BEFORE THE DUNEDIN CITY COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application for resource consents for Subdivision and Land Use at Te Ngaru
BY	**LEX ANDERSON AND HILDA CRAIGHEAD**
	Applicants

STATEMENT OF EVIDENCE OF REGINALD MAURICE DAVIS ON BEHALF OF THE APPLICANTS

CPG New Zealand Ltd
1st Floor John Wickliffe House
265-269 Princes Street
PO Box 910
Dunedin 9054
New Zealand
Telephone: +64 3 477 7133
Fax: +64 3 477 4236
E-mail: dunedin@nz.cpg-global.com

1. **Introduction**

1.1 My name is Reginald Maurice Davis, I reside in Dunedin and I am employed by CPG New Zealand Ltd as a Marine and Coastal Engineer.

1.2 I have been engaged by the Applicants to prepare a report on the effects that predicted rise in the sea level could have on the subdivided land or its use.

2. **Qualifications**

2.1 My qualifications are:

a. Bachelor of Engineering, (Civil) (NZ)
b. Chartered Engineer, (UK)
c. Member of the Royal Institution of Naval Architects, (UK)
d. Fellow of the Institution of Professional Engineers, New Zealand
e. Chartered Professional Engineer, (NZ)
f. International Professional Engineer, (NZ Register)
g. APEC Engineer
h. Maritime New Zealand Recognised Surveyor (18 categories).

3. **Relevant Experience**

3.1 As a child, I lived at Aramoana when my father was in charge of the quarries and mole construction works. In my youth, and early adulthood, I frequently visited Aramoana in my leisure and recreational pursuits.

3.2 From 1961 until 1987 I was employed by the Otago Harbour Board, initially as Senior Assistant, then Chief Engineer. In these roles, I had overall responsibility for the operation of the quarries at Aramoana and construction and maintenance works on the mole (training wall) at the entrance to Otago Harbour.

3.3 These works demanded frequent visits to Aramoana, sometimes daily, when major works were being carried out.

3.4 Works in which I have been involved and which have contributed to my knowledge of the area include:

- The operation of three quarries
- The mole at the harbour entrance
- Training walls at the Spit and at Harington Bend in the harbour channel
- Erosion protection on the south western shoreline of the Aramoana flats close to Te Ngaru
- Roading in the Aramoana Village
- Erosion control in the dunes on the Spit
- The old railway embankment across the tidal flats at the Spit

3.5 Since retiring from the harbour board, I have practised as a consulting marine and coastal engineer and have worked on projects for shoreline and coastal protection throughout New Zealand and in South East Asia. Of particular relevance is my recent involvement in projects for shore protection in Otago Harbour including at Te Rauone Beach.

4. Scope of Evidence

4.1 My evidence discusses the physical and hydrological features of Otago Harbour, the site in relation to these features and the effects they have on conditions at the site.

4.2 I will then discuss some current aspects of sea level rise and climate change and finally examine the effects of these on the proposed subdivision at Te Ngaru.

4.3 Although this is a Dunedin City Council Hearing, I record that I have read the Environment Court's Code of Conduct for Expert Witnesses (2006) and agree to comply with that Code.

5. Features of Otago Harbour

5.1 Physical

5.1.1 In the context of present considerations and put in the simplest of terms, Otago Harbour is a tidal inlet, practically surrounded by high ground with only a narrow opening to the sea.

5.1.2 The harbour is predominantly shallow, a significant proportion of the bed being exposed at low tide and the narrow entrance is sheltered from the heaviest ocean swells by Taiaroa Head.

5.1.3 There are two constrictions to the passage of water, and specifically to the entry of offshore surges into the harbour: The distance between the end of the mole and Taiaroa Head is only 620m but an even narrower “throat” is created at Harington Point where the opening between the Point and the Spit is only 450 metres.

5.1.4 As a consequence of these features, the passage through the entrance of waves created offshore and into the harbour is significantly restricted and for those waves that do penetrate beyond the constriction of the entrance, further propogation is reduced when the waves pass into the shallow waters on both sides of the channel.

5.1.5 It is important to note that there are no recorded events nor is there evidence of storm surges having any significant effect on the level of water in the harbour. Likewise, long period surges or waves associated with tsunamis have shown only minor fluctuations on the recording tide gauges in the harbour in comparison to effects observed on the coast.

6. Location of the Site

6.1 In assessing the possible effects of sea level rise and climate change, it is necessary to examine the extent to which the site will be exposed to these effects.

6.2 The present high tide mark at its closest point to the site of the proposed subdivision is approximately 4.8km from the harbour entrance and more than 3km from the “throat” at Harington Point. Furthermore, for any surge or long period wave to have any effect on the shore adjacent to the proposed subdivision, it would have to be refracted/diffracted through more than 90^{o} and pass over more than 3000 metres of very shallow water. During these processes the energy of any wave or surge would be substantially reduced.

6.3 Note that the conditions I have used in the previous section exist at high tide. At lower water levels, the site is further protected by tidal flats that presently dry at low tide and provide even greater levels of wave attenuation.

6.4 In short, the site of the proposed subdivision is well protected from surges or long period waves originating offshore and in these circumstances, its exposure to the effects of sea level rise and climate change can be confined to the assessment of effects of conditions created within the harbour, namely sea level rise, waves generated by local winds and wave set-up, the latter being the effect of wind shear forces tending to elevate water levels at the downwind edge of a large area of exposed water.

6.5 In the next paragraphs, I use the terms “fetch” or “fetch distance”. This is the distance that wind passes over clear water in which waves will be created by the wind. Note however that the depth of water over the fetch distance has a major influence on the height of waves created; shallow water severely limits the wave height.

6.6 The shore adjacent to the site is sheltered from winds (and waves) from west through north to north east. To the east, the fetch distance is 3.8km but the majority of this distance is very shallow water and waves created in storm conditions are of low amplitude even at high tide. To the south, the fetch distance is 3.3km at high tide but the majority of this is also in very shallow water even at high tide and the wave height is also limited by water depth.

To the south west, the fetch distance is 5.1km and is in predominantly deep water. However the generation of waves is limited by the proximity of high ground to the west and the shore adjacent to the site is sheltered to a large extent by headlands and a rock groyne on its south side. It is also noted that almost 1km of the fetch close to the site is shallow water.

6.7 In the conditions described above, where wave generation is limited by shallow water and relatively short fetch distances, the height of waves generated by future and possibly more severe storms will not be

significantly greater than has been experienced in the past. More severe winds will simply "blow the tops off" without increasing wave height.

6.8 Assessed in the context of the conditions detailed above, the effects of climate change on the shore at Te Ngaru will be minor and the effects on the adjacent land in the proposed subdivision will be negligible. It remains then, to examine the effects of rising sea levels.

6.9 The attached aerial photograph clearly illustrates the conditions described above.

7. Extent of Sea Level Rise

7.1 For the purpose of the present assessment of likely effects, I have adopted the advice of Professor Fitzharris who, in his report "Climate Change Impacts on Dunedin" of April 2010, states that a 0.66m rise should be assumed for the planning period to 2090.

7.2 Complementary to this, DCC currently require the floor level of coastal dwellings to be at or above 102.15m relative to Otago Metric Datum. This level is equivalent to 3.138m above Chart Datum (the lowest astronomical tide) or 1.309m above the present level of mean High Water Spring Tides.

7.3 Having adopted this standard, it is however important to note the high degree of uncertainty in the prediction of sea level rise. In this respect, I quote further from Professor Fitzharris' Report:

7.4 In summarising various predictions of sea level rise he states"

Such a wide range of values means that a reliable upper bound for sea level rise by 2090 can not be specified at this time

and

For Dunedin City, it is suggested that coastal risk assessments should assume that the probability of sea level rise of at least 0.5m by 2090 is very high and it could be as much as 1.6m

and

Consequently there is considerable uncertainty when assessing the impact of sea level rise and adaption options and in Section 6 Conclusions and Recommendations he states:

At this time, projected sea level rise of at least one metre by 2090 would be prudent for impact and planning exercises. The science in this area is currently inconclusive and needs to be followed closely by Council so as to continually adjust this estimate.

7.4 This uncertainty and the recognised fact that the processes of sea level rise and climate change are taking place at a very slow rate, support a strong argument for the assessment of the effects of sea level rise to be made with due consideration for the expected life or duration of the relevant activity and the ability to update or modify requirements as the science of sea level rise and climate change evolve.

8. Assessment of the Effects of Predicted Sea Level Rise

8.1 The following assessment has been based on a predicted rise of 0.66m by 2090 as quoted in the DCC Planner's Report, Clause 13.6 and the DCC requirement for the floor level of coastal dwellings.

8.2 Dealing firstly with the floor level requirement:

For a rise in sea level of 0.66m, the level of Mean High Water Spring Tides would be 101.501m above Otago Datum. A dwelling constructed in accordance with the DCC requirement would have its floor at 102.15m above Otago Datum giving a freeboard (clearance) above water level at mean high tide of 0.65m.

8.3 The highest tide recorded in Otago Harbour is 101.862m above Otago Datum. This was an extreme event and has not been repeated but it does provide us with some useful information:

8.4 Firstly, the level of this extreme tide was 0.36m above the level of mean high spring tides which would result from the predicted 0.66m rise in sea level.

- This extreme tide did create some inconvenience but did not cause any damage to persons or property.

- The water level simply rose and then fell as it does in the normal tidal cycle.
- There was some temporary flooding of low lying areas around the harbour but in relation to the site at Te Ngaru, the only inconvenience was the temporary flooding of parts of the road between Te Ngaru and Deborah Bay.
- To my knowledge, the road remained opened to traffic.

8.5 It should also be noted that sections of the Aramoana Road between Deborah Bay and Te Ngaru are subject to flooding at normal high spring tides and from my experience these occurences are not .

8.6 While inconvenient and of some concern to users of the road, there is no evidence of damage or adverse effects on the environment. Of greater significance is the fact that there was no detrimental effect on the properties at Te Ngaru and specifically, there is no evidence of flooding resulting from the high tide.

8.7 The level of some existing residential sections in Te Ngaru is lower than in the proposed subdivision so it is reasonable to conclude that there will be no detrimental effects on these from sea level rise up to the suggested extent of 0.66m to 2090.

8.8 Similarly there are no activities proposed for the new subdivision that could affect any natural process which may result from sea level rise. Natural processes would include shoreline erosion, littoral transport mechanism and drainage from storm water or tidal inundation.

9. Conclusion

9.1 On the basis of the rationale detailed above, I can find no reason to decline the application on the grounds that the resultant use will affect or be affected by sea level rise up to the predicted extent of 0.66m by the year 2090.

9.2 Furthermore there are existing properties in Te Ngaru which will be subjected to any possible effects to an equal or greater extent than the proposed new subdivision.

9.3 The only tangible effect identified in my assessment is that resulting from flooding on Aramoana, Road. While this occurs only at high tide and will remain thus, it is temporary and, in present conditions, not damaging.

9.4 Should these conditions change and the road becomes as issue, any decisions on maintenance, upgrading or protection will be made with due consideration of the needs of the communities at Te Ngaru and Aramoana and will not be materially influenced by the addition of three materially more allotments at Te Ngaru.

9.5 There is also a very convincing argument to maintain road access to Aramoana irrespective of sea level rise to allow maintenance of the mole which serves a very critical function in maintaining the entrance channel.

9.6 Although outside the brief for this evidence, but an issue which should be taken into account when considering the possible effects of sea level rise, I respectfully remind the Panel that there are areas of residential development on the shores of the harbour which are far more susceptible in terms of levels and exposure, to the adverse effects of sea level rise and climate change. The Harwood Flats and Te Rauone Beach are prime examples.

9.7 Finally, and with reference to my observations in paragraph 7.4 of this evidence, the Building Code will require that any dwellings proposed for the subdivision have a design life of 50 years. On the basis of DCC's current policy, sea level rise over this period would be 0.42 metre which not only provides an even greater freeboard than derived in my calculations, but in accepting that DCC will have the opportunity to update its policy in line with the science at the time of considering any new application for building consents, I reiterate that

the effects of rising sea level do not provide a valid reason to decline this application.