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Report 2a: HMD Flow Series Comparison

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Contact Details

Lizzie Fox

WSP
Greymouth Office
23 High Street
Greymouth 7840
+64 3 769 9330
+64 27 540 1780
Lizzie.fox@wsp.com

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Prepared by
S. Yeo

Reviewed by
L. Fox

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L. Fox

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Preface

A large proportion of New Zealand's electricity needs are met by generation from hydro power. Information about the distribution of inflows and the capability of the various hydro systems is necessary to ensure a reliable, competitive, and efficient market and electricity system.

The hydrological modelling dataset (HMD) is a dataset of hydrological information made available by the Electricity Authority. The dataset was known as the SPECTRA update until 2010. In 2015 the dataset was revised to become the HMD, a comprehensive dataset that can be relied upon by modellers and analysts to test scenarios, provide commentary and inform decisions.

The HMD is comprised of data provided by hydro generators and supplemented with some from other sources. These parties are acknowledged for their contribution and for making this data available.

The HMD consists of three main components:

1. Infrastructure and hydrological constraint attributes:

   This dataset records standing information about the capability of the main hydro schemes.
2. Flows:

   This time series dataset records data for inflows for reservoirs and flows at various existing or potential hydro generating sites.
3. Storage and spill:

   This time series dataset records storage for the main hydro schemes.

This report describes the differences between the 2020 HMD flow series data and the 2022 HMD flow series data.

Contents

1 Introduction

1.1 Datasets and mean flows

Care is taken to ensure consistency of data between successive HMD updates. A comparison of the mean flows for each flow series is listed in Table 1.1 for the North Island and Table 1.2 for the South Island. Following the last HMD full update it was requested that the analysis of the datasets be extended back to 1 July 1931. Therefore, the data from the 2022 update (1 July 1931 – 31 December 2022) will be compared to data from the previous full update (2020) which contains data from 1 January 1932 to 31 December 2020.

Table 1.1: North Island flow dataset names and mean values derived from the previous HMD update (2020) and this HMD update (2022).

Flow	Model flow name	Flow site number	Mean flow (m^3/s)		Type
			1 Jan 1932 to 31 Dec 2020	1 Jul 1931 to 31 Dec 2022	
Arapuni Tribs	Arapuni	92724 (1)	81.49	81.69	A
Karapiro Tribs	Karapiro	92714 (1)	91.08	90.90	A
Tokaanu	TokaanuTPD	92790 (3)	52.39	52.54	A
Tokaanu	Toka_Linear	22790 (3)	53.24	53.19	A
Taupo	TaupoTPD	92790 (1)	155.45	155.95	A
Taupo	Taupo_Linear	22790 (1)	154.13	154.17	A
Taupo	Taupo_Actual	42790 (1)	139.91	140.14	A
Taupo	Taupo_Infrastructure	72790 (1)	148.60	149.23	A
Taupo	Taupo_Natural	62790 (1)	125.55	126.00	N
Rangipo	RangipoTPD	92790 (2)	34.62	34.68	A
Rangipo	Rangi_linear	22790 (2)	28.8	28.76	A
Waikaremoana	Waikaremoana	3650 (1)	17.64	17.71	N+A
Matahina	Matahina	93254 (1)	64.40	64.35	A
Wheao	Wheao	15462(1)	12.82	12.61	A
Mangahao	Mangahao	97502(1)	8.70	8.96	A
Patea	Patea	34300(1)	19.55	19.87	A
Kaimai	Wairoa	14130(1)	11.86	11.88	A
Ngaruroro	Whanawhana	123103 (1)	34.97	34.85	N+A
	Kuripapango	123104 (1)	17.69	17.72	N+A
	Chesterhope	123150 (1)	43.64	43.57	N+A
Mohaka	Raupunga	121801 (1)	78.91	79.02	N+A

"N" denotes a natural flow, uncontrolled flow
"A" denotes an actual flow
"N+A" denotes a flow that is both actual and natural
(*) Denotes item number of historic Tideda file, data is now stored in Hilltop Manager and uses the primary number

Table 1.2 South Island flow dataset names and mean values derived from the previous HMD update (2020) and this HMD update (2022).

Flow	Model flow name	Flow site number	Mean flow (m^3/s)		Type
			1 Jan 1932 to 31 Dec 2020	1 Jan 1932 to 31 Dec 2022	
Waitaki P.S. Tribs	Waitaki	98714 (2)	149.60	149.61	A
Benmore	Benmore	98614 (4)	132.77	132.95	A
	Ben_tp	98615 (2)	123.41	123.44	A
Ohau (separate Tekapo model)	OhauRes	98614 (6)	70.39	70.27	A
	Ohau	98614 (3)	80.29	80.25	N+A
Pukaki	Pukaki	98614 (2)	195.59	196.01	A
Natural Pukaki	Nat_Puk	98770 (1)	126.52	126.94	N
Natural Tekapo	Nat_Tek	98770 (2)	83.43	83.89	N
Tekapo	Tekapo	98614 (1)	69.13	83.43	A
Natural Tekapo	Nat_Tek	98770 (2)	83.62	83.89	N+A
Manapouri	Manawmara	99551 (1)	137.07	138.01	A
	Manapouri	99550 (1)	122.14	123.92	N
	Manareduced	99552 (1)	125.78	126.31	A
Te Anau	Teanau	9570 (1)	284.48	284.14	N+A
Monowai	Mono_Inflow	199540 (1)	12.96	12.93	N+A
Roxburgh	Roxburgh	99110 (1)	446.64	446.80	A
Wanaka	Wanaka	9154 (1)	197.63	197.80	N+A
Hawea	Hawea	9170 (1)	64.47	64.42	N+A
Cobb	Cobb	97904 (2)	5.38	5.37	N+A
Coleridge	Coleridge	97904 (1)	24.77	24.67	A
Highbank	Highbank	7968(1)	13.48	13.44	A
Waipori	Waipori	174395(1)	7.41	7.36	A
Grey+Taramakau-Taipo	Grey_tara CLOSED	77106(1)	436.32	436.84	A
Grey+Taramakau-Taipo	Grey_tara	77106(2)	431.80	354.14	A
Waiau	Clarence	162105 (1)	14.41	14.48	N+A
	Glenhope	164604 (1)	33.63	34.06	N+A
	Marble Point	164602 (1)	93.78	94.41	N+A
Wairau	Dip Flat	160114 (1)	26.48	26.72	N+A
Hurunui	Mandamus	165104 (1)	51.12	51.49	N+A
	SH 1 Bridge	165101 (1)	66.21	66.72	N+A
Lake Onslow	Onslow	175237 (1)	5.40	2.92	N+A

"N" denotes a natural flow, uncontrolled flow
"A" denotes an actual flow
"N+A" denotes a flow that is both actual and natural

(*) Denotes item number of historic Tideda file, data is now stored in Hilltop Manager and uses the primary number
Lake Onslow is a new site and therefore was not in the previous update.

2 Data Differences for Calculated Flow Sites

Differences between datasets may occur from one update to the next for a variety of reasons. These include rating changes; data modifications; inflows being recalculated, and various other reasons. Table 2.1 shows if there were any differences in the data between the previous and current updates for North Island flow sites and Table 2.2 shows if there were any differences for South Island flow sites. The following sections highlight the reasons for these differences.

Table 2.1: Data differences for previous and current updates for North Island flow sites

Flow site number and item number	Flow site name	Data differs
92724 (1)	Arapuni Tributary inflows	Y
92714 (1)	Karapiro Tributary inflows	Y
22790 (1)	Taupo linear Inflows	Y
22790 (2)	Rangipo linear Inflows	Y
22790 (3)	Tokaanu linear Inflows	Y
92790 (1)	Taupo non-linear Inflows	Y
92790 (2)	Rangipo non-linear Inflows	Y
92790 (3)	Tokaanu non-linear Inflows	Y
42790 (1)	Taupo operational inflows	Y
72790 (1)	Taupo infrastructure inflows	Y
62790 (1)	Taupo natural inflows	Y
3650 (1)	Waikaremoana inflows	N
93254 (1)	Matahina Outflows	Y
15462 (1)	Wheao/Flaxy Outflows	Y
97502 (1)	Mangahao Inflows	Y
34300 (1)	Patea Outflows	N
14130 (1)	Kaimai Outflows at Ruahihi	Y
123103 (1)	Ngaruroro - Whanawhana	Y
123104 (1)	Ngaruroro - Kuripapango	N
123150 (1)	Ngaruroro - Chesterhope	Y
121801 (1)	Mohaka - Raupunga	Y

Table 2.2: Data differences for previous and current updates for South Island flow sites

Flow site number and item number	Flow site name	Data differs
98714 (2)	Waitaki Tributaries (Benmore)	Y
98614 (4)	Benmore Tributary Flows	Y
98615 (2)	Benmore_tp	N
98614 (6)	Ohau Residual Flows	N
98614 (3)	Ohau (Ohau B and C)	N
98614 (2)	Pukaki	Y
98770 (1)	Pukaki natural inflows	Y
98614 (1)	Tekapo	Y
98770 (2)	Tekapo natural inflows	Y
99550 (1)	Manapouri local inflow (no Mararoa)	Y
99551 (1)	Manapouri local inflow (incl. Mararoa)	Y
99552 (1)	Manapouri local inflow (no Mararoa + water right reduction)	Y
9570 (1)	Lake Te Anau inflow	Y
199540 (1)	Monowai Inflow	N
99110 (1)	Roxburgh tributary flows	N
9154 (1)	Wanaka Outflow	N
9170 (1)	Hawea Inflow	Y
97904 (2)	Cobb Inflow	Y
97904 (1)	Coleridge Inflow	Y
7968 (1)	Highbank Outflows	Y
174395 (1)	Waipori Outflows	N
77106 (1)	Grey + Taramakau - Taipo	Y
162105 (1)	Waiau - Jollies	N
164604 (1)	Waiau - Glenhope	Y
164602 (1)	Waiau - Marble Point	Y
160114 (1)	Wairau - Dip Flat	N
165104 (1)	Hurunui - Mandamus	N
165101 (1)	Hurunui - SH1 Bridge	N
175237 (1)	Lake Onslow inflows	Y

3 North Island Flow Sites

3.1 92724 (1) Arapuni Tributaries

There are minor differences between updates due to one of the input sites, Lake Taupo Total Outflow, has had a rating change.

Table 3.1 Arapuni tributaries (92724 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	81.69	77.38	636.28
2020	0.00	81.31	77.02	636.28

3.2 92714 (1) Karapiro Tributaries

There are minor differences between updates due to one of the input sites, Lake Taupo Total Outflow, has had a rating change.

Table 3.2 Karapiro tributaries (92714 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	90.90	86.07	572.34
2020	0.00	91.33	86.31	572.34

3.3 22790 (1) Taupo Inflow Linear

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series.

Table 3.3 Taupo Inflow Linear (22790 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	22.65	154.17	134.42	1489.29
2020	23.76	154.64	134.85	1489.29

3.4 22790 (2) Rangipo Linear

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series.

Table 3.4 Rangipo Linear (22790 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	28.76	26.02	90.71
2020	0.00	28.88	26.19	90.69

3.5 22790 (3) Tokaanu Linear

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series.

Table 3.5 Tokaanu Linear (22790 (3)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	7.88	53.19	47.63	226.12
2020	7.99	53.47	47.75	226.12

3.6 92790 (1) Taupo

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series. However these do not change the maximum values due to the rules of the simulated dataset.

Table 3.6 Taupo non-linear (92790 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	2.50	155.95	135.76	1426.67
2020	0.47	155.95	135.90	1426.67

3.7 92790 (2) Rangipo

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series. However these do not change the maximum values due to the rules of the simulated dataset.

Table 3.7 Rangipo non-linear (92790 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	34.68	32.36	63.00
2020	0.00	34.70	32.40	63.00

3.8 92790 (3) Tokaanu

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, including Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series. However these do not change the maximum values due to the rules of the simulated dataset.

Table 3.8 Tokaanu non-linear (92790 (3)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	52.54	47.60	158.91
2020	0.00	52.58	47.62	158.91

3.9 42790 Taupo Actual Inflows

There are minor changes due to the change in rating at the Waikato at Reids farm flow site, which is used to represent the Total Outflows of Taupo. This site is used to derive the Total Inflows and therefore have altered the statistics.

Table 3.9 Taupo Actual Inflows (42790 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	2.00	140.14	120.875	1357.313
2020	2.00	139.90	121.02	1357.313

3.10 62790 Taupo Natural Inflows

There are minor changes due to the change in rating at the Waikato at Reids farm flow site, which is used to represent the Total Outflows of Taupo. This site is used to derive the Total Inflows, and subsequent Natural Total Inflows, and therefore have altered the statistics.

Table 3-10: Taupo natural inflows (62790 (1)) data difference table.

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	2.00	126.00	106.81	1357.31
2020	2.00	125.96	107.08	1357.31

3.11 72790 Taupo Infrastructure Inflows

There are minor changes as new data was provided from Genesis, as well as rating changes occurring for several input sites, specifically the TPD and Lake Taupo Total Outflow which is used to create Lake Taupo Inflow and naturalised series. Due to the changes in TPD data

meant a new rating relationship was established, which has aaltered the maximum value slightly.

Table 3-11: Taupo infrastructure inflows (72790 (1)) data difference table.

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	2.00	149.23	130.47	1426.69
2020	2.00	148.90	130.09	1431.68

3.12 3650 (1) Waikaremoana

No differences between updates, the 'apparent' mean and median differences appear due to software rounding, the actual data has not changed.

Table 3.12 Waikaremoana (3650 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	17.71	11.07	686.14
2020	0.00	17.70	11.05	686.14

3.13 123103 (1) Ngaruroro - Whanawhana

There are very minor differences due to updated ratings provided for the flow data between updates.

Table 3.13 Ngaruroro at Whanawhana (123103 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	1.40	34.85	25.73	837.36
2020	1.40	35.13	25.86	837.36

3.14 123104 (1) Ngaruroro - Kuripapango

No differences between updates, the 'apparent' median difference appear due to software rounding, the actual data has not changed.

Table 3.14 Ngaruroro at Kuripapango (123104 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.85	17.72	12.67	385.09
2020	0.85	17.72	12.66	385.09

3.15 123150 (1) Ngaruroro – Chesterhope

There are very minor differences due to updated ratings provided for the flow data between updates.

Table 3.15 Ngaruroro at Chesterhope(123150 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	1.00	43.57	27.99	1698.97
2020	1.00	43.68	28.02	1698.97

3.16 121801 (1) Mohaka – Raupunga

There are very minor differences due to updated ratings provided for the flow data between updates.

Table 3.16 Mohaka (121801 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	13.72	79.02	59.82	1619.11
2020	13.25	79.19	59.92	1619.11

3.17 97502 (1) Mangahao

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data. This included additional spill data which has changed the maximum amount, but is more representative of the overall 'outflow' of Mangahoa, which is used to represent the 'inflow' into the reservoir.

Table 3.17 Mangahao Inflows (97502 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	8.96	6.60	239.15
2020	0.00	8.70	6.34	320.11

3.18 14130 (1) Kaimai Outflows at Ruahihi

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data. Although for this site it does not noticeably impact the overall statistics, when comparing datasets one would notice a change from the 2000s onwards.

Table 3.18 Kaimai Outflows at Ruahihi (14130 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	11.88	11.24	25.95
2020	0.00	11.86	11.28	25.95

3.19 15462 (1) Wheo/ Flaxy Outflows

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 3.19 Wheo/ Flaxy Outflows (15462 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	12.61	11.93	23.46
2020	0.00	12.82	12.08	26.61

3.20 34300 (1) Patea Outflows

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data. This includes updating some previous negative numbers to being zeroed to be more representative of potential outflows.

Table 3.20 Patea Outflows (34300 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	19.87	6.34	719.80
2020	-0.51	19.55	7.81	719.80

3.21 93254 (1) Matahina Outflows

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 3.21 Matahina Outflows (93254 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	64.35	58.98	622.00
2020	0.00	64.40	59.04	622.94

4 South Island Flow Sites

4.1 98714 (2) Waitaki Tributaries

Very minor differences due to updated interpolation of historical data.

Table 4.1 Waitaki tributaries (98714 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	149.61	131.99	1441.52
2020	0.00	149.31	131.80	1441.52

4.2 98614 (4) Benmore Tributary Flows

Very minor differences due to updated interpolation of historical data.

Table 4.2 Benmore tributaries (98614 (4)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	7.66	132.95	98.82	2962.93
2020	7.66	132.62	98.66	2962.93

4.3 98615 (2) Benmore_tp

Very minor differences due to updated interpolation of historical data.

Table 4.3 Benmore tributaries (98615 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	7.66	123.44	98.72	2019.61
2020	7.66	123.35	98.51	2019.61

4.4 98614 (2) Pukaki

Minor changes due to an updated rating for the Waitaki at Kurow relationship, which has slightly modified the maximum flow value and the values throughout the dataset.

Table 4.4 Pukaki (98614 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	196.01	162.65	2828.37
2020	0.00	195.25	162.01	2829.44

4.5 98614 (1) Tekapo

Very minor differences due to new data received from Genesis this update.

Table 4.5 Tekapo (98614 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	4.48	69.21	62.33	130.00
2020	4.48	68.97	61.46	130.00

4.6 98770 (2) Tekapo Naturals

Differences due to new data received from Genesis this update which has increased the estimated maximum flow value for this dataset.

Table 4.6 Tekapo Natural (98770 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.03	83.89	66.91	1393.90
2020	0.03	83.43	66.66	1175.35

4.7 98770 (1) Pukaki Naturals

Differences due to new data received from Genesis this update which has increased the estimated maximum flow value for this dataset.

Table 4.7 Pukaki Natural (98770 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	126.94	98.82	2698.37
2020	0.00	126.33	98.06	2699.44

4.8 99550 (1) Manapouri local inflow (no Mararoa)

Minor changes are due to rating changes of the input sites, but do not significantly cause changes between updates.

Table 4.8 Manapouri local inflow (99550 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	123.92	79.13	2313.26
2020	0.00	122.13	77.97	2313.26

4.9 99551 (1) Manapouri local inflow (incl. Mararoa)

Minor changes are due to rating changes of the input sites, but do not significantly cause changes between updates.

Table 4.9 Manapouri local inflow (99551 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	138.01	96.39	2313.26
2020	0.00	137.03	96.12	2313.26

4.10 99552 (1) Manapouri local inflow (no Mararoa + water right reduction)

Minor changes are due to rating changes of the input sites, but do not significantly cause changes between updates.

Table 4.10 Manapouri local inflow (99552 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	126.31	83.74	2532.31
2020	0.00	125.74	83.63	2532.31

4.11 199540 (1) Monowai inflows

Very minor differences due to slight change in the raw data supplied this update.

Table 4.11 Monowai (199540 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	12.93	8.56	251.80
2020	0.00	12.94	8.56	251.80

4.12 99110 (1) Roxburgh tributary flows

Minor changes are due to rating changes of the input sites, but do not significantly cause changes between updates.

Table 4.12 Roxburgh (99110 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	446.80	402.48	3314.97
2020	0.00	445.16	400.05	3314.97

4.13 77106 (1) Grey + Taramakau – Taipo

Differences in the rating for the Grey River at Dobson flow site has resulted in minor changes.

Table 4.13 Grey River (77106 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	42.00	436.84	325.80	7740.00
2020	42.00	436.32	325.19	7740.00

4.14 77106 (2) Grey + Taramakau – Taipo

Differences in the rating for the Grey River at Dobson flow site has resulted in a change in relationship between this synthetic record and the original Grey River script. This particularly causes a shift at the top end, significantly increasing the maximum flow value. The relationship has a high r^2 value (of 0.99) but likely will be over estimating the peak flow. As potential generation would theoretically be limited in generation capacity during 'flood' conditions, this should not impact the purpose of this dataset, since 'average' flows are more important.

Table 4-14: Grey River (77106 (1)) data difference table.

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	8.59	435.80	318.88	8404.03
2020	40.77	432.11	326.02	7641.40

4.15 162105 (1) Waiau – Jollies

Very minor differences due to slight change in flow ratings.

Table 4.15 Waiau at Jollies (162105 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	1.71	14.48	10.76	405.65
2020	1.71	14.46	10.73	405.65

4.16 164604 (1) Waiau – Glenhope

Change in flow ratings means the correlation of flows between sites was updated, resulting in statistical differences between the previous and current update.

Table 4.16 Waiau at Glenhope (164604 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	4.91	34.06	26.40	617.68
2020	5.82	33.75	26.50	582.89

4.17 164602 (1) Waiau - Marble Point

Minor differences due to changes in the flow ratings at this site.

Table 4.17 Waiau at Marble Point (164602 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	18.97	94.41	73.20	1578.58
2020	19.48	94.15	72.92	1578.58

4.18 160114 (1) Wairau – Dip Flat

Minor differences due to changes in the flow ratings at this site.

Table 4.18 Waiau at Dip Flat (160114 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	4.01	26.72	20.35	587.88
2020	4.01	26.51	20.29	587.88

4.19 165104 (1) Hurunui – Mandamus

Minor differences due to changes in the flow ratings at this site.

Table 4.19 Hurunui at Mandamus (165104 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	7.91	51.49	39.54	1066.08
2020	7.91	51.18	39.35	1066.08

4.20 165101 (1) Hurunui – SH1 Bridge

Minor differences due to changes in the flow ratings at this site.

Table 4.20 Hurunui at SH1 Bridge (165101 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	7.00	66.72	52.01	1827.52
2020	7.00	66.32	51.84	1827.52

4.21 9154 (1) Lake Wanaka

Very minor differences due to changes in the flow ratings at this site.

Table 4.21 Lake Wanaka (9154 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	38.71	197.80	177.17	1414.18
2020	38.71	196.77	175.77	1414.18

4.22 9170 (1) Lake Hawea

Very minor differences due to changes in the flow ratings at this site.

Table 4.22 Lake Hawea (9170 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.84	64.56	47.77	1648.20
2020	0.84	64.38	47.57	1648.20

4.23 9570 (1) Lake Te Anau

Minor differences due to changes in the flow ratings at this site.

Table 4.23 Lake Te Anau (9570 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.03	284.14	185.16	4830.50
2020	0.03	283.31	184.22	4830.50

4.24 98614 (1) Ohau Inflows

Minor differences due to changes in the flow ratings at this site.

Table 4.24 Ohau Inflows (98614 (1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	2.00	80.25	63.23	1605.93
2020	2.00	80.31	63.38	1605.93

4.25 98614 (2) Ohau Residual Inflows

Minor differences due to changes in the flow ratings at this site, which are used in this simulated dataset.

Table 4.25 Ohau Residual Inflows (98614 (2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	70.27	52.93	1593.93
2020	0.00	70.33	52.99	1593.93

4.26 175237 (1) Lake Onslow Inflow

Significant differences for this dataset due to the incorrect scaling factor was used in the 2020 update. This has been rectified in the 2021 Interim update, and is correct moving forward. Negative values are also removed.

Table 4.26 Lake Onslow Inflows (175237(1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	2.92	2.58	22.88
2020	-0.04	5.40	4.87	41.98

4.27 7968(1) Highbank Outflow

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 4.27 Highbank Outflow (7698(1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	13.44	15.71	28.96
2020	0.00	13.48	15.82	32.30

4.28 174395 (1) Waipori Outflow

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 4.28 Waipori Outflow (174395(1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	7.36	6.49	57.64
2020	-0.05	7.41	6.68	57.64

4.29 97904 (1) Coleridge Inflow

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 4.29 Coleridge Inflow (97904(1)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	24.67	23.15	479.28
2020	0.00	24.77	23.59	118.45

4.30 97904 (2) Cobb Inflow

There are differences this update as Manawa Energy provided additional data back to the 2000s; this new data overwrote historical data.

Table 4.30 Cobb Inflow (97904(2)) data difference table

Update year	Minimum (m^3/s)	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)
2022	0.00	5.37	3.57	136.00
2020	0.00	5.38	3.71	143.52

5 Negative Flows in Datasets

The HMD series are derived to indicate potential generation. Therefore, a negative value implies that there is no water for generation. Negative data cannot exist as this implies that water is being lost from the system. Therefore, although a negative data value is not incorrect it shows that there is no water available for generation. For clarity, where negative values are either provided or initially calculated in scripts have been 'zeroed' out to prevent any confusion.

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