



**HEGLEY ACOUSTIC
CONSULTANTS**

**Lyttelton Port of Christchurch
Coal Stockyard Expansion Project
Response to Further Information Request - Noise Matters**

PURPOSE

Lyttelton Port Company has applied for a suite of resource consents to expand the coal stockyard and the quarrying at Gollans Bay.

The purpose of this report is to answer the questions relating to the noise effects. These are questions 41 (effects of underwater noise) and 46 – 50 (noise effects from the hillside excavation) from Environment Canterbury and questions 13 – 17 from the Christchurch City Council. The report answers the questions in the order set out in those requests.

QUESTION 41

The reclamation and wharf construction activities will generate underwater noise. Please provide details of the expected levels of underwater noise that will be generated by the various activities, and assess the potential underwater acoustic effects on marine ecology, particularly the effects on Hector's dolphins

In order to assess the noise effects of the proposed construction activities it is necessary to determine the existing background noise levels and the noise from the proposed construction work. With this information it is then practical to determine the potential noise effects on marine ecology, including the potential effects on Hector's dolphins.

The existing underwater noise environment was measured on a calm day on an outgoing tide at 4m in a total water depth of 7m. Measurements were undertaken using a Brüel & Kjær 2250 Hand-held Analyser platform with Sound Level Meter Software BZ 7222, Frequency Analysis Software BZ 7223, Logging Software BZ 7224 and Sound Recording Software BZ 7226. This equipment has been factory

calibrated and the re-calibration is next due in February 2011. A Brüel & Kjær type 8104 hydrophone was used and the equipment was field calibrated before and after measurements using a Brüel & Kjær 4229 hydrophone calibrator. A Wav file was also recorded to allow additional analysis if required. There was no shipping activity in the immediate area during the measurements.

The measurements were undertaken in Te Awaparahi Bay at the position shown on Figure 1.



Figure 1. Noise Measurement Location

As shown on Figure 2 the noise level measured over a five minute period (although only part of the trace is included) varied between a low of 72dB re 1 μ Pa to a maximum of 110dB with L_{eq} being 98dB re 1 μ Pa. These are relatively low levels of noise and reflect the calm conditions with no shipping in the area other than general port activities some distance away at the time of the measurements.

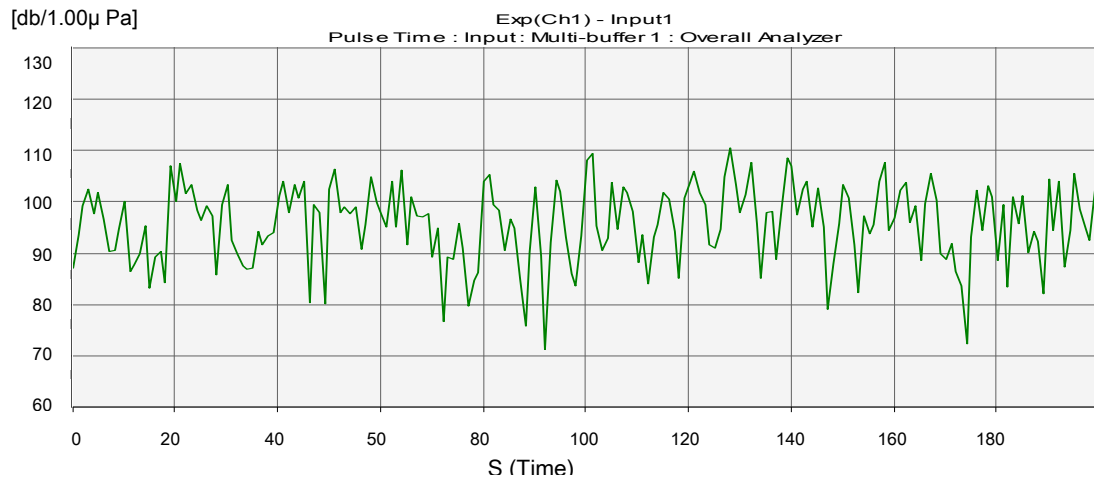


Figure 2. Existing Ambient Levels

Figure 3 shows a waterfall of the sound spectrum over the same measurement period as for Figure 2. The higher section of the sound spectrum around 250Hz is most likely some distant ship operating out of sight of the measurement location, possibly at the Port, but close enough to influence the measurements. The analysis shows the ambient sound in the area was relatively quiet on the day of the measurements. The analysis was not been taken beyond 4kHz as the proposed construction activities generate little noise above this frequency so the results would have been of little significance to the project.

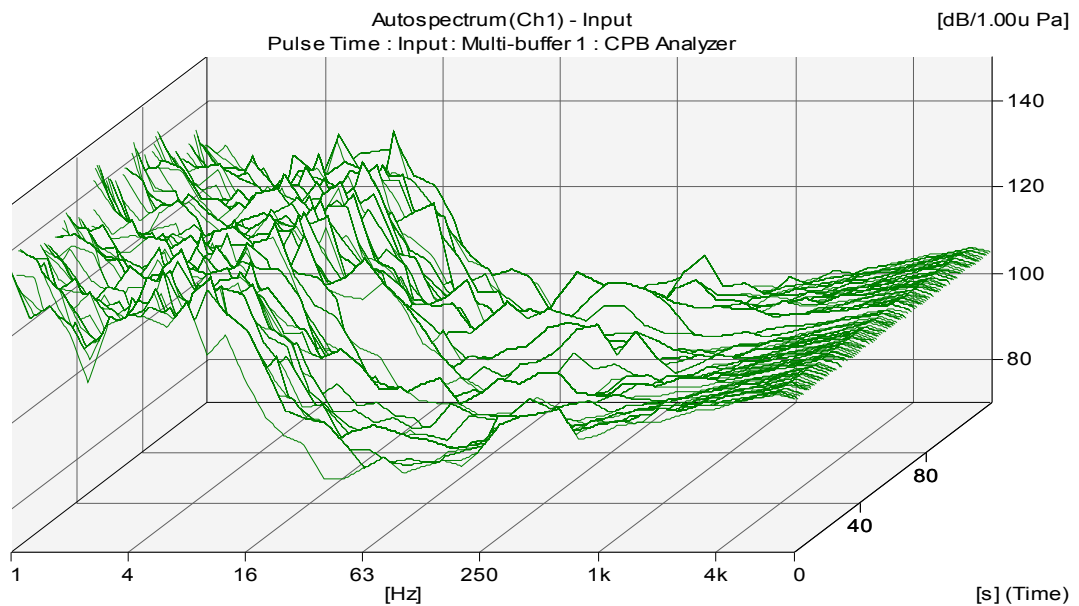


Figure 3. Ambient Sound Spectrum

Piling Noise

The activity that could potentially generate a significant levels of underwater noise is pile driving. Piles will need to be sunk in order to establish a small jetty off the western side of Sticking Point Breakwater. This would involve the placement of four piles in the seabed with the two large piles expected to be 1500mm in diameter and the two small piles 600mm in diameter. The piles would be between 45 - 55m in length. It is estimated that installing one 1500mm diameter pile would take 6 days and one 600mm diameter pile would take 2 days. The installation of all four piles should take about 4 weeks.

The piles are anticipated to be driven in by a crane mounted pile driver. As the steel piles are driven through any seawall rubble and the underlying deposits, the encapsulated material from within the steel casing will be excavated by grabbing, pumping, baling or rotary drilling equipment. A “plug” of material would be retained at the foot of the casing at all times.

The sound spectrum for underwater piling of 1.5m (the same as proposed for the two larger piles at the Lyttelton site), 1.6m and 3.5m diameter piles is shown on Figure 4¹

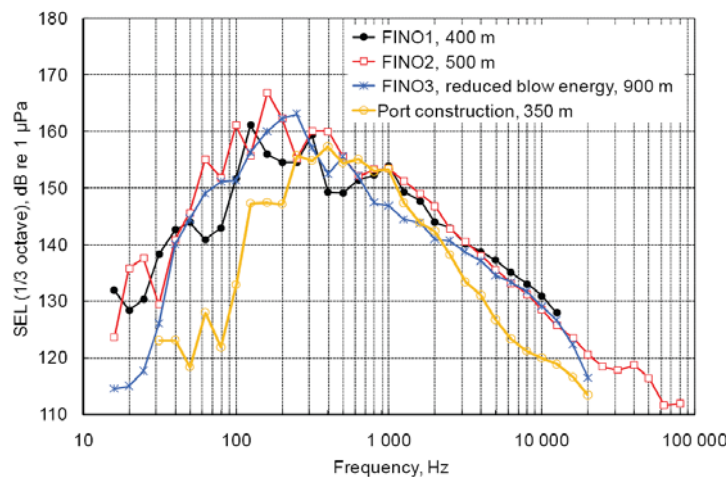


Figure 4. Acoustic spectra of pile driving blows for various measurement distances and pile diameters (FINO1:1.6m, FINO2:3.5m, FINO3:4.7m blow energy reduced to 30% of required value during measurement, Port construction:1.5m). All spectra are averages of 10 to 30 blows.

¹ Measurement of Construction Noise During Pile Driving of Offshore Research Platforms and Wind Farms, Rainer Matuschek, Klaus Betke

Figure 5¹ shows a typical time function of a pile driving blow as measured over a 0.6 second period.

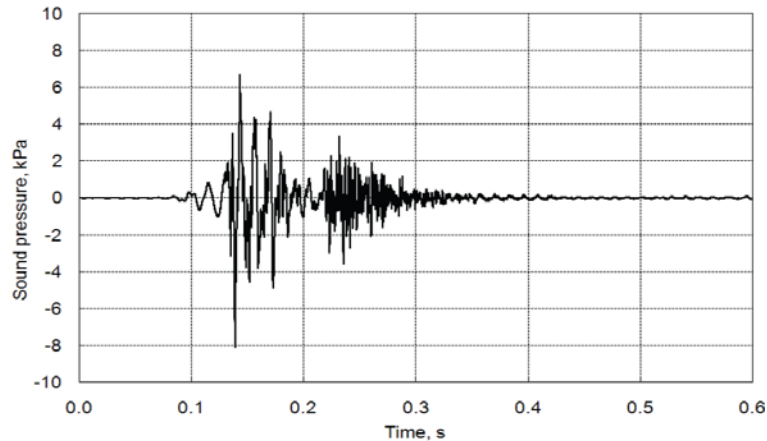


Figure 5. Underwater noise impulse caused by an impact pile driver.
Distance = 700m, pile diameter = 4m, blow energy 850kJ

Figure 6² shows the reduction of piling noise with distance. The piles used during this test were 500mm and 900mm diameter and for the proposed 1.5m diameter piles a similar result can be expected.

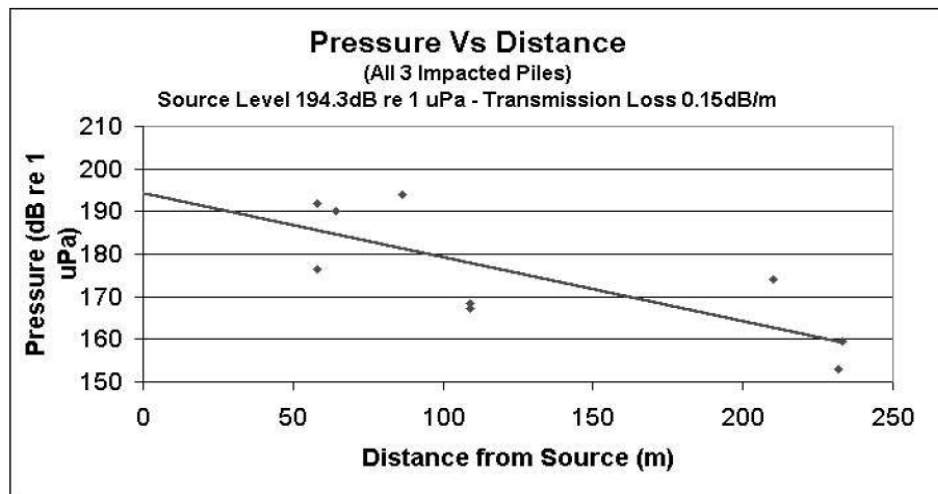


Figure 6. Variation of peak-to-peak pressure with distance for impact driving

² Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish. Subacoustech Ltd 2003

Figure 7 shows the noise from piles of various diameters. The noise from the piles will increase as the radiating surface increases. Further, as the diameter increases a larger pile driver is used so there is more energy involved and hence more noise generated from the pile driving.

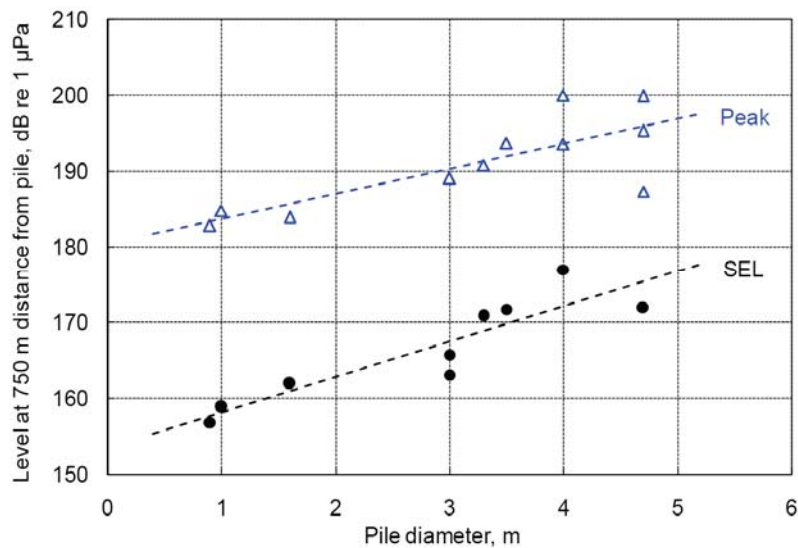


Figure 7. Measured Noise Level vs Pile Diameter

Assuming the noise levels as set out on Figure 7, which are approximately 20dB above the levels on Figure 6 so the value adopted is conservative (at the upper level likely to be experienced), the noise level at 1m will be 236dB peak re 1µPa. This is approximately twice as loud as the echolocation click of the White-beaked dolphin. The predicted level at 200m from the piling will be 190dB peak or 165dB SEL. These levels will reduce to 182dB peak and 157dB SEL at 500m and 176dB peak and 151dB SEL at 1000m.

To assist in understanding the existing noise environment that is experienced in the sea, the following sets out some natural sounds generated by marine life and from shipping activities.

Table 1. Natural Underwater Sounds

Source	Broadband Source Level (dB re 1μPa at 1m)
Sperm Whale Clicks	163 - 223
Beluga Whale Echolocation Click	206 - 225 (peak-to-peak)
White-beaked Dolphin Echolocation Clicks	194 - 219 (peak-to-peak)
Spinner Dolphin Pulse Bursts	108 - 115
Bottlenose Dolphin Whistles	125 - 173
Fin Whale Moans	155 - 186
Blue Whale Moans	155 - 188
Gray Whale Moans	142 - 185
Bowhead Whale Tonals, Moans and Song	128 - 189
Humpback Whale Song	144 - 174
Humpback Whale Fluke and Flipper Slap	183 - 192
Right Whale	172 - 175
Southern Right Whale Pulsive Call	172 - 187
Snapping Shrimp	183 - 189 (peak-to-peak)

Table 2³. Summary of sound frequencies produced by shipping traffic and their source levels.

Type of vessel	Frequency (kHz)	Source level dB re 1μPa	Reference
Rigid inflatable (rescue craft)	6.3	152	Malme et al. 1989
7m outboard motor boat	0.63	156	Malme et al. 1989
Fishing boat	0.25-1.0	151	Greene 1985
Fishing trawler	0.1	158	Malme et al. 1989
Tug pulling empty barge	0.037 1.0 5.0	166 164 145	Buck & Chalfant 1972; Miles et al. 1989
Tug pulling loaded barge	1.0 5.0	170 161	Miles et al. 1989
34m (twin diesel engine) workboat	0.63	159	Malme et al. 1989
Tanker (135m)	0.43	169	Buck & Chalfant 1972
Tanker (179m)	0.06	180	Ross 1976
Super tanker (266m)	0.008	187	Thielele and Odengaard 1983
Container ship (219m)	0.033	181	Buck & Chalfant 1972
Container ship (274m)	0.008	181	Ross 1975
Freighter (135m)	0.041	172	Thielele & Odengaard 1983

³ Simmonds et al, 2003, Table 3.2, p. 25

The effects of the noise are partly dependent of the frequency of the pile driving and the ability of sea mammals to hear the sound. Figure 8 shows that the noise from pile driving is typically broad band, which means there is a relatively flat sound spectrum up to about 4kHz before dropping off.

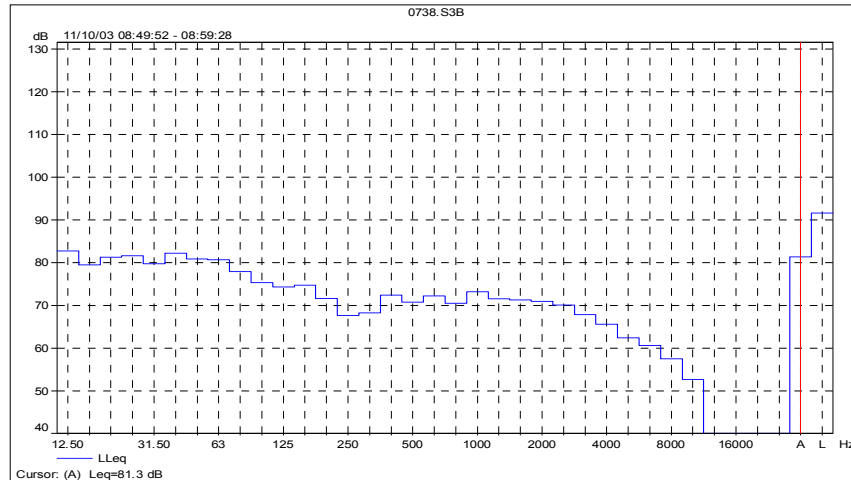


Figure 8. Piling Noise at 20m re 20 μ Pa

Figure 9 shows the audiograms⁴ of three dolphin and whale (odontocete) species found in coastal waters off northern Europe. The audiogram of the Harbour Porpoise has been taken as a provisional representative for a Hector's dolphin as both dolphin species are similar in their physiology and sound repertoire. It is noted the Hector's dolphin is unique from other dolphins in that it produces very few sounds and those that are produced are basically clicks that are short in duration and very high-frequency around 120kHz, which is well above the noise produced by piling. The Hector's dolphin does not whistle like Bottlenose dolphins to communicate but instead changes the rate of clicking.

It can be seen that all audiograms exhibit the characteristic U-shaped form with relatively high thresholds at and below 1kHz and areas of best hearing in the

⁴ Effects of offshore wind farm noise on marine mammals and fish Frank Thomsen, Karin Lüdemann, Rudolf Kafemann and Werner Piper July 06, 2006

ultrasonic range (>20kHz). That is, the hearing ability of these mammals is relatively poor below about 1kHz. In simple terms, at 1kHz the hearing threshold of these underwater mammals is 80dB and 100dB at 500Hz. Piling noise at these frequencies will be about 150dB re 1 μ Pa at 200m. That is, the noise at these frequencies is about 50 – 70dB above the threshold of hearing for these mammals so will intrude into their environment, in a similar way as a 179m tanker approximately 75m away.

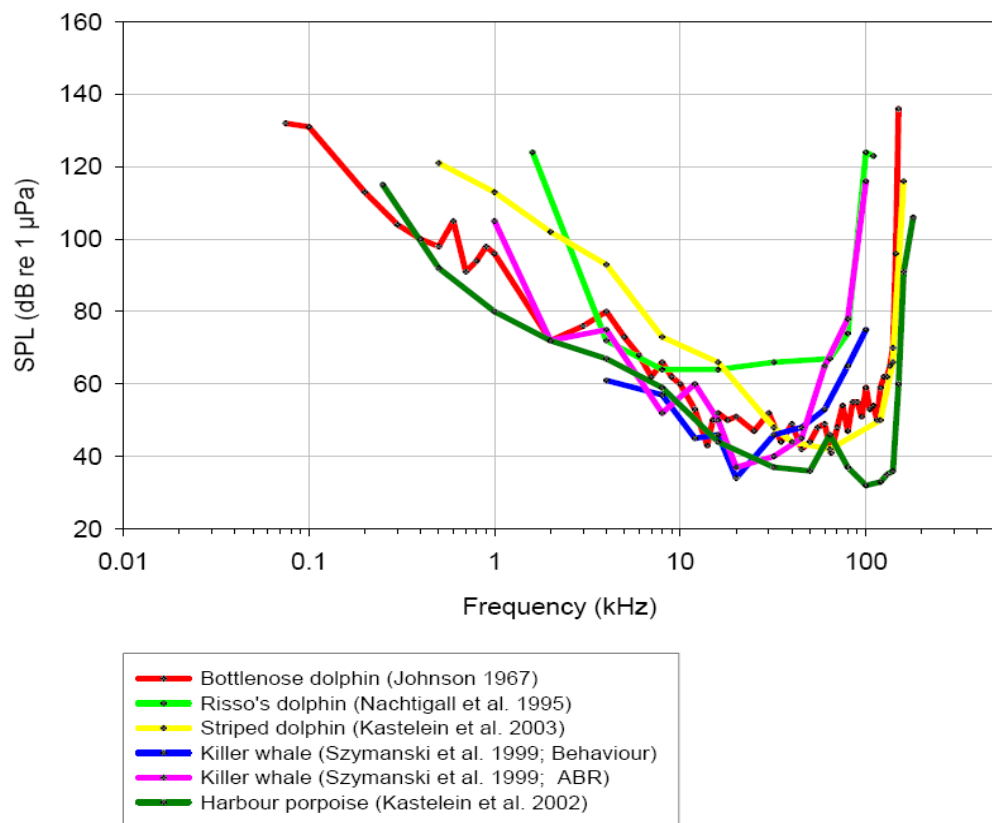


Figure 9. Exemplary Audiograms of Odontocete Species

Further research undertaken by the US Navy Marine Mammal Program and the Point Defiance Zoo and Aquarium jointly worked on testing the hearing of two white whales (Beluga) beginning in 2001. The goal was to train two white whales (Beluga) so that a behavioural audiogram could be taken on each subject. Being able to obtain such audiograms is a first step in understanding the hearing of these marine mammals.

Figure 10 shows reported hearing thresholds of Bottlenose dolphins and white whales (Beluga)⁵.

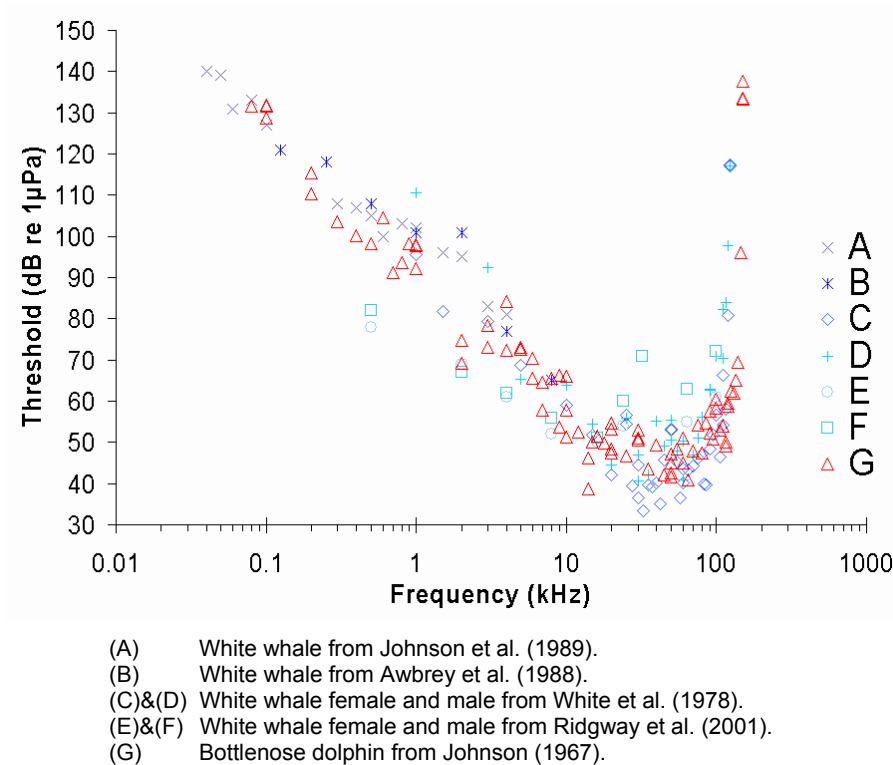


Figure 10 Hearing Thresholds for Bottlenose Dolphins and White Whales

It has been reported⁶ that marine mammals tend to be adapted for living in noisy underwater environments, and typically have hearing thresholds that are much less sensitive than those adapted for the atmospheric environment, such as humans. For this reason, marine species are able to tolerate much higher levels of noise.

The frequencies used by porpoise (and assumed to be similar for the Hector's dolphin) are:

⁵ Testing the Hearing of Whales and Dolphins, Information by Wesley R Elsberry and Diane Blackwood 2003.

⁶ Assessment of Tidal Current Turbine Noise at the Lynmouth site and predicted impact of underwater noise at Strangford Lough. Report No. 628 R 0102 by Mr S J Parvin, Mr R Workman, Mr P Bourke and Dr J R Nedwell 10th May 2005.

- Low frequency sounds at 1.4 – 2.5kHz for communication
- Sonar-clicks (echolocation) at 110 – 140kHz
- Low-energy sounds at 30 – 60kHz
- Broadband signals at 13 – 100kHz

As set out above, the Hector's dolphin produces very few sounds and those that are produced are basically clicks, short in duration with a frequency of around 120kHz.

As shown in Figures 10 and 11 the hearing of dolphins and whales (odontocetes) is best between about 10 – 100kHz with them being able to hear to relatively low frequencies, providing the noise level generated is relatively high. As an example, for the sound to appear as loud for the dolphin at 1kHz as at 10kHz it would need to be approximately 40dB louder at 1kHz than 10kHz. As piling noise is toward the lower end of the hearing threshold for dolphins and at the lower end of their vocalisation range the effects will be less than had the sound been above 10kHz.

The frequency range used by baleen whales is relatively wide and although various ranges are given baleen whales generally vocalise in the lower frequencies, between 10 and 4000Hz. There is currently no evidence that baleen whales have the ability to echolocate. To date, no psychoacoustical or electrophysiological work on baleen whale hearing has been completed, although most anthropogenic sounds that have elicited reactions were at frequencies less than 1kHz.

This information results in the noise as heard by the baleen whales being similar to that being heard by the Harbour Porpoise and the Hector's dolphin.

Figure 11⁷ shows the relationship between noise level and exposure times to induce temporary threshold shift (TTS) to the hearing of dolphins. From this information it would be necessary for a dolphin to remain within 5 – 10m of the piling for at least 30 minutes for there to be any potential TTS. This is an unlikely scenario given it is understood that there is a lack of evidence that the proposed reclamation area

⁷ Sonar-induced temporary hearing loss in dolphins. T Aran Mooney, Paul E Nachtigall and Stephanie Vlachos.

serves as important, unique and/or rare habitat for any marine mammal species in terms of feeding, resting and/or breeding activities⁸. In other words it is unlikely any of the sea mammals would remain in close proximity to a high noise environment.

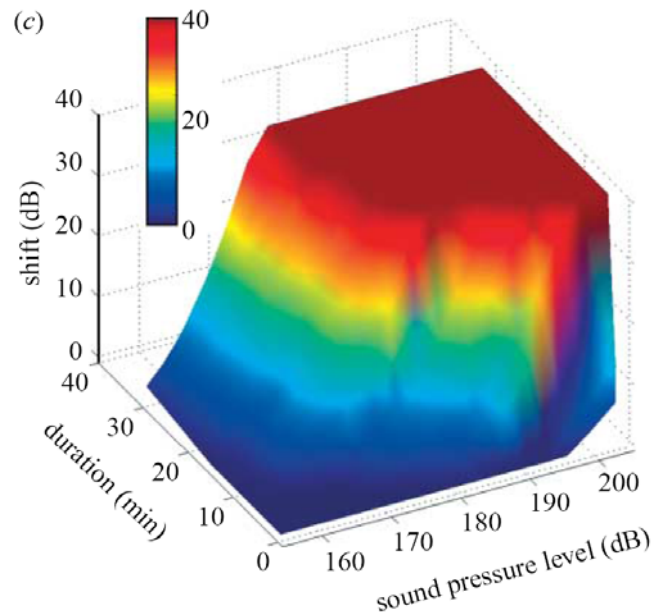


Figure 11. Surface plot of measured and predicted dolphin TTS for sonar and noise exposures of varying exposure SPLs

In addition to the above the effects of noise on fish have been considered. The principles of hearing in fish differ from those of marine mammals and while many fish species hear in the range of about 30 Hz to 1 kHz (with best hearing generally from 100 - 400 Hz), some investigations have demonstrated species-specific hearing capabilities in the infrasonic range of less than 20 Hz (Karlsen 1992; Knudsen et al. 1997; Sand et al. 2000).

The majority of research on the hearing of fish has been undertaken in the northern hemisphere and this information has been adopted in the following analysis. As an example, in the entire North Sea region, 224 fish species have been described (Yang 1982) and four of these species, whose hearing capabilities are well

⁸ Cawthron Institute: Lyttelton Port of Christchurch Coal Stockyard Expansion Project: Response to Question 40 of the Further Information Request – Marine Ecological Matters

investigated have been selected as representative of different levels of auditory capabilities⁹. Figure 12 shows the audiogram of these four species (dab, Atlantic salmon, Atlantic cod and Atlantic herring).

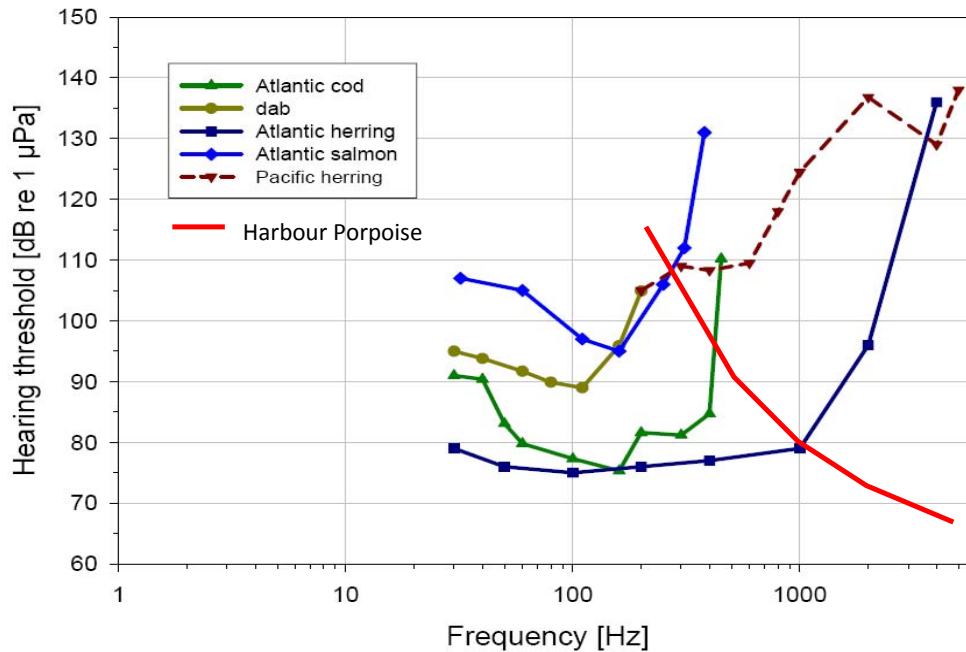


Figure 12. Audiograms of Atlantic Salmon, Atlantic Cod, Atlantic Herring and Pacific Herring and Harbour Porpoise.

It is noted that the audiogram for the Harbour Porpoise has been added to Figure 12 from Figure 9 to provide an indication of the relative hearing ability of the difference species.

As Atlantic salmon has the most sensitive hearing this audiogram has been adopted in the following assessment of the predicted noise effects on fishes to provide a conservative evaluation.

⁹ Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). Effects of offshore wind farm noise on marine mammals and fish, biola, Hamburg, Germany on behalf of COWRIE Ltd.

As set out above, the predicted level at 200m from the proposed piling will be typically 190dB peak or 165dB SEL reducing to 182dB peak and 157dB SEL at 500m and 176dB peak and 151dB SEL at 1000m. At these levels the level will be well above the threshold of hearing for the fish. As an example, when considering that the predicted piling noise will peak around 300 – 400Hz this frequency will be approximately 75dB re 1 μ Pa above the threshold of hearing for the more sensitive fish at 500m increasing to typically 90dB when at 100m from the piling. This is considered to be loud for the fish although when taking into account many sounds they already experience (see Table 2) the noise is not unreasonable, particularly as piling noise will only be intermittent over approximately 16 days.

The effects of an average sound exposure level (SEL) of 178dB and mean peak sound level of 207dB re 1 μ Pa from Seismic air guns on three species of fish (northern pike, broad whitefish, and lake chub) has been measured¹⁰. This study concluded that with exposure to up to 20 air gun shots that these three species of fish were not likely to be substantially impacted by a hearing loss and only the northern pike and lake chub experienced any temporary threshold shift (TTS) to their hearing, which recovered within 24 hours. There was no TTS in the broad white fish exposure to the air gun array used. The report pointed out that care must be taken in extrapolation to other species and to fishes exposed to air guns in deeper water or where the animals are exposed to a larger number of air gun shots over a longer period of time.

A further study showed that after 4 hours of sound exposure to a level of 140dB re 1 μ Pa in the 300Hz – 1000Hz range the TTS in goldfish lasted 2 - 4 hours with complete recovery afterwards.

When taking into account the much lower noise levels at this site than for the fish exposed to the air gun noise and the findings for an expected exposure period for goldfish, it is unlikely there would be any temporary hearing loss for fish in this area and no permanent hearing loss from the proposed piling.

¹⁰ Effects of exposure to seismic airgun use on hearing of three fish species, Popper et al 2005. J. Acoust. Soc. Am., Vol. 117, No. 6, June 2005

The effect on the behaviour of fish as a result of noise has been reviewed. The report on the effects of piling noise (Nedwell et al. 2003c) was from observing brown trout in cages positioned at different distances from vibro and impact pile-driving operations in Southampton harbour. Startle-reactions and fish activity level were investigated prior and during piling and the observations revealed no evidence that trout reacted to impact piling at 400m, nor to vibropiling at less than 50m with a source level of impact pile-driving of 194 dB peak to peak re 1 μ Pa. It is noted that this study was not considered exhaustive so is subject to changes. However, it does indicate there is unlikely to be any adverse behaviour effects from piling unless fish are very close (\approx 30m) to the piling.

In summary, assuming there are both mammals and fish present, there is not expected to be any more than some temporary alteration to the behavior of sea mammals and to a lesser extent fish, in the vicinity of the proposed piling. No other aspects of the proposed construction works are, from an underwater noise perspective, expected to have any adverse effects on sea mammals or fish in the area.

QUESTION 46

The proposed excavation of the hillside will generate noise in the vicinity of Lyttelton. Please confirm the proposed duration and hours of operation for the hillside excavation phase.

The proposed construction duration is approximately two construction seasons although this is weather dependent; if there is a significant amount of poor weather the duration could be extended. Any blasting would be undertaken during daylight hours although the loading of excavated material and transporting it for deposition in the reclamation paddock could occur on a 24 hour / seven day week basis. The hours of work will be controlled by the requirements of the Construction Standard NZS6803:1999.

QUESTION 47

Please provide a full plant equipment inventory required for the hillside excavation and assumed sound power levels for the equipment.

As the contract to undertake the work has not yet been selected the equipment can only be estimated and this has been done on the basis of the noisiest likely equipment to be used on site. Regardless, the selected contractor will be required to comply with the relevant noise criteria. As set out in Hegley Acoustic Consultants Report No 8479 (Appendix 19 of the AEE), the equipment assumed in the analysis was:

345C Excavator –118dBA SWL
 W600 Loader – 120dBA SWL
 D375 Dozer – 118dBA SWL
 Dump Truck – 116dBA SWL

QUESTION 48

Please assess the potential noise levels from the hillside excavation in relation to the L_{Amax} limits for long-term duration works as identified in the New Zealand Standard NZS 6803:1999 Acoustics – Construction Noise.

At the closest residential site in Lyttelton = 43dB

At the closest residential site in Diamond Harbour = 41dB

QUESTION 49

It is stated in the application that construction activity will occur over a 24 hour period (excluding blasting activities). Please assess noise effects on local residents due to associated heavy vehicle movements on the external road network during the night time period.

Based on vehicle movements as provided by the traffic engineer the one hour L_{eq} noise level has been calculated for the existing conditions and assuming up to 3 construction related trucks per hour throughout the night (taken as between 10:00pm – 7:00am the following day), which is the noisiest likely scenario. The results at the closest house to the road, and assuming a 180° clear view of the road, which is an over prediction, the results are:

Time	Existing Level dB 1 hour L_{Aeq}	Increase in Level dB 1 hour L_{Aeq}
00:00 – 1:00	51	2
1:00 – 2:00	50	3
2:00 – 3:00	51	2
3:00 – 4:00	50	3
4:00 – 5:00	50	3
5:00 – 6:00	55	0
6:00 – 7:00	61	0
22:00 – 23:00	56	0
23:00 – 00:00	53	1

Table 3. Predicted Traffic Noise, 1 hour dB L_{Aeq}

From Table 3 it can be seen that there is currently significant traffic noise for the residents and when including the possible construction road traffic at night time there will be up to a 3dB increase (1 hour L_{Aeq}) in the existing noise level during the construction period. A 3dBA increase is generally considered to be reasonable in terms of the effects of noise. Based on the existing noise levels and the requirements of *NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads* the resulting noise level when assuming the maximum likely number of trucks operating, will remain within a reasonable limit. Based on generally accepted traffic noise criteria the traffic noise would not cause sleep disturbance so the effects of the proposed construction traffic will be no more than minor.

QUESTION 50

Blasting is proposed during daylight hours to excavate the hill. Please provide further information on the proposed hillside blasting methods including a blast noise monitoring plan and details of proposed best practice blasting methods. Please include details of the time(s) of the day and days of the week that blasting will occur, the predicted number of blasts per day or week, and the expected duration of the blasting.

As noted by Ashby Consults Ltd (refer **Annexure B**), the charges will be initiated in a delay sequence to minimise vibration and noise and to minimise any damage to the surrounding rock mass. Although total flexibility is necessary with a blasting programme to take into account delays that can be caused due to weather, delays

due to equipment operation and other work schedules, the proposal is to blast from approximately 9am to 3pm. Once a work pattern has been established blasting times would be set for the same time of the day. The number of blasts a week will be dependent on the amount of material available after each blast and the rate of progress in moving the material, which is in part weather dependent. However, it is expected that on average there would be approximately 1 - 2 blasts a week although for some periods it could be a daily occurrence. Blasting would continue for the duration of the hillside excavation which is expected to be over 1 - 2 construction seasons. A recommended blast monitoring condition is included in the answer to Question 17.

CHRISTCHURCH CITY COUNCIL QUESTIONS

QUESTION 13

It is noted that estimates related to the use of explosives indicate ready compliance (at the nearest Lyttelton dwelling) with the specific criterion of 115 dB (Lin peak) for airblast overpressure; i.e. predicted levels of:

- 85 dB (Lin peak) Gollans Bay Quarry (s. 5.3 of Hegley Acoustic Consultant's report)
- 95 dB (Lin peak) Te Awaparahi Bay (s. 5.1 of Hegley Acoustic Consultant's report).

However, it is considered that there should be an estimate and assessment of the blast noise with respect to the L_{max} (dBA) criterion of the New Zealand Standard for Construction Noise. Please provide such an assessment.

The Banks Peninsula Proposed District Plan sets the noise limit for blasting at a peak non-frequency weighted (linear or flat) level of 115dB. Furthermore, Section 8.1.4 of NZS 6803:1999 Acoustics – Construction Noise requires blast noise to be evaluated based on peak levels. The very short duration of blast noise means the L_{max} value can be unreliable in both actual level and its correlation with community response and it is for that reason the L_{max} value is not normally used. Further, there is no daytime L_{max} in the District Plan. However, based on field measurements of blast noise it is predicted the L_{max} would be a minimum of 20 – 30dB below the peak level to give the dBA level.

QUESTION 14

Please provide information regarding the times and duration of blasting at the Gollans Bay quarry. Specifically, please advise:

- *The time(s) of day and days of the week that blasting will occur (for example, weekdays only?)*
- *The number of blasts per day or per week, and for how long this level of activity is expected to continue.*

The reclamation is expected to be constructed over a period of 2 - 3 years depending on whether the reclamation is staged. Again, it is expected that on average there would be approximately 1 - 2 blasts each week at the quarry during construction of the reclamation although for some periods it could be a daily occurrence. Blasting would occur between the hours of 9am and 3pm.

Unless another major project is initiated by LPC, blasting would only occur on occasions to supply rock needed for maintenance of seawalls and other minor works, or perhaps to supply entities requiring heritage stone for the city.

QUESTION 16

Submitters on the proposal raised concerns relating to what they termed the "amphitheatre effect". They considered that the noise from the operation of the Gollans Bay quarry could be reflected and reverberated off the back wall of the quarry, thus increasing the noise effects for residents on the southern side of Lyttelton Harbour. Please advise if the effects of reflected noise have been considered in the Hegley Acoustic Consultants noise report or, if not please provide an assessment of this effect.

Report No 8479 concluded that the noise levels in the rural area across the harbour will be typically 28dBA L₁₀, which is well within the Proposed District Plan limit of 40dBA L₁₀ during the night time. The concerns of the submitters with respect to what they have termed to be the amphitheatre effects were taken into account in the noise predictions.

QUESTION 17

Comment for the applicant's information: if it is found to be necessary or appropriate to undertake monitoring with respect to the Banks Peninsula

District Plan rules, it should be noted that measurement of peak particle velocity and airblast overpressure is a relatively specialised function. It is therefore considered appropriate to signal that the conditions of any consent granted may include provisions for the recovery of expenses related to this. The applicant may wish to provide comment regarding this at an early stage. For example, it may be that the applicant would be willing to also undertake some 'self-monitoring' and provide the results to the consenting authority.

This work is normally undertaken by the operator conducting the blasting as part of their work and could be provided to Council on request. To verify that blast noise complies with the District Plan the following conditions are recommended:

- 1 *Blasting shall not exceed a peak particle velocity of 5 mm/sec, provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin peak) at any time.*

Airblast overpressure from blasting on any land shall not exceed a peak non-frequency weighted (linear or flat) level of 115dB provided that this level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level shall not exceed 120dB (Lin Peak) at any time.

- 2 *Blast monitoring shall be conducted to verify that blasting at Te Awaparahi Bay and at Gollans Bay Quarry complies with the limits described in Condition 1 above:*
 - (a) *The first five blasts at the Gollan Bay Quarry and the first five blasts at Te Awaparahi Bay shall be measured by a person experienced in measuring vibration and over pressure noise within 1m of the façade of a residential dwelling in Lyttelton. The results are to be provided to the Christchurch City Council's Regulatory Services Manager within one week of undertaking the measurements.*
 - (b) *At any other time requested by the Christchurch City Council's Regulatory Services Manager, at least three blast measurements shall be conducted by a person experienced in measuring blasting at a location to be determined by the Council. The results are to be*

provided to the Christchurch City Council's Regulatory Services Manager within one week of undertaking the measurements.

- (c) *In the event of any non-compliance the Consent Holder shall advise the Christchurch City Council's Regulatory Services Manager and the Community Liaison Group within 24 hours, or the next weekday, of the steps they will implement to achieve compliance and the time they expect to take to resolve the matter. Additional measurements shall be undertaken once the activity has been modified and the blast measured and reported as set out above.*



Nevil Hegley
July 2010