Reviewed by:	*Approved for release by:*
Tim Davie Scientist Landcare Research	Alison Collins Science Leader Soil Landscape Responses

Contents

1. Background

This small project is a contribution to the economic assessment of the option of no water augmentation scheme being pursued for the Waimea Plains, but with the expectation that water rationing could be implemented to maintain a higher residual flow in the Waimea River of 800 litres per second.

The project developed a hydrological model based on 48 years of river flows at Wairoa Gorge to predict approximately when water rationing cuts of up to 50% of allocations would have been necessary to maintain that residual flow.

Model predictions for a 25-year drought (1982-83) and an average summer (2004-05) have then been passed to Agfirst Consultants (John Bealing) to estimate the production losses which could arise from irrigation restrictions on pasture, apples, and grapes/olives. Those losses are then factored into an overall economic assessment by Crighton Anderson & Co of the costs incurred for both irrigation and urban water use over a 20 year period.

2. Methods

The brief for the economic work dated 1 September 2006 (Appendix 1) is based on two main assumptions:

It is assumed that the over-allocation of water from the Waimea water system will increase over time, as a result of a future increase in the instream minimum flow requirements. The following assumptions are made:

- *That the current operative minimum instream requirement of 225 l/sec at the Appleby Bridge is increased to 800 l/sec*
- *That the allocation response to this is a reduction in security of supply (rather than reduction in water permits issued).*

The assumption behind the non-augmentation option is at the worst-case end of the spectrum of options. The assumption is that water rationing would be imposed on water users to maintain a minimum flow of 800 l/sec in the Waimea River. This flow has been adopted for the purposes of calculating the effects of the non-augmentation scenario for the economic assessment for the following reasons:

- The original and currently operative minimum flow requirement in the Waimea Water Management Plan was 225 l/sec, and this was raised to 500 l/sec when the Tasman Resource Management Plan (TRMP) water rules were notified in 2001. The 500 l/sec minimum flow target is still under contest by submitters.

- TDC now has ecological information that suggests that this flow is not adequate (the Waimea water augmentation study has identified more appropriate minimum flows in the range of 500 l/sec to 1300 l/sec measured at the Appleby Bridge).
- In the absence of the augmentation project it is reasonable to assume that at some stage in the future there may be a change to the TRMP minimum flow requirement.
- It appears reasonable to assume that such a process under the Resource Management Act would result in a compromise flow being adopted (somewhere between the existing figure and the range of recommended figures)
- 800 l/sec has been adopted for the purposes of the current assessment as being a probable outcome scenario.
- The moratorium on any further granting of water permits across the Waimea Basin is expected to continue.

The relationship between natural Wairoa Gorge river flows and the minimum flow down river in the Waimea River is not simple nor linear. It depends on factors including Wai-iti tributary inflows, groundwater pumpage, time of season and riverbed morphology. To understand these linkages, a groundwater flow model was developed for the Waimea Plains in the 1980s (Fenemor, 1988) and has since been upgraded for 2001 conditions (Hong, 2003). While the resources required were beyond the scope of this project, the groundwater model could be calibrated over a longer period and run to simulate Waimea River low flows under current irrigation and no irrigation scenarios to give a detailed assessment of likely frequency of water rationing. A simpler modelling approach has been adopted here, recognizing that the error margins in this estimation are probably similar to those associated with the economic analysis itself.

The natural flow record for Wairoa Gorge has been used to generate a spreadsheet of periods when rationing is predicted to have been at Step 1 (20% cut in allocations), Step 2 (35% cut in allocations) and Step 3 (50% cut in allocations) for the entire period of record from 1958 to 2006.

3. Assumptions

The model has been built based on these assumptions:

1. The GNS groundwater model indicates based on 1982-83 and 2000-01 data that a river flow of 800 l/sec near Appleby corresponds roughly to a Wairoa Gorge flow of 2800 l/sec. This is a very approximate assumption for the reasons given above.

2. Rationing would be triggered, in accordance with the current TDC 3-step rationing regime, whenever Wairoa Gorge flow falls below 3000 l/sec. The buffer between the 3000 l/sec trigger and the 2800 l/sec target for maintaining 800 l/sec downstream is small, of the order of 1-2 days flow recession. Based on typical flow recession curves for Wairoa Gorge, to allow 2 weeks lead-in for a target flow of 2800 l/sec would require rationing to be triggered somewhere in the range of flows 4200-5800 l/sec. These flows occur so often in summer that it is considered unlikely that the Council would set such a high rationing trigger.

3. Rationing is assumed to operate in a similar manner to the current regime, whereby Step 1 lasts 2 weeks, Step 2 lasts 2 weeks, and Step 3 is ongoing for as long as natural Wairoa Gorge flow remains below 3000 l/sec. It is likely under prolonged drought conditions that Step 3 (50%) rationing would not be sufficient to retain a minimum flow of 800 l/sec and that the Council would in those situations impose even higher rationing cuts – probably up to 100% - if it wanted to maintain the 800 l/sec minimum. Such draconian cuts may not be implemented, which is why the assumption of ongoing Step 3 (50%) cuts has been adopted.

4. Having run the model to generate a timeseries of rationing periods, all those of less than 24 hours duration have been ignored. These largely arise because of fluctuations in the original chart recorded flow data which are not real. Also rationing is normally only triggered after ongoing declines in river flows of more than just a day.

5. The irrigation season runs November-April inclusive so any cuts predicted outside this period are ignored.

4. Results

The spreadsheet of cuts for the entire 48 years of flow data is attached in Appendix 2 as *Modelled Water Rationing Steps based on Wairoa Gorge flows for 1958-2006*. Columns in the spreadsheet are:

Date and time of end of this period of rationing
Duration of this whole period of rationing (hrs)
Maximum rationing step reached (1,2 or 3)
Three columns showing Start date and time for this rationing step and mean Wairoa Gorge flow during that step, for Steps 1, 2, and 3 if reached in that event.

This data could be used to assess potential economic losses arising for these levels of rationing over any period of up to the full 48 years of record.

The brief calls for analysis for 1982-83 (a 25-33 year drought[1]), or 2000-01 (a 27-85 year drought) plus an average summer. For the average summer, 2004-05 has been selected. Modelled rationing for these three summers has been extracted from Appendix 2 to provide this summary data for the economic analysis:

Table 1: Modelled Water Rationing for 1982-83, 2000-01 and 2004-05 summers

Date that the period ended	Rationing duration (total days for this period if>24hrs)	Max rationing step reached	Date start rationing Step 1 (20%) yymmdd	Date start rationing step 2 (35%) yymmdd	Date start rationing step 3 (50%) yymmdd

[1] Fenemor 2006: Waimea Water Augmentation Project: Review of Catchment Modelling and Storage Requirement. Landcare Research Contract Report LC0304/103 for Tonkin and Taylor Ltd.

11/11/1982	8	1	821104		
19/11/1982	5	1	821114		
27/11/1982	7	1	821120		
29/11/1982	2	1	821127		
12/12/1982	12	1	821130		
21/12/1982	6	1	821215		
25/12/1982	1	1	821224		
5/01/1983	7	1	821229		
13/01/1983	4	1	830109		
29/03/1983	60	3	830128	830211	830225
7/04/1983	8	1	830330		
14/04/1983	3	1	830412		
10/12/2000	*5*	*1*	*001206*		
28/12/2000	*2*	*1*	*001225*		
16/01/2001	*3*	*1*	*010113*		
26/01/2001	*8*	*1*	*010118*		
3/04/2001	*66*	*3*	*010127*	*010210*	*010224*
22/04/2001	*17*	*2*	*010404*	*010418*	
11/02/2005	2	1	050209		
7/03/2005	3	1	050303		
25/03/2005	12	1	050313		

5. Conclusions and Interpretation

Based on this model, the total days of water rationing days would have been 123 days in the 1982-83 summer, 101 days in 2000-01 and 17 in the average 2004-05 summer. Note that the higher frequency drought of 2000-01 would have had slightly fewer days of rationing because of the pattern of rainfalls during that period, but it would have had longer at Step 3 50% restrictions (which started on almost the same day at the end of January).

The brief calls for comment on what other responses the Council could implement in the event of water augmentation not proceeding. In order of economic impact, I consider these to be:

- Adopt the currently proposed 500 l/sec target minimum flow for the Waimea River, with water users faced with the continuing lower level of supply security than they would like.
- Carry out a 'bona fide' review of all water permits across the Waimea Plains to remove all unused allocations and reduce allocation limits accordingly (i.e. no re-allocation, but a slight increase in supply security for water users)
- An across-the-board reduction in allocations on water permits to achieve an agreed level of supply security which is higher than currently, in conjunction with implementation of a flexible water trading regime to allow transfers to highest value water uses
- Investigation and implementation of smaller scale water augmentation measures, such as the building of rock weirs in the Wairoa and Waimea Rivers to enhance aquifer recharge and storage; artificial aquifer recharge via pumped recharge wells; construction of Motutere Gravel gully dams for water augmentation in sites already investigated including Teapot Valley, and possibly Eves Valley.

6. References

Fenemor, A.D. 1988. A Three-dimensional Model for Management of the Waimea Plains Aquifers, Nelson. Publication No. 18 of DSIR Hydrology Centre, 133 pp.

Hong, T. 2003 Effects of abstraction on groundwater levels and river flows in the Waimea Plains: modelling and management scenario simulations for droughts inclusive of various Waimea East Irrigation Scheme (WEIS) pumping scenarios. Client report 2003/69 for Tasman District Council. Institute of Geological and Nuclear Sciences Ltd. 27pp.

7. Acknowledgements

Thanks to Martin Doyle, hydrologist at Tasman District Council for providing the flow data, and processing it using the Tideda process PSIM. Thanks also to Sally Marx at Tonkin and Taylor in Wellington for comments on the draft report.

Appendix 1 Project Brief (Sally Marx, Tonkin & Taylor Ltd)

SCOPE OF ECONOMIC ASSESSMENT

To assist Tonkin & Taylor (T&T) to undertake a feasibility study for the Waimea Water Augmentation Committee (WWAC) of water augmentation in the Waimea Catchment, Tasman District.

Specifically to undertake a high-level economic analysis of the preferred water harvesting and storage option, as follows.

The work involves working closely with T&T on the project in a collaborative way and to T&T's direction.

1. Objective

To provide an economic analysis of the preferred water storage option to enable a determination of the economic feasibility of the augmentation project, with particular emphasis on the indicative cost of water on a per hectare basis. The assessment is also to estimate (high level estimation) the economic implications of no augmentation (ie should the project not proceed).

2. Background

WWAC is undertaking a study into potential water storage reservoirs to augment flows in the Waimea River for irrigation and instream demands. Following a staged selection process, WWAC decided in August 2006 to focus future investigations on Site 11 – Upper Lee River (grid reference N28: 234715).

T&T will now complete an indicative capital costing for the project (including infrastructure replacement). This information will be provided to Crighton Anderson to enable the economic analysis to be completed.

3. Scope of Work

3.1 Augmentation

Scope

The analysis is to identify:

- The cost of the project expressed per hectare of irrigable land. This is to be presented for four cases covering:
  - ➢ Existing irrigated area
  - ➢ Existing plus potential new irrigated area
  - ➢ Each of the above two cases incorporating a provision for 'future regional water need'

- The effects of incorporating depreciation in the above costings; ie the cost per hectare with and without depreciation

- The costs per hectare for the above cases assuming consumptive users pay for the entire scheme, compared with cost per hectare assuming a split payment (consumptive users pay for consumptive portion; community pays for environmental flows)

- The options for ownership and operating structure for the irrigation scheme, and the impacts of the alternatives on indicative irrigation costs.

Note: the analysis **excludes**:

- an assessment of on-farm benefits

- an assessment of district or regional economic effects arising from the scheme.

Information Provision/Task Responsibility

- Land purchase costs for scheme development (TDC)
- Current irrigated area, by 3-4 crop types (AgFirst – received)
- New irrigable areas, by 3-4 crop types (AgFirst – received)
- Provision for future regional needs (TDC – received)
- Construction costs (including infrastructure replacement) (T&T – A Pickens)
- Construction timeframe (T&T – A Pickens)
- Proportion of water demand required for consumptive use cf proportion for environmental flows (T&T – D Leong)

3.2 Non-augmentation ("do-nothing" scenario)

Scope

It is assumed that the over-allocation of water from the Waimea water system will increase over time, as a result of a future increase in the instream minimum flow requirements. The following assumptions are made:

- That the current minimum instream requirement of 500 l/sec at the Appleby Bridge is increased to 800 l/sec

- That the allocation response to this is a reduction in security of supply (rather than reduction in water permits issued)

The economic assessment of the non-augmentation scenario is to:

- Assess the change in value of production from the currently irrigated area of the Waimea Plains that would result from the above assumptions (ie from the more limited irrigation scenario).

- This assessment is to be based on the hydrological record of two summer periods:

    - Either the 1982/83 summer or 2000/01 summer (representing drought conditions)

- An 'average' summer.

- From these hydrological records, identify when flow restrictions would commence, at what level of restriction, and for what duration.

- Based on the above restrictions, evaluate the potential loss in income (based on production quantity and quality) for three crops (pasture, apples, grapes/olives). Validating these losses may require consultation with an irrigator in each landuse category.

- The resulting aggregate losses over a 20 year period are to be assessed.

- Assess the approximate restriction in economic growth rate arising from no additional provision for water for future urban supply from the augmentation scheme.

- Report the assumptions made in the above analysis.

- Brief comment on what other response options may exist (ie alternatives to accepting instream flow requirement of 800 l/sec).

Information Provision/Task Responsibility

- Capital cost of planting range of crops (AgFirst)
- Current $/hectare produced by various crops (AgFirst)
- Hydrological modelling (A Fenemor in conjunction with TDC hydrologist)
- Identification of when flow restrictions would commence at what level of restriction, and for what duration(AgFirst)
- Evaluation of losses in income (AgFirst)
- Assessment of aggregate losses based on above (Crighton Anderson)

4. Information Provision

The information noted above is to be provided to Crighton Anderson (via the Project Manager Sally Marx) by each of the nominated parties.

5. Output

The output from this work will be a report prepared by Crighton Anderson outlining the work undertaken, methods used, and the results, including a summary and comparative evaluation of the various cases.

The report should also outline any recommendations for further work that may be required to confirm or quantify the analysis.

Appendix 2 Modelled Water Rationing Steps based on Wairoa Gorge flows for 1958-2006

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
22/04/1958 02:00	301	1	580409	140000	2732						
29/01/1959 18:00	101	1	590125	140000	2857						
10/02/1959 01:00	223	1	590131	190000	2571						
20/02/1959 20:00	138	1	590215	30000	2573						
8/03/1959 17:00	351	2	590222	30000	2241	590308	30000	2060			
1/12/1959 00:00	92	1	591127	50000	2756						
6/12/1959 04:00	95	1	591202	60000	2666						
8/12/1959 17:00	46	1	591206	200000	2833						
5/01/1960 10:00	40	1	600103	190000	2901						
25/01/1960 03:00	403	2	600108	90000	2581	600122	90000	2382			
9/03/1960 01:00	308	1	600225	60000	2474						
17/12/1960 14:00	63	1	601214	240000	2866						
30/12/1960 03:00	185	1	601222	110000	2477						
17/01/1961 09:00	393	2	610101	10000	2198	610115	10000	1827			
28/02/1961 01:00	22	1	610227	40000	2851						
25/10/1961 16:00	44	1	611023	210000	2862						
13/12/1961 09:00	60	1	611210	220000	2690						
30/12/1961 13:00	399	2	611213	230000	2060	611227	230000	1729			

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
12/02/1962 05:00	62	1	620209	160000	2738						
17/02/1962 06:00	96	1	620213	70000	2754						
3/03/1962 20:00	337	1	620217	200000	2096						
7/04/1962 00:00	47	1	620405	20000	2934						
9/04/1962 22:00	40	1	620408	70000	2838						
26/12/1962 11:00	70	1	621223	140000	2766						
7/01/1963 03:00	105	1	630102	190000	2725						
8/02/1963 21:00	548	2	630117	20000	2218	630131	20000	2036			
27/03/1963 08:00	40	1	630325	170000	2771						
5/11/1963 12:00	86	1	631101	230000	2285						
26/11/1963 00:00	94	1	631122	30000	2685						
2/12/1963 22:00	135	1	631127	80000	2183						
2/01/1964 09:00	647	2	631206	110000	2055	631220	110000	1634			
8/01/1964 05:00	112	1	640103	140000	1990						
18/02/1964 20:00	447	2	640131	60000	2167	640214	60000	1891			
27/02/1964 09:00	143	1	640221	110000	2377						
27/04/1964 02:00	640	2	640331	110000	2325	640414	110000	1779			
1/11/1965 12:00	35	1	651031	20000	2933						
29/03/1966 16:00	303	1	660317	20000	2540						
1/03/1967 04:00	241	1	670219	40000	2665						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
10/03/1967 09:00	188	1	670302	140000	2537						
23/03/1967 19:00	46	1	670321	220000	2757						
8/02/1968 11:00	47	1	680206	130000	2871						
1/03/1968 06:00	198	1	680222	10000	2597						
8/03/1968 17:00	174	1	680301	120000	2326						
1/04/1968 07:00	55	1	680330	10000	2885						
25/03/1969 14:00	44	1	690323	190000	2935						
3/04/1969 12:00	145	1	690328	120000	2699						
11/11/1969 05:00	66	1	691108	120000	2868						
21/11/1969 08:00	27	1	691120	60000	2870						
28/02/1970 08:00	680	3	700131	10000	2539	700214	10000	1632	700228	10000	2010
7/03/1970 17:00	55	1	700305	110000	2736						
14/12/1970 09:00	129	1	701209	10000	2832						
4/01/1971 13:00	408	2	701218	140000	2631	710101	140000	2613			
1/02/1971 08:00	337	1	710118	80000	2427						
23/02/1971 07:00	512	2	710201	240000	1983	710215	240000	1680			
25/03/1971 11:00	225	1	710316	30000	2570						
13/04/1971 13:00	275	1	710402	30000	2386						
21/12/1971 02:00	93	1	711217	60000	2812						
31/12/1971 07:00	229	1	711221	190000	2532						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
29/01/1972 05:00	107	1	720124	190000	2901						
24/02/1972 23:00	487	2	720204	170000	2426	720218	170000	1972			
4/03/1972 22:00	187	1	720226	40000	1783						
24/03/1972 21:00	99	1	720320	190000	2743						
17/12/1972 17:00	53	1	721215	130000	2870						
11/01/1973 18:00	60	1	730109	70000	2724						
4/03/1973 08:00	1197	3	730113	120000	2484	730127	120000	1910	730210	120000	1412
10/03/1973 09:00	56	1	730308	20000	2442						
16/03/1973 09:00	130	1	730310	240000	2079						
20/04/1973 18:00	829	3	730317	60000	1910	730331	60000	1451	730414	60000	1559
22/10/1973 07:00	147	1	731016	50000	2592						
18/12/1973 07:00	96	1	731214	80000	2579						
24/01/1974 07:00	58	1	740121	220000	2888						
4/02/1974 19:00	254	1	740125	60000	2198						
15/03/1974 19:00	94	1	740311	220000	2681						
3/04/1974 15:00	345	2	740320	70000	2287	740403	70000	1935			
9/01/1975 03:00	406	2	741223	60000	2529	750106	60000	2266			
16/01/1975 02:00	130	1	750110	170000	2369						
19/01/1975 13:00	27	1	750118	110000	2667						
9/01/1976 12:00	84	1	760106	10000	2765						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
22/03/1976 20:00	201	1	760314	120000	2728						
28/03/1976 14:00	72	1	760325	150000	2772						
10/04/1977 11:00	244	1	770331	80000	2795						
4/02/1978 20:00	238	1	780125	230000	2637						
16/02/1978 16:00	234	1	780206	230000	2380						
3/03/1978 03:00	315	1	780218	10000	2160						
19/03/1978 22:00	383	2	780303	240000	1981	780317	240000	1923			
28/03/1978 05:00	184	1	780320	140000	2143						
14/04/1978 21:00	319	1	780401	150000	2302						
7/12/1978 04:00	28	1	781206	10000	2997						
28/01/1979 07:00	172	1	790121	40000	2663						
5/02/1979 04:00	141	1	790130	80000	2516						
15/02/1979 00:00	151	1	790208	180000	2540						
15/03/1979 20:00	200	1	790307	130000	2783						
20/01/1981 13:00	523	2	801229	190000	2499	810112	190000	2005			
2/03/1981 22:00	888	3	810124	230000	2181	810207	230000	1665	810221	230000	1410
8/03/1981 20:00	97	1	810304	200000	2344						
19/02/1982 07:00	464	2	820130	240000	2510	820213	240000	2009			
24/02/1982 03:00	82	1	820220	180000	2444						
24/03/1982 02:00	223	1	820314	200000	2634						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
31/03/1982 12:00	169	1	820324	120000	2265						
29/04/1982 19:00	143	1	820423	210000	2709						
11/11/1982 23:00	186	1	821104	60000	2620						
19/11/1982 18:00	119	1	821114	200000	2547						
27/11/1982 03:00	166	1	821120	60000	2259						
29/11/1982 17:00	42	1	821127	240000	2542						
12/12/1982 00:00	279	1	821130	100000	2374						
21/12/1982 10:00	152	1	821215	30000	2406						
25/12/1982 21:00	28	1	821224	180000	2872						
5/01/1983 08:00	162	1	821229	150000	2490						
13/01/1983 07:00	103	1	830109	10000	2488						
29/03/1983 14:00	1434	3	830128	210000	2269	830211	210000	1714	830225	210000	1488
7/04/1983 12:00	185	1	830330	200000	1631						
14/04/1983 17:00	61	1	830412	50000	2651						
15/11/1984 10:00	70	1	841112	130000	2899						
18/04/1985 22:00	670	2	850322	10000	2705	850405	10000	2410			
26/04/1986 02:00	50	1	860424	10000	2855						
12/02/1987 10:00	50	1	870210	90000	2746						
23/02/1987 22:00	54	1	870221	170000	2767						
2/03/1987 17:00	67	1	870227	230000	2761						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
9/03/1987 21:00	106	1	870305	120000	2565						
3/02/1988 06:00	108	1	880129	190000	2643						
23/03/1989 21:00	133	1	890318	90000	2669						
15/01/1990 15:00	72	1	900112	160000	2875						
17/01/1990 11:00	44	1	900115	160000	2703						
29/01/1990 09:00	113	1	900124	170000	2716						
8/02/1990 14:00	79	1	900205	80000	2763						
10/03/1990 01:00	679	3	900209	190000	2338	900223	190000	1710	900309	190000	2681
20/03/1990 01:00	36	1	900318	140000	2824						
9/04/1990 16:00	353	2	900325	240000	2251	900408	240000	2466			
18/04/1990 17:00	200	1	900410	100000	2227						
24/04/1990 00:00	109	1	900419	120000	2458						
11/11/1990 21:00	52	1	901109	180000	2884						
7/01/1991 20:00	99	1	910103	180000	2642						
16/01/1991 18:00	152	1	910110	110000	2423						
21/01/1991 05:00	68	1	910118	100000	2700						
14/03/1991 09:00	161	1	910307	170000	2676						
27/03/1991 18:00	240	1	910317	190000	2494						
3/04/1991 03:00	58	1	910331	180000	2811						
27/11/1991 04:00	93	1	911123	80000	2665						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
29/12/1991 21:00	152	1	911223	140000	2459						
8/03/1992 10:00	90	1	920304	170000	2797						
16/03/1992 16:00	124	1	920311	130000	2492						
12/02/1993 09:00	138	1	930206	160000	2649						
20/02/1993 21:00	198	1	930212	160000	2364						
30/03/1993 12:00	36	1	930329	10000	2955						
27/08/1993 17:00	68	1	930824	220000	2794						
4/09/1993 06:00	106	1	930830	210000	2784						
20/02/1994 04:00	319	1	940206	220000	2306						
21/04/1994 10:00	152	1	940415	30000	2754						
26/04/1994 13:00	61	1	940424	10000	2646						
30/12/1994 15:00	99	1	941226	130000	2859						
8/01/1995 20:00	179	1	950101	100000	2384						
19/01/1995 17:00	93	1	950115	210000	2651						
22/01/1995 18:00	53	1	950120	140000	2535						
30/12/1996 22:00	93	1	961227	20000	2847						
11/01/1997 03:00	218	1	970102	20000	2573						
19/01/1997 21:00	45	1	970118	10000	2873						
4/02/1997 21:00	361	2	970120	210000	2218	970203	210000	2360			
11/02/1997 17:00	58	1	970209	80000	2709						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
24/02/1997 13:00	256	1	970213	220000	2229						
6/03/1997 03:00	132	1	970228	160000	2426						
22/03/1997 00:00	209	1	970313	80000	2481						
6/04/1997 13:00	108	1	970402	20000	2787						
8/04/1997 10:00	32	1	970407	30000	2714						
15/11/1997 16:00	426	2	971028	230000	2564	971111	230000	2370			
29/11/1997 09:00	199	1	971121	30000	2344						
16/12/1997 10:00	292	1	971204	70000	2188						
20/12/1997 22:00	44	1	971219	30000	2720						
16/01/1998 19:00	194	1	980108	180000	2528						
23/01/1998 17:00	145	1	980117	170000	2311						
28/01/1998 12:00	98	1	980124	110000	2553						
14/02/1998 01:00	232	1	980204	100000	2273						
17/02/1998 11:00	58	1	980215	20000	2385						
23/04/1998 17:00	64	1	980421	20000	2824						
14/01/1999 08:00	224	1	990105	10000	2653						
31/01/1999 02:00	62	1	990128	130000	2911						
20/02/1999 22:00	216	1	990211	230000	2618						
27/02/1999 01:00	130	1	990221	160000	2304						
5/03/1999 18:00	35	1	990304	80000	2874						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
30/03/2000 09:00	40	1	000328	180000	2948						
2/04/2000 19:00	25	1	000401	190000	2896						
10/12/2000 23:00	119	1	001206	10000	2766						
28/12/2000 06:00	57	1	001225	220000	2799						
16/01/2001 16:00	74	1	010113	150000	2818						
26/01/2001 07:00	180	1	010118	200000	2474						
3/04/2001 03:00	1579	3	010127	90000	2028	010210	90000	1664	010224	90000	1432
22/04/2001 02:00	417	2	010404	180000	1524	010418	180000	1328			
15/03/2002 00:00	176	1	020307	170000	2705						
18/03/2002 16:00	82	1	020315	70000	2586						
30/03/2002 08:00	39	1	020328	180000	2940						
6/04/2002 08:00	119	1	020401	100000	2585						
25/04/2002 04:00	347	2	020410	180000	2334	020424	180000	2307			
21/05/2002 18:00	304	1	020509	30000	2418						
20/02/2003 03:00	544	2	030128	120000	2304	030211	120000	1997			
3/03/2003 09:00	253	1	030220	210000	1974						
29/03/2003 17:00	555	2	030306	150000	1929	030320	150000	1663			
24/12/2003 02:00	156	1	031217	150000	2666						
28/12/2003 07:00	89	1	031224	150000	2516						
7/01/2004 03:00	145	1	040101	30000	2436						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
19/01/2004 14:00	140	1	040113	190000	2465						
28/01/2004 06:00	137	1	040122	140000	2377						
8/04/2004 09:00	79	1	040405	30000	2915						
11/02/2005 16:00	45	1	050209	200000	2890						
7/03/2005 02:00	79	1	050303	200000	2733						
25/03/2005 02:00	286	1	050313	50000	2560						
25/10/2005 07:00	73	1	051022	70000	2858						
31/10/2005 04:00	129	1	051025	200000	2493						
7/11/2005 08:00	154	1	051031	230000	2304						
15/11/2005 04:00	185	1	051107	120000	2102						
21/11/2005 17:00	125	1	051116	130000	2255						
24/11/2005 16:00	48	1	051122	170000	2520						
6/12/2005 22:00	256	1	051126	70000	2076						
10/12/2005 03:00	62	1	051207	140000	2189						
15/12/2005 02:00	98	1	051211	10000	2618						
4/01/2006 07:00	181	1	051227	190000	2475						
14/01/2006 10:00	193	1	060106	100000	2263						
19/01/2006 02:00	100	1	060114	230000	2179						
24/01/2006 21:00	94	1	060120	240000	2302						
6/02/2006 04:00	57	1	060203	200000	2827						

Date and time that the period ended	Duration of Rationing (hours, for periods >24hrs)	Max Rationing step reached (1=20% cut; 2=35% cut; 3=50% cut)	Date Start (yymmdd)	Time Start (hhmmss)	Mean flow rationing Step 1 (l/sec)	Date start Step 2 start	Time start Step 2 start	mean flow rationing Step 2	Date start Step 3	Time start Step 3	mean flow rationing Step 3
8/02/2006 08:00	30	1	060207	30000	2669						
3/04/2006 05:00	882	3	060225	120000	2279	060311	120000	1842	060325	120000	1700
7/04/2006 07:00	29	1	060406	30000	2698						