

Before a Board of Inquiry
Transmission Gully
Notices of Requirement and Consents

under: the Resource Management Act 1991

in the matter of: Notices of requirement for designations and resource consent applications by the NZ Transport Agency, Porirua City Council and Transpower New Zealand Limited for the Transmission Gully Proposal

between: **NZ Transport Agency**
Requiring Authority and Applicant

and: **Porirua City Council**
Local Authority and Applicant

and: **Transpower New Zealand Limited**
Applicant

Statement of evidence of Dr Dalice Audrey Sim (Probability of coincident rainfall and wind event during construction) for the NZ Transport Agency and Porirua City Council

Dated: 14 November 2011

REFERENCE: John Hassan (john.hassan@chapmantripp.com)
Nicky McIndoe (nicky.mcindoe@chapmantripp.com)

STATEMENT OF EVIDENCE OF DALICE AUDREY SIM FOR THE NZ TRANSPORT AGENCY AND PORIRUA CITY COUNCIL

QUALIFICATIONS AND EXPERIENCE

- 1 My full name is Dr Dalice Audrey Sim.
- 2 I am a statistical consultant at the Victoria University of Wellington School of Mathematics, Statistics and Operations Research. I have a BA in mathematics (1974) and MPhil (1st class) in mathematics (1976), both from the University of Auckland. I also have a PhD in biostatistics from the University of Washington, Seattle, Washington USA (1981).
- 3 I have over 10 years' experience collaborating with researchers in various biological and medical fields, providing statistical consultation. Most recently, I have provided statistical consultation for Boffa Miskell Limited regarding the impact of wind farms on avifauna.
- 4 I understand the NZ Transport Agency (*NZTA*), Porirua City Council (*PCC*) and Transpower NZ Limited (*Transpower*) have lodged Notices of Requirement (*NoRs*) and applications for resource consent with the Environmental Protection Authority (*EPA*) in relation to the Transmission Gully Proposal (*the Proposal*).
- 5 The Proposal comprises three individual projects, being:
 - 5.1 The 'NZTA Project', which refers to the construction, operation and maintenance of the Main Alignment and the Kenepuru Link Road by the NZTA;
 - 5.2 The 'PCC Project' which refers to the construction, operation and maintenance of the Porirua Link Roads by PCC¹; and
 - 5.3 The 'Transpower Project' which refers to the relocation of parts of the PKK-TKR A 110kV electricity transmission line between MacKays Crossing and Pauatahanui Substation by Transpower.
- 6 My evidence is given in support of only the NZTA and PCC Projects, which I collectively refer to as the *TG Project* or *Project*. It does not relate to the Transpower Project.
- 7 I am the author of the report "Calculation of Probabilities of Coincident Rain and Wind Events in the Porirua Basin" contained in Appendix 11.M to Technical Report 11 (Ecological Impact Assessment) of the Assessment of Environmental Effects (*AEE*) lodged in support of the Project.

¹ The Porirua Link Roads are the Whitby Link Road and the Waitangirua Link Road.

- 8 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2011), and I agree to comply with it as if this Inquiry were before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence 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 expressed.

SCOPE OF EVIDENCE

- 9 My evidence will deal with the following:
- 9.1 Background and role in relation to the Project;
 - 9.2 The probability of a coincident high rainfall and wind event in the Porirua basin area; and
 - 9.3 Conclusions.

SUMMARY OF EVIDENCE

- 10 Using statistically reasonable assumptions, and based on the observed data given in Technical Report 15, I have calculated estimates of the probability of at least one coincident average return interval (ARI) 10 year rain event and wind (either northerly or southerly) for periods at risk of 1 to 8 years². The margin of error for each of these probabilities, given as a 95% confidence interval based on the exact binomial distribution, gives a range of reasonable values for the estimated probabilities.
- 11 For example, for a 2-year period (which I understand to be the likely period of peak earthworks), the table of probabilities in my report (page 3) gives a predicted probability of a northerly wind plus an ARI 10 year rain event as 12%. However, the 95% confidence interval is 4% to 23%. Thus, one might reasonably expect the actual incidence to be anywhere between 4% and 23%, based on the available data.

MY ROLE IN RELATION TO THE PROJECT

- 12 I was asked by the NZTA and PCC to calculate the probability of a specific weather event (involving both major rainfall and wind) occurring in the Porirua basin, during the construction period of the Project.
- 13 I have prepared a report providing this information which is titled "Calculation of Probabilities of Coincident Rain and Wind Events in

² I understand the construction period is likely to be up to 8 years.

the Porirua Basin.” My report is included as Appendix 11.M to the Ecological Impact Assessment (Technical Report 11).

- 14 My report was based on data provided in Technical Report 15, specifically the information in Table 15.37 of that report. This report was prepared by Sinclair Knight Mertz (*SKM*) and is discussed in the evidence of **Ms Malcolm**, **Mr Martell** and **Mr Roberts**.
- 15 My evidence explains the conclusions reached in my report regarding the probability of a weather event, involving both high rainfall and wind, occurring during the construction phase of the Project.
- 16 I have not completed any further work relevant to the Project since my report was completed.

PROBABILITY OF HIGH RAINFALL AND WINDFALL EVENT

Probability of certain weather event

- 17 Table 15.37 of Technical Report 15, prepared by SKM, gives the number of days when an ARI 10 year rainfall (i.e. rainfall at a level which occurs once in 10 years) occurred in Porirua at the same time as the wind recorded at Wellington Airport was: >5m/s in a Northerly direction (3 events); >5 m/s in a southerly direction (2 events); or accompanied by neither of these wind events (1 event). These event numbers were based on approximately 50 years of data.
- 18 I was asked to use this historical data to calculate the probability of a specific weather event in the Porirua basin which includes both:
- 18.1 ARI 10 year rainfall (i.e. an average recurrence interval ten year rainfall event); and
- 18.2 Wind of a speed of at least 5m/s from a south-southeast (SSE) (170°) or north-northwest (NNW) direction (340°) (these being the two most predominant wind directions in the harbour area);

over several time periods relevant to the construction period for the Project (between one and eight years). In order to calculate this probability, I had to ignore the effect of wind speed, since the data available related to wind events recorded at Wellington Airport. It is my understanding that wind events at Wellington Airport are predictive of wind events at Porirua only in terms of direction, not in terms of speed. Therefore, the data supplied gives no information about the speed of a coincident wind and ARI 10 year rain event at Porirua, only about the direction of the wind of such an event. Hence a probability can only be calculated for an event that includes direction and not speed.

Assumptions in relation to the event probability

- 19 Assumption 1: The observed events in Table 15.37 of Technical Report 15 are the events of interest in assessing the potential of deleterious environmental effects. The appropriateness of this assumption depends on ecological and environmental factors, outside the scope of my area of expertise.
- 20 Assumption 2: The binomial distribution accurately models the event occurrence (i.e. each year is an independent trial when either no coincident rain and wind events occur, or at least one coincident rain and wind event occurs. The probability of at least one coincident rain and wind event is the same for each year).
- 21 Assumption 3: The rate of occurrence in the future is the same as the rate of occurrence in the past.
- 22 Assumption 4: Of all coincident wind and rain events as defined, approximately 50% will be accompanied by a northerly wind, and 33% will be accompanied by a southerly wind. The remaining rain events will be accompanied either by no wind, or wind from another direction. These proportions were used because the data for both ARI 10 year and ARI 2 year events followed this pattern.

Methodology for calculating probability

- 23 To estimate the probability of an event in the future from these past data, a statistical model needs to be used for the probabilistic mechanism behind these event occurrences. The formula on page 120 of Technical Report 15 defines how SKM calculated the probability of one or more ARI 10 year rain events occurring over each specified time period (1-8 years). From these, the estimated probability of one or more rain event plus northerly wind event, and one or more rain event plus southerly wind was calculated as described in the report (Appendix 11.M in Technical Report 11).
- 24 The probability of at least one coincident rain and wind event occurring in a given year was calculated as 6/50, as six such events occurred over the 50 years of observation. Of these, three or 50% occurred with a northerly wind, and two (33%) occurred with a southerly wind. Hence the probability of either of these events happening in a year was calculated as the relevant percentage of the overall probability. The probability of at least one event occurring for years 1 through 8 was calculated from these yearly probabilities using the formula found on page 2 of my report which is attached as Appendix 11.M to Technical Report 11 (and repeated on page 120 of Technical Report 15).
- 25 However, any estimate of future incidence has a margin of error, which I quantified by providing the 95% confidence interval based

on the exact binomial distribution³. The binomial distribution models each year as an independent trial where the probability of an event (at least one coincident wind plus rain event) is the same for each year. The margin of error depends on the number of events observed (total of six here), as well as the observation length (50 years here). The 95% confidence interval incorporates this margin of error to give a range of values for each probability which are also reasonable estimates of the incidence probability.

- 26 Confidence intervals for the overall probability ("All events") were found using the exact binomial formulation⁴. For each time period, the probabilities and confidence intervals for events with a northerly or southerly wind were calculated by multiplying the probabilities and confidence limits by 0.5 and 0.33 respectively. These results are presented in table form in my report (page 3 of Appendix 11.M in Technical Report 11).

Probability of weather event

- 27 In the tables in my report, the estimated probability of at least one occurrence of the specified coincident rain and wind event is given for each period at risk from 1 to 8 years. This is followed by the 95% confidence interval for that probability. For example, the estimated probability of at least one ARI 10 year rain event and coincident northerly wind over 5m/s happening over two⁵ years is 0.1164, or 12%. The 95% confidence interval for this estimated probability is (0.0449, 0.2284), indicating that probabilities between 4% and 23% are also reasonable estimates of the probability of this event happening at least once in the two years. Since these probabilities pertain only to events described by rain and wind direction, not wind speed, they refer to ARI 10 year rain events plus winds (northerly or southerly) of any speed (greater than 5m/s). Therefore, if the event of interest consists of ARI 10 year rain plus wind at a higher speed (eg, greater than 10 m/s), these probabilities can only be considered as upper bounds to those probabilities.



Dr Dalice Audrey Sim
14 November 2011

³ (<http://statpages.org/confint.html>).

⁴ Available at <http://statpages.org/confint.html>.

⁵ I understand two years to be the period of peak earthworks.