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DAVIS OGILVIE
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MEMORANDUM

To: Otago Regional Council

From: Ian Lloyd, Davis Ogilvie

Date: 21 May 2021

Subject: Manuherekia Hydrology Model – Scenario Memorandum – Final Draft

1.0 BACKGROUND

This Scenario Memorandum was originally developed to provide initial output from the Manuherekia Hydrology Model to facilitate discussion by the Otago Regional Council (ORC). It describes the various scenarios developed by ORC which have been run through the model and provides the requested hydrological model output from those model runs.

Earlier drafts of this Scenario Memorandum dated 12, 16 and 23 February 2021, 19 March 2021 and 16 April 2021, were circulated. This Scenario Memorandum updates and replaces the earlier drafts based on feedback received from ORC including various requests to undertake additional scenarios.

The Manuherekia Hydrology Model is to be documented in a formal model report. However, as at 21 May 2021 the model report had not been commissioned. It is anticipated that the contents of this Scenario Memorandum will feed into the Model Report.

The ORC are in the process of developing a Water Management Plan for the Manuherekia Catchment and have developed various consultation documents which are scheduled for release on 21 May 2021. In the absence of a Model Report, this Scenario Memorandum along with two other memorandums[1] have been updated in order to provide background to ORC's consultation documents. It is noted that the three memorandums were originally produced as internal documents to facilitate discussion and provide model output. They were not intended to be public documents and as such all three updated memorandums continue to be issued as drafts. The Model Report will be the official documentation of the model.

This Scenario Memorandum updates and replaces the earlier draft dated 16 April 2021. It has been reviewed internally by Davis Ogilvie but has not been reviewed or formally adopted by the Manuherekia Hydrology Group. At the time of updating this Scenario Memorandum (21 May 2021) the Manuherekia Hydrology Model has not been documented, reviewed nor has it been formally adopted or approved by the Manuherekia Hydrology Group.

[1] A Calibration Memorandum (dated 21 May 2021) which briefly describes the model build process and model calibration / verification, and an Ecological Memorandum (dated 21 May 2021) which discusses ecological aspect of the Manuherekia Hydrology Model and provides ecological output from the model.

2.0 MODEL BUILD

Development of the Manuherekia Hydrology Model was informed by the model scoping document dated 6 July 2020. Details of the model build and the calibration/verification process are briefly outlined in a memorandum entitled "*Manuherekia Hydrology Model – Calibration Memorandum – Final Draft*" dated 21 May 2021. Details of the ecological parts of the model and various ecological output from the model are provided in a memorandum entitled "*Manuherekia Hydrology Model – Ecological Memorandum – Final Draft*" dated 21 May 2021.

3.0 MODEL SCENARIOS

In addition to the calibration run (called Estimated Existing or Status Quo in the model) the ORC initially requested that eight scenarios (seven future water management scenarios based on differing minimum flows at Campground namely *"900", "1200", "1500", "1700", "2000", "2500"* and *"3000",* plus a *"Full Dams and No Irrigation*" scenario) be run through the Manuherekia Hydrology Model. Following a Manuherekia Reference Group (MRG) meeting on the 4 and 5 March 2021 ORC requested that the following additional future scenarios be run:

1. Various scenarios to assess the implications of the current Falls Dam management practices of:
    (a). Imposing voluntary irrigation restrictions on irrigators in the Manuherekia Valley in order to retain storage in Falls Dam.
    (b). Using storage in Falls Dam to augment minimum flows at Campground.

In preparation for an ORC Manuherekia Flow Regime and Allocation meeting held on 25 March 2021 ORC requested that the following additional scenarios be run:

1. Various scenarios to assess the implications of the following components of a potential Manuherekia Flow and Allocation regime:
    (a). Minimum flow.
    (b). Residual flow.
    (c). Flow sharing.
    (d). Allocation.

The requested additional future scenarios resulted in a total of 29 scenarios (excluding the calibration run (called Estimated Existing or Status Quo in the model) being assessed. Scenario details are briefly provided below.

- The area irrigated remains the same for all scenarios, other than for the *"Full Dams and No Irrigation"* scenario and the four scenarios that assess allocation. In the *"Full Dams and No Irrigation"* scenario there is no irrigation anywhere in the catchment although Mt Ida Race remains operational. For two of the four scenarios which assess allocation, the area irrigated in the Lauder catchment was reduced. For the remaining two scenario the unit irrigation demand for the Manuherekia Valley was reduced which has a similar effect as reducing the irrigated area.
- Flow sharing is only applied to one scenario related to Lauder Creek.

- In all the scenarios supply priority is given to minimum flows and residual flows over irrigation.
- Storage in Falls Dam is used to supplement downstream main stem minimum flows in 20 of the 29 scenarios.
- Management imposed irrigation restrictions based on storage in Falls Dam are applied to nine of the scenarios namely *"900", "1200", "1500", "1700", "2000", "2500", "3000"* and the two scenarios that assess allocation over the whole Manuherekia Valley. The management imposed irrigation restrictions are imposed on all irrigation within the Manuherekia Valley other than Crawford Hills and that part of the Galloway Scheme supplied from the Manor Burn.
- The Ida Burn, Pool Burn and Manor Burn sub-catchments remain the same for all the scenarios and these sub-catchments have no minimum flows or residuals. This does not apply to *"Full Dams and No Irrigation"* scenario for which there is no irrigation anywhere in the catchment.
- For 18 of the scenarios (i.e. all scenarios other than "*900*", *"Full Dams and No Irrigation"*, four of the 13 future scenarios designed to assess the effect of Falls Dam management practices and five of the eight future scenarios designed to assess components of the flow and allocation regime), ORC requested flow proportional minimum flows for the Dunstan, Lauder, Thomsons and Chatto Creek tributaries. The flow proportional minimum flows were estimated using the relative contribution of the four tributaries to flow at Campground as derived from modelled 5th percentile flows under the *"Full Dams and No Irrigation"* scenario and assuming all other tributaries do no contribute to flow at Campground.

Table 1: Manuherekia Hydrology Model Scenarios – Requested by ORC

Mode Run / Scenario		Total irrigated area	Falls Dam outlet restrictions	Falls Dam irrigation restrictions	Falls Dam storage used to supplement minimum flows at Campground	Below Falls Minimum flow	Ophir Minimum flow	Campground Minimum flow	Main stem residuals below takes	Dunstan Confluence Minimum Flow	Dunstan Residual below take	Lauder Confluence Minimum flow	Lauder Residual below take	Thomsons Confluence Minimum flow	Thomsons Residual below take	Chatto Confluence Minimum flow	Chatto Residual below take	Flow Sharing	Comment
		ha				L/s	L/s	L/s	L/s	L/s	L/s	L/s	L/s	L/s	L/s	L/s	L/s	%	
Calibration Run – Estimated Existing or Status Quo		27,210	Current	Yes	Yes	500	820	0	100	0	30	0	10	0	10	0	10	nil	Calibration was based on measured flow data particularly in the Manuherekia River at Campground. As there is currently no minimum flow at Campground none was applied to ensure the model replicated measured flow data.
900	Scenario name is based on the minimum flow at Campground.	27,210	Current	Yes - apply to whole Manuherekia Valley	Yes	500	820	900	100	0	30	0	10	0	10	0	10	nil	Scenario designed to represent current water management objectives.
1200								1200		410		130		70		70			Future scenarios developed by ORC.
1500								1500		510		160		80		90			
1700								1700		580		180		90		100			
2000								2000		680		210		110		120			
2500								2500		850		260		140		150			
3000								3000		1020		320		170		180			
Full Dams and No Irrigation		0	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0		This scenario was designed to assist with the ecological interpretations, it was not designed to represent "natural" hydrological conditions. Caution is required when interpreting the model output for this scenario as the model was not developed to assess such a major change from current conditions
No Falls Irrigation Restrictions	Status Quo	27,210	None	None	Yes	500	820		100		30		10		10		10	nil	Designed to assess implications of the Management Imposed Restrictions. Outlet restrictions removed to allow clearer comparison.
	900							900											
	1200							1200		410		130		70		70			
	1500							1500		510		160		80		90			
	3000							3000		1020		320		170		180			
No Falls Irrigation Restrictions and no Augmentation.	Status Quo				No			0		0		0		0		0			Designed to assess implications of the use of storage in Falls dam to augment minimum flows at Campground. Outlet restrictions removed to allow clearer comparison.
	900							900											
	1200							1200		410		130		70		70			
	1500							1500		510		160		80		90			
	3000							3000		1020		320		170		180			
No Falls Irrigation Restrictions no Augmentation higher residual below Falls	1200					620		1200		410		130		70		70			Designed to assess implications of the use of storage in Falls dam to augment minimum flows at Campground but with higher residual flows below Falls Dam. The higher residual flows below Falls Dam have been estimated using the relative contribution of the Falls Dam Catchment to flow at Campground as derived from modelled 5th percentile flows under the "Full Dams and No Irrigation" scenario and assuming only Falls Dam and the four main tributaries contribute to flow at Campground, plus 100 L/s to be consistent with current 500 L/s residual. Outlet restrictions removed to allow clearer comparison.
	1500					760	820	1500	100	510	30	160	10	80	10	90	10		
	3000					1410		3000		1020		320		170		180			
Flow regime components Lauder Creek 1500 base	Base											0	0						Designed to show the effects that each of the various components, that make up a potential flow and allocation regime, have on flow. The Lauder Catchment is used to highlight the effects.
	Min Flow											160							
	Residual (50)												50						
	Flow sharing				Yes	500		1500		510		0		80		90		50	
	Allocation 80	80%											0						
	Allocation 50	50%																nil	
Allocation Manuherekia Valley 1500 base	Allocation 80	80%		Yes								160	10						Designed to show the effects that differing levels of allocation across the Manuherekia Valley has on flow at Campground.
	Allocation 50	50%																	

Notes: The Calibration Run (Estimated Existing or Status Quo – blue shaded) the five yellow shaded future scenarios are the scenarios that ORC initially requested feed into the production modelling and economic assessment. ORC subsequently requested that the orange shaded scenario (1200) be included in the economic assessment.

4.0 MODEL OUTPUT

ORC requested the following hydrological model output plots and data from the Manuherekia Hydrology Model for the calibration run (called Estimated Existing or Status Quo in the model) and the eight scenarios (seven future water management scenarios based on differing minimum flows at Campground namely *"900", "1200", "1500", "1700", "2000", "2500"* and *"3000",* plus a *"Full Dams and No Irrigation*" scenario).

1. Key flow statistics (Minimum flow, 1 day MALF, 7 day MALF, Median, Mean, 1st, 5th, 10th and 20th percentile exceedance flows, annual days below 50% of 7 day MALF for the Full Dams and No Irrigation scenario and annual maximum consecutive days below 50% of 7 day MALF for the Full Dams and No Irrigation scenario) for five sites down the main stem of the Manuherekia River (below Falls Dam, below OIS intake, below Dunstan confluence, at Ophir and at Campground) and at the confluence of the four main tributaries (Dunstan, Lauder, Thomsons and Chatto creeks) under each of the scenarios. Flow statistics were requested for each site for both the full 1 June 1973 to 31 May 2020 model period, and for the irrigation months only (1 September to the following 30 April).
2. Flow duration curves for five main stem sites and 4 tributary sites outlined above under each of the scenarios. Flow duration curves are provided for each site for both the full 1 June 1973 to 31 May 2020 model period and for the irrigation months only (1 September to the following 30 April).
3. Hydrographs of daily flow for the period 1 June 2014 to 31 May 2015 (a recent drought season) for the five main stem sites and four tributary sites outlined above.

The above results are presented for each of the five main stem sites and four tributary sites in turn.

4. The volume of water that is released from Falls Dam storage for irrigation and for environmental reasons (does not apply to *"Full Dams and No Irrigation"* scenario).
5. The volume of water used for irrigation and environmental reasons in Dunstan, Lauder, Thomsons, and Chatto creeks - does not apply to the *"Full Dams and No Irrigation"* scenario.
6. Longitudinal plots of Median Flow, 7 day MALF and 10th percentile flow at various locations down the main stem of the Manuherekia River from inflow into Falls Dam to Campground. As modelled 7 day MALF for most of the scenarios generally occurs after the irrigation season when the dam is refilling, longitudinal plots of flow on 30 December 2014 (a typical low Falls inflow, high irrigation demand, high storage in Falls Dam (approximately 60-70% full) and no (or very limited) management imposed irrigation restrictions, situation) and 28 January 2014 (a typical very low Falls inflow, high irrigation demand, low storage in Falls Dam (approximately 15-25% full) and high management imposed irrigation restrictions, situation) are also provided.
7. Total catchment yield under the *"Full Dams and No Irrigation"* scenario at the following locations: into Falls, from Dunstan, Lauder, Thomsons, Chatto, Manor Burn, Pool Burn and Ida Burn tributaries, at Ophir and at Campground.
8. The total volume of water used for irrigation from the whole catchment and from the Manuherekia Valley only, under all scenarios (does not apply to *"Full Dams and No Irrigation"* scenario).

In regard to the 13 future scenarios designed to assess the implications of the current Falls Dam management practices; ORC requested plots, flow statistics and commentary to suitably explain the potential implications.

In regard to the six future scenarios designed to assess the effect, each of the five potential components of a Manuherekia Flow and Allocation regime, have on downstream flow; ORC requested a comparative hydrograph of daily flow for the period 1 June 2014 to 31 May 2015 (a recent drought season). This analysis was undertaken for the Lauder Catchment only using the 1500 scenario as the base case. Hydrographs are provided for Lauder Creek both immediately below the modelled combined irrigation intake and at the confluence with the Manuherekia River. Commentary explaining the potential implications was specifically not requested.

In regard to the two future scenarios designed to assess the effect that allocation within the Manuherekia Valley has on flow at Campground, ORC requested a comparative hydrograph of daily flow for the period 1 June 2014 to 31 May 2015 (a recent drought season). A similar comparative plot of storage in Falls Dam was also provided Commentary explaining the potential implications of allocation was specifically not requested.

While some of the above requested output can be generated within the Manuherekia Hydrology Model, for ease of calculation and for presentation of the longitudinal plots most of the above results were generated by post processing model results in Excel. The requested results and plots are included in the following tables and plots.

As highlighted in Section 1, at the time of updating this Scenario Memorandum (21 May 2021) the Manuherekia Hydrology Model has not been documented, reviewed nor has it been formally adopted or approved by the Manuherekia Hydrology Group. While the Manuherekia Hydrology Model was specifically developed to allow potential future water management scenarios to be assessed, its ability to suitably do so has not, as yet, been reviewed or independently checked.

Due to the nature of the Manuherekia Hydrology Model, when interpreting the following data and plots it is recommended that readers focus on the relative change between scenarios rather than the specific values for any one scenario. The model will be most accurate at assessing relatively small changes to current management. As the degree of change increases the model's ability to suitably estimate the implications of the change will reduce. Similarly, the model will have higher uncertainties in sub-catchments with limited measured data namely the Chatto Creek, Ida Burn, Pool Burn and Manor Burn sub-catchments.

4.1 Manuherekia River below Falls Dam

Table 2: Manuherekia River below Falls Dam – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	300	300	300	300	300	300	300	300	300
1 day MALF	1112	855	848	840	834	828	822	791	737
7 day MALF	1267	948	936	927	913	899	884	862	832
1 percentile	820	500	500	500	500	500	500	500	500
5 Percentile	1246	1045	976	950	905	862	799	751	712
10 percentile	1536	1788	1726	1686	1593	1537	1480	1382	1271
20 percentile	2038	2480	2464	2442	2423	2420	2396	2346	2296
Median	3906	3707	3695	3750	3865	3903	3966	4051	4121
Average	5254	5251	5251	5251	5251	5251	5252	5253	5254

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 3: Manuherekia River below Falls Dam – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
1974-1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975-1976	0	0	32	32	32	32	32	32	32	32	33	33	33	33	33	33	26	24
1976-1977	0	0	4	4	4	4	4	4	5	5	5	5	5	5	5	5	6	6
1977-1978	0	0	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
1978-1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981-1982	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1982-1983	0	0	5	5	5	5	5	5	5	5	5	5	6	6	6	6	7	7
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
1985-1986	0	0	7	7	9	9	10	10	12	12	12	12	12	12	12	12	13	13
1986-1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987-1988	0	0	6	6	6	6	6	6	7	7	8	8	10	10	16	16	23	23
1988-1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1989-1990	0	0	8	8	9	9	9	9	10	10	11	11	12	12	17	17	21	21
1990-1991	0	0	1	1	2	2	4	4	5	5	6	6	7	7	9	9	9	9
1991-1992	0	0	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
1992-1993	0	0	48	39	50	41	50	41	53	41	56	41	62	41	69	41	73	41
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	9	7	32	32	32	32	32	32	33	33	33	33	34	34	34	34	34	34
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
1996-1997	0	0	3	3	3	3	3	3	3	3	3	3	4	4	6	6	8	8
1997-1998	1	1	14	14	15	15	16	16	16	16	17	17	18	18	19	19	22	21
1998-1999	31	21	4	4	7	7	10	7	15	8	18	11	21	14	25	17	29	21
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	5	4	27	27	27	27	27	27	27	27	27	27	26	26	15	5	9	4
2001-2002	1	1	77	50	84	52	86	52	86	52	86	52	86	52	87	50	88	51
2002-2003	0	0	36	36	36	36	38	36	43	36	46	36	50	36	60	31	58	30
2003-2004	0	0	15	15	18	18	19	19	20	20	21	21	21	21	22	22	24	24
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	8	8	9	9	9	9	9	9	9	9	9	9	9	9	11	9
2006-2007	3	1	34	34	34	34	34	34	34	34	34	34	33	33	30	30	22	20
2007-2008	2	1	51	30	53	31	54	32	56	34	56	34	58	35	63	37	66	39
2008-2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4
2009-2010	0	0	29	29	29	29	29	29	30	30	30	30	30	30	33	33	33	33
2010-2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011-2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012-2013	14	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	3	3	4	4	4	4	4	4	5	5	5	5	6	6	6	6
2014-2015	1	1	18	18	19	19	19	19	19	19	19	19	19	19	20	19	20	19
2015-2016	0	0	23	23	24	24	24	24	24	24	24	24	24	24	24	24	23	23
2016-2017	0	0	7	7	7	7	7	7	7	7	8	7	9	8	12	10	16	12
2017-2018	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1
2018-2019	0	0	16	16	17	17	19	19	22	22	24	24	27	27	29	29	30	30
2019-2020	0	0	17	17	17	17	17	17	20	20	21	21	21	21	21	21	21	21
Median	0	0	6	6	7	7	7	7	7	7	8	8	9	9	12	9	11	9
Mean	1	1	13	12	14	12	14	13	15	13	15	13	16	13	16	13	17	14
Maximum	31	21	77	50	84	52	86	52	86	52	86	52	86	52	87	50	88	51

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.

Figure 1: Manuherekia River below Falls Dam - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

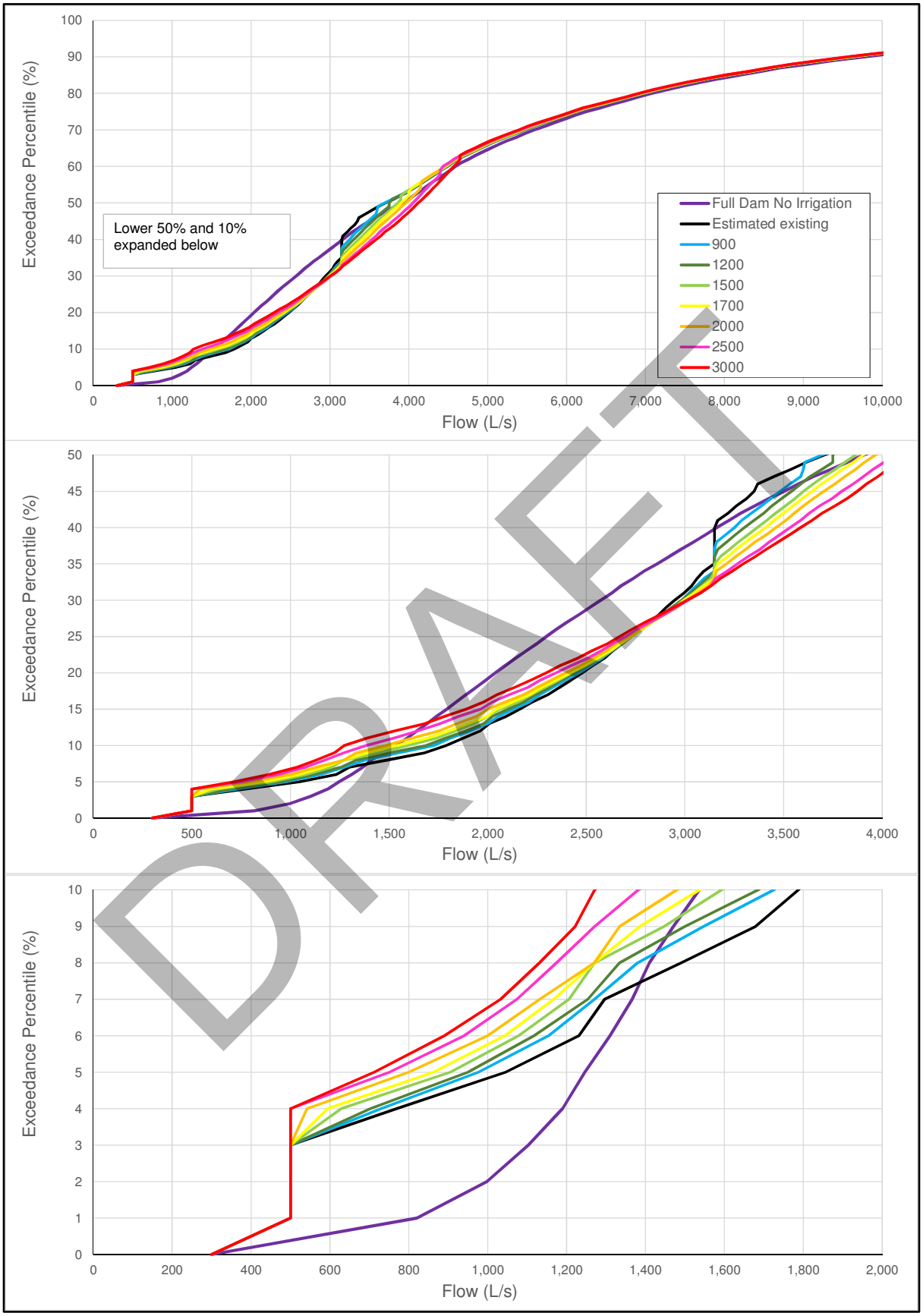


Figure 2: Manuherekia River below Falls Dam - Flow Hydrograph 1 June 2014 to 31 May 2015.

Table 4: Manuherekia River below Falls Dam – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	300	300	300	300	300	300	300	300	300
1 day MALF	1130	1082	1062	1049	1034	1021	1001	965	928
7 day MALF	1301	1231	1208	1196	1179	1165	1151	1149	1140
1 percentile	759	770	757	738	692	667	629	613	590
5 Percentile	1180	1326	1271	1271	1266	1238	1205	1155	1123
10 percentile	1390	1876	1807	1780	1734	1692	1628	1561	1468
20 percentile	1800	2532	2524	2509	2480	2477	2460	2395	2344
Median	3658	3410	3600	3699	3797	3850	3928	4057	4161
Average	5180	5306	5313	5316	5322	5326	5334	5349	5365

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

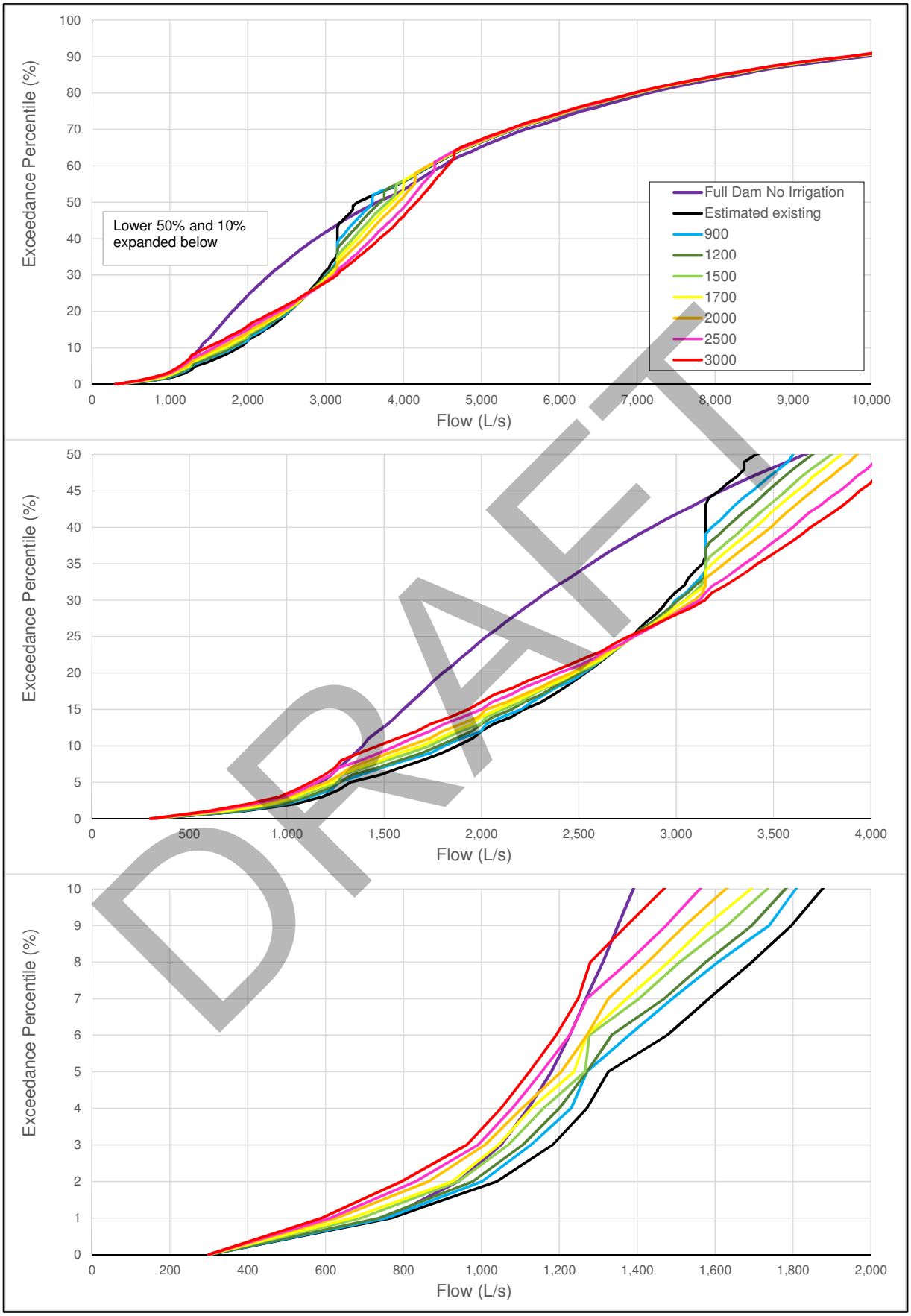
Table 5: Manuherekia River below Falls Dam – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1974-1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975-1976	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1
1976-1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977-1978	0	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1978-1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981-1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982-1983	0	0	5	5	5	5	5	5	5	5	5	5	6	6	6	6	7	7
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985-1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986-1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987-1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988-1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989-1990	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1990-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991-1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992-1993	0	0	9	9	9	9	9	9	12	12	12	12	12	12	12	12	12	12
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	9	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	3	3	3	3	3	3	3	3	3	3	4	4	5	5	5	5
1997-1998	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
1998-1999	31	21	4	4	7	7	10	7	15	8	18	11	21	14	25	17	29	21
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4
2001-2002	1	1	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
2002-2003	0	0	5	5	5	5	5	5	5	5	5	5	5	5	4	3	2	2
2003-2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	3
2006-2007	1	1	3	3	3	3	3	3	3	3	3	3	2	2	0	0	0	0
2007-2008	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008-2009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009-2010	0	0	2	2	2	2	2	2	3	3	3	3	3	3	6	6	6	6
2010-2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011-2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012-2013	14	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	3	3	4	4	4	4	4	4	5	5	5	5	5	5	5	5
2014-2015	1	1	5	5	5	5	5	5	5	5	5	5	5	5	6	5	6	5
2015-2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016-2017	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2017-2018	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1
2018-2019	0	0	16	16	17	17	19	19	22	22	24	24	27	27	28	28	26	26
2019-2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	2	3	3
Maximum	31	21	16	16	17	17	19	19	22	22	24	24	27	27	28	28	29	26

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.

Figure 3: Manuherekia River below Falls Dam - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.2 Manuherekia River below OIS Intake

Table 6: Manuherekia River below OIS Intake – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	300	100	100	100	270	273	273	273	273
1 day MALF	1112	491	491	491	495	495	496	491	491
7 day MALF	1267	501	497	497	500	502	504	508	515
1 percentile	820	500	500	500	500	500	500	500	500
5 Percentile	1246	500	500	500	500	500	500	500	500
10 percentile	1536	500	500	500	500	500	500	500	500
20 percentile	2038	500	500	500	550	630	760	920	1063
Median	3906	2780	2770	2764	2759	2753	2739	2710	2670
Average	5254	4108	4120	4127	4138	4147	4160	4185	4214

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 7: Manuherekia River below OIS Intake – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	84	38	64	26	58	27	58	30	58	39	58	40	49	24	45	23
1974-1975	0	0	86	38	80	42	63	23	51	19	45	18	40	17	35	12	34	17
1975-1976	0	0	136	83	118	81	116	67	87	35	71	33	57	33	46	33	40	24
1976-1977	0	0	96	91	84	32	70	30	59	30	51	25	47	26	34	19	24	15
1977-1978	0	0	101	65	86	65	85	66	75	60	72	58	65	56	59	56	50	37
1978-1979	0	0	59	30	49	31	47	30	41	20	38	16	33	18	31	21	26	20
1979-1980	0	0	16	9	16	9	16	9	16	9	16	9	13	7	10	7	9	7
1980-1981	0	0	59	32	40	20	37	21	31	22	29	22	27	23	28	23	25	24
1981-1982	0	0	135	63	113	64	106	64	94	58	84	56	72	53	66	53	60	51
1982-1983	0	0	69	68	68	50	65	50	55	46	54	45	53	46	51	46	50	47
1983-1984	0	0	28	12	28	12	28	12	23	10	21	10	19	6	12	3	9	3
1984-1985	0	0	134	96	113	59	111	57	98	51	88	50	77	50	60	44	44	26
1985-1986	0	0	49	19	43	14	43	14	40	13	38	13	29	12	30	13	34	13
1986-1987	0	0	42	21	39	22	40	25	35	24	31	24	27	24	26	25	27	26
1987-1988	0	0	136	78	133	78	128	78	124	79	114	46	103	48	90	49	101	56
1988-1989	0	0	52	21	54	28	48	28	45	29	42	29	39	19	33	18	38	14
1989-1990	0	0	159	68	138	69	125	36	108	27	99	27	92	25	78	27	69	29
1990-1991	0	0	157	102	133	64	117	64	94	48	88	49	84	50	79	52	71	46
1991-1992	0	0	125	66	81	64	71	65	71	64	68	63	63	61	60	56	55	37
1992-1993	0	0	160	121	162	121	162	121	142	46	138	48	131	52	120	49	113	51
1993-1994	0	0	20	11	20	11	20	11	20	11	20	11	20	11	20	11	9	4
1994-1995	9	7	163	163	157	121	148	118	142	118	135	118	126	83	117	83	110	83
1995-1996	0	0	2	2	2	2	2	2	2	2	2	2	2	1	3	3	7	6
1996-1997	0	0	132	99	132	99	130	84	125	84	123	83	118	63	113	65	100	61
1997-1998	1	1	163	81	153	80	149	81	139	81	133	72	115	50	104	51	99	53
1998-1999	31	21	130	81	116	80	111	80	109	80	107	80	107	66	106	67	102	67
1999-2000	0	0	35	23	35	23	35	23	31	11	29	11	29	25	27	26	28	27
2000-2001	5	4	150	68	113	48	110	48	103	49	101	49	88	26	52	12	43	21
2001-2002	1	1	147	59	132	58	126	59	121	58	116	57	105	52	92	50	92	51
2002-2003	0	0	131	66	103	64	100	62	102	62	103	62	104	62	95	31	88	30
2003-2004	0	0	69	22	64	22	60	23	57	23	56	23	53	24	52	24	51	24
2004-2005	0	0	24	13	24	13	24	13	24	13	24	13	22	13	17	13	19	14
2005-2006	0	0	157	71	122	52	117	36	107	17	91	16	75	14	61	13	52	13
2006-2007	3	1	109	68	93	63	79	56	68	51	63	39	54	34	41	30	29	20
2007-2008	2	1	207	139	189	127	190	130	185	71	179	70	169	36	150	37	140	39
2008-2009	0	0	108	43	99	43	90	43	92	69	87	67	87	68	74	33	70	31
2009-2010	0	0	137	68	118	66	108	38	94	35	86	34	78	34	71	33	60	33
2010-2011	0	0	34	13	25	13	22	13	18	13	18	13	12	5	6	2	4	2
2011-2012	0	0	61	27	51	25	47	25	42	14	35	13	28	9	22	7	22	8
2012-2013	14	12	108	68	101	60	92	59	89	60	84	41	75	32	49	25	42	24
2013-2014	0	0	120	64	98	60	86	30	73	28	64	28	53	27	49	28	44	28
2014-2015	1	1	128	90	119	56	110	56	99	55	93	55	83	55	71	55	51	33
2015-2016	0	0	195	85	154	83	141	83	131	80	127	41	117	32	92	27	69	23
2016-2017	0	0	126	91	126	91	126	91	113	59	104	59	96	59	76	44	70	45
2017-2018	2	1	71	27	53	25	47	26	42	26	37	25	35	25	31	25	29	25
2018-2019	0	0	92	92	84	46	75	47	66	49	65	50	65	53	53	37	43	30
2019-2020	0	0	134	106	133	106	128	89	122	89	116	89	107	88	95	54	76	52
Median	0	0	109	66	98	56	86	47	75	46	71	39	65	33	52	28	45	26
Mean	1	1	103	61	91	53	85	49	78	43	73	40	67	36	58	32	53	30
Maximum	31	21	207	163	189	127	190	130	185	118	179	118	169	88	150	83	140	83

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.

Figure 4: Manuherekia River below OIS Intake - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

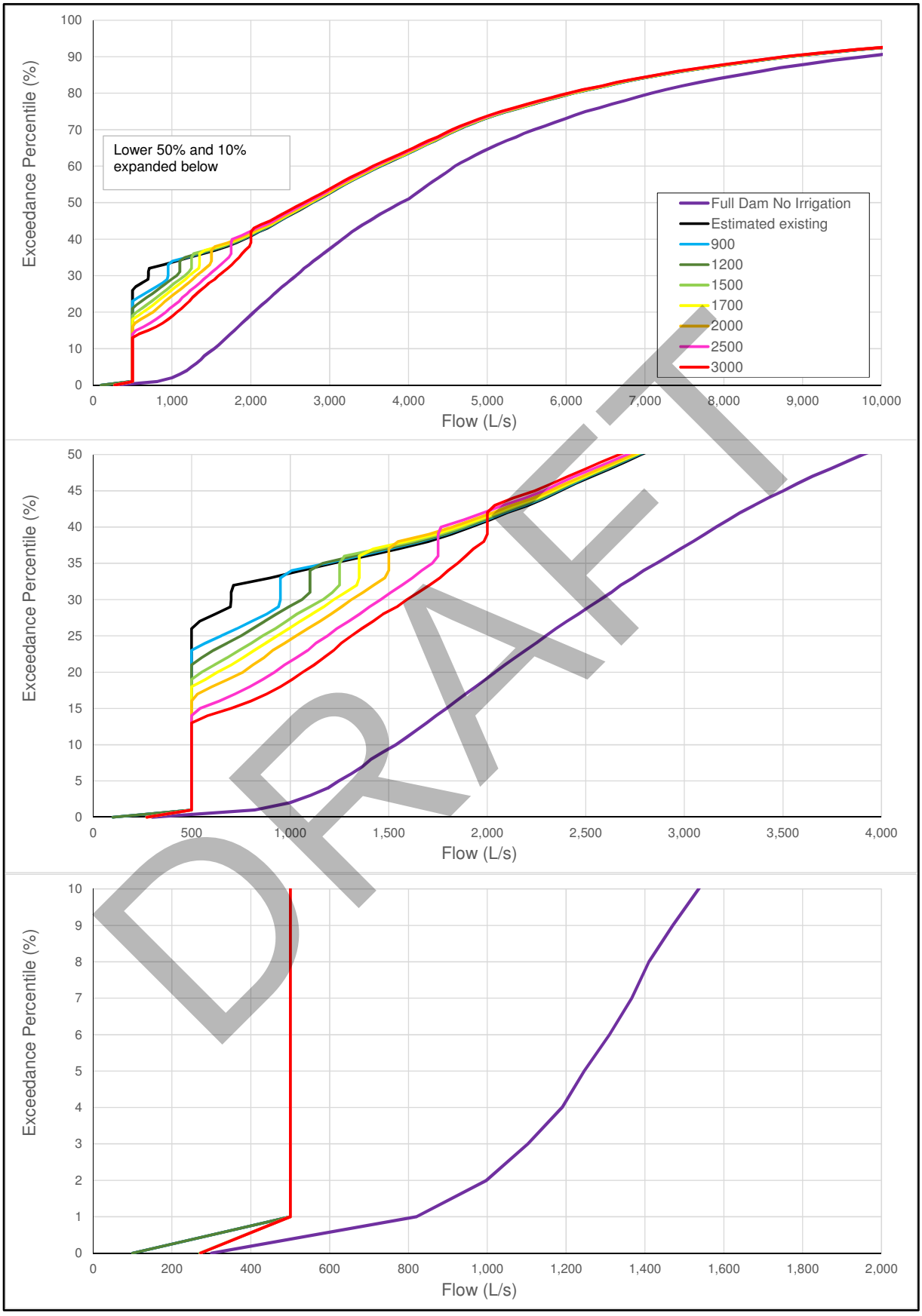


Figure 5: Manuherekia River below OIS Intake - Flow Hydrograph 1 June 2014 to 31 May 2015.

Table 8: Manuherekia River below OIS Intake – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	300	100	100	100	270	273	273	273	273
1 day MALF	1130	491	491	491	495	495	496	491	491
7 day MALF	1301	501	497	497	500	502	507	523	536
1 percentile	759	500	500	500	500	500	500	500	500
5 Percentile	1180	500	500	500	500	500	500	500	500
10 percentile	1390	500	500	500	500	500	500	500	500
20 percentile	1800	500	500	500	500	500	560	774	948
Median	3658	1564	1552	1535	1509	1496	1500	1750	2000
Average	5180	3598	3622	3637	3659	3675	3702	3755	3812

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 9: Manuherekia River below OIS Intake – Low Flow accrual periods

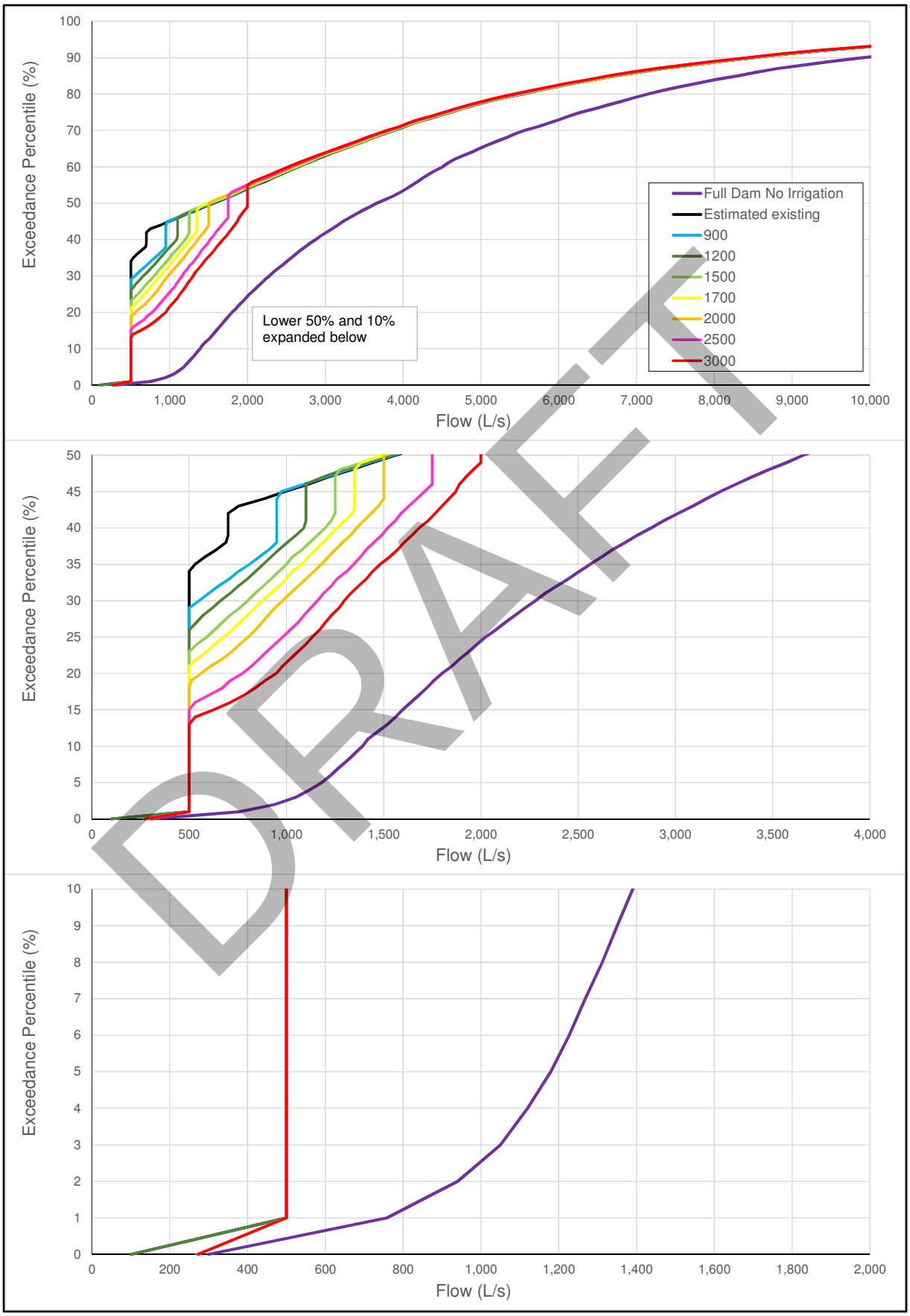
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	71	38	51	26	45	27	45	30	45	39	45	40	36	24	32	23
1974-1975	0	0	86	38	80	42	63	23	51	19	45	18	40	17	35	12	34	17
1975-1976	0	0	105	52	87	50	85	36	56	19	40	9	26	6	15	4	15	4
1976-1977	0	0	90	89	77	32	63	30	51	27	42	21	37	21	21	11	9	6
1977-1978	0	0	80	44	65	44	64	45	54	39	51	37	44	35	38	35	29	16
1978-1979	0	0	59	30	49	31	47	30	41	20	38	16	33	18	31	21	26	20
1979-1980	0	0	16	9	16	9	16	9	16	9	16	9	13	7	10	7	9	7
1980-1981	0	0	59	32	40	20	37	21	31	22	29	22	27	23	28	23	25	24
1981-1982	0	0	115	43	93	44	86	44	74	38	64	36	52	33	46	33	40	31
1982-1983	0	0	69	68	68	50	65	50	55	46	54	45	53	46	51	46	50	47
1983-1984	0	0	28	12	28	12	28	12	23	10	21	10	19	6	12	3	9	3
1984-1985	0	0	103	65	82	28	80	26	67	20	57	19	46	19	29	13	16	6
1985-1986	0	0	42	19	34	14	33	14	28	13	26	13	17	12	18	13	21	12
1986-1987	0	0	42	21	39	22	40	25	35	24	31	24	27	24	26	25	27	26
1987-1988	0	0	122	64	119	64	114	64	109	64	98	30	85	30	66	25	70	25
1988-1989	0	0	52	21	54	28	48	28	45	29	42	29	39	19	33	18	37	14
1989-1990	0	0	155	64	133	64	120	36	102	26	92	23	84	20	65	16	52	16
1990-1991	0	0	147	92	122	53	104	51	80	34	73	34	68	34	61	34	53	28
1991-1992	0	0	94	37	50	33	40	34	40	33	37	32	32	30	29	25	24	15
1992-1993	0	0	121	121	121	121	121	121	101	46	94	45	81	43	63	33	52	31
1993-1994	0	0	20	11	20	11	20	11	20	11	20	11	20	11	20	11	9	4
1994-1995	9	7	134	134	128	92	119	89	112	88	105	88	95	52	86	52	79	52
1995-1996	0	0	2	2	2	2	2	2	2	2	2	2	2	1	3	3	6	6
1996-1997	0	0	132	99	132	99	130	84	125	84	123	83	118	63	112	64	97	58
1997-1998	1	1	151	69	140	67	135	67	125	67	118	57	99	34	87	34	80	34
1998-1999	31	21	124	75	110	74	105	74	103	74	101	74	101	60	100	61	96	61
1999-2000	0	0	35	23	35	23	35	23	31	11	29	11	29	25	27	26	28	27
2000-2001	5	4	119	55	82	22	79	23	72	21	70	18	59	16	36	12	40	21
2001-2002	1	1	73	35	51	29	43	28	38	27	33	26	22	11	9	4	8	4
2002-2003	0	0	100	35	72	33	67	31	64	31	62	31	59	31	39	20	32	17
2003-2004	0	0	54	22	46	22	41	23	37	23	35	23	32	24	30	24	27	24
2004-2005	0	0	24	13	24	13	24	13	24	13	24	13	22	13	17	13	19	14
2005-2006	0	0	152	66	116	46	111	36	101	17	85	16	69	14	55	11	46	12
2006-2007	1	1	78	37	62	32	48	25	37	20	32	10	23	5	11	3	7	3
2007-2008	1	1	152	114	132	101	132	104	125	55	119	44	107	36	83	21	70	16
2008-2009	0	0	108	43	99	43	90	43	92	69	87	67	87	68	73	33	62	31
2009-2010	0	0	110	41	91	39	81	27	67	13	59	12	51	11	44	11	33	7
2010-2011	0	0	34	13	25	13	22	13	18	13	18	13	12	5	6	2	4	2
2011-2012	0	0	61	27	51	25	47	25	42	14	35	13	28	9	22	7	22	8
2012-2013	14	12	96	56	89	48	80	47	76	47	71	28	62	19	36	12	29	11
2013-2014	0	0	120	64	98	60	86	30	73	28	64	28	53	27	48	27	43	27
2014-2015	1	1	115	77	105	42	96	42	85	41	79	41	69	41	57	41	37	19
2015-2016	0	0	165	55	123	52	110	52	100	49	96	41	87	32	65	14	46	13
2016-2017	0	0	122	87	122	87	122	87	109	55	99	55	90	54	67	37	57	36
2017-2018	2	1	71	27	53	25	47	26	42	26	37	25	35	25	31	25	29	25
2018-2019	0	0	92	92	84	46	75	47	66	49	65	50	65	53	52	36	39	26
2019-2020	0	0	107	79	106	79	101	62	92	59	85	58	76	57	64	23	45	21
Median	0	0	94	43	80	39	67	30	56	27	54	26	46	24	36	21	32	17
Mean	1	1	90	51	77	43	71	40	63	34	58	31	52	27	42	22	37	20
Maximum	31	21	165	134	140	121	135	121	125	88	123	88	118	68	112	64	97	61

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 633 L/s.

Figure 6: Manuherekia River below OIS Intake - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.3 Manuherekia River below Dunstan Confluence

Table 10: Manuherekia River below Dunstan Confluence – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	1075	538	539	780	978	972	980	1075	1075
1 day MALF	2179	739	821	970	1065	1133	1239	1383	1520
7 day MALF	2410	855	984	1118	1218	1286	1384	1559	1711
1 percentile	1846	654	816	917	1015	1084	1183	1352	1521
5 Percentile	2375	852	1021	1138	1230	1294	1407	1583	1744
10 percentile	2842	1036	1180	1355	1473	1550	1661	1867	2040
20 percentile	3678	1548	1567	1623	1766	1931	2083	2324	2560
Median	6818	5231	5225	5222	5212	5203	5191	5171	5129
Average	9228	7613	7629	7651	7672	7688	7714	7765	7821

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 11: Manuherekia River below Dunstan Confluence – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	59	39	33	21	2	1	1	1	1	1	0	0	0	0	0	0
1974-1975	0	0	24	4	13	3	4	2	2	1	2	1	1	1	0	0	0	0
1975-1976	0	0	130	114	91	49	63	28	24	14	11	5	3	3	0	0	0	0
1976-1977	0	0	46	33	42	27	31	12	17	7	11	4	9	4	0	0	0	0
1977-1978	0	0	87	66	69	44	27	8	17	7	13	7	10	7	0	0	0	0
1978-1979	0	0	25	17	11	3	2	1	1	1	0	0	0	0	0	0	0	0
1979-1980	0	0	6	5	6	5	6	5	6	5	6	5	1	1	0	0	0	0
1980-1981	0	0	58	33	38	21	9	7	1	1	0	0	0	0	0	0	0	0
1981-1982	0	0	94	61	61	13	22	12	10	4	3	1	1	1	0	0	0	0
1982-1983	0	0	22	12	22	12	15	11	14	10	13	9	13	9	0	0	0	0
1983-1984	0	0	5	3	5	3	4	3	2	1	1	1	1	1	0	0	0	0
1984-1985	0	0	76	75	66	57	50	29	30	20	19	7	4	1	0	0	0	0
1985-1986	0	0	14	14	5	3	2	2	2	2	1	1	0	0	0	0	0	0
1986-1987	0	0	23	21	18	13	5	5	1	1	0	0	0	0	0	0	0	0
1987-1988	0	0	62	22	59	22	55	22	52	22	41	10	27	8	0	0	0	0
1988-1989	0	0	29	29	26	14	1	1	1	1	0	0	0	0	0	0	0	0
1989-1990	0	0	59	26	39	15	27	15	10	3	5	3	2	1	0	0	0	0
1990-1991	0	0	80	47	59	28	38	20	16	4	7	4	2	1	0	0	0	0
1991-1992	0	0	99	53	86	36	45	10	31	8	23	8	21	8	0	0	0	0
1992-1993	0	0	50	25	50	25	50	25	34	16	26	14	20	11	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	45	27	38	27	34	27	28	26	27	26	19	17	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	34	11	34	11	32	11	29	11	28	9	25	9	0	0	0	0
1997-1998	0	0	49	26	29	14	22	8	15	8	10	6	4	3	0	0	0	0
1998-1999	13	5	70	31	36	7	24	7	20	7	21	6	23	6	14	5	14	5
1999-2000	0	0	4	2	4	2	4	2	2	2	2	2	2	2	0	0	0	0
2000-2001	0	0	88	74	84	62	52	25	40	16	33	14	21	11	0	0	0	0
2001-2002	0	0	42	32	34	17	11	6	7	6	6	6	6	6	2	2	0	0
2002-2003	0	0	63	37	60	37	25	10	14	6	8	4	5	2	0	0	0	0
2003-2004	0	0	36	25	14	8	1	1	1	1	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	133	33	107	27	65	25	43	19	27	7	11	3	0	0	0	0
2006-2007	0	0	62	26	55	26	26	11	5	2	1	1	1	1	0	0	0	0
2007-2008	0	0	123	36	112	36	95	36	83	36	71	36	51	32	0	0	0	0
2008-2009	0	0	42	29	28	17	17	6	10	6	7	6	7	6	0	0	0	0
2009-2010	0	0	106	32	94	32	33	17	17	8	10	6	3	1	0	0	0	0
2010-2011	0	0	14	9	4	4	4	4	4	4	3	2	1	1	0	0	0	0
2011-2012	0	0	29	14	20	14	16	14	15	7	11	6	5	1	0	0	0	0
2012-2013	0	0	48	25	45	25	30	25	29	25	28	17	15	4	0	0	0	0
2013-2014	0	0	62	31	41	20	34	18	28	11	16	9	11	6	0	0	0	0
2014-2015	0	0	66	31	41	12	10	2	3	2	2	2	2	2	0	0	0	0
2015-2016	0	0	77	14	34	14	27	14	22	14	17	8	10	6	0	0	0	0
2016-2017	0	0	29	13	29	13	29	13	21	11	19	11	15	11	0	0	0	0
2017-2018	0	0	40	20	10	10	2	2	0	0	0	0	0	0	0	0	0	0
2018-2019	0	0	36	23	35	16	27	9	7	1	3	1	2	1	0	0	0	0
2019-2020	0	0	72	37	72	37	68	37	58	37	50	37	47	37	0	0	0	0
Median	0	0	48	26	35	15	24	10	14	6	7	5	3	2	0	0	0	0
Mean	0	0	51	28	40	19	24	12	16	8	12	6	9	5	0	0	0	0
Maximum	13	5	133	114	112	62	95	37	83	37	71	37	51	37	14	5	14	5

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1205 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1205 L/s.

Figure 7: Manuherekia River below Dunstan Confluence - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

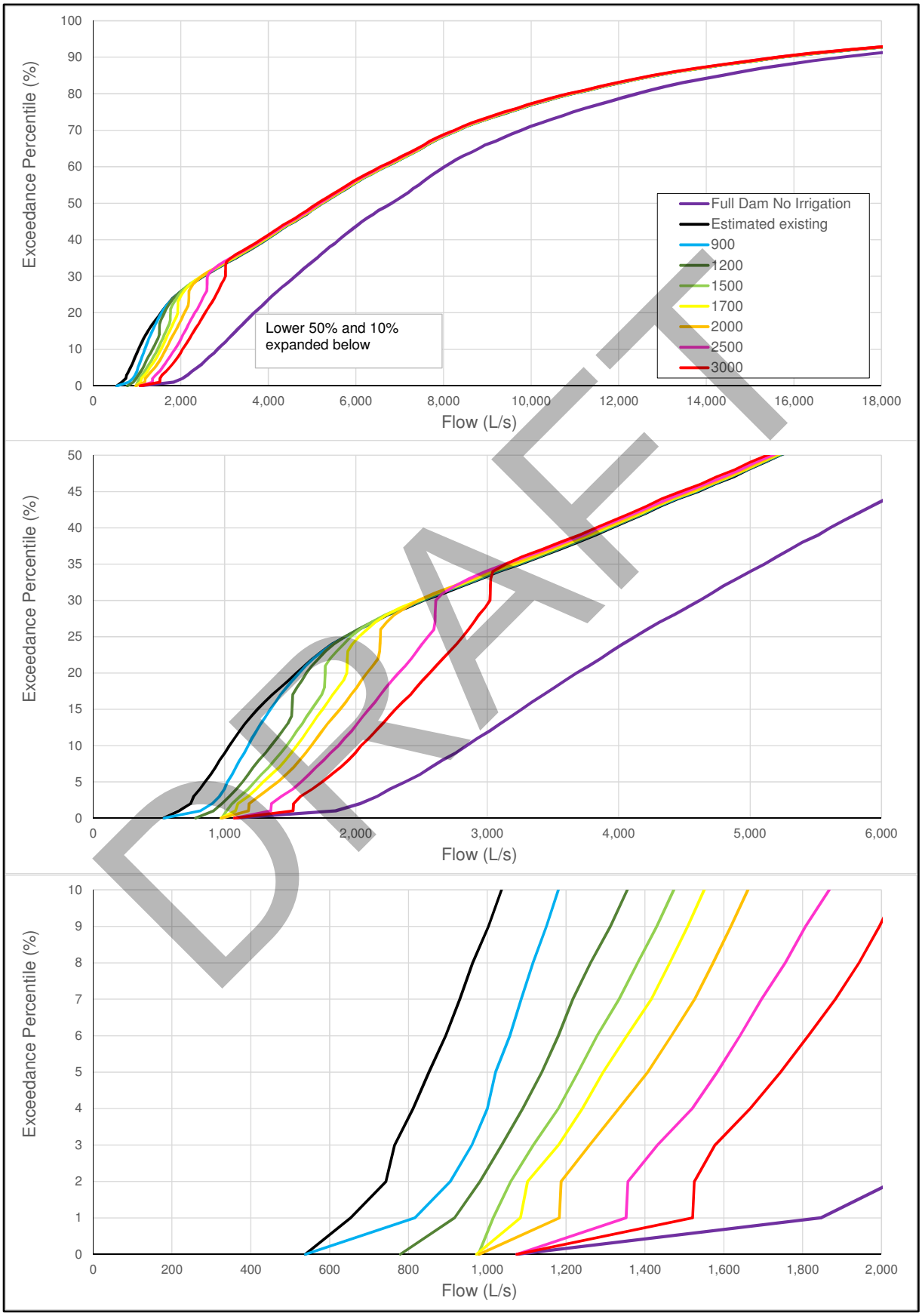


Figure 8: Manuherekia River below Dunstan Confluence - Flow Hydrograph 1 June 2014 to 31 May 2015.

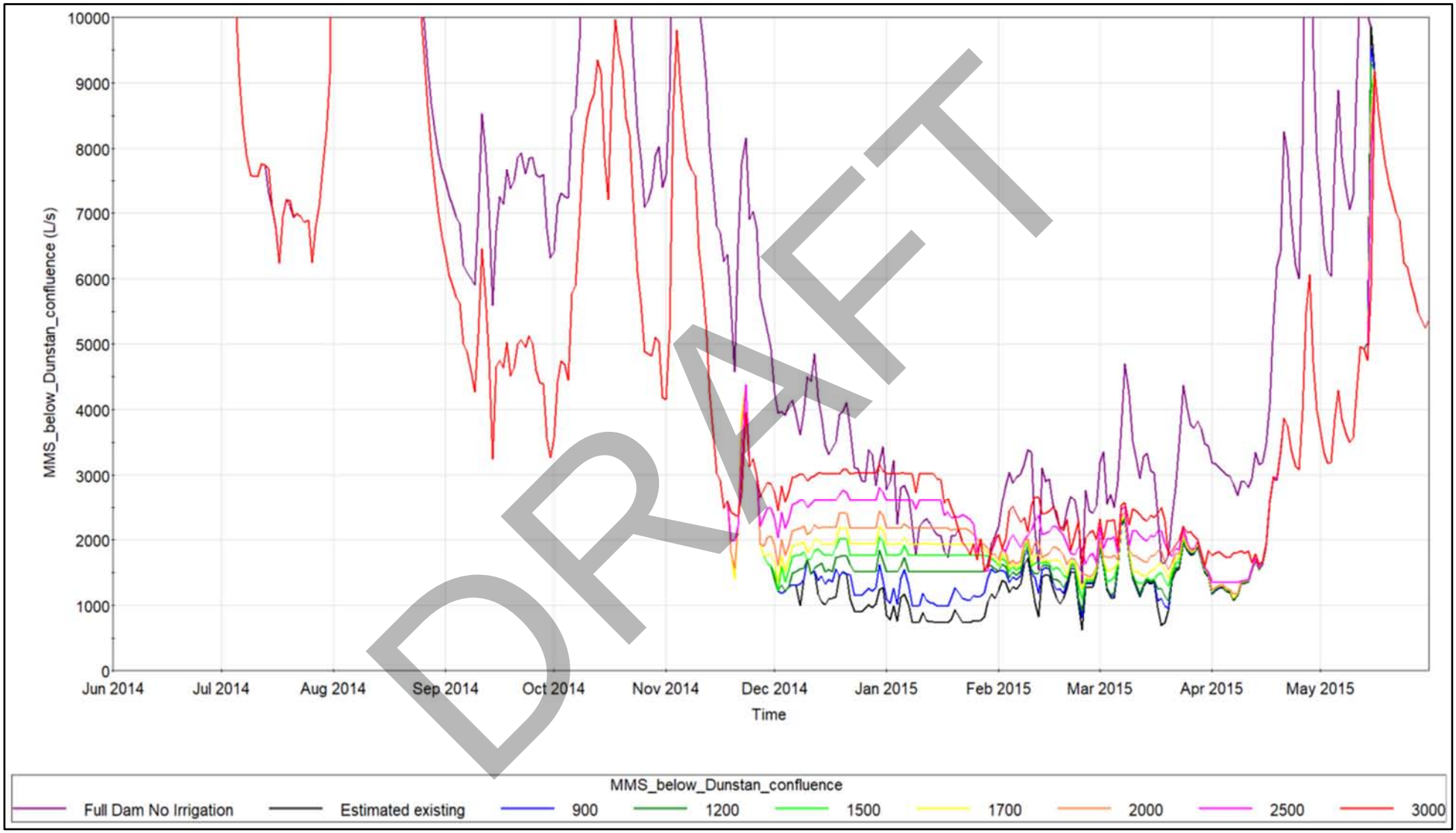


Table 12: Manuherekia River below Dunstan Confluence – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	1075	538	539	780	978	972	980	1075	1075
1 day MALF	2230	739	821	970	1065	1134	1242	1389	1529
7 day MALF	2490	855	984	1118	1219	1287	1388	1578	1743
1 percentile	1792	597	768	914	1013	1082	1181	1351	1520
5 Percentile	2243	775	983	1055	1142	1207	1296	1479	1662
10 percentile	2614	919	1077	1208	1326	1407	1525	1745	1960
20 percentile	3326	1167	1290	1503	1626	1718	1870	2127	2359
Median	6507	3759	3754	3743	3735	3726	3706	3680	3630
Average	9208	6895	6926	6963	6999	7028	7074	7164	7263

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 13: Manuherekia River below Dunstan Confluence – Low Flow accrual periods

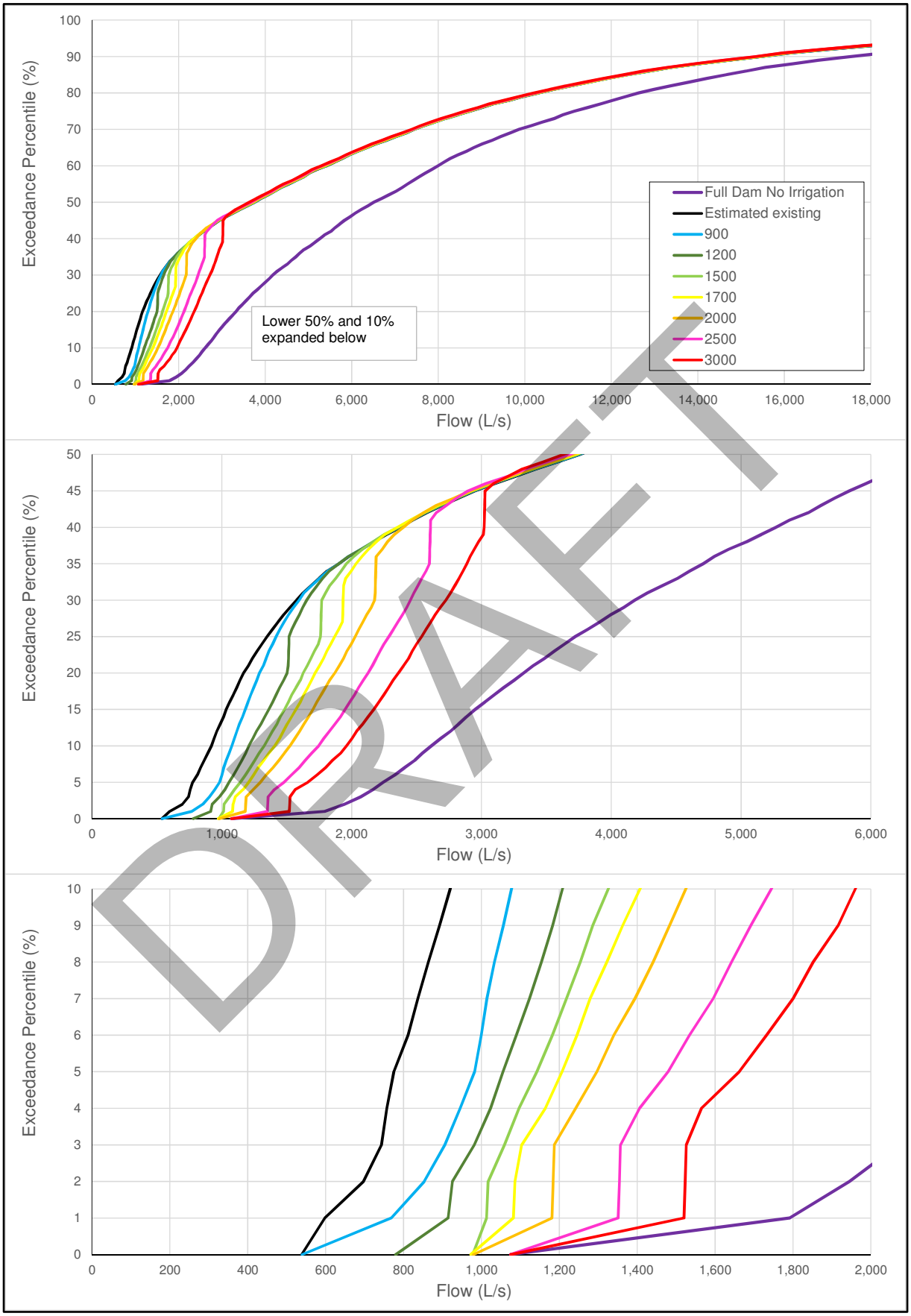
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	59	39	33	21	2	1	1	1	1	1	0	0	0	0	0	0
1974-1975	0	0	24	4	13	3	4	2	2	1	2	1	1	1	0	0	0	0
1975-1976	0	0	130	114	91	49	63	28	24	14	11	5	3	3	0	0	0	0
1976-1977	0	0	46	33	42	27	31	12	17	7	11	4	9	4	0	0	0	0
1977-1978	0	0	87	66	69	44	27	8	17	7	13	7	10	7	0	0	0	0
1978-1979	0	0	25	17	11	3	2	1	1	1	0	0	0	0	0	0	0	0
1979-1980	0	0	6	5	6	5	6	5	6	5	6	5	1	1	0	0	0	0
1980-1981	0	0	58	33	38	21	9	7	1	1	0	0	0	0	0	0	0	0
1981-1982	0	0	94	61	61	13	22	12	10	4	3	1	1	1	0	0	0	0
1982-1983	0	0	22	12	22	12	15	11	14	10	13	9	13	9	0	0	0	0
1983-1984	0	0	5	3	5	3	4	3	2	1	1	1	1	1	0	0	0	0
1984-1985	0	0	76	75	66	57	50	29	30	20	19	7	4	1	0	0	0	0
1985-1986	0	0	14	14	5	3	2	2	2	2	1	1	0	0	0	0	0	0
1986-1987	0	0	23	21	18	13	5	5	1	1	0	0	0	0	0	0	0	0
1987-1988	0	0	62	22	59	22	55	22	52	22	41	10	27	8	0	0	0	0
1988-1989	0	0	29	29	26	14	1	1	1	1	0	0	0	0	0	0	0	0
1989-1990	0	0	59	26	39	15	27	15	10	3	5	3	2	1	0	0	0	0
1990-1991	0	0	80	47	59	28	38	20	16	4	7	4	2	1	0	0	0	0
1991-1992	0	0	93	53	80	36	39	10	25	8	17	6	15	6	0	0	0	0
1992-1993	0	0	50	25	50	25	50	25	34	16	26	14	20	11	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	45	27	38	27	34	27	28	26	27	26	19	17	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	34	11	34	11	32	11	29	11	28	9	25	9	0	0	0	0
1997-1998	0	0	49	26	29	14	22	8	15	8	10	6	4	3	0	0	0	0
1998-1999	13	5	70	31	36	7	24	7	20	7	21	6	23	6	14	5	14	5
1999-2000	0	0	4	2	4	2	4	2	2	2	2	2	2	2	0	0	0	0
2000-2001	0	0	84	72	80	62	48	25	36	16	29	14	19	11	0	0	0	0
2001-2002	0	0	36	32	28	17	5	4	1	1	0	0	0	0	0	0	0	0
2002-2003	0	0	63	37	60	37	25	10	14	6	8	4	5	2	0	0	0	0
2003-2004	0	0	36	25	14	8	1	1	1	1	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	133	33	107	27	65	25	43	19	27	7	11	3	0	0	0	0
2006-2007	0	0	62	26	55	26	26	11	5	2	1	1	1	1	0	0	0	0
2007-2008	0	0	123	36	112	36	95	36	83	36	71	36	51	32	0	0	0	0
2008-2009	0	0	42	29	28	17	17	6	10	6	7	6	7	6	0	0	0	0
2009-2010	0	0	106	32	94	32	33	17	17	8	10	6	3	1	0	0	0	0
2010-2011	0	0	14	9	4	4	4	4	4	4	3	2	1	1	0	0	0	0
2011-2012	0	0	29	14	20	14	16	14	15	7	11	6	5	1	0	0	0	0
2012-2013	0	0	48	25	45	25	30	25	29	25	28	17	15	4	0	0	0	0
2013-2014	0	0	62	31	41	20	34	18	28	11	16	9	11	6	0	0	0	0
2014-2015	0	0	66	31	41	12	10	2	3	2	2	2	2	2	0	0	0	0
2015-2016	0	0	77	14	34	14	27	14	22	14	17	8	10	6	0	0	0	0
2016-2017	0	0	29	13	29	13	29	13	21	11	19	11	15	11	0	0	0	0
2017-2018	0	0	40	20	10	10	2	2	0	0	0	0	0	0	0	0	0	0
2018-2019	0	0	36	23	35	16	27	9	7	1	3	1	2	1	0	0	0	0
2019-2020	0	0	71	37	71	37	67	37	57	37	49	37	46	37	0	0	0	0
Median	0	0	48	26	35	15	24	10	14	6	7	4	3	1	0	0	0	0
Mean	0	0	51	28	39	19	24	12	16	8	12	6	8	5	0	0	0	0
Maximum	13	5	133	114	112	62	95	37	83	37	71	37	51	37	14	5	14	5

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1205 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1205 L/s.

Figure 9: Manuherekia River below Dunstan Confluence - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.4 Manuherekia River at Ophir

Table 14: Manuherekia River at Ophir – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	1818	944	983	1120	1265	1263	1321	1470	1482
1 day MALF	3105	1672	1751	1886	1981	2046	2153	2332	2491
7 day MALF	3400	1834	1948	2087	2199	2277	2396	2614	2794
1 percentile	2643	1394	1547	1691	1756	1840	1994	2231	2379
5 Percentile	3353	1824	1971	2160	2269	2347	2463	2666	2891
10 percentile	3987	2109	2242	2410	2554	2652	2805	3045	3258
20 percentile	5235	2828	2824	2861	2963	3090	3308	3628	3957
Median	9945	8080	8072	8057	8050	8045	8028	8003	7970
Average	13589	12226	12235	12258	12275	12291	12317	12369	12426

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 15: Manuherekia River at Ophir – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	21	21	4	3	0	0	0	0	0	0	0	0	0	0	0	0
1974-1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975-1976	0	0	78	75	74	70	56	54	55	40	16	5	1	1	1	1	0	0
1976-1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977-1978	0	0	41	25	33	22	14	14	12	8	5	4	0	0	0	0	0	0
1978-1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	0	0	26	19	16	8	3	2	1	1	1	1	0	0	0	0	0	0
1981-1982	0	0	42	25	28	21	15	14	1	1	1	1	1	1	0	0	0	0
1982-1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	5	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
1985-1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986-1987	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987-1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988-1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989-1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990-1991	0	0	7	7	4	2	1	1	1	1	0	0	0	0	0	0	0	0
1991-1992	0	0	40	17	17	6	3	3	0	0	0	0	0	0	0	0	0	0
1992-1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997-1998	0	0	16	8	4	2	1	1	0	0	0	0	0	0	0	0	0	0
1998-1999	0	0	40	25	30	21	23	9	21	13	19	11	20	7	19	6	14	5
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	0	0	32	7	16	7	13	5	7	3	6	3	3	2	0	0	0	0
2001-2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002-2003	0	0	18	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003-2004	0	0	14	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	47	13	26	9	8	4	2	1	0	0	0	0	0	0	0	0
2006-2007	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007-2008	0	0	31	14	30	11	13	5	8	4	4	4	0	0	0	0	0	0
2008-2009	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009-2010	0	0	45	22	34	14	22	9	18	6	5	3	1	1	0	0	0	0
2010-2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011-2012	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2012-2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014-2015	0	0	40	21	26	9	3	2	1	1	0	0	0	0	0	0	0	0
2015-2016	0	0	9	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2016-2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017-2018	0	0	15	15	6	4	0	0	0	0	0	0	0	0	0	0	0	0
2018-2019	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019-2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0	0	12	7	8	5	4	3	3	2	1	1	1	0	0	0	0	0
Maximum	0	0	78	75	74	70	56	54	55	40	19	11	20	7	19	6	14	5

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1700 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1700 L/s.

Figure 10: Manuherekia River at Ophir - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

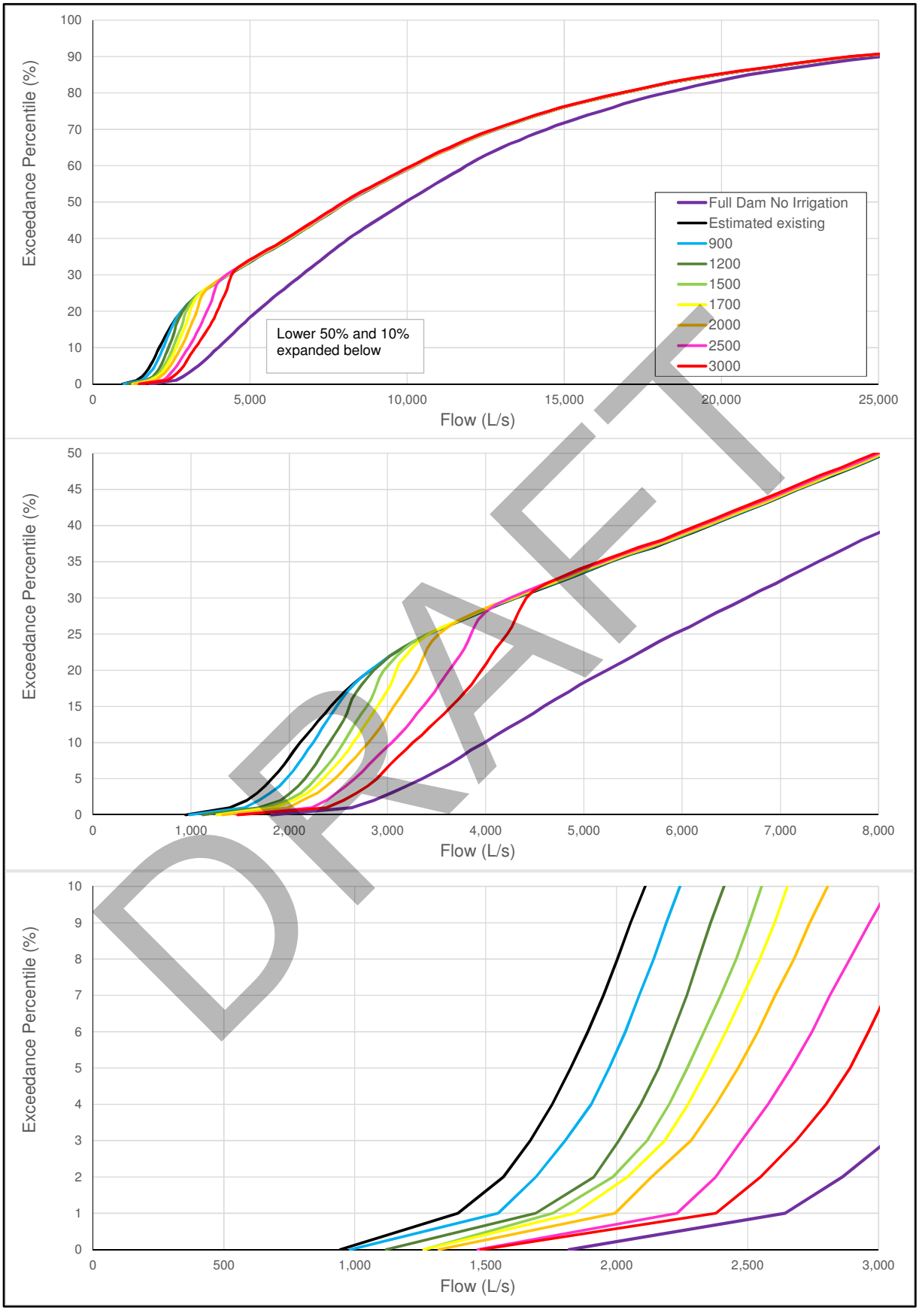


Figure 11: Manuherekia River at Ophir - Flow Hydrograph 1 June 2014 to 31 May 2015.

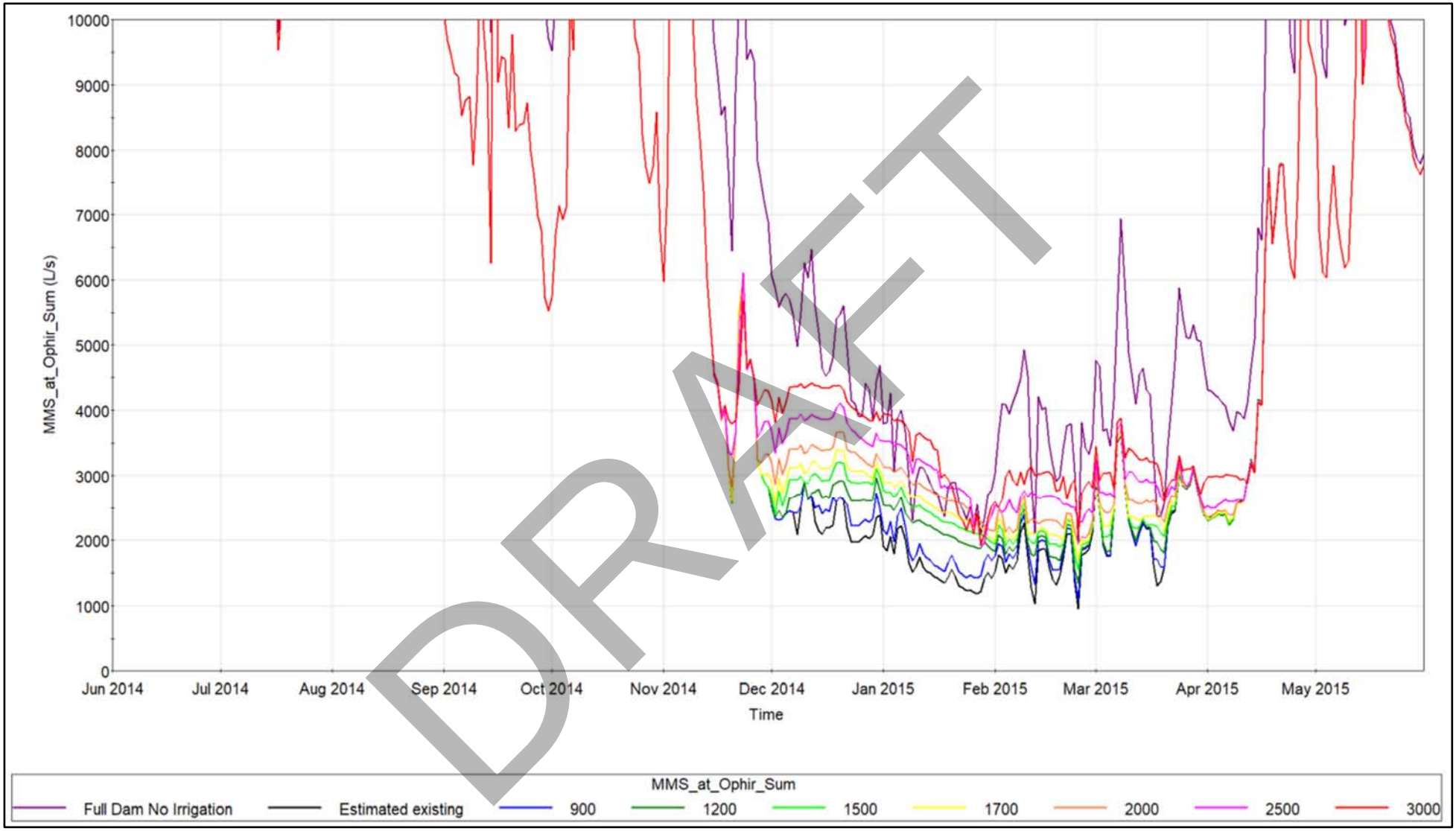


Table 16: Manuherekia River at Ophir – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	1818	944	983	1120	1265	1263	1321	1470	1482
1 day MALF	3174	1672	1758	1895	1992	2060	2172	2354	2529
7 day MALF	3519	1840	1961	2103	2215	2295	2426	2673	2881
1 percentile	2554	1342	1461	1586	1688	1786	1950	2224	2331
5 Percentile	3150	1699	1844	2054	2168	2251	2365	2591	2829
10 percentile	3678	1934	2078	2269	2410	2501	2643	2871	3127
20 percentile	4637	2341	2425	2588	2746	2862	3049	3379	3694
Median	9251	6117	6113	6110	6086	6079	6065	6012	5987
Average	13088	10824	10843	10882	10914	10941	10988	11079	11180

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 17: Manuherekia River at Ophir – Low Flow accrual periods

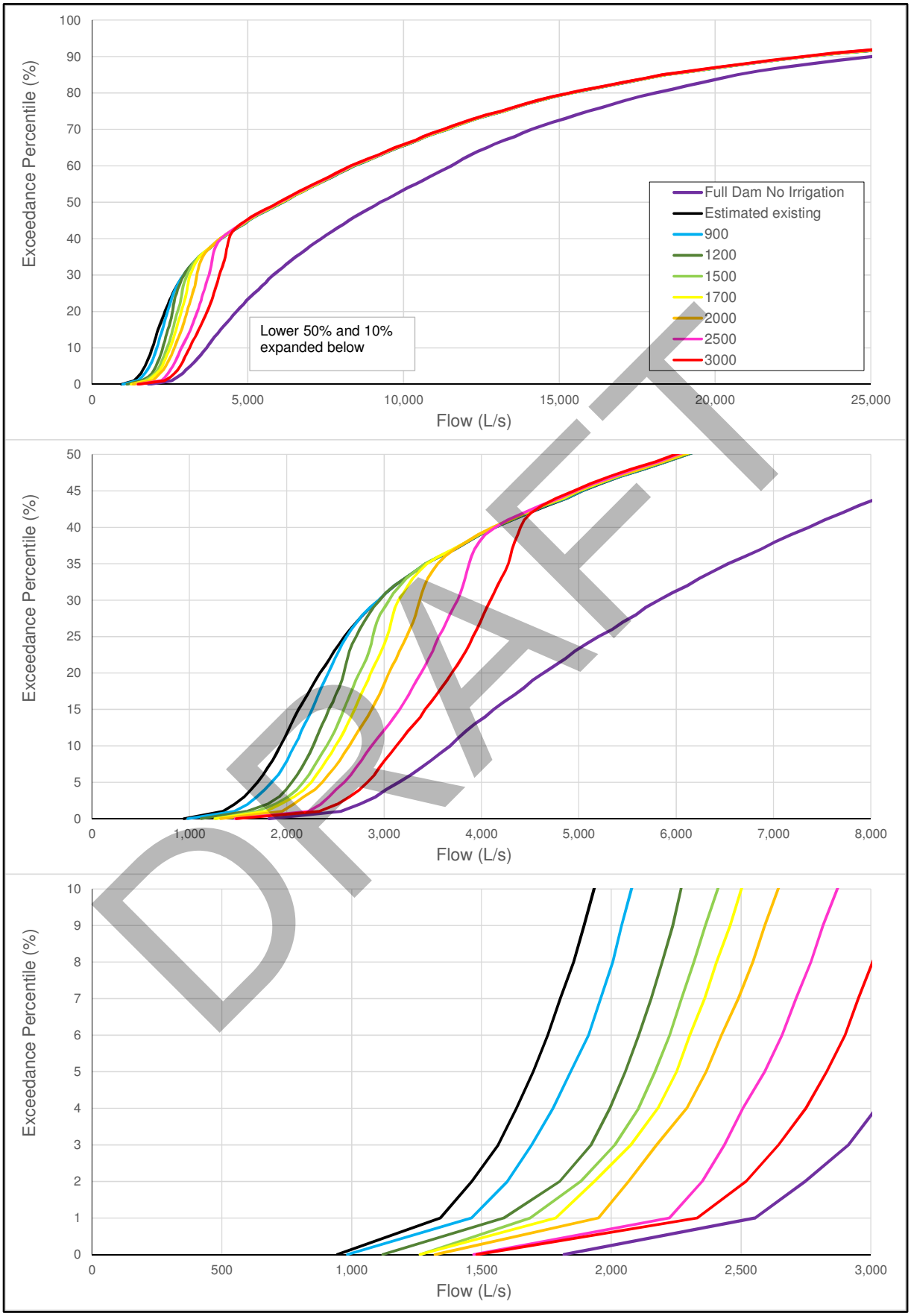
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	21	21	4	3	0	0	0	0	0	0	0	0	0	0	0	0
1974-1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975-1976	0	0	78	75	74	70	56	54	55	40	16	5	1	1	1	1	0	0
1976-1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977-1978	0	0	41	25	33	22	14	14	12	8	5	4	0	0	0	0	0	0
1978-1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	0	0	26	19	16	8	3	2	1	1	1	1	0	0	0	0	0	0
1981-1982	0	0	42	25	28	21	15	14	1	1	1	1	1	1	0	0	0	0
1982-1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	5	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
1985-1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986-1987	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987-1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988-1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989-1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990-1991	0	0	7	7	4	2	1	1	1	1	0	0	0	0	0	0	0	0
1991-1992	0	0	40	17	17	6	3	3	0	0	0	0	0	0	0	0	0	0
1992-1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997-1998	0	0	16	8	4	2	1	1	0	0	0	0	0	0	0	0	0	0
1998-1999	0	0	40	25	30	21	23	9	21	13	19	11	20	7	19	6	14	5
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	0	0	27	7	11	7	8	5	2	2	1	1	0	0	0	0	0	0
2001-2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002-2003	0	0	18	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2003-2004	0	0	14	7	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	47	13	26	9	8	4	2	1	0	0	0	0	0	0	0	0
2006-2007	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007-2008	0	0	31	14	30	11	13	5	8	4	4	4	0	0	0	0	0	0
2008-2009	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009-2010	0	0	45	22	34	14	22	9	18	6	5	3	1	1	0	0	0	0
2010-2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011-2012	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2012-2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014-2015	0	0	40	21	26	9	3	2	1	1	0	0	0	0	0	0	0	0
2015-2016	0	0	9	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2016-2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017-2018	0	0	15	15	6	4	0	0	0	0	0	0	0	0	0	0	0	0
2018-2019	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019-2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	0	0	12	7	7	5	4	3	3	2	1	1	0	0	0	0	0	0
Maximum	0	0	78	75	74	70	56	54	55	40	19	11	20	7	19	6	14	5

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1700 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 1700 L/s.

Figure 12: Manuherekia River at Ophir - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.5 Manuherekia River at Campground

Table 18: Manuherekia River at Campground – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	2075	365	612	858	1065	1203	1348	1584	1742
1 day MALF	3696	672	917	1143	1355	1509	1788	2271	2670
7 day MALF	4038	818	1031	1245	1457	1614	1885	2356	2768
1 percentile	2986	482	806	1060	1277	1441	1721	2217	2650
5 Percentile	3927	685	909	1203	1500	1700	2000	2499	2945
10 percentile	4750	1092	1171	1285	1507	1705	2004	2503	3002
20 percentile	6500	2464	2469	2477	2501	2524	2570	2647	3008
Median	13062	10151	10140	10134	10124	10126	10105	10069	10019
Average	17326	14602	14615	14635	14658	14677	14714	14783	14861

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 19: Manuherekia River at Campground – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	72	67	72	67	72	67	72	67	71	67	70	67	0	0	0	0
1974-1975	0	0	62	20	63	21	63	21	63	21	62	21	61	21	0	0	0	0
1975-1976	0	0	135	80	135	80	135	80	133	76	133	76	131	76	0	0	0	0
1976-1977	0	0	60	44	60	44	60	44	60	44	58	44	58	44	0	0	0	0
1977-1978	0	0	91	66	90	65	90	65	90	65	90	65	88	56	0	0	0	0
1978-1979	0	0	48	32	48	32	48	32	48	32	48	32	47	31	0	0	0	0
1979-1980	0	0	6	5	6	5	6	5	6	5	6	5	5	3	0	0	0	0
1980-1981	0	0	72	69	72	69	72	69	72	69	71	59	70	59	0	0	0	0
1981-1982	0	0	116	92	116	92	116	92	114	90	114	90	113	51	0	0	0	0
1982-1983	0	0	18	18	18	18	18	18	18	18	18	18	18	18	0	0	0	0
1983-1984	0	0	14	6	14	6	14	6	14	6	13	6	13	6	0	0	0	0
1984-1985	0	0	82	37	82	37	82	37	82	37	80	35	78	34	0	0	0	0
1985-1986	0	0	34	25	34	25	34	25	34	25	34	25	33	25	0	0	0	0
1986-1987	0	0	38	30	38	30	37	30	37	30	36	29	36	29	0	0	0	0
1987-1988	0	0	70	18	70	18	70	18	69	18	68	18	59	10	0	0	0	0
1988-1989	0	0	42	40	42	40	42	40	42	40	42	40	41	36	0	0	0	0
1989-1990	0	0	90	41	90	41	88	40	88	40	88	40	86	40	0	0	0	0
1990-1991	0	0	103	45	103	45	103	45	101	45	100	40	97	40	0	0	0	0
1991-1992	0	0	83	47	83	51	81	46	81	46	80	46	78	45	0	0	0	0
1992-1993	0	0	62	15	62	15	62	15	59	13	58	13	50	12	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	48	22	48	22	48	22	46	22	45	22	43	22	0	0	0	0
1995-1996	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
1996-1997	0	0	21	12	21	12	21	12	21	12	19	12	19	12	0	0	0	0
1997-1998	0	0	75	35	75	35	74	35	74	35	74	35	71	35	0	0	0	0
1998-1999	0	0	73	65	72	65	72	65	72	65	71	39	71	39	23	10	24	11
1999-2000	0	0	14	14	14	14	14	14	14	14	14	14	14	14	0	0	0	0
2000-2001	0	0	94	54	92	53	92	53	91	52	91	52	85	36	0	0	0	0
2001-2002	0	0	60	44	60	44	60	44	60	44	60	44	60	44	0	0	0	0
2002-2003	0	0	69	35	69	35	68	35	68	35	67	34	63	34	0	0	0	0
2003-2004	0	0	60	33	60	33	60	33	59	33	59	33	59	33	0	0	0	0
2004-2005	0	0	5	4	5	4	5	4	5	4	5	4	5	4	0	0	0	0
2005-2006	0	0	136	64	137	64	135	43	131	43	129	43	126	43	0	0	0	0
2006-2007	0	0	82	41	82	41	82	41	83	41	83	41	79	39	0	0	0	0
2007-2008	0	0	82	26	81	26	80	26	79	26	77	26	71	21	0	0	0	0
2008-2009	0	0	61	32	61	32	61	32	59	32	57	32	54	32	0	0	0	0
2009-2010	0	0	123	42	121	42	120	42	116	29	116	29	116	29	0	0	0	0
2010-2011	0	0	35	27	35	27	35	27	34	27	34	27	33	27	0	0	0	0
2011-2012	0	0	38	25	38	25	38	25	38	25	36	25	36	25	0	0	0	0
2012-2013	0	0	58	26	58	26	58	26	58	26	58	26	51	26	0	0	0	0
2013-2014	0	0	91	33	91	33	91	33	90	33	89	31	88	31	0	0	0	0
2014-2015	0	0	109	73	108	73	106	66	102	66	101	66	95	66	3	2	3	2
2015-2016	0	0	107	26	108	26	107	26	106	26	105	26	101	26	0	0	0	0
2016-2017	0	0	47	23	47	23	47	23	47	23	47	23	41	22	0	0	0	0
2017-2018	0	0	66	60	66	60	66	60	66	60	66	60	65	60	0	0	1	1
2018-2019	0	0	43	33	43	33	43	33	43	33	42	33	41	33	0	0	0	0
2019-2020	0	0	47	22	47	22	47	22	44	22	40	21	40	21	0	0	0	0
Median	0	0	62	33	62	33	62	33	60	32	60	32	59	31	0	0	0	0
Mean	0	0	63	36	63	36	62	35	61	34	61	33	59	31	1	0	1	0
Maximum	0	0	136	92	137	92	135	92	133	90	133	90	131	76	23	10	24	11

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 2019 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 2019 L/s.

Figure 13: Manuherekia River at Campground - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

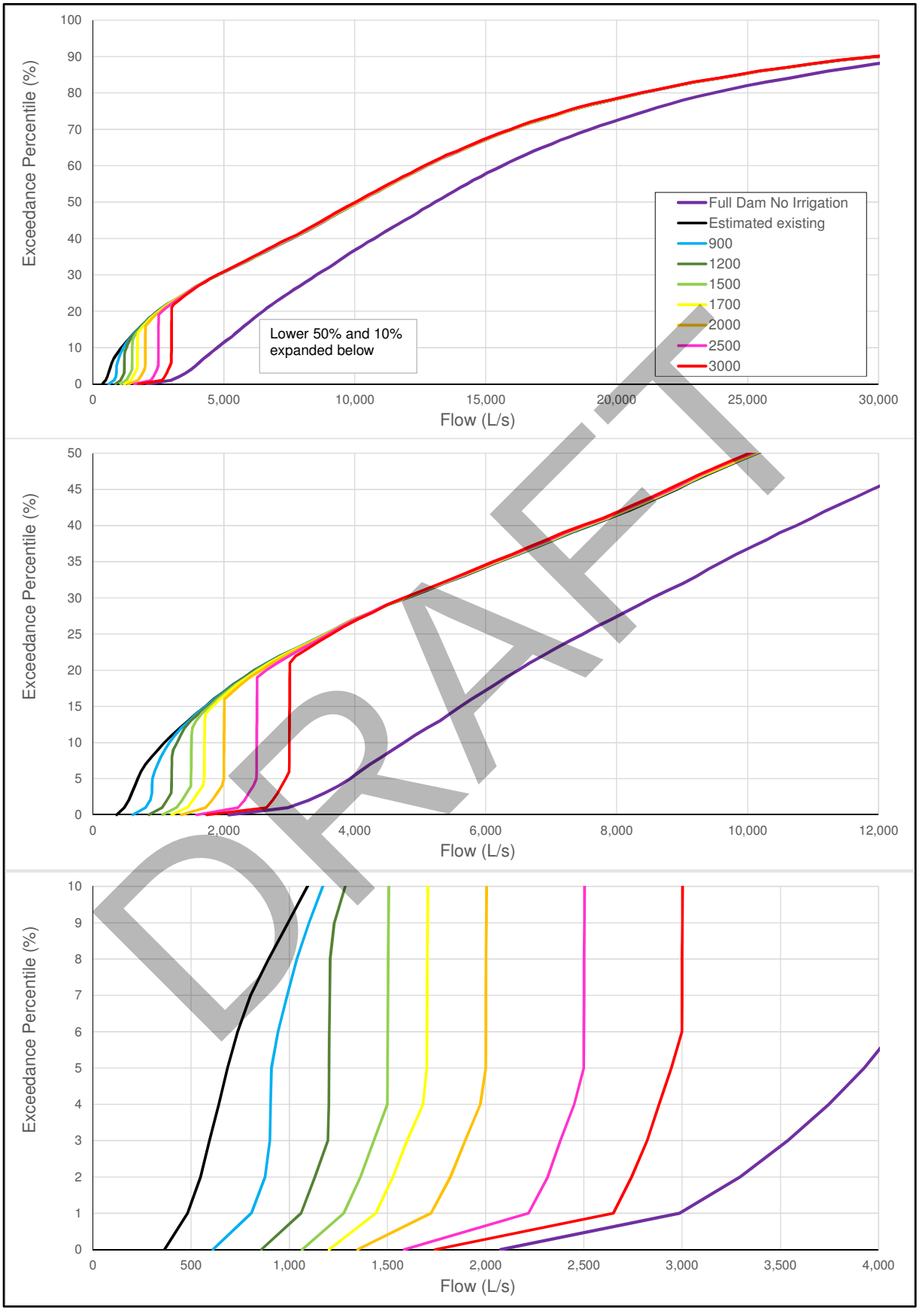


Figure 14: Manuherekia River at Campground - Flow Hydrograph 1 June 2014 to 31 May 2015.

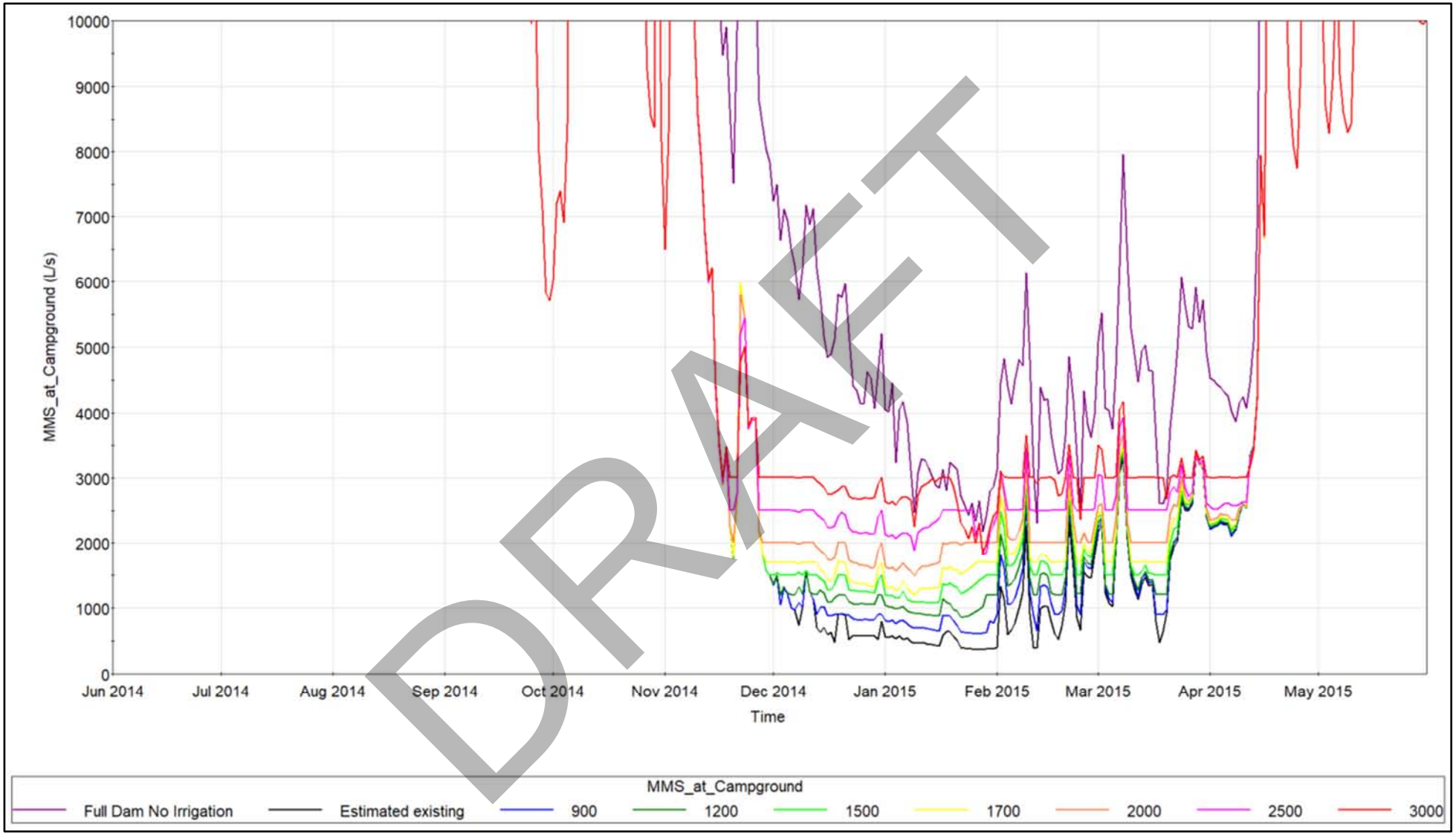


Table 20: Manuherekia River at Campground – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	2075	365	612	858	1065	1203	1348	1584	1742
1 day MALF	3734	672	917	1143	1355	1509	1788	2271	2670
7 day MALF	4107	818	1031	1245	1457	1614	1885	2356	2768
1 percentile	2924	457	769	1028	1239	1397	1681	2179	2583
5 Percentile	3667	608	903	1200	1454	1622	1917	2402	2843
10 percentile	4268	774	971	1205	1502	1702	2001	2500	3000
20 percentile	5531	1486	1500	1534	1598	1708	2007	2505	3004
Median	11444	6611	6611	6605	6585	6579	6563	6551	6533
Average	16044	12109	12136	12170	12210	12243	12305	12424	12555

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

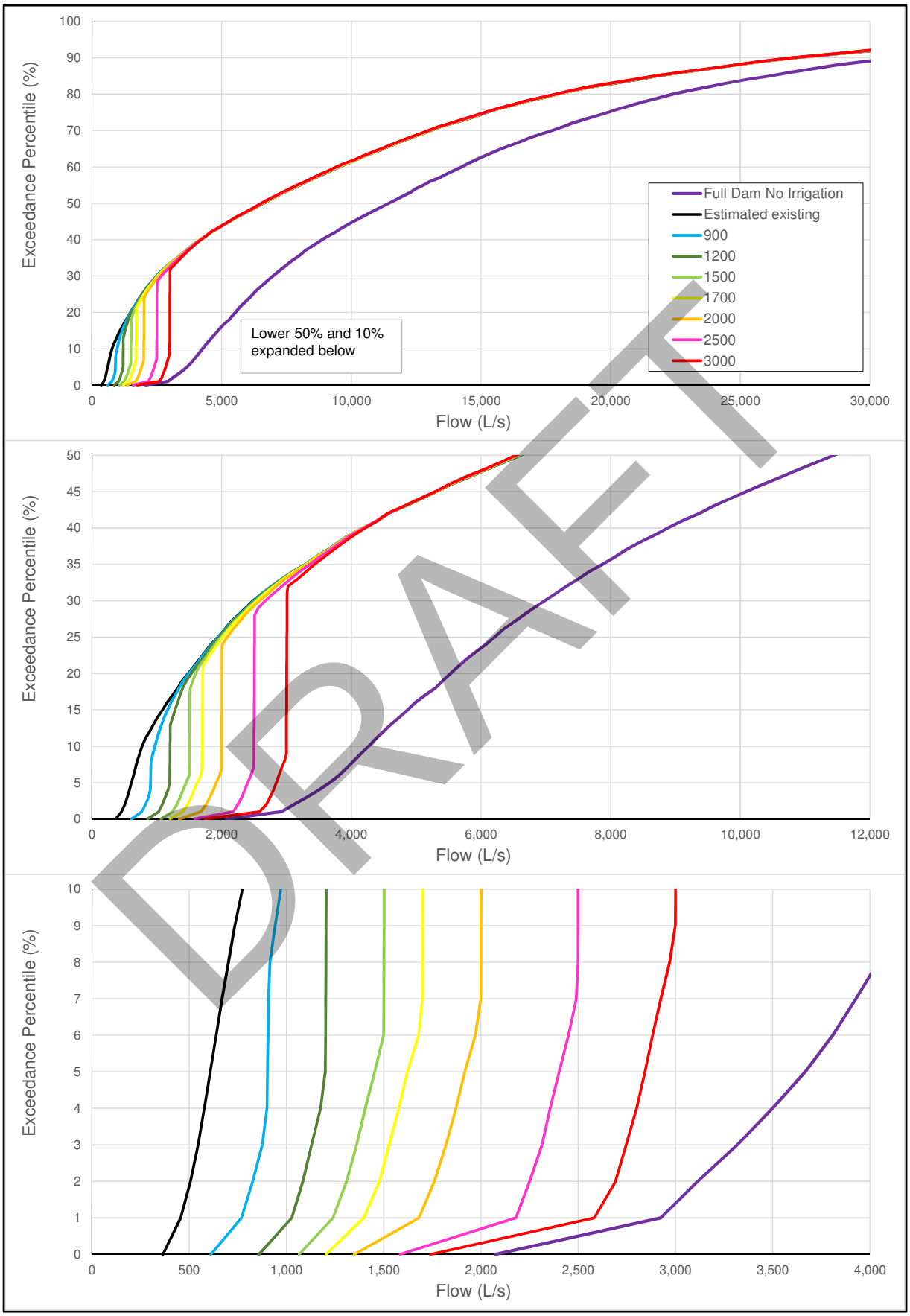
Table 21: Manuherekia River at Campground – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	72	67	72	67	72	67	72	67	71	67	70	67	0	0	0	0
1974-1975	0	0	62	20	63	21	63	21	63	21	62	21	61	21	0	0	0	0
1975-1976	0	0	135	80	135	80	135	80	133	76	133	76	131	76	0	0	0	0
1976-1977	0	0	60	44	60	44	60	44	60	44	58	44	58	44	0	0	0	0
1977-1978	0	0	91	66	90	65	90	65	90	65	90	65	88	56	0	0	0	0
1978-1979	0	0	48	32	48	32	48	32	48	32	48	32	47	31	0	0	0	0
1979-1980	0	0	6	5	6	5	6	5	6	5	6	5	5	3	0	0	0	0
1980-1981	0	0	72	69	72	69	72	69	72	69	71	59	70	59	0	0	0	0
1981-1982	0	0	116	92	116	92	116	92	114	90	114	90	113	51	0	0	0	0
1982-1983	0	0	18	18	18	18	18	18	18	18	18	18	18	18	0	0	0	0
1983-1984	0	0	14	6	14	6	14	6	14	6	13	6	13	6	0	0	0	0
1984-1985	0	0	82	37	82	37	82	37	82	37	80	35	78	34	0	0	0	0
1985-1986	0	0	34	25	34	25	34	25	34	25	34	25	33	25	0	0	0	0
1986-1987	0	0	38	30	38	30	37	30	37	30	36	29	36	29	0	0	0	0
1987-1988	0	0	70	18	70	18	70	18	69	18	68	18	59	10	0	0	0	0
1988-1989	0	0	42	40	42	40	42	40	42	40	42	40	41	36	0	0	0	0
1989-1990	0	0	90	41	90	41	88	40	88	40	88	40	86	40	0	0	0	0
1990-1991	0	0	103	45	103	45	103	45	101	45	100	40	97	40	0	0	0	0
1991-1992	0	0	83	47	83	51	81	46	81	46	80	46	78	45	0	0	0	0
1992-1993	0	0	62	15	62	15	62	15	59	13	58	13	50	12	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	48	22	48	22	48	22	46	22	45	22	43	22	0	0	0	0
1995-1996	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
1996-1997	0	0	21	12	21	12	21	12	21	12	19	12	19	12	0	0	0	0
1997-1998	0	0	75	35	75	35	74	35	74	35	74	35	71	35	0	0	0	0
1998-1999	0	0	73	65	72	65	72	65	72	65	71	39	71	39	23	10	24	11
1999-2000	0	0	14	14	14	14	14	14	14	14	14	14	14	14	0	0	0	0
2000-2001	0	0	88	54	86	53	86	53	85	52	85	52	80	36	0	0	0	0
2001-2002	0	0	60	44	60	44	60	44	60	44	60	44	60	44	0	0	0	0
2002-2003	0	0	69	35	69	35	68	35	68	35	67	34	63	34	0	0	0	0
2003-2004	0	0	60	33	60	33	60	33	59	33	59	33	59	33	0	0	0	0
2004-2005	0	0	5	4	5	4	5	4	5	4	5	4	5	4	0	0	0	0
2005-2006	0	0	136	64	137	64	135	43	131	43	129	43	126	43	0	0	0	0
2006-2007	0	0	82	41	82	41	82	41	83	41	83	41	79	39	0	0	0	0
2007-2008	0	0	82	26	81	26	80	26	79	26	77	26	71	21	0	0	0	0
2008-2009	0	0	61	32	61	32	61	32	59	32	57	32	54	32	0	0	0	0
2009-2010	0	0	123	42	121	42	120	42	116	29	116	29	116	29	0	0	0	0
2010-2011	0	0	35	27	35	27	35	27	34	27	34	27	33	27	0	0	0	0
2011-2012	0	0	38	25	38	25	38	25	38	25	36	25	36	25	0	0	0	0
2012-2013	0	0	58	26	58	26	58	26	58	26	58	26	51	26	0	0	0	0
2013-2014	0	0	91	33	91	33	91	33	90	33	89	31	88	31	0	0	0	0
2014-2015	0	0	109	73	108	73	106	66	102	66	101	66	95	66	3	2	3	2
2015-2016	0	0	105	26	106	26	105	26	104	26	103	26	99	26	0	0	0	0
2016-2017	0	0	47	23	47	23	47	23	47	23	47	23	41	22	0	0	0	0
2017-2018	0	0	66	60	66	60	66	60	66	60	66	60	65	60	0	0	1	1
2018-2019	0	0	43	33	43	33	43	33	43	33	42	33	41	33	0	0	0	0
2019-2020	0	0	47	22	47	22	47	22	44	22	40	21	40	21	0	0	0	0
Median	0	0	62	33	62	33	62	33	60	32	60	32	59	31	0	0	0	0
Mean	0	0	62	36	62	36	62	35	61	34	61	33	59	31	1	0	1	0
Maximum	0	0	136	92	137	92	135	92	133	90	133	90	131	76	23	10	24	11

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 2019 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 2019 L/s.

Figure 15: Manuherekia River at Campground - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.6 Dunstan Creek at Confluence

Table 22: Dunstan Creek at Confluence – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	543	38	39	409	509	543	543	543	543
1 day MALF	1004	197	202	450	539	602	692	830	921
7 day MALF	1111	267	273	476	558	620	709	853	967
1 percentile	880	61	67	411	511	580	680	849	880
5 Percentile	1101	280	317	416	515	584	683	851	1020
10 percentile	1286	516	541	556	586	604	687	854	1022
20 percentile	1638	1040	1044	1046	1051	1055	1062	1076	1096
Median	2927	2501	2501	2501	2502	2502	2502	2504	2504
Average	3974	3505	3509	3524	3534	3541	3554	3579	3607

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 23: Dunstan Creek at Confluence – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	50	37	49	33	46	32	44	31	0	0	0	0	0	0	0	0
1974-1975	0	0	7	3	7	3	7	3	7	3	0	0	0	0	0	0	0	0
1975-1976	0	0	102	83	84	32	79	32	64	32	0	0	0	0	0	0	0	0
1976-1977	0	0	36	32	36	32	36	32	36	32	0	0	0	0	0	0	0	0
1977-1978	0	0	76	66	68	56	61	53	57	49	0	0	0	0	0	0	0	0
1978-1979	0	0	22	13	22	13	22	13	22	13	0	0	0	0	0	0	0	0
1979-1980	0	0	5	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0
1980-1981	0	0	52	32	52	32	51	32	48	28	0	0	0	0	0	0	0	0
1981-1982	0	0	81	50	70	39	66	35	59	23	0	0	0	0	0	0	0	0
1982-1983	0	0	11	8	11	8	11	8	11	8	0	0	0	0	0	0	0	0
1983-1984	0	0	4	3	4	3	4	3	4	3	0	0	0	0	0	0	0	0
1984-1985	0	0	69	34	69	34	69	34	69	34	0	0	0	0	0	0	0	0
1985-1986	0	0	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0	0
1986-1987	0	0	20	17	20	17	20	17	20	17	0	0	0	0	0	0	0	0
1987-1988	0	0	41	15	41	15	41	15	41	15	0	0	0	0	0	0	0	0
1988-1989	0	0	26	14	26	14	25	13	25	13	0	0	0	0	0	0	0	0
1989-1990	0	0	41	24	41	24	40	23	39	22	0	0	0	0	0	0	0	0
1990-1991	0	0	69	25	67	15	57	13	49	13	0	0	0	0	0	0	0	0
1991-1992	0	0	78	50	71	45	70	43	58	31	0	0	0	0	0	0	0	0
1992-1993	0	0	29	11	29	11	29	11	29	11	0	0	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	29	25	29	25	29	25	24	13	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	15	9	15	9	15	9	15	9	0	0	0	0	0	0	0	0
1997-1998	0	0	32	15	30	15	28	15	26	9	0	0	0	0	0	0	0	0
1998-1999	0	0	48	28	43	28	41	28	36	28	0	0	0	0	0	0	0	0
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	0	0	82	61	78	61	78	61	73	50	0	0	0	0	0	0	0	0
2001-2002	0	0	33	31	33	31	33	31	33	31	0	0	0	0	0	0	0	0
2002-2003	0	0	53	35	51	35	51	35	50	34	0	0	0	0	0	0	0	0
2003-2004	0	0	33	23	29	23	23	23	22	13	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	113	27	103	27	92	27	76	26	0	0	0	0	0	0	0	0
2006-2007	0	0	55	26	55	26	55	26	54	25	0	0	0	0	0	0	0	0
2007-2008	0	0	89	22	83	22	81	22	77	21	0	0	0	0	0	0	0	0
2008-2009	0	0	28	27	28	27	28	27	27	20	0	0	0	0	0	0	0	0
2009-2010	0	0	93	32	86	31	80	30	70	25	0	0	0	0	0	0	0	0
2010-2011	0	0	10	5	10	5	10	5	10	5	0	0	0	0	0	0	0	0
2011-2012	0	0	23	12	23	12	23	12	23	12	0	0	0	0	0	0	0	0
2012-2013	0	0	32	10	32	10	31	10	30	10	0	0	0	0	0	0	0	0
2013-2014	0	0	45	15	45	15	45	15	43	15	0	0	0	0	0	0	0	0
2014-2015	1	1	54	32	49	23	47	22	46	22	1	1	1	1	1	1	1	1
2015-2016	0	0	52	14	48	14	47	14	39	13	0	0	0	0	0	0	0	0
2016-2017	0	0	16	8	16	8	16	8	16	8	0	0	0	0	0	0	0	0
2017-2018	0	0	28	15	25	12	23	11	17	11	0	0	0	0	0	0	0	0
2018-2019	0	0	29	17	29	17	29	17	29	17	0	0	0	0	0	0	0	0
2019-2020	0	0	61	17	61	17	61	17	61	17	0	0	0	0	0	0	0	0
Median	0	0	33	17	32	17	31	17	30	15	0	0	0	0	0	0	0	0
Mean	0	0	40	22	38	20	37	20	34	18	0	0	0	0	0	0	0	0
Maximum	1	1	113	83	103	61	92	61	77	50	1	1	1	1	1	1	1	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 556 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 556 L/s.

Figure 16: Dunstan Creek at Confluence - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

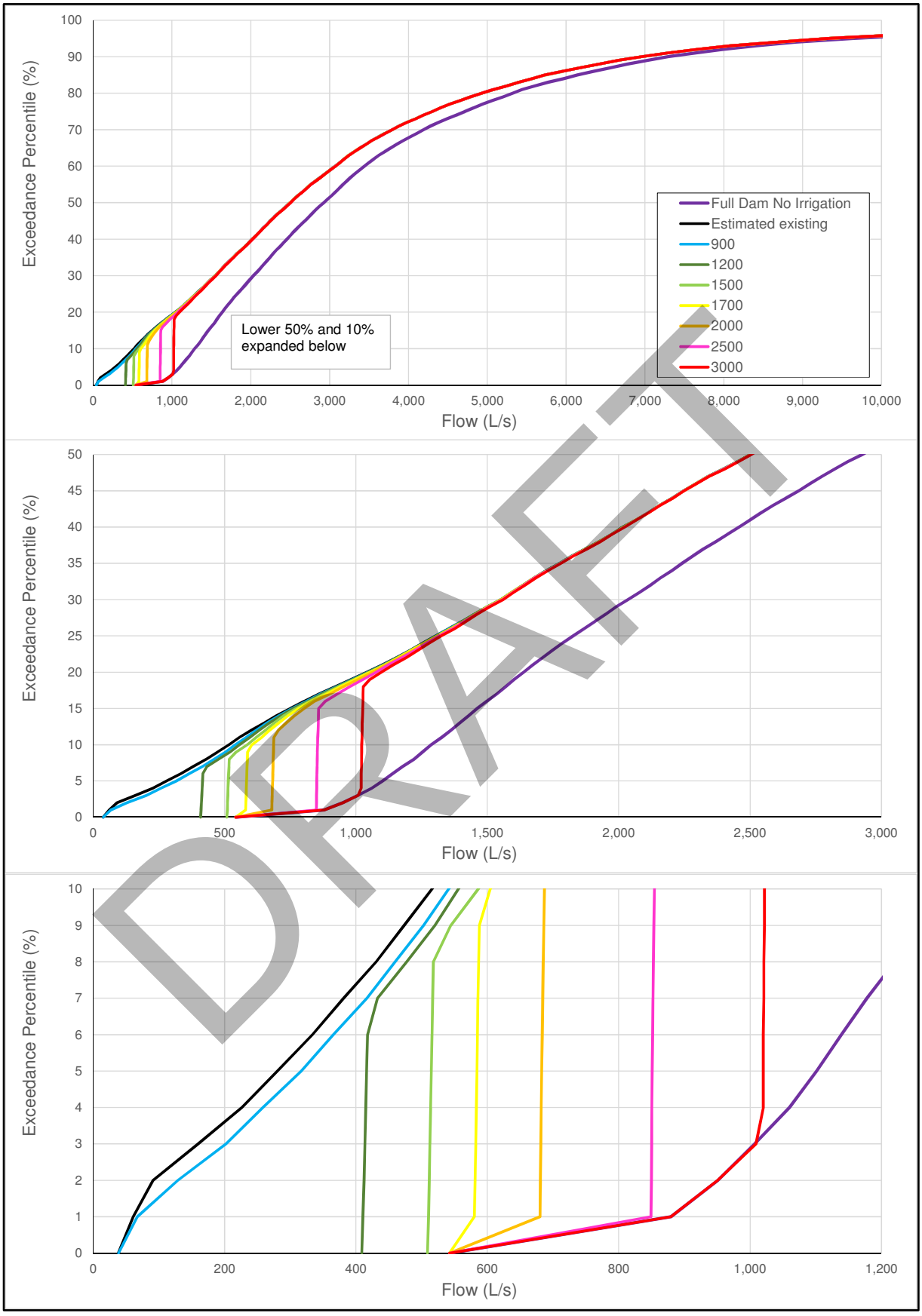


Figure 17: Dunstan Creek at Confluence - Flow Hydrograph 1 June 2014 to 31 May 2015.

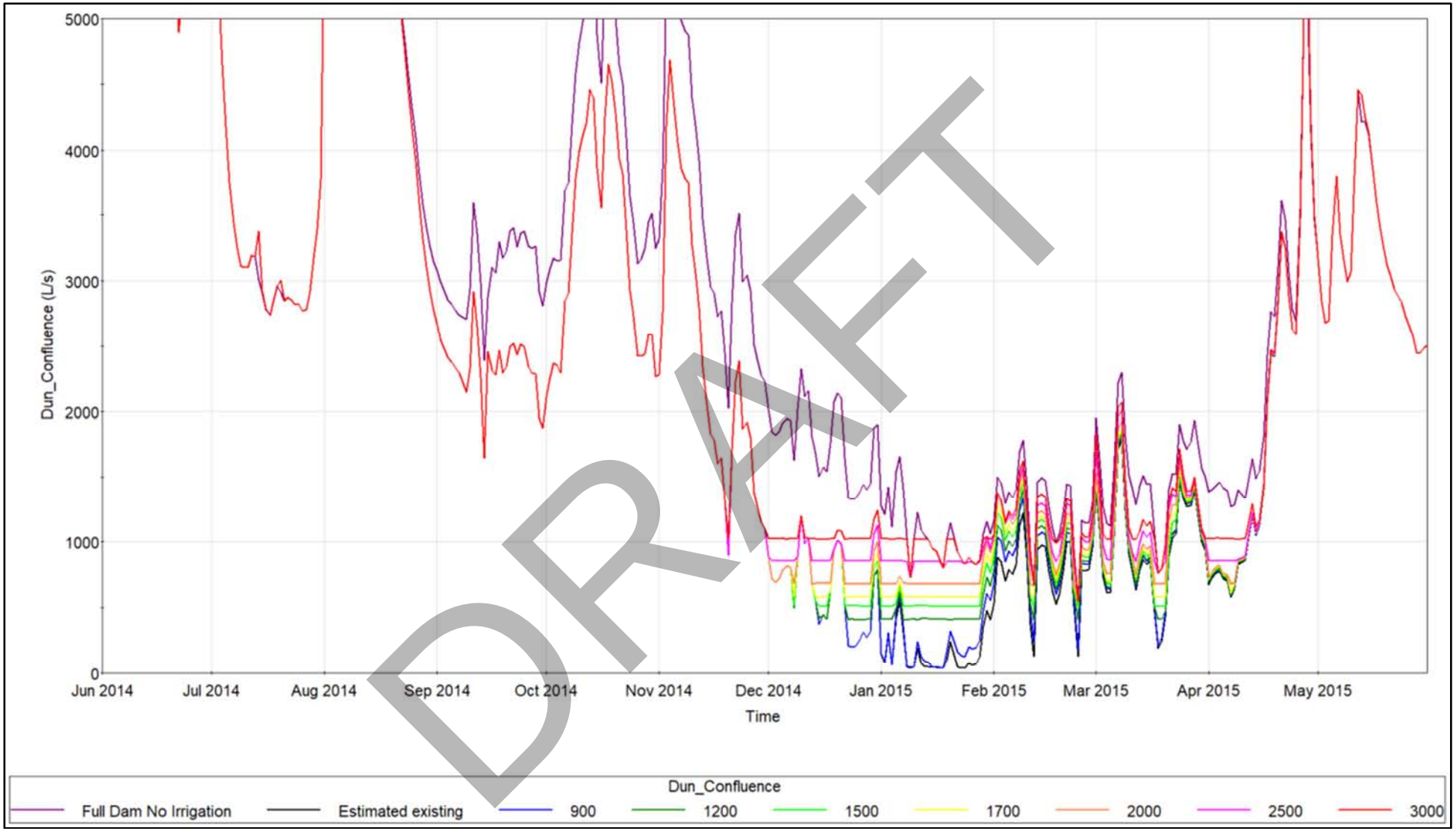


Table 24: Dunstan Creek at Confluence – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	543	38	39	409	509	543	543	543	543
1 day MALF	1050	197	202	450	539	602	692	834	935
7 day MALF	1162	280	286	489	571	633	722	870	987
1 percentile	853	54	59	410	510	580	680	849	853
5 Percentile	1048	182	222	414	513	583	682	850	1020
10 percentile	1208	363	399	419	516	586	684	852	1021
20 percentile	1526	664	677	686	704	720	748	857	1025
Median	2904	2125	2125	2125	2125	2126	2128	2130	2133
Average	4029	3297	3304	3326	3341	3352	3371	3409	3451

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

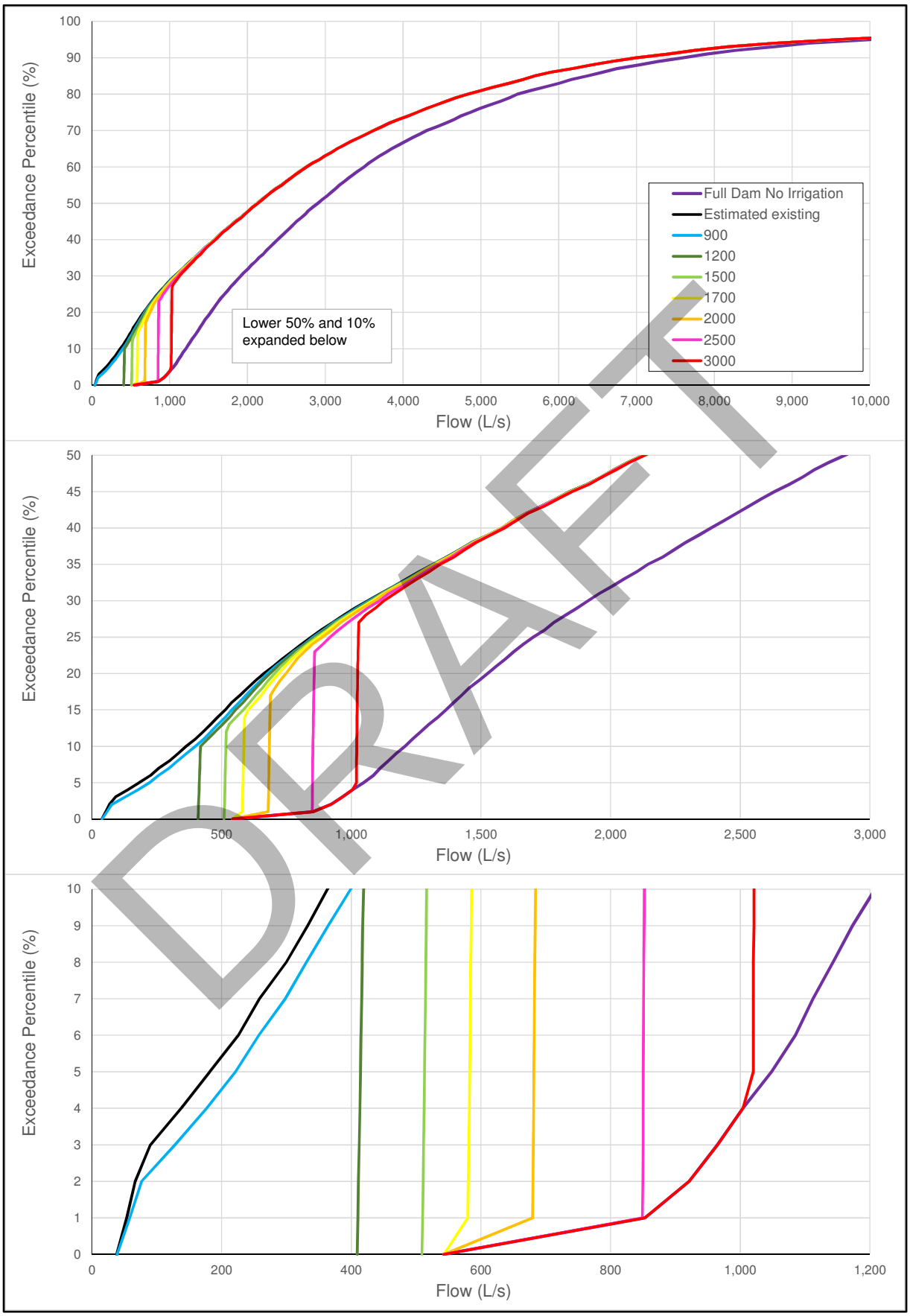
Table 25: Dunstan Creek at Confluence – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	50	37	49	33	46	32	44	31	0	0	0	0	0	0	0	0
1974-1975	0	0	7	3	7	3	7	3	7	3	0	0	0	0	0	0	0	0
1975-1976	0	0	102	83	84	32	79	32	64	32	0	0	0	0	0	0	0	0
1976-1977	0	0	36	32	36	32	36	32	36	32	0	0	0	0	0	0	0	0
1977-1978	0	0	76	66	68	56	61	53	57	49	0	0	0	0	0	0	0	0
1978-1979	0	0	22	13	22	13	22	13	22	13	0	0	0	0	0	0	0	0
1979-1980	0	0	5	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0
1980-1981	0	0	52	32	52	32	51	32	48	28	0	0	0	0	0	0	0	0
1981-1982	0	0	81	50	70	39	66	35	59	23	0	0	0	0	0	0	0	0
1982-1983	0	0	11	8	11	8	11	8	11	8	0	0	0	0	0	0	0	0
1983-1984	0	0	4	3	4	3	4	3	4	3	0	0	0	0	0	0	0	0
1984-1985	0	0	69	34	69	34	69	34	69	34	0	0	0	0	0	0	0	0
1985-1986	0	0	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0	0
1986-1987	0	0	20	17	20	17	20	17	20	17	0	0	0	0	0	0	0	0
1987-1988	0	0	41	15	41	15	41	15	41	15	0	0	0	0	0	0	0	0
1988-1989	0	0	26	14	26	14	25	13	25	13	0	0	0	0	0	0	0	0
1989-1990	0	0	41	24	41	24	40	23	39	22	0	0	0	0	0	0	0	0
1990-1991	0	0	69	25	67	15	57	13	49	13	0	0	0	0	0	0	0	0
1991-1992	0	0	78	50	71	45	70	43	58	31	0	0	0	0	0	0	0	0
1992-1993	0	0	29	11	29	11	29	11	29	11	0	0	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	29	25	29	25	29	25	24	13	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	15	9	15	9	15	9	15	9	0	0	0	0	0	0	0	0
1997-1998	0	0	32	15	30	15	28	15	26	9	0	0	0	0	0	0	0	0
1998-1999	0	0	48	28	43	28	41	28	36	28	0	0	0	0	0	0	0	0
1999-2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000-2001	0	0	81	61	77	61	77	61	72	50	0	0	0	0	0	0	0	0
2001-2002	0	0	33	31	33	31	33	31	33	31	0	0	0	0	0	0	0	0
2002-2003	0	0	53	35	51	35	51	35	50	34	0	0	0	0	0	0	0	0
2003-2004	0	0	33	23	29	23	23	23	22	13	0	0	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	113	27	103	27	92	27	76	26	0	0	0	0	0	0	0	0
2006-2007	0	0	55	26	55	26	55	26	54	25	0	0	0	0	0	0	0	0
2007-2008	0	0	89	22	83	22	81	22	77	21	0	0	0	0	0	0	0	0
2008-2009	0	0	28	27	28	27	28	27	27	20	0	0	0	0	0	0	0	0
2009-2010	0	0	93	32	86	31	80	30	70	25	0	0	0	0	0	0	0	0
2010-2011	0	0	10	5	10	5	10	5	10	5	0	0	0	0	0	0	0	0
2011-2012	0	0	23	12	23	12	23	12	23	12	0	0	0	0	0	0	0	0
2012-2013	0	0	32	10	32	10	31	10	30	10	0	0	0	0	0	0	0	0
2013-2014	0	0	45	15	45	15	45	15	43	15	0	0	0	0	0	0	0	0
2014-2015	1	1	54	32	49	23	47	22	46	22	1	1	1	1	1	1	1	1
2015-2016	0	0	52	14	48	14	47	14	39	13	0	0	0	0	0	0	0	0
2016-2017	0	0	16	8	16	8	16	8	16	8	0	0	0	0	0	0	0	0
2017-2018	0	0	28	15	25	12	23	11	17	11	0	0	0	0	0	0	0	0
2018-2019	0	0	29	17	29	17	29	17	29	17	0	0	0	0	0	0	0	0
2019-2020	0	0	60	17	60	17	60	17	60	17	0	0	0	0	0	0	0	0
Median	0	0	33	17	32	17	31	17	30	15	0	0	0	0	0	0	0	0
Mean	0	0	40	22	38	20	36	20	34	18	0	0	0	0	0	0	0	0
Maximum	1	1	113	83	103	61	92	61	77	50	1	1	1	1	1	1	1	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 556 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 556 L/s.

Figure 18: Dunstan Creek at Confluence - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.7 Lauder Creek at Confluence

Table 26: Lauder Creek at Confluence – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	173	12	12	129	159	173	173	173	173
1 day MALF	318	90	86	133	160	179	208	254	292
7 day MALF	346	103	99	141	167	186	215	261	305
1 percentile	278	53	45	130	160	180	209	259	278
5 Percentile	342	113	111	133	162	181	211	260	320
10 percentile	395	138	138	137	164	183	212	262	321
20 percentile	498	191	192	192	193	193	217	266	325
Median	922	756	757	757	757	757	757	756	756
Average	1256	1134	1134	1137	1140	1144	1150	1161	1174

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 27: Lauder Creek at Confluence – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	75	69	74	68	74	68	74	68	0	0	0	0	0	0	0	0
1974-1975	0	0	52	25	52	25	52	25	52	25	0	0	0	0	0	0	0	0
1975-1976	0	0	142	113	142	113	142	113	139	84	0	0	0	0	0	0	0	0
1976-1977	0	0	52	41	52	41	53	42	53	42	0	0	0	0	0	0	0	0
1977-1978	0	0	98	87	97	82	96	81	95	72	0	0	0	0	0	0	0	0
1978-1979	0	0	38	28	38	28	38	28	38	28	0	0	0	0	0	0	0	0
1979-1980	0	0	3	2	3	2	3	2	4	4	0	0	0	0	0	0	0	0
1980-1981	0	0	72	44	72	44	71	43	70	33	0	0	0	0	0	0	0	0
1981-1982	0	0	109	91	109	91	109	91	109	91	0	0	0	0	0	0	0	0
1982-1983	0	0	27	27	27	27	27	27	28	27	0	0	0	0	0	0	0	0
1983-1984	0	0	23	8	23	8	23	8	23	8	0	0	0	0	0	0	0	0
1984-1985	0	0	82	37	83	37	83	37	83	37	0	0	0	0	0	0	0	0
1985-1986	0	0	18	14	18	14	18	14	18	14	0	0	0	0	0	0	0	0
1986-1987	0	0	30	29	30	29	30	29	30	29	0	0	0	0	0	0	0	0
1987-1988	0	0	68	19	68	19	68	19	68	19	0	0	0	0	0	0	0	0
1988-1989	0	0	41	38	41	38	41	38	42	39	0	0	0	0	0	0	0	0
1989-1990	0	0	63	38	63	38	63	38	63	38	0	0	0	0	0	0	0	0
1990-1991	0	0	100	64	104	64	104	64	104	64	0	0	0	0	0	0	0	0
1991-1992	0	0	87	52	88	51	88	51	88	51	0	0	0	0	0	0	0	0
1992-1993	0	0	38	11	38	11	38	11	45	11	0	0	0	0	0	0	0	0
1993-1994	0	0	7	6	7	6	7	6	7	6	0	0	0	0	0	0	0	0
1994-1995	0	0	64	27	65	28	65	28	64	28	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	32	11	32	11	32	11	32	11	0	0	0	0	0	0	0	0
1997-1998	0	0	68	36	69	36	69	36	68	36	0	0	0	0	0	0	0	0
1998-1999	0	0	91	66	85	59	81	40	79	40	0	0	0	0	0	0	0	0
1999-2000	0	0	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0	0
2000-2001	0	0	93	71	92	61	91	61	90	61	0	0	0	0	0	0	0	0
2001-2002	0	0	41	41	41	41	41	41	41	41	0	0	0	0	0	0	0	0
2002-2003	0	0	67	39	66	38	67	38	66	38	0	0	0	0	0	0	0	0
2003-2004	0	0	54	33	54	33	54	33	54	33	0	0	0	0	0	0	0	0
2004-2005	0	0	7	4	7	4	7	4	7	4	0	0	0	0	0	0	0	0
2005-2006	0	0	133	66	132	66	132	66	132	66	0	0	0	0	0	0	0	0
2006-2007	0	0	62	38	62	38	62	38	65	38	0	0	0	0	0	0	0	0
2007-2008	0	0	108	26	108	26	108	26	112	26	0	0	0	0	0	0	0	0
2008-2009	0	0	69	31	69	31	69	31	69	31	0	0	0	0	0	0	0	0
2009-2010	0	0	135	43	135	43	135	32	132	31	0	0	0	0	0	0	0	0
2010-2011	0	0	37	25	37	25	37	25	37	25	0	0	0	0	0	0	0	0
2011-2012	0	0	49	26	49	26	49	26	49	26	0	0	0	0	0	0	0	0
2012-2013	0	0	45	24	45	24	45	24	47	24	0	0	0	0	0	0	0	0
2013-2014	0	0	76	42	76	42	76	42	80	43	0	0	0	0	0	0	0	0
2014-2015	1	1	115	72	110	71	104	65	96	65	1	1	1	1	1	1	1	1
2015-2016	0	0	100	20	102	21	105	25	104	22	0	0	0	0	0	0	0	0
2016-2017	0	0	75	25	75	25	75	25	75	25	0	0	0	0	0	0	0	0
2017-2018	0	0	68	37	68	37	68	37	68	37	0	0	0	0	0	0	0	0
2018-2019	0	0	30	18	30	18	30	18	30	18	0	0	0	0	0	0	0	0
2019-2020	0	0	30	16	30	16	34	16	45	16	0	0	0	0	0	0	0	0
Median	0	0	63	31	63	31	63	31	64	31	0	0	0	0	0	0	0	0
Mean	0	0	61	36	61	35	61	35	61	34	0	0	0	0	0	0	0	0
Maximum	1	1	142	113	142	113	142	113	139	91	1	1	1	1	1	1	1	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 173 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 173 L/s.

Figure 19: Lauder Creek at Confluence - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

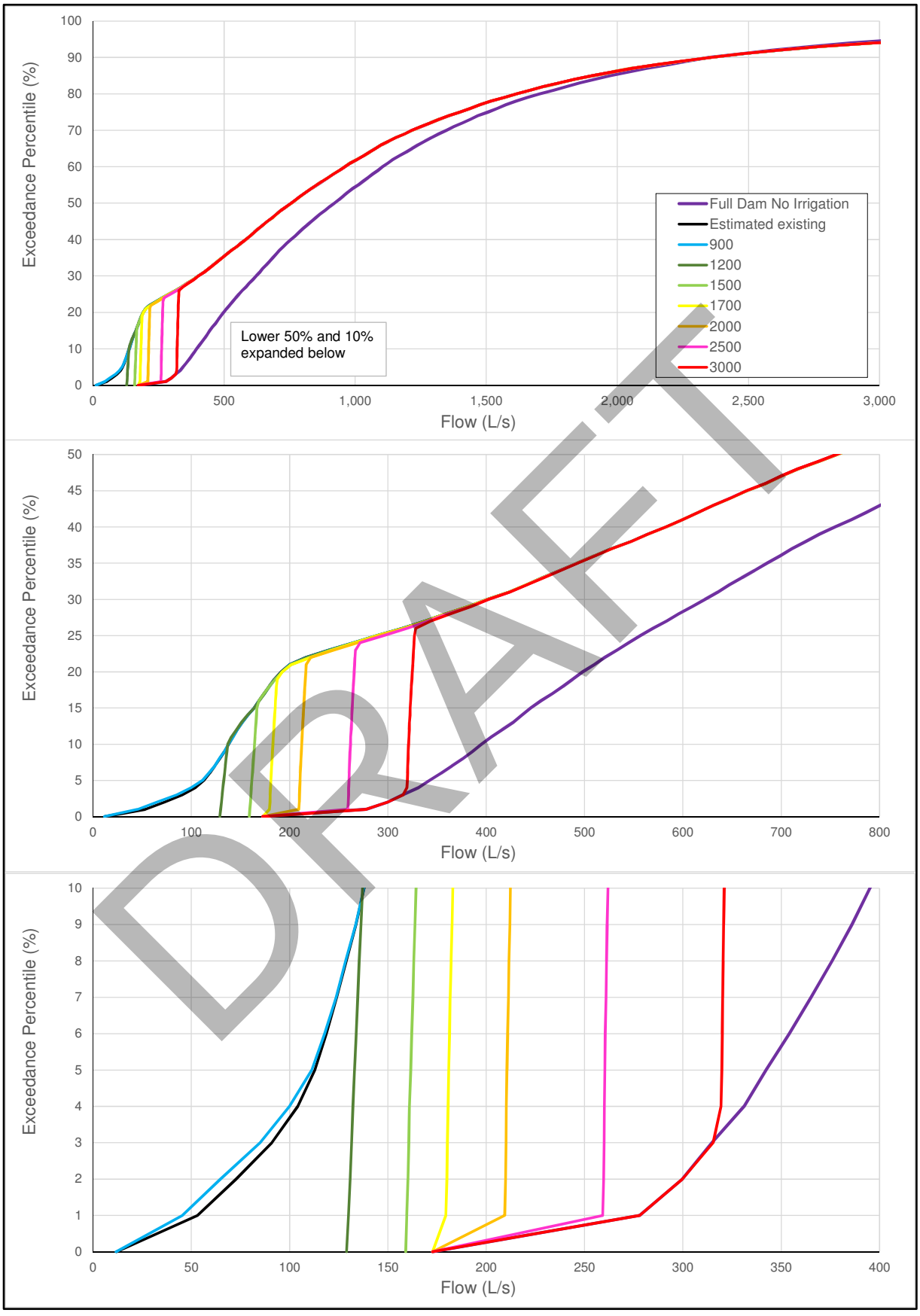


Figure 20: Lauder Creek at Confluence - Flow Hydrograph 1 June 2014 to 31 May 2015.

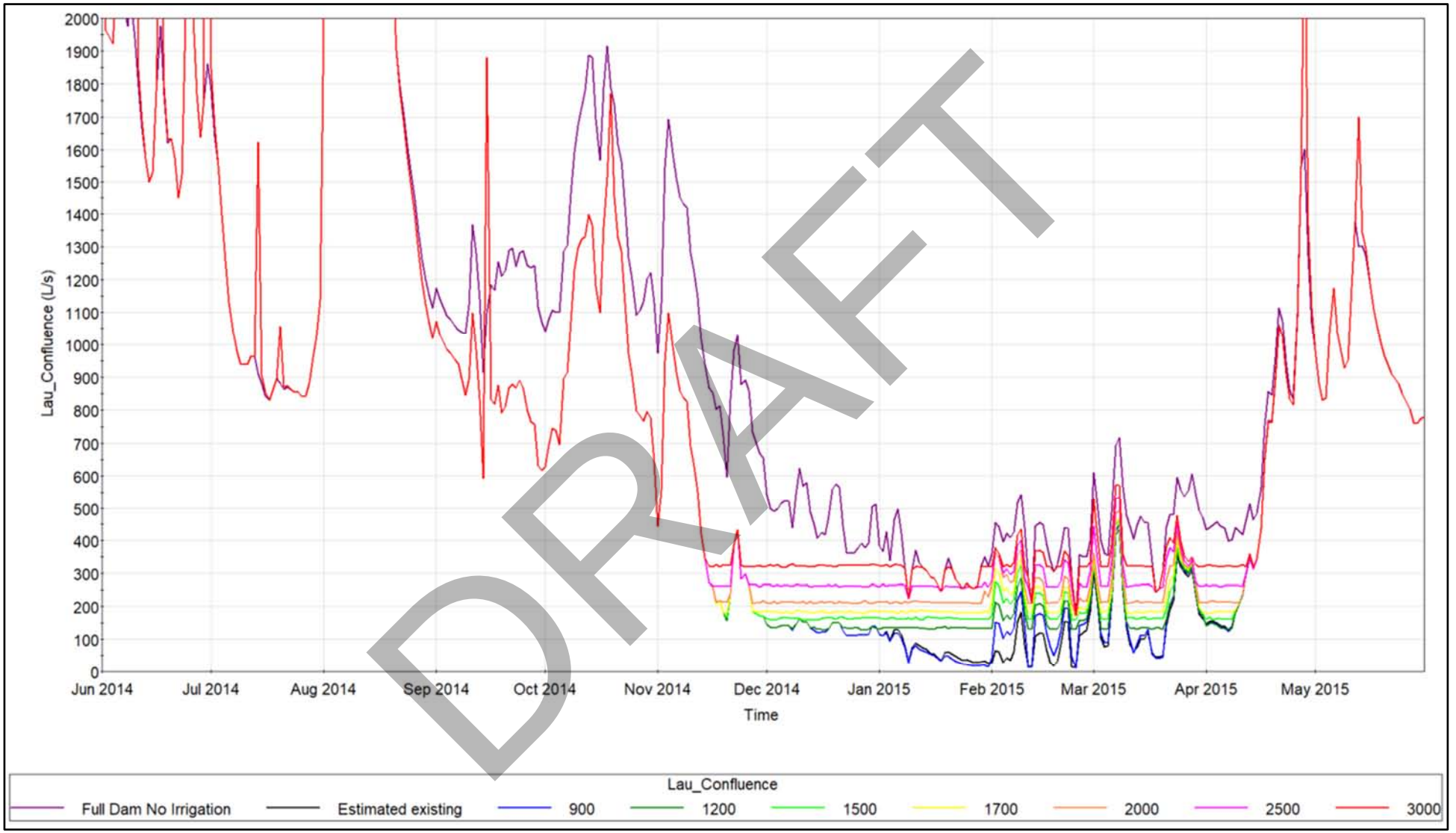


Table 28: Lauder Creek at Confluence – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	173	12	12	129	159	173	173	173	173
1 day MALF	331	90	86	133	160	179	208	255	296
7 day MALF	361	103	99	141	167	186	215	263	308
1 percentile	271	41	37	130	159	179	209	259	271
5 Percentile	327	94	90	132	161	180	210	260	319
10 percentile	371	122	122	134	163	182	211	261	320
20 percentile	458	153	153	152	166	185	214	263	322
Median	908	559	559	559	560	560	560	560	560
Average	1275	1033	1032	1037	1042	1047	1056	1073	1093

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

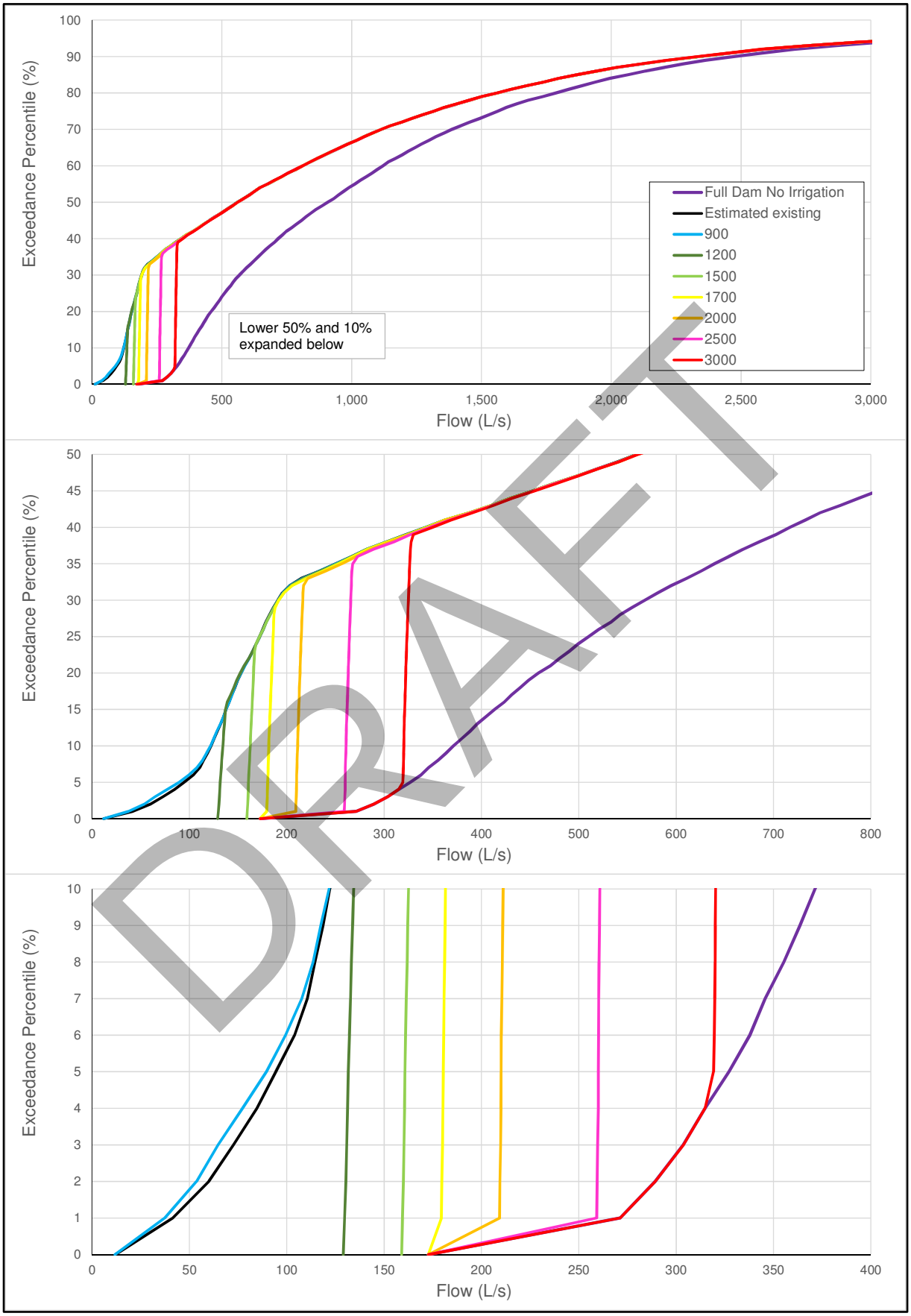
Table 29: Lauder Creek at Confluence – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	75	69	74	68	74	68	74	68	0	0	0	0	0	0	0	0
1974-1975	0	0	52	25	52	25	52	25	52	25	0	0	0	0	0	0	0	0
1975-1976	0	0	142	113	142	113	142	113	139	84	0	0	0	0	0	0	0	0
1976-1977	0	0	52	41	52	41	53	42	53	42	0	0	0	0	0	0	0	0
1977-1978	0	0	98	87	97	82	96	81	95	72	0	0	0	0	0	0	0	0
1978-1979	0	0	38	28	38	28	38	28	38	28	0	0	0	0	0	0	0	0
1979-1980	0	0	3	2	3	2	3	2	4	4	0	0	0	0	0	0	0	0
1980-1981	0	0	72	44	72	44	71	43	70	33	0	0	0	0	0	0	0	0
1981-1982	0	0	109	91	109	91	109	91	109	91	0	0	0	0	0	0	0	0
1982-1983	0	0	27	27	27	27	27	27	28	27	0	0	0	0	0	0	0	0
1983-1984	0	0	23	8	23	8	23	8	23	8	0	0	0	0	0	0	0	0
1984-1985	0	0	82	37	83	37	83	37	83	37	0	0	0	0	0	0	0	0
1985-1986	0	0	18	14	18	14	18	14	18	14	0	0	0	0	0	0	0	0
1986-1987	0	0	30	29	30	29	30	29	30	29	0	0	0	0	0	0	0	0
1987-1988	0	0	68	19	68	19	68	19	68	19	0	0	0	0	0	0	0	0
1988-1989	0	0	41	38	41	38	41	38	42	39	0	0	0	0	0	0	0	0
1989-1990	0	0	63	38	63	38	63	38	63	38	0	0	0	0	0	0	0	0
1990-1991	0	0	100	64	104	64	104	64	104	64	0	0	0	0	0	0	0	0
1991-1992	0	0	87	52	88	51	88	51	88	51	0	0	0	0	0	0	0	0
1992-1993	0	0	38	11	38	11	38	11	45	11	0	0	0	0	0	0	0	0
1993-1994	0	0	7	6	7	6	7	6	7	6	0	0	0	0	0	0	0	0
1994-1995	0	0	64	27	65	28	65	28	64	28	0	0	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	32	11	32	11	32	11	32	11	0	0	0	0	0	0	0	0
1997-1998	0	0	68	36	69	36	69	36	68	36	0	0	0	0	0	0	0	0
1998-1999	0	0	91	66	85	59	81	40	79	40	0	0	0	0	0	0	0	0
1999-2000	0	0	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0	0
2000-2001	0	0	93	71	92	61	91	61	90	61	0	0	0	0	0	0	0	0
2001-2002	0	0	41	41	41	41	41	41	41	41	0	0	0	0	0	0	0	0
2002-2003	0	0	67	39	66	38	67	38	66	38	0	0	0	0	0	0	0	0
2003-2004	0	0	54	33	54	33	54	33	54	33	0	0	0	0	0	0	0	0
2004-2005	0	0	7	4	7	4	7	4	7	4	0	0	0	0	0	0	0	0
2005-2006	0	0	133	66	132	66	132	66	132	66	0	0	0	0	0	0	0	0
2006-2007	0	0	62	38	62	38	62	38	65	38	0	0	0	0	0	0	0	0
2007-2008	0	0	108	26	108	26	108	26	112	26	0	0	0	0	0	0	0	0
2008-2009	0	0	69	31	69	31	69	31	69	31	0	0	0	0	0	0	0	0
2009-2010	0	0	135	43	135	43	135	32	132	31	0	0	0	0	0	0	0	0
2010-2011	0	0	37	25	37	25	37	25	37	25	0	0	0	0	0	0	0	0
2011-2012	0	0	49	26	49	26	49	26	49	26	0	0	0	0	0	0	0	0
2012-2013	0	0	45	24	45	24	45	24	47	24	0	0	0	0	0	0	0	0
2013-2014	0	0	76	42	76	42	76	42	80	43	0	0	0	0	0	0	0	0
2014-2015	1	1	115	72	110	71	104	65	96	65	1	1	1	1	1	1	1	1
2015-2016	0	0	98	20	100	21	103	25	102	22	0	0	0	0	0	0	0	0
2016-2017	0	0	75	25	75	25	75	25	75	25	0	0	0	0	0	0	0	0
2017-2018	0	0	68	37	68	37	68	37	68	37	0	0	0	0	0	0	0	0
2018-2019	0	0	30	18	30	18	30	18	30	18	0	0	0	0	0	0	0	0
2019-2020	0	0	30	16	30	16	34	16	45	16	0	0	0	0	0	0	0	0
Median	0	0	63	31	63	31	63	31	64	31	0	0	0	0	0	0	0	0
Mean	0	0	61	36	61	35	61	35	61	34	0	0	0	0	0	0	0	0
Maximum	1	1	142	113	142	113	142	113	139	91	1	1	1	1	1	1	1	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 173 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 173 L/s.

Figure 21: Lauder Creek at Confluence - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.8 Thomsons Creek at Confluence

Table 30: Thomsons Creek at Confluence – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	74	11	11	69	74	74	74	74	74
1 day MALF	167	32	31	72	82	91	109	133	149
7 day MALF	185	41	40	79	88	97	116	141	159
1 percentile	140	18	17	70	80	90	110	139	140
5 Percentile	181	27	28	72	82	92	111	140	170
10 percentile	216	53	55	75	84	94	114	142	171
20 percentile	290	152	153	153	154	154	154	156	176
Median	570	499	499	499	499	499	499	499	498
Average	777	731	731	736	737	738	741	746	751

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 31: Thomsons Creek at Confluence – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	68	66	66	66	66	66	66	66	23	16	0	0	0	0	0	0
1974-1975	0	0	43	11	43	11	43	11	43	11	13	3	0	0	0	0	0	0
1975-1976	0	0	142	114	142	114	141	85	137	74	68	22	0	0	0	0	0	0
1976-1977	0	0	45	32	45	32	45	32	45	32	27	16	0	0	0	0	0	0
1977-1978	0	0	89	81	87	72	86	72	84	71	44	11	0	0	0	0	0	0
1978-1979	0	0	35	28	35	28	35	28	35	28	17	4	0	0	0	0	0	0
1979-1980	0	0	5	5	5	5	5	5	5	5	2	2	0	0	0	0	0	0
1980-1981	0	0	65	33	64	33	64	33	63	33	27	8	0	0	0	0	0	0
1981-1982	0	0	106	90	105	89	105	89	102	78	40	8	0	0	0	0	0	0
1982-1983	0	0	25	12	25	12	25	12	25	12	14	6	0	0	0	0	0	0
1983-1984	0	0	12	6	12	6	12	6	12	6	5	1	0	0	0	0	0	0
1984-1985	0	0	86	37	86	37	86	37	86	37	46	10	0	0	0	0	0	0
1985-1986	0	0	22	17	22	17	22	17	22	17	12	6	0	0	0	0	0	0
1986-1987	0	0	28	28	28	28	28	28	28	28	8	3	0	0	0	0	0	0
1987-1988	0	0	62	18	62	18	62	18	62	18	28	7	0	0	0	0	0	0
1988-1989	0	0	37	36	37	36	37	36	37	36	10	5	0	0	0	0	0	0
1989-1990	0	0	58	35	58	35	58	35	58	35	24	8	0	0	0	0	0	0
1990-1991	0	0	100	64	100	64	97	64	95	64	38	5	0	0	0	0	0	0
1991-1992	0	0	83	51	82	50	81	49	80	48	33	10	0	0	0	0	0	0
1992-1993	0	0	57	12	57	12	57	12	57	12	38	5	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	52	26	52	26	52	26	52	26	20	6	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	30	10	30	10	30	10	30	10	20	6	0	0	0	0	0	0
1997-1998	0	0	56	36	56	36	55	36	53	27	21	6	0	0	0	0	0	0
1998-1999	0	0	70	38	65	38	63	38	58	38	35	13	0	0	0	0	0	0
1999-2000	0	0	4	4	4	4	4	4	5	5	4	2	0	0	0	0	0	0
2000-2001	0	0	86	61	83	61	83	61	83	61	42	17	0	0	0	0	0	0
2001-2002	0	0	38	32	38	32	38	32	38	32	18	6	0	0	0	0	0	0
2002-2003	0	0	66	37	66	37	66	37	66	37	41	10	0	0	0	0	0	0
2003-2004	0	0	51	32	51	32	51	32	51	32	25	9	0	0	0	0	0	0
2004-2005	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
2005-2006	0	0	129	67	124	33	122	33	117	27	69	15	0	0	0	0	0	0
2006-2007	0	0	61	34	61	34	61	34	61	34	35	11	0	0	0	0	0	0
2007-2008	0	0	106	25	105	25	105	25	105	25	46	10	0	0	0	0	0	0
2008-2009	0	0	45	20	45	20	45	20	45	20	22	5	0	0	0	0	0	0
2009-2010	0	0	122	43	121	43	119	30	117	30	70	16	0	0	0	0	0	0
2010-2011	0	0	32	23	32	23	32	23	33	26	15	6	0	0	0	0	0	0
2011-2012	0	0	44	26	44	26	44	26	44	26	25	7	0	0	0	0	0	0
2012-2013	0	0	42	17	42	17	42	17	42	17	27	5	0	0	0	0	0	0
2013-2014	0	0	73	36	73	36	73	36	72	36	36	8	0	0	0	0	0	0
2014-2015	2	1	86	59	78	53	78	53	75	52	48	17	2	1	2	1	2	1
2015-2016	0	0	93	18	91	16	90	15	90	15	44	6	0	0	0	0	0	0
2016-2017	0	0	45	18	45	18	45	18	46	19	26	4	0	0	0	0	0	0
2017-2018	0	0	56	30	56	30	56	30	55	30	20	12	0	0	0	0	0	0
2018-2019	0	0	39	33	39	33	39	33	39	33	13	3	0	0	0	0	0	0
2019-2020	0	0	9	8	9	8	9	8	9	8	2	1	0	0	0	0	0	0
Median	0	0	52	30	52	30	52	30	52	28	25	6	0	0	0	0	0	0
Mean	0	0	55	32	55	31	54	30	54	29	26	8	0	0	0	0	0	0
Maximum	2	1	142	114	142	114	141	89	137	78	70	22	2	1	2	1	2	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 93 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 93 L/s.

Figure 22: Thomsons Creek at Confluence - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

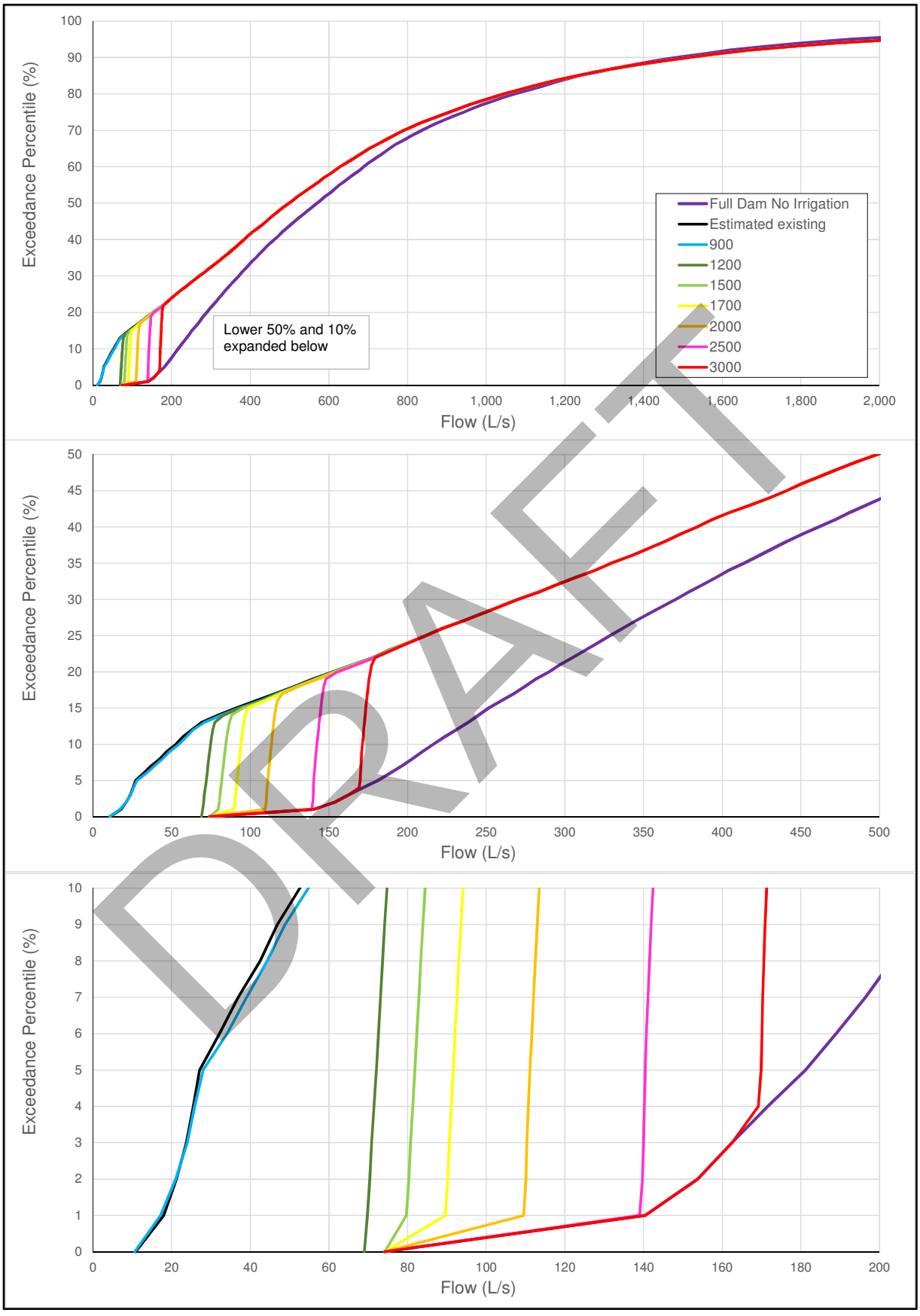


Figure 23: Thomsons Creek at Confluence - Flow Hydrograph 1 June 2014 to 31 May 2015.

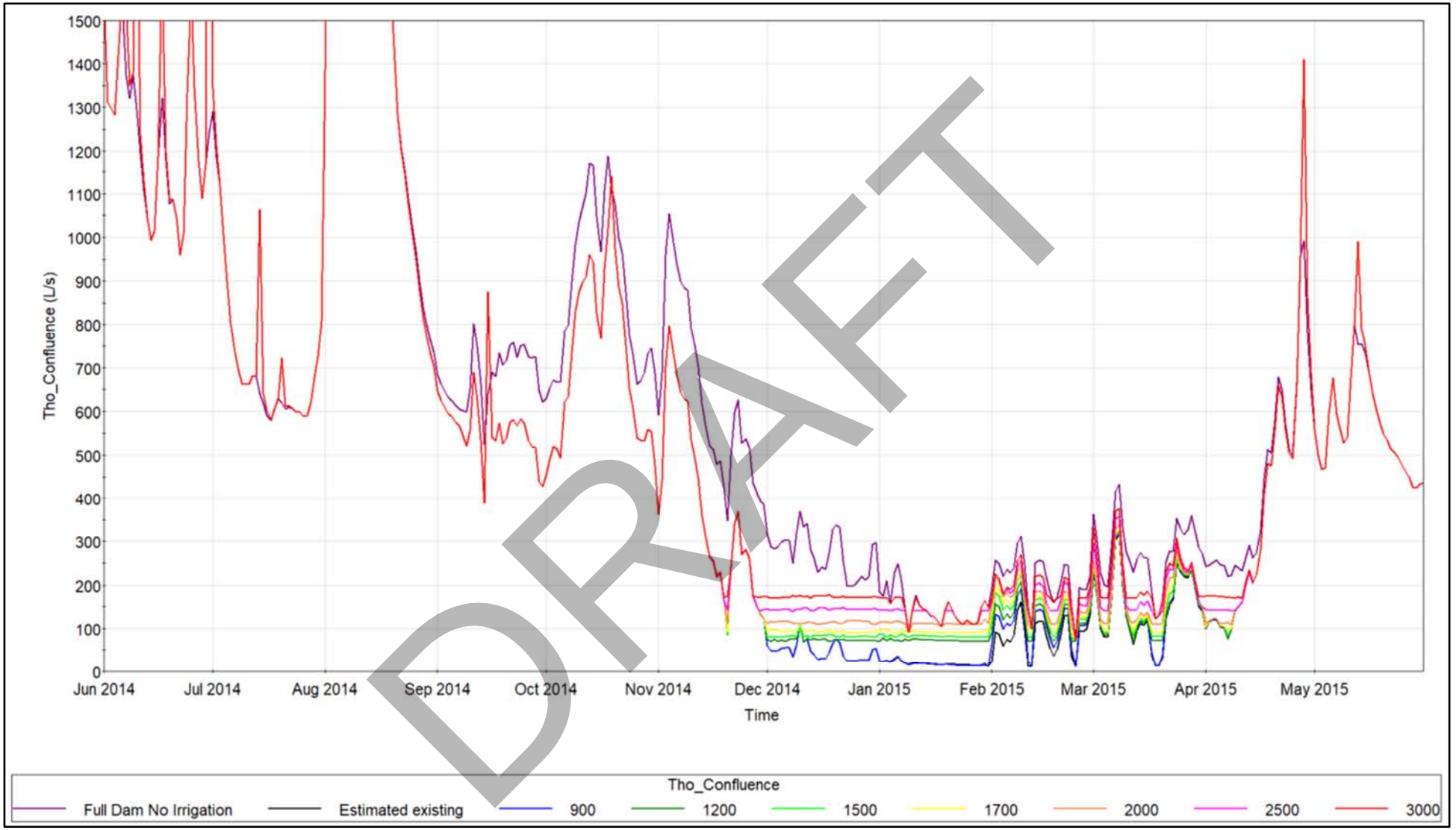


Table 32: Thomsons Creek at Confluence – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	74	11	11	69	74	74	74	74	74
1 day MALF	175	32	31	72	82	91	109	134	152
7 day MALF	196	41	41	80	89	98	116	142	162
1 percentile	135	17	16	70	79	89	109	135	135
5 Percentile	169	24	25	71	81	91	110	140	169
10 percentile	201	35	37	73	83	92	112	141	170
20 percentile	258	71	73	78	87	96	115	144	173
Median	541	391	391	391	391	391	391	392	391
Average	770	664	664	671	673	675	680	687	694

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

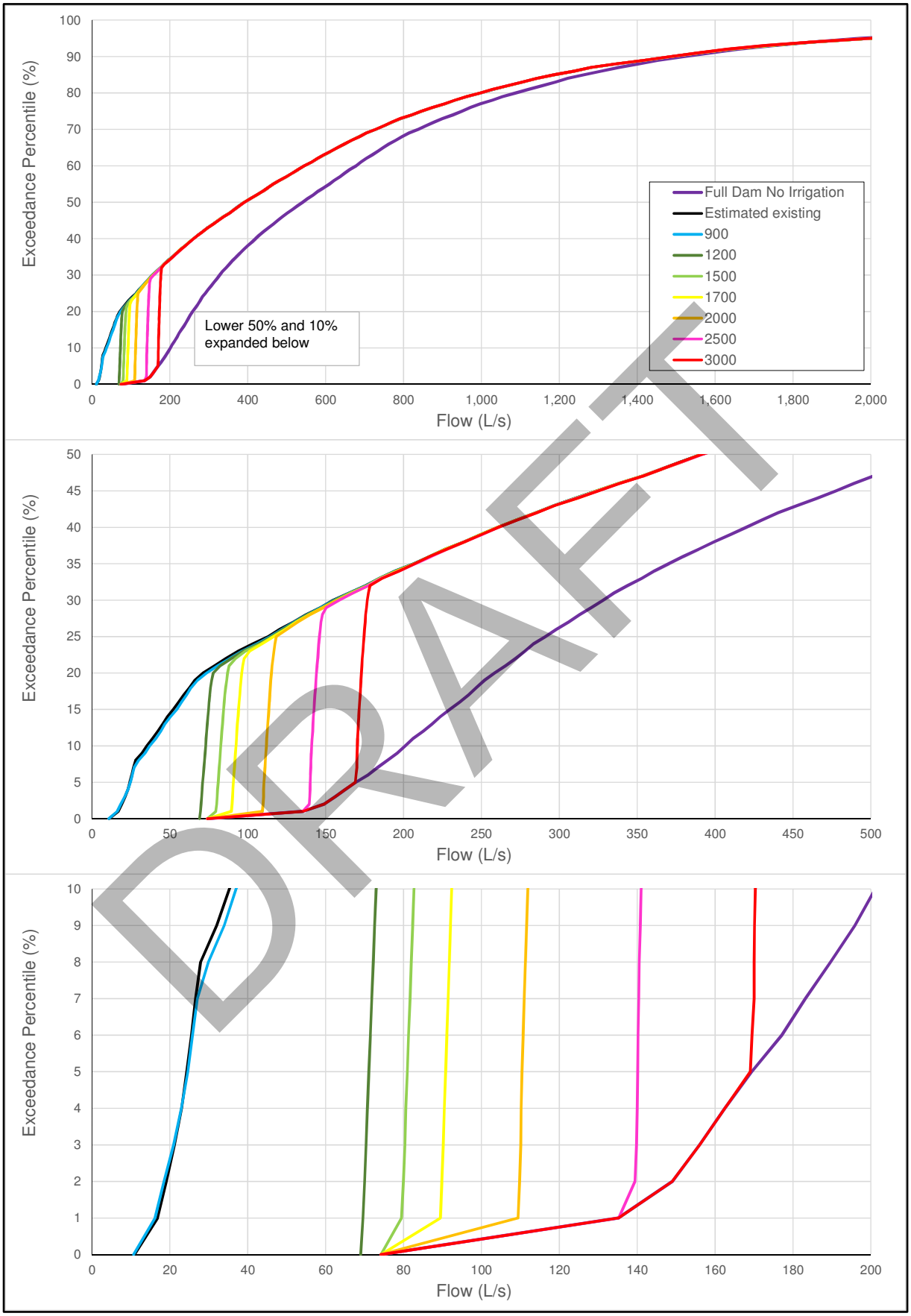
Table 33: Thomsons Creek at Confluence – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	68	66	66	66	66	66	66	66	23	16	0	0	0	0	0	0
1974-1975	0	0	43	11	43	11	43	11	43	11	13	3	0	0	0	0	0	0
1975-1976	0	0	142	114	142	114	141	85	137	74	68	22	0	0	0	0	0	0
1976-1977	0	0	45	32	45	32	45	32	45	32	27	16	0	0	0	0	0	0
1977-1978	0	0	89	81	87	72	86	72	84	71	44	11	0	0	0	0	0	0
1978-1979	0	0	35	28	35	28	35	28	35	28	17	4	0	0	0	0	0	0
1979-1980	0	0	5	5	5	5	5	5	5	5	2	2	0	0	0	0	0	0
1980-1981	0	0	65	33	64	33	64	33	63	33	27	8	0	0	0	0	0	0
1981-1982	0	0	106	90	105	89	105	89	102	78	40	8	0	0	0	0	0	0
1982-1983	0	0	25	12	25	12	25	12	25	12	14	6	0	0	0	0	0	0
1983-1984	0	0	12	6	12	6	12	6	12	6	5	1	0	0	0	0	0	0
1984-1985	0	0	86	37	86	37	86	37	86	37	46	10	0	0	0	0	0	0
1985-1986	0	0	22	17	22	17	22	17	22	17	12	6	0	0	0	0	0	0
1986-1987	0	0	28	28	28	28	28	28	28	28	8	3	0	0	0	0	0	0
1987-1988	0	0	62	18	62	18	62	18	62	18	28	7	0	0	0	0	0	0
1988-1989	0	0	37	36	37	36	37	36	37	36	10	5	0	0	0	0	0	0
1989-1990	0	0	58	35	58	35	58	35	58	35	24	8	0	0	0	0	0	0
1990-1991	0	0	100	64	100	64	97	64	95	64	38	5	0	0	0	0	0	0
1991-1992	0	0	83	51	82	50	81	49	80	48	33	10	0	0	0	0	0	0
1992-1993	0	0	57	12	57	12	57	12	57	12	38	5	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	52	26	52	26	52	26	52	26	20	6	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	30	10	30	10	30	10	30	10	20	6	0	0	0	0	0	0
1997-1998	0	0	56	36	56	36	55	36	53	27	21	6	0	0	0	0	0	0
1998-1999	0	0	70	38	65	38	63	38	58	38	35	13	0	0	0	0	0	0
1999-2000	0	0	4	4	4	4	4	4	5	5	4	2	0	0	0	0	0	0
2000-2001	0	0	85	61	82	61	82	61	82	61	41	17	0	0	0	0	0	0
2001-2002	0	0	38	32	38	32	38	32	38	32	18	6	0	0	0	0	0	0
2002-2003	0	0	66	37	66	37	66	37	66	37	41	10	0	0	0	0	0	0
2003-2004	0	0	51	32	51	32	51	32	51	32	25	9	0	0	0	0	0	0
2004-2005	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
2005-2006	0	0	129	67	124	33	122	33	117	27	69	15	0	0	0	0	0	0
2006-2007	0	0	61	34	61	34	61	34	61	34	35	11	0	0	0	0	0	0
2007-2008	0	0	106	25	105	25	105	25	105	25	46	10	0	0	0	0	0	0
2008-2009	0	0	45	20	45	20	45	20	45	20	22	5	0	0	0	0	0	0
2009-2010	0	0	122	43	121	43	119	30	117	30	70	16	0	0	0	0	0	0
2010-2011	0	0	32	23	32	23	32	23	33	26	15	6	0	0	0	0	0	0
2011-2012	0	0	44	26	44	26	44	26	44	26	25	7	0	0	0	0	0	0
2012-2013	0	0	42	17	42	17	42	17	42	17	27	5	0	0	0	0	0	0
2013-2014	0	0	73	36	73	36	73	36	72	36	36	8	0	0	0	0	0	0
2014-2015	2	1	86	59	78	53	78	53	75	52	48	17	2	1	2	1	2	1
2015-2016	0	0	90	18	88	16	87	15	87	15	43	6	0	0	0	0	0	0
2016-2017	0	0	45	18	45	18	45	18	46	19	26	4	0	0	0	0	0	0
2017-2018	0	0	56	30	56	30	56	30	55	30	20	12	0	0	0	0	0	0
2018-2019	0	0	39	33	39	33	39	33	39	33	13	3	0	0	0	0	0	0
2019-2020	0	0	9	8	9	8	9	8	9	8	2	1	0	0	0	0	0	0
Median	0	0	52	30	52	30	52	30	52	28	25	6	0	0	0	0	0	0
Mean	0	0	55	32	55	31	54	30	54	29	26	8	0	0	0	0	0	0
Maximum	2	1	142	114	142	114	141	89	137	78	70	22	2	1	2	1	2	1

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 93 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 93 L/s.

Figure 24: Thomsons Creek at Confluence - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.9 Chatto Creek at Confluence

Table 34: Chatto Creek at Confluence – Flow statistics Full model period 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	45	10	10	45	45	45	45	45	45
1 day MALF	192	71	71	102	116	123	135	149	161
7 day MALF	215	88	88	116	129	135	148	163	175
1 percentile	103	16	15	70	89	99	103	103	103
5 Percentile	190	30	33	74	93	103	122	151	180
10 percentile	262	103	105	106	110	112	127	155	183
20 percentile	387	259	260	260	260	261	262	266	271
Median	850	790	790	790	790	791	791	791	791
Average	1365	1314	1314	1318	1319	1320	1322	1326	1329

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

Table 35: Chatto Creek at Confluence – Low Flow accrual periods
Full model period 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	47	18	47	18	46	18	46	18	41	18	0	0	0	0	0	0
1974-1975	0	0	56	19	56	19	56	19	56	19	53	10	0	0	0	0	0	0
1975-1976	83	29	142	81	142	81	142	81	140	55	137	29	83	29	83	29	83	29
1976-1977	0	0	20	8	20	8	20	8	20	8	20	8	0	0	0	0	0	0
1977-1978	14	7	131	23	131	23	131	23	130	18	126	18	14	7	14	7	14	7
1978-1979	0	0	25	16	25	16	25	16	25	16	24	16	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	14	4	58	19	58	19	58	19	57	19	56	19	14	4	14	4	14	4
1981-1982	0	0	104	26	104	26	103	26	102	26	92	26	0	0	0	0	0	0
1982-1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	18	6	18	6	17	6	13	6	11	6	0	0	0	0	0	0
1985-1986	0	0	10	5	10	5	10	5	10	5	10	5	0	0	0	0	0	0
1986-1987	0	0	61	26	61	26	61	26	61	26	57	15	0	0	0	0	0	0
1987-1988	0	0	20	9	20	9	20	9	20	9	17	7	0	0	0	0	0	0
1988-1989	0	0	10	4	10	4	10	4	10	4	10	4	0	0	0	0	0	0
1989-1990	0	0	55	14	55	14	55	14	55	14	54	14	0	0	0	0	0	0
1990-1991	0	0	42	18	42	18	42	18	42	18	40	11	0	0	0	0	0	0
1991-1992	0	0	59	16	58	16	53	16	37	16	34	11	0	0	0	0	0	0
1992-1993	0	0	4	3	4	3	4	3	4	3	4	3	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	20	8	20	8	20	8	20	8	19	8	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	17	10	17	10	17	10	17	10	17	10	0	0	0	0	0	0
1997-1998	0	0	9	3	8	3	8	3	8	3	7	3	0	0	0	0	0	0
1998-1999	34	34	73	35	73	35	73	35	73	35	73	35	34	34	34	34	34	34
1999-2000	0	0	18	8	18	8	18	8	18	8	17	8	0	0	0	0	0	0
2000-2001	0	0	28	9	21	9	19	9	16	9	15	9	0	0	0	0	0	0
2001-2002	0	0	45	23	45	23	45	23	45	23	42	19	0	0	0	0	0	0
2002-2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003-2004	0	0	46	22	46	22	46	22	46	22	45	19	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	70	15	66	12	65	12	55	12	54	12	0	0	0	0	0	0
2006-2007	0	0	59	21	59	21	59	21	58	21	55	13	0	0	0	0	0	0
2007-2008	0	0	16	12	16	12	16	12	16	12	15	9	0	0	0	0	0	0
2008-2009	0	0	17	8	17	8	17	8	17	8	16	8	0	0	0	0	0	0
2009-2010	1	1	64	27	63	27	59	27	47	27	45	20	1	1	1	1	1	1
2010-2011	1	1	43	29	43	29	43	29	43	29	41	20	1	1	1	1	1	1
2011-2012	0	0	21	9	21	9	21	9	21	9	21	9	0	0	0	0	0	0
2012-2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	79	15	79	15	79	15	79	15	74	9	0	0	0	0	0	0
2014-2015	26	15	115	32	113	32	113	32	112	32	110	32	26	15	26	15	26	15
2015-2016	0	0	81	27	81	27	80	27	80	27	77	27	0	0	0	0	0	0
2016-2017	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
2017-2018	22	12	83	23	83	23	83	23	83	23	80	16	22	12	22	12	22	12
2018-2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019-2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	21	10	21	10	20	10	20	10	20	9	0	0	0	0	0	0
Mean	4	2	38	14	37	14	37	14	36	13	34	11	4	2	4	2	4	2
Maximum	83	34	142	81	142	81	142	81	140	55	137	35	83	34	83	34	83	34

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 107 L/s.
- Max Days = Maximum number of consecutive days below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 107 L/s.

Figure 25: Chatto Creek at Confluence - Flow Duration Plot
Full model period 1 June 1973 to 31 May 2020.

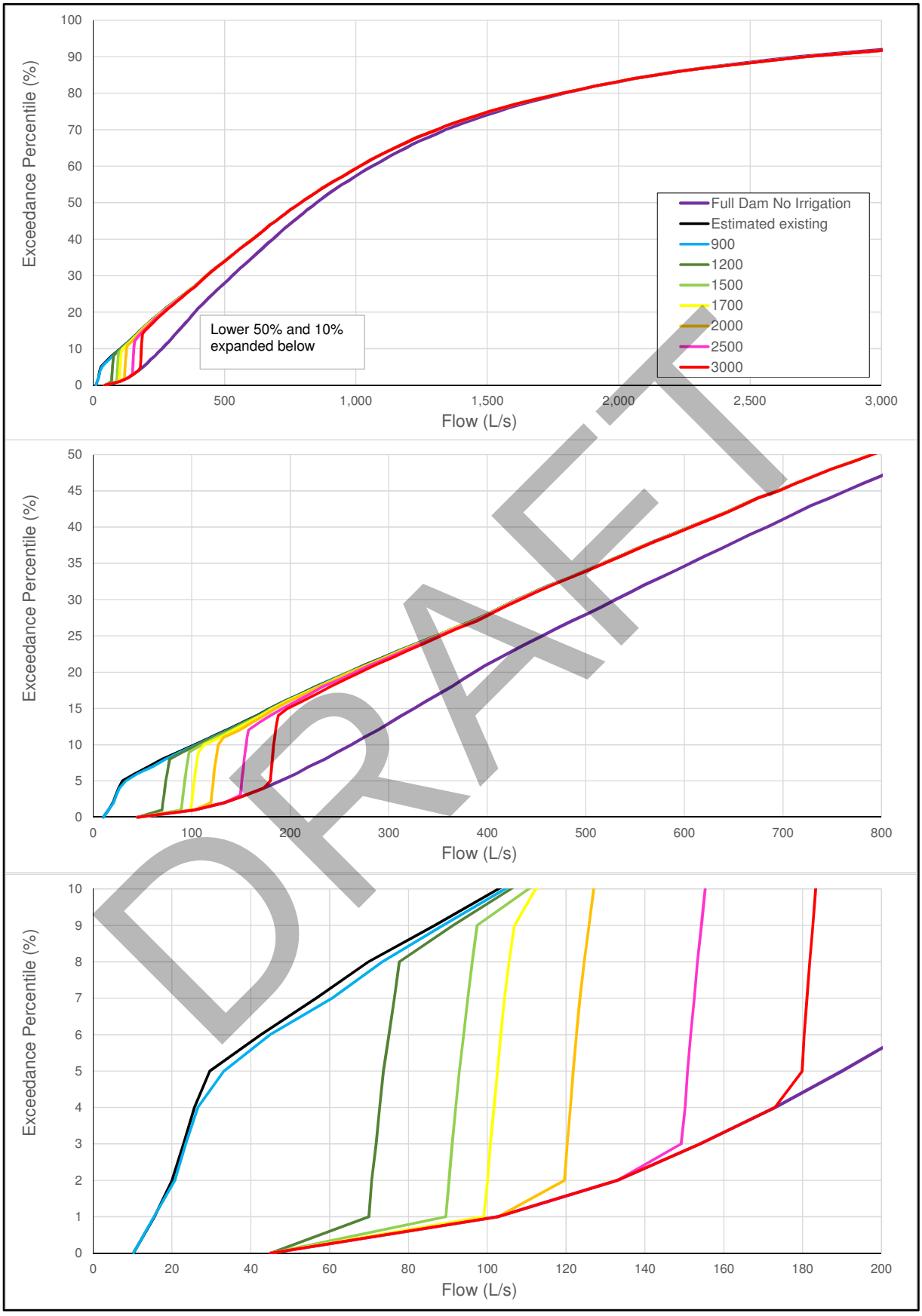


Figure 26: Chatto Creek at Confluence - Flow Hydrograph 1 June 2014 to 31 May 2015.

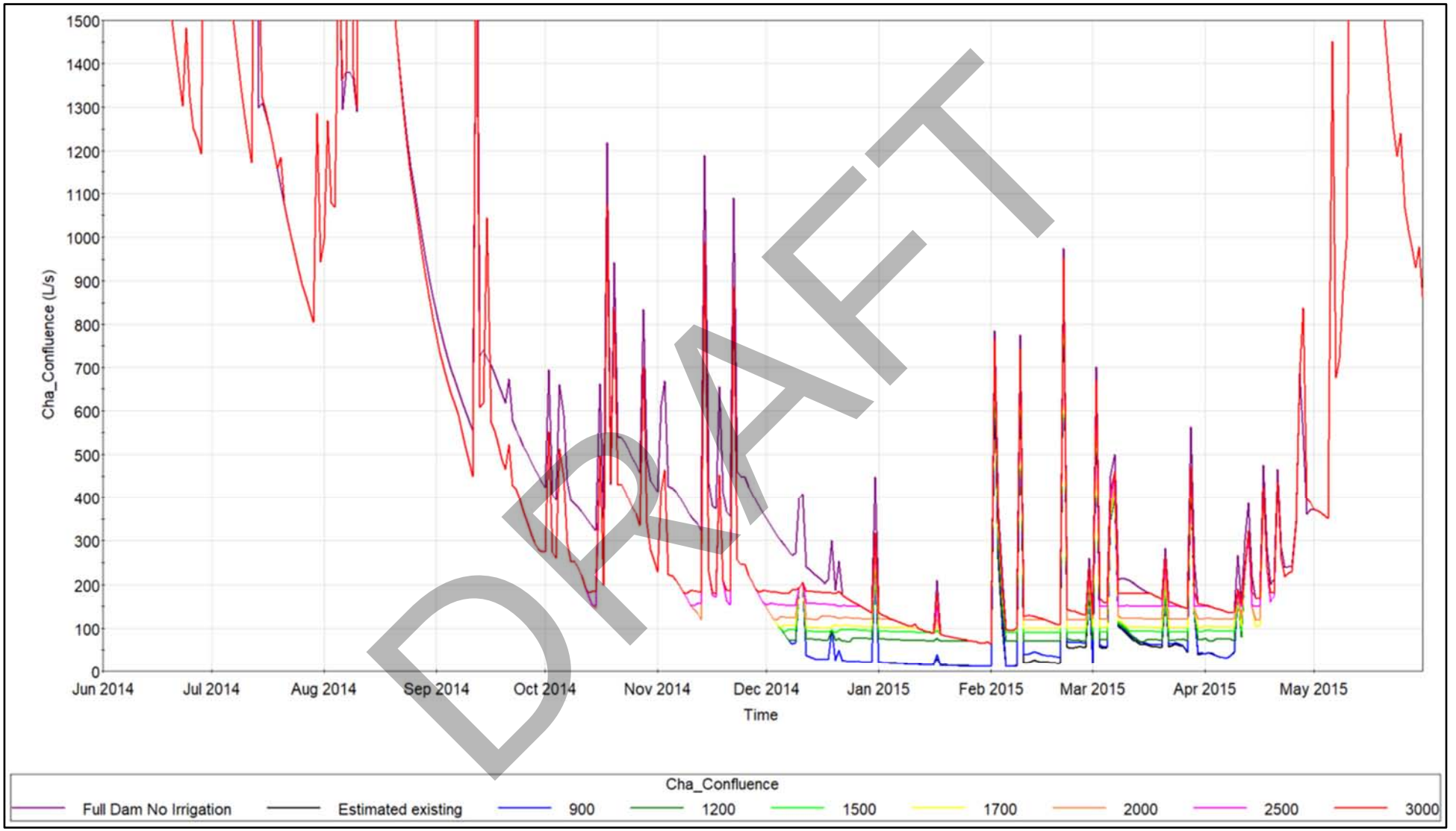


Table 36: Chatto Creek at Confluence – Flow statistics Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.									
Flow Statistic (L/s)	**Scenario**								
	Full Dam and No Irrigation	**Status Quo**	**900**	**1200**	**1500**	**1700**	**2000**	**2500**	**3000**
Minimum	45	10	10	45	45	45	45	45	45
1 day MALF	199	71	72	103	116	123	135	150	163
7 day MALF	224	89	90	118	130	137	150	165	177
1 percentile	86	14	14	69	86	86	86	86	86
5 Percentile	161	24	24	72	91	101	121	150	161
10 percentile	217	51	55	76	95	104	123	152	181
20 percentile	314	154	155	156	158	160	165	172	187
Median	689	564	565	565	565	565	566	566	567
Average	1246	1146	1146	1151	1154	1156	1159	1164	1169

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.

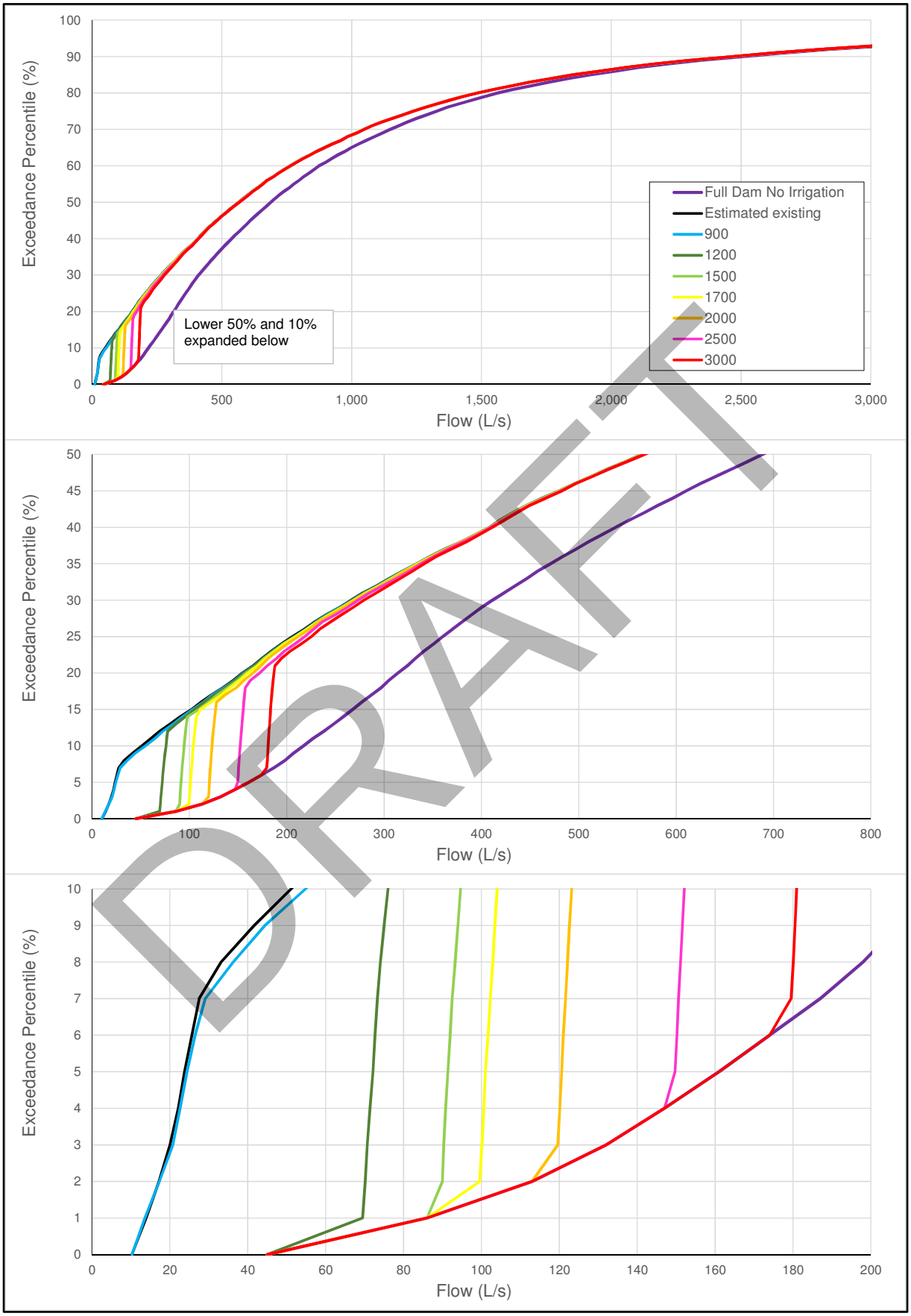
Table 37: Chatto Creek at Confluence – Low Flow accrual periods
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.

Hydro-logical year	Full Dam and No Irrigation		Status Quo		900		1200		1500		1700		2000		2500		3000	
	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days	Days	Max Days
1973-1974	0	0	47	18	47	18	46	18	46	18	41	18	0	0	0	0	0	0
1974-1975	0	0	56	19	56	19	56	19	56	19	53	10	0	0	0	0	0	0
1975-1976	83	29	142	81	142	81	142	81	140	55	137	29	83	29	83	29	83	29
1976-1977	0	0	20	8	20	8	20	8	20	8	20	8	0	0	0	0	0	0
1977-1978	14	7	131	23	131	23	131	23	130	18	126	18	14	7	14	7	14	7
1978-1979	0	0	25	16	25	16	25	16	25	16	24	16	0	0	0	0	0	0
1979-1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980-1981	14	4	58	19	58	19	58	19	57	19	56	19	14	4	14	4	14	4
1981-1982	0	0	104	26	104	26	103	26	102	26	92	26	0	0	0	0	0	0
1982-1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983-1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984-1985	0	0	18	6	18	6	17	6	13	6	11	6	0	0	0	0	0	0
1985-1986	0	0	10	5	10	5	10	5	10	5	10	5	0	0	0	0	0	0
1986-1987	0	0	61	26	61	26	61	26	61	26	57	15	0	0	0	0	0	0
1987-1988	0	0	20	9	20	9	20	9	20	9	17	7	0	0	0	0	0	0
1988-1989	0	0	10	4	10	4	10	4	10	4	10	4	0	0	0	0	0	0
1989-1990	0	0	55	14	55	14	55	14	55	14	54	14	0	0	0	0	0	0
1990-1991	0	0	42	18	42	18	42	18	42	18	40	11	0	0	0	0	0	0
1991-1992	0	0	59	16	58	16	53	16	37	16	34	11	0	0	0	0	0	0
1992-1993	0	0	4	3	4	3	4	3	4	3	4	3	0	0	0	0	0	0
1993-1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994-1995	0	0	20	8	20	8	20	8	20	8	19	8	0	0	0	0	0	0
1995-1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996-1997	0	0	17	10	17	10	17	10	17	10	17	10	0	0	0	0	0	0
1997-1998	0	0	9	3	8	3	8	3	8	3	7	3	0	0	0	0	0	0
1998-1999	34	34	73	35	73	35	73	35	73	35	73	35	34	34	34	34	34	34
1999-2000	0	0	18	8	18	8	18	8	18	8	17	8	0	0	0	0	0	0
2000-2001	0	0	28	9	21	9	19	9	16	9	15	9	0	0	0	0	0	0
2001-2002	0	0	45	23	45	23	45	23	45	23	42	19	0	0	0	0	0	0
2002-2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003-2004	0	0	46	22	46	22	46	22	46	22	45	19	0	0	0	0	0	0
2004-2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-2006	0	0	70	15	66	12	65	12	55	12	54	12	0	0	0	0	0	0
2006-2007	0	0	59	21	59	21	59	21	58	21	55	13	0	0	0	0	0	0
2007-2008	0	0	16	12	16	12	16	12	16	12	15	9	0	0	0	0	0	0
2008-2009	0	0	17	8	17	8	17	8	17	8	16	8	0	0	0	0	0	0
2009-2010	1	1	64	27	63	27	59	27	47	27	45	20	1	1	1	1	1	1
2010-2011	1	1	43	29	43	29	43	29	43	29	41	20	1	1	1	1	1	1
2011-2012	0	0	21	9	21	9	21	9	21	9	21	9	0	0	0	0	0	0
2012-2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013-2014	0	0	79	15	79	15	79	15	79	15	74	9	0	0	0	0	0	0
2014-2015	26	15	115	32	113	32	113	32	112	32	110	32	26	15	26	15	26	15
2015-2016	0	0	81	27	81	27	80	27	80	27	77	27	0	0	0	0	0	0
2016-2017	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
2017-2018	22	12	83	23	83	23	83	23	83	23	80	16	22	12	22	12	22	12
2018-2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019-2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	0	0	21	10	21	10	20	10	20	10	20	9	0	0	0	0	0	0
Mean	4	2	38	14	37	14	37	14	36	13	34	11	4	2	4	2	4	2
Maximum	83	34	142	81	142	81	142	81	140	55	137	35	83	34	83	34	83	34

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Days = Total number of days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 107 L/s.
- Max Days = Maximum number of consecutive days flow below 50% of 7day MALF for the Full Dam No Irrigation scenario i.e. below 107 L/s.

Figure 27: Chatto Creek at Confluence - Flow Duration Plot
Irrigation months only (1 September to 30 April) from 1 June 1973 to 31 May 2020.



4.10 **Falls Dam Volumes Released**

Table 38: Falls Dam Storage Water Use as estimated by the Manuherekia Hydrology Model.

Scenario	Irrigation water released (GL)							Environmental water released Residual and Minimum Flow (GL)						
	Total 1 June 1973-31 May 2020	Minimum Annual	10% year (approx. 1 in 10 year drought)	1 June 2014 - 31 May 2015	Median Annual	Average Annual	Maximum Annual	Total 1 June 1973-31 May 2020	Minimum Annual	10% year (approx. 1 in 10 year drought)	1 June 2014 - 31 May 2015	Median Annual	Average Annual	Maximum Annual
Status Quo	1697.1	25.3	30.0	36.7	37.2	36.1	42.6	787.6	15.8	19.1	19.8	16.1	16.8	21.2
900	1689.3	25.3	30.0	36.3	36.5	35.9	42.6	867.6	15.8	22.6	23.1	17.6	18.5	25.4
1200	1685.5	25.3	30.0	36.0	36.5	35.9	42.6	884.1	15.8	23.0	23.3	18.3	18.8	24.8
1500	1680.2	25.3	30.0	35.6	36.5	35.7	42.6	938.9	15.8	25.2	25.2	19.2	20.0	27.3
1700	1676.9	25.3	30.0	35.2	36.5	35.7	42.6	978.9	15.8	26.6	26.4	19.8	20.8	28.9
2000	1672.3	25.3	30.0	34.7	36.4	35.6	42.6	1041.0	15.8	28.8	28.7	21.2	22.1	32.4
2500	1665.6	25.3	30.0	34.1	36.2	35.4	42.5	1169.6	15.8	33.8	34.6	24.5	24.9	39.6
3000	1659.5	25.3	29.9	33.6	36.0	35.3	42.5	1349.8	16.0	40.9	41.3	27.7	28.7	53.6

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Environmental water released includes water released from Falls Dam to meet residual flows immediately below the dam (note some of this water is available to be taken for downstream irrigation) and augmentation to meet shortfalls in the lower catchment below Ophir. In the model shortfalls below Ophir are defined as shortfalls in the minimum flow at Campground plus shortfalls in irrigation supply to the Manuherekia Irrigation Scheme's Main Race intake on the Manuherekia River. Note in the model all tributary water that enters the main stem of the Manuherekia River is available for all downstream main stem water uses.
- 1 GL = 1 gigalitre = 1 million cubic metres.

4.11 Dunstan, Lauder, Thomsons and Chatto Creeks Volumes Used

Table 39: Tributary water use as estimated by the Manuherekia Hydrology Model.

Tributary	Scenario	Irrigation water use (GL)							Environmental water use Residual and Minimum Flow (GL)						
		Total 1 June 1973-31 May 2020	Minimum Annual	90% year (approx. 1 in 10 year drought)	1 June 2014 - 31 May 2015	Median Annual	Average Annual	Maximum Annual	Total 1 June 1973-31 May 2020	Minimum Annual	90% year (approx. 1 in 10 year drought)	1 June 2014 - 31 May 2015	Median Annual	Average Annual	Maximum Annual
Dunstan	Status Quo	744.5	10.9	17.8	16.2	16.3	15.8	18.6	44.5	0.9	0.9	0.9	0.9	0.9	0.9
	900	741.8	10.9	17.8	16.1	16.2	15.8	18.6	44.5	0.9	0.9	0.9	0.9	0.9	0.9
	1200	718.8	10.9	17.0	15.1	15.6	15.3	18.4	83.6	0.9	3.0	2.2	1.5	1.8	3.5
	1500	705.3	10.9	16.8	14.6	15.1	15.0	18.2	108.6	0.9	3.8	2.8	2.1	2.3	4.3
	1700	694.1	10.9	16.6	14.2	14.8	14.8	17.9	130.4	0.9	4.7	3.3	2.5	2.8	5.4
	2000	675.6	10.9	16.3	13.6	14.5	14.4	17.4	168.6	0.9	6.0	4.0	3.3	3.6	7.4
	2500	637.8	9.7	15.7	12.5	13.7	13.6	16.4	242.7	0.9	8.2	6.3	5.0	5.2	10.8
	3000	596.6	7.9	15.1	11.3	13.1	12.7	15.3	321.7	0.9	10.7	9.1	6.5	6.8	13.4
Lauder	Status Quo	290.0	4.2	7.1	6.8	6.2	6.2	7.7	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	900	290.3	4.2	7.1	6.7	6.2	6.2	7.7	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	1200	285.5	4.2	7.0	6.3	6.1	6.1	7.5	23.6	0.3	0.9	0.9	0.4	0.5	1.2
	1500	279.9	4.2	6.9	6.1	6.0	6.0	7.4	31.9	0.3	1.2	1.2	0.5	0.7	1.6
	1700	274.9	4.2	6.7	5.9	5.8	5.8	7.2	39.5	0.3	1.4	1.4	0.7	0.8	2.0
	2000	265.7	4.0	6.5	5.5	5.7	5.7	7.0	53.1	0.3	1.8	1.8	1.0	1.1	2.4
	2500	248.9	3.3	6.2	5.0	5.5	5.3	6.6	79.0	0.3	2.6	2.5	1.7	1.7	3.3
	3000	228.1	2.6	5.8	4.4	5.0	4.9	6.0	112.3	0.3	3.6	3.5	2.4	2.4	4.3
Thomsons	Status Quo	136.8	1.8	3.4	3.2	3.0	2.9	3.7	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	900	136.7	1.8	3.3	3.2	3.0	2.9	3.7	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	1200	129.8	1.8	3.2	2.9	2.8	2.8	3.6	23.4	0.3	0.7	0.6	0.5	0.5	0.9
	1500	127.7	1.8	3.2	2.8	2.7	2.7	3.5	26.2	0.3	0.8	0.7	0.5	0.6	1.0
	1700	125.5	1.8	3.1	2.7	2.7	2.7	3.4	29.2	0.3	0.9	0.8	0.6	0.6	1.2
	2000	120.9	1.8	3.0	2.6	2.6	2.6	3.3	36.1	0.3	1.1	1.0	0.7	0.8	1.5
	2500	113.2	1.5	2.9	2.3	2.4	2.4	3.1	48.5	0.3	1.5	1.4	1.0	1.0	1.9
	3000	105.4	1.2	2.7	2.1	2.3	2.2	2.9	62.1	0.3	1.9	1.8	1.3	1.3	2.3
Chatto	Status Quo	119.7	1.6	3.0	2.6	2.6	2.5	3.1	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	900	119.5	1.6	3.0	2.6	2.6	2.5	3.1	14.8	0.3	0.3	0.3	0.3	0.3	0.3
	1200	114.6	1.6	2.8	2.2	2.5	2.4	3.1	20.9	0.3	0.6	0.8	0.4	0.4	1.0
	1500	112.1	1.6	2.8	2.0	2.4	2.4	3.1	24.4	0.3	0.8	1.0	0.4	0.5	1.1
	1700	110.7	1.5	2.8	2.0	2.4	2.4	3.1	26.4	0.3	0.9	1.1	0.5	0.6	1.3
	2000	107.8	1.4	2.8	1.8	2.4	2.3	3.1	30.9	0.3	1.1	1.3	0.5	0.7	1.5
	2500	103.3	1.3	2.7	1.6	2.2	2.2	3.0	38.6	0.3	1.4	1.6	0.7	0.8	1.9
	3000	98.5	1.2	2.6	1.5	2.1	2.1	3.0	47.7	0.3	1.7	1.9	1.0	1.0	2.3

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- Environmental water use includes water allowed to pass the main intake site to meet residual flows below the intake and augmentation to meet shortfalls in the confluence minimum flow. Note in the model all tributary water that enters the main stem of the Manuherekia River is available for all downstream main stem water uses.
- 1 GL = 1 gigalitre = 1 million cubic metres.

4.12 Manuherekia Main Stem Longitudinal Flow Plots

Figure 28: Manuherekia Main Stem Modelled Median Flow 1 June 1973 - 31May 2020

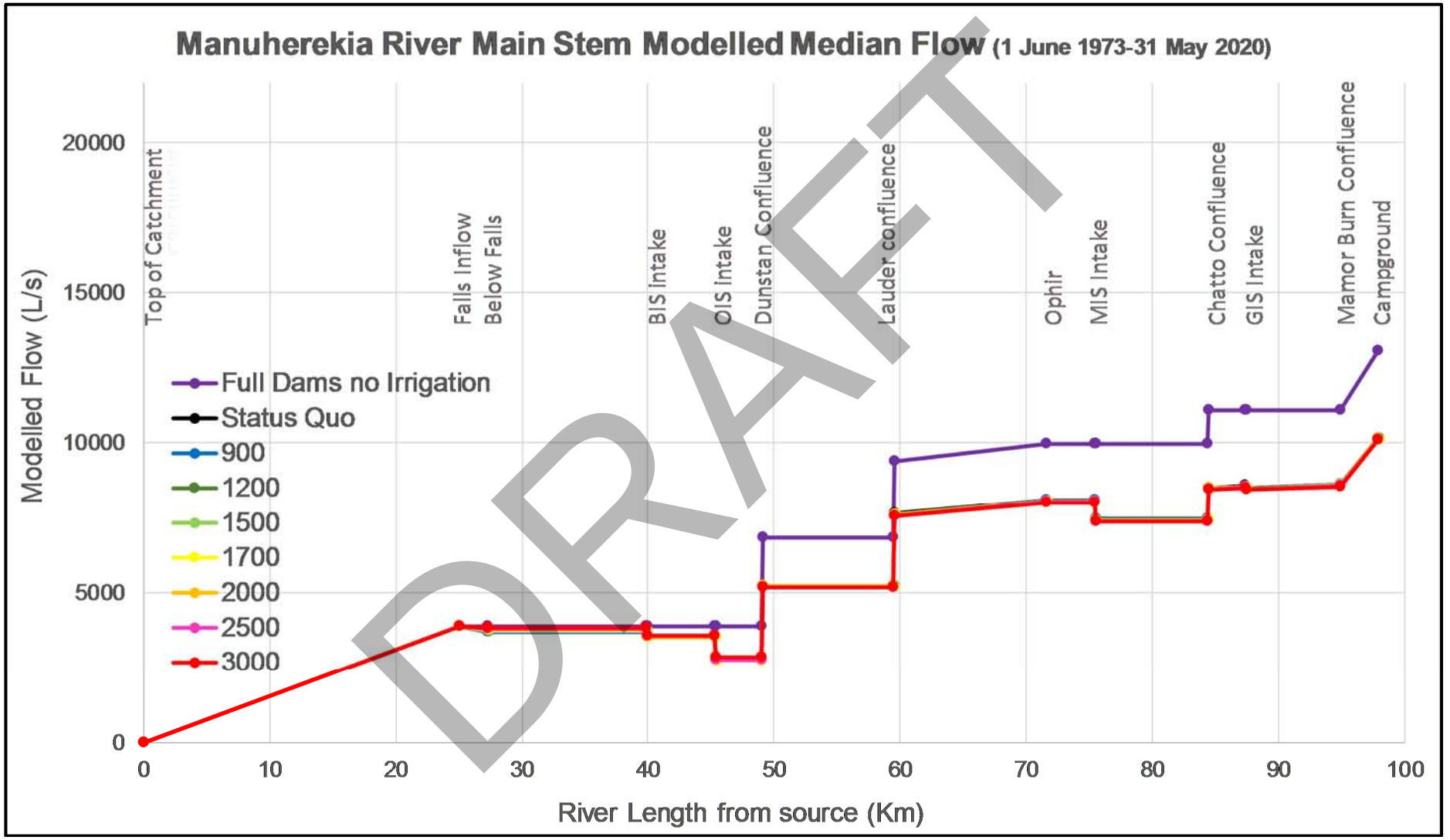


Figure 29: Manuherekia Main Stem Modelled 7 day MALF 1 June 1973 - 31May 2020

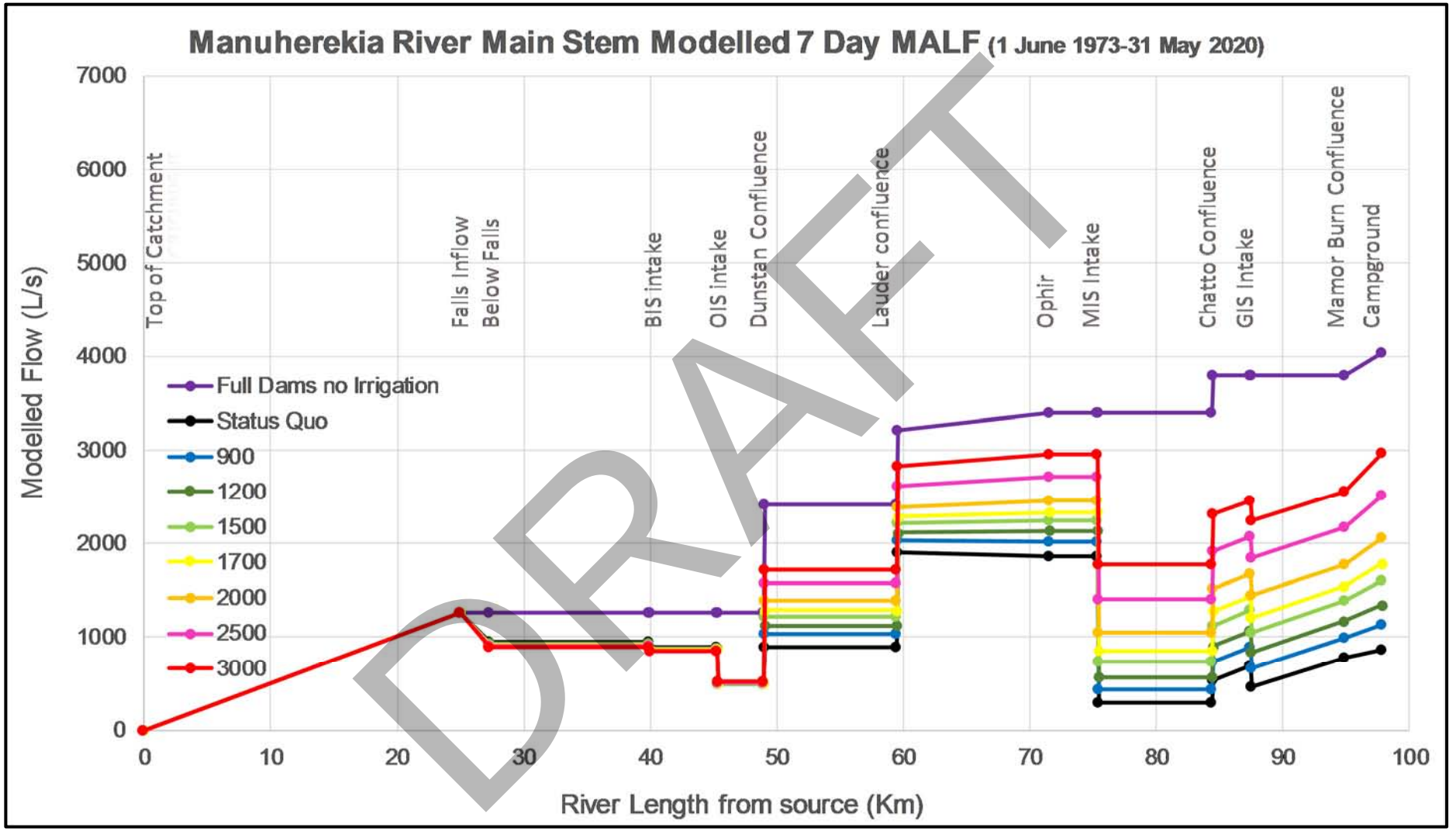


Figure 30: Manuherekia Main Stem Modelled 10th Percentile Flow 1 June 1973 - 31May 2020

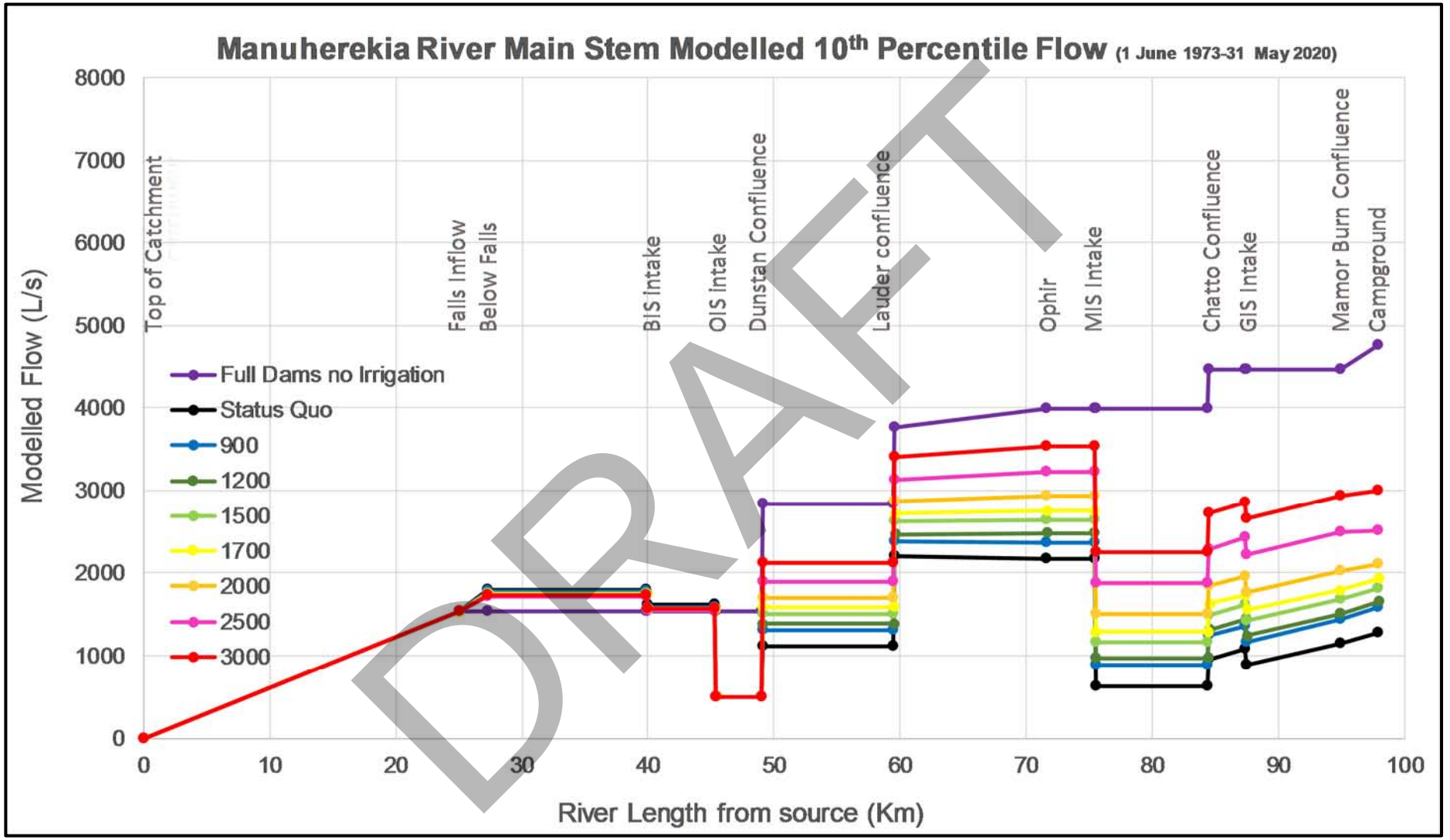


Figure 31: Manuherekia Main Stem Modelled 15th Percentile Flow 1 June 1973 - 31May 2020

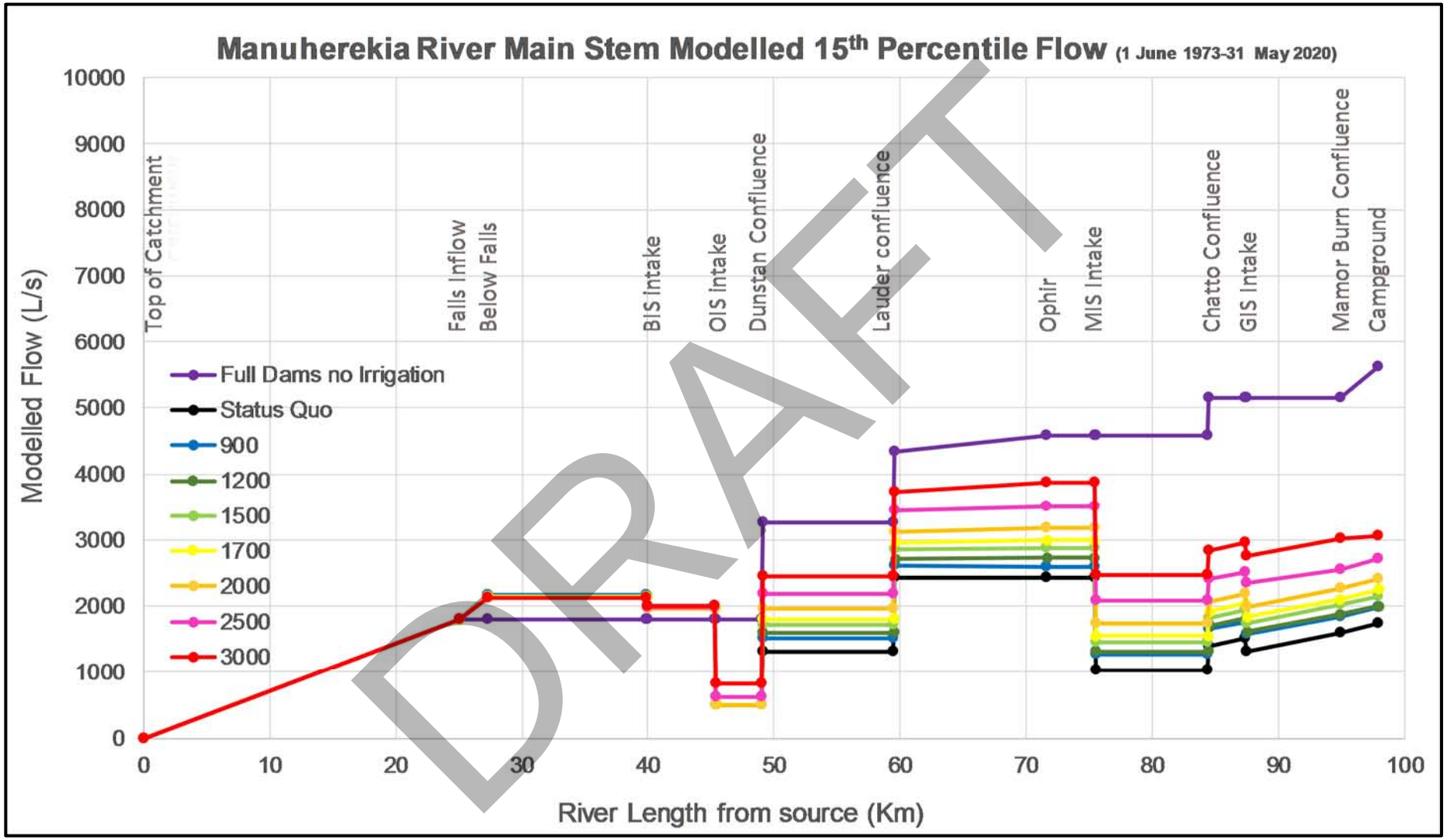


Figure 32: Manuherekia Main Stem Modelled Flow on 30 December 2014

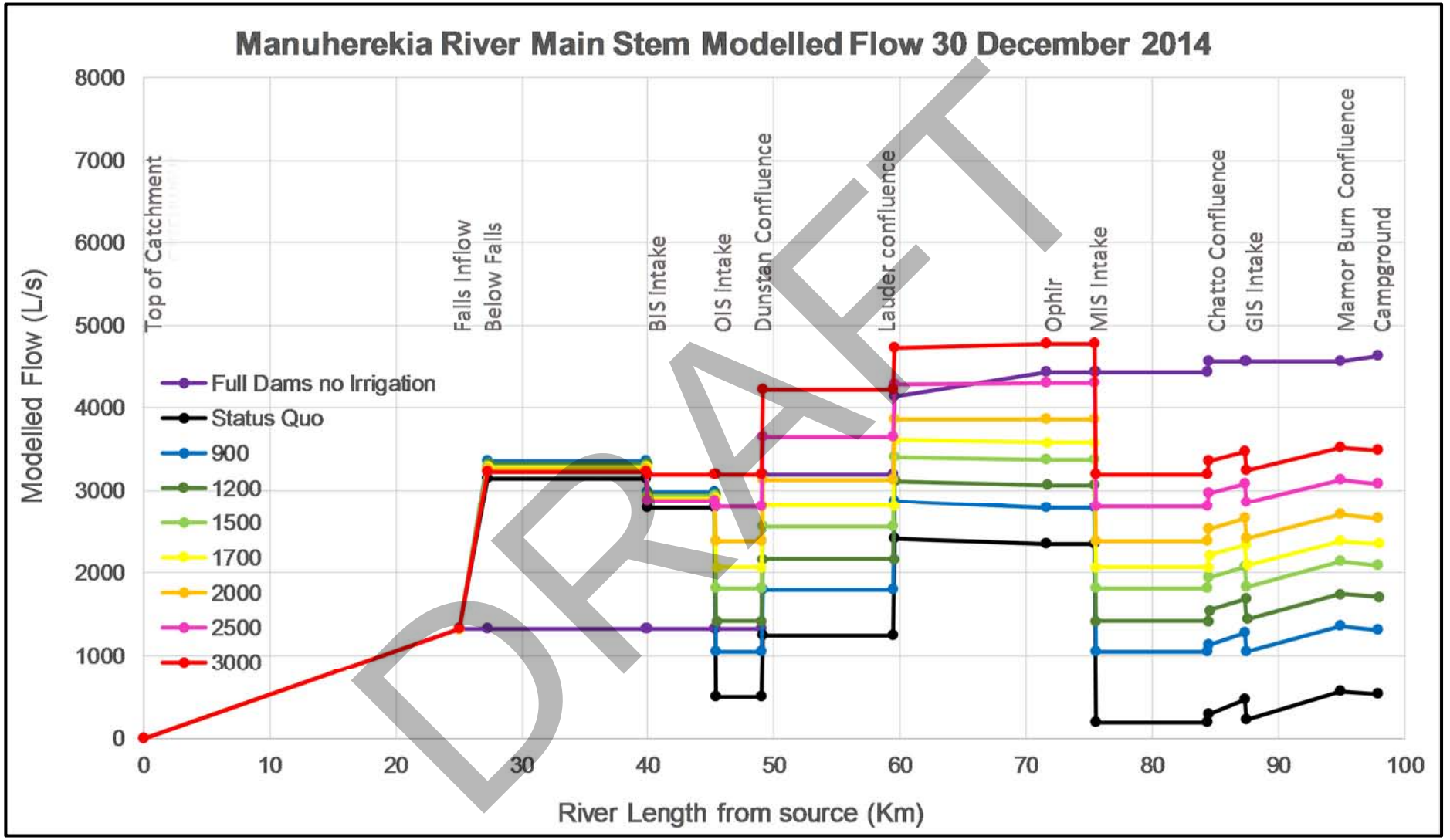
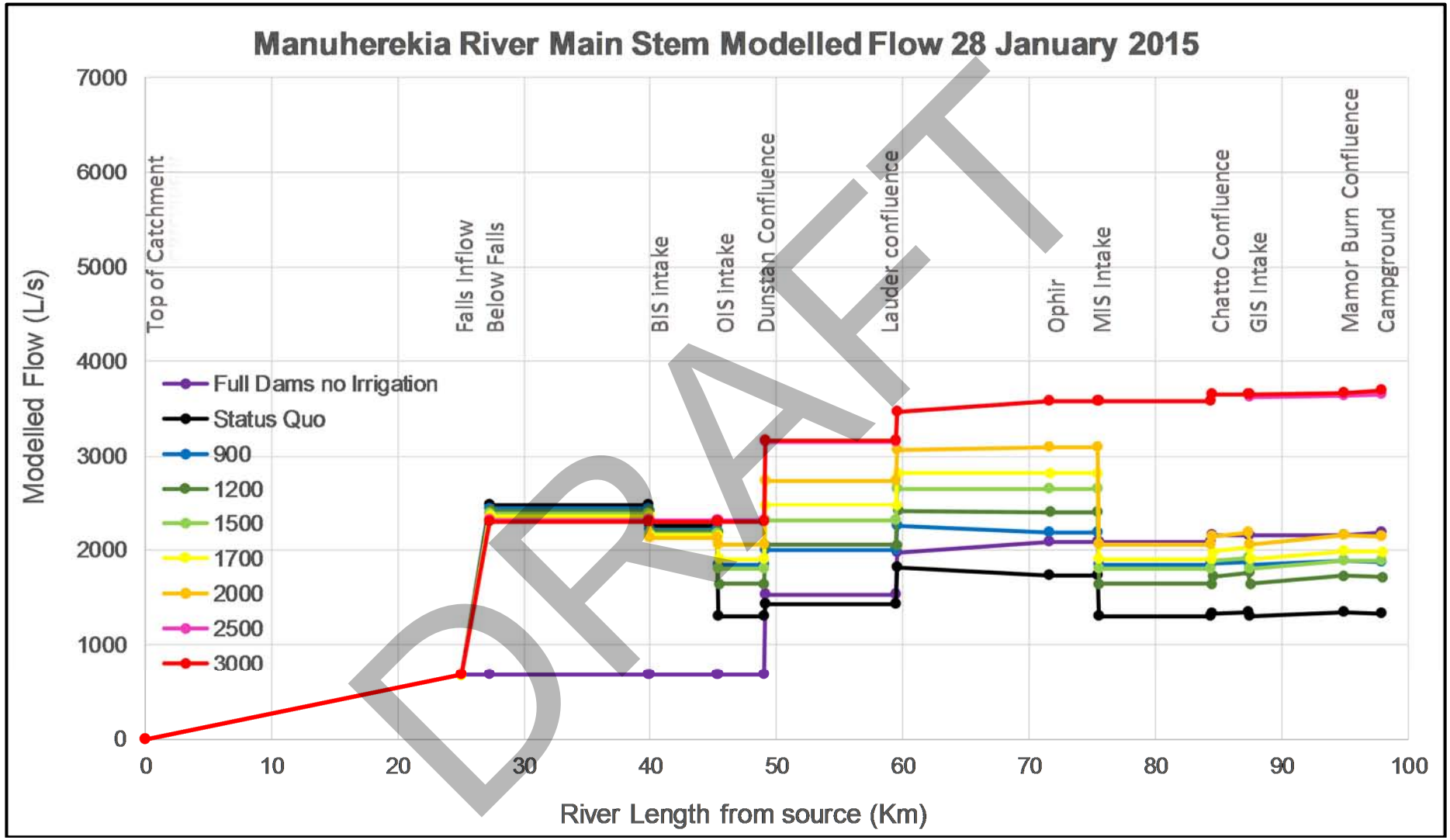


Figure 33: Manuherekia Main Stem Modelled Flow on 28 January 2015



4.13 **Yield**

Table 40: Manuherekia Yields as estimated by the Manuherekia Hydrology Model.											
Location		**Falls Inflow**	**At Ophir**	**At Campground**	**Dunstan Creek**	**Lauder Creek**	**Thomsons Creek**	**Chatto Creek**	**Manor Burn**	**Pool Burn**	**Ida Burn** (includes Pool Burn)
Yield (GL)	Total 1 June 1973-31 May 2020	7793.5	20155.1	25698.5	5893.9	1862.6	1152.4	2025.0	3518.4	1733.2	1719.5
	Minimum Annual	92.6	242.5	328.4	68.9	22.3	13.4	17.4	27.2	12.8	17.3
	10% year	113.8	292.8	380.3	86.2	27.5	16.8	26.3	43.0	18.5	20.6
	1 June 2014 – 31 May 2015	134.3	357.6	465.4	102.0	32.8	20.5	22.7	85.1	41.8	26.2
	Median Annual	153.5	386.2	503.9	116.1	36.6	23.1	40.3	70.4	34.8	30.4
	Average Annual	165.8	428.8	546.8	125.4	39.6	24.5	43.1	74.9	36.9	36.6
	Maximum Annual	305.9	778.2	994.4	229.9	72.4	45.0	88.9	152.2	79.9	120.3

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020 for the "*Full Dam No Irrigation"* scenario. The "*Full Dam No Irrigation"* scenario was designed to assist with the ecological interpretations, it was not designed to represents "natural" hydrological conditions, as such the above yields are not "natural" catchment yields. Caution is required when interpreting model output from the "*Full Dam No Irrigation"* scenario as the model was not developed to assess such a major change from current conditions.
- Annual values are based on hydrological years 1 June to following 31 May.
- 1 GL = 1 gigalitre = 1 million cubic metres.

4.14 Irrigation Water Use

Table 41: Manuherekia Irrigation Water Use as estimated by the Manuherekia Hydrology Model.

Scenario	Area	Unit	Cumulative Seasonal Water Use						
			Total 1 June 1973-31 May 2020	Minimum Annual	90% year (≈ 1 in 10 year drought)	1 June 2014 – 31 May 2015	Median Annual	Average Annual	Maximum Annual
Estimated Existing (Status Quo)	Full catchment	GL	4024.7	25.0	108.8	102.7	89.4	85.6	118.4
		% Campground Flow	18.6%			28.5%			
	Manuherekia Valley	GL	2845.4	21.9	75.9	70.0	62.4	60.5	83.9
		% Campground Flow	13.1%			19.4%			
900	Full catchment	GL	3959.5	25.0	105.6	99.3	87.4	84.2	117.1
		% Campground Flow	18.2%			27.3%			
	Manuherekia Valley	GL	2780.1	21.9	72.5	66.6	61.3	59.2	82.5
		% Campground Flow	12.8%			18.3%			
1200	Full catchment	GL	3934.9	25.0	104.7	98.3	86.7	83.7	116.4
		% Campground Flow	18.1%			26.9%			
	Manuherekia Valley	GL	2755.6	21.9	72.1	65.6	60.9	58.6	81.8
		% Campground Flow	12.7%			18.0%			
1500	Full catchment	GL	3886.1	25.0	103.4	96.0	85.6	82.7	115.3
		% Campground Flow	17.8%			26.1%			
	Manuherekia Valley	GL	2706.7	21.9	70.9	63.4	59.7	57.6	80.8
		% Campground Flow	12.4%			17.3%			
1700	Full catchment	GL	3891.5	25.0	103.7	96.4	85.8	82.8	115.5
		% Campground Flow	17.8%			26.3%			
	Manuherekia Valley	GL	2712.2	21.9	71.2	63.8	60.0	57.7	81.0
		% Campground Flow	12.4%			17.4%			
2000	Full catchment	GL	3789.0	25.0	100.4	91.8	83.2	80.6	113.0
		% Campground Flow	17.3%			24.7%			
	Manuherekia Valley	GL	2609.6	21.9	68.3	59.1	57.6	55.5	78.5
		% Campground Flow	11.9%			15.9%			
2500	Full catchment	GL	3668.2	25.0	97.0	85.6	80.1	78.0	110.1
		% Campground Flow	16.7%			22.7%			
	Manuherekia Valley	GL	2488.8	21.9	65.4	52.9	52.9	53.0	75.6
		% Campground Flow	11.3%			14.0%			
3000	Full catchment	GL	3516.1	25.0	93.3	79.6	77.5	74.8	105.2
		% Campground Flow	15.9%			20.8%			
	Manuherekia Valley	GL	2336.8	21.8	61.6	46.9	49.7	49.7	70.7
		% Campground Flow	10.5%			12.2%			

Notes:

- Above flow statistics are based on modelled output from the Manuherekia Hydrology Model for the period 1 June 1973 to 31 May 2020.
- Annual values are based on hydrological years 1 June to following 31 May.
- % Campground Flow is percentage of estimated water use for that scenario relative to cumulative flow at Campground for that scenario. Percentages are only provided for variables that are comparable. For example the minimum water use year does not necessary relate to the minimum flow at Campground year.
- Water Use represents water taken for irrigation less the water returned from the irrigated area. Note the returned water includes all rainfall runoff and drainage from the irrigated area. As such, Water Use is similar to the concept of “Net Use” but is slightly lower as it includes more return water (namely the runoff and drainage for the irrigated area if it was not irrigated).
- 1 GL = 1 gigalitre = 1 million cubic metres.

4.15 **Implications of Falls Dam Management Practices**

The current Falls Dam management practices of: imposing voluntary irrigation restrictions on irrigators in the Manuherekia Valley in order to retain storage in Falls Dam and using storage in Falls Dam to augment minimum flows at Campground, have a significant effect on storage in Falls Dam and flow and irrigation reliability throughout the Manuherekia Valley. In describing the effects we have focused on the calibration run (called Estimated Existing or Status Quo in the model) and the following two future scenarios *"1200" and "3000"*. For each plots of: Storage in Falls Dam, volumetric water supply reliability (volume supplied / volume demanded) for the Omakau Irrigation Scheme's Main Race and low flow at Campground and brief explanatory commentary is provided.

Calibration Run - Estimated Existing or Status Quo:

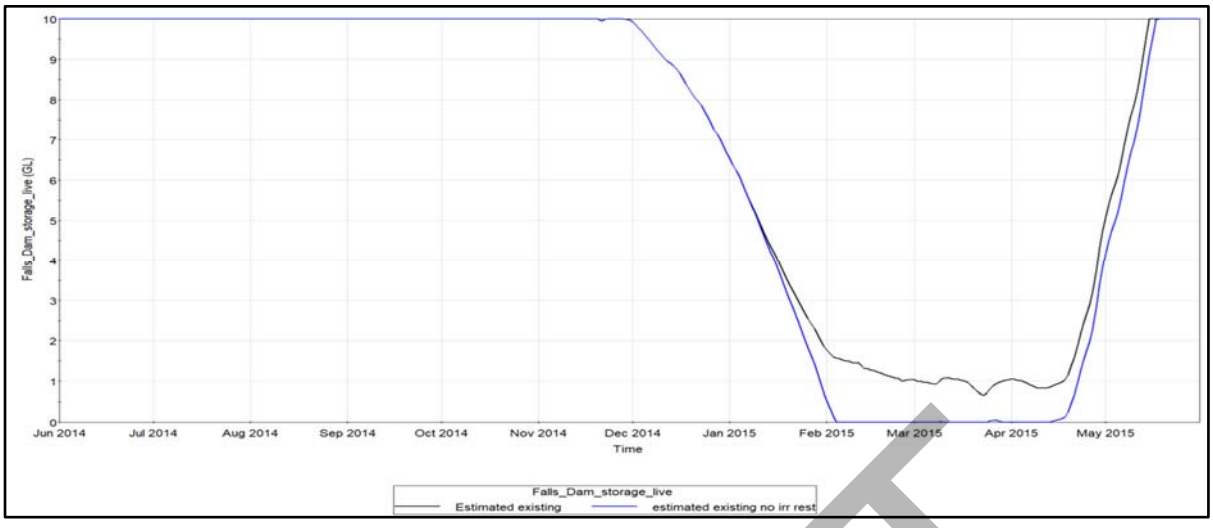
The Calibration Run (Status Quo) does not use Falls Dam storage to directly augment flows at Campground, rather it uses voluntary irrigation restrictions imposed by Falls Dam to control downstream irrigation and maintain flows . The voluntarily imposed irrigation restrictions achieve two things:

(a). They restrict irrigation takes thereby reducing run of river demand and allowing more water to be retained in the tributaries and main stem thereby improving downstream flows. This has a particularly strong influence in the tributaries.

(b). Restricting the main stem irrigation takes reduces demand on storage in Falls Dam. Storage is retained for longer prolonging the ability of Falls Dam to provide both irrigation water to main stem irrigators and potentially augment downstream flows. Retaining storage and prolonging irrigation supplies benefits the majority of the main stem as it is used to convey irrigation water, particularly Falls Dam to the MIS Intake and to a lesser extent down to the Galloway Intake. It also prolongs return irrigation water - while most of the water supplied to irrigators is used, a proportion is returned to the system through irrigation not being 100% efficient in terms of water use.

The effect of the voluntary imposed irrigation restrictions is shown in the following plots. Over the 2014-2015 summer the voluntary imposed irrigation restrictions (black line) ensured storage was maintained in Falls Dam throughout the season. Without the restrictions (blue line) the storage is expected to have drained by early February 2015 and would have remained drained through to the end of the irrigation season in mid April 2015.

Figure 34: Status Quo - Storage in Falls Dam 1 June 2014 – 31 May 2015

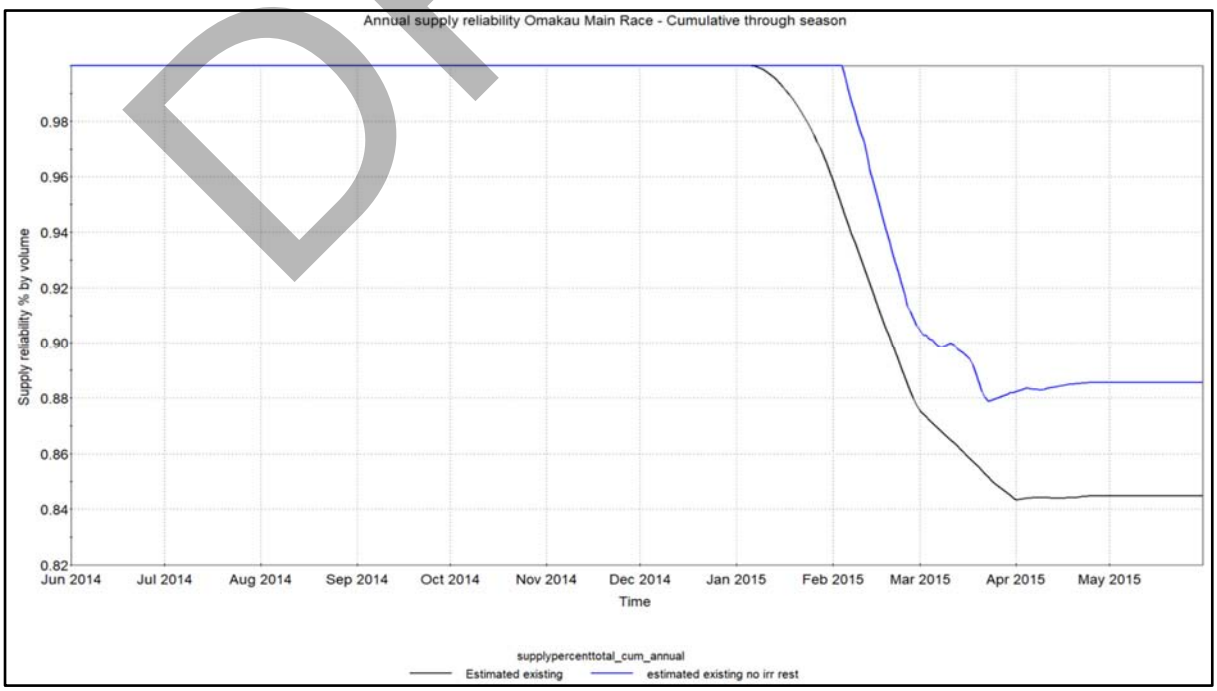


The voluntary imposed irrigation restrictions (black line) reduce the supply reliability irrigators experience, increasing soil moisture deficits and reducing growth. Over the 2014-15 season the effect on water supply reliability had two key components:

(a). The voluntarily imposed irrigation restriction (black line) start approximately a month earlier (early January 2015 compared with early February 2015) than restrictions due to lack of water supply (blue line). Generally the earlier restrictions start the more effect they have on overall growth.

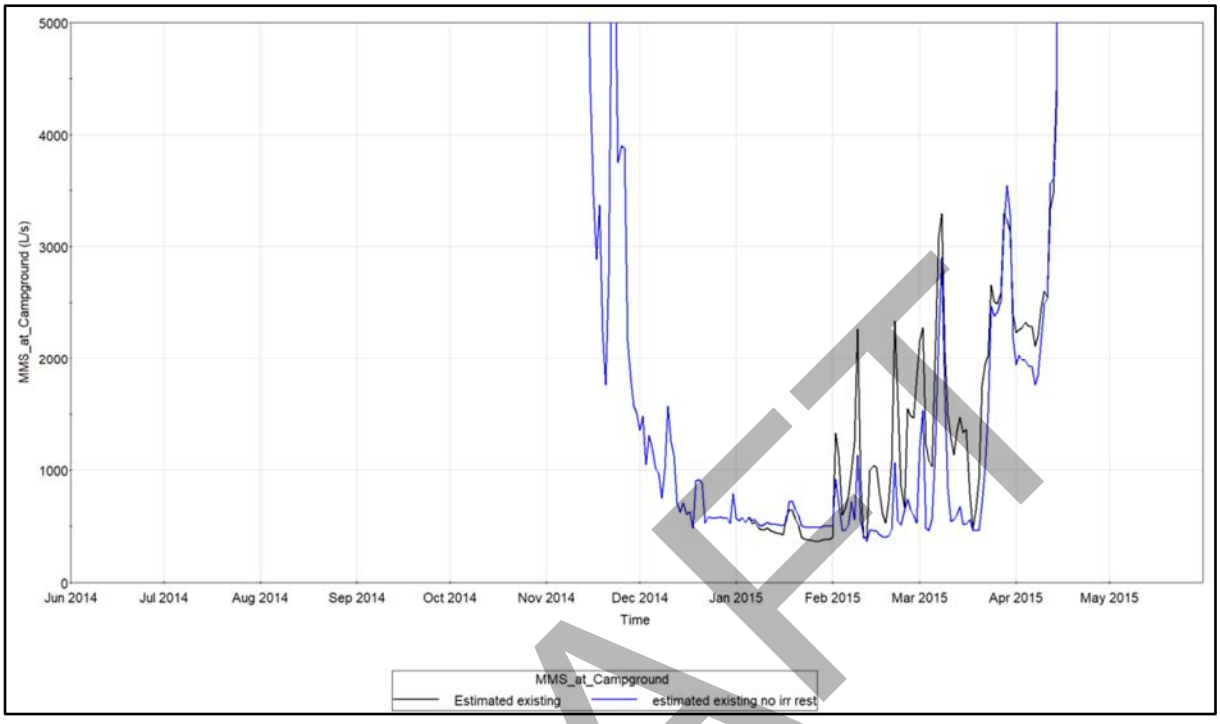
(b). The overall supply reliability for the season was reduced from 89% (blue line) to 84% (black line).

Figure 35: Status Quo - Volumetric Water Supply Reliability for the Omakau Irrigation Scheme's Main Race 1 June 2014 – 31 May 2015



The voluntary imposed irrigation restrictions (black line) have a positive effect on flow at Campground which is most pronounced later in the season. Once storage in Falls Dam is depleted flow at Campground is reduced quite considerably.

Figure 36: Status Quo - Flow in the Manuherekia River at Campground 1 June 2014 – 31 May 2015



1200:

Four options under the future 1200 scenario have been assessed:

(a). *1200* - voluntary irrigation restrictions imposed and Falls Dam storage used to augment minimum flows at Campground.

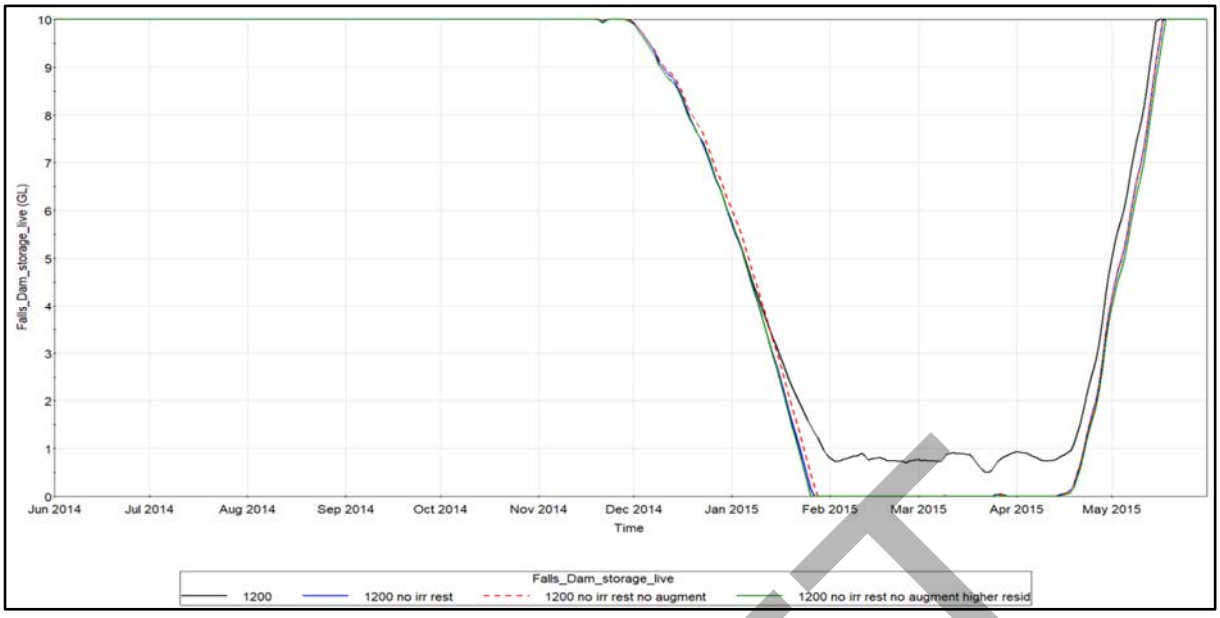
(b). *1200 no irr rest* – no voluntary irrigation restrictions imposed but Falls Dam storage used to augment minimum flows at Campground.

(c). *1200 no irr rest no augment* – no voluntary irrigation restrictions imposed and Falls Dam storage used solely for irrigation and not to augment minimum flows at Campground.

(d). *1200 no irr rest no augment higher resid* – no voluntary irrigation restrictions imposed, Falls Dam storage used solely for irrigation and not to augment minimum flows at Campground but with a higher residual flow below Falls Dam of 620 L/s compared with the current 500 L/s used in the previous scenarios.

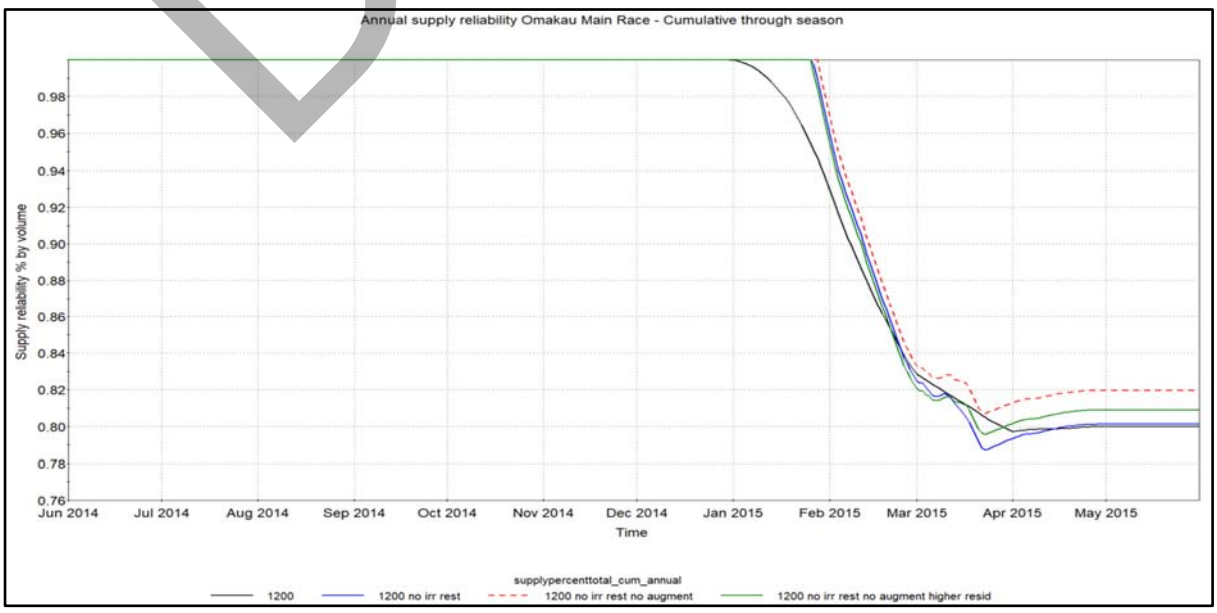
As with the Status Quo situation, without the voluntary imposition of irrigation restrictions Falls Dam drains. Not using storage in Falls Dam to augment minimum flows at Campground (red dashed line) retains storage for slightly longer (a few days). Relative to the Status Quo scenarios, increasing the minimum flow at Campground to 1200 L/s results in storage at Falls Dam draining approximately 1 week earlier (late January 2015 compared with early February 2015).

Figure 37: 1200 - Storage in Falls Dam 1 June 2014 – 31 May 2015



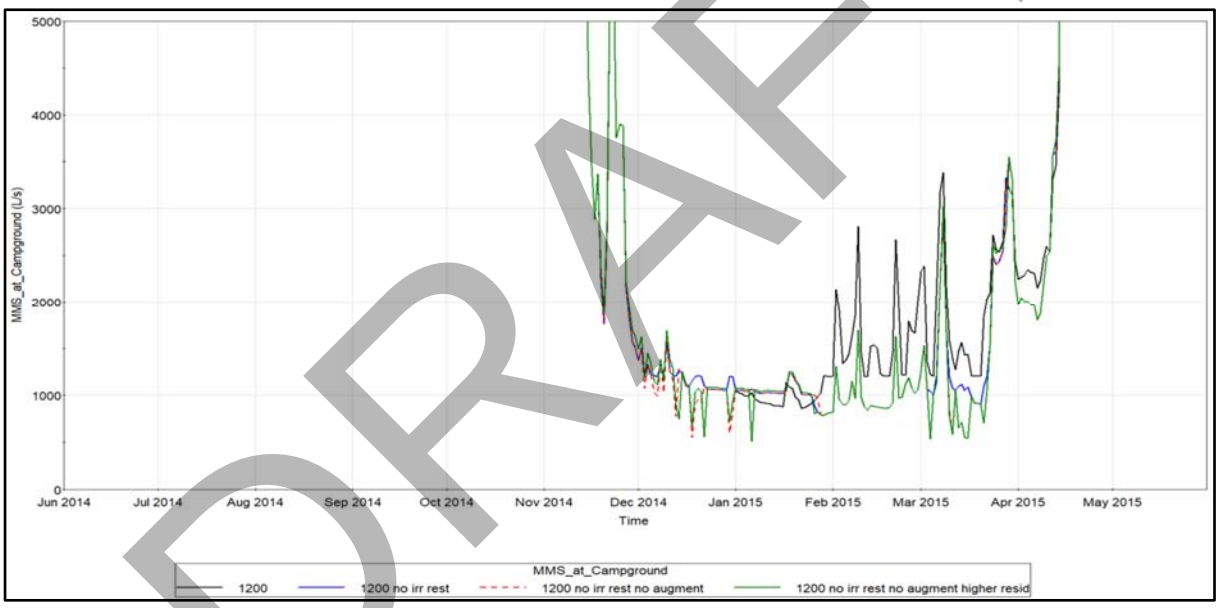
Increasing the minimum flow at Campground to 1200 L/s reduces volumetric supply reliability for irrigators on the OIS Main Race with an approximately 4% reduction relative to the Status Quo. At 1200 the voluntary imposed irrigation restrictions (black line) have a reduced effect on supply reliability than for the Status Quo. While voluntarily imposed irrigation restriction (black line) start approximately a month earlier (early January 2015 compared with early February 2015) than restrictions due to lack of water supply (blue line) the overall supply reliability for the season does not change significantly. Not using storage in Falls Dam to augment minimum flows at Campground improves seasonal supply reliability by approximately 2% over the baseline 1200 scenario (red dashed line). Increasing the residual flow below Falls Dam from 500 to 620 L/s (green line) improves supply reliability (as the increased residual flow is available for downstream irrigators to use) by approximately 1% relative to the baseline 1200 scenario.

Figure 38: 1200 - Volumetric Water Supply Reliability for the Omakau Irrigation Scheme's Main Race 1 June 2014 – 31 May 2015



As expected, increasing the minimum flow at Campground to 1200 generally increases flow at Campground relative to the Status Quo. As with the Status Quo situation, voluntary imposed irrigation restrictions (black line) have a significant positive effect on flow at Campground. The positive effect is most pronounced later in the season with flows being in the order of 400 L/s higher with voluntary imposed irrigation restrictions than without. Not using storage in Falls Dam to augment minimum flows at Campground (red dashed line) has a significant effect on low flow at Campground. The effect occurs periodically throughout the season even before storage in Falls Dam is drained. This is due to low contributions from the tributaries. The effect of not having voluntary imposed irrigation restrictions and not using Falls Dam storage to augment flow at Campground is such that periodically flow is expected to be lower than under the Status Quo scenario. Increasing the residual flow below Falls Dam from 500 to 620 L/s (green line) does not significantly alter the situation and very low flows are still expected to periodically occur at Campground.

Figure 39: 1200 - Flow in the Manuherekia River at Campground 1 June 2014 – 31 May 2015

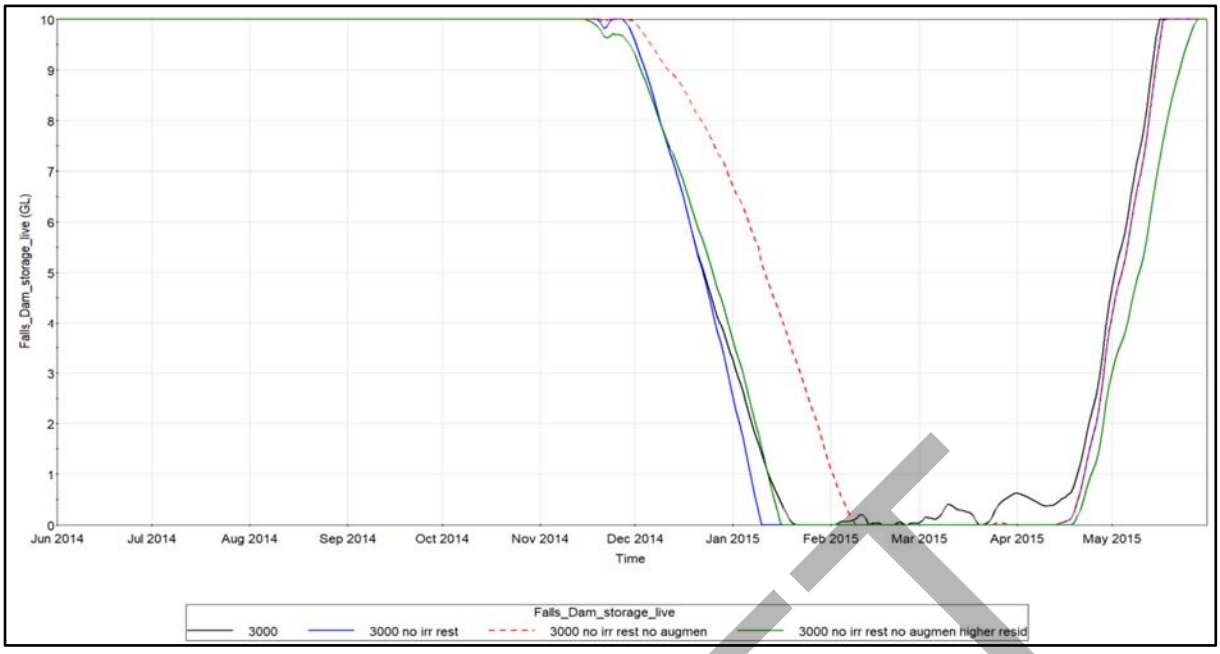


3000:

Four similar future scenarios were assessed for the 3000 option as for the 1200 option although a higher residual flow below Falls Dam of 1410 L/s was used.

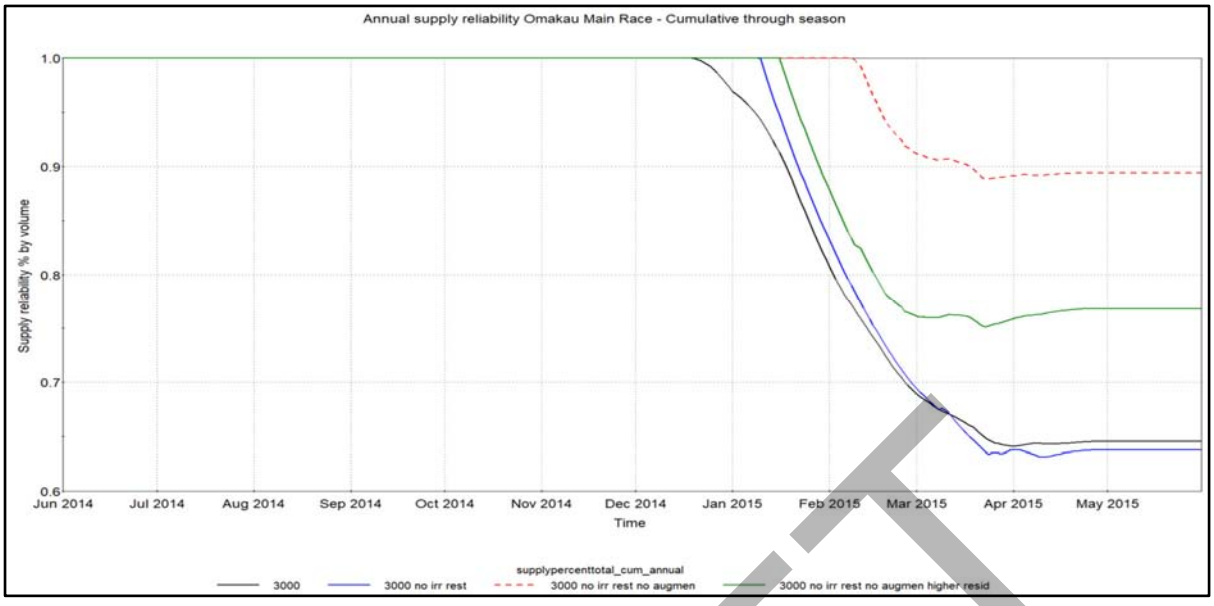
Under this high minimum flow scenario Falls Dam drains under all scenarios even with the voluntary imposition of irrigation restrictions. The voluntary imposition of irrigation restrictions retains storage for approximately 10 days longer (Falls Dam storage drained 20 January 2015 compared to 10 January 2015). Not having voluntary imposed irrigation restrictions and not using storage in Falls Dam to augment minimum flows at Campground (red dashed line) retains storage for approximately 1 month longer, to mid February 2015. Relative to the Status Quo scenarios increasing the minimum flow at Campground to 3000 L/s results in storage at Falls Dam draining approximately 3 weeks earlier (10 January 2015 compared with early February 2015).

Figure 40: 3000 - Storage in Falls Dam 1 June 2014 – 31 May 2015



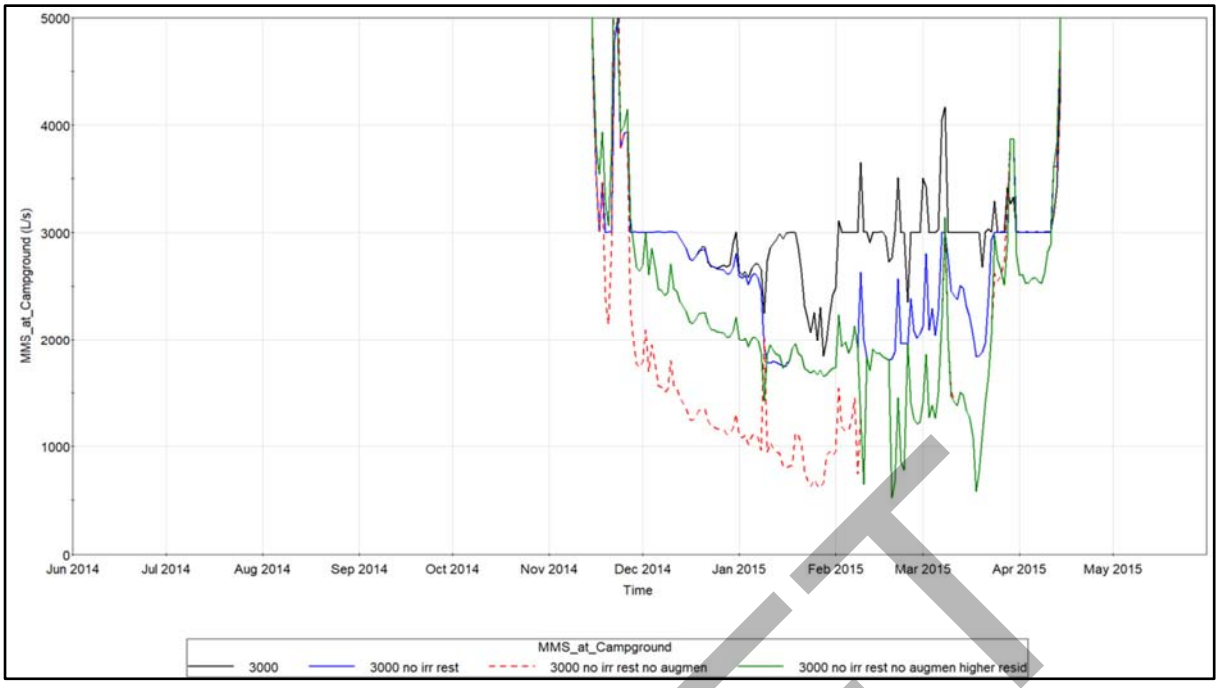
Increasing the minimum flow at Campground to 3000 L/s further reduces the supply reliability irrigators on the OIS Main Race experience with an approximately 20% reduction in volumetric supply reliability relative to the Status Quo. As with the 1200 scenario, at 3000 the voluntary imposed irrigation restrictions (black line) have a reduced effect on supply reliability than for the Status Quo. While voluntarily imposed irrigation restriction (black line) start approximately 3 weeks earlier (20 December 2014 compared with 11 January 2015) than restrictions due to lack of water supply (blue line) the overall supply reliability for the season does not change significantly but is extremely low at approximately 65 %. Not using storage in Falls Dam to augment minimum flows at Campground improves seasonal supply reliability by approximately 25% over the baseline 3000 scenario (red dashed line) and results in higher supply reliability than under the Status Quo scenario. Increasing the residual flow below Falls Dam from 500 to 1410 L/s (green line) improves supply reliability (as the increased residual flow is available for downstream irrigators to use) by approximately 12% relative to the baseline 3000 scenario.

Figure 41: 3000 - Volumetric Water Supply Reliability for the Omakau Irrigation Scheme's Main Race 1 June 2014 – 31 May 2015



Increasing the minimum flow at Campground to 3000 L/s generally increases flow at Campground relative to both the 1200 and the Status Quo scenarios. At this high minimum even with voluntary imposed irrigation restrictions (black line) there are significant periods during the season when flow at Campground drops below 3000 L/s. Removing the voluntary imposed irrigation restrictions further reduces flow at Campground resulting in it being below the 3000 L/s minimum from 20 December 2014 to 24 March 2015. The positive effect of the voluntary imposed irrigation restrictions is most pronounced later in the season with flows being in the order of 1000 L/s higher with voluntary imposed irrigation restrictions than without. At this high Campground minimum flow, not using storage in Falls Dam to augment minimum flows (red dashed line) has a very significant effect on flow at Campground. The effect occurs throughout the season from mid November 2014 even before storage in Falls Dam is drained. This is due to low contributions from the tributaries. Under the 3000 scenario, not having voluntary imposed irrigation restrictions and not using Falls Dam storage to augment flow at Campground is expected to results in flows at Campground during the 2014-2015 season which are similar to the base 1200 scenario and once storage in Falls Dam is drained are expected to be periodically similar to the Status Quo scenario. Increasing the residual flow below Falls Dam from 500 to 1410 L/s (green line) does not significantly alter the situation and flow at Campground is still expected to remain below the 3000 L/s minimum for most of the season and very low flows similar to the Status Quo are expected to periodically occur.

Figure 42: 3000 - Flow in the Manuherekia River at Campground 1 June 2014 – 31 May 2015



Overall comment:

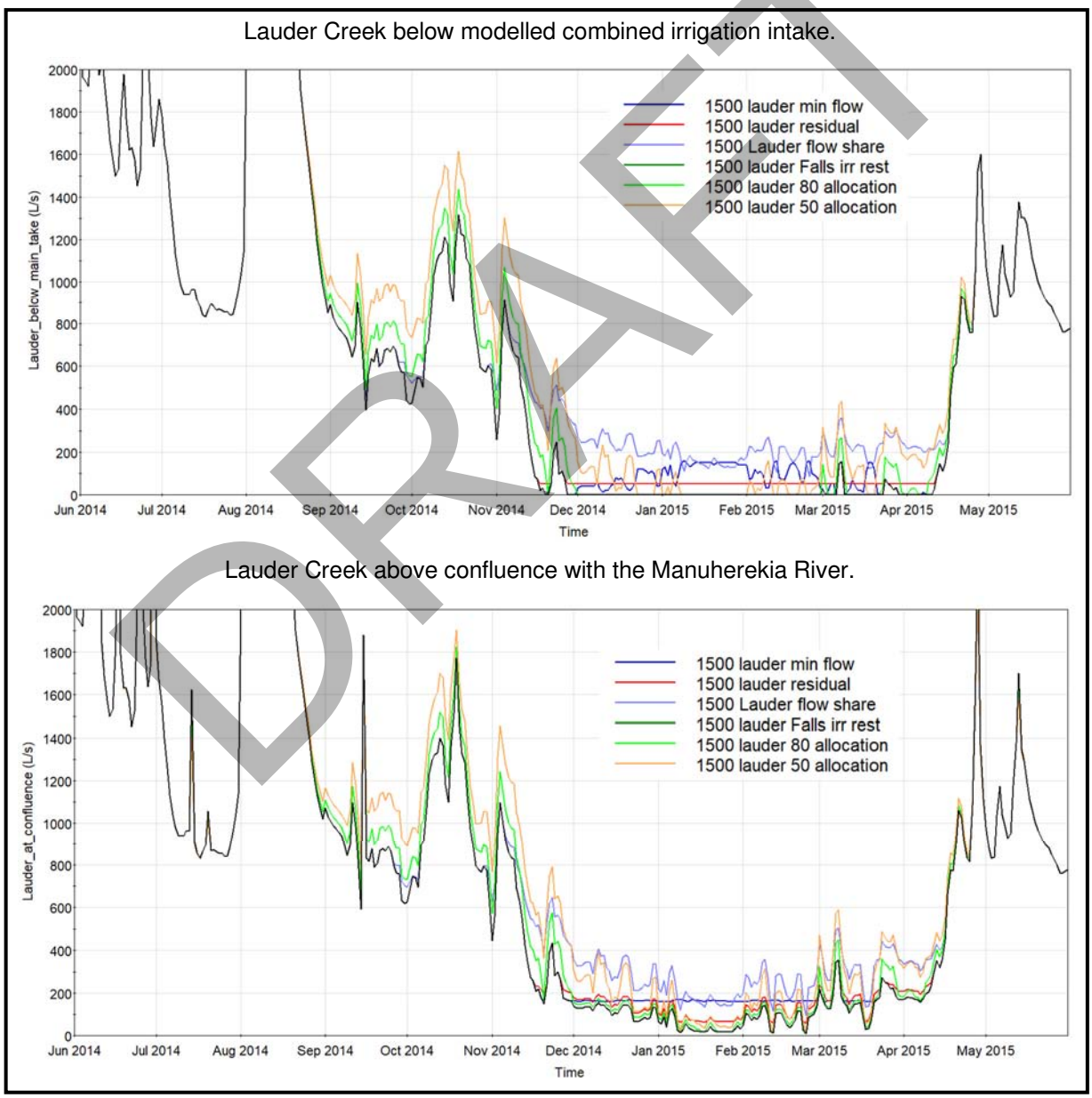
The current Falls Dam management practices of: imposing voluntary irrigation restrictions on irrigators in the Manuherekia Valley in order to retain storage in Falls Dam and using storage in Falls Dam to augment minimum flows at Campground, have a significant effect on the modelled scenarios particularly as the Campground minimum flow increases. The management practices affect all parts of the system including flow in the tributaries and main stem, storage in Falls Dam and irrigation reliability throughout the Manuherekia Valley. As the minimum flows increase the effect of these currently voluntarily management practices become more significant and results in the reallocation of water from irrigation to the environment. Without the management practices, flow in the tributaries and the main stem quickly reduces and particularly for the higher minimum flow scenarios, results in the stated minimum flows not being maintained and flow quickly receding to levels similar to the current Status Quo situation. At the higher minimum flow options the effect on the overall system of the current Falls Dam management practices is expected to be greater than the effect of the actual minimums.

Under the Status Quo scenario the current Falls Dam management practices are expected, during the drought season of 2014-2015, to be resulting in irrigators experiencing water restrictions which commence approximately 1 month earlier and which result in an approximately 5% reduction in seasonal volumetric water supply reliability, relative to no management practices.

4.16 **Implications of potential components of a Manuherekia Flow and Allocation regime – Lauder Creek example**

Hydrographs for the period 1 June 2014 to 31 May 2015 (a recent drought season) are provided for flow in Lauder Creek both immediately below the modelled combined irrigation intake (upper plot) and at the confluence with the Manuherekia River (lower plot). Each hydrographs shows the effect of the 4 potential components of a flow and allocation regime for the Manuherekia River namely (minimum flow, residual flow, flow sharing, and allocation). The hydrograph below the modelled combined irrigation intake (upper plot) is included to more clearly show the effect of a nominal 50 L/s residual flow.

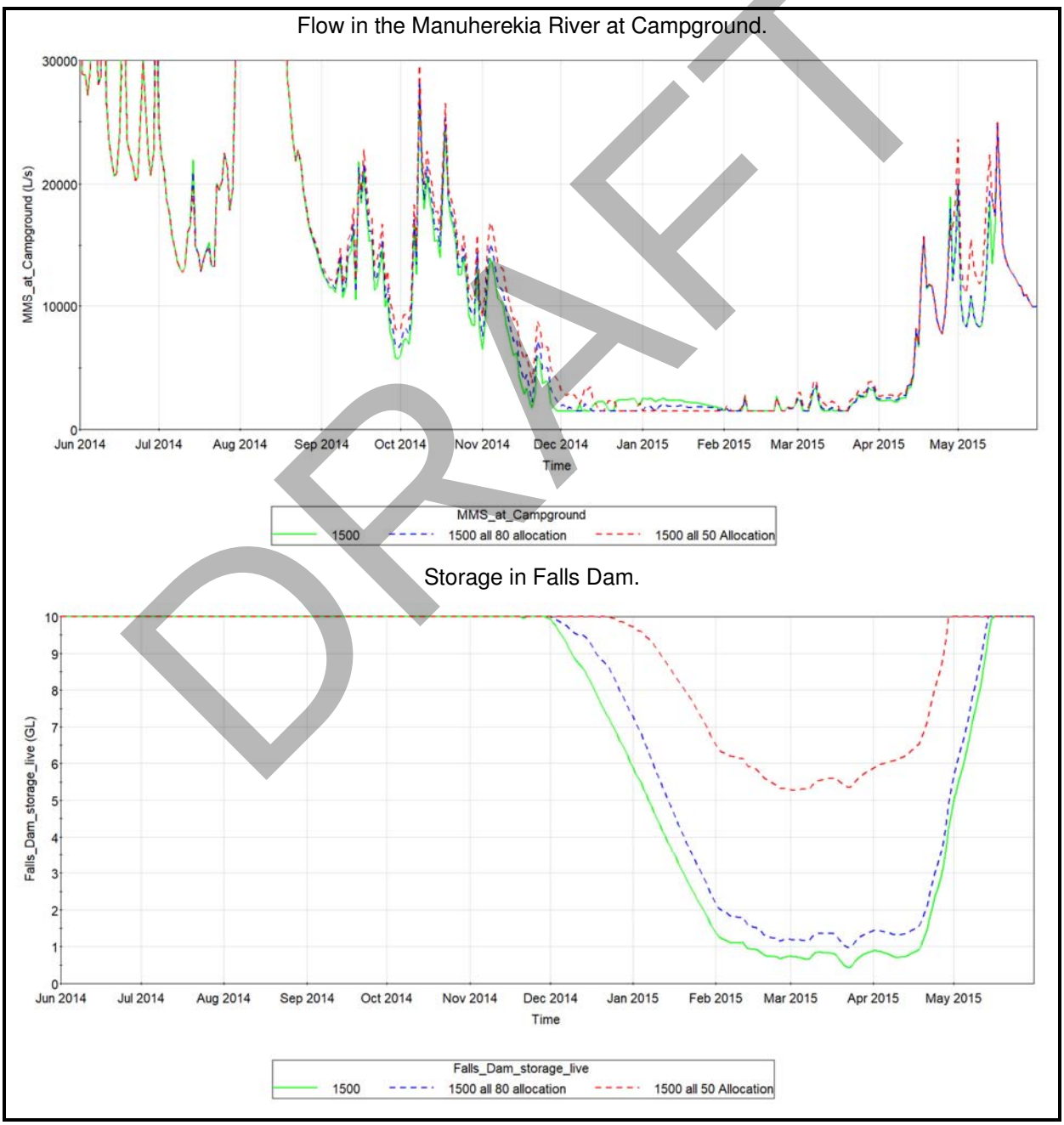
Figure 43: Flow implications of potential components of a Manuherekia Flow and Allocation regime Lauder Creek 1 June 2014 – 31 May 2015



4.17 **Manuherekia Valley Allocation effect on flow in the Manuherekia River at Campground**

Hydrographs for the period 1 June 2014 to 31 May 2015 (a recent drought season) are provided for flow in the Manuherekia River at Campground and for storage in Falls Dam. Each hydrographs shows current allocation (green solid line), 80% of current allocation (blue dashed line) and 50% of current allocation (red dashed line). The Manuherekia Hydrology Model was not set up to easily change allocation across the whole catchment and while it can be achieved by changing irrigated area there are approximately 50 irrigated area that would need to be altered. To provide an initial indication of the effect of allocation the unit irrigation demand was reduced by 20% and 50 % respectively rather than reducing the irrigated area.

Figure 44: Allocation Effects – Manuherekia River Flow at Campground and Storage in Falls Dam 1 June 2014 – 31 May 2015



5.0 CLOSURE

The Manuherekia Hydrology Model has not yet been documented, reviewed nor has it been formally adopted or approved by the Manuherekia Hydrology Group. It has been constructed using all the available hydrological data and current understanding of the catchment. It has been developed to suitably replicate the hydrology of the Manuherekia catchment and to allow potential future water management scenarios to be assessed. Based on the model calibration / verification results the Manuherekia Hydrology Model is considered to suitably replicate the catchment's hydrology and current water management regime. While the Manuherekia Hydrology Model's ability to suitably assess future water management scenarios has not, as yet, been reviewed or independently checked, the predictions from the various scenarios and the relative change between the scenarios are as expected.

Due to the nature of the Manuherekia Hydrology Model, when interpreting the data and plots it is recommended that readers focus on the relative change between scenarios rather than the specific values for any one scenario. The model will be most accurate at assessing relatively small changes to current management. As the degree of change increases the model's ability to suitably estimate the implications of the change will reduce. Similarly, the model will have higher uncertainties in sub-catchments with limited measured data namely the Chatto Creek, Ida Burn, Pool Burn and Manor Burn sub-catchments.

The model is very sensitive to the scenario data especially the tributary minimum flows and the management imposed irrigation restrictions. Due to the complexity of the model and how the system adjusts to changes care is required when developing and assessing scenarios.

Yours faithfully,
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