IN THE MATTER: of the Resource Management Act 1991 (**RMA**)

AND

IN THE MATTER: Proposed Plan Change 2: Pukehangi Heights to the Rotorua District Plan under Part 5, Sub-Part 5 – Streamlined Planning Process and Schedule 1 Part 5 of the RMA

SUMMARY OF EVIDENCE OF PETER BLACKWOOD ON BEHALF OF BAY OF PLENTY REGIONAL COUNCIL – UTUHINA FLOOD FREQUENCY & RAINFALL TEMPORAL VARIATION

21 September 2020

Qualifications and Experience

1. My full name is Peter Lindsay Blackwood. I hold the position of Principal Technical Engineer at Bay of Plenty Regional Council (**Regional Council**). I hold the qualifications and experience as outlined in paragraphs 2 to 8 of my Statement of Evidence dated 18 September 2020.

2. I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014 and I agree to comply with it. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where I state I am relying on the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from my expressed opinion.

Background and Scope of Evidence

3. My evidence relates to the flood risk aspects of the Proposed Plan Change 2. In particular my evidence will cover:

    a. The flood frequency estimates for the Utuhina Stream. How these have varied over time and the current design estimates;

    b. A very brief commentary on the relationship between rainfall frequency and flood frequency; and

    c. Evidence confirming the centrally located nested hyetograph adopted for modelling is an appropriate design rainfall profile; using the observation of the occurrence in several major storms of the "heavy ended" rainfall profile.

Flood Frequency Estimates for Utuhina Stream

4. Utuhina Stream has a catchment area of 59.6 square kilometres above the recorder located at the State Highway 5 Bridge (at Lake Road). Prior to construction of the Utuhina River stopbanks several areas adjacent to the stream were vulnerable to flooding. Around 57 ha was flooded in the years prior to the flood protection scheme.[1]

5. Evidence covered by Mr West, Mr Wallace and Mrs Thiel-Lardon will refer to the fact the river scheme is at full capacity for the 100 year and cannot accept more flood flows

[1] (Reference Section 2.4.7 (a) of *Kaituna Asset Management Plan*, Environment BOP Operations Report 2003/09, October 2003, Philip Wallace, Technical Services Department).

in the 1% AEP flood. However, there are still areas where flooding occurs and water cannot successfully drain to the scheme.

6. Mr Pennington in his Summary of Evidence has advised "*the objective of stormwater masterplan is to identify integrated solutions to facilitate future urban growth while also addressing existing floodable areas where possible*". Extreme care will be needed in any suggestion to utilise potential off-site stormwater detention storage possibilities for new housing developments. These potential detention storages are already required to mitigate existing problems, currently occurring infill development and the impacts of climate change upon flood risk.

7. Detailed frequency analyses have been periodically carried out as the database of annual maximum flows on the Utuhina Stream lengthens. The original scheme documents referenced a 1% AEP ("Q_{100}") of 3820 cusecs, being 108 cumecs[2].

8. These analyses in recent years have combined the data from both the original Lake Road and the additional Depot Street recorder sites.

9. The report entitled "*Rivers and Drainage Asset Management Plan 2018-2068*", Bay of Plenty Regional Council advises the current 1% AEP value 55 cumecs for the Utuhina Stream.

10. Following the resumption of my duties at Bay of Plenty Regional Council I critically reviewed the flood frequency distribution for the Utuhina Stream at SH5, applying the updated data now available through to 2017. The conclusions from application of the Log Pearson 3 distribution to the lengthened database, were that the estimated values were only minorly different to the previous analyses, dropping by 4% to a 1% AEP value of 53 cumecs. In my opinion it is not a wise to further lower the 1% AEP design flow from 55 cumecs, as periodic changes in the spectrum of floods experienced could increase or decrease the number (as happened following the 2018 Ngongotahā flood).

11. Thus the design 1% AEP flow of 55 cumecs is confirmed as a reliable design estimate for the Utuhina Stream at State Highway 5 site.

[2] (Reference Table 5.4.IV of *Upper Kaituna Major Scheme – Lakes Rotorua and Rotoiti*, Volume 4, undated c 1969, A.P.Griffiths, Bay of Plenty Catchment Commission).

Relationships Between Rainfall Frequency and Flood Frequency

12. The evidence from Mark Stuart Pennington dwells at length on the relationship and at times a "mis-match" between rainfall frequency and flood frequency. In paragraphs 29 and 30 several hydrologically plausible reasons are advance for this "mis-match". In particular the Kaituna at Whakarewarewa raingauge is not within the Utuhina catchment. Radar imagery of the 28-29 April 2018 heavy rainfall event showed a big variation in rainfalls across the catchments at Rotorua City.

13. It is important to present that the reverse may well occur, in which a rainfall of a given ARI may result in a flood of a larger ARI. This typically happens when the catchment is wetter than normal prior to the onset of the rainfall event.

14. In the flooding of the Bay of Plenty over 3-7 April 2017, the flood peaks in the both lower Whakatāne River and Rangitāiki River (as measured by inflows to Matahina Dam) were record values and well over the 1% AEP flood size. However, in the catchments upstream of these sites only one raingauge recorded anywhere near a 1% AEP rainfall The main reason being that for the preceding month of March the six raingauges upstream of the lower rivers averaged a substantial 314 percent of the normal monthly rainfall.[3] The catchments were very wet and flood sizes were larger than normal.

15. The application of, for instance a 1% AEP design rainfall (with the appropriate methodology and areal reduction factors), to estimate a 1% AEP flood flow is a totally accepted methodology by the hydrological profession. As we are dealing with nature, then the exactitudes of other scientific disciplines are impossible to satisfy. However, this an internationally accepted methodology applied universally.

16. Storm Temporal Rainfall Profile

17. Section 3.1.2.2 of the Rotorua Lakes Council Stormwater Report advises "*the use of 'nested' storms tends to produce much higher peak discharge when compared to either normalised storm hyetographs (based on 'typical' observed storm events) (McConchie,*

[3] Reference *Hydro-meteorological Report of April 2017 Storm Event & Cyclone Cook*, 2 June 2017, Glenn Ellery, Environmental Publication 2017/03.

2019), flood frequency analysis using observed flow data, or other industry standard temporal patterns, like those identified within recent national guidance (NIWA, 2018)."

18. I do not agree with the ramifications of Section 3.1.2.2. Indeed there is good evidence to suggest that there are other hyetograph profiles that produce higher flows that should be considered. However, the BOPRC designers collegially agreed to go with the centrally located "nested" storm as a good middle of the road approach.

19. I was part of the team of Regional Council reviewers of the recent national guidance (NIWA, 2018). The methodology was extensively discussed and is based on the method of "Averaged Variability" as presented previous versions of the document *Australian Rainfall and Runoff – A Guide for Flood Estimation*[4].

20. The current version of this document 2019 (ARR2019) changes the advice to the application of **ensemble storms** particular in Sections 5.5[5] . This is because, on its own the use of the "Averaged Variability" was inadequate to describe appropriate design temporal rainfall profiles – and in particular the "heavy ended" storm profile was likely to be lost from design considerations.

21. Section 5.9.2 of ARR (2019) states: "*The use of an ensemble of 10 temporal patterns as discussed in Book 2, Chapter 5, Section 5 is recommended. The temporal patterns have been chosen to represent the variability in observed patterns"; and "The ensemble of 10 pattern provides a range of plausible answers. The practitioner should consider the benefits of investigating multiple temporal patterns or Monte Carlo for sensitive designs and solutions***."**

22. To put the advice into context Section 5.9.2 of ARR (2019) also states "*It is not recommended that the temporal pattern that represents the worst (or best) case be used by itself for design. Testing has demonstrated that on most catchments large number of events in the ensemble patterns are clustered around the mean and median.*"

23. Therefore I have not advocated that the worst case "heavy ended" storm be the basis for temporal profile. However, I would just note that the downstream catchment is indeed "sensitive" to the addition of stormwater flows.

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[4] Government of Australia.

[5] Reference Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia), 2019

24. The following identified “heavy ended” storms are in the main very major storms. As such they require detailed examination for the design ramifications.

    a. 1 May 1999 “Fletcher Marathon flood”

    b. 18 May 2005 Matatā and Tauranga thunderstorms

    c. 3-7 April 2017 “Edgecumbe” Flood

    d. 28-29 April 2018 Rotorua Storm

    e. 25-26 December 2019 Rotorua Storm

    f. 20-21 June 2015 Great Whanganui flood

25. I have very good familiarity of the important characteristics of all the above storms, as I was a Flood Manager in all except storm e (25-26 December 2019 Rotorua Storm); and I was consulted during this storm, whilst on leave in Melbourne.

26. **Conclusions on Rainfall Temporal Profile**

    I. Heavy ended storms are expected to generate larger peak flows as the most intense rain falls on a more saturated catchment.

    II. As there is strong evidence of their regularity, the assessment of heavy ended storms for developments in sensitive catchments in line with ARR (2019) is proposed to be included in the next update to the document “Hydrological and Hydraulic Guidelines”, Bay of Plenty Regional Council Guideline 2012/02.

    III. However, I must stress that the adopted design 72-hour nested storm is centrally located and not heavy ended. Therefore, it is certainly not conservative.

DATE 18 September 2020

Peter Blackwood