CLYDE TERMINAL CONVERSION PROJECT

APPENDIX H

NOISE IMPACT ASSESSMENT

Clyde Terminal Conversion Project
The Shell Company of Australia Ltd
06-Nov-2013

Noise Impact Assessment

Clyde Terminal Conversion Environmental Impact Statement

Noise Impact Assessment

Clyde Terminal Conversion Environmental Impact Statement

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Executive Summary

A noise and vibration assessment has been conducted for the conversion and continued operation of the Clyde Terminal to store, blend and distribute finished petroleum products.

Unattended noise monitoring has been conducted at two locations representing the worst affected receiver catchment areas surrounding the Project Area. Attended measurements were also conducted to validate unattended monitoring results and quantify industrial noise contributions to the background noise levels, in accordance with the INP.

Noise impacts have been assessed to four catchment areas:

- Rosehill;
- Silverwater;
- Newington; and
- Rydalmere.

The potential for adverse noise impact as a result of construction and operational activities has also been assessed for potentially affected non-residential receivers in the area.

Construction Noise

Construction noise has been assessed in accordance with the ICNG. Exceedances have been predicted of up to 4dB(A) at some residential receivers, however this is assuming included plant is operating simultaneously and is a conservative prediction. Mitigation measures and management procedures have been recommended to reduce construction noise impacts and minimise disturbance to residences.

Construction Vibration

Adverse impacts on surrounding structures or comfort of residences from construction vibration is highly unlikely due to large distances to the nearest residences and the absence of plant which produce significant vibration levels. No mitigation measures are considered necessary.

Construction Blasting

Blast vibration and overpressure levels are largely dependent ground composition, blast pressure and charge mass.

Blast vibration levels from a 1.72 kg charge are predicted to comply with the appropriate criteria at all sensitive receiver locations under “average” conditions.

Blast overpressure levels from a 1.72 kg charge are predicted to comply with the appropriate criteria at all residential locations and all non-residential locations except for some industrial premises adjacent to the Project Area with a site constant K_a value of 100. A 1.72 kg charge would comply with the appropriate criteria at all residential and all non-residential locations with a K_a value of 10.

Mitigation measures have been provided in order to minimise impacts of blasting.

Operational Noise

Noise from the worst case proposed terminal operations has been assessed in accordance with the INP, with a worst case meteorological scenario of a 3m/s source to receiver wind and an F-class temperature inversion assumed. No exceedances are predicted at any surrounding residential or non-residential receiver, and therefore no mitigation measures are considered necessary. No INP modifying factor adjustments are required for noise emissions from the Clyde Terminal.

Construction Generated Traffic Noise

Increased noise from construction traffic, generated by the vehicles involved with the conversion of the Clyde Terminal, has been assessed and is predicted to increase existing noise levels by less than 2dB, representing a minor impact that is considered barely perceptible to the average person. No mitigation is considered necessary for traffic generated noise.

1.0 Introduction and Project Details

The Shell Company of Australia Ltd (Shell) is seeking approval for the conversion of the Clyde Terminal to consolidate site assets and change operations solely to storage, blending and distribution of finished petroleum products. AECOM Australia Pty Ltd (AECOM) has been commissioned to provide a noise and vibration impact assessment on potentially noise sensitive receivers nearby to the Project Area.

1.1 Scope

This report will address the following:

- Establish compliance criteria for noise for the proposed demolition and construction works, as well as for the operation of the fully converted Clyde Terminal;
- Establish safe working vibration levels for the proposed demolition and construction works within the Clyde Terminal premises;
- Characterise the existing acoustic environment and identify nearby sensitive receivers;
- Establish operating conditions of the Clyde Terminal;
- Assess the noise emission from the Project Area during demolition and construction activities;
- Assess the noise and vibration emissions from the blasting during demolition works at the Project Area;
- Assess the noise emission from the Project Area during the operation of the fully converted Clyde Terminal;
- Assess the vibration levels during construction and demolition works at the Clyde Terminal;
- Assess noise impacts due to traffic generated by demolition construction activities; and
- Provide recommendations where necessary.

1.2 Project Description

Shell is seeking Development Consent for the following conversion works at the Clyde Terminal:

- Demolition of redundant tanks and other infrastructure; and
- Upgrades and improvements to site infrastructure.

The key components of the conversion of the Project Area would comprise:

- Demolition of the existing Clyde Terminal processing units and other redundant infrastructure at the Project Area. Existing storage tanks to be retained would be reallocated into final grades of finished petroleum products. Storage tanks surplus to the ongoing operation of the Clyde Terminal would be demolished. This would reduce the capacity and quantity of storage for petroleum fuels at the Clyde Terminal from 638 ML to 264 ML of fuels;
- Conversion of part of the existing Clyde Terminal assets to more efficiently receive, blend, store and distribute solely imported finished petroleum products. These products would continue to be supplied from the Clyde Terminal to Shell's existing Parramatta Terminal (which lies adjacent to the Clyde Terminal), and directly via existing pipelines from the Clyde Terminal to Sydney Airport and Newcastle.

The proposed Project would also include:

- Geodesmic domes would be installed over Jet fuel storage Tanks 34, 35 and 42, located in Tankfarm B2. These geodesmic domes would be designed so as to retain the majority of potential odours and emissions emitted from these Jet fuel storage tanks;
- Upgrades to tank instrumentation and tank control systems to enable remote and automated control;
- Upgrades to tank bunds where necessary;
- Reduction of the gas storage capacity of the Clyde Terminal from 10,851 cubic metres (m^3) to 1,550 m^3 metres to accommodate the continued receipt (by road tanker) and storage of Butane. Butane would continue to be blended with winter grades of Gasoline;

- Upgrades to the electrical supply, control and safeguarding systems;
- Increased automation of terminal systems;
- Installation of equipment to provide improved product quality segregation;
- Revised drainage and water treatment to suit reduced operations;
- Changes to the current fire system to provide articulated foam deployment and fire response for the converted Clyde Terminal arrangement;
- Revised internal facility pumping and piping arrangements;
- Associated works to increase the efficiency and effectiveness of the Clyde Terminal and to facilitate safe and efficient operations, such as lighting, safety shutdown systems, control room facilities and amenity upgrades; and
- An overall reduction in the operational footprint of the Clyde Terminal.

The Project would only involve minimal excavation activities, including grading works surrounding existing tankfarms, and foundation works for new substations and firewater tanks and the removal of some existing foundations. No other sub-surface disturbance is anticipated as part of the Project.

The Clyde Terminal would remain operational as a receipt (from the Gore Bay Terminal), storage and distribution facility for finished petroleum products during the proposed works. Once the Project is executed and implemented, the Clyde Terminal would continue to receive, store and distribute finished petroleum products.

It is expected that the conversion works would be undertaken progressively and would be completed within five to 10 years after the grant of development consent.

1.3 Site Description

The Clyde Terminal comprises 86 hectares and is located in the Parramatta Local Government Area (LGA) on parts of Lot 1, DP 109739, Lot 1 DP 383675, Lot 101 DP 809340, and Lot 2 DP 224288 which are owned by Shell. Shell's Clyde Terminal operations also take place on a small parcel of land adjoining Parramatta River (Lot 1 DP 534905) that is leased by Shell from Roads and Maritime Service (RMS). On this parcel of land Shell operates a small wharf area including administrative buildings and a small jetty extending into the Parramatta River. The Project Area includes the Shell Terminal Warehouse which is located on Lot 1, DP 109739, but which is surrounded by Shell's Parramatta Terminal operations.

The proposed site layout is shown in **Figure 1**.

G:\Projects\602 Projects\60236231 Clyde\60236231 F1 The Project Area 17 05 2013 TO

AECOM

THE PROJECT AREA

Clyde Terminal Conversion Project
Environmental Impact Statement

FIGURE 1

2.0 Operating Conditions

2.1 Current Operations

Shell ceased refining operations at the Clyde Terminal in late 2012. Since that time, the Clyde Terminal has continued to receive, store, blend and distribute finished petroleum products that arrive from Shell's associated Gore Bay Terminal. Fuel products at the Clyde Terminal are then distributed to the Sydney Airport, Newcastle, and other NSW destinations via pipelines from the Clyde Terminal and road tankers from the adjoining Parramatta Terminal.

2.2 Proposed Operations

Shell is seeking development consent to convert its Clyde Terminal into a more efficient finished petroleum product import, storage, blending and distribution terminal. These conversion works would improve the efficiency of these operations at the Clyde Terminal by removing redundant refining infrastructure. The Project would also reduce the environmental impact and further improve the safety of the Clyde Terminal while continuing to operate it as a viable and efficient finished petroleum product receipt storage and distribution terminal.

3.0 Existing Acoustic Environment

3.1 Receivers

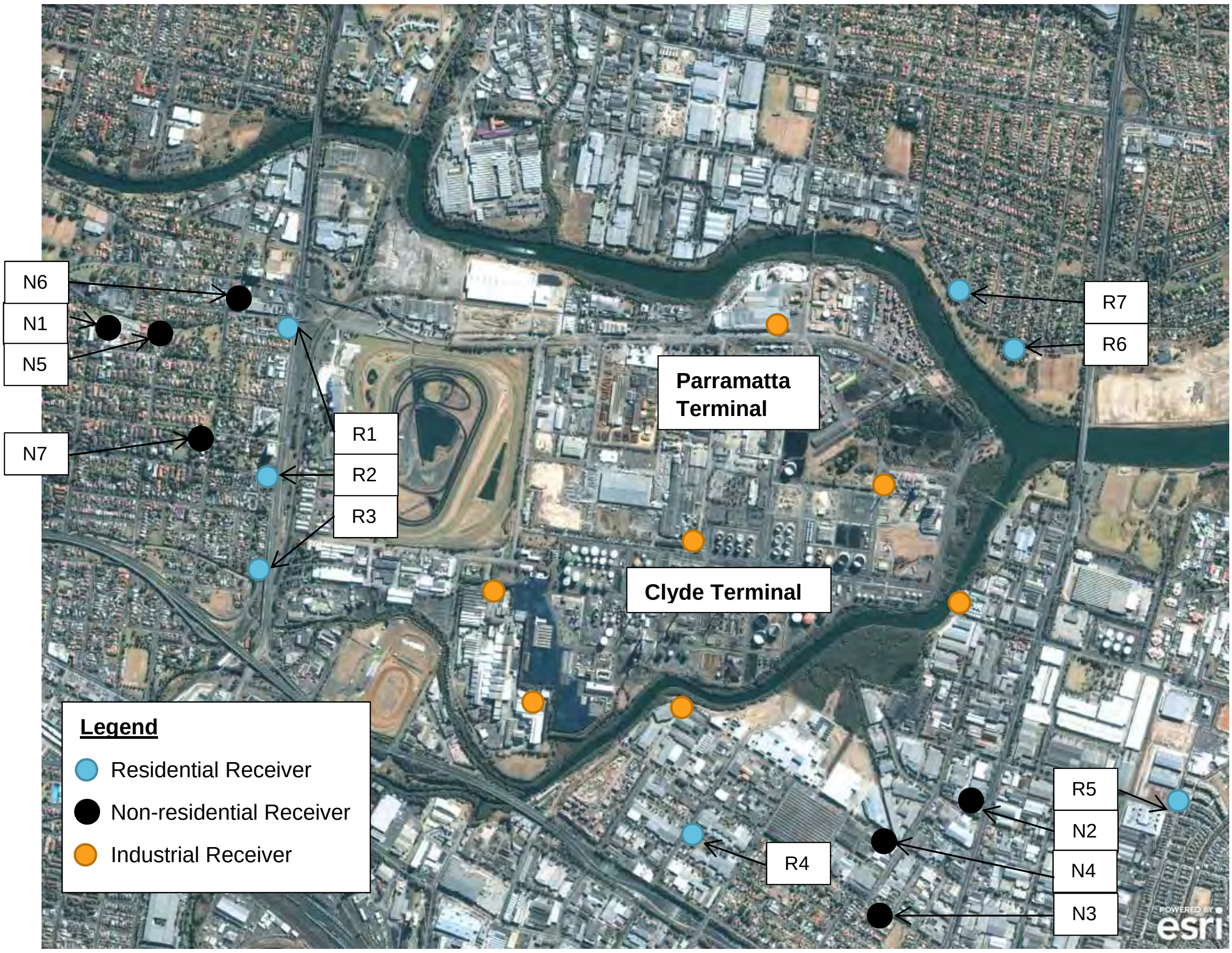
Residential areas have been divided in to receiver catchment areas, which are represented by residences identified as the likely worst affected residences in the area. These residences have been listed in **Table 1** below and shown in **Figure 2**.

Potentially affected non-residential receivers have also been identified and are listed in **Table 1**.

Table 1 Residential and Non-residential Receivers

Catchment Area	Receiver Number	Address	Approximate Distance and Direction from Project Area Boundary
Residential Receivers			
Rosehill	R1	128 James Ruse Dr, Rosehill	1km north west
	R2	82–100 James Ruse Dr, Rosehill	850m west
	R3	71 James Ruse Dr, Rosehill	850m west
Silverwater	R4	92 Asquith St, Silverwater	600m south
Newington	R5	1-9 Mockridge Ave, Newington	1.1km south east
Rydalmere	R6	529 John St, Rydalmere	400m north east
	R7	35 John St, Rydalmere	400m north east
Non-Residential Receivers			
N1	Our Lady of Lebanon Maronite Church		1.6km north west
N2	C3 Church, Silverwater		830m south east
N3	Sydney Korean Catholic Community Church		880m south
N4	Sydney Baha'I Centre		670m south east
N5	Our Lady of Lebanon Aged Care Hostel		1.4km north west
N6	Rosehill Child Care Centre		1.3km north west
N7	Rosehill Public School		1.1km west
N8	Bordering Industrial Premises		Adjacent in all directions

Figure 2 Receiver and Project Area Locations

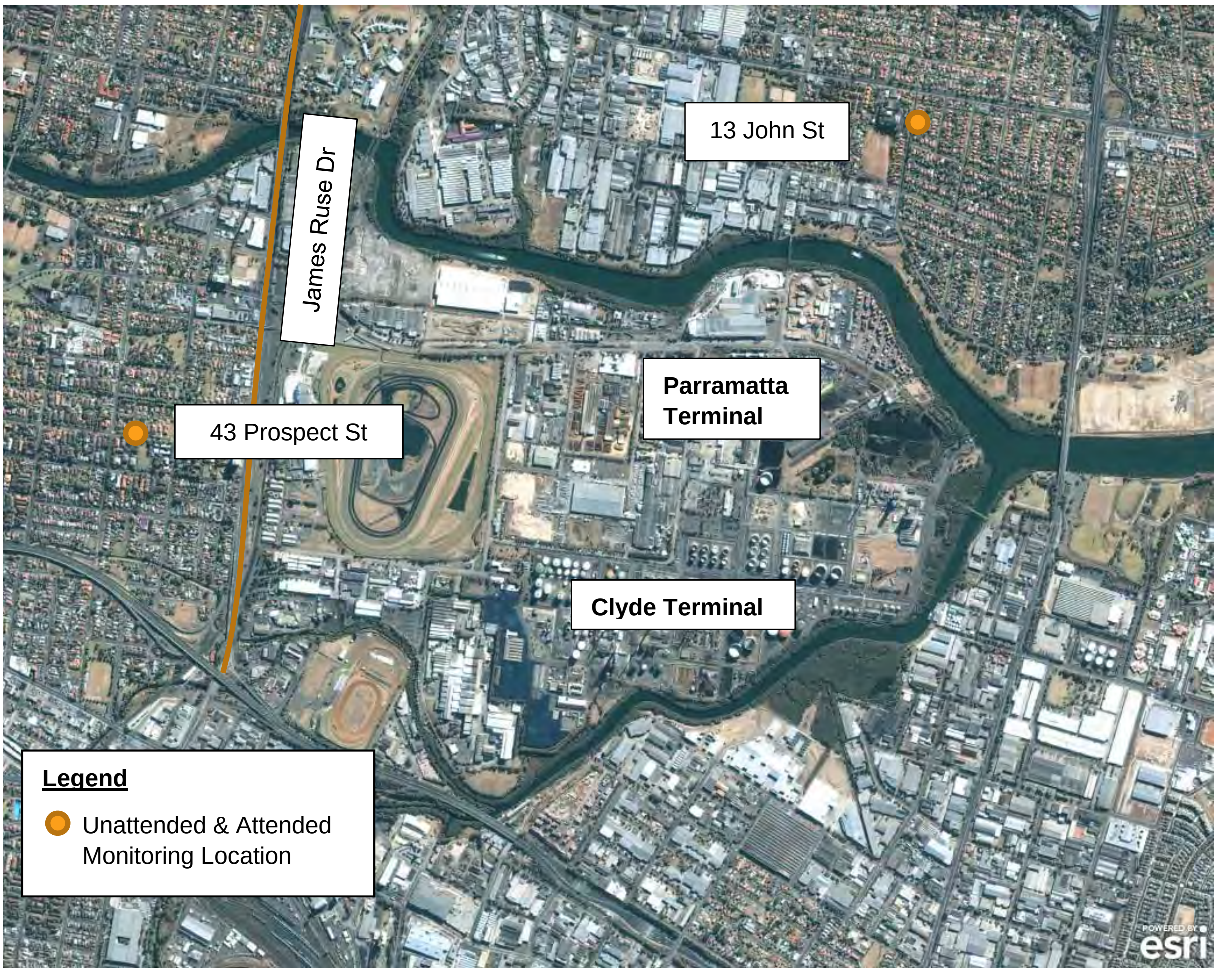


3.2 Noise Monitoring

Unattended and attended noise monitoring was conducted at two locations in order to quantify background and ambient noise levels, and also identify contribution from existing industrial noise sources. Two catchment areas were identified based on the observations that worst affected receivers to the east of James Ruse Drive would have similar background noise environments with significant industrial noise contributions, whereas receivers to the west of James Ruse Drive would also have similar background noise levels, although less affected by industrial noise.

The noise monitoring locations are shown in **Figure 3**.

Figure 3 Monitoring Locations



3.2.1 Unattended Monitoring

Noise logging was conducted from 15 August, 2012 to 29 August, 2012. Loggers were set up at two locations to represent receivers affected by noise from the Clyde Terminal, shown in **Figure 3**. The locations were:

- 13 John St, Rydalmere; and
- 43 Prospect St, Rosehill.

The background noise level is defined by the NSW Environmental Protection Authority (EPA) in the INP as 'the underlying level of noise present in ambient noise when all unusual extraneous noise is removed'. It can include sounds that are normal features of a location and may include birds, traffic, insects etc. The background noise level is represented by the L_{A90} descriptor. The noise levels measured at the Project Area were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the INP, for each monitoring location.

The ABL is established by determining the lowest ten-percentile level of the L_{A90} noise data acquired over each period of interest. **Table 2** presents individual ABL's for each day's assessment periods.

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 period. **Table 2** also presents the existing L_{Aeq} ambient noise level selected for each day, evening and night-time period, in accordance with the INP. An overall representative L_{Aeq} noise level is determined by logarithmically averaging each assessment period for the entire monitoring period.

Periods which were affected by noise from extraneous wind and rain were omitted from results as noise from blowing trees, falling rain and increased tyre noise from wet roads may affect results.

A graphical representation of unattended monitoring results is presented in **Appendix B**.

Table 2 Existing Background (L_{A90}) and ambient (L_{Aeq}) noise levels, dB(A)

Measurement Date	L_{A90} Background Noise Levels			L_{Aeq} Ambient Noise Levels		
	Day	Evening	Night	Day	Evening	Night
13 John St, Rydalmere						
Thursday 16 August, 2012	-	35	30	-	48	40
Friday 17 August, 2012	35	40	33	57	50	41
Saturday 18 August, 2012	42	40	34	56	50	48
Sunday 19 August, 2012	42	38	32	56	51	42
Monday 20 August, 2012	34	33	30	49	48	37
Tuesday 21 August, 2012	35	40	30	56	49	41
Wednesday 22 August, 2012	36	43	31	53	50	44
Thursday 23 August, 2012	39	42	33	54	50	45
RBL	36	40	31	-	-	-
Log Average L_{Aeq}	-	-	-	55	50	43
43 Prospect St, Rosehill						
Wednesday 15 August, 2012	-	41	38	-	47	44
Thursday 16 August, 2012	36	38	35	51	52	47
Friday 17 August, 2012	39	43	36	54	49	43
Saturday 18 August, 2012	41	41	36	55	49	42
Sunday 19 August, 2012	37	36	33	54	46	41
Monday 20 August, 2012	36	44	33	55	48	43
Tuesday 21 August, 2012	36	39	35	51	48	43
Wednesday 22 August, 2012	38	39	35	62	49	43
RBL	**37**	**40**	**35**	**-**	**-**	**-**
Log Average L_{Aeq}	**-**	**-**	**-**	**56**	**49**	**44**

Notes:
- No periods were affected by rain or wind noise.
- Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and Public Holidays.
- Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday and Public Holidays.
- Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays and Public Holidays.

3.2.2 Attended Noise Monitoring

Attended monitoring was conducted at the same two monitoring locations on 24 August and 31 August 2012. The attended noise monitoring locations are shown in **Figure 3**.

The purpose of these measurements was to qualify and quantify the noise environment in the vicinity of the Project Area. Monitoring locations were chosen to best represent background noise levels in absence of noise from the Project Area and traffic noise. **Table 3** presents a summary of these measurements.

Weather conditions were generally fine with little to no wind on the day and night of monitoring.

Table 3 Attended Noise Monitoring 24 and 31 August 2012, dB(A)

Monitoring Location	Period	Date / Time	Description	Attended Meas. Levels		Unattended Meas. Levels*	
				$L_{Aeq, 15min}$	$L_{A90, 15min}$	$L_{Aeq, 15min}$	$L_{A90, 15min}$
13 John St, Rydalmere	Day	24/08/12 13:07	Local traffic and as well as a class of children within the school yard were the major contributors to the noise level. Industry noise was barely noticeable.	55	49	57	41
	Night	31/08/12 00:14	Light traffic main contributor to noise level. Insects also noted. Industry noise noticeable.	49	46	41	36
43 Prospect St, Rosehill	Day	24/08/12 13:42	Noise from local traffic is dominant. Rustling of trees is heard constantly. Children within the school yard are also minor contributors. Industrial noise could not be heard.	62	55	57	42
	Night	31/08/12 00:41	Intermittent local traffic main contributor to noise. Insects and bats also noted. Industry faint in distance.	49	41	40	36

Note: *Unattended measurement levels show the average of unattended logged $L_{Aeq(15min)}$ at the closest 15 minute interval to the attended measurement period.

Differences in attended and unattended levels were measured. The large differences in levels during both the day and night at 43 Prospect Street and the night at 13 John Street were attributed mainly to the constant rustling of trees or cricket noise which controlled the background noise level during the monitoring period but would not be present during the entire long-term monitoring period. These noise sources would affect the entire 15 minute measurement and due to their constant nature would raise both the L_{eq} and L_{90} levels of the attended measurements. During day time monitoring at 13 John Street differences in unattended and attended measured levels were attributed to schoolyard noise being louder during the short term monitoring periods than over the entire logging period, which was noted as the largest contributor during measurements. Discrepancies may also be due to heavier traffic flow during the short term monitoring period, and differences in activity in the area during attended measurements.

It was noted during attended monitoring that industrial noise impacts were noticed during the night at Rydalmere, and less so during the day, and faintly during the night at Rosehill, but not during the day. Industrial noise heard was characterised by a constant hiss or hum coming from the south at Rydalmere, and the east at Rosehill.

4.0 Construction Noise and Vibration Criteria

4.1 Construction Noise

The Interim Construction Noise Guidelines (ICNG) aims to manage noise from construction works regulated by the Environmental Protection Authority (EPA). Construction noise includes not only noise from buildings works but also from demolition, remediation, renewal and maintenance.

The Guideline seeks to promote a clear understanding of ways to identify and minimise noise from construction works. Construction is to be undertaken during recommended standard hours unless approval is given for works which cannot completed during these hours. The guideline focuses on applying all 'reasonable and feasible' work practices to minimise construction noise impacts. Depending on the extent of impact and the scale of the works, managing noise impacts may involve community engagement.

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 likely 'worst case' construction scenario, has been carried out for the development.

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

NMLs for residential receivers are derived using the information in **Table 4** (excerpt from the ICNG).

Table 4 Noise at Residences Using Quantitative Assessment

Time of Day	Management Level L_{Aeq} (15min)*	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.*
	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:*

Time of Day	Management Level L_{Aeq} (15min)*	How to Apply
		• *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: * 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.

NMLs for premises other than residential, as provided by the ICNG, are shown in **Table 5**.

Table 5 Noise Management Levels for Premises other than Residences Using Quantitative Assessment

Premise	Descriptor	NML
Classrooms at schools	$L_{Aeq(15min)}$ (internal)	45 dB(A)
Places of worship	$L_{Aeq(15min)}$ (internal)	45 dB(A)

4.1.1 Construction Noise Management Levels

It is assumed that demolition and construction activities would take place during recommended standard working hours (07.00 am – 6.00 pm Monday to Friday and 8.00 am – 1.00 pm Saturday). However, oversized loads and emergency work may need to be conducted outside recommended standard working hours.

Construction NML's for the most affected residential receivers are shown in **Table 6**.

Table 6 Construction Noise Management Levels – Residential Receivers

Receivers	Period	RBL, L_{A90} dB(A)	Noise Management Levels L_{Aeq} dB(A)
Residents East of James Ruse Drive* (Rydalmere, Silverwater & Newington)	Day	36	46
	Evening	40	45
	Night	31	36
Residents West of James Ruse Drive* (Rosehill)	Day	37	47
	Evening	40	45
	Night	35	40

Notes: *Shown in **Figure 3**

4.2 Construction Vibration

Due to the large distances between the Project Area and receivers, as well as the absence of any demolition and construction plant which produce significant levels of vibration, any adverse effects of construction vibration are extremely unlikely, with respect to either human comfort or structural damage. Therefore construction vibration is not considered an issue and no mitigation measures are considered necessary.

The distance a large 1600kg hydraulic hammer should safely operate from an occupied building to comply with human comfort criteria in the EPA document *Assessing Vibration – A Technical Guideline* is 73m, and 22m to prevent the likelihood of cosmetic structural damage. Since the closest residential premise to the Project Area is approximately 400m away, and no plant which produce significant levels of vibration are to be used during construction or demolition works, it is highly unlikely any adverse vibrational impacts will be experienced at this residence, and no further assessment of vibrational impact of demolition or construction activities is considered necessary.

4.3 Construction Blasting 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.

The Australian and New Zealand Environment Council (ANZEC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* has been adopted by the EPA as comfort criteria. The guidelines are not intended to be structural damage criteria; however they do provide a conservative approach to assessing blasting impacts.

4.3.1 Ground Vibration

- The ANZEC 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% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time; and
- 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.

4.3.2 Times and Frequency of Blasting

- Blasting should generally only be permitted during the hours of 9.00 am – 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays;
- Blasting should generally take place no more than once per day; and
- 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 criteria are summarised in **Table 7**.

Table 7 ANZECC Guideline Blast Criteria Summary

Impact	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

Australian Standard 2187.2 'Explosives – Storage and use Part 2: Use of explosives' notes that damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133 dB(lin peak).

5.0 Operational Noise Criteria

5.1 *Protection of the Environment Operations Act 1997* – Section 139

The main acoustic requirement of *Protection of the Environment Operations Act 1997* (PoEOA) 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 source of noise is offensive, a primary consideration is to determine whether the noise 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 Project Area boundary, including noise mechanical services or associated with site buildings would be assessed in accordance with the INP. This means 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 particular land uses for residences and other land uses.

5.1.1 Intrusive Noise Impacts

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(A). 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 potentially annoying characteristics such as tonality or impulsiveness.

5.1.2 Protecting 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.

Receivers affected by the proposed Project are classified as Urban as defined by Section 2.2.1 of the INP. This is supported by the observations that the area "*is near commercial districts or industrial districts"*.

For residential receivers in urban areas, the amenity criteria are shown in **Table 8**.

Table 8 Recommended L_{Aeq} 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 Upper Limit
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

During attended noise measurements it was noted that during the night time industrial noise from surrounding sites was noted at 13 John Street, Rydalmere, and barely noticeable at 43 Prospect Street, Rosehill. During the day time industrial noise was barely noticeable only at 13 John Street, Rydalmere, and not noticeable at 43 Prospect Street, Rosehill.

5.2 Final Environmental Noise Criteria

A summary of the environmental noise criteria are given in **Table 9**.

Table 9 Final Environmental Noise Criteria, dB(A)

Catchment Area	Period	RBL, L_{A90}	Intrusive Criterion RBL+5	Estimated $L_{eq(15min)}$ Industrial Noise Only	Amenity Criterion[1]	EPA Noise Goals, $L_{eq(15min)}$
Residents East of James Ruse Drive (Rydalmere, Silverwater & Newington)	Day	36	41	50	60	41
	Evening	40	41[2]	45	48	41
	Night	31	36	41	43	36
Residents West of James Ruse Drive* (Rosehill)	Day	37	42	52	60	42
	Evening	40	42[2]	39	50	42
	Night	35	40	39	44	40

Notes:

- *Shown in **Figure 3**
- [1]Amenity criterion have been calculated in accordance with Table 2.2 of the INP
- [2]Intrusiveness Criterion for Evening and Night have been set to no greater than Daytime levels in accordance with the INP Application Notes

5.2.1 Other Noise Sensitive Receivers

The INP specifies the following noise criteria for non-residential noise sensitive land uses as detailed in **Table 10**.

Table 10 Non-residential Receiver Noise Criteria

Type of receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level dB(A)	
			Acceptable	Recommended Upper Limit
School classroom - internal	All	Noisiest 1-hour period when In use	35	40
Place of worship - internal	All	When in use	40	45
Industrial premises	All	When in use	70	75

6.0 Construction Noise Assessment

6.1 Construction Noise Model

In order to assess noise impact from the Project Area during demolition and construction, a noise model was created to represent the worst periods of demolition and construction activity.

The demolition and construction works have been modelled in SoundPLAN Version 7.0. The following features were included in the noise model:

- Ground topography;
- Ground absorption and reflection;
- Buildings (residential and industrial);
- Receivers (listed in **Table 1**); and
- Sources (listed in **Table 11**).

Noise emissions from the Project Area have been modelled using an implementation of the CONCAWE propagation algorithm.

6.1.1 Noise Sources

A list of demolition and construction plant has been provided by Shell which is to be used in the demolition and construction works at the Clyde Terminal.

The nominated demolition and construction plant and typical sound power levels are shown in **Table 11**.

Table 11 Demolition and Construction Equipment Usage and Sound Power Levels

Construction Plant	L_{eq} Sound Power Level dB(A)	Plant Usage	
		Demolition	Construction
Excavator equipped with mechanical shears	107	2	
Excavator equipped with hydraulic shears	107	2	
Trucks	108	4	4
Crane	105	2	2
Air compressors	94		3
Pneumatic wrenches	107		3
Cutting torches	110	3	

6.1.2 Predicted Construction Noise Impact

The predicted impact from demolition and construction noise at the representative receivers during each stage of the works has been assessed. It has been assumed that demolition and construction activities will take place during standard working hours only. The assessment assumes no noise mitigation at the Project Area and is representative of a worst case assessment i.e. all plant is operating concurrently for the entire 15 minutes.

Predicted demolition and construction noise impacts are shown in **Table 12**.

Table 12 Predicted Construction Noise Impacts

Rec	Address	Fl.	NML	Demolition		Construction		Construction & Demolition	
				Predicted $L_{eq\ (15min)}$	Exceed.	Predicted $L_{eq\ (15min)}$	Exceed.	Predicted $L_{eq\ (15min)}$	Exceed.
Residential Receivers									
R1	128 James Ruse Dr, Rosehill	1	47	41	-	39	-	43	-
R2	82–100 James Ruse Dr, Rosehill	1	47	41	-	40	-	44	-
		2	47	41	-	40	-	44	-
		3	47	41	-	40	-	44	-
		4	47	41	-	40	-	44	-
		5	47	41	-	40	-	44	-
		6	47	41	-	40	-	44	-
R3	71 James Ruse Dr, Rosehill	1	47	41	-	40	-	44	-
		2	47	41	-	40	-	44	-
R4	92 Asquith St, Silverwater	1	46	47	**1**	45	-	49	**3**
R5	1-9 Mockridge Ave, Newington	1	46	42	-	37	-	43	-
		2	46	42	-	37	-	43	-
		3	46	42	-	37	-	43	-
		4	46	42	-	37	-	43	-
R6	529 John St, Rydalmere	1	46	49	**3**	43	-	50	**4**
R7	35 John St, Rydalmere	1	46	48	**2**	43	-	49	**3**
Non-Residential Receivers									
N1	Our Lady of Lebanon Maronite Church	1	45 (internal)	27 (internal)[1]	-	25 (internal)[1]	-	19 (internal)[1]	-
N2	C3 Church, Silverwater	1	45 (internal)	36 (internal)[1]	-	32 (internal)[1]	-	28 (internal)[1]	-
N3	Sydney Korean Catholic Community Church	1	45 (internal)	34 (internal)[1]	-	31 (internal)[1]	-	25 (internal)[1]	-
N4	Sydney Baha'I Centre	1	45 (internal)	36 (internal)[1]	-	32 (internal)[1]	-	27 (internal)[1]	-
		2	45 (internal)	36 (internal)[1]	-	32 (internal)[1]	-	27 (internal)[1]	-
		3	45 (internal)	36 (internal)[1]	-	32 (internal)[1]	-	27 (internal)[1]	-
N5	Our Lady of Lebanon Aged Care Hostel	1	47[2]	35	-	35	-	28	-

Rec	Address	Fl.	NML	Demolition		Construction		Construction & Demolition	
				Predicted $L_{eq\ (15min)}$	Exceed.	Predicted $L_{eq\ (15min)}$	Exceed.	Predicted $L_{eq\ (15min)}$	Exceed.
N6	Rosehill Child Care Centre	1	47[2]	39	-	37	-	31	-
N7	Rosehill Public School	1	45 (internal)	39 (internal)[1]	-	28 (internal)[1]	-	30 (internal)[1]	-
N8	Bordering Industrial Premises - East	1	75	65	-	59	-	66	-
N9	Bordering Industrial Premises – North	1	75	61	-	49	-	61	-
N10	Bordering Industrial Premises – North East	1	75	61	-	60	-	64	-
N11	Bordering Industrial Premises – North West	1	75	60	-	60	-	63	-
N12	Bordering Industrial Premises – South	1	75	49	-	48	-	51	-
N13	Bordering Industrial Premises – South East	1	75	55	-	48	-	56	-
N14	Bordering Industrial Premises – South West	1	75	50	-	50	-	53	-
N15	Bordering Industrial Premises – West	1	75	54	-	54	-	57	-

Notes:

1. Noise management level is internal noise level. Generally a 10 dB reduction can be achieved with an open window and 20 dB with a closed window
2. In the absence of a noise management level for aged care facilities or child care facilities, the Our Lady of Lebanon Aged Care Hostel and Rosehill Child Care Centre has been assessed against the residential noise management levels.

The results presented in **Table 12** indicate that during the demolition works an exceedance of up to 4 dB of the noise management levels occur at three assessment locations. During the construction works all identified receivers comply with the noise management levels.

This assessment has conservatively considered the worst case scenario of all equipment operating for a full 15 minute period. This is unlikely to occur for an extended period of time. In the context of demolition and construction noise, these exceedances are considered relatively small, and an increase of 1 or 2dB is considered barely perceptible to the average person, and an increase of 3dB is considered minimal.

Mitigation measures should however be considered to help reduce the impact on the noise sensitive receivers.

6.2 Noise Mitigation Measures

The noise level emissions from site plant and the potential annoyance to sensitive receptors would depend on the selection of plant, the type of operation, the activity duration and the time of day it is conducted. The contractor should demonstrate best practicable means and include noise mitigation measures in the construction management plan.

- Contractors should demonstrate best practicable means and include noise mitigation measures in the CEMP plan, which could include: Construction activities to be limited to between 7am and 6pm Monday to Friday and 8am to 1pm Saturday;
- Where work is undertaken outside of the standard working hours it would be in accordance with the EPA Interim Construction Noise Guideline (EPA 2009);
- Construction of noise bunds, where feasible, at the early construction stage i.e. stockpiling of top soil or materials;
- Use of temporary barriers for stationary noisy equipment;
- Possible restrictions to construction hours (beyond the above hours) where noise impacts are significant;
- All plant items should be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise;
- All pneumatic tools should be fitted with silencers or mufflers;
- Any compressors brought on to site should be silenced or sound reduced models fitted with acoustic enclosures;
- Consultation with property owners likely to be affected prior to works being carried out; and
- Noise monitoring at sensitive locations as agreed with EPA for any excessive noise or noise complaints being assessed with appropriate action taken.

7.0 Construction Vibration Assessment

7.1 General Construction Activities

Due to the large distances between the Project Area and receivers, as well as the absence of any construction plant which produce significant levels of vibration, any adverse effects of construction vibration are extremely unlikely, with respect to either human comfort or structural damage. Therefore construction vibration is not considered an issue and no mitigation measures are considered necessary.

The distance a large 1600kg hydraulic hammer can safely operate from an occupied building to comply with human comfort criteria in the EPA document *Assessing Vibration – A Technical Guideline* is 73m. A distance of 22m will typically comply with cosmetic structural damage criteria detailed in BS7385-*2 Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration*. Since the closest residential receiver to the Project Area is approximately 400m away, and no vibration intensive plant is proposed to be used during construction or demolition works, it is highly unlikely any adverse vibrational impacts will be experienced at this receiver or those further away, and no further assessment of vibrational impact of demolition or construction activities is considered necessary.

7.2 Construction Blasting

The use of blasting has been proposed in the demolition of a maximum of five chimney stacks on the terminal site. Stack details are shown in Table 13.

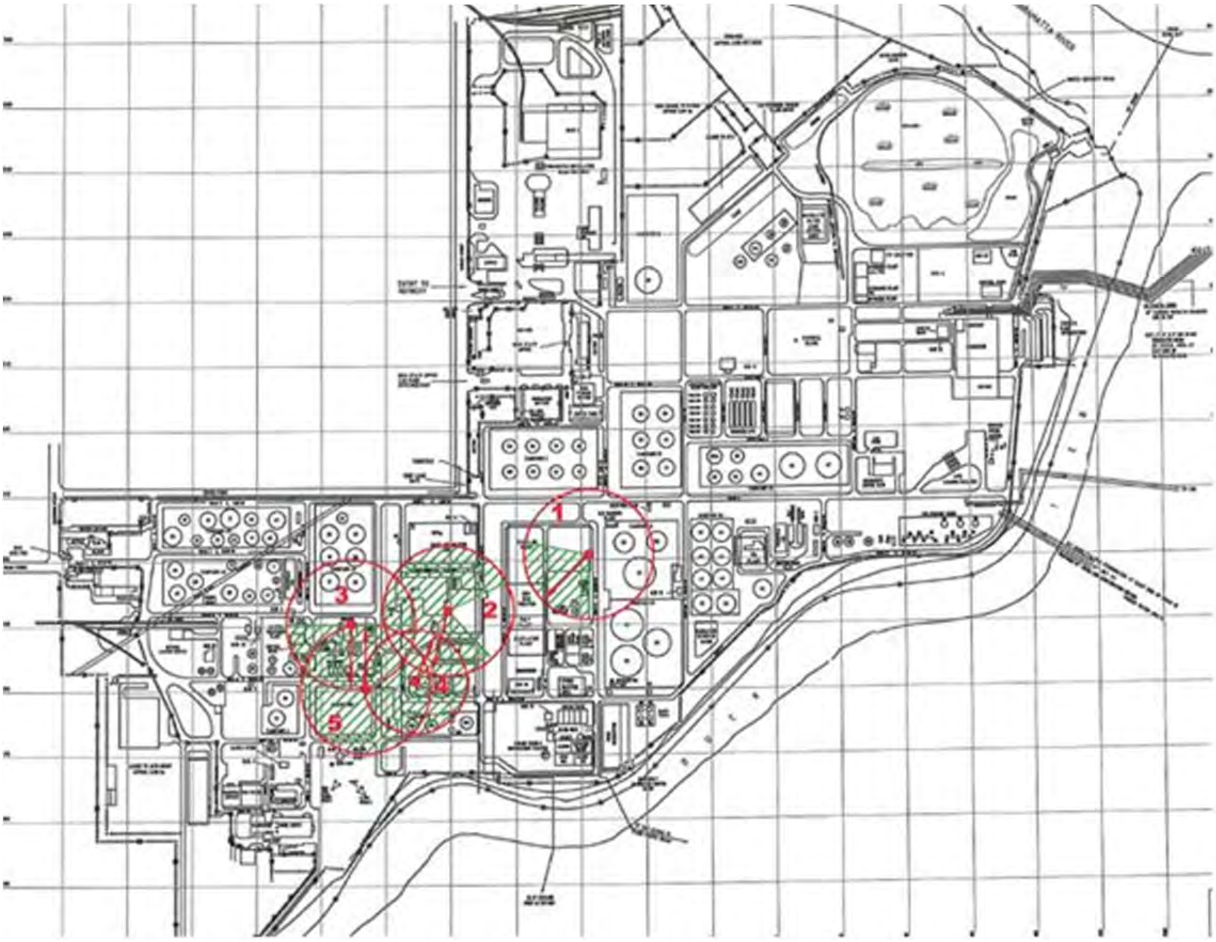
7.2.1 Location of Stacks

Figure 4 details the location of the five stacks within the demolition zone. It further details the possible fall radius based on the stack height, (outlined in red), safe fall arc, (shaded in green) and the nominal fall line, (red arrow), for each stack.

7.2.2 Preparation Work

In order to prepare for the planning phase a specialist rope access company has been engaged to enter each stack and characterize the internals. Samples will be taken in order to identify any possible hazardous material. The information from this activity will then feed into the forward planning of the blasting.

Figure 4 **Stack locations, fall radii (red circles), safe fall arcs (green) and nominal fall lines (red arrows).**



A detailed planning phase is yet to be undertaken for this work and this figure should be taken as indicative only.

7.2.3 Timing

The stack demolition would take place once all other demolition activities have been completed and the ground area cleared. Current scheduling shows this activity in October 2015 and would comprise five single events.

Table 13 **Chimney Stack Details Proposed for Demolition**

Stack Location	Height (m)	Base Diameter		Shell Thickness (mm)	Construction
		Outside (m)	Inside (m)		
Crude distillation unit	100	8	7.3	381	External reinforced concrete shell. Internally lined with brick corbel.
Catalytic cracking unit	82	5.45	4.8	270	External reinforced concrete shell. Internal refractory lined. Original interior lining was brick corbel.
High vacuum unit	80	4.5	4.1	203	External reinforced concrete shell. Internal refractory lined. Original interior lining was brick corbel.
Boilers Stack	100	6	5.4	241	External reinforced concrete shell. Internally lined with brick corbel.
Platformer 3	102	8.2	7.9	260	External reinforced concrete shell. Internal 2 MT OD steel liner.

7.2.4 Size of Explosive Charges

The indicative size of the explosive charge to be employed per stack is as detailed in Table 14.

Table 14 Size of Explosive Charges

Stack Location	Total Explosives (kg)	Maximum Instantaneous Charge (kg)	Timed Delays, 25ms Intervals
Crude distillation unit	21.62	1.38	19
Catalytic cracking unit	14.018	1.032	16
High vacuum unit	11.484	0.812	17
Boilers Stack	11.716	0.812	18
Platformer 3	38.098	1.72	29

7.2.5 Blasting Vibration Levels

The blasting impact at nearby residential and industrial receivers has been assessed to ANZEC guidelines. As no trial blasts have yet taken place the assessment uses generic values recommended in *AS 2187.2:2006 Explosives – Storage and use – Use of explosives*. The values used are considered to be conservative. It is understood that blasting will take place during standard hours as defined in **Section 4.3**.

The ground vibration arriving at a point remote from a blast is a function of many factors, including:

- Charge mass of explosive per delay;
- Explosive type and coupling;
- Distance from blast;
- Ground transmission characteristics;
- Firing sequence;
- Origin of the rock mass;
- Presence of bedding and joints; and
- Degree and depth of weathering of surface at the point.

Some of these factors are difficult to accurately quantify without specific site knowledge. Many site factors will affect the transmission of vibration through the ground, the most accurate predication graph for a site will be that generated from vibration measurements taken at the site. However, in the absence of such site data, ground vibration can be estimated using the following equation:

$$PPV = K_g \left(\frac{R}{\sqrt{Q}} \right)^{-B}$$

where: PPV = peak particle velocity (mm/s)

Q = Maximum instantaneous charge(kg)

R = distance (m)

K_g, B = Constants related to site and rock properties for estimation purposes

Ground vibration levels depend on the maximum instantaneous charge (effective charge weight per delay), and not the total charge weight, provided the effective delay interval is appropriate.

Constants of K_g 1140 and B 1.6 will provide an estimate of vibration levels in 'average' conditions. In practice, due to variations in ground conditions and other factors, the resulting ground vibration levels can vary from two fifths to four times that estimated. In cases where the site parameters have not been reliably determined from prior experience, advice should be obtained from suitably qualified and experienced persons, who may recommend initial trial blasts with conservative charge quantities.

Vibration levels have been predicted for the smallest maximum instantaneous charge of 0.812kg and the largest maximum instantaneous charge of 1.72kg. Results at sensitive receivers are shown in .

Table 15 Predicted Vibration at Sensitive Receivers with a K_g Value = 1140

Site Number	Minimum Distance to Blasting (m)	Criteria	Predicted PPV (mm/s)	
			0.812kg Charge	1.72 kg Charge
Residential				
R1	1500	5	0.0	0.0
R2	1300	5	0.0	0.0
R3	1300	5	0.0	0.0
R4	800	5	0.0	0.0
R5	1700	5	0.0	0.0
R6	1100	5	0.0	0.0
R7	1100	5	0.0	0.0
Non - Residential				
N1	2000	5	0.0	0.0
N2	1000	5	0.0	0.0
N3	1100	5	0.0	0.0
N4	860	5	0.0	0.0
N5	1900	5	0.0	0.0
N6	1600	5	0.0	0.0
N7	1600	5	0.0	0.0
N8	400	5	0.1	0.1
N9	780	5	0.0	0.0
N10	180	5	0.2	0.4
N11	450	5	0.1	0.1
N12	210	5	0.2	0.3
N13	740	5	0.0	0.0
N14	310	5	0.1	0.2
N15	510	5	0.0	0.1

Table 15 indicates that blast vibration levels from the largest proposed maximum instantaneous charge of 1.72kg would comply with the appropriate criteria at all sensitive receiver locations under “average” conditions.

Control measures that may be effective in reducing the impact of ground vibration as a result of blasting at a particular site would include one or more of the following:

- Reducing maximum instantaneous charge for example by reducing blasthole diameter or deck loading;
- Using a combination of appropriate delays;
- Allowing for excessive humps or toe in the blast design;

- Optimising blast design by altering drilling patterns, delaying layout or alter blasthole inclination from the vertical;
- Exercising strict control over the location, spacing and orientation of all blastholes an using the minimum practicable sub-drilling that gives satisfactory toe conditions; and
- Establishing times of blasting to suit the situation.

7.2.6 Blasting Noise Levels

Air-blast overpressure noise levels have been calculated based on Australian Standard 2187.2 - 2006 Explosives – Storage and Use Part 2: Use of Explosives. The Standard uses the following equation to calculate blast overpressure (AS2187.2 – 2006, J7.2):

$$P = K_a \left(\frac{R}{Q^{\frac{1}{3}}} \right)^a$$

Where P = pressure, in kilopascals

Q = explosive charge mass, in kilograms

R = distance from charge, in meters

K_a = site constant

a = site exponent

It has been assumed that confined blasthole charges will be used. Australian Standard 2187.2 recommends that a good estimation can be gained by using a site exponent value of a = -1.45. For confined blasthole charges when using an exponent of a = -1.45, the site constant K_a, is commonly in the range 10 to 100.

The results of the calculations for the smallest maximum instantaneous charge of 0.812kg and the largest maximum instantaneous charge of 1.72kg are provided in and using varying values for K_a.

Table 16 Predicted Noise at Receivers from Blasting (K_a = 100)

Site Number	Minimum Distance to Blasting (m)	Criteria	Predicted Airblast Overpressure dB(lin)	
			0.812kg Charge	1.72 kg Charge
Residential				
R1	1500	115	101	104
R2	1300	115	103	106
R3	1300	115	103	106
R4	800	115	109	112
R5	1700	115	99	103
R6	1100	115	105	108
R7	1100	115	105	108
Non - Residential				
N1	2000	115	97	101
N2	1000	115	106	109
N3	1100	115	105	108
N4	860	115	108	111
N5	1900	115	98	101
N6	1600	115	100	103
N7	1600	115	100	103
N8	400	115	118	121
N9	780	115	109	112
N10	180	115	128	131
N11	450	115	116	119
N12	210	115	126	129
N13	740	115	110	113
N14	310	115	121	124
N15	510	115	115	118

Note: Red values signify an exceedance of the criteria.

Table 17 Predicted noise at receivers from blasting (K_a = 10)

Site Number	Minimum Distance to Blasting (m)	Criteria	Predicted Airblast Overpressure dB(lin)	
			0.812kg Charge	1.72 kg Charge
Residential				
R1	1500	115	81	84
R2	1300	115	83	86
R3	1300	115	83	86
R4	800	115	89	92
R5	1700	115	79	83
R6	1100	115	85	88

Site Number	Minimum Distance to Blasting (m)	Criteria	Predicted Airblast Overpressure dB(lin)	
			0.812kg Charge	1.72 kg Charge
R7	1100	115	85	88
Non - Residential				
N1	2000	115	77	81
N2	1000	115	86	89
N3	1100	115	85	88
N4	860	115	88	91
N5	1900	115	78	81
N6	1600	115	80	83
N7	1600	115	80	83
N8	400	115	98	101
N9	780	115	89	92
N10	180	115	108	111
N11	450	115	96	99
N12	210	115	106	109
N13	740	115	90	93
N14	310	115	101	104
N15	510	115	95	98

Note: Red values signify an exceedance of the criteria.

The results in indicate that blast overpressure levels from a 1.72 kg charge would comply with the appropriate criteria at all residential locations and all non-residential except for some industrial premises adjacent to the Project Area with a K_a value of 100. indicates that a 1.72 kg charge would comply with the appropriate criteria at all residential locations and all non-residential locations with a K_a value of 10.

Site constant K_a, and site exponent *a*, are highly dependent on individual site characteristics. For this reason it is recommended that test blasts are used and monitoring is conducted at a sensitive receiver location to determine the exposure to noise. Sensitive receivers close to the Project Area include residential premises and places of worship.

For further noise mitigation it is recommended that noise management measures consistent with the Project's noise and vibration management plan are implemented where practicable. This includes the following measures:

- Experienced blast contractor to be used;
- Series of test blasts to be used to determine site specific conditions. As a results of these tests the Maximum Instantaneous Charge (MIC) should be determined;
- Blasting will be restricted or ceased if the predictions indicate that air blast overpressure levels are likely to be exceeded at neighbouring dwellings unless agreed with the owner(s);
- All reasonable attempts will be made to contact sensitive receivers located within 500 metres of a blast location;
- Linear enclosures or shielding will be used to assist in airblast attenuation if required;
- Ensuring stemming type and length is adequate;
- Using a combination of appropriate delays;
- Eliminating exposed detonating cord. Investigate alternative initiation method;

- Making extra efforts to eliminate the need for two shots (e.g. better control of drill patterns);
- Using survey methods, as appropriate, to ensure burden is adequate;
- Considering delaying or cancelling the blast by not loading if the weather forecast is unfavourable, e.g. storms;
- Allowing for the effects of temperature inversion and wind speed and direction on the propagation of airblast to surrounding areas;
- Orientating faces where possible so that they do not face directly towards residences;
- Varying the direction of initiation;
- Exercising strict control over the burden, spacing and orientation of all blastholes;
- Taking particular care where the face is already broken or where it is strongly jointed, sheared or faulted; and
- Considering deck loading where appropriate to avoid broken ground or cavities in the face (e.g. from back break);
- All blasts should be adequately monitored to help minimise complaints and also to provide documentation in the event of any claims for damages arising from blasting; and

Records of any complaints associated with blasting should be kept, identifying the nature of the complaint, the particular operation that initiated the complaint, and documenting action taken.

8.0 Operational Noise Assessment

Noise emissions from the operation of mechanical plant at the fully converted Clyde Terminal have been modelled in SoundPLAN Version 7.0. The following features were included in the noise model:

- Ground topography;
- Ground absorption;
- Buildings;
- Receivers; and
- Sources (listed in **Table 18**).

Noise emissions from the Project Area have been modelled using an implementation of the Concawe propagation algorithm, which is considered appropriate for the source to closest receiver distances in this study.

8.1.1 Meteorological Considerations

Meteorological effects, such as wind effects and thermal inversions, can increase the impacts at noise sensitive receivers. Meteorological data was obtained from the AECOM Air Quality team.

Meteorological Data

Meteorology in the area surrounding the Clyde Terminal is affected by several factors such as terrain, land use and coastal effects. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale.

In the absence of suitable site-specific meteorological data for the Project Area, the TAPM prognostic model was used to predict local meteorology for use in the modelling. TAPM is an approved model within the NSW Approved Methods where "*neither site-specific nor site-representative meteorological data are available that are suitable for use in regulatory modelling applications*" (DECCW 2005). The TAPM output data were incorporated into the CALMET model for the generation of the required meteorological data sets for the Project Area.

The meteorological data used in the assessment were from the year 2011. These data are the most recent full year available within the TAPM model when the meteorological data file was created in 2012.

Wind Effects

The INP states that wind affects need to be assessed when 'wind speeds (at 10 m height) of 3 m/s or less occur for 30 per cent of the time or more in any assessment period (day, evening, night) in any season'. A summary of the occurrence of winds less than 3m/s is presented as wind roses in **Appendix D**.

Meteorological data shows that winds of less than 3 m/s occurs for more than the 30% requirement specified by the INP, hence a 3m/s source to receiver wind has been included in the model.

Thermal Inversions

The INP states that thermal inversions need to be assessed when an initial screening test shows that inversion effects on noise are potentially significant. "*An occurrence of 30% of the total night –time during winter (June, July and August) has been selected as representing a significant noise impact warranting further assessment*." The data set indicates that moderate and strong (F and G class) temperature inversions occur approximately 88% of the night time period in Winter, above the 30% requirement specified by the INP, hence temperature inversions have been included in the model.

8.2 Noise Sources

Onsite noise sources have been identified by site inspections and measured sound power levels are presented in **Table 18**.

Table 18 Mechanical Plant Sound Power Levels

Plant Item	Overall Sound Power Level, dB(A)	Frequency & Duration of Operation	INP Modifying Factor Penalty*	Operation	
				Day	Night
Return pump to GB	92	24 / 7	-	ON	ON
U91 delivery pump to gantry A & B	99 each	24 / 7	-	A ON, B on call	A ON, B on call
U98 delivery pump to gantry	92	24 / 7	-	ON	ON
U95/U98 recirculation pump	89	24 / 7	-	ON	ON
U95 delivery pump to gantry	88	24 / 7	-	ON	ON
U91 transfer pump to T90	104	24 / 7	-	ON	ON
AGO recirculation pump	102	24 / 7	-	ON	ON
AGO delivery pump to gantry	95	24 / 7	-	ON	ON
AD40 delivery pump to gantry	95	24 / 7	-	ON	ON
Jet A1 delivery pump to JUHI	98	24 / 7	-	ON	OFF
Butane injection pump	95	24 / 7	-	ON	ON
Butane blend / U91 recirculation pump	104	24 / 7	-	ON	ON
Stadis injection pump	89	24 / 7	-	ON	ON
Delivery to NCL - Hunter pump	100	24 / 7	-	ON	ON
Slops transfer pump from T91/92 to T86/87	89	24 / 7	-	ON	ON
Quick flush pumps	104	24 / 7	-	ON	ON
Interface slops transfer pump from import manifold to T82	negligible	24 / 7	-	ON	ON
Slops transfer pump from MCR slop tank to T91/92	negligible	24 / 7	-	ON	ON
Jet A1 recirculation pump	97	24 / 7	-	ON	ON
Instrument air compressor (Duty/Standby)	87	24 / 7	-	ON	ON
AGO delivery pump to Hunter pump	102	24 / 7	-	ON	ON
AGO delivery pump to gantry	95	24 / 7	-	ON	ON
AGO delivery pump to gantry	95	24 / 7	-	ON	ON
AD40 recirculation pump	95	24 / 7	-	ON	ON
Jet A1 delivery pump to JUHI	98	24 / 7	-	ON	ON
Firewater pump testing	99	5 minutes per week	-15 for short duration	ON	OFF
Slops transfer pump from T91/92 to T86/87	89	24 / 7	-	ON	ON

Plant Item	Overall Sound Power Level, dB(A)	Frequency & Duration of Operation	INP Modifying Factor Penalty*	Operation	
				Day	Night
Slops transfer pump from PH2 CPI to T91/92	89	24 / 7	-	ON	ON
Heavy vehicles on site	108	257 per day, travelling on site for 5 mins each	-	ON	OFF
Light vehicles on site		32 per day travelling on site for 1 min each	-	ON	OFF

8.3 Results

Table 19 Predicted Operational Noise Impacts, dB(A)

Rec	Address	Floor	Day			Night		
			EPA Noise Goals	Predicted $L_{eq\ (15min)}$	Exceed.	EPA Noise Goals	Predicted $L_{eq\ (15min)}$	Exceed.
Residential Receivers								
R1	128 James Ruse Dr, Rosehill	1	42	36	-	40	31	-
R2	82–100 James Ruse Dr, Rosehill	1	42	38	-	40	32	-
		2	42	38	-	40	32	-
		3	42	38	-	40	32	-
		4	42	38	-	40	32	-
		5	42	38	-	40	32	-
		6	42	38	-	40	32	-
R3	71 James Ruse Dr, Rosehill	1	42	38	-	40	31	-
		2	42	38	-	40	31	-
R4	92 Asquith St, Silverwater	1	41	37	-	36	36	-
R5	1-9 Mockridge Ave, Newington	1	41	35	-	36	33	-
		2	41	36	-	36	33	-
		3	41	36	-	36	33	-
		4	41	36	-	36	33	-
R6	529 John St, Rydalmere	1	41	38	-	36	34	-
R7	35 John St, Rydalmere	1	41	40	-	36	36	-
Non-Residential Receivers								
N1	Our Lady of Lebanon Maronite Church	1	45 (internal)	18 (internal)1	-	-	15 (internal)1	-
N2	C3 Church, Silverwater	1	45 (internal)	31 (internal)1	-	-	28 (internal)1	-
N3	Sydney Korean Catholic Community Church	1	45 (internal)	28 (internal)1	-	-	25 (internal)1	-

Rec	Address	Floor	Day			Night		
			EPA Noise Goals	Predicted $L_{eq\ (15min)}$	Exceed.	EPA Noise Goals	Predicted $L_{eq\ (15min)}$	Exceed.
N4	Sydney Baha'I Centre	1	45 (internal)	31 (internal)[1]	-	-	28 (internal)[1]	-
		2	45 (internal)	31 (internal)[1]	-	-	28 (internal)[1]	-
		3	45 (internal)	31 (internal)[1]	-	-	28 (internal)[1]	-
N5	Our Lady of Lebanon Aged Care Hostel	1	41[2]	32	-	36[2]	26	-
N6	Rosehill Child Care Centre	1	41[2]	35	-	36[2]	29	-
N7	Rosehill Public School	1	45 (internal)	25 (internal)[1]	-	-	19 (internal)[1]	-
N8	Bordering Industrial Premises - East	1	75	52	-	-	48	-
N9	Bordering Industrial Premises – North	1	75	46	-	-	41	-
N10	Bordering Industrial Premises – North East	1	75	51	-	-	48	-
N11	Bordering Industrial Premises – North West	1	75	60	-	-	51	-
N12	Bordering Industrial Premises – South	1	75	44	-	-	45	-
N13	Bordering Industrial Premises – South East	1	75	50	-	-	49	-
N14	Bordering Industrial Premises – South West	1	75	49	-	-	43	-
N15	Bordering Industrial Premises – West	1	75	52	-	-	45	-

Notes:

1. Noise management level is internal noise level. Generally a 10 dB reduction can be achieved with an open window and 20 dB with a closed window.
2. In the absence of a noise management level for aged care facilities or child care facilities, the Our Lady of Lebanon Aged Care Hostel and Rosehill Child Care Centre has been assessed against the residential noise goals.

Results show that no exceedances of INP noise goals are predicted at any affected receivers during the day or night during worst case operations. Noise impacts at both R4 – 92 Asquith Street, Silverwater to the south, and R7 – 35 John Street, Rydalmere, to the north east, are predicted to equal the night time noise criteria of 36dB(A).

Since no exceedances are predicted, no mitigation measures are considered necessary for operations at the Clyde Terminal.

8.4 INP Modifying Factors

Noise emissions from the Clyde Terminal were not identified as being impulsive, intermittent or irregular. Noise emissions have been assessed at the receivers for tonality and low-frequency using modelled predictions. No results showed tonal characteristics or low-frequency components in noise emissions. A full assessment of tonality and low-frequency at the nearest receivers is included in **Appendix C**.

9.0 Traffic Noise Assessment

9.1 Impact of Increased Road Traffic Noise

The impact of increased road traffic noise from traffic generated by the Project has been assessed in accordance with the EPA Road Noise Policy (RNP). Traffic data was obtained from a Traffic Impact Assessment of an integrated recycling park at Grand Avenue, Camellia, prepared in 2011 by Traffix Traffic and Transport Planners.

The residential property likely to be most affected by noise from traffic generated by the proposed Project is 43 Oak St, Rosehill, affected by traffic leaving the Clyde Terminal along James Ruse Drive. Noise impacts have been calculated at 1 m from the most affected facade of this property in accordance with the RNP. No traffic noise measurements were conducted due to the low volumes of site generated traffic and low likelihood of issues with traffic noise increases.

Traffic noise impacts have been calculated using the Calculation of Road Traffic Noise (CoRTN) algorithm. Existing and increased traffic flows as well as noise level increases are detailed in **Table 20**. Only AM and PM peak hourly traffic volumes were available for this area. Peak hourly compliance with L_{Aeq} noise goals will ensure daytime 15 hour levels also comply.

It is noted that the traffic counts taken to determine existing traffic flows included traffic from the previous operating conditions of the Parramatta Terminal. Counts excluding Parramatta Terminal traffic were not available, however the impact of Parramatta Terminal traffic on overall results is expected to be minor.

In the absence of peak hour traffic generated at the Clyde Terminal, it has been assumed that light vehicles, which will be predominantly workers' vehicles, arrive and depart in the same hour at the beginning or end of a working day, and heavy vehicles, which will predominantly be deliveries, will arrive spread evenly across an eight hour working day.

Table 20 Existing and Proposed Traffic Volumes

Data Type	Previous Refinery Operations	Existing traffic flows	Construction & Demolition		Operation	
			Overall traffic flow	Change in traffic flow	Overall traffic flow	Change in traffic flow
Average annual daily traffic	238LV 265HV	40LV 257HV	169 LV 277 HV	+129LV +20HV	32 LV 257 HV	-8LV 0HV
Peak hour traffic*	119 LV 33 HV	20LV 32HV	85 LV 35 HV	+65LV +3 HV	16 LV 32 HV	-4 LV 0 HV

Notes: Peak hour traffic volumes assume 50% of light vehicles arrive in 1 hour in morning and 50% in 1 hour in afternoon, heavy vehicles arrive spread evenly over an 8 hour day.

Traffic volumes include traffic flows generated by the Clyde Terminal as well as other supply terminals.

The construction and demolition activities at the Clyde Terminal will produce daily traffic flows of approximately 169 light vehicles and 277 heavy vehicles. This results in a peak hourly increase of 65 light vehicles and an increase of 3 heavy vehicles.

The operation of the fully converted Clyde Terminal will produce daily traffic flows of 32 light vehicles and 257 heavy vehicles per day. This results in a peak hourly decrease of 4 light vehicles and no change in heavy vehicles.

Table 21 shows resultant noise levels from each scenario.

Table 21 Summary of Traffic Flow Increase in the Peak Periods (Vehicles/hr)

Period	Traffic Noise Criteria (Daytime)	Existing Traffic Flow (including traffic generated by previously operating refinery)		Proposed Construction & Demolition Traffic Flow		Increase in Noise Levels, dB(A)	Proposed Operation Traffic Flow		Increase in Noise Levels, dB(A)
		Volume	Noise Impact at Most Affected Resident* L_{Aeq} dB(A)	Volume	Noise Impact at Most Affected Resident* L_{Aeq} dB(A)		Volume	Noise Impact at Most Affected Resident* L_{Aeq} dB(A)	
James Ruse Dr, south of Grand Ave									
AM	60	5704	79	5672	79	0	5600	79	0
PM	60	6681	80	6649	80	0	6577	80	0

Notes: * Most affected resident from traffic noise from Project is 43 Oak Street, Rosehill.

Data source: Traffic Impact Assessment of an integrated recycling park at Grand Avenue, Camellia, Traffix Traffic and Transport Planners, 2011.

Existing noise levels are calculated to be 79 dB(A) during the AM peak hour and 80 dB(A) during the PM peak hour, which are above the noise assessment criteria. Noise levels resulting from increased peak hour traffic flow are not predicted to increase exiting noise levels. The RNP states *"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",* hence no mitigation measures are considered necessary.

The existing OEMP includes provisions for vehicle protocols in and around the Clyde Terminal and the Parramatta Terminal. This would be revised for the operations once the demolition and construction works have been completed.

10.0 Conclusion

A noise and vibration assessment has been conducted for the demolition and construction associated with the conversion of the Clyde Terminal and continued operation solely to store, blend and distribute finished petroleum products.

Unattended noise monitoring has been conducted at two locations representing the worst affected receiver catchment areas surrounding the Project Area. Attended measurements were also conducted to validate unattended monitoring results and quantify industrial noise contributions to the background noise levels, in accordance with the INP.

Noise impacts have been assessed to four catchment areas:

- Rosehill;
- Silverwater;
- Newington; and
- Rydalmere.

The potential for adverse noise impact as a result of construction and operational activities has also been assessed to potentially affected non-residential receivers in the area.

Construction Noise

Construction noise has been assessed in accordance with the ICNG. Exceedances have been predicted of up to 4dB(A) at some residential receivers, however this is assuming included plant is operating simultaneously and is a conservative prediction. Mitigation measures and management procedures have been recommended to reduce construction noise impacts and minimise disturbance to residences.

Construction Vibration

Adverse impacts on surrounding structures or comfort of residences from construction vibration is highly unlikely due to large distances to the nearest residences and the absence of plant which produce significant vibration levels. No mitigation measures are considered necessary.

Construction Blasting

Blast vibration and overpressure levels are largely dependent ground composition, blast pressure and charge mass.

Blast vibration levels from a 1.72 kg charge are predicted to comply with the appropriate criteria at all sensitive receiver locations under “average” conditions.

Blast overpressure levels from a 1.72 kg charge are predicted to comply with the appropriate criteria at all residential locations and all non-residential locations except for some industrial premises adjacent to the Project Area with a site constant K_a value of 100. A 1.72 kg charge would comply with the appropriate criteria at all residential and all non-residential locations with a K_a value of 10. For confined blasthole charges when using an exponent of a = -1.45, the site constant K_a, is commonly in the range 10 to 100.

Mitigation measures have been provided in order to minimise impacts of blasting.

Operational Noise

Noise from the worst case proposed Clyde Terminal operations has been assessed in accordance with the INP, with a worst case meteorological scenario of a 3m/s source to receiver wind and an F-class temperature inversion assumed. No exceedances are predicted at any surrounding residential or non-residential receiver, and therefore no mitigation measures are considered necessary. No INP modifying factor adjustments are required for noise emissions from the Clyde Terminal.

Construction Generated Traffic Noise

Increased noise from construction traffic, generated by the vehicles involved with the conversion of the Clyde Terminal, has been assessed and is predicted to increase existing noise levels by less than 2dB, representing a minor impact that is considered barely perceptible to the average person. No mitigation is considered necessary for traffic generated noise.

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.

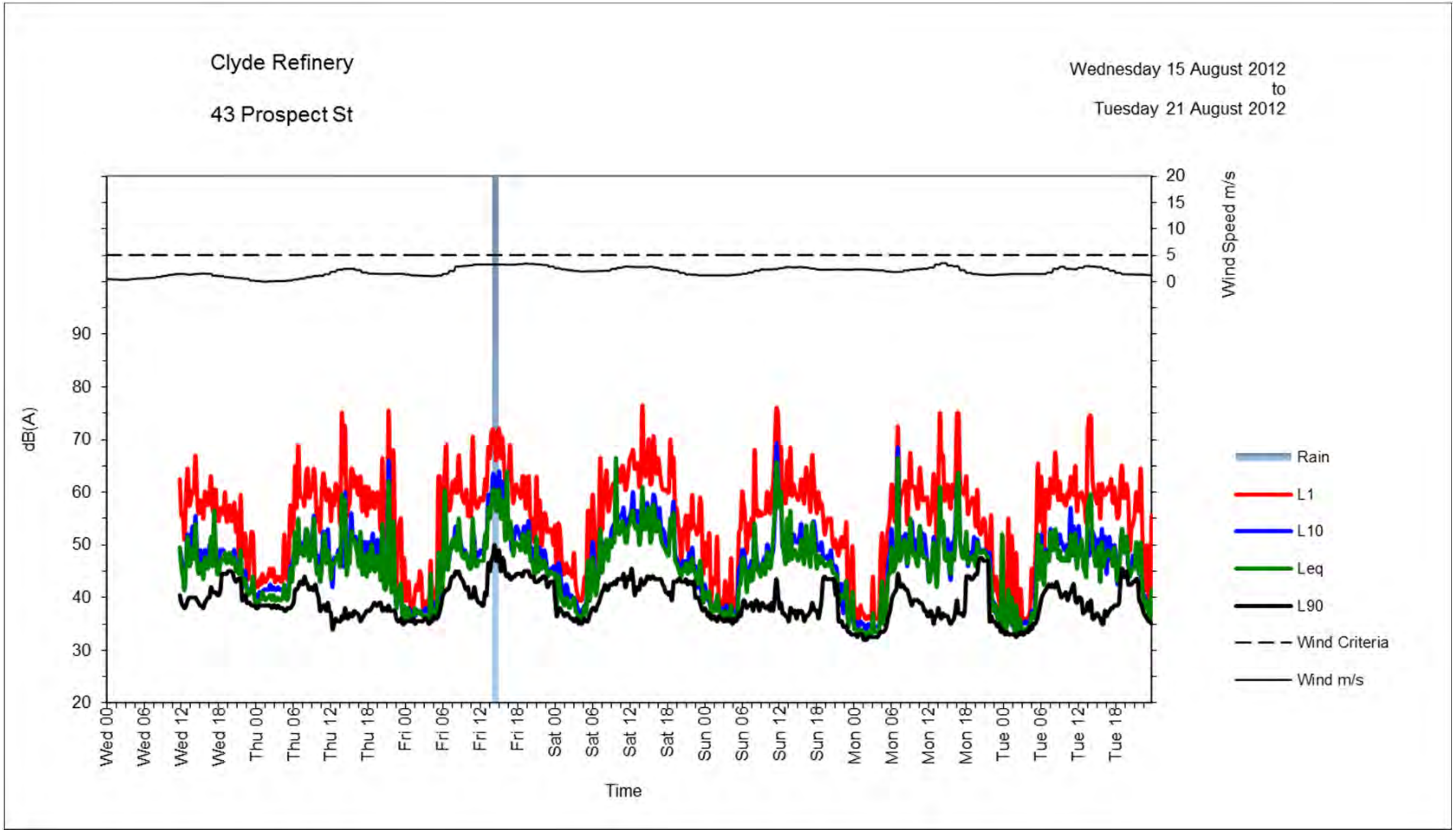
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound 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.

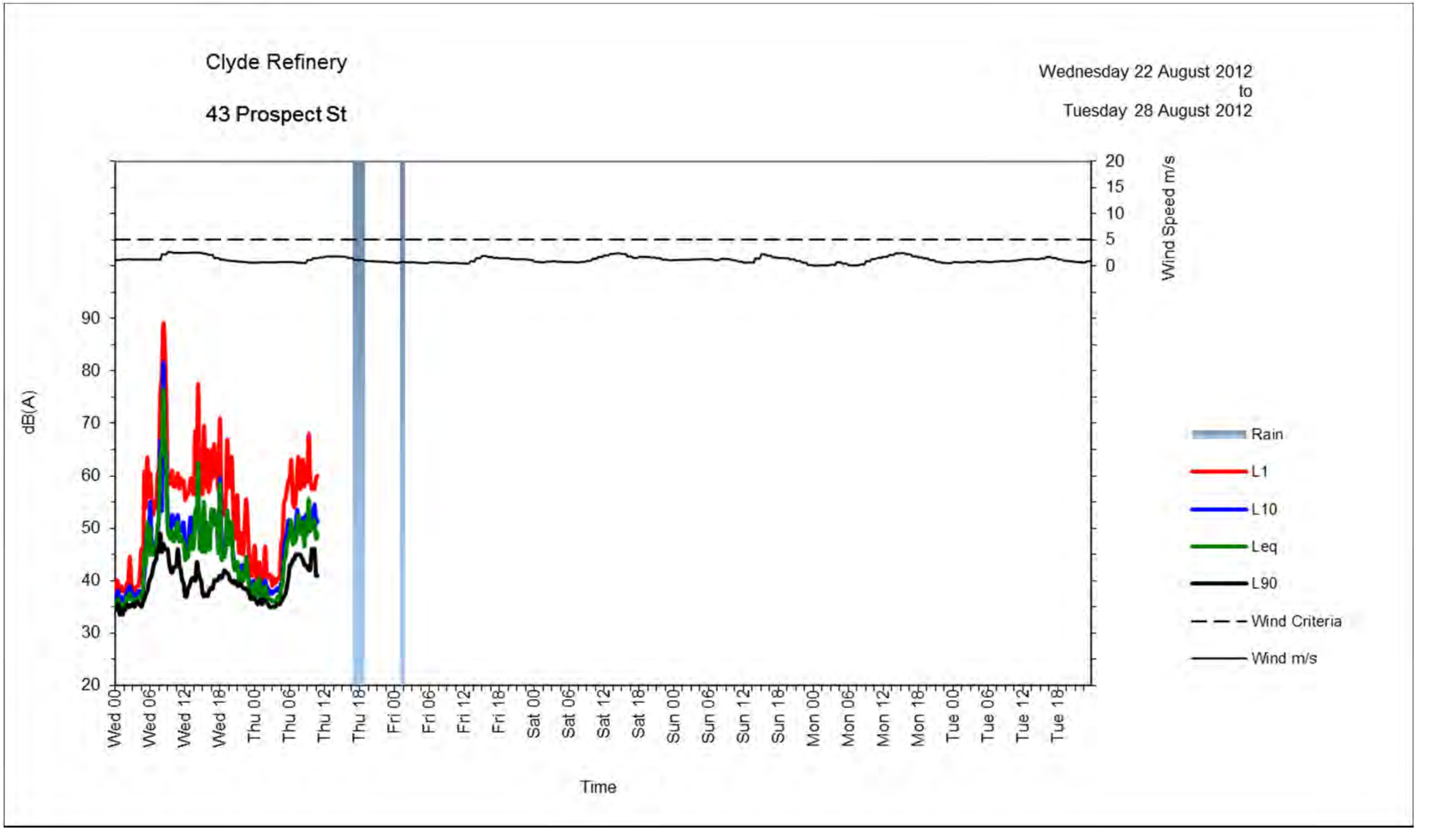
*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Industrial Noise Policy and the EPA's Road Noise Policy.

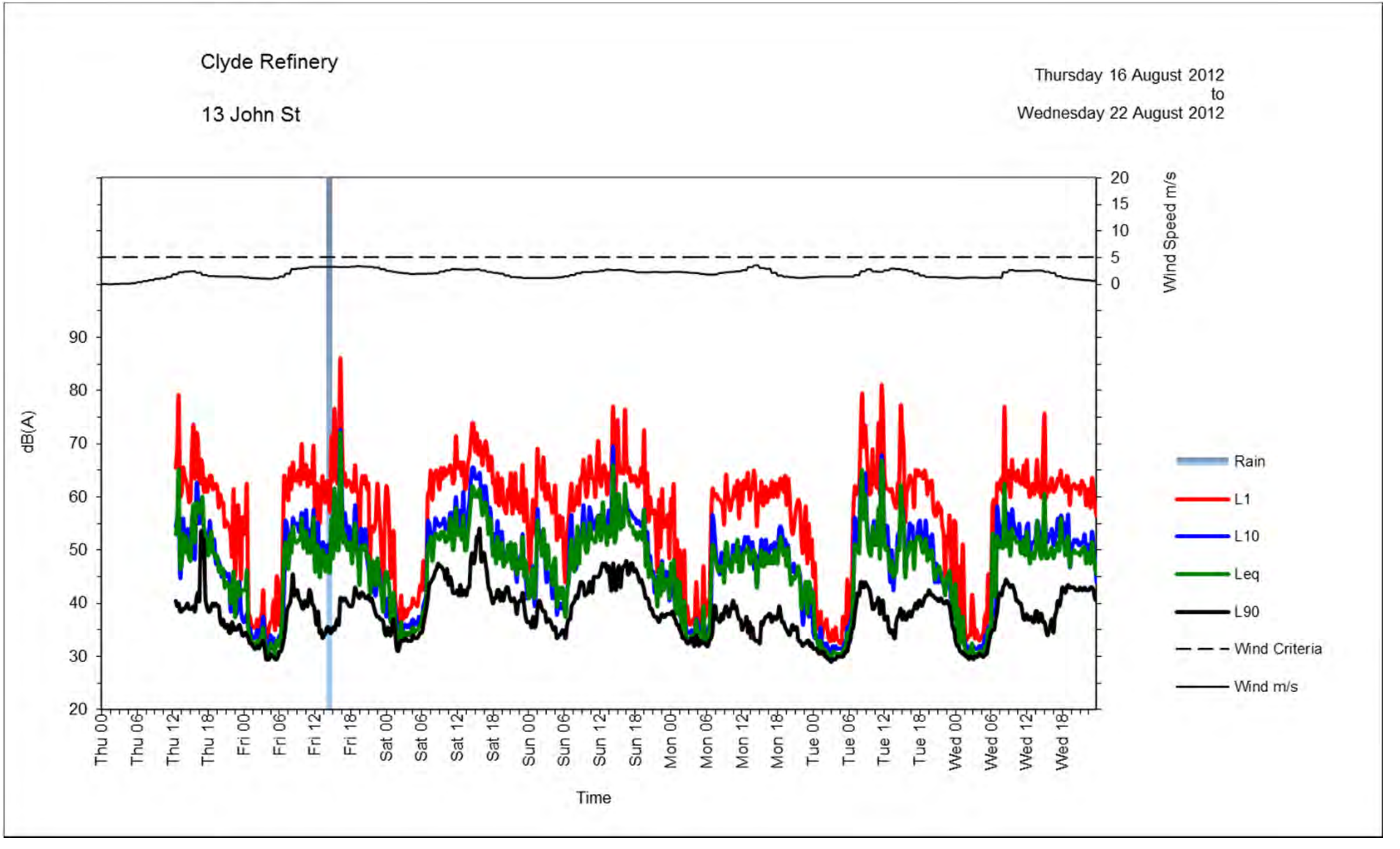
Appendix B

Logger Graphs

Appendix B Logger Graphs




Clyde Refinery
43 Prospect St
Wednesday 22 August 2012
to
Tuesday 28 August 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Clyde Refinery
13 John St
Thursday 16 August 2012
to
Wednesday 22 August 2012
dB(A)
Wind Speed m/s
20
15
10
5
0
90
80
70
60
50
40
30
20
Thu 00
Thu 06
Thu 12
Thu 18
Fri 00
Fri 06
Fri 12
Fri 18
Sat 00
Sat 06
Sat 12
Sat 18
Sun 00
Sun 06
Sun 12
Sun 18
Mon 00
Mon 06
Mon 12
Mon 18
Tue 00
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Wed 12
Wed 18
Time
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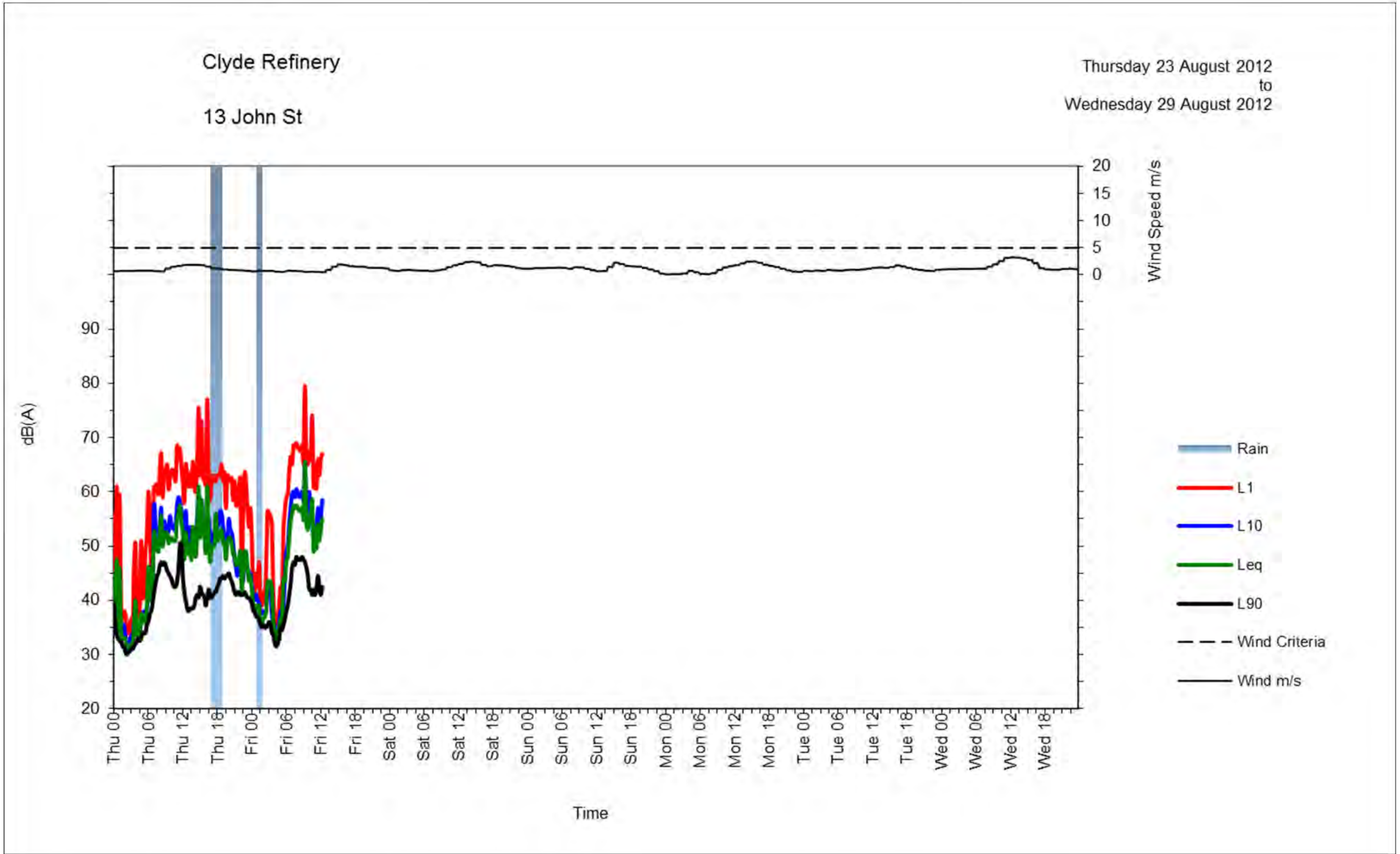
L1
L10
Leq
L90
Wind Criteria
Wind m/s


Clyde Refinery
13 John St
Thursday 23 August 2012
to
Wednesday 29 August 2012
dB(A)
Wind Speed m/s
Time
Rain
L1
L10
Leq
L90
Wind Criteria
Wind m/s
Thu 00
Thu 06
Thu 12
Thu 18
Fri 00
Fri 06
Fri 12
Fri 18
Sat 00
Sat 06
Sat 12
Sat 18
Sun 00
Sun 06
Sun 12
Sun 18
Mon 00
Mon 06
Mon 12
Mon 18
Tue 00
Tue 06
Tue 12
Tue 18
Wed 00
Wed 06
Wed 12
Wed 18

Appendix C

Tonality and Low-Frequency Noise Assessment

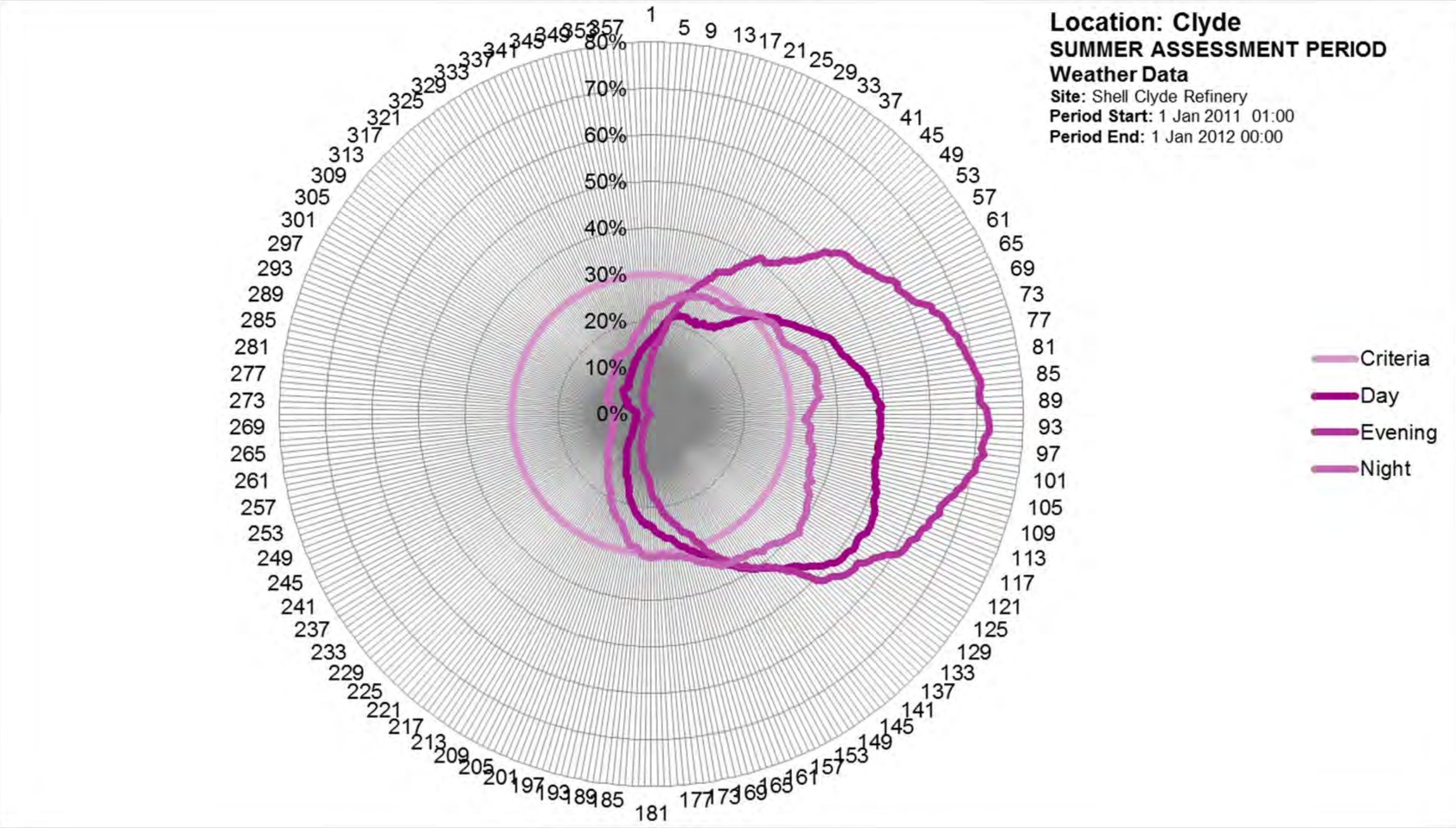
Appendix C Tonality and Low-Frequency Noise Assessment

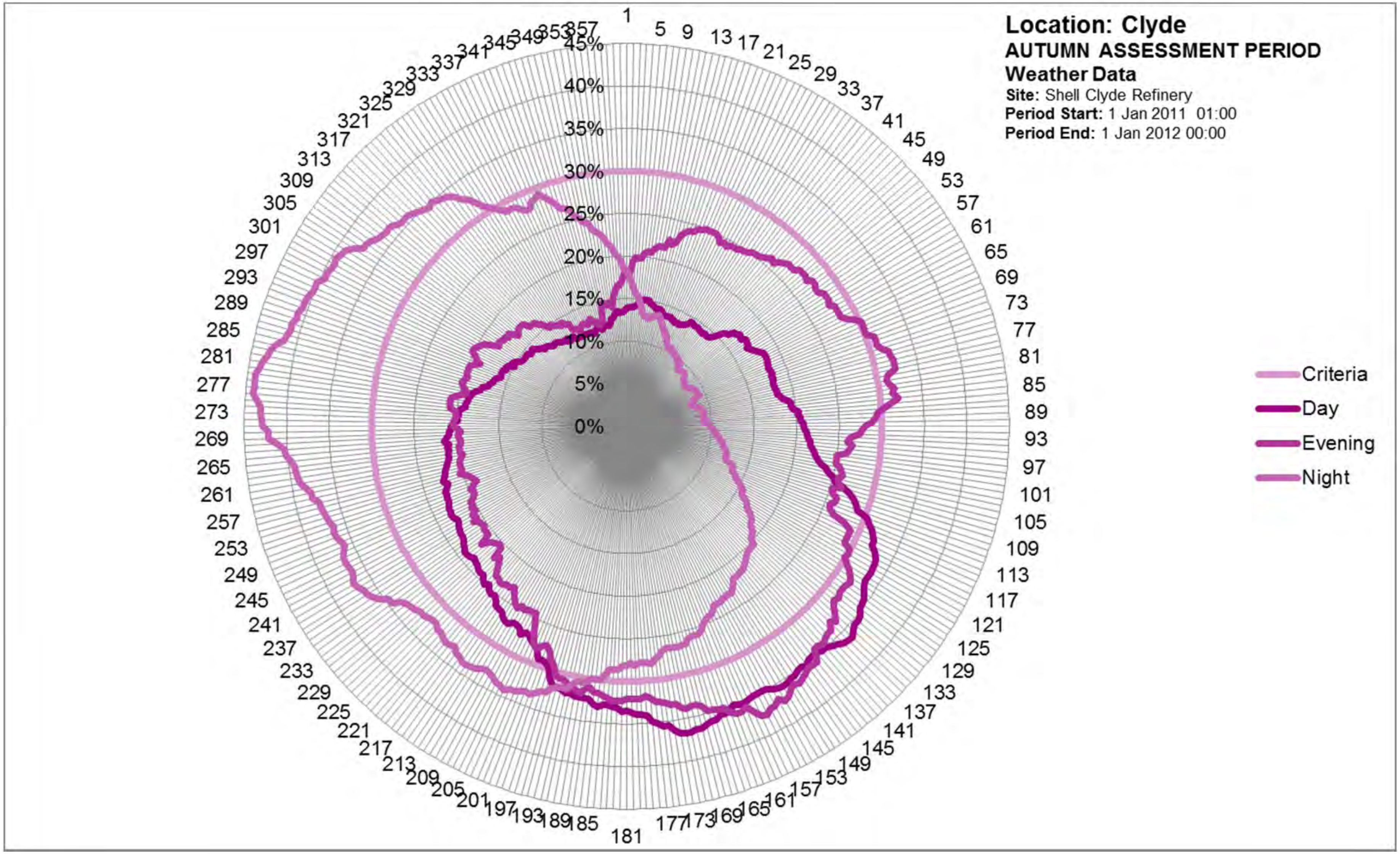
1/3 Octave Band (Hz)	1/3 Octave Band INP Exceedance Criteria (dB)	Measured Background at Worst Affected Receiver (dB)	Predicted Contribution (dB)		Tonality Check		Contribution + Background (dB)		Tonality Check	
			R7	R4	R7	R4	R7	R4	R7	R4
25	15	35	26	23	-	-	35	35	-	-
31.5	15	36	26	23	-	-	36	36	-	-
40	15	39	34	29	-	-	40	39	-	-
50	15	39	30	26	-	-	40	40	-	-
63	15	40	26	23	-	-	40	40	-	-
80	15	40	27	24	-	-	40	40	-	-
100	15	37	27	25	-	-	38	38	-	-
125	15	36	28	27	-	-	37	37	-	-
160	8	33	25	25	-	-	33	33	-	-
200	8	31	24	24	-	-	32	32	-	-
250	8	30	26	26	-	-	31	32	-	-
315	8	28	28	30	-	-	31	32	-	-
400	8	28	31	32	-	-	33	33	-	-
500	5	28	30	30	-	-	32	32	-	-
630	5	27	30	31	-	-	32	32	-	-
800	5	25	28	28	-	-	30	30	-	-
1000	5	24	27	27	-	-	29	29	-	-
1250	5	22	27	25	-	-	28	27	-	-
1600	5	20	24	21	-	-	25	23	-	-
2000	5	16	22	19	-	-	23	21	-	-
2500	5	13	17	14	-	-	18	16	-	-
3150	5	9	14	11	-	-	15	13	-	-
4000	5	5	6	2	-	-	8	7	-	-
5000	5	3			-	-	3	3	-	-
6300	5	2			-	-	2	2	-	-
8000	5	1			-	-	1	1	-	-
	Overall (dB(A))	34	36	36			38	38		
	Overall (dB(C))	47	40	40			48	48		
	dB(C) - dB(A)	13	5	4			10	10		
	Low Frequency	**No**	**No**	**No**			**No**	**No**		

Appendix D

Wind Roses

Appendix D Wind Roses

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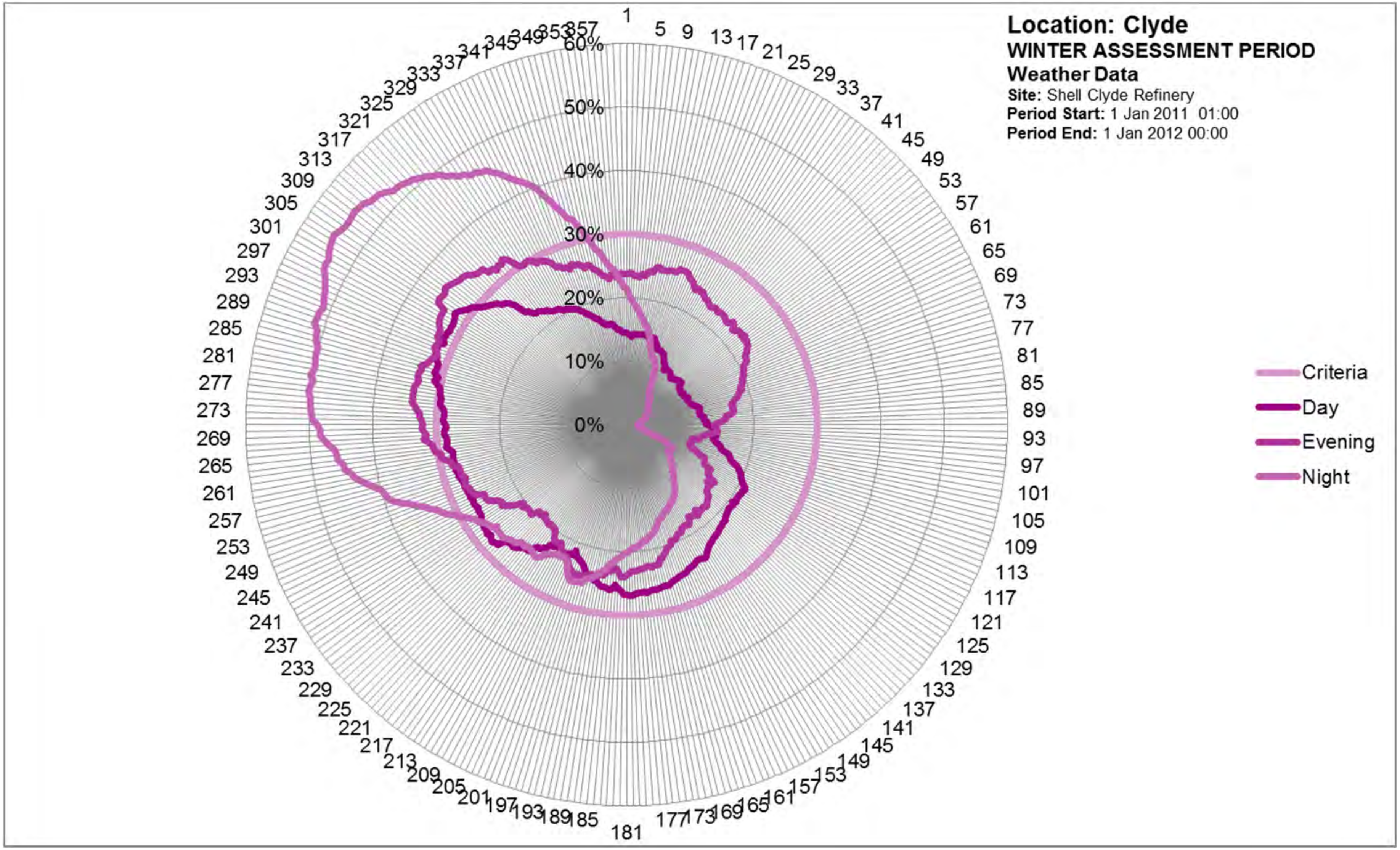
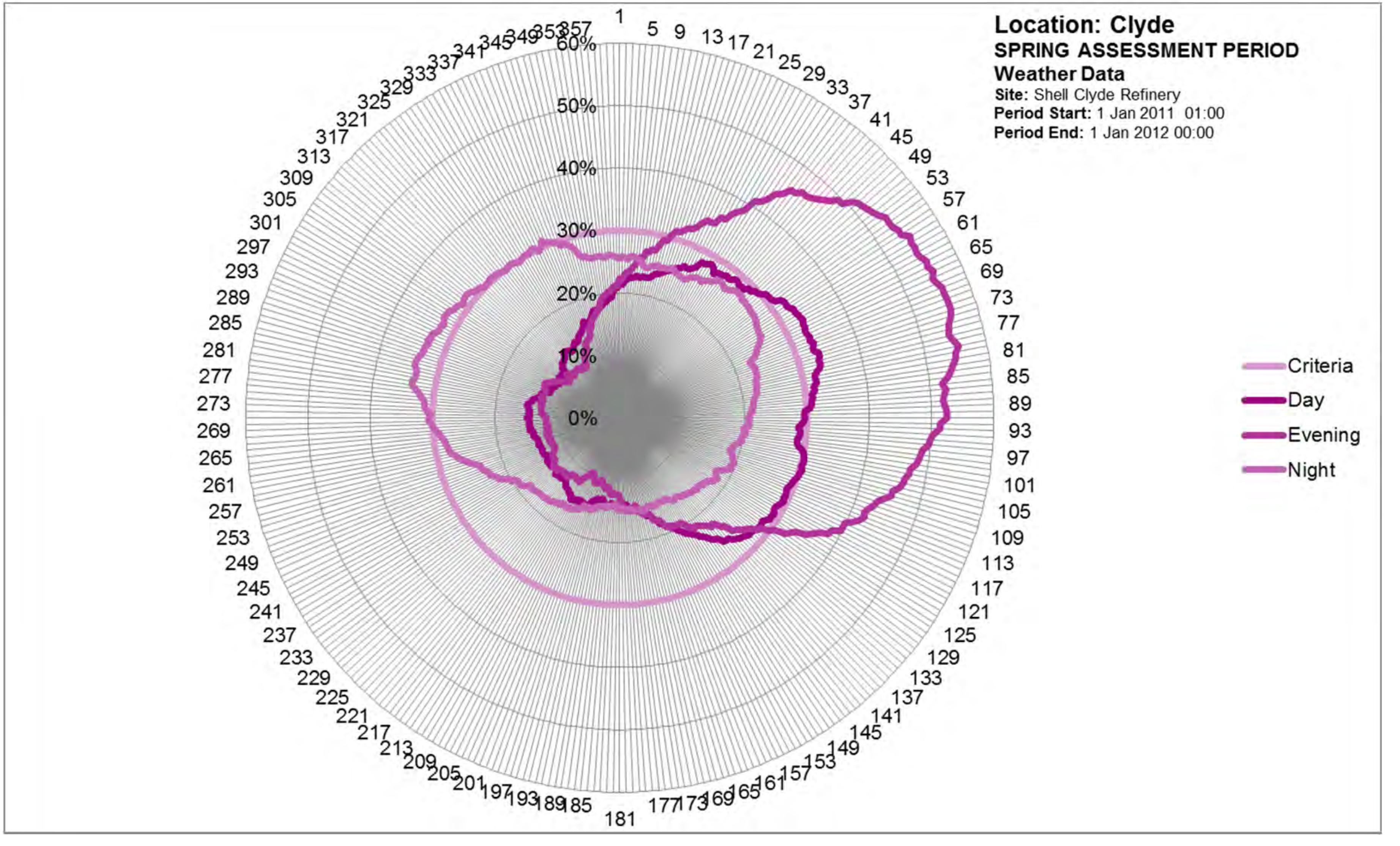
AUTUMN ASSESSMENT PERIOD
Weather Data
Site: Shell Clyde Refinery
Period Start: 1 Jan 2011 01:00
Period End: 1 Jan 2012 00:00
Criteria
Day
Evening
Night
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%


Location: Clyde
WINTER ASSESSMENT PERIOD
Weather Data
Site: Shell Clyde Refinery
Period Start: 1 Jan 2011 01:00
Period End: 1 Jan 2012 00:00
60%
50%
40%
30%
20%
10%
0%
Criteria
Day
Evening
Night


Location: Clyde
SPRING ASSESSMENT PERIOD
Weather Data
Site: Shell Clyde Refinery
Period Start: 1 Jan 2011 01:00
Period End: 1 Jan 2012 00:00
Criteria
Day
Evening
Night
0%
10%
20%
30%
40%
50%
60%

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