NAPIER PORT

19 March 2018

Hawke's Bay Regional Council
Private Bag 6006
Napier 4142

Attention: Reece O'Leary

NAPIER PORT PROPOSED WHARF AND DREDGING PROJECT - RESPONSES TO RMA Section 92 FURTHER INFORMATION REQUEST

The purpose of this letter is to provide a response to the Council's request for further information dated 26 February 2018, relating to applications CL180008C and Others to undertake a wharf expansion and dredging project under the Resource Management Act 1991.

The full response is attached, including where appropriate, the name of the technical specialist which has provided the response.

It is noted that some of the responses are technical in nature and if needed, the Port's technical advisers would be happy to clarify any of the matters with you or Richard Reinen-Hamill, Dr Terry Hulme or Dr Shane Kelly.

We trust this response provides sufficient further information to help Hawke's Bay Regional Council better understand the proposed activities and the associated potential effects.

An erratum and explanation relating to wind speed units is also provided at the end of the attachment – this matter arose subsequently to the S92 request.

Yours sincerely,

Todd Dawson
Chief Executive Officer

NAPIER PORT

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Further information requested

1. **Please explain whether the historic ecological data (which in some cases is 13-14 years old) provides an accurate representation of current ecological condition and please provide information detailing the current ecological values and condition of the dredging and disposal areas.**

Response

Cawthron Institute carefully considered the age of the ecological data, and whether it posed issues for the current assessment in the lead up to the work for this project. This matter was a key impetus for Cawthron's validation in 2016 of the benthos of the outer fairway with four additional triplicate samples and epifaunal dredge tows.

Dr Kelly has pointed out that the data suggests that temporal variability in benthic infaunal communities is as great, or greater, than inter-site variability. Such variability is however unlikely to materially affect the assessment. Dredging results in the complete loss of communities within the footprint of the activity. The assessment considers whether these communities have ecological value to the extent that their loss will impact the wider ecological functioning of the near-coastal area. While soft sediment communities may have changed in composition since 2005, it is extremely unlikely that this would involve an increase in ecological value which was not at the same time reflected in the very large area of similar benthic habitats outside the footprint, especially when one also considers that a significant proportion of the capital dredging footprint is already subject to periodic maintenance dredging. It must also be emphasised that any increase in ecological value as a result of existing temporal variability in such a dynamic inshore environment is intrinsically temporary.

The area of the proposed offshore dredge disposal ground is deeper and the soft sediment benthic communities may as a consequence be less perturbed by periodic storm and swell events. Hence they may be somewhat more stable. However, a similar rationale applies. There is no evidence to suggest that the proposed disposal area is (or may have become) ecologically distinct from the vast area of soft sediment habitat that exists locally in similar depths. While benthic communities may have changed slightly in community composition since 2005, it is extremely unlikely that:

1. Such change would not be reflected in all similar habitat to the north and south; and
2. Such change would exceed that which will be sustained over the short to intermediate term as a result of the deposition of dredged material (as assessed).

Together with the benthic surveys carried out for the inshore Westshore disposal grounds over the last 20 years, the compiled data provides a robust insight into the soft sediment benthos of the Port vicinity and its variability. This in turn leads to a sound level of confidence in the assessment conclusions as a whole.

(Commentary provided by Cawthron Institute)

2. **Please provide confirmation of whether or not unwanted marine pests are currently present in the dredging areas, together with an assessment of their potential impacts. Furthermore, provide information on the proposed methods for detecting and responding to unwanted marine pests when exercising the consents (if granted) and for the duration of the proposed consents.**

Response

Analyses of both the 2005 and 2016 epifaunal and macrofaunal samples did not identify the presence of any unwanted marine pests or harmful marine organisms (HMOs) in the vicinity of the dredging proposal. The absence of such pests from the Westshore disposal grounds in 2012 and Jan 2018 are a strong indication that they are also absent from soft sediment areas of the Port and its approaches (Smith 2013, Sneddon 2018).

Populations of non-indigenous species living in the dynamic sediment environments of exposed coastal sites (such as those of the proposed project) are unlikely to remain contained in small areas but are instead likely to spread with sediment and water movement. Examples of this include the recent spread of the Mediterranean fanworm (*Sabella spallanzanii*) and Asian paddle crab (*Charybdis japonica*) around soft-sediment habitats in Waitemata and Whangarei Harbours. Non-indigenous species identified in sediments from the 2004 and 2016 Napier surveys include the small bivalve *Theora lubrica* and the capitellid polychaete *Barantolla lepte*, both of which were also identified from the earlier baseline biosecurity survey for Port of Napier (Inglis et al. 2006).

The Mediterranean fanworm (*S. spallanzanii*) and clubbed tunicate (*Styela clava*) have a high affinity for hard substrata, but are also known to occur in soft sediment habitats, especially where shell material is present (e.g. Grange et al. 2011; pers comm. J. Atalah, Cawthron Institute). These species have not yet been recorded from Napier (https://www.marinebiosecurity.org.nz/), but given their substrate preference and principal introduction vector (shipping), it would be unlikely for them to establish exclusively in soft sediments (where chances of early detection would also be very low).

In addition to *Sabella* and *Styela*, New Zealand's list of designated marine pests includes a number of species that can be associated with soft-sediment habitats, namely: two species of soft-sediment bivalves (*Arcuatula senhousia* and *Potamocorbula amurensis*); three crab species (*C. japonica*; Chinese mitten crab, *Eriocheir sinensis*; European shore crab, *Carcinus maenas*); the northern Pacific seastar (*Asterias amurensis*); and a green seaweed (*Caulerpa taxifolia*)[1]. All have a high capacity for natural dispersal once established locally. Only *A. senhousia* (Bay of Plenty to Northland) and *C. japonica* (Coromandel to Northland) have been recorded in New Zealand.

For there to be a risk of dredge material transfer of HMOs, they need to be present in the dredged material, but not the disposal area, and not only survive the transfer process but also establish self-sustaining populations in the disposal area. Sessile species such as *Styela* and *Sabella* would be unable to reattach to hard substrates and would be very unlikely to survive.

The significance of this biosecurity risk furthermore relies on dredged material transfer being the principal pathway by which HMO spread and establishment in the disposal area could occur. For the assessment of risk, the overall proximity of the disposal area to the dredging areas (~5 km) is a key mitigating factor, since such distance would generally be covered by HMO propagules in natural

[1] https://www.marinebiosecurity.org.nz/what-are-marine-pests/

dispersion processes; that is, the transfer of pests in dredge spoil would not appreciably expedite such spread as would occur naturally. In regard to the spread of encrusting species, the nearest hard substrate to the disposal area is Pania Reef (3.3 km), but the Reef is also just approximately 1.5 km from the Port itself and closer again to the existing shipping channel. Sinner et al. (2012) concluded that short distance translocation of HMOs by the disposal of dredged material is of little consequence considering the natural dispersal ability of most marine species. The species on the MPI unwanted list that have not yet been recorded in Napier are certainly capable of natural spread across the relatively small distances involved and there are considered to be no oceanographic processes or habitat conditions that would act as barriers to such dispersal.

Theoretically, physical disturbance and alteration of sediment textural properties as a result of dredging and disposal could provide habitat conditions that are more suited to certain non-indigenous species. While it is generally accepted that the small bivalve *Theora lubrica* can be more abundant under conditions of moderate disturbance or pollution (Inglis et al. 2006), this NIS is already well established in Hawke Bay and is not considered an HMO. Short-term locally enhanced abundances would therefore be of negligible significance. Disturbed conditions from dredging and spoil disposal are not expected to markedly favour any of the HMOs noted above. In addition, the dredging proposal represents the expansion of an existing periodic activity and the spoil ground has generally lower exposure to shipping vectors than the Port and its immediate approaches.

(The above commentary has been prepared by Cawthron Institute, taking into account the footnoted references[2])

Port of Napier also notes that the proposed Regional Pest Management Plan 2018 – 2038 indicates that two unwanted marine pests of concern - Mediterranean fanworm (*Sabella spallanzanii*) and the Clubbed Tunicate (*Styela clava*) are currently not present in Hawke Bay.

The Port has recently undertaken (following discussion with the Council's Pest Management Team) to:

- increase awareness of the two pests though internal education;
- undertake public education through its web page about those pests; and
- ensure that identification of those pests is included in various procedures such as underwater pile inspections, underwater hull inspections of Napier Port owned vessels, navigation buoy removal and turbidly buoy maintenance.

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2 Grange K, Carney D, Carter M. 2011. Waikato marine finfish farming: site investigation. Draft NIWA client report no. NEL2011-004. 17p.

Inglis G, Gust N, Fitridge I, Floerl O, Woods C, Hayden B, Fenwick G. 2006. Port of Napier Baseline survey for non-indigenous marine species (Research Project ZBS2000/04). Biosecurity New Zealand Technical Paper No: 2005/13. Prepared for BNZ Post-clearance Directorate. 52p plus appendices.

Sinner J, Berkett N, Forrest B, Hopkins G. 2012. Harmful aquatic organisms - recommendations for the Auckland unitary plan. Cawthron Report 2232. Prepared for Auckland Council. 71p plus appendices.

Smith S. 2013. Monitoring of benthic effects of dredge spoil disposal at sites offshore from the Port of Napier: 2012 Survey, Triplefin Environmental Consulting. 41p plus appendices.

Sneddon R. 2018. Monitoring of benthic effects from dredge spoil disposal offshore from the Port of Napier: 2018 Survey. Report prepared for Port of Napier Ltd. Napier, Cawthron Institute: In prep.)

To avoid a duplication of regulations or regional rules under of the Biosecurity Act 1993 or those proposed under the Regional Pest Management Plan 2018 – 2038 respectively, Napier Port would be comfortable with a condition involving monitoring for detection and a managed response to unwanted marine pests when undertaking capital and maintenance dredging. Such condition could best be developed in close co-ordination with HBRC.

3. **Please describe the nature of the cohesive dredge material that may be deposited as clumps with limited friability. For instance, will this material be in the form of substantial lumps that alter the physical characteristics of the seabed at the disposal site. If so, how persistent are these lumps likely to be and will their presence affect ecological recovery?**

Response

It is difficult to determine the exact nature or persistence of cohesive material which may result from the dredging operation. This was considered in section 7.1.3 of Appendix H to the applications. As explained there, it is very likely that the deposition of dredge spoil will result in some change to sediment texture within the disposal area, and this change may persist, at least over the short to intermediate term. The presence of clumps of stiff silt material will not impede ecological recovery; however, the end-point of such recovery will be dependent upon the existing physical conditions of the substrate.

To arrive at a benthic community structure indistinguishable from that existing before deposition (or that which continues to exist in similar depths locally) would require a complete return to pre-existing physical conditions. Rapid 'recovery' of this nature is unlikely, since even the grading effect of deposition and subsequent winnowing of the "mound" by dispersive processes will result in textural changes that persist over the intermediate term. Accepting this, the more important question becomes that set out in the last part of the further information request, which can be encapsulated as: "Is this change likely to be adverse in terms of near-shore ecology in the wider area?"

No features of the disposal area mark it out as supporting a habitat or benthos that is unique or spatially limited in the wider area. Any increase in the structural complexity of the seabed will result in an eventual increase in local diversity, even if only at the discontinuities between differing substrates. Concomitant changes in ecological productivity are very unlikely to be negative. Such changes have been observed elsewhere in otherwise fairly uniform expanses of soft sediment seabed and the potential implications of this were considered in the assessment. The conclusion remains that, following ecological recovery, any persistent effects will be at worst ecologically neutral.

(Commentary provided by Cawthron Institute)

4. Please confirm whether, in relation to turbidity monitoring, the Environmentally Weighted Moving Average method of analysis referred to in Sneddon et al. (2017) is the same as the Exponentially Weighted Moving Average method of analysis.

Response

Where it appeared in Appendix H, the term "environmentally weighted moving average" was used in error. Exponentially weighted moving average is the correct term.

5. Provide an assessment of effects that the proposed wharf and dolphins may have on coastal processes.

Response

Wave energy incident on coastal structures along the alignment of the proposed wharf development will be dependent upon:

- Wave height, period and direction incident at the tip of the existing breakwater immediately north of the proposed development;
- Diffraction of wave energy past the breakwater tip; and
- Refraction of incident wave energy by the navigation channel adjacent to the Port entrance.

In this assessment the refraction of wave energy can be ignored as the navigation channel will either remain the same depth, in which case the degree of wave refraction will remain the same, or the navigation channel will be deepened, causing wave energy to be refracted to the eastern side of the revetment, which is more effectively sheltered by the breakwater, and the angle of incidence relative to the revetment will tend to reflect energy to the interior of the breakwater rather than to the wider marine environment.

Wave diffraction

Figure 1 shows a SPM nomogram (USASCE, 1984) of the wave height coefficient of a wave diffracting past the breakwater. To provide a conservative estimate the wavelength has been scaled to that of a 16s wave in 8m water depth. The incident wave direction considered is that of a wave approaching from due east at the Triaxis wave buoy.

The wave height coefficient due to diffraction (K_{diff}) at the toe of the replacement revetment (red line in figure) varies from 0.15 to 0.7 – that is, the wave height at the toe of the revetment is in the region of 20% to 70% of the wave height at the tip of the breakwater.

This compares with the wave height coefficient for the present port structure (blue line) of 0.6 to ~0.18.

Wave reflection

The reflection coefficient for various types of coastal structures is given in Figure 2, below. The reflection coefficient (K_{refl}) for a vertical quay wall with crow above water ranges from 1.0 (perfect reflection) to 0.7. The reflection coefficient for a rubble revetment breakwater with slope 1V:3H ranges from 0.6 to 0.3.

Comparison of change in wave energy reflected from new W6 revetment, compared to existing vertical sea wall:

- Existing: Assume best-case reflection coefficient in range, Kr = 0.7.
- W6: Assume worst-case reflection coefficient in range, Kr = 0.6.
- Consider 2m wave height at Triaxis wave buoy:

<u>Comparison of relative change in energy reflected to the wider marine environment</u>:

Wave height reflected from toe of structure and dispersed to wider marine environment:
$Hm0_{refl} = Hm0_{incoming} \times K_{diff} \times K_{refl}$

- For 2m incident wave and range of diffraction coefficients along the existing vertical wall, $Hm0_{refl}$ = 2.0 x 0.18 x 0.7 *to* 2.0 x 0.6 x 0.7 = 0.25m *to* 0.84m.

- For 2m incident wave and range of diffraction coefficients along the W6 development, $Hm0_{refl}$ = 2.0 x 0.2 x 0.6 *to* 2.0 x 0.7 x 0.6 = 0.24m *to* 0.84m

That is, the wave energy reflected to the wider marine environment for the proposed wharf and revetment will be the same or less than is reflected by the present port structure.

The analysis and commentary above was provided by Advisian. In addition, comment was also sought from Shore Processes and Management Ltd. This reviewed and confirmed the Advisian interpretation of the effects of the proposed wharf and dolphins on coastal processes. It also noted that very localised and minor disturbance of the seabed may occur adjacent to the piles of the dolphins due to turbulent currents, but this will not have an adverse effect on the stability of the piles or on wider coastal processes.

Figure 1: Diffraction nomogram scales to wavelength of 16s wave diffracting past tip of existing breakwater (nomogram from SPM (USACE, 1984)). The red line corresponds to the toe alignment of the revetment below the proposed new wharf

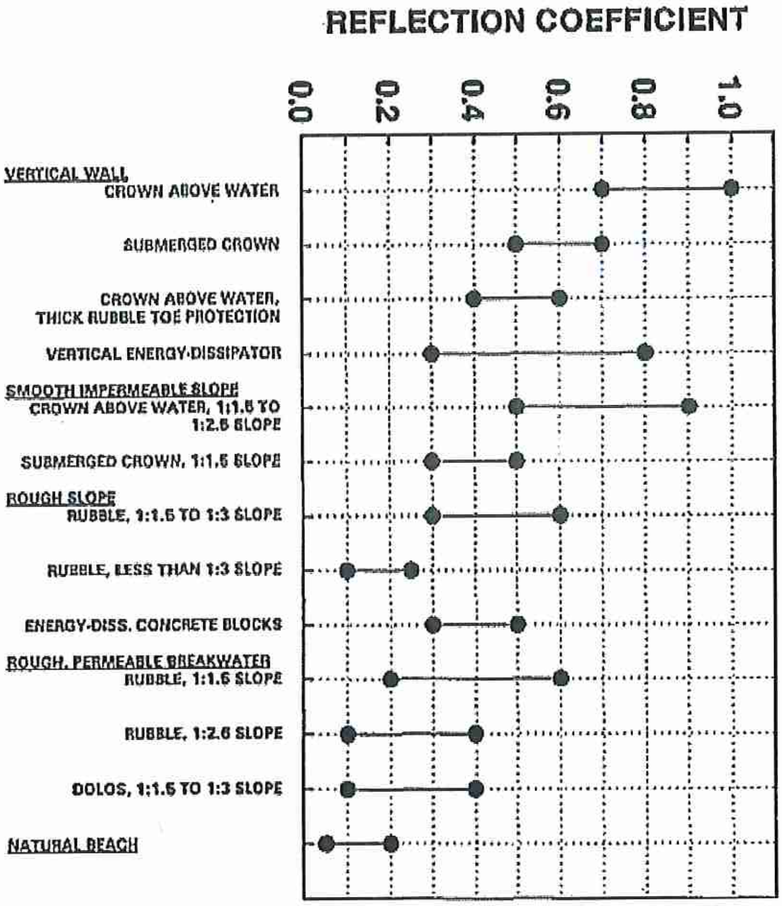

Figure 2: Reflection coefficients for common types of reflective coastal structures. DHI (2011).

6. **Please provide further information in relation to the effects from sea level rise and changes in storm surge/wave intensity on the proposed activities. The potential effect of the wharf, dredged channel and disposal should be considered/discussed. Furthermore, the possible changes to wave climate and tidal currents on sediment transport trends needs to be explained and discussed.**

Response

The project was developed and designed taking into account the former MfE guidance (July 2008) for coastal hazards and climate change. It is noted that the new MfE Guidance[3] was published only in December 2017. The main difference in the new guidance is a recommendation to test proposals against slightly more extreme weather conditions and sea level rise. In terms of NZCPS policy relating to development in areas of coastal hazard risk (NZCPS policy 25), the key consideration is to avoid increasing the risk of "social, environmental and economic harm", and any change in land use that would increase the risk of adverse effects from coastal hazards. This has been considered in relation to port infrastructure, as outlined later.

[3] Coastal Hazards and Climate Change – Guidance for Local Government, MfE, December 2017

In general terms, sea level rise has been considered in the assessment of effects of the dredged channel and wharf design. With regard to the channel, a higher sea level will be to reduce the effects of the deeper channel on the wave field and associated currents. Similarly, higher sea level will result in deeper water over the disposal area, and a reduction in the effect of the disposal mound on the wave field, and a reduction in bottom current speeds that may entrain sediment particles. The proposed work by Port Napier will not increase the level of coastal risk exposure in relation to sea level rise and climate change.

With regard to possible changes in storm frequency and intensity, the effects of the proposed work have been modelled under extreme wave conditions, and found to be minor or less than minor in relation to effects of the existing environment. There are no projections as to how more extreme future wave conditions may be, but an increase in frequency of storm events will not result in a different effect of the proposed work than has been identified.

(The commentary in the two paragraphs above has been provided by Shore Processes and Management Ltd)

In relation to the design of the wharf structure, a 1m rise in sea level was taken into account and provided for, as is noted in the Assessment of Effects. This is provided for and still enables the wharf and the adjoining reclamation area to operate as a continuous surface. Sea level rise beyond this will become a port-wide problem and simply constructing the new wharf higher than the current wharf levels will not provide any security against the effects of sea level rise. In particular the main operating areas of the port will remain susceptible regardless of the height of construction of the new wharf.

Napier Port intends over time to develop its overall strategy to tackle sea level rise in a holistic manner and has a number of potential strategies which it can use in the future. These include raising the existing wharves, either by lifting the decks, by applying overlays, or by providing external barriers. Such wharf modifications would need to be done in conjunction with a strategy for the land assets, which also can be in many forms including raising land levels, dewatering pumps and the like. Such an approach is in line with the NZCPS policy relating to strategies for protecting significant existing development from coastal hazard risk (NZCPS policy 27) and the DAPP (dynamic adaptive pathways planning) approach espoused in the new MfE coastal guidance.

Finally, it is noted that the wharf and dolphin structures will also require consents under the Building Act, which will address the detail of the design.

7. **It is noted that no information has been provided on expected maintenance dredge volumes. Can you confirm the proposed dredge disposal area and the existing consented areas have sufficient capacity for both capital and maintenance dredging and that the effects of maintenance dredging disposal has been considered (i.e. presumably this results in an increased elevation of disposal mounds and/or it is expected that a proportion of the placed material will migrate).**

Response

Napier Port historically requires maintenance dredging every 2-3 years, with an annualised volume of approximately 25,000m^3 per annum. Areas that require dredging are typically the eastern boundary of the main channel, in particular after large swell events, and in-filling of finer material from the west. Although the channel will be somewhat wider and deeper it is not expected that the level of in-filling will increase significantly where the development overlaps the existing channel and swinging basin, and will only be increased proportionally for the additional length of channel. The expected maintenance dredging volumes are significantly less than the capital volumes, and will not significantly alter the bathymetry of the disposal area. These volumes have been allowed for in assessing the effects of the overall disposal of dredged material.

Maintenance dredge material is expected to have dispersion characteristics depending on the grain size distribution, as described in the application documentation.

8. Please provide a response and further information in relation Richard Reinen-Hamill's concerns relating to sediment transport and potential effects associated with the proposal (below in italics):

Mean changes in wave direction (Appendix D – Table 7.1) can result in changes in alongshore sediment transport and these results suggest increase alongshore transport from Westshore to Bayview and similarly from Port Beach to Ahuriri Inlet. While it is understood that these changes may be less than the natural variability, this constitutes a net change that moves the baseline that variability will occur. Appendix D – Figure 8-4 appears to suggest a realignment of the shoreline between Port Beach and Ahuriri in the order of 2 degrees. If this results in a change in the stable coast angle, this could result in lowering sea beds to the east and increased seabed/beach levels to the west that may have implications on existing revetment stability and/or overtopping frequency and quantity from storm events (not mean wave events) as well as increase sediment ingress into the lagoon.

There appears to be a similar, but lesser effect along Westshore Beach with a more subtle reorientation of the wave energy. While the findings set out in Section 9.3 of Appendix D and Section 4 of Appendix G discuss net changes, it does not fully extend to the implications of these effects. A more developed assessment of the potential effects of the identified changes would be useful taking into account present day and future sea level rise and whether these changes could contribute to existing erosion processes.

While Single (Appendix G) discusses the change in land elevation resulting from the earthquake there is no discussion of the uplift and subsequent down cutting of the seabed seaward of Westshore, both in terms of sediment budget, transport rates and likely sediment properties. This is material in that while sediment placed in Area R will move, the speed of removal and the effect the increased seabed elevation makes on gravel alongshore transport may be material.

I note Appendix G – Figure 2.5 appears to support the findings of some north easterly sand transport pathway off the Port. Figure 5-6 (for 125 micron of 70% of vibrocore) shows predominantly northerly transport for all but the NW scenario and this seems to be supported in Figure 6-7 (Appendix F). The mean transport vectors for 125 micron that show southerly transport therefore is largely due to the large rates of southerly transport during the NW wind which occur less than 13% of the time and during winds from these sectors, no significant wave heights are measured. What wind condition, combined with the NW wind results in the transport vectors shown in Figure 5-6 and are these combinations likely?[4]

Responses

[4] Tonkin & Taylor, Port of Napier Proposed Wharf and Dredging Project AEE - Preliminary coastal processes review. Prepared by Richard Reinen-Hamill, 24 January 2018

Response to Paragraph 1

Please refer to Appendix D to the application documentation, Figure 7-1 and Table 7-1. The net direction of longshore transport between HDR02 and PB01 is eastward, as is evidenced by the orientation of Port Beach and sand accumulating against the western edge of the groyne close to point HDR01 (see also Figure 3, on the following page). The clockwise rotation of wave activity between PB01 and HDR02 will therefore reduce overall littoral transport, as the change in wave direction will reduce eastward transport rather than increase westward transport.

Somewhere between HDR02 and HDR03 the net direction in littoral drift changes to become westward. Therefore between HDR03 and AI01 littoral drift would increase, although noting that the change in wave direction along this section of the beach is equal to or less than 1°. This rotation can only be realised if there is sufficient wave energy on the beach to drive morphological change.

The beach at the eastern mole of Ahuriri Inlet is in close alignment with the incident wave direction and would require a clockwise beach rotation of about 4 degrees before the MSL contour moved seaward of the Ahuriri Inlet eastern training wall. That is, any adjustment of the beach is likely to be minor and contained within the bounds of the Ahuriri Inlet eastern training wall and the rubble shore at Spriggs Park.

The commentary above has been provided by Advisian, and reviewed and confirmed by Shore Processes and Management.

In addition, proposed conditions 12 and 13 (Coastal Monitoring) in section 26.3 of the Description and Assessment of Effects document have been put forward to assess the actual change to this section of shore, and can additionally provide for recommendations of mitigation actions if required. Shore Processes and Management considers that potential necessary mitigation (if needed) is likely to be limited to occasional additional maintenance dredging of the Ahuriri Inlet channel.

Response to Paragraph 2

Previous analysis by WorleyParsons has shown that the present beach plan alignment at Westshore is 'out of equilibrium' relative to the prevailing wave direction climate. This situation may have also been affected by the 1931 earthquake. The 2005 analysis suggested that the equilibrium shoreline position at Westshore is landward of its present position. The predicted 1° clockwise rotation at Westshore due to the extended navigation channel (the geometry of which has been optimised as much as possible to mitigate impacts) will not significantly influence the underlying trend of shoreline readjustment at Westshore.

Any SLR will reduce the relative change in wavelength (and therefore celerity) for a wave of given period propagating from deep to shallow water. This will tend to reduce the degree of wave refraction by the navigation channel.

The commentary above has been provided by Advisian, and reviewed and confirmed by Shore Processes and Management. Shore Processes and Management also notes that the effects of the proposal will not be discernible as separate from the existing variability of coastal processes and coastal change along Westshore.

Figure 3: Beach alignment between Port Beach and Ahuriri Inlet.

Response to Paragraph 3

Shore Processes and Management has commented as follows:

The 1931 earthquake effects at Westshore and the subsequent adjustment of the seabed and shore since 1931 are part of the existing environment. Although there is scope for placement of suitable dredged sediment in Area R, the volumes of such sediment are not foreseen to be more than have been placed historically, and are done so to provide possible nourishment for the beach. If HBRC monitoring shows this to not be beneficial, then that activity could be stopped.

Response to Paragraph 4

The simulations shown in Appendix F, Figure 6-7 were run assuming extremely severe conditions that were not observed in wind data between 2005 and 2015.

These extremely severe conditions were selected to show where silt at the offshore disposal site might move to under a hypothetical, extremely severe, storm event that (a) has wave orbital velocities strong enough to suspend coarse silt at a depth of 20 meters, and (b) has wind driven currents strong enough at the bottom of the water column to move coarse silt a significant distance before it is able to settle out of the water column.

The purpose of the simulations were to show if, under an almost impossibly conservative scenario, there might be any potential for silt at the offshore disposal site to be suspended over and deposited upon Pania Reef.

The wave condition selected was Hm0 = 3.3m (Tp = 13s). Figure 4 shows that this particular wave height has not been observed in combination with NW winds of any speed (as derived from hourly-averaged wind speed and direction) in over 10 years of data.

The wind speeds used in the simulations presented in Appendix F, Figure 6-7 were the hourly-averaged wind speeds that, on average, are not exceeded for more than a total of 24 non-contiguous hours throughout the year (Table 1). These wind speeds were then assumed to blow continuously for 72 hours. That is, wind conditions that have not yet been observed in available wind measurements at Napier but might happen under a very rare storm event.

The pathways for each wind scenario shown in Appendix F, Figure 6-7 are therefore not intended to be additive to produce a 'mean annual' pathway, as has been done in Appendix F, Figures 5-5 to 5-8.

The simulations presented in Appendix F, Figures 5-5 to 5-8 assumed more moderate wind and wave conditions to assess sediment transport pathways: Simulations assumed a wave height of 2.2m (Tp = 13s), which is a storm wave that has been observed in combination with all hourly-averaged wind directions measured at Napier Port anemometer. This was applied in combination with the hourly-averaged wind speed not exceeded more than 24 hours per year (Table 1). The simulations were run for a prototype time of 24 hours to allow the water column to 'spin-up'.

Table 1: Hourly-averaged wind speed not exceeded for more than 24 hours per year (99.7th percentile), for the 6 most important wind directions.

Sector	NE	E	SE	SW	W	NW
Speed (m/s)	10.4	12.3	12.6	11.4	15.8	15.2

The relatively high wind speeds applied for the NW reflects that this sector tends to have a higher percentage of strong winds than, say, the more frequently occurring south-west (as shown in the wind rose in Appendix F, Figure 2-2).

Higher percentile winds (>90th Percentile), which are disproportionately responsible for transporting sediment due to promoting stronger wind-driven currents (sediment transport proportional to [current speed]^3), preserve the relative magnitude of wind speeds between each sector shown in Table 1.

One-hour averaged wind speeds were used as it is considered a more realistic measure of wind activity relative to the response time of the water column, compared to 1-minute gust speeds. However it is worth noting that the wind speeds in Table 1 compare to between the 90th and 99th percentile 1-minute wind speed given in Appendix D, Figure 2-4, so whilst high they are not 'extremal' in magnitude – the duration is likely also important.

What matters in deriving the sediment transport vector maps shown in Appendix F, Figures 5-5 to 5-8, is that the relative strength of wind speed between sectors is preserved, which is the case if one considers wind events corresponding to the same percentile across the compass bearings. The circulation patterns for a lower wind speed will be the same, but with a lower current.

The high transport rates for wind approaching from the NW (relative to that realised for the other directions) is a function of wind speed, but even more so the plan alignment of the coastline and bathymetric contours. This effect is shown in Appendix D, Figure 8-7, where, for the same wind speed and event duration, winds from the NW resulted in a much higher depth-averaged current speed around Napier Port than for the other compass bearings.

The commentary above has been provided by Advisian, and reviewed and confirmed by Shore Processes and Management.

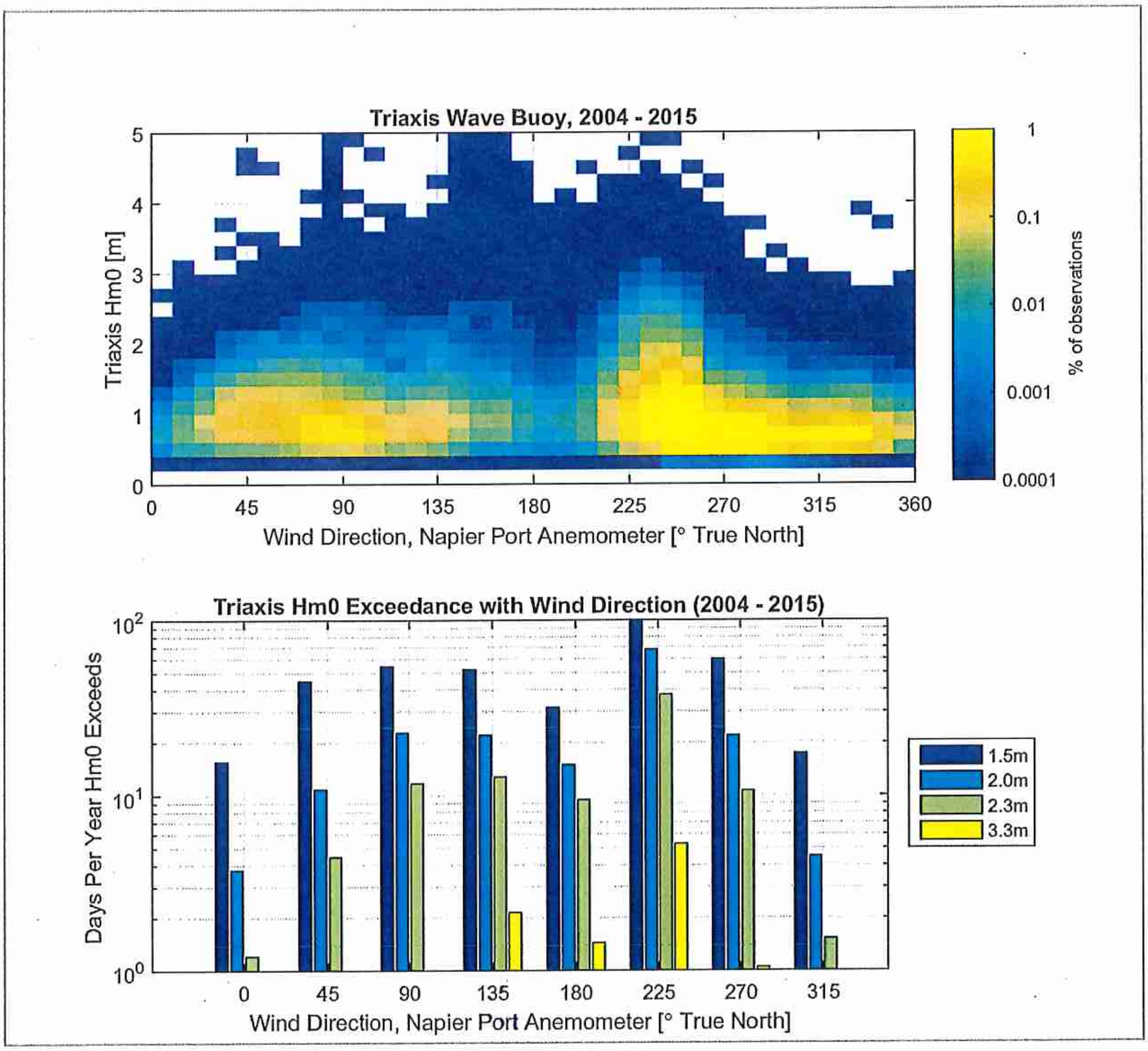

Figure 4: Statistical comparison between wave height measured at Triaxis buoy and hourly averaged wind direction, as measured at Napier Port anemometer.

9. In relation to effects on coastal processes, Please explain the use of the Boussinesq simulation and use of the calibrated and validated SWAN spectral wave model for the predictions. Furthermore, please explain the selection of the storm event measured in July 2016 on which to base the simulations.

Response

Use of SWAN model vs Boussinesq model

Where applicable the calibrated SWAN model is applied to assess coastal processes around Napier Port. However in the immediate vicinity of the Port, along Port Beach and the eastern section of Hardinge Road, wave diffraction is an important process, as is strong wave refraction by very sharp bathymetric changes due to the navigation channel. Here the Boussinesq model is applied to illustrate the relative change in wave height expected for a specific wave condition relevant for surfing.
It is not feasible to run the Boussinesq model for a large number of wave conditions and analyse time-series output for each one to assess changes in wave height and directionality. Hence, the SWAN wave model is applied for this larger number of wave conditions and analysed to calculate the relative change in wave height and direction.

Swan model calibration

As Appendix D, Section 4.2.1 and Figure 4-2 clearly describe, two storm events were used to calibrate the wave model using friction and directional spreading as independent variables, with water level as an additional sensitivity test. The storms selected provided a total of 150 data points on which to calculate error metrics and calibrate the model. The storms encompassed Hm0 from 0.5 to 1.5m, Tp from 5s to 15s, and incident wave direction from 80° TN to 135° TN. That is, the calibration data encompassed most of the generally observed wave conditions described statistically from the long term wave climate in Appendix F, Figure 4-4.

The calibrated model was subsequently validated against three further storm events that together included an even wider range of wave conditions, with Hm0 ranging to 3m, Tp ranging from 5 to 20 seconds, and MWD ranging from 90° to 135° TN.

As shown from the calibration error metrics presented in Appendix 4-3 to 4-5, and the time series at the validation locations in Figure 4-9 to 4-10, the performance of the wave model was judged against a total of five wave events (not one as suggested by the reviewer), encompassing most of the wave climate variability shown in Appendix F, Figure 4-4, and was found to be entirely satisfactory.

(The commentary above has been provided by Advisian)

10. Discuss the effect that the small changes in sediment transport predicted in Appendix D (Figure 8-4 and the realignment of the shoreline between Port Beach and Ahuriri in the order of 2 degrees) may have on the wave quality at the respective breaks.

Response

The small changes in sediment transport described in Appendix D (Figure 8-4) and the predicted realignment of the shoreline would only occur if there is sufficient wave energy to drive morphological change. Any sediment transport changes that would occur in the vicinity of the breaks would therefore affect the finer sediment transport fractions, with the wave energy being insufficient to cause any morphological changes to the coarser, cobble/gravel fractions. The bathymetric levels at the respective surf breaks would likely not change, therefore, for the portions of the break that are on cobbles.

As described in our response to Q8 (Para 1) above, the net direction of longshore transport along the eastern half of Port Beach is eastward, as evidenced by the orientation of Port Beach and sand accumulating against the western edge of the groyne at Battery Road (refer Figure 3). The clockwise rotation of wave activity in this area will therefore reduce overall littoral transport, as the change in wave direction will reduce eastward transport rather than increase westward transport. Further west along the beach at Hardinge Road, the change in wave direction along this section of the beach is equal to or less than 1°. The clockwise change in wave angle would reduce the tendency at the eastern half of the beach, where the surf break is located, for sediment to be transported eastward towards Port Beach, but sediment transport potential will still be toward the east in this location. Thus the mean local sediment transport patterns at the Hardinge Road surf break would likely remain unchanged from the existing pattern and there would be little or no change to the bathymetry at the surf break at Hardinge Road.

As described also in our response to Q8, the beach at the eastern mole of Ahuriri Inlet is in close alignment with the incident wave direction and would require a clockwise beach rotation of about 4 degrees before the MSL contour moved seaward of the Ahuriri Inlet eastern training wall. That is, any adjustment of the beach is likely to be minor and contained within the bounds of the Ahuriri Inlet eastern training wall and the rubble shore at Spriggs Park. Therefore, there would be little or no additional sediment supply to the City Reef break from east of Ahuriri Inlet that would affect the bathymetry at the City Reef break.

As discussed in Section 6 of Appendix D, the peel angle at the breaks is defined as the angle between the crest of an unbroken wave and the trail of the broken wave (white water). As the trail of the broken water is parallel to the bottom bathymetry contours at the breaking location, any rotation in the bathymetric contours at either City Reef or Hardinge Road that may occur over time in response to a rotation in wave approach angle would tend to counteract the changes in peel angle that would occur – i.e. the peel angle at the breaks would initially be slightly larger than existing but would tend to return toward their existing values over time as the seabed bathymetric contours rotate.

Any realignment of the shoreline as described in Appendix D would, therefore, not be expected to have any noticeable effect on the wave quality at the respective breaks.

The commentary above has been provided by Advisian, and reviewed and confirmed by Shore Processes and Management.

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11. In relation to the post disposal fate of dredged sediments, justify and explain the choice of critical shear stress for erosion of cohesive sediments and the choice of the 'erosion parameter'.

Response

The critical shear stress is normally a site specific quantity best measured *in situ*. However in the absence of site specific data a value was selected on the basis of values described in engineering literature, and referenced within Appendix F. Reviews of other studies report a similar range of values.

The critical shear stress chosen for erosion of cohesive sediments has been chosen based on the assumption that the bed sediments in the dredged areas comprise "partly consolidated mud" in accordance with the range of values presented in Table 4.2 of Appendix F.

We have chosen a critical shear stress of 0.2 N/m^2, which is at the lower bound of the values recommended for partly consolidated mud in Partheniades (1965) and Parchure & Mehta (1985). A lower threshold value tends to indicate that the sediment would be more likely to be re-suspended, which provides for a conservative analysis. The chosen value is conservative for the natural underlying cohesive sediments which have undergone natural consolidation over time, making it less likely that these sediments would be resuspended.

Note that the modelling is representative of the processes during and immediately after the dredging. The value is considered appropriate for the softer sediments which have been deposited, partly consolidated and resuspended solely from the dredging works at the project site.

As the goal of the simulations was to maximise sediment mobility for a given magnitude of wave stirring and current speed in the overlying water column, the specific value selected was chosen at the lower bounds for partially consolidated mud, which is considered reasonably approximate to the silty clay matrix described in geotechnical borehole data. If sediments were considered to be hard mud, for example, the corresponding critical erosion sear stress would be much higher and sediment mobility commensurately less.

The selected value of 0.2 N/m^2 compares to a critical erosion value of ~0.15 N/m^2 for non-cohesive fine sand and coarse silt (**http://www.leovanrijn-sediment.com/papers/Thresholderosion2016.pdf**, Figure 1.5). That is, it is expected that the silt material deposited at the offshore disposal ground will have a degree of cohesion that will slightly increase the shear stress required to initiate mobility.

The 'erosion parameter' governs the rate at which material is entrained to the water column once the critical erosion shear stress is exceeded. The higher the number, the greater the sediment mass injected into the water column per unit area and unit time.

For numerical modelling of 'pseudo-cohesive' sediments (muddy silt), transport is typically limited by sediment availability (which is certainly the case at the proposed off-shore disposal area) and by the erosion rate, which is governed in the simulations by the 'erosion parameter'. Other authors report using erosion parameter in the range of $1E^{-5}$ and $1E^{-6}$ for short-term, 'engineering type' studies for erosion of partially consolidated bed sediment. The erosion parameter used in this study lies above the upper limit of this reported value. That is, the simulations reported in Appendix F Section 6.3 provide a conservative estimate of sediment mobility. Note that the 'erosion parameter' is a parameter that can be tuned during the model calibration process.

(The commentary above has been provided by Advisian)

ERRATUM

It has been drawn to the Port's attention that Appendix D, Figures 2-3, 2-4 and 2-5, give wind speed in m/s but in fact show the 1-minute wind speed in knots. This was however not carried through to the modelling undertaken by Advisian and reported in Appendix D and F – the wind speeds were converted to m/s prior to use as a boundary condition.

Figure 2-3 is repeated in section 7.6 of the Description and Assessment of Effects. Replacement diagrams are attached.

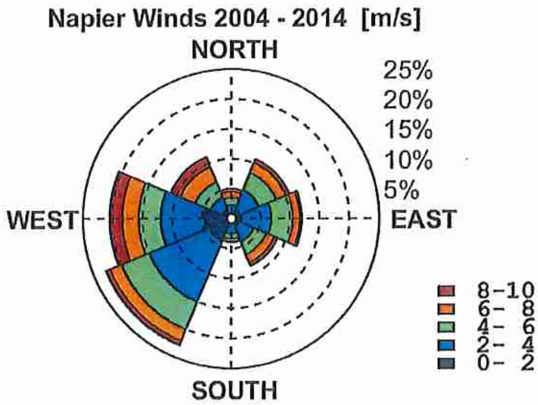

Figure Error! No text of specified style in document.**-5: Rose plots of 1-minute average wind speed measured at Napier Port. Directions given as 'coming from'.**

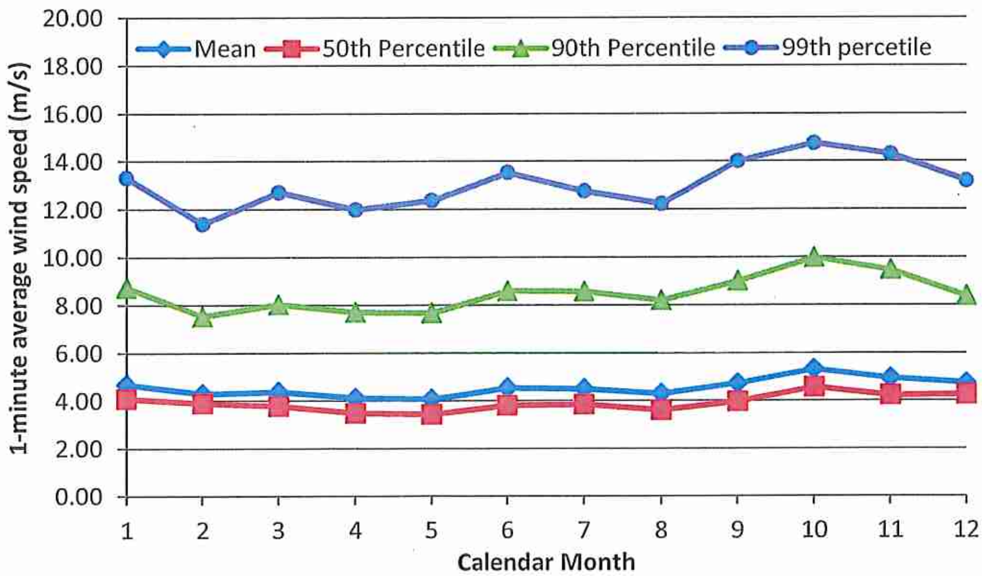

Figure Error! No text of specified style in document.**-6: Monthly statistics of 1-minute average wind speeds at Napier Port anemometer.**

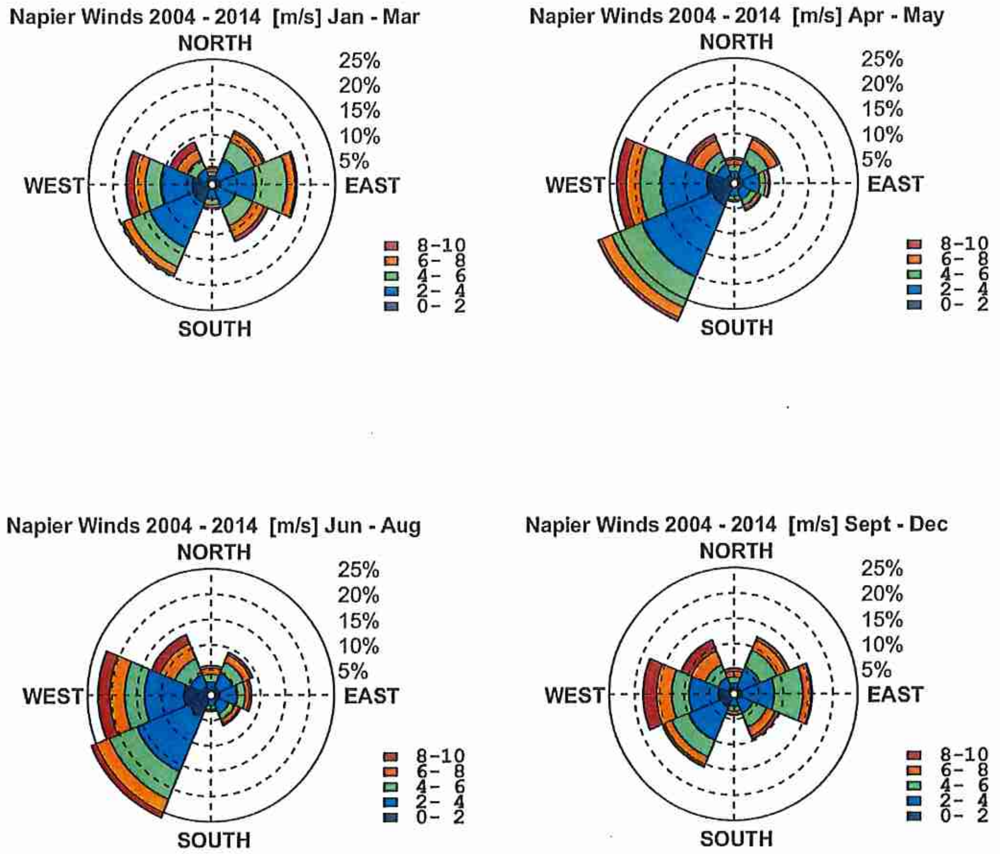

Figure Error! No text of specified style in document.**-7: Seasonal wind roses of 1-minute average wind speed and directions at Napier Port anemometer. Directions given as 'coming from'.**