BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY

IN THE MATTER of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the Act)

AND

IN THE MATTER of an Application under Section 38 of the Act for Marine Consent by Trans-Tasman Resources Limited (TTRL) in relation to the iron sand extraction and processing application (the Application)

JOINT STATEMENT OF EXPERTS IN THE FIELD OF

SEDIMENT PLUME MODELLING – Setting Worst Case Parameters

Dated Thursday, 23rd February, 2017

INTRODUCTION

1. Expert conferencing of the Sediment Plume Modelling experts took place in person and by telephone on Thursday, 23rd February, 2017.
2. The conference was attended by
    a) Dr. Michael Dearnaley
    b) Dr. Alexis Berthot
    c) Dr. David Petch
    d) Mr. Dougal Greer
    e) Mr. Joris Jorissen
    f) Dr. Greg Barbara

CODE OF CONDUCT

3. We confirm that we have read the Environment Court's Code of Conduct 2014 and agree to comply with it. We confirm that the issues addressed in this Joint Statement are within our area of expertise.

SCOPE OF STATEMENT

4. Having considered evidence provided on the sediment plume model, the DMC considered it would be of value for an additional expert conferencing session on this evidence, where the experts are to focus on establishing appropriate worst case scenario parameters to apply to a re-run of the sediment plume model.
5. This statement supplements the previous joint witness statement but does not supersede it.
6. We have endeavoured to define a worst case scenario using the parameters available in the model and combining parameters in a way that could lead to the worst sediment discharge from the integrated mining vessel (IMV). However we have not defined this worst case scenario based on the potential outcome at a receptor or for a particular marine species (as we have not discussed this with marine ecologists). We have proposed a worst case modelling scenario that allows the worst case release rates to occur at times of different hydrodynamic conditions to give a broad indication of worst case conditions across the footprint of the area that can be affected by the sediment plume.

Run of Mine (ROM)

7. The average ROM (see Table 1) has an ultra fine fraction (<8 μm) of 0.8%. The ROM assumed for the representative scenario modelled to inform the Impact Assessment was selected to have an ultra fine fraction (<8 μm) of 1.6%. Proposed Condition 47(e) requires that areas that have been mined are demonstrated to have an average ultra fines content of no more than 1.8% over the reporting period.
8. The independent experts have not been provided with the complete reports including a full analysis of the sediment samples and cannot verify the validity of the sediment fractions that have been used in the modelling. The experts have had to make assumptions on the PSD and processing rate onboard the IMV based on verbal accounts from Dr Dearnaley, who has been informed by TTR, without being able to review how the values have been derived.
9. In general, the independent experts think the information regarding the mining process and the inter-relation with the ROM was not concisely collated for this application. Details of the mining operation and ROM have been revealed through the conferencing sessions which has made it difficult to fully assess the schematisation of the mining process in the models.
10. The approach agreed by the experts to establish a worst case scenario was to include a time varying source term in the model runs where the variation happened over periods of weeks to a month rather than hours to days. The plausible maximum source terms will thus be associated with the highest ultra fines content ROM that TTR can process on the IMV.
11. TTR have confirmed that the highest ultra fines content that they could operate at for a period of weeks to one month is 2.25%. TTR would not mine material with an ultra fines content of 10%. Should such an unlikely event occur, production staff would immediately see the effect on the processing equipment and TTR would cease extraction and move to another block within its current spread. TTR would not return to the affected location until the extent of the ultra-fines could be determined. TTR would not consider bypassing the on board processing equipment

and effectively use the IMV to dredge and discharge through high mud content layers. TTR confirm that the costs and negative implications to equipment of using the IMV in such a manner is both prohibitive and imprudent.

12. None of the independent experts have had the opportunity to confirm these values provided by TTR. Greg Barbara, Joris Jorissen and Dougal Greer want it recorded they are unable to sign off on the values provided by TTR in paragraph 11 without having reviewed the source data.
13. We recommend that if consent is granted a condition is added to limit the content of ultra fines of the excavated seabed material. The proposed condition would be an upper limit for an average ultra fines (<8 microns) content of 2.25% averaged over any one week period, as determined by a minimum of 20 representative samples of the excavated sea bed material.
14. An indicative PSD for a ROM with 2.25% ultra-fines has been created by taking the ROM from Table 1, previously circulated with the first Joint Expert Witness Statement, for Sth010RC 0-11m and increasing the cumulative mass passing a PSD class below 212 microns by 6.6%. This leads to a fines content (< 38 microns) of 5.69% in the ROM.

Discharge from the IMV

15. The discharge (kg/s) from the integrated mining vessel (IMV) has been calculated for the fine fractions < 38 microns from the TTR production model for a series of ROM with different ultra-fines content. This is shown in the following table. The table has been prepared based on TTRL's assessment of their mining process. The independent experts have not had the opportunity to review this process so, as noted above, the validity of the table cannot be validated by them:

	Discharge of < 38 micron fraction for Ultra fines content (< 8 microns)			
	0.30%	0.90%	1.60%	2.25%
U/Flow (T/hr)	15	24	30	50
O/Flow (T/hr)	113	164	207	319
Combined (T/hr)	128	188	237	369
Combined (kg/s)	35.6	52.2	65.9	102.5

16. As a matter of scientific due diligence Joris Jorissen, Greg Barbara and Dougal Greer are not prepared to sign off on the values presented in the table from paragraph 15 until they have had the opportunity to review TTR's source data on PSD analysis, sediment core logs and complete laboratory reports on the PSD. Based on the lack the evidence it not possible to accurately define the worst case parameters for fines discharge.

17. For the 2.25% ultra fines content material the discharge of fines < 38 microns is 369 T/hr. With a mining rate of 8,000T/hr this represents 4.6% of the mined fraction. This is less than the 5.69% fines present in the seabed. It is noted that the percentage of discharge of a particular size fraction does not need to be equal to or higher than the size fraction in the ROM. Some of the finest fractions are captured in the mining product which is aimed at having a purity of 56-57%.

18. The experts agreed that the simulation should be based on mining of a 900m wide lane, 5m deep, with the mining encountering a first 300m length of very high fines content (2.25% ultra fine) material whilst the mound is being constructed. This schematisation of the first 300 m leads to source term variability that would be expected to occur in a representative simulation and in itself is not conservative. The 2.25% ultra fines content is a worst case scenario as it represents a situation that TTR state can occur for a period of weeks to one month.

Production rate

19. It takes about 14 days of continuous production at 8,000T/hour to mine 300m length of lane 900m wide and 5m deep. Taking downtime into account (26%) this means that on average each 300m length of lane will take 20 days to complete (14.8 days of mining, 5.2 days of downtime).

20. It is agreed to consider the 20 day time period / 300m length of lane, average depth 5m, as the unit around which to schematise the worst case model simulation.

21. Taking a mining lane of 2,700m in length it is proposed to represent the lane as being made up of 300m lengths with 2.25% ultra fines and 600m lengths of 1.60% ultra fines with this sequence repeating. The 2,700m lane will take 180 days of operations including downtime to mine. The mound will be created for 1/9th of the total time it takes to mine the lane.

Retention of fines on the seabed

22. The discharge from mining the first 300m length of each lane is formed into a mound on the existing seabed. It is agreed that during the period of discharge into the mound that only 5% of the 0.01mm/s and 0.1mm/s settling class fractions are retained in the mound (in the pores between the sand grains). Thereafter, for the remaining 2,400m of the lane it is agreed that 5% of the 0.01 mm/s, settling class, 50% of the 0.1 mm/s class and 90% of the 1 mm/s class are retained in the mining pit except for periods when wave height exceeds 2.5. At these times the retention of the 0.1 mm/s class reduces to 20% (see Annex 1 for details). This retention is summarised in the table below:

Settling Class	Retention (%)		
	Discharge to mound	Discharge to pit (waves <2.5m Hs)	Discharge to pit (waves >2.5m)*
0.01 mm/s	5	5	5
0.1 mm/s	5	50	20
1 mm/s	90	90	90
10 mm/s	100	100	100

* There will be no mining operations when waves exceed 4m

23. Dougal Greer feels that the effect of high period waves on retention of the 0.1 mm/s material in the mining pit has not been thoroughly explored and that the use of a 2.5 m wave as a cut off does not represent a worst case scenario.

Settling characteristics

24. The settling properties of the fine material in the model are described in settling classes of 0.01, 0.1, 1 and 10 mm/s. It has been agreed for purposes of the worst case model scenario to use the NIWA interpretation of the laboratory results rather than that of HR Wallingford. NIWA selected a distribution of 16%, 31%, 44% and 9% respectively. The discharge rates are presented in the table below:

Settling Class	% mass in class	Discharge rate for 2.25% ultra fines (kg/s)	Discharge rate for 1.60% ultra fines (kg/s)
0.01	16	16.4	10.6
0.1	31	31.8	20.4
1	44	45.1	29.0
10	9	9.2	5.9
Total		102.5	65.9

Time varying source terms

25. Combining the 2.25% ultra fines and 1.6% ultra fine material to create the worst case scenario involves the following combinations of source terms:

Settling Class	Discharge (kg/s) for source term scenario				
	2.25% ultra fines			1.60% ultra fines	
	Mound	Pit (waves <2.5m)	Pit (waves>2.5m)	Pit (waves<2.5m)	Pit (waves>2.5m)
0.01	15.6	15.6	15.6	10.1	10.1
0.1	30.2	15.9	25.4	10.2	16.3
1	4.5	4.5	4.5	2.9	2.9
10	0	0	0	0	0
Total	50.3	36.0	45.5	23.2	29.3

Comparisons with the source terms used in the Impact Assessment

26. For comparison the source term used for the representative scenario that was modelled to inform the Impact Assessment is provided below:

Settling Class	Discharge (kg/s)
0.01	6.85
0.1	14.35
1	1.7
10	0
Total	22.9

27. Hence the proposed source terms for the worst case scenario include for the discharge rate of the 0.01mm/s class increasing by between 50 and 130% compared to the representative case run for the Impact Assessment. For the 0.1 mm/s class the worst case scenario includes for some times when the discharge is reduced by 30% and other times when it is increased by up to 110%.
28. Over a 180 day period for the mining of one lane of 2,700m length, assuming that waves exceed 2.5m for 17% of the time, the average source terms for the settling classes are shown below:

Settling Class	Average Discharge (kg/s)	Discharge used in representative scenario (kg/s)	Average % increase for worst case scenario
0.01	11.95	6.85	74
0.1	14.75	14.35	3
1	3.45	1.7	103
10	0	0	0
Total	30.15	22.9	32

Other model parameters

29. It is agreed to keep other parameters used in the modelling the same as used in the representative modelling. The erosion threshold and erosion rate will not be changed. The threshold for suspension was derived from the 3 samples analysed by HRW. It is considered by some of the independent

experts that the erosion threshold for the fines released by the mining activity will vary throughout the mining area, but in the absence of measured data a worst case scenario for this parameter cannot be established. There is some uncertainty around the erosion rate in the model, but as with the erosion threshold, a worst case scenario cannot be established.

Communication of model results

30. It is agreed that the worst case sediment plume model results should be used to rerun the optical model.
31. It is agreed that the model results should be presented in the same format as they have been previously. Time series data should be presented at the agreed locations at a scale such that the detail of the influence of the time variation in source term can be assessed. In addition, SSC contour plots and median and 99th percentile plots should be generated for shorter periods of time corresponding to the periods of highest release. These periods should include for a period of time with a northerly flow.

Signed and dated on 2 March 2017

Dr. Michael Dearnaley

Dr. Alexis Berthot

Dr. David Petch

Mr. Dougal Greer

Mr. Joris Jorissen

Dr. Greg Barbara