BEFORE AN INDEPENDENT HEARINGS COMMISSIONER AT NELSON

COUNCIL REF: RM200488, RM200489 AND RM220578

UNDER THE	Resource Management Act 1991
IN THE MATTER OF	Land use consent applications by CJ Industries Limited to extract gravel from 134 Peach Island Road, Motueka from the berm of the Motueka River and on the landward side of the stopbank at Peach Island with vehicle access via a right of way over 493 Motueka River West Bank Road, Crown land and unformed legal road (RM200488 and RM200489); and discharge permit application by CJ Industries Limited to discharge contaminants to land from backfill material associate with the proposed gravel extraction (RM220578)

STATEMENT OF EVIDENCE OF DR MICHAEL HARVEY ON BEHALF OF VALLEY RESIDENTS AGAINST GRAVEL EXTRACTION (FLOOD PLAIN, STOPBANK AND EROSION IMPACTS)

Dated 11 November 2022

QUALIFICATIONS AND EXPERIENCE

1. My full name is Dr Michael David Harvey. I am a retired water resources engineer/fluvial geomorphologist. I currently reside in the Tasman District and I am very familiar with the Motueka River having fished it for over 50 years.

2. I have a PhD in Fluvial Geomorphology (1980 Colorado State University), an MSc in Soils and Hydrology (1973 University of Canterbury) and a BSc in Agricultural Science (1969, University of Canterbury). I have worked as a consultant in the field of river engineering/fluvial geomorphology for over 40 years, primarily based in the USA. I have authored and co-authored over 100 technical publications and four books, and I have prepared in excess of 150 technical reports during my career. I have extensive experience with hydrologic, one-and two-dimensional hydraulic and both fixed- and mobile- bed sediment transport models.

3. As a consultant, I have worked on identifying the impacts of aggregate mining as well as developing mitigation and restoration solutions, in rivers and on floodplains throughout the western USA (California, Colorado, Arizona, New Mexico), Jamaica and Indonesia. I have also investigated the impacts of mineral extraction and mine waste disposal on rivers and floodplains in New Zealand, the western USA (Washington, Idaho, California, Nevada, Montana, Wyoming, Colorado, South Dakota, New Mexico), Western Australia, Papua New Guinea and Peru. I have been qualified as an expert witness and testified in both U.S. Federal and State Courts on matters related to in-channel and floodplain mining and levee (stopbank) failure.

CODE OF CONDUCT

4. I have lodged a submission opposing the grant of consent. Therefore, I acknowledge I am not completely independent. My submission focused on review of technical aspects submitted by consultants in support of the CJ Industries Ltd application. I have read and sought to comply with the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note 2014. The issues addressed in this statement are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

BACKGROUND AND ROLE

5. My evidence is given on behalf of Valley Residents Against Gravel Extraction Inc (Valley R.A.G.E), a submitter on CJ Industries Limited's resource consent applications to extract and transport gravel from Peach Island, Motueka.

6. In preparing my evidence I have:

 6.1 visited the area of the proposed quarry in Peach Island and viewed the Motueka River at the upstream and downstream limits of the Peach Island Stopbanks; the Motueka River overbank channel (also referred to as the backchannel) from its upstream point of divergence from the current channel of the Motueka River to its downstream confluence with the river; the un-named local tributary channel that flows within the former Motueka River channel; and the Peach Island stopbanks.

 6.2 read the Tonkin & Taylor Hydraulic and Stopbank Stability Analysis report dated 16 December 2020

 6.3 read the Envirolink groundwater analysis (4, June 2021)

 6.4 read the LandVision, Ltd Peach Island LUC and Soil Survey report (May 2021)

 6.5 reviewed the conditions volunteered by CJ Industries, and

 6.6 reviewed the information provided in the Assessment of Environmental Effects (AEE) on effects on the flood plain and stopbanks (pages 43 – 46) including the comments made by the Council's River and Coastal Engineer, Giles Griffith summarised in the s42A report (28/10.2022), including Recommended Conditions (Attachment 2).

7. In addition, I have read the 15 July 2022 and 4 November 2022 statements of evidence of the following:

7.1 Timothy George Corrie-Johnston – Corporate and Operations.

7.2 Simon James Aiken – Flooding

7.3 David John Averill – Geotechnical

7.4 Dr Calum MacNeil – Surface Water Quality and Ecology

7.5 Dr Reece Blackburn Hill – Soil Management and Land Productivity

7.6 Ryan Charles Smith Nicol – Groundwater and Clean Fill Management.

8. I have reviewed the following documents regarding the construction, maintenance, design flows and potential failure modes of the Motueka River Stopbanks and alternative sources of aggregate in the Tasman region:

8.1 Tasman District Council Motueka Flood Control Project Newsletter, Issue 01, July 2010

8.2 Tasman District Council Motueka Flood Control Project Newsletter, Issue 02, April 2011

8.3 M.P. Hill, 2021. Aggregate Opportunity Modelling for New Zealand, GNS Science Report 2021/10. (Appendix 2, Map 22, Aggregate Opportunity Modelling- Gravel model results- Marlborough-Nelson).

SCOPE OF EVIDENCE

9. My evidence will focus on the potential effects of the proposed quarry activities on erosion of the Motueka River floodway (backchannel) during Stage 1 of the mining and immediately following pit backfilling and consequent fine sediment delivery to the Motueka River and Taman Bay, which are within my field of expertise.

10. My evidence:

10.1 Describes CJ Industries proposal

10.2 Describes the floodplain area

10.3 Describes the impacts of the gravel extraction on floodplain erosion at the margins of the pits

10.4 Describes the potential for erosion of the backfilled pits during flood flows

10.5 Addresses the potential for stopbank failure regardless of the proposed mining

10.6 Sets out conclusions based on my assessment.

EXECUTIVE SUMMARY

11. Erosion and sediment run-off risks from the quarry proposal are significant and have not, in my view, been accurately modelled or assessed by the applicant's experts. In addition, flooding events are more common than those modelled by Tonkin & Taylor. The annual probability of flooding is 100% as evidenced from the multiple large flood events in 2021 alone. The erosion and flooding risks cumulatively have a strong potential to increase sediment loading to the Motueka River and Tasman Bay.

12. Backfill for the borrow pits in Stage 1 will be obtained from a range of sources and the physical characteristics of the backfill material will be variable. This combined with a seasonally variable water table means there is likely to be differential settlement of the backfilled pits. This in turn will adversely affect the regraded contour and therefore the potential for erosion of the placed, overlying uncompacted subsoil and topsoil. Again, this creates an increased risk of sediment loading to the Motueka River and Tasman Bay during flood events.

13. Alluvial aggregate is available from other sources in the Region and these should be preferred to Peach Island given the existing residential development, rural characteristics and risks of increased sediment loading outlined in my evidence.

THE APPLICANT'S PROPOSAL

14. The following is a summary of the application as I understand it, and as it relates to river hydrology, flood management and floodplain erosion.

15. The applicant is proposing to excavate an area of approximately 7.4 ha, consisting of about 2.49 ha (Stage 1) located outside of the Peach Island Stopbanks within a former channel of the Motueka River (backchannel) and 4.5 ha (Stages 2 and 3) between the stopbanks. Proposed excavation depths are in the order of 5m but will be dependent on groundwater elevations at the time of mining. The applicant intends to maintain a minimum separation at any time of one metre to groundwater. At any given time, the area of active mining in Stage 1 will not exceed 1600 m^2, in a pit with dimensions of 20m x 80m, oriented parallel to flow.

16. The applicant proposes a 20m buffer strip between the toe of the Peach Island stopbanks and its extraction activities to mitigate any potential impacts on stopbank stability resulting from pit mining.

17. After the aggregate resource is extracted, it will be stockpiled on site within the stopbanks and then taken to a processing plant.

18. I understand that there will be stockpiles of topsoil and overburden stripping as well as backfill materials located within the stopbanks, with the exception of temporary topsoil and backfill materials that will be used to meet the daily 1600 m^2 open pit condition, stored on the floodplain.

19. The applicant proposes to partially backfill the excavated areas with clean fill brought into the site from a wide range of locations that meets the WasteMINZ clean fill standards. Backfilling is an important part of site rehabilitation to approximate the pre-mining contours. Uncompacted subsoil and topsoil will be replaced over the backfill and will be revegetated within one month of reinstatement.

DESCRIPTION OF THE FLOODPLAIN AREA

20. Stage 1 of the site is located on the modern floodplain of the Motueka River and is primarily composed of a former channel of the river that is also partially occupied by an unnamed channel that conveys flows from three westside tributaries via the

former channel to the confluence with the Shaggery River and thence to the Motueka River.

21. Because the site is located in a former channel of the Motueka River, the underlying materials are composed of river emplaced alluvial sediments, that are generally finer (sands, silts and clays) at the ground surface and coarser (sands, gravels and cobbles) at depth.

22. Topographically, the Stage 1 site is relatively flat with slopes between 0 and 7 degrees (Hill, 2022; 3.28) but a former channel depression that is in the order of 2m in depth occupies much of the site and extends south-eastwards to the Motueka River (Figure 1).

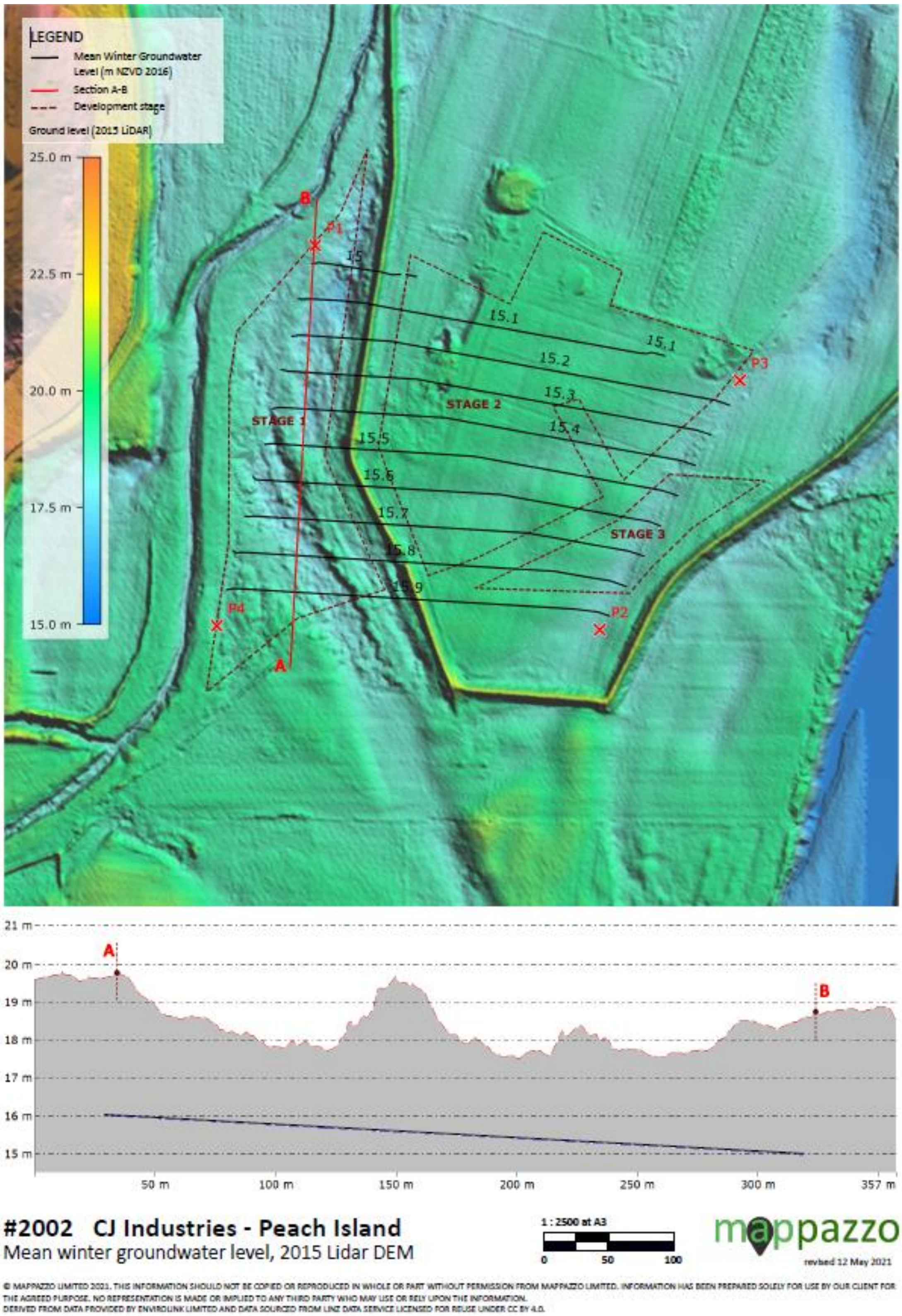

Figure 1. Site topography (Mappazzo, 2021)

FLOOD RISK AND SEDIMENTATION / RUN-OFF TO THE MOTUEKA RIVER AND TASMAN BAY

23. To assess potential project-related flood conveyance impacts and risks to the Peach Island stopbanks, Tonkin & Taylor (2020) modelled a 10-year Annual Recurrence Interval (ARI) (10% Annual Exceedance Probability (AEP)) and 100- year ARI (1% AEP) flood event with- and-without 2 borrow pits and provided flow depth and velocity distributions for each condition within the Stage 1 mining area (backchannel). No assessment of floodplain erosion risks in the vicinity of modelled borrow pits in Stage 1, either during mining, or following backfilling was undertaken. Given the surface area of Stage 1 (2.49 ha), provided that open borrow pit areas are limited to 20m x 80m, there is a potential for approximately 15 pits to be active over the life of the mine.

24. Local records (provided by Coralie Le Frantz at 131 Peach Island Road) indicate that the backchannel where Stage 1 of the mining is proposed has been flooded 10 times between 2013 and 2022 (10 years), which indicates that the annual probability of flooding is approximately 100% (Table 1). These observations are supported by Dr Hill's statement that "the land outside the stopbank is not suited for agricultural land development due to limitations of an inherent seasonally-high water table, flood risk and variable or shallow soil depth" (Hill, 2022 2.7). Figure 2 shows flooding around Peach Island during the July 2021 event that had an estimated annual recurrence interval of 30 years (Martin Doyle, TDC, 2021). During that event, portions of the west Peach Island stopbank were overtopped (Figure 3). Therefore, the Tonkin & Taylor analysis that only considers the 10% and 1% AEP flood events understates the erosion risk associated with backchannel flooding.

Year	No. of Floods	Year	No. of Floods
2013	3	2018	1 (TC Gita)
2014	1	2019	0
2015	0	2020	0
2016	1	2021	2
2017	1	2022	1

Table 1. Backchannel flooding records provided by Coralie Le Frantz 131 Peach Island Road

Figure 2. View downstream of the Peach Island reach of the Motueka River during the July 2021 floods (Photo provided by Ollie Langridge).

Figure 3. Overtopping of the west Peach Island stopbank during the July 2021 flood. The backchannel is located to the left of the stopbank. (Photo provided by Rob O'Grady, TDC, 2 November 2021).

25. Acceleration of flood flows into both the upstream and downstream margins of a modelled pit (Figures 4 and 5; Aiken 2022) prior to the pit filling clearly indicate that erosion of the pit headwalls (headcutting) will occur during a flood event (Kondolf, 1997). This will release fine sediments (sands, silts and clays) from floodplain storage (topsoil and subsoil thickness varies from 0.5m to 1.0; Corrie-Johnson, 2022 3.7) into the flows thereby increasing the suspended sediment load that ultimately will be transported downstream to the Motueka River and then into Tasman Bay. The potential for this mode of erosion was not evaluated by Tonkin & Taylor even though its omission had been identified in my previous submission (27 January 2022). Visual evidence of the headcutting process on the Motueka River floodplain can be seen in Figures 6 and 7 which were taken at the head of the Douglas Road pit following the 17-18 July 2021 flood.

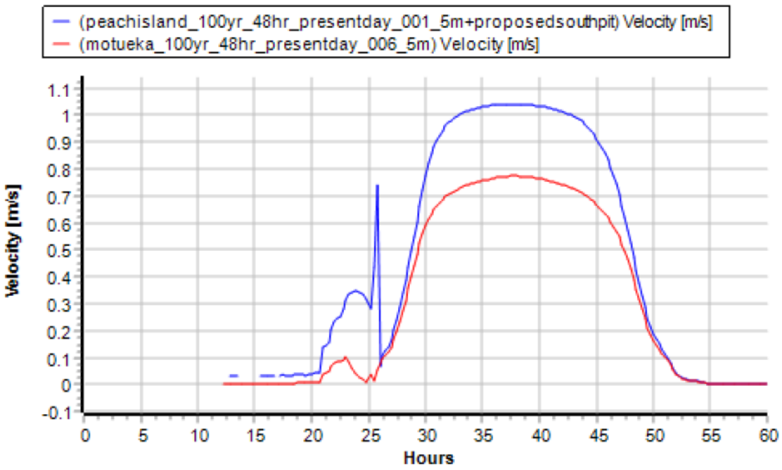

Figure 4. Time series of velocity for model cell immediately adjacent to modelled borrow pit for the 1% AEP flood event (Aiken, 2022, Figure 6)

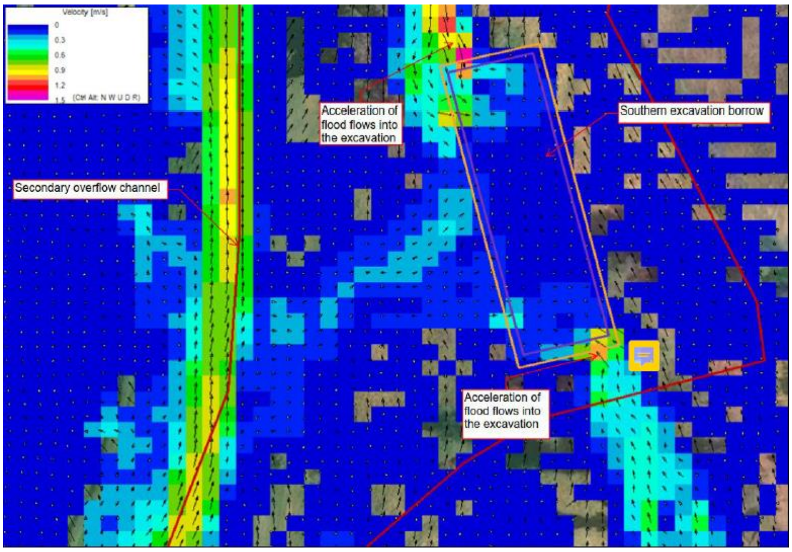

Figure 5. Flood flows accelerating into the excavation pit at the 25 hr timestep for the modelled 1% AEP event (Aiken, 2022, Figure 7).

Figure 6. View west of headcut erosion of fine-grained floodplain sediments at the upstream end of the northern pit at Douglas Road following the 17-18 July 2021 flood. The Motueka River is in the background. (Photo provided by Pete Taia)

Figure 7. View east of the headcut erosion of fine-grained sediments at the upstream end of the northern pit at Douglas Road following the 17-18 July 2021 flood (Photo provided by Pete Taia)

26. Contrary to the statement by Mr Aiken (3.14) that he considered the scenarios assessed in the Tonkin & Taylor report as being conservative representations of the proposed activity because a significantly larger excavation footprints was modelled

(30m X 100m) than is currently being proposed (20m x 80m), engineering literature (Barman et al., 2019) indicates that the headcut erosion potential at the upstream pit margin increases as the Length/Width ratio of the pit increases. Reduction of the pit dimensions from 30m x 100m to 20m x 80m increases the Length/Width ratio from 3.3 to 4 and therefore is likely to increase the headcut erosion potential for any given borrow pit.

BACKFILL

27. Backfill for the borrow pits in Stage 1 will be obtained from a wide range of sources (Corrie-Johnson, 2022 3.42) and the physical characteristics of the backfill material will be highly variable as a result. Because there are no requirements for compaction of the backfill (TDC s42A report; 91-96) and there is a seasonally variable water table, there is likely to be differential settlement of the backfilled pits which will adversely affect the regraded contour and thus the potential for erosion of the placed, overlying uncompacted (Hill, 2022, 3.24) subsoil and topsoil.

28. I do not agree with the evidence provided by Dr MacNeil that the presence of stopbanks and separation distance from stopbanks and water bodies will protect the water quality of the Motueka River. Neither Dr MacNeil nor Mr Aiken have evaluated the erosion potential of the backfilled pits and the overlying replaced soils prior to vegetation becoming established. Dr Hill states that the main erosion risk is associated with exposure of bare soils (Hill, 2022: 3.28) and I agree with this. Given the annual probability of flood flows in the backchannel and its hydraulic connection to the Motueka River downstream of the Peach Island stopbanks (Figure 8), there is potential for erosion of the backfilled soil before it becomes revegetated and thus an increase in the suspended sediment delivery to the Motueka River and Tasman Bay.

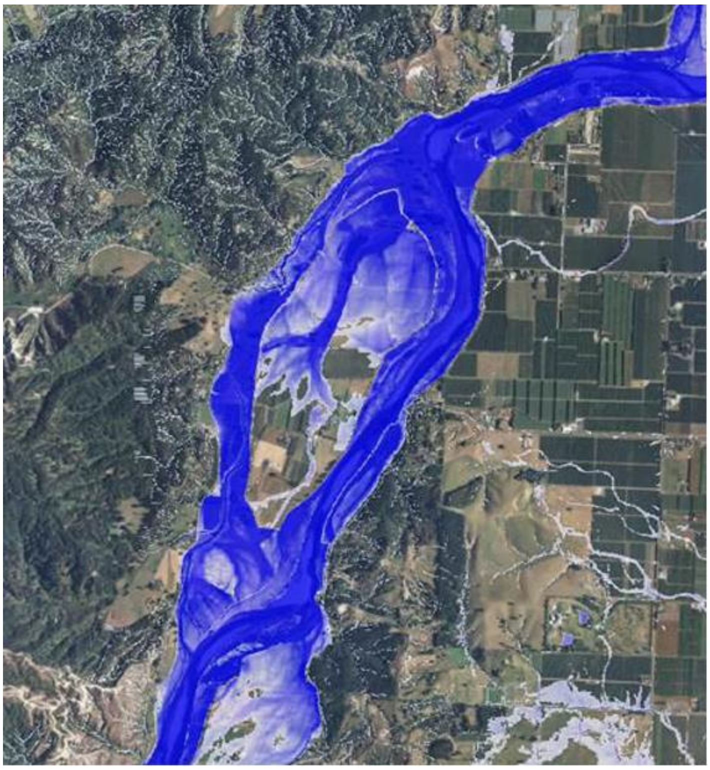

Figure 8. Modelled flow distribution of the 1% AEP event showing the hydraulic connection of the backchannel and the Motueka River in the vicinity of Peach Island. (Image provided by R. O'Grady, TDC, from Peach Island Flood Response and Mitigation Public Meeting 2 November 2021)

29. Soil textures in the Stage 1 mining area are predominantly silt loams (LandVision, Ltd. 2021) composed of sands (~20%), silts and clays (~ 70%). Permissible velocities (i.e. non-eroding velocities) for these soil textures range from 0.46 m/s to 0.69 m/s (Table 2; Fischenich, 2001), and therefore velocities in excess of these values are likely to cause erosion. Time series velocity plots on the floodplain in the Stage 1 mining area for the existing conditions 100-yr ARI event (Figures 9 and 10; Aiken, 2022), show that the velocities on the floodplain exceed the range of permissible velocities for most selected locations (Figure 3; Aiken, 2022) for durations of between 20 and 30 hours. Under these conditions, bare, uncompacted soils of these textures are expected to erode thereby increasing the fine sediment delivery to the Motueka River and Tasman Bay. While time series plots of velocities for the 10% AEP event were not produced, it is likely that the absolute velocities over the floodplain will be of the same magnitude, or possibly higher, than those for the 1% AEP event because

of downstream backwater caused by flow constriction below Peach Island (refer to Figure 8).

Soil Texture	Permissible Velocity (ft/s)	Permissible Velocity (m/s)
Fine sand	1.5	0.46
Sandy loam	1.75	0.53
Alluvial silt	2	0.61
Silt loam	1.75-2.25	0.53-0.69

Table 2. Permissible velocities for various soil textures (Fischenich, 2001, Table 2)

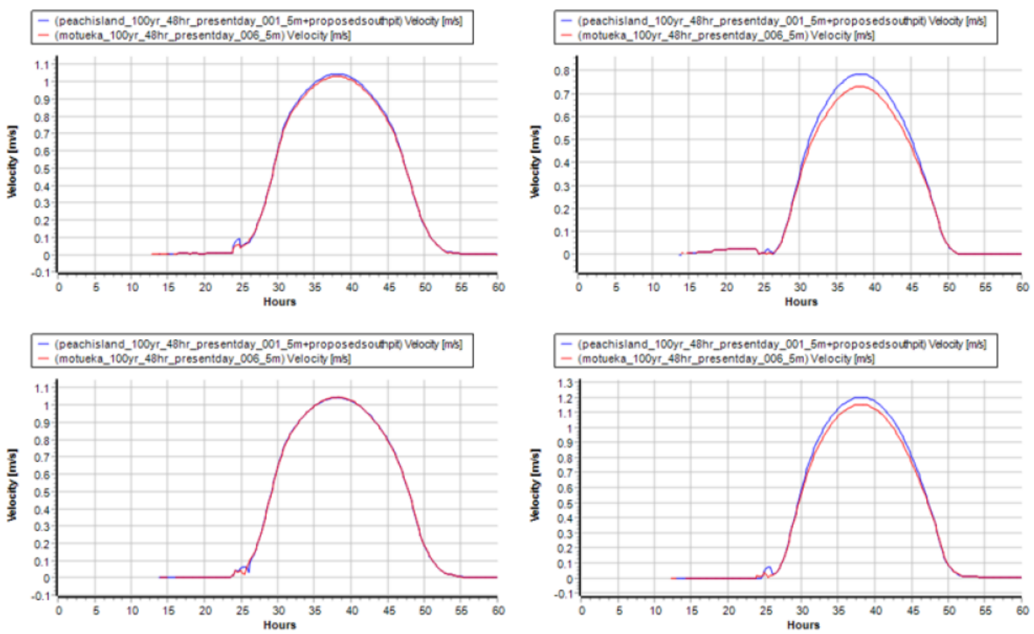

Figure 9. Time series plots of velocity during the 1% AEP flood event from four locations in the vicinity of the southern modelled pit. (Aiken, 2022, Figure 4)

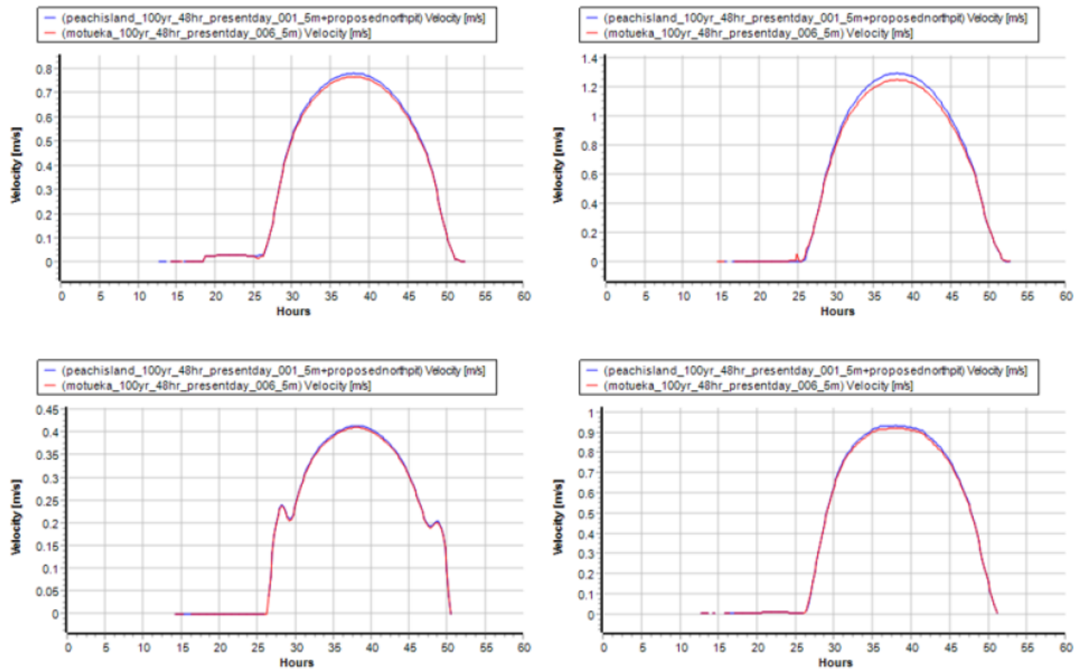

Figure 10. Time series plots of velocity during the 1% AEP flood event from four locations in the vicinity of the northern modelled pit. (Aiken, 2022, Figure 5)

STOPBANKS

30. I agree with Mr Averill that the proposed mining, provided that the 20m setback from the levee toe is maintained, is unlikely to adversely affect the stability of the existing Peach Island stopbanks (Averill, 2022; 2.3). However, because the stopbanks were constructed in the 1950's from local floodplain materials with methods that are unacceptable today (Figure 11) there is a risk that there will be failure (Figure 12), primarily as a result of seepage or sloughing of a saturated embankment during a flood event with an undetermined ARI (Tonkin and Taylor, 2020, p.4). Maintenance activity on the Peach Island stopbanks is intermittent and there is evidence of stock tracking and rabbit burrowing, both of which compromise the integrity of the stopbanks (TDC, Rob O'Grady meeting notes, 2 November 2021.) If the stopbanks were to fail, stockpiles of overburden material, topsoil and backfill material stored between the stopbanks at all 3 stages of the mine life would be at risk of erosion and

would significantly increase fine sediment loading to both the Motueka River and Tasman Bay.

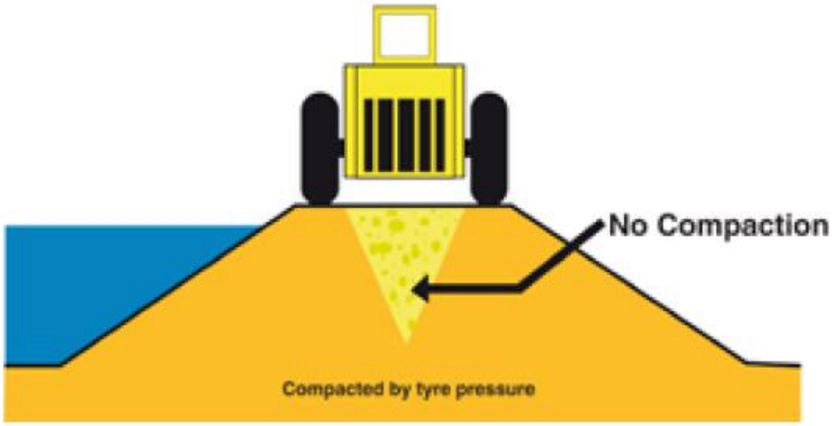

Figure 11. Schematic of Motueka River stopbank construction methods during construction in the 1950's showing lack of compaction in the stopbank core (TDC, 2010; Motueka Flood Control Project, Newsletter Issue 01, July 2010)

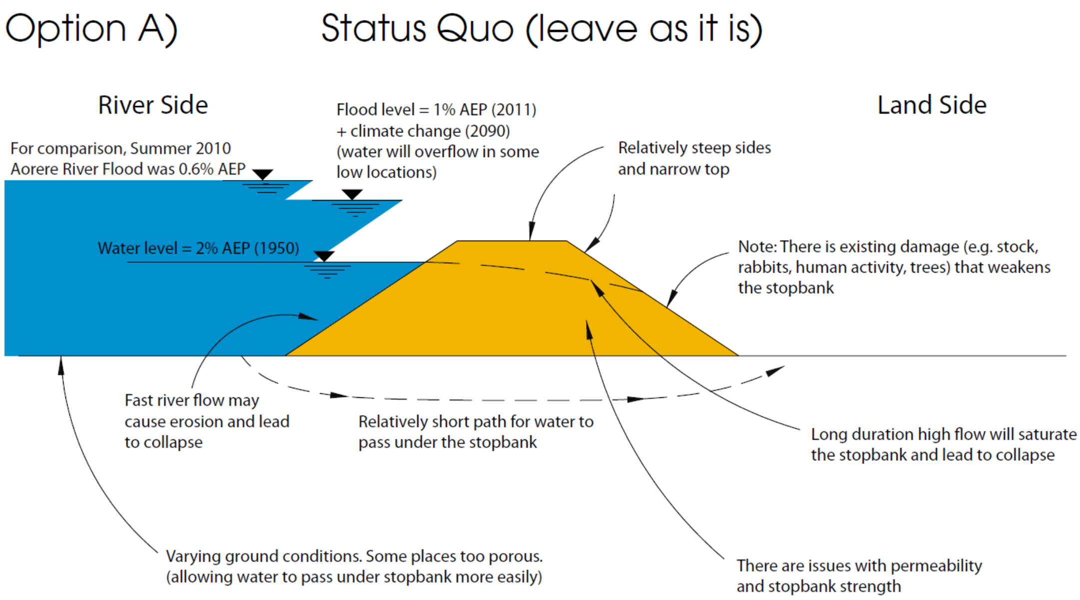

Figure 12. Schematic of the Motueka River stopbanks identifying design flows, projected future flow elevations for the 1% AEP flood event and various modes of likely failure (TDC, 2011; Motueka Flood Control Project, Newsletter Issue 02, April 2011)

POTENTIAL IMPACTS ON TASMAN BAY

31. As I have indicated in paragraphs 25 and 29, fine sediment loading to Tasman Bay as a result of pit headcut erosion and erosion of unvegetated pit backfills is likely to occur, especially since flooding of the backchannel is an annual event and the backchannel is hydraulically connected to the Motueka River downstream of Peach Island. Silts and clays from this erosion will be transported in suspension by the river and then be delivered into Tasman Bay. Scallops have all but disappeared from Tasman Bay and this decline has been in part attributed to fine sediment loading from the upstream Motueka River watershed (Fenemor, 2013). Integrated catchment management is critical to reversing the decline in fish and species habitat (Basher, 2003).

MY ASSESSMENT OF THE APPLICANT'S PROPOSAL AND METHODOLOGY

32. Tonkin & Taylor's assessment of the impacts of the proposed mining on the Motueka River floodplain in Stage 1 fails to take into account headcut erosion of the pits during flows in the backchannel and further does not consider erosion of the uncompacted soils emplaced above the pit backfill material prior to establishment of a vegetation cover. Assessment of the 1% and 10% AEP events is appropriate for evaluating the impacts of the project on flood conveyance and flow depths with respect to overtopping of the stopbanks, but it understates the erosion risk to the floodplain since flood flows in the backchannel occur on an annual basis.

OTHER OPPORTUNITIES FOR AGGREGATE EXTRACTION IN THE REGION

33. I am familiar with the geology and geomorphology of the Motueka River catchment (Basher, 2003) and I am also familiar with the fluvial sediments transported and deposited by the Motueka River that comprise potential sources of aggregate in the riverbed and floodplain of the river. I am also familiar with the history of aggregate extraction from the river (Basher, 2003) and TDC (2022).

34. I have reviewed the Aggregate Opportunities database published by GNS Science (https://data.gns.cri.nz/geology/) and the accompanying report (Hill, 2021).

35. The GNS maps show that alluvial aggregate is available from other sources in the region (Figure 13). Their particular accessibility and constraints would need to be investigated.

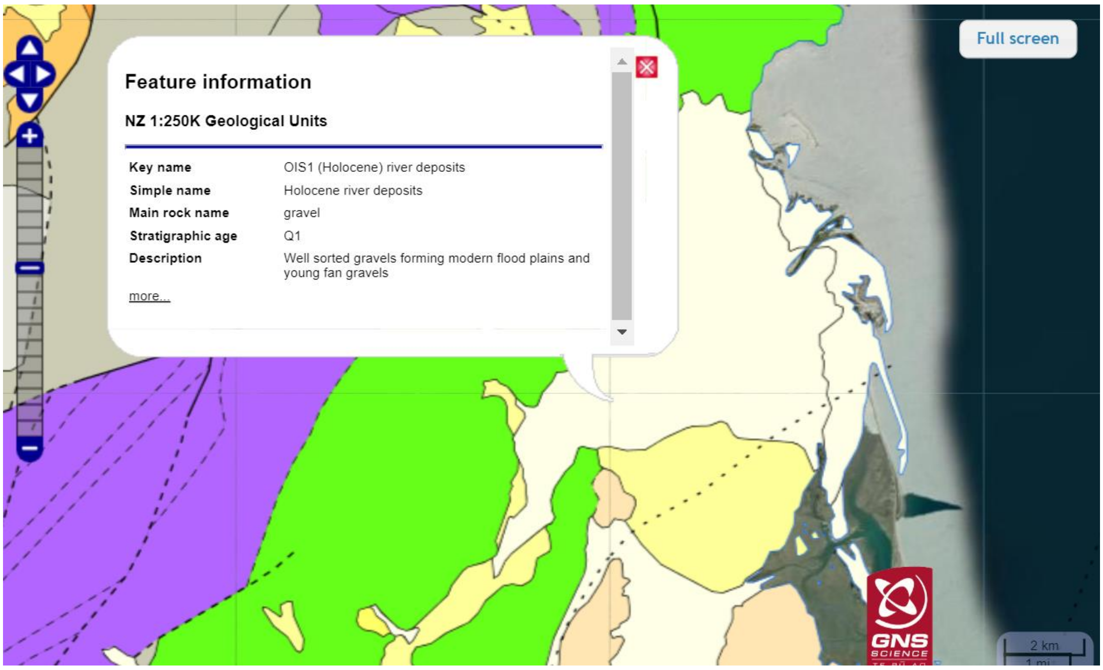

Figure 13. Aggregate resources (Holocene river deposits) within the Motueka area (GNS, 2021).

36. In addition, aggregate is also readily available from other sources (eg Waimea River) that do not seem to impact on highly productive soils (Figure 14). More detailed analysis of this is obviously needed but I understand has not been provided in the application documents. I have calculated the approximate travel distance from the Hau Road processing plant to these Waimea River sources as around 25km, so not much more than the current proposed haulage and transport route from Peach Island (15 km), especially when taking into account the relative road conditions.

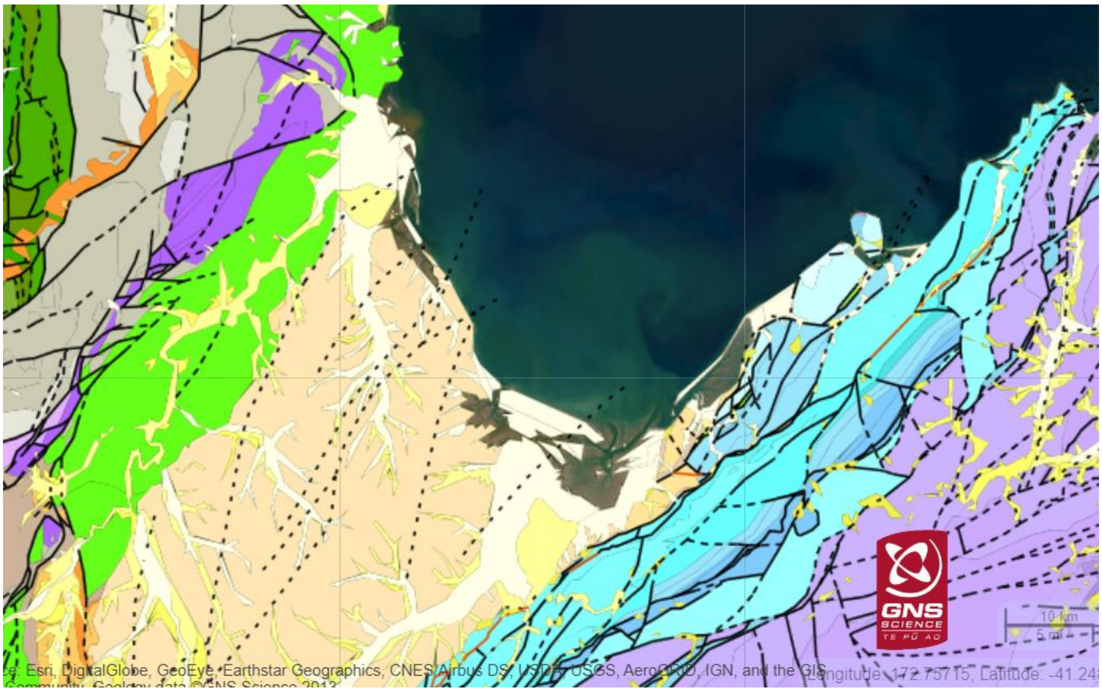

Figure 14. Aggregate resources (Holocene river deposits) within the wider Tasman area (GNS, 2021)

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Dr Mike Harvey

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