BEFORE THE HEARINGS PANEL

IN THE MATTER of hearings on submissions concerning the Proposed One Plan notified by the Manawatu-Wanganui Regional Council

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SECTION 42A REPORT OF MR BRENT DAVID WATSON ON BEHALF OF HORIZONS REGIONAL COUNCIL

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1. INTRODUCTION

Qualifications and experience

1. My name is Brent David Watson. I studied for a BSc in Geology and Physical Geography at Victoria University and left in my third year to take up a graduate position at Auckland Regional Council. I am currently completing a post-graduate diploma in Quality Management at Massey University. I am a member of the New Zealand Hydrological Society and the newly formed IPENZ (Institution of Professional Engineers New Zealand) Rivers Group.

2. I have 10 years post-graduate experience in the field of Operational Hydrology and Environmental Monitoring (including Water Quantity/Quality and Air Quality), having been employed at:
   - Auckland Regional Council (Graduate Student – South Auckland low flow gauging programme (1997-1999).
   - Auckland Regional Council (Graduate Technician – Hydrology and Air Quality 1999-2001).
   - Greater Wellington Regional Council (Environmental Monitoring Officer – Field Hydrology, Air Quality and Quality Management (2001-2004).

3. I was employed by Horizons Regional Council as Senior Hydrology Technician (2004-2008) responsible for management of the Northern and Eastern Hydrology teams and the Regional Air Quality Network. During 2006 I also took over management of Horizons' hydrological archive and data validation processes.

4. During 2008 I was promoted to Senior Catchment Data Coordinator, responsible for the management and verification of all collected continuous environmental data.

5. My current role with Horizons consists of:
   - Management of the Flood Modeling and Telemetry systems.
   - Management and development of the Catchment Data Team's registered ISO 9001:2008 Quality Management System.
   - The provision of technical hydrological support and statistical analysis to assist/support the Regional Planning and Regulatory Group's activities (ie. Compliance, Consents, Policy and Science teams).
   - Training and development of Catchment Data (Hydrology) graduate staff in areas of quality management, data collection and verification.

6. Over the past three years I have supplied technical hydrological analysis and support to water allocation reviews, including that for the Upper Manawatu Catchment. I have also been involved with the water take monitoring and water metering project working group, providing field and data support, and the development of processes for flow meter data correction/verification and river flow naturalisation.

7. During my employment history, I have attended numerous environmental monitoring training courses, including national and international conferences in relation to the field of environmental monitoring.

8. Outside of Horizons, I am actively involved in the national Local Authority Environmental Monitoring Group (LAEMG), undertaking the development of Local Authority National Environmental Monitoring Standards, procedures and protocols, and for the collection, verification and archiving of continuous environmental data.

9. I have read the Environment Court's practice note Expert Witnesses - Code of Conduct, and agree to comply with it.

My role in the Proposed One Plan

10. I have participated in the work of the water allocation working group on the development of the Regional Water Allocation Framework. My major role in this working group has been the provision of information in relation to hydrological flow statistics and application of analytical methods for the purpose of calculating river flows in catchments that do not have long-term continuous flow records.

2. EVIDENCE

11. The application of the flow information and analyses that I have completed is presented in the evidence of Ms Raelene Hurndell.

12. The provision of hydrological information to inform the water allocation framework that has been developed builds on the work of the flow statistics report (Henderson and Dietrich, 2007) and consists of the following aspects:

    a. Continuous river flow data used for the provision of hydrological information has been collated from three sources:

        i. Horizons' hydrometric archives.

        ii. Horizons' sub archives comprising verified data that is awaiting archive approval.

iii. The National Archive, administered by the National Institute of Water and Atmospheric Research Ltd (NIWA), Christchurch.

b. All collated data collected by Horizons has been verified as correct to the Catchment Data Team's registered ISO 9001:2008 Quality Management System. The Catchment Data (Hydrology) Team operates its river level and river flow continuous monitoring programme to the following (but not limited to) international standards: ISO 748 and ISO 1100-1 and 1100-2.

c. To summarise the Catchment Data Team's adopted standards:
   i. Continuous water level with measured accuracy of +/- 3 mm over full range.
   ii. Continuous river flow +/- 8%, with an aim of +/- 5% at low flows in critical catchments.

13. NIWA has provided permission for the use of its data as part of the Proposed One Plan process. In some cases, Horizons has verified the continuous flow data provided from the National Archive and supplied by NIWA, with spot flow gauging measurements and site inspections undertaken by Horizons' Catchment Data Team.

14. Horizons' proposed Water Allocation Framework uses the river flow statistics for the one-day Mean Annual Low Flow (MALF) as part of many of the calculations for minimum flows and allocation limits. These have been calculated from the continuous record using standard hydrological statistical software. An explanation of the MALF and how it is calculated is provided below. This process has been undertaken with the use of Hilltop Software Ltd's time-series statistical software.

15. The one-day MALF is the overall average of the annual lowest recorded daily average flow for each recorded "Water Year" (1 July to 30 June). An example of the output for a site is shown below. In simple terms, the MALF calculation moves through the continuous flow records calculating the 24-hour average flow. The lowest value for this number in the water year (July to June) is recorded for that year and this value is termed the annual minima. Once the value for the years of record have been calculated, the average of all of these is calculated. This is the one-day MALF. In some cases where there are partial years of data, an assessment of the year will be completed to see if it did contain the lowest flow for the year. In the event it is judged to do so, then that year will be added into the calculation.

16. From the 16 years of records at the Makino at Boness Road site in the example below it can be seen that the annual minima range from 0.030 to 0.141 m^3/s and the overall average of these values (ie. the MALF) is 0.081 m^3/s. To reflect the realistic accuracy of the measurement of river flow ± 8%), the MALF values have been rounded to the nearest 0.005 m^3/s. The MALF for the Makino at Boness Road record is rounded to 0.080 m^3/s. The ±8% accuracy applied to a flow of 0.080 m^3/s is 0.006 m^3/s.

Example calculation: Makino at Boness Road.

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Hilltop Hydro Version 5.78
~~~ PMOVE ~~~  VER 1.9
Source is Y:\Hydrology Data Analysis\Water Allocation 2009\Flow_master.hts
Flow (m³/s) at Makino at Boness Road
From  1-Jul-1992 00:00:00 to 30-Jun-2008 24:00:00
Minimum moving averages over 1 Day interval

    Year Ending           Minimum Value  - Flow (m³/s)
30-Jun-1993 24:00:00               0.092 at interval beginning 27-Feb-1993 19:30:00
30-Jun-1994 24:00:00               0.071 at interval beginning 27-Feb-1994 05:00:00
30-Jun-1995 24:00:00               0.066 at interval beginning  2-Mar-1995 06:00:00
30-Jun-1996 24:00:00               0.097 at interval beginning 10-Feb-1996 19:15:00
30-Jun-1997 24:00:00               0.114 at interval beginning 16-Mar-1997 21:30:00
30-Jun-1998 24:00:00               0.075 at interval beginning 14-Apr-1998 03:45:00
30-Jun-1999 24:00:00               0.063 at interval beginning  4-Mar-1999 11:30:00
30-Jun-2000 24:00:00               0.030 at interval beginning 10-Mar-2000 15:30:00
30-Jun-2001 24:00:00               0.080 at interval beginning 22-Dec-2000 10:45:00
30-Jun-2002 24:00:00               0.141 at interval beginning  9-Feb-2002 19:15:00
30-Jun-2003 24:00:00               0.059 at interval beginning 18-Mar-2003 09:00:00
30-Jun-2004 24:00:00               0.083 at interval beginning 17-Jan-2004 12:15:00
30-Jun-2005 24:00:00               0.109 at interval beginning 25-Feb-2005 12:45:00
30-Jun-2006 24:00:00               0.096 at interval beginning 18-Mar-2006 21:15:00
30-Jun-2007 24:00:00               0.068 at interval beginning 28-Feb-2007 12:30:00
30-Jun-2008 24:00:00               0.057 at interval beginning  9-Feb-2008 11:45:00
Mean annual Minimum =      0.081
(For complete years only)
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17. Horizons hydrometric archive contains data gaps in its continuous record where it has been impossible to model or synthesise missing record periods. The statistical analysis for the Water Allocation Framework has included the partial years that have been included within the document titled Statistical Analysis of River Flow Data in the Horizons Region (Henderson and Dietrich, 2007).

18. Where stations contained less than 10 years of record, there has been an attempt to "extend" the length of record, by the use of upstream or nearby stations with similar catchment characteristics. This process required significant overlapping records and/or paired gaugings. If records failed to meet the required quality or certainty, the extended data was removed from the statistical analysis.

19. The calculation of flow statistics for unknown management zones has been undertaken using the methods outlined in the Ministry for the Environment's (MfE) 1998 Flow Guidelines for Instream Values (Page 21-23, see Appendix One).

20. The MfE guidelines have been applied in the following order of quality and certainty:

a. Paired gaugings to continuous flow records.

b. Paired gaugings.

c. Catchment area yield versus gaugings.

d. Catchment area yield corrections for geology (Tiraumea Water Management Zone).

21. For those Water Management Zones where continuous data was unavailable or did not meet the length required to justify good hydrological records, data relationships were checked against hydrological knowledge of the catchment and only used where the relationships were considered accurate enough to inform decision-making.

22. The final statistical analysis undertaken was the verification of surety of supply. This verification was undertaken using entire continuous flow records and comparing the daily mean flow to the full range of allocation options, to indicate the number of days per year that fall in restriction. Surety of supply is further discussed in the evidence of Dr Jon Roygard and Ms Raelene Hurndell.

3. CONCLUSION

23. The recommended flow statistics and surety of supply calculations have been produced by sound hydrological methodologies and I recommend the use of these as a part of the overall Water Allocation Framework.

4. REFERENCES

Ministry for the Environment (MfE) 1998. Flow guidelines for instream values, Volume B. ISBN 0-478-09023-4. http://www.mfe.govt.nz/publications/water/flow-guidelines-for-instream-values-a-may98.pdf

Henderson R. & Diettrich J. 2006. Statistical analysis of river flow data in the Horizons Region. NIWA Client Report: CHC2006-154.

Brent Watson

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APPENDIX ONE Use of methodologies from the MfE report Flow Guidelines for Instream Values

The 1998 Instream Flow Guidelines Report published by the Ministry for Environment included a technical background document (Volume B). The technical material presented in the guidelines report included several methods about hydrology, flow data and methods to determine flow statistics (pages 11-26). The following excerpts provide some information from the MfE report that explain methodologies used as a part of the determination of flow statistics for the One Plan.

Section from Volume B : Technical Background, Chapter 1 : Hydrology

"*1.3 Availability of flow data*

New Zealand has an extensive network of river flow recording sites dating from 1906. Time-series data of flow were recorded for more than 200 sites by NIWA and more than 100 sites by Regional Councils in 1995.

There are a large number of closed flow recording stations for which useful records are available. Flow records are stored on a National Archive administered by NIWA and on Regional Council archives. Some Territorial Authorities also collect data at sites and administer their own records. Existing and closed flow recording sites with more than five years of records (Walter, 1994) are shown in Appendix 1 of this document (Volume B).

1.4 Estimates of low and flood flow in catchments without flow records

Many catchments which are significant water resources do not have flow records. Estimates of low flows and flood flows for these catchments can be made by:

- *Synthesis of flow records*
- *Regional methods*
- *Comparison with records in a catchment with similar source of flow (possibly relating an established flow record to flows in a catchment using concurrent gauging).*

1.4.1 Concurrent gauging

Perhaps the most useful method of deriving flow records and statistics for catchments without flow records is the method of concurrent gauging. Hydrological data from catchments with flow records can be extended to other catchments within the same hydrological region. This is accomplished by carrying out a series of concurrent gaugings on the catchment without a flow record and using these to establish a

relationship with flow in the gauged catchment. This relationship can then be used to produce either a flow record or flow statistics for the ungauged catchment.

Using this method requires some forward planning. At least five and preferably seven or more concurrent gaugings are required to establish a relationship over a range of flows. If these gaugings are carried out over a period from late winter to the summer low flow period, a relationship can be established in less than six months. A useful description of this method is described in Chandler (1969). Applications of the method are discussed in Waugh (1970), Grant (1971), Harrison (1988), and Clausen et al. (1997)." MfE 1998

Volume B : Technical Background, Chapter 1 : Hydrology, Page 22,

"*1.4.2 Synthesising flow data*

Some catchments have very short periods of record which may not be sufficient to make statistical estimates from. Generally a flow recording site will be at a strategic location in the catchment with respect to water resource use, but often information is needed for a location in the gauged catchment which is remote from the recorder site. In these situations flow records can be synthesised.

Short records can be "extended" by comparing flows to flows at a nearby site for which climatic and geological conditions are similar, resulting in similar flow regimes. Comparison of the short period of record can be used to derive a relationship from which the short record can be extended by applying the derived relationship to the longer record.

In some situations a long period of rainfall record is available for a catchment with or without a period of water level record. Mathematical models run on computers can convert rainfall to flow. This is called rainfall-runoff modelling. If some flow data are available, this can be used to calibrate the model and the rainfall record can then be used to extend the flow record to the same length as the rainfall record. This can provide a flow record from which more certain statistical estimates can be made. Where there is no flow record available, model parameters can be derived from nearby catchments with the same climatic and geological conditions. The rainfall record can then be used to synthesise a flow record." MfE 1998.

References

Ministry for the Environment (MfE) 1998. Flow guidelines for instream values, Volume B. ISBN 0-478-09023-4. http://www.mfe.govt.nz/publications/water/flow-guidelines-for-instream-values-a-may98.pdf