

NOISE IMPACT ASSESSMENT

Rp 001 2017068 (Greenore Port)

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PROJECT: NOISE IMPACT ASSESSMENT

PREPARED FOR: GREENORE PORT
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CO. LOUTH
IRELAND

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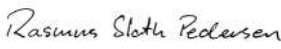

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1 INTRODUCTION

Irwin Carr Ltd have been commissioned to undertake a noise impact assessment for Greenore Port Ltd, Greenore, Co. Louth, Republic of Ireland

Greenore Port intends to apply for permission to Louth County Council for the rehabilitation of the existing Berth No.2 and the quay deck. .

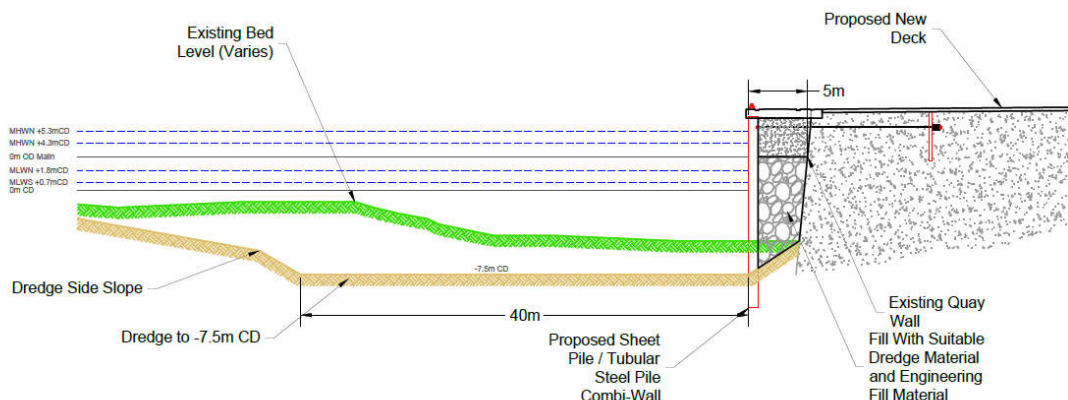
In relation to noise there are two aspects to review, the underwater noise sources arising during the construction phase and their impact on the marine animals within Carlingford Lough and the on-shore noise associated with the construction phase and how it will potentially affect sensitive receptors in the vicinity of the works area.

The purpose of this application for permission is solely to rehabilitate the existing berth and quay deck to provide for safer operational conditions. The proposed works will thus not give rise to any additional noise sources during the operational phase. The rehabilitation will not result in the intensification of vessel movements which are restricted due to channel depth, width and towage power within Carlingford Lough. Therefore, an operational noise assessment is not included within this report.

1.1 Underwater Noise

Dredging in front of Berth No.2 will be required to make it consistent with the existing Berth No.1 depth. It is proposed to dredge the sea bed to -7.5m Chart Datum. The dredge pocket is illustrated on Figure 1 below.

Figure 1. Cross-sectional view of the proposed dredging pocket outlining the end state of Berth 2 after improvements.



Section AA Scale 1:500

The following plant will be mobilised for the dredging phase:

- Long-reach back-hoe excavator;
- Dredge barge;
- 1000m³ hopper barge
- Tug boat
- 8-wheel tipper trucks; and,
- Safety boat

The construction of the quay wall will necessitate the mobilisation of a piling rig. The rig will be used to core into the bedrock for the installation of the proposed combi-sheet pile wall. Once the coring is complete, a crane will install circular steel piles (king piles). When 2No. king piles have been installed, an impact hammer will be fitted to the crane, and 3No. sheet piles will be driven into the bedrock. The process will be repeated over the length of the wall, c. 139m.

The noise associated with the activities described above has the potential to impact on local wildlife and thus dredging and piling have been included in this impact assessment. It was assessed from available literature (Willis, Broduic, Bhurosah, & Masters, 2010) & (Health and Safety Laboratory, 2007) that the rock breaking would have minimal impact on the impact assessment given is lower noise level. Inclusion of the rock breaking would change the noise levels by less than 0.1 dB, which is negligible compared to uncertainties stemming from confounding environmental factors.

The construction is planned to be completed in 26 weeks, with up to 6 weeks anticipated for dredging works and a further 6 weeks required for marine dredging.

Multiple protected sites are in the vicinity of the site, with two being potentially relevant to the underwater noise aspect of the construction, namely:

- Special Area of Conservation (SAC) “Carlingford Shore”
- Special Protection Area (SPA) “Carlingford Lough”

The features of interest associated with Carlingford Shore SAC are:

- Annual vegetation of drift lines [1210]
- Perennial vegetation of stony banks [1220]

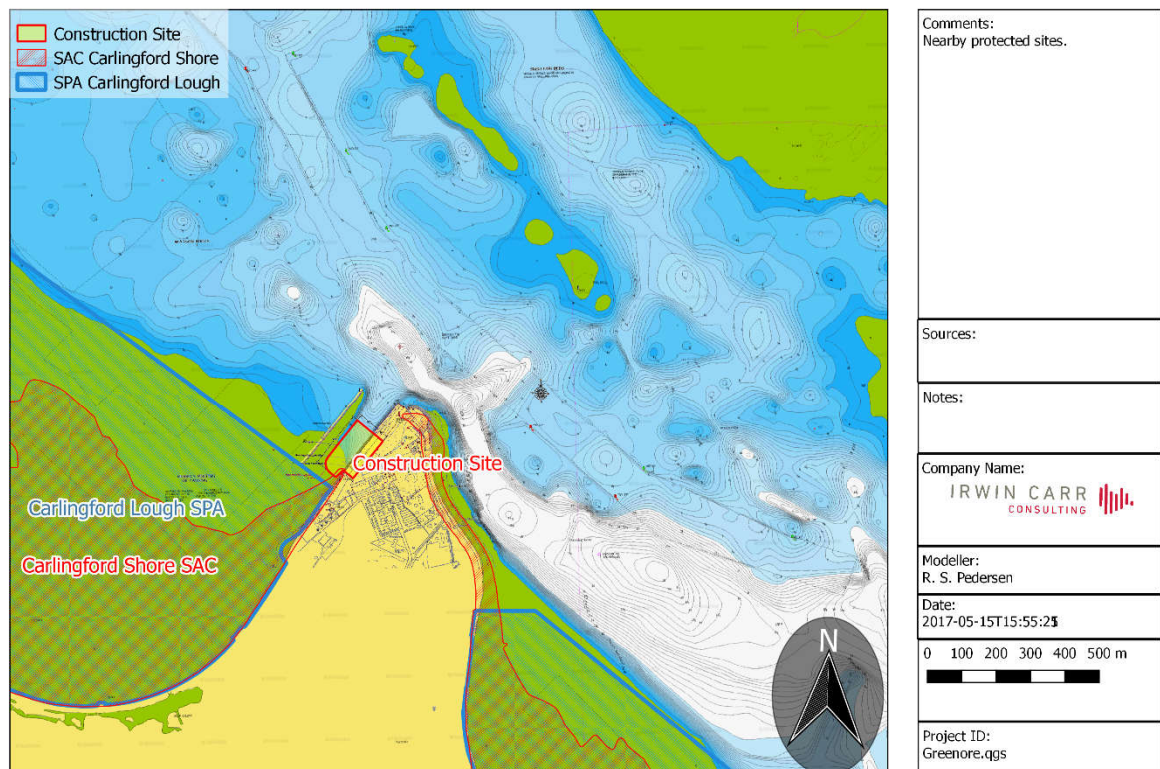
While, the features of interest associated with Carlingford Lough SPA are:

- Pale-bellied Brent Goose (*Branta bernicla hrota*) [A046]
- Wetland and Waterbirds [A999]

The two areas are also important as breeding sites for harbour seal (*Phoca vitulina*) and as haul-out sites for grey seal (*Halichoerus grypus*).

In addition, harbour porpoises (*Phocoena phocoena*) are irregular visitors within the lough.

Figure 2. Overview of the construction site and the location of protected sites in the Republic of Ireland relevant to the underwater noise emission.



1.2 Onshore Noise

This report also assesses the impact of the proposed development during the construction, on the nearest noise sensitive receptors in the vicinity of the application area. It considers the potential impacts on identified sensitive receptors by taking background noise levels at the nearest residential properties and using this information to establish limit level.

The predicted noise levels from the construction phase will be compared to BS5228 limit levels.

2 UNDERWATER NOISE - ASSESSMENT CRITERIA

The proposed noise limits and method of assessment are described in this section.

2.1 Noise

For initially assessing noise impact we adhere to the “Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing” (NOAA, 2016) along with several studies of behavioural effects not directly related to hearing impairment in the relevant species (Dahne, et al., 2013; Culloch, et al., 2016; Erbe, Reichmuth, Cunningham, Licke, & Dooling, 2016). We do however *not* weigh the noise levels according to hearing groups when assessing permanent threshold shift (PTS), as the mechanism for PTS is not as well understood as for temporary threshold shift (TTS). In this respect, we deviate from the NOAA methodology, but adhere to a more conservative practise, recognising a lack of scientific understanding on the topic.

Table 1 below shows how different types of sound levels can be ranked in terms of impact. No single level is given as they all depend on both the temporal and spectral composition of the noise as well as the auditory abilities and disturbance threshold of the receiver. It is common that dB_{P,P} and dB_{SEL} levels are exceeded at very different distances from the source, but exclusion zones are determined from whichever threshold is exceeded first.

Table 1. Severity of sound levels. See section 2.3 p. 8 for definitions of units.

| Category | Examples, description & symptoms | Limit: | Impulsive | Continuous |
|-------------------------|---|--|--|--|
| Physical (non-auditory) | Shock waves from explosions or other extremely loud sound sources. Tissue damage and gas embolisms due to violent and rapid pressure changes | | | |
| Physical (auditory) | Sound from pile driving, seismic sources, high-power sonars. Damage to hearing, can be either: Permanent threshold shift (PTS): Partial or complete destruction of ear structures. Irreversible. Temporary threshold shift (TTS): Reversible change in hearing sensitivity, no permanent structural damage to auditory system. | PTS Porpoise: Seals: TTS Porpoise: Seals: | > 202 dB _{P,P} > 155 dB _{SEL24h} > 232 dB _{P,P} > 203 dB _{SEL24h} > 196 dB _{P,P} > 140 dB _{SEL24h} > 226 dB _{P,P} > 188 dB _{SEL24h} | > 173 dB _{SEL24h} > 219 dB _{SEL24h} > 153 dB _{SEL24h} > 199 dB _{SEL24h} |
| Perceptual | Shipping, dredging, rock filling – general marine activities - can lead to auditory injury from fatigue. Masking of biologically important sound e.g. sound from conspecifics, prey, bio-sonar, environment. Leads to loss of fitness through displacement, disturbance of feeding/breeding/migrating/resting -behaviour. | | | |
| Chronic | Long duration noise. Decreased fecundity of local population | | | |
| Indirect stresses | Displacement of prey, permanent habitat change, change in ecosystem composition. | | | |

For the purposes of this report we will assess the measured and calculated levels against the above levels. This is in part because the limits are practical, but mainly because they represent a large effort in gathering available evidence on the topic. Furthermore, the Irish Wildlife Act of 1976 states that it is an offence to: “injure or wilfully interfere with, disturb or destroy the resting or breeding place of a protected species”, and levels over TTS-thresholds are seen as causing injury and disturbance (as per Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters, Dept. of Arts, Heritage and the Gaeltacht, 2014)

The Technical Noise Group of the European Union have agreed on minimum levels (Table 2), below which sources are deemed not to have “significant adverse impact” on the surrounding environment. Sources above this threshold should be evaluated separately for their environmental impact.

Table 2. Minimum limits for significance of noise sources according to the EU Technical Noise Group. Levels are at 1 metre from the equivalent point source.

| Noise type | Minimum Level |
|--------------------------------------|-----------------------------|
| Explosive | $M_{TNTeq} > 8 \text{ g}$. |
| Airgun | $dB_{P,P} > 215$ |
| Impact Piledriving | No minimum level |
| Other impulsive | $dB_{SL} > 186$ |
| Low-mid frequency sonar | $dB_{SL} > 176$ |
| Low-mid frequency acoustic deterrent | $dB_{SL} > 176$ |
| Other continuous noise source | $dB_{SL} > 176$ |

No maximum thresholds are given, and breaching of the above levels only indicate that a further investigation should take place to establish population impact. Most noise sources in this report are over the given thresholds, and are therefore considered in the following sections.

2.2 Designated Areas

Two relevant designated areas are located near the site:

- Special Area of Conservation, “Carlingford Shore” (SAC 002306) (NPWS, 2013). These areas are given special protection under the European Union's Habitats Directive. The specific site is designated to protect:
 - Annual vegetation of drift lines (habitat type 1210).
 - Perennial vegetation of stony banks (habitat type 1220).
- Special Protection Area, “Carlingford Lough” (SPA 004078) (NPWS, 2013). Areas designated under the European Commission on the conservation of wild birds (the Birds Directive). All EU member states are required to identify internationally important areas for breeding, over-wintering and migrating birds and designate them as SPA's. The specific site is designated to protect:
 - Pale-bellied Brent *Branta bernicla hrota* (code A046).
 - Wetland and Waterbirds (code A999).

None of the above sites are designated for areas below the low water mark, but the presence of three marine mammal species (harbour seal, grey seal and harbour porpoise) mean that the marine environment adjacent to the site is subject to the outlined assessment criteria (Table 1 p 7).

2.3 Units for Reporting Sound Levels

There are multiple ways to report sound levels. We will adhere to the recommendations of NOAA, using the following units (NOAA, 2016):

dB_{SPL} RMS Sound Pressure Level. Applicable to continuous sounds¹.

Defined as:
$$dB_{SPL} = 20 \cdot \log_{10} \left(\frac{\sqrt{\frac{\sum_{n=1}^n p(n)^2}{n}}}{1 \cdot 10^{-6} \text{ Pa}} \right) \quad (2-1)$$

With “n” the number of samples included and “p” the pressure in Pascals at sample “n”.
For continuous noise dB_{SPL} is equal to the Leq value. If we use an RMS level in a time-series we will state the RMS window length.

dB_{SEL} Sound Exposure Level. Applicable to continuous sound exposure.

Defined as:
$$dB_{SEL} = 10 \log_{10} \left(fs \cdot \frac{\int_{t_0}^t P(t)^2 dt}{(1 \cdot 10^{-6})^2 \text{ Pa}} \right) \quad (2-2)$$

$$dB_{SEL} = dB_{SPL} + 10 \cdot \log_{10}(n \cdot fs) \quad (2-3)$$

With “fs” the sample rate for the P/dB_{SPL} value. As per (NOAA, 2016) dB_{SEL} will often be set to cover a 24-hour (86,400 seconds) sometimes with animal hearing sensitivity and duty cycle of the noise source considered.

dB_{P-P} Peak to Peak Level. Used for characterising impulsive sounds²

Defined as:
$$dB_{P-P} = 20 \cdot \log_{10} \left(\frac{P_{max} - P_{min}}{1 \cdot 10^{-6} \text{ Pa}} \right) \quad (2-4)$$

dB_{ht} Sound Pressure Level weighted for a specific hearing threshold.

Defined as:
$$dB_{ht} = 10 \cdot \log_{10} \left(\sqrt{\sum_{Hz_{min}}^{Hz_{max}} \left(\left(10^{\frac{dB_{SPL}(Hz) + dB_{weighting}(Hz)}{10}} \right)^2 \right)} \right) \quad (2-5)$$

effectively setting “dB_{weighting}³” as a new reference value (instead of 1e-6 Pa) and then summing over frequencies as non-coherent (assuming random phase distribution).

dB_{SL} Source Level. This is the sound pressure level of an equivalent point source as measured at one metre’s distance. This value will usually be estimated from dB_{SPL} or dB_{P-P} and information about transmission losses between source and receiver position.

2.3.1 SPECTRA

For spectra, we will usually show the power spectrum⁴ along with a moving average for clarity. Also, we will often display levels in one-third octave bands.

3 dBSea UNDERWATER NOISE PROPAGATION MODELLING

Noise propagates readily underwater partly due to a high sound speed compared to air, and partly due to very low attenuation from absorption and dispersion. We use dBSea underwater noise propagation modelling software to estimate transmission losses while considering a large range of environmental variables. Details about the software can be obtained from www.dBSea.co.uk.

The software uses three different solvers/algorithms to calculate transmission loss. The solvers are built on the principles outlined in (Jensen, Kuperman, & Schmidt, 2011).

¹ Continuous defined as being with slow (> 1 second) rise and fall times, and generally of duration greater than 10 seconds.

² Impulsive here means short rise and fall times and 95 % of energy within 1 second.

³ Weighting curves have a maximum of 0 dB at the most sensitive region of hearing, going to negative values in less sensitive part of the spectrum.

⁴ dB_{SPL} per 1 Hz band, RMS window length equal to FFT length/sample rate.

1. **dBSeaModes:**
Uses modal algorithm to approximate sound paths in range-dependent environment such as with a varying seabed. It is good especially for low frequencies, but becomes computationally inefficient at higher frequencies⁵.
2. **dBseaPE:**
A parabolic equation solver that similarly to dBSeaModes is best suited to lower frequencies, but not very shallow environments. If applicable this method is preferred due to better documentation.
3. **dBSeaRay:**
Uses tracing of individual rays to approximate sound field. Applicable over a wide range of frequencies bar the lowest. This is currently the only computationally efficient method at high frequencies.

3.1 Bathymetry

We have used data sets from the UK Hydrographic Office (UKHO) for the bathymetry input for our modelling. As this data does not cover the tidal mudflats, some extrapolation has taken place to cover these areas as well. We have used spline interpolation from the Quantum GIS software package to do this interpolation. The result has been compared to Nautical navigation charts to verify and modify results. Note that sound propagation in very shallow water is highly restricted due to the large number of surface and seabed reflections occurring as well as absorption, especially of low frequencies in the sediment.

3.2 Noise Sources

All noise sources are characterised as equivalent point sources, meaning that a simplification has taken place. Most noise sources are not equally loud in all directions, and do not emit all frequencies uniformly. We are, however not trying to estimate the exact sound field of the sound source in question, but rather give the maximum noise impact of a given scenario. Source levels are estimated either from back-calculation (to one metre from the source) of recorded levels from similar equipment or from earlier reports of similar equipment.

3.2.1 PILING NOISE

As precise pile and hammer characteristics were unavailable at the time of modelling, estimated source levels have been used for impact type piling. In an effort to accurately do this estimation we have collected noise data from 15 different recorded piling scenarios. Levels were recorded at various distances from the pile and back-calculated to one metre (from an equivalent point source). Levels measured much further away than the local depth were back-calculated assuming transmission losses between cylindrical and spherical spreading loss along with a small loss to friction:

$$dB_{SL} = dB_{P-P} + 15 * \text{Log}_{10}(\text{range}) + 0.01 * \text{range} \quad (3.1)$$

Levels measured close to the source (< 3 times depth) are assumed to have undergone spherical loss:

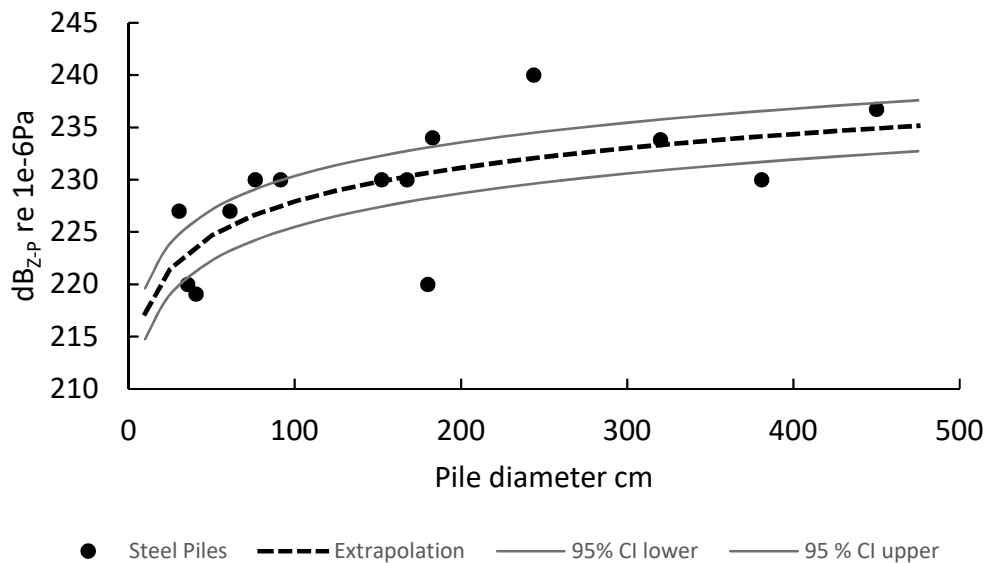
$$dB_{SL} = dB_{P-P} + 20 * \text{Log}_{10}(\text{range}) \quad (3.2)$$

Both the above likely overestimates transmission loss, leading to a conservative source level estimate.

We have further assumed (due to lack of information) that no piling cushion will be used and that tubular support piles will have a diameter of one metre.

⁵ “High” and “low” frequencies in this section are not clearly defined as it will depend on the specific scenario. Generally, the change from “low” to “high” is between 500 Hz and 1 kHz.

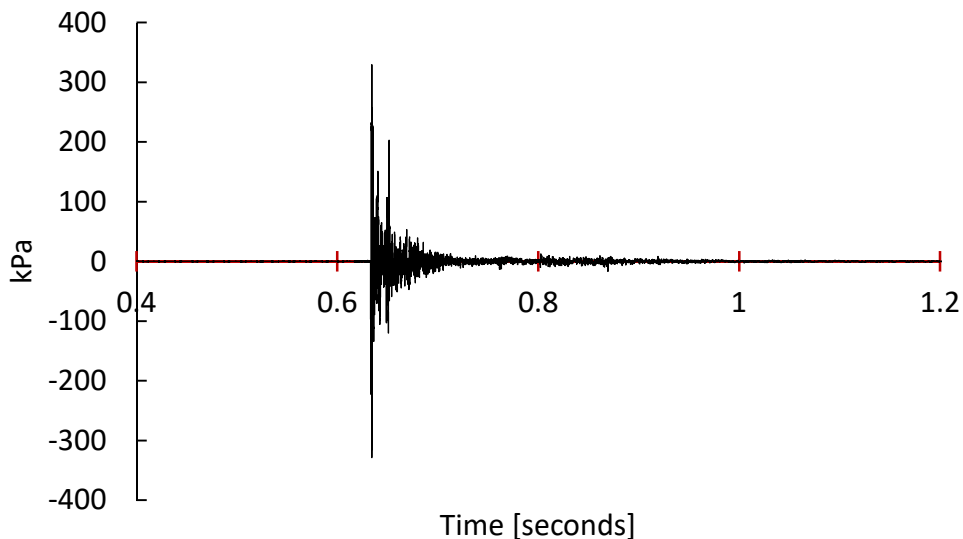
Figure 3. Data used for estimating pile driving broadband noise levels. Extrapolation curve is a fitted logarithmic function (maximising R²), with pile diameter being the input variable. Grey lines are 95 % confidence intervals (from dB-values).



A one metre steel pile will, according to the above, have an estimated equivalent point source level of 230 dB_{Z-P}⁶, choosing the upper 95 % confidence level as the representative level.

A pile strike with a representative spectrum has been amplified to this level for use in dBSea. We further assumed 1000 pile strikes per day.

Figure 4. Pile strike used in modelling. From actual recording at 10 metres from pile. Pressure adjusted to match level of 230 dB_{Z-P} / 134 dB_{SEL} (single event).



3.2.2 DREDGING NOISE

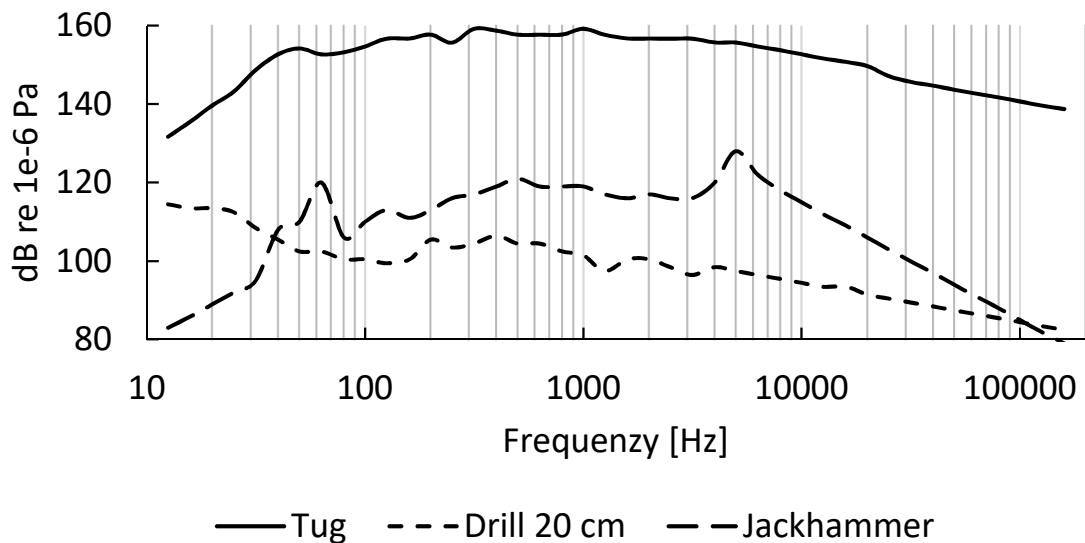
Noise from dredging activities is quite different to pile driving in that the main concern isn't the acute trauma caused by the high pressure, but rather the cumulative fatigue from prolonged exposure.

⁶ Equivalent to 236 dB_{P-P}

As the dredging is being carried out by a barge lacking a motor the main noise source during removal of soft material is from the tug boat moving the hopper barge.

Rock breaking (chiselling) noise data is not available so this has been estimated from several sources, both literature (Health and Safety Laboratory, 2007; Willis, Broduic, Bhurosah, & Masters, 2010) and previously recorded levels from a rock breaking drill. All these indicate that the noise from the rock breaking will contribute very little (<0.1dB) to the overall sound level compared to the contribution from the associated tug boat. Further reducing the impact from the rock breaking is the conditions under which the activity takes place; two hours before and after low tide. This means that the noise from the rock breaking activity will be contained by the breakwater, the south-west end of the berth and the sand banks north-east of the port. The contribution to the 24-hour exposure from this activity is thus minimal.

Figure 5. Levels for the tug boat associated with the hopper barge, 171 dB_{SPL}. Drilling: 121 dB_{SPL}. Rock breaking: 127 dB_{SPL}. all levels are broadband noise levels



For calculating dB_{SEL} for 24-hour periods we assumed that the tug boat was active at all times and the rock breaking was limited to two 4 hour periods daily (a duty cycle of 33 %)

3.3 Environmental Variables

The site has a spring tidal range of 4.6m, and subject to very strong currents associated with the tidal cycle. Current speed does not affect the noise transmission much as the current speed is a small fraction of the sound speed (<0.1 %).

The worst-case scenario for noise propagation is assumed to be at high tide for several reasons:

- Shallow water acts as a high-pass filter, and as lower frequencies propagate further, noise will travel further during high tide.
- The site is bounded by a breakwater on the north-western side that is fully submerged during high tide, but not covered during low tide. When the breakwater is not covered, all but the lowest frequencies will be blocked, and significant sound energy will not propagate. The same is true for the many small sand banks and islands close to the site.

The seabed composition is significant with respect to noise propagation and is assumed to be sand in the top two metres and rock below that. The quay itself is modelled as concrete.

4 RECORDING, EQUIPMENT AND MOORING

An Ocean Instruments® SoundTrap® 300HF (ST) was used for background noise measurements at the site. The unit sampled at 288 kHz, providing effective frequency coverage up to 115 kHz (6th order filter yielding >10 dB attenuation over Nyquist limit). A bit depth of 16 bits provide 96 dB of range; 90-186 dB SPL. Pre- and post-calibrations show a drift of 0.87 dB. For details concerning calibration, frequency response and self-noise see figures Figure 6 & Figure 7.

Figure 6. Calibration output from Soundtrap 300 HF unit. Input 149 dB re 1 μ Pa at 250 Hz from B&K pistonphone 4220.

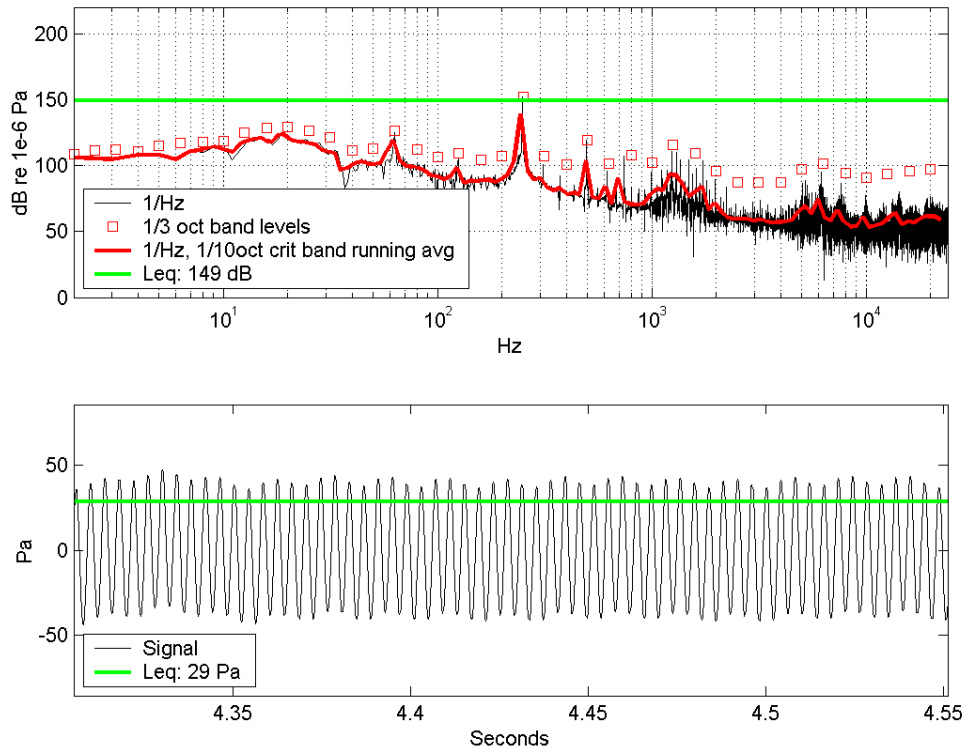


Figure 7. The frequency response of the Soundtrap 300 HF unit. Lighter areas denote 95 % confidence interval. Note that 95 % confidence interval is <2.5 dB throughout. Sensitivity given as both dB re V/ μ Pa (red) and μ V/Pa (green). Note that calibration under 10 kHz was done in air as described by (Brüel & Kjær, 2006) & (Bøgholm, 2009).

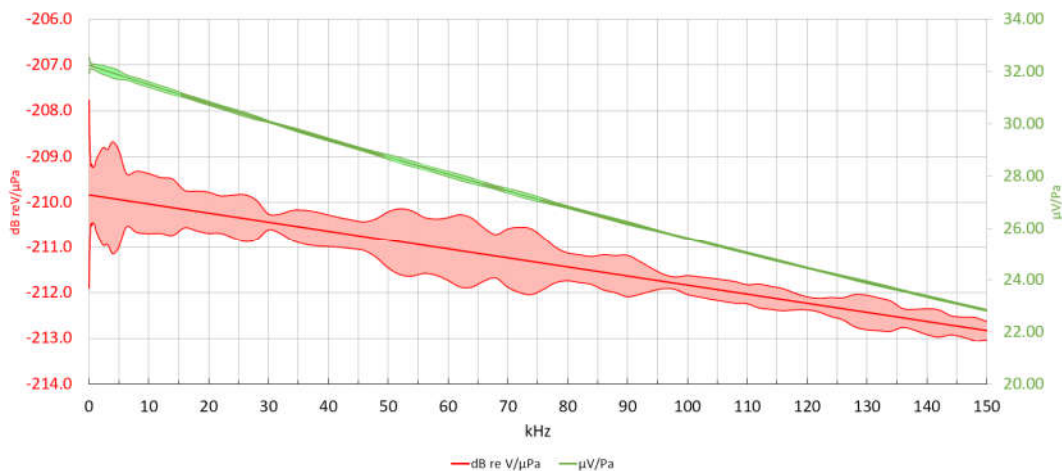
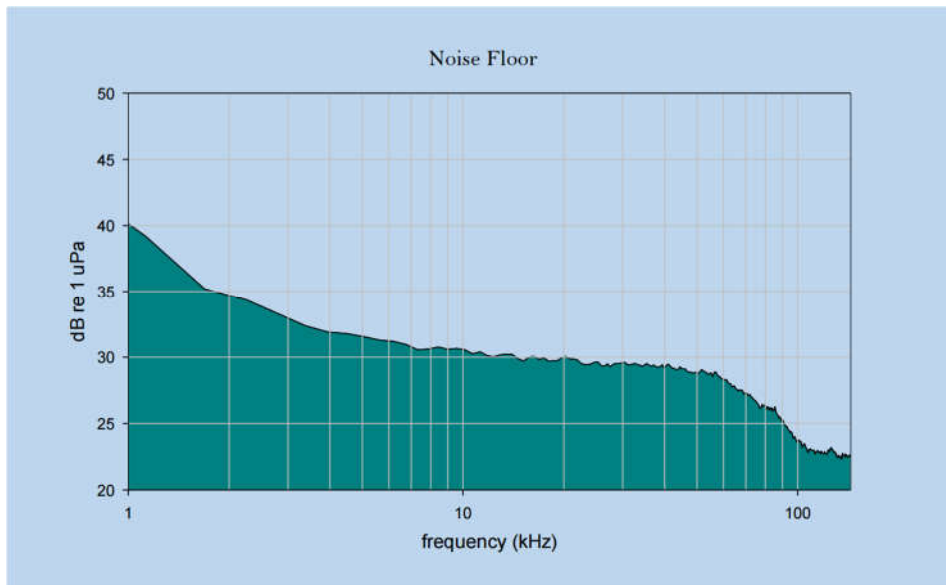


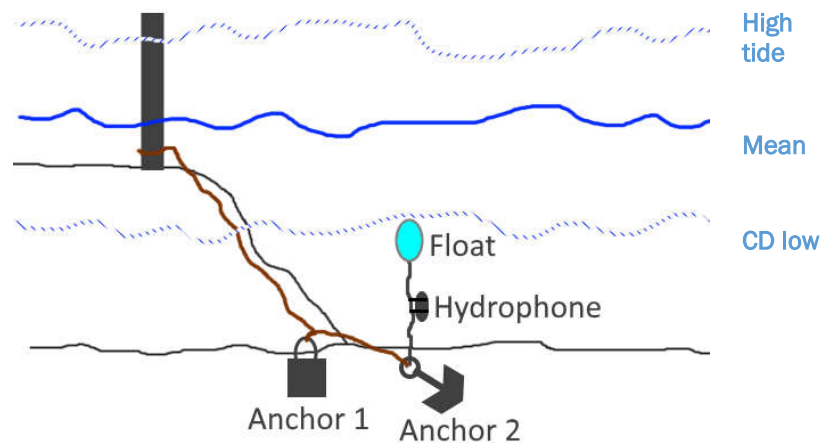
Figure 8. Noise floor of recording system as specified by the manufacturer.



The mooring for the ST-unit consisted solely of webbing without moving metal links (i.e. mooring chain), and the hydrophone was moored away from other chain moorings.

The hydrophone was suspended over the seabed by a float positioned under the chart datum low water limit⁷ at the location (54.03532N 6.13433W). A two-anchor system was used to mitigate risks from local strong tidal current as well parasitic noise from the main mooring line.

Figure 9. Mooring of hydrophone. Main mooring line from breakwater connected to separate anchor (anchor 1) from hydrophone (anchor 2) to mitigate parasitic noise.



⁷ Chart Datum low water limit from UK Hydrographic Office Nautical Chart

5 RESULTS

5.1 Background Noise

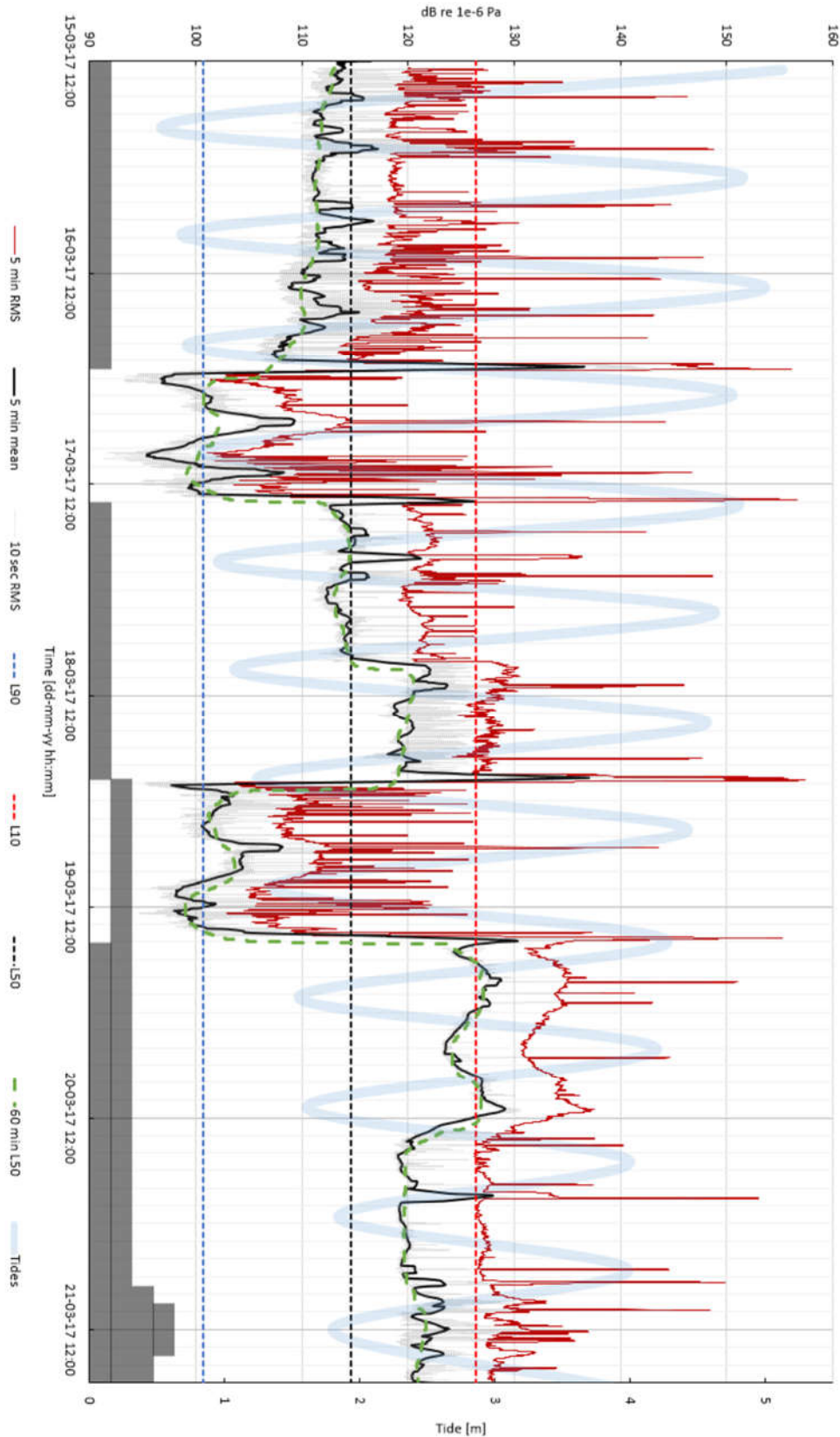
For a duration of 150 hours (6.25 days; 15 to 21 March 2017) the noise at a location of 3-8 metres' depth (depending on tide) was recorded. Broadband noise levels from 80-115,000 Hz were obtained (see Figure 10 for details). Based on broadband ten-second RMS levels we calculated tendencies for the typical noise levels present at the site:

- **L₁₀: 126** dB re 1 μ Pa (10 s RMS)⁸
- **L₉₀: 101** dB re 1 μ Pa (10 s RMS)
- **L₅₀: 115** dB re 1 μ Pa (10 s RMS)

The site background noise was variable and depended to a large degree on the presence of noise from vessels docked in the port. The above levels hide a clear trend for the noise level to be at *one* of four levels: 100 dB, 114 dB, 120 dB or 126 dB. Only for very short periods did the background noise level get outside these characteristic levels that are not associated with the tide but rather vessel presence and activity in the Port (Figure 10).

⁸ L₁₀ and L₉₀-levels are sometimes cause for confusion. "L_{xx}" indicates the level exceeded 'xx' % of the time.

Figure 10. Noise levels during a 6-day period with normal operation of Greenore Port and associated services. Level are broadband levels (80 – 115,000 Hz) initially assessed as 10 second RMS levels. Noise spikes are engine noise from passing vessels or machinery hitting the hull of vessels moored at the quay. Notice 60 min L50 shows clear plateauing (depending on vessel activity in the Port). Grey bars indicate vessel presence in the Port.



5.2 Modelling Results

We modelled two scenarios (Piling and dredging), leading to six cases with exclusion zones corresponding to TTS limits as per Table 1, p.7:

As peak-to-peak ($\text{dB}_{\text{P-P}}$) limits led to larger exclusion zones than did sound exposure limits (dB_{SEL}) for impulsive noise, we only present the (larger) exclusion zones from the $\text{dB}_{\text{P-P}}$ limit in the piling scenario.

Modelled noise from underwater construction work was well above both background noise levels and normal Port operation noise levels, meaning that the associated increased noise represents a significant change in the habitat. This reaffirms the need for mitigation and monitoring of local marine mammals.

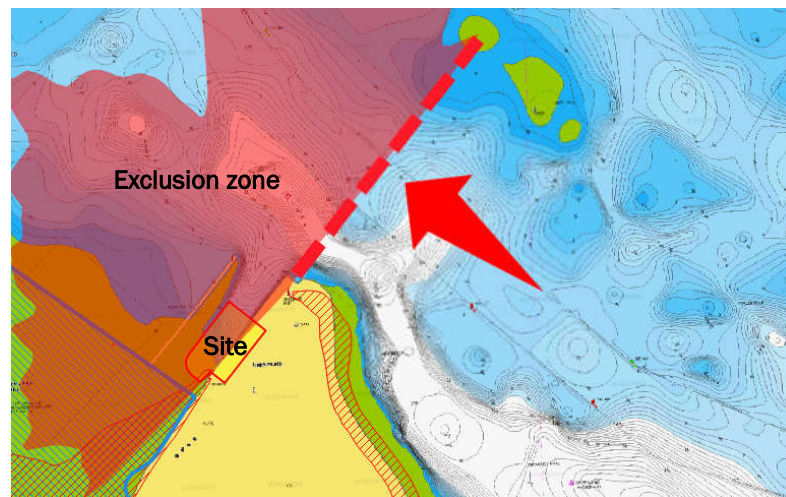
The harbour porpoise is the most sensitive of the two marine mammal groups, and per the modelling, the only marine mammal species to be exposed to noise levels exceeding its TTS-limit outside the immediate vicinity of Greenore Port. Modelled sound exposure levels during piling were too low to give a meaningful exclusion zone for seals and thus only four exclusion zones have been generated:

1. Seals 226 $\text{dB}_{\text{P-P}}$ limit exclusion zone during impact piling.
2. Seals 199 dB_{SEL} limit exclusion zone during dredging.
3. Porpoises 196 $\text{dB}_{\text{P-P}}$ limit exclusion zone during impact piling.
4. Porpoises 153 dB_{SEL} limit exclusion zone during dredging.

Keep in mind that all scenarios and cases are modelled as worst case scenarios with respect to noise. During low tide, noise will be limited to the berth and the deep channel immediately outside the port.

The physical layout of the site that serves to limit the noise extend, also works to create abrupt changes in noise levels along the edges of the ensonified water volume. This means that animals can swim in relative quiet up to a noisy area, and rather suddenly find itself in very noisy surroundings.

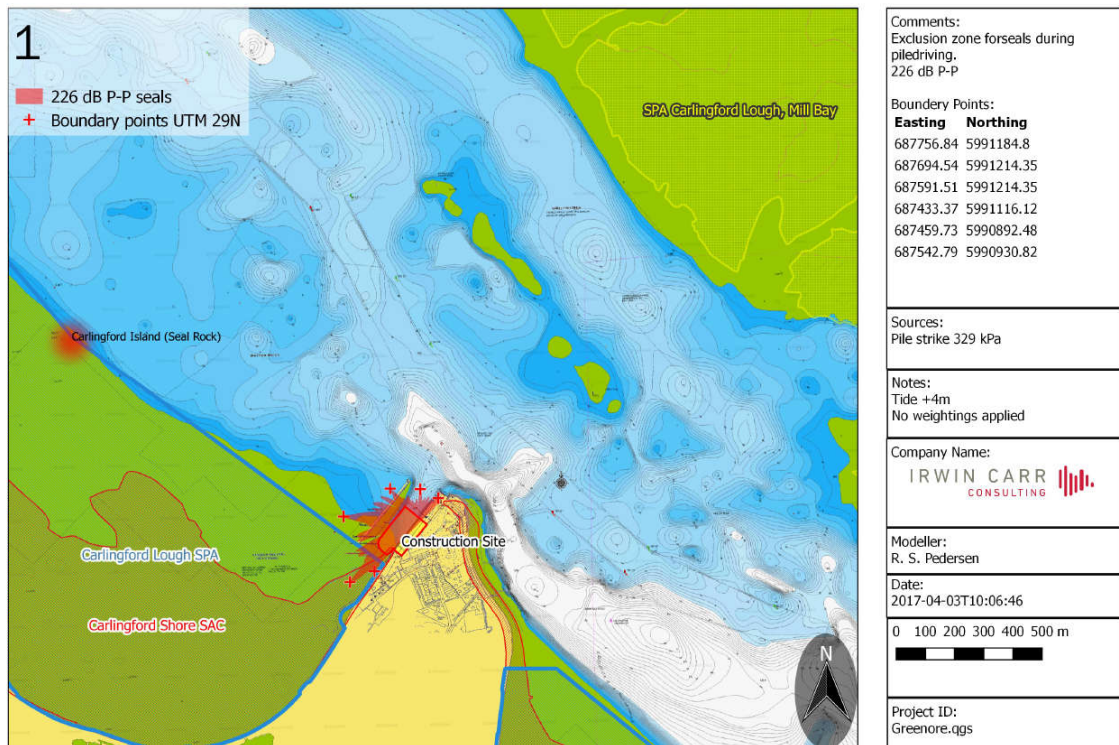
Figure 11. There is a predicted abrupt change in noise levels when passing from one side of the red dashed line to the other.



5.2.1 SEALS, PILING

The underwater noise from the piling is extremely unlikely to exceed TTS-limits (226 dB P-P) outside the berths in Greenore Port (Figure 12). This does not rule out behavioural disturbance, but means that acute damage to the seals is very unlikely. The cumulative noise from piling activities is below the TTS-threshold of seals and thus no exclusion zone was generated.

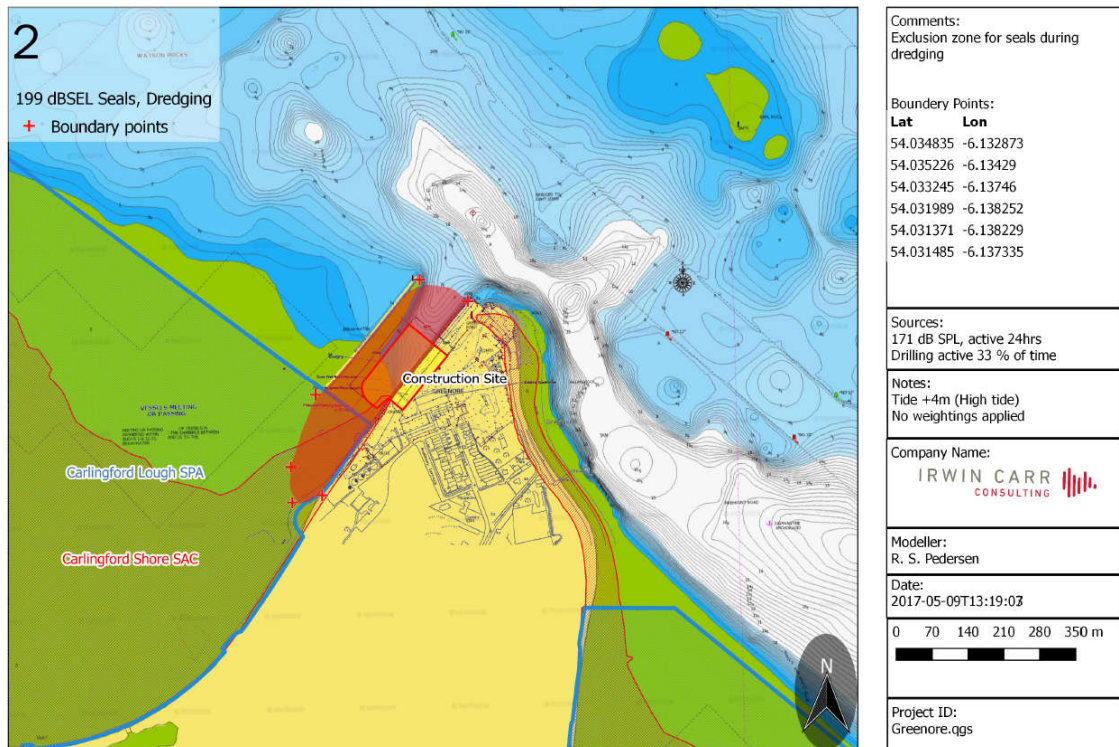
Figure 12. Exclusion zone based on TTS-levels for seals. Map shows extend of constructions site as well as predicted exclusion zone at 226 dB P-P based on 1000 daily strikes of 329 kPa, acoustic pressure. Green areas are dry during mean low tide. Closest large seal haul-out site is Carlingford Island (Seal Rock).



5.2.2 SEALS, DREDGING

The continuous nature of noise from dredging means that the load on the auditory system can cause fatigue and damage from sustained stress if the animal stays for prolonged periods within the exclusion zone. The TTS-limit (199 dBSEL) for seals is exceeded in the berth and approximately 250 m to the south-west (Figure 13).

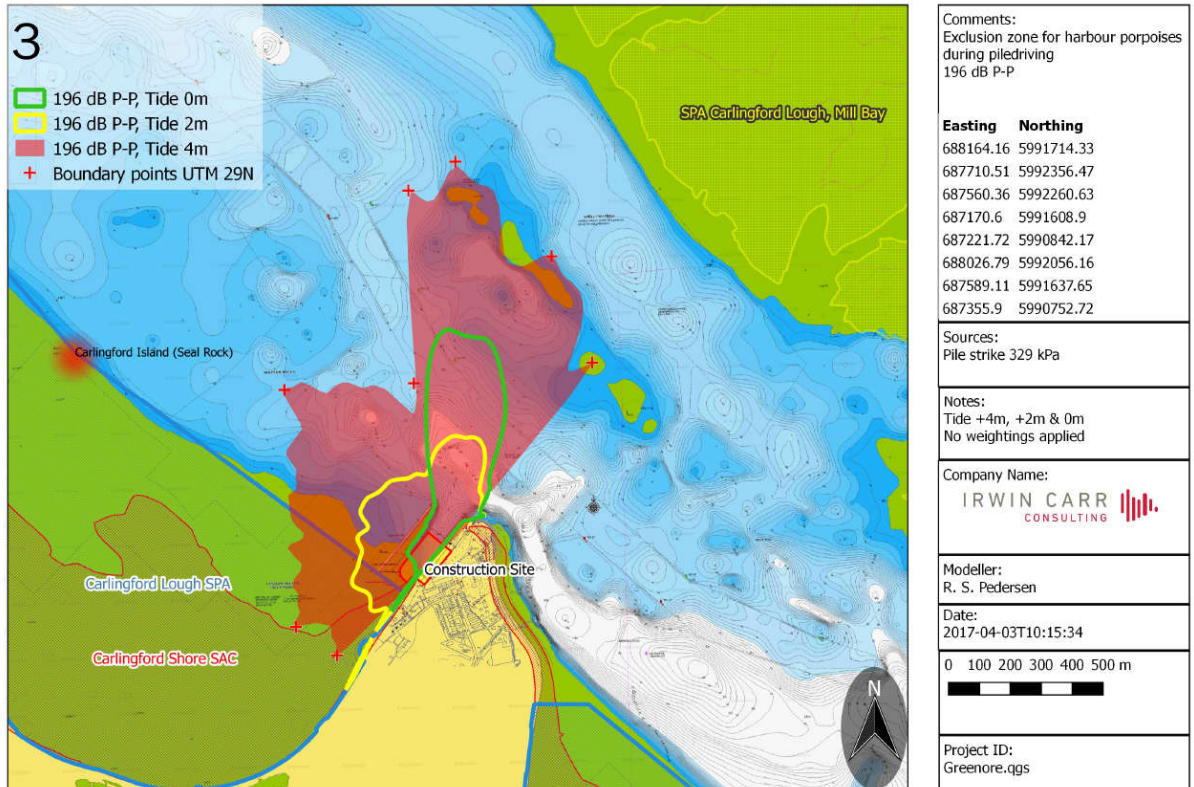
Figure 13. Exclusion zone based on TTS-levels for seals. Map shows extend of constructions site as well as predicted exclusion zone at 199 dB_{SEL24hr} based on 170.6 dB_{SL} re 1 µPa dredging vessel, 24 hours with active chiselling 33 % of the time. Green areas are dry during mean low tide. Closest large seal haul-out site is Carlingford Island (Seal Rock).



5.2.3 PORPOISES, PILING

The TTS-limit for porpoises of 196 dB_{P-P} is exceeded in a substantial area, extending well into the Lough, with maximal extend directly north (1200 metres) (APPENDIX B, 3).

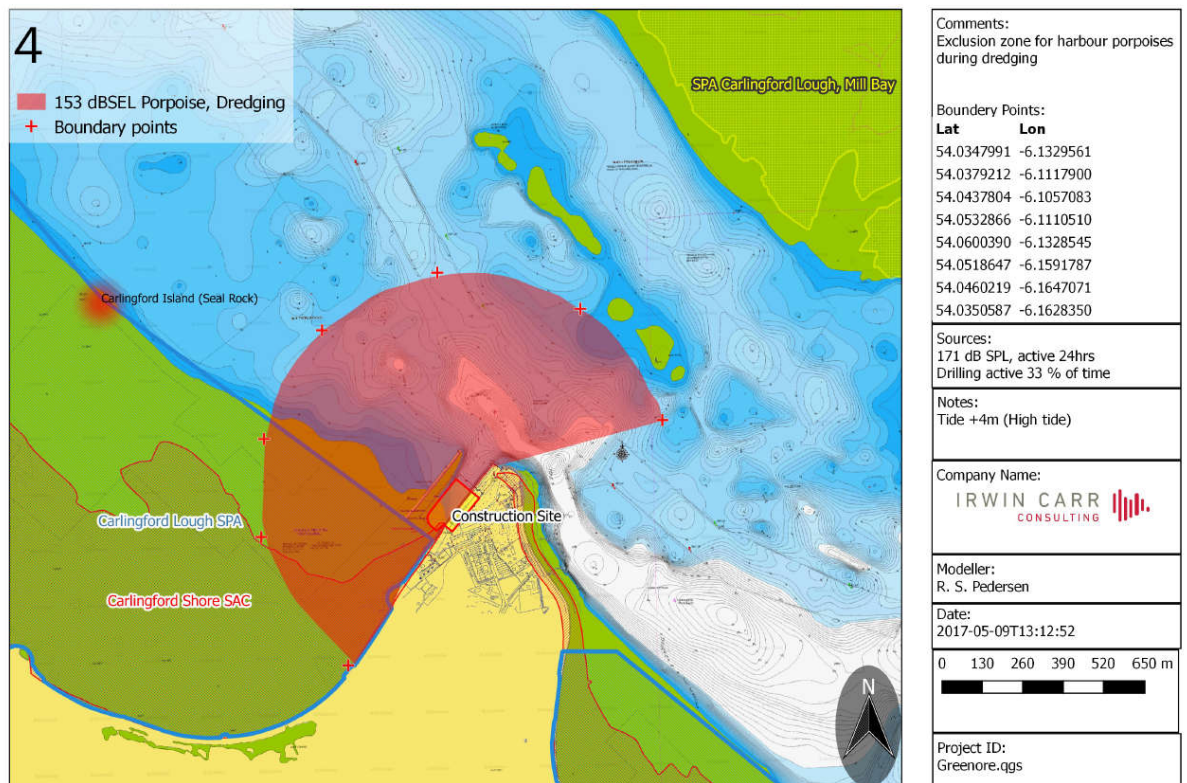
Figure 14. Exclusion zone based on TTS-levels for porpoises. Map shows extend of constructions site as well as predicted exclusion zone at 196 dB_{P-P} based on 1000 daily strikes of 329 kPa, acoustic pressure. Green areas are dry during mean low tide. Exclusion zones at low tide (0m) and mean water level (2m) included for comparison.



5.2.4 PORPOISES, DREDGING

The TTS-limit (153 dBSEL) for porpoises during exposure to continuous noise is the lowest of all the marine mammal groups, leading to a larger area of potential exceedance of TTS-limits during dredging (Figure 15). The area extends to roughly 600 metres from the port (0.9 km²). At low tide (CD +1 metre) the affected area is reduced further with the exclusion zone extending approximately 500 metres around the port (not shown in figure).

Figure 15. Exclusion zone based on TTS-levels for porpoises. Map shows extend of constructions site as well as predicted exclusion zone at 153 dB_{SEL24hr} based on 170.6 dB_{SL} re 1 µPa dredging vessel, 24 hours with active chiselling 33 % of the time.



ONSHORE NOISE

6 CONSTRUCTION NOISE ASSESSMENT CRITERIA

6.1.1 BS 5228 ASSESSMENT

The Code of practice for noise and vibration control on construction and open sites (BS 5228-1:2014) provides a number of methodologies for assessing the significance of construction noise at residential receptors. These methodologies “would generally apply to projects of a significant size”, with a more generalised consideration of construction noise impact recommended for smaller projects.

The standard presents criteria based on fixed limits and noise change criteria. Given the scale of the project under assessment and the rural setting, it is appropriate to adopt the noise change criteria using the “ABC Method”.

6.1.2 THE ABC METHOD

The existing ambient noise level at a residential property is rounded to the nearest 5 dB and this number is used to determine the threshold value for each of three time periods (if applicable): Night-time, Evenings and Weekends, and Daytime. The threshold values are shown in Table 3.

The total ambient noise level (including construction noise) is then compared with the threshold values to determine if a significant effect is likely.

A significant effect is deemed to occur if the total L_{Aeq} noise level, including construction noise, exceeds the threshold level for the Category appropriate to the ambient noise level.

Table 3: BS5228 Construction noise assessment (ABC Method) Ref BS5228

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

A) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
 B) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
 C) Category C: Threshold values to use when ambient noise levels rounded to the nearest 5 dB) are higher than category A values.
 D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

7 NOISE SENSITIVE RECEPTORS

The site is located to the north west of Greenore village. To the south of the site, there are a number of terraced houses on Euston Street. The co-ordinates of the three individual end-terrace properties which are considered to be the most sensitive to noise from the proposed project have been identified as the closest properties to the site:

Table 4: Receiver locations

| Receiver | Irish Grid Ref. Co-ordinates | |
|----------------|------------------------------|--------|
| | X | Y |
| H1 - Euston St | 722230 | 810864 |
| H2 - Euston St | 722263 | 810874 |
| H3 - Euston St | 722298 | 810888 |

8 ENVIRONMENTAL NOISE SURVEY

Noise levels were measured at the locations shown in Appendix A and Table 5: Noise Monitoring Locations, from 10 to 15 March 2017. The survey was undertaken using the following equipment:

- 01 dB DUO Sound Level Meter fitted with double skinned wind shield
- 01 dB CAL21 Acoustic Calibrator

Table 5: Noise Monitoring Locations

| Location (Irish Transverse Mercator Grid) | |
|---|----------------|
| Noise Monitoring Location 1 | 722318, 810875 |

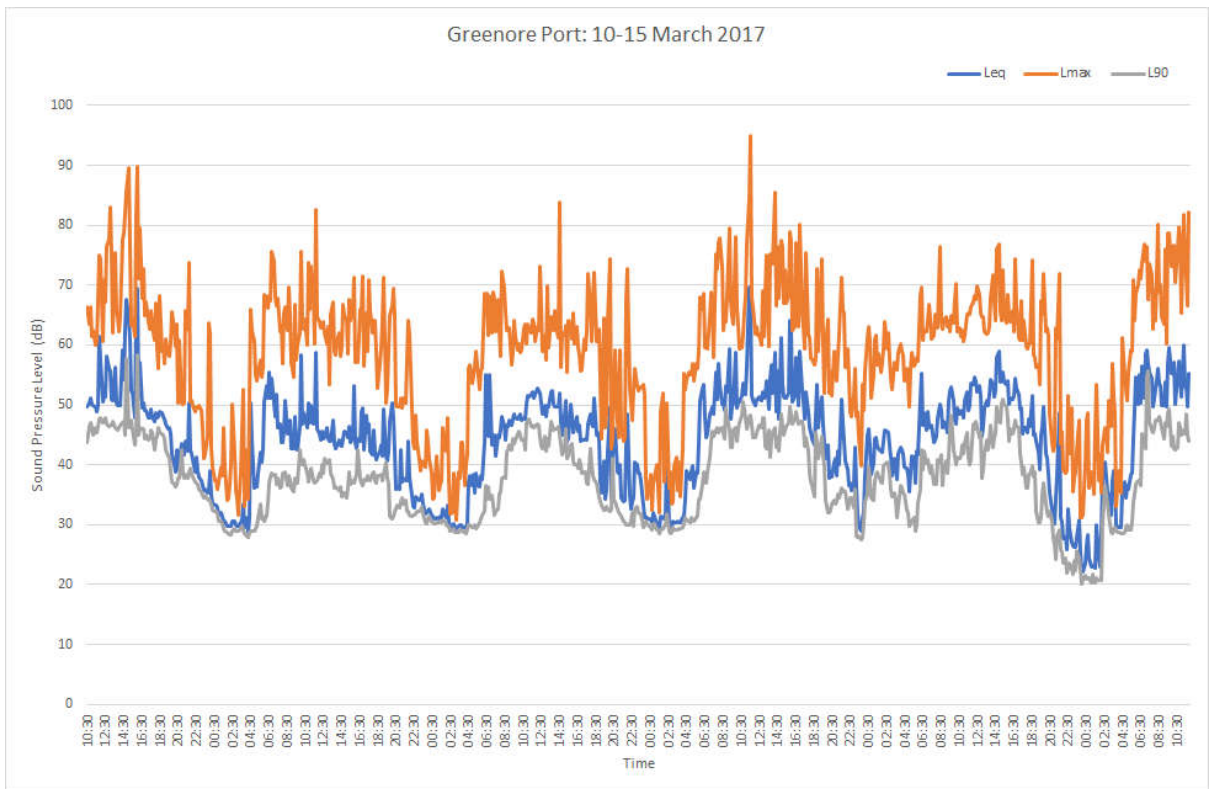
The noise monitoring location was selected to best represent dwellings in closest proximity to the site.

The acoustic parameters measured included L_{Aeq} , L_{A90} and L_{AFMax} . Instrumentation was checked calibrated before and after the survey period, presenting 94dB on all occasions.

8.1 Survey Results

Figure 16 presents the results of the noise measurements over the 6-day survey period. These background noise levels are commensurate with the existing locality (i.e. existing port with surrounding road network) which presents higher daytime noise levels than night.

Figure 16: Overall Noise Level

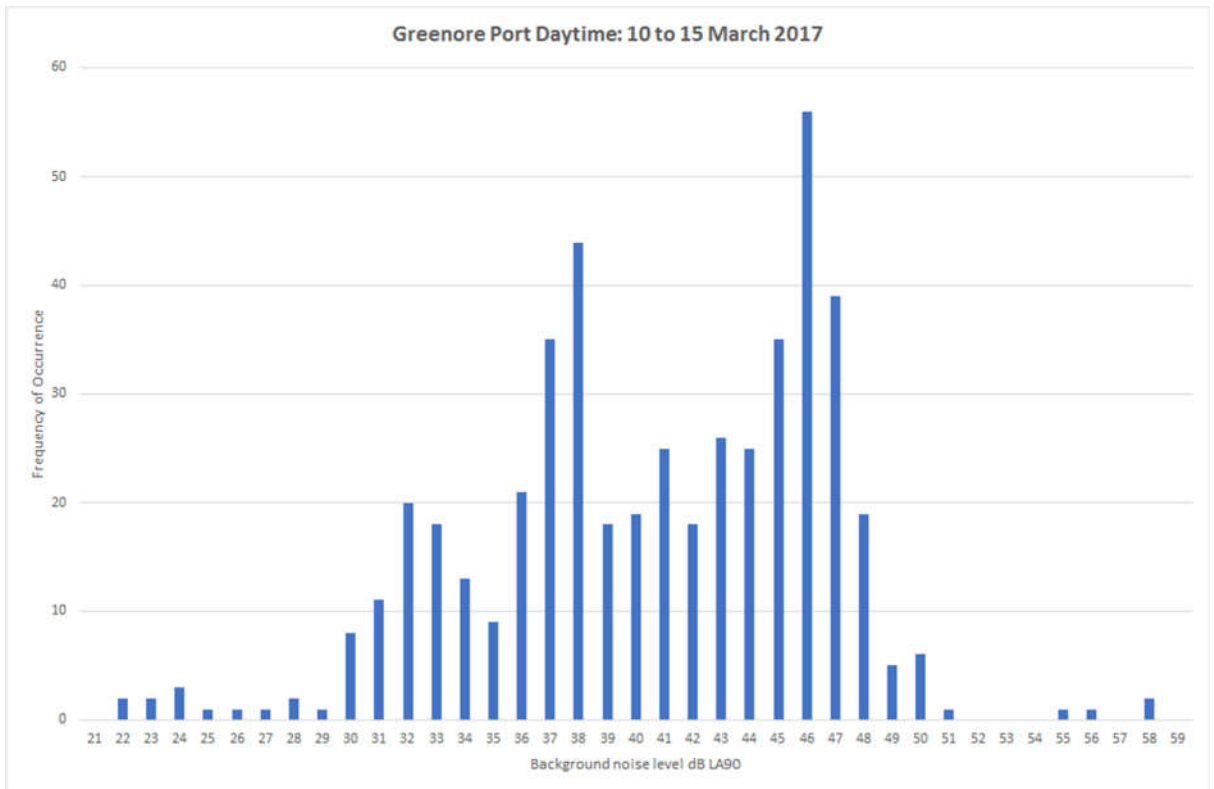


8.2 Background Sound Level

Background sound pressure levels were determined for the purposes of the BS5228 assessment of noise of a construction associated with the proposed site. The standard uses a typical background level ($L_{A90, \tau}$) in the absence of the specific sound under consideration.

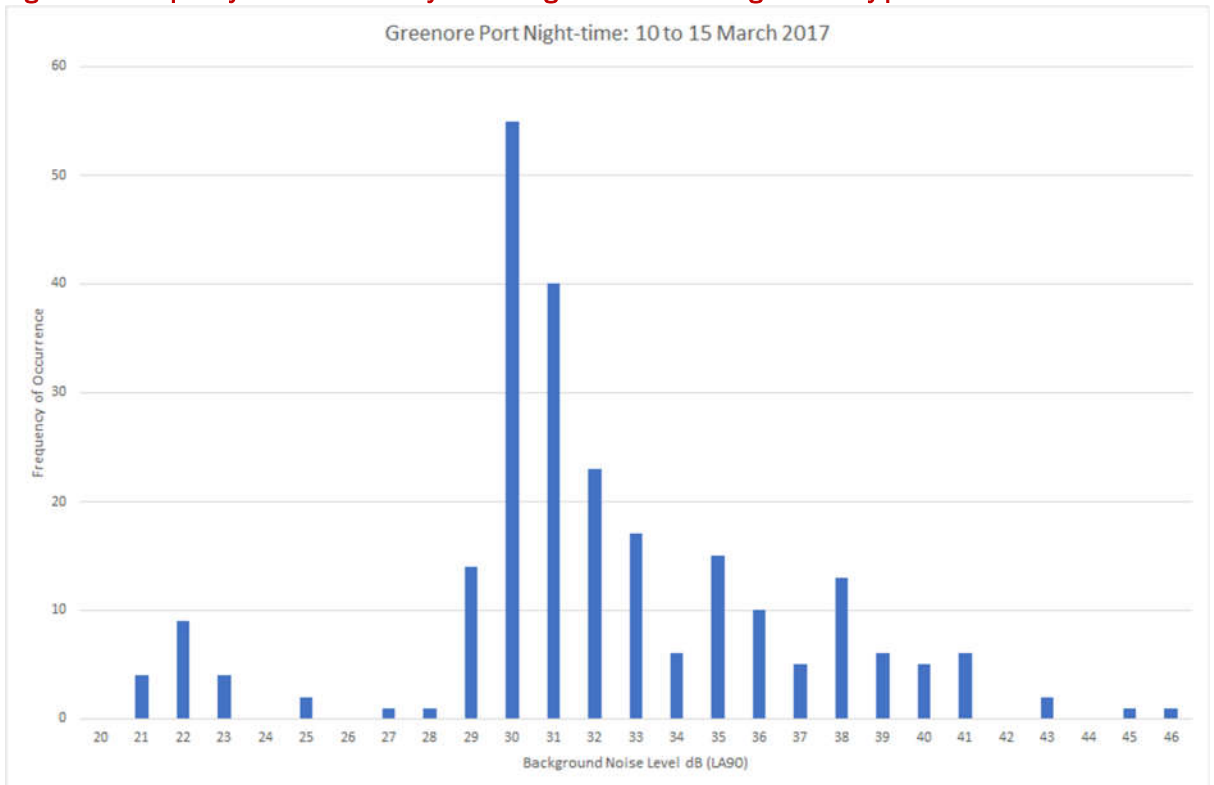
The results are shown below, where the measured background levels are shown as per the frequency of each occurrence. The results are presented for daytime and night-time in Figures 17 and 18.

Figure 17: Frequency distribution of daytime background levels during the survey period



The typical daytime background sound level was derived as **46 dB LA90, 15min** as it sits centrally within the frequency distribution.

Figure 18: Frequency distribution of daytime background levels during the survey period



The typical night-time background sound level was derived as **30 dB LA90, 15min** the mean noise level due to relatively even distribution across a range of noise levels.

9 ASSESSMENT

9.1 Construction Noise

For the purposes of the noise assessment, the noise emissions from the construction activities have been predicted using SoundPLAN acoustic modelling software.

The model was implemented in *SoundPLAN* version 8.0, which is produced by Braunstein & Berndt GmbH. The *SoundPLAN* implementation of ISO9613 has been tested in-house by *SoundPLAN* developers to ensure calculated results are within 0.2dB of the standard.

The model is integrated, allowing noise from all sources, with prediction methodologies to be undertaken simultaneously. The noise model takes into consideration the following parameters:

- Topographical effects
- Atmospheric absorption
- Ground absorption
- Screening effects
- Reflections
- Focusing effects
- Metrological conditions

The model predicts the propagation of noise for each octave-band and source-receiver pair and produces a noise level contour map. The noise level contours are colour coded for ease of interpretation.

9.1.1 MODEL INPUTS

In accordance with the Method Statement the equipment on the landside of the development will include:

- Floating barge
- Safety boat
- Barge crane
- Diving plant and equipment
- Piling and excavating plant
- Site based excavators and transport vehicles
- Stock piling of steel piles

The equipment will be operational in the following sequence:

- Driving of circular steel piles into rock through soft overburden.
- Driving of sheetpile infill sections.
- Demolition and removal of old concrete apron slab behind wall.
- Installation of concrete bearing piles under new apron.
- Infilling of void between old wall face and new wall.
- Construction of concrete capping beam on top of combi wall.
- Construction of new concrete apron slabs.
- Dredging of overburden and rock to form deeper berthing pocket.
- Installation of ancillary infrastructure and quay furniture.
- Upon completion of the works, the Contractor will demobilise and remove all temporary formwork and site fencing.

The noise levels from the piling will generate the highest noise levels. The most significant additional noise source while the piling is occurring is the movement of material around the harbour. Thus the worst case scenario is assessed as being the time when both the dumper truck and the piling are occurring within the same 1-hour period.

Table 6 summarises the sound power levels associated with the activities identified as having the greatest potential to generate noise. Noise levels are taken from BS 5228:1-2009+A1 2014.

The 'on-time' for each item of equipment shows the typical percentage of time during which the plant is operational, with reference to a 1-hour averaging period.

The noise level of the dumper is assumed to represent a HGV or other vehicles on the site at the same time as the piling.

Table 6: Measured equipment noise levels

| Item | BS5228 Table and Item No. | Un-weighted Octave band centre frequency, Hz | | | | | | | Overall SWL L _{Aeq, T} | 'On time' | Time-corrected SWL, L _{Aeq, T} |
|--------|---------------------------|--|-----|-----|-----|----|----|----|------------------------------------|-----------|---|
| | | 63 | 125 | 250 | 500 | 1k | 2k | 4k | | | |
| Piling | C3.3 | 87 | 93 | 85 | 87 | 83 | 80 | 75 | 111 | 100% | 111 |
| Dumper | C4.3 | 84 | 81 | 74 | 73 | 72 | 68 | 61 | 107 | 50 % | 104 |

9.2 Predicted Noise Levels

The predicted noise levels at the nearest sensitive receptor location are shown in Table 5 below. These results represent the specific noise level for the site for both the daytime and night-time periods.

Table 5: Predicted Noise Levels

| Receptor Location | Predicted noise level (dB L _{Aeq, 1hr}) |
|-------------------|---|
| H1 | 49.1 |
| H2 | 47.7 |
| H3 | 46.3 |

10 ASSESSMENT

10.1 Construction Noise Assessment

The predicted noise levels at the nearest noise sensitive receptors are provided above.

The majority of the construction of the proposed site will take place between 0700-19:00 from Monday to Friday and between 08:00-13:00 on Saturdays. No construction will take place on Sundays.

The appropriate limits are provided in Table 3 above, with the daytime limit for category A being 65dB.

The predicted level of 49.1dB can be rounded to 50dB, which is significantly lower than the daytime threshold level for Category A. Therefore, the noise from the site activity would not be deemed significant.

11 CONCLUSIONS

An underwater and onshore noise assessment was carried out for the proposed development at Greenore Port.

11.1 Underwater Noise

The rehabilitation of Berth No.2 at Greenore Port does not cause underwater noise levels in exceedance of TTS-limits for seals outside the berths, and thus is highly unlikely to cause acute damage to the local population of seals. Latest seal count, from 2011, indicate that the largest haul-out sites (75 % of seals) are east of, or outside the impacted water body (Wilson, O'Malley, Cassidy, & Clarke, 2011). Impact as a result of disruption of daily foraging trips are estimated to be limited.

For porpoises, the risk of acute injury is thought to be limited but present during the piling phase of construction. This is mitigated by the proposed method of a 30-minute observed absence of porpoises before piling start, and a ramped up start of noisy activities. The 200-metre exclusion zone should be extended to 500 metres for porpoises as indicated by exclusion zone in (Figure 14 p 20). During high tide the TTS-limit is exceeded to a range of 1,200 m northwards of the Port. We recommend that the effects of the tide be taken into account with respect to the pile driving.

The risk of acute injury associated with the dredging is assessed to be small with the exclusion zone extending out to ~600 meters from the port, and the proposed 200-metre zone should thus be expanded to match this range.

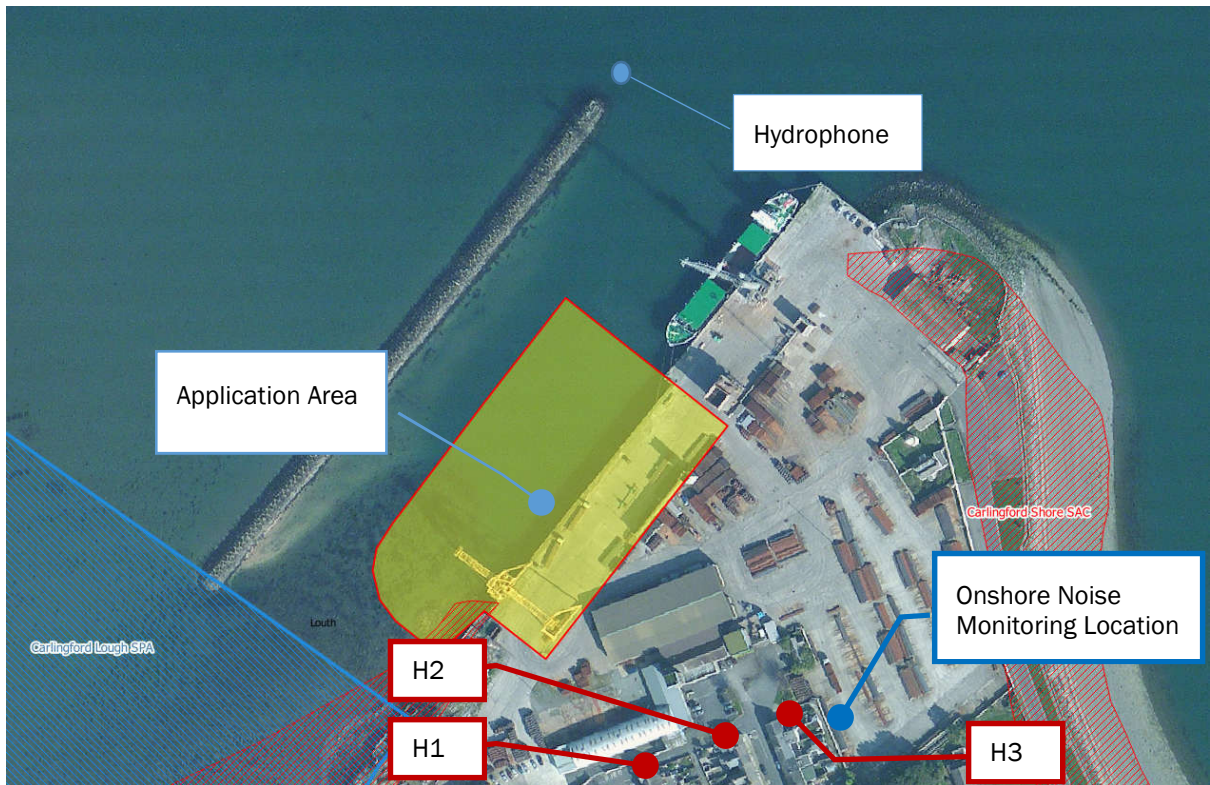
11.2 Onshore Noise

A BS5228 construction noise assessment was carried out in relation to the closest residential properties to the port and the outcome of the worst case assessment shows that the activities are predicted to be below the level of significance for construction sites.

12 References

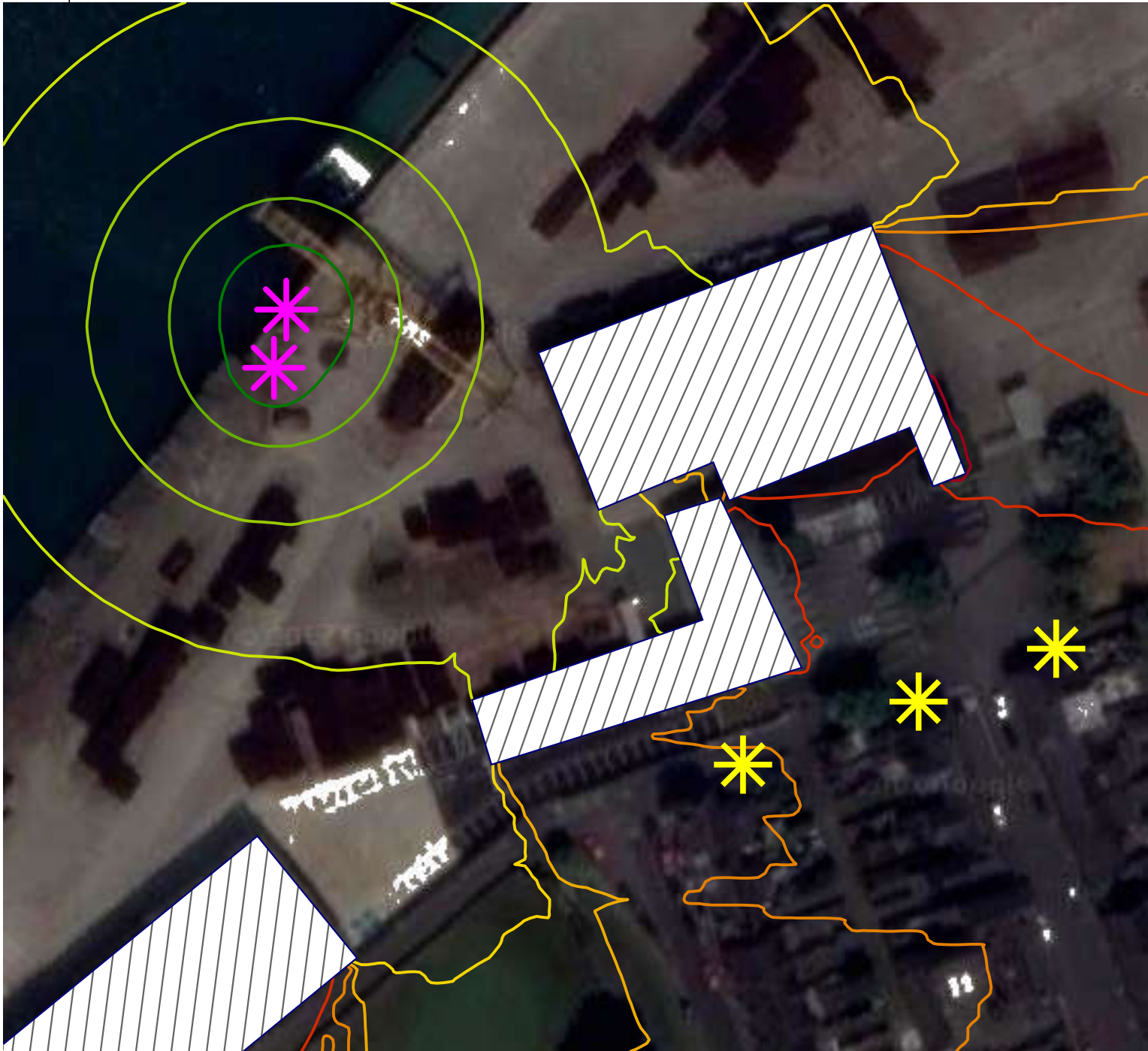
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APPENDIX A SITE LAYOUT



APPENDIX B NOISE MAP

322200



Customer:
 Greenore Port
 Project: Greenore Port
 Project-No. 2017068

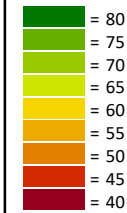
Map

1



During Construction
 Piling and Dumper operating at the same time

Levels Ld
 in dB(A)

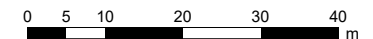


Signs and symbols

- Emission line
- Point receiver
- Noise calculation area
- Point source
- Main building
- Ground effects



Length scale 1:973



322200