind roses show a good wind speed and direction correlation between the Kurnell, Little Bay and Sydney Airport Observations and the GRAMM predictions at these locations. A comparison of the observational data and GRAMM data found:

- For Kurnell, both observational and GRAMM data show similar distribution patterns; the dominant wind direction is from the northeast and both south and south south-westerly winds are also common. The GRAMM data predicts a slightly higher frequency of low wind speeds (up to 3 m/s) and may be considered conservative. The predicted frequency of calms is also similar at 0.8% for the observational data and 1.0% for the GRAMM data.
- For Little Bay the dominant wind direction from the observational data is from the north northeast, and similarly from the northeast within the GRAMM data. Both datasets also show a high frequency of north-westerly and southerly winds. The predicted frequency of calms is also similar at 1.4% for the observational data and 0.9% for the GRAMM data.
- For Sydney Airport both data sets show a hi frequency of north easterly and southerly winds. The GRAMM data set however underestimates the frequency of north-easterly winds. The frequency of calms predicted by GRAMM was slightly more conservative estimated at 1.7% compared to 0.2% occurrence within the observational data.