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Gladstone Ports Corporation

Report for Western Basin Dredging and Disposal Project

Noise and Vibration Assessment

October 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

Gladstone Ports Corporation commissioned GHD to assess the potential noise and vibration impacts resulting from the construction of the Western Basin Dredging and Disposal Project. The assessment has been undertaken with consideration to the following Queensland Environment Protection Agency (EPA) publications:

- *Environmental Protection Act 1994*;
- Environmental Protection (Noise) Policy 2008; and
- Planning for Noise Control Guidelines 2004.

The results of the assessment suggest that construction activities associated with the reclamation of the Western Basin Dredging and Disposal Project will not significantly impact on the amenity of sensitive residential receivers. Predicted noise levels comply with site-specific noise criteria for all identified noise sensitive receivers, and due to the distances between the site and any receivers vibration impacts will likely be insignificant.

Results of the assessment suggest that noise from dredging activities has the potential to exceed the adopted noise goals by 3 dB during the night time period at one receiver (R4 – Tide Island) during neutral meteorological conditions and an additional receiver (R9 – Gladstone residents near Port Central) by approximately 1 dB during noise enhancing meteorological conditions. Dredging activities are considered transient in nature and any exceedance of noise goals will be temporary.

Underwater noise from dredging is likely to result in marine mammals avoiding the project site, however marine mammals may exhibit tolerance to such noise and may come into close proximity to construction activities. It is well documented for marine animals to avoid dredging activities and therefore impacts on marine life from dredging are expected to be minimal.

Physiological impacts on marine mammals arising from underwater piling noise are assumed to be insignificant, as the noise would be detected well before the animals would reach the distance from the source established as the ‘impact zone’, which is approximately 5m from the source.

Modelling suggest that noise levels experienced on nearby tidal flats will range from 40 – 55 dB(A) during assumed dredging activities. These levels are similar to noise levels experienced adjacent to other sites within the GSDA and comparable to noise levels in natural environments during windy conditions or experiencing elevated insect noise.

Glossary

Abbreviation	Definition
dB	Unit of measurement for Sound Pressure Level.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
L_N	Statistical sound measurement recorded on the linear scale.
L_{AN}	Statistical sound measurement recorded on the "A" weighted scale.
$L_{A10\ (Time)}$	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
$L_{A10\ (1\ hour)}$	The L_{A10} level measured over a 1-hour period.
$L_{A10\ (18\ hour)}$	The arithmetic average of the L_{A10} levels for the 18-hour period between 0600 and 2400 hours on a normal working day. It is a common traffic noise descriptor.
$L_{Aeq\ (Time)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring. This is considered to represent ambient noise.
$L_{Aeq\ (15\ hr)}$	The L_{Aeq} noise level for the period 7 am to 10 pm. (Day and Evening)
$L_{Aeq\ (9\ hr)}$	The L_{Aeq} noise level for the period 10 pm to 7 am. (Night)
$L_{Aeq\ (1\ hr)}$	The L_{Aeq} noise level for a one-hour period. It represents the highest tenth percentile hourly A-weighted L_{eq} during the period 7 am to 10 pm, or 10 pm to 7 am, (whichever is relevant).
$L_{A90\ (Time)}$	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$
$L_{AMax\ (Time)}$	The maximum sound level recorded during a specified time interval.
$L_{AMin\ (Time)}$	The minimum sound level recorded during a specified time interval.
Noise Sensitive Place	*Noise sensitive place* means any of the following places— (a) a dwelling; (b) a library, childcare centre, kindergarten, school, college, university or other educational institution; (c) a hospital, surgery or other medical institution; (d) a protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest, under the *Nature Conservation Act 1992*; (e) a marine park under the *Marine Parks Act 1982*; (f) a park or garden that is open to the public (whether or not on payment of money) for use other than for sport or organised entertainment.

Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24 hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of: All the day assessment background levels over the monitoring period for the day; (7 am to 6 pm); All the evening assessment background levels over the monitoring period for the evening; (6 pm to 10 pm) or All the night assessment background levels over the monitoring period for the night. (10 pm to 7 am).
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level of 20 micropascals.

1. Noise and Vibration

1.1 Introduction

Gladstone Ports Corporation (GPC) commissioned GHD to assess the potential noise and vibration impacts resulting from the construction of the Western Basin Strategic Dredging and Disposal Project (Project).

The assessment has been undertaken with consideration to the following Queensland Environment Protection Agency (EPA) publications:

- *Environmental Protection Act 1994*;
- Environmental Protection (Noise) Policy 2008; and
- Planning for Noise Control Guidelines 2004.

1.1.1 Project Description

The Port of Gladstone Western Basin Dredging and Disposal Project seeks to accommodate the long term dredging and dredged material disposal that is required to provide safe and efficient access to the existing and proposed Port facilities in the harbour over the foreseeable future.

Two areas of development are required for the long-term strategic development of the Port:

- The Western Basin dredging and reclamation works are required for access to proposed wharf facilities located in the Western Basin area of the Port and for the disposal of dredged material; and
- The outer harbour works are associated with the duplication of channels to account for increased traffic through the port. This will be investigated at a later stage.

The proposed Western Basin reclamation is 10 km north of Gladstone City immediately adjacent to the existing Fisherman's Landing reclamation and proposed 153 ha Fisherman's Landing reclamation (Figure 1). The development of the Western Basin will incorporate dredging associated with the deepening and widening of existing channels and swing basins, and the creation of new channels, swing basins and berth pockets. Figure 1 displays the proposed Western Basin dredging and reclamation areas. Dredged material will be placed in a bunded reclamation, which will create a land reserve to be used to service the new port facilities.

1.1.2 Scope of Work

The scope of works for the noise and vibration assessment comprised:

- Identify sensitive receivers using available aerial photography and planning maps;
- Review existing noise monitoring data in the vicinity of the proposed project at potentially impacted receivers;
- Comment on existing background and ambient noise levels for the day, evening and night time periods;
- Comment on any current activities near the Project area which may contribute to the background level of noise and ground vibration;

- Establish project specific noise levels with consideration to the Queensland EPA publications Environmental Protection (Noise) Policy 2008, Noise Measurement Manual 2000, Planning for Noise Control 2004, and Australian Standard AS 1055.2:1997 – Acoustics – Description and measurement of environmental noise;
- Undertake a desktop review of client supplied information detailing noise levels for proposed construction plant, equipment and other activities at the proposed dredging area; and
- Comment on the potential noise impact on sensitive receivers from dredging of the Western Basin area;
- Undertake a literature review of underwater noise from various construction activities and impacts of noise on marine fauna.

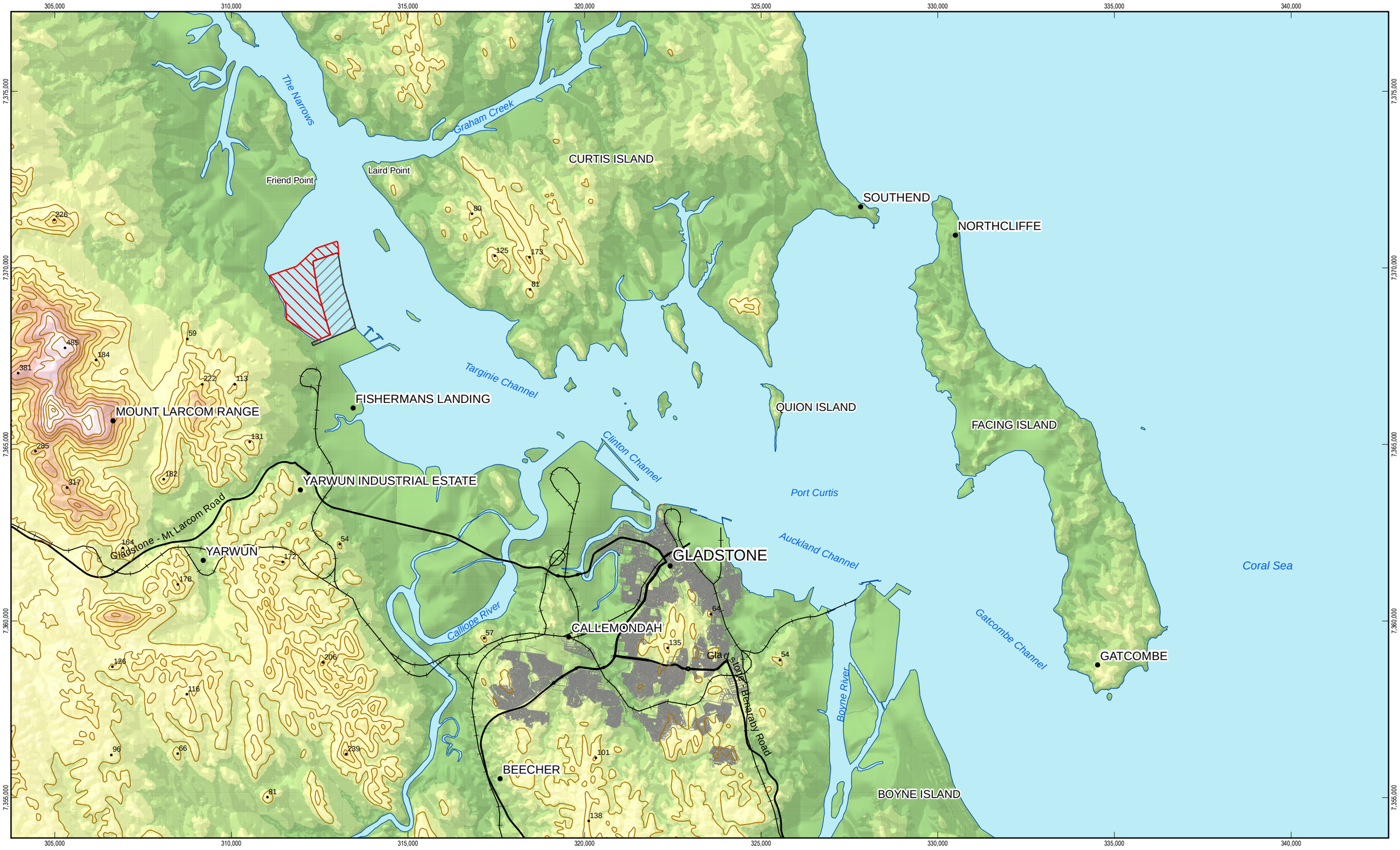
1.1.3 Limitations

This report has been prepared for Gladstone Ports Corporation. The purpose of the report is to provide an independent review of the proposed Western Basin Strategic Dredging and Disposal.

It is not the intention of the assessment to cover every element of the acoustical environment, but rather to conduct the assessment with consideration to the prescribed work scope.

In conducting this assessment and preparing the report, current guidelines for noise were referred to. This work has been conducted in good faith with GHD's understanding of the client's brief and the generally accepted consulting practice.

No other warranty, expressed or implied, is made as to the information and professional advice included in this report. It is not intended for other parties or other uses.



Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

Port of Gladstone
Western Basin Dredging and Disposal Project

Location

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 1

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1.2 Existing Environment

1.2.1 Description of Environmental Values

Environmental Values for the Acoustic Environment

The environmental values to be enhanced or protected under the Queensland Environmental Protection (Noise) Policy 2008 are the qualities of the environment that are conducive to:

- protecting the health and biodiversity of ecosystems;
- human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to sleep, study or learn and be involved in recreation, including relaxation and conversation; and
- protecting the amenity of the community.

Acoustic quality objectives are also set out in the EPP (Noise) schedule 1 and are expressed as a measurement of an acoustic descriptor for various sensitive receptors, time of day and environmental value. The time of day periods are defined in the EPP (Noise) as

- Daytime means the period after 7 am on a day to 6 pm on the day;
- Evening means the period after 6 pm on a day to 10 pm on the day; and
- Night-time means the period after 10 pm on a day to 7 am on the next day.

Whilst these times are consistent with other noise standards and policies, the PNC also indicates that daytime is defined as from 9 am to 6 pm on Sundays and public holidays.

The *Environmental Protection Act 1994* outlines how to protect Queensland's environment from environmental nuisance and section 51 of the Environmental Protection Regulation 2008 provides matters to be considered for environmental management decisions, including but not limited to, the management hierarchy, environmental values, quality objectives, the management intent and the characteristics of the receiving environment.

For industrial developments there is another mechanism to assist in achieving a balance between the social and economic amenity of the community, and the needs of the individual for sleep and relaxation. The Queensland EPA Ecoaccess Guideline Planning for Noise Control 2004 (PNC) is for setting conditions related to noise emitted from industrial premises, which are intended for planning purposes. The guideline also includes criteria for estimating the probability of sleep disturbance from transient noise.

Noise descriptors reported in this chapter, in dB(A), include L_{A90} and L_{Aeq} which are representative of background noise levels and time average noise levels for the period of measurement respectively.

Noise and Vibration Sensitive Receivers

Noise sensitive receivers were identified based on aerial photography, a site visit and liaison with GPC. The nearest sensitive receivers are listed in Table 1 below. These receivers are within or adjacent to the Gladstone State Development Area (GSDA).

Table 1 Nearest Sensitive Receivers

	Type	Location	Distance to proposal
R01	Residential	Mt Larcom Gladstone Road	5500m from reclamation area
R02	Residential	Mt Larcom Gladstone Road	4800m from reclamation area
R03	Residential	Fisherman's Road	2500m from reclamation area
R04	Residential	Tide Island	450m from dredging
R05	Residential	Witt Island	750m from dredging
R06	Residential	Compigne Island	2700m from dredging
R07	Residential	Turtle Island	2500m from dredging
R08	Residential	Quoin Island	3400m from dredging
R09	Residential	Endeavour Parade, Flinders Parade, Aukland Street, Oaka Lane	1000m from the dredging area
R10	Protected Area	Between Friend Point and Laird Point	2500m from the reclamation area

Baseline Noise Monitoring and Review

The Western Basin Strategic Dredging and Disposal Project is located adjacent to the GSDA which is set aside for the purpose of future industrial development, or alternatively, buffer areas for future industrial development. Noise monitoring has also been undertaken in the area for several other noise impact assessments including the Fisherman's Landing EIS, the Gladstone LNG Project, Gladstone Pacific Nickel and the Wiggins Island Coal Terminal.

Existing Noise Sources

Significant noise sources in the surrounding area include the following:

- Rio Tinto Alumina Yarwun;
- Comalco Alumina Refinery;
- Comalco Plant – Fisherman's Landing;
- Stuart Shale Oil;
- RG Tanna Coal Terminal;
- Barney Point Coal Terminal;
- Port Central;
- Landing Road, Forest Road and Mount Larcom Gladstone Road; and
- Dredging activities in the area.

Noise Survey and Instrumentation

Unattended noise monitoring was undertaken for the Fisherman's Landing Northern Reclamation EIS to gain an appreciation of the ambient noise environment at nearby sensitive receivers. Noise monitoring undertaken by GHD (October 2008) in this assessment has been outlined below as it is considered directly relevant to the Western Basin Strategic Dredging and Disposal Project

Both unattended and attended noise monitoring was undertaken with consideration to the specifications outlined in AS 1055 (1997) 'Description and Measurement of Environmental Noise'. Unattended noise monitoring was undertaken from 23 September 2008 to 1 October 2008 at two locations around the subject site to gain an appreciation of the ambient noise environment at nearby sensitive receivers.

Attended noise monitoring was undertaken on 23 September and 24 September 2008 to supplement logger data as well as at several locations around the existing subject site.

Prior to deployment, the loggers and sound level meters (SLMs) were calibrated with a sound pressure level of 94 dB at 1000 Hz using a Rion Type NC73 calibrator. At completion of the unattended 7 day monitoring period, the loggers were retrieved and calibration was rechecked. The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s, or when rainfall occurred. Weather data over the monitoring period were collected from the Bureau of Meteorology (BoM) Gladstone Airport Weather Station. Table 2 provides details of the noise loggers at each monitoring location.

Table 2 Noise Monitoring Details

Monitoring Location	**Location 1 (Lot 59 Targinie Road), unattended monitoring**	**Location 2 (Fisherman's Road), unattended monitoring**	**All Locations (16), attended monitoring**
Instrument	Rion NL21	Rion NL21	Larson Davis 831 SLM
Logger Serial No.	00176072	00376386	01619
Measurement Started	23/09/2008 16.00	24/09/2008 10.00	September 23, 2008
Measurement Ceased	01/10/2008 11.00	01/10/2008 11.00	September 24, 2008
Pre-measurement Calibration	94.0 dB(A)	93.9 dB(A)	94.0 dB(A)
Post Measurement Calibration	93.9 dB(A)	93.9 dB(A)	93.9 dB(A)
Frequency Weighting	A	A	A
Time Response	Fast	Fast	Fast

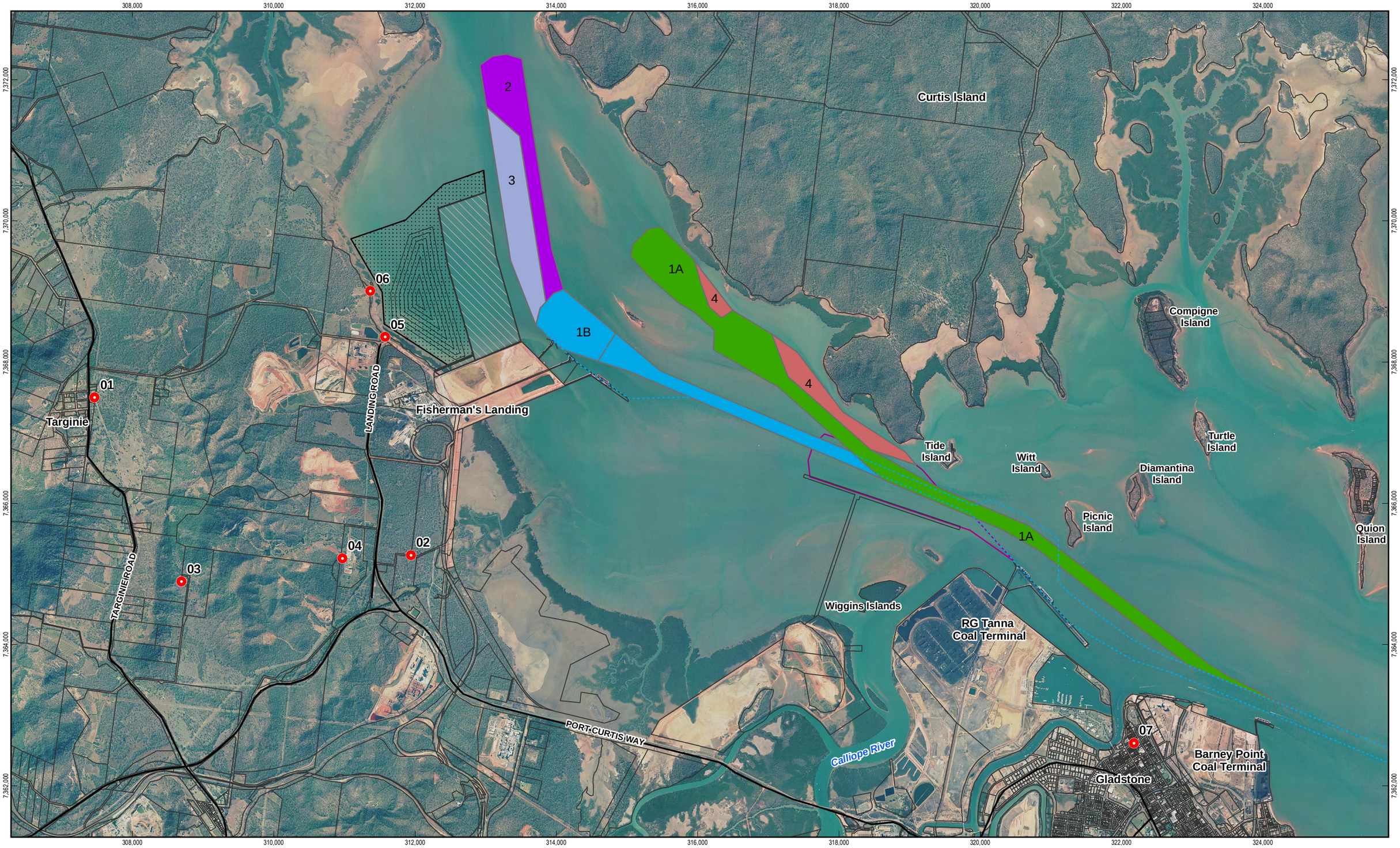
Noise Monitoring Sites

The locations for which noise monitoring was undertaken for both unattended and attended monitoring are described in Table 3 and shown in Figure 2. Unattended monitoring was undertaken at Location 1 and Location 2 only, whilst attended monitoring was undertaken for all sites.

Table 3 Noise Monitoring Site Locations

Site	Location	Detail
Location 1	Lot 59 Targinie Road	Undertaken in the free field, in residential property located off Targinie Road.
Location 2	Fisherman's Road	Undertaken in the free field, out the front of a residential property adjacent to Fisherman's Road.
Location 3	Residence Elsie Road	Undertaken in the free field, in residential property located off Elsie Road.
Location 4	Transpacific	Undertaken in the free field, adjacent to industrial property located off Guerassimoff Road.
Location 5	Adjacent Expansion Reclamation South	Undertaken in the free field, west of the proposed reclamation area.
Location 6	Adjacent Expansion Reclamation North	Undertaken in the free field, west of the proposed reclamation area.
Location 7[1]	12 Lord Street Gladstone	Undertaken in the free field, next to property letterbox.

[1] Noise monitoring undertaken by Connell Hatch (Wiggins Island Coal Terminal EIS, 2006)



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Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Noise Monitoring Location
- Cadastre
- Fisherman's Landing Northern Expansion
- Western Basin Reclamation
- Wiggins Island (Approved)
- Stage 1A - North China Bay LNG Precinct
- Stage 1B - Fisherman's Landing LNG
- Stage 2 - Laird Point LNG
- Stage 3 - Fisherman's Landing
- Stage 4 - Hamilton Point

Port of Gladstone
Western Basin Dredging and Disposal Project

Noise Monitoring Locations and Dredge Scenarios

Job Number	42-15386
Revision	A
Date	30 Aug 2009

Figure 2

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Noise Measurements

Unattended monitoring results for the two loggers are summarised in Table 4 and Table 5 respectively, with photographs of each logger presented immediately after these tables. Data are presented in graphical format in Appendix A.

Table 4 Summary of Noise Monitoring Results for Location 1

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Tuesday -23-Sep-08	-	35.5	-	-	43.6	-
Wednesday -24-Sep-08	32.5	-	29.5	47.1	-	50.3
Thursday -25-Sep-08	-	-	-	-	-	-
Friday -26-Sep-08	-	37.1	33.9	-	43.7	50.0
Saturday-27-Sep-08	-	35.8	31.5	-	43.9	50.2
Sunday-28-Sep-08	32.8	36.3	23.0	54.0	42.9	49.2
Monday-29-Sep-08	33.1	40.1	29.4	53.7	49.2	45.3
Tuesday-30-Sep-08	-	-	-	-	-	-
RBL and L_{eq} Overall	32.8	36.3	29.5	52.5	45.4	49.3

Note: '-' refers to invalid data that has been excluded from the data set.

Figure 3 – Noise Logger at Location 1, view towards dwelling

Figure 4 – Noise Logger at Location 1, view towards Western Basin

Table 5 Summary of Noise Monitoring Results for Location 2

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Wednesday -24-Sep-08	37.9	-	-	48.5	-	-
Thursday -25-Sep-08	-	-	-	-	-	-
Friday -26-Sep-08	-	38.8	41.5	-	41.3	48.1
Saturday-27-Sep-08	-	35.9	38.6	-	43.2	47.4
Sunday-28-Sep-08	33.5	35.5	38.2	45.4	39.5	47.5
Monday-29-Sep-08	36.5	38.2	36.5	45.4	43.6	51.0
Tuesday-30-Sep-08	-	-	-	-	-	-
RBL and L_{eq} Overall	36.5	37.0	38.2	46.7	46.9	48.2

Note: '-' refers to invalid data that has been excluded from the data set.

Figure 5 – Noise Logger at Location 2, view towards dwelling

Figure 6 – Noise Logger at Location 2, view towards Fisherman's Road

Noise monitoring has been undertaken in Gladstone near Port Central as part of previous noise assessments. This area has been noted to experience elevated evening and night-time noise levels due to industrial noise. This includes rail shunting, existing maintenance dredging in the Clinton Channel industrial noise from Port Central and road traffic noise in the area. Residents are located within 200m of road, rail and industrial activities that operate 24 hours a day. Unattended noise monitoring results are summarised in Table 6.

Table 6 Noise Monitoring Results in Gladstone

Site	Monitoring Period	Day			Evening			Night		
		L_{A10}	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}
12 Lord St[2]	5/4/06 – 18/4/06	56	53	42	60	57	45	44	44	36

Attended Measurements

Attended monitoring results for the six locations are summarised in Table 7 along with identified contributing sources of background noise.

Table 7 Summary of Attended Monitoring Results dB(A)

Location	Time	Duration (minutes)	L_{A90}	L_{Aeq}	Comment
Location 1 - Logger 1	11.00 am	15	29.5	38.8	Birds and insects. Few cars on Mt Larcom Gladstone Road. Industrial noise not audible.
Location 2 – Logger 2	9.50 am	15	38.0	42.0	Noise from industrial sources constant. Road traffic noise from Landing Road. Birds and insects. Some low frequency noise (possibly dredging).
Location 3 - Residence Elsie Road	2.44 pm	15	25.6	31.6	Located within “acoustic shadow” of the hill, far from the industrial activities at Fisherman’s Landing. Birds, wind in leaves and some distance traffic noise from Mt Larcom Gladstone Road.
Location 4 - Transpacific	2.18 pm	15	37.5	42.9	Road traffic noise from Landing Road. Intermittent industrial noise from Transpacific. Some wind associated noise.
Location 5 - Adjacent Expansion Reclamation South	10.28 am	15	36.5	48.3	Queensland Cement, constant noise (200-400 Hz). Birds in the area (4000Hz). Some cars on the nearby road.
Location 6 - Adjacent Expansion Reclamation North	1.57 pm	15	39.0	40.8	Industrial noise from Cement Australia constant. Birds and some light wind in leaves.
Location 7 – 12 Lord Street[3]	1.06 am	15	41.5	45.2	Maximum noise levels due to rail noise; continuous background noise due to road traffic noise.

[2] Noise Assessment for Wiggins Island Coal Terminal, Connell Hatch 2006

[3] Noise Assessment for Wiggins Island Coal Terminal, Connell Hatch 2006

Noise Criteria

In Queensland, construction activities should be in accordance with general building work hours as described under Section 440R – "Building Work" of the QLD Environmental Protection Act 1994. Under the regulation, no audible noise is permitted at the following times:

- 6.30 pm to 6.30 am – Monday to Saturday; and
- Sundays and public holidays.

The time restrictions are designed to strike a balance between protecting noise amenity and the need to start dredging activities early in the morning.

As reclamation activities will be undertaken for a long period of time (over 12 months) and may be necessary outside normal building work hours, reclamation activities have been compared to planning noise guidelines generally related to fixed industrial premises, commercial premises and mining operations.

Guidance on the assessment of operational noise impacts is provided within the QLD Environment Protection Agency (EPA) *Planning for Noise Control* (PNC) guideline, 2004. The guideline includes both noise criteria that are designed to protect sensitive receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver, hence protecting the amenity.

In line with the above mentioned guidelines, noise from continuous sources should be limited to 3 dB(A) above the background noise level, unless the combined (ambient plus site contribution) noise level would exceed the recommended ambient noise level for the receiver zone. In that case, the noise limit for the site is set so that the combined noise level for the receiver zone does not exceed the recommended level. The specific noise level ($L_{Aeq,\ 1\ hr}$) can be calculated from Equation 1.

Equation 1

Specific noise level: $L_{Aeq,\ 1hr} = \min L_{A90,\ 1\ hr} + 3$

A Z2 noise category area [Negligible transportation. Less than 80 vehicles an hour] has been selected for determining the Planning Noise Level at the receiver on Targinie Road.

A Z4 noise area category [Medium density transportation or some commerce or industry] has been selected for determining the Planning Noise Level (PNL) at the receiver on Fisherman's Road. This is assumed to be a representative category for the areas surrounding the proposed site.

The project specific noise goals can then be calculated according to Equation 2.

Equation 2

Planning noise level = $L_{Aeq,\ 1hr} – K_1 – K_2$

Where,

$L_{Aeq,\ 1hr}$ – Derived from Equation 1;

K_1 – Tonal adjustment; and

K_2 – Impulse adjustment.

The recommended PNLs and project specific noise goals are presented in Table 8 to Table 9.

Table 8 Project Specific Noise Goals for Location 1 (Lot 59 Targinie Road)

Criterion	Time Period		
	Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
Measured Background (RBL), $L_{A90\ min,\ 1hr}$	33	36	30
Recommended Background, minL_{A90} (PNC Table 1)	40	35	30
Adjusted Background, minL_{A90} (PNC Table 2)	38	26	20
Measured Existing Level, L_{Aeq}	53	45	49
Recommended PNL, L_{Aeq} (PNC Table 3, Cat Z2)	50	45	40
Adjusted PNL, L_{Aeq} (PNC Table 4)	43	37	39
Project Specific Level, L_{Aeq} [min $L_{A90,\ 1\ hr}$ + 3]	**41**	**29**	**23**

Table 9 Project Specific Noise Goals for Location 2 (Fisherman's Road)

Criterion	Time Period		
	Day (7am to 6pm)	**Evening (6pm to 10pm)**	**Night (10pm to 7am)**
Measured Background (RBL), $L_{A90\ min,\ 1hr}$	37	37	38
Recommended Background, minL_{A90} (PNC Table 1)	55	50	45
Adjusted Background, minL_{A90} (PNC Table 2)	42	42	43
Measured Existing Level, L_{Aeq}	47	47	48
Recommended PNL, L_{Aeq} (PNC Table 3, Cat Z4)	60	55	50
Adjusted PNL, L_{Aeq} (PNC Table 4)	60	55	46
Project Specific Level, L_{Aeq} [min $L_{A90,\ 1\ hr}$ + 3]	**45**	**45**	**47**

Dredging

Dredging activities will be undertaken over stages, and will not be fixed in any one area. Noise impact from dredging may impact on residents of Witt Island, Tide Island, Compigne Island, Turtle Island, Quion Island and also residents of Gladstone, near Port Central. In order to assess the potential impact on these receivers, recommended outdoor background noise planning levels have been assumed for receivers on the islands adjacent to proposed dredging locations. The PNC guideline has been used to determine suitable background noise levels. The project is entirely within the Gladstone Port limits and therefore the receiver land use has been chosen as 'residential area near an industrial area' with the receiver dominant land use being 'residential'. Project specific noise goals for identified receivers in close proximity to dredging are summarised in Table 10.

Table 10 Project Specific Noise Goals – Receivers within the Port Limits dB(A)

	Time Period		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
Recommended outdoor background noise planning level minL_{A90}, 1 hour	45	40	35
Specific/component noise level	48	43	38

Sleep Disturbance Criteria

Construction activities are not planned to be undertaken at night time. However, should this requirement change throughout the course of the construction project, maximum noise levels over the night-time period should be restricted to prevent sleep disturbance. The PNC strategy is to limit the external maximum noise impact level according to the number of occurrences likely to occur and the potential noise reduction from outside to inside.

The policy recommends that instantaneous internal sound pressure levels do not exceed in the order of 45 dB(A) Lmax more than 10 to 15 times per night as a rule in planning for short term or transient events.

Worse case construction noise has been assessed against the more stringent project specific operational noise criteria and sleep disturbance is therefore no longer discussed in this assessment.

Protected Areas

The EPP (Noise) 2008 states that for a protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or an area of major interest the acoustic quality objectives are ‘the level of noise that preserves the amenity of the existing area or place’.

The Great Barrier Reef Marine Park is protected by the *Marine Parks Act 2004*, and the appropriate noise criteria is specified in the EPP (Noise) 2008 as being ‘the level of noise that preserves the amenity of the existing marine park’.

Vibration Criteria

General

In the absence of specific QLD guideline addressing vibration issues, consideration was given to the following publications for the determination of monitoring sites and appropriate measurement parameters:

- NSW Department of Environment and Climate Change (DECC) Assessing Vibration: A Technical Guideline, 2006;
- British Standard BS6472:1992 Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz); and
- British Standard BS7385-2:1993 Evaluation and Measurement for Vibration in Buildings, Part 2 - Guide to damage levels from ground borne vibration.

The above standards are typically adopted by industry in Australia for the assessment of construction and operational vibration impacts.

Effect of Vibration on Structures

Transient and continuous vibration guidelines in order to ensure a minimal risk of cosmetic damage to residential and other sensitive buildings are presented in Table 11. These guide values are conservative, as the actual degree of tolerance of a building depends on the structural characteristics and frequency spectrum of the vibration. In the case of continuous vibration, BS7385-2:1993 recommends that targets outlined below be reduced to 50%.

Table 11 Transient Vibration Guidelines for Cosmetic Damage (BS7385 – 2:1993 – Evaluation and measurement for vibration in buildings)

Vibration Type	Peak Particle Velocity		
	Reinforced or framed structures Industrial and heavy commercial buildings	Unreinforced or light framed structures Residential or light commercial type buildings	
Transient vibration	50 mm/s at 4 Hz and above	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Continuous vibration	25 mm/s at 4 Hz and above	7.5 mm/s at 4 Hz increasing to 10 mm/s at 15 Hz	10 mm/s at 15 Hz increasing to 25 mm/s at 40 Hz and above

Human Comfort

Acceptable values of human exposure to continuous and impulsive vibration are dependent on the time of day and the activity taking place in the occupied space. When assessing intermittent vibration, the Vibration Dose Value (VDV) is used as a reference. Acceptable VDVs, as sourced from BS6472:1992 and outlined in the NSW DECC Technical Guideline, are presented in Table 12. The VDV accumulates the vibration energy received over the daytime and night-time periods.

Table 12 Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime[4]		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[5]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

[4] **Daytime is 7:00 to 22:00 and Night-time is 22:00 to 7:00**

[5] Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These goals are only indicative, and there may be need to assess intermittent values against the continuous or impulsive goals for critical areas y

When assessing continuous vibration, weighted root-mean-squared (rms) acceleration in the 1-80 Hz range is used as a reference. Acceptable weighted rms acceleration levels, as sourced from BS6472:1992 and outlined in the Technical Guideline, are presented in Table 13. The VDV accumulates the vibration energy received over the daytime and night-time periods.

Table 13 Preferred and Maximum Weighted RMS Values for Continuous Vibration Acceleration (m/s^2) 1 – 80Hz

Location	Assessment Period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Critical areas[5]	Day or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
Workshops	Day or night-time	0.040	0.029	0.080	0.058

1.3 Potential Impacts and Mitigation Measures

1.3.1 Overview

Reclamation

Reclamation activities undertaken as part of the project may generally involve pumping of the material directly into the reclaim area from the dredging equipment (trailing suction hopper dredger or cutter suction dredger). Worst-case activities may include general earthworks (including excavation, filling, compaction). Construction of the reclamation area is likely to occur over a number of years.

Dredging

Dredging of the Western Basin area will occur over a number of years. Dredging will take place in three scenarios and is summarised below:

- Scenario One – (Start: Late 2010, Finish: Late 2012)
  - Stage 1A;
  - Stage 1B commence;
- Scenario Two – (Start: Late 2012, Finish: Early 2014)
  - Stage 1B full;

- Stage 2;

- Scenario Three – (Start: Early 2014, Finish: unknown)
  - Stage 3;
  - Stage 4.

The scenarios can be seen in Figure 2.

1.3.2 Noise Model Configuration

Acoustic modelling was undertaken using Computer Aided Noise Abatement software (CadnaA) to predict the effects of noise generated by the construction of the proposed Fisherman's Landing Northern Reclamation. Modelling results should only be used as a guide for comparative purposes. CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to ISO 96132, "Acoustics – Attenuation of sound during propagation outdoors". Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

The proposed construction activities associated with the construction of the bund wall of the reclamation area and dredging locations have been modelled based on available data. Layout, and noise generating equipment were based on information provided at the time of the assessment. Detailed topography data was supplied for use in the noise model for the subject site as well as surrounding areas with contour intervals set at a maximum of five metres.

CONCAWE has been used to assess worst-case meteorological conditions for the Project. CONCAWE allows wind and atmospheric stability variables to be assessed in the prediction. Worst case meteorological conditions assessed for the site include a F-class stability constant and a 3m/s easterly wind as this is the dominant wind direction throughout the year.

As such, modelling results should only be used as a guide for comparative purposes.

1.3.3 Noise Sources

Reclamation

Construction noise and vibration sources associated with construction of the reclamation area may include tip trucks for importing the fill material, earthmoving machinery and vibratory rollers for site preparation, and other smaller construction vehicles.

GHD has assumed likely fixed and mobile on-site equipment and operating schedules. GHD sourced sound power levels (L_W) and spectra for all assumed noise sources from GHD's sound level database and manufacturers specifications.

Construction activities will likely be undertaken between the hours of 6.30am and 6.30pm, Monday to Saturday. No construction activities should be undertaken on Sunday's or public holidays. Any works scheduled outside these hours, will need to comply with the night time site specific noise criteria.

Modelled overall L_w and source characteristics are summarised in Table 14. These L_W's are maximum levels produced when machinery is operating under full load. Due to the nature of the project, construction related activities will be a source of transient noise such as trucks entering the site and dumping fill, and also continuous noise from excavators operating on site throughout the day. Worst-case

noise modelling has been undertaken and modelled sources have been assumed to operate under full load at all times.

Table 14 Reclamation Noise Source Characteristics

Source	Sound Power Level (L_W) dB(A)	Modelled Height (m)	Number modelled onsite
35t tracked excavator – 128 kW	107	2.5	1
Dump Truck	118	2.5	1
12t vibratory roller	109	2.5	1
Dredger	110	4.0	1

Dredging

Dredging noise and vibration sources associated with dredging of the Project will likely include the following or similar equipment:

- Large trailing suction hopper dredger;
- Medium trailing suction hopper dredger;
- Large cutter suction dredger;
- Medium cutter suction dredger; and
- Backhoe dredger.

There will also be workboats, survey boats and tug boats associated with the project.

GHD sourced likely sound power levels (L_W) and spectra, where available, for all assumed noise sources from GHD's sound level database and manufacturers specifications.

Dredging activities will likely be undertaken seven days a week, 24 hours a day. And as of such dredging activities have been assessed against the night time site specific noise criteria.

Modelled overall L_w and source characteristics are summarised in Table 15.

Table 15 Dredging Noise Source Characteristics

Source	Sound Power Level (L_W) dB(A)	Modelled Height (m)	Number modelled onsite
Grab hopper dredging ship	110	4	1
Long reach tracked excavator	105	4	1
Tug boat	110	4	1
Barge	104	4	1

Pile Driving

There are up to nineteen beacons that will be installed around the northern extents of channel 1A and also in the Clinton bypass channel. The exact location of the beacons is unknown, however the installation of the beacons will be undertaken in a relatively short period of time (approximately one day per beacon). Pile driving will be undertaken during the daytime (6.30am to 6.30pm) only (approximately one day for each pile) and as such noise impact on sensitive receivers are not considered to be significant. Underwater noise from pile driving is discussed in more detail below.

1.3.4 Noise Results

Noise impact at the identified nearby receivers is summarised in Table 16 below. Receivers 1 – 3 have been assessed using noise impact from the reclamation area, and receivers 4 – 10 have been assessed with noise from dredging activities. The closest activities have been assessed, as these will have the greatest potential noise impact. Noise contours displaying potential noise impact for worst-case dredging and reclamation activities are displayed in Figure 7 to Figure 10.

Results are presented as worst case with all equipment onsite operating simultaneously and are considered conservative.

These predicted levels are below the ambient and background noise levels and comply with the worst case night time site specific criteria of 45 dB(A) for the receiver on Fisherman's Road and 25 dB(A) for the receivers on Targinie Road.

Noise levels have the potential to exceed the night time construction goal of 38 dB(A) at receivers R04 and R10 and an additional receiver (R9 – Gladstone residents near Port Central) by 1 dB during noise enhancing meteorological conditions. Appropriate management of construction activities is needed to help minimise impacts on these receivers during dredging activities.

Table 16 Predicted Noise Levels from Proposed Dredging Activities – 1.5m above ground dB(A) re:20µPa

Location	Distance from source	Neutral meteorological conditions Predicted Noise Impact dB(A)	Noise-enhancing meteorological conditions Predicted Noise Impact dB(A)
R01	9000m from reclamation	15	22
R02	8500m from reclamation	18	25
R03	5500m from reclamation	25	31
R04	450m from dredging	**41**	**45**
R05	750m from dredging	34	37
R06	2700m from dredging	23	27
R07	2500m from dredging	22	26
R08	3400m from dredging	18	23
R09	1100m from dredging	35	**39**

Location	Distance from source	Neutral meteorological conditions Predicted Noise Impact dB(A)	Noise-enhancing meteorological conditions Predicted Noise Impact dB(A)
R10	600m from dredging	**41**	**45**

Impacts on Protected Areas

The waters surrounding the Project are a declared Dugong Protection Area. Airborne noise transmission from construction of the reclamation into the surrounding waters will likely be insignificant when compared to natural underwater noise in the area. Gerjuoy (1947) showed that for sound incident at an angle greater than 13° to the normal, all of the energy is reflected back from the water surface, and within this range increasing proportions of the sound's energy will be transmitted. According to this, only construction activities being undertaken on, or directly adjacent to the water, will likely transmit airborne sound into the water, although some sound may enter the water outside this region because of surface roughness. As well as the angle of incidence, the difference in acoustic impedance affects the amount of acoustic energy transferred from one substance to another. For air and water this difference is large and it is thought unlikely that airborne transmission of construction noise will contribute significantly to the level of underwater sound from construction activities.

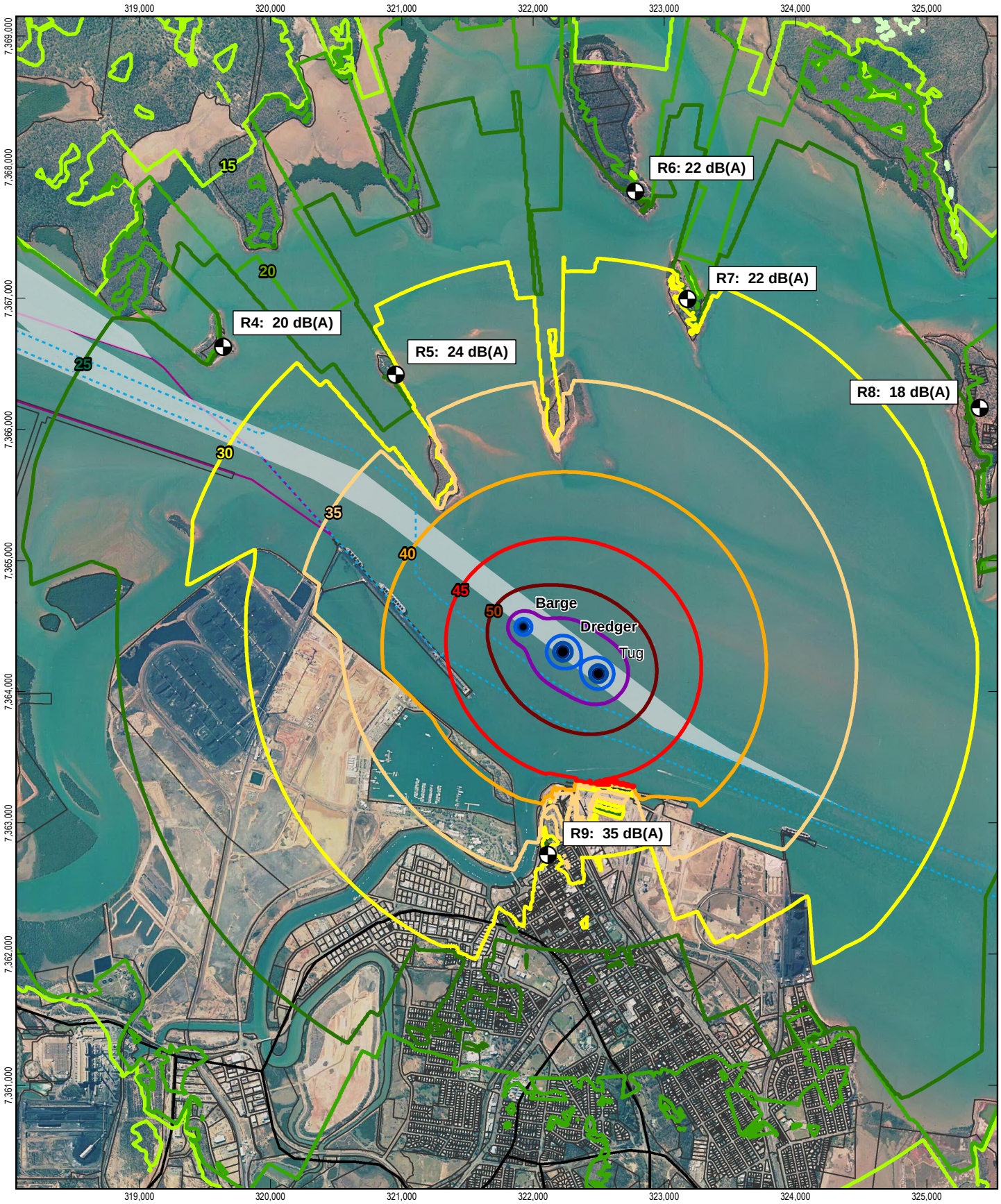
The Great Barrier Reef Marine Park is protected by the *Marine Parks Act 2004*, and the appropriate noise criteria is specified in the EPP (Noise) 2008 as being 'the level of noise that preserves the amenity of the existing marine park'.

The nearest zoned marine park to the proposed site is habitat protection zone of the Great Barrier Reef Coastal Marine Park (State) located to the north between Friend Point and Laird Point, approximately 2.5 km north of the reclamation area.

Migratory birds have the potential to be influenced by noise from the proposal. Studies of birds (Larkin, 1996) have shown that they will habituate to loud noises that are not biologically meaningful for them. For example if the noise is associated with possible harm such as thunder on a cloudy day, birds will avoid it, but routine noises such as traffic will not disturb them. Examples are provided of seabirds that voluntarily coexist with relatively loud noise environments, such as around airports, and birds roosting on light posts above busy motorways.

Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds.

The proposed site is adjacent to the GSDA and is currently subject to relatively high ambient noise levels from industrial sources. Noise levels in areas immediately adjacent to the worksite will likely be higher than existing ambient levels during construction activities, with any birds or fauna on nearby tidal flats being exposed to noise levels of approximately 40 – 55 dB(A) during construction activities. These levels are similar to noise levels experienced adjacent to other sites within the GSDA and comparable to noise levels in natural environments during windy conditions or experiencing elevated insect noise.



LEGEND

- Noise Receptor
- Existing Channels, Swing Basins and Berths
- Proposed Dredging

Sound Pressure Level dB(A)

80	40
70	30
60	20
50	10

NOTES:
Sound Pressure Level dB(A)
Results based on modelling assumptions
Predicted Noise Contribution Contours: 1.5m
Worst-Case LAeq
Wind/Atmosppheric conditions: Neutral.

1:40,000 (at A4)
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Noise Prediction Contours for Dredging Activities (South-east Section of Scenario 1A)

Job Number 42-15386
Revision A
Date 12 Oct 2009

Figure 7

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

LEGEND

- Noise Receptor
- Existing Channels, Swing Basins and Berths
- Proposed Dredging

Sound Pressure Level dB(A)

- 80
- 70
- 60
- 50
- 40
- 30
- 20
- 10

NOTES:
Sound Pressure Level dB(A)
Results based on modelling assumptions
Predicted Noise Contribution Contours: 1.5m
Worst-Case LAeq
Wind/Atmosppheric conditions: Neutral.

1:60,000 (at A4)

0 0.5 1 1.5 2

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Noise Prediction Contours for Dredging Activities (Scenario 1A)

Job Number 42-15386
Revision A
Date 12 Oct 2009

Figure 8

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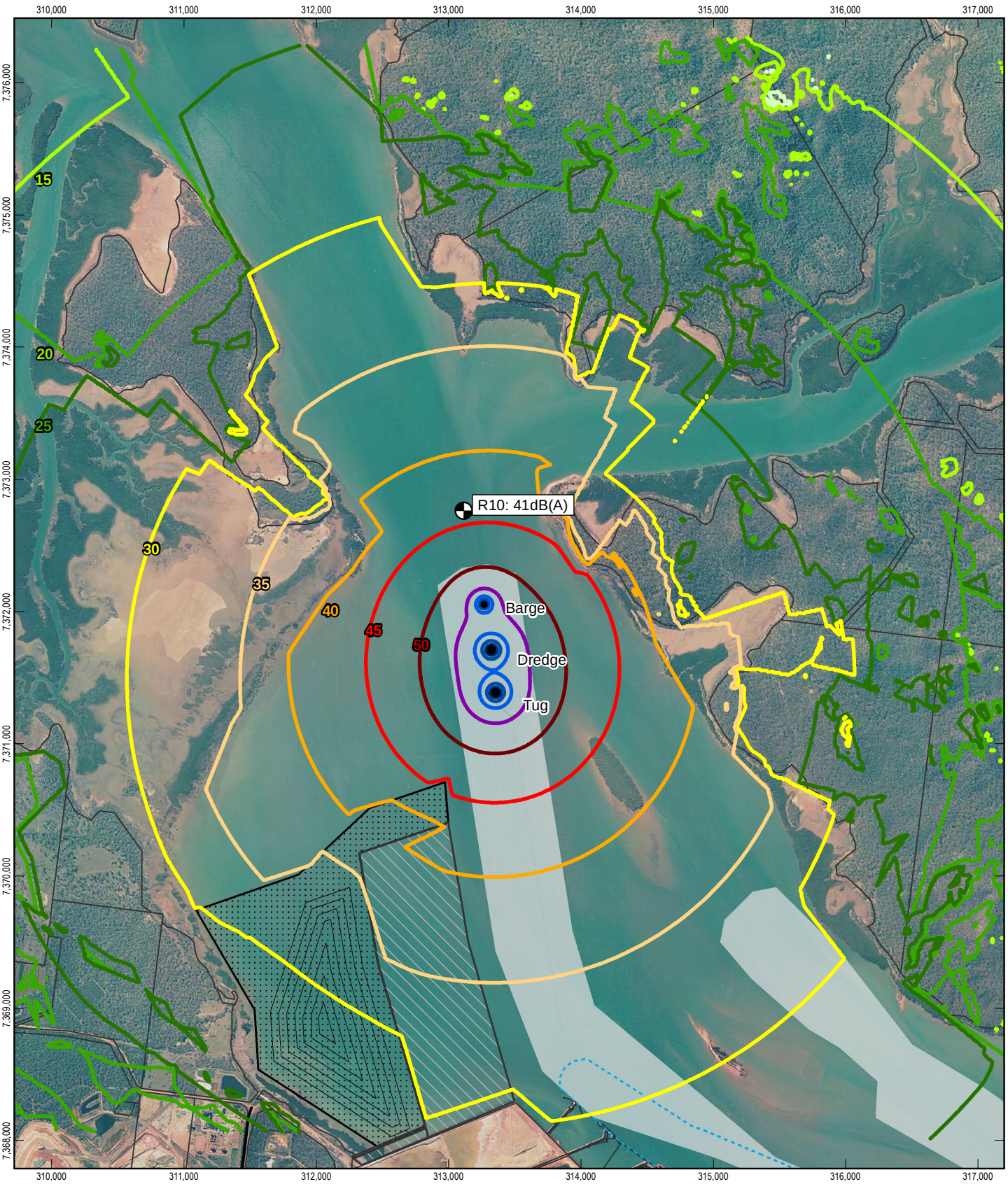

LEGEND

- Noise Receptor
- Existing Channels, Swing Basins and Berths
- Proposed Dredging
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion

Sound Pressure Level dB(A)

80	40
70	30
60	20
50	10

NOTES:
Sound Pressure Level dB(A)
Results based on modelling assumptions
Predicted Noise Contribution Contours: 1.5m
Worst-Case LAeq
Wind/Atmosppheric conditions: Neutral.

1:40,000 (at A4)
0 0.25 0.5 0.75 1
Kilometers
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Noise Prediction Contours for Dredging Activities (Scenario 2)

Job Number 42-15386
Revision A
Date 12 Oct 2009

Figure 9

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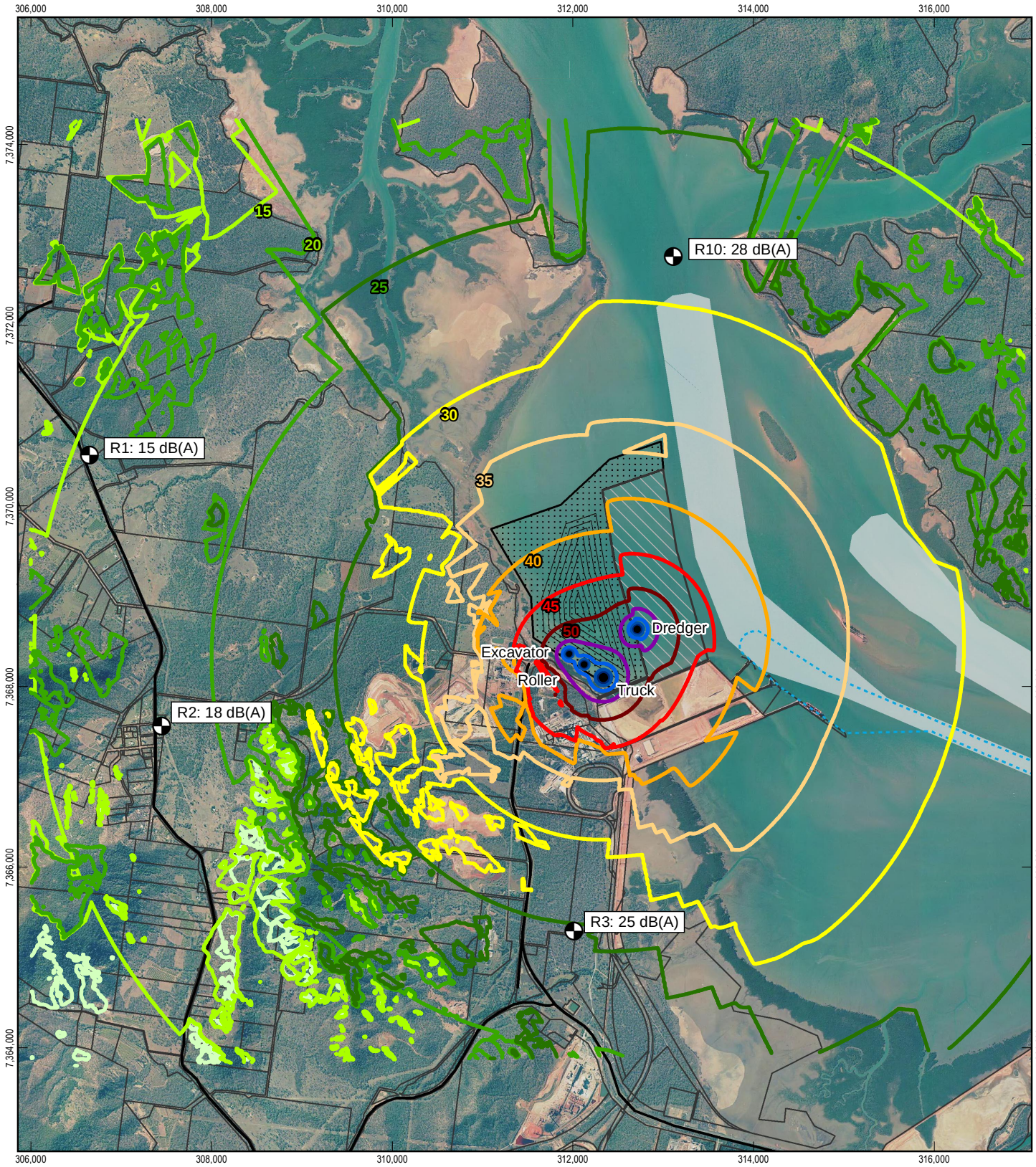
Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com



LEGEND

- Noise Receptor
- Existing Channels, Swing Basins and Berths
- Proposed Dredging
- Western Basin Reclamation Area
- Fisherman's Landing Northern Expansion

Sound Pressure Level dB(A)

80 70 60 50 40 30 20 10

NOTES:
Sound Pressure Level dB(A)
Results based on modelling assumptions
Predicted Noise Contribution Contours: 1.5m
Worst-Case LAeq
Wind/Atmosppheric conditions: Neutral.

1:60,000 (at A4)
0 0.5 1 1.5 2
Kilometers
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Port of Gladstone
Western Basin Dredging and Disposal Project

Noise Prediction Contours for Worst-Case Reclamation Activities

Job Number 42-15386
Revision A
Date 12 Oct 2009

Figure 10

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Level 4 201 Charlotte Street Brisbane QLD 4000 Australia T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

1.3.5 Construction Vibration

It is possible that local sensitive receivers will perceive construction vibration at times. However, the level of annoyance will depend on individuals. Such issues are practically best managed by site monitoring.

Distance between the potentially most impacted receivers and site construction activities will generally be in excess of 500m. However, it is possible that some infrastructure and road works be carried out at smaller distances.

The nature and levels of vibration emitted by the site will vary with the activities being carried out on site. Table 17 lists down the types of vibrations that may be generated by the site. These are further represented in Figure 11, for informative purposes.

Figure 12 presents estimates of the vibration levels generated by common construction activities/equipment at various distances.

Table 17 Types of Construction Vibrations

Vibration Type	Energy Type	Equipment Type
Transient or impact vibrations	Impulsive	Dynamic compaction
		Pavement breaker
Steady-state vibrations	Reciprocating	Vibration roller
		Vibroflotation
Pseudo-steady state vibrations	Rotating	Trencher
		Tunnel boring machine
	Rolling	Heavy vehicles

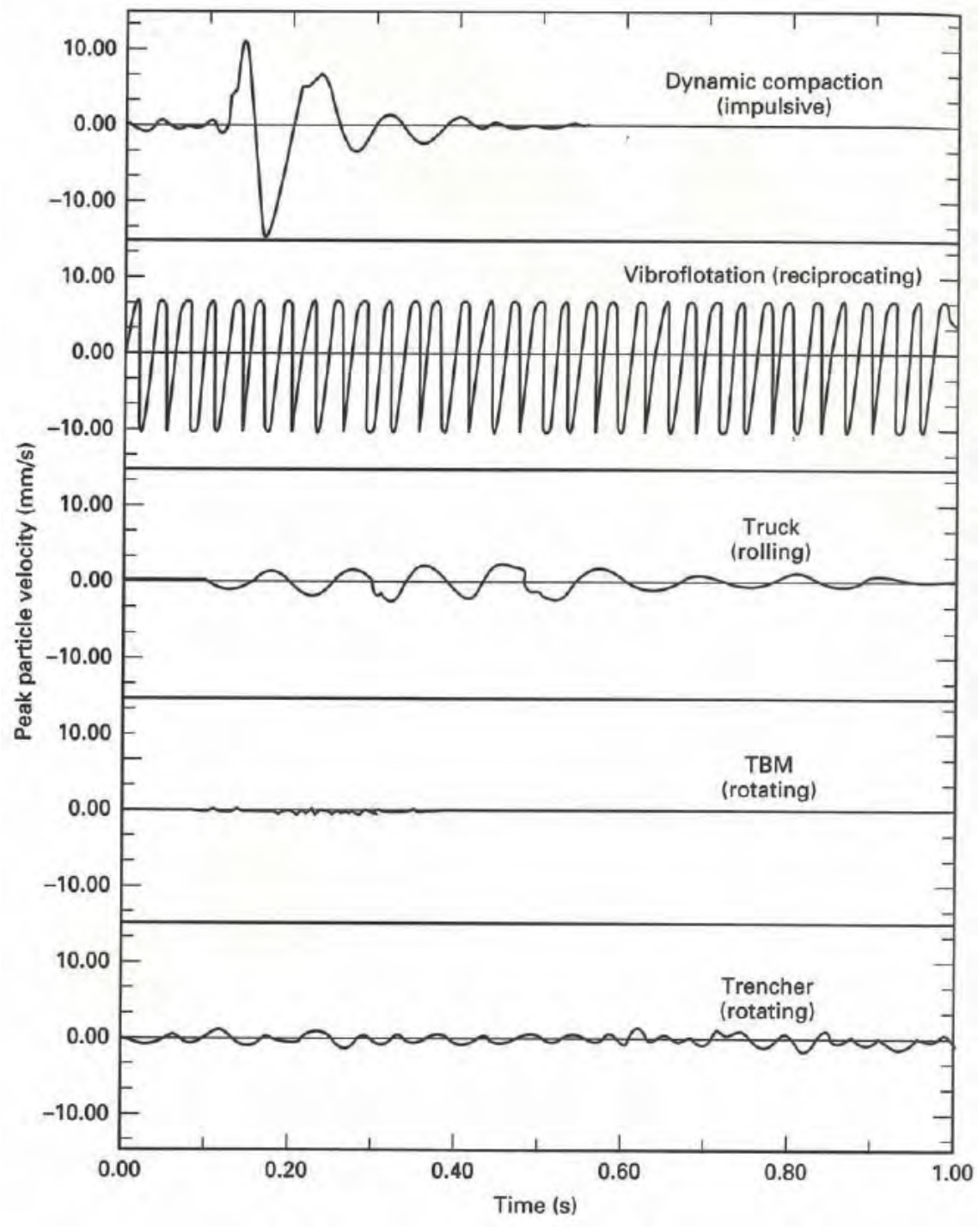


Figure 11 - Typical Waveforms Associated with Various Construction Activities (Source: Dowding)

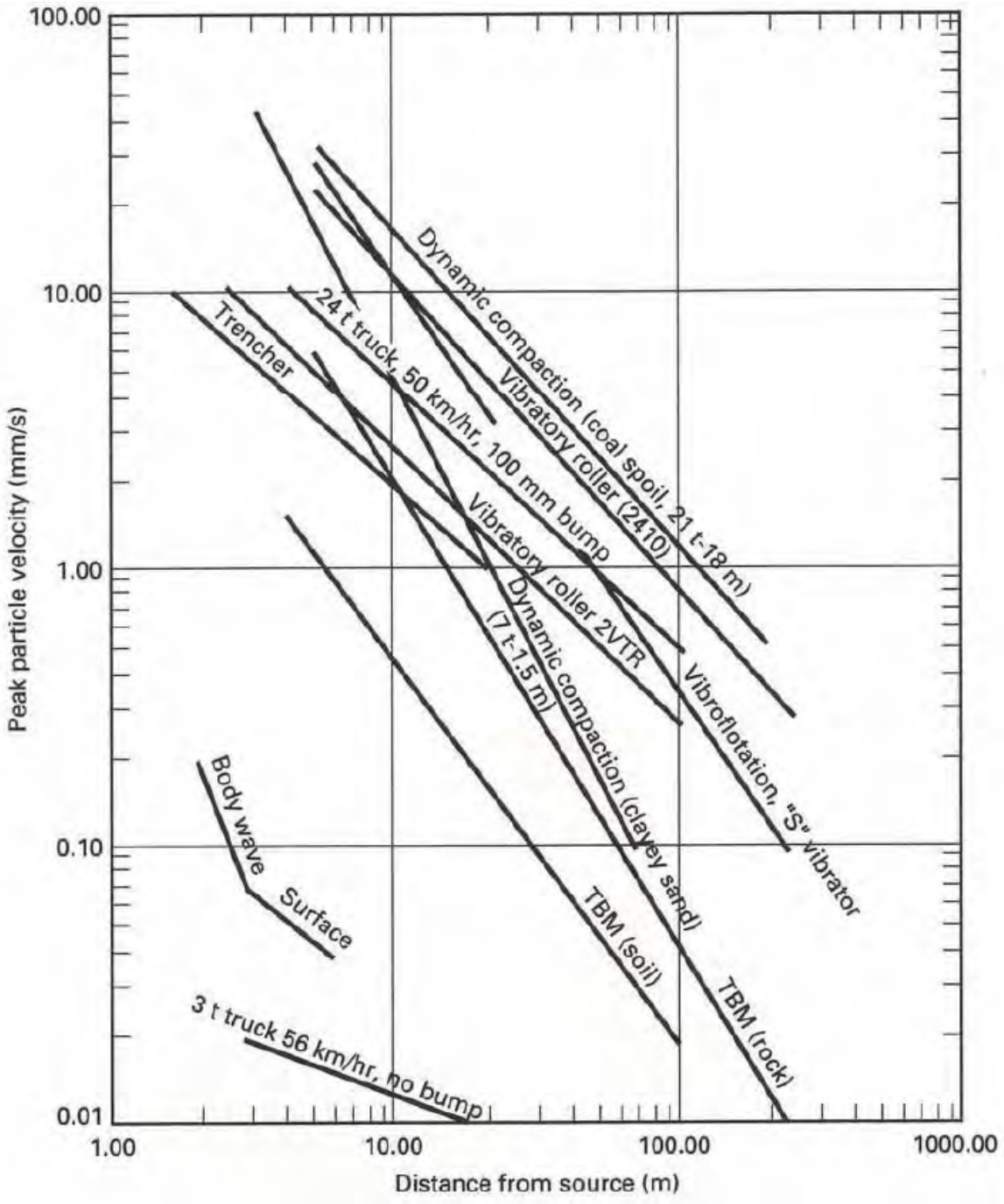


Figure 12 - Typical Vibration Levels of Common Construction Activities (Source: Dowding)

As can be seen in Figure 12, the building damage 7.5mm/s lower limit is normally not exceeded by general construction activities at distances greater than 20-30m from the nearest sensitive receivers.

In the context of the Project, the nearest sensitive receivers will be located further than 500m of the construction activities and as such no appreciable impact is expected.

1.3.6 Impacts to Marine Fauna

The potential for underwater noise impacts of the Project has been considered in detail in the Megafauna report (GHD 2009). Activities that may create underwater noise include dredging, piling driving, underwater surveying, and boats.

There is considerable national and international concern that the sounds introduced into the sea by humans could be having detrimental effects on marine mammals, by interfering with their ability to detect calls from individuals of the same species, echolocation pulses or other important natural sounds (Richardson et al. 1995).

Underwater noise from dredging is likely to result in marine mammals avoiding the Project site, however marine mammals may exhibit tolerance to such noise and may come into close proximity to construction activities. It is well documented for marine animals to avoid dredging activities and therefore impacts on marine life from dredging are expected to be minimal.

19 channel markers may be installed as part of the Project. Installation of the channel markers will involve piling to a depth of 6-8 metres. It is expected than piling may take up to one day per marker.

An assessment of piling driving noise in the Western Basin was undertaken for the Wiggins Island Coal Terminal (Connell Hatch 2006). This assessment was based on piling activities using a 9t and 14t hammer, assuming piling noise levels ranging from 197 dB (re 1µPa) up to 226 dB (re 1µPa) at a distance of 1m from the source. The underwater sound propagation used in the Western Basin for this assessment is consistent with the method commonly used in shallow water less than 40m deep (Urich 1983). The assessment determined an impact zone, which is an area where peak pressure levels from pile driving are predicted to be lower than the 218 dB (re 1µPa (peak)) threshold. The purpose of this impact zone is to prevent death or injury to marine mammals, fish and sea turtles. The assessment (Connell Hatch, 2006), found that using a 14t hammer for pile driving, the maximum range for the impact zone is predicted to be less than 5m. Physiological impacts on marine mammals arising from underwater noise were assumed to be insignificant, as the noise would be detected well before the animals would reach the distance from the source established as the 'impact zone'.

It is expected that risks to marine mammals during piling will not be significant providing appropriate management measures are in place.

1.3.7 Mitigation Measures

Dredging noise is not likely to have a significant impact on the local ambient environment. Results suggest that noise levels may exceed the adopted noise criteria at one resident (receiver 4) during night-time dredging.

While dredging noise is unlikely to be an issue, to minimise noise emissions, the following management and mitigation measures are available to ameliorate likely noise impacts:

Reclamation

- All combustion engine plant, such as generators and compressors should be checked to ensure they produce minimal noise;
- Vehicles and boats should be kept properly serviced and fitted with appropriate mufflers.
- Where practical, all vehicular movements to and from the dredging site should be made only during normal working hours;

- Where practical, machines should be operated at low speed or power and will be switched off when not being used rather than left idling for prolonged periods;
- Activities that cause excessive noise such as pile driving should be limited to Saturdays or business days between 6:30 am and 6:30 pm; and
- Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made.

Dredging and piling

Appropriate mitigation techniques during dredging activities:

- Active community consultation with noise sensitive receivers prior to works commencing;
- Where possible, avoid dredging in close proximity to noise sensitive receivers during the night time period;
- Boats, dredgers and tugs should be kept properly serviced and fitted with appropriate mufflers
- Slow start-up procedures should be used after each shutdown, this may reduce the risk of injury to species by giving them time to leave the area,
- Undertake piling at low tide, where possible; and
- Where a marine mammal is observed within the 'impact zone' which is approximately 5m from the pile driving site, piling should be halted until the mammal has departed.

1.3.8 Conclusion

The results of the assessment suggest that construction activities associated with the reclamation of the Western Basin Dredging and Disposal Project will not significantly impact on the amenity of sensitive residential receivers. Predicted noise levels comply with site specific noise criteria for all identified noise sensitive receivers, and due to the distances between the site and any receivers vibration impacts will likely be insignificant.

Results of the assessment suggest that noise from dredging activities has the potential to exceed the adopted noise goals by 3 dB during the night time period at one receiver (R4 – Tide Island) during neutral meteorological conditions and an additional receiver (R9 – Gladstone residents near Port Central) by 1 dB during noise enhancing meteorological conditions. Dredging activities are considered transient in nature and any exceedance of noise goals will be temporary.

Underwater noise from dredging is likely to result in marine mammals avoiding the Project site, however marine mammals may exhibit tolerance to such noise and may come into close proximity to construction activities. It is well documented for marine animals to avoid dredging activities and therefore impacts on marine life from dredging are expected to be minimal.

Physiological impacts on marine mammals arising from underwater piling noise are assumed to be insignificant, as the noise would be detected well before the animals would reach the distance from the source established as the 'impact zone', which is approximately 5m from the source.

Modelling suggest that noise levels experienced on nearby tidal flats will range from 40 – 55 dB(A) during assumed dredging activities. These levels are similar to noise levels experienced adjacent to other sites within the GSDA and comparable to noise levels in natural environments during windy conditions or experiencing elevated insect noise.

2. References

Baker, C. S. and L. M. Herman (1989). The behavioural responses of summering humpback whales to vessel traffic: Experimental and opportunistic observations. Kewalo Basin Marine Mammal Laboratory 1129 Ala Moana Blvd, Honolulu HI 96814 Report 84.

Bies, D.A and Hansen, C.H (2003) Engineering Noise Control *3rd Edition* Available from: Spon Press

British Standards Institution (1992) *British Standard BS6472:1992 Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz).*

British Standards Institution (1993) British Standard *BS7385-2:1993 Evaluation and Measurement for Vibration in Buildings, Part 2 - Guide to damage levels from ground borne vibration*

Connell Hatch (2006) Wiggins Island Coal Terminal Environmental Impact Statement; Noise and Vibration.

Department of Environment and Climate Change (NSW) (DECC) Assessing Vibration: A Technical Guideline, 2006.

Deutsches Institut fur Normung (1999) German Standard *DIN 4150-3:1999 Structural Vibration – Part 3: Effects of vibration on structures.*

Dowding, C (1996) Construction Vibrations *2nd Edition*

EPA (2000) *Queensland Noise Measurement Manual*. Available from http://www.epa.qld.gov.au

EPA (2004) *Planning for Noise Control*. Available from http://www.epa.qld.gov.au

Gisiner, R. C. (1998) Workshop on the effects of anthropogenic noise in the marine environment. Marine Mammal Science Program, Office of Naval Research Proceedings of a workshop 141.

Gerjuoy, E.(1947), *The sound pressure in water resulting from a point source in air*, Physical Review, vol. 72, p. 745

Huson and Associates, 2009. Underwater Noise Impact Assessment Gladstone LNG Project.

Jurasz, C. M. and V. P. Palmer (1981). Humpback whale (*Megaptera novaeangliae*) and vessel interactions in Glacier Bay National Monument, Alaska: 1975-1979. Sea Search, Ltd. P.O. Box 93 Auke Bay, AK 99821 Report 79.

Ketten, D. R. (1998). Marine Mammal Auditory Systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA National Marine Fisheries Service La Jolla, California NOAA Technical Memorandum NMFS 40JBNF600312 74 pp.

Larkin, R. P, *Effects of Military Noise on Wildlife: A Literature Review*, Centrefor Wildlife Ecology, Illinois, 1996

McCauley, R.D. 1994. Environmental implications of off-shore oil and gas development in Australia – Seismic Surveys, pp 19 – 122 in J.M. Swan, J.M. Neff and P.C. Young (1994). Environmental implications of off-shore oil and gas development in Australia.

McCauley, R. D., C. Jenner, J. L. Bannister, C. L. K. Burton, D. H. Cato and A. Duncan 2001. Blue whale calling in the Rottnest Trench - 2000, Western Australia. Curtin University Perth Project cmst 241 R2001-6 55 pp.

Norris, K. S. and R. R. Reeves (1978). Report on a workshop on problems related to humpback whales (Megaptera novaeangliae) in Hawaii. Marine Mammal Commission 1625 I Street. N.W., Washington, DC 20006 90 pp.

O'Brien, P. E. (2002) Impacts of marine acoustic technology on the Antarctic environment SCAR Ad Hoc group on marine acoustic technology; unpublished 32 pp.

Richardson, W. J., C. R. J. Greene, C. I. Malme and D. H. Thomson (1995). Marine mammals and noise. San Diego, Academic Press.

Schlundt, C. E., J. J. Finneran, D. A. Carder and S. H. Ridgway (2000). "Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whales, Delphinapeterus leucas, after exposure to intense tones." Journal of Acoustical Society of America 107(6): 3496-3508.

Standards Australia (1997) Australian Standard *AS 1055.1 - 1997 Acoustics – Description and Measurement of Environmental Noise*

Standards Australia (1997) *AS2107:2000 – Acoustics – Recommended design sound levels and reverberation times for building interiors;*

Tasker, M. L. and C. Weir 1998 Proceedings of the seismic and marine mammals workshop London Proceedings.

Watkins, W. A. (1986). "Whale reactions to human activities in Cape Cod waters." Marine Mammal Science **2**(4): 251-262.

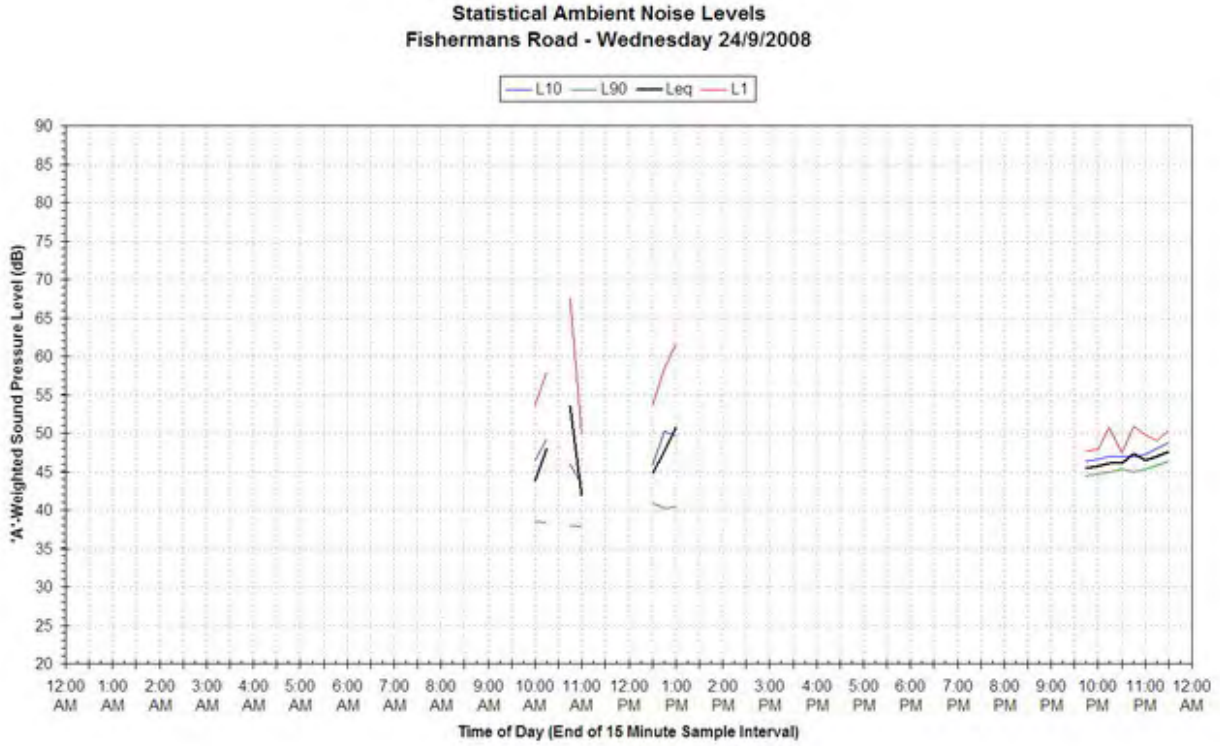
Urich, R. J. (1983). Principles of Underwater Sound, 3rd ed. McGraw-Hill Company New York.

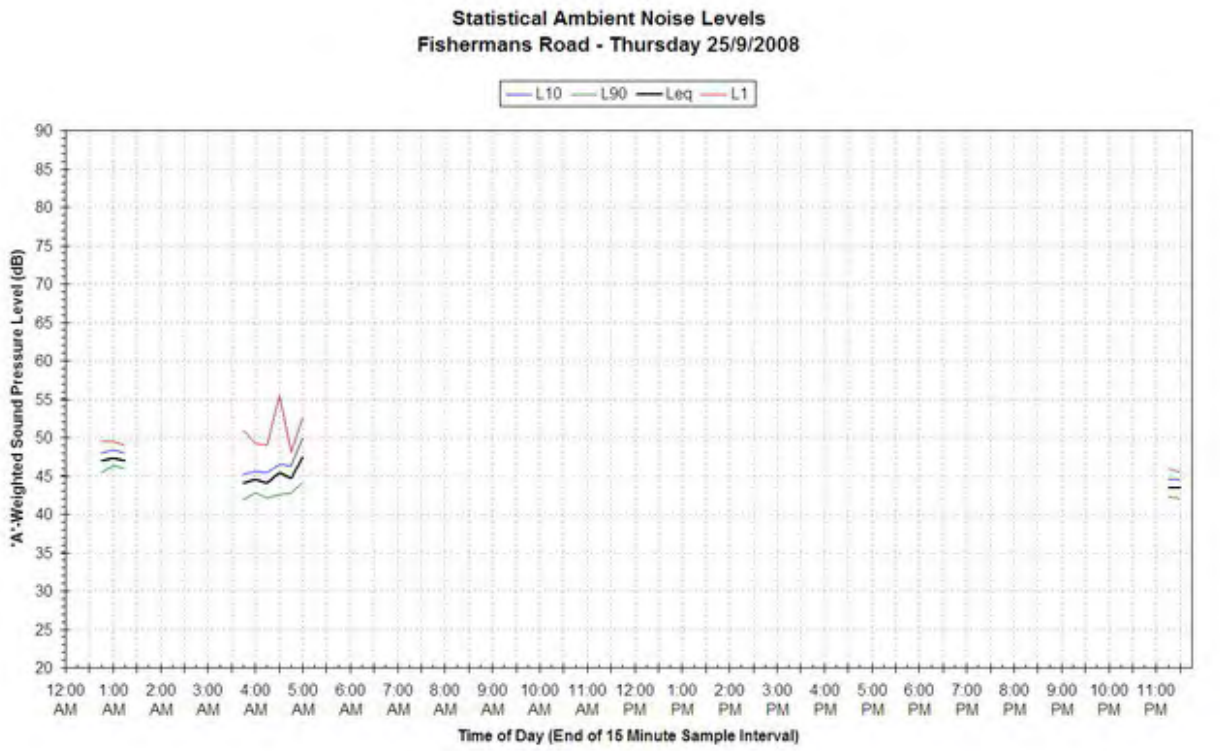
URS 2004, The review: Draft Review of DEH Guidelines on the Application of the EPBC Act to Interactions between Off-shore Seismic Operations and Larger Cetaceans.

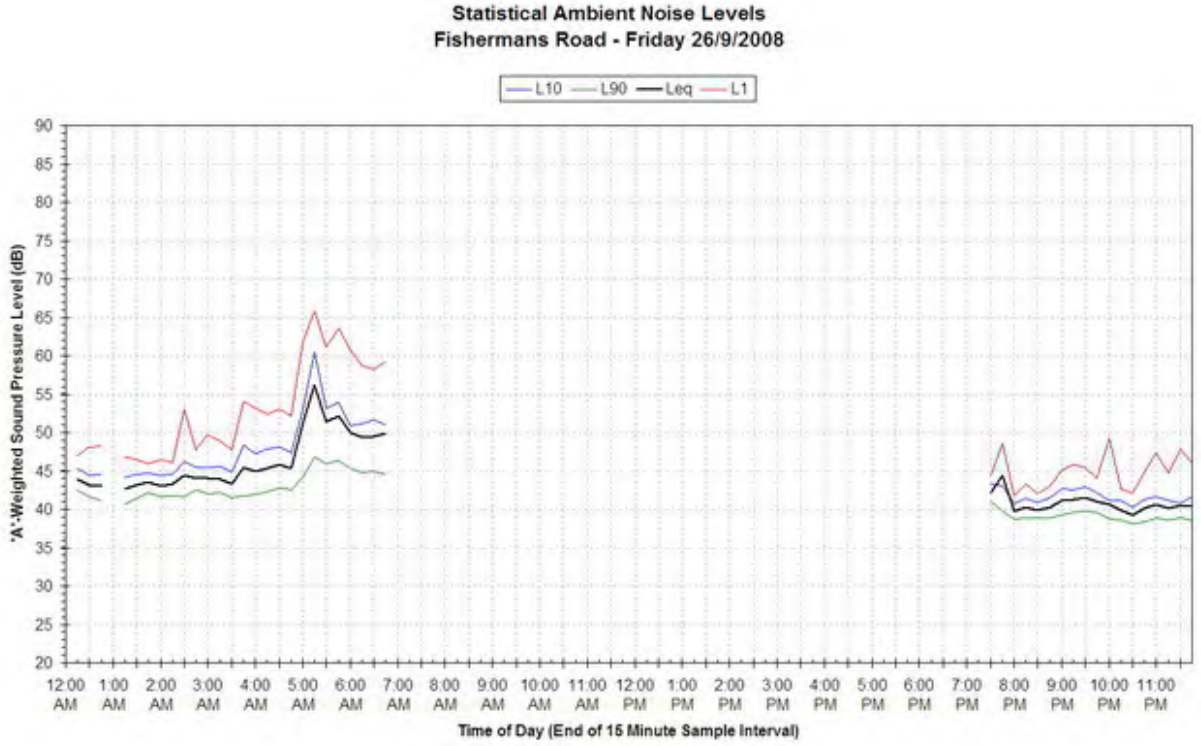
Appendix A

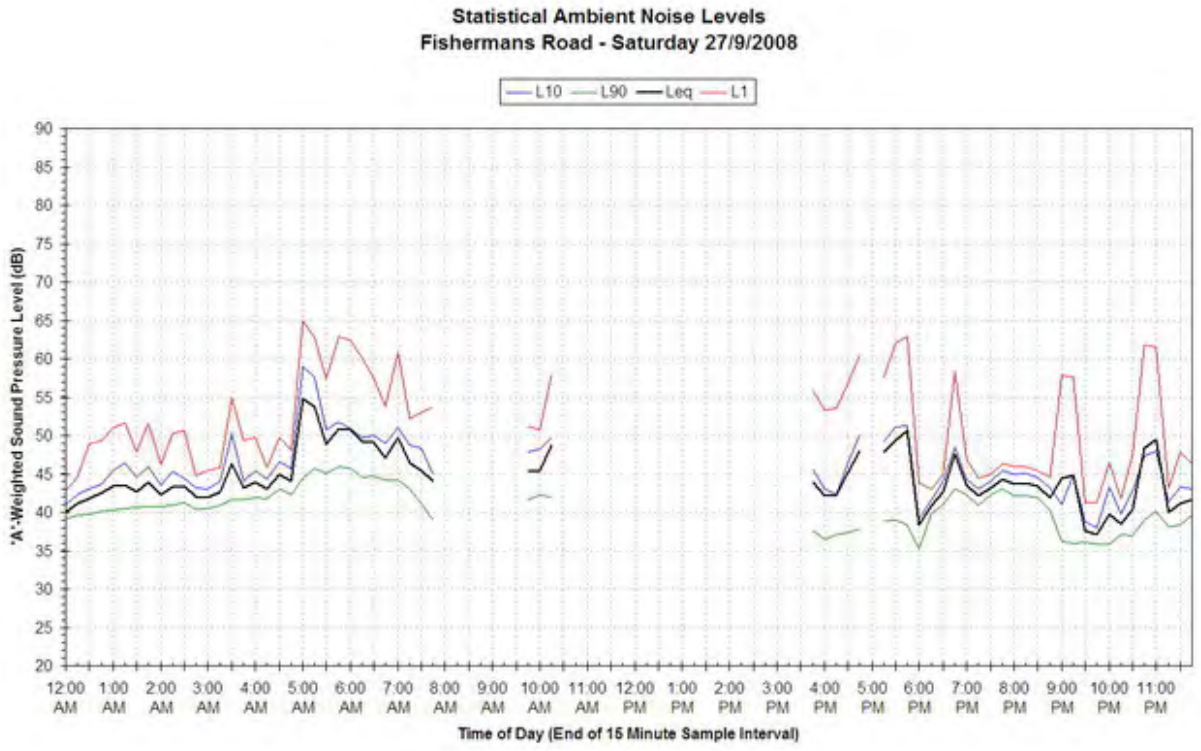
Details of Ambient Noise Monitoring

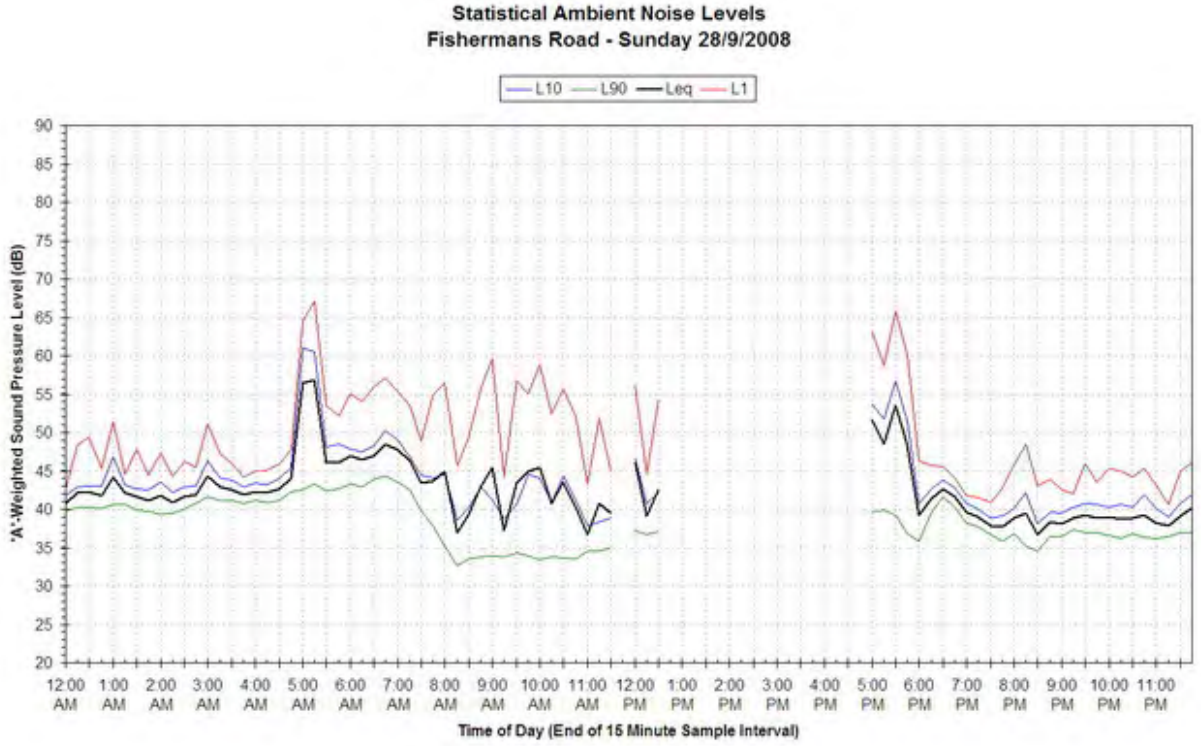
Noise Logger Data Graphs


Statistical Ambient Noise Levels
Fishermans Road - Wednesday 24/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Thursday 25/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Friday 26/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Saturday 27/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Sunday 28/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
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5:00 PM
6:00 PM
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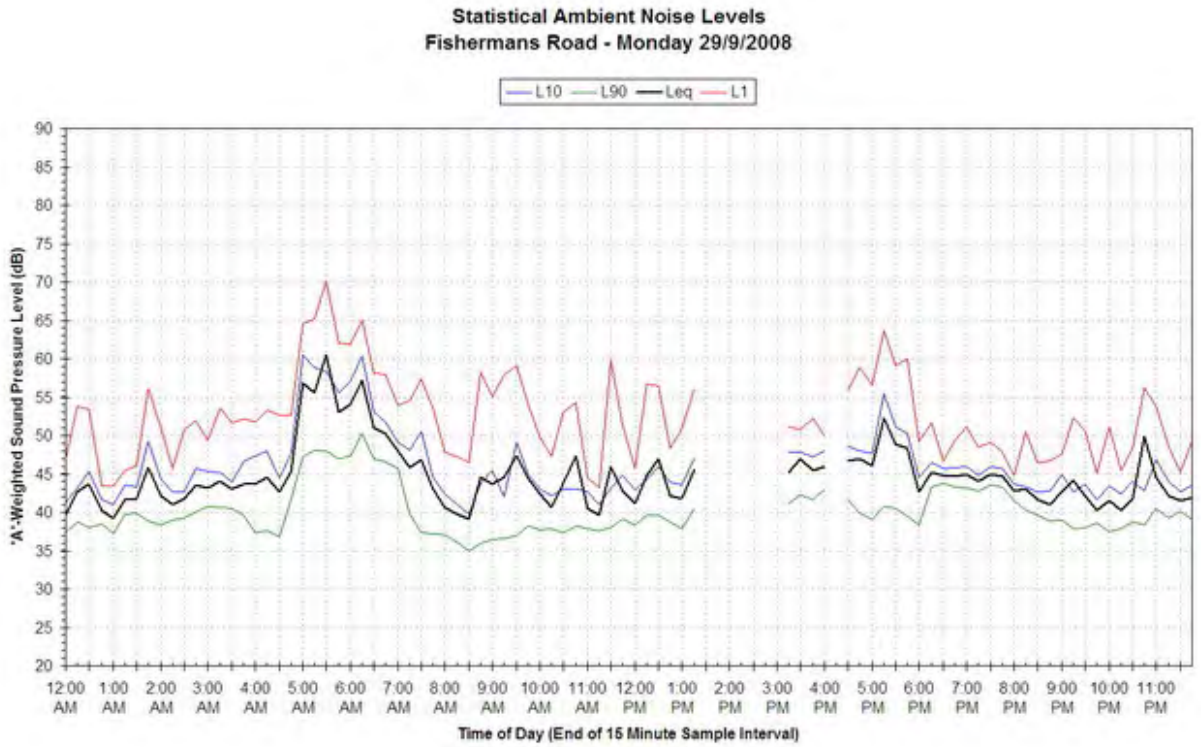
8:00 PM
9:00 PM
10:00 PM
11:00 PM
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Monday 29/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
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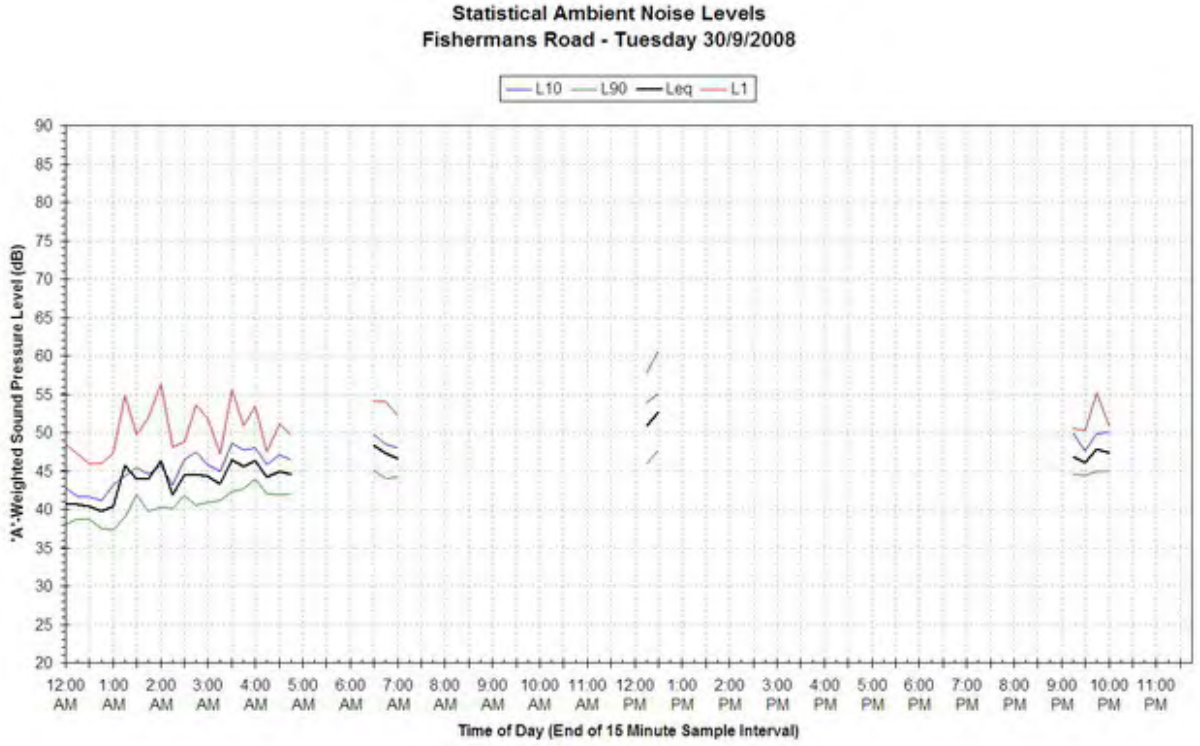
11:00 PM
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Tuesday 30/9/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
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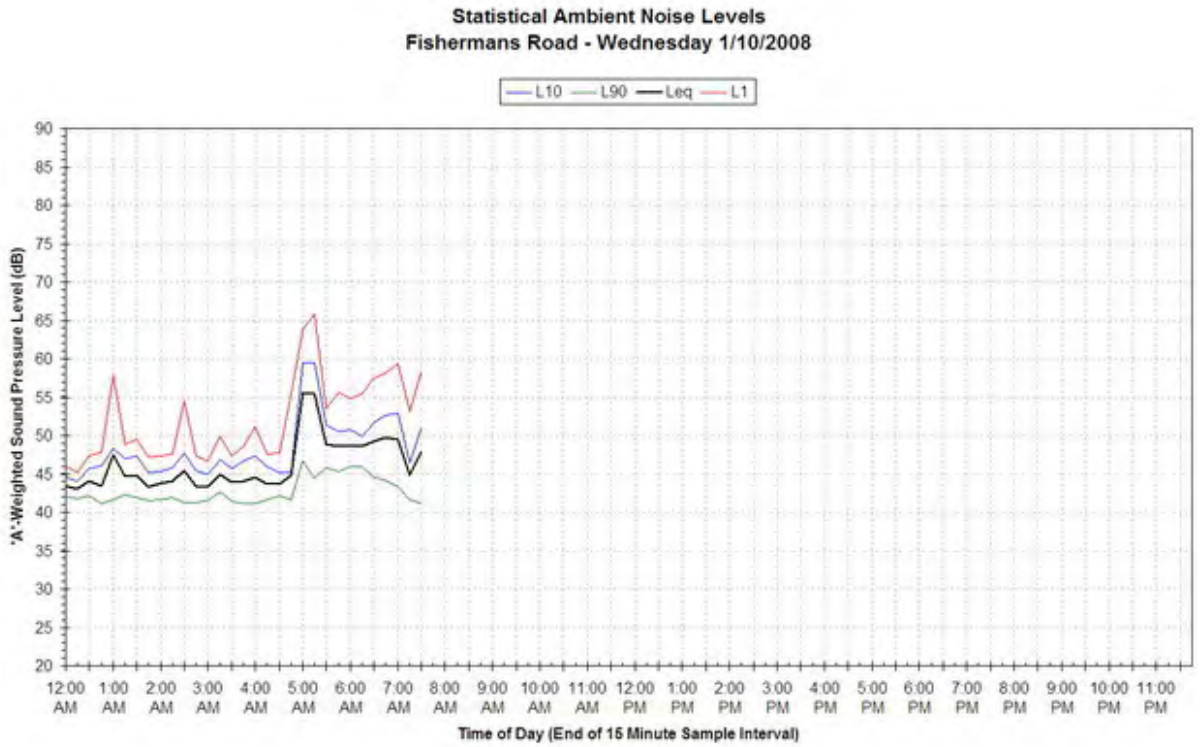
8:00 PM
9:00 PM
10:00 PM
11:00 PM
Time of Day (End of 15 Minute Sample Interval)


Statistical Ambient Noise Levels
Fishermans Road - Wednesday 1/10/2008
L10
L90
Leq
L1
'A'-Weighted Sound Pressure Level (dB)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
12:00 AM
1:00 AM
2:00 AM
3:00 AM
4:00 AM
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
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5:00 PM
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7:00 PM
8:00 PM
9:00 PM
10:00 PM
11:00 PM
Time of Day (End of 15 Minute Sample Interval)

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Document Status

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