Licence variation application – premises

This is an application to vary a premises-based activity licence issued under the *Protection of the Environment Operations Act 1997* ('*POEO Act*').

A variation includes the substitution, omission or amendment of an existing condition, or attaching a new condition to a licence. If a licence holder wishes to seek a variation to licence conditions, this is the application form to fill in.

The form provides for the following scenarios:

- undertaking a new scheduled activity or ceasing a scheduled activity
- deleting an activity covered by a water licence or adding a new activity to be covered by the licence
- changing the scale/capacity of an activity
- extending a scheduled development works licence to cover the next stage of the development works or converting it to a scheduled activity licence
- adding an environmental improvement program
- any other variations.

To complete this form you may need the *Guide to licensing* prepared by the Environment Protection Authority (EPA) and available at www.epa.nsw.gov.au/licensing/licenceguide.htm and/or *Waste Classification Guidelines* which are available at www.epa.nsw.gov.au/wasteregulation/classify-waste.htm .

If you need help filling out the form, please contact your nearest EPA office from the list at the end of this form.

Once completed and signed, the form should be sent to your nearest EPA office (as indicated at the end of this form).

1. Licence to be varied

1.1 Licence to be varied

Licence number	761 – Vales Point Power Station

1.2 Name of current licence holder(s)

Full name(s) of licence holder(s)	Sunset Power International Pty Ltd trading as Delta Electricity
ACN /ABN (if applicable)	ACN: ABN: 75 162 696 335

2. Changes to scheduled activities

If you have stopped undertaking a scheduled activity that is covered by your current licence, or propose to commence a new scheduled activity, you should advise the EPA. For more details on changing your activity type, please refer to the EPA's *Guide to licensing*.

2.1 Adding a new scheduled activity

Write down the short descriptions of the categories of scheduled activity you would like added to the licence for your premises. These are listed in Schedule 1 of the *POEO Act* available at www.legislation.nsw.gov.au.

Description of scheduled activities	N/A

Please attach extra page(s) if more space is needed.

2.2 Deleting a scheduled activity

Write down the short descriptions of the categories of scheduled activity no longer conducted at these premises and that you would like deleted from the licence. These are listed in Schedule 1 of the *POEO Act* available at www.legislation.nsw.gov.au.

Description of scheduled activities	N/A

Please attach extra page(s) if more space is needed.

3. Changes to 'non-scheduled activity' licence

If you hold a 'non-scheduled activity' licence and you want to add or delete activities covered by that licence, you must advise the EPA.

If your activity fits the description of a category of activity listed in Schedule 1 of the *POEO Act*, it will need a Scheduled Activity Licence, and you will need to answer Question 2 instead of this question. Please refer to Schedule 1 of the *POEO Act* available at www.legislation.nsw.gov.au to check whether the activity is a scheduled activity.

3.1 Adding a new activity

Write down the short description of the any new non-scheduled activity(ies) proposed to be conducted at these premises and that you would like added to the licence.

Description of activities to be added	N/A

Please attach extra page(s) if more space is needed.

3.2 Deleting an existing activity

Write down the short description of any non-scheduled activity(ies) no longer conducted at these premises, and that you would like deleted from the licence.

Description of activities to be deleted	N/A

Please attach extra page(s) if more space is needed.

4. Fee-based activity

The licence administrative fee varies according to the classification and scale of your activity. Classification descriptions are found in Schedule 1 of the *POEO Act* while activity scales are found in Schedule 1 of the *POEO (General) Regulation 2009* available at www.legislation.nsw.gov.au.

A change to the activity classification or activity scale may result in a change to your licence administrative fee. It may also result in a change in, or addition of, a load-based fee if the proposed activity has assessable pollutants as identified by the *POEO (General) Regulation 2009*.

4.1 Change to applicable fee-based activities

An addition or a deletion of a scheduled activity may result in a change to your fee-based activities.

The classifications used to determine licence fees can be found in Schedule 1 of the *POEO (General) Regulation 2009*.

Please provide details of the applicable fee-based activities and scales of activities that your licence will cover ***as a result of the change***.

	Fee-based activity classification after proposed variation	Activity scale after proposed variation
1	N/A	
2		
3		
4		

The EPA will notify you if there is an adjustment to your licence administrative fee.

4.2 Change to applicable fee-based activity scale/capacity

A change to the scale or capacity of your currently licensed activity may result in a change to your fee-based activity scale.

Please write down the fee-based classification of the proposed activity and the new activity scale in the space provided below, as shown in Schedule 1 of the *POEO (General) Regulation 2009*.

Please provide details of any ***changes to the scale*** of your ***currently*** licensed activities.

	Fee-based activity classification	**Current** activity scale	**Proposed** activity scale
1	N/A		
2			
3			
4			

The EPA will notify you if there is an adjustment to your licence administrative fee.

5. Scheduled development work

5.1 Scheduled development work – progression to next stage

If you hold a 'staged scheduled development work' licence and want to commence the next stage of work, please provide the information required below. You may need to provide extra documentation – refer to the conditions of your licence and Appendix 1 of the EPA's *Guide to licensing*.

Please provide a brief description of the work to be conducted:

Description of activities	N/A

How many stages to the development work are there?	N/A

Which stage of the development work does this application relate to?	N/A

When will the next stage commence?	day/month/year
When will the next stage be completed?	day/month/year

You will need to apply to vary the licence if you conduct any further stages.

Please attach to this application any documents about the scheduled development work that are specified in Appendix 1 of the EPA's *Guide to licensing* and list them in the table in **Section 9**.

5.2 Scheduled development work – change to a 'scheduled activity' licence

If you hold a 'scheduled development work' licence and you want to commence the scheduled activity, you will need to vary your licence to a 'scheduled activity' licence. You cannot start the scheduled activity until a 'scheduled activity' licence authorises it.

You may need to provide extra documentation – refer to the conditions of your licence and Appendix 1 of the EPA's *Guide to licensing*.

Please provide the following information:

When will the activity commence?	day/month/year

Please tick (✓) 'Yes' or 'No'.

		Yes		No
5.2.1	Will you still be completing some of the development work while carrying on the scheduled activity?	N/A		N/A

Please provide a brief description of the work that still needs to be completed:

Description of activities	N/A

When will the work be completed?	day/month/year

Please attach to this application any documents about the scheduled development work that are specified in Appendix 1 of the EPA's *Guide to licensing* and list them in the table in **Section 9**.

6. Environmental improvement program

Environmental improvement programs (EIPs) are programs of actions that deliver demonstrated environmental improvement outside those required to comply with the *Protection of the Environment Operations Act, 1997 (POEO Act)*, *Regulations* or existing conditions on a licence issued under the *POEO Act*.

If you are applying to add an EIP to your licence you will need to provide details of the program and the expected environmental improvements that will be delivered by the EIP.

It is important that you have discussed any program of actions with the EPA prior to applying for an EIP. EIPs are attached to the licence as a condition and the EPA may remove the EIP from the licence if the key milestones or any other conditions of the EIP are not met. If the EIP is removed from the licence the EPA will add an amount equivalent to the total score reduction received for the EIP, on to the environmental score for the following licence fee period.

Please provide a brief description of the program of actions including the proposed completion date, key reporting milestones and costs.

Description of the program of actions	N/A
Description of activities	

Please attach extra page(s) if more space is needed.

Please provide a description of the expected environment improvements delivered by the EIP. Note: you will need to demonstrate that the EIP is outside those required to achieve compliance with legislative requirements or any existing conditions on your licence.

Description of expected environmental improvements	N/A
Description of activities	

Please attach extra page(s) if more space is needed.

7. Details of other variations

Your licence can be varied by deleting or amending a condition, or substituting one condition for another.

Please provide details of any other proposed variations not covered previously in this application.

Licence condition number	Details of proposed change	Reason for proposed change
Condition L3.7	Delta requests this condition be amended to read: *"For the purposes of NO2 and NO or both, as NO2 equivalent, at point 2 and 3 and in accordance with the Protection of the Environment Operations (Clean Air) Regulation 2010, the activity or plant defined by the licence at these locations is taken to belong to Group 2 until 1 January 2027 or unless otherwise approved in writing by the EPA."*	Delta seeks an extension to the current Group 5 exemption with the limits to remain as per condition L3.4. The justification for this request is provided in Attachment A.

Please attach extra page(s) if more space is needed.

8. Development consent

Please tick (✓) 'Yes' or 'No'.

		Yes		No
8.1	Have the proposed variation(s) listed above been the subject of environmental assessment and public consultation under the *Environmental Planning and Assessment Act 1979*?			✓

If you answered **'Yes'** to this question, please attach a copy of the development consent.

If you answered **'No'** to this question, please tick (✓) the statement below that is correct.

A development application has been made to obtain development consent	
No development consent is necessary for the new activities	✓

If development consent is ***not*** necessary, please provide details indicating why:

Details	There is no change proposed to plant operations, emissions and no development or construction activities
	associated with the variation application.

9. Supporting documentation

Appendix 1 of the EPA's *Guide to licensing* provides details of the supporting documentation that is required when applying for a licence.

Please provide details of documentation included with this application.

Document title	1 Attachment A – Extension of Group 5 NOx Emission Limit Exemption
	2
	3

	4
	5

Please attach extra page(s) if more space is needed.

10. Signature of licence holder

This application may only be signed by a person(s) with the legal authority to sign it. The various ways in which the application may be signed, and the people who may sign the application, are set out in the categories below.

Please tick (✓) the box next to the category that describes how this application is being signed.

If the proposed licence holder is:		The application must be signed and certified by one of the following:
an individual	☐	the individual.
a company	☐	the common seal being affixed in accordance with the *Corporations Act 2001*, or
	☐	two directors, or
	☑	a director and a company secretary, or
	☐	if a proprietary company that has a sole director who is also the sole company secretary – by that director.
a public authority other than a council	☐	the chief executive officer of the public authority, or
	☐	by a person delegated to sign on the public authority's behalf in accordance with its legislation (Please note: a copy of the relevant instrument of delegation must be attached to this application).
a local council	☐	the general manager in accordance with s.377 of the *Local Government Act 1993* ('LG Act'), or
	☐	the seal of the council being affixed in a manner authorised under the LG Act.

I/We (the licence holder):

- ***apply for the variation of the licence listed in Section 1***
- ***declare that the information in this form (including any attachment) is not false or misleading in any material particular.***

Signature	[signature]	Signature	[signature]
Name (printed)	Greg Everett	Name (printed)	STEPHEN GURNEY
Position	Managing Director	Position	COMPANY SECRETARY
Date	22/12/2020	Date	22/12/2020

Seal (if signing under seal):

Additional information

1. It is an offence to supply any information in this form that is false or misleading in a material particular. There is a maximum penalty of $22,000 for a corporation or $11,000 for an individual.
2. Details of the licence application and licence will appear on the EPA's Public Register. The EPA can be asked by any person to provide reasons for refusing or granting a licence application.

Send this form to your nearest EPA office:

Metropolitan

Parramatta
Environment Protection Authority NSW
PO Box 668
PARRAMATTA NSW 2124

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Fax: 9995 6900

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WOLLONGONG EAST NSW 2520

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NEWCASTLE NSW 2300

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BATHURST NSW 2795

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Environment Protection Authority NSW
PO Box 397
GRIFFITH NSW 2795

Phone: 6969 0700
Fax: 6969 0710

Queanbeyan
Environment Protection Authority NSW
PO Box 622
QUEANBEYAN NSW 2620

Phone: 6122 3100
Fax: 6299 3525

Waste Operations

Environment Protection Authority NSW
PO Box A290
SYDNEY SOUTH NSW 1232

Phone: 9995 5000
Fax: 9995 5930

Attachment A

Vales Point Power Station - EPL 761
Licence Variation Application
Extension of Group 5 NO_x Emission Limit Exemption

December 2020

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Appendix A: Vales Point Power Station - Application for the Revision of the Environment Protection Licence (Malfroy Environmental Strategies, October & December 2010)

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Appendix C: 2016-2019 Review of Annual Ambient Air Quality Data (Todoroski Air Sciences)

Executive summary

Under the *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) scheduled plants belong to one of six (6) Groups, depending on the year in which the plant commenced operating. The Clean Air Regulation includes emission standards for a range of pollutants that apply to each Group and these standards become stricter in moving from Group 1 through to Group 6.

The Clean Air Regulation specifies 'grandfathering' provisions aimed at ensuring the use of old technology and/or process design is not causing a significant risk of environmental harm. Under the 'grandfathering' provisions, from 2012 any Group 2 plant is taken to belong to Group 5 *unless* the plant's Environmental Protection Licence (EPL) includes a condition that the plant is taken to belong to Group 2.

Where it can be demonstrated that the operation of Group 2 plant will not result in any adverse environmental or human health impacts, a licence variation may be granted by the NSW Environment Protection Authority (EPA) exempting the premises from complying with Group 5 standards for up to five years. The requirements and determination of a licence variation application (application) for an exemption from Group 5 facility are specified in Clauses 35, 36 & 37 of the Clean Air Regulation.

Vales Point Power Station (Vales Point), currently owned and operated by Delta Electricity (Delta), belongs to Group 2 due to the commencement dates of the existing unit 5 & unit 6 in 1978 and 1979, respectively. To continue as Group 2, an application for the variation of the conditions of the EPL was required before the beginning of 2011.

In June 2011, Delta received formal notification granting an exemption to Group 5 emission limits for oxides of nitrogen (NO_x) until 1 January 2017, but with a more stringent EPL NO_x emission limit of 1,500 mg/m^3 compared with the Group 2 NO_x emission limit of 2,500 mg/m^3. Delta successfully re-applied for the exemption to be extended for a further 5 years to 1 January 2022 in 2015.

This report has been prepared in accordance with Clauses 36 & 37 of the Clean Air Regulation to support the application that seeks to vary EPL 761 and amend condition L3.8, such that the current provisions for a Group 5 exemption with respect to emissions of NO_x are extended for a further 5 years from 1 January 2022 to 1 January 2027. The current EPL 100th percentile NO_x emission limit of 1,500 mg/m^3 and 99th percentile concentration limit on NO_x of 1,100 mg/m^3 is proposed to be maintained.

This report demonstrates the current NO_x emission limits as per EPL 761 meet the requirements of Clause 36 of the Clean Air Regulation as:

- NO_x emissions are continuously monitored in accordance with the EPA approved method CEM-2 and US EPA Procedure 1;
- the air pollutant impact assessments used for previous exemption applications remain valid and are demonstrated to be conservative estimates of NO_x impact;
- a Pollution Reduction Program for NO_x controls was completed in 2017 as per EPL 761; and
- the unit 6 burner tips will be replaced in early 2021 and are expected to reduce NO_x emissions to the same level as unit 5.

Further, the exemption for NO_x emissions will not result in any adverse environmental or human health impacts, which is most evident by the following:

- the latest Lake Macquarie Wyong Air Quality (LMWAQ) reports prepared by Todoroski Air Sciences (Appendix C) has shown the air quality on the Central Coast has consistently been very good with respect to ground level concentrations of NO_2 from 2014 to 2019;
- the Vales Point NO_x emissions are discharged from a very tall (178 m) stack and the plume is considered to be buoyant. This means that the plume from Vales Point is less likely to impact on ground level NO_x concentrations when compared to NO_x emissions from ground level sources such as motor vehicles (refer Appendix A);
- the Delta ambient air quality data indicates that the maximum NO_2 concentrations at the Delta Ambient Air Monitoring Station (AAMS) has always been well below the ambient air quality criteria;
- the conservative modelling assessment, which is validated by the actual measured ambient air concentrations at Wyee, demonstrates that the operation of Vales Point under existing conditions would not result in any adverse environmental or human health impacts; and
- the typical average operating conditions for unit 5 NO_x emissions at Vales Point are currently within the Group 5 limit of 800 mg/m^3, as demonstrated in Table 2.

Delta is incentivised by the LBL scheme to investigate and identify opportunities for improvement to reduce NO_x and, if practicable and economically viable, implement these options. This incentive caused Delta to reconsider upgrading the burner tips on unit 5 as planned in 2014 when it was apparent the change to unit 6 burner tips negatively impacted NO_x emissions. The unit 6 burner tips will also be replaced with the original burner design in early 2021.

For Vales Point to meet the Group 5 limit (i.e. 800 mg/m^3) at all times, the Pollution Reduction Program report prepared by Jacobs showed that it would require changes to burners or emission controls that are prohibitively expensive. Such controls would produce no to little environmental benefit in terms of local and regional air quality given the existing air quality on the Central Coast over recent years has always been in the good to very good range with respect to ground level NO_2 levels. The implementation of low NO_x controls could entail negative environmental impacts, such as increased carbon dioxide emissions due to poorer efficiency and increased particulate emissions due to ammonia slip introduced in the case of potential NO_x controls such as Selective Catalytic Reduction and Non Selective Catalytic Reduction.

Therefore, implementation of such controls just to meet Group 5 would be inconsistent with the Clean Air Regulation, where it can be demonstrated that the operation of the existing configuration is unlikely to result in any adverse environmental or human health impacts.

In addition, it is relevant to note that:

- the application does not propose change to the power station's boilers or firing systems that is likely to result in an increase in the potential maximum emission rates or concentrations at which any substances would be emitted from the power station;
- the current 100th percentile NO_x limit of 1,500 mg/m^3 and 99th percentile limit of 1,100 mg/m^3 in the EPL is required to maintain a margin for compliance for excursions above the average that have been demonstrated to be of short duration and unpredictable in nature;
- the recent 5 yearly review of the Vales Point EPL by the EPA introduced a tighter NO_x limit by imposing a 99th percentile limit of 1,100 mg/m^3. This demonstrates cooperation by Delta with regulatory actions by the EPA to modify and tighten NO_x emissions as recently as July 2020; and

- the closure of Munmorah power station by Delta in 2012 and the closure of Wallerawang power station in 2014 has permanently removed a significant source of NO_x emissions from the local and regional air-sheds. The proposed closure of Liddell power station in 2022 and 2023 will further reduce the amount of NO_x emissions in the Greater Sydney Metropolitan Area.

In conclusion, Delta believes this report satisfactorily demonstrates that the current 100th percentile NO_x emission limit of 1,500 mg/m^3 and the 99th percentile limit of 1,100 mg/m^3 in Vales Point EPL 761, condition L3.4 and L3.5 does not present a significant risk of adverse environmental or human health impacts and, as such, these limits can be maintained for a further 5 years.

1. Introduction

1.1 Background

Under the *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) scheduled plants belong to one of six (6) Groups, depending on the year in which the plant commenced operating. The Clean Air Regulation includes emission standards for a range of pollutants that apply to each Group and these standards tend to become stricter in moving from Group 1 through to Group 6.

The Clean Air Regulation specifies 'grandfathering' provisions aimed at ensuring the use of old technology and/or process design is not causing a significant risk of environmental harm. Under the 'grandfathering' provisions, from 2012 any Group 2 plant is taken to belong to Group 5 *unless* the plant's Environmental Protection Licence (EPL) includes a condition that the plant is taken to belong to Group 2.

Under Clause 37 of the Clean Air Regulation, the EPA must consider the impact on local and regional air quality and amenity when granting such an application. The requirements and determination of a licence variation application for an exemption from Group 5 facility are specified in Clauses 35, 36 & 37 of the Clean Air Regulation.

Vales Point Power Station (Vales Point), currently owned and operated by Delta, belongs to Group 2 due to the commencement dates of the existing Unit 5 & Unit 6 in 1978 and 1979 respectively. To have continued as Group 2 to the present time, an application for the variation of the conditions of the EPL was required before the beginning of 2011.

In 2010 Delta submitted an application to the EPA seeking an exemption from complying with Group 5 emissions limits specified in the Clean Air Regulation for Vales Point. On 2 June 2011 Delta received formal notification from the EPA granting an exemption to Group 5 emission limits for oxides of nitrogen (NO_x) until 1 January 2017, but with a more stringent EPL NO_x emission limit of 1,500 mg/m^3 compared with the Group 2 NO_x emission limit of 2,500 mg/m^3. Delta applied for, and was granted, a second exemption in 2015 for the period to 1 January 2022.

The purpose of this report is to support the application that seeks to vary Vales Point EPL 761 and amend condition L3.8 such that the current provisions for a Group 5 exemption with respect to emissions of NO_x only are extended for a further 5 years from 1 January 2022 to 1 January 2027.

It should be noted that Delta's application does not propose changes to the power station's boilers or firing systems that would likely increase the potential maximum emission rates or concentrations at which substances would be emitted. With respect to all emissions (other than NO_x), Vales Point complies with Group 5 requirements under the Clean Air Regulation.

1.2 Location

Vales Point is located on the southern shore of Lake Macquarie (about 110kms north of Sydney, NSW) within both the Central Coast Council (CCC) Local Government Area (LGA) and Lake Macquarie City Council (LMCC) LGA. The location of Vales Point, as well as the regional context, is shown in **Figure 1**.

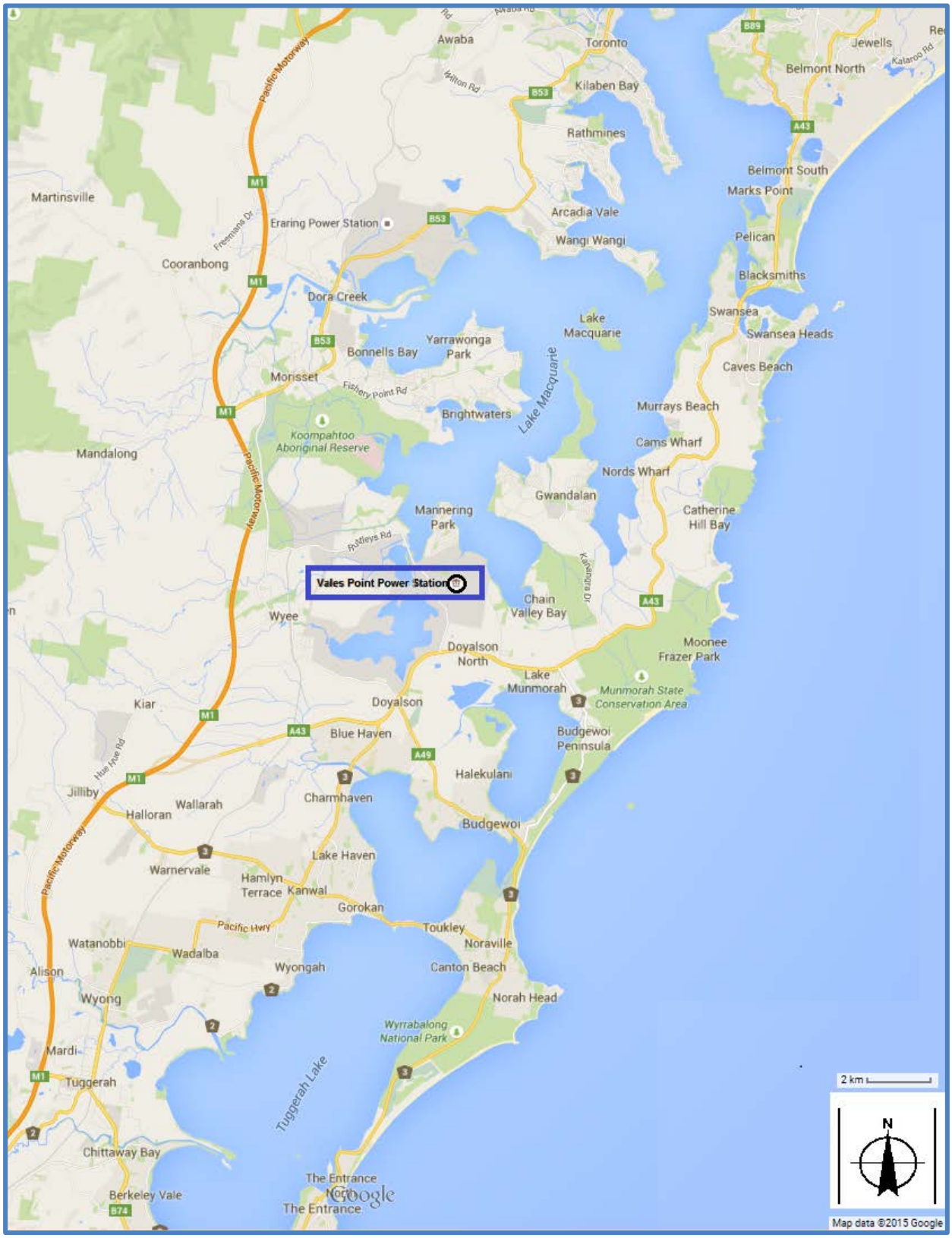

Figure 1. Location of the Vales Point Power Station

2. Scope of Report

2.1 Vales Point Licence Variation Application Scope

This report presents information to support the licence variation application (the application) submitted by Delta to extend the current Group 5 exemption for NO_x, which will enable the EPA to make an assessment against the relevant regulatory requirements. The report's scope includes:

- a review of the relevant regulatory requirements under the Clean Air Regulation;
- a review of the emission concentrations from Vales Point and a comparison of these emission concentrations with the relevant emission limits in the Clean Air Regulation;
- an air quality assessment of potential impacts, including a:
    - review of NO_x emission sources in the region;
    - review of recent government and industry ambient air quality data in the Central Coast region published by the EPA; and
    - detailed assessment of ambient air quality data collected at three monitoring stations located at sites relevant to Vales Point;
- a review of relevant air quality studies, including:
    - air quality modelling of emissions from Vales Point and other power stations in the region and comparison with relevant assessment criteria for the 2010 application; and
    - the CSIRO Inter Regional Transport of Air Pollutants Study (IRTAPS) (Nelson *et al* 2002).
- a review of current emissions and potential NO_x control options as outlined by Jacobs in the 2017 Pollution Reduction Program report submitted to the EPA.

2.2 Clean Air Regulation

The Clean Air Regulation includes a number of clauses relevant to the application to vary the Vales Point EPL to extend the Group 5 exemption and maintain the current NO_x limit for a further five years.

Delta submitted an initial application in 2010 with respect to Clause 35(3)(a) seeking an exemption from complying with Group 5 emissions limits specified in the Clean Air Regulation. On 2 June 2011 Delta received formal notification from the EPA granting an exemption to Group 5 emission limits for NO_x until 1 January 2017, but with a more stringent EPL NO_x emission limit of 1,500 mg/m^3 compared with the Group 2 NO_x emission limit of 2,500 mg/m^3. Delta successfully re-applied for the exemption to be extended for a further 5 years to 1 January 2022 in 2015. In July 2020, the EPA included a new condition L3.5 in EPL 761 to include an additional constraint on NO_x emissions from Vales Point by inserting a 99% percentile concentration limit on NO_x of 1,100 mg/m3.

This report has been prepared with respect to Clause 35(3)(b), Clause 35(4) and Clause 36 to support the application for a subsequent variation to amend EPL 761 condition L3.8 by extending the current licence condition for unit 5 and unit 6 to belong to Group 2 under the Clean Air Regulation for a further 5 years, i.e. from 1 January 2022 to 1 January 2027.

3. Information to Support Application

The following section includes the information required by the Clean Air Regulation to support the current application to extend the current Group 5 exemption for a further 5 years and maintain the existing EPL 100th percentile NO_x emission limit of 1,500 mg/m^3 and the 99th percentile limit of 1,100 mg/m^3 (both of which are more stringent than the Group 2 emission limit of 2,500 mg/m^3).

3.1 Emission Concentration and Limits

3.1.1 Oxides of Nitrogen (NO_x) Emissions

The stack emission monitoring for NO_x is undertaken using continuous emission monitoring systems (CEMS), and calibration testing is performed routinely to demonstrate compliance, as required by the Vales Point EPL.

Table 1 shows the average NO_x emissions obtained from the CEMS operating on each of Vales Point's two generating units (unit 5 and unit 6) for the 5 year period July 2015 to June 2020. The CEMS provide data of nitric oxide (NO), nitrogen dioxide (NO_2) and total NO_x, where NO + NO_2 = NO_x.

In this report, wherever NO_x is expressed as a mass concentration it is as NO_2 *equivalent*, consistent with the Clean Air Regulation.

The data in **Table 1** are hourly averages filtered to remove data points when:

- the unit was operating during a start up or shut down, i.e. load was not constant[1];
- the unit was out of service; and
- there was faulty data.

The filtering of the raw data resulted in valid data capture rates of between 99% and 100%, as indicated in Table 1, which is greater than required by the EPL (85%).

A review of **Table 1** indicates that:

- the average hourly NO_x emission for both units was typically less than 1000 mg/m^3 with a range of 585 – 931 mg/m^3, at least 30% below the current licence limit of 1,500 mg/m^3;
- maximum hourly average NO_x emissions from each of Vales Point's units were below the current limit of 1,500 mg/m^3.

[1] *Clean Air Regulation – Clause 31(2)*

Table 1: Annual Minimum, Average and Maximum 1 hour NO_x emissions (mg/m^3 - dry STP @7% O_2)

EPL Reporting Year	Unit	Avg 1 hour NO_x (mg/m^3)	Max 1 hour NO_x (mg/m^3)	Data Capture Rate
2015 - 2016	Unit 5	643	1060	99%
	Unit 6	931	1397	100%
2016 - 2017	Unit 5	585	964	100%
	Unit 6	861	1130	100%
2017 - 2018	Unit 5	619	1055	100%
	Unit 6	797	1161	100%
2018 - 2019	Unit 5	604	899	100%
	Unit 6	844	1153	100%
2019 - 2020	Unit 5	635	1117	100%
	Unit 6	754	1197	100%

Table 2 outlines the amount of time Vales Point units have operated under various NO_x levels. 800 mg/m^3 is the Group 5 limit that Vales Point is applying for an exemption from, while 1,500 mg/m^3 and 1,100 mg/m^3 are respectively the 100th and 99th percentile limits currently applied to Vales Point and other power stations in NSW. The exception is Eraring which has a limit of 1,100 mg/m^3, a condition imposed as part of its development application to upgrade the unit capacity of the power station from 660 MW to 750 MW in 2008.

It is noted that both Bayswater and Mt Piper power stations do not require an exemption to operate at their current NO_x limit of 1,500 mg/m^3 as Vales Point and Liddell power stations do. If Vales Point is not successful in its application for an exemption from Group 5 NO_x limits, it will be required to operate at lower emission levels than other industry participants when there are no adverse environmental or human health impacts arising from the current NO_x emission levels.

Vales Point has been fully compliant with the current licence conditions for the last 4 years. Unit 5 operates for the vast majority of the time under 800 mg/m^3 and the times where it is above 800 mg/m^3 are examined in section 3.3.1 of this report.

Table 2: Amount of time 1 hour NO_x emissions less than the various 3 limits (mg/m^3)

Unit 5	<800 mg/m^3	<1,100 mg/m^3	<1,500 mg/m^3
2015/16	98.32%	100%	100%
2016/17	98.66%	100%	100%
2017/18	99.20%	100%	100%
2018/19	99.39%	100%	100%
2019/20	99.08%	99.99%	100%
Unit 6	**<800 mg/m^3**	**<1,100 mg/m^3**	**<1,500 mg/m^3**
2015/16	11.48%	90.18%	100%
2016/17	28.74%	99.96%	100%
2017/18	47.71%	99.95%	100%
2018/19	27.89%	99.71%	100%
2019/20	65.84%	99.96%	100%

The new wide range burner tips were installed on unit 6 in 2012 to improve overall plant efficiency, improve plant performance at low loads and reduce carbon in ash, and therefore reduce overall greenhouse carbon emissions, all of which was achieved. Alstom, the providers of the new burners, had indicated when selling the equipment to Delta that these improvements would be achieved with a negligible change in NO_x emissions.

However, contrary to Alstom's advice, increases in NO_x emissions were observed on unit 6 after the unit came back into service in July 2012. The NO_x emissions have remained within the current licence limit of 1500 mg/m^3.

Delta and Alstom conducted investigations into the performance of unit 6 to identify the reason for the increase in the NO_x emissions. It was assessed that, while the new burner tips have provided the expected improvements in efficiency and plant performance, a reason for the higher than expected NO_x emissions remained unexplained given installations of the same burners on similarly designed boiler plant at Wallerawang and Liddell did not have this effect.

Importantly though, the same wide range Alstom burner tips were scheduled to be installed on unit 5 during the major outage in August and September 2014. However, as Alstom were unable to provide a solution to reduce the NO_x emissions on unit 6 and guarantee the same increase would not be seen on unit 5, Delta made the decision not to install the new burner tips on unit 5 in order to eliminate the risk of further increases in total NO_x emissions from Vales Point.

It is planned to re-install the original burner tip design on unit 6 in early 2021. While it is expected that unit 6 NO_x emissions will reduce once the burner tips are replaced, the slightly different combustion characteristics of each unit means it is difficult for it to be guaranteed that it will operate at the same level as unit 5. Emissions of NO_x from power stations can vary according to several factors including coal characteristics, generating load and plant operational characteristics.

3.2 Air Quality Assessment

It is only the emissions of NO_x that are of concern with respect to compliance with the Group 5 emission limits at Vales Point. Accordingly, this section of the report presents a detailed assessment of the potential air quality impacts arising from the current emission of NO_x from Vales Point.

The assessment involves:

- a review of NO_x emission sources in the region;
- a detailed examination of ambient air quality data;
- air quality modelling of Vales Point and other power stations; and
- a review of recent, relevant scientific investigations.

As noted in the Introduction, the proposed licence variation application to Vales Point EPL 761 does not involve any physical changes to plant and/or equipment. The potential future NO_x emission rates, both maximum short term rates and average rates over longer periods, will remain unchanged and therefore the proposed licence variation, if approved, would not increase either the potential short or long term air quality impacts arising from the operation of Vales Point. The NO_x emissions from Vales Point should reduce from mid 2021 as the standard design burner tips are installed on unit 6 at that time and it is expected that NO_x emissions will reduce to levels similar to unit 5.

3.2.1 Emissions of NO_x in the Central Coast Region

The National Pollutant Inventory (NPI) database provides information on the sources of NO_x emissions in the Central Coast and Lake Macquarie local government areas (LGAs) where Vales Point is located. Power stations represent the major industry emissions sources in the Central Coast airshed.

A summary of the data for the year 2008/09, which was provided in the report prepared by Malfroy Environmental Strategies (Malfroy, 2010) and submitted with Delta's 2010 application for the original Group 5 exemption is provided in **Table 2**.

A summary of the data for the year 2018/19, the latest NPI data available on the NPI database for 2018/19 is presented in **Table 3**. It shows that NO_x emissions in the region have reduced by over 25% since the original exemption application. The NO_x modelling being relied upon for this exemption application is the same as used for the 2010 and 2015 exemption applications. The modelling is considered to be conservative due to the assumption NO_x emissions from all power stations were constant and at the limit.

Table 3 shows that the NO_x contribution from electricity generation in the Lake Macquarie and Wyong LGA's has decreased by 30% since the 2008/09 NPI reporting year. The main reasons for this are that:

- Munmorah power station has ceased operations, which has permanently removed approximately 6,000,000 kilograms (kg) of NO_x per annum (based on only one unit operating in 2008) from the Central Coast airshed;
- Vales Point emissions have reduced by 3,000,000 kg compared to 2008/09 due to reduced generation levels; and
- Eraring emissions have reduced by 11,000,000 kg compared 2008/09 due to changes made as part of a capacity upgrade, approved in 2008.

This exemption application is considered to be even more conservative than the original exemption application due to the significant reduction in industrial NO_x emission sources in the region.

Table 2: NPI Emissions in the Lake Macquarie and Wyong Areas for 2008 – 2009

Emission Source Category	Wyong	Lake Macquarie	Combined
	Total NO_x Emissions (kilograms)		
Electricity Generation	29,700,000	34,000,000	63,700,000
Motor Vehicles	3,400,000	3,600,000	7,000,000
Railways	84,000	120,000	204,000
Coal Mining	-	140,000	140,000
Commercial Shipping / Boating	46,000	58,000	104,000
Burning (fuel reduction, regeneration, agriculture)	48,000	-	48,000
Other	122,000	82,000	204,000
TOTAL	**33,400,000**	**38,000,000**	**71,400,000**

Source: NPI Database

Table 3: NPI Emissions in the Lake Macquarie and Wyong LGAs for 2018 – 2019

Emission Source Category	Wyong	Lake Macquarie	Combined
	Total NO_x Emissions (kilograms)		
Electricity Generation	21,000,000	23,000,000	44,000,000
Motor Vehicles	3,400,000	3,600,000	7,000,000
Railways	84,000	120,000	204,000
Coal Mining	-	180,000	180,000
Commercial Shipping / Boating	46,000	58,000	104,000
Burning (fuel reduction, regeneration, agriculture)	48,000	-	48,000
Other	422,000	42,000	464,000
TOTAL	**25,000,000**	**27,000,000**	**52,000,000**

Source: NPI Database

3.2.2 Existing Ambient Air Quality in the Lake Macquarie – Wyong Areas

In June 2014 the EPA implemented a program to analyse industry ambient air quality monitoring data collected in the Lake Macquarie and Wyong areas from September 2013 to the end of 2016, along with EPA ambient air data for Wyong and Wallsend.

The EPA has used the data to prepare annual air quality reports that summarise and analyse the available air quality and meteorological information, which was published on the EPA's website[2] in a form intended to be accessible and easily understood by the general public.

[2] *https://www.epa.nsw.gov.au/your-environment/air/regional-air-quality/lake-macquarie-wyong-air-quality*

The Lake Macquarie–Wyong Air Quality Monthly Reports (LMWAQ reports) were first published on the EPA website in July 2015 and provide a summary of available air quality and meteorological information from industry and government monitoring sites, including the Delta Wyee ambient AAMS for the years 2014, 2015 and 2016. The EPA has ceased publishing the annual data but Delta has continued to prepare the reports for the years 2017 to 2019 (provided in Appendix C).

Figure 2 shows the location of the ambient air and meteorological monitoring sites presented in the EPA LMWAQ reports in relation to the power stations and the major towns of the region.

Delta has undertaken a review of the LMWAQ reports for the period from 2014. The review indicates that the air quality on the Central Coast at the Wyee AAMS is predominantly in the very good range with respect to NO_2 (refer Figure 3), with the maximum hourly values for NO_2 always well below the EPA ambient air quality criteria.

Figure 2: Central Coast Ambient Air Monitoring Stations

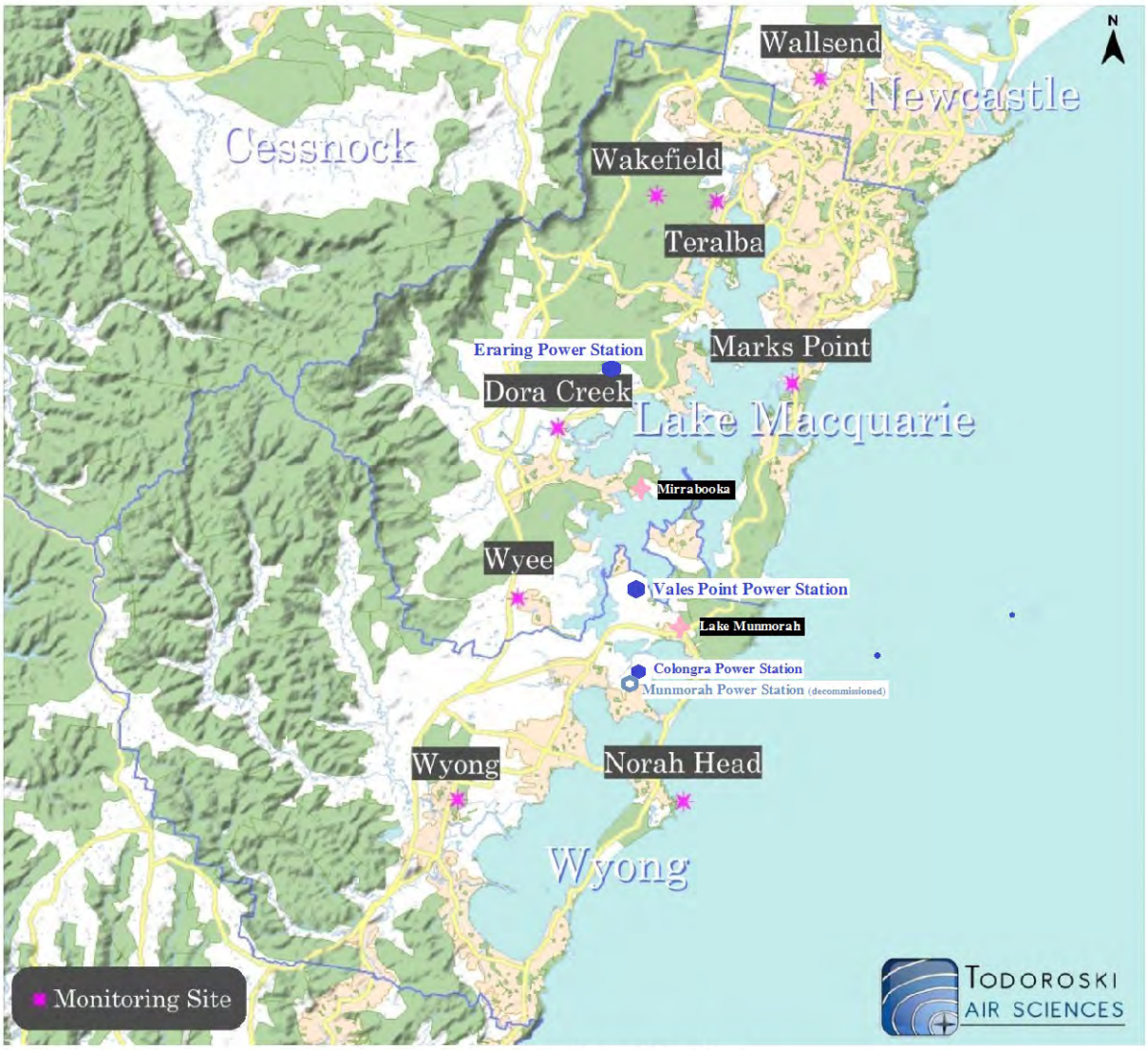

Figure 4-1: Monitoring site locations

Table 4-1: Monitoring sites

Monitoring Station	Type	Recorded Parameters	Recording Periods
Wallsend	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Wyong	NSW EPA site	PM_{10} (TEOM), $PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly/Daily
Marks Point	Industry site	NO_2, SO_2, WS, WD	Hourly
Wyee	Industry site	$PM_{2.5}$, NO_2, SO_2, WS, WD	Hourly
Dora Creek	Industry site	NO_2, SO_2, WS, WD	Hourly
Norah Head	BOM weather station	WS, WD	Hourly
Wakefield HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day
Teralba HVAS	Industry site	PM_{10} (HVAS)	Every 6th Day

PM_{10} - Particulate matter < 10µm
$PM_{2.5}$ - Particulate matter < 2.5µm
TEOM - Tapered Element Oscillating Microbalance (which samples air continuously)
NO_2 - Nitrogen dioxide
SO_2 - Sulfur dioxide
HVAS - High volume air sampler (which samples for a 24-hour period every 6 days)
WS - Wind speed
WD - Wind direction
BOM - Bureau of Meteorology

Note: The Lake Munmorah and Mirrabooka monitoring sites were decommissioned in May 2014
Figure Source: NSW EPA reports: http://www.epa.nsw.gov.au/esdsmoky/lake-mac-wyong-air-quality.htm

Figure 3: Lake Macquarie – Wyong Air Quality 1-hour Average NO_2 for 2014, 2015, 2016, 2017, 2018 & 2019

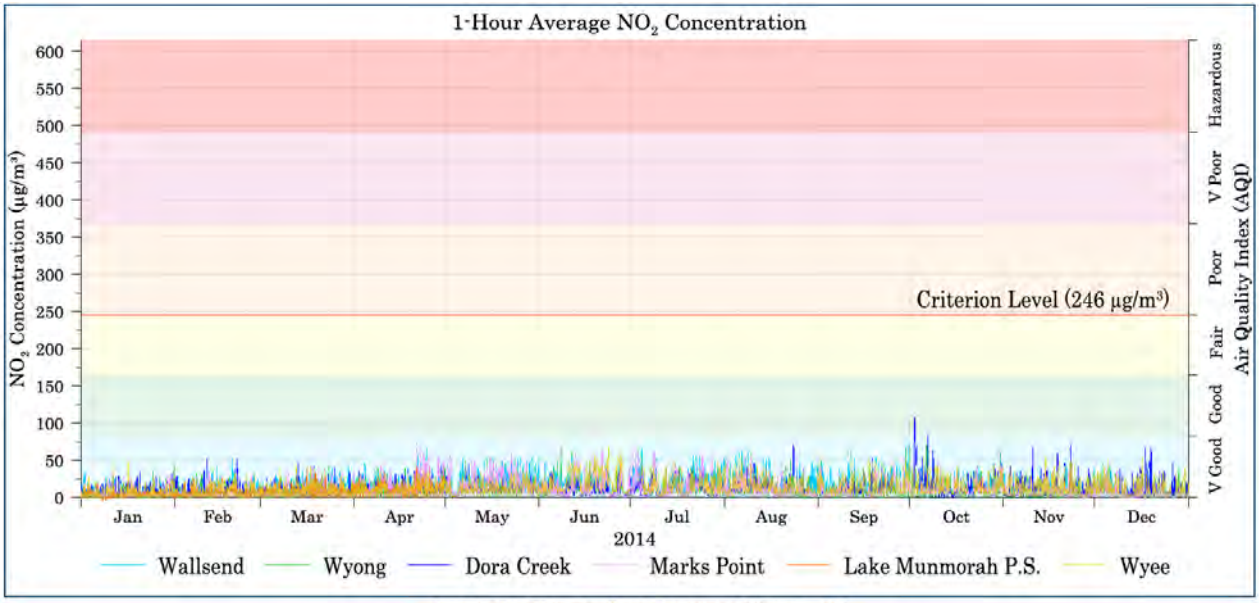

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2014

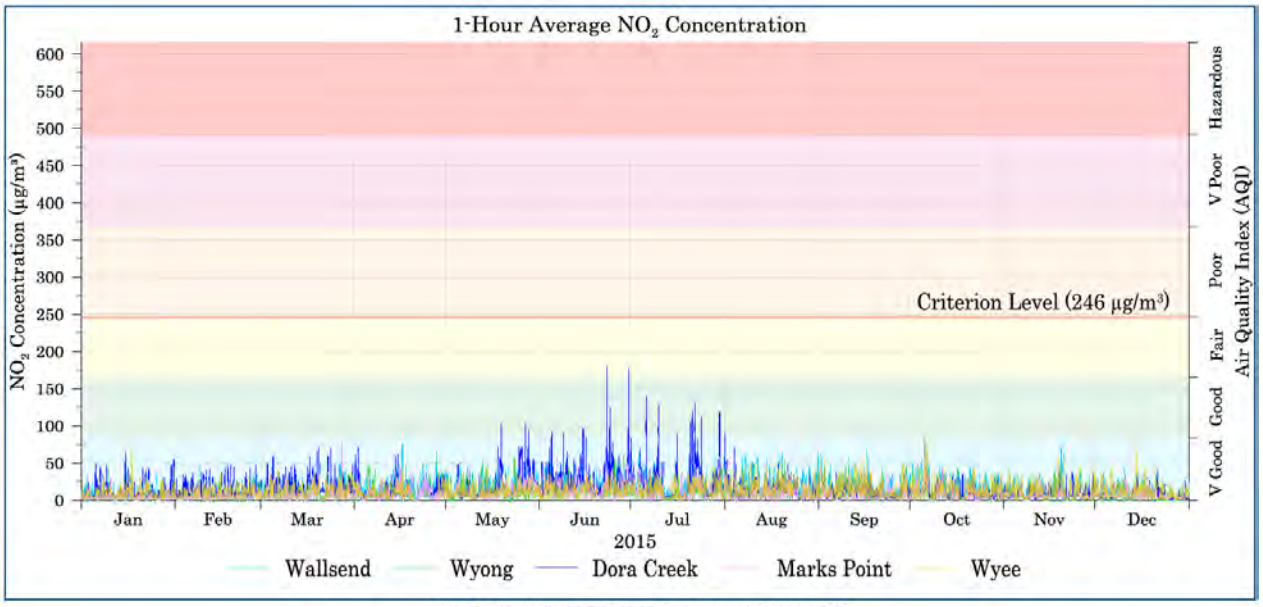

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2015

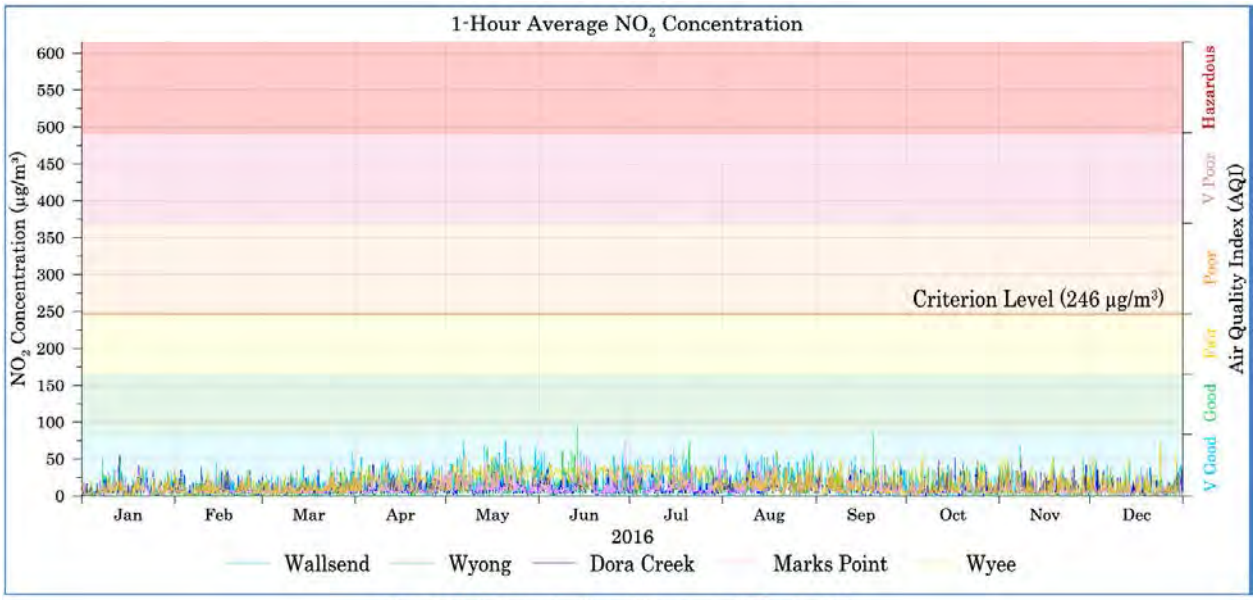

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2016

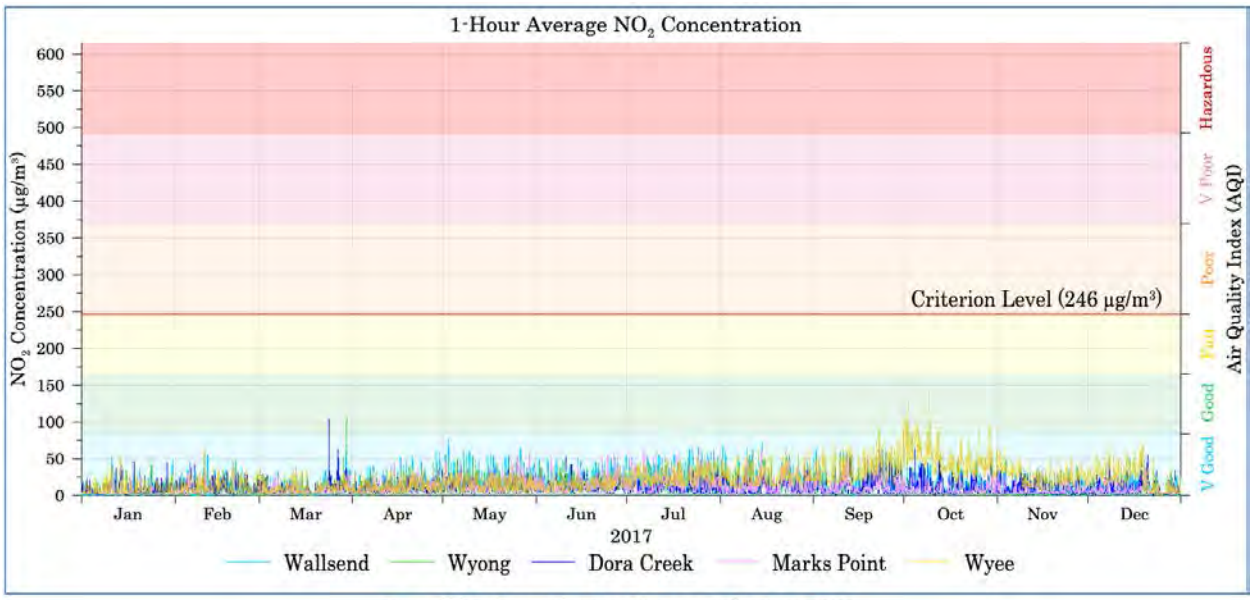

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2017

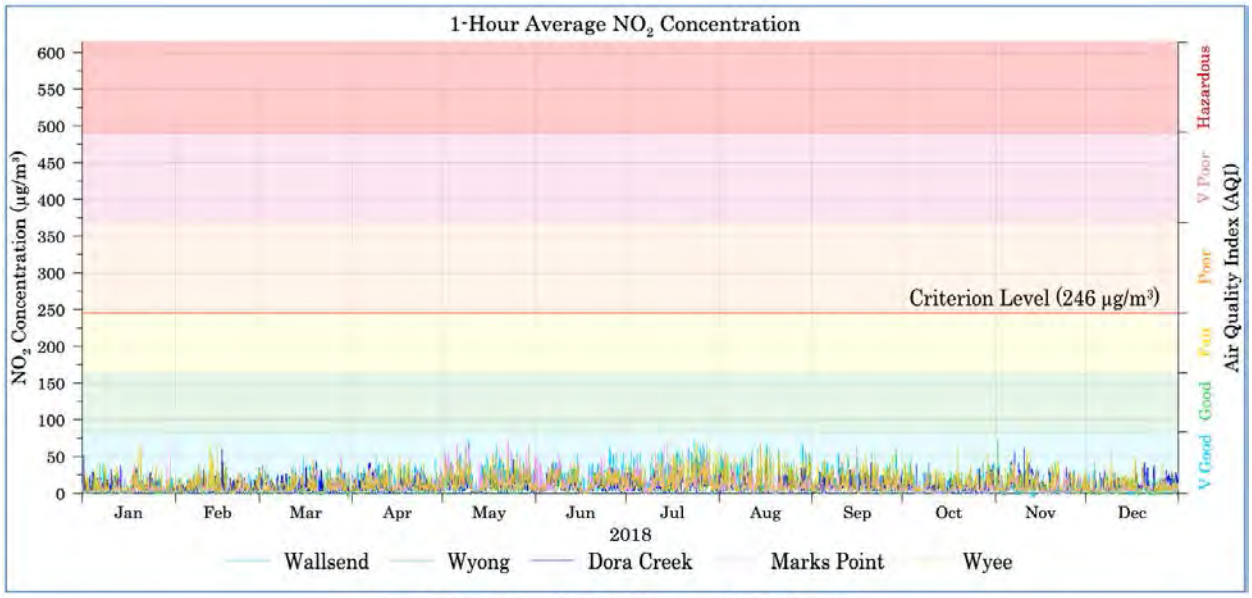

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2018

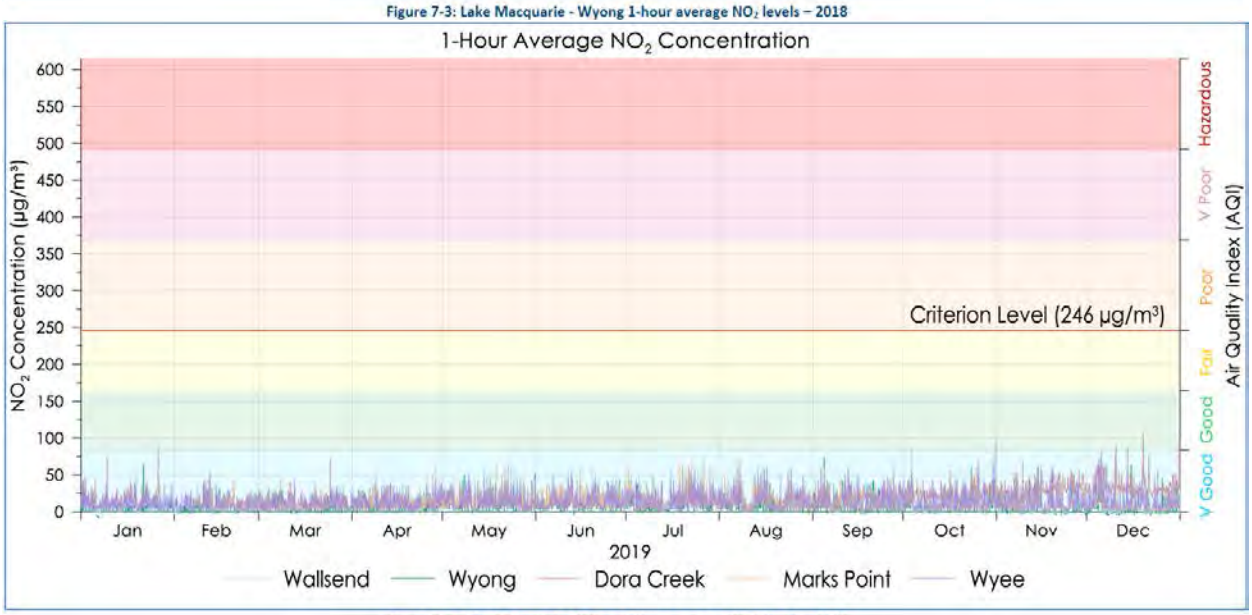

Figure 7-3: Lake Macquarie - Wyong 1-hour average NO_2 levels – 2019

The graphs in **Figure 3** present the monthly maximum 1-hour ambient air NO_2 concentrations in the Lake Macquarie and Wyong areas for the period 2014 to 2019, which is plotted against the NO_2 ambient air quality goal of 246 mg/m^3.

The graphs in **Figure 3** demonstrate that:

- there have been no exceedances of the 1-hour NO_2 ambient air quality goal at any of the ambient monitoring stations sites over a 5 year period;
- the 1-hour NO_2 levels were good or very good at all times, with the exception of the Dora Creek monitor which recorded two hours with fair levels in 2015;
- the maximum 1-hour NO_2 levels have typically been four to five times less than the NO_2 ambient air quality goal at less than 50 µg/m^3 compared to the current NEPM 1-hour goal of 246 µg/m^3; and
- extending the exemption for Group 5 NOx limits for a further 5 years will not be detrimental to regional air quality given the already very good levels experienced.

3.2.3 Air Quality Modelling Assessment

For the 2010 Vales Point Group 5 exemption application, Delta engaged Katestone Environmental (Katestone) through Malfroy Environmental Strategies (Malfroy) to assess the potential air quality impacts associated with emissions of NO_x from Vales Point. There have been some changes in emissions from the power stations on the Central Coast since the Katestone report was prepared in 2010, with the closure of Munmorah, which has meant a total reduction in overall NO_x emissions.

Delta considers that the modelling undertaken by Katestone, and the covering reports prepared by Malfroy, are valid, and more importantly conservative with respect to the air modelling assessment of potential impacts of Vales Point on ambient air quality for the current application, given the closure of Munmorah.

The findings of the original Malfroy reports and Katestone study have been reviewed and are summarised below with additional information and commentary on current operations. Copies of the Malfroy and Katestone reports are provided in **Appendix A** and **Appendix B** respectively.

The features of the Katestone air dispersion modelling study are:

- it was conducted in accordance with the EPA '*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales'* (Approved Methods). Both the modelling and method remain current in 2020;
- it employed the CSIRO atmospheric dispersion model "The Air Pollution Model" (TAPM) Version 4 to simulate the regional meteorological conditions at a scale of one kilometre for the period 1 January to 31 December 2004. Version 4 of remains the latest version of the TAPM software;
- previous studies have shown TAPM is well suited to modelling emissions under the conditions experienced in the Central Coast region;
- predictions of ground level concentrations were made for an area within about 15 kilometres of the power station at a resolution of 500 metres;
- it included emissions from the Vales Point, Eraring, Colongra power stations and the now demolished Munmorah power station;
- it is conservative in that all power stations sources were modelled operating at maximum emission rates continuously for all hours of the year, including Colongra peaking station, which does not occur. Vales Point and Eraring generally power down overnight when demand for electricity is lower and again during the middle of the day when solar generation is high. Colongra operates only very occasionally for a few hours at a time as peak demand requires;
- it included a "background" contribution from the ground level sources, such as motor vehicles, which is discussed further later in this section;
- predictions of NO_2 from modelled NO_x concentrations were made using the NO_2:NO_x ratio determined from the monitoring records, as has been done in a number of recent assessments (refer also Appendix A – Malfroy, December 2010**,** which addresses EPA concerns regarding the validity of using this ratio);
- predictions were provided for a number of scenarios:
  - Vales Point emissions in isolation;
  - surrounding source emissions (Munmorah, Colongra and Eraring) excluding Vales Point; and
  - surrounding source emissions plus Vales Point emissions.

The modelling assessment by Katestone also included background concentrations for the region which enables the potential impacts of Vales Point emissions on the local regional air quality to be assessed. The EPA Approved Method notes that*: "The background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at the proposed site. As this is extremely rare, data is typically obtained from a monitoring site as close as possible to the proposed location where the sources of air pollution resemble the existing sources at the proposal site*.

With respect to the Katestone modelling assessment the following points are made:

- extensive, high-quality ambient air quality data was available from three (3) sites in the vicinity around Vales Point;
- the existing monitoring records include the contribution made from all major existing emission sources, including those that have been explicitly modelled (the four power stations) and those that have not been modelled (the diffuse motor vehicle ground-level sources); and
- the existing ambient air monitoring records were conservatively used to establish a constant "background' level, which was added to the predicted ground level concentrations, but may over-estimate potential impacts if the influence of the existing modelled sources is not accounted for in the background data.

Malfroy (October 2010) noted that to overcome the above limitations and arrive at a representative "background" NO_2 level that is reasonably unaffected by the power station sources being explicitly modelled, the following approach was adopted:

- the ambient air quality data sets for the 3 monitoring sites for the years 2007 – 2009 were sorted to exclude NO_2 data when power station plumes were being recorded at the surface. This was achieved by using SO_2 at a concentration above 15 µg/m^3 as a "marker" for power station emissions;
- in the modified data set with the power station influence removed, the average NO_2 concentration for those hours in which the power station plumes can be observed at ground (typically between 0800 and 1700 hours) level was determined to be about 40 µg/m^3;
- the ambient background NO_2 concentration of 40 µg/m^3 was added to the hourly average model predictions of emissions from the power stations to account for the ground-level sources, such as motor vehicles;
- for the prediction of the annual average NO_2 concentrations, the monitored annual average NO_2 concentration was adopted as the "background", without filtering as described above, recognising that this a very conservative approach as it involves "double-counting" of the power station impact; and
- all scenarios were considered with the constant "background" concentrations added.

Source Characteristics used in the Modelling

The emission characteristics of the modelled sources used in the Katestone modelling are reproduced and presented in Table 4. It is important to note that the emissions modelled by Katestone are conservative and over-estimate potential impacts of current operations on the basis that:

- Munmorah emissions are included in the modelling but has since been demolished;
- Colongra is a peak-demand power station that operates infrequently for short periods but was modelled as a continuous emission source over the year using the maximum

licence NO_x emission limit of 90 mg/m^3 for diesel fuel (and not the natural gas fuel limit of 60 mg/m^3); and

- Eraring was modelled assuming a continuous maximum emission equivalent to the licence limit (1,100 mg/m^3). A review of Eraring emission data (available on the Eraring website[3]) indicates that the modelled rate is at least three times the recorded maximum hourly NO_x emission observed over the first ten months of 2020.

Table 4: Emission Characteristics of the power stations modelled by Katestone

Source	Stack Height	Stack Diameter	Exit Velocity	Exit Temperature	Emission Rate NO_x (as NO_2)
	(m)	(m)	(m/s)	(°K)	(g/s)
Vales Point	178	5.15	26	403	1130 [1]
Munmorah	155	3.95	19.4	426	305
Colongra	35	6	44	791	154.7 [2]
Eraring Stack 1 Stack 2	 200 200	 5.24 5.24	 26.2 26.2	 403 403	 1685 [3] 1685 [3]

Notes:

1. Assumed a NO_x (as NO_2) concentration of 1,000 mg/Nm^3 which was not the absolute highest from the 2009 CEMS record
2. Assumed a NO_x (as NO_2) concentration of 90 mg/Nm^3 on distillate firing (60 mg/m^3 on gas firing) and operating 24/7
3. Assumed a NO_x (as NO_2) concentration of 1100 mg/Nm^3 (Eraring EPL emission limit)

Predicted Ground Level Concentrations

The Katestone TAPM modelling predicted ground level concentrations for various emission scenarios and sensitive receptors in order to determine the potential maximum impact Vales Point emissions make to the regional occurrence of NO_2. Table 5 illustrates the spatial and temporal disparity between maximum 1-hour NO_2 concentrations identified in the contour maps in the Katestone report for specific sensitive receptor areas. The cumulative impacts do not cause an exceedance of the assessment criteria for 1-hour average NO_2 and are well below the assessment criteria of 246 µg/m^3 for 1-hour average concentration.

Table 5 – Katestone modelled maximum 1-hour average concentration of NO2 at the sensitive receptor areas for Vales Point in isolation, the contemporaneous maximum 1-hour concentration of NO2 from the surrounding sources and the combined maximum 1 hour average concentration of NO2 (ambient concentration of 40 µg/m3 has been added to the combined total)

Receptor	Vales Point only (µg/m^3)	Surrounding sources (µg/m^3)	All Sources (µg/m^3)	All Sources plus 40 µg/m^3 (µg/m^3)
Wyee	91	2	93	133
Wyee Point/Morisset Hospital	26	0.1	26	66
Morisset Peninsula	28	3	31	71
Summerland Point	29	1	30	70

[3] http://www.originenergy.com.au/about/who-we-are/what-we-do/generation.html

Mannering Park	36	3	39	79
Lake Munmorah	45	1	46	86
Blue Haven/San Remo	75	1	76	116

The modelling results presented in Table 5 show the highest NO_2 levels are well below the NO_2 ambient air quality goal of 246 µg/m^3. The maximum level modelled occurs at Wyee. A comparison of model data and actual monitoring data is presented in Table 6 for Wyee. Table 6 shows the maximum predicted 1-hour NO_2 ground level concentration (glc) at the Wyee ambient air station (Appendix A, Table 9) compared with the maximum 1-hour NO_2 measured at the Wyee ambient air station between 2014 and 2019 (refer Appendix C) plus ambient data from Appendix A for 2007 to 2009, as used in the original exemption application. The actual ambient data compares favourably with the model as expected and shows the representative nature of the modelling, confirming its validity for this NO_x exemption application.

Table 6: Modelled versus actual maximum 1-hour NO_2 ground level concentration at Wyee ambient air station

Vales plus surrounding sources (modelled) µg/m³	Measured maximum 1-hour NO_2 glc (actual) µg/m³								
	2007	2008	2009	2014	2015	2016	2017	2018	2019
133	75	72	65	49	70	74	144	76	93

2017 recorded ambient NO_2 levels slightly higher than the modelled figure and well above all other years. Upon review of the data, the October 2017 event can be demonstrated to be not attributable to emissions from Vales Point. The Malfroy report (Appendix A) refers to SO_2 concentrations being a “marker” for power station emissions in the region when compared to other sources of NO_x. In October 2017, when the highest NO_2 levels were recorded at Wyee, there was no change in SO_2 levels at that time for the same location (refer Figure 4), suggesting that sources other than power stations contributed to the high ground level concentration of NO_2 in October 2017.

Figure 4 Lake Macquarie – Wyong Air Quality 1-hour Average SO_2 for 2017

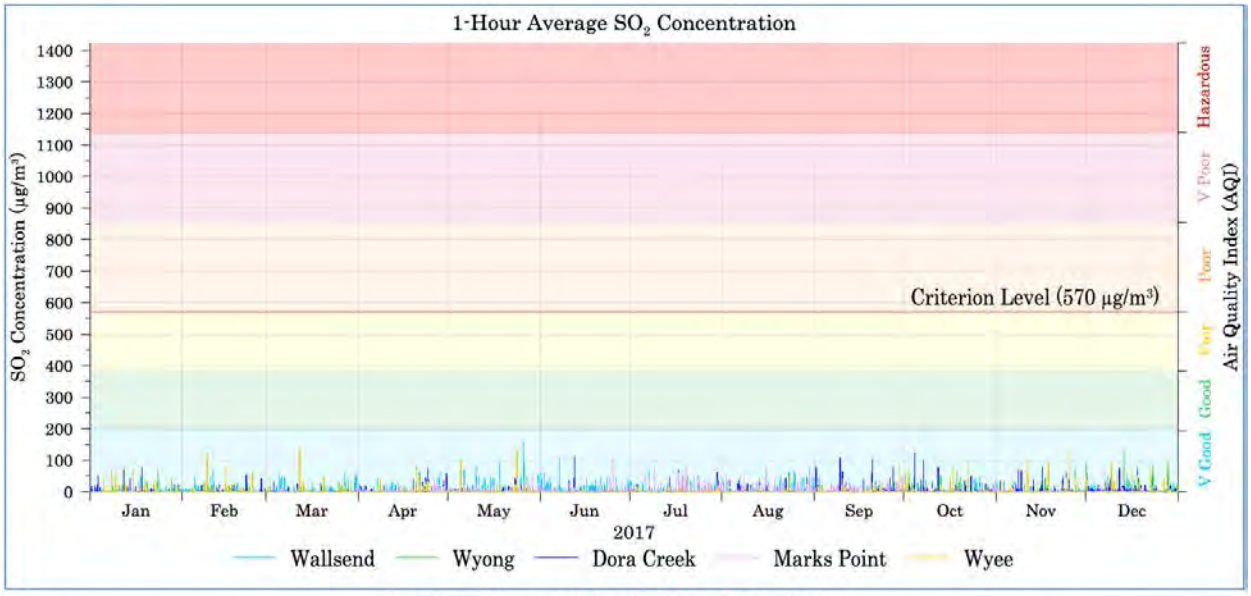

Figure 7-4: Lake Macquarie - Wyong 1-hour average SO_2 levels – 2017

It is noted that the plots for the predicted maximum 1-hour ground level concentrations scenarios in Figure 6 to Figure 9 of Appendix A indicate that the Wyee, Wyong and Dora Creek ambient air monitoring stations are in approximately the right locations to record the maximum predicted ground level concentrations for NO_2. This again confirms the validity of the modelling used in this exemption application. This is demonstrated further by the actual maximum recorded NO_2 ground level concentrations presented in Figure 3 being in the good to very good range on a daily basis for the period 2014 to 2019.

At a regional scale, there has been no ground level exceedances observed at any of the regional monitoring sites in the data presented despite the Katestone modelling showing that regional exceedances would occur due to other NO_x sources. This confirms the conservative assumptions used in the modelling where maximum emission limits have been assumed to be continuous and which the actual ambient air data and NPI data shows to be a considerable overestimate.

Air Quality Modelling Conclusions

In summary:

- the maximum predicted ground level concentrations of NO_2 in the Central Coast airshed due to Vales Point plus the contemporaneous contribution from the surrounding sources and background are predicted to be well below the NO_2 ambient air quality criteria;
- maximum predicted 1-hour ground level concentrations of NO_2 attributed to Vales Point are spatially and temporally separated from those caused by the surrounding sources (Eraring and Colongra);
- the area where Vales Point is predicted to contribute most to the ground-level concentration of NO_2 is southwest of the Vales Point. However, in this area both the predicted and measured ground level concentrations of NO_2 due to Vales Point are well below the NO_2 ambient air criteria;
- the maximum predicted 1-hour average ground level concentration of NO_2 predicted at the Wyee ambient air station attributed to Vales Point with background and contemporaneous contributions of other sources is 133 µg/m^3, just over half the NO_2 ambient air criteria (246 µg/m^3) and just below the actual maximum ground level

concentration of 144 µg/m^3 measured at Wyee in October 2017 (an event not attributable to Vales Point emissions of NO_2); and

- the conservative modelling assessment, which is validated by the actual measured ambient air concentrations, demonstrates that the operation of the Vales Point plant under existing conditions with a current emission limit of 1,500 mg/m^3 does not cause significant environmental harm.

Regional Photochemical Impacts

The air quality modelling assessment in the previous section addressed potential impacts arising from power station NO_x emissions in the Central Coast airshed. Appendix A from also includes a review of potential impacts beyond the Central Coast airshed in the Greater Metropolitan Region (GMR) due to the inter-regional transport of emissions.

Malfroy noted that the CSIRO Inter-Regional Transport of Air Pollutants Study (Nelson *et al* 2002) undertook a comprehensive assessment of the potential for NO_x emissions from all coal-fired power stations in NSW to affect photochemical smog (NO_2 and ozone) levels in the Sydney GMR airshed. The CSIRO assessment included modelling techniques to assess the incidence of inter-regional transport from the three main power station regions in NSW (Central Coast, Hunter Valley and Blue Mountains).

The CSIRO study concluded that:

- in the near-field of the power stations, the effect of NO_x emissions is to lower ozone concentrations (by a process known as 'titration');
- the contribution of power station NO_x emissions to elevated ozone levels in the Sydney basin airshed is, at most, small (less than 5% of the standard) and infrequent; and
- for the majority of the time power station emissions make no contribution to elevated ozone levels in the Sydney basin airshed.

From the CSIRO assessment it can be concluded that Vales Point would have at most, a negligible impact on smog levels at significant distances downwind.

3.2.4 Ecological Sustainable Development Principles

Under Clause 37 of the Clean Air Regulation, in considering an application for a licence variation, the EPA must consider the potential impact on local and regional air quality from the proposed variation, having regard to (amongst other things) the principles of ecologically sustainable development (ESD) as set out in the *Protection of the Environment Administration Act 1991* (POEA Act).

Appendix A of this report considers this aspect and noted that in terms of the ESD principles and programs, and in particular the precautionary principle, the NO_x modelling assessment undertaken is based on very good data sets providing a high level of confidence that the current operation of Vales Point results in acceptable environmental outcomes and would not result in any changes to emissions from the power station when compared to the current approved operations.

3.3 Load Reduction Agreements & Pollution Reduction Programs

Under Clause 37 of the Clean Air Regulation, in considering the application for the licence variation the EPA must also have regard to:

- any pollution reduction programs (PRP) that Delta has established, or has agreed to establish, in relation to the activity or plant;

- any control equipment that has been installed, or that Delta has agreed to install, in relation to the activity or plant; and
- any load reduction agreement that has been entered into between Delta and the EPA.

Following is information in relation to each of these three items.

3.3.1 Pollution Reduction Programs

Following the approval of a second NO_x exemption in 2015 for Vales Point, the EPA included a PRP requirement on the Vales Point EPL to investigate further controls to reduce NO_x emissions with the aim of assessing the feasibility of achieving reductions in NO_x at the premises.

Delta has fully complied with the licence condition and submitted a report to the EPA in June 2017 prepared by Jacobs.

The Jacobs report reviewed historic NO_x measurement data and contemporaneous operational information to identify any operational practices that result in changes in NO_x concentrations. Jacobs found that:

- unit 5 achieved 800 mg/m3 of NO_x for greater than 98.4% of the time assessed (2015-2016);
- unit 6 achieved 800 mg/m3 of NO_x for 15% of the time assessed (2015-2016);
- replacement of Unit 6 burner tips to original design should reduce NO_x emissions by about 180 mg/m3. The higher NO_x levels on unit 6 were found to be due to the increased turbulence of the primary air and coal mixture increased the intensity of combustion (improving efficiency but increasing NO_x emissions). The report noted that it may not be possible to guarantee the same level of performance as unit 5 but Delta has committed to undertaking this work in 2021;
- high levels of NO_x (above 800 mg/m3) was found to occur at all different loads and were found to be typically one-off events, making operational changes to control NO_x below 800 mg/m^3 difficult to achieve. There was some correlation between mine contamination causing mill blockages and high NO_x levels. Subsequent to the report, Delta required the mine concerned to install a screening plant to remove foreign material and this work was completed in March 2019. Since that time, mine contamination has been reduced significantly;
- installation of low NO_x burners could achieve the desired 100% of NO_x emissions at 800 mg/m3 or better but the tangentially fired boiler design (compared to wall fired boilers where low NO_x burners have been successfully installed elsewhere), makes the retrofit of low NO_x burners impractical. For example, the upper level of burners would need to be removed in one option which would take out a mill and reduce the capacity of the power station. Another low NO_x burner design requires a downwards burner tilt that would increase residence time for combustion, permitting a reduction in NO_x but would significantly reduce efficiency and increase greenhouse gas emissions; and
- other controls such as selective non-catalytic reduction or selective catalytic reduction have high capital costs and would involve ammonia slip emissions that may include secondary nitrates which would increase fine particle emissions and counter any environmental benefit that might come from reducing NO_x emissions.

The Jacobs report fulfilled the requirements of a previous Pollution Reduction Program. As has been noted, Delta is committed to replacing the wide range burner tips on unit 6 and re-installing the original burner design to reduce NO_x emissions to previous levels. This should result in greater than 95% compliance with the Group 5 limit as evidenced by unit 5 performance.

However, as the Jacobs report and analysis of NO_x emissions at Vales Point has detailed, the events where high NO_x does occur from time to time is short and random in nature, making it impossible for Delta to comply with the Group 5 limit of 800 mg/m3 despite the majority of emissions anticipated to be within this limit in future.

3.3.2 NOx control equipment

The issue regarding the replacement of unit 6 burner tips in 2012 that inadvertently increased NOx emissions has already been raised earlier in this report. It had been planned to install the original design burner tips on unit 6 in March 2020 but this work was delayed due to the COVID-19 pandemic. Delta has committed to replacing the unit 6 burner tips at the major outage planned for March and April 2021 with the parts already procured and on site. It is envisaged that this will reduce the NO_x emissions from unit 6 to levels similar to unit 5 results provided in Table 1.

3.3.3 Load Reduction Agreements

Load Reduction Agreements (LRAs) are voluntary agreements between licensees and the EPA that provide immediate fee reductions for companies willing to commit to future reductions of assessable pollutants. Delta is required to pay well over one million dollars each year in Load Based Licensing fees for its NO_x emissions alone. However, due to the imminent replacement of the burner tips on unit 6 and the lack of availability of a planned outage to perform the work earlier, it is not proposing a LRA with respect to unit 6 burner tip replacement and reduced NO_x emissions.

3.4 Other Relevant Information

3.4.1 Vales Point Annual Returns

In accordance with Condition R1 of EPL 761, Delta is required to complete an Annual Return within 60 days of the end the licence reporting year in the approved EPA form comprising:

- a Statement of Compliance; and
- a Monitoring and Complaints Summary.

There have been no non-compliances of the stack NO_x emissions at Vales Point EPL 761 since the approval of the licence variation in 2012. Summary copies of the Vales Point Annual Returns are publicly available on the EPA website.

The latest Vales Point 2019-20 Annual Return was submitted to the EPA in August 2020.

Publication of Pollution Monitoring Data

In accordance with section 66(6) of the POEO Act, all licensees who maintain a website are required to make any pollution monitoring data, collected in compliance with monitoring conditions attached to their licence, publicly available on the website since April 2012.

Delta has published all pollution monitoring data for Vales Point monthly on the Delta website as required by the POEO Act and compliance with this requirement has been certified in the Vales Point Annual Returns submitted by Delta.

3.4.2 Delta ISO 14001 Environmental Management System

Delta takes its environmental compliance obligations very seriously and seeks to always avoid breaches of its EPL. To assist achieving this goal, Delta has implemented and maintains an Environmental Management System (EMS) for the Vales Point operation, which is certified to ISO 14001. Delta was the first electricity generator in NSW to achieve this.

The Delta EMS undergoes a mandatory Recertification Audit every three years and a mandatory Surveillance Audit in the intervening years. The EMS was recertified in July 2020 and certification is valid for 3 years.

4. Conclusion

This report has been prepared in accordance with Clauses 36 & 37 of the Clean Air Regulation to support the application that seeks to vary EPL 761 and amend condition L3.7, such that the current provisions for a Group 5 exemption with respect to emissions of NO_x are extended for a further 5 years from 1 January 2022 to 1 January 2027. It is proposed that the current 100th percentile NO_x emission limit of 1,500 mg/m^3 and the 99th percentile NOx emission limit of 1,100 mg/m^3 is maintained.

Delta believes that this report demonstrates the current operation with a NO_x exemption is not resulting in any adverse environmental or human health impacts, which is most evident by:

- regional air quality showing the air quality on the Central Coast has consistently been very good with respect to NO_2;
- the local ambient air quality data indicates that the maximum NO_2 concentration has always been well below the ambient air quality criteria;
- the conservative modelling assessment has been validated by the actual measured ambient air concentrations at Wyee, demonstrating that the operation of the Vales Point plant under existing conditions with an emission limit of 1,500 mg/m^3 would not result in any adverse environmental or human health impacts; and
- the 2017 Pollution Reduction Program study for Vales Point shows that options to further reduce NOx are not feasible.

While some further reductions in NO_x may be possible, indications are that to meet the Group 5 limit (i.e. 800 mg/m^3) at all times is likely to require controls that are prohibitively expensive.

In addition, Delta believes any additional controls would provide negligible additional benefit in terms of local and regional air quality given the existing air quality on the Central Coast over recent years has always been in the very good range with respect to NO_x levels.

Therefore, implementation of such controls just to meet Group 5 would arguably be inconsistent with the Clean Air Regulation, where it can be demonstrated that the operation of the existing Group 2 plant is unlikely to cause environmental harm.

In addition, it is relevant to note that:

- the application does not involve change to the power station's boilers or firing systems that is likely to result in an increase in the potential maximum emission rates or concentrations at which any substances would be emitted from the power station;
- the typical average operating condition for NO_x emissions on unit 5 at Vales Point is currently within the Group 5 limit of 800 mg/m^3 and the current 1,500 mg/m^3 EPL NO_x limit is required to maintain a margin for compliance for excursions above the average; and
- the closure of Munmorah power station by Delta in 2012 has permanently removed a significant source of NO_x emissions from the local and regional air-shed.

In conclusion, Delta believes the report satisfactorily demonstrates that the current NO_x emission rate of 1,500 mg/m^3 in Vales Point EPL 761, condition L3.4 does not present a significant risk of environmental harm and, as such, this limit can be maintained with condition L3.7 amended to read:

"For the purpose of NO_2 and NO or both, as NO_2 equivalent, at point 2 and 3 and in accordance with the Protection of the Environment Operations (Clean Air) Regulation 2010, the activity or

plant defined by the licence at these locations is taken to belong to Group 2 until 1 January 2027 or unless otherwise approved in writing by the EPA."

Appendix A

Vales Point Power Station - Application for the Revision of the Environment Protection Licence

Malfroy Environmental Strategies
(October & December 2010)

Vales Point Power Station
Application for the Revision of the Environment Protection Licence

Prepared by Malfroy Environmental Strategies Pty Ltd.

For Delta Electricity

October, 2010

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SUMMARY

From January 1st, 2012, any plant, belonging to Group 2 of the Protection of the Environment (Clean Air) Regulation 2010 will be taken to belong to Group 5 *unless* the plant's Environment Protection Licence (EPL) includes a condition that the plant is taken to belong to Group 2.

The purpose of this application is to seek to vary Vales Point Power Station's EPL to include a condition to the effect that from January 1st, 2012, the power station will be taken to belong to Group 2 of the Clean Air Regulation with respect to emissions of oxides of nitrogen (NO_x).

This application includes all the necessary information specified in the Clean Air Regulation 2010 in order for the Environment Protection Authority (EPA) to assess the application. In summary, the application demonstrates that:

- With the exception of oxides of nitrogen (NOx), the emission rates from Vales Point Power Station meet the Clean Air Regulation's Group 5, and in most cases Group 6, emission limits for all relevant substances;
- Current maximum emission rates of NOx from Vales Point Power Station are below the Group 5 emission limit of 800mg/m^3 for about 80% of the time and emission rates above 1,000 mg/m^3 occur very infrequently, (~ 0.2% of the time);
- Based on an extensive monitoring record, NO_x emissions from Vales Point and other sources in the region, including other power stations and motor vehicles, have not resulted in an exceedence of either the hourly average or annual average ambient air quality standards for nitrogen dioxide (NO_2). Maximum hourly average and annual average concentrations are about 40% and 20% of the respective air quality standards.
- An air quality modelling assessment showed that NO_x emissions from Vales Point Power Station considered either in isolation or combined with emissions from other power stations in the region and including the contribution from other sources, such as motor vehicles, are unlikely to result in an exceedence of either the hourly average or annual average ambient air quality standards for NO_2 and that for the significant majority of time emissions from Vales Point Power Station make a small contribution to ground level concentrations of NO_2 in the region;
- Based on a state-of-the-art air quality assessment by CSIRO, NO_x emissions from Vales Point Power Station are unlikely to have a measurable impact on regional, or inter-regional, smog levels.

Note is also taken of recent and relevant changes to the EPLs of three other power stations. In 2009, Macquarie Generation successfully applied for Liddell Power Station to operate at a maximum NOx emission level of 1,500 mg/m^3 following the phasing out of the Group 2 limit in 2012. The new limit is above the Group 5 limit of 800 mg/m^3 and below the Group 2 limit of 2,500 mg/m^3.

The EPLs of Eraring Power Station and Mt Power Piper Power Station have also recently been revised as a result of plant upgrades which have been completed at Mt Piper and are in-progress at Eraring. Both these stations are "younger" than Vales Point and, while in different Clean Air Regulation Groups to Vales Point, the same Group 2 NO_x limit of 2,500mg/m^3 previously applied to them. As a result of the EPL revisions associated with plant upgrade proposals, it is understood that the EPA has approved new NOx emission limits of 1,500 mg/m^3 and 1,100

mg/m^3 for Mt Piper and Eraring respectively, to apply from when the plant upgrades have been completed.

As was the case with Macquarie Generation's recent Liddell application, Delta Electricity is not planning any upgrades to Vales Point Power Station and the proposal presented in this report does not involve any physical change to the power station's boilers or firing systems and will not result in an increase in the potential maximum rates or concentrations at which substances would be emitted from the power station. Nor would it result in an increase in the potential air quality and environmental impacts arising from the power station emissions.

It is concluded that this application meets the requirements of the Clean Air Regulation in relation to conditions which must be satisfied in order to vary Vales Point Power Station's EPL in relation to NOx emissions following the phasing out of Group 2 emission limits.

1. INTRODUCTION

Under the Protection of the Environment (Clean Air) Regulation (2010), (**NSW Government 2010**) scheduled plants belong to one of 6 Groups, depending on the year in which the plant commenced operating. The Regulation includes emission standards for a range of pollutants that apply to each Group and these standards tend to become stricter in moving from Group 1 through to Group 6. Vales Point Power Station belongs to Group 2 due to its commencement date in 1978 / 79.

Under the "phase out" provisions of the Clean Air Regulation, from 2012, any Group 2 plant will be taken to taken to belong to Group 5 *unless* the plant's Environment Protection Licence (EPL) includes a condition that the plant is taken to belong to Group 2. To continue as Group 2, an application for the variation of the conditions of the EPL must be made to the Environment Protection Authority (EPA) before the beginning of 2011.

The Clean Air Regulation specifies the information that is required to be included in an application for continuation as a Group 2 facility.

The purpose of this application is to seek to vary Vales Point Power Station's Environmental Protection Licence to include a condition to the effect that from January 1st, 2012, Vales Point Power Station will be taken to belong to Group 2 of the Clean Air Regulation, with respect to emissions of oxides of nitrogen.

It should be noted that the proposal does not involve any physical change to the power station's boilers or firing systems and will not result in an increase in the potential maximum rates or concentrations at which substances would be emitted from the power station. Nor would it result in an increase in the potential air quality and environmental impacts arising from the power station emissions.

2. SCOPE OF THE APPLICATION

This application presents information that will enable the EPA to make an assessment against the relevant regulatory requirements. The application's scope includes:

- A review of the relevant regulatory requirements under the Protection Of The Environment Operations (Clean Air) Regulation 2010;
- A review of the emission concentrations from Vales Point Power Station and a comparison of these emission concentrations with the relevant emission limits in the Clean Air Regulation;
- An air quality assessment of potential impacts:
    - A review of oxides of nitrogen (NO_x) emission sources in the region;
    - A detailed assessment of ambient air quality data collected at 3 monitoring stations located at sites relevant to emissions from Vales Point Power Station;
    - Air quality modelling of emissions from Vales Point and other power stations in the region and comparison with relevant assessment criteria;
- A review of recent, relevant air quality studies, including:
    - The CSIRO Inter Regional Transport of Air Pollutants Study (IRTAPS) (**Nelson et al 2002**);

- A model validation study by CSIRO **(Lilley et al 2007)**.

- Assessment of impacts relevant to the principles of ecologically sustainable development, as set out in the Protection of the Environment Administration Act 1991.
- Consideration of other matters included in the Clean Air Regulation that may be relevant, including Pollution Reduction Programs, Load Reduction Agreements and control equipment.

3. REGULATORY REQUIREMENTS

The Clean Air Regulation includes a number of Clauses relevant to the application to vary Vales Point's EPL. These clauses are outlined below and their relevance to the Vales Point application identified.

Clause 32: General grouping of activities and plant
Clause 32 groups an activity or plant operated on schedule premises into one of 6 groups generally according to the date on which operations commenced

- Group 1: Prior to 1st January, 1972;
- Group 2: Between 1st January, 1972 and 1st July, 1979;
- Group 3: Between 1st July, 1979 and 1st July, 1986;
- Group 4: Between 1st July, 1986 and 1st August, 1997;
- Group 5: Between 1st August, 1997 and 1st September, 2005;
- Group 6: After 1st September, 2005[1].

Commencing before July 1979 Vales Point Power Station currently belongs to Group 2.

Clause 33: Effect on grouping of alteration or replacement of emission units
This clause is not relevant to this application to vary the Vales Point EPL as the application does involve alteration or replacement of an emission unit, but is referenced here for completeness in relation to the Clean Air Regulation clauses between 32 and 37 which are relevant to the emission Groups and licence variations.

Clause 33 requires that where a Group 1, 2, 3, 4 or 5 emission unit is altered in such a way that there is an increase in the emission of air impurities, or a change in the nature of the air impurities emitted or the intensity with which air impurities are emitted, from the plant of which the emission unit forms part, or to which it is attached, the emission unit will become subject to Group 6 emission limits.

If a Group 1, 2, 3, 4 or 5 emission unit operated in the Greater Metropolitan Area is replaced, the replacement emission unit is taken to belong to Group 6.

Clause 34: Phasing out of Group 1
This clause is not relevant to this application to vary the Vales Point EPL as Vales Point did not belong to Group 1, but is referenced here for completeness in relation to the Clean Air

[1] Any activity or plant that would belong to Group 6 on the basis of a commencement date after 1 September 1997 is taken to belong to Group 5 if it is the subject of a development consent before 1 September 2005.

Regulation clauses between 32 and 37 which are relevant to the emission Groups and licence variations.

Clause 34 required that Group 1 plants move to Group 2 from the 1st January, 2008.

Clause 35: Phasing out of Group 2
Clause 35 requires that on and from 1 January 2012, any plant, immediately prior to that date, belonging to Group 2 (including any activity or plant previously in Group 1) will be taken to belong to Group 5 *unless* the plant's EPL includes a condition that the plant is taken to belong to Group 2.

To continue as Group 2, an application for the variation of the conditions of the EPL must be made to the EPA before the beginning of 2011.

A variation of the conditions of a licence under this clause expires at the end of 5 years after the date on which notice of the variation is given to the holder of the licence. Subsequent application(s) for further EPL variation(s) can be made up to 1 year prior to the expiry of the current variation.

Vales Point Power Station will move to Group 5 on 1st January 2012 unless its EPL is varied to include a condition to the effect that it belongs to Group2.

Clause 36: Alternative standards of concentration imposed by licence conditions
Clause 36 specifies the information that is required to be included in an application for variation of an EPL in relation to the phasing out of Group 2 (Clause 35).

The application is to be accompanied by a report containing the following:

(a) Information on air emissions based on sampling, analysis and monitoring carried out in accordance with the Approved Methods (Sampling and Analysis) **(DEC 2007)**

(b) An air pollutant impact assessment, conducted in accordance with the Approved Methods (Modelling and Assessment) (**DEC 2005**),

(c) Details of any pollution reduction programs that have been established in relation to the activity, plant or emission unit,

(d) Details of any control equipment that has been installed in relation to the activity, plant or emission unit,

(e) Any other relevant information to demonstrate the acceptability of impacts associated with the alternative standards arising from the proposed variation of conditions.

The following sections of this report explicitly address the requirements listed in Clause 36.

Clause 37: Determination of application for variation of licence
In determining an application to vary the conditions of a licence for a plant with respect to the phasing out of Group 2, the EPA must consider the impact on local and regional air quality and amenity, having regard to:

(a) any pollution reduction programs relevant to the plant:

(b) any control equipment relevant to the plant;

(c) any load reduction agreement that has been entered into between the EPA and the applicant; and

(d) the principles of ecologically sustainable development set out in section 6 (2) of the Protection of the Environment Administration Act 1991 , (**NSW Government 1991**) and

(e) such other matters as are relevant.

When granting an application to vary the conditions of a licence under this clause, the EPA can include other conditions in the licence, including conditions imposing more stringent standards of concentration than those applicable to the Group to which the plant will belong as a consequence of the variation.

Clause 37 also notes that refusal of an application to vary the conditions of a licence may be appealed under section 287 of the Environmental Protection and Operations Act 1997 Act **(NSW Government 1997)**. An application is taken to have been refused if it is not granted within 60 days after it has been made.

In other sections of this report explicit consideration is given to the points (a) – (d) above, including the principles of ecologically sustainable development as set out in the Protection of the Environment Administration Act 1991.

4. EMISSION CONCENTRATIONS AND LIMITS

Table 1 presents the emission monitoring that is required under Vales Point's EPL and compares results obtained over a number of years with relevant Clean Air Regulation limits.

A number of points require explanation with respect to the emission limits set out in **Table 1.**

Schedule 3 of the Clean Air Regulation includes emission limits for specific purposes, with one of these purposes being "Electricity generation". Where emission limits exist for specific substances in Schedule 3 for electricity generation they are included in **Table 1**.

Schedule 4 of the Clean Air Regulation includes "General standards of concentration" which are applicable to all scheduled plants and applying when a limit is not included in the specific purpose limits of Schedule 3. For each substance listed in **Table 1** it is noted whether the relevant limit is sourced from Schedule 3 or Schedule 4 of the Clean Air Regulation.

In the case of volatile organic compounds (VOCs) and as noted in **Table 1**, emission testing is required by EPL for substances that are not included in Group 2 *or* Group 5 of the Regulation, but rather an emission limit first appeared with the introduction of Group 6. In these cases, the Vales Point emission test results are compared against the Group 6 emission limit.

It should also be noted that in a number of cases the Group 5 limit is the same as the Group 6 limit.

Table 1 shows that with the exception of NOx emissions, which are considered in detail in the next section, concentrations from Vales Point are well below the relevant Group 5 emission limits and in the case of VOCs well below the Group 6 emission limit.

In addition to the statutory emission limits, Vales Point's EPL also contains the requirement to produce an air emissions exceedence report if the concentration of sulfur dioxide measured by the continuous emission monitoring systems (CEMS) exceeds 600 parts per million (ppm). Over the years that this reporting condition has been in place there have been no exceedences reported

.

Table 1: Vales Point Emissions – Assessment against Clean Air Regulation 2010 Group 5 and Group 6 limits

Substance	**Limit mg/m^3 (unless noted otherwise)**	**VP EPL 100th percentile concentration limit mg/m^3**	**Vales Point performance 2007 – 2009 mg/m^3(unless noted otherwise) Lowest – highest and average concentrations**	**Comment – data source: EPL - Environment Protection licence CEMS – Continuous emission monitoring system**
Solid particles (**1)**	100 (Group 5)	250	1.4 – 21.0 12.5	EPL – periodic test results
NO_2 or NO or both expressed as NO_2 equivalent (**1)**	800 (Group 5)	2,500	Highest emissions > than Group 5 limit **See Table 2**	EPL -CEMS 2009 hourly data from 2 units
Fluorine, as HF equivalent (**1**)	50 (Groups 5 & 6)	50	0.5 – 5.3 2.4	EPL – periodic test results
Hazardous substances -Type 1 and Type 2 substances in aggregate **(1) (3)**	5 (Group 5)	5.0	0.02 - 0.76 0.12	EPL – periodic test results A significant number of results for individual metals < LoD. Assumed < LoD results were equal to the LoD.
Cd or Hg individually (**1**)	1 (Group 5)	1.0	0.0001 – 0.0078 0.0015 Cd 0.00002 – 0.0009 Hg 0.00022	EPL – periodic test results See comment above.
VOCs as n propane **(1) (4).**	40 VOC **or** 125 CO (Group 6)	N.A	VOC <0.2 – <4	Most results below limits of detection. EPL - periodic test results. Measurement of CO not required by EPL.
Smoke (**1**)**(5)**	In approved circumstances: Ringlemann 3 or 60% opacity In other circumstances: Ringlemann 1 or 20% opacity (Groups 5 &6)	N.A	Generally less than 15% (**6**)	EPL - CEMS opacity data 2008 – 2009 hourly average data

Substance	**Limit mg/m^3 (unless noted otherwise)**	**VP EPL 100th percentile concentration limit mg/m^3**	**Vales Point performance 2007 – 2009 mg/m^3(unless noted otherwise) Lowest – highest and average concentrations**	**Comment – data source: EPL - Environment Protection licence CEMS – Continuous emission monitoring system**
Hydrogen chloride (**2**)	100 (Groups 5 & 6)	400	0.05 – 11.0 7.04	EPL – periodic test results
Chlorine (Cl_2) (**2**)	200 (Groups 5 & 6)	200	< 0.13 – 1.43 < 0.4	Most results below limits of detection EPL – periodic test results
Hydrogen sulphide (**2**)	5 (Groups 5 & 6)	N.A	Below level of detection **(7)**	Testing not required by EPL
Sulfuric acid mist or Sulfur trioxide or both expressed as sulfur trioxide equivalent (**2**)	100 (Groups 5 & 6)	100	1.43 – 14.0 7.35	EPL – periodic test results

N.A. No concentration limit included in the EPL

1. Schedule 3 of the Clean Air Regulation 2010.

2. Schedule 4 of the Clean Air Regulation 2010

3. Type 1: antimony, arsenic, cadmium, lead or mercury.

Type 2: Beryllium, chromium, cobalt, manganese, nickel, selenium, tin &vanadium.

Type 1 included in Group 2.

Type 1 and Type 2 included in Group 5.

4. There is no Group 5 limit for VOCs in the Clean Air Regulation. The more recent Group 6 limit is shown which applies to plant commencing operation, or in some cases modified, after September 2005.

5. Approved circumstances –: (a) that smoke is emitted, as a result of blowing soot from a boiler, for a period of no more than 10 minutes per 8 hours, and (b) that all practicable means are employed to prevent or minimise the emission of smoke during that period.

6. Based on hourly average data. Clean Air Regulation standards based on 6 minute rolling average data.

7. Based on measurements by Stephenson and Associates 1999

5. OXIDE OF NITROGEN EMISSIONS

Table 2 shows NOx emissions obtained from the CEMS operating on each of Vales Point's 2 generating units in 2009. The CEMS provide hourly average data, in ppm, of nitric oxide (NO), nitrogen dioxide (NO_2) and nitrogen oxides (NOx), the latter being the sum of NO and NO_2. As shown in **Table 1**, the Regulation limit is expressed as mass concentration (mg/m^3) and as if all the NOx is emitted as NO_2, or as "NO_2 *equivalent"*, that is, as if the NO, which usually comprises in the order of 95%, or more, of the total NO_X, is emitted as NO_2. In this report, wherever NOx is expressed as a mass concentration it is as NO_2 *equivalent.* [2]

The data in **Table 2** are hourly averages filtered to remove data points when:

- The unit was out of service;
- The unit was operating at low load during a start up or shut, that is, load was not constant;
- Faulty data.

The filtering of the raw data resulted in valid data capture rates (as a percentage of a full year - 8760 hours) of:

- Unit 5A 88%
- Unit 5B 86 %
- Unit 6A 91 %
- Unit 6B 89 %

Table 2 indicates that highest hourly average NOx emissions from each of Vales Point's 2 units were well below the Group 2 limit of 2,500 mg/m^3 but exceeded the Group 5 emission limit of 800 mg/m^3 for about 20% of the time in 2009. The occurrence of emission concentrations above 1,000 mg/m^3 is very infrequent, being about 0.2% of the time for both units.

It should be noted that emissions of NOx from power stations can vary according to a number of factors including coal characteristics, generating load and plant operational characteristics.

Table 2: NOx emissions from Vales Point Power Station, 2009

	NOx concentrations, mg/m^3 "dry" STP @7% O_2				
	Lowest	***Highest***	***Median***	***% > 800 mg/m^3***	***% > 1,000 mg/m^3***
Unit 5A / 5B	251	1164	707	19.5	0.2
Unit 6A / 6B	321	1208	707	18.4	0.2

6. AIR QUALITY ASSESSMENT

The previous sections of this report identified that it is only the emissions of NOx that are of concern with respect to the Group 5 emission limits. Accordingly, this section of the report presents a detailed assessment of the potential air quality impacts arising from the current emission of NOx from Vales Point Power Station.

The assessment involves:

- A review of NOx emission sources in the region;

[2] NOx in ppm is converted to mg/m^3 (NO_2 equivalent) by:
NOx mg/m^3 = NOx ppm x molecular wt NO_2 (46.01) / 22.414

- A detailed examination of ambient air quality data;
- Air quality modelling;
- A review of recent, relevant scientific investigations.

As noted in the Introduction, the proposed variation to Vales Point's EPL does not involve any physical changes to plant and/or equipment. The potential future emission rates, both maximum short term rates and average rates over longer periods, will remain unchanged and therefore the proposed licence variation, if approved, would not increase either the potential short or long term air quality impacts arising from the operation of Vales Point Power Station.

Emissions of NOx in the region

The National Pollutant Inventory (NPI) database was used to provide information on the sources of NOx emissions in the Wyong and Lake Macquarie local government areas in 2008 – 2009.

Data in **Table 3** show that the power stations (Vales Point, Munmorah and Eraring[3]) emitted nearly 90% of the NOx in the 2 local government areas in 2008 – 09 area with motor vehicles contributing most of the remaining 10%. A range of small sources each contributed about 1% between them to the total emission of NOx in the areas.

Care is required in interpreting emissions data from sources with very different emission characteristics. A kilogram of a pollutant emitted from a large source with a tall stack and buoyant plume, such as a power station, is likely to have a much lower impact on ground level concentrations than a kilogram of the same pollutant emitted from near ground level from much less buoyant sources. In the next section, emission and ambient data are used to demonstrate that while power stations are the dominant emitters of NOx in the region, their impact on ground level concentrations is probably comparable to the much smaller ground-level emitters.

Existing air quality

Delta Electricity operates 3 air quality monitoring stations in the vicinity of Vales Point and the nearby Munmorah Power Station (Wyee, Lake Munmorah and Morisset Peninsula). **Figure 1** shows the location of the monitoring sites in relation to the power stations and the major towns of the region.

Table 4 summarises ambient data for nitrogen dioxide (NO_2) collected in the three years 2007 - 2009 at the 3 monitoring locations and compares these data with impact assessment criteria presented in the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (**DEC 2005**).

Note that ambient air quality criteria apply to nitrogen dioxide (NO_2) which together with nitric oxide (NO) comprises oxides of nitrogen (NOx).

The table shows that maximum hourly average concentrations of NO_2 have been well below the assessment criterion of 246 $\mu g/m^3$ (or 12 pphm) in all 3 years at all 3 sites.

The maximum one hour average value recorded over the three years at 3 sites of 92 $\mu g/m^3$ is less than 50% of the assessment criterion of 246 μg/m3 (or 12 pphm). Further information on the hourly average concentrations is provided below.

[3] Munmorah power station is operated by Delta Electricity and Eraring Power Station is operated by Eraring Energy. See Figure 1 for the location of the power stations.

Table 4 also shows that annual average concentrations of NO_2 are consistently well below the air quality standard of 62 μg/m^3 (or 3 pphm) at all 3 sites. Maximum annual average concentrations are about 20% of the assessment criterion of 62 μg/m3 (or 3 pphm).

Table 3: NOx emissions in Wyong and Lake Macquarie local government areas, 2008 – 2009 (Source: NPI http://www.npi.gov.au/)

Emission source category		Wyong	L. Macquarie	Combined
		Emissions, kg		
Electricity Generation		29,700,000	33,921,518	63,621,518
Munmorah	5,700,000			
Vales Point	24,000,000			
Eraring	33,916,034			
Awaba	5,484			
Motor Vehicles		3,424,733	3,571,257	6,995,990
Railways [*]		83,928	121,275	205,202
Coal Mining			143,689	143,689
Commercial Shipping/Boating		46,244	58,249	104,494
Fuel Combustion - sub reporting threshold facilities		26,911	37,685	64,596
Burning (fuel red., regen., agric.)/ Wildfires		48,004	9,173	57,176
Gaseous fuel burning (domestic)		20,383	28,554	48,937
Solid fuel burning (domestic)		16,226	22,269	38,495
Ceramic Product Manufacturing		32,664		32,664
Lawn Mowing (public open spaces)		11,013	18,139	29,152
Recreational Boating		2,436	22,769	25,204
Lawn Mowing		5,985	8,215	14,200
Grain Mill and Cereal Product Manufacturing			10,130	10,130
Other Food Product Manufacturing		6,117	3,194	9,311
Barbeques		2,075	2,699	4,774
Aeroplanes			2,624	2,624
Fertiliser and Pesticide Manufacturing			2,196	2,196
Liquid fuel burning (domestic)		889	1,245	2,134
TOTALS		**33,427,608**	**37,984,879**	**71,412,487**

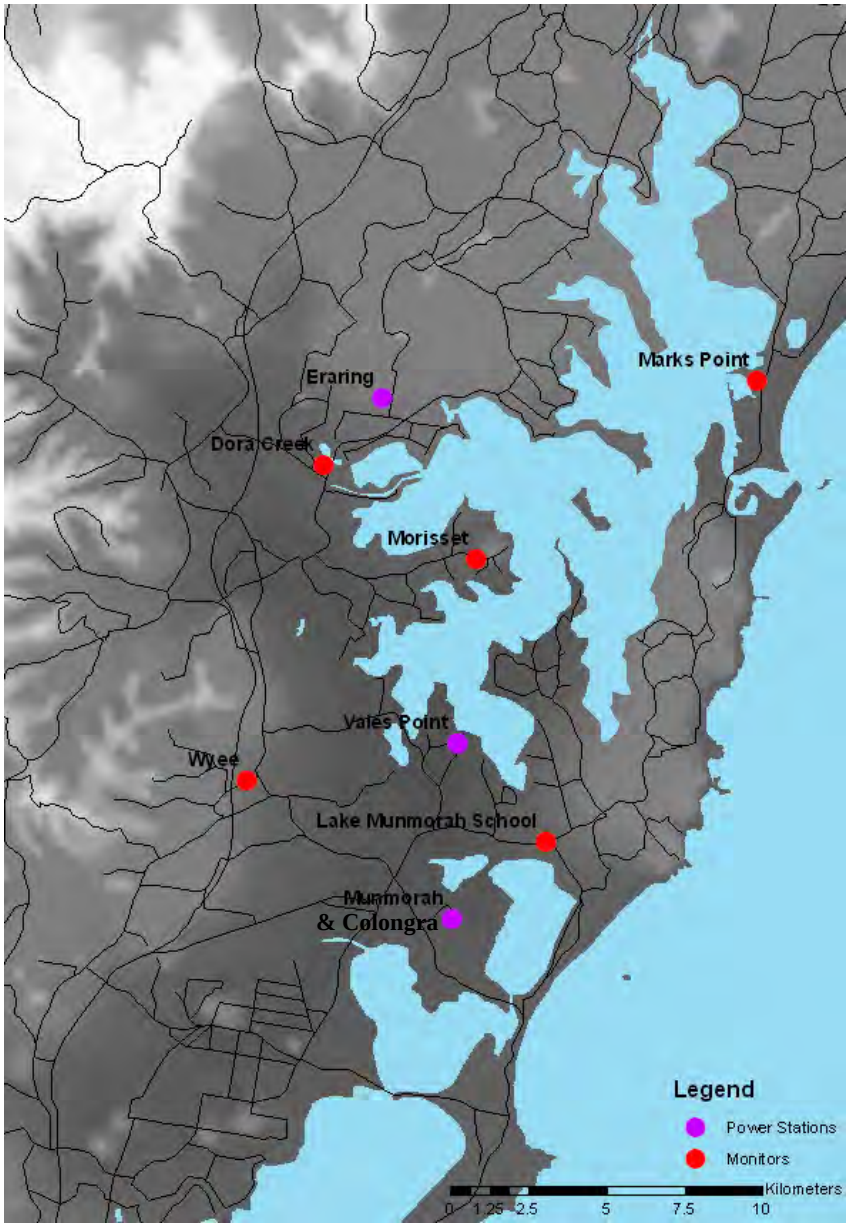

Figure 1: Location of power stations and monitoring sites in the Central Coast Region. Eraring Power station is owned by Eraring Energy who operate the Marks Point and Dora Creek monitoring stations.

Table 4: Summary of ambient nitrogen dioxide concentrations at the 3 Central Coast monitoring sites between 2007 and 2009.

		Wyee			Lake Munmorah			Morrisset Peninsula			Impact Assessment criteria (1)
		2007	**2008**	**2009**	**2007**	**2008**	**2009**	**2007**	**2008**	**2009**	**.**
Highest and second highest one hour averages)	**pphm**	3.65 3.43	**3.50** 3.10	3.18 3.12	**4.47** 3.48	3.57 3.45	3.85 3.62	**4.50** 4.50	4.00 3.90	3.9 3.70	**12 pphm**
	µg/m^3	74.82 70.38	**71.75** 63.55	65.26 63.89	**91.57** 71.41	73.12 0.73	78.92 74.14	**92.25** 92.25	82.00 79.95	79.95 75.855	**246 µg/m^3**
Annual average	**pphm**	**0.53**	0.55	0.39	0.57	0.66	**0.68**	**0.65**	0.61	0.60	**3 pphm**
	µg/m^3	**10.86**	11.27	8.00	11.68	13.53	**13.94**	**13.32**	12.51	12.30	**62 µg/m^3**

1. Sourced from Table 7.1 Approved Methods for Modelling and Assessment of Air Pollutants in NSW which in turn sourced the criteria from the National Environment Protection (Ambient Air Quality) Measure (**NEPC 2003**), which includes an allowance of one exceedence per year of the one hour average NO_2 criterion.
µg/m^3 - micrograms per cubic metre
pphm - parts per hundred million

The very infrequent occurrence of "higher" NO_2 concentrations (which are all well less than the assessment criterion of 246 µg/m^3 (or 12 pphm) is further demonstrated by the frequency distributions of hourly average NO_2 concentrations recorded at the 3 monitoring sites in 2009, shown in **Figure 2**. The curves for all 3 sites are very similar and indicate that about 90% of the results are below about 25 µg/m^3 – or 10% of the criterion. In brackets next to each site's name in the legend of the figure is the relevant 99.9th concentration (the 9th highest value, approximately). At each site the 99.9th percentile is about 25% of the air quality criterion of 246 µg/m^3

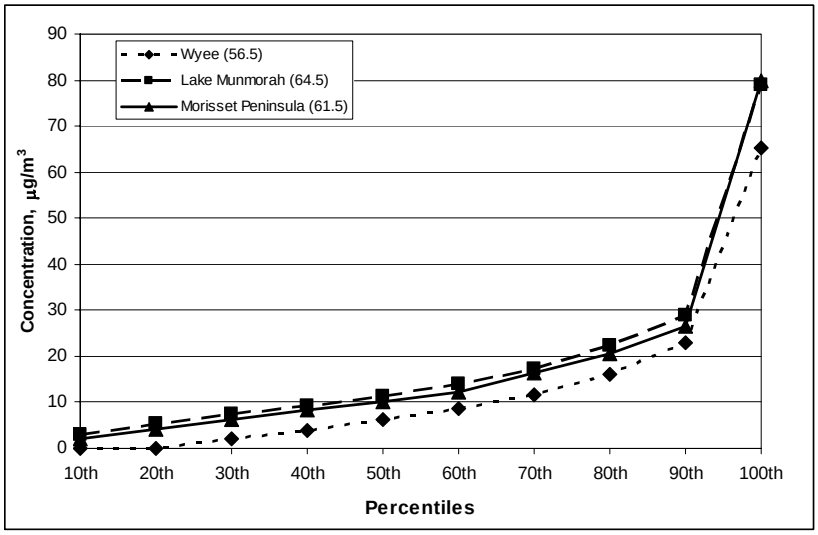

Figure 2: Frequency distributions of hourly average NO_2 concentrations, 2009

In the remainder of this section data from the ambient monitoring sites are used to demonstrate that sources other than power stations contribute significantly to ground level concentrations (glcs) of NOx in the Central Coast. As noted above, it is the concentration of nitrogen dioxide – NO_2 – that is of importance when assessing air quality. However, when assessing the significance of emitting sources it is often useful to use total NOx concentrations because most sources emit most of their NOx as nitric oxide – NO. Once emitted to the atmosphere, the NO undergoes oxidisation to NO_2, at a variable rate dependent on the physical and chemical conditions in the atmosphere at the time. The conversion of NO to NO_2 is considered further in the following section on air quality modelling.

Figure 3 shows contemporaneous hourly average SO_2 and NOx measurements from the 3 monitoring sites in 2009. Data from all 3 sites show that NOx occurs in significant concentrations in the absence of SO_2 emissions. This is particularly evident in the Wyee and Lake Munmorah data in which the 2 distinct groups of data points emanating from the origin of the graph suggest that there are (at least) 2 emission source types in the region. The NO_x data points associated with SO_2 concentrations (with a NO_x:SO_2 ratio of between about 1.5 – 2) indicate power station emissions are contributing to these events (using SO_2 as a "marker" for power station emissions). At both Wyee and Lake Munmorah the highest NO_x levels occur in the absence of SO_2, which indicates a non-power station source(s) for these events.

In **Figure 4** the diurnal variation in NOx and SO_2 in 2009 shows that at Wyee and Lake Munmorah the highest NO_x concentrations are out of phase with the highest SO_2 concentrations. The highest NOx concentrations occur in the absence of SO_2 concentrations and at times of the day (evening, overnight and early morning) when SO_2 is not measured at the ground in significant concentrations.

Further, the highest SO_2 concentrations only occur during the middle hours of the day, which is consistent with the understanding that power station plumes in the Central Coast generally come to the ground only when surface heating creates strong convective mixing in the lower atmosphere. Conversely, higher NOx emissions can occur at any time of the day, with the highest NOx concentrations occurring in the evening, over night and in the early hours of the morning – times at which power station plumes generally remain "aloft" due to the lack of vertical mixing in the lower atmosphere. At these times, the frequent occurrence of stable conditions near the surface and light surface winds are associated with restricted mixing of emissions near ground level and consequently higher glcs of NOx from ground-level sources, of which motor vehicles are the most significant.

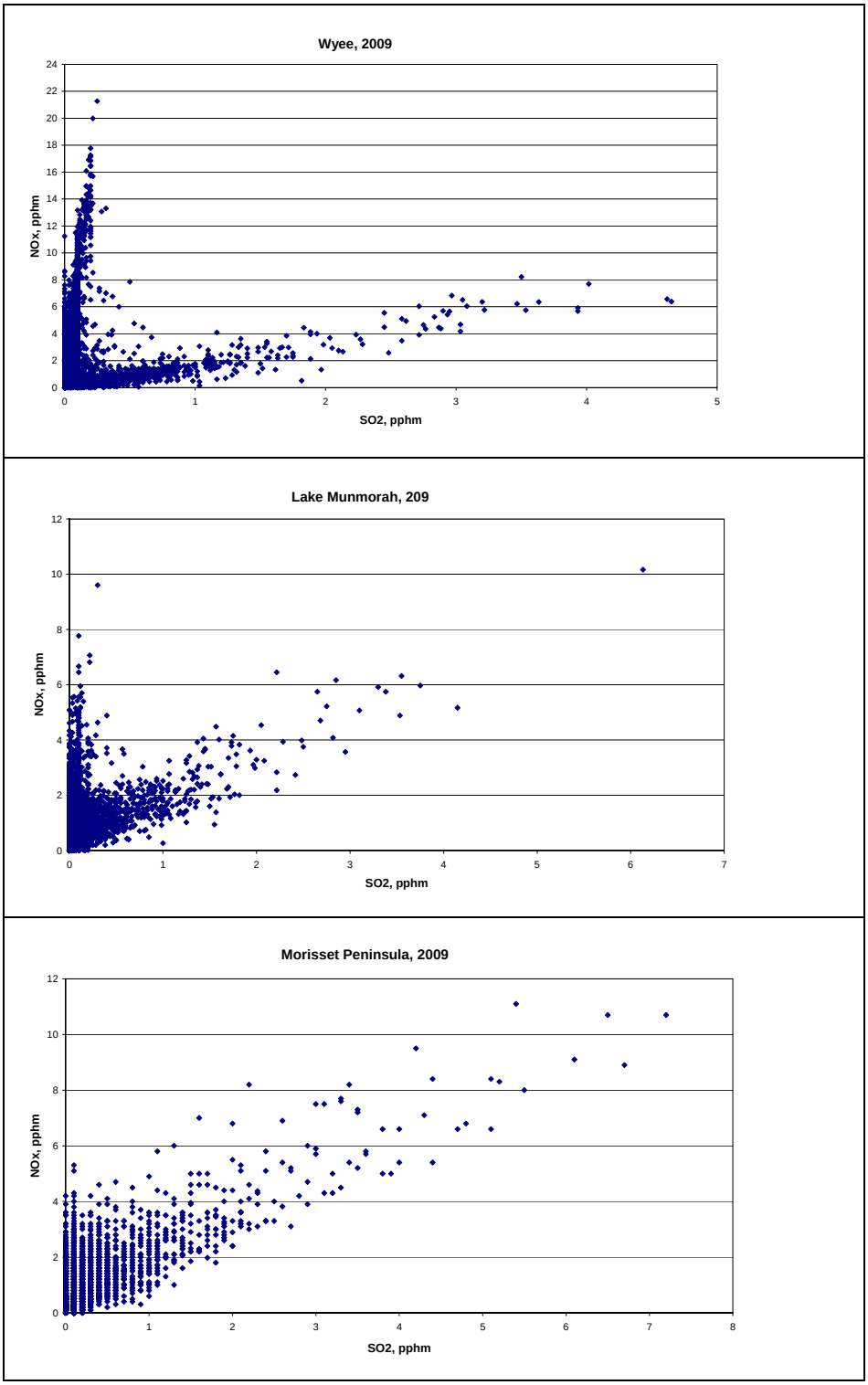

Figure 3: Contemporaneous SO_2 and NOx measurements at the Central Coast monitoring sites in 2009.

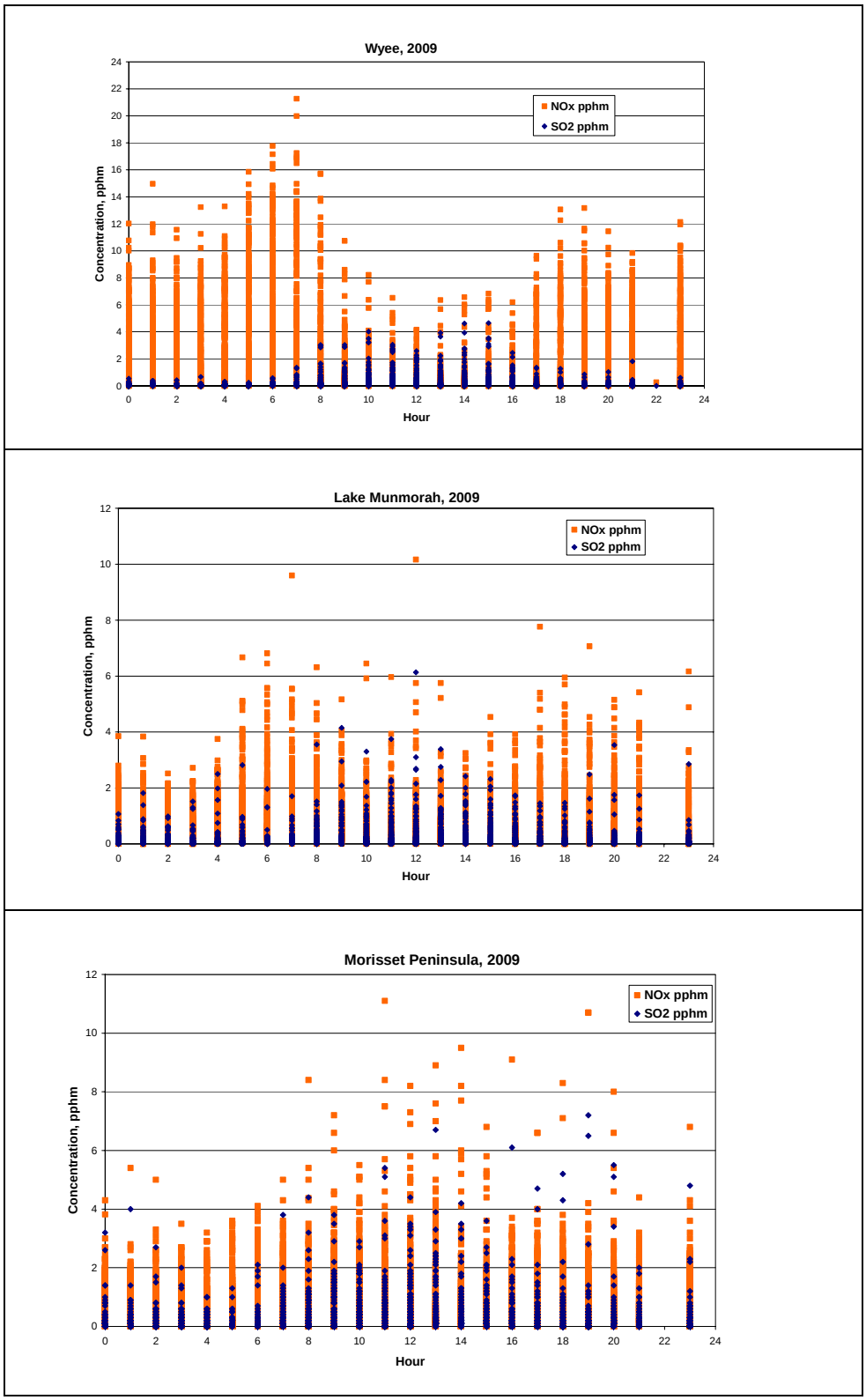

Figure 4: The diurnal occurrence of SO_2 and NOx at the Central Coast monitoring stations in 2009.

The comparisons presented above demonstrate that that the maximum ground-level NOx concentrations from ground-level sources can be greater than the maximum concentrations from the power station source group. While this finding may appear to be "at odds" with the NPI data in **Table 3**, which showed annual power stations emissions are about an order of magnitude higher than the ground-level sources, it can be understood by considering that emissions from tall buoyant plumes remain aloft for long periods of time and are usually greatly diluted by the time they are mixed to the surface. On infrequent occasions, the plumes are brought to the surface in higher concentrations. On the other hand, the ground-level sources, while of less magnitude than the power stations, are constantly emitting into the lowest layer of the atmosphere. In the evening and early morning, when emissions from the main ground-level source, motor vehicles, are at maximum levels, the lower atmosphere is often stable resulting in reduced mixing.

Figure 5 illustrates that the diurnal variation in NO_2 is considerably less than for NOx, and as noted above, all NO_2 concentrations are well below the air quality criterion of 12 pphm.

In the following section NO_x and NO_2 data are further examined in order to establish a representative "background" NO_2concentration and a NO_2:NOx ratio to be used in the air quality modelling component of the proposal.

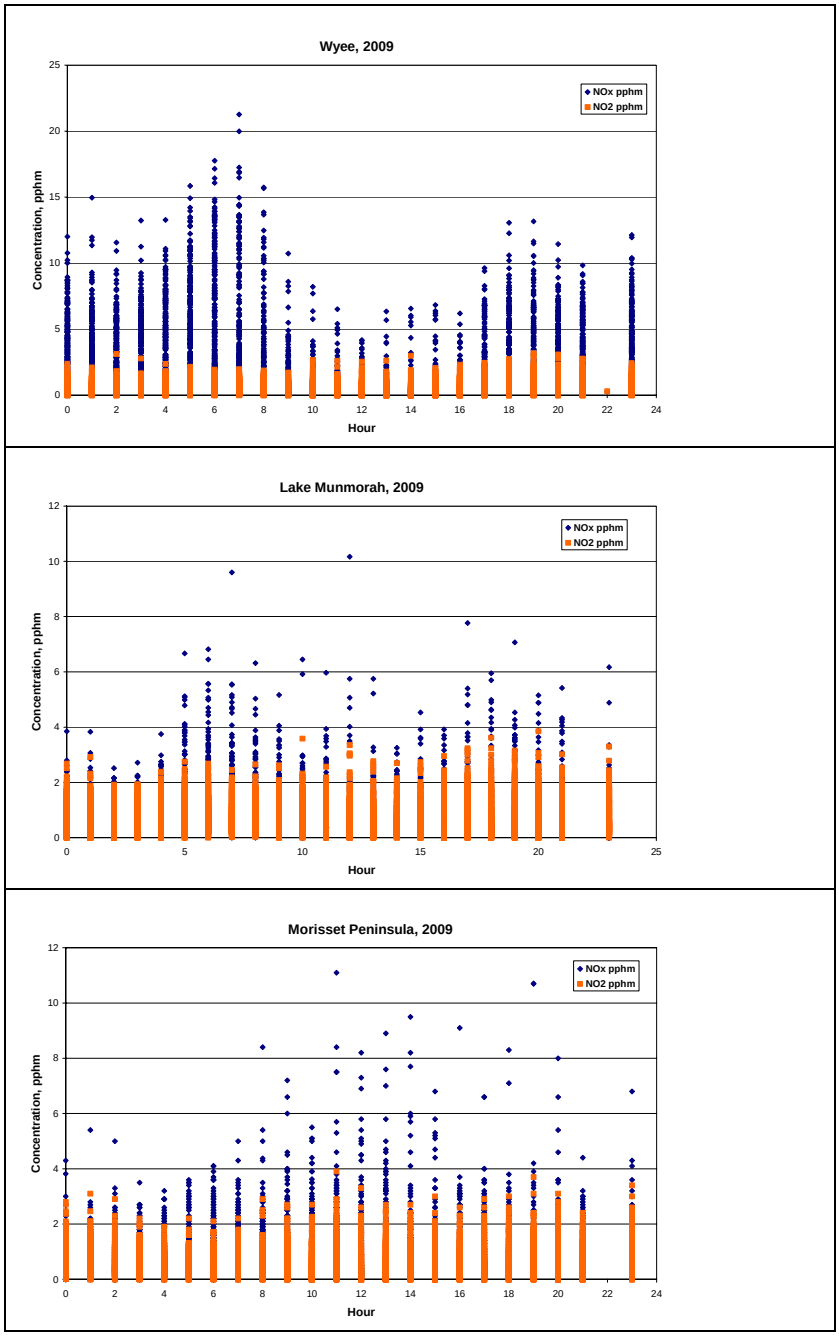

Figure 5: The diurnal varaion of NOx and NO_2 at the Central Coast monitoring stations in 2009.

Air quality modelling

Malfroy Environmental Strategies Pty Ltd engaged Katestone Environmental Pty Ltd. to conduct an assessment of the potential air quality impacts associated with emissions of NOx Vales Point Power Station (**Katestone 2010**). The Katestone report is appended to this report.

Features of the modelling study are:

- It was conducted in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales;
- It employed the CSIRO atmospheric dispersion model TAPM Version 4 (**CSIRO 2008**) to simulate the regional meteorological conditions at a scale of one kilometre for the period 1st January to 31st December, 2004. Predictions of glcs were made for an area within about 15 kilometres of the power stations at a resolution of 500 metres. Previous studies have shown TAPM is well suited to modelling emissions under the conditions experienced in the Central Coast region. (Lilley et al 2007a);
- 2004 chosen as modelled year as a recent assessment showed it be representative year meteorologically(**Aurecon 2009**);
- It explicitly included emissions from the existing Vales Point, Munmorah and Eraring Power Stations as well as from the yet to be commissioned Colongra Gas Turbines.
- It included a "background" contribution from the ground level sources, such as motor vehicles, which were not explicitly modelled. Determination of the "background" is considered below;
- It was conservative in that all power stations sources were modelled at maximum emission rates and full load for all hours of the year, which is most unlikely to occur in reality;
- Predictions were made for 7 specific sensitive receptor areas as well as the region as a whole;
- Predictions of NO_2 from modelled NOx concentrations were made using the NO_2:NO_x ratio determined from the monitoring records, as has been done in a number of recent assessments (**Malfroy 2009, Holmes 2005**);
- Predictions were provided for a number of scenarios:
    - Vales Point emissions in isolation;
    - Surrounding source emissions (Munmorah, Colongra and Eraring power stations) excluding Vales Point;
    - Surrounding source emissions plus Vales Point emissions;
    - Vales Point emissions plus the contemporaneous contribution from the surrounding sources.

All scenarios were considered with the background concentrations added.

Background concentrations

The Approved Methods makes the following introductory comment regarding background concentrations:

Including background concentrations of pollutants in the assessment enables the total impact of the proposal (i.e. impact of emissions on existing air quality) to be assessed. The background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at the proposed site. As this is extremely rare, data is typically obtained from a monitoring site as close as possible to the proposed location where the sources of air pollution resemble the existing sources at the proposal site.

In relation to the current application the following points are made:

- Extensive, high-quality ambient air quality data are available from 3 sites in the vicinity of the Vales Point power station.
- The existing monitoring record includes the contribution made from all existing emission sources – those that have been explicitly modelled (3 power stations) and those that are not (the ground-level sources).
- To use the existing monitoring record to establish a "background' level to add to predicted levels could clearly over-estimate potential impacts if the influence of the existing modelled sources is not accounted for.

In order to overcome the above limitation and to arrive at a "background" NO_2 level which is representative of the ground-level sources but which is not unreasonably affected by the sources which are explicitly modelled, the following approach was adopted.

- The ambient air quality data sets for the 3 monitoring sites for the years 2007 – 2009 were sorted to exclude NO_2 data when power station plumes were being recorded at the surface. This was achieved by using SO_2 at a concentration above 0.5 pphm as a "marker" for power station emissions.
- In the modified data set with the power station influence removed the average NO_2 concentration for those hours in which the power station plumes can be observed at ground (typically between 0800 and 1700 hours) level was determined to be about 40 $\mu g/m^3$.
- The ambient background NO_2 concentration of 40 $\mu g/m^3$ was added to the hourly average model predictions of emissions from the power stations to account for the ground-level sources, such as motor vehicles.
- For the prediction of the annual average NO_2 concentrations, the monitored annual average NO_2 concentration was adopted as the "background", without filtering as described above, recognising that this a very conservative approach as it involves "double-counting" of the power station impact.

NO_2 : NOx ratio

For comparison with air quality criteria it is necessary to make predictions of NO_2, but as noted earlier the majority of the NOx emitted by power stations is in the form of NO. An analysis of Vales Point's 2008 – 2009 CEMS data found that less than 3% of the NOx emitted was in the form of NO_2. Ultimately all nitric oxide emitted into the atmosphere is oxidised to NO_2 and then

further to other higher oxides of nitrogen (such as nitric acid and nitrates). The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours. The rate of conversion is important, because from the point of emission to the point of maximum ground-level concentration there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low it is unimportant that the oxidation has taken place. However, if the oxidation is rapid and the dispersion slow then high concentrations of NO_2 might occur.

An examination of monitoring data included in a recent air quality assessment on the Central Coast of NSW (**Holmes 2005)** established a NO_2 to NOx ratio of 0.2 for the purposes of modelling power station emissions. The assessment which used this ratio was approved by the then Department of Environment and Climate Change (DECC)[4] and accordingly it is considered appropriate to use a NO_2:NO_x ratio of 0.2 in the current assessment. This means that a predicted NOx glc of 100 μg/m3, for example, will result in a predicted NO_2 glc of 20 $\mu g/m^3$.

Alternatively, the oxidation of NO to NO_2 can be estimated using the Ozone Limiting Method or OLM. This method uses the predicted NO_x concentration with background ozone and NO_2 data to estimate the NO_2 concentration. However, ozone concentrations are not measured at any of the monitoring sites in the Central Coast region which restricts the applicability of this method. The nearest ozone measurements are made in the Lower Hunter- Newcastle area, some 40 kilometres to the north of Vales Point.

It is also possible to explicitly model the conversion of NO to NO_2 as was done by CSIRO in a photochemical pollution assessment for the Colongra Gas Turbine assessment (**CSIRO 2005**) but this approach was not within the scope of the modelling undertaken by Katestone.

[4] Now the Department of Environment, Climate Change and Water DECCW

Source characteristics and emission rates

The emission characteristics of the modelled sources used in the Katestone modelling are presented in **Table 7**.

Table 7: Emission characteristics of the modelled power station sources

Source	Easting (m)	Northing (m)	Stack Height (m)	Radius (m)	Exit Velocity (m/s)	Exit Temperature (°K)	NO_X as NO_2 Emission Rate (g/s)
Vales Point	364375	6329950	178	5.15	26	403	1130[1]
Munmorah	364200	6324300	155	3.95	19.4	426	305[2]
Colongra GT	364500	6324500	35	6	44	791	154.7[3]
Eraring Stack 1	361950	6340900	200	5.24	26.2[4]	403	1685[5]
Eraring Stack 2	361900	6340700	200	5.24	26.2[4]	403	1685[5]

Note: [1] Assuming a NO_X (as NO_2) concentration of 1,000 mg/Nm^3 which is not the absolute highest from the 2009 CEMS record (Table 2) but is exceeded by only 0.2% of the data.

[2] Assuming a NO_X concentration of 500 mg/Nm^3 (Group 6 limit)

[3] Assuming 90 mg/Nm^3 on distillate firing (49 mg/m3 on gas firing)

[4] Historical value of 23 x 1.14 to account for plant upgrade in progress

[5] Assuming a NO_X (as NO_2) concentration of 1100 mg/Nm^3 following upgrade (revised licence condition

Predicted concentrations

Table 8 provides a summary of the Katestone TAPM predicted glcs for the four emission scenarios assessed:

- Vales Point emissions in isolation;
- Surrounding source emissions (Munmorah, Colongra and Eraring power stations) excluding Vales Point;
- Surrounding source emissions plus Vales Point emissions;
- Vales Point plus contemporaneous surrounding source contribution.

All four scenarios include the ambient background concentrations of 40 μg/m^3 (hourly average) and 14 μg/m^3 (annual average). The results from the emission scenarios are shown in **Figures 6 – 13**.

Table 8: Predicted domain-wide maximum hourly average and annual average concentrations for four modelling scenarios. All in μg/m^3 and including the ambient background of 40 μg/m^3.

	Vales Point in isolation	Surrounding sources	Surrounding sources plus Vales Point	Vales Point plus contemporaneous
	μg/m^3	*μg/m^3*	*μg/m^3*	
Maximum hourly average	198	318	318	199
Number of hourly average exceedences	0	20	20	0
Annual average	14.5	15.7	15.9	

Hourly average concentrations

The four scenarios listed above were modelled in an attempt to determine the potential maximum impact Vales Point emissions make to the regional occurrence of NO_2, given that there are other significant sources in the region, one of which is a significantly bigger source than Vales Point.

The data in **Table 8** and **Figure 6** indicate that Vales Point emissions in isolation result in predicted maximum glcs well below the assessment criterion of 246 mg/m3 with the highest concentrations occurring to the south-west of the power station.

The data in **Table 8** also indicate that the (equal) highest predicted hourly average glc occurs under the surrounding sources (Colongra, Eraring, and Munmorah and excluding Vales Point) scenario and that the addition of Vales Point to the surrounding sources does not change the highest glc – or the number of predicted glcs above the assessment criterion of 246 µg/m^3. That Vales Point emissions do not significantly contribute to the highest concentrations in the region is illustrated by the close similarity of the contours in **Figure 7** (Surrounding sources only) and **Figure 8** (Surrounding sources plus Vales Point).

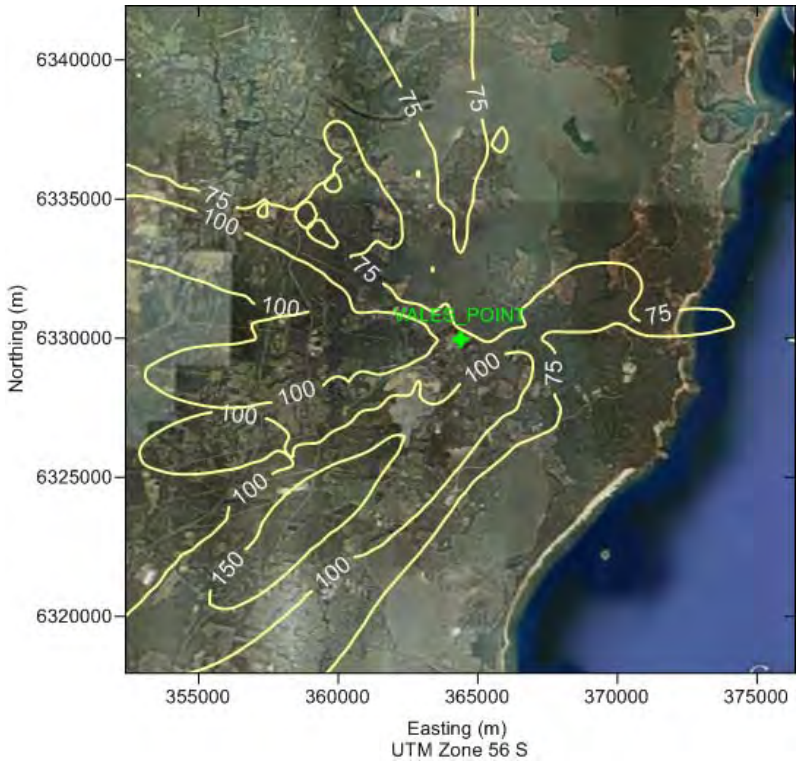

Figure 6: Maximum 1-hour ground-level concentrations of Nitrogen Dioxide due to Vales Point in isolation. An ambient background concentration of 40 µg/m^3 has been added

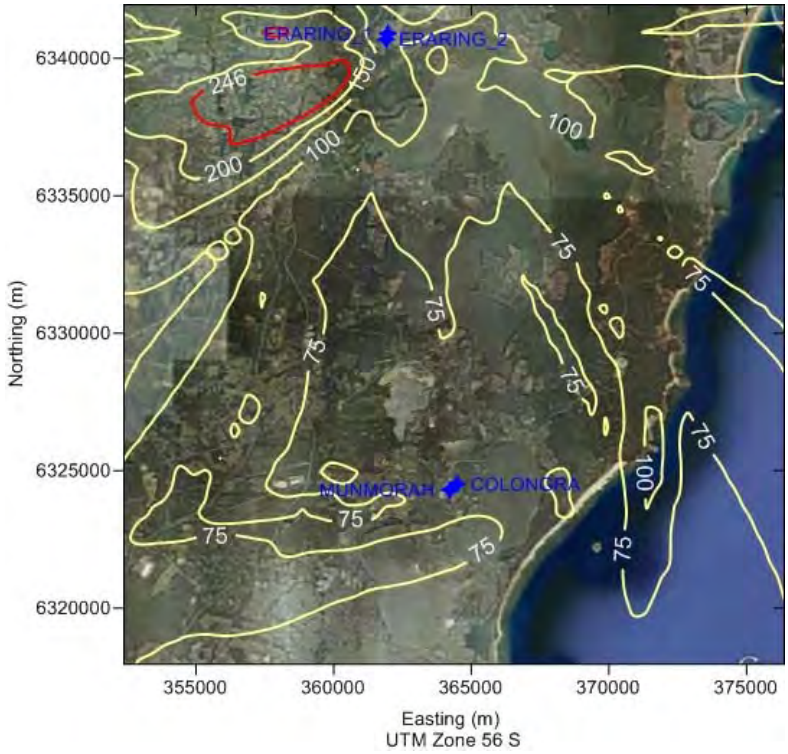

Figure 7: Maximum 1-hour ground-level concentrations of Nitrogen Dioxide due to surrounding sources, Vales Point excluded. An ambient background concentration of 40 µg/m^3 has been added. The distance between number markings on the horizontal and vertical scales of this and similar, subsequent figures is 5 kilometres.

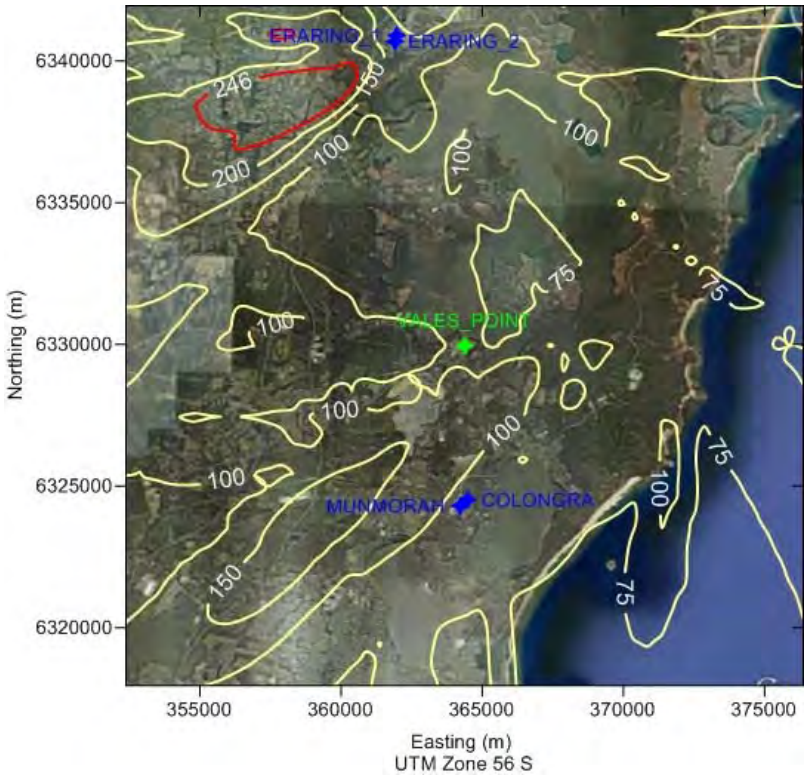

Figure 8: Maximum 1-hour ground-level concentrations of Nitrogen Dioxide from surrounding sources and Vales Point. An ambient background concentration of 40 µg/m^3 has been added.

Figure 6 shows that the maximum glc contours for Vales Point in isolation have a very different spatial "footprint" to the above 2 scenarios. Closer inspection of **Figures 6, 7 and 8** reveals that the predicted ground-level concentrations from Vales Point and the surrounding sources are not co-located in space and time, meaning that the maximum potential impact arising from Vales Point emissions can, by and large, be considered in isolation from the surrounding sources.

The final scenario, Vales Point plus contemporaneous contribution from the surrounding sources, shown in **Figure 9** shows close similarity to **Figure 6,** confirming that that the ground level maximum from Vales Point in isolation is enhanced by a very small amount due to interaction with plumes from the other power stations.

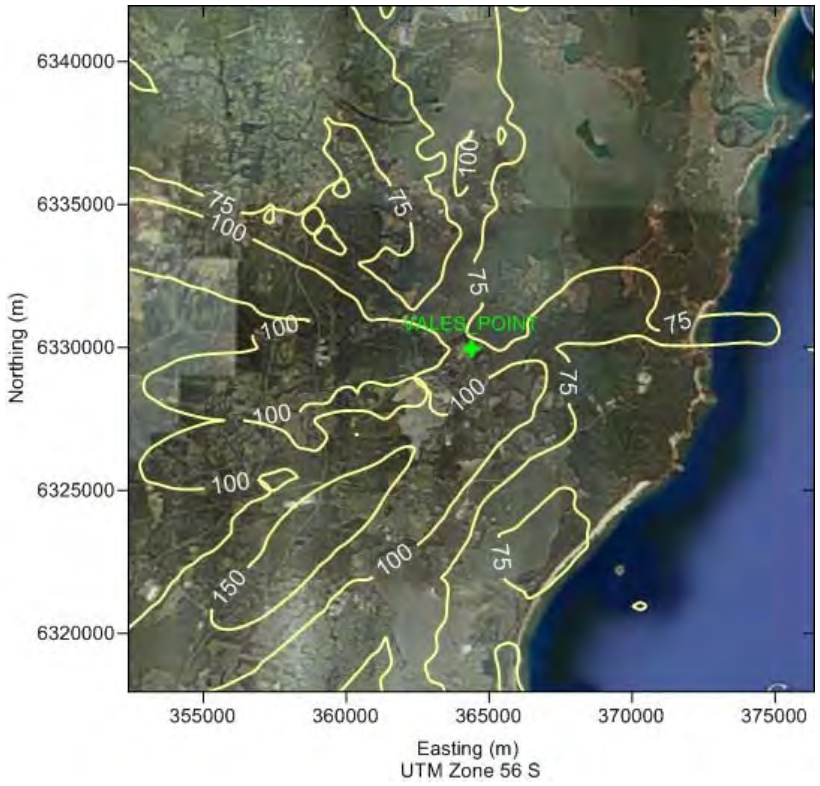

Figure 9: Maximum ground-level concentrations of Nitrogen Dioxide from Vales Point and corresponding contemporaneous contribution of surrounding sources. An ambient background concentration of 40 µg/m^3 has been added.

The time series of domain-wide predicted maximum glcs for each hour of the year shown in **Figure 10** provides further insight into the contribution of Vales Point emissions to regional NO_2 concentrations. The data are for Vales Point in isolation (without the background concentration) and show that the highest values are well below the assessment criterion of 246 µg/m^3. The figure also shows that there are only 2 predicted glcs above 50% of the criterion and that the significant majority (90%) of predicted glcs are less than 10% of the criterion.

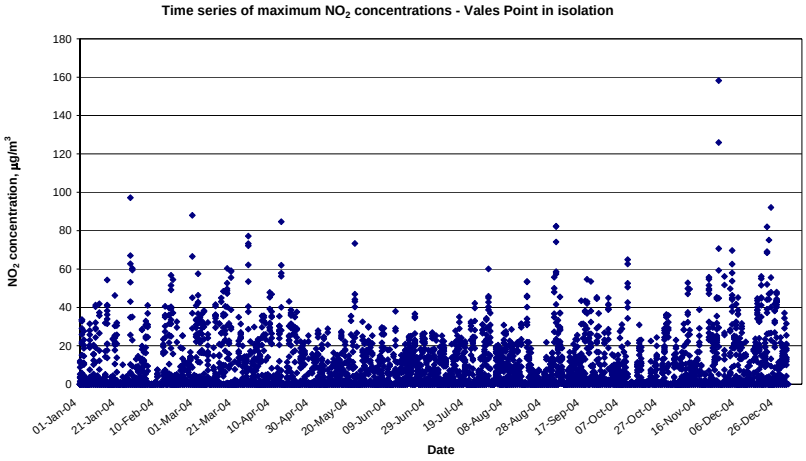

Figure 10: Time series of maximum predicted NO_2 concentrations - Vales Point in isolation and without the addition of "background" concentrations.

It is relevant to note that a recent evaluation of the performance of air quality models approved for use by DECCW (**Lilley et al 2007**) found that while TAPM is well suited to model emissions from tall buoyant sources, like power stations, it does have the potential to over-estimate predictions at the "top-end" of the frequency distribution. This finding has been supported by other investigations including a more recent review of elevated TAPM predictions in the Central Coast region (**Malfroy 2010, Physick, 2010**). From this it is considered that the highest NO_2 predictions from the TAPM modelling shown in **Figures 9 and 10,** while below levels of concern**,** are likely to be an artefact of the model and probably not indicative of concentrations that might be expected to occur, or that have been monitored, in the region due to power station emissions.

As the predicted domain-wide maxima resulting from Vales Point emissions (plus contemporaneous surrounding sources and background) are below the assessment criterion it follows that maximum predictions at all sensitive areas will also be below the criterion. The locations of the sensitive receivers are shown **Figure 11** and maximum predicted glcs at these sensitive areas are shown in **Table 9**.

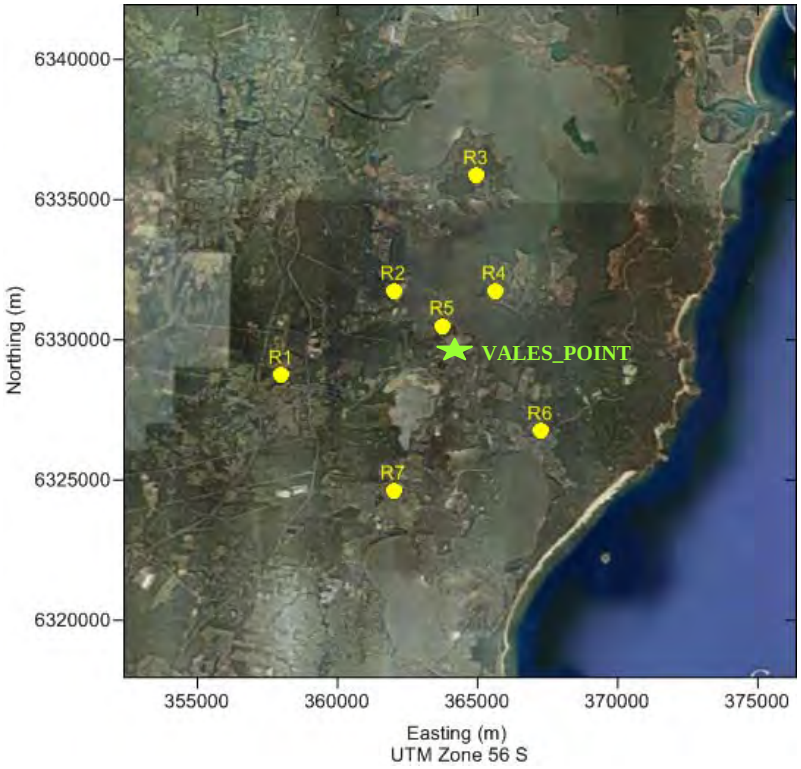

Figure 11: Location of sensitive receivers in relation to vales Point. Refer to Table 9 for location names.

Table 9: Maximum 1 hour average concentration of NO_2 at the sensitive receptor areas for Vales Point in isolation, the contemporaneous maximum 1-hour concentration of NO_2 from the surrounding sources and the combined maximum 1 hour average concentration of NO_2 (ambient concentration of 40 µg/m^3 has been added to the combined total)

Receptor	Code		Vales Point in isolation	Surrounding sources contemporaneous contribution	Vales Point plus Surrounding sources contemporaneous contribution plus 40 µg/m^3
Wyee	R1	Residential / Aged care and near Wyee monitoring station	91	2	133
Wyee Point/ Morisset Hospital	R2	Residential / Hospital	26	0.1	66
Morisset Peninsula	R3	Residential / monitoring site	28	3	71
Summerland Point	R4	Residential	29	1	70
Mannering Park	R5	Residential	36	3	79
Lake Munmorah	R6	Residential, school, monitoring station	45	1	86
Blue Haven/ San Remo	R7	Residential	75	1	116

Annual average concentrations

Table 8 indicates that the highest predicted annual average NO_2 concentration across the region are about 15 μg/m^3 and less than 25% of the assessment criterion of 62 μg/m^3, even with the addition of the assumed, overly conservative, background concentration of 14 μg/m^3.

Figures 12 and 13 show the predicted highest annual average concentrations in the region for Vales Point in isolation and for the surrounding sources plus Vales Point.

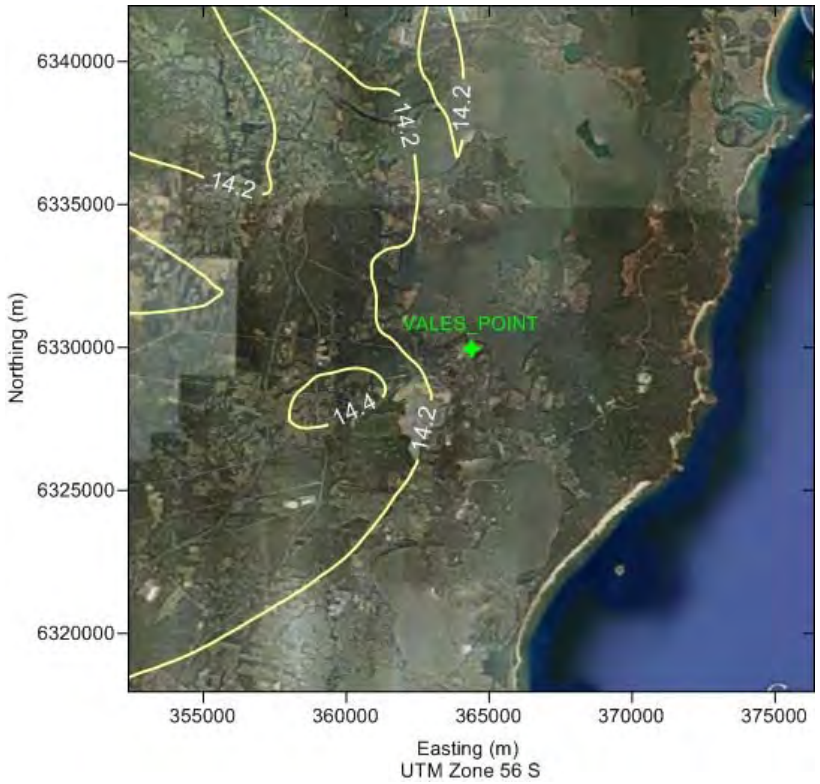

Figure 12: Annual average ground-level concentrations of Nitrogen Dioxide due to Vales Point. An ambient background concentration of 14 μg/m^3 has been added.

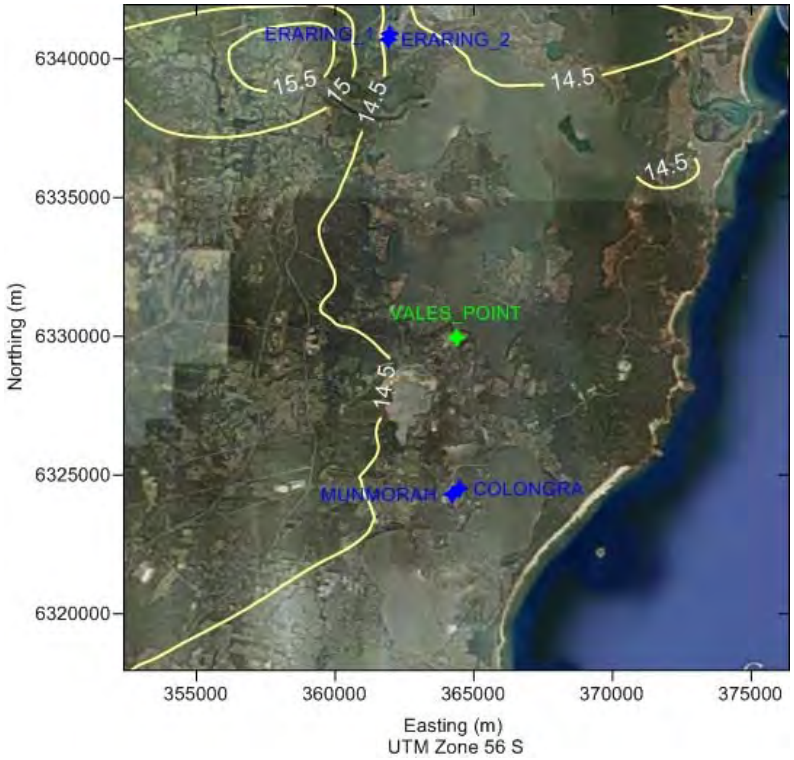

Figure 13: Annual average ground-level concentrations of Nitrogen Dioxide due to surrounding sources and Vales Point. An ambient background concentration of 14 µg/m^3 has been added.

Conclusions from modelling

- On a regional scale, the maximum ground-level concentrations of NO_2 due to Vales Point power station plus the contemporaneous contribution from the surrounding sources (Eraring, Munmorah and Colongra) and background are predicted to be well below the air quality criteria.
- Maximum ground-level concentrations of NO_2 attributed to Vales Point power station are spatially and temporally separated from those caused by the surrounding sources (Eraring, Munmorah and Colongra). The area where Vales Point power station is predicted to contribute most to the ground-level concentration of NO_2 is southwest of the Vales Point power station. However, even in this area the predicted ground-level concentrations of NO_2 due to Vales Point power station and surrounding sources are well below the assessment criteria.
- All predicted exceedences of the hourly-average NO_2 assessment criterion are attributable to the surrounding sources operating in the region.
- Vales Point power station does not add to the maximum ground-level concentration predicted in the region or to the number of exceedences of the impact assessment criterion for 1-hour average NO_2.
- The maximum 1-hour average ground-level concentration of NO_2 predicted at a sensitive receptor attributed to Vales Point power station with contemporaneous contributions of other sources plus an ambient background concentration of 40 µg/m^3 is 133 µg/m^3, 54% of the impact assessment criterion.

- Other surrounding sources are predicted to contribute 3 $\mu g/m^3$ of NO_2 for a 1-hour average ground-level concentration at the time of peak contributions from Vales Point power station at the Morisset Peninsula (R3) and Mannering Park (R5) representative sensitive receptor areas.

Regional photochemical impacts

The assessment of ambient air quality in the previous section addressed potential impacts arising from power station NOx emissions in the in the near to medium field (several kilometres out to about 20 kilometres). Also of relevance are potential impacts at larger distances due to the so-called "inter-regional transport" of emissions.

The CSIRO Inter Regional Transport of Air Pollutants Study (**IRTAPS, Nelson et al 2002**) undertook a comprehensive assessment of the potential for NOx emissions from all coal-fired power stations in NSW to affect smog (NO_2 and ozone, O_3) levels in the Sydney region.

In this state-of-the-art study, air quality assessment and modelling techniques were used to assess:

- The incidence of inter regional transport from the 3 power station regions in NSW (Central Coast, Hunter Valley and Western);
- The impact of inter regional transport of power station emissions on air quality in the Sydney region.

The study concluded that:

- In the near-field of the power stations the effect of NOx emissions is to lower O_3 concentrations by the process of titration.
- the contribution of power station NOx emissions to elevated ozone levels in the Sydney region is, at most, small (less than 5% of the standard) and infrequent.
- For the majority of the time power station emissions make no contribution to elevated ozone levels in the Sydney region.

From this it can be concluded that Vales Point Power Station would have at most a negligible impact on smog levels at significant distances downwind.

The conclusions from a more recent assessment undertaken by CSIRO (**CSIRO, 2005**) for the Colongra gas turbine assessment are consistent with the previous Inter Regional Transport Study.

7. CONSIDERATION OF ECOLOGICALLY SUSTAINABLE DEVELOPMENT PRINCIPLES

Under Clause 37 of the Clean Air Regulation, in determining an application to vary the conditions of a licence, the EPA must consider the potential impact on local and regional air quality from the proposed variation, having regard to (amongst other things) the principles of ecologically sustainable development (ESD.) as set out in the Protection of the Environment Administration Act 1991. For the purposes of the Act, ESD can be achieved through the implementation of the following principles and programs:

(a) the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

(b) inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,

(c) conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

(d) improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services, such as:
(i) polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,
(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,
(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

In terms of the ESD principles and programs, and in particular the precautionary principle, it is noted that the assessment undertaken here is based on very good data sets providing a high level of confidence that the current operation of Vales Point power station results in acceptable environmental outcomes. The licence variation, if approved, would, similarly result in acceptable environmental outcomes, as the proposed licence change would not result in any changes to emissions from the power station.

In relation to improved valuation, pricing and incentive mechanisms it is noted that Vales Point power station operates under DECCW's Load-based licensing scheme, which is an example of a "polluter pays" system, providing incentives to reduce emission loads.

8. LOAD REDUCTION AGREEMENTS and POLLUTION REDUCTION PROGRAMS

Under Clause 37 of the Clean Air Regulation, in considering an application for a licence variation the EPA must also have regard to:

- any pollution reduction programs (PRPs) that have been established, or that the holder of the licence has agreed to establish, in relation to the activity or plant, and
- any control equipment that has been installed, or that the holder of the licence has agreed to install, in relation to the activity or plant, and
- any load reduction agreement that has been entered into between the EPA and the applicant.

Listed below is information extracted from the Vales Point EPL in relation to each of these three items.

PRPs
Vales Point's EPL contains 2 PRPs, neither of which is directly relevant to the current application.

- **U1**: Any new continuous emission monitoring systems installed on the premises for the purposes of monitoring emissions to the atmosphere must comply with "Approved methods of (sic) the sampling and analysis of air pollutants in New South Wales"
- **U2**: Noise assessment report new dust control plant at Vales Point Power Station. Within sixty (60) days of commissioning the new dust control plant the licensee must conduct a noise assessment in accordance with the NSW Industrial Noise Policy 2000 (INP).

Control equipment

There are no agreements in place to install new control equipment. It should be noted however, that the replacement of electrostatic precipitators with installation of fabric filters in the mid 2000s resulted in a significant reduction in the emission of particulate matter from Vales Point.

The installation of fabric filters also contributes to the performance of Vales Point in relation to a number of other Group 5 and 6 emission limits, particularly for those substances which may be associated with particulate emissions, such as the hazardous pollutants.

Load reduction agreements

The load reduction agreement included in Vales Point's EPL in relation to the emission of Coarse Particles and Fine Particles (included below) is not considered to be relevant to the current application.

Condition L2.3 When a Load Reduction Agreement expires or is terminated the DECC will, after consultation with the licensee, apply a new load limit having regard to the agreed load in the table below or the load that may be achievable if the agreement is terminated early.

Assessable Pollutant	*Agreed Load (kg)*
Coarse Particles	*725,000*
Fine Particles	*900,000*

9. CONCLUSIONS

This application includes all the necessary information specified in the Clean Air Regulation 2010 in order for the Environment Protection Authority to assess the application. In summary the application demonstrates that:

- With the exception of oxides of nitrogen (NOx), the emission rates from Vales Point Power Station meet the Clean Air Regulation's Group 5, and in most cases Group 6, emission limits for all relevant substances;
- Current maximum emission rates of NOx from Vales Point Power Station are below the Group 5 emission limit of 800mg/m^3 for about 80% of the time and emission rates above 1,000 mg/m^3 occur very infrequently, (~ 0.2% of the time);
- Based on an extensive monitoring record, NO_x emissions from Vales Point and other sources in the region, including other power stations and motor vehicles, have not resulted in an exceedence of either the hourly average or annual average ambient air quality standards for nitrogen dioxide (NO_2). Maximum hourly average and annual average concentrations are about 40% and 20% of the respective air quality standards.

- An air quality modelling assessment showed that NO_x emissions from Vales Point Power Station considered either in isolation or combined with emissions from other power stations in the region and including the contribution from other sources, such as motor vehicles, are unlikely to result in an exceedence of either the hourly average or annual average ambient air quality standards for NO_2 and that for the significant majority of time emissions from Vales Point Power Station make a small contribution to ground level concentrations of NO_2 in the region;
- Based on air quality assessments undertaken by CSIRO, NO_x emissions from Vales Point Power Station are unlikely to have a measurable impact on regional, or inter-regional, smog levels.

It is concluded that this application meets the requirements of the Clean Air Regulation in relation to conditions which must be satisfied in order to vary Vales Point Power Station's EPL in relation to NOx emissions following the phasing out of Group 2 emission limits in 2012.

10. REFERENCES

Aurecon Australia Pty Ltd (2009). *Munmorah Rehabilitation. Updated Air Quality Assessment, Attachments B and C*. Reference 41442. Report prepared for Delta Electricity

CSIRO (2005). *Photochemical Pollution Assessment Of A Proposed Gas-Fired Power Station At Munmorah.* Prepared for Parsons Brinckerhoff Australia Pty Limited.

CSIRO (2008). *TAPM V4* http://www.cmar.csiro.au/research/tapm/docs/tapm_v4_information_sheet.pdf Accessed 20 July, *20009*

Department of Environment and Conservation NSW (2007). *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*
http://www.environment.nsw.gov.au/air/appmethods.htm
Accessed 14 July 2009

Department of Environment and Conservation NSW (2005). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
http://www.environment.nsw.gov.au/air/appmethods.htm
Accessed 14 July 2009

Holmes Air Sciences (2005). *Air Quality Impact Assessment: Proposed Open Cycle Gas Turbine Plant At Munmorah Power Station*. Prepared for Parsons Brinckerhoff Australia Pty Limited, October 2005.

NSW Government, *Protection of the Environment Operations (Clean Air) Regulation 2010*
http://www.austlii.edu.au/au/legis/nsw/num_reg/poteoa1997poteoar20102010428l13a20101172.pdf
Accessed 4th October, 2010 at 11:30 am).

Katestone Environmental (2010). *Dispersion Modelling Study of Emissions of Oxides of Nitrogen from the Vales Point Power Station*. Prepared for Malfroy Environmental Strategies Pty Ltd.

Lilley W., Rae M., Malfroy H, Physick B., Boras M., Edwards M. (2007a). *Ambient Air Modelling Study for power stations in the Central Coast and Western Coalfields regions of NSW*. Prepared for Delta Electricity.

Lilley W., Malfroy H., Physick W. (2007b). *Variations In The Highest Predictions From Approved Air Quality Models And Implications For Air Quality Assessments*. Proceedings of the IUAPPA World Congress September 2007, Brisbane.

Malfroy H. (2009). *Liddell Power Station Application for the Revision of the Environment Protection Licence* Prepared by Malfroy Environmental Strategies for Macquarie Generation.

Malfroy H. (2010). *Munmorah Power Station Rehabilitation Project Assessment of elevated sulfur dioxide predictions* Prepared by Malfroy Environmental Strategies Pty Ltd for Aurecon Pty Ltd.

Nelson P., Azzi M., Cope M., Lilley W., Carras J., Hurly P., Hyde R. (2002). *Inter-regional Transport of Air Pollutants Study (IRTAPS).* Investigation Report ET/IR 570R. A report prepared for Pacific Power International

National Environment Protection Council National Environment Protection (Ambient Air Quality) Measure ,as varied 2003
http://www.ephc.gov.au/sites/default/files/AAQ_NEPM__Ambient_Air_Quality_NEPM_Varied_scaleplus_Final_200305_1.pdf Accessed 14 July 2009

NSW Government, Protection of the Environment Administration Act 1991
http://www.legislation.nsw.gov.au/scanview/inforce/s/1/?TITLE=%22Protection%20of%20the%20Environment%20Administration%20Act%201991%20No%2060%22&nohits=y
Current version for 1 May 2009 to date (accessed 14 July 2009 at 16:30)

NSW Government Website EP an O Act www.legislation.nsw.gov.au
Protection of the Environment Operations Act 1997
http://www.legislation.nsw.gov.au/scanview/inforce/s/1/?TITLE=%22Protection%20of%20the%20Environment%20Operations%20Act%201997%20No%20156%22&nohits=y
Current version for 6 July 2009 to date (accessed 14 July 2009 at 16:48)
NSW Government Website EP an O Act www.legislation.nsw.gov.au

Physick W. (2010). *Expert Review of "Munmorah Power Station Rehabilitation Project Review of Elevated Sulfur Dioxide Emissions" Report.* Final Report for Aurecon Australia Pty. Ltd

11. APPENDIX: KATESTONE MODELLING REPORT

Supplementary report:

Vales Point Power Station

Environment Protection Licence Variation Application

Prepared for

Delta Electricity

By

Malfroy Environmental Strategies Pty Ltd.

December, 2010

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Summary

This supplementary report addresses three issues raised by the Department of Environment, Climate Change and Water (DECCW) with respect to the assessment report, *Vales Point Power Station Application for the Revision of the Environment Protection Licence* **(M_E_S, 2010).**

The three issues raised by DECCW are:

1. The absence of a proposed NOx emission limit between the Group 2 and Group 5 limits of 800 mg/m^3 and 2,500 mg/m^3, respectively.
2. The use of a fixed NO_2 to NOx ratio of 0.2, with DECCW requiring that evidence be provided to support its use.
3. The absence of local meteorological data assimilation into the model predictions.

In relation to these three issues this report concludes that:

1. A conservative assessment indicates that a NOx emission concentration of 1,500 mg/m^3 applied to Vales Point Power Station would not result in exceedences of the relevant air quality criterion;
2. A single, fixed NO_2 to NOx ratio of 0.2 provides a conservative estimate of potential maximum NO_2 concentrations;
3. While data assimilation might have been incorporated into the modelling, its omission would not have had a significant impact on the results obtained.

1. Introduction

Malfroy Environmental Strategies Pty Ltd (M_E_S) was engaged by Delta Electricity to prepare an application to vary Vales Point Power Station's (VPPS) Environment Protection Licence (EPL), which if approved by the Department of Environment, Climate Change and Water (DECCW) would enable VPPS to delay moving to the Clean Air Regulation Group 5 emission limit for oxides of nitrogen (NO_x) upon phasing out of the Group 2 limits in 2012, as is provided for in the Regulation.

Following submission of the application to DECCW a meeting was arranged between officers from Delta Electricity, DECCW and M_E_S to discuss a number of issues arising from the DECCW review.

This supplementary report addresses the issues raised by DECCW with respect to the original assessment report.

2. The issues

DECCW raised 3 issues that require consideration:

1. The absence of a proposed NOx emission limit between the Group 2 and Group 5 limits of 800 mg/m^3 and 2,500 mg/m^3, respectively. In discussing this issue at the meeting it was noted that the development of a new NOx limit could be influenced by the veracity of the 2 highest model predictions – which occurred on consecutive hours (on the 26th November of the modelled year, 2004) and that therefore an analysis of these 2 predictions was required;
2. The use of a fixed NO_2 to NOx ratio of 0.2, with DECCW requiring that evidence be provided to support its use.
3. The absence of local meteorological data assimilation into the model predictions.

This report addresses each of these 3 issues.

3. Assessment of TAPM predictions for the 26/11/2004

As part of the assessment for the application for a variation of VPPS's EPL, potential air quality impacts were predicted using CSIRO's air pollution model, TAPM, Version 4 (CSIRO, 2008). The modelling was undertaken according to the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DECC 2005). http://www.cmar.csiro.au/research/tapm/docs/tapm_v4_user_manual.pdf. Details of the modelling can be found in the original assessment report (M_E_S, 2010a).

Over the 8,784 hours in the modelled year (2004), predicted NO_2 concentrations were within the relevant air quality criterion. However, the predicted concentrations on consecutive hours of one day (10:00 – 11:00 26th, November, 2004) were elevated compared with concentrations throughout the rest of the year. While the two highest concentrations are below the air quality criterion, they may influence a new NOx licence limit to be applied to VPPS.

A recent CSIRO report[1] (Lilley et al 2007a) assessed the performance of the three air quality models approved for use in the *Approved Methods*. Amongst other things the report found that

"..the 100th percentile concentration is not appropriate for assessing the potential impacts from tall stacks under the diverse range of conditions examined in this project, due to potential over estimation at the very top end of the frequency distribution. This is due to uncertainty in several critical meteorological parameters in the lower atmosphere which are either predicted or derived from measurements at ground level."

[1] A copy of this report was provided to, and discussed with DECCW. A paper arising from this work was presented at the IUAPPA World Congress in Brisbane, 2007 (Lilley et al 2007b)

Before finalisng a new NOx emission limit for VPPS it was agreed that the veracity of the two highest predictions should be examined. In examining the likelihood of the two elevated predictions occurring the following tasks have been undertaken:

- Extraction of data from the TAPM output files for the day in question, with particular reference to critical meteorological parameters;
- Review of the 2007 model evaluation assessment:
  - Critical parameters;
  - Examination of 100th percentile predictions;
  - Examination of "case-study" days of elevated predictions;
- Obtain relevant observational data from the Bureau of Meteorology (BoM) and Delta Electricity for the 2 day in question;
- Develop an understanding of the nature of the day in question from an air pollution dispersion perspective, with particular reference to critical meteorological parameters.

Modelled concentrations

Figure 1 shows the 2004 time series of maximum predicted NO_2 concentrations from VPPS in isolation, showing the 2 highest hourly average concentrations on the 26th of November. With the exception of the 2 hours of the 26th November, all hourly average concentrations were less than 100 μg/m^3, with the vast majority being less than 80 μg/m^3. The two highest predicted concentrations were 158 and 126 μg/m^3, respectively.

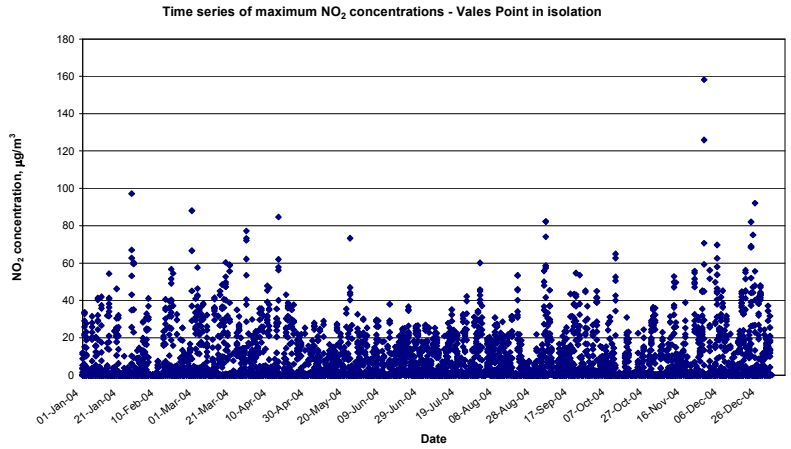

Figure 1: Time series of maximum predicted NO_2 concentrations - Vales Point in isolation and without the addition of "background" concentrations.

Critical meteorological (boundary layer) parameters

The 2007 CSIRO report (Lilley et al 2007) found that TAPM was generally well suited to model dispersion from tall stacks in the Central Coast region which experiences complex meteorology due to the coastal / lake location and varied terrain. This is consistent with the findings from a number of other studies reported on by Lilley at al. Notwithstanding these generally good results, it has also been reported that TAPM (and other models approved for regulatory use) has the potential to over-estimate concentrations at the very top end of the frequency distribution. For example, Hibberd et al (2003) found that TAPM modelled concentrations at each of four monitoring locations well when comparing the third highest modelled concentration with the maximum observed concentration in each of three years modelled. That is, when the top 2 predictions were discarded.

Lilley et al found that TAPM consistently over-estimated the very highest concentrations at particular monitoring sites in both the Central Coast and Western Coalfields regions of NSW and concluded that in regions of complex meteorology and / or terrain, the 99.9th percentile prediction (9th highest) may be a more appropriate indicator of maximum concentrations to be expected.

From an examination of a number of case study days, Lilley et al concluded that the potential to over-estimate at the top of the frequency distribution is likely to be due to *"..uncertainty in several critical meteorological parameters in the lower atmosphere which are either predicted or derived from measurements at ground level."*

From information presented in Lilley et al, the critical meteorological factors can be summarised as:

- Very light wind speeds through the boundary layer up to plume height (generally less than 1.5 m/s);
- Little directional wind shear through the boundary layer;
- Limitation on mixing height in the boundary layer (generally less than ~800m); and
- Convection in the boundary layer capable of bringing the plume to ground.

These factors operate in concert to determine the likelihood of emissions from a tall stack being mixed to the ground in high concentrations. As noted above, the values for these parameters are not input to the model from measurements but rather are estimated or derived from other values. It is therefore possible that the model's meteorological module's prediction(s) for one or more of these critical parameters can lead to plume behaviour which, while theoretically possible, results in predictions which are not observed in the "real world".

In the following section, actual conditions in the boundary layer on the day of predicted elevated concentrations are compared with TAPM predicted meteorology, in order to assess the likelihood of the predicted elevated concentrations occurring in reality.

Observed conditions

Synoptic (large-scale) conditions drive the meteorology of the boundary layer[2]. TAPM uses specific synoptic scale meteorological and other more general data on things like vegetation cover, to predict a number of the critical boundary parameters relevant to plume dispersion. This section looks at the synoptic conditions and the observed meteorological conditions prevailing on the 26th November, 2004.

Synoptic conditions

Figure 2 shows the synoptic weather charts for 0400 and 1000 hours on the 26th November, 2004. The charts show eastern Australia was dominated by surface high pressure system, likely to result in stable, weather conditions with light winds.

Data from the nearest BoM sites, Williamtown and Mascot[3], indicate that clear skies prevailed on the 26th.

BoM wind and temperature profiles for this day are examined in the next section.

[2] The boundary layer is that part of the atmosphere directly above the surface; its height varies both temporally and spatially, reaching a maximum height up to about 2,000m.

[3] Williamtown is approximately 60 km to the north of Munmorah and Mascot is about 90 km to the south of Vales Point.

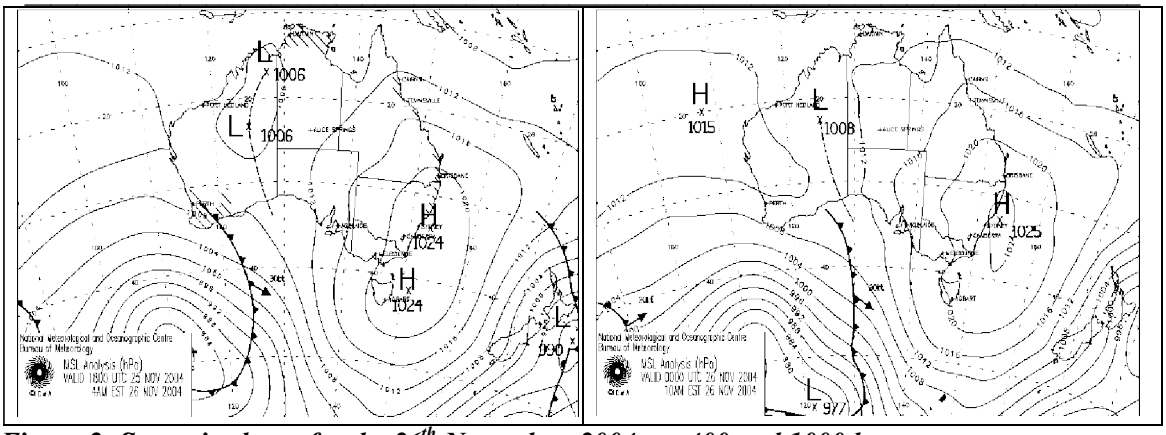

Figure 2: Synoptic charts for the 26th November, 2004 at o400 and 1000 hours.

Boundary layer parameters

Boundary layer data for the 26th November are available from the BoM Williamtown and Sydney airport sites (wind and temperature profile data through the lower atmosphere) and from Delta Electricity surface sites in the Central Coast region.

Wind (0600, 1000 and 1600 hours, local time) and temperature (0600 and 1600 hours, local time) profiles from Mascot and are shown in **Figure 3**.

Wind (0700, 1000 and 1500 hours, local time) and temperature (1000 hours, local time) from Williamtown are shown in **Figure 4**.

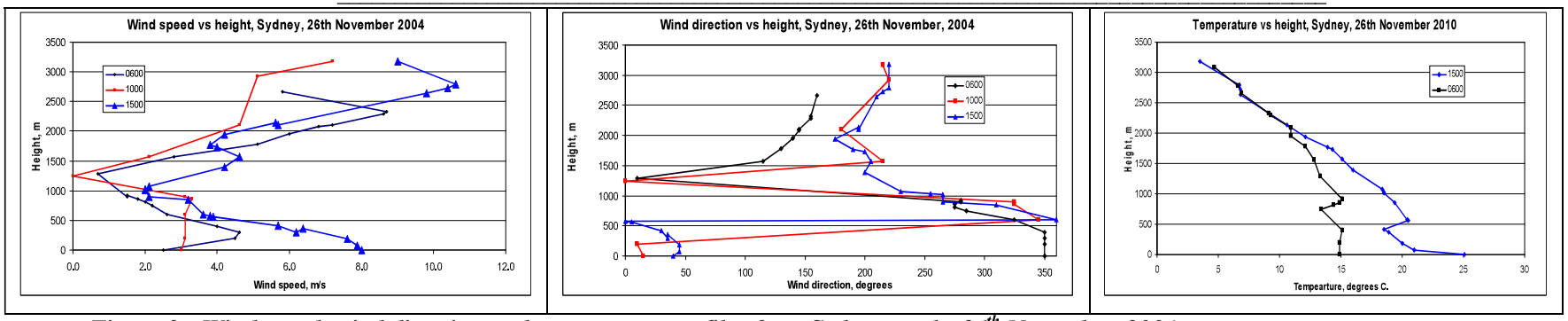

Figure 3: Wind speed, wind direction and temperature profiles from Sydney on the 26th November, 2004

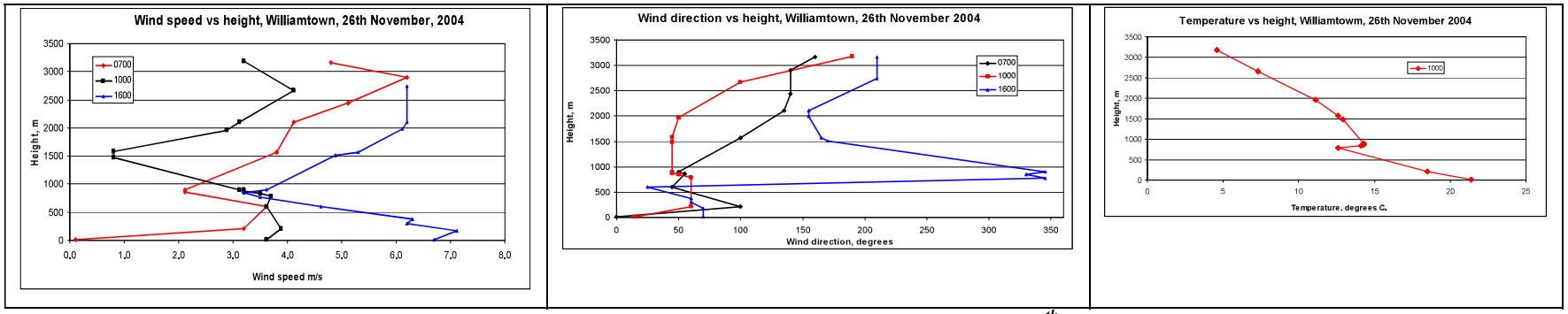

Figure 4: Wind speed, wind direction and temperature profiles from Williamtown on the 26th November, 2004

The morning temperature profiles do not suggest that there was a strongly developed radiation inversion, although there is elevated stability around 700 metres. Wind speeds through the boundary layer during the morning were in the order of 3 - 4 m/s from NW to NE. The afternoon profiles show the evidence of a sea breeze with stronger winds nearer the surface.

Data from the surface anemometers in the region indicated light and variable direction winds in the morning followed by the arrival of what appears to be a sea breeze mid to late morning. Wind speeds increased to 3-4 /m/s from the east, north-east with the arrival of the sea breeze around 1000 hours with temperatures up to about 23 degrees C.

Net radiation recorded at the Munmorah Power Station increased to 641 W/m^2 at 1000 hours, indicative of clear skies and strong surface heating.

The Wyee monitoring site recorded a sulfur dioxide concentration of 6.7 parts per hundred million (pphm) and NO_x of 8.7 pphm at between 0900 and 1000 hours which is the fifth and third highest hourly average concentration for the year, respectively.

TAPM boundary layer predictions

Data were extracted from the TAPM output[4] files to illustrate the model's predictions for boundary layer parameters on the 26th November. Boundary layer profiles for 1000 hours and 1100 hours (the hour of highest glcs) are shown in **Figures 5** and **6** respectively.

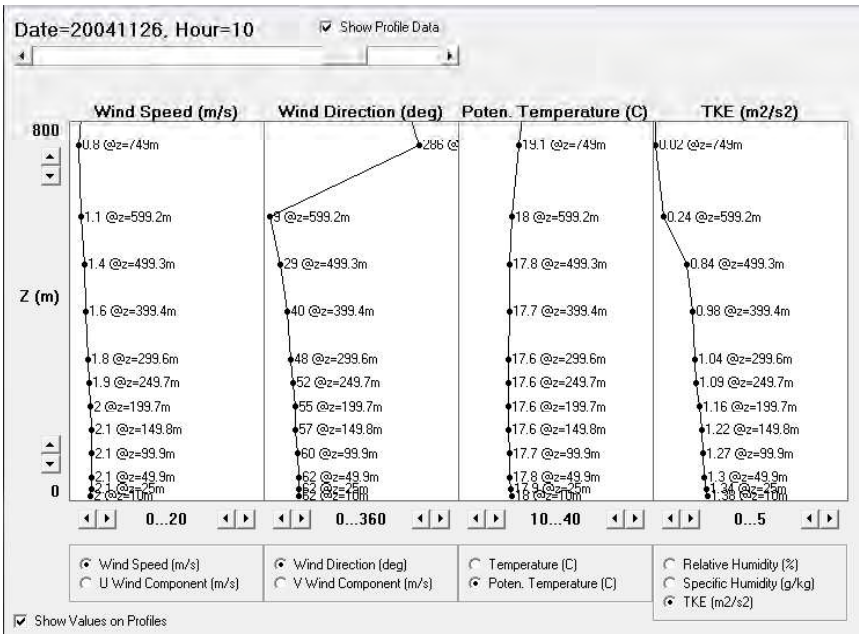

Figure 5: TAPM predictions of wind speed, wind direction, potential temperature and turbulence (TKE) at 1000 hours on the 26th November, 2004.

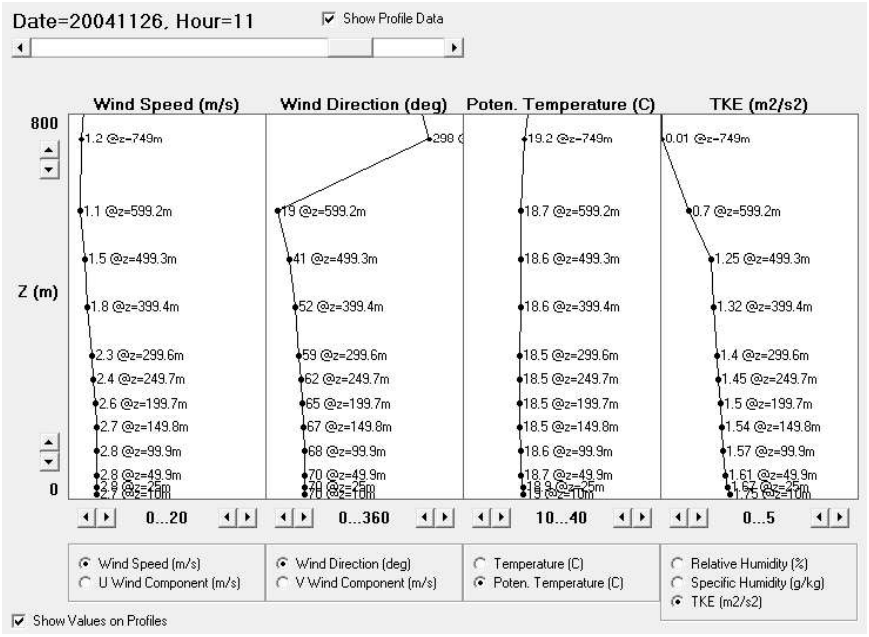

Figure 6: TAPM predictions of wind speed, wind direction, temperature and relative humidity at 1100 hours on the 26th November, 2004.

[4] Katestone Environmental extracted and provided data and figures from the TAP model run.

The figures at 1000 hours show that the lower atmosphere is slightly stable (as indicated by the potential temperature profile) with light (1 - 3 m/s) wind speeds in the lower atmosphere from NNE to ENE below about 600 m and NW above 600m.

At 1100 hours conditions are very similar with speeds slightly stronger in the lower atmosphere. Between about 1000 and 1100 hours, TAPM predicted mixing heights of about 600 m in the region and the effect of this is reflected in **Figure 7** which, at the time of maximum predicted concentrations, shows TAPM predicted that the VPPS plume was mostly contained below 600 m.

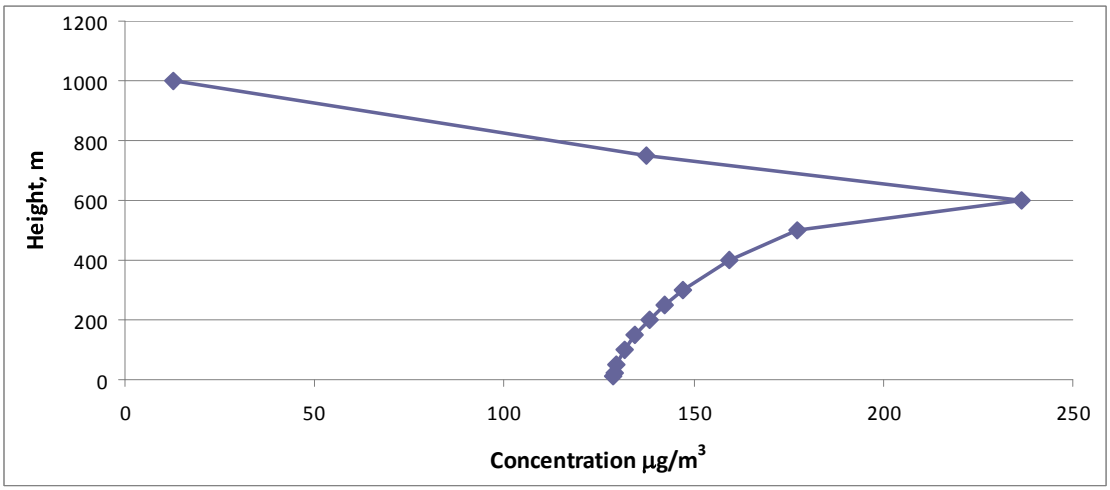

Figure 7: Modelled concentration profile on the 26th November, 2004

Summary of TAPM predictions

At the time of maximum glcs, it is considered that TAPM may have under-estimated the (very light) wind speeds in the boundary layer. BoM profiles for the relevant hours from Sydney and Williamtown suggest higher wind speeds, particularly at plume heights, than were predicted by TAPM. Also, 10m wind speeds recorded at Wyee and Munmorah at these times (3 – 4 m/s) were greater than predicted by TAPM (from Figures 6 and 7). The potential significance of these small differences in (light) wind speeds is discussed below.

Also of note, is that TAPM predicted very little direction shear (change in direction with height) through the lower boundary layer containing the plume. Again, BoM profile data, obtained some distance from – but to the north and south of - VPPS, show greater directional shear with height through the boundary layer.

From the earlier discussion it is apparent that conditions in the boundary layer on the 26th November, 2004 satisfy the "critical" boundary layer conditions considered to be associated with the occurrence of elevated glcs from tall stack emissions, namely:

- Very light wind speeds through the boundary layer up to plume height (generally less than 1.5 m/s);
- Little directional wind shear through the boundary layer;
- Limitation on mixing height in the boundary layer (generally less than ~800m); and
- Convection in the boundary layer capable of bring the plume to ground.

However, it should be noted that the parameters are called "critical", in part, because small changes in one or more of these parameters can bring about a significant change in the predicted glcs.

In the assessment of the boundary layer conditions on the 26th November, TAPM's predictions of a number of these critical parameters probably resulted in plume dispersion being under-estimated and hence maximum concentrations being over-estimated.

First, and most importantly, it was shown that TAPM may have under-predicted wind speeds in the boundary layer at the times of maximum predicted concentrations. At the very light wind speeds being considered on this day, an under-prediction of as little as 0.5 m/s, for example, could result in glcs being over-predicted by 50%.

Secondly, it was shown that TAPM predicted very little wind shear through the boundary layer at the times of maximum predicted concentrations. In comparison, BoM data for Mascot and Williamtown showed greater directional shear through the lower boundary layer. The effect of directional shear with height is to mix, or spread, the plume horizontally in the atmosphere prior to it mixing to the ground and hence resulting in lower glcs compared with the situation where there is little shear, other things remaining equal.

The overall conclusion from this assessment is that while TAPM performed well in predicting the gross boundary layer conditions on the day in question, and that while the predicted conditions are physically plausible, the TAPM predictions for the critical boundary layer factors probably resulted in maximum concentrations being over-estimated.

It is further considered that relatively small, realistic changes to the predicted critical factors, based on the observational data on the days in question, could result in maximum concentrations significantly less than those predicted by TAPM.

The results from this assessment are consistent with a similar assessment undertaken for the recent Munmorah rehabilitation project (Malfroy 2010b). The conclusions arising from that assessment were supported by Dr W Physick, meteorologist and former CSIRO scientist (Physick, 2010).

4. NOx Ratio

In order to address DECCW's concern that the use of a single, fixed NO2 to NOx ratio (of 0.2) may not be appropriate under all conditions an analysis of NOx data from the 3 Delta Electricity Central Coast monitoring sites for the past 2 years has been undertaken.

In **Figures 8a** and **8b** the NO_2 to NOx ratio across the range of monitored NOx concentrations are presented for 2008 (upper) and 2009 (lower). The figures include data from the 3 monitoring sites (Wyee, Lake Munmorah School and Morisset Peninsula).

The figures show a consistent trend of decreasing NO_2 to NOx ratio as NOx concentrations increase. At NOx concentrations below about 50 $\mu g/m^3$ (expressed as NO_2 equivalent), the NO_2 to NOx ratio is generally about 1.0. At the highest NOx concentrations (above 400 $\mu g/m^3$), the NO_2 to NOx ratio is less than 0.1. The figures also show much greater scatter in the NO_2 to NOx ratio at lower NOx concentrations.

The red lines in **Figures 8a** and **8b** describe a variable NO_2 to NOx ratio, defined by the exponential function shown on the figures. The variable NOx ratio curve is generally conservative in that the vast majority of data points lie below the line, that is, the line defines close to the maximum NO_2 to NOx ratio that might be expected at any given NOx concentration.

The exponential relationship was used to determine NO_2 concentrations according to the variable ratio, as shown on the figures' second "y" axis. Also shown on the second "y" axis are predicted NO_2 concentrations by using the single fixed ratio of 0.2. Several points arise from the predicted NO_2 concentrations:

- The highest predicted NO2 concentrations (of about 60 $\mu g/m^3$) from the variable ratio model occur at (relatively low) NOx concentrations of between 100 – 200 $\mu g/m^3$ and a ratio of close to 0.5.
- The lowest predicted NO_2 concentrations (of about 10 $\mu g/m^3$) from the variable ratio model occur at (high) NOx concentrations of above 400 $\mu g/m^3$ and a ratio of less than 0.1.
- The single, fixed ratio (of 0.2) is likely to under-estimate NO_2 concentrations at low NOx concentrations and over-estimate NO_2 concentrations at high NOx concentrations.
- The highest predicted NO_2 concentration (of about 100 $\mu g/m^3$) from the single, fixed ratio is significantly higher than the highest prediction from the use of the variable ratio, and it occurs in association with a different NOx concentration and different ratio.

Three conclusions arise from this analysis of NOx ratios in the Central Coast region:

- The use of a single, fixed NO_2 to NOx ratio of 0.2 is likely to provide a conservative estimate of the highest NO_2 concentration over the range of predicted NOx concentrations;
- The maximum predicted NO_2 concentration presented in the Vales Point Assessment report is likely to be conservative;
- The use of a variable NO_2 to NOx ratio is likely to provide better estimates of NO_2 concentrations over the range of predicted NOx concentrations compared with the use of a single, fixed NO_2 to NOx ratio.

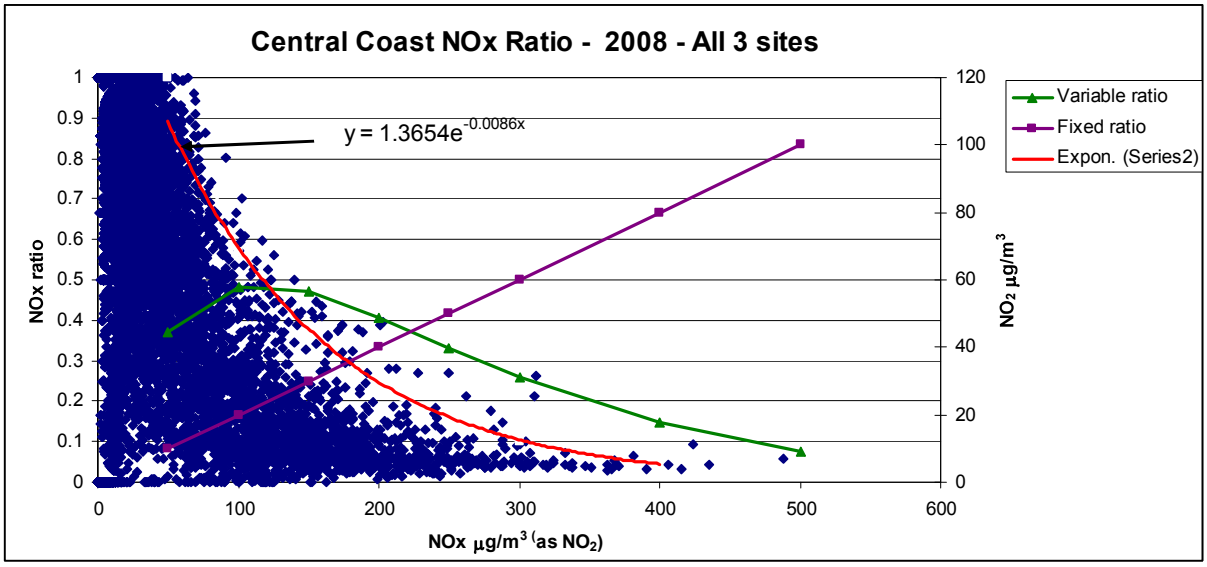

Figure 8a: NO_2 to NO_x ratios and predicted NO_2 concentrations in 2008 using data from Wyee, Lake Munmorah and Morrisset Peninsula monitoring sites.

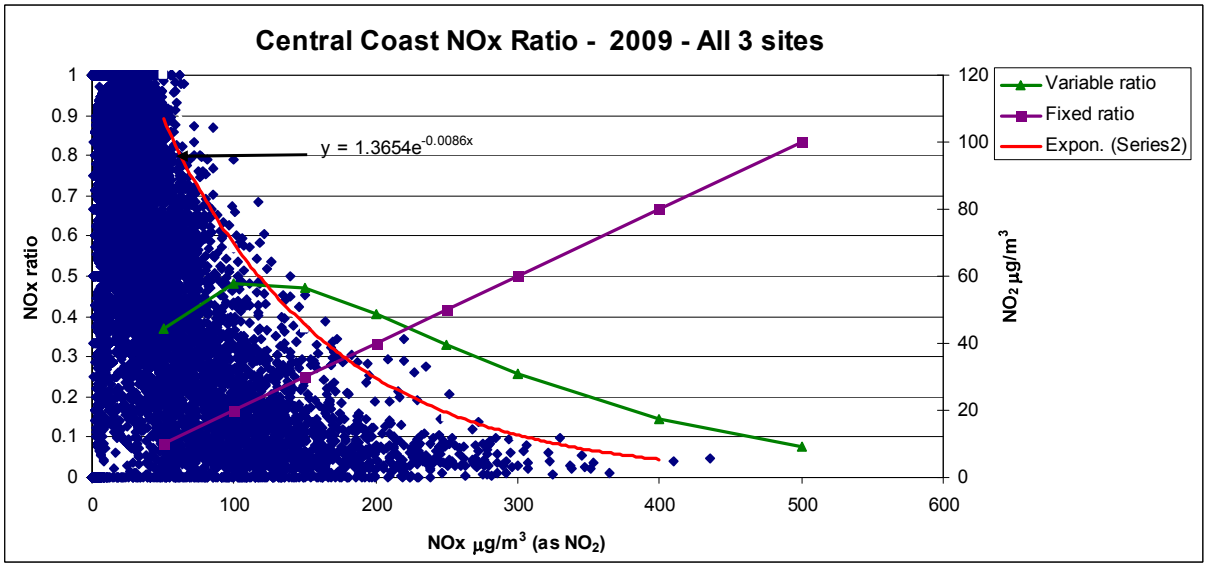

Figure 8b: NO_2 to NO_x ratios and predicted NO_2 concentrations in 2009 using data from Wyee, Lake Munmorah and Morrisset Peninsula monitoring sites.

5. Local meteorological data

Delta Electricity collects meteorological data at 4 locations within about 7 km of VPPS and these data might have been assimilated into the TAPM modelling to "nudge" the predictions. In the model validation study of 2007 (Lilley et al 2007) local meteorological data assimilation was not performed and TAPM was assessed as being the best performing "approved" model. It is considered that while data assimilation might have been incorporated into the modelling, its omission would not have had a significant impact on the results obtained.

6. Proposed NOx limit

In applying for an EPL variation Delta Electricity is seeking approval for VPPS to emit NO_x at a concentration above the Group 5 limit of 800 mg/m^3 and below the (to-be-phased out) Group 2 limit of 2,500 mg/m^3.

This section of the report uses the above discussion on TAPM predictions and the NOx ratio to support a new NOx limit for VPPS of 1,500 mg/m^3.

The following points are considered in developing the proposed emission concentration:

- The air quality modelling undertaken for the Vales Point assessment used a NOx emission concentration of 1,000 mg/m^3. While this concentration was based on recent monitoring data it is recognised that some allowance should be made for the possibility of higher concentrations occurring;
- From the assessment of TAPM predictions and NOx ratios it is considered that a maximum predicted NO_2 concentration 100 μg/m^3 can be assumed for VPPS without background concentrations. This is based on "discounting" the 2 highest predictions (shown in **Figure 1**) on the 26th November, for reasons argued above. However, irrespective of the TAPM predictions, it is suggested that 100 μg/m^3 is a conservative maximum concentration given the variable NOx ratio analysis in this report indicates that a maximum NO_2 concentration of about 60 μg/m^3 is more realistic than 100 μg/m^3.
- If the modelled emission concentration of 1,000 mg/m^3 is scaled up to 1,500 mg/m^3, the emission concentration would increase proportionally, *ceteris paribus,* resulting in a maximum NO_2 concentration of 150 μg/m^3 for VPPS. Addition of a background concentration of 40 μg/m^3 results in a concentration of 190 μg/m^3, below the assessment criterion of 246 μg/m^3. The addition of the contribution from the other power stations in the region would not materially change the predicted maximum, as the original assessment report found that these other sources added only a very small amount to the Vales Point maximum concentration.

It is concluded that a NOx emission limit of 1,500 mg/m^3 applied to VPPS would not result in exceedences of the assessment criterion for nitrogen dioxide.

7. References

- Department of Environment and Conservation NSW (2005). *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* http://www.environment.nsw.gov.au/air/appmethods.htm Accessed 14 July 2009

- Hibberd M., Physick W., and Park G., (2003) *Verification of several aspects of TAPM against multi-year monitoring data at Collie. In Proc. 17th Clean Air Conference, CASANZ*

- Lilley W., Rae M., Malfroy H, Physick B., Boras M., Edwards M. (2007a). *Ambient Air Modelling Study for power stations in the Central Coast and Western Coalfields regions of NSW*. Prepared for Delta Electricity.

- Lilley W., Malfroy H., Physick W. (2007b). *Variations In The Highest Predictions From Approved Air Quality Models And Implications For Air Quality Assessments*. Proceedings of the IUAPPA World Congress September 2007, Brisbane.

- Malfroy Environmental Strategies (2010) *Vales Point Power Station Application for the Revision of the Environment Protection* Licence. Report prepared for Delta Electricity.

- Malfroy Environmental Strategies (2010). *Munmorah Power Station Rehabilitation Project Assessment of elevated sulfur dioxide prediction.* Report prepared for Delta Electricity.

- Physick W.,(2010). *Expert Review of "Munmorah Power Station Rehabilitation Project Review of Elevated Sulfur Dioxide Emissions" Report*. Final Report for Aurecon Australia Pty. Ltd

Appendix B

Dispersion Modelling Study of Emissions of Oxides of Nitrogen from the Vales Point Power Station

Katestone Environmental (June 2010)

Dispersion Modelling Study of Emissions of Oxides of Nitrogen from the Vales Point Power Station

Prepared for

Malfroy Environmental Strategies

KE1003761

June 2010

Final

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Document Quality Details

Job Number: KE1003761

Title: Dispersion Modelling Study of Emissions of Oxides of Nitrogen from the Vales Point Power Station

Client: Malfroy Environmental Strategies

Document reference: Malfroy Environmental Central Coast Report v 1.0

Prepared by: Andrew Wiebe & Ella Castillo

Reviewed by: Simon Welchman

Revision	Date	Approved	Signature
Final 1.0	10/6/10	Simon Welchman	

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1. Introduction

Katestone Environmental was commissioned by Malfroy Environmental Strategies (M_E_S) to conduct air dispersion modelling of the Vales Point power station.

The study was commissioned to establish the maximum potential effect of emissions of oxides of nitrogen (NO_x) from the Vales Point power station on ground-level concentrations of nitrogen dioxide (NO_2). The modelling has been conducted to support an application for Values Point power station to not move to the Group 5 limits that are specified in the *Protection of the Environment Operations (Clean Air) Regulation 2002*.

This study has been prepared in accordance with the Department of Environment Climate Change and Water's (DECCW) Approved Methods for the Modelling of Air Pollutants in NSW (DECCW 2005). The Air Pollution Model (TAPM) has been used to model meteorological conditions and dispersion of emissions from the Vales Point power station. Other major sources of NO_x have also been modelled consisting of three coal fired power stations and one gas fired power station. NO_x emissions from motor vehicles have been accounted for as a fixed value added to the modelled ground-level concentrations.

This report summarises the outcomes of the assessment and provides details of the modelling methodology, model configuration and meteorological conditions likely to influence the dispersion of emissions from the Vales Point power station.

2. Methodology

2.1 Air Dispersion Model

The Air Pollution Model (TAPM) is an atmospheric model developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). TAPM integrates a prognostic meteorological model and an air dispersion model. TAPM is an incompressible, primitive equation model with a terrain-following vertical coordinate for three-dimensional simulation, which can be run in either hydrostatic or non-hydrostatic mode. TAPM resolves regional scale meteorology and incorporates local terrain and land use information to predict meteorological conditions representative of the locations of interest.

The dispersion modelling component of TAPM uses the meteorology and turbulence from the meteorological component. The Eulerian Grid Module (EGM) solves prognostic equation for the mean and variance of concentration; while near-source dispersion is optimised by using the Lagrangian Particle Module (LPM). More detailed discussion of the model can be found on the TAPM Technical Report (CSIRO, 2008).

2.2 Model Configuration

TAPMv4 was used to predict local meteorological conditions and pollution dispersion for the Central Coast Area for the year 2004 this year was determined to be a representative year in a recent assessment of the Munmorah power station (Aurecon Australia Pty Ltd, 2009). The meteorological component of the model was configured to run in a nested domain, with resolutions of 30 km, 10 km, 3 km, and 1 km, with 25 grid points along the x- and y- axes, and centred at Vales Point.

There was no local meteorological data available for assimilation into TAPM or for evaluation of the models performance. TAPM has been validated in numerous studies and is accepted as generating realistic meteorological conditions for air dispersion studies, such as sea

breezes and the influence of complex terrain important to the Central Coast region (Katestone Environmental 2009 and CSIRO 2008).

Emissions of NO_X were modelled in TAPM within a fine mesh grid of 500m using LPM for near field dispersion before converting to EGM for far field calculations. The conversion timestep from LPM to EGM was set to 900 s (TAPM default). A 20% NO_x/NO_2 conversion factor was used, based on the recent assessment of Colongra Gas Turbine Station (Holmes Air Sciences, 2005); and applied to the calculated ground-level concentrations in post processing.

An ambient background concentration of 40 µg/m^3 of NO_2 was added to the maximum one-hour concentration to represent the contribution of motor vehicles and urban influences. This value was extrapolated from monitoring data and filtered to remove the influence of the surrounding power stations (M_E_S 2010). For the predicted annual NO_2 concentrations, a background concentration of 14 µg/m^3 was assumed, based on the highest monitored annual average NO_2 concentration for the year 2004.

The following two scenarios were modelled:

- Vales Point power station modelled in isolation
- Other major industrial sources of NO_x in the region being the Colongra Gas Turbine Station and two coal-fired power stations (two stacks at Eraring Power Station and one stack in Munmorah Power Station)

2.3 Model Analysis

Meteorological variables important to the dispersion of air pollutants are presented in Section 3. The meteorology is discussed in light of its potential influence to the dispersion of air pollutants.

The modelling results indicate that maximum ground-level concentrations of NO_2 from Vales Point and surrounding sources are not coherent in space and time. Meaning that the ground level maxima from surrounding power stations have very little interaction with plumes from the Vales Point power station; hence, ground level concentrations are not significantly enhanced by this interaction. Additionally, the maximum ground-level concentration associated with Vales Point is masked by the contribution of the surrounding sources.

Hence the modelling results have been analysed to produce the following statistics to highlight the contribution of Vales Point power station:

- Number of times the impact assessment criterion of 1-hour average NO_2 concentrations are predicted to exceed 246 µg/m^3 for :
    - Surrounding sources plus ambient “background”(40 µg/m^3)
    - Vales Point power station in isolation plus ambient (40 µg/m^3)
    - Surrounding sources plus Vales Point power station plus ambient (40 µg/m^3)
- Maximum 1 hour average ground-level concentration of NO_2 due to Vales Point power station plus the contemporaneous contribution from surrounding sources for the corresponding hour in the model at each sensitive receptor area. Plus background ambient?

3. Meteorology

3.1 Temperature

The ambient temperature at the site of the Vales Point power station was extracted from the model at a height of 2 m above ground level. The average, minimum and maximum temperatures for day (7 am to 6 pm) and night (7 pm to 6 am) are shown in Figure 1. There is only 3 degrees difference between the average day time and average night time temperature, with the minimum and maximum temperatures varying by only several degrees about the mean. This is due to the site's close proximity to a large water body which can moderate temperature fluctuations due to its large heat capacity.

3.2 Wind Speed and Wind Direction

Wind speed and wind direction were extracted from the model at the site of the Vales Point power station. Figure 2 to Figure 4 show the annual, seasonal and diurnal wind roses. Winds are predominantly gentle to moderate (3 to 8 m/s) from the ENE and WSW quadrant accounting for 48% of the annual wind frequency. The remainder of the winds are distributed about all quadrants with predominantly light to gentle breezes (0.5 to 3 m/s) (Figure 2).

The summer months are dominated by ENE winds, most likely due to sea breezes, while the winter months are predominantly characterised by WSW winds associated with the passage of cold fronts. Autumn and spring show a prevalence of both ENE and WSW winds although to a lesser extent than summer and winter months (Figure 3).

Late night and early morning winds are dominated by WSW winds probably due to drainage flows and land sea breeze circulations. Afternoon and early evening winds show a reversal of this trend with a predominance of ENE winds associated with the onset of the sea breeze circulation (Figure 4).

3.3 Stability and Mixing Height

Atmospheric stability class and mixing heights have been extracted from the model at the site of the Vales Point power station. Stability classification is a measure of the stability of the atmosphere. The stability classes range from A class, which represents very unstable atmospheric conditions that may typically occur on a sunny day to F class stability which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Classes A to C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for the most frequently occurring Class D conditions are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface. During the night, the atmospheric conditions are generally stable (often classes E and F).

Table 1 shows the percentage of stability classes calculated by the model. The high proportion of D class stability is due to the absence of strong temperature gradients due to the sites close proximity to large water bodies.

Table 1 Frequency of occurrence (%) of surface atmospheric stability conditions over Vales Point

Pasquill-Gifford Stability Class	Frequency (%)	Classification
A	1%	Extremely unstable
B	10%	Unstable
C	15%	Slightly unstable
D	41%	Neutral
E	16%	Slightly stable
F	17%	Stable

The mixing height refers to the height above ground within which the air pollutants can mix with ambient air. Mixing height is an important factor for stack emission sources, such as the sources modelled in this study. Figure 5 shows a diurnal profile of mixing heights at the site of the Vales Point power station. This plot shows a typical profile with the mixing height increasing from 9 am with highest mixing heights generally occurring from 2 to 4 pm.

For the purposes of this study the mixing height is only relevant during daytime convective conditions where there is a possibility of the plume coming down to ground and when the boundary layer grows or collapse to the level of the plume giving rise to potential fumigation events.

4. Emission Source Characteristics

The source characteristics of the Vales point power station and surrounding sources have been provided by M_E_S. These have been used in the dispersion modelling and are summarised in Table 2. All sources were modelled as point sources at a constant rate for the entire period, in LPM mode.

Table 2 Source Characteristics used in the dispersion modelling

Source	Easting (m)	Northing (m)	Stack Height (m)	Radius (m)	Exit Velocity (m/s)	Exit Temperature (°K)	NO_X as NO_2 Emission Rate (g/s)
Eraring Stack 1	361950	6340900	200	5.24	26.2[1]	403	1685[2]
Eraring Stack 2	361900	6340700	200	5.24	26.2[1]	403	1685[2]
Munmorah	364200	6324300	155	3.95	19.4	426	305[4]
Colongra GT	364500	6324500	35	6	44	791	154.7[5]
Vales Point	364375	6329950	178	5.15	26[6]	403	1130[3]

Note [1] Historical value of 23 x 1.14 to account for plant upgrade in progress

[2] Assuming a NO_X (as NO_2) concentration of 1100 mg/Nm^3 following upgrade (revised licence condition)

[3] Assuming a NO_X (as NO_2) concentration of 1000 mg/Nm^3 based on 2009 CEMS data

[4] Assuming a NO_X concentration of 500 mg/Nm^3 (Group 6 limit)

[5] Assuming 90 mg/Nm^3 on distillate firing (49 mg/m3 on gas firing)

[6] Consistent with recent CSIRO modelling

5. Receptors

Due to the large extent of the modelling domain it was not feasible to identify every individual sensitive receptor location. Table 3 identifies the type of sensitive receptors assessed in the study and Figure 6 shows the location of these receptor areas within the modelling domain. These sensitive receptor areas are considered to be representative of the sensitive receptors most likely to be affected by emissions from the Vales Point power station.

Table 3 Location of sensitive receptors

Name	Code	Description	Easting (m)	Northing (m)
Wyee	R1	Residential / Aged care and near Wyee monitoring station	358000	6328750
Wyee Point/Morisset Hospital	R2	Residential / Hospital	362000	6331750
Morisset Peninsula	R3	Residential / monitoring site	364950	6335875
Summerland Point	R4	Residential	365625	6331750
Mannering Park	R5	Residential	363750	6330500
Lake Munmorah	R6	Residential, school, monitoring station	367250	6326750
Blue Haven/San Remo	R7	Residential	362000	6324625

6. Results

Contour plots showing the maximum 1-hour average ground-level concentration of NO_2 for Vales Point in isolation, surrounding sources and Vales Point plus surrounding sources are shown in Figure 7 to Figure 9.

Figure 7 shows that Vales Point power station in isolation plus an ambient background concentration of 40 µg/m^3 shows maximum concentrations of approximately 150 µg/m^3 within the modelling domain, well below the assessment criterion of 246 µg/m^3 for 1-hour average concentration.

Figure 8 shows the impact of the surrounding sources with an ambient background of 40 µg/m^3. This contour shows that an area of exceedence occurs to the west of Eraring power station.

Figure 9 shows that the area of exceedence does not change in shape with addition of Vales Point power station. This is also shown in Table 4 where the number of exceedences of the 1-hour average impact assessment criterion does not increase when Vales Point power station is accounted for in the modelling.

Table 4 Number of exceedances of the impact assessment criterion for 1 hour average concentration of NO_2 of 246 µg/m^3 due to Vales Point, surrounding sources and all sources.

Number of Exceedences		
Vales Point in isolation	Surrounding sources	Surrounding sources plus Vales Point
0	20	20

Closer inspection of Figure 7 and Figure 8 reveals that the predicted ground-level concentrations from Vales Point and the surrounding sources are not co-located in space. Further comparison of the areas of high concentrations with the maximum one-hour concentrations shown in Figure 9 suggest that the near-identical contours in the southwest region of the modelling domain in Figure 7 and Figure 9 indicate that Vales Point is the dominant source in for this region. A comparison of Figure 8 and Figure 9 shows that similarities in contours in the other regions of the modelling domain are due mostly to the surrounding sources.

This is illustrated in Figure 10 where the maximum 1-hour ground-level concentration of NO_2 from Vales Point power station does not significantly change when the contemporaneous contribution of the surrounding sources and an ambient background concentration are added.
Table 5 illustrates the spatial and temporal disparity between maximum 1-hour NO_2 concentrations identified in the contour maps for specific sensitive receptor areas. Clearly the predicted maximum 1-hour average ground-level concentrations of NO_2 for Vales Point power station do not coincide with the predicted maxima for the surrounding sources. The cumulative impacts do not cause an exceedence of the assessment criteria for 1-hour average NO_2.

The annual average NO_2 concentrations from all sources, surrounding sources, and Vales Point power station in isolation are shown in Figure 11 to Figure 13. The impact assessment criterion is not exceeded for any scenario, even with the addition of the ambient concentration of 14 µg/m^3.

Domain-wide maximum 1-hour average NO_2 concentrations for the different scenarios are shown in Table 6. The maximum NO_2 concentrations over the modelling domain are identical for the all sources scenario and the scenario showing only the surrounding sources. This indicates that the impacts can be attributed to the surrounding sources; and that the impact of Vales Point at the time occurrence of the domain-wide maximum is not significant.

Table 5 Maximum 1-hour average concentration of NO_2 at the sensitive receptor areas for Vales Point in isolation, the contemporaneous maximum 1-hour concentration of NO_2 from the surrounding sources and the combined maximum 1 hour average concentration of NO_2 (ambient concentration of 40 µg/m^3 has been added to the combined total)

Receptor	Code	Vales Point	Surrounding sources	All Sources	All Sources plus 40 µg/m^3
Wyee	R1	91	2	93	133
Wyee Point/Morriset Hospital	R2	26	0.1	26	66
Morriset Peninsula	R3	28	3	31	71
Summerland Point	R4	29	1	30	70
Mannering Park	R5	36	3	39	79
Lake Munmorah	R6	45	1	46	86
Blue Haven/San Remo	R7	75	1	76	116

Table 6 Predicted domain-wide maximum 1-hour average and annual average NO_2 concentrations for the four modelling scenarios. All in µg/m³ and including the ambient background (Maximum Hourly: 40 µg/m3; Annual: 14 µg/m³)

Parameter	Vales Point in isolation (µg/m^3)	Surrounding sources (µg/m^3)	Surrounding sources plus Vales Point (µg/m^3)	Vales Point plus contemporaneous (µg/m^3)
Maximum 1-hour average	198	318	318	199
Number of exceedences	0	20	20	-
Annual average	14.5	15.7	15.9	-

7. Conclusions

An air quality impact assessment has been conducted to estimate the ground-level concentrations of nitrogen dioxide (NO_2) that can be attributed to the Vales Point power station. The assessment has been conducted to support an application for Values Point power station to not move to the Group 5 limits that are specified in the *Protection of the Environment Operations (Clean Air) Regulation 2002*. The air quality impact assessment has been conducted using conservative assumptions.

The study showed the following:

- On a regional scale, the maximum ground-level concentrations of NO_2 due to Vales Point power station plus surrounding sources (Eraring, Munmorah and Colongra) and background are predicted to be well below air quality criterion.
- Ground-level concentrations of NO_2 attributed to Vales Point power station are spatially and temporally separated from those caused by the surrounding sources (Eraring, Munmorah and Colongra). The area where Vales Point power station is predicted to contribute most to the ground-level concentration of NO_2 is southwest of the Vales Point power station. However, even in this location the predicted ground-level concentrations of NO_2 due to Vales Point power station and surrounding sources are well below the assessment criterion.
- All predicted exceedences of the assessment criterion are attributable to the surrounding sources operating in the region.
- Vales Point power station does not add to the number of exceedences of the impact assessment criterion for 1-hour average NO_2.
- Other surrounding sources are predicted to contribute 3 µg/m^3 of NO_2 for a 1-hour average ground-level concentration at the time of peak contributions from Vales Point power station at the Morriset Peninsula (R3) and Mannering Park (R5) representative sensitive receptor areas.
- The maximum 1-hour average ground-level concentration of NO_2 predicted at a sensitive receptor attributed to Vales Point power station with contemporaneous contributions of other sources plus an ambient background concentration of 40 µg/m^3 is 133 µg/m^3, 54% of the impact assessment criterion.

8. References

Aurecon Australia Pty Ltd (2009) *Munmorah Rehabilitation. Updated Air Quality Assessment*, Attachments B and C. Reference 41442. Report prepared for Delta Electricity

CSIRO, 2008. 'TAPM V4. Part 2: Summary of some verification studies'. Peter Hurley, Mary Edwards and Ashok Luhar. CASIRO Marine and Atmospheric Research Paper No. 26.

Department of Environment and Climate Change, 2005. Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

Holmes air Sciences (2005) Air Quality Impact Assessment: Proposed Open Cycle Gas Turbine Plant At Munmorah Power Station. Prepared for Parsons Brinckerhoff Australia Pty Limited

Katestone Environmental, 2009. 'Air Quality Impact Assessment for the Proposed Bayswater B Power Station Project.' Report to Macquarie Generation.

Malfroy Environmental Strategies Pty Ltd, 2010. 'Munmorah Power Station Rehabilitation Project Assessment of elevated sulphur dioxide predictions' Report to Aurecon Australia Pty Ltd.

Malfroy Environmental Strategies (2010) Vales Point Power Station Application for the Revision of the Environment Protection Licence. Prepared for Delta Electricity.

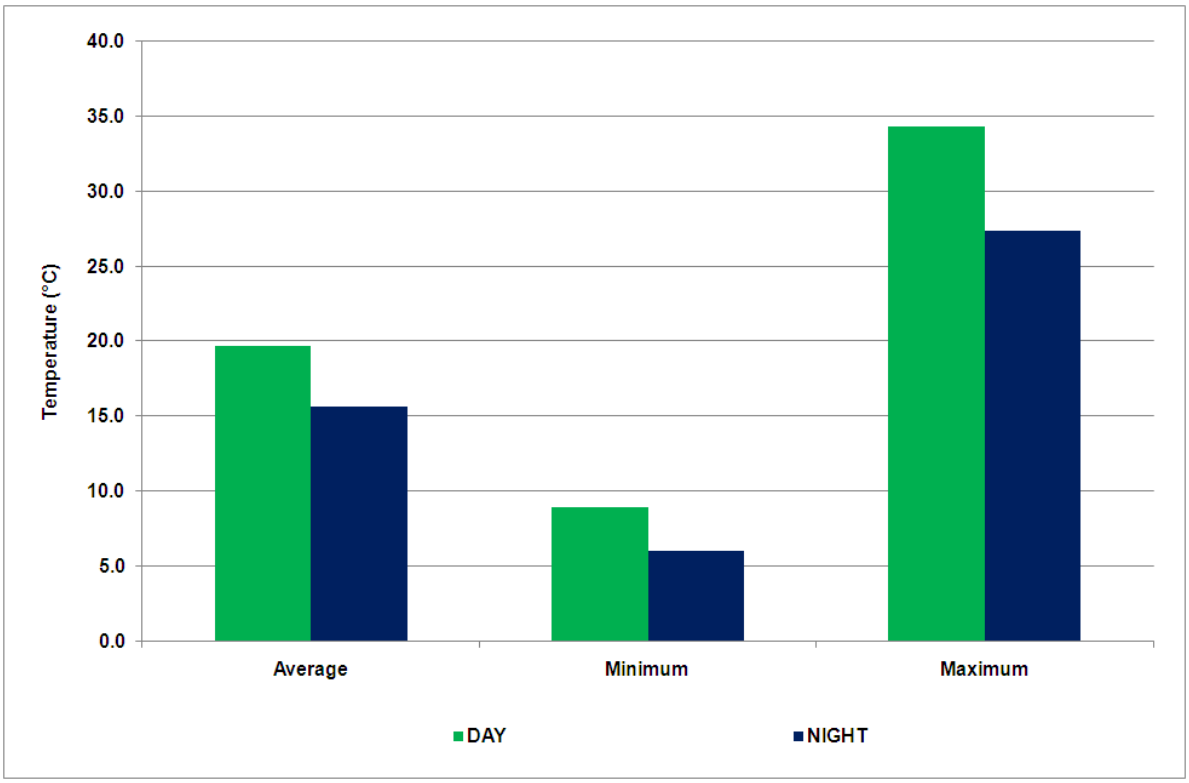

Figure 1 Average, minimum and maximum temperatures for daytime and nightime.

Location: Vales Point	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** Degrees Celcius (°C)
Type: Bar chart	**Objective:** n/a	**Prepared by:** Andrew Wiebe	**Date:** June 2010

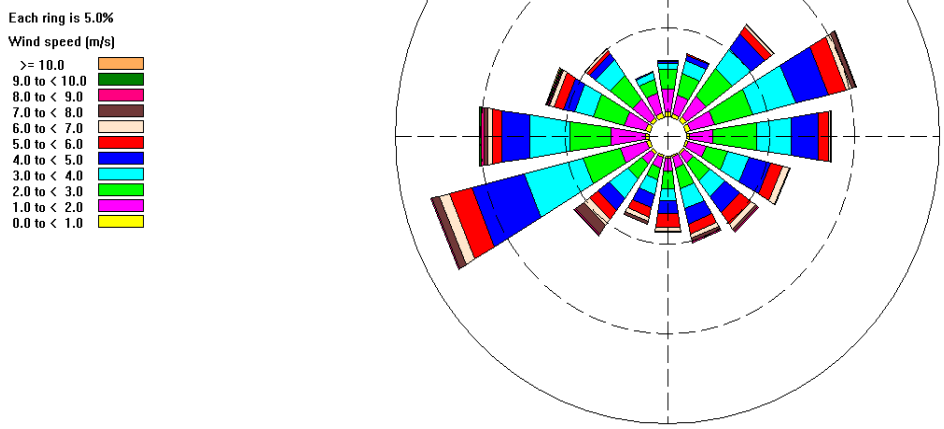

Figure 2 Annual wind rose

Location: Vales Point	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** Metres per second & Degrees
Type: Wind Rose	**Objective:** n/a	**Prepared by:** Andrew Wiebe	**Date:** June 2010

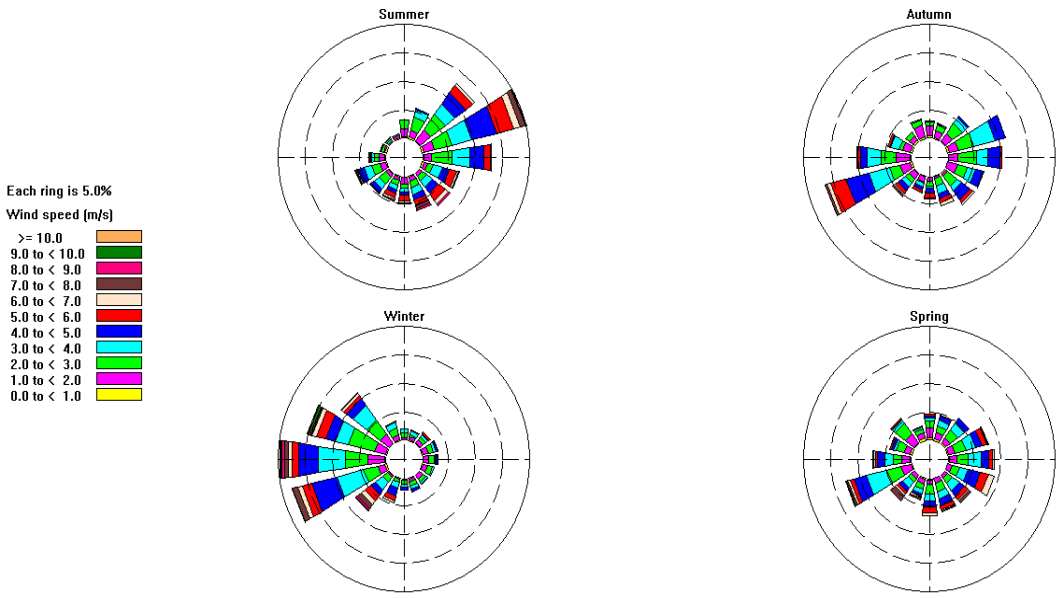

Figure 3 Seasonal wind rose

Location: Vales Point	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** Metres per second & Degrees
Type: Wind Rose	**Objective:** n/a	**Prepared by:** Andrew Wiebe	**Date:** June 2010

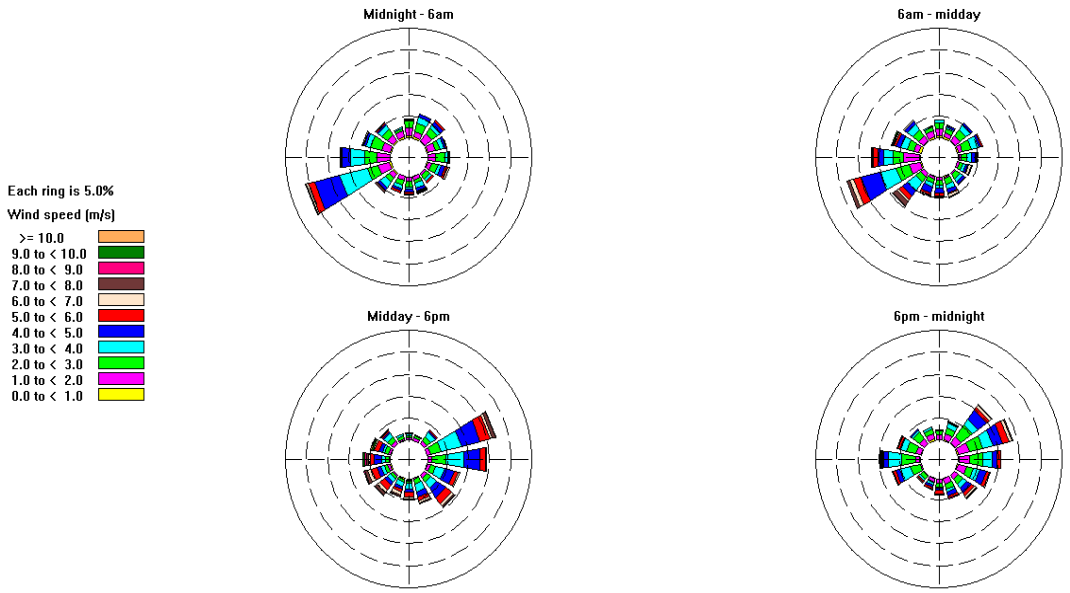

Figure 4 Diurnal wind rose

Location: Vales Point	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** Metres per second & Degrees
Type: Wind Rose	**Objective:** n/a	**Prepared by:** Andrew Wiebe	**Date:** June 2010

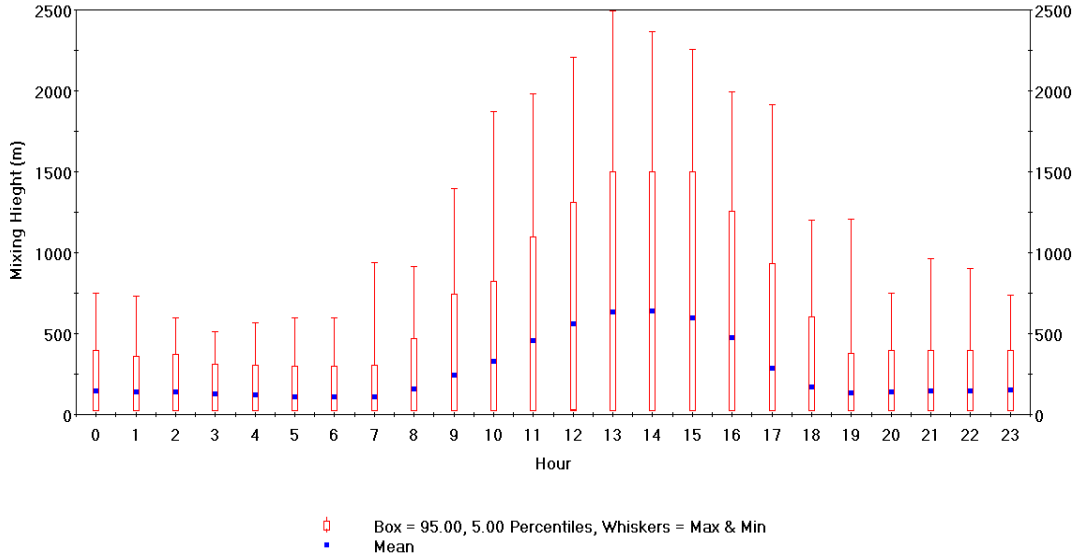

Figure 5 Mixing Height

Location: Vales Point	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** Metres
Type: Box and whisker	**Objective:** n/a	**Prepared by:** Andrew Wiebe	**Date:** June 2010

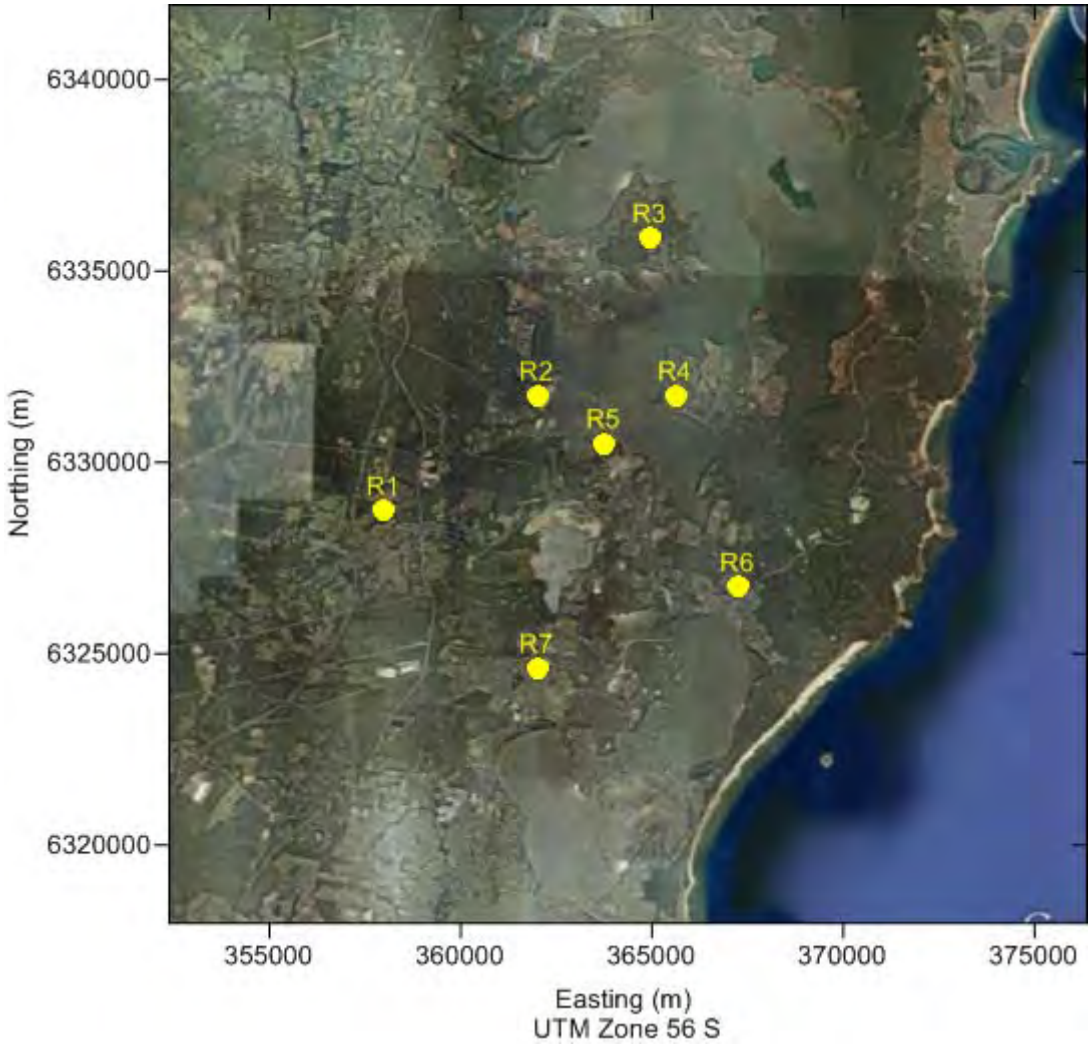

Figure 6 Sensitive receptor areas.

Location: Central Coast	**Averaging period:** 1-hour	**Data source:** TAPMv4	**Units:** µg/m³
Type: Maximum	**Objective:** 246 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

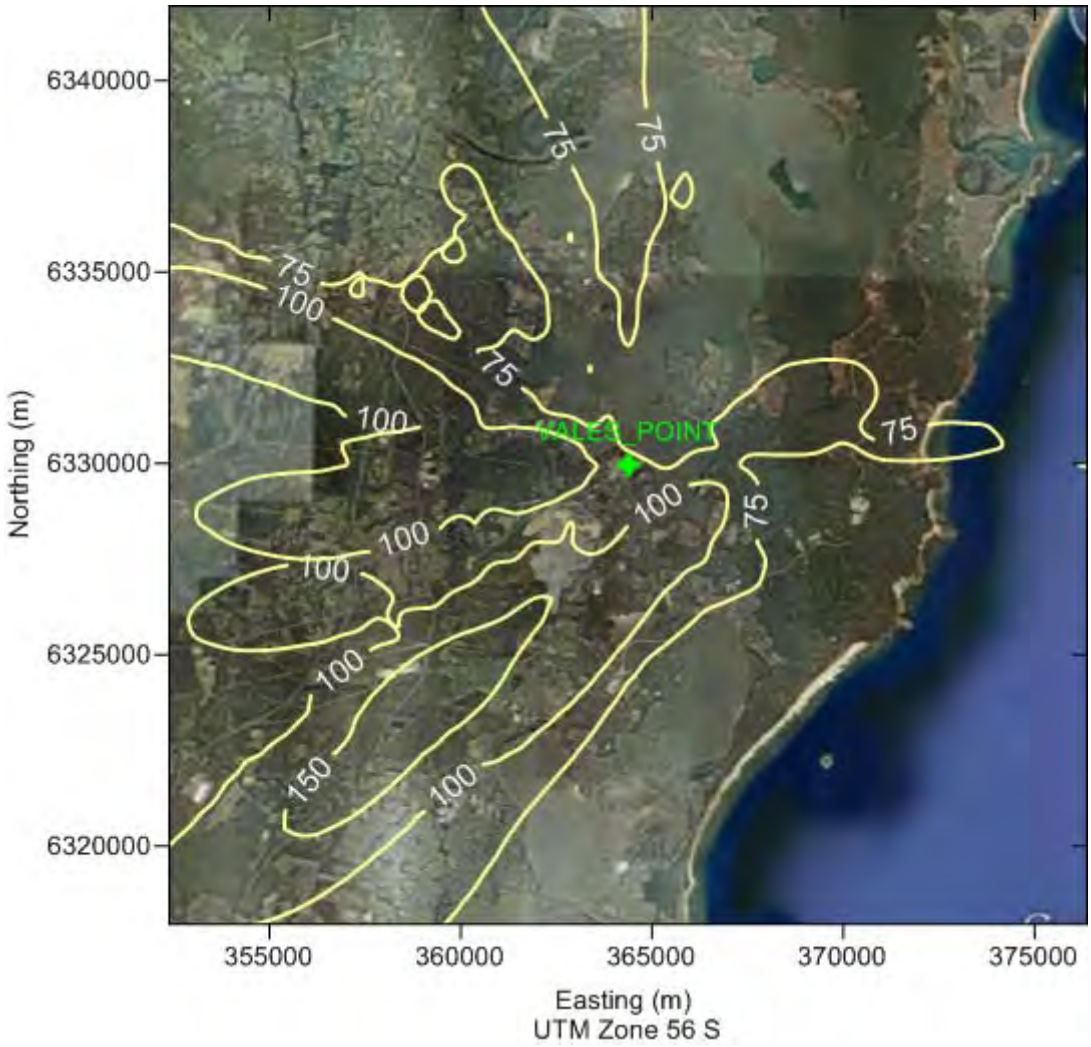

Figure 7 **Maximum 1-hour ground-level concentrations of Nitrogen Dioxide due to Vales Point in isolation. An ambient background concentration of 40 µg/m³ has been added.**

Location: Central Coast	**Averaging period:** 1-hour	**Data source:** TAPMv4	**Units:** µg/m³
Type: Maximum	**Objective:** 246 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

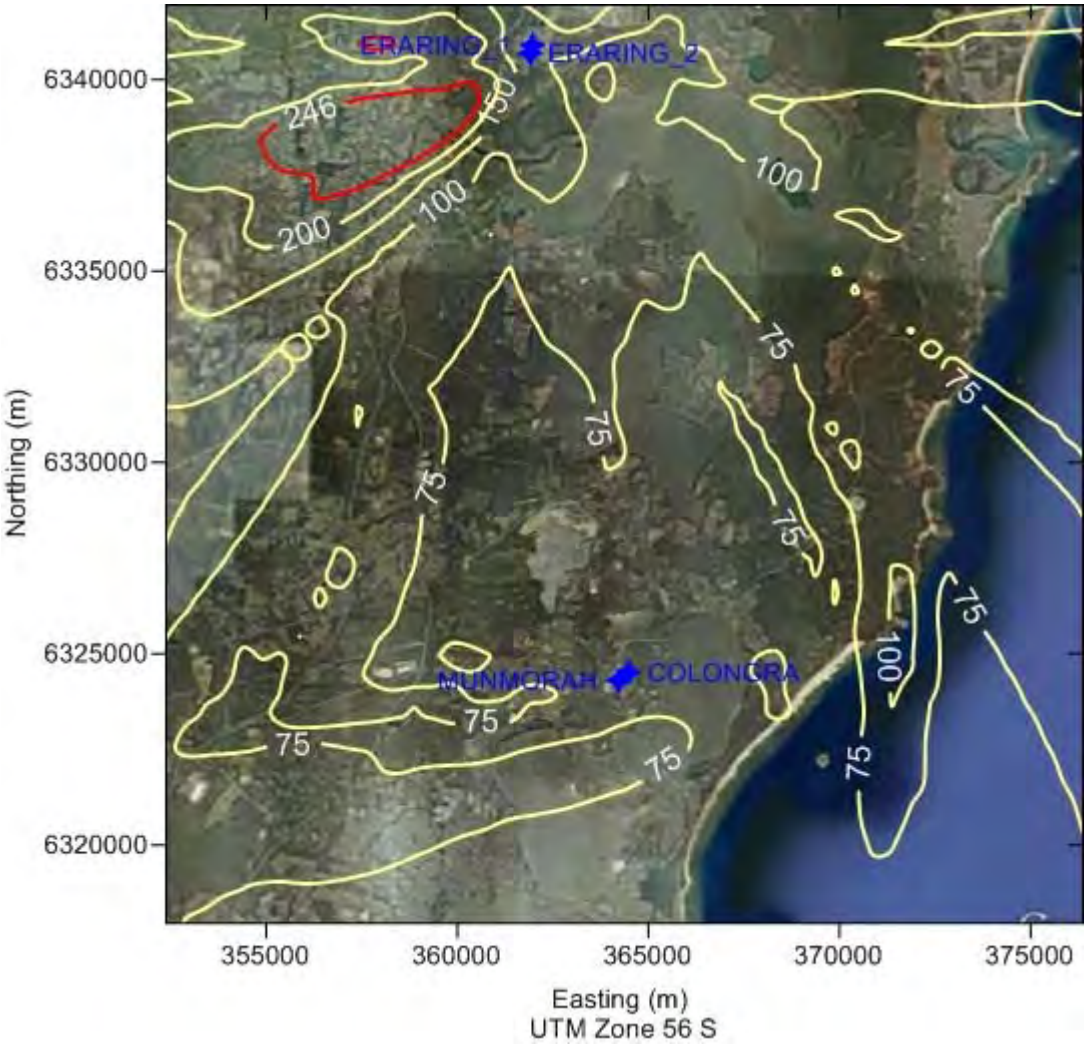

Figure 8 **Maximum 1-hour ground-level concentrations of Nitrogen Dioxide due to surrounding sources, Vales Point excluded. An ambient background concentration of 40 µg/m³ has been added.**

Location: Central Coast	**Averaging period:** 1-hour	**Data source:** TAPMv4	**Units:** µg/m³
Type: Maximum	**Objective:** 246 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

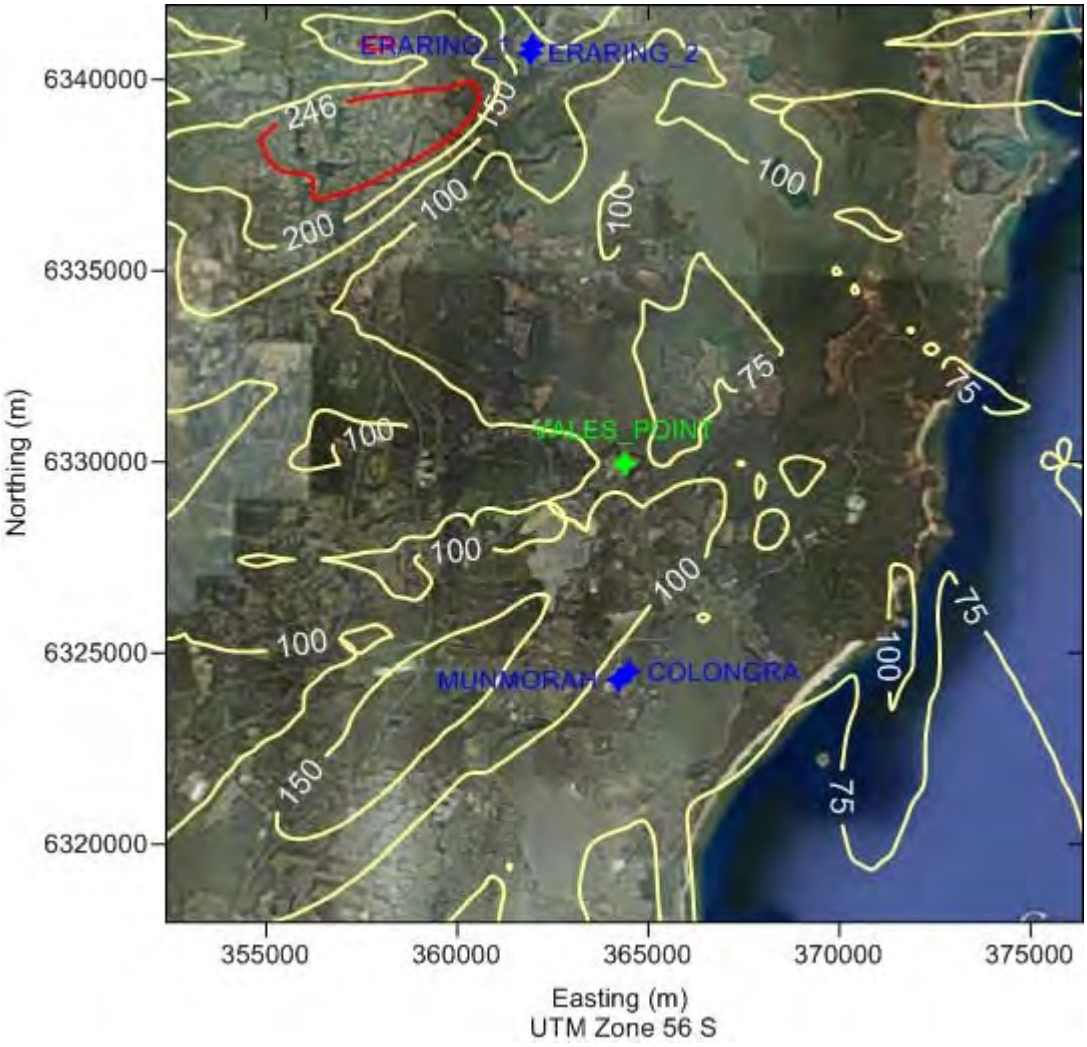

Figure 9 **Maximum 1-hour ground-level concentrations of Nitrogen Dioxide from surrounding sources and Vales Point. An ambient background concentration of 40 µg/m³ has been added.**

Location:	**Averaging period:**	**Data source:**	**Units:**
Central Coast	1-hour	TAPMv4	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum	246 µg/m³	Ella Castillo	May 2010

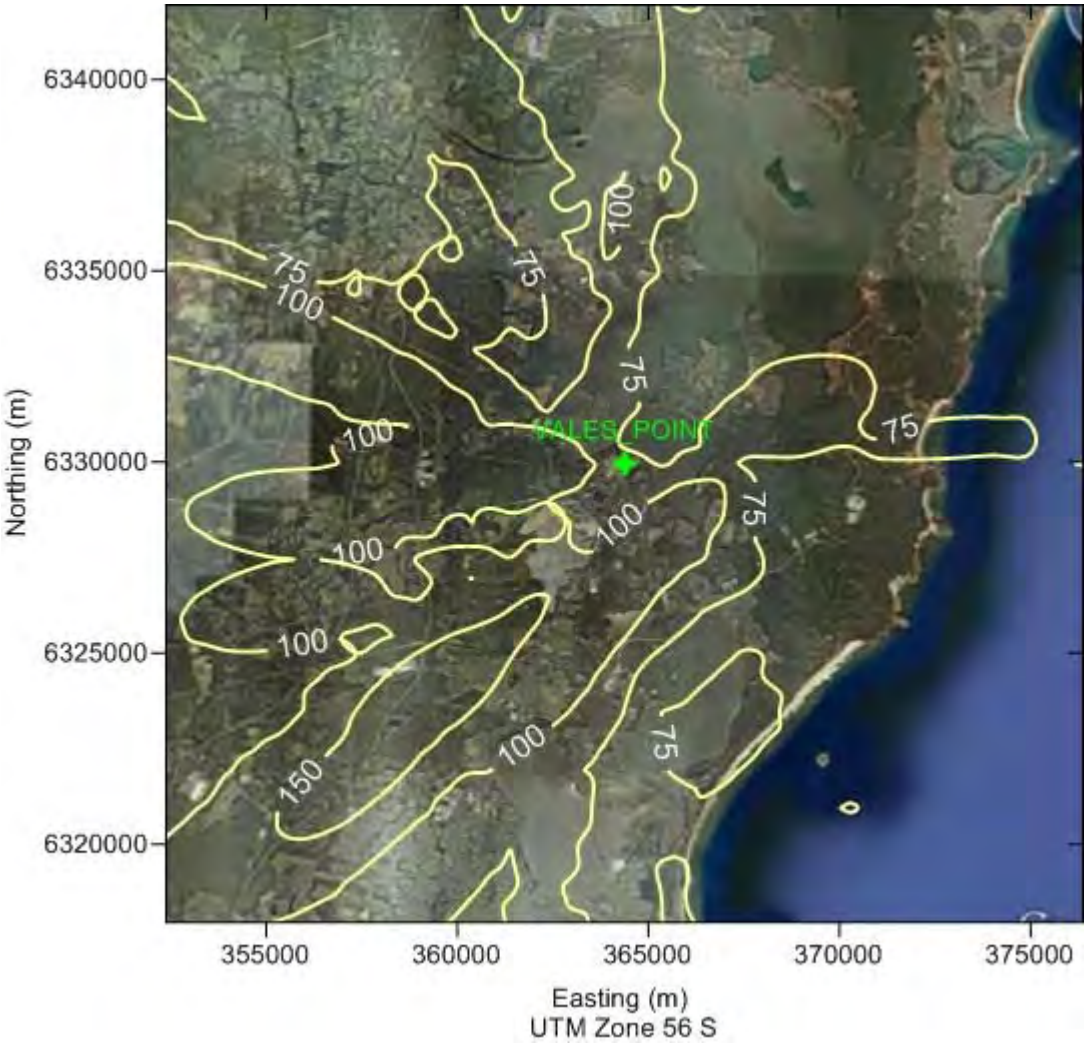

Figure 10 Maximum ground-level concentrations of Nitrogen Dioxide from Vales Point and corresponding contribution of surrounding sources. An ambient background concentration of 40 µg/m³ has been added.

Location: Central Coast	**Averaging period:** 1-hour	**Data source:** TAPMv4	**Units:** µg/m³
Type: Maximum	**Objective:** 246 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

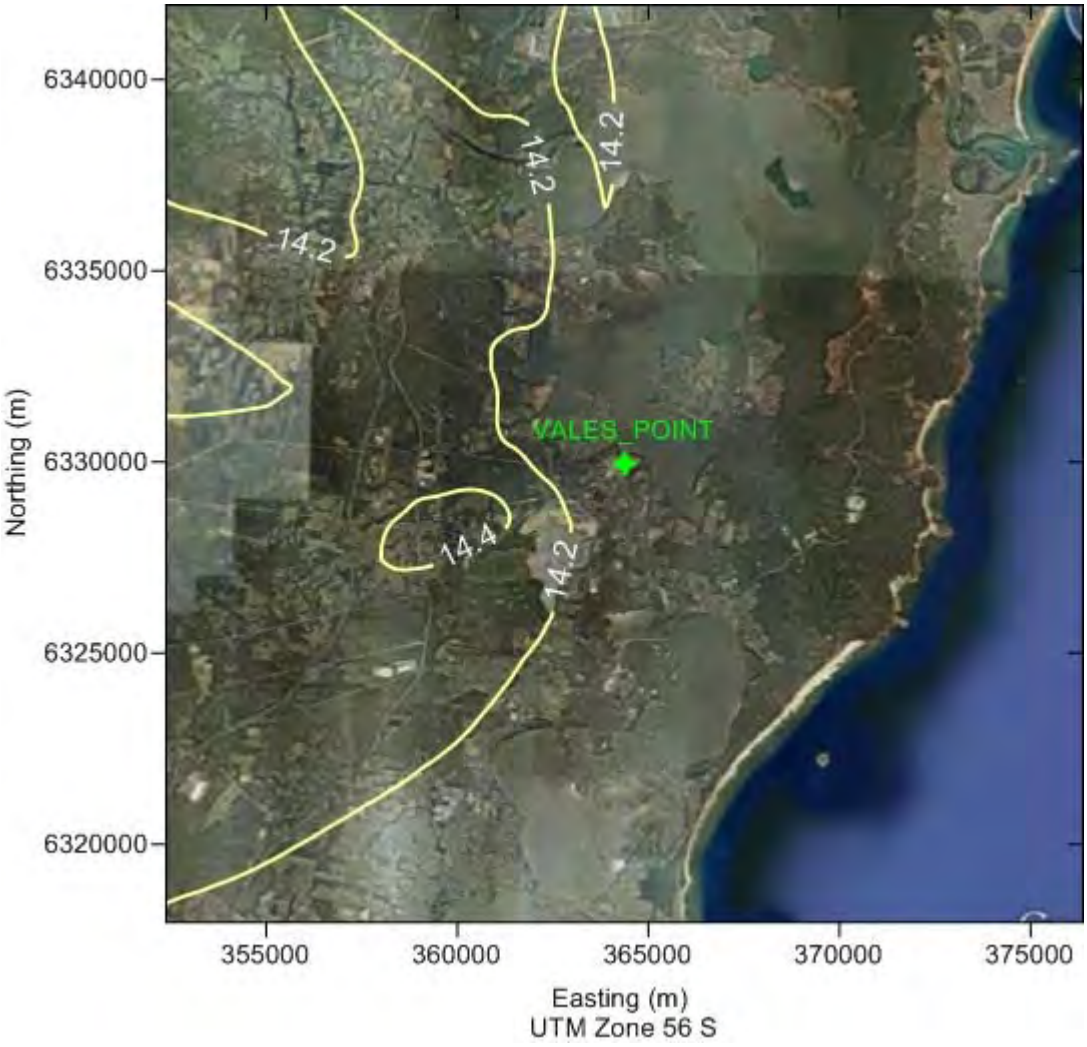

Figure 11 Annual average ground-level concentrations of Nitrogen Dioxide due to Vales Point. An ambient background concentration of 14 µg/m³ has been added.

Location: Central Coast	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** µg/m³
Type: Average	**Objective:** 62 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

Figure 12 Annual average ground-level concentrations of Nitrogen Dioxide due to surrounding sources. An ambient background concentration of 14 µg/m³ has been added.

Location: Central Coast	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** µg/m³
Type: Average	**Objective:** 62 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010

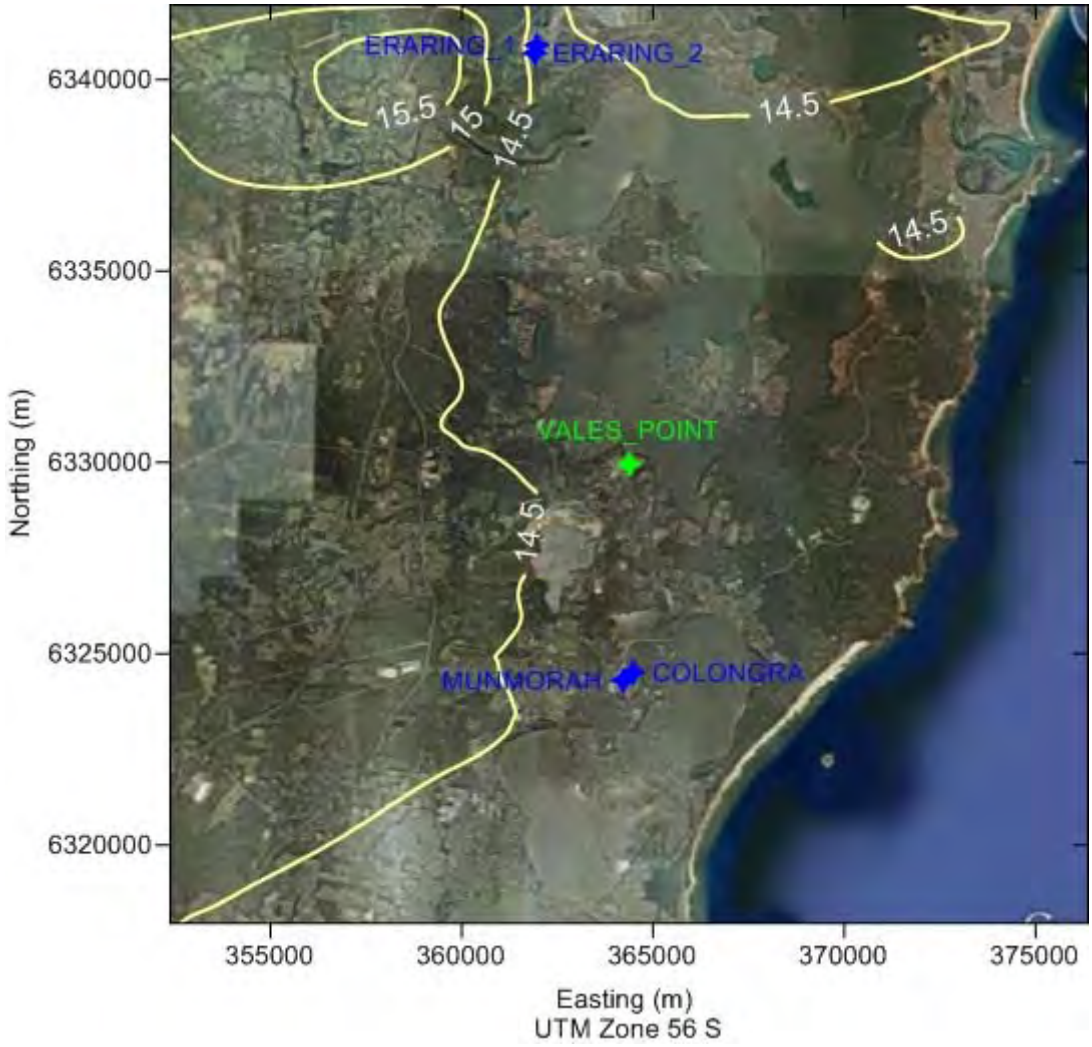

Figure 13 Annual average ground-level concentrations of Nitrogen Dioxide due to surrounding sources and Vales Point. An ambient background concentration of 14 µg/m³ has been added.

Location: Central Coast	**Averaging period:** Annual	**Data source:** TAPMv4	**Units:** µg/m³
Type: Average	**Objective:** 62 µg/m³	**Prepared by:** Ella Castillo	**Date:** May 2010