Arup**Sustainability**

Johnson Property Group

Trinity Point Marina and Mixed Use Resort Development

Air Quality Assessment

ArupSustainability

Johnson Property Group

Trinity Point Marina and Mixed Use Resort Development

Air Quality Assessment

May 2008

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 10 201 Kent Street,
Sydney NSW 2000
Tel +61 2 9320 9320 Fax +61 2 9320 9321
www.arup.com

Job number 86790

Job title	Trinity Point Marina and Mixed Use Resort Development		Job number 86790
Document title	Air Quality Assessment		File reference

Document ref

Revision	Date	Filename	Trinity Point AQ assessment_Revised Final for Issue.doc		
Issue	22/05/08	Description	Revised for Issue		
			Prepared by	Checked by	Approved by
		Name	MCK	SCH	KB
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

			Page
1	Introduction		1
	1.1	Background	1
	1.2	Scope of Assessment	1
2	Project Description		2
	2.1	Marina	2
	2.2	Helipad	2
	2.3	Repair and Maintenance Facilities	4
	2.4	Breakwater Jetty	4
	2.5	Commercial and Tourist Accommodation	5
3	Legislative Context		6
	3.1	Protection of the Environment Operations Act 1997 (POEO Act)	6
	3.2	Protection of the Environment Operations Act (Clean Air) Regulation 2002	6
	3.3	National Environment Protection Measures	7
	3.4	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales	9
	3.5	NSW Action for Air	11
	3.6	Summary	11
4	Existing Conditions		13
	4.1	Site Description	13
	4.2	Surrounding Areas	13
	4.3	Sensitive Receptors	13
	4.4	Meteorology	15
	4.5	Existing Air Quality	15
5	Construction Impacts		17
	5.1	Potential Impacts	17
	5.2	Mitigation Measures	17
6	Operational Impacts		19
	6.1	Potential Impacts	19
	6.2	Mitigation Measures	22
7	Conclusions and Recommendations		25
	7.1	Construction Impacts	25
	7.2	Operational Impacts	25
8	References		27

Tables

Table 1 Applicable POEO (Clean Air) Regulation Standards of Concentration
Table 2 NEPM Standards for Ambient Air Quality
Table 3 Air Toxics NEPM Monitoring Investigation Levels
Table 4 NSW DEC Impact Assessment Criteria
Table 5 NSW EPA Action for Air Goals
Table 6 Potential Sources of Air Pollution during Operation
Table 7 Summary of Operational Impacts

Figures

Figure 1 Proposed Site Layout
Figure 2 Sensitive Receptors

Appendices

Appendix A

NSW DECC Impact assessment criteria for individual toxic air pollutants

Appendix B

Windroses for Norah Head

1 Introduction

1.1 Background

Johnson Property Group are proposing to develop a marina and mixed use resort within 'Trinity Point', a master-planned, lakefront residential community on the southwest edge of Lake Macquarie. The following air quality assessment has been prepared by Arup to address air quality issues associated with the proposed development.

The air quality assessment has been prepared for Johnson Property Group to form part of an application to NSW Department of Planning (DoP) for Concept Plan approval for the development.

1.2 Scope of Assessment

Director General's Environmental Assessment Requirements (DGEARs) for the Concept Plan were issued to Johnson Property Group on 17 March 2008.

Part 14.1 of the DGEARs prescribe that air quality is to be addressed by the Environmental Assessment under Part 14.1, specifically:

- Address the potential marina impacts on air quality including dust generation during construction activities and boat maintenance and repairs.

The air quality assessment therefore addresses this requirement.

2 Project Description

The Project relates to the marina, tourist village and helipad components of the overall Trinity Point Marina and Mixed Use Resort development including:

- staged 308 berth floating marina and associated services;
- a breakwater jetty structure;
- a floating helipad pontoon;
- repair and maintenance facilities; and
- commercial and tourist accommodation.

The proposed layout of the project is presented in Figure 1.

2.1 Marina

The marina would comprise a 308 berth floating marina for craft in the length range of 8m to 20m. The marina will extend approximately 300m from the shoreline with access to the berths via a floating system of walkway, with finger units at right angles creating the berthing pens. The floating walkway would be connected to the marina village via a 10m aluminium gangway connecting to a fixed boardwalk. A sliding gate would be installed at the head of the access gangway for security.

The marina berths would be supplied with water, power, fire and lighting services, with the capacity for introduction of telephone and TV if required. These services would be available to the berths via service pedestals supplied from land-based infrastructure.

2.1.1 Fuelling Berth

A fuelling berth would be provided on a floating pontoon arrangement accessed from a gangway along the marina breakwater the refuelling of boats. A dual bowser located on the wharf deck would dispense diesel and unleaded petrol (ULP) pumped from on land above ground storage tanks (ASTs).

The diesel and ULP ASTs will have a capacity of 40kL and 25kL respectively. It is anticipated that the ASTs and will be refilled approximately once a fortnight resulting in a maximum dispensing capacity of approximately 1.04ML/year of diesel and 0.64ML/year of ULP.

2.1.2 Sewage Pumpout Facilities

A sewage pumpout facility would be provided at the same berth as the fuel facilities for use by all craft at the marina equipped with on-board holding tanks. The sewage pumpout facility would consist of a pumpout unit to empty holding tanks on craft and a waste slops hopper for manual collection of chemical toilet waste equipped with a pump. The sewage pumpout unit and chemical toilet waste pump would deliver the contents to the on land site sewage pumping station for disposal to the sewer. The will be no holding tanks at the berth.

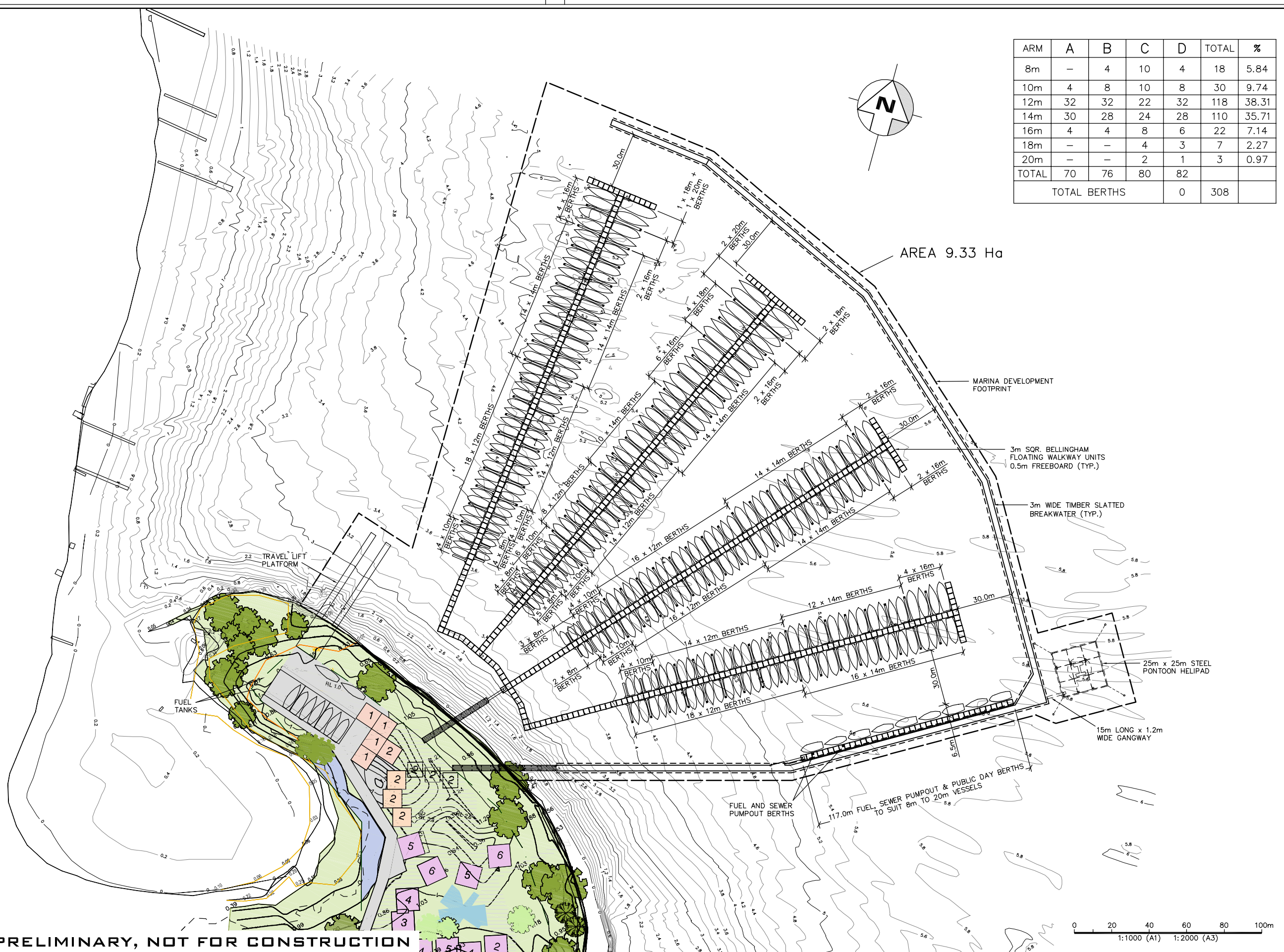
2.1.3 Oily Bilge Pumpout

A bilge water pumpout system would be provided adjacent to the sewage pumpout facilities. The bilge water would be pumped to the oily waste storage tank for recycling by a commercial contractor.

2.2 Helipad

A floating helicopter landing platform is proposed on a pontoon on the eastern side of the marina breakwater. The helipad would be a 25m by 25m floating steel pontoon anchored to the lake bed, with an access gangway directly from the breakwater walkway.

ARM	A	B	C	D	TOTAL	%
8m	–	4	10	4	18	5.84
10m	4	8	10	8	30	9.74
12m	32	32	22	32	118	38.31
14m	30	28	24	28	110	35.71
16m	4	4	8	6	22	7.14
18m	–	–	4	3	7	2.27
20m	–	–	2	1	3	0.97
TOTAL	70	76	80	82		
TOTAL BERTHS				0	308	



DRG STATUS : PRELIMINARY, NOT FOR CONSTRUCTION

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
B	RE-ISSUED FOR REVIEW	AHP	SAC			06.11.07
A	ISSUED FOR REVIEW	AHP	SAC			12.10.07

INITIALS SHOWN IN THE ADJACENT ISSUE RECORDS INDICATE THE STAGES UNDERTAKEN IN THE DRAWING APPROVAL PROCESS. DRAWINGS ARE ONLY TO BE USED WHEN APPROVED BY PATTERSON BRITTON & PARTNERS AND THEN ONLY AS NOTED FOR DRG STATUS. THE ORIGINAL SIGNATURES CAN BE FOUND ON THE REVERSE SIDE OF THE ORIGINAL OF THE DRG REGISTER/TRANSMITTAL FORM No.5.2.2. HELD BY PATTERSON BRITTON & PARTNERS

14 Telford Street
Newcastle East 2300

telephone (02) 4928 7777
facsimile (02) 4926 2111
mail@newcastle.pattbrit.com.au
A.C.N. 003 220 228

Patterson Britton & Partners Pty Ltd
consulting engineers

Client: JOHNSON PROPERTY GROUP

Project: TRINITY POINT MARINA

Title: MARINA DEVELOPMENT LAYOUT & FOOTPRINT

Drawing No. 6759.10-SK2

Issue B

Cad File No. 6759-10-SK2

Xref.(s)

A1

N:\Drafting Jobs\6759.10 Trinity Point PP (SAC)\cad\6759-10-SK2-REVB.dwg 06/11/2007

2.3 Repair and Maintenance Facilities

The repair and maintenance facilities would comprise a ship travel lift, hardstand area and workshop and would be located on the western side of the site.

2.3.1 Travel lift

A travel lift is proposed for the marina and will consist of a large, movable steel frame outfitted with lifting mechanisms and supporting belts. In order to dock ships, the travel lift must move on two concrete piers which are arranged parallel to one another and grounded on steel piles. After lowering the supporting belts, the ship is manoeuvred between the two piers and lifted via the supporting belts connected with the lifting mechanisms.

The travel lift facility would be situated at the north-western corner of the hardstand area and will have the capacity in the range of 70 to 75 tonnes and capable of lifting a vessel of up to approximately 25m in length and 8m beam. The travel lift will be powered by a diesel fuelled motor with a maximum power rating of 82 kW.

2.3.2 Hardstand Area

The hardstand area would be approximately 45m by 25m to accommodate 7 to 9 vessels at any one time. The hardstand area will also include a 50m long and 15m width runway area for the ship travel lift. Activities undertaken on the hardstand would include

- washing down and cleaning;
- minor surface repairs including scraping down, abrasive blasting, sanding, painting as well as fibreglass, timber and metal work; and
- minor mechanical/electrical repairs and fit outs.

The hardstand would be fenced for safety and security by a mesh wire fence.

2.3.3 Work Shop

A two storey work shop servicing the marina would be incorporated into the north western edge of the marina village building development adjacent to the hardstand area. Activities to be undertaken on the ground floor include any minor maintenance and repair activities which require protection from outdoor exposure and are likely to include mechanical and electrical repairs such as gear breakages and minor surface repairs. Any major repairs are to be conducted off site.

The workshops will generally be naturally ventilated for energy efficient operation. Local extract ventilation will be provided as required to exhaust minor contaminants from workshop activities discharging above roof level.

For any spray painting or fibreglass activities, it will be required that temporary spray booth structures are installed.

Any spray booth will be designed and installed in accordance with AS/NZS 4114.1:2003 in order to isolate the controlled environment and create a continuous, uniform and evenly distributed flow of clean air across the operator. Exhaust air from the booth will be cleaned and filtered before discharging to atmosphere. The installation and management of the temporary spray booths will be the responsibility of independent and experienced contractors.

A plant room and amenities are also proposed for the ground floor.

On the first floor of the workshop would be offices and amenities.

2.4 Breakwater Jetty

The breakwater would consist of two rows of parallel tubular steel piles driven in to the lake bed, with timber slats supported on outer side of each row of piles. This arrangement is

designed to attenuate wave energy within the marina, as well as, minimising the reflection of wave energy and subsequent impacts on surrounding foreshore areas.

The breakwater would also have a fixed timber walkway, allowing access around the perimeter of the marina approximately 300m from the shoreline and for access to the Helicopter Landing Platform.

2.5 Commercial and Tourist Accommodation

2.5.1 Village Centre

The village centre would incorporate restaurants, a function room, meeting rooms, cafes, commercial offices and retail, public and marina patron amenities, marina operations offices, maintenance workshop and offices, and a manager's residence (apartment).

2.5.2 Tourist Accommodation

Immediately to the south of the village centre, short term tourist accommodation would be provided including resort and serviced apartments style lodging.

3 Legislative Context

3.1 Protection of the Environment Operations Act 1997 (POEO Act)

Part 3 of the *Protection of the Environment Operations Act, 1997* (POEO Act) establishes a system of environment protection licensing for 'scheduled' activities with the potential to have a significant impact on the environment. Schedule 1 of the POEO Act lists the activities requiring an EPA licence including:

> *Marinas and boat repair facilities comprising:*
>
> *(1) pontoons, jetties, piers or other structures (whether water-based or land-based) designed or utilised to provide moorings or dry storage (other than swing moorings) for 80 or more vessels (excluding rowing boats, dinghies or other small craft), or*
>
> *(2) works such as slipways, hoists or facilities for the repair and maintenance of vessels (other than boat repair facilities that are not adjacent to waters) at which 5 or more vessels (being vessels other than rowing boats, dinghies or other small craft) or any vessel 25 metres or longer is handled or capable of being handled at any one time.*

The proposed marina and boat facilities therefore qualify as a scheduled activity and as such will be subject to an Environment Protection Licence (EPL). The EPL may prescribe limits for emissions to air or requirement for air quality monitoring.

Furthermore, Part 5.4 of the POEO Act deals specifically with air pollution including the obligation that occupiers of non-residential premises:

- do not cause air pollution by failing to operate or maintain plant, carry out work or deal with materials in a proper and efficient manner and comply with any air emission standards prescribed by regulations; and
- take all practicable means to prevent or minimise air pollution (even where standards for a particular pollutant are not prescribed by regulation).

3.2 Protection of the Environment Operations Act (Clean Air) Regulation 2002

Part 4 of the *Protection of the Environment Operations (Clean Air) Regulation,* 2002 deals with emission of air pollutants from industrial activities and plant. In particular, the Regulation sets maximum limits on emissions from activities and plant for a number of substances, including oxides of nitrogen, smoke, solid particles, chlorine, dioxins, furans and heavy metals at the point of discharge. The standards are based on levels that are achievable through the application of reasonably available technology and good environmental practices.

The legislation specifying air emission standards has been reviewed a number of times over the 35 years it has been in operation setting more stringent standards for new industry at the time of each review. These new standards have not generally been applied retrospectively to existing industry and so several groups of emission standards exist as a result of the introduction of progressively tighter requirements.

The Regulation provides that any plant or equipment that commenced to be carried on, or to operate, on or after 1 September 2005, as a result of an EPL granted under the *Protection of the Environment Operations Act* 1997 pursuant to an application made on or after 1 September 2005 becomes subject to the latest (Group 6) emission standards.

The emission limits for Group 6 emission units are presented in Table 1 below.

Table 1 Applicable POEO (Clean Air) Regulation Standards of Concentration

Pollutant	Emission Unit	Standard of Concentration**
Solid particles (Total)	Any activity or plant	50 mg/m^3
Nitrogen dioxide (NO_2) or Nitric oxide (NO) or both, as NO_2 equivalent	Any activity or plant (except boilers, gas turbines and stationary reciprocating internal combustion engines	350 mg/m^3
	Stationary reciprocating internal combustion engines	450 mg/m^3
Type 1 and Type 2 substances in aggregate*	Any activity or plant	1 mg/m^3
Cadmium (Cd) or mercury (Hg) individually	Any activity or plant	0.2 mg/m^3
Sulfuric acid mist (H_2SO_4) or sulfur trioxide (SO_3) or both, as SO_3 equivalent	Any activity or plant	100 mg/m^3
Hydrogen sulfide (H2S)	Any activity or plant	5 mg/m^3
Fluorine (F_2) and any compound containing fluorine, as total fluoride (HF) equivalent	Any activity or plant	50 mg/m^3
Chlorine (Cl_2)	Any activity or plant	200 mg/m^3
Hydrogen chloride (HCl)	Any activity or plant	100 mg/m^3
Volatile organic compounds (VOCs), as n-propane	Any activity or plant involving combustion	40 mg/m^3 VOCs or 125 mg/m^3 CO

* **Type 1 substances**: antimony, arsenic, cadmium, lead or mercury or any compound containing one or more of those elements

Type 2 substances: beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium or any compound containing one or more of those elements

** at standard temperature and pressure, dry basis, 3% O_2

3.3 National Environment Protection Measures

National Environment Protection Measures (NEPMs) are broad framework-setting statutory instruments defined in the *National Environment Protection Council (NEPC) Act*, 1994. They outline agreed national objectives for protecting or managing particular aspects of the environment. The Ambient Air Quality NEPM and Air Toxics NEPM are the relevant NEPMs for air quality.

3.3.1 Ambient Air Quality NEPM

In June 1998 the NEPC agreed to set uniform standards for ambient air quality (ambient air does not include indoor air). The standards contained in the NEPM for ambient air quality are listed in Table 2 below.

Table 2 NEPM Standards for Ambient Air Quality

Pollutant	Averaging Period	Maximum Concentration	Goal within 10 years Maximum Allowable Exceedances
Carbon monoxide (CO)	8 hours	9.0 ppm	1 day a year
Nitrogen dioxide (NO_2)	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
Sulfur dioxide (SO_2)	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Lead	1 year	0.50 µg/m^3	none
Particles as PM_{10}	1 day	50 µg/m^3	5 days a year

Note 1: Particulate Matter 10 (PM_{10}) represents a fraction of the Total Suspended Particulates/Solids (TSP or TSS) and is the concentration of suspended particles with an aerodynamic diameter of less than 10µm.

3.3.2 Air Toxics NEPM

The Air Toxics NEPM is primarily concerned with the collection of data on ambient (i.e. outdoor) levels of formaldehyde, toluene, xylene, benzene and polycyclic aromatic hydrocarbons (PAH) at locations where elevated levels are expected to occur and there is a likelihood that significant population exposure could occur including clusters of industrial sites, heavily trafficked or congested roads and areas affected by wood smoke.

The NEPM includes monitoring investigation levels for the five air toxics to assist jurisdictions in the interpretation of monitoring data as presented in Table 3. It should be noted that the monitoring investigation levels do not apply as design criteria or emission limits for individual point sources. They have been established for use in assessing the significance of the monitored levels of air toxics with respect to protection of human health.

Table 3 Air Toxics NEPM Monitoring Investigation Levels

Pollutant	Averaging period	Monitoring Investigation Level
Benzene	Annual	0.003ppm
Benzo(a)pyrene as a marker for Polycyclic Aromatic Hydrocarbons	Annual	0.3ng/m3
Formaldehyde	24 hours	0.04 ppm
Toluene	24 hours Annual	1 ppm 0.1 ppm
Xylenes (as total of ortho, meta and para isomers)	24 hours Annual	0.25ppm 0.2 ppm

3.4 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales

The NSW Department of Environment and Climate Change (DECC) Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (AMMAAP) lists the methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW and is referred to in Part 4 of the *POEO (Clean Air) Regulation, 2002*. The AMMAAP prescribes assessment criteria for ground level concentrations at sensitive receptors to protect against adverse air quality impacts. The NSW DECC criteria are consistent with the Ambient Air Quality NEPM criteria for common pollutants but are slightly more stringent as they do not allow for any exceedances.

The NSW DECC criteria are presented in Table 4 over page.

Table 4 NSW DEC Impact Assessment Criteria

Pollutant	Averaging Period	Concentration		Source
		pphm	µg/m^3	
Sulfur dioxide (SO_2)	10 minutes	25*	712*	NHMRC[1] (1996)
	1 hour	20*	570*	NEPC[2] (1998)
	24 hours	8*	228*	NEPC[2] (1998)
	Annual	2*	60*	NEPC[2] (1998)
Nitrogen dioxide (NO_2)	1 hour	12*	246*	NEPC[2] (1998)
	Annual	3*	62*	NEPC[2] (1998)
Photochemical oxidants (as ozone)	1 hour	10*	214*	NEPC[2] (1998)
	4 hours	8*	171*	NEPC[2] (1998)
Lead	Annual	-	0.5*	NEPC[2] (1998)
PM_{10}	24 hours	-	50*	NEPC[2] (1998)
	Annual	-	30	NEPC[2] (1998)
Total suspended particulates (TSP)	Annual	-	90	EPA[3] (1998)
		g/m²/month	g/m²/month	
Deposited Dust	Annual	2	4	NHMRC[1] (1996)
		ppm	mg/m^3	
Carbon monoxide (CO)	15 minutes	87	100	WHO[4] (2000)
	1 hour	25	30	WHO[4] (2000)
	8 hours	9	10	NEPC[2] (1998)
		µg/m^3 *	µg/m^3 **	
Hydrogen Fluoride	90 days	0.5	0.25	ANZECC[5] (1990)
	30 days	0.84	0.4	ANZECC[5] (1990)
	7 days	1.7	0.8	ANZECC[5] (1990)
	24 hours	2.9	1.5	ANZECC[5] (1990)

*General land use, which includes all areas other than specialised land use.

** Specialised land use, which includes all areas with vegetation sensitive to fluoride, such as grape vines and stone fruits.

1 NEPC Ambient Air NEPM (See Section 3.3.1)

2 NSW EPA Action for Air (See section 3.5)

3 National Health and Medical Research Council Ambient Air Quality Goals

4 World Health Organisation Air Quality Guidelines for Europe

5 Australian and New Zealand Environment and Conservation Council, National Goals for Fluoride in Ambient Air and Forage

The pollutants included in Table 4 are defined as the principle air pollutants on the basis that they are carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent in the environment. In addition the AMMAAP prescribes impact assessment criteria for 115 individual air pollutants including air toxics. These criteria are presented in Appendix ??.

3.5 NSW Action for Air

The NSW *Action for Air* was introduced by the NSW EPA in 1998 as a 25 year plan to address photochemical smog and brown haze specifically affecting the Greater Metropolitan Region of Sydney, the Illawarra and the Lower Hunter. Objective 4 of Action for Air is to promote cleaner business by actions that concentrate on the control of NOx. For smaller commercial sources, the goal of the Action Plan is to reduce emissions of reactive organic compounds (ROCs) in the most cost-effective way and, in the process, help reduce air toxics and workplace exposure to chemicals. Action for Air specifies regional ambient air quality guidelines for pollutant concentrations as specified in Table 5

Table 5 NSW EPA Action for Air Goals

Pollutant	Averaging time	Action for Air interim goal	Long-term reporting goal
Ozone (O3)	1 hour 4 hour	0.10 ppm 0.08 ppm	0.08* ppm 0.06* ppm
Nitrogen dioxide (NO2)	1 hour Annual	0.125 ppm 0.03 ppm**	0.105* --
Particulate matter < 10 µm (PM10)	24 Hours Annual	50 µg/m3	-- 30 µg/m3
Particulate matter < 2.5 µm (PM2.5)	24 Hours	Standard being developed Insufficient data at this stage	Standard being developed. Insufficient data at this stage
	Annual	Standard being developed Insufficient data at this stage	Standard being developed Insufficient data at this stage
Total suspended particulates (TSP)	Annual	90 µg/m3	

* WHO goal

** Consistent with WHO goal of 0.021-0.026ppm

Note 1: Particulate Matter 10 (PM_{10}) and Particulate Matter 2.5 ($PM_{2.5}$) represents a fraction of the Total Suspended Particulates/Solids (TSP or TSS) and are the concentration of suspended particles with an aerodynamic diameter of less than 10µm and 2.5µm respectively.

3.6 Summary

There are a number of air quality criteria that apply to the project. For pollutant concentrations at emission sources, the *POEO (Clean Air) Regulation* limits as specified in Table 1 will apply.

For pollutant concentrations at ground level at the locations of sensitive receiver, the NEPM and Action for Air goals as well as the NSW DECC impact assessment criteria will all apply. The NSW DECC criteria have legislative underpinning under the *POEO Act* and therefore must be met in order for development to proceed. The NEPM and Action for Air goals provide the policy framework for the setting of criteria under the *POEO Act* and therefore are generally consistent with the NSW DECC criteria. Action for Air also specifies long term

reporting goals which may be adopted by NSW DECC in the future and should therefore be observed by the project.

4 Existing Conditions

4.1 Site Description

The site is located on a headland on the south western banks of Lake Macquarie and approximately 6km east of the Morisset town centre.

The topography of the site is dominated by a near vertical rock cliff along the southern side of the site. From the cliff line, the site gently slopes up to a hill crest with an elevation of 9m above sea level and then down to alluvial flats on the northern side of the point to an elevation of 1.6m above sea level. Towards the eastern end of the site, there is a gap in the cliff line, where the southern shoreline is wide and flat, with a soil bank rising up to the site.

The site has been extensively cleared and has in recent times has been used as grazing and horse agistment paddocks with grasses and few remnant trees (mainly eucalyptus). The vegetation along the foreshore is dense in places, particularly on the north eastern banks of the site buffering the site from the nearest residences.

4.2 Surrounding Areas

The site is surrounded to the north, south and east by Lake Macquarie with Bardens Bay to the north east. The western edge of the site is an extension of the cleared area with approval for residential development. Further to the west are low density residential lots.

The nearest arterial road is Macquarie Street located approximately 4km to the north west of the site. Access to the site from Macquarie Street is via Fisher Point Road and Morriset Park Road. The Sydney to Newcastle Freeway is located approximately 6.5km to the west of the site.

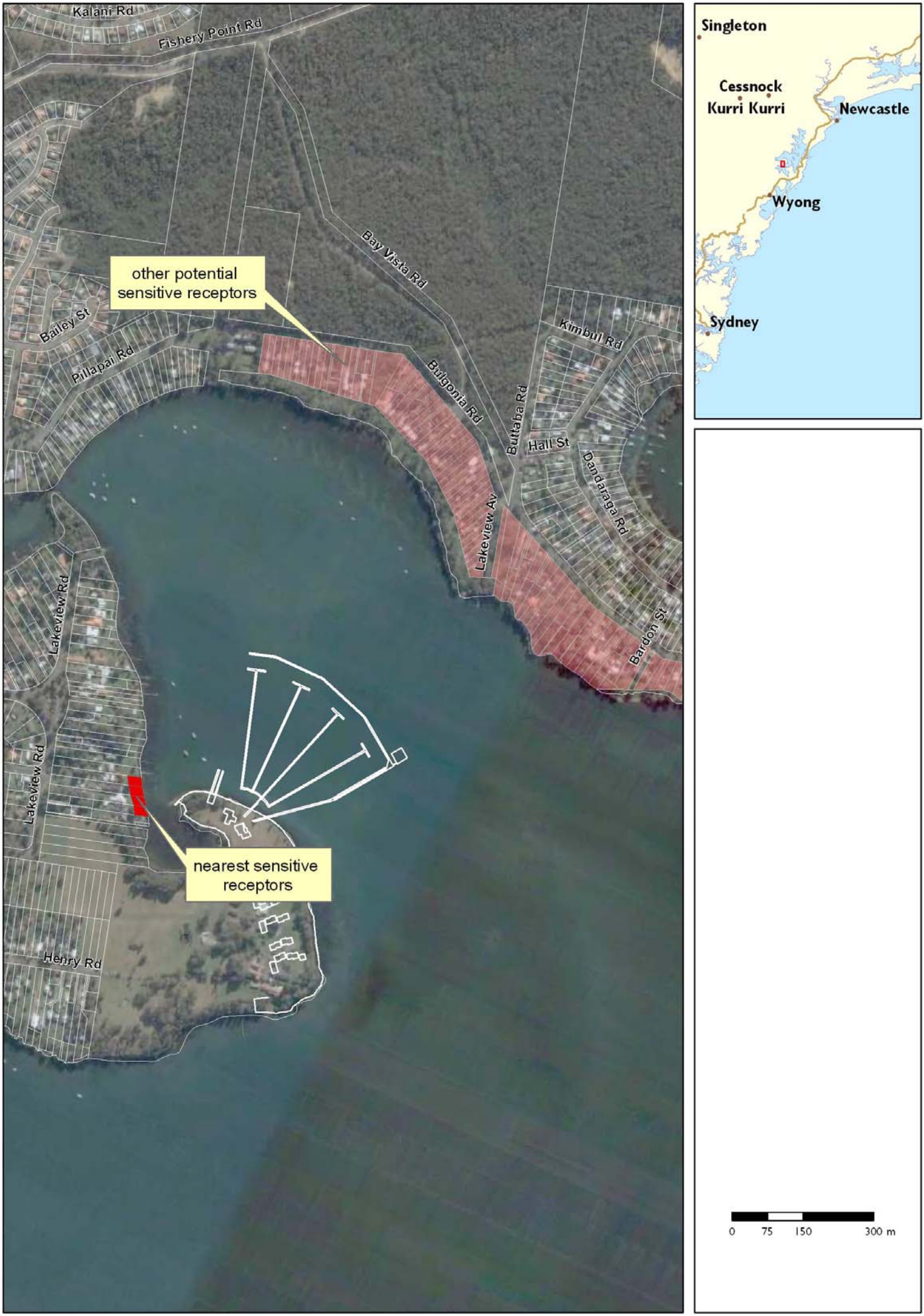
There are several coal fired power stations within the vicinity of the site which may be potentially significant in the context of existing air quality. The nearest of these power stations is Vales Point, operated by Delta Electricity, at the southern end of Lake Macquarie, approximately 5km south of the site. The Vales Point power station and stacks are clearly visible from the southern end of the site. The power station currently operates two 660 MW generating units. Delta electricity also operates the Munmorah coal fired powered station approximately 11 km to the south of the site from the site on the coastal strip between the Tuggerah Lakes with a capacity of 1200MW. The third and largest of the power stations is the Eraring Energy coal fired power station operating four 660 MW generating units approximately 7km to the north of the site on the western shore of Lake Macquarie

4.3 Sensitive Receptors

The nearest sensitive receptors are the series of residences located on the foreshore of Bardens Bay to the north west of the site accessed from Lakeview Road. The nearest of these receptors (57A Lakeview Road) is approximately 100m to the north west of the site. These residences are buffered by eucalypts along the foreshore such that they are not visible from within the site. The location of these nearest sensitive receptors is shown in Figure 2.

Other potentially significant residential receptors include the residents on the opposite side of Bardens Bay, approximately 700m from the foreshore of the site and 400m from the outer extent of the marina within the suburb of Brightwaters. These residences are clearly visible from the site. The location of these potential sensitive receptors is shown in Figure 2.

Future sensitive receptors also include the residential area to be developed to the immediate west of the site and the future occupants of the commercial and tourist areas within the marina development itself.


Kalani Rd
Fishery Point Rd
Bay Vista Rd
other potential sensitive receptors
Bailey St
Pillapai Rd
Bulgonia Rd
Buttaba Rd
Kimbul Rd
Hall St
Dandaraga Rd
Lakeview Av
Lakeview Rd
Bardon St
Lakeview Rd
nearest sensitive receptors
Henry Rd
Singleton
Cessnock
Kurri Kurri
Newcastle
Wyong
Sydney
0
75
150
300 m

4.4 Meteorology

The meteorology at the site is influenced by several factors including surrounding topography and the differential heating of the land and water. On a relatively small scale, winds would be largely affected by the local topography and influence of the Lake while at larger scales, winds are affected by synoptic scale winds, which are modified by sea breezes near the coast in the daytime in summer (also to a certain extent in the winter) and also by a complex pattern of regional drainage flows that develop overnight.

The site is likely to be affected by seasonal trends that are common for an eastern coastal location with sea breezes and southerly winds prevailing in summer and offshore winds prevailing in winter and the cooler months.

The nearest weather station operated by bureau of meteorology is at Norah Head, located approximately 18km to the south of the site at an elevation of 19km above sea level. Wind roses obtained for this station are presented in Appendix A. The exposure of the weather station and its close vicinity to the cost mean it is likely to be affected by stronger winds than the project site, however it is able to give an indication of the broad scale meteorology observed in the area.

The wind roses for 9am data recorded at Norah Head data show that the strong southerlies dominate in the summer months with calm to moderate westerlies from late autumn to early spring. The 3pm data shows moderate to strong southerlies and north easterlies dominating all year round with the strongest winds during summer. Moderate south easterlies are also observed during late autumn into winter.

The broad scale data indicates that the site is likely to experience good dispersion conditions with generally strong winds.

The presence of the lake adjacent to the site will also affect dispersion at a local scale. A temperature gradient is established at the shoreline as land heats up and cools down faster that water. In the absence of prevailing wind conditions, this gradient will likely transport pollutants lakeward at night and inland again during the day in the same way as a sea breeze functions.

4.5 Existing Air Quality

Lake Macquarie is part of a regional airshed covering the Greater Metropolitan Area (Wollongong to Newcastle), and as such can receive pollutants from all these areas depending on wind patterns. The air quality at the site may be particularly affected by local sources of emissions including industrial sites, areas with high heavy vehicle traffic. Emissions from the nearby power stations however are less localised because of the dispersing effects of the high stacks.

The nearest EPA air quality monitoring station to the site is at Wallsend. The Wallsend station is located in the Newcastle City Council Swimming Pool, off Frances Street, Wallsend. It is situated in a residential area south-west of Newcastle and is at an elevation of 8 metres. The following air pollutants are currently measured at Wallsend:

- ozone (O_3);
- nitrogen oxides (NO, NO_2 and NO_x)
- sulfur dioxide (SO_2)
- fine particles (by nephelometry)
- fine particles ($PM_{2.5}$ and PM_{10} using a tapered element oscillating microbalance)

Monitoring results for Wallsend during the 12 month period from January to December 2006 were reviewed as part of this assessment. The results showed that:

- there were no exceedances of the NSW long term reporting goal or NEPM Standard level for ozone (See Table 2);
- there were no exceedances of the NSW long term reporting goal (See Table 5) or NEPM Standard level for nitrogen dioxide (See Table 2);
- there was one minor exceedance of the NEPM Standard level for PM10 (See Table 2) recorded in November 2006[1]; and
- no exceedances of the NEPM Standard levels for SO_2 (See Table 2).

The existing air quality at the site and nearby sensitive receptor is therefore likely to be of good quality with only occasional exceedance of criteria for particulate pollution likely to be the result of regional meteorological conditions.

During the site inspection low levels of dust were observed consistent with the nature of an exposed site.

[1] A maximum 24-hour value of 51µg/m^3 was recorded in November 2006 which represents a minor exceedance of the NEPM Standard Level of 50µg/m^3

5 Construction Impacts

5.1 Potential Impacts

It is proposed that the construction is undertaken under 4 stages with a total construction period of approximately 70 weeks. The major emission sources during construction are likely to be:

- dust generation where soil is exposed during excavation and piling for the new buildings and may be transported off site in windy conditions or by vehicles; and
- emissions from construction traffic plant and equipment including particulates, carbon monoxide, nitrogen oxides and volatile organic compounds.

Stage 1 works will occur over 46 weeks and include the construction of the majority of the offshore marina structure and the eastern most marina arm connected to the helipad including:

- the breakwall superstructure (piling and installation);
- timber jetties and decking;
- pontoons and floating units (piling and installation);
- fuel berths;
- the helipad pontoon (piling and installation);
- the access gangways; and
- services.

The majority of these works are off shore including off shore piling with the exception of the service installation which will require some land disturbance and the use of bobcats and excavators. Therefore emissions associated with these works will include those associated with delivery vehicles and plant and equipment and are anticipated to be minor.

Stage 1 onshore works includes the on shore construction of the travel lift, hardstand and workshop areas and a 32 week period for construction of the commercial and tourist accommodation building. This will include significant earthworks including piling.

The emissions during these works will include dust generation as a result of subsurface works as well as those associated with delivery vehicles and plant and equipment.

Stages 2, 3 and 4 include the construction of the other 3 marina arms with an overall construction period of 25 weeks. These works will be mainly off shore and will not involve land disturbance with the exception service installation.

5.2 Mitigation Measures

Management measures to reduce air quality impacts during construction include:

- assigning access and haul roads to permanent paved areas;
- stabilising temporary designated haul roads with road base or watering;
- watering of exposed soil and excavations;
- reducing the requirement for soil stockpiles (i.e. dispose or re-use immediately);
- minimising the duration of soil stockpiling by expedient disposal or re-use;
- minimising the duration of open excavations by construction programming;
- ensuring vehicles, plant and equipment are adequately maintained so as to minimise air quality impacts from exhaust;

- ensuring vehicles or items of plant or equipment generating excessive exhaust (smoke) are not permitted or removed from site;
- ensuring vehicles entering and leaving the site are free of excessive mud by utilising a truck wash, dry brushing area or shake down strip; and
- ensuring that all trucks have canopies secured over the load and their tailgates closed on entering and leaving the site; and
- scheduling deliveries so they do not occur at peak traffic times.

6 Operational Impacts

6.1 Potential Impacts

6.1.1 Helicopter

Helicopters may create emissions to air by both the combustion of fuel and generation of dust from surface disturbance upon landing and taking off. The exhaust emissions from one helicopter are not likely to be significant and furthermore will only have the potential to impact the local air quality when the helicopter is at a relatively low height. This will only occur in the relatively short period of less than two minutes when the helicopter is taking off or landing once or twice a day.

Generally, the greater concern relating to helicopters and air emissions is the potential for dust generation during takeoff and landing. However, the location of the helipad, approximately 300m from the foreshore will result in minimal potential for disturbance to land. Also, the foreshore will generally be either hardstand or well vegetated and unlikely to generate significant dust.

6.1.2 Vessels

Exhaust emissions from the various vessels berthed in the marina will vary depending on the age, condition, engine and fuel type of individual vessels. These emissions are difficult to control as maintenance and management are generally controlled by the vessel owners. However, it is anticipated that only a fraction of the potential 308 vessels will be in operation at any one time resulting in insignificant potential for impact to local air quality.

6.1.3 Travel lift

The travel lift will be diesel powered with a 100L capacity fuel tank operating a maximum power rating of 82kW with the potential to produce combustion related exhaust emissions. The travel lift will be required when any one of the potential 308 vessels berthed within the marina are required to be removed from the water for maintenance or transportation. This infrequent use means that the travel lift is unlikely to be a significant source of emissions.

6.1.4 Operational Road Traffic

The traffic using the network of roads throughout the commercial and tourist areas will mainly be private vehicles with occasional deliveries by truck to the commercial facilities and once fortnightly fuel tanker deliveries. As with vessels, vehicle emissions are difficult to control and will depend on the type of vehicle but are subject to government requirements for emission controls. High volumes of road traffic are not anticipated to occur as a result of the marina development and are not likely to be a significant source of emissions

6.1.5 Fuel Storage and Dispensing

It is proposed that both diesel fuel and petrol will be stored and dispensed at the marina. The main emissions from fuel storage are standing and working losses mostly from petrol storage which is significantly more volatile than diesel.

Standing losses are the result of atmospheric changes and the resulting changes in pressure and temperature. These changes may result in vapour lost from the expansion and contraction of the vessel contents without any resulting change in liquid level.

Working losses are the most significant losses and occur during arise when the tanker delivers the fuel and when fuel is dispensed to vessels from the filling and emptying of the storage tank. During this process a change in pressure occurs in the tank, because of the change in liquid level in the tank. This pressure change forces expulsion of vapour to counter the change in pressure inside the vessel with vapour vented to relief valves.

Vapour can also be lost where spills occur.

The most significant source of emissions associated with fuel storage and dispensing are fugitive vapours which are released when the tanker delivers the fuel and when fuel is dispensed to vessels particularly for petrol.

Vapour recovery systems are proposed for both the petrol storage tanks and dispensing units to reduce these emissions to the extent possible.

6.1.6 Surface Preparation of Vessels

Surface preparation is a common boat maintenance activity and involves the removal of build-up from the surface of a vessel to ensure that subsequent surface coatings will not prematurely fail due to poor adhesion. Surface preparation will likely be carried out to various extents within the workshop and hardstand areas.

Surface preparation activities are likely to be a source of emissions from both the volatile components of the chemicals used as well as particulates such as mill scale, rust, dirt, dust, salts, old paint, grease removed from ship hulls which may become airborne as a result of high pressure and other physical processes.

Depending on the surface location, contaminants and materials, a number of different surface preparation techniques may be used.

6.1.7 Solvent, Detergent and Steam Cleaning

Solvent cleaning involves the use of organic solvents to clean the vessel surface by spraying, immersion or the use of rags or brushes. Solvent cleaning may result in the release of volatile organic compounds to air.

Inorganic compounds such as chlorides, sulfates, weld flux, rust and mill scale cannot be removed with organic compounds and may be removed by steam cleaning or high-pressure washing for dirt and grime that is present on top of the existing paint, and bare steel with negligible emissions to air

6.1.8 Sanding and Stripping

Physical sanding and stripping occurring on the hardstand and workshop areas may generate particulate emissions. These particulates may also contain heavy metals and volatile organic compounds commonly found in antifouling paints.

6.1.9 Abrasive Blasting

In some cases abrasive blasting may be required to remove build-up. This requires the use of abrasives such as copper slag, coal slag, steel grit, steel shot, glass and garnet. Abrasive blasting may occur on the hardstand or workshop area where an experienced contractor with mobile units is brought to site. Abrasive blasting may occur in either centrifugal blasting machines or by air nozzle blasting (or dry abrasive blasting).

6.1.10 Chemical Surface Preparation

This method of antifouling removal uses a chemical sprayed or brushed on the surface or a dip-coat system to soften the coating. It can then be scraped off and caught on a plastic drop-sheet. Where chemical surface preparation is required experienced contractors with mobile units will be brought to site.

6.1.11 Paint Application

It is proposed that some painting will occur on the hardstand and within the work shop areas. Paints are made up of three main ingredients: pigment, binder, and a solvent vehicle all of which contain chemicals that may be emitted to air either directly by spray application or volatilise upon application.

The pigment components of paint are small particles that generally determine the colour as well as many other properties associated with the coating and include: zinc oxide, talc, carbon, coal tar, lead, mica, aluminium, and zinc dust. The binder holds the paint pigments together and determines a coating's performance characteristics (eg. flexibility, chemical resistance, durability and finish, etc). Many paints are referred to by their binder type, (i.e.

epoxy, alkyd, urethane, vinyl, phenolic, etc. The solvent is added to thin the paint so that it will flow to the surface and then dry. The solvent portion of the paint evaporates when the paint dries. Some typical solvents include acetone, mineral spirits, xylene, methyl ethyl ketone, and water.

There are many types of paint application equipment used in the boating industry the most effective of which is the airless sprayers. Any airless spraying on site is to be conducted within a temporary spray booth erected on the hardstand area designed and installed in accordance with AS4114 in order to isolate the controlled environment and create a continuous, uniform and evenly distributed flow of clean air across the operator. Exhaust air from the booth will be cleaned and filtered before discharging to atmosphere.

Other minor conventional spray painting will be conducted on the hardstand are with suitable shelter. Non-spray application will be permitted both within the workshop and on the hardstand.

6.1.12 Fibreglass

Any major fibreglass repair to vessels will be required to occur offsite at a facility appropriately equipped. However, it is envisaged that minor fibreglass repair may be required from time to time. The processes involved in fibreglassing, whether using epoxy, polyester, or vinylester resins for small or big jobs, can release emissions and odour. The process involves combining polymerising resin with fibreglass reinforcing material. The resin is supplied in liquid form containing a solvent such as acetone, methanol, methyl ethyl ketone, or styrene and is injected with a catalyst in a separate line in order to thermoset the polyester resin. Catalysts are likely to consist of amines, anhydrides, aldehyde condensation products, and Lewis acid products. Specialist contractors and equipment including booths will be required to be brought on site where there is any need for fibreglass repair.

6.1.13 Summary

A summary of the potential emission sources, associated pollutants and potential impacts is presented in Table 6.

Table 6 Potential Sources of Air Pollution during Operation

Source	Location	Potential Impact		Pollutants
		without Management Measures	with Management Measures	
Ship Travel lift	Hardstand area	Negligible	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Operational Road Traffic	Marina Village	Negligible	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Helicopters	Helicopter Pontoon	Negligible	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Vessels	Marina	Negligible	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Fuel storage and delivery	Above ground storage tank adjacent workshop	Low	Negligible	VOCs
Fuel dispensing	Fuel berth	Low	Negligible	VOCs, Particulates (PM_{10}, TSP)
Surface Preparation	Hardstand area	Medium (in unfavourable wind conditions)	Negligible	VOCs
Painting	Workshop/ Hardstand area	Low	Negligible	VOCs
Fibreglass	Hardstand Area	Low	Negligible	VOCs, Particulates (PM_{10}, TSP)

6.2 Mitigation Measures

6.2.1 Surface Preparation

To reduce dust and particulates during surface preparation the following mitigation measures are proposed:

- sanding machines are to be fitted with a dust bag or extraction system;
- sanding and any abrasive blasting activities are to be conducted either in the workshop with a dust extraction system integrated with the workshop mechanical systems or in a temporary booth with a dust extraction system;
- any temporary booths enclosure is to be properly sealed with a filtration system that is capable of dealing with the amount of particulates and dust produced;
- any abrasive blasting is to be undertaken by an experienced contractor; and

- after the completion of surface preparation activities spent material is to be swept or vacuumed and placed in a bin with a closed lid.

6.2.2 Paint Application

To reduce VOC and particulate emissions during painting the following measures will be implemented:

- outside painting and respraying is to be restricted to minor repair and detailing work;
- outside painting and respraying is to occur only at times where the weather conditions do not promote the release of pollutants to the air (such as hot and windy days);
- outside painting and respraying is to be shrouded as much as possible;
- the outdoor perimeter of the hardstand area is to be monitored for evidence of overspray;
- use of waterbased paints or low VOC paints are to be used in preference to high VOC paints;
- paint application methods are to be used in the following order preference:
    1. rollers or brushes
    2. airless spray guns
    3. high-volume low-pressure (HVLP) spray guns (which reduce the amount of over spray paint usage, release of volatile organic compounds (VOCs) and odours)
- spray painting is to be conducted either in the workshop with a vapour extraction system integrated with the workshop mechanical systems or in a temporary booth with a vapour extraction system;
- any temporary booth enclosure is to be properly sealed with a filtration system that is capable of dealing with the VOCs produced; and
- any booth spray painting is to be undertaken by an experienced contractor.

6.2.3 Fibreglass

To reduce VOC and particulate emissions during fibreglassing, boat owners will be encouraged to conduct this work at off site facilities. However for minor repairs, fibreglassing may take place where following measures will be implemented:

- fibreglassing spray lay-up is to be carried out in a booth or enclosure fitted with appropriate environmental controls;
- drums, brushes and containers of resin and other fibreglassing chemicals are to be stored in a bunded and covered storage area; and
- fibreglass mat off cuts that are not used are to be sealed in plastic bags before disposal.

6.2.4 Vessels

While emissions from vessels are difficult to control by marina management, boat owners are to be informed of and encouraged to implement measures to improve engine efficiency, reduce fuel use and reduce emissions including:

- increased use of unleaded fuels;
- regular maintenance and engine tuning;
- increased use of catalytic converters (which can reduce marine emissions by over 90%);
- increased use of four-stroke 'low pollution engines' or direct fuel injection two-stroke engines; and

- reduced idling time in marina with engines turned on as late as possible before departure and turned off as soon as possible after berthing.

6.2.5 Travel lift

Exhaust emissions from the travel lift will be reduced by ensuring that:

- the travel lift is operated by trained and experienced personnel; and
- the travel lift is to be operated for the minimum time possible by turning on the motor as late as possible before operation and turning off as soon as possible after operation.

6.2.6 Fuel Storage, Filling and Dispensing

The following measures are to be adopted for fuel storage, filling and dispensing activities to minimise the potential for release of vapours to the atmosphere from standing losses, working losses and spills including:

- a vapour recovery systems is to be implemented when the tanker refills the AST to ensure that vapours are transferred back to the delivery tanker during the fill[2];
- tank filling is to be undertaken by experienced contractors including a supervisor;
- fuel dispensing facilities are to have back pressure automatic shut-off nozzles which cut off automatically when back-pressure reaches a certain level, and cannot be locked in the 'on' position;
- fuel tank, fuel lines and bowsers are to be regularly checked for leaks;
- boat operators are to be advised of their requirements to follow correct procedures in relation to health, safety and the environment when refuelling;
- Customers are to be discouraged from overfilling including from topping up fuel tanks once the automatic cut-off shows the tank is full;
- a spill kit, with clear instructions visible, accessible from every pump are to be provided at the fuel berth and the storage tanks;
- an emergency shut-off button is to be fitted next to each pump and on the land side of the berth so that the pump can be stopped easily if the pipe hose fails; and
- a fuel spill avoidance plan is to be developed and implemented.

[2] Marinas located in the Sydney Metropolitan area that have petrol storage tanks with a capacity of 8 to 150 kilolitres are required to have vapour recovery under the POEO Act. This does not apply to the Lake Macquarie Area, however the DECC encourages all marinas to install vapour recovery for the environmental benefits, hazard reduction and occupational health and safety benefits.

7 Conclusions and Recommendations

7.1 Construction Impacts

Construction emissions are temporary in nature and may be reduced by the implementation of the mitigation measured presented in Section 5.2.

7.2 Operational Impacts

7.2.1 Sources of Air Pollution

The following potential sources of air pollution were identified impacts were identified.

Table 7 Summary of Operational Impacts

Source	Location	Potential Impact	Pollutants
Ship Travel lift	Hardstand area	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Operational Road Traffic	Marina Village	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Helicopters	Helicopter Pontoon	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Vessels	Marina	Negligible	SO_x, NO_x, CO, Particulates (PM_{10}, TSP)
Fuel storage and delivery	Above ground storage tank adjacent workshop	Negligible with management	VOCs
Fuel dispensing	Fuel berth	Negligible with management	VOCs, Particulates (PM_{10}, TSP)
Surface Preparation	Hardstand area	Negligible with management	VOCs
Painting	Workshop/hardstand area	Negligible with management	VOCs
Fibreglass	Hardstand Area	Negligible with management	VOCs, Particulates (PM_{10}, TSP)

7.2.2 Impact to Sensitive Receivers

The air quality impact to sensitive receivers as a result of the marina operations is likely to be low due to:

- the predicted negligible impact of the air pollution sources;
- the dispersion conditions; and
- the mitigation measures proposed.

Furthermore the relatively good air quality in the vicinity of the site means that no new criteria exceedances are likely to occur at the sensitive receptors

7.2.3 Statement of Commitments

It is recommended that the following commitments related to air quality are adopted by the Trinity Point Marina Development:

1. Air quality considerations are to be included within the construction environmental management plan including dust mitigation measures and measures to reduce

emissions from construction vehicles plant and equipment to the extent practicable.

2. All plant and equipment are to comply with the applicable POEO (Clean Air) Regulation Standards of Concentration

3. Any abrasive blasting, spray painting, or fibreglass activities are to be conducted by an experienced operator in a temporary booth designed and installed in accordance with AS4114 and the exhaust air from the booth will be cleaned and filtered before discharging to atmosphere.

3. A code of conduct is to be prepared to guide the environmental management and control of air emissions for activities undertaken by boat operators in the workshop or on the hard stand areas

4. A code of conduct is to be prepared to guide the environmental management and control of air emissions for activities undertaken by boat operators in the refuelling facilities

5. A code of conduct is to be prepared to guide the environmental management and control of air emissions for vessel operation within the marina including recommendations for operation and maintenance and possible options for engine upgrades to improve fuel efficiency and reduce emissions.

6. A vapour recovery system is to be implemented during filling of the above ground petrol AST to ensure that vapours from AST are returned to the tanker.

7. Fuel dispensing facilities are to have back pressure automatic shut-off nozzles which cut off automatically when back-pressure reaches a certain level, and cannot be locked in the ‘on’ position;

8. An emergency shut-off button is to be fitted next to each fuel dispenser and on the land side of the berth so that the pump can be stopped easily if the pipe hose fails;

9. A fuel management plan is to be developed to check for leaks and avoid spills associated with the marina’s fuel facilities including the ASTs, fuel lines and bowsers

8 References

Bureau of Meteorology *Climatic Averages Australia*, Bureau of Meteorology website, 2007 <www.bom.gov.au>

Department of the Environment and Heritage*, Fuel and Organic Liquid Storage Emission Estimation Technique Manual*, version 2.5, October 2004 <http://www.npi.gov.au/handbooks/approved_handbooks/fols.html>

Department of the Environment and Heritage, *National Pollutant Inventory Emission Estimation Technique Manual for Shipbuilding Repair and Maintenance*, December 1999 <http://www.npi.gov.au/handbooks/approved_handbooks/fshbldng.html>

Environment Canada, *Best Management Practices (BMPs) for Marinas and Small Boatyards in British Columbia*, August 1995 <http://www.pyr.ec.gc.ca/boatyards/FRAP%20Documents/9516.htm**>**

Great Barrier Reef Marine Park Authority, Environmental Guidelines for Marinas in the Great Barrier Reef Marine Park, July 1994 <http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/misc_013/index.html>

National Environment Protection Council, *National Environment Protection (Ambient Air Quality) Measure*, May 2003 <http://www.nepc.gov.au/nepms/air/air_nepm.html>

National Environment Protection Council, *National Environment Protection (Air Toxics) Measure,* April 2004 <http://www.nepc.gov.au/nepms/air/air_toxics.html>

NSW Department of Environment and Climate Change, *Action for Air: The NSW Fovernment's 25-Year Air Quality Management Plan*, 1998 <http://www.environment.nsw.gov.au/air/actionforair/actionair.htm>

NSW Department of Environment and Climate Change, *Environmental Action for Marinas, Boatsheds and Slipways*, June 2007 <http://www.environment.nsw.gov.au/sustainbus/marinas.htm>

NSW Department of Environment and Climate Change, *Quarterly Air Quality Monitoring Reports 1-4*, 2006 <http://www.epa.nsw.gov.au/air/datareports.htm>

NSW Department of Environment and Climate Change, *The Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (AMMAAP),* January 2007 <http://www.epa.nsw.gov.au/air/appmethods.htm>

Standards Australia, *AS/NZS 4114.1:2003 Spray painting booths, designated spray painting areas and paint mixing rooms - Design, construction and testing*, 2003

Arup**Sustainability**

Appendix A

NSW DECC Impact assessment criteria for individual toxic air pollutants

Table 7.2a: Impact assessment criteria for principal toxic air pollutants (Victorian Government Gazette 2001)

Substance	Averaging period	Code	Impact assessment criteria	
			mg/m^3 [a]	ppm
Acrolein	1 hour	1	0.00042	0.00018
Acrylonitrile	1 hour	2	0.008	0.0037
Alpha chlorinated toluenes and benzoyl chloride	1 hour	3	0.009	0.0018
Arsenic and compounds	1 hour	4	0.00009	N/A
Asbestos	1 hour	4	0.18	N/A
Benzene	1 hour	4	0.029	0.009
Beryllium and beryllium compounds	1 hour	4	0.000004	N/A
1,3-butadiene	1 hour	3	0.04	0.018
Cadmium and cadmium compounds	1 hour	4	0.000018	N/A
Chromium VI compounds	1 hour	4	0.00009	N/A
1,2-dichloroethane (ethylene dichloride)	1 hour	5	0.07	0.018
Dioxins and furans[b]	1 hour	4	2.0E–09	N/A
Epichlorohydrin	1 hour	3	0.014	0.0037
Ethylene oxide	1 hour	4	0.0033	0.0018
Formaldehyde	1 hour	6	0.02	0.018
Hydrogen cyanide	1 hour	1	0.20	0.18
MDI (diphenylmethane diisocyanate)	1 hour	1	0.00004	N/A
Nickel and nickel compounds	1 hour	4	0.00018	0.00009
Polycyclic aromatic hydrocarbon (as benzo[a]pyrene)[c]	1 hour	3	0.0004	N/A
Pentachlorophenol	1 hour	1	0.0009	N/A
Phosgene	1 hour	1	0.007	0.0018
Propylene oxide	1 hour	2	0.09	0.037
TDI (toluene-2,4-diisocyanate; toluene-2,6-diisocyanate)	1 hour	1	0.00004	N/A
Trichloroethylene	1 hour	3	0.5	0.09
Vinyl chloride	1 hour	4	0.024	0.009

a Gas volumes are expressed at 25°C and at an absolute pressure of 1 atmosphere (101.325 kPa).
b Toxic equivalent as defined in clause 29 of the Regulation
c Refer to Table 7.2c

Codes:

1. USEPA extremely toxic
2. USEPA Group B1 carcinogen (probable human carcinogen)
3. IARC Group 2A carcinogen (probable human carcinogen)
4. IARC Group 1 carcinogen (known human carcinogen)
5. Mutagen (USEPA)
6. IARC Group 2B carcinogen (possible human carcinogen)

Table 7.2b: Impact assessment criteria for individual toxic air pollutants (Victorian Government Gazette 2001)

Substance	Averaging period	Impact assessment criteria	
		mg/m^3 [a]	ppm
Acetone	1 hour	22	9.2
Acrylic acid	1 hour	0.11	0.037
Ammonia	1 hour	0.33	0.46
Aniline	1 hour	0.14	0.037
Antimony and compounds	1 hour	0.009	N/A
Asphalt (petroleum) fumes	1 hour	0.09	N/A
Barium (soluble compound)	1 hour	0.009	N/A
Biphenyl	1 hour	0.024	0.0037
Bromochloromethane	1 hour	19	3.7
Bromoform (tribromomethane)	1 hour	0.09	0.009
Bromotrifluoromethane	1 hour	112	18
Carbon black	1 hour	0.05	N/A
Carbon tetrachloride (tetrachloromethane)	1 hour	0.012	0.0018
Chlorine	1 hour	0.05	0.018
Chlorine dioxide	1 hour	0.0051	0.0018
Chloroform (trichloromethane)	1 hour	0.9	0.18
Chloromethane (methyl chloride)	1 hour	1.9	0.9
Chromium (III) compounds	1 hour	0.009	N/A
Copper fumes	1 hour	0.0037	N/A
Copper dusts and mists	1 hour	0.018	N/A
Cotton dust (raw)	1 hour	0.0037	N/A
Crotonaldehyde	1 hour	0.1	0.037
Cyanide (as CN)	1 hour	0.09	N/A
Cyclohexane	1 hour	19	5
Cyclohexanol	1 hour	3.8	0.9
o-dichlorobenzene	1 hour	5.5	0.9
1,2-dichloroethylene	1 hour	14.4	3.7
Dichlorvos	1 hour	0.018	0.0018
Dinitrobenzene (all isomers)	1 hour	0.018	0.003
Dinitrotoluene	1 hour	0.027	N/A
Ethanolamine	1 hour	0.14	0.05
Ethylbenzene	1 hour	8.0	1.8
Ethyl butyl ketone	1 hour	4.2	0.9
Ethyl chloride (chloroethane)	1 hour	48	18

Substance	Averaging period	Impact assessment criteria	
		mg/m^3 [a]	ppm
Ethylene glycol (vapour)	1 hour	1	N/A
n-hexane	1 hour	3.2	0.9
2-hexanone	1 hour	1.8	0.46
Hydrogen chloride	1 hour	0.14	0.09
Iron oxide fumes	1 hour	0.09	N/A
Magnesium oxide fumes	1 hour	0.18	N/A
Maleic anhydride	1 hour	0.018	0.0046
Manganese and compounds	1 hour	0.018	N/A
Mercury organic	1 hour	0.00018	N/A
Mercury inorganic	1 hour	0.0018	N/A
Methyl acrylate	1 hour	0.66	0.18
Methyl bromide (bromomethane)	1 hour	0.35	0.09
Methylene chloride (dichloromethane)	1 hour	3.19	0.9
Nitric acid	1 hour	0.09	0.037
n-pentane	1 hour	33	11
2-pentanone	1 hour	12.8	3.7
Phthalic anhydride	1 hour	0.1	0.018
Propylene glycol monomethyl ether	1 hour	6.6	1.8
Silver metal	1 hour	0.0018	N/A
Silver, soluble compounds (as Ag)	1 hour	0.00018	N/A
Sulfuric acid	1 hour	0.018	N/A
1,1,1-trichloroethane (methyl chloroform)	1 hour	12.5	2.3
1,1,2-trichloroethane	1 hour	1.0	0.18
Trichlorofluoromethane	1 hour	103	18.3
Trimethylbenzene (mixed isomers)	1 hour	2.2	0.46
Vinyl toluene	1 hour	4.4	0.9
Welding fumes (total particulate)	1 hour	0.09	N/A
Wood dust hardwoods	1 hour	0.0018	N/A
Wood dust softwoods	1 hour	0.009	N/A
Zinc chloride fumes	1 hour	0.018	N/A
Zinc oxide fumes	1 hour	0.09	N/A

a Gas volumes are expressed at 25°C and at an absolute pressure of 1 atmosphere (101.325 kPa).

Arup**Sustainability**

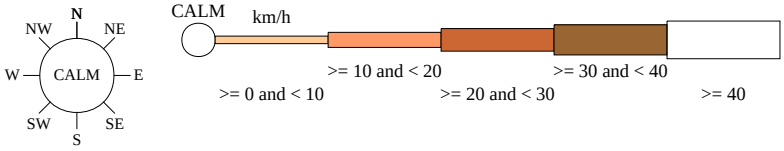
Appendix B

Windroses for Norah Head

Rose of Wind direction versus Wind speed in km/h (01 Feb 1995 to 31 Dec 2006)
NORAH HEAD AWS

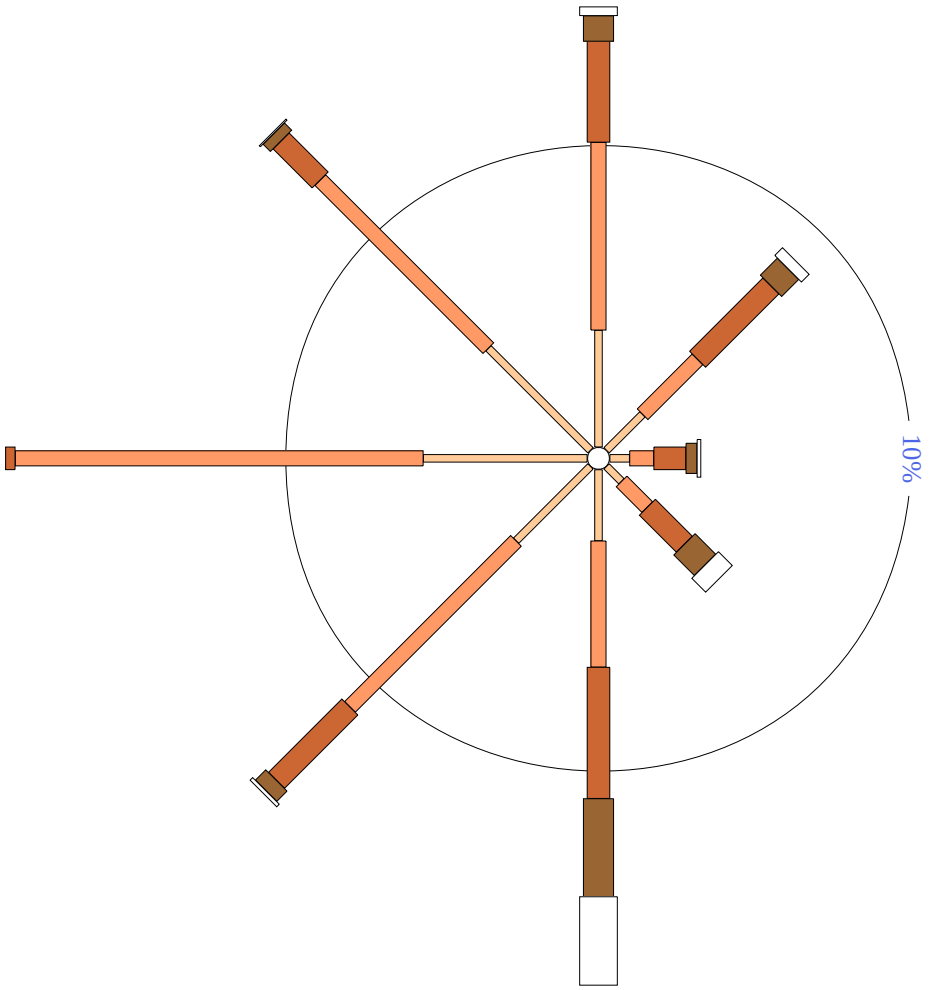
Site No: 061366 • Opened Jan 1989 • Still Open • Latitude: -33.2815° • Longitude: 151.5766° • Elevation 18.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
4159 Total Observations

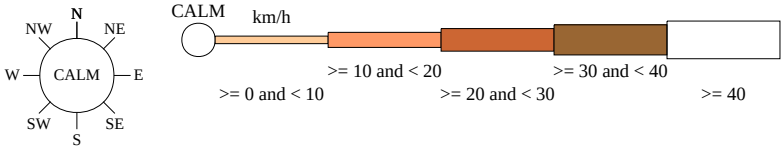
Calm 2%



Rose of Wind direction versus Wind speed in km/h (01 Feb 1995 to 31 Dec 2006)
NORAH HEAD AWS

Site No: 061366 • Opened Jan 1989 • Still Open • Latitude: -33.2815° • Longitude: 151.5766° • Elevation 18.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



3 pm
4159 Total Observations

Calm *