BEFORE THE HEARINGS PANEL

In the matter of hearings on submissions concerning the Proposed One Plan notified by the Manawatu-Wanganui Regional Council

STATEMENT OF EVIDENCE OF ARTHUR JOHN ROWLAND MALE

Dated: 9th October 2009

Introduction

1. My name is Arthur John Rowland Male. I hold the qualifications of BSc and MSc (Hons) from the University of Auckland. These degrees included study in botany, geology, geomorphology and hydrology along with being a tutor in statistics. My thesis was on assessment and mapping of regional water resources. I also undertook training at the Institute of Hydrology in England on the application of statistics to the regionalisation and transferring of hydrologic variables. My career in hydrology, water resources and catchment management fields spans over 35 years.

2. I joined GHD Ltd as a principal hydrologist in 2004 and am now employed as the company International Irrigation Service Line Leader and the New Zealand Group Manager for Waterways and Water Resources. I act as a project director or project manager for many of the projects that are undertaken in that field of work.

3. From 1986 to 2004, except for two years in the construction industry during 1989 and 1990, I was self employed or worked for other international consultancies in New Zealand and overseas on a range of hydrologic, hydraulic, water resources, integrated catchment management and fluvial geomorphologic projects.

4. Prior to that the Water and Soil Division of the Ministry of Works and Development employed me for 10 years. I managed the team responsible for the hydrometric network north of Mercer and this included the design and operation of river and rainfall stations along with the processing of the data. At the same time I was involved in work on research catchments looking at land use impacts and on the mapping of water resources throughout much of Northland.

5. I have a broad range of experience in water resources and catchment management work but of particular relevance to this project is my expertise and project involvement in:

   (a) Hydrologic and hydraulic modelling of catchments and rivers;

   (b) Installation and management of hydrometric networks;

   (c) Evaluation of water resources and water demand across catchments;

   (d) River erosion, sediment transport and sedimentation in lakes; and

   (e) Impacts of land use change on the water quality of rivers and lakes.

Scope of Evidence

6. In my evidence I address;

(a) Summary of Evidence

(b) Approaches to Water Allocation

(c) Management Zones and Values

(d) Minimum and Management Flows

(e) Core Allocation and Surety of Supply

(f) Water Use, Efficiency and Net Take Position

(g) Water Quality

(h) Groundwater

(i) Supplementary Allocations

(j) Conclusions

7. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice note and that I have complied with it in the preparation of my statement of evidence. I agree to comply with it when presenting this evidence before this Panel. I confirm that the evidence I present is within my area of expertise and I am not aware of any material facts that may alter or detract from the opinions I express.

8. In preparing my evidence I have reviewed:

(a) Chapters 6, 13, 15 and 16 of the Proposed One Plan

(b) Schedules B, Ba, and C of the Proposed One Plan

(c) The Horizons section 42A Officer Reports prepared by Dr Roygard, Ms Clark, Ms Hurndell, Dr Hayes, Mr Stewart, Mr Hay, Mr Watson, Mr Callander, Mrs McArthur, and Dr Biggs.

Summary of Evidence

9. The allocation of water throughout New Zealand is largely based on the allocation of a volume above a threshold that has been set to protect perceived environmental values. Horizons has followed this same approach in the Proposed One Plan with the setting of minimum flows.

10. The minimum flows have been set directly from measurements or by estimation based on equations. While I endorse in principle the methods that have been used I

am concerned as to quality of the base hydrologic data and the way statistical methods have been applied. There is no indication that an independent peer review has been undertaken. This leads to a lack of confidence in the minimum flow estimates.

11. Core allocation volumes that have been set above minimum flows have been based on a surety of supply analysis. The surety of supply varies between catchments and appears to have a degree of subjectivity in the analysis. There appears to be an inequity between environmental protection and the confidence consent holders can have in exercising their consents.

12. In setting values for the management zones a very broad approach seems to have been applied and there is going to be a need for most large take applications to undertake a site-specific analysis.

13. The values have been assumed to apply constantly throughout the year without consideration of seasonal dynamics. Inclusion of seasonal factors could lead to a more efficient use of the water resource.

14. The potential implications of some water uses do not appear to have been considered in the Proposed One Plan. A storage dam integrates all runoff from a catchment. Consequently any groundwater abstractions upstream of the dam will impact on water availability. The same would apply for a diversion scheme when minimum flow is reached and where water harvesting is undertaken through supplementary allocations. The combined effect of water that may be permitted or consented under the Proposed One Plan would significantly impact any hydroelectricity generation operation.

15. The potential impact of permitted uses on core allocations does not appear to have been evaluated. Changes in land use patterns and farming systems has the potential to consume significantly more water as of right potentially changing the hydrologic regime in a catchment.

Approaches to Water Allocation

16. The allocation of water by Regional Councils in New Zealand is predominantly based on a concept of allocating a volume of water above a threshold. While this overall concept of leaving a volume of water in the natural environment and providing a volume for use is generally universal there is considerable variation in the way the concept is applied from region to region.

17. Historically thresholds have been based on a hydrologic statistic. The most commonly used statistics are the mean annual low flow (MALF) and the 1 in 5 year low flow (Q_5).

18. These hydrologic statistics are applied in a number of ways. Sometimes the statistic itself is the minimum flow limit at which time abstraction ceases or is regulated. Other times it is a percentage of the hydrologic statistic that is allocated meaning that the minimum flow is less than the hydrologic statistic flow. Further, the choice of hydrologic statistic that is used within a region to set the minimum flow can change depending on how a river is valued.

19. Three trends in the management of water allocation are developing across the country:

    (a) The first is a move toward measurement of environmental response and habitat requirements to set minimum flow thresholds rather than relying upon use of the indirect approach of hydrologic statistics, Instream flow incremental methodologies (IFIM) that quantify the hydraulic conditions in a stream and evaluate those conditions in terms of quantified habitat requirements for critical species is the most commonly accepted approach internationally to establish minimum flow thresholds.

    (b) The second is to quantify the amount of water available for abstraction and set allocation blocks or volumes. In some regions these blocks are partitioned into two or three separately managed categories. This regulates the abstraction rates as flows fall toward the ultimate threshold. It provides varying degrees of surety of water availability depending on in which allocation block consent is held.

    (c) The third is more detailed consideration of abstractions when flows are much higher than minimum flow thresholds. These are controls on water harvesting regimes to maintain a semblance of the natural flushing flow regime.

20. The management philosophy taken by Horizons in the development of the Proposed One Plan has been to embrace all of the approaches I have commented on in paragraphs 19(a) to 19(c) while every endeavour has been made by Horizon's to keep things simple and transparent. A minimum flow is set and an abstraction volume, called the core allocation, is set above that. This core allocation has been determined based on a surety of supply assessment.

21. The advantage of this approach is its simplicity but I have concerns about the setting of the minimum flows and in the determination of the core allocation. Further, as the flows reduce toward the minimum flow inequities may develop between consent holders. If this approach is applied where there is out of river hydro generation, utilising a diversion scheme, at the point where the minimum flow threshold occurs there is an immediate cessation of abstraction for non-essential takes. Unless hydropower generation is considered an essential take the occurrence of a minimum flow may lead to potential loss of electricity supply.

22. If electricity generation is included as an essential service then this issue would be solved. However operation of a hydroelectric generation scheme during a water shortage or low flow situation is likely to be a matter addressed at the time of consenting a scheme. Once consented the operator should have the ability to use the water allocated during a period of water shortage on a priority basis.

Management Zones and Values

23. To facilitate management of the allocated water the region has been divided into management zones. A range of criteria have been applied to define the zones including the location of existing hydrologic and water quality monitoring sites. My concern is whether these monitoring locations adequately reflect the hydrology and water quality of the zone such that they can be considered representative of that zone or sub zone.

24. For flow data to be transferred from a base site to one with little or no information there is an assumption that the partial flow duration curves for the sites are similar. This may not be the case for a variety of reasons. Tributaries often have different flow characteristics to the main stem of a catchment. The exchange between surface and groundwater may vary along a channel so any relationship between a monitoring station and a point on a channel within the subzone may not be consistent over the full range of flows. Consequently the use of a single point within a water management subzone is potentially a coarse measure to manage water allocation within the subzone. From a hydrologic perspective regional flow mapping and / or a regionalisation model are the best ways to improve the reliability of management within the zone.

25. Mighty River Power has a particular interest in the Whangaehu Catchment and its management zone boundaries. Whau 2, a zone within the Whangaehu catchment, has no subzones yet there are large tributaries joining the main river within the zone. In Whau 1 the tributaries have been separated into subzones yet further downstream there is no such intensification of zone subdivision. Further the downstream boundary of Whau 2 is simply in the middle of a long reach. Setting the upstream

and downstream boundaries at confluences provides a better framework for the management of flows within the zone. The zones are characterised by assessment of 22 different values. The level at which the values are applied varies with each characteristic. Some are applied zone wide and others at a more local scale. The values are assessed by way of tick box approach. Given the size of some of the zones there is a degree of subjectivity and generalisation in their application. Further I would have expected:

(a) Values to include suitability for hydro generation and for boating and kayaking; and

(b) Values to have been developed and applied in a way that reflects the variability in values throughout the year.

26. While it could argued that boating and kayaking could be part of contact recreation the needs for those activities differ from other contact activities and consequently the way values are assessed may differ.

27. Table 6.2 and Schedule Ba contain similar tables of values and create some confusion in their use. Duplication should be avoided and the ambiguity created by using such broad classes for the individual values requires more definition or the focus should be on site-specific values.

Minimum and Management Flows

28. Six scenarios have been used to set flows in the Proposed One Plan. The scenarios change depending on the extent of information available to set them. The issue I have is with the methods of estimation when there is a reduced amount of data available and estimation procedures are required.

29. In the development of this evidence access was sought to the audited time series hydrologic data set in order to carry out some analyses to confirm the approach taken by Horizons. Unfortunately the data were not able to be made available and we are therefore not in a position to comment on the approach taken in the preparation of the proposed One Plan at this stage. We did get some data from NIWA sites in the region to compare various flow statistics.

30. Hydrologic record is used in one form or another for setting minimum and management flows. This is either by analysis of an existing record or through the use of that record to estimate flows at a point on a river where there is little hydrologic information. The terms used by Horizons for the hydrologic record that is required for this analysis are ‘robust’ or ‘good’. Robust or good are rather vague and subjective terms to describe hydrologic records. The hydrologic record should firstly have been

audited and there should be evidence of the quality assurance process for that. Secondly the hydrologic record should have consistency in a statistical sense, that is, any estimate of hydrologic statistics should be statistically significant. I have no knowledge of whether the data Horizon's has relied upon meets the two criteria I have outlined above.

31. The suggested methods by Horizons for the determination of mean annual low flow where there is no hydrologic record and the application of mean annual low flow as a predictor of IFIM minimum flow raises questions for me in terms of the reliability of estimation. Hydrologic data often requires an appropriate transformation so that linear regression can be applied legitimately. There is no indication that a test of the need for transformation is recommended or has it been undertaken where linear regression has been applied. Consequently there is uncertainty as to the reliability of the estimate of mean annual low flow and / or IFIM minimum flow estimates.

32. Further where mean annual low flow is used as a predictor of IFIM minimum flow the best-fit line appears to have been forced through the origin at zero for all three-flow ranges that are used as shown in Box 11 of Dr Roygard's evidence. This may or may not be appropriate except for the lowest flow class.

33. In addition to these three equations for determining IFIM flows a single equation incorporating all the data for a full range of flows has been developed. There does not appear to be any statistical analysis that evaluates whether there is a significant difference between all these equations. So it is unknown whether the difference between the set of three equations or the single equation produces an estimate that can be considered statistically different. This is relevant to the confidence in the flow estimate for the minimum flows listed in Schedule B. On that basis I don't have sufficient confidence to accept the need for three equations or whether one will do, and if three are required whether the flow class boundaries of 0.46m^3/s and 3.7m^3/s are the best flow boundaries.

34. Twenty one IFIM studies throughout the region have been used to establish the flow classes for the IFIM predictor equation development. These have all been incorporated into one analysis. More detailed analysis of the different data sets based on individual catchments would give more confidence as to the applicability of the results on a region wide basis. There should be an assessment that indicates that there is no significant variability in the application of the predictor equation from catchment to catchment. As the equations stand it appears that there are no other variables that have been considered to explain the variance in the data. Also no data has been separated for validation of the predictor model equation.

35. On the basis of the analysis that has been provided in the Proposed One Plan then there is uncertainty with the minimum flows listed in Schedule B because;

    (a) Data may need to be transformed to develop appropriate equations;

    (b) There is no definitive statement as to which is the most appropriate IFIM predictor based on the relationship with MALF; and

    (c) There is no indication whether the MALF / IFIM equation is applicable across all catchments in the Region or whether there is some variability between catchments.

Core Allocation and Surety of Supply

36. The core allocation determination is based on actual data or a flow estimate, and is the difference between the management flow, as defined in the Proposed One Plan, and an assessment of the flow that is determined to provide an appropriate level of protection for the environmental values of a particular river or stream.

37. Based on section 3.4 in Ms Hurndell's evidence it appears the practice though is to determine the minimum flow and then the core allocation limit to set the management flow by addition. This is to ensure that out of stream users have reasonable ability to use their consents. It would seem that the analysis is dependent on the magnitude of existing consents

38. The magnitude of the management flow is based on an assessment of the surety of supply. This surety assessment indicates the number of days on average there will be flow restrictions. A subjective approach as to what might a reasonable surety of supply seems to have been applied and the number of days where restrictions might apply varies from zone to zone.

39. Because of this variability in the surety of supply but the high levels of consistency of the same percentage of MALF being used to set minimum flows and core allocations I question whether the driver for setting these allocations and flows has really been a balance between reasonable expectation of being able to exercise a consent and the protection of environmental values.

40. Further the protection of environmental values would seem to be set at a constant flow yet the natural environment generally has seasonal cycles and the degree of protection required is likely to vary throughout the seasons. Situations like this justify a more dynamic consideration of values. For instance, if fish spawning is the value driving the determination of minimum flow requirements, with no other values, and it is not spawning time and there was a minimum flow event then why should an activity

such as power generation be restricted when the other value does not need to be sustained at that time.

41. Given that there is variability in the surety of supply across catchments and that the determination of the core allocation has some subjectivity to the assessment then independent verification of those values should be undertaken. In the Whangaehu where Mighty River Power has an interest I believe that the setting of flow thresholds and the core allocation needs to be peer reviewed considering the comments I have made on the setting of minimum and management flows.

Water Use, Efficiency and Net Take Position

42. Horizons has assessed water use and efficiency for municipal and stock supplies. The proposed One Plan summarises that over 60% of water use is consented for agriculture and overall uses have doubled over the last 12 years. The potential impact on water allocation management from irrigation has not been considered in detail. Actual water use, how efficiently it is used, and how that may change is of significant interest to hydro generators.

43. The concern for any major infrastructure investor such as for hydro generation is the potential impact changes in water use may have on resource availability. These impacts can arise because of permitted use allocations such as the 70l/head/day used for stock. Increased stock use, irrigation conversions and even subdivision permitted under District Plans can all lead to increases in water demand and a potential consequent reduction in generation potential, purely because of permitted take policies. For this reason hydro generation needs to be protected as a water user even though hydro generation is not a consumer of water.

44. From a hydro generation perspective how water used for generation is included in the allocation framework is important for the community that expects a continuous and assured electricity supply. Unless water is diverted away and lost from a catchment as part of the generation scheme then water is not taken in the normal sense. Even if it is diverted through an off river diversion scheme there is no net water take but rather it is taken from the waterway for a certain length of the river and is used for the community or national benefit. In the using of the water the natural flow regime may be modified depending on the type of generation scheme but unless this modification of the flow regime and duration curve has a significant negative impact on the environment then the water used for generation should not be considered part of any allocation block. Further the volume of water available for use downstream of a scheme would also be a factor determined at the time of consenting and could ultimately be reflected in the allocation regime.

Water Quality

45. Responsibility for mitigating any water quality impact should lie with the generator of that impact. In that regard Mighty River Power accepts its responsibilities like it expects any other party too. The potential for assimilative capacity in streams to be exceeded by some land use activity is of concern to hydro generation and the operation of any scheme. In such circumstances the risk for the generator is that it may be called upon to modify flow releases to maintain residual flows at higher levels or to provide flushing flows in order to mitigate an impact outside of its control.

46. While such water quality mitigation offsets are theoretically possible there is a cost to the generator in terms of lost income from not being able to optimise power production. Mighty River Power seeks to ensure that any point and non point sources discharges be managed at source, as far as practical, to minimise the risk of the wider community having to provide for the required mitigation offsets.

Groundwater

47. The groundwater evidence presented by Horizons largely addresses bore development, management and the potential effect a groundwater take may have on another bore or a stream. I agree with how the proposed One Plan has addressed these matters but from a hydro generation perspective the matter of overall catchment water mass balance is also potentially significant, especially where 5% of the annual rainfall is allocated for groundwater abstraction.

48. For the most part groundwater eventually joins a river and provides a significant portion of the river flow. So while a bore may not be close to a stream or have a direct affect on the stream in the short term it will reduce the overall catchment water balance through the abstraction. Any water abstracted above a storage dam will therefore impact on the total runoff that reaches the dam and on the generation capacity of power stations associated with that storage.

49. Groundwater management zones have been determined and groundwater allocation limits set. The Whangaehu catchment is a groundwater management zone and has one of the largest groundwater allocation volumes. At present this groundwater is linked directly to the flows recorded in the catchment, unless it is already allocated and abstracted. Consequently where long term storage is involved the future abstraction of groundwater will impact on the total runoff from the catchment, potentially changing hydrologic flow estimates upon which the Proposed One Plan is based unless naturalised flows are used for allocation purposes.

50. Consequently any investment in infrastructure based on the total flow in a catchment needs to be protected from any changes in upstream abstractions, be they surface or

groundwater, unless they have been already included in the overall catchment mass balance.

Supplementary Allocations

51. Supplementary allocations are for takes at higher flows and primarily for the filling of storages under water harvesting. Policy 6 – 18(a) allows takes up to 10% of the natural flow once flows in the river exceed median flow. These takes can occur even if the flow regime is altered as Policy 6 – 18(a) and Policy 6 – 18(b) are either / or policies.

52. For storage owners downstream of any supplementary take it means that there is a potential to lose a significant portion of the water use potential of their own storage.

53. The potential changes in land use activity that could alter the volume of water taken under supplementary allocations, groundwater allocations and through permitted uses means that there is a significant risk to any storage and especially hydro generation. Consequently where any investment is made in storage infrastructure there needs to be a value established for such infrastructure so that it recognised under Schedule Ba.

Conclusions

54. My opinion is that the Proposed One Plan provides a workable framework to manage the allocation of water but needs to further address:

    (a) The specific needs of hydro generation in terms of how the core allocation applies to protect the investment made

    (b) The benefits from the continued use of water downstream of a scheme when the water is available for use by other users after use for hydro electricity. Availability of water will depend upon any minimum flows set for a new hydro scheme.

    (c) Once consented and an allocation is made to electricity generation there needs to be measures put in place to protect that use from upstream users

    (d) The risk to storage owners that they may be called upon to provide residual or flushing flows to offset impacts created by others needs to be clarified. The need for this should not occur if point and diffuse sources of contaminant runoff are managed in accordance with the provisions of the Proposed One Plan.

(e) The potential for increased water use under permitted take policies as it is theoretically possible for such use to grow to a point where it will impact on the surety of supply for consent holders.

Arthur John Rowland Male