BEFORE THE CANTERBURY REGIONAL COUNCIL

IN THE MATTER OF	**the Resource Management Act 1991**
AND	
IN THE MATTER OF	**Resource consent applications (42 applications for water take and 13 associated land use and discharge permits)**
APPLICANTS	**LOWER WAITAKI APPLICANTS**

AFFIDAVIT OF FRANK SCARF ON BEHALF OF THE CENTRAL SOUTH ISLAND FISH AND GAME COUNCIL

August 2008

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Qualifications and Experience

1. My full name is Frank Scarf and I reside in Timaru. I am an hydrologist and hold an New Zealand Certificate of Engineering (Civil) and a Bachelor of Science (Mathematics). I am now retired but continue to provide hydrological advice from time to time to Fish and Game (Central South Island), particularly in relation to water resources assessment, modelling and management rules.

2. Throughout my working life spanning more than 45 years, I worked in hydrology, water resources management and related fields. During the 1990s, I was employed in various senior management positions within the Canterbury Regional Council including Southern Area Manager and Group Manager (Regulations and Consents). Throughout the 1980s, I filled the position of Water Resources Manager with the South Canterbury Regional Water Board.

3. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses (31 March 2005). This evidence is within my area of expertise except where I state that I am relying on what I have been told by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

4. This evidence is based on hydrological records provided by Environment Canterbury and on my personal knowledge of the Waitaki River and its water resources from living and working in the South Canterbury area for the past 27 years.

5. This evidence addresses the following:

   a) Flow records at Waitaki Dam and impacts to those records resulting from construction of various dam structures and the diversion of water to fill permanent reservoir storage.
   b) Changes to Meridian's current practises to comply with provisions established by the Waitaki Catchment Water Allocation Regional Plan
   c) Meridian's role in water management
   d) Conditions applying to consent to take water for irrigation
   e) Other Matters – Rivers and tributaries.

Introduction

6. I have been asked by Central South Island Fish and Game ("Fish and Game") to prepare and present hydrological evidence in relation to the proposed water take applications by the mid-river New Applicants Group (MRNAG). I have previously given evidence to Commissioners on Fish and Game's behalf

in respect of both the Meridian NBTC application and the Hunter Downs Irrigation Scheme application. Whilst I do not intend to repeat that evidence, there is a degree of overlap. In particular, my evidence on the Waitaki River hydrological record is highly relevant to understanding how the proposed takes will operate, and what degree of reliability the use of that water for irrigation is likely to enjoy. Of course, what minimum flow is applies to the consent is also critical in that regard. The question is what the best flow records are for the Waitaki River for modelling purposes, in order to understand the impact of the proposed water takes on the river.

7. Flow records for the Waitaki River date from about 1925. Early records were of lesser quality. The second period extends from 1950 to 1977. This record includes more detailed and rigorous recording of flows both on the mainstem and tributaries throughout the Waitaki catchment.

8. The third period extends from December 1977 to date. This record for the Kurow site is much more reliable and is based on the flow recorded every 15 minutes at that site.

9. The water resources of the Waitaki River have been progressively developed for hydro power generation purposes since 1935 and the construction of Waitaki Dam.

10. During the course of that development the natural hydrology of the lower Waitaki river has been modified significantly through the creation of additional water storage, and in particular the construction of Benmore Dam during the early 1960s and the raising of Lake Pukaki in the late 1980s. Meridian Energy Limited has the responsibility to manage that water storage in the national interests and its energy needs. That management has resulted in a shift in the seasonal distribution of flow throughout the year as shown in Table 1 below and Figure 1 that is attached as Exhibit 1 to my affidavit.

Table 1: Waitaki River at Kurow – Important flow statistics (m3/s)

Pre development (1927 –50)			Post development (1979-07)		
mean	median	MALF	mean	median	MALF
353	310	127	370	360	207

11. Increased storage has resulted in an attenuation of historic flood events, and just as significantly, a low flow regime much higher than that which existed prior to hydro development. Now, for 80% of the time the flow during the irrigation season (Sept – Apr) is maintained within the range 242-507 m3/s.

Has the diversion of water to fill increased storage been taken into account in the irrigation certainty risk analysis?

12. I have been asked by Fish and Game to review the hydrological information relating to the Mid River New Applicants Group (MRNAG) and in particular, matters relating to the raising of Lake Pukaki and the filling of Lake Benmore and how those events impact the conclusions reached by Potts et al and supported by Mr Leong at the HDIS Hearing.

13. At that hearing, I referred to evidence presented by Mr Henderson[1] and the annual hydrograph plots (his Figure 13) in particular, and noted that long periods of sustained low flow are not a feature in the post 1978 data. Such events are however a feature of the pre 1978 hydrographs, notable among which are 1937/38, 1941/42, 1952/53, 1954/55, 1960/61, 1963/64, 1964/65, 1973/74, 1976/77 and 1977/78.

14. A similar impression is obtained from the perusal of the chart included in Stuart Ford's supplementary evidence[2] where the incidence of partial and total restrictions in the far right 26 lines of the HDI 150 Full chart (i.e. from 1978/79 to 2003/04) feature markedly less than for the remainder of the chart (i.e. pre 1978/79).

15. I then noted that 1976/77 to 1977/78 is coincident with the raising and filling of Lake Pukaki and that 1963/64 and 1964/65 is coincident with the filling of Lake Benmore. In terms of total irrigation restriction days (partial and full restrictions) throughout the lower Waitaki, these years were ranked 5th, 1st, 4th and 6th respectively in the 73 years included in the Henderson and Ford analyses.

16. This in turn raised the question as to the extent to which the natural water flow in those particular years was diverted to fill the increased permanent storage now contained behind those structures, and so effectively reducing the

[1] Henderson R: Brief of evidence to HDIS Hearing (Figure 13 – annual hydrograph plots)
[2] Ford S: Supplementary brief of evidence to HDIS Hearing (Chart entitled HDI 150 Full)

natural flow that would otherwise have been realised at Waitaki Dam during those years.

17. At the HDIS hearing, this question was put to Mr Leong appearing for Environment Canterbury who assured the Commissioners that the two periods in question coincided with some of the driest years on record and that the diversion of water to fill the permanent storage concerned had been adequately taken into account. I do not agree, for the reasons I now turn to.

The raising of Lake Pukaki

18. The 1976 –79 period coincides with the raising of Lake Pukaki by 37m, adding about 5500 - 6000 Mm3 to storage within the Upper Waitaki basin. Putting this in perspective, to fill this additional storage would require diverting the whole flow of the Waitaki River at Kurow for about 180 days.

19. It took almost two years from September 1977 through to April 1979 to fill the increased storage within Lake Pukaki.

20. The Tekapo Canal linking lakes Tekapo and Pukaki was commissioned in May 1977[3] but while some flow testing of the canal was carried out during August - September that year the canal did not become fully operational until January 1978. At this point all of the water previously discharged from the Tekapo powerhouse into and down the Tekapo River to Lake Benmore was being diverted via the Tekapo Canal and Tekapo B power station into Lake Pukaki. This situation, except for minor spills and the occasional recreational release flow, continues to this day.

21. The Pukaki Canal linking lakes Pukaki and Ohau was commissioned in March 1979.

22. Referring to Mr Henderson's chart for the 1977/78 water year (reproduced here as **Exhibit 2** to my affidavit)you will note the large number of 'low' flow days between September and February. Mr Henderson concludes that for the HDI 150 Full scenario (Table 7 of his evidence) the number of water restriction days would be 121 days and the highest in the 73 years of record he modelled.

[3] Sheridan M (1995): Dam dwellers - End of an era. Sheridan Press

23. I have compared the monthly mean flow recorded for the Kurow site for the period January 1978 through to December 1979 (supplied by ECan), with the record supplied by Meridian and used in the Henderson and Ford analyses. My analysis is attached to my affidavit as Exhibit 3 and is titled ''Table 2''. Table 2 shows that the two records to be almost identical. Any differences between the two records can be ascribed to minor differences in the ratings involved in converting water levels to flow for the Kurow record and power generation to flow for the Waitaki Dam record.

24. The Kurow record is a base hydrology record and has not been modified. The similarity in monthly mean flows leads me to the conclusion that the Waitaki Dam record also is a base record and like the Kurow record describes nothing more than the flow through Waitaki Dam. If a correction for infilling of Lake Pukaki had been imposed I would have expected the monthly mean flows throughout the peak filling months from October 1977 to May 1979 to be some 50 –100 m3/s higher than the observed record. This is clearly not the case, as shown in Figure 2 which is attached as Exhibit 4 to my affidavit. Figure 2 indicates that, at least for the extent of the common record (from Jan 1978 onwards), the monthly mean flows recorded at Kurow (the redline) and Waitaki Dam (the blue line) are the same.

25. This supports my contention that the Waitaki Dam record has not been modified and contrary to the opinion expressed by Mr Leong, the diversion of water into permanent storage created by the Pukaki high dam during the 1977-79 period has not been compensated for.

26. Turning now to the monthly mean inflow and outflow records for Lake Pukaki. These are included in the Works Consultancy Services report dated 1990[4]. Attached to my affidavit as Exhibit 5 is Table 3 that lists the monthly mean inflows and outflows relating to Lake Pukaki for the three water years 1976/77 to 1978/79 inclusive. The volume of water diverted into permanent storage during the three years from July 1976 to Jun1977 totals about 4200 million cubic metres. The information contained in Table 3 is plotted in Exhibit 6 attached to my affidavit which is titled Figure 3.

27. Between October 1977 and May 1979 the average water level in Lake Pukaki was raised some 37.8m from 494.5 to 532.3 m RL .

[4] Works Consultancy Services 1990: Waitaki Hydrology Update 1990

The filling of Lake Benmore

28. Benmore Dam was constructed in the early 1960s. Filling of the 110 m high dam commenced on 3 November 1964 forming a reservoir with a surface area of about 75 km2 and similar in area to that of Lake Tekapo.

29. Attached as Exhibit 7 to my affidavit is Table 4. Table 4 summarises the inflows to the Benmore site occurring during the final stages of construction and subsequent filling of the storage dam. The table extends over the three water years 1963/64 to 1965/66 inclusive.

30. The inflow to the Benmore site has been calculated by summing outflows from each of the alpine lakes Tekapo, Pukaki and Ohau, the Ahuriri River flow, the Forks River flow (all recorded) and adding an estimate (10 m3/s) for the remaining tributaries. This monthly inflow data was then compared to the corresponding flow data for Waitaki Dam and the differences noted. The data shown in Table 4 is plotted in Figure 4 which is attached to my affidavit as Exhibit 8.

31. Prior to the completion of Benmore, there was little in-river storage downstream from the alpine lakes. Aviemore was not constructed until the late 1960's and the only storage of any size was that relating to Waitaki Dam. The operating range for this dam is quite limited (about 2m) and flow passing the Benmore site prior to 1965 was discharged through Waitaki Dam with little attenuation.

32. Referring to Figure 4, the flow at Waitaki Dam is generally 0-40 m3/s higher than the flow at Benmore except for the two month period Dec1964 to January 1965 when Benmore was being filled.

33. In December 1964, inflows totalled 667 m3/s while flows at Waitaki Dam averaged only 42 m3/s. Similarly in January 1965, inflows totalled 309 m3/s while Waitaki dam recorded an average for that month of 242 m3/s. The differences, 625 m3/s for December and 67 m3/s in January, equate to a volume of 1850 Mm3 or about 65% of the water volume contained within Lake Benmore.

34. Attached to my affidavit as Exhibit 9 is Figure 5. Figure 5 shows the flows through Waitaki Dam for the 1964/65 water year. Mr Henderson[5] (refer his Table 7 HDI evidence) calculated that for this particular water year and the HDI 150 Full scenario (assumes that Lower Waitaki allocation has been taken up with 150 m3/s minimum flow at Waitaki Dam), there would have been 73 days of partial or full restrictions on irrigation takes, including a continuous period of 50 days. This season is ranked the 6th most severe in the 73 years of record used in his analysis.

35. Comparing Mr Henderson's chart (refer figure 13 -1964/65 and attached to my affidavit as Exhibit 10) with Figure 5 it is clear that the bulk of the irrigation restriction occurring that season coincides with the period when Benmore Dam was being filled. Certainly, the 50 days of continuous restrictions extending from late November to mid January can be directly attributed to dam filling.

36. Reviewing the monthly inflow and outflow data for lakes Tekapo, Pukaki and Ohau for October and November 1964, I accept that this particular spring was dryer than normal and as a consequence some partial restrictions (about 23 days) would have been imposed during those two months. This however, in terms of restriction days, relegates the 1964/65 year from 6th to about 30th on the severity scale.

37. With dam building it is practice to construct a bypass structure or tunnel above the historic bed level. A low level coffer dam is then constructed to divert flow through that structure to enable construction of the main dam structure. During this process some filling of the reservoir occurs up to the level of the coffer dam and the bypass structure. I am uncertain as to the extent and timing that this occurred in the Benmore and Pukaki Dam situations. Most likely that partial filling occurred within two years preceding the completion date. Looking at Table 4 (my exhibit 7) for example, it appears that for the Benmore Dam, some initial holding back of flow into storage occurred during the autumn of 1964.

Other storages

38. The creation of Lake Benmore in 1964 and the raising and filling of Lake Pukaki about 1978 constituted significant reservoir storage events for the Waitaki

[5] Henderson R D 2007: Brief of evidence and application for consents by SC Irrigation Trust and Meridian Energy Ltd, October 2007

system. However, these are not the only occasions when flow has been transferred to fill permanent storage. Other lesser events include the fillings of Aviemore Dam (1968), the Tekapo Pukaki Canal (1977), the Pukaki Ohau canals (1979), the Ruatanawha Dam (ca 1982) and the lower Ohau canal (ca 1984).

39. Of these the most significant would have been the filling of Aviemore, involving about 400 Mm3. This occurred in July 1968. Flows through Benmore for that month averaged 450 m3/s while flows through Waitaki averaged only 283 m3/s, a difference of 167 m3/s equivalent to about 430 Mm3. Flows through Waitaki Dam were reduced down to 70 m3/s during the latter part of the month from a background level of about 380 m3/s occurring immediately before and after that period of peak filling.

40. I have no information regarding the timing and rate of filling for other lesser storages but within the context of the volume discharged annually through Waitaki Dam (about 11700 Mm3) the diversion of volumes involving 100 Mm3 or less is not particularly significant.

41. It is worth noting at this point that the Waitaki Valley Acclimatisation Society applied to the National Water and Soil Conservation Authority to establish a minimum flow on the Waitaki River in October 1984 some 2 years after completion of the Upper Waitaki hydro power development. Prior to that date, the Crown agencies (principally Ministry of Works and NZ Electricity Department) directly involved in that development regulated flow through Waitaki Dam consistent with the dictates of meeting power generation needs coupled with power development construction demands occurring at the time.

Conclusions regarding diversion of water into permanent storage

42. I do not believe the hydrological record used by Mr Henderson has been adjusted to account for water held back in permanent storage. The record used by Mr Henderson is to all intent and purpose, the same as that recorded at Kurow, at least from January 1978 when recording began at that site. There is no reason to conclude that the Waitaki Dam record prior to January 1978 has been treated any differently and thus it too is a pure hydrological record describing nothing other than the actual flows through Waitaki Dam.

43. From these analyses, I consider that the extent of irrigation restrictions that would be imposed under the HDI 150 Full scenario particularly for the 1964/65, 1976/77, 1977/78 and 1978/79 water years, are overstated by Messrs Henderson and Ford.

44. It is worth noting at this point that prior to 1968 when the Water and Soil Conservation Act 1967 came into force there was no statutory requirement to consider environmental effects. Even then, Crown agencies were exempt. Little, if any, consideration was given by NZED and MWD as to potential effects resulting from induced low flows throughout the lower Waitaki River. Had the lower Waitaki irrigation schemes been operating in December 1964 during the time Benmore was being filled, I am of the opinion that an induced mean flow of 42 m3/s for this peak irrigation month would not have been tolerated.

45. Because of the uncertainties associated with:

    a) dam and infrastructural development; and

    b) the lack of any requirement to consider modern day public expectation and accountability with regard to environmental, cultural and social effects;

    I consider that the pre-1979 record, particularly the period between 1960 and 1978, is flawed to the extent that storage and management decisions exercised by NZED were significantly impacted by the construction demands of the MWD , and in particular the timing and rate of filling of new permanent storage. For this reason I considered the post construction flow data extending from 1979 to date is a more consistent representation of current management practise and as such provides a better record for modelling purposes.

Water allocation to irrigation

46. Many of the irrigation consent applicants seek a minimum flow of 100 m3/s and are contrary to the WAB Plan which sets a minimum flow of 150 m3/s from 'Waitaki Dam to the sea'. At the earlier HDI Hearing I presented a table describing the seasonal irrigation profile for full allocation of 90 m3/s and 1250 Mm3/yr for agricultural and horticultural use downstream from Waitaki Dam. This table has been expanded and is included here as Table 5 and attached to my affidavit as Exhibit 11.

47. The 1250 Mm3/yr allocation downstream from Waitaki Dam includes 150 Mm3/yr granted specifically to takes from the mainstem and tributaries between Waitaki Dam and Black Point. Black Point is identified to be at Map Reference J40:345905 and immediately upstream from the LWIS and the HDIS (proposed) intakes.

48. As noted by various submitters to the previous HDI hearing, many of the existing irrigation consents specify only the peak abstraction rate and do not include a seasonal volumetric rate. Potts and Page have summarised all existing consents and new applications, and have made a seasonal volumetric allocation recommendation for each consent based on irrigation application method, soil type and rainfall (approx 610 mm/yr for spray irrigation and 1780 mm/yr for border dyke).

49. However, until such time as existing consents are reviewed to include seasonal volumetric rate there remains some doubt regarding the exact position surrounding the total seasonal volume currently allocated and with that, uncertainty surrounding the volume available for new consents. Setting that aside, the individual consent allocations prepared by Potts and Page and posted by ECan appear reasonable and form the bases for an appropriate consent review in due course.

50. Looking at Table 5 you will note that the 'Others' seasonal allocation of 158 Mm3/yr exceeds the Plan allocation limit of 150 Mm3/yr. I do not consider this to be of major issue since the Commissioners are in the position to restrict the seasonal limit on each new consent approved to 150/158 (or 95%) of the maximum sought. Should this be considered overly restrictive the parties concerned have recourse to apply for a Plan change.

Meridian's role in water management

51. At the HDI Hearing, I along with others, expressed the opinion that the hydrological regime at Waitaki Dam is no longer natural, a situation that has persisted since 1979 and the raising of Pukaki. Storage throughout the catchment is managed by Meridian primarily in the interests of national hydro power generation. This includes the capturing of higher than average flows in summer and autumn for release during the higher power demand winter and spring months.

52. Over recent years Meridian has actively promoted and supported local irrigation proposals. Depending on the outcome of these hearings, it faces the prospect of having to modify its storage management practise to meet reliability of supply expectations to existing and new irrigation throughout the Waitaki catchment, while at the same time meeting the intent and direction of the WAB Plan in respect of minimum flows at Waitaki Dam.

53. The mean flow of the Waitaki River at Kurow is about 370 m3/s while the mean annual low flow is about 207 M3/s. Meridian has the means and authority to manage storage within the Waitaki basin to meet a peak irrigation release requirement of 80 m3/s between October and March as per Rule 7 while meeting a minimum flow requirement of 150 m3/s between 'Waitaki Dam to the sea'.

54. At the HDI hearing, I presented detailed evidence with regard to irrigation water allocation and risk modelling. Those analyses were carried out based on 90 m3/s and 1250 Mm3/yr allocated to agricultural and horticultural use as prescribed in the WAP. I refer you to that previous evidence, and in particular, paragraphs 28-55.

55. In summary that analysis showed that:

    a) Under the existing 120 m3/s minimum flow situation (80 m3/s downstream from the lowermost take) existing consent holders authorised to take about 56 m3/s in total, enjoy a reliability of supply close to 100 %.

    b) With the WAP minimum flow of 150 m3/s from 'Waitaki Dam to the sea' that reliability is reduced to 97.5%.

    c) Adding the HDIS take of 20.5 m3/s to the existing take brings the peak rate to about 76.5 m3/s and with that the reliability is reduced from 97.5% to 96.2%.

    d) With a peak rate of 90 m3/s, including the applications under consideration at this Hearing, irrigation reliability for all irrigation is reduced to 95.1%. This is marginally better than the 95% required by Policy 46.

56. However, the lower Waitaki situation is unusual in so far that reliability of supply to existing and new irrigators within the 90 m3/s allocation limit, is able to be

maintained at close to 100% through the management of upstream storage controlled by Meridian. As stated previously, release of water to maintain irrigation reliability in itself is not lost generation opportunity; all it means is that Meridian may be required to exercise that generation potential at a less profitable time.

57. To satisfy the minimum flow involves very little adjustment, the worst case in the last 27 years being in 1989/90 when 2.2 Mm3 would have needed to be released to meet the 4 day shortfall in December 1989.

58. To satisfy projected shortfalls to meet irrigation demand with close to 100% certainty over and above the minimum flow of 150 m3/s involves on average 29.3 Mm3/yr, ranging from zero to 71.6 Mm3 (2003/04).

59. Were the reliability standard to be relaxed to include:

c) close to 100% for existing irrigators; and

d) 95% for HDIS and other irrigation;

then the volume shortfall required to be released by Meridian from storage would average about 15 Mm3/yr compared to 29.3 Mm3/yr for the total reliability standard.

60. To put these figures in perspective, the flow through Waitaki Dam averages about 11500 Mm3/year. Under the Plan, Meridian is required to manage that volume in a manner that preserves 4730 Mm3/yr for minimum flow and enables 1250 Mm3/yr to be taken for irrigation purposes. Taking into account that Meridian manages some 40000 cumec days (approximately 3500 Mm3) of active water storage in the upper Waitaki basin, any adjustments involving 75 Mm3/yr and less, necessary to meet occasional shortfalls in minimum flow and irrigation demand, appears relatively minor in the context of these total volumes.

61. Other than providing Meridian with a more flexible and less demanding water management regime, there appears to be no good reason to lower the minimum flow from 150 to 100 m3/s. My analysis shows that with appropriate storage management, Meridian is able to meet the minimum flow regime of 150 m3/s plus projected irrigation demands downstream from Waitaki Dam.

62. Were the Commissioners to decide that there should be equal priority among all irrigation takes (existing, HDIS and MRNAG applications) then I recommend that the following condition be included on the MRNAG consents.

63. Note this condition is drafted consistent for maximum cumulative take rate of 12 m3/s and 150 Mm3/year between Waitaki Dam and Black Point including takes from tributaries (i.e. Hakataramea, Maerewhenua, Otekaieke, etc) flowing into the Waitaki between the two sites. This is for the 150 m3/s minimum flow scenario.

Whenever the flow in the Waitaki River at Kurow (map ref. I40:079068) as estimated by the Canterbury Regional Council falls below 230 m3/s the taking of water from the Waitaki River catchment between Waitaki Dam (map ref. I40:060100) and Black Point (map ref. J40:345905) shall not exceed the total cumulative rate as calculated using the following formula:

*rate of take = (Flow at Kurow – 150) * 12/90*

or the total cumulative monthly maximum rates shown in the following table, whichever is the lesser.[6]

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
5	*6*	*9*	*10*	*10*	*10*	*5*	*3*

For the purposes of this condition, the flow at Kurow shall be the average flow recorded over the previous 24 hours as assessed at 9 am each day.

The Canterbury Regional Council will post on its website (www.ecan.govt.nz) any restrictions applying in respect of this condition together with percentage reduction in the maximum rate of take that consent holders are required to observe to comply with this restriction.

64. In the above condition, I have recommended that restrictions are based on the average flow recorded at Kurow over the previous 24 hour as opposed to the 1 hour rolling average specified within Rule 2 Table 3 xvii of the Plan. The record at Kurow is highly variable hour to hour dictated by power generation

[6] For existing consents the formula adjustment factor would be 56/90 instead of 12/90 and the respective monthly rates are 27, 38, 50, 52, 52, 52, 38 and 25 for Sept to Apr, respectively. For HDIS the factor is 20.5/90 and the monthly average rates of take are 8, 10, 16, 17, 17, 17, 9 and 5 respectively. (Refer Table 5)

timing and output decisions at Waitaki Power Station. Given that the time of travel of flow from Kurow to Black Point and the bulk of the irrigation abstraction is about 15-20 hours, and coupled with the fact that the variable flow regime released through Waitaki Dam is to some degree attenuated through in-river storage, I consider that the average over the previous 24 hours is an adequate measure for management purposes.

65. Should you decide that existing irrigators (totalling about 56 m3/s) are to retain priority and that MRNAG and HDIS (including Waihao Downs) have equal secondary priority then the above condition needs to read:

Whenever the flow in the Waitaki River at Kurow (map ref. I40:079068) as estimated by the Canterbury Regional Council falls below 230 m3/s the taking of water from the Waitaki River catchment between Waitaki Dam (map ref. I40:060100) and Black Point (map ref. J40:345905) shall not exceed the total cumulative rate as calculated using the following formula:

*i) rate of take = (Flow at Kurow – MMF) * 12/34*

[7] where the MMF for each month is as follows:

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
178	*188*	*202*	*202*	*202*	*202*	*188*	*175*

ii) or the monthly maximum rates shown in the following table, whichever is the lesser.

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
5	*6*	*9*	*10*	*10*	*10*	*5*	*3*

For the purposes of this condition, the flow at Kurow shall be the average flow recorded over the previous 24 hours as assessed at 9 am each day.

[7] Correction There is an error in paragraph 80.6 of my HDIS evidence previously presented. The formula should simply read: Rate of take= (flow at Kurow –MMF) as the intent of the condition is that HDIS has priority to any water in excess of that required to meet existing irrigation consent requirements plus a minimum flow of 150 m3/s. This differs from the situation set out in this condition which assumes the MRNAG and HDIS have equal priority and that any excess water is distributed proportionately.

The Canterbury Regional Council will post on its website (www.ecan.govt.nz) any restrictions applying in respect of this condition together with the percentage reduction in the maximum rate of take that consent holders are required to observe to comply with this restriction.

North Bank Tunnel

66. I have previously presented evidence with regard to NBTC and the following two paragraphs taken from that evidence summarises the major findings in relation to these applications.

67. Introduction of the NBTC will impact the hydrological character of the Waitaki River for some 34 km between Waitaki dam and Stonewall. Mean flow at Kurow is predicted to reduce from 364 m3/s to about 180 m3/s under the Waitaki Regional Plan (WRP) rules. Downstream from Kurow, tributary inflow will increase the mean flow by up to 14 m3/s[8] depending on the extent of abstractive use during the year. On this basis the mean flow immediately above Stonewall will likely be around 190 m3/s. Downstream from Stonewall and the discharge from the NB tunnel the mean flow reverts to about 364 m3/s.

68. About 51% of the available flow is diverted through the NB tunnel under the WRP compared to 55% under the AFR[9] rules. Under the latter scenario the flow diverted through the tunnel averages 200 m3/s as opposed to 184 m3/s under WRP rules, a difference of about 8%. This however translates to a lesser amount in lost power production since water not discharged through the NB tunnel continues to generate power through Waitaki Dam but through a much reduced head (21m instead of 128m).

69. I believe it is reasonable to conclude that abstraction between Waitaki Dam and Black Point is largely catered for through tributary inflow and that a minimum flow of 150 m3/s would continue to be maintained. There is no evidence to my knowledge to suggest any significant loss of surface flow to groundwater throughout this 35 km reach and based on this, any minimum flow established at Kurow will continue at or slightly above that level through to Black Point.

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[8] In evidence to these Hearings, Stewart concludes that the tributary contribution is about 13 m3/s.
[9] AFR (Alternative flow regime) is a minimum flow regime with the following monthly minimum flow (in m3/s) thresholds. Jun – Aug 110, Sep 120, Oct and Apr 125, Nov 130, Dec-Jan 140, Feb 150, Mar 145.

70. Should the Commissioners decide in favour of the NBTC application then the condition I have recommended for the MRNAG applications will need to be changed from that outlined previously in this affidavit. I would recommend the following:

Whenever the flow in the Waitaki River at Kurow (map ref. I40:079068) as estimated by the Canterbury Regional Council falls below 160 m3/s the taking of water from the Waitaki River catchment between Waitaki Dam (map ref. I40:060100) and Black Point (map ref. J40:345905) shall not exceed the total cumulative rate as calculated using the following formula:

rate of take = (Flow at Kurow -150)

or the maximum rate shown in the following table, whichever is the lesser.

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
5	*6*	*9*	*10*	*10*	*10*	*5*	*3*

All taking of water shall cease if the flow at Kurow is at or below 150 m3/s. For the purposes of this condition, the flow at Kurow shall be the average flow recorded over the previous 24 hours as assessed at 9 am each day.

The Canterbury Regional Council will post on its website (www.ecan.govt.nz) any restrictions applying in respect of this condition together with the percentage reduction in the maximum rate of take that consent holders are required to observe to comply with this restriction.

71. For those irrigation take sites between Black Point and the sea (i.e. LWIS, MGIS, HDIS etc) and assuming equal priority for both existing and new consent holders, the condition for this block of irrigators would need to read:

Whenever the flow in the Waitaki River at Black Point (map ref. J40:345905) as estimated by the Canterbury Regional Council falls below 230 m3/s the taking of water from the Waitaki River catchment between Black Point (map ref. J40:345905) and the sea shall not exceed the total cumulative rate as calculated using the following formula:

i) rate of take = (Flow at Black Point -150)

ii) or, the monthly maximum rates shown in the following table, whichever is the lesser.

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
35	*48*	*66*	*69*	*69*	*69*	*47*	*33*

The taking of water shall cease when the flow at Black Point is at or below 150 m3/s. For the purposes of this condition, the flow at Black Point shall be the average flow over the previous 24 hours at 9 am each day as estimated by the Canterbury Regional Council based on the following:

Flow at Black Point = Flow at Kurow + Flow through NBT

72. Should the Commissioners decide that existing irrigators should retain priority over HDIS and any new applicants, then for the existing irrigators group the same condition applies except that the thresholds shown in (ii) need to read:

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
27	*38*	*50*	*52*	*52*	*52*	*38*	*25*

73. For Hunter Downs were that to be approved with secondary priority the condition needs to read:

Whenever the flow in the Waitaki River at Black Point ((map ref. J40:345905) as estimated by the Canterbury Regional Council falls below 230 m3/s the taking of water from the Waitaki River catchment between Black Point (map ref. J40:345905) and the sea shall not exceed the rate as calculated using the following formula:

*i) rate of take = (Flow at Kurow – MMF) * 20.5/34*

where the MMF for each month is as follows:

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
178	*188*	*202*	*202*	*202*	*202*	*188*	*175*

ii) or the monthly maximum rates shown in the following table, whichever is the lesser.

Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*
8	*10*	*16*	*17*	*17*	*17*	*9*	*5*

Other Matters

a) Rivers and Tributaries

74. Referring to Rule 2 Table 3 in the WAP it has been noted that some rivers, for example the Upper Ohau River, are listed simply as the 'Upper Ohau River' as opposed to the Twizel River which is listed as the 'Twizel River and tributaries'. Some submitters have concluded that the difference in wording constitutes a definite intent by the Board to exclude tributaries from consideration and thus they seek to divorce the tributaries from the mainstem.

75. I do not support such a conclusion. By definition, a river exists as a consequence of flows from its tributaries. The flow in a tributary exists as the result of flows from its sub tributaries, and so on. A tributary in this context includes both surface and sub surface contributing streamflow. The Water Allocation Board recognises this in Policy 1 of the WAP.

76. To argue that consents issued on tributaries, say to the Hakataramea River for example, should be excluded from meeting any minimum flow regime on the Hakataramea (and indeed the Waitaki River), to me, is simply not sustainable. A take of 100 l/s irrespective of whether it is taken from a tributary still reduces the flow in the river by 100 l/s.

77. What constitutes the 'mainstem' as distinct from a 'tributary' is often ill defined. To allow for any real or perceived advantage to those abstracting from a tributary over those taking from the mainstem (whatever that is) only opens up argument as to the legal definition and constitution of the tributary concerned. I believe it is important that those taking from a tributary are captured by the same provisions as those taking from the mainstem.

78. From a water management point of view, I consider that all consents downstream from Waitaki Dam, whether on tributaries or not, should ideally be subject to the Waitaki Dam minimum flow provision. Those holding consent to take from say the Hakataramea River would need to comply with minimum flow provisions relating to the Hakataramea in addition to those relating to the Waitaki. Those seeking to take from a tributary of the Hakataramea could well

be subject to even another level of minimum flow provisions should the Regional Council consider that such additional provisions are necessary to protect the instream environment of the tributary. This may well be a condition consistent with that prescribed under Rule 2 Table 3 xxii (Other rivers and streams) of the Plan.

79. Only in this way is the Authority able to exercise integrated water management throughout the catchment.

SWORN at TIMARU)
by FRANK SCARF) _____
this day of August 2008) (FRANK SCARF)
before me:)

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A Solicitor of the High Court of New Zealand