BEFORE THE BAY OF PLENTY REGIONAL COUNCIL

UNDER	the Resource Management Act 1991
AND	
IN THE MATTER OF	resource consent applications by the Western Bay of Plenty District Council for the continued operation of, and discharge of treated wastewater from, the Te Puke Wastewater Treatment Plant

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STATEMENT OF EVIDENCE OF ZHUO CHEN

ON BEHALF OF WESTERN BAY OF PLENTY DISTRICT COUNCIL

Process/Water Quality/Public Health

29 March 2019

Qualifications and experience

1. My name is Zhuo Chen and I am a Senior Environmental Engineer at GHD Limited (**GHD**) based in Auckland. Prior to joining GHD in June 2018, I was a Principal Environmental Engineer at AECOM New Zealand Limited (**AECOM**). I have a BE in Chemical Engineering (Nanjing University of Science and Technology 1997), an MSc in Environmental Science (Nanjing University 2000), and a PhD in Civil & Environmental Engineering (University of Iowa, 2006). I have over ten years of working experience in environmental consultancy within New Zealand (at URS New Zealand Ltd and AECOM New Zealand Ltd), focusing on aquatic chemistry, water/wastewater treatment, assessment of environmental effects, assessment of public health risks and consenting.

2. My previous academic background prior to consultancy involved undertaking research projects aimed at improving water/wastewater treatment technologies, understanding the fate and transport of environmental pollutants, and quantifying public health risks associated with treated wastewater discharge.

3. I have prepared assessments of environmental effects for a number of wastewater treatment plant (**WWTP**) consent applications and renewals, and have served as technical lead in various WWTP discharge water quality assessment/reporting projects (e.g. Waihi Beach WWTP and Matata WWTPI have also served as process engineer reviewing or assessing various wastewater treatment processes and providing process design solutions for a number of WWTP upgrade projects (e.g. Cambridge WWTP, Taipa WWTP, Dungog WWTP and Mangere WWTP

Code of Conduct for Expert Witnesses

4. I have read and am familiar with the Code of Conduct for Expert Witnesses in the current (2014) Environment Court Practice Note. I agree to comply with

this Code of Conduct in giving evidence to this hearing and have done so in preparing this written brief. The evidence I am giving is within my area of expertise, except where I state I am relying on the opinion or evidence of other witnesses or third parties. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

5. I prepared the "Process Performance Review" dated 19 May 2016 (the **Review**) and attached as Appendix H to the resource consent application for the Te Puke WWTP, and the "Preliminary Process Modelling Report" (the **Report**) dated 18 December 2017 and provided to Bay of Plenty Regional Council (**BOPRC**) as part s 92 of the Resource Management Act 1991 (**RMA**) request.

6. I also prepared the "Public Health Risk Assessment" dated 16 Oct 2015 (**PH Assessment**) and attached as Appendix E to the resource consent application.

7. I was not directly involved in assessing the water quality impact on the receiving aquatic environment. Hence my evidence herein regarding water quality is based on the methodology and findings documented in the report "Water Quality, Stream and Terrestrial Ecology Assessment" (**WQ Assessment**) dated 16 October 2015[1] and the "Addendum Water Quality and Receiving Environment" (**Addendum**) dated 25 January 2018,[2], which I agree with.

[1] AECOM New Zealand Limited *Water Quality, Stream and Terrestrial Ecology Assessment* (Western Bay of Plenty District Council, October 2016). Prepared by Jeremy Hunt (Environmental Engineer, BSc (Physical Geography), Jeremy has over 6 years' experience in the environmental field with expertise in stream ecology/air quality assessments), Kristina Healy (Environmental Scientist, PGDipSci (Environmental Management) 2008 University of Auckland and BSc (Environmental Science) 1998 University of Auckland, Kristina has over 14 years' experience in water quality monitoring) and Anthony Kirk (Environmental Scientist, MSc (Hons) Chemistry Massey University 2000, BSc (Chemistry and Earth Science), Anthony has over 11 years' experience in water quality assessment).

[2] Prepared by Kristina Healy.

8. My evidence will cover:

   (a) The current status of the treatment process and envisaged upgrades required.

   (b) The existing environmental context and status of Waiari Stream and Kaituna River with respect to water quality.

   (c) The quality of the treated effluent expected from the upgraded Te Puke WWTP, and its potential impact on the receiving water quality.

   (d) Responses to concerns raised by submitters and the Officer's Report with regard to water quality, public health risks and treatment processes.

   (e) Proposed consent conditions.

9. I confirm that I have read and am familiar with the submissions, Officer's Report and proposed consent conditions. I visited the Te Puke WWTP on 30 June 2015 to obtain an understanding of the current treatment processes and general environmental context of the discharge point and immediate receiving environment.

Executive summary

10. It is my view that the current assets at Te Puke WWTP are not adequate to meet the envisaged future effluent quality limits. In addition to redundancy issues associated with some process units that need to be addressed (e.g. inlet works and solid handling processes), a reasonable upgrade for the secondary treatment system (i.e. increase of both anoxic zone and aerobic zone) with associated recycling streams will be necessary to meet the proposed discharge quality limits.

11. In my opinion, it is likely that the Te Puke WWTP effluent discharge is contributing to the nutrient elevation, phosphorus in particular, observed at the Waiari Stream downstream to the effluent discharge. This conclusion was derived based on historical monitoring of the nutrient levels both downstream and upstream of the discharge point. I note that the wider agricultural land use in the catchment is still the predominant nutrient source for the aquatic environment. With the proposed more stringent nutrient concentration and mass load limits within the treated effluent, water quality within the receiving water body will be maintained for the whole term of the consent.

12. I note that the surface water quality assessment has focused primarily on the Waiari Stream as it is the direct receiving environment of the Te Puke WWTP discharge. The localised water quality monitoring within the Waiari Stream has been undertaken over 10 years. Based on my review of the historical monitoring results and understanding of the Waiari Stream, the discharge associated with this consent application is not likely to increase nutrient loading in the Waiari Stream.

13. It is also my view that the Te Puke WWTP discharge is not expected to cause discernible water quality degradation within the Kaituna River or the Maketu Estuary. Additional trade waste connection may require additional treatment or pre-treatment to ensure that the proposed consent conditions are not exceeded and water quality is maintained.

14. In my opinion, the public health risk associated with recreational use of both the Waiari Stream and the Kaituna River as a result of the Te Puke WWTP discharge, is not noticeable. I acknowledge that this conclusion is based on assumptions that the Te Puke WWTP operates normally and no outbreaks of endemic diseases occur in the community. Such circumstances may trigger a public health alert which may involve restricting public access of recreational sites along the Waiari Stream. The public health risk assessment is normally

required to be updated periodically (e.g. in 5-10 year intervals) to reflect changes in processes and public exposure routes if there are any.

15. I support the proposed consent conditions. In my view, the proposed conditions set more stringent effluent quality limits compared to the current consent, and allow for sufficient environmental monitoring and timely response procedures to investigate and alleviate any potential adverse effects that the treated wastewater discharge may pose on the receiving environment.

Current Te Puke WWTP process and upgrade needs

WWTP current process

16. The below figure is taken from the Report and shows the current Te Puke WWTP process layout:

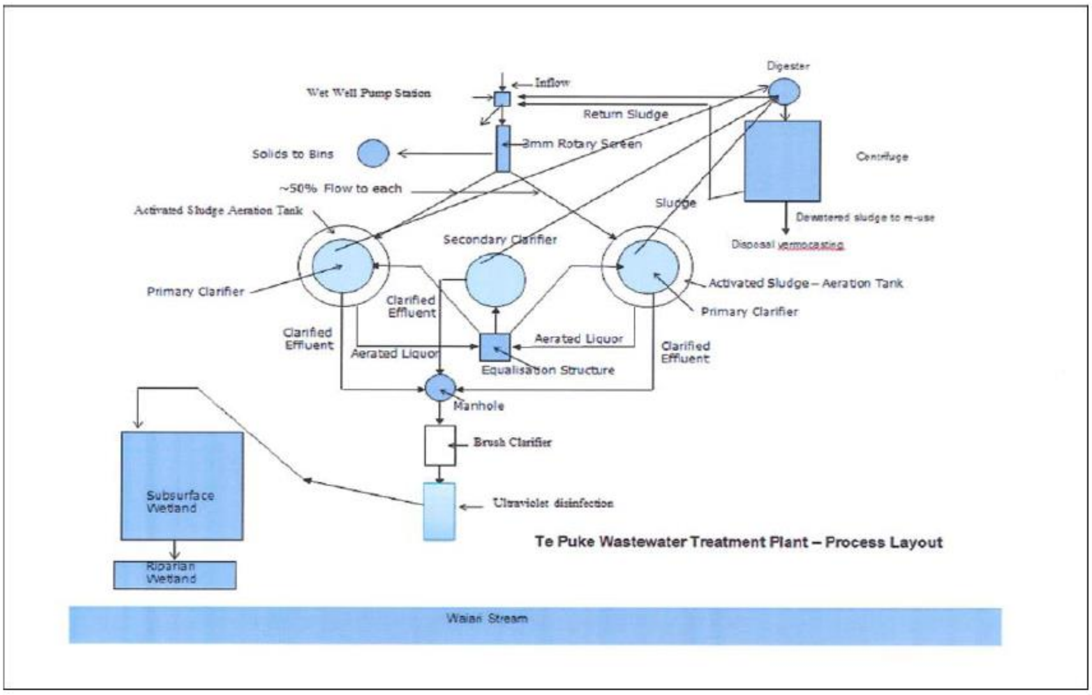


Figure 1 Te Puke WWTP Current Process Layout

17. Wastewater enters the Te Puke WWTP into a wet well pump station, and is then pumped through a 3mm rotary screen which removes large particles and other materials to landfill. The remaining wastewater then enters two secondary reactors composed of an initial anoxic zone and an aerobic zone, before being fed into three circular clarifiers. From the clarifiers, Return Activated Sludge (**RAS**) is recycled through the system to maintain sludge retention time. The secondary effluent flows into a tertiary brush clarifier for further solid polishing before entering the Ultra Violet (**UV**) plant for disinfection. The disinfected effluent then flows through the constructed wetland before being discharged into the Waiari Stream via the constructed riparian wetland.

Flow volume

18. The below figure is taken from the Review and shows the daily wastewater inflow volume into the Te Puke WWTP alongside rainfall records:

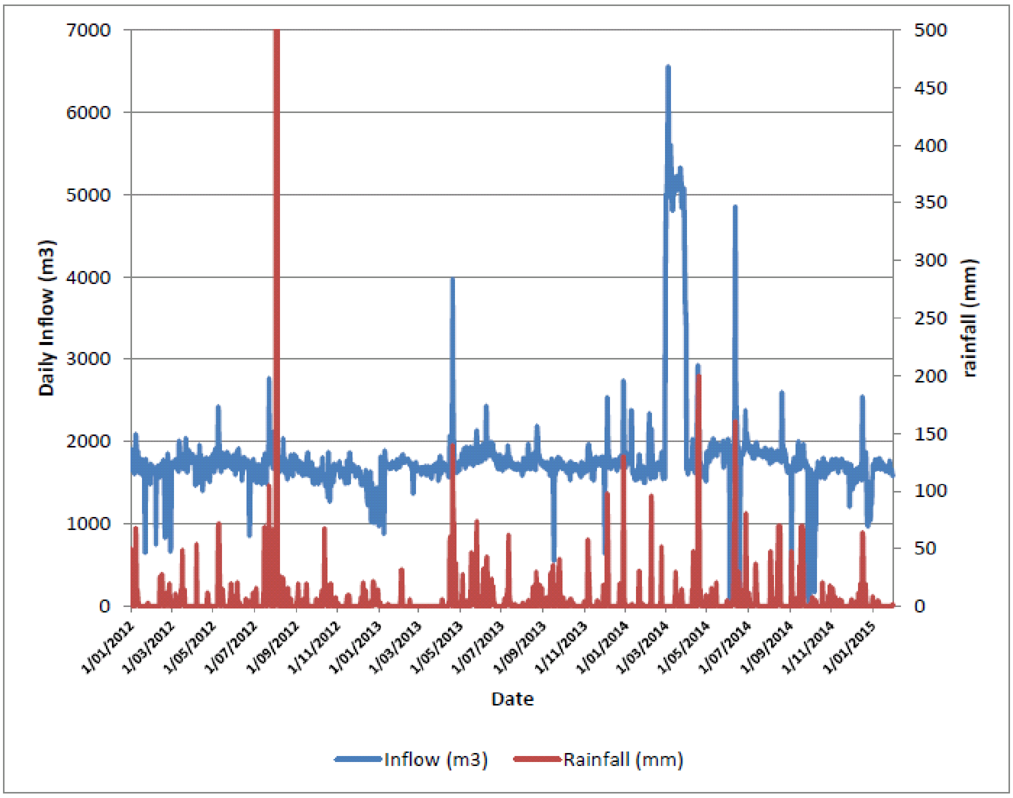


Figure 2 Observed Daily Wastewater Inflow Volume into the Te Puke WWTP and Rainfall Records (2012-2015)

19. As shown in Figure 2, annual daily average wastewater flow into the Te Puke WWTP has been relatively stable at around 1800 m^3/day in recent years. The flow pattern shows a relatively weak correlation with rainfall records, indicating a very low observed peaking factor (ratio of maximum flow to the average daily flow). The original design applied a peaking factor of 2.35, which I believe is adequate based on the observed plant records and has been applied in my assessment.

20. As set out in the Review, the annual average flow (**AAF**) for the Te Puke WWTP is calculated based on existing observed per capita flow of 223 L/day. By 2051, based on the Smart Growth Western Bay of Plenty District Council (**WBOPDC**) population projection (discussed in the evidence of Ms Coral-Lee Ertel), the projected AAF is expected to reach approximately 2348 m^3/day, with a peak wet weather flow at 5519 m^3/day.

21. I understand that the Te Puke WWTP is likely to receive wastewater generated from Rangiuru Business Park (**RBP**) which is to be developed in the future. The timeframe and details of the development is still unknown to WBOPDC at this stage.

22. It is my opinion that the acceptable volume and wastewater characteristics from RBP need to be reviewed and confirmed to ensure that the Te Puke WWTP has the required treatment capacity and that the final combined effluent quality meets the proposed consent limits at all times.

Influent characterisation

23. Due to the lack of adequate influent characterisation, in the Review I applied typical wastewater strength as part of the initial assessment. This was subsequently updated in a preliminary process simulation work, using analytical results from a monthly sampling programme carried out during January 2016

and July 2017. The updated influent characteristics used for the Report, along with previous assumptions, are summarised in Table 1.

Table 1 Influent Wastewater Characteristics for Te Puke WWTP

Parameters	Previous Assumption	Influent Analytical Results (2016-2017) mg/L		
	mg/L	Average	10%ile (low load)	90%ile (peak load)
BOD	375	310	207	439
COD	660	685	435	955
TSS	320	377	181	557
Ammonia	60	41	29	51
TKN	75	60	43	78
Total Phosphorous	10	8.4	6.3	11.4
Alkalinity (CaCO3 equivalent)	302	-	-	-
pH	7.3	7.5	7.2	7.9

24. Based on the influent sampling data shown above, the average chemical oxygen demand (**COD**) to 5-day biochemical oxygen demand (**BOD_5**) ratio is found to be approximately 2.2, which is within the normal range for typical municipal wastewater. Further wastewater fractionation parameters were also determined as part of the process simulation work. These included determination of key fractions such as readily biodegradable COD, phosphate component, ammonia fraction and soluble unbiodegradable COD. These are not repeated in this evidence, but can be found in detail within the Report. Most of the fractionation parameters adopted indicated typical municipal wastewater characteristics.

Upgrades

25. The Review sets out performance and operational issues at the Te Puke WWTP, which include inadequate aeration, short sludge retention time and a lack of redundancy for certain units. Detailed process review findings are set out in the Review and I will not repeat them in this evidence.

26. Based on the Review and future flow/loading forecast, some key process upgrades are proposed for the Te Puke WWTP. Accordingly a suite of upgrade works/projects have been developed by WBOPDC with specific timeframes to meet the required growth demand. The detailed upgrade list is presented within Ms Coral-Lee Ertel's evidence.

27. The scoped upgrade works are developed to address plant operational and treatment constraints. I will briefly discuss some of the key identified upgrade works that have a direct impact on improving effluent quality:

    (a) Upgrade of the brush clarifier: this will improve solids removal prior to the UV treatment, ensure that the UV system operates effectively and the effluent pathogen level is adequately reduced before being discharged into the Waiari Stream.

    (b) Grit removal system: this will help to remove grits at the inlet works and improve aeration tank operation.

    (c) Inlet screen upgrade: this will provide additional screening capacity to cater for future flow increase.

    (d) A sludge thickener: this will improve sludge handling constraints currently observed and improve the sludge dewatering capacity.

(e) Reactor upgrade: this is envisaged between 2021/2022 and 2027/2028. In my view, this is the key upgrade to meet future demand and improve effluent quality. Pending detail design, I envisage that this will involve increasing the sludge retention time and/or improve the internal recycling streams of the bioreactors. This will improve ammonia removal and facilitate biological nitrogen removal so that effluent total nitrogen level can be further reduced in the effluent.

(f) Fixed generator: along with a switchboard upgrade project that is currently underway, this is to ensure that the Te Puke WWTP operates normally during power failure (e.g. UV operation is never compromised).

28. The proposed reactor upgrade was incorporated in a preliminary process model (refer to the Report), which showed that the suggested upgrade work will be sufficient to achieve the proposed effluent quality.

Environmental context

29. The treated effluent flows through constructed wetlands before being discharged into the Waiari Stream via the constructed riparian wetland. Due to observed elevation of faecal coliform within the constructed wetland, it is proposed as part of this consent application that the constructed wetland be decommissioned and replaced with a new rock passage chamber. This will convey the UV treated wastewater directly to the riparian wetland along the Waiari Stream, avoiding further degradation of the water quality by bird life and other fauna associated with the constructed wetlands.

30. The Waiari Stream is located within a highly modified rural catchment. After the discharge point, the Waiari Stream continues for a further 2 km before feeding into the Kaituna River. Like the Waiari Stream, the Kaituna River is located within a highly modified environment, surrounded by rural land uses.

As concluded in the WQ Assessment, in general, water quality in the Kaituna River is good in the upper sections of the river, but declines in the lower reaches along with a trend of increasing nutrients.

31. Schedule 9 of the Regional Natural Resources Plan (**RNRP**) classifies the relevant reach of the Waiari Stream at the location of the Te Puke WWTP as a 'Modified Stream with Ecological Value'. The relevant water quality and key purpose of such a classification are discussed in detail within the evidence of Mr Richard Harkness; and will be referred to as part of the water quality assessment in my evidence. To summarise, this quality criteria is set to maintain the water quality, habitat and migratory pathways of indigenous fish and prevent further degradation.

32. In my opinion, the lower water quality within the lower reaches of the Waiari Stream and the Kaituna River is mainly caused by the rural surrounding land use and has been consistent over the past decade. Some examples of other point source discharges in vicinity of the Te Puke WWTP include the following:

    (a) AFFCO New Zealand operate the Rangiuru freezing works approximately 5.5 km upstream from the Waiari Stream confluence and treated wastewater from the freezing works is discharged directly into the Kaituna River; and

    (b) There are numerous farm drains discharging into the Waiari Stream (both upstream and downstream of the Te Puke WWTP).

33. Consequently, the water quality along the Waiari Stream and the Kaituna River in the vicinity of the Te Puke WWTP is indicative of a highly modified rural environment, with reduced riparian margins, limited availability of stable habitats and the potential influence of diffuse and point source discharges.

Baseline water quality

34. The WQ Assessment includes a baseline water quality and effects assessment. The purpose of this work was to assess historical effluent quality and receiving environment monitoring data to provide a baseline or 'snapshot' for the current receiving environment. This allows assessment of the potential environmental effects of the proposed treated effluent discharge into the Waiari Stream. Below I will summarise the methodology and key findings of this assessment, and provide an overview of the current water quality in the receiving water bodies. This reflects the current cumulative effects of all discharges on the Waiari Stream and the Kaituna River and provides a baseline for the assessment of the proposed future discharges from the Te Puke WWTP.

WQ Assessment – surface water quality

35. As set out in the WQ Assessment, water quality, stream ecology and riparian terrestrial monitoring was carried out on June 30 and July 1 2015. This monitoring was undertaken at the following key locations:

(a) Waiari Stream, approximately 100m upstream of the Te Puke WWTP discharge point (**WU 1A**).

(b) Waiari Stream, approximately 100m downstream of the Te Puke WWTP discharge point (**WD 2A**).

(c) Kaituna River, approximately 400m upstream of the Waiari Stream confluence (**K1**).

(d) Kaituna River, approximately 400m downstream of the Waiari Stream confluence (**K2**).

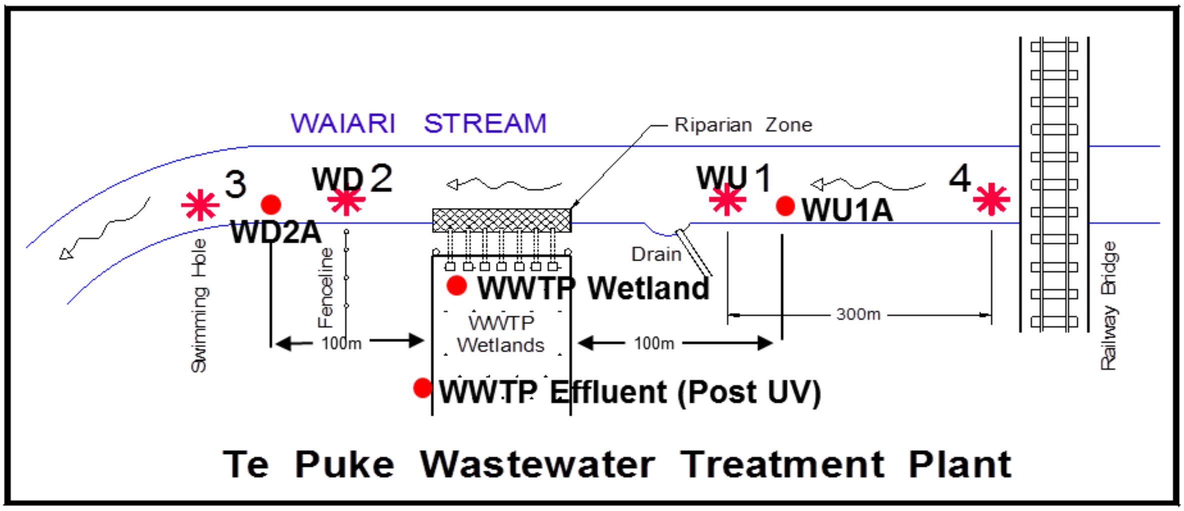
36. The WQ Assessment also reviews the results of historical monitoring undertaken by WBOPDC within the Waiari Stream in accordance with the current Te Puke WWTP consent conditions. These locations are set out in Table 2 (along with the above monitoring sites) and are shown in

37. Figure 3, both of which are taken from the WQ Assessment. I have attached a map as Appendix A to my evidence showing the surface water monitoring locations.

Table 2 WBOPDC and AECOM water quality monitoring locations

Location	Description
4	WBOPDC Waiari Stream background monitoring location approximately 330m upstream of the WWTP outfall. Samples only analysed for faecal coliforms and enterococci.
WU 1A	AECOM Waiari Stream sample location. Sampled on 1 July 2015. Located 100m upstream of WWTP outfall.
WU 1	WBOPDC Waiari Stream sample location. Located approximately 30m upstream of the WWTP outfall.
WWTP Treated Effluent (post UV)	WWTP treated effluent post UV discharge prior to entering the wetland.
WWTP Wetland	WWTP post wetland sample location prior to discharge into the Waiari Stream.
WD 2	WBOPDC Waiari Stream sample location. Located approximately 30m downstream of the WWTP outfall.
WD 2A	AECOM Waiari Stream sample location. Sampled on 1 July 2015. Located 100m downstream of WWTP outfall.
3	WBOPDC Waiari Stream monitoring location approximately 70m downstream of the WWTP outfall. Samples only analysed for faecal coliforms and enterococci.

Figure 3 **Diagram illustrating location of Te Puke WWTP water quality monitoring locations (not to scale, locations are approximate)**



38. The ecology monitoring results and the potential ecological effects of the Te Puke WWTP are discussed in the evidence of Ms Fiona Davis. My evidence serves to summarise the water quality assessment findings, and provide my opinion on the results and the potential effects of the Te Puke WWTP with respect to water quality.

39. Relevant guidelines were used for comparison, which included the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (**ANZECC 2000**) and the National Policy Statement for Freshwater Management (**NPSFM**) (2014, amended 2017).

40. A detailed comparison of surface water quality within the Waiari Stream and the Kaituna River against the NPSFM is shown in Table 3. The observed data shows the cumulative effects of current Te Puke WWTP discharges along with other sources in the catchment upstream of the monitoring locations.

41. As can be seen in the table, the ammoniacal nitrogen within both the Waiari Stream and the Kaituna River is within Category A specified by the NPSFM. Ammonia is a one of the key potential contaminants from the Te Puke WWTP

discharge and has direct toxicity to fish. The monitored level of ammonia reflects the current cumulative effects from the Te Puke WWTP discharge and other point and nonpoint source discharges upstream of the monitoring locations. From the current data, it is my opinion that the ammonia toxicity within the lower reaches of the Waiari Stream, and subsequently the Kaituna River, is not an issue.

42. Pending more statistical confirmation, the snapshot sampling outlined in the WQ Assessment shows that the 2015 nitrate levels within the Waiari Stream and the Kaituna River are within Category A (Kaituna River) or Category B (Waiari Stream); both significantly better than the national bottom line requirement.

43. The total phosphorus levels in the Waiari Stream and the Kaituna River are both in Category C of the NPSFM, and are above the national bottom line except for the Waiari Stream downstream site. The elevation of total phosphorus as the Waiari Stream flows pass the Te Puke WWTP discharge point does not seem to be carried over to the Kaituna River, as no significant difference is observed when comparing downstream and upstream results in the Kaituna River.

44. The faecal coliform levels from previous sampling showed good status of both the Waiari Stream and the Kaituna River, in terms of human health recreational contact risks, meeting Category A of the NPSFM. Later in my evidence I will summarise the public health risk assessment of the Waiari Stream and the Kaituna River regarding the impact of the Te Puke WWTP discharge.

Table 3 Comparison of water quality stream monitoring results against NPSFM guidelines (sampling locations as per WQ Assessment)

Parameter	Waiari WU 1A (upstream)	Waiari WD 2A (downstream)	Kaituna K1 (upstream)	Kaituna K2 (downstream)	NPSFM
TSS (mg/L)	5	<3	<3	<3	-
TN (mg/L)	1.16-1.19	1.87-1.93	0.74-0.75	0.76-0.78	-
NH4-N (mg/L)	0.011-0.014 A	0.010-0.012 A	0.018 A	0.016-0.018 A	• A: 0.03 (annual median); 0.05 (annual max) for 99% species protection • B: 0.03-0.24 (annual median); 0.05-0.4 (annual max) for 95% species protection • C: 0.24-1.3 L (annual median); 0.4-2.2 L (annual max) for 80% species protection • National Bottom Line: 1.3 (annual median); 2.2 (annual max)
NO3-N (mg/L)	1.07-1.08 A-B	1.69-1.71 A-B	0.6-0.61 A	0.62 A	• A: 1 (annual median); 1.5 annual 95%ile: no effects on sensitive species • B: 1-2.4 (median); 1.5-3.5 (annual 95%ile): for 95% species protection • C: 2.4-6.9 (annual median); 3.5-9.8 (annual 95%ile). • National Bottom Line: 6.9 (annual median); 9.8 (annual 95%ile).
TKN (mg/L)	<0.1	0.13-0.18	0.13-0.15	0.14-0.16	-
DRP (mg/L)	0.034-0.036	0.140-0.144	0.022	0.022	-
TP (mg/L)	0.040 C	0.140-0.144 C	0.028-0.029 C	0.029-0.031 C	• A: 0.010 Natural reference conditions (rare to no impact) • B: 0.010-0.020 slight impact • C: 0.020-0.050 moderate impact • National Bottom Line: 0.050 moderate impact
Faecal Coliforms (cfu/ 100mL)	1-46 A	100-110 A	6-47 A	7-9 A	• A: E. Coli 130 (median); 540 (95%ile) infection risk is less than 1% • B: E. Coli 130 (median); 1000 (95%ile) infection risk is less than 2% • C: E. Coli 130 (median); 1200 (95%ile) infection risk is less than 3% (National Bottom Line) • D: E. Coli >130 (median); >1200 (95%ile) infection risk is higher than 3% • E: E. Coli >260 (median); >1200 (95%ile) infection risk is higher than 7%

45. According to the WQ Assessment, the total nitrogen (**TN**) and total phosphorus (**TP**) within the Waiari Stream are of the magnitude of 1.15 - 2.0 mg/L and 0.04 - 0.14 mg/L, respectively, both exceeding the ANZECC trigger levels for TN (0.614 mg/L) and TP (0.033 mg/L) for lowland rivers– slightly disturbed ecosystem in New Zealand (ANZECC 2000).

46. The TN and TP concentrations within the Kaituna River are in the order of 0.74-0.78 mg/L and 0.029-0.031 mg/L. Both are significantly lower than those observed in the Waiari Stream. The Kaituna River water quality in the vicinity of the Waiari Stream confluence exceeds slightly the ANZECC trigger level for TN (0.614 mg/L), but is below the TP trigger level of 0.033 mg/L.

47. This indicates that the Waiari Stream is currently stressed in terms of nutrients, reflecting the agricultural land use of the area (*e.g.* dairy stock grazing) and the highly modified nature of the Waiari Stream. The microbial levels (faecal coliforms) within the Waiari Stream were also found to reflect the heavy agricultural influence.

48. I also noted that the WQ Assessment 'snap-shot' sampling of the Kaituna River showed no significant variation between upstream and downstream results from the Waiari Stream confluence in the Kaituna River.

WQ Assessment – groundwater quality

49. In addition to the surface water monitoring locations, there are four groundwater monitoring wells down-gradient of the Te Puke WWTP in the vicinity of the wetland that have been routinely monitored by site staff.

50. Monitoring wells No.1, No.2 and No.3, positioned between the wetland and the Waiari Stream, are considered to be hydraulically down-gradient of the wetland. Monitoring well No.4, whilst not positioned between the wetland and the Waiari Stream, is also considered to be within the radius of influence of the wetland. It is noted that, information regarding background water quality that may represent the influence of surrounding land use activities, is not available for the site.

51. The locations of the groundwater monitoring wells are shown on the map attached to my evidence as Appendix B.

52. The groundwater monitoring results between 2007 and 2015 showed elevated nutrient and faecal coliform concentrations, suggesting a potential influence from wastewater discharge.

BOPRC report

53. BOPRC has recently published a review of freshwater in the Bay of Plenty[3], recording the recent freshwater quality across the region and comparing it against the recommended water quality guidelines. Although the monitoring locations are not the same as those investigated in the WQ Assessment, the monitoring results are helpful in assessing the state of the Kaituna River with respect to water quality.

54. A few monitored locations as part of this report are located in Kaituna River and they are located upstream of the Waiari Stream confluence (Kaituna at Lake Rotoiti outlet, Kaituna at Waitangi and Kaituna at Maungarangi, all located upstream of Te Puke WWTP). Key water quality attributes have been monitored including nitrate, ammonia, E.coli, Dissolved Oxygen (**DO**), temperature and invertebrate communities. The water quality assessment results are compared against relevant NPSFM guidelines in Table 4. Attributes related to ecological health of the river are discussed within the evidence of Ms Fiona Davis.

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[3] *Freshwater in the Bay of Plenty: Comparison against the recommended water quality guidelines*. BOPRC Environmental Publication 2018/10 December 2018. Prepared by Rochelle Carter (Environmental Scientist, BSc Waikato University 2002 and Bachelor of Environmental Science (Hons) Deakin University 2007, Rochelle has over 10 years' experience in the environmental industry), Alastair Suren (Freshwater Ecologist, Bachelor of Science Monash University 1985 and PhD Canterbury University 1991, Alastair has over 7 years' experience as an ecologist for BOPRC, NIWA and DSIR), James Dare (Water Quality Scientist, MSc (Hons) University of Auckland 2008, James was an environmental scientist at NIWA, Ministry of Fisheries and Environment Southland), Paul Scholes (Groundwater Scientist, BSc Geology and Msc Resource Studies (Hons) Lincoln University 1997, Paul has worked at BOPRC for over 15 years as a water quality scientist) and Jack Dodd (Bachelor of Environmental Science student at the time, now a Regulatory Compliance Officer at BOPRC, BSc (Environmental) majoring in geology and geography (2017) University of Canterbury).

Table 4 Comparison of BOPRC surface water quality results (2013-2017) against NPSFM guidelines

Parameter	Kaituna River	NPS for Freshwater Guideline Values
TSS (mg/L)	-	-
TN (mg/L)	-	-
DO	A-B	A: ≥7.5 (1-day minimum); ≥8 (7-day mean minimum) B: 5-7.5 (1-day minimum); 7-8 (7-day mean minimum) C: 4-5 (1-day minimum); 5-7 (7-day mean minimum) (National bottom line) D: <4 (1-day minimum); <5 (7-day mean minimum)
NH4-N (mg/L)	A	A: 0.03 (annual median); 0.05 (annual max) for 99% species protection B: 0.03-0.24 (annual median); 0.05-0.4 (annual max) for 95% species protection C: 0.24-1.3 L (annual median); 0.4-2.2 L (annual max) for 80% species protection National bottom line: 1.3 (annual median); 2.2 (annual max)
NO3-N (mg/L)	A	A: 1 (annual median); 1.5 annual 95%ile: no effects on sensitive species B: 1-2.4 (median); 1.5-3.5 (annual 95%ile): for 95% species protection C: 2.4-6.9 (annual median); 3.5-9.8 (annual 95%ile). National bottom line: 6.9 (annual median); 9.8 (annual 95%ile).
TP (mg/L)	-	A: 0.010 Natural reference conditions (rare to no impact) B: 0.010-0.020 slight impact C: 0.020-0.050 moderate impact National bottom line: 0.050 moderate impact
E. Coli (cfu/ 100mL)	A-B	A: E. Coli 130 (median); 540 (95%ile) infection risk is less than 1% B: E. Coli 130 (median); 1000 (95%ile) infection risk is less than 2% C: E. Coli 130 (median); 1200 (95%ile) infection risk is less than 3% (National bottom line) D: E. Coli >130 (median); >1200 (95%ile) infection risk is higher than 3% E: E. Coli >260 (median); >1200 (95%ile) infection risk is higher than 7%

55. As can be seen from the table above most of the water quality attributes at monitored Kaituna River sites showed either Category A or Category B quality, based on suggested guideline values within NPSFM. This is consistent with the WQ Assessment results. Total phosphorus was not reported for the Kaituna River within this BOPRC report.

Effluent

Proposed conditions

56. The Te Puke WWTP has generally achieved good compliance with consent conditions in term of effluent quality. However I note that the consent conditions, set in 1998, were not as stringent as is currently expected. For example, the maximum load of 90 kg/day of total nitrogen (TN) and maximum level of 20 mg/L dissolved reactive

phosphorus (DRP) are relatively easy to comply with, and there are no other nutrient discharge limits in the current consent.

57. Under the RMA framework and particularly the NPSFM, in my opinion more stringent requirements on nutrient discharges should be proposed for this consent. In my view the proposed consent conditions were developed to reflect the relevant RMA provisions and water quality objectives of the NPSFM.

58. The proposed conditions for flowrate and effluent limits are summarised in **Error! Reference source not found.** Table 5 (taken from Mr Richard Harkness' evidence) and are more stringent than the current consent conditions. Due to the unclear nature of the expected future trade waste connection, the maximum flow is proposed to be consistent with the existing maximum flow allowance (i.e. 9000 m^3/day), which is higher than the envisaged peak wet weather flow for 2051.

Table 5 Proposed consent conditions in comparison with current conditions

	Current			Proposed[1]				
Parameter	Median	Maximum	Maximum Load	Median	10 out of 12 consecutive samples	Maximum	Median Mass Load	Maximum Mass load
Flow		9000 m^3/day				9000 m^3/day		
cBOD5	-	30 g/m^3	55 kg/day	15 g/m^3	20 g/m^3	-		
TSS	-	30 g/m^3	60 kg/day	15 g/m^3	20 g/m^3	-		
TN[2]	-	-	90 kg/day	15 g/m^3	25 g/m^3	-	36 kg/day	90 kg/day [2]
DRP	-	20 g/m^3	-		-	-		
TP	-	-	-	5 g/m^3	8 g/m^3	-	12 kg/day	
TAN	-	-	-	5 g/m^3	15 g/m^3			
Faecal coliforms	200 /100 mL	1000 /100 mL	-		-	-		
E. coli	-	-	-	150 CFU/100mL	200 CFU/100 mL	1000 CFU/ 100 mL		

1: Suggested consent conditions proposed to be operational immediately after consent being granted, except for TN.
2: Current TN mass load maximum limit of 90 kg/day applies till 30 April 2025, after which other suggested TN limits apply.

59. In my opinion, the proposed effluent limits provide a more stringent control of effluent quality when compared to the current consent conditions, with particular emphasis on

achieving better nutrient discharge loading into the natural environment. The proposed effluent limits reflect the expected effluent quality from a well-operated secondary wastewater treatment plant typically serving a community size similar to the Te Puke WWTP.

60. They were also developed under the provisions of relevant guidelines in NZ (e.g. ANZECC 2000 and the NPSFM), aiming to support the ecosystem of the receiving water bodies and protect the health of people and communities that may be affected by contact with the aquatic environment. The water quality effects and public health impact of the effluent discharge are discussed in further detail in my witness.

61. The RBP development is likely to discharge wastewater to the Te Puke WWTP. In order to maintain the water quality over the term of the consent, I have recommended adding median mass load limits of 36 kg/day for TN and 12 kg/day for TP. These limits shall be applied after the upgrade of the Te Puke WWTP is completed (i.e. after 30 April 2025).

62. These are the current median nutrient loads from the Te Puke WWTP, and should be met throughout the whole duration of the consent. By setting these limits, WBOPDC will be committed to ensuring that the water quality of the receiving environment will be maintained over the term of the consent.

Tapuika CIA

63. Following the lodgement of the consent application, a Tapuika Cultural Impact Assessment (**CIA**) was undertaken. Relevant suggestions have been made by Tapuika Iwi to review the performance of the Te Puke WWTP and potentially seek revised effluent quality standards in the future. The comparison of proposed standards vs Iwi suggestions are summarised in Table 6 below, along with my opinions.

64. In general, Tapuika Iwi had originally proposed more stringent effluent standards in comparison to those proposed by WBOPDC. The consultation resulted in further suggestions proposed by Tapuika Iwi (as shown in Table 6 below) which involve ongoing

monitoring post the upgrade work and review/revision of the effluent standards if supported by the monitoring results.

65. The Iwi suggested levels tabulated in Table 6 are largely in line with the currently proposed levels. In my opinion the proposed effluent standards reflect the technical capacity of the proposed upgrades at the Te Puke WWTP, and will ensure that water quality is maintained across the term of the consent. In addition, the proposed consent review condition is in accordance with the Iwi suggested monitoring and reviewing mechanism, which will allow potential revision of the effluent standards.

66. I have proposed some further modifications of the effluent quality standards as mentioned above and detailed in the "Condition" section of my evidence, which WBOPDC has adopted. The modified requirements reflects WBOPDC's commitment to maintain the water quality in the receiving water bodies during the whole term of the consent and are more stringent than what were previously proposed.

Table 6 Comparison of proposed consent conditions with Iwi suggestions

	WBOPDC Proposed				Iwi Proposed	Iwi suggestion after consultation	Comments
Parameter	Median	10 out of 12 consecutive samples	Maximum	Median mass load	Maximum		
Flow			9000 m^3/day		9000 m^3/day	No change	No comments
cBOD5	15 g/m^3	20 g/m^3	-		15 g/m^3	Iwi suggests monitoring for 6 years post the upgrade and revise the standard to 15 g/m^3 (as 10 out of 12) if supported by monitoring results.	I believe the WBOPDC proposed BOD5 standard reflects the technical capacity of the secondary treatment. The current consent review condition allows future updates of the effluent standard.
TSS	15 g/m^3	20 g/m^3	-		15 g/m^3	Iwi suggests 25 g/m^3 (as 10 out of 12).	This is in agreement with updated consent condition post s 92 response.
TN	15 g/m^3	25 g/m^3	-	36 kg/day	5 g/m^3	15 g/m^3 (as 10 out of 12) if supported by 6 years of monitoring post the upgrade.	The current consent review condition allows this. The additional mass load limit for TN is adequate to maintain water quality.
DRP		-	-		5 g/m^3	-	I consider TP a better substitute for DRP monitoring.
TP	5 g/m^3	8 g/m^3	-	12 kg/day	5 g/m^3	Iwi suggest monitoring for 6 years following the upgrades and revised to 10 g/m^3 (as a 10 out of	The updated consent condition post s 92 response is more stringent.

	WBOPDC Proposed				Iwi Proposed	Iwi suggestion after consultation	Comments
Parameter	Median	10 out of 12 consecutive samples	Maximum	Median mass load	Maximum		
						12) if supported by the monitoring results.	
TAN	5 g/m^3	15 g/m^3			-	-	I believe TAN standard is required.
Faecal coliforms		-	-		100 CFU/ 100 mL	-	I consider E. coli. a better substitute freshwater pathogen indicator.
E. Coli	150 CFU/100mL	200 CFU/100 mL	1000 CFU/ 100 mL		100 CFU/ 100 mL	-	The Iwi proposed limit will result in over-design of the UV system and is unnecessary from public health risk point of view.

Mixing zone and dilution factor in the Waiari Stream

Mixing zone and dilution factor

67. In my opinion, it is general practice that the mixing of the effluent and receiving water is considered when determining the effluent quality. Pending the policy of the regulatory bodies, such a mixing consideration could be expressed in the form of a dilution allowance or mixing zone. The dilution allowance is typically expressed as the flow portion of a river or stream. A regulatory mixing zone generally is expressed as a limited area or volume of water in any type of waterbody where initial dilution of a discharge takes place and within which the water quality standards allow certain water quality criteria to be exceeded.

68. As set out in the PH Assessment, the typical flow range for the Waiari Stream varies from 3500 L/s (5%ile) to 4400 L/s (95%ile). The minimum and maximum flow recorded in 2014 was 3399 L/s and 83270 L/s, respectively. For the purpose of the water quality assessment, only the low flow condition of the Waiari Stream (3500 L/s, 5%ile) was utilised to provide a conservative assessment. I agree with this approach. Higher stream flow rates (e.g. average flow condition or winter flow condition) will result in greater dilution potential.

69. As set out in the PH Assessment, the current average flow rate of treated effluent from the Te Puke WWTP is 20.8 L/s (1800 m^3/d). The dilution factor applied to the treated effluent water quality data after complete mixing is 168 for the current scenario. The Te Puke WWTP discharge is expected to increase from a current annual average flow of 1800 m^3/day to 2348 m^3/day in 2051 (based on 30% population increase). This increase will reduce the dilution factor of the Waiari Stream from approximately 168 to 130 (23% decrease) based on the 5th percentile flow rate. This is still a significantly high dilution factor.

70. While no water quality model was applied within the Te Puke WWTP water quality assessment, I consider the applied methodology similar to a “steady-state” water

quality assessment using critical conditions (e.g. typical effluent flow projection, maximum concentrations of key contaminants and low flow of the Waiari Stream)

71. In my experience, there are usually two major types of mixing scenarios that would be taken into consideration when assessing the water quality impact of point-source discharges:

(a) Rapid and complete mixing, where lateral variation of contaminant concentration in the direct vicinity of the outfall is small; and

(b) Incomplete mixing, where there is no demonstration of rapid and complete mixing.

72. An assumption of incomplete mixing is conservative. Generally for lakes, bays or open ocean outfall, incomplete mixing is assumed; while for rivers and streams, rapid and complete mixing may be adopted if there is the presence of a diffuser. In the absence of hydrodynamic mixing study, I will summarise some general practice rules applicable for setting up acceptable mixing zones for rivers or streams.

73. The treated effluent at the Te Puke WWTP is transferred to a bank-side perforated diffuser pipe that discharges the effluent via a riparian wetland on the left bank of the Waiari Stream. The low flow rate of the Waiari Stream appears to be 168 times higher than the annual average flow of the effluent. This normally justifies an assumption of rapid and complete mixing. The reach of the Waiari Stream at the discharge point has a channel depth of higher than 1 metre and a width of approximately 10 metres. If incomplete mixing (a conservative approach) is assumed, the mixing zone is usually required to have a longitudinal limit of less than 5 - 6 times the stream width downstream (50 -60 m).

74. It is therefore my expectation that beyond the mixing zone, the effluent will be completely mixed with the Waiari Stream flow and no significant adverse effects on aquatic life is to be observed beyond the mixing zone.

75. These are general assumptions based on my understanding of the effluent discharge and ambient flow conditions, which may be further confirmed by either water quality modelling or field studies. Alternatively the mixing zone or dilution factor allowance may be stipulated as part of the consent conditions, which can be met via compliance monitoring or hydrodynamic modelling. This is formulated in my suggested consent conditions summarised in the "Conditions" section of my evidence.

Waiari take

76. I understand Tauranga City Council (**TCC**) and WBOPDC have been granted joint resource consent to take up to 60,000 m^3/day from the Waiari Stream (Waiari Water Supply Take Consent RC65637), upstream of Te Puke for water supply for Papamoa.

77. Whilst the proposed water intake during the low flow period of the Waiari Stream will result in the decrease in the effective dilution factor, I note that it is very difficult to predict the exact impact. This is because the water intake schedule is unknown with variable water demand, and the flow rate of the Waiari Stream can vary significantly during different seasons. The spring-feed nature of the Waiari Stream will also alleviate the potential impact of the intake on the stream flow rate. Additionally it is likely that some of the upstream nutrient load is removed via this water intake, reducing the overall nutrient loading to the Maketu Estuary.

78. The water quality assessment submitted as part of the water intake consent application was based on an average Te Puke WWTP discharge flow rate of 19 L/s (1642 m^3/day) and a lowest recorded 7-day low flow of 2655 L/s at the Waiari Stream[4]. According to this assessment, the dilution of effluent after full mixing would be approximately 140-fold, which is reduced to 103-fold after 60,000 m^3/day abstraction. In my opinion this

[4] Ian Jowett Consulting *Effect of Water Abstraction on the Waiari Stream* (Tauranga City Council, 4 May 2008). Prepared by Ian Jowett (Bachelor of Engineering (Hons) 1967 and a Postgraduate in Engineering Hydrology University of New South Wales 1970).

assessment represents a worst-case scenario and should be considered very conservative.

79. I note that under the conditions of the consent RC65637, monitoring is required above and below the intake site as well as above and below the Te Puke WWTP discharge point. The survey is to be undertaken by the consent holders (joint TCC and WBOPDC), recognising the potential effect of the water take on the mixing zone for the Te Puke WWTP discharge of treated wastewater. The required monitoring parameters include temperature, pH, turbidity, dissolved oxygen, invertebrate composition on hard substrates and macrophytes, macro invertebrate indices and abundancy and fish composition and abundance of the species present.

80. In my opinion, this monitoring will provide good information on the potential cumulative impact that the water intake and the Te Puke WWTP discharge may have on the Waiari Stream in terms of water quality. The monitoring results will be reviewed as required by the consent condition.

Assessment of surface water quality

81. I will now discuss the assessment of water quality provided in connection with this application. The assessment considers the potential future effects of the WWTP discharge on the Waiari Stream and the Kaituna River. I will focus on those aspects related to surface water quality in this section. Matters related to public health risks will be discussed later in my evidence and environmental effects relating to ecology will be covered in the evidence of Ms Fiona Davies.

82. I will focus on summarising the key findings related to the issues raised by the parties (including the issues raised within the Officer's Report issued on 22 March 2019). The full documents underlying these matters are included in the WQ Assessment and the Addendum submitted as part of the s 92 response.

Kaituna River/Maketu Estuary

83. The direct receiving water body of the Te Puke WWTP discharge is the Waiari Stream, which flows into Kaituna River. The area lies within the Kaituna, Maketū, Pongakawa and Waitahanui Water Management Area (**WMA**). The water quality classification of the Kaituna River between the confluence of the Waiari Stream and the Pacific Ocean is stipulated within Schedule 9 of the Regional Natural Resources Plan (**RNRP**) and is classified as "Contact Recreation". This indicates that the recreational contact values of the river are to be protected from the adverse effects of discharges.

84. As discussed above in the "baseline water quality" section, the water quality within the Kaituna River is considered relatively good. This is based on the BOPRC monitoring results from 2013 to 2017, and is consistent with the one off "snapshot" monitoring outlined in the WQ Assessment. Based on the recommended guideline values stipulated within the NPSFM, most water quality attributes in the Kaituna River (at the monitored locations) are in Category A or B, with the exception of total phosphorus, which is classified as Category C. This reflects the highly-modified nature of the catchment and agricultural land use predominantly present in the area.

85. As concluded in the WQ Assessment, in general, water quality in the Kaituna River is good in the upper sections of the river, but declines in the lower reaches along with a trend of increasing nutrients. In my opinion, the lower water quality within the lower reaches of the Waiari Stream and the Kaituna River is mainly caused by the rural surrounding land use and has been consistent over the past decade[**Error! Bookmark not defined.**].

86. In my opinion there is no discernible effect on the Kaituna River water quality that can be attributed to the Te Puke WWTP. This is due to the relatively low nutrient load contribution from the Te Puke WWTP in the wider Kaituna catchment. It is my opinion that any potential localised water quality impact that the Te Puke WWTP may have on the Waiari Stream is not expected to carry over to the Kaituna River.

87. The Officer's Report has estimated that the Te Puke WWTP is responsible for a relatively low contribution of nutrients (e.g. approximately 2.6% of nitrogen) from the Te Puke WWTP to the Maketu Estuary. Although I cannot confirm whether that percentage is accurate, it is consistent with my conclusion that I do not expect there to be discernible water quality effects beyond the Waiari Stream caused by the Te Puke WWTP.

88. Although I consider that the Te Puke WWTP discharge contributes only a very small percentage of the total nutrient loading to the Kaituna River and Maketu Estuary, I do note that ongoing assessment of alternative discharge options will still be carried out for the Te Puke WWTP, which may further reduce the nutrient loading from the Te Puke WWTP into the receiving water bodies.

89. In terms of cumulative effects, my opinion is that this needs to be managed with a holistic approach encompassing point discharges such as the Te Puke WWTP or AFFCO discharges, and other non-point discharges such as grazing paddock runoffs. I understand that catchment-wide nutrient management is to be addressed by the proposed Plan Change 12 of the RNRP.

90. WBOPDC's proposed consent conditions will maintain water quality over the term of the consent. WBOPDC is also committed to ongoing environment monitoring, reporting, and periodical consent review. This, in my opinion, will provide a mechanism to verify the effects, address any additional unprecedented effects, and react to any policy change that enables more effective mitigation of cumulative effects.

Waiari Stream

91. From the baseline water quality assessment results, I noted that there is an increase in both total nitrogen and total phosphorus when comparing the downstream to the upstream monitoring sites within the Waiari Stream. The Te Puke WWTP discharge appears to contribute to this increase. For instance, the average Dissolved Reactive Phosphorus (DRP) concentration of the diluted treated effluent discharge is 0.025 mg/L while the average difference between the upstream and downstream concentrations

is 0.085 mg/L (from WQ Assessment). The average nitrate concentration of the diluted treated effluent discharge is 0.092 mg/L while the average difference between the upstream and downstream concentrations is 0.156 mg/L.

92. I summarise the potential mass load of TN and TP in Table 7 below, which is taken from the Addendum. The Waiari Stream upstream and downstream mass loads are calculated based on the historical water quality sampling results (2012-2015 median concentration) outlined in the WQ Assessment and the 5th percentile flow rate (3500 L/s). This provides a conservative approach to calculating the mass load of the receiving environment.

93. The current Te Puke WWTP treated effluent mass load calculation is based on the current average daily flow of 1800 m^3/day and the 2012-2015 median concentration of TN. The projected annual average discharge flow rate (2348 m^3/day) of treated effluent from the WWTP is based on a population increase of 30%.

Table 7 Current and projected nutrient mass load (from the Addendum)

Items	Total Nitrogen	Total Phosphorus	Comments
Waiari Upstream mass load	355.32 kg/day	15.12 kg/day	Calculated based on historical median concentration and 5th percentile flow rate.
Waiari Downstream mass load	443.02 kg/day	43.24 kg/day	Calculated based on historical median concentration and 5th percentile flow rate.
Variance Upstream - Downstream	87.70 kg/day	28.12 kg/day	This variance may be contributed by WWTP discharge and other farm drains.
Current WWTP Effluent Mass Load	36 kg/day (annual average)	-	Currently the WWTP contributes approximately 39% of TN mass load increase within Waiari Stream.
Potential Mass Load Current Scenario	27 kg/day (annual average)	9 kg/day (annual average)	Suggested consent condition will result in a 21% reduction in TN mass load.

Items	Total Nitrogen	Total Phosphorus	Comments
Potential Mass Load Projected Scenario(2051)	35.22 kg/day (annual average)	11.74 kg/day (annual average)	Projected Mass Load in 2051 is expected to be similar to or less than the current mass load

94. As can be seen in Table 7, there is an increase in TN and TP mass load when comparing the Waiari Stream downstream to upstream sites and Te Puke WWTP is contributing a significant portion of it (e.g. 39% of the TN increase may be due to WWTP discharge). I note that this calculation is based on 5^{th} percentile flow rate within Waiari Stream, hence should be considered very conservative.

95. Should the proposed new nutrient limits be put in place, the current average mass load of TN and TP from the WWTP will be reduced significantly (i.e. 21% reduction of current TN mass load), with the future projected mass load being similar to the current situation (circa 36 kg/day TN and 12 kg/day TP in 35 years). This indicates, in my opinion, that water quality will be maintained within this reach of the Waiari Stream.

96. I understand that other trade waste connections such as RBP may occur in the future and may pose additional treatment constraints and result in the additional flow of treated effluent into the Waiari Stream. Due to the lack of detailed information of the potential trade waste connection, it is not possible to assess the surface water quality impact at this stage.

97. Nevertheless it is my view that the current nutrient mass load from the Te Puke WWTP should be kept consistent. By setting the mass load limits in the proposed consent condition, WBOPDC will ensure that no trade waste connection will result in additional nutrient loading in the receiving water body. Therefore water quality will be maintained over the term of the consent. The proposed mass load limits for total nitrogen and total phosphorus are discussed below in the “Conditions” section.

Assessment of groundwater quality

98. The WQ Assessment outlines that groundwater is expected to flow towards the Waiari Stream, and that elevated nutrient and faecal coliforms currently found in the groundwater monitoring wells indicated the likely influence of wastewater. This is largely due to that fact that treated wastewater causes water level elevation within the wetland, generating the flow of treated wastewater into the surrounding shallow groundwater. The key groundwater parameters observed in the four monitoring wells are shown in Table 8.

99. As set out previously in my evidence, monitoring wells No.1, No.2 and No.3, positioned between the wetland and the Waiari Stream, are considered to be hydraulically down-gradient of the wetland. Monitoring well No.4, whilst not positioned between the wetland and the stream, is also considered to be within the radius of the influence of the wetland.

Table 8 Ranges of Measured Parameters in Groundwater Bores (from WQ Assessment)

Sample Location		Groundwater Parameters			
		Ammonia Nitrogen g/m3	Total Oxidised Nitrogen g/m3	Phosphorus - Dissolved Reactive g/m3	Faecal Coliforms per 100mL
Bore 1	Median	1.89	1.83	0.03	6
	Average	2.73	2.34	0.03	477
	Min	< 0.05	0.07	0.01	< 1
	Max	8.00	7.99	0.06	3700
Bore 2	Median	3.07	3.72	0.04	2
	Average	2.97	3.35	0.12	59
	Min	0.08	< 0.015	0.01	< 1
	Max	4.13	4.90	0.79	700
Bore 3	Median	< 0.05	3.72	0.03	4
	Average	0.29	4.52	0.03	25

Sample Location		Groundwater Parameters			
		Ammonia Nitrogen g/m3	Total Oxidised Nitrogen g/m3	Phosphorus - Dissolved Reactive g/m3	Faecal Coliforms per 100mL
	Min	<0.05	0.05	0.01	< 1
	Max	1.44	13.30	0.06	98
Bore 4	Median	0.05	1.62	0.02	29
	Average	0.45	2.28	0.03	570
	Min	< 0.05	< 0.01	0.01	< 1
	Max	3.78	7.18	0.07	6200

100. As can be seen in Table 8, faecal coliforms concentrations are significantly higher in groundwater samples from monitoring well No.4, suggesting a direct influence of wastewater. Phosphorous concentrations are relatively low (inferred to be due to adsorption on pumiceous soils), but highest in monitoring well No.2. Total nitrogen concentrations are generally consistent (average of 4-5 mg/L) in groundwater samples collected from monitoring wells No.1, No.2 and No.3.

101. Considering the groundwater flows into the Waiari Stream, it is my opinion that the influence of treated wastewater on groundwater will be limited to within the immediate vicinity of the wetland.

102. Overall, I concur with the WQ Assessment's conclusion that effects to groundwater should be considered relatively limited as they are very localised. I understand it is currently proposed to decommission the constructed wetland with the effluent being discharged via a rock passage chamber directly to the riparian wetland. This will avoid the potential of groundwater effects in the future.

Assessment of public health risks

103. I will now summarise the methodology and findings of the PH Assessment, which was focused on investigating the potential health risks associated with public contact within the Waiari Stream and the Kaituna River.

Qualitative assessment

104. A high-level microbial public health risk assessment was undertaken in the context of the requirements of the microbiological guidelines for freshwater inherent with the "Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas"[5]. For the purpose of this study, the expected bacteriological indicator concentrations were compared directly to the various levels of microbial quality levels to allow a qualitative assessment of potential public health risks that may be potentially posed by the discharge of wastewater effluent.

105. Based on direct communication with the local community in recent times, there are a number of activities undertaken within or near the Waiari Stream and the Kaituna River. These include, but may not be limited to, kayaking/canoeing and waka amo (outrigger canoes), eeling, food gathering, trout fishing, boating from Bell Road boat ramp (rowing boats, small dinghies and power boats for water skiing, wake boarding and sea-biscuiting), swimming, paddling, rafting, picnic type gatherings/BBQs on stream/river banks and customary and traditional practices for local iwi/hapu groups.

106. In my opinion, drinking water source contamination can be ruled out because no private or community drinking water supplies are present in the study area. In terms of fishing, the human pathogens of concern are not expected to infect fish. Therefore the risks for people who eat the fish being brought into contact with human pathogens will be very low. Cooking is also expected to further reduce this risk.

[5] MfE 2002 Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.

107. Shellfish may present a greater health risk due to their feeding habits resulting in a higher concentration of waterborne microorganisms. Nevertheless, shellfish is not reported to be harvested in either the Waiari Stream or the Kaituna River by the time this assessment was carried out. Therefore the threat of infectious disease following consumption of shellfish has not been considered in this public health risk assessment.

108. At the time that the PH Assessment was completed, the CIA had not been completed, which was then carried out in May 2016. The three CIAs did not identify specific food gathering or recreational water use of the Waiari Stream other than those already considered by the public health risk assessment except for koura or kakahi harvest (both are shellfish). Kakahi collection is common in the Te Arawa Lakes but hasn't been reported in the Waiari Stream. Koura collection is also not confirmed in the region.

109. Regarding the pathogen levels within the treated effluent, I note the generally good compliance with current consent limits (i.e. a post-UV median level of less than 200 cfu/100 mL and a post-UV maximum level less than 1000 cfu/100 mL) has been demonstrated due to the satisfactory performance of the UV disinfection. As for the microbiological quality of the Waiari Stream, consistently low to moderate faecal coliform levels have been recorded within the stream, without a distinctive difference observed between downstream and upstream sites (as outlined in the PH Assessment).

110. Based on the expected pathogen levels within the treated effluent (e.g. median of 200 cfu/100mL and maximum of 1000 cfu/100mL faecal coliform), and the low flow regime selected for the receiving water bodies (the Waiari Stream and the Kaituna River), a conservative estimate of the likely pathogen concentrations within the Waiari Stream and the Kaituna River was calculated and shown in the PH Assessment .

111. Due to the expected dilution factors that can be achieved when treated effluent reaches the Waiari Stream and subsequently the Kaituna River, the E. coli or enterococci levels within the receiving water bodies were estimated to be reasonably low. For instance, when the E. Coli concentration reaches 630 cfu/100 mL in 2051 (maximum level allowed by the current consent), the resulting concentration of E. coli

within the Waiari Stream immediately after discharge is calculated to be slightly less than 5 cfu/100 mL, which will be further diluted to below 1 cfu/100 mL when the effluent reaches the Kaituna River. These levels of E. coli will be classified as Microbiological Assessment Category A and considered as “Acceptable/Green Mode” by the current Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.

112. It is therefore my opinion that the current pathogen levels within the Waiari Stream and the Kaituna River are most likely contributed by agricultural runoffs and other farm drains in the catchment.

113. I note that overall the pathogen levels within the Waiari Stream and the Kaituna River are low, as shown in Table 3 and Table 4 of my evidence. In terms of human health risk, the waterbodies are Category A to Category B according to the NPSFM guidelines (based on BOPRC’s report and the WQ Assessment).

114. It is acknowledged that the current constructed wetlands have contributed to the elevation of public health risks due to the increased bird life and other associated fauna within the wetlands. I understand that WBOPDC is committed to decommission the constructed wetlands and replace them with a rock passage chamber, which will divert the UV disinfected effluent directly to the riparian wetland. This in my opinion will reduce potential groundwater influence of the treated effluent and reduce public health risks.

Quantitative assessment

115. In addition to the conservative but qualitative microbial risk assessment summarised above, I also carried out a quantitative microbial risk assessment (**QMRA**) as part of this investigation. Based on observed distribution of key parameters (such as flow rates, pathogen occurrence and reduction functions, etc.) a random sampling of flow rates for the treated effluent from the Waiari Stream and the Kaituna River was undertaken by the QMRA model. The values of these randomly generated flow rates are always in

agreement with the corresponding distribution patterns as observed from the actual records. All detailed distribution functions applied in the QMRA study are presented in the PH Assessment.

116. The QMRA study showed that the infection probability for recreational water users was found to be generally low, as long as the viral load in the raw sewage is normal. The 95 percentile infection probability values for recreational users were found to be below 0.5% for the Waiari Stream and below 0.05% for the Kaituna River, when rotavirus load in the influent was normal. This means that for 95% of the time, less than 1 person out of a group of 100 people is expected to be infected by rotavirus on a random visit to swim in the investigated Stream and River.

117. Individual Infection Risks (IIRs) and gastrointestinal (GI) illness risks were also calculated as part of the QMRA study. The calculated IIRs were compared to the 0.1 % infection occurrence risk (commonly accepted as a no-calculated-risk level (NCRL) by MfE's microbiological guideline for recreational freshwater) and the estimated GI illness risks were compared to the 1% GI illness risk (commonly accepted as a no-observed-adverse-effect level (NOAEL) in most epidemiological studies).

118. The calculated IIRs for recreational water users were found to be below 0.1% when the virus load in raw sewage is normal. And the GI illness risks were found to be below 1% for recreational users for all year around. This level of infection or illness risk is classified with a "very good" grading for recreational water. This indicates that the gastrointestinal illness risk posed by the virus associated with the treated Te Puke WWTP effluent is considered no more than minor within the studied waterways.

119. In my opinion, this is reasonably expected due to the good performance of the UV disinfection system. An extreme scenario simulation (e.g. there is a virus outbreak within the community) showed an elevated health risk associated with recreational water use of the water bodies. This extreme scenario, unusual as it is, may occur occasionally. This may trigger a health risk notification or other applicable

communication measures from the local district health board to prevent public recreational water contact.

120. Apart from a swimming hole identified 100 m downstream of the Te Puke WWTP (communal use of this swimming hole is yet to be confirmed), swimming is not a year-round recreational water use activity within these waterbodies. In my opinion these QMRA findings should be deemed relatively conservative. The most common recreational activities in the Kaituna River or the Waiari Stream include boating, kayaking and canoeing which involves much less direct water contact when compared with swimming.

121. Various conservative approaches have been adopted in this QMRA study, which need to be taken into consideration when interpreting the results. For instance, the rotavirus load in the raw wastewater was assumed to be 10 times higher than that adopted by previous QMRA work by others. No viral die-out was considered in this study, and the viral reduction rates through the Te Puke WWTP unit processes were also set at much lower levels compared to some other QMRA studies previously completed in NZ. These provide a larger safety margin when assessing the potential public health risks arising from the Te Puke WWTP effluent discharge and contribute to an overall conservative approach.

Submissions

122. I have summarised above the current plant processes, required plant upgrades, and the likely water quality/public health effects due to the discharge of treated effluent into the Waiari Stream. Now I will address the issues raised by the submitters.

Makahae Marae Committee

123. The Makahae Marae Committee raised the concern of exacerbated environmental impacts due to the consented Waiari Stream water intake upstream of the Te Puke WWTP discharge point. I understand TCC and WBOPDC have been granted joint

consent to take up to 60,000 m^3/day from the Waiari Stream (Waiari Water Supply Take Consent RC65637), upstream of the Te Puke WWTP for water supply for Papamoa.

124. I have reviewed the relevant assessment reports submitted as part of the water abstraction consent application and a recent monitoring report as required by the consent, namely:

(a) Effect of Water Abstraction on the Waiari Stream, dated May 2008, prepared by Ian Jowett Consulting.[6]

(b) Proposed Abstraction from Waiari Stream: Effects on Downstream Water Quality, dated June 2008, prepared by Environmental Management Services Ltd.[7]

(c) Proposed Abstraction from Waiari Stream: Potential Effects on Stream Ecology, dated August 2002, prepared by NIWA.[8]

(d) Waiari Water Treatment Plant: Waiari Stream Baseline Monitoring Report 2017, dated March 2017, prepared by 4Sight Consulting.[9]

125. The water quality assessment was based on an average Te Puke WWTP discharge flow rate of 19 L/s (1642 m^3/day) and a lowest recorded 7-day low flow of 2655 L/s at the Waiari Stream. According to this assessment, the dilution of effluent after full mixing

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[6] Above n 4.
[7] Environmental Management Services Limited *Proposed Abstraction From Waiari Stream: Effects on Downstream Water Quality* (Tauranga City Council and Western Bay of Plenty District Council, June 2008). Prepared by David Ray (Senior Environmental Engineer, Bachelor of Engineering (Civil) University of Canterbury 1981 and Master of Science (Resource and Environmental Planning) University of Waikato 1996).
[8] NIWA *Proposed Abstraction from Waiari Stream: Potential Effects on Stream Ecology* (Tauranga District Council, August 2002). Prepared by David Ray (see qualifications from EMS 2008 report), Kevin Collier (Associate Professor (Biological Sciences), BSc University of Waikato), Rohan Wells (NIWA) and Eddie Bowman (Environmental Monitoring Technician, Bachelor of Science (Biology) University of Waikato 1981).
[9] 4Sight Consulting *Waiari Water Treatment Plant: Waiari Stream Baseline Monitoring Report 2017* (Tauranga City Council, March 2017). Prepared by Arie Spyksma (Ecology Consultant, BSc (Environmental Science) University of Waikato 2011, Postgraduate Diploma in Science (Marine Sciences) University of Auckland 2012 and PhD in Marine Sciences University of Auckland 2016)) and Keren Bennett (Ecology Manager and Principal Ecology Consultant, BSc (Zoology) University of Auckland and Diploma of Wildlife Management University of Otago).

would be approximately 140-fold, which is reduced to 103-fold after 60,000 m^3/day abstraction. In my opinion this assessment represents a worst-case scenario and should be considered very conservative.

126. The key potential concern of water contaminant is ammonia, which can lead directly to fish toxicity in natural waters. I concur with the findings of this assessment that the accumulative ammonia level within the Waiari Stream is not expected to pose any discernible issues under the worst-case scenario.

127. Whilst it is envisaged that the proposed abstraction during the low flow period of the Waiari Stream will result in an increase in nutrient concentration, I note that it is still very difficult to predict the exact impact at this stage. This is because the water intake schedule is unknown with variable water demand, and the flow rate of the Waiari Stream can vary significantly during different seasons. The spring-feed nature of the Waiari Stream may also alleviate the potential impact of the intake on the stream flow rate.

128. I note that under the conditions of consent RC65637, monitoring is required above and below the intake site as well as above and below the Te Puke WWTP discharge point. The survey is to be undertaken by the consent holders (joint TCC and WBOPDC), recognising the potential effect of the water take on the mixing zone for the Te Puke WWTP discharge of treated wastewater. The required monitoring parameters include temperature, pH, turbidity, dissolved oxygen, invertebrate composition on hard substrates and macrophytes, macro invertebrate indices and abundancy, and fish composition and abundance of the species present.

129. In my opinion, this monitoring will provide adequate information on the potential cumulative impact that the water intake and the Te Puke WWTP discharge may have on the Waiari Stream in terms of water quality and ecological habitat. The monitoring results will be reviewed as required by the consent condition.

Quayside

130. Quayside Properties Limited (**Quayside**) is the promoter of the RBP and has submitted in support of the Te Puke WWTP application.

131. I note that the maximum flow and influent characteristics from RBP is still unknown at this stage. As such, I recommend removal of the previously proposed discharge limit of 4000 m^3/day as 10 out of 12 consecutive days.

132. It is my understanding that WBOPDC is committed to ensure that any future trade waste connection does not result in any compromise of treatment capacity or exceedance of consent limits regarding effluent quality. The proposed mass load limits for nutrients are consistent with the current nutrient load from the Te Puke WWTP. By setting this limit, the effluent quality from the Te Puke WWTP will need to be improved significantly so that the effluent nutrient loads into the Waiari Stream for the consent period remain unchanged. This requires WBOPDC to take all necessary measures to maintain the Waiari Stream's water quality over the term of the consent.

*Bay of Plenty District Health Board (**BOPDHB**)*

133. BOPDHB indicated that the PH Assessment was undertaken in 2015 and requested it to be updated with any new information.

134. I have summarised the methodology and key findings of the QMRA above and noted that this QMRA should be updated regularly (e.g. in a 5 to 10 year interval) to reflect changes at the Te Puke WWTP (e.g. flow increase, process modification) and changes in terms of public exposure potential (e.g. increase of recreational use or change of use pattern of the receiving water body). To my knowledge, there hasn't been any significant change in the Te Puke WWTP processes or influent characteristics since the submission of the consent application. Drinking water sources under the influence of the Te Puke WWTP discharge can still be ruled out for this area.

135. The completed QMRA considered swimming along the Waiari Stream as the “worst-case” scenario of recreational contact, which should be considered conservative in terms of public health risks. Although there is a swimming hole identified 100 m downstream of the Te Puke WWTP, the major recreational use of the Waiari Stream is still by boat or kayaks, which involves significantly less water contact when compared to swimming. Therefore in my opinion, there is currently no need to update the public health risk assessment at this stage.

136. The CIA was undertaken after the completion of the public health risk assessment. The CIA has nominated, in general terms, a few food gathering practices within the Waiari Stream including tuna (eels), watercress, inanga, koura and kakahi. Most of these food sources have been considered in the PH Assessment, however I cannot confirm if koura or kakahi collection occurs or not within the Waiari Stream. Kakahi collection is endemic to NZ (eg. Te Arawa Lakes) but hasn’t been reported for the Waiari Stream. It may occur in a sporadic or isolated nature, if it does.

137. BOPDHB has also raised the concern of weekly sampling of E. coli in treated effluent being inadequate to ensure effective function of UV disinfection. I concur with this concern and would like to point out that online monitoring of the UV transmissivity is usually an important control factor for most UV systems (including the one currently in operation at the Te Puke WWTP) to ensure that the UV dosage provided is adequate and energy-efficient. An alarming mechanism associated with low UV transmittance is already included as part of the UV system control. A shut-down mechanism or a high UV dose may be initiated upon low UV level detection as part of the functional control of the UV system.

138. I understand that WBOPDC is currently upgrading the tertiary filter, replacing the existing brush clarifier with a Veolia Hydrotech Disc Filter. This new filter is designed to reduce effluent TSS as an effective safeguard measure to ensure that the UV system works effectively. The tertiary filter upgrade is covered in more detail in the evidence of Ms Coral-Lee Ertel.

139. I agree with the maximum E.coli limit of 1000 CFU/100mL being proposed as part of the consent conditions. This is further summarised below in the "Conditions" section. The UV operational procedure should be well documented in the WWTP Operation and Maintenance Manual or WWTP Operation and Management Plan. This document will be updated upon any treatment plant upgrade works and submitted for BOPRC review and acceptance.

140. I agree with BOPDHB's opinion that any future Te Puke WWTP upgrade works should consider the prevention of effluent that does not meet the effluent standards from being discharged into the receiving water body. Nevertheless I would like to point out that wastewater treatment is a biological process, the efficiency and effectiveness of which may fluctuate depending on a variety of ambient conditions. 100% return of out-of-specification effluent back to the treatment train incurs significant infrastructure investment (e.g. large effluent storage capacity, return pump capacity and reduction of hydraulic capacity of the plant) and is not commonly practiced among WWTPs.

141. This is why the discharge limits for key parameters such as BOD, TSS, ammonia and total nitrogen are usually set at statistical levels (e.g. median and 10 out of 12 samples). The development of effective engineering solutions to ensure minimal environmental effects should be carried out at the design stage of the upgrade works.

Wai Ora Wai Maori Assessment Tool

142. A few submitters have raised that a Wai Ora Wai Maori assessment tool may be used for a freshwater ecosystem health assessment. I have not applied this tool previously and have no knowledge at this stage of procedures and methodologies that this tool utilises. Therefore I cannot assess the applicability of this tool in terms of water quality. This issue is further discussed in the evidence of Mr Richard Harkness.

Officer's Report

143. I have reviewed the Officer's s 42A Report issued on 22 March 2019. I support the recommendations in principle, but have some further comments to make, and some amendments for the draft set of conditions.

144. The Officer's Report recommends a mixing zone of 60 m, taking into consideration wetland seepage. I agree with this recommendation, and recommend monitoring or water quality modelling to confirm that the mixing zone is within 60 m of the boundary. The mixing zone monitoring and minimisation in accordance with RNRP are currently included in the proposed consent conditions and I agree with them.

145. The Officer's Report has estimated the relatively low contribution of nutrients (e.g. approximately 2.6% of nitrogen) from the Te Puke WWTP to the Maketu Estuary, and acknowledged the proposed nutrient reduction effort currently in the consent condition.

146. The Report also recommends periodic reviews of the nutrient load as more flows are introduced over time (i.e. every 6 years) and further reduction of nutrients from the Te Puke WWTP effluent may be required pending water quality and ecological monitoring findings. I largely agree with this recommendation. In addition to this, I propose that following the upgrade of the Te Puke WWTP (e.g. 2025), the median mass load of TN and TP are set to be 36 kg/day and 12 kg/day respectively.

147. This will ensure that the proposed water quality within the receiving environment is maintained throughout the whole term of the consent, irrespective of any additional trade waste connections that may be received at the Te Puke WWTP.

148. The Report requested that the grab samples are taken in the Waiari Stream upstream and downstream of the discharge (after reasonable mixing) on a weekly basis for contaminants analysis such as TN, TP, TSS, $cBOD_5$, pH, and E. coli. Whilst I agree that the receiving environment water quality monitoring is required, the frequency of such monitoring should be reduced to monthly instead of weekly. Weekly monitoring of the

effluent quality will be carried out. In my opinion, monthly monitoring of the Waiari Stream over the period of six years as proposed by the proposed consent condition will provide adequate information for the assessment of the environmental impact from the effluent discharge.

Conditions

149. The consent conditions are discussed by each WBOPDC witness as appropriate to their areas of expertise. In my evidence above, I have focussed on those relevant to process operation, water quality and public health risks.

150. I have reviewed the conditions contained in Mr Richard Harkness' evidence and agree with the proposed conditions. In my opinion, they provide for adequate receiving environment monitoring (i.e. receiving water monitoring) and appropriate operation and management procedure (i.e. Management Plan) in alleviating any potential adverse effects, should they occur.

151. There have been some relevant changes to the proposed conditions since the application was lodged, discussed below:

(a) I agree with removing the previously proposed 10 out of 12 consecutive sample flow limit of 4000 m^3/day and retaining the maximum 9000m^3/day flow limit.

(b) I agree with adding median mass load limits for TN and TP at 36 kg/day and 12 kg/day, respectively. This will ensure that any future trade waste connection (e.g. such as the Rangiuru Business Park connection) will not result in additional nutrient loading into the Waiari Stream, hence maintaining water quality in the receiving environment.

(c) I agree with including an E.coli limit of 1000 CFU/100mL within the treated effluent.

(d) Within 12 months after the commissioning of the rock chamber and diffuser, the consent holder shall carry out adequate monitoring or water quality modelling work to confirm the mixing zone boundary within the Waiari Stream. The required standards or criteria after reasonable mixing of the discharge with the Waiari Stream are stipulated within BOPRC's Regional Natural Resource Plan (RNRP) Schedule 9, section 7. The findings of such monitoring or modelling work shall be submitted to BOPRC for review. Should the modelling or monitoring results show that the mixing zone is beyond 60 m downstream of the discharge point, the consent holder shall review the existing discharge infrastructure and develop options to improve the mixing of treated effluent within the Waiari Stream. I agree with this amendment.

(e) I consider grab sampling in the Waiari Stream upstream and downstream of the discharge (after reasonable mixing) on a monthly basis over a period of six years, instead of on a weekly basis, to be adequate in providing information for the assessment of the impact of the effluent discharge on water quality. I agree with this amendment.

Conclusion

152. Based on the findings of the process and performance review work that I undertook, it is my opinion that the current assets at Te Puke WWTP need to be upgraded to address some current capacity issues and meet the envisaged future effluent quality limits. The upgrade works may include, but are not limited to, the upgrade of the secondary reactors, improved internal recycling stream and increased solid handling process capacity. I understand that WBOPDC have already started with some of the recommended upgrade projects with further major upgrades planned for the current LTP cycle.

153. My evidence regarding the existing and envisaged water quality within the receiving environment is based on the WQ Assessment and the Addendum. Based on the investigation methodology documented and the findings provided in these two

documents, the elevated nutrients found downstream of the effluent discharge, phosphorus in particular, is likely to be contributed by the Te Puke WWTP discharge. Nevertheless, the surrounding agricultural land use is the predominant nutrient source in the catchment.

154. The proposed treated effluent limits are significantly more stringent than the current conditions. In my opinion these new effluent limits will reduce the current nutrient load into the Waiari Stream and prevent further degradation of the water quality within the Waiari Stream. More trade waste connections such as those from RBP may pose additional treatment and hydraulic constraints on the Te Puke WWTP and should be investigated in detail when the nature of the wastewater connection is more certain. It is my understanding that WBOPDC is committed to ensure that no trade waste connection would result in breaching the proposed consent conditions, which are developed to maintain the water quality in the receiving water body for the whole term of the consent.

155. A quantitative microbial risk assessment was carried out to assess the potential public health risks associated with any direct recreational contact with the Waiari Stream and the Kaituna River. Based on the findings, I concluded that the public health risks associated with the recreational use of both the Waiari Stream and the Kaituna River are minimal. This conclusion was based on assumptions that the viral load in the raw sewage is normal and all of the Te Puke WWTP unit processes are in normal operating condition. The public health risk assessment does need to be updated periodically (e.g. in the order of 5-10 years) to reflect any changes in treatment processes, influent characteristics and in community contact patterns.

Zhuo Chen

Date: 29 March 2019

Appendix A – Surface Water Monitoring Locations

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Rev.	By	App.	Description	Date

Notes:

Printed	28 Mar 2019 14:20		
Approved	JH	Date	28/03/2019
Designed	SS	Checked	JH
Drawn	SS		
File Name			

Map features depicted in terms of NZTM projection.

Data Sources:
NZ Topographical Features – LINZ NZ National Topo Dataset 2014
Cadastral Boundaries – LINZ NZ Cadastral Dataset 2014

AECOM

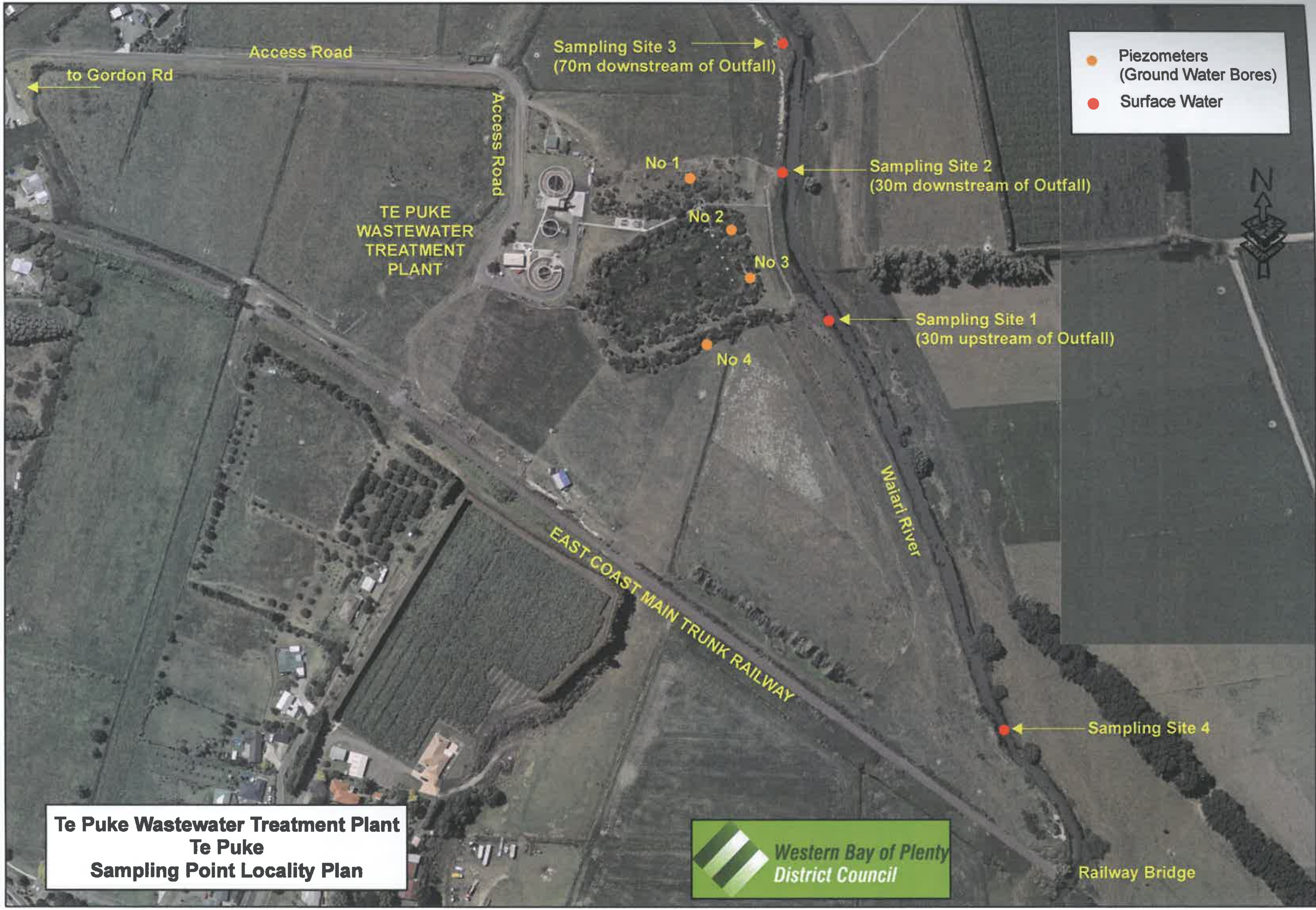
Project: TE PUKE WWTP

Title: ECOLOGICAL AND WATER QUALITY MONITORING LOCATIONS

Scale: 1:10,000 (A3 size) — 100 50 0 100 200 300 400 m

Status: Final | Map No. FIGURE 3 | Sheet No. | Rev. A

Appendix B – Bore Sites



Te Puke Wastewater Treatment Plant
Te Puke
Sampling Point Locality Plan