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Report

TQ HOLDINGS AUSTRALIA –NOISE AND VIBRATION ASSESSMENT FOR PROPOSED PORT KEMBLA BULK LIQUIDS TERMINAL

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EXECUTIVE SUMMARY

Overview

TQ Holdings Australia is seeking approval for the construction and operation of a bulk liquids Terminal (the Project) in Port Kembla to turnover approximately 2,900 mega litres of finished fuel products when the site is fully developed.

The key potential noise issues for the project were identified as:

- Noise and vibration generated by construction.
- Noise generated from operation activities.
- Road traffic noise.

Existing Environment

The existing acoustic environment was quantified by background noise monitoring across three locations at the closest residential receivers north to north-west of the site. The monitoring campaign was completed from 28 May to 5 June 2015. The monitoring indicated the existing noise environment as typical of an urban area with significant traffic and minor industrial influence. Noise Criteria for each noise catchment area were determined based on the NSW industrial noise policy (INP).

Analysis of meteorological conditions indicated south east to north easterly winds as a feature of the project area.

Assessment Methodology

The conceptual site plan for the Project was analysed and used to develop detailed noise emission profiles for the key noise generating activities for operation and construction of the terminal. The operational scenarios assessed were considered representative of worst-case operations, where product throughput and vehicle usage is at a maximum. The construction scenario was also assessed to account for earthworks and assembly of structures. The assessment of impacts was made with reference to the INP and Interim Construction Noise Guidelines (ICNG) (**DECC, 2009**).

Operational Noise Impact Assessment

A computer based noise model was developed for the operational scenario to predict noise levels at the surrounding sensitive receivers. The noise model included all significant noise sources and accounted for meteorological conditions and attenuation due to ground effects, shielding from topographical features and barriers, air absorption and geometrical spreading.

The operational noise modelling scenario was developed based on the number and type of mobile and fixed equipment operating during that year. Sound power levels were assigned to each item based on previous measurements, data from other similar operations and published sources.

The noise modelling results for the most conservative stage of operations (Stage 3) predicted there to be no exceedances of the INP noise criteria. The assessment indicated that low frequency noise is predicted to be within acceptable levels. Further, the assessment also indicated that no privately owned receiver would experience noise levels above the guideline levels for sleep disturbance.

Cumulative noise impacts from existing industry in Port Kembla have been accounted for in the criteria selected for operational and construction noise criteria.

Construction Impact Assessment

The construction impact assessment was conducted using the model developed for the operational assessment. The assessment was conducted with reference to the ICNG and considered three scenarios including:

1. Bulk earthworks for the establishment of foundations
2. Establishment of structures and foundations for equipment
3. Installation and assembly of the bulk liquids terminal infrastructure

The results show that none of the sensitive receivers are anticipated to exceed the respective ICNG noise criteria. Further, no receivers are predicted to be highly noise affected for any of the construction scenarios.

A construction vibration assessment was conducted and developed safe working distances for vibration activities to occur within to avoid adverse impacts.

Road Impact Assessment

The road noise impact assessment used measured traffic volumes to estimate the impact of Project generated traffic on Springhill Road and Masters Road.

The assessment concluded that noise level increases associated with Project generated traffic would be less than 2 dB which meets the RNP traffic noise criteria.

Noise Management

Noise management and monitoring measures have been recommended to assist in the control and reduction of adverse noise impacts. A noise management plan is recommended.

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1 INTRODUCTION

TQ Holdings Australia propose to operate a bulk liquids terminal (the Project) in the Port Kembla Inner Harbour area for the importation, storage and distribution of finished fuel products at NSW Ports land, between the GrainCorp and Port Kembla Coal Terminal. This noise vibration assessment has been prepared as part of Environmental Impact Statement (EIS) prepared by Cardno.

1.1 Study Requirements

The draft Secretary's Environmental Assessment Requirements (SEARs) issued on 21 January 2015 as relating to the Noise and Vibration assessment includes:

- a description of all potential noise sources, including construction, operational and transport sources;
- a quantitative assessment of construction, operational and transport noise and vibration impacts to surrounding receivers from on site and off site activities (including shipping) in accordance with the relevant EPA guidelines; and
- details of the proposed management, mitigation and monitoring measures.

1.2 Scope of Work

This report includes an assessment of all construction and operational noise aspects of the proposed development and was conducted with consideration to the following policies and guidelines:

- Industrial Noise Policy (INP) (**EPA, 2000**).
- Road Noise Policy (RNP) (**DECCW, 2011**).
- Interim Construction Noise Guidelines (ICNG) (**DECC, 2009**).
- Assessing Vibration: A Technical Guideline (**DEC, 2006**).

2 PROJECT DESCRIPTION AND LOCAL SETTING

2.1 Introduction

The Proposed Port Kembla Bulk Liquids Terminal at will operate as an import terminal, from which finished fuel products will be stored and despatched by road tankers. The Project is proposed to operate 24 hours a day, 365 days a year and will primarily handle a range of flammable and combustible liquid products and biofuels.

The initial construction phase is anticipated to commence in October 2015 (under existing planning approvals) and continue in varying degrees of intensity until Stage 2 of operations commences in late 2017 / early 2018. The timing of stage 3 is unknown at present.

The operational phase of the facility will be split into three stages. Throughput in Stage 1 is expected to be 1,200 mega litres per annum (MLpa) with the throughput increasing over the stages to a maximum when the site is fully developed in Stage 3.

The construction and operational phases of the project will results in traffic movements between the Project and the road network. The peak number of vehicles for construction and operation during Stage 1 includes 150 light and 94 heavy vehicles per day. Stage 3 operation of the facility includes 12 light and 206 heavy vehicles per day. Heavy vehicles are expected to access the site from the Princes Highway via Masters Road and Spring Hill Road.

A conceptual plant layout provided by **TQ Holdings Australia** (**2015**) is presented in **Figure 2.1** showing the layout of the site. Noise emission sources for the construction and operational stages are presented in **Appendix C**.

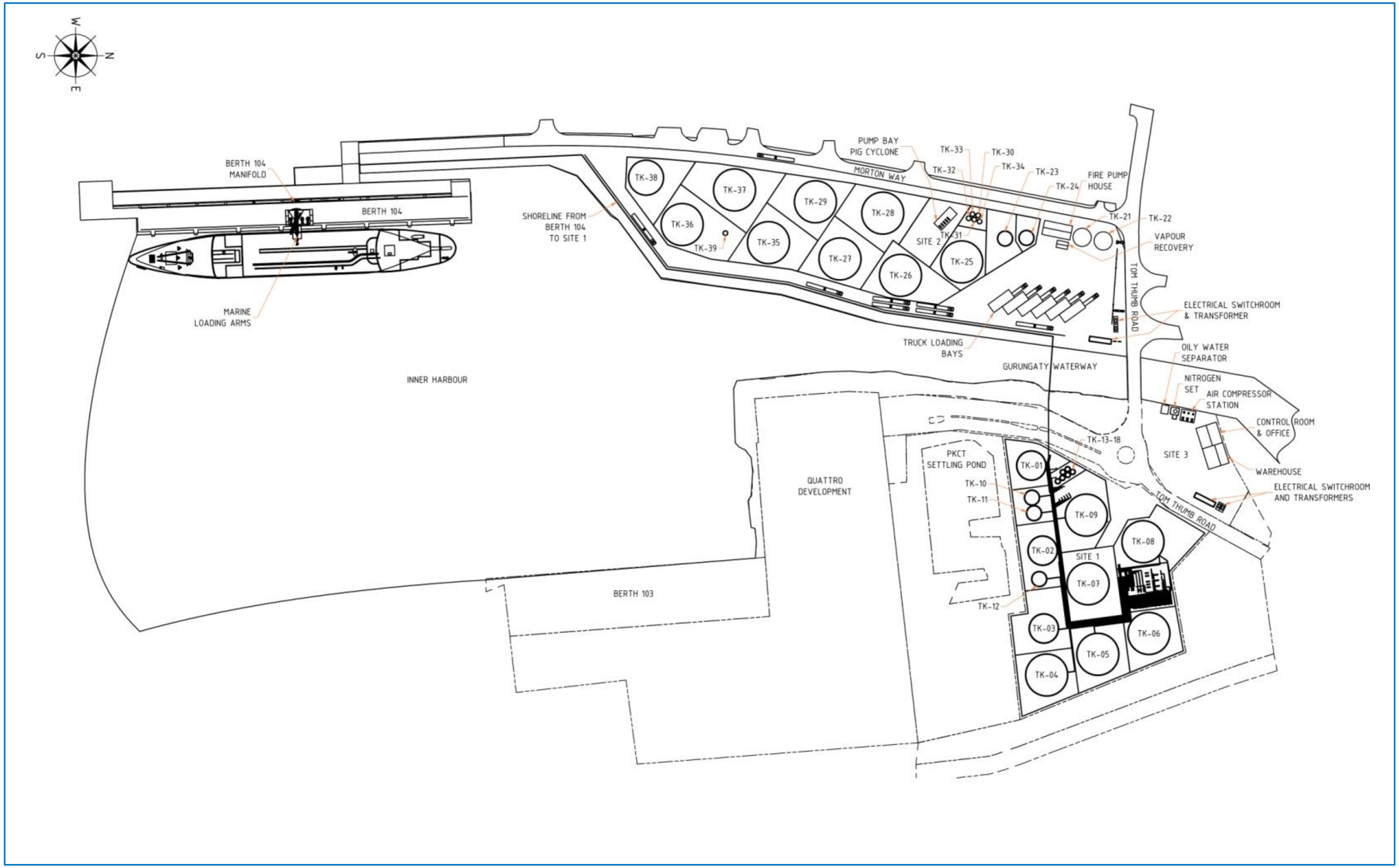

Figure 2.1: Concept Site Layout

2.2 Local Setting

The TQ Holdings Australia site is located on NSW Ports Land, Port Kembla, NSW. The site is in an industrial area with other major industrial development including the Port Kembla Steelworks, Port Kembla Grain Terminal, GrainCorp's Grain Terminal and Port Kembla Cement Grinding Mill surrounding the proposed facility.

The suburbs around the proposed site include Wollongong to the north, Coniston to the north-west and Mount St Thomas to the west. The receivers in the respective suburbs have been grouped into Noise Catchment Areas, presented in **Table 2.1**.

Table 2.1: Noise Catchment Areas

Noise Catchment Area	Suburb	Receiver types
A	Wollongong	Residential, churches, and passive recreation areas
B	Coniston	Residential, schools, commercial and passive recreational areas
C	Mt St Thomas	Residential, churches, commercial and active recreation areas

Figure 2.2 shows the site location, noise catchment areas and locations where background noise was recorded. The discrete receiver locations presented in **Appendix A** were chosen for the purpose of assessing noise impacts from the Project. These locations are the closest potentially affected receiver locations to the site.

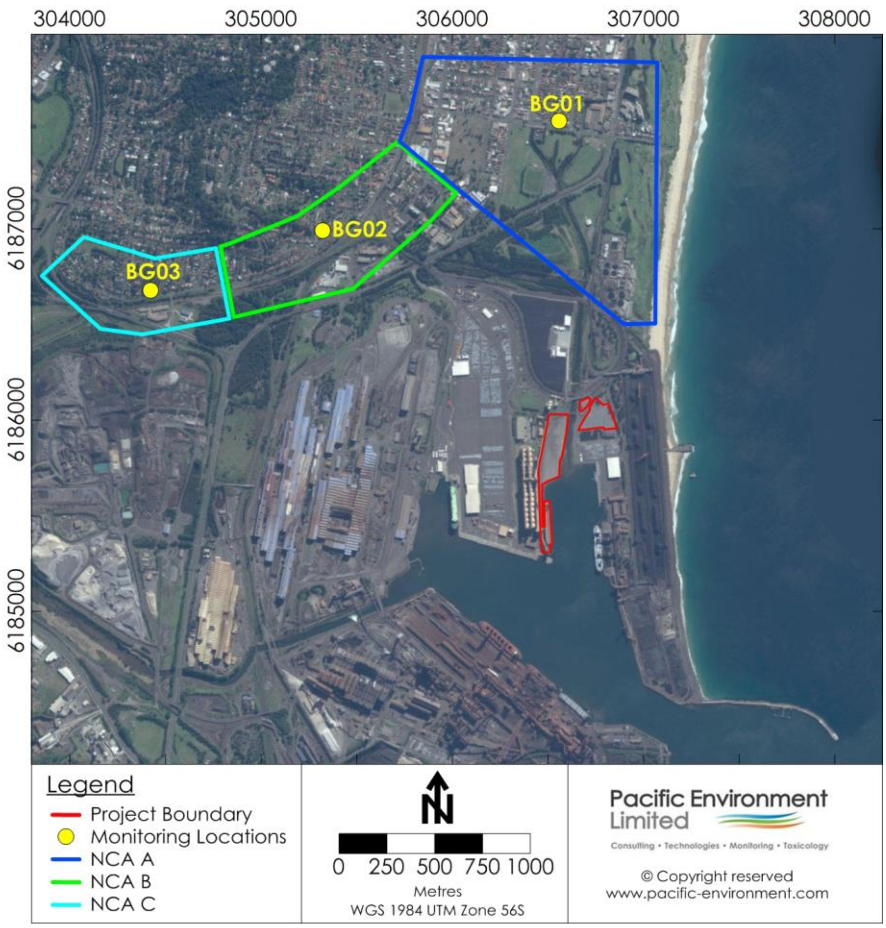

Figure 2.2: Local Setting

2.3 Monitoring Locations

The existing acoustic environment was characterised by a combination of long term and short term noise measurements.

A campaign of background noise monitoring was undertaken in the suburbs of Wollongong, Coniston and Mount St Thomas from 28 May to 5 June 2015. Unattended background noise monitoring was carried out at the three locations shown in **Table 2.2** during these monitoring periods.

Table 2.2: Noise Monitoring Locations, MGA Zone 56

Location ID	NCA	Address	Suburb	Easting (m)	Northing (m)
BG01	A	91 Evans St	Wollongong	306534	6187559
Attended Measurement		16 Swan St[1]		306951	6187490
BG02	B	176 Gladstone Ave	Coniston	305336	6186953
BG03	C	318 – 320 Gladstone Ave	Mt St Thomas	304442	6186671

Notes: 1 additional attended monitoring location

2.4 Monitoring Methodology

The noise loggers were set to record A-weighted noise levels every 15 minutes and set to 'fast' response time. Calibration was checked before and after each measurement with no significant drift observed.

Short term (attended) noise measurements were also carried out at the three background monitoring locations and 16 Swan St, Wollongong. Measurements were undertaken over 15 minute intervals using an NTi Audio XL2 Type 1 Sound Level Meter. Field calibration was checked before and after each measurement occasion with no significant drift (±0.5 dB) observed.

For the duration of monitoring, weather conditions were recorded at the Port Kembla weather station (no 68253). Where weather conditions unsuitable for noise monitoring occurred, as defined in the INP, the monitoring data was filtered accordingly. Data was also excluded for identified extraneous noise events.

The noise levels obtained are expressed in terms of $L_{A10, 15min}$, $L_{A90,15min}$ and $L_{Aeq,15min}$.

- $L_{A10,15min}$ is the A-weighted noise level that is exceeded for 10% of the monitoring time period (15 minutes).
- $L_{A90,15min}$ is the A-weighted noise level that is exceeded for 90% of the monitoring time period (15 minutes).
- The $L_{Aeq,15min}$ is the 15 minute equivalent continuous noise level containing the same acoustic energy as the actual fluctuating noise level.

The $L_{A90,15min}$ is commonly referred to as the background noise level and the lowest 10th percentile $L_{A90,15min}$ over a period (day, evening, night) is referred to as the period assessment background level (ABL). The Rating Background Level (RBL) for each day, evening and night period of the monitoring occurrence is then calculated from the ABLs.

2.5 Monitoring Results

2.5.1 Logging

Table 2.3 provides a summary of the noise monitoring data from this location. Daily graphs for the noise monitoring results are included in **Appendix B**.

Table 2.3: Long Term Noise Monitoring Results

Location	NCA	Measured Noise Level, dB(A)								
		Day			Evening			Night		
		L_{10}	RBL	L_{eq}	L_{10}	RBL	L_{eq}	L_{10}	RBL	L_{eq}
BG01	A	56	41	51	53	42	49	49	39	44
BG02	B	71	48	65	68	50	62	64	47	58
BG03	C	64	51	60	62	50	58	60	46	56

2.5.2 Attended

Short term (attended) noise measurements were also carried out at the three background monitoring locations and 16 Swan St, Wollongong. The weather conditions on the 28th August, 4th and 5th June were sunny with light to medium northerly winds. **Table 2.4** provides a summary of the attended noise measurements.

Table 2.4: Attended Noise Measurement Results

Date and Time (Day, Eve, Night)	Location	Measured Noise Level dB(A)				Comments
		$L_{A1,15min}$	$L_{A10,15min}$	$L_{A90,15min}$	$L_{Aeq,15min}$	
NCA A						
28/05/2015 12:00	91 Evans St	74	69	44	64	Background noise environment consists of industry from Port Kembla 43-44 dB(A) and distant traffic. Car passes with peaks 67-68 dB(A). Local fauna (birds) and dogs barking in the distance.
04/06/2015 19:50	91 Evans St	69	61	47	57	Background noise environment consists of industry from Port Kembla and substation approximately 80m from the logging location. 48-50 dB(A). Car passes with peaks 64-67 dB(A). People heard in the field across the road and dogs barking in the distance.
04/06/2015 23:25	91 Evans St	66	54	46	53	Background noise environment consists of industry from Port Kembla and substation 46-48 dB(A). Car passes with peaks 65-66 dB(A).
04/06/2015 20:10	16 Swan St	59	55	49	53	Background noise environment consists of road noise from Springhill Road, 46-58 dB(A). Truck passes with peaks of 63-64 dB(A). Background includes ocean swell and distant traffic.
04/06/2015 23:05	16 Swan St	59	57	50	54	Background noise environment consists of road noise from Springhill Road, 48-50 dB(A). Background includes ocean swell and distant traffic.
NCA B						
28/05/2015 13:00	176 Gladstone Ave	74	69	44	64	Background noise environment consists of traffic from Springhill Road, 42-43 dB(A). Car passes with peaks 68-72 dB(A) and buses with peaks of 79 dB(A). Train audible moving along the tracks. Industry audible when no automobiles present.
04/06/2015 19:25	176 Gladstone Ave	74	67	48	63	Background noise environment consists of traffic from Springhill Road, 46-48 dB(A). Car passes with peaks 70-75 dB(A). Train audible moving along the tracks and high pitch reversing alarm heard from industry.
04/06/2015 23:45	176 Gladstone Ave	68	54	47	55	Background noise environment consists of traffic from Springhill Road, 50-51 dB(A). Car passes with peaks 73-76 dB(A). Train audible moving along the tracks 54-55 dB(A). Short term peaks Port Kembla Steel Mill 56-57 dB(A).
NCA C						
04/06/2015 16:05	318 – 320 Gladstone Ave	70	65	50	60	Background noise environment consists of traffic from Masters Road, 49-51 dB(A). Car passes with peaks 66-70 dB(A) and trucks with peaks of 55-56 dB(A).
04/06/2015 19:10	318 – 320 Gladstone Ave	70	62	52	59	Background noise environment consists of traffic from Masters Road, 50-52 dB(A). Car passes with peaks 63-69 dB(A) and trucks with peaks of 58-65 dB(A). Short duration high pitch alarm heard from industry, 55-56 dB(A).
05/06/2015 00:05	318 – 320 Gladstone Ave	66	54	45	53	Background noise environment consists of traffic from Masters Road, 47-48 dB(A). Car passes with peaks 66-68 dB(A) and trucks with peaks of 70-71 dB(A).

Notes: All values are in dB(A),

2.6 Discussion of Results

Noise monitoring indicated an urban noise environment influenced by industrial and traffic noise sources at each of the monitoring locations. Noise levels followed typical diurnal patterns with increased levels of traffic and community noise influence during the day time hours and lower ambient noise levels during the night time hours. Local fauna including birds, wind rustling and barking dogs were also heard. Traffic noise was the primary influence on the L_{Aeq} noise descriptor. Industrial noise was audible at all logging locations in the background during lulls in existing traffic noise.

The L_{A90} noise level recorded during the logging period can be considered as a conservative estimate of constant industrial noise sources from industry in the local area. This is because traffic noise is also contributing to the L_{A90} descriptor at BG2 and BG3.

Review of the noise logger graphs showed increased night time background noise levels at BG2 and BG3 on the 3rd and 4th of June 2015 indicating potential noise enhancing inversion conditions.

The median L_{A90} noise level during periods of minimal extraneous influence (that is the night time period) at BG1 was 40 dB(A), BG2 was 48 dB(A) and BG3 was 49 dB(A).

2.7 Meteorological Analysis

Meteorology data prepared for the Project site and used for air dispersion modelling (**Pacific Environment 2015**) at Port Kembla has been referenced in determining the likelihood of noise enhancing weather conditions.

Meteorological features were determined in accordance with the INP to identify the likelihood of weather conditions which may increase noise levels at sensitive receivers in the project area.

As stated in the INP, a noise enhancing wind is considered to be a feature of the site if winds 3 m/s or below occur for more than 30% of the time in any assessment period in any season.

Table 2.5 presents statistical analysis of wind speeds and directions completed using the EPA's Noise Enhancement Wind Analysis Program (**NEWA, 2013**). The field of influence applied to determine wind occurrence was a conservative 60°C either side of the source.

Table 2.5: Wind Frequency by Assessment Period under 3 m/s

Wind Direction	Wind Frequencies, % of Season and Time Period (< 3 m/s)											
	Summer			Autumn			Winter			Spring		
	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night
N	7%	11%	21%	11%	16%	19%	13%	11%	15%	11%	16%	23%
NE	4%	15%	27%	8%	29%	**31%**	17%	**35%**	**30%**	6%	25%	29%
E	1%	15%	**32%**	8%	**40%**	**43%**	20%	**48%**	**47%**	4%	29%	**36%**
SE	1%	15%	27%	7%	**39%**	**39%**	20%	**48%**	**44%**	4%	28%	**30%**
S	8%	16%	22%	12%	16%	17%	18%	19%	17%	12%	17%	18%
SW	11%	15%	16%	15%	10%	10%	11%	5%	5%	14%	12%	8%
W	19%	16%	12%	18%	7%	4%	11%	2%	2%	20%	6%	5%
NW	9%	11%	9%	12%	7%	5%	7%	2%	2%	15%	4%	4%

Note: Bolded text indicates a dominant wind direction where the wind directions occur for at least 30 percent of the time.

Wind directions were identified as dominant when wind between 0.5 – 3.0 m/s occurred greater than 30% of the time. Dominant winds were identified during the evening and night between north-east and south-east. The potential for drainage flows is considered unlikely due to the location of the sources and receivers near sea level on a relatively flat plain.

In accordance with Table C2 in Appendix C of the INP, the potential for temperature inversions was considered, where they occur for 30% or more of the time during the night time period (6.00pm-7.00am) in the winter months (June, July and August).

Analysis of stability class data has been performed using CALMET data prepared for the Project. Temperature inversions were identified to occur for 24% of the time during winter nights, and hence these conditions were not considered as part of the assessment.

3 ASSESSMENT CRITERIA

3.1 Operational Noise

3.1.1 Industrial Noise Policy

Operational noise is assessed according to the INP (**EPA, 2000**). Two criteria are considered for intrusive and amenity noise impacts from industrial noise. The criteria set in the INP are non-mandatory, however it is emphasised that all reasonable and feasible measures should be implemented in an attempt to achieve the criteria. Where the criteria are not met, additional considerations may apply.

Intrusiveness Noise Criterion – The $L_{Aeq,15min}$ noise level within the day (7.00am to 6.00pm, 8.00am to 6.00pm Sundays and Public Holidays), evening (6.00pm to 10.00pm) or night time (10.00pm to 7.00am, 10.00pm to 8.00am Sundays and Public Holidays) assessment periods should not exceed the Rating Background Level[a] (RBL) within that period by more than 5 dB(A).

Amenity Noise Criterion – The maximum ambient L_{Aeq} noise level from industrial sources within the day, evening and night assessment period should not exceed the "acceptable noise levels" (ANL) published in the INP and reproduced in **Table 3.1.**

The ANL is dependent on the relevant receiver type and area category for the residential receiver. The purpose of this noise goal is to provide an upper limit to industry related noise emission and prevent industrial noise from creeping higher with each new successive industrial development.

Where the existing industrial noise level is close to or exceeds the acceptable noise level, the project specific amenity noise criterion is then set lower than ANL so that the total level of industrial noise (i.e. new plus existing) does not exceed the deemed INP acceptable level. Adjustments to the ANL are presented in **Table 3.2**. On the other hand, where the existing level of industrial noise is higher than the INP acceptable level, then the project specific noise criterion is set 10dB(A) lower than the prevailing noise level if it is unlikely that the prevailing industrial noise level will reduce in the future. If it is likely that the overall noise level will reduce, then the project specific amenity criterion is set 10 dB(A) below the INP acceptable noise level.

For this assessment, receivers in NCA A, NCA B and NCA C were considered Urban. This was identified during noise monitoring where the catchment areas were influenced by nearby and distant traffic noise and industry. Each of the monitoring locations was considered as having an 'urban hum'. These descriptions of the background levels are consistent with the description applied to urban environments in the INP.

[a] The overall single figure background level representing each assessment period (day/evening/night) over the whole monitoring period.

Table 3.1: Amenity Criteria, Recommended LAeq 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
School Classroom – internal	All	Noisiest 1-hour period when in use	35	40
Places of Worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Note: This table is a reproduction of Table 2.1 of the INP. It should be read in conjunction with the notes from Section 2.2.1 of the INP.

Table 3.2: Modification to ANL to Account for Existing Level of Industrial Noise

Total existing L_{Aeq} noise level from industrial sources dB(A)	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is *likely to decrease* in future: acceptable noise level minus 10 If existing noise level is *unlikely to decrease* in future: existing level minus 10
Acceptable noise level plus	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

Note: This table is a reproduction of Table 2.2 of the INP.

The INP project specific noise levels (PSNL) for the Project are presented in **Table 3.3** for land uses and receiver types within the Project area. Table 2.2 of the INP provides a modification to acceptable noise levels (ANLs) to account for existing industrial noise. The resulting criteria has accounted for existing industrial noise in the project area. As previously discussed in **Section 2.6** traffic noise was observed significantly influencing average noise levels at residential noise receivers. However constant background industrial noise was observed during attended measurements. To provide an estimation of existing industrial influence at each of the monitoring locations the background L_{A90} noise level has been assumed to approximate industrial influence.

Table 3.3: Project Specific Noise Levels

Receiver/Land Use	Descriptor	Operational Noise Criteria, dB(A)[1]		
		Day	Evening	Night
Residential (**NCA A**)	$L_{Aeq,15min}$	46	47	43
Residential (**NCA B**)	$L_{Aeq,15min}$	53	46	38
Residential (**NCA C**)	$L_{Aeq,15min}$	56	44	39
School Classroom– external[2]	$L_{Aeq,15min}$	45 (when in use)	45 (when in use)	45 (when in use)
Places of Worship (external) (when in use)	$L_{Aeq, period}$	50 (when in use)	50 (when in use)	50 (when in use)
Area specifically reserved for passive recreation (when in use)	$L_{Aeq, period}$	50	50	50
Active recreation area (when in use)	$L_{Aeq, period}$	55 (when in use)	55 (when in use)	55 (when in use)
Commercial premises	$L_{Aeq, period}$	65	65	65
Industrial premises	$L_{Aeq, period}$	70	70	70

Notes:
1. Day (7.00am-6.00pm Monday to Saturday and 8.00am-6.00pm Sundays and Public Holidays), Evening (6.00pm-10.00pm), Night (10.00pm-7.00am, unless preceding a Sunday or Public Holiday).
2. Noise criteria specified in the INP as internal limits are assessed using an external limit based on an outside to inside correction of 10 dB as specified in Section 2.2.1 of the INP.

The noise criteria for 24hr operation of the Port Kembla Bulk Liquids Terminal is limited by the night time criteria of 43 dB(A) for residential receivers in the suburb of Wollongong, 38 dB(A) in the suburb of Coniston and 39 dB(A) in the suburb of Mount St Thomas in accordance with the INP.

3.2 Draft Industrial Noise Guideline

During September 2015, the NSW EPA released an update noise policy document in draft format for consultation. The document is titled the Industrial Noise Guideline (ING). The guideline provides a terminology updates and assessment criteria updates. The assessment criteria differences between the ING and INP include a revised approach to establishing an amenity noise limit. Intrusive limits are consistent across both documents.

The ING amenity goals are consistent with the INP as presented in **Table 3.1** of this report, however the draft ING recommends a project amenity noise level of the recommended amenity level minus 5 dB(A). As such a nigh time noise limit of 40 dB(A) would apply for all residential receivers.

3.2.1 Low Frequency Noise

The characteristics of a noise source can increase annoyance for sensitive receivers. Examples of annoying characteristics are: prominent tones, impulsiveness, intermittent sources and low frequency noise. The INP provides guidance on 'modifying factors' which should be applied to predicted or measured noise levels when a dominant low frequency[b] noise characteristic is present. Table 4.1 of the INP states that low frequency noise is considered dominant where the difference between the A-weighted and C-weighted noise levels is 15 dB or greater. Where this difference occurs the INP recommends a modifying factor of 5 dB is added to the predicted noise level.

[b] Contains the major components within the low frequency range (20 Hz – 250 Hz) of the frequency spectrum.

3.2.2 Low Frequency Noise - Draft Industrial Noise Guideline

Table C1 of the draft ING states that low frequency noise is considered dominant where the difference between the A-weighted and C-weighted noise levels exceeds 15 dB and for noise levels in the range of 10-160Hz:

- Where any of the 1/3 octave noise levels in Table C2 are exceeded by up to 5 dB and cannot be mitigated, a 2 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period.
- Where any of the 1/3 octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5 dB(A) positive adjustment to measured/predicted A weighted levels applies for the evening/night period and a 2 dB positive adjustment applies for the daytime period.

Table 3-4: Draft *Industrial Noise Guideline* (Table C2: Low Frequency Thresholds)

One-third octave $L_{Zeq,\ 15\ minute}$ Threshold Level													
f, Hz	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes: dB(z) = decibel (Z-weighted); f,Hz = frequency in Hertz; Hz/dB(Z) = hertz per decibel (Z-weighted). For the assessment of low frequency noise, care should be taken to select a wind screen that has wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler et.al. 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.
Low frequency noise shall be assessed under the meteorological conditions under which noise limits would apply. Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or Environment Protection Licence and at locations nominated in the development consent or license.

3.3 Sleep Disturbance

There are currently no universally accepted criteria applicable to protection from sleep disturbance. That is, at the current level of understanding, it is not possible to establish absolute noise level goals that would correlate to levels of sleep disturbance for all, or even a majority of people. However, sleep disturbance from noise is recognised by the World Health Organisation (WHO) as having the potential to adversely affect the health and wellbeing of people and it is the subject of ongoing research.

The WHO Guidelines for Community Noise (1999) provides guidance on sleep disturbance effects from noise. It states that where the noise is not continuous, the maximum A weighted noise level or L_{Amax} can be used to indicate the probability of noise-induced awakenings. It states that:

"Effects have been observed at individual L_{Amax} exposures of 45 dB or less."

Furthermore, it states that the guidelines should be based on the combination of values of the ambient L_{Aeq} noise and the L_{Amax}. The WHO guideline external value for sleep disturbance is L_{Amax} 60 dB(A). This value is an external level, based upon the assumed outside to inside correction of 15 dB assuming windows are open. However it has been noted that the outside to inside correction has been observed to vary between 5-15 dB[c] where windows are open to windows partially closed. Therefore in order to provide a conservative approach, a value of L_{Amax} 50 dB(A) has been used.

3.3.1 Maximum Noise levels Draft Industrial Noise Guideline

The draft ING identified a night time project trigger level of $L_{Aeq\ 15minute}$ of 40 dB(A) and a maximum noise level screening criteria of L_{Amax} 52 dB(A).

[c] Outside to Inside correction as documented in the following publications: Queensland Department of Environment and Heritage Protection EcoAccess Guideline Planning for Noise Control, NSW Environmental Criteria for Road Traffic Noise, NSW RTA Environmental Noise Management Manual and WHO Guidelines for Community Noise.

3.4 Construction Noise

The ICNG provides noise management levels for the control of noise from construction. In general these criteria are that construction noise should not exceed the background noise level by more than 10 dB(A) during standard hours, and by more than 5 dB(A) outside of standard hours. The criteria for residential receivers for this Project are given in **Table 3.5.**

Table 3.5: Construction Noise Management Levels at Private Residences using Quantitative Assessment

Time of Day	Management Level $L_{Aeq,15min}$	How to Apply
Recommended Standard Hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or Public Holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured $L_{Aeq,(15min)}$ 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.
	Highly noise affected 75dB(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: 1. 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 2. 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 + 5dBA	▪ A strong justification would typically be required for works outside the recommended standard hours[d]. ▪ 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.

[d] Justification for construction works outside of standard hours by TQ Holdings Australia is provided in **Section 6.2.2**.

A summary of the Project specific construction noise management levels for residential receivers and other receiver types is presented in **Table 3.6**. The unattended measured background noise levels summarised in **Section 2.5** has been used for residential receivers.

Table 3.6: Project Specific Construction Noise Management Level, dB(A)

Land Use	Construction Noise Management Level, $L_{Aeq,15min}$ dB(A)			
	Standard Hours	Outside of Standard Hours		
	Monday to Friday 7am to 6pm Saturday 8am to 1pm	Day Saturday 7am-8am, 1pm to 6pm, Sunday 8am-4pm	Evening Monday to Sunday 6pm to 10pm	Night time Monday to Saturday 10pm to 7am Sunday & Public Holidays 10pm to 8am
Residential (**NCA A**)	51	46	46	46
Residential (**NCA B**)	58	53	53	53
Residential (**NCA C**)	61	56	56	56
Active Recreation Area	65	65	65	65
Passive Recreation Area	60	60	60	60
Classrooms at Schools and other Educational Institutions[1]	55	55	55	55
Places of Worship[1]	55	55	55	55
Commercial	65	65	65	65
Industrial	70	70	70	70

Notes: 1. External noise level based on an outside to inside correction of 10 dB(A), in accordance with the INP.

3.5 Vibration

Impacts from vibration can be considered both in terms of effects on building occupants (human comfort) and the effects on the building structure (building damage). Of these considerations, the human comfort limits are the most stringent. Therefore, for occupied buildings, if compliance with human comfort limits is achieved, it will follow that compliance will be achieved with the building damage objectives.

3.5.1 Human Comfort

The EPA administered guideline entitled "*Assessing Vibration: A Technical Guideline,*" which provides acceptable values for continuous and impulsive vibration in the range 1-80Hz.

Where vibration is intermittent, such as for construction sources, a vibration dose is calculated and acceptable values are shown in **Table 3.7** below.

Table 3.7: Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night Time[1]	
	Preferred Value	Maximum Values	Preferred Value	Maximum Value
Critical areas [2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1 Daytime is 7.00am to 10.00pm and night time is 10.00pm to 7.00am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source BS 6472-1992.

3.5.2 Building Damage

German Standard *DIN 4150-3-1999 "Structural Vibration – Part 3 Effects of vibration on structures"* provides methods for evaluating the effects of vibration on structures in the absence of an Australian Standard.

The recommended limits (guide values) from DIN 4150 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 3.8**.

Table 3.8: Guideline Vibration Values for Short Term Vibration on Structures (mm/s)

Type of Building	Guideline values for velocity (mm/s)			
	1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	Vibration at horizontal plane of highest floor at all frequencies
Commercial and Industrial Building	20	20-40	40-50	40
Dwellings and buildings of similar occupancy or design	5	5-15	15-20	15
Structures that, because of their particular sensitivity to vibration cannot be classified under lines 1 and 2 and are of great intrinsic value	3	3-8	8-10	8

3.6 Road Traffic Noise

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, the RNP states that any increase in the total traffic level should be limited to 2 dB above the road traffic noise level without the development. The RNP application notes states that this limit should be applied wherever the noise level without the development is within 2 dB of or exceeds the noise assessment criterion.

4 OPERATIONAL NOISE

4.1 Operational Noise

4.1.1 Modelling Methodology

Noise modelling has been undertaken using the *ISO 9613 Acoustics – Attenuation of sound during propagation* outdoors (**ISO, 1996**) and CONCAWE's *Special Task Forces in Noise Propagation* (**CONCAWE, 1981**) algorithms, as implemented within the CadnaA 4.4 acoustic modelling package. The noise modelling takes into consideration the sound power level of the proposed site operations, activities and equipment, and applies adjustments for attenuation from geometric spreading, acoustic shielding from intervening ground topography, ground effect, meteorological effects and atmospheric absorption.

4.1.2 Modelling Scenarios

The modelling has assumed a conservative 15 minute scenario representative of Stage 3 (worst case) of the proposed operations. This phase will include operation at full development, with an increased level of vehicle movement on site. It represents the most conservative of the proposed operational stages and was therefore selected to be modelled.

Presented in **Appendix C** is the locations and number of equipment modelled, in addition to the predicted truck and vehicle routes on site. Further, to present a conservative approach, each of the equipment used is assumed to have 100% utilisation.

4.1.3 Meteorological Conditions

Table 4.1 presents the meteorological conditions included in the assessment.

Table 4.1: Meteorological Modelling Conditions

ID	Period	Meteorological Conditions	Wind	Modelling Parameters		
				Pasquil-Gifford Stability Class	Relative Humidity	Air Temperature
1	Day	Neutral	No Wind	D	70%	20°C
2	Evening/Night	Neutral	No Wind	D	90%	10°C
3	Evening/Night	Gradient Wind	3 m/s NE	D	90%	10°C
4	Evening/Night	Gradient Wind	3 m/s E	D	90%	10°C
5	Evening/Night	Gradient Wind	3 m/s SE	D	90%	10°C

4.1.4 Sound Power Levels

The sound power levels used in the operational noise assessment are presented in **Table 4.2**. The sound power levels are taken from Pacific Environments noise source database which includes data from the UK DEFRA construction noise database and the British Standard 5228.

Table 4.2: Modelled Sound Power Levels

Item	Sound Power Level L_{Aeq} dB(A)	Number	Height (m)
Marine Loading Arm[1]	95	1	3
Air Compressor[2]	102	1	1.5
Loading and Product Pump[1]	100	10	1.5
Vapour Recovery Unit Pump[1]	97	1	1.5
Fuel Tanker[3]	107	3	2
Light Vehicle[3]	85	1	2
Idling Truck[3]	89	2	2
Ship Auxiliary Power[4]	106	1	5

Notes: 1. SWL estimated from pump power rating (Bies and Hansen 2009).
2. SWL estimated from 85dB(A) at 1 metre.
3. SWL referenced from DEFRA database.
4. SWL referenced from publically available Auxiliary ship data.

4.1.5 Operational Noise Modelling Results

Predicted noise levels for the most impacted receivers are presented in **Table 4.3** for Stage 3 of operations. The complete noise modelling results are presented in **Appendix D**, with noise contours shown in **Appendix E**. All receivers shown in the table are predicted to receive acceptable noise levels for all assessed meteorological conditions during Stage 3 of operations when assessed against the INP and ING.

Table 4.3: Predicted Operational Noise

Receiver ID	Receiver Type	Criteria $L_{Aeq,15min}$			Predicted Noise Level $L_{Aeq,15min}$ dB(A)				
		Day	Eve	Night	Day 1 (Neutral)	Eve/Night 2 (Neutral)	Eve/Night 3 (NE wind)	Eve/Night 4 (E wind)	Eve/Night 5 (SE wind)
NCA A									
5	Residence	46	47	43	24	26	31	31	31
NCA B									
16	Residence	53	46	38	29	30	30	35	35
18	School	45	-	-	29	31	30	36	36
20	School	45	-	-	31	32	30	37	37
NCA C									
21	Passive Recreation Area	50	50	50	30	31	27	36	37
24	Residence	56	44	39	30	31	27	35	36
27	Place of Worship	50	50	50	26	27	24	31	33
36	Residence	56	44	39	29	30	26	29	35
40	Commercial	65	65	65	34	34	33	34	39
42	Active Recreation Area	55	55	55	40	40	39	39	44
43	Active Recreation Area	55	55	55	38	39	37	41	43

4.2 Low Frequency Noise

4.2.1 Methodology

An assessment for potential impacts relating to low frequency noise has been conducted using both guidance from the INP and current acoustic assessment practice relating to contemporary research into the impacts of noise where low frequency is a dominant factor.

Noise levels were predicted as C-weighted noise levels. The difference between the A and C weighted noise levels in addition to the absolute C-weighted level have been used to predict whether impacts are likely to occur. Where the predicted noise level exceeds both criteria, adverse impacts are likely and should be considered as part of noise management measures.

The C-weighted noise levels were calculated for privately owned receivers for the modelled Stage 3 scenario.

4.2.2 Low Frequency Noise Modelling Results and Assessment

Presented in **Table 4.4** are the most affected receivers from low frequency noise. The predicted C-weighted noise levels for all privately owned receivers are presented in **Appendix D**.

Table 4.4: Predicted Low Frequency Noise

Receiver ID	Receiver Type	Criteria 24 hr operation	Predicted Noise Level $L_{Ceq,15min}$ dB(A) Day 1 (Neutral)	Eve/Night 2 (Neutral)	Eve/Night 3 (NE wind)	Eve/Night 4 (E wind)	Eve/Night 5 (SE wind)
NCA A							
5	Residence	$L_C - L_A$ <15 dB	41	41	44	44	44
NCA B							
16	Residence	60	44	44	44	47	47
NCA C							
36	Residence	60	44	44	42	44	47

At some receivers, the difference between the A and C weighted noise levels was found to be greater than 15 dB. However, when comparing the predicted frequency data with the draft ING low frequency guidance, no additional penalties would apply.

In this case, as both criteria have not been exceeded at any privately owned receiver, the predicted impacts are considered to be acceptable.

4.3 Sleep Disturbance

4.3.1 Methodology

Sleep disturbance events have the potential to be caused by short high level noise events from operations. These can be caused by a number of activities and equipment items including trucks being loaded, engine start-ups and revving, tonal reversing alarms, warning and system alarms.

A conservative noise level of L_{Amax} 120 dB(A) has been assumed to represent typical maximum noise level events from a truck air break release or similar peak noise events.

4.3.2 Sleep Disturbance Noise Modelling Results and Assessment

The predicted maximum noise level results at the most sensitive residential receivers are presented in **Table 4.5**. Results are below the sleep disturbance criteria for all receivers for the Stage 3 operational scenario modelled. Complete noise modelling results are presented **Appendix D**.

Table 4.5: Predicted L_{Amax} Noise Levels for Stage 3 of Operations

Receiver ID	Receiver Type	Criteria L_{Amax} Night	Predicted Noise Level L_{Amax} dB(A)			
			Eve/Night 2 (Neutral)	Eve/Night 3 (NE winds)	Eve/Night 4 (E winds)	Eve/Night 5 (SE winds)
NCA A						
5	Residence	50	33	39	39	39
NCA B						
16	Residence	50	37	37	42	42
NCA C						
36	Residence	50	37	33	33	42

4.4 Cumulative Noise

The cumulative noise impact resulting from existing industry around the proposed facility has been accounted for during criteria setting for amenity noise limits. As predicted noise levels meet the noise criteria, cumulative industrial noise impacts are not anticipated.

5 OPERATIONAL VIBRATION

No significant operational vibration sources are anticipated to impact on the nearest residential areas from operations at the facility.

6 CONSTRUCTION NOISE AND VIBRATION

6.1 Construction Activity

Construction of the Project is expected to commence in October 2015 and continue in varying degrees of intensity until Stage 2 of operations commences in December 2017. Construction of Stage 3 will take place in the future, as determined by market demand.

For noise assessment purposes the construction stages are:

- Scenario 1 – Landform and earthworks
- Scenario 2 – Establishment of foundations and structures
- Scenario 3 – Assembly and installation of the bulk liquids terminal infrastructure
- Scenario 4 – Outside of standard hours works

Bulk earthworks for the infrastructure is expected to include cut and fill, drainage, geotechnical preperation for the establishment of the facility area. The establishment of foundations is expected to include piling for foundations, concreting and formwork. The third scenario will included the delivery of equipment and assembly of site structures, buildings and plant.

The final scenario represents the works that will occur outside of standard hours. Further detail is provided in **Section 6.2.2**.

Table 6.1 presents a summary of the construction noise scenarios. All of the scenarios were assessed under the ICNG.

Table 6.1: Construction Noise Scenarios

Scenario	Description	NCA	Criteria L_{Aeq},15min dB(A)
1	Earthworks	A	51
2	Foundations	B	58
3	Assembly	C	61
4	Outside of Standard Hours Works	A	46
		B	53
		C	56

6.2 Construction Noise Assessment

6.2.1 Noise Modelling Methodology

Construction noise levels were predicted for the original construction scenario using the noise model approach described in **Section 4.1.1**.

6.2.2 Modelling Scenarios

6.2.2.1 Standard Hours

The primary construction phases will occur over three scenarios, earthworks, foundations and assembly. It is anticipated civil earthworks will level the existing ground before foundations can be prepared for the equipment and storage tanks. The third phase of construction will involve the assembly of tank and pipework infrastructure.

6.2.2.2 Outside of Standard Hours

Some of the construction activities will be completed outside of standard hours. These include:

- Transport of large items such as pre-fabricated switchrooms, pre-fabricated tanks, and other large OEM equipment such as the Marine Loading Arms.
- Electrical outages to connect transformers and electrical infrastructure.
- Rigging and preparation for heavy crane lifts.

These activities will be completed outside of standard hours for logistical and safety reasons. The rigging operation will ensure that lifts can be undertaken in the early hours of the morning to avoid winds and unsafe lifting conditions.

These activities occurring outside of standard hours have been modelled to occur simultaneously and at 100% utilisation, representing the worst-case scenario.

Table 6.2 summarises the construction scenarios that were modelled.

Table 6.2: Modelled Construction Scenarios

Construction Phase	Construction Scenario
Earthworks	1
Foundations	2
Assembly	3
Outside of Standard Hours Works	4

Table 6.3 presents a summary of the indicative equipment fleet which has been used in each modelling scenario across the construction phase.

Table 6.3: Indicative Construction Fleet

Construction Fleet	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Excavator	-	2	2	-
Roller	2	-	-	-
Grader	1	-	-	-
Concrete Truck & Pump	-	2	-	-
Concrete Mixer	-	2	-	-
Pile Driving Rig	-	2	-	-
Crane	-	2	2	1
Hand Tools	-	6	6	2
Welder	-	2	-	-
Generator	-	3	3	-
Heavy Vehicle Access	1	1	1	3
Light Vehicles	3	3	3	3
Heavy Vehicle Idling	2	2	2	2

6.2.3 Construction Sound Power Levels

Sound power levels for plant used in construction are taken from Pacific Environment measurements, the UK DEFRA construction noise database and the British Standards 5228.

The sound power levels for construction equipment are presented in **Table 6.4.**

Table 6.4: Construction Equipment Sound Power Levels, dB(A)

Construction Fleet	Sound Power Level, L_{Aeq} dB(A)
Excavator	100
Roller	103
Grader	107
Concrete Truck & Pump	103
Concrete Mixer	105
Pile Driving Rig	115
Crane	98 / 103
Hand Tools	98
Welder	101
Generator	102
Heavy Vehicle	104
Light Vehicles	85
Heavy Vehicle Idling	89

6.2.4 Construction Noise Modelling Results and Assessment

Full predicted noise levels for construction scenarios are presented in **Appendix D**. **Table 6.5** and **Table 6.6** show the noise modelling results for receivers in scenario 1, 2, 3 and 4 at the most affected receiver locations across all Noise Catchment Areas.

Noise levels were predicted under the meteorological condition identified in **Table 4.1**. The results show that for all construction scenarios, the anticipated noise level at the most sensitive receivers will be below the criteria goals.

Further, no receivers are predicted to be highly noise affected (noise levels of 75 dB(A) or above) for any of the construction scenarios modelled.

Table 6.5: Predicted Construction Noise – Scenarios 1, 2 and 3

Receiver ID	Receiver Type	Criteria $L_{Aeq,15min}$ dB(A)	Predicted Noise Level $L_{Aeq,15min}$ dB(A)		
			Scenario 1	Scenario 2	Scenario 3
NCA A					
5	Residence	51	23	30	21
NCA B					
16	Residence	58	27	34	26
18	School	55	27	34	26
20	School	55	29	37	27
NCA C					
21	Passive Recreation Area	60	29	36	27
24	Residence	61	28	35	26
27	Place of Worship	55	25	31	23
36	Residence	61	27	34	25
40	Commercial	65	31	39	30
42	Active Recreation Area	65	37	45	35
43	Active Recreation Area	65	35	45	34

Table 6.6: Predicted Construction Noise – Scenarios 4 (outside standard hours)

ID	Receiver Type	Criteria $L_{Aeq,15min}$ dB(A)	Criteria L_{Amax} dB(A)	Predicted Noise Level $L_{Aeq,15min}$ dB(A) L_{Aeq} (Neutral)	L_{Amax} (Neutral)	L_{Aeq} (NE wind)	L_{Amax} (NE wind)	L_{Aeq} (E wind)	L_{Amax} (E wind)	L_{Aeq} (SE wind)	L_{Amax} (SE wind)
NCA A											
5	Residence	46	50	20	33	26	39	26	39	26	39
NCA B											
16	Residence	53	50	24	37	24	37	30	42	30	42
NCA C											
36	Residence	56	50	24	37	20	32	20	32	30	42

6.3 Construction Vibration Assessment

The methodology contained in the USA's Federal Transit Administration *Noise and Vibration Impact Assessment Manual*, (**FTA Manual, 2006**) as recommended in *Assessing Vibration a Technical Guideline*, was used to predict vibration levels of plant at a range of distances. Vibration source levels were taken from the ENMM and the FTA Manual. **Table 6.7** presents a summary of the predicted levels.

Table 6.7: Predicted Vibration Levels

Item[1,2]	Guideline Levels (mm/s)[3] Industrial	Residential	Sensitive	Predicted Vibration Level PPV mm/s at Distance (m) 5	10	20	30	40	50
Pile Driving Rig	20	5	3	-	-	3.6	-	-	2.0
Vibratory Roller (15t)				23	8	2.8	1.5	1.0	0.7

Note: 1. Vibration source levels taken from Section 9 of ENMM. Predictions are indicative only and will vary depending on specific type of plant and geotechnical conditions.
2. Piling source level from BS5228-2:2009 driving through made ground.
3. Criteria presented are the most stringent criteria from DIN 4150-3

The results indicate that vibration from construction activities will have no significant impact at nearest sensitive receivers to the construction activity.

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7 ROAD TRAFFIC NOISE

7.1 Introduction

Based on the information provided to Pacific Environment by TQ Holdings Australia, the Project related roads which could potentially generate significant additional traffic noise at residences are:

- Masters Road
- Springhill Road

On Springhill Road and Masters Road the posted speed is 80 km/h.

Two scenarios have been considered a worst case construction scenario, they include;

- Stage 1 operations and Stage 2 traffic; and
- Worst case operations in Stage 3.

7.2 Project Generated Traffic

The Project is expected to generate traffic from construction and operation staff light vehicles going to and from the site and heavy vehicles taking the product off-site. **Table 7.1** presents the projected project generated traffic as number of trips.

Table 7.1: Project Daily Generated (vehicle trips)

Year	Stage 1 (operation), Stage 2 (construction)		Stage 3 (operation)	
	Day Period	Night Period	Day Period	Night Period
Light Vehicles	150	150	12	12
Heavy Vehicles	118	70	254	158

Reference: **Cardno 2015**

Light vehicle movements for employees are expected to be generated at the start and end of work shifts. Heavy vehicle movement are expected to occur at a constant rate throughout 24hr operation.

7.3 Methodology

The increase in road traffic noise levels was predicted using the Calculation of Road Traffic Noise (CoRTN).

The standard prediction procedures have been modified as follows:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CoRTN algorithms using the well-validated approximation of $L_{Aeq,1hr} = L_{A10,1hr} - 3$.
- All other factors such as distance, field of view, height of propagation and shielding were kept constant.

7.4 Traffic Volumes

The project will increase average daily heavy vehicles as per **Table 7.1**. The assessment has modelled the impact to account for the maximum number of vehicles on Springhill Road and Masters Road during the daytime and night time periods.

Table 7.2 provides a summary of the existing traffic volumes on these roads. Annual daily traffic volumes referenced from the Project Traffic Assessment (**Cardno 2015**). The proportion of light and heavy vehicles and day and night time period traffic volumes was referenced from a mid-block count undertaken for the Traffic Assessment on Springhill Road. These proportions were applied to Masters Road to estimate day/night and heavy/light traffic mix.

Table 7.2: Existing Traffic Movements

Road Section	Day time 7am – 10pm		Night time 10 pm – 7am	
	Light	Heavy	Light	Heavy
Springhill Road	45315	2385	4770	530
Masters Road	30383	2287	3267	363

Traffic volumes associated with the Project have been added to the existing traffic volumes listed and the traffic noise impacts calculated utilising the method described. No additional road network traffic growth has been included giving a conservative estimate of traffic noise increase.

7.5 Assessment

The calculated noise level and noise levels increase for each road section is listed **Table 7.3** for the day time and night time periods for each road section.

Table 7.3: Predicted Increase in Traffic Noise Levels

Road		Stage 1 Construction and Operations		Stage 3 Peak Operations	
	Distance (m)	Day Period (dB)	Night Period (dB)	Day Period (dB)	Night Period (dB)
Springhill Road	240	0.2	0.9	0.2	0.8
Masters Road	140	0.2	0.9	0.1	0.9

A review of **Table 7.3** shows that the predicted worse case in total traffic noise level increases as a result of the Project for the maximum anticipated traffic flow scenario will increase existing levels by less than 1 dB which is within the 2dB(A) increase criteria.

8 NOISE MANAGEMENT

Noise management is required to ensure that the Project operates within the criteria and to reduce the potential for increased noise emissions to occur. A Noise Management Plan should be developed for operation of the facility.

8.1 Construction Noise Management

Construction noise for the earthworks and other construction activities should be effectively managed to minimise potential impacts. This would include development of noise and vibration management requirements within a Construction Environmental Management Plan (CEMP) prior to commencement of works onsite. This would utilise more detailed information in relation to the proposed construction methodology, activities, durations and equipment type and numbers. It is envisaged that the CEMP would consider the following at a minimum:

- The nearby residences and other sensitive land uses.
- The noise management levels identified in this assessment.
- Address the potential impact from the proposed construction methods.
- Develop reactive and proactive strategies for dealing with any noise complaints.
- Identify a site contact person to follow up complaints.

8.2 Road Traffic Noise Management

The road traffic assessment did not identify any exceedance of the increase to the existing traffic noise levels. However in order to manage noise from road traffic associated with the Project, road traffic noise management should be included as part of CEMP as well as an Operational Environmental Management Plan (OEMP). These management plans would identify the related routes associated with the Project, including Springhill Road and Masters Road and Tom Thumb Road.

Measures to assist in the management of road traffic noise should include staff and contractor education and training of road traffic noise impacts. The education should include educating drivers on appropriate driving behaviours to minimise noise generation. This would include adhering to posted speed limits and avoiding aggressive acceleration and driving styles.

9 CONCLUSION

An assessment of noise and vibration impacts from the Project has been conducted. The assessment was conducted with reference to the SEARs and other relevant agency's requirement according to current guidelines, standards and assessment methods.

In relation to operational noise, the assessment indicated the following:

- There are no exceedances of noise criteria predicted.
- There is not anticipated to be impacts on receivers from low frequency noise.

For construction noise and vibration, the assessment considered four construction scenarios including civil earthworks, establishment of foundations, assembly of plant infrastructure and outside of standard hours works. It is predicted that there will be no sensitive receivers exceeding the ICNG criteria and therefore the impacts are considered negligible.

No receivers are predicted to be highly noise affected (noise levels of 75 dB(A) or above) for any of the construction scenarios.

The road traffic noise assessment indicated that the majority of project related traffic is expected on Springhill Road and Masters Road. The assessment indicated that increases in traffic noise would be below the traffic noise increase criteria of 2 decibels.

Noise management measures were recommended which included the development of a noise management plan within the CEMP and OEMP.

10 REFERENCES

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Appendix A RECEIVER DETAIL

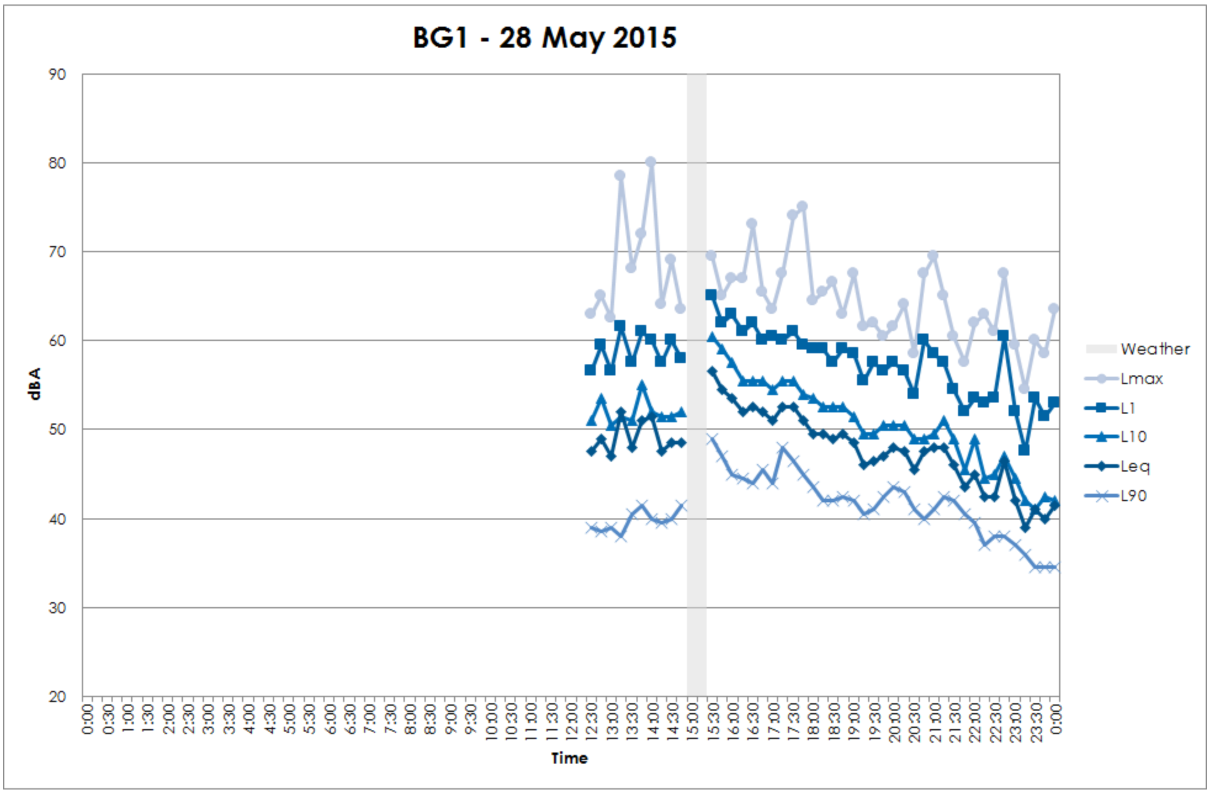
Table A.1: Summary of Sensitive Receivers

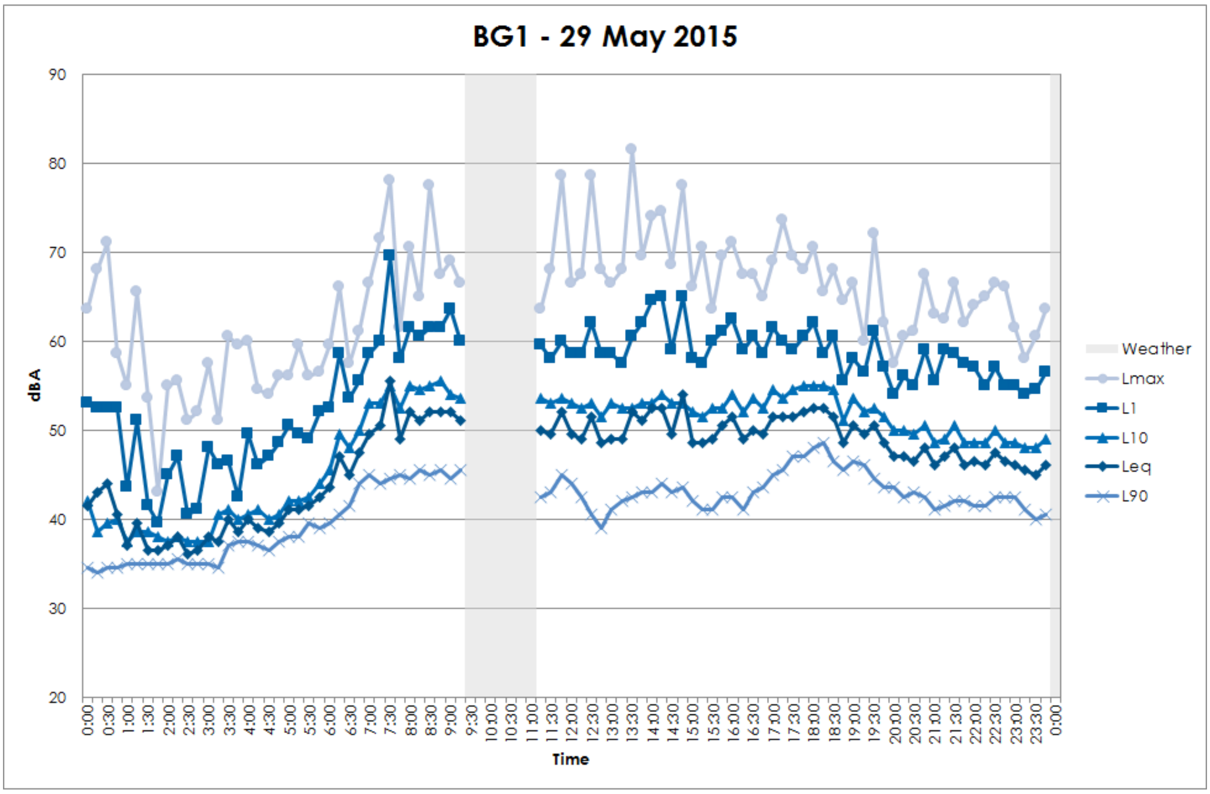
Noise Catchment Area	Sound Receiver ID	Type	Address	Easting (m)	Northing (m)
A (residential)	SR1	Residence	352 Gladstone Ave, Mt St Thomas	304103	6186718
	SR2	Residence	84 Taronga Ave, Mt St Thomas	304259	6186650
	SR3	Residence	326 Gladstone Ave, Mt St Thomas	304393	6186649
	SR4	Residence	310 Gladstone Ave, Mt St Thomas	304496	6186667
	SR5	Residence	290 Gladstone Ave, Mt St Thomas	304598	6186681
	SR6	Residence	272 Gladstone Ave, Mt St Thomas	304694	6186695
B	SR7	Residence	248 Gladstone Ave, Mt St Thomas	304887	6186727
	SR8	Residence	228 Gladstone Ave, Mt St Thomas	305031	6186763
	SR9	Residence	Lot 16 Gladstone Ave, Mt St Thomas	305253	6186878
	SR10	Residence	139 Gladstone Ave, Mt St Thomas	305284	6186853
	SR11	Residence	133 Gladstone Ave, Mt St Thomas	305335	6186889
	SR12	Residence	176 Gladstone Ave, Coniston	305336	6186952
	SR13	Residence	119 Gladstone Ave, Coniston	305371	6186929
	SR14	Residence	109 Gladstone Ave, Coniston	305432	6186979
	SR15	Residence	160 Gladstone Ave, Coniston	305406	6187023
	SR16	Residence	146A Gladstone Ave, Coniston	305520	6187088
	SR17	Residence	140 Gladstone Ave, Coniston	305564	6187145
	SR18	School	Cedars Christian College	305482	6187227
	SR19	Commercial	Coniston Train Station	305701	6187237
	SR20	School	Coniston Public School	305898	6187146
	SR21	Passive Recreation Area	Coniston Cemetery	306183	6187197
	SR22	Residence	147 Kenny St, Coniston	306191	6187294
	SR23	Residence	135 Kenny St, Coniston	306199	6187387
	SR24	Residence	392 Keira St, Coniston	306248	6187287

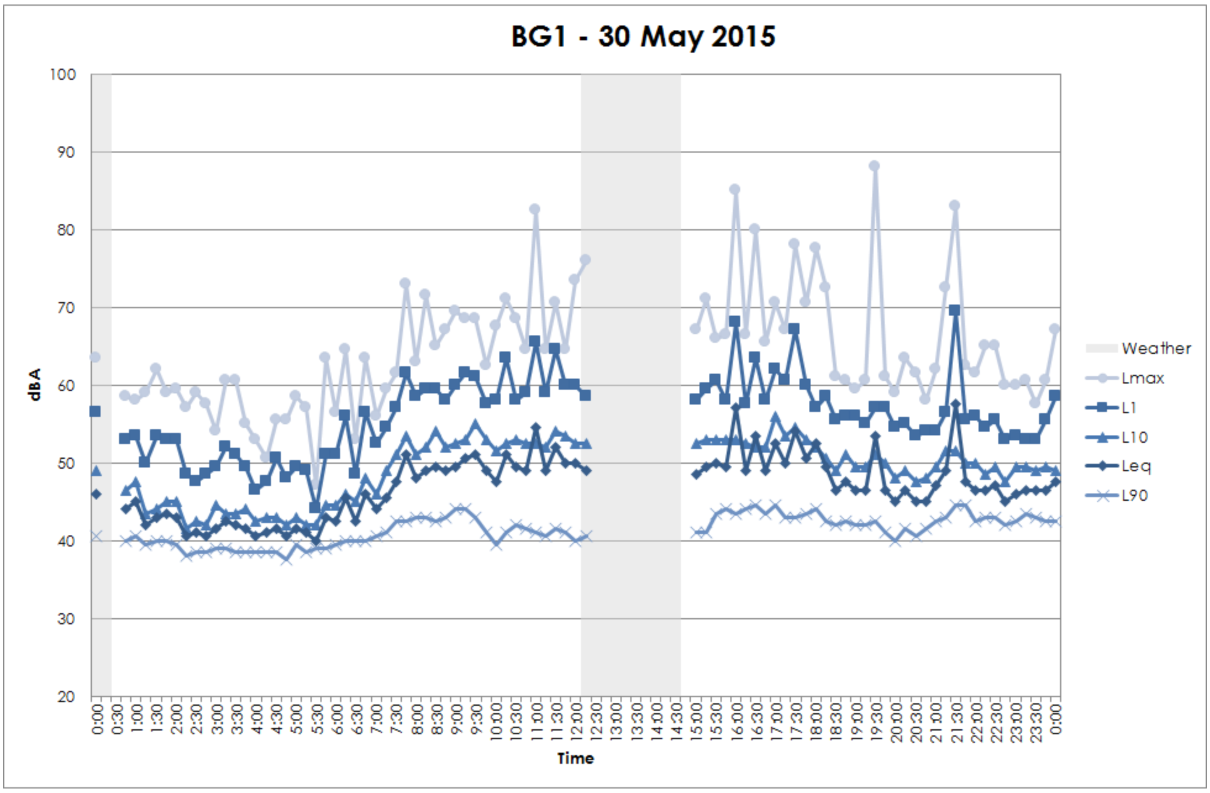
Noise Catchment Area	Sound Receiver ID	Type	Address	Easting (m)	Northing (m)
C	SR25	Residence	372 Keira St, Coniston	306269	6187438
	SR26	Residence	362 Keira St, Coniston	306280	6187515
	SR27	Place of Worship	Wollongong Baptist Church	306330	6187818
	SR28	Residence	46 Swan St, Wollongong	306348	6187570
	SR29	Commercial	215 Church St, Wollongong	306457	6187552
	SR30	Commercial	38 Swan St, Wollongong	306497	6187546
	SR31	Residence	93 Evans St, Wollongong	306549	6187541
	SR32	Residence	168 Kembla St, Wollongong	306639	6187527
	SR33	Commercial	34 Swan St, Wollongong	306701	6187520
	SR34	Commercial	JJ Kelly Park	306704	6187439
	SR35	Commercial	Lot 1 Swan St, Wollongong	306805	6187502
	SR36	Residence	179 Corrimal St, Wollongong	306867	6187491
	SR37	Commercial	16 Swan St, Wollongong	306946	6187480
	SR38	Commercial	Wollongong Golf Club	306984	6187558
	SR39	Active Recreation Area	JJ Kelly Park	306429	6187160
	SR40	Commercial	Wollongong Heliport	306697	6187016
A (recreation area)	SR41	Active Recreation Area	Wollongong Golf Course	306837	6186991
	SR42	Active Recreation Area	Wollongong Golf Course	306950	6186563
	SR43	Active Recreation Area	Wollongong Greenhouse Park	306632	6186758

Appendix B NOISE MONITORING

B.1 BACKGROUND LOCATION 1



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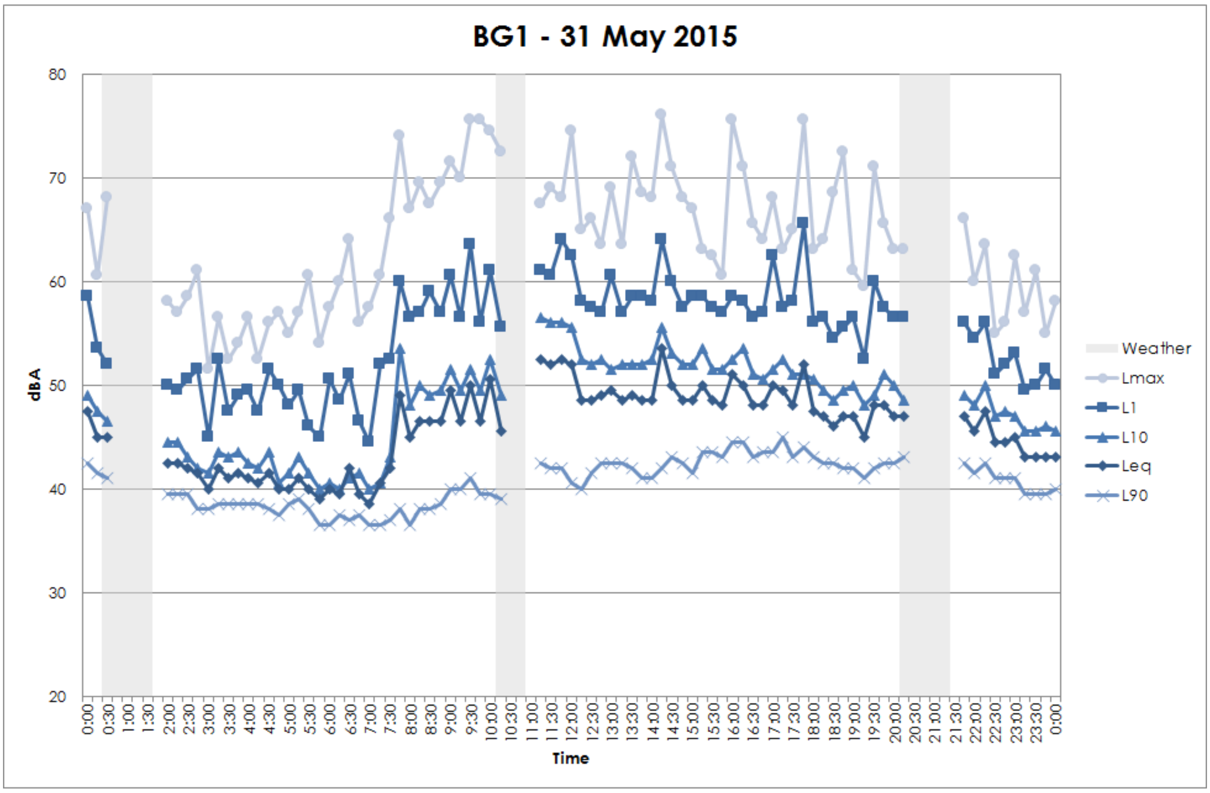
dBA
Time
Weather
Lmax
L1
L10
Leq
L90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Time
Weather
Lmax
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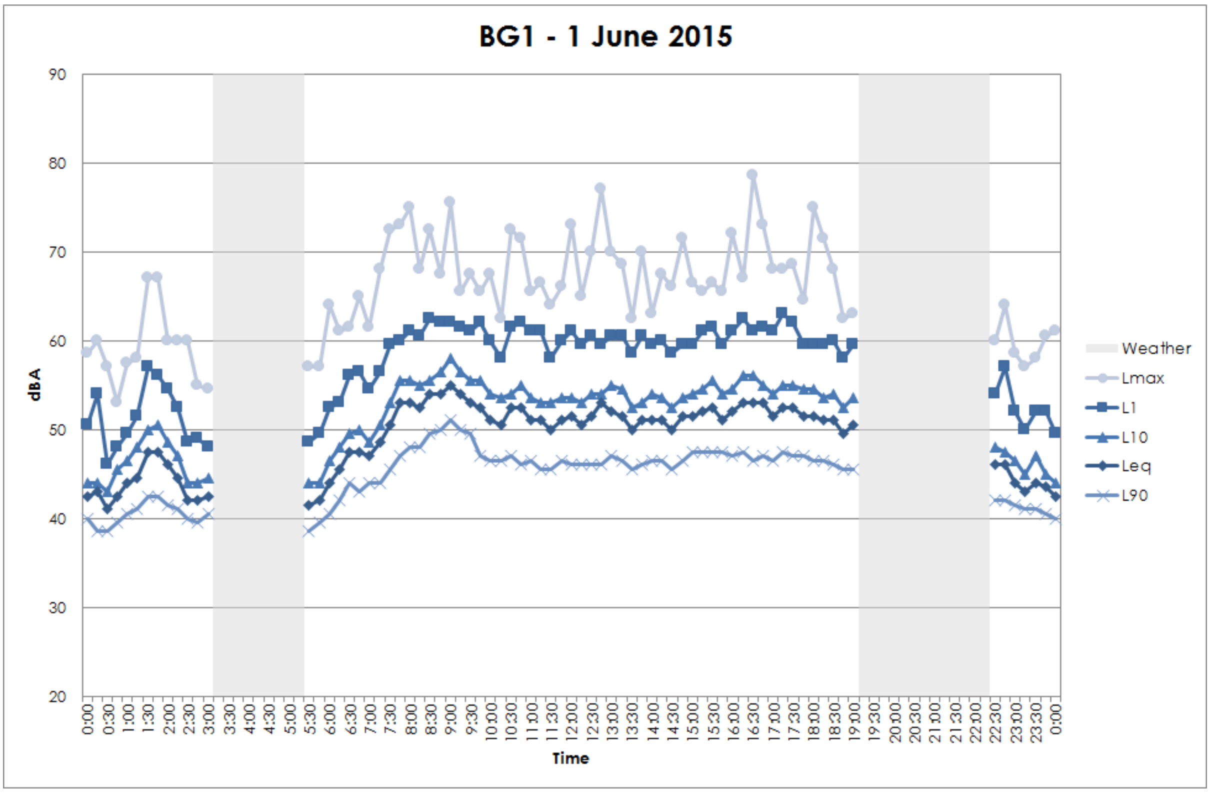
L90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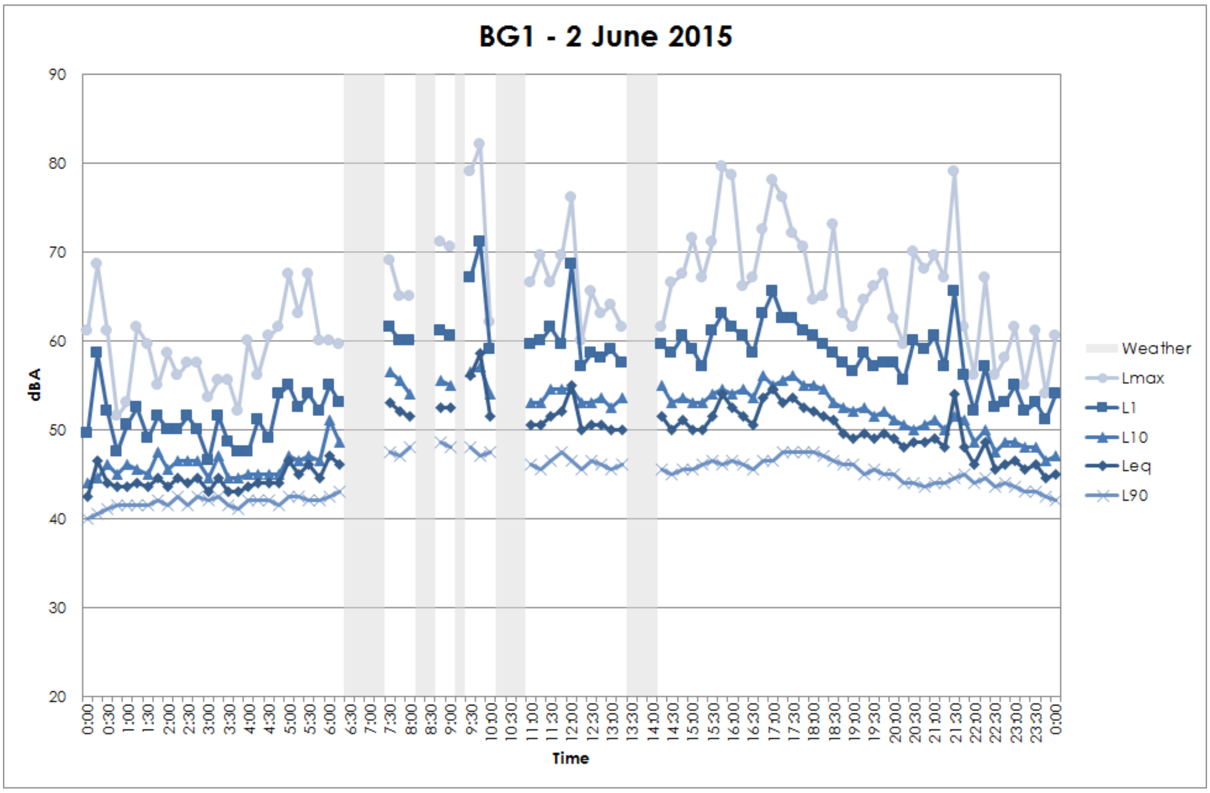
80
70
60
50
40
30
20
dBA
Time
Weather
Lmax
L1
L10
Leq
L90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40
30
20
dBA
Time
Weather
Lmax
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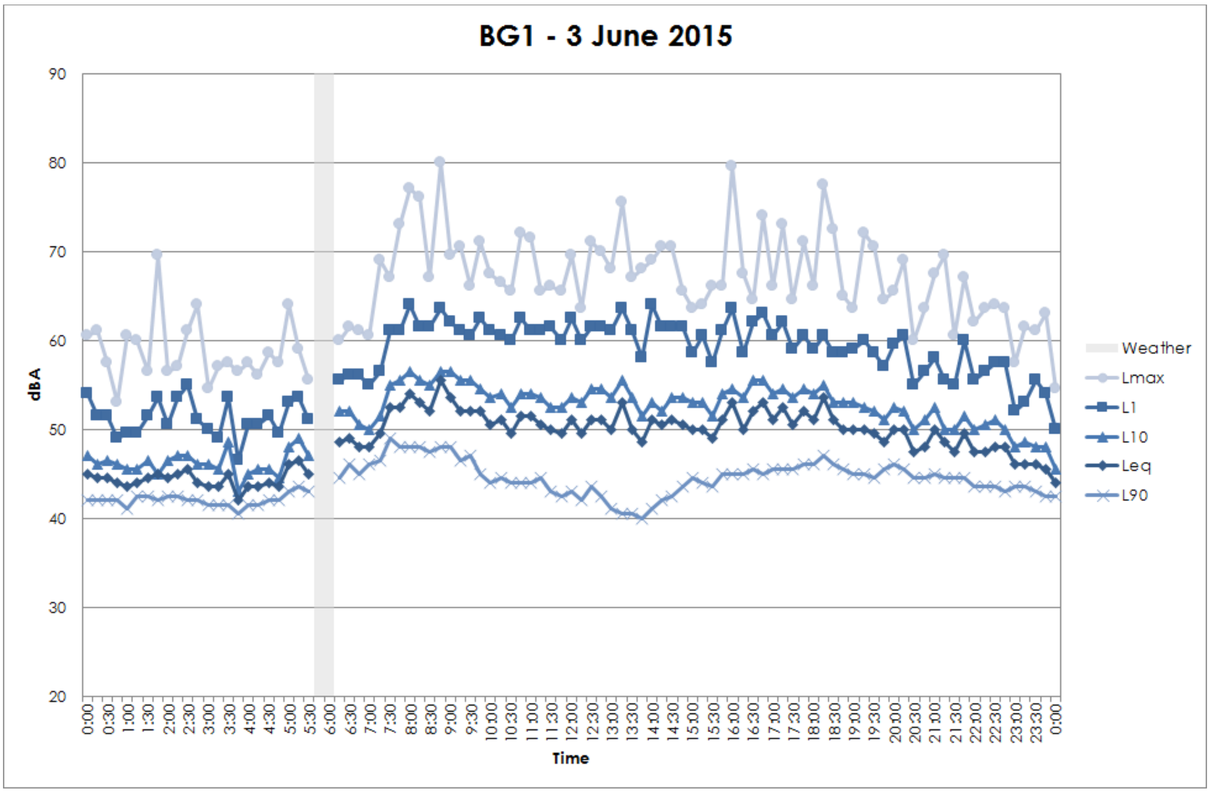
L10
Leq
L90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20
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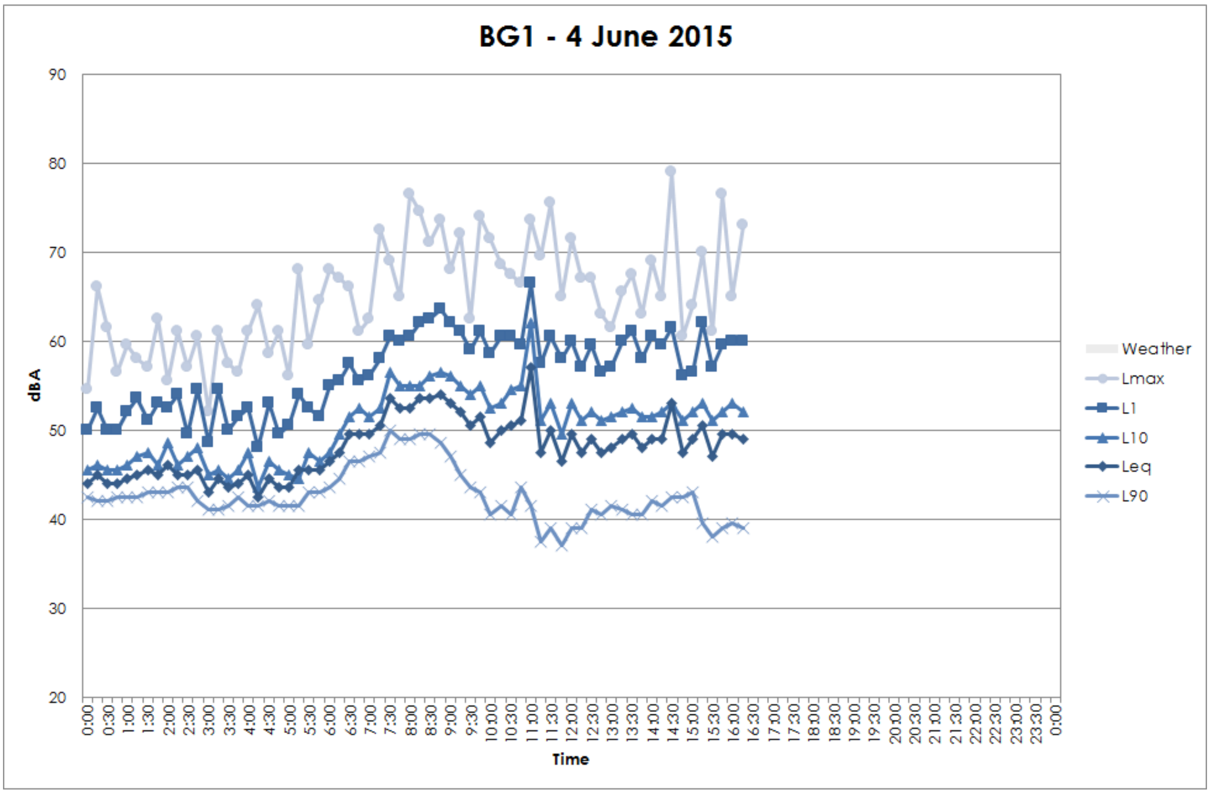
Time
Weather
Lmax
L1
L10
Leq
L90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30
20
dBA
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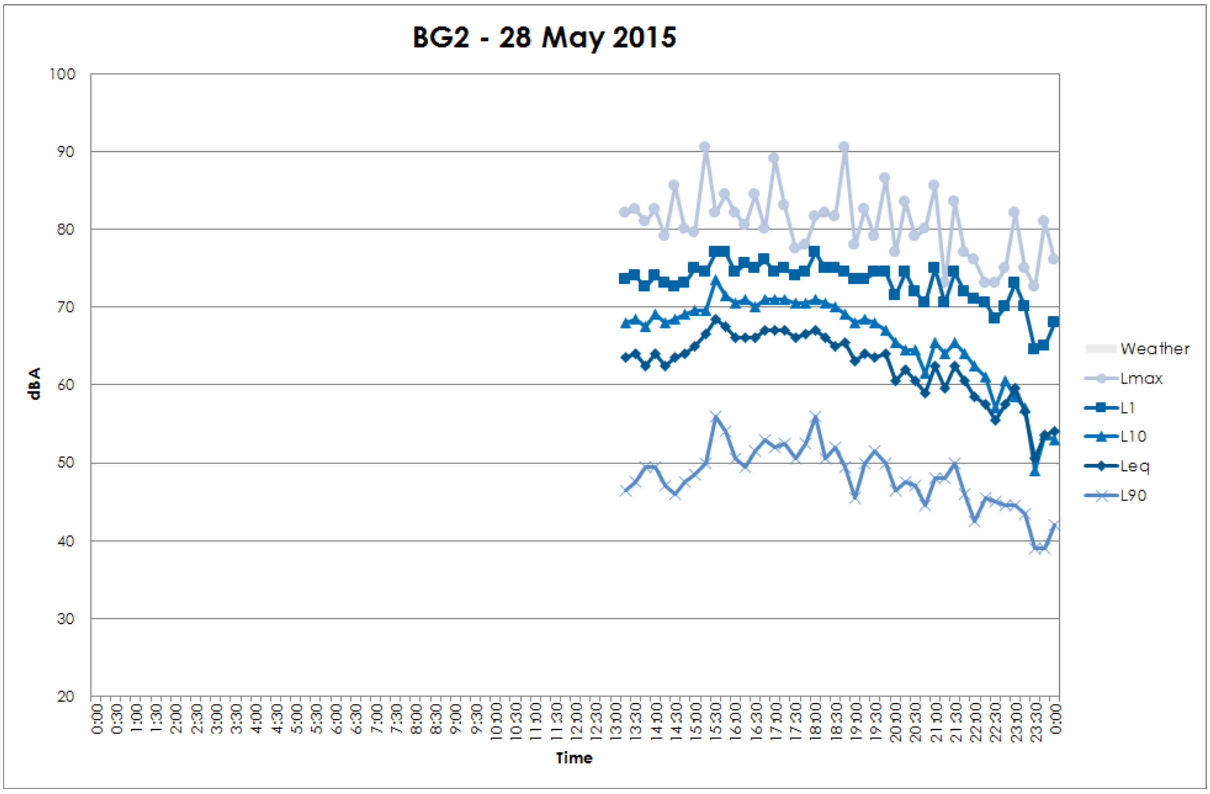
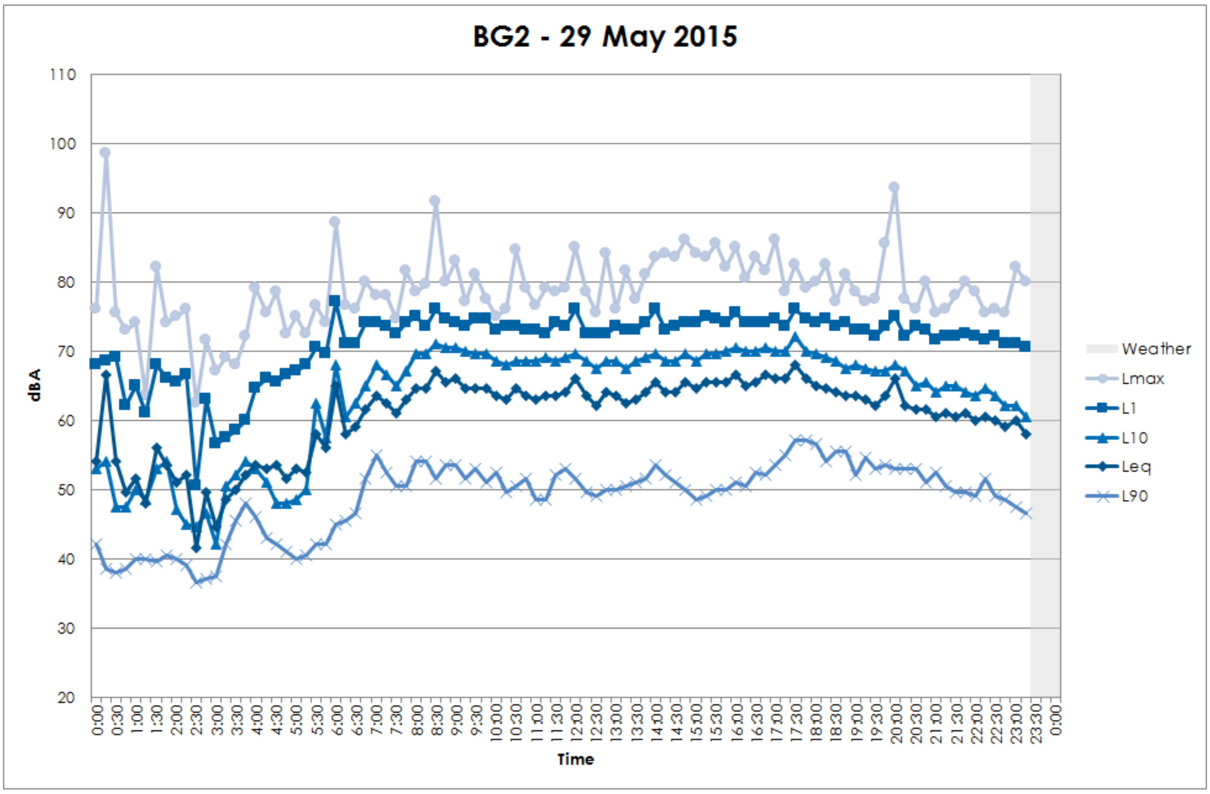
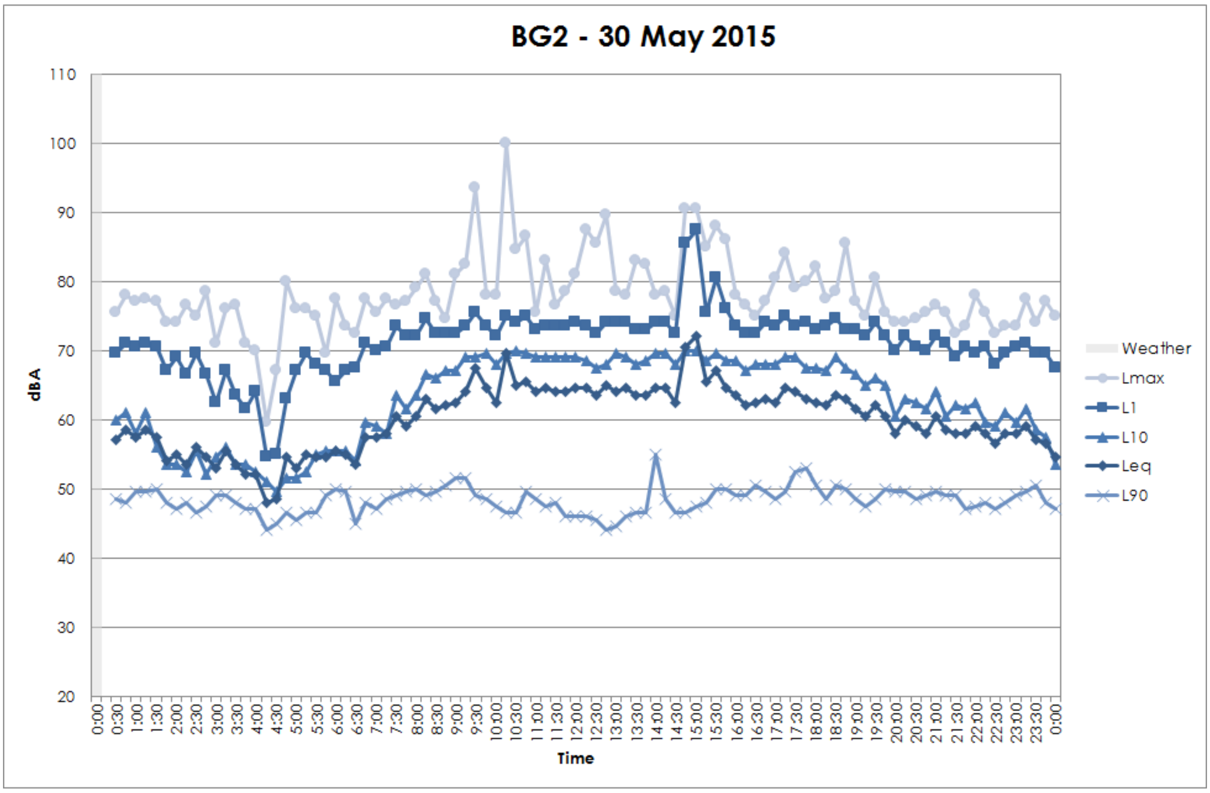
Time
Weather
Lmax
L1
L10
Leq
L90

B.2 BACKGROUND LOCATION 2



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dBA
Time
Weather
Lmax
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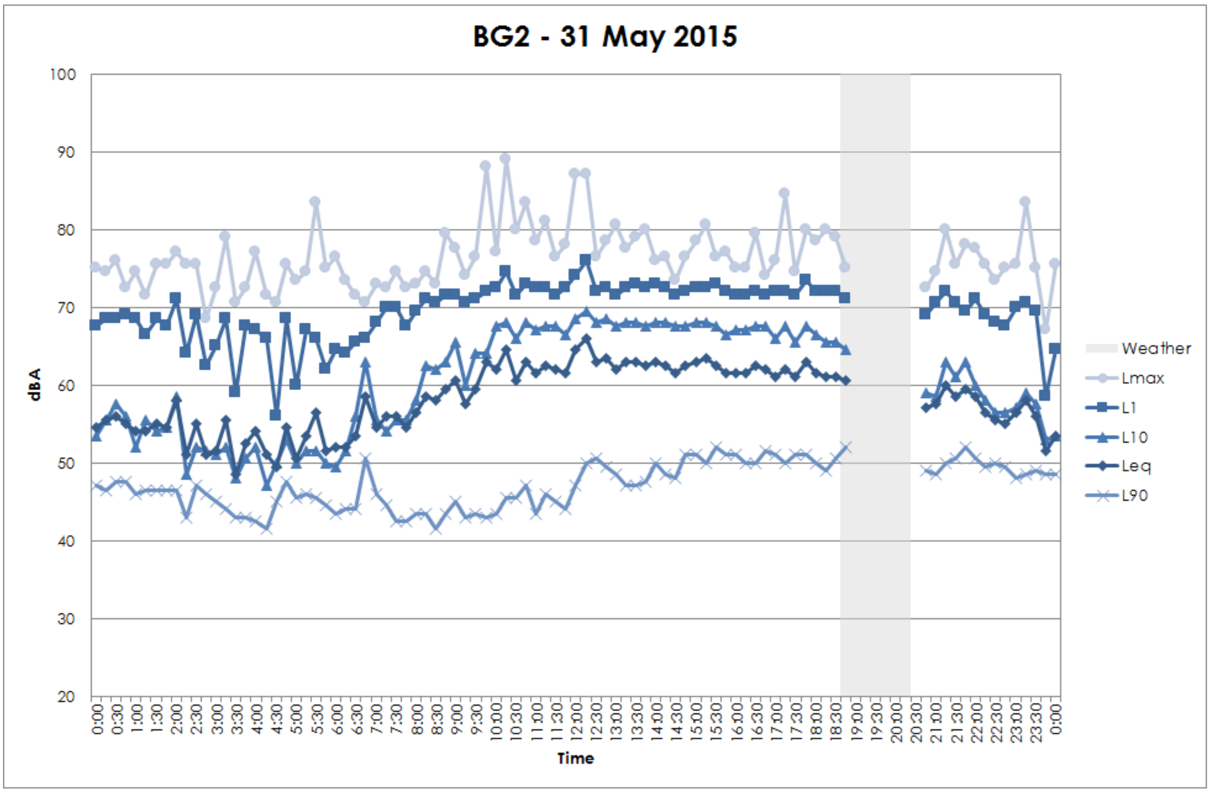
L10
Leq
L90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dBA
Time
Weather
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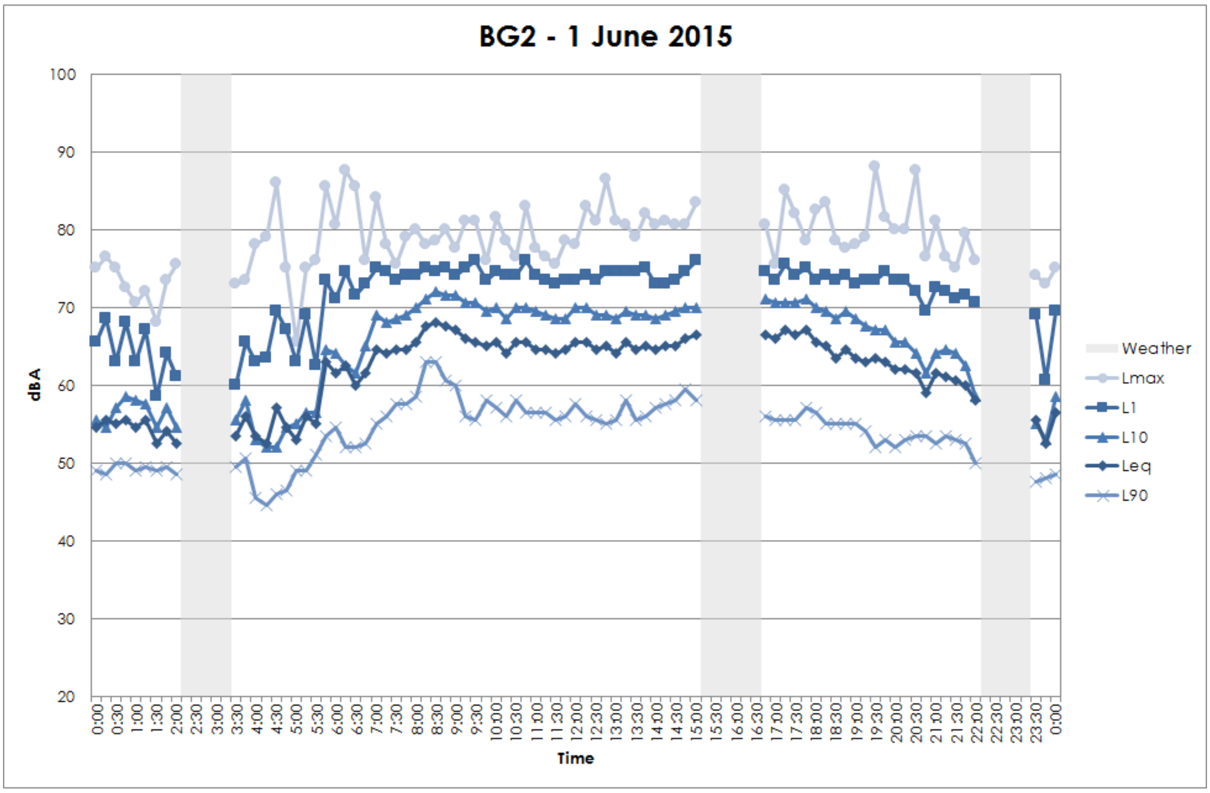
L10
Leq
L90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50
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30
20
dBA
Time
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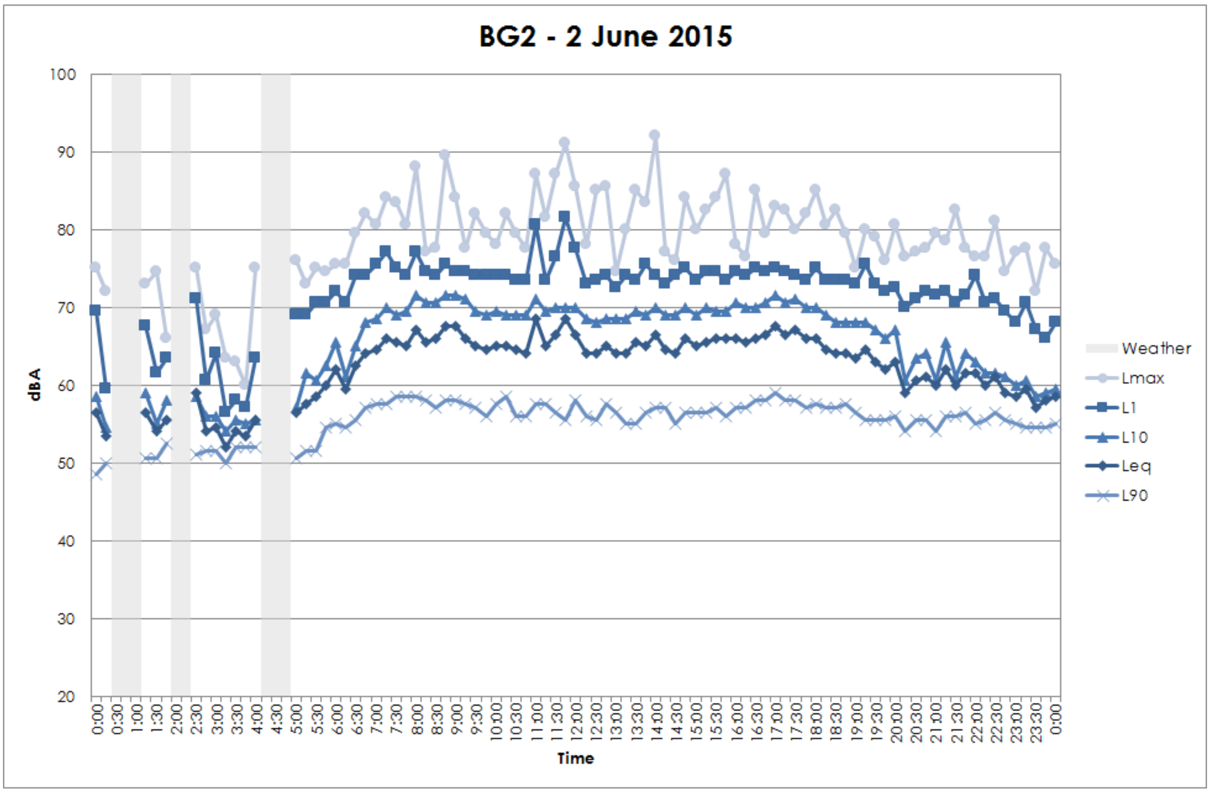
Weather
Lmax
L1
L10
Leq
L90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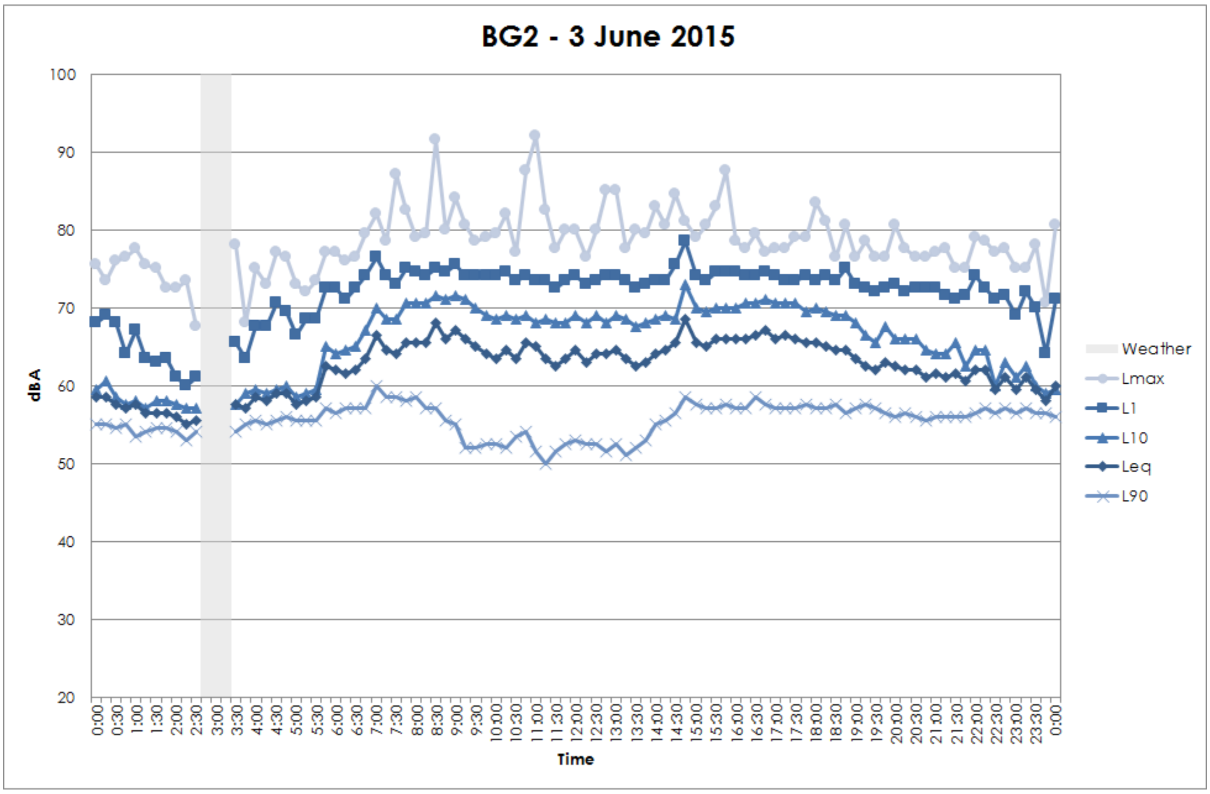
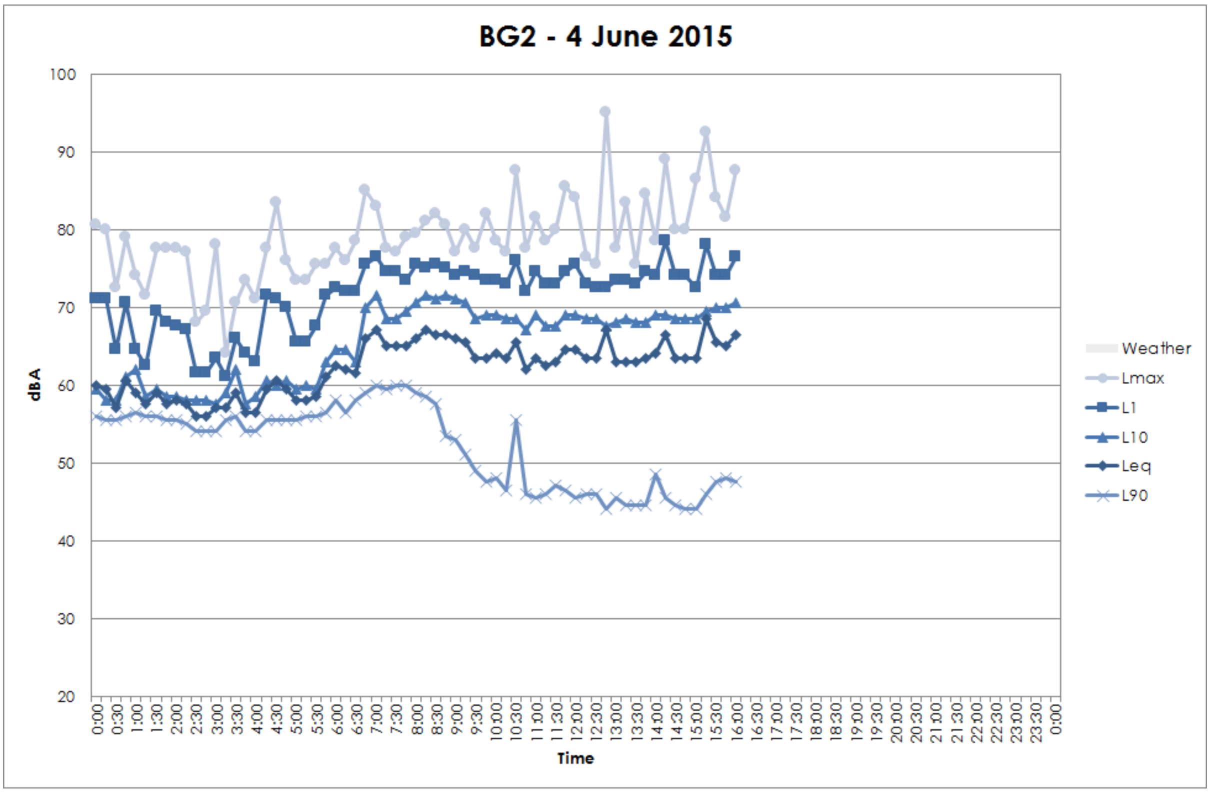
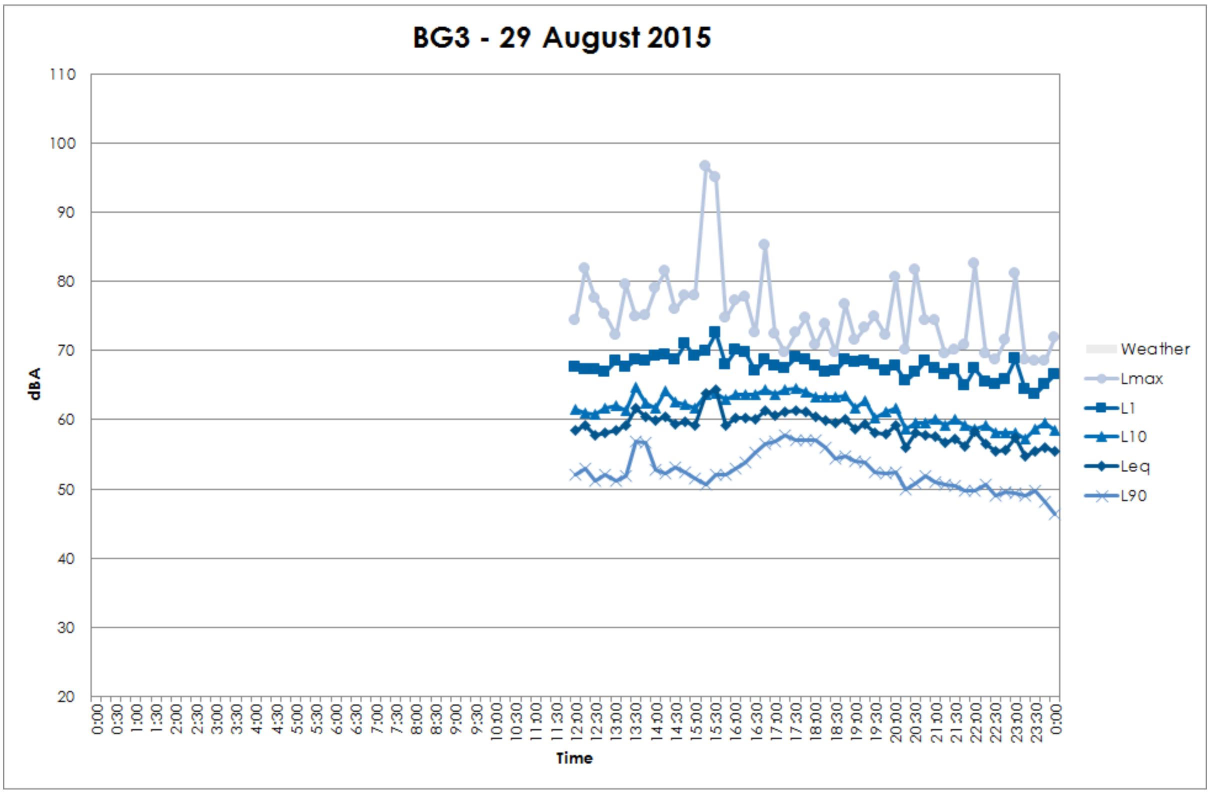
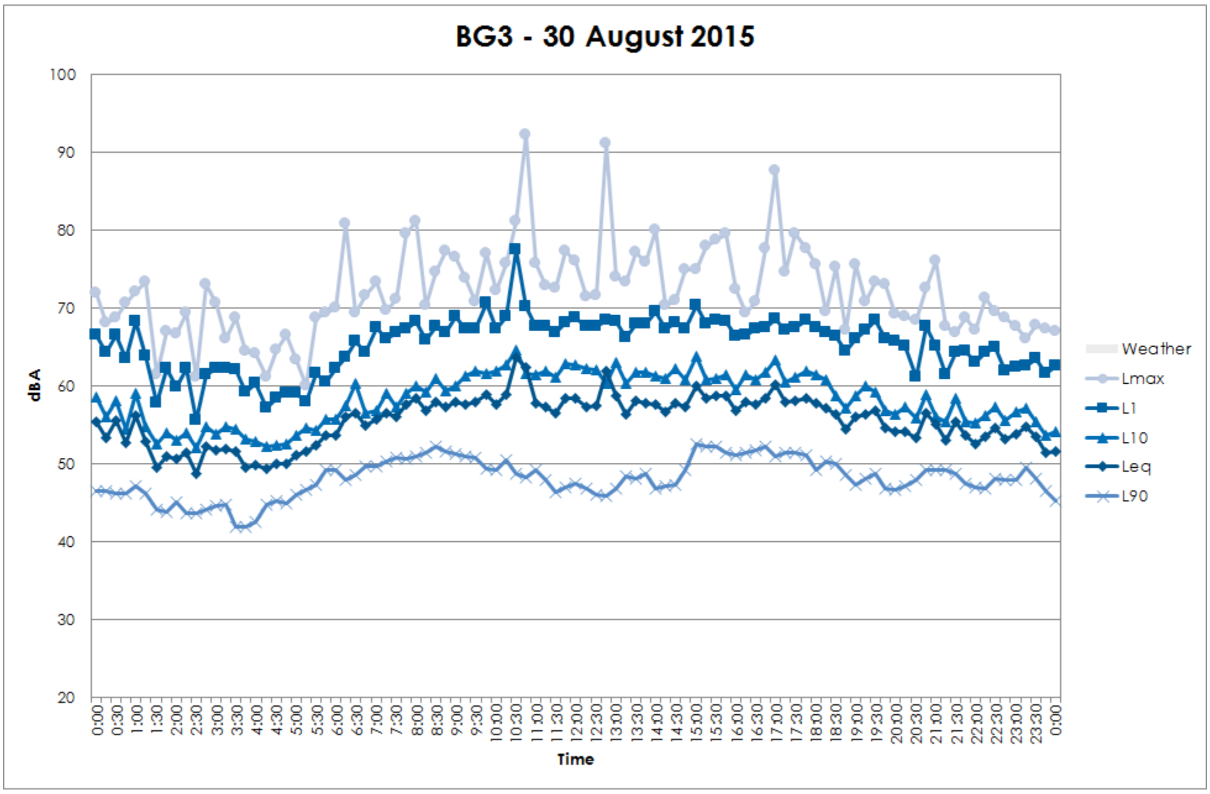
30
20
dBA
Time
0:00 0:30 1:00 1:30 2:00 2:30 3:00 3:30 4:00 4:30 5:00 5:30 6:00 6:30 7:00 7:30 8:00 8:30 9:00 9:30 10:00 10:30 11:00 11:30 12:00 12:30 13:00 13:30 14:00 14:30 15:00 15:30 16:00 16:30 17:00 17:30 18:00 18:30 19:00 19:30 20:00 20:30 21:00 21:30 22:00 22:30 23:00 23:30 0:00
Weather
Lmax
L1
L10
Leq
L90

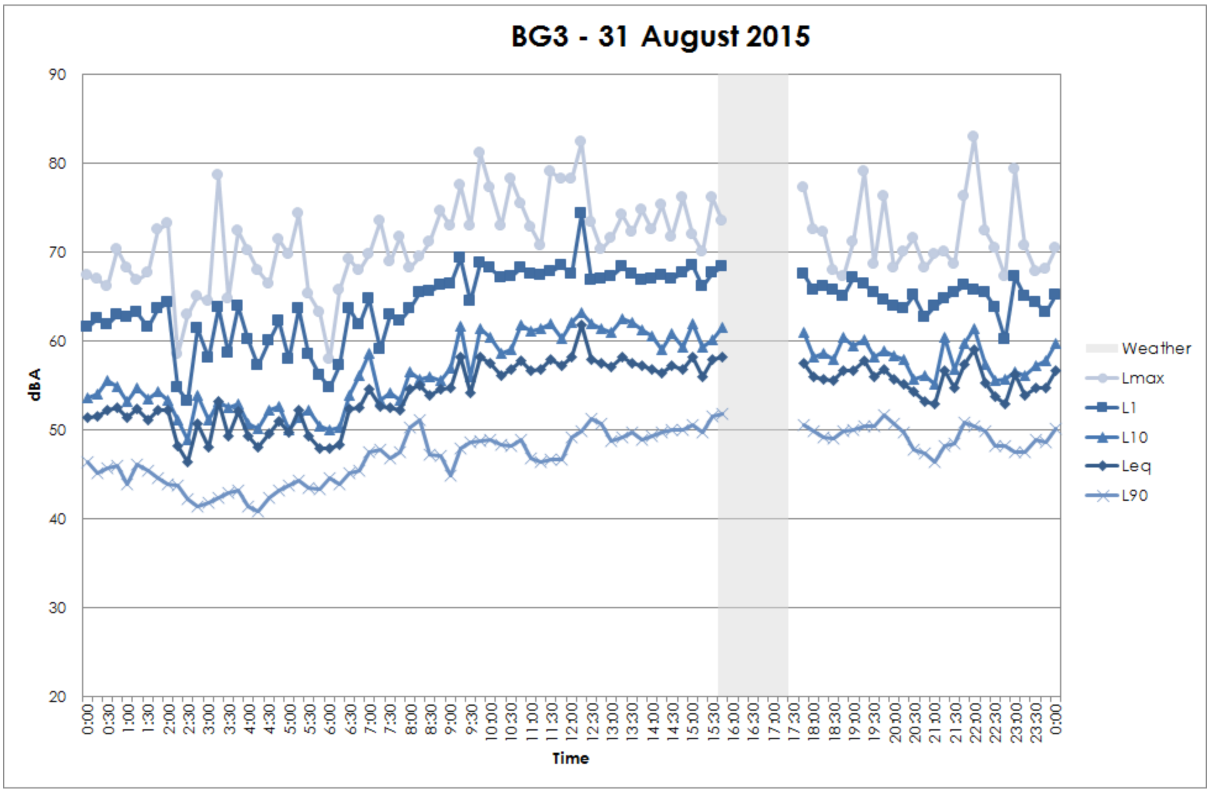

BG2 - 3 June 2015
dBA
Time
Weather
Lmax
L1
L10
Leq
L90


BG2 - 4 June 2015
dBA
Time
Weather
Lmax
L1
L10
Leq
L90

B.3 BACKGROUND LOCATION 3






BG3 - 31 August 2015
dBA
Time
Weather
Lmax
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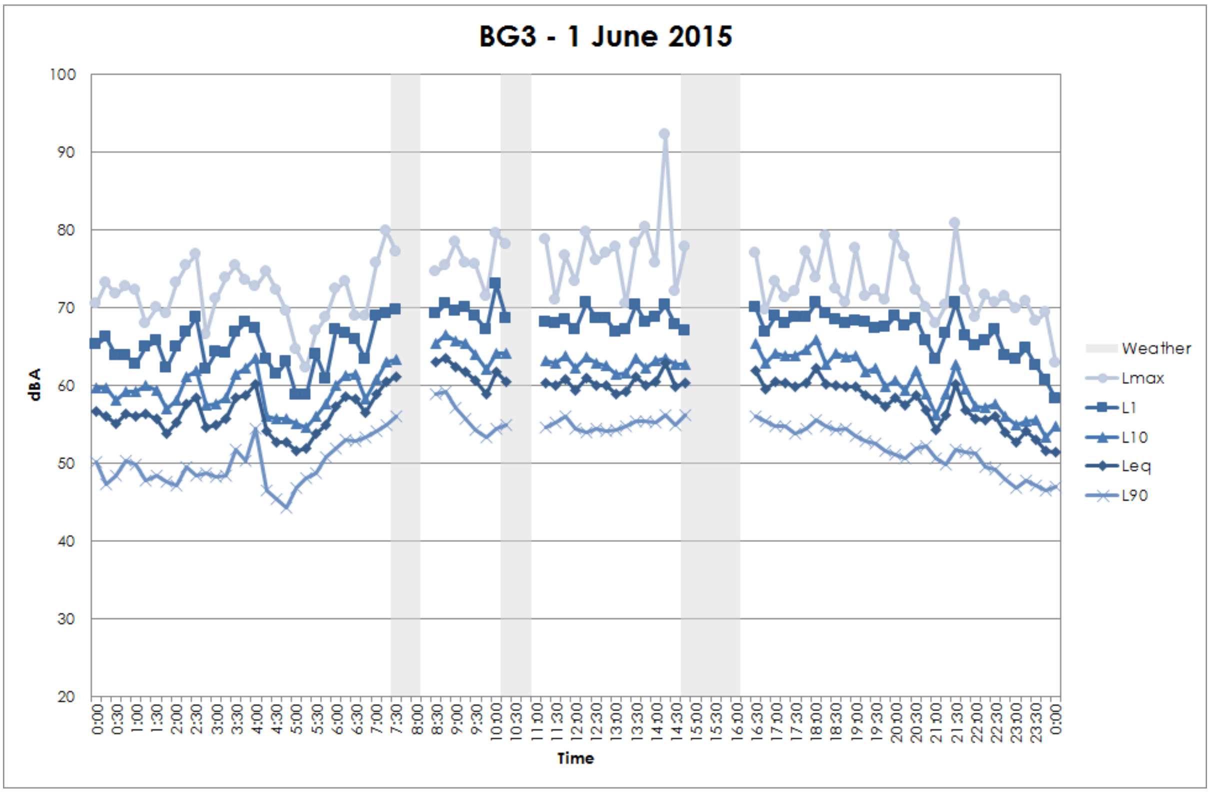
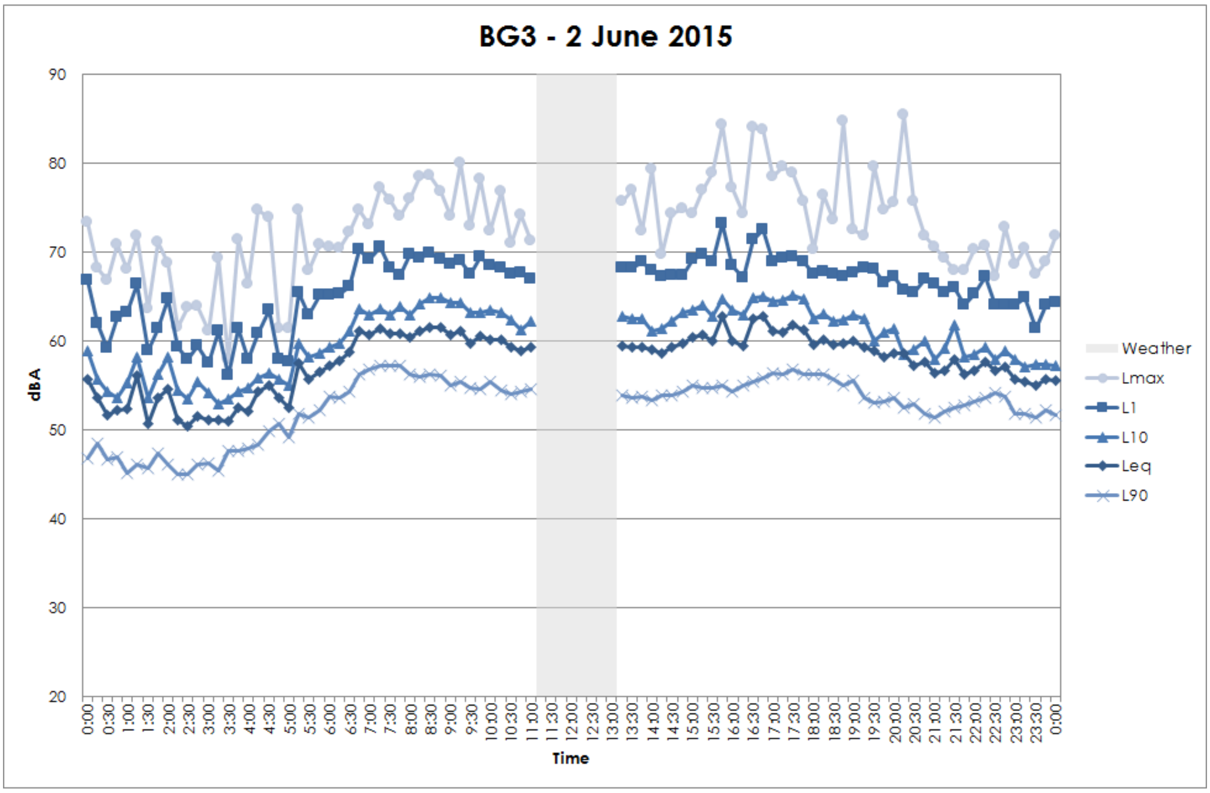
L10
Leq
L90


BG3 - 1 June 2015
dBA
Time
Weather
Lmax
L1
L10
Leq
L90


BG3 - 2 June 2015
dBA
Time
Weather
Lmax
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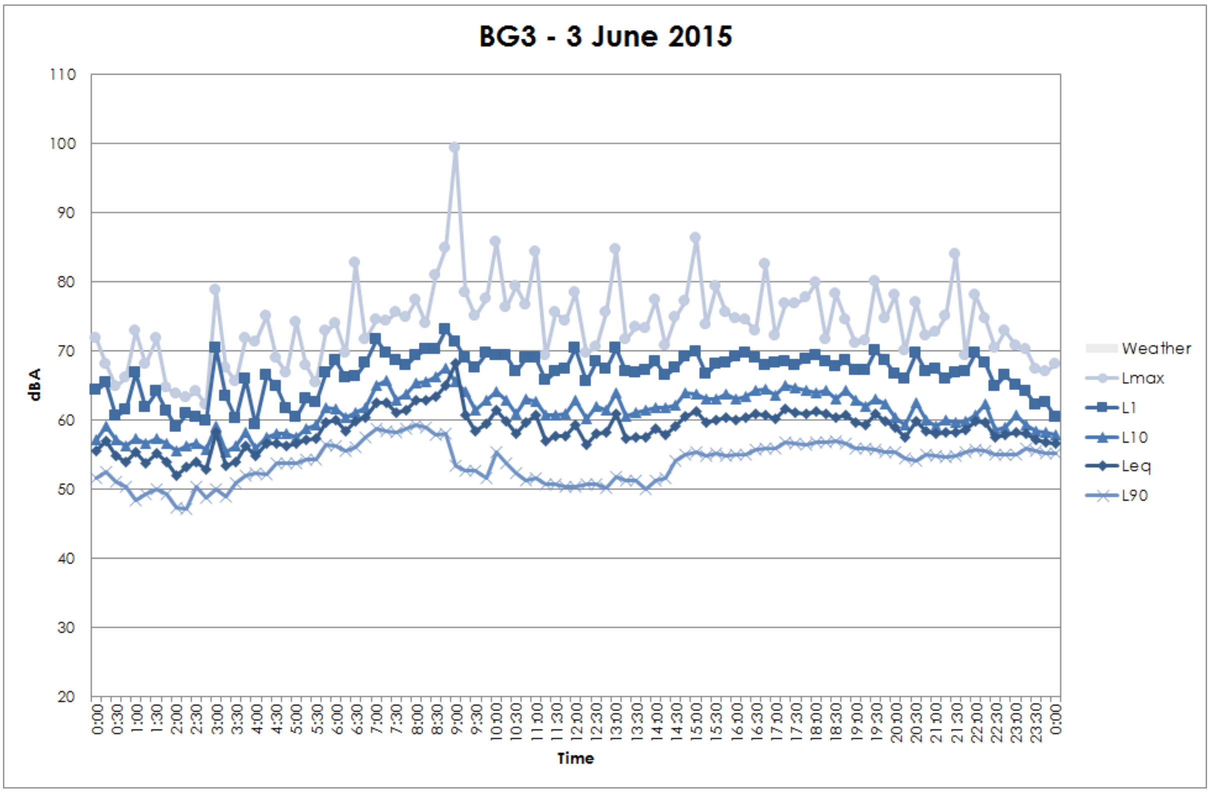
L10
Leq
L90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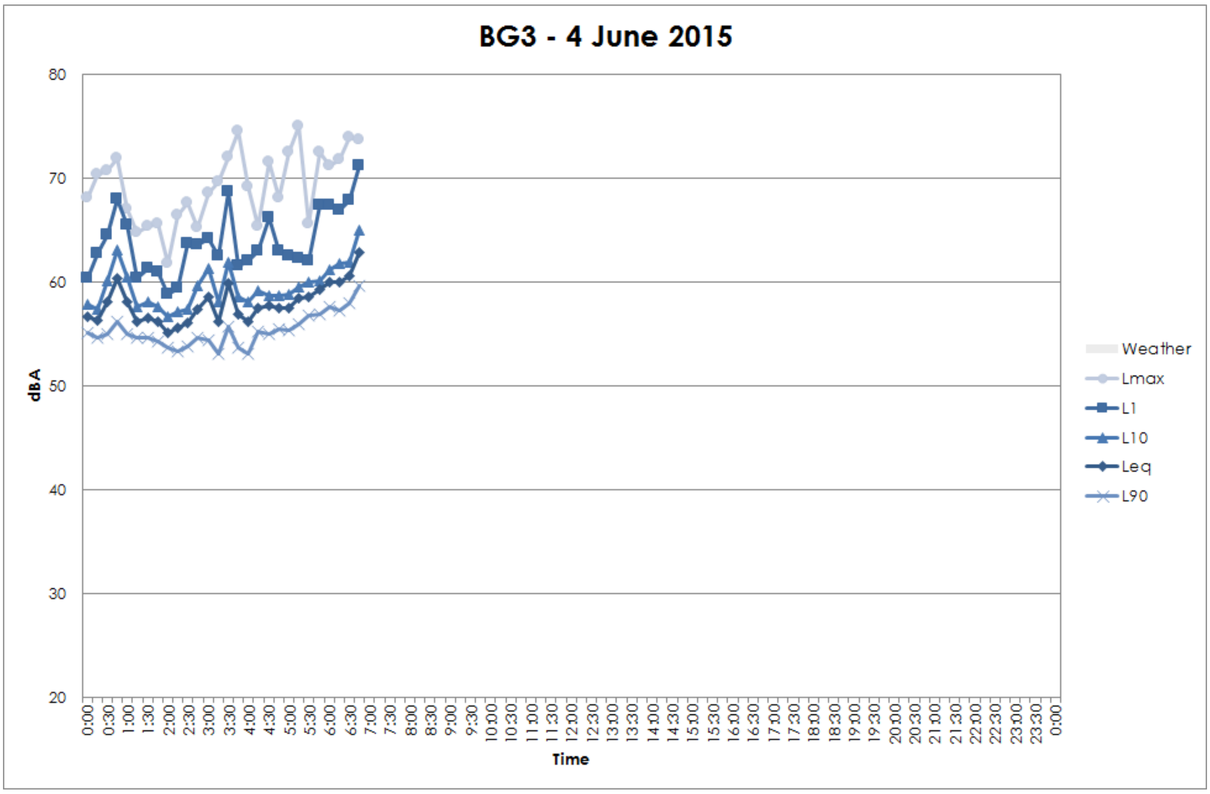
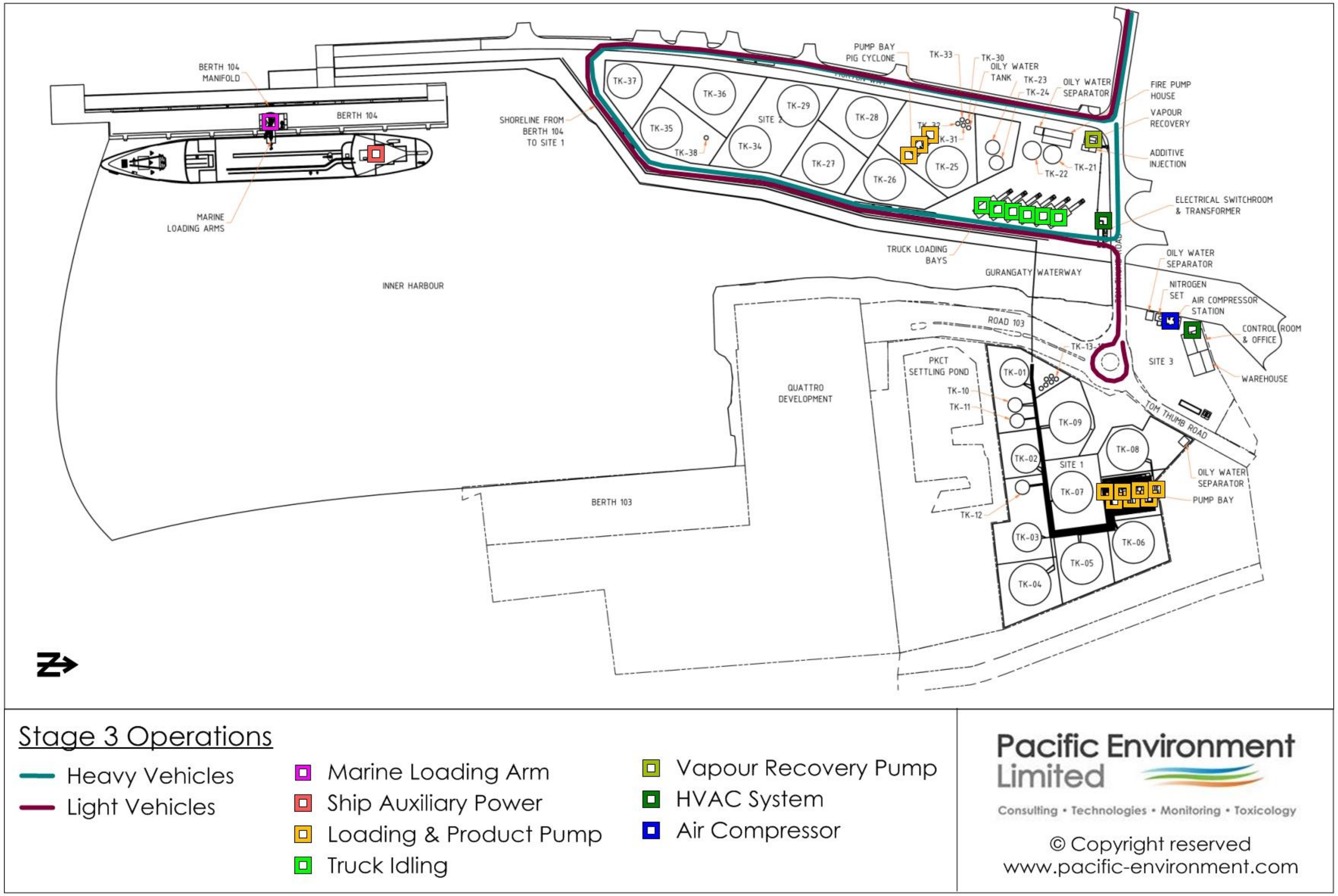
dBA
Time
Weather
Lmax
L1
L10
Leq
L90

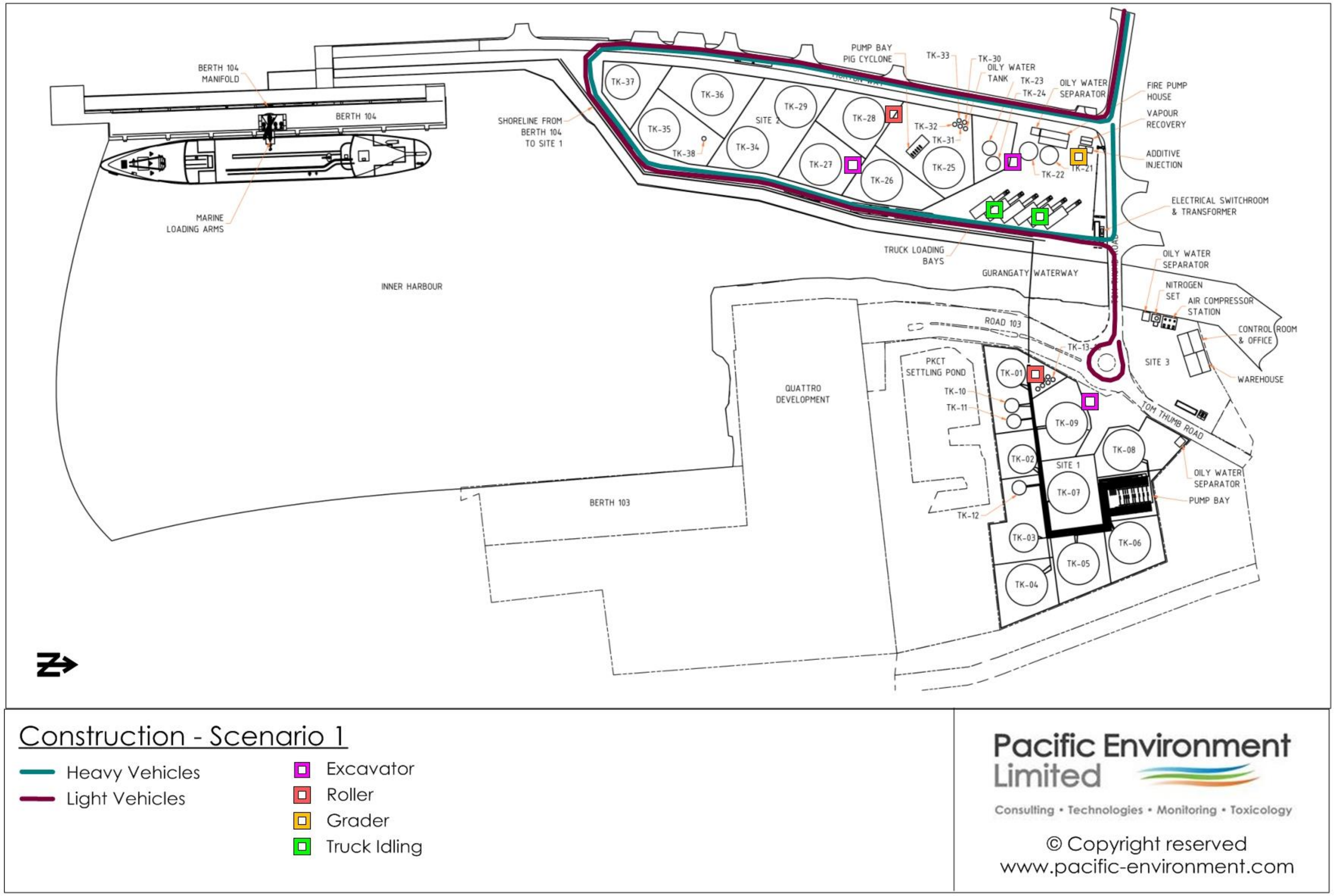

BG3 - 4 June 2015
dBA
80
70
60
50
40
30
20
Time
Weather
Lmax
L1
L10
Leq
L90

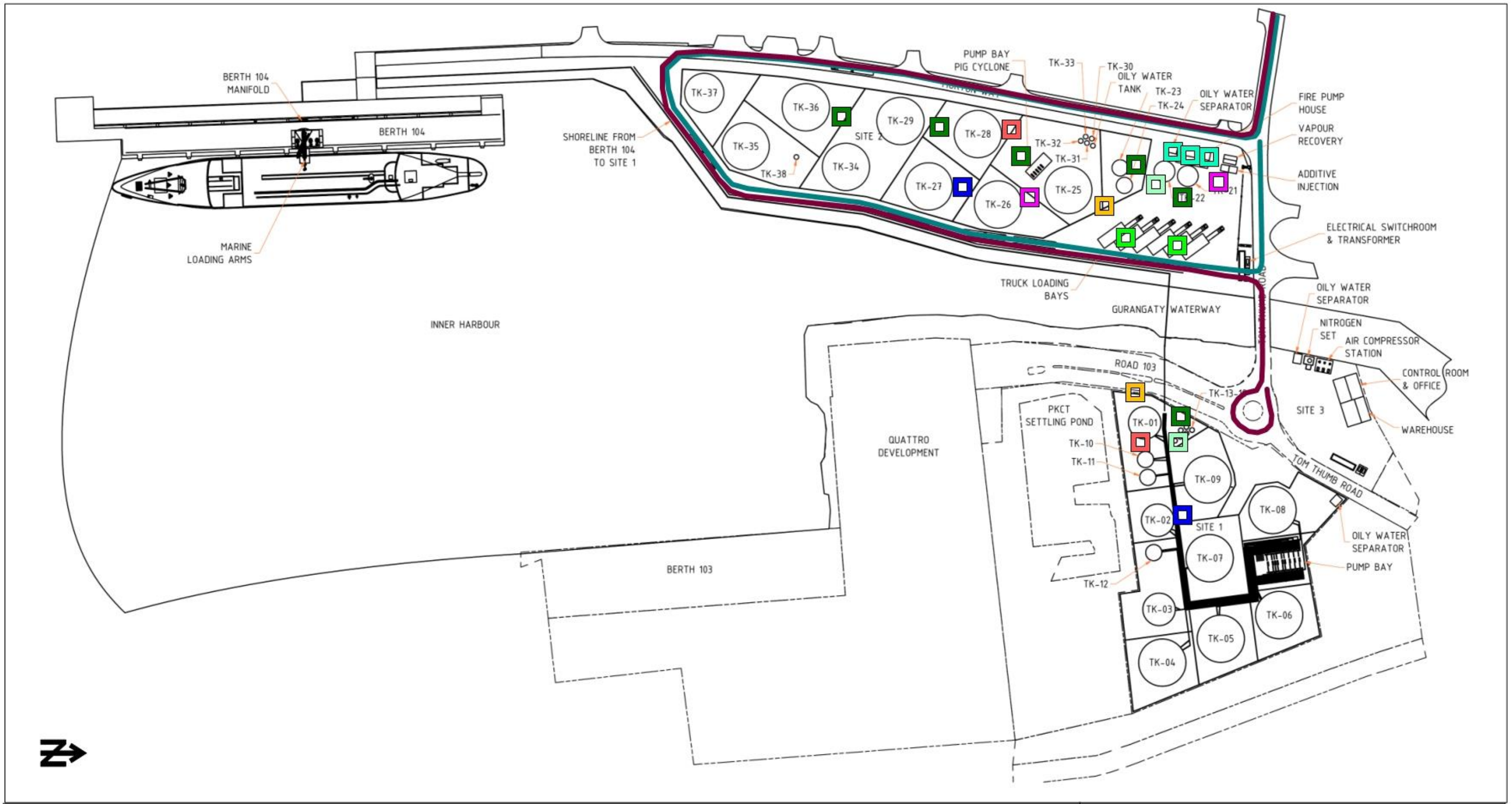
Appendix C SOURCE LOCATIONS

C.1 OPERATIONS



C.2 CONSTRUCTION





Construction - Scenario 2

- Heavy Vehicles
- Light Vehicles
- Hand Tools
- Concrete Truck
- Concrete Mixer
- Truck Idling
- Generator
- Crane
- Welder
- Piling Rig

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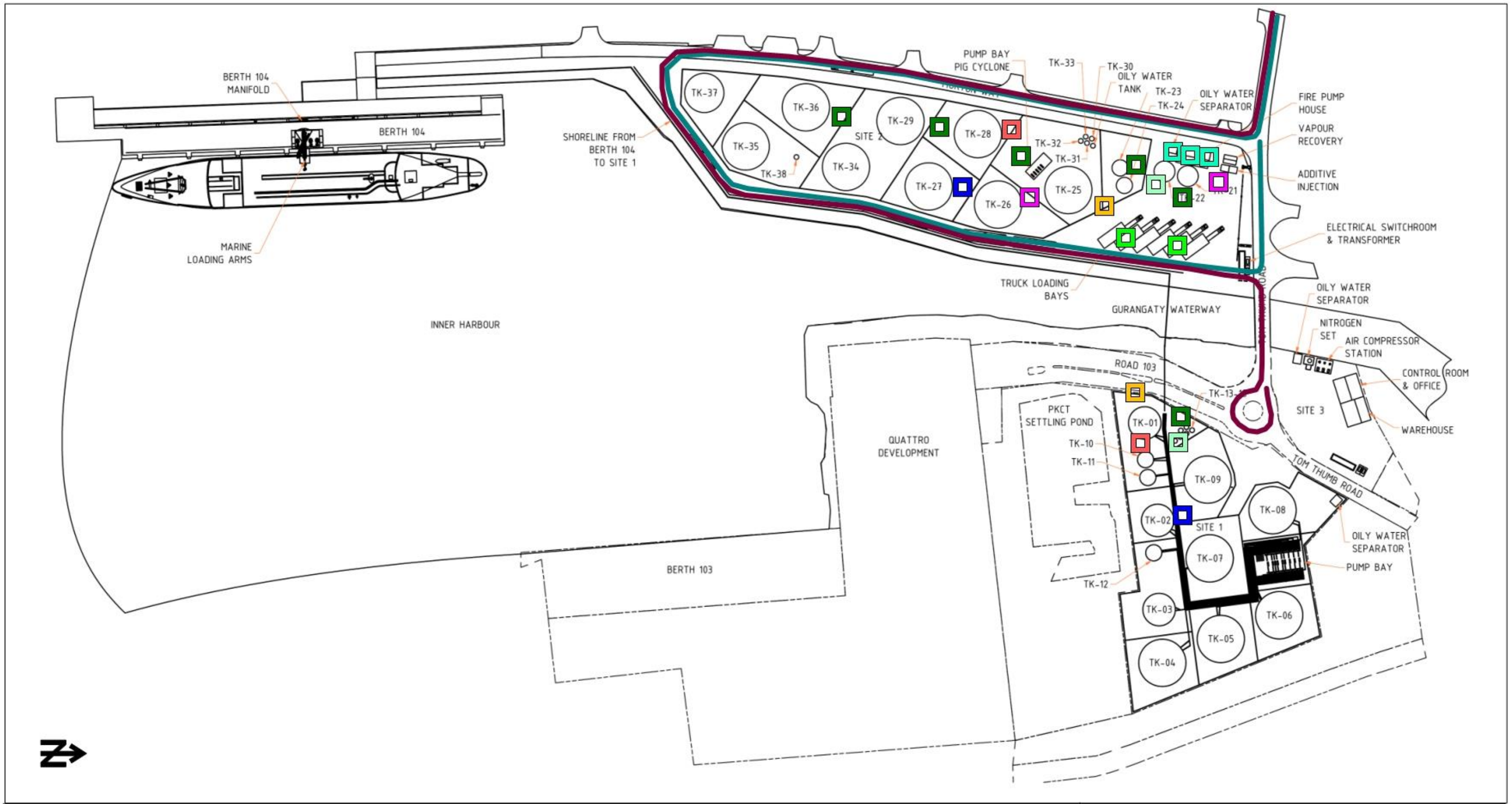

Construction - Scenario 1

- Heavy Vehicles
- Light Vehicles
- Hand Tools
- Concrete Truck
- Concrete Mixer
- Truck Idling
- Generator
- Crane
- Welder
- Piling Rig

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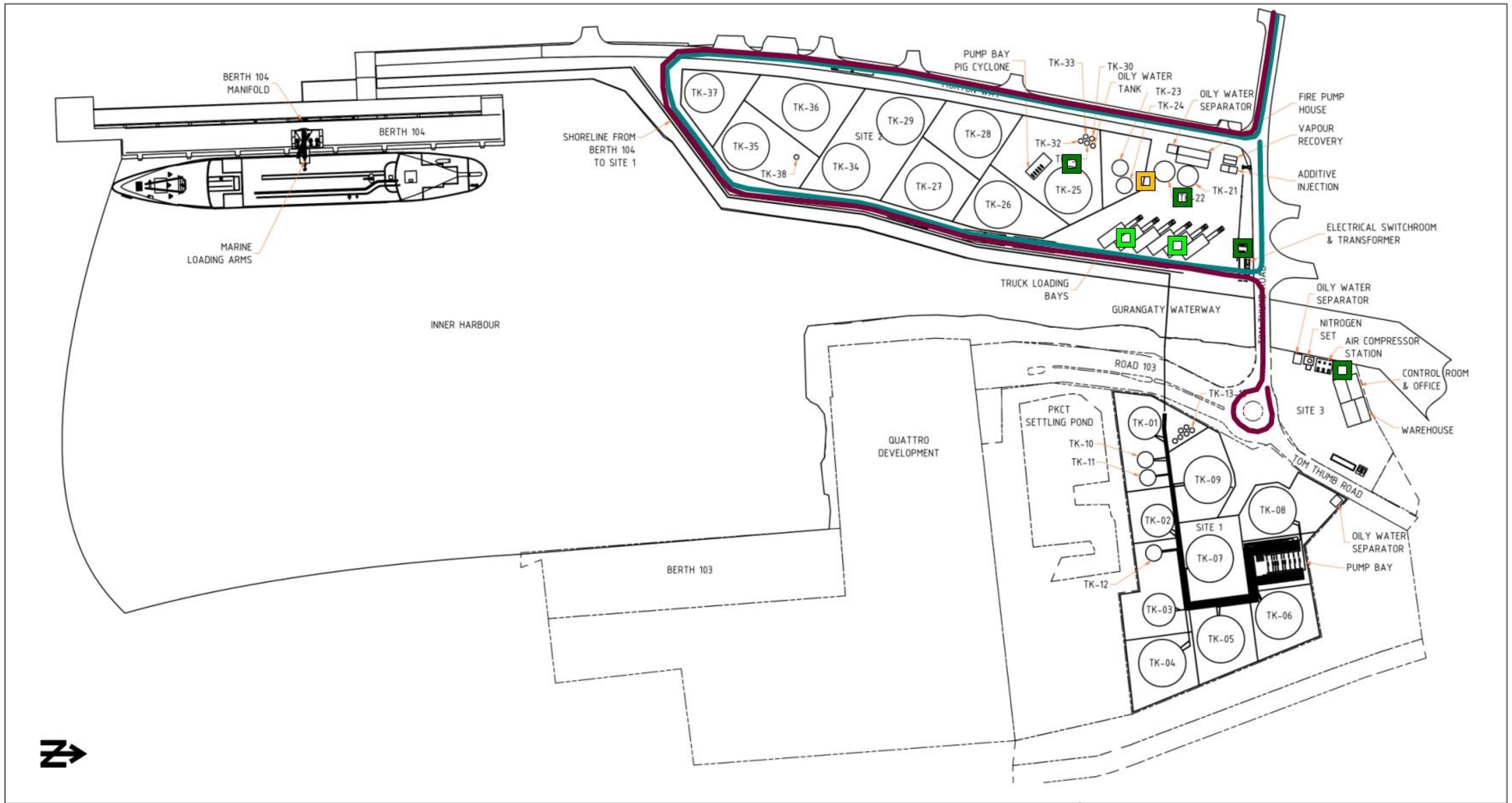

Construction - Scenario 4

- Heavy Vehicles
- Light Vehicles
- Hand Tools
- Crane
- Truck Idling

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Appendix D NOISE MODELLING RESULTS

D.1 OPERATIONAL NOISE MODELLING RESULTS

Table D.1: Stage 3 Operational Modelling Results

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)				
Period	Day	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	1	2	3	4	5
Receiver ID					
SR1	21	22	28	28	28
SR2	21	22	28	28	28
SR3	22	23	29	29	29
SR4	25	26	32	32	32
SR5	24	26	31	31	31
SR6	24	25	31	31	31
SR7	24	26	31	31	31
SR8	27	28	33	34	34
SR9	26	27	32	33	33
SR10	24	25	29	30	30
SR11	24	24	28	29	29
SR12	27	28	31	33	33
SR13	26	27	31	33	33
SR14	28	29	31	34	34
SR15	28	29	30	34	34
SR16	29	30	30	35	35
SR17	29	30	29	35	35
SR18	29	31	30	36	36
SR19	27	28	26	33	33
SR20	31	32	30	37	37
SR21	30	31	27	36	37
SR22	27	28	24	33	33
SR23	29	30	26	35	35
SR24	30	31	27	35	36
SR25	29	30	26	34	35
SR26	28	29	25	33	35
SR27	26	27	24	31	33
SR28	28	29	25	32	34
SR29	28	29	25	32	34
SR30	28	29	25	32	34
SR31	28	29	25	29	34
SR32	28	29	25	29	35
SR33	28	29	25	29	34
SR34	29	30	26	30	35
SR35	29	30	26	29	35
SR36	29	30	26	29	35
SR37	29	30	26	28	35

Period	Day	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	1	2	3	4	5
Receiver ID	Predicted Noise Level $L_{Aeq,15min}$ dB(A)				
SR38	29	30	26	27	35
SR39	29	30	26	33	35
SR40	34	34	33	34	39
SR41	34	34	33	34	39
SR42	40	40	39	39	44
SR43	38	39	37	41	43

D.2 C-WEIGHTED NOISE MODELLING RESULTS

Table D.2: Stage 3 C-Weighted Noise Modelling Results

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)				
Period	Day	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	1	2	3	4	5
Receiver ID					
SR1	38	38	41	41	41
SR2	38	38	41	41	41
SR3	39	39	41	41	41
SR4	41	41	44	44	44
SR5	41	41	44	44	44
SR6	41	41	44	44	44
SR7	41	41	43	43	43
SR8	43	43	45	45	45
SR9	42	42	44	45	45
SR10	42	42	44	44	44
SR11	41	41	43	44	44
SR12	42	42	44	45	45
SR13	42	42	44	45	45
SR14	43	43	43	45	45
SR15	43	43	43	45	45
SR16	44	44	44	47	47
SR17	44	44	43	47	47
SR22	43	43	41	45	45
SR23	44	44	41	46	46
SR24	45	45	42	47	47
SR25	44	44	42	46	47
SR26	44	44	41	45	46
SR28	43	43	41	45	46
SR31	44	44	41	44	46
SR32	44	44	41	44	46
SR36	44	44	42	44	47

D.3 SLEEP DISTURBANCE NOISE MODELLING RESULTS

Table D.3: Stage 3 Sleep Disturbance Modelling Results

Period	Predicted Noise Level $L_{Aeq,15min}$ dB(A)			
	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	2	3	4	5
Receiver ID				
SR1	25	31	31	31
SR2	24	30	30	30
SR3	25	31	31	31
SR4	32	38	38	38
SR5	33	39	39	39
SR6	33	39	39	39
SR7	34	40	40	40
SR8	35	41	41	41
SR9	36	41	41	41
SR10	34	39	39	39
SR11	32	32	37	37
SR12	36	37	41	41
SR13	36	37	41	41
SR14	37	37	42	42
SR15	36	37	42	42
SR16	37	37	42	42
SR17	37	37	42	42
SR22	36	32	41	41
SR23	37	33	42	42
SR24	38	34	43	43
SR25	37	33	42	42
SR26	36	32	42	42
SR28	36	32	37	41
SR31	36	32	36	42
SR32	36	32	36	42
SR36	37	33	33	42

D.4 CONSTRUCTION NOISE MODELLING RESULTS

Table D.4: Scenario 1 Construction Noise Modelling Results

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
Period	Day
Condition ID	1
Receiver ID	
SR1	20
SR2	20
SR3	21
SR4	24
SR5	23
SR6	23
SR7	24
SR8	26
SR9	25
SR10	23
SR11	22
SR12	26
SR13	25
SR14	26
SR15	26
SR16	27
SR17	27
SR18	27
SR19	25
SR20	29
SR21	29
SR22	26
SR23	27
SR24	28
SR25	27
SR26	27
SR27	25
SR28	26
SR29	27
SR30	27
SR31	27
SR32	27
SR33	27
SR34	28
SR35	27
SR36	27
SR37	27
SR38	27

Period	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
	Day
Condition ID	1
Receiver ID	
SR39	28
SR40	31
SR41	31
SR42	37
SR43	35

Table D.5: Scenario 2 Construction Noise Modelling Results

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
Period	Day
Condition ID	1
Receiver ID	
SR1	27
SR2	27
SR3	28
SR4	30
SR5	30
SR6	30
SR7	30
SR8	34
SR9	32
SR10	31
SR11	30
SR12	32
SR13	32
SR14	33
SR15	33
SR16	34
SR17	34
SR18	34
SR19	32
SR20	37
SR21	36
SR22	33
SR23	34
SR24	35
SR25	34
SR26	34
SR27	31
SR28	33
SR29	33
SR30	34
SR31	34
SR32	34
SR33	34
SR34	35
SR35	34
SR36	34
SR37	34
SR38	34
SR39	34
SR40	39

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
Period	**Day**
Condition ID	**1**
Receiver ID	
SR41	39
SR42	45
SR43	45

Table D.6: Scenario 3 Construction Noise Modelling Results

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
Period	Day
Condition ID	1
Receiver ID	
SR1	18
SR2	19
SR3	19
SR4	21
SR5	21
SR6	22
SR7	22
SR8	24
SR9	24
SR10	22
SR11	20
SR12	24
SR13	24
SR14	25
SR15	25
SR16	26
SR17	26
SR18	26
SR19	24
SR20	27
SR21	27
SR22	23
SR23	25
SR24	26
SR25	25
SR26	25
SR27	23
SR28	24
SR29	24
SR30	24
SR31	25
SR32	25
SR33	25
SR34	26
SR35	25
SR36	25
SR37	25
SR38	25
SR39	25
SR40	30

Period	Predicted Noise Level $L_{Aeq,15min}$ dB(A)
	Day
Condition ID	1
Receiver ID	
SR41	30
SR42	35
SR43	34

Table D.7: Scenario 4 Construction Noise Modelling Results, L_{eq}

	Predicted Noise Level $L_{Aeq,15min}$ dB(A)			
Period	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	2	3	4	5
Receiver ID				
SR1	17	23	23	23
SR2	17	23	23	23
SR3	17	23	23	23
SR4	21	26	26	26
SR5	20	26	26	26
SR6	20	26	26	26
SR7	21	26	26	26
SR8	23	28	28	28
SR9	23	25	28	28
SR10	20	23	25	25
SR11	18	19	23	23
SR12	23	23	28	28
SR13	21	22	27	27
SR14	24	24	29	29
SR15	23	23	29	29
SR16	24	24	30	30
SR17	24	24	30	30
SR18	24	24	30	30
SR19	23	19	28	28
SR20	26	22	31	31
SR21	26	21	31	31
SR22	22	18	27	28
SR23	24	20	29	29
SR24	25	21	29	30
SR25	24	20	28	30
SR26	24	19	27	29
SR27	22	18	22	28
SR28	24	19	24	29
SR29	24	19	24	29
SR30	24	19	24	29
SR31	24	19	24	29
SR32	24	19	24	29
SR33	24	19	24	29
SR34	25	20	24	30
SR35	24	20	23	29
SR36	24	20	20	30
SR37	24	20	20	30
SR38	24	20	20	30
SR39	25	21	25	30
SR40	28	24	27	33

Predicted Noise Level $L_{Aeq,15min}$ dB(A)				
Period	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	2	3	4	5
Receiver ID				
SR41	28	23	23	33
SR42	33	29	30	37
SR43	32	29	32	37

Table D.8: Scenario 4 Construction Noise Modelling Results, L_{max}

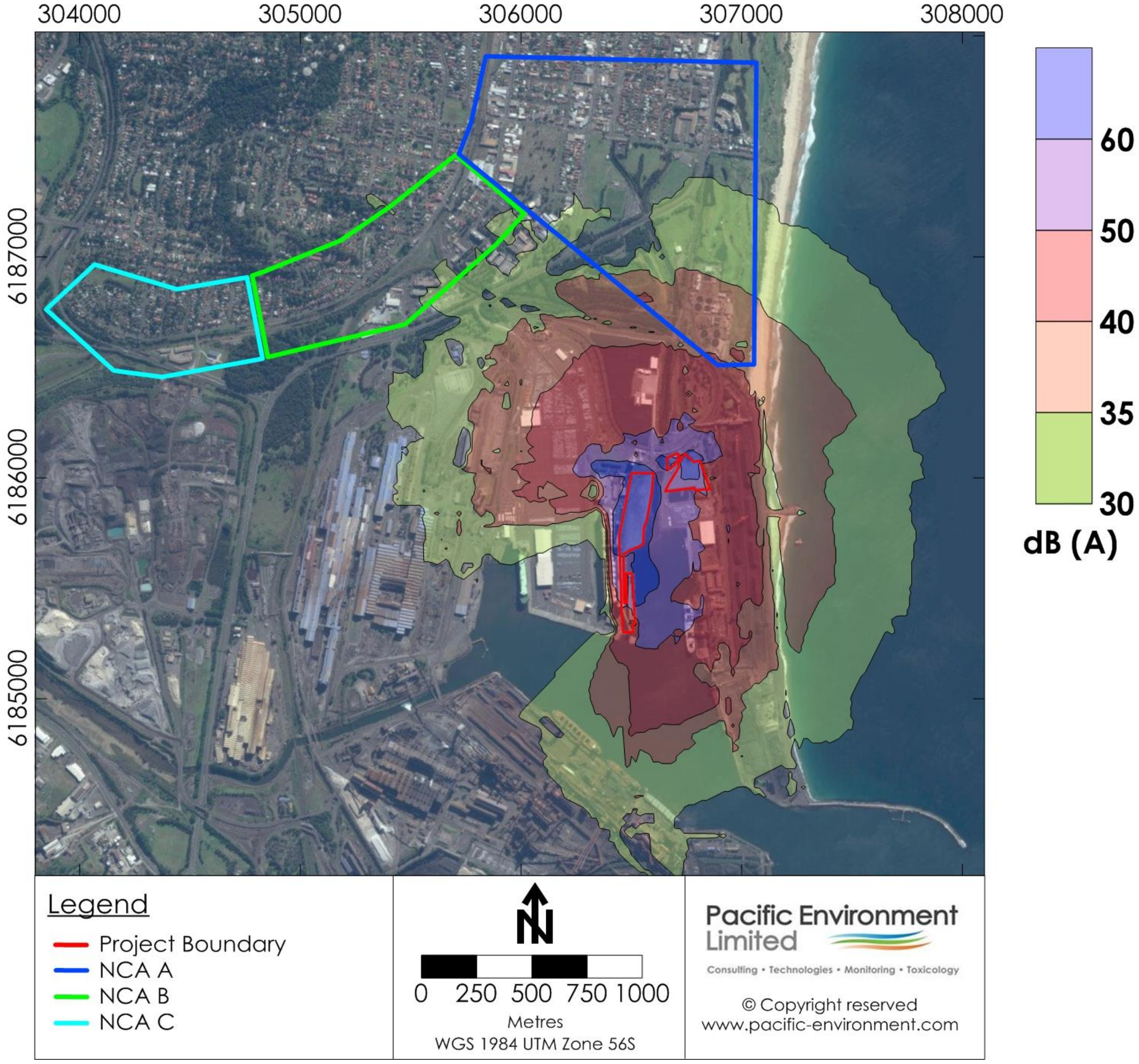
Period	Predicted Noise Level $L_{Amax,15min}$ dB(A)			
	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	2	3	4	5
Receiver ID				
SR1	30	36	36	36
SR2	30	36	36	36
SR3	31	37	37	37
SR4	32	38	38	38
SR5	33	39	39	39
SR6	33	39	39	39
SR7	35	40	40	40
SR8	36	41	41	41
SR9	36	41	42	42
SR10	33	39	39	39
SR11	31	31	37	37
SR12	37	37	42	42
SR13	36	36	41	41
SR14	37	37	42	42
SR15	37	37	42	42
SR16	37	37	42	42
SR17	37	37	42	42
SR18	37	37	42	42
SR19	33	28	38	38
SR20	39	34	44	44
SR21	37	33	42	42
SR22	30	27	36	36
SR23	33	29	38	38
SR24	35	31	41	41
SR25	37	33	42	43
SR26	37	32	42	42
SR27	34	30	34	40
SR28	36	32	36	42
SR29	37	32	37	42
SR30	37	32	37	42
SR31	37	32	37	42
SR32	37	32	37	42
SR33	37	32	37	42
SR34	37	33	37	43
SR35	37	32	37	42
SR36	37	32	32	42
SR37	37	32	32	42
SR38	36	32	32	42
SR39	38	34	38	44
SR40	41	37	41	46

Period	Predicted Noise Level $L_{Amax,15min}$ dB(A)			
	Eve/Night	Eve/Night	Eve/Night	Eve/Night
Condition ID	2	3	4	5
Receiver ID				
SR41	40	35	35	45
SR42	47	42	46	51
SR43	45	40	45	49

Appendix E NOISE CONTOURS

E.1 OPERATIONAL STAGE 3

E.1.1 Daytime neutral conditions



E.1.2 Night time SE winds