5.6 Air

5.6.1 Introduction

The following chapter presents an assessment of the impacts of proposed construction of a new cruise ship facility in Dun Laoghaire Harbour in terms of Noise and Vibration of the local environment as defined in the Environmental Protection Agency's *Advice notes on Current Practice in the Preparation of EIS* (2003). The facility is herein referenced as the subject site.

The nearest residential noise sensitive locations are situated to the south of the proposed development approximately.

The following methodology has been adopted for this assessment:

- Identify appropriate noise criteria for the site.
- Carry out noise monitoring at a number of critical locations (e.g. in the vicinity of nearest sensitive properties) to identify existing levels of noise in the vicinity of the development.
- Undertake calculations to predict levels of noise during the construction and operational phases of the development.
- Comment on predicted levels against the appropriate criteria and outline required mitigation measures (if any).

In the first instance it is considered appropriate to review some basic fundamentals of acoustics.

5.6.1.1 Fundamentals of Acoustics

In order to provide a broader understanding of some of the technical discussion in this report, this section provides a brief overview of the fundamentals of acoustics and the basis for the preparation of this noise assessment.

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. In order to take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels is 0dB (for the threshold of hearing) to 120dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3dB.

The frequency of sound is the rate at which a sound wave oscillates, and is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz. In order to rank the SPL of various noise sources, the measured level has to be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. Several weighting mechanisms have been proposed but the 'A-weighting' system has been found to provide one of the best correlations with perceived loudness. SPL's measured using 'A-weighting' are expressed in terms of dB(A). An indication of the level of some common sounds on the dB(A) scale is presented in Figure 5.6.1.

The 'A' subscript denotes that the sound levels have been A-weighted. The established prediction and measurement techniques for this parameter are well developed and widely

applied. For a more detailed introduction to the basic principles of acoustics, reference should be made to an appropriate standard text.

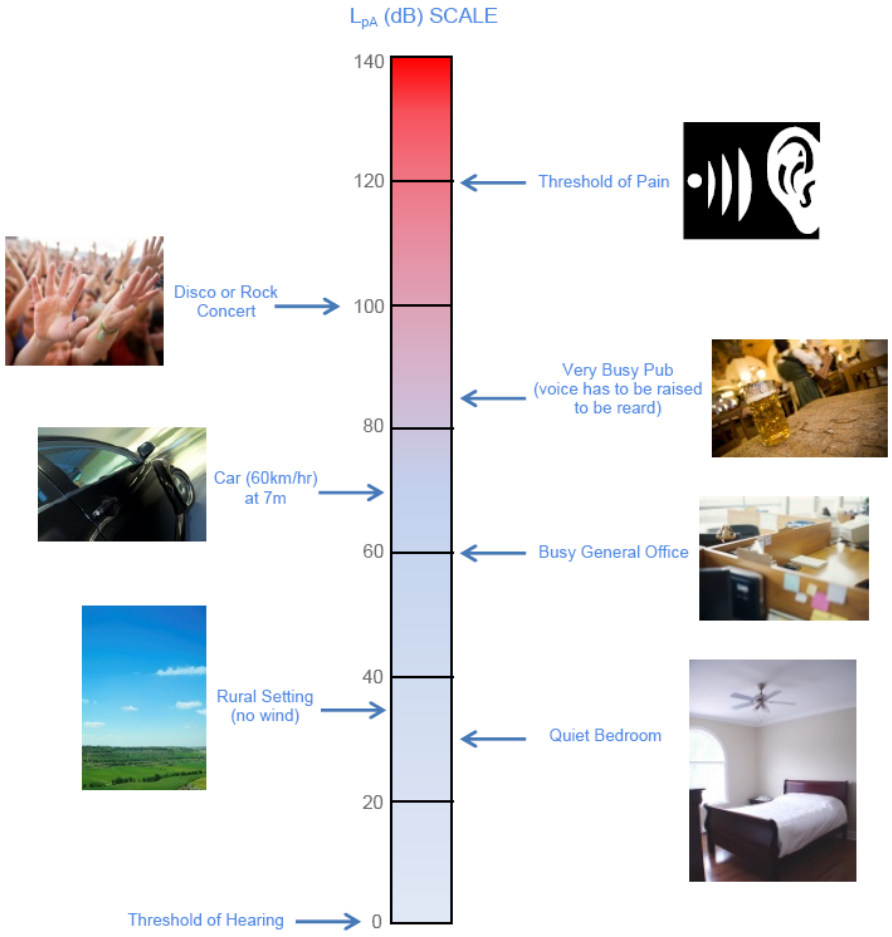

Figure 5.6.1 dB(A) Scale & Indicative Noise Levels[1]

5.6.2 Methodology

In advance of describing the baseline noise climate in the vicinity of the proposed development, it is important to outline criteria against which the impacts of the proposed development will be assessed.

The impacts of the proposed development will be assessed during both the construction and operational phases. Due to the duration and nature of each phase of the development, separate assessment criteria have to be applied to each.

The following sections outline the framework against which the impacts of the proposed development shall be assessed.

[1] EPA: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4 – 2012)

5.6.2.1 Construction Phase

Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard *BS 5228: 2009+A1 2014 – Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*.

The approach adopted here calls for the designation of a noise sensitive location into a specific category (A, B or C) based on exiting ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded at this location, indicates a significant noise impact is associated with the construction activities.

This document sets out guidance on permissible noise levels relative to the existing noise environment. Table 5.6.1 sets out the values which, when exceeded, signify a significant effect at the facades of residential receptors as recommended by *BS 5228-1*. These are cumulative levels, i.e. the sum of both ambient and construction noise levels.

Table 5.6.1 Example threshold of significant effect at dwellings

Assessment category and threshold value period (L_{Aeq})	Threshold value, in decibels (dB)		
	Category A [A]	Category B [B]	Category C [C]
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Evenings and weekends [D]	55	60	65
Night-time (23:00 to 07:00hrs)	45	50	55

a) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

b) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

c) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

d) 19:00 – 23:00 weekdays , 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

It should be noted that this assessment method is only valid for residential properties.

For the appropriate periods (i.e. daytime, evening and night time) the ambient noise level is determined and rounded to the nearest 5dB.

If the total noise level (i.e. construction noise plus existing ambient noise level) exceeds the appropriate category value, then a significant effect is deemed to occur.

Vibration

Vibration standards are generally split into two categories, those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. In both instances, it is appropriate to consider the magnitude of vibration in terms of Peak Particle Velocity (PPV).

It is acknowledged that humans are particularly sensitive to vibration stimuli and that any perception of vibration may lead to concern. In the case of road traffic, vibration is perceptible at around 0.5mm/s and may become disturbing or annoying at higher magnitudes. However, higher levels of vibration are typically tolerated for single events or events of short duration. For example, rock breaking and piling, two of the primary sources of vibration during construction, are typically tolerated at vibration levels up to 12mm/s and 5mm/s respectively. This guidance is applicable to the daytime only; it is unreasonable to expect people to be tolerant of such activities during the night.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- British Standard *BS 7385: 1993 - Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration*, and;
- British Standard *BS 5228: 2009+A1 2014 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*.

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS 5228 recommends that, for soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak component particle velocity (in frequency range of predominant pulse) of 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. Below these values minor damage is unlikely. Where continuous vibration is such as to give rise to dynamic magnification due to resonance, the guide values may need to be reduced by up to 50%. *BS 5288-2* also comments that important buildings which are difficult to repair might require special consideration on a case by case basis.

The NRA document Guidelines for the Treatment of Noise and Vibration in National Road Schemes also contains information on the permissible construction vibration levels as follows:

Table 5.6.2 Allowable vibration during construction phase

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

5.6.2.2 Operational Phase

Noise

Due consideration must be given to the nature of the primary noise sources when setting criteria. Criteria for noise from these sources, with the exception of additional vehicular traffic

on public roads, will be set in terms of the $L_{Aeq,T}$ parameter (the equivalent continuous sound level).

Given that vehicle movements on public roads are assessed using a different parameter (the ten percentile noise level; L_{A10}), it is appropriate to also consider the increase in traffic noise level that arises as a result of vehicular movements associated with the development in terms of the L_{A10} parameter.

With respect to plant or engine noise arising from the cruise ships themselves, there are no Irish Standards containing guidance that is applicable in this instance. In the absence of such standards, best practice dictates that the potential noise impact of the proposed development is assessed against appropriate guidance and standards. These have been outlined and described in the following section.

Dun Laoghaire Rathdown County Council Guidance

In this instance it is important to note that Dun Laoghaire Rathdown County Council (DLRCC) has issued its own specific guidance in relation to acceptable noise levels associated with developments of this nature. These are outlined in detail in Appendix 5.6.1 of this EIS. In summary the following would be expected to apply to this site:

The noise level at any residence:

- Shall not contain pure tones.
- Shall not exceed the background level by 10dB(A) or more or exceed NG4 limits whichever is lesser.

The NG4 is a reference to the Environmental Protection Agency (EPA) document *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)*. Note that the current iteration of the guidance is similar in intent to previous versions of the guidance that would have been applicable to the 2011 assessment preformed for the site.

This DLRCC guidance stipulates the following noise limits for daytime, evening and night time periods:

- Daytime (07:00 to 19:00hrs) 55dB $L_{Ar,T;}$
- Evening (19:00 to 23:00hrs) 50dB $L_{Ar,T}$;
- Night-time (23:00 to 07:00hrs) 45dB $L_{Aeq,T}$.

The guidance also goes onto state:

- In cases where it is impossible to measure the noise due, for example, to the interference of traffic noise, prediction methods should be used.
- The duration and frequency of noise events should be considered when assessing annoyance.
- A correction for impulsive character of 5dB(A) shall be added to the measured or predicted level where appropriate.

The document presents the following definitions:

> *"Noise Level: The L_{eq} for worst hour by day or worst 15 minutes by night with impulsive correction.*

Background Level: The L_{95} at the appropriate time and under similar conditions."

In summary the guidance calls for the relevant noise criteria to be established through a review of background noise levels (measured in terms of the L_{A95} statistical parameter).

The noise emissions from the commercial activity in question should be corrected as appropriate for any impulsive components. No tonal emissions are allowed at noise sensitive residences.

British Standard BS 8233 (2014)

The standard, BS8233: 2014 - Sound Insulation and Noise Reduction for Buildings – Code of Practice, sets out recommended internal noise levels for several different building types from external noise sources. The guidance is primarily for use by designers and hence BS 8233 may be used as the basis for an appropriate schedule of noise control measures. The recommended indoor ambient noise levels for residential dwellings are set out in table 5.6.3.

Table 5.6.3 Indoor ambient noise levels for dwellings from BS8233: 2014

Activity	Location	Day 07:00 to 23:00hrs dB $L_{Aeq,16hour}$	Night 23:00 to 07:00hrs dB $L_{Aeq,8hour}$
Resting	Living room	35	-
Dining	Dining room/area	40	-
Sleeping (daytime resting)	Bedroom	35	30

It is appropriate to derive external limits based on the internal criteria noted in the paragraph above. This can be done by factoring in the degree of noise reduction afforded by a partially open window. This is nominally deemed to fall in the range of 15dB.

Due to the fact that there is the potential for short periods of noise to cause a greater disturbance at night-time, a shorter assessment time period (T) is adopted. Appropriate periods are 1 hour for daytime (07:00 to 23:00 hours) and 5 minutes for night-time (23:00 to 07:00 hours).

In summary, the following criteria apply at the façades of those residential properties closest to the proposed development:

- Daytime (07:00 to 23:00 hours) 55dB $L_{Aeq,1hr}$
- Night-time (23:00 to 07:00 hours) 45dB $L_{Aeq,5min}$

Road Traffic Noise

In order to assist with the interpretation of the noise associated with vehicular traffic on public roads, Table 5.6.4 offers guidance as to the likely impact associated with any particular change in traffic noise level.

Table 5.6.4 Likely impact associated with change in traffic noise level

Change in Sound Level (dB L_{A10})	Subjective Reaction	Impact
< 3	Inaudible	Imperceptible
3 – 5	Perceptible	Slight
6 – 10	Up to a doubling of loudness	Moderate
11 – 15	Over a doubling of loudness	Significant
> 15		Profound

Vibration

Guidance as to an acceptable magnitude of vibration during the operational phase of the development is best taken from British Standard *BS 6472-1:2008- Guide to Evaluation of Human Exposure to Vibration in Buildings: Vibration Sources Other Than Blasting*. This standard outlines that adverse comment is possible if the vibration levels in residential buildings exceeds a Vibration Dose Value (VDV) of 0.2 to 0.4 $m/s^{-1.75}$ by daytime and 0.4 to 0.8 $m/s^{-1.75}$ by night-time.

5.6.3 Receiving Environment

An environmental noise survey was conducted in order to quantify the existing noise environment. The survey was conducted in general accordance with *ISO 1996: 2007: Acoustics – Description, Measurement and Assessment of Environmental Noise*. Specific details are set out below.

5.6.3.1 Survey Details

For the purpose of this assessment, daytime is taken to be between 07:00hrs and 19:00hrs, whilst night-time is between 23:00hrs and 07:00hrs. An additional survey period has been included for to cover the evening period of 19:00 to 23:00.

Measurements were undertaken to quantify the existing noise environment in the vicinity of the nearest noise sensitive locations. Noise measurements were conducted over the course of the following periods:

- Daytime 12:44hrs - 17:25hrs on 15 April 2014, and;
- Evening 21:51hrs – 23:10hrs on 28 April 2014
- Night-time 23:14hrs - 01:39hrs on 28 to 29 April 2014.

Personnel and Instrumentation

Ronan Murphy (AWN) conducted the baseline noise survey.

The noise measurements were performed using a Brüel & Kjær Type 2250 Sound Level Analyser. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

Measurement Locations

Three measurement locations were selected and are described in turn below and also shown on Figure 5.6.2.

Location S01 was located on Stable Lane adjacent to the front façade of Connaught House.

Location S02 was located in the green space fronting the Marine Court Apartment Complex.

Location S03 was located at the car park access of the Marine View/Square Apartment Complex.

Location S04 was located on the public walkway to the rear of the Pavilion apartment Complex directly above the "Itsa" Café.

Figure 5.6.2 Noise survey locations (*Google Earth*)

Methodology

Measurements were conducted on a cyclical basis at the locations noted above. Sample periods for the noise measurements were 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample, and were also saved to the instrument memory for later analysis if required. Survey personnel noted the primary noise sources contributing to noise build-up.

Weather

The weather during the daytime survey period was dry and with wind speeds ranging from 3-4m/s. Temperatures were of the order of 13°C.

The weather during the night-time survey period was dry and calm with wind speeds from 0 to 1m/s. Temperatures were of the order of 10°C.

Measurement Parameters

The noise survey results are presented in terms of the following five parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period. It is typically used as a descriptor for ambient noise.

L_{Amax} is the instantaneous maximum sound level measured during the sample period.

L_{Amin} is the instantaneous minimum sound level measured during the sample period.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to 2x10-5 Pa.

5.6.3.2 Survey Results and Discussion

Location S01

The survey results for Location S01 are given in Table 5.6.5 below.

Table 5.6.5 Summary of results for Location S01

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
Day	12:44 - 12:59	63	73	48	68	53
	14:57 - 15:12	66	76	47	70	54
	16:10 - 16:25	66	89	46	68	51
Evening	21:51 - 22:06	63	80	37	68	42
Night	23:14 - 23:30	61	77	33	65	36
	01:24 - 01:39	51	75	30	42	32

During daytime monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included construction noise from a site on Bentley Villas and intermittent use of the car park by vehicles and pedestrians and the passing of the DART. Low level plant noise was audible intermittently from the roof of the Irish Lights Building. Daytime noise levels were in the range of 63 to 66dB L_{Aeq} and 51 to 54dB L_{A90}.

During night time monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. The dominant continuous noise source during the survey period was a generator running in the council depot or construction yard. Night time noise levels were in the range of 51 to 61dB L_{Aeq} and 32 to 36dB L_{A90}.

Location S02

The survey results for Location S02 are given in Table 5.6.6 below.

Table 5.6.6 Summary of results for Location S02

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
Day	13:01 - 13:16	67	83	46	70	55
	14:10 - 14:25	65	76	47	69	53
	16:28 - 16:43	66	80	44	69	53
Evening	22:10 - 22:25	63	76	34	68	41
Night	23:32 - 23:47	60	76	29	64	33
	01:06 - 01:21	51	77	28	34	29

During daytime monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included the passing of the DART and the sounding of the Stena fog horn. Daytime noise levels were in the range of 65 to 67dB L_{Aeq} and 51 to 54dB L_{A90}.

During night time monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included the passing of the DART and men talking at the bus stop on the road. Night time noise levels were in the range of 51 to 60dB L_{Aeq} and 29 to 33 dB L_{A90}.

Location S03

The survey results for Location S03 are given in Table 5.6.7 below.

Table 5.6.7 Summary of results for Location S03

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
Day	15:15 - 15:31	70	90	46	73	56
	15:32 - 15:47	68	84	47	72	56
	16:50 - 17:05	69	81	48	73	55
Evening	22:35 - 22:50	63	80	35	68	40
Night	23:50 - 00:05	61	79	32	63	33
	00:48 - 01:03	59	81	32	57	33

During daytime monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included intermittent use of the car park by vehicles, the passing of the DART and bus operation at the terminus opposite the road. Daytime noise levels were in the range of 68 to 69dB L_{Aeq} and 55 to 56dB L_{A90}.

During night time monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. The dominant continuous noise source during the survey period was low level plant extract from the car park. Idling buses were also influencing the measurements temporarily. Night time noise levels were in the range of 59 to 61dB L_{Aeq} and 33dB L_{A90}.

Location S04

The survey results for Location S04 are given in Table 5.6.8 below.

Table 5.6.8 Summary of results for Location S04

Time		Measured Noise Levels (dB re. $2x10^{-5}$ Pa)				
		L_{Aeq}	L_{AFmax}	L_{AFmin}	L_{AF10}	L_{AF90}
Day	13:41 - 13:56	60	80	54	62	57
	15:51 - 16:06	59	75	50	61	54
	17:10 - 17:25	58	78	49	60	54
Evening	22:55 - 23:10	49	70	34	53	39
Night	00:12 - 00:27	42	57	30	44	32
	00:27 - 00:42	45	60	29	50	31

During daytime monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included construction noise from the nearby construction site as well as children playing in the nearby playground. Daytime noise levels were in the range of 59 to 60 dB L_{Aeq} and 54 to 57dB L_{A90}.

During night time monitoring periods the dominant intermittent source of noise at this location was road traffic on Crofton Road. Other intermittent sources included a pedestrian with a roller bag and people talking nearby. Night time noise levels were in the range of 42 to 45dB L_{Aeq} and 31 to 32 dB L_{A90}.

5.6.3.3 Review of Applicable Noise Criteria

The results of the survey demonstrate that the noise climate at the nearest noise sensitive locations is dominated by road traffic during the day. Road traffic noise was observed to fall off significantly during the night time periods and this was reflected in the measured levels.

Construction Phase

Noise

The baseline monitoring carried out as part of this assessment would indicate that the categories detailed in Table 5.6.9 are appropriate in terms of the nearest noise sensitive locations being considered in this instance.

Table 5.6.9 Rounded Baseline Noise Levels and Associated Categories

Period	Rounded Baseline Noise Level L_{Aeq} (dB)	Category	Applicable Noise Limit L_{Aeq} (dB)
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	B	70
Evening (19:00 to 23:00hrs)	60	B	60
Night time (23:00 to 07:00hrs)	55	C	55

Vibration

In the context of the proposed development, during the construction phase, it is envisaged that piling works will be undertaken in the bay.

The limits outlined in section 5.6.2.2 can be regarded as appropriate criteria against which to assess such vibration should it occur.

Operational Phase

Noise

Based on the measured levels, it is deemed appropriate to adopt the following limits on operational noise from the proposed development.

Table 5.6.10 Proposed Operational Noise Criteria

Criteria	Daytime (07:00 to 19:00hrs)	Evening (19:00 to 23:00hrs)	Night-time (23:00 to 07:00hrs)
Baseline Noise Level[2]	65dB $L_{Aeq(15mins)}$	50dB $L_{Aeq\ (15mins)}$	43dB $L_{Aeq(15mins)}$
Proposed Operational Noise Criteria	55dB $L_{ArT(15mins)}$	50dB $L_{ArT\ (15mins)}$	43dB $L_{Aeq(15mins)}$

Vibration

It is not envisaged that vibration will be generated from proposed development during the operational phase. The limits outlined in section 5.6.2.2 can be regarded as appropriate criteria against which to assess such vibration should it occur.

5.6.4 Characteristics Of The Proposal

The primary element of the proposed development will be the construction of a cruise ship berth. The proposed structure will extend approximately 450m and consist of a 120m long by 20m wide concrete quay supported on tubular steel piles. This quay will be connected to the marina breakwater by an approximately 8.5m wide concrete access causeway.

It is envisaged that the proposed berth will be used for "port of call" visits whereby ships will arrive and leave within a single day. In terms of services, the ships will be self-sustaining and will run on on-board generators during the period of stay.

Another element of the proposed development is the development of landside access facilities which shall include provision for a small access road and taxi and coach parking spaces.

When considering a development of this nature, the potential noise and vibration impact on the surroundings must be considered for each of two distinct stages:

- Construction phase, and;
- Operational phase.

The construction phase will involve extensive piling in the harbour as well as ground clearance and excavation over the hardstand development site.

The primary sources of noise in the operational context are discussed below, it is important to note that in all cases, due to the nature of use, the noise associated with the use of the cruise terminal is also likely to be short in duration and relatively infrequent;

- Ship noise – Noise may be generated from ventilation points and on-board power generators when berthed as well as main engine exhaust noise when the ship is manoeuvring into and out of the harbour, and;
- Additional vehicular traffic on public roads.

[2] Based on measured background noise levels (L_{A90} plus 10dB)

These issues are discussed in detailed in the following sections.

5.6.5 Potential Impact Of The Proposal

5.6.5.1 Nearest Noise Sensitive Receptors

Noise levels have been calculated for a total of 6 no. noise sensitive receptors in the vicinity of the site. Due to the multi-storey nature of many of the properties, noise levels have been predicted to 4th storey level[3] in all cases.

The receptors have been illustrated in Figure 5.6.3 below. The receptor coordinates are outlined in Table 5.6.11.

Table 5.6.11 Nearest Noise Sensitive Receptors

Receptor Number	Estimated Ground Level (masl)	Grid Coordinate (Irish Transverse Mercator (ITM))	
		Easting	Northing
R01	10	724,296	728,808
R02	9	724,142	728,864
R03	9	724,097	728,888
R04	10	723,983	728,920
R05	11	723,873	728,919
R06	3	723,943	729,027

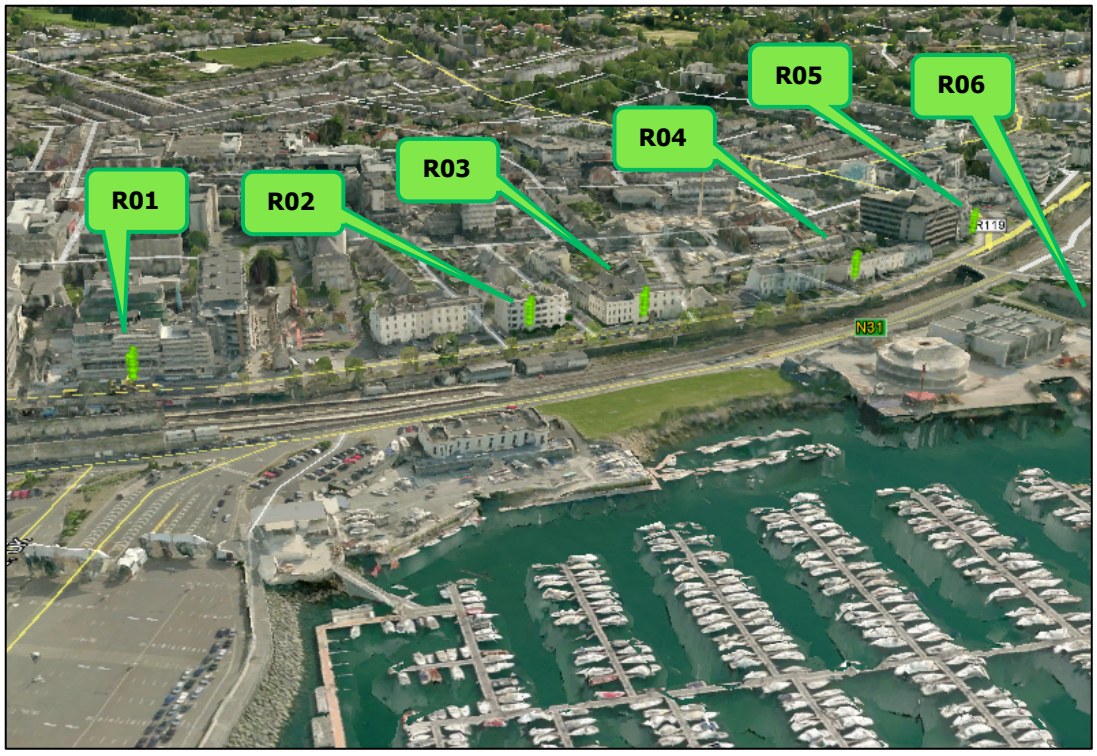

Figure 5.6.3 Receptor Locations (*Google Earth*)

[3] This equates to a model heights of 1.5m, 4m, 6.5m, 8m and 9m in all cases.

5.6.5.2 Noise Model

In order to accurately predict the noise impact associated with the proposed development, a noise prediction model has been developed for the site. This model has informed elements of the assessment of noise generated during the construction and operational phases of the development.

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, Brüel & Kjær Type 7810 Predictor, calculates noise levels in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- The magnitude of the noise source in terms of a weighted sound power levels (LWA);
- The distance between the source and receiver;
- The presence of obstacles such as screens or barriers in the propagation path;
- The presence of reflecting surfaces;
- The hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

5.6.5.3 Construction Phase

It is likely that the construction phase of the programme will involve four distinct stages. These will include:

- Dredging of sand and silt from the navigation channel;
- Construction of the new quay and jetty;
- Partial demolition of existing hardstand and structures, and;
- Construction of a dedicated hardstand area including an access road and coach parking.

It is anticipated that construction will be undertaken during normal construction hours i.e. 08:00 to 18:00hrs Monday to Friday. However it is possible that the contractor may wish to carry out certain operations outside these hours i.e. Saturday working or evening hours during long summer days etc. Such occurrences will be kept to a minimum and take place over a short timeframe and as such are unlikely to cause excessive disturbance.

Due to the nature of daytime activities undertaken on a construction site of this nature, there is potential for generation of significant levels of noise.

The potential for vibration at neighbouring sensitive locations during construction is typically limited to drilling and excavation works as well as vehicle movements to and from site. Due to the distance of sensitive locations to site works however, there is little likelihood of structural or even cosmetic damage to existing neighbouring dwellings as a result of vibration.

Due to the fact that the construction programme has been established in outline form only, it is difficult to calculate the actual magnitude of noise emissions to the local environment.

Source sound power has been derived from sound pressure level outlined in Appendix C of *British Standard BS 5228-1:2009+A1:2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites: Noise*. Table 5.6.12 outlines the assumed noise levels associated onsite activities.

Table 5.6.12 Source Noise Levels Used for Prediction Model

Site Activity	Machine	Source	On-time	Sound Power L_{WA}
Demolition	Excavator with rock breaker	BS 5228-1:2009+A1:2014 Table C1.9	60%	116
	Excavator with bucket	BS 5228-1:2009+A1:2014 Table C2.16	60%	100
	Lorry	BS 5228-1:2009+A1:2014 Table C6.21	60%	117
Channel dredging	Trailing suction hopper dredger	Sospan report	60%	107
Jetty Construction	Crane	BS 5228-1:2009+A1:2014 Table C3.28	60%	104
	Generator/Power pack 6tonne	BS 5228-1:2009+A1:2014 Table C3.10	60%	103
	Vibratory hammer piler PVE 38M	BS 5228-1:2009+A1:2014 Table C3.8	60%	115
	Rotary drilling rig Wirth	BS 5228-1:2009+A1:2014 Table C3.14	60%	114
Road construction	Asphalt	BS 5228-1:2009+A1:2014 Table C5.30	60%	103
	Roller	BS 5228-1:2009+A1:2014 Table C5.20	60%	112
	Lorry	BS 5228-1:2009+A1:2014 Table C6.21	60%	117
	Excavator	BS 5228-1:2009+A1:2014 Table C2.16	60%	100

For the purposes of presenting a robust assessment, it has been assumed that items of plant listed in Table 5.6.12 operate simultaneously during each phase of the construction period on an assumed 60% "on time". This assumes a completely worst case scenario.

The results of the noise prediction model for each scenario have been outlined in Table 5.6.13. Noise contour maps for each scenario are included at Appendix 5.6.2 of the EIS.

Table 5.6.13 Predicted Construction Noise Levels

Receptor	Height	Predicted Noise Level ($L_{Aeq, 1hour}$)				
		Demolition	Dredging	Jetty Construction	Road Construction	Cumulative
R01_A	1.5	60	41	54	63	65
R01_B	4	60	41	54	63	65
R01_C	6.5	60	41	54	63	65
R01_D	8	61	41	54	64	66

Receptor	Height	Predicted Noise Level ($L_{Aeq, 1hour}$)				
		Demolition	Dredging	Jetty Construction	Road Construction	Cumulative
R01_E	9.5	61	40	54	64	66
R02_A	1.5	53	33	46	56	58
R02_B	4	53	33	46	56	58
R02_C	6.5	53	33	46	56	58
R02_D	8	53	34	47	57	59
R02_E	9.5	54	35	48	57	59
R03_A	1.5	51	40	53	54	58
R03_B	4	51	40	53	54	57
R03_C	6.5	51	40	52	54	57
R03_D	8	51	40	52	54	57
R03_E	9.5	51	39	52	54	58
R04_A	1.5	55	39	51	51	58
R04_B	4	55	39	51	51	57
R04_C	6.5	54	38	51	51	57
R04_D	8	54	38	51	50	57
R04_E	9.5	54	38	50	50	57
R05_A	1.5	53	30	46	44	54
R05_B	4	53	30	46	44	54
R05_C	6.5	52	30	46	48	55
R05_D	8	52	30	46	48	54
R05_E	9.5	52	30	46	48	54
R06_A	9.5	54	39	51	48	57
R06_B	9.5	54	39	51	45	56
R06_C	9.5	54	39	51	45	56
R06_D	9.5	54	38	51	45	56
R06_E	9.5	54	38	50	46	56

It can be seen that the cumulative noise impact arising from the proposed construction will be below the adopted noise assessment criteria of 70dB $L_{Aeq, 1hour}$ for the daytime period.

Given that these noise levels constitute worst case conditions with the listed construction activities all being conducted at the closest development area location to the nearest noise sensitive location, actual construction noise level emission will likely be lower than the levels listed above. However, given the low background evening and night time noise levels measured in the vicinity, consideration should still be given to the mitigation measures outlined in the Construction Mitigation Measures section towards the end of this chapter, if it is desired to undertake construction works during evening or weekend periods.

With respect to potential vibration impact, the only significant source of vibration is expected to be due to rock breaking activities and from heavy goods vehicles driving over uneven surfaces. However, the distance between the areas where these activities are to occur and the nearest noise sensitive locations are such that vibration transmission would be both imperceptible and well below recommended guideline criteria.

5.6.5.4 Operational Phase

The primary sources of outward noise in the operational context are deemed to be short term in nature due to the infrequent nature of the cruise ship visits. The two primary sources of noise in the operational context can be summarised as follows:

- Ship noise which includes the following sources;
  - Main engine exhaust noise when the ship is manoeuvring into and out of the harbour;
  - Sounding of the ships horn when the ship is manoeuvring into and out of the harbour;
  - Generator exhaust noise when the ship is berthed, and;
  - Ship ventilation noise when the ship is berthed.
- Road Traffic Noise – From additional vehicular traffic on public roads.

These primary noise sources are addressed in turn in the following section. Please also note that there are no significant sources of vibration associated with the operational phase of the proposed development.

Ship Noise – General

Noise generated from ships when entering or exiting the harbour is not expected to be significant due to the intermittent frequency and short duration of such events. Likewise the sounding the ship horn is likely to be infrequent and short term in nature.

Ship Noise – Engines

Modern cruise liners typically have separate power systems for propulsion and general power consumption. Many of the larger craft use separate power systems such as gas turbines for propulsion and diesel or gas generators for on-board power and additional propulsion. Operation of these generators when the ships are berthed has the potential to generate noise due to the continuous nature and elevated position of the exhaust ports which are typically routed through the main engine exhausts shafts.

The noise impact from cruise ship generators when berthed has been modelled using the established Predictor noise propagation for the site. The sound power level for a typical cruise ship generator exhaust stack is presented in table 5.6.14.

Table 5.6.14 Typical Cruise Ship Engine Generator Noise

Item	L_W								Total
	63	125	250	500	1k	2k	4k	8k	
MAN B&W V48/60B[4] 20000kw	124	126	129	133	135	135	133	130	141
Assumed Muffler Insertion Loss	20	25	23	21	20	19	18	18	30
A weighting	-26	-16	-9	-3	0	1	1	-1	-
A Weighted Emission (per stack)	78	85	97	109	115	117	116	111	122

[4] Danish Environmental Protection Agency *Noise from ships in ports Possibilities for noise reduction* Environmental Project No. 1330 2010

The height of the stack has been assumed as 45m absl[5]. It is assumed that only one engine would be run when in harbour. Noise contour maps have been prepared at a height of 4m and 8m height above ground level, roughly corresponding to a standard 2 and 4 storey dwelling respectively. These maps have been presented in Appendix 5.6.3 of this EIS.

Engine generator noise emissions are predicted to fall in the region of 48dB L_{Aeq} at the nearest noise sensitive receptor.

This level would comply with the recommended day and evening time limits set out by Dun Laoghaire Rathdown County Council.

Ship Noise – Ventilation

Ventilation systems on board ships may be a significant contributor to the noise generated by the ship in the surroundings if no noise reducing measures have been included in the design.

The noise impact from cruise ship ventilation when berthed has been modelled using the established Predictor noise propagation for the site. The sound power level for typical cruise ship engine room ventilation system is presented in table 5.6.15.

Table 5.6.15 Typical Cruise Ship Engine Room Ventilation Noise

Item	L_W								Total
	63	125	250	500	1k	2k	4k	8k	
33000m3 axial engine room fan[6]	64	79	96	99	101	99	94	88	106
Assumed Muffler Insertion Loss	7	8	8	7	7	6	6	6	16
A weighting	-26	-16	-9	-3	0	1	1	-1	
A Weighted Emission	31	55	79	89	94	94	89	81	98

Two engine ventilation sources have been assumed amidships, at a height of 15m absl. Noise contour maps have been prepared at a height of 4m and 8m height above ground level, roughly corresponding to a standard 2 and 4 storey dwelling respectively. These maps have been presented in Appendix 5.6.3 of this EIS.

Engine room ventilation noise emissions are predicted to fall in the region of 30dB L_{Aeq} at the nearest noise sensitive receptor.

This level would comply with the recommended day, evening and night time limits set out by Dun Laoghaire Rathdown County Council.

Ship Noise – Cumulative

The predicted level of ship noise at each noise sensitive receptor is presented in table 5.6.16.

[5] Based on typical cruise ship stack heights as outlined in *National Park Service – Southeast Alaska Inventory and Monitoring Program - Emission Inventory Skagway, Alaska 2008*

[6] Danish Environmental Protection Agency *Noise from ships in ports Possibilities for Noise Reduction* Environmental Project No. 1330 2010

Table 5.6.16 Worst Case Predicted Ship Noise Levels

Receptor	Height	Predicted Noise Level ($L_{Aeq, 1hour}$)		
		Generator	Ventilation	Cumulative
R01_A	1.5	47	27	47
R01_B	4	47	27	47
R01_C	6.5	48	28	48
R01_D	8	48	28	48
R01_E	9.5	48	28	48
R02_A	1.5	46	26	46
R02_B	4	46	26	46
R02_C	6.5	47	30	47
R02_D	8	47	30	47
R02_E	9.5	47	30	48
R03_A	1.5	46	29	46
R03_B	4	46	29	46
R03_C	6.5	47	29	47
R03_D	8	47	29	47
R03_E	9.5	47	29	47
R04_A	1.5	45	28	45
R04_B	4	45	28	45
R04_C	6.5	45	28	46
R04_D	8	46	28	46
R04_E	9.5	46	28	46
R05_A	1.5	39	19	39
R05_B	4	45	19	45
R05_C	6.5	46	19	46
R05_D	8	44	20	44
R05_E	9.5	44	23	44
R06_A	1.5	45	29	45
R06_B	4	45	29	45
R06_C	6.5	45	28	45
R06_D	8	45	28	46
R06_E	9.5	46	29	46

Cumulative ship noise emissions arising from both engine generator and ventilation sources are predicted to fall in the region of 48dB L_{Aeq} at the nearest noise sensitive receptors.

This level would comply with the recommended day and evening time limits set out by Dun Laoghaire Rathdown County Council.

Although this level would exceed the night time limit prescribed by DLRCC, it is AWN understanding that cruise ships will generally not be berthed overnight or between the hours of 23:00 to 07:00. As such, ship noise during this period will generally not be of concern.

In rare circumstances, it may be necessary for ships to overnight at the terminal in the case of engine malfunction or failure. This has been discussed further in section 5.6.6.

Additional Vehicular Traffic on Public Roads

A preliminary study on roads and traffic has been prepared by Waterman Moylan Consulting Engineers. Information from this report has been used to determine the predicted change in noise levels on the surrounding road network by the proposed development during the opening year and design years 2017 and 2032 (opening year + 15).

For the purposes of assessing potential noise impact, it is appropriate to consider the relative increase in noise level associated with traffic movements with and without the development using the provided peak movements in addition to the overall Annual Average Daily Traffic (ADDT) data.

In terms of the overall traffic data as described by the AADT parameter, in order to increase traffic noise levels by 1dB, traffic volumes would need to increase by the order of 25% approximately. For reference the calculated increase in road traffic noise for each scenario has been presented in Table 5.6.17 for each of the four main roads to experience road traffic increases as a result of the proposed development.

Table 5.6.17 Predicted Road Traffic Noise Increase for Main Roads

Road	Change in Noise Level (dB L_{A10}) between the Do Nothing and Do Something Scenarios without the Masterplan[7]	
	2017	2032
Harbour Road	<2	<2
Crofton Road West	<1	<1
Marine Road	<1	<1
Queens Road	<1	<1

Additionally, it is understood that the implementation of the proposed harbour development masterplan would result in additional traffic increases. The resultant noise level increase as a result of the implementation has been assessed and the results presented in Table 5.6.18.

Table 5.6.18 Predicted Road Traffic Noise Increase for Main Roads

Road	Change in Noise Level (dB L_{A10}) between the Do Nothing and Do Something Scenarios with the Masterplan[8]	
	2017	2032
Harbour Road	3	3
Crofton Road West	1	1
Marine Road	<1	<1
Queens Road	1	1

Reference to Table 5.6.4 demonstrates that the increases in respect of total traffic increases would be largely inaudible and the resultant impact imperceptible. In the case of the harbour road, it is noted that the increase in road traffic noise would be of the order of 3dB which would indicate that road traffic noise level increases would be just perceptible with a slight impact. It is important to note that only one receptor is located on Harbour road at the Irish Lights cottages.

7 Assumes the proposed development would be in place

8 The Do Nothing Scenario in this context assumes that neither the proposed development or the masterplan would be in place. Likewise, the Do Something Scenario assumes that both the proposed development and Masterplan would be in place.

It must be noted that the diurnal distribution of traffic associated with the proposed development is concentrated in and around the morning and evening periods whereby passengers from the cruise ships will embark and disembark on day trips to the surrounding area. In terms of peak traffic levels during these periods, the traffic noise level generated is presented in terms of 2 hourly periods. The upper range estimate for two coach traffic associated with the proposed development ranges from 31 to 33 coaches per 2 hour period. The maximum value is predicted to occur during the lunchtime period of 12:00 to 14:00.

The potential noise impact of peak coach traffic on the surrounding road network has been assessed through consideration of the cumulative noise level associated with a series of individual events. The noise level associated with an event of short duration, such as a vehicle drive-by, may be expressed in terms of its Sound Exposure Level (L_{Ax}). The SEL can be used to calculate the contribution of an event or series of events to the overall noise level in a given period. The appropriate formula is as follows.

$$L_{Aeq,\,T} = L_{Ax} + 10log10(N) - 10log10(T) - 20log10(r_2/r_1) - S\ dB$$

Where:

$L_{Aeq,\,T}$	is the equivalent continuous sound level over the time period T (s);
L_{Ax}	is the "A-weighted" Sound Exposure Level of the event under consideration (dB);
N	is the number of events over the course of time period T.
r_2	is the distance from the edge of the entrance road to the facade of nearest property
r_1	is the distance from vehicle to the point of original measurement
S	is the attenuation due to screening

The mean value of Sound Exposure Level for a HGV or coach at low speeds is of the order of 87dB L_{Ax} at a distance of 5m from the edge of the road. This figure is based on a series of measurements conducted under controlled conditions.

For the purposes of calculations a worst-case scenario of 31 coach movements in any one-hour period during the daytime is used. The predicted daytime noise level at a distance of 10m from the road is calculated as 60dB $L_{Aeq,1hr}$.

It is important to note however that existing road traffic noise levels along Crofton Road were measured between 63 to 66dB L_{Aeq}. As such, in terms of noise impacts, the additional coach traffic associated with the proposed development is therefore deemed to be insignificant during peak periods of 12:00 to 14:00.

5.6.5.5 Do-Nothing Impact

In the event that the project does not proceed, there will be no change to the existing local environment.

5.6.6 Avoidance, Remedial Or Reductive Measures

5.6.6.1 Construction Phase

The contractor will be obliged to give due regard to *BS5228-1: 2009*, which offers detailed guidance on the control of noise from construction activities. In particular, it is proposed that various practices be adopted during construction, including:

- Limiting the hours during which site activities likely to create high levels of noise are permitted;
- Establishing channels of communication between the contractor, local authority and residents;
- Appointing a site representative responsible for matters relating to noise;
- Monitoring typical levels of noise during critical periods and at sensitive locations.
- Selection of plant with low inherent potential for generation of noise;
- Siting of noisy plant as far away from sensitive properties as permitted by site constraints.

5.6.6.2 Operational Phase

Ship Noise

The results of the modelling exercise has shown the worst case level of ship noise will comply with the day and evening limits espoused by Dun Laoghaire Rathdown County Council. Although the predicted level of noise exceeds the night time noise limit, generally, cruise ships will not overnight at the terminal and are not expected to berth before 07:00 each morning.

In exceptional circumstances such as engine failure or malfunction, for safety reasons, a ship may need to overnight at the terminal. Where such a scenario occurs, it will be necessary for cruise ship captain to ensure that the engine generators are run in a manner that does not generate noise levels in excess of the DLRCC night time noise level criteria.

Additional Vehicular Traffic on Public Roads

The noise impact assessment outlined above has demonstrated that mitigation measures are not required.

5.6.7 Predicted Impact Of The Proposal

This section summarises the likely noise impact associated with the proposed development, taking into account the mitigation measures. In both instances, the predicted impact of the proposed development represents a worst case outlook in terms of both construction and operational noise levels.

Construction Phase

During the construction phase of the project, there should be no impacts on nearby residential properties due to noise emissions from site. Given that the construction phase of the development is temporary in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration impact is kept to a minimum.

Operational Phase

Ship Noise

The results of the modelling exercise has shown the worst case level of ship noise will comply with the day and evening limits espoused by Dun Laoghaire Rathdown County Council. Although the predicted level of noise exceeds the night time noise limit, generally, cruise ships will not overnight at the terminal and are expected to have docked after 07:00 each morning.

The resultant noise impact is therefore not significant during this period.

Additional Vehicular Traffic on Public Roads

The increase in the level of road traffic noise along all adjacent roads as a result of the proposed development will imperceptible when compared with existing levels of road traffic noise.

The resultant noise impact is therefore not significant.