Trans-Tasman Resources Ltd consent application: Ecological monitoring

M.R. James[1], A. MacDiarmid[2]

Prepared for Trans-Tasman Resources ltd

January 2016

[1]Aquatic Environmental Sciences Ltd
PO Box 328
Whangamata 3643

Email: markj@aquaticsciences.co.nz
Cell: 021 0538379

[2]National Institute of Water and Atmospheric Research Ltd
Greta point, Wellington

1. Introduction

Trans-Tasman Resources Ltd (TTR) intends to apply for marine consent from the Environmental Protection Agency (EPA) for the recovery of iron ore deposits from marine sands within the South Taranaki Bight (STB). An earlier application by TTR in 2013 / 2014 was declined by the Decision Making Committee (DMC) appointed by the EPA. In response to this decision TTR have commissioned additional investigations / assessment to support the new marine consent application. One of the main issues identified by the DMC in the previous decision were concerns about the lack of details on environmental responses and the lack of information on triggers or compliance levels.

TTR have undertaken an extensive programme to update and refine the physical models that support some of the effects assessments and to address the areas of uncertainty and the concerns raised by the DMC including the issue of environmental responses. This brief report provides an overview of the approach proposed by TTR with regards to the required monitoring programme and approach to environmental limits.

2. Background

The tolerance levels for different components of the ecosystem in the region potentially impacted by the Iron Sand Recovery (ISR) operation have been discussed in James (2016). Environmental limits have been placed on dredging projects in New Zealand and overseas (Otago Region - James et. al. 2009, Singapore - Doorn-Groen 2007, Port of Melbourne 2008). These limits are often applied at two levels, with the first level initiating management action which would include further investigation and/or increased monitoring and a second limit that would require direct management action, taking into account the severity and duration of impacts, this often includes cessation of the activity within the affected area. Examples of environmental limits for water column turbidity and suspended sediment concentrations that have been applied recently for dredging projects are presented in **Table 1** with most based on a period of exposure of a few weeks and rolling averages, a seasonal component is also sometimes included.

Based on field observations and field and laboratory experiments off Whitianga, Schwarz et al. (2006) suggested a suspended sediment threshold level of 20 mg/L to maintain the productivity of the common kelp *Ecklonia radiate*, 25 mg/L to avoid a drop off in mussel condition and 35 mg/L to avoid mortality of paua and kina larvae.

As discussed in James (2016), the suspended sediment threshold for protecting terns and gannets was set at 25 mg/L by Port of Melbourne (2008) and 2 and 3 mg/L was recommended by Lowe (2013) and Page (2014) and applied in MacDiarmid et al. (2015) as the level that would be avoided by pelagic and demersal fish respectively. Acute and chronic impacts of suspended sediments on adult fish would be expected to be at much higher concentrations.

In the case of the TTR operations, TTR propose a monitoring programme that has been developed with appropriate management triggers that will ensure that the extent and severity of the combined mining and naturally occurring plume of suspended sediments does at no point during operations exceed the 95th percentile of levels of natural suspended sediment concentration variability currently experienced at key sites within the STB. In addition to these triggers, TTR will monitor the suspended sediment levels to ensure that the suspended sediment generated by the TTR operations does at no point exceed the forecasted levels.

3. Overview of monitoring programme

Critical elements of a monitoring plan include the requirement for the plan to be practical, sufficiently robust to detect changes if they were to occur, and take into account the tolerances of important biota and natural variability in time and space.

A full Environmental Monitoring Plan (EMP) will be developed. In terms of the ecological monitoring it is recommended that the following be included in the EMP:

- Monitoring of the extent of the sediment plume in the near-field to confirm that levels and extent are as predicted.

- Monitoring of turbidity and optical properties during the ISR operations in the far-field to ensure that the effects on TSS and optical properties of the receiving environment are no worse than predicted.

- Appropriate limits for exceedance

- Surveys of the benthic communities in the consented area to confirm recovery rates and that effects are no more than predicted. The surveys will be carried out prior to the operations beginning as a baseline and will include microphytobenthos.

Water column

The major driver of effects on the water column is the development and dispersion of suspended sediment plumes derived from the recovery of iron sands and the release of de-ored sediment back to the environment. A good understanding of the background levels of suspended sediment concentrations (SSC) and optical properties have been derived from measurements in-situ, from satellite imagery and modelling of changes in space and time (Hadfield & Macdonald 2015, Pinkerton & Gall 2015). Extensive modelling has then been used to assess the impacts of ISR operations and the changes in SSC and optical properties that would be predicted from plume development. Important parameters included in these assessments are suspended sediments measured as mg/L or from backscatter as NTU and in terms of light photosynthetic available radiation (PAR) which is a major driver of primary production. Chlorophyll *a* is measured as a proxy for phytoplankton biomass.

The major elements of a recommended monitoring programme are:

1. Near field effects

   Synoptic surveys of key physical attributes along transects emanating from the ISR operation site and including:

   - Directly west towards the Kupe platform;
   - Inshore towards Hawea;
   - North-east towards Whanganui; and
   - Directly south towards deeper offshore waters.

   The attributes to be measured along these transects at least monthly are:

   - Temperature;
   - Salinity;
   - Optical backscatter measured as NTU (plus water samples for NTU/SS calibration) plus other relevant optical parameters;
   - Chlorophyll *a* measured as fluorescence (plus water samples for chl a); and

- Measurements of the attenuation of photosynthetically available radiation.

2. Far-field effects

   Long-term moorings installed at the following sites:

   - 20 km to the east in the direction of the main plume
   - Inshore at the Traps
   - Inshore at Graham's Bank
   - At least one site inshore near the near-shore reefs

   A control site was considered but because of the dynamic environment and potential extent of the plume at low concentrations it is considered better to monitor a gradient away from the ISR operations site.

   Parameters to be measured continuously and telemetered back to include:

   - Temperature
   - Salinity
   - Optical backscatter measured as NTU as well as other relevant optical parameters plus water samples periodically for NTU/SS calibration)
   - Chlorophyll *a* measured as fluorescence (plus water samples periodically for chl a)
   - Photosynthetically available radiation at two depths

   The moorings will be installed at least 2 years prior to the start of the ISR operations to provide further baseline measurements.

Monitoring the recovery of benthic species in mined areas

The ISR process will almost entirely extinguish the fauna and flora living on and in the shallow seafloor sediments in the immediate consent area. This biota is comprised of short-lived, fast-growing species that respond to the regular disturbance caused by storm and wave events (Beaumont et al. 2013). Monitoring of this biota in the consent area using sediment cores and underwater imaging is recommended every three months for two years before and for four years after ISR operations commence to establish (i) background seasonal and inter annual variation in the composition and abundance of this biota and (ii) the trajectory of recovery after ISR operations cease. This will provide information valuable for future consent applications to mine west coast

iron sands. It is not possible to formulate any thresholds for recovery as there are no available data to suggest the trajectory of recovery for different species.

Monitoring of benthic communities, such as macro-algae in areas outside the mining areas and ascribing cause and effect to any changes in density or condition are very difficult, if not impossible because of the dynamic and complex exposed environment. Thus it is recommended that the focus is on the water column values of SSC and light attenuation and dispersion of the plume.

Thresholds

Biota in the water column and the benthic environment of the STB are adapted to this dynamic and exposed environment which includes river inputs and regular strong wave activity. Thus background levels and natural variability in SSC and the underwater light environment are high and need to be taken into consideration when analyzing the monitoring data.

It is proposed that assessments in the far-field (>2 km) be based on a real-time model of predicted SSC based on the activity location, wind direction, etc., and regular monitoring surveys (at least monthly) carried out by the support vessel as well as information coming from permanent buoys at several sites. The initial trigger requiring closer investigation would be the 80th percentile of levels of background suspended sediment concentration variability predicted by the model of Hadfield and Macdonald (2015), with the trigger for management actions set at the 95th percentile of natural suspended sediment concentration variability likely to be experienced within the STB at selected sites.Baseline data collected for the 2 years prior to the start of recovery operations would provide further verification of the model.

The limits to be applied to the ISR operations will be based on predictions of background SSC at different locations in the modelled domain (listed in Table 2), to be confirmed following the 2 years baseline monitoring and will be included in the EMP for the different locations. In addition to the limits the monitoring will be used to confirm that the effects, if they were to occur, were no more than those predicted under high and low natural background levels. This was the basis for the overall assessments of effects.

Although the limits will be based on model predictions they are well below the limits for SSC applied elsewhere to protect bird and benthic biota. As noted in James et al. (2016) an absolute SSC limit of 25 mg/L as a rolling average has been used in other

cases to ensure that levels would not affect sea-bird foraging and would protect benthic fauna. There would only be short periods of time when the levels would be high enough to cause avoidance by fish and would always be well below levels that have been found to impact directly on fish species (see James et al. 2016).

Statistical approach

Details of the statistical analyses including how limits would be assessed (e.g. rolling average over 1-7 days) will be detailed in the EMP. A summary of the background 50th (median), 80th and 95th percentiles of surface and near-bottom suspended sediment concentration (SSC) at 11 sites in the STB (Figures 1 and 2) are provided in Table 2,. These data were extracted from the predictive models of Hadfield and Macdonald (2015).

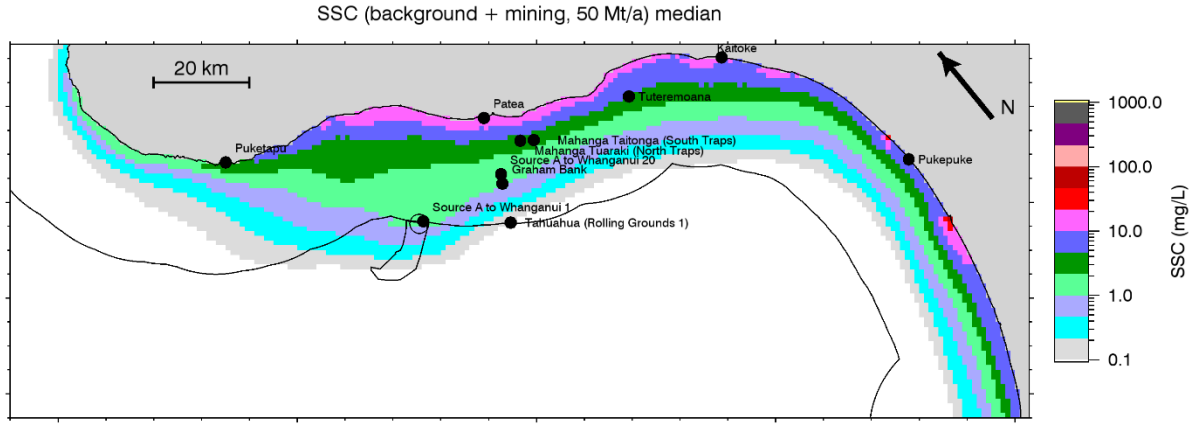

Figure 1. Median surface SSC for background sediments and mining sediments released from mining site A. The location of sites of interest are indicated.

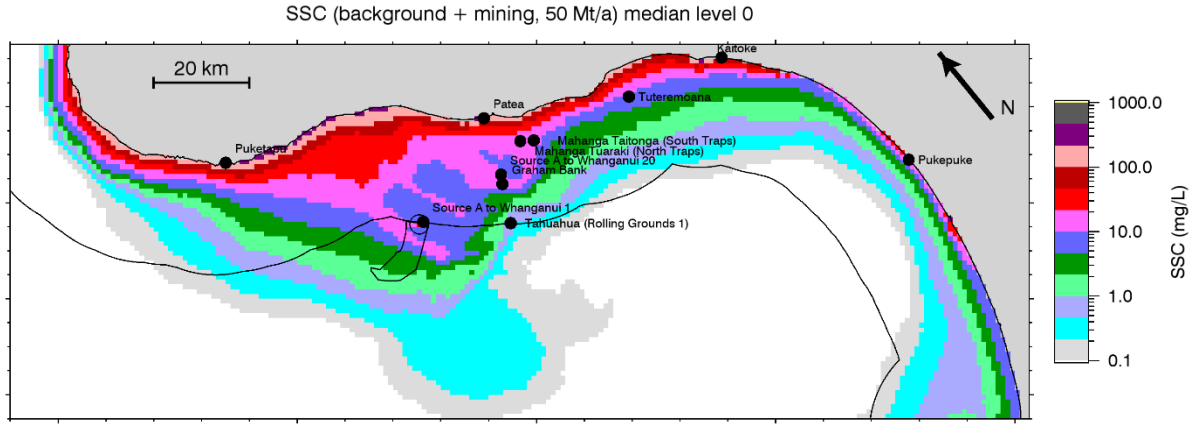

Figure 2. Median bottom SSC for background sediments and mining sediments released from mining site A. The location of sites of interest are indicated.

References:

Beaumont, J.; Anderson, T.J.; MacDiarmid A.B. (2013). Benthic flora and fauna of the Patea Shoals region, South Taranaki Bight NIWA Client Report No: WLG2012-55.

Doorn-Groen, S.M. (2007). Environmental monitoring and management of reclamations works close to sensitive habitats. *Terra et Aqua 108*. 3-18 p.

Hadfield, M.; Macdonald, H. (2015). Sediment plume modelling. NIWA Client Report No. WLG2015-22, 103 p.

James, M.R. (2016). Trans-Tasman Resources Ltd consent application: Ecological assessments. AES report for Trans-Tasman Resources Ltd.

James, M.; Probert, K.; Boyd, R.; Sagar, P. (2009). Biological resources of Otago Harbour and offshore: assessment of effects of proposed dredging and disposal by Port Otago Ltd. NIWA Client Report HAM2008-152, Project: POL08201.

Lowe, M.L. (2013). Factors affecting the habitat usage of estuarine juvenile fish in northern New Zealand. Doctor of Philosophy in Marine Science. University of Auckland, Auckland: 238.

MacDiarmid, A.; Thompson, D.; Grieve, J. (2015). Assessment of the scale of marine ecological effects of seabed mining in the South Taranaki Bight: Zooplankton, fish, kai, moana, sea birds, and marine mammals. NIWA Client Report: WLG2015-13. Report prepared for Trans-Tasman Resources Ltd.

Page, M. (2014). Effects of total suspended solids on marine fish: pelagic, demersal and bottom fish species avoidance of TSS on the Chatham Rise. NIWA Client Report No: WLG2014-7, 25 p.

Port of Melbourne Corporation (2008). Channel Deepening Project Environmental Management Plan – CDP_IMS_PL_004 Rev 2.

Schwarz, A.; Taylor, R.; Hewitt, J.; Phillips, N.; Shima, J.; Cole, R.; Budd, R. (2006). Impacts of terrestrial runoff on the biodiversity of rocky reefs. New Zealand Aquatic Environment and Biodiversity Report No. 7. Ministry of Fisheries.

Table 1. Examples of environmental limits of water column turbidity and suspended sediment concentrations for various taxonomic groups and dredging operations.

Activity	Biota	Limits	Purpose	Reference
Dredging	Benthic invertebrates	15-35 NTU, 50 mg/L	To protect benthic taxa such as sea tulips	Port of Melbourne (2008)
	Seagrass	15 NTU	To protect seagrass communities	
	Fish	70 NTU or 100 mg/L	To protect eggs and larvae	
Dredging	Benthic invertebrates	Limit 1 – 19 NTU Limit 2 – 24 NTU Environmental limit – 35 NTU	To protect benthic invertebrate communities on rocky reefs	James et al. (2009)
	Cockles and fish	Limit 1 – 19 NTU Limit 2 – 24 NTU Environmental limit – 35 NTU	To protect cockle beds and fish populations	

Table 2. Background 50th (median), 80th and 95th percentiles of surface and near-bottom suspended sediment concentration (SSC) at 11 sites in the STB. Data extracted were from the predictive models of Hadfield and Macdonald (2015).

STB sites (in order of increasing 95th percentile background SSC in surface waters)	Background percentiles (SSC mg/L)					
	Surface			Bottom		
	50th	80th	95th	50th	80th	95th
Rolling Grounds	0.06	0.27	1.10	0.56	3.49	15.03
Graham Bank	0.53	1.60	1.97	12.29	32.32	82.07
Source A to Whanganui 20km	0.76	2.07	5.51	10.95	28.39	74.54
South Traps	2.75	5.80	10.53	15.80	36.98	93.88
North Traps	3.19	6.70	12.16	20.30	45.77	111.62
Tuteremoana	4.28	7.94	13.27	8.19	23.23	61.82
Puketapu	2.60	6.80	17.76	125.52	251.16	510.17
Pukepuke	6.35	12.96	26.15	5.66	33.40	105.62
Patea	14.33	25.63	50.93	101.87	221.29	438.64