BEFORE A HEARING PANEL: WHAKATĀNE DISTRICT COUNCIL AND BAY OF PLENTY REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of submissions and further submissions on Plan Change 1 (Awatarariki Fanhead, Matatā) to the Operative Whakatāne District Plan and Plan Change 17 (Natural Hazards) to the Bay of Plenty Regional Natural Resources Plan

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STATEMENT OF EVIDENCE OF DR GANESH NANA ON BEHALF OF WHAKATĀNE DISTRICT COUNCIL

APPLYING MULTI CRITERIA ANALYSIS TO ASSIST DECISION-MAKING

15 January 2020

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1. EXECUTIVE SUMMARY

1.1. I introduce the motivation behind Multi Criteria Analysis (**MCA**) and describe how it can be used in complex decision making in Section 7. I cite specific examples of where MCA has been applied to decision making process in the context of increased risk of flooding.

1.2. I then describe the nature of the decision faced by the Whakatāne District Council (**District Council**) in Section 8. Of particular note is that this decision is to be made in a context where not all stakeholders are in agreement and under complex circumstances. This decision requires balancing factors that can be quantified with those that cannot be. This implies that MCA is an appropriate decision making tool.

1.3. I describe the specific MCA model BERL designed for the District Council in Section 9.

1.4. This model follows what is the generally accepted design. We surveyed the relevant literature and all MCA models follow a series of methodical steps:

(a) The model begins with identifying the options to be considered;

(b) Then the criteria on which to base the decision are identified and listed;

(c) These criteria are then assessed against each other to yield a relative ranking;

(d) A series of calculations using these relative rankings yields "weights" to apply to each criterion;

(e) Next, a numeric value is attached to each criterion based on how well each option will affect the criterion; and

(f) Finally, a series of calculations results in a final score for each option which allows direct comparison. The option with the greatest value score is chosen.

1.5. I then finish my evidence with some commentary on the appropriateness of the results of the MCA in the Indicative Business Case.

1.6. I can attest that the results of the MCA are appropriate to use in this decision due to its nature and complexity. The District Council has incorporated the MCA results and the results of cost-benefit analysis into a cohesive decision making framework.

1.7. Incorporating the results of MCA into a wider decision making framework is, in my opinion, the most appropriate use of the results. No tool is useful in isolation and MCA is designed to complement conventional cost-benefit analysis.

2. INTRODUCTION

2.1. My full name is Dr. Ganesh Nana

2.2. My evidence is given on behalf of the District Council in relation to:

(a) Proposed Plan Change 1 (Awatarariki Fanhead, Matatā) to the Operative Whakatāne District Plan; and

(b) Proposed Plan Change 17 (Natural Hazards) to the Bay of Plenty Regional Natural Resources Plan (a private plan change request from the District Council)

(together referred to as the **Proposed Plan Changes**).

3. QUALIFICATIONS AND EXPERIENCE

3.1. I hold the position of Research Director at Business Economic Research Limited (**BERL**), having previously held the position of Chief Economist and Executive Director.

3.2. My qualifications include a PhD in Economics from Victoria University of Wellington (**VUW)**, New Zealand, awarded in 2001.

3.3. I have more than 35 years of experience working as a professional economist.

3.4. I have worked full-time for BERL for 21 years, completing research projects and studies on regional development, the Māori economy, the impact of economic policy proposals, and commentating on wider economic trends, issues and debates. Prior to working at BERL, I was employed by VUW in various positions (tutor, researcher, and lecturer). I have also worked as a consulting economist at Oxford Economic

Forecasting Limited, England, as well as in the House of Commons operating the UK Treasury economic model and the IMF Multimod economic model.

4. MY ROLE

4.1. I was involved in this process as lead researcher and peer reviewer of the BERL team's work in designing and communicating the MCA model to the District Council.

4.2. In preparing this evidence I have reviewed the following documents and reports:

(a) Dassanayake, Dilani R., Andreas Burzel, and Hocine Oumeraci. "Methods for the evaluation of intangible flood losses and their integration in flood risk analysis." Coastal Engineering Journal 57.1 (2015): 1540007-1;

(b) Stewart, S. and J Farrell (2017), Debris Flow Risk: A way forward for the Awatarariki Fanhead Indicative Business Case, Whakatāne District Council;

(c) Tonkin & Taylor (2015a): Supplementary risk assessment, debris flow hazard, Matatā, Bay of Plenty, Client Report for WDC; and

(d) Tonkin & Taylor Ltd (September 2015b): Awatarariki debris-flow fan annual individual fatality risk calculations and map.

5. CODE OF CONDUCT

5.1. Although this is a Council hearing I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Consolidated Practice Note 2014. I also agree to comply with the Code when presenting evidence to the Hearings Panel. I confirm that the issues addressed in this brief of evidence are within my area of expertise, except where I state that I rely upon the evidence of another expert witness. I also confirm that I have not omitted to consider material facts known to me that might alter or detract from the opinions.

6. SCOPE OF EVIDENCE

6.1. My evidence introduces and explains the motivations and theory behind the MCA model and outlines the process and results from applying the MCA model to the managed retreat options at the Awatarariki Fanhead.

6.2. I also describe why I consider the use of the MCA method to be appropriate in the District Council's decision-making.

6.3. My evidence does not cover technical matters such as risk analysis or modelling of future debris flow scenarios. These aspects of the Proposed Plan Changes are addressed in the evidence statements of Kevin Hind and Tim Davies, the drafts of which I have read and accept. I take this data as given, and focus on the use of MCA, as a decision making tool, by the District Council. My evidence will cover:

(a) The use of MCA in complex decision-making;

(b) The appropriateness of using multi-criteria analysis in the Awatarariki Fanhead Indicative Business Case;

(c) The MCA model used for assessment in the Awatarariki Fanhead Indicative Business Case; and

(d) The appropriateness of the results of the multi-criteria analysis in the Awatarariki Fanhead Indicative Business Case.

7. USING MULTI-CRITERIA ANALYSIS IN COMPLEX DECISION-MAKING

7.1. MCA is suitable when an intuitive approach is not appropriate, for example because the decision-maker(s) feel the decision is too large and complex to handle intuitively, because it involves a number of conflicting objectives, or involves multiple stakeholders with diverse views. Often there is a desire for a formal procedure so that the decision making process can be made open and transparent, and to ensure that it is (and is seen to be) fair.

7.2. The MCA framework and process provides a logical methodology for selecting the action to take and a verifiable record of the steps taken to reach that decision.

7.3. MCA is a useful tool when considering non quantifiable factors, as the methodology is designed to rank factors against one another in a meaningful order.

7.4. MCA has been used in New Zealand for a similar decision. In 2015, BECA and Opus published a report for the Christchurch City Council titled Dudley Creek Flood Remediation Downstream Options Multi Criteria Analysis. In this case, MCA was used to rank the proposed options for the Dudley Creek Flood Remediation Project.

7.5. Internationally, MCA has been used in similar scenarios involving a response to increased flood risk. Dassanayake, Burzel, and Oumeraci (2015) cite multiple cases of GIS based MCA and develop new methods for assessing cultural losses using MCA.

8. APPROPRIATENESS OF MCA IN THE AWATARARIKI FANHEAD INDICATIVE BUSINESS CASE

8.1. The Awatarariki Fanhead Indicative Business Case is centred on a decision of how to manage the risk of a future debris flow. In this case, a future debris flow could result in loss of life and property if no action is taken.

8.2. The issue is a complex one because the people currently residing on the land at risk of a debris flow have different perspectives on the risk that their properties are subject to, have different tolerance levels with respect to the risk, and as a result, not all are willing to relocate. Additionally, there are a number of proposed solutions that must be tested against each other.

8.3. Many of the factors to be weighed in the decision were not readily amenable to financial valuation. These factors include: risk of loss of life, stress levels of the residents, and keeping the community together, among others.

8.4. We note that Value of Statistical Life (**VOSL**) estimates are used by some agencies to proxy the financial impacts of injuries and/or fatalities in their benefit-cost assessments (**BCA**). However, the application of financial valuations to human lives causes difficulties to some because of ethical considerations.

8.5. Moreover, the use of a VOSL within a BCA framework becomes more complicated when there is a lengthy and uncertain recurrence interval of the risk being assessed. The complexity is because the length of time over which benefits and costs are assessed is critical to any BCA framework. In turn, the recurrence interval of the risk being assessed is critical to determining that length of time. In addition, the lengthier is this time period, the more diluted is the VOSL in the BCA calculation, with this dilution being accentuated by the adoption of any discount rate significantly above 1 percent.

8.6. In this context, recurrence interval is the estimated or expected period of time between each risk 'event' (e.g. a 1 in 50-year flood). The recurrence interval is related to the estimated probability of an expected event occurring over a period of time.

8.7. In contrast, MCA is a useful tool when considering non quantifiable factors as the methodology is designed to rank factors against one another in a meaningful order.

8.8. The complexity of the issue, the multiple possible solutions and the non-quantifiability of many of the relevant factors made MCA an appropriate tool to use.

8.9. As described in section 7 MCA has been used in New Zealand and internationally in making decisions on how to respond to an increase in flood risk.

8.10. Based on these observations I conclude that using MCA in the Awatarariki Fanhead Indicative Business Case was appropriate.

THE MCA MODEL

9. THE MCA MODEL PROCESS

9.1. Ideally, the MCA process should have begun as soon as all options were identified and included broad engagement with stakeholders and community. This option, however, was not available to us. As such, the BERL team liaised with officers of the District Council to undertake the process described below.

9.2. The MCA model we used in the Awatarariki Fanhead Indicative Business Case can be summarised as a sequence of five steps:

(a) First, identify the options to choose from;

(b) Secondly, identify the criteria (factors) that will influence the decision;

(c) Thirdly, specify the relative importance of each of the above criteria;

(d) Fourthly, assess the impact each option will have on each of the criteria; and

(e) Fifthly, combine the results from steps three and four to determine the most preferred option.

10. THE OPTIONS

10.1. Five (5) options were identified, as listed in paragraphs 10.2 to 10.6 below.

10.2. Status Quo – this option is to do nothing, residents continue to live on the Fanhead and the land is not re-zoned.

10.3. Managed voluntary retreat: existing dwellings only – Managed retreat for existing dwellings only (16 homes), based on magnitude event of 300,000m^3, delivered by the District Council by 2020 and funded by central and local government through a retreat package. A magnitude 300,000m^3 event has been chosen as this best represents a similar event to the 2005 debris flows. The risk to life safety of a repeat debris flow of this magnitude has been modelled as affecting an area containing 16 homes.

10.4. Managed voluntary retreat: 300,000m^3 – Managed retreat for all properties (16 homes and 18 vacant sections), based on a magnitude event of 300,000m^3.

10.5. Managed voluntary retreat: 450,000m^3 – Managed retreat for all properties (18 homes and 18 vacant sections), based on a magnitude event of 450,000m^3, delivered by WDC by 2036 and funded by central and local government through a retreat package. A magnitude

450,000m3 event was also modelled by Tonkin and Taylor (2015) as a possibility and has been chosen to represent planning for a larger event compared with the 2005 debris flows. The risk to life safety of a repeat debris flow of this magnitude has been modelled as affecting an area containing 18 homes (2 additional properties to Options 1 and 2) and 18 privately owned sections.

10.6. Compulsory retreat - Compulsory retreat for all properties (18 homes and 18 vacant sections), based on a magnitude event of 450,000m^3, delivered by Bay of Plenty Regional Council (**BOPRC**) or central government by 2020, and funded by homeowners and/or BOPRC and/or central government.

11. THE CRITERIA

11.1. There were seven (7) criteria identified as influencing the decision. Criteria here refers to a set of factors against which each decision is judged. These criteria are listed in paragraphs 11.2 to 11.8 below.

11.2. Loss of life – the main risk of a significant debris flow event is that one or more of the residents of the Awatarariki Fanhead is killed.

11.3. Optimal land use – a relevant consideration for Council is that the land of the Awatarariki Fanhead should be used for the purpose for which it is best suited. A retreat (managed or compulsory) necessarily takes precedence over any other use of the land if undertaken in order to prevent loss of life and where no viable alternative risk reduction option exists.

11.4. Stress levels – many residents of the Awatarariki Fanhead have little other assets than their home and land on the Fanhead. A retreat of any kind forces these people to change where and how they live. This change as well as the lack of certainty causes stress on the residents. Another source of stress is the ongoing exposure to the risk of loss of life and property damage should another event occur.

11.5. Preparation for future changes – as part of a retreat (managed or compulsory) the zoning of the land in the Awatarariki Fanhead will be changed. In the future, if circumstances on the Fanhead change then

the chosen option should not preclude any advantageous future decision.

11.6. Keep community together – residents on the Awatarariki Fanhead have formed a community by living in close proximity to one another. A retreat of any kind will necessarily force some community members to exit the community. This criterion also refers to keeping the community together emotionally by not creating rifts and ongoing conflicts.

11.7. Provide certainty for residents/investors – owners of properties on the Awatarariki Fanhead have been living with uncertainty since the debris flow event of 2005. Changing the zoning status of land on the Awatarariki Fanhead may provide a degree of certainty in terms of options for future development and/or investments. Plan changes may clarify (or inhibit) future opportunities, depending on the level of certainty they provide to those considering future investments.

11.8. Achievable in practice – the chosen solution has to fit within the scope of the Council's strategy as well as fit in to the Council's fiscal constraints.

12. THE RELATIVE IMPORTANCE OF EACH CRITERION

12.1. The next step is to determine the relative importance of each criterion (paragraphs 11.2 to 11.8) against one another. Beginning with two of the criteria, the question is asked: are these two criteria of equal importance? If not, which one is more important than the other, and by how much?

12.2. This process is repeated for each of the possible pairs of criteria.

12.3. To do so, stakeholders were asked to rank each of the criteria against one another (separately) on a scale of 1 to 9.

12.4. A scale of importance with 9 levels was chosen as it allows for a range of shades between the "levels" of importance. Each of the 9 levels in the scale represents a degree of importance: where "1" reflects that the criterion is of equal importance to the other criteria and "9" reflects that the criterion is of extreme importance compared to the other criteria. The other levels in this scale can be denoted as follows:

(a) Equal importance is signified as “1”

(b) Equal to moderate importance is signified as “2”

(c) Moderate importance is signified as “3”

(d) Moderate to strong importance is signified as “4”

(e) Strong importance is signified as “5”

(f) Strong to very strong importance is signified as “6”

(g) Very strong importance is signified as “7”

(h) Very strong to extremely strong importance is signified as “8”

(i) Extreme importance is signified as “9”.

12.5. The intensity of importance has enough categories to be able to describe a wide range of degrees of importance. This allows the methodology to be responsive to nuanced views and perspectives.

12.6. As an example, comparing the two criteria “loss of life” and “achievable in practice”, the stakeholder responses indicated “loss of life as being of extreme importance compared to achievable in practice”. This response is recorded as a 9, while the inverse (i.e. 1/9, or 0.11) is recorded for the mirror comparison (achievable in practice compared to loss of life).

12.7. Another example, comparing “keep community together” and “optimal land use”, the stakeholder responses indicated “keep community together” as being of moderate to strong importance compared to “optimal land use”. This response is recorded as a 4, while the inverse (i.e. ¼, or 0.25) is recorded for the mirror comparison (“optimal land use” compared to “keep community together”).

12.8. We considered reducing the number of importance levels but this would have resulted in the final decision being less robust.

12.9. Combining these various pairwise degrees of importance leads to an overall level of importance for each criterion.

13. IMPACT OF EACH OPTION

13.1. Fourthly, the impact of each option (paragraphs 10.2 to 10.6) on each criterion (paragraphs 11.2 to 11.8) needs to be determined. Estimates of the impact of each option on each criterion were ranked on a scale where 100 was chosen as the “best” outcome and 0 as the “worst” outcome.

14. DECISION

14.1. The final decision is then made based on the results of the MCA model determining the option with the “best” impacts across all the criteria, weighted according to the relative importance of each of the criteria.

THE MCA MODEL RESULTS

15. THE RELATIVE IMPORTANCE OF EACH CRITERION

15.1. Of the seven criteria identified in paragraphs 11.2 to 11.8, the third step in the MCA process (as described in Section 9) led to loss of life being the most important criterion.

15.2. Further, loss of life criterion is over three times more important than the second most important criteria – that of providing certainty for residents/investors.

15.3. Indeed, loss of life criterion is more important than all the other criteria combined.

15.4. Optimal land use is determined to be the least important criterion.

15.5. Combining the responses to all the pairwise degrees of importance comparisons leads to the overall importance of each criterion (on a scale of 0 to 1, where 0 is not important at all and 1 is totally important to the exclusion of all others) as in the following table (rounded to 3 decimal places)

Criterion	Overall Importance
Loss of life	0.513
Provide certainty for residents/investors	0.164
Achievable in practice	0.099
Preparation for future changes	0.076
Stress levels	0.067
Keep community together	0.041
Optimal land use	0.039

16. THE IMPACT OF THE OPTIONS

16.1. The tables describing the impact of each of the five options on each of the criteria (the fourth step in the MCA process as described in Section 9) are attached (paragraph 20.1).

16.2. The outcome interpretations listed in the tables in paragraph 20.1 should be read separately, not collectively. That is, the impact of each option on each individual criterion are assessed separately from other considerations. For example, the outcome interpretation of the compulsory retreat option on the loss of life criterion as 'best' is solely in relation to that criterion, and not to any other criteria.

16.3. Assessment of the five options identified indicated that the compulsory retreat option has the greatest benefit in terms of the lowest risk of loss of life, optimal land use and on certainty to residents/investors.

16.4. The 300,000 m^3 and 450,000 m^3 managed voluntary retreat options equally have the greatest negative impacts on stress levels and being achievable in practice.

16.5. All options except a compulsory retreat share an equal impact on preparation for the future and on keeping the community together.

16.6. The options of a 300,000 m^3 and 450,000 m^3 voluntary retreat have the same impact on being achievable in practice (they are relatively easy to achieve).

17. RESULT

17.1. Putting together the impacts of the options, and combining with the relative rankings of the criteria, the MCA model indicates that the 300,000 m^3 and 450,000 m^3 voluntary retreat options are ranked first equal. This equality arises from their similar impacts on each of the criteria listed. The numerical scores (rounded to 1 decimal place) along a possible range of 0 to 100, are as follows

Option	Score
Status quo	17.2
Managed voluntary retreat – dwellings only	73.1
Managed voluntary retreat – 300,000 m3	78.2
Managed voluntary retreat – 450,000 m3	78.2
Compulsory retreat	74.1

17.2. This result indicates that the status quo is a considerably inferior option. This is unsurprising, arising primarily from it having the worst negative outcome in terms of the loss of life criterion – the criterion that was assessed by the stakeholder group as being the most important by far.

17.3. In comparison, the managed voluntary retreat options have better outcomes for optimal land use and stress levels, although less so for the dwellings only option.

17.4. The compulsory retreat option scores highly from its best positive outcome in terms of the most important loss of life criterion. However, this is more than balanced by the worst negative outcomes impacts on stress levels, preparation for future, and keep community together criteria. In addition, the poor negative outcome in terms of achievable in practice drag down the total score for the compulsory retreat option.

17.5. This use of the results of the MCA model is appropriate because it recognises the drawbacks of a conventional BCA approach. These drawbacks are that BCA assessments have difficulty in dealing with non-monetary factors. This is especially so in cases where benefits are

spread over a lengthy period of time. In such a case, the assumed discount rate becomes a critical factor in the overall BCA assessment. The presence of an uncertain recurrence interval further complicates a BCA approach.

17.6. MCA is specifically designed to consider non-monetary factors, so using it in combination with benefit-cost analysis is appropriate in situations like the Awatarariki Fanhead Indicative Business Case where issues relating to individuals' livelihoods and ways of life arise, including factors such as loss of life and stress and the frequency of future debris flow events is uncertain.

18. NON MCA MODEL CONSIDERATIONS

18.1. The District Council then adds the results of the MCA analysis to a number of other assessments which do not involve the MCA model:

(a) Non-Monetary Benefit score (out of 10);

(b) Benefit Rank;

(c) Risk score;

(d) Risk Rank; and

(e) Number of properties affected.

18.2. In summary, the results of the MCA model have been used by the District Council to augment a larger, robust, decision making model which utilises benefit-cost analysis and risk analysis.

19. CONCLUSIONS

19.1. The MCA model designed by BERL and used by the District Council in its Awatarariki Fanhead Indicative Business Case is robust and follows generally accepted principles of MCA model design.

19.2. The MCA model BERL designed for the District Council is a robust methodical process that goes from identifying options, to ranking those options against each other.

19.3. The District Council has incorporated the results of this MCA model into a wider decision making framework. This is an appropriate use of the

results and helps to augment an already robust decision making framework to incorporate non-monetary considerations.

Ganesh Nana

15 January 2020

20. APPENDIX

20.1. The impacts of each of the options on each of the criteria are listed below.

Impact on loss of life	**Score**	**Outcome - interpretation**
Status quo	0	Worst – certainty of fatality
Managed voluntary retreat – dwellings only	75	Good – 75% of people no longer at risk
Managed voluntary retreat – 300,000 m^3	75	Good – 75% of people no longer at risk
Managed voluntary retreat – 450,000 m^3	75	Good – 75% of people no longer at risk
Compulsory retreat	100	Best – no chance of fatality

Impact on optimal land use	**Score**	**Outcome - interpretation**
Status quo	25	Poor – land is utilised for 4th best use
Managed voluntary retreat – dwellings only	50	Medium – land is utilised for 3rd best use
Managed voluntary retreat – 300,000 m^3	75	Good – land is utilised for 2nd best use
Managed voluntary retreat – 450,000 m^3	75	Good – land is utilised for 2nd best use
Compulsory retreat	100	Best – land is utilised for best use

Impact on stress levels	**Score**	**Outcome - interpretation**
Status quo	50	Medium – quite stressed, but coping
Managed voluntary retreat – dwellings only	50	Medium – quite stressed, but coping
Managed voluntary retreat – 300,000 m^3	75	Good – slightly stressed
Managed voluntary retreat – 450,000 m^3	75	Good – slightly stressed

Compulsory retreat	0	Worst – highly stressful, completely compromised quality of life

Impact on preparation for future	**Score**	**Outcome - interpretation**
Status quo	50	Medium – retains alternative options should future circumstances change
Managed voluntary retreat – dwellings only	50	Medium – retains alternative options should future circumstances change
Managed voluntary retreat – 300,000 m^3	50	Medium – retains alternative options should future circumstances change
Managed voluntary retreat – 450,000 m^3	50	Medium – retains alternative options should future circumstances change
Compulsory retreat	0	Worst – eliminates all alternative responses to any changes in future circumstances

Impact on keep community together	**Score**	**Outcome - interpretation**
Status quo	100	Best – community maintained, no one exits against their will
Managed voluntary retreat – dwellings only	100	Best – community maintained, no one exits against their will
Managed voluntary retreat – 300,000 m^3	100	Best – community maintained, no one exits against their will
Managed voluntary retreat – 450,000 m^3	100	Best – community maintained, no one exits against their will
Compulsory retreat	0	Worst – community lost, as many forced to exit

Impact on provide certainty for residents/investors	Score	Outcome - interpretation
Status quo	0	Worst– increases uncertainty to extent that precludes investment by potential investors and residents
Managed voluntary retreat – dwellings only	100	Best – establishes certainty and does not inhibit potential investment
Managed voluntary retreat – 300,000 m^3	100	Best – establishes certainty and does not inhibit potential investment
Managed voluntary retreat – 450,000 m^3	100	Best – establishes certainty and does not inhibit potential investment
Compulsory retreat	100	Best – establishes certainty and does not inhibit potential investment

Impact on achievable in practice	Score	Outcome - interpretation
Status quo	50	Medium – is achievable but large barriers to overcome
Managed voluntary retreat – dwellings only	50	Medium – is achievable but large barriers to overcome
Managed voluntary retreat – 300,000 m^3	75	Good – achievable, but with a few barriers
Managed voluntary retreat – 450,000 m^3	75	Good – achievable, but with a few barriers
Compulsory retreat	25	Poor – unlikely to be achievable