

South Hedland Power Station
Air Quality Assessment

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1 Introduction

1.1 Background

TEC Hedland Pty Ltd (TEC Hedland), a subsidiary of TransAlta Energy (Australia) Pty Ltd (TransAlta) proposes to construct and operate a 191 MW power station, located near South Hedland within the Boodarie Resource Processing Estate, Western Australia (Figure 1). The power station proposed by TEC Hedland is intended to replace Horizon Power's 120 MW South Hedland Power Station currently approved for the site. TEC Hedland proposes to modify the operation and capability of the approved South Hedland Power Station to satisfy the power requirements of Horizon Power and The Pilbara Infrastructure Pty Ltd.

The current approval for the South Hedland Power Station, previously obtained by Horizon Power, permits the project to be developed in two stages. Stage 1 involves the operation of 60 MW of temporary generation capacity, and Stage 2 involves the operation of 120 MW as the permanent capacity. The revised TEC Hedland proposal for the South Hedland Power Station involves the construction and operation of 191 MW as permanent generating capacity, and does not involve the operation of temporary generating capacity.

ENVIRON Australia Pty Ltd (ENVIRON) has been engaged by Strategen to undertake an air quality assessment of the atmospheric emissions associated with TEC Hedland's proposal for the South Hedland Power Station. The air quality assessment has been completed in support of the referral of the proposal to the Environmental Protection Authority (EPA).

The TEC Hedland revised South Hedland Power Station proposal is referred to within this report as the "proposed South Hedland Power Station", and Horizon Power's original South Hedland Power Station proposal is referred to as the "currently approved South Hedland Power Station".

1.2 Purpose of this Report

This report presents the assessment of the potential air quality impacts arising from atmospheric emissions from the proposed South Hedland Power Station, including the approach, methodology and results of the air dispersion modelling.

The following compounds have been considered in the air dispersion modelling assessment:

- Oxides of nitrogen (NO_x), including nitrogen dioxide (NO_2);
- Carbon monoxide (CO);
- Sulphur dioxide (SO_2); and
- Particulate Matter (PM).

The cumulative impact of NO_x emissions from the proposed South Hedland Power Station and other existing power station sources and other approved sources within the region have been evaluated using air dispersion modelling results. Where ambient monitoring data is available for the compounds of interest, this has been used to determine the cumulative impacts of the proposed South Hedland Power Station at the monitoring locations.

1.3 Site Description

The proposed South Hedland Power Station will be located within the existing Horizon Power premises, at Lot 601 on Deposited Plan 70566, Boodarie Station Access Road. The site is located within the Boodarie Resource Processing Estate, approximately 6 km from the Town of South Hedland and approximately 13 km south of Port Hedland (Figure 1).

The area surrounding the site of the proposed South Hedland Power Station is predominantly flat with sparse vegetation. The nearest residences to the site of the proposed South Hedland Power Station are:

- South Hedland Rural Estate (Boodarie locality), 5 km to the east south-east;
- Town of South Hedland, 6 km to the north east; and
- Boodarie Homestead, approximately 8 km to the west.

Power to the region is currently supplied by the Port Hedland Power Station, operated by Alinta DEWAP Pty Ltd (Alinta). The Port Hedland Power Station is comprised of a facility located adjacent (north east) of the Horizon Power premises boundary, and a facility that is located approximately 5 km to the north at the site of the old BHP Billiton Direct Reduced Iron Pty Ltd plant. The Boodarie Waste to Energy and Materials Recovery Facility proposed by New Energy Corporation (New Energy) is located adjacent (north west) to the Horizon Power premises boundary.

1.4 Project Description

The proposed South Hedland Power Station will have a total installed plant generating capacity of 191 MW, generated by two Combined Cycle Gas Turbines (CCGT) units (107 MW combined), and two Open Cycle Gas Turbines (OCGT) units (84 MW combined).

During normal operations the gas turbines (GTs) will be operated on natural gas, however the units will have the ability to operate on distillate fuel during an emergency. The CCGTs are intended to supply base load power, and the OCGTs are intended to operate during periods of peak power demand. All GTs will be fitted with Dry Low Emission (DLE) technology for NO_x control that will reduce NO_x emissions to 25 ppmv (dry, at 15% O_2) during natural gas operations.

A layout of the proposed South Hedland Power Station is provided as Figure 2 highlighting the locations of the emission sources considered in this assessment.

2 Air Quality Criteria

2.1 Ambient Air Quality Guidelines

In June 1998 the National Environment Protection Council (NEPC) set uniform standards for ambient air quality to allow for the adequate protection of human health and wellbeing. This was achieved via the creation of the National Environmental Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2003) which defined ambient air quality standards for criteria pollutants, including (but not limited to) NO_2, CO, SO_2 and particulates (as particles less than 10 µm in equivalent aerodynamic diameter [PM_{10}]). Amendments were made to the Ambient Air Quality NEPM in 2003 to include advisory reporting standards for particles less than 2.5 µm in equivalent aerodynamic diameter ($PM_{2.5}$).

The Western Australian State Government has recommended the adoption of the NEPM standards for ambient air quality as part of the draft State Environmental (Ambient Air) Policy 2009 (Government of WA, 2009). The NEPM standards applied in this assessment and are presented in Table 1.

Table 1: NEPM Ambient Air Quality Standards and Goals

Pollutant	Averaging Period	Standard	Units [1]	Goals[2]
NO_2	1-hour	0.12	ppm	1 day a year
	Annual	0.03	ppm	none
CO	8-hour	9.0	ppm	1 day a year
SO_2	1-hour	0.20	ppm	1 day a year
	24-hour	0.08	ppm	1 day a year
	Annual	0.02	ppm	none
PM_{10}	24-hour	50	µg/m^3	5 days a year
$PM_{2.5}$[3]	24-hour	25	µg/m^3	na
	Annual	8	µg/m^3	na

Notes
1. µg/m^3 referenced to 0ºC, and 101.3 kPa.
2. Maximum number of allowable exceedences.
3. Advisory reporting standards.

2.2 Emission Standards and Limits

In the absence of any applicable regulatory emission standards in Western Australia, NO_x emissions from the proposed South Hedland Power Station have been compared to the emission standards specified in the New South Wales *Protection of the Environment Operations (Clean Air) Regulation 2010* for electricity generation (Table 2).

Table 2: Emission Standards for Electricity Generation [1]

Activity	Pollutant	Standard (mg/Nm^3) [2]
Any turbine operating on gas, being a turbine used in conjunction with an electricity generation system	NO_2 or nitric oxide (NO), or both, as NO_2 equivalent	70 [34 ppm]
Any turbine operating on a fuel other than natural gas, being a turbine used in conjunction with an electricity generation system		90 [44 ppm]

Notes

1. New South Wales *Protection of the Environment Operations (Clean Air) Regulation 2010* for Group 6 activity (i.e. activity commenced after 1 September 2005), and for units with a generating capacity of more than 30 MW.
2. mg/Nm^3 dry, at STP (0^oC, 101.3 kPa), referenced to 15% O_2.

The maximum NO_x emission specification of the proposed South Hedland Power Station GTs during normal operations is 25 ppmv (dry, at 15% O_2) for natural gas, and is within the emission standard specified in New South Wales.

For distillate fuel operations the maximum NO_x emission specification for the proposed South Hedland Power Station GTs is 85 ppmv (dry, at 15% O_2), and does not achieve the emission standard specified in New South Wales. However, the proposed South Hedland Power Station will only be operated on distillate fuel in the event of an emergency. The potential air quality impact associated with NO_x emissions during emergency operation of the proposed South Hedland Power Station has been considered as part of this assessment (refer to Section 6).

It should be noted that for the purposes of the NO_x emission specifications, normal GT operations is defined as the operating range from 75% to 100% of full load.

3 Existing Environment

3.1 Climate and Meteorology

The Port Hedland climate is a semi-desert tropical climate. Weather patterns are characterised by extremes in both temperature and rainfall. Tropical cyclonic activity generally occurs between November and March, although tropical cyclones can occur outside of this period (New Energy, 2012).

Local meteorological conditions at the site are influenced by coastal wind patterns, tropical cyclonic activity, and the low surface roughness of the surrounding environment. Winds are variable seasonally in direction and strength. The windiest conditions are experienced in summer, with winds generally prevailing from the north-west. West and north-westerly winds are dominant in summer, spring and most of autumn. In general, westerly winds are dominant in the morning, shifting to north-westerly in the afternoon, with an accompanying increase in speed. In winter, east to south-easterly winds are dominant in the mornings and shift to north-easterlies in the afternoon before easing in the evening in response to diurnal land temperature changes (New Energy, 2012).

A description of the site meteorological dataset used for modelling is provided in Section 4.2.

3.2 Existing Air Quality

The Port Hedland Industries Council (PHIC) has established a network of ambient air quality monitoring stations around the Port Hedland area. The network has been established to ensure that dust generated by port and industry operations does not adversely impact the Port Hedland community (PHIC, 2013). The focus of the monitoring network is therefore on the measurement of particulates, however ambient NO_2 and SO_2 are being monitored at a number of locations to determine the relative change in the ambient concentration of these pollutants over time. The monitoring locations nearest to the proposed South Hedland Power Station include Acacia Way, Wedgefield, and Bureau of Meteorology (BoM). PM_{10} is monitored at all three of these locations, and NO_2 and SO_2 is measured at Acacia Way and at the BoM site.

The most recently published monitoring results for the period 1 July 2012 to 30 June 2013 (PHIC, 2013) are presented in Figures 3 to 5. The monitoring results indicate that the ambient concentrations of NO_2 measured at Acacia Way and the BoM site comfortably complied with the relevant ambient criteria. The highest short-term (1-hour average) ambient concentration of NO_2 measured at Acacia Way (0.04 ppm) most closely approached (33%) the ambient criteria, although only marginally lower concentrations were measured at the BoM site.

The ambient concentrations of SO_2 measured at Acacia Way and the BoM site also comfortably complied with the relevant ambient criteria. The highest short-term (1-hour average) ambient concentration of SO_2 measured at the BoM site (0.02 ppm) most closely approached (10%) the ambient criteria, although only marginally lower concentrations were measured at Acacia Way.

Historically ambient PM_{10} concentrations in the Port Hedland region have been elevated due to dust generated by port and industry activity, as well as naturally high background dust levels throughout the region. As such, there were a number of occasions during the monitored period when the measured concentration of PM_{10} exceeded the ambient criteria. The particularly high level of PM_{10} measured in Wedgefield during the monitored period was likely caused by localised activities and sources at the monitoring station (PHIC, 2013), and therefore is not considered to be representative of background air quality in the region.

4 Modelling Methodology

4.1 Air Dispersion Model

The air dispersion modelling has been conducted using the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). AERMOD is a United States Environmental Protection Agency (USEPA) recommended air dispersion model that has been designed to support regulatory modelling programs in the United States. It is widely used throughout Australia and internationally for regulatory modelling applications.

AERMOD is a current-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD incorporates the Plume Rise Model Enhancements (PRIME) building downwash algorithms, which provide a more realistic handling of downwash effects than previous approaches.

4.2 Meteorological Data

The modelling has been completed using a meteorological dataset derived from observations obtained at the BoM's Port Hedland Airport over a five calendar year period from 2009 to 2013. The Western Australian Air Quality Modelling Guidance Notes (DER, 2006) recommends that at least one, preferable two or more years of meteorological data should be employed for air quality dispersion modelling purposes.

The Port Hedland Airport is located approximately 10 km north east of the site of the proposed South Hedland Power Station, and both are located between 8 and 10 km from the coastline and thus would experience very similar weather conditions. As such the Port Hedland Airport observation data is expected to be representative of the site meteorological conditions.

As upper air observations were not available for Port Hedland on a daily basis, The Air Pollution Model (TAPM) (Version 4.0.4) was used to predict the vertical temperature profile. The predicted vertical temperature was adjusted based on the difference between the predicted and measured surface temperature for the temperature profile at sunrise. This adjusted temperature profile was then used with the measured surface temperatures to calculate the convective mixing height used as input to the modelling.

Figure 6 presents the windrose for the five calendar year period (2009 to 2013) that has been derived from hourly average wind speed and direction data for the Port Hedland Airport. From this windrose it can be seen that the winds in the region are predominantly west to north westerly, and to a lesser extent south easterly.

Figure 7 presents the seasonal windroses for the period modelled, and shows the extent to which winds change seasonally. During summer and spring the winds are predominantly from the west to north west, and relatively strong. In contrast, during autumn and winter the winds are predominantly from the south east, and winds tend to be lighter in strength. Calms (<0.5 m/s) occur most often in winter (1.2%) and autumn (0.9%), compared to summer (0.7%) and spring (0.7%).

The South Hedland Rural Estate is located downwind of the proposed South Hedland Power Station under north westerly winds, and therefore is expected to be impacted relatively frequently by the atmospheric emissions from the proposed South Hedland Power Station during summer and spring. The Town of South Hedland is located downwind of the proposed South Hedland Power Station under south westerly winds, and therefore is not expected to be impacted as frequently by the atmospheric emissions from the proposed South Hedland Power Station.

Figure 8 presents the diurnal variation in the predicted mixing height used for modelling, and shows a cycle of relatively low night-time mixing height, followed by an increase in the mixing height from around sunrise due to the onset of convective mixing, and then a decrease in mixing height around sunset and the return of the mechanical night-time mixing regime.

4.3 Modelling Approach

Air dispersion modelling was used to predict ground level concentrations (GLCs) across the model domain, and at nominated receptor locations. The air quality impacts associated with emissions from the proposed South Hedland Power Station were considered in isolation. An assessment of the potential cumulative impacts due to other emission sources in the region was also completed by modelling the cumulative impacts of emissions from the proposed South Hedland Power Station, combined with emissions from the existing Port Hedland Power Station and the approved Boodarie Waste to Energy facility. The results of ambient air quality monitoring in the region were also used to assess potential cumulative impacts.

4.4 Model Parameterisation

AERMOD (Version 14134) was used to predict GLCs across the model domain, and at nominated discrete receptor locations (refer to Section 4.6). AERMOD was set up using a model domain of 15 km by 15 km centred at 664,000 mE, 7,746,000 mN (UTM), and with grid intervals of 200 m.

Terrain elevation data for the model domain was obtained from the US National Aeronautics and Space Administration’s (NASA) Shuttle Radar Topography Mission (SRTM3/SRTM1), and incorporated into AERMOD using the AERMAP terrain processor.

AERMOD was run using the rural dispersion coefficient and the adjusted friction velocity option (Adjust Horizontal Meander) was selected, in line with the treatment of meteorological data within AERMET.

An AERMOD input file is provided as Appendix A.

4.5 Treatment of Oxides of Nitrogen

The modelling completed for this assessment assumed the conversion of NO to NO_2 in the presence of ozone (O_3) according to the following reaction:

$$NO + O_3 \rightarrow NO_2 + O_2$$

This reaction is considered to be approximately correct at night-time, but conservative (potentially over-estimates) NO_2 in the near field (less than one hour downwind of the source) during daylight hours when photochemical reactions (i.e. due to photo-dissociation) become important (CSIRO, 2005). The extent of NO_2 formation is determined by the minimum of the NO and O_3 concentration in the ambient air.

Accounting for the conversion of NO emissions in the presence of background O_3 levels, and accounting for the composition of NO_2 present in the emissions at the point of release, the GLC of NO_2 has been calculated according to Equation 1.

$$NO_2 = [NOe_2] + \text{Min}\ \{ [NO]\ ,\ [O_3] \} \qquad \text{Equation 1}$$

Where:

NO_2 = estimated ground level concentration of NO_2 (ppb)

NOe_2 = predicted ground level concentration of NO_2 attributable to NO_2 present in emissions (ppb)

NO = predicted ground level concentration of NO (ppb)

O_3 = background concentration of O_3 (ppb)

A constant background O_3 concentration has been applied for this assessment, based on the highest 1-hour average concentration of 60 ppb measured at the Karratha town site during the Pilbara Air Quality Study (DER, 2004). The total NO_x emissions (as NO_2) and the initial ratio of NO_2 to total NO_x were used with Equation 1 to determine the total predicted GLC of NO_2. The predicted NO_2 GLC was calculated as the sum of the NO_2 concentrations predicted from direct emissions of NO_2, and the amount of NO converted to NO_2 as a result of the reaction with O_3.

An NO_2 to NO_x ratio of 0.1 has been assumed for all NO_x emissions sources modelled, typical for combustion emission sources (MfE, 2004), and consistent with the NO_x emissions information provided by TEC Hedland for the proposed South Hedland Power Station.

4.6 Sensitive Receptors

A number of discrete locations were selected to represent areas with sensitive receptors, including residential areas located within the Town of South Hedland and the South Hedland Rural Estate (Table 3). The location of the receptors is shown in Figure 9.

Table 3: Sensitive Receptors

Reference	Location Description	Location [1]	
		mE	mN
R1	Quartz Quarry Road, South Hedland Rural Estate	666,130	7,738,865
R2	Port Hedland Golf Club	664,308	7,743,142
R3	Wedgefield	665,655	7,745,537
R4	South Hedland Sports Complex	666,364	7,743,109
R5	Scadden Rd, South Hedland	666,298	7,742,616
R6	Colebatch Way, South Hedland	666,105	7,741,983
R7	Wambiri St, South Hedland	666,985	7,741,465
R8	Steamer Ave, South Hedland	667,325	7,740,973
R9	Cottier Dr (roundabout), South Hedland	667,487	7,742,749
R10	Parker St, South Hedland	666,900	7,744,025

Notes
1. GDA94

5 Atmospheric Emissions

5.1 Proposed South Hedland Power Station

This study has considered emissions from the proposed South Hedland Power Station under three different operating scenarios, as follows:

- Full Load – Natural Gas: both CCGTs and both OCGTs operating at full load, fuelled by natural gas;
- Part Load – Natural Gas: both CCGTs operating at full load, and both OCGTs operating at part load (50%), fuelled by natural gas; and
- Emergency – Distillate Fuel: both CCGTs and both OCGTs operating at full load, fuelled by distillate.

For air dispersion modelling purposes, it has been assumed that emissions remain constant over the modelled period, although in reality the operation of the GTs will be frequently adjusted according to variations in power demand. It has also been assumed that emissions associated with the Emergency operating scenario occurs continuously, although in reality emergency operations would only occur if the supply of natural gas was interrupted.

The study has not considered emissions from the proposed South Hedland Power Station under start-up operations, as it will take less than six minutes for a GT to reach full load during start-up operations (*Pers. Comm*. James McEnhill, 4 June 2013), and therefore the air quality impacts are not expected to be significant.

The emissions information and stack release parameters used as inputs to the modelling (Table 4) were derived from information supplied by TEC Hedland.

SO_2 and PM_{10} emissions associated with the Emergency – Distillate Fuel scenario were estimated using distillate fuel consumption data provided by TansAlta. To calculate SO_2 emissions a fuel sulphur content of 10 ppm was assumed, in accordance with the National Diesel Fuel Quality Standard. To calculate PM_{10} emissions an emission factor of 5,200 kg/PJ was applied, sourced from the Emission Estimation Techniques Manual for Fossil Fuel Electricity Generation (Commonwealth of Australia, 2012). SO_2 and PM_{10} emissions associated with natural gas fired operations were considered negligible, and have not been modelled.

Table 4: Summary of Emission Estimates and Stack Parameters – Proposed South Hedland Power Station

Parameter	Unit	Full Load – Natural Gas		Part Load – Natural Gas		Emergency – Distillate Fuel	
		CCGTs	OCGTs	CCGTs	OCGTs	CCGTs	OCGTs
Location [1]	-	[2]	[3]	[2]	[3]	[2]	[3]
Exhaust Stack Height	m	35	25	35	25	35	25
Stack-tip Diameter	m	2.27	3.16	2.27	3.16	2.27	3.16
Exhaust Flowrate	Nm^3/s (wet) [4,5]	97.8	97.8	97.8	66.5	96.3	96.3
Exit Velocity	m/s	33.9	33.9	33.9	24.1	33.4	33.0
Exit Temperature	K	383	743	383	776	383	733
Modelled Compounds							
NO_x	ppmv (dry, 15% O_2)	25	25	25	200	85	85
	g/s	5.6	5.6	5.6	30.3	18.7	18.7
CO	ppmv (dry, 15% O_2)	25	25	25	200	25	25
	g/s	3.4	3.4	3.4	18.5	3.3	3.3
SO_2 [6]	g/s	-	-	-	-	0.05 [7]	0.05 [8]
PM_{10} [6]	g/s	-	-	-	-	0.5 [9]	0.5 [10]

Notes
1. Stack locations identified from plant layout drawing (DA-N12889-21) dated 13.10.25, overlain on Google Earth.
2. Location of CCGTs: 661,356.13 mE and 7,740,044.52 mN (Unit 3); 661,378.29 mE and 7,740,019.36 mN (Unit 4).
3. Location of OCGTs: 661,302.15 mE and 7,740,087.83 mN (Unit 1); 661,325.22 mE and 7,740,061.73 mN (Unit 2).
4. Nm^3/s is referenced to 0^oc and 101.3 kPa.
5. Exhaust gas moisture equal to 11.8%, and O_2 content equal to 13.5%, for all operating scenarios modelled.
6. SO_2 and PM_{10} emissions during natural gas operations considered to be negligible.
7. SO_2 emission calculated from fuel Low Heat Value (LHV) (42,800 kJ/kg), fuel consumption (371 GJ/hr LHV), and fuel sulphur content (10 ppm).
8. SO_2 emission calculated from fuel Low Heat Value (LHV) (42,800 kJ/kg), fuel consumption (377 GJ/hr LHV), and fuel sulphur content (10 ppm).
9. PM_{10} emissions calculated using an emission factor of 5,200 kg/PJ (NPI, 2012) and fuel consumption (371 GJ/hr LHV).
10. PM_{10} emissions calculated using an emission factor of 5,200 kg/PJ (NPI, 2012) and fuel consumption (377 GJ/hr LHV).

5.2 Other Emission Sources

Alinta operates the Port Hedland Power Station, which is comprised of three 30 MW gas turbines (A1- A3) located at the site adjacent to the Horizon Power premises boundary, and two 30 MW gas turbines (A4 - A5) located approximately 5 km to the north. The emissions information and stack release parameters for the Port Hedland Power Station has been sourced from previous air dispersion modelling reports (PAE, 2011) (ENVIRON, 2008).

The previous modelling assessment completed for the currently approved South Hedland Power Station (PAE, 2011) used a stack exit velocity of 3.8 m/s to model sources A1 to A3, however this is considered to be too low for a gas turbine exhaust. A factor of 10 adjustment to increase the stack exit velocity was applied for these sources so that they are consistent with typical gas turbine exhaust conditions.

New Energy has environmental regulatory approval for the Boodarie Waste to Energy and Materials Recovery Facility proposed to be located on a site adjacent to the Horizon Power premises boundary. The emissions information and stack release parameters for this facility has been sourced from the Air Quality Impact Assessment report (Synergetics, 2012).

The emissions information and stack release parameters used as inputs to the modelling are presented in Table 5. It should be noted that the modelling of cumulative impacts has been confined to NO_x emissions.

Table 5: Summary of Emission Estimates and Stack Parameters – Other Sources

Parameter	Unit	Port Hedland Power Station		Waste to Energy
		A1 – A3 [1]	A4 – A5 [2]	Main [3]
Location [4]	mE	[5]	[6]	660,600
	mN			7,740,800
Exhaust Stack Height	m	13	15.5	30
Stack-tip Diameter	m	3.2	3.5	2.5
Exit Velocity	m/s	38 [7]	24.4	18
Exit Temperature	K	773	813	438
Modelled Compounds				
NO_x	ppmv (dry, 15% O_2)	83	92	-
	g/s	10 [7]	14.4	2.7

Notes
1. Emission estimates and stack parameters sourced from PAE (2011).
2. Emission estimates and stack parameters sourced from ENVIRON (2008).
3. Emission estimates and stack parameters sourced from Synergetics (2012).
4. Stack locations for existing sources identified from Google Earth. Location of the Main stack for the proposed Boodarie Waste to Energy facility is an approximation only.
5. Location of A1 – A3: 661652.73 mE and 7740278.07 mN (A1); 661674.83 mE and 7740261.88 mN (A2); 661696.39 mE and 7740245.72 mN (A3).
6. Location of A4 – A5: 660573.23 mE and 7745893.7 mN (A4); 660579.59 mE and 7745886.59 mN (A5).
7. A factor of 10 adjustment has been applied to the exit velocity for sources A1 to A3, so that the stack exit velocity is consistent with typical gas turbine exhaust conditions. This adjustment has also been applied to the calculated emission rate.

6 Modelling Results

6.1 Proposed South Hedland Power Station in Isolation

The maximum GLCs across the model domain and at the nominated receptor locations have been predicted for the proposed South Hedland Power Station in isolation under three different operating scenarios. A summary of the modelling results for the proposed South Hedland Power Station in isolation is presented in Table 6. Contours of the maximum predicted 1-hour average GLC of NO_2 are presented in Figure 10 (Full Load – Natural Gas), Figure 11 (Part Load – Natural Gas) and Figure 12 (Emergency – Distillate Fuel).

The results of the modelling indicate that the air quality impacts due to emissions from the proposed South Hedland Power Station in isolation are predicted to be well below the relevant ambient criteria at the receptor locations for all of the operating scenarios included in the modelling. Notwithstanding, the cumulative impact due to background pollutant levels and other emission sources in the region needs to be taken into account to enable an assessment of overall compliance with the ambient criteria (refer to Section 6.2).

For the Full Load – Natural Gas scenario the maximum 1-hour average GLC of NO_2 predicted across the model domain was equal to 30% of the relevant ambient criteria, and the annual average was equal to 5% of the relevant ambient criteria. The maximum 8-hour average GLC of CO predicted across the model domain is equal to less than 1% of the relevant ambient criteria. Considerably lower impacts are predicted to occur at the receptor locations, with the predicted GLCs of NO_2 remaining below 4% of the relevant ambient criteria.

For the Part Load – Natural Gas scenario the maximum 1-hour average GLC of NO_2 predicted across the model domain is equal to 67% of the relevant ambient criteria, and the annual average is equal to 14% of the relevant ambient criteria. The maximum 8-hour average GLC of CO predicted across the model domain is equal to 1% of the relevant ambient criteria. The maximum GLCs are predicted to occur in the immediate vicinity of the proposed site, within the Boodarie Industrial Estate power plant buffer. Considerably lower impacts are predicted to occur at the receptor locations, with the predicted GLCs of NO_2 remaining below 18% of the relevant ambient criteria.

For the Emergency – Distillate Fuel scenario the maximum 1-hour average GLC of NO_2 and the maximum 8-hour average GLC of CO predicted across the model domain are very similar to the model results for the Part Load – Natural Gas scenario. The maximum GLCs are also predicted to occur in the immediate vicinity of the proposed site, within the Boodarie Industrial Estate power plant buffer. Considerably lower impacts are predicted to occur at the receptor locations, with the predicted GLCs of NO_2 remaining below 14% of the relevant ambient criteria.

The air quality impacts associated with emissions of SO_2 and PM_{10} were also considered for the Emergency – Distillate Fuel scenario. The maximum GLC of SO_2 predicted for various averaging periods across the model domain are all equal to less than 1% of the relevant ambient criteria. The maximum 24-hour average GLC of PM_{10} predicted across the model domain is equal to 6% of the relevant ambient criteria. The predicted impacts of SO_2 and PM_{10} are considered negligible within the context of existing ambient concentrations measured in the region, particularly as distillate fuel operations will occur infrequently.

Table 6: Maximum Predicted Ground Level Concentrations (µg/m³)[1] – Proposed South Hedland Power Station in Isolation

Compound	Averaging Period	Full Load – Natural Gas			Part Load – Natural Gas			Emergency – Distillate Fuel			Ambient Criteria [2]
		Model Domain	Receptors		Model Domain	Receptors		Model Domain	Receptors		
NO_2	1-h	67	9	R2	152	26	R1	146	31	R2	226
	Annual	3	0.3	R1	8	1	R1	-	-	-	56
CO	8-h	28	2	R1	108	7	R1	28	2	R1	10,311
SO_2	1-h	-	-	-	-	-	-	0.6	0.08	R2	524
	24-h	-	-	-	-	-	-	0.3	0.02	R1	209
	Annual	-	-	-	-	-	-	0.03	0.003	R1	52
PM_{10}	24-h	-	-	-	-	-	-	3	0.2	R1	46

Notes
1. µg/m³ is assumed to be referenced to 25°C and 101.3 kPa, as predicted by AERMOD.
2. Ambient air quality criteria referenced to 25°C and 101.3 kPa, to ensure consistency with AERMOD predictions.

6.2 Cumulative Impact Assessment

An assessment of the potential cumulative impacts due to other emission sources in the region has been completed by modelling the cumulative impacts of NO_x emitted from the proposed South Hedland Power Station as well as the existing Port Hedland Power Station and the approved Boodarie Waste to Energy facility. To account for existing background air quality, the results of ambient air quality monitoring and model predictions have been summed to provide an estimate of the potential cumulative impacts, and also to provide an indication of the incremental increase in air quality impacts attributable to emissions from proposed South Hedland Power Station.

Table 7 presents a summary of the results of the cumulative impact assessment. The model predictions are presented as the maximum 1-hour and annual average GLCs of NO_2 predicted at the nominated receptor locations, as follows:

- Port Hedland Power Station in isolation (existing sources);
- Port Hedland Power Station and Boodarie waste to energy facility (approved sources); and
- Port Hedland Power Station, Boodarie waste to energy facility, and the proposed South Hedland Power Station (cumulative)

NO_2 concentrations are measured at the Acacia Way (M2) and BoM (M3) monitoring sites. Marginally higher 1-hour and annual average concentrations of NO_2 were measured at the Acacia Way monitoring site during the 2012/13 reporting period, and therefore have been used to define existing “worst-case” background pollutant concentrations. It should be noted that this assessment is particularly conservative for the short term (i.e. 1-hour) averaging times as it is assumed that the maximum predicted GLCs from the modelled emission sources coincides with the highest measured background concentrations, which is unlikely to occur in reality.

Contours of the predicted cumulative maximum 1-hour average GLC of NO_2 for all modelled sources is presented in Figures 13, assuming Full Load – Natural Gas operations for the proposed South Hedland Power Station.

The modelling results presented in Table 7 indicate that the cumulative maximum GLCs of NO_2 predicted at the nominated receptor locations comply with the relevant ambient criteria.

Using the results of ambient monitoring and model predictions of the maximum 1-hour average GLC of NO_2, the results indicate that the cumulative impact of the proposed South Hedland Power Station at the receptor locations will not exceed 92 $\mu g/m^3$ (or 41% of the ambient criteria) for Full Load – Natural Gas operations, and will not exceed 113 $\mu g/m^3$ (or 50% of the ambient criteria) for Emergency – Distillate Fuel operations. Further, model predictions indicate that the cumulative 1-hour average GLC of NO_2 for all modelled emissions (i.e. excluding measured background concentrations) will not exceed 18 $\mu g/m^3$ (or 8% of the ambient criteria) at receptor locations for Full Load – Natural Gas operations, and will not exceed 39 $\mu g/m^3$ (or 17% of the ambient criteria) at receptor locations for Emergency – Distillate Fuel operations.

Similarly, in terms of long-term average GLCs of NO_2, model predictions of the annual average GLC of NO_2 indicate that the cumulative impact of the proposed South Hedland Power Station will not exceed 10.5 $\mu g/m^3$ (or 19% of the ambient criteria) at receptor locations for Full Load – Natural Gas operations for the proposed South Hedland Power Station. Model predictions also indicate that the cumulative annual average GLC of NO_2 for all modelled emissions (i.e. excluding measured background concentrations) will not exceed 0.7 $\mu g/m^3$ (or 1% of the ambient criteria) at receptor locations.

Model predictions indicate that the GLCs of NO_2 at the receptor locations will increase marginally due to emissions from the proposed South Hedland Power Station. The absolute increase in the maximum 1-hour average GLCs of NO_2 is predicted to be less than 10 $\mu g/m^3$ at the receptor locations, which is not considered significant relative to the ambient criteria (226 $\mu g/m^3$) and existing ambient concentrations measured in the region (maximum of 74 $\mu g/m^3$).

Table 7: Maximum Predicted Ground Level Concentrations (μg/m³)[1] of Nitrogen Dioxide – Cummulative Impact

Averaging Period	Receptor	Measured Concentration [2] (μg/m³)[1]	Model Predictions				Measured Concentrations and Model Predictions			Ambient Criteria [3]
			Existing Sources	Approved Sources	Cumulative		Approved Sources	Cumulative		
					Full Load – Natural Gas	Emergency – Distillate Fuel		Full Load – Natural Gas	Emergency – Distillate Fuel	
1-h	M1	-	6	6	12	27	-	-	-	226
	M2	74	6	6	13	29	80	87	103	
	M3	70	5	6	12	27	76	82	96	
	R1	74	8	9	18	39	83	92	113	
	R2	74	7	7	17	39	82	91	113	
	R3	74	6	6	12	28	80	86	102	
	R4	74	6	7	13	31	81	87	105	
	R5	74	6	7	12	30	81	86	104	
	R6	74	7	7	14	31	81	88	105	
	R7	74	6	6	12	27	80	86	101	
	R8	74	6	7	12	26	81	86	100	
	R9	74	6	7	13	26	81	87	100	
	R10	74	7	7	12	28	81	86	102	

Table 7: Maximum Predicted Ground Level Concentrations (μg/m³)[1] of Nitrogen Dioxide – Cummulative Impact

Averaging Period	Receptor	Measured Concentration [2] (μg/m³)[1]	Model Predictions				Measured Concentrations and Model Predictions			Ambient Criteria [3]
			Existing Sources	Approved Sources	Cumulative		Approved Sources	Cumulative		
					Full Load – Natural Gas	Emergency – Distillate Fuel		Full Load – Natural Gas	Emergency – Distillate Fuel	
Annual	M1	-	0.3	0.3	0.3	-	-	-	-	56
	M2	9.8	0.3	0.3	0.5	-	10.1	10.2	-	
	M3	9.4	0.3	0.3	0.4	-	9.7	9.8	-	
	R1	9.8	0.4	0.4	0.7	-	10.2	10.5	-	
	R2	9.8	0.3	0.3	0.4	-	10.1	10.2	-	
	R3	9.8	0.3	0.3	0.4	-	10.1	10.2	-	
	R4	9.8	0.3	0.3	0.4	-	10.1	10.2	-	
	R5	9.8	0.3	0.3	0.5	-	10.1	10.3	-	
	R6	9.8	0.3	0.4	0.5	-	10.1	10.3	-	
	R7	9.8	0.3	0.4	0.6	-	10.1	10.4	-	
	R8	9.8	0.4	0.4	0.6	-	10.2	10.4	-	
	R9	9.8	0.3	0.3	0.5	-	10.1	10.3	-	
	R10	9.8	0.3	0.3	0.4	-	10.1	10.2	-	

Notes
1. All measured and predicted concentrations (μg/m³) are assumed to be referenced to 25°C and 101.3 kPa, to ensure consistency with AERMOD predictions.
2. The highest 1-hour and annual average concentrations measured at the Acacia Way (M2) monitoring site have been used to define existing “worst-case” pollutant levels in the region.
3. Ambient air quality criteria referenced to 25°C and 101.3 kPa, to ensure consistency with AERMOD predictions.

7 Conclusions

Air dispersion modelling has been completed to assess the potential air quality impacts associated with emissions from the proposed South Hedland Power Station. The air dispersion model AERMOD has been used to predict GLCs across the model domain and at nominated receptor locations. Three different operating scenarios have been included in the modelling assessment, including:

- Full Load – Natural Gas;
- Part Load – Natural Gas; and
- Emergency – Distillate Fuel.

The results of the modelling indicate that the air quality impacts due to emissions from the proposed South Hedland Power Station in isolation are predicted to be well below the relevant ambient criteria at the receptor locations for all of the operating scenarios included in the modelling. For the Full Load – Natural Gas scenario, the GLCs of NO_2 are predicted to be less than 4% of the relevant ambient criteria. For the Part Load – Natural Gas and Emergency – Distillate Fuel scenarios, the GLCs of NO_2 are predicted to be less than 18% of the relevant ambient criteria. The predicted impacts of SO_2 and PM_{10} emissions associated with the Emergency – Distillate Fuel scenario are considered negligible.

Ambient monitoring data available for NO_2 has been used, together with model predictions, to determine the cumulative impacts of the proposed South Hedland Power Station at the receptor locations. The maximum predicted 1-hour average GLC of NO_2 at the receptor locations indicate that the cumulative impact of the proposed South Hedland Power Station will not exceed 92 $\mu g/m^3$ (or 41% of the ambient criteria) for Full Load – Natural Gas operations, and will not exceed 113 $\mu g/m^3$ (or 50% of the ambient criteria) for Emergency – Distillate Fuel operations. The predicted cumulative impacts have been determined on the basis of existing "worst-case" background pollutant concentrations, and are considered to be particularly conservative for the short term (1-hour) averaging times.

Model predictions indicate that the GLCs of NO_2 at the receptor locations will increase marginally due to emissions from the proposed South Hedland Power Station. The increase in the maximum 1-hour average GLCs of NO_2 at receptor locations is predicted to be less than 10 $\mu g/m^3$. This increase is not considered to be significant when compared to existing air quality and the relevant ambient air quality criteria.

All GTs will be fitted with Dry Low Emission (DLE) technology for NO_x control that will reduce NO_x emissions to 25 ppmv (dry, at 15% O_2) during natural gas operations, and 85 ppmv (dry, at 15% O_2) during distillate fuel operations. The proposed South Hedland Power Station will only be operated on distillate fuel in the event of an emergency.

8 References

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9 Limitations

ENVIRON Australia prepared this report in accordance with the scope of work as outlined in our proposal to Strategen dated 22 May 2014 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent ENVIRON's professional judgment based on information made available during the course of this assignment and are true and correct to the best of ENVIRON's knowledge as at the date of the assessment.

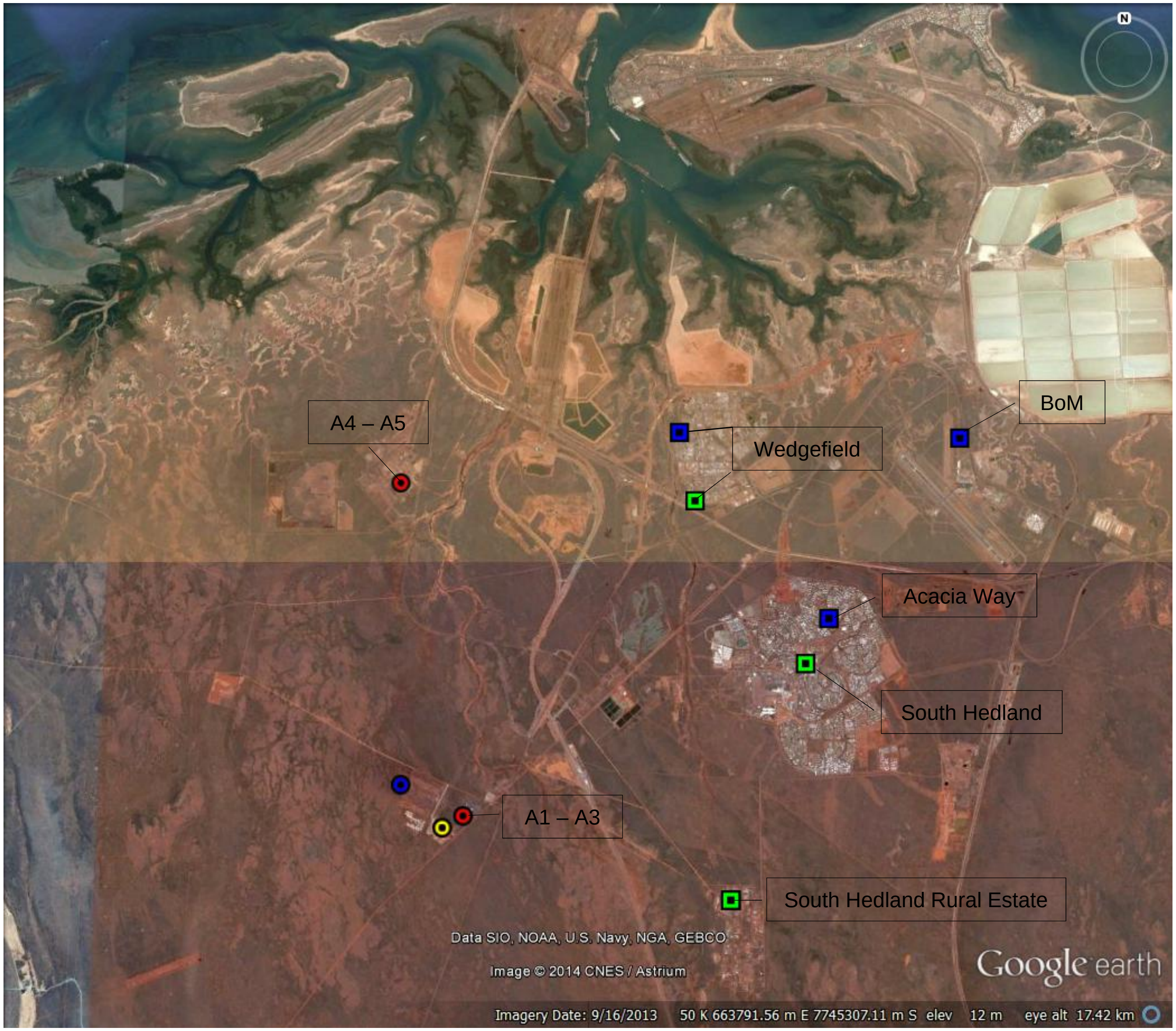
ENVIRON did not independently verify all of the written or oral information provided to ENVIRON during the course of this investigation. While ENVIRON has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to ENVIRON was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

9.1 User Reliance

This report has been prepared exclusively for Strategen and may not be relied upon by any other person or entity without ENVIRON's express written permission.

Figures



Emission Sources

- Proposed South Hedland Power Station
- Port Hedland Power Station
- Waste to Energy Facility

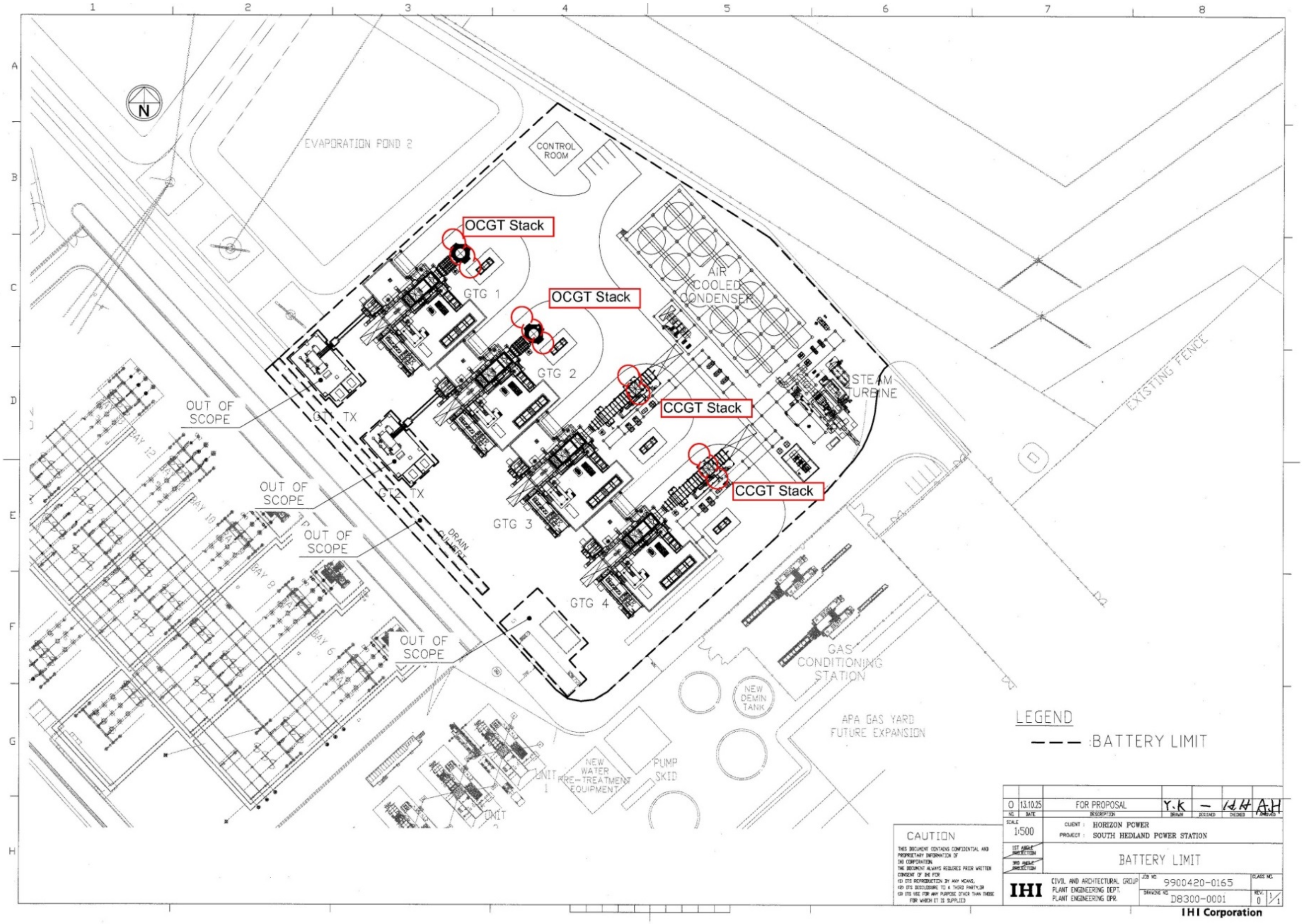
Receptor Locations

- Residential Receptor Locations
- Air Quality Monitoring Sites

South Hedland Power Station – Air Quality Assessment

Project Location
Image Source: Google Earth

ENVIRON JOB NO: AS110726 DATE: June 2014 FIGURE 1



South Hedland Power Station – Air Quality Assessment

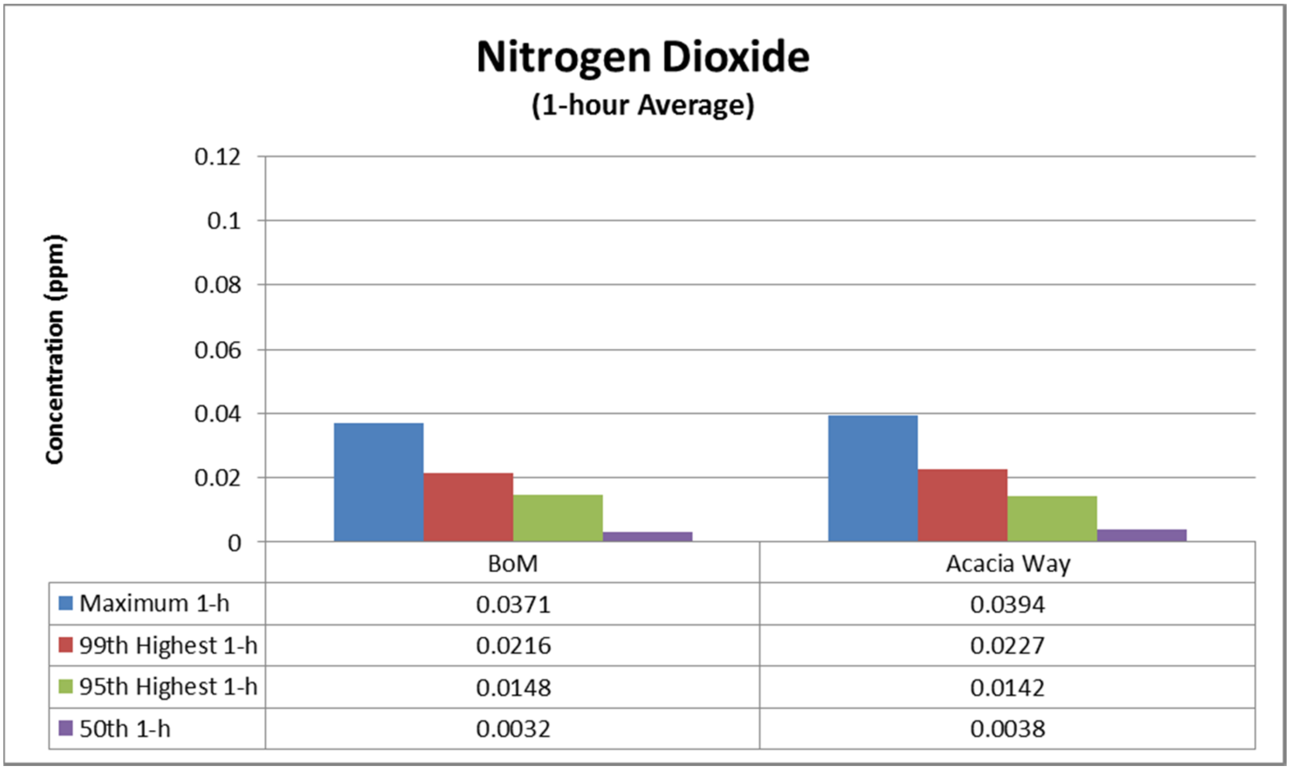
Site Layout

ENVIRON

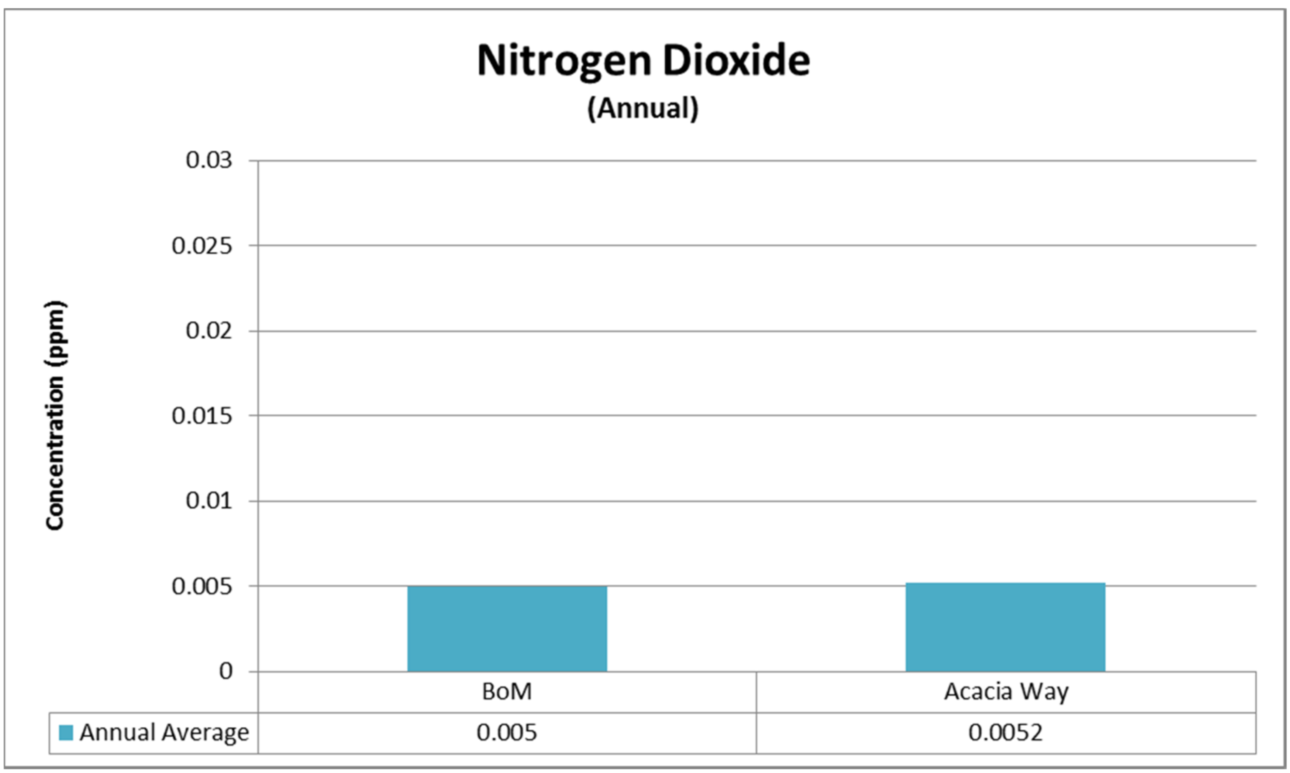
JOB NO: AS110726

DATE: June 2014

FIGURE 2



	BoM	Acacia Way
Maximum 1-h	0.0371	0.0394
99th Highest 1-h	0.0216	0.0227
95th Highest 1-h	0.0148	0.0142
50th 1-h	0.0032	0.0038



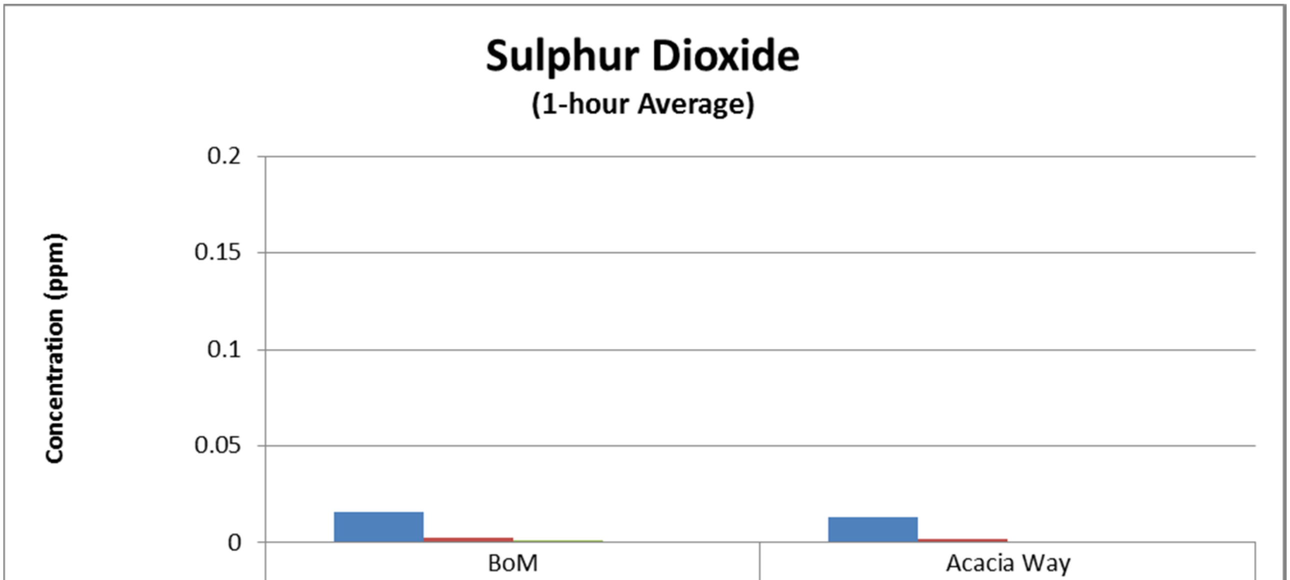
	BoM	Acacia Way
Annual Average	0.005	0.0052

Measured Ambient Concentration of Nitrogen Dioxide

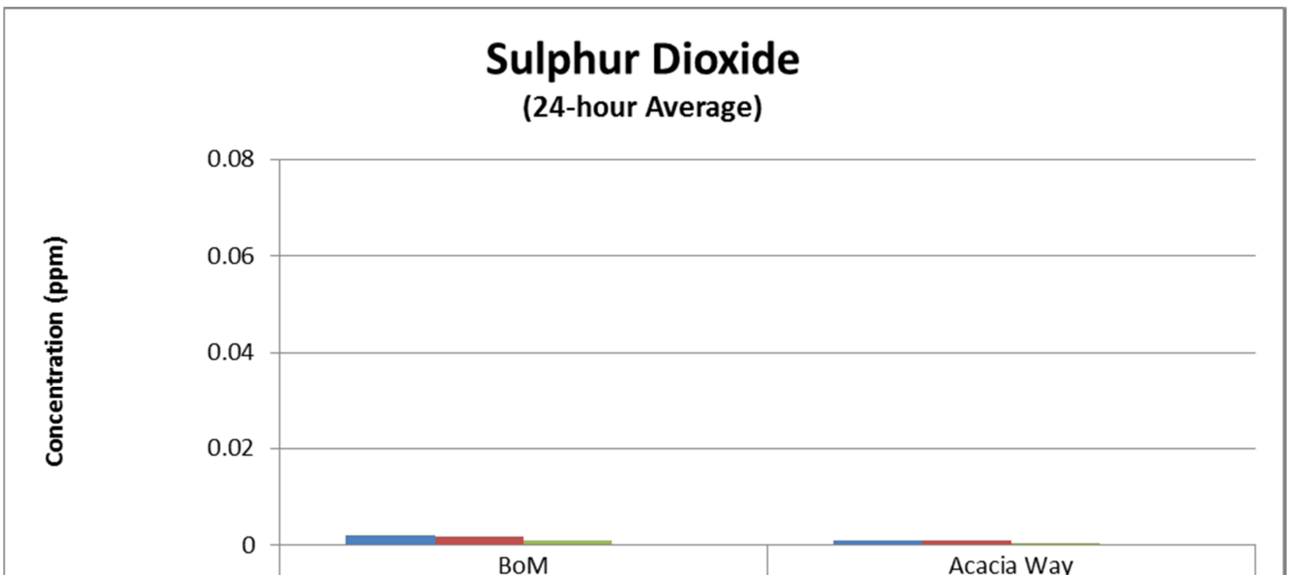
Port Hedland Industries Council Monitoring Network
2012/13 Financial Year

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 3



	BoM	Acacia Way
Maximum 1-h	0.0158	0.0133
99th Highest 1-h	0.0029	0.0018
95th Highest 1-h	0.0013	0.0009
50th 1-h		



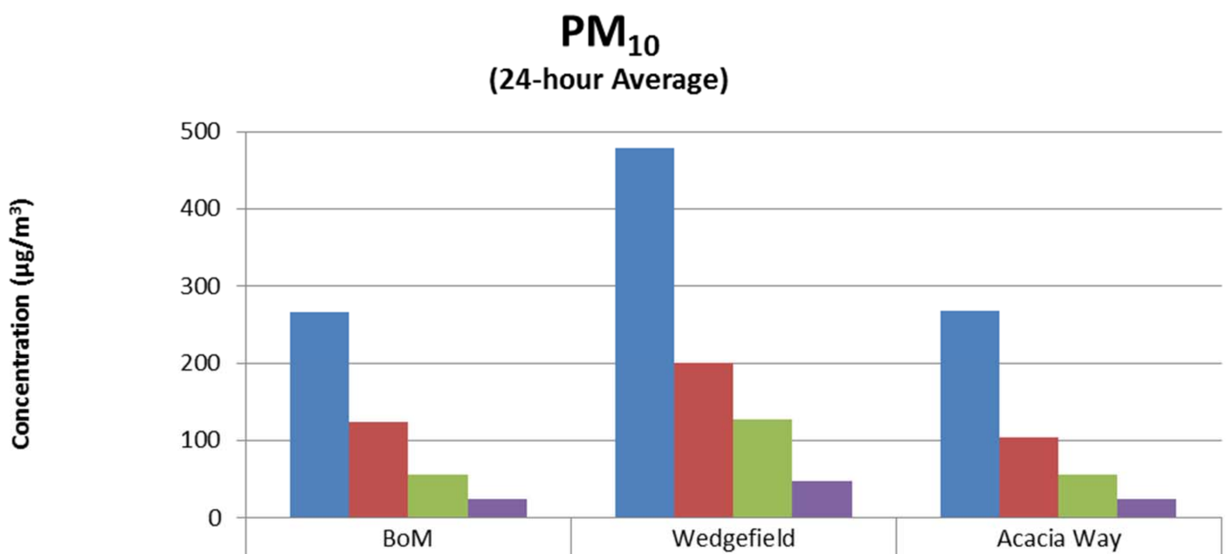
	BoM	Acacia Way
Maximum 24-h	0.0022	0.0011
99th Highest 24-h	0.0017	0.001
95th Highest 24-h	0.0011	0.0006
50th 24-h	0.0001	

Measured Ambient Concentration of Sulphur Dioxide

Port Hedland Industries Council Monitoring Network
2012/13 Financial Year

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 4



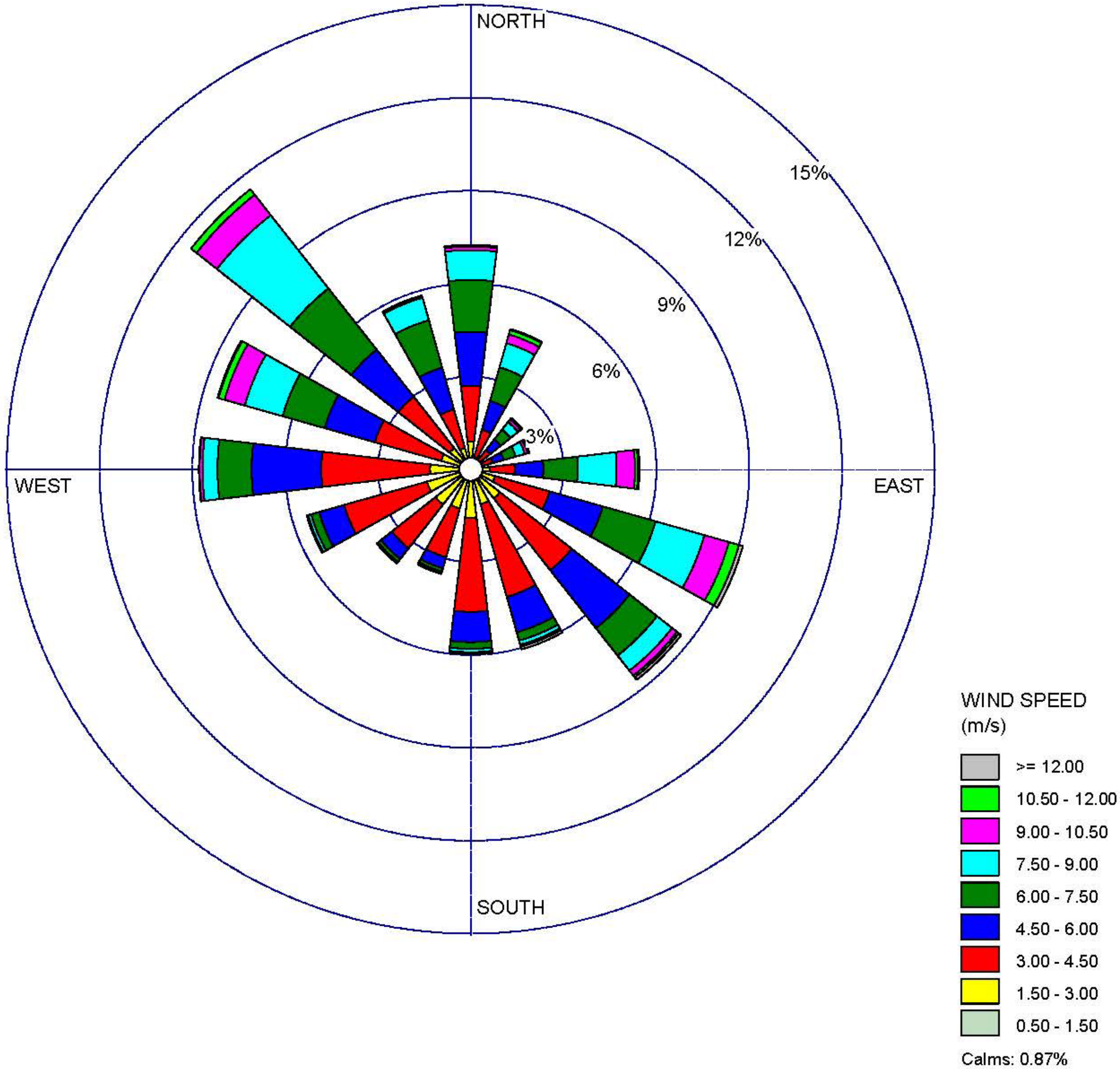
	BoM	Wedgefield	Acacia Way
Maximum 24-h	266	479	269
99th Highest 24-h	124	201	104
95th Highest 24-h	57	128	56
50th 24-h	25	48	24

Measured Ambient Concentration of PM_{10}

Port Hedland Industries Council Monitoring Network
2012/13 Financial Year

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 5

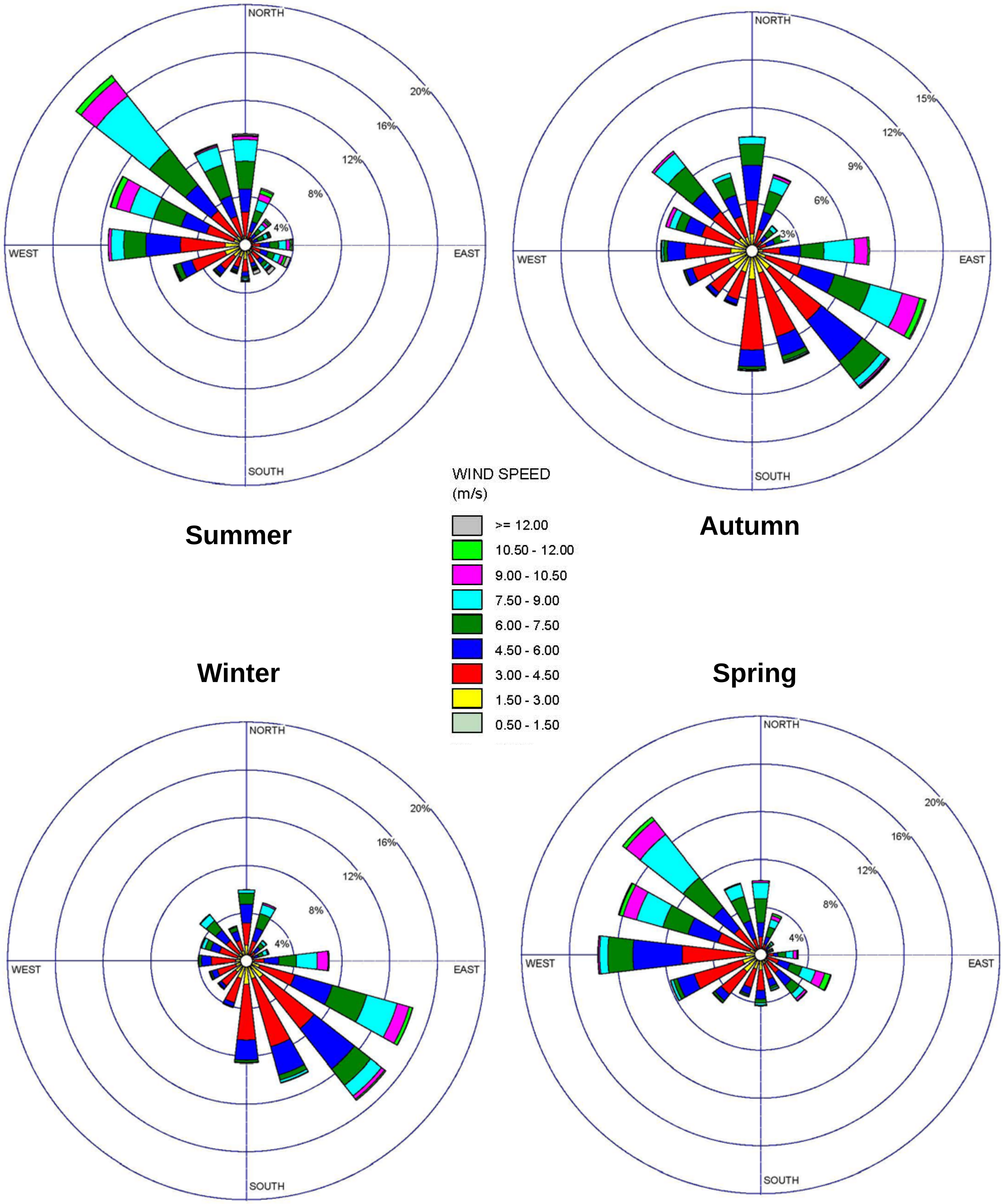


Windrose for Port Hedland Airport

Five Year Calendar Period 2009 - 2013

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 6

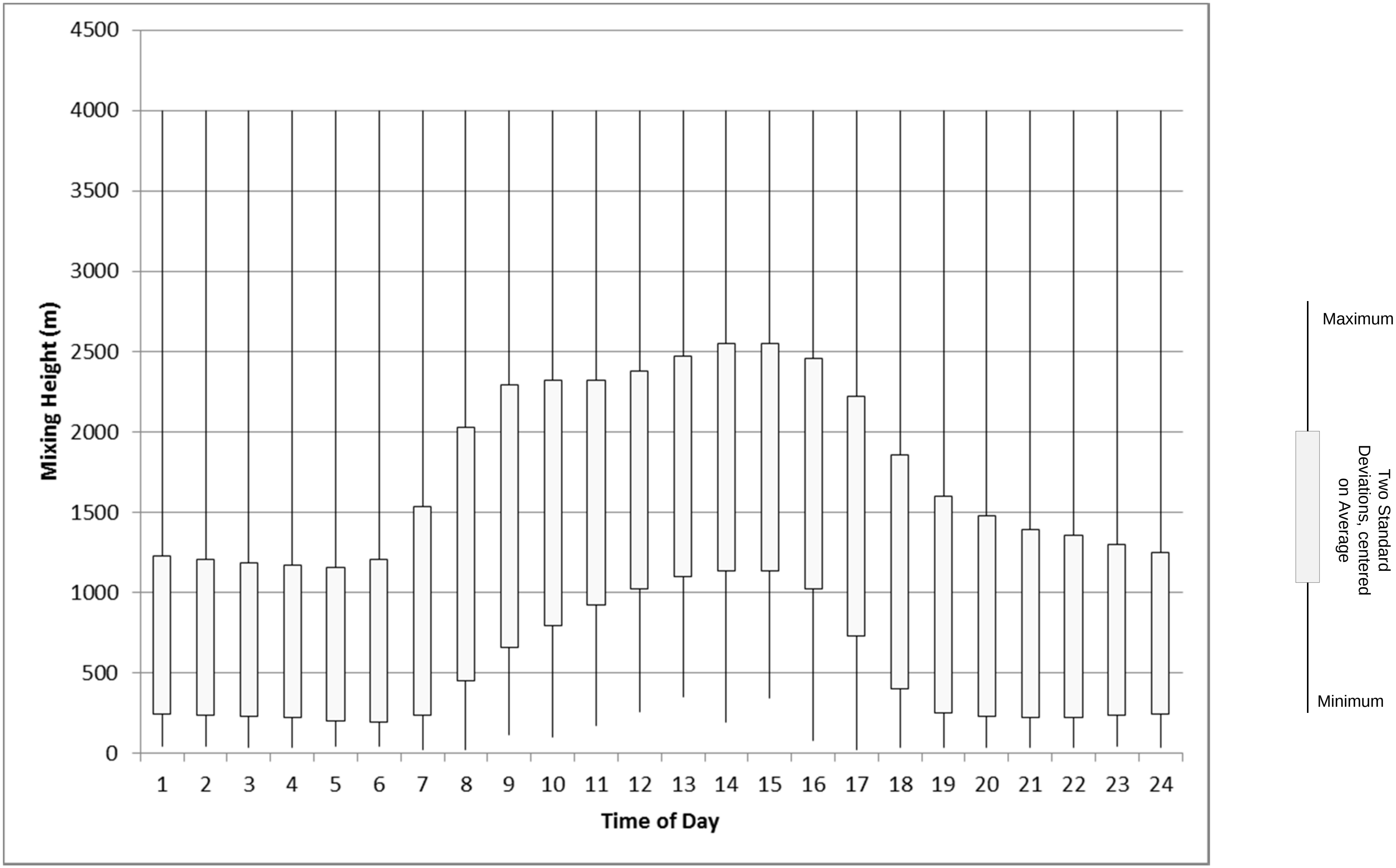


Seasonal Windrose for Port Hedland Airport

Five Year Calendar Period 2009 - 2013

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 7



South Hedland Power Station – Air Quality Assessment

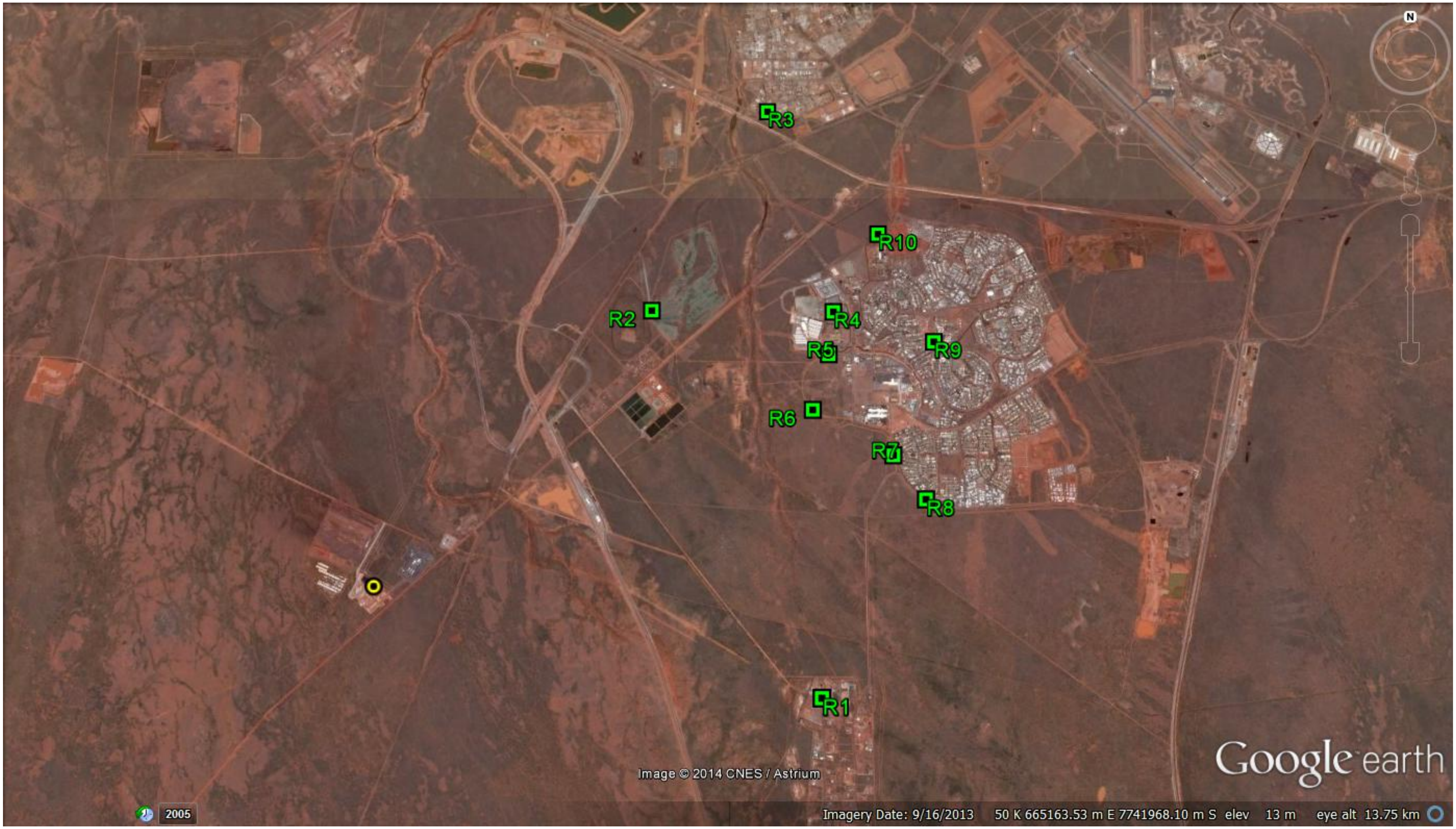
Analysis of Mixing Height With Time of Day

ENVIRON

JOB NO: AS110726

DATE: June 2014

FIGURE 8



Proposed South Hedland Power Station

Residential Receptor Locations

South Hedland Power Station – Air Quality Assessment

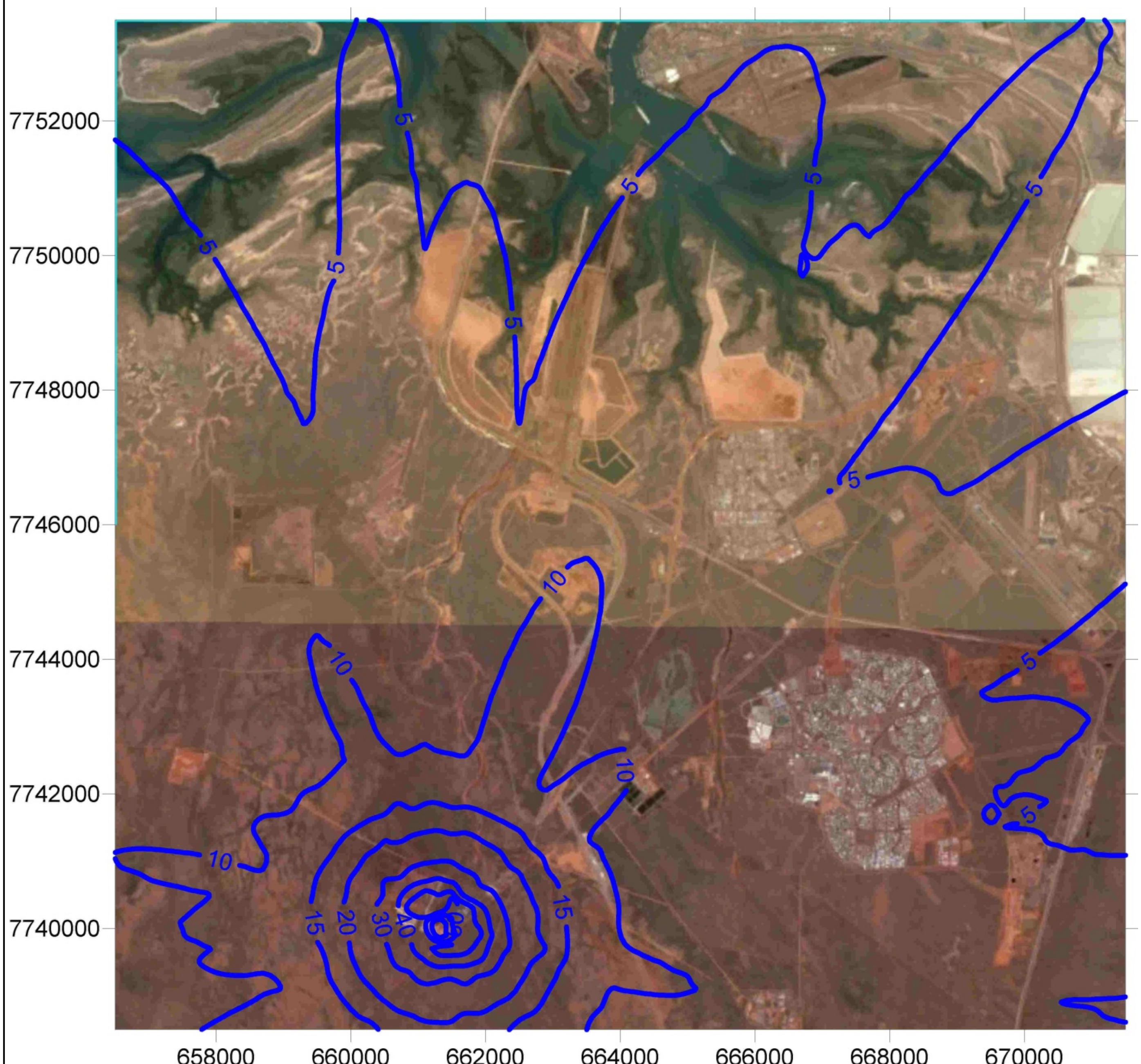
Receptor Locations
Image Source: Google Earth

ENVIRON

JOB NO: AS110726

DATE: June 2014

FIGURE 9

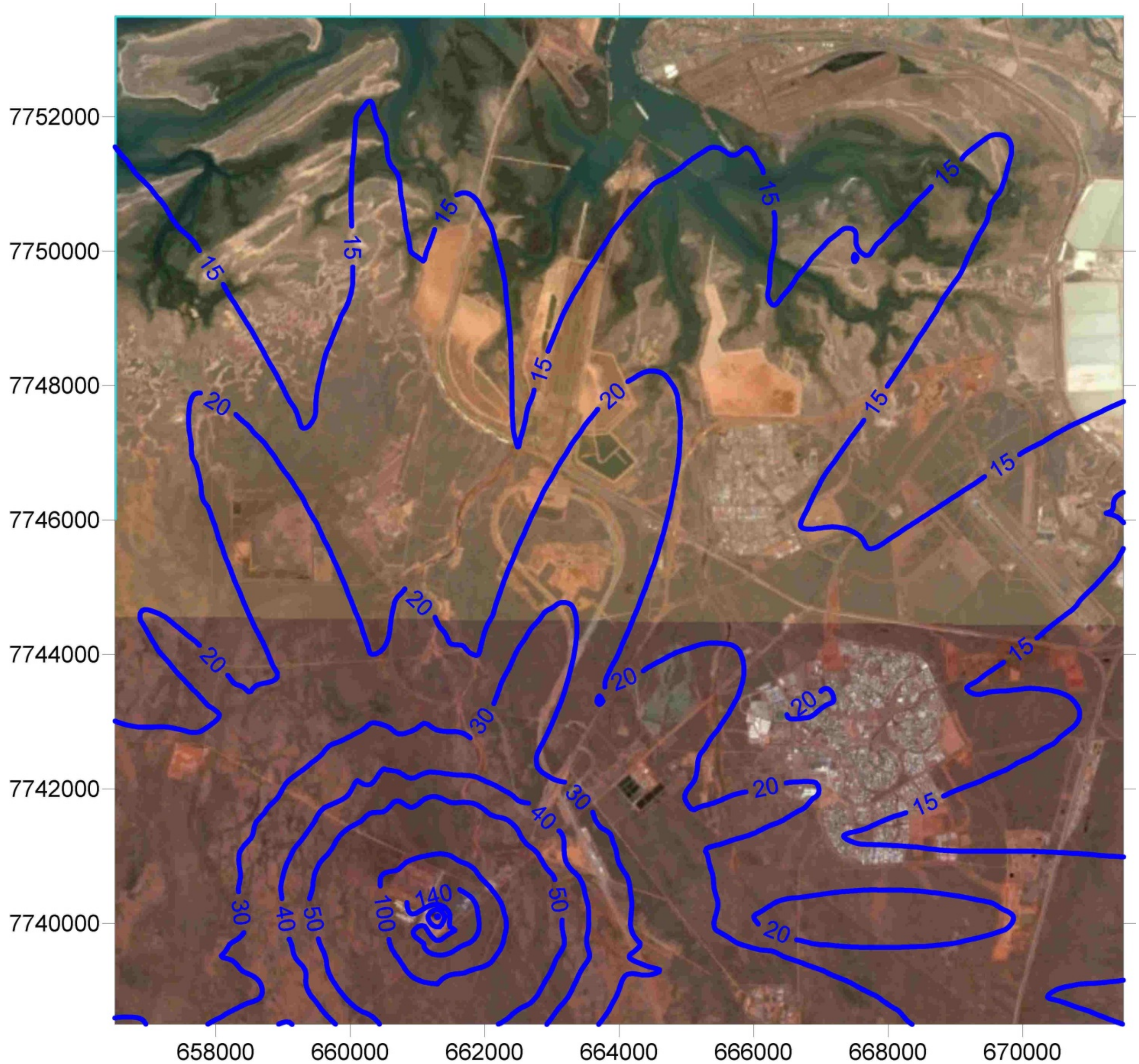


Maximum Predicted 1-hour Average GLC of NO_2 (µg/m^3)

Full Load – Natural Gas

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 10

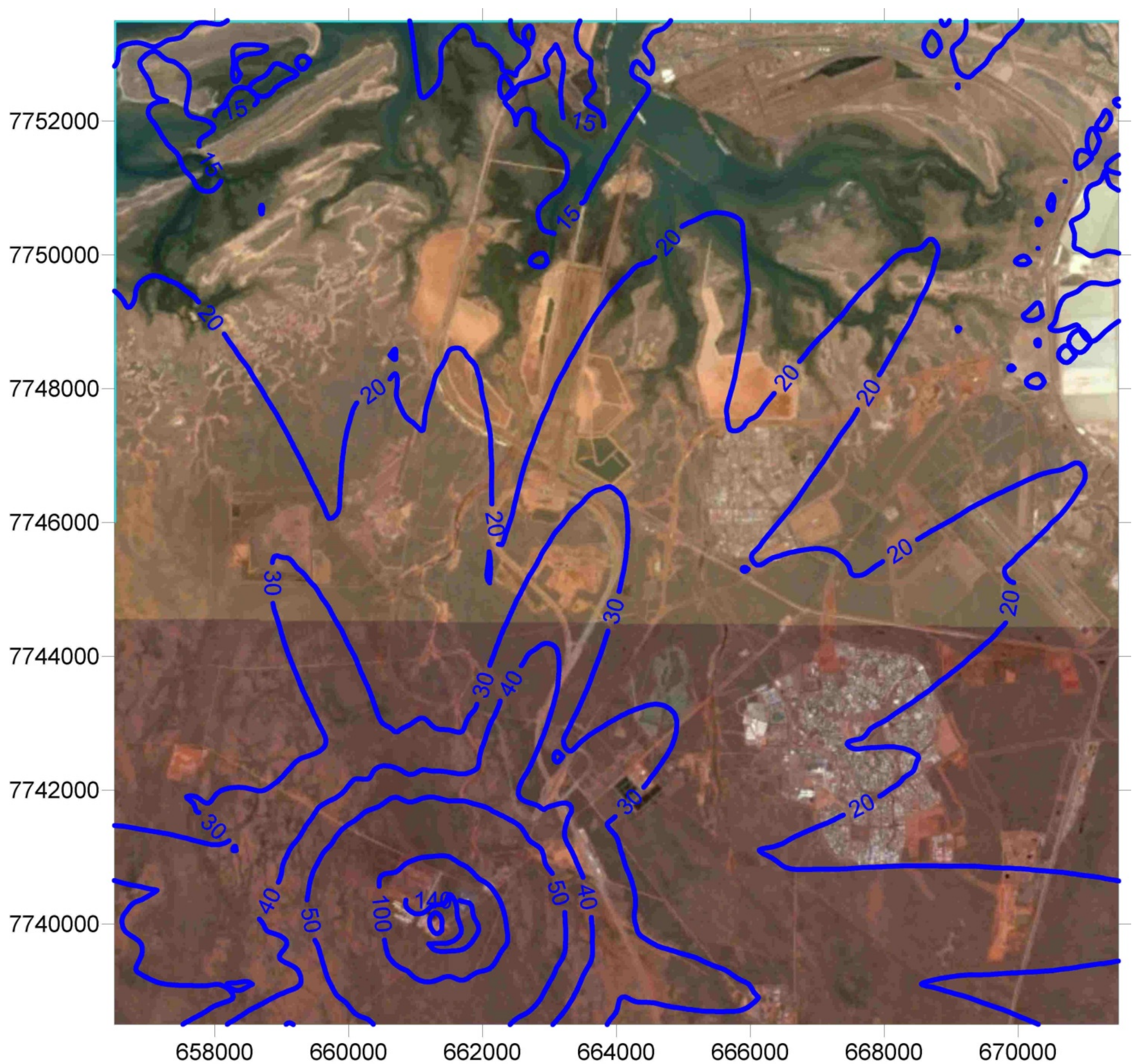


Maximum Predicted 1-hour Average GLC of NO_2 ($\mu g/m^3$)

Part Load – Natural Gas

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 11

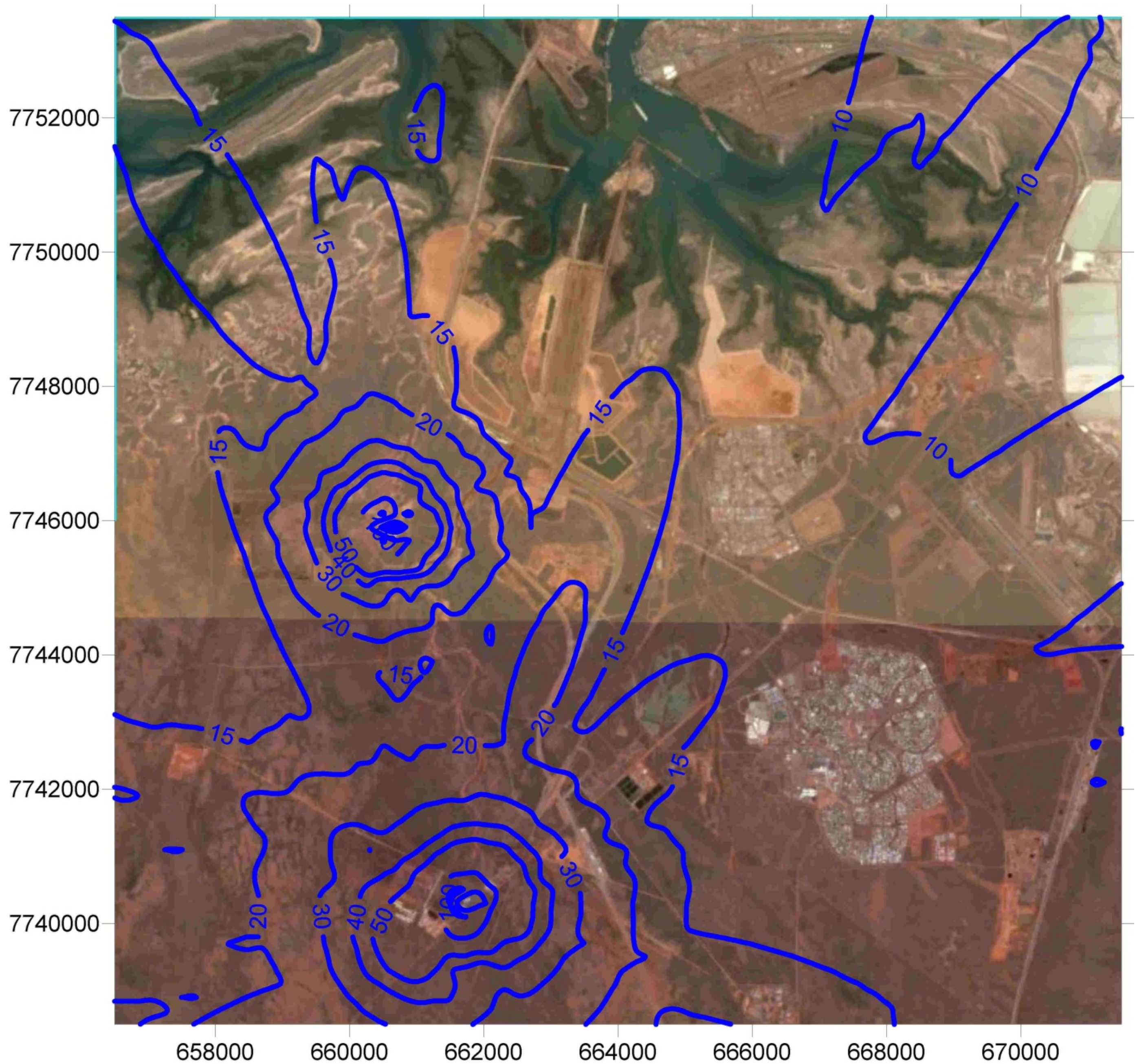


Maximum Predicted 1-hour Average GLC of NO_2 (µg/m^3)

Emergency – Distillate Fuel

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 12



Predicted Cumulative Maximum 1-hour Average GLC of NO_2 (µg/m^3)

Full Load – Natural Gas

South Hedland Power Station

ENVIRON JOB NO: AS110691 DATE: June 2014 FIGURE 13

Appendix A

AERMOD Input File

```
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****************************************
**
** AERMOD Input Produced by:
** AERMOD View Ver. 8.7.0
** Lakes Environmental Software Inc.
** Date: 10/06/2014
** File: E:\AS110726 Strategen S Hedland PS\Scenarios\Scenarios.ADI
**
****************************************
**
**
****************************************
** AERMOD Control Pathway
****************************************
**
**
CO STARTING
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   TITLETWO TEA South Hedland Power Station -Met Assessment
   MODELOPT CONC  BETA
   AVERTIME 1
   POLLUTID CO
   RUNORNOT RUN
   SAVEFILE Scenarios.sv1 5
   ERRORFIL Scenarios.err
CO FINISHED
**
****************************************
** AERMOD Source Pathway
****************************************
**
**
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
   LOCATION OC1_GAS      POINT      661302.000  7740087.783       17.300
** DESCRSRC OC1_gas
   LOCATION OC2_GAS      POINT      661325.000  7740061.681       16.970
** DESCRSRC OC2_gas
   LOCATION CC3_GAS      POINT      661356.000  7740044.465       16.830
** DESCRSRC CC3_gas
   LOCATION CC4_GAS      POINT      661378.000  7740019.308       17.120
** DESCRSRC CC4_gas
   LOCATION OC1_G50      POINT      661302.000  7740087.783       17.300
** DESCRSRC OC1_g50
   LOCATION OC2_G50      POINT      661325.000  7740061.681       16.970
** DESCRSRC OC2_g50
   LOCATION OC1_OIL      POINT      661302.000  7740087.783       17.300
** DESCRSRC OC1_oil
   LOCATION OC2_OIL      POINT      661325.000  7740061.681       16.970
** DESCRSRC OC2_oil
   LOCATION CC3_OIL      POINT      661356.000  7740044.465       16.830
** DESCRSRC CC3_oil
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** DESCRSRC CC4_oil
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   SRCPARAM CC3_GAS            1.0    35.000   383.150  33.90100     2.270
   SRCPARAM CC4_GAS            1.0    35.000   383.150  33.90100     2.270
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   BUILDHGT OC2_G50         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC2_G50         0.00     0.00    22.00    22.00    22.00    22.00
   BUILDHGT OC2_G50        22.00    22.00    22.00    22.00     0.00     0.00
   BUILDHGT OC2_G50         0.00     0.00     0.00     0.00     0.00     0.00

   BUILDHGT OC1_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC1_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC1_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC1_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC1_OIL        22.00    22.00    22.00    22.00    22.00     0.00
   BUILDHGT OC1_OIL         0.00     0.00     0.00     0.00     0.00     0.00

   BUILDHGT OC2_OIL         0.00     0.00    22.00    22.00    22.00    22.00
   BUILDHGT OC2_OIL        22.00    22.00    22.00    22.00     0.00     0.00
   BUILDHGT OC2_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT OC2_OIL         0.00     0.00    22.00    22.00    22.00    22.00
   BUILDHGT OC2_OIL        22.00    22.00    22.00    22.00     0.00     0.00
   BUILDHGT OC2_OIL         0.00     0.00     0.00     0.00     0.00     0.00

   BUILDHGT CC3_OIL        22.00    22.00    22.00    22.00    22.00    22.00
   BUILDHGT CC3_OIL        22.00    22.00    22.00     0.00     0.00     0.00
   BUILDHGT CC3_OIL         0.00     0.00     0.00     0.00    22.00    22.00
   BUILDHGT CC3_OIL        22.00    22.00    22.00    22.00    22.00    22.00
   BUILDHGT CC3_OIL        22.00    22.00    22.00     0.00     0.00     0.00
   BUILDHGT CC3_OIL         0.00     0.00     0.00     0.00    22.00    22.00

   BUILDHGT CC4_OIL        22.00    22.00    22.00    22.00     0.00     0.00
   BUILDHGT CC4_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT CC4_OIL         0.00     0.00     0.00    22.00    22.00    22.00
   BUILDHGT CC4_OIL        22.00    22.00    22.00    22.00     0.00     0.00
   BUILDHGT CC4_OIL         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDHGT CC4_OIL         0.00     0.00     0.00    22.00    22.00    22.00

   BUILDWID OC1_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_GAS        65.15    63.06    59.06    53.26    45.84     0.00
   BUILDWID OC1_GAS         0.00     0.00     0.00     0.00     0.00     0.00

   BUILDWID OC2_GAS         0.00     0.00    64.38    61.33    63.39    65.26
   BUILDWID OC2_GAS        65.15    63.06    59.06    53.26     0.00     0.00
   BUILDWID OC2_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC2_GAS         0.00     0.00    64.38    61.33    63.39    65.26
   BUILDWID OC2_GAS        65.15    63.06    59.06    53.26     0.00     0.00
   BUILDWID OC2_GAS         0.00     0.00     0.00     0.00     0.00     0.00

   BUILDWID CC3_GAS        64.56    65.46    64.38    61.33    63.39    65.26
   BUILDWID CC3_GAS        65.15    63.06    59.06     0.00     0.00     0.00
   BUILDWID CC3_GAS         0.00     0.00     0.00     0.00    56.95    61.69
   BUILDWID CC3_GAS        64.56    65.46    64.38    61.33    63.39    65.26
   BUILDWID CC3_GAS        65.15    63.06    59.06     0.00     0.00     0.00
   BUILDWID CC3_GAS         0.00     0.00     0.00     0.00    56.95    61.69

   BUILDWID CC4_GAS        64.56    65.46    64.38    61.33     0.00     0.00
   BUILDWID CC4_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID CC4_GAS         0.00     0.00     0.00    50.48    56.95    61.69
   BUILDWID CC4_GAS        64.56    65.46    64.38    61.33     0.00     0.00
   BUILDWID CC4_GAS         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID CC4_GAS         0.00     0.00     0.00    50.48    56.95    61.69

   BUILDWID OC1_G50         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_G50         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_G50         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_G50         0.00     0.00     0.00     0.00     0.00     0.00
   BUILDWID OC1_G50        65.15    63.06    59.06    53.26    45.84     0.00
   BUILDWID OC1_G50         0.00     0.00     0.00     0.00     0.00     0.00
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BUILDWID OC2_G50          0.00    0.00   64.38   61.33   63.39   65.26
BUILDWID OC2_G50         65.15   63.06   59.06   53.26    0.00    0.00
BUILDWID OC2_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC2_G50          0.00    0.00   64.38   61.33   63.39   65.26
BUILDWID OC2_G50         65.15   63.06   59.06   53.26    0.00    0.00
BUILDWID OC2_G50          0.00    0.00    0.00    0.00    0.00    0.00

BUILDWID OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC1_OIL         65.15   63.06   59.06   53.26   45.84    0.00
BUILDWID OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00

BUILDWID OC2_OIL          0.00    0.00   64.38   61.33   63.39   65.26
BUILDWID OC2_OIL         65.15   63.06   59.06   53.26    0.00    0.00
BUILDWID OC2_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID OC2_OIL          0.00    0.00   64.38   61.33   63.39   65.26
BUILDWID OC2_OIL         65.15   63.06   59.06   53.26    0.00    0.00
BUILDWID OC2_OIL          0.00    0.00    0.00    0.00    0.00    0.00

BUILDWID CC3_OIL         64.56   65.46   64.38   61.33   63.39   65.26
BUILDWID CC3_OIL         65.15   63.06   59.06    0.00    0.00    0.00
BUILDWID CC3_OIL          0.00    0.00    0.00    0.00   56.95   61.69
BUILDWID CC3_OIL         64.56   65.46   64.38   61.33   63.39   65.26
BUILDWID CC3_OIL         65.15   63.06   59.06    0.00    0.00    0.00
BUILDWID CC3_OIL          0.00    0.00    0.00    0.00   56.95   61.69

BUILDWID CC4_OIL         64.56   65.46   64.38   61.33    0.00    0.00
BUILDWID CC4_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID CC4_OIL          0.00    0.00    0.00   50.48   56.95   61.69
BUILDWID CC4_OIL         64.56   65.46   64.38   61.33    0.00    0.00
BUILDWID CC4_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDWID CC4_OIL          0.00    0.00    0.00   50.48   56.95   61.69

BUILDLEN OC1_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_GAS         50.48   56.95   61.69   64.56   65.46    0.00
BUILDLEN OC1_GAS          0.00    0.00    0.00    0.00    0.00    0.00

BUILDLEN OC2_GAS          0.00    0.00   37.03   27.10   33.18   42.48
BUILDLEN OC2_GAS         50.48   56.95   61.69   64.56    0.00    0.00
BUILDLEN OC2_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC2_GAS          0.00    0.00   37.03   27.10   33.18   42.48
BUILDLEN OC2_GAS         50.48   56.95   61.69   64.56    0.00    0.00
BUILDLEN OC2_GAS          0.00    0.00    0.00    0.00    0.00    0.00

BUILDLEN CC3_GAS         53.26   45.84   37.03   27.10   33.18   42.48
BUILDLEN CC3_GAS         50.48   56.95   61.69    0.00    0.00    0.00
BUILDLEN CC3_GAS          0.00    0.00    0.00    0.00   63.06   59.06
BUILDLEN CC3_GAS         53.26   45.84   37.03   27.10   33.18   42.48
BUILDLEN CC3_GAS         50.48   56.95   61.69    0.00    0.00    0.00
BUILDLEN CC3_GAS          0.00    0.00    0.00    0.00   63.06   59.06

BUILDLEN CC4_GAS         53.26   45.84   37.03   27.10    0.00    0.00
BUILDLEN CC4_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN CC4_GAS          0.00    0.00    0.00   65.15   63.06   59.06
BUILDLEN CC4_GAS         53.26   45.84   37.03   27.10    0.00    0.00
BUILDLEN CC4_GAS          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN CC4_GAS          0.00    0.00    0.00   65.15   63.06   59.06

BUILDLEN OC1_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_G50         50.48   56.95   61.69   64.56   65.46    0.00
BUILDLEN OC1_G50          0.00    0.00    0.00    0.00    0.00    0.00

BUILDLEN OC2_G50          0.00    0.00   37.03   27.10   33.18   42.48
BUILDLEN OC2_G50         50.48   56.95   61.69   64.56    0.00    0.00
BUILDLEN OC2_G50          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC2_G50          0.00    0.00   37.03   27.10   33.18   42.48
BUILDLEN OC2_G50         50.48   56.95   61.69   64.56    0.00    0.00
BUILDLEN OC2_G50          0.00    0.00    0.00    0.00    0.00    0.00

BUILDLEN OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00
BUILDLEN OC1_OIL         50.48   56.95   61.69   64.56   65.46    0.00
BUILDLEN OC1_OIL          0.00    0.00    0.00    0.00    0.00    0.00

BUILDLEN OC2_OIL          0.00    0.00   37.03   27.10   33.18   42.48
BUILDLEN OC2_OIL         50.48   56.95   61.69   64.56    0.00    0.00
BUILDLEN OC2_OIL          0.00    0.00    0.00    0.00    0.00    0.00
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BUILDLEN OC2_OIL       0.00     0.00    37.03    27.10    33.18    42.48
BUILDLEN OC2_OIL      50.48    56.95    61.69    64.56     0.00     0.00
BUILDLEN OC2_OIL       0.00     0.00     0.00     0.00     0.00     0.00

BUILDLEN CC3_OIL      53.26    45.84    37.03    27.10    33.18    42.48
BUILDLEN CC3_OIL      50.48    56.95    61.69     0.00     0.00     0.00
BUILDLEN CC3_OIL       0.00     0.00     0.00     0.00    63.06    59.06
BUILDLEN CC3_OIL      53.26    45.84    37.03    27.10    33.18    42.48
BUILDLEN CC3_OIL      50.48    56.95    61.69     0.00     0.00     0.00
BUILDLEN CC3_OIL       0.00     0.00     0.00     0.00    63.06    59.06

BUILDLEN CC4_OIL      53.26    45.84    37.03    27.10     0.00     0.00
BUILDLEN CC4_OIL       0.00     0.00     0.00     0.00     0.00     0.00
BUILDLEN CC4_OIL       0.00     0.00     0.00    65.15    63.06    59.06
BUILDLEN CC4_OIL      53.26    45.84    37.03    27.10     0.00     0.00
BUILDLEN CC4_OIL       0.00     0.00     0.00     0.00     0.00     0.00
BUILDLEN CC4_OIL       0.00     0.00     0.00    65.15    63.06    59.06

XBADJ    OC1_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_GAS     -97.97  -105.94  -110.69  -112.08  -110.06     0.00
XBADJ    OC1_GAS       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    OC2_GAS       0.00     0.00    26.68    37.83    39.41    37.68
XBADJ    OC2_GAS      34.80    30.87    26.00    20.34     0.00     0.00
XBADJ    OC2_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC2_GAS       0.00     0.00   -63.71   -64.93   -72.59   -80.15
XBADJ    OC2_GAS     -85.28   -87.82   -87.69   -84.90     0.00     0.00
XBADJ    OC2_GAS       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    CC3_GAS      13.88    20.29    26.09    31.09    26.72    19.43
XBADJ    CC3_GAS      11.56     3.33    -5.00     0.00     0.00     0.00
XBADJ    CC3_GAS       0.00     0.00     0.00     0.00   -63.07   -66.11
XBADJ    CC3_GAS     -67.14   -66.13   -63.12   -58.18   -59.90   -61.91
XBADJ    CC3_GAS     -62.04   -60.28   -56.69     0.00     0.00     0.00
XBADJ    CC3_GAS       0.00     0.00     0.00     0.00     0.00     7.05

XBADJ    CC4_GAS      34.84    36.41    36.87    36.22     0.00     0.00
XBADJ    CC4_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    CC4_GAS       0.00     0.00     0.00   -89.28   -91.67   -91.27
XBADJ    CC4_GAS     -88.10   -82.25   -73.91   -63.32     0.00     0.00
XBADJ    CC4_GAS       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    CC4_GAS       0.00     0.00     0.00    24.12    28.60    32.21

XBADJ    OC1_G50       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_G50       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_G50       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_G50       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_G50     -97.97  -105.94  -110.69  -112.08  -110.06     0.00
XBADJ    OC1_G50       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    OC2_G50       0.00     0.00    26.68    37.83    39.41    37.68
XBADJ    OC2_G50      34.80    30.87    26.00    20.34     0.00     0.00
XBADJ    OC2_G50       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC2_G50       0.00     0.00   -63.71   -64.93   -72.59   -80.15
XBADJ    OC2_G50     -85.28   -87.82   -87.69   -84.90     0.00     0.00
XBADJ    OC2_G50       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    OC1_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC1_OIL     -97.97  -105.94  -110.69  -112.08  -110.06     0.00
XBADJ    OC1_OIL       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    OC2_OIL       0.00     0.00    26.68    37.83    39.41    37.68
XBADJ    OC2_OIL      34.80    30.87    26.00    20.34     0.00     0.00
XBADJ    OC2_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    OC2_OIL       0.00     0.00   -63.71   -64.93   -72.59   -80.15
XBADJ    OC2_OIL     -85.28   -87.82   -87.69   -84.90     0.00     0.00
XBADJ    OC2_OIL       0.00     0.00     0.00     0.00     0.00     0.00

XBADJ    CC3_OIL      13.88    20.29    26.09    31.09    26.72    19.43
XBADJ    CC3_OIL      11.56     3.33    -5.00     0.00     0.00     0.00
XBADJ    CC3_OIL       0.00     0.00     0.00     0.00   -63.07   -66.11
XBADJ    CC3_OIL     -67.14   -66.13   -63.12   -58.18   -59.90   -61.91
XBADJ    CC3_OIL     -62.04   -60.28   -56.69     0.00     0.00     0.00
XBADJ    CC3_OIL       0.00     0.00     0.00     0.00     0.00     7.05

XBADJ    CC4_OIL      34.84    36.41    36.87    36.22     0.00     0.00
XBADJ    CC4_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    CC4_OIL       0.00     0.00     0.00   -89.28   -91.67   -91.27
XBADJ    CC4_OIL     -88.10   -82.25   -73.91   -63.32     0.00     0.00
XBADJ    CC4_OIL       0.00     0.00     0.00     0.00     0.00     0.00
XBADJ    CC4_OIL       0.00     0.00     0.00    24.12    28.60    32.21
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   YBADJ    OC1_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_GAS         33.63    20.49     6.73    -7.24   -20.98     0.00
   YBADJ    OC1_GAS          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    OC2_GAS          0.00     0.00   -39.54   -31.09   -21.70   -11.65
   YBADJ    OC2_GAS         -1.24     9.20    19.37    28.95     0.00     0.00
   YBADJ    OC2_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC2_GAS          0.00     0.00    39.54    31.09    21.70    11.65
   YBADJ    OC2_GAS          1.24    -9.20   -19.37   -28.95     0.00     0.00
   YBADJ    OC2_GAS          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    CC3_GAS        -19.10   -11.78    -4.09     3.71    11.41    18.76
   YBADJ    CC3_GAS         25.53    31.54    36.58     0.00     0.00     0.00
   YBADJ    CC3_GAS          0.00     0.00     0.00     0.00    31.80    25.84
   YBADJ    CC3_GAS         19.10    11.78     4.09    -3.71   -11.41   -18.76
   YBADJ    CC3_GAS        -25.53   -31.54   -36.58     0.00     0.00     0.00
   YBADJ    CC3_GAS          0.00     0.00     0.00     0.00   -31.80   -25.84

   YBADJ    CC4_GAS          6.93    17.50    27.54    36.74     0.00     0.00
   YBADJ    CC4_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    CC4_GAS          0.00     0.00     0.00    24.73    14.51     3.84
   YBADJ    CC4_GAS         -6.93   -17.50   -27.54   -36.74     0.00     0.00
   YBADJ    CC4_GAS          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    CC4_GAS          0.00     0.00     0.00   -24.73   -14.51    -3.84

   YBADJ    OC1_G50          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_G50          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_G50          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_G50          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_G50         33.63    20.49     6.73    -7.24   -20.98     0.00
   YBADJ    OC1_G50          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    OC2_G50          0.00     0.00   -39.54   -31.09   -21.70   -11.65
   YBADJ    OC2_G50         -1.24     9.20    19.37    28.95     0.00     0.00
   YBADJ    OC2_G50          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC2_G50          0.00     0.00    39.54    31.09    21.70    11.65
   YBADJ    OC2_G50          1.24    -9.20   -19.37   -28.95     0.00     0.00
   YBADJ    OC2_G50          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    OC1_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC1_OIL         33.63    20.49     6.73    -7.24   -20.98     0.00
   YBADJ    OC1_OIL          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    OC2_OIL          0.00     0.00   -39.54   -31.09   -21.70   -11.65
   YBADJ    OC2_OIL         -1.24     9.20    19.37    28.95     0.00     0.00
   YBADJ    OC2_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    OC2_OIL          0.00     0.00    39.54    31.09    21.70    11.65
   YBADJ    OC2_OIL          1.24    -9.20   -19.37   -28.95     0.00     0.00
   YBADJ    OC2_OIL          0.00     0.00     0.00     0.00     0.00     0.00

   YBADJ    CC3_OIL        -19.10   -11.78    -4.09     3.71    11.41    18.76
   YBADJ    CC3_OIL         25.53    31.54    36.58     0.00     0.00     0.00
   YBADJ    CC3_OIL          0.00     0.00     0.00     0.00    31.80    25.84
   YBADJ    CC3_OIL         19.10    11.78     4.09    -3.71   -11.41   -18.76
   YBADJ    CC3_OIL        -25.53   -31.54   -36.58     0.00     0.00     0.00
   YBADJ    CC3_OIL          0.00     0.00     0.00     0.00   -31.80   -25.84

   YBADJ    CC4_OIL          6.93    17.50    27.54    36.74     0.00     0.00
   YBADJ    CC4_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    CC4_OIL          0.00     0.00     0.00    24.73    14.51     3.84
   YBADJ    CC4_OIL         -6.93   -17.50   -27.54   -36.74     0.00     0.00
   YBADJ    CC4_OIL          0.00     0.00     0.00     0.00     0.00     0.00
   YBADJ    CC4_OIL          0.00     0.00     0.00   -24.73   -14.51    -3.84

   SRCGROUP N_CC     CC3_GAS CC4_GAS
   SRCGROUP N_OC     OC1_GAS OC2_GAS
   SRCGROUP Low_CC   CC3_GAS CC4_GAS
   SRCGROUP Low_OC   OC1_G50 OC2_G50
   SRCGROUP Oil_CC   CC3_OIL CC4_OIL
   SRCGROUP Oil_OC   OC1_OIL OC2_OIL
SO FINISHED
**
****************************************
** AERMOD Receptor Pathway
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**
**
RE STARTING
   INCLUDED Scenarios.rou
RE FINISHED
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**
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** AERMOD Meteorology Pathway
****************************************
**
**
ME STARTING
   SURFFILE ..\AERMET\AirportMetMix\BOM_PortHedland_2009_2013.SFC
   PROFFILE ..\AERMET\AirportMetMix\BOM_PortHedland_2009_2013.PFL
   SURFDATA 0 2009
   UAIRDATA 4032 2009
   SITEDATA 4032 2009
   PROFBASE 10.0 METERS
ME FINISHED
**
****************************************
** AERMOD Output Pathway
****************************************
**
**
OU STARTING
   RECTABLE ALLAVE 1ST
   RECTABLE 1 1ST
   POSTFILE 1 N_CC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
   POSTFILE 1 N_OC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
   POSTFILE 1 Low_CC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
   POSTFILE 1 Low_OC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
   POSTFILE 1 Oil_CC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
   POSTFILE 1 Oil_OC UNFORM SCENARIOS.AD\01_GN_CC.POS 31
** Auto-Generated Plotfiles
OU FINISHED
**
****************************************
** Project Parameters
****************************************
** PROJCTN  CoordinateSystemUTM
** DESCPTN  UTM: Universal Transverse Mercator
** DATUM    World Geodetic System 1984
** DTMRGN   Global Definition
** UNITS    m
** ZONE     -50
** ZONEINX  0
**
```