MEMORANDUM

TO: Olivier Ausseil
(Aquanet Consulting Ltd)
Stuart Watson
(Environmental Services, Ruapehu District Council)

FROM: Marianne Watson

DATE: 24 March 2021

SUBJECT: Revised hydrology of the Mangaparare Stream after gauging 22-March-2021, for Ohura public water supply consent application.

This memo follows from the preliminary assessment dated 4 December 2020, and revises estimates of flows in the Mangaparare Stream downward.

On arrival on 22-March-2021, observed stream flow was much less than anticipated. Flow through the box culvert was only apparent on the true right side and not measurable in the culvert due to negligible depth. In the reach upstream of the culvert silt accumulation, oxygen weed, and very slow velocities were not conducive to current meter measurement. Suitable access and sufficient depth and velocity for measurement using a mechanical meter were only found further upstream at the golf course but even so, the cross-section was far from ideal for good discharge measurement and too small for more than a few velocity samples, which means the discharge results have large uncertainty associated with them.

Figure 1 shows the relative locations. Figure 2 shows the catchment areas above and below the gauging location. Some 5-6% of the catchment to the pump was not measured but expected to add at most up to 1 L/s to the gauged flow.

Because the measurement location was essentially the best of a bad lot, I measured twice at cross-sections 200mm apart (but using the same offsets) to assess how much uncertainty might be due to lack of cross-section uniformity and consequent velocity disturbances. Oxygen weed and filamentous algae mats were raked clear of the vicinity prior to gauging. The stream bed is a combination of soft silt, sand, and broken concrete. The reach and cross-sections are shown in Figures 3 and 4.

Gauging discharge results are:	
22-March-2021 12:05 NZST	Discharge 12 L/s ± 20.7% (ISO 748:2007, 95% level of confidence)
22-March-2021 12:15 NZST	Discharge 10 L/s ± 21.4% (ISO 748:2007, 95% level of confidence)
Pooled result 11 ± 2.3 L/s (95% level of confidence)	

I did not measure the Mangaroa River flow because access to a suitable wading gauging cross-section was hazardous. Horizons last gauged 1845 L/s there on 27-Jan-2021 and it is very unlikely the rating has changed since then, so the additional expense and risk was not warranted. Mangaroa flow obtained from Horizons website dropped from 711 L/s to 696 L/s over the hour from 12:00 to 13:00 NZST, although my assessment of their rating curve, incorporating the January gauging, is that it is overpredicting by about 10 L/s at these low flows.

Figure 1 Gauging location relative to supply intake and plant.

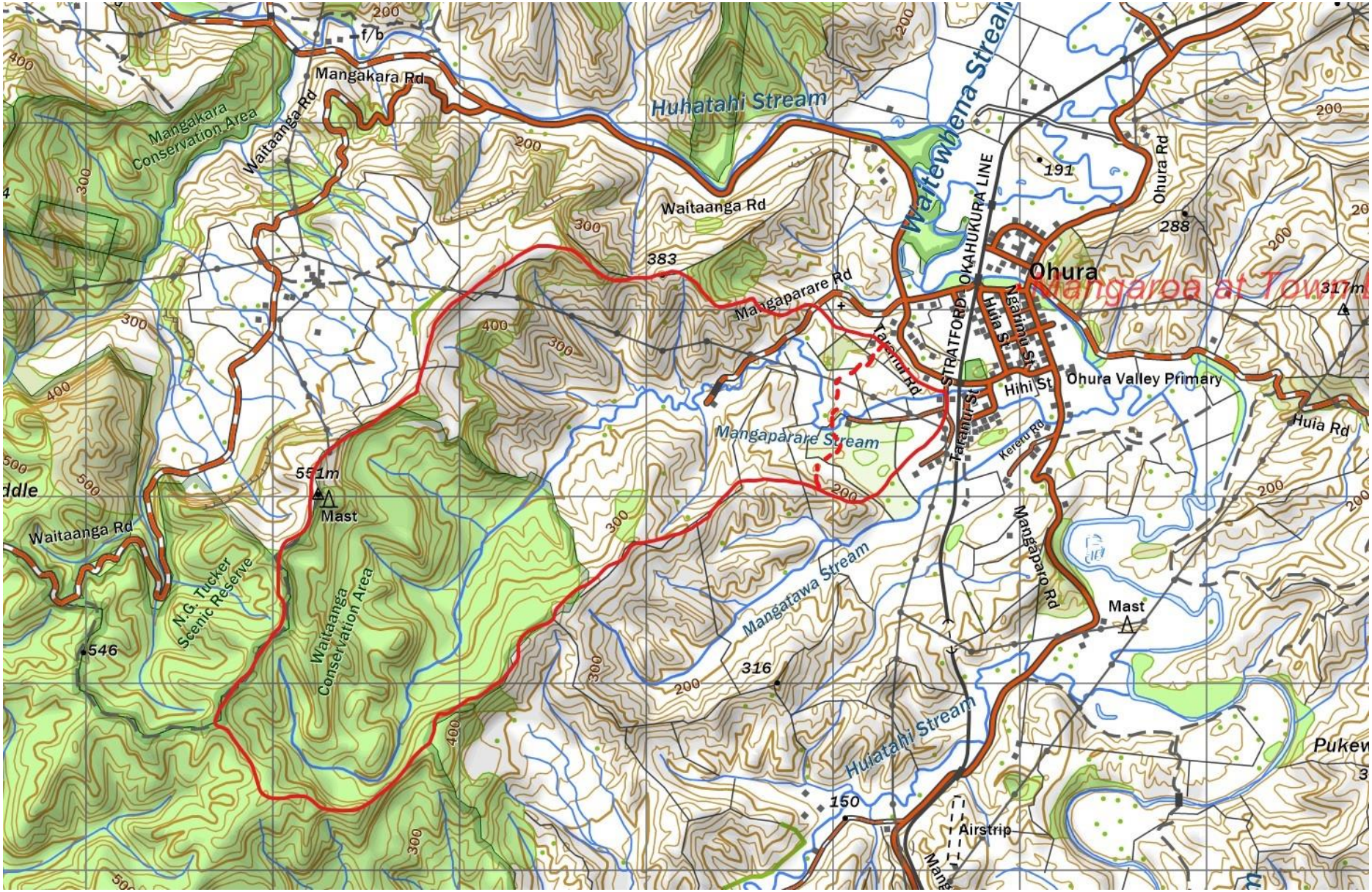

Figure 2 Catchment area above and below gauging location.

Figure 3 (clockwise from left) Views upstream, at, and downstream of gauging location

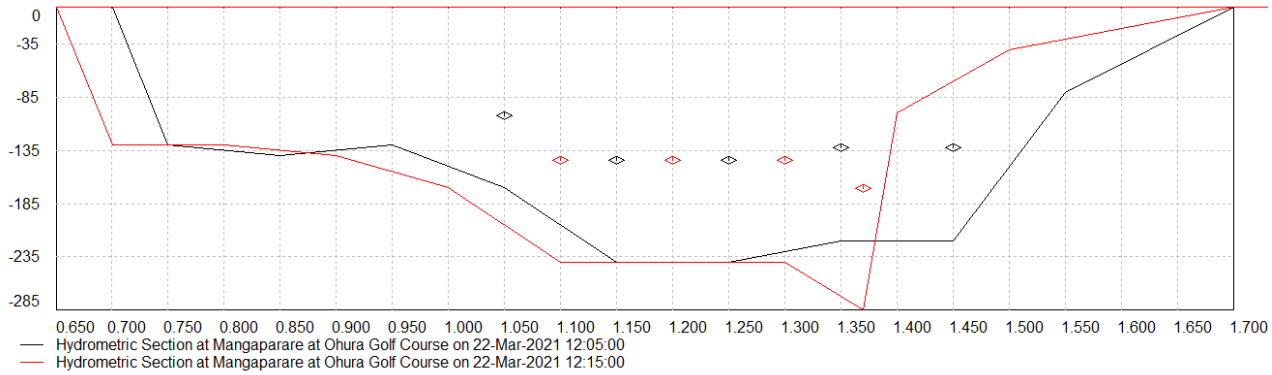

Figure 4 Measured cross-sections and velocity sampling points

After consideration of the Mangaparare gauging results, I have reassessed the possible yield of the Mangaparare Stream above the PWS intake to be more like the Waitewhena tributary of the Mangaroa River, which is estimated (on the basis of limited concurrent measurements presented in the previous memo) as 75% of Mangaroa yield.

Estimated Mangaparare Stream flow statistics have been reduced accordingly and are presented below. The Mangaroa statistics are reproduced from the earlier memo for convenience.

FLOW ESTIMATES Mangaparare at Ohura PWS Intake			
Percentile	Flow (L/s)	Percentile	Flow (L/s)
0	3793	90	18
10	423	91	17
20	225	92	16
25	175	93	15
30	139	94	13
40	99	95	12
50	72	96	10
60	55	97	8
70	42	98	6
75	36	99	5
80	30	100	4
mean	177		
MALF	12		
MAF	2901		

ESTIMATES OF MONTHLY MEAN FLOW STATISTICS Mangaparare at Ohura PWS Intake												
Flow (L/s)	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
max.	405	515	214	329	503	369	110	218	104	173	332	408
75%	268	313	198	167	393	265	103	176	102	166	284	401
mean	238	261	155	134	259	194	70	99	57	117	226	316
median	215	221	174	83	223	161	61	58	43	152	211	378
25%	178	164	109	77	145	125	46	38	17	51	170	202
min.	168	155	75	64	26	66	23	9	17	42	144	186

Mangaroa at Ohura Town Bridge (1965-70)			
Percentile	Flow (m^3/s)	Percentile	Flow (m^3/s)
0	165.026	90	0.800
10	18.389	91	0.754
20	9.793	92	0.696
25	7.632	93	0.634
30	6.066	94	0.586
40	4.288	95	0.520
50	3.138	96	0.442
60	2.398	97	0.357
70	1.838	98	0.247
75	1.578	99	0.199
80	1.298	100	0.159
mean	7.717		
MALF	0.501		
MAF	126.240		

Mangaroa at Ohura Town Bridge Summary Statistics of Monthly Mean Flows (1965-70)												
Flow (m^3/s)	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
max.	17.633	22.430	9.324	14.302	21.896	16.068	4.788	9.502	4.531	7.512	14.445	17.757
75%	11.653	13.615	8.630	7.259	17.116	11.547	4.503	7.644	4.460	7.205	12.349	17.470
mean	10.368	11.345	6.760	5.832	11.260	8.460	3.041	4.299	2.465	5.074	9.854	13.744
median	9.339	9.599	7.591	3.591	9.705	7.023	2.667	2.542	1.881	6.596	9.166	16.467
25%	7.749	7.148	4.734	3.372	6.324	5.443	2.015	1.632	0.745	2.199	7.376	8.793
min.	7.315	6.730	3.265	2.790	1.116	2.867	0.982	0.377	0.722	1.837	6.259	8.101

Marianne Watson

Appendix 1: Gauging details follows.

Hydrometric Gauging at Mangaparare at Ohura Golf Course at 22-Mar-2021 12:05:00

Summary Results

Stage	0.000 m	Flow	0.012 m3/s	Area	0.156 m2
Mean Vel.	0.076 m/s	Max. Depth	0.240 m	Slope	0 mm/km
Width	1.000 m	Hyd Radius	0.128 m	Wet Perim.	1.214 m
Sed. Conc.	-1 mg/l	Temperature	-1.0 C	Stage Change	0 mm/hr
Method & Vert	605	Verticals	51002003	Gauging No	377
Meter S/N OSSPC10909P1.2021		Slope	0.060	Intercept	0.019

Vertical spacing was Poor.
The uncertainty is 23.1% and flow is between 0.009 and 0.015 using ISO748:1979
The uncertainty is 20.7% and flow is between 0.009 and 0.014 using ISO748:2007
Uncertainties and flows are to the 95% confidence limit.

Details

OFFSET (m)	DEPTH (m)	POINT VELOCITIES (method code = vel (m/s)	MEAN VEL (m/s)	SEGMENT VALUES VEL (m/s)	AREA (m2)	FLOW (m3/s)
0.700	0.000		P			
					0.0032	
0.750	0.130		N			
					0.0135	
0.850	0.140		E=50%			
					0.0135	
0.950	0.130		S			
				0.057	0.0150	0.002
1.050	0.170	6=0.114	0.114			
				0.105	0.0205	0.002
1.150	0.240	6=0.096	0.096			
				0.088	0.0240	0.002
1.250	0.240	6=0.080	0.080			
				0.120	0.0230	0.003
1.350	0.220	6=0.161	0.161			
				0.119	0.0220	0.003
1.450	0.220	6=0.077	0.077			
				0.039	0.0150	0.001
1.550	0.080		E=50%			
					0.0060	
1.700	0.000		P			
				Totals	0.1557	0.012

Hydrometric Gauging at Mangaparare at Ohura Golf Course at 22-Mar-2021 12:15:00

Summary Results

Stage	0.000 m	Flow	0.010 m3/s	Area	0.149 m2
Mean Vel.	0.067 m/s	Max. Depth	0.285 m	Slope	0 mm/km
Width	1.050 m	Hyd Radius	0.110 m	Wet Perim.	1.357 m
Sed. Conc.	-1 mg/l	Temperature	-1.0 C	Stage Change	0 mm/hr
Method & Vert	604	Verticals	41002003	Gauging No	378
Meter S/N OSSPC10909P1.2021		Slope	0.060	Intercept	0.019

Vertical spacing was Poor.
The uncertainty is 26.2% and flow is between 0.007 and 0.013 using ISO748:1979
The uncertainty is 21.4% and flow is between 0.008 and 0.012 using ISO748:2007
Uncertainties and flows are to the 95% confidence limit.

Details

OFFSET (m)	DEPTH (m)	POINT VELOCITIES (method code = vel (m/s)	MEAN VEL (m/s)	SEGMENT VALUES VEL (m/s)	AREA (m2)	FLOW (m3/s)
0.650	0.000		P			
					0.0032	
0.700	0.130		N			
					0.0130	
0.800	0.130		E=50%			
					0.0135	
0.900	0.140		S			
					0.0155	
1.000	0.170		S			
				0.044	0.0205	0.002
1.100	0.240	6=0.089	0.089			
				0.084	0.0240	0.002
1.200	0.240	6=0.080	0.080			
				0.099	0.0240	0.002
1.300	0.240	6=0.119	0.119			
				0.126	0.0184	0.002
1.370	0.285	6=0.133	0.133			
					0.0058	
1.400	0.100		S			
					0.0070	
1.500	0.040		S			
				0.067	0.0040	0.001
1.700	0.000		E=50%			
				Totals	0.1489	0.010