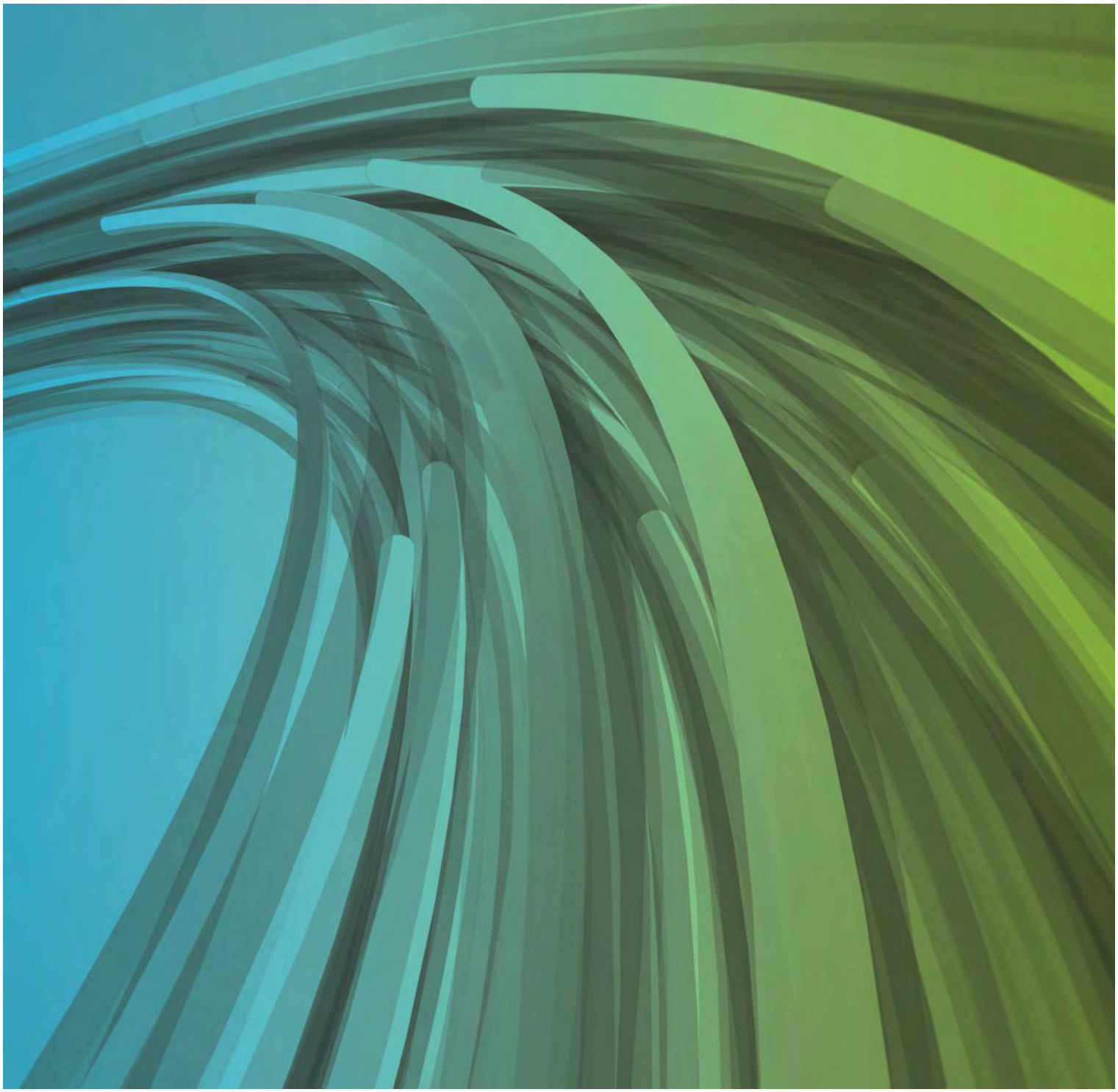
APPENDIX J

Noise and Vibration Impact Assessment

Port Kembla Port Corporation
27-Mar-2014
Doc No. 60305813

Modification to Port Kembla Outer Harbour Development

Noise and Vibration Impact Assessment



Modification to Port Kembla Outer Harbour Development

Noise and Vibration Impact Assessment

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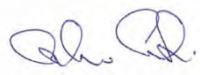
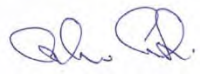
00	29-May-2013	Preliminary Draft	Andrew Cook Technical Director	
01	30-May-2013	Final Draft	Andrew Cook Technical Director	
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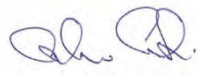
03	27-Mar-2104	Final - Updated	Andrew Cook Technical Director	

Table of Contents

Executive Summary

AECOM Australia Pty Ltd (AECOM) has conducted a Noise and Vibration Impact Assessment (NVIA) of the construction and operational activities associated with the proposed modification of the Port Kembla Outer Harbour (PKOH) development.

This NVIA has been undertaken to assess the proposed modifications to PKOH to satisfy the Director General's Requirements prepared for the modification request. The NVIA has been developed following consultation with the NSW Environment Protection Authority (EPA) and the Department of Planning and Infrastructure (DP&I).

The impact of noise emissions from plant associated with the construction and operation of the Concept Plan and Major Project of the PKOH development have been assessed. Construction and operational impact assessments have been carried out based on plant that is likely to be associated with each phase of the PKOH development.

Construction Noise

Construction noise has been assessed against the NSW EPA Interim Construction Noise Guideline (DECCW, 2009). Results of the assessment show that for the majority of the construction, noise levels are predicted to comply with the noise management levels. Construction mitigation and management measures have been recommended where exceedances are predicted to occur and as 'best practice' to reduce and manage the impact on nearby noise sensitive receivers.

Construction vibration has been assessed against appropriate standards. Given the distance between the construction areas and the receiver locations, human comfort and cosmetic damage levels are unlikely to be breached.

Blasting

The modifications to the Major Project and the overall Concept Plan do not include any additional blasting requirements to those previously assessed as part of Stage 1 of the PKOH development. Therefore the blasting assessment presented in the previous noise and vibration impact assessment undertaken for the approved Major Project and Concept Plan remains valid for these modifications to the PKOH development.

Typical blasting noise and vibration levels have been previously provided. However, it is recommended that a detailed assessment is undertaken to consider specific site and nearby building conditions to quantify allowable charge sizes.

Operational Noise

Operational noise has been assessed for the Major Project modification and the Concept Plan. Operational noise has been assessed against the NSW EPA Industrial Noise Policy (EPA, 2000). In most circumstances the development would comply with the appropriate criteria. Where exceedances have been predicted, additional approvals would be required for the development along with an operational noise and vibration management plan which would outline a progressive mitigation plan to ensure the nearby noise sensitive receivers are not adversely impacted. Given the long term plan for the development, detailed mitigation would be investigated at subsequent stages to ensure appropriate noise goals can be met.

Road Traffic Noise

Road traffic noise has been assessed for both the operational and construction stages of the Major Project. The development has been assessed against the NSW EPA Road Noise Policy. The increase in road traffic noise levels as a result of the project has been found to be below the allowable increase. Therefore, the development complies with the requirements of the NSW EPA Road Noise Policy.

Rail Activity Noise

Noise generated from rail activities within the 'balloon' loop have been assessed against the NSW EPA Industrial Noise Policy. Activities including movements, train joining/re-joining, horn 'toots' and loading/unloading have been assessed. Where noise contribution from the train activities is significant mitigation has been recommended. The mitigation recommended in this report ensures that noise levels at the nearby sensitive receivers is controlled and is acceptable.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) has conducted a Noise and Vibration Impact Assessment (NVIA) of the construction and operational activities associated with the proposed modification of the Port Kembla Outer Harbour (PKOH) development.

This NVIA has been undertaken to assess the proposed modifications to PKOH to satisfy the Director General Requirements (DGRs) prepared for the modification request. The NVIA has been developed following consultation with the NSW Environment Protection Authority (EPA) and the Department of Planning and Infrastructure (DP&I).

1.1 Existing Approvals

In March 2011, Port Kembla Port Corporation (PKPC) was granted Concept Plan approval for the long-term Master Plan for the Outer Harbour and Major Project Approval for Stage 1 of the development under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This entailed the expansion of port side and landside facilities in the Outer Harbour of the Port.

The Concept Plan outlines the progressive development of the Outer Harbour over a 30 year period, to be constructed in a series of three stages. As currently approved, the Outer Harbour Development would comprise of dredging and reclamation for the creation of multi-purpose and container terminals within the Outer Harbour which would receive Panamax size vessels. The multi-purpose terminals would consist of three berths for the import and export of dry bulk and general cargo up to 6.25 million tonnes per annum. The container terminal would consist of four berths with a throughput of up to 1.2 million twenty-foot equivalent units (TEUs) per annum.

The Concept Plan includes construction and operation of infrastructure associated with the port development, including land-side terminal facilities, upgrades to the existing freight rail link to the Outer Harbour and construction of a new road link from Christy Drive to Foreshore Road.

The Major Project encompasses construction and operation of Stage 1 of the Concept Plan. The key elements of Stage 1 include dredging and reclamation for the footprint of the total development (except the northern area of the multi-purpose terminal and dredging part of the swing basin), construction and operation of one new multi-purpose terminal berth and construction of the first container berth. Associated infrastructure upgrades contained in the Major Project approval include rail infrastructure improvements in the South Yard and the construction of an internal port road extending from Christy Drive.

Major Project approval for Stages 2 and 3 of the Concept Plan would be subject to separate applications for approval at a later date. This NVIA satisfies the modified DGRs. This NVIA also considers the existing Conditions of Approval (CoA) and Statement of Commitments (SoC) for the existing Stage 1 Conditions of Approval.

The proposed modification to the Major Project (Stage 1) and the Concept Plan is referred in the report as ‘the Major Project’ and ‘the Concept Plan’.

1.2 The Proposed Modification

Due to growing customer demand and greater recognition of the strategic role of the PKOH as detailed in the *Draft NSW Freight and Ports Strategy* (TfNSW, 2012), PKPC is now seeking to modify its approval to accommodate an increase in the bulk cargo throughput handled at PKOH from 4.25 million tonnes per annum to 16 million tonnes per annum. All additional bulk cargo volumes would be moved by rail. To facilitate this increase in bulk trade, this modification includes:

- Increase in the bulk cargo capacity to 16 million tonnes per annum through the first multi-purpose berth.
- Amendments to the dredging and reclamation footprint between the multi-purpose and container terminals to cater for the larger Cape-size vessels and Super Post-Panamax size vessels.
- Increased number of ship movements to cater for increased bulk volumes and more efficient movement of cargo.
- An enlarged operational land area for the multi-purpose terminal to support the increase in cargo volumes.

- Covered conveyors and construction of storage sheds to enable the movement and storage of dry bulk product between trains, trucks and ships.
- Increased train movements to facilitate delivery of larger volumes of bulk cargo, resulting in an additional nine trains per day accessing the PKOH (totalling 13 bulk trains per day).
- Additional rail and supporting infrastructure to facilitate increased train movements, including two bulk loops, two bulk unloaders and sidings.
- Changes to road infrastructure in the vicinity of the PKOH to accommodate increased train movements, including the potential road closure, diversion or overbridge at the railway level crossing on Old Port Road.
- An increase in the volume of material temporarily stockpiled for land reclamation purposes at the Outer Harbour from 100,000 cubic metres to 360,000 cubic metres across two sites.
- A slight increase in construction traffic due to the increase in construction activity under the Major Project.
- A revised alignment of the Salty Creek extension on a more direct route through the reclamation area.

There would be no change to the approved capacity for general cargo or container cargo at the PKOH.

1.3 Scope of Acoustic Assessment

AECOM has previously undertaken a NVIA (AECOM, 2011) for the PKOH development (referred to as the previous NVIA). The acoustic assessment presented in this report addresses the DGRs of the modification to Stage 1 (i.e. Major Project) and the overall Concept Plan.

While only some aspects of the Major Project and the Concept Plan development would be modified, the whole development has been reassessed for completeness and to satisfy the DGRs. In doing so, the key changes to the Concept Plan and Major Project relate to the additional bulk train movements, a larger operational area for the multi-purpose terminal under the Major Project, enclosed storage sheds and conveyor systems. There is also an improved understanding of rail and terminal operations based on further rail planning undertaken by PKPC associated with the initial works for the Major Project. This has resulted in some adjustments to the original assumptions implemented on the previous NVIA.

This assessment considers likely construction and operational scenarios associated with the Concept Plan and the Major Project. A detailed operational NVIA for the Major Project has been carried out. At this stage of the development, detailed construction and operational methodology for the overall Concept Plan is not available, and Stages 2 and 3 would be subject to further project approvals where a more detailed assessment would be undertaken. This assessment has therefore been carried out based on likely site activities associated with the Concept Plan that have been confirmed with PKPC.

Construction noise has been assessed as part of the previous NVIA for the approval of the PKOH, and remains relatively unchanged for this assessment. A ‘reasonable’ worst case construction scenario was modelled in the previous NVIA for both the Concept Plan and the Major Project.

A cumulative noise impact assessment has been undertaken. The assessment considers the potential for overlapping construction activities between Stage 1 and Stage 2 construction. Construction of the Concept Plan would utilise similar plant and have a similar potential for cumulative impacts.

It is understood that the construction phase is to include 24 hour dredging operations requiring underwater blasting to take place. The modifications to the Major Project and the overall Concept Plan do not include any additional blasting requirements to those previously assessed as part of Stage 1 of the PKOH development. Therefore the blasting assessment presented in the previous NVIA remains valid for these modifications to the PKOH development.

Typical blasting noise and vibration levels have been previously provided. However, it is recommended that a detailed assessment is undertaken to consider specific site and nearby building conditions to quantify allowable charge sizes.

AECOM has been advised that the construction works are to take place generally during standard EPA working hours (Monday to Friday 7am to 6pm and Saturday 8am to 1pm), with the exception of dredging, which will be operational 24 hours a day. Any out of hours work would be managed in accordance with Project Approval condition C4.

Operational activities associated with the Concept Plan and the Major Project would take place 24 hours a day, seven days a week. The predicted noise impact resulting from operation of the Major Project alone and the Concept Plan has been assessed.

Rail activities in the North and South Yards associated with the Major Project and the Concept Plan have been assessed.

The potential for sleep disturbance as a result of operational activities associated with the Concept Plan and the Major Project have also been assessed.

1.4 Director General's Requirements

The Director General's Requirements (DGRs) for the proposed modification of the Port Kembla Outer Harbour Development were issued by DP&I on 17 December 2012.

The DGRs require that for noise and vibration the points in Table 1 be addressed. Details of where each requirement is covered in this document are provided in Table 1.

Table 1 Director-General's Requirements and document references

Description **Key Issues**	Document Reference
Noise and Vibration - including but not limited to: • a description of the noise and vibration from all activities and sources during operation both on and off site; and • a revised noise assessment, taking into account the *NSW Industrial Noise Policy* (Environment Protection Authority, 2000) and the *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects* (Department of Environment and Climate Change/ Department of Planning, 2007 *).* The noise assessment must consider the construction and operational impacts from the proposed modification in isolation and in a cumulative context. Operational impacts are to include noise associated with increased shipping movements, increased rail movements (including shunting, acceleration and deceleration), conveyor systems, unloading and loading activities, and scrubber systems (if installed).	**Section 5.0**
General Construction Impacts – including but not limited to an assessment of the potential impacts associated with the construction of the modification application where the nature and potential impact of construction activities associated with the modification application differ to those assessed for the approved project. The assessment must take into account the *Interim Construction Noise Guidelines* (Department of Environment and Climate Change, 2009).	**Section 4.0**

2.0 Existing Noise Environment

2.1 Noise Logging

Three unattended noise loggers were used to continuously measure background noise levels between Thursday 18th September 2008 and Wednesday 24th September 2008. The loggers were located at 7 Wentworth Street, 14 O'Donnell Street and 2 Reservoir Street, Port Kembla. These locations are considered to be representative of the sensitive receivers in the area. . There have been no notable changes to the surrounding noise environment since the time of logging. Therefore, the logged data is considered representative of the current noise environment. The data from the logger located at 2 Reservoir Street was not used as the logger experienced technical difficulties and only gathered reliable data for the period Thursday 18th Sept 2008 to 21st September 2008. An additional logger was used to continuously measure road traffic noise levels between Thursday 18th September 2008 and Wednesday 24th September 2008. The logger was located at 43-57 Five Islands Road, Cringila adjacent to the carriageway. The loggers and receiver locations are shown on Figure 1.

A noise logger measures the noise level over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, L_{Amax} and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period respectively. The L_{Amax} is indicative of maximum noise levels due to individual noise events. The L_{A90} is taken as the background noise level.

The Assessment Background Level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or Rating Background Level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration.

The NSW Environment Protection Authority (EPA) *Industrial Noise Policy* (INP) (EPA, 2000) application notes recommend that when higher background noise levels (RBL) occur in the night time or evening assessment periods, the criteria are generally set to the lower evening or daytime criteria in accordance with community expectations.

Measured ambient noise levels are shown in Table 2. Graphical representation of the logging results is shown in Appendix B.

Table 2 Summary of ambient noise levels dB(A)

Logger Location	Day		Evening		Night	
7 Wentworth Street	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Thurs 18th September 2008	-	-	48	52	45	52
Fri 19th September 2008	50	56	47	56	49	53
Sat 20th September 2008	47	55	39	54	37	50
Sun 21st September 2008	43	67*	45	53	46	53
Mon 22nd September 2008	49	56	48	52	44	51
Tues 23rd September 2008	43	53	40	48	43	51
Wed 24th September 2008	47	54	46	51	48	53
RBL	**47**	**-**	**46**	**-**	**45**	**-**
Log Average L_{Aeq}	**-**	**61**	**-**	**53**	**-**	**52**
14 O'Donnell Street	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}	L_{A90}	L_{Aeq}
Thurs 18th September 2008	-	-	40	44	37	44
Fri 19th September 2008	43	51	43	48	41	47
Sat 20th September 2008	39	50	38	43	26	45
Sun 21st September 2008	37	49	40	44	40	47
Mon 22nd September 2008	41	50	42	46	35	47
Tues 23rd September 2008	39	48	32	43	31	44
Wed 24th September 2008	38	54	38	45	41	48
RBL	**39**	**-**	**40**	**-**	**37**	**-**
Amended RBL*	**39**	**-**	**39**	**-**	**37**	**-**
Log Average, L_{Aeq}	**-**	**51**	**-**	**45**	**-**	**46**

* Result of noisy afternoon activity

Road traffic noise levels from Five Islands Road have been logged and post-processed in accordance with the EPA's NSW Road Noise Policy (RNP) (DECCW, 2011). Results of the noise logging are summarised in Table 3.

Table 3 Summary of road traffic noise levels at 7 metres from Five Islands Road

Location	Daytime $L_{Aeq, (15\ hour)}$, dB(A)	Night time $L_{Aeq, (9\ hour)}$ dB(A)
7 m from Five Islands Road	71	68

2.2 Noise Sensitive Receivers

The logger located at 7 Wentworth Street was controlled by road traffic noise from the nearby Five Islands Road, industrial and rail noise. This location has been assumed to be representative of residential properties adjacent to or in close proximity to the more heavily used roads in the area. This area has been designated Sensitive Catchment Area 1 (SCA1).

The logger located at 14 O'Donnell Road is considered to be representative of residential properties located further away from the more heavily used roads and industrial noise in the area. This area has been designated Sensitive Catchment Area 2 (SCA2).

Sensitive receivers, along with the receiver type assessed in this report are presented below in Table 4.

Table 4 Representative noise receiver locations

Receiver	Address	Receiver Type	Sensitive Catchment Area
R1	48 Flagstaff Rd, Warrawong	Residential	SCA1
R2	5-7 Military Rd, Port Kembla	Residential	SCA1
R3	7 Wentworth St, Port Kembla	Residential	SCA1
R4	1 Holman St , Port Kembla	Residential	SCA1
R5	14 Lawarra St , Port Kembla	Residential	SCA1
R6	1 Jubilee Rd , Port Kembla	Residential	SCA2
R7	14 O'Donnell St , Port Kembla	Residential	SCA2
R8	2 Reservoir St, Port Kembla	Residential	SCA1
R9	188 Wentworth St, Port Kembla	Residential	SCA2
R10	St Patricks School - 45 Kembla St, Port Kembla	School	-
R11a	St Stephens Anglican Church - 111 Military Rd, Port Kembla	Church	-
R11b	Port Kembla Tongan Uniting Church – 4 Fitzwilliam St, Port Kembla	Church	-
R12	21-23 Military Rd , Port Kembla	Commercial	-
R13	37 Five Islands Rd, Port Kembla	Industrial	-
R14	Lot 1 Darcy Rd, Port Kembla	Industrial	-

Figure 1 shows the ambient noise logging locations and defines SCA1 and SCA 2. Figure 2 shows the traffic noise logger location and noise sensitive receivers adjacent to Five Islands Road, Cringila. Figure 3 shows noise sensitive receivers at Masters Road.

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Figure 1 Sensitive receivers (SCA1 and SCA2) and noise logging locations

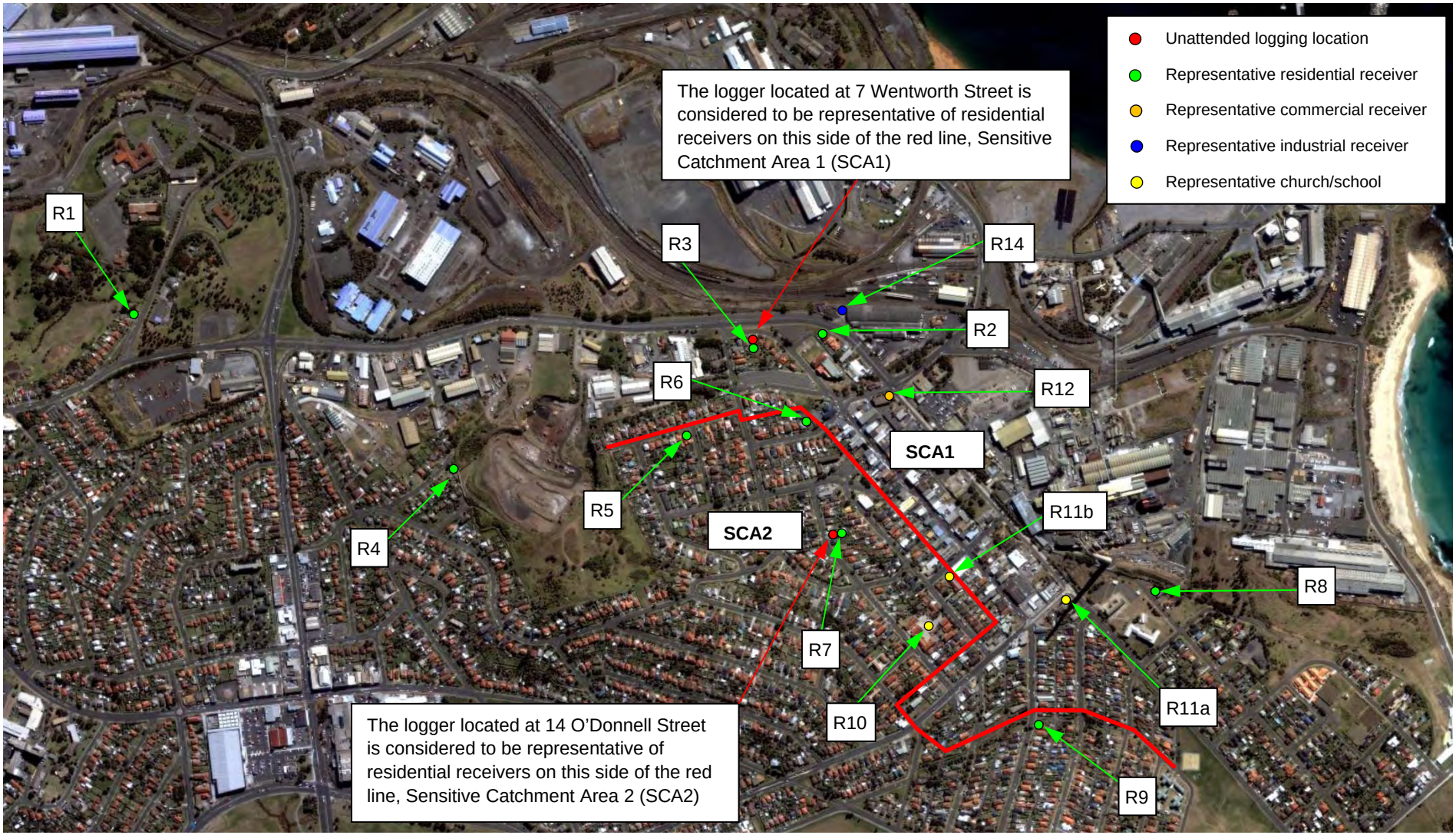

Figure 2 Five Islands Road, Cringilla noise logging location and most affected traffic noise receivers

Figure 3 Masters Road, Mount St Thomas traffic noise receivers

3.0 Noise and Vibration Criteria

3.1 Construction Noise Criteria

In July 2009, the NSW Department of Environment, Climate Change and Water (DECCW) (now Environment Protection Authority (EPA)) published the *Interim Construction Noise Guidelines* (ICNG) (IDECCW, 2009) for use in construction noise assessment. This document replaces the previous publication the *Environmental Noise Control Manual* (ENCM) and is used as the basis for establishing construction noise criteria for the proposed development.

Under the ICNG a construction noise management plan is required to be compiled by the Contractor, prior to construction commencing. Noise level objectives must be set for the daytime evening and night-time periods, and must be complied with where reasonably practicable. Work that is proposed outside of standard working hours, as defined in the ICNG, generally requires strong justification.

The noise management plan should detail the '*best practice*' construction methods to be used, presenting a reasonable and feasible approach. The plan should identify the extent of the residential area affected and assess the impact on residents. The plan should detail any community relation programs that are planned e.g. prior notification for particularly noisy activities, letter box drop regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The ICNG defines what is considered to be feasible and reasonable as follows:

> *"Feasible*
>
> *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*
>
> *Reasonable*
>
> *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."*

The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the EIA process'*. A quantitative assessment, based on a 'reasonable' worst case construction scenario, has been carried out for the PKOH development.

Predicted noise levels at nearby sensitive receivers (residential, commercial and industrial premises) are compared to the levels provided in Section 4 of the ICNG. Where an exceedance of the criteria is predicted the ICNG advises that the proponent should apply all feasible and reasonable work practices to minimise the noise impact.

Construction noise management levels (NMLs) for residential receivers are set using the information in Table 5.

Table 5 Construction noise at residences using quantitative assessment, as established by the ICNG

Time of Day	Management Level L_{Aeq} (15min)[1]	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

Time of Day	Management Level L_{Aeq} (15min)[1]	How to Apply

	Highly noise affected
	75 dB(A)
		- The highly noise affected level represents the point above which there may be strong community reaction to noise.
		- Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:
		  - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences
		  - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended standard hours	Noise affected RBL + 5 dB	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see Section 7.2.2 (ICNG).

Notes:

1 Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

3.1.2 Construction noise management levels

It is assumed that the construction activities would take place during recommended standard working hours (7am – 6pm Monday to Friday and 8 am – 1 pm Saturday). However it is likely that dredging would be operational 24 hours a day.

Construction noise management levels for the most affected residential receivers are shown in Table 6.

Table 6 Construction noise management levels – Residential receivers

Receivers	Background Noise Level, L_{A90} Day dB(A)	Standard Construction Hours Noise Management Levels (NMLs) L_{Aeq} dB(A)	Background Noise Level, L_{A90} Night dB(A)	Out of Hours Works – Night-time Noise Management Levels (NMLs) L_{Aeq} dB(A)
Sensitive Catchment Area 1	47	57	45	50
Sensitive Catchment Area 2	39	49	37	42

Criteria for other sensitive land uses, such as schools, hospitals or places of worship are shown in Table 7.

Table 7 Construction noise management levels – Sensitive land uses other than residential

Land Use	Management Level, L_{Aeq} (15 min) (Applies when Properties are in Use)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses.

Criteria for industrial and commercial premises are shown below:

- Industrial premises: external $L_{Aeq\ (15min)}$ 75 dB(A), and
- Offices, retail outlets: external $L_{Aeq\ (15min)}$ 70 dB(A).

3.1.3 Construction traffic noise

The EPA's ICNG does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads.

Given the relative short duration of most construction activities and taking into consideration the EPA's RNP which provides guidance when assessing relative increases in criteria, namely:

> '*In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person'.*

Thus, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A).

3.2 Operational Noise and Vibration Criteria

3.2.1 Operational noise criteria

3.2.1.1 Protection of the Environment Operations Act 1997 – Section 139

The main acoustic requirement of *Protection of the Environment Operations Act 1997* (POEO) is to ensure that "a noise is not offensive". The definition for an offensive noise is included below.

offensive noise *is:*

(d) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(e) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.

To determine if a noise source is offensive, a primary consideration is to determine whether the noise source is intrusive. The EPA provides guidelines for external noise emissions from developments in the INP. The INP recommends a method which can be used to ascertain the intrusiveness of noise emissions.

EPA states that the relationship between the statutory definition of offensive noise and intrusive noise is that intrusive noise can represent offensive noise, but whether this is always true can depend on the source of the noise, noise characteristics and cumulative noise levels. Therefore to avoid the emission of an offensive noise, noise emissions should not be intrusive as defined by the EPA in the following manner:

> *A noise source is generally considered to be intrusive if noise from the source, when measured over a 15 minute period, exceeds the background noise by more than 5 dB(A).*

Any noise generated within the PKOH development site boundary, including noise from plant, truck movements, rail movements (including South and North Yard activities), loading/unloading activities, and mechanical services or associated with site buildings must be assessed in accordance with the INP. These sources include existing operational noise sources, those assessed in the previous NVIA and the additional sources proposed in the modification.

The assessment procedure for industrial noise sources has two components, which are:

- Controlling **intrusive noise** impacts in the short term for residences; and
- Maintaining **noise level amenity** for residences and other land uses.

3.2.2 Industrial Noise Policy

3.2.2.1 Intrusive noise

The INP states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB. This is termed the *Intrusiveness Criterion*. The Rating Background Level (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in Section 3.1 of the INP. Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or impulsiveness.

The intrusive noise criteria for each SCA are presented below in Table 8.

Table 8 Recommended $L_{Aeq,\ 15\ minute}$ intrusive noise criteria levels from industrial noise sources

Receiver area	Time of day	RBL ($L_{A90,\ 15\ minute}$)	Intrusive Criterion RBL + 5, dB(A)
Sensitive Catchment Area 1	Day	47	52
	Evening	46	51
	Night	45	50
Sensitive Catchment Area 2	Day	39	44
	Evening	39	44
	Night	37	42

3.2.2.2 Noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. That is, the background noise level should not exceed the level appropriate for the particular locality and land use. This is termed the *Amenity criterion*.

For a residential receiver in an urban area, the amenity criteria are shown in Table 9.

Table 9 Recommended $L_{Aeq,\ period}$ amenity noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	
			Acceptable	Recommended Maximum
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

Where there are high levels of existing industrial or transportation noise then noise from the new source must be controlled to preserve the amenity of the area. Table 2.2 in the INP provides modification factors for areas with existing high levels of industrial or transportation noise.

Due to this contribution from existing industrial noise sources the amenity criteria has been modified as per the recommendations in Table 2.2 of the INP and is presented in the final environmental noise criteria in Section 3.2.2.5.

3.2.2.3 Cumulative impacts

Environmental noise criteria must consider the cumulative impact from all operational activities associated with the Major Project and the overall Concept Plan.

The Major Project will be operating independently of the Concept Plan for a period of time. The operational activities associated with the Major Project phase have been assessed on both a standalone basis and as part of the Concept Plan. As such, the assessment of the Concept Plan addresses the assessment of cumulative noise from the entire of the PKOH development, for feasibility.

Existing industrial noise impacts from the Port Kembla operations and all other industrial noise source in the area have been quantified for each SCA. Where industrial noise is a feature of the area, allowable industrial noise levels are reduced to protect the amenity of the area. For this project, industrial noise from all sources a have been considered under the amenity criteria. Where industrial noise is a feature, relevant adjustments to the noise criteria have been made in accordance with table 2.2 of the NSW INP. The final adjusted amenity criteria are presented below in Section 3.2.2.5. For the Cement Australia Cement Grinding Mill, located within Major Project footprint has been discussed later in this report.

3.2.2.4 Conditions of Approval for the Major Project

The Minister for Planning and Infrastructure granted consent to the Concept Plan and Major Project subject to Conditions of Approval (CoA). This included, for the Major Project a CoA for operational noise.

The Major Project CoA's noise limits have been reproduced below:

D1. The Proponent shall design to operate the project with the objective of ensuring that noise contributions do not exceed the project noise limits specified in Table D1 at any sensitive receiver during the periods indicated. The noise limits apply under the following meteorological conditions:

1 Wind speed up to 3 m/s at 10 m above ground; and/or

2 Temperature inversion conditions of up to 3 ºC/100 m and source to receiver gradient winds of up to 2 m/s at 10 m above ground level

Table D1: Maximum Allowable Noise Contributions

Location	$L_{Aeq(15min)}$ dB(A)			$L_{A1, (1min)}$ dB(A)
	Day	Evening	Night	Night
Military Road	Note 1	39	39	62
Wentworth Street	Note 1	42	42	60
Jubilee Road	Note 1	Note 1	36	59
Any other residential receiver	Note 1	Note 1	35	Note 1
St Patrick's Primary School	39	39	39	Note 1
Church on Church Street and Military Road	39	39	39	Note 1

Notes:

1 Noise limits have not been set as predicted noise levels with mitigation measures proposed in the Environmental Assessment (EA) are below the reported background noise level. Where street locations are mentioned, the noise limit applies to any residential receiver on that street.

Although specific noise limits have been set for the approved Major Project, the acoustic assessment presented this report of the proposed modification to Major Project and the Concept Plan has been undertaken to satisfy the DGRs prepared for the PKOH modification request. The main reason for applying the DGRs (i.e. NSW INP) for the acoustic assessment of the Concept Plan and Major Project (as modified) is to take into account the proposed increased in the capacity of the bulk cargo handling at the PKOH development.

3.2.2.5 Final environmental noise criteria

A summary of the environmental noise criteria and the resultant project specific noise goals are given in Table 10.

Table 10 Environmental noise criteria and project specific noise goals

Receiver	Period	RBL (L_{A90})	Intrusive Criterion RBL + 5	Ambient (L_{Aeq})	Amenity Criterion
Sensitive Catchment Area 1	Day	47	52	61	52
	Evening	46	51	53	43
	Night	45	50	52	42
Sensitive Catchment Area 2	Day	39	44	51	60
	Evening	39	44	45	48
	Night	37	42	46	37

As the noise emissions from the Concept Plan and Major Project would be a mixture of relatively constant activities and short term noise events the noise emissions during a 'reasonable' worst case 15-minute period and entire night period may vary considerably. As such both the amenity ($L_{Aeq, period}$) and intrusive ($L_{Aeq, 15 min}$) scenarios have been assessed separately against the relative criterion. Operational assessment scenarios for both assessment periods have been developed for the modelling purposes, to ensure compliance with both the intrusive and amenity criteria at nearby noise sensitive receivers.

The project specific noise goals in Table 10 are applicable for all the operational noise sources associated with the Major Project and the Concept Plan at the residential receivers most likely to be affected.

3.2.2.6 Other noise sensitive receivers

The INP specifies the following noise criteria for non-residential land uses as detailed in Table 11. These criteria are applicable to receivers R10, R11a, R11b, R12, R13 and R14.

Table 11 Non-residential receiver noise criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	
			Acceptable	Recommended Maximum
School classroom	Noisiest 1-hour period when in use	When in use	50[1,2]	55[1,2]
Place of worship	Noisiest 1-hour period when in use	When in use	50[2]	55[2]
Commercial Premises	All	When in use	65	70
Industrial Premises	All	When in use	70	75

Notes:

1 In the INP, the school classroom criteria is an internal noise level, with an acceptable noise level of 35 dB(A) and a recommended maximum of 40 dB(A). However, this acceptable level is increased to 40 dB(A) in the case that the school is affected by noise from existing industry.

2 A 10 dB reduction has been assumed between external and internal noise levels based upon a window being open for adequate natural ventilation.

3.2.3 Tonality and INP modifying factors

The INP provides additional guidance and criteria for assessing noise emission from sources defined as 'tonal' in nature. Penalties of up to 5 dB(A) may be applied where the subject noise emission is tonal in character at the receiver.

A penalty is applied when the level of a one-third octave band exceeds the level of each adjacent band by:

- 5 dB(A) or more if the frequency band containing the tone is above 400 Hz
- 8 dB(A) or more if the frequency band containing the tone is below 400 Hz and above 160 Hz inclusive
- 15 dB(A) or more if the frequency band containing the tone is below 160 Hz

As part of this assessment, a 'screening test' to determine the potential for tonality has been conducted, to assess if the sources have the potential to generate tonal noise.

Additionally the INP provides guidance on applying penalties if the noise source contains characteristics such as impulsiveness, intermittency, irregularity or dominant low-frequency content. These have been reviewed in the operational noise assessment.

3.2.4 Sleep disturbance criteria

The EPA's INP has been updated in June 2013 with application notes which discuss sleep disturbance and its objective assessment.

To minimise the risk of sleep disturbance as a result of industrial type operations during the night-time period, the INP application notes recommends that, the $L_{A1(1\ minute)}$ noise level outside a bedroom window should not exceed the L_{A90} background noise level by more than 15 dB(A) during the night-time period (10 pm to 7 am). The EPA considers it is appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The INP Application Notes reference the NSW RNP for some guidance in assessing the potential for sleep disturbance. The RNP contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. Section 5.4 of the RNP states that 'Maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep'. Therefore, given that an open window provides 10 dB(A) noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions.

The sleep disturbance criteria for SCA 1 and SCA 2 are summarised in Table 12.

Table 12 Sleep disturbance criteria

Catchment Area	Measured RBL $L_{A90,\ 15\ mins}$ dB(A)	Sleep Disturbance Criteria $L_{A1\ (1\ minute)}$ dB(A)	
		Screening Level	Awakening Reaction
SCA 1	45	60	65
SCA 2	37	52	65

3.3 Rail Related Activities Noise Criteria

Rail related activities undertaken within the Port Kembla 'balloon' loop (which includes the North and South Yard) have been assesses against the EPA's INP.

Item 2 'Key Issues' of the DGRs mentions the following assessment to be undertaken for the PKOH development:

> *a revised noise assessment, taking into account the NSW Industrial Noise Policy (Environment Protection Authority, 2000) and the Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (Department of Environment and Climate Change/ Department of Planning, 2007).*

AECOM does not agree with the abovementioned DGRs in that the rail noise activities occurring within the Port Kembla 'balloon' loop should be assessed in accordance with the EPA's Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects (IGANRIP). The IGANRIP generally applies to rolling stock activities occurring on the main network line.

The 'balloon' loop is part of the PKOH development and activities associated with the 'balloon' loop include; loading and unloading of trains, train joining/re-joining operations, train idling, splitting of trains, etc. It is considered that these activities and therefore the operation of the 'balloon' loop should be assessed against the EPA's Industrial Noise Policy and not the IGANRIP.

In addition, the recently release EPA's Rail Infrastructure Noise Guidelines (EPA, May 2013) which replaces the IGANRIP, presents the following discussion in Appendix 3 'Non-network rail lines on or exclusively servicing industrial sites':

> *"Rail related activities (such as movement of rolling stock on rail loops or sidings, loading and shunting activities etc) occurring within the boundary of an industrial premises as defined in an environment protection licence are to be assessed as part of the industrial premises using the NSW Industrial noise policy (EPA, 2000) (INP)."*

Rail activities noise emissions when part of the PKOH operations (i.e. 'balloon' loop activities) have been assessed against the NSW Industrial Noise Policy.

The modification involves upgrades to the rail infrastructure within the Outer Harbour rail loop which is owned and operated by NSW Ports. Therefore this investigation has assessed noise impacts associated with trains travelling within the Outer Harbour rail loop. This is consistent with the Director-General's Environmental Assessment Requirements for the modification dated 18 December, 2012 which required that the noise assessment be conducted in accordance with the INP. The noise assessment was undertaken on this basis.

In consultation with DP&I it was agreed that rail noise associated with trains travelling on the wider rail network was beyond the scope of this modification. The modification will result in an increase in train movements on the

wider rail network and there will need to be rail infrastructure upgrades on the network to accommodate this increase in train movements. However, these infrastructure upgrades will be the responsibility of the rail owner/operator, such as ARTC, or potential customers, such as mining companies who are supplying the product. The exact detail and timing of these infrastructure upgrades are still to be determined and ultimately they will be subject to a separate assessment/approval process. Noise impacts associated with increased train movements on the wider rail network should be assessed at this time.

3.4 Road Traffic Noise Levels

The PKOH development is predicted to generate additional heavy vehicle and light vehicle traffic movements. Therefore, noise from traffic movements to and from the PKOH development will be assessed using the EPA Road Noise Policy (DECCW, 2011). The main roads around the facility with increased traffic flow are Five Islands Road, Flinders Road and Old Port Road. These roads are considered to be arterial and sub-arterial roads under the RNP. There are no residential properties in the vicinity of Old Port Road.

Table 13 presents the RNP's road traffic noise assessment criteria for residential land use developments with potential to create additional traffic on existing roads, the applicable criteria for residences nearby roads with increased traffic flows. The external criteria are assessed at 1 metre from the affected residential building façades and at a height of 1.5 metres from the floor.

Table 13 Road traffic noise assessment criteria for residential land uses

Road Category	Type of Project/Land Use	Assessment Criteria - dB(A)	
		Day (7 am – 10 pm)	Night (10 pm – 7 am)
Freeway/arterial /sub-arterial roads	3. Existing residences affected by **additional traffic** on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60	$L_{Aeq, (9\ hour)}$ 55

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

These criteria are applicable to operational and construction traffic.

3.5 Operation and Construction Vibration Criteria

3.5.1 Building exposure to vibration - Structural damage

Vibration generated by operation and construction activities can travel though the ground and causing nearby building structures to vibrate. This may cause damage to the building structure ranging from minor hairline cracking to major structural cracking.

Two guidelines have been considered as part of this assessment:

- DIN Standard 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures.
- British Standard 7385: Part 2 1993 Evaluation and Measurement of Vibration in Buildings.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. It should also be noted that these levels are "safe limits", up to which no damage due to vibration effects has been observed for the particular class of building. "Damage" is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits will not necessarily result in damage, the limits are generally recognised as being conservative.

BS 7385 quantifies three different levels of damage to structures:

- **Cosmetic** – The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction;
- **Minor –** The formation of large cracks or loosening and falling of plaster or drywall surfaces, or cracks through bricks/concrete blocks; and
- **Major** – Damage to structural elements of the building, cracks in support columns, loosening of joints, splaying of masonry cracks, etc.

BS 7385-1993 provides guidance on assessing the possibility of vibration-induced damage in buildings due to a variety of sources and sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95 per cent probability of no effect.

The standard states that there is a major difference between the sensitivity of people in feeling vibration and the onset of levels of vibration which may damage the structure. The levels of vibration at which people are likely to comment are below levels of vibration which damage buildings, except at lower frequencies.

3.5.2 Human exposure to tactile vibration

Long term exposure to vibration in buildings may cause annoyance. The levels at which annoyance occurs are much lower than the structural damage criteria in buildings.

British Standard 6472-1992 Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) and NSW EPA publication 'Assessing Vibration – A Technical Guideline' provides guidance on human response to vibration are used to set guideline vibration levels for this project. BS 6472-1992 has recently been superseded by BS 6472-2008. Although a new version of BS 6472 has been published, the EPA still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time and accordingly the 1992 version is referred to in this document.

EPA guideline is based on Vibration Dose Values (VDVs). VDV level can be directly related to vibration discomfort experienced by a person.

The VDV is a cumulative measure and increases as the exposure duration increases.

3.5.3 Operation and construction vibration criteria summary

The recommended criteria presented in BS 7385-1993, DIN 4150 and BS 6472 have been summarised below in Table 14. Measurement of vibration should be taken at the base of the building facing the source of the vibration in the vertical and two horizontal directions. For multi-story structures where vibration amplification is likely measurements should also be made on the floor with the highest vibration level.

Table 14 Operation and construction vibration criteria summary

Category	Human Comfort, VDV ($m/s^{1.75}$)		Structural Damage (mm/s)
	Day	Night	
Particularly sensitive structures (e.g. listed buildings under preservation order)	0.2 – 0.8 (depending on its use)	0.13 – 0.8 (depending on its use)	3
Residential Structures	0.2	0.13	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Offices, schools, educational institutions and places of worship	0.4	0.4	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Occupied non-sensitive structures	0.8	0.8	50 mm/s at 4 Hz and above

Category	Human Comfort, VDV (m/s$^{1.75}$)		Structural Damage (mm/s)
	Day	Night	
of reinforced concrete or steel construction (e.g. factories and commercial premises)			
Occupied non-sensitive, light framed structures	0.8	0.8	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Unoccupied non-sensitive structures of reinforces concrete or steel construction (e.g. factories and commercial premises)	N/A	N/A	50 mm/s at 4 Hz and above
Unoccupied non-sensitive, light framed structures	N/A	N/A	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

3.5.4 Ground-borne noise

Vibration generated by train movement enters buildings via the ground. This causes the floors, walls and ceilings to vibrate and to radiate noise. This noise is commonly referred to as structure- or ground-borne noise or regenerated noise. Regenerated noise is low frequency and if audible is perceived as a 'rumble'.

The ground-borne noise goals as outlined in the EPA document IGANRIP are employed as a guide to assess ground borne noise. These noise goals are summarised in Table 15.

Table 15 Recommended ground-borne noise goals for operational activities

Receiver	Time of Day	Noise Trigger Levels dB(A)
Residential	Day (7 am – 10 pm)	40 dB(A) LAmax, slow
	Night (10 pm – 7 am)	35 dB(A) LAmax, slow
Schools, educational institutions, places of worship	When in use	40-45 dB(A) LAmax, slow

The closest residential receivers that may be impacted by ground borne noise from rail movements are located approximately 100 metres from the South Yard, on Wentworth Street.

3.6 Blasting Vibration Criteria

Construction blasting can result in two adverse environmental effects – airblast and ground vibration. The airblast and ground vibration produced may cause human discomfort and may have the potential to cause damage to structures, architectural elements and services.

Airblast will have no impact during the construction stage of the Major Project or Concept Plan as all blasting is to take place under a minimum water depth of 5 metres. The acoustic impedance mismatch between air and water means that the vast majority of acoustic energy from an underwater blast will be reflected at the water surface. The minimal amount of energy that is not reflected is likely to be at a low sound pressure level at infrasound frequencies, and as such would comply with the airborne noise criteria at the nearest receivers.

Two guidelines have been considered as part of this assessment:

- ANZECC Guidelines - Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.
- Australian Standard 2187.2-2006 Explosives - Storage and Use Part 2: Use of Explosives – Appendix J.

3.6.1 ANZECC guidelines

The Australian and New Zealand Environment Conservation Council (ANZECC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* has been adopted by the EPA as comfort criteria, i.e. *criteria to minimise annoyance and discomfort to persons at noise sensitive sites (e.g. residences, hospitals, schools etc.) caused by blasting*. The guidelines are not intended to be structural damage criteria; however they do provide a conservative approach to assessing blasting impacts. The guidline limits are to be assessed at the foundation of the relevant structure.

- The ANZECC recommended maximum level for ground vibration is 5 mm/s (Peak Particle Velocity, PPV).
- The PPV of 5 mm/s may be exceeded on up to 5 per cent of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Experience has shown that for almost all sites a PPV of less than 1 mm/s is generally achieved. It is recognised that it is not practicable to achieve a PPV of this level at all sites and hence a recommended maximum level of 5 mm/s has been selected. However, it is recommended that a level of 2 mm/s (PPV) be considered as the long term regulatory goal for the control of ground vibration.
- Blasting should generally only be permitted during the hours of 9 am – 3 pm Monday to Friday and 9 am – 12 pm on Saturday. Blasting should not take place on Sundays or Public Holidays.
- Blasting should generally take place no more than once per day. (This requirement would not apply to minor blasts such as for clearing crushers, feed chutes etc.).
    - The restrictions on times and frequency of blasting do not apply to those premises where the effects of the blasting are not perceived at noise sensitive sites.

The ANZECC guidelines for sensitive sites (e.g. residences, hospitals, schools etc.) criteria are summarised in Table 16.

Table 16 ANZECC guideline blast criteria for sensitive sites summary

	ANZECC Guidelines
Noise	≤ 115 dB(linear) peak for 95% of total number of blasts in 12 months ≤ 120 dB(linear) peak for any blast
Vibration	≤ 5 mm/sec PPV for 95% of total number of blasts in 12 months ≤ 10 mm/sec PPV for any blast

3.6.2 AS 2187.2-2006 Explosives – Storage and use Part 2: Use of explosives – Appendix J

AS 2187.2 recommends ground vibration limits which are consistent with the ANZECC guidelines, however this standard provides more detail. It considers criteria for human comfort and structural damage and different types of structures such as more sensitive masonry and plasterboard buildings and less sensitive reinforced concrete buildings.

AS 2187.2-2006 notes that damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133 dB(lin peak).

3.6.3 Blasting vibration criteria summary

The blasting criteria presented in AS 2187.2-2006 has been summarised in Table 17. The potential controlling criterion has been indicated in bold. It is recommended that the AS 2187.2-2006 be considered for blasting

vibration assessments at PKOH. Measurement of vibration should be taken at the base of the building facing the source of the vibration in the vertical and two horizontal directions. For multi-story structures where vibration amplification is likely measurements should also be made on the floor with the highest vibration level.

Table 17 Blasting criteria summary

Category	Human Comfort	Structural damage
Sensitive structures (e.g residential, theatres, schools etc.)	**5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply**	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Occupied non-sensitive structures of reinforces concrete or steel construction (e.g. factories and commercial premises)	**25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacture's specifications or levels that can be shown to adversely affect the equipment operation.**	50 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply*
Occupied non-sensitive structures that include masonry, plaster and plasterboard in their construction (e.g. factories and commercial premises)	**25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacture's specifications or levels that can be shown to adversely affect the equipment operation.**	**15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above**
Unoccupied non-sensitive structures of reinforces concrete or steel construction (e.g. factories and commercial premises)	N/A	**50 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply***
Unoccupied non-sensitive structures that include masonry, plaster and plasterboard in their construction	N/A	**15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above**
Services structures, such as pipelines, powerlines and cables	N/A	Limit to be determined by structural design methodology. Special consideration may be required for high pressure gas pipelines.

Note these requirements do not cover high rise buildings, buildings with long span floors, specialist structures such as reservoirs, dams and hospitals, or buildings housing scientific equipment sensitive to vibration. These require special considerations, which may necessitate taking additional measurements on the structure itself. Particular attention should be given to the response of suspended floors.

3.6.3.1 Conditions of approval for PKOH Stage 1 – Blasting limits (C10)

The CoA for the Major Project includes a condition for blasting limits (Condition Approval No. 10), which has been reproduced below:

C10. Ground vibration peak particle velocity from blasting operations at the project shall not exceed 5mm/sec more than 5 percent of the total number of blasts over each reporting period and shall not exceed 10mm/sec at any time.

This does not differentiate between residential, commercial and other non-sensitive receivers and can render the blasting operation overly restrictive for non-sensitive receivers (e.g. commercial, non-sensitive masonry structures, etc.). CoA C10 and any other blasting vibration limits should reflect the vibration limits presented in Table 17.

4.0 Construction Noise and Vibration Assessment

4.1 Noise Modelling

Construction noise emissions were modelled using SoundPLAN v7.0 (industry standard) noise modelling software. The construction noise levels were predicted using an implementation of CONCAWE[1] algorithms in the SoundPLAN noise propagation software. This is considered an appropriate algorithm give the distance to receivers.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment and acoustic shielding. However, a conservative approach has been adopted and all equipment is operating for a full 15 minute period.

The noise models take into account significant noise source sound level emissions and locations, screening effects, receiver locations, ground topography and noise attenuation due to geometrical spreading air absorption and ground absorption. The noise model was based on ground topography, general site layouts and indicative plant equipment sound power levels.

Predicted noise levels are free field, at least 3.5 metres away from any reflecting surface, and have been made at a receiver location of 1.5 metres above ground level at the most-affected point within a residential property boundary within 30 metres of the nearest facade.

4.2 Construction Noise and Vibration Assessment

Construction noise from the PKOH development has previously been assessed by AECOM as part of the previous NVIA. These construction works are currently underway. There is an existing construction noise management plan for the Stage 1, as part of which noise monitoring is been undertaken on a regular basis. No noise complaints have been received from the construction works underway at PKOH. As part of this assessment a construction noise assessment has been undertaken that is considered to be a 'reasonable' worst case scenario. This assessment considers additional construction activity and the additional construction footprint towards the south of the site, demolition of jetties, terminal and berth construction, rail infrastructure upgrades and general construction such as access roads, shed construction and dredging and spoil emplacement.

A review of the potential noise levels from typical construction scenarios are included as part of this assessment, with recommended mitigation measures where applicable. The construction scenarios modelled for the construction noise impact assessment have been agreed in discussion with PKPC and AECOM maritime engineers. The assessment assumes that all plant are operating continuously for the full 15-minute assessment period, which is a conservative assessment.

4.3 Major Project - Construction Activities

An assessment of the Major Project construction activities has been undertaken. The construction activities outlined in Table 18 have been considered as part of the construction noise impact assessment. For each activity the equipment has been assumed to be used simultaneously. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, "*Guide to noise and vibration control on construction, demolition and maintenance sites*" and the UK Department for Environment, Food and Rural Affairs (DEFRA) "*Update of noise database for prediction of noise on construction and open sites*" noise database and assume equipment is modern and in good working order. In AECOM's experience L_{A1} sound power levels are typically up to 8 dB above L_{Aeq} sound power levels.

1 CONCAWE – The oil companies' international study group for conservation of clean air and water – Europe (established in 1963) Report 4/81 "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

Additional construction considered as part of this modification includes:

- Demolition of jetties
- Dredging and spoil displacement
- General construction of access roads, sheds, compounds and bridges
- Rail infrastructure upgrades.

The additional construction footprint is also considered in the assessment. Specific equipment and the associated sound power levels are provided below in Table 18.

Table 18 Construction plant and equipment (Major Project)

Construction Activity	Equipment	Task	SWL, L_{Aeq} dB(A)	Number
Demolition of Jetties No. 3 and No. 4 (12 months)	Cranes barges, boats	Moving structural timber, timber fenders and decking from jetty structure	112	2
	Excavator	Dismantling jetties	101	1
	Wheeled loader	Moving demolished material around active construction work area	105	1
	Tip truck	Transporting demolished material to salvage yard or landfill	106	18 movements in any 15 minute period
Dredging and spoil emplacement (18 months)	Trucks	Delivery of fill material	106	18 movements in any 15 minute period
	Trains	Delivery of fill material	102	1
	Vibratory roller and compactors	Compaction of fill	109	2
	Graders	Grading final surface of fill	113	2
	Excavator and long reach excavator	Trenching/placing material for Salty Creek diversion and Darcy Road drain extension. Placing rock material for rock revetments.	106	2
	Front end loaders	Moving rock material for revetments	105	2
	Bulldozers	Levelling reclamation	111	2
	Grab/backhoe dredgers	Dredge sediments and rock	110	2
	Cutter suction dredger	Dredge contaminated sediments	110	2
	Barges	Storage of dredged sediment and rock material before placing in reclamation	112	2
	Tugs and small craft	Tow barges laden with sediment	100	2
	Water carts	Dust suppression	100	2
	Blasting equipment	Rock blasting	Refer to Section 4.7	

Construction Activity	Equipment	Task	SWL, L_{Aeq} dB(A)	Number
General construction such as access roads, shed construction, construction compound, potential bridge construction (6 – 12 months)	Excavator	Minor excavation of existing surface	101	1
	Grader	Levelling surface	113	1
	Roller	Compaction of surface	109	1
	Asphalt paver	Laying asphalt	106	1
	Bitumen spray truck	To seal surface of road	110	1
	Padfoot and smooth drum	Compaction of surface	99	1
	Mobile franner crane	Position pre-fabricated materials and heavy loads	93	1
	Pile rig	To drill pile holes	111	1
	Articulated dump truck	Earth moving trucks	107	18 movements in any 15 minute period
	Sweeper	Clean surface between stages of road construction	104	1
	Concrete trucks	Move and pour concrete	106	1
	Water cart	Dust suppression	100	1
Terminal and berth construction including multi-purpose berth, container berth and utilities installation (18 months per berth)	Cranes and piling cranes	Position pre-fabricated materials and heavy loads	106	2
	Excavator	Foundations for amenities	101	1
	Asphalt paver	Laying asphalt	106	1
	Rotary bore piling rig	Installation of piles for quay walls	111	1
	Backhoe	Excavation for services and relocation of sulphuric acid pipeline	102	1
	Front end loader	Stockpiling material behind quay walls	105	1
	Grader	Grading and levelling surface	113	1
	Roller	Compaction and completion of surface	109	1
	Trucks	Concreting and movement of fill around site	106	18 movements in any 15 minute period
	Compressor	Power tools	109	1
	Generator	Power equipment during construction	101	1
Rail infrastructure upgrades	Excavator	Excavate area for new turnout and rail siding	101	1
	Dump truck	Transport of spoil and ballast around site	107	18 movements in any 15 minute period
	D9 bulldozer	Levelling area	111	1
	Rail ballast	Adjust ballast once track is laid	100	1

Construction Activity	Equipment	Task	SWL, L_{Aeq} dB(A)	Number
	tamper			
	Mobile crane	Move rail infrastructure into place and remove turnout	106	1
	Demolition saw	To aid turnout removal	115	1
	Water cart	Dust suppression	100	1
	Track layer	Machine on front of train which lays railway tracks	102	1
	Regulator	Shape ballast	102	1
	Trains	To carry rail and track layer	102	1
	Portable welding equipment	Welding	101	1
	Scraper	Movement of spoil	113	1

It is understood that fill material is to be sourced from dredging activities and also would be imported to site from various external earthworks projects.

Fill material will be transported to site by road and rail. On average, less than one single train per day will transport fill material to the site during the Major Project construction phase. The impact on nearby receivers of the road and rail movements associated with the delivery of fill material has been included in the assessment of construction noise, and found to comply with the construction noise management levels at the closest residential receivers.

AECOM has been advised that, with the exception of dredging related activities, construction activities would not be undertaken outside of standard daytime working hours. The assessment for the evening and night-time periods therefore assumes that only the dredging related activities are taking place.

The assessed scenarios are recommended typical construction scenarios. A construction noise and vibration management plan (CNVMP) should be developed at the construction stage to more accurately assess noise impacts when a detailed construction programme is available. Predicted construction noise levels are presented in Table 19 to Table 23. These predicted construction $L_{Aeq(15\ min)}$ noise levels have been predicted to each of the representative noise sensitive receivers.

Table 19 Predicted daytime construction noise levels - Demolition of Jetties No. 3 and No. 4

Receiver	Receiver Type	Construction Noise Levels, $L_{Aeq\ 15min}$		
		Criterion	Result	Exceedance
R1	Residential	57	31	-
R2	Residential	57	43	-
R3	Residential	57	44	-
R4	Residential	57	30	-
R5	Residential	57	41	-
R6	Residential	49	42	-
R7	Residential	49	41	-
R8	Residential	57	44	-
R9	Residential	49	25	-
R10	School	55 (when in use)	38	-
R11a	Place of worship	55 (when in use)	42	-
R11b	Place of worship	55 (when in use)	41	-
R12	Commercial	70	46	-
R13	Industrial	75	40	-
R14	Industrial	75	47	-

Table 20 Predicted daytime construction noise levels - General construction such as access roads, shed construction, construction compound, potential bridge construction

Receiver	Receiver Type	Construction Noise Levels, $L_{Aeq\ 15min}$		
		Criterion	Result	Exceedance
R1	Residential	57	36	-
R2	Residential	57	49	-
R3	Residential	57	48	-
R4	Residential	57	31	-
R5	Residential	57	45	-
R6	Residential	49	46	-
R7	Residential	49	44	-
R8	Residential	57	47	-
R9	Residential	49	27	-
R10	School	55 (when in use)	44	-
R11a	Place of worship	55 (when in use)	45	-
R11b	Place of worship	55 (when in use)	45	-
R12	Commercial	70	50	-
R13	Industrial	75	43	-
R14	Industrial	75	52	-

Table 21 Predicted daytime construction noise levels - Terminal and berth construction including multi-purpose berth, container berth and utilities installation

Receiver	Receiver Type	Construction Noise Levels, $L_{Aeq\ 15min}$		
		Criterion	Result	Exceedance
R1	Residential	57	34	-
R2	Residential	57	48	-
R3	Residential	57	47	-
R4	Residential	57	34	-
R5	Residential	57	44	-
R6	Residential	49	42	-
R7	Residential	49	44	-
R8	Residential	57	46	-
R9	Residential	49	26	-
R10	School	55 (when in use)	42	-
R11a	Place of worship	55 (when in use)	43	-
R11b	Place of worship	55 (when in use)	44	-
R12	Commercial	70	48	-
R13	Industrial	75	43	-
R14	Industrial	75	50	-

Table 22 Predicted daytime construction noise levels - Rail infrastructure upgrades

Receiver	Receiver Type	Construction Noise Levels, $L_{Aeq\ 15min}$		
		Criterion	Result	Exceedance
R1	Residential	57	42	-
R2	Residential	57	58	1
R3	Residential	57	61	4
R4	Residential	57	43	-
R5	Residential	57	49	-
R6	Residential	49	43	-
R7	Residential	49	41	-
R8	Residential	57	43	-
R9	Residential	49	26	-
R10	School	55 (when in use)	45	-
R11a	Place of worship	55 (when in use)	43	-
R11b	Place of worship	55 (when in use)	45	-
R12	Commercial	70	46	-
R13	Industrial	75	52	-
R14	Industrial	75	56	-

As dredging is proposed to take place up to 24 hours a day it has been assessed against both the standard construction noise management levels and the out of hour noise management levels.

Table 23 Construction noise - Dredging and spoil emplacement

Receiver	Construction Noise Levels, $L_{Aeq\ 15min}$					Sleep disturbance, $L_{A1\ 1min}$		
	Predicted Noise Level, dB(A)	Standard Construction Hours NMLs	Exceedance	Out of Hours Works NMLs	Exceedance	Predicted noise level, dB(A)	Criterion	Exceedance
R1	32	57	-	50	-	34	65	-
R2	47	57	-	50	-	49	65	-
R3	47	57	-	50	-	49	65	-
R4	31	57	-	50	-	33	65	-
R5	43	57	-	50	-	45	65	-
R6	43	49	-	42	1	45	65	-
R7	42	49	-	42	-	44	65	-
R8	45	57	-	50	-	47	65	-
R9	26	49	-	42	-	28	65	-
R10	41	55	-	55	-	N/A	N/A	-
R11a	43	55	-	55	-	N/A	N/A	-
R11b	43	55	-	55	-	N/A	N/A	-
R12	47	70	-	70	-	N/A	N/A	-
R13	42	75	-	75	-	N/A	N/A	-
R14	50	75	-	75	-	N/A	N/A	-

All construction activities associated with the Major Project of the PKOH development, with the exception of the rail infrastructure upgrade, are predicted to comply with the daytime and night time noise management levels as presented in Table 19 to Table 23. The predicted daytime construction noise levels associated with the rail infrastructure upgrades in the rail loop and in particular the South Yard which is closest to the sensitive receivers, are predicted to exceed the noise management levels at receivers R2 and R3 by 1 dB and 4 dB respectively. The controlling noise source as part of the construction works are the demolition saw and mobile plant. Operations of the demolition saw are expected to persist for only a fraction of the assessment period, and the overall construction works. Therefore, it is unlikely that this situation would occur for more than a short period of time.

This is a worst case assessment, that is, it assumes the shortest distance between source and receivers and that the noisiest activities would be occurring concurrently.

Given the predicted exceedance of the construction noise management levels, noise mitigation options have been investigated, refer to Section 6.1.

4.4 Cumulative Construction Noise Impact

The cumulative construction noise impact of each of the proposed construction scenarios overlapping has been assessed on nearby representative noise sensitive receivers. The results from the cumulative construction noise assessment, assuming all operations are occurring concurrently, and that all plant are in operating throughout the assessment period are detailed in Table 24

Table 24 Predicted daytime construction noise levels – Cumulative noise impact

Receiver	Receiver Type	Construction Noise Levels, $L_{Aeq\ 15min}$		
		Criterion	Result	Exceedance
R1	Residential	57	44	-
R2	Residential	57	59	2
R3	Residential	57	62	5
R4	Residential	57	44	-
R5	Residential	57	52	-
R6	Residential	49	50	1
R7	Residential	49	50	1
R8	Residential	57	52	-
R9	Residential	49	33	-
R10	School	55	50	-
R11a	Place of worship	55	50	-
R11b	Place of worship	55	51	-
R12	Commercial	70	55	-
R13	Industrial	75	54	-
R14	Industrial	75	59	-

The results of the cumulative impact assessment show that an exceedance of up to 5 dB would occur at receiver R3. In addition three other receivers would experience an exceedance between 1 and 2 dB.

The results of the cumulative impact assessment also confirm that construction activities at the South Yard are the dominant source of construction noise, and should carefully be managed to reduce noise impacts at nearby sensitive receiver locations.

4.5 Construction Road Traffic Noise Assessment

Road traffic associated with the construction phase would add an additional 35 heavy vehicles per hour during the peak flow period during Stage 1. This is representative of the 'reasonable' worst case construction traffic movements during Stage 1 of the construction. All additional traffic will pass receivers near Lake Avenue (adjacent to Five Island Road) and along Gladstone Avenue (adjacent to Masters Road). The predicted increase in noise level at the worst affected receivers resulting from construction traffic is shown in Table 25.

Table 25 Construction Traffic - Predicted increase in noise levels along construction traffic path

Time Period	2016 Heavy Vehicle Peak Hour Traffic Flow – Without Construction	2016 Heavy Vehicle Peak Hour Traffic Flow – With Construction	Predicted Increase in Noise Levels, dB
AM peak	258	293	< 1.0
PM peak	228	263	< 1.0

The increase in noise levels resulting from construction traffic is predicted to comply with the road traffic noise criteria for the peak hour flow rates at the worst affected receivers. Consideration of road traffic noise mitigation measures is not required.

4.6 Construction Vibration Assessment

Construction activities that can generate high levels of vibration include:

- General earthworks
- Ground compaction (e.g. vibratory rollers)
- Re-sleepering
- Rail tamping and dynamic track stabilisation
- Spoil removal via road.

This construction vibration assessment focuses on ground compaction, rail tamping or dynamic track stabilisation as these activities are significantly more vibration intensive than earthworks and spoil removal.

4.6.1 Structural damage

Table 26 lists the estimated setbacks for these activities which are likely to be required to ensure that a peak particle velocity of 5 mm/s (residential) and 10 mm/s (commercial) is not exceeded.

Table 26 – Required setbacks to limit PPVs to within 5 mm/s and 10 mm/s

Activity	Required Setback to Limit PPV to Less 5 mm/s (Residential)	Required Setback to Limit PPV to Less 10 mm/s (Commercial)
2-tonne vibratory roller	5 m	3 m
10-tonne vibratory roller	20 m	12 m
Rail tamping	5 m	3 m
Dynamic track stabilization	10 m	6 m

The required minimum setback distances to avoid breaching the cosmetic damage criteria range from 5 metres through to 20 metres for a residential receiver. Given that there are no sensitive receivers, residential or otherwise, located within 20 metres of the proposed construction works the cosmetic damage vibration criteria is unlikely to be breached.

It is recommended that attended vibration monitoring is undertaken in situations if a plant is predicted to exceed the applicable vibration criteria (i.e. the separation of the plant to critical receivers is less than the required setbacks in Table 26). Attended measurements will allow for establishing site rules and for determining safe working distances.

The estimated setbacks must be considered as preliminary since they depend on geological and other factors. This preliminary study should be refined following early works once site-rules and buffer distances are established.

4.6.2 Human comfort – Tactile vibration

In general the human response to vibration is found to be a complex phenomenon. There are wide variations in vibration tolerance of humans and accordingly acceptance goals for human comfort are hard to define and quantify. Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g. workshop, office, or residence) and the character of vibration (e.g. continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

As the closest residential receivers are located approximately 100 metres from the proposed construction area, it is deemed very unlikely that residential receivers will be adversely affected by vibration from construction activities. Receivers located closer to the works may require careful management.

The mitigation methods are likely to include but are not restricted to:

1. Source controls
    a. Use of less noise and vibration intensive equipment;
    b. Respite periods;
2. Management methods
    a. Community consultation;
    b. Complaint response;
    c. Site layout;
    d. Avoiding work during sensitive time periods (e.g. night work);
    e. Noise and vibration logging and attended measurements;
    f. Training;
3. Path controls
    a. Noise enclosures;
    b. Avoid vibration intensive works in a concentrated area and try to work over a large area in order to reduce maximum vibration dose values.

The mitigation measures will be further developed in a "*Construction Noise and Vibration Management Plan*" (CNVMP) framework that takes into account relevant documents including EPA's "*Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects*", "*Interim Construction Noise Guideline*" and Transport for NSW (TfNSW) "*Construction Noise Strategy (Rail Projects)*" and the DGRs as specified by the DP&I. It is expected that the management measures would be similar to those for the Major Project approval.

4.6.3 Human comfort – Ground-borne noise

Vibration generated by compacting enters buildings via the ground. This causes the floors, walls and ceilings to vibrate and to radiate noise. This noise is commonly referred to as structure-borne, ground-borne noise or regenerated noise. Ground-borne noise is low frequency and if audible is perceived as a 'rumble'.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise from the construction activities. Regenerated noise levels, if present, will be masked by air-borne noise associated with the construction activities.

The mitigation measures will be further developed in a CNVMP framework that takes into account relevant documents including EPA's *Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects*", "*Interim Construction Noise Guideline*" and Transport for NSW (TfNSW) "*Construction Noise Strategy (Rail Projects)*" and the DGRs as specified by the DP&I. It is expected that the management measures would be similar to those for the Major Project approval.

4.7 Blasting Assessment

The modifications to the Major Project and the overall Concept Plan do not include any additional blasting requirements to those previously assessed as part of Stage 1 of the PKOD development. Therefore the blasting assessment presented in the previous NVIA remains valid for these modifications to the PKOH development.

Typical blasting noise and vibration levels have been previously provided. However, it is recommended that a detailed assessment is undertaken to consider specific site and nearby building conditions to quantify allowable charge sizes.

5.0 Operational Noise and Vibration Assessment

An assessment of operational noise impact from the Major Project and the Concept Plan has been carried out. Both assessments are based on likely operational scenarios that were arrived at following discussion with AECOM maritime engineers and PKPC.

The impact assessed in each case is based on the 'reasonable' worst case scenario, i.e. the shortest likely distance between source and receivers for each of the intrusive and amenity assessment periods. AECOM has been advised that the facility is to operate 24 hours a day, but that operations will likely be less extensive during the night-time period. However, for assessment purposes daytime, evening and night-time operations have been assumed to be the same, where activities are evenly spread over the 24 hour period. 'Reasonable' worst case intrusive and amenity scenarios have been developed, assessed and compared against the daytime, evening and night-time project specific noise goals.

Where modelling has predicted exceedance of the relevant project specific noise goal, noise mitigation options have been investigated. At this stage detailed mitigation solutions have not been designed as these will form part of the overall detailed design phase. The effect of mitigation has been demonstrated in principle to indicate that appropriate mitigation can reduce the predicted noise impact to an acceptable level.

5.1 Noise Modelling

Operational noise emissions were modelled using SoundPLAN v7.0 (industry standard) noise modelling software. The levels were predicted using an implementation of CONCAWE[2] algorithms in the SoundPLAN noise propagation software. 'Reasonable' worst case meteorological conditions have been assumed, with the assessment requirements being with wind speeds of up to 3 m/s source to receiver during the daytime and F-Class temperature inversion during the evening and night period. Although worst case meteorological conditions may not occur frequently, a conservative approach has been undertaken and they have been assessed in accordance with the requirements of the INP. Further discussion on meteorological conditions is provided in section 5.2.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment and acoustic shielding.

The noise models take into account significant noise sources and locations, screening effects, receiver locations, ground topography and noise attenuation due to geometrical spreading air absorption, ground absorption and the effects of the prevailing weather conditions.

Predicted noise levels are free field, at least 3.5 metres away from any reflecting surface and have been made at a receiver location of 1.5 metres above ground level at the most-affected point within a residential property boundary within 30 metres of the nearest facade. In addition, predicted noise levels have been made at one metre from the dwelling façade (to determine compliance with the traffic and sleep disturbance requirements).

All buildings, residential or otherwise have been included at appropriate heights to provide shielding and reflections where appropriate in the model.

Noise contours for the adverse weather conditions for both the intrusive and amenity periods generated by the assessment of both the Major Project and Concept Plan are included in Appendix C. The 3 m/s winds have been applied during the daytime and an F class temperature inversion has been applied during the evening and night time. It can be noted in Appendix C that noise appears to travel further on the eastern side of the maps. This is not a result of noisy activity from the proposed PKOH development but due to the efficient propagation of noise over water.

5.2 Meteorological conditions

Meteorological conditions such as the presence of a temperature inversion or light to moderate winds can have an effect on sound propagation. Data used to perform the meteorological assessment was sourced from the EPA Wollongong Automatic Weather Station (AWS) which is approximately 6 kilometres north of the PKOH site.

2 CONCAWE – The oil companies' international study group for conservation of clean air and water – Europe (established in 1963) Report 4/81 "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

The occurrence of F and G-Class temperature inversions was determined in accordance with Appendix E of the INP. It was concluded that F and G-Class inversions occurred more than 30 percent of the total winter night-time period, with an overall average of 74 per cent combined occurrence of both F and G-Class inversions.

The INP considers wind effects to be assessed when source-to-receiver wind speeds of 3 m/s or below occur for at least 30 per cent of the assessment period in any season. Results of the assessment are presented in Appendix D. It was found that 3 m/s winds are not a feature of the area during the evening and night time.

Therefore, worst case meteorological conditions consist of an F-class temperature inversion during the evening and night-time period and a 3 m/s source to receiver wind during the daytime. This has been incorporated in the operational modelling in accordance with the requirements of the INP.

5.3 Operational Scenario Assumptions

The following section of the report explains the different scenarios that will be operating at the PKOH development, and how they feature in the noise assessment. The scenarios have been developed to demonstrate the noise emissions from a “reasonable” worst case scenario.

5.3.1 Ship operations

During the ‘reasonable’ worst case scenario, all berths are to be occupied as part of the assessment scenarios. This means one ship at multi-purpose berth during the assessment of the Major Project. For the Concept Plan this means that three ships at the multi-purpose berth, and four container ships at the container terminal would be assessed. This represents a conservative scenario as the likelihood of all seven berths being occupied at any one time is unlikely.

It is understood that the moored ships will be operating using only auxiliary power units (APUs), and at this stage, shore power is not available. Ships at berth were previously not included in the noise modelling, but clarifications with EPA and DP&I have concluded that they are to be included in this modification assessment. It should be noted that there are a large variety of ships that will operate out of the PKOH, and PKPC do not have control of the ship type that will be operated out of the PKOH. Ship noise emissions can vary significantly, and so a ‘reasonable’ worst case assumed noise level from the ships’ APU has been included in the modelling.

5.3.2 Rail operations

Operational scenarios for both the reasonable worst case 15-minute intrusive assessment period, and the amenity assessment periods were developed to determine the intrusive and amenity period predicted noise limits.

Rail operational scenarios have been developed in consultation with PKPC and AECOM rail engineers.

The impact at noise sensitive receivers resulting from Major Project and Concept Plan operations at the proposed South Yard has been included in the operational assessment for both Major Project and Concept Plan.

The assessment has been based upon a conservative set of ‘reasonable’ worst case operations during the night-time period.

Following discussions with AECOM rail engineers, it was determined as a reasonable assumption that when a train comes into a siding they would be idling for about 15 minutes, and after this they would turn off the locos. When the train was then required to move, it would idle for five minutes, and then move away.

When a train is moving around the rail loop, it has been assumed that it would be operating in Notch 1. Notch 1 is the lowest engine setting. Notch 1 would generally be used for low speed and low gradient tracks such as the PKOH development ‘balloon’ loop.

Train joining/re-joining operations are only to occur in association with the operations of the general purpose and container trains. For all other trains, the operations have been designed to avoid the requirement of shunting movements for typical operations.

The assessment has assumed that the trains would arrive at PKOH consistently throughout a 24 hour period. The assumptions for the train movements have then been allocated as per Table 27.

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Table 27 Operational train numbers assumptions

Period	Coal Trains	Iron Ore/Bauxite Trains	Container	General Purpose
Stage	Major Project		Concept Plan	
Total trains (24 hours)	7	7	16	1

5.3.2.1 Major Project rail operations

Intrusive assessment

The 'reasonable' worst case operating scenario for the Major Project intrusive assessment is as follows:

- One train having entered the north yard and remains idling.
- One coal train moving through the unloader (located at the shortest distance between the closest receivers as it moves around the loop during unloading).
- One iron ore/bauxite train having just completed moving through the unloader, and then then train moves into the South Yard.
- One train preparing to leave the south yard.

Amenity assessment

The 'reasonable' worst case operating scenario for the Major Project amenity assessment is as follows. The number of trains operating during a 24 hour period is presented in Table 27. Each coal train is assumed to undertake the following operations as they move around the rail loop:

- Move into the North Yard, and potentially wait in the north siding before entering the unloader.
- Move through the unloader
  - Coal trains will be pulled through by the front two locomotives, with the rear two locomotives switched off.
  - Iron ore/ bauxite trains will have all locos switched off during the unloading process as they would be pulled through the unloader by an indexer, but then use the front locos to move into the South Yard to wait.
- Wait in the South Yard for a path out.

5.3.2.2 Concept Plan rail operations

For the Concept Plan operations an additional sixteen container trains per day and one general purpose train per day will be added to the trains already in operation as part of the Major Project operations. The sixteen container trains would likely operate consistently throughout a 24 hour period, and as such the train movements have a maximum of eight movements during the day, three during the evening and seven during the night time period.

At this stage the proposed operations at the South Yard are indicative only and have been assessed based on a likely operational scenario.

Intrusive assessment

The 'reasonable' worst case operating scenario for the Concept Plan intrusive assessment is as follows:

- Coal and iron ore/bauxite trains as descried in the Major Project intrusive scenario
- One general purpose train located in the Gateway siding
- One container train arriving and preparing to breaking up in the south yard
- One container train having reassembled and preparing to leave the south yard
- One container train broken into two halves and located at the container terminal unloading.

Amenity assessment

The 'reasonable' worst case operating scenario for the Concept Plan amenity assessment is as follows. The number of trains operating during each period is presented in Table 27. Each train is assumed to undertake the following operations as they move around the rail loop:

- Move into the north siding, and potentially wait before moving through the unloader
- Move through the unloader
    - Coal trains will be pulled through by the front two locomotives, then into the south yard to wait
    - Iron ore/ bauxite train will have all locos switched off during the unloading process, but then use the front locos to move into the south yard to wait.
- Wait in the south yard for a path out.

Operations of the container trains include the following:

- Enter the 'balloon' loop and move into the South Yard
- Train is broken into two at the south yard
- Broken trains move through to the container terminal where they are unloaded/loaded
- Trains move through to South Yard where they are re-joined
- Trains exit 'balloon loop' through the South Yard.

Operations of the general purpose trains include the following:

- Enter the 'balloon' loop and move into the North Yard
- Train is broken into two at the North Yard
- Broken trains move through to gateway terminal where they are unloaded/loaded
- Trains move through to the North Yard where they are re-joined
- Trains exit 'balloon loop' through the North Yard.

5.3.3 Dry bulk storage sheds

It has been assumed that the design of the bulk storage sheds is such that the noise emission contribution from operations taking place within the dry bulk storage sheds is considered negligable at all sensitive receiver locations.

5.3.4 Conveyor systems

It has been assumed all conveyors and transfer towers would be enclosed. As such, based upon previously measured fully enclosed conveyor systems, a sound power level per metre of 71 dB(A)/m has been adopted. The transfer towers sound power levels have been based upon measured open transfer towers in operation, and it has been assumed that a 10 dB(A) loss would result from fully enclosing the transfer towers.

5.3.5 Trucks

All internal truck movements are to move onto the site via Flinders Street/Christy Drive. A typical breakdown of internal truck movements has been done to represent the different truck operations throughout the site. For the Major Project, it has been assumed that all truck movements travel from Christy Drive to the southern break bulk area. This area is located closer to the sensitive receivers than the multi-purpose berth which is the destination for the dry bulk trucks, and so represents a conservative scenario for truck operations.

It has been assumed that the 'reasonable' worst 15-minute period truck numbers would be equal to the peak hour truck numbers. This has been used to calculate the day evening and night truck numbers for both the Major Project and the Concept Plan. Specific internal truck movements are presented below in Table 28.

Table 28 Internal site truck movement assumptions

Stage	Peak Hour Trucks	Trucks per 15 Minutes on Site
Major Project	21	6
Concept Plan	64	16

5.3.6 Reverse alarms

PKPC would commit to the use of broadband type reverse alarms for operational plant as part of PKOH operations and all lessors.

However, the use of tonal reverse alarms from general delivery truck operations has been assumed in this assessment as this is out of the control of PKPC and provides a conservative assessment. A review of the third octave spectrum at nearby receiver locations was reviewed to determine if a 5 dB(A) penalty as per the INP was required. The review indicated that the overall noise contribution at nearby residential receivers was not tonal and therefore no penalty for tonality has been applied.

Furthermore, a penalty will not be applied to tonal reverse alarms when assessed for sleep disturbance at night as this is assessed as an absolute level rather than frequency analysis.

5.4 Major Project assessment

The noise impact at noise sensitive receivers resulting from operations associated with the Major Project has been assessed. Operational noise emissions have been based upon an assumed 'reasonable' worst case set of activities, and if these activities vary or the sound power levels of the plant operated vary greatly from those used for modelling purposes the noise emissions should be reassessed.

Operational activity associated with the Major Project relates to the operation of one berth at the multi-purpose terminal and can be broadly split into two categories:

Materials exporting

- Export material will arrive by train and be unloaded directly to a mobile conveyor system that feeds dry bulk storage sheds.
- Material from the stockpiles is transferred from the dry bulk storage sheds to another mobile conveyor system which feeds directly to the ship unloader and into the ships hold.
- Break bulk export to be partly in storage sheds and part open storage and bulk liquid export via a dedicated pipeline is also available at the multi-purpose berth.

Materials importing

- Material is unloaded by ship cranes/occasional quayside crane and loaded directly into either:
  - Hoppers which feed directly into trucks (up to 21 two way peak hour movements)
  - Break bulk export and bulk liquid import via a dedicated pipeline is also available at the multi-purpose berth

Sound power levels (L_w) for the plant included in the Major Project operational noise model are shown in Table 29.

Table 29 Major Project - Plant sound power levels (L_w), dB

Plant/Operation	Octave Band Sound Power Levels (L_w)						
	63 Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Truck moving	80	90	96	101	101	101	97
Enclosed conveyor belt	78	72	68	72	64	60	51
Train idling	109	106	103	100	95	91	90
Train moving	126	113	99	91	86	83	80
Quayside crane	98	97	91	92	91	91	82
Ship crane	100	95	98	94	84	84	74
Ship APU	102	99	103	97	96	91	83

Moving and linear noise sources have been modelled as line sources, with the sound power expressed as power per metre. This has been derived from the sound power of the plant and adjusted to account for:

- The number of plant items traversing the line source path in the assessment period
- The proportion of the assessment period that the source is operational/moving
- The length of the line source.

The adjustment has been applied using the following equation:

$$\mathbf{SWL_{metre} = SWL_{truck} + (10\ log_{10}\ (t_{event}/t_{assessment}) + (10\ log_{10}\ n_{sources}) - (10\ log_{10}\ l_{line}))}$$

Where:

- SWL = Sound Power in dB (or dB(A))
- t_{event} = duration of the event in seconds (s)
- $t_{assessment}$ = duration of the assessment period in seconds (s)
- $n_{sources}$ = number of sources
- l_{line} = length of the line source in metres (m)

The purpose of the adjustment is to capture all the noise energy from all the noise events during the assessment period (including any breaks in activity if appropriate) and spread the energy equally over the length of the line source/vehicle route.

The noise data used in the assessment are from the AECOM in-house noise database and the UK DEFRA document '*Update of noise database for prediction of noise on construction and open sites*'.

Plant details as used in the SoundPLAN model are summarised in Table 30.

Table 30 – Major Project - Operational plant data used for modelling purposes

Project Phase	Plant	Source Type	Source Height (mAOD)	L_W dB(A)
Major Project	Trucks on site and accessing/leaving Major Project area	Point/Line	3.6	98[1]
	Ship Loader Front	Point	23	104
	Ship Loader Rear	Point	8.2	100
	Train Idling	Point	4.5	102
	Train moving in Notch 1	Line	4.5	102 per metre
	Unloader –Tippler (enclosed)	Point	5	107
	Unloader –Bottom dump coal unloader (enclosed)	Point	5	96
	Enclosed Conveyor	Line	6	71 per metre
	Enclosed Transfer Towers	Point	6	86
	Ship APU	Point	25	100
	Low Loaders	Point	3.6	102
	Small Mobile Crane	Point	3.5	96
	Forklift	Point	3.5	104
	Horn toot	Point	0.5	129

5.4.1 Predicted noise level results

The predicted noise levels at sensitive receivers in Sensitive Catchment Areas 1 and 2, as a result of operations associated with the Major Project have been assessed.

In the INP, the school classroom and place of worship criteria are an internal noise level, with an acceptable noise level of 35 dB(A) and a recommended maximum of 40 dB(A) for classrooms and an acceptable noise level of 40 dB(A) and a recommended maximum of 45 dB(A) for place of worship. A 10 dB reduction has been assumed between external and internal noise levels based upon a window being open for adequate natural ventilation.

The noise impacts on schools are to be assessed during school hours. As there is not a significant variation in noise levels between the day and night operations, the predicted night-time noise levels at the school have been assessed against the school criteria to determine the noise impact.

5.4.2 Intrusive scenario – No mitigation

Table 31 presents the Major Project intrusive operational noise modelling results with no mitigation.

Table 31 Major Project - Intrusive - No Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	51	50	37	- / - / -	40	- / -	41	-
R2	52	51	50	55	3 / 4 / 5	56	5 / 6	56	4
R3	52	51	50	57	5 / 6 / 7	57	6 / 7	58	6
R4	52	51	50	38	- / - / -	40	- / -	41	-
R5	52	51	50	45	- / - / -	47	- / -	48	-
R6	44	44	42	41	- / - / -	43	- / 1	44	-
R7	44	44	42	38	- / - / -	41	- / -	42	-
R8	44	44	42	41	- / - / -	45	1 / 3	46	2
R9	52	51	50	27	- / - / -	30	- / -	30	-
R10	50	50	50	40	- / - / -	43	- / -	44	-
R11a	50	50	50	40	- / - / -	43	- / -	44	-
R11b	50	50	50	41	- / - / -	44	- / -	45	-
R12	65	65	65	43	- / - / -	46	- / -	47	-
R13	70	70	70	47	- / - / -	49	- / -	50	-
R14	70	70	70	56	- / - / -	57	- / -	57	-

The results of the assessment show that there are exceedances of the criteria of up to 5 dB, 6 dB and 7 dB during the day, evening and night respectively under neutral meteorological conditions. A total of two receivers would experience an exceedance of the criteria under neutral meteorological conditions during the day, evening and night time periods. These receivers are R2 and R3.

The results of the assessment also show that there are exceedances of the criteria of up to 6 dB and 7 dB during the evening and night respectively under an F-Class thermal inversion. A total of three receivers during the evening and four receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R6 and R8.

Lastly, the results of the assessment also show that there are exceedances of the criteria of up to 6 dB during the day under a 3 m/s source to receiver wind. A total of three receivers during the day would experience an exceedance of the criteria under a 3 m/s source to receiver wind. These receivers are R2, R3 and R8.

5.4.3 Amenity scenario – No mitigation

Table 32 presents the Major Project amenity operational noise modelling results with no mitigation.

Table 32 Major Project - Amenity - No Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	43	42	30	- / - / -	34	- / -	35	-
R2	52	43	42	44	- / 1 / 2	45	2 / 3	46	-
R3	52	43	42	45	- / 2 / 3	46	3 / 4	47	-
R4	52	43	42	30	- / - / -	33	- / -	34	-
R5	52	43	42	37	- / - / -	40	- / -	41	-
R6	60	48	37	36	- / - / -	39	- / 2	40	-
R7	60	48	37	36	- / - / -	40	- / 3	41	-
R8	60	48	37	40	- / - / 3	43	- / 6	44	-
R9	52	43	42	22	- / - / -	26	- / -	26	-
R10	50	50	50	36	- / - / -	40	- / -	41	-
R11a	50	50	50	37	- / - / -	41	- / -	42	-
R11b	50	50	50	37	- / - / -	41	- / -	42	-
R12	65	65	65	41	- / - / -	43	- / -	44	-
R13	70	70	70	39	- / - / -	41	- / -	42	-
R14	70	70	70	44	- / - / -	46	- / -	46	-

The results of the assessment show that there are exceedances of the criteria of up to 2 dB and 3 dB during the evening and night respectively under neutral meteorological conditions. A total of two receivers during the evening and three receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R2, R3 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 3 dB and 6 dB during the evening and night respectively under an F-Class thermal inversion. A total of two receivers during the evening and five receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R6, R7, and R8.

Lastly, the results of the assessment also show that there are no exceedances of the criteria during the day under a 3 m/s source to receiver wind.

5.4.4 Intrusive scenario – Major Project with mitigation

It is important to note that Major Project will be staged and as such it will take a number of years before the Major Project is fully operational, as it will respond to market demands. Based on this, it is unlikely that all of the following mitigation measures would be required from day one. An operational noise and vibration management plan (ONVMP) would be prepared which would outline the proposed approach to mitigation for the Major Project development. This ONVMP would develop the noise mitigation program in order to comply with the established noise limits.

Mitigation options have been investigated, and the following are recommended mitigation measures for the Major Project so that it meets that required noise limits. These mitigation options are to be further investigated and developed by PKPC taking into consideration the likely progressive development of the Major Project.

- **South Rail Yard barrier** - 420 metre long 8 metre high barriers along part of the South Yard adjacent to the residential area on the opposite side of Five Islands Road to reduce noise from rail operations.
- **South Break Bulk area** - Enclosure of the open southern break bulk area with a shed, this shed can be open to the north.
- **Multi-purpose Berth operations** - As part of the equipment selection and on-going noise mitigation program (to be outlined in an ONVMP) the following equipment would need to reduce their sound power levels, as assumed in the noise model:
    - Entire ship loader – Reduced by 3 dB. A 3 dB reduction is considered to be to be feasible by using enclosures
- **Rail Loop operations** - Tippler Unloader – Reduced by 3 dB. A 3 dB reduction is considered to be to be feasible by using enclosures.

5.4.5 Amenity scenario – With Major Project mitigation

Table 33 presents the Major Project intrusive operational noise modelling results with Major Project mitigation.

Table 33 Major Project - Intrusive – With Major Project Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	51	50	37	- / - / -	40	- / -	41	-
R2	52	51	50	47	- / - / -	48	- / -	49	-
R3	52	51	50	49	- / - / -	50	- / -	51	-
R4	52	51	50	38	- / - / -	40	- / -	41	-
R5	52	51	50	44	- / - / -	46	- / -	47	-
R6	44	44	42	39	- / - / -	41	- / -	42	-
R7	44	44	42	36	- / - / -	39	- / -	40	-
R8	44	44	42	37	- / - / -	41	- / -	42	-
R9	52	51	50	25	- / - / -	27	- / -	28	-
R10	50	50	50	37	- / - / -	40	- / -	40	-
R11a	50	50	50	36	- / - / -	39	- / -	40	-
R11b	50	50	50	38	- / - / -	41	- / -	42	-
R12	65	65	65	41	- / - / -	43	- / -	44	-
R13	70	70	70	47	- / - / -	49	- / -	50	-
R14	70	70	70	39	- / - / -	39	- / -	40	-

The results of the assessment show that there are no exceedances of the criteria in any time period under any meteorological conditions.

5.4.6 Amenity scenario – With Major Project mitigation

Table 34 presents the Major Project amenity operational noise modelling results with Major Project mitigation.

Table 34 Major Project - Amenity – With Major Project Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	43	42	30	- / - / -	33	- / -	34	-
R2	52	43	42	36	- / - / -	38	- / -	39	-
R3	52	43	42	40	- / - / -	42	- / -	43	-
R4	52	43	42	29	- / - / -	32	- / -	33	-
R5	52	43	42	35	- / - / -	38	- / -	39	-
R6	60	48	37	32	- / - / -	35	- / -	36	-
R7	60	48	37	33	- / - / -	36	- / -	37	-
R8	60	48	37	34	- / - / -	39	- / 2	39	-
R9	52	43	42	18	- / - / -	21	- / -	22	-
R10	50	50	50	32	- / - / -	35	- / -	36	-
R11a	50	50	50	32	- / - / -	36	- / -	37	-
R11b	50	50	50	33	- / - / -	36	- / -	37	-
R12	65	65	65	37	- / - / -	40	- / -	41	-
R13	70	70	70	38	- / - / -	40	- / -	41	-
R14	70	70	70	27	- / - / -	28	- / -	29	-

The results of the assessment also show that there is an exceedance of the criteria of 2 dB during the night under an F-Class thermal inversion at receiver R8.

The same receiver would experience an exceedance of the criteria under an F-Class thermal inversion during the night.

The results of the assessment show that there are no other exceedances of the criteria in any time period under any meteorological conditions.

5.5 Concept Plan assessment

The impact at noise sensitive receivers resulting from operations associated with the overall Concept Plan has been assessed.

In addition to the operation of one berth for the multi-purpose terminal associated with the Major Project, the operations associated with the Concept Plan include the balance of the multi-purpose terminal (two additional berths) and the container terminal (four berths). This gives a total of seven berths for Concept Plan operations.

Operations at the multi-purpose terminal will comprise of offloading using ship and occasional quayside cranes, transportation of offloaded goods to storage areas by forklift and then transportation of goods off site by truck and the import of bulk liquids via a dedicated pipeline. This pipeline is currently in operation at the berth and would be relocated as part of the Concept Plan.

Operational activity associated with the Container Terminal can be broadly summarised as follows:

Goods importing:

- Full containers arriving on ship are unloaded by quayside rail mounted quayside cranes. Containers are then transferred across the terminal by shuttle carriers and placed in stacks by rail mounted gantry cranes (RMGs).
- The stacks are transferred onto waiting trains and trucks by RMGs.

Goods exporting:

- Trains arriving on site with full/empty containers are unloaded by the RMGs. Containers are then transferred either directly onto ship or to a 'buffer' stack area by shuttle carrier.
- Containers transferred to the stock area are moved by RMG.

It is understood that approximately 90 per cent of containers will be moved by rail and 10 per cent by road.

Sound power levels (L_W) for the plant included in the Concept Plan operational noise model are shown in Table 35. These activities are in addition to the activities specified in Table 30, which were also included in the Concept Plan modelling assessment.

Table 35 Concept Plan - Plant sound power levels (L_w), dB

Plant/Operation	Octave Band Sound Power Levels (Lw)						
	63 Hz	125Hz	250Hz	*500Hz*	*1kHz*	*2kHz*	*4kHz*
Multi-purpose Terminal							
Truck Moving	80	90	96	101	101	101	97
Forklift moving/loading	101	98	98	111	93	90	86
Quayside Crane	98	97	91	92	91	91	82
Ship mounted cranes	100	95	98	94	84	84	74
Container Terminal							
Rail Mounted Gantry Cranes	109	106	102	104	100	96	95
Train Moving – Class 81 Locomotive	127	114	101	92	88	85	82
Train Idling – Class 81 locomotive	104	107	98	98	98	91	79
Mobile Stackers	110	107	103	105	101	97	96
Quayside Crane	98	97	91	92	91	91	82
Truck Moving	80	90	96	101	101	101	97
Forklift moving/loading	101	98	98	111	93	90	86

The noise data used in the assessment are from the AECOM in-house noise database and the UK DEFRA document '*Update of noise database for prediction of noise on construction and open sites'*.

Plant details as used in the SoundPLAN model are summarised in Table 36.

Table 36 – Concept Plan - Operational plant data used for modelling purposes

Project Phase	Plant	Source Type	Source Height (mAOD)	% On-time in typical 15 min period	Number of plant	L_W dB(A)
Multi-purpose Terminal	Truck on site access road	Line	3.6	10	5 per 15 mins	107 per metre
	Trucks accessing warehousing	Line	3.6	10	3 per 15 mins	107 per metre

Project Phase	Plant	Source Type	Source Height (mAOD)	% On-time in typical 15 min period	Number of plant	L_W dB(A)
	Trucks accessing outside storage areas	Point	3.6	10	2 per 15 mins	107 per metre
	Forklift moving offloaded goods	Line	2	10-20	5 (each with 3 movements in 15 mins)	82 per metre
	Forklift loading goods	Line	2	5	2 (each with 3 movements in 15 mins)	82 per metre
	Quayside Crane	Point	3.5	100	1	102
	Ship mounted cranes	Point	25	100	4	94
	Train Moving	Line	4.5	25	1	93 per metre
Container Terminal	Rail Mounted Gantry Cranes	Point	2	100	10	105
	Quayside Cranes (rail Mounted)	Point	2	100	8	105
	Mobile Stackers	Line	3	5	20	84 per metre
	Train Moving	Line	4.5	25	2	93 per metre
	Train Idling	Point	4.5	100	4	102
	Trucks Accessing Site	Line	3.6	10	5	76 per metre
	Forklift Loading Goods	Line	2	10	2 (each with 3 movements per 15 min)	82 per metre

5.5.1 Predicted noise level results

The predicted noise levels at sensitive receivers in Sensitive Catchment Areas 1 and 2, as a result of operations associated with the Concept Plan have been assessed.

5.5.2 Intrusive scenario – No mitigation

Table 37 presents the Concept Plan intrusive operational noise modelling results with no mitigation.

Table 37 Concept Plan - Intrusive - No Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	51	50	40	- / - / -	43	- / -	44	-
R2	52	51	50	61	9 / 10 / 11	62	11 / 12	62	10
R3	52	51	50	59	7 / 8 / 9	59	8 / 9	60	8
R4	52	51	50	40	- / - / -	43	- / -	44	-
R5	52	51	50	48	- / - / -	51	- / 1	51	-
R6	44	44	42	46	2 / 2 / 4	49	5 / 7	49	5
R7	44	44	42	42	- / - / -	46	2 / 4	47	3
R8	44	44	42	46	2 / 2 / 4	50	6 / 8	51	7
R9	52	51	50	30	- / - / -	34	- / -	34	-
R10	50	50	50	43	- / - / -	47	- / -	47	-
R11a	50	50	50	45	- / - / -	48	- / -	49	-
R11b	50	50	50	45	- / - / -	49	- / -	49	-
R12	65	65	65	48	- / - / -	51	- / -	52	-
R13	70	70	70	50	- / - / -	52	- / -	53	-
R14	70	70	70	61	- / - / -	61	- / -	61	-

The results of the assessment show that there are exceedances of the criteria of up to 9 dB, 10 dB and 11 dB during the day, evening and night respectively under neutral meteorological conditions. A total of four receivers during the day, evening and four night time periods would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R2, R3, R6 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 11 dB and 12 dB during the evening and night respectively under an F-Class thermal inversion. A total of five receivers during the evening and six receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R5, R6, R7 and R8.

Lastly, the results of the assessment also show that there are exceedances of the criteria of up to 10 dB during the day under a 3 m/s source to receiver wind. A total of 5 receivers during the day would experience an exceedance of the criteria under a 3 m/s source to receiver wind. These receivers are R2, R3, R6, R7 and R8.

5.5.3 Amenity scenario – No mitigation

Table 38 presents the Concept Plan amenity operational noise modelling results with no mitigation.

Table 38 Concept Plan - Amenity - No Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	43	42	35	- / - / -	40	- / -	40	-
R2	52	43	42	55	3 / 12 / 13	55	12 / 13	55	3
R3	52	43	42	51	- / 8 / 9	52	9 / 10	53	1
R4	52	43	42	34	- / - / -	38	- / -	38	-
R5	52	43	42	43	- / - / 1	46	3 / 4	47	-
R6	60	48	37	43	- / - / 6	46	- / 9	47	-
R7	60	48	37	41	- / - / 4	45	- / 8	45	-
R8	60	48	37	45	- / - / 8	49	1 / 12	49	-
R9	52	43	42	28	- / - / -	32	- / -	32	-
R10	50	50	50	41	- / - / -	45	- / -	45	-
R11a	50	50	50	43	- / - / -	47	- / -	48	-
R11b	50	50	50	43	- / - / -	47	- / -	47	-
R12	65	65	65	46	- / - / -	49	- / -	50	-
R13	70	70	70	44	- / - / -	46	- / -	47	-
R14	70	70	70	57	- / - / -	57	- / -	58	-

The results of the assessment show that there are exceedances of the criteria of up to 3 dB, 12 dB and 13 dB during the day, evening and night respectively under neutral meteorological conditions. A total of one receiver during the day, two receivers during the evening, six receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R2, R3, R5, R6, R7, R8.

The results of the assessment also show that there are exceedances of the criteria of up to 12 dB and 13 dB during the evening and night respectively under an F-Class thermal inversion. A total of four receivers during the evening and six receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R5, R6, R7, R8.

Lastly, the results of the assessment also show that there are exceedances of the criteria of up to 3 dB during the day under a 3 m/s source to receiver wind. A total of two receivers during the day would experience an exceedance of the criteria under a 3 m/s source to receiver wind. These receivers are R2 and R3.

5.5.4 Intrusive scenario – With Mitigation from Major Project

Table 39 presents the Concept Plan intrusive operational noise modelling results with Major Project mitigation. This is the mitigation measures discussed in Section 5.4.4 of this report.

Table 39 Concept Plan - Intrusive – With Major Project Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	51	50	40	- / - / -	43	- / -	44	-
R2	52	51	50	50	- / - / -	51	- / 1	52	-
R3	52	51	50	51	- / - / 1	53	2 / 3	53	1
R4	52	51	50	40	- / - / -	43	- / -	44	-
R5	52	51	50	47	- / - / -	49	- / -	50	-
R6	44	44	42	44	- / - / 2	48	4 / 6	48	4
R7	44	44	42	41	- / - / -	45	1 / 3	46	2
R8	44	44	42	45	1 / 1 / 3	49	5 / 7	50	6
R9	52	51	50	29	- / - / -	33	- / -	33	-
R10	50	50	50	42	- / - / -	45	- / -	46	-
R11a	50	50	50	44	- / - / -	47	- / -	48	-
R11b	50	50	50	44	- / - / -	47	- / -	48	-
R12	65	65	65	47	- / - / -	50	- / -	51	-
R13	70	70	70	50	- / - / -	52	- / -	53	-
R14	70	70	70	44	- / - / -	44	- / -	45	-

The results of the assessment show that there are exceedances of the criteria of up to 1 dB, 1 dB and 3 dB during the day, evening and night respectively under neutral meteorological conditions. A total of one receiver during the day, one receiver during the evening, three receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R3, R6 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 5 dB and 7 dB during the evening and night respectively under an F-Class thermal inversion. A total of four receivers during the evening and five receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R6, R7 and R8.

Lastly, the results of the assessment also show that there are exceedances of the criteria of up to 6 dB during the day under a 3 m/s source to receiver wind. A total of 4 receivers during the day would experience an exceedance of the criteria under a 3 m/s source to receiver wind. These receivers are R3, R6, R7 and R8.

5.5.5 Amenity scenario – With Mitigation from the Major Project

Table 40 presents the Concept Plan amenity operational noise modelling results with recommended mitigation for the Major Project. This is the mitigation measures discussed in Section 5.4.4 of this report.

Table 40 Concept Plan - Amenity – With Major Project Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	43	42	35	- / - / -	40	- / -	40	-
R2	52	43	42	44	- / 1 / 2	46	3 / 4	47	-
R3	52	43	42	45	- / 2 / 3	48	5 / 6	49	-
R4	52	43	42	34	- / - / -	38	- / -	38	-
R5	52	43	42	42	- / - / -	46	3 / 4	46	-
R6	60	48	37	42	- / - / 5	46	- / 9	46	-
R7	60	48	37	40	- / - / 3	44	- / 7	45	-
R8	60	48	37	44	- / - / 7	48	- / 11	49	-
R9	52	43	42	28	- / - / -	32	- / -	32	-
R10	50	50	50	40	- / - / -	44	- / -	45	-
R11a	50	50	50	43	- / - / -	47	- / -	47	-
R11b	50	50	50	42	- / - / -	46	- / -	47	-
R12	65	65	65	45	- / - / -	49	- / -	49	-
R13	70	70	70	44	- / - / -	46	- / -	47	-
R14	70	70	70	41	- / - / -	42	- / -	42	-

The results of the assessment show that there are exceedances of the criteria of up to 2 dB and 7 dB during the evening and night respectively under neutral meteorological conditions.. No receivers would experience exceedances of the criteria during the day and under neutral meteorological conditions.

A total of two receivers during the evening and five receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R2, R3, R6, R7 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 5 dB and 11 dB during the evening and night respectively under an F-Class thermal inversion. A total of three receivers during the evening and six receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R5, R6, R7 and R8.

Lastly, the results of the assessment also show that there are zero exceedances of the criteria during the day under an 3 m/s source to receiver wind.

5.5.6 Intrusive scenario – Concept Plan with additional mitigation

Concept Plan mitigation options have been investigated, and the following are recommended mitigation measures so that it meets that required noise limits. This targets the key sources of noise under the Concept Plan and assumes that all of the Major Project mitigation measures as identified in Section 5.4.4 are implemented.

Additional methods of reducing contributions from the Concept Plan include the following:

- **Container Terminal operations -** All rail mounted gantry cranes and quayside cranes (rail mounted) are selected with quieter sound power levels, or mitigation applied (3 dB(A) reduction would be feasible)
- **Further treatment to rail noise** – At the Concept Plan stage any further treatment to rail noise by the use of barriers or sheds should be assessed to determine if they are feasible and reasonable. Initial investigations show that a sizable barrier with a roof provides a 1 dB noise reduction at the nearest residential receiver. This is not considered a cost effective mitigation measure. It should be noted, that this assessment has modelled potential simultaneous trains moving through the unloaders. This is a very conservative assessment.

5.5.7 Intrusiveness scenario – With Concept Plan mitigation

Table 41 presents the Concept Plan intrusive operational noise modelling results with Concept Plan mitigation.

Table 41 Concept Plan - Intrusive – With Concept Plan Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	51	50	39	- / - / -	43	- / -	43	-
R2	52	51	50	50	- / - / -	51	- / 1	51	-
R3	52	51	50	51	- / - / 1	52	1 / 2	53	1
R4	52	51	50	40	- / - / -	43	- / -	44	-
R5	52	51	50	46	- / - / -	49	- / -	50	-
R6	44	44	42	43	- / - / 1	46	2 / 4	47	3
R7	44	44	42	40	- / - / -	43	- / 1	44	-
R8	44	44	42	43	- / - / 1	47	3 / 5	48	4
R9	52	51	50	28	- / - / -	31	- / -	32	-
R10	50	50	50	40	- / - / -	44	- / -	45	-
R11a	50	50	50	42	- / - / -	46	- / -	47	-
R11b	50	50	50	42	- / - / -	46	- / -	47	-
R12	65	65	65	45	- / - / -	49	- / -	49	-
R13	70	70	70	50	- / - / -	52	- / -	53	-
R14	70	70	70	44	- / - / -	44	- / -	45	-

The results of the assessment show that there are exceedances of the criteria of up to 1 dB during the night under neutral meteorological conditions. A total of zero receivers during the day, zero receivers during the evening and three receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R3, R6 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 3 dB and 5 dB during the evening and night respectively under an F-Class thermal inversion. A total of three receivers during the evening and five receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R6, R7 and R8.

Lastly, the results of the assessment also show that there are exceedances of the criteria of up to 4 dB during the day under a 3 m/s source to receiver wind. A total of three receivers during the day would experience an exceedance of the criteria under a 3 m/s source to receiver wind. These receivers are R3, R6 and R8.

5.5.8 Amenity scenario – With Concept Plan mitigation

Table 42 presents the Concept Plan for the amenity operational noise scenario, with Concept Plan mitigation.

Table 42 Concept Plan - Amenity – With Concept Plan Mitigation, operational noise modelling results

Receiver Number	Criteria, dB(A)			Predicted Noise Levels, dB(A) and Exceedances, dB Under Meteorological Conditions					
	Day	Evening	Night	Neutral Conditions	Exceedance, Day / Evening / Night	Temperature Inversion	Exceedance, Evening / Night	3 m/s wind	Exceedance, Day
R1	52	43	42	34	- / - / -	38	- / -	39	-
R2	52	43	42	43	- / - / 1	45	2 / 3	46	-
R3	52	43	42	45	- / 2 / 3	47	4 / 5	48	-
R4	52	43	42	33	- / - / -	37	- / -	38	-
R5	52	43	42	41	- / - / -	44	1 / 2	45	-
R6	60	48	37	40	- / - / 3	44	- / 7	45	-
R7	60	48	37	39	- / - / 2	43	- / 6	43	-
R8	60	48	37	43	- / - / 6	47	- / 10	48	-
R9	52	43	42	26	- / - / -	30	- / -	30	-
R10	50	50	50	39	- / - / -	43	- / -	43	-
R11a	50	50	50	41	- / - / -	45	- / -	46	-
R11b	50	50	50	40	- / - / -	45	- / -	45	-
R12	65	65	65	44	- / - / -	47	- / -	48	-
R13	70	70	70	43	- / - / -	46	- / -	46	-
R14	70	70	70	41	- / - / -	42	- / -	42	-

The results of the assessment show that there are exceedances of the criteria of up to 2 dB, 6 dB during the evening and night respectively under neutral meteorological conditions. A total of zero receivers during the day, one receiver during the evening and five receivers during the night would experience an exceedance of the criteria under neutral meteorological conditions. These receivers are R2, R3, R6, R7 and R8.

The results of the assessment also show that there are exceedances of the criteria of up to 4 dB and 10 dB during the evening and night respectively under an F-Class thermal inversion. A total of three receivers during the evening and six receivers during the night would experience an exceedance of the criteria under an F-Class thermal inversion. These receivers are R2, R3, R5, R6, R7 and R8.

Lastly, the results of the assessment also show that there are no exceedances of the criteria during the day under a 3 m/s source to receiver wind.

Concept plan noise levels exceed the relevant criteria by up to 10 dB at one receiver during the night. While 10 dB is a considerable exceedance it is important to acknowledge the time frame for the development of the concept plan. Mitigation to fixed facilities in the development could be applied at various stages throughout the long term development plan. Separate applications and conditions of consent would be required with project specific noise goals for each stage. By frequent approvals and a phased mitigation to be outlined in an ONVMP, compliance for the Concept Plan is feasible. Detailed mitigation should be investigated during each of the approval stages.

5.5.8.1 Residual exceedances of the noise criteria

The acoustic assessment indicates that when the Concept Plan is fully operational, some residual exceedance of the established criteria will remain. The main contributing noise sources are the ship's APUs.

It is important to note that the acoustic assessment is based on worst case scenarios, which assumes that all berths at the multi-purpose terminal and container terminals are working at maximum capacity at the same time, with the peak traffic flow rates for each terminal occurring coincidentally while there is an F-Class temperature inversion or 3 m/s prevailing wind from source to receivers.

5.5.9 Cumulative noise impacts

Cumulative noise impacts from the entire site have been taken into account through the modelling of both the Major Project and Concept Plan, and the comparison against the same overall site noise criteria. All existing industrial noise contributions are also taken account of in the long term noise logging surveys.

The construction and operations of Cement Australia's Cement Grinding Mill facility was approved in September 2011, and the approval includes noise limits for the operations at the site. The operations noise limits allow for noise levels of up to:

- 40 dB(A) L_{Aeq} 15 minute during the day, evening or night period for receivers in SCA1
- 37 dB(A) L_{Aeq} 15 minute during the day, evening or night period for receivers in SCA2.

In the case that the Cement Grinding Mill does produce these predicted noise levels at receiver locations, then it can be expected that the cumulative industrial noise contribution would increase by 2-3 dB(A) from the predicted noise levels.

It is anticipated that there will a significant period between the Cement Grinding Mill commencing its operation to when Stage 1 operations begin at the multi-purpose terminal. This lead time will allow measurement the noise levels emitted from the Cement Grinding Mill and investigation of potential excedances associated with cumulative impacts. PKPC would be responsible for noise emissions from the Major Project and the Concept Plan. Existing consent conditions require noise monitoring and management. Management of the PKOH development noise includes the progressive assessment of noise emissions as capacity of the development increases. Additional mitigation would be considered where it is required at each stage of the development.

5.6 Sleep Disturbance Assessment

A sleep disturbance assessment has been undertaken in accordance with the INP Application Notes and with consideration of the NSW RNP sleep disturbance research. The assessment is applicable to the Concept Plan and Major Project as it relates to loud noises which would be common to all stages of development.

The INP Application Notes state the following:

> *"Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.*
>
> *Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.*
>
> *From the research, the EPA recognised that the current sleep disturbance criterion of an LA1, (1 minute) not exceeding the LA90, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.*
>
> *The detailed analysis should cover the maximum noise level or LA1, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:*

- *how often high noise events will occur*
- *time of day (normally between 10pm and 7am)*
- *whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).*

The LA1, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either LA1, (1 minute) or LA, (Max)."

This indicates that where the L_{A1} (1 minute) exceeds the background noise level L_{A90} (15 minute) by more than 15 dB(A) further analysis is recommended.

The RNP concludes as a result of the review of research that:

- *"Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions; and*
- *One or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly."*

An open bedroom window generally provides an approximate attenuation of about 10 dB(A), which, given that internal levels below 50-55 dB(A) are unlikely to cause awakening reactions, means external levels of 60-65 dB(A) are unlikely to cause awakening reactions.

Metal 'clangs' from the container operations and noise from train horn 'toots' are likely to provide the greatest L_{A1} values. Both of these operations have been assessed for sleep disturbance.

5.6.1 Container operations

Metal 'clangs' from the 'non-weather sensitive' container stacks and from container operations in the truck staging area to the south of the container terminal would result in instantaneous high noise levels. The contribution of the container stack operations have been considered for sleep disturbance.

5.6.2 Train horns

Train horns are currently sounded at night in three locations within the Port Kembla balloon loop (which includes the South Yard). Horns are currently used as trains cross Old Port Road at the at grade rail crossing on the eastern side of the rail loop, at Foreshore Road (currently not used) and as trains join the main line at Flinders Street Bridge. However, it should be noted that Foreshore Road is also a location where horns are sounded, however it is not proposed to be used as part of Major Project operations. As part of the Concept Plan the crossing of Foreshore road may result in trains drivers sounding the horn. A number of options are being investigated for the treatment of the rail crossing on Old Port Road and two of these options include a permanent closure of the crossing or at grade separation of the crossing. Should the crossing be closed it would nullify the horn noise issue for this location.

As part of the original NVIA it was noted that PKPC would commit to the use of short duration horn 'toots' being included in the noise management plan for the PKOH development. As such, this assessment has only looked at the impacts of horn 'toots' in contrast to blasts. A horn 'toot' is generally considered to be less than a second in duration, while a horn 'blast' may persist for 2-3 seconds.

5.6.3 Sleep disturbance results

The results of the sleep disturbance modelling are presented below in Table 43.

Table 43 Sleep disturbance results

Receiver	Receiver Type	Predicted $L_{A1(1min)}$, dB(A)	Sleep Disturbance - Screening Criteria	Exceedance – Screening Criteria	Sleep Disturbance Criteria – Awakening Reaction	Exceedance – Awakening Reaction
R1	Residential	54	60	-	65	-
R2	Residential	61	60	1	65	-
R3	Residential	59	60	-	65	-
R4	Residential	53	60	-	65	-
R5	Residential	54	60	-	65	-
R6	Residential	55	52	3	65	-
R7	Residential	55	52	3	65	-
R8	Residential	53	52	1	65	-
R9	Residential	35	60	-	65	-
R10	School	52	N/A[1]	-	N/A[1]	-
R11a	Place of worship	53	N/A[1]	-	N/A[1]	-
R11b	Place of worship	53	N/A[1]	-	N/A[1]	-
R12	Commercial	60	N/A[1]	-	N/A[1]	-
R13	Industrial	57	N/A[1]	-	N/A[1]	-
R14	Industrial	63	N/A[1]	-	N/A[1]	-

Notes:

1. There is no requirement to assess non-residential receivers against a sleep disturbance criteria

The results in Table 43 show that the sleep disturbance screening criteria would be breached at receivers R2, R6, R7 and R8 by up to 3 dB. A further investigation has been undertaken against the sleep disturbance awakening reaction. The results of this assessment show compliance at each of the identified receivers.

The predicted external impact at R2 is 61 dB(A), giving a likely internal impact (with an open window) of approximately 51 dB(A). This is unlikely to result in waking reactions, which is supported by the fact that train horns are currently sounded at this location without complaint. The frequency of train 'toots' would increase as a result of the Major Project, and there would be no change in frequency of movements for the operations under Stage 2 and Stage 3. However, as demonstrated the resulting noise levels would be within the sleep disturbance awakening reaction criteria.

5.7 Road Traffic Noise Assessment

The road traffic assessment has provided data on the number of vehicle movements associated with the site. Figures for 2016 without and with the Major Project and for 2036 without and with the Concept Plan have been assessed. It is noted that there is no significant change in operational traffic volumes associated with the modification apart from a minor increase in employee traffic.

All of the operational traffic generated by the Major Project and Concept Plan will travel along Flinders Street and Five Islands Road towards the Southern Freeway. The most potentially affected receivers will be located at Cringila, situated around Lake Avenue, adjacent to Five Islands Road (Figure 2) and along Gladstone Avenue, adjacent to Masters Road.

The existing traffic flows for these roads were determined from a Roads and Maritime Services (RMS) permanent count stations, Station No. 07.097, located on Five Islands Rd, north of Flinders Rd, Station No. 07.700, located on Masters Rd, west of Springhill Rd. Traffic on surrounding roads would be altered as detailed in Table 44 as a result of the PKOH modification. The average weekday daily traffic for the daytime and the night time is presented below in Table 45.

Table 44 Road traffic movement cap for the Outer Harbour Development, excluding the Cement Grinding Mill

Proposed and Approved Traffic Volumes	Major Project*	Concept Plan*
Approved vehicle movement cap for Outer Harbour Development	28 vehicle movements per hour (20 trucks + 8 employees)	84 vehicle movements per hour (64 trucks + 19 employees)
Proposed additional vehicle movements	8 employees	8 employees
Proposed additional vehicle movement cap for Outer Harbour Development	36 vehicle movements per hour (62 trucks + 16 employees)	91 vehicle movements per hour (64 trucks + 27 employees)

Table 45 Road traffic volumes for the PKOH Development

Period	Average Period Weekday (7 day Period) Traffic Count
Five Islands Rd - North of Flinders Road	
Day (7:00 am – 10:00 pm)	35,773[1]
Night (10:00 pm – 7:00 am)	4,991
Masters Road, West of Springhill Road	
Day (7:00 am – 10:00 pm)	26,181
Night (10:00 pm – 7:00 am)	4,838

Notes:

1 Values taken from RMS survey 13/08/12 to 20/08/12.

Table 46 presents predicted increase in noise levels as result of the increase in traffic volumes associated with the operation of the Major Project and Concept Plan for the PKOH development.

Table 46 Predicted increase in traffic noise levels

Location	Existing Traffic Noise Levels	Existing Traffic Volume	Net Increase	% Increase	Increase in Noise Levels, dB(A)
MAJOR PROJECT					
Five Islands Rd - North of Flinders Road					
Daytime	71 dB(A) $L_{Aeq, (15\ hour)}$	24,648	126	0.5%	<0.5
Night	68 dB(A) $L_{Aeq, (9\ hour)}$	4,991	210	4.2%	<0.5
Masters Road, West of Springhill Road					
Daytime	71 dB(A) $L_{Aeq, (15\ hour)}$	26,181	126	0.5%	<0.5
Night	68 dB(A) $L_{Aeq, (9\ hour)}$	4,838	210	4.3%	<0.5
CONCEPT PLAN					
Five Islands Rd - North of Flinders Road					
Daytime	71 dB(A) $L_{Aeq, (15\ hour)}$	24,648	384	1.6%	<0.5
Night	68 dB(A) $L_{Aeq, (9\ hour)}$	4,991	640	12.8%	0.5
Masters Road, West of Springhill Road					
Daytime	71 dB(A) $L_{Aeq, (15\ hour)}$	26,181	384	1.5%	<0.5
Night	68 dB(A) $L_{Aeq, (9\ hour)}$	4,838	640	13.2%	<0.5

The predicted increase in traffic noise levels presented in Table 46, indicate compliance with the EPA's RNP traffic noise criteria at noise sensitive receivers during the daytime and night time periods.

5.8 Operational Vibration Assessment

5.8.1 Operational phase – Tactile Vibration

For the closest commercial receiver, located on Foreshore Road at a distance of approximately 20 m setback, the predicted VDVs are 8 times below the recommended level. For the closest residential receivers, located on Wentworth Street at a distance of approximately 100 metres setback, the predicted VDVs are approximately 40 times lower than the night time criterion.

Vibration intensive operations remain unchanged from the previous NVIA, with the only vibration intensive operation being train movements. Given that the distance offset is unchanged for the modification, the tactile vibration assessment from the previous NVIA remains unchanged.

5.8.2 Operational phase – Regenerated Noise

Vibration intensive operations remain unchanged from the previous NVIA, with the only vibration intensive operation being train movements. Given that the distance offset is unchanged for the modification, the regenerated noise assessment from the previous NVIA remains unchanged.

The previous NVIA concluded that regenerated noise criteria for the closest commercial receiver located on Foreshore Road has not been assessed as it is anticipated that the regenerated noise would be masked by air-borne noise associated with train movements. Therefore further assessment of regenerated noise is not required.

6.0 Discussion and Recommendations

6.1 Construction Noise and Vibration Impact

6.1.1 Construction noise - Major Project

An assessment of the 'reasonable' worst case scenario Major Project construction activities has been undertaken, refer Section 4.0.

All construction activities associated with Stage 1 of the PKOH modification, with the exception of the rail infrastructure upgrades, are predicted to comply with the daytime and night time noise management levels as presented in Table 19 to Table 23. The predicted daytime construction noise levels associated with the rail infrastructure upgrades in the rail loop and in particular the South Yard, are predicted to exceed the noise management levels at receivers R2 and R3 (Wentworth Street) by 1 dB and 4 dB respectively. The controlling noise source as part of the construction works is the demolition saws. Operations of the demolition saw are expected to persist for only a fraction of the assessment period, and the overall construction works.

The construction noise impact assessment has conservatively considered the potential cumulative noise impact arising from Stage 1 Berth Construction and the Stage 1 South Yard construction works taking place concurrently. The predicted impact with both construction scenarios operating concurrently is dominated by the construction work in the South Yard, which is discussed further below. The predicted contribution from the berth construction works does not increase the overall predicted impact when South Yard construction is taking place.The EPA's ICNG recommend that the contractor demonstrates best practicable means and include noise mitigation measures in the CNVMP to minimise the noise impact at sensitive receivers. The best mitigation technique for construction can often be keeping the affected people informed as to the duration and progress of the works. Mitigation strategies that should be considered are described below. Mitigation specific to the South Yard is provided in section 6.1.2.

Community notification

- Contact potentially noise-affected neighbours at the earliest possible time before any site work begins;
- Inform potentially noise-affected neighbours about the nature of the construction stages and the noisier activities – for example excavation and rock-breaking;
- Give clear indication to potentially noise-affected neighbours of how long noisy activities will take;
- Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment;
- Keep potentially noise-affected neighbours up to date on progress;
- Provide contact details on a site board at the front of the site, and keep a complaints register suited to the scale of works;
- Ask about any concerns that potentially noise-affected neighbours may have and discuss possible solutions;
- Provide a copy of the noise management plan to potentially noise-affected neighbours.

Operate plant in a quiet and efficient manner

- Turn off plant that is not being used;
- Examine, and implement where feasible and reasonable, alternative work practices which generate less noise – for example use hydraulic rock splitters instead of rock breakers, or electric equipment instead of diesel or petrol powered equipment;
- Examine, and implement where feasible and reasonable, the option of using silenced equipment.
- Ensure plant is regularly maintained;
- Locate noisy plant away from potentially noise-affected neighbours or behind barriers, such as sheds or walls; and
- Where reasonable, provide respite periods for very noisy activities.

Involve workers in minimising noise

- Avoid dropping materials from a height;
- Talk to workers about noise from the works and how it can be reduced; and
- Use radios and stereos indoors rather than outdoors.

Handle complaints

- Review, and implement where feasible and reasonable, work practices to minimise noise from construction that are the subject of noise complaints.

6.1.2 South Yard construction noise mitigation

The principal contributor to the exceedance of the construction noise criteria is the use of demolition saws and mobile plant, such as dump trucks and bulldozers around the south yard site.

It is likely that demolition saws would be used for only a fraction of the construction period. Furthermore, construction of a suitable temporary noise barrier around the site where saws are in use would reduce the predicted noise impact by up to 5 dB(A).

It is recommended that suitably constructed temporary noise barriers are utilised to shield the use of demolition saws and other noise intensive equipment used in construction of the rail infrastructure in the South Yard from noise sensitive receivers. This could reduce the predicted impact by up to 10 dB(A) from this plant and up to 5 dB(A) overall. It is important to note that demolition saws are only likely to be operational for a fraction of the construction assessment period.

Furthermore, it is recommended that the CNVMP for the South Yard construction works identify respite periods when demolition saws cannot be used, for example, before 9 am when local residents may still be at home and from 12pm– 1pm when local residents may be eating lunch.

It is recommended that feasible and reasonable mitigation measures are reviewed and incorporated into the CNVMP. The CNVMP would include the following generic mitigation measures:

- Construction activities to be limited to between 7 am and 6 pm Monday to Friday and 8am to 1pm Saturday where practicable;
- Where work is undertaken outside of the standard working hours it would be in accordance with the EPA Interim Construction Noise Guideline (EPA 2009);
- Very noisy activities should be programmed for standard working hours, if this is not achievable then it should be completed in the least sensitive period practicable;
- Provision of induction and training to staff and sub-contractors outlining their responsibilities with regard to noise, they should be trained to use equipment in such a way so as to minimise noise, shouting and slamming of vehicle doors should also be minimised;
- Adoption of quieter work methods and equipment including the use of mufflers and silencers where possible;
- All plant and equipment should be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise;
- The use of non-tonal reversing alarms, and where practicable, endeavour to provide drive-through facilities to minimise utilisation of reverse warning devices; and
- Timing of noisy activities to occur simultaneously to reduce their impact and duration where possible.

6.1.3 Construction vibration – Major Project

The likelihood of construction activity resulting in structural damage to buildings or human discomfort has been assessed. Minimum safe working distances have been provided for vibration intensive plant. It is recommended that on site vibration measurements are conducted as a part of the Construction Noise and Vibration Management Plan in order to determine site specific safe working distances.

Human reaction to vibration varies significantly from individual to individual and as a result it can be difficult to set appropriate criteria for human comfort in relation to vibration.

Due to the large distances between construction activity and residential receivers it is considered unlikely that construction activities will result in adverse reaction.

Mitigation measures have been discussed and should be developed further in the Construction Noise and Vibration Management Plan.

6.2 Operational Noise Impact

6.2.1 Major Project

6.2.1.1 Operations

The noise assessment was undertaken assuming 'reasonable' worst case operational conditions and adverse weather conditions; 3m/s source to receiver wind speed during the daytime and evening periods and an F-Class thermal inversion during the night time.

Rail movements, idling and loading/unloading activities in the South Yard associated with the Major Project operations are predicted to result in exceedance of the project specific noise goals for SCA1. The worst case predicted exceedance is 7 dB(A) at night at receiver R3 (7 Wentworth Street), directly opposite the South Yard.

The predicted exceedances at all receivers are primarily due to the activities within the South Yard, the southern break bulk area and multi-purpose berth operations. The following mitigation options have been recommended to meet the established noise criteria:

- Construction of a 420 metre long 8 metre high acoustic barrier between the South Yard and the nearby noise sensitive receivers
- Enclose the south break bulk area with a shed, this can be open to the north
- Noise reduction to multi-purpose berth equipment
- Noise reduction to Tippler unloader.

These mitigation options are to be further investigated and developed by PKPC taking into consideration the proposed staged approach for the Major Project development.

It is considered likely that appropriate mitigation in the South Yard would result in compliance with the project specific noise goals at all noise sensitive receivers.

If it is possible for the night-time rail operations associated with the Major Project to be minimised then PKPC will endeavour to do so. It is difficult to predict at this stage exactly when rail movements will take place as trains will arrive and depart the outer harbour in accordance with the availability of paths on the network and in accordance with operations at the point of origin or destination. As additional information pertaining to PKPCs client needs becomes available this option can be explored further.

PKPC is committed to the selection of acoustically considerate plant where possible and the use of noise reducing measures such as silencers, multi frequency reversing alarms, visual system reversing warnings, enclosures and shrouds.

6.2.1.2 Conveyor systems - Enclosed

PKPC are to install an enclosed conveyor systems as well as the sourcing of acoustically considerate equipment associated with the conveyor operations (i.e. transfer towers). The use of enclosed conveyors has been included in the noise modelling. It is recommended that the acoustic performance of conveyor systems be reviewed to determine if it meets the recommended sound power levels included in the modelling. This can be addressed as part of the evolving noise and vibration management plan for the site.

6.2.1.3 Rail noise

Rail noise emissions when operating at part of the PKOH operations has been assessed against the NSW Industrial Noise Policy (INP). It is recommended that noise outside of the development be assessed as part of a larger review of the rail network by the rail infrastructure providers who are planning to upgrade capacity . Rail activities have been included in the operational scenarios which have been assessed against the INP criteria.

6.2.1.4 Sleep disturbance

Train horns need to be sounded on the Port Kembla 'balloon' loop when the rail lines cross public roads and when trains pass from privately owned sidings back onto the main line.

PKPC has proposed that operations restrict trains from re-joining the main line at the southern end of the South Yard, which is in close proximity to receivers on Wentworth Avenue and Military Road. Trains will instead pass through the South Yard on a siding and re-join the main line at the Flinders Street Bridge, which is further removed from the closest residential receivers.

PKPC would commit to no train horns being sounded when trains move onto sidings from the main line.

PKPC are currently investigating the possibility of removing train horn use completely. Options being considered include grade separation at Old Port Road during Stage 1 to remove the requirement for horn sounding and the removal of the crossing at Foreshore Road during Stage 2, which would also eliminate the need for horn soundings.

6.2.2 Concept Plan

6.2.2.1 Operations

The Concept Plan operational scenario used in the noise modelling includes activities associated with the planned multi-purpose terminal, container terminals and rail activities.

With no mitigation in place the Concept Plan operational scenario is predicted to exceed the project specific noise goals for SCA1 and SCA2 by up to 9 dB(A) during the daytime, up to 12 dB(A) during the evening and up to 13 dB(A) during the night time.

The predicted exceedance of the project specific noise goals is, in most cases, the result of rail activities in the South Yard and the multi-purpose berth. The Concept Plan operational scenario was reassessed assuming the Major Project mitigation is applied, including the proposed noise barrier. The mitigation options examined for the Major Project are discussed in Section 5.4.4 and 5.5.6.

The predicted exceedances with the mitigations in place are up to 1 dB(A) during the daytime, 5 dB(A) during the evening and 11 dB(A) during the night-time.

Concept Plan mitigation options have been investigated, and the following measures are recommended:

- All Major Project mitigation measures have been assumed as part of the Concept Plan mitigation measures.
- Additional potential methods of reducing the Concept Plan noise emission that have been investigated include:

Multi-purpose Berth operations

As part of the equipment selection and on-going noise mitigation program (to be outlined in an ONVMP) the following equipment will need to reduce their sound power levels from that assumed in the noise model:

Container Terminal operations

All rail mounted gantry cranes and quayside cranes (rail mounted) are selected with quieter sound power levels, or mitigation applied (assumed 3 dB(A) reduction would be feasible).

6.2.2.2 Further treatment

It is considered likely that appropriate noise mitigation in the South Yard and elsewhere on site would further reduce the predicted noise levels. The noise mitigation constructed on site can be further refined to greater benefit during detailed design for Stages 2 and 3 of the project. PKPC will consider operational controls and additional mitigation where appropriate to further reduce the noise impact of operations associated with the Concept Plan.

Furthermore, it is important to consider that this assessment represents a 'reasonable' worst case scenario and to look at how likely and how often this scenario is to occur.

The assessment assumes that all berths at the multi-purpose terminal and container terminals are working at maximum capacity at the same time, with the peak traffic flow rates for each terminal occurring coincidentally while there is an F-Class temperature inversion or 3 m/s prevailing wind from source to receivers.

Furthermore, the predicted exceedances are not the result of any large individual impacts but rather the cumulative impact of a large number of relatively low noise impacts.

Exceedances of this nature can be difficult to mitigate using standard mitigation measures such as acoustic barriers. While it may be feasible to reduce the predicted impact level by constructing barriers and screens, the cost associated with this approach is often not reasonable. Due to the terrain local terrain the effectiveness of noise barrier diminish at low heights, resulting in poor cost effectiveness. This is largely due to receivers being elevated above the noise sources.

It is likely that the opportunity to reduce the predicted operational noise exceedances will present itself at several stages of the Concept Plan when subsequent project approvals are required. At this time an additional noise assessment will look at operations in greater detail and allow targeted management controls to be put in place with a focus on reducing noise emissions at night and noise emissions from rail operations.

6.2.2.3 Sleep disturbance

The noise impact from container 'clang' associated with operations at the container terminal and rail horn 'toots' are predicted to exceed the sleep disturbance screening criteria at 4 receivers. However, further investigation demonstrated compliance with the sleep disturbance awakening reaction criteria at all receivers.

The potential noise impact resulting from use of limited duration train horn soundings (i.e. horn toots) has been assessed at the three locations on the Port Kembla balloon loop where horns are currently sounded. Horn toots at the Old Port Road and Foreshore Road crossings are predicted to exceed the INP sleep disturbance screening criteria by up to 3 dB(A). The number of train movements, associated with Stage 2 and Stage 3 would not increase as a result of the proposed modification.

It also recommended that sleep disturbance impacts arising from increased rail movements associated with the Concept Plan be investigated further as part of applications for planning approval for Stages 2 and 3, and once the rail master plan has been carried out.

6.3 Road Traffic Noise

Given that road traffic noise levels are not predicted to exceed the allowable increase of 2 dB, consideration of further mitigation is not required.

6.4 Operational Vibration

Operational vibration levels are unlikely to change from the previous NVIA based on the modifications. Therefore no additional discussion is required.

6.5 Noise and Vibration Management Plan

During discussion with EPA and PKPC it was agreed that a flexible operational and construction noise and vibration management plans for the PKOH development be developed to deal with the growing and changing nature of this development.

Given the proposed timescale for development of the PKOH and the various stages involved, it is appropriate that a coherent noise and vibration management plan be developed as construction and operation progresses, commencing with Major Project.

It is anticipated that the Major Project and all subsequent stages of upgrades would be implemented in phases. It would be appropriate to assess the requirement for mitigation as operations increase rather than when the upgrade becomes operational. AECOM would recommended that the ONVMP would be flexible in it implementation of mitigation measures and regularly reassess the requirements for mitigation.

7.0 Conclusion

AECOM Australia Pty Ltd (AECOM) has conducted a NVIA of the construction and operational activities associated with the proposed modification of the Port Kembla Outer Harbour (PKOH) development.

This NVIA has been undertaken to assess the proposed modifications to PKOH to satisfy the Director General Requirements prepared for the modification request. The NVIA has been developed following consultation with the NSW EPA and the DP&I.

The impact of noise emissions from plant associated with the construction and operation of the Concept Plan and Major Project of the PKOH development have been assessed. Construction and operational impact assessments have been carried out based on plant that is likely to be associated with each phase of the PKOH development.

Construction Noise

Construction noise has been assessed against the NSW EPA ICNG. Results of the assessment show that for majority of the construction, noise levels are predicted to comply with the noise management levels. Construction mitigation measures have been recommended where exceedances are predicted and as 'best practice' to reduce the impact on nearby noise sensitive receivers.

Construction vibration has been assessed against a number of appropriate standards. Given the distance between the construction areas and the receiver locations, human comfort and cosmetic damage levels would not be breached.

Blasting

The modifications to the Major Project and the overall Concept Plan do not include any additional blasting requirements to those previously assessed as part of Stage 1 of the PKOH development. Therefore the blasting assessment presented in the previous NVIA remains valid for these modifications to the PKOH development.

Typical blasting noise and vibration levels have been previously provided. However, it is recommended that a detailed assessment is undertaken to consider specific site and nearby building conditions to quantify allowable charge sizes.

Operational Noise

Operational noise has been assessed for the Major Project modification and the Concept Plan. Operational noise has been assessed against the NSW EPA INP. In most circumstances the development would comply with the appropriate criteria. Where exceedances have been predicted, numerous project approvals would be required for the development along with a progressive mitigation to be outline in the ONVMP to ensure the nearby noise sensitive receivers are not adversely impacted. Given the long term plan for the development, detailed mitigation would be investigated to ensure appropriate noise goals can be met.

Road Traffic Noise

Road traffic noise has been assessed for both the operational and construction stages of the Major Project. The development has been assessed against the NSW EPA RNP. The increase in road traffic noise levels as a result of the project has been found to be below the allowable increase. Therefore, the development complies with the requirements of the NSW EPA RNP.

Rail Activity Noise

Noise generated from rail activities within the 'balloon" loop have been assessed against the NSW EPA INP. Activities including movements, shunting, horn toots and loading/unloading have been assessed. Where noise contribution from the train activities is significant mitigation has been recommended. The mitigation recommended in this report ensures that noise levels at the nearby sensitive receivers is controlled and is acceptable.

Appendix A

Acoustic Terminology

Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level — The total sound emitted by a source

Sound pressure level — The amount of sound at a specified point

Decibel [dB] — The measurement unit of sound

A Weighted decibels [dB(A]) — The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).

Decibel scale — The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency [f] — The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.

Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period
L_{min}	The minimum sound pressure level measured over the measurement period
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Industrial Noise Policy and the EPA's NSW Road Noise Policy.

Appendix B

Noise Logging Charts

Appendix B Noise Logging Charts

Wentworth Road

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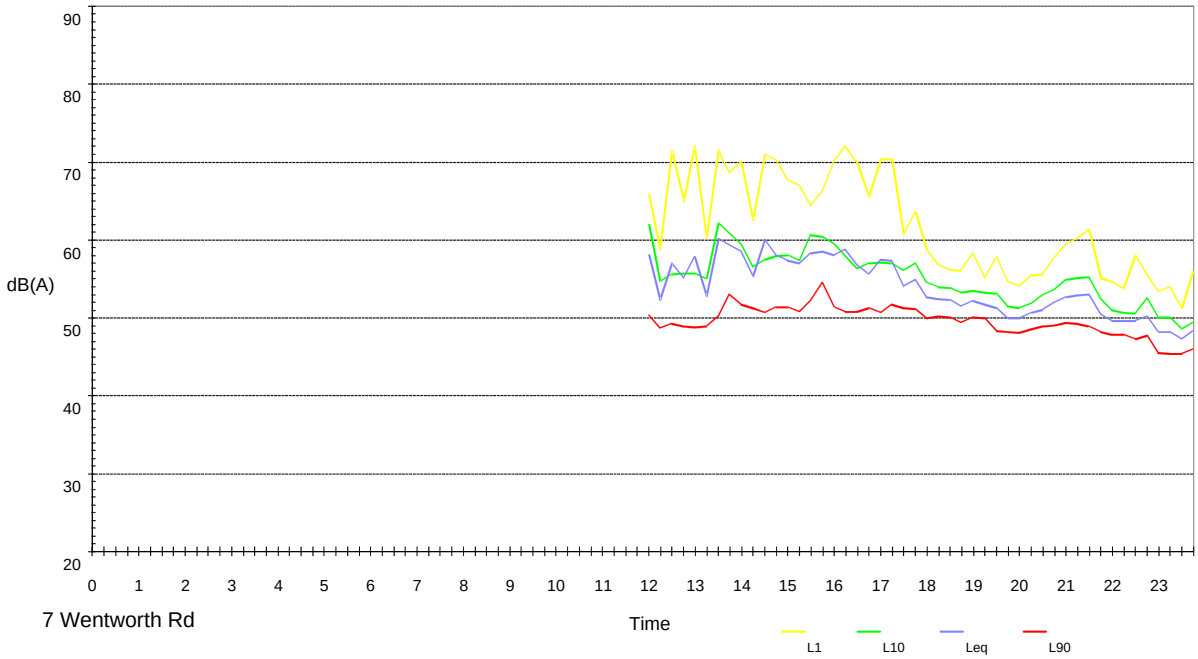

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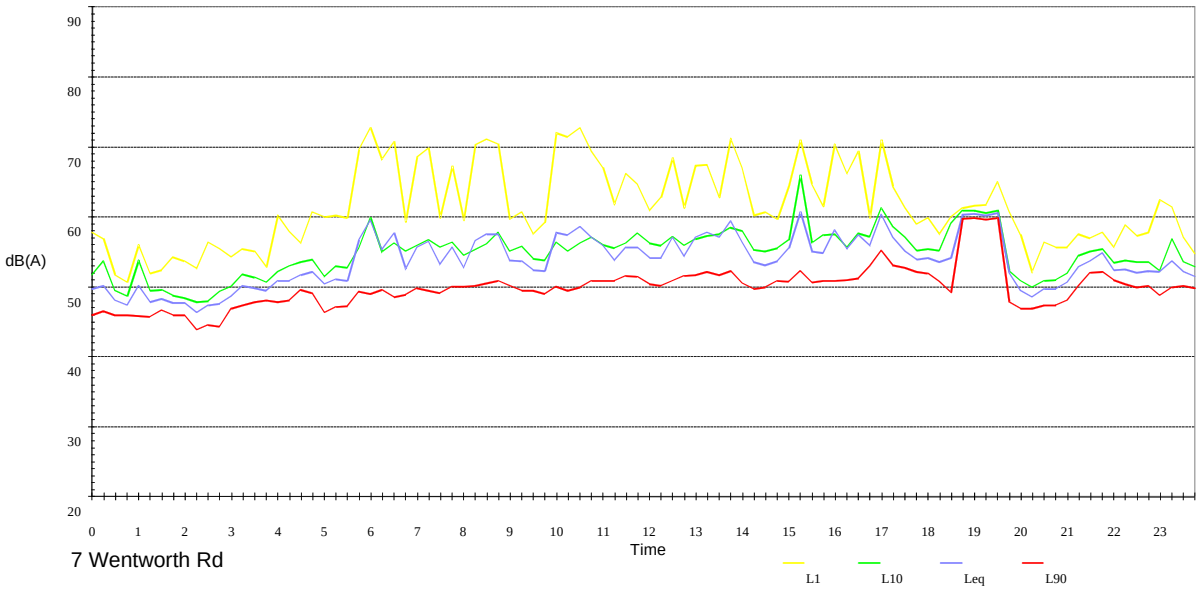

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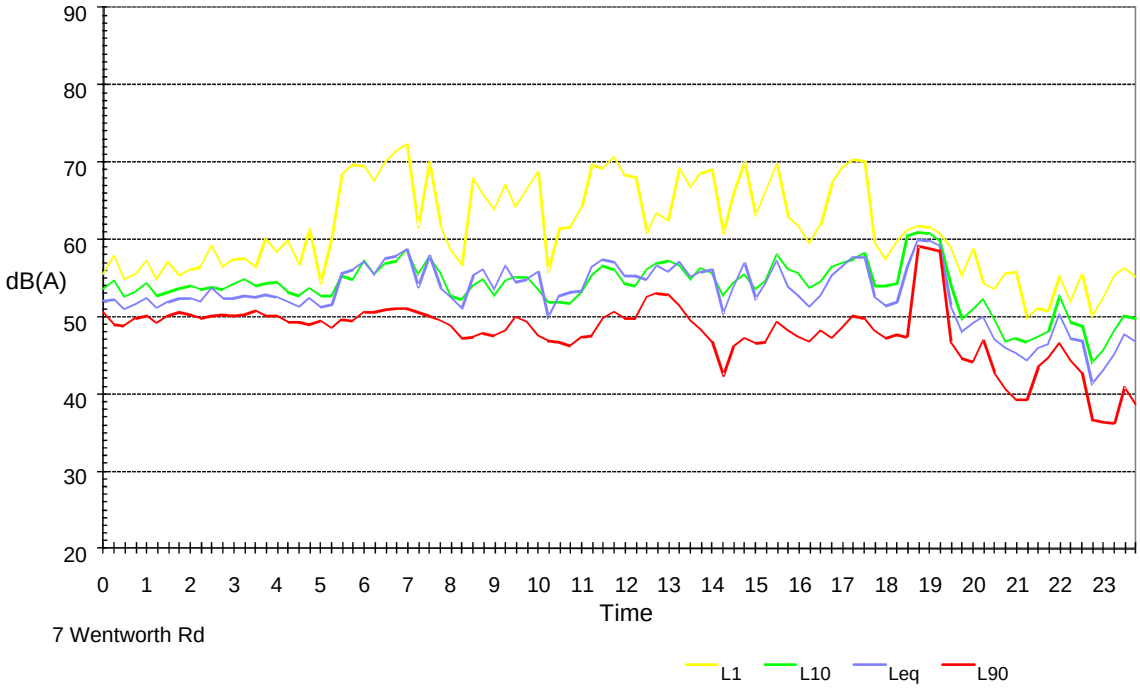

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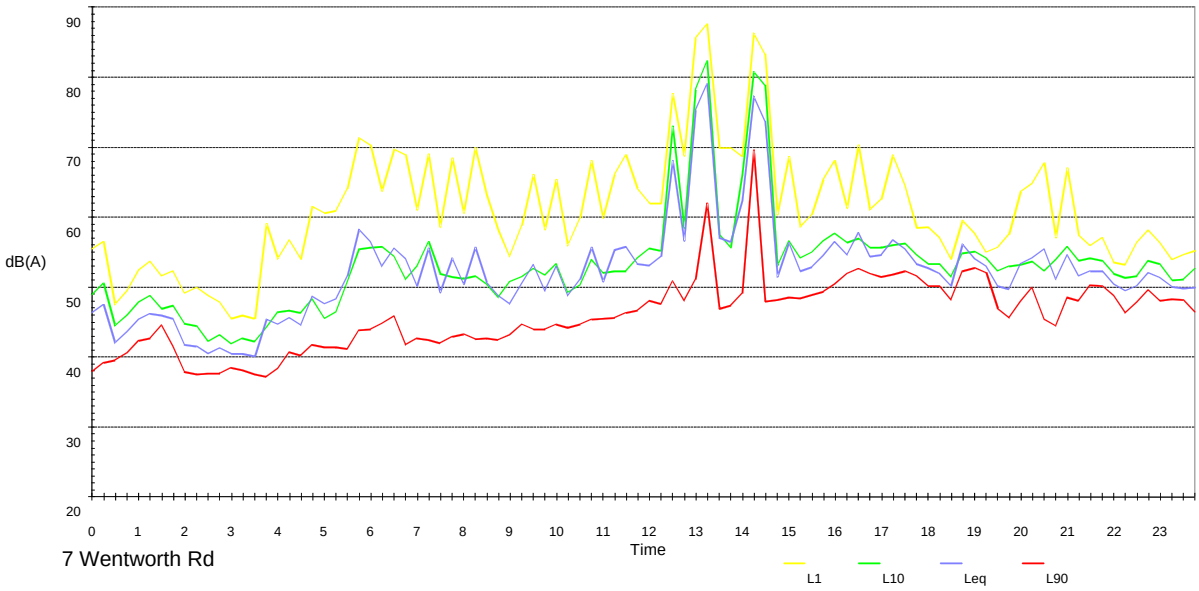

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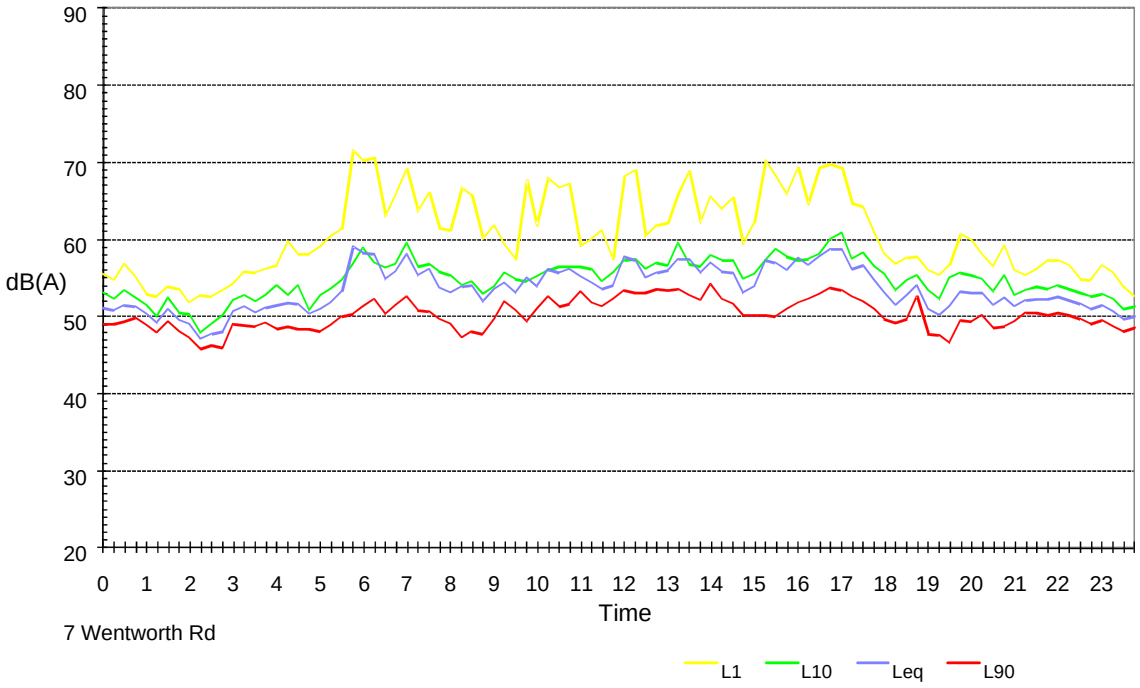

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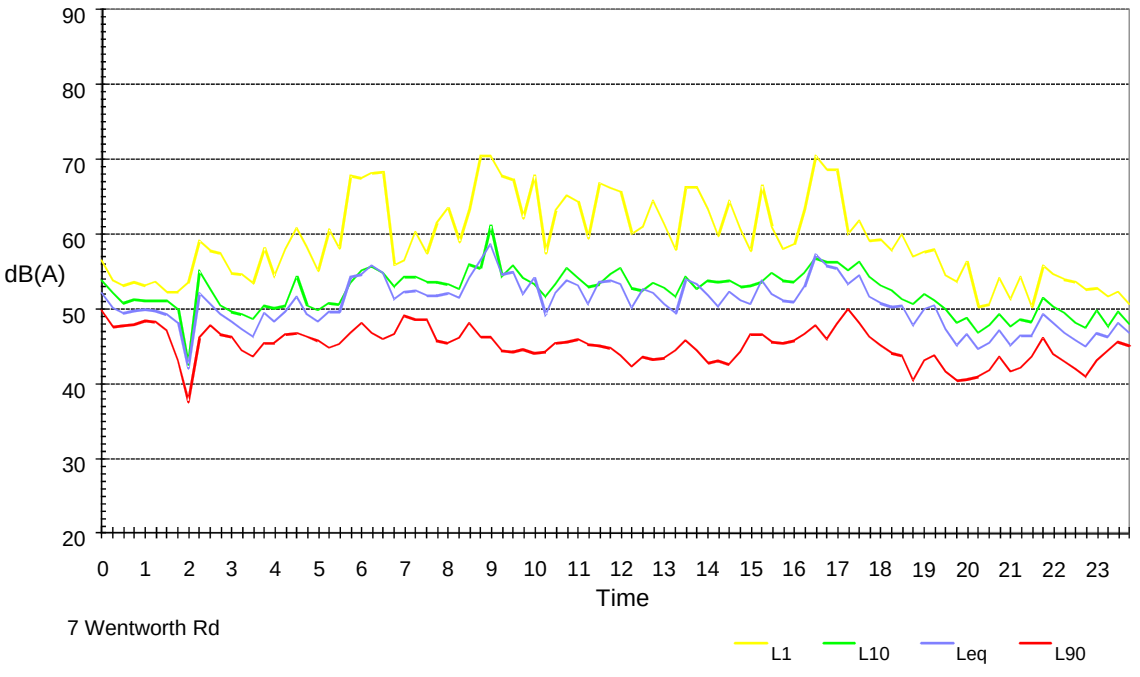

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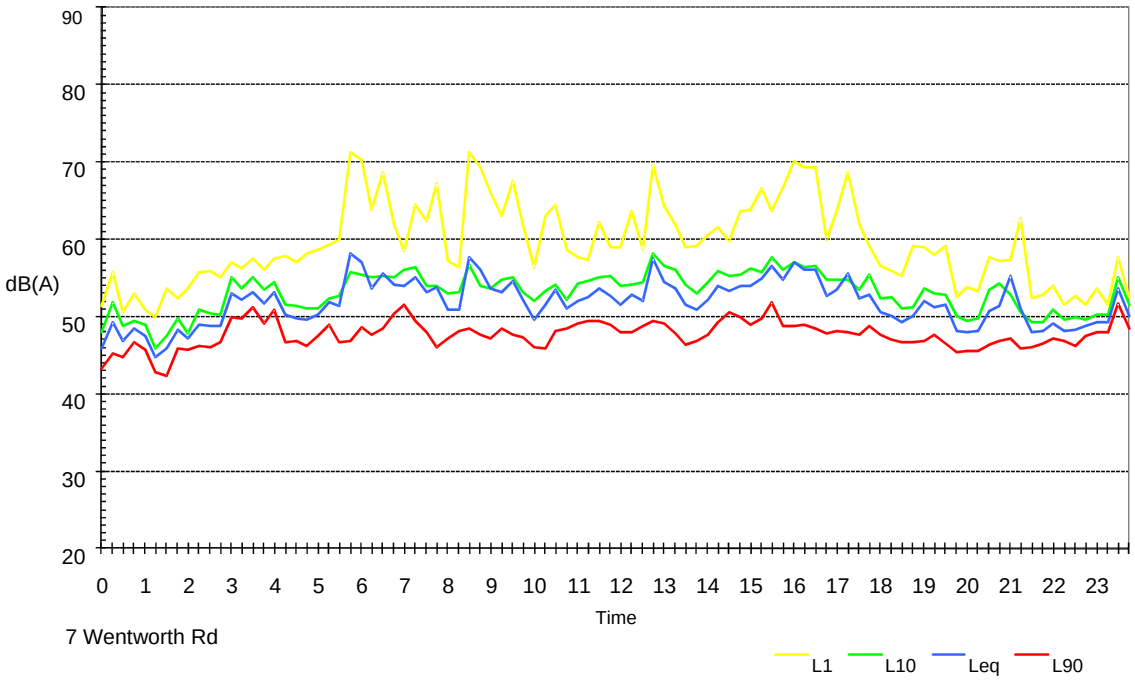

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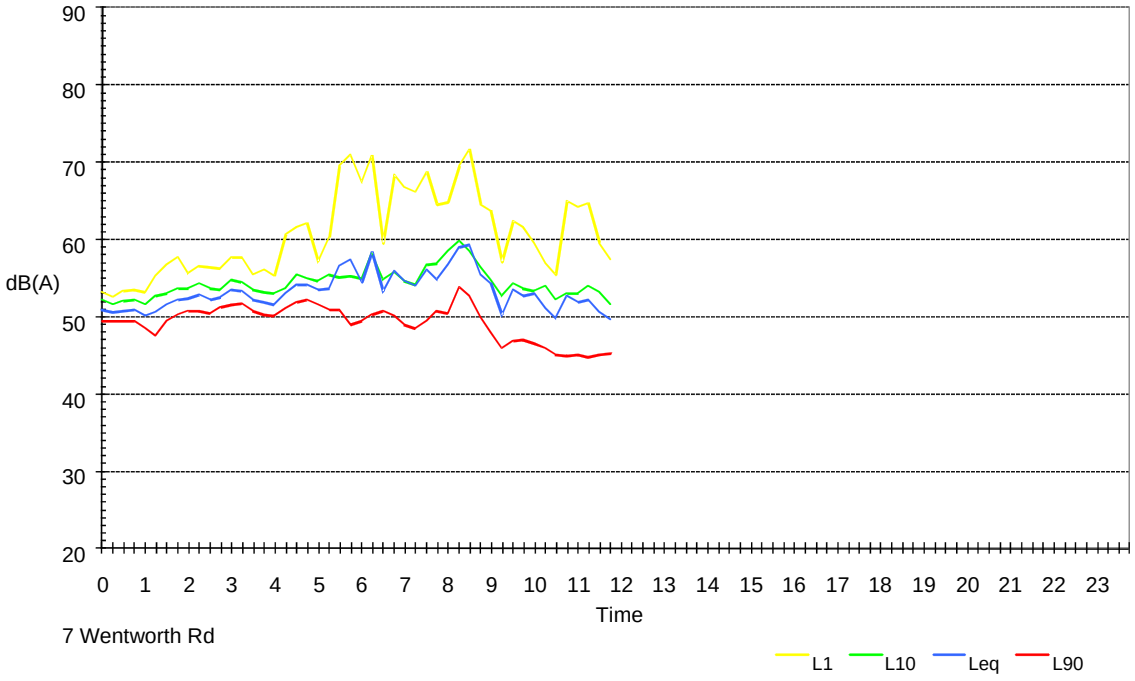

O'Donnell Street

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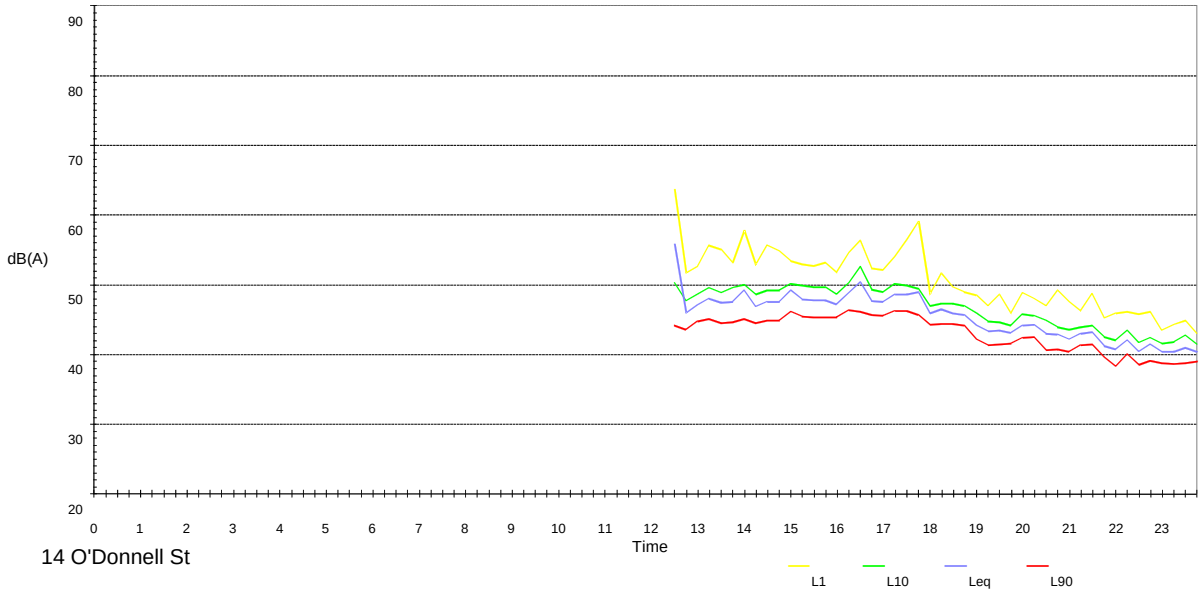

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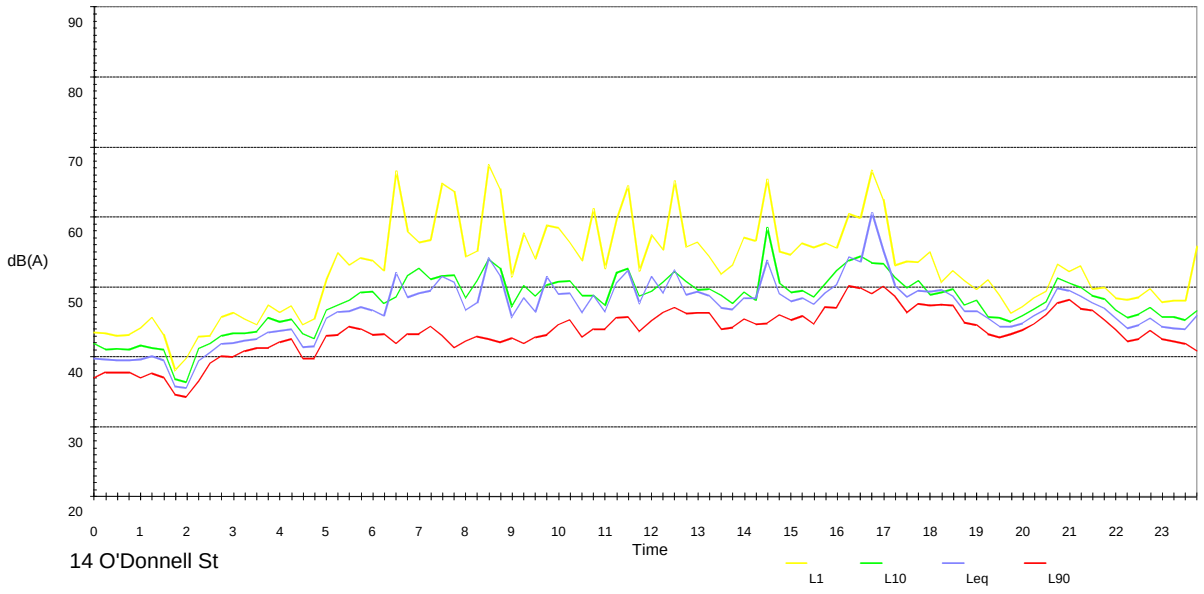

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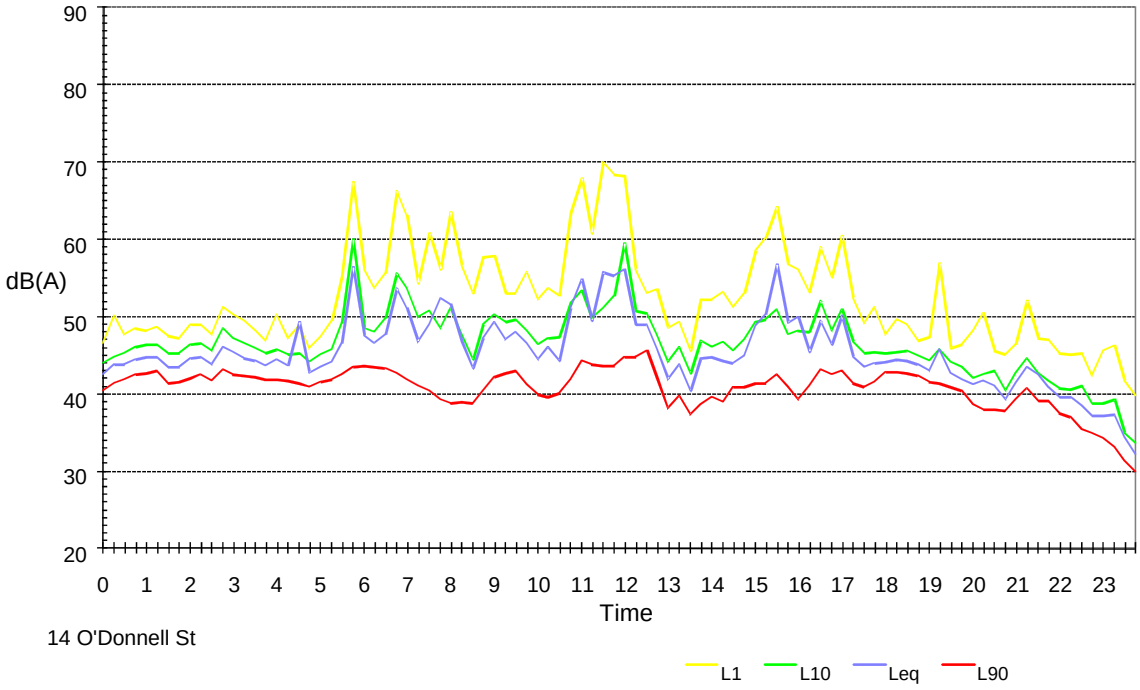

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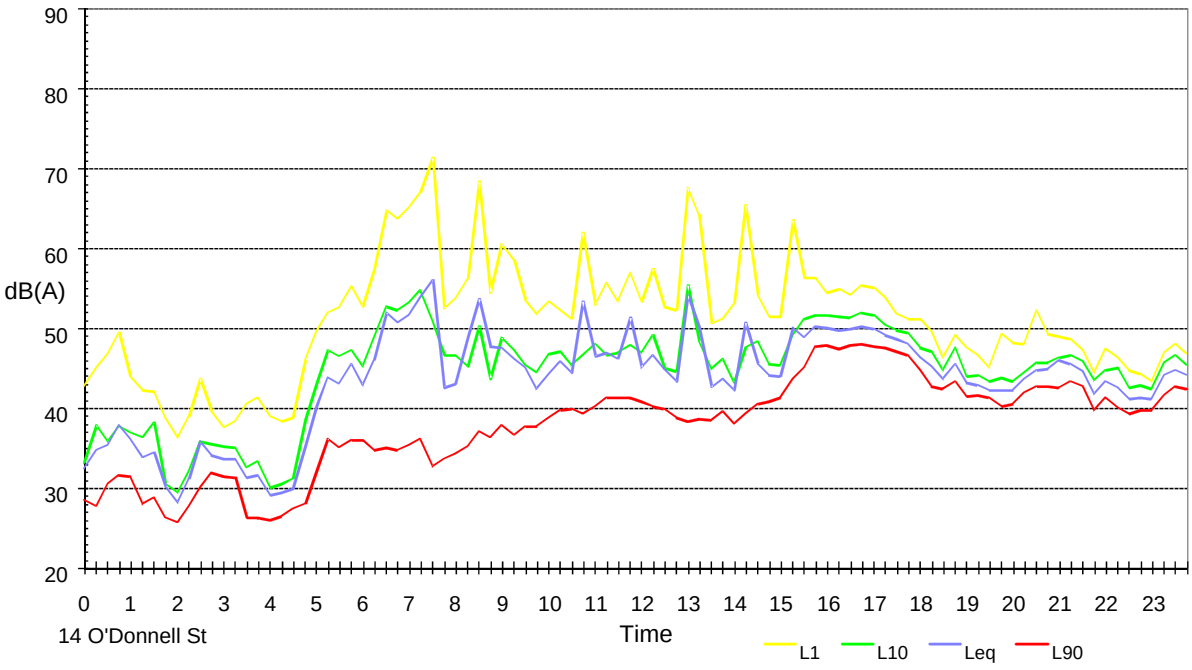

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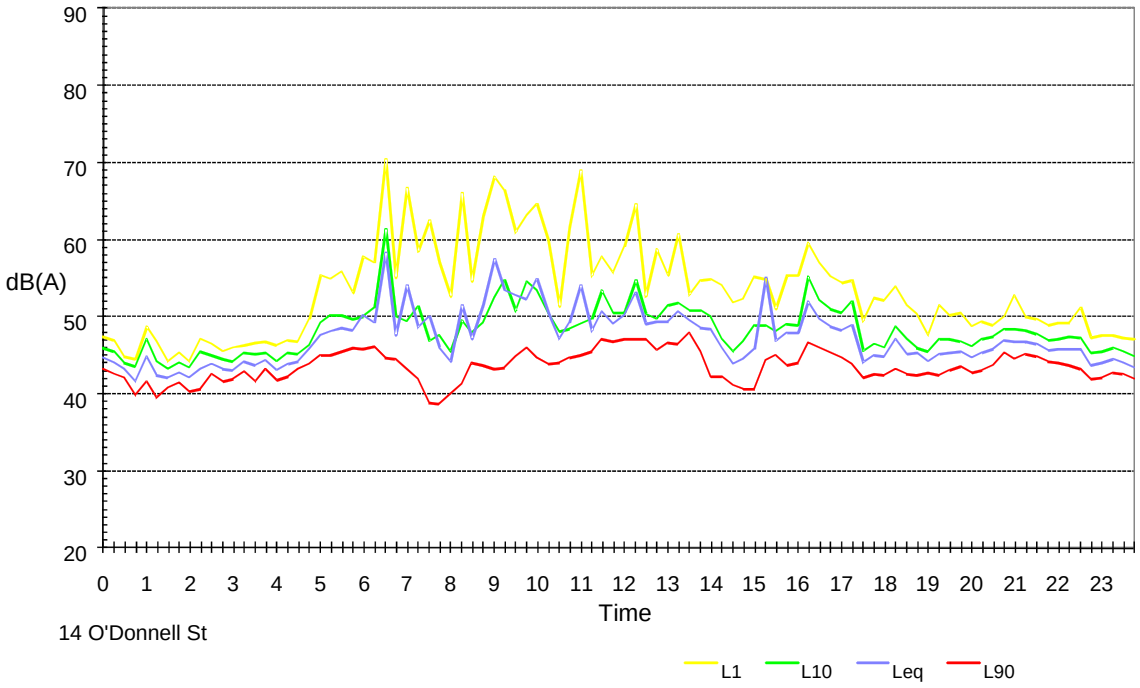

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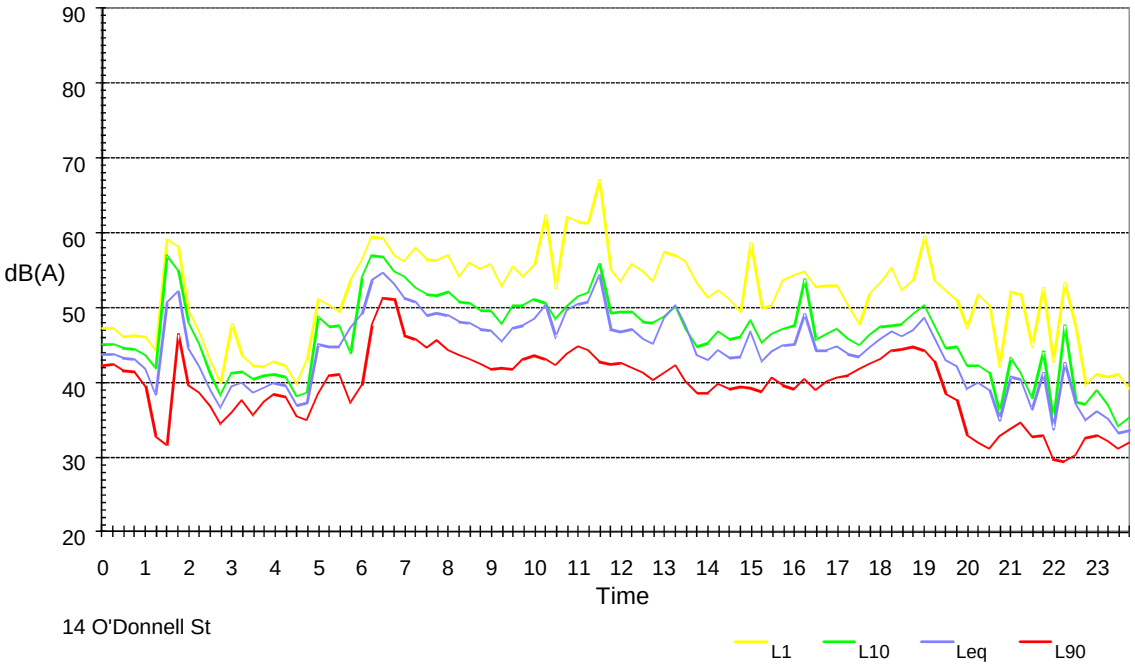

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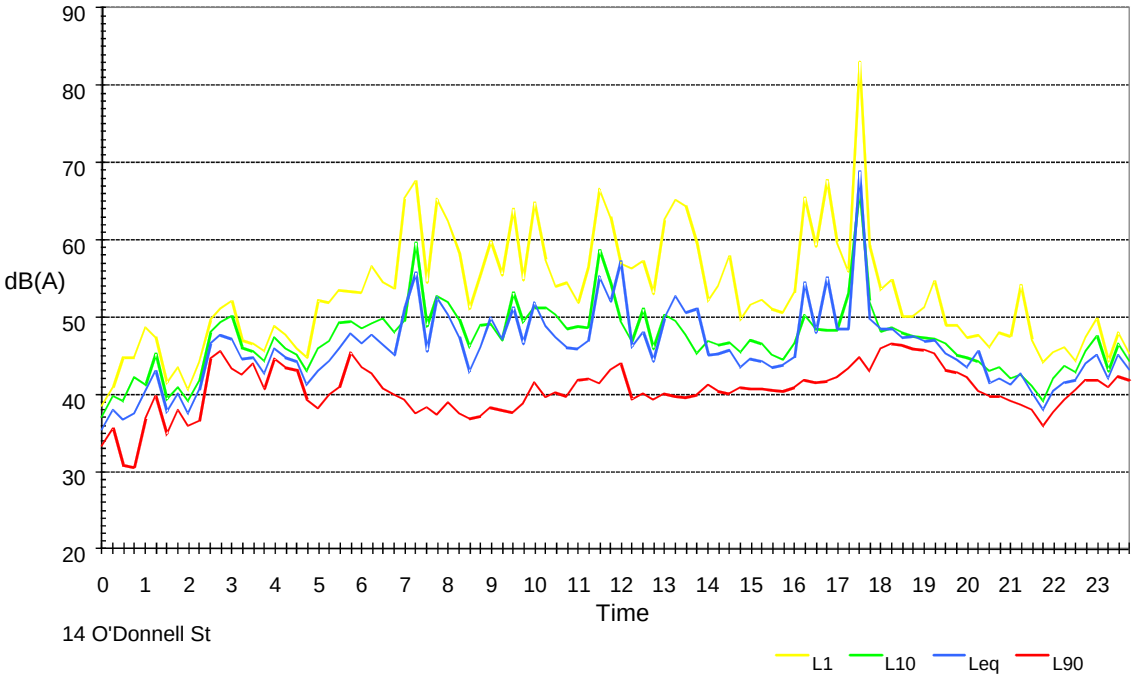

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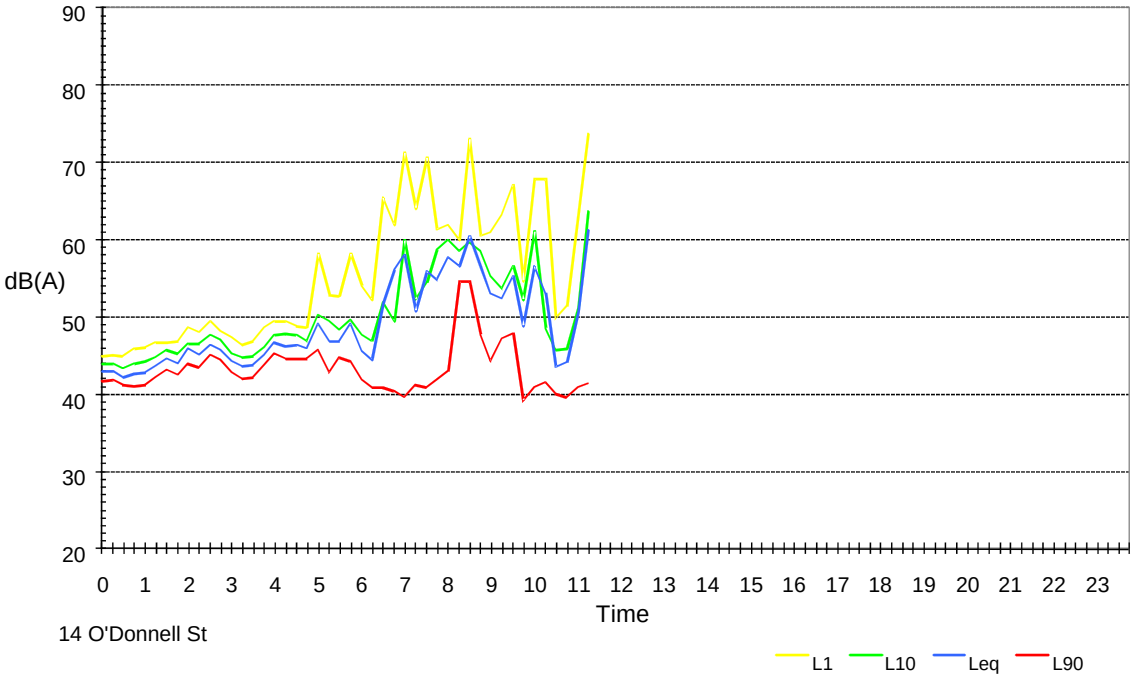

Reservoir Road

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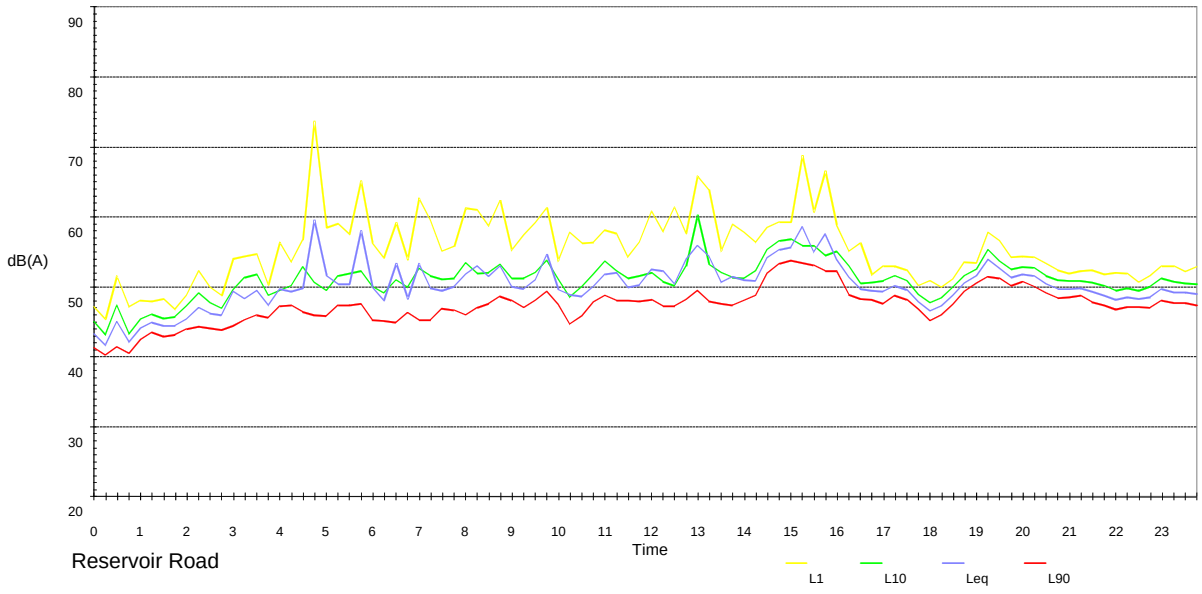

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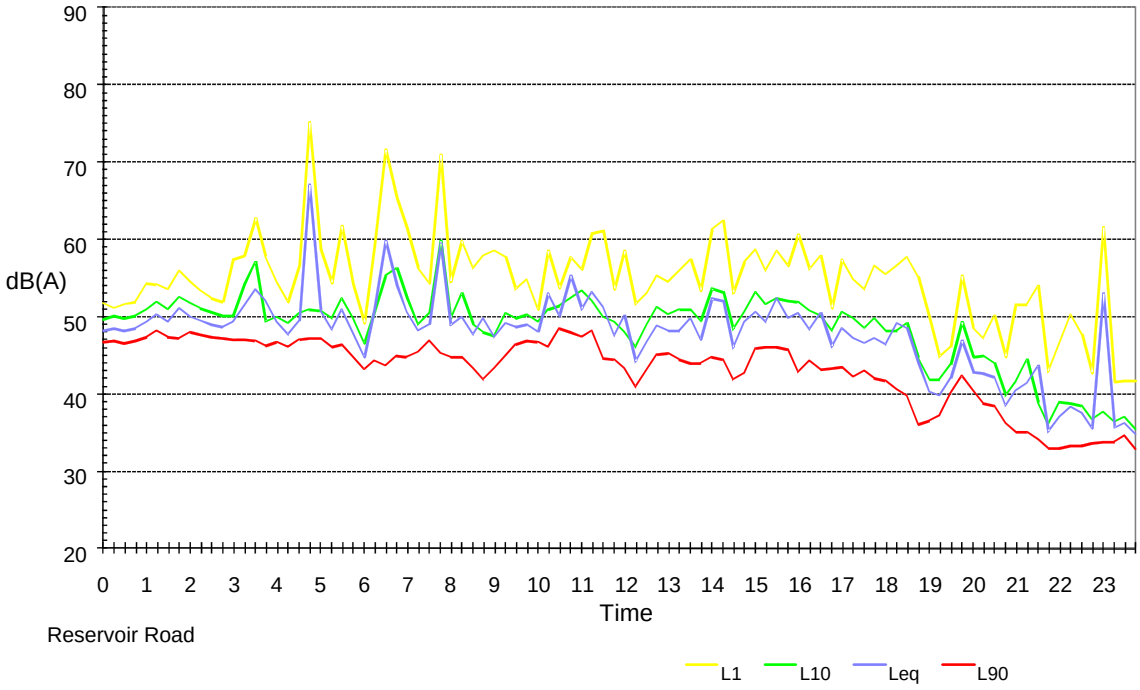

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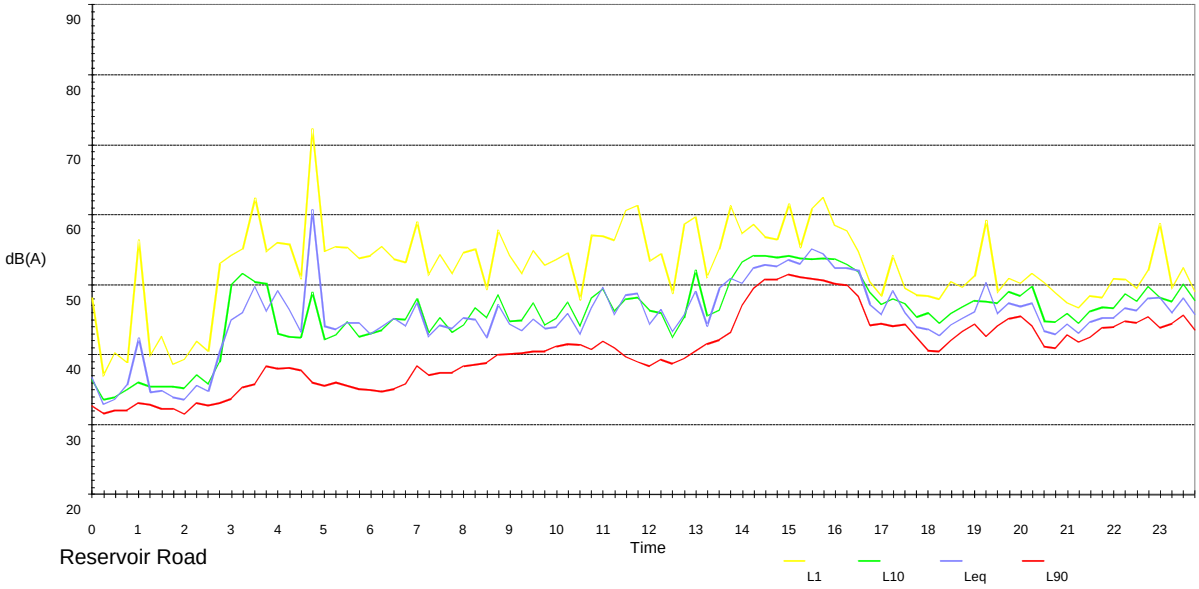

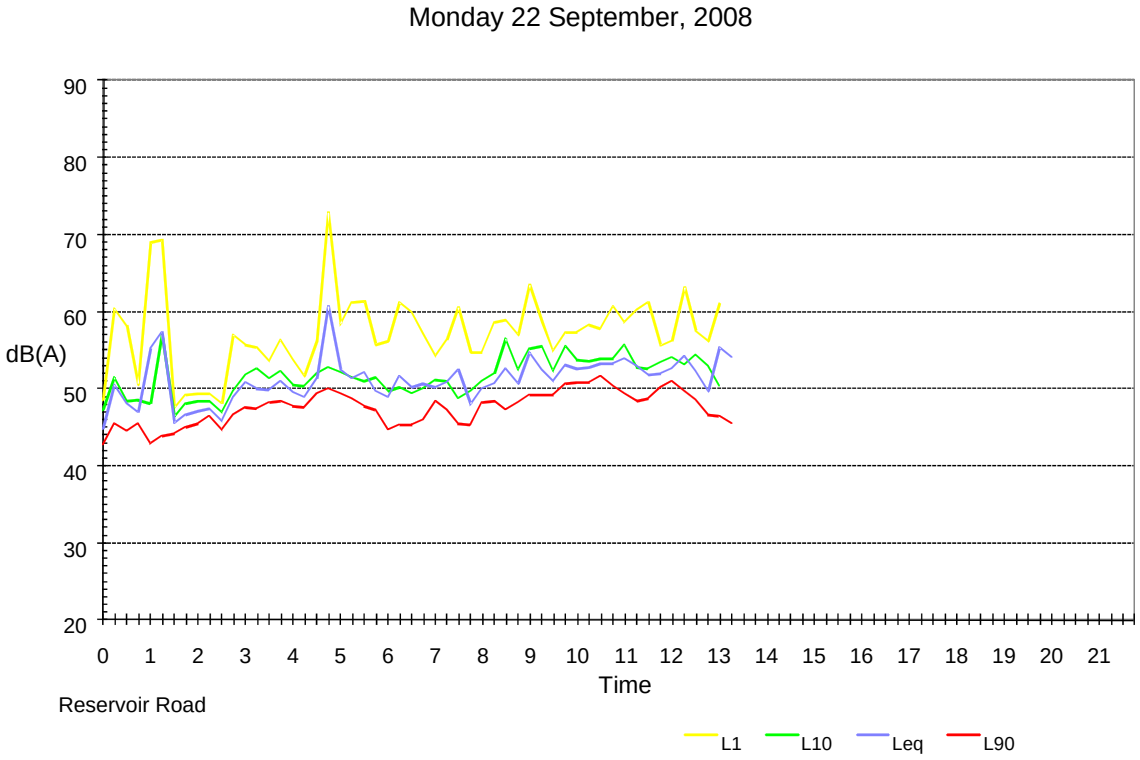
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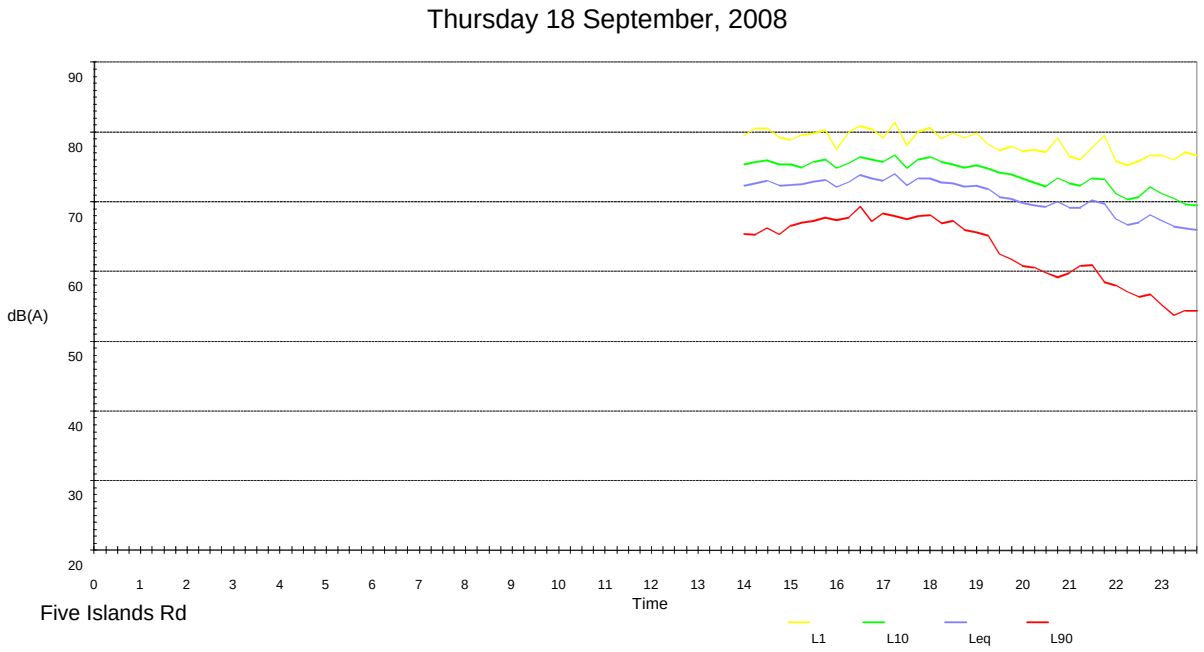
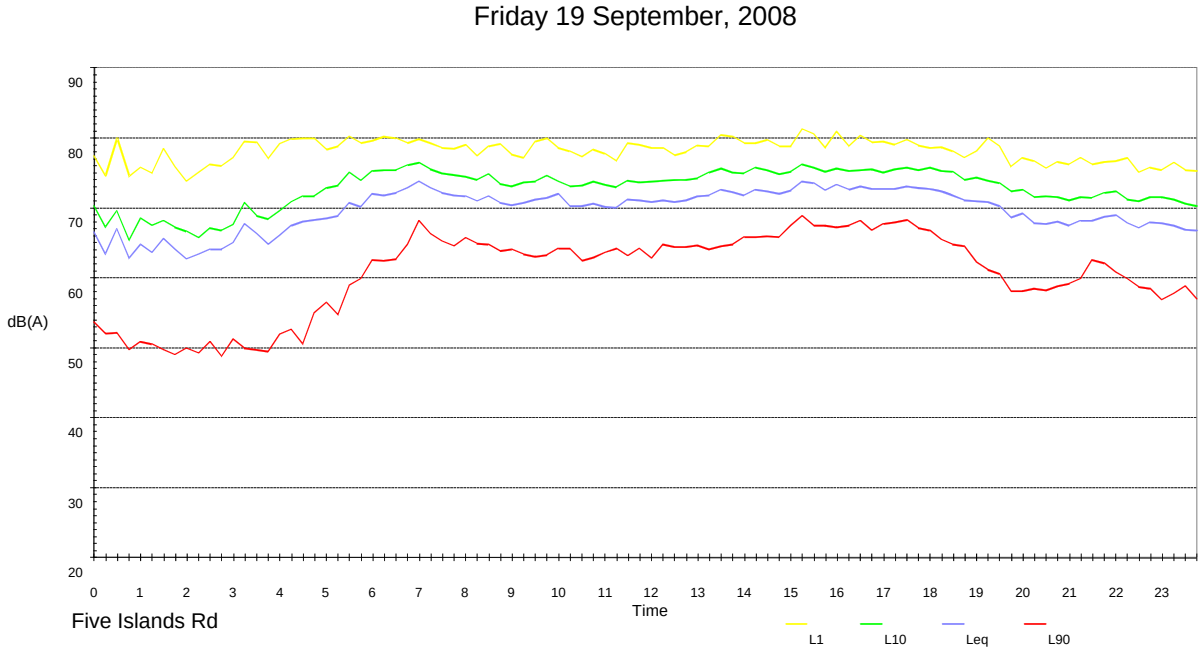
90
80
70
60
50
40
30
20
dB(A)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Time
Reservoir Road
L1
L10
Leq
L90

Five Islands Road – Traffic Noise





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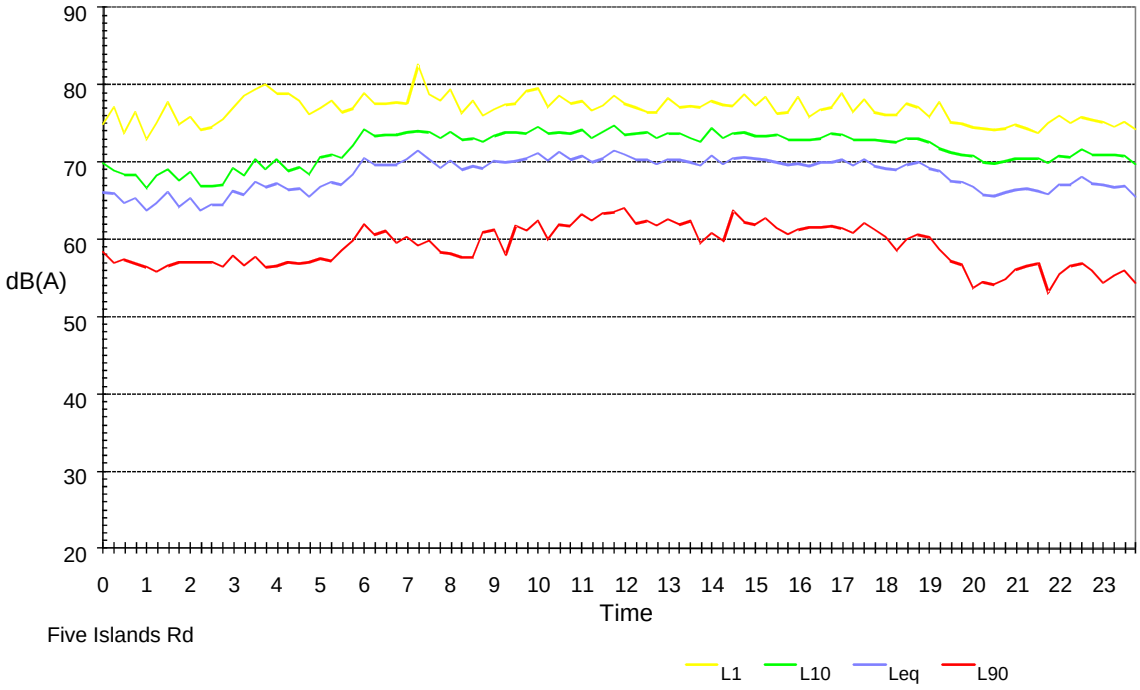

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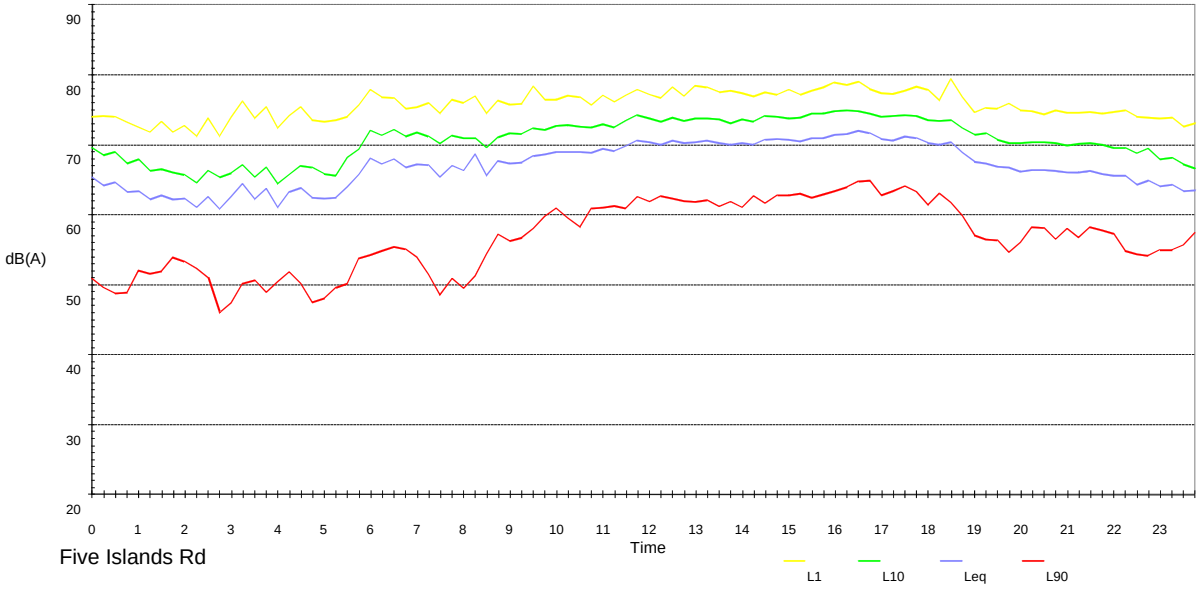

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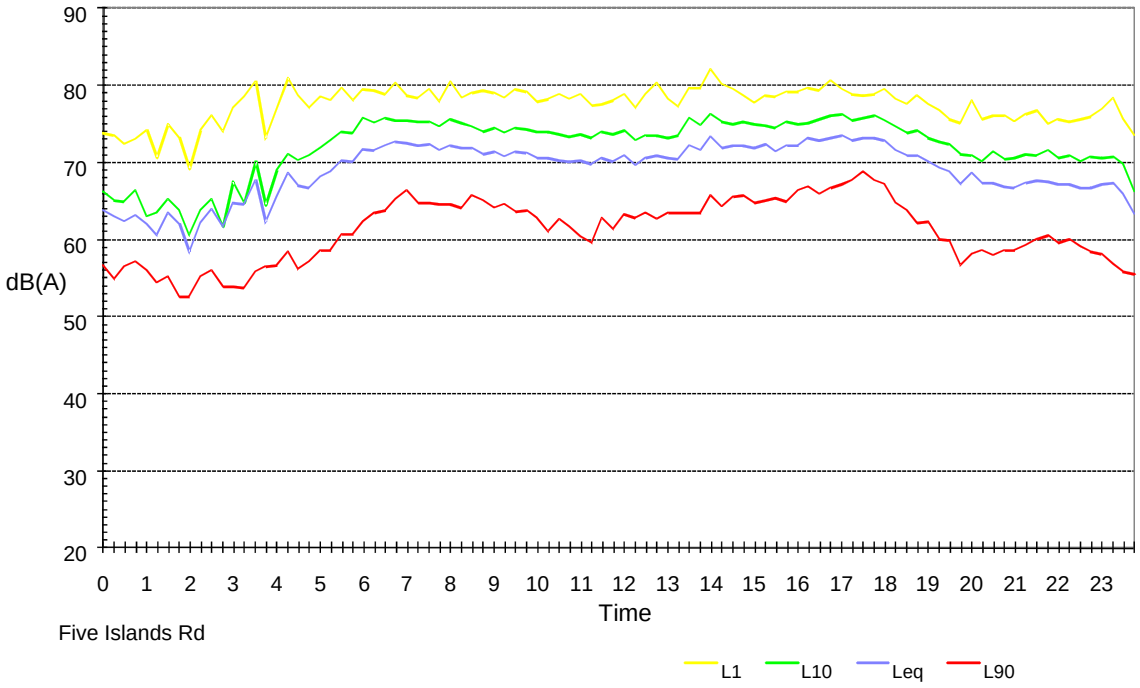

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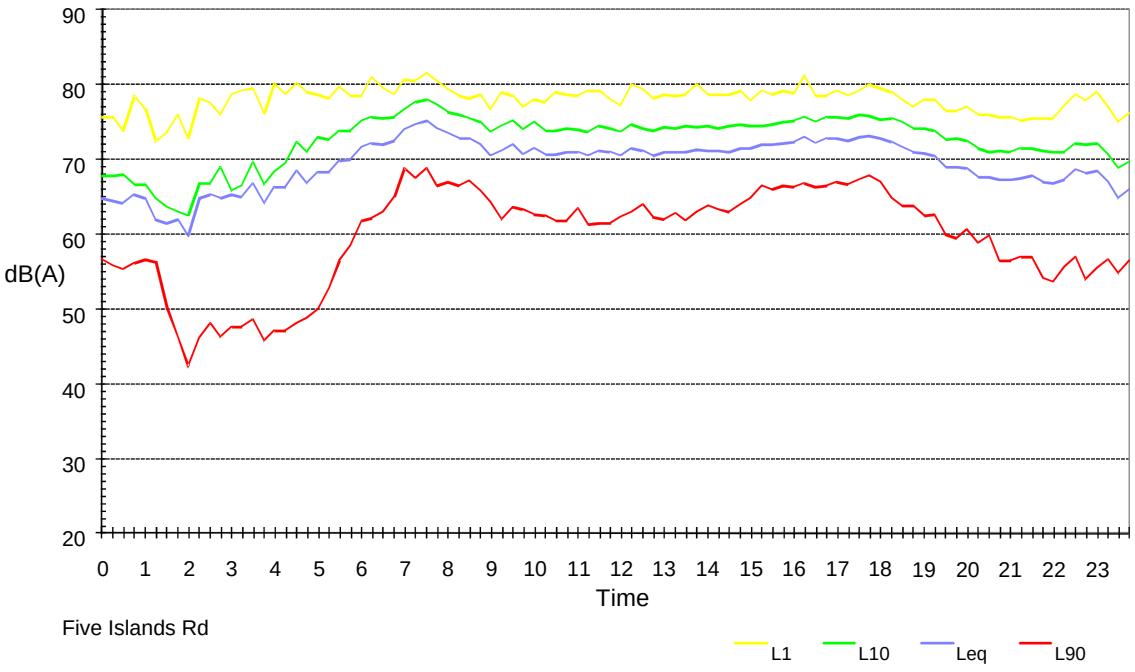

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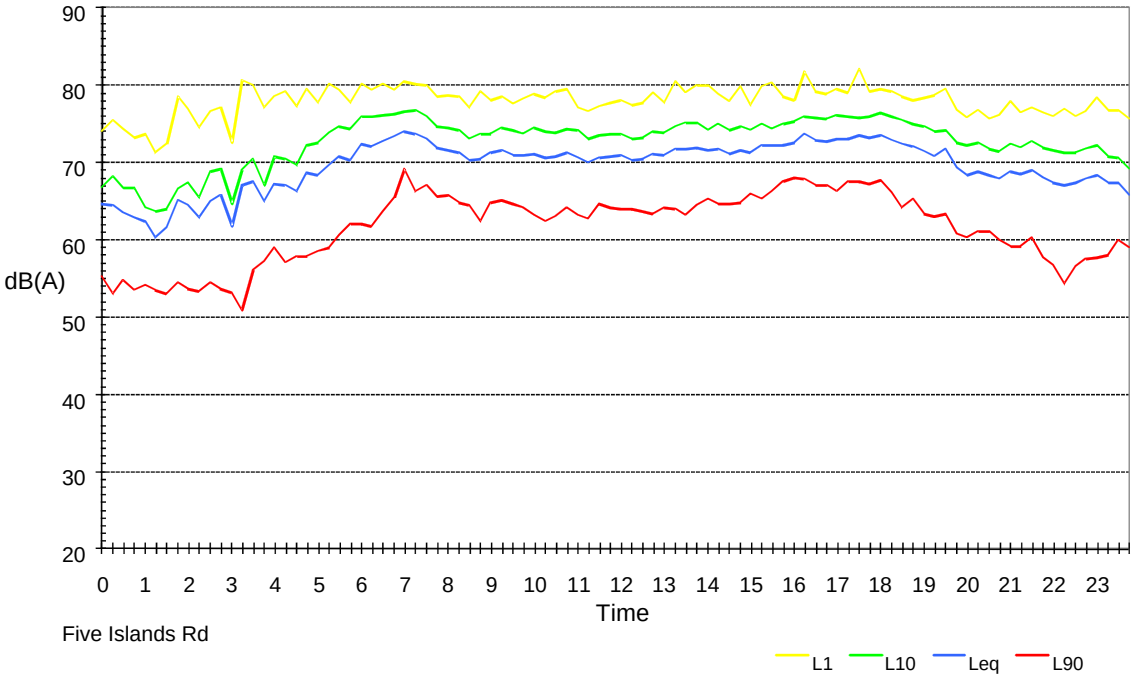

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