IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	resource consent applications and Notices of Requirement by the Bay of Plenty Regional Council to undertake the proposed Kaituna River Re-diversion and Ongatoro / Maketū Estuary Enhancement Project

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STATEMENT OF EVIDENCE OF MARTIN BERNARD SINGLE

INTRODUCTION

Qualifications and experience

1. My name is Martin Bernard Single. I am an environmental consultant with 25 years of experience. I hold a Ph.D. in Geography, which investigates coastal processes and geomorphological change. I am a director and principal consultant for Shore Processes and Management Limited, specialising in the science, management and planning of coastal lands and waters.

2. I am an associate member of the Institute of Professional Engineers of New Zealand, a member of the International Coastal Navigation Association PIANC, and a member of the New Zealand Coastal Society. I also hold a position as a Senior Fellow in the Geography Department, University of Canterbury.

3. I have authored or co-authored over one hundred reports dealing with coastal geomorphology and management in New Zealand, Scotland and Fiji, including hazard assessment and mitigation measures, nearshore, beach and estuarine sediment transport, dredge spoil dispersal, beach nourishment, beach management prescriptions, and planning and audit control of consents for coastal protection structures and lake shoreline change.

4. My areas of specialisation are coastal processes and coastal management of New Zealand ocean beaches, lakeshores and harbours.

5. My work on river mouth and inlet geomorphology includes teaching about the process dynamics at Canterbury University and research on North Island estuaries such as Tairua and Whangamata. I have also investigated harbour inlet and channel sedimentation to provide advice for consent matters for:

   5.1 Thames Coromandel District Council, at Tairua and Whangamata harbours;

   5.2 Beca, review of the Rangitoto Channel dredging work;

   5.3 Port Otago Limited at Otago Harbour; and

   5.4 TrustPower Limited regarding the river mouth dynamics and navigation issues of the Rangitaiki River.

6. The work on the Rangitaiki River mouth is directly relevant to the Kaituna / Te Tumu cut due to the similarity in the process environment and the concerns raised by submitters regarding navigation and passage between the river and the sea.

Scope of Evidence

7. I have been asked to provide a peer review of the technical assessment undertaken by DHI and EcoNomos Limited on the potential effects of the Project on the Kaituna River mouth and navigability of the river bar.

8. My evidence will cover:

   8.1 The current conditions and navigation situation at the Cut;

   8.2 The key drivers that affect the mouth and the river bar;

   8.3 The findings of the numerical modelling and potential adverse impacts of the Project on the river bar and its use; and

   8.4 Whether monitoring and / or mitigation should be required.

9. I will also provide comments on the submissions as they relate to the scope of my evidence. Other witnesses also provide comments on the submissions relevant to their areas of expertise and project involvement.

10. I have read and am familiar with the section 42A report and the proposed set of consent conditions and will refer to these where relevant to my evidence.

11. Lastly, I have read the Code of Conduct for Expert Witnesses in the Updated Environment Court Practice Note (2014) and agree to comply with the Code. This evidence is within my area of expertise, except where relying on the evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

EXECUTIVE SUMMARY

12. The Kaituna River mouth comprises a narrow entrance channel with a wave dominated ebb tide bar system. Flows in and out of the channel including fluvial, flood and ebb tide components modify, but during normal flow conditions are not adequate to maintain an all tide safe, navigable channel to the sea. Wave action and alongshore transport (littoral drift) of sediments act to block the channel with movement of sediment from one side of the river mouth to the other across the ebb tide bar and other nearshore shoals.

13. Flood flows can scour the channel and ebb tide bar, potentially providing deeper access to the sea across the nearshore, but the persistence of this access is limited, and will quickly change with an increase in wave energy and subsequent alongshore sediment transport. The river mouth is not safely navigable at all times, and the Bay of Plenty Harbourmaster has recommended to users that safe crossing can only be made within two to three hours of high tide. That withstanding, the Maketū Coastguard require security in knowledge that access through the channel will not be compromised by the Project.

14. The DHI modelling of the hydrodynamics and morphological effects of changes to the flow regime from the Project show that there is potential for changes to the entrance morphology, including depth over the bar and the scouring effects of flood flows. However these changes are small, of the order of 1 to 2 cm in change in depth, and are well within the natural variability of the bar form and not practically measureable in the environment. Therefore the effects of the Project on the navigability and geomorphology of the Kaituna River mouth will be not be discernible from the natural variability arising from interaction of the nearshore oceanic conditions and existing flow regime.

KAITUNA RIVER MOUTH PROCESS DYNAMICS

15. In reviewing the technical reports assessing the effects of the potential effects of the Project on the Kaituna River mouth and navigability of the river bar at Te Tumu, I carried out a desktop study of the dynamics of the river mouth. I assessed the findings of the DHI modelling with regard to the theoretical aspects of this type of river with coastal processes such as the wave environment, sediment transport along the shore and tidal flows and sediment transport into and out of the river mouth. I also referred to descriptions and investigations of the Kaituna River mouth including the technical memorandum for the project prepared by Mr Jim Dahm.[1] I have visited the river mouth and examined diagrams and photographs of the river mouth contained in research literature, web pages and historical maps. I have also reviewed the Eco Nomos Ltd. memorandum "*Effect of proposed re-diversion on Te Tumu entrance and bar"*, also known as the "Navigation memo" from March 2015, authored by Mr Jim Dahm and Mr Ben Tuckey.

16. Figure 1 shows the river mouth. Although there is an artificial aspect to the initiation and maintenance of the river mouth position, the process dynamics are consistent with a natural river mouth. Fluvial and coastal processes influence the geomorphology of the river mouth. In essence, waves and alongshore transport of sediment act to block the river mouth while river flows transport sediment to the coast and act to keep the mouth open. Tidal flows can transport sediment into and out of the river mouth. Depending on the relative strength of the oceanic and fluvial processes, one set will dominate over the other in determining the stability of the channel to the sea.

[1] *Kaituna River re-diversion and Ongatoro/Maketū Estuary enhancement project: Effects on coastal and riverbank erosion and morphology*.

Figure 1: Low tide view of entrance and bar (ebb tidal bar) at Te Tumu (Aerial photograph from December 2012)

Geomorphology of the river mouth

17. Although the river mouth position is artificially maintained, and known as Te Tumu cut, having been engineered in 1956, it is in a position where the Kaituna River naturally breached the beach in 1907 and 1922, and very likely at other times during the past. The river channel to the sea is bounded to the west by a rock revetment that controls the position of the eastern boundary of the river mouth. The predominant alongshore drift of sand from west to east maintains the eastern position of the channel.

18. The river mouth type can be classified as a straight-banked river mouth as there is no estuary landform associated with the river mouth, and flood tidal delta development is limited. However, the mouth area does contain other features associated with estuaries. The dynamic geomorphology of the mouth is dominated by the relatively large alongshore sediment transport regime in relation to the fluvial flows, and there is a relatively large tidal prism (volume of water flowing through the river mouth on the flood and ebb tides) in relation to the fluvial flows. There is a quasi-stable throat, or inlet channel, that varies in width. The throat is long and narrow, so is subject to erosion of the sides and base by fluvial and tidal through-flows. Aerial photographs indicate that

the main channel position landward of the active beach is relatively stable. However the channel through the beach and across the ebb tidal delta / bar system is subject to variation in position, width and depth, controlled by nearshore sediment movement across the channel and the interaction with fluvial flows.

The adjacent coastal environment

19. The Bay of Plenty coastline is an open sand system exposed to a range of wave conditions. Calm conditions are common in the winter, but moderate to high-energy waves occur regularly. There is a seasonal component to wave conditions, with northeast swell waves dominating from December to April, and local wind-generated waves predominant through the winter. The prevailing direction of wave approach is from the north to easterly sectors. The largest waves are generated by subtropical lows. These waves come from the northeast, and can have heights in excess of 4 m.

20. The tidal regime is semi-diurnal and meso-tidal. The spring tidal range is about 1.6 m and the Neap range is about 1.2 m.

21. Estimates of long-term net rates of alongshore sediment movement range from 22,000 to 40,000 m^3/yr. Modelling by DHI showed potential alongshore transport can vary year to year, ranging from 60,000 m3 north-westward to 260,000 m3 south-eastward. Based on changes to beach profiles, and using long-term wave fields, the models calculated net alongshore sediment transport of 52,000 m^3/yr to the southeast. The estimate of gross sediment movement in the nearshore zone is in the order of 400,000 m^3/yr.

22. The Kaituna River supplies approximately 7,000 to 8,500 m^3 of bedload sediment to the coast each year. This contribution and sediment movement from along the shore appear to keep the shoreline sediment budget in a state of dynamic equilibrium, with no erosion or progradation of the shoreline position since 1978.

Inlet Stability

23. Te Tumu Cut inlet (present Kaituna River mouth) is a dynamic environment, and changes with changes in the sediment movement across the inlet (coastal sands) and flows through the inlet (mainly fluvial, but with a base ebb and flood tidal flow). These changes can result in the inlet changing shape

(width, depth and cross-sectional area) or moving position along the coast. There is a delicate balance of factors that regulate the changes.

24. The definition of stability of an inlet is that it maintains a channel – in cross section and position. Achievement of stability is based on a balance between forces trying to cover up the inlet – for example longshore drift of sediment - and currents going in and out of the inlet giving a scouring effect. The relationship between these forces is critical in controlling inlet stability.

25. Longshore drift can shape an inlet, the surrounding coastal morphology and barriers that may impede navigation through the inlet channel, such as the ebb-tide delta, or nearshore bar at the Kaituna River mouth. Where one boundary is stable, like the eastern side of the Kaituna River mouth for example, then there is a less complex offsetting of the inlet channel. In effect, the rock wall stabilises the position of the mouth and inlet channel across the beach and along the lowest reach of the river.

26. Longshore drift of sediment tends to narrow an inlet, to choke it up and to try and bypass the inlet (move to the other side) and continue along the coast. This sediment bypassing may be a continuous or intermittent process. There are three main types of bypassing on tidal inlets, as illustrated in Figure 2 below.

    1. Bar bypassing – indicated by “Wave” in Figure 2, as it is a result of wave induced current processes, is when sediment does not enter the inlet but is transported past on a bar, or migrates across on the ebb tide bar.
    2. Tidal bypassing – when sediment is swept into the inlet on the flood tide and ejected back out on the ebb.
    3. Mixed or transitional situation – when sediment is sometimes swept into the inlet, and is sometimes transported across the bar.

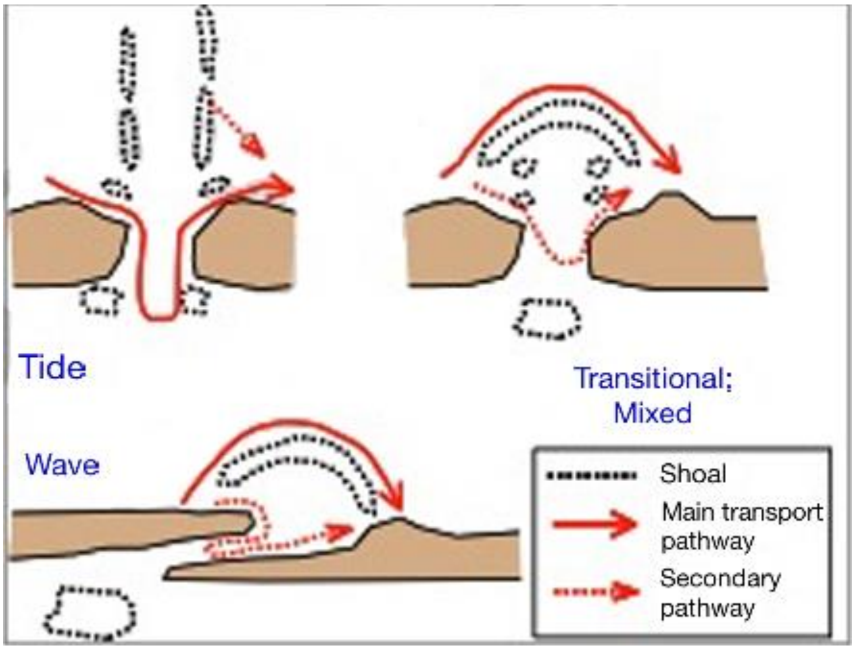

Figure 2. Representative plan-form morphology and mode of bypassing of natural inlets, depending on wave or tide dominance (Source: Kraus, N.C. 2008: Engineering of Tidal Inlets and Morphological Consequences, US Army Engineer Research and Development Centre, Coastal and Hydraulics Laboratory, Vicksburg, MS. 39p).

27. Which of these processes is dominant depends on the relationship between the volume of the tidal compartment (or tidal prism denoted by Ω) and the total gross annual longshore drift (denoted by Mtot). Bar bypassing will occur when Ω/Mtot is low, so there is a small tidal range and/or a large drift. Tidal bypassing will occur when Ω/Mtot is high, so there is a large tidal range and/or a small drift.

28. Under different conditions the estuary may behave differently. A bar bypassing system may during a large flood (i.e. increased tidal prism, Ω) become tidal bypassing. An ocean storm with increased longshore transport can change tidal bypassing to bar bypassing.

29. Generally, stability situations of the inlet can be related to the Ω/Mtot relationship as follows:

   1. Ω/Mtot >= 150 Tidal bypassing – little bar and good flushing. Good stability.

   2. Ω/Mtot 100 - 150 Offshore bar form more pronounced, mixed tidal/bar bypassing. Fair stability.

   3. Ω/Mtot 50 - 100 Entrance bar is large but usually has a channel through it, mixed bypassing. Poor stability.

4. Ω/Mtot 20 - 50 Bar bypassing – inlets keep form by episodic river floods. Dangerous to navigate. Poor stability.

5. Ω/Mtot < 20 Inlet really only opens during storms. Inlet is usually not navigable.

Stability of the Kaituna River mouth

30. DHI found that the tidal prism at the Kaituna River mouth during typical (particularly mean and low) flows varies from about 1.6 to 2 million cubic metres. With regard to the bypassing of sediment from west to east along the coast, the Kaituna River mouth is likely to be a bar bypassing system, with an ebb tide (or offshore) bar present at most times. This type of situation presents a significant hazard potential for boat navigation in and out of the river mouth, especially when there are moderate to high waves present, and/or when there is an incoming tide flowing against the river flow.

31. Observations of the Kaituna River mouth show the stability of the eastern margin of the inlet and locational stability of the main channel landward of the beach. As the channel crosses the ebb tidal bar, there is less stability of the channel position, width and depth. Figure 3 shows the potential variability as conceptual models where:

- **Model 2 – Stable inlet processes**: The main channel through the ebb tidal bar is stable but sediment deposited on the updrift side of the entrance (western side at Te Tumu Cut) is eroded by ebb tide currents and carried into the nearshore where it is deposited on the ebb tidal bar. This sediment is then reworked by waves to form landward migrating bars that eventually weld to the adjacent shorelines.

- **Model 3 – ebb tidal bar breaching:** Occurs where the main channel over the bar cyclically migrates downdrift (to the east at Te Tumu). Sediment accumulation on the updrift side causes a deflection of the main ebb channel. Over time the spillover channels become the main channel due to the increase of the ebb flow strength during the tidal cycle or from regular variation in the outflow over a longer time period. In addition, the sediment slug moving from downdrift to updrift across the channel thins and becomes a weaker barrier against the main channel flow. The channel then breaks out seaward of the inlet channel, while the downdrift slug of sediment gradually moves onshore and attaches to the downdrift shoreline.

- **Model 4 – Outer channel shifting:** This is similar to ebb tidal bar breaching but deflection of the channel through the nearshore zone is limited to seaward of the main ebb tide bar and the bypassing of sediment involves smaller volumes.

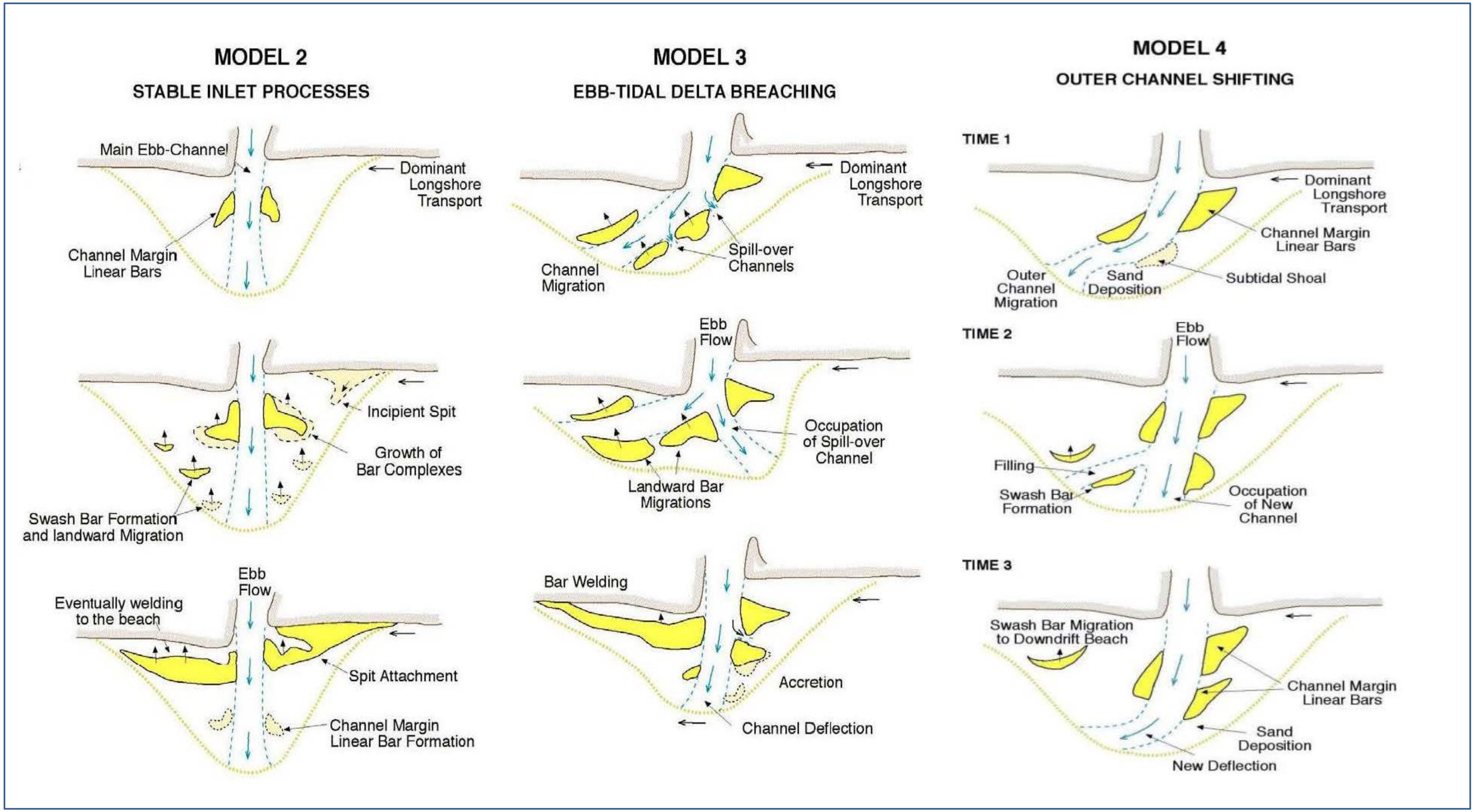

Figure 3: Bypassing models most similar to Kaituna River mouth (adapted from Fitzgerald et al, 2000).

32. These situations can all occur at the Kaituna River mouth, although due to variability in wave approach directions, the deflection of the channel can also be to the west as shown in Figure 4.

Figure 4: Observations of channel and bar morphology and associated outflow current pattern as observed by BoPRC monitoring Sunday 1 February 2015.

33. This type of relationship between sediment movement and flows through the inlet will generally depend on the mean river flow and mean coastal conditions, although storm waves, and consequent large sediment movement along the shore, or flood conditions will change the nature of the stability.

34. Although the river mouth can be navigable outside of the two to three hours either side of high tide, there can be periods when storm waves and low flows widen the bar form and shift the main channel position. Regular users of the river mouth are aware of the instability of the bar and the channel, and treat crossing the bar with caution.

35. High river flows also result in dynamic variability of the bar over time. The Kaituna River mouth ebb tide bar is scoured during major floods. This can result in a relatively deep, and more readily navigable channel across the ebb tide bar directly opposite the river channel. The persistence of this channel over time depends on the occurrence of wave-driven longshore transport that carries sediment across and into the channel, resulting in shoaling of the channel and progressive reduction in depths over the bar to more typical conditions.

NUMERICAL MODELLING AND EFFECTS

36. Modelling by DHI included simulation of flows over a one-year period (2006/7) to provide information to assess morphological changes of the river and estuary entrances. The simulated year included periods with large wave events, a large flood and periods of low flows in the river. Additional simulations of the large flood event and a period of low flows with moderate to large wave conditions were also carried out.

37. The first six months of the simulated year included some significant wave and elevated river flow events. The modelling predicts a slight increase (less than 10 cm) in depth through the river mouth and across the ebb tide bar, and a similar magnitude but decrease in depth at the landward end of the inlet channel.

38. The modelling indicates that the proposed re-diversion will result in a reduction in outflows through the Kaituna River mouth during flood events as some of the floodwater is diverted to Ongatoro / Maketū Estuary. The model predicts that the flood would still result in scouring of the channel bed and realignment of the channel position across the ebb tide bar to be more directly in line with the inlet channel. The morphological modelling predicts the re-diversion will result in a slight decrease in depths during high flows, although there is no difference in peak flow or current speed before and after the proposed re-diversion.

39. It is likely that the morphological modelling overestimates changes to the bed levels due to scaling factors. Large flood events will have potential to do more geomorphological work than is able to occur due to the available sediments that can be moved being less than the potential volume that could be moved by the energy of the flood flows. The differences between the pre- and post-project effects of a flood on the morphology of the channel and ebb tide bar are relatively small within this dynamic environment, and will persist only until the next time waves and/or alongshore sediment transport processes move sediment in the nearshore and across the channel. This could be a matter of hours or days, rather than weeks or months.

40. The final four months of the simulated year contained river flows that were typically low during a period of a relatively high-energy wave climate. The model showed that a bar developed across the river mouth under these conditions. The situation was similar for the existing situation and under the flows modelled for the proposed re-diversion. The main difference was slightly decreased depths (of 1 to 5 cm) over the bar with the re-diversion flow regime.

41. The model results are consistent with the process dynamics of the river mouth. The proposed changes to the flow regime will not change the nature of the bar-bypassing system, or the variable nature of the ebb tide bar morphology and channel movement.

42. In particular, the channel position will continue to move across the ebb tide bar depending on the strength of the fluvial and tidal flows, the wave energy and the volume of sediment transported in the nearshore. At times there will be a small decrease in the depth over the bar in comparison to the situation without the diversion flow regime, but the change in depth will be of the order of a few centimetres, within the error margin of physical measurement of the depth, and not noticeable by users of the channel.

43. Any differences to the channel and bar morphology as a result of floods with the diversion in place in comparison to the existing situation will likely be small although possibly measureable, but would be of limited duration and difficult to attribute solely to the re-diversion due to other variability within the process environment.

44. I consider that the Project operating regime will result in small changes to the flows through the Kaituna River mouth and to the morphology. These changes are unlikely to change the nature of the inlet stability for navigation.

MONITORING AND / OR MITIGATION

45. Safe navigation of the Kaituna River mouth depends on a number of environmental conditions. These include the state of the tide, the presence and size of the ebb-tide bar, and the immediate and recent wave conditions. Navigation hazards occur mainly during low tide and/or low flows depending mainly on the state of the bar. Hazards can also occur at moderate to high flows due to the interaction between fluvial and tidal currents and wave conditions.

46. Separating out the effects of the various process variables in determining the state of the channel, ebb tide bar and navigability at any time is problematic. Possible monitoring has been considered by the Applicant in relation to identifying adverse effects on navigation through the Kaituna River mouth. Measurement of the depth over the bar, or the bar morphology is technically difficult and unlikely to provide information that could be used with confidence in determining effects of the diversion as separate from existing variability, or to indicate the difference between pre- and post-project conditions.

47. In my opinion it is not necessary to impose conditions on the consent that relate to the natural River mouth dynamics. However measurement of outflows upstream of the inlet channel could be useful in calibrating and/or validating the model predictions. Based on the predicted effects of the change in flow regime, the sensitivity of the flow on the morphology

of the bar, and in particular bar depth was examined. It was found that flows would need to be 20% less than predicted before a measureable effect on bar depth would result. The effect would be a decrease in bar depth of about 10 to 12 cm rather than 1 to 2 cm. This is still a very small amount in relation to the spatial variability of the depth over the bar at any time, but does provide an indication of difference to the existing situation that could become adverse and can be mitigated by adjusting the flow through the diversion.

RESPONSE TO SUBMISSIONS

48. I have considered the submissions that have raised issues relating to the scope of my role in the Project, in particular relating to navigability of the Kaituna River mouth at Te Tumu. The concerns generally cover four themes. These are:

48.1 Safety of navigation through the river mouth (including two submissions referring also to safety at the mouth of Ongatoro / Maketū Estuary),

48.2 Sedimentation at “the Cut”,

48.3 Maintenance and/or reliability of accessibility to the sea across the bar, and

48.4 Ensuring that there is “24/7” access for the Coastguard.

49. The first theme shows an acknowledgement by the submitters, of the changeable and dangerous nature of navigation through the river mouth. Submitters recounted incidents they had either had or been aware of, where boats had hit the bar. The Bay of Plenty regional Harbour Master has also put out a public notice warning users of the Maketū bar and Kaituna Cut that recent conditions had made them “no longer safe to cross near low tide, and boaties should only attempt to cross Maketū bar within three hours either side of high tide. Kaituna was even more dangerous.” (Bay of Plenty Times 19th and 20th February 2015).

50. Three submitters also referred to crossing the bar of the Maketū Estuary. Grey noted that the Maketū beach and bar were dangerous in the past and expressed concern that that area could be more dangerous for swimming and boat navigation with the Project. Beer noted that he used the Maketū entrance when waves were higher than 0.5 m but less than 1.0 m as the Kaituna bar was too dangerous when waves were over 0.5 m. Maassen noted there may be improved conditions at Maketū as a result of the Project.

51. The dynamic nature of the Kaituna River mouth and ebb tide bar, the interconnectedness of fluvial and oceanic processes in modifying the morphology, and the very small, predicted effects of the Project on the morphological processes, the Project is unlikely to change the

level of danger, or safety, of navigation through the channel. Navigational safety through the Maketū estuary inlet may be improved slightly, but will remain dangerous and require caution when using.

52. The second theme covers general sedimentation through the channel and on the ebb tide bar. Some submitters also expressed concern that increased flood tide flows could result in sedimentation and silting of the channel upstream of the mouth of the Kaituna River. At present, there is no permanent or easily discernible flood tide delta, but the river upstream of the straightened channel (the cut) is shallower than the seaward part of the channel.

53. Sediment transport modelling predicted that there would be no change in net sediment transport through the channel, and in particular, no additional upstream shoaling or formation of a flood tide delta. The modelling predicted 1 to 2 cm reduction in water depth over the ebb tide bar due to additional sedimentation and/or changes in flows. This amount is within the error bounds of physical measurement of water depth, and is consistent with natural variability of the system. It will not result in noticeable changes to the navigability of the channel or river mouth entrance.

54. Most of the submitters expressed a view that the entrance should be maintained (the third theme) including that there should be reliability of access through the entrance. A number of submitters suggested or asked that the Council should monitor and keep the channel open. The effects of the Project do not warrant such action by the Applicant. Any work to noticeably improve navigation through the bar would likely require either significant engineering works, such as jetties or groynes on either side of the channel, extending out from the beach across the nearshore area to deeper water, or significant ongoing maintenance dredging.

55. The Coastguard Maketū wants the Council to ensure 24-hour access to the sea. A number of submitters support the Coastguard, noting the importance of the Coastguard service. The effects of the Project will not change the navigability of the access, so there should be no change to the existing situation.

SECTION 42A REPORT

56. Section 11.7 of the Officer's report discusses issues relating to navigation and geomorphological changes at the Maketū estuary entrance and the Kaituna River mouth (Te Tumu Cut). Information is presented from the DHI modelling study, the Eco Nomos Navigation Memo and from caucusing between the Council peer reviewers and the Applicants technical experts. I was involved in reviewing the Navigation Memo, and provided input into its content. I was also a participant in the caucusing.

57. The peer reviewers and the Applicants were in agreement with most of the information regarding navigation and geomorphology of the Kaituna River mouth. As a result of the meeting, matters regarding monitoring were agreed, with the outcome being that the only reliable and practical means of monitoring was to measure outflows from the river to test the modelling calibration. I have addressed this modelling above in paragraph 46, and it is included as Proposed Conditions 27.1 and 27.4.

58. The remaining matter regards the effect of the Project on scouring at Te Tumu during floods. The modelling shows that there is potential for a reduction in the scouring effect of peak flows during floods. It is my opinion, based on inlet process principles and empirical evidence from other similar river mouths that any reduction in scouring will be unlikely to have a noticeable effect on navigability or geomorphology of the river mouth.

59. I have addressed the process relationships between flood flows and the dynamic variability of the river mouth navigation in paragraphs 34 and 35. Investigations by NIWA in relation to flows on the Waitaki River, the Rakaia River and others in relation to flow variations have shown that the geomorphological work performed by flood flows is limited by the capacity of the river to do work. This capacity is reached at flows that are less than the peak flood flow. In other words, the sediment that can be eroded from the banks or scoured from the bed has become mobile before the peak of the flood. So once the flows get greater than that capacity, no additional work can be done than is being done. With the Project in place, during floods on the Kaituna, mitigation measures that prevent flooding around Maketū Estuary will result in flows through the Kaituna River mouth that are likely to result in no discernible difference in geomorphic work to that that would occur in the existing situation. This conclusion is consistent with the findings of Mabin.[2]

60. In 2004, Kench carried out studies of changes to the Rangitaiki River mouth as a result of a 1 in 100 year flood in July of that year.[3] He found that the flood resulted in scour of the true left (eastern) bank of the entrance. The channel was wider and shallower than prior to the flood. Bank erosion was limited due to the presence of a rock revetment along the true right bank, similar to the situation at the Kaituna River mouth. Subsequent measurement of the channel in October 2004 showed that sediment had been transported shoreward to rebuild the beach and infill the eastern side of the entrance channel. Normal flows through the entrance had scoured the bed of the channel so that it was deeper than after the flood, with the position of the deepest part of the channel at about the same position as prior to the

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[2] 2007, Responses to ECan s92 requests for further information of 2nd November 2007 *URS Memorandum to Walter Lewthwaite with regard to Central Plains Water Scheme: effects of water abstraction on the Waimakariri River*.

[3] Coastal Consultants Ltd. *Geomorphological monitoring of the Rangitaiki River entrance. Special report: effect of the July 18, 2004 flood.* September 2004. *Geomorphological monitoring of the Rangitaiki River entrance, October 2004.* November 2004.

flood. The entrance channel was returning to “dimensions consistent with the envelope of change measured during baseline monitoring”. Kench noted “the flood response of the entrance and the subsequent recovery was entirely consistent with the behaviour of sandy inlet systems that adjust rapidly to changes in the volume of water passing through the entrance”. This type of response to flood flows and subsequent recovery is also likely for the Kaituna River, with the additional feature of the ebb bar reforming with the transition from a flow dominated entrance to a wave dominated entrance as shown earlier in Figure 2.

CONCLUSION

61. Safe navigation of the Kaituna River mouth (Te Tumu cut) depends on a number of environmental conditions. These include the state of the tide, the presence, position and size of the ebb-tide bar, the immediate and recent wave conditions and the fluvial flows. At present access to the sea is hazardous and recommended only within three hours of high tide. Caution is also recommended when crossing the bar. I am confident that the changes to flows resulting from the Project, and the predicted difference in morphology between the pre- and post- Project simulations will have an indiscernible effect on the situation at the River mouth, and will not compromise the existing navigability of the entrance.

62. In my opinion conditions proposed by the Bay of Plenty Regional Council to monitor flows upstream of the mouth to compare with the model predictions (Proposed Conditions 27.1 and 27.4), to be used to assess the validity of the model findings, and to be used to adaptively manage the Project flow regime are adequate in light of the effects on the river mouth morphology and navigability.

Martin Single

17 April 2015