Notes on groundwater available for allocation, 'Te Puna', 'Te Puna area' and 'Wairoa-Wairoa' groundwater catchments, Western Bay of Plenty, in regards of the report:

White, P.A. Meilhac, C., Zemansky, G., Kilgour, G. 2008. Groundwater resource investigations of the Western Bay of Plenty area stage 1 – conceptual geological and hydrological models and preliminary allocation assessment. GNS Client report 2008/240 to Environment Bay of Plenty.

P.A. White

May 2020

1.0 Background

In 2019 and 2020, BOPRC pointed to a possible error in the calculation of maximum groundwater available for allocation in three groundwater catchments ('Te Puna', Te Puna area' and 'Wairoa-Wairoa') in the Western Bay area of the Bay of Plenty region (White et al., 2008).

An assessment of water budget calculations, described in this note, found errors in the water budgets of these groundwater catchments. Geology in these catchments includes 'shallow' geological units (e.g., Tauranga Group sediments) and deep ignimbrites (Waiteariki Ignimbrite and Aongatete Ignimbrite) which form BOPRC's deep groundwater allocation zones (e.g., WAI 1'shallow' and 'deep').

This note recalculates water budgets in these three groundwater catchments and recalculates maximum groundwater available for allocation in BOPRC's groundwater allocation zones that are relevant to these three catchments. Results are summarised in the associated Excel spreadsheet (Western BOP report recalculations and differences with White et al 2008 27a May 2020.xls). The note also summarises the implications of these recalculations on the maximum groundwater available for allocation in each groundwater catchment and groundwater allocation zones, i.e., compares recalculated water budgets with the results of White et al. (2008).

2.0 Recalculation of groundwater budgets

Recalculation of water budgets for the three groundwater catchments used the same methods as White et al. (2008). This recalculation included assessment of the following, with reference to the tables in White et al. (2008):

- catchment rainfall (Table 5.2);
- rainfall recharge (Table 5.5);
- surface water flows (Table 5.6)
- groundwater flow balance (Table 5.7);

3.0 Recalculation of maximum groundwater available for allocation

Recalculation of maximum groundwater available for allocation (also termed 'GAA' in BOPRC reports that followed White et al., 2008) for the three groundwater catchments used the same methods as White et al. (2008). This recalculation included assessment of the following, with reference to the tables in White et al. (2008):

- deep groundwater recharge, by groundwater catchment (Table 5.8);
- deep groundwater recharge, by geological unit (Table 5.9);

- deep groundwater recharge to Tauranga Group sediments (Table 5.10);
- Maximum groundwater allocation in 'shallow' geological units by catchment (Table 6.4);
- maximum groundwater available for allocation in 'deep' zones (i.e., Waitearikl Ignimbrite and Aongatete Ignimbrite), Table 6.5;
- Groundwater allocation (White et al., 2008 calculation) as a percentage of maximum groundwater available for allocation (Table 6.6);
- Groundwater use (White et al., 2008 calculation) as a percentage of maximum groundwater available for allocation (Table 6.8).
- deep groundwater recharge by geological unit (Appendix 17).

4.0 'Te Puna' and 'Te Puna area' groundwater budgets

Recalculated values in Table 5.5 differ from those of White et al. (2008). The cause of the error in White et al. (2008) was a transcription error between Table 5.2 and Table 5.5, with an incorrect assignment of land area, which was possibly related to the similar catchment names (i.e., 'Te Puna' and 'Te Puna area') used by White et al. (2008).

5.0 'Wairoa-Wairoa' groundwater budget

The Wairoa-Wairoa deep groundwater recharge of 408 L/s is in error in Table 5.8 (White et al., 2008). Here, the adjusted deep groundwater recharge should equal 483 L/s (see White et al., 2008; page 61). This figure is corrected in the associated spreadsheet and propagated through other tables.

6.0 Apology

Please accept my apologies for these errors. Please note that I had recommended to BOPRC, a number of years ago, that all maximum groundwater allocation (GAA) calculations in White et al. (2008), and other similar reports, should be double-checked before their use in groundwater allocation regimes; this suggestion was declined.

7.0 Implications of maximum groundwater available for allocation recalculation

The error in the 'Te Puna' and 'Te Puna area' groundwater budgets has 'propagated' through other White et al. (2008) tables with the recalculation of deep groundwater recharge/groundwater available for allocation (see the associated Excel spreadsheet). For example, recalculated deep groundwater recharge for the Te Puna groundwater catchment was 131 L/s whereas White et al. (2008) calculated 0 L/s (Table 1). In contrast, recalculated deep groundwater recharge in the Te Puna area was 42 L/s, which is considerably less than the calculation of White et al. (2008).

Recalculated maximum groundwater available for allocation is greater than allocation in the Te Puna groundwater catchment. Therefore, recalculation changes the 'excess' status of allocation in this catchment (Table 2).

Recalculation results in a decrease in maximum groundwater available for allocation in the WAI 1 zone of 226 L/s (Table 1). This decrease was mostly due to the recalculation of the maximum groundwater available for allocation in the 'Te Puna' and 'Te Puna area' groundwater catchments (Table 1). However, the full effect of these changes was not mirrored in the WAI 1 zone because: all groundwater recharge in these catchments does not flow to the WAI 1 zone; and recalculation included an increase of recharge to the zone from the Wairoa-Wairoa groundwater catchment.

Table 1. Groundwater budget: recalculations compared with White et al. (2008).

Table	Item 1	Item 2	White et al. (2008)	Recalculated groundwater budget (May 25 2020)	Units
Table 5.8	Deep groundwater recharge by catchment	Te Puna groundwater catchment	0	131	L/s
		Te Puna area groundwater catchment	771	42	L/s
Table 6.4	Maximum groundwater available for allocation in 'shallow' geological units by catchment	Te Puna groundwater catchment	0	66	L/s
		Te Puna area groundwater catchment	463	25	L/s
Table 6.5	Maximum groundwater available for allocation in 'deep aquifers (Waitearikiki Ignimbrite and Aongatete Ignimbrite)	WAI 1 zone	3711	3485	L/s

Table 2. Allocation and maximum groundwater available: recalculations compared with White et al. (2008).

Table	Item 1	Item 2	White et al. (2008)	Recalculated groundwater budget (May 25 2020)	Units
Table 6.6	Allocation/ maximum groundwater available (%)	Te Puna groundwater catchment	Excess	31	L/s
		Te Puna area groundwater catchment	0	2	L/s

Please contact me if you have any questions about this note.

Yours sincerely

Paul White.

Item	Action
	Cross check latest digital version against printed version of report
Table 5.2	OK
Table 5.5	OK
Table 5.6	OK
Table 5.7	OK
Table 5.8	OK
Table 5.10	OK
Table 6.4	OK
Table 6.5	OK
Table 6.6	OK
Table 6.8	OK
Appendix 17	OK

Latest digital version
File name
File size
File creation date

Notes

Table	Status
Table 5.2	Done
Table 5.5	Done
Table 5.6	Done
Table 5.7	Done
Table 5.8	Done
Table 5.9	Done
Table 5.10	Done
Table 6.4	Done
Table 6.5	Done
Table 6.6	Done
Table 6.8	Done
Appendix 17	Done

Checking process Date Water budget and GAA recalculation (2020) relative to White et al. (2008).

First check	9th March 2020	yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
		blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report
Second check	11th March 2020	ochre= checked 'Te Puna area': different value to 2008 report
		green= checked 'Te Puna area': same value as the 2008 report
Numbers here are the cumulative result of the first check and the second check		

Table 5.2 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

No.	Catchment Name	Area (km^2)	Mean Annual Rainfall (mm/y)	Mean Annual Rainfall* (m^3/s)
1	Aongatete	46	1904.2	2.8
2	Apata	12.1	1738	0.7
3	Kaitemako	12.7	1576.2	0.6
4	Katikati Streams	8.7	1594.2	0.4
5	Kopurererua	74.1	1854.1	4.4
6	Lower Kaituna	398.8	1806.1	22.8
7	Maketu	2.1	1196.7	0.1
8	Mangapapa/Opuiaki	165.1	2255.8	11.8
9	Mangorewa	185.7	2193.6	12.9
10	Matakana Island	60.2	1235.1	2.4
11	Maungatawa area	46.8	1305.8	1.9
12	Omanawa	84.4	2129.2	5.7
13	Ongare/Tanners Point	14.1	1422	0.6
14	Otumoetai area	14.9	1254.1	0.6
15	Oturu	9	1484.6	0.4
16	Tahawai	11.7	1939.6	0.7
17	Tauranga City area	5.9	1218.2	0.2
18	Te Mania	13.1	2008.7	0.8
19	Te Puna	28.6	1870.3	1.7
20	Te Puna area	3.4	1310.8	0.1
21	Te Rereatukahia	18.6	2077.2	1.2
22	Tuapiro	52.2	1935	3.2
23	Uretara	32.9	2093	2.2
24	Waiau	33.3	1695.9	1.8
25	Waihi Beach	25.6	1611.5	1.3
26	Waimapu	111.7	1922	6.8
27	Wainui	38.5	2025.4	2.5
28	Waione	8.2	1689.4	0.4
29	Waipapa	45.3	1924.7	2.8
30	Wairoa_Ngamawahine	112.7	2154.6	7.7
31	Wairoa_Ohourere	30.2	2017.6	1.9
32	Wairoa_Wairoa	70.3	1754.7	3.9
33	Waitao area	37.3	1768.8	2.1
34	Waitekohe	21.8	1860.2	1.3
35	Welcome Bay area	14.5	1432.2	0.7
36	Whatakao	28.9	1966.4	1.8

First check

econd chec

yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

ochre= checked 'Te Puna area': different value to 2008 report

green= checked 'Te Puna area': same value as the 2008 report

Table 5.5 PW Mar 2020 check

		50% Rainfall recharge area				30% Rainfall recharge area				Sum of mean groundwater recharge from rainfall
No	Catchment name	Area (km^2)	Mean rainfall (mm/y)	Mean rainfall recharge (mm/y)	Mean rainfall recharge (L/s)	Area (km^2)	Mean rainfall (mm/y)	Mean rainfall recharge (mm/y)	Mean rainfall recharge (L/s)	(L/s)
1	Aongatete	35.9	1917.9	958.9	1091	10.1	1855.7	556.7	178	1269
2	Apata	7.8	1792.8	896.4	222	4.3	1635	490.5	66	288
3	Kaitemako	10.2	1640.5	820.2	265	2.5	1320.7	396.2	32	297
4	Katikati Stre	*	*	*	*	8.7	1594.2	478.3	132	132
5	Kopurererua	74	1854.1	927.1	2175	**	**	**	**	2175
6	Lower Kaitu	270.8	1993.3	996.6	8558	127.9	1403.8	421.1	1708	10266
7	Maketu	*	*	*	*	2.1	1196.7	359	24	24
8	Mangapapa	165.1	2255.8	1127.9	5905	**	**	**	**	5905
9	Mangorewa	184.6	2197	1098.5	6432	1.1	1557.3	467.2	16	6448
10	Matakana Is	*	*	*	*	60.2	1235.1	370.5	707	707
11	Maungatawa	10.8	1535.8	767.9	264	35.9	1234.7	370.4	422	686
12	Omanawa	84.4	2129.2	1064.6	2848	**	**	**	**	2848
13	Ongare/Tan	*	*	*	*	14.1	1422	426.6	190	190
14	Otumoetai a	4.2	1264.8	632.4	84	10.7	1250.6	375.2	127	211
15	Oturu	2	1640.6	820.3	51	7	1418	425.4	95	146
16	Tahawai	4.2	2096.2	1048.1	139	7.5	1795.5	538.7	129	268
17	Tauranga C	1.9	1269.3	634.7	38	4	1192.6	357.8	46	84
18	Te Mania	4.8	1985.1	992.6	150	8.4	2022	606.6	161	311
19	Te Puna	20.4	2018.3	1009.15	653	8.3	1511.8	453.54	119	772
20	Te Puna are	*	*	*	*	3.4	1310.8	393.2	42	42
21	Te Rereatuk	11.9	2055.3	1027.7	388	6.7	2132.3	639.7	135	523
22	Tuapiro	43.5	1995.4	997.7	1375	8.7	1682.1	504.6	139	1514
23	Uretara	17.3	2167.3	1083.6	595	15.6	2033.8	610.1	301	896
24	Waiau	23.2	1772.3	886.1	653	10	1545.7	463.7	147	800
25	Waihi Beacl	12	1688.4	844.2	320	13.6	1564.1	469.2	203	523
26	Waimapu	110.6	1927.1	963.5	3380	1	1350.7	405.2	13	3393
27	Wainui	31.2	2100.4	1050.2	1039	7.3	1726.4	517.9	120	1159
28	Waione	*	*	*	*	8.2	1689.4	506.8	132	132
29	Waipapa	35.1	2051.1	1025.5	1142	10.2	1549.8	464.9	150	1292
30	Wairoa_Nga	112.7	2154.6	1077.3	3850	**	**	**	**	3850
31	Wairoa_Oh	30.2	2017.6	1008.8	965	**	**	**	**	965
32	Wairoa_Wa	59.4	1818.4	909.2	1712	11	1379.7	413.9	144	1856
33	Waitao area	34.8	1802.1	901.1	994	2.6	1351.1	405.3	33	1026
34	Waitekohe	12.6	1863.1	931.5	371	9.2	1881.3	564.4	165	536
35	Welcome Ba	12	1451.2	725.6	277	2.5	1361.7	408.5	32	309
36	Whatakao	20	2022.5	1011.2	642	8.9	1851.4	555.4	156	798
									Total	52641

* Whole catchment is included in the 30% rainfall recharge area.

** Whole catchment is included in the 50% rainfall recharge area.

Recalculation (2020) relative to White et al. (2008).

First check

yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check

ochre= checked 'Te Puna area': different value to 2008 report

green= checked 'Te Puna area': same value as the 2008 report

Table 5.6 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

First check

yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check

ochre= checked 'Te Puna area': different value to 2008 report

green= checked Te Puna area: same value as the 2008 report

Catchment No.	Catchment	D/s site river name	D/s site name	D/s site number	G/F*	Number of gaugings	Mean flow (L/s)	Median flow (L/s)
1	Aongatete	Aongatete	S.H. 2 Br.	13607	G	40	862	583
17	Tauranga City area	-	-	-	-	-	-	-
18	Te Mania	Te Mania	S.H. 2 Br.	13505	G	95	299	210
19	Te Puna	Te Puna	S.H. 2 Br.	14004	G	13	643	641
20	Te Puna area	-	-	-	-	-	-	-
	Waipapa (2)	Waipapa	S.H. 2 Br.	13806	G	21	698	476
30	Wairoa_Ngamawahine	Ngamuwahine	S.H. 29 Br.	14129	G	34	1318	925
31	Wairoa_Ohourere	Ohourere	Crawfords Rd. Br.	14107	G	4	382	166
32	Wairoa_Wairoa (1)	Wairoa	above Ruahihi	14130	F	-	3840	695
	Wairoa_Wairoa (2)	Wairoa	Power station	14132	F	-	11921	11130
33	Waitao area	Waitao	Welcome Bay Rd.	-	G	1	202	202
34	Waitekohe	Waitekohe R/B Trib.	U/S Estuary	-	G	3	128	132
35	Welcome Bay area (1)	Waikite	Welcome Bay Rd.	14505	G	12	31	9
	Welcome Bay area (2)	Kawhia Creek	Welcome Bay Rd.	14512	G	11	50	32
	Welcome Bay area (3)	Ngapeke	Welcome Bay Rd. Br.	14506	G	1	8	8
36	Whatakao	Whatakao	Walford Rd. Br.	13602	G	24	300	266

* G: gauging site

* F: continuous flow measurement site (Environment Bay of Plenty, 2001)

[1] The Kaituna (Te Matai) mean and medium flow are taken for the period 21st October 1981 to 22 April 2005. This is to estimate outflows from the lower Kaituna catchment for the same period as inflows to the catchment from Lake Rotoiti (Kaituna River at the Taaheke recording site).

[2] Median flow from this catchment is taken as the median of the two measurements at pond outlet.

Table 5.7 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

First check
yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check
ochre= checked 'Te Puna area': different value to 2008 report
green= checked 'Te Puna area': same value as the 2008 report

Catchment number	Catchment name	Rainfall (L/s)	Rainfall Recharge to groundwater (L/s)	Surface water inflow to catchment (L/s)	Groundwater outflow to Lake Rotorua catchment (L/s)	Stream baseflow discharge (L/s)	Rainfall recharge plus surface water inflow minus groundwater outflow minus baseflow discharge (L/s)	Estimated deep groundwater recharge (L/s)
1	Aongatete	2776	1269	0	0	583	686	686
2	Apata	664	288	0	0	28	260	260
3	Kaitemako	636	297	0	0	70	227	227
4	Katikati Streams	442	132	0	0	0	132	132
5	Kopurererua	4353	2175	0	0	1713	462	462
6 (part), 9	Lower Kaituna (foothills) and Mangorewa	30035	15007	19700	1400	40628	-7321	-7321
6 (part)	Lower Kaituna (Plains)	5693	1708	0	0	0	1708	1708
7	Maketu	79	24	0	0	0	24	24
8	Mangapapa/Opuiaki (included in Wairoa Power Sche	-	-	-	-	-	-	-
8,12,30,32	Wairoa Power scheme	29121	14459	0	1300	13275	-116	-116
9	Mangorewa (included in Lower Kaituna, hills)	-	-	-	-	-	-	-
10	Matakana Island	2358	707	0	0	0	707	707
11	Maungatawa area	1936	686	0	0	184	502	502
12	Omanawa (included in Wairoa Power Scheme)	-	-	-	-	-	-	-
13	Ongare/Tanners Point	634	190	0	0	15	175	175
14	Otumoetai area	592	211	0	0	207	4	4
15	Oturu	424	146	0	0	30	116	116
16	Tahawai	722	268	0	0	69	199	199
17	Tauranga city area	229	84	0	0	0	84	84
18	Te Mania	837	311	0	0	210	101	101
19	Te Puna	1698	772	0	0	641	131	131
20	Te Puna area	139	42	0	0	0	42	42
21	Te Rereatukahia	1223	523	0	0	220	303	303
22	Tuapiro	3200	1514	0	0	1012	502	502
23	Uretara	2183	896	0	0	406	490	490
24	Waiau	1788	800	0	0	321	479	479
25	Waihi Beach	1309	523	0	0	25	498	498
26	Waimapu	6805	3393	0	0	1444	1949	1949
27	Wainui	2474	1159	0	0	1753	-594	-594
28	Waione	441	132	0	0	3	129	129
29	Waipapa	2764	1292	0	0	516	776	776
30	Wairoa_Ngamawahine (included in Wairoa Power Sc	-	-	-	-	-	-	-
31	Wairoa_Ohourere	1929	965	0	0	166	799	799
32	Wairoa_Wairoa (included in Wairoa Power Scheme)	-	-	-	-	-	-	-
33	Waitao area	2094	1026	0	0	202	824	824
34	Waitekohe	1285	536	0	0	132	404	404
35	Welcome Bay area	658	309	0	0	49	260	260
36	Whatakao	1801	798	0	0	266	532	532
	Sum (L/s)	113322	52642	19700	2700	64168	5474	5474
	Sum (m^3/s)	113.3	52.6	19.7	2.7	64.2	5.5	5.5

Table 5.8 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

Catchment number	Catchment name	Adjusted deep g/w recharge (L/s)
1	Aongatete	686
2	Apata	260
3	Kaitemako	227
4	Katikati Streams	132
5	Kopurererua	462
6 (part)	Lower Kaituna, (hills)	0
6 (part)	Lower Kaituna, Plains	854
7	Maketu	24
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	707
11	Maungatawa area	502
12	Omanawa	0
13	Ongare/Tanners Point	175
14	Otumoetai area	4
15	Oturu	116
16	Tahawai	199
17	Tauranga City area	84
18	Te Mania	101
19	Te Puna	131
20	Te Puna area	42
21	Te Rereatukahia	303
22	Tuapiro	502
23	Uretara	490
24	Waiau	479
25	Waihi Beach	498
26	Waimapu	1949
27	Wainui	0
28	Waione	129
29	Waipapa	776
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	799
32	Wairoa_Wairoa	483
33	Waitao area	824
34	Waitekohe	404
35	Welcome Bay area	260
36	Whatakao	532
	Sum (L/s)	13134
	Sum (m^3/s)	13.1

First check

yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check

ochre= checked 'Te Puna area': different value to 2008 report

green= checked 'Te Puna area': same value as the 2008 report

pg 61 of the report - deep gw flow from the Wairoa-Wairoa catchment outside the Wairoa hydropower catchment

Table 5.9 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

Geological unit	Estimated deep groundwater recharge (L/s)	Estimated deep groundwater recharge (m^3/s)
Tauranga Group Sediments	4460	4.5
Mamaku Ignimbrite	915	0.9
OTP Ignimbrite	649	0.6
Waitеariki Ignimbrite	4243	4.2
Minden Rhyolite	792	0.8
Aongatete Ignimbrite	2076	2.1
Sum (L/s)	13135	
Sum (m^3/s)		13.1

First check	yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
	blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report
Second check	ochre= checked 'Te Puna area': different value to 2008 report
	green= checked 'Te Puna area': same value as the 2008 report

Note sum of deep gw recharge differs from Table 5.8 (by 1 L/s) due to rounding

Table 5.10 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

First check
yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check
ochre= checked 'Te Puna area': different value to 2008 report
green= checked 'Te Puna area': same value as the 2008 report

TAURANGA GROUP SEDIMENTS		Estimated deep groundwater recharge (L/s)
1	Aongatete	206
2	Apata	104
3	Kaitemako	45
4	Katikati Streams	66
5	Kopurererua	162
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	512
7	Maketu	14
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	495
11	Maungatawa area	251
12	Omanawa	0
13	Ongare/Tanners Point	158
14	Otumoetai area	2
15	Oturu	70
16	Tahawai	100
17	Tauranga City area	46
18	Te Mania	61
19	Te Puna	39
20	Te Puna area	25
21	Te Rereatukahia	212
22	Tuapiro	201
23	Uretara	245
24	Waiau	144
25	Waihi Beach	249
26	Waimapu	195
27	Wainui	0
28	Waione	90
29	Waipapa	155
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	0
32	Wairoa_Wairoa	48
33	Waitao area	165
34	Waitekohe	162
35	Welcome Bay area	52
36	Whatakao	186
	Sum (L/s)	4460
	Sum (m^3/s)	4.5

Table 6.4 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

First check
yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check
ochre= checked 'Te Puna area': different value to 2008 report
green= checked 'Te Puna area': same value as the 2008 report

Shallow geology catchment number	Catchment Name	Estimated maximum groundwater allocation (L/s)
1	Aongatete	206
2	Apata	104
3	Kaitemako	91
4	Katikati Streams	66
5	Kopurererua	393
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	512
7	Maketu	14
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	495
11	Maungatawa area	351
12	Omanawa	0
13	Ongare/Tanners Poin	158
14	Otumoetai area	3
15	Oturu	81
16	Tahawai	100
17	Tauranga City area	71
18	Te Mania	61
19	Te Puna	66
20	Te Puna area	25
21	Te Rereatukahia	212
22	Tuapiro	201
23	Uretara	245
24	Waiau	240
25	Waihi Beach	249
26	Waimapu	1169
27	Wainui	0
28	Waione	90
29	Waipapa	233
30	Wairoa_Ngamawahin	0
31	Wairoa_Ohourere	320
32	Wairoa_Wairoa	145
33	Waitao area	412
34	Waitekohe	162
35	Welcome Bay area	156
36	Whatakao	186
	Sum (L/s)	6817
	Sum (m^3/s)	6.8

Table 6.5 PW Mar 2020 check

Waitearikl Ignimbrite and Aongatete Ignimbrite Zone	Estimated maximum groundwater allocation (L/s)
WAI 1	3485
WAI 2	2483
WAI 3	351
Sum (L/s)	6319
Sum (m^3/s)	6.3

Recalculation (2020) relative to White et al. (2008).

First check	yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
	blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report
Second check	ochre= checked 'Te Puna area': different value to 2008 report
	green= checked 'Te Puna area': same value as the 2008 report

Table 6.6 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

Catchment number	Catchment name	Deep groundwater recharge/groundwater available for allocation (L/s)	Current groundwater allocation (L/s)	Allocation/deep groundwater recharge %
1	Aongatete	686	15	2
2	Apata	260	14	5
3	Kaitemako	227	2	1
4	Katikati Streams	132	20	15
5	Kopurererua	462	95	21
6	Lower Kaituna (hills)	0	409	Excess allocation
6a	Lower Kaituna (Plain)	854	1246	Excess allocation
7	Maketu	24	0	0
8	Mangapapa/Opuiaki	0	0	na
9	Mangorewa	0	88	Excess allocation
10	Matakana Island	707	11	2
11	Maungatawa area	502	210	42
12	Omanawa	0	39	Excess allocation
13	Ongare/Tanners Point	175	111	63
14	Otumoetai area	4	33	Excess allocation
15	Oturu	116	51	44
16	Tahawai	199	18	9
17	Tauranga City area	84	27	32
18	Te Mania	101	21	21
19	Te Puna	131	40	31
20	Te Puna area	42	1	2
21	Te Rereatukahia	303	22	7
22	Tuapiro	502	27	5
23	Uretara	490	11	2
24	Waiau	479	127	27
25	Waihi Beach	498	41	8
26	Waimapu	1949	88	5
27	Wainui	0	25	Excess allocation
28	Waione	129	64	50
29	Waipapa	776	249	32
30	Wairoa_Ngamawahine	0	1	Excess allocation
31	Wairoa_Ohourere	799	150	19
32	Wairoa_Wairoa	483	57	12
33	Waitao area	824	13	2
34	Waitekohe	404	13	3
35	Welcome Bay area	260	30	12
36	Whatakao	532	9	2
	Sum (L/s)	13134	3378	
	Sum (m^3/s)	13.1	3.4	

First check

yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check

ochre= checked 'Te Puna area': different value to 2008 report

green= checked 'Te Puna area': same value as the 2008 report

Table 6.8 PW Mar 2020 check

Recalculation (2020) relative to White et al. (2008).

First check: yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report
First check: blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report
Second check: ochre= checked 'Te Puna area': different value to 2008 report
Second check: green= checked 'Te Puna area': same value as the 2008 report

Catchment number	Catchment name	Deep groundwater recharge/groundwater available for allocation (L/s)	Estimated groundwater use (L/s)	Allocation/deep groundwater recharge %
1	Aongatete	686	6	1
2	Apata	260	10	4
3	Kaitemako	227	2	1
4	Katikati Streams	132	15	11
5	Kopurererua	462	55	12
6	Lower Kaituna	854	819	96
7	Maketu	24	0	0
8	Mangapapa/Opuiak	0	0	na
9	Mangorewa	0	36	excess
10	Matakana Island	707	6	1
11	Maungatawa area	502	175	35
12	Omanawa	0	21	excess
13	Ongare/Tanners Pc	175	68	39
14	Otumoetai area	4	32	excess
15	Oturu	116	25	22
16	Tahawai	199	11	6
17	Tauranga City area	84	27	32
18	Te Mania	101	17	17
19	Te Puna	131	26	20
20	Te Puna area	42	1	2
21	Te Rereatukahia	303	20	7
22	Tuapiro	502	7	1
23	Uretara	490	8	2
24	Waiau	479	119	25
25	Waihi Beach	498	35	7
26	Waimapu	1949	61	3
27	Wainui	0	12	excess
28	Waione	129	28	22
29	Waipapa	776	208	27
30	Wairoa_Ngamawah	0	1	excess
31	Wairoa_Ohourere	799	150	19
32	Wairoa_Wairoa	483	46	10
33	Waitao area	824	8	1
34	Waitekohe	404	11	3
35	Welcome Bay area	260	25	10
36	Whatakao	532	4	1
	Sum (L/s)	13134	2095	
	Sum (m^3/s)	13.1	2.1	

WBoP catchment & estimated deep recharge Appendix 17; 2020 calculations

Recalculation (2020) relative to White et al. (2008).

First check: yellow= checked 'Te Puna' and Wairoa-Wairoa; different value to the 2008 report

First check: blue= checked 'Te Puna' and Wairoa-Wairoa; same value as the 2008 report

Second check: ochre= checked 'Te Puna area': different value to 2008 report

Second check: green= checked 'Te Puna area': same value as the 2008 report

Tauranga Group Sediments catchment number	Catchment	Estimated deep groundwater recharge (L/s)
1	Aongatete	206
2	Apata	104
3	Kaitemako	45
4	Katikati Streams	66
5	Kopurererua	162
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	512
7	Maketu	14
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	495
11	Maungatawa area	251
12	Omanawa	0
13	Ongare/Tanners Point	158
14	Otumoetai area	2
15	Oturu	70
16	Tahawai	100
17	Tauranga city area	46
18	Te Mania	61
19	Te Puna	39
20	Te Puna area	25
21	Te Rereatukahia	212
22	Tuapiro	201
23	Uretara	245
24	Waiau	144
25	Waihi Beach	249
26	Waimapu	195
27	Wainui	0
28	Waione	90
29	Waipapa	155
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	0
32	Wairoa_Wairoa	48
33	Waitao area	165
34	Waitekohe	162
35	Welcome Bay area	52
36	Whatakao	186
	Sum (L/s)	4460
	Sum (m^3/s)	4.5

Mamaku/Waimakariri Ignimbrite catchment number	Catchment	Estimated deep groundwater recharge (L/s)
1	Aongatete	0
2	Apata	0
3	Kaitemako	0
4	Katikati Streams	0
5	Kopurererua	185
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	0
7	Maketu	0
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	0
11	Maungatawa area	0
12	Omanawa	0
13	Ongare/Tanners Point	0
14	Otumoetai area	0
15	Oturu	0
16	Tahawai	0
17	Tauranga city area	0
18	Te Mania	0
19	Te Puna	0
20	Te Puna area	0
21	Te Rereatukahia	0
22	Tuapiro	0
23	Uretara	0
24	Waiau	0
25	Waihi Beach	0
26	Waimapu	682
27	Wainui	0
28	Waione	0

29	Waipapa	0
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	0
32	Wairoa_Wairoa	48
33	Waitao area	0
34	Waitekohe	0
35	Welcome Bay area	0
36	Whatakao	0
	Sum (L/s)	915
	Sum (m^3/s)	0.9
OTP Ignimbrite catchment number	**Catchment**	**Estimated deep groundwater recharge (L/s)**
1	Aongatete	0
2	Apata	0
3	Kaitemako	45
4	Katikati Streams	0
5	Kopurererua	46
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	0
7	Maketu	0
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	0
11	Maungatawa area	100
12	Omanawa	0
13	Ongare/Tanners Point	0
14	Otumoetai area	0
15	Oturu	0
16	Tahawai	0
17	Tauranga city area	25
18	Te Mania	0
19	Te Puna	0
20	Te Puna area	0
21	Te Rereatukahia	0
22	Tuapiro	0
23	Uretara	0
24	Waiau	0
25	Waihi Beach	0
26	Waimapu	0
27	Wainui	0
28	Waione	0
29	Waipapa	0
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	80
32	Wairoa_Wairoa	0
33	Waitao area	247
34	Waitekohe	0
35	Welcome Bay area	104
36	Whatakao	0
	Sum (L/s)	649
	Sum (m^3/s)	0.6
Waitearíki Ignimbrite catchment number	**Catchment**	**Estimated deep groundwater recharge (L/s)**
1	Aongatete	343
2	Apata	130
3	Kaitemako	102
4	Katikati Streams	53
5	Kopurererua	46
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	256
7	Maketu	7
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	141
11	Maungatawa area	100
12	Omanawa	0
13	Ongare/Tanners Point	0
14	Otumoetai area	1
15	Oturu	23
16	Tahawai	60
17	Tauranga city area	8

18	Te Mania	20
19	Te Puna	52
20	Te Puna area	13
21	Te Rereatukahia	30
22	Tuapiro	151
23	Uretara	98
24	Waiau	144
25	Waihi Beach	0
26	Waimapu	487
27	Wainui	0
28	Waione	26
29	Waipapa	466
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	400
32	Wairoa_Wairoa	290
33	Waitao area	330
34	Waitekohe	121
35	Welcome Bay area	52
36	Whatakao	293
	Sum (L/s)	4243
	Sum (m^3/s)	4.2
Minden Rhyolite catchment number	**Catchment**	**Estimated deep groundwater recharge (L/s)**
1	Aongatete	0
2	Apata	0
3	Kaitemako	0
4	Katikati Streams	0
5	Kopurererua	0
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	0
7	Maketu	0
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	0
11	Maungatawa area	0
12	Omanawa	0
13	Ongare/Tanners Point	0
14	Otumoetai area	0
15	Oturu	12
16	Tahawai	0
17	Tauranga city area	0
18	Te Mania	0
19	Te Puna	26
20	Te Puna area	0
21	Te Rereatukahia	0
22	Tuapiro	0
23	Uretara	0
24	Waiau	96
25	Waihi Beach	0
26	Waimapu	292
27	Wainui	0
28	Waione	0
29	Waipapa	78
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	240
32	Wairoa_Wairoa	48
33	Waitao area	0
34	Waitekohe	0
35	Welcome Bay area	0
36	Whatakao	0
	Sum (L/s)	792
	Sum (m^3/s)	0.8
Aongatete Ignimbrite catchment number	**Catchment**	**Estimated deep groundwater recharge (L/s)**
1	Aongatete	137
2	Apata	26
3	Kaitemako	34
4	Katikati Streams	13
5	Kopurererua	23
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	85
7	Maketu	2

8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	71
11	Maungatawa area	50
12	Omanawa	0
13	Ongare/Tanners Point	18
14	Otumoetai area	0
15	Oturu	12
16	Tahawai	40
17	Tauranga city area	4
18	Te Mania	20
19	Te Puna	13
20	Te Puna area	4
21	Te Rereatukahia	61
22	Tuapiro	151
23	Uretara	147
24	Waiau	96
25	Waihi Beach	249
26	Waimapu	292
27	Wainui	0
28	Waione	13
29	Waipapa	78
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	80
32	Wairoa_Wairoa	48
33	Waitao area	82
34	Waitekohe	121
35	Welcome Bay area	52
36	Whatakao	53
	Sum (L/s)	2075
	Sum (m^3/s)	2.1

Sum all	Catchment	Estimated deep groundwater recharge (L/s)
1	Aongatete	686
2	Apata	260
3	Kaitemako	226
4	Katikati Streams	132
5	Kopurererua	462
6 part	Lower Kaituna (hills)	0
6 part	Lower Kaituna (plain)	853
7	Maketu	23
8	Mangapapa/Opuiaki	0
9	Mangorewa	0
10	Matakana Island	707
11	Maungatawa area	501
12	Omanawa	0
13	Ongare/Tanners Point	176
14	Otumoetai area	3
15	Oturu	117
16	Tahawai	200
17	Tauranga city area	83
18	Te Mania	101
19	Te Puna	130
20	Te Puna area	42
21	Te Rereatukahia	303
22	Tuapiro	503
23	Uretara	490
24	Waiau	480
25	Waihi Beach	498
26	Waimapu	1948
27	Wainui	0
28	Waione	129
29	Waipapa	777
30	Wairoa_Ngamawahine	0
31	Wairoa_Ohourere	800
32	Wairoa_Wairoa	482
33	Waitao area	824
34	Waitekohe	404
35	Welcome Bay area	260
36	Whatakao	532
	Sum (L/s)	13134
	Sum (m^3/s)	13.1