BEFORE THE TARANAKI REGIONAL COUNCIL AND NEW PLYMOUTH DISTRICT COUNCIL

MT MESSENGER BYPASS PROJECT

In the matter	of the Resource Management Act 1991
and	
In the matter	of applications for resource consents, and a notice of requirement by the NZ Transport Agency for an alteration to the State Highway 3 designation in the New Plymouth District Plan, to carry out the Mt Messenger Bypass Project

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STATEMENT OF REBUTTAL EVIDENCE OF KEITH DAVID HAMILL (FRESHWATER ECOLOGY) ON BEHALF OF THE NZ TRANSPORT AGENCY

30 July 2018

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INTRODUCTION

1. My name is Keith David Hamill.

2. This rebuttal evidence is given in relation to applications for resource consents, and a notice of requirement by the NZ Transport Agency ("the **Transport Agency**") for an alteration to the State Highway 3 designation in the New Plymouth District Plan, to carry out the Mt Messenger Bypass Project ("**the Project**"). It is my third statement of evidence for the Project, following my evidence in chief ("**EIC**") dated 25 May 2018 and my supplementary statement of evidence ("**Supplementary Evidence**") dated 17 July 2018).

3. I have the qualifications and experience set out in my EIC.

4. I repeat the confirmation given in my EIC that I have read the 'Code of Conduct' for expert witnesses and that my evidence has been prepared in compliance with that Code.

5. In this evidence I use the same defined terms as in my EIC and Supplementary Evidence.

RESPONSE TO EVIDENCE

6. This evidence responds to the evidence of Thomas Drinan and Richard Duirs on behalf of DOC.

EVIDENCE OF THOMAS DRINAN

Biodiversity values for headwater streams

7. Dr Drinan proposes additional multiplication factors for headwater streams (paragraph 89). He claims that *"the ECR calculations do not incorporate these high biodiversity values"* [of headwater streams] (paragraph 88) and appears to argue that headwater streams are not just important, but more important than other streams in the landscape. Consequently, he argues that headwater streams should be assigned an extra weighting when calculating Ecological Compensation Ratios (ECRs).

8. I agree that headwater streams are important parts of our ecological landscape and that they have often been overlooked in the past. In my assessment I have taken care to account for all waterways regardless of size, and the proposed Restoration Package has been designed to be contiguous with forested headwaters to help ensure good restoration outcomes.

9. However, I do not consider headwater streams to be intrinsically more important than, for example, the main stem of the Mangapepeke Stream or Mimi River. I have discussed reasons for this in my EIC (paragraph 131 – 136). My survey work has found that for fish, headwater tributaries of the Mangapepeke Stream and Mimi River provide less fish habitat, less fish abundance and less fish biodiversity than the main stem.

10. The SEV method has recently been assessed as being appropriate to apply to intermittent streams, which are some of the smallest of our headwater streams (Neale et al. 2016). Contrary to the claims of Dr Drinan (para. 88), the SEV method has in fact reflected the high habitat values and biodiversity values found in the Mangapepeke Stream and Mimi River. This is seen in the high SEV scores for forested headwater streams (e.g. 0.92 for site E5) and correspondingly high ECR scores for these sites.

11. The SEV approach does not automatically give a high SEV score to a small headwater stream just because it is a headwater stream (e.g. site Ea28). Headwater streams do not have intrinsically higher biodiversity values just because they are small, or just because they are located upstream. Streams are integrated systems and aquatic biota move through them in multiple directions. This upstream and downstream connectivity is allowed for by functions within the SEV.

12. Dr Drinan accepts my view that the SEV is a tool and that expert judgement is also needed in any final decision about appropriate mitigation and offsets (paragraph 100), but he is critical that I have only used a higher weighting to streams through kahikatea swamp forest and not in other areas. The reason I have taken this approach is because in most situations the SEV does a good job of reflecting stream values. The kahikatea swamp forest streams are a special situation, in that they are relatively rare and the features found in them take a particularly long time to recreate; in my view this justified a higher multiplication factor.

Stream Ecological Valuation Method suitability and application

13. Dr Drinan expresses the view that the SEV is "*not an appropriate or sufficient tool for assessing biodiversity values, nor for quantifying the amount of compensation required for lost biodiversity values*" (Paragraphs 14 and 69). He also has a number of criticisms of how the SEV has been applied. I will address these issues in turn.

14. Dr Drinan argues (e.g. paragraph 69) that the SEV gives limited regard to biodiversity values. In fact, the SEV is a holistic ecosystem valuation system that assesses a range of stream values of which biodiversity is an important part. It is ordered around four function types (hydraulic, biogeochemical, habitat and biodiversity), but there is considerable co-correlation between the variables used and they support each other.

15. I used the SEV approach as the primary way to calculate offset, but it was only one of multiple measures used in the AEE reports for assessing biodiversity values. The assessment of ecological effects followed Ecological Impact Assessment guidelines (EcIA) produced by the Environment Institute of Australia and New Zealand. High SEV scores, the presence of at-risk fish species, and high ecological integrity were all considered and the Ecological

Value of most of the streams affected by the Project was scored as ‘High’ or ‘Very High’ (see sections 2.8 and 4.1 of Freshwater Ecology Report).

SEV application

16. Dr Drinan raises a number of issues and queries with how I have applied the SEV in his paragraph 105. I address these in turn below:

    (a) At sites where an SEV survey was not undertaken, a potential SEV score was estimated where it was needed to calculate an ECR. The potential SEV score was based on SEV scores at nearby reference sites and tested against a hypothetical restoration scenario (see paragraph 43 of my EIC, Freshwater AEE Report and Supplementary Freshwater Report). SEV assessments were undertaken at representative sites affected by the Project.

    (b) ECRs were calculated inclusive of the biotic functions ‘fish fauna intact’ and ‘invertebrate fauna intact’, but conservative values were used when making any future predictions regarding biological outcomes. This lifted the current and potential SEV scores at impact sites. Overall this approach made the resulting ECRs more conservative (higher) than if they were excluded. The inclusion of these functions might also go some way towards addressing Dr Drinan's criticism in paragraphs 73 and 100 that the SEV method under-emphasises biodiversity values.

    (c) Dr Drinan expresses the view that the SEV of culverts (SEVi-I) should be 0 on the basis that, in his view, they do not support biodiversity values (paragraph 105c). Dr Drinan’s views are not supported by evidence relating to either SEV scores in general or biodiversity in particular. Culverts have reduced ecological values compared to most open streams, but they nevertheless can have some values, particularly for water quality.

        Where SEV assessments have been undertaken on culverts the scores are typically about 0.2 to 0.25 (Dr Richard Storey pers. comm. 2018). For the purpose of calculating an SEV for culverts, I assumed that they would provide no, or almost no biodiversity values. However, this is a conservative assumption, because culverts do support aquatic macroinvertebrate communities. For example, Neale and Moffett (2015) found the invertebrate community in culverts were less rich and less abundant compared to when they were restored to open channel streams, but they had similar MCI scores and QMCI scores. Furthermore, inanga and eel were found living in the culverts (see Rebuttal evidence by Dr Neale). I am aware of other examples where eel and banded kōkopu have taken up residence in culverts.

        The culverts in the Neale and Moffett (2015) study were poorly designed for fish passage and had virtually no natural substrate in the bottom. A

considerably more diverse macroinvertebrate community is likely to be found in the Mt Messenger culverts because of their upstream bush catchments and attention to having designs that, in most cases, will retain natural stream bed substrate. Culverts will provide more habitat and biodiversity values when they more closely reflect a stream simulation design and retain substrate. In short, culverts generally reduce habitat and biodiversity values, but not to zero. The 0.15 / 0.23 SEV scores I applied to culverts are in my view appropriate and likely to be conservative for culverts where stream simulation is applied.

I do assign an SEV of 0 to an impact stream when it is lost completely (refer to my Supplementary Evidence). If culverts were also assigned a score of zero as proposed by Dr Drinan then there would be no incentive to minimise stream loss or find designs that maximise the habitat features with culverts.

(d) I have discussed the method used for calculating ECRs for stream diversions in my EIC (paragraph 45), Supplementary Evidence (paragraph 23) and Freshwater AEE Reports. As already discussed, it makes no difference to the actual restoration whether the ECR for stream diversion are is express as '0.5 plus remediation of the stream diversion', or '1.5 including remediation of the stream diversion'. I am comfortable expressing this either way now that we have high certainty about where the restoration package will undertake stream restoration. However, my preference is to keep consistency with the method described in the AEE to avoid confusion. For the purpose of reference, the length/area affected by stream diversions is 1050m/798m^2.

(e) Dr Drinan re-calculated ECRs assuming diversions assuming an SEV of 0 for culverts and with a higher ECR for most stream diversions reflecting that remediation of stream diversion is part of the restoration package. By his estimate the Project restoration package should be 1,893m^2 greater. This would equate to 10,046m^2 compared to my calculation of 8,153m^2. Most of Mr Drinan's increase is from assuming an SEV of 0 for culverts and as already discussed I do not think this appropriately reflects the actual ecological values of the culverts. Nevertheless, even if this approach was accepted, the Restoration Package proposed for the Project would already provide about 690m^2 more restoration than as calculated by Dr Drinan plus another 798m^2 from remediating stream diversions to their current condition before any additional restoration (as discussed above).

A strict SEV approach requires restoration of an equivalent stream area, but the Project has chosen to undertake the quantum of restoration as calculated by stream length. Given the location of the Restoration Package, this is a conservative approach because the average width of affected streams (0.91m) is less than the average width of streams

proposed for restoration (1.27m). The length proposed for restoration is 8,455m, which equates to about 10,738m^2 of stream by the Restoration Package (plus the 798m^2 from remediating stream diversions).

Additional multiplication factor

17. Dr Drinan recommends applying an additional multiplication factor "*to account for the loss of higher biodiversity values within the headwater systems, in addition to the standard multiplication factor of 1.5*" used in standard SEV calculations (paragraph 107). He proposes that the additional multiplication factor is the percent difference in MCI scores between forested headwater streams and those on the valley floor. In my view this approach produces outcomes that have little relationship to actual biodiversity values, is biased towards a subset of the macroinvertebrate community, and takes no account of fish communities. More importantly the additional weighting is not justified. The SEV scores already incorporate MCI scores (plus other measures of fish and invertebrate biodiversity), ECRs are already higher at sites with mature forest cover and high MCI scores, and I have already discussed the problem with assuming that headwater streams have intrinsically higher biodiversity values than other streams.

ECR comparison with other Projects

18. Dr Drinan compares the average ECR for the Project with that of Transmission Gully Project (3.3) and average ECR for Auckland (3) (Paragraph 16 and 112). Caution is need when comparing projects because they have different existing habitat, different restoration packages and different combinations of effects. For example a stream diversion will have less overall effects than complete stream loss but will have a lower ECR. Dr Drinan has made no account for such differences and as a consequence his comparisons are misleading. He calculated the average ECR for the Mt Messenger Project for both culverts and diversions, while the ECRs quoted for Transmission Gully Project (and presumably Auckland) is just for the culverts.

19. The Transmission Gully Project applied an ECR of 1.7 for stream diversions, 4.1 for steep culverts, 2.2 for flat culverts and 6 where there was complete stream loss. Steep culverts were defined as greater than 20% slope – steeper than any proposed for Mt Messenger[1]. The length weighted ECR for Transmission Gully culverts (including where there was complete stream loss) was 3.1[2]. In contrast the length weighted ECR applied to culverts on the Mt

[1] Table 11.53, Boffa Miskell (2011). Transmission Gully Project Technical Report #11 Ecological Impact Assessment, August 2011.
[2] The ECR for culverts but excluding where there was complete stream loss was 2.4. Transmission Gully had large lengths of complete stream loss compared to Mt Messenger.

Messenger Project is 4.0. This is a larger amount of offset than used for Transmission Gully and more than the ECR generally applied in Auckland[3].

Fish Passage

20. I agree with Dr Drinan's view that it is important for the Project to maintain fish passage. However, I disagree with the implication that the Project poses a potential high risk of adverse effects on kākahi populations (paragraph 92). This is hypothetical and disconnected from the realities of what is proposed.

21. There are no structures proposed in the Mimi catchment that would affect fish movement to or from known kākahi populations or stream reaches with potential habitat for kākahi. Similarly, there is only one permanent structure proposed in the Mangapepeke Stream that would affect fish movement to a stream reaches with potential habitat for kākahi. This is culvert 9 (site Ea10a) which should provide good fish passage using the stream simulation approach. Stream habitat upstream of other structures are not suited to kākahi because they are typically shallow and lack suitable stable substrate.

22. Dr Drinan recommends in paragraph 98 (b) "*that spoiler baffles be used regardless of culvert gradient – as per the New Zealand Fish Passage Guidelines (Franklin et al. 2018)*". I disagree with this recommendation. Spoiler baffles work best where the culvert gradient is less than 2% because their ability to lower velocity reduces as the slope increases. They can reduce water velocities on slopes up to 3% but performance at this grade has not been well tested and their use at this grade is not recommended (Stevenson et al. 2008). In one example, spoiler baffles were retrofitted to a 74m long culvert with an average grade of 1.4% and a very short (2m) section at about 4% grade. Investigations found that the baffles allowed the passage of smelt and inanga through the culvert (previously not occurring upstream) but capture and release studies found that the success rate was relatively low (8 to 28%) (Franklin 2012, Franklin et al. 2018).

23. The Project proposes the use of flexible iris baffles as one option to help ensure fish passage through some of the steeper culverts. These have the benefits of weir baffles in being very effective at reducing overall water velocities (more effective the spoiler baffles), but do not have the disadvantage of traditional types of weir baffles of causing fish to get stuck between weirs. They also provide much better resting areas than spoiler baffles. There are numerous observations and video footage showing this. I understand that further investigations of the performance of flexible iris baffles are occurring over the coming year.

24. Dr Drinan takes a different view to me with regard to the potential magnitude of effects of restricted fish passage at Site Ea6 and potentially restricted fish

[3] Auckland Council have built a database of consented offset / mitigation over the last 10 years. An ECR just under 3 was the average value after the first two years of use. However, the longer dataset shows an average ECR across projects of closer to 2.4 (Josh Markham pers. comm. 2018). Also see rebuttal evidence by Dr. Neale.

passage to some sites during the construction phase (paragraph 98c) but gives no reasons for his view. I have discussed these issues in paragraphs 94 to 98 and paragraph 107 of my EIC.

25. Dr Drinan takes a different view to me with regard to the precise wording to describe fish passage (paragraph 99). I discuss the main issues in paragraph 158-159 of my EIC. From an effects perspective, the key issue is to provide sufficient passage of fish that would naturally occur so as to maintain healthy populations of fish that would naturally occur upstream of the culvert.

Sediment

26. Dr Drinan provides an overview of potential effects of suspended sediment that complements my assessment in the Freshwater AEE (paragraphs 114 - 117). He expressed concern that the effect of sedimentation may be more than 'low' (paragraph 118). Understanding the actual stream context is important. I based my view of low effects after mitigation on:

    (a) The high level of erosion and sediment control described by Mr Ridley (and reiterated in his rebuttal evidence).

    (b) Restrictions on the timing of in-stream works to minimise any effects on the spawning of giant kōkopu spawning and redfin bully.

    (c) An aquatic community accustomed to the naturally high concentrations of suspended sediment and sediment deposition that has been observed and measured in the rivers. Most of the stream length potentially exposed to sediment from the Project have fine sediment cover well above the 20% tipping point identified by Burdon et al. (2013) and most are soft-bottomed (Table 3 in my EIC). The exceptions are E4, E5 and E6. Even site E4 had >70% fine sediment cover during the November site visit (see Figure 6 in my EIC)[4].

    (d) Similar aquatic macroinvertebrate and fish communities occurring in the western tributary of the Mangapepeke Stream compared to the eastern tributary (where the Project is occurring), despite measuring considerably higher sediment concentration in the western tributary. [5]

    (e) The stream restoration proposed as part of the offset package will reduce sediment inputs to the streams over the long term. So there is some balancing of short-term effects over long term benefits. The benefits of restoration planting will be most evident in the Mimi River where the pasture is more developed.

[4] The ELMP provides for sspecific ecological monitoring to assess sediment effects upstream of E4 and downstream of E6.
[5] The western tributary of the Mangapepeke Stream had about four times higher sediment concentrations during flood events compared to the eastern tributary.

27. A comprehensive water quality and ecological monitoring programme has been proposed in the CWDMP and ELMP to assess and manage any sediment effects.

Stream fragmentation

28. I have discussed macroinvertebrate passage through culverts in my EIC (paragraph 145 -149). Dr Drinan adds some useful and additional information about adult insect movements. He takes the view that: "*Overall, stream fragmentation effects will have major implications for the invertebrate communities of the Project area*" (paragraph 124). Culverts can fragment invertebrate communities but there is little evidence of it affecting invertebrate communities outside of urban areas. In my view, the culverts installed for the Project will have little effect on the aquatic macroinvertebrate community in the upstream catchment as discussed in paragraph 149 of my EIC.

Flow from water take

29. Dr Drinan makes a number of criticisms of my calculation of a minimum flow limit. Many of the criticisms are based on a misunderstanding of how the calculations were undertaken. Rather than provide a point-by-point rebuttal, I will simply note that the calculations considered the depth preferences of eel, inanga and redfin bully. The calculations are approximate, being based on limited data (a longitudinal survey and two cross-sections) that necessitated a number of assumptions (see footnotes to paragraph 89 of my EIC). Nevertheless, in my view the calculated flow limits provide an appropriate basis for making an informed decision considering that the take is small and short term. Also relevant to the issue of methodological accuracy is that the actual statistic used for flow limit setting (i.e. maintaining two thirds of instream habitat available at MALF) is itself somewhat arbitrary.

30. Dr Drinan takes the view that the mean annual low flow (MALF) should be based on measured flow rather than modelled data (Paragraph 127). Unfortunately, this is not practical for the Project because there are no historical records for these rivers and it takes many years of monitoring to obtain a sufficiently long hydrological record to calculate a MALF.

31. The key question for the consent hearing is whether to adopt the Applicant's proposed approach (restricting the instantaneous rate of take to 5 L/s up to a maximum of 150 m^3/day from the Mimi River and 300 m^3/day from the Mangapepeke Stream) or adopt TRC's proposed approach (i.e. an abstraction of up to 10 L/s but no more than 25% of the instantaneous flow).

32. As discussed in my EIC (paragraph 92), the TRC approach would allow more water abstraction when the Mangapepeke Stream is at mean annual low flow (MALF) (31 L/s) and only start to become more protective when the flow drops below 20 L/s (i.e. at about two thirds of the MALF). The effect of abstraction is more apparent at lower flows but there is less likelihood of flows below 20 L/s

than above. We do not know the precise probability of encountering flows below 20 L/s because we do not have a long-term flow record (as rightly noted by Dr Drinan). We can say that for most of the time during baseflow the Applicant's approach will be more protective but occasionally, during extreme low flows, the TRC approach will be more protective.

33. My main concern with the TRC approach is that it is harder to manage, harder to enforce compliance and requires establishing a weir (which is additional disturbance to the stream). The stream bed appears to be mobile, so there is a high chance that rating curves will become inaccurate after flood events - necessitating repeated gaugings and retrospective corrections and making it difficult to ensure and enforce compliance. In practice a weir would need to be built to ensure an accurate and consistent rating curve[6]. This would, in my opinion, be an unnecessary effect on the stream.[7]

34. My recommendation is to adopt the Applicant's approach for the water take. It is a small take for a short duration from a stream that is relatively insensitive to water takes due to the numerous deep pools. It is more protective than the TRC approach under most flow conditions, is easy to ensure compliance and, importantly, does not require the construction of a weir so would cause fewer direct environmental effects.

Fish Recovery Protocols

35. Dr Drinan recommends changes to the Fish Rescue and Recovery Protocols (paragraphs 129-133, 142). I consider the changes proposed by Dr Drinan will results in considerably more effort for, at best, negligible benefit, but will probably result in more fish injury and death.

36. The reason for the additional risk of harm is because sampling methods that are not completely benign and Dr Drinan's recommendations will expose more fish to more risk. Electro-fishing is an effective and valuable technique for capturing fish, but it is not uncommon for it to cause mortality and injuries from convulsions of the body such as spinal injuries and hemorrhages. One study found injuries caused to 50% of fish examined internally, an often these injuries are not externally obvious. (in Snyder 2004). Such injuries can occur anywhere in the electrofishing field at or above the intensity threshold for the twitch response.

37. Death and injuries can be reduced by using direct current or pulsed direct current and by good practice. However, mortality may still occur even with experience operators because you cannot simultaneously manage all the variables to reduce injury to all fish in a stream. Dr Drinan's recommendations

[6] Jack McConchie, Hydrologist pers comm. 2018
[7] A weir is not required for the water take inlet as there are numerous large scour pools providing sufficient water depth, but I understand that it has been retained as part of the proposed consent conditions as a precaution in case the TRC conditions are adopted.

would result in some fish being exposed to electro-fishing multiple times, which could result in cumulative injuries (Snyder 2004).

38. Similarly, traps and nets are not completely benign. Even using fine-mesh nets with exclusion barriers it is common to find some dead or injured fish as a result of predation, stress or getting stuck in the net or exclusion barriers.

39. Allowing fish to 'voluntarily leave' a stream as water recedes as a first stage of fish rescue was first recommended to me by an ecologist at Waikato Regional Council. I have since applied this approach on many occasions and found it to be very effective and safe. I have not observed any fish injury or mortality using this approach. It is a controlled and managed process not comparable to the rapid draw-down that can strand fish below dams. The Fish Recovery Protocols have procedures to manage the rate at which water recedes. This can include partial draw-down. As water recedes fish (particularly eels and galaxiids) tend to swim downstream or accumulate in pools from which they can be promptly removed using hand nets, or if necessary, electro-fishing.

40. Dr Drinan proposes active searching for kākahi at all sites and not just those which have suitable habitat. In my view this is an unnecessary precaution. I have visited all sites affected by the Project and most of the streams where kākahi recovery is not proposed are intermittent or have substrate not suitable for kākahi. However, I have noted one site (site Ea23) where kākahi search is not currently indicated but, in my view, should occur.

41. Dr Drinan proposes a prescriptive, one-size-fits-all approach to fish recovery which takes little account of stream conditions. His proposed changes (paragraph 142) with respect to prior netting and electric fishing will, in my view, result in more fish harm than benefit.

Freshwater Ecological Monitoring

42. Dr Drinan agrees with most of the proposed monitoring (paragraph 143) but has suggested some modifications that I briefly comment on below:

    (a) The ELMP allows that after at least one year of baseline ecological monitoring and one year of construction monitoring, the biannual ecological monitoring may be reduced to an annual frequency. In my view this is a reasonable approach. It does not exclude reinstating biannual monitoring as part of any recommendation in the annual monitoring report.

    (b) Quantitative sampling of aquatic macroinvertebrates is proposed for the two sites with hard-bottom substrate (downstream of fill 12 and 13). The other sites are soft-bottomed. The standard protocols for quantitative sampling of aquatic macroinvertebrates in soft-bottom streams requires the destructive sampling of macrophytes. I do not recommend using the quantitative method at these sites because macrophytes are not present

at all sites, where they are present they are often sparse and repeated extraction may compromise the native plants, and the qualitative method better represents the range of macroinvertebrates at the site.

(c) I am comfortable with the monitoring being done by the spotlighting method instead of electric fishing or netting, however I do not consider it necessary to apply two methods at every site. Some methods are better suited to particular species but the key issue is to ensure consistency over time. Furthermore, some of the downstream sites are not well suited to spotlighting (being deep and turbid) and the change is not trivial - it would nearly double the work load for little benefit.

(d) Baseline monitoring is proposed for all sites.

43. Overall, it is my view that the ecological monitoring described in the ELMP will provide robust information to assess any ecological effects on the streams.

Freshwater Ecological Response Monitoring

44. The ELMP only proposes event-based ecological monitoring in response to sediment deposition on the edge of the Mimi Swamp Forest reflecting the importance of this area (ELMP chapter 8.4.4). Dr Drinan recommends additional aquatic macroinvertebrate monitoring in response to trigger events (paragraph 144 – 148). I have considered this approach and do not support it. There are several reasons for this:

(a) Any trigger is likely to correspond with flood events, and flood events have large impacts on fish and macroinvertebrate communities with rapid changes occurring during the weeks following them, this makes it difficult to distinguish between the effects of the flood compared to any sediment input. Standard sampling methods recommend waiting two to three weeks following floods.

(b) The biannual/annual monitoring is designed to detect effects of sediment on habitat, macrophytes, macroinvertebrates and fish. Effects not detected by this monitoring are likely to be small and of short duration.

(c) If there is a major sediment load to a stream it is likely to be obvious to the visual inspection and there is a corresponding management response described in the CWDMP. Slips naturally occur around Mt Messenger; examples of this are shown in Figure 4.2 of the Freshwater Ecology AEE Report. I have observed a number of examples around Mt Messenger where a slip has recently blocked a river and the river has cut through it. Aquatic macroinvertebrate monitoring is not needed to detect and respond to this sort of event.

(d) The mitigation responses proposed by Dr Drinan, such as Sand Wands, would be ineffective in the Mangapepeke Stream and Mimi River

because of high natural sediment deposition and will possibly do more harm than good by causing more disturbance. Practical responses to a major sediment input (e.g. from a landslide) would include removing any blockage and stabilising the site (as provided for in the CWDMP), adding large woody material to the stream and re-establishing native macrophyte if they were affected. Any restoration using wood or macrophytes would be most appropriate near the end of the Project. Augmenting the streams with wood could be considered as a standard part of stream restoration in addition to riparian planting, but is likely to be only appropriate in the upper catchment to minimise the risk of it aggravating flooding.

(e) The CWDMP already provides for management responses to any sediment events based on the water quality monitoring and visual inspections. This needs to be case specific.

45. Dr Drinan raised concerns about the trigger for sediment deposition changing from 5mm to 6mm. This is a negligible change but was done to make it easier to observe any difference when using the astroturf method. The trigger is somewhat arbitrary and much less than what has been measured in the adjacent raupo wetland. To put it in context, during a three-month period (February and May 2018) about 200mm of sediment was deposited over sediment plates in the raupo wetland where the stream channel from Site E6 dissipates in the wetland. The monitoring period covered multiple rain-events but nevertheless shows a lot of sediment deposition.

Fish Passage

46. Dr Drinan recommends fish passage monitoring on culverts with steeper grades, i.e. culverts 11 and 17 (Ea12 and Ea21) (paragraph 149). In my view this is unnecessary and impractical. These are very small streams which will probably have insufficient water to support fish upstream of the culverts. Ea12 is ephemeral upstream of the culvert and Ea21 is probably intermittent. No fish were present at Ea21 when it was fished. Koura were present but in very low abundance. This will make population monitoring unreliable. The current proposed monitoring focuses on major catchments, which I think is appropriate.

47. Dr Drinan's recommends an inspection of culverts four years after their installation (paragraph 151). I understand that culvert inlets and outlets will be inspected post-instillation and that there will be ongoing inspections as part of maintenance. In my view this is appropriate. I note that some erosion or scour of the stream bed or stream banks can be positive for ecology so long as culverts do not become perched or fish passage compromised. It is often scour holes and under cuts that provide the key fish habitat is streams. The key issue is to inspect the culverts from a fish passage perspective.

Riparian offset and restoration planting

48. I agree in part with Dr Drinan's comment in paragraph 136a about design and management of stream restoration works. In my view review and input from landscape architects and freshwater ecologists are both valuable and important for the successful design and implementation of stream restoration as they have different skill sets. A freshwater ecologist should in particular have an input to the rehabilitation and restoration associated with stream diversions, but I do not think they would need to take the lead role.

Stream diversions

49. There is merit in Dr Drinan's recommendation to undertake SEV assessments at a couple of stream diversion sites three to five years after restoration has been undertaken. Post restoration monitoring is not very common but is very helpful in understanding the effectiveness of restoration measure.

50. More critical is to ensure that the final stream diversion design and construction are consistent with the Ecological Design Principles described in the LEDF. In my view, any post-construction ecological monitoring is a nice-to-have rather than core monitoring because there is already post-construction monitoring of the restoration planting proposed in the ELMP (see evidence by Mr MacGibbon).

Adult invertebrate passage

51. Dr Drinan recommends that malaise netting is undertaken at fish monitoring sites to determine if permanent culverts are impeding the upstream flight of adult aquatic insects along stream channels (paragraph 157 – 160). In my view the movement of adult insects is of academic interest but is not definitive from an effects perspective.

52. It is important to consider the life history of aquatic insect life history, the naturally high mortality of emerging adult macroinvertebrates due to predation, and that relatively few adults are needed to sustain upstream populations (e.g. Humphries and Ruxton 2002). So even if there are reductions in the abundance of adult insects passing through a culvert, this can have little impact on maintaining sustainable upstream populations.

Water quality monitoring

53. Dr Drinan proposes a different method to trigger a management response based comparing the difference in turbidity at 'control' sites and 'impact' sites (Paragraph 162 – 187). In my view this approach is not ideally suited to the Mt Messenger Project and will not necessarily be more conservative in triggering a management response - sometimes it will be and sometimes it won't be depending on natural sediment inputs (e.g. from slips) occurring during each specific event.

54. Near continuous turbidity monitoring is proposed in the CWDMP at downstream sites. Management responses are triggered when turbidity at these sites exceeds a threshold determined by baseline monitoring. I do not consider upstream turbidity monitoring to be critical for the purpose of ensuring an appropriate management response. Furthermore, although we have reasonable control sites, there remain large sections of the site that have no true upstream site that can be practically monitored. This issue is also discussed in rebuttal evidence by Mr Ridley.

55. Having said this, there is value for the Applicant in installing turbidity loggers at the control sites, so as to interpret turbidity results in the context of water quality variations that occur naturally in parts of the landscape unaffected by the works. Upstream loggers used in this way do not need to be telemetered and the data can be downloaded and interpreted retrospectively. Its main value is to disaggregate turbidity effects caused by the works compared to what might occur naturally, although it will not be definitive.

56. Dr Drinan promotes calculating the load of TSS to waterways (paragraph 163). While this is of academic interest, it adds little if any additional value for managing the any effects on the site or in assessing effects. Stream aquatic organisms respond to changes clarity, sediment concentrations and deposition rather than load. Furthermore, measuring TSS load from the east branch of the Mangapepeke Stream has little value for understanding total load to the estuary unless measurements are also made in the much larger catchments of Mangaongaonga Stream and Tongaporutu River.

EVIDENCE OF RICHARD DUIRS

Sediment

57. Mr Duirs (paragraph 3.4) describes Dr Drinan's evidence as identifying "*the aquatic receiving environments within the site as comprising largely intact, natural state water bodies with good riparian cover from mature native forest, good to excellent water quality and habitat values and a high diversity of native fish*." This is partially correct but may be misinforming Mr Duirs' conclusions with respect to the effects of sediment on aquatic life.

    (a) Firstly, these streams do not have good water quality with respect to sediment. My first impression of the streams around Mt Messenger was surprise at the amount and cover of fine sediment in streams that should be close to pristine condition. Further surveys and monitoring has confirmed that there is a large amount of naturally occurring fine sediment in the streams.

    (b) Secondly, most of the downstream receiving environments downstream of culvert outlets are soft-bottom streams on the valley floor and grazed

by cattle. The fish community has high values, but in most cases I would not describe the streams as particularly sensitive to sedimentation because of the considerable amount of naturally derived soft sediment already present. Possible exceptions are where there is Swamp Forest downstream (i.e. Mimi River sites Ea25, Ea20, Ea21) and to a lesser extent hard bottom stream sites downstream of the works footprint near E5 and E6. Degradation to some of the highest quality sites is already accounted for in offset calculations.

58. Mr Duirs says in paragraph 5.9 that "*the [predicted 46% increase in sediment load] within the Mangapepeke catchment represents a significant increase in sediment yield and is at a level which I consider could give rise to adverse sedimentation effects within the catchment watercourses*". It is not clear to me how Mr Duirs reaches this conclusion or whether any consideration was given to actual ecological conditions in streams around the Mt Messenger area. A 46% increase may sound like a big number, but it is not in the context of natural variations during floods, or the much higher sediment concentrations observed in the Mangapepeke Stream west branch. [8] I note Mr Ridley also discusses the importance of putting sediment load increases into their proper context in his rebuttal evidence.

59. Mr Duirs prefers to compare downstream turbidity monitoring with simultaneous monitoring from a 'control site' rather than a 'baseline' site (paragraph 6.7). As already discussed, there are advantages and disadvantages to both approaches. One approach better matches flood magnitude and temporal variation and the other better matches catchment conditions and spatial variation. The key issue is to set the trigger at an appropriate level. In my view, this can be done using either approach.

Ecological response

60. Mr Duirs correctly notes that there is a gap in the feedback between annual/biannual ecological monitoring and any response (paragraph 6.13 – 6.14). The current ELMP is not explicit on how to link any effects identified in the biological monitoring to a response nor does it describe any independent review of ecological monitoring. On reflection, I think this is a gap and there should be independent ecological reviews of monitoring reports and recommendations by a suitably qualified expert. This is now allowed for in the proposed condition relating to the Ecological Review Panel (see rebuttal evidence by Mr Roan). In particular I propose the following changes to section 8.5 of the ELMP:

    (a) Add a bullet point under annual freshwater ecology reporting to say: "*recommendations for any additional monitoring or mitigation if the*

[8] The mean TSS during rising flood was about four times higher in the west branch compared to the east branch.

overall ecological effects from construction are assessed as 'moderate' or greater."

(b) Add a paragraph to say: "*The annual freshwater ecology reporting and the event-based reporting shall be reviewed by a suitably qualified independent ecological reviewer(s). The independent reviewer shall review monitoring reports, any identified effects and any additional mitigation proposed to address effects. Recommendations from Independent Ecological Reviewer shall be presented to the Applicant and Taranaki Regional Council (TRC) to agree an appropriate course of action*."

61. I have attached a flow diagram (**Appendix 1**) describing the intended responses that will occur as a result of monitoring described in the EMLP.

Keith Hamill

30 July 2018

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APPENDIX 1: FLOW DIAGRAM SHOWING RESPONSES TO WATER QUALITY AND AQUATIC ECOLOGICAL MONITORING

[Separate document]