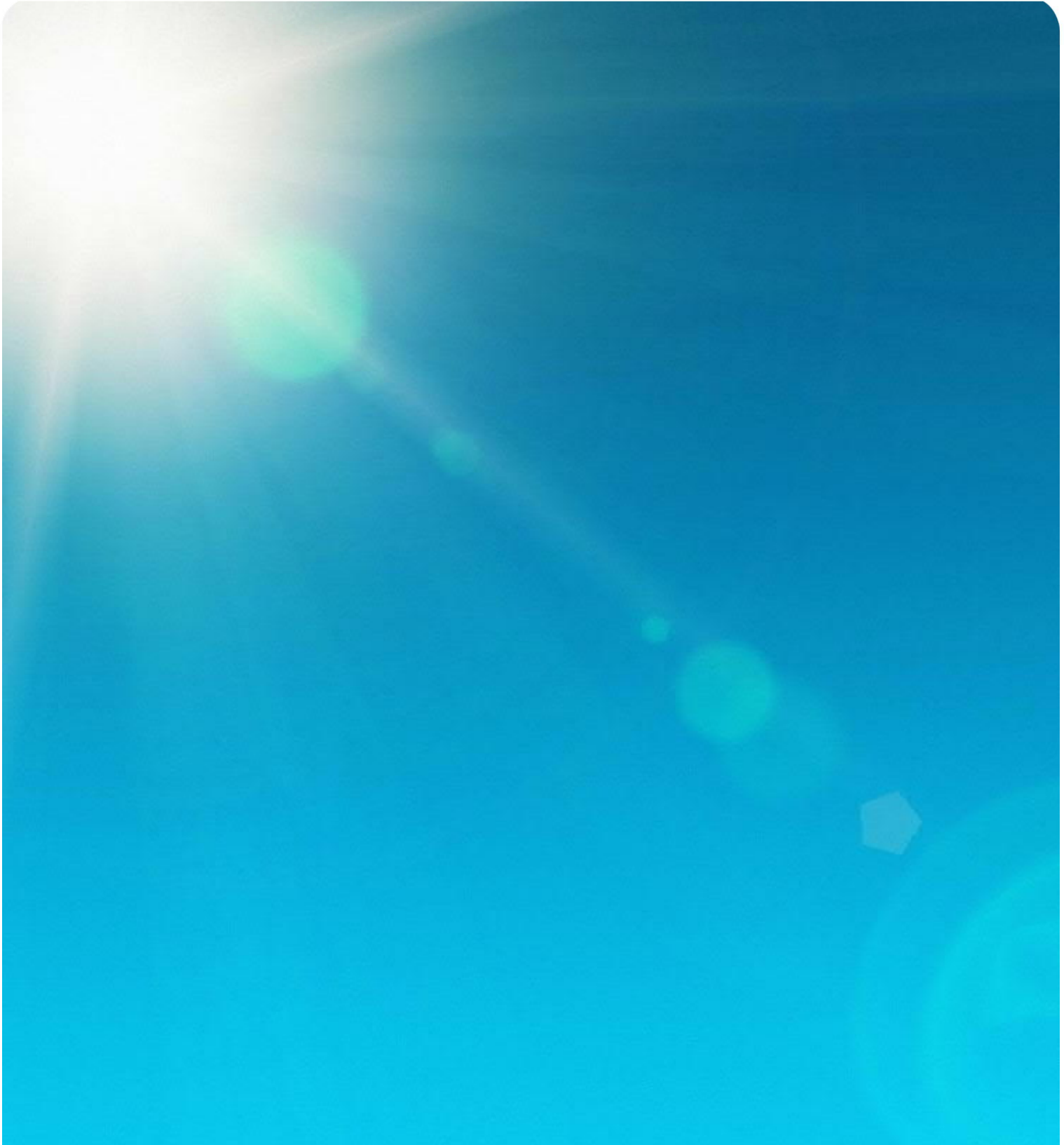


March 2022

Appendix U – Air Quality Impact Assessment

Australia-Asia PowerLink Environmental Impact Statement



Construction Air Quality Impact Assessment

*Prepared for
EcOz Environmental Consultants
for the*

Sun Cable Australia Asia PowerLink Project

3 March 2022

This page has intentionally been left blank

Disclaimer

This document is intended only for its named addressee and may not be relied upon by any other person. Air Environment Consulting Pty. Ltd. disclaims any and all liability for damages of whatsoever nature to any other party and accepts no responsibility for any damages of whatsoever nature, however caused arising from misapplication or misinterpretation by third parties of the contents of this document.

This document is issued in confidence and is relevant only to the issues pertinent to the subject matter contained herein. The work conducted by Air Environment Consulting Pty. Ltd. in this commission and the information contained in this document has been prepared to the standard that would be expected of a professional environmental consulting firm according to accepted practices and techniques. Air Environment Consulting Pty. Ltd. accepts no responsibility for any misuse or application of the material set out in this document for any purpose other than the purpose for which it is provided.

Although strenuous effort has been made to identify and assess all significant issues required by this brief we cannot guarantee that other issues outside of the scope of work undertaken by Air Environment Consulting Pty. Ltd. do not remain. An understanding of the site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part or issued in any way incomplete without prior checking and approval by Air Environment Consulting Pty. Ltd. Air Environment Consulting Pty. Ltd. accepts no responsibility for any circumstances that arise from the issue of a report that has been modified by any party other than Air Environment Consulting Pty. Ltd.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client, their employees, subcontractors, agents or nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified except where expressly stated and, for the purposes of this report, it is assumed that the information provided to Air Environment Consulting Pty. Ltd. is both complete and accurate.

Copyright

This document, electronic files or software are the copyright property of Air Environment Consulting Pty. Ltd. and the information contained therein is solely for the use of the authorized recipient and may not be used, copied or reproduced in whole or part for any other purpose without the prior written authority of Air Environment Consulting Pty. Ltd. Air Environment Consulting Pty. Ltd. makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document, electronic files or software or the information contained therein.

© Copyright Air Environment Consulting Pty. Ltd.

Document Reference

Client: EcOz Environmental Consultants
Postal address: GPO Box 381, Darwin, 0801
Project: Sun Cable Australia Asia PowerLink Project
Project number: 0100.2012
Document title: Construction Air Quality Impact Assessment
Reference: Air Environment, 2022. Report prepared by Air Environment for EcOz Environmental Consultants, Construction Air Quality Impact Assessment for the Sun Cable Australia Asia PowerLink Project, 3 March 2022, Brisbane, Australia.

Authors: Dr. Mike Power and Andrew Balch
Reviewed by: Andrew Balch
Project director: Andrew Balch

Report approved for issue by:

Date:



3 March 2022

Andrew Balch
Director and Principal Consultant
Air Environment

A: 12/783 Kingsford Smith Drive, Eagle Farm, Queensland 4009 Australia
P: PO Box 673, The Gap, Queensland 4061 Australia
E: info@airenvironment.com.au

TABLE OF CONTENTS

EXECUTIVE SUMMARY	15
1 INTRODUCTION.....	18
2 PROJECT DESCRIPTION	22
3 OVERVIEW OF THE ASSESSMENT METHODOLOGY	23
4 LEGISLATIVE REQUIREMENTS, CONTEXT AND AIR QUALITY ASSESSMENT CRITERIA	25
4.1 NATIONAL ENVIRONMENT PROTECTION MEASURE	25
4.2 NORTHERN TERRITORY LEGISLATIVE FRAMEWORK	25
4.3 ADOPTED REQUIREMENTS FOR THE PROTECTION OF THE AIR ENVIRONMENT.....	25
4.3.1 NSW Approved Methods guidance	25
4.3.2 Ambient air quality impact assessment criteria	26
4.3.3 Approach to the air quality impact assessment	27
5 EXISTING ENVIRONMENT	28
5.1 PARTICULATE MATTER AS PM _{2.5}	28
5.2 PARTICULATE MATTER AS PM ₁₀	29
5.3 NITROGEN DIOXIDE.....	30
5.4 OZONE	31
5.5 ESTIMATED BACKGROUND CONCENTRATIONS.....	32
6 EMISSIONS INVENTORY	34
6.1 DUST EMISSIONS FROM CONSTRUCTION ACTIVITIES.....	34
6.2 EMISSIONS FROM DIESEL-FUELLED CONSTRUCTION EQUIPMENT.....	35
6.2.1 Roadworks at the solar array site	35
6.2.2 Intermodal facility at the solar array site	38
6.2.3 Railway construction activities at the solar array site.....	39
6.2.4 Broadacre solar array	40
6.2.5 Overhead Transmission Line.....	41
6.2.6 Darwin Converter Site	42
6.2.7 Underground cable construction activities	43
6.2.8 NO _x emission rate summary.....	44
7 DISPERSION MODELLING AND IMPACT ASSESSMENT METHODOLOGY	45
8 AMBIENT AIR QUALITY IMPACT ASSESSMENT	46
8.1 SOLAR PRECINCT SITE.....	46
8.1.1 24-hour average PM _{2.5}	46
8.1.2 Annual-average PM _{2.5}	47
8.1.3 24-hour average PM ₁₀	48
8.1.4 Annual-average PM ₁₀	49
8.1.5 Annual-average TSP.....	50
8.1.6 1-hour average NO ₂	51
8.1.7 Annual-average NO ₂	55
8.1.8 Annual-maximum monthly dust deposition rate	59
8.2 OVERHEAD TRANSMISSION LINE: SOUTHERN SITES.....	60
8.2.1 24-hour average PM _{2.5}	60
8.2.2 24-hour average PM ₁₀	61
8.2.3 1-hour average NO ₂	62
8.2.4 Annual-maximum monthly dust deposition rate	63
8.3 OVERHEAD TRANSMISSION LINE: NORTHERN SITES	64
8.3.1 24-hour average PM _{2.5}	64
8.3.2 24-hour average PM ₁₀	65
8.3.3 1-hour average NO ₂	66
8.3.4 Annual-maximum monthly dust deposition rate	67

8.4	DARWIN CONVERTER SITE	68
8.4.1	24-hour average PM _{2.5}	68
8.4.2	Annual-average PM _{2.5}	70
8.4.3	24-hour average PM ₁₀	72
8.4.4	Annual-average PM ₁₀	74
8.4.5	Annual-average TSP.....	76
8.4.6	1-hour average NO ₂	78
8.4.7	Annual average NO ₂	80
8.4.8	Annual-maximum monthly dust deposition rate for the Darwin Converter Site	82
8.5	TRENCHING WORKS AT MURRUMUJUK	83
8.5.1	24-hour average PM _{2.5}	83
8.5.2	24-hour average PM ₁₀	84
8.5.3	1-hour average NO ₂	85
8.5.4	Annual-maximum monthly dust deposition rate	86
<u>9</u>	<u>INTERPRETATION OF AIR QUALITY ASSESSMENT FINDINGS</u>	<u>87</u>
9.1	SOLAR PRECINCT SITE.....	87
9.2	SOUTHERN OHTL SITES	88
9.3	NORTHERN OHTL SITES	89
9.4	TRENCHING WORKS AT MURRUMUJUK	89
9.5	RECOMMENDED SEPARATION DISTANCES	90
9.6	DARWIN CONVERTER SITE	91
<u>10</u>	<u>CONCLUSIONS</u>	<u>93</u>
<u>11</u>	<u>REFERENCES</u>	<u>95</u>

LIST OF TABLES

Table 4-1	Ambient air quality impact assessment criteria used in the assessment	27
Table 5-1	Summary statistics of observed PM _{2.5} concentrations	28
Table 5-2	Summary statistics of observed PM ₁₀ concentrations	29
Table 5-3	Summary statistics of observed NO ₂ concentrations	30
Table 5-4	Summary statistics of observed O ₃ concentrations	31
Table 5-5	Estimated background concentrations in relation to the assessment criteria	33
Table 6-1	Composite emission factors selected to characterise construction dust emissions	35
Table 6-2	Estimated NO _x mass emission rates by construction phase for main access road construction activities within the Solar Precinct	36
Table 6-3	Estimated NO _x mass emission rates by construction phase for secondary access road construction activities within the Solar Precinct	37
Table 6-4	Estimated NO _x mass emission rate for construction activities at the Intermodal facility	38
Table 6-5	Estimated NO _x mass emission rate for railway construction activities at the solar array site	39
Table 6-6	Estimated NO _x mass emission rate for construction of the broadacre solar array	40
Table 6-7	Estimated NO _x mass emission rate for OHTL site preparation and construction equipment	41
Table 6-8	Estimated NO _x mass emission rate for the Darwin Converter site during simultaneous site preparation, formation and landscaping activities	42
Table 6-9	Estimated construction equipment and NO _x mass emission rate for the underground cable connecting the Darwin Converter Site to the Land Sea Joint Station	43
Table 6-10	Summary of total NO _x mass emission rates used by construction area	44
Table 9-1	Predicted incremental and cumulative separation distances applying to construction activities at the Solar Farm site	87
Table 9-2	Predicted incremental and cumulative separation distances applying to construction activities at southern OHTL sites	88
Table 9-3	Predicted incremental and cumulative separation distances applying to construction activities at northern OHTL sites	89
Table 9-4	Predicted incremental and cumulative separation distances applying to trenching works at Murrumujuk	89
Table 9-5	Required separation distances and their controlling factors	90
Table 9-6	Incremental and cumulative model predictions for construction activities at the Darwin Converter site	91

Table 10-1 Separation distances for transient construction areas93

LIST OF FIGURES

Figure 1-1 Overview map of the Sun Cable project showing the solar array site near Elliott, the route of the OHTL, and the location of the Darwin Converter Site at Murrumujuk. 19

Figure 1-2 12,000 ha solar array site at Powell Creek Station near Elliott20

Figure 1-3 The Darwin Converter Station site and shore crossing at Murrumujuk21

Figure 5-1 Time series of 24-hour average concentrations of PM_{2.5}.....29

Figure 5-2 Time series of 24-hour average concentrations of PM₁₀30

Figure 5-3 Time series of 1-hour average concentrations of NO₂.....31

Figure 5-4 Time series of 1-hour average concentrations of O₃32

Figure 6-1 Analysis of the diurnal frequency distribution of wind speeds recorded at the BoM Noonamah station (Site 14314), 21 June 2013 to 5 December 201734

Figure 8-1 Predicted incremental maximum 24-hour average PM_{2.5} distance decay relationship for the solar array site46

Figure 8-2 Predicted cumulative maximum 24-hour average PM_{2.5} distance decay relationship for the solar array site47

Figure 8-3 Predicted incremental annual-average PM_{2.5} distance decay relationship for the solar array site47

Figure 8-4 Predicted cumulative annual-average PM_{2.5} distance decay relationship for the solar array site48

Figure 8-5 Predicted maximum incremental 24-hour average PM₁₀ distance decay relationship for the solar array site48

Figure 8-6 Predicted maximum cumulative 24-hour average PM₁₀ distance decay relationship for the solar array site49

Figure 8-7 Predicted incremental annual-average PM₁₀ distance decay relationship for the solar array site49

Figure 8-8 Predicted cumulative annual-average PM₁₀ distance decay relationship for the solar farm site50

Figure 8-9 Predicted incremental annual-average TSP distance decay relationship for the solar array site50

Figure 8-10 Predicted cumulative annual-average TSP distance decay relationship for the solar array site.....51

Figure 8-11 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for roadwork construction activities at the solar array site51

Figure 8-12 Predicted cumulative maximum 1-hour average NO₂ distance decay relationship for roadwork construction activities at the solar array site52

Figure 8-13 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site52

Figure 8-14	Predicted cumulative maximum 1-hour average NO ₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site	53
Figure 8-15	Predicted incremental maximum 1-hour average NO ₂ distance decay relationship for rail construction activities at the solar array site	53
Figure 8-16	Predicted cumulative maximum 1-hour average NO ₂ distance decay relationship for rail construction activities at the solar array site	54
Figure 8-17	Predicted incremental maximum 1-hour average NO ₂ distance decay relationship for construction activities at the broadacre solar array site	54
Figure 8-18	Predicted cumulative maximum 1-hour average NO ₂ distance decay relationship for construction activities at the broadacre solar array site	55
Figure 8-19	Predicted incremental annual average NO ₂ distance decay relationship for roadwork construction activities at the solar array site	55
Figure 8-20	Predicted cumulative annual average NO ₂ distance decay relationship for roadwork construction activities at the solar array site	56
Figure 8-21	Predicted incremental annual average NO ₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site	56
Figure 8-22	Predicted cumulative annual average NO ₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site	57
Figure 8-23	Predicted incremental annual average NO ₂ distance decay relationship for rail construction activities at the solar array site	57
Figure 8-24	Predicted cumulative annual average NO ₂ distance decay relationship for rail construction activities at the solar array site	58
Figure 8-25	Predicted incremental annual average NO ₂ distance decay relationship for construction activities at the broadacre solar array site	58
Figure 8-26	Predicted cumulative annual average NO ₂ distance decay relationship for construction activities at the broadacre solar array site	59
Figure 8-27	Distance decay relationship in incremental annual-maximum monthly dust deposition rate for the solar array site	59
Figure 8-28	Predicted maximum incremental 24-hour average PM _{2.5} distance decay relationship for southern OHTL sites.....	60
Figure 8-29	Predicted maximum cumulative 24-hour average PM _{2.5} distance decay relationship for southern OHTL sites.....	60
Figure 8-30	Predicted maximum incremental 24-hour average PM ₁₀ distance decay relationship for southern OHTL sites.....	61
Figure 8-31	Predicted maximum cumulative 24-hour average PM ₁₀ distance decay relationship for southern OHTL sites.....	61
Figure 8-32	Predicted maximum incremental 1-hour average NO ₂ distance decay relationship for southern OHTL sites.....	62
Figure 8-33	Predicted maximum cumulative 1-hour average NO ₂ distance decay relationship for southern OHTL sites.....	62

Figure 8-34	Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for southern OHTL sites.....	63
Figure 8-35	Predicted maximum incremental 24-hour average PM _{2.5} distance decay relationship for northern OHTL sites	64
Figure 8-36	Predicted maximum cumulative 24-hour average PM _{2.5} distance decay relationship for northern OHTL sites	64
Figure 8-37	Predicted maximum incremental 24-hour average PM ₁₀ distance decay relationship for northern OHTL sites	65
Figure 8-38	Predicted maximum cumulative 24-hour average PM ₁₀ distance decay relationship for northern OHTL sites	65
Figure 8-39	Predicted incremental maximum 1-hour average NO ₂ distance decay relationship for northern OHTL sites	66
Figure 8-40	Predicted maximum cumulative 1-hour average NO ₂ distance decay relationship for northern OHTL sites	66
Figure 8-41	Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for northern OHTL sites	67
Figure 8-42	Predicted maximum incremental 24-hour average PM _{2.5} concentration for the Darwin Converter Site	68
Figure 8-43	Predicted maximum cumulative 24-hour average PM _{2.5} concentration for the Darwin Converter Site	69
Figure 8-44	Predicted maximum incremental annual-average PM _{2.5} concentration for the Darwin Converter Site	70
Figure 8-45	Predicted maximum cumulative annual-average PM _{2.5} concentration for the Darwin Converter Site	71
Figure 8-46	Predicted maximum incremental 24-hour average PM ₁₀ concentration for the Darwin Converter Site	72
Figure 8-47	Predicted maximum cumulative 24-hour average PM ₁₀ concentration for the Darwin Converter Site	73
Figure 8-48	Predicted incremental annual-average PM ₁₀ concentration for the Darwin Converter Site	74
Figure 8-49	Predicted cumulative annual-average PM ₁₀ concentration for the Darwin Converter Site	75
Figure 8-50	Predicted incremental annual-average TSP concentration for the Darwin Converter Site	76
Figure 8-51	Predicted cumulative annual-average TSP concentration for the Darwin Converter Site	77
Figure 8-52	Predicted incremental 1-hour average NO ₂ concentration for the Darwin Converter Site	78
Figure 8-53	Predicted cumulative 1-hour average NO ₂ concentration for the Darwin Converter Site	79

Figure 8-54	Predicted incremental annual average NO ₂ concentration for the Darwin Converter Site	80
Figure 8-55	Predicted cumulative annual average NO ₂ concentration for the Darwin Converter Site	81
Figure 8-56	Incremental annual-maximum monthly dust deposition rate for the Darwin Converter Site	82
Figure 8-57	Predicted maximum incremental 24-hour average PM _{2.5} distance decay relationship for trenching works at Murrumujuk	83
Figure 8-58	Predicted maximum cumulative 24-hour average PM _{2.5} distance decay relationship for trenching works at Murrumujuk	83
Figure 8-59	Predicted maximum incremental 24-hour average PM ₁₀ distance decay relationship for trenching works at Murrumujuk	84
Figure 8-60	Predicted maximum cumulative 24-hour average PM ₁₀ distance decay relationship for trenching works at Murrumujuk	84
Figure 8-61	Predicted incremental maximum 1-hour average NO ₂ distance decay relationship for trenching works at Murrumujuk	85
Figure 8-62	Predicted maximum cumulative 1-hour average NO ₂ distance decay relationship for trenching works at Murrumujuk	85
Figure 8-63	Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for trenching works at Murrumujuk	86
Figure 10-1	Critical exposure footprints of predicted impacts around the Darwin Converter Site at Murrumujuk	94

APPENDICES

Appendix A: Detailed Model Configuration Summary and Analysis of Dispersion Meteorology



Glossary

Term	Definition
Units of measurement	
Am ³ /s	actual cubic metres per second (volumetric flow rate at actual temperature and pressure)
Atm	Atmosphere (unit of air pressure)
d	day
g/kWh	Grams per kiloWatt hour
h	hour
ha	Hectare(s)
K	Kelvin (unit of temperature)
km	kilometre
km/h	kilometres per hour
kV	kilovolt
m	metre
m/s	metres per second (velocity)
m ²	square metres
m ³	cubic metres
m ³ /s	cubic metres per second (volumetric flow rate)
min	minute
Nm ³ /s	normalised cubic metres per second (volumetric flow rate at 0 °C and 1 Atm)
°C	degrees Celsius
s	second
rad	radians (unit of angle)
Sm ³ /s	standard cubic metres per second (volumetric flow rate at 25 °C and 1 Atm)
yr	year

Abbreviations/Definitions

3D	three-dimensional
AAPowerLink	Australia Asia Power Link
AC	Alternating Current
Ausplume	A Gaussian plume atmospheric dispersion model developed by Vic EPA
AWS	automatic weather station
BOM	Bureau of Meteorology
DC	Direct Current
DEM	digital elevation model
DKIS	Darwin Katherine Integrated System
ESS	Energy Storage System
HVAC	High voltage alternating current
HVDC	High voltage direct current
OHTL	Overhead transmission line
OLM	Ozone Limiting Method
NOx	Nitrogen oxides
PV	Photovoltaic
TAPM	The Air Pollution Model. Prognostic meteorological and air dispersion model developed by the Australian Government's Commonwealth Scientific and Industrial Research Organisation (CSIRO).
VSC	Voltage source converter
USEPA	United States Environmental Protection Agency



This page has intentionally been left blank



Executive Summary

Air Environment was commissioned by EcOz Environmental Consultants to conduct an ambient air quality impact assessment of construction activities associated with the Sun Cable Australia Asia PowerLink (AAPowerLink) Project in the Northern Territory (NT).

The AAPowerLink Project area comprises of six key components:

- Powell Creek Solar Precinct in the Barkly Region of the NT where electricity will be generated, stored, and transmitted
- Overhead Transmission Line (OHTL) to transmit electricity from the Solar Precinct to Darwin
- Darwin Converter Site including Voltage Source Converters (VSC), energy storage and network connection to supply electricity to the Darwin region
- Cable Transition Facilities at Gunn Point Beach to transition power cables between land and sea
- Subsea Cable System extending between the Cable Transition Facilities and Singapore
- Singapore Converter Station to receive electricity and supply the Singapore electrical network.

The Solar Precinct will have a peak generation capacity of approximately 17GW, subject to final modelling. The proposed transmission system rating is approximately 6.4 GW for the OHTL and 5.4 GW for the Subsea Cable System. Generation and transmission capacity will be built in stages in response to market demand, with the OHTL, Voltage Source Converters (VSCs), batteries and Subsea Cable Systems able to be installed progressively and operated as two or more independent power systems dispatching power offshore.

A screening level impact assessment was conducted to determine the potential impact to air quality in the local areas associated with emissions from construction activities at the Solar Precinct southwest of Elliott, along the Overhead Transmission Line (OHTL), and at the Darwin Converter Site at Murrumujuk. The critical air pollutants focused on in the assessment were associated with emissions of particulate matter from site ground preparation works, infrastructure construction and heavy non-road construction equipment, and nitrogen oxides (NO_x) from fuel burning in the same construction equipment.

The assessment was based on site-specific meteorology developed using the TAPM prognostic meteorological model and atmospheric dispersion modelling using the AUSPLUME model. Emissions of particulate matter were estimated from emissions factors for generic 'whole of site' construction activities based on the total active area, while construction equipment diesel engine emissions of nitrogen oxides were estimated from the engine capacities of equipment proposed to be used on each site and conservative emission concentration standards.

The air assessment was then conducted in two ways, i.e.:

1. The determination of appropriate separation distances between the construction areas and nearby sensitive receptors for the Solar Precinct, OHTL towers, and a 2.7 km trench extending between the Darwin Converter Site and shore crossing site, due to their mobile nature and not being fixed in a single location over the project's construction period, and
2. Determination of the potential impact footprint around the Darwin Converter Site at Murrumujuk as construction in this area will be confined to a specific area for the duration of the project's construction.

As the construction of the infrastructure upstream of the Darwin Converter Site will be transient over the entire construction period and each OHTL tower will not take a year to construct, the assessment was based on shorter hourly and daily averaged predicted impacts of total suspended particulates (TSP), PM₁₀, PM_{2.5} and nitrogen dioxide (NO₂), for the determination of the required separation distances. Cumulative impacts were also considered.



Ambient air quality impact assessment criteria were determined for each pollutant and averaging time using the more stringent of the relevant Air NEPM standards and the NSW EPA Approved Methods impact assessment criteria. There are no Air NEPM standards or Approved Methods impact assessment criteria for TSP, so the Environmental Protection (Air) Policy 2019 (Queensland) annual TSP criterion was adopted to assess the impact of TSP impacts.

The minimum separation distances required to ensure compliance with the identified air quality criteria at sensitive receptor locations are provided for the Solar Precinct and OHTL tower construction areas in Table ES 1. If the distance between a construction area and the closest sensitive receptor is greater than the relevant separation distance provided in Table ES 1 then all air quality criteria are predicted to be met for construction-related activities. If a sensitive receptor site is located within the minimum separation distance for a construction area then one or more of the relevant air quality criteria are predicted to be exceeded and additional pollutant mitigation measures are required.

The critical exposure footprints of predicted impact around the Darwin Converter Site at Murrumujuk, i.e., the limits at which the criteria are predicted to be exceeded, are presented in Figure ES1.

Table ES 1 Minimum separation distances for the Solar Precinct and OHTL towers construction areas

Construction area	Buffer limiting pollutant	Separation distance (m)
Solar precinct at Powell Creek Station near Elliott	PM ₁₀	1,079
OHTL at southern end near Elliott	NO ₂	468
OHTL at northern end near Murrumujuk	NO ₂	327
Trenching activities at Murrumujuk	NO ₂	397

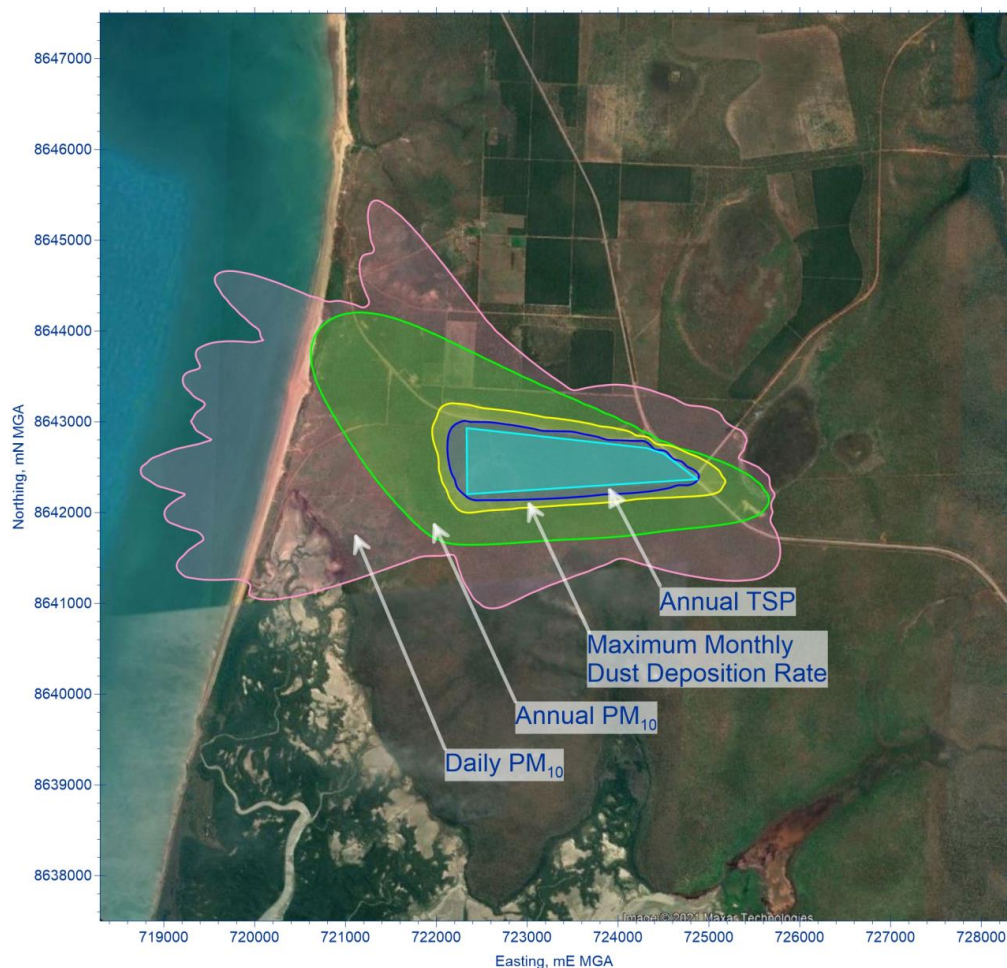


Figure ES 1 Critical exposure footprints of predicted dust/particle impacts around the Darwin Converter Site at Murrumujuk

Solar Precinct and OHTL infrastructure are expected to be constructed primarily in remote areas away from sensitive receptors, and consequently cause no adverse impacts in sensitive areas. However, if some infrastructure is to be developed in close proximity to receptors, the separation distances determined in this assessment provide a means to manage those activities to prevent adverse air quality impacts. These separation distances would be incorporated into the project's Construction Environmental Management Plan.

The assessment of potential construction related air quality impacts at the Darwin Converter Site at Murrumujuk indicated that there are unlikely to be any adverse impacts to sensitive areas in the local area.



1 Introduction

Air Environment was commissioned by EcOz Environmental Consultants to conduct an ambient air quality impact assessment of construction activities associated with the Sun Cable AAPowerLink Project.

The AAPowerLink Project will be located in two main areas in the NT, as shown in Figure 1-1, and connected by overhead high voltage direct current transmission lines:

1. A 17 to 20 gigawatt photovoltaic (PV) Solar Precinct occupying 12,000 ha of land on Powell Creek Station, 70 km southwest of Elliott, NT, as shown in Figure 1-2
2. A power converter site at Murrumujuk near Darwin, NT comprising a battery energy storage system (ESS) and voltage source converter (VSC), as shown in Figure 1-3.

This report details the methods for the development of an inventory of critical construction related air emissions and their impact assessment using atmospheric dispersion modelling. The report also presents the findings and conclusions of the assessment, which identifies the impact to air quality in the local area and the minimum separation distances required between construction activities and sensitive receptors to mitigate any potential adverse air impacts.

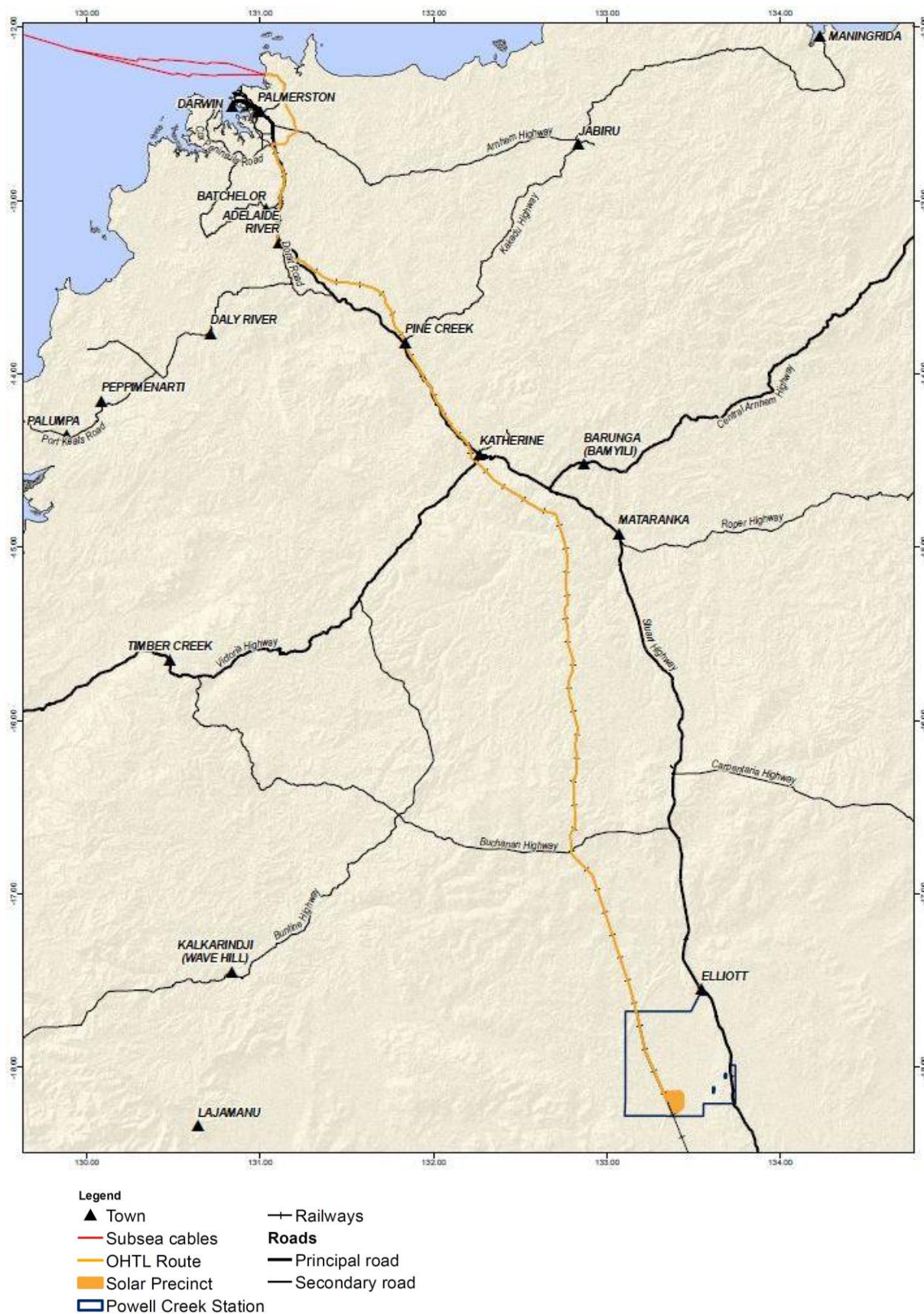


Figure 1-1 Overview map of the Sun Cable project showing the solar array site near Elliott, the route of the OHTL, and the location of the Darwin Converter Site at Murrumujuk

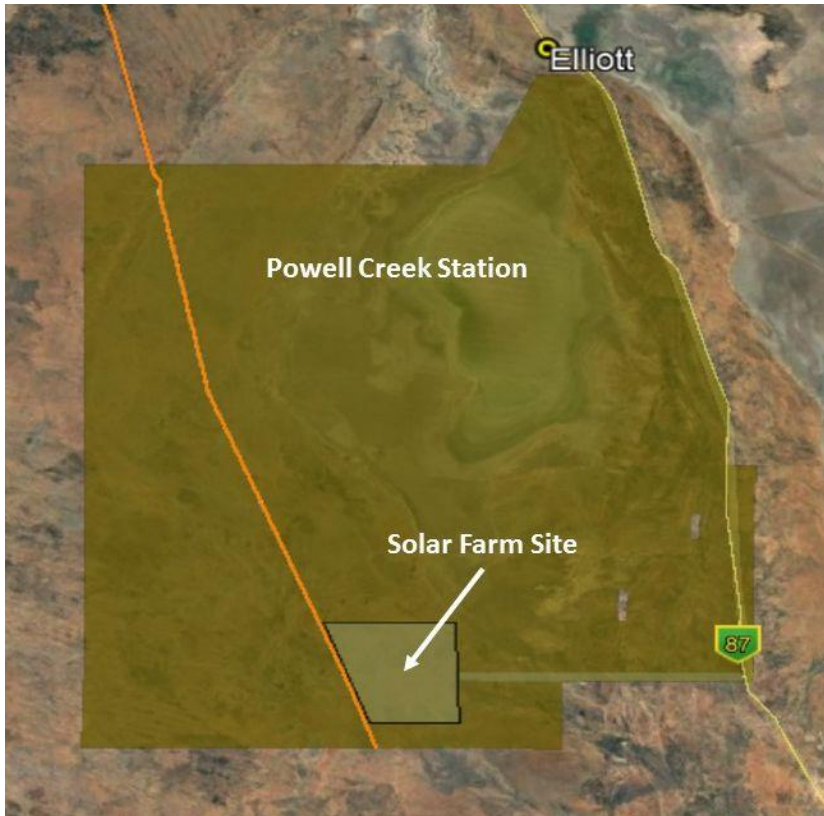
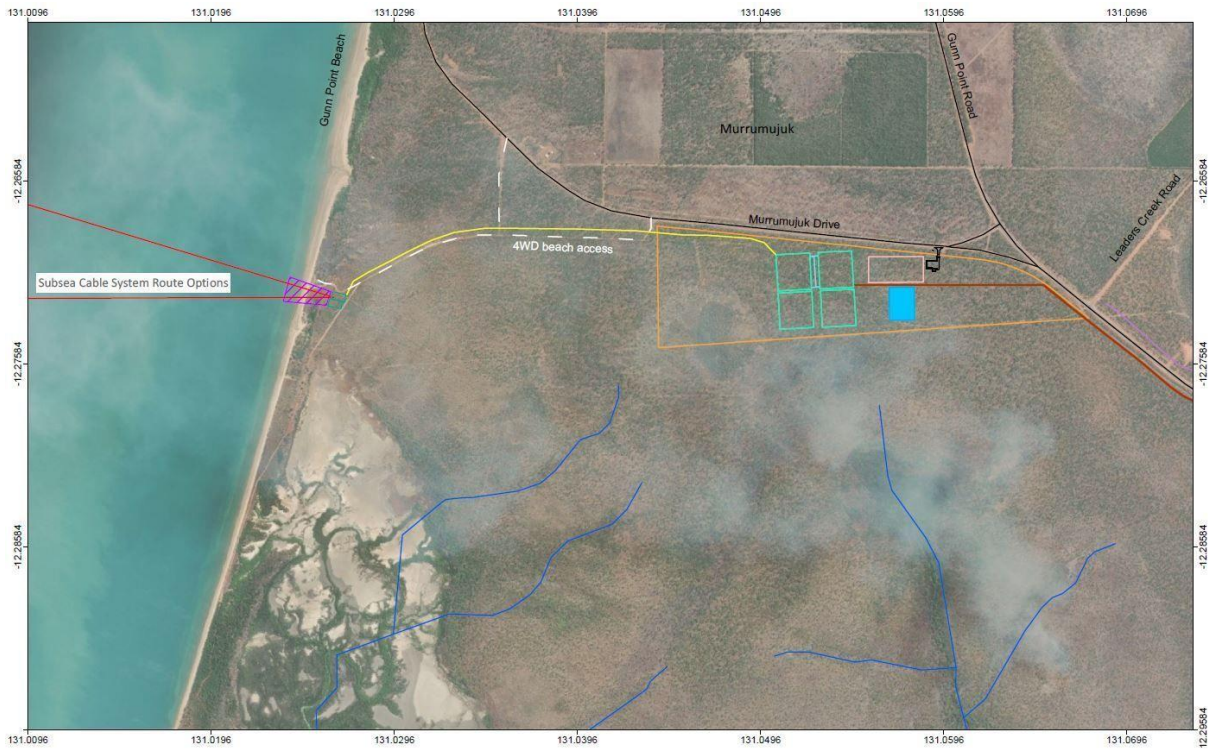


Figure 1-2 12,000 ha solar array site at Powell Creek Station near Elliott



Legend

- Subsea Cable System Route options
- OHTL Route
- Darwin Converter Site
- Shore Crossing
- Battery Facility
- Land Sea Joint Station
- Operations and Maintenance Facility
- Voltage Source Converter
- Underground Cable Corridor
- Streams
- Carpark and vehicle access

Figure 1-3 The Darwin Converter Station site and shore crossing at Murrumjuk



2 Project Description

Sun Cable is an Australian company established in 2018 with a mission to deliver dispatchable, competitively priced renewable electricity to the energy markets of the NT, Singapore and other Asian countries. The company vision is to establish a high-voltage direct current (HVDC) transmission network across the Indo-Pacific region supplied by large-scale solar and storage facilities utilising the abundant high-quality solar resource in northern Australia. Sun Cable is privately held by a number of Australian individuals and private investment funds and has offices in Australia, Singapore and Indonesia.

Sun Cable is developing the Australia Asia PowerLink (AAPowerLink; the project), an innovative energy project, which proposes to generate, store, transmit and deliver reliable, competitively priced renewable energy to NT and Asia markets.

The proposed action comprises six primary components:

- Powell Creek Solar Precinct in the Barkly Region of the NT where electricity will be generated, stored, and transmitted
- Overhead Transmission Line (OHTL) to transmit electricity from the Solar Precinct to Darwin
- Darwin Converter Site including Voltage Source Converters (VSC), energy storage and network connection to supply electricity to the Darwin region
- Cable Transition Facilities at Gunn Point Beach to transition power cables between land and sea
- Subsea Cable System extending between the Cable Transition Facilities and Singapore
- Singapore Converter Station to receive electricity and supply the Singapore electrical network.

The project has the capacity to facilitate a material increase in energy supply to the Darwin-Katherine Integrated System (DKIS) and off-grid industrial loads, thereby enabling the development of new industrial and commercial developments in the NT. The AAPowerLink will also have capacity to supply approximately 20% of Singapore's electricity supply from renewable sources.

Construction of the Project is scheduled to extend from end of 2023 to end of 2027. Connection to the DKIS and industrial loads in the NT is planned for 2026 with the link to Singapore completed in 2027. Full supply to Singapore is planned to be operational by the end of 2027. The project may be constructed and commissioned in stages.



3 Overview of the Assessment Methodology

Air emissions associated with construction related activities and their impact were assessed using a screening approach. The method of assessment was based on the following.

- Identification of construction activities with the potential to generate air emissions:
 - Site ground preparation, earthmoving, site grading, piling, movement of heavy construction equipment and wind-blown crustal material
 - Diesel emissions from heavy non-road construction equipment and vehicles.
- Identification of critical air pollutants:
 - Suspended dust as particulate matter with an aerodynamic diameter of greater than 10 (TSP), less than 10 (PM₁₀) and less than 2.5 (PM_{2.5}) microns
 - Deposited dust, i.e., dust that has settled on surfaces
 - NO₂.
- Development of an air emissions inventory for dust and NO_x for construction activities at each site, including the:
 - Solar Precinct at Powell Creek Station:
 - Dust emissions from ground disturbing construction activities
 - Vehicle emissions (NO_x) from road construction activities
 - Vehicle emissions (NO_x) from construction of the Intermodal Logistics Facility
 - Vehicle emissions (NO_x) from rail construction activities
 - Vehicle emissions (NO_x) from construction of the broadacre solar array
 - OHTL near Elliott
 - OHTL near the Darwin Converter Site
 - Darwin Converter Site at Murrumujuk
 - Underground cable connecting the Darwin Converter Site to the Land Sea Joint Station.
- Dust emissions based on total construction site-based emission factor and construction activity areas:
 - Solar Precinct construction activity areas assumed to be 500 m by 500 m
 - OHTL construction activity areas assumed to be 100 m by 100 m
 - Darwin Converter Site activity area encompasses the entire converter site
 - Underground cable/trenching activity area assumed to be 100 m by 100 m.
- NO_x emissions from diesel engines estimated based on construction equipment engine capacity, US EPA Tier 3 emissions standards for non-road vehicles and the number of equipment units
- Assessment of baseline air quality based on Environmental Protection Authority (EPA) monitoring data in the Darwin region
- Assessment of observed meteorology in the project area
- Meteorological modelling of the solar array and Darwin Converter Site project areas for use in the dispersion models
- Atmospheric dispersion modelling using the AUSPLUME Gaussian Plume Model



- Assessment of the source-receptor separation distance required for the most critical air pollutant to ensure compliance with the air impact assessment criteria
- Results presented for incremental and cumulative impacts.



4 Legislative Requirements, Context and Air Quality Assessment Criteria

4.1 National Environment Protection Measure

The National Environment Protection Council defines national ambient air quality standards and goals in consultation with, and with agreement from, all state governments. The air quality standards and goals were first published in 1998 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM), with the supplementary National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) being promulgated in 2004. The Air NEPM and Air Toxics NEPM are ambient monitoring-based measures that set out compliance standards and goals for specific large urban locations. The Air NEPM has identified air quality standards for the following six criteria pollutants that are important to consider for the protection of human health:

- Nitrogen dioxide
- Carbon monoxide
- Sulfur dioxide
- Particulate matter as PM₁₀
- Particulate matter as PM_{2.5}
- Lead

The NEPM contaminants determined to be important in this assessment include particulate matter as PM₁₀, particulate matter as PM_{2.5}, and nitrogen dioxide.

4.2 Northern Territory legislative framework

The principle statutory legislation in the Northern Territory governing the environment, and in particular the air environment, is the *Waste Management and Pollution Control Act 1998* (EPA 1998). Among other things, this legislation sets out the concept of a general environmental duty and establishes the environmental protection objectives on which (EPA 1998):

- *Environmental quality is to be maintained, enhanced, managed or protected,*
- *Pollution, or environmental harm resulting from pollution, is to be assessed, prevented, reduced, controlled, rectified or cleaned up, and*
- *Effective waste management is to be implemented or evaluated.*

Under EPA (1998), air quality is specified as an environmental protection objective. The Act states that the objectives may specify goals, standards or guidelines and environmental indicators with which to manage and assess environmental quality. Notwithstanding this, there is no subordinate legislation within the Northern Territory's statutory framework to guide air quality impact assessments or provide ambient air quality impact assessment criteria, against which an air assessment can be made. In cases where there are no relevant air quality impact assessment approaches and criteria, it is standard practice to adopt these from neighbouring jurisdictions. The assessment approach and ambient air quality impact assessment criteria promulgated in NSW have therefore been used in this assessment.

4.3 Adopted requirements for the protection of the air environment

4.3.1 NSW Approved Methods guidance

The methods that are to be used for modelling and assessing emissions of air pollutants from stationary sources in NSW are outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2016)* (NSW EPA, 2016). The Approved Methods provides guidance on the air quality impact assessment process including the:



- Preparation of emission inventories,
- Preparation of meteorological data,
- Quantification and accounting for background concentrations and cumulative impact assessment,
- Dispersion modelling methodology,
- Presentation and interpretation of dispersion model predictions, and
- Impact assessment criteria and assessment outcomes.

The Approved Methods also prescribes two levels of impact assessment:

1. Level 1 – screening-level dispersion modelling technique using worst case input data.
2. Level 2 – refined dispersion modelling technique using site-specific input data.

The assessment levels are designed so that the second level of assessment should be more accurate than the first, but that the first level is more conservative than the second. The intention of the assessment level system is not to conduct a level two assessment upon completion of a level one assessment, particularly if the level one assessment adequately demonstrates that the development is not expected to cause an impact to the air environment in relation to the impact assessment criteria.

In accordance with the guidance provided in the NSW EPA (2016), the assessment of project construction activities has been conducted as a level two impact assessment through the use of site-specific input data, including:

- Local terrain and land use for meteorological modelling,
- Actual locations of construction activities and sensitive receptors,
- TAPM prognostic model simulations over the region,
- Configuration of the AUSPLUME dispersion model using site-specific emission source characteristics, dimensions and coordinate locations¹, and
- Emission rate estimates based on site-specific activity data and worst-case emissions data.

4.3.2 Ambient air quality impact assessment criteria

NSW EPA (2016) sets out the ambient air quality impact assessment criteria under which air quality impacts in NSW are to be assessed. These criteria have been used for this assessment in the NT. Impact assessment criteria for the key air pollutants associated with project activities are outlined in Table 4-1.

¹ Note: When modelling area sources in the AUSPLUME model, as was done in this assessment, the model does not recognise variable topography.



Table 4-1 Ambient air quality impact assessment criteria used in the assessment

Substance	Impact assessment criterion	Averaging period	Where the assessment criterion is applied	Modelled percentile statistic used
NO ₂	246 µg/m ³ 62 µg/m ³	1 hour Annual	Nearest offsite sensitive receptor	100 N/A
PM _{2.5}	25 µg/m ³ 8 µg/m ³	24 hour Annual	Nearest offsite sensitive receptor	100 N/A
PM ₁₀	50 µg/m ³ 25 µg/m ³	24 hour Annual	Nearest offsite sensitive receptor	100 N/A
TSP	90 µg/m ³	Annual	Nearest offsite sensitive receptor	N/A
Deposited dust	2 mg/m ² /month	Annual	Nearest offsite sensitive receptor	100

Sources: NSW EPA (2016) Approved Methods.

4.3.3 Approach to the air quality impact assessment

This air quality impact assessment has been undertaken primarily as a level two impact assessment (as defined in the Approved Methods, NSW EPA 2016) with the inclusion of site-specific information and modelling processes. Notwithstanding this approach, some additionally conservative level one assessment measures have also been incorporated to account for any uncertainty in the methodology and assumptions used, due to the project being in the early stages of construction logistics planning at the time the assessment was undertaken.

Criteria air pollutants have been assessed as the 100th percentile of predicted impact plus the 70th percentile background concentrations recorded at the local monitoring network at the most-affected off-site sensitive receptor.



5 Existing Environment

There are a limited number of air quality monitoring sites in the Northern Territory with long term monitoring data being available for the Darwin suburbs of Palmerston, Stokes Hill and Winnellie. A monitoring site has recently been established at Katherine. Data were assessed for the period between 1 November 2014 and 31 October 2019 (five years) at the Palmerston and Winnellie sites. Data collected at Stokes Hill were assessed for the period between 5/05/2017 and 31/10/2019. At the time of analysis long term data were not available for Katherine.

Regional average particle concentrations were calculated, using the mean of the observations across all three sites with averaging occurring for each timestep and particle size range.

5.1 Particulate matter as PM_{2.5}

Descriptive statistics for the 24-hour and annual average concentrations of PM_{2.5} at each site are presented in Table 5-1. Time series plots of 24-hour average concentrations of PM_{2.5} at each site are presented in Figure 5-1.

Darwin has distinct wet and dry seasons, with the wet season commencing on 1 November and ending on 30 April the following year. The dry season extends between 1 May and 31 October. The seasons are depicted in Figure 5-1 by the red (dry season) and white (wet season) shaded areas, while the applicable air quality criterion is shown with a dotted red line.

The plot shows that the 24-hour average PM_{2.5} criterion of 25 µg/m³ is exceeded on multiple days each year across all Darwin sites. The exceedances are largely restricted to the dry season and are associated with biomass burning events.

Table 5-1 Summary statistics of observed PM_{2.5} concentrations

Averaging period	Statistic	Palmerston (µg/m ³)	Darwin - Stokes Hill (µg/m ³)	Winnellie (µg/m ³)	Regional average (µg/m ³)
24-hour ¹	Maximum	111.7	43.6	77.9	77.7
	99 th percentile	35.6	34.5	34.4	34.8
	70 th percentile	10.1	11.3	9.9	10.4
	50 th percentile	6.1	6.7	5.6	6.1
	Mean (entire period)	8.1	8.6	8.0	8.4
Annual ²	Mean of 1-hour data	8.3	8.7	8.0	8.3

Table note: ¹ 24-hour criterion: 25 µg/m³
² Annual criterion: 8 µg/m³

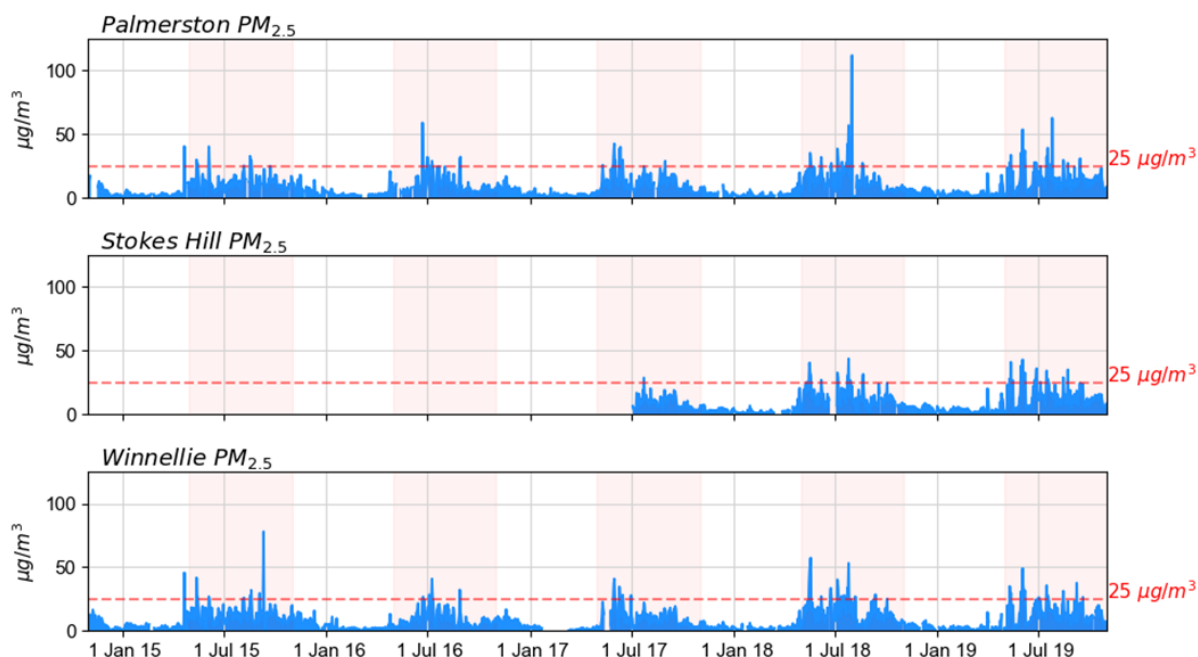


Figure 5-1 Time series of 24-hour average concentrations of PM_{2.5}

5.2 Particulate matter as PM₁₀

The equivalent PM₁₀ monitoring statistics and 24-hour average time series plots are provided in Table 5-2 and Figure 5-2 respectively. Once again, the PM₁₀ criterion of 50 µg/m³ is exceeded on multiple days each year across all three sites, with exceedances most frequently occurring during the dry season as a result of biomass burning events.

Table 5-2 Summary statistics of observed PM₁₀ concentrations

Averaging period	Statistic	Palmerston (µg/m ³)	Darwin - Stokes Hill (µg/m ³)	Winnellie (µg/m ³)	Regional average (µg/m ³) ³
24-hour ¹	Maximum	143.1	95.2	107.7	115.3
	99 th percentile	53.7	56.8	54.1	54.8
	70 th percentile	23.3	27.5	22.1	24.3
	50 th percentile	17.0	21.3	15.3	17.9
	Mean (entire period)	19.5	22.5	18.0	20.0
Annual ²	Mean of 1-hour data	19.5	22.4	17.9	19.9

Table note: ¹ 24-hour criterion: 50 µg/m³
² Annual criterion: 25 µg/m³
³ The background concentration for 24-hour model predictions is estimated using the 70th percentile value. The annual background is estimated using the mean of all available 1-hour measurements.

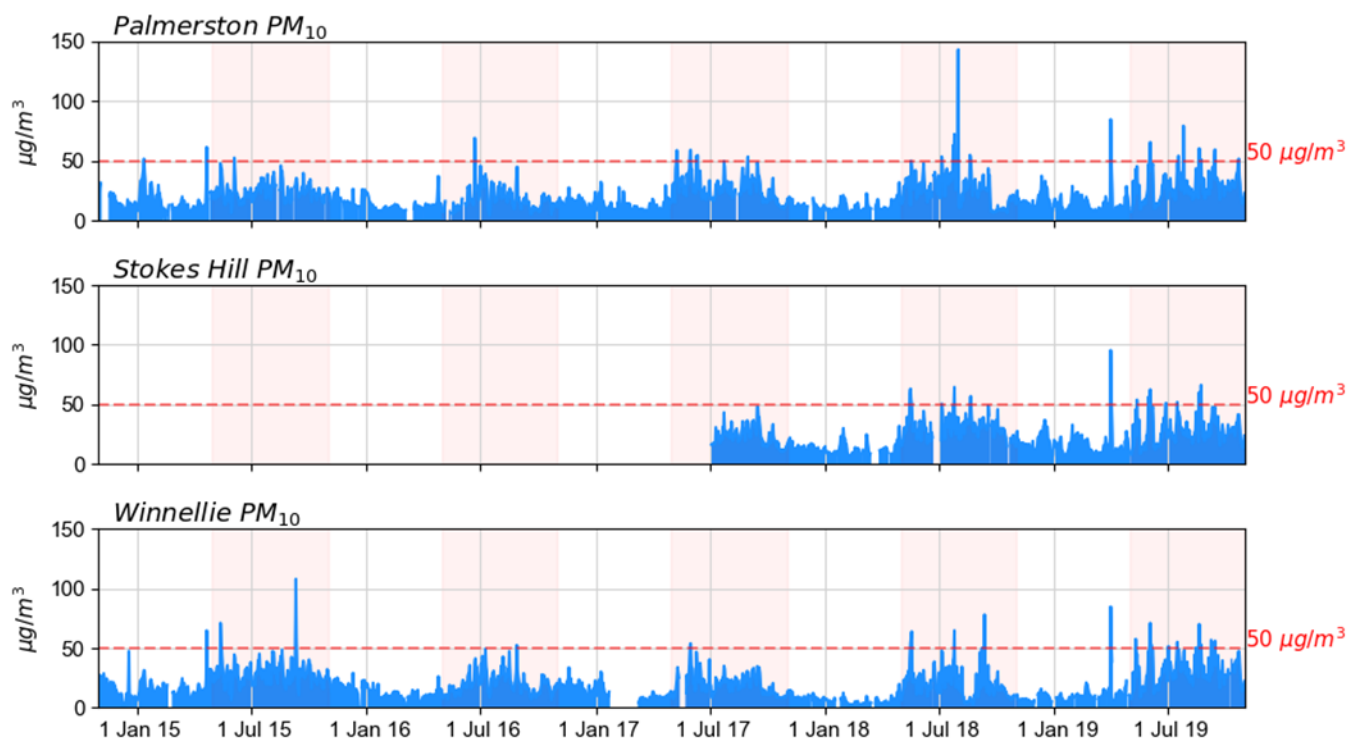


Figure 5-2 Time series of 24-hour average concentrations of PM₁₀

5.3 Nitrogen dioxide

The equivalent NO₂ monitoring statistics and 1-hour average time series plots are provided in Table 5-3 and Figure 5-3 respectively. Observed NO₂ concentrations are low across the region, with the highest observation, 116 µg/m³ at Palmerston, accounting for only 47% of the assessment criterion.

Table 5-3 Summary statistics of observed NO₂ concentrations

Averaging period	Statistic	Palmerston (µg/m ³)	Darwin - Stokes Hill (µg/m ³)	Winnellie (µg/m ³)	Regional average (µg/m ³) ³
1-hour ¹	Maximum	116.4	49.9	57.7	74.6
	99 th percentile	34.4	34.3	39.6	36.1
	70 th percentile	6.0	5.1	5.7	5.6
	50 th percentile	3.2	3.0	3.2	3.1
	Mean (entire period) ²	5.0	4.3	4.8	4.7

Table note: ¹ 1-hour criterion: 246 µg/m³
² Annual criterion: 62 µg/m³
³ The background concentration for 1-hour model predictions is estimated using the 70th percentile value. The annual background is estimated using the mean of all available measurements.

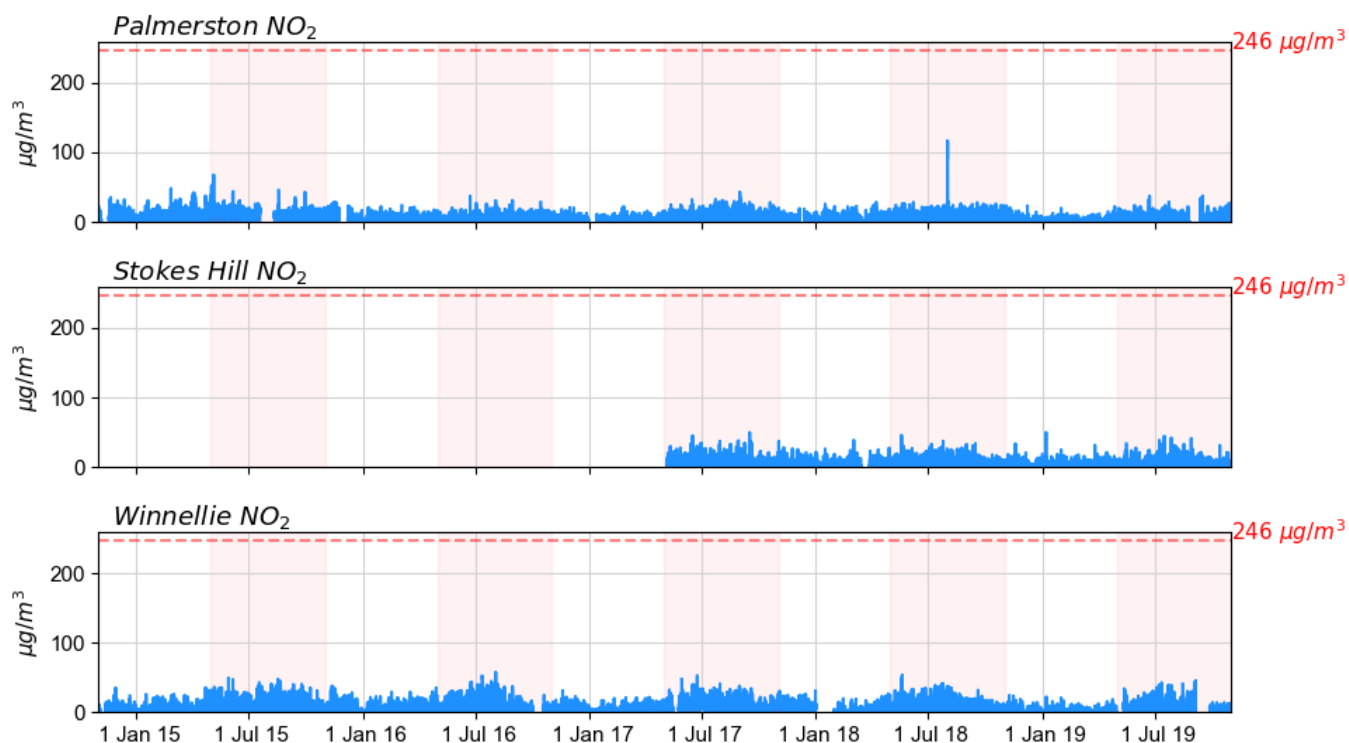


Figure 5-3 Time series of 1-hour average concentrations of NO₂

5.4 Ozone

Descriptive statistics for the 1-hour average concentrations of ozone at each site are presented in Table 5-4. Time series plots of 1-hour average concentrations of ozone over the entire monitoring period at each site are presented in Figure 5-4.

Table 5-4 Summary statistics of observed O₃ concentrations

Averaging period	Statistic	Palmerston (µg/m ³)	Darwin - Stokes Hill (µg/m ³)	Winnellie (µg/m ³)	Regional average (µg/m ³)
1-hour ¹	Maximum	196.2	200.2	291.9	183.1
	99 th percentile	94.4	99.6	90.7	91.0
	70 th percentile	46.9	55.1	46.9	47.7
	50 th percentile	35.8	43.9	37.0	37.2

Table note: ¹ 1-hour criterion: 214 µg/m³

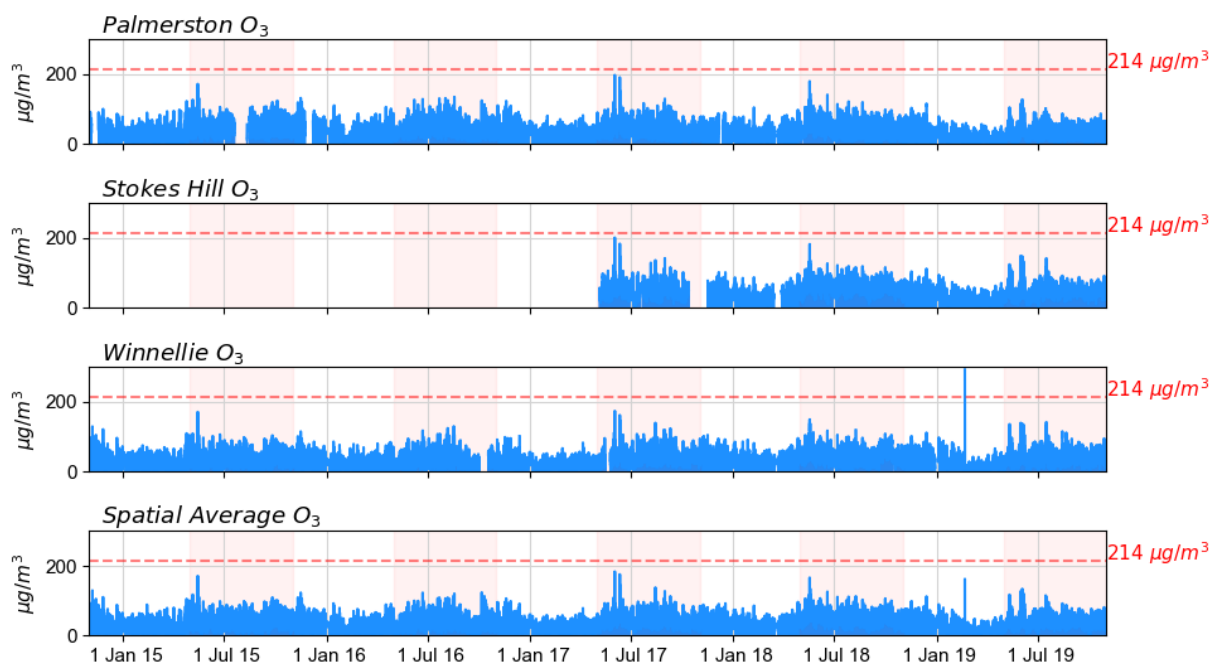


Figure 5-4 Time series of 1-hour average concentrations of O₃

5.5 Estimated background concentrations

Background concentrations were estimated for use in calculating cumulative (i.e. construction emission source plus background) model predictions, as provided in Table 5-5. The 70th percentile of observed monitoring results is routinely used to estimate short-term background concentrations. The assessment criteria for particles have either 1-hour, 24-hour or annual timeframes, whilst that for NO₂ has a 1-hour and annual timeframe.

The background concentrations for use with modelled 1-hour and 24-hour predictions were taken as the regional average of the 70th percentile concentration across the five-year period of record. The 24-hour average background concentrations for PM_{2.5} and PM₁₀ were therefore estimated to be 10.4 and 24.3 µg/m³ respectively. The 1-hour average background for NO₂ was estimated to be 5.6 µg/m³. The 1-hour average background ozone concentration, which is necessary to estimate NO₂ concentrations from total concentrations of NO_x, was estimated as the maximum of the spatially-averaged concentrations.

There was no monitoring data available for TSP or deposited dust. The background TSP concentration of 39.8 µg/m³ was estimated using the well-established assumption of a factor-of-two relationship between PM₁₀ and TSP concentrations.



Table 5-5 Estimated background concentrations in relation to the assessment criteria

Pollutant	Assessment criterion ($\mu\text{g}/\text{m}^3$)		Background concentration ($\mu\text{g}/\text{m}^3$)	
	24-hour	Annual	24-hour ¹	Annual ²
PM _{2.5}	25	8	10.4 (41.6%)	8.3 (103.8%)
PM ₁₀	50	25	24.3 (48.6%)	19.9 (79.6%)
TSP ³	-	90	-	39.8 (44.2%)
Deposited dust	-	2 g/m ² /month (inc) 4 g/m ² /month (cum)	-	-
Pollutant	1-hour	Annual	1-hour ¹	Annual ²
NO ₂	246	62	5.6 (2.3%)	4.7 (7.6%)
O ₃	214	-	183 (85.5%)	40 (-)

Table notes: ¹ 1-hour and 24-hour background concentrations were estimated as the mean of the 70th percentile concentrations across all three sites for hourly and daily observations respectively.

² Annual average background concentrations were estimated as the mean of all 1-hour average concentrations over the period of record, averaged across all three sites.

³ Annual average background TSP concentration was estimated as being twice that of the adopted annual average PM₁₀ background concentration.



6 Emissions Inventory

6.1 Dust emissions from construction activities

Construction dust emissions were estimated using the WRAP Fugitive Dust Handbook (Countess Environmental, 2004), which provides general composite emission factors to characterise PM₁₀ emissions arising from construction activities. The composite emission factors account for the cumulative effect of all construction activities occurring onsite. A Level 1 PM₁₀ emission factor of 0.11 ton/acre/month was selected, applying to construction activity not involving large-scale cut and fill operations. This is equivalent to 24.66 g/m²/month.

It was assumed that construction activities will occur for 12 hours per day, during daytime hours only. Wind erosion during non-construction nighttime hours was not expected to be a consideration, as an analysis of approximately 4.5 years of observed Bureau of Meteorology winds at Noonamah (Site 14314) shows that the frequency of winds exceeding the wind erosion threshold of 5.4 m/s during evening (6pm to midnight) and nighttime (midnight to 6am) hours is virtually zero (see Figure 6-1).

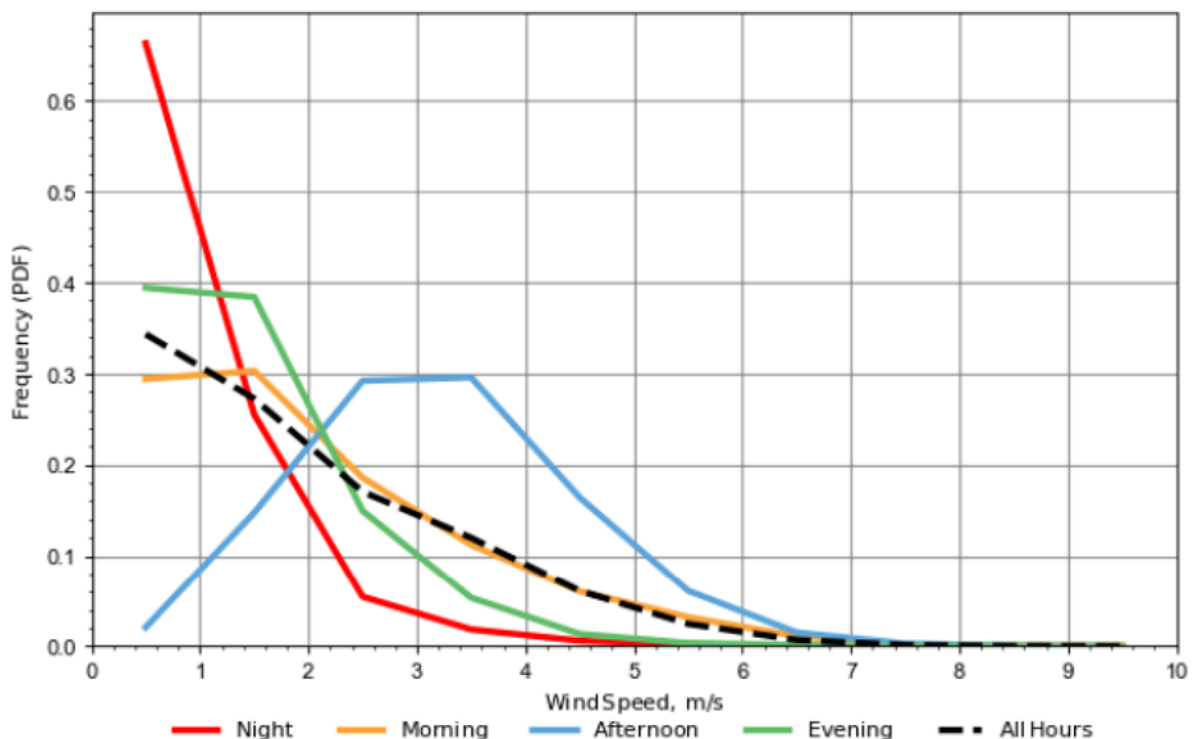


Figure 6-1 Analysis of the diurnal frequency distribution of wind speeds recorded at the BoM Noonamah station (Site 14314), 21 June 2013 to 5 December 2017

The monthly PM₁₀ emission factor was therefore conservatively apportioned to a twelve-hour dust emission window per day, providing a composite PM₁₀ emission factor of 1.903x10⁻⁵ g/m²/s. TSP and PM_{2.5} emission factors were estimated from the PM₁₀ emission factor by applying the widely-adopted TSP/PM₁₀ ratio of 2.0 and PM_{2.5}/PM₁₀ ratio of 0.1.

The composite emission factors selected to characterise dust emissions arising from construction activities are summarised in Table 6-1. These factors assume the effects of typical dust control measures such as routine watering, which provide a dust control effectiveness of 50%. The assumption has been made in this assessment that watering will be used as a dust control measure. Therefore, if watering is not to be used at any site, the emissions should be doubled, to more accurately reflect the actual dust emissions from construction activities.



Table 6-1 Composite emission factors selected to characterise construction dust emissions

TSP (g/m ² /s)	PM ₁₀ (g/m ² /s)	PM _{2.5} (g/m ² /s)
3.805x10 ⁻⁵	1.903 x10 ⁻⁵	1.903 x10 ⁻⁶

6.2 Emissions from diesel-fuelled construction equipment

From experience, the critical air pollutant associated with fossil-fuel burning (i.e. coal, gas and liquid fuels such as diesel) in engines and boilers is NO₂. This is based on the potential for health-related impacts of the substances emitted and the ratio of the emission rate to the relevant short-term air impact criterion (typically based on a 1-hour exposure period). Consequently, the critical emissions are NO_x. For this screening level air quality assessment, only NO₂ was assessed as the worse case for air quality impacts.

NO_x emissions from diesel-fuelled construction vehicles were estimated using USEPA Tier 3 non-road diesel engine emission standards (available at: <https://dieselnet.com/standards/us/nonroad.php#tier3>). These provide emission factors on the basis of vehicle production date (Tier 3 emission standards were phased in from 2006 to 2008) and engine power. USEPA Tier 3 standards provide emission factors for NO_x, carbon monoxide (CO) and total hydrocarbons. There are no USEPA Tier 3 standards for sulfur dioxide (SO₂), as SO₂ emissions largely vary as a function of fuel sulfur content. Modern diesel fuels tend to have a relatively low sulfur content and, as a result, SO₂ emissions are low and not likely to cause an air impact. This is also evident in the very low ambient air concentrations of SO₂ observed in the airsheds of Australian capital cities.

Details were obtained from Sun Cable outlining the site preparation and construction equipment proposed for use in developing the Solar Precinct, OHTL, Darwin Converter Site, and underground cable sites. These were used to develop an emissions inventory of total emissions from each site by construction activity.

6.2.1 Roadworks at the solar array site

Diesel emissions associated with the construction of the main access road within the Solar Precinct are provided in Table 6-2. The bulk earthworks phase produces the highest NO_x emissions (2.991 g/s), with the lowest emissions (0.151 g/s) being generated during landscaping activities.

Diesel emissions associated with the construction of the secondary all-weather access road within the Solar Precinct are provided in Table 6-3. The site preparation phase produces the highest NO_x emissions (2.961 g/s), with the lowest emissions (0.151 g/s) being generated during landscaping activities.

Given the similarity between the peak diesel emissions associated with the construction of the main and secondary access roads, NO_x emissions from all road construction activities were conservatively characterised using the NO_x emission rate of 2.991 g/s developed for the bulk earthworks phase of the main access road.



Table 6-2 Estimated NO_x mass emission rates by construction phase for main access road construction activities within the Solar Precinct

Proposed equipment by construction phase	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing and Grubbing:				
Grader: Cat 140	1	136	4.0	0.151
Water cart: 18kL	2	362	4.0	0.804
Dozer: D10	1	447	4.0	0.497
Bulk Earthworks:				
Water cart: Cat 740 GC ADT 35kL	1	327	4.0	0.363
Grader: Cat 140	1	136	4.0	0.151
Scraper: Cat 623	2	272	4.0	0.604
Excavator/Loader: Cat 326	1	150	4.0	0.167
Truck: Cat ADT 740	1	327	4.0	0.363
Compactor: Cat 825	4	302	4.0	1.342
Road Sealing:				
Grader: Cat 140	2	136	4.0	0.302
Roller: 10 ton Cat CB10	4	97	4.0	0.431
Truck: 15T tipper Cat 730 EJ	1	274	4.0	0.304
Bitumen sprayer: 12,000 litre, truck mounted	2	324	4.0	0.720
Multyre Roller: Cat CW12	1	75	4.0	0.083
Landscaping:				
Grader: Cat 140	1	136	4.0	0.151
Concrete Structures:				
Agitated truck 6.0m ³ : ISUZU FYJ 300-350 Agitator Cab Chassis	1	257	4.0	0.286
Concrete pumping boom mounted on a FUSO Fighter 1627 Euro 6 truck	1	199	4.0	0.221
Crane: (20 t Franna crane)	1	205	4.0	0.228
Flatbed Truck: Shacman 10 ton	1	199	4.0	0.221
Light Vehicle: Hilux ute	4	150	4.0	0.667
<i>Total Site Preparation</i>				1.452
<i>Total Bulk Earthworks</i>				2.991
<i>Total Road Sealing</i>				1.841
<i>Total Landscaping</i>				0.151
<i>Total Concrete Structures</i>				1.622



Table 6-3 Estimated NO_x mass emission rates by construction phase for secondary access road construction activities within the Solar Precinct

Proposed equipment by construction phase	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing and Grubbing:				
Grader: Cat 140	3	136	4.0	0.453
Water cart: 18kL	5	362	4.0	2.011
Dozer: D10	1	447	4.0	0.497
Bulk Earthworks:				
Water cart: Cat 740 GC ADT 35kL	1	327	4.0	0.363
Grader: Cat 140	1	136	4.0	0.151
Scraper: Cat 623	2	272	4.0	0.604
Excavator/Loader: Cat 326	1	150	4.0	0.167
Truck: Cat ADT 740	2	327	4.0	0.727
Compactor: Cat 825	2	302	4.0	0.671
Unsealed Road:				
Grader: Cat 140	1	136	4.0	0.151
Roller: 10 ton Cat CB10	2	97	4.0	0.216
Truck: 15T tipper Cat 730 EJ	1	274	4.0	0.304
Multityre Roller: Cat CW12	1	75	4.0	0.083
Landscaping:				
Grader: Cat 140	1	136	4.0	0.151
Concrete Structures:				
Agitated truck 6.0m ³ : ISUZU FYJ 300-350 Agitator Cab Chassis	1	257	4.0	0.286
Concrete pumping boom mounted on a FUSO Fighter 1627 Euro 6 truck	1	199	4.0	0.221
Crane: (20 t Franna crane)	1	205	4.0	0.228
Flatbed Truck: Shacman 10 ton	1	199	4.0	0.221
Light Vehicle: Hilux ute	2	150	4.0	0.333
<i>Total Site Preparation</i>				2.961
<i>Total Bulk Earthworks</i>				2.683
<i>Total Unsealed Road</i>				0.754
<i>Total Landscaping</i>				0.151
<i>Total Concrete Structures</i>				1.289



6.2.2 Intermodal facility at the solar array site

Diesel emissions associated with the construction of the Intermodal Logistics Facility within the Solar Precinct are provided in Table 6-4. The bulk earthworks phase produces the highest NO_x emission rate (1.380 g/s), causing this to be conservatively adopted to characterise construction-related NO_x emissions at the Intermodal facility site. The lowest emissions (0.151 g/s) are generated during landscaping activities.

Table 6-4 Estimated NO_x mass emission rate for construction activities at the Intermodal facility

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing and Grubbing:				
Grader: Cat 140	1	136	4.0	0.151
Water cart: 18kL	1	362	4.0	0.402
Dozer: D10	1	447	4.0	0.497
Bulk Earthworks:				
Water cart: Cat ADT 35kL	1	327	4.0	0.363
Grader: Cat 140	1	136	4.0	0.151
Excavator/Loader: Cat 326	1	150	4.0	0.167
Truck: Cat ADT 740	1	327	4.0	0.363
Compactor: Cat 825	1	302	4.0	0.336
Bitumous sprayed hardstand:				
Grader: Cat 140	1	136	4.0	0.151
10 ton Roller: Cat CB10	2	97	4.0	0.216
Excavator/Loader: Cat 326	1	150	4.0	0.167
15T Tipper truck: Cat 730 EJ	1	274	4.0	0.304
12,000 Litre Truck Mounted Bitumen sprayer	1	324	4.0	0.360
Multityre Roller: Cat CW12	1	75	4.0	0.083
Landscaping:				
Grader: Cat 140	1	136	4.0	0.151
Light Vehicle: Hilux ute	1	150	4.0	0.167
<i>Total Site Preparation</i>				<i>1.050</i>
<i>Total Bulk Earthworks</i>				<i>1.380</i>
<i>Total Hardstand Preparation</i>				<i>1.281</i>
<i>Total Landscaping</i>				<i>0.318</i>



6.2.3 Railway construction activities at the solar array site

Diesel emissions associated with the construction of railway facilities at the Solar Precinct are provided in Table 6-5. The bulk earthworks phase produces the highest NO_x emission rate (2.911 g/s), causing this to be conservatively adopted to characterise railway construction-related NO_x emissions. The lowest emissions (0.449 g/s) are generated during construction of the railway station building.

Table 6-5 Estimated NO_x mass emission rate for railway construction activities at the solar array site

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing and Grubbing:				
Grader: Cat 140	1	136	4.0	0.151
Water cart: 18kL	1	362	4.0	0.402
Dozer: D10	1	447	4.0	0.497
Bulk Earthworks:				
Water cart: Cat ADT 35kL	2	327	4.0	0.727
Grader: Cat 140	1	136	4.0	0.151
Scraper: Cat 623	1	272	4.0	0.302
Excavator/Loader: Cat 326	2	150	4.0	0.333
Truck: Cat ADT 740	2	327	4.0	0.727
Compactor: Cat 825	2	302	4.0	0.671
Ballast:				
Truck: Cat ADT 740	2	327	4.0	0.727
Excavator/Loader: Cat 326	2	150	4.0	0.333
Crane: Frana (20 t)	1	205	4.0	0.228
Flatbed Truck: Shacman 10 ton	1	199	4.0	0.221
Concrete Structures:				
Agitated truck 6.0m ³ : ISUZU FYJ 300-350 Agitator Cab Chassis	1	257	4.0	0.286
Concrete pumping boom mounted on a FUSO Fighter 1627 Euro 6 truck	1	199	4.0	0.221
Station Building				
Crane: Frana (20 t)	1	205	4.0	0.228
Flatbed Truck: Shacman 10 ton	1	199	4.0	0.221
Landscaping:				
Grader: Cat 140	1	136	4.0	0.151
Light Vehicle: Hilux ute	2	150	4.0	0.333



Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Total Site Preparation				1.050
Total Bulk Earthworks				2.911
Total Ballast				1.509
Total Concrete Structures				0.507
Total Buildings				0.449
Total Landscaping				0.484

6.2.4 Broadacre solar array

Diesel emissions associated with the construction of the broadacre solar array are provided in Table 6-6. The bulk earthworks phase produces the highest NO_x emission rate (3.139 g/s), causing this to be conservatively adopted to characterise solar array construction-related NO_x emissions. The lowest emissions (0.151 g/s) are generated during the landscaping phase.

Table 6-6 Estimated NO_x mass emission rate for construction of the broadacre solar array

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing and Grubbing:				
Slasher: Towed by John Deer 6R Mid Frame tractor	2	108	4.0	0.240
Water cart: 18kL	2	362	4.0	0.804
Dozer: D10	1	447	4.0	0.497
Bulk Earthworks:				
Water cart: Cat ADT 35kL	2	327	4.0	0.727
Grader: Cat 140	2	136	4.0	0.302
Truck: Cat ADT 740	1	327	4.0	0.363
Scraper: Cat 623	2	272	4.0	0.604
Excavator/Loader: Cat 326	1	150	4.0	0.167
Compactor: Cat 825	2	302	4.0	0.671
15 T tipper truck: Cat 730 EJ	1	274	4.0	0.304
Landscaping:				
Grader: Cat 140	1	136	4.0	0.151



Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Pole Installations:				
Excavator: 50 ton / 30 ton	1	316	4.0	0.351
Boring machine: DH20 LODRIL, with CAT C6.4 engine	1	103	4.0	0.114
Piling rig	1	231	4.0	0.257
Agitated truck 6.0m ³ : ISUZU FYJ 300-350 Agitator Cab Chassis	1	257	4.0	0.286
Concrete pumping boom mounted on a FUSO Fighter 1627 Euro 6 truck	1	199	4.0	0.221
Trenching:				
Trencher: Vermeer T1055	1	301	4.0	0.334
Excavator: 50 ton / 30 ton	2	316	4.0	0.702
Grader: Cat 140	1	136	4.0	0.151
Truck: Cat ADT 740	1	327	4.0	0.363
Compactor: Cat 825	1	302	4.0	0.336
Light Vehicle: Hilux ute	5	150	4.0	0.833
<i>Total Site Preparation</i>				1.541
<i>Total Bulk Earthworks</i>				3.139
<i>Total Landscaping</i>				0.151
<i>Total Pole Installation</i>				1.229
<i>Total Trenching</i>				2.720

6.2.5 Overhead Transmission Line

Diesel emissions associated with the site preparation and installation of poles at each OHTL site are provided in Table 6-7. The pole installation phase produces the highest NO_x emission rate (1.751 g/s), causing this to be conservatively adopted to characterise OHTL-related NO_x emissions. NO_x emissions are slightly lower during the site preparation phase, at 1.354 g/s.

Table 6-7 Estimated NO_x mass emission rate for OHTL site preparation and construction equipment

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation- Clearing, Grubbing and Formation:				
Grader CAT 140	1	136	4.0	0.151
Water Cart 18kL	1	362	4.0	0.402
Bulldozer D10T CAT27	1	447	4.0	0.497



Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Truck 15T Tipper Cat	1	274	4.0	0.304
Pole Installation:				
Excavator: 50 ton / 30 ton	1	316	4.0	4.0
Boring machine: DH20 LODRIL, with CAT C6.4 engine	1	103	4.0	4.0
Piling rig	1	231	4.0	4.0
Agitated truck 6.0m ³ : ISUZU FYJ 300-350 Agitator Cab Chassis	1	257	4.0	4.0
Concrete pumping boom mounted on a FUSO Fighter 1627 Euro 6 truck	1	199	4.0	4.0
70 t Grove Crane	1	320	4.0	4.0
Toyota Hilux WorkMate	1	150	4.0	4.0
<i>Total Site Preparation</i>				1.354
<i>Total Pole Installation</i>				1.751

6.2.6 Darwin Converter Site

Given the relatively large size of the Darwin Converter site, it was assumed that the site preparation, formation, and landscaping activities could feasibly occur simultaneously at different locations within the site. Total diesel emissions arising from these activities simultaneously occurring across the converter site are provided in Table 6-8. The total NO_x emission rate was calculated to be 4.004 g/s.

Table 6-8 Estimated NO_x mass emission rate for the Darwin Converter site during simultaneous site preparation, formation and landscaping activities

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation:				
Grader: CAT140	2	136	4.0	0.302
Water Cart 18kL	4	362	4.0	1.609
Bulldozer D10T CAT27	1	447	4.0	0.497
Site Formation:				
Grader: CAT140	1	136	4.0	0.151
Water Cart: CAT ADT 35kL	1	331	4.0	0.368
10 T Roller: CAT CB10	1	97	4.0	0.108
15T Tipper Truck Cat	1	274	4.0	0.304



Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Landscaping:				
Grader: CAT140	1	136	4.0	0.151
BobCat - R Series T66	1	55.2	4.0	0.061
Truck: Isuzu FXD 165-35O 4x2	1	257	4.0	0.286
Toyota Hilux WorkMate	1	150	4.0	0.167
<i>Total</i>				4.004

6.2.7 Underground cable construction activities

Diesel emissions associated with the site preparation, trenching and excavating, and cable installation and backfilling phases for the underground cable site at Murrumujuk are provided in Table 6-9. The cable installation and backfilling phase produces the highest NO_x emission rate (2.172 g/s), causing this to be conservatively adopted to characterise underground cable-related NO_x emissions. NO_x emissions are lowest during the site preparation phase, at 1.050 g/s.

Table 6-9 Estimated construction equipment and NO_x mass emission rate for the underground cable connecting the Darwin Converter Site to the Land Sea Joint Station

Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
Site Preparation:				
Grader: CAT140	1	136	4.0	0.151
Water Cart 18kL	1	362	4.0	0.402
Bulldozer D10T CAT27	1	447	4.0	0.497
Trenching and Excavating:				
Trencher: Vermeer T1055	1	301	4.0	0.334
Excavator: 50 ton / 30 ton	2	316	4.0	0.702
15T Tipper Truck Cat	1	274	4.0	0.304
Cable Installation and Backfilling:				
Truck: Cat ADT 740	1	333	4.0	0.370
Compactor: Cat 825	1	302	4.0	0.336
Toyota Hilux WorkMate	2	150	4.0	0.333
70 t Grove Crane	1	320	4.0	0.356
Low Loader	2	350	4.0	0.778



Proposed equipment	Number of units assessed	Net power (kW)	US EPA Tier 3 diesel engine emission standard (g/kWh)	NO _x mass emission rate (g/s)
<i>Total Site Preparation</i>				1.050
<i>Total Trenching and Excavating</i>				1.341
<i>Total Cable Installation and Backfilling</i>				2.172

6.2.8 NO_x emission rate summary

The NO_x emission rates used to characterise total construction vehicle emission rates at each construction area are summarised in Table 6-10, showing that the greatest NO_x emissions occur at the Darwin Converter site. The lowest NO_x emissions (1.380 g/s) occur at activity areas associated with the Intermodal Logistics Facility.

Table 6-10 Summary of total NO_x mass emission rates used by construction area

Construction area	Limiting phase	Total NO _x mass emission rate (g/s)
Roadworks at the solar array site	Bulk earthworks	2.991
Intermodal facility at the solar array site	Bulk earthworks	1.380
Railway at the solar array site	Bulk earthworks	2.911
Broadacre solar array	Bulk earthworks	3.139
Overhead transmission line sites	Pole installation	1.751
Darwin Converter site	Simultaneous site preparation, formation, and landscaping	4.004
Murrumujuk underground cable	Cable installation and backfilling	2.172



7 Dispersion Modelling and Impact Assessment Methodology

The configuration settings for the TAPM prognostic meteorological model and the AUSPLUME Gaussian plume dispersion model, along with the predicted dispersion meteorology for the Solar Farm Precinct and the Darwin Converter site at Murrumujuk are provided in detail in Appendix A.



8 Ambient Air Quality Impact Assessment

8.1 Solar Precinct site

8.1.1 24-hour average $PM_{2.5}$

The incremental and cumulative distance decay curves for 24-hour average $PM_{2.5}$ predictions for the solar array construction site are provided in Figure 8-1 and Figure 8-2 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average $PM_{2.5}$ criterion of $25 \mu\text{g}/\text{m}^3$ is met within 38 m of the activity area boundary. The minimum separation distance rises to 89 m when the assumed background concentration of $10.4 \mu\text{g}/\text{m}^3$ is accounted for.

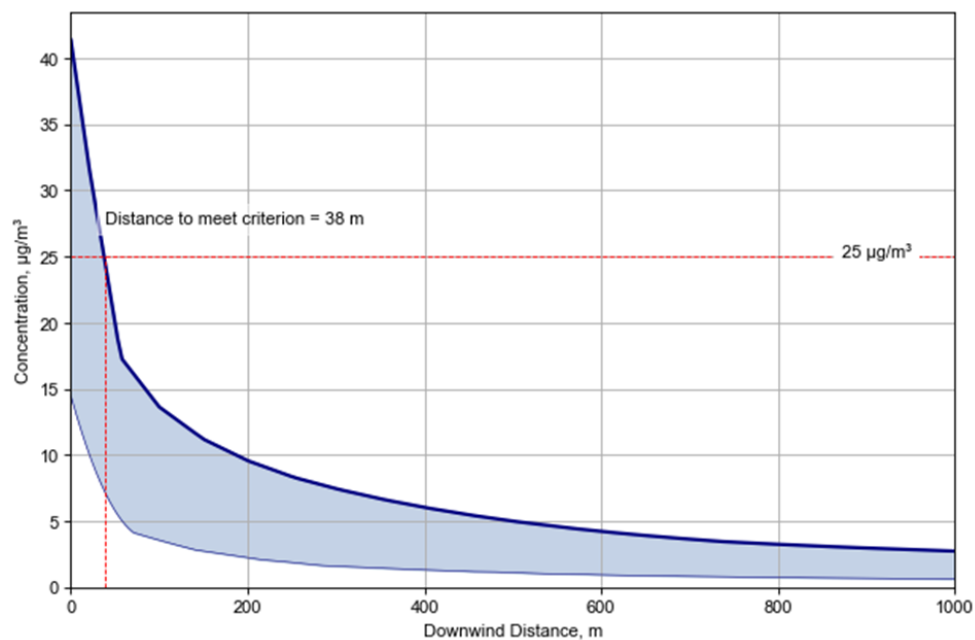


Figure 8-1 Predicted incremental maximum 24-hour average $PM_{2.5}$ distance decay relationship for the solar array site

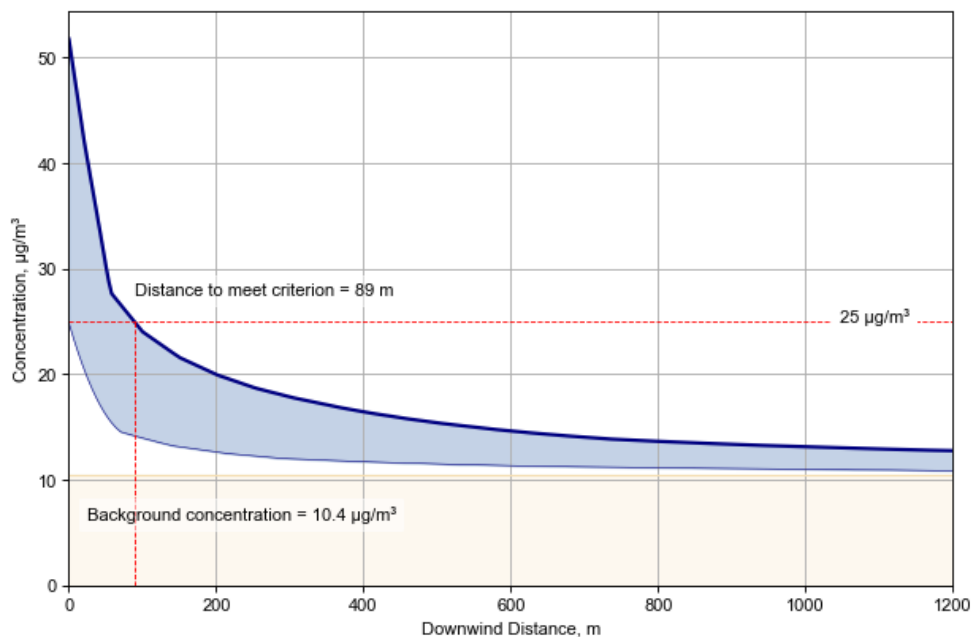


Figure 8-2 Predicted cumulative maximum 24-hour average PM_{2.5} distance decay relationship for the solar array site

8.1.2 Annual-average PM_{2.5}

The incremental and cumulative distance decay curves for annual average PM_{2.5} predictions for the solar array construction site are provided in Figure 8-3 and Figure 8-4 respectively. When the incremental effect of construction emissions is considered on its own then the annual average PM_{2.5} criterion of 8 µg/m³ is met within 41 m of the activity area boundary. The assumed background concentration of 8.3 µg/m³ is greater than the 8 µg/m³ criterion, meaning that the criterion cannot be met at any point in the modelling domain and the assessment is focused on the incremental effect alone.

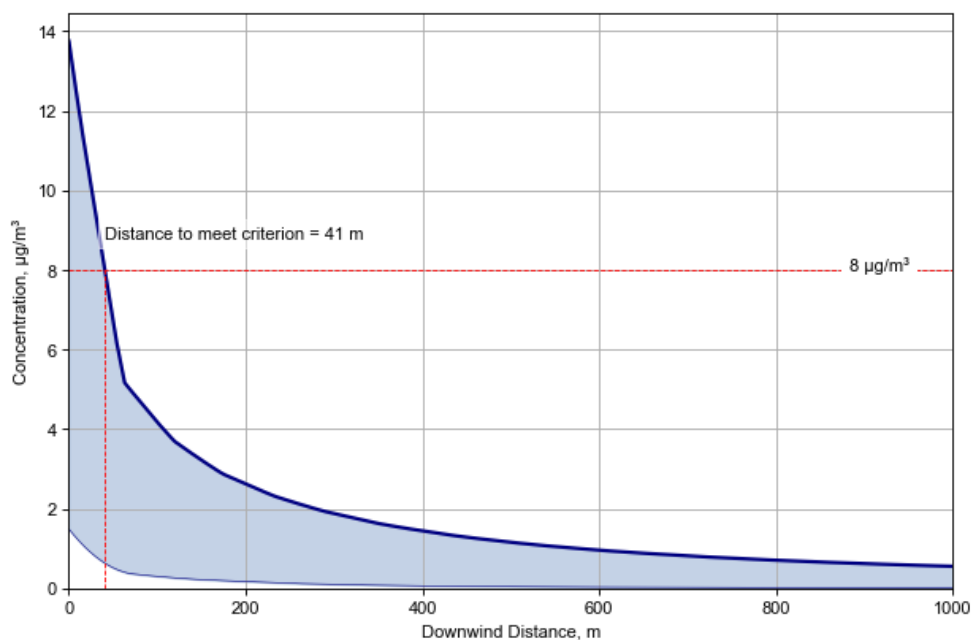


Figure 8-3 Predicted incremental annual-average PM_{2.5} distance decay relationship for the solar array site

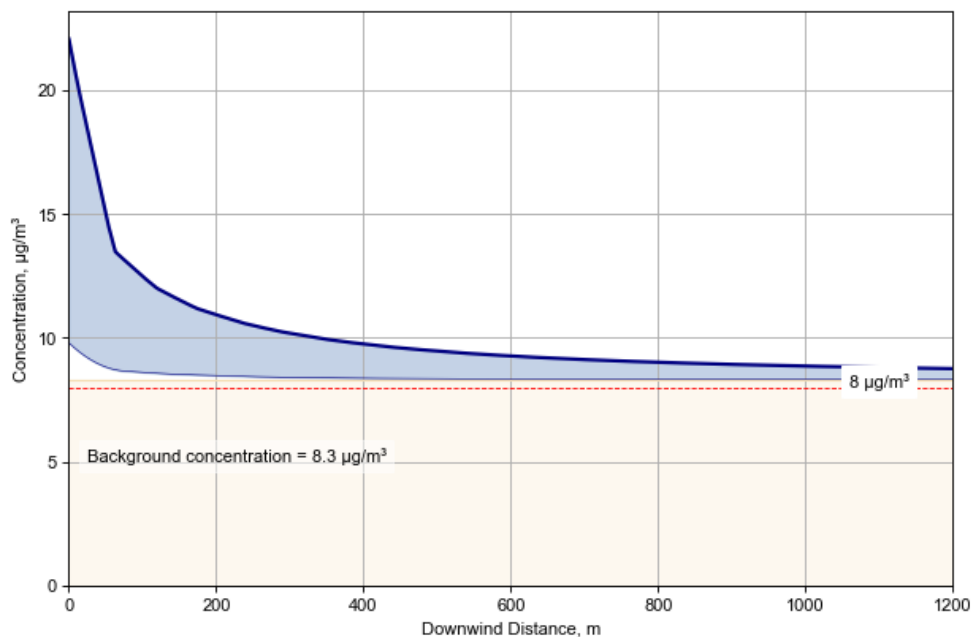


Figure 8-4 Predicted cumulative annual-average $PM_{2.5}$ distance decay relationship for the solar array site

8.1.3 24-hour average PM_{10}

The incremental and cumulative distance decay curves for 24-hour average PM_{10} predictions for the solar array construction site are provided in Figure 8-5 and Figure 8-6 respectively. When the incremental effect of construction site emissions is considered on its own then the 24-hour average PM_{10} criterion of $50 \mu\text{g}/\text{m}^3$ is met within 501 m of the activity area boundary. The minimum separation distance rises to 1079 m when the assumed background concentration of $24.3 \mu\text{g}/\text{m}^3$ is accounted for.

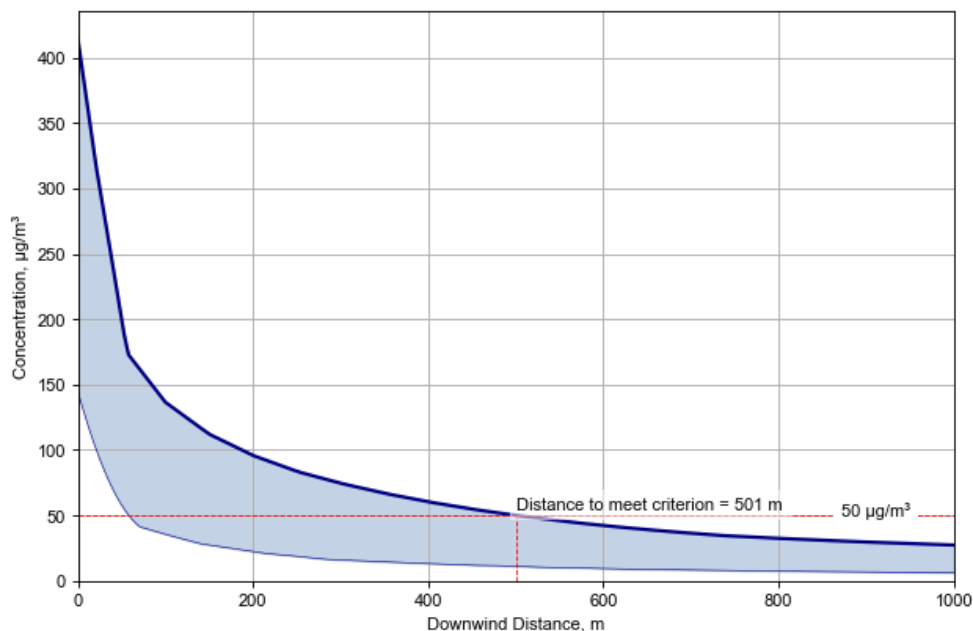


Figure 8-5 Predicted maximum incremental 24-hour average PM_{10} distance decay relationship for the solar array site

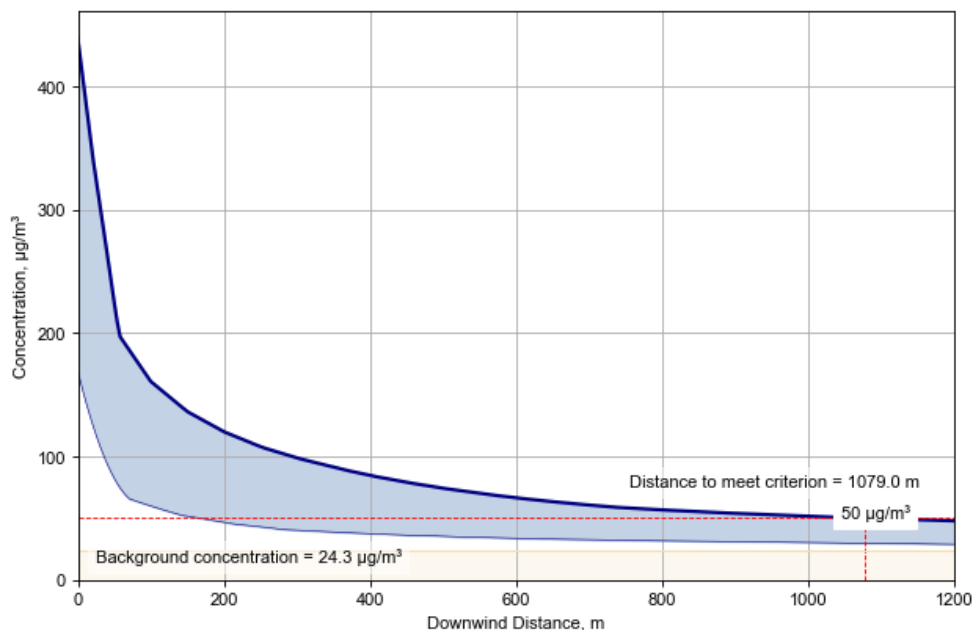


Figure 8-6 Predicted maximum cumulative 24-hour average PM₁₀ distance decay relationship for the solar array site

8.1.4 Annual-average PM₁₀

The incremental and cumulative distance decay curves for annual average PM₁₀ predictions for the solar array construction site are provided in Figure 8-7 and Figure 8-8 respectively. When the incremental effect of construction emissions is considered on its own then the annual average PM₁₀ criterion of 25 µg/m³ is met within 214 m of the activity area boundary. The minimum separation distance rises to 1073 m when the assumed background concentration of 19.9 µg/m³ is accounted for.

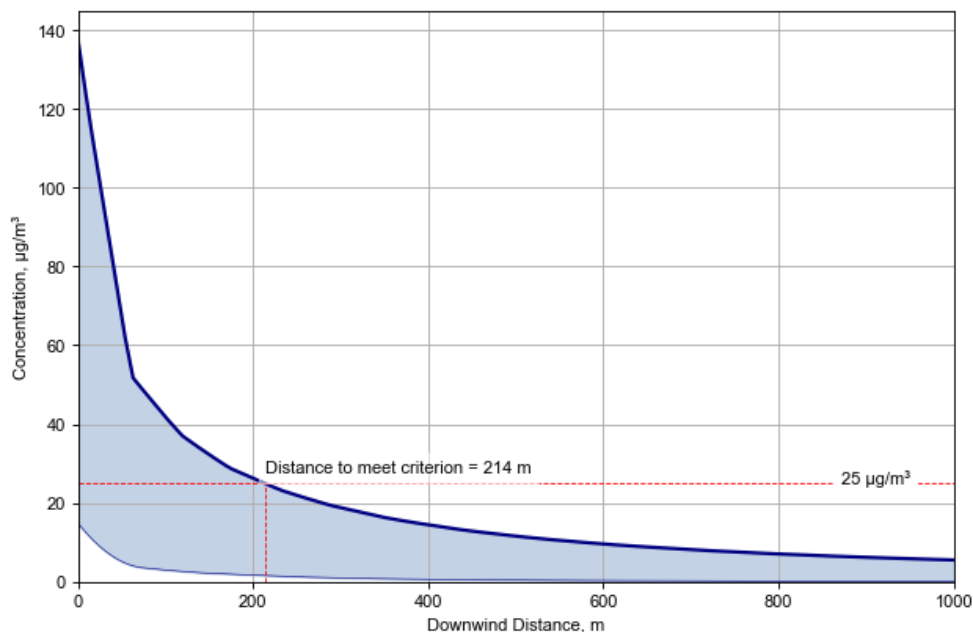


Figure 8-7 Predicted incremental annual-average PM₁₀ distance decay relationship for the solar array site

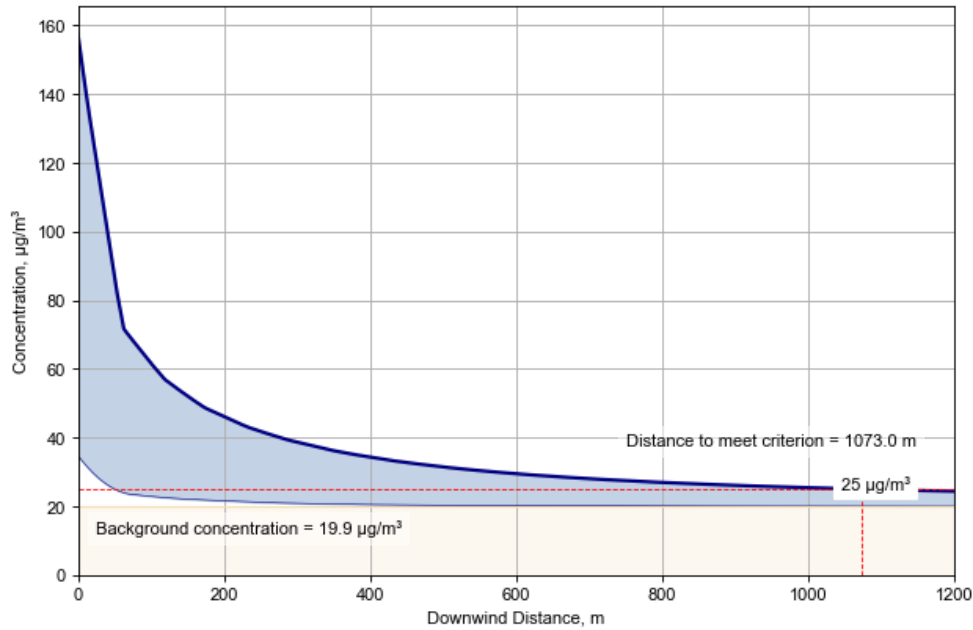


Figure 8-8 Predicted cumulative annual-average PM_{10} distance decay relationship for the solar farm site

8.1.5 Annual-average TSP

The incremental and cumulative distance decay curves for annual average TSP predictions for the solar array construction site are provided in Figure 8-9 and Figure 8-10 respectively. When the incremental effect of construction emissions is considered on its own then the annual average TSP criterion of $90 \mu\text{g}/\text{m}^3$ is met within 88 m of the activity area boundary. The minimum separation distance rises to 213 m when the assumed background concentration of $39.8 \mu\text{g}/\text{m}^3$ is accounted for.

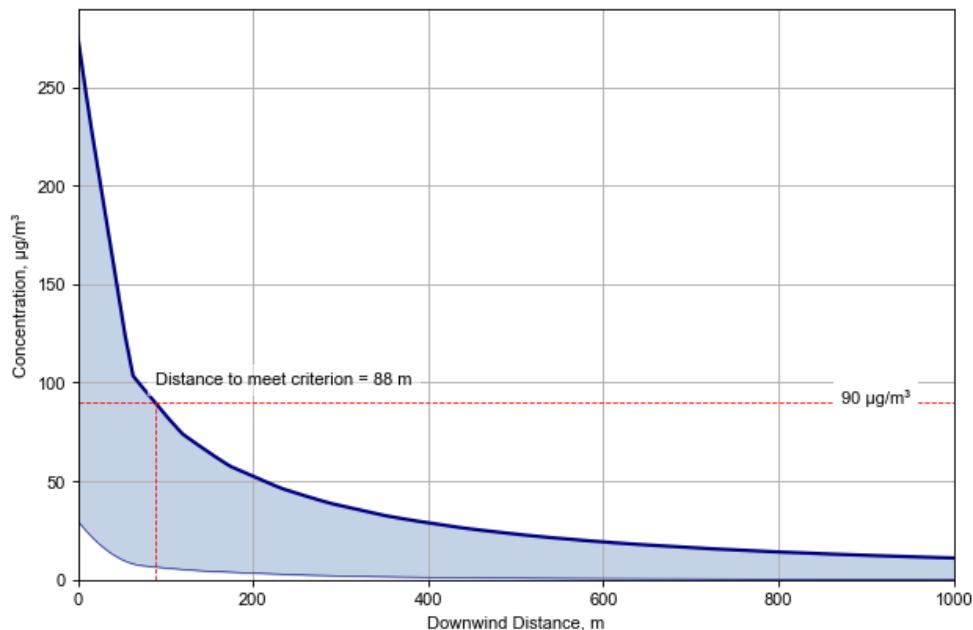


Figure 8-9 Predicted incremental annual-average TSP distance decay relationship for the solar array site

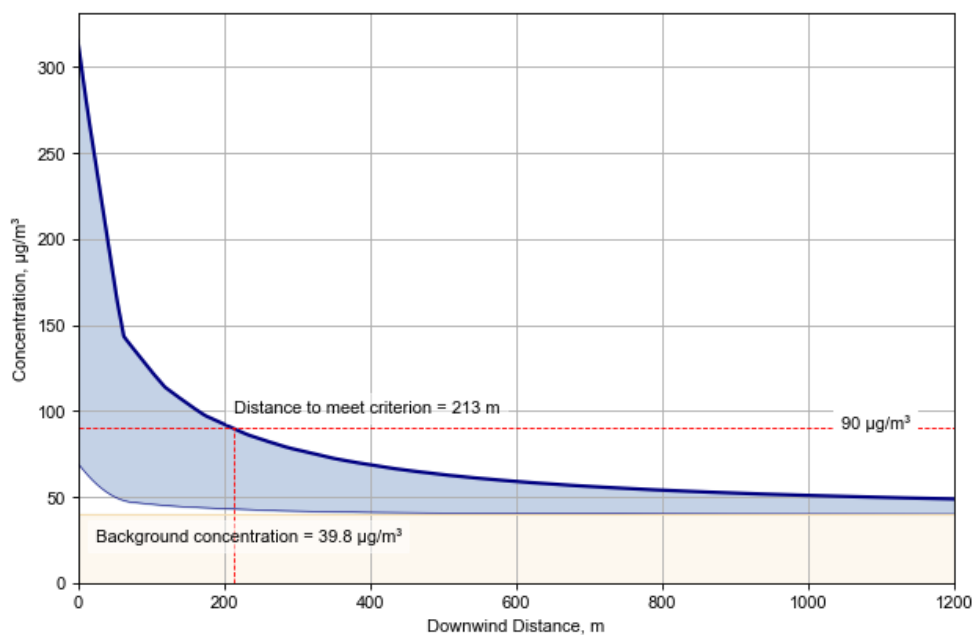


Figure 8-10 Predicted cumulative annual-average TSP distance decay relationship for the solar array site

8.1.6 1-hour average NO₂

Roadworks

The incremental and cumulative distance decay curves for 1-hour average NO₂ predictions for road construction activities at the solar array site are provided in Figure 8-11 and Figure 8-12 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 51 m of the activity area boundary. The minimum separation distance rises to 80 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

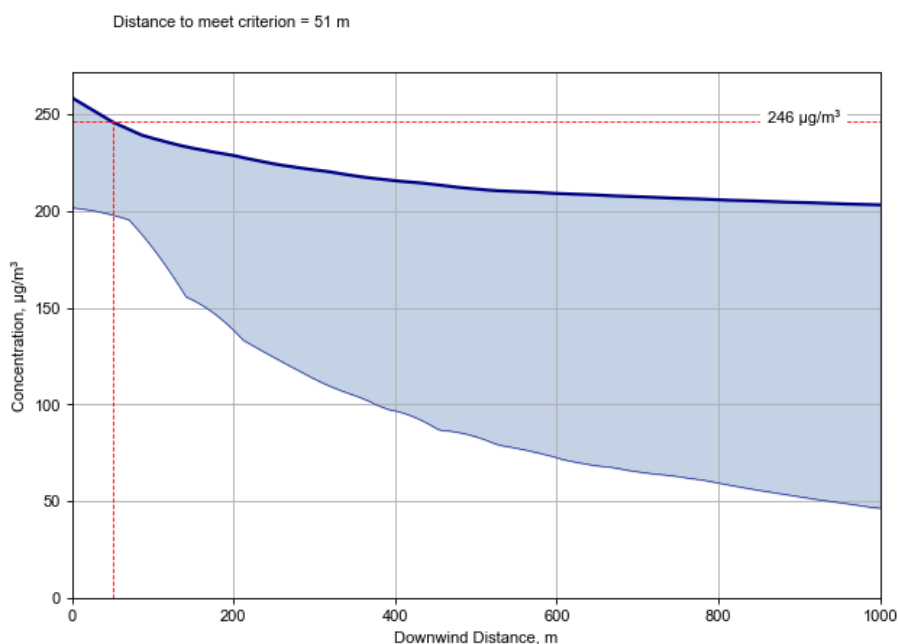


Figure 8-11 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for roadwork construction activities at the solar array site

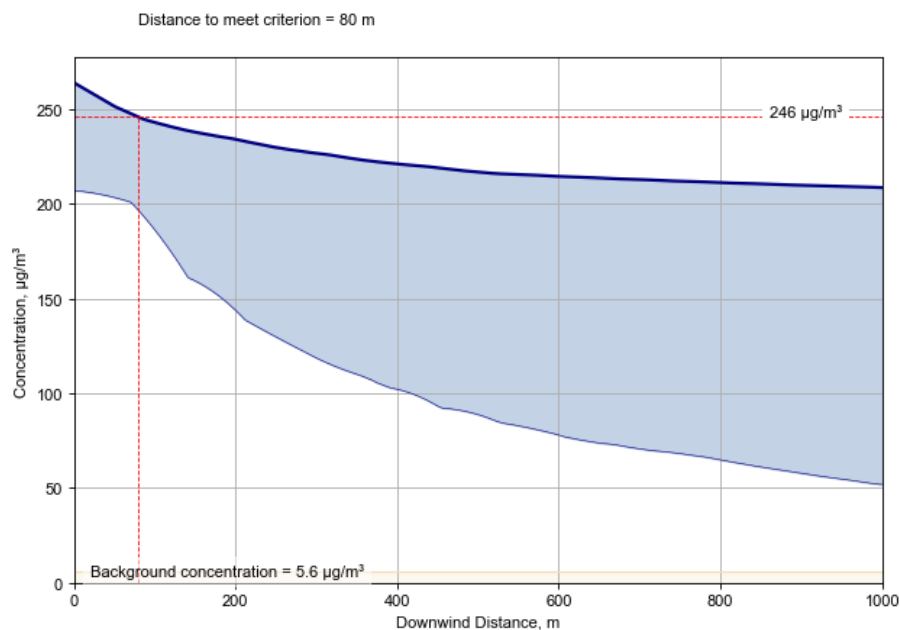


Figure 8-12 Predicted cumulative maximum 1-hour average NO₂ distance decay relationship for roadwork construction activities at the solar array site

Intermodal facility

The incremental and cumulative distance decay curves for 1-hour average NO₂ predictions for construction activities at the Intermodal Logistics Facility site are provided in Figure 8-13 and Figure 8-14 respectively. The 1-hour average NO₂ criterion of 246 µg/m³ is met within the activity area boundary for both incremental and cumulative emission scenarios.

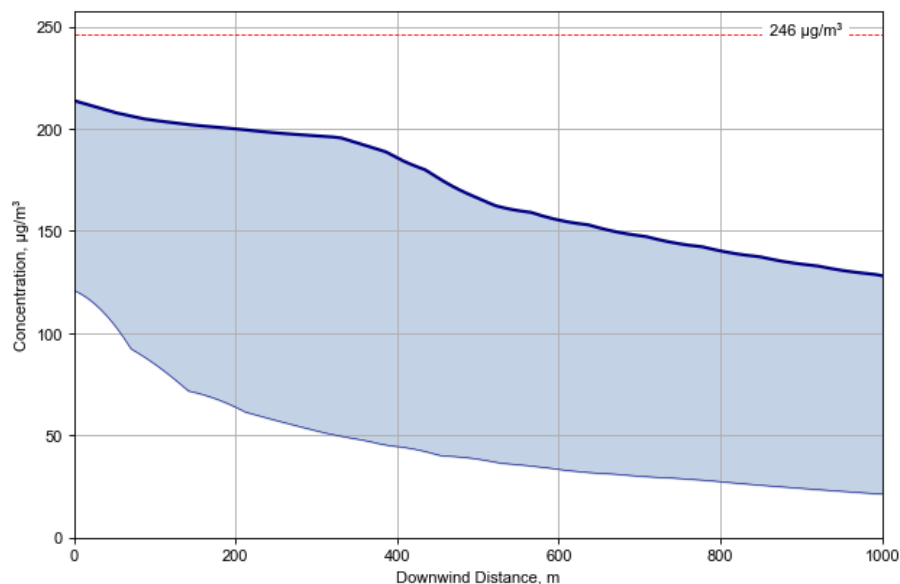


Figure 8-13 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site

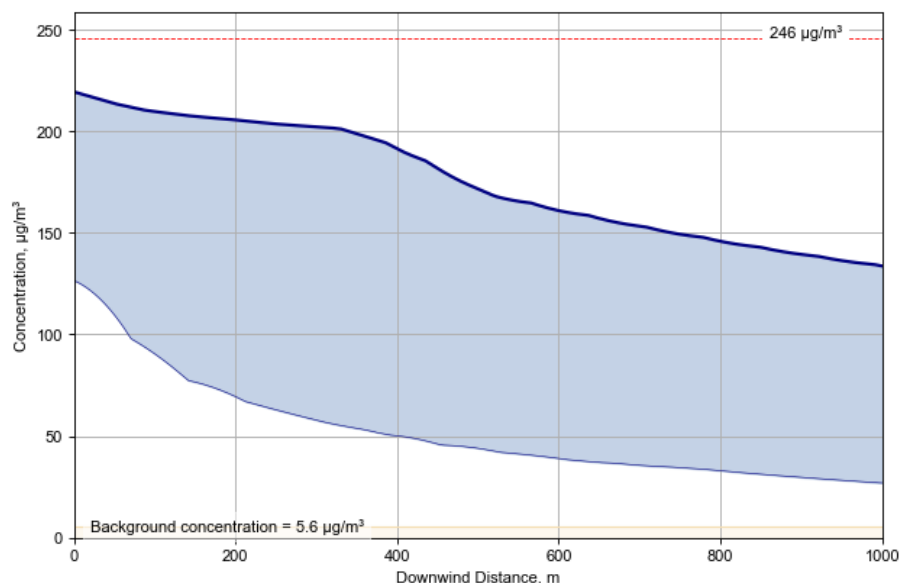


Figure 8-14 Predicted cumulative maximum 1-hour average NO₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site

Rail

The incremental and cumulative distance decay curves for 1-hour average NO₂ predictions for rail construction activities at the solar array construction site are provided in Figure 8-15 and Figure 8-16 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 43 m of the activity area boundary. The minimum separation distance rises to 71 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

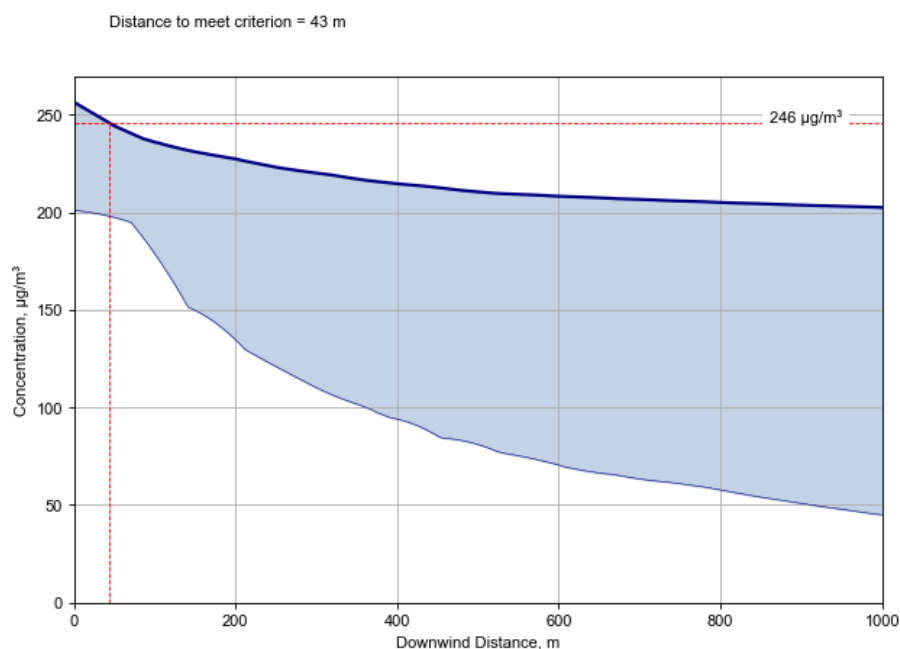


Figure 8-15 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for rail construction activities at the solar array site

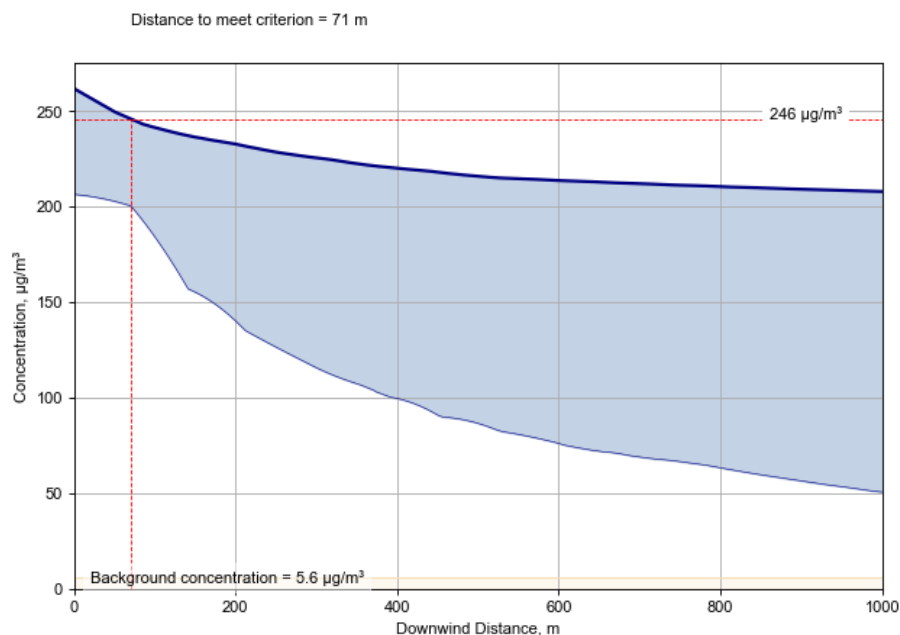


Figure 8-16 Predicted cumulative maximum 1-hour average NO₂ distance decay relationship for rail construction activities at the solar array site

Broadacre solar array

The incremental and cumulative distance decay curves for 1-hour average NO₂ predictions for construction activities at the broadacre solar array site are provided in Figure 8-17 and Figure 8-18 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 68 m of the activity area boundary. The minimum separation distance rises to 103 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

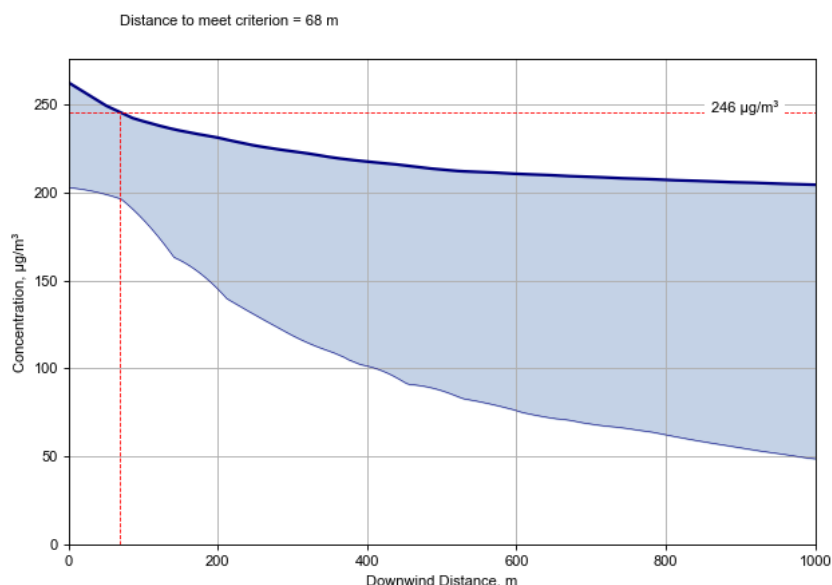


Figure 8-17 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for construction activities at the broadacre solar array site

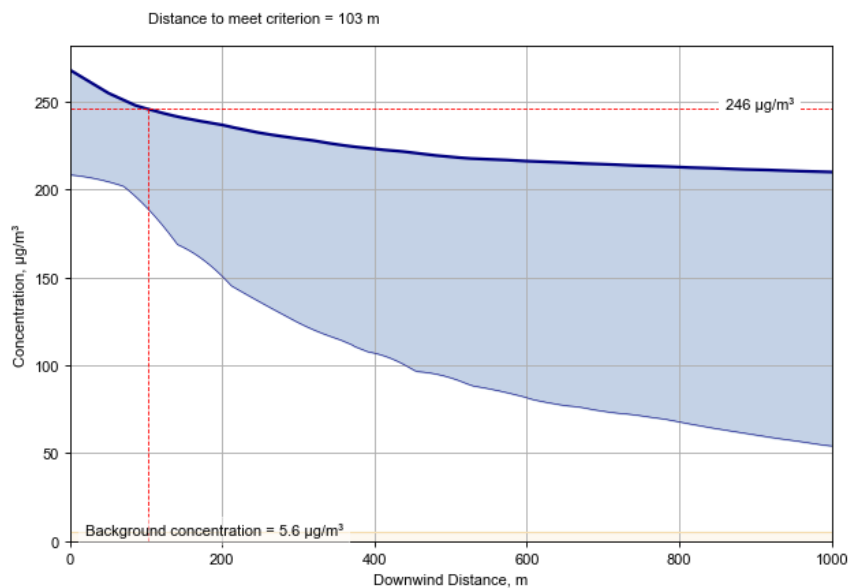


Figure 8-18 Predicted cumulative maximum 1-hour average NO₂ distance decay relationship for construction activities at the broadacre solar array site

8.1.7 Annual-average NO₂

Roadworks

The incremental and cumulative distance decay curves for annual average NO₂ predictions for road construction activities at the solar array construction site are provided in Figure 8-19 and Figure 8-20 respectively. The annual average NO₂ criterion of 62 µg/m³ is met within the activity area boundary for both the incremental and cumulative emission scenarios.

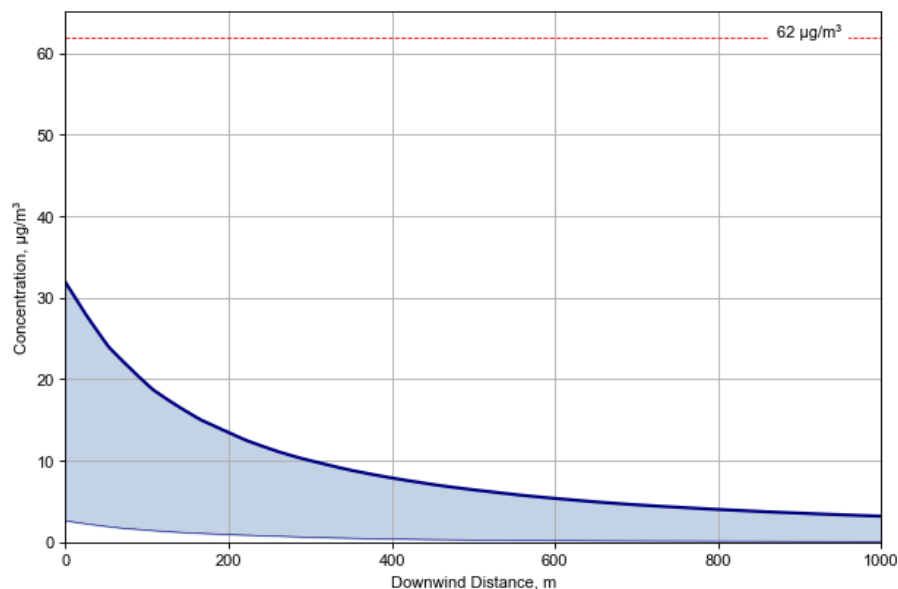


Figure 8-19 Predicted incremental annual average NO₂ distance decay relationship for roadwork construction activities at the solar array site

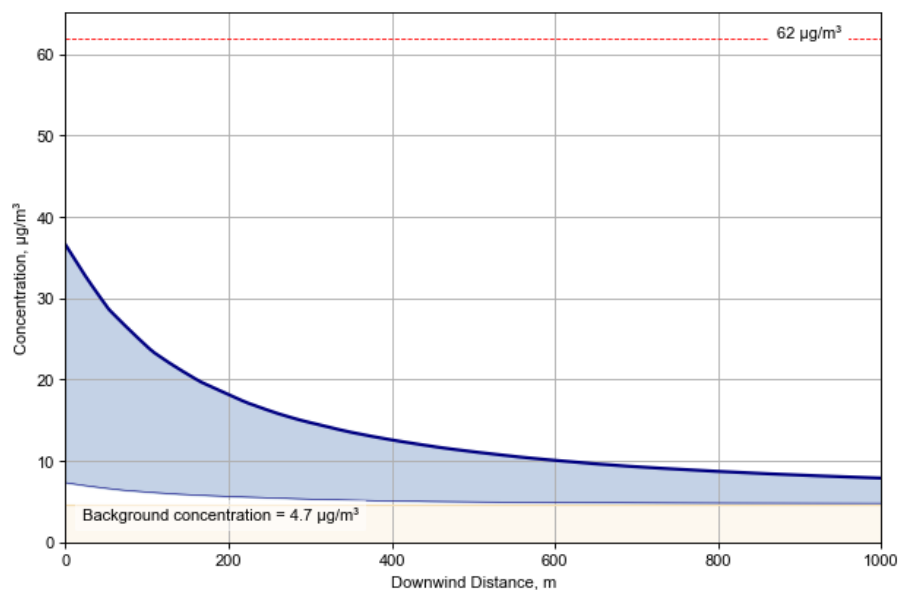


Figure 8-20 Predicted cumulative annual average NO₂ distance decay relationship for roadwork construction activities at the solar array site

Intermodal facility

The incremental and cumulative distance decay curves for annual average NO₂ predictions for construction activities at the Intermodal Logistics Facility site are provided in Figure 8-21 and Figure 8-22 respectively. The annual average NO₂ criterion of 62 µg/m³ is met within the activity area boundary for both the incremental and cumulative emission scenarios.

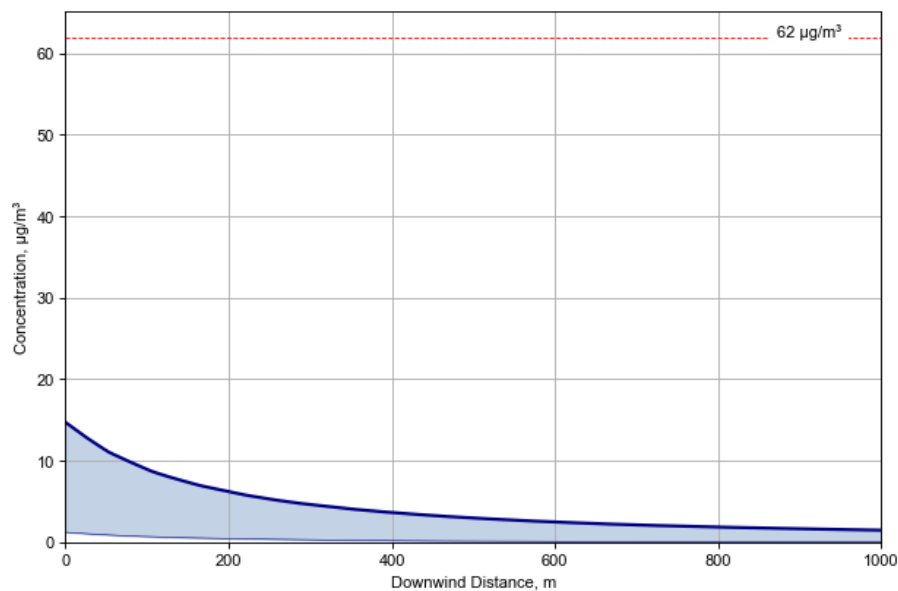


Figure 8-21 Predicted incremental annual average NO₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site

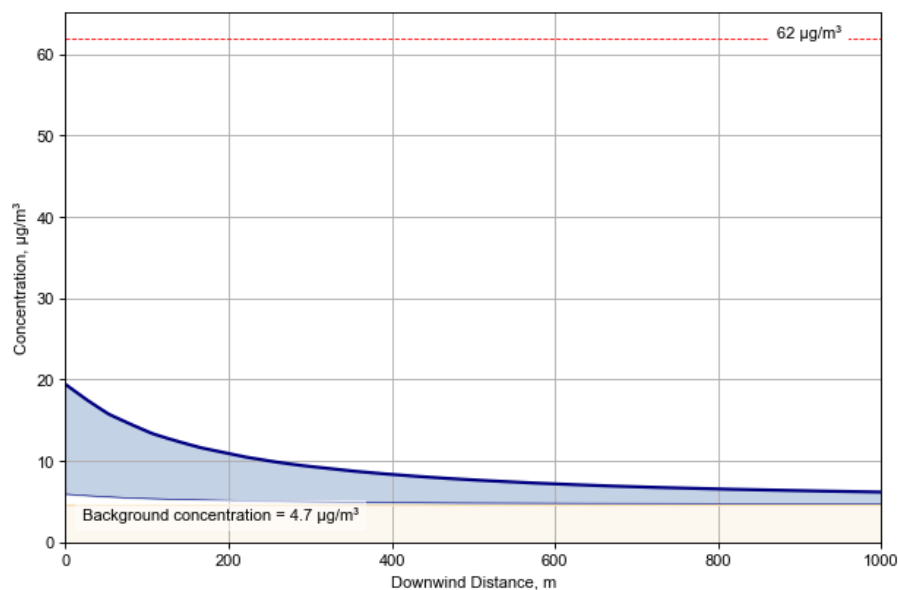


Figure 8-22 Predicted cumulative annual average NO₂ distance decay relationship for construction activities at the Intermodal Logistics Facility site

Rail

The incremental and cumulative distance decay curves for annual average NO₂ predictions for rail construction activities at the solar array construction site are provided in Figure 8-23 and Figure 8-24 respectively. The annual average NO₂ criterion of 62 µg/m³ is met within the activity area boundary for both the incremental and cumulative emission scenarios.

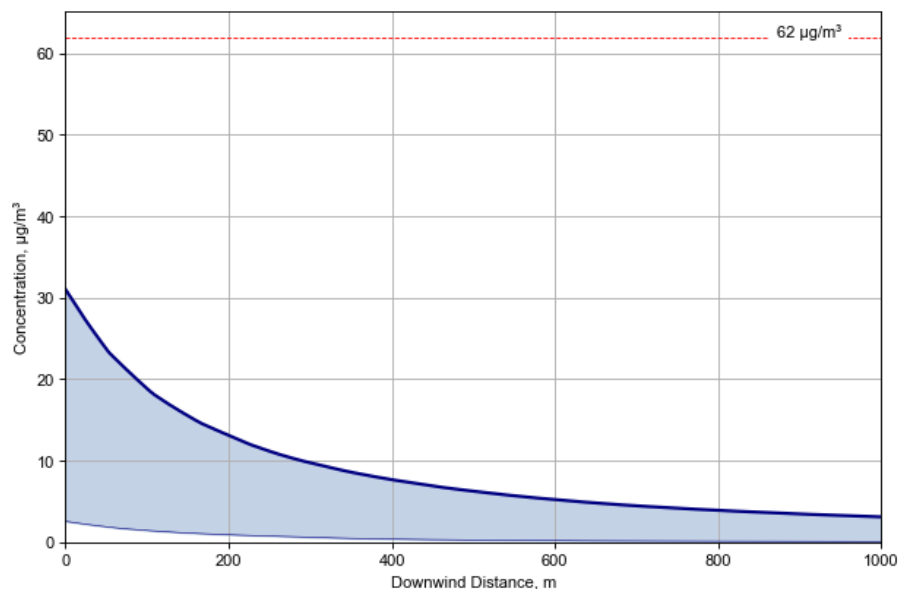


Figure 8-23 Predicted incremental annual average NO₂ distance decay relationship for rail construction activities at the solar array site

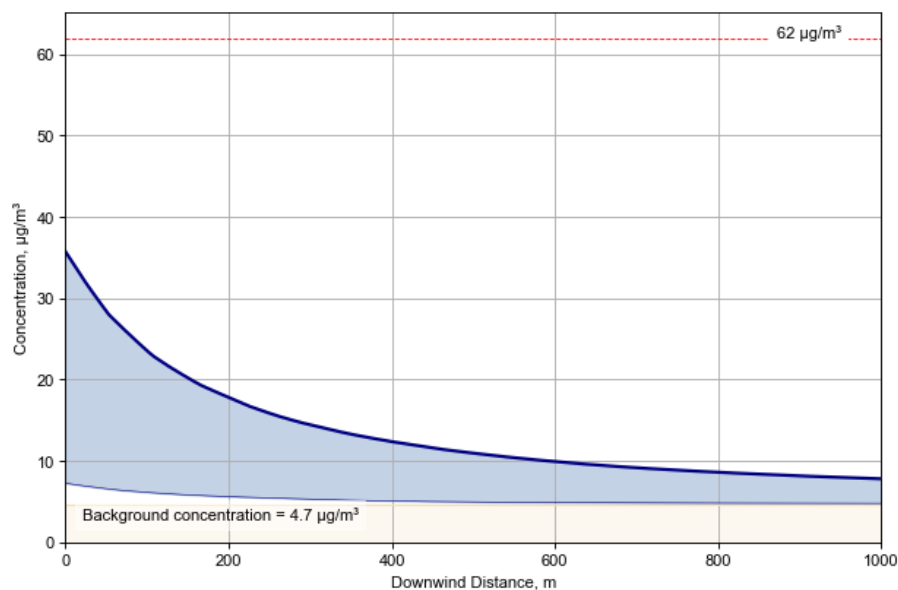


Figure 8-24 Predicted cumulative annual average NO₂ distance decay relationship for rail construction activities at the solar array site

Broadacre solar array

The incremental and cumulative distance decay curves for annual average NO₂ predictions for construction activities at the broadacre solar array site are provided in Figure 8-25 and Figure 8-26 respectively. The annual average NO₂ criterion of 62 µg/m³ is met within the activity area boundary for both the incremental and cumulative emission scenarios.

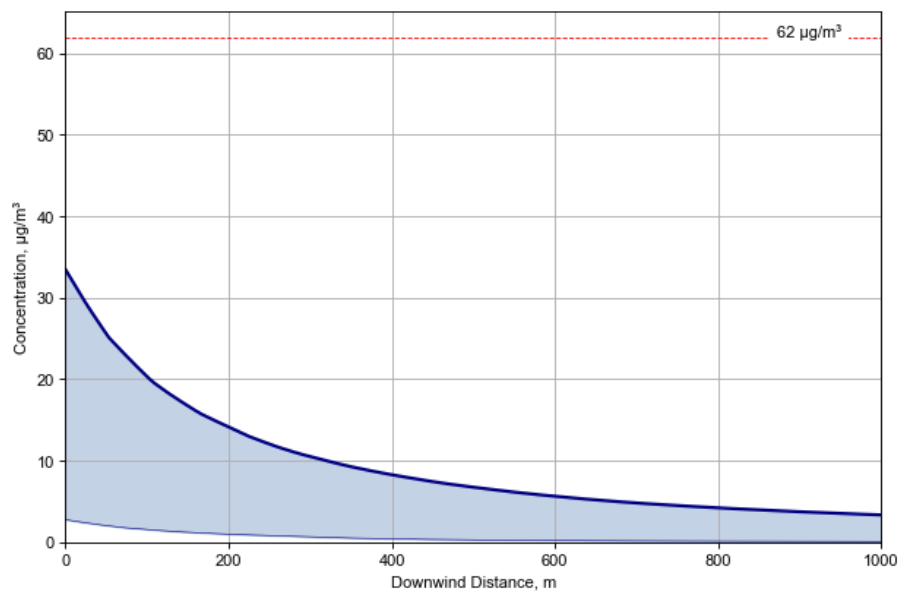


Figure 8-25 Predicted incremental annual average NO₂ distance decay relationship for construction activities at the broadacre solar array site

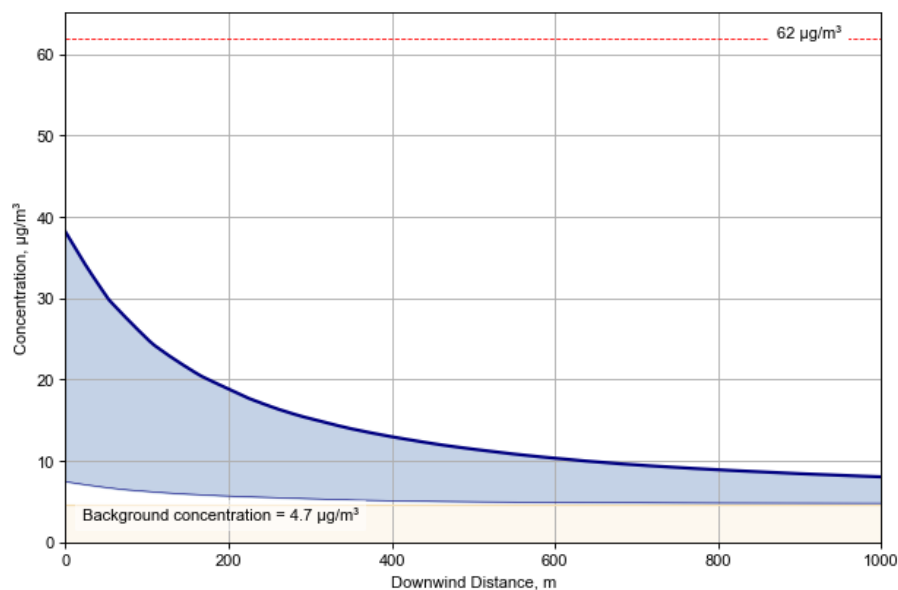


Figure 8-26 Predicted cumulative annual average NO₂ distance decay relationship for construction activities at the broadacre solar array site

8.1.8 Annual-maximum monthly dust deposition rate

The incremental distance decay curve for annual-maximum monthly dust deposition rate predictions for the solar array construction site is provided in Figure 8-27. The 2 mg/m²/month criterion, assessing the maximum allowable increase in deposited dust, is met within 244 m of the activity area boundary.

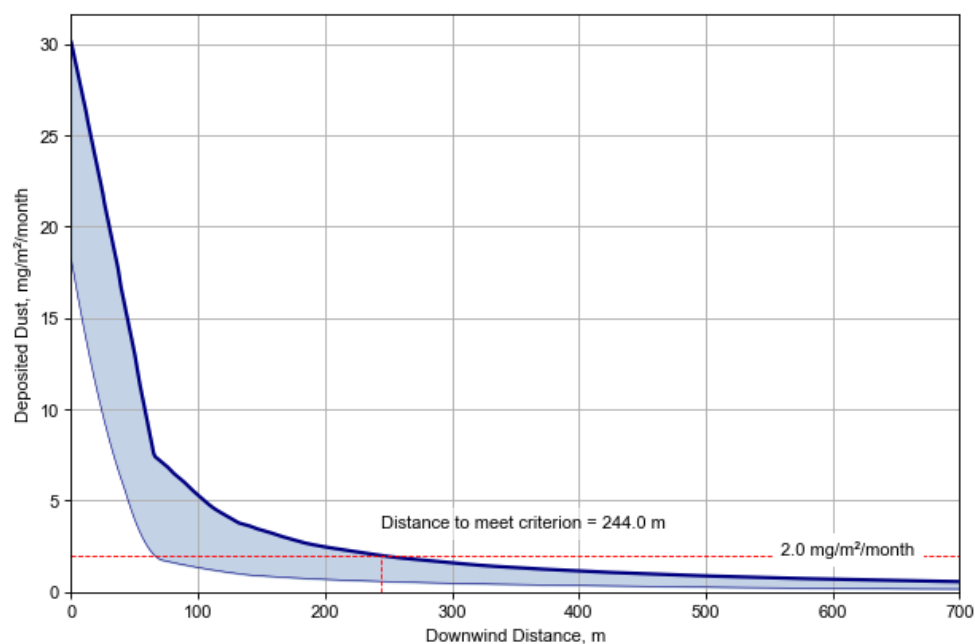


Figure 8-27 Distance decay relationship in incremental annual-maximum monthly dust deposition rate for the solar array site



8.2 Overhead transmission line: Southern sites

8.2.1 24-hour average PM_{2.5}

The incremental and cumulative distance decay curves for 24-hour average PM_{2.5} predictions for southern OHTL construction sites are provided in Figure 8-28 and Figure 8-29 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM_{2.5} criterion of 25 µg/m³ is met within 5 m of the activity area boundary. The minimum separation distance rises to 30 m when the assumed background concentration of 10.4 µg/m³ is accounted for.

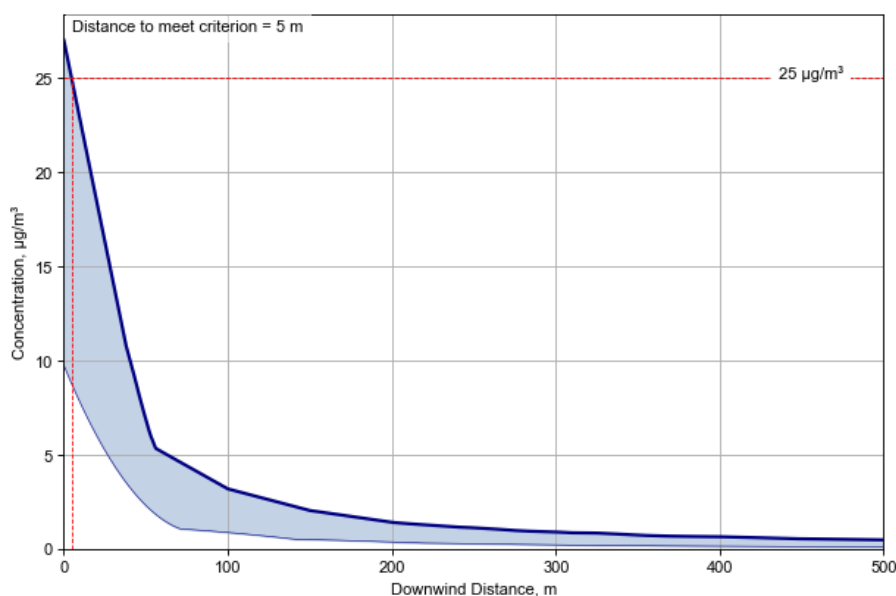


Figure 8-28 Predicted maximum incremental 24-hour average PM_{2.5} distance decay relationship for southern OHTL sites

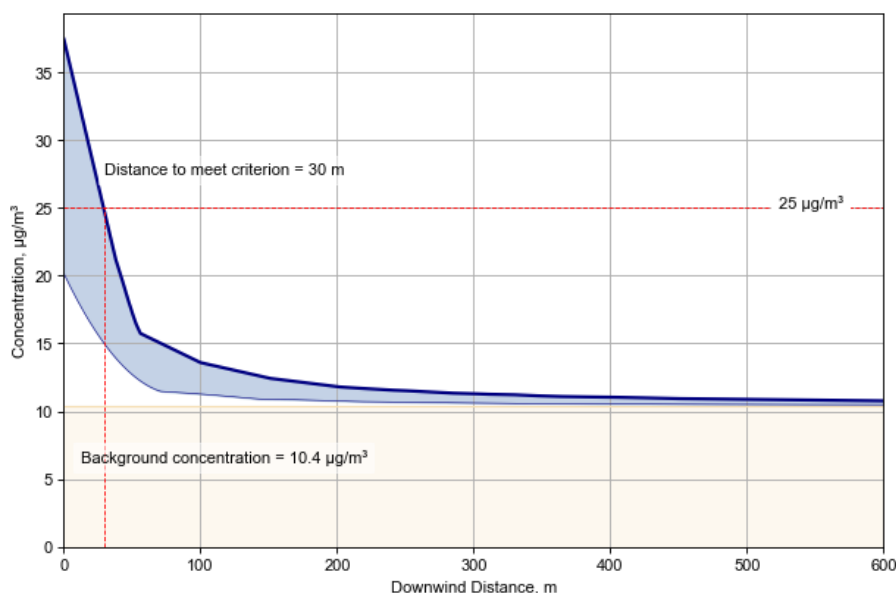


Figure 8-29 Predicted maximum cumulative 24-hour average PM_{2.5} distance decay relationship for southern OHTL sites



8.2.2 24-hour average PM₁₀

The incremental and cumulative distance decay curves for 24-hour average PM₁₀ predictions for southern OHTL construction sites are provided in Figure 8-30 and Figure 8-31 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM₁₀ criterion of 50 µg/m³ is met within 63 m of the activity area boundary. The minimum separation distance rises to 127 m when the assumed background concentration of 24.3 µg/m³ is accounted for.

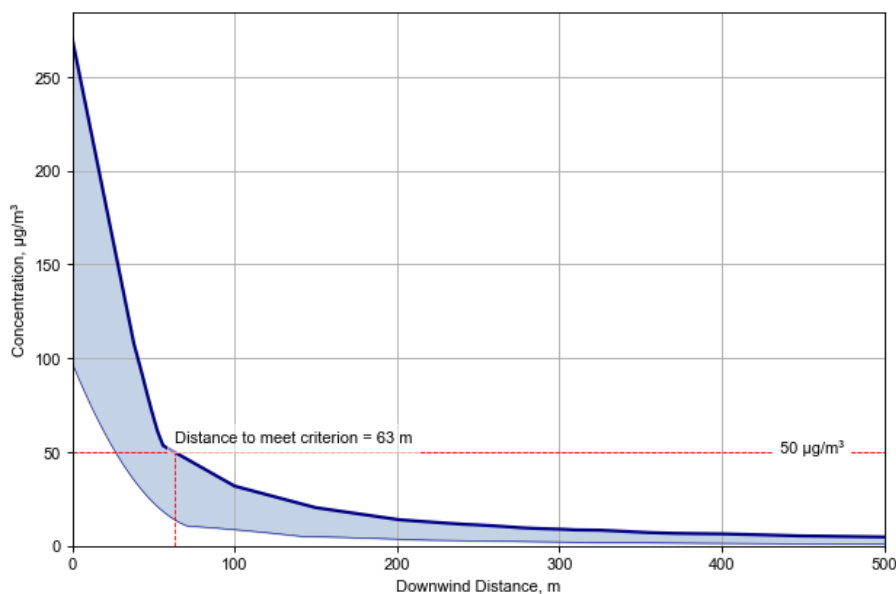


Figure 8-30 Predicted maximum incremental 24-hour average PM₁₀ distance decay relationship for southern OHTL sites

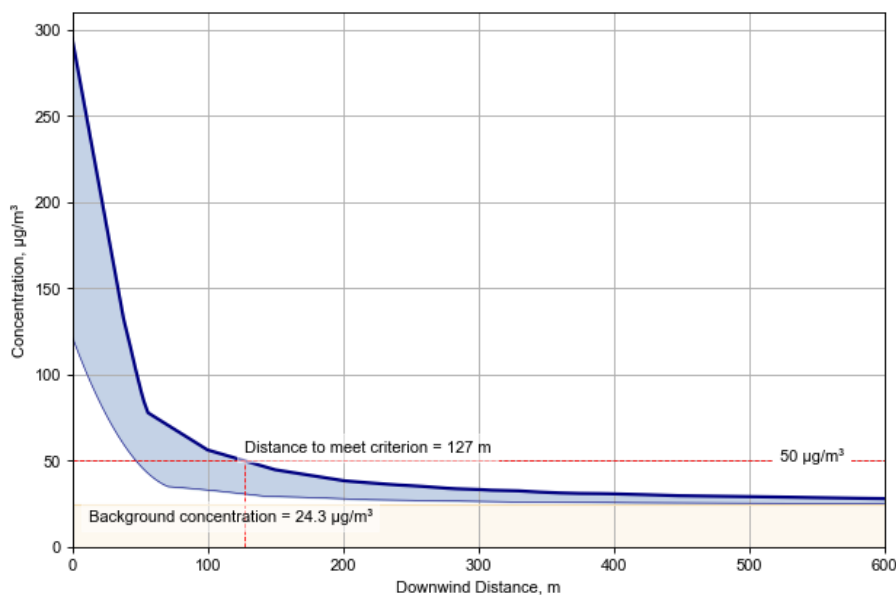


Figure 8-31 Predicted maximum cumulative 24-hour average PM₁₀ distance decay relationship for southern OHTL sites



8.2.3 1-hour average NO₂

The incremental and cumulative distance decay curves for 1-hour average NO₂ predictions for southern OHTL construction sites are provided in Figure 8-32 and Figure 8-33 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 444 m of the activity area boundary. The minimum separation distance rises to 468 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

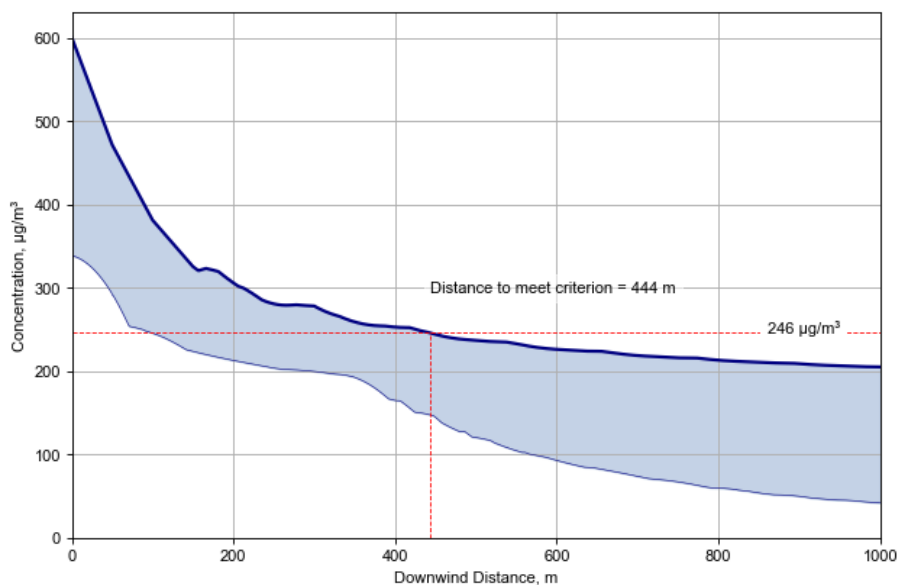


Figure 8-32 Predicted maximum incremental 1-hour average NO₂ distance decay relationship for southern OHTL sites

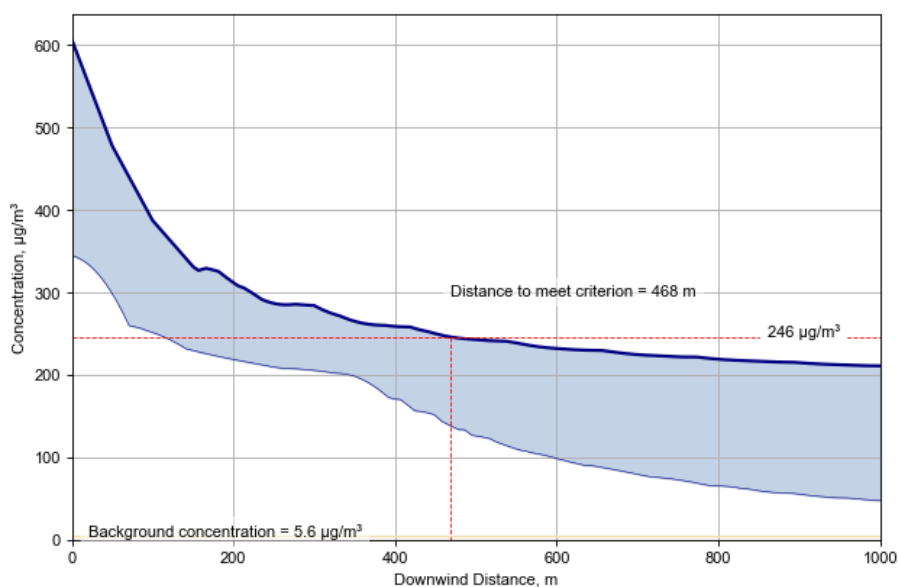


Figure 8-33 Predicted maximum cumulative 1-hour average NO₂ distance decay relationship for southern OHTL sites



8.2.4 Annual-maximum monthly dust deposition rate

The incremental distance decay curve for annual-maximum monthly dust deposition rate predictions for southern OHTL construction sites is provided in Figure 8-34. The 2 mg/m²/month criterion, assessing the maximum allowable increase in deposited dust, is met within 105 m of the activity area boundary.

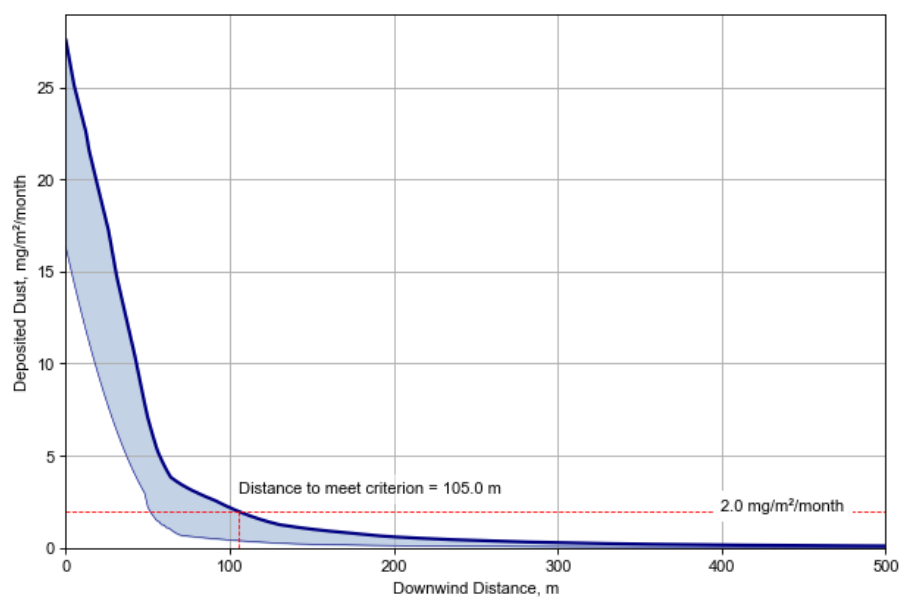


Figure 8-34 Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for southern OHTL sites



8.3 Overhead transmission line: Northern sites

8.3.1 24-hour average PM_{2.5}

The incremental and cumulative distance decay curves for 24-hour average PM_{2.5} predictions for northern OHTL construction sites are provided in Figure 8-35 and Figure 8-36 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM_{2.5} criterion of 25 µg/m³ is met within 48 m of the activity area boundary. The minimum separation distance rises to 69 m when the assumed background concentration of 10.4 µg/m³ is accounted for.

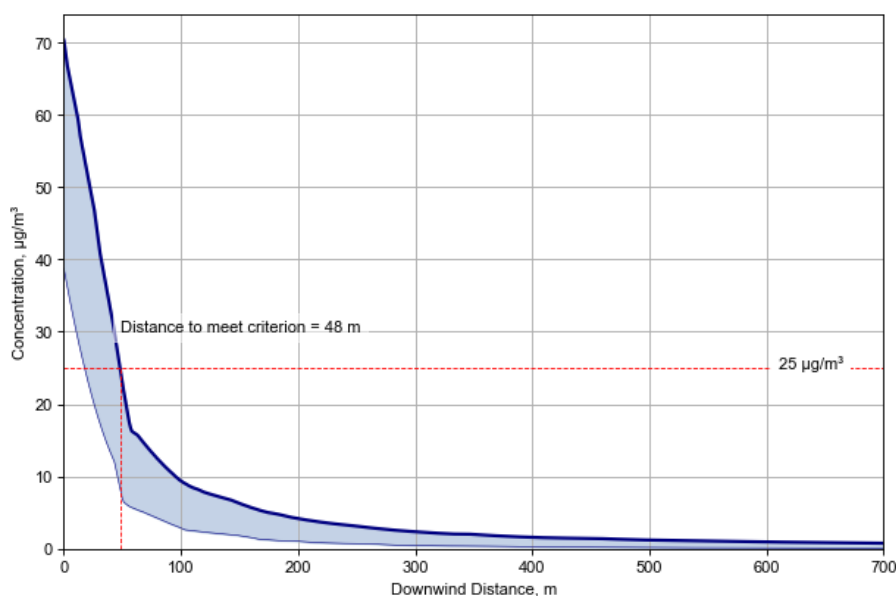


Figure 8-35 Predicted maximum incremental 24-hour average PM_{2.5} distance decay relationship for northern OHTL sites

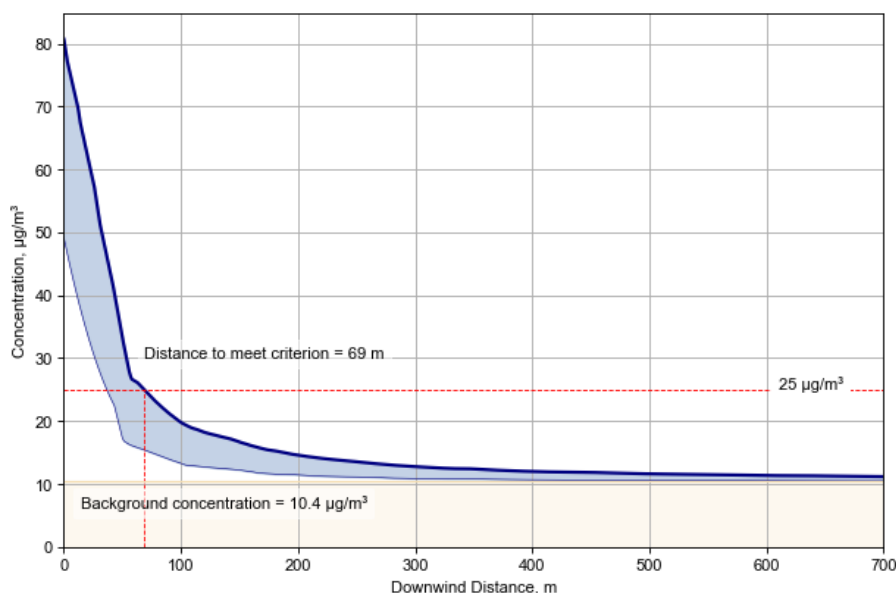


Figure 8-36 Predicted maximum cumulative 24-hour average PM_{2.5} distance decay relationship for northern OHTL sites



8.3.2 24-hour average PM₁₀

The incremental and cumulative distance decay curves for 24-hour average PM₁₀ predictions for northern OHTL construction sites are provided in Figure 8-37 and Figure 8-38 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM₁₀ criterion of 50 µg/m³ is met within 175 m of the activity area boundary. The minimum separation distance rises to 283 m when the assumed background concentration of 24.3 µg/m³ is accounted for.

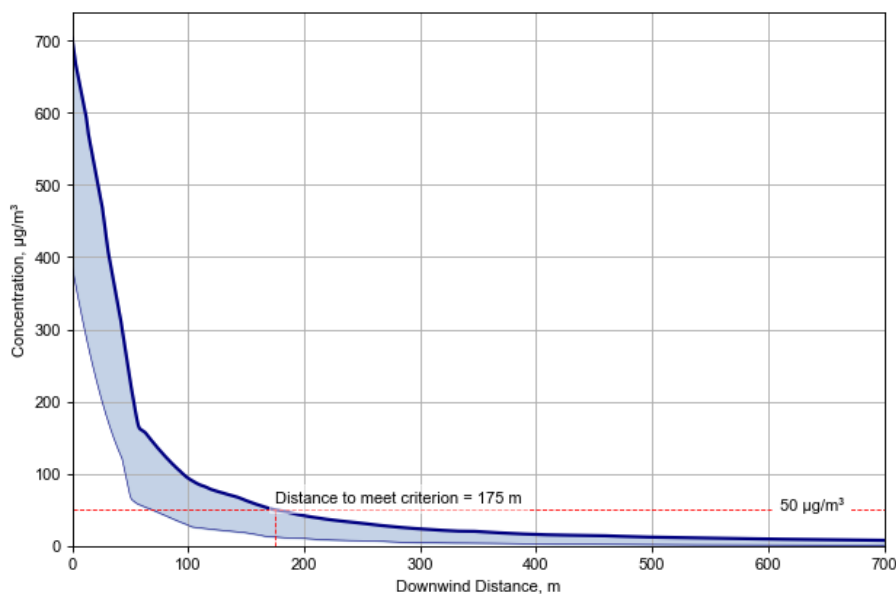


Figure 8-37 Predicted maximum incremental 24-hour average PM₁₀ distance decay relationship for northern OHTL sites

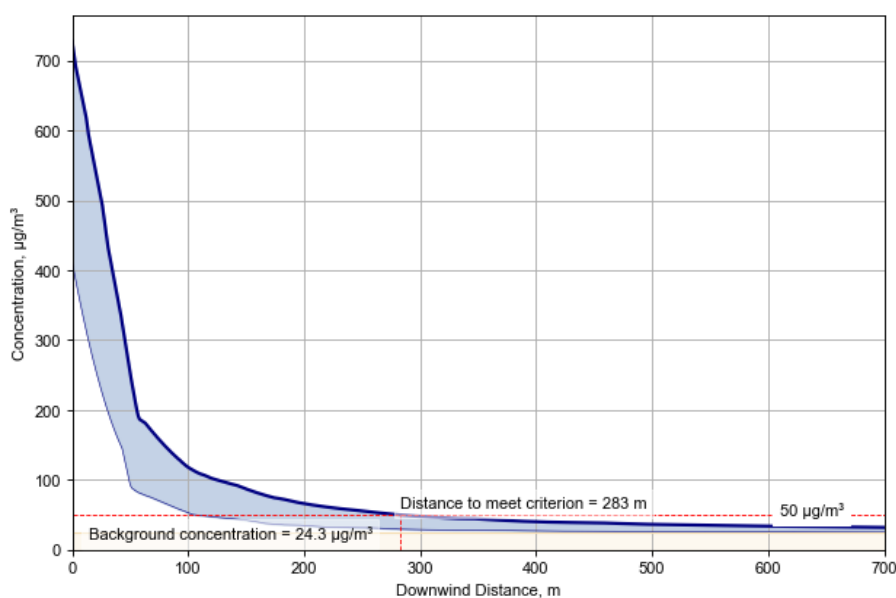


Figure 8-38 Predicted maximum cumulative 24-hour average PM₁₀ distance decay relationship for northern OHTL sites



8.3.3 1-hour average NO₂

The incremental and cumulative distance decay curves for maximum 1-hour average NO₂ predictions for northern OHTL construction sites are provided in Figure 8-39 and Figure 8-40 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 307 m of the activity area boundary. The minimum separation distance rises to 327 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

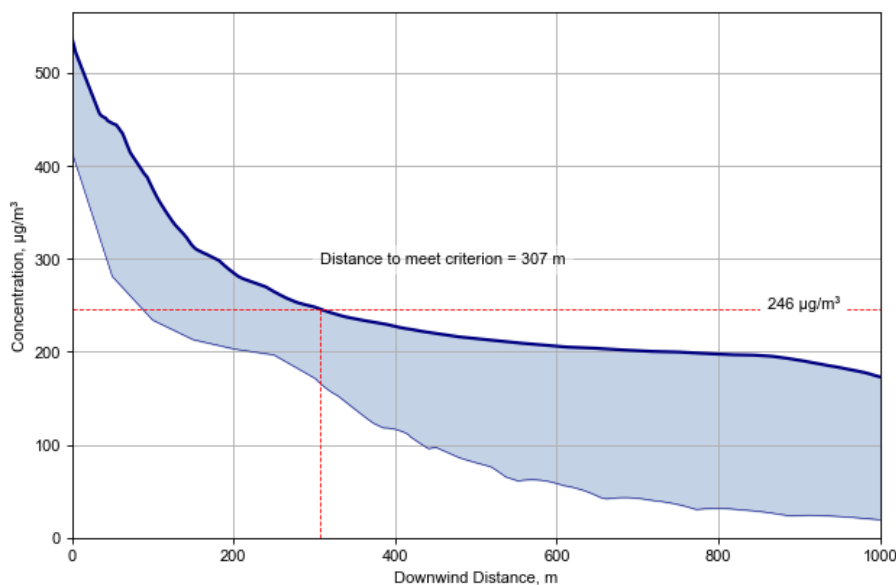


Figure 8-39 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for northern OHTL sites

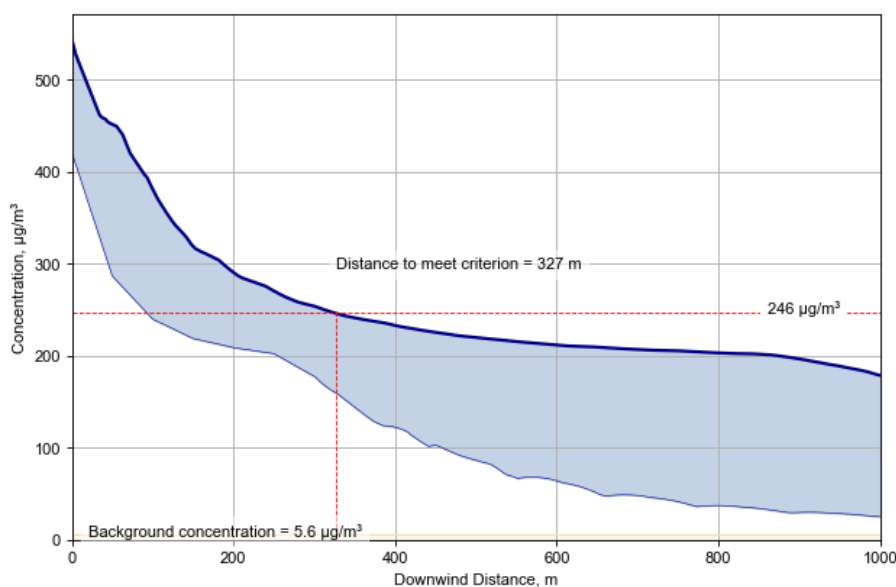


Figure 8-40 Predicted maximum cumulative 1-hour average NO₂ distance decay relationship for northern OHTL sites



8.3.4 Annual-maximum monthly dust deposition rate

The incremental distance decay curve for annual-maximum monthly dust deposition rate predictions for northern OHTL construction sites is provided in Figure 8-41. The 2 mg/m²/month criterion, assessing the maximum allowable increase in deposited dust, is met within 123 m of the activity area boundary.

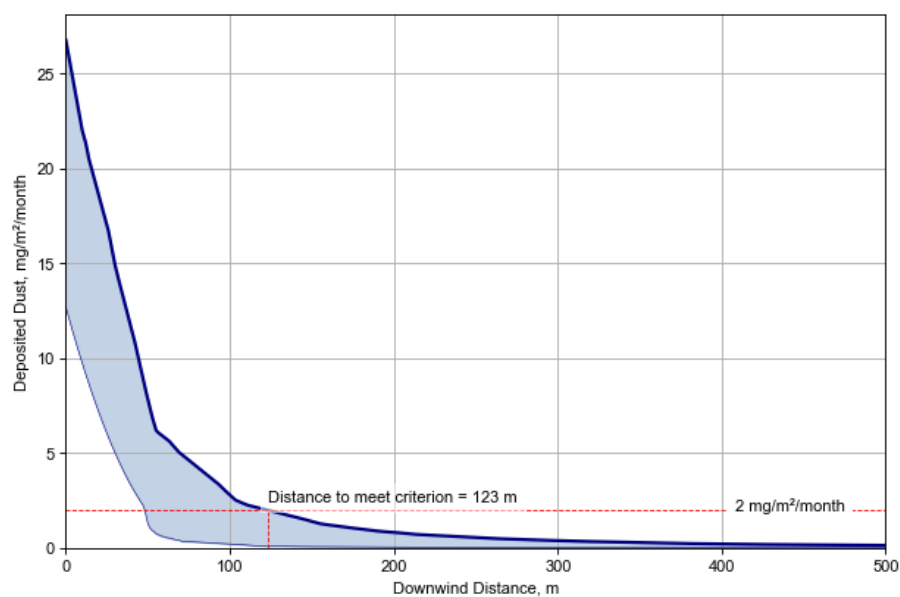


Figure 8-41 Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for northern OHTL sites



8.4 Darwin Converter Site

8.4.1 24-hour average PM_{2.5}

The incremental and cumulative 24-hour average PM_{2.5} predictions for the Darwin Converter Site are provided in Figure 8-42 and Figure 8-43 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM_{2.5} criterion of 25 µg/m³ is largely met within the site boundary, with a maximum offsite prediction of 36 µg/m³. The highest offsite concentration rises to 46 µg/m³ when the assumed background concentration of 10.4 µg/m³ is accounted for.

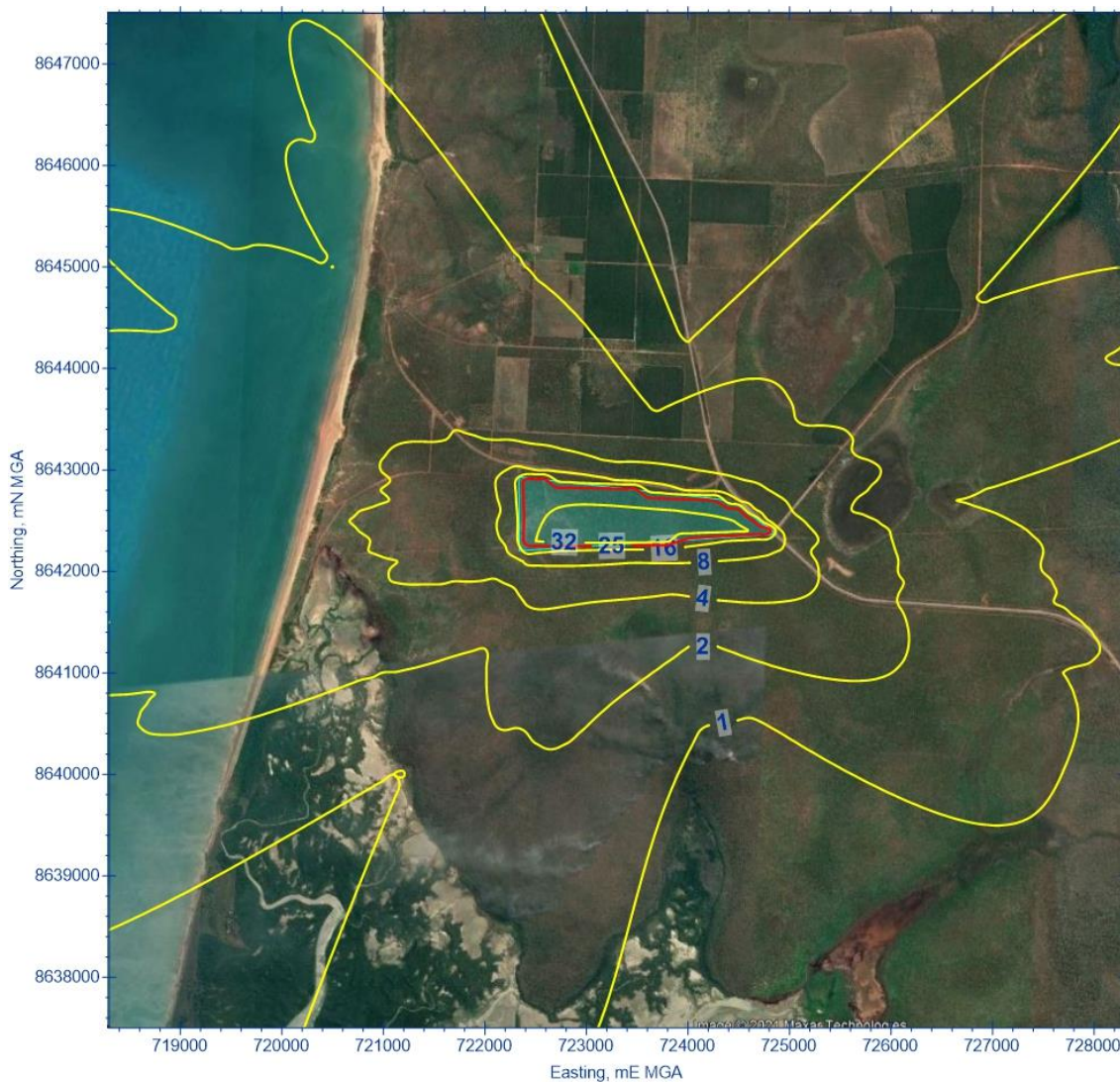


Figure 8-42 Predicted maximum incremental 24-hour average PM_{2.5} concentration for the Darwin Converter Site

Assessment scenario: Maximum incremental 24-hour average PM _{2.5} concentration	Units: µg/m ³
Contours: 1, 2, 4, 8, 16, 25, 32 µg/m ³	Assessment criterion: 25 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



Figure 8-43 Predicted maximum cumulative 24-hour average $PM_{2.5}$ concentration for the Darwin Converter Site

Assessment scenario: Maximum cumulative 24-hour average $PM_{2.5}$ concentration (background = $10.4 \mu\text{g}/\text{m}^3$)	Units: $\mu\text{g}/\text{m}^3$
Contours: 16, 25, $32 \mu\text{g}/\text{m}^3$	Assessment criterion: $25 \mu\text{g}/\text{m}^3$ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.4.2 Annual-average PM_{2.5}

The incremental and cumulative annual average PM_{2.5} predictions for the Darwin Converter Site are provided in Figure 8-44 and Figure 8-45 respectively. The assumed background concentration of 8.3 µg/m³ is greater than the 8 µg/m³ criterion, meaning that the criterion cannot be met at any point in the modelling domain and the assessment should focus on the incremental effect. The maximum offsite incremental annual average PM_{2.5} concentration of 14.6 µg/m³ occurs at the site boundary, with concentrations falling rapidly with distance from the boundary.



Figure 8-44 Predicted maximum incremental annual-average PM_{2.5} concentration for the Darwin Converter Site

Assessment scenario: Maximum incremental annual average PM _{2.5} concentration	Units: µg/m ³
Contours: 1, 2, 4, 8 µg/m ³	Assessment criterion: 8 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021

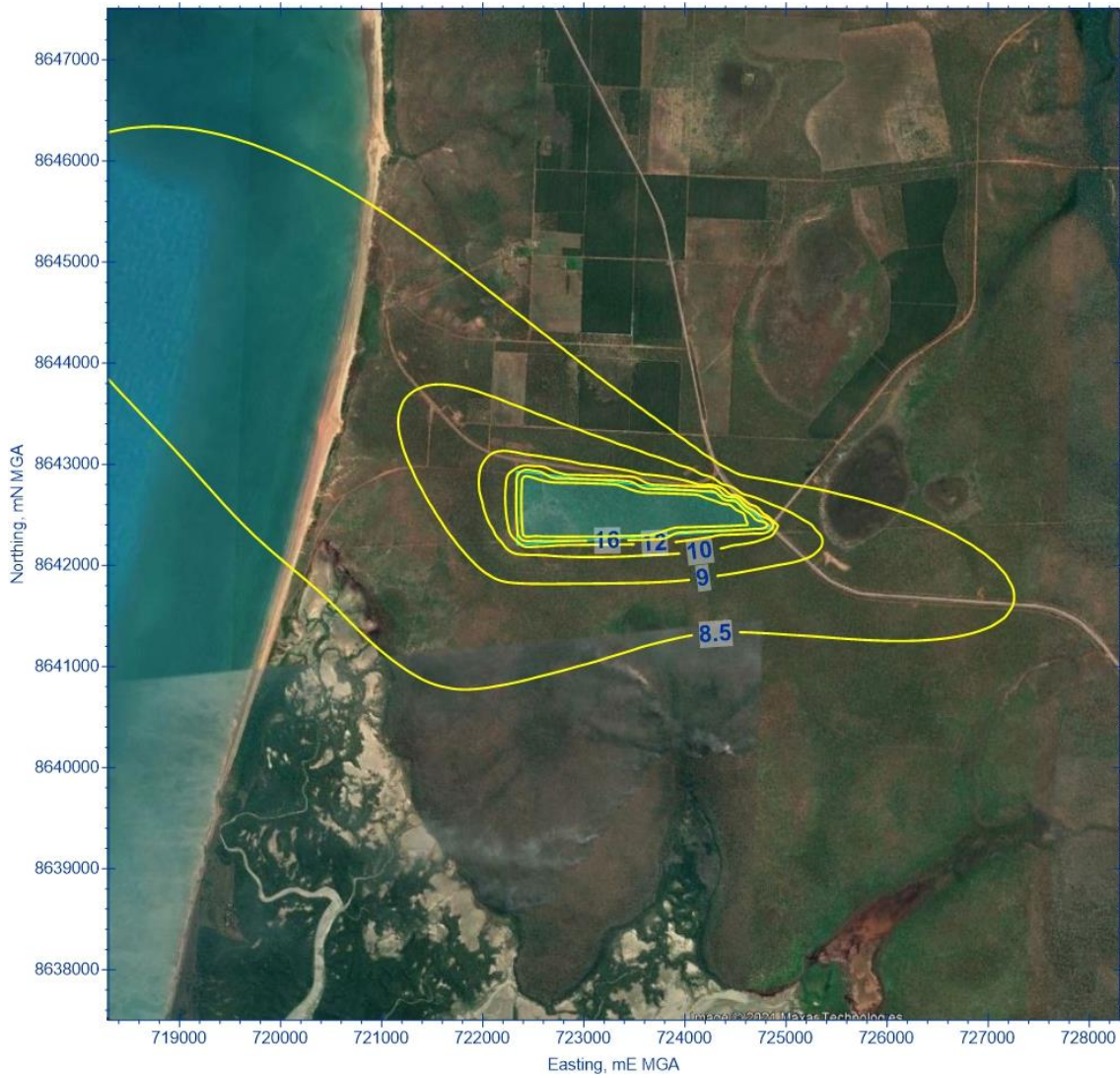


Figure 8-45 Predicted maximum cumulative annual-average PM_{2.5} concentration for the Darwin Converter Site

Assessment scenario: Maximum cumulative annual average PM _{2.5} concentration (background = 8.3 µg/m ³)	Units: µg/m ³
Contours: 8.5, 9, 10, 12, 16 µg/m ³	Assessment criterion: 8 µg/m ³
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.4.3 24-hour average PM₁₀

The incremental and cumulative 24-hour average PM₁₀ predictions for construction activities at the Darwin Converter Site are provided in Figure 8-46 and Figure 8-47 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM₁₀ criterion of 50 µg/m³ is exceeded within a region extending between approximately 170 and 950 m from the site boundary. The criterion isopleth extends approximately 3.6 km to the west of the site boundary when the assumed background concentration of 24.3 µg/m³ is accounted for, however it does not impact any sensitive receptor locations.

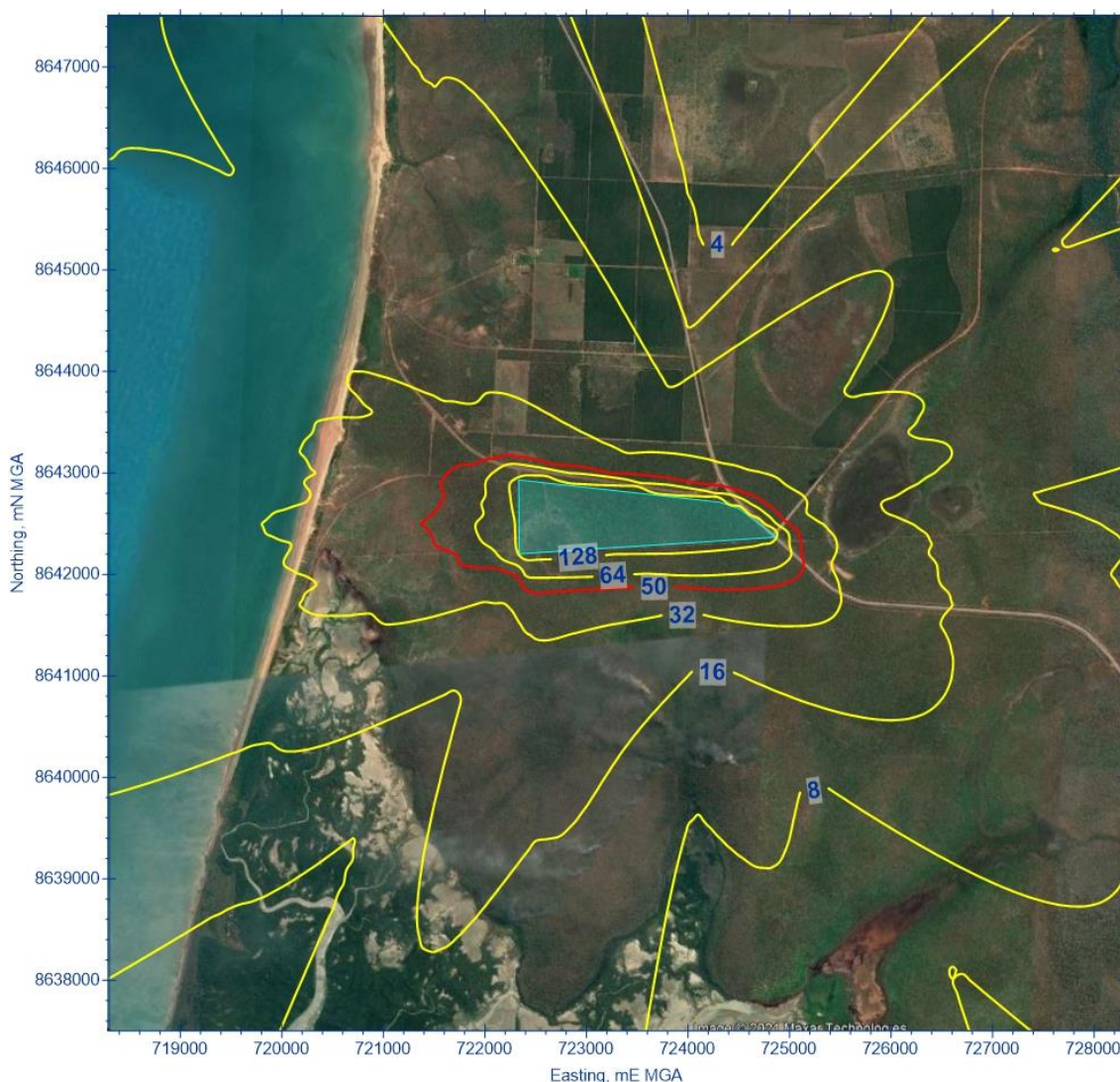


Figure 8-46 Predicted maximum incremental 24-hour average PM₁₀ concentration for the Darwin Converter Site

Assessment scenario: Maximum incremental 24-hour average PM ₁₀ concentration	Units: µg/m ³
Contours: 4, 8, 16, 32, 50, 64, 128 µg/m ³	Assessment criterion: 50 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



Figure 8-47 Predicted maximum cumulative 24-hour average PM_{10} concentration for the Darwin Converter Site

Assessment scenario: Maximum cumulative 24-hour average PM_{10} concentration (background = $24.3 \mu\text{g}/\text{m}^3$)	Units: $\mu\text{g}/\text{m}^3$
Contours: 32, 50, 64, 128 $\mu\text{g}/\text{m}^3$	Assessment criterion: 50 $\mu\text{g}/\text{m}^3$ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Costello
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.4.4 Annual-average PM₁₀

The incremental and cumulative annual average PM₁₀ predictions for the Darwin Converter Site are provided in Figure 8-48 and Figure 8-49 respectively. When the incremental effect of construction emissions is considered on its own then the annual average PM₁₀ criterion of 25 µg/m³ is exceeded in a region extending up to 216 m from the site boundary. This exceedance region extends approximately 1950 m to the coast when the assumed background concentration of 19.9 µg/m³ is accounted for.

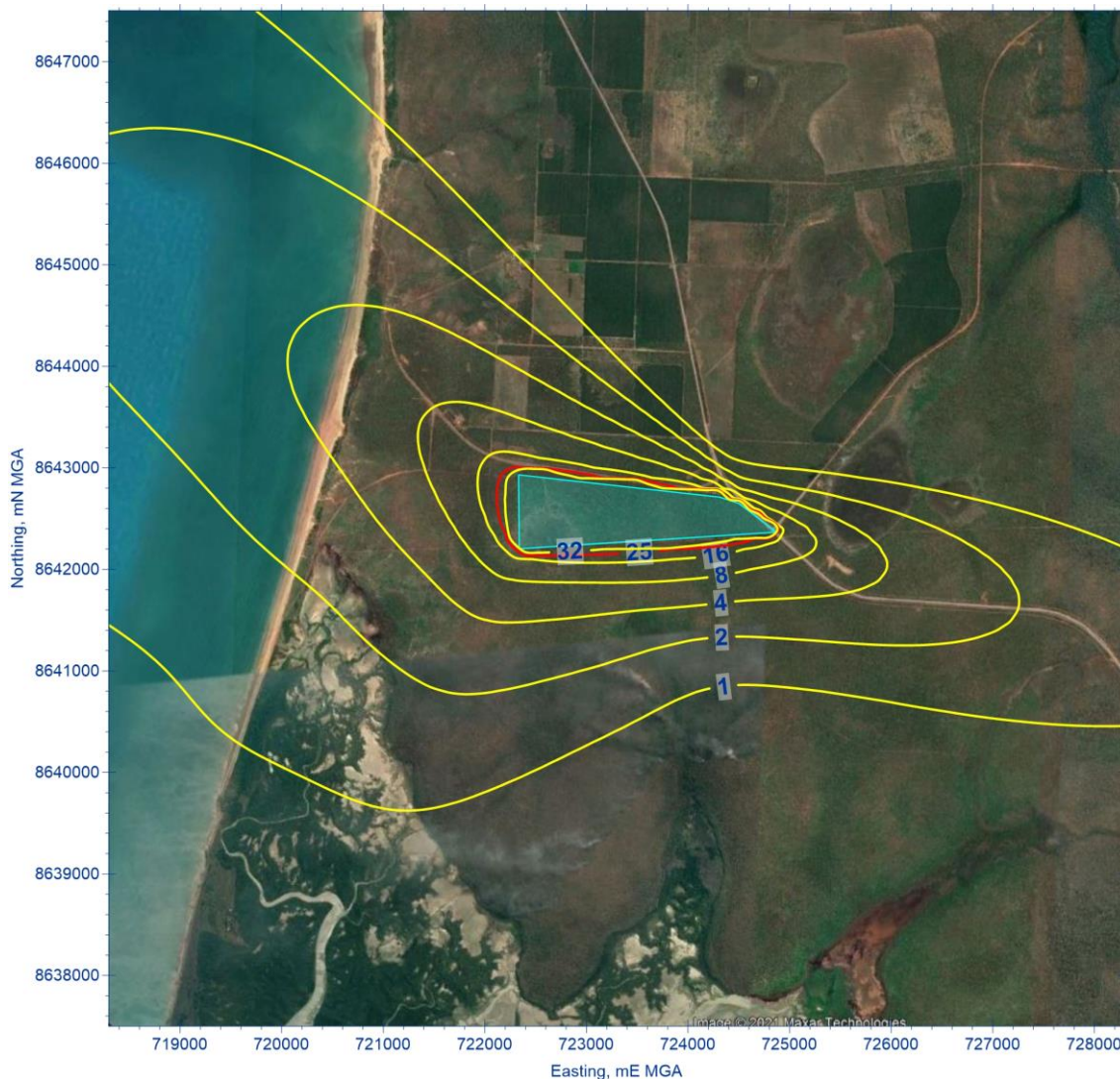


Figure 8-48 Predicted incremental annual-average PM₁₀ concentration for the Darwin Converter Site

Assessment scenario: Incremental annual average PM ₁₀ concentration	Units: µg/m ³
Contours: 1, 2, 4, 8, 16, 25, 32 µg/m ³	Assessment criterion: 25 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021

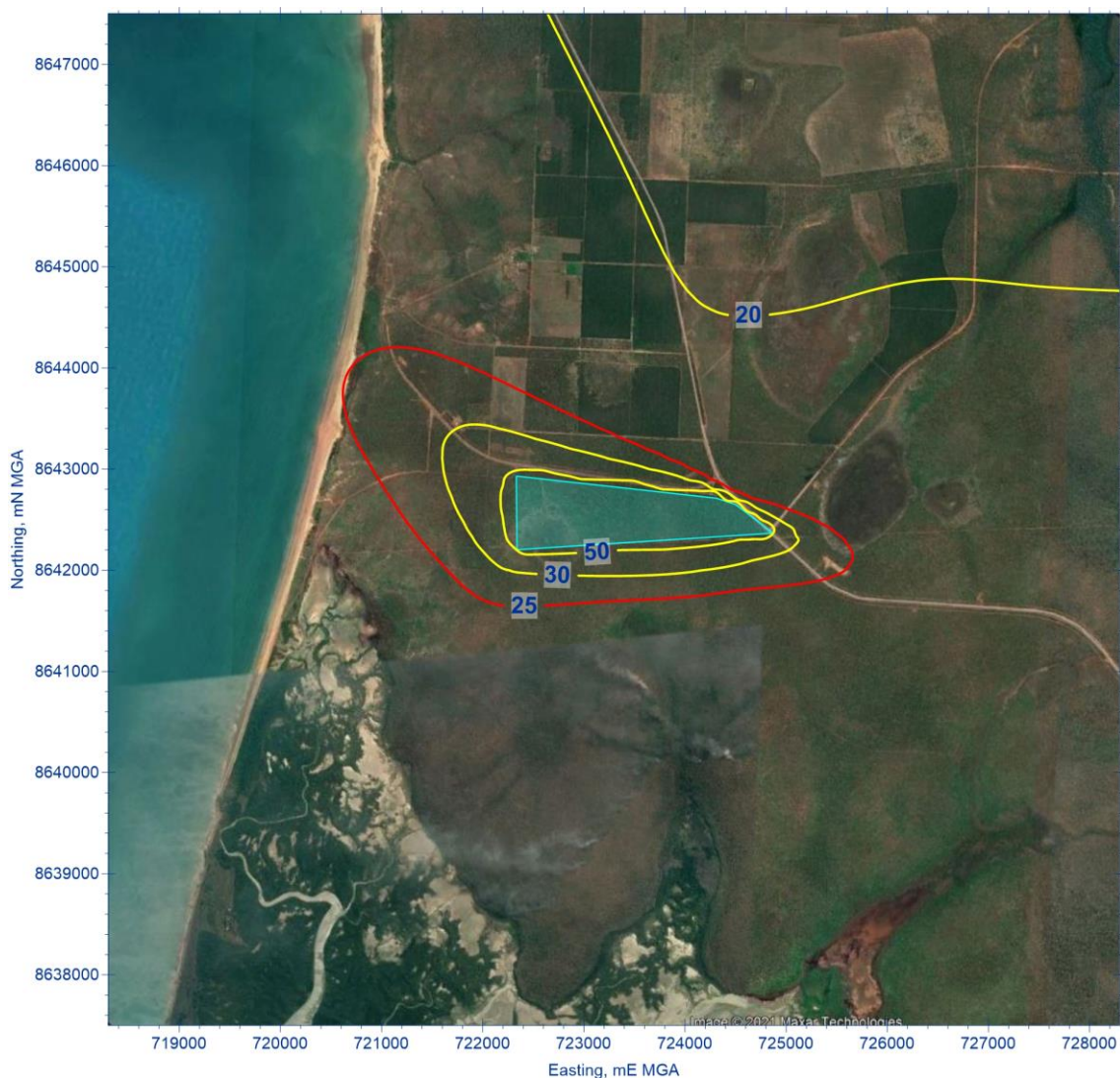


Figure 8-49 Predicted cumulative annual-average PM₁₀ concentration for the Darwin Converter Site

Assessment scenario: Cumulative annual average PM ₁₀ concentration (background = 19.9 µg/m ³)	Units: µg/m ³
Contours: 20, 25, 30, 50 µg/m ³	Assessment criterion: 25 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.4.5 Annual-average TSP

The incremental and cumulative annual average TSP predictions for the Darwin Converter Site are provided in Figure 8-50 and Figure 8-51 respectively. When the incremental effect of construction emissions is considered on its own then the annual average TSP criterion of $90 \mu\text{g}/\text{m}^3$ is met within 80 m of the site boundary. The minimum separation distance rises to 222 m when the assumed background concentration of $39.8 \mu\text{g}/\text{m}^3$ is accounted for.

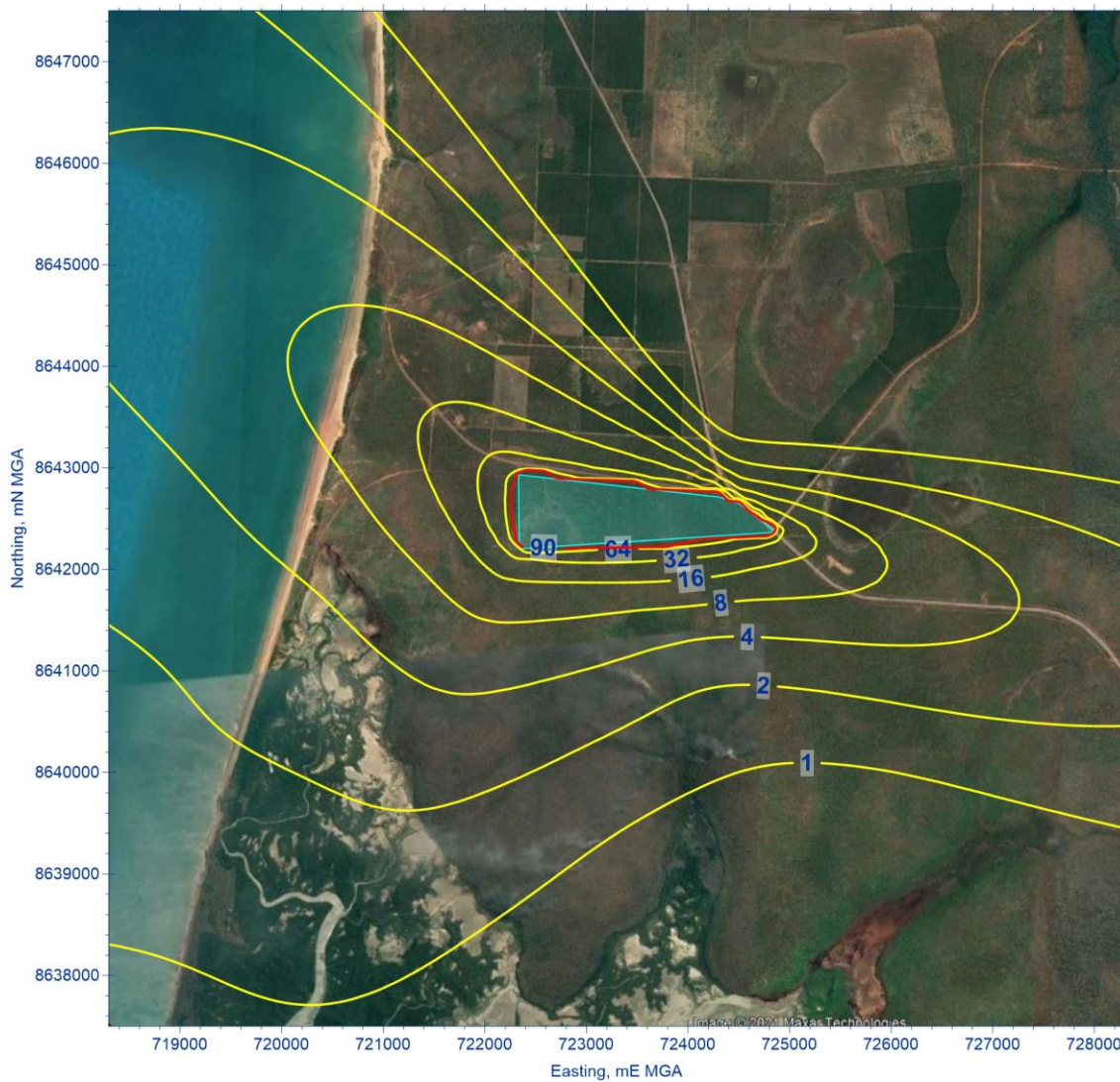


Figure 8-50 Predicted incremental annual-average TSP concentration for the Darwin Converter Site

Assessment scenario: Incremental annual average TSP concentration	Units: $\mu\text{g}/\text{m}^3$
Contours: 1, 2, 4, 8, 16, 32, 64, $90 \mu\text{g}/\text{m}^3$	Assessment criterion: $90 \mu\text{g}/\text{m}^3$ (shown in red)
Data source: AUSPLUME	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021

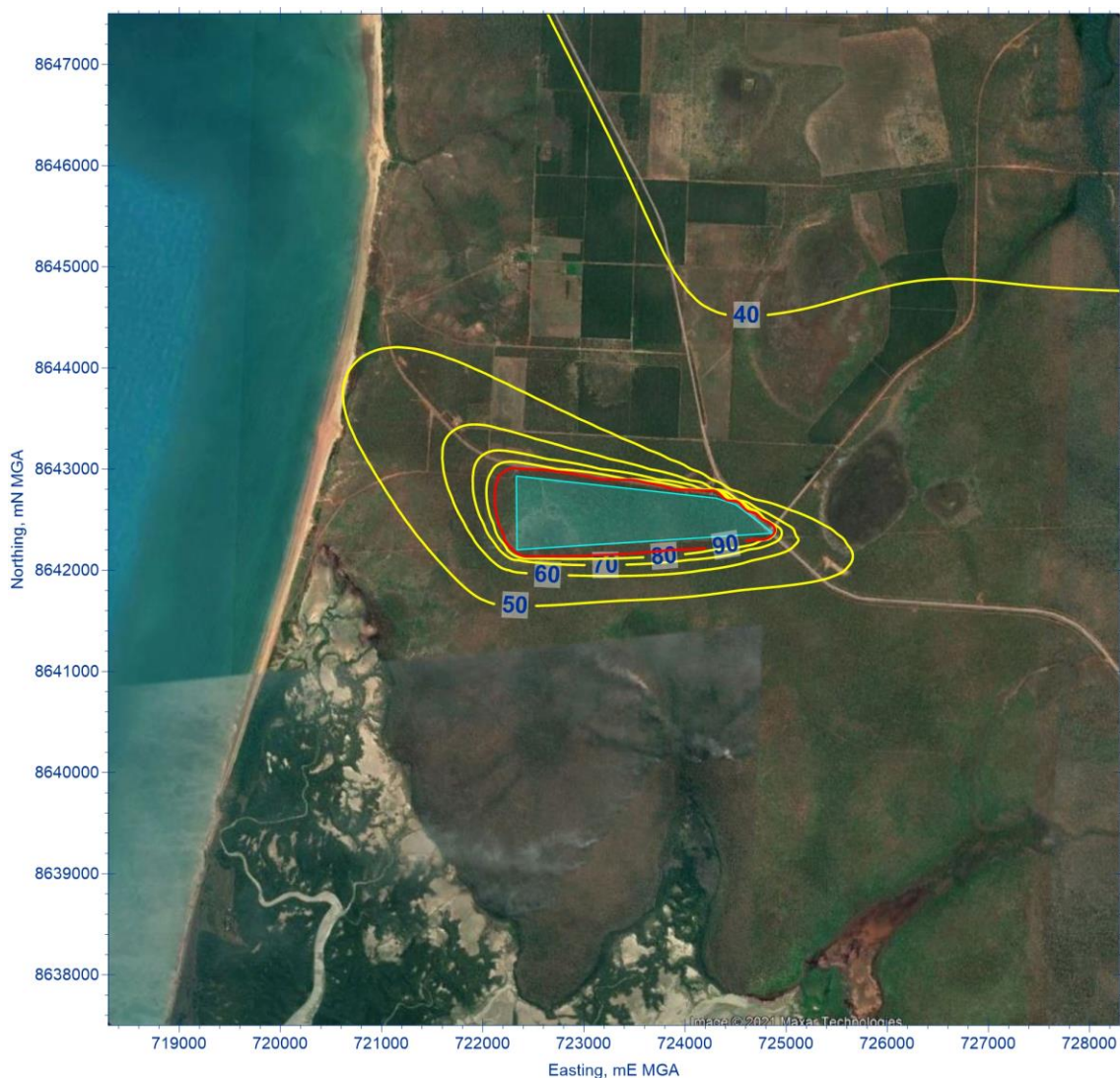


Figure 8-51 Predicted cumulative annual-average TSP concentration for the Darwin Converter Site

Assessment scenario: Cumulative annual average TSP concentration (background = 39.8 $\mu\text{g}/\text{m}^3$)	Units: $\mu\text{g}/\text{m}^3$
Contours: 40, 50, 60, 70, 80, 90 $\mu\text{g}/\text{m}^3$	Assessment criterion: 90 $\mu\text{g}/\text{m}^3$ (shown in red)
Data source: AUSPLUME	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.4.6 1-hour average NO₂

The incremental and cumulative 1-hour average NO₂ predictions for the Darwin Converter Site are provided in Figure 8-52 and Figure 8-53 respectively. The 1-hour average NO₂ criterion of 246 µg/m³ is contained within the site boundary for both the incremental and cumulative emissions scenarios.

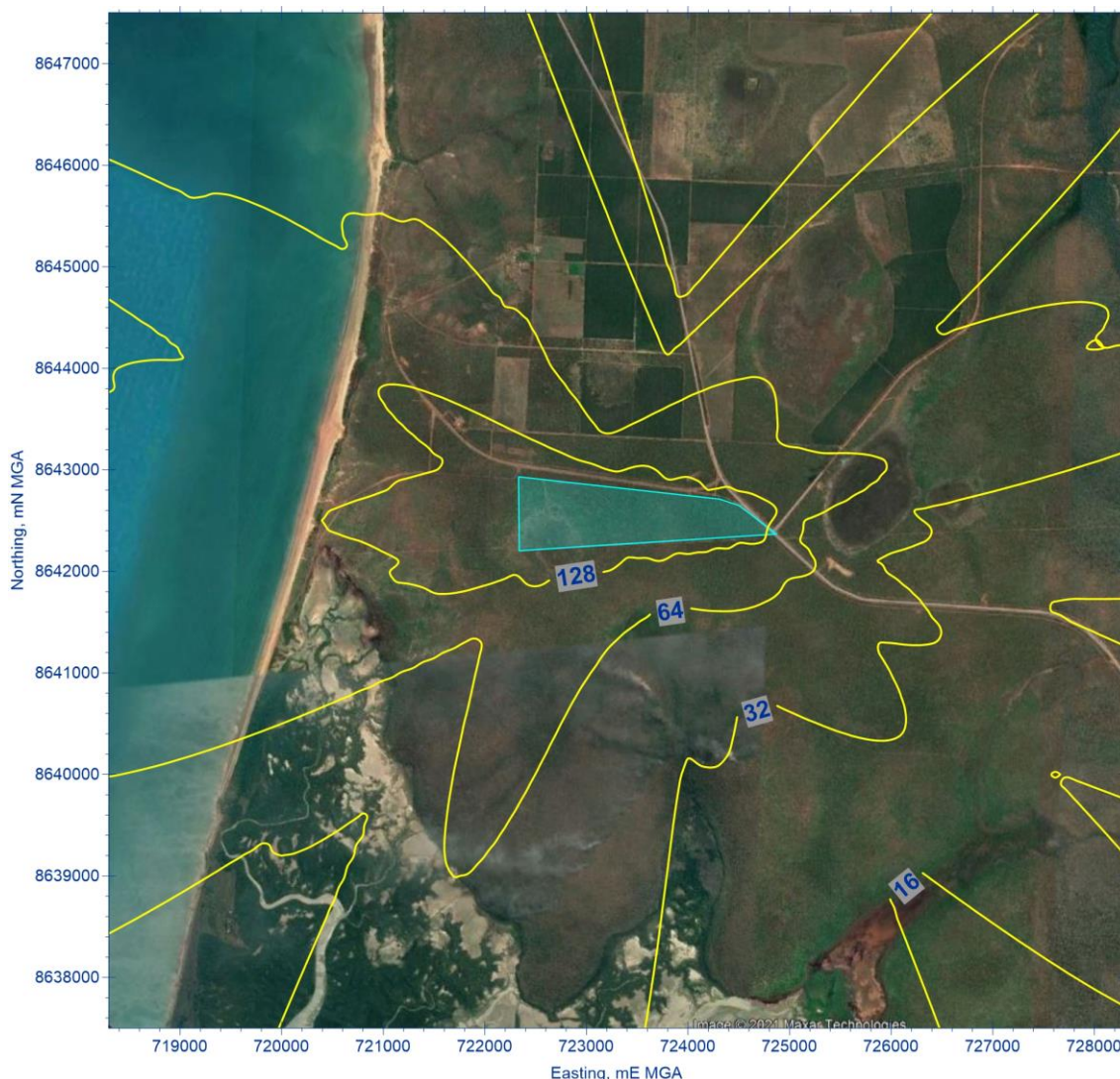


Figure 8-52 Predicted incremental 1-hour average NO₂ concentration for the Darwin Converter Site

Assessment scenario: Incremental 1-hour average NO ₂ concentration	Units: µg/m ³
Contours: 16, 32, 64, 128 µg/m ³	Assessment criterion: 246 µg/m ³
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 13 December 2021

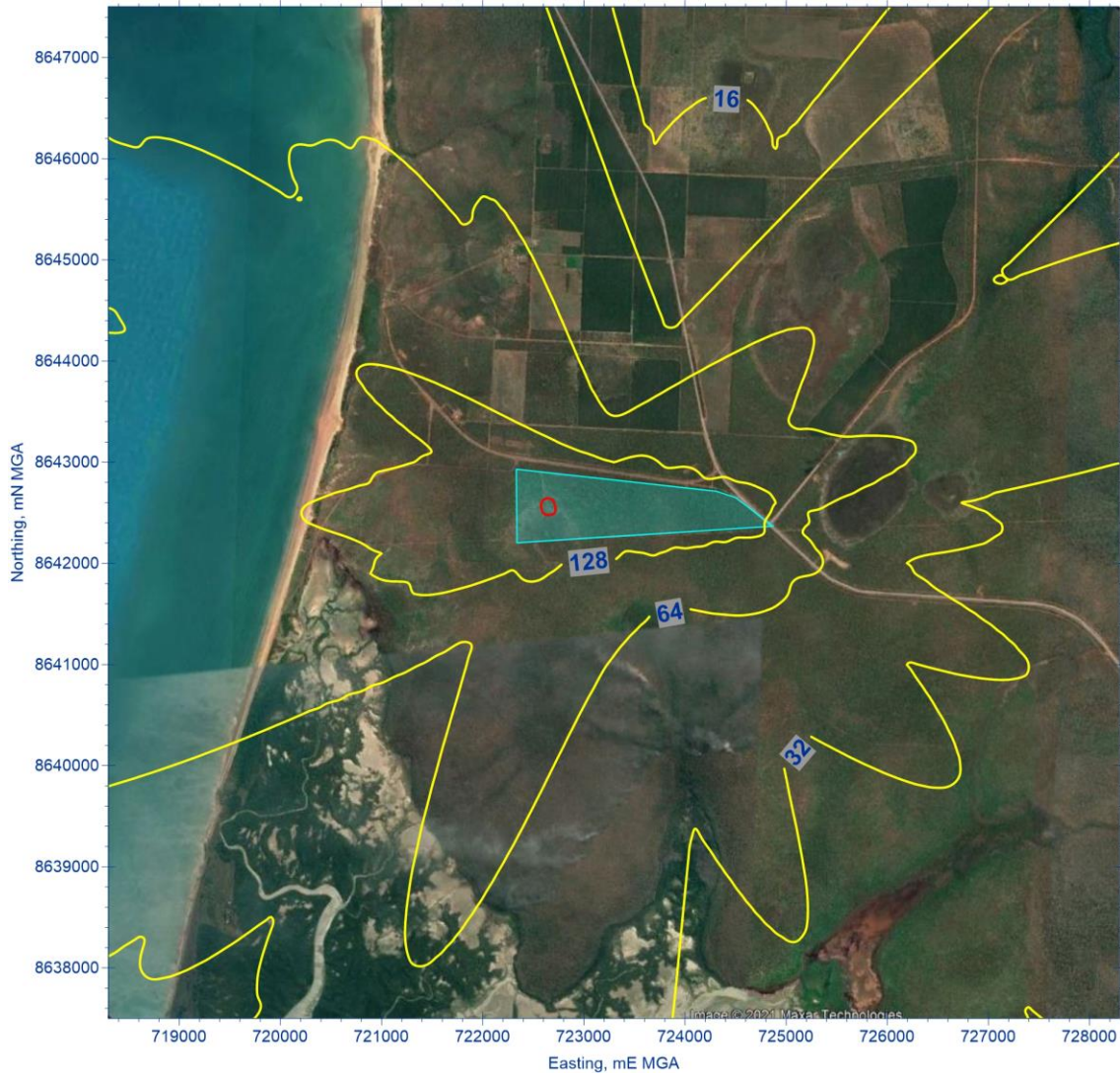


Figure 8-53 Predicted cumulative 1-hour average NO₂ concentration for the Darwin Converter Site

Assessment scenario: Cumulative 1-hour average NO ₂ concentration (background = 5.6 µg/m ³)	Units: µg/m ³
Contours: 32, 64, 128, 246 µg/m ³	Assessment criterion: 246 µg/m ³ (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 13 December 2021



8.4.7 Annual average NO₂

The incremental and cumulative annual average NO₂ predictions for the Darwin Converter Site are provided in Figure 8-54 and Figure 8-55 respectively. The annual average NO₂ criterion of 62 µg/m³ is met at all sites within the modelling domain for both the incremental and cumulative scenarios, with grid maximum concentrations of 25.9 and 30.6 µg/m³ respectively.

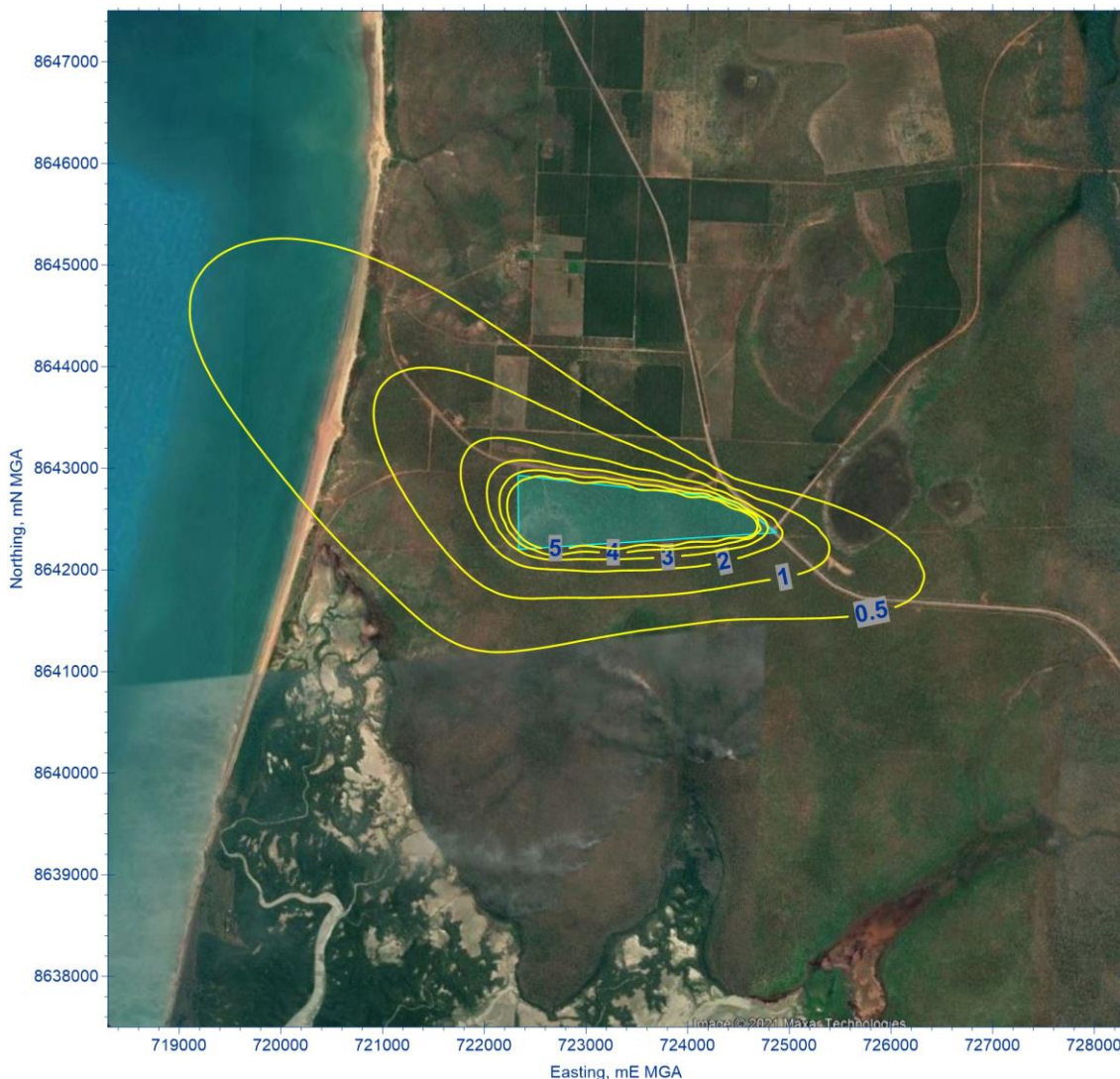


Figure 8-54 Predicted incremental annual average NO₂ concentration for the Darwin Converter Site

Assessment scenario: Incremental annual average NO ₂ concentration	Units: µg/m ³
Contours: 0.5, 1, 2, 3, 4, 5 µg/m ³	Assessment criterion: 62 µg/m ³
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 13 December 2021

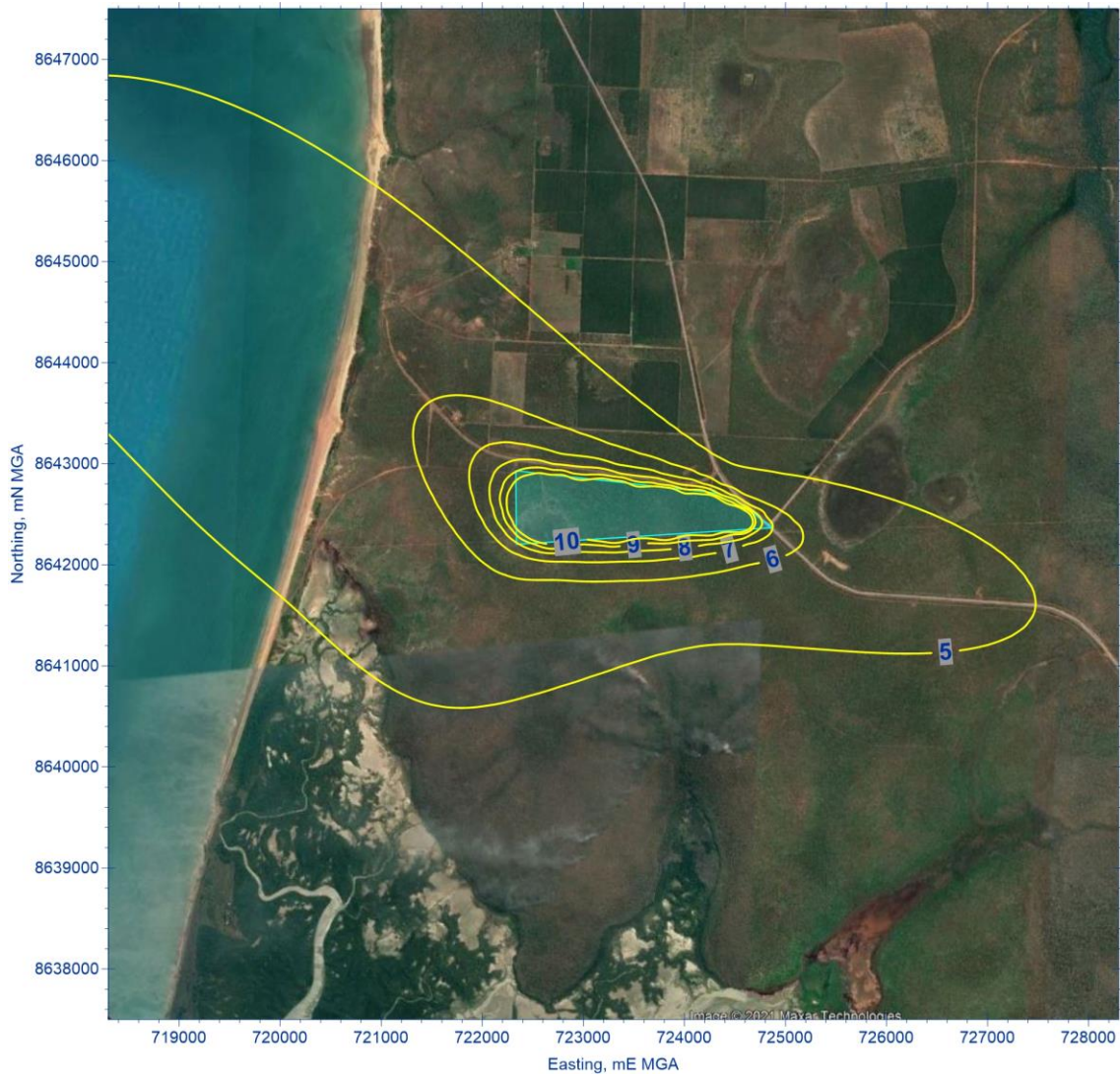


Figure 8-55 Predicted cumulative annual average NO₂ concentration for the Darwin Converter Site

Assessment scenario: Cumulative annual average NO ₂ concentration (background = 4.7 µg/m ³)	Units: µg/m ³
Contours: 5, 6, 7, 8, 9, 10 µg/m ³	Assessment criterion: 62 µg/m ³
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 13 December 2021



8.4.8 Annual-maximum monthly dust deposition rate for the Darwin Converter Site

The incremental and cumulative predictions for annual-maximum monthly dust deposition rate for the Darwin Converter Site are provided in Figure 8-56. The 2 mg/m²/month criterion, assessing the maximum allowable increase in deposited dust, is met within approximately 380 m of the site boundary.

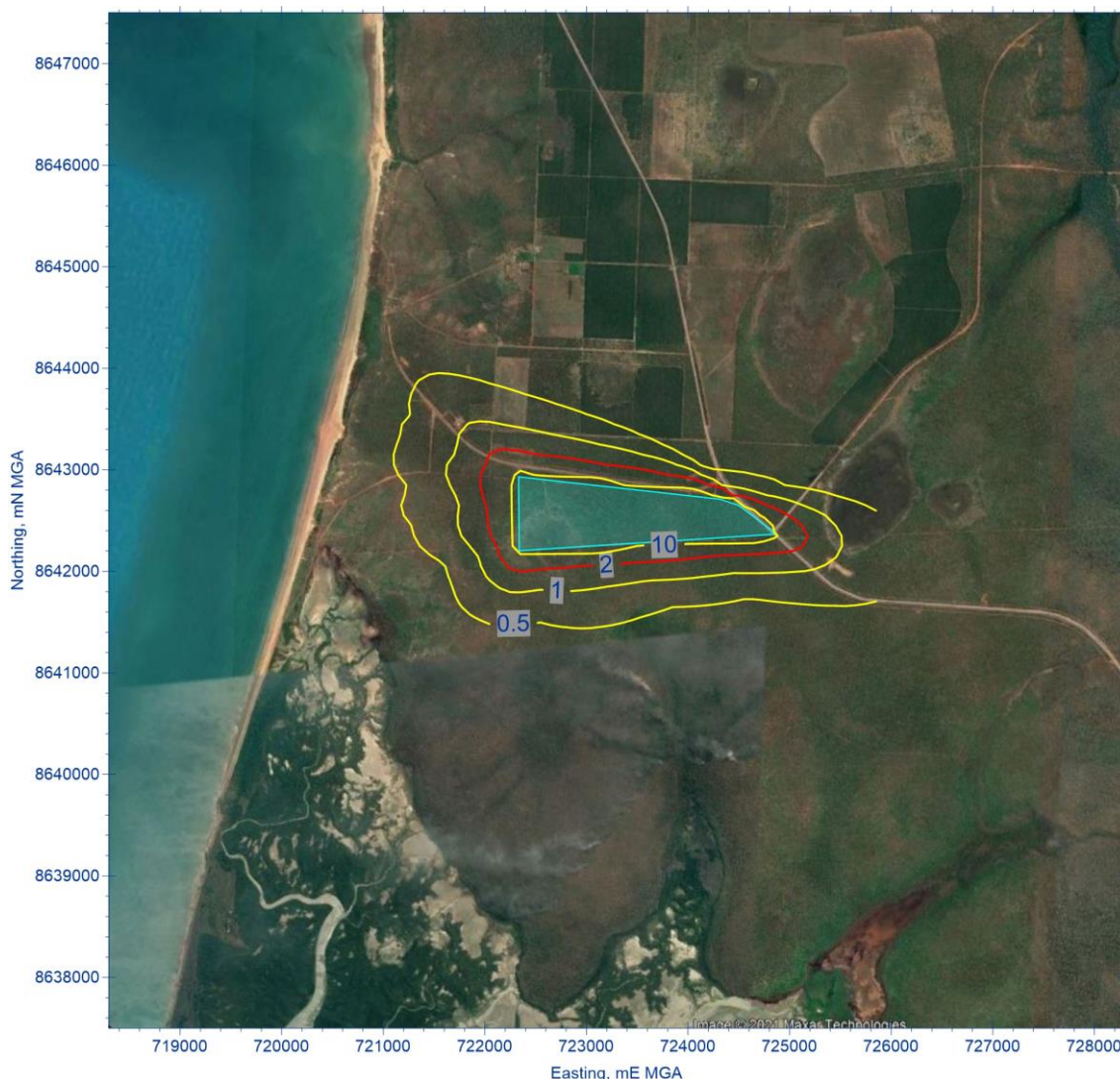


Figure 8-56 Incremental annual-maximum monthly dust deposition rate for the Darwin Converter Site

Assessment scenario: Incremental annual-maximum monthly-average dust deposition rate	Units: mg/m ² /month
Contours: 0.5, 1, 2, 10 mg/m ² /month	Assessment criterion: 2 mg/m ² /month (shown in red)
Data source: AUSPLUME modelling	Prepared by: M. Power
Location: Murrumujuk, Darwin, NT	Date: 2 December 2021



8.5 Trenching works at Murrumujuk

8.5.1 24-hour average PM_{2.5}

The incremental and cumulative distance decay curves for 24-hour average PM_{2.5} predictions for trenching works between the Darwin Converter and the Land Sea Joint Station sites at Murrumujuk are provided in Figure 8-57 and Figure 8-58 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM_{2.5} criterion of 25 µg/m³ is met within 48 m of the activity area boundary. The minimum separation distance rises to 69 m when the assumed background concentration of 10.4 µg/m³ is accounted for.

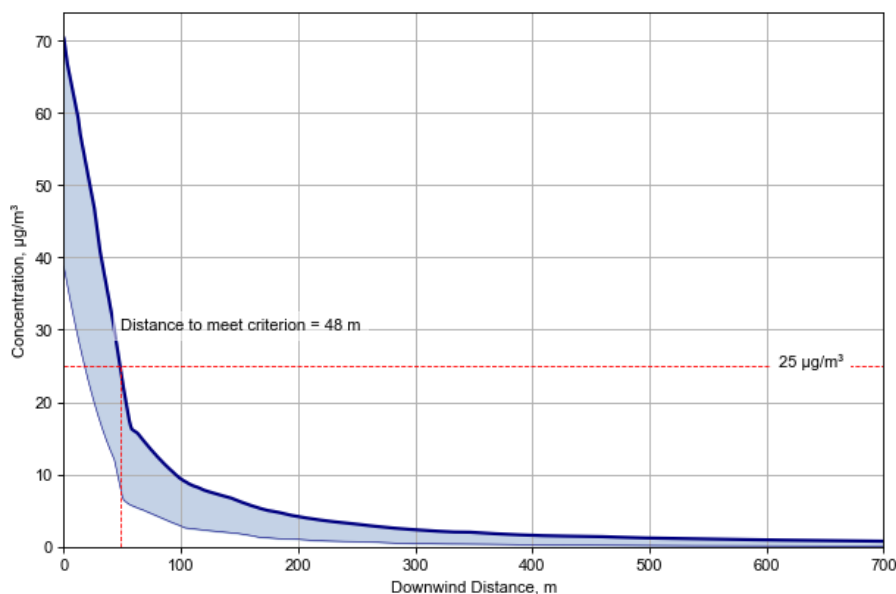


Figure 8-57 Predicted maximum incremental 24-hour average PM_{2.5} distance decay relationship for trenching works at Murrumujuk

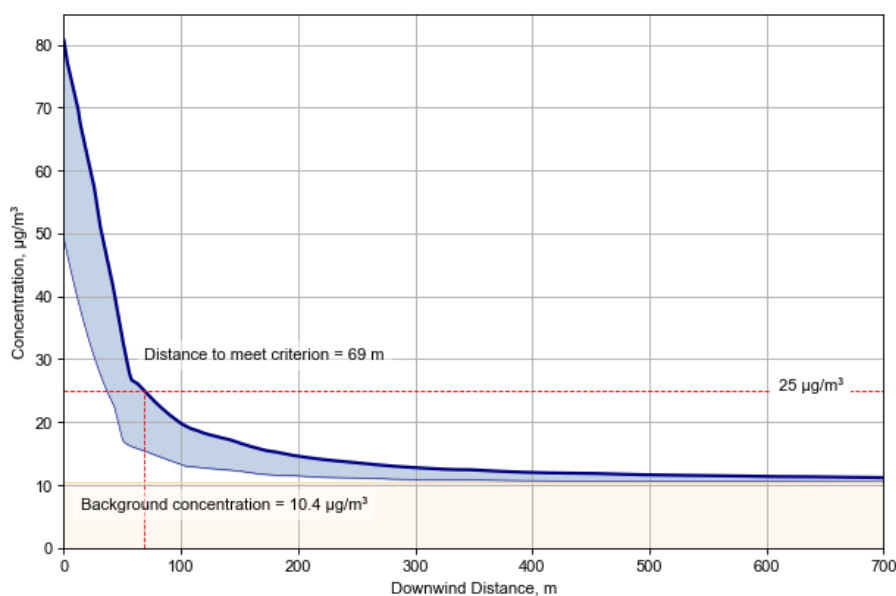


Figure 8-58 Predicted maximum cumulative 24-hour average PM_{2.5} distance decay relationship for trenching works at Murrumujuk



8.5.2 24-hour average PM₁₀

The incremental and cumulative distance decay curves for 24-hour average PM₁₀ predictions for trenching works at Murrumujuk are provided in Figure 8-59 and Figure 8-60 respectively. When the incremental effect of construction emissions is considered on its own then the 24-hour average PM₁₀ criterion of 50 µg/m³ is met within 175 m of the activity area boundary. The minimum separation distance rises to 283 m when the assumed background concentration of 24.3 µg/m³ is accounted for.

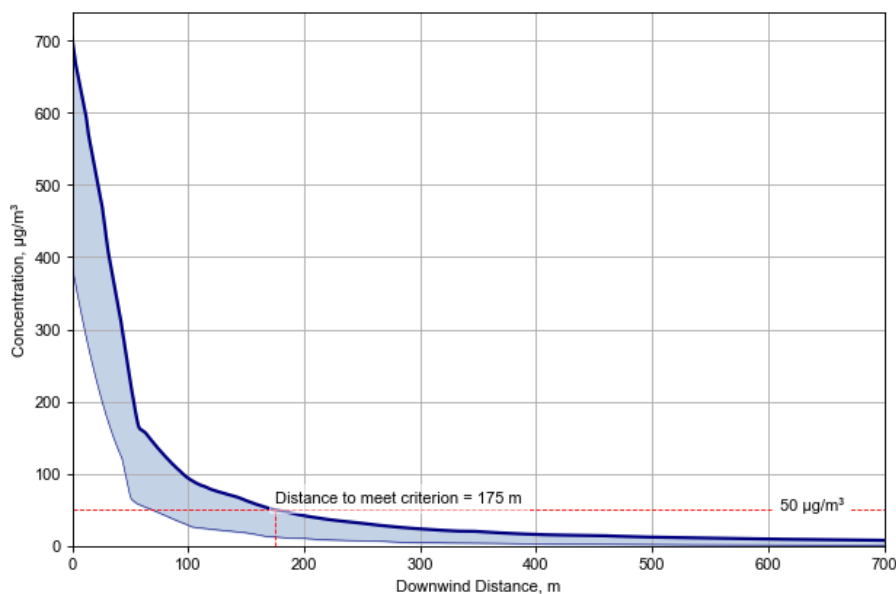


Figure 8-59 Predicted maximum incremental 24-hour average PM₁₀ distance decay relationship for trenching works at Murrumujuk

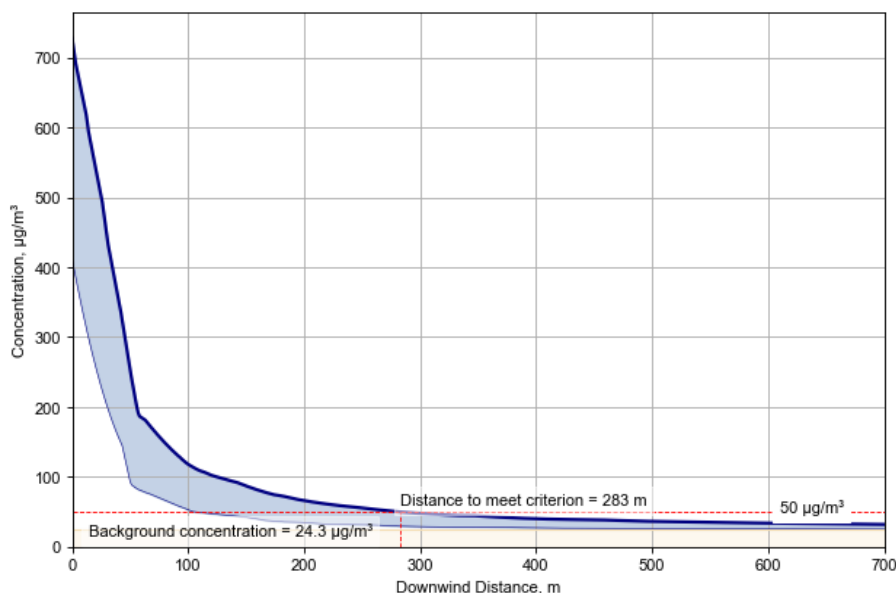


Figure 8-60 Predicted maximum cumulative 24-hour average PM₁₀ distance decay relationship for trenching works at Murrumujuk



8.5.3 1-hour average NO₂

The incremental and cumulative distance decay curves for maximum 1-hour average NO₂ predictions for trenching works at Murrumujuk are provided in Figure 8-61 and Figure 8-62 respectively. When the incremental effect of construction emissions is considered on its own then the 1-hour average NO₂ criterion of 246 µg/m³ is met within 370 m of the activity area boundary. The minimum separation distance rises to 397 m when the assumed background concentration of 5.6 µg/m³ is accounted for.

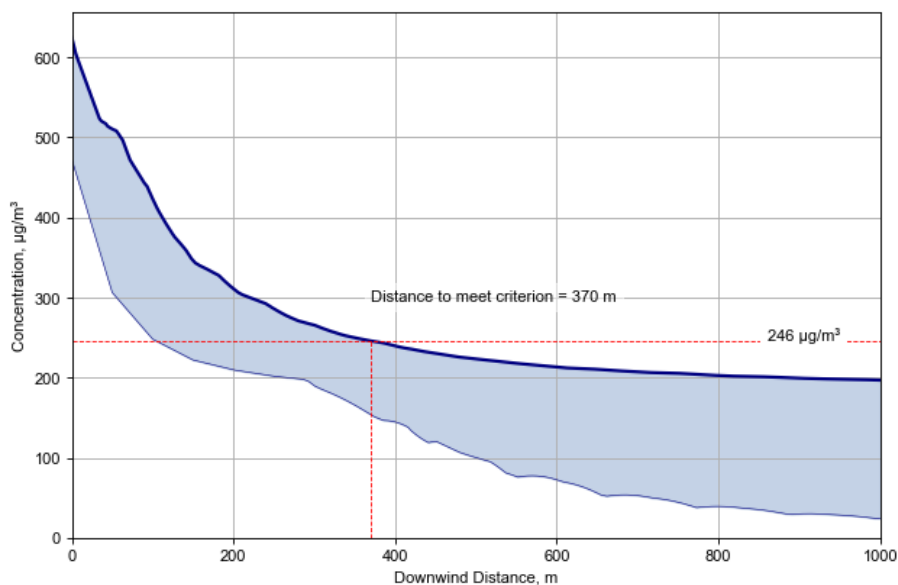


Figure 8-61 Predicted incremental maximum 1-hour average NO₂ distance decay relationship for trenching works at Murrumujuk

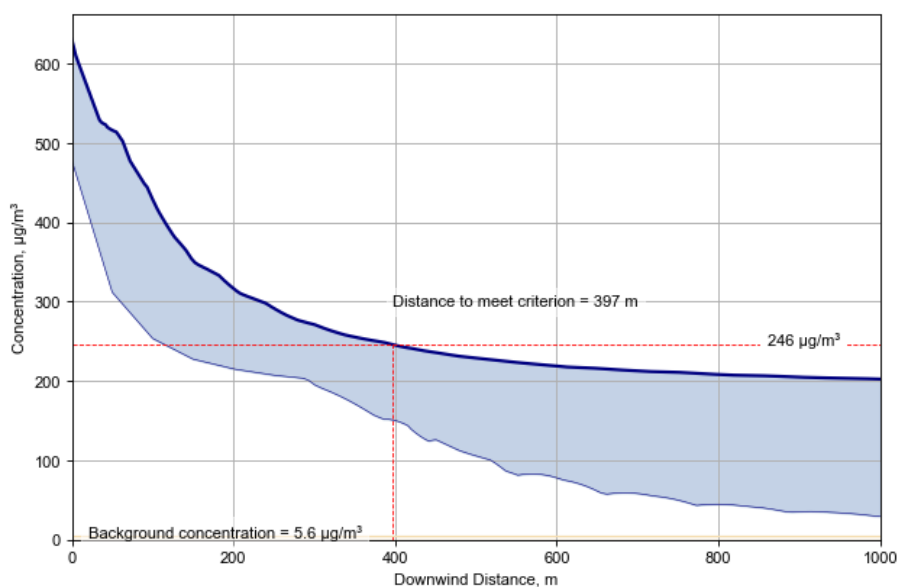


Figure 8-62 Predicted maximum cumulative 1-hour average NO₂ distance decay relationship for trenching works at Murrumujuk



8.5.4 Annual-maximum monthly dust deposition rate

The incremental distance decay curve for annual-maximum monthly dust deposition rate predictions for trenching works at Murrumujuk is provided in Figure 8-63. The 2 mg/m²/month criterion, assessing the maximum allowable increase in deposited dust, is met within 123 m of the activity area boundary.

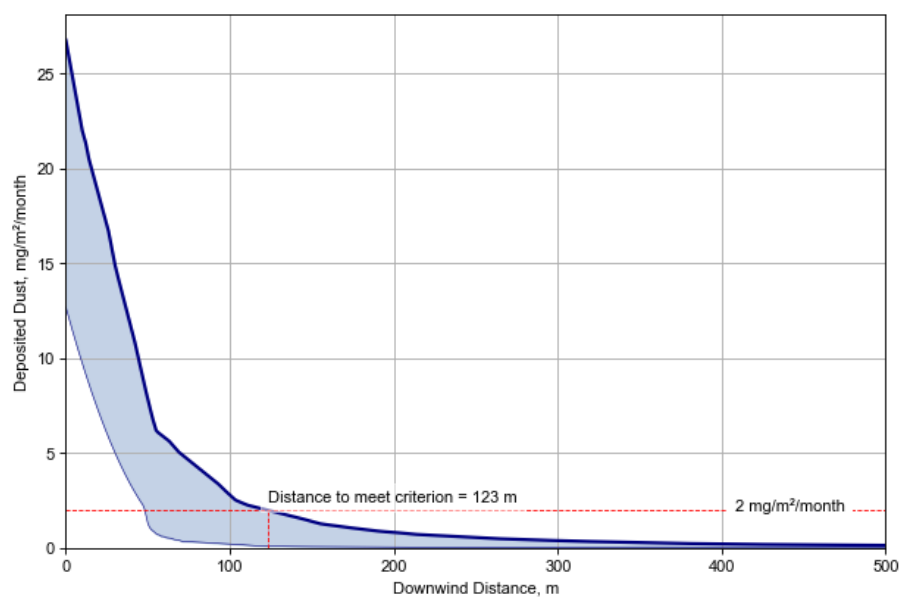


Figure 8-63 Predicted incremental annual-maximum monthly dust deposition rate distance decay relationship for trenching works at Murrumujuk



9 Interpretation of Air Quality Assessment Findings

A conservative screening level approach was adopted for the air quality impact assessment of emissions associated with construction activities. Dust emission estimation was based on generic emission factors for general construction activities on the basis of the area of active construction. Conservative assumptions were made for the construction area footprint at each site. Emission impacts were then predicted using the AUSPLUME air dispersion model based on modelled site-specific meteorology. The findings of the impact assessment are summarised below.

9.1 Solar Precinct site

Model predictions for the solar array site are summarised in Table 9-1, which shows that a separation distance of 1079 m is required, based on the predicted maximum cumulative 24-hour average PM₁₀ impact being the determining pollutant. In the absence of any background concentrations, the separation distance based on the maximum incremental impact for the 24-hour average concentration of PM₁₀ would be 501 m.

For construction activities where the ground is not being disturbed and emissions come solely from diesel-fuelled vehicles, minimum separation distances of 80 m and 71 m apply at road and rail construction sites respectively.

Table 9-1 Predicted incremental and cumulative separation distances applying to construction activities at the Solar Farm site

Pollutant	Assessment criterion (µg/m ³)	Incremental separation distance to meet the criterion (m)	Assumed background concentration (µg/m ³)	Cumulative separation distance to meet the criterion (m)
All Solar Farm Precinct sites				
24-hour average PM _{2.5}	25	38	10.4	89
Annual average PM _{2.5}	8	41	8.3	Background exceeds criterion
24-hour average PM ₁₀	50	501	24.3	1079
Annual average PM ₁₀	25	214	19.9	1073
Annual average TSP	90	88	39.8	213
Annual-maximum monthly dust deposition rate	2 mg/m ² /month	244	-	-
Road Construction				
1-hour maximum NO ₂	246	51	5.6	80
Annual NO ₂	62	0	4.7	0
Intermodal Logistics Facility				
1-hour maximum NO ₂	246	0	5.6	0
Annual NO ₂	62	0	4.7	0
Rail Construction				
1-hour maximum NO ₂	246	43	5.6	71
Annual NO ₂	62	0	4.7	0



Pollutant	Assessment criterion ($\mu\text{g}/\text{m}^3$)	Incremental separation distance to meet the criterion (m)	Assumed background concentration ($\mu\text{g}/\text{m}^3$)	Cumulative separation distance to meet the criterion (m)
Broadacre Solar Array				
1-hour maximum NO_2	246	68	5.6	103
Annual NO_2	62	0	4.7	0
Maximum				
Roadworks	-	501	-	1079
Intermodal Site	-	501	-	1079
Rail	-	501	-	1079
Broadacre Solar Array	-	501	-	1079

9.2 Southern OHTL sites

Model predictions for southern OHTL sites are summarised in Table 9-2, which shows that a separation distance of 468 m is required, based on the predicted maximum cumulative 1-hour average NO_2 impact being the determining pollutant. In the absence of any background concentrations, the separation distance based on the maximum 1-hour average concentration of NO_2 is 444 m.

Table 9-2 Predicted incremental and cumulative separation distances applying to construction activities at southern OHTL sites

Pollutant	Assessment criterion ($\mu\text{g}/\text{m}^3$)	Incremental separation distance to meet the criterion (m)	Assumed background concentration ($\mu\text{g}/\text{m}^3$)	Cumulative separation distance to meet the criterion (m)
24-hour average $\text{PM}_{2.5}$	25	5	10.4	30
24-hour average PM_{10}	50	63	24.3	127
Annual-maximum monthly dust deposition rate	2 $\text{mg}/\text{m}^2/\text{month}$	105	-	-
1-hour maximum NO_2	246	444	5.6	468
Maximum	-	444	-	468



9.3 Northern OHTL sites

Model predictions for northern OHTL sites are summarised in Table 9-3, which shows that a cumulative separation distance of 327 m is required, with 1-hour maximum NO₂ being the determining pollutant. In the absence of any background concentrations, this separation distance drops to 307 m with 1-hour maximum NO₂ remaining the determining pollutant.

Table 9-3 Predicted incremental and cumulative separation distances applying to construction activities at northern OHTL sites

Pollutant	Assessment Criterion (µg/m ³)	Incremental Separation Distance to Meet the Criterion (m)	Assumed Background Concentration (µg/m ³)	Cumulative Separation Distance to Meet the Criterion (m)
24-hour average PM _{2.5}	25	48	10.4	69
24-hour average PM ₁₀	50	175	24.3	283
Annual-maximum monthly dust deposition rate	2 mg/m ² /month	123	-	-
1-hour maximum NO ₂	246	307	5.6	327
Maximum		307		327

9.4 Trenching works at Murrumujuk

Model predictions for trenching works at Murrumujuk are summarised in Table 9-4, which shows that a cumulative separation distance of 397 m is required, with 1-hour maximum NO₂ being the determining pollutant. In the absence of any background concentrations, this separation distance drops to 370 m with 1-hour maximum NO₂ remaining the determining pollutant.

Table 9-4 Predicted incremental and cumulative separation distances applying to trenching works at Murrumujuk

Pollutant	Assessment Criterion (µg/m ³)	Incremental Separation Distance to Meet the Criterion (m)	Assumed Background Concentration (µg/m ³)	Cumulative Separation Distance to Meet the Criterion (m)
24-hour average PM _{2.5}	25	48	10.4	69
24-hour average PM ₁₀	50	175	24.3	283
Annual-maximum monthly dust deposition rate	2 mg/m ² /month	123	-	-
1-hour maximum NO ₂	246	370	5.6	397
Maximum		370		397



9.5 Recommended separation distances

In summary, the recommended minimum separation distance between construction activities and sensitive receptors are presented in Table 9-5.

Table 9-5 Required separation distances and their controlling factors

Location	Buffer limiting pollutant	Separation distance required based on incremental impact (m)	Separation distance required based on cumulative impact (m)
Solar Farm near Elliott	Maximum 24-hour average PM ₁₀	501	1079
Road construction sites on Solar Farm precinct with no ground disturbance (vehicle emissions only)	Maximum 1-hour average NO ₂	51	80
Rail construction sites on Solar Farm precinct with no ground disturbance (vehicle emissions only)	Maximum 1-hour average NO ₂	43	71
OHTL near Elliott	Maximum 1-hour average NO ₂	444	468
OHTL near Murrumujuk	Maximum 1-hour average NO ₂	307	327
Trenching works near Murrumujuk	Maximum 1-hour average NO ₂	370	397



9.6 Darwin Converter Site

Model predictions for the Darwin Converter Site are summarised in Table 9-6. The assessment determined that the air quality criteria are not met at the boundaries of the sites. Sensitive receptors in the local area would need to be identified, in order to assess whether construction emissions have the potential to cause adverse impacts.

Table 9-6 Incremental and cumulative model predictions for construction activities at the Darwin Converter site

Pollutant	Assessment criterion ($\mu\text{g}/\text{m}^3$)	Predicted maximum incremental ground level concentration at the site boundary ($\mu\text{g}/\text{m}^3$)	Assumed background concentration ($\mu\text{g}/\text{m}^3$)	Predicted maximum cumulative ground level concentration at the site boundary ($\mu\text{g}/\text{m}^3$)	Maximum proportion of assessment criterion at the site boundaries (%)
24-hour average $\text{PM}_{2.5}$	25	36.0	10.4	46.4	186
Annual average $\text{PM}_{2.5}$	8	14.62	8.3	22.92	286
24-hour average PM_{10}	50	360.6	24.3	384.9	770
Annual average PM_{10}	25	146.5	19.9	166.4	666
Annual average TSP	90	292.9	39.8	332.7	370
Annual-maximum monthly dust deposition rate	2 $\text{mg}/\text{m}^2/\text{month}$	30.7 $\text{mg}/\text{m}^2/\text{month}$	-	-	1535
1-hour maximum NO_2	246	246.6	5.6	252.2	102
Annual NO_2	62	25.9	4.7	30.6	49

A key limiting factor in the assessment was the assumptions made in regard to background air quality. Air quality data was drawn upon from the EPA monitoring network in the Darwin region as no monitoring is conducted in the project areas and no baseline monitoring was conducted as part of this project. This artefact of the assessment was noticeable in the assessment of $\text{PM}_{2.5}$ and PM_{10} emissions, whereby:

- Annual average $\text{PM}_{2.5}$ concentrations are 104% of the criterion
- Annual average PM_{10} concentrations are 80% of the criterion
- 24-hour average PM_{10} concentrations are 49% of the criterion.

This high dust load is typical for the Darwin region and is caused by regular biomass burning and dust storms occurring in the outback to the southeast (upwind) of Darwin during the dry season. Background dust concentrations in the region around and upwind of the solar array site are not expected to be as high



as this, as the area is less likely to be impacted by upwind bushfires, though dust storms in the arid environment may also occur from time to time. As a consequence of this, the cumulative dust impact assessment is dominated by background emissions from natural sources of particulate matter (both PM₁₀ and PM_{2.5}). The incremental contributions of dust to the impacts from construction activities are significantly lower.

In addition to this, a limiting factor in the assessment was the predicted annual dust impact. However, construction activities tend to be transient and not entirely stationary in a single location. This is particularly important to the construction of the solar array and OHTLs. Consequently, the annual average assessments of each pollutant should not be considered the definitive means to assess the potential impact of construction activities. The hourly (NO₂) and daily (PM₁₀ and PM_{2.5}) average criteria are considered to be the critical criteria for assessing air quality impacts for the project.



10 Conclusions

A screening level impact assessment was conducted to determine the potential impact to air quality in the local areas associated with emissions from construction activities at the Solar Precinct southwest of Elliott, along the OHTL, at the Darwin Converter Site at Murrumujuk, and along the trenching works between the converter site and the shoreline crossing. The critical air pollutants focused on in the assessment were associated with emissions of particulate matter from site ground preparation works, infrastructure construction and heavy non-road construction equipment, and NO_x emissions from the same construction equipment.

The assessment was conducted in two ways, i.e.:

1. The determination of separation distances between the construction areas and nearby sensitive receptors for the Solar Precinct, trenching activities at Murrumujuk, and OHTL towers, due to their mobile nature and not being fixed in a single location over the project's construction period, and
2. Determination of the potential impact footprint around the Darwin Converter Site at Murrumujuk as construction in these areas will be confined to a specific area for the duration of the project's construction.

As the construction of the Solar Precinct, OHTL towers, and underground cable at Murrumujuk will be transient over the entire construction period, i.e., it is not fixed in a single location, and each OHTL tower will not take a year to construct, the assessment of annual average impacts of TSP, PM₁₀, PM_{2.5} and NO₂ were presented but have been overlooked in the determination of the required separation distances. In accordance with the air quality criteria for particles and NO₂, any assessment must be based on the cumulative impact (i.e., the existing background concentrations plus the predicted incremental increase caused by the activity). Notwithstanding this, the baseline air quality data for the calculation of the cumulative impact at the Solar Precinct and along the OHTL has been based on EPA monitoring data from the Darwin region, which is unlikely to be representative of the air quality in the regions of these activities. This is likely to result in an overly conservative estimate of the separation distance. The estimated footprint of potential air quality impact at the Darwin Converter Site at Murrumujuk is expected to be more reasonable.

The separation distances for the transient construction sites are presented in Table 10-1. The critical exposure footprints of predicted impact around the Darwin Converter Site at Murrumujuk, i.e., the limits at which the criteria are predicted to be exceeded, are presented in Figure 10-1.

Table 10-1 Separation distances for transient construction areas

Construction area	Buffer limiting pollutant	Separation distance
Solar Precinct at Powell Creek Station near Elliott	PM ₁₀	1,079 metres
OHTL at southern end near Elliott	NO ₂	468 metres
OHTL at northern end near Murrumujuk	NO ₂	327 metres
Trenching activities at Murrumujuk	NO ₂	397 metres

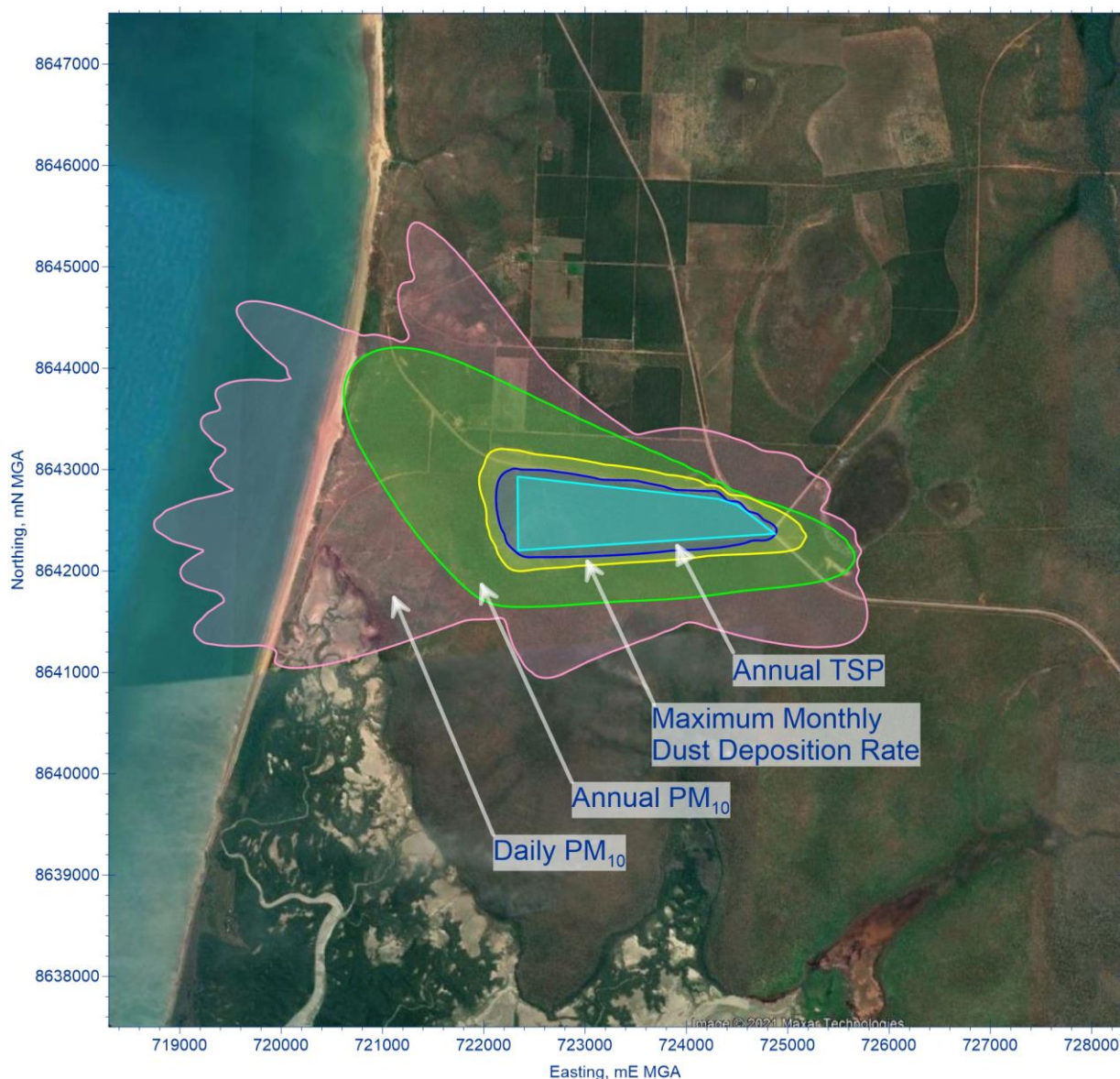


Figure 10-1 Critical exposure footprints of predicted impacts around the Darwin Converter Site at Murrumujuk

Solar Precinct and OHTL infrastructure are expected to be constructed primarily in remote areas away from sensitive receptors. However, if some infrastructure is to be developed in close proximity to receptors, the separation distances determined in this assessment provide a means to manage those activities to prevent adverse air quality impacts. These separation distances would be incorporated into the project's Construction Environmental Management Plan.

The assessment of potential construction related air quality impacts at the Darwin Converter Site at Murrumujuk indicated that there are unlikely to be any adverse impacts to sensitive areas in the local area.



11 References

Countess Environmental, 2004. *WRAP Fugitive Dust Handbook*, Prepared for Western Governors' Association, Westlake Village, California: 191 pp.

EPA Victoria, 2012. *Publication 1459*, Construction of Input Meteorological Data Files for AUSPLUME, April 2012. Available at <https://www.epa.vic.gov.au/about-epa/publications/1459>.

TAPM, 2008. Version 4.0.5 developed by the CSIRO (www.dar.csiro.au/TAPM).

Appendix A

Detailed Model Configuration Summary & Analysis of Dispersion Meteorology



TABLE OF CONTENTS

<u>1</u>	<u>METEOROLOGICAL MODELLING</u>	<u>5</u>
1.1	TAPM PROGNOSTIC METEOROLOGICAL MODEL	5
1.2	PYTHON METEOROLOGICAL PRE-PROCESSOR	6
<u>2</u>	<u>ANALYSIS OF DISPERSION METEOROLOGY AT THE SOLAR FARM SITE</u>	<u>7</u>
2.1	WIND SPEED AND DIRECTION	7
2.2	AIR TEMPERATURE	11
2.3	ATMOSPHERIC STABILITY AND MIXING HEIGHT	11
<u>3</u>	<u>ANALYSIS OF DISPERSION METEOROLOGY AT THE DARWIN CONVERTER SITE</u>	<u>14</u>
3.1	WIND SPEED AND DIRECTION	14
3.2	AIR TEMPERATURE	17
3.3	ATMOSPHERIC STABILITY AND MIXING HEIGHT	18
<u>4</u>	<u>AUSPLUME MODEL AND EMISSION SOURCE CONFIGURATION</u>	<u>20</u>
4.1	MODEL CONFIGURATION	20
4.2	SOLAR FARM	20
4.3	OHTL AND MURRUMJUK TRENCHING SOURCES	21
4.4	DARWIN CONVERTER SITE	22
<u>5</u>	<u>SAMPLE AUSPLUME CONFIGURATION FILE</u>	<u>25</u>
<u>6</u>	<u>DISTANCE DECAY ASSESSMENT METHODOLOGY</u>	<u>32</u>
<u>7</u>	<u>METHOD FOR CONVERSION OF NO_x TO NO₂</u>	<u>33</u>

LIST OF TABLES

Table 2-1 Annual and diurnal mean wind speeds at the solar farm site7

Table 3-1 Annual, seasonal and diurnal mean wind speeds at the Darwin Converter site.... 14

Table 4-1 Volume source characteristics for diesel emissions from construction vehicles at the Darwin Converter Site24

Table 7-1 Parameter values used to calculate NO₂ using the OLM.....33

LIST OF FIGURES

Figure 2-1	Annual distribution of winds at the solar farm site	8
Figure 2-2	Diurnal distribution of winds at the solar farm site.....	9
Figure 2-3	Predicted monthly and hourly profiles of wind speed and direction at the solar farm site	10
Figure 2-4	Predicted monthly and hourly profiles of air temperature at the solar farm site	11
Figure 2-5	Frequency distribution of atmospheric stability classifications at the solar farm site	12
Figure 2-6	Hourly distribution of atmospheric stability classifications at the solar farm site	12
Figure 2-7	Distribution of hourly mixing heights at the solar farm site	13
Figure 3-1	Annual distribution of winds at the Darwin Converter site	15
Figure 3-2	Diurnal distribution of winds at the Darwin Converter site	16
Figure 3-3	Predicted monthly and hourly profiles of wind speed and direction at the Darwin Converter site.....	17
Figure 3-4	Predicted monthly and hourly profiles of air temperature at the Darwin Converter site	17
Figure 3-5	Frequency distribution of atmospheric stability classifications at the Darwin Converter site.....	18
Figure 3-6	Hourly distribution of atmospheric stability classifications at the Darwin Converter site	19
Figure 3-7	Distribution of hourly mixing heights at the Darwin Converter site	19
Figure 4-1	Location and extent of the polygonal integrated area source representing construction emissions from the Darwin Converter Site	23
Figure 4-2	Location and extent of the five volume sources representing diesel emissions from construction vehicles at the Darwin Converter Site	24
Figure 6-1	Example of transects surrounding the boundary of the OHTL area source, with transects spaced at 5° intervals, and grid points along the transect at 1m intervals.	32



1 Meteorological Modelling

The meteorological files used in the AUSPLUME Gaussian plume dispersion models for the solar farm precinct and the Darwin Converter sites were developed using the TAPM prognostic meteorological model.

1.1 TAPM prognostic meteorological model

The Air Pollution Model (TAPM) was developed by CSIRO for use in simulating regional meteorological and air pollution events. TAPM is a coupled mesoscale prognostic meteorological and air dispersion modelling system designed to operate on a standard desktop computer.

The model requires synoptic meteorological information inputs for the region of interest that are generated by a global model similar to the large-scale models used to forecast the weather. TAPM incorporates re-analysed and validated synoptic weather forecast data at a resolution of approximately 75 km and at elevations of between 100 m and 5,000 m above the surface, with regionally-specific terrain, land use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

Landcover data for TAPM are sourced from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC) at 30-second (approximately 1 km) grid spacing.

TAPM (version 4.0.5) was configured for the solar farm and Darwin Converter sites as follows:

- Modelling period of one year from 1 November 2018 to 31 October 2019, with each month being modelled within a separate TAPM simulation. The modelling year was selected to be representative of long-term conditions and to align with single complete wet and dry seasons.
- Grid point domain:
 - 50 columns x 50 rows at the solar farm site
 - 31 columns x 31 rows at the Murrumujuk site
 - Outer grid of 30 km and nesting grids of 10 km, 3 km, and 1 km
 - 30 vertical levels extending from the surface up to 8,000 m above the ground,
- Grid centres:
 - Centre of the solar farm site
Latitude 18° 12' S, Longitude 133° 24'E; 330794 mE, 7986949 m N MGA, UTM Zone 53K
 - Darwin Converter Site at Murrumujuk
Latitude 12° 16.5' S, Longitude 131° 3'E; 722976 mE, 8642189 m N MGA, UTM Zone 52L
- Terrain and land use data for nests 1 to 4 based on Geoscience Australia 9 second (approximately 300m) terrain and land use data (TAPM default terrain and land use),
- Default options selected for advanced meteorological inputs, and
- No data assimilation.



1.2 Python meteorological pre-processor

TAPM model predictions for the solar farm and Darwin Converter sites were converted into AUSPLUME meteorological file form following the guidance provide by EPA Victoria (EPAV, 2012) in Publication 1459. In this approach daytime Pasquill-Gifford stability classifications are determined on the basis of modelled wind speed and solar radiation. During the night time hours Pasquill-Gifford stability class is determined using wind speed and net radiation.

A Python script was developed to read in monthly TAPM meteorological files and produce a single year-long AUSPLUME meteorological file following the Publication 1459 approach.



2 Analysis of Dispersion Meteorology at the Solar Farm Site

This section describes the meteorology used in the AUSPLUME model that is important to the dispersion of air pollutants in the region close to the solar farm site. Meteorological predictions were developed for the closest TAPM model grid point to the centre of the solar farm site (at 330793 mE, 7986948 mN, UTM Zone 53 K).

2.1 Wind speed and direction

Wind speed and wind direction are important meteorological parameters that influence the dispersion of air pollutants. The annual and diurnal distributions of winds predicted at the solar farm site by the TAPM meteorological modelling system for 1 November 2018 to 31 October 2019 are presented as wind rose diagrams in Figure 2-1 and Figure 2-2, respectively.

The assessment of wind conditions at the solar farm site indicated the following:

- 41.7% of hourly average wind speeds over the year are less than 2 m/s (at 10 m above the ground).
- 75.7% of annual hourly average winds blow from the southeast quadrant, i.e. between the east and south.

The mean annual and diurnal wind speeds and proportion of calms are presented in Table 2-1.

Table 2-1 Annual and diurnal mean wind speeds at the solar farm site

Period	Mean wind speed (m/s)	Calms (%)
Annual	2.5	0.2
Night: Midnight to 6am	2.0	0.1
Morning: 6am to Midday	2.8	0.2
Afternoon: Midday to 6pm	3.1	0.2
Evening: 6pm to midnight	2.0	0.2

The modelled profiles of wind speed and direction have also been presented graphically as heat maps in Figure 2-3, to illustrate the monthly and hourly trends in wind conditions.

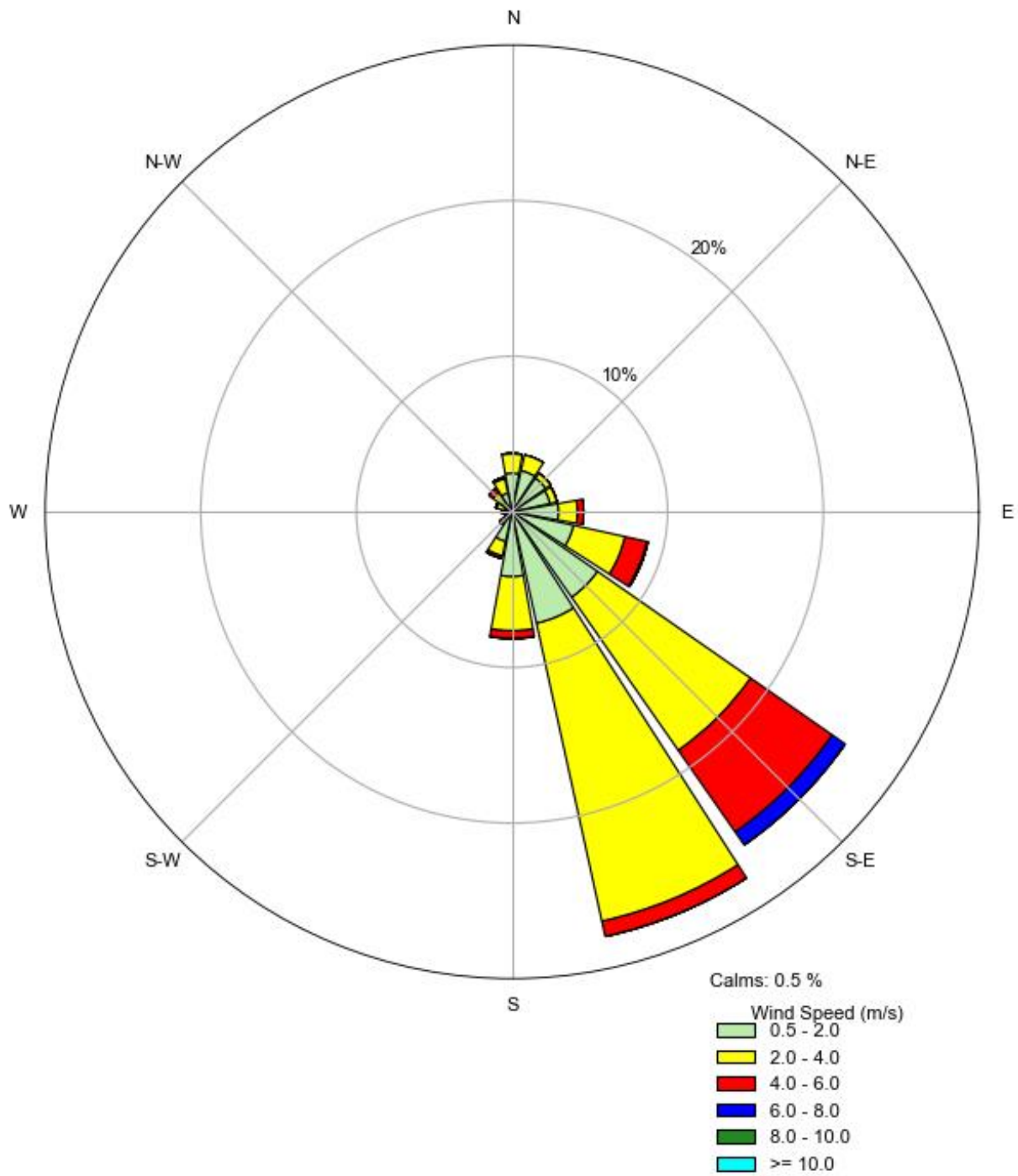


Figure 2-1 Annual distribution of winds at the solar farm site

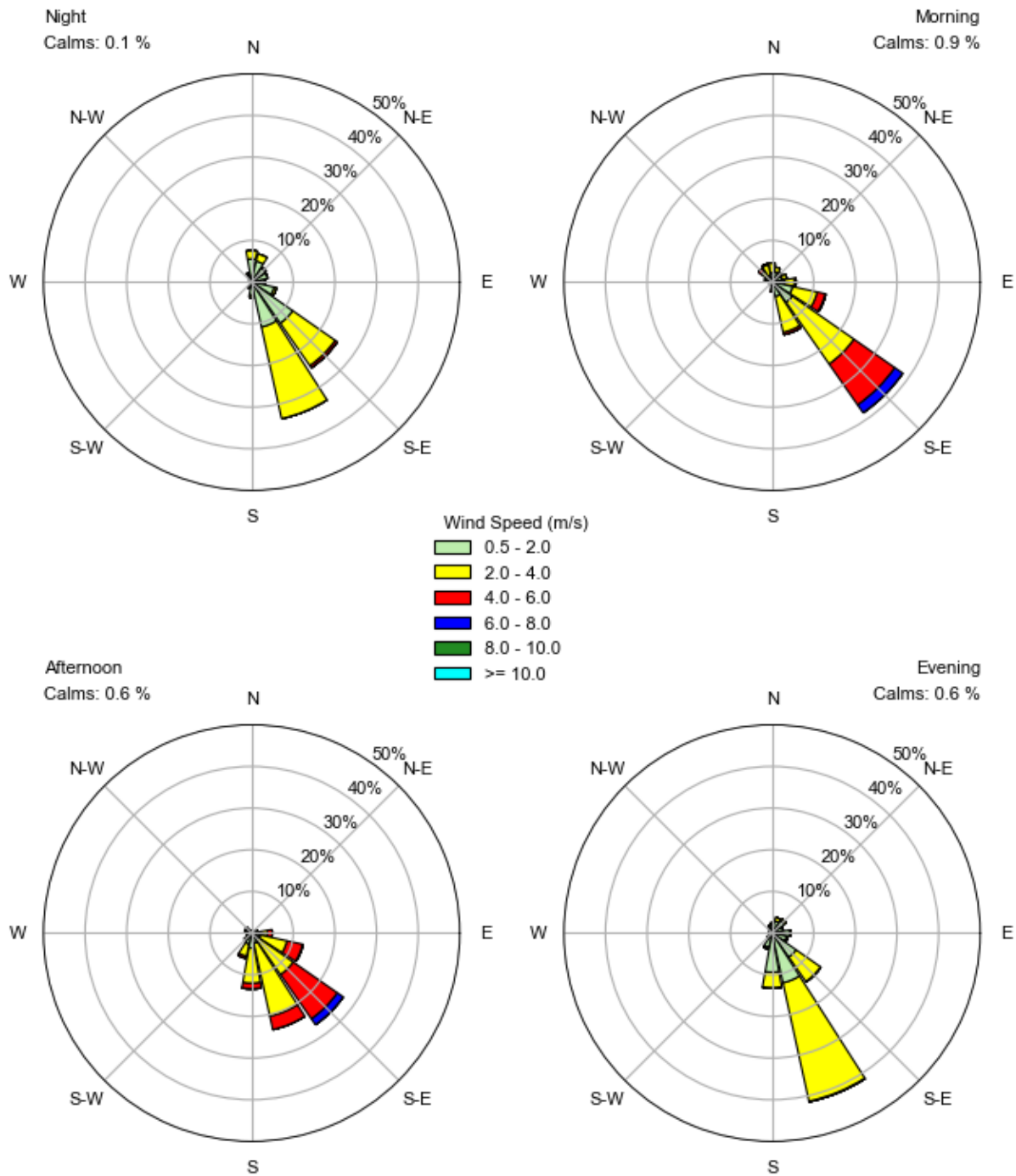


Figure 2-2 Diurnal distribution of winds at the solar farm site

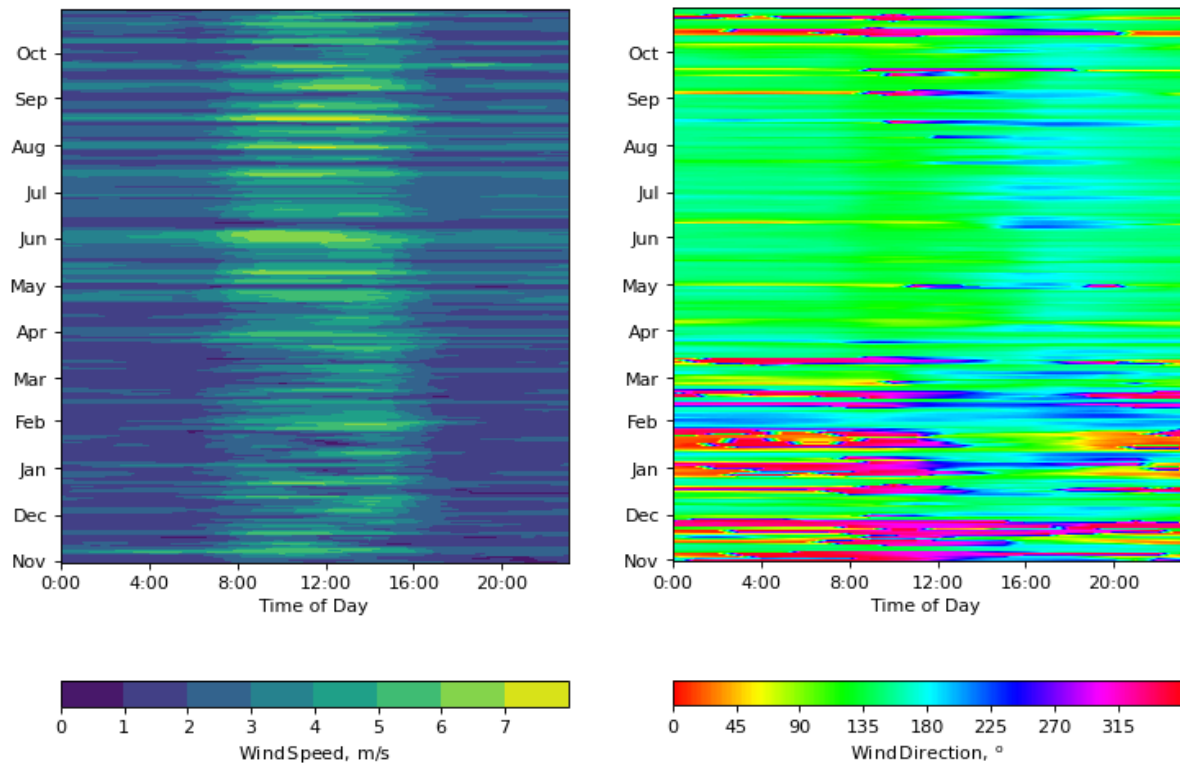


Figure 2-3 Predicted monthly and hourly profiles of wind speed and direction at the solar farm site



2.2 Air temperature

The diurnal and monthly variation in air temperature at the solar farm site is shown in Figure 2-4.

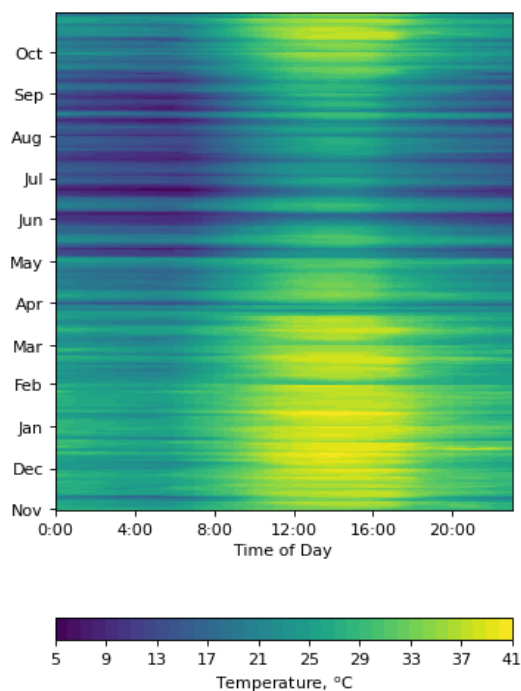


Figure 2-4 Predicted monthly and hourly profiles of air temperature at the solar farm site

2.3 Atmospheric stability and mixing height

Atmospheric stability is commonly defined in terms of six main stability classifications designated as A (highly unstable or convective), B (moderately unstable), C (slightly unstable), D (neutral), E (slightly stable) and F (stable). This is known as the Pasquill-Gifford stability classification and is widely used to describe the turbulent state of the atmosphere.

Unstable conditions (Classes A-C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground, and usually results in material from a plume becoming well mixed into the surrounding air. This turbulent mixing is the main driver of dispersion during unstable conditions.

Dispersion processes for neutral conditions (Class D) are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface, such as terrain features and building structures. During the night, the atmospheric conditions are neutral or stable (Class D, E and F).

During stable conditions, plumes from short stacks or fugitive releases will be subject to minimal atmospheric turbulence, and will not be well mixed into the surrounding air allowing concentrations to remain high.

The frequencies of Pasquill-Gifford stability classes extracted from the AUSPLUME meteorological file are presented in Figure 2-5. The distribution of Pasquill-Gifford stability classes by hour of day is illustrated in Figure 2-6, showing the lack of stable conditions during the daytime hours and unstable conditions during the nighttime.

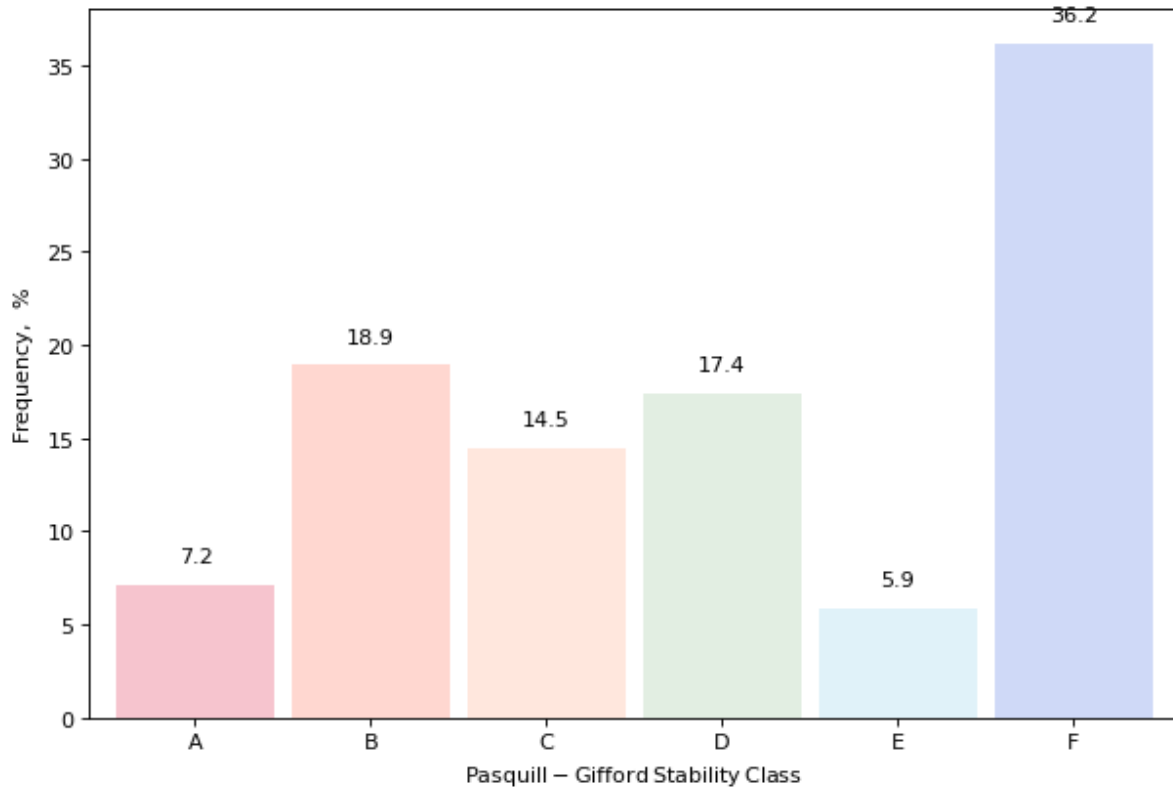


Figure 2-5 Frequency distribution of atmospheric stability classifications at the solar farm site

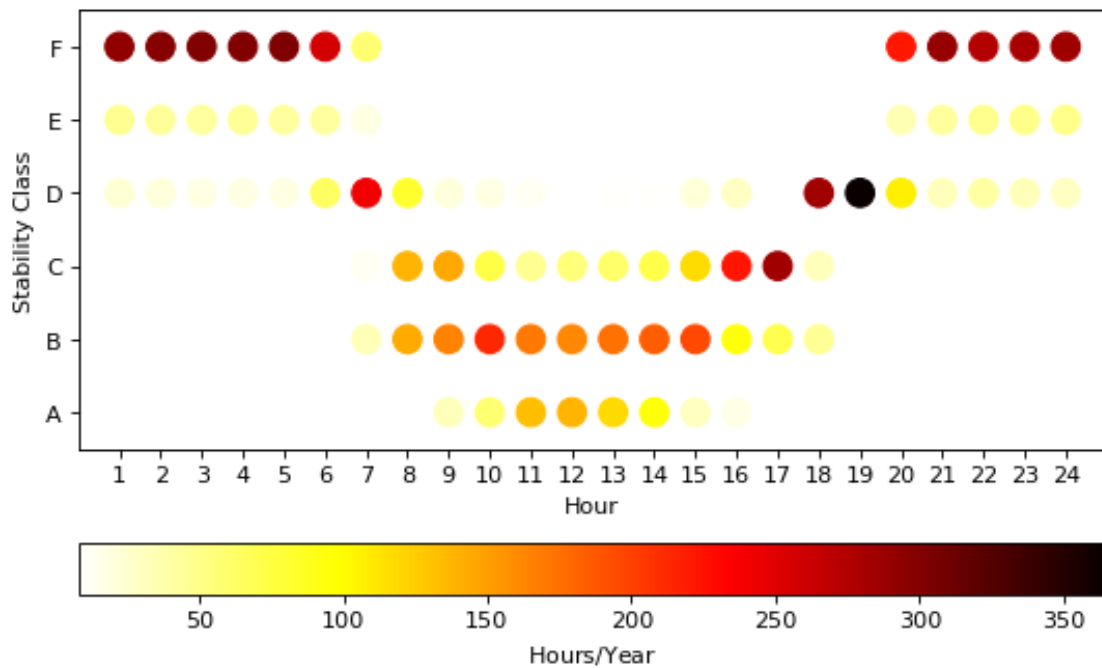


Figure 2-6 Hourly distribution of atmospheric stability classifications at the solar farm site



The mixing height refers to the height above ground within which the plume can mix with ambient air. During stable atmospheric conditions at night, the mixing height is often quite low. During the day, incoming short-wave solar radiation from the sun heats the ground, which in turn re-radiates long wave radiation back into the atmosphere, heating the air above it. The heating of the air near the ground generates the growth of convection cells causing the air, and hence the mixing height, to rise. The air above the mixing height during the day is generally cooler. The growth of the mixing height is dependent on how well the air can mix with the cooler upper levels of air and therefore depends on turbulence, i.e. meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions, the air will be well mixed resulting in a large mixing height.

The hourly distributions of mixing height at the solar farm site from the TAPM model are presented as a box and whiskers plot in Figure 2-7.

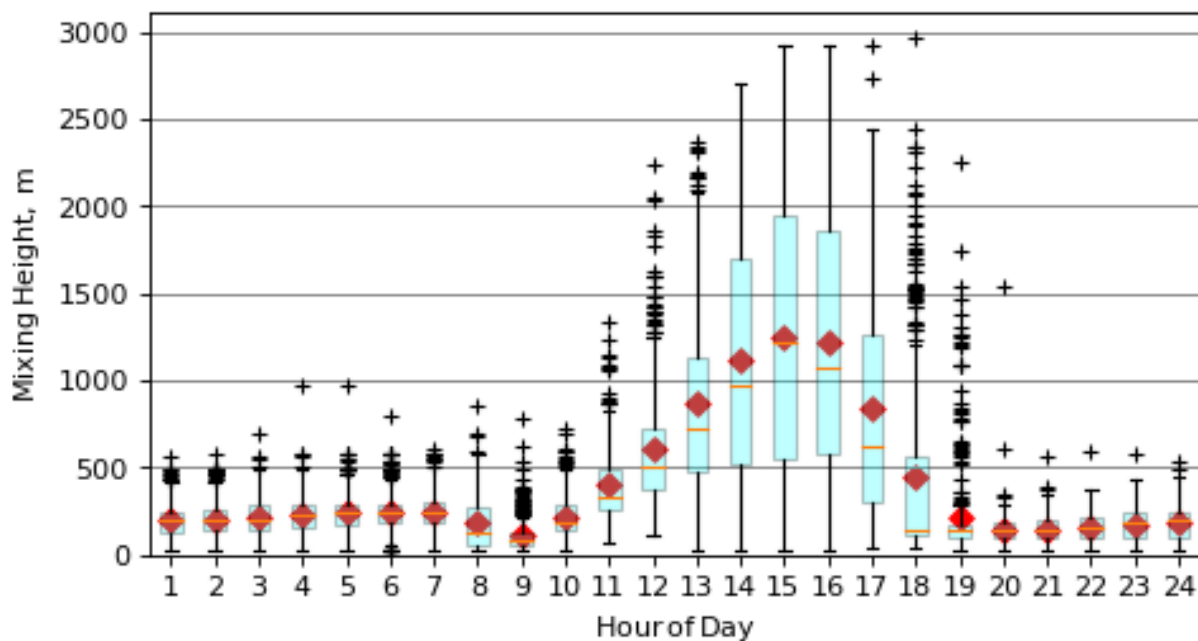


Figure 2-7 Distribution of hourly mixing heights at the solar farm site



3 Analysis of Dispersion Meteorology at the Darwin Converter Site

This section describes the dispersion meteorology used in the AUSPLUME model that is important to the dispersion of air pollutants in the region close to the Darwin Converter site. Meteorological predictions were developed for the closest TAPM model grid point to the centre of the Darwin Converter Site (at 722976 mE, 8642189 m N MGA, UTM Zone 52L).

3.1 Wind speed and direction

The annual and diurnal distributions of winds predicted at the Darwin Converter site by the TAPM meteorological modelling system for 1 November 2018 to 31 October 2019 are presented as wind rose diagrams in Figure 3-1 and Figure 3-2, respectively.

The assessment of wind conditions and the solar farm site indicated the following:

- 31.2% of hourly average wind speeds over the year are less than 2 m/s (at 10 m above the ground).
- 38.9% of annual hourly average winds blow from the southeast quadrant, i.e. between the east and south, and 38.6% blow from the northwestern quadrant i.e. between the west and north.

The mean annual and diurnal wind speeds and proportion of calms are presented in Table 3-1.

Table 3-1 Annual, seasonal and diurnal mean wind speeds at the Darwin Converter site

Period	Mean Wind Speed (m/s)	Calms (%)
Annual	3.3	0.8
Night: Midnight to 6am	2.3	1.6
Morning: 6am to Midday	3.9	0.7
Afternoon: Midday to 6pm	4.9	0.0
Evening: 6pm to midnight	2.3	0.8

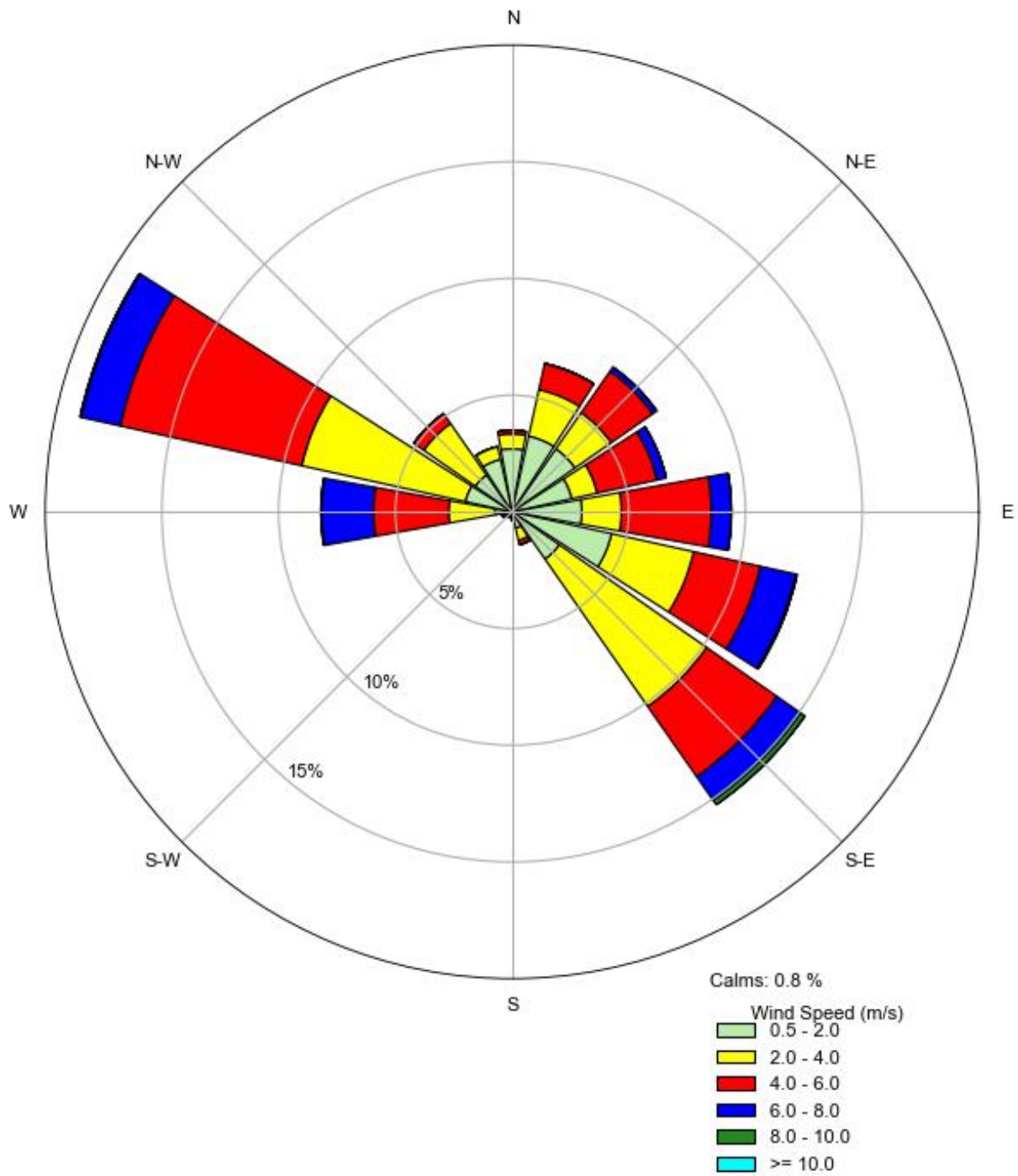


Figure 3-1 Annual distribution of winds at the Darwin Converter site

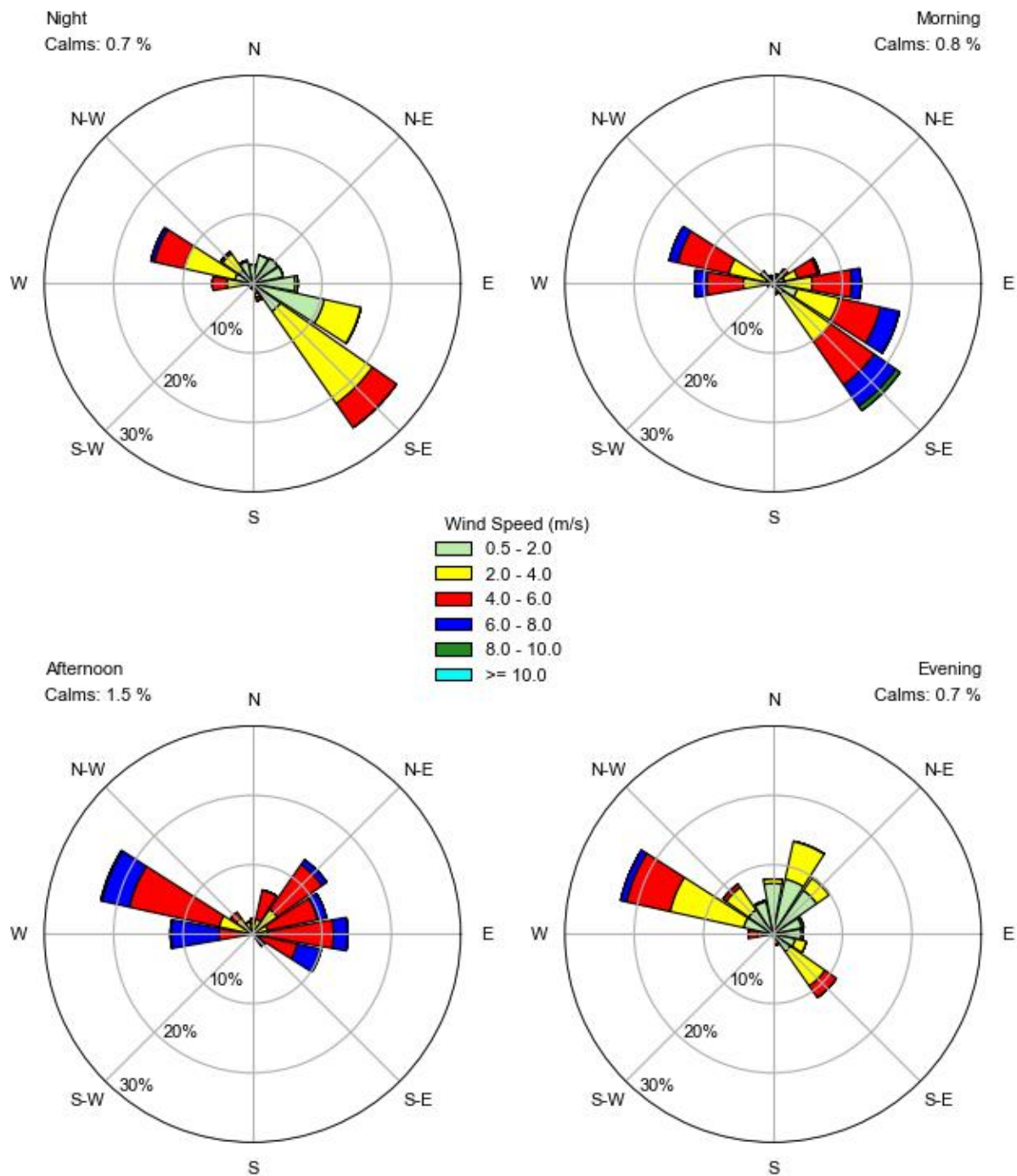


Figure 3-2 Diurnal distribution of winds at the Darwin Converter site

The modelled profiles of wind speed and direction have also been presented graphically as heat maps in Figure 3-3, to illustrate the monthly and hourly trends in wind conditions.

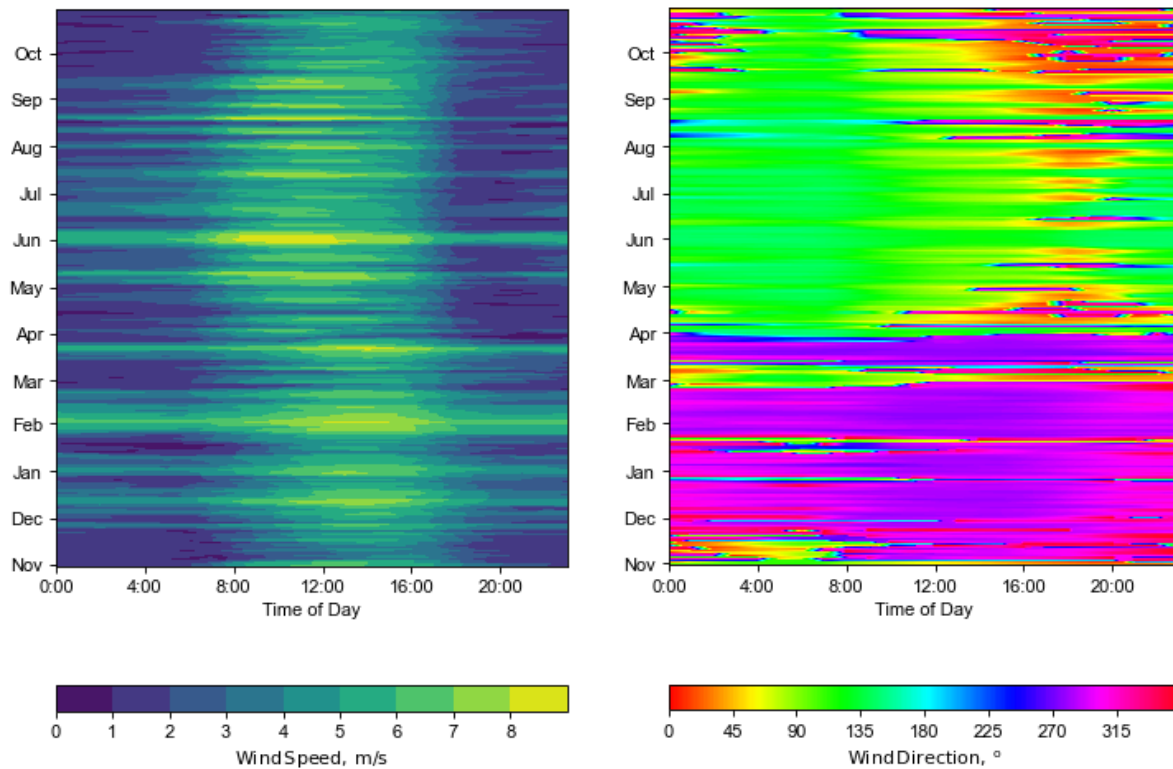


Figure 3-3 Predicted monthly and hourly profiles of wind speed and direction at the Darwin Converter site

3.2 Air temperature

The diurnal and monthly variation in predicted air temperature at the Darwin Converter site is shown in Figure 3-4.

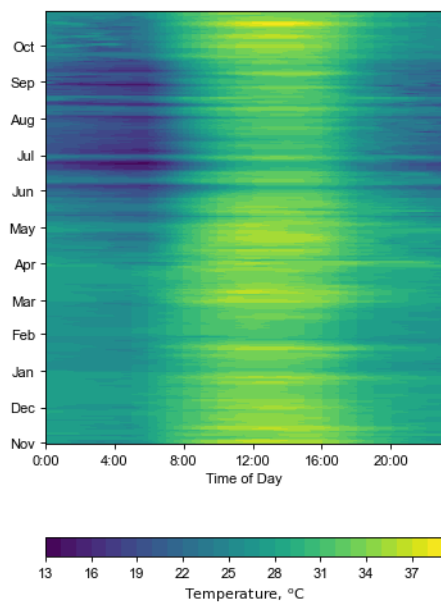


Figure 3-4 Predicted monthly and hourly profiles of air temperature at the Darwin Converter site



3.3 Atmospheric stability and mixing height

The frequencies of Pasquill-Gifford stability classes at the Darwin Converter site, based on the TAPM model predictions, are presented in Figure 3-5. The distribution of Pasquill-Gifford stability classes by hour of day is illustrated in Figure 3-6.

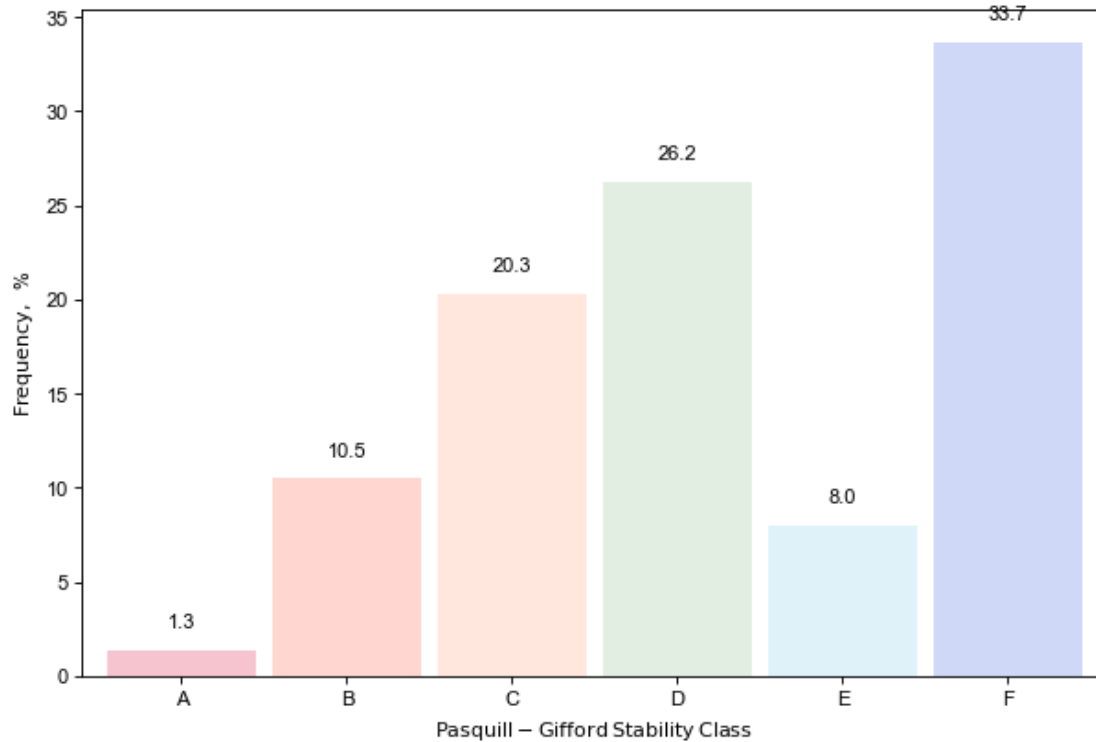


Figure 3-5 Frequency distribution of atmospheric stability classifications at the Darwin Converter site

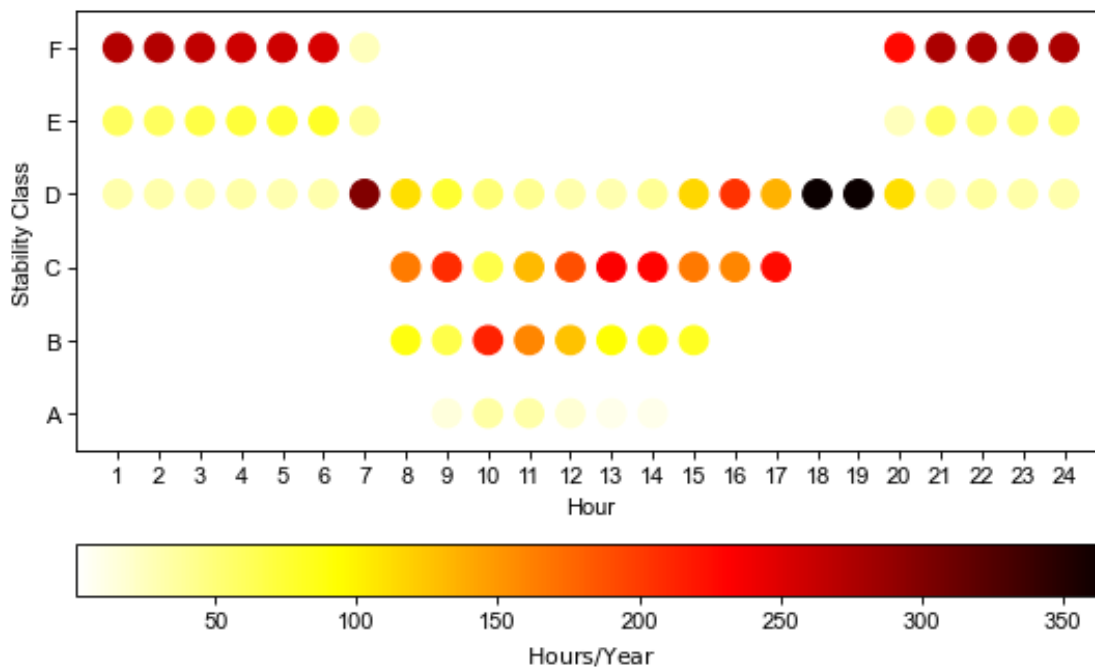


Figure 3-6 Hourly distribution of atmospheric stability classifications at the Darwin Converter site

The hourly distributions of mixing height at the Darwin Converter site from the TAPM model are presented as a box and whiskers plot in Figure 3-7.

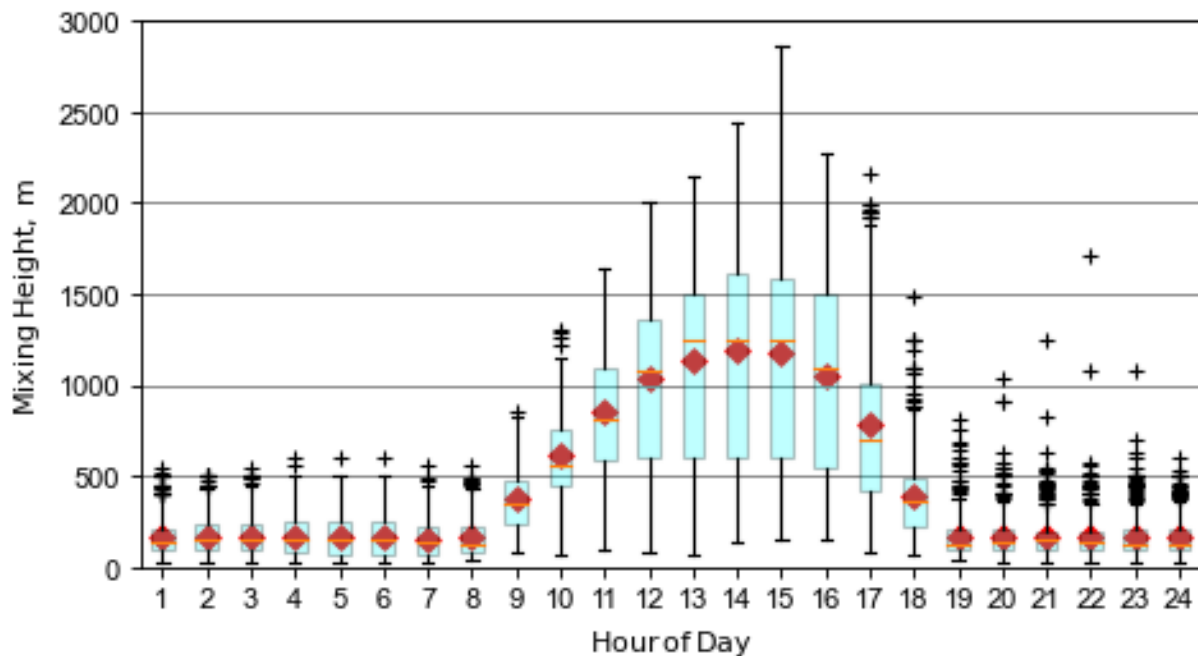


Figure 3-7 Distribution of hourly mixing heights at the Darwin Converter site



4 AUSPLUME Model and Emission Source Configuration

4.1 Model configuration

Multiple AUSPLUME Version 6.0 modelling scenarios were run to simulate dispersion of suspended particle emissions (as TSP, PM₁₀, and PM_{2.5}), deposited dust, and NO_x emissions from diesel fuelled vehicles during site preparation and construction activities at the following sites:

- The Solar Farm site at Powell Creek Station near Elliott
- Individual inland OHTL sites, using the Solar Farm meteorological file
- Individual coastal OHTL sites, using the Murrumujuk meteorological file
- The Darwin Converter site at Murrumujuk
- Trenching activities at Murrumujuk.

The concept of an 'activity area' was utilised in order to best configure emission sources for the solar farm, OHTL and trenching sites. This is important as construction activities vary in time and space, and given the large area of the solar farm and Darwin Converter sites (12,000 ha, 54 ha respectively) it was important to group numerous site preparation and construction activities in the same locality to establish a realistic emissions profile.

In each case, AUSPLUME was configured with:

- No terrain effect (flat terrain) due to the modelling of area sources
- Meteorological file for the Solar Farm or Darwin Converter sites as appropriate
- Sigma-theta horizontal dispersion curves for sources less than 100 m high
- Pasquill-Gifford vertical dispersion curves for sources less than 100 m high
- Roughness height of 0.10 m ("Flat Rural")
- Default boundary-layer potential temperature gradients
- Default wind speed categories
- Irwin Rural wind profile exponents
- Pollutant averaging times of 1 hour, 24 hours, and 1 year

4.2 Solar farm

Dispersion of construction emissions from the various Solar Farm source activity areas were modelled using:

- Varying receptor grid extents and grid spacings according to the emission source:
 - Suspended particles: 5000 m by 5000 m receptor grid centred on Point (0,0) with a 50 m grid spacing
 - Deposited dust: 2500 m by 2500 m receptor grid centred on Point (0,0) with a 50 m grid spacing
 - NO_x emissions from construction vehicles: 5000 m by 5000 m receptor grid centred on Point (0,0) with a 50 m grid spacing



- Square area sources, representing emissions of suspended particles or deposited dust, with the following characteristics:
 - Centred on Point (0,0)
 - Side length of 500 m
 - Orientation angle of 0°
 - Source elevation of 0 m
 - Initial vertical spread of 2 m
 - Release height of 0 m
- Deposited dust sources used the following standard gravitational settling parameters:
 - Particle density of 2.5 g/cm³
 - PM_{2.5} particles accounting for 3.2% of all particles
 - The coarse particle size fraction (those between 2.5 and 10 µm) accounting for 32.3% of all particles
 - The remainder, those between 10 and 50 µm, accounting for 64.5% of all particles.
- Volume sources, representing NO_x emissions from diesel-fuelled vehicles, with the following characteristics:
 - Ground elevation of 0 m
 - Initial horizontal spread of 116.279 m, corresponding to a source width of 500 m
 - Initial vertical spread of 2.325 m, corresponding to an initial mixing depth of 10 m
 - A release height of 5 m, ensuring that emissions are evenly spread over the entire 10 m mixing depth.
- Unit mass emission rate of 1 g/s emitted during hours 7 to 18 (6 am to 6 pm), with no emissions outside of these hours
- Model results scaled by the appropriate mass emission rates, as provided in the emissions inventory section of the main report (Section 6), during the post-processing phase.

4.3 OHTL and Murrumujuk trenching sources

Dispersion of construction emissions from the OHTL and Murrumujuk trenching sources were modelled using:

- Varying receptor grid extents and grid spacings according to the emission source
- Suspended particles: 5,000 m by 5,000 m receptor grid centred on Point (0,0) with a 50 m grid spacing (101 rows by 101 columns)
 - Deposited dust: 2,500 m by 2,500 m receptor grid centred on Point (0,0) with a 50 m grid spacing (51 rows by 51 columns)
 - NO_x emissions from construction vehicles: 5,000 m by 5,000 m receptor grid centred on Point (0,0) with a 50 m grid spacing (101 rows by 101 columns)



- Square area sources, representing emissions of suspended particles or deposited dust, with the following characteristics:
 - Centred on Point (0,0)
 - Side length of 100 m
 - Orientation angle of 0°
 - Source elevation of 0 m
 - Initial vertical spread of 2 m
 - Release height of 0 m
- Deposited dust sources used the following standard gravitational settling parameters:
 - Particle density of 2.5 g/cm³
 - PM_{2.5} particles accounting for 3.2% of all particles
 - The coarse particle size fraction (those between 2.5 and 10 µm) accounting for 32.3% of all particles
 - The remainder, those between 10 and 50 µm, accounting for 64.5% of all particles.
- Volume sources, representing NO_x emissions from diesel-fuelled vehicles, with the following characteristics:
 - Ground elevation of 0 m
 - Initial horizontal spread of 23.25 m, corresponding to a source width of 100 m
 - Initial vertical spread of 2.325 m, corresponding to an initial mixing depth of 10 m
 - A release height of 5 m, ensuring that emissions are evenly spread over the entire 10 m mixing depth.
- Unit mass emission rate of 1 g/s emitted during hours 7 to 18 (6 am to 6 pm), with no emissions outside of these hours
- Model results scaled by the appropriate mass emission rates, as provided in the emissions inventory section of the main report (Section 6), during the post-processing phase.

4.4 Darwin Converter Site

Dispersion of construction emissions from the Darwin Converter Site was modelled using:

- Varying receptor grid extents and grid spacings according to the emission source:
- Suspended particles: 10,000 m by 10,000 m receptor grid centred on Point (723300, 8642500) with a 100 m grid spacing (101 rows by 101 columns)
- Deposited dust: 5,000 m by 5,000 m receptor grid centred on Point (723350, 8642550) with a 100 m grid spacing (51 rows by 51 columns)
- NO_x emissions from construction vehicles: 10,000 m by 10,000 m receptor grid centred on Point (723300, 8642500) with a 100 m grid spacing (101 rows by 101 columns)
- Square area sources, representing emissions of suspended particles or deposited dust, with the following characteristics:



- modelled using a polygonal integrated area source (see Figure 4-1)
- Source base elevation of 0 m
- Initial vertical spread of 2 m
- Release height of 0 m

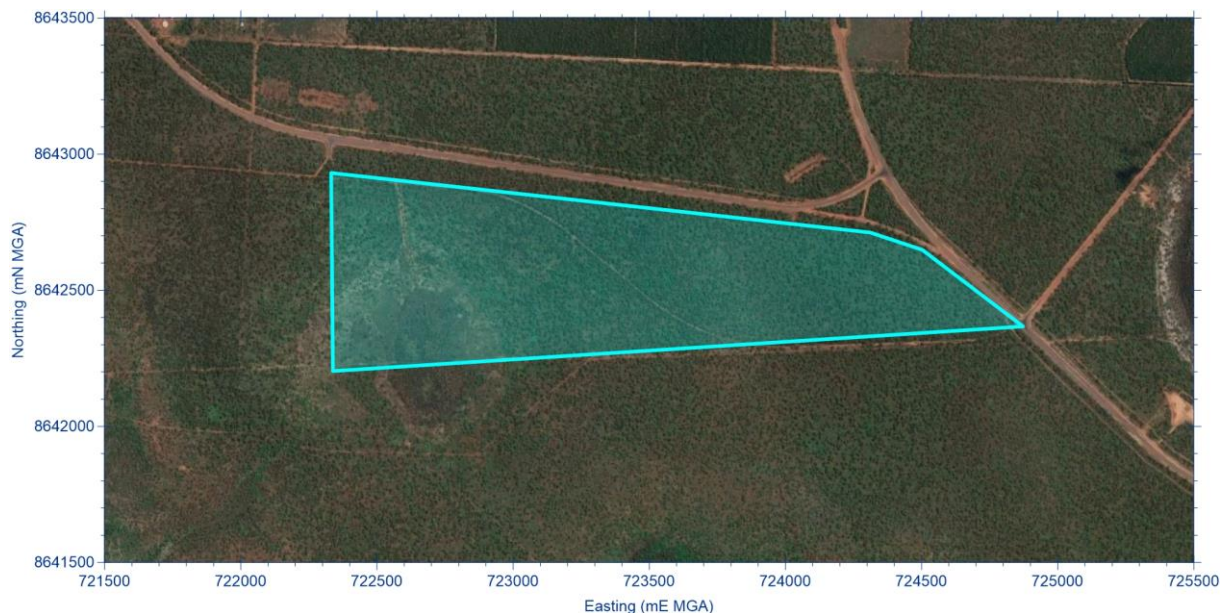


Figure 4-1 Location and extent of the polygonal integrated area source representing construction emissions from the Darwin Converter Site

- Deposited dust sources used the following standard gravitational settling parameters:
 - Particle density of 2.5 g/cm³
 - PM_{2.5} particles accounting for 3.2 % of all particles,
 - The coarse particle size fraction (those between 2.5 and 10 µm) accounting for 32.3% of all particles, and
 - The remainder, those between 10 and 50 µm, accounting for 64.5% of all particles.
- Volume sources, representing NO_x emissions from diesel-fuelled vehicles, with the following characteristics:
 - Ground elevation of 0 m
 - Five adjacent volume sources (see Figure 4-2 and Table 4-1)
 - Mass emission rate from each volume source proportional to its area.
 - Total emission rate from all sources adding up to 1 g/s (unit emissions)
 - Volume sources active during hours 7 to 18 (6 am to 6 pm), with no emissions outside of these hours.
 - Model results scaled by the appropriate mass emission rates, as provided in the emissions inventory section of the main report (Section 6), during the post-processing phase.



Figure 4-2 Location and extent of the five volume sources representing diesel emissions from construction vehicles at the Darwin Converter Site

Table 4-1 Volume source characteristics for diesel emissions from construction vehicles at the Darwin Converter Site

Source Number	Easting, mE MGA	Northing, mN MGA	Source Length & Width, m	Sigma-Y ₀ , m	Release Height, m	Sigma-Z ₀ , m	Proportional Unit Mass Emission Rate, g/s
1	722680	8642556	682	158.60	5	2.33	0.38
2	723304	8642547	568	132.09	5	2.33	0.27
3	723822	8642528	464	107.91	5	2.33	0.18
4	724253	8642514	392	91.16	5	2.33	0.13
5	724570	8642459	246	57.21	5	2.33	0.05

- Unit mass emission rate of 1 g/s emitted during Hours 7 to 18 (6 am to 6 pm), with no emissions outside of these hours.
- Model results scaled by the appropriate mass emission rates, as provided in the emissions inventory section of the main report (Section 6), during the post-processing phase.
- The AUSPLUME model configuration file for vehicle emissions from the Darwin Converter site is presented below in Section 5.



5 Sample AUSPLUME Configuration File

1

Murrumujuk Vehicle Emissions_5 Vol Sources

Concentration or deposition	Concentration
Emission rate units	grams/second
Concentration units	microgram/m ³
Units conversion factor	1.00E+06
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Averaging time for sigma-theta values	60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Sigma-theta
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.100m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class					
	A	B	C	D	E	F

1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES

Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES

1 hour
24 hours
average over all hours



1

Murrumujuk Vehicle Emissions_5 Vol Sources

SOURCE CHARACTERISTICS

VOLUME SOURCE: VOL1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
722680	8642556	0m	5m	159m	2m

Emission rates by hour of day in grams/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 3.80E-01	8 3.80E-01
9 3.80E-01	10 3.80E-01	11 3.80E-01	12 3.80E-01
13 3.80E-01	14 3.80E-01	15 3.80E-01	16 3.80E-01
17 3.80E-01	18 3.80E-01	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: VOL2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
723304	8642547	0m	5m	132m	2m

Emission rates by hour of day in grams/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 2.70E-01	8 2.70E-01
9 2.70E-01	10 2.70E-01	11 2.70E-01	12 2.70E-01
13 2.70E-01	14 2.70E-01	15 2.70E-01	16 2.70E-01
17 2.70E-01	18 2.70E-01	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: VOL3

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
723822	8642528	0m	5m	108m	2m

Emission rates by hour of day in grams/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 1.80E-01	8 1.80E-01
9 1.80E-01	10 1.80E-01	11 1.80E-01	12 1.80E-01
13 1.80E-01	14 1.80E-01	15 1.80E-01	16 1.80E-01
17 1.80E-01	18 1.80E-01	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: VOL4

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
724253	8642514	0m	5m	91m	2m

Emission rates by hour of day in grams/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 1.30E-01	8 1.30E-01
9 1.30E-01	10 1.30E-01	11 1.30E-01	12 1.30E-01
13 1.30E-01	14 1.30E-01	15 1.30E-01	16 1.30E-01
17 1.30E-01	18 1.30E-01	19 0.00E+00	20 0.00E+00



21 0.00E+00 22 0.00E+00 23 0.00E+00 24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: VOL5

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
724571	8642459	0m	5m	57m	2m

Emission rates by hour of day in grams/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 5.00E-02	8 5.00E-02
9 5.00E-02	10 5.00E-02	11 5.00E-02	12 5.00E-02
13 5.00E-02	14 5.00E-02	15 5.00E-02	16 5.00E-02
17 5.00E-02	18 5.00E-02	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

1

Murrumujuk Vehicle Emissions_5 Vol Sources

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

718300.m 718400.m 718500.m 718600.m 718700.m 718800.m 718900.m
719000.m 719100.m 719200.m 719300.m 719400.m 719500.m 719600.m
719700.m 719800.m 719900.m 720000.m 720100.m 720200.m 720300.m
720400.m 720500.m 720600.m 720700.m 720800.m 720900.m 721000.m
721100.m 721200.m 721300.m 721400.m 721500.m 721600.m 721700.m
721800.m 721900.m 722000.m 722100.m 722200.m 722300.m 722400.m
722500.m 722600.m 722700.m 722800.m 722900.m 723000.m 723100.m
723200.m 723300.m 723400.m 723500.m 723600.m 723700.m 723800.m
723900.m 724000.m 724100.m 724200.m 724300.m 724400.m 724500.m
724600.m 724700.m 724800.m 724900.m 725000.m 725100.m 725200.m
725300.m 725400.m 725500.m 725600.m 725700.m 725800.m 725900.m
726000.m 726100.m 726200.m 726300.m 726400.m 726500.m 726600.m
726700.m 726800.m 726900.m 727000.m 727100.m 727200.m 727300.m
727400.m 727500.m 727600.m 727700.m 727800.m 727900.m 728000.m
728100.m 728200.m 728300.m

and these y-values (or northings):

8637500.m 8637600.m 8637700.m 8637800.m 8637900.m 8638000.m 8638100.m
8638200.m 8638300.m 8638400.m 8638500.m 8638600.m 8638700.m 8638800.m
8638900.m 8639000.m 8639100.m 8639200.m 8639300.m 8639400.m 8639500.m
8639600.m 8639700.m 8639800.m 8639900.m 8640000.m 8640100.m 8640200.m
8640300.m 8640400.m 8640500.m 8640600.m 8640700.m 8640800.m 8640900.m
8641000.m 8641100.m 8641200.m 8641300.m 8641400.m 8641500.m 8641600.m
8641700.m 8641800.m 8641900.m 8642000.m 8642100.m 8642200.m 8642300.m
8642400.m 8642500.m 8642600.m 8642700.m 8642800.m 8642900.m 8643000.m
8643100.m 8643200.m 8643300.m 8643400.m 8643500.m 8643600.m 8643700.m
8643800.m 8643900.m 8644000.m 8644100.m 8644200.m 8644300.m 8644400.m
8644500.m 8644600.m 8644700.m 8644800.m 8644900.m 8645000.m 8645100.m
8645200.m 8645300.m 8645400.m 8645500.m 8645600.m 8645700.m 8645800.m
8645900.m 8646000.m 8646100.m 8646200.m 8646300.m 8646400.m 8646500.m
8646600.m 8646700.m 8646800.m 8646900.m 8647000.m 8647100.m 8647200.m
8647300.m 8647400.m 8647500.m

METEOROLOGICAL DATA : Sun Cable Murrumujuk, Nov 2018 to Oct 2019, TAPM/Pyth



1 Peak values for the 100 worst cases (in microgram/m3)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	1.78E+02	07,16/01/19	(722600, 8642600, 0.0)
2	1.72E+02	07,19/01/19	(722700, 8642500, 0.0)
3	1.70E+02	10,15/04/19	(722700, 8642600, 0.0)
4	1.70E+02	08,15/03/19	(722700, 8642500, 0.0)
5	1.69E+02	11,20/09/19	(722700, 8642600, 0.0)
6	1.65E+02	11,25/10/19	(722700, 8642600, 0.0)
7	1.64E+02	09,15/10/19	(722700, 8642500, 0.0)
8	1.62E+02	09,19/01/19	(722700, 8642600, 0.0)
9	1.57E+02	08,27/10/19	(722700, 8642500, 0.0)
10	1.52E+02	08,16/01/19	(722600, 8642600, 0.0)
11	1.47E+02	07,18/01/19	(722700, 8642600, 0.0)
12	1.46E+02	08,12/03/19	(722700, 8642600, 0.0)
13	1.46E+02	09,26/10/19	(722700, 8642600, 0.0)
14	1.45E+02	08,12/11/18	(722700, 8642500, 0.0)
15	1.45E+02	15,31/03/19	(722700, 8642600, 0.0)
16	1.45E+02	08,05/11/18	(722600, 8642500, 0.0)
17	1.45E+02	09,30/09/19	(723300, 8642500, 0.0)
18	1.43E+02	07,12/11/18	(722700, 8642500, 0.0)
19	1.41E+02	07,12/03/19	(722600, 8642600, 0.0)
20	1.41E+02	11,15/04/19	(723300, 8642500, 0.0)
21	1.39E+02	18,02/04/19	(722600, 8642600, 0.0)
22	1.38E+02	09,27/10/19	(722700, 8642500, 0.0)
23	1.36E+02	08,17/11/18	(722700, 8642500, 0.0)
24	1.34E+02	07,05/11/18	(722600, 8642600, 0.0)
25	1.32E+02	10,20/09/19	(722600, 8642600, 0.0)
26	1.32E+02	10,06/11/18	(722800, 8642600, 0.0)
27	1.25E+02	07,30/10/19	(722600, 8642600, 0.0)
28	1.25E+02	08,29/11/18	(722700, 8642500, 0.0)
29	1.24E+02	07,15/03/19	(722600, 8642600, 0.0)
30	1.24E+02	09,06/11/18	(722700, 8642500, 0.0)
31	1.23E+02	08,26/10/19	(723300, 8642500, 0.0)
32	1.23E+02	11,17/08/19	(722800, 8642500, 0.0)
33	1.22E+02	12,30/03/19	(722700, 8642500, 0.0)
34	1.22E+02	08,08/11/18	(723800, 8642500, 0.0)
35	1.22E+02	12,09/11/18	(723300, 8642600, 0.0)
36	1.20E+02	08,19/01/19	(722600, 8642500, 0.0)
37	1.20E+02	10,07/10/19	(722700, 8642500, 0.0)
38	1.18E+02	07,20/01/19	(722600, 8642600, 0.0)
39	1.18E+02	10,13/10/19	(722700, 8642500, 0.0)
40	1.18E+02	08,16/11/18	(722700, 8642500, 0.0)
41	1.18E+02	13,09/03/19	(722700, 8642500, 0.0)
42	1.17E+02	09,07/10/19	(723300, 8642600, 0.0)
43	1.09E+02	07,13/01/19	(722700, 8642500, 0.0)
44	1.09E+02	07,02/12/18	(722700, 8642500, 0.0)
45	1.09E+02	07,14/11/18	(722600, 8642500, 0.0)
46	1.09E+02	08,30/09/19	(722700, 8642600, 0.0)
47	1.08E+02	08,07/11/18	(722700, 8642500, 0.0)
48	1.07E+02	07,17/01/19	(722700, 8642600, 0.0)
49	1.07E+02	10,29/11/18	(723300, 8642500, 0.0)
50	1.05E+02	10,27/02/19	(722700, 8642500, 0.0)
51	1.05E+02	07,11/11/18	(722700, 8642500, 0.0)
52	1.05E+02	10,25/10/19	(722800, 8642500, 0.0)
53	1.04E+02	08,25/02/19	(722700, 8642500, 0.0)
54	1.04E+02	07,18/11/18	(722700, 8642600, 0.0)
55	1.03E+02	07,27/02/19	(722600, 8642600, 0.0)
56	1.02E+02	10,19/01/19	(722700, 8642600, 0.0)
57	1.02E+02	09,27/02/19	(723800, 8642500, 0.0)
58	1.01E+02	07,08/11/18	(722600, 8642500, 0.0)



59	1.01E+02	07,28/02/19	(722600, 8642500, 0.0)
60	9.86E+01	07,16/11/18	(722600, 8642500, 0.0)
61	9.80E+01	10,15/10/19	(723300, 8642500, 0.0)
62	9.65E+01	09,29/11/18	(723300, 8642500, 0.0)
63	9.54E+01	07,06/03/19	(722600, 8642500, 0.0)
64	9.49E+01	07,29/11/18	(722700, 8642500, 0.0)
65	9.46E+01	07,26/02/19	(722600, 8642600, 0.0)
66	9.39E+01	09,06/04/19	(723300, 8642500, 0.0)
67	9.31E+01	07,06/11/18	(722600, 8642600, 0.0)
68	9.28E+01	09,23/11/18	(723300, 8642500, 0.0)
69	9.28E+01	13,18/08/19	(723300, 8642500, 0.0)
70	9.24E+01	08,31/10/19	(722700, 8642500, 0.0)
71	9.19E+01	07,26/10/19	(722600, 8642500, 0.0)
72	9.12E+01	07,26/12/18	(722600, 8642600, 0.0)
73	9.08E+01	07,30/09/19	(722600, 8642600, 0.0)
74	8.86E+01	07,25/02/19	(722600, 8642600, 0.0)
75	8.79E+01	09,08/11/18	(723300, 8642600, 0.0)
76	8.78E+01	08,16/10/19	(722700, 8642600, 0.0)
77	8.77E+01	09,12/11/18	(723300, 8642500, 0.0)
78	8.77E+01	09,12/10/19	(723300, 8642600, 0.0)
79	8.75E+01	07,29/03/19	(722700, 8642600, 0.0)
80	8.73E+01	07,03/12/18	(722700, 8642500, 0.0)
81	8.73E+01	07,22/11/18	(722700, 8642500, 0.0)
82	8.73E+01	07,25/11/18	(722700, 8642500, 0.0)
83	8.62E+01	07,23/11/18	(722700, 8642500, 0.0)
84	8.54E+01	11,06/11/18	(722700, 8642600, 0.0)
85	8.49E+01	07,06/04/19	(722600, 8642600, 0.0)
86	8.47E+01	07,16/04/19	(722600, 8642600, 0.0)
87	8.37E+01	09,13/10/19	(723300, 8642600, 0.0)
88	8.36E+01	07,24/11/18	(722700, 8642500, 0.0)
89	8.34E+01	09,15/03/19	(723300, 8642500, 0.0)
90	8.32E+01	09,15/04/19	(722700, 8642600, 0.0)
91	8.32E+01	08,30/10/19	(723300, 8642500, 0.0)
92	8.28E+01	07,12/10/19	(722600, 8642600, 0.0)
93	8.24E+01	07,08/03/19	(722600, 8642600, 0.0)
94	8.24E+01	07,07/11/18	(722600, 8642600, 0.0)
95	8.22E+01	07,31/10/19	(722600, 8642500, 0.0)
96	8.21E+01	09,25/02/19	(722700, 8642500, 0.0)
97	8.14E+01	07,08/10/19	(722600, 8642600, 0.0)
98	8.13E+01	07,18/10/19	(722600, 8642600, 0.0)
99	8.09E+01	07,17/11/18	(722600, 8642600, 0.0)
100	8.04E+01	07,27/10/19	(722600, 8642600, 0.0)

1 Peak values for the 100 worst cases (in microgram/m3)
Averaging time = 24 hours

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	3.17E+01	24,19/01/19	(722700, 8642500, 0.0)
2	2.86E+01	24,06/11/18	(722700, 8642500, 0.0)
3	2.67E+01	24,27/10/19	(722700, 8642500, 0.0)
4	2.52E+01	24,29/11/18	(722700, 8642500, 0.0)
5	2.43E+01	24,12/11/18	(722700, 8642500, 0.0)
6	2.15E+01	24,05/11/18	(722700, 8642500, 0.0)
7	2.12E+01	24,15/04/19	(722600, 8642500, 0.0)
8	2.11E+01	24,17/11/18	(722700, 8642500, 0.0)
9	2.10E+01	24,26/10/19	(722700, 8642500, 0.0)
10	2.04E+01	24,25/02/19	(722700, 8642500, 0.0)
11	1.98E+01	24,28/02/19	(723300, 8642500, 0.0)
12	1.97E+01	24,24/11/18	(722700, 8642500, 0.0)
13	1.94E+01	24,23/11/18	(722700, 8642500, 0.0)
14	1.90E+01	24,15/10/19	(723300, 8642500, 0.0)
15	1.90E+01	24,25/10/19	(722700, 8642600, 0.0)
16	1.86E+01	24,07/11/18	(722700, 8642500, 0.0)
17	1.86E+01	24,15/03/19	(722700, 8642500, 0.0)



18	1.84E+01	24,31/10/19	(723300, 8642500,	0.0)
19	1.82E+01	24,07/10/19	(722600, 8642600,	0.0)
20	1.80E+01	24,10/11/18	(722700, 8642500,	0.0)
21	1.78E+01	24,16/04/19	(723800, 8642500,	0.0)
22	1.75E+01	24,31/03/19	(722700, 8642600,	0.0)
23	1.74E+01	24,12/03/19	(722700, 8642600,	0.0)
24	1.74E+01	24,18/01/19	(722700, 8642600,	0.0)
25	1.73E+01	24,08/03/19	(723300, 8642500,	0.0)
26	1.71E+01	24,30/09/19	(722600, 8642500,	0.0)
27	1.67E+01	24,13/01/19	(722700, 8642500,	0.0)
28	1.67E+01	24,16/01/19	(722700, 8642600,	0.0)
29	1.63E+01	24,27/02/19	(723300, 8642500,	0.0)
30	1.62E+01	24,30/10/19	(723300, 8642500,	0.0)
31	1.61E+01	24,02/12/18	(722700, 8642500,	0.0)
32	1.61E+01	24,16/11/18	(723300, 8642500,	0.0)
33	1.59E+01	24,17/10/19	(722700, 8642500,	0.0)
34	1.59E+01	24,15/01/19	(722700, 8642500,	0.0)
35	1.58E+01	24,07/03/19	(723300, 8642500,	0.0)
36	1.55E+01	24,17/01/19	(722700, 8642600,	0.0)
37	1.53E+01	24,11/11/18	(722700, 8642500,	0.0)
38	1.52E+01	24,17/08/19	(722700, 8642600,	0.0)
39	1.51E+01	24,13/11/18	(722700, 8642500,	0.0)
40	1.51E+01	24,02/04/19	(722600, 8642600,	0.0)
41	1.51E+01	24,20/01/19	(722600, 8642500,	0.0)
42	1.49E+01	24,13/03/19	(722700, 8642500,	0.0)
43	1.48E+01	24,28/12/18	(722700, 8642500,	0.0)
44	1.48E+01	24,06/03/19	(723300, 8642500,	0.0)
45	1.48E+01	24,20/11/18	(723300, 8642500,	0.0)
46	1.48E+01	24,30/11/18	(722700, 8642500,	0.0)
47	1.44E+01	24,14/11/18	(723300, 8642500,	0.0)
48	1.44E+01	24,24/09/19	(722600, 8642500,	0.0)
49	1.43E+01	24,18/08/19	(722800, 8642600,	0.0)
50	1.42E+01	24,29/03/19	(722700, 8642600,	0.0)
51	1.41E+01	24,26/02/19	(723300, 8642500,	0.0)
52	1.40E+01	24,16/10/19	(722700, 8642600,	0.0)
53	1.38E+01	24,20/09/19	(722700, 8642500,	0.0)
54	1.35E+01	24,06/04/19	(723300, 8642500,	0.0)
55	1.35E+01	24,14/01/19	(722700, 8642500,	0.0)
56	1.33E+01	24,05/04/19	(722600, 8642600,	0.0)
57	1.33E+01	24,09/11/18	(723300, 8642500,	0.0)
58	1.31E+01	24,03/12/18	(722700, 8642500,	0.0)
59	1.30E+01	24,13/10/19	(722700, 8642500,	0.0)
60	1.30E+01	24,25/11/18	(722700, 8642500,	0.0)
61	1.30E+01	24,26/12/18	(722600, 8642500,	0.0)
62	1.30E+01	24,30/03/19	(722700, 8642500,	0.0)
63	1.28E+01	24,08/11/18	(723300, 8642500,	0.0)
64	1.28E+01	24,23/12/18	(722700, 8642500,	0.0)
65	1.28E+01	24,19/11/18	(722700, 8642500,	0.0)
66	1.27E+01	24,19/09/19	(722600, 8642500,	0.0)
67	1.27E+01	24,22/11/18	(722700, 8642500,	0.0)
68	1.27E+01	24,29/09/19	(723800, 8642500,	0.0)
69	1.26E+01	24,12/10/19	(723300, 8642600,	0.0)
70	1.25E+01	24,27/03/19	(722700, 8642600,	0.0)
71	1.25E+01	24,21/11/18	(722700, 8642500,	0.0)
72	1.24E+01	24,01/12/18	(722700, 8642500,	0.0)
73	1.24E+01	24,18/11/18	(722700, 8642600,	0.0)
74	1.24E+01	24,19/08/19	(722600, 8642500,	0.0)
75	1.23E+01	24,17/04/19	(722600, 8642500,	0.0)
76	1.21E+01	24,11/10/19	(723300, 8642600,	0.0)
77	1.21E+01	24,15/06/19	(722600, 8642500,	0.0)
78	1.20E+01	24,03/10/19	(723300, 8642500,	0.0)
79	1.20E+01	24,21/01/19	(723300, 8642500,	0.0)
80	1.19E+01	24,08/12/18	(722700, 8642500,	0.0)
81	1.18E+01	24,28/10/19	(722600, 8642600,	0.0)
82	1.17E+01	24,15/11/18	(722600, 8642500,	0.0)
83	1.16E+01	24,12/01/19	(722700, 8642500,	0.0)
84	1.16E+01	24,04/12/18	(722700, 8642500,	0.0)
85	1.16E+01	24,08/08/19	(722600, 8642600,	0.0)
86	1.16E+01	24,29/12/18	(722700, 8642500,	0.0)



87	1.15E+01	24,08/10/19	(722600, 8642500,	0.0)
88	1.14E+01	24,30/12/18	(722700, 8642500,	0.0)
89	1.13E+01	24,07/01/19	(722700, 8642500,	0.0)
90	1.13E+01	24,28/03/19	(722700, 8642600,	0.0)
91	1.13E+01	24,14/03/19	(723300, 8642500,	0.0)
92	1.12E+01	24,25/12/18	(722700, 8642500,	0.0)
93	1.11E+01	24,09/03/19	(722600, 8642600,	0.0)
94	1.11E+01	24,17/05/19	(722600, 8642500,	0.0)
95	1.11E+01	24,18/04/19	(722600, 8642500,	0.0)
96	1.11E+01	24,10/10/19	(722600, 8642500,	0.0)
97	1.11E+01	24,16/02/19	(722700, 8642500,	0.0)
98	1.11E+01	24,08/04/19	(722600, 8642500,	0.0)
99	1.11E+01	24,07/08/19	(722700, 8642600,	0.0)
100	1.10E+01	24,21/09/19	(723300, 8642500,	0.0)



6 Distance Decay Assessment Methodology

The solar farm site within the Powell Creek Pastoral Lease will cover an area of up to 12,000 ha. The nature of the site preparation process means that dust generating activities will only occur within a small portion of the site at any given time prior to moving on to an adjacent area. Similarly, site preparation activities along the extent of the Over Head Transmission Line (OHTL) will be contained within small activity areas surrounding the 50 m high monopole sites, which are spaced 300 to 400 m apart.

Rather than map predicted concentrations across the entire solar farm site, and at each of the many OHTL sites, a distance decay approach has been used to determine the maximum downwind distance from a site preparation or construction activity area required to meet the relevant criteria. The red square at the centre of Figure 6-1 represents a modelled construction area. Model results are extracted at 1 m intervals along downwind transects extending from the construction area boundary out to downwind distances of up to 1200 m. Transects are established at 5° intervals to ensure that all wind directions are accounted for.

Distance decay curves are plotted from this information showing the range of predicted pollutant concentrations at each downwind distance and providing the separation distance required to meet the assessment criterion.

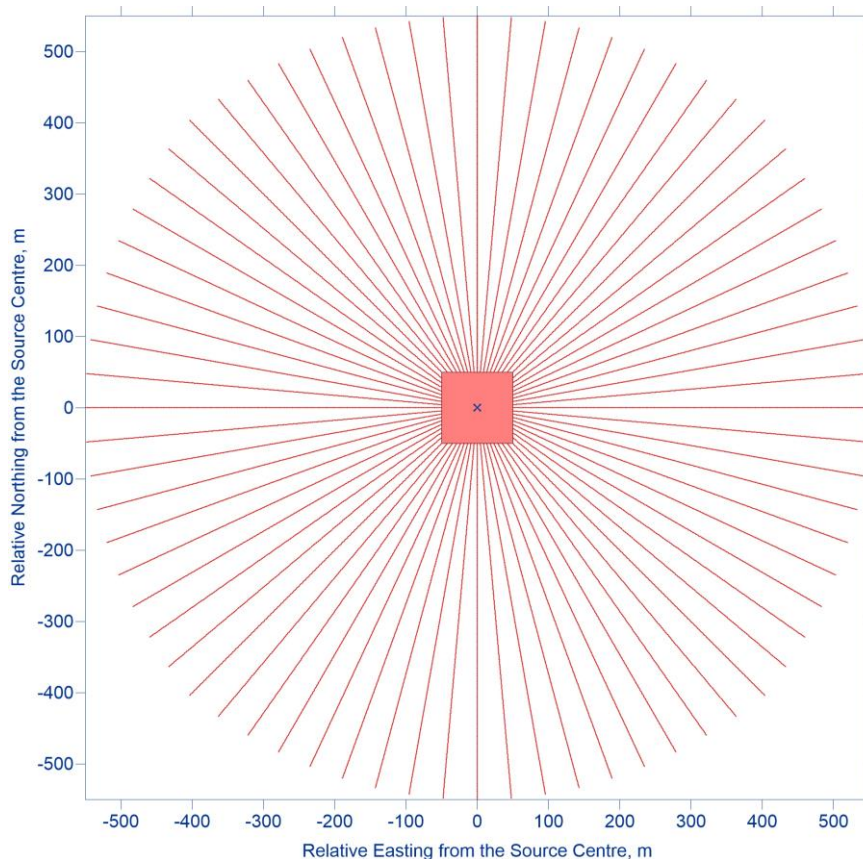


Figure 6-1 Example of transects surrounding the boundary of the OHTL area source, with transects spaced at 5° intervals, and grid points along the transect at 1m intervals.



7 Method for Conversion of NO_x to NO₂

The assessment of predicted NO₂ impact was based on the conversion of NO_x to NO₂ using the Level 1 Ozone Limiting Method, as described in the NSW EPA Approved Methods, (Section 8.1.2, p.39) (EPA, 2017). The OLM equation is as follows:

Equation 1:

$$[\text{NO}_2]_{\text{total}} = \{0.1 \times [\text{NO}_x]_{\text{pred}}\} + \text{Min}\{(0.9) \times [\text{NO}_x]_{\text{pred}} \text{ Or } (46/48) \times [\text{O}_3]_{\text{bkgd}}\} + [\text{NO}_2]_{\text{bkgd}}$$

Where:

- [NO₂]_{total} = the predicted concentration of NO₂ in µg/m³
- [NO_x]_{pred} = the dispersion model prediction of the ground-level concentration of NO_x in µg/m³
- Min = the minimum of the two quantities within the braces
- [O₃]_{bkgd} = the background ambient O₃ concentration in µg/m³
- (46/48) = the molecular weight of NO₂ divided by the molecular weight of O₃
- [NO₂]_{bkgd} = the background ambient NO₂ concentration in µg/m³

The data used to calculate NO₂ from predicted NO_x concentrations in the model domain using the OLM equation are presented in Table 7-1.

Table 7-1 Parameter values used to calculate NO₂ using the OLM

Parameter	Averaging period	Value
In-stack proportion of NO ₂ /NO _x	N/A	10%
NO ₂ background concentration	1-hour	5.6 µg/m ³
	Annual	4.7 µg/m ³
O ₃ background concentration	1-hour	183
	Annual	40