RESPONSES TO QUESTIONS FROM HBRC RELATING TO NAPIER PORT'S WHARF AND DREDGING PROJECT APPLICATIONS, RECEIVED 5TH JULY 2017

Question 1:

We previously asked the following question:

Appendix E and F provide information on re-suspension. However, material finer than coarse silt has not been modelled. Why has this material not been modelled?
What are the effects associated with the re-suspension of this material?

The answer came back as:

Clay and silt fractions are included in the deposition modelling shown in Figs 29 and 35 of Appendix E (see Sections 5.3 to 5.5). This addresses initial deposition. The explanation of why clay and fine silt are not included in the resuspension analysis is given in Section 4.2.2 of Appendix F. The assumptions relating to resuspension at the offshore disposal grounds are set out in Section 6 of Appendix F.

Appendix E explains that clay and silt are included in the modelling, but the accompanying graphs Figs 29 and 35 show modelling output just for silt (and not clay). Is this just an error in the caption? (The same applies to the 2 plots sent with the s.92 response)

Response:

The captions for Figures 29 and 35 should read "Silt and finer material deposition percentile exceedances, ...".

Please note that the deposition output in Figures 29 and 35 includes all six silt and clay fractions modelled up 62 micron, from Table 2 in Section 4.2.2 of Appendix E, as reproduced below. The deposition of the sand fractions are represented separately in Figures 30 and 36. Thus the plots in Figures 29 and 35 show both silt and clay deposition and do not omit the clay fractions.

Table 2: Particle size classes and settling velocities used for the modelling assessment

Particle Size Fraction [micron]	Settling Velocity [cm/sec]
2 (clay)	0.00035
4 (clay)	0.0014
8 (silt)	0.0057
16 (silt)	0.023
31 (silt)	0.085
62 (silt)	0.329
125 (sand)	1.2
250 (sand)	3
500 (sand)	8
1,000 (sand)	15
2,000 (sand)	28

Question 2:

What proportion of the capital works dredgings will be of grain size fine sand or larger and suitable for disposal in the nearshore off Westshore?

The DRAFT MoU states "Napier Port will make suitable material from its capital and maintenance dredging consents available for the purposes of beach nourishment or other coastal protection in the vicinity of Westshore". Therefore, please provide an approximate m^3 figure that represents the volume of material considered 'suitable' by the Port's expert in this field.

The m^3 figure of suitable 'capital' material **from this project** =
The % of future 'maintenance' material likely to be suitable =

Response:

As indicated in the application, the investigations show that none of the material available for the capital component is likely to be suitable for disposal at the existing disposal site RExt. While the investigations indicate that some areas later in the dredging programme have a higher percentage of sand-sized material, this is still mixed in with high portions of fine material. Based on the presently-known grain size distribution of the material our advice is that there is no sand with suitable grain size distribution which may provide benefit to Westshore. It is impractical to filter or sort the percentage of larger grain sized sand from the overall material available. However, the Port will continue to investigate the material for its suitability as the dredging programme proceeds and more detail of the subsurface material comes available. It is therefore unrealistic to provide any estimate of potential volumes at this stage.

A similar situation applies to expected maintenance dredging material, based on recent sampling (supplied in the previous response), but again the Port will continue to sample this material. As explained in the application, the timing of the capital dredging programme is not known and it is also not known whether there will be separate maintenance dredging campaigns between capital dredging stages, or whether all maintenance dredging will be undertaken as part of the next stage of capital dredging until the dredging project is completed.

In the context of the draft MOU/SOI, the term 'suitable material' also refers to the suitability of the sand for use in alternative methods that may be explored by others, for instance in conjunction with control structures or disposal at an alternative location such as further south than RExt. The consent obtained by others would form the basis of what is considered suitable.

Question 3:

Please provide information/clarification on the matter of wind speed. The issue was raised by submitter, Richard Karn.

HBRC experts need confidence that the wind speed used is correct to ensure their assessment of the effects influenced by wind speed are based on accurate information.

Context

The points that Richard Karn has made regarding windspeed need to be clarified urgently. NIWA data shows windspeeds over 57km//hr are rare.

https://www.niwa.co.nz/static/Hawkes%20Bay%20WEB.pdf

There are also orographic effects with the wind data from the Port that may concentrate westerly focus compared to the airport but most plots show similar ball park trends. A quick check on all directions of wind from the Cliflo database from the airport suggest less than 0.1% of wind occurs greater than 16 m/s and only 0.5% above 14 m/s. The WP (2005) report wind rose (Section 2.4, fig 2.6) does seem to support the view that wind speed units may have been incorrectly assessed by Advisian. If wind speed units were in fact incorrectly assessed, HBRC experts need to know the implications of this.

While noting the wind rose in Fig 2.6 (WP, 2005) is from 1999-2005 and Figure 2.3 (Advisian, 2017) is from 2004-2014 and the scale bars are for different frequency bins, the WP (2008) frequencies from the south west are just over 15%, while Advisian (2017) has frequencies from the same direction of approaching 24%. Similarly the wind speed bands appear to show higher frequencies of occurrence in the Advisian report than the WP report. The Advisian report may well be correct that the median wind speed is in the order of 8 m/s, but the wind rose they provide suggests an average speed of between 4-6 m/s (on their scale).

Response:

(The response below is provided by Ben Williams of Advisian).

The wind speed units in Appendix F, Table 3-1 have been misinterpreted and are in knots, rather than m/s. The values have been applied to the 3D hydrodynamic model as m/s to derive the sediment transport pathways as shown in Appendix F, Figure 5-8. The implications of this misinterpretation are explained below.

The issue of wind speed, direction, occurrence interval and duration has not played any part in assessing the erosion of sediments at Westshore. The ability of waves and currents to move sandy sediments, of a particular grain size distribution and at a particular location, has been assessed purely on the basis of site-specific *measured* wave and current observations – no numerical simulation played a part in this. The important results are Appendix F, Figures 5-1 to 5-4.

Once sediments have been mobilized by ambient wave and current conditions, the 3D simulations estimate the most likely direction in which sediments would move “over the long term” (inter-annual to decadal). The sediment transport vectors provided by the 3D model are *relative* magnitudes. That is, the relative scale is preserved between simulation results for different sediment fractions and wind sectors. There is no quantitative prediction inferred from the 3D simulation results.

What matters in the 3D simulation results is that the relative strength in wind speed is preserved between sectors, at a particular recurrence interval (that is, percentile wind speed). A high wind speed percentile was deliberately chosen across the octants, as the model ‘spins up‘ to achieve a quasi-steady-state much more quickly than if some mean value is used. There is no requirement for a link between wind speed and duration to a simulated current pattern, only that steady-state (or quasi-steady-state) conditions are achieved

A high percentile (rather than the mean) wind speed is appropriate to derive sand-sized sediment transport pathways within Hawke's Bay because, for a particular sediment diameter, the carrying capacity of the water column is roughly proportional to <current speed>^{3}. This means that if you double the current speed, the amount of sediment it can carry increases by a factor of 8. This means that, over the long term, sediment transport *patterns* tend to be determined by relatively infrequent events (such as storms).

The vectors in the transport pattern then must be scaled down appropriately to represent 'mean' or 'long term' conditions. In our case, the simulations are required only to assess long-term sediment transport pathways – that is, the directionality, not the magnitude. The scale factor is therefore determined by the relative occurrence of each wind sector applied to the model.

Table 1 below shows the % occurrence of each wind direction based on 1-minute wind data, averaged to hourly values, for the period 2004 – 2018. Table 2 shows an example of wind speed-duration for the NW sector (units m/s). Hourly averaged wind speeds >14 m/s are observed at the anemometer and can persist over several hours. That is, the wind speeds applied to the simulations are high but based on values observed to occur.

The concept of sediment transport conditions being determined by conditions more severe than the mean or most frequently occurring condition is sketched in Figure 1, below, for winds occurring from the NW. The occurrence of speeds >14 m/s, whilst relatively rare, are not negligible when it comes to sediment transport.

The concept of simplifying boundary conditions to reproduce a target sediment transport pattern for non-cohesive morphological simulations is found elsewhere in coastal engineering:

- In tidal estuaries, as a rule-of-thumb the net directionality and relative magnitude of residual sediment transport *patterns* (pathways) is generally determined by the spring tide. The *magnitudes* from these simulations must then be scaled down to that expected from the mean tide.

- The ability of sediment transport (bypassing) around coastal structures such as groynes is linked to the concept of the "closure depth", which is often empirically linked to the wave height not exceeded for more than 12 hours per year. The magnitude of annual-average long-shore sediment transport is generally determined from conditions closer to the mean.

- In my own research, for which I wrote a genetic algorithm to identify the most morphodynamically relevant boundary conditions and their 'optimal' weighting from a "medium-term" (weeks and months to years) dataset, the AI consistently found that the *pattern* was best determined from a limited combination of large events but with the weighting scaled appropriately to achieve the morphodynamically relevant *magnitude*.

In all such simulations that use a subset of the full environmental forcing to determine the overall target *pattern*, a 'reality-check' must be undertaken against site-specific data. For the simulations of sediment transport patterns around Napier Port, the 'reality check' is benchmarking the weighted simulation results against measured current meter data at several locations around the Port. The current data, measured by ADCP and tilt-drag current meter over a period of months to a year, including both summer and winter seasons, clearly show the presence of a net residual current, with directions that very strongly corroborate the sediment transport patterns determined from the simulations, at multiple locations.

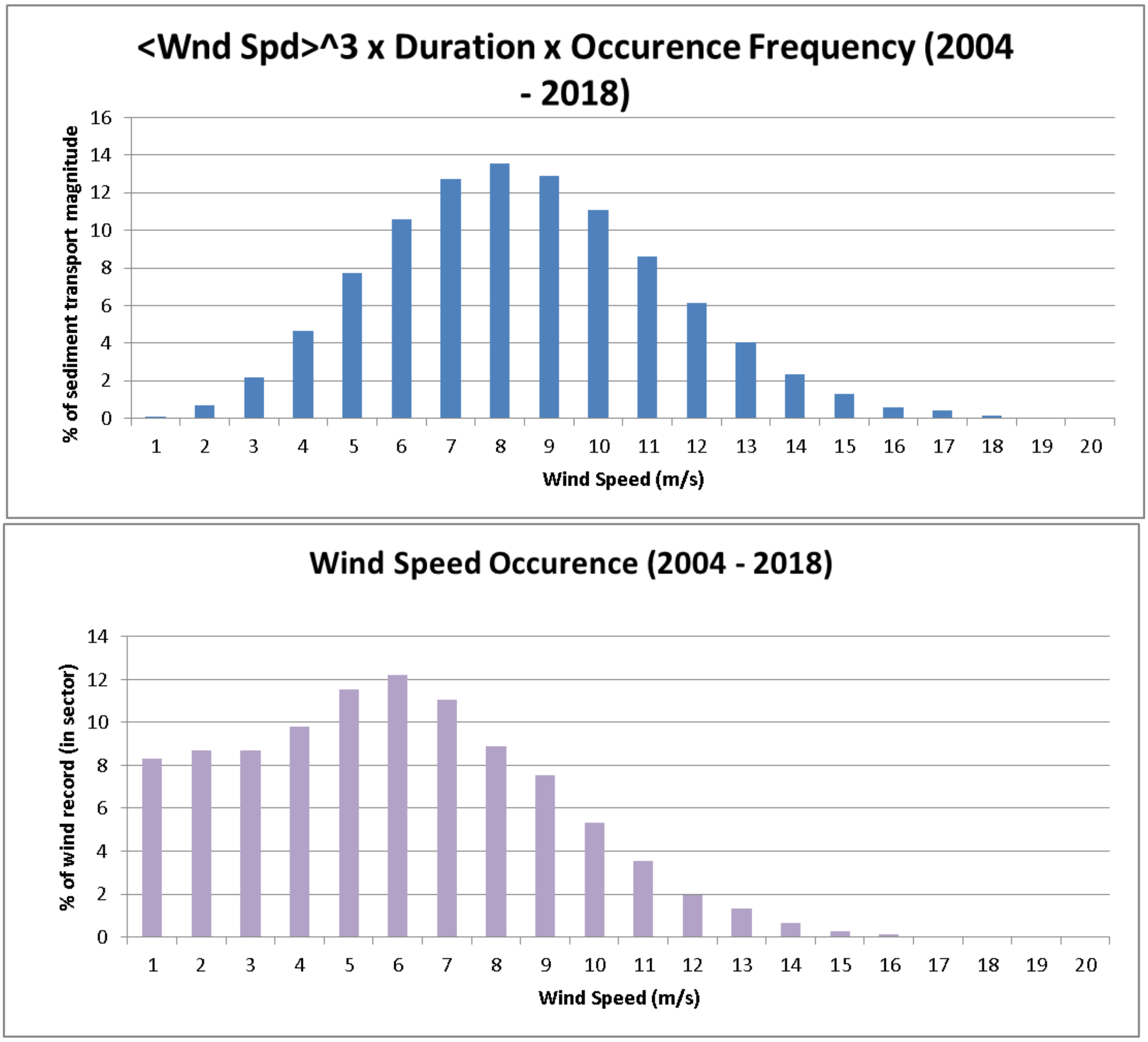

Figure 1: Simplified sketch of relationship between wind speed and expected contribution to sediment transport.

We can further say that the current roses determined from each location are a very good indicator of the mean sediment transport direction (and variation around the mean direction) because the current roses have been assessed for sediment transport using the Van Rijn sediment transport algorithm that combines the full range of waves and currents measured at the sites. These show that, exterior to the surf zone, the current direction generally determines the direction in which sediment will move.

An additional, independent benchmark of the long-term directionality inferred from the 3D non-cohesive sediment transport simulations is provided by previous hydrodynamic simulations of windinduced current speed and direction (Figure 2). These consider a uniform wind speed (9 m/s), for the six main wind directions (SW, W, NW, NE, E, SE). Table 1 shows the relative contribution of these sectors to the long-term wind climate, of which the SW, W and NW sectors dominate. The current vectors clearly show the same overall directionality as measured by ADCP and current meters, and as also indicated by the 3D non-cohesive sediment transport simulations.

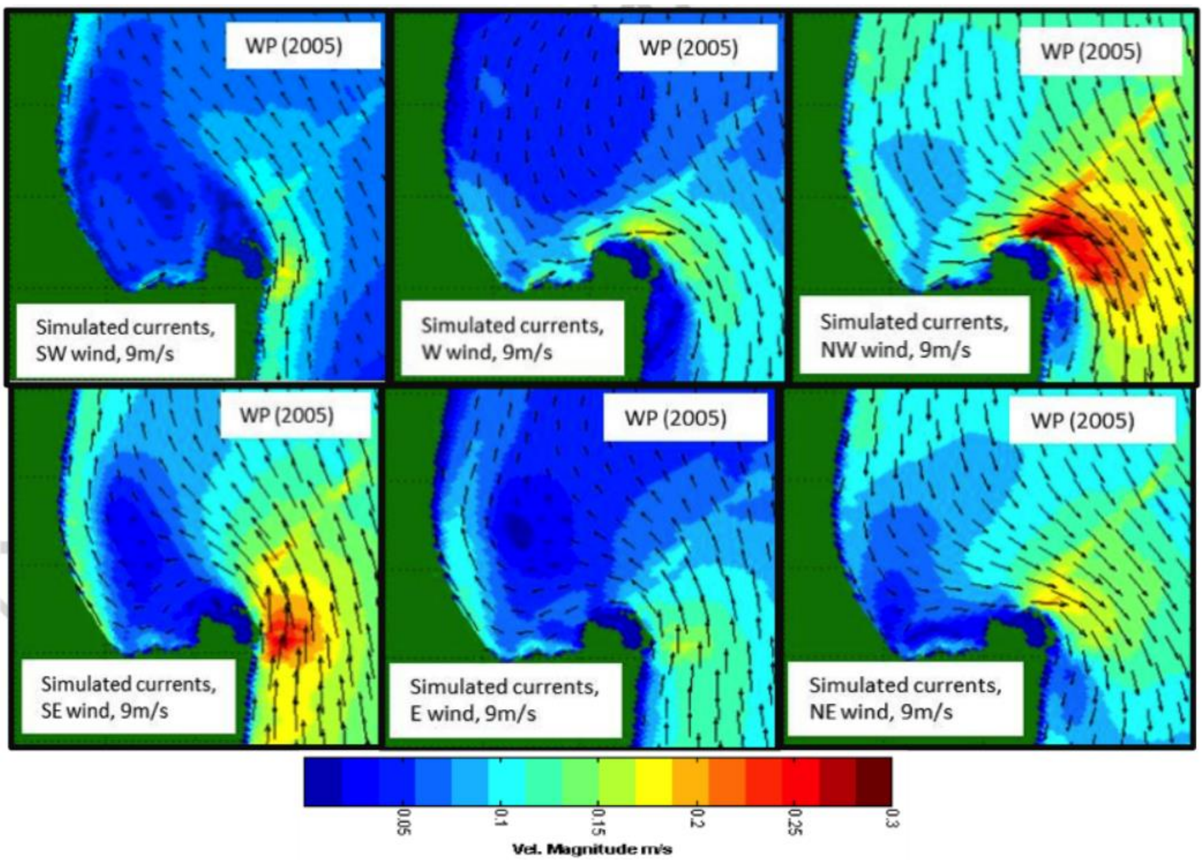

Figure 2: Current vectors and magnitude for uniform wind speed of 9 m/s applied for six wind directions.

Table 1: Wind Occurrence Frequency for Winds at Napier Port Anemometer, Jan 2004 – May 2018. Data averaged to hourly values from 1-minute wind speeds.

Sector	Total ≥1 m/s	% of wind record
N	6339	5.8%
NE	12168	11.1%
E	13390	12.2%
SE	8829	8.1%
S	4349	4.0%
SW	25190	23.0%
W	24766	22.6%
NW	14344	13.1%
	Total years:	**12.5**

Table 2: Wind speed-duration histogram for winds occurring from NW at Napier Anemometer.

Wind Record 1st Jan 2004 - 31st May 2018, hourly averaged wind speed from 1-minute average raw readings																								
North West (292.5 - 337.5 degrees North)																								
Wind Speed (m/s)	Duration (hours)																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	≥24
1	###	759	466	294	199	139	112	90	68	54	44	37	21	15	23	8	11	10	8	5	8	4	3	9
2	###	671	446	271	185	139	108	80	63	52	42	36	25	10	21	9	13	10	5	5	6	5	2	7
3	###	626	396	257	175	121	96	76	58	46	38	36	22	8	17	8	13	7	6	4	4	2	2	7
4	###	573	375	231	147	99	90	63	58	47	31	27	16	13	12	5	15	5	3	2	3	2	2	4
5	###	530	325	211	136	88	71	60	43	38	27	17	12	11	7	5	9	3	3	1	5	0	0	1
6	971	487	264	162	103	79	56	42	33	28	21	10	9	10	4	6	3	1	1	0	2	0	0	1
7	820	371	223	122	70	60	43	29	27	19	11	7	6	5	6	2	1	2	0	1	1	0	0	0
8	685	271	157	88	54	42	30	29	12	15	6	4	5	1	3	1	0	0	0	0	1	0	0	0
9	512	196	113	59	34	27	24	14	5	6	7	3	1	1	1	0	0	0	0	1	0	0	0	0
10	331	126	73	41	30	15	11	5	4	3	3	3	1	1	0	0	0	0	0	0	0	0	0	0
11	198	90	44	24	17	8	6	3	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12	135	54	18	12	13	2	0	3	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13	77	28	11	4	3	2	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
14	37	15	6	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	21	5	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	9	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Further reading:

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de Vriend, H. J., M. Capobianco, T. Chesher, H. E. de Swart, B. Latteux and M. J. F. Stive (1993). "Approaches to long term modelling of coastal morphology: A review." Coastal Engineering 21: 225 - 269.

Roelvink, D. & Reniers, A. (2012). A guide to modelling coastal morphology. Advances in Coastal and Ocean Engineering. 292p, World Scientific (pub.) ISBN 978-981-4304-25-2

Steijn, R. C. (1989). Schematisation of natural conditions in multi-dimensional numerical models of coastal morphology. Delft Hydraulics, Rept. H 526-1.

Napier Port
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