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Kaipara Limited
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6 April 2020

Attention: Steve Riddell

Dear Steve

Kaipara Limited - Offshore Sand Consent Application - S92 Response- Coastal Processes

This letter sets out responses to coastal processes components of Auckland Council's Section 92 Request for Further Information of 7 October 2019. Responses have been prepared on the basis of information available to us and are presented with the item numbers and information requests as set out in Auckland Council's request letter. Responses presented here include only those that require input in relation to coastal processes queries. It is to be read in conjunction with the response to the ecological components of the Section 92 Request.

Ecology - Item 2 (Cumulative Effects on Coastal Processes)

While it is noted that Section 5.3 of the ecological assessment provides an assessment on the effects of the continuation of sand extraction, this section does not address cumulative ecological effects or cumulative effects on coastal processes. Please provide cumulative effects assessment in relation to the consent and other consents in the area. Please provide analysis undertaken to support this claim if any.

Response

Key Points

- **Effects on inshore coastal processes are considered to be limited given that the offshore sand extraction has taken place seaward of the depth of closure**
- **Monitoring required by the EMMP for the offshore extraction consent is confined to the extraction areas based on the point above**
- **Observed cumulative effects of extraction to date indicate a small distributed lowering of the bed level within the extraction areas**
- **Changes in seabed features and sediment texture over the consent period were identified but were consistent across the extraction areas and the control area, and are attributed to seasonal wave climate variations**
- **The offshore consent area lies seaward of the Pakiri nearshore sand extraction permit areas, and of the depth of closure i.e. the inshore extraction and offshore extraction are effectively separated from a coastal processes perspective, minimising any cumulative**

effects. In addition, the operators of the inshore consent are required to undertake regular detailed survey of the beach and bar system. Monitoring and analysis of the data collected does not indicate cumulative changes beyond natural beach process variations.

Analysis

The cumulative effects of offshore sand extraction over the 20 years of the current consent period as observed by the progressive monitoring required by the consent Environmental Monitoring and Management Plan (EMMP), are summarised in Section 3.3 of the Review of Coastal Processes Effects. The effects monitored cover bathymetric comparisons, observed physical seabed characteristics, and seabed texture changes as required by the consent conditions. The consent conditions did not include the requirement for nearshore monitoring on the basis that the offshore extraction areas are outside the depth of closure and thus will not affect the nearshore processes.

The observations to date indicate that the extraction to date has resulted in a small and progressive distributed lowering of the seabed generally in the vicinity of the extraction process and expected to spread and reduce over time as sediments redistribute under natural conditions. Changes indicated by bathymetric survey to date under the existing consent are shown over discrete areas centred around the targeted extraction locations. To mitigate this effect going forward, it is proposed that extraction in future under the renewed consent will follow a planned distribution pattern to minimise localised effects and to result in small but evenly spread level changes over the proposed extraction area.

As explained in the effects review, these changes are small (expected to be less than 100mm over the consent period) in relation to the accuracy of the survey methods available and to date cannot be reliably quantified by survey. While changes in seabed features and seabed sediment texture were observed between surveys of the offshore extraction areas, similar and contemporaneous changes were observed in the control area monitored and are thus considered to have been related to seasonal and annual wave climate variations rather than the extraction process. Proposed ongoing monitoring will maintain a watch on the cumulative effects of extraction over time and will be used as input to the management of extraction.

As explained in the response to Item 5 below, the effects of the offshore extraction described above are not expected to result in any observable changes to the surf corridor in relation to wave refraction or shoaling, and will thus not influence the wave environment approaching the nearshore, and thus remain independent of beach processes. This is consistent with the established depth of closure concept which establishes the principle that coastal conditions that can affect beach and bar processes are confined to depths shallower than 25m based on the established wave environment and seabed conditions at this location, and thus inshore of the offshore extraction areas relevant to the current application.

Other consents that may affect the coastal processes in the embayment are the inshore extraction permits, which allow the annual extraction of up to 76,000m³ from nearshore

areas inshore of the depth of closure¹. The inshore extraction and offshore extraction are therefore effectively separated from a coastal processes perspective, as the offshore extraction area is beyond the depth of closure. This minimises any potential for cumulative effects of the inshore and offshore extraction.

The monitoring requirements of the inshore consents include extensive regular (six monthly) and detailed monitoring and analysis of the beach and bar system over the life of the consent and beyond. The information provided by this monitoring under the inshore consents and made available to Kaipara Limited up to 2019 (Ref Jacobs 2019) indicates evidence of episodes of erosion and accretion of the regularly surveyed beach and bar profiles, but there is no reported cumulative observed change within the accuracy of the survey methods used that cannot be attributed to anything beyond natural variations arising from weather pattern variations.

Coastal Processes - Item 5

The coastline adjacent to the proposed extraction area is a surf zone. The proposed extraction works fall within the swell corridor of the surf break. Please provide an assessment of how the surf zone will be affected by the proposal.

Response

Key Points

- **The effects of deepening a shore parallel strip of seabed on the inshore translation of swell waves have been reviewed. Calculated refraction and shoaling characteristics of waves were compared for the existing and modified seabed. Wave period distribution and site-specific approach angles were obtained from published hindcast data.**
- **Wave records for the site show that 74% of waves are of periods of 6 seconds or less and as such are not affected by the seabed until they are in water less than 25m deep. The proposed offshore extraction, located seaward of the 25m depth contour, will not affect these waves.**
- **The remaining 26% of waves have longer periods. Initial calculation of the effects of the estimated average deepening that would result from the extraction of 2,000,000m³ over the nominated extraction area showed negligible effect on the wave characteristics.**
- **The calculations were repeated for a 0.5m deepening over a 700m wide shore parallel strip seaward of the 25m contour as an upper bound / temporary condition sensitivity check. Changes to wave refraction and shoaling were smaller than could be practically observed (0.1 degrees; 0.2%). Inshore of the deepened area the refraction and shoaling parameters resumed their previous values as the waves continued shoreward (i.e. negligible effect on wave height and direction).**

¹ The depth of closure is the water depth in which, by definition, effective interchange of seabed sediments between nearshore beach processes and the inner continental shelf is minimal.

- **In summary, based on the calculations, the proposed offshore extraction will have negligible effects on the swell corridor of the surf break and the surf zone. Wave period does not change with water depth and is unaffected by the proposed extraction.**

Analysis

Assessment of the effect on the surf zone of offshore sand extraction in the swell corridor can be made by assessing the hydrodynamics of wave refraction and shoaling. These processes occur after the shore approaching wave reaches a depth at which it becomes influenced by the seabed. Water depths greater than this threshold depth, which is related to wave period, are defined as Deep Water where waves have little effect on the ocean bottom. Inshore of (or shallower than) this point, the wave enters a Transition Zone where the effect of seabed friction and interaction with the wave becomes gradually more marked, slowing the wave velocity with bottom friction and increasing wave height with shoaling as the wave approaches the surf break. Wave period is unaffected by change in water depth.

For waves of a specific period the inshore extent of Deep Water, and thus the commencement of the Transition Zone, is defined as the water depth that is one half of the wavelength L in metres where $L = 1.56 \times T^2$ and T is the wave period in seconds. The inshore extent of the Transition Zone is where water depth is $0.05L$. As water depths become shallower than this, waves begin to become unstable and breaking occurs. At Pakiri the range of wave periods dictates that the breaking zone is inshore of 8m depth.

The offshore extraction will take place in water depths greater than 25m. From the relationship above it can be shown that waves with periods less than 5.7 seconds will not be affected by interaction with the seabed. Based on 20 year hindcast data derived for Mangawhai (Gorman et al, 2003) approximately 74% of waves at this location have a period of less than 6 seconds, and thus this proportion of waves will remain nominally unaffected by changes in bathymetry resulting from extraction at and beyond 25m depth.

The remaining 26% of waves approaching the coast have longer periods (up to 10 seconds) and will be influenced by contact with the seabed beyond 25m depth. These longer period waves are of particular interest to surfers, providing more substantial and powerful waves that shoal more prior to breaking to create larger and cleaner surfing conditions.

Assessment has been made of wave mechanics analysis and based on calculation methods presented in the US Army Corps of Engineers Coastal Engineering Manual (an internationally accepted guideline). The natural shoreward translation of waves is influenced by refraction which is the process of wave approach angle being modified by seabed contours. The shoaling coefficient, or the proportion of the offshore wave height at each depth contour, reduces initially as the wave loses energy through friction, then increases as the wave velocity reduces and wave height builds prior to breaking.

These parameters were calculated for a range of approach angles and wave periods over a regular bathymetry. The calculation was then repeated with a section of increased depth beyond 25m to simulate change to seabed level resulting from sand extraction and provide comparison of the modified wave behaviour. The calculation was done for regularly spaced shore-parallel depth contours, with waves approaching from offshore at 15 and 25 degrees from perpendicular to the shore. This range covers the dominant wave approach directions identified by Gorman et al (2003) and illustrates the amount of refraction that can be

expected at the Mangawhai-Pakiri site. Waves have been translated inshore to 10m depth where localised and variable bed changes within the bar system will affect wave propagation further inshore and breaking, generally inshore of 5m depth.

The effect of sand extraction has been examined for an average increase in depth between the natural 30m and 25m depth contours which represents a 700m wide shore-parallel strip. The extraction is planned to recover sand from long narrow shore-parallel tracks of typically 50mm to 80mm depth². Natural redistribution of the seabed is estimated to result in a depth increase over the extraction area of less than 100mm, during the consent period. The calculations for a 0.05m depth increase over the proposed extraction area shows effectively no change to wave characteristics.

An additional sensitivity assessment was therefore undertaken. The effect of an exaggerated seabed change of 0.5m depth increase over the 700m wide strip was calculated. This approach allows assessment of sensitivity to the magnitude of depth change and provides assessment of the type and degree of influence on the swell resulting from the depth change as it progresses inshore.

Results for wave periods from 6 to 10 seconds are presented in the plots below. These show the progression of wave approach angle as depth reduces and waves fronts bend to better align with the bed contours, and shoaling coefficients which show initial relative loss of wave height in the transition zone and then increase as the waves slow and height builds towards breaking.

Changes compared to the unmodified depth values for approach angle are evident across the deeper extraction zone section where refraction angle change is delayed because the water is deeper, but restored to the unmodified value at the inshore edge of the extraction zone where the bed rises to the original value and the local refraction change is greater. The theoretical magnitude of the difference in angle between modified and unmodified seabed conditions across this zone is greater for the longer period waves. For example, for 9 sec period, which is a practical upper value for the wave climate (Gorman et al 2003), the difference is 0.058 degrees for the 15 deg offshore approach angle, and 0.100 deg for the 25 deg approach angle. For 6 sec period waves the equivalent angle differences values are less at 0.007 and 0.008 deg respectively. These changes are negligible and are very unlikely to be measurable across the extraction area, with no change to the inshore wave characteristics.

² Trials with the new dredger have indicated the extraction depth along the dredge track for an individual run will be around 50mm to 80 mm. This is less than the 300mm considered in the assessment of coastal processes effects. The depth increase averaged over the extraction area remains unchanged from that given in the Review of Coastal Processes Effects (less than 100mm).

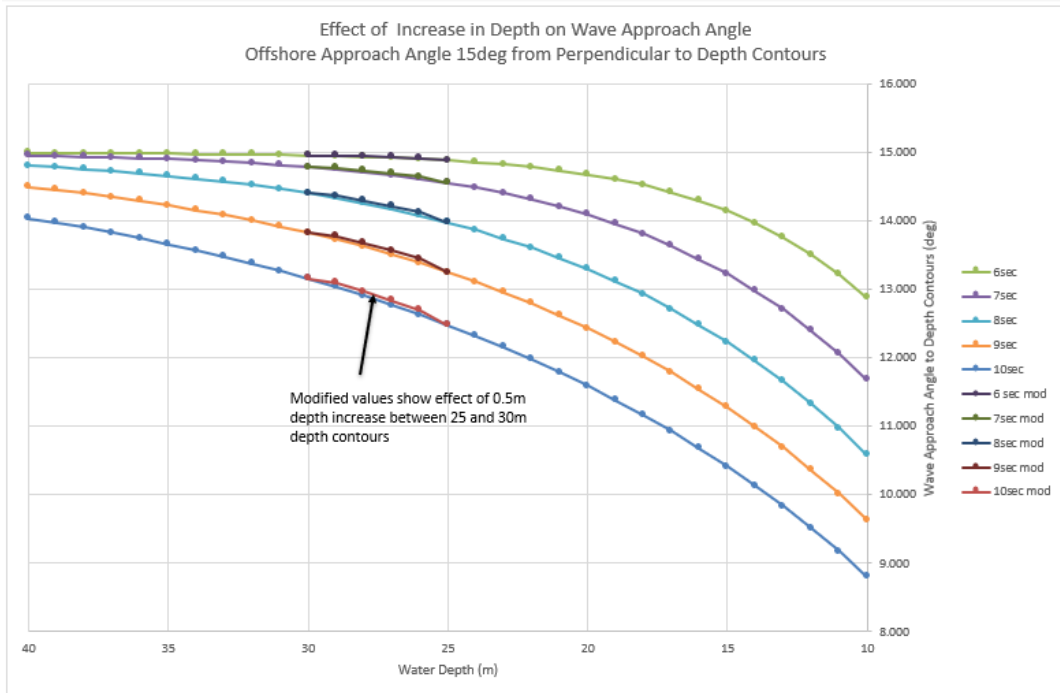


Figure 1 – Wave Approach Angle Under Refraction – Offshore Approach 15 degrees

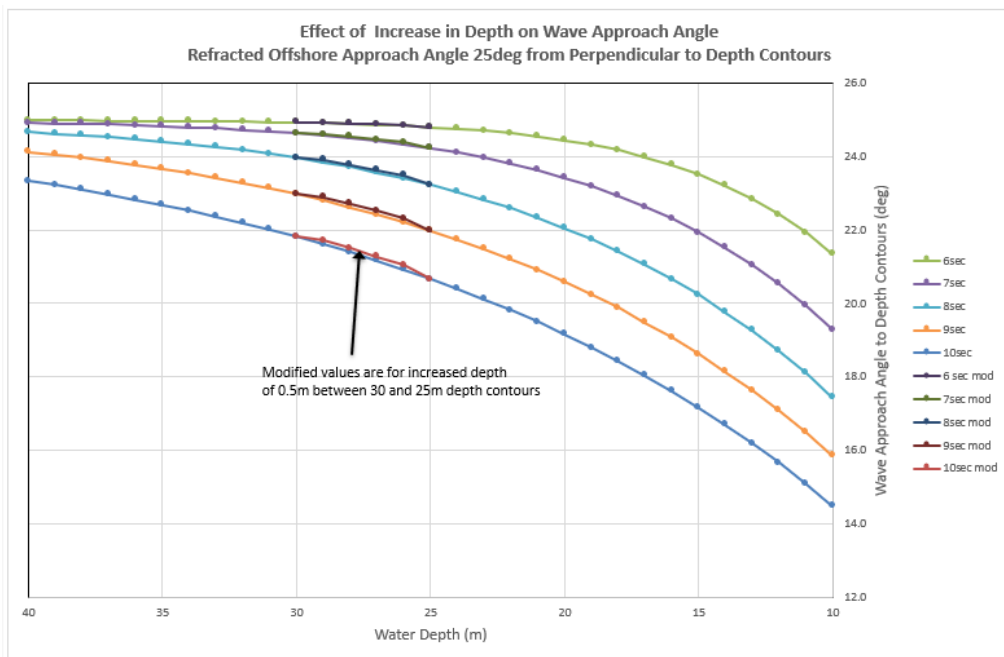


Figure 2 – Wave Approach Angle Under Refraction – Offshore Approach 25 degrees

Changes to shoaling coefficients show a similar pattern with reduced loss of wave height across the deeper extraction zone and return to the unmodified values with transition to the unchanged inshore profile. In this case the temporary difference in shoaling coefficient is smallest for the longer period swell waves, and in all cases less than 0.2%. Again, these changes are negligible and occur across the extraction zone only. The changes are smaller than practically measurable.

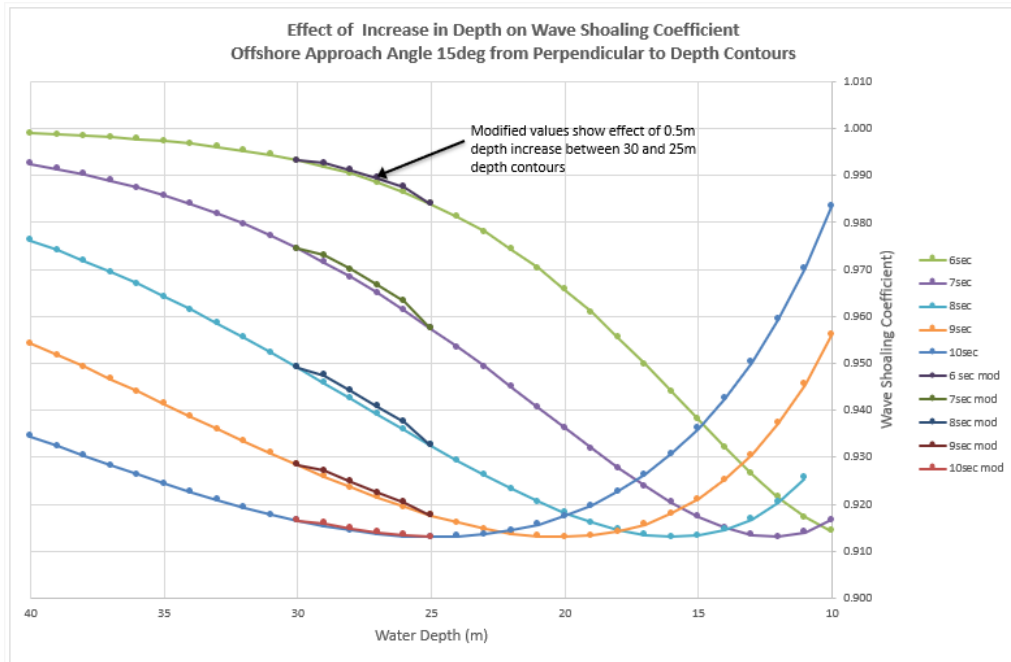


Figure 3 – Wave Shoaling Coefficient – Offshore Approach 15 degrees

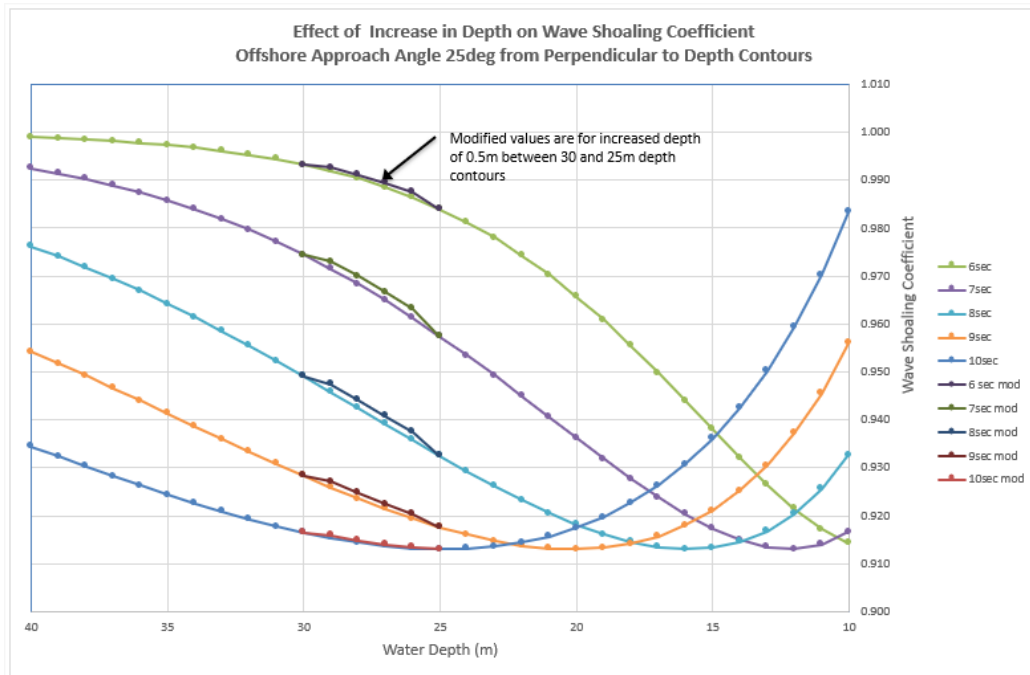


Figure 4 – Wave Shoaling Coefficient – Offshore Approach 15 degrees

In summary, calculation of the effects of an exaggerated depth change on the swell corridor of the surf break shows that theoretical changes to refraction and shoaling characteristics occur temporarily as waves cross the deeper zone. These changes are negligible and not practically measurable, and the characteristics revert to unmodified conditions once the wave has passed the extraction area. On this basis the proposed offshore extraction will have negligible effects on the swell corridor of the surf break and the surf zone. As noted

previously, wave period does not change with water depth; this characteristic is unaffected by the proposed extraction.

References

Gorman R M, Bryan K R, Laing A K, *Wave Hindcast for the New Zealand region: nearshore validation and coastal wave climate* – New Zealand Journal of Marine and Freshwater Research 2003, Vol 37: 567-588

U.S. Army Corps of Engineers, (2002), *Coastal Engineering Manual (CEM), Engineer Manual 1110-2-1100*, U.S. Army Corps of Engineers, Washington, D.C. (6 volumes).

Coastal Processes - Item 6

The application states that the proposed works fall out of the depth of closure and hence will not affect the coastline. Please provide a historical assessment of the coastline changes close to the extraction areas to demonstrate that the works did not affect the coastline.

Response

Key Points

- **The offshore extraction consent was recognised as operating beyond the depth of closure by the Environment Court decision, and on this basis the monitoring undertaken by the consent holder, does not extend to coastline changes.**
- **Coastline monitoring and analysis has been undertaken by the inshore extraction consent holder, as required by the inshore consent, with reports submitted to Auckland Council. Coastline changes identified by these reviews will include any effects of the offshore extraction if they exist.**
- **A selection of these monitoring reports provided by the inshore consent holder to Kaipara Limited concluded that redistribution of sand in the beach and nearshore is within the magnitude of seasonal and storm induced effects, and that results show no discernible effects on the coastline as a result of sediment extraction.**

Analysis

The current consent held by Kaipara Limited allows for sand recovery from an extensive area beyond 25m water depth. The substantial body of investigation and reporting undertaken prior to the granting of that consent established that the extraction consented for this offshore area was beyond the depth of closure, or the outer depth limit across which there is practically no exchange of sediment. In other words, extraction of sand from beyond this depth will not affect the seabed and coastal processes inshore. This concept was accepted by the authorities in the granting of the offshore consent and confirmed the intent of the consent holder that sand recovery from depths beyond 25m would result in minimal impact on physical coastal processes.

The agreed Environmental Monitoring and Management Plan (EMMP) for the offshore sand extraction was established on the basis of the acceptance of these principles, and required the progressive monitoring, surveying and reporting of: bathymetry, seabed surface

characteristics, sediment texture, and biological analysis within and immediately adjacent to the offshore extraction areas, and also in a similarly exposed but undisturbed control area. The results of this monitoring are summarised in the present consent application. Monitoring of the coastline was not required by the consent conditions or the EMMP for the existing offshore consent.

The inshore extraction consents are held by McCallum Bros Limited. The inshore extraction areas lie partly within the extent of the active surf zone, inshore of and separate from the offshore extraction areas. The consent conditions for the inshore consents require regular and detailed monitoring and analysis of the coastline and nearshore environment, and related reporting. This monitoring and analysis covers the full length of the beach from Mangawhai to south of Pakiri. It has been undertaken on behalf of McCallum Bros Limited and the reports submitted to Auckland Council. The monitoring and analysis provides a 10-year record of nearshore and foreshore changes, with comparison of beach volumes and the excursion of beach level contours. Expert interpretation of the results has been submitted by McCallum Bros Limited as part of the monitoring reports. This has identified seasonal and storm-induced redistribution of sand stored in the beach and nearshore (between the upper beach and bar systems). The expert assessment and reporting has consistently concluded that there is no evidence for correlation between beach and nearshore bar volumes and extraction volumes, and that the data and analysis do not show any discernible effects on the sediment system as a result of sediment extraction. These findings are included in the following representative monitoring assessments that have been provided to Kaipara Limited (we understand that all these reports have previously been submitted to Auckland Council by the inshore consent holder):

- DTec Consulting Limited – Results of March 2010 Pakiri Nearshore Monitoring for McCallum Bros Ltd Sand Extraction Consents
- Tonkin and Taylor Ltd – REPORT McCallum Bros Ltd, Pakiri Beach Monitoring – Nearshore Surveys, February 2014
- Jacobs New Zealand Limited – McCallum Bros Pakiri Sand Extraction – Results of Consent Condition 21 Review, August 2019.

Coastal Processes - Item 7

Please confirm if the proposed area for extraction will be defined by co-ordinates or depth. The application documents state that the maximum depth of extraction will be 40m, but the geographic co-ordinates show depths more than this.

Response

The area for extraction is defined by co-ordinates, with management of extraction to be based on progressive sand recovery from sub-areas within the overall boundary defined by co-ordinates.

The outer limit of the extraction area was selected to conveniently provide a nominal boundary over an area where charted depth points are sparse. While the straight-line outer boundary for the proposed area shown drawn between two points of approximately 40m depth straddles greater depths indicated on the marine chart, it is not intended to recover sand from beyond 40m depth which provides a practical outer limit for dredge operation.

If Council has any concerns regarding this, the applicant would be willing to limit extraction to between the 25m and 40m isobaths.

Coastal Processes - Item 8

Please provide a comparison of the baseline bathymetry at the beginning of the consent with the last bathymetry obtained and provide a comparison of changes in depth over the consent period.

Response

Compilation and comparison of bathymetric surveys carried out over the life of the existing offshore consent has been undertaken for Kaipara Ltd by Survey Worx. Survey Worx has undertaken the most recent two monitoring surveys (2015 and 2018). Earlier surveys were undertaken by different survey companies: pre-dredge baseline surveys in 2003 (Area 1) and 2006 (Area 2); and subsequent surveys of Area 1 in 2011 and Area 2 in 2015. These surveys, and the more recent coverage of Areas 1 and 2 in 2018 correspond with cumulative 500,000m³ extraction milestones defined in the EMMP.

The process of evaluation of the differences between surveys by Survey Worx has required the digital comparison of surveys undertaken by different survey companies and using survey equipment with different capabilities which have advanced over time and provide different levels of coverage intensity. Manipulation of the raw survey data using software and manual intervention is required to smooth anomalies that arise as a result of the huge amount of data created by the multibeam survey system. Inherent errors related to the equipment performance, sea conditions and water quality combine to provide potential survey errors that exceed the magnitude of the seabed changes indicated. These issues are outlined in Section 3.3.1 of Beca's Review of Coastal Processes Effects submitted as part of the application, and the caution that realistic quantification of volume changes between surveys is not practicable is stressed.

Survey Worx's report on the December 2018 survey of the offshore consent areas and incorporating comparisons with seabed profiles from earlier surveys is submitted independently of this response. The report includes contour plots of differences between surveys undertaken by Survey Worx and providing a visual indication of the changes apparent.

Additional Comment Related to Biogenic Sand Production

Extensive research on the sand resource has been carried out in the past, including the Mangawhai-Pakiri Sand Study. Study results and expert hearings evidence have provided approximate and variable quantities of sediment input and output to the system from a range of sources, including biogenic sand production.

We have recently been made aware that Hilton's study on rates of biogenic sand production which became the accepted basis of this contribution to sediment budget may not be accurate (refer to the Bioresarches ecological response to the Section 92 Request).

Annual production rates proposed since the 1990s for this biogenic component of the sediment budget for the Mangawhai-Pakiri embayment range from 900,000m³ to less than 1000m³. The Beca

Review of Coastal Processes Effects related to the Offshore Sand Extraction submitted with the consent application recognises the potential for this variability in sediment budget.

The report concludes that the offshore extraction site is largely independent of the sediment budget changes. The existing and proposed extraction sites are beyond the depth of closure, and thus in water deeper than the identified sediment transport processes operate except in unusual and extreme conditions. On this basis the offshore extraction consent application and anticipated effects remain independent of the uncertainties in the sediment budget that are raised by the reassessment of biogenic sand production rates.

We trust the information presented adequately addresses the coastal processes related matters raised in the S92 request.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Ian Goss', with a stylized flourish at the end.

Ian Goss
Senior Associate - Civil Engineering

on behalf of

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