International Power

APPENDIX C

Air Quality

URS

F I N A L   R E P O R T

Air Quality Assessment for Proposed Parkes Peaking Power Plant, NSW

Prepared for

International Power (Australia) Pty Ltd

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Executive Summary

International Power (Australia) Pty Ltd (IPRA) proposes to construct and operate a gas fired peaking power plant, approximately 10km north west of Parkes, NSW. Subject to final gas turbine plant selection, the peaking plant will comprise three 40MW to 50MW gas turbines, operating up to 10% of the year. URS has performed an air quality assessment of the proposed plant investigating local air quality impacts and aviation safety. A greenhouse gas assessment has also been performed.

The impact of the proposed plant on local air quality has been assessed using the CSIRO's TAPM dispersion model with the incorporation of meteorological data from Parkes Airport. The modelled species included oxides of nitrogen (NO_x), particulate matter (PM_{10}), carbon monoxide (CO) sulphur dioxide (SO_2) and Hazardous Air Pollutants (HAPs).

In addition to this, AUSPLUME modelling has been performed in order to screen against TAPM's worst case predicted impacts. This component of the assessment utilised synthetic worst case meteorology, and demonstrated TAPM's predictions to be conservative against AUSPLUME methodology.

The assessment has used a conservative approach, in accordance with the DEC (2005) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. To cover a range of meteorological conditions, it has been assumed that all three turbines would run continuously for every hour of a full year, for operation both on natural gas and distillate fuel. This is very conservative with respect to distillate-fuelled operation, which will be limited to 200 hours per year per turbine unit.

The assessment of the cumulative impacts against regulatory criteria of NO_X, PM_{10}, CO and SO_2 has used the aggregate of the worst case predicted plant impacts, and peak background concentrations from DECC (NSW EPA) monitoring stations.

The air dispersion modelling assessment concluded that under worst case meteorological condition with all units operating all hours using distillate the predicted impacts on ground level air quality for NO_2, PM_{10}, CO and SO_2 when added to the background air quality concentrations, are well within the DECC Regulatory criteria.

The highest cumulative 1-hour concentration of NO_2 (using peak annual impact, peak annual background and assuming all NO_x emissions to exist as NO_2) was predicted to be 179.8 µg/m^3 against the criteria of 246 µg/m^3. The peak 1-hour concentration was shown to occur approximately 3.5 km to the south of the site. The 24 hour averaged background levels of PM_{10} were shown to have a maximum cumulative impact of 47.6µg/m^3 against the criteria of 50µg/m^3. A peak PM_{10} background concentration of 45.0µg/m^3 was used, indicating that PM_{10} impacts from the peaking power plant were negligible, whilst the worst case background concentrations were approaching regulatory criteria. Annual cumulative concentrations for NO_2 and PM_{10} were below regulatory criteria. SO_2 and CO were shown to be well within the DECC's criteria and have minor impacts on local and regional air sheds and ambient air quality.

As per the approved methods, HAPs were assessed for incremental impact (from the plant alone) and were well below regulatory criteria. Under natural gas operation, the most significant incremental impact was formaldehyde, for which the worst case 1 hour concentration constituted 1.3% of DEC assessment criteria. Under distillate operation, PAH emissions formed the most significant incremental impact, in which the worst case 1 hour concentration constituted 5.2% of DEC assessment criteria.

Based on the upper limit of proposed operation, total greenhouse gas emissions from the Parkes Peaking Power Plant are estimated to be 0.109 Mt CO_2-e per year, which will contribute 0.07% of all existing greenhouse gas sources in NSW, and up to 0.019% of the Australian emissions of greenhouse gases for all sectors.

A plume rise assessment / aviation safety study was performed which shows that the peaking power plant would produce exhaust plumes with vertical velocities that exceed 4.3m/s above the Obstacle Limitation Surface for approximately 5% of the year, based on a full year of three turbines operating.

Given the infrequent operating time of the peaking power plant and the conservative nature of the air quality assessment, it is considered that the potential for adverse air quality impacts of the proposed Parkes Peaking Power Plant will be negligible.

Section 1 Introduction

1.1 Proposed Development

International Power (Australia) Pty Ltd (IPRA) propose to build an open cycle gas turbine power plant for peaking operation, with a capacity in the range of 120- 150MW. The proposed facility is to be located approximately 10km north west of Parkes, and will comprise three gas turbines in the range of 40-50MW fuelled primarily by natural gas from the Central West Gas Pipeline. The peaking power plant is to be designed with the capability to operate on distillate fuel should the gas supply be unavailable, however operation on distillate fuel will be limited to less than 200 hours per year. Operating duty of the peaking power plant would be determined by network requirements, however IPRA estimate operation to be between 5% and 10% of the year with a limit of 10% of the year.

1.2 Turbine Operation

In each gas turbine generator, air is drawn in through filters to remove particulate matter and passed into the compressor section of the gas turbine. In each compressor, multiple rows of rotating blades raise the temperature and pressure of the air. Following compression of the air to pressures of 15 to 30 atmospheres, the air flows into the combustors where fuel is injected and burnt, increasing the temperature to approximately 1,100 - 1,200°C.

The combustion products enter the turbine section of the gas turbine and expand to toward atmospheric pressure, reducing in temperature to around 550°C. As the gas expands, the gases drive the turbine, which in turn, drives the compressor and an electrical generator. From the turbine, the hot exhaust gases are discharged directly to the stack.

1.3 Turbine Emissions

The primary atmospheric emissions from gas turbines are typical for combustion sources, namely: nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), water vapour (H_2O), oxides of nitrogen (NO_x) and carbon monoxide (CO). Other gaseous emissions are likely to include oxides of sulphur (SO_x), and low concentrations of particulates, Volatile Organic Compounds (VOC's) and air toxics. Carbon dioxide has been excluded from this component, as it has been addressed as part of the greenhouse gas assessment (**Appendix A**). The various species of interest and their sources are listed in **Table 1-1**.

Table 1.1: Exhaust Components and their relevant sources

Species	Source/s
N_2, O_2,	Inlet Air
H_2O	Inlet Air, oxidation of hydrogen in fuel
NO_x	Oxidation of primarily atmospheric and also fuel-bound nitrogen
SO_x	Oxidation of fuel-bound sulphur
CO_2	Oxidisation of carbon in fuel
CO	Incomplete oxidation of carbon in fuel
Particulate Matter	Particulate matter in air, Incomplete oxidation of fuel, Impurities in fuel
Hazardous Air Pollutants / VOC	Impurities in fuel and incomplete oxidation of fuel

Section 1 Introduction

Gas turbines are extremely clean burning when compared with boilers and reciprocating internal combustion engines. The fuel is burnt at very high temperatures, with a large amount of excess air, which promotes complete combustion of the fuel, thus improving (reducing) the emissions of particulates, carbon monoxide and VOCs. The large volumes of air in the gas turbine combustion process minimises VOC and particulate production. However excess air at high temperatures does promote the formation of NO_x, where atmospheric nitrogen is oxidised into nitric oxide (NO) and nitrogen dioxide (NO_2).

Following is a discussion of the various pollutant species considered in this assessment:

1.3.1 Oxides of nitrogen

Oxides of nitrogen (NO_X) is the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). In gas turbines the primary mechanism for NO_X formation is termed "thermal NO_X". This occurs in the burners, where high temperatures allow the dissociation of atmospheric nitrogen (N_2), after which the nitrogen may combine with excess oxygen. Generally the NO_x emissions from a combustion stack comprise approximately 90% NO to 10% NO_2.

In the atmosphere NO and NO_2 are linked in a circular reaction with oxidants such as ozone, which generate NO_2 from NO and sunlight which breaks NO_2 down to NO. Due to this reaction sequence, the exact amount of NO and NO_2 within emissions is often unknown, and consequently the sum emission of both species (i.e. NO_x) is quoted. The ambient concentration of NO_2 near to a NO_X source is dependent on the amount of oxidant and sunlight at the time.

In ambient concentrations usually found within the atmosphere, NO has no impact on either human health or the environment. Conversely, it is known that short term concentrations of NO_2 greater than 200ppb (411µg/m^3) (NEPC, 1998a), has the potential to cause irritation in certain individuals. To ensure that individuals are protected from potential health impacts of short term concentrations, maximum short term exposure is set within NSW at 246 µg/m^3 (120ppb). The long term effects of NO_2 are less well known although some evidence suggests poor lung function of inhabitants of areas with high NO_2 concentrations. To address the potential long term effects of NO_2, an annual average limit of 62 µg/m^3 has been set by the Department of Climate Change & Environment (DECC), now incorporating the New South Wales Environment Protection Authority (NSW EPA).

1.3.2 Particulate Matter

Particulate matter is generally divided into two broad fractions - deposited and suspended. Deposited particulate matter is dust that, because of its aerodynamic diameter and density, rapidly falls from the air. In general terms, deposited particulate has a diameter of greater than about 20 µm. However there is no distinct dividing line between these particles and the smaller particles of suspended matter that fall more slowly out of the air. Because of the size of the particulate matter, most of this material will not enter the body. Hence the effects of deposited particulate are primarily nuisance, and may only affect health via annoyance reactions and the like.

Major natural sources of background particulate levels include forest fires, pollen and wind-blown dust from exposed areas. Anthropogenic sources include stationary and mobile combustion sources, road dust, agriculture, mining, major fires and emissions from industrial processes. Background levels vary widely depending on location, meteorology and proximity of major point or area sources.

1.3.3 Sulphur dioxide

Emissions of sulphur dioxide are defined by the sulphur content of the fuel. Both of the fuels proposed for use at Parkes are regulated for sulphur content, such that sulphur dioxide emissions are low to negligible.

The Natural gas supply to the site is regulated by the Australian Standard AS4564-2005 (Standards Australia 2005), which specifies a concentration of less than 50mg/m^3 (at 1atm, 15°C), with a slightly lower concentration specified in the access arrangement for the Central West Gas Pipeline. Regardless, sulphur dioxide emissions in this assessment have been based on the limit 50mg/m^3 as specified in the Australian Standard.

Under distillate operation, the plant will use low sulphur distillate to Australian Standard AS3570 which has been refined to standards specified in the Commonwealth *Fuel Quality Standards Act* (2000). Since 1 January 2006, this act has regulated the sulphur content of automotive diesel to 50mg/kg, with a further reduction to 10mg/kg as of the 1 January 2009. Sulphur dioxide emissions in this assessment have been based on the current specification for sulphur content of 50mg/kg.

1.3.4 Carbon monoxide

Carbon monoxide (CO) is produced due to the incomplete combustion of any fuel containing carbon, where there is too little oxygen within the mix or the fuel. In gas turbines this occurs primarily during the 10-minute start up phase of operation for the turbines proposed to be used at Parkes.

1.3.5 Hazardous Air Pollutants

Hazardous Air Pollutants (HAP) emissions from gas turbines are lower than for other combustion sources e.g. internal combustion engines (USEPA, 1995). This is due to the combustion environment present, where high temperatures and high amounts of excess air promote more complete combustion of the fuel. The most prominent HAP under natural gas combustion is formaldehyde, whilst for distillate-fired turbines, formaldehyde emissions are lower than for natural gas with Polycyclic Aromatic Hydrocarbons (PAH) and VOC such as Benzene, Toluene, Ethylbenzene and Xylene (BTEX) forming a greater component of HAP emissions.

Section 2 Air Quality Criteria

2.1 General

There are three main types of air quality criteria relevant to industrial developments such as the power generation facility proposed by IPRA.

Emission Standards – which are maximum allowable pollutant emission concentrations (gas turbine exhaust stack concentrations) specified for particular types of equipment;

Air Impact Assessment Criteria – which are designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources; and

Ambient Air Quality Standards – which set standards against which ambient air quality monitoring results may be assessed.

In general, Emission Standards and Air Impact Assessment Criteria are used to evaluate the expected impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant Ambient Air Quality Standards.

2.1.1 Emission Standards

The *Protection of the Environment Operations (Clean Air) Regulation 2002* sets emission limits for air impurities from stationary plant and equipment. The current standards, taken from Schedule 3 (Electricity Generation) of the Regulation, relevant to the International Power peaking power plant are presented in **Table 2-1**. The plant is classified as a Group 6 source, as it will commence operation after 1 September 2005.

Table 2.1: Emission Standards for Electricity Generation (from Schedule 3, Protection of the Environment Operation (Clean Air) Regulation 2002)

Pollutant	Applicability	Limit
Solid Particulates (Total)	-	50 mg/m^3
NO_2 or NO or both as NO_2 equivalent	Any turbine operating on gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more	70 mg/m^3 as NO_2
	Any turbine operating on a fuel other than gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more	90 mg/m^3 as NO_2

Note: An activity is designated to "Group 6"if it commenced to be carried on, or to operate, on or after 1 September 2005, as a result of an environment protection licence granted under the Protection of the Environment Operations Act 1997 pursuant to an application made on or after 1 September 2005.

The emission rates used in this assessment have been based on conservative worse case emission rates. Specific turbine emission concentrations will depend upon the type of gas turbines ultimately selected but the proponent will ensure that turbine emissions, for both natural gas and distillate, will comply with the limits stipulated in the Development Approval.

Section 2 Air Quality Criteria

2.1.2 Air Impact Assessment Criteria

In August 2005, the DECC (NSW EPA) released the DEC (2005a) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. This document specifies a range of impact assessment criteria for toxic and odorous air pollutants. The impact assessment criteria for those pollutants associated with the proposed peaking power plant are shown in **Table 2-2**.

Table 2.2: DEC Impact Assessment Criteria for Primary Pollutants[A]

Pollutant	Concentration		Averaging Period
	(ppm)	(µg/m^3)	
NO_2	0.12	246	1 hour
	0.03	62	Annual
PM_{10}	-	50	24 hour
	-	30	annual
SO_2	0.25	712	10 minutes
	0.20	570	1 hour
	0.08	228	24 hours
	0.02	60	Annual
CO	87	100,000	15 minutes
	25	30,000	1 hour
	9	10,000	8 hours

[A]: Primary pollutants are regional pollutants identified by the DEC as pollutants that are known to adversely impact human health and the atmosphere.

2.1.3 Ambient Air Quality Criteria

In February 1998 the NSW EPA issued 'Action for Air' - the NSW Government's 25-year Air Quality Management Plan. In this plan the EPA adopted a number of regional ambient air quality goals for a range of air pollutants. This Plan was updated in August 2006 [A] and focuses on the Greater Metropolitan Region of NSW with emphasis on measures to reduce the adverse impact of photochemical smog and fine particle pollution.

Whilst the guidelines contained in NEPC (1998) and DEC (2006d) are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria the proposed peaking power plant emissions have not been assessed directly against these guidelines, however it should be noted that the guidelines for NO_2, PM_{10}, SO_2 and CO are identical to the DEC (2005a) criteria.

[A] DEC 2006d *Action For Air 2006 Update*. NSW Government.

Section 3 Climate & Meteorology

3.1 Climate

A summary of climatological data collected at the Parkes Station (MacArthur Street) by the Bureau of Meteorology, located approximately 9km to the south east of the site, is provided in **Table 3-1**. **Table 3-1** indicates that the region experiences hot summers and mild winters. The records indicate that average daily temperatures for summer generally range between 23-30°C and can exceed 40°C in January. The area has a low rainfall, with a mean annual rainfall of 585 mm reported over an average of 86 rain days per year.

3.2 Meteorology

As site specific meteorology was not available, the meteorological data used in the dispersion modelling was generated using the CSIRO's model, The Air Pollution Model (TAPM) dispersion model (Hurley, 2005). To further augment the meteorological data, local meteorological data from Parkes Airport (which is separate from the Parkes Macarthur Street Station) was also incorporated into the TAPM. The method for developing site specific meteorological data is provided in **Appendix B** of this report.

The approved methods (DEC, 2005a) state that at least 12 months of meteorological data must be used in an air quality assessment. **Appendix B** states that 2005 was chosen for the 12 months to be assessed, after an assessment of meteorology from 2000 through 2005 showed 2005 as being a representative year. The output files from TAPM can be made available on request.

The TAPM derived meteorological data is presented as an annual wind roses in **Figure 3-1**. As shown in **Figure 3-1**, the predicted winds on site primarily blow from the north east and south west quadrants.

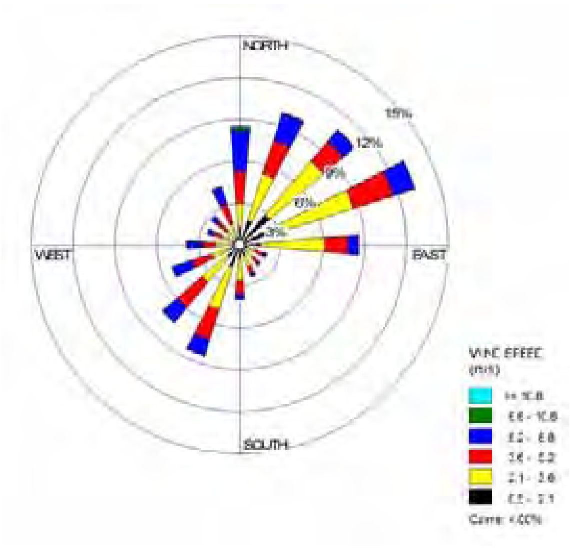

Figure 3-1: TAPM generated annual wind rose for proposed Parkes development site (2005)

Section 3 Climate & Meteorology

Table 3-1: Climate averages for Station: 065026 Parkes (MacArthur Street), Commenced: 1889 (Bureau of Meteorology, 2006)

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Number of years	% complete
Mean daily maximum temperature - deg C	32.1	31.5	28.4	23.5	18.5	14.9	13.9	15.8	19.4	23.5	27.5	30.6	23.4	94.4	97
Mean no. of days where Max Temp >= 40.0 deg C	0.9	0.5	0	0	0	0	0	0	0	0	0.1	0.4	1.9	47.4	100
Mean no. of days where Max Temp >= 35.0 deg C	8.2	5.6	1.3	0	0	0	0	0	0	0.2	1.9	5.2	22.4	47.4	100
Mean no. of days where Max Temp >= 30.0 deg C	21.6	18.5	10.6	0.9	0	0	0	0	0.2	2.3	8.7	17.1	79.8	47.4	100
Highest daily Max Temp - deg C	45.2	45.5	40	35.4	27.8	26.7	23.3	27.8	34	37.7	42	42.5	45.5	47.4	100
Mean daily minimum temperature - deg C	17.8	17.7	15	11	7.6	5.2	4	5	7.4	10.3	13.4	16.2	10.9	93.8	96
Mean no. of days where Min Temp <= 2.0 deg C	0	0	0	0.1	2.2	6.4	9.7	6	1.9	0.2	0	0	26.4	47.4	100
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0	0	0.3	1.6	3.1	1.9	0.3	0	0	0	7.1	47.4	100
Lowest daily Min Temp - deg C	8.7	6	4.9	1.2	-1.1	-2.6	-4.2	-3.6	-2	1	3	6.7	-4.2	47.4	100
Mean 9am air temp - deg C	23.3	22.7	20.5	16.8	12.1	8.7	7.6	9.6	13	16.9	19.5	22.3	16.1	49	100
Mean 9am wet bulb temp - deg C	17.4	17.4	15.8	13.1	10	7.3	6.2	7.5	9.9	12.5	14.1	15.9	12.2	46.9	96
Mean 9am dew point - deg C	12.8	13.4	12	9.7	7.8	5.7	4.4	5	6.5	8.1	9.2	10.7	8.7	45.9	97
Mean 9am relative humidity - %	54	58	60	65	76	82	82	75	67	59	54	50	65	46.9	96
Mean 9am wind speed - km/h	10.8	9.9	8.9	7.3	5.8	5.1	5.8	7.9	9.7	11.3	11.6	11	8.8	47.3	99
Mean 3pm air temp - deg C	30.3	29.8	27	22.6	17.5	14.2	12.9	14.7	17.9	21.8	25.5	28.7	21.9	48.9	100
Mean 3pm wet bulb temp - deg C	19.4	19.6	17.9	15.1	12.5	10.3	9.2	10.1	12.1	14.4	16.1	17.8	14.5	46.8	96
Mean 3pm dew point - deg C	11.3	12.2	10.7	8.4	7.5	6	4.7	4.7	5.9	7.1	7.7	8.9	7.9	45.9	97
Mean 3pm relative humidity - %	34	37	40	43	54	59	60	54	49	43	36	33	45	46.8	96
Mean 3pm wind speed - km/h	13.4	11.9	11.6	11.1	11	11.2	12	13.4	14	14.4	14.9	14.2	12.8	47.2	99
Mean monthly rainfall - mm	59.3	47.4	47.4	42.7	48.4	49	49.2	49.9	41.8	52.7	46.8	50.8	585.2	113.8	99
Median (5th decile) monthly rainfall - mm	43.1	32	37.9	31.5	46.2	41.9	45.5	47	33.8	41.9	37.4	42.4	554.8	111	-
9th decile of monthly rainfall - mm	140.7	118.2	109	87.9	99.7	96	87.3	92.1	80.2	98.9	107.7	110.7	839.9	111	-
1st decile of monthly rainfall - mm	6.3	3.3	2.5	6.8	6.7	15.1	10.2	13.9	11.4	16.2	5.3	9	375.7	111	-
Mean no. of raindays	5.7	5.2	5.4	5.3	7.4	9.2	10.2	9.4	7.8	7.7	6.2	6	85.5	113.4	99
Highest monthly rainfall - mm	251.9	218.3	197.7	299	205	165.1	132.9	116.2	126.4	191.4	189	171.9	-	113.8	99
Lowest monthly rainfall - mm	0	0	0	0	0	0.6	4.4	1	1.5	0	0.1	0	-	113.8	99
Highest recorded daily rainfall - mm	118.9	100.8	72.6	68.6	96	39.4	44.5	62.8	55	81.3	149.9	81.5	149.9	111.4	97
Mean no. of clear days	13	11.7	13.7	12.8	10.3	9.1	9.2	9.5	10.9	10.6	10.7	13	134.5	47.4	100
Mean no. of cloudy days	6.9	5.8	6.1	7.2	10.6	11.4	12.8	11.4	9.3	8.9	7.5	7.7	105.5	47.4	100
Mean daily evaporation - mm	7.4	6.4	5.2	3.4	2	1.4	1.5	2.1	3.2	4.6	5.9	7.9	4.2	11.9	100

Section 4 Background Air Quality

4.1 Background Air Quality

Background air quality is generally a function of regional industrial and residential air emission sources. The area being assessed is a comparatively sparsely populated rural area, and combustion source emissions such as NO_x, SO_2 and CO are low. The main air pollutant of concern is particulate matter (PM_{10}) which is primarily due to the natural processes in the surrounding environment and rural and industrial activities. It is necessary to assess the background concentrations of air pollutants as they provide a baseline level, to which the predicted impact of the development can be added in order to produce a cumulative air quality impact.

DEC (2005a) requires that the peak annual background (pre-existing) concentration of a pollutant, measured by an appropriate monitoring station is used to represent the background concentration of that pollutant for the region. This results in a conservative assessment, as the concentrations of an individual pollutant are constantly varying in time and space, in which a full year's data most likely contains several atypical peaks in concentration due to specific events such as bushfires or dust storms.

The availability of background data in regional New South Wales is limited and the data was selected with the following objectives:

- isolated from coastal meteorology;
- isolated from urban air sheds;
- isolated from complex terrain; and
- completeness of data for the entire year 2005.

The background data for PM_{10} was taken from the closest DECC monitoring station at Bathurst, located approximately 150km ESE from the proposed site, however, levels of NO_x, SO_2, CO were not available at Bathurst, consequently, background NO_x, SO_2 and CO data for 2005 was sourced from the most suitable DECC monitoring stations as per the objectives above. The closest monitoring stations were found to be Bargo (north of Goulburn) and Liverpool, which lie in the Sydney airshed. As Bargo data was considered more representative of Parkes compared with Liverpool, where possible, data from Bargo was used.

Apart from PM_{10} which was sourced from Bathurst, the remainder of the data was sourced from regions south west of Sydney. Given the proximity of the Bargo and Liverpool monitoring stations to the large urban airshed of Sydney, the use of this data for the estimation of cumulative concentration of pollutant species at Parkes is considered conservative.

Where pollutant concentrations were required to be assessed for averaging times less than one hour, namely for SO_2 and CO, Equation 1 was used to convert the hourly averaged background data (EPA Victoria, 2005).

$$C_t = C_{60}\left[\frac{60}{t}\right]^{0.2} \qquad \text{…[Equation 1]}$$

Where:
C_t = concentration of pollutant at time t
C_{60} = concentration of pollutant based on averaging time of 60 minutes;
t = time (in minutes)

Section 4 Background Air Quality

A summary of the background air quality concentrations used in this assessment, as measured by DECC, is provided in **Table 4-1**.

Table 4-1 Summary of Background data used in Air Quality Modelling

Species	Averaging Time	DEC Monitoring Station Data	Maximum Background Concentration (µg/m^3)	Air Quality Critera (µg/m^3)
NO_2	1 hour	Bargo	86.6	246
	Annual average		34.5	62
CO	15 minute	Liverpool	5900	100,000
	1 hour		4470	30,000
	8 hour		3210	10,000
SO_2	10 minute	Bargo	33.7	712
	1 hour		23.6	570
	24 hour		7.9	228
	Annual average		3.1	60
PM_{10}	24 hour	Bathurst	45	50
	Annual average		14.8	30
Ozone (O_3)	1 hour	Bathurst	120	214
	4 hour		115	171

Note: Data obtained from NSW DEC (2005b), NSW DEC (2006a), NSW DEC (2006b) and NSW DEC (2006c).

Section 5 Assessment Methodology

5.1 Construction Impacts

The estimated duration of construction through to commissioning is 6-8 months, although construction activity on site may only be evident for 5 months. The construction phase will include mobilisation, bulk earthworks, establishing and preparing foundations, construction of buildings and plant and demobilisation.

During the construction phase, there is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicles movements. The minimisation and control of dust emissions during the construction period will be implemented using procedures contained in the Construction Environmental Management Plan (CEMP).

Construction activities on previously occupied industrial sites have been known to give rise to odours or dust containing contaminants. Given the agricultural nature of the site, there is considered to be no significant potential for any dust emissions from construction activities to contain contaminants, or for the works to give rise to odorous emissions, consequently a comprehensive assessment of emissions during construction has not been quantified. The distance to the nearest residential dwellings (approximately 1 km) provides a sufficient buffer zone between the main work area and neighbouring land uses to prevent nuisance dust impacts.

5.2 Dispersion Modelling

Where site specific meteorological data does not exist, the DEC (2005a) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* suggests the use of CSIRO's "The Air Pollution Model" (TAPM) to predict site specific meteorology, which is based on regional meteorological observations.

Through a number of verification studies (e.g. Hurley, 2005), TAPM has been identified as a suitable model of choice to simulate meteorological fields and plume dispersion in a number of situations [2] including high temperature buoyant plumes such as power plants. TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical co-ordinate for three-dimensional simulations. It includes parameterisations for cloud/rain micro-physical processes, turbulence closure, urban/vegetative canopy and soil, and radiative fluxes.

TAPM was run to calculate meteorological fields for the modelling domain Default options were selected, except where noted otherwise below:

- Grid centre coordinates –33°6' latitude, 148° 4'30'' longitude (600310 mE, 6337113 mN);
- Four nested grid domains (25 x 25): 30 km, 10 km, 3 km and 1 km;
- Meteorological grid consisting of four nests of 25 x 25 grid points at 30, 10, 3 and 1 km spacing, with 25 vertical grid levels from 10 to 8000 m;
- Pollution grid set at twice the resolution of the meteorological grid (four nests of 15, 5, 1.5 and 0.5 km spacing). Based on preliminary results, a finer resolution within 1km of the plant was not considered necessary, as primary impacts were in the 3 to 4km south of the source;
- Eulerian dispersion was used on the outer nests, whilst Lagrangian dispersion was used on the innermost nest;

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[2] CSIRO, 2005. *The Air Pollution Model (TAPM) Version 3. Part 2: Summary of Some Verification Studies.* CSIRO Atmospheric Research Technical Paper 72, 2005.

- Buoyancy enhancement from multiple stacks was calculated according to the method described in Manins et al. 1992;
- Building downwash effects were considered to be negligible as the turbines are the only significant structures proposed for the development;
- The Parkes Airport meteorological data was used on a radius of influence of 35km. The centre of influence was also relocated to the project site and configured to affect the lowest two levels of TAPM generated wind fields (9.8 and 24.8m);
- Terrain at 9 arc-second (approximately 270m) resolution from the Geoscience Australia terrain database. Land characterisation data at approximately 1km resolution, sourced from the US geological Survey, Earth Resources Observation System (EROS) Data Centre Distributed Active Archive Centre (EDC DAAC). Sea surface temperature data at 100 km grid intervals from the US National Centre for Atmospheric Research (NCAR);
- Six hourly synoptic scale meteorology from the BoM Limited Area Prediction System.

5.2.1 Operational Scenario

The operational emission parameters, pollutant data and turbine exhaust stack characteristics and locations used in the dispersion modelling are contained in **Tables 5.1** and **5.2**. The emission rates for the proposed gas turbines were provided as typical by IPRA. **Appendix E** contains calculations for oxides of nitrogen, sulphur dioxide, and Hazardous Air Pollutants (HAPs).

HAP emissions have been calculated from the USEPA's AP-42 emission database (USEPA 1995). Sulphur dioxide emission rates were based on the pipeline limit of 50mg/m^3 as specified in the Australian Standard, and the 50mg/kg specified in the *Fuel Quality Standards Act* (2000), for natural gas and distillate operation respectively.

Table 5.1: Stack Parameters and Emission Rates (Full Load)

Stack Parameter	Units		
Stack Height (above ground level)	(m)	20m	
Stack Diameter	(m)	4	
Nominal Capacity	(MW)	40	
Exit Temperature	(°C)	541	
Exit Velocity	(m/s)	26	
Stack Emissions [A] (per stack)		**Natural Gas**	**Distillate**
NO_X (as NO_2)	g/s	9.7	15.0
CO	g/s	6	1.4
SO_2	g/s	0.36	0.42
PM_{10}	g/s	0.6	2.1
Acetaldehyde	g/s	4.00E-05	-
Acrolein	g/s	6.40E-06	-
Benzene	g/s	1.20E-05	5.50E-05
Ethylbenzene	g/s	3.20E-05	-
Formaldehyde	g/s	7.10E-04	2.80E-04
PAH	g/s	2.20E-06	4.00E-05
Toluene	g/s	1.30E-04	-
Xylenes	g/s	6.40E-05	-

[A] Calculations for various species provided in **Appendix E**

Table 5.2: Gas Turbine Stack Locations

Stack	Location (GDA94)	
Stack 1	600200mE	6336666mN
Stack 2	600240mE	6336660mN
Stack 3	600280mE	6336654mN

5.2.2 Start-up Scenario

Start-up scenarios were not included as part of this assessment. Given the relatively small scale of the proposed turbines, coupled with their open cycle configuration, they are able to reach full load within 10 minutes from the commencement of combustion. The predicted run profile for the proposed peaking power plant nominates 20-50 starts per turbine per year, which equates to a worse case start-up duty of less than 0.3% of the year.

It should also be noted that, based on the proposed turbines, formation of the primary pollutant, namely NO_2, increases in intensity throughout the load profile with greatest emissions occurring during full operational load.

On this basis, start-up emissions were not considered suitable for representation in annual hourly averaged maximum statistics, and were excluded from the atmospheric dispersion modelling component of this assessment.

Section 6 Assessment of Potential Air Quality Impacts

6.1 Summary of Local Air Quality Impacts

Table 6-1 and 6-2 display the results of the dispersion modelling, which are also displayed in the **Figures** Section. None of the species modelled were shown to exceed the DEC regulatory criteria.

AUSPLUME modelling was also performed in order to screen against TAPM's worst case predicted impacts. This component of the assessment is detailed in **Appendix D**. Synthetic worst case meteorology was utilised, and demonstrated TAPM's predictions to be conservative against AUSPLUME methodology.

Table 6-1: Dispersion Modelling Results for Natural Gas Operation

Species	Averaging Time	Maximum Predicted Impact ($\mu g/m^3$)	Maximum Background ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	DEC Criteria ($\mu g/m^3$)
NO_2	1 hour	60.2	86.6	146.8 [A]	246
	Annual	0.2	34.5	34.7	62
CO	15min	49.2	5900	5949.2	100000
	1 hour	37.3	4470	4507.3	30000
	8 hour	17.4	3210	3227.4	10000
SO_2	10min	3.2	33.7	36.9	712
	1 hour	2.2	23.6	25.8	570
	24 hour	0.5	7.9	8.4	228
	Annual	0.01	3.1	3.11	60
PM_{10}	24 hour	0.8	45	45.8	50
	Annual	0.02	14.8	14.82	30
Acetaldehyd	1 hour	0.015	-	0.015	42
Acrolein	1 hour	0.002	-	0.002	0.42
Benzene	1 hour	0.005	-	0.005	290
Ethylbenzen	1 hour	0.012	-	0.012	8000
Formaldehyd	1 hour	0.268	-	0.268	20
PAH	1 hour	0.001	-	0.001	0.4
Toluene	1 hour	0.049	-	0.049	360
Xylenes	1 hour	0.024	-	0.024	190

[A]: All emitted NO_x is assumed to be in the form NO_2.

Table 6-2: Dispersion Modelling Results for Distillate Operation

Species	Averaging Time	Max Predicted Impact (µg/m³)	Max Background (µg/m³)	Total Impact (µg/m³)	DECC Criteria (µg/m³)
NO_2	1 hour	93.2	86.6	179.8 [A]	246
	Annual	0.4	34.5	34.9	62
CO	15min	11.5	5900	5911.5	100000
	1 hour	8.7	4470	4478.7	30000
	8 hour	4.1	3210	3214.1	10000
SO_2	10min	3.7	33.7	37.4	712
	1 hour	2.6	23.6	26.2	570
	24 hour	0.5	7.9	8.4	228
	Annual	0.01	3.1	3.11	60
PM_{10}	24 hour	2.6	45	47.6	50
	Annual	0.05	14.8	14.85	30
Benzene	1 hour	0.028	-	0.028	290
Formaldehyde	1 hour	0.145	-	0.145	20
PAH	1 hour	0.021	-	0.021	0.4

[A]: All emitted NO_x is assumed to be in the form NO_2.

6.2 Local Air Quality

6.2.1 Nitrogen Dioxide

The ground level guidelines for oxides of nitrogen are limited to NO_2, the principal species of concern in terms of health effects. For both the 1 hour and annual averages, cumulative concentrations of NO_2 were shown to occur at concentrations below regulatory guidelines. The NO_2 assessment is considered to be conservative, as discussed in the following paragraphs.

Oxides of nitrogen (NO_x) from combustion sources are emitted at a ratio of approximately 90% nitric oxide (NO) to 10% nitrogen dioxide (NO_2). The NO_x species undergo complex interaction after emissions from the plant with the ratio of NO_2 to total NO_x increasing due to the oxidation of NO by ambient ozone. At the peak impact area, approximately 3.5km from the plant, it is expected that the majority of the plant emitted NO_x will consist of NO, with NO_2 comprising the balance.

The 1 hour averaged NO_2 figure presented in **Tables 5-1** and **5-2** show NO_x present as NO_2, which is added to the worst case measured background concentration of NO_2 [3], consequently it is considered that the cumulative NO_2 values estimated as part of this assessment are conservative.

It should again be noted that the peaking power plant is expected to operate for less than 10% of the year, and that the modelling results shown in **Tables 5-1** and **5-2** represent the worst case predictions based on the peaking power plant operating for every hour of the year, consequently the impacts are likely to be significantly less than modelled. In addition, the annual average NO_2 concentrations, when modelled under the Operating conditions were shown to be below criteria of 62 µg/m³. Given the background concentration of 34.5 µg/m³, and the predicted cumulative impact from operation of the natural gas and distillate scenarios showed concentrations at or less than 0.4 µg/m³, long term impacts are considered negligible.

[3] From the DECC Bargo Air Quality Measurement Station during 2005

6.2.2 Photochemical Smog

Photochemical smog is produced during extended periods of light winds (several hours to several days) accompanied by strong sunlight, as a result of reactions involving the precursor pollutants NO_x and non-methane hydrocarbons (NMHCs). These reactions produce O_3, NO_2, peroxyacetyl nitrate and aldehydes. Aerosols are also formed, which result in visible orange-brown hazes.

While there is NO_x available, the formation of photochemical smog is said to be in a "light-limiting" regime. When NO_x is limiting the formation of smog, it is called "NO_x limited". Fresh NO_x emissions, or the reaction of nitrogen oxide with partially oxidised NMHCs, may restart these photochemical reactions.

There are few major industrial sources of hydrocarbons in the area and emissions of NO_x and VOCs from vehicles would be significantly lower than the levels experienced in major metropolitan air sheds such and Sydney and Melbourne. The potential for smog generation in Parkes and similar rural locations is therefore considered to be low and this is reflected in the ozone concentrations recorded by DECC, shown in **Table 4-1**. Photochemical smog is unlikely to occur due to operations of the gas turbine plant.

The atmospheric dispersion modelling study has indicated that NO_2 emissions from the proposed Parkes Peaking Power Plant would not result in exceedances of relevant ambient air quality criteria under normal operating conditions. It is therefore concluded that further quantitative investigations of any likely increases in the potential for smog generation as a result of the proposed Parkes Peaking Power Plant emissions are not warranted. No further investigations into smog generation have therefore been undertaken.

6.2.3 Particulate Matter (as PM_{10})

The maximum 24 hourly background concentrations of PM_{10} was shown to be 45 µg/m³ whilst the average for the 12 month period was shown to be 14.8 µg/m³ (see **Table 6-1** and **6-2**). The maximum incremental concentration of PM_{10} (24 hour average) for either of the modelled fuels, was 2.6 µg/m³ which equates to 5% of the DECC criteria (50 µg/m³). The highest annual PM_{10} concentration was shown to be 0.1 µg/m³ from the distillate turbine, which represents 0.3% of the DECC criteria. Thus it is considered that increases in annual PM_{10} concentrations from the proposed development are minimal.

6.2.4 Hazardous Air Pollutants

Hazardous Air Pollutants were assessed in accordance with approved methods, for incremental impact (from the plant alone) and were well below regulatory criteria.

Under natural gas operation, the most significant incremental impact was formaldehyde, for which the worst case 1 hour concentration (0.268 µg/m³) constituted 1.3% of DECC criteria. Under distillate operation, PAH emissions formed the most significant incremental impact, for which the worst case 1 hour concentration (0.021 µg/m³) constituted 5.2% of DECC criteria.

6.2.5 Sulphur Dioxide

For the proposed peaking power plant, the maximum predicted ground level concentration of SO_2 is 37.4 µg/m³ as a 10 minute average and occurs using distillate fuel. This is well below the 10 minute criteria for SO_2 of 712 µg/m³. Likewise, the 1 hour, 24 hour and annual concentrations of SO_2 are well below their respective guidelines for both the natural gas and distillate fuels. Consequently, no adverse impacts on local air quality are expected as a result of the discharge of SO_2 from the proposed peaking power plant.

6.2.6 Carbon Monoxide

The predicted impact of CO from the proposed development are shown to be well below criteria, hence no adverse impacts on local air quality are expected as a result of the intermittent discharge of CO from the proposed peaking power plant.

6.3 Greenhouse Gas

Total greenhouse gas emissions in Australia for 2005 were estimated to be 559.1 million tonnes of CO_2-e[4] while NSW was estimated to emit 158.2 million tonnes CO_2-e from all sources (28% of national emissions). Most of the greenhouse gas emissions in NSW come from stationary energy sources (48% of NSW emissions).

Based on the upper limit of proposed operation the Parkes Project is estimated to release 0.109 million tonnes of CO_2-e (includes full fuel cycle emissions) per year as a peak load station, representing 0.19% of the emissions associated with electricity generation in NSW, or 0.07% of all sources of greenhouse gas in NSW in 2005.

The greenhouse gas production from the Parkes Peaking Plant represents 0.06% of emissions associated with electricity generation in Australia, and 0.019% of all sources of greenhouse gas in Australia, based on the 2005 inventory.

The impact of greenhouse gases derived from the proposed Parkes Peaking Power Plant is discussed in **Appendix A**.

6.4 Aviation Safety

Due to the plume rise from the stack emissions, an aviation hazard analysis based on the predicted impacts of the proposed facility has been performed and is shown in **Appendix C**. The statistics have been compiled in accordance with the Civil Aviation Safety Authority's (CASA) Advisory Circular *"Guidelines for Conducting Plume Rise Assessments"* (June, 2004). Where there is potential for an exhaust plume with a vertical velocity greater than 4.3m/s at the Obstacle Limitation Surface (OLS) of 110m, a hazard analysis is required.

This assessment involved use of the TAPM model which was used to create site-specific meteorological data, including meteorology for the upper atmosphere. TAPM was also used to calculate plume rise trajectories for the turbine emissions.

The modelling results show that the peaking power plant would produce exhaust plumes with vertical velocities that exceed 4.3m/s above the OLS for approximately 5% of the year (assuming the plant was running at full load for all hours of the modelled year, 2005). The maximum, minimum and average heights at which the plume velocity is greater than 4.3 m/s are provided in **Table 6-3**.

Table 6.3 Maximum, Minimum and Average Critical Plume Extents

	Critical Vertical Plume Extent (m)	Critical Horizontal Plume Extent (m)
Maximum	360	83
Minimum	28	13
Average	46	24

[4] *Australia's National Greenhouse Accounts, State and Territory Greenhouse Gas Inventories 2005,* Australian Greenhouse Office 2007.

Section 7 Conclusion

7.1 Local Air Quality

The impact of the proposed peaking power plant on local air quality, at Parkes, has been assessed using the TAPM dispersion model. The species assessed included oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter (PM_{10}) and Hazardous Air Pollutants (HAPs).

The dispersion modelling has used a largely conservative approach, in accordance with the DEC (2005a) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. The conservative approach assumed that the peaking power plant would be running all three turbines for every hour of the year, however, it is expected that the plant will only be operating approximately 5-10% of the year. In addition the peaking power plant is designed to operate on both natural gas and distillate with natural gas as its primary fuel, however both fuel types were assessed. It was also assumed that all NO_x emissions from the peaking power plant were in the NO_2 form.

In order to assess the cumulative impact of the plant emissions on the local air quality, background concentrations of the primary pollutants were obtained from the DECC monitoring station at Bathurst, Bargo and Liverpool, which are the closest monitoring stations to the proposed development site that measure the primary pollutants. The assessment of background data showed that none of the species studied exceeded criteria, although peak background PM_{10} (24 hour average) values, taken from the DECC Bathurst Monitoring Station were shown to be approaching criteria.

The results of the worst case dispersion modelling showed that the predicted impacts in ground level concentrations of NO_2, PM_{10}, CO and SO_2, when added to peak background concentrations, were within the DECC regulatory criteria. A summary of the modelling results for each species follows:

- The highest concentration of NO_2 (1 hour average) was predicted to be 179.8µg/m^3 (includes maximum background concentration of 86.6 ug/m^3) against the criteria of 246 µg/m^3, which was shown to occur approximately 3.5 km south of the site. This value conservatively assumed all NO_x emitted from the peaking power plant was NO_2. The highest annual average NO_2 concentration was 34.9 µg/m^3 against criteria of 62 µg/m^3 (includes annual background concentration of 34.5 ug/m^3) however, the actual value is likely to be considerably lower than the modelling result given the intermittent operating time over the year;
- The highest 24 hour averaged background levels of PM_{10} were shown to have a cumulative maximum impact of 47.6µg/m^3 against the criteria of 50 µg/m^3 (includes maximum background concentration of 45 ug/m^3). Whilst the maximum peaking power plant impact was shown only to be 2.6 µg/m^3 (24 hour average), the high background concentration contributes significantly to the level approaching DECC criteria. The highest annual average PM_{10} impact from the plant was 0.05 µg/m^3 and when added to the background concentration of 14.8 µg/m^3, resulted in a concentration of 14.85 µg/m^3 which was below the criteria of 30 µg/m^3, However, the actual impact is likely to be considerably lower than the predicted result, given the likely operating time of 5-10%;
- SO_2 showed minor impact, with the highest predicted cumulative 1 hour average result of 26.2 µg/m^3 against a criteria of 570 µg/m^3.
- Similarly, CO showed a slight impact, with the highest predicted cumulative 1 hour average result of 4507.3 µg/m^3 against a criteria of 30,000 µg/m^3.

Air quality impacts associated with emissions of Hazardous Air Pollutants were assessed for incremental impact. Predicted worst case impacts of these pollutants formed at most a small proportion of regulatory criteria. Under natural gas operation, the most significant incremental impact was formaldehyde, for which the worst case 1 hour concentration (0.268 µg/m^3) constituted 1.3% of DEC criteria. Under distillate operation, PAH emissions formed the most significant incremental impact, for which the worst case 1 hour concentration (0.021 µg/m^3) constituted 5.2% of DEC criteria.

In conclusion, it is considered that this assessment has been conservative and actual operating impacts on local air quality from this proposal will be considerably lower than those presented in this assessment. The assessment has also demonstrated with a high level of confidence that air quality guidelines will not be breached as a result of the proposal.

7.2 Greenhouse Gas

The greenhouse gas assessment indicated that based on the upper limit of proposed operation, total greenhouse gas emissions from the Parkes Peaking Power Plant are estimated to be 0.109 Mt CO_2-e per year, which will contribute 0.07% of all existing greenhouse gas sources in NSW.

The greenhouse gas production from the Parkes Peaking Plant represents 0.06% of emissions associated with electricity generation in Australia, and 0.019% of all sources of greenhouse gas in Australia, based on the 2005 inventory.

7.3 Aviation Safety

Finally, an aviation safety study was performed which show that the peaking power plant would produce exhaust plumes with vertical velocities that exceed 4.3m/s above the Obstacle Limitation Surface for approximately 5% of the year, based on a full year of three turbines operating.

Section 8 References

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Section 9 Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of International Power (Australia) Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

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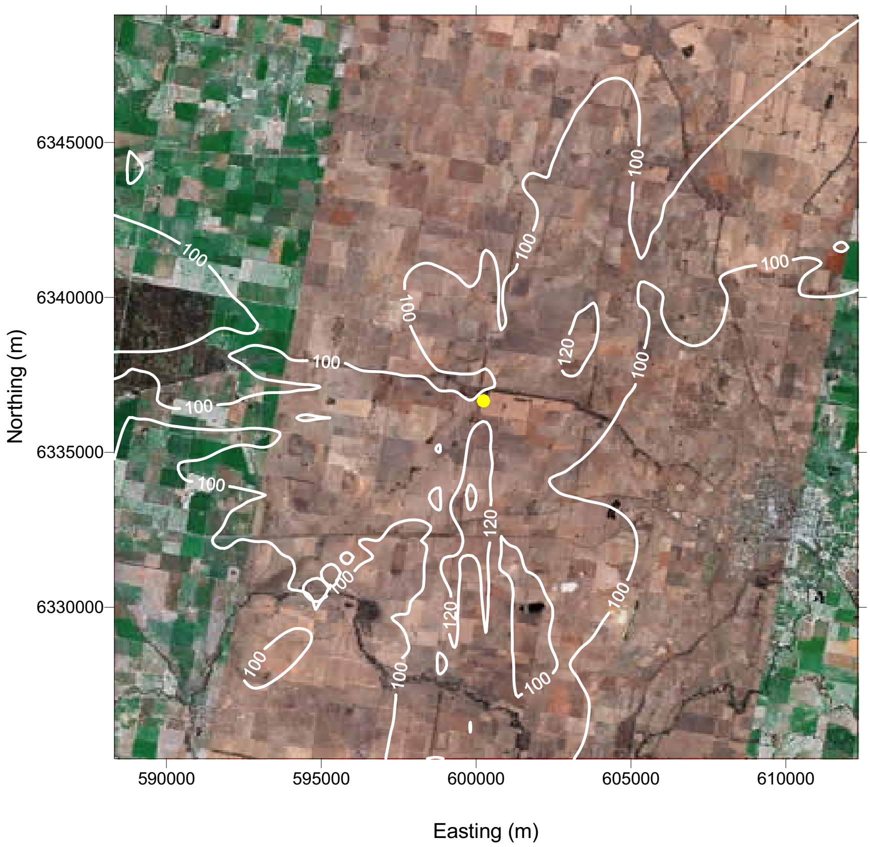
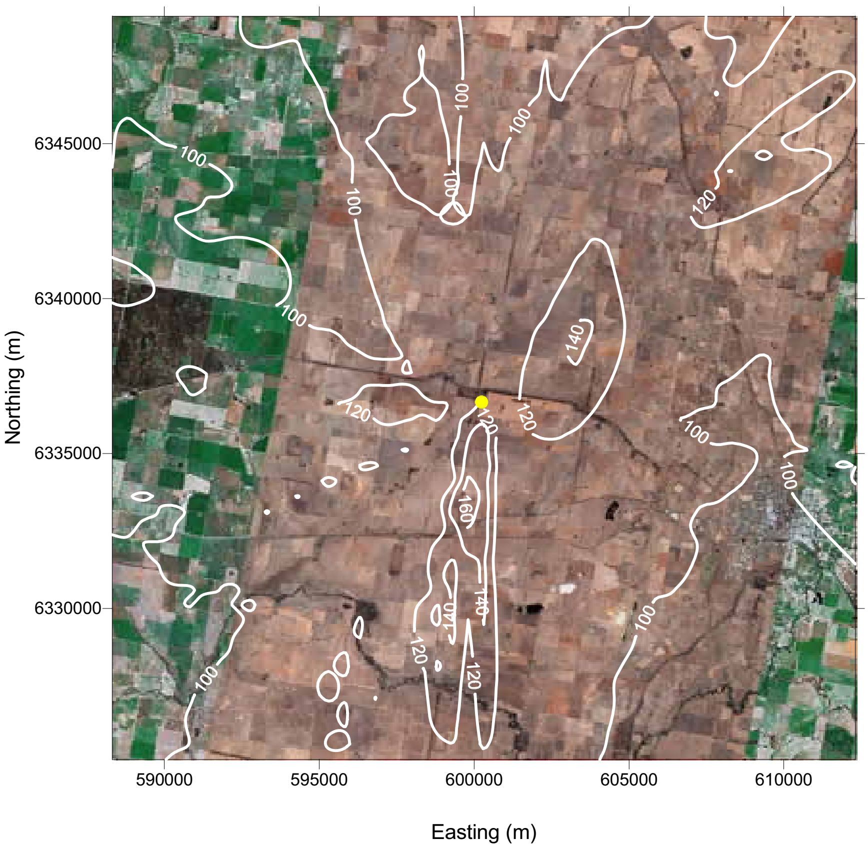
Figures

NATURAL GAS



DISTILLATE



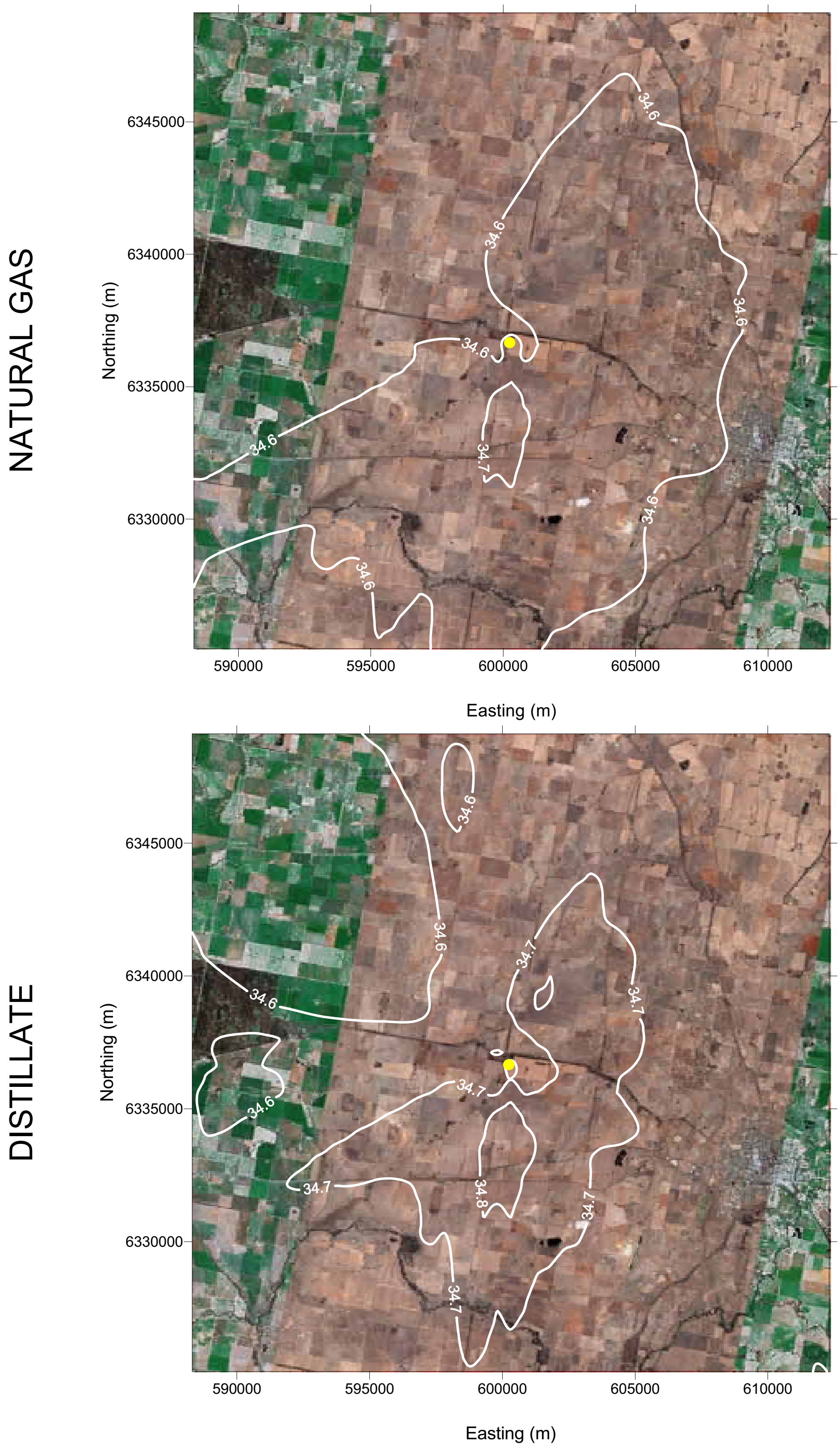
Contours in $\mu g/m^3$

Background Concentration: $86.6 \mu g/m^3$

DECC Assessment Criteria: $246 \mu g/m^3$

Proposed stack locations

Client: INTERNATIONAL POWER (AUSTRALIA) PTY LTD	Project: ENVIRONMENTAL ASSESSMENT PARKES PEAKING POWER STATION			Title: NO_2 1 Hour Averaging Maximum Cumulative Concentration	
URS	Drawn: MDT	Approved: DRAFT	Date: August 2007	Figure: 1	Rev: A
	Job No: 43177456	File: 43177456 Figure A1.srf			A4



Contours in $\mu g/m^3$
Background Concentration: $34.5\mu g/m^3$
DECC Assessment Criteria: $62\mu g/m^3$
● Proposed stack locations

Client: INTERNATIONAL POWER (AUSTRALIA) PTY LTD	Project: ENVIRONMENTAL ASSESSMENT PARKES PEAKING POWER STATION		Title: NO_2 Annual Averaging Cumulative Concentration
URS	Drawn: MDT	Approved: DRAFT	Date: August 2007
	Job No: 43177456	File: 43177456 Figure A2.srf	Figure: 2 — Rev: A — A4