

NOISE AND VIBRATION

A noise and vibration assessment of the LNG Facility proposed for Curtis Island and associated infrastructure in the Gladstone region as part of the Queensland Curtis LNG (QCLNG) Project has been undertaken¹. This assessment:

- quantifies the existing noise environment, based on unattended and short-term attended noise monitoring
- proposes Project noise and vibration objectives to facilitate assessment of impacts in accordance with relevant guidelines
- models the construction and operational noise for assessment locations based on anticipated operations
- assesses potential noise impacts arising from the QCLNG Project
- investigates cumulative noise levels for proposed industrial projects in the locality
- proposes in-principle management strategies to mitigate impacts where required.

Activities associated with construction and operation of the proposed LNG Facility addressed as part of the noise and vibration assessment encompass:

A. Construction of the LNG Facility on Curtis Island, including:

- construction activities on the LNG Facility site
- transport of equipment and personnel across Gladstone Harbour from Auckland Point
- laydown area at Auckland Point
- road traffic noise within the Gladstone region associated with construction activities, focused on Auckland Point
- construction of a new ferry terminal near RG Tanna or bridge/road to Curtis Island (if built)
- construction of the Export Pipeline within the Gladstone region (east of Calliope River–Targinie Road)

B. Operational activities, including:

- LNG Facility operation on Curtis Island
- LNG vessels transiting Gladstone Harbour
- LNG shipping including transit of Gladstone Harbour by ferry (or road traffic if bridge/road is constructed).

¹ Environmental Resources Management Australia, 2009. *Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure: Noise and Vibration Impact Assessment*. Unpublished report for Queensland Gas Company Limited (QGC), Report Reference 0086165/20_Noise&Vibration_R01.v0, April 2009.

A summary of the existing noise environment, assessment methodology, and key findings of the noise and vibration assessment is outlined below. The complete noise and vibration assessment *Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure: Noise and Vibration Impact Assessment* (April 2009) is included in *Appendix 5.14*.

The Project environmental objective for noise and vibration is: to ensure that impacts arising from noise and vibration on ecological health, public amenity or safety are minimised.

13.1 **EXISTING NOISE ENVIRONMENT (BASELINE ASSESSMENT)**

A key element in assessing environmental noise is quantification of the existing ambient and background noise environment.

13.1.1 **Noise Assessment Locations**

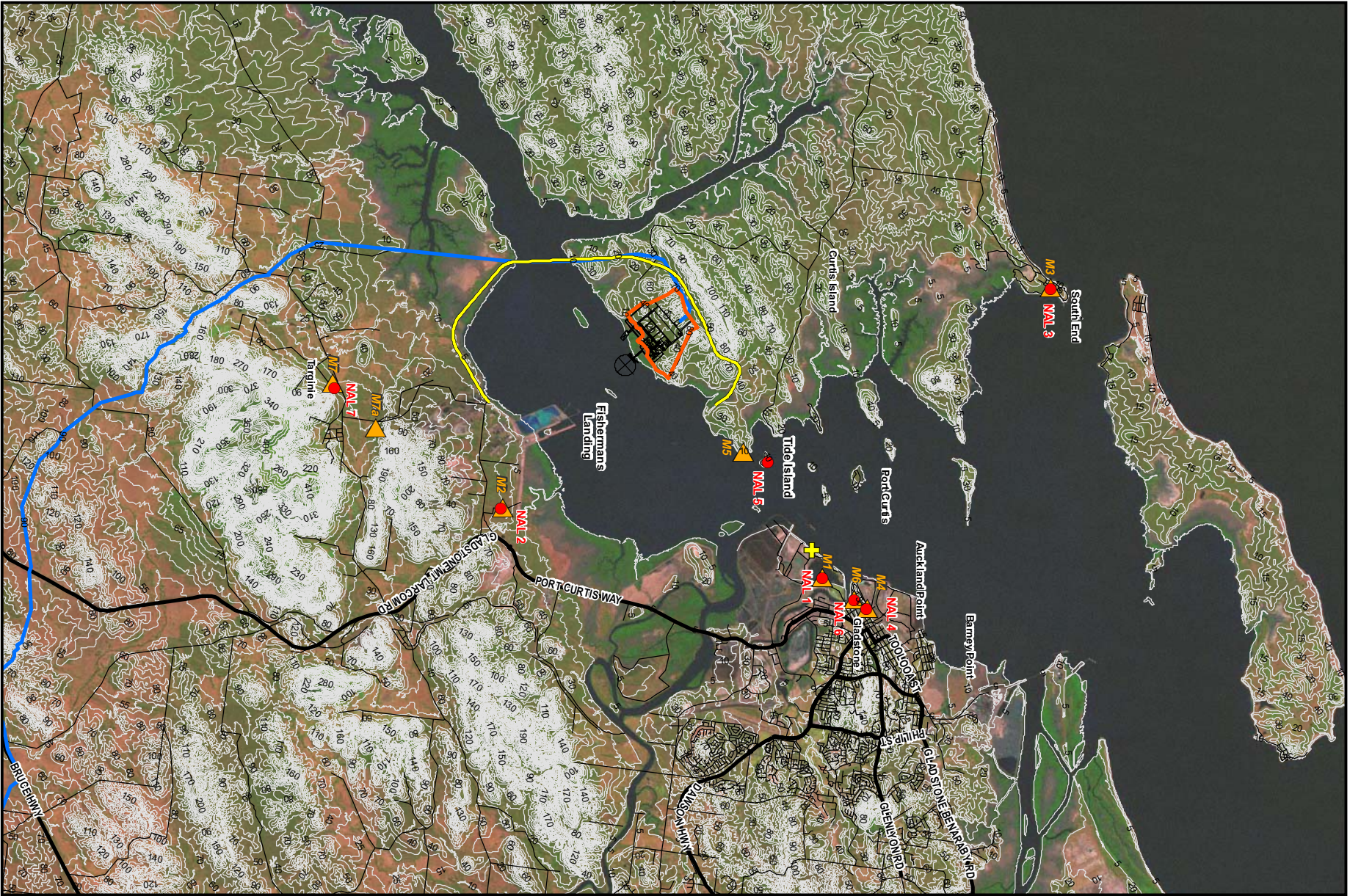
Seven residential properties were identified as representative of the nearest sensitive receptors for noise from the proposed LNG Facility and were designated as noise assessment locations (NALs) for the purposes of the assessment. These NALs are summarised in *Table 5.13.1* and are illustrated in *Figure 5.13.1*.

Table 5.13.1 Noise Assessment Locations

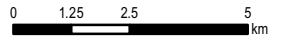
Noise Assessment Location	Address	Approximate Distance from Curtis Island LNG Site (km)
NAL 1	Jetty G/H, Gladstone Marina	8.5
NAL 2	Lot 2 Fisherman's Road, Yarwun	6.5
NAL 3	Turtle Street, South End, Curtis Island	11.5
NAL 4	71 Flinders Parade, Gladstone	10
NAL 5	Tide Island	5
NAL 6	12 Lord St, Gladstone	9.5
NAL 7	Smith St, Targinie	9

13.1.2 **Unattended Monitoring**

Five noise loggers (M1–M5) were used to monitor background noise levels at locations that were conservatively selected as having an acoustic climate representative of the NALs. The loggers continuously recorded and logged noise statistics every hour for the duration of logging. Additional data from prior studies was obtained for locations M6 and M7. Noise monitoring locations and durations are summarised in *Table 5.13.2*, while the locations are shown in *Figure 5.13.1*.



Projection: UTM MGA Zone 56 Datum: GDA 94



Legend

- Proposed QCLNG Site Boundary
- QCLNG Footprint Plant Layout
- Possible Curtis Island Road/ Bridge Corridor
- Proposed Export Pipeline
- Major Roads
- ▲ Noise Monitoring Locations
- Noise Assessment Locations
- + Proposed Ferry Terminal

Source Note:

StreetPro Australia - Pitney Bowes MapInfo
 Curtis Island Road/Bridge - Connell Wagner
 Environmental Resources Management Australia, 2009.
 Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure:
 Noise and Vibration Impact Assessment.
 Unpublished report for Queensland Gas Company Limited (QGC),
 Report Reference 0086165/20_Noise&Vibration_R01.v0, April 2009.



 QUEENSLAND CURTIS LNG <small>A BG group business</small>		 Environmental Resources Management Australia Pty Ltd	
Project Queensland Curtis LNG Project		Title Noise Assessment Locations	
Client GGC - A BG Group business		Volume Volume 5	
Drawn KP	Approved DS	Figure Figure 5.13.1	
Date 05.05.09	Revision 1	Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.	

Table 5.13.2 Unattended Noise Monitoring Locations

Monitoring Location	Address	Start-Finish Date (Duration)	Logging Representative of:	Monitoring Source Company
M1	Jetty G/H, Gladstone Marina	9 - 25 Sept 08 (17 days)	Permanent residents living on boats in the marina	ERM
M2	Lot 2 Fisherman's Road, Yarwun	9 - 25 Sept 08 (17 days)	Resident	ERM
M3	Turtle Street, South End, Curtis Island	10 - 26 Sept 08 (17 days)	Resident	ERM
M4	71 Flinders Parade, Gladstone	10 - 26 Sept 08 (17 days)	Resident	ERM
M5 ¹	Hamilton Point, Curtis Island	10 - 26 Sept 08 (17 days)	Tide Island resident	ERM
M6	12 Lord St, Gladstone	5 -19 April 06 (15 days)	Resident	Heggies Australia ²
M7a ²	Forest Road, Targinie	12-19 Apr 08 (8 days)	Smith St, Targinie Resident	Savery & Ass ³

1. Monitoring undertaken at Hamilton Point proxy for Tide Island.

2. Monitoring was undertaken at a location representative of the Targinie area.

Noise loggers M4 (Flinders Parade) and M5 (Hamilton Point) also recorded one-minute audio samples at the beginning of each hourly statistical sample throughout the duration of noise logging. This data was used in addition to attended noise monitoring to better quantify the existing ambient noise environment.

Weather data including wind speed, direction and rainfall for the sample period was sourced from both Gladstone Airport and Gladstone Radar weather stations operated by the Bureau of Meteorology (BOM). For periods where wind speeds exceeded 5 m/s, or while raining, noise data from the affected period was disregarded. The logger data has been separately processed using both sets of weather data; with the lower of the two resulting Rating Background Level (RBL) values being adopted.

Unattended noise monitoring data is presented in *Sub-Annex B* of the appended *Noise and Vibration Impact Assessment (Appendix 5.14)*.

2 Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006.

3 Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing", Document No. S792-1, Revision 0, dated 23 July 2008.

13.1.3 ***Attended Monitoring***

Day, evening and night-time attended monitoring was conducted to supplement the unattended noise monitoring surveys and to quantify the contribution from existing industry, road and other sources at the noise assessment locations.

The attended monitoring indicated that industrial, road traffic or rail noise was audible at all locations at various times of the day, with the exception of NAL 3 (South End, Curtis Island). The results of the unattended and attended monitoring events are summarised in *Sub-Annex B of Appendix 5.14* of the appended *Noise and Vibration Impact Assessment*.

13.1.4 ***Seasonal Variation in Noise Levels***

Seasonal variations in ambient noise levels can have significant effects on monitored noise levels. Seasonal variations in ambient noise levels are typically the result of an increase in insect activity, which usually occurs in the warmer months of the year.

To determine the contribution from insect noise, spectral unattended noise monitoring data was analysed for NAL 2 (Fisherman's Landing), NAL 3 (South End) and NAL 5 (Tide Island) (insects were audible at these locations during attended monitoring). Hourly audio recordings taken with unattended monitoring for NAL 5 were also used to determine insect presence and to correlate spectral data with audible noise sources.

Analysis of the spectra and audio recordings show a significant contribution from insect noise during the evening at the three locations. Analysis also shows that while insect noise was present during the evening, the night-time contribution was negligible and as such does not affect monitored Rating Background Level (RBL) at these three locations. Evening RBL levels will be increased by insect noise in some cases. However this does not have a significant effect on the noise criteria.

13.1.5 ***Analysis and Summary of Results***

Analysis of logger data was conducted in accordance with the Department of Environment and Resource Management (DERM), formerly the Environmental Protection Agency, EcoAccess guideline⁴. The methodology is prescribed in terms of the measured Assessment Background Level (ABL) and RBL or $\text{min}L_{A90,1\text{hour}}$. In accordance with the EcoAccess guideline, a minimum of one week of representative data was then selected for analysis to determine the RBL.

Table 5.13.3 provides a summary of RBL values for each noise monitoring

⁴ Queensland Environmental Protection Agency. *Guideline – Noise: Planning for Noise Control*

location. In addition to the day, evening, and night periods, a RBL value has been calculated for 6 am to 7 am for the locations monitored by Environmental Resources Management Australia (ERM) and the Savery & Associates data⁵.

Table 5.13.3 Unattended Monitoring RBL Results dB(A)

Monitoring Location	Rating Background Level (RBL) ¹ – dB(A)			
	Day	Evening	Night	6am–7am
M1	45	47	43	43
M2	36	36	37	39
M3	32	35	27	29
M4	40	36	36	40
M5	30	31	29	37
M6	42	45	36	– ²
M7a	30	32	31	38

1. RBL or min L₉₀ is an overall single figure representing each assessment period over the whole monitoring period, and is defined in the glossary of Annex A of the appended *Noise and Vibration Impact Assessment* report.

2. Data not available from Heggies Australia⁶ report.

13.2 PROJECT NOISE AND VIBRATION CRITERIA

13.2.1 Noise and Vibration Criteria

Noise criteria were drawn from the relevant state legislation and guidelines, along with the International Finance Corporation World Bank Group (IFC) guidelines and BG Group standards.

Specific legislation and guidelines drawn upon included:

- the Queensland *Environment Protection Act 1994*
- the Queensland Environmental Protection (Noise) Policy 2008
- the Queensland Environmental Protection Regulation 2008
- DERM EcoAccess Guideline *Planning for Noise Control*
- DERM EcoAccess DRAFT Guideline *Assessment of Low Frequency Noise*
- Department of Environment and Conservation's *E1 environmental guideline: Noise from Construction, Renovation, Maintenance and Demolition sites*

5 Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing (Rev 0)", Doc. No. S792-1, 23 July 2008.

6 Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006

- IFC Environmental Noise Management Guideline⁷
- BG Environmental Expectation Standard BGS-HSSE-ENV-ST-1509⁸.

13.2.2 Construction Noise Criteria

DERM does not prescribe criteria for construction noise, although construction noise criteria are contained in its *E1 environmental guideline*⁹. This guideline prescribes recommended hours of operation and sets noise-level limits for out-of-hours works. *Table 5.13.4* outlines the E1 construction noise criteria.

Table 5.13.4 E1 Construction Noise Criteria

	Period	Construction Noise Criteria
Monday – Friday	7am – 6pm	No criteria, although all equipment must be properly attenuated
	6pm – 10pm	RBL + 10dB(A) $L_{Amax(adj, 15min)}$
	10pm – 7am	Inaudible within any habitable room of a residence
Saturday	7am – 12pm	No criteria, although all equipment must be properly attenuated
	12pm – 10pm	RBL + 10dB(A) $L_{Amax(adj, 15min)}$
	10pm – 7am	Inaudible within any habitable room of a residence
Sunday/ Public Holidays	7am – 6pm	RBL + 10dB(A) $L_{Amax(adj, 15min)}$
	6pm – 10pm	Inaudible within any habitable room of a residence
	10pm – 7am	Inaudible within any habitable room of a residence

1. The E1 guideline uses an $L_{max (adj, 15min)}$ parameter to compare against the Background + 10 (taken as the RBL+10 dB(A)) criterion. The L_{A10} parameter is commonly used in place of the $L_{max (adj, 15min)}$ parameter. The L_{A10} and $L_{max (adj, 15min)}$ represent the average maximum noise level measured over a 15-minute time period. The LA10 is the noise level exceeded for 10% of the time period.

Construction noise could be taken to be inaudible when the level is equal to or less than the RBL at the receiver location.

Table 5.13.5 provides the specific construction noise criteria based on noise monitoring results applied for each NAL for the purposes of the noise assessment. The E1 construction guideline applies for the majority of the day (7am to 6pm). For the shoulder period of 6am to 7am, the RBL for this period can be used. During continuous construction activities (e.g. slipforming of the

7 International Finance Corporation, 2007. Environmental, Health and Safety (EHS) Guidelines: General EHS Guidelines. Environmental (Section 1.7: Noise)

8 BG Group document, 1 July 2007. Sets out minimum environmental requirements.

9 Department of Environment and Conservation's (now EPA) E1 environmental guideline Noise from Construction, Renovation, Maintenance and demolition sites

LNG tanks, marine works) and for scheduling reasons, some work may be undertaken outside of these hours and on weekends.

Table 5.13.5 Construction Noise Criteria for Project Noise Assessment Locations

Period	Noise Criteria, dB(A)							
	NAL 1	NAL 2	NAL 3	NAL 4	NAL 5	NAL 6	NAL 7	
Monday – Friday	7am – 6pm	-	-	-	-	-	-	
	6pm – 10pm	57	46	45	46	41	55	42
	10pm – 7am	43	37	27	36	29	36	31
Saturday	7am – 12pm	-	-	-	-	-	-	
	12pm – 10pm	57	46	45	46	41	55	42
	10pm – 7am	43	37	27	36	29	36	31
Sunday/ Public Holidays	7am – 6pm	55	46	42	50	40	52	42
	6pm – 10pm	47	36	35	36	31	45	32
	10pm – 7am	43	37	27	36	29	36	31
Shoulder Period	6am- 7am	43	39	29	40	37	36 ³	38

Notes:

1. Criteria to be compared with L₁₀ levels.
2. (-) No criteria apply during this time period.
3. No data available for NAL 6 but conservatively the night period RBL could be used.

13.2.3 Operational Noise Criteria

13.2.3.1 Environmental Protection Act, Policy and Regulation

In Queensland, the relevant noise legislation under the *Environmental Protection Act 1994 (EP Act)* (Qld) are the Environmental Protection (Noise) Policy 1997 (EPP (Noise)) and the Environmental Protection Regulation 1998 (EP Reg) as amended in late 2008.

The objective of the *EP Act* is to protect Queensland's environment while enabling ecologically sustainable development. The *EP Act* enables development of the Protection Policies and sets criteria for specific noise offences. The EPP (Noise) provides acoustic quality objectives. However, it does not set noise criteria for industrial development.

The EP Reg describes the standards for measurement of noise. It is understood that these documents do not set criteria for assessing noise impacts from proposed new industry. However, the DERM has developed separate guidelines to assist in the assessment of noise from industrial projects as discussed below.

13.2.3.2 EcoAccess Guideline Planning for Noise Control

Noise emissions from the proposed LNG Facility are assessable under

DERM’s EcoAccess guideline *Planning for Noise Control*. EcoAccess has been developed for setting conditions relating to noise emitted from industrial premises, commercial premises and mining operations. The guideline takes into account four factors:

- the determination of planning noise levels which are based on the dominant land use around the receiver in consideration
- the control and prevention of background creep in the case of steady-state noise level from equipment such as that caused by ventilation fans and other continuously operating machinery
- the containment of variable noise levels and short-term noise events, such as those caused by forklift trucks and isolated hand tools, to an “acceptable” level above background noise
- the setting of noise levels that should not be exceeded to avoid sleep disturbance.

Based on the attended and unattended monitoring data, as described in *Section 13.1.2*, operational Project specific noise criteria have been derived and are presented in *Table 5.13.6*. Supporting calculations are provided in *Sub-Annex C to Appendix 5.14* of this EIS.

Table 5.13.6 Operational Project-specific Noise Criteria

Noise Assessment Location	Operational Criteria dB(A) ($L_{Aeq,1hour}$)			Sleep Disturbance Criteria dB(A) ($maxL_{pA}$) ¹
	Day	Evening	Night	
NAL 1	48	47	40	52
NAL 2	39	39	40	52
NAL 3	35	25	27	52
NAL 4	43	39	39	52
NAL 5	33	34	32	52
NAL 6	45	35	38	52
NAL 7	33	35	33	52

Notes:

1. $maxL_{pA}$ is the maximum noise level measured with the sound level meter set to 'fast' response, 'A' weighting network.
2. $L_{Aeq,1hour}$ is the level with the same energy as the actual fluctuating noise level, measured over one hour.

The LNG Facility will contain various noise sources that may produce low-frequency tonal noise including gas turbines, compressors, flare, pumps and fin-fan air coolers. Given the large distances to the nearest noise sensitive receptors and the large number of individual noise sources emitting noise at different frequencies at the LNG Facility, it is expected that the industry noise may be heard as a low frequency source, with no distinguishable tonal components. Hence, no adjustment for tonal characteristics has been made to the criteria. However, the predicted noise levels will be assessed against the low-frequency guideline to determine the acceptability of the LNG Facility

noise.

The nature of the noise generated by the LNG Facility is a continuous noise, with no significant impulsive characteristics. Hence the maxLpA (the maximum noise level measured with the sound level meter set to “fast” response) sleep disturbance criterion is not applicable.

13.2.3.3 *DERM EcoAccess DRAFT Guideline Assessment of Low Frequency Noise*

This draft guideline provides suggested methods to evaluate low-frequency noise below 200 Hertz (Hz). The guideline centres on measurement of low-frequency noise, where accurate noise levels in 1/3rd octave bands can be recorded for analysis. It discusses Infrasound in the frequency range below 20 Hz, where the sound is often felt (e.g. as a pulsating sensation or pressure on the ears or chest) rather than heard, and also low-frequency noise between 20 and 200 Hz.

The guideline suggests initial screening criteria as follows:

- the overall sound-pressure level inside residences should not exceed 50 dB (Linear) – this would equate to 55 dB (Linear) outside the premises.

If the internal level exceeds 50 decibel (dB) (Linear) and the dB (Linear) level exceeds the dB(A) level by more than 15dB, then a 1/3rd octave bands analysis should be undertaken for the measured data.

The guideline centres on measurement of low-frequency noise, where accurate noise levels in 1/3rd octave bands can be recorded for analysis. For predicted noise levels (e.g. using noise modelling software) the accuracy of the overall dB(A) level can be quite good. However, there is significantly less accuracy in octave or 1/3rd octave bands.

For predicted noise levels, they should also be compared to the measured ambient noise levels at the noise-sensitive receptor. If the predicted noise level is below the existing background (L_{A90}) level, then the low-frequency industrial noise will be more difficult to hear.

13.2.3.4 *IFC Criteria*

IFC General Environmental Health and Safety Guidelines for noise specify a daytime (out of doors) level of 55 dBA during daytime (7 am to 10 pm) and 45 dBA at night (10pm – 7am). These levels apply for residential, institutional, and educational facilities and are to be measured as a one-hour L_{eq} , or the summation of noise over a selected period of time. IFC Guidelines state that noise impacts should not exceed these levels, or “*result in a maximum increase in background levels of 3dB at the nearest receptor location off site*”.

This can be interpreted to mean that the noise from industry should not exceed the background noise level in order that the total noise level does not increase by more than 3dB(A). The IFC Guidelines state that “in general, the

noise level limit is represented by the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation”.

Reading the IFC Guidelines in conjunction with the referenced World Health Organisation (WHO) *Guidelines for Community Noise*, it is clear that the IFC Guidelines are based on ambient L_{eq} noise levels, and not L_{90} noise levels, as “background” is normally measured in Australia.

The criteria are presented in *Figure 5.13.7*, based on the ambient L_{eq} levels measured by ERM and others.

Table 5.13.7 IFC Noise Criteria for QCLNG

Monitoring Location	IFC Criteria dB(A)	
	Day	Night
NAL 1	50	50
NAL 2	41	43
NAL 3	40	38
NAL 4	49	48
NAL 5	41	43
NAL 6	51	45
NAL 7	41	45

1. Daytime criteria are the lower of the measured day and evening L_{eq} noise levels

2. L_{eq} levels are averages of logged levels for each time period for NAL 1–NAL 5, and the lower of ERM attended monitoring and previously reported data for NAL 6 and NAL 7.

13.2.3.5 BG Group Criteria

BG Group specifies minimum environmental criteria for its projects¹⁰. The noise criteria (based on hourly measurements) are as follows for the nearest residential, institutional or educational building located outside the QCLNG Project’s LNG Facility boundary.

- Day (7am to 10pm) 55 dB(A)
- Night (10pm to 7am) 45 dB(A)

13.3 MODELING METHODOLOGY

Modelling for the construction and operational noise impact assessment was undertaken using SoundPLAN software, using the CONCAWE model. The CONCAWE model is an empirical model specifically developed for the

¹⁰ BG Group: *Environmental Expectation Standard*. Unpublished document, BG Reference BGS-HSSE-ENV-ST-1509

assessment of noise impacts from petrochemical complexes on nearby communities. The model allows for incorporation of meteorological and topographical effects into noise calculations.

13.3.1 *Terrain*

Modeling incorporated topographic data including LNG Facility site benching levels. Areas of open water (i.e. Gladstone Harbour) were modelled as areas with very low absorption, while land areas were modelled as absorptive. While typical Australian ground surfaces are often relatively hard and not fully absorptive, vegetation above ground was not included in the model, thus it will tend to underestimate the combined vegetation scattering and ground absorption effects.

The natural terrain (ridge running north to south) provides shielding for the eastern site of Curtis Island.

13.3.2 *Meteorological Effects*

Where modelling was undertaken, consideration was given to “neutral” and “adverse” weather conditions. Neutral conditions were assumed to be calm winds, with Pasquill¹¹ stability class ‘D’ (neutral). Adverse conditions were considered to be the presence of a moderate temperature inversion¹² (3°C/100 m), with calm winds.

Due to the flat topography between the LNG Facility site and the sensitive receptors, no drainage flow¹³ was assessed. While this is considered to be a “worst case” meteorological condition, inversions are likely to be infrequent in the Gladstone Harbour area, as they are less likely to form over water, and winds are calm for only 14 per cent of the time, based on BOM wind roses (winter 9 am data).

The DERM EcoAccess Guideline *Planning for Noise Control* states occurrences of less than 30 per cent of the total night-time period during winter are not considered to be significant.

Due to the prevalence of the east–south-easterly (ESE) sea breezes which occur in Gladstone, a “typical” weather condition was also modelled, with an east–south-easterly breeze.

Meteorological conditions incorporated into the SoundPLAN model for these

11 Pasquill stability class is a method of categorising the amount of atmospheric turbulence present, ranging from A (very unstable) to F (very stable). Sound is scattered by turbulence.

12 Temperature inversions occur under certain meteorological conditions (including calm winds), and usually occur over land during winter. They result in the sound being more clearly heard at greater distances than under non-inversion conditions.

13 Drainage flows can occur where cooler air flows down a hill or ridge into the valley creating an air movement that can influence sound propagation in a similar way to a light wind.

conditions are as follows.

Table 5.13.8 Meteorological Conditions Modelled

Condition	Neutral	Adverse	Typical
Temperature	20°C	10°C	20°C
Relative Humidity	60%	50%	60%
Atmospheric Pressure	1013hPa	1013hPa	1013hPa
Pasquill Stability Class	D	F	B
Wind Speed	calm	calm	2 ms ⁻¹
Wind Direction	–	–	ESE

13.4 IMPACT ASSESSMENT

13.4.1 Construction: LNG Facility

Detail of proposed LNG Facility construction activities, including major stages of construction, is included in *Volume 2, Chapter 13* of this Environmental Impact Statement (EIS). For the purposes of the noise assessment, consideration was given to peak noise arising from:

- bulk earthworks and plant construction on the LNG Facility site
- pipeline construction
- Auckland Point laydown area activities
- transportation of plant, equipment and personnel to and from the construction site on Curtis Island.

Key activities and impacts arising from these two items are described below.

13.4.1.1 Bulk Earthworks and Facility Construction

Assumptions

Construction works will include sheet piling for the landing dock, piling for the wharf and loading facilities, piling beneath LNG and LPG storage tanks (subject to ongoing geotechnical assessment) and construction of LNG process trains and all Ancillary Infrastructure. Assembly of the LNG Facility and Ancillary Infrastructure is likely to produce low levels of noise compared to bulk earthworks and piling activities.

Bulk earthworks (i.e. site clearing, excavation and benching, filling) will be undertaken with typical earthmoving plant, such as bulldozers, excavators, and dump trucks. Piling works may also be undertaken concurrently with earthmoving activities (initially for the Materials Offloading Facility, or MOF).

Noise impacts from construction were modelled as a series of point sources

representing various items of earthmoving and piling equipment. These sources were placed at a nominal 2 m above natural terrain level in various areas of the site.

While most construction activities will take place between 6 am and 6 pm, it is anticipated some construction activity will be undertaken at night (e.g. during slipforming of the LNG tanks, schedule make-up, marine works). Indicatively it is assumed that night works on-site will be undertaken for two to three periods of three to four weeks throughout the construction program. At other times, due to scheduling, some work may be required outside 6 am to 6 pm on weekdays and on weekends.

Two scenarios have been modelled:

- *facility construction* scenario including heavy earthmoving equipment, piling equipment and a concrete batch plant for pouring of foundations. This has been modelled for neutral, adverse and typical sea breeze conditions, as these are representative of daytime and occasional night-time occurrences
- *tank slipforming* scenario including the concrete batch plant, concrete pumps and cranes located in the tank area. This has been modelled for neutral, adverse and typical sea breeze conditions, as these are representative of night-time occurrence [*Note: Slipforming construction has been assumed for modelling purposes, however, additional tank construction methodologies will be considered during the detailed design process*].

Noise source levels for these construction scenarios are presented in *Table 5.13.9* and *Table 5.13.10*.

Table 5.13.9 Facility Construction Noise Sources

Item	Sound Power Level, dB(A)	Number of sources modelled
Bulldozer	114 dB(A)	2
Front end loader	110 dB(A)	4
Grader	114 dB(A)	4
Heavy roller	114 dB(A)	4
Excavator	109 dB(A)	4
Dump truck	106 dB(A)	10
Piling rig	125 dB(A)	7
Bobcat/loader	106 dB(A)	1
Concrete batch plant	105 dB(A)	1
Concrete mixers	100 dB(A)	12
Crane, 120 kW	106 dB(A)	4

1. Sound power levels from AS 2436, manufacturer's data, or ERM library

Table 5.13.10 Tank Slipforming Construction Noise Sources

Item	Sound Power Level, dB(A)	Number modelled
Concrete batch plant	105 dB(A)	1
Concrete mixers	100 dB(A)	12
Concrete pumps	109 dB(A)	2
Crane 120 kW	106 dB(A)	4

1. Sound power levels from AS 2436, manufacturer's data, or ERM library

Predicted Noise Assessment

Predicted noise levels from construction activities are presented in *Table 5.13.11* and *Table 5.13.12*. Modelled construction noise contours from the LNG Facility site for construction under typical, neutral and adverse weather conditions are presented in *Figure 5.13.2*, *Figure 5.13.4* and *Figure 5.13.5*.

Tank slipforming noise contours under typical, neutral and adverse weather conditions are presented in *Figure 5.13.5* and *Figure 5.13.6* and *Figure 5.13.7*.

Table 5.13.11 Predicted Facility Construction Noise Levels

Receptor	Neutral Weather	Adverse Weather	Typical Sea Breeze
NAL 1 – Marina	23	34	17
NAL 2 – Fishermans Rd	30	40	35
NAL 3 – South End ²	-	3	-
NAL 4 – Flinders Pde	19	31	14
NAL 5 – Tide Is	31	40	25
NAL 6 – Lord St	20	32	15
NAL 7 – Targinie	21	32	28

1. All levels in dB(A)

2. Predicted levels at South End are below 0 dB(A) for 'neutral' and 'typical' sea breeze weather conditions.

Facility construction noise may be just audible at NAL 5 (Tide Island) under "neutral" weather conditions as the levels are 1 dB(A) above the daytime RBL. However, daytime construction (7 am to 6 pm) has no set criteria and the predicted construction noise levels are below the 6 am to 7 am period levels. Hence the Facility construction noise meets the construction criteria at all locations for 6 am to 6 pm under neutral and typical sea breeze conditions.

This is considered the most common scenario during LNG Facility construction.

Occasional weekend or night LNG Facility construction work would result in an exceedance of 2dB(A) above the night-time construction noise criteria at NAL 5 (Tide Island) under neutral conditions. Given that this exceedance would only occur on occasions when LNG Facility construction activities were undertaken after hours and during “neutral” wind conditions (i.e. calm winds), the noise impact is unlikely to be significant.

Comparison of the adverse weather noise levels in *Figure 5.13.6* and *Figure 5.13.7*.

Table 5.13.11 with the construction criteria indicates that the highest exceedances would occur at night as follows: NAL 2 (Fishermans Road) 3dB(A), NAL 5 (Tide Island) 11dB(A), and NAL 7 (Targinie) 1dB(A). The exceedance at NAL 5 (Tide Island) indicates that the construction noise would be clearly audible under these unusual conditions. However, these levels would only occur for a small percentage of the year on occasions with full LNG Facility construction occurring, on a calm night, with a temperature inversion.

Based on the above, LNG Facility construction is not expected to cause a significant noise impact.

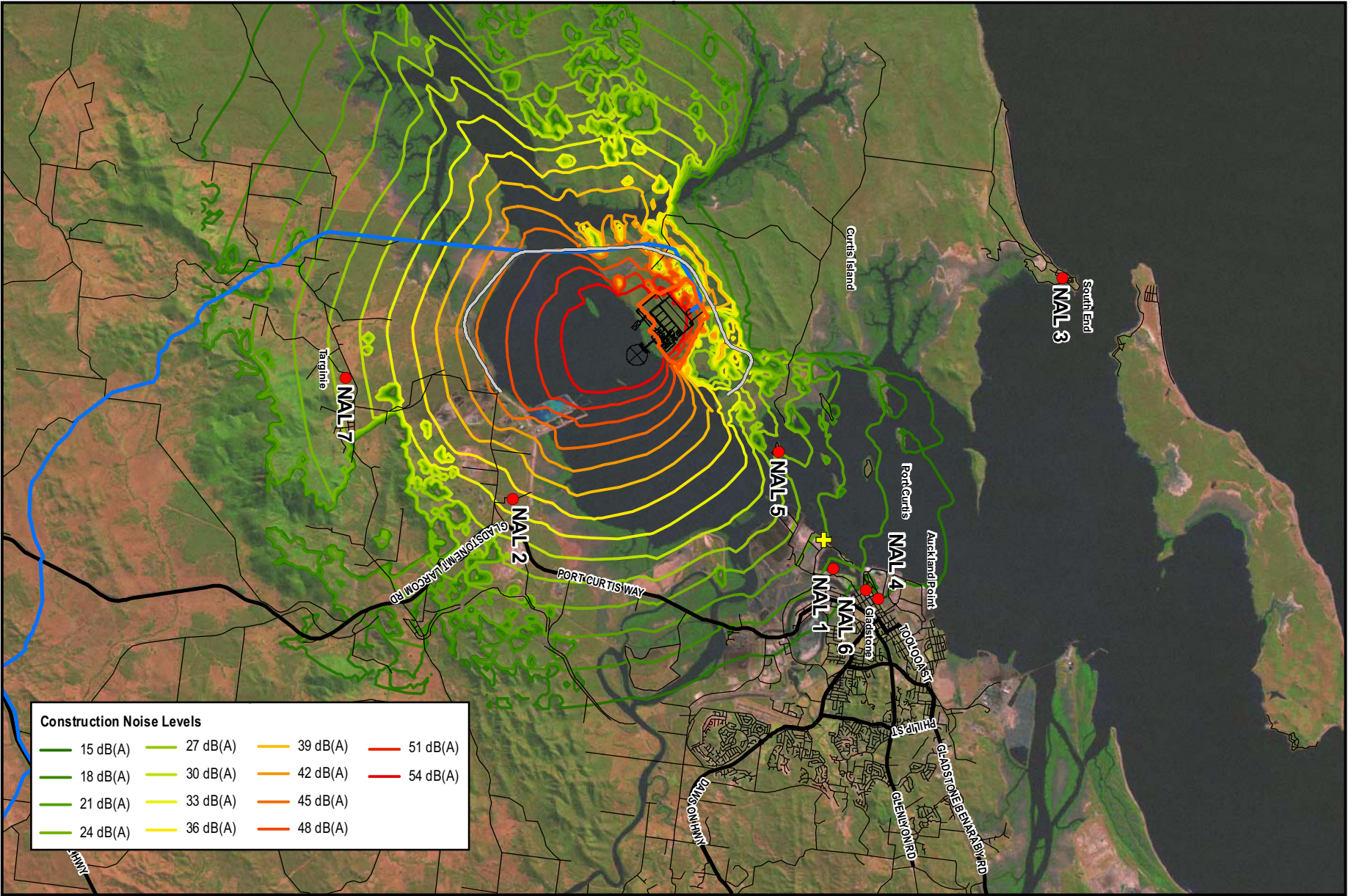
Table 5.13.12 Predicted Tank Slipforming Construction Noise Levels

Receptor	Neutral Weather	Adverse Weather	Typical Sea Breeze
NAL 1 – Marina	7	16	3
NAL 2 – Fishermans Rd	13	22	17
NAL 3 – South End	–	–	–
NAL 4 – Flinders Pde	5	14	1
NAL 5 – Tide Is	12	21	8
NAL 6 – Lord St	6	16	2
NAL 7 – Targinie	6	16	13

1. All levels in dB(A)

2. Predicted levels at South End are below 0 dB(A)

Tank slipforming construction noise levels are well below the measured RBL at all receptors and would generally be inaudible at all sites, including under adverse meteorological conditions.



Construction Noise Levels			
15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

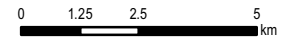
Legend

- Proposed QCLNG Site Boundary
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- Proposed Export Pipeline
- Major Roads
- Noise Assessment Locations
- Proposed Ferry Terminal

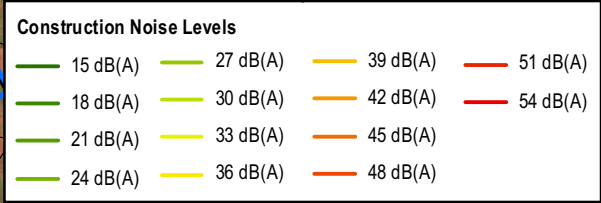
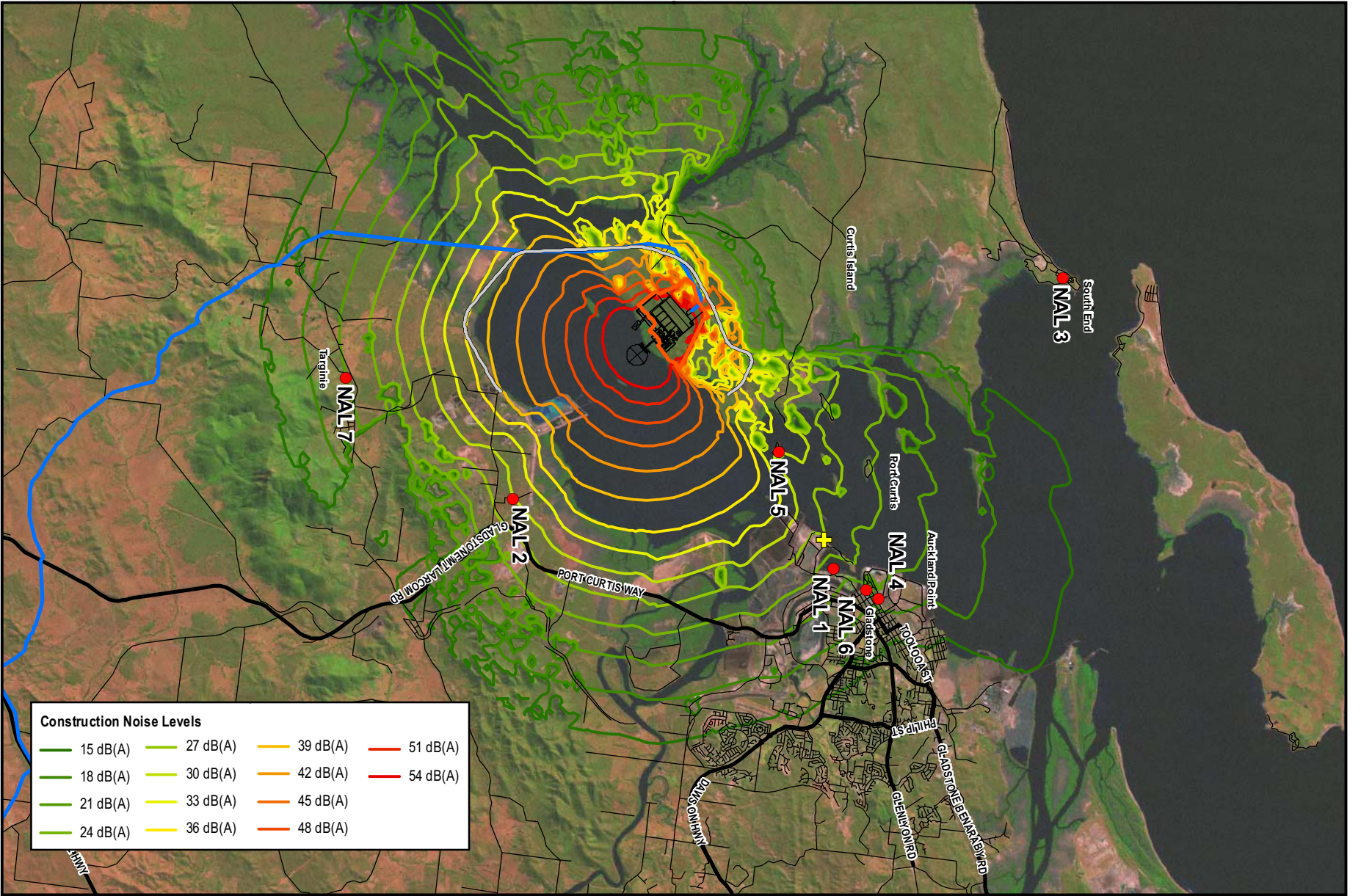
Source Note:

StreetPro Australia - Pitney Bowes MapInfo
 Curtis Island Road/Bridge - Connell Wagner
 Environmental Resources Management Australia, 2009.
 Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure:
 Noise and Vibration Impact Assessment.
 Unpublished report for Queensland Gas Company Limited (QGC),
 Report Reference 0086165/20_Noise&Vibration_R01.v0, April 2009.

Projection: UTM MGA Zone 56 Datum: GDA 94



<p>QUEENSLAND CURTIS LNG A BG group business</p>		<p>Project Queensland Curtis LNG Project</p>		<p>Title LNG Facility Construction Noise Contours, Typical Weather Conditions</p>	
<p>ERM Environmental Resources Management Australia Pty Ltd</p>		<p>Client GGC - A BG Group business</p>		<p>Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.</p>	
<p>Drawn JF/KP</p>	<p>Volume 5</p>	<p>Figure 5.13.2</p>			
<p>Approved MS</p>	<p>File No. 0086165_ERM_AC_GISN 0. FS.13.2</p>				
<p>Date 23.03.09</p>	<p>Revision 1</p>				



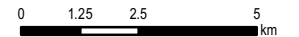
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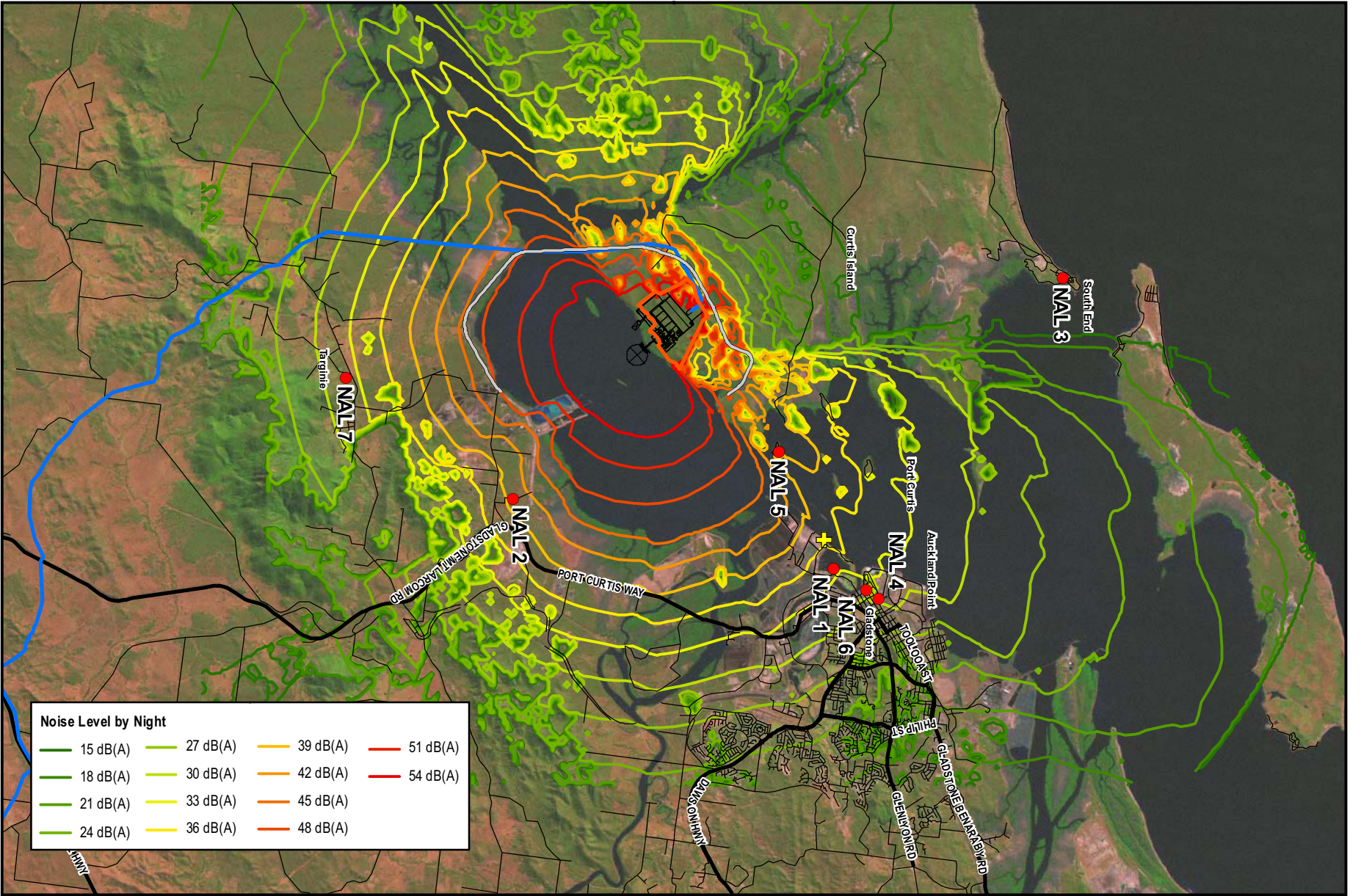
Source Note:

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Projection: UTM MGA Zone 56 Datum: GDA 94



<p>QUEENSLAND CURTIS LNG A BG group business</p>		<p>Project Queensland Curtis LNG Project</p>		<p>Title LNG Facility Construction Noise Contours, Neutral Weather Conditions</p>	
<p>ERM Environmental Resources Management Australia Pty Ltd</p>		<p>Client GGC - A BG Group business</p>		<p>Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.</p>	
<p>Drawn JF/KP</p>	<p>Volume 5</p>	<p>Figure 5.13.3</p>			
<p>Approved MS</p>	<p>File No.: 0086165_ES_AC_GIS09_FS133</p>				
<p>Date 2.04.09</p>	<p>Revision 2</p>				



Noise Level by Night			
15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

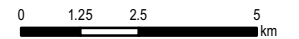
Legend

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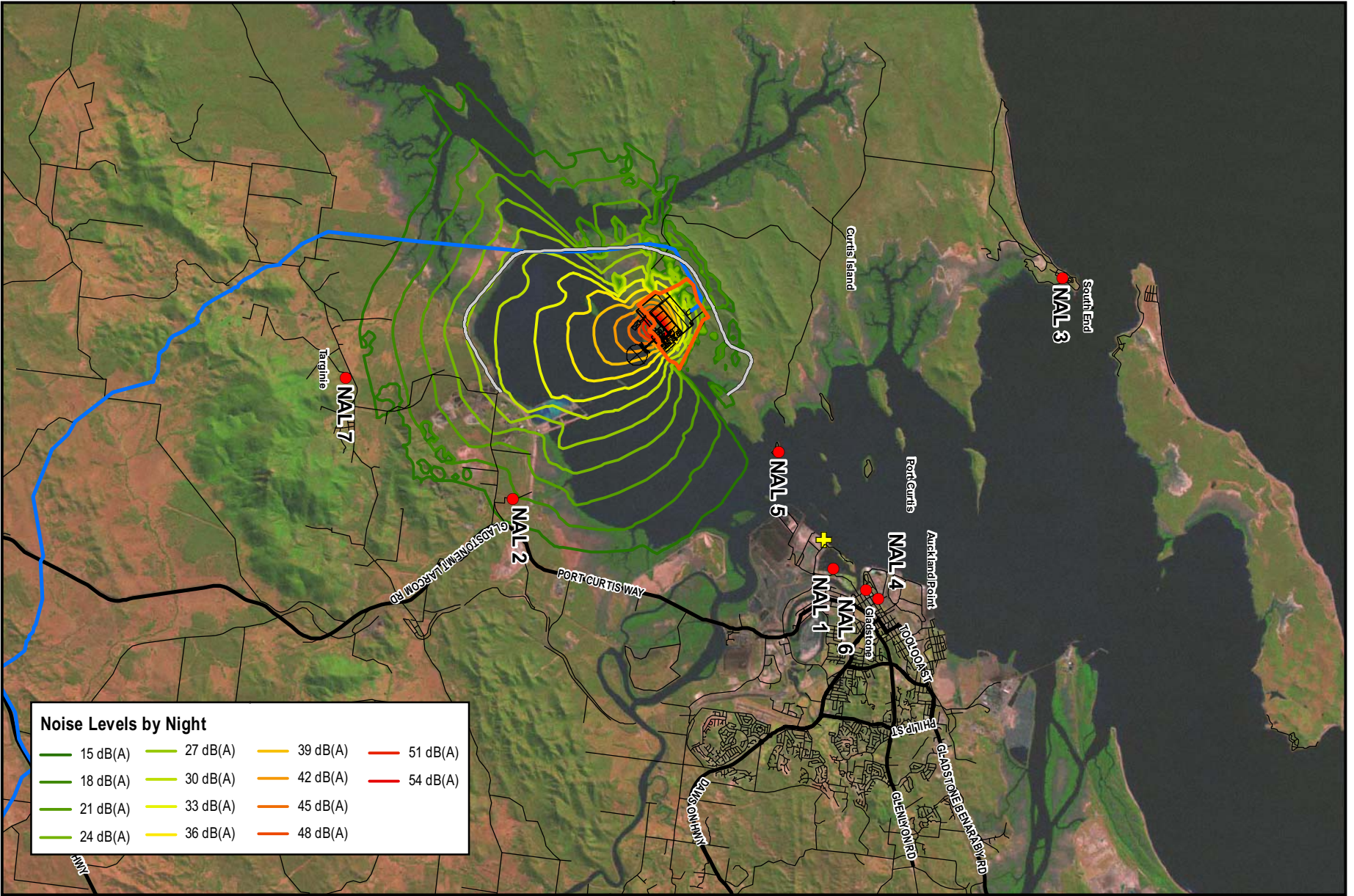
Source Note:

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 Queensland Curtis LNG Project: LNG Facility and Associated Infrastructure:
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Projection: UTM MGA Zone 56 Datum: GDA 94



<p>QUEENSLAND CURTIS LNG A BG group business</p>		Project		Queensland Curtis LNG Project	
		Client		GGC - A BG Group business	
<p>ERM Environmental Resources Management Australia Pty Ltd</p>		Drawn	JF/KP	Volume 5	Figure 5.13.4
		Approved	MS	File No.: 0086165_ERG_AC_GIS01_4_F5.13.4	
		Date	25.03.09	Revision	1
Disclaimer:		Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.			
Title		LNG Facility Construction Noise Contours, Adverse Weather Conditions			



Noise Levels by Night			
15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

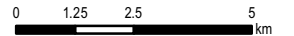
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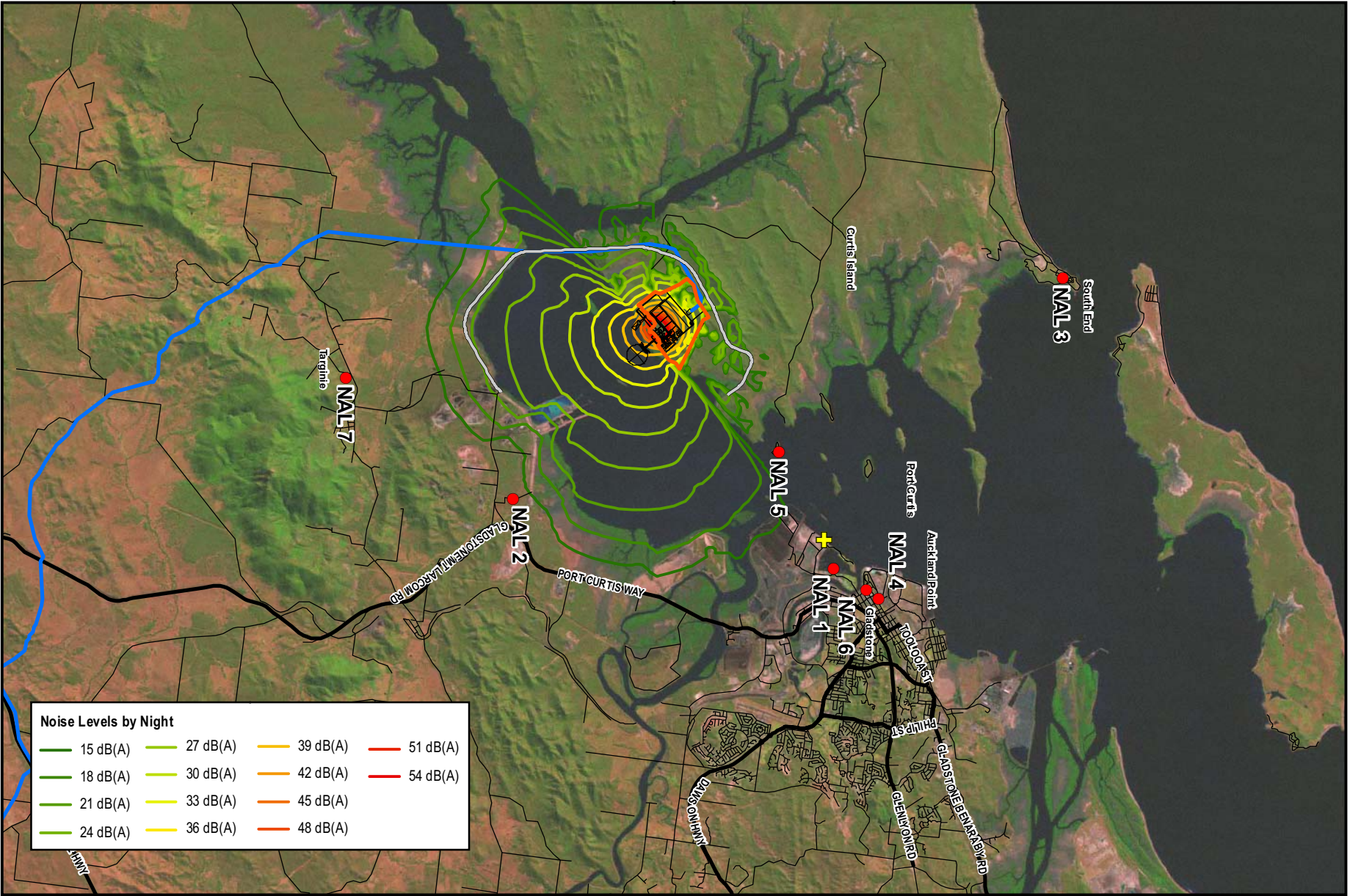
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Projection: UTM MGA Zone 56 Datum: GDA 94



<p>QUEENSLAND CURTIS LNG A BG group business</p>		<p>Project Queensland Curtis LNG Project</p>	
<p>ERM Environmental Resources Management Australia Pty Ltd</p>		<p>Client GGC - A BG Group business</p>	
Drawn	JF/KP	Volume 5	Figure 5.13.5
Approved	MS	File No.: 0086165_ERG_AC_GIS015_F5.13.5	
Date	02.04.09	Revision	1
<p>Title Tank Slipforming Construction Noise Contours, Typical Weather Conditions</p>		<p>Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.</p>	



15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

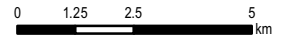
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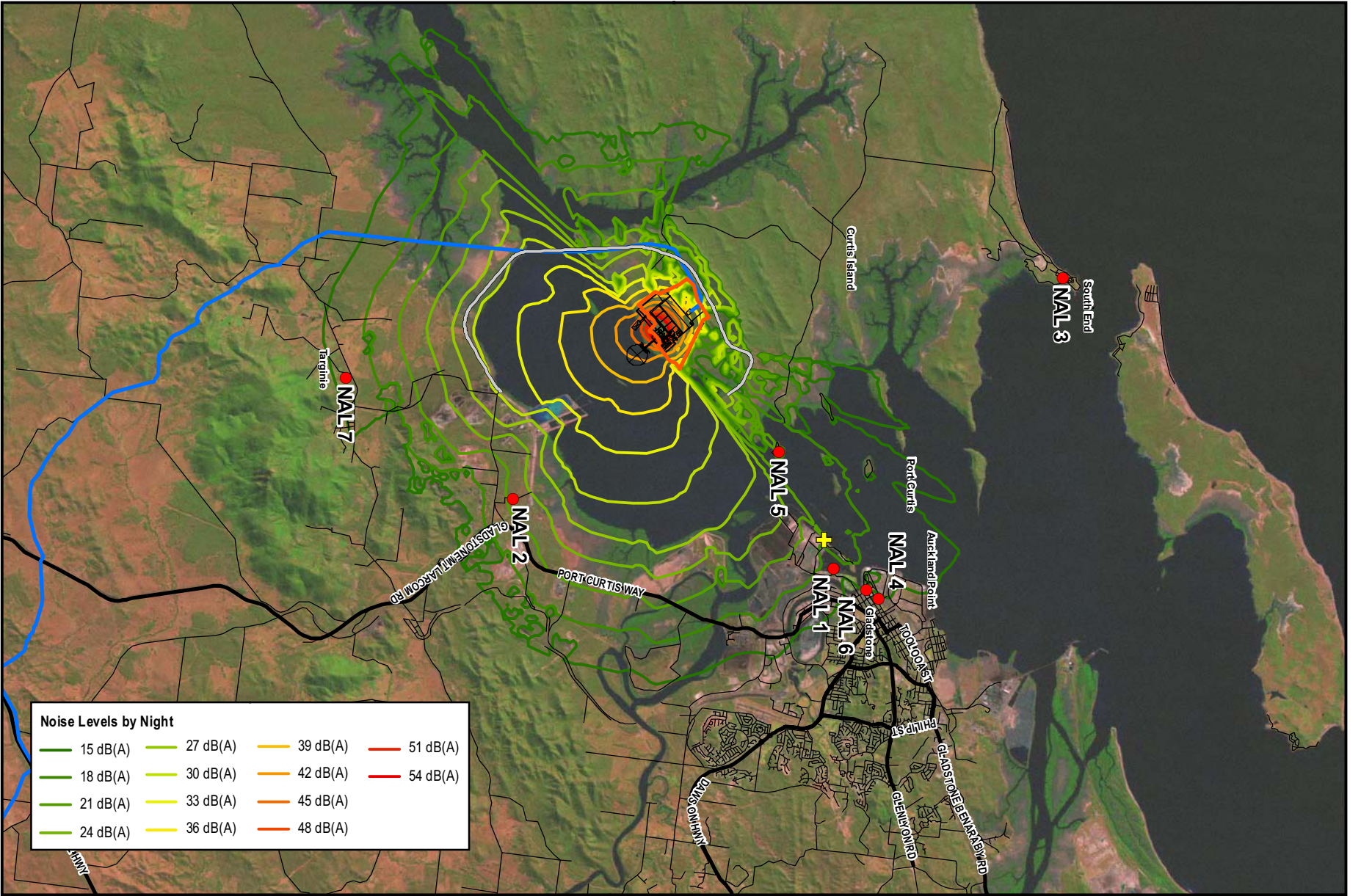
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Projection: UTM MGA Zone 56 Datum: GDA 94



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<p>ERM Environmental Resources Management Australia Pty Ltd</p>		<p>Client GGC - A BG Group business</p>		<p>Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.</p>	
Drawn	JF/KP	Volume	5	Figure	5.13.6
Approved	MS	File No.:	0086165_EIS.AC.GIS011.F5.13.6		
Date	02.04.09	Revision	2		



15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

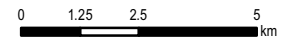
Legend

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<p>QUEENSLAND CURTIS LNG A BG Group business</p>		<p>Project Queensland Curtis LNG Project</p>	
<p>Environmental Resources Management Australia Pty Ltd</p>		<p>Client GGC - A BG Group business</p>	
<p>Drawn JF/KP</p>	<p>Volume 5</p>	<p>Figure 5.13.7</p>	
<p>Approved MS</p>	<p>File No. 0086165_EIS_AC_GIS07.2.5.13.7</p>	<p>Title Tank Slipforming Construction Noise Contours, Adverse Weather Conditions</p>	
<p>Date 23.03.09</p>	<p>Revision 1</p>	<p>Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.</p>	

Vibration

Construction activities such as pile driving and vibratory rollers can produce significant vibration levels at close range (e.g. 50 m). However, given the distance to nearest offsite vibration sensitive receptors, these activities are not considered likely to cause a vibration impact. No major blasting is proposed during construction, although some minor light shock blasting may be required to assist with loosening the rock along lines of existing weakness and allow ripping to be undertaken. If required (subject to ongoing detailed geotechnical assessment), this will be a rare occurrence during the first year of construction only.

13.4.1.2 *Ferrying of Construction Facility, Personnel & Equipment in Gladstone Harbour*

Assessment Assumptions

During construction, cargo and personnel will be loaded onto barges and ferries at the Auckland Point laydown area and transported to Curtis Island. Some materials (e.g. trees cleared from the site, other waste) will be shipped from the site back to Auckland Point for removal. Access to the laydown area will be by the Port Access Road, a designated heavy vehicle route.

As final specifications on ferries to be used is not currently available, a noise level of 70 dB(A) at 30 m was assumed to assess impacts.

Predicted Noise Assessment

Predicted noise levels from barges transiting between Auckland Point and the Curtis Island site are presented in *Table 5.13.13*.

Table 5.13.13 Predicted Peak Noise Levels from Barge/Ferry Movements

Receptor Location	Noise at full power	Rating Background Level
NAL 1	34	43
NAL 2	13	36
NAL 3	8	27
NAL 4	31	36
NAL 5	43	29
NAL 6	30	36
NAL 7	3	30

1. All noise levels in dB(A)
2. RBLs are the lowest of day/evening/night levels for each site

Noise levels are below background levels at all locations other than NAL 5, Tide Island. The average L_{10} noise level measured at NAL 5, Hamilton Point, was 44 dB(A), higher than the predicted barge/ferry noise level. Given the transient nature of the noise, and given that the predicted peak level is less than typical noise levels measured in the area, barge/ferry traffic is expected to have no significant noise impact on the residence at Tide Island.

During operation of the LNG Facility, personnel would access the site via ferry and/or water taxi, from a new ferry terminal to be built adjacent to the RG Tanna Wharf (refer to Volume 2 of this EIS). Construction works would include building the floating dock, terminal building and a car park (for around 100 vehicles). Given the small nature of this construction project, its location in an industrial area (e.g. ship-building facilities, coal terminal) and the distance to the nearest noise-sensitive receptors (located in the Gladstone Marina some 800 m distant), the construction activities are expected to have negligible noise impact.

13.4.1.3 *Road Traffic Noise*

Auckland Point

Road transport in and out of Auckland Point during construction is assumed to be via the Port Access Road. Existing traffic on Port Access Road has high levels of heavy vehicle usage (the roadway has been designed for this purpose) and as such substantial treatments have been applied to minimise the disturbance to nearby residential and commercial receptors. Refer to *Volume 5, Chapter 14* for details of current and project traffic along the Port Access Road.

While heavy vehicle movement through Auckland Point will vary throughout construction (especially due to one-off mobilisation/demobilisation of plant and equipment), regular heavy vehicle movement¹⁴ to and from Auckland Point during the construction process is assumed to include:

- transport of cement (approximately one truck per day)
- transport of waste (approximately one truck per day)
- transport of fuel (approximately one truck per day)
- transport of refrigerated food and dry goods (approximately one truck per day)
- transport of water (approximately one truck per day for the first 12 months of construction).

14 Halcrow MWT, "Draft - Queensland Curtis LNG project EIS Traffic and Transport Impact Assessment (Rev 0)", Doc. No. 083827r01, 9 February 2009.

Given the existing heavy vehicle movements on Port Access Road (around 650 heavy vehicles per day), the impacts at the nearest sensitive receptors from equipment transportation would be negligible.

Having the construction camp located on Curtis Island will reduce the traffic movements to and from the Auckland Point terminal as a proportion of the workforce will stay on site during the work “week”. It is expected that during the peak in workforce for the Project (expected to occur for four months), around 1,000 local personnel will travel to site and back to Gladstone each day. These personnel will park their vehicles at Auckland Point. The personnel are expected to work a nine-day/90-hour per fortnight shift (5 days on, 2 days off, 4 days on, 3 days off). This means that traffic movements for around 1,000 personnel will occur daily during the peak period. Calculations using the CoRTN¹⁵ method indicate that the additional traffic movements (up to 2,000 movements) would cause an increase in $L_{10,18hr}$ ¹⁶ noise level of 1.6dB(A). This is not a significant increase in noise level over the 18-hour period. The morning movement of up to 1,000 vehicles travelling to Auckland Point to start work at 6 am is expected to be a noticeable change in movements. Vehicles returning to Gladstone at the end of the shift around 6 pm would be in the city peak-traffic period and may be less noticeable. During these personnel traffic movements to and from Auckland Point, sensitive receptors may experience an increase in noise levels. However, given the limited duration during construction and the substantial treatments that have been applied to minimise the disturbance to nearby residential and commercial receptors from the heavy vehicle usage of the existing road, impacts at the nearest sensitive receptors are expected to be low.

13.4.1.4 Auckland Point Laydown Area

Auckland Point is to be used for personnel car parking and materials storage. These uses would have no significant noise emissions and as such would not impact on the sensitive receptors to the west, particularly due to the high level of existing industrial activity.

The area may also be used for some minor prefabrication and preassembly works. *Table 5.13.14* outlines the predicted noise levels at NAL 4 (which is representative of the nearest residential area) with typical equipment in the event that it is used for prefabrication and preassembly.

15 CoRTN which stands for “Calculation of Road Traffic Noise”, Department of Transport, Welsh Office, 1988, HMSO. This is the calculation method preferred in Queensland.

16 $L_{10,18hr}$ is the standard parameter used for assessment of road traffic noise in the CoRTN method. It is the arithmetic average of the L_{10} values over the time period from 6am to 12 midnight.

Table 5.13.14 Typical Laydown Area Equipment – Noise Levels

Plant/Activity	Sound Power Level dB(A)L ₁₀	Noise Level @ NAL 4 dB(A) L ₁₀	Daytime L ₁₀ / 6am–7am RBL NAL 4 ¹
Compressor	100	37	
Generator	99	36	
Generator for welding	95	32	
Tracked mobile crane 132kW	92	29	56 / 40
Wheeled mobile telescopic crane	105	42	
Large forklift	110	47	
Angle grinding	108	45	

1. Daytime L₁₀ taken from attended monitoring data

It is assumed that any prefabrication/preassembly at Auckland Point would be predominantly in daylight hours. A comparison of existing ambient L₁₀ noise levels at NAL 4, against the typical L₁₀ construction noise emissions, indicates that noise emissions will be below the existing ambient L₁₀ noise levels. Therefore, impacts at the nearest sensitive receptors are predicted to be low.

During the daytime (7 am to 6 pm), there are no noise limits. For daytime construction activities starting at 6 am, the shoulder period RBL noise level at NAL 4 of 40dB(A) would be exceeded by louder activities. Hence the noise levels from these activities may be audible to the residents. However, comparison with the daytime L₁₀ level of 56dB(A) shows the construction levels would not be excessive compared to the existing ambient (which includes train shunting and truck noise), and therefore impacts at the nearest sensitive receptors are predicted to be low.

Operation on occasions outside these hours or on weekends would exceed the most stringent construction criteria at NAL 4 of 36dB(A) for several activities. However, occasional exceedances should be acceptable provided they are appropriately managed.

13.4.2 Construction: Bridge and Road

Assessment of noise arising from construction of the potential bridge and associated roadways is necessarily limited, given that detailed design is ongoing on behalf of the Queensland Department of Infrastructure and Planning and that QGC will not be the proponent for this bridge infrastructure in the event that it is constructed. However, a preliminary assessment has been undertaken.

The nearest noise-sensitive receptors to proposed bridge construction activities are Targinie residences located approximately 6 km to the south west. Resultant noise levels are predicted to be inaudible at these residences for the majority of construction equipment.

For example, a piling hammer with a sound power level of 125 dB(A) would result in a residential noise level of 17 dB(A) which, when compared to the lowest RBL of 30 dB(A) in Targinie, would be inaudible. On this basis, bridge construction noise impacts at the nearest residential receivers are predicted to be negligible.

13.4.3 Construction: Pipeline

Noise arising from construction of the Export Pipeline east of Calliope River -Targinie Road (approximately 4 km inland) will be temporary as the Pipeline is built and buried. This section of pipeline generally lies within State Development Land which is intended for future industrial development.

A wheel trencher, rock-saw or excavator will be used to dig the trench in which the pipe will be placed. The length of trench open at any one time will depend on the ground conditions and the rates of construction progress being achieved in given areas. Several work sites may operate at any one time and a variety of excavation methods may be used including open trenching, boring or directional drilling.

Based on the transitory nature of construction and the absence of specific daytime noise limits, construction noise impacts are expected to be low. Construction noise and vibration impacts will be mitigated should higher impacts for certain residences be identified.

13.4.4 Start-up / Commissioning

Prior to commencement of operation of each LNG train, pneumatic line cleaning (shock release cleaning) and testing of pipework will be undertaken. This will occur over several months and will result in numerous intermittent noise events over this period, with each event characterised by a sharp initial noise (as valves are released), followed by a rapid decrease (over several seconds).

Given the intermittent and variable nature of this testing, further detailed assessment and modeling has not been undertaken.

13.4.5 Operations: LNG Facility

Assessment Assumptions

Modelling for operational noise was constructed using a series of aggregate noise sources representing different parts of the LNG Facility. These sources are set out in *Table 5.13.15*, and represent a “rolled up” estimate of noise sources summarised in *Volume 2, Chapter 9* of this EIS.

Table 5.13.15 Operational Noise Sources

Source	Height above ground	Sound Power Level
4 BOGs	1 m	122.5 dB(A)
4 GTGs	12 m	117.7 dB(A)
LNG Train at grade	2 m	120.2 dB(A)
LNG Train at 10 m	10 m	124.0 dB(A)
LNG Train at 20 m	20 m	123.0 dB(A)
LNG Train at 36 m	36 m	117.1 dB(A)

1. Heights and sound power levels provided by Bechtel (Engineer, Procure, Construct (EPC) contractor for the Project)

These sources were located at the relevant parts of the LNG Facility site, with heights above the bench levels of that area.

Two scenarios were modelled; the first, representing the long-term noise impact, included the boil-off gas systems, gas turbine generators, and three LNG trains (each consisting of four sources at different heights as set out above). The second scenario included only one LNG train, representing an early operational stage. Each scenario was run three times, for neutral, adverse, and typical meteorological conditions.

Predicted Noise Assessment

Predicted noise levels from operational noise are set out in *Table 5.13.16*. Noise contours for one train under typical, neutral and adverse weather conditions are shown in *Figure 5.13.8*, *Figure 5.13.9* and *Figure 5.13.10* respectively. Noise contours for three trains under typical, neutral and adverse conditions are shown in *Figure 5.13.11*, *Figure 5.13.12* and *Figure 5.13.13* respectively.

Table 5.13.16 Predicted Operational Noise Levels

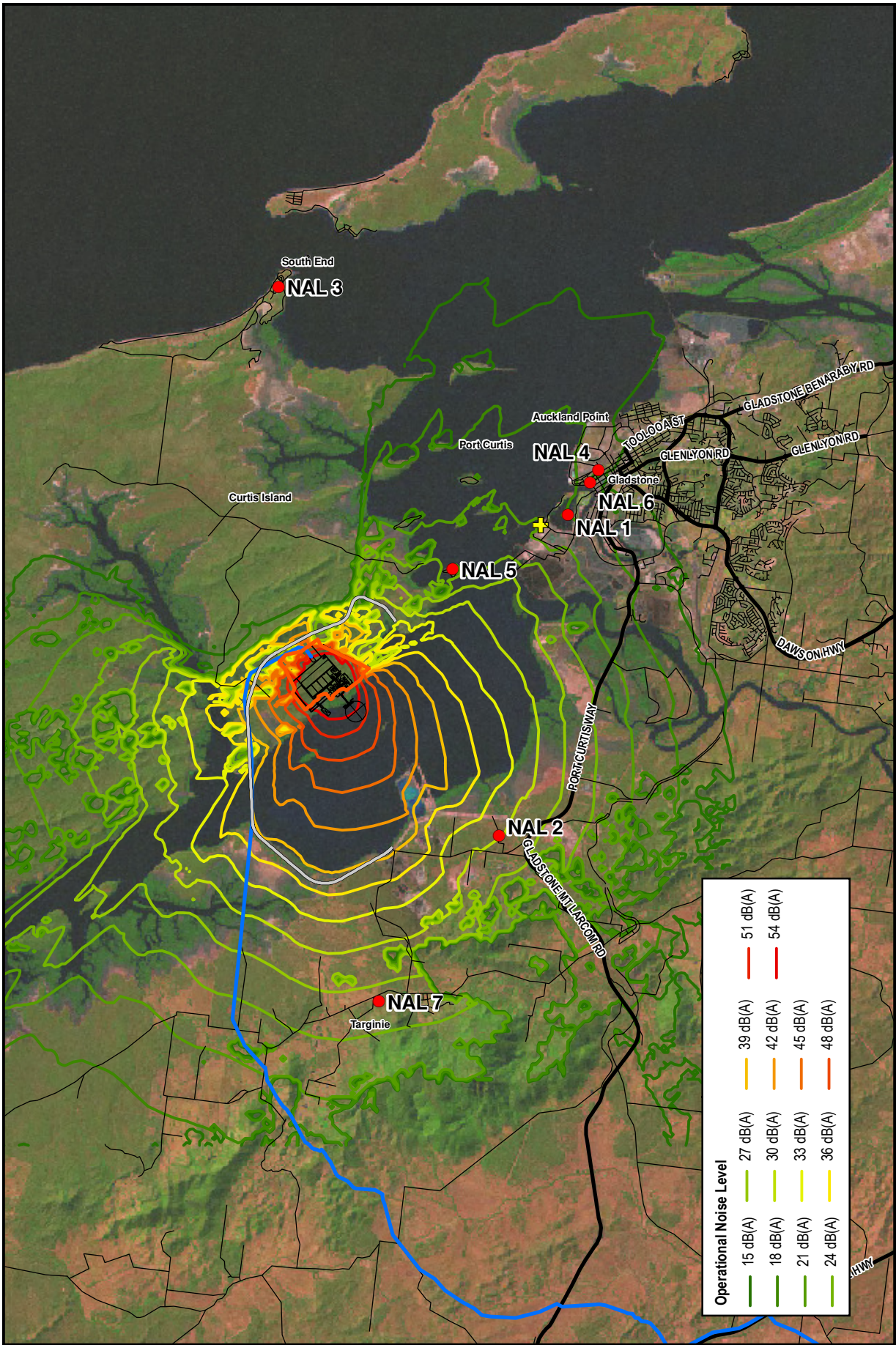
Receptor Location	Criteria D/E/N	Operational Noise, 3-train			Operational Noise, 1-train		
		Typical	Neutral	Adverse	Typical	Neutral	Adverse
NAL 1	48/47/40	22	25	33	18	21	29
NAL 2	39/39/40	34	30	38	31	26	34
NAL 3	35/25/27	8	11	18	–	–	4
NAL 4	43/39/39	21	24	32	17	20	28
NAL 5	33/34/32	27	30	37	23	26	33
NAL 6	45/35/38	21	24	32	17	20	28
NAL 7	33/35/33	30	24	32	26	20	28

1. All levels are in dB(A)
2. Levels in bold exceed the lowest criterion for that location
3. Levels shown as “-” were less than zero dB(A)
4. ‘Neutral’ is calm weather, ‘adverse’ is a moderate temperature inversion, ‘typical’ is ESE breeze

Table 5.13.16 shows that predicted operational noise levels are below the relevant criteria for all locations under neutral and typical weather conditions. Under adverse conditions, predicted operational noise levels are below the relevant criteria for all locations except NAL 5 (Tide Island).

Location NAL 5 exceeds the criteria under adverse conditions. However, inversions are likely to be infrequent in the Gladstone Harbour area. While the predicted noise levels are 5 dB(A) above the criteria, it is likely that noise from the proposed LNG Facility will be masked by noise from other industry, including the RG Tanna coal terminal and the proposed Wiggins Island coal terminal.

IFC criteria are met at each location for every time period under all meteorological conditions. This presents a useful comparison to the EcoAccess criteria which are based on particularly quiet conditions (the RBL being based on the lowest 10th percentile of the L₉₀ noise levels, which are already the lowest 10th percentile noise level for each monitoring interval).



Projection: UTM MGA Zone 96 Datum: GDA 94

0 1.25 2.5 5 km

Legend

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Source Note:

StreetPro Australia - Pitney Bowes MapInfo
 Curtis Island Road/Bridge - Connell Wagner
 Environmental Resources Management Australia, 2009.
 Queensland Curtis LNG Project LNG Facility and Associated Infrastructure:
 Noise and Vibration Impact Assessment
 Unpublished report for Queensland Gas Company Limited (QGC),
 Report Reference 0086165/20_Noise&Vibration_R01.v01, April 2009.

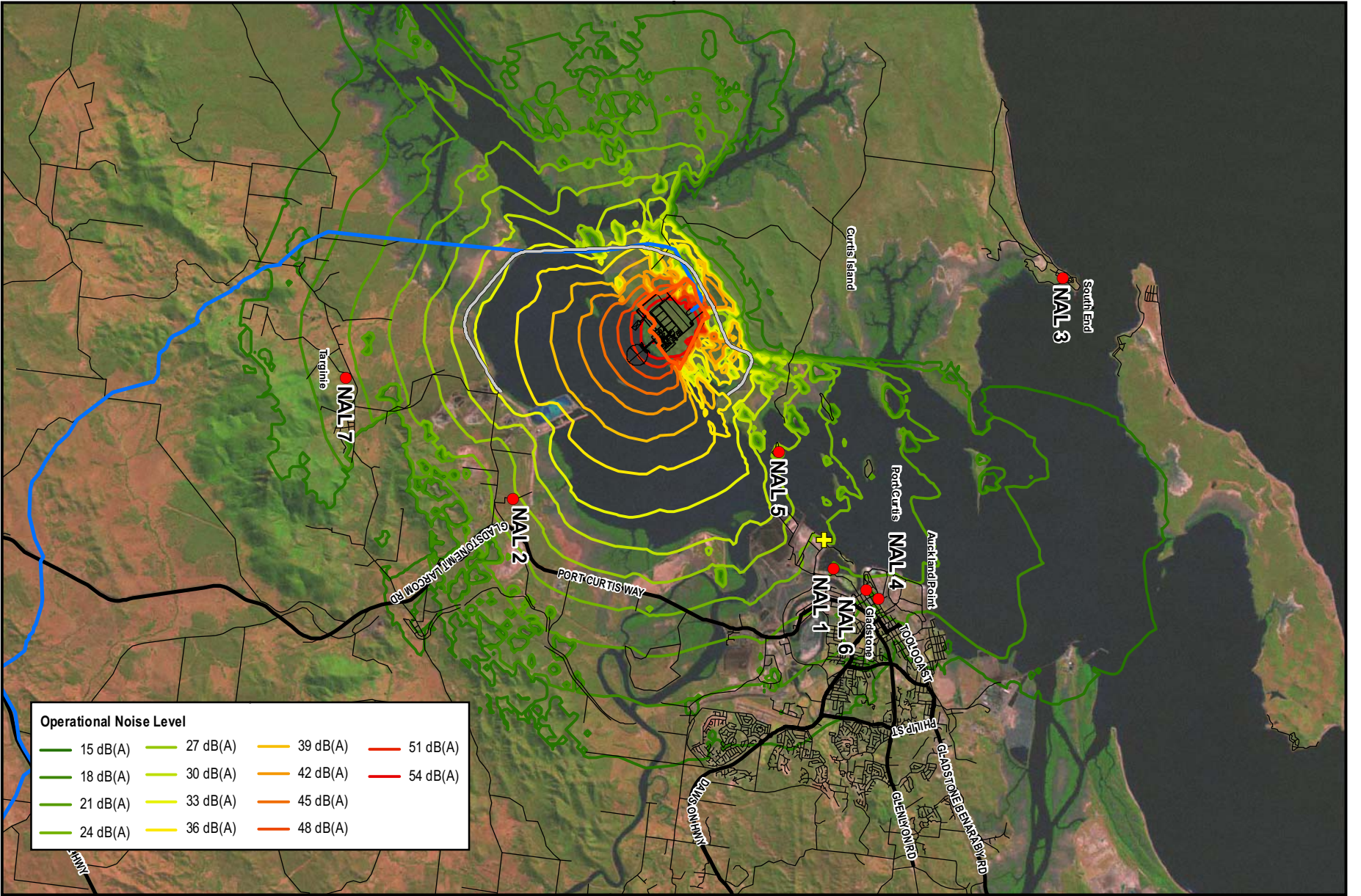
QUEENSLAND CURTIS LNG
A BG Group business

Environmental Resources Management Australia Pty Ltd

Project	Queensland Curtis LNG Project		
Client	QGC - A BG Group business		
Drawn	JF/KP	Volume 5	Figure 5.13.8
Approved	MS	File No: 0086165b_EIS_AC_GIS008_F5.13.8	
Date	25.03.09	Revision	1

Title LNG Facility Operational Noise Contours, 1-Train Model, Typical Weather Conditions

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Operational Noise Level			
15 dB(A)	27 dB(A)	39 dB(A)	51 dB(A)
18 dB(A)	30 dB(A)	42 dB(A)	54 dB(A)
21 dB(A)	33 dB(A)	45 dB(A)	
24 dB(A)	36 dB(A)	48 dB(A)	

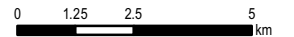
Legend

- Proposed QCLNG Site Boundary
- QCLNG Footprint Plant Layout
- Possible Curtis Island Road/ Bridge Corridor
- Proposed Export Pipeline
- Major Roads
- Noise Assessment Locations
- Proposed Ferry Terminal

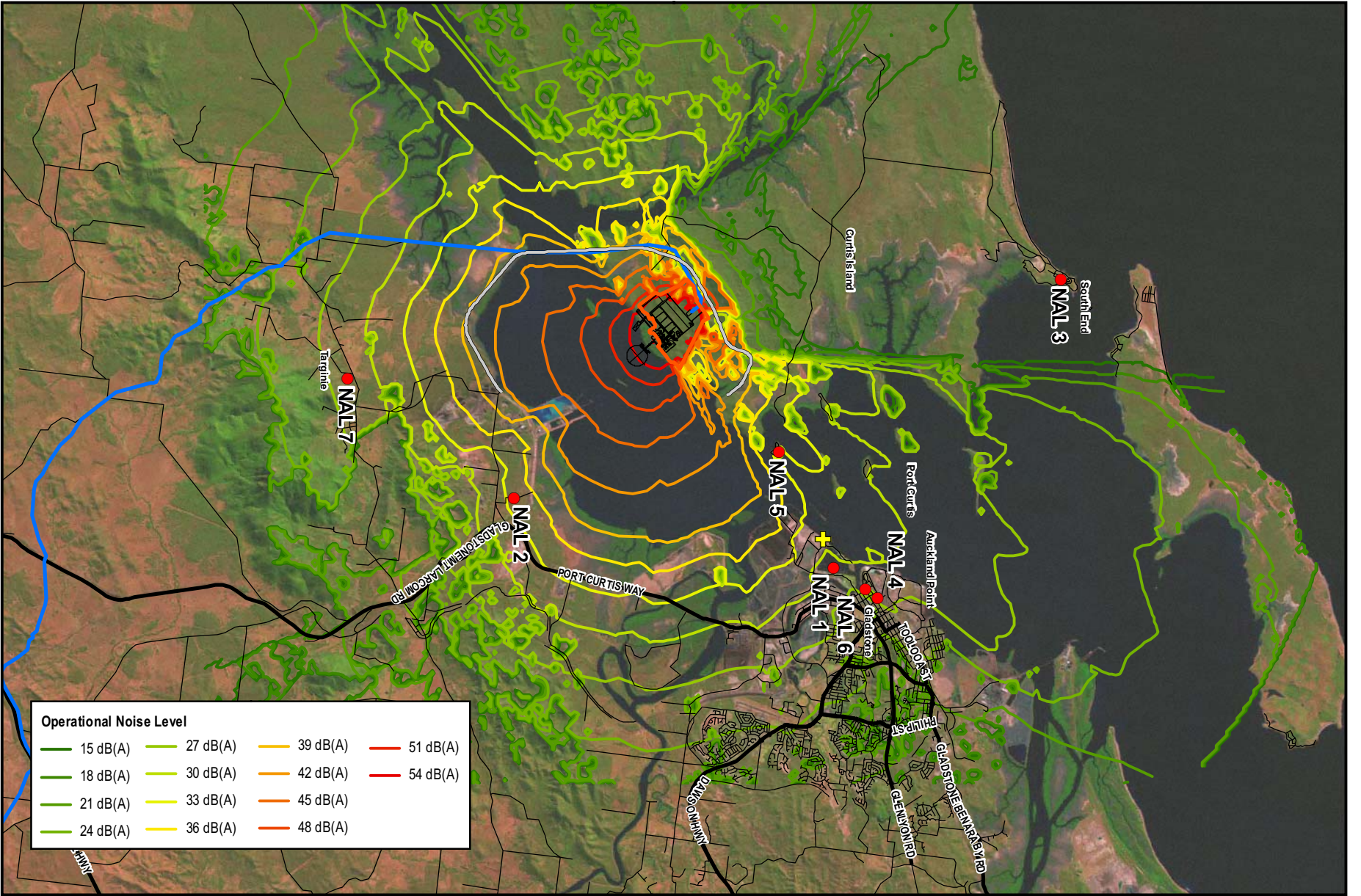
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Projection: UTM MGA Zone 56 Datum: GDA 94



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		Client		GGC - A BG Group business	
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Title		LNG Facility Operational Noise Contours, 1-Train Model, Neutral Weather Conditions			



Operational Noise Level			
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21 dB(A)	33 dB(A)	45 dB(A)	
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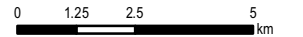
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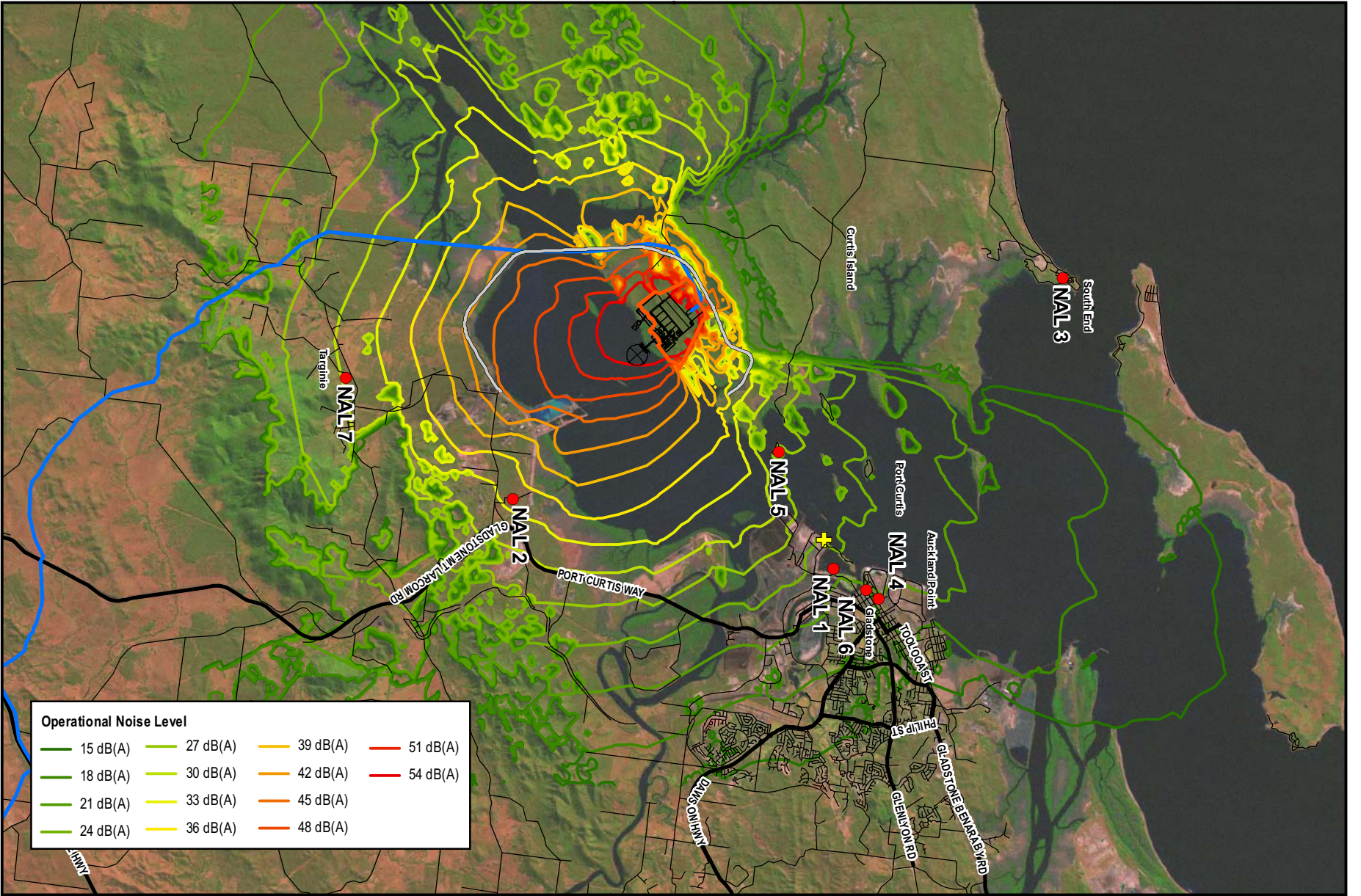
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		Client GGC - A BG Group business		
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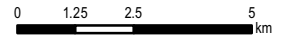
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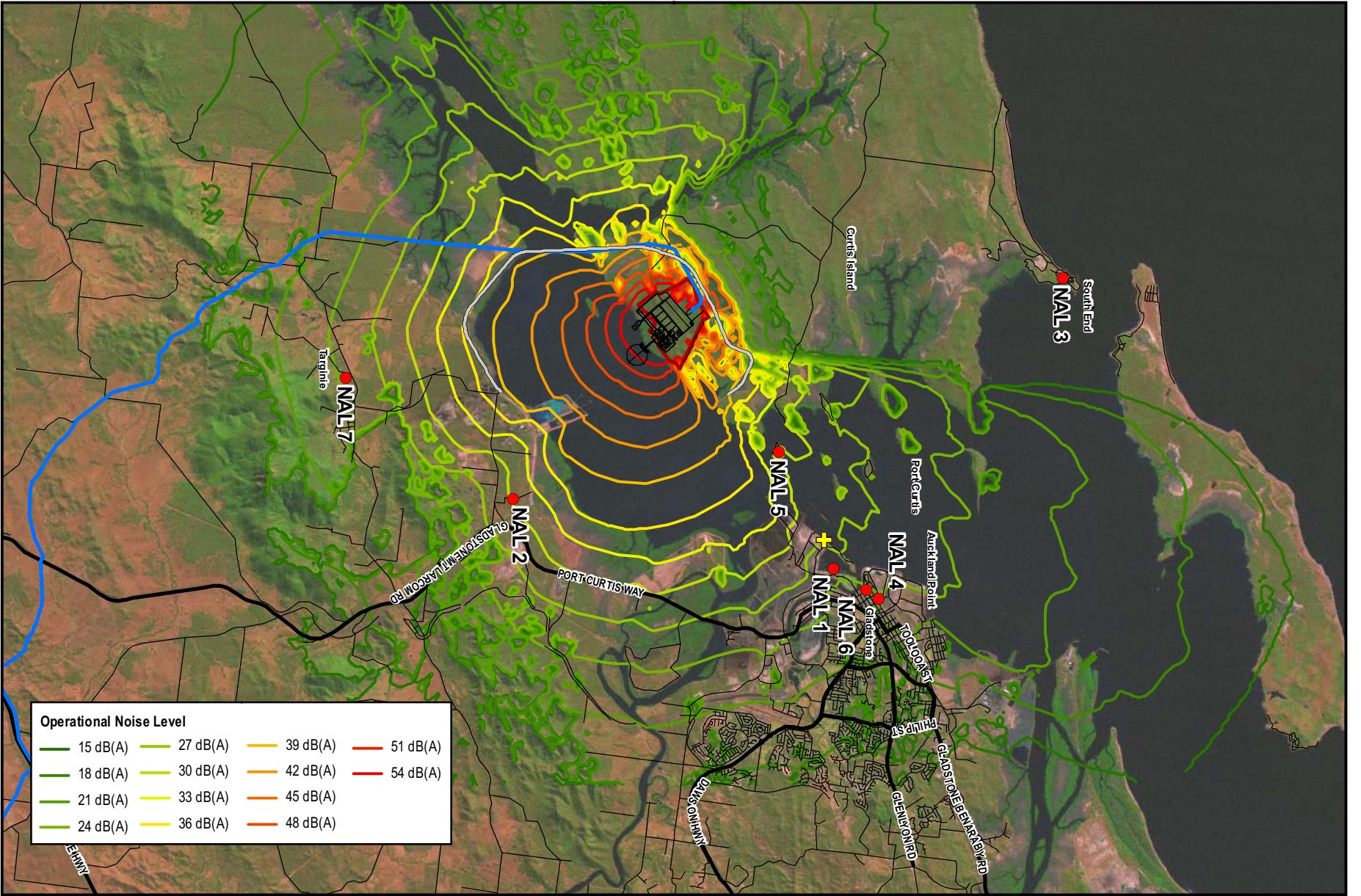
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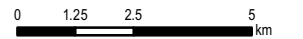
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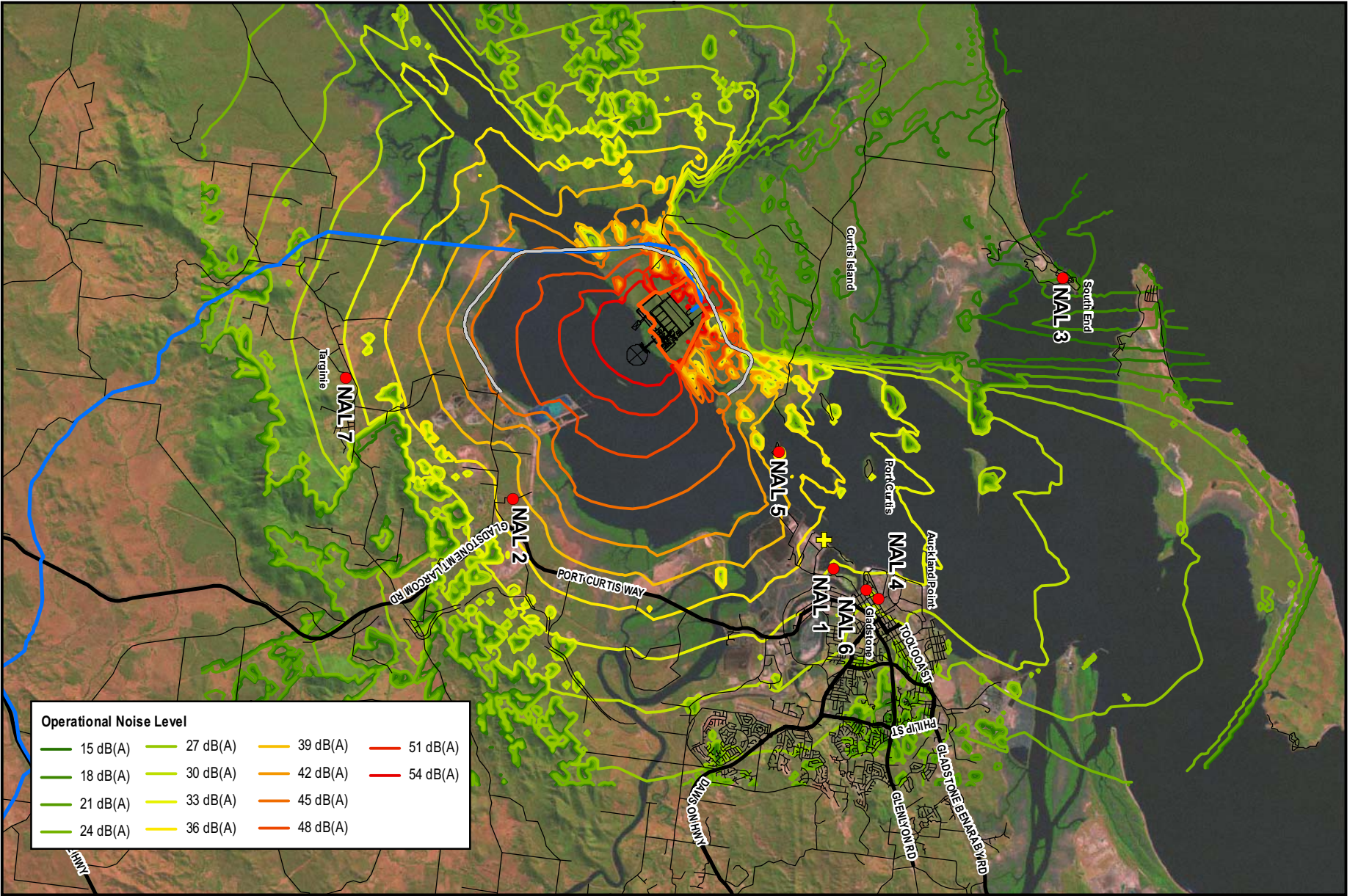
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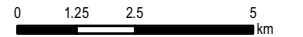
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 QUEENSLAND CURTIS LNG <small>A BG group business</small>		Project Queensland Curtis LNG Project		Title LNG Facility Operational Noise Contours, 3-Train Model, Adverse Weather Conditions	
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Date	23.03.09	Revision	1		

13.4.5.2 *Low Frequency Noise*

Noise levels in dB (Linear) have been calculated from the noise modelling and are presented in *Table 5.13.17*.

Table 5.13.17 Predicted Operation Noise Levels – Linear Frequency Weighting

Location	Operation Noise, 3-train			Operation Noise, 1-train		
	Neutral	Adverse	Typical	Neutral	Adverse	Typical
NAL 1	44	49	42	40	45	38
NAL 2	50	54	52	46	50	48
NAL 3	29	35	26	17	22	15
NAL 4	43	48	41	39	45	37
NAL 5	49	53	47	45	49	43
NAL 6	43	49	41	39	45	37
NAL 7	44	49	48	39	45	44

1. All levels in dB (Linear)

None of the predicted linear-weighted noise levels exceed the 55 dB(A) (Linear) criterion, thus no further assessment of low-frequency noise is required at this time.

13.4.5.3 *Noise Level at LNG Site Boundary*

Operational noise levels within the site boundary have been modelled by the EPC contractor for a four-train scenario¹⁷ (to provide concept design stage assessment of worst possible case for noise). Predicted noise levels are summarised in *Table 5.13.18*.

These levels are not expected to cause a noise impact given the LNG Facility is located in the State Development Area for Curtis Island, and adjoining uses will be industrial.

¹⁷ Bechtel Oil, Gas and Chemicals, Inc. 2008, "Queensland Curtis LNG Project: CTR #44 - Noise Modelling Report (Rev 00A)", Confidential, Bechtel Doc. No. NNR-NV00-00001, 28 October 2008

Table 5.13.18 Predicted Operational Noise Levels at Facility Boundary: Nominal Four-Train Facility

Facility Boundary	Predicated Operational Noise Levels (dBA)
<i>Plant west property line (coastline)</i>	63 ~ 71 dBA
<i>Plant east property line</i>	60 ~ 67 dBA
<i>Plant north property line</i>	64 ~ 69 dBA
<i>Plant south property line</i>	63 ~ 68 dBA

13.4.5.4 Flaring

As outlined in *Volume 2, Chapter 9*, there will be no continuous flaring at the LNG Facility except for a small pilot flame. The pilot flame will not impact the noise levels of the LNG Facility. The flare will operate in a number of different scenarios: emergency, pressure blow-down, maintenance and start-up. Given the infrequent and short-term nature of the flaring events, the noise impact of flaring has not been assessed further.

13.4.5.5 LNG Shipping

Noise levels for a nominal LNG carrier under full power (nominal level of 70 dB(A) at 30 m) have been used to conduct an indicative assessment of potential shipping noise impacts. Actual noise levels from ships are likely to be considerably lower, due to constraints on vessel speed while in the Harbour.

Predicted noise impacts at the assessment locations from a LNG carrier under full power are shown in *Table 5.13.19*. These levels represent the highest noise level experienced as the ship passes, and would generally occur only for a brief period. For comparison, the RBL have been included in the table, representing ambient noise levels during particularly quiet periods.

Table 5.13.19 Predicted Upper-Bound Ship Noise Levels

Receptor Location	Ship noise at full power	Rating Background Level
NAL 1	34	43
NAL 2	13	36
NAL 3	8	27
NAL 4	31	36
NAL 5	46	29
NAL 6	30	36
NAL 7	2	30

Receptor Location	Ship noise at full power	Rating Background Level
1. All noise levels in dB(A)		
2. RBLs are the lowest of day/evening/night levels for each site.		

The only location where maximum potential ship noise exceeds the RBL is NAL 5 (by 17 dB(A)), the residence at Tide Island. This receptor would only be exposed to noise from LNG carriers for a brief period as vessels pass the island.

For three operational trains, approximately three ships per week will depart the LNG terminal (for a total six ship movements per week, comprising three arrivals, three departures). With the combination of brief exposure, relatively low level, and infrequent occurrence, it is considered unlikely that LNG carrier movements would cause a noise nuisance to the residence on Tide Island.

13.4.5.6 *Personnel Movements*

During operation of the LNG Facility, personnel will access the site via water taxi, from a new ferry terminal to be built adjacent to RG Tanna Wharf. Personnel vehicles and some trucks (a few per day) would access the terminal via Alf O'Rourke Drive. Parking for around 100 vehicles would be provided at the terminal, with up to 80 persons travelling via ferry per operational shift. The area around the ferry terminal is industrial in character and the nearest noise-sensitive receptors would be located in the Gladstone Marina some 800 m distant. Noise from the water-taxi movements is not expected to generate significant noise levels at sensitive receptors and the low number of vehicle movements along the largely industrial route would have negligible noise impact.

In the event that a bridge across The Narrows is constructed, then transportation of personnel once the LNG Facility is operational would be via road from the mainland to Curtis Island. Operational personnel would travel via Landing Road and Gladstone-Mt Larcom Road which would connect to the bridge and Curtis Island. The existing routes presently service the industry north of Gladstone and have high heavy vehicle movements. The surrounding land use to both roads is industrial and as such there are no sensitive receptors proximate to the connecting or proposed roads, therefore, negligible noise impact is expected.

13.4.6 *Cumulative Noise Impact*

In order to assess potential cumulative noise impacts, consideration has been given to potential operational noise levels arising from a number of proposed and approved developments in the Gladstone area.

The proposed projects considered include:

- Santos LNG (also referred to as the Gladstone LNG Project, Curtis Island):

An EIS for this project had not been published at the time of the noise assessment. Therefore, estimates of noise levels have been made based on noise emissions for the LNG trains at the QCLNG Project and on published information¹⁸ for the Santos proposal (e.g. two LNG trains proposed, each of similar throughput to the QCLNG Project trains).

- Gladstone LNG (also referred to as Gladstone LNG, Fisherman's Landing): a smaller LNG facility to be located on reclaimed land at Fisherman's Landing. Noise levels were drawn from the EIS report¹⁹ for this project.
- Sun LNG: a smaller LNG facility of similar scale to the Gladstone LNG proposal, to be located next to Gladstone LNG at Fisherman's Landing. Predicted noise levels were assumed to be similar to those from Gladstone LNG.
- Wiggins Island Coal Terminal: a large coal ship-loading facility to be constructed at Wiggins Island, west of the existing RG Tanna Coal Terminal. Predicted noise levels were taken from the EIS report²⁰ for this project.
- Gladstone Pacific Nickel: A nickel refinery to be constructed south of the Gladstone–Mt Larcom Road at Yarwun. Predicted noise levels were drawn from the supplementary EIS report²¹ for this project.

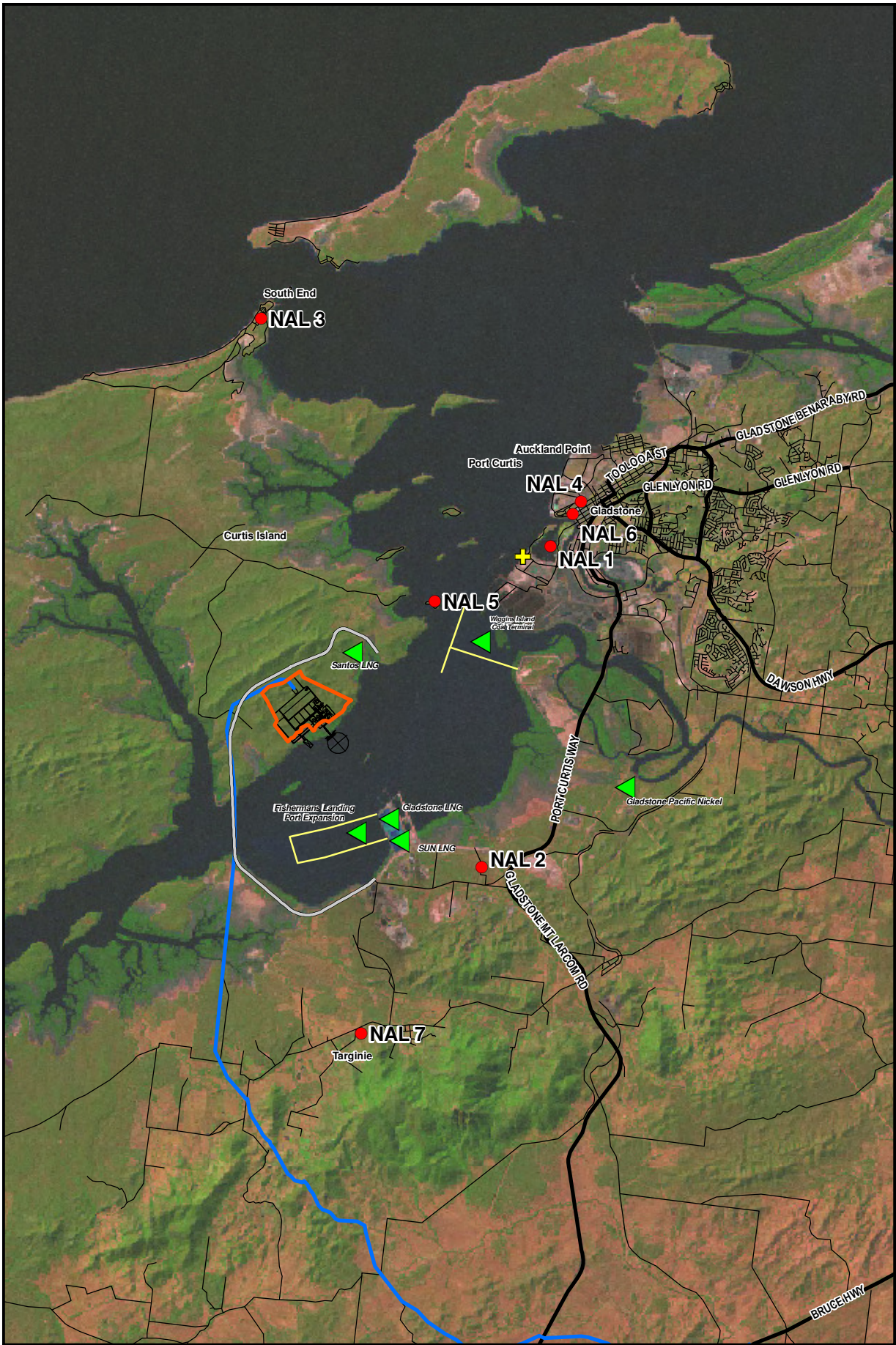
The location of proposed Gladstone industrial projects is provided on *Figure 5.13.14*.

18 Santos, "Gladstone Liquefied Natural Gas Initial Advice Statement", 19 July 2007

19 Savery & Associates, "Noise Impact Statement Gladstone LNG Project Fisherman's Landing", Document No. S792-1, Revision 0, dated 23 July 2008

20 Heggies Australia, "Wiggins Island Noise Impact Assessment", contained in the "Wiggins Island Coal Terminal Impact Statement" report by Connell Hatch, 3 November 2006.

21 ASK, "Gladstone Pacific Nickel - Response to EIS Submission Queries & Comments", Doc No. 3600R02, 22 October 2007.



Projection: UTM MGA Zone 56 Datum: GDA 94

0 1.25 2.5 5 km

Legend

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Table 5.13.20 compares predicted noise levels from the QCLNG Project with those arising from these other projects under neutral meteorological conditions.

Table 5.13.20 Noise Levels from Proposed Projects Around Gladstone Harbour

Location	QCLNG	Santos LNG (est)	Gladstone LNG	Sun LNG (est)	Wiggins Island	Gladstone Nickel	Total no QCLNG	Total with QCLNG	Current ⁵ L _{Aeq}
NAL1	25	29			36		37	37	50
NAL2	30	30	35	35		41	43	43	41
NAL3	11	18					18	19	38
NAL4	24	28					28	29	48
NAL5	30	41	25	25	54		54	54	41
NAL6	24	28			32	19	34	34	45
NAL7	24	21	22	22			27	29	41

1. All levels in dB(A)
2. Levels are for neutral weather conditions.
3. QGC Plant levels are for 3 train operation.
4. Total levels are logarithmic sums of the individual levels, with and without QGC levels
5. Typical minimum daily L_{Aeq} levels at the locations.

Figure 5.13.15 shows the comparative noise levels for proposed industrial projects in the Gladstone Area, while Figure 5.13.16 shows the cumulative noise levels.

Examination of the noise levels in Table 5.13.20 suggests that the predicted noise impact from the QCLNG Project is exceeded by that from other major industrial projects at all locations except NAL 7 (Smith St, Targinie). The Targinie area falls within the Gladstone State Development Area (GSDA), or designated industrial development. Furthermore, the total level at NAL 7 is well below the current minimum daily L_{Aeq} noise level.

The cumulative total with and without the QCLNG Project varies by 0 to 2 dB(A), indicating that the Project does not make a significant contribution to the cumulative noise levels. At all locations, the cumulative total without the QCLNG Project is higher than the predicted noise level from the QCLNG Project alone.

Comparison of the total noise levels with the current L_{Aeq} noise levels indicates that the most significant change will occur at NAL 5 (Tide Island) due to projects other than the QCLNG Project (primarily the proposed Wiggins Island Project). Total noise levels at NAL 2 (Lot 2 Fisherman’s Road, Yarwun) also approach the existing L_{Aeq} noise level, although it is noted that this location is on industrial land.

Figure 5.13.15 Indicative Comparative Noise Levels for Proposed Industrial Projects in Gladstone Area

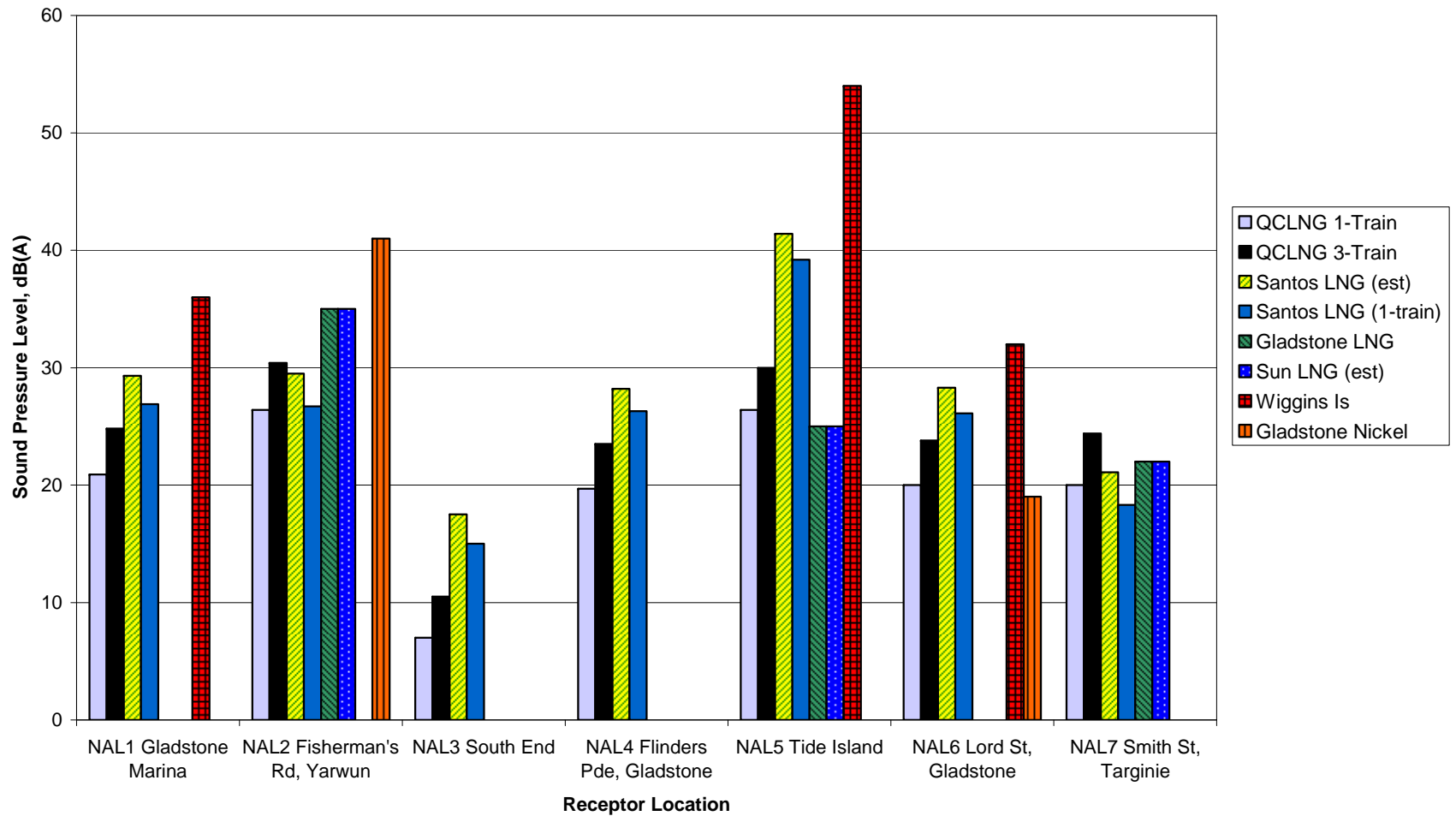
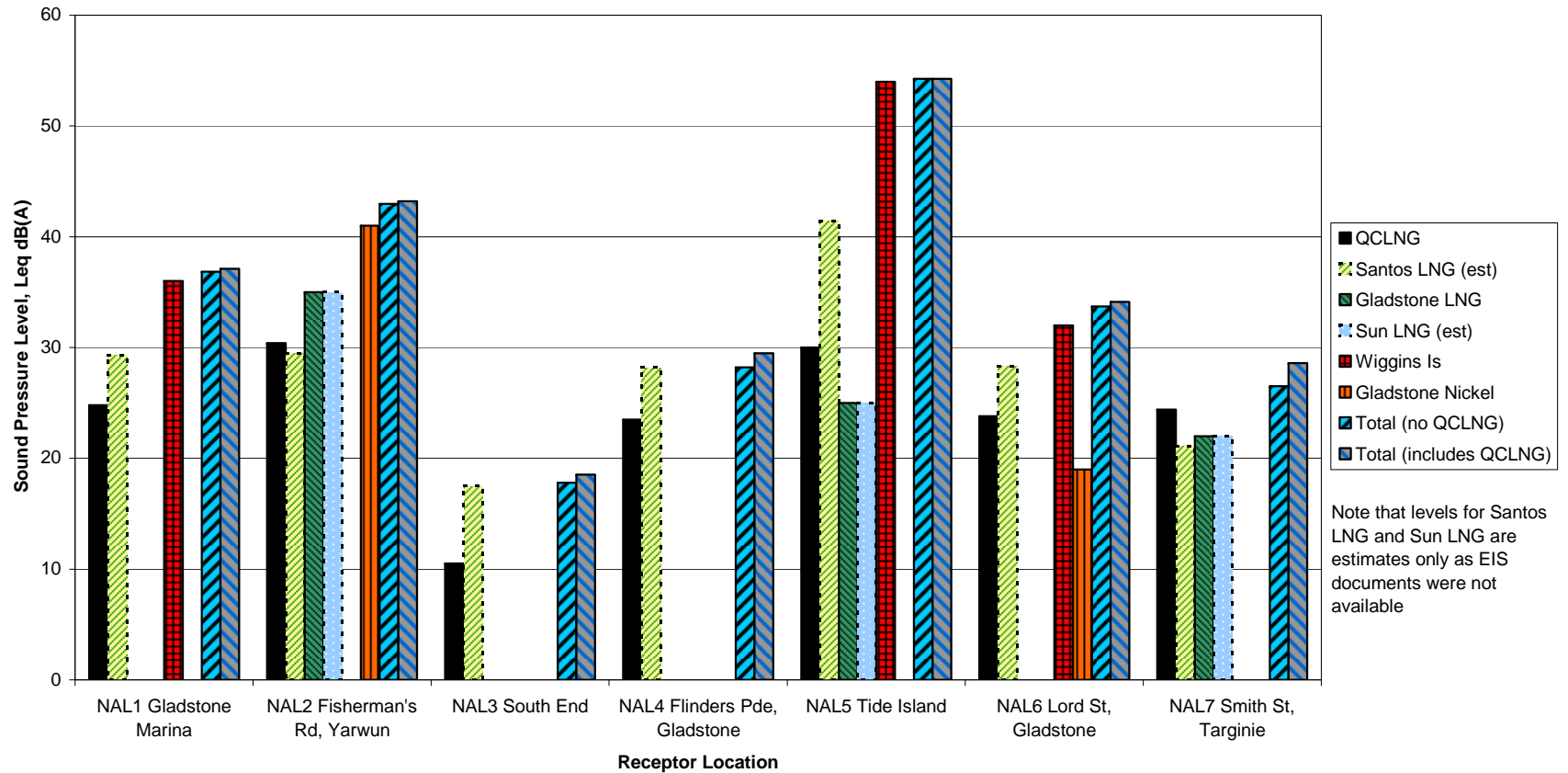


Figure 5.13.16 Cumulative Noise Levels for Proposed Industrial Projects in Gladstone Area



13.4.6.1 *Cumulative Construction Noise*

No assessment has been made of cumulative construction noise, as there is insufficient information to predict construction noise levels from other projects.

13.5 **MANAGEMENT AND MITIGATION MEASURES**

13.5.1 **Construction**

No significant noise impacts have been identified during the construction period and, therefore, no specific constraints are anticipated for construction activities. However, standard management practices will be implemented to minimise noise impacts, including the following:

- Where practicable, construction works will be undertaken during daylight hours (noting that night-works may be required for special activities and for schedule makeup as required).
- Noisy activities at the Auckland Point laydown area will be scheduled, as much as possible, between 7am to 6pm on weekdays.
- Transport routes suitable for construction traffic (e.g. Port Access Road and Hanson Road) will be used.
- Equipment to be kept in good repair including mufflers and equipment covers.
- Barge and ferry routes selected to minimise noise impacts on Tide Island. Barge and ferry mufflers and engines to be well maintained to minimise radiated noise levels.
- Requirement for more detailed assessment of potential impacts arising from any proposed blasting on the LNG Facility site will be determined once the need for blasting (currently being assessed in the light of ongoing geotechnical work) has been further refined.

13.5.2 **Operation**

On the basis of modelling undertaken, no significant impacts are expected during operation of the plant at the LNG Facility plant. However, noise monitoring will be undertaken during start-up of the plant and during early operational stages to validate modelled noise levels at noise sensitive receptors. Consideration will also be given to further ambient noise monitoring just prior to commencement of construction works and just prior to commencement of operations, to provide more detailed baseline data for future reference with regard to the Projects' contribution to cumulative noise levels in the Gladstone harbour area.

13.6**CONCLUSIONS**

The site selected for the QCLNG Project's LNG Facility is located away from residential receptors and is separated from the eastern side of Curtis Island by natural terrain (a ridge running north to south). This results in low impacts for the nearest noise-sensitive receptors.

Based on the monitoring, modelling and assessment undertaken in the ERM study, the following conclusions can be drawn.

13.6.1**Construction**

- Construction of the proposed LNG Facility should be inaudible under most conditions during the day and under all conditions during tank slipforming works (24-hour work using a reduced amount of construction equipment). LNG Facility construction activity noise meets the construction criteria for 6 am to 6 pm. Occasional weekend or night construction work would result in an exceedance of 2 dB(A) above the night-time construction noise criteria at NAL 5 (Tide Island) under neutral wind conditions. Under adverse weather conditions (i.e. temperature inversion), full construction at night may exceed the construction criteria by 3 dB(A) at NAL 2 (Fisherman's Road), 11 dB(A) at NAL 5 (Tide Island) and 1 dB(A) at NAL 7 (Targinie). The exceedance at NAL 5 (Tide Island) indicates that the construction noise would be clearly audible under these unusual conditions. However, these levels would only occur for a small percentage of the year on occasions with full construction occurring, on a calm night and with a temperature inversion. Based on the above, construction is not expected to cause a significant noise impact.
- Construction of a ferry terminal near RG Tanna for the operational stage is a relatively small construction project. Given its location in an industrial area and distance to the nearest noise-sensitive receptors (Gladstone Marina, 800 m away), it is not expected to cause a significant noise impact.
- Construction of the potential bridge is expected to be inaudible at the nearest NAL.
- Road traffic generated during construction will include vehicles travelling to the Auckland Point laydown areas (from 2010 to 2013) and vehicles travelling via the new road and bridge to Curtis Island after 2013 (if the bridge is built). The number of worker vehicles accessing Auckland Point will peak at around 1,000 per day, with most movements occurring around 6 am and 6 pm. The increase in movements, particularly in the morning, may be noticeable and sensitive receptors may experience an increase in noise levels. The increase in daily traffic noise levels will only be minor (1.6 dB(A)). The main road to access the Auckland Point laydown area is Port Access Road, which is designed as a heavy-vehicle route with substantial noise-control treatments. The roads to Curtis Island currently service Gladstone's industrial areas. Given the limited duration of the construction work, impacts from road transport are expected to be low.

- The Auckland Point Laydown Area is located among existing rail and industrial areas and hence while some site activities may be audible, these are expected to have a low impact on the nearest residential areas.
- The section of the main pipeline from Curtis Island to Targinie Road (approximately 4 km inland) will be built in stages and generally lies within State Development Land which is intended for future industrial development. Based on the transient nature of construction activities, construction noise impacts are expected to be low.
- Construction activities such as pile driving and vibratory rollers can produce significant vibration levels at close range (e.g. 50 m). However, as the nearest offsite vibration-sensitive receptors will be several kilometres away, these activities will not cause a vibration impact. No major blasting is proposed during construction, although some shock blasting may be required to assist with loosening the rock along lines of existing weakness and allow ripping to be undertaken. If required (subject to ongoing detailed geotechnical investigation) this will be a rare occurrence during the first stage of construction only.

13.6.2

Operation

- Predicted operational noise levels are below the relevant DERM criteria for all locations under neutral and typical weather conditions.
- Under adverse conditions (temperature inversion and calm winds), predicted operational noise levels are below the relevant criteria for all locations except NAL 5 (Tide Island), the closest sensitive receptor to the LNG Facility. The exceedance of 5 dB(A) under adverse conditions is expected to occur only occasionally as temperature inversions infrequently form over water and winds are calm for only 14 per cent of the time. As this is less than the 30 per cent referred to in the DERM EcoAccess Guideline *Planning for Noise Control*, this exceedance is not expected to be significant.
- In the future, noise from the proposed LNG Facility may well be masked at NAL 5 by noise from other industry, including the proposed Wiggins Island coal terminal.
- The predicted linear-weighted noise levels meet the DERM Draft criterion for low-frequency noise, thus no further assessment is required at this time as the levels are unlikely to cause complaints due to low-frequency noise.
- The nature of the noise generated by the LNG Facility is a continuous noise, with no significant impulsive characteristics. Hence the DERM ($_{\max}L_{pA}$) sleep disturbance criterion is not applicable to this assessment.
- The IFC criteria are met at each location for every time period under all meteorological conditions. This indicates that under average conditions, the proposed LNG Facility will not be audible and presents a useful comparison to the EcoAccess Guideline *Planning for Noise Control* criteria which are based on particularly quiet conditions.

- BG criteria of 55 dB(A) during the day and evening and 45 dB(A) at night are met at each receptor location for every time period, under all conditions.
- Flaring will occur for relatively short periods on rare occasions during LNG Facility start-up and operation for maintenance and emergency. Given the infrequent and short-term nature of the flaring events, the impact of the flare is not expected to be significant.
- Predicted worst-case noise levels (based on noise levels for ships under full power) for LNG vessels indicate noise will be inaudible at all locations other than NAL 5 (Tide Island). Impact will be transient and hence shipping traffic is not expected to have a significant noise impact on the residence at Tide Island.
- Transportation of personnel once the LNG Facility is operational would be via water taxi from a new ferry terminal to be built adjacent to the RG Tanna Wharf. Noise from the water-taxi movements and the low number of vehicle movements along the largely industrial route is not expected to generate significant noise levels at sensitive receptors.
- In the event that a bridge across The Narrows is constructed, then transportation of personnel via road from the mainland to Curtis Island would be expected to cause negligible noise impacts, as the surrounding land use to these roads is industrial.
- The LNG Facility and equipment primarily involves rotating machinery, which will transfer relatively low levels of vibration to the ground. Hence, operation of the LNG Facility will not produce significant levels of ground vibration.

13.6.3

Cumulative

- Comparison of the QCLNG Project with five other proposed industrial projects in the Gladstone area indicates that the predicted noise impact from the Project is likely to be exceeded by that from other major industrial projects at all NAL locations except NAL 7 (Smith St, Targinie). The Targinie area is State Development Land which will be developed for industrial purposes in the foreseeable future. Furthermore, the total level at NAL 7 is well below the current L_{Aeq} noise level. At all NAL locations, the cumulative total without the Project is significantly higher than the predicted noise level from Project alone.
- Comparison of the total noise levels with the current minimum daily L_{Aeq} noise levels indicates that the most significant change will occur at NAL 5 (Tide Island) due to projects other than LNG Project. Total noise levels at NAL 2 (Lot 2 Fisherman's Road, Yarwun) also slightly exceed the current minimum daily L_{Aeq} noise level due to projects other than the LNG Component of the QCLNG Project. However, it is understood that this location is on industrial land.
- Cumulative construction noise is not expected to be an issue as it is unlikely that the loudest noise-producing construction activities at different

project sites will occur simultaneously. Hence, the noise impacts should be limited to those of individual projects.

A summary of the impacts outlined in this chapter is provided in *Table 5.13.21*.

Table 5.13.21 Summary of impacts for Noise and Vibration

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short term for construction and shipping noise and vibration and shipping noise Long term for noise and vibration generated during operations
Impact extent	Local
Impact likelihood	High

Overall assessment of impact significance: Minor as construction and operations phase noise and vibration are not predicted to impact on sensitive receptors under most conditions. Predicted exceedences of EPA noise criteria will be experienced infrequently by residents of Tide Island during adverse weather conditions (temperature inversion and calm winds) and by passing LNG carriers.