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16 February 2021

Attention: Darren de Klerk

Dear Darren

Growth Impact Assessment - Small WWTPs

1 Introduction

This letter provides an update to the basis of design for the Takapau, Pōrangahau, and Te Paerahi Wastewater Treatment Plants (WWTP). Revised influent wastewater inlet flows and loads and pond outlet flows for the three WWTPs are presented in this letter, along with commentary on how they were revised from the previous assessment in 2020. The flows and loads have been revised to reflect the updated population projections adopted by Central Hawke's Bay District Council in July 2020.

In the short to medium term the ponds at these three WWTPs are expected to be retained, with improvements made downstream of the pond to the treatment processes and a transition to (or improving existing) land discharges for the treated wastewater discharges. The flow values in the previous assessment were estimated based on pond outlet flow measurements and so were considered appropriate for this purpose.

However for any upgrades upstream of the existing ponds or more wholesale changes to the WWTP processes, using the pond outlet flows as a basis may not be sufficient as they make no allowance for any losses from the ponds through infiltration or evaporation. This is particularly relevant for Pōrangahau, and Te Paerahi, WWTPs, which may be replaced by a new common treatment system in the future, but the numbers are equally applicable to any improvements made upstream of the existing WWTPs.

This revised assessment has therefore developed separate inlet and outlet flow estimates, to be used as follows:

- 'inlet' flows, for sizing new treatment processes or pre-treatment prior to the existing ponds, and
- 'outlet' flows, for sizing equipment or systems downstream of the existing ponds

The outlet flows are a direct revision of the previous design flow estimates, updated for the new population projections. The inlet flows are estimated in a similar manner but also include an allowance for infiltration and evaporation losses that are not present in the outlet flows.

The wastewater contaminant inlet loads in the previous assessment were estimated by applying per-capita values to each town's population. The values in this letter have been estimated in the same manner using the revised population projections, as they are not affected by the revised wastewater inlet flow estimates.

2 Background

2.1 Previous Population Projection

Central Hawke's Bay District Council (Council) has previously commissioned Beca to prepare options reports for the Takapau[1], Te Paerahi and Pōrangahau[2] WWTPs. These reports included a basis of design for projected wastewater influent flows and loads through to the year 2048. Council provided population projections developed by Economic Solutions Ltd, Napier, for developing the basis of design. The projections from this report, titled *Central Hawke's Bay District Long Term Planning – Demographic and Economic Growth Projections 2018 – 2048* (28 August 2017) are summarised in Table 2-1.

Table 2-1 Economic Solutions Ltd Population Projections (August 2017)

Area	2013	2017	2018	2028	2048
Central Hawke's Bay District	13,250	13,720	13,840	14,200	14,900
Pōranagahau	220	235	245	255	335
Takapau	530	530	530	535	545
Poranagahau, + Takapau	750	765	775	790	880

In the August 2017 population projection, the population living in Te Paerahi was not considered as part of the assessment. The geographical area for Pōrangahau excluded Te Paerahi (see Figure 1). The population of Te Paerahi connected to the WWTP was therefore assumed to be 312, based on an Assessment of Environmental Effects report prepared by Opus in 2007[3]. The Beca Options Report (March 2020) retained this value and assumed that Te Paerahi would have negligible population change over the design horizon as it is largely a holiday destination. The Options Report design basis had allowed for the seasonal population change associated with this by assuming the population connected the WWTP doubles during the summer months.

[1] Takapau Options Report (Beca, October 2020)

[2] Te Paerahi and Porangahau Options Report (Beca, March 2020)

[3] Porangahau Beach (Te Paerahi) Wastewater Treatment and Disposal Resource Consent Application (*Opus International Consultants Limited*, May 2007)

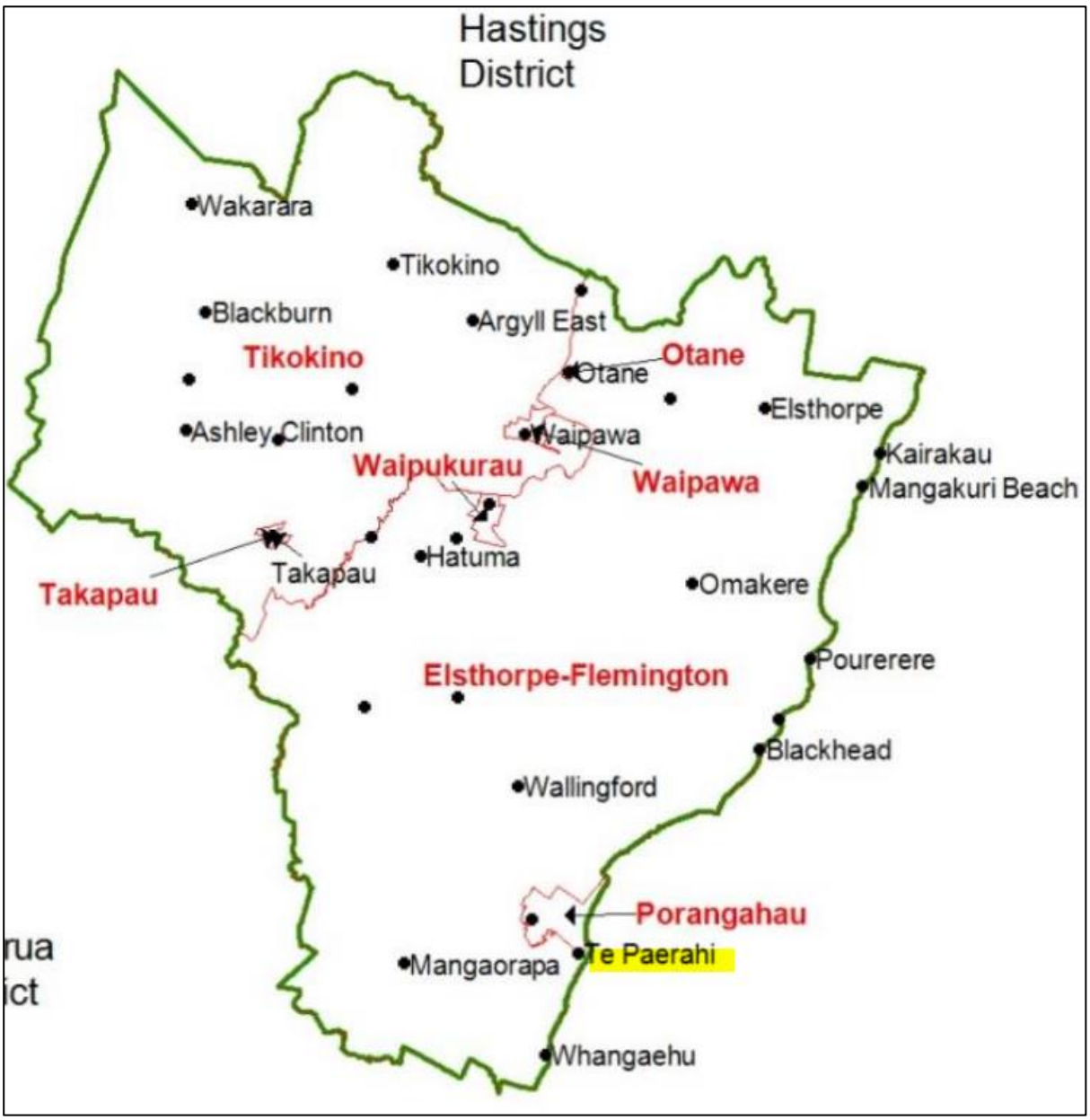

Figure 1 Geographic boundaries according to August 2017 projection (Economic Solutions Ltd, 2017)

2.2 Revised Population Projection

On 30 July 2020, Council advised that a revised set of projections had been adopted for the Long Term Plan. These projections have been developed by Squillions Ltd, as documented in the report titled Central Hawke's Bay District Demographic and Economic Growth Projections 2020 – 2051. The 'High' growth scenario has been adopted by Council as summarised in Table 2-2.

Table 2-2 Squillions Ltd Population Projections – High Scenario (July 2020)

Area	2019	2031	2051
Central Hawke's Bay District	14,850	18,770	23,980
Pōranagahau	210	377	731
Takapau	620	846	1,137
Pōranagahau, Takapau	830	1,223	1,868

The two population projections are graphed in Figure 2-2.

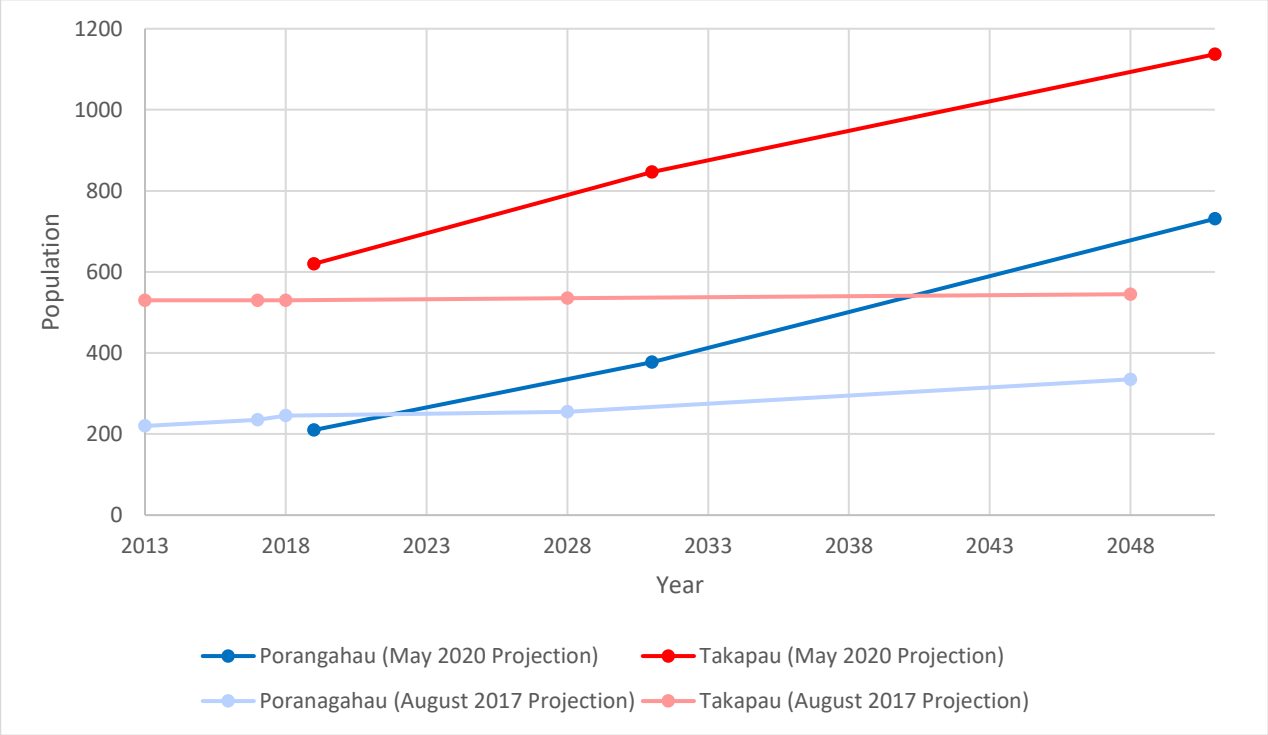

Figure 2-2 Comparison of July 2020 and August 2017 Population Projections for Pōrangahau and Takapau

The changes to the population projection for each of the two areas are summarised below. The changes between the two projections are shown in Table 2-3.

Table 2-3 Comparison of Design Horizons for Population Projections

Area	2028			2048		
	Old projection	New projection	% Change	Old projection	New projection	% Change
Central Hawke's Bay District	14,200	17,790	25.3%	14,900	23,199	55.7%
Pōrangahau	255	335	31.5%	335	678	102.4%
Takapau	535	790	47.6%	545	1,093	100.6%
Pōrangahau, Takapau	790	1,125	42.4%	880	1,771	101.3%

Overall comparing these projections shows that the projected population growth in the region has increased by 55.7% from the 2017 projection. Pōrongahau and Takapau's projected population growth has doubled from the previous projection.

2.2.1 Pōrangahau

The August 2017 projection expected the population to increase from 220 to 335 inhabitants between 2013 and 2048, which is a relative increase of approximately 52%. The May 2020 projection expects growth to be much higher, with 521 additional inhabitants between 2019 and 2051 for a relative increase of 136%.

2.2.2 Takapau

The August 2017 projection expected an increase of 15 (2.8%) inhabitants between 2013 and 2048, from a population of 530 to 545. By contrast, the May 2020 projection expects population to increase to 1,137 (115%) in the year 2051.

2.2.3 Te Paerahi

For the May 2020 population projection, the boundaries for Pōrangahau shown included the Pōrangahau Beach and Te Paerahi[4] area (see Figure 3). However, the 2019 population for Pōrangahau was stated as 255, which is lower than the previously estimated population of 312 for Te Paerahi (Opus 2007). Due to this discrepancy, we are assuming that the "Pōrangahau" population projection presented in the report only applies to the population in the Pōrangahau township which is connected to the Pōrangahau WWTP.

The previous assumptions regarding the population of Te Paerahi have been retained following an assessment of recent aerial photography to determine the number of houses currently connected. This means that the township population is assumed to remain at 312, with a seasonal population peaking factor of 2 during the summer months. The population is also assumed to be constant through to 2048.

Given the lack of growth projections for Te Paerahi we have assumed that designing for double the resident population in summer months will provide some headroom for growth.

[4] Geographic Boundaries, Appendices of Central Hawke's Bay District Demographic and Economic Growth Projections 2020 – 2051 (Squillions Ltd, May 2020)

Pōrangahau

Pōrangahau includes Pōrangahau Beach and the small nearby township. The two SA1 areas shown (7016777 and 7016780) excluded a small area of nearby rural/lifestyle properties areas that were included in the Pōrangahau area unit with the pre-2018 boundaries.

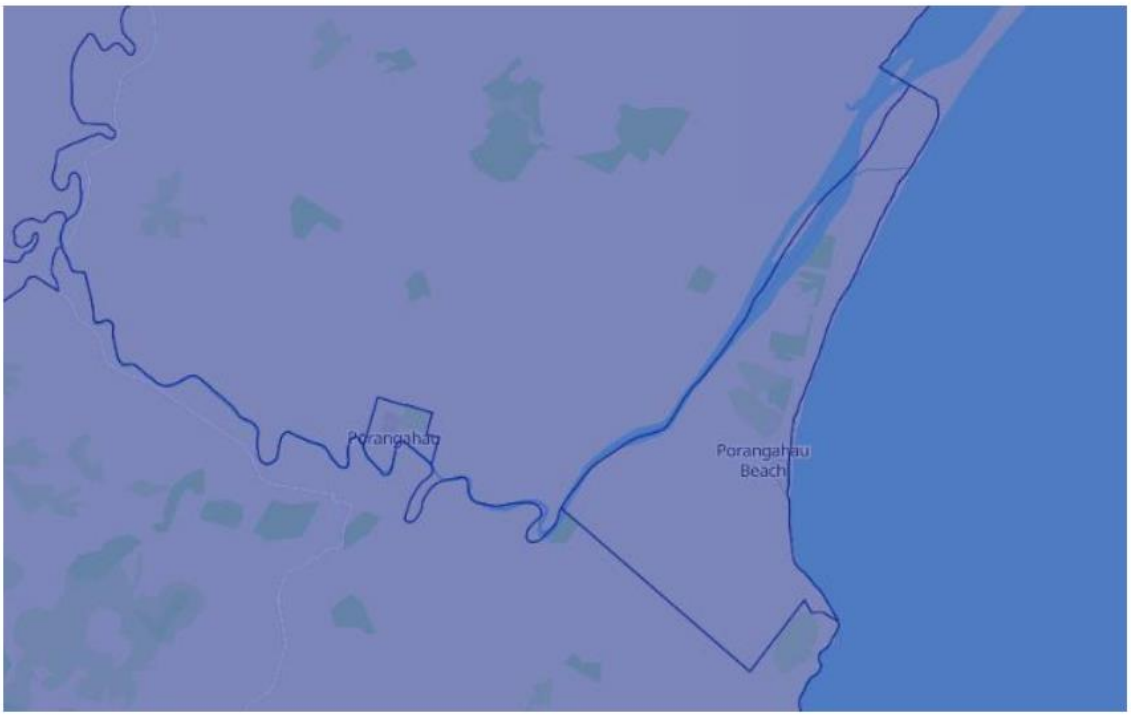

Figure 3 Geographic boundary of Pōrangahau according to May 2020 projection.

3 Updated Basis of Design

3.1 Takapau

3.1.1 Wastewater Flows

The pond discharge flows from 2008 – 2020 previously assessed in the options report were used to re-calculate the per capita flows for 2019, using the revised population for the year 2019 from the May 2020 population projection (see Table 3-1).

The method used to calculate these flows differs from the previous assessment as follows:

- The original assessment did not may any allowance for the effects of pond evaporation and seepage losses on the pond outflow during dry weather when calculating the average dry weather flow. For this assessment both inlet and outlet flows have been estimated.
- The inlet flows have been estimated by adding an estimated value for infiltration and evaporation losses where appropriate to the volumes estimated using per-capita allowances. The losses were estimated using the following factors:

  - For evaporation 4.8 mm/d was used, which is the highest monthly average daily evaporation rate from local climate data (Dannevirke weather station). For Takapau this gives a dry weather daily evaporation volume of **29 m³/d**
  - For seepage 3 mm/d was used, assuming the pond has a 300mm thick clay liner with a hydraulic conductivity of $1x10^{-8}$ m/s[5]. This gives a daily seepage loss volume of **18 m³/d**
- For the ADWF both volumes are added, and for the other values only the infiltration value was added.
- The peak and 99th percentile flows were taken as being the 2019 maximum or 99th percentile flow, plus the contribution from the additional population using the per capita flow rates for the average daily flow, plus pond losses for the inlet flow. This was the approach used for Pōrangahau in the Beca Options Report.
- All other flows have been estimated using the same assumptions as the previous assessment – i.e. developing per capita flows for average daily and average dry weather flow using outflow data divided by the 2019 population.
- Due to the higher than projected population in 2019 (530 predicted vs 620 actual), the per capita flow values have reduced from those presented in the Beca Options Report.

Table 3-1 also provides a comparison with theoretical flow per capita values.

Table 3-1 Takapau Per Capita Wastewater Flows

	Theoretical Flow per Capita (L/head/day) [6]	Actual Flow per Capita (L/head/day)
Dry Weather Flow (ADWF)	150	108
Average Daily Flow	250	290

By applying the per capita flow and the estimated losses across the ponds to the population projections for the years 2028 and 2048 the projected wastewater flows in Table 3-2 and Table 3-3 are obtained). The values recommended for design are shown in bold.

[5] IPENZ Practice Note 21: Farm Dairy Effluent Ponds (2017)

[6] Metcalf & Eddy Wastewater Engineering Treatment and Resource Recovery 5th Edition

Table 3-2 Takapau Projected Wastewater Inflows

Year	2019		2028		2048	
Population	620		790		1,093	
Projection Type	**Actual**	Theoretical	**Actual**	Theoretical	**Actual**	Theoretical
Dry Weather Inflow (ADWF) (m^3/d)	**114**	93	**133**	118	**165**	164
Average Daily Flow (m^3/d)	**198**	155	**247**	197	**335**	273
99%ile Flow (m^3/d)	**613**	-	**671**	-	**774**	-
Maximum Flow (m^3/d)	**768**	186	**825**	237	**928**	328
Peaking Factor 99th Percentile Max flow	**5** 7	- 2.0	**5** 6	- 2.0	**5** 6	- 2.0

Table 3-3 - Takapau Projected Wastewater Outflows

Year	2019	2028	2048
Population	620	790	1,093
Projection Type	**Actual**	**Actual**	**Actual**
Dry Weather Inflow (ADWF) (m^3/d)	**67**	**85**	**118**
Average Daily Flow (m^3/d)	**180**	**229**	**317**
99%ile Flow (m3/d)	**595**	**653**	**756**
Maximum Flow (m3/d)	**750**	**807**	**910**

3.1.2 Wastewater Loads

To remain consistent with the approach used in the options report, a typical per capita wastewater load was assumed for Takapau, due to the limited influent sampling information available. These are summarised in Table 3-4.

Table 3-4 Assumed Per Capita Wastewater Loads[7]

Parameter	Load Per Capita (g/p/day)
COD	193
Unfiltered $cBOD_5$	76
TSS	74
TKN	13.2
Ammonia	7.7
TP	2.1

[7] Reproduced from Metcalf & Eddy Wastewater Engineering Treatment and Resource Recovery 5th Edition Table 3-18

Applying the rates in Table 3-4 to the May 2020 population projection gives the loads presented in Table 3-5. Given the higher projected population, the wastewater load projections increase from the previous values presented in the options report.

Table 3-5 Takapau Projected Wastewater Loads

Year	2019	2028	2048
Population	620	790	1,093
COD (kg/d)	120	152	211
Unfiltered $cBOD_5$ (kg/d)	47	60	83
TSS (kg/d)	46	58	81
TKN (kg/d)	8.2	10.4	14.4
Ammonia (kg/d)	4.8	6.1	8.4
TP (kg/d)	1.3	1.7	2.3

3.2 Pōrangahau

3.2.1 Wastewater Flows

Similarly to Takapau, the pond discharge flows from 2008 – 2020 as previously assessed were used to re-calculate the per-capita flows for 2019, which are presented in Table 3-6. As with Takapau, the inflow estimates now account for evaporation and seepage losses in the pond at rates of 4.8 mm/d and 3 mm/d[8] respectively. The total daily volume loss through the pond due to infiltration is estimated to be **9 m^3/d** and the volume lost through evaporation in dry weather is estimated to be **15 m^3/d**. As with Takapau, both these values have been applied to the average dry weather inflows, and for the other inflow values only the infiltration losses have been added.

The maximum and 99th percentile flows were taken as being the 2019 maximum flow, plus the contribution from the additional population using the per capita flow rates for the average daily flow, plus pond losses for the inlet flow. This method was used for peak flow rates in the original options report, but has been applied to the 99th percentile values in this assessment as well as this is considered a more representative method for estimating wet weather flows.

The population for the year 2019 was projected to be 245, based on the August 2017 population projection. The May 2020 population projection report estimates the population in 2019 to be 210 people, based on the 2018 Census and partial indicators. For this reason, the actual flows per capita have increased from the values presented in the options report.

[8] IPENZ Practice Note 21: Farm Dairy Effluent Ponds (2017)

Table 3-6 Pōrangahau Per Capita Wastewater Flows

	Theoretical Flow per Capita (L/head/day)	Actual Flow per Capita (L/head/day)
Dry Weather Flow (ADWF)	150	148
Average Daily Flow[1]	250	243

Notes:

1) The average flow per person from the whole dataset was 631 L/head/day, probably due to high rates of infiltration during wet weather. To separate this infiltration from the population figures this average daily flow value was determined by dividing that average flow by a wet weather factor of 2.6 to compensate for infiltration. The wet weather factor was determined by comparing data collected on the effluent volume during dry and wet days.

The projected wastewater flows in Table 3-7 and Table 3-8 are obtained by applying the per capita wastewater flows to the population projection and adding the pond losses where appropriate.

Table 3-7 Pōrangahau Projected Wastewater Inflows

Year	2019		2028		2048	
Population	210		335		678	
Projection Type	**Actual**	Theoretical	**Actual**	Theoretical	**Actual**	Theoretical
Dry Weather Flow (ADWF) (m^3/d)	**55**	32	73	50	**124**	102
Average Daily Flow (m^3/d)	**60**	53	**90**	84	**174**	169
99%ile Flow (m^3/d)	**861**		**940**		**1,156**	
Maximum Flow (m^3/d)	**2,259**	63	**2,338**	101	**2,554**	203
Peaking Factor 99th Percentile Max flow	**16** 41	- 2.0	**13** 32	- 2.0	**9** 21	- 2.0

Table 3-8 Pōrangahau Projected Wastewater Outflows

Year	2019	2028	2048
Population	210	335	678
Projection Type	**Actual**	**Actual**	**Actual**
Dry Weather Inflow (ADWF) (m^3/d)	**31**	**49**	**100**
Average Daily Flow (m^3/d)	**51**	**81**	**165**
99%ile Flow (m3/d)	**852**	**931**	**1,147**
Maximum Flow (m3/d)	**2,250**	**2,329**	**2,545**

Even allowing for the corrections for evaporation, seepage and wet weather the 99th percentile and maximum flows are noted to be significantly higher than the average dry weather flow. Typical wastewater treatment systems allow for a peaking factor of between 4 and 6. Further work is required to establish if this ratio of peak to average dry weather flow is accurate, and if so assess how it can be managed. The peak values could be influenced by the accuracy of the pond outlet flowmeter or how the ponds are operated. Once sufficient inflow data is available these flows should be re-assessed.

3.2.2 Wastewater Loads

The influent samples collected on a two-monthly basis during 2014 to 2019 were found to be lower in concentration on average, when compared to typical municipal wastewater compositions. This is likely due to dilution from infiltration. As a conservative approach, the typical per capita wastewater loads in Table 3-4 were used to determine the projected wastewater loads (Table 3-9).

Table 3-9 Pōrangahau Projected Wastewater Loads

Year	2019	2028	2048
Population	210	335	678
COD (kg/d)	41	65	131
Unfiltered $cBOD_5$ (kg/d)	16	25	52
TSS (kg/d)	16	25	50
TKN (kg/d)	2.8	4.4	8.9
Ammonia (kg/d)	1.6	2.6	5.2
TP (kg/d)	0.4	0.7	1.4

3.3 Te Paerahi

As previously discussed in Section 2.2.3, the Options Report assumed that the population connected to the Te Paerahi WWTP is 312, based on the 2007 Opus AEE report. This is an estimate based on the number of properties connected to the WWTP at the time. Visual assessment of the current number of houses using more recent aerial photography indicates that little to no new development has taken place since 2007, and so this assumption appears to still be valid.

The population is expected to double during the summer months, as it is a holiday destination. Population growth throughout the design horizon is assumed to be negligible. For these reasons, the basis of design presented in the options report remains unchanged other than to allow for evaporation and seepage losses in the pond at rates of 4.8 mm/d and 3 mm/d respectively in the calculation of the inflow values. The total daily volume of these losses for Te Paerahi is estimated to be 7.9 m^3/d.

The revised wastewater flows and loads are presented in Table 3-10.

Table 3-10 Te Paerahi Projected Wastewater Flows

	Per Capita Values (L/head/d)	Annual Average Flows (m^3/d)		Peak Season Flows (m^3/d)	
	Outflow	Inflow	Outflow	Inflow	Outflow
Dry weather flow (ADWF)	119	45	37	90	74
Average daily flow[1]	237	82	74	164	148
99%ile flow	436	144	136	288	272
Max flow	1304	415	407	830	814

Notes:

1) The average daily flow is based on the average flow from effluent monitoring records (the average daily flow, including wet weather), divided by a wet weather factor of 1.6 to compensate for infiltration. The wet weather factor was determined from data collected on the effluent volume during dry and wet days.

Table 3-11 Te Paerahi Projected Wastewater Loads

Parameter	Design Load (kg/d)	Peak Design Load (kg/d)
COD	64	78
Unfiltered $cBOD_5$	25	31
TSS	24	30
VSS	19	23
ISS	5	7
TKN	4	5
Ammonia	2.5	3
TP	1	1

3.4 Assumptions

The revised loads and flows were calculated using the same methodology for the options report to remain consistent. The assumptions which were made have also been carried forward. These assumptions are listed in the following sections below. While best efforts have been made to ensure all major assumptions have been captured, this should not be treated as a comprehensive list.

3.4.1 Overall Assumptions

- Population growth between 2019 and 2031, and between 2032 and 2051 is linear. This allows the populations for the years 2028 and 2048 to be linearly interpolated, as populations for these specific years were not provided in the May 2020 population projection.
- Pond discharge flow data from all three sites, once corrected for wet weather influence, is assumed to be generally reflective of the inlet flow.
- Growth is expected to be infill rather than whole new subdivisions.
- The peak flows due to inflow and infiltration are too high to be accommodated in treatment design. 99th percentile flows will used as the design peaks.
- Records of measured effluent volumes include network infiltration and rainfall in the pond.

- Typical per capita wastewater loads from literature were adopted[9] for calculating loads, due to the limited number of influent samples collected for all three systems.
- The wastewater composition remains the same over the design horizon, with no new industrial or commercial discharges to the WWTPs.

3.4.2 Pōrangahau Specific Assumptions

- Wastewater volumes from the water treatment plant are assumed to increase proportionally with population growth, as it was assumed that the total measured wastewater flows include the components from the water treatment plant.
- The wet weather correction factor of 2.6 was selected, based on an assessment of the effluent data during wet and dry weather flows. The average flow calculated from the effluent monitoring data is converted to the average daily flow using this this factor, as it accounts for the additional inflow and infiltration during wet weather.

3.4.3 Te Paerahi Specific Assumptions

- The 2007 Opus AEE report estimates the population connection to the Te Paerahi WWTP as being 312. It is assumed that this is still the connected population, and population growth over the design horizon is negligible.
- The population connected to the WWTP doubles during the summer months.

4 Summary

The revised flow and load projections presented in this letter are intended to replace the previous estimates for concept design work for the Porangahau, Te Paerahi and Takapau wastewater schemes.

The wastewater inlet loads tabulated in Table 3-5, Table 3-9 and Table 3-11 are the revised design loads for the selected design horizon. Because a per capita load factor has been used to calculate wastewater loads, the difference between the two projections is equivalent to the change in population. Therefore, the overall wastewater loads for Takapau have increased by 101% from the projections made in the options report. For Porangahau, this is a 102% increase.

With regard to the wastewater flows presented in Table 3-2, Table 3-6 and Table 3-10, where ‘actual’ and ‘theoretical’ projections are shown, **future design work should use the actual average dry weather flow (ADWF) and average daily flow (ADF) as the basis for the plant capacity**. Given the very high peak flows recorded, using the actual 99th percentile flows as peak design flows is recommended, once the flow information has been confirmed as accurate. The theoretical flow values do not provide an adequate fit with the actual data and are not considered representative of the actual conditions. For Te Paerahi the peak summer design case should be used as the design basis values.

Table 4-1 and Table 4-2 compare the new projected 2048 inlet and outlet flows against the original flows presented in the Options report for Takapau and Pōrangahau and Te Paerahi. A summary of the new projected inlet and outlet flows for Te Paerahi is re-stated in Table 4-3. For design work requiring **inlet flows**, for example new treatment processes or pump stations, the **inlet** flows in these tables should be

[9] Metcalf & Eddy Wastewater Engineering Treatment and Resource Recovery 5th Edition Table 3-18

used. For design work requiring **outflows from the existing ponds**, such as land discharge or treatment systems for treated wastewater from the existing ponds, the **outlet** flows should be used.

Table 4-1 Comparison of projected flows for Takapau in 2048 (m³/d)

	Original 2048 Flow Projections	New Inflow Projections	New Outflow Projections	% Change (Inflow)	% Change (Outflow)
Population	545	1,093		+101%	
Dry Weather Flow	69	165	118	+139%	+71%
Average Daily Flow	185	335	317	+81%	+71%
99%ile Flow	612	774	756	+26%	+24%
Max Flow	771	928	910	+20%	+18%

Table 4-2 Comparison of projected flows for Porangahau in 2048 (m³/d)

	Original 2048 Flow Projections	New Inflow Projections	New Outflow Projections	% Change (Inflow)	% Change (Outflow)
Population	335	678		+102%	
Dry Weather Flow	45	124	100	+176%	+122%
Average Daily Flow	70	174	165	+149%	+136%
99%ile Flow[1]	1,165	1,156	1,147	-1%	-2%
Max Flow[2]	2,288	2,554	2,545	+12%	+11%

Notes:

1) The 99th percentile flow has reduced slightly due to the change in estimation method from a straight per-capita factor like the ADWF and ADF to the same method as was used for the maximum flow.

2) The maximum flow has a comparatively smaller than the other parameters because the calculation differs as discussed in Section 3.2.1 (i.e. the maximum flow is taken as being the 2019 maximum flow, plus the contribution from the additional population, using the per capita flow rates for the average daily flow).

Table 4-3 - Updated projected flows for Te Paerahi

	Average Inflow (m³/d)	Average Outflow (m³/d)	Peak Season Inflow (m³/d)	Peak Season Outflow (m³/d)
Dry Weather Flow	45	37	90	74
Average Daily Flow	82	74	164	148
99%ile Flow	144	136	288	272
Max Flow	415	407	830	814

Yours sincerely

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Principal - Wastewater

on behalf of

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