
In the matter of: the Resource Management Act 1991

and

In the matter of: resource consent applications CRC050565, CRC050566
and CRC050567 for the purposes of a hydro-electricity
scheme

applicant: Clarkesfield Holdings (1996) Limited

submitter: Meridian Energy Limited

Brief of evidence of **Sioban Doreen Hartwell**

Dated: August 2008

BRIEF OF EVIDENCE OF SIOBAN DOREEN HARTWELL

QUALIFICATIONS AND EXPERIENCE

- 1 My full name is **Sioban Doreen Hartwell**
- 2 I am a Principal Water Resources Engineer with URS New Zealand Limited. I have over 18 years experience in surface water management and specialise in hydrological studies, erosion and sediment control design, flood risk studies and catchment management planning.
- 3 In the course of my work I have developed or had input to water balance models for a range of projects and river systems. Specifically I have prepared water balance models for the Globe Progress Mine (1994), Lake Rowlands Dam NSW (1998) the Opihi River (2006) the Martha Mine site (1997-2006) and the proposed Millerton Mine (2007).
- 4 I am authorised to give this evidence on behalf of Meridian Energy Limited (*Meridian*) in support of the Clarkesfield Holdings (1996) Limited (*Clarkesfield*) applications to construct a hydro-electricity scheme in the lower Waitaki River. Meridian is assisting Clarkesfield in giving evidence on the Clarkesfield hydro-scheme applications.
- 5 I have a degree in civil engineering from Birmingham University and am a chartered civil engineer.
- 6 In preparing my evidence I have reviewed:
 - 6.1 The Code of Conduct for Expert Witnesses;
 - 6.2 The application by Clarkesfield to take up to 4.2 cumecs for hydro-generation; and
 - 6.3 The material I referred to in my evidence presented as a part of the NBTC hearing.

SCOPE OF EVIDENCE

- 7 I have been asked to prepare evidence in relation to the effects of the proposed NBTC flow regime operating in tandem with the hydro-electricity scheme proposed by Clarkesfield on the water balance in the Lower Waitaki. This will confirm that the proposed Clarkesfield and NBTC schemes can operate independently and alongside each other – principally on the assumption that both schemes would

operate under the AFR with hydro regime in the event that NBTC was consented and constructed. I understand that Clarksfield as a primary position is seeking a 100 cumec minimum flow.

- 8 However, even under the current approach (100 cumecs) some discussion of the water balance model is necessary to ensure there is no effect on other abstractors.
- 9 My evidence is based on what I presented in support of NBTC and the report prepared by URS New Zealand Limited titled "*North Bank Tunnel Concept-Water Consents, Water Balance-Appendix 16*".
- 10 I have elected not to repeat the detail and modelling background I presented in respect of the NBTC hearing. This can be taken directly from my NBTC evidence which has been included as **Annexure 2**.
- 11 This evidence will instead be limited to a brief description of the overall water balance and the predicted effects of the Clarksfield hydro-electricity scheme operating alongside the Meridian NBTC project. The only NBTC regime referred to is the alternative AFR-with hydro.
- 12 The AFR-with hydro is considered by Meridian to be a regime that incorporates sustainable monthly operating flows for the lower Waitaki River between Waitaki Dam and BlackPoint. If NBTC is operational then this flow regime (with the addition of flushing flows) will be relatively constant throughout the year.

PROPOSED NBTC SCHEME

- 13 In order for the Clarksfield application to be assessed for compatibility alongside the NBTC it is necessary to briefly review the evidence associated with the Alternative Flow with Hydro regime (AFR) that was presented as a part of that hearing.
- 14 The values in Table 1 are minimum flows for the AFR. However, due to floods and high flow events that will occur on occasion, more water than the minimum flow will be discharged through Waitaki Power Station to the lower Waitaki River. Table 2 shows the values calculated by **Mr Henderson** for actual discharges to the river through the Waitaki power station.
- 15 The river would also be subject to at least 4 flushing flows per year of 450 m³/s to remove undesirable silt deposits and periphyton

growth. These were not included in the water balance assessment which is consistent with the NBTC NIWA Report.

- 16 It is also noted that Meridian has undertaken to provide some further flows over and above those proposed in Table 1 for downstream users (primarily during the irrigation season). These have also not been included in Table 2.

Table 1 Proposed Waitaki River Minimum Flows for the AFR with hydro

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Minimum Flow (m ³ /s)	110	110	120	125	130	140	140	150	145	125	120	110

Table 2: Mean and Medium flows under NBTC

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Mean river flow in m ³ /s	135	142	149	145	169	210	212	191	218	155	136	122
Median flows in m ³ /s	112	112	125	131	138	148	148	158	151	129	122	112

- 17 The Water Balance analysis I presented at the NBTC hearings demonstrated the gains and loses of water between Waitaki Dam and Stonewall. Included within this was a discussion of the effect of tributary inflows on the water balance and how the flow in the Waitaki River increases between Waitaki Dam and Black Point as these tributaries flows enter the river. My Water Balance model used the data summarised in Table 2 as an input. In my model I did include additional releases for downstream irrigators between Waitaki Dam and Black Point, as proposed by Meridian.

- 18 The tributary data was not, however, relied on in the ecological assessments in that part of the river. This means that there will be surplus or additional water that has not been considered by any of the scientists at the NBTC hearing above the AFR minimum flow due to high flow and flood flow events on occasion increasing flows through and over the dam and a consistent contribution from the tributaries between the Waitaki dam and Black Point.
- 19 The flow data for the main tributaries was based on recorded flows for the Otekaieke, Maerewhenua, and Awamoko Rivers. The Hakataramea River also has flow records covering most of the analysis period.
- 20 Where tributaries had gaugings but not continuous records of flow (Awakino, Malcolm's, Kurow and Otiake Rivers), the flow series was based on correlations with the flows in tributaries with flow recorders.
- 21 A summary of the model's tributary inputs is set out in **Annexure 1**.
- 22 In some cases recorded flows were only available for a portion of the period under consideration. In these cases the flow series was artificially extended using correlations between the record being considered and other catchments which do have records covering these periods.
- 23 The wider basis of the artificial records is described in my NBTC evidence. The characteristics of these flows are summarised in Table 3 following.

Table 3 Main Tributary Flow Statistics

	Hakataramea (SW4)	Awakino (SW3)	Kurow (SW5)	Otiake (SW7)	Otekaieke (SW9)	Maerewhenua (SW16)
Mean Daily Flow (l/s)	5442	1000	600	670	1100	3060
Median Daily Flow (l/s)	3125	422	380	440	620	160
Minimum Daily Flow (l/s)	500	330	120	150	81	74
Maximum Daily Flow (l/s)	515,235	30,350	38,270	42,150	80,840	241,537

- 24 None of the other minor tributaries have flow gaugings from which correlations with recorded flows could be developed. For these catchments the flow series is based on the available series with the closest matching characteristics in terms of topography, rainfall and geology; with the recorded flows being adjusted pro rata to catchment area and rainfall.
- 25 The basis of the artificial records is also described in my NBTC evidence.

CLARKESFIELD HYDRO SCHEME

- 26 Clarkesfield Holdings has submitted resource consent applications to provide for a continuous diversion of 4.2 m³/s in the reach between Priests Road and Duntroon. The approximate location of the diversion is shown on Figure 1 attached to my evidence.
- 27 I have used the water balance model to check the effects of this diversion on the flows in the main branch of the Waitaki River. The purposes of doing this is to demonstrate that even if the two schemes were subject to the same minimum flow regime there be sufficient additional water in the system to ensure that the NBTC AFR flow regime will be maintained in the Waitaki River between the Clarkesfield Holdings intake and outfall. My water balance model also includes irrigation abstractions from the river at the relevant locations between Waitaki Dam and Black Point and assumes their will be no effect on these existing and future takes.

- 28 For NBTC and the Clarkesfield scheme, the model indicates that for the AFR with hydro scheme there would be 5 days where the minimum AFR flow in the reach between the intake and outfall was not met. However for all of these days the flow calculated by the model was within 0.5 m³/s of NBTC AFR minimum flow. In my opinion these deficits fall well below the accuracy bounds I discussed in my NBTC evidence and can be discounted. For all other days in the 26 year period of record used in the record, sufficient additional water exists in this section of the river due to tributary inflows and high flow/flood flow events so that Clarkesfield can in all instances operate in tandem with the NBTC.
- 29 I have also considered the situation where Clarkesfield are operating and NBTC has not been constructed. Under these circumstances Clarkesfield are proposing a minimum flow of 100 cumecs. At this location in the river my analysis of the Water Balance model indicates that for the period of record sufficient flow occurs on all days to ensure that more than a minimum flow of 100 cumecs is maintained in the river between the Clarkesfield intake and outfall when the hydro scheme is operating and irrigation abstractions are occurring.

SUMMARY

- 30 The water balance analysis indicates sufficient water exists in the river upstream of Duntroon to provide for a diversion of 4.2 m³/s of flow to the proposed Clarksfield Holdings hydro-electricity scheme.
- 31 This is regardless of whether it is the NBTC AFR flow regime or the sought 100 cumec minimum flow that was attached to the Clarkesfield consent.
- 32 Overall, even if subject to the same flow restrictions, both schemes can operate independently of each other without undermining the water balance assessments undertaken for NBTC or the reliability of other irrigators while Clarkesfield is operating.

Dated: 2008

Sioban Hartwell

Annexure 1: Model Input Summary Tables

Table 1- Basis for Artificial/Extended Flow Series - Major Tributaries

	Period of Record	Artificial Record Period	Record used to Generate Artificial Flow Sequence	Relationship (l/s)
Hakataramea (SW4)	1 st January 1964 - 31 st December 2005	Nil		
Awakino (SW3)	Gaugings	1 st July 1979 - 31 st December 2005	Otekaieke	0.76 Otekaieke
Malcolm's (SW6)	Gaugings	1 st July 1979 - 31 st December 2005	Otekaieke	0.05 Otekaieke – 4
Kurow (SW5)	Gaugings	1 st July 1979 - 31 st December 2005	Otekaieke	0.49 Otekaieke + 70
Otiake (SW7)	Gaugings	1 st July 1979 - 31 st December 2005	Otekaieke	0.54 Otekaieke + 60
Otekaieke (SW9)	18 th December 1970 – 30 June 1995	1 st July 1995 – 31 st December 2005	Maerewhenua	0.40 Maerewhenua
Maerewhenua (SW16)	5 th March 1970 - 31 st December 2000	Small gaps, 1 January 2001 – 31 st December 2005	Otekaieke	2.5 Otekaieke

Table 2-Basis for Artificial/Extended Flow Series – Minor Tributaries

	Period of Record	Artificial Record Period	Record used to Generate Artificial Flow Sequence	Relationship (l/s)
Little Awakino (SW2)	Nil	1 st July 1979 to 31 st December 2005	Otekaieke (extended)	0.03 Otekaieke – 2
Waitoura/Doctors (SW 8)	Nil	1 st July 1979 to 31 st December 2005	Otekaieke (extended)	0.24 Otekaieke
Penticotico (SW 14)	Nil	1 st July 1979 to 31 st December 2005	Otekaieke (extended)	0.67 Awamoko
Grassy Hills (SW18)	Nil	1 st July 1979 to 31 st December 2005	Awamoko (extended)	0.07 Awamoko

Table 3-Minor Tributaries Flow Statistics

	Little Awakino (SW2)	Waitoura/Doctors (SW 8)	Penticotico (SW14)	Grassy Hills (SW18)
Mean Daily Flow (l/s)	30	270	70	10
Median Daily Flow (l/s)	20	17	30	3
Minimum Daily Flow (l/s)	3	10	0	0
Maximum Daily Flow(l/s)	2,340	18,710	6,460	680

Annexure 2: NBTC Evidence