Summary of key outcomes:

Construction activities would typically be undertaken during the day time, however some activities, particularly dredging, would also be undertaken at night.

Construction noise levels expected from night time dredging would comply with the EPA night time noise criteria. During day time, some construction activities would produce noise levels above the noise criteria, particularly wharf construction due to piling activities. However, a Noise Management Plan would be implemented to mitigate construction noise. The noise level contribution from construction traffic would comply with the *Environmental Criteria for Road Traffic Noise.*

Vibration criteria to protect buildings from damage would be complied with. The vibration comfort criteria would also be complied with.

Estimates of typical "worst case" operational noise levels at the residences closest to the new terminal indicated that the night time noise level criteria could be exceeded by up to 10 dBA without noise mitigation once the terminal was fully operational. Consideration was, therefore, given to a range of noise mitigation measures such as noise barriers and noise controls to machinery which could be incorporated into the Port Botany Expansion. A 4 m high noise barrier bordering the northern and eastern boundaries of the new terminal, in addition to noise controls to machinery were considered the most effective noise mitigation measures. Those mitigation measures would reduce "worst case" operational noise levels to a maximum of 5 dBA above the night time criteria during certain weather conditions at residences to the north of the golf course but typically between 0 and 3 dBA at the nearest residences. There would be no exceedences at non-residential locations.

Sleep disturbance criteria at a number of locations, particularly to the north and northwest of the new terminal, would be exceeded. However, many of these locations are already subject to industrial noise impacts of levels similar to those to be expected as a result of the Port Botany Expansion. In addition, these predicted noise levels would be below the external level of 65 dBA which some researchers consider would not result in awakening reactions.

While the operation of the new terminal would result in exceedences of the EPA noise criteria, the noise levels expected from the new terminal would only be about 1 dBA above what would be expected from the operation of the existing terminals in the future without the presence of the new terminal. It is also only once the new terminal is fully developed that noise levels would reach the "worst case" levels predicted by the noise modelling. By this time, technological and operational changes are likely to be available which would reduce operational noise levels at the new terminal.

Noise levels from potential increases in truck movements from the Port Botany Expansion would comply with EPA traffic noise criteria as would the contribution to overall traffic noise levels from all port trucks when the entire port is at capacity.

Additional trains on the Botany Freight Rail Line, as a result of the Port Botany Expansion, would not result in significant increases in noise at residential areas adjacent to the line.

A Noise Management Plan, outlining environmental management measures to assess and minimise noise levels, would be developed for the construction and operation of the new terminal. The Noise Management Plan would include options for noise barriers, equipment alarms, traffic management, machinery noise control, noise monitoring, complaints handling and operator awareness programs.

22.1 Introduction

The purpose of this chapter is to identify and analyse the noise impacts of the proposal by examining: noise criteria; noise emissions from the existing terminal; noise emissions from the construction and operation of the new terminal (including road and rail traffic noise); and the safeguard measures proposed to mitigate potential noise impacts. Vibration impacts are also assessed.

This chapter presents a summary of the noise and vibration impact assessment undertaken by Wilkinson Murray Pty Ltd titled *Port Botany Container Terminal Expansion Noise Assessment* (2003) together with the additional advice dated 21 October 2003 which is provided in **Appendix Q.**

22.2 Existing Noise Environment

The Port Botany area is currently subject to noise emissions from existing port operations, road traffic (particularly Foreshore Road), rail traffic from the Botany Freight Rail Line, Sydney Airport and other industrial activities.

Noise from the existing terminals at Port Botany results from:

- loading and unloading of containers from trucks, trains and ships by quay cranes, straddle carriers, gantries, forklifts and reach stackers;
- movement of containers within the terminals; and
- transport of containers on trucks and trains to and from the terminal.

Measurements of noise from the existing Port Botany container terminal and ambient noise levels were undertaken. Ambient noise measurements were recorded at the nearest potentially affected residential receivers. The purpose of these noise measurements was to determine the background noise and existing industrial noise levels in the area. Measured noise levels were then compared with the relevant EPA noise criteria contained in the NSW *Industrial Noise Policy* (INP) (EPA 2000).

A glossary of acoustic terminology used in this chapter is contained in **Table 22.1**.

Table 22.1 Acoustic Terminology

TERM	DEFINITION
ABL	The Assessment Background Level is the single figure background level representing each assessment period (day, evening and night) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.
Ambient Noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Background Noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor.
L_{Amax}	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.
L_{A1}	The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

TERM	DEFINITION
L_{A10}	The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.
L_{A50}	The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.
L_{A90}	The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.
RBL	The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period (day, evening and night).

22.2.1 Background Noise Measurements

Ambient noise levels were measured using unattended noise loggers between 11 April 2002 and 26 April 2002 at locations shown in **Table 22.2** and **Figure 22.1**.

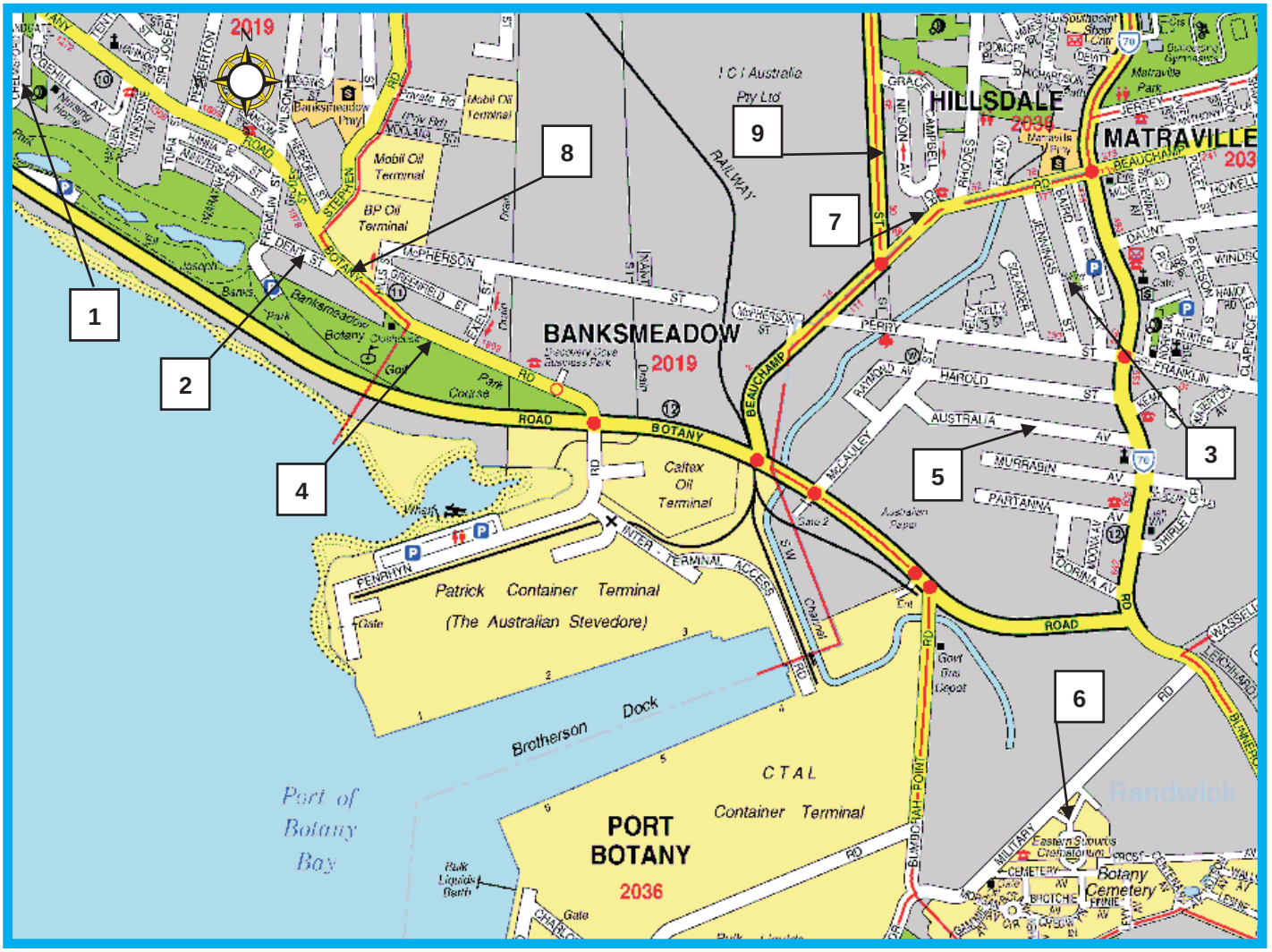
Table 22.2 Unattended Noise Measurement Locations

LOCATION NUMBER	DESCRIPTION
Location 1	Chelmsford Avenue, Botany
Location 2	34 Dent Street, Banksmeadow
Location 3	42 Jennings Street, Matraville
Location 4	The northern boundary of Botany Golf Course
Location 5	74 Australia Avenue, Matraville
Location 6	Eastern Suburbs Crematorium Military Road, Matraville
Location 7	36 Beauchamp Road, Hillsdale
Location 8	1424 Botany Road, Botany
Location 9	44 Denison Street, Hillsdale

In accordance with the Director General's Requirements, locations 1 to 6 (residential areas surrounding the port) were selected to be representative of the most noise affected location in each area as defined by Section 3.1.2 of the NSW INP. They were chosen to represent areas closest to or unshielded from the proposed new terminal and with the lowest background levels such that they represent the areas where the noise levels from the proposed Port Botany Expansion would have the greatest impact.

Measurements were carried out Locations 7, 8, and 9 to ascertain existing levels of traffic noise.

The RBL was determined in accordance with the EPA INP for each of the locations listed above (wind and rain affected data were excluded). The RBL values for each of the time periods (Day/Evening/Night) defined in the INP are provided in **Table 22.3**.



Source: Wilkinson Murray Pty Ltd 2003

Ambient Noise Monitoring Locations **Figure 22.1**

Location 1 – Chelmsford Avenue, Botany
Location 2 – 34 Dent Street, Banksmeadow
Location 3 – 42 Jennings Street, Matraville
Location 4 - The northern boundary of Botany Golf Course
Location 5 -74 Australia Avenue, Matraville
Location 6 -Eastern Suburbs Crematorium Military Road, Matraville.
Location 7 -36 Beauchamp Road, Hillsdale
Location 8 -1424 Botany Road, Botany
Location 9 - 44 Denison Street, Hillsdale

Table 22.3 Rating Background L_{A90} Level

LOCATION	RATING BACKGROUND L_{A90} LEVELS (DBA)			DOMINANT NOISE SOURCES
	Day * (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night (10:00 pm – 7:00 am)	
Location 1 - Chelmsford Avenue	49*	45	36	Traffic
Location 2 - Dent Street	47	43	36	Traffic
Location 3 - Jennings Street	40	39	40	Traffic/Industrial
Location 4- North of Golf Course	57	50	43	Traffic
Location 5- Australia Avenue	42	40	42	Industrial
Location 6- Military Road	46	46	45	Industrial/Traffic
Location 7- Beauchamp Road	50	43	42	Traffic
Location 8- Botany Road	56	45	37	Traffic
Location 9- Denison Street	52	50	47	Traffic

** These values were based on less data than required by the INP for the assessment of background noise levels due to weather exclusions. The values are based only on valid recorded data.*

The measured ambient L_{Aeq} noise levels are provided in **Table 22.4.**

Table 22.4 Measured Ambient L_{Aeq} Level

LOCATION	AMBIENT L_{AEQ} LEVELS (DBA)		
	Daytime (7:00 am – 6:00 pm)	Evening (6:00 pm – 10:00 pm)	Night time (10:00 pm – 7:00 am)
Location 1 - Chelmsford Avenue	57	55	51
Location 2 - Dent Street	61	58	57
Location 3 - Jennings Street	53	48	51
Location 4- North of Golf Course	63	60	58
Location 5- Australia Avenue	59	53	49
Location 6- Military Road	65	57	58
Location 7- Beauchamp Road	65	62	59
Location 8 - Botany Road	70	65	64
Location 9 - Denison Street	69	65	62

22.2.2 Existing Container Terminal Noise Measurements

Attended noise measurements of existing container terminal activities were conducted on the night/morning of 23/24 April 2002. Attended noise level measurements were made at each of the locations in **Table 22.2**, along Foreshore Road and at the Penrhyn Road Boat Ramp for the purposes of:

- estimating noise contributions resulting from existing activities within the terminal; and
- evaluating sources, other than those from the existing terminals, contributing to the noise environment.

The results of the attended noise monitoring are presented in **Appendix Q**.

Attended noise measurements were made at night and in the early hours of the morning, for the following reasons:

- the new terminal is proposed to operate 24 hours per day, 7 days per week. As night time is the time for which there is greatest potential for noise impact, night time ambient noise levels are more critical;
- extraneous noises, such as noise from motor vehicles, lawn mowers and the like, are lower at night, making it easier to obtain good measurements of existing noise contributions at sensitive receiver locations (i.e. residences).

The results of the background and attended noise measurements indicate that at some of the monitoring locations, noise levels from sources other than the existing container terminals dominate the noise environment. At these locations it was therefore difficult to estimate the L_{Aeq} level attributable to the existing container terminals.

To the extent possible, the measurements of port noise were used to calibrate the noise prediction model. These predicted noise levels were then compared to the measured noise levels.

22.3 Noise and Vibration Assessment Criteria

22.3.1 Construction

The Construction Noise Guideline of the NSW EPA's *Environmental Noise Control Manual* (ENCM) (EPA 1994) states that:

- *"For construction periods of greater than 26 weeks:*

  The L_{A10} level measured over a period of not less than 15 minutes when the construction site is in operation shall not exceed the background level by more than 5dBA."

The ENCM recommends that construction operations occur:

- *"Monday to Friday 7.00 am to 6.00 pm;*
- *Saturday, 7.00 am to 1.00 pm if inaudible at residential premises, otherwise: 8.00 am to 1.00 pm; and*
- *No construction work to take place on Sundays or public holidays."*

Although the ENCM recommends that construction activities occur during day time only, construction at night time is possible, provided that noise levels meet the criteria for construction greater than 26 weeks (i.e. background noise level +5 dBA). The resulting construction noise criteria, calculated by adding 5 dBA to the RBL values from **Table 22.3** are shown in **Table 22.5**. This is presented for Locations 1 to 6 (residential areas surrounding the Port). Locations 7 to 9 are assessed in road traffic noise in Section 22.4.3 .

Table 22.5 L_{A10} Construction Noise Criteria for Long Term Construction

LOCATION	L_{A10} CONSTRUCTION NOISE CRITERIA (DBA)		
	Day 7:00 am – 6:00 pm	Evening 6:00 pm – 10:00 pm	Night 10:00 pm – 7:00 am
Location 1 – Chelsmford Avenue	54	50	41
Location 2 – Dent Street	52	48	41
Location 3 – Jennings Street	45	44	45
Location 4 – North of Golf Course	62	55	48
Location 5 – Australia Avenue	47	45	47
Location 6 – Military Road	51	51	50

22.3.2 Operational Noise Criteria

Current criteria from industrial premises are specified in the INP. The INP is a "whole-of-government" policy which has the concurrence of PlanningNSW and other State government authorities as well as the NSW EPA.

The INP requires noise to be evaluated against two criteria – the "intrusiveness" criteria, and the "amenity" criteria.

Intrusiveness Criteria

The INP goal for noise at residential premises, as a result of noise emission from a premise, is an $L_{Aeq,\ 15\ minute}$ not to exceed the existing rating background level by more than 5 dBA (the noise "intrusiveness" criteria).

Table 22.6 shows the L_{Aeq} intrusiveness noise level criteria for the new terminal which are derived by adding 5 dBA to the rating background L_{A90} levels in **Table 22.3.** This is presented for Locations 1 to 6 (residential areas surrounding the port).

Table 22.6 EPA Intrusiveness Criteria

LOCATION	INTRUSIVENESS CRITERIA $L_{AEQ,\ 15\ MINUTE}$ LEVELS (DBA)		
	Day 7:00 am – 6:00 pm	Evening 6:00 pm – 10:00 pm	Night 10:00 pm – 7:00 am
Location 1 – Chelsmford Avenue	54	50	41
Location 2 – Dent Street	52	48	41
Location 3 – Jennings Street	45	44	45
Location 4 – North of Golf Course	62	55	48
Location 5 – Australia Avenue	47	45	47
Location 6 – Military Road	51	51	50

Amenity Criteria

In addition to the intrusiveness criteria, the INP recommends that noise levels from industry do not exceed the levels considered appropriate for the land use activity of the area (the noise "amenity" criteria).

The recommended amenity noise levels (L_{Aeq}) for residential properties in suburban and urban areas are shown in **Table 22.7** and **Table 22.8**. Based on the definitions contained in the INP, residential areas to the west of the golf club are considered suburban while those close to the golf club and those to the east of Beauchamp Road are considered to be urban (**Figure 22.1**). This distinction is made because those areas to the west of Beauchamp Road are generally not affected by industrial noise, but are affected by relatively distant road traffic noise. In contrast, those areas to the east of Beauchamp Road are affected by noise from the existing port operations and other heavy industry.

Table 22.7 EPA Residential Amenity Criteria – Suburban Area

AMENITY CRITERIA	NOISE LEVEL (TIME OF DAY)
$L_{Aeq,1hour}$	55 dBA during day time (7:00 am – 6:00 pm)
$L_{Aeq,4hour}$	45 dBA during evening (6:00 pm – 10:00 pm)
$L_{Aeq,9hour}$	40 dBA during night time (10:00 pm – 7:00 am)

Table 22.8 EPA Residential Amenity Criteria – Urban Area

AMENITY CRITERIA	NOISE LEVEL (TIME OF DAY)
$L_{Aeq,1hour}$	60 dBA during day time (7:00 am – 6:00 pm)
$L_{Aeq,4hour}$	50 dBA during evening (6:00 pm – 10:00 pm)
$L_{Aeq,9hour}$	45 dBA during night time (10:00 pm – 7:00 am)

The aim of the amenity criteria is to ensure that overall levels of industrial noise do not exceed these recommended levels. Where existing levels of industrial noise are above the recommended L_{Aeq} levels the amenity criterion for a new development is 10 dBA below existing levels. This would apply near the port, particularly east of Beauchamp Road.

When a new industrial noise source of a level 10 dBA below the existing level is added to the existing noise environment a noise level increase of 0.4 dBA above the existing noise level is the result. A 0.4 dBA increase is imperceptible to the human ear, which is the aim of this policy. A noise level increase of 2 dBA is considered barely perceptible.

In instances where existing levels of transportation are the dominant noise source and transportation noise exceeds the recommended L_{Aeq} levels by more than 10 dBA and future levels of traffic noise are not likely to reduce, then the acceptable noise level (ANL) becomes the existing traffic noise level minus 10 dBA. The project specific criterion is then derived using Table 2.2 of the INP such that when the new noise source is added to the existing industrial noise the overall industrial noise level does not exceed the ANL.

Overall Noise Criteria for the Port Botany Expansion

The noise criteria at the locations around the Port Botany Expansion have been determined in accordance with the intrusiveness and amenity criteria outlined above.

Port operations are expected to be carried out on a 24-hour basis, therefore, the most stringent criteria apply at night time. The night time criteria are shown in **Table 22.9**.

Table 22.9 Adopted Noise Criteria (Night Time)

LOCATION	LEVEL OF EXISTING INDUSTRIAL NOISE (DBA)	AMENITY CRITERION L_{Aeq} FOR THE NEW DEVELOPMENT ONLY (DBA)
Location 1 – Chelsmford Avenue	Not Measurable	40
Location 2 – Dent Street	Not Measurable	40
Location 3 – Jennings Street	44	39
Location 4 – North of Golf Course	48	40
Location 5 – Australia Avenue	48	38
Location 6 – Military Road	48	40

It can be seen from **Table 22.6** and **Table 22.9** that the night time intrusiveness criteria are at least 1 dBA higher than the night time amenity criteria. Therefore, the night time amenity criterion is more stringent at all locations. This becomes the project specific noise criterion at each location.

The night time amenity criteria is the $L_{Aeq,\ 9\ hour}$ measure for the night time period from 10:00 pm to 7:00 am. In the case of the Golf Club, Australia Avenue and Military Road, the high traffic noise approach has been adopted in accordance with the INP. Despite the fact that the traffic noise levels from Foreshore Road measured at Chelmsford Avenue and Dent Street were observed to be high, there are some houses in the area which are shielded to a greater degree from Foreshore Road. Accordingly, the high traffic noise approach was not used for these locations.

It should be noted that these amenity criteria apply to the proposed expansion and not to the existing terminals. The criteria for the new development at most locations is 10 dBA below the existing level of industrial noise, such that when added to the existing noise level, no perceptible increase in overall noise level occurs as a result of the proposed expansion.

Sleep Disturbance Noise Criteria

The EPA provides guidelines for individual transient noise events so as to avoid sleep disturbance from industrial operations. Noise between 10:00 pm and 7:00 am from industrial operations requires assessment in order to determine whether sleep disturbance may occur.

To avoid sleep disturbance from industrial operations, the EPA recommends that the $L_{A1,\ 1\ min}$ of the intruding noise should not exceed the background noise level by more than 15 dBA. The $L_{A1,\ 1\ min}$ represents the typical maximum noise level of transient events such as container impacts and horns.

Based on the measured background L_{A90} levels (Rating Background Level values in **Table 22.3**) the night time sleep disturbance criteria at the residential locations are given in **Table 22.10.** This is presented for Locations 1 to 6 (residential areas surrounding the port).

Table 22.10 L_{A1} Sleep Disturbance Criteria

LOCATION	L_{A1} SLEEP DISTURBANCE CRITERIA (DBA) Night 10.00 pm – 7.00 am
Location 1 – Chelmsford Avenue	51
Location 2 – Dent Street	51
Location 3 – Jennings Street	55
Location 4 – North of Golf Course	58
Location 5 – Australia Avenue	57
Location 6 – Military Road	60

It should be noted that some research presented in the NSW EPA *Environmental Criteria for Road Traffic Noise* (ECRTN) claims that internal noise levels of 50-55 dBA (corresponding to external noise levels of 60 to 65 dBA with windows open) are unlikely to cause awakening reactions. It is considered therefore, that the sleep disturbance criteria of background +15 dBA given in **Table 22.10** are conservative.

22.3.3 Operational Noise Criteria for Non-Residential Receivers

The INP also provides noise criteria for non residential noise sensitive receivers such as schools, churches and recreational areas. These criteria are reproduced in **Table 22.11** below.

Table 22.11 Noise Criteria for Non Residential Noise Sensitive Receivers

RECEIVER	ACCEPTABLE L_{AEQ}
School Classroom (Internal)	35 (1) (2)
Places of Worship	40 (1)
Passive Recreation Area (National Parks)	50
Active Recreational Area (School Playground, Golf Course)	55

Notes: *(1) With windows open this corresponds to an external criterion 10 dBA higher.*
(2) Where existing school classrooms are affected by existing industrial noise, the acceptable level may be increased to 40 dBA.

22.3.4 Road Transport Noise Criteria

Overall Traffic Noise

Criteria for road traffic noise are specified in the document *Environmental Criteria for Road Traffic Noise* (ECRTN) (1999) published by the NSW EPA.

Different criteria apply to different types of road development. The nominated road traffic noise criteria for the new terminal "*land use developments with the potential to create additional traffic on existing freeways/arterial roads*" and "*land use developments with the potential to create additional traffic on collector roads*" are reproduced in **Table 22.12**.

Table 22.12 Nominated Road Traffic Noise Criteria

TYPE OF DEVELOPMENT	DAY (7:00 am–10:00 pm) dBA	NIGHT (10:00 pm – 7:00 am) dBA	WHERE CRITERIA ARE ALREADY EXCEEDED
Land use developments with the potential to create additional traffic on existing freeways/arterials.	$L_{Aeq, 15\ hour}$ 60	$L_{Aeq, 9\ hour}$ 55	Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.
Land use developments with the potential to create additional traffic on collector road.	$L_{Aeq, 1\ hour}$ 60	$L_{Aeq, 1\ hour}$ 55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA.

From ambient traffic noise measurements conducted (see **Table 22.4**), it is clear that the above criteria are exceeded at all traffic noise monitoring locations (i.e. locations 7 to 9). The noise criterion which applies to all roads is, therefore, that additional traffic as a result of the proposed Port Botany expansion should not increase noise levels by more than 2 dBA. This criterion has also been applied to assess construction traffic noise through the construction period.

Sleep Disturbance Due to Truck Movements

The ECRTN also considers the potential for sleep disturbance due to traffic. It is recognised that transient events from traffic have different characteristics to other transient events in that they have a slower rise time or less sudden onset. The ECRTN states that:

- maximum internal noise levels of 50 to 55 dBA are unlikely to cause awakening reactions; and
- one or two noise events per night, with maximum internal noise levels of 65 to 70 dBA are not likely to affect health and well being significantly.

22.3.5 Vibration Criteria

Vibration standards are used to protect buildings against damage and to protect human comfort within buildings. The human comfort limits are the more stringent limits.

British Standard BS6472:1992 sets the following vibration limits for human comfort (above 8 Hz):

- 0.28 mm/s peak velocity within residences during day time; and
- 0.56 mm/s peak velocity within offices during day time.

In regard to potential building damage, the *German Standard DIN4150* suggests a limit of 10 mm/s peak particle velocity (ppv) within any normal building and the *British Standard BS7385: Part 2* - 1993 sets a limit within buildings which depends upon the vibration frequency and varies from 7.5 mm/s ppv at 4 Hz to 25 mm/s ppv at 40 Hz and above. Given that the bulk of the vibration energy from construction of the new terminal would fall in the range 10-100 Hz, it is reasonable to adopt an overall vibration limit to protect against building damage of 10 mm/s ppv.

DIN4150 also sets a vibration limit of 3 mm/s (ppv) at the foundation of heritage buildings and sensitive structures.

22.4 Assessment of Impacts

22.4.1 Construction Noise Impacts

Predictions of noise emissions from the proposed Port Botany Expansion during construction have been made by grouping together the noise sources for the various construction phases. **Table 22.13** presents the Sound Power Levels (L_{A10}) of plant likely to be used for the various phases of construction.

Table 22.13 Typical L_{A10} Sound Power Levels from Construction Plant

PLANT ITEM	SOUND POWER LEVEL (DBA)
Backhoe	107
Excavator	107
Dump Truck	109
Compactor	112
Bulldozer	119
Scraper	117
Vibrating Roller	106
Water cart	109
Grader	109
Front End Loader	109
Asphalt Paver	100
Bored Piling Rig	111
Dredge	108
Tug	93
Diesel Hammer	141

Predictions have been made for the noisiest construction stages only and these are presented in **Table 22.14.** The predicted noise levels shown in **Table 22.14** are expected to occur during normal day time construction hours, with the exception of dredging which would occur on a 24-hour basis.

Additional assessment locations (Livingston Avenue, Tupa Street and Waratah Road) in the vicinity of Location 2, which are anticipated to be impacted upon by construction activities, have been included as part of the assessment.

The noise levels expected from night time dredging would comply with the night time noise criteria. During day time, some construction activities would produce noise levels above the noise criteria, particularly wharf construction due to piling work. However, the assessment has taken a "worst case" approach and assumed the construction equipment would be located closest to the residences. Therefore, noise levels would be lower when construction occurs in the more distant areas of the port.

It is likely that some construction activities may overlap. In the worst case, where two activities are of similar noise level this would result in noise levels 3 dBA higher than the noisiest individual activity. Where one activity is significantly noisier than the other, the louder activity would dominate and the increase would be between 0 and 1 dBA. If one activity is 10 dBA quieter than the other then the overall noise level would be that of the noisier activity.

Table 22.14 Noise Levels from Construction

	PREDICTED CONSTRUCTION L_{A10} (LEVELS (DBA)							L_{A10} CONSTRUCTION NOISE CRITERIA (DBA)		
TIME PERIOD	CONSTRUCTION OF EMBANKMENT	SITE TRIMMING AND STABILISATION	PRE-LOADING	WHARF CONSTRUCTION	BEACH CONSTRUCTION (INCL. RECREATION AREA AND PENRHYN ESTUARY WORKS)	NIGHT TIME DREDGING[1]	TERMINAL FACILITIES	Daytime (7 am-6 pm)	Evening[2] (6 pm-10 pm)	Night Time[2] (10 pm-7 am)
Location 1: Chelmsford Ave	49	50	53	62	58	34 34	48	54	50	41
Location 2: Dent St	51	57	60	67	49	38 40	55	52	48	41
Livingston Ave	51	53	57	65	57	37 38	52	52	48	41
Tupa St	51	54	57	65	51	38 39	53	52	48	41
Waratah Rd	51	55	59	67	54	36 39	53	52	48	41
Location :3: Jennings St	28	32	35	47	25	8 18	29	45	44	45
Location 4: North of Golf Course	50	57	60	67	45	38 41	54	62	55	48
Location 5: Australia Ave	27	28	33	49	27	13 25	28	47	45	50

Notes 1: For the isothermal (first row) and temperature inversion conditions (second row).
2: Relevant to night time dredging works only.

Construction Traffic

The peak traffic generating year for construction would occur in the second year. During this year it is expected that approximately 100 trucks per day may enter the site. It has been assumed that all of these would travel along Foreshore Road. The distribution of these truck movements throughout the day cannot be predicted at this stage. However, assuming an even distribution across an 11-hour working day and based on existing traffic flows, the maximum contribution to existing traffic noise levels from construction traffic would be 0.3 dBA in any one hour on Foreshore Road.

This noise level contribution complies with the EPA *ECRTN.*

Vibration

Ground-borne vibration levels generated by typical construction activities associated with the Port Botany Expansion would depend upon the response of the ground at that site. The greatest vibration levels likely to arise from activities associated with the construction would result from impact piling.

Only approximate predictions of vibration levels can be made due to variations in ground conditions. For piling into unusually resistant materials, a vibration level of approximately 0.3 mm/s would result at a distance of 100 m. At 300 m, which is the approximate distance to the nearest sensitive receivers, the vibration level from piling would be approximately 0.05 mm/s. Therefore, the vibration criteria described in Section 22.3.5 would be complied with.

In respect of potential damage, at the closest building the most stringent limit of 3 mm/s for heritage buildings and sensitive structures would be complied with. The vibration comfort criteria would also be expected to be complied with.

22.4.2 Operation Noise Impacts

Operational Noise Sources

Predictions of operational noise from the new terminal have been made based on estimated noise levels for the activities and items of plant on the new terminal. L_{Aeq} noise levels for various items and combinations of plant and activities have been measured at the existing container terminals. These included:

- unloading of a ship at each berth using two quay cranes combined with four straddle carriers to transfer containers from the quay crane to the container stacking area;
- loading and unloading of trucks in the truck exchange area by straddle carriers or RMGs;
- general straddle carrier activity within the container stacking area;
- truck traffic on access roads;
- arrival of train at the rail siding on the terminal (both 400 m and 600 m sidings on new terminal have been considered);
- train idling while containers are unloaded by RMGs;
- ships auxiliary power units; and
- tugs (engine exhaust noise).

Modelling Assumptions

Noise level predictions from the new terminal were calculated assuming:

- four vessels would be in port: three along the western edge of the wharf and one on the southern berth;
- sound power levels for ship auxiliary power units would be near the lower end of the range of existing units to take account of technological improvement over time;
- most mobile equipment proposed for the new terminal would be operating in loading and unloading operations. All mobile equipment was modelled incorporating noise control kits;
- one train would be located on the terminal with two locos located at the northern end, during loading/unloading on the new terminal. The model also includes a loco situated on the main access rail loop to the new terminal parallel to Foreshore Road;
- audible alarms were included in the noise model to the extent they were measured in typical loading/unloading activities on the existing terminal; and
- the operational L_{eq} was calculated on the basis that across an eight hour shift, operations would occur for 6.75 hours with 1.25 hours downtime incorporating breaks and operator changeover time.

Operational Noise Calculations

Noise levels were calculated for still isothermal conditions, typical of a still warm night or day time.

The NSW EPA INP requires that where a temperature inversion occurs on at least 30% of winter nights, then it is a significant weather condition which would have an effect on noise levels in the area. Data from the periods 1 January 1997 and 31 December 1997, and 1 January 2000 and 31 December 2002 shows that inversions occurred on an average of 25% of winter nights. Accordingly, an assessment of noise levels under temperature inversion conditions was not required.

The INP also requires that noise levels be assessed for prevailing wind conditions when wind is a feature of the area. Wind is regarded as a feature of the area when any wind component occurs for at least 30% of the time in any direction for wind speeds up to 3m/s. An analysis of wind data from Sydney Airport collected over several years indicates that the dominant wind direction in all seasons is northwest. The season with the greatest percentage of winds in this direction is winter and the percentage of time in winter that this wind occurs is just over 30%. No other wind occurs more than 30% of the time from any direction or during any season.

Accordingly, assessment of noise for a northwesterly wind at 3m/s was included in the assessment in accordance with the INP.

Noise Control Measures

Preliminary estimates of noise levels in the surrounding area indicated that noise levels would exceed the criteria discussed in Section 22.3. Accordingly, consideration was given to a range of noise control measures which might be able to be incorporated into the Port Botany Expansion.

In addition to noise control kits used on mobile equipment, the construction of a noise barrier, generally on the northern and eastern side of the new terminal was considered the most practical form of noise control.

Three suitable locations for the barrier were identified, each with different merits. Accordingly, the noise operational levels were calculated for each of the three barrier options.

These barrier options were:

- *Option 1* – 4 m high barrier on site along the northern and eastern boundaries of the new terminal itself;
- *Option 2* – 4 m high barrier situated on the southern side of Foreshore Road; and
- *Option 3* – 4 m high barrier situated off site on the northern side of Foreshore Road.

Option 1 was the preferred option as it was considered the most effective in attenuating operational noise from the proposed new terminal, would be the least visually intrusive and would be located entirely on Sydney Ports Corporation land. Option 1 is shown on **Figure 22.2.**

Results of Noise Calculations – Noise Levels from Proposed Expansion

Table 22.15 provides the predicted noise levels from the operation of the new terminal at the nearest residential receiver locations. The three barrier options and noise control kits included and the levels are compared with the operational noise criteria. (Refer to **Table 22.9**).

Table 22.15 Predicted L_{Aeq} Levels for the Operation of the New Terminal Only at Residential Receivers

LOCATION		L_{AEQ} PREDICTED NOISE LEVEL (DBA) BARRIER OPTION			
		NO NOISE CONTROLS	BARRIER 1 + NOISE CONTROLS	BARRIER 2 AND 3 + NOISE CONTROLS	CRITERION
Location 1: Chelmsford Ave	Isothermal	44	38	39	40
	3 m/s wind from NW	41	35	36	
Location 2: Dent Street	Isothermal	49	43	44	40
	3 m/s wind from NW	48	41	42	
Livingstone Avenue	Isothermal	46	41	41	40
	3 m/s wind from NW	44	38	39	
Tupa Street	Isothermal	47	41	42	40
	3 m/s wind from NW	45	39	40	
Waratah Road	Isothermal	47	42	43	40
	3 m/s wind from NW	46	40	41	
Location 3: Jennings Street	Isothermal	28	27	28	39
	3 m/s wind from NW	34	34	34	
Location 4: North of Golf Course	Isothermal	49	43	44	40
	3 m/s wind from NW	50	45	46	
Location 5: Australia Avenue	Isothermal	26	25	26	38
	3 m/s wind from NW	36	33	36	
Location : Military Road	Isothermal	32	31	31	40
	3 m/s wind from NW	41	40	40	

Preferred Noise Wall Location **Figure 22.2**

Preferred Noise Wall Location (approx. 4m high)

The noise levels shown in **Table 22.15** are conservative as they are modelled on the port expansion operating at typical worst case (90th percentile operational capacity) at night.

Table 22.16 shows noise levels predicted at non-residential receivers.

Table 22.16 Predicted L_{Aeq} Levels for the Operation of the New Terminal Only at Non-Residential Receivers

LOCATION		L_{AEQ} PREDICTED NOISE LEVEL (DBA) BARRIER OPTION			
		NO BARRIER NO NOISE CONTROLS	BARRIER 1 + NOISE CONTROLS	BARRIER 2 AND 3 + NOISE CONTROLS	CRITERION
Church, Hannon	Isothermal	39	38	39	50 (1)
	3 m/s Wind	37	35	36	
Church, Rancon Street	Isothermal	45	40	40	50 (1)
	3 m/s Wind	44	38	39	
Banksmeadow Primary School	Isothermal	45	41	43	55 (1)
	3 m/s Wind	44	40	42	
Matraville Primary School	Isothermal	27	26	27	55 (1)
	3 m/s Wind	33	33	33	
Church, Bunnerong Road	Isothermal	26	26	26	50 (1)
	3 m/s Wind	33	34	33	
Sir Josephs Banks Park/Botany Golf Course	Isothermal	51	45	45	50 (2)
	3 m/s Wind	50	43	44	

Note: *(1) External noise criterion*
(2) Criterion is 55 dBA for Golf Course

The noise levels in **Table 22.15** and **Table 22.16** were predicted assuming no containers would be stacked on the site. In reality there will be container stacks in the central part of the site for most of the time and particularly when the operations are approaching capacity. These would have some shielding effect when situated between on site noise sources and sensitive receivers. Modelling assuming two high container stacks in conjunction with the 4 m noise barrier and noise controls to onsite machinery showed that predicted noise levels as given in **Table 22.15** and **Table 22.16** would be reduced by up to 1 dBA at some locations with a reduction of around 0.5 dBA being common.

It is evident from **Table 22.15** that with no noise mitigation the noise level criteria would be exceeded by the new port operations by up to 10 dBA. Installation of a noise barrier and noise mitigation to individual plant items is therefore recommended as these measures reduce noise levels by up to 7 dBA. **Table 22.16** shows that the most effective location for the noise barrier would be close to the terminal boundary on the northeastern and northern sides (Barrier Option 1).

With the barrier, the maximum exceedence of the criteria would be 5 dBA at Botany Road north of the Botany Golf Course during winds from the northwest. The exceedences at all other residences would be between 0 dBA and 3 dBA. No exceedences would occur at the non-residential receivers. It is important to note that It is only once the new terminal is fully developed that noise levels would reach the “worst case” levels predicted

by the noise modelling. By this time, technological and operational changes are likely to be available which would reduce operational noise levels at the new terminal.

With reference to **Table 22.4** it can be seen that, even without the noise mitigating barrier, L_{Aeq} levels from the Port Botany Expansion would be below existing ambient night time and day time L_{Aeq} levels.

Barrier Option 3 (north of Foreshore Road) would provide up to 6 dBA attenuation to the noise levels from the proposed expansion but would significantly reduce traffic noise levels from Foreshore Road by around 10 dBA. While this option may be desirable in terms of its reduction of traffic noise levels it would not be as effective in insulating against the effect of transient noise levels, for example container impacts.

Construction of Barrier Options 2 and 3 would also need to occur on land that is not owned by Sydney Ports Corporation and would entail a significantly greater visual impact.

It is therefore recommended that a 4 m noise barrier (Option 1) be constructed along the eastern and northern edges of the new terminal as it would be the most feasible and effective method of reducing operational noise impacts from the proposed expansion.

Sleep Disturbance Impacts

The predicted noise levels at each of the locations were assessed against the sleep disturbance criteria given in **Table 22.10.** Container impacts from the existing operations were measured north of the Botany Golf Course at L_{A1} 52 dBA to 57 dBA. This represents the typical range of noise levels, but high levels may result from time to time, particularly as a result of accidental container dropping.

Assuming Barrier Option 1, **Table 22.17** shows the typical range of L_{A1} levels to be expected from container handling. Higher levels may result in the occasional event of a container drop.

Table 22.17 Typical Predicted L_{A1} Noise Levels from Container Handling at New Terminal

LOCATION	PREDICTED L_{A1} (DBA)	CRITERION (DBA)
Location 1: Chelmsford Avenue	49 - 53	51
Location 2:		
Dent Street	53 - 59	51
Livingstone Avenue	52 - 57	51
Tupa Street	52 - 58	51
Waratah Road	52 - 59	51
Location 3: Jennings Street	33 - 45	55
Location 4: North of Golf Course	52 - 59	58
Location 5: Australia Avenue	31 - 43	57
Location 6: Military Road	18 - 35	

The upper end of the range of L_{A1} levels expected would exceed the sleep disturbance criteria at a number of locations, particularly to the north and northwest. However, many of these locations are already subjected to industrial noise impacts of levels similar to those predicted from the operation of the new terminal.

All predicted noise levels would be below the external level of 65 dBA which some researchers consider would not result in awakening reactions.

The assessment found that L_{A1} noise levels at residences to the north of the site would be expected to increase due to the new terminal. However, the proposed noise barrier would reduce these levels down towards current levels.

The number of audible container handling impacts likely to occur would vary widely from night to night, depending upon the location of the ship being loaded/unloaded and also the accuracy of the crane operator on the particular occasion. However, generally speaking it is probable that several impacts would occur during any night time hour period. The frequency of such impacts is expected to reduce in the future due to improved operator training and technological improvements in container handling equipment.

Apart from noise events being generated by existing port operations, local noise sources at all locations, particularly traffic on Foreshore Road and Botany Road, Bunnerong Road and Military Road, presently result in L_{A1} noise levels which exceed the EPA sleep disturbance criteria. Reduction of transient noises such as container impacts would be specifically addressed by a noise management plan as outlined in Section 22.5.2.

Results of Noise Calculations – Noise Levels from Combined Port Operations

The future noise levels resulting from the new terminal combined with the existing port facilities (P&O and Patrick Stevedore terminals) were calculated to enable consideration of the cumulative impact on residential receivers in the vicinity of Port Botany. Noise levels were based on both the proposed new terminal and the existing port facilities operating at capacity.

Table 22.18 provides a comparison of Port Botany with the new terminal in operation (i.e. including the new terminal) with the existing port operation at capacity.

Table 22.18 Predicted L_{Aeq} Levels for Expanded Port Botany Operations (with New Terminal) and Existing Terminal Operations

LOCATION		L_{AEQ} PREDICTED NOISE LEVEL (DBA)				
		FUTURE WITH EXPANSION[1]	FUTURE WITHOUT EXPANSION	DIFFERENCE	EXISTING AMBIENT L_{Eq} NIGHT TIME (10.00 pm – 7.00 am)	OVERALL CHANGE IN L_{Eq},9HR NIGHT TIME (10.00 pm – 7.00 am)
Location 1 Chelmsford Avenue	Isothermal	44	43	1	51	0.8
	Wind 3 m/s from NW	42	41	1		0.5
Location 2 Dent Street	Isothermal	49	48	1	57	0.7
	Wind 3 m/s from NW	47	46	1		0.4
Livingstone Avenue	Isothermal	46	45	1	57	0.3
	Wind 3 m/s from NW	44	43	1		0.2
Tupa Street	Isothermal	47	46	1	57	0.4
	Wind 3 m/s from NW	45	44	1		0.3

LOCATION		L_{AEQ} PREDICTED NOISE LEVEL (DBA)				
		FUTURE WITH EXPANSION[1]	FUTURE WITHOUT EXPANSION	DIFFERENCE	EXISTING AMBIENT L_{Eq} NIGHT TIME (10.00 pm – 7.00 am)	OVERALL CHANGE IN L_{Eq},9HR NIGHT TIME (10.00 pm – 7.00 am)
Waratah Road	Isothermal	48	47	1	57	0.5
	Wind 3 m/s from NW	46	45	1		0.3
Location 3 Jennings Street	Isothermal	41	41	0	51	0.4
	Wind 3 m/s from NW	44	43	1		0.7
Location 4 North of Golf Course	Isothermal	53	52	1	58	1.1
	Wind 3 m/s from NW	51	50	1		0.8
Location 5 Australia Avenue	Isothermal	44	44	0	49	0.7
	Wind 3 m/s from NW	46	46	0		1.8
Location 6 Military Road	Isothermal	47	47	0	58	0
	Wind 3 m/s from NW	54	54	0		1.5

Note *(1) With Barrier Option 1 and noise controls to machinery at the new terminal.*

Table 22.18 demonstrates that the maximum difference in noise level between the future operation with the new terminal and the existing terminals at capacity would be 1 dBA. A noise level difference of 1 dBA is considered by acoustic experts to be unnoticeable to the human ear.

22.4.3 Road Traffic Noise

Noise measurements were carried out Locations 7, 8, and 9 (refer to **Table 22.2**) to ascertain existing levels of traffic noise in the vicinity of the existing container terminals.

The EPA ECRTN sets noise criteria for developments likely to generate road traffic. The absolute noise criteria are already exceeded at Locations 7, 8 and 9 and at other locations near Foreshore Road by existing levels of road traffic in the area. The proposal should, therefore, not lead to an increase in existing noise levels of more than 2 dBA.

The noise level impact of traffic generated by the Port Botany Expansion has been modelled in terms of the noise level contribution from trucks using the new terminal and the change in absolute noise level due to the change in the number of trucks resulting from the proposed expansion.

Noise level predictions have been made using the *Calculation of Road Traffic Noise* (CORTN) model.

Noise level predictions made at capacity have been considered and the contribution of trucks from the new terminal to overall traffic noise levels (i.e. trucks plus other vehicles) has been determined. The *CORTN* model has been adopted to permit the calculation of hourly $L_{Aeq,1hr}$ levels using the acceptable approximation $L_{Aeq,1hr} = L_{A10,1hr} - 3$ dBA.

The traffic flow figures used in the calculations are based on predicted daily traffic flows provided by Maunsell Australia Pty Ltd distributed throughout the 24-hour period. Table 6-1 in **Appendix Q** shows the

contribution of the truck movements associated with the proposed Port Botany Expansion to overall future road traffic noise levels.

In all cases, the increased truck movement due to the proposed expansion would not cause an increase in overall noise level of more than 0.6 dBA. This is an unnoticeable change in noise level to the human ear.

Table 6-2 in **Appendix Q** shows the contribution of the truck movements associated with all container terminal operations at Port Botany (P & O and Patrick Stevedore terminals and the new terminal) to overall future road traffic noise levels.

As the predicted noise contribution from the new terminal is no more than 0.6 dBA and the cumulative noise increases are not more than 2 dBA, the noise level contribution of the Port Botany Expansion complies with the ECRTN.

Consideration has also been given to the reduction of existing road traffic noise.

As the contribution of port truck movements to overall future road traffic noise levels is small, no more than 2 dBA, modifications to port traffic or trucks would not have a significant effect upon existing road traffic noise levels on port transportation routes.

The only other effective form of traffic noise control that could be conceivably practicable in this case is the erection of roadside noise barriers. However, noise barriers adjacent to the roads would restrict access to these houses and are therefore not considered practicable.

In the case of Foreshore Road, the affected residences are north of the road. Option 3 barrier discussed in Section 22.4.2, being north of Foreshore Road, would provide some traffic noise shielding to these residences. However, this barrier would provide less attenuation to the port noise which is considered more significant and would create a more significant visual impact and block the connection between Sir Joseph Banks Park and the Bay. Accordingly, a barrier on the northern side of Foreshore Road is not proposed.

22.4.4 Rail Traffic Noise

Trains carrying containers to and from the new terminal would travel on the Botany Freight Rail Line (or part of the line) which exists between Port Botany and the Enfield Marshalling Yards. Beyond Enfield, freight trains share the rail network with passenger trains.

The freight rail line is a single track between the Botany Yard and Cooks River. The line was recently duplicated by RIC between Cooks River and Marrickville and it has been duplicated for some time between Marrickville and Enfield. There has been a commitment by the NSW Government to duplicate the remaining single track between the Botany Yard and Cooks River to encourage the use of rail to transport freight.

As part of the duplication of the Botany Freight Rail Line between Cooks River and Marrickville and the proposed duplication between Cooks River and Botany Yard, RIC has undertaken noise impact assessments to assess the impact of future freight rail use on land uses adjoining these sections of the rail line. Results of these noise assessments and discussion of the potential impact from the new terminal are outlined below. Discussion of potential noise impacts from rail freight associated with the new terminal beyond Marrickville is also provided.

Botany Yard to Cooks River

Noise modeling was undertaken by Environmental Results for RIC in April 2002 to assess noise impact from the proposed duplication of the Botany Freight Rail Line between Cooks River and the Botany Yard (a copy of this study is included in **Appendix Q**). This study was based on a predicted total of 35 train movements per day based on a total port throughput of 2.3 million TEUs. Sydney Ports Corporation predicts an increased capacity of 3.2 Million TEU for the port, including the proposed new terminal. Based on this throughput, a maximum of 54 trains per day would visit the port, of which 19 would be to/from the new terminal.

The noise report prepared for RIC identifies 23 dwellings at which noise levels would exceed the EPA criteria for rail noise, as contained in the EPA's *Environmental Noise Control Manual (*ENCM), due to the use of the duplicated line by 35 trains per day. These criteria are: 85 dBA L_{Amax} and 60 dBA $L_{Aeq,24hr}$.

Noise levels of up to 66 dBA $L_{Aeq,24hr}$ were predicted but would generally be up to 62 dBA. L_{Amax} levels were predicted to be up to 83 dBA which is within the guidelines. It is understood that six of the affected dwellings are home units which have acoustic treatment.

Environmental Results (2002) suggests that the upgraded track and proposed changes to train operations would result in some reductions in certain types of rail noise. The proposed duplication would minimise the need for trains to stop and start at crossings and intersections and therefore would reduce noise levels from locomotives decelerating, accelerating and the bumping noises from wagons. The use of locomotive horns would also be reduced.

An increased number of train movements, in accordance with Sydney Ports Corporation predictions would have an additional noise impact in terms of the frequency of disturbance (and hence the $L_{Aeq,24hr}$), but not the maximum level of noise in each passby (ie L_{Amax}).

On the basis that all the additional trains are assumed to have similar noise characteristics as those assessed for RIC, then the L_{Aeq} noise level adjacent to the rail line would increase in accordance with the number of movements. The increase in L_{Aeq} resulting from the predicted 54 trains per day in comparison to the 35 trains per day modelled by RIC has been calculated as approximately 2 dBA.

An increase of 2 dBA in the L_{Aeq} level is expected to be just noticeable to residents living adjacent to the line. Whilst a 2 dBA increase is normally not detectable by the human ear, it is expected to be detectable in this case because the increase in the number of movements would be detectable.

While there are no guidelines for the assessment of increased rail movements, equivalent guidelines for the assessment of road traffic (ECRTN) recommend a maximum L_{Aeq} increase of 2 dBA for developments which affect road traffic. It is therefore concluded that the 2 dBA increase would generally be consistent with the approach for road traffic noise.

An increase of 2 dBA could potentially result in up to 10 residences, in addition to the 23 identified in the RIC assessment, being within the 60-65 dBA noise contour. The estimated additional number of dwelling in this contour bracket is likely to closer to six, however, difficulty in determining additional dwellings relation to a 2 dBA increase within a 5 dBA contour has meant a conservative upper estimate of 10 has been adopted.

Rail noise for the NSW rail network, including the Botany Freight Rail Line, is being addressed through a whole-of-government approach coordinated by the OCGR. In particular, OCGR is working closely with RIC (the rail track owner and manager) and the NSW EPA (the regulatory authority for noise) on this matter.

Sydney Ports would liaise with OCGR as part of this process regarding freight generated by the new terminal.

Cooks River – Marrickville Section

As part of the duplication of this section of the Botany Freight Rail Line, a noise impact assessment was carried out for RIC by Richard Heggie Associates in October 2000. This assessment was based on a maximum number of 72 trains per day. The maximum of 54 trains related to the port (35 to/from existing operations and 19 to/from the new terminal) would be included within the assessment of 72 trains per day. The remaining 18 trains would include those only proceeding to Cooks River, without travelling to the port.

Richard Heggie Associates (2000) presents a summary of noise mitigation works that would be required to comply with EPA rail noise criteria at most residences. The report suggests that a combination of rail lubricating devices and noise barriers would be necessary. The report indicates that in the absence of noise controls approximately 90 dwellings in this section would be above EPA rail noise criteria. With noise barriers and other mitigation this number would reduce to approximately 20. Compliance with the $L_{Aeq,24hr}$ criterion is generally achieved with $L_{Aeq,24hr}$ of 54 to 59 dBA occurring. The L_{Amax} criterion of 85 dBA is, however, marginally exceeded with noise levels of 87 dBA occurring between Unwins Bridge Road and the Princes Highway.

RIC, together with the EPA, are presently undertaking a community consultation process to identify appropriate mitigation measures. However, the Port Botany Expansion would not change the results in the assessment undertaken by RIC or the extent of mitigation required.

The above assessments of train noise between the Botany Yard and Marrickville do not take into account any reduction in noise levels due to improved rolling stock and rail operation technology in the future. It would be expected however that improvements in diesel locomotive design and rail wheel interaction technology would result in reductions of overall noise levels.

Marrickville – Enfield Section

This section of the Botany Freight Rail Line shares the corridor (Marrickville to Campsie /Belmore rail corridor), with the Metropolitan Passenger network. Noise impacts from future freight and passenger movements through this corridor have not been previously assessed by RIC and no information was available on the current noise impacts along this section of the line.

Approximately 90 passenger trains (180 movements) currently travel along the shared Freight / Passenger Rail corridor each weekday, as part of the passenger service between Liverpool and the City. These trains would be significant contributors to noise along the corridor.

Based on information provided by RIC on the future freight movements on this section of the line and the port train estimates from Maunsell (2003), without the new terminal there would in the future be approximately 65 trains per day, with the new terminal there would be a total of some 83 trains.

The new terminal's contribution of 19 trains to the total freight and passenger trains on this line is small and would not create a perceptible increase in noise levels. Notwithstanding this, some attempt has been made to quantify the future change in freight noise associated with the new terminal. This change would in reality be much smaller between Marrickville and Belmore/Campsie as the noise contribution by the passenger trains is not included in this assessment.

The difference in noise due to train movements with and without the new terminal is calculated to be up to 1dB, which is considered to be barely perceptible to the human ear.

Beyond Enfield

Beyond Enfield, the Botany Freight Rail Line joins and shares the track with passenger trains. Assuming that all 19 trains from the new terminal travel beyond Enfield (which is conservative as trains could also travel to White Bay or on the Illawarra line to the South Coast), and considering the predicted breakdown of destinations from Enfield, approximately 50% of the 19 trains would travel on the western line, 25% on the northern line and 25% on the southwestern line. It is considered that the impact of the additional 19 trains from the new terminal, spread over the western, northern and southwestern lines, and entering into the passenger network, would be sufficiently "diluted" within the system such that the effects would not be considered significant.

22.5 Mitigation Measures

22.5.1 Construction

A Noise Management Plan would be developed for the construction of the Port Botany Expansion and would be incorporated into the Construction EMP for the project. Mitigation measures would include:

- *Piling noise* - Where impact piling cannot be avoided, all efforts would be made to reduce noise levels from the piling hammers. Resilient dollies would be placed in between the pile and the hammer. The hammer would also be shrouded to provide acoustic attenuation where practical. The exact degree of attenuation depends on hammer design and therefore cannot be predicted accurately at this stage.
- *Machinery noise control* – Where practical, noise levels from diesel powered machinery would be reduced by fitting noise control kits to machinery.
- *Awareness and training* – Provision of training to ensure that construction workers are aware of the noise created during construction and are appropriately trained to minimise noise where possible.
- *Complaints* – Complaints would be assessed and responded to in a quick and effective manner.
- *Noise monitoring* – Noise monitoring would be conducted to assess impacts from construction noise at monthly intervals and in response to any complaints which may be received.

22.5.2 Operation

A Noise Management Plan containing environmental management measures to assess and minimise noise from the operation of the new terminal would be developed. The Noise Management Plan would be included in the Operational EMP for the new terminal. Mitigation measures would include:

- *Noise Barriers* – A 4 m high barrier on site along the northern and eastern boundaries of the new terminal would be erected to reduce noise from the proposed new container terminal.
- *Machinery Noise Control* – Noise level emissions would be a criteria for selection of new plant for the site. The quietest possible plant that satisfied the operational performance specifications would be

selected and noise control kits fitted where required. Regular maintenance of machinery would be carried out to ensure optimal and efficient operation.

- *Equipment Alarms* –Audible safety alarms on some terminal equipment would be turned off during night hours (between 10.00 pm and 6.00 am) and replaced with visual alarms. It is understood that for certain types of equipment e.g. quay cranes (long travel alarm and high wind alarm) alarms are required to remain for safety reasons. In respect of other items of equipment, a safety assessment would be undertaken to identify where the audible alarms could be replaced with visual alarms without affecting safety.
- *Operator Awareness and Training* - Operator awareness and training would be regularly conducted. Good training and awareness of noise issues would be implemented to minimise poor cargo handling practices.
- *Complaints* – Complaints would be assessed and responded to in a quick and efficient manner.
- *Noise monitoring* – Noise monitoring would be conducted to assess impacts from the operation of the new terminal at locations most likely to be affected by the new terminal operations. The results of this monitoring would be discussed with the EPA and PlanningNSW to identify any responses required, although the predicted noise levels would not be expected to occur for some years after the commencement of operations in about 2010. By this time, technological and operational changes are likely to be available which would reduce operational noise levels at the new terminal.

The Noise Management Plan would also contain the option for shore power to be provided to ships in the future.

A Traffic Noise Management Plan would be developed for the new terminal. This plan would consider traffic route selection, traffic clustering and traffic rescheduling.

22.6 Conclusion

Construction activities would typically be undertaken during the day time, however, some activities, particularly dredging, would also be undertaken at night.

Construction noise levels expected from night time dredging would comply with the EPA guidelines for night time noise criteria. During day time, some construction activities would produce noise levels above the noise criteria, particularly wharf construction due to piling activities. However, a Noise Management Plan would be prepared to mitigate construction noise. The noise level contribution from construction traffic would comply with the ECRTN.

Vibration criteria to protect buildings from damage would be complied with. The vibration comfort criteria would also be complied with.

Modelling of operational noise levels at residences closest to the new terminal when the terminal is operating at a typical “worst case” indicated that the night time noise level criteria would be exceeded by up to 10 dBA without noise mitigation. Consideration was, therefore, given to a range of noise mitigation measures such as noise barriers and noise controls to machinery which could be incorporated into the Port Botany Expansion. A 4 m high noise barrier bordering the northern and eastern boundaries of the new terminal in addition to noise controls to machinery were considered the most effective noise mitigation measures.

Those measures reduce noise levels to a maximum of 5 dBA above night time criteria during certain weather conditions at residences to the north of the golf course, but typically between 0 and 3 dBA at the nearest residences. There would be no exceedences at non-residential locations.

It is also only once the new terminal is fully developed that noise levels would reach the “worst case” levels predicted by the noise modelling. By this time, technological and operational changes are likely to be available which would reduce operational noise levels at the new terminal.

With the proposed barrier and noise controls to machinery on the new terminal, total cumulative noise levels from all future port facilities (including the new terminal) would be no more than 1 dBA higher than noise levels from existing port terminals, operating at future capacity.

Sleep disturbance criteria at a number of locations, particularly to the north and northwest of the new terminal, would be exceeded. However, many of these locations are already subject to industrial noise impacts of levels similar to those to be expected as a result of the Port Botany Expansion. In addition, these predicted noise levels would be below the external level of 65 dBA which some researchers consider would not result in awakening reactions.

Noise levels from potential increases in truck movements from the Port Botany Expansion would comply with EPA traffic noise criteria as would the contribution to overall traffic noise levels from all port trucks when the entire port is at capacity.

Additional trains on the Botany Freight Rail Line, as a result of the Port Botany Expansion, would not result in significant increases in noise at residential areas adjacent to the line.

A Noise Management Plan, outlining environmental management measures to assess and reduce (where possible) noise levels, would be developed for the construction and operation of the new terminal. The Noise Management Plan would include options for noise barriers, equipment alarms, machinery noise control, noise monitoring, complaints handling and operator awareness programs.

A Port Traffic Noise Management Plan would be produced in conjunction with the operators of the existing and new terminals that would consider traffic re-routeing, traffic clustering and traffic re-scheduling to reduce the possible impacts of increased traffic on residences and sensitive receivers.

Summary of key outcomes:

Dispersion modelling of dust emissions from construction of the proposed new terminal showed that there are low risks that incremental airborne particulate matter (PM_{10})(24-hour) concentrations and monthly dust depositions would exceed the EPA site criteria of 16 $\mu g/m^3$ and 2 g/m^2/month respectively at residences closest to the work sites (to the north of Foreshore Road). Concentrations of PM_{10} during construction would result in at most two additional exceedences per year of the 50$\mu g/m^3$ criteria measured in the vicinity of the site in recent years, which is not considered to be significant. Predicted total suspended particulate concentrations are significantly lower than the EPA criteria of 90 $\mu g/m^3$ beyond the site boundary.

A Dust Management Plan, as part of the Construction EMP, would be prepared to mitigate offsite dust emissions from construction of the new terminal. In addition, a high-volume air sampler, three dust deposition gauges and an onsite meteorological station would be installed to monitor dust impacts during construction in surrounding residential areas and Penrhyn Estuary where dust impacts are likely to be greatest.

Air quality impacts from Port Botany's current and estimated future operations (i.e. including the existing container terminal and the new terminal) were assessed by dispersion modelling of both "peak" and "normal" operation. The potential for adverse air quality impacts from the operation of the proposed new terminal, combined with existing container terminals in the future, would be minimal. There would only be marginal increases in nitrogen dioxide (NO_2), carbon monoxide (CO), PM_{10} and sulphur dioxide (SO_2) concentrations in the areas surrounding Port Botany, with modelling results showing no exceedences of the NSW EPA criteria within residential areas or at sensitive receivers.

An assessment of greenhouse gas emissions found that construction and operation of the Port Botany Expansion would reduce overall greenhouse gas emissions in the future "Long Term" operating scenario when compared to the "do nothing" scenario. Therefore, there are significant advantages in terms of greenhouse emissions of locating additional container handling facilities within Sydney.

23.1 Introduction

The purpose of this chapter is to identify and analyse any air quality impacts of the proposal by examining existing air quality, determining air quality criteria, discussing sources of emissions to air from the construction and operation of the new terminal and proposing safeguard measures to mitigate potential air quality impacts.

This chapter presents a summary of the air quality impact assessment undertaken by Sinclair Knight Merz titled *Port Botany Upgrade EIS: Local Air Quality Study* (2003) which is provided in **Appendix R**.

The objective of the air quality study was to review the existing air quality in the Port Botany area and to provide an assessment of the likely impacts on air quality during the construction and future operation of the new terminal. To achieve this objective, the following tasks were undertaken:

- review of air quality issues as relevant to the construction and operation of the proposed new terminal;
- outline of ambient air quality objectives relevant to this project;
- description of existing climate and ambient air quality in Port Botany;
- quantification and assessment of air quality impacts relating to dust emissions during construction of the new terminal;
- quantification and assessment of air quality impacts relating to train, truck, ship and terminal equipment emissions during operation of the new terminal; and
- provision of safeguard measures to mitigate any adverse impacts and any on-going monitoring requirements.

23.2 Factors Affecting Air Quality

Air pollution is not a single entity, but comprises several types of pollutants, which may have separate sources and effects.

The main air quality impacts associated with construction of the new terminal would be restricted to dust emissions in the form of airborne particulate matter (PM_{10}) and deposited dust.

Sources of dust during reclamation and berth construction would include:

- dust from the dumping of rock to the temporary stockpile area, located at the site of the future boat ramp, and transfer of this rock to barge;
- wind erosion of the reclaimed terminal; and
- truck unloading of rock material associated with direct end tipping of rock material.

Sources of dust during the construction and installation of terminal facilities would include:

- dust from typical road making and pavement laying machinery and traffic;
- construction of road and rail infrastructure;

- construction of public open space areas;
- exposed ground for the installation of internal power, water and wastewater services;
- construction activity for installation of rail mounted gantries and main crane rails; and
- construction of site buildings.

The main air quality impacts associated with the ongoing operation of the proposed new terminal would include:

- emissions of airborne particulate matter (PM_{10});
- emissions of oxides of nitrogen (NO_x);
- emissions of sulphur dioxide (SO_2); and
- emissions of carbon monoxide (CO).

The majority of these emissions are from the use of fossil fuels for ships, trucks and trains, and for the powering of terminal equipment such as forklifts and straddle carriers.

23.3 Air Quality Criteria

There are two main types of air quality criteria relevant to the Port Botany Expansion:

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

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

In general, air impact assessment criteria are used to evaluate the expected impact of air emissions on air quality and, therefore, the need for any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant ambient air quality standards.

23.3.1 Ambient Air Quality Standards

In February 1998, the NSW EPA issued *Action for Air*, the NSW Government's 25-year Air Quality Management Plan (EPA 1998). In this plan the EPA adopted a number of regional ambient air quality goals for a range of air pollutants.

In addition, in June 1998, the National Environment Protection Council (NEPC) released a National Environment Protection Measure (NEPM) for Ambient Air Quality, setting out national standards and goals for six common ambient air pollutants (NEPC 1998). When reviewing the standards and goals set out in the NEPM for Ambient Air Quality, it should be noted that they are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria.

Ambient air quality standards for air pollutants expected to be emitted from the Port Botany Expansion are discussed below.

Total Suspended Particulates (TSP)

Suspended particulate matter is dust or aerosol that stays suspended in the atmosphere for significant periods. In general terms, suspended particulate matter has a diameter up to about 10 to 20 μm, although there is no sharp dividing line between suspended and deposited particulate matter, which rapidly drops out of the air.

Inhalable particulate refers to that portion of TSP which penetrates the upper respiratory tract and deposits in the fine airways of the lung. The indicator of inhalable particulate PM_{10} refers to that fraction of TSP with an aerodynamic diameter smaller than 10 μm. These particles have been recognised as being of greatest concern in terms of potential human health impacts because of their ability to reach the lower regions of the respiratory tract. Recent research, however, has indicated that particles with a diameter of less than 2.5 μm ($PM_{2.5}$) penetrate further into the lung and therefore pose a greater health risk.

Particulate matter is generated by industry, motor vehicles, refuse disposal, ocean salt, volcanic ash, products of wind erosion, roadway dust, bush fires and plant pollen and seed.

In *Action for Air*, the NSW EPA adopted the regional ambient air quality goals as shown in **Table 23.1.** Deposited dust, if present in sufficiently high levels, can reduce the amenity of an area. The NSW EPA, therefore, has maintained an annual guideline for TSP of 90 $\mu g/m^3$ which is designed to protect against amenity loss. The 24-hour average goal of 50 $\mu g/m^3$ adopted by the NSW EPA is the same as that set in the NEPM for Ambient Air Quality. The annual goal for PM_{10} adopted by the NSW EPA is 30 $\mu g/m^3$. There are no ambient air quality goals for $PM_{2.5}$ for the assessment of air pollutants in NSW.

Table 23.1 Suspended Particulate Ambient Air Quality Goals

POLLUTANT	GOAL $\mu G/M^3$ (1atm, 0°C)	AVERAGING PERIOD	AGENCY	NOTES
TSP	90	Annual	NSW EPA	Set to protect against amenity loss
PM_{10}	50*	24 hrs	NEPC (NEPM) and NSW EPA	Regional goal (by 2008) with maximum allowable exceedences of 5 days/yr
PM_{10}	30	Annual	NSW EPA	Long-term regional reporting goal

** 5 exceedences/year*

Deposited Particulate Matter

Deposited particulate matter is dust that, because of its aerodynamic diameter and density, falls from the air. In general terms, deposited particulate matter has a diameter greater than about 20 μm. Because of the size of the particulate matter, most of this material will not enter the body. Hence the effects of deposited particulates are primarily nuisance. This larger fraction of particulate would only be emitted from the site during construction activities.

The dust deposition rate is measured as the amount of dust deposited on a horizontal surface as a result of gravitational settling over a specified time period. The units for this parameter are grams per square metre per month (g/m^2/month).

There are no ambient air quality guidelines for deposited dust set in NSW other than the design criteria discussed in Section 23.4.2 and shown in **Table 23.5**.

Oxides of Nitrogen

Oxides of nitrogen, which include nitrogen dioxide (NO_2), nitric oxide (NO) and nitrous oxide (N_2O), are formed by the direct combination of oxygen and nitrogen during a variety of thermal processes. Of these compounds, it is NO_2 which is of most significance in terms of potential human health effects and it is this compound that is the focus of ambient quality guidelines and standards. NO emitted into the air, however, will react with the atmosphere to form additional NO_2, hence emission limits normally relate to total nitrogen oxide (NO_x) emissions expressed as NO_2.

Human activities that are sources of NO_2 include operation of internal combustion engines (motor vehicles being the major sources of NO_2 in the urban environment) and thermal power generating stations.

Ambient air quality criteria set in Australia for NO_2 are shown in **Table 23.2**. They include National Health and Medical Research Council (NHMRC) goals as well as the NEPM for Ambient Air Quality (NEPC 1998). These standards are set to protect the health of the general population taking into consideration sensitive individuals such as the young, the elderly and those with respiratory complaints. Although NHMRC goals have no regulatory status, they may be referenced by States and Territories as appropriate health guidelines.

Table 23.2 NO_2 Ambient Air Quality Guidelines

AGENCY	CONCENTRATION		AVERAGING PERIOD
	(ppm)	($\mu g/m^3$, 0°C)	
NHMRC	0.16	329	1 hour
NEPC (NEPM)	0.12*	246*	1 hour
	0.03	62	annual

** Goal includes a maximum number of allowable exceedences of one day per year.*

Sulphur Dioxide

Ambient air quality criteria set in Australia for SO_2 are shown in **Table 23.3**. Sulphur dioxide (SO_2) is a colourless, pungent, irritating and reactive gas, which is soluble in water. SO_2 and its reaction products (sulphurous and sulphuric acids and sulphate particles) are generally removed from the atmosphere by rain, and by direct uptake at plant, soil and water surfaces.

The main human activities that are sources of SO_2 include power generation from the burning of coal, oil or gas containing significant amounts of sulphur, the roasting or smelting of mineral ores containing sulphur, oil refining, and industrial plants that burn large quantities of fuels with a high sulphur content. In urban areas, motor vehicles contribute about 10% of ambient SO_2 levels.

Table 23.3 SO_2 Ambient Air Quality Guidelines

AGENCY	CONCENTRATION		AVERAGING PERIOD
	(ppm)	($\mu g/m^3$, 0°C)	
NHMRC	0.25	715	10 minutes
	0.20	572	1 hour
	0.02	57	annual
NEPC (NEPM)	0.20*	572	1 hour
	0.08*	229*	24 hours
	0.02	57*	annual

* *Goal includes a maximum number of allowable exceedences of 1 day per year.*

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas produced by the incomplete combustion of carbon in fuels. Major CO sources include transportation activities, as well as incinerators and industrial sources. When CO enters the bloodstream it reduces the delivery of oxygen to organs and tissues. Ambient air quality criteria set in Australia for CO are shown in **Table 23.4.**

Table 23.4 CO Ambient Air Quality Guidelines

AGENCY	CONCENTRATION		AVERAGING PERIOD
	(ppm)	($\mu g/m^3$, 0°C)	
NHMRC	9	11,250	8 hours
NEPC (NEPM)	9*	11,250*	8 hours

** Goal includes a maximum number of allowable exceedences of one day per year.*

23.3.2 Air Impact Assessment Criteria

In August 2001, the NSW EPA released a document entitled *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. This document lists a range of impact assessment criteria for air pollutants and has incorporated a number of the NHMRC and NEPM ambient air quality standards. The NSW EPA standards are the appropriate ones for assessing the impact of the Port Botany Expansion. The impact assessment criteria set for those pollutants relevant to the construction and operational aspects of the Port Botany Expansion are shown in **Table 23.5** and **Table 23.6.**

Deposited dust, if present in sufficiently high levels, can reduce the amenity of an area. **Table 23.5** shows the EPA's maximum acceptable increase in dust deposition over the existing dust levels.

Table 23.5 NSW EPA Criteria for Dust Deposition

EXISTING DUST DEPOSITION LEVEL (g/m^2/month)	MAXIMUM ACCEPTABLE INCREASE OVER EXISTING DEPOSITION LEVELS (g/m^2/month)	
	Residential	Other*
2	2	2
3	1	2
4	0	1

** Other refers to rural, semi-rural, urban, commercial and industrial.*

The maximum acceptable increase in the mean annual dust deposition rate is 2 g/m^2/month in those areas where the existing dust deposition rate does not exceed 2 g/m^2/month. The aim of the dust deposition criteria is to limit the total dust deposition rate to 4 g/m^2/month in suburban residential areas and to 5 g/m^2/month in rural, semi-rural, commercial and industrial areas.

The air quality objectives noted by the NSW EPA, which are relevant to assessing the construction and operational air quality impacts of this proposal are listed in **Table 23.6**.

Table 23.6 NSW EPA Impact Assessment Criteria Relevant to the Proposal

POLLUTANT	AVERAGING PERIOD	CRITERIA	NUMBER OF ALLOWABLE EXCEEDENCES DAYS/YEAR**
NO_2	1 – hour	12 pphm or 246 $\mu g/m^3$*	1
	Annual	3 pphm or 62 $\mu g/m^3$*	None
SO_2	10 – minute	25 pphm or 712 $\mu g/m^3$*	1
	1 – hour	20 pphm or 570 $\mu g/m^3$*	1
	24 – hour	8 pphm or 228 $\mu g/m^3$*	1
	Annual	2 pphm or 60 $\mu g/m^3$*	None
PM_{10}	24 – hour	50 $\mu g/m^3$*	5
	Annual	30 $\mu g/m^3$*	None
CO	15-minute	87 ppm or 100 mg/m^3	1
	1-hour	25 ppm or 30 mg/m^3	1
	8-hour	9 ppm or 10 mg/m^3	1

* *at 273 K and 101.3 kPa*

** *from the Ambient Air Quality NEPM*

23.4 Existing Environment

23.4.1 Climate

Average climate data for the Botany area was obtained from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Sydney Airport located at 33^0 56.46'S, 151^0 10.35'E and at an elevation of 6 m. A brief discussion of the data obtained is provided below.

Temperature

In general, the Botany area experiences a warm to mild climate. The annual mean of daily maximum temperatures is 22.1°C with an annual mean of daily minimum temperatures of 13.2°C.

The 9 am mean daily temperature ranged between 10.5°C in July and 22.3°C in January. The 3 pm mean temperature range is between 16.0°C in July and 24.7°C in February. January and February are generally the warmest months of the year with mean daily maximum temperatures of 26.3°C. July is the coolest month, experiencing a mean daily maximum temperature of 16.9°C.

Rainfall and Evaporation

On average, the Botany area experiences a mild seasonal variation in the distribution of rain, with most rain falling during the late summer and autumn months. The mean annual rainfall at Sydney Airport is approximately 1,106 mm, which occurs over an average of approximately 129 days. The driest month is September, which receives a mean monthly rainfall of 62 mm. The wettest months of the year are March and June, receiving 122 mm and 123 mm respectively. Rain typically falls on at least 9 days per month throughout the year, with the highest number of rain days (12) occurring during March.

Evaporation is generally strongest during the warm summer months and least during the cooler winter months. Mean monthly evaporation rates range from approximately 75 mm/month in June to 229 mm/month in December. Evaporation typically exceeds rainfall during all months except May and June.

Relative Humidity

Relative humidity varies on both a daily and seasonal cycle. On average, the 9 am humidity is highest during the cooler months from April to July. The annual range in 9 am humidity is between 61% in October and 75% in June. The 3 pm relative humidity readings are typically lower that the 9 am values, and are generally greatest during the warmer summer months. The 3 pm readings range between 50% in August and 63% in February.

Wind Direction and Wind Speed

Wind direction and wind speed observations are currently recorded by the BoM at Sydney Airport at 9 am and 3 pm only. Data collected at the Sydney Airport station since 1939 have been reviewed and examination of this data indicates the following:

- during summer, winds are predominantly from the south and by mid afternoon winds tend to move to more easterly directions;

- during late autumn and winter, winds from the west and the northwest predominate in the morning, with afternoon winds coming predominantly from the south to west. There are some afternoon winds that begin to come from the northeast by late winter;
- the percentage of winds from the northeast during the afternoon increases in spring, and then by summer this direction represents the highest percentage of wind directions during the afternoon;
- afternoon winds during autumn are from the northeast through to the south, with only a small percentage of winds blowing from westerly directions. By late autumn, afternoon wind directions from these westerly (and other) directions increase in percentage occurrence, however, winds from the south still dominate;
- during winter, afternoon winds are generally either from the south or west, however, winds from all directions are often experienced; and
- wind speeds are generally greatest during spring, with the highest monthly mean 9 am wind speed occurring during October. November and December experience the highest mean 3 pm wind speed. For all months of the year, wind speeds are lower in the morning, and then pick up in speed by the afternoon.

Wind roses based on the data collected at the Sydney Airport AWS are presented in **Appendix R**.

23.4.2 Existing Ambient Air Quality

Air quality within the area surrounding Port Botany is influenced by both local and regional pollutant sources, including road traffic, domestic sources, aircraft and a variety of industrial emissions. The proximity to local pollutant sources and the influence of sea breezes play significant roles in the dispersion of pollutants around Botany Bay.

Air quality monitoring data collected between July 2000 and August 2002 (26 months) from the nearby Sydney Airport monitoring site at Mascot (located approximately 2.7 km from the residential area closest to the site of the proposed new terminal) was used to describe the existing air quality in Port Botany. Monthly average and monthly maximum PM_{10}, NO_2, and SO_2 concentration data were compared with the criteria given in **Table 23.5** and **Table 23.6**.

Suspended Particulate (PM_{10})

The NSW EPA 24-hour criteria for PM_{10} of 50 $\mu g/m^3$ was exceeded for all of the summer months where data was available. In December 2001 and January 2002, bushfires were most likely the cause of the exceedences, with severe bushfires in Sydney at this time. The exceedences of the criterion during the cooler months of the year may likely be a result of the use of solid fuel heaters during this time of the year.

The NSW EPA has also adopted an annual (all hours) criteria for PM_{10} of 30 $\mu g/m^3$. From the data obtained at Mascot for the period during 2000 – 2002, the PM_{10} (annual) average is 20 $\mu g/m^3$, which is below the EPA criteria.

Dust Deposition

The NSW EPA criterion for dust deposition in residential areas is 4 g/m^2/month. The existing background dust level in the Port Botany region is 1.5 - 2 g/m^2/month, which allows an increment over existing levels of 2 - 2.5 g/m^2/month. In order to be conservative, the maximum acceptable increase over existing dust levels is taken as 2 g/m^2/month, which has therefore been used as the project specific criterion for impact assessment.

Nitrogen Dioxide (NO_2)

The site did not record any exceedences of the 1-hour average NSW EPA criteria of 246 μg/m^3 at any time from July 2000 to August 2002. The annual (all hours) background NO_2 concentration recorded at the Mascot site from July 2000 to August 2002 was 24 μg/m^3. This compares to the NSW EPA criterion of 62 μg/m^3.

Sulphur Dioxide (SO_2)

There have been no exceedences of the NSW EPA 1-hour and 24-hour criterion of 570 μg/m^3 and 228 μg/m^3 respectively, with recorded concentrations well below the criteria. The annual (all hours) background SO_2 concentration recorded at the Mascot site from July 2000 to August 2002 was 6 μg/m^3. This compares to the NSW EPA criterion of 60 μg/m^3. There have been no recorded 10 minute SO_2 concentrations.

23.5 Project Specific Air Quality Objectives

Having set out the recognised NSW EPA ambient air quality criteria (Section 23.4.2) and having summarised existing ambient air quality in Port Botany (Section 23.5.2), project specific ambient air criteria for key pollutants associated with the construction and operation of the new terminal were determined. The proposal's specific air quality criteria are the difference between the NSW EPA objectives and the background level for the respective pollutants. This is shown in **Table 23.7.**

Due to the timeframe of the project, the NSW EPA long term air quality goals (where appropriate) have been included in **Table 23.7**.

Table 23.7 Site Specific Air Quality Criteria

POLLUTANT	AVERAGING PERIOD	MONTHLY AVERAGE BACKGROUND*	MONTHLY MAXIMUM BACKGROUND*	AVERAGE BACKGROUND FOR IMPACT ASSESSMENT**	CURRENT CRITERION	
					NSW EPA CRITERION	PROJECT SPECIFIC CRITERION
PM_{10}	24 – hour	20 µg/m^3	47 µg/m^3	34 µg/m^3	50 µg/m^3	16 µg/m^3
	Annual	-	-	20 µg/m^3	30 µg/m^3	10 µg/m^3
Dust Deposition	-	-	-	15 –2 g/m^2/ month	4 g/m^2/ month	2 g/m^2/ month
SO_2	10 – minute	N/A	N/A	N/A	712 μg/m^3	712 μg/m^3 ***
	1 – hour	4 µg/m^3 (0.2 pphm)	49 µg/m^3 (1.9 pphm)	27 µg/m^3 (1.0 pphm)	570 µg/m^3 (20 pphm)	543 µg/m^3 (19 pphm)

POLLUTANT	AVERAGING PERIOD	MONTHLY AVERAGE BACKGROUND*	MONTHLY MAXIMUM BACKGROUND*	AVERAGE BACKGROUND FOR IMPACT ASSESSMENT**	CURRENT CRITERION	
					NSW EPA CRITERION	PROJECT SPECIFIC CRITERION
	24 – hour	6 µg/m^3 (0.2 pphm)	16 µg/m^3 (0.5 pphm)	11 µg/m^3 (0.4 pphm)	228 µg/m^3 (8 pphm)	217 µg/m^3 (7.6 pphm)
	Annual	-	-	6 µg/m^3 (0.2 pphm)	60 µg/m^3 (2 pphm)	54 µg/m^3 (1.8 pphm)
NO_2	1 – hour	24 µg/m^3 (1.2 pphm)	103 µg/m^3 (5.0 pphm)	64 µg/m^3 (3.1 pphm)	246 µg/m^3 (12 pphm)	182 µg/m^3 (8.9 pphm)
	Annual	-	-	24 µg/m^3 (1.2 pphm)	62 µg/m^3 (3 pphm)	38 µg/m^3 (1.8 pphm)

* *Average for all months July 2000 – August 2002*
** *The combined average of monthly average and monthly maximum values*
N/A Data not available
*** *Background data for 10-minute averaging period is not available. As such, the NSW EPA ambient air objective for SO_2 (10-minute) of 712 µg/m^3 is used to assess impacts*

Table 23.7 shows that the existing ambient PM_{10} and NO_2 concentrations make up a moderate proportion of the relevant NSW EPA criterion. Therefore, a project specific criterion based on the average of average and maximum ambient air quality data may potentially underestimate predicted PM_{10} and NO_2 impacts. As such, these pollutants were modelled using an hourly background air quality data file as input to the model such that the modelling predicts hourly impacts including both background and impact levels of air pollution. The meteorological data file used for modelling covers the same time period as the ambient air quality data.

23.6 Assessment of Impacts

23.6.1 Construction

Assessment Methodology

The methodology for assessing dust impacts from the construction of the new terminal was based on the NSW EPA guidelines *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (2001). An inventory of expected dust emissions from the construction of the new terminal was prepared and emissions were then modelled using the EPA regulatory air dispersion modelling software AUSPLUME (V5.4).

Modelled air quality for the construction of the proposed Port Botany Expansion takes into account existing air quality. To do this, air quality impacts determined by AUSPLUME included background PM_{10} concentrations. Hourly average background PM_{10} data were available over a period of 3 years from 2000 through to 2002. Where gaps existed in the data, a database of the hourly average background PM_{10} data from each of the three years was used.

Hourly meteorological data were also available for 2000-2002 to provide a time match of meteorological data to pollutant data.

In the period of assessment the background PM_{10} data revealed 27 exceedences of the PM_{10} (24 hour) criteria of 50 μg/m3 under existing conditions. As such, construction phase PM_{10} impacts were assessed by predicting the number of exceedences of 50 $\mu g/m^3$ over the 12-month assessment period.

Three construction scenarios were identified from the construction schedule as worst case scenarios in terms of dust emissions. These scenarios, defined over the most intense three month work periods for each of the first three years of construction, and the important construction activities within those periods, are listed in **Table 23.8**.

Table 23.8 Three Intensive Construction Activity Periods

3-MONTH PERIOD	CONSTRUCTION ACTIVITIES
Year 1 (Y1)	Boat Ramp/Tug Berth Construction, Dredging & Reclamation, Rock Embankment Placement.
Year 2 (Y2)	Tug Berth Construction (Truck Deliveries, Retaining Wall), Dredging & Reclamation, Rock Armouring (Wharf/Deck Construction), Beach Enhancement.
Year 3 (Y3)	Boat Ramp Construction (Wheel Generated Dust by trucks), Dredging & Reclamation (Pre-loading), Rock Armouring (Wharf/Deck Construction).

Dust impacts were assessed for PM_{10} (24-hour) concentrations, monthly dust deposition levels and annual TSP concentrations. Modelling incorporated certain levels of dust controls including watering of roads, application of water sprays and windbreaks for the scenario involving beach enhancement (Y2).

Predicted impacts at sensitive receivers and at residential areas were then compared to the NSW EPA air quality objectives and project criteria shown in **Table 23.7**.

Assessment Results

Air dispersion modelling results for dust emissions for the three construction scenarios are provided in **Table** 23.9**.** Contour plots produced by dispersion modeling are provided in **Appendix R**.

Table 23.9 Results of Air Quality Assessment – Construction Stage

KEY POLLUTANT AND AVERAGING PERIOD	SCENARIO	NSW EPA CRITERION ($\mu g/m^3$)	AVERAGE BACKGROUND CONCENTRATION* ($\mu g/m^3$)	SITE CRITERION ($\mu g/m^3$)	MAX CONCENTRATION AT A RESIDENTIAL RECEIVER ($\mu g/m^3$)
PM10 * (24-hour)	Y1	50 $\mu g/m^3$	34 $\mu g/m^3$	16 $\mu g/m^3$	~2 $\mu g/m^3$
	Y2	50 $\mu g/m^3$	34 $\mu g/m^3$	16 $\mu g/m^3$	~16 $\mu g/m^3$
	Y3	50 $\mu g/m^3$	34 $\mu g/m^3$	16 $\mu g/m^3$	~16 $\mu g/m^3$
Dust Deposition (Annual)	Y1	4 g/m^2/month	2 g/m^2/month	2 g/m^2/month	~0.3 g/m^2/month
	Y2	4 g/m^2/month	2 g/m^2/month	2 g/m^2/month	~2 g/m^2/month
	Y3	4 g/m^2/month	2 g/m^2/month	2 g/m^2/month	~2 g/m^2/month

** The PM10 results predict the sixth highest PM10 (24-hour) concentrations in order to provide direct comparisons with the NEPM PM10 objective that allows five PM10 (24-hour) exceedences of the 50 $\mu g/m^3$ criterion per year.*

The modeling results show that for:

- *Scenario Y1* - The PM_{10} (24-hour) impact predicted at nearby residential areas is approximately 2 $\mu g/m^3$, with most of the residential area to the north of Foreshore Road experiencing maximum PM_{10} (24-hour) impacts of 2 $\mu g/m^3$ or less. These results are well below the project-specific criterion of 16 $\mu g/m^3$.

  Additionally, the construction activity does not result in any additional exceedences of the PM_{10} (24-hour) criteria, when added to the measured background concentrations, within the residential areas closest to the construction area.

  Dust deposition predicted within residential areas does not exceed the project criterion of 2 g/m^2/month, with the houses closest to the work sites experiencing levels of less than 0.3 g/m^2/month. The majority of houses to the north of Foreshore Road are well below this level, with levels predominantly from 0.1 to 0.3 g/m^2/month.

  Annual TSP for this scenario is substantially lower than the EPA criteria of 90 $\mu g/m^3$ at all locations beyond the site boundary.

- *Scenario Y2* – The PM_{10} (24-hour) impacts predicted for nearby residences are less than or approximately equal to the project specific criterion of 16 $\mu g/m^3$. Most of the residential area to the north of the Foreshore Road experiences maximum PM_{10} levels of between 10 $\mu g/m^3$ and 16 $\mu g/m^3$.

  When added to the measured background concentrations of PM_{10} (24-hour), the construction operations at Port Botany have the potential to result in two additional exceedences of the PM_{10} (24-hour) criteria within the residential areas closest to the construction area. The NEPM for Ambient Air Quality allows for five exceedences of the 50 $\mu g/m^3$. As such, this result is not considered significant given the annual average of 27 exceedences of the 50 $\mu g/m^3$ criterion which has been measured in the vicinity of the site in recent years.

  Dust deposition does not exceed the project criterion of 2 g/m^2/month within any of the residential areas surrounding the construction area.

  Annual TSP for this scenario is substantially lower than the EPA criteria of 90 $\mu g/m3$ at all locations beyond the site boundary.

- *Scenario Y3* - The maximum PM_{10} (24-hour) impacts predicted for nearby residential areas are less than or approximately equal to the project-specific criterion of 16 $\mu g/m3$. Most of the residential area to the north of Foreshore Road experiences PM_{10} (24-hour) impacts of between 10 $\mu g/m^3$ and 16 $\mu g/m^3$.

  Similar to the Y2 scenario, construction operations at Port Botany have the potential to result in 2 additional exceedences of the PM_{10} (24 hour) criteria within the nearest residential area to the construction area. This result is not considered significant given the annual average of 27 exceedences of the 50 $\mu g/m^3$ criterion which has been measured in the vicinity of the site in recent years.

  Dust deposition does not exceed the project criterion of 2 g/m^2/month within any of the residential areas surrounding the construction area.

  Annual TSP for this scenario is substantially lower than the EPA criteria of 90 $\mu g/m^3$ at all locations beyond the site boundary.

The modelled results show there is not likely to be an impact on the visibility in the immediate area surrounding the site, with low dust concentration and deposition levels predicted in the area surrounding all runways and approaches. Therefore, aircraft operations would not be affected.

The impact of dust emissions from works within Penrhyn Estuary are considered to be minimal.

23.6.2 Operation

Assessment Methodology

The methodology for assessing operational impacts from the proposed new terminal was similar to that used for assessing construction impacts and is based on the NSW EPA guidelines *Approved Methods and Guidance for the Modelling and Assessment of Air Pollution in NSW* (August 2001).

Impacts of PM_{10}, SO_2, NO_x and CO from the operation of the new terminal were assessed using three scenarios:

- *Scenario 1* - existing case;
- *Scenario 2* - the proposed terminal operating by itself at a throughput of 1.6 million TEUs; and
- *Scenario 3* - all the terminals operating at a collective throughput of about 3.2 million TEUs.

Air quality impacts were assessed by developing an emissions inventory for both "peak" and "normal" operations at the terminals, and included the consideration of emissions from ships, trains, trucks, and dockside equipment. Operations were modelled 24 hours a day, 7 days a week. PM_{10}, SO_2, and NO_x emissions were then modelled using AUSPLUME and assessed in relation to the site specific air quality criteria described in **Table 23.7**.

Impacts from SO_2 emissions were assessed from ship emissions, as SO_2 emissions from trucks, trains and dockside equipment are particularly low compared to ship emissions, and would not have any significant impact on air quality.

The modelling of CO emissions to predict ground level concentrations was not undertaken as part of the impact assessment. CO emissions represent either a lower quantity of emission (g/s) compared to NO_x and SO_2 emissions (for the case of ship emissions), or are not more than one order of magnitude greater than NO_x emissions. The NSW EPA impact assessment criteria for CO are significantly higher (3 orders of magnitude) than for NOx and SO_2, and as such CO impacts expected at residential receivers would be much lower than the relevant criteria. Modelling of CO emissions was therefore not considered necessary.

Peak ship emissions were assessed by assuming a worst case scenario in any given hour, and a worst case positioning of ships whilst at berth at Port Botany (in terms of TEU size) was made. This is such that the ships with the highest emissions were positioned closest to residential receivers. Peak emissions were assumed to include:

- Scenario 1 – Six ships (three each at the Patrick Stevedores and P&O Ports terminals). All ships running auxiliary engines and two ships running main engines;
- Scenario 2 – Four ships at the new terminal (three at eastern berth and one on the southern berth). All ships running auxiliary engines and one ship running main engine; and

- Scenario 3 – Ten ships (four at the new terminal and three each at the Patrick Stevedores and P&O Ports terminals). All ships running auxiliary engines and two ships running main engines.

Traffic emissions were based on a traffic and transport study prepared by Maunsell (Nov 2002) for the proposed Port Botany Expansion. Peak truck and train emissions were determined from a "peak week", which was defined as 1.33 times the normal operational activity, in terms of truck and train arrivals.

Assessment Results

Incremental PM_{10} ground level concentrations are summarised in **Table 23.10**, results of NO_x emissions (modelled to predict incremental NO_2 ground level concentrations) are summarised in **Table 23.11,** while incremental SO_2 concentrations from ship emissions are summarised in **Table 23.12**. It is noted 10-minute, 1-hour and 24-hour averaging period model predictions are for "peak" emission rates from "peak" operations at the terminals, whilst annual averaging period model predictions are for normal annual averaged operation activity.

The results are compared to the site specific criteria which were described in **Table 23.7**.

Particulate Matter

The existing and proposed particulate emission sources were modelled to obtain estimates of current and proposed worst case offsite concentrations. Incremental PM_{10} ground level concentrations are shown in **Table 23.10**.

Table 23.10 Predicted PM_{10} Ground Level Concentrations

AVERAGING PERIOD	SCENARIO	SITE CRITERION ($\mu g/m^3$)	MAX CONCENTRATION AT RESIDENTIAL RECEIVER ($\mu g/m^3$)	*MAX CONCENTRATION BEYOND SPC TERMINAL BOUNDARY* ($\mu g/m^3$)*
24-hour	1 - Existing	16	4	*9*
	2 - New Terminal at 1.6 million TEU throughput	16	4	*7*
	3 - All Terminals at 3.2 million TEU throughput	16	7	*13*
Annual	1 - Existing	10	1	*2*
	2 - New Terminal at 1.6 million TEU throughput	10	1	*2*
	3 - All Terminals at 3.2 million TEU throughput	10	2	*4*

** on land, that is not including within Botany Bay*
Note: The PM_{10} results predict the sixth highest PM_{10} (24-hour) concentrations in order to provide direct comparisons with the NEPM PM_{10} objective that allows five PM_{10} (24-hour) exceedences of the 50 $\mu g/m^3$ criterion per year.

The results indicate that there are no exceedences of the site criterion for 24-hour and annual averaging periods for any of the scenarios.

The addition of the proposed new terminal would only provide a marginal increase in PM_{10} concentrations within neighbouring residential areas. The residential area most impacted by the addition of the proposed terminal (in terms of PM_{10} 24-hour impacts) is that around Phillip Bay and La Perouse. The maximum predicted incremental PM_{10} (24-hour) concentration at a residential receiver is 7 $\mu g/m^3$ (for Scenario 3), which compares to the site criterion of 16 $\mu g/m^3$ and the NSW EPA ambient air objective of 50 $\mu g/m^3$.

Oxides of Nitrogen

NO_x emissions (modelled to predict total NO_2 ground level concentrations, background plus impact) are shown in **Table 23.11.** Total NO_2 impacts were predicted in a similar manner to construction phase PM_{10} impacts by using an hourly background NO_2 file as input to the modelling.

Table 23.11 Predicted NO_2 Ground Level Concentrations

AVERAGING PERIOD	SCENARIO	EPA CRITERION ($\mu g/m^3$)	MAX CONCENTRATION AT RESIDENTIAL RECEIVER ($\mu g/m^3$)	*MAX CONCENTRATION BEYOND SPC TERMINAL BOUNDARY* ($\mu g/m^3$)*
1-hour	1 - Existing	246	200	*220*
	2 - New Terminal at 1.6 million TEU throughput	246	150	*175*
	3 - All Terminals at 3.2 million TEU throughput	246	210	*230*
Annual	1 - Existing	62	35	*40*
	2 - New Terminal at 1.6 million TEU throughput	62	34	*39*
	3 - All Terminals at 3.2 million TEU throughput	62	35	*40*

** on land, that is not including within Botany Bay*

Table 23.11 indicate that total NO_2 impacts do not exceed EPA criteria under any Scenario for either 1 hour or annual averaging periods.

Modelling results show that the operational NO_2 impacts do not at present or would not in the future cause any exceedence of EPA criteria when existing background levels are considered on an hourly basis.

Sulphur Dioxide

The existing SO_2 emission sources were also modelled to obtain estimates of current and proposed worst case off-site concentrations. The maximum ground level concentrations predicted by the model are shown in **Table 23.12**.

Table 23.12 Predicted SO_2 Ground Level Concentrations

AVERAGING PERIOD	SCENARIO	SITE CRITERION ($\mu g/m^3$)	MAX CONCENTRATION AT RESIDENTIAL RECEIVER ($\mu g/m^3$)	*MAX CONCENTRATION BEYOND SPC TERMINAL BOUNDARY** ($\mu g/m^3$)
10-minute	1 - Existing	712**	155	*190*
	2 - New Terminal at 1.6 million TEU throughput	712**	100	*115*
	3 - All Terminals at 3.2 million TEU throughput	712**	205	*205*
1 – hour	1 - Existing	543	145	*245*
	2 - New Terminal at 1.6 million TEU throughput	543	130	*170*
	3 - All Terminals at 3.2 million TEU throughput	543	210	*270*
24 – hour	1 - Existing	217	45	*70*
	2 - New Terminal at 1.6 million TEU throughput	217	45	*65*
	3 - All Terminals at 3.2 million TEU throughput	217	90	*100*
Annual	1 - Existing	54	3	*5*
	2 - New Terminal at 1.6 million TEU throughput	54	3	*5*
	3 - All Terminals at 3.2 million TEU throughput	54	8	*14*

* *on land, that is not included within Botany Bay*

** *background data for 10-minute averaging period is not available. As such, the NSW EPA ambient air objective for SO2 (10-minute) of 712 $\mu g/m^3$ is used to assess impacts*

The results indicate that there are no exceedences of the site criterion for 10-minute, 1-hour, 24-hour or annual averaging periods for any of the scenarios. The maximum incremental SO_2 (1-hour) concentration experienced beyond the site boundary is 270 $\mu g/m^3$ (for Scenario 3), which is less than half the site criterion of 543 $\mu g/m^3$. The maximum incremental SO_2 (1-hour) concentration experienced at a residential receiver (210 $\mu g/m^3$ for Scenario 3) is at houses immediately due east of the Amcor site (located on Botany Road, Matraville).

Carbon Monoxide

No dispersion modelling assessment of CO was undertaken as part of this assessment as CO emissions from port operations were lower than NO_2 emissions. As the CO criteria are significantly higher (three orders of magnitude) than for NO_x and SO_2, in all scenarios total CO emissions expected at residential receivers would be much lower than the relevant criteria.

23.7 Greenhouse Gas Considerations

Sinclair Knight Mertz (2002) undertook an assessment investigating several potential future operating scenarios for the transport of container cargo through Sydney in the long term (approximately 2020 to 2025). The options were assessed in terms of ESD, measured by greenhouse gas (carbon dioxide (CO_2)) emissions generated by road, rail and shipping transport of containers to and from Sydney.

The study found that construction and operation of the Port Botany Expansion would reduce overall greenhouse gas emissions by approximately 505,000 tonnes per annum in the future "Long Term" operating scenario, when compared to the "do nothing" scenario (refer to **Appendix R**). These reductions are largely a result of the decrease in the total kilometres travelled by trucks and trains which would otherwise have to travel from other locations within NSW or from interstate to Sydney to deliver cargo, in the absence of the Port Botany Expansion.

Therefore, there are significant advantages in terms of greenhouse emissions of locating additional container handling facilities within Sydney.

23.8 Mitigation Measures

23.8.1 Construction

The potential for offsite dust emissions from exposed work areas during the construction of the new terminal would be minimised through the development and implementation of a Dust Management Plan (DMP) as part of the Construction EMP that would be prepared for the project. The DMP would include those mitigation measures that were incorporated into the air quality modelling such as:

- apply water, through the use of water trucks, to active earthwork areas, stockpiles, gravel roads and loads of soil being transported to reduce wind blown dust emissions;
- site roads to consist of coarse gravel and to be kept wet to minimise wheel generated dust emissions;
- place a thin bituminous membrane layer to sections of the reclaimed area not being used for considerable periods of time, but where subsequent construction activities are to take place on site, to stabilise and reduce wind blown dust emissions; and
- construct wind breaks along an appropriate work zone on Foreshore Road during beach enhancement to reduce wind erosion from the work area.

The DMP would also include safeguard measures such as:

- keep the working face and areas of open excavation to a minimum;
- vegetate stockpiles where material is to remain on site for a long period of time;
- cease work if excess dust is observed, or phase down while the source is being actively investigated and suppression measures are implemented;
- restrict construction traffic to defined roads and implement a speed limit;
- remove soil adhering to the wheels and undercarriage of vehicles prior to departure from the site; and

- progressively landscape and vegetate areas as the construction activities proceed, where practical.

23.8.2 Operation

The results of this assessment show that operational impacts on air quality associated with the Port Botany Expansion are acceptable. On a local scale the incremental increase in emissions of PM_{10}, NO_2, SO_2 and CO do not result in any exceedence of the NSW EPA air quality objectives. In terms of greenhouse gases, the future operation of an expanded Port Botany is shown to result in lower emissions (quantified as CO_2) when compared with the "do nothing" scenario. As a result, no specific air quality mitigation measures would be required during operation of the new terminal.

Notwithstanding the fact that the proposed expansion is shown to result in acceptable impacts, the new terminal would be designed and constructed such that it could support the use of alternative energy for ships at berth (i.e. shore power), should ships be able to accept such power in the future. This would reduce ship emissions in the local area.

23.9 Monitoring

23.9.1 Air Quality Monitoring

Prior to and during construction, monitoring in areas considered most likely to receive dust impacts during the construction period would be undertaken. All monitoring would be undertaken in accordance with the NSW EPA *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (2001). All monitoring devices would be located in accordance with *Australian Standard AS 2922-1987 – Ambient Air - Guide for Siting of Sampling Units*.

In particular, one high-volume air sampler (HVAS) would be installed within the residential area to the north of Foreshore Road, preferably to the south of Botany Road. This location is shown by dispersion modelling to receive the greatest dust impacts during construction. This HVAS would monitor PM_{10} on a six-day cycle in accordance with *Australian Standard AS 3580.9.6-1990 – Particulate matter – PM_{10} – high-volume sampler with size-selective inlet*.

Three dust deposition gauges would also be installed within residential areas – two in the residential area north of Foreshore Road, and one in the Matraville residential area immediately east of Amcor (Botany Road, Matraville). An additional dust deposition gauge would also be located in Penrhyn Estuary. To ensure minimal impact on sensitive habitats and to minimise the potential for sedimentation in shallow waters, on going monitoring of sediment levels within these sensitive areas would be undertaken. Sampling would be undertaken in accordance with *Australian Standard AS 3580.10.1-1991 – Particulates – deposited matter (gravimetric method)*.

Monitoring would commence 6 to 12 months prior to the commencement of construction. The purpose of the initial monitoring would be to confirm if the background PM_{10} and dust deposition levels are consistent with the background levels set out in Section 23.6. Once construction commences, monitoring would assist in identifying any levels above PM_{10} (24-hour) of 50 $\mu g/m^3$, and where these episodes are reported and shown to be attributed to the earthworks at the site, additional dust management measures would be implemented.

23.9.2 Meteorological Monitoring

A meteorological monitoring station would be installed at the existing port. The meteorological station would be installed in accordance with *Australian Standard AS 2922-1987 – Ambient Air – Guide for Siting of Sampling Units* and *Australian Standard AS* 2923-1987 *– Ambient Air – Guide for the Measurement of Horizontal Wind for Air Quality Applications*.

The primary purpose of the meteorological monitoring station is to collect data sufficient to identify whether adverse air quality impacts within neighbouring residential areas can be attributed to construction works for the new terminal.

23.10 Conclusion

An assessment of the existing ambient air quality within the Port Botany local area was made and an air quality impact assessment undertaken for the construction and operation of the new terminal and the existing and future operation of the existing container terminals. Impacts were compared to the NSW EPA ambient air quality objectives, taking into account the existing air quality.

Dispersion modelling of dust emissions from construction of the proposed new terminal showed that PM_{10} (24-hour) concentrations and monthly dust depositions did not exceed the project criterion of 16 $\mu g/m^3$ and 2 g/m^2/month respectively at residences closest to the work sites (to the north of Foreshore Road) for the periods of maximum construction activity. Concentrations of PM_{10} during construction would result in at most two additional exceedences per year of the 50$\mu g/m^3$ criteria measured in the vicinity of the site in recent years, which is not considered to be significant. Predicted TSP concentrations are significantly lower than the EPA criteria of 90 $\mu g/m^3$ beyond the site boundary.

A DMP, as part of the Construction EMP, would be prepared to mitigate offsite dust emissions from construction of the new terminal. In addition, a high-volume air sampler, three dust deposition gauges and an onsite meteorological station would be installed to monitor dust impacts during construction in surrounding residential areas and Penrhyn Estuary where dust impacts are likely to be greatest.

Air quality impacts from Port Botany's current and estimated future operations were assessed by dispersion modelling of both "peak" and "annual averaged" (normal) operation. The potential for adverse air quality impacts from the operation of the proposed new terminal, combined with the P&O Ports and Patrick Stevedores terminals, at a throughput of 3.2 million TEUs, is minimal. There are expected to be only marginal increases in CO, NO_2, SO_2 and PM_{10} concentrations in surrounding areas due to the Port Botany Expansion, with modelling results showing no exceedences of the site criteria within residential areas or at sensitive receivers.

An assessment of greenhouse gas emissions found that construction and operation of the Port Botany Expansion would reduce overall greenhouse gas emissions in the future "Long Term" operating scenario, when compared to the "do nothing" scenario. Therefore, there are significant advantages in terms of greenhouse emissions of locating additional container handling facilities within Sydney.

Summary of key outcomes:

No Aboriginal sites were recorded between the Parallel Runway and Molineux Point, including the foreshore area, and the potential for Aboriginal relics in this area is negligible.

The main European heritage item in the primary study area is the former Government Pier. The remains of this structure can be seen at the southeastern end of Foreshore Beach. The significance of the Pier lies in its association with the Government's first attempt at fostering trade and creating port infrastructure within Botany Bay. The Pier would be conserved by Sydney Ports Corporation as part of the development.

The location of the former Sir Joseph Banks Hotel Jetty and baths, that were built in front of the Sir Joseph Banks Hotel Pavilion, and Dent's Boatyard Jetty are partially located within the development area, although these locations have been covered by previous foreshore reclamation. It is unlikely that physical evidence relating to these structures have survived beneath the current land surface. However, any subsurface disturbance in the vicinity of these jetty locations would be monitored with a view to detecting any remains, should they exist.

With the implementation of the mitigation measures described in this chapter, the Port Botany Expansion would not have a significant impact on European heritage items.

Within Botany Bay, including the foreshore areas, the hydrodynamic and coastal processes study showed that there would be negligible change to waves, currents, and coastal processes. Therefore, the potential impact on any Aboriginal or European cultural resource around the Bay would be negligible.

24.1 Introduction

This chapter is based on the report *Cultural Heritage Assessment of the Proposed Port Botany Expansion. An assessment of maritime and terrestrial archaeological potential* (January 2003) by Navin Officer Heritage Consultants in conjunction with Cosmos Archaeology Pty Ltd. This report is presented in **Appendix S**.

This chapter describes the existing Aboriginal, European and Maritime heritage values and items, and assesses any impacts of the proposed Port Botany Expansion on these items.

24.2 The Study Area

The study area for the primary cultural heritage assessment consisted of the area between the Parallel Runway and Molineux Point, and bounded to the north by Foreshore Road as shown in **Figure 24.1**. This area includes the proposed new terminal, areas of dredging, Penrhyn Estuary, Foreshore Beach and adjacent areas.

As the implementation of the proposed development may have indirect impacts beyond the immediate vicinity of the works, a secondary study area was broadly established which encompasses all of Botany Bay.

24.3 Study Methodology

A study methodology has been implemented to ensure that the assessment of Aboriginal, European and Maritime heritage issues associated with the Port Botany Expansion is both comprehensive and sound in relation to accepted practice and regulatory requirements.

24.3.1 Land-based Assessment

The methodology for the land based assessment included the following steps, which are detailed below:

- literature and document review;
- consultation; and
- land-based field surveys.

Literature and Document Review

Background research into the cultural heritage and archaeological resources of the study included:

- a review of heritage and archaeological literature relating to the site;
- a review of the heritage listings held by the Australian Heritage Commission, the Heritage Council of NSW, the National Trust of Australia (NSW), and local heritage schedules compiled by Botany Council; and
- a review of site cards, reports and associated documents relevant to the study area held by NPWS on the Aboriginal Sites Register of NSW and the National Native Title Tribunal.

Source: Navin Officer 2003

0 500 2000m

Cultural Heritage Assessment - Study Area **Figure 24.1**

Secondary Study Area

Primary Study Area

Consultation

The primary study area falls within the La Perouse Local Aboriginal Land Council (LALC) boundaries. A meeting was held on Thursday June 27, 2002 with the LALC to discuss the Port Botany Expansion. Present at the meeting were representatives of the LALC and two La Perouse Aboriginal elders.

Community members were familiar with the history of the primary study area and knew that the proposed development was planned for an area located well beyond the original pre-contact shoreline due to previous reclamation activities in the northern part of Botany Bay. Their concerns were therefore not about direct impact on Aboriginal sites, but did include concern about any possible indirect impact on Aboriginal sites around the Bay in areas such as Towra Point.

Land-Based Survey

A field survey of the primary study area was undertaken to identify all visible Aboriginal and European heritage sites and features, and to define areas of archaeological potential that may require further management. Particular attention was paid to exposed soil sections, significant features or structures and areas of obvious disturbance.

The history of Aboriginal use of the area, past archaeological investigations, and site history since European settlement were used to assess the nature and likely distribution of Aboriginal and European sites in, and immediately adjacent to, the primary study area. The level of surface and subsurface disturbance was analysed to determine if and where intact deposits might remain. Areas of potential deposits were identified based on this information and checked against field observations.

24.3.2 Maritime Assessment

The methodology for the maritime assessment included the following steps:

- identification of the potential for the presence of cultural deposits and structures within the primary study area;
- visual inspection of the study area (above, not underwater);
- assessment of the condition of cultural remains not visible – buried or underwater;
- preliminary significance assessment of the identified cultural remains;
- determination of the impact of the proposed development on the identified cultural remains within the primary study area;
- determination of the impact of the proposed development on the potential cultural remains within the secondary study area; and
- recommendation of mitigation measures.

The presence of various types of cultural formations or deposits that could exist in the study area was assessed, including:

- shipwrecks;
- maritime related structures;

- cultural deposits formed from littoral sites;
- cultural deposits formed offshore; and
- submerged terrestrial sites.

24.4 Legislative Requirements

There are a range of statutory measures at both State and Commonwealth levels which can be invoked to protect cultural and natural heritage features and places. Relevant legislation is outlined below.

24.4.1 NSW Heritage Act 1977

The purpose of the NSW *Heritage Act* 1977 is to ensure that the heritage of New South Wales is adequately identified and conserved. In practice the NSW *Heritage Act* 1977 has focussed on items and places of European heritage to avoid overlap with the *National Parks and Wildlife Act* 1974 (NPW Act), which has primary responsibilities for nature conservation and the protection of Aboriginal relics and places in NSW.

Generally protection under the *Heritage Act* 1977 is given to items that have been identified, assessed and listed on various registers including State government Section 170 registers, local government Local Environmental Plans and the State Heritage Register. The only blanket protection provisions in the Act relate to the protection of archaeological deposits and relics greater than 50 years old.

Section 139 of the Act specifically provides protection for any item classed as a relic. A relic is defined as:

> "*...any deposit object or material evidence:*
>
> *(a) which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement; and*
>
> *(b) which is 50 or more years old.*"

Section 139 (1) of the Act states that:

> *"A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit."*

The Act requires that an application for an excavation permit should be lodged with the NSW Heritage Office, prior to any works with the potential to disturb "*relics*" as defined under the Act. In practice, excavation permits are required only for relics that according to their assessed heritage significance warrant this form of documentation and control.

Section 146 of the Act requires that the discovery of a previously unknown relic be reported to the Heritage Council within a reasonable time of its discovery. At the time of writing, any cultural feature deposited or constructed in 1953 or earlier is considered a 'relic' under the Act and requires a permit to disturb.

In general, the Act is also used as a means of protecting shipwrecks but only within inland and state waters. Although, the Act may also protect maritime relics within three miles of the coast. In NSW, the Commonwealth *Historic Shipwrecks Act* 1976 is generally applied as the principal means of protecting

shipwreck sites and associated artefacts. Other, maritime relics such as wharves, jetties or aeroplane wrecks are considered to be included in the general application of the NSW *Heritage Act* 1977.

24.4.2 NSW National Parks and Wildlife Act 1974

The NPW Act provides the basis for the legal protection and management of Aboriginal sites within NSW. The implementation of the Aboriginal heritage provisions of the NPW Act is the responsibility of the NSW NPWS.

The NPW Act aims to prevent the unnecessary or unwarranted destruction of Aboriginal relics, and the active protection and conservation of Aboriginal relics that are of high cultural significance. Generally, it is an offence to disturb or excavate any land for the purpose of discovering, disturbing or moving a relic without the written consent of the Director-General of the NPWS under section 90 of the NPW Act. Consents regarding the use or destruction of relics are managed through a NPWS permit system. The issuing of permits is dependent upon archaeological review and assessment and liaison with the Aboriginal community.

24.4.3 NSW Aboriginal Land Rights Act 1983

The *Aboriginal Land Rights Act* 1983 was designed to give control over land, where possible, to local Aboriginal communities. Section 36 of the Act defines claimable land as Crown Land which is not lawfully used or occupied and which is neither needed nor likely to be needed for "*an essential public purpose*". The NSW Department of Lands includes the following as lands which need to be retained for future public purposes: lands needed or likely to be needed for conservation reserves, dams, forestry, flood mitigation, urban, commercial and industrial development, public recreation, and public access.

The study area does not meet the definition of claimable Crown Land and so the provisions of this statute do not apply.

24.4.4 Commonwealth Native Title Act 1993

The *Native Title Act* 1993 was enacted to recognise and protect Native Title, which can be defined as the "*rights and interests in land and waters that Aboriginal and Torres Strait Islander people have under laws and customs and that are recognised by the common law*" (section 223).

The proposed Port Botany Expansion lies within the boundary of the Dharug Tribe Aboriginal Corporation Native Title Claim (Federal Court File # NG6061 of 1998), however, it is not within the "*Area of Application subject to claim*". This claim was accepted for registration in 1997 and has not yet been finalised. The application covers "*specifically identified parcels of Crown Land within an external boundary*". The claim does not cover the waters of Botany Bay and the foreshore area within which the proposed development area is located. The closest parcel of claimed land is located approximately one kilometre north-northwest of the primary study area.

24.4.5 Commonwealth Australian Heritage Commission Act 1975

The *Australian Heritage Commission Act* 1975 established the Australian Heritage Commission as the Commonwealth Government's adviser on the protection of Australia's National Estate. Section 4(1) of the Act defines the National Estate as consisting:

> *"of those places, being components of the natural environment of Australia or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as for the present community."*

The Australia Heritage Commission maintains a Register of the National Estate.

The Act places obligations on Commonwealth Ministers, departments and authorities to protect the National Estate. Such government bodies should ensure that their actions do not adversely affect the national estate values of places in the Register, unless there are no feasible and prudent alternatives, in which case all reasonable measures should be taken to minimise the adverse effect.

There would be no impacts on places on the Register of the National Estate as a result of the proposed Port Botany Expansion.

24.5 Cultural Heritage Context

In considering the potential and known cultural heritage resource in the primary study area, it is important to understand the history of the area so that any sites, relics or material evidence may be assessed within the historical context of Botany Bay and its environs. This section provides a historical framework for Botany Bay with an emphasis on the northern side of the Bay.

24.5.1 Aboriginal Heritage

Within the period of the human occupation of Australia, Botany Bay was once dry land. The present day sea level at Botany Bay would have been reached approximately 6,200 years ago.

The topography of the study area prior to inundation would have been similar to that which existed along the northern shore of Botany Bay at the time of European arrival - scrubby sand dune systems punctuated by swamps in the hollows and occasionally linked by watercourses. The resources that were available in this diverse environment would have been valuable and supportive of relatively large and sedentary populations.

During the latest rise in sea level, the inhabitants of the study area would have gradually abandoned their camp sites and moved to higher ground. In the process, it is inevitable that they left behind cultural material. Such remaining artefacts would have been inundated by rising sea levels. The forces of wave action, tidal influences and currents would have washed away, or at least re-deposited, large amounts of artefacts. Organic materials, in particular, would have been exposed to both mechanical abrasion and biological attack and would have stood little chance of surviving. Therefore, the chances of any material surviving, or staying recognisable, in such conditions is negligible.

The chances of survival for artefacts during inundation would be influenced by their location. Exposed artefacts would be most affected by environmental conditions whereas material left in somewhat protected areas would have stood a much higher chance of surviving *in situ*. Areas containing rock shelters and caves

have the potential to contain significant cultural deposits. Many of these deposits will be buried under marine sediments.

Given the situation of the Port Botany study area, which is exposed to a five kilometre fetch to the south, it is very likely that open sites and middens would have been scrambled by wave action during inundation. Lithics from submerged terrestrial sites could be present, however, their contexts would be so ambiguous that it would greatly diminish their archaeological value. The geomorphology of the area suggests that submerged rock shelters potentially protecting archaeological contexts, and common elsewhere in the Sydney area, would be unlikely to be present. In addition to these natural effects, there exists a large depression in the sea bed within the study area that is the result of dredging for the Parallel Runway. No archaeological remains would be expected to remain in this part of the primary study area.

24.5.2 Post-European Contact

Captain Cook arrived in Botany Bay on April 29, 1770. However, it wasn't until January 18, 1788 that Europeans established a permanent presence in Australia with the arrival of the First Fleet under the command of Captain Arthur Phillip.

Within a short period of time after white settlement, the Sydney Aboriginal population was greatly reduced as a result of two epidemics, probably smallpox. The first epidemic occurred only a short time after settlement in 1789, and the second from 1829 to 1831. The first outbreak of the disease is believed to have killed 50% of the Aboriginal population in the area.

Aboriginal culture did not disappear with the arrival of Europeans in Botany Bay. In 1800, there was still apparently a relatively large Aboriginal population around the foreshores of Botany Bay and in the gullies north of the Bay. From 1810 to 1830, the occupancy of the Aborigines was seriously disturbed by European hunters and fishermen.

Subsequent European settlement in the area occurred as a result of migration from Port Jackson. Land grants were made to Europeans from the 1820's onwards, with the first private land grant on which a private dwelling was built being made in 1823.

The Sir Joseph Banks Hotel was constructed around 1844, several kilometres northwest of the primary study area. The Hotel established a long history of sporting recreation in the La Perouse and Banksmeadow area. At its peak, the hotel boasted a jetty with bathing houses, five cinder running tracks and a grandstand and stadium that seated several thousand people. Any remains of the Hotel jetty and bath houses would now be buried beneath past foreshore reclamation works.

From 1840 to 1890, Dent's Boatyard, jetty and slipway were located west of the Government Pier, presumably near Dent Street. Apparently small craft were built at this boatyard. Any remains of Dent's Boatyard, slipway and jetty would now be buried beneath past foreshore reclamation works.

La Perouse continued to develop in the latter half of the nineteenth century, principally by extension of existing facilities. A road from Sydney to the headland was surveyed and built in 1869. A telegraph cable was laid from New Zealand to La Perouse in the 1870's and the construction of the Bare Island Fort commenced in 1881.

A tramline to La Perouse was opened in 1902 and a jetty was constructed on the western side of the headland in 1905. A road linking the tram terminus to the jetty was built, allowing visitors to access the area

by ferry from Kurnell. The tramline was removed in the 1960's and a new ring road around the headland was constructed.

24.5.3 Early Industries

Early industries in the Botany Bay area included grazing, fishing, market gardening, boat building, wool scours and tanneries, and the production of shell lime and salt.

The Botany market gardens were the main vegetable supply for Sydney. Extensive garden areas have been reported in and around the area, including Hancock's and Lobb's Gardens, and Corey's Tea Gardens.

Lime burning was one of Botany Bay's earliest industries. The earliest Sydney lime mortars were derived by burning accumulations of shell found just above the high tide mark, particularly around Botany Bay and the Georges River. It seems probable that the Aboriginal midden sites historically recorded along this part of Botany Bay were exploited for lime.

Other prominent industries in the locality of the study area include wool mills; the State Sand, Lime and Brick Works; a wool scouring plant; the Armstrong Tannery; and a paper mill. In 1914, there were 40 tanneries and wool scouring establishments existing within the Botany municipality.

Small-scale boat building was also important along the foreshore prior to the Second World War. The Botany Water Works, which supplied Sydney's water from 1858 to 1888, had a jetty located nearby on the foreshore.

In 1880, the Government Pier or Long Pier was built at Banksmeadow. This could be seen as the first effort by the Government to establish Botany Bay as a functioning port. Its principal purpose was to unload coal from Newcastle to supply the needs of growing industries in the area. A tramway associated with the Pier was opened in May 1882. The Pier was still in use when the Bunnerong Power Station was built by the Sydney Municipal Council in about 1929.

Also around 1929, the Australian oil company H C Sleigh Ltd established a terminal on the Alexandra Canal and in 1948 Bitumen and Oil Refineries Australia Ltd (BORAL) established a refinery at Matraville on the northern side of the entrance of Botany Bay. Also at this time, a tanker mooring buoy was laid off Yarra Bay, with a submarine pipeline to Yarra Point to carry crude oil direct from ships to the refinery. Other pipelines and moorings were established off Yarra Bay and Bumborah Point in subsequent years. Generally, the development of port facilities for industry in the study area before 1950 was on a relatively small scale and designed to utilise the naturally deeper waters of the northern foreshore.

By the1960's, the Government Pier, still functioning but in a limited capacity, was starting to deteriorate. By 1968, the pier was not being used and by 1969 associated equipment was removed. Demolition of the pier began in1970, but was discontinued and never fully completed. The remains of the Government Pier are visible at the southeastern end of Foreshore Beach.

24.5.4 Dredging and Reclamation

Reclamation schemes have been a major feature of both past and proposed developments on the shores of Botany Bay. It was observed as early as 1891 that the Botany foreshore was eroding, and by 1922 nearly all of the Banksmeadow Park west of the Government Pier had been eroded away. Reclamation works on the Banksmeadow foreshore took place between 1927 and 1932, moving the shoreline 130 m further into the Bay.

Spoil from the construction of the Bunnerong Power Station in 1927 was deposited on the beach adjacent to the eastern end of Banksmeadow Reserve as part of these works. This added eight acres to the reserve. In 1936, a seawall was built along the foreshore of Sir Joseph Banks Park to control erosion.

The construction of Sydney Airport from 1947 onwards involved the diversion of the mouth of the Cooks River to the west. In 1958, the Botany Bay Land Reclamation Committee was formed and in the following years a number of reclamation projects were approved. Generally all reclamation projects have involved dredging of Botany Bay to provide fill.

In 1964, the Department of Public Works began construction on the north-south runway of Sydney Airport into Botany Bay by dredging approximately 3.5 million m^3 of sand from an area of Botany Bay near Lady Robinsons Beach for use in the runway reclamation. These works were associated with changes to the erosion and accretion regime in this area of the Bay. Additional reclamation works were undertaken during the 1970's to extend the existing runways.

The construction of the present port facilities at Botany Bay began in 1970. The first stage of the port development involved the dredging of 13 million m^3 of sand for the approach channel, part of the initial basin and initial reclamation for the port. The construction of Brotherson Dock involved dredging 7.5 million m^3 of sand for reclamation. It was during this time that the construction of Foreshore Road and the reclamation of the foreshore to its present position took place.

It is not only the reclamation works in the primary study area which has altered the foreshore since European settlement. The sea bed has also been subject to a variety of impacts. For example, the area of the proposed Port Botany Expansion land reclamation was dredged for the building of the Parallel Runway. The relatively high degree of disturbance of the sea bed in the vicinity of the proposed development means there is a reduced likelihood of finding intact archaeological deposits, including shipwrecks, over much of the area.

24.6 Existing Cultural Heritage

24.6.1 Aboriginal Sites

No Aboriginal sites were recorded in the primary study area. In addition, the potential for submerged Aboriginal sites to be present has been assessed as negligible.

The closest recorded Aboriginal site to the Port Botany study area is a rock engraving at Bumborah Point (NPWS Site #45-6-639) which is outside the primary study area. The site was first recorded in 1897 and includes engravings of two whales, one of which is superimposed with several fish and two anthropomorphic figures. It is described in the NPWS listing as occurring 6 m (20 feet) above high water mark, in Botany Bay near the Botany Cemetery on a smooth rocky surface.

It is likely that prior to the construction of the Bunnerong Power Station and the various reclamation projects that have resulted in the modern shoreline of Botany Bay in the vicinity of the primary study area, Aboriginal sites would almost certainly have existed along the foreshore. The presence of nearby creeks and swamps and the food resources provided by the Bay itself would have meant that Aboriginal people would have hunted, fished and camped in the area. However, the natural shoreline is inland of the current shoreline, and during the pre-contact and immediate post-contact period the current shoreline would have been well below the high tide mark.

Therefore, the potential for Aboriginal sites in the primary study area is negligible.

24.6.2 European Sites

The major reclamation for the existing port and airport has created a new shoreline in the northern part of Botany Bay. This means that early historic evidence of shoreline occupation and activity is likely to be well to the north of the current shoreline, on the other side of Foreshore Road. Clear evidence of this is provided by the remains of the stone retaining wall that was once on the shoreline in front of the Sir Joseph Banks Hotel, but which is now located at least 400 m from the current shoreline.

The only possibilities for potential archaeological deposits in relation to the historic period are items that may have extended into the Bay, for example jetties, wharfs, pipelines, or items which occur within the Bay, including baths and shipwrecks. The only known item that would have been long enough to extend beyond the current shoreline is the Government Pier that was built around 1880. This structure was still standing in 1960, but was then partially demolished. This structure is discussed in more detail below.

Maritime Structures

In the primary study area, the Government Pier has been partially buried, but several wharf posts associated with the head of the Pier protrude above the surface of the water and are still evident immediately off the current shoreline.

Field observations by Navin Officer indicate fill material and ballast associated with the Government Pier may not have been removed. A white painted navigational marker has been positioned in this area warning of the location of the submerged “ballast island”.

The location of the former Sir Joseph Banks Hotel Jetty and baths is buried under the foreshore reclamation work (**Figure 24.2**). Given that the Jetty does not appear on plans after 1860, it is unlikely that evidence of the structures would remain beneath the current land surface. The remains, if they existed, would be significant as the Jetty is the earliest known maritime related structure in Botany Bay. The baths themselves would be one of the earliest recreational structures of its type in Sydney.

Previous assessments conducted in relation to the construction of the Parallel Runway (Clark, 1992 cited in Navin Officer 2003) also point to the existence of Dent’s Boatyard, jetty and slipway west of the Government Pier. As with the Sir Joseph Banks Hotel Jetty, the remains of Dent’s Boatyard Jetty, if they survived up until the period of reclamation, would have been buried beneath the foreshore reclamation work.

Activities associated with the Sir Joseph Banks Hotel Jetty and the nearby Dent’s Boatyard, jetty and slipway would have resulted in material being deposited in the primary study area. The chances, however, of detecting and identifying such remains would be remote due to the extensive modification through wave action and reclamation and dredging activities undertaken in and around the primary study area.

Figure 24.2 shows the main heritage items located in the primary study area.

Source: Navin Officer 2003

0 500m

Approximate Locations of Identified Maritime Heritage Features and Former Coastline

Figure 24.2

Shipwrecks

The NSW Heritage Office has a database of all known shipwrecks in NSW. It is recorded that fourteen vessels are known to have been lost predominantly at the entrance to Botany Bay Of the listed 14 vessels, there are no known remains of the wrecks within the primary study area.

The schooner *Prompt* was the only vessel reportedly wrecked in the primary study area. The *Prompt* was lost on the 30th January 1881 (Australasian Shipping News 5/2/1881), the schooner reportedly sunk whilst discharging cargo at the Government Pier during a gale. As no wreckage has been found, it seems likely that the ship was removed so as not to pose a serious obstacle to a functioning wharf. However, there has been no record found to confirm this.

Other ships wrecked in the vicinity of the study area include the fishing yawl, *Olive,* lost near La Perouse. The *Advance* was wrecked on Lady Robinsons Beach and was relaunched. The *Minnie Wamsley,* which was wrecked in Botany Bay during a storm in 1903, could conceivably be within the primary study area.

A remote sensing survey carried out in 1992, which encompassed the primary study area did not identify the remains of any shipwreck material. This result does not assume that such sites may not be present in the primary study area, as they may be buried too deep to be detected or disturbed to such a degree that they cannot be identified using conventional remote sensing techniques. However, it should also be noted that during dredging of the primary study area for fill material for the Parallel Runway, no evidence of these wrecks was encountered.

24.7 Assessment of Impacts During Construction

24.7.1 Aboriginal Heritage

The construction of the proposed development would have no identifiable impact on Aboriginal archaeological heritage values as there were no Aboriginal sites recorded within the primary study area and the potential for submerged Aboriginal sites is negligible given that any cultural material would have been exposed to, and affected greatly by, waves, tides and currents. This would have had the effect of destroying any archaeological context. Therefore, a permit under section 90 of the NPW Act would not be required.

24.7.2 European Heritage

The proposed dredging would have the effect of destroying any cultural remains or shipwrecks on the sea bed where the dredging would take place. Reclamation, on the other hand, would have the effect of permanently burying any cultural material or shipwrecks likely to be in the area of the new terminal footprint. However, the likelihood of cultural material or shipwrecks existing in the areas to be dredged and reclaimed is considered to be extremely low because:

- a remote sensing survey of the area did not locate any submerged heritage resources; and
- much of the area has been already dredged during the construction of the Parallel Runway.

The remains of the Government Pier and any physical evidence relating to Sir Joseph Banks Hotel Jetty and baths, Dent's Boatyard Jetty, the *Prompt* and *Minnie Wamsley* shipwrecks and any associated cultural deposits would be considered "relics" under the NSW Heritage Act 1977.

The remains of the Government Pier, above and below water, and associated cultural deposits would be incorporated within the proposed habitat enhancement plan for Penrhyn Estuary as a remnant of the Government's first attempt at fostering trade and creating port infrastructure within Botany Bay.

Some construction activities around the foreshore area (e.g. dredging of the channel between the new terminal and Foreshore Beach) have the potential to impact on the locations of the former Sir Joseph Banks Hotel Jetty and baths and Dent's Boatyard Jetty and associated cultural deposits, should they exist. Mitigation measures would also be implemented to address these potential impacts (refer to Section 24.9).

It is considered highly unlikely that reclamation and dredging activities for the proposed development would impact the *Prompt* and *Minnie Wamsley* shipwrecks.

24.7.3 Bay-Wide Impacts

The hydrodynamics and coastal processes study (**Appendix H**) identified very minor changes in wave height and/or direction at only two locations around the Bay, Towra Beach and Silver Beach. Any changes would be so small that they would not be measurable or visible. Therefore, the potential impact on any Aboriginal or European cultural resource would be negligible.

As there were no changes predicted elsewhere around Botany Bay there would be no other impacts on cultural heritage.

24.8 Assessment of Impacts During Operation

During the operational phase of the Port Botany Expansion there would be no impacts on Aboriginal, European or maritime heritage resources in the primary or secondary study area.

24.9 Mitigation Measures

The following mitigation measures would be implemented to protect heritage resources:

- should any dredging or subsurface excavations be planned in the channel between the new terminal and Foreshore Beach in the proximity of the former Sir Joseph Banks Hotel Jetty and baths and Dent's Boatyard Jetty, a program of archaeological monitoring would be implemented and an excavation permit under section 140 of the NSW *Heritage Act* 1977 would be applied for with the NSW Heritage Office. It is noted, however, that the chance of unearthing archaeological remains at these locations is low;
- the remains of the Government Pier, above and below water, and associated cultural deposits, would be conserved as part of the early history of government regulation and development of port infrastructure in Botany Bay; and
- future onsite interpretation of the Government Pier would be incorporated into the development.

24.10 Conclusion

The construction and operation of the proposed development would have no identifiable impact on Aboriginal archaeological heritage values in the primary or secondary study areas.

European structures of maritime cultural heritage significance have been identified in close proximity to the proposed reclamation and dredging area. The main maritime heritage feature identified was the former Government Pier. The Pier would be conserved by Sydney Ports Corporation as part of the development.

In addition to the Pier, the remains of the former Sir Joseph Banks Hotel Jetty and baths and Dent's Boatyard Jetty may be partially located within the primary study area, although any remains would now be buried beneath the foreshore reclamation work. The likelihood of finding archaeological remains at these locations is low.

With the implementation of the mitigation measures described in this chapter, the Port Botany Expansion would not have a significant impact on European heritage items. The Government Pier, a significant item of European heritage, would be retained and would be interpreted onsite.