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PROJECT: **Assessment of Noise Effects from Project Next Generation – Dredging and Operation**

REPORT NO.: **2009248A r04**

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EXECUTIVE SUMMARY

An assessment has been carried out of the effects of the proposal to deepen the shipping channel in Otago Harbour. Ambient noise surveys have been undertaken at representative locations and the noise environment has been found to be typical of a rural coastal environment. During calm periods the environment is quiet, with low noise levels. During periods with high winds the environment can be noisy, with levels of 50 dBA or more.

An examination of the relevant District and Regional Plan rules indicates that there are no specific noise limits that would apply to the dredging and other construction activities, although the Regional Plan notes that regard should be had to the Construction Noise Standard and Marshall Day has used this as the basis of assessment. The operational aspects of the wharf extension are covered by the Noise Mitigation Plan for Port Chalmers.

Noise levels have been predicted for the TSHD dredging activity. Worst case noise emission and sound propagation have been assumed. Dredging would be a 24 hour activity with similar noise levels at night as during the day. The predicted noise levels indicate that during the daytime significant noise effects are not expected, and compliance with the Construction Noise Standard should be achieved. At night, noise levels could be at times above the 45 dBA limit of the Construction Noise Standard. However, even with worst case assumptions, this is likely to be only at a limited number of locations and for a few periods at night and only for a limited number of nights (14 – 30) over many months of the project.

Mitigation measures that would be used include programming of night-time activity away from residential areas, reduction of dredge noise as far as practicable, taking advantage of weather conditions that either raise the background noise, or reduce sound propagation in particular directions, and reducing internal noise levels in bedrooms where possible (e.g. by enabling windows to be closed without reducing necessary ventilation). An active consultation programme would be undertaken to inform people of the extent and duration of the dredging activities as it might affect them.

Overall it is considered that noise effects from dredging are likely to be minor. The predicted noise levels, while above 45 dBA at times, are unlikely to exceed 50 dBA. The times when noise would exceed 45 dBA would be limited to a few periods during the night, and at any particular location would occur for a limited number of nights. The nature of the noise would be similar to existing noise sources such as shipping and is therefore, less likely to be disturbing.

Operational noise from the wharf extension has been predicted for two scenarios. For the scenario in which the new 6000 TEU class vessel uses the Container Terminal wharf there would be no discernable change in noise effects compared to the current situation and no adjustments would be required to the programme of house insulation that is currently in progress. For the scenario where the new vessel is berthed and worked at the multi-purpose berth there is a small, probably insignificant reduction in noise at Port Chalmers, but a noticeable increase in noise in Careys Bay. This would require up to 12 houses in Harbour Terrace to be included in the sound insulation programme, with 2-3 of these being in the 60-65 dBA zone which could involve significant upgrading of the dwellings.

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1.0 INTRODUCTION

Port Otago is proposing to deepen the channel between Port Chalmers and Taiaroa Head to accommodate larger container vessels. A full description of the project is contained in other documents prepared for the project. It would take many months to complete the work necessary over the entire 12 kilometre stretch of the lower harbour channel and would involve continuous operation over that time. The channel is close to several settlements along the Peninsula and the effects of noise from the dredge would be apparent particularly at night when the dredge is working in an area close to houses.

Marshall Day Acoustics has undertaken an assessment of the effects of noise from this proposed project. The basic methodology involved measurement of the existing noise environment, prediction of noise levels form the dredging operation and use of the wharf extension, comparison of these levels with the relevant regional and district rules, and a discussion of methods of mitigating any adverse effects of noise.

2.0 EXISTING NOISE ENVIRONMENT

The noise effects from the project would be experienced along the sides of the channel and in areas around the swinging basin.

The channel is mainly located to the northern side of the harbour and passes close to small communities at Careys Bay, Deborah Bay, Waipuna Bay and as it goes out the heads is close to the Harington Point community. In addition, there are a number of isolated dwellings at points along each side of the channel.

These settlements are well away from major roads or commercial activity and consequently the noise environment is mostly dominated by natural noise, wind, sea, insects, birds and other animals, with at times contribution from human activity such as cars, farming activity and shipping using the harbour. It is best described as a quiet coastal environment, with many residents undoubtedly valuing the low noise levels as an important feature of their local amenity.

To quantify the existing noise environment two noise monitors were set up at representative points along the Peninsula. The locations are shown in fig. 1 below.

126 Aramoana Rd (Deborah Bay)

30 Pakihau Rd (Harington Point)

Fig. 1 Noise monitor locations for ambient measurements

As an example of the data recorded the noise level at 30 Pakihau Road at Harington Point is shown in fig 2 below over a period of 13 days. The dark blue line shows the average noise level (L_{eq}) in consecutive 15-minute periods, the dotted red line shows the L_{95} (or "mean minimum") in each period, and the green line is the maximum noise level in each period.

It can be seen that the noise fluctuates over a wide range; the $L_{eq\ (15min)}$ varies from 25 dBA to 60 dBA. The quietest times are at night, where noise levels can go below 30 dBA on calm nights (e.g. around midnight on the night of 24/25 May). But at times the noise levels can be above 50 dBA for long periods (for instance from midnight on 22 May through to 6pm on 23 May, and from mid day on 30 May to mid day on 31 May) which is due to the noise from wind and waves. Noise levels are generally between 40 – 50 dBA during the day, but can at times be up to 60 dBA.

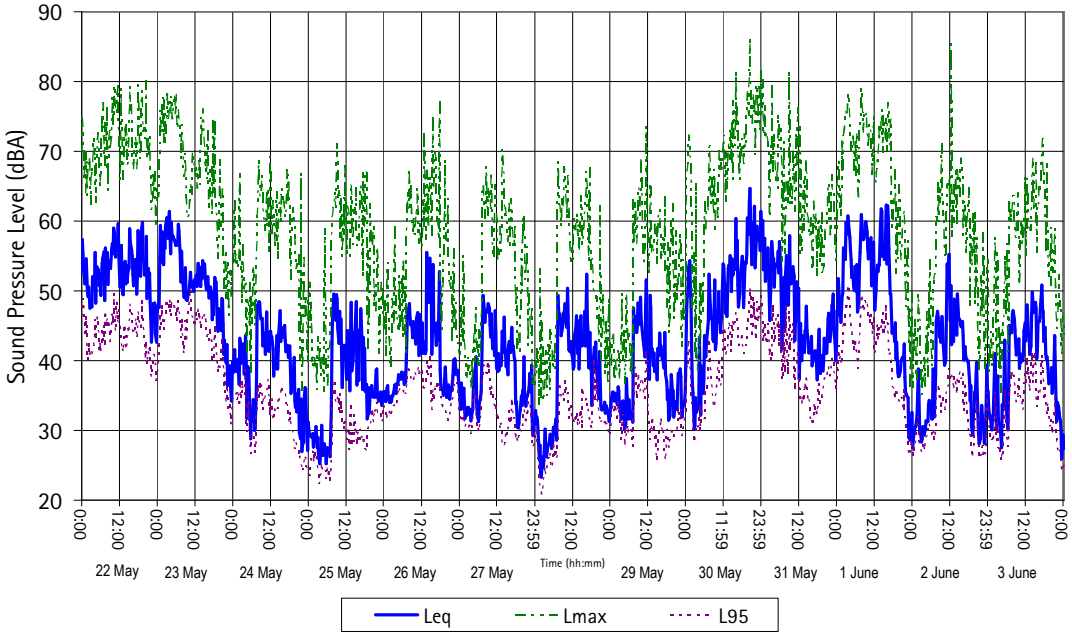


Fig.2 Ambient Noise measurements at 30 Pakihau Rd (22 May-3 June)

The ambient noise levels are higher in Port Chalmers and in Careys Bay due to port activity and a larger number of dwellings (which each generate some noise from domestic activity and car traffic). Data from previous noise surveys carried out for the Port were used to assess these environments. Although these measurements were undertaken several years ago it is considered that the noise environment would not have changed significantly and these data still represent the current noise environment. The measurements are summarised in fig 3 which shows the monthly average L_{dn} at each measurement location. It can be seen that the majority of locations in both Port Chalmers and Careys Bay are exposed to average levels of about 55 dBA L_{dn}, with a few quieter spots (L_{dn}dBA) and some noisier locations (up to L_{dn} 69 BA) which are exposed either to port noise or to railway noise.

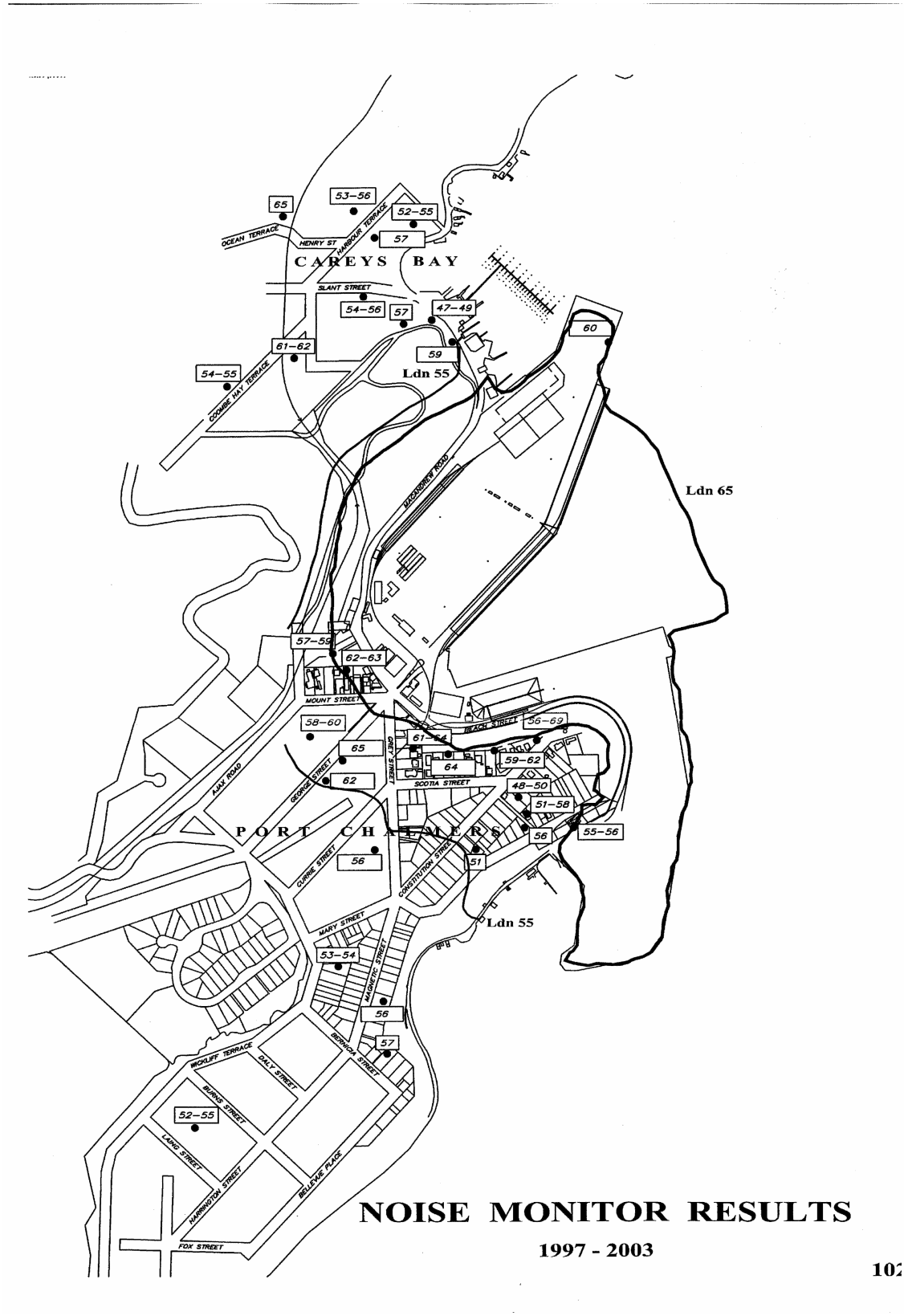


Fig 3 Ambient noise levels in Port Chalmers and Careys Bay

Careys Bay is mostly shielded from port noise except for higher street numbers in Harbour Terrace and some sites higher up the hill. Noise sources are a mixture of

natural sources such as wind, insects and birds, and low levels of traffic noise and other typical suburban sources, with the major noise source being trains (for instance Coombe Hay Tce and Ocean Terrace locations). Re-analysis of the data showed that for a typical location such 26 Coombe Hay Tce in Careys Bay which had an L_{dn} 54 -55 dBA, the average daytime ambient level was between 43–52 dBA and the average night time level was between 40 to 55 dBA Leq although at times the ambient levels could be above 50 dBA for more than a day during bad weather, similar to what was observed at the other positions further up the harbour.

Table 2.1: Summary of Ambient noise measurements

Location	L_{eq} Day (mean and range) dBA	L_{eq} Night (mean and range) dBA
30 Pakihau Road (Harington Point)	50 (57-44)	50 (57-30)
128 Aramoana Road (Deborah Bay)	54 (53-54)	42 (43-40)
26 Coombe Hay Tce (Careys Bay)	49 (52-43)	49 (55-40)

The results summarised in table 2.1 above show the ambient noise environment on both sides of the harbour is typical of a rural coastal area. At times when the weather is calm the ambient noise level can be as low as 25 dBA particularly at night. But when the weather is more unsettled the noise levels can be 50 dBA or higher right through the day and night.

3.0 PREDICTED NOISE LEVELS

3.1 Construction Activities

The main activities that would produce noise are the operation of the large Trailing Suction Hopper Dredge (TSHD), the small TSHD (the existing dredge the New Era) and the Backhoe Dredge which is required to remove more difficult material such as blasted rock.

3.1.1 Dredging

The primary noise sources on a dredge are the diesel motors that provide propulsion to the dredge. In addition there would be secondary noise sources such as generators, pumps and gearboxes. The current dredge (the New Era which is the small TSHD) has been measured in operation and found to have a sound power level of 110 dBA. From information supplied by Van Oord, and Jan de Nul (and cross-checked with information in Marshall Day Acoustics' data base and data from the Melbourne Channel deepening project), the likely noise emission of the large TSHD is between 105 – 112 dBA (Sound Power level) and the Backhoe Dredge could be 110 - 118 dBA (Sound Power level). For the purposes of this report the large TSHD has conservatively been assumed to have a sound power level of 112 dBA

When heard from a distance the noise from a dredge would be perceived as a relatively steady noise, although atmospheric propagation effects would cause some gradual fluctuation of noise, depending on wind and temperature gradients and the noise would vary slowly as the dredge moved past the receiver. The character of the noise would be similar to shipping which uses the channel.

The large TSHD would operate in the channel, moving back and forth along an area until full (approximately 80 minutes) and then motoring along the channel, out the heads to the disposal areas and back. The return journey would take from 90 to 130 minutes depending on the location of the dredged area. The dredging of the whole 12 km stretch of the channel would take many months.

The small TSHD New Era is used for maintenance and incremental improvement work. A typical cycle for New Era or a similar small TSHD would be up to 90 minutes to fill the hopper and between 20 minutes and 2 hours to motor to and from the disposal ground depending on whether dredging was being undertaken at the entrance or in the Port Chalmers swinging basin.

The Backhoe dredge is used to remove harder material such as rock, which is present off Acheron Head, and Rocky Point. There is potential also for the Backhoe dredge to be used on the sand material on the eastern side of the Port Chalmers swinging basin as this material can not be dredged with the large TSHD. The total times at each location would be limited to a few days or weeks, with a total of six to seven weeks for the whole contract.

For reasons explained in other documents, both dredges would generally operate for 24 hours per day, 6.5 days per week.

Large TSHD Dredge

Once the sound power level of the noise source and its location has been established then the noise level at different surrounding points can be calculated using well established calculation methods. These methods account for the reduction in sound pressure as the sound spreads out from the source, the excess absorption of sound due to air and ground, and any barrier effects. In this situation predicting noise propagation is straight forward, as there is no ground absorption (sea water is acoustically hard) and by and large the closest houses would have a clear line-of-sight and therefore there would usually be no barrier attenuation.

However because the dredge is always moving, the noise level at any point would not be continuous at one particular value. Typically, the dredge would dredge in a straight line for two to three kilometres, at a speed of two to three knots, then motor to the spoil disposal area outside the heads at about 10 knots. A simple indicative calculation has been carried out for a dredge moving along the path shown in Fig. 4, the noise level is calculated for a worst case position of a receiver in Hamilton Bay indicated by a small blue triangle (This is 323 Aramoana Road). This receiver is approximately 400 metres from the dredge at its closest point of approach. The noise level at the receiver position is shown in fig. 5 as a function of time, the dredge

dredging for 80 minutes and then travelling out past the Heads before returning to the start point. The noise level is averaged into a 15 minute assessment period.

In this case the whole cycle would take about 3¼ hours (200 minutes). The noise level at the receiving location would be up to 50 dBA at times as the dredge moves past the closest approach point, and then would reduce to low levels when the dredge travels out to the disposal areas. The noise levels are averaged over 15 minute periods, but because of the relatively slow movement of the dredge instantaneous levels are not expected to be significantly higher. Within a 3¼ hour dredging cycle the noise level would be inaudible for well over half the time, and would be above 45 dBA for less than 40% of the time. The dredging cycle has been repeated over a 24 hour period and superimposed on a plot of the existing ambient noise level at Deborah Bay for a "quiet" day (fig 6).

It can be seen that there are likely to be two to three dredging cycles over the night time period. There would be significant quiet periods between dredging activity. During windy periods the dredging noise could be masked by the ambient noise level for the whole 24 hour period.

Fig.4 Illustration of noise model for dredging off Acheron and Pulling Points

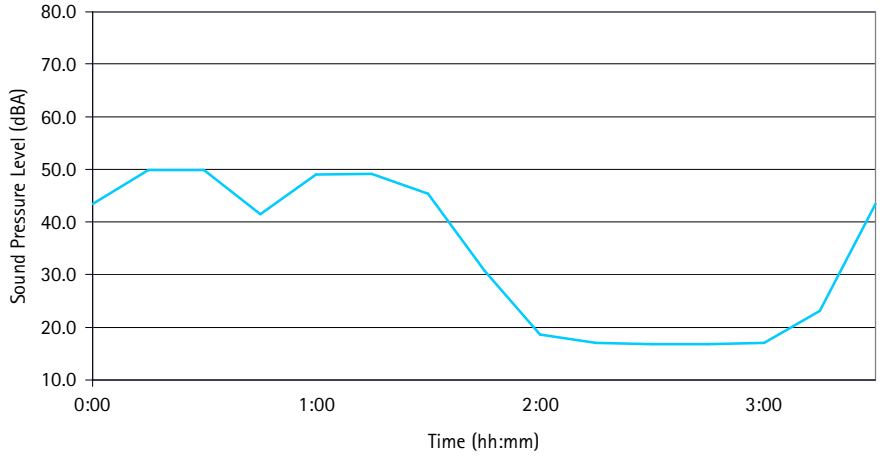


Fig. 5 Predicted variation of sound level with time at Hamilton Bay for one dredging cycle

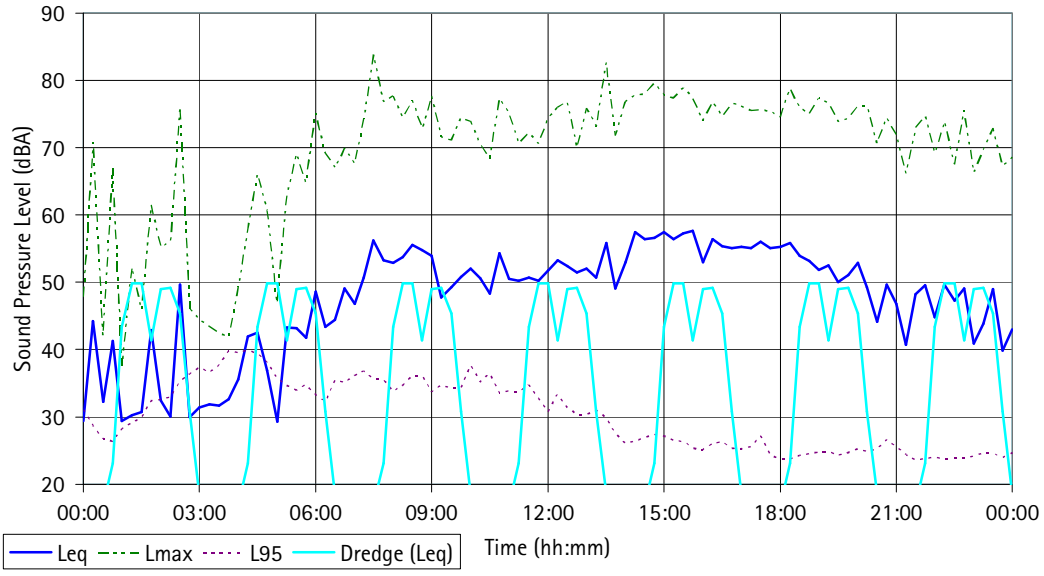


Fig 6 Noise level of large TSHD super-imposed on measured ambient of a "Quiet" day

Note that these calculations are made for perfectly still weather conditions with a slight temperature inversion (typical of a clear night). These provide optimum propagation conditions and so the noise levels shown are reasonable worst case conditions. When there is a wind blowing from receiver to source, or on a calm sunny day when there is a normal temperature lapse (air temperature decreasing with height), the noise levels can be considerably lower than the above predictions.

Fig.7 Illustration of noise model for dredging off Harington Point

Similar calculations were carried out for dredging off Harington Point (see fig 7 above). In this case the residences are a little further away (600 metres) and thus the noise levels are a little less, but the time taken to motor out to the disposal areas and back is much less and so there are more cycles per day with less space between them. In this case the highest noise level ($L_{eq,\ 15min}$) was calculated to be 46 dBA at for instance 901 Harington Point Road.

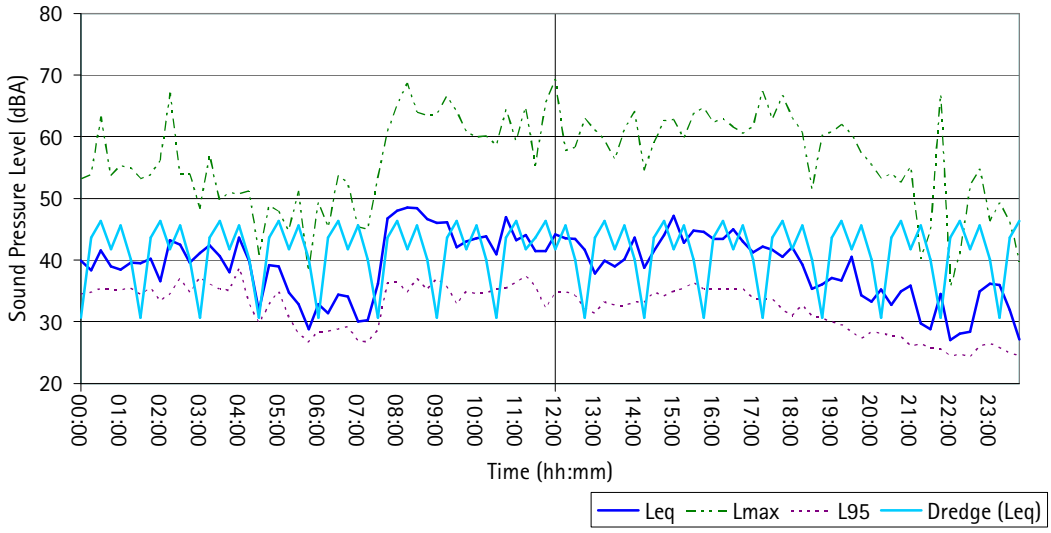


Fig 8 Noise level of large TSHD super-imposed on measured ambient of a "Quiet" day

A table of estimated noise levels at various distances from the dredge is given below. This assumes ideal propagation conditions with a clear line-of-sight to the dredge.

Table 3.1: Estimated Noise Levels versus Distance for different Dredge Sound Power Levels

Predicted Sound Level (L_{eq},15min dBA)	Dredge Sound Power Level		
	L_w 110 dBA	L_w 112 dBA	L_w 118 dBA
	Distance (metres)		
45	590 metres	750 metres	1500 metres
50	330 metres	420 metres	840 metres
55	190 metres	240 metres	480 metres
60	100 metres	200 metres	250 metres

Circles have been drawn around the closest dwellings along each side of the harbour to show the areas inside which a dredge with a sound power level of 112 dBA would exceed 45 dBA at that dwelling. These circles which are of 750 metres radius are shown in fig 9 and provided the dredge kept outside those circles then it could dredge at any time and not exceed 45 dBA $L_{eq\ 15\ minutes}$ at any dwelling. Similar circles are shown in fig 10 (of 590 metre radius) representing the 45 dBA limit for a sound power level of 110 dBA.

It can be seen that in fig 9 the circles overlap most of the channel and leave only a short section of the channel able to be dredged without exceeding 45 dBA at some dwelling.

In fig 10 a reduction in noise emission from the dredge to 110 dBA sound power level allows a much greater area of the channel to be dredged without exceeding 45 dBA and further calculations indicate that if it were possible to achieve a sound power level of 107 dBA then most of the channel could be dredged without exceeding 45 dBA at any residence. As noted before it has been assumed that a large TSHD would have a sound power level of 112 dBA and the small TSHD a sound power level of 110 dBA (the New Era).

Fig. 9 Zones inside which a dredge of 112 dBA L_w would exceed 45 dBA at dwelling (750 metre radius from dwelling)

Fig. 10 Zones inside which a dredge of 110 dBA L_w would exceed 45 dBA at a dwelling (590 metre radius from dwelling)

To show what the highest noise exposure (Leq) could be, noise boundary lines have been prepared by the simple procedure of moving a source of 112 dBA sound power level along the channel and noting the maximum noise levels reached at each point. The lines have been labelled as noise boundaries, as they represent the boundary, outside which the maximum noise level would be less than the marked level. Lines have been drawn at 45, 50, and 55 dBA.

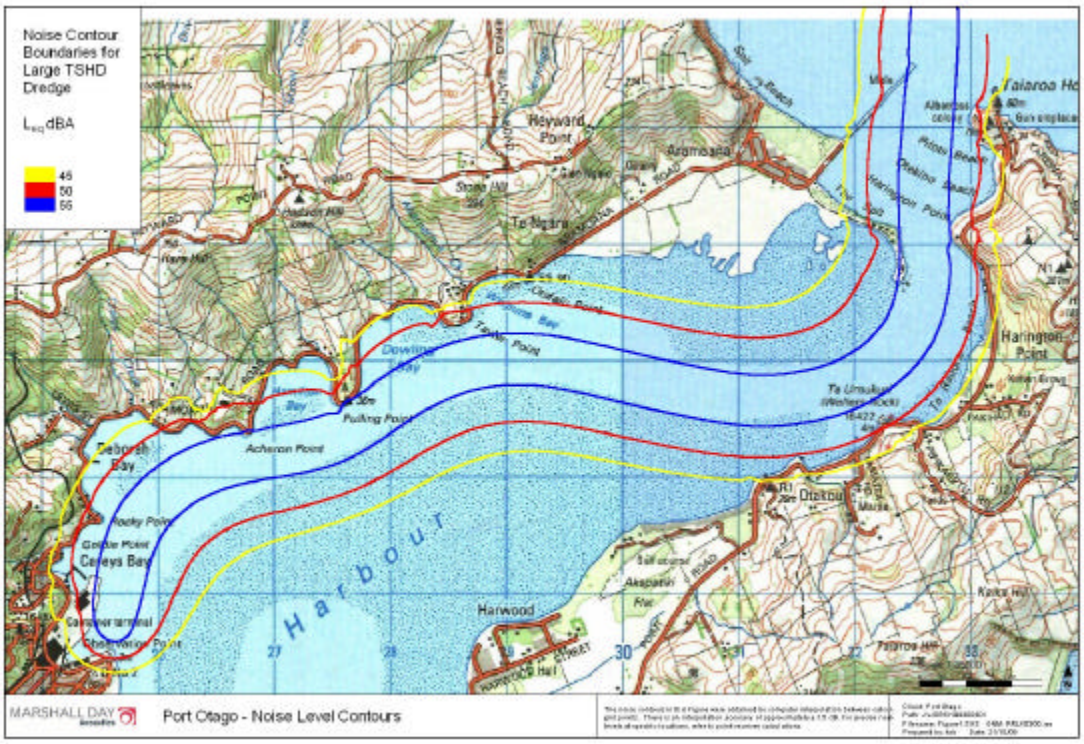


Fig. 11 Noise Boundaries for large TSHD operating along the channel

Note these lines are not noise contours in the normal sense in that the noise would not be at 45 dBA simultaneously all along the green line. Rather the yellow line represents points at which 45 dBA may be reached at some time during the course of the dredging. As an example it is estimated that the properties at Harington Point/Otakou which are shown as being between the 45 and 50 dBA noise boundaries, would be exposed up to these noise levels only intermittently over about 14 nights.

Furthermore, as noted before, these are based on worst case sound propagation conditions. Wind direction would have a significant effect on sound propagation. The predominant wind directions are north-east and south-west. With a wind from the north-east quarter, the actual measured levels could be 5 – 10 dBA lower on the northern side of the channel (Waipuna, Dowling, Hamilton and Deborah Bays), alternatively with a wind from the south-west noise levels would be less at Otakou and Harrington Point settlements.

If the large TSHD dredge could be quietened to have a sound power level of less than 107 dBA then operation along the channel would not give rise to a noise level exceeding 45 dBA $L_{eq,15min}$ at any dwelling adjacent to the channel (apart from the "Pilot Houses" located on the Spit). There are three houses on the Spit known as the "Pilot Houses". These were formerly owned by Port Otago or its predecessors but are now privately owned. It is not known whether any of these are permanently occupied. They are approximately 300 metres from the centreline of the channel and so are significantly closer than any other houses in the harbour. Noise levels may be up to 3 dBA higher than at the other worst case locations (such as the closest house in

Hamilton Bay at 323 Aramoana Road) and so noise levels could be up to 55 dBA $L_{eq,15min}$ during dredging operations.

Backhoe Dredge and Blasting

The Backhoe dredge is used to remove harder material such as rock, which is present off Acheron Head and Rocky Point and for sand removal in the Port Chalmers Swinging Basin. It is more stationary than the TSHD, working in an area for hours at a time. Because it does not move appreciably the noise is more constant and easier to predict. Referring to table 3.1 above shows that for the worst case Backhoe dredge of 118 dBA sound power level, houses within a1500 metre radius would experience noise levels of 45 dBA or greater under enhanced sound propagation conditions. These propagation conditions would include a moderate wind from dredge to Careys Bay, or a still clear evening. For operation in the areas requiring the Backhoe dredge this 1500 metre radius would include large parts of Careys Bay, Deborah Bay and Bluff Hill in Port Chalmers. If a quieter Backhoe (of say 112 dBA sound power level) could be obtained then there would be some areas that the dredge could be used that would not expose any houses to noise levels above 45 dBA. These can be seen in fig. 10 as areas outside the circles.

There would be some meteorological conditions under which sound would be attenuated in the landward direction. These would include moderate winds from land towards the dredge and during hot summer days where normal temperature lapse conditions would cause a shadow zone further than 200-300 metres from the noise source. Under these conditions noise levels could be 5 to 10 dBA less than predicted by table 3.1.

As discussed in sections 4 and 5, dredging during day time hours would generally comply with construction noise limits if noise levels at dwellings were less than 70 dBA $L_{eq,15min}$. Even with the worst case dredge with a sound power level of 118 dBA, sound levels from the dredge would have reduced to less than 70 dBA further than 100 metres away from the dredge. It is not anticipated that any Backhoe operations would need to be carried out this close to any houses.

There would also be some noise associated with drilling and blasting. This work would be required to loosen rock off Acheron and Rocky Points. The noise from drilling would be similar to noise levels from dredging, however it is anticipated that this activity can be confined to day time periods and so would easily comply with construction noise limits. Blasting would take place only during day time and is not expected to cause any perceptible noise effects on land due to the muffling effect of the water.

3.2 Operational Noise

3.2.1 Vessel Passage

The deepening of the channel would permit the passage of larger ships and noise will be heard on land as the vessels pass down the channel from the heads to the berth at Port Chalmers. The noise level has been calculated assuming the larger ships would

travel at a speed of between 8 and 12 knots and would have a sound power level the same as the 4100 TEU class of vessel. This is considered a conservative assumption as the 4100 TEU vessels are particularly noisy vessels and anecdotal evidence is that the larger ships are actually quieter. The sound level ($L_{eq,15min}$) was calculated to be 53 dBA at the nearest residences to the channel (for instance 323 Aramoana Road) and 49 dBA at slightly more distant residences. A time level trace is shown in fig. 12 below for a receiver at 1015 Harington Point Road with the ship noise in light blue superimposed over a typical "quiet day" noise trace at this location. It is evident that the passage of the ship would be clearly audible if it passed at night, but the noise would be of short duration, much less than the dredge for instance which travels at a slower speed.

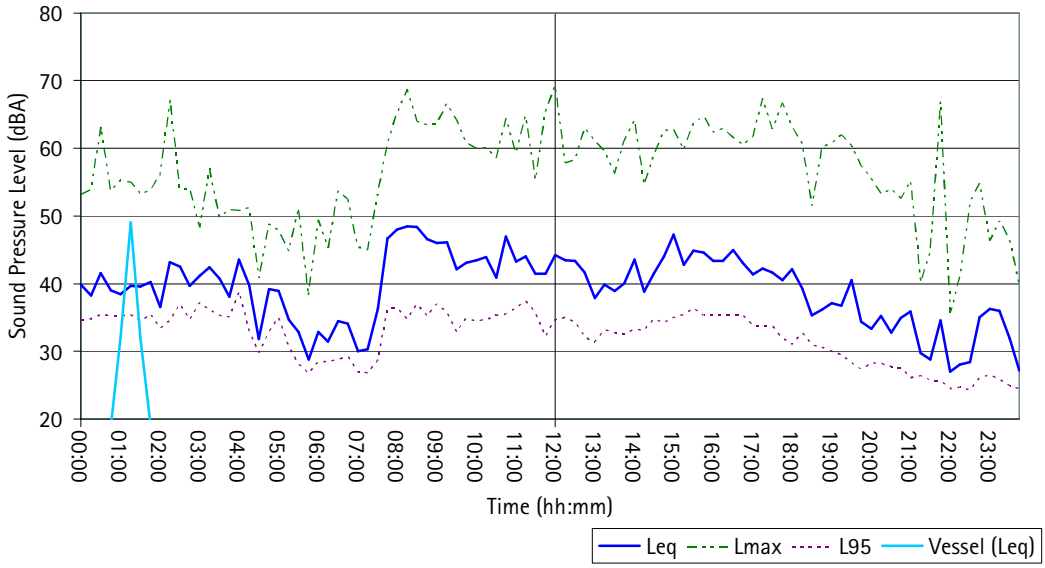


Fig. 12 Predicted Noise level of 6000TEU vessel travelling in the channel

3.2.2 Port Operations

The purpose of the dredging is to accommodate larger vessels (such as the new 6000 TEU container ships) at Port Chalmers. Visits of these ships have the potential to increase operational noise from the port area due to the longer period these vessels would be at berth, and the additional equipment (such as straddle carriers and container cranes) that would be used to work them. Two scenarios have been examined which assume the current 4100 TEU class of vessel is replaced by the 6000 TEU vessel: either the vessel berthed at George St Wharf or at the Multi Purpose berth. It is noted that it is Port Otago's stated preference to berth these large container vessels at the George St Wharf.

A detailed noise model has previously been developed for the port operation for the 2009 year. This was used to predict the noise contours in Port Chalmers and Careys Bay for the two scenarios listed above and for the same two scenarios but with the current 4100 TEU class vessel. The detailed noise contours are given in figs. A1-A8 in

Appendix A and these can be examined to determine the noise levels for each scenario and to compare between scenarios. While the noise contours contain a lot of detailed information the differences between the scenarios can be summarised broadly as follows:

- The noise level in Port Chalmers decreases by about 1 dBA at all locations for the vessel at the multi-purpose berth compared to the George St berth
- The noise level in Careys Bay increases by about 2-3 dBA for the vessel at the multi-purpose berth compared to the George St berth.
- With the 6100 vessel at the George St wharf the noise levels in Port Chalmers and Careys Bay are increased by much less than 1 dBA.
- With the 6100 vessel at the multi-purpose berth noise levels in Careys Bay would increase by about 1 dBA compared to the 4100 vessel.

The difference between the current noise contours (which are the 4100 vessel at George St) compared to the worst case scenario for Careys Bay (6000 vessel at the multi-purpose berth) is about 3-4 dBA at houses in Harbour Terrace. The noise level at these houses would increase from about 55-56 dBA Ldn to 58-60 dBA Ldn which would be a noticeable increase in noise.

A further scenario was briefly examined. There could be rare occasions when an arriving vessel can not safely turn and therefore it berths with its bow facing in to Port Chalmers (rather than bow out to sea). This places the noise source further away from Port Chalmers and closer to Careys Bay. Because this is not a usual situation detailed noise contours have not been shown but initial review shows that with the vessel at the multi-purpose berth the noise levels in the northern parts of Careys Bay (northern end of Harbour Tce and Macandrew Rd) would increase by about 1 dBA for the "bow in" situation compared to the "bow out" situation.

4.0 NOISE LIMITS

4.1 Construction Noise

4.1.1 Planning Documents

The proposed dredging activity would be carried out in the Coastal Marine Area of the Otago Regional Plan and would be subject to the provisions of that Plan. There are no noise rules contained in the Plan, but the Plan states:

> *"The objective and policy contained with this chapter give guidance to the consideration of activities that require resource consents under any or all of the other chapters of the plan."*

The objective and policy sections contain the following:

"12.3.1 To manage and control noise levels with the Coastal Marine Area to minimise any adverse effect on amenity values, conservation values and the use of the Coastal Marine Area."

"12.4.1 In managing and controlling noise levels within the Coast Marine Area:

a) Particular regard will be had to ensuring consistency with any noise control provisions or standards in any District Plan for adjacent land; and

b) Regard will be had to the New Zealand Standards NZS 6801 (1991), NZS 6802 (1991), NZS 6803P (1984) and NZS 6807 (1994); and

c) Regard will be had to any other relevant information relating to the emission and effects of noise, and the measures which may be taken to avoid, remedy or mitigate those effects; and

d) Regard will be had to the duration and nature of noise produced."

The noise effects would occur within the area covered by the Dunedin City Plan. Although the noise rules in this Plan may not directly apply to the activity, the Regional Plan as noted in a) above shall have *"particular regard to ensuring consistency with noise control provisions or standard in any district plan for adjacent land"*, such as this.

It is worth noting at this point that in the Dunedin City Plan the relevant noise control is Rule 21.5 which contains the following exemption:

"v) Exemptions

.....

e) Construction noise, except with the Abbotsford Residential 6 Zone outside the period between 7.00 am to 7.00 pm Monday to Saturday inclusive, and all Sunday."

Marshall Day's interpretation of this exemption is that there is no specific rule to control construction noise, and therefore other provisions of the Resource Management Act such as Section 16 (duty to avoid unreasonable noise) and Section 17 (duty to avoid, remedy or mitigate adverse effects) would govern activities.

We note in passing that for non-construction activity, the Dunedin City District Plan would apply different noise limits to several parts of the area adjacent to the dredging area. For the Rural zoned areas (see for instance Map 66 in Appendix B), the normal noise limits are 55 dBA L_{10} during the day, and 40 dBA during the night. For some of the coastal communities, for instance Harington Point and Deborah Bay (see Map 66

and Map 67 in Appendix B), the noise limits are 50 dBA during the day, 45 dBA during the evening and 35 dBA at night.

For the larger Residential areas of Careys Bay and Port Chalmers, the noise limits are 50 dBA during the day, 45 dBA during the evening and 40 dBA at night. For these limits the assessment point is at the boundary of the site or within any other site, or in a rural zone at the notional boundary of any dwelling not on the same site. This in effect would generally mean a position close to the dwelling of the noise receiver.

After consideration of both Regional and District Plans our assessment is that there are no specific noise rules applying to construction activity in the Coastal Marine Area. Since the dredging would clearly be a construction activity, there are therefore, no specific noise rules applying to the proposal.

For granting consent regard shall be had to the Construction Noise Standard NZS 6803P:1984, and to Sections 16 and 17 of the Resource Management Act.

4.1.2 Construction Noise Standard

Because construction noise is usually difficult to control, but is of limited duration, normal noise limits are inappropriate. A New Zealand Standard, NZS 6803 has been developed to provide a better assessment of construction noise effects. This Standard was published in 1984 and revised in 1999. The two Standards are quite similar and for this project the difference in noise limits would be small. It is recommended that the most recent Standard is used.

The recommended noise limits depend on the duration of construction and the time of day. The table below sets out the recommended limits. For this project the "Typical Duration" limits would apply.

Table 2: Recommended upper limits for construction noise received in residential zones and dwellings in rural areas.

Time of Week	Time Period	Duration of Work					
		Typical Duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekday	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and	0630-0730	45	75	45	75	45	75

Public Holidays	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

4.2 Operational Noise

The use of the wharf extension would be covered by provisions in the Dunedin City Council District Plan. Rule 21.5 sets performance standards generally, but noise generated with the Port 1 Zone at Port Chalmers is specifically exempt. Rule 21.5.2 sets noise mitigation standards for Port Chalmers and specifies that operations should be in accordance with the Port Noise Management Plan. The Port Noise Management Plan requires dwellings to be insulated against port noise to achieve an internal noise level of 40 dBA Ldn inside habitable rooms based on predicted Ldn noise contours for a busy five day scenario. A house insulation programme is currently underway in Port Chalmers to achieve the required sound insulation for all noise affected dwellings for the current operational situation.

5.0 ASSESSMENT

Noise is a wide spread environmental nuisance, the most common source of community noise being from transportation activities such as road or air traffic. It can have many effects such as potential hearing damage, interference with conversation or listening, sleep disturbance and general annoyance. For the range of ambient noise levels experienced in New Zealand hearing damage is extremely unlikely and a level of 75 dBA L_{dn} has been identified as a sufficient limit on environmental noise to avoid any risk of hearing damage to exposed communities. Other health effects such as heart disease have been linked with noise however generally the links are weak and a limit of about 65-70dBA $L_{eq\ ,\ 24hr}$ has been identified as a limit below which there are no significant risk of health effects.

Noise rules are usually set much lower than these upper limits in order to protect the amenity value of urban and rural environments, with a gradual trend to slightly lower limits over the last two decades. Day time noise limits are generally set higher because there are higher levels of ambient noise from many sources and because humans are generally more sensitive to noise at night, in part because of the need to preserve good conditions for sleeping. There will be a range of individual reactions to noise, with any individual's reaction due to a complex mix of factors, of which the actual sound level may be only a part. For this reason noise limits are set to protect most of the population, with the realisation that even at quite low noise levels some individuals may still be affected.

5.1 Construction Noise

5.1.1 Small TSHD Dredge (New Era)

The operation would be classed as long-term duration and would therefore be required to meet 70 dBA between 7.30am and 6pm, and 45 dBA between 8pm and 6.30am with intermediate limits applying between these times, depending on the day of the week.

During the day the noise level from this dredge would comply with the construction noise limits at all houses. At night this dredge would be able to operate within the noise limit of 45 dBA provided it was no closer than 590 metres to any house. It can be seen from fig. 10 that a significant proportion of the channel falls outside this restriction and no specific mitigation would be required in these areas.

5.1.2 TSHD Dredge

The predicted noise boundaries for the large TSHD are shown in fig 11. It should be remembered that these are reasonable worst case limits, based on the noisiest likely dredge and is more likely that noise levels could be 2 – 5 dBA lower than shown if the large TSHD has a sound power level of 110 dBA or less. These boundaries indicate that very few if any dwellings are likely to be subject to above 60 dBA. Therefore, by reference to Table 2 of the Construction Noise Standard, it can be seen that the dredging activity would be within the recommended upper limits for long duration projects from 7.30 am to 8.00 pm weekdays, and 7.30 am to 6.00 pm Saturdays. Therefore dredging could be undertaken at these times in compliance with the standard. Exceptions are small areas (at Rocky Point, Acheron Point, Pulling Point and Tayler Point) for periods between 7.30 am and 6.00 pm on Sundays and Public Holidays where the more stringent limits applying at these times are predicted to be exceeded

However, as noted in Section 3, dredging activity would in general be a 24 hour activity, and there would be periods when some dwellings would be exposed to noise levels at night which exceed the construction noise night-time limit of 45 dBA if the dredge is a worst case of 112 dBA sound power level.

While there is some ability to carry out work at night on areas which are well away from residential area, there would be periods when dredging activity would take place at night time near residences:

- Harington Point/Otakou Community – 14 days;
- Te Ngaru/Waipuna Bay – 17 days;
- Deborah Bay – 25 to 30 days;
- Careys Bay/Port Chalmers – 50 days.

The above community exposures are based on the current information supplied by Port Otago for the large TSHD of 10,800m3 capacity. In the event that a smaller dredge is contracted to undertake the work then the above exposure times could increase.

Over a full week the Construction Noise Standard places a 45 dBA limit on about 50% of the total hours available. But there is only about 36% of the available volume to dredge in the channel that is further than 750 metres from any residence, at which distance a dredge would be below 45 dBA at all times (see fig 9). Of this 36%, 13% is restricted or unproductive due to being contained within a short distance (which would require excessive turning movements) or it is off the entrance channel which will be unworkable at times due to swell. It can be seen therefore that there are

insufficient areas of the channel available to dredge at night during the 50% of the hours when the 45 dBA limit applies. It is explained in other documents that it is considered impractical to dredge only for day time hours.

During the day, while the noise would be audible at coastal areas closest to the dredge, (depending on weather conditions), the noise levels are unlikely to cause any significant effects as noise levels would be similar to noise levels experienced in that environment already. For instance, noise levels from dredging would be unlikely to interfere with conversations outside or listening to a radio while gardening. Indoors the noise, while audible under some conditions, is unlikely to be disturbing.

During the periods when night-time noise levels are in excess of 45 dBA there is the potential for some effects from the noise. This would depend on weather conditions at the time and the exact noise emission from the actual dredge used (which may be less than assumed). But in the event of still conditions and the noisiest equipment, then noise levels of 45 – 50 dBA could be experienced at times for residences at Harington Point and Otakou, Waipuna, Deborah Bay and Careys Bay. Noise levels between 50 - 55 dBA could be experienced at Rocky, Acheron, Pulling and Tayler Points and the Spit.

These noise levels could disturb sleep and might cause annoyance and community complaints. While in many instances acceptable sleeping conditions could be achieved inside the dwelling with closed windows for external noise levels up to 50 dBA or more, it may not be practical or acceptable to have windows closed on all affected nights. With open windows there may be disturbance to some residents at times.

It is generally accepted that a night time noise level of 30 dBA L_{eq} is a very good standard **inside** a bedroom. Since open windows generally provide about 15 dBA of attenuation this means that an **external** level of 45 dBA would provide good sleeping conditions. The sound insulation of a typical house when windows are closed would be 20-23 dBA or more and so an external level of 50 to 53 dBA would be acceptable under these conditions.

The night time noise level of 30 dBA $L_{eq,8h}$ (and 45 dBA L_{max}) inside a bedroom is the guideline to protect sleep set by the World Health Organisation][1]. This represents a conservative recommendation that is designed to prevent the onset of health effects from noise and would be regarded as a high standard of protection by the majority of population. The publication does however note that to protect sensitive persons, a still lower guideline value would be preferred when the background level is low. On the other hand 35 dBA in a bedroom has been previously accepted as a reasonable night time internal noise limit, and the Environment Court set a limit of 40 dBA L_{dn} (inside) for port noise affecting Port Chalmers residences which is approximately 35 dBA L_{eq} (inside) at night for continuous port noise. Furthermore it should be noted that these

[1] "Guidelines for Community Noise" 1999 (Edited by B Berglund, T. Lindvall, & D H Schwela).

recommendations are for long term exposure and some minor exceedance for temporary activities would not be unreasonable.

5.1.3 Backhoe Dredge and Blasting

Noise from Backhoe operations off Pulling Point, Acheron Head, Rocky Point and in the Port Chalmers Swinging Basin could produce noise levels at nearest dwellings above the construction night time noise limit of 45 dBA L_{eq} but below the day time limit of 70 dBA. The worst case Backhoe (118 dBA) could generate noise levels of up to 55 dBA at the closest houses in Careys Bay under neutral or favourable meteorological conditions. Therefore 24 hour operation of this type of dredge would be likely to cause significant adverse noise effects, except when weather conditions such as high winds, either cause a very high level of background masking noise, or moderate off shore winds cause a sound shadow in the landwards direction. Hence this type of dredge would be limited to day time operation.

For quieter backhoe dredges (112 dBA) noise levels are predicted to be 45-48 dBA at the closest houses for typical work areas, and some parts of the operation at the eastern side of the Port Chalmers swinging basin, could be carried out at night without exceeding the 45 dBA limit.

5.1.4 Wharf Construction

Construction of the wharf extension would involve normal construction operations and would include piling, trucking of fill material, concreting and paving. Piling is likely to be the loudest activity and might be carried out by a variety of techniques; however the noisiest method is understood to be "top driving". The nearest house is approximately 350 metres away in Careys Bay and calculations of the noise level at the nearest residence due to piling, using this method, predict a noise level of 65 -70 dBA L_{eq}. Thus all wharf construction activities are predicted to comply with the construction noise limits of NZS 6803:1999 for weekdays and Saturdays between the hours of 7.30 am and 6.00 pm.

5.2 Operational Noise

Port operational noise levels have been predicted for two different scenarios for the new 6000 TEU class vessel. If the vessel were to berth and be worked at the George St wharf then noise levels would be insignificantly different from current noise levels for both Port Chalmers and Careys Bay. No change in noise effects would be expected. If the new vessels were to be berthed and worked at the multi-purpose berth then the noise levels in Port Chalmers would decrease by 1 dB which is insignificant, but would increase in the northern parts of Careys Bay (Harbour Tce) by up to 4 dBA. This would be a discernable change in noise level for about fifteen to twenty houses and would bring about ten or twelve of these houses inside the 55 dBA L_{dn} contour and perhaps two or three houses of them inside the 60 dBA L_{dn} contour. These houses would then be noise affected properties according to Rule 21.5.2 in the Dunedin City District Plan and would be subject to the provisions for noise insulation in the Port Noise Management Plan.

6.0 NOISE MANAGEMENT AND MITIGATION

In accordance with Sections 16 and 17 of the RMA it is recommended that in addition to all practicable steps being taken to reduce the noise levels and its effects through careful management of the activity, where this is not possible, that some form of mitigation of the effects is undertaken.

6.1 Construction Noise

There are a number of mitigation measures that have been developed and included in the proposal. These include the selection and use of the quietest practicable equipment that is capable of carrying out the work, and the programming of work in particular areas to limit night-time exposure to residences. The maximum sound power level emitted by the dredges would be specified in the tender documents and incentives would be investigated to further reduce the sound power level as far as practical. These factors would be an essential component of the tendering process and the noise levels of equipment and the management of the contractors work programme to minimise disturbance of residential areas would be a key factor in evaluating tenders.

6.1.1 TSHD Dredge

If it is possible to achieve a sound power level lower than 112 dBA for the large TSHD dredge then the areas that could be dredged at night without exceeding 45 dBA $L_{eq,15min}$ would increase significantly. This is illustrated in figs. 9 and 10 where circles of appropriate diameter have been drawn around the closest houses to indicate the areas inside which a limit of 45 dBA would be exceeded for sound power levels of 112 dBA (assumed worst case) or 110 dBA (average TSHD dredge). It can be seen that even an apparently small reduction of 2 dBA can significantly enlarge the area that can be dredged without exceeding 45 dBA. Initial noise monitoring of the dredge in operation would be undertaken to define the distance of the 45 dBA L_{eq} contour or boundary for the actual dredge used. From this a map similar to figs. 9 and 10 would be prepared to show the areas that can be dredged without restriction, and which should be reserved for the night time periods.

In addition there could be opportunities to take advantage of meteorological conditions that either mask the noise from the dredge, or that do not favour noise propagation in a particular direction. Thus during periods when the wind is consistently above 10 m/s the background noise generated by wind and waves would be high enough to generally mask noise from dredging and so areas closer to residences might be able to be dredged at those times. Also when the wind is more than 5 m/s from a northerly direction, sound propagation to land on the northern side of the channel would be reduced and so dredging could be carried out on the parts of the channel close to residences on this side without exceeding 45 dBA. Likewise, with winds from the southeast, sound would be attenuated on the southern side of the channel (e.g. Harington Point) and dredging could be carried out in the channel close to Harington Point without exceeding 45 dBA.

As noted before a noise monitoring programme would be carried out at the beginning of the dredging programme to confirm actual noise levels compared with the predictions contained in this report. This would allow more precise identification of the houses that could be exposed to noise levels over 45 dBA, and the likely extent of the exposure. Once the exposed dwellings are identified then individual owners would be consulted.

A range of mitigating options would be investigated in consultation with each resident. In some cases the location of bedrooms may be such that they are shielded to some degree, and actual exposure of the bedrooms could be within acceptable limits. This might be the case when bedrooms are located at the rear of a house facing away from the harbour. In other situations it may be possible to offer temporary measures to improve the sound insulation of bedrooms. Generally more modern buildings which are built with high thermal insulation in mind, or substantial buildings with brick or masonry construction, will achieve a good degree of acoustic insulation and may achieve sufficient noise reduction without further measures to reduce internal noise levels in bedrooms at night to 30 dBA.

If no other mitigation measures are practical then alternative accommodation could be arranged for the nights if noise levels are unacceptable to the resident. This would generally be regarded as a last resort as it is quite disruptive to peoples' lives. Some residents may find the noise levels experienced less disruptive than temporarily moving to alternative accommodation provided they are fully informed of the dredging programme and understand the reasons for and extent and duration of the noise.

In the event that a smaller capacity dredge is contracted to undertake the work then the basic mitigation options discussed above would be unchanged. However there could be some difference in the balance of options applied as the smaller capacity dredge would increase dredging duration but would be expected to quieter.

In addition to the mitigation measures discussed above, a continuing programme of communication with the local communities will be invaluable in keeping residents informed. This would include providing the dredging schedule on a weekly basis so that residents would be aware of expected dredging activity and know the likely extent and duration. It is generally found that the degree of community disturbance is reduced when the duration and extent of noisy activities is well communicated and understood. In addition communication with residents would include contact numbers for registering complaints or feedback, and there would be a defined procedure for registering and responding to complaints.

6.1.2 Backhoe Dredge and Blasting

The Backhoe dredge would involve similar considerations as discussed above for the TSHD dredge such as selection of tenders to minimise noise output of equipment, programming of work, and community consultation. For a noisy Backhoe dredge (118 dBA) however, additional mitigation options such as temporary treatment of bedrooms or temporary relocation of occupants would be unlikely to be practical because of the large number of dwellings involved. For a quiet Backhoe dredge (112 dBA) the

mitigation options would essentially be similar to that of the large TSHD and so work in some areas at night may be able to be carried out within the 45 dBA limit.

Blasting work would be carried out during the day time only and this contract would have conditions to require compliance with the Construction Noise Standard.

6.1.3 Noise Monitoring During Construction

In addition to the initial monitoring of the noise emission of the large TSHD dredge to define the 45 dBA contour, spot noise monitoring would be carried out in response to residents requests. A contact point would be given in the material distributed to local communities, so that people wanting to have the noise exposure at their house monitored can request that someone come to their house and measure the noise level. This would act as a check on any variations to conditions or assumptions that might occur, and would provide reassurance that work is being undertaken in accordance with what has been outlined in this report.

6.2 Operational Noise

For operational noise from the berth extension noise mitigation would be required for about ten or twelve houses in Harbour Terrace in Careys Bay for the scenarios involving a 6000 TEU vessel being berthed and worked at this location. This mitigation would be as required by the Port Chalmers noise mitigation plan and would involve individual assessment of each house, design of walls, floors, ceilings, roofs, windows, doors and ventilation in order to meet an internal noise level of 40 dBA L_{dn} in all habitable spaces of the house when exposed to the noise level predicted by the contours (plus a 3 dB margin). This work would become part of the programme overseen by the Port Noise Liaison Committee and once work is complete would require a certificate of compliance with the noise mitigation plan requirements.

7.0 SUMMARY AND CONCLUSIONS

An assessment has been carried out of the effects of the proposal to deepen the shipping channel in Otago Harbour. Ambient noise surveys have been undertaken at representative locations and the noise environment has been found to be typical of a rural coast environment. During calm periods the environment is quiet, with low noise levels. During periods with high winds the environment can be noisy, with ambient levels of 50 dBA or more.

An examination of the relevant District and Regional Plan rules indicates that there are no specific noise limits that would apply to the dredging and other construction activities, although the Regional Plan notes that regard should be had to the Construction Noise Standard and Marshall Day has used this as the basis of assessment. The operational aspects of the wharf extension are covered by the Noise Mitigation Plan for Port Chalmers.

Noise levels have been predicted for the TSHD dredging activity. Worst case noise emission and sound propagation have been assumed. Dredging would be a 24 hour activity with similar noise levels at night as during the day. The predicted noise levels

indicate that during the daytime significant noise effects are not expected, and compliance with the Construction Noise Standard should be achieved. At night, noise levels could be at times above the 45 dBA limit of the Construction Noise Standard. However, even with worst case assumptions, this is likely to be only at a limited number of locations and for a few periods at night (of up to an hour each) and only for a limited number of nights (14 – 30) over many months of the project.

Mitigation measures that would be used include programming of night-time activity away from residential areas, reduction of dredge noise as far as practicable, taking advantage of weather conditions that either raise the background noise, or reduce sound propagation in particular directions, and reducing internal noise levels in bedrooms where possible (e.g. by enabling windows to be closed without reducing necessary ventilation). An active consultation programme would be undertaken to inform people of the extent and duration of the dredging activities as it might affect them.

Overall it is considered that noise effects from dredging are likely to be minor. The predicted noise levels, while above 45 dBA at times, are unlikely to exceed 50 dBA. The times when noise would exceed 45 dBA would be limited to a few periods during the night, and at any particular location would occur for a limited number of nights. The nature of the noise would be similar to existing noise sources such as shipping and is therefore, less likely to be disturbing.

Operational noise from the wharf extension has been predicted for two scenarios. For the scenario in which the new 6000 TEU class vessel uses the Container Terminal wharf there would be no discernable change in noise effects compared to the current situation and no adjustments would be required to the programme of house insulation that is currently in progress. For the scenario where the new vessel is berthed and worked at the multi-purpose berth there is a small, probably insignificant reduction in noise at Port Chalmers, but a noticeable increase in noise in Careys Bay. This would require up to 12 houses in Harbour Terrace to be included in the sound insulation programme, with 2-3 of these being in the 60 - 65 dBA zone which could involve significant upgrading of the dwellings.

APPENDIX A – NOISE CONTOURS OF PORT OPERATION

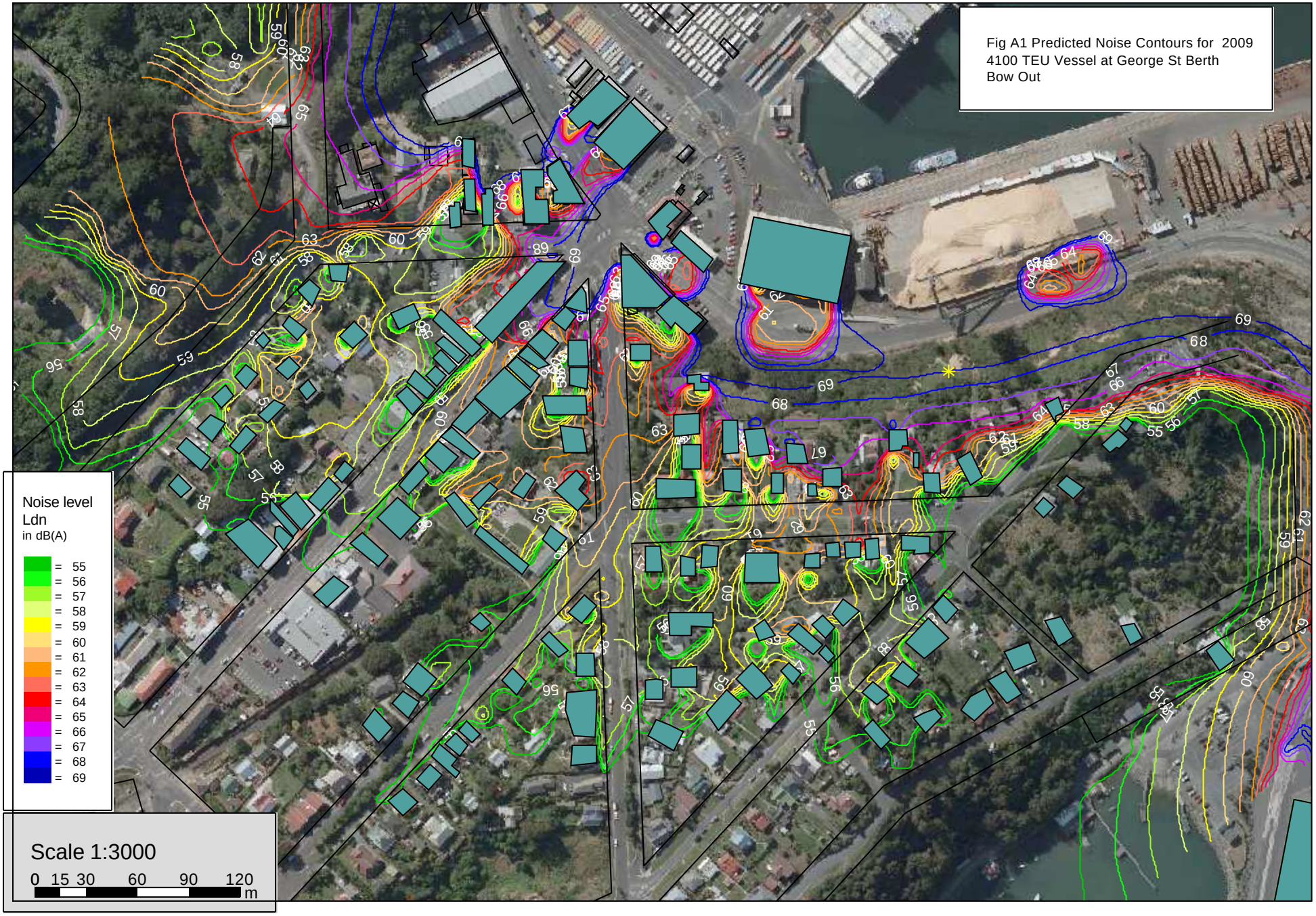


Fig A1 Predicted Noise Contours for 2009
4100 TEU Vessel at George St Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3000
0 15 30 60 90 120
m

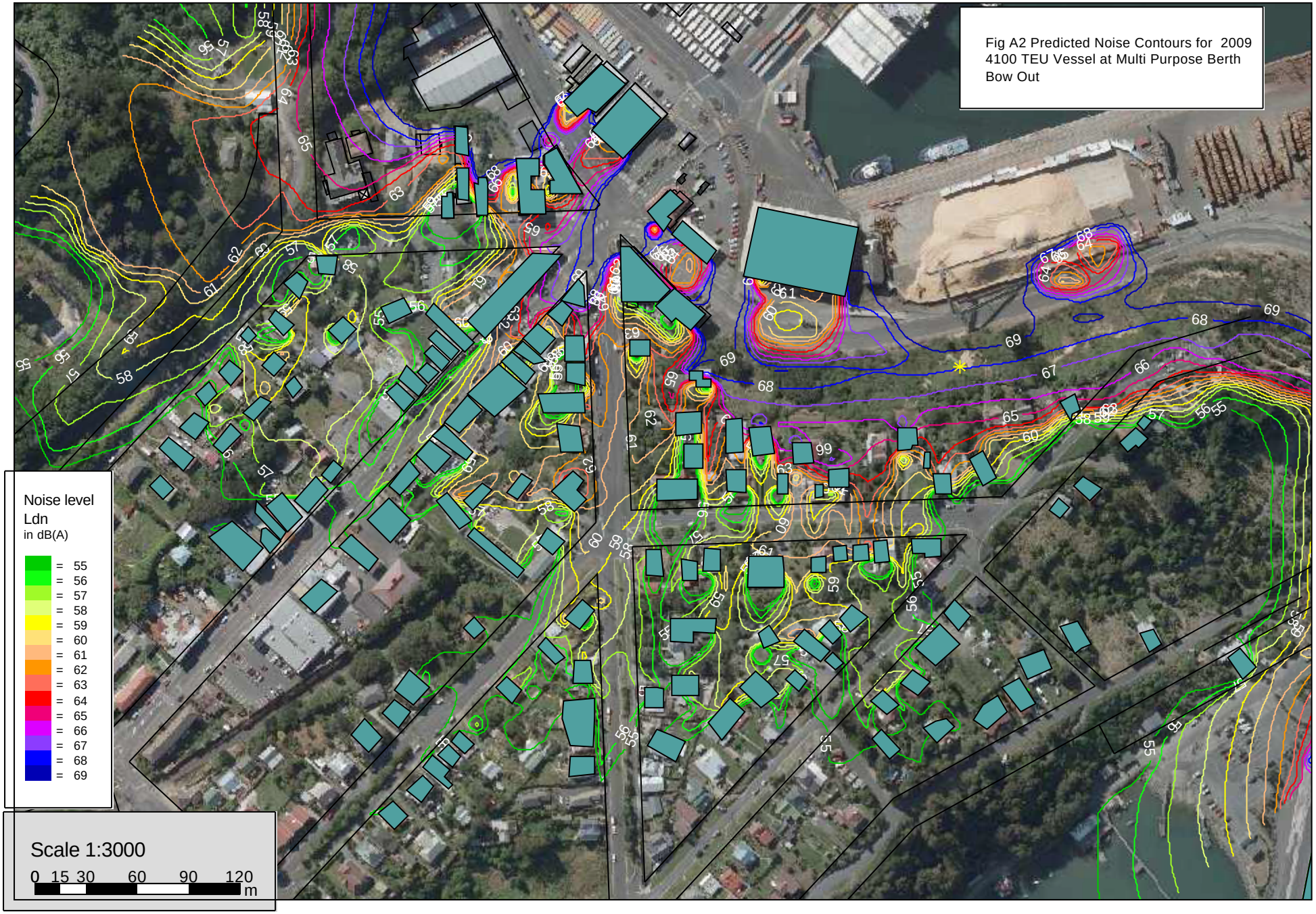


Fig A2 Predicted Noise Contours for 2009
4100 TEU Vessel at Multi Purpose Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3000
0 15 30 60 90 120
m

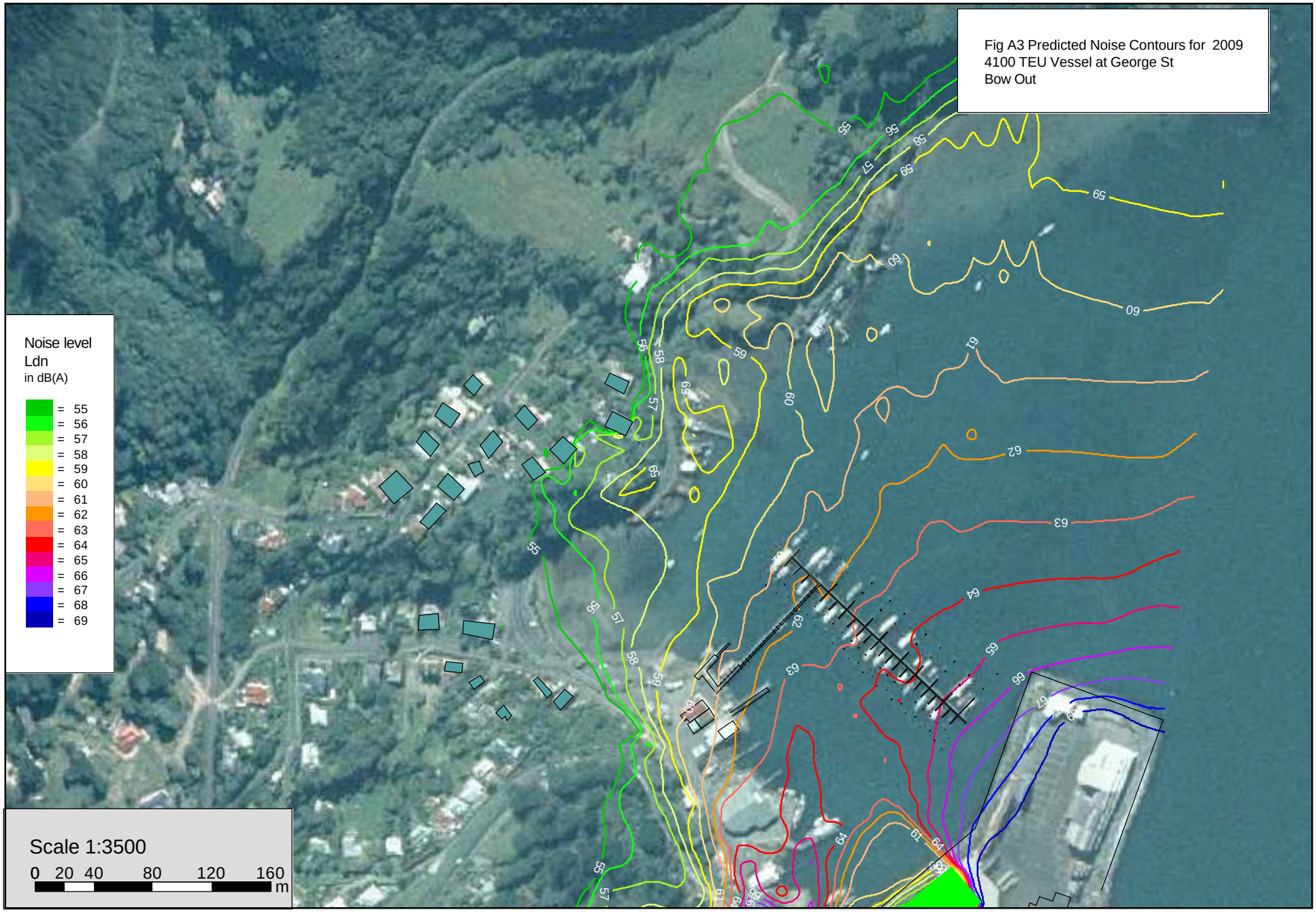


Fig A3 Predicted Noise Contours for 2009
4100 TEU Vessel at George St
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3500
0 20 40 80 120 160
m

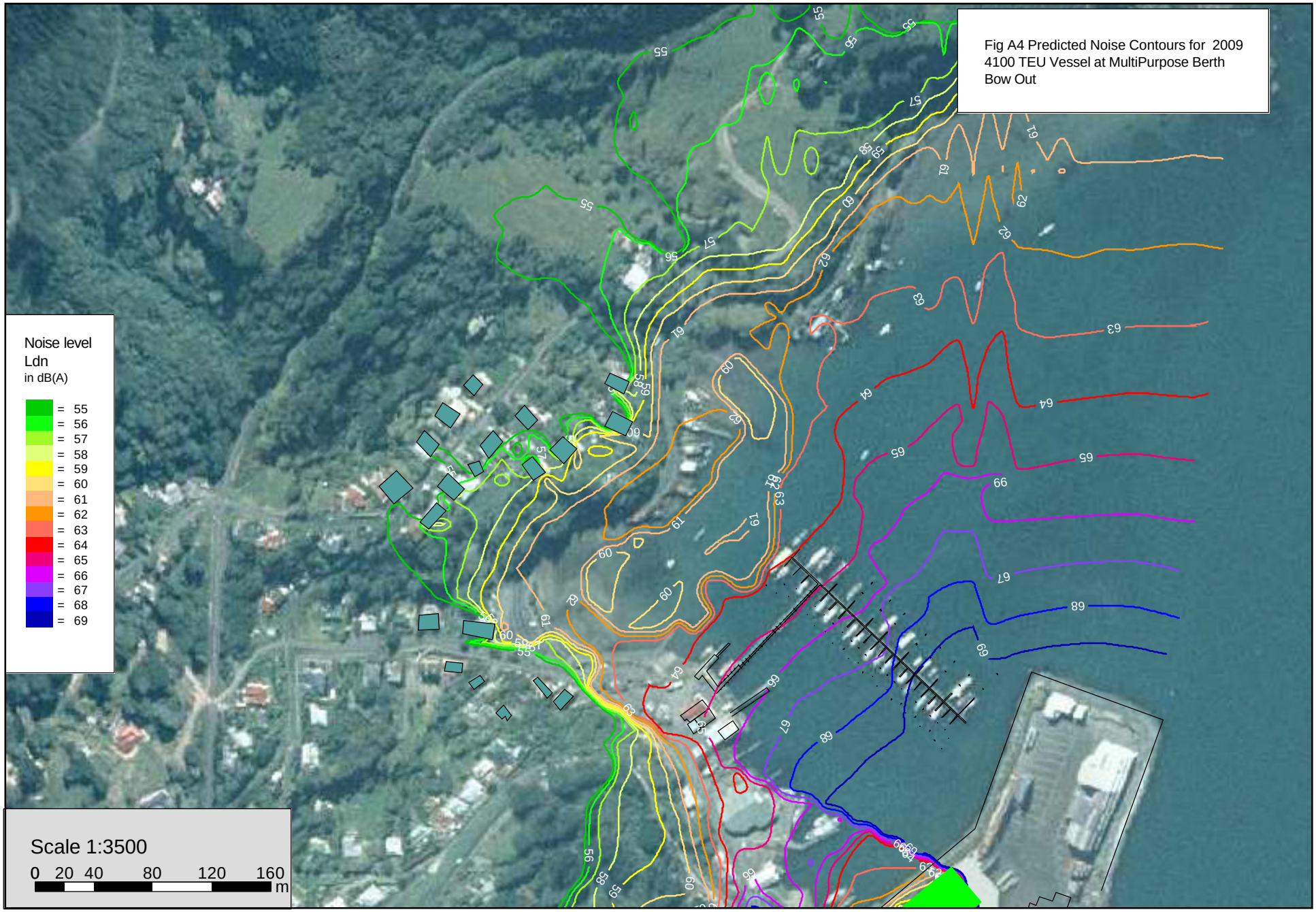


Fig A4 Predicted Noise Contours for 2009
4100 TEU Vessel at MultiPurpose Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3500
0 20 40 80 120 160
m

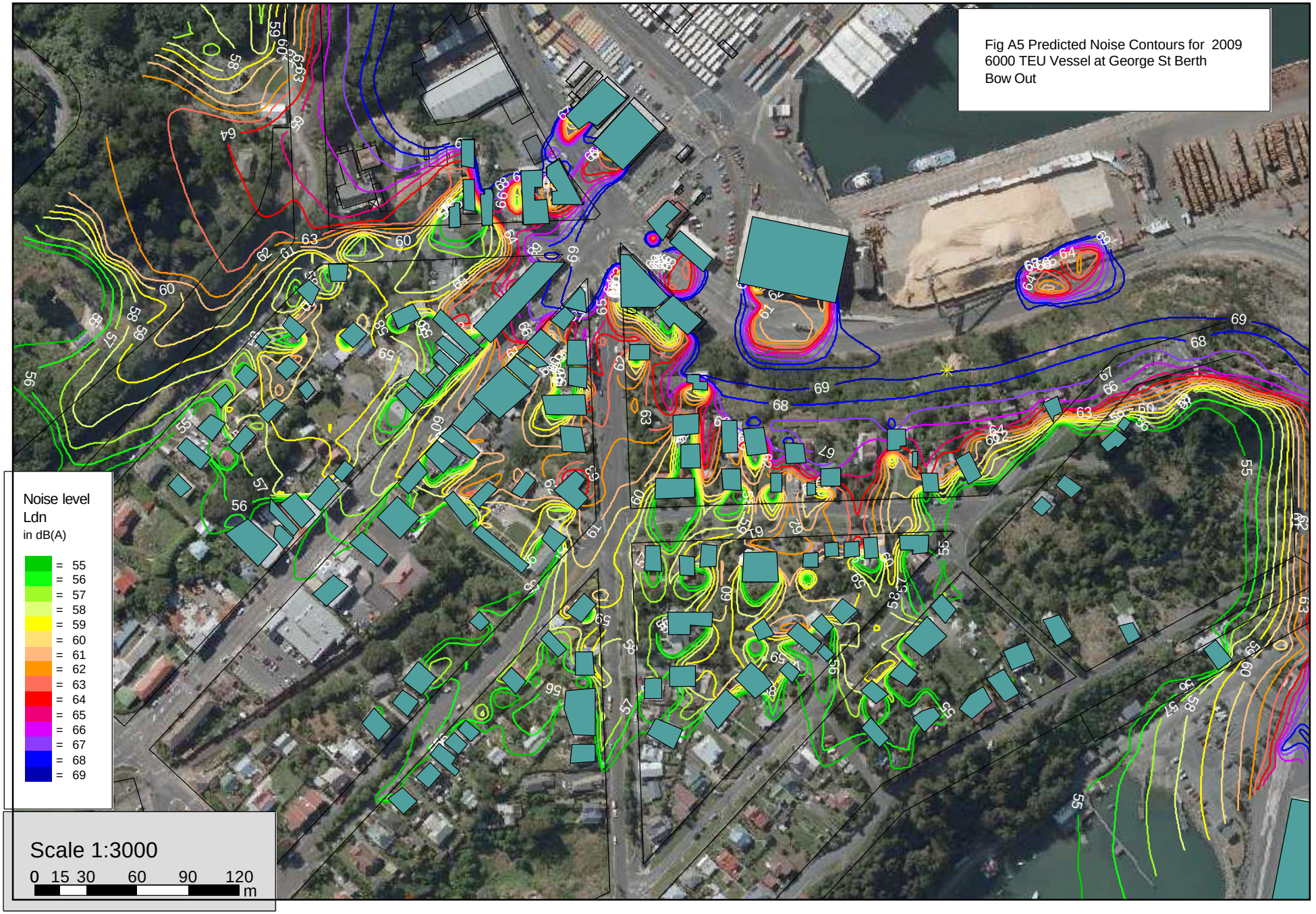


Fig A5 Predicted Noise Contours for 2009
6000 TEU Vessel at George St Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3000
0 15 30 60 90 120
m

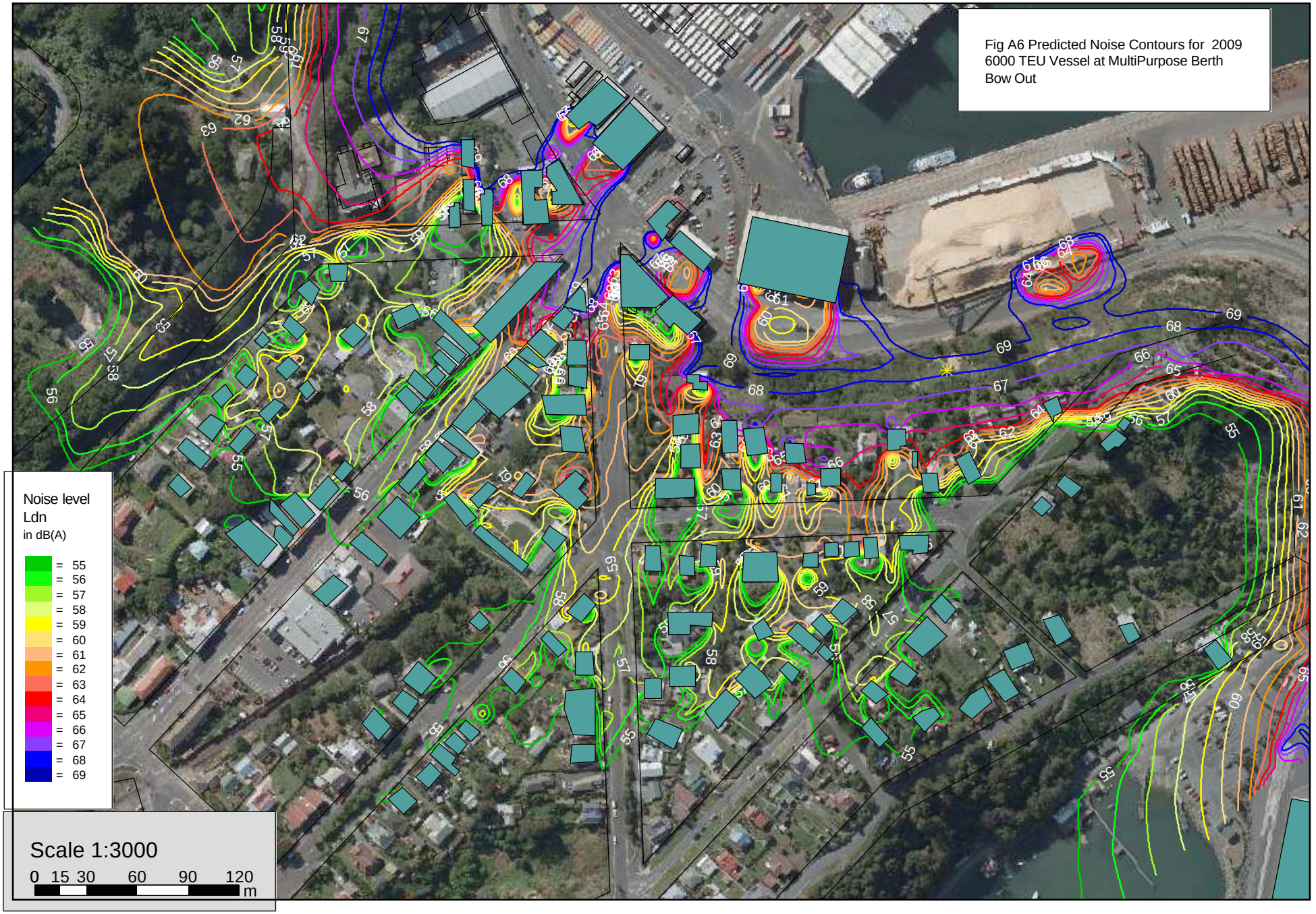


Fig A6 Predicted Noise Contours for 2009
6000 TEU Vessel at MultiPurpose Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3000
0 15 30 60 90 120
m

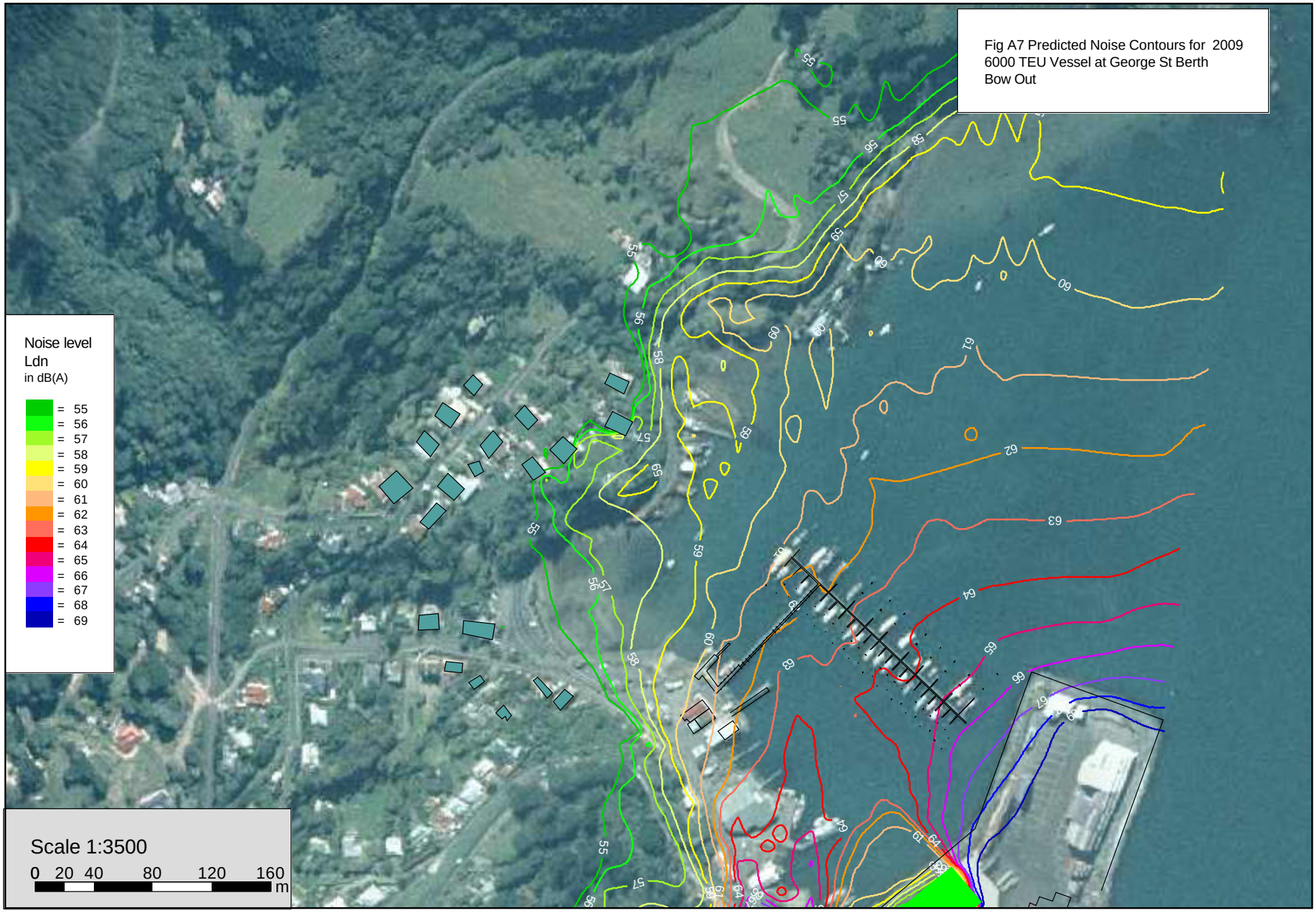


Fig A7 Predicted Noise Contours for 2009
6000 TEU Vessel at George St Berth
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3500
0 20 40 80 120 160
m

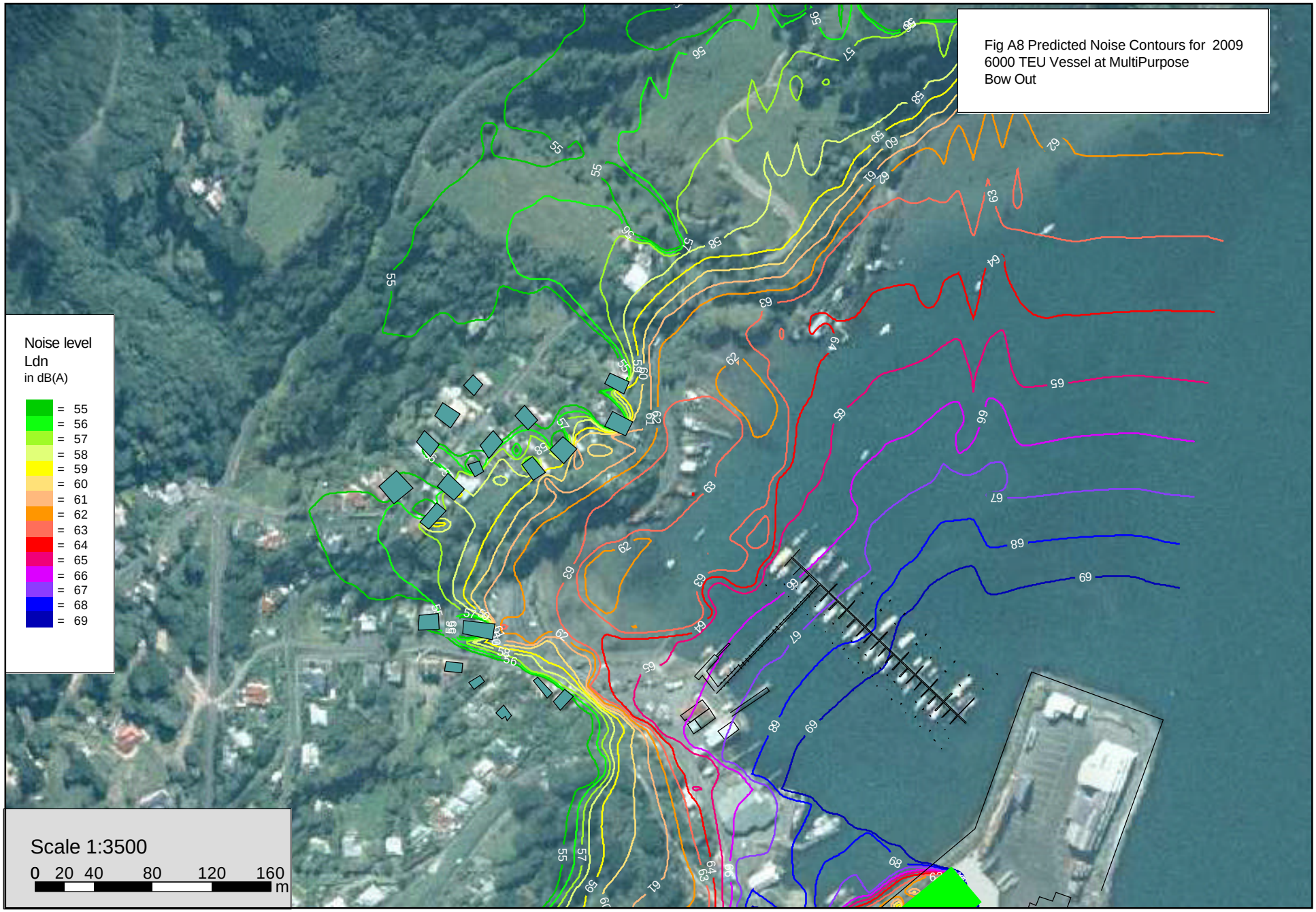
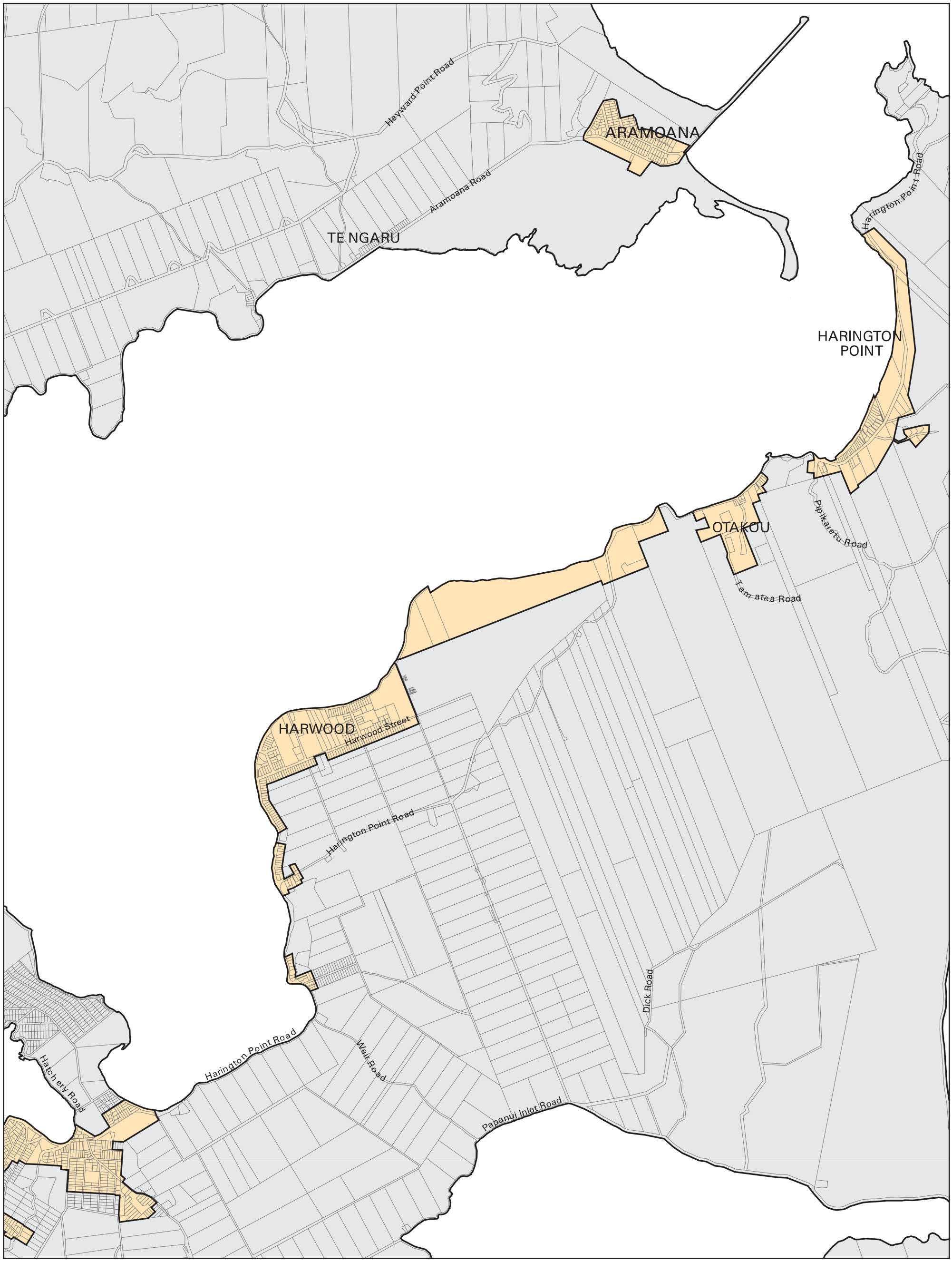


Fig A8 Predicted Noise Contours for 2009
6000 TEU Vessel at MultiPurpose
Bow Out
Noise level
Ldn
in dB(A)
= 55
= 56
= 57
= 58
= 59
= 60
= 61
= 62
= 63
= 64
= 65
= 66
= 67
= 68
= 69
Scale 1:3500
0 20 40 80 120 160
m

APPENDIX B – DUNEDIN CITY PLANNING MAPS



Noise Areas

- 60Dt/Nt dBA*
- 55Dt/40Nt dBA*
- 50Dt/40Nt dBA, 45SP dBA*
- 50Dt/35Nt dBA, 45SP dBA*
- 55 Dt/40Nt dBA* within 50m of a residence

* Refer to Index to Noise Maps for abbreviations

DUNEDIN CITY COUNCIL

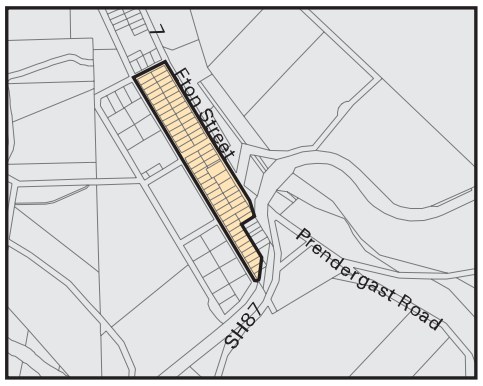
Map Printed December 2005

Outer Harbour

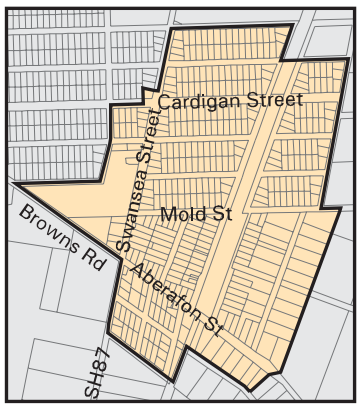
NOISE

Map 66

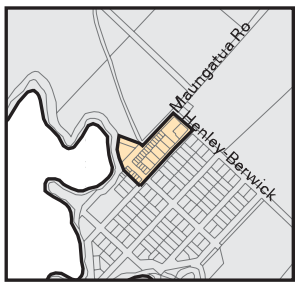
Scale 1:25000



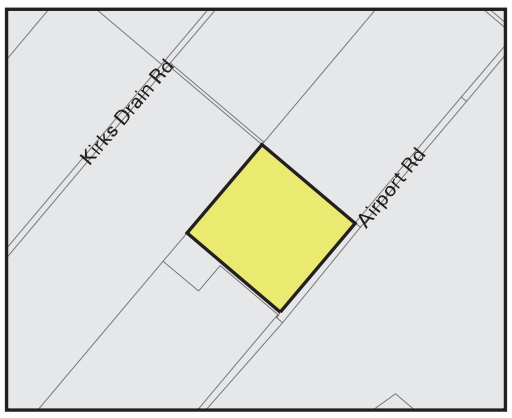
Hyde



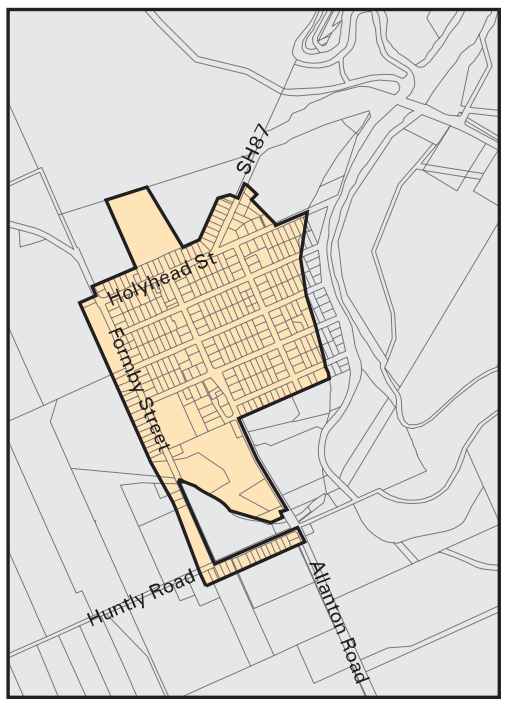
Middlemarch



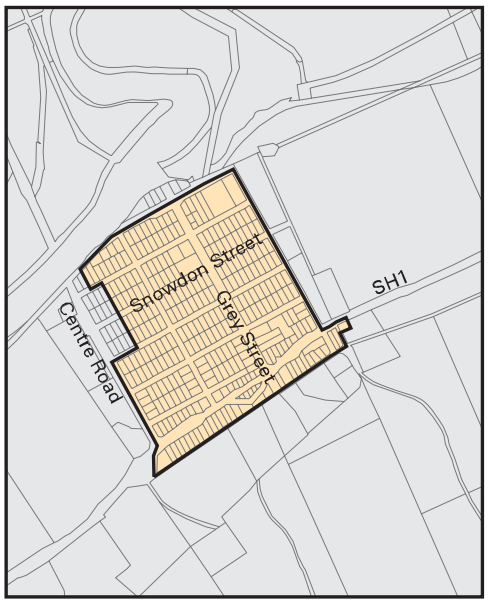
Berwick



Dunedin Airport



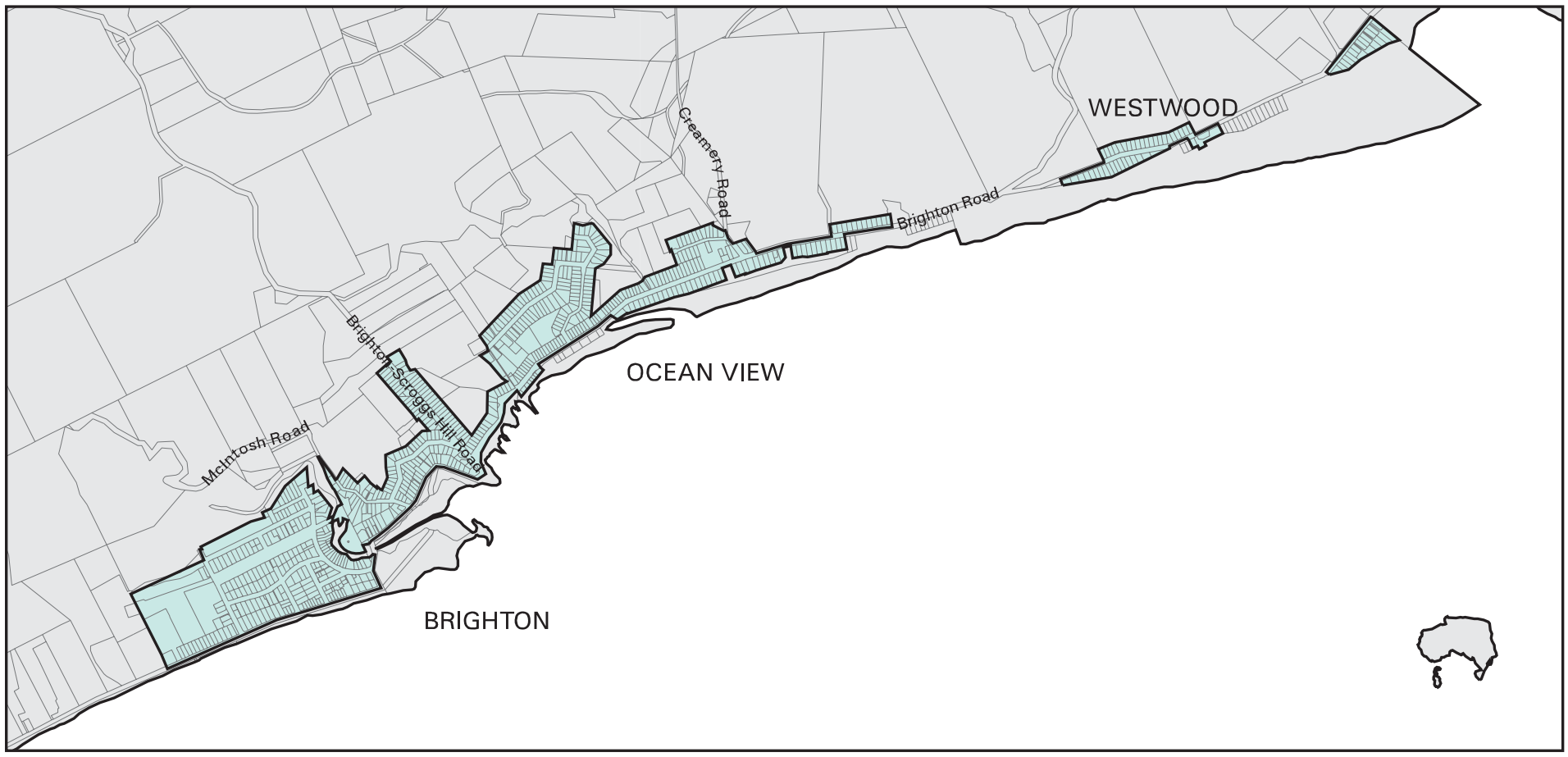
Outram



Allanton

Woodside

Deborah Bay



Brighton - Westwood

Noise Areas

- 60Dt/Nt dBA*
- 55Dt/40Nt dBA*
- 50Dt/40Nt dBA, 45SP dBA*
- 50Dt/35Nt dBA, 45SP dBA*
- 55 Dt/40Nt dBA* within 50m of a residence

* Refer to Index to Noise Maps for abbreviations

DUNEDIN CITY COUNCIL

Map Printed December 2005

NOISE

Map 67

Scale 1:25000