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 FIONA DAVIES
ON BEHALF OF WESTERN BAY OF PLENTY DISTRICT COUNCIL

Ecology

29 March 2019

Introduction

1. My name is Fiona Louise Davies. I am employed by AECOM New Zealand Limited (**AECOM**) where I hold the position of Associate Director Environmental Scientist. I have held that position at AECOM since January 2019 based in Auckland. I have also held the position of Team Leader of the Natural Resources team at AECOM since 2017.

2. Previous to this I held the position of Principal Environmental Scientist at AECOM from January 2016 when URS New Zealand Limited (**URS**) merged with AECOM. I was employed by URS from March 2008 where I started as a Senior Environmental Scientist in the Environment Team and by the time of the merger with AECOM in 2016 was working in the position of Associate Environmental Scientist. My combined years of experience at AECOM/URS amount to 11 years.

3. Whilst working at AECOM/URS I have worked as an ecological technical specialist on projects (freshwater and fauna) in a wide range of industries including roads, wastewater, stormwater and residential development.

4. My previous experience includes working on major rail projects in London, United Kingdom. I worked as an environmental scientist/manager (specialising in ecology) on projects such as the Thameslink 2000 upgrade (employed by Railtrack), West Coast Route Modernisation (employed by Railtrack) and Metronet Alliance – London Underground (employed by Atkins).

5. My professional qualifications are a Master of Science, 2001 (Biology/Zoophysiology) and a Bachelor of Science, 1998 (Biology/Marine Biology) both from the University of Auckland. In 2016 I completed a post graduate paper at the University of Auckland in Aquatic Ecological Assessments. I am a full member and Auckland Branch Co-ordinator for the Environmental Institute of Australia and New Zealand (**EIANZ**). I am also an AECOM certified Project Manager.

6. For the past 2 years I have been a committee member for the Campbells Bay Urban Sanctuary/Centennial Park Bush Society in Auckland. My priority has been the restoration and monitoring of the Campbells Bay stream within Centennial Park.

Code of Conduct for Expert Witnesses

7. I have read and agree to comply with the Code of Conduct for Expert Witnesses, Environment Court of New Zealand Practice Note 2014. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

8. AECOM (previously URS) was engaged by Western Bay of Plenty District Council (**WBOPDC**) to provide professional engineering, environmental and planning services in support of a resource consent application for the continued operation of, and discharge of treated wastewater from, the Te Puke Wastewater Treatment Plant (the **Te Puke WWTP**). I was not involved in the ecological assessment or reporting. My involvement with the application has been since December 2018 as an expert witness for this hearing.

An ecological assessment has been provided by way of the Water Quality, Stream and Terrestrial Ecology Assessment dated 16 October 2015 (**WQ Assessment**)[1] annexed as Appendix F to the AEE, and the supplementary

[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).

Addendum Water Quality and Receiving Environment Assessment dated 25 Jan 2018 (**2018 Assessment**)[2].

9. This statement does not repeat the contents of these assessments, but it does highlight the main points and summarises the conclusions, and I have drawn conclusions based on the data included in those assessments. In addition to the above assessments, my evidence relies on a series of other reports/surveys, which are specifically referred to throughout my evidence.

10. My evidence will cover:

    (a) An assessment of the existing environment with respect to aquatic ecology; and

    (b) An assessment of the effects of the proposed discharges on aquatic ecology.

11. I have read and am familiar with the submissions, Officer's Report and proposed consent conditions.

12. I visited the Te Puke WWTP and Waiari Stream on Friday 18th January 2019 where I undertook a site walkover to familiarise myself with the environment. This included a tour of the Te Puke WWTP facilities, the adjacent wetland, stream riparian margin (true left bank only) and farm discharges.

Executive summary

13. The Te Puke WWTP discharge (current and future) is contributing to the nutrient loading of the Waiari Stream. The Te Puke WWTP discharge is part of a wider picture of catchment wide stream nutrient inputs and other effects (e.g. lack of riparian vegetation) that are impacting stream ecology. In the short term the

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[2] Prepared by Kristina Healy.

effects of the Te Puke WWTP on aquatic ecology may improve with the implementation of more stringent nutrient consent limits.

14. As population growth increases to 30% the stream ecological impacts will be in line with what they are today, which I consider are minor. The Waiari Stream is fast flowing and high volume in its nature, therefore it appears to be more resilient to the effects of the Te Puke WWTP and the cumulative wider catchment inputs. Nevertheless mitigation and monitoring of ecological impacts are proposed as conditions of consent, which I support.

Assessment of Existing Environment – Stream Ecology – WQ Assessment

15. As outlined in the WQ Assessment, stream ecology monitoring was undertaken by AECOM on 30 June 2015 and 1 July 2015. This monitoring comprised a stream habitat assessment and a macroinvertebrate assessment and was undertaken at the following locations (see Appendix A for a map of these locations along with other key features referred to in this evidence such as the 'Northern' and 'Southern' drains):

    (a) W1 – Waiari Stream, approximately 100 m upstream of WWTP discharge point.

    (b) W2 – Waiari Stream, approximately 100 m downstream of the Te Puke WWTP discharge point.

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

    (d) K2 – Kaituna River, approximately 400 m downstream of the Waiari Stream confluence. The Kaituna River was sampled to ascertain whether the effects of the WWTP were having any discernible effects on the downstream reach of the Kaituna River.

16. The following methodology was used at each monitoring reach:

(a) Stream habitat assessment:

(i) A description of:

(1) Instream habitat – including channel width and depth;
(2) Inorganic and organic materials;
(3) Predominant substrate i.e. sand/silt/rock; and
(4) Channel shade – based on overhead vegetation cover, riparian understorey and canopy vegetation.

(ii) In addition, the Auckland Council scoring system for assessing habitat quality was applied. Functions assessed include aquatic habitat diversity and abundance, hydraulic heterogeneity, channel shade and riparian vegetation integrity.

(1) A score out of 100 was given, whereby the following categories would apply depending on the score:

- 0 – 25 = Poor habitat
- 26 – 50 = Marginal habitat
- 51 - 75 = Suboptimal habitat
- 76 – 100 = Optimal

(b) Macroinvertebrate sample collection methodology:

(i) Macroinvertebrate samples were collected using the MfE Protocol C2 (semi-quantitative), developed for wadeable, soft-bottomed New Zealand streams.

Stream habitat assessment results

17. The habitat and stream morphology were comparable between the upstream and downstream locations within each of the watercourses however the habitat in the Waiari Stream and Kaituna River were quite different. Table 1 summarises the physical habitat recorded at each monitoring location, taken from the WQ Assessment:

Location	AC Habitat Score	Predominant Substrate	Organic Substrate	Channel Shade	Channel Width	Channel Depth
W1	41	Sand	Wood (8%)	Very low (30%)	11 m	> 1 m
W2	43	Sand	Wood (13%)	Low (45%)	9 m	> 1 m
K1	29	Silt/Mud	Wood (2%)	Ineffective (10%)	30 m	> 2 m
K2	31	Silt/Mud	Wood (5%)	Very low (15%)	35 m	> 2 m

Table 1- Summary of Stream Habitat Assessment

18. The results show that the Kaituna River monitoring sites were significantly lower in ecological value compared to the Waiari Stream monitoring sites.

19. With respect to the Waiari Stream, the overall Auckland Council Habitat Score was similar at 41 (upstream) and 43 (downstream) out of 100, indicating marginal habitat conditions. The downstream site had slightly higher woody organic substrate (13%) than the upstream site (8%). The downstream site also had more channel shading (45%) compared with the upstream site (30%). Both sites had sandy stream bottoms.

20. The Kaituna River had Auckland Council Habitat Scores of 29 (upstream) and 31 (downstream) out of 100, indicating poor habitat conditions. Organic substrate (wood) was very low at between 2-5% with ineffective to very low shading. Both sites had silt/mud bottoms.

Macroinvertebrate sampling results

21. Figure 1 in Schedule 1 to my evidence shows the results with respect to taxonomic diversity. The diversity of macroinvertebrate communities is much greater at the Waiari Stream locations compared to the Kaituna River. However, the diversity is similar between upstream and downstream sites within the same waterbody.

22. Figure 2 in Schedule 1 to my evidence shows the results with respect to taxonomic abundance. The results show a similar abundance between the upstream and downstream sites with respect to the Waiari Stream. The Kaituna River had a higher number of individuals at both upstream and downstream sites compared with the Waiari Stream, in particular the downstream site. This is attributed to the high number of *Potamopyrgus* mollusc likely attached to the submerged macrophytes sampled in the Kaituna River.

23. Figure 3 in Schedule 1 to my evidence shows the results with respect to community composition. There were differences in the macroinvertebrate community composition between the Waiari Stream upstream and downstream sites, as follows:

    (a) The upstream site had a higher proportion of Ephemeroptera/mayfly, Plecoptera/stonefly, Trichoptera/caddisfly (EPT) species that are generally associated with higher quality streams (84% for upstream and 40% downstream). Mayfly was found to be the most dominant species at both sites (75% upstream and 32% downstream).

    (b) The upstream site had a smaller proportion of pollution tolerant taxa such as the truefly, oligochaetes, crustacea and mollusca compared with the downstream site (16% and 60% respectively). Based on these results, the upstream site consisted of a greater proportion of higher scoring species.

The presence of these species may indicate a better quality aquatic environment at this location.

24. In comparison, the Kaituna River was absent of EPT species and was dominated by molluscs, oligochaetes and crustacea which are species that are tolerant of nutrient enriched waters. The results show a similar composition between upstream and downstream sites.

25. Figure 4 in Schedule 1 to my evidence shows the results with respect to MCI-sb values, taken from the WQ Assessment. The MCI-sb results (macroinvertebrate community index, soft bottomed streams) between the Waiari Stream upstream and downstream sites differed by 10 points (out of 120 = 8%). The upstream value was 107, indicating a stream with 'Possible Mild Pollution'. The downstream value was 97, indicating a stream with 'Probable Moderate Pollution'. Species presence alone (and not abundance) is used in the scoring of MCI values.

26. The MCI-sb results for the Kaituna River were considerably lower than for the Waiari Stream. The upstream and downstream sites were both indicative of a watercourse with Probable Severe Pollution (scoring 68 and 64 respectively).

27. Figure 5 in Schedule 1 to my evidence shows the results with respect to QMCI-sb values. The QMCI-sb results (quantitative macroinvertebrate community index, soft bottomed streams) show more obvious differences between the Waiari Stream upstream and downstream sites, which differ by 2.3 (out of 8 = 29%). The upstream value was 7.6, indicating 'Clean Water'. The downstream value was 5.2, indicating 'Possible Mild Pollution'. The QMCI index uses abundance in the scoring and is often used for long term monitoring programmes.

28. The QMCI-sb results for the Kaituna River were considerably lower than for the Waiari Stream. The upstream and downstream sites were both indicative of a watercourse with ‘Probable Severe Pollution’ (scoring 7.6 and 5.3 respectively).

29. I note that sampling for macroinvertebrates at the upstream and downstream Waiari Stream sites was made up of approximately the same amount of substrate type (10 fixed areas of $0.3m^2$) – wood debris, submerged macrophytes, emergent macrophytes and bankside vegetation. I consider that this means any differences between samples are not due to differences in substrate sampled.

Assessment of Existing Environment – Riparian Vegetation – WQ Assessment

30. A visual assessment of riparian vegetation adjacent to the stream sites was undertaken.

31. Treated wastewater is discharged via a number of diffuse outlets within a stepped/cut section (‘riparian wetland’) of the Waiari Stream’s flood bank. Vegetation was described as pastoral and exotic grasses, with no tree canopy or indigenous vegetation. Although fenced from cattle, grazing was evident immediately adjacent to the Waiari Stream’s edge.

32. The riparian margins of the Kaituna River at the site locations were described as surrounding pastoral farmland with grazing evident. Patches of crack willow were present extending over the water and small clusters of pampas. The predominant ground cover was reed sweet-grass and willow weed along the Kaituna River’s margin.

Assessment of Existing Environment – Kaituna River – BOPRC (2018)

33. BOPRC has recently published a review of freshwater in the Bay of Plenty,[3] which sets out recommended water quality and ecology attributes (based on the NPSFM and a 2017 BOPRC report).[4] Historical monitoring data for rivers, streams and lakes in the Bay of Plenty was compared to those attributes in order to provide a baseline for discussions with stakeholders about setting freshwater objectives and limits to achieve them.

34. No direct sampling of the Kaituna River for macroinvertebrates was included in the report, but macroinvertebrate sampling results are described for tributaries of the Kaituna River, including the Waiari Stream. The MCI-sb scores at this location were provided as a range between 106-124, indicating a watercourse with 'Possible Mild Pollution'. This scoring is similar to the MCI-sb scoring from the WQ Assessment of the Waiari Stream upstream and downstream locations (107 and 97 respectively).

35. The report states that trend analysis undertaken on MCI and EPT richness found only a small number of sites displayed significant trends and that this did not include the Waiari/Kaituna confluence site. The authors suggest that the reason for this is that there has been no major change in invertebrate communities because land use has not changed since the stream monitoring programme began in 1991. It is noted that the first Te Puke WWTP resource consent was granted in 1998.

[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 has been 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).

[4] *Water Quality and Ecological Attributes for Rivers and Lakes in the Bay of Plenty* (BOPRC Environmental Publication 2017/06, November 2017). Prepared by Rochelle Carter, Alastair Suren and Paul Scholes.

Assessment of Existing Environment - Other Discharges – WQ Assessment and 2019 Site Walkover

36. The WQ Assessment states that there are several small drain discharge points between the monitoring locations, as well as the potential for non-point discharges and that this might impact the monitoring results. Only one specific potentially contaminated point discharge was highlighted within the riparian margin of the Te Puke WWTP, which consisted of stagnant water, dead organic vegetation build up and brown algae growth. Aerial photography suggested that this discharge was associated with rural runoff from the surrounding farms.

37. Although the WQ Assessment does not state the exact location of the potentially contaminated discharge point, it is evident from the 2015 field photographs that it is located between the Te Puke WWTP discharge point and the W1 (upstream) sampling location (referred to as the "Southern Drain"). Therefore this discharge could impact the results of the downstream monitoring.

38. During my site walkover in February 2019 I was unable to locate the point discharge described above. However the riparian margin was more overgrown during this visit compared to 2015, so it may have been covered.

39. Subsequent follow up with the wetland design drawings[5] shows that this "Southern Drain" was culverted under the stop bank to discharge directly into the Waiari Stream as part of the wetland construction. The discharge is approximately 20 metres upstream of the upstream wetland weir. In my opinion this is the discharge that was observed during the 2015 survey.

40. During the February 2019 site visit, I observed an additional farm drainage discharge point, which included a large discharge from a farm drain ("the

[5] Worley Consultants, 1998, Te Puke Sewage Treatment Plant – Stage 3 Upgrade and Expansion, Drawing Set Sheet No. 109 (Rev A - New Main Wetland – Wetland Effluent Collection Piping and Stopbank Culvert Extn).

Northern Drain"), located approximately 170m downstream of the Te Puke WWTP (refer to Appendix A). This discharge point was further downstream from the W2 downstream monitoring location.

Assessment of Existing Environment – Stream Ecology - 4Sight 2017 Survey

41. In February 2017 4Sight Consulting undertook water quality and stream ecology surveys of the Waiari Stream. This was done as a condition of consent for the water take consent (No. 65637) held by Tauranga City Council (**TCC**) and WBOPDC. The consent requires monitoring to cover macroinvertebrate communities, fish surveys, macrophytes and basic water quality monitoring. It also requires three consecutive years of baseline monitoring of the stream prior to the commencement of any works. Monitoring was undertaken between 2010 and 2012, however commissioning of the water take project was then put on hold. The project has now being rescheduled and as such stream monitoring has restarted.

42. The monitoring results were reported in the Spyksma A and Bennett K (4Sight Consulting) 2017, Waiari Water Treatment Plant: Waiari Stream baseline monitoring report 2017 (**4Sight 2017 Survey**).[6] I have relied on the results of this monitoring in forming my opinion as to the aquatic ecology conditions of the Waiari Stream.

43. Four sites were sampled:

    (a) Sites 1 and 2 were located upstream and downstream (respectively) of the proposed water intake site at 315 No. 1 Road.

[6] 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).

(b) Sites 3 and 4 were located 55m upstream and 165m downstream (respectively) of the Te Puke WWTP, off Gordon Street.[7] The Te Puke WWTP is located approximately 2km downstream of the proposed water take.

44. My evidence will predominantly focus on the results of the monitoring of Sites 3 and 4 as Sites 1 and 2 are not as relevant to the Te Puke WWTP.

Macroinvertebrate results

45. Macroinvertebrate communities were dominated by snails and trueflies at Site 3 (upstream) and 4 (downstream) which are more pollution tolerant species. This is shown in Figure 6 in Schedule 1 to this evidence.

46. The mean MCI-sb score for Site 3 (upstream) was 83.4 (fair water quality) and 80 (fair water quality) for Site 4 (downstream) (Figure 7, Schedule 1). The mean QMCI-sb score for Site 3 (upstream) was 2.25 (poor water quality) and 3.52 (poor water quality) for Site 4 (downstream) (Figure 8, Schedule 1).

47. I reviewed data collected in previous monitoring events between 2010 and 2012. Sites 3 and 4 show a high degree of natural variability in community composition and indices during these years. The data shows no trends (declining or improving) in stream ecological value between years or between the upstream (Site 3) and the downstream (Site 4) from the Te Puke WWTP. These results are shown in Figure 9 in Schedule 1.

48. There was greater taxa diversity and a greater number and abundance of EPT taxa at the Waiari Stream upstream sites (Sites 1 and 2), that are generally associated with higher quality streams (Figure 10, Schedule 1). The authors thought this may be due to variation in habitat types and sampling

[7] The distances of upstream and downstream monitoring locations from the WWTP discharge have been estimated from Figure 1 of the 4Sight report. This is because the NZGD Latitude/Longitude and NZTM Northing/Easting provided in Table 1 of the report were inaccurate.

methodologies/substrate types between the two areas. The Waiari Stream downstream (Sites 3 and 4) macroinvertebrate sampling substrate was made up of entirely aquatic plant communities, compared to woody debris at the upstream sites (Sites 1 and 2).

49. At Sites 3 and 4 the exotic oxygen weed *Elodea canadensis* was the dominant macrophyte, covering 60-70% of the Waiari Stream width at each site (Figure 11, Schedule 1). Excessive macrophyte cover (i.e. over 50%) such as this are often indicative of nutrient enriched waters and can have adverse effects on stream ecological health.

50. High water quality was recorded at Sites 3 and 4 (Temperature, Dissolved Oxygen (**DO**), Conductivity, pH and Turbidity were measured) (Figure 12, Schedule 1). No differences between upstream and downstream sites were observed within the results which would indicate an influence from the Te Puke WWTP.

51. Fish species recorded during the survey are included in the fish desktop review below.

Assessment of Existing Environment – Fish desktop review

52. Desktop or infield fish surveys were not undertaken as part of the WQ Assessment. I have relied on the following resources to undertake a desktop review of fish species located within the Waiari Stream:

    (a) Bay of Plenty Regional Natural Resources Plan – Schedule 1.

(b) Jowett I. 2008. Effects of water abstraction on the Waiari Stream. Client Report U0705, prepared for Tauranga District Council. Pukekohe: Ian Jowett Consulting.[8]

(c) The 4Sight 2017 Survey.

(d) Crow S., 2017, New Zealand Freshwater Fish Database.[9]

53. A review of the above sources shows that 12 freshwater fish species have been recorded in Waiari Stream between 1979 and 2018. Freshwater mussels (*Hyridella menziesi*), freshwater shrimp (*Paratya curvirostris*) and koura (*Paranephrops* spp.) have also been recorded in the Stream.

54. Table 1 provides a summary of the freshwater fish and invertebrate species which have been recorded in the Waiari Stream. Six species have a threat classification of 'Threatened' or 'At Risk'.[10]

Table 1 - Freshwater fish species recorded in Waiari Stream, Bay of Plenty

Common name	Scientific name	Threat classification
Common bully	*Gobiomorphus cotidianus*	Not Threatened
Common smelt	*Retropinna retropinna*	Not Threatened
Freshwater mussel	*Hyridella menziesi*	At Risk - Declining
Freshwater shrimp	*Paratya curvirostris*	Not Threatened
Giant bully	*Gobiomorphus gobioides*	At Risk - Naturally Uncommon
Giant kokopu	*Galaxias argenteus*	At Risk - Declining
Grey mullet	*Mugil cephalus*	Not Threatened
Inanga	*Galaxias maculatus*	At Risk - Declining

[8] 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).

[9] Prepared by Shannon Crow (Freshwater Fish Ecologist, PhD).

[10] This classification is based on the following sources: Dunn NR, Allibone RM, Closs GP, Crow SK, David BO, Goodman JM, Griffiths M, Jack DC, Ling N, Waters JM, Rolfe JR. 2018. Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Wellington: Department of Conservation; and Grainger N, Collier K, Hitchmough R, Harding J, Smith, Sutherland D. 2014. Conservation status of New Zealand freshwater invertebrates, 2013. New Zealand Threat Classification Series 8. Wellington: Department of Conservation.

Common name	Scientific name	Threat classification
Koura	*Paranephrops spp.*	Not Threatened
Lamprey	*Geotria australis*	Threatened - Nationally Vulnerable
Longfin eel	*Anguilla dieffenbachii*	At Risk - Declining
Mosquito fish	*Gambusia affinis*	Introduced and Naturalised
Rainbow trout	*Oncorhynchus mykiss*	Introduced and Naturalised
Redfin bully	*Gobiomorphus huttoni*	Not Threatened
Shortfin eel	*Anguilla australis*	Not Threatened

55. The Waiari Stream is also recognised for its locally significant trout habitat and fishery values in Schedule 1 of the Bay of Plenty Regional Natural Resources Plan. Table 2 summarises the results of the 4Sight 2017 Survey with respect to fish and large macroinvertebrate species:

Table 2 –Fish and large macroinvertebrate species captured during 4Sight 2017 fish survey

Genus	Species	Common Name	WTP Intake		WWTP Outfall	
			Site 1	Site 2	Site 3	Site 4
Anguilla	sp.	Elver			1	1
	diffenbachii	Longfin eel	2		5	1
Galaxias	*maculatus*	Inanga	1	1	5+*	6+*
	argenteus	Giant Kokopu	1	1		
Gobiomorphus	sp.	Bully sp.		2	16	3
	cotidianus	Common Bully				4
	huttoni	Redfin Bully	6	16	1	4
Retropinna	*retropinna*	Common smelt		1		
Mugil	*cephalus*	Mullet?				1
Paranephrops	sp.	Koura				1
Total Number of Fish			10	21	28+	20+

* schools observed

56. Based on the results of the fish species caught during the 4Sight 2017 Survey, the fish Quantile Index of Biotic Integrity (QIBI) was calculated and was indicative of 'excellent' habitat quality or connectivity for fish migrations at all sites (Site 3 = 52, Site 4 = 52). Fish species included longfin eel, Inanga, redfin bully, common bully and grey mullet. Freshwater shrimp and crayfish (koura) were also caught in nets.

Assessment of Environmental Effects – Current Te Puke WWTP Discharge

Water quality results

57. The water quality monitoring results and the potential effects of the Te Puke WWTP are discussed in the evidence of Mr Zhuo Chen. My evidence briefly covers these results as they relate to the ecology of the stream. This is because water quality and ecology are intrinsically linked whereby the quality of the water will influence the community of flora and fauna of stream inhabitants. However, the overall health of the stream inhabitants will be different in each stream environment depending on a multitude of factors including water quality, flow, geology, surrounding catchment, riparian vegetation quality and instream habitat.

58. As outlined in Mr Zhuo Chen's evidence, upstream and downstream water quality sampling undertaken in 2015 and historical WBOPDC monitoring (2012 - 2015) of the Waiari Stream show ANZECC (2000) exceedances in total nitrogen, total phosphorus, nitrate-nitrogen and dissolved reactive phosphorus (**DRP**). The downstream samples were generally at higher levels.

59. Mr Zhuo Chen concludes in his evidence that with the proposed conditions implemented, water quality will be maintained over the term of the consent.

Effects on Riparian Habitat – Waiari Stream

60. The WQ Assessment found that the overall Auckland Council Habitat Score was similar at 41 (upstream) and 43 (downstream) out of 100. The downstream site had slightly higher woody organic substrate (13%) than the upstream site (8%). The downstream site also had more channel shading (45%) compared with the upstream site (30%). Both sites had sandy stream bottoms.

61. The WQ Assessment considered that the Te Puke WWTP was having no impact on the riparian margins of the Waiari Stream or Kaituna River. I understand that ongoing maintenance of the weirs is required to ensure that this is the case.

62. Further planting of the WWTP riparian margin is recommended to improve the functioning of this area and improve overall conditions for the stream in regards to factors such as shading and instream habitat. This has been recommended as a condition of consent.

Effects on Fish – Waiari Stream

63. High densities of macrophyte cover (i.e. over 50%) is often a sign of nutrient loading (particularly in summer low flow) to a stream that contributes to decreased stream ecological health and can effect fish. Extensive oxygen weed (*Elodea*) was observed in the 4Sight 2017 Survey at upstream and downstream sites from the Te Puke WWTP, forming thick expansive beds along stream edges. In my opinion this may be a result of nutrient enrichment and lack of shading, but to some degree also provides valuable shelter for fish.

64. Historical fish data (including the 4Sight 2017 Survey) indicate 'excellent' habitat quality and/or connectivity for fish species upstream and downstream of the Te Puke WWTP discharge. Fish species found in the more recent 4Sight 2017 Survey included longfin eel, Inanga, redfin bully, common bully and grey mullet. Freshwater shrimp and crayfish (koura) were also caught.

65. I note that fish population composition can take longer to show the effects of changing pollution (due to their long life history), however in my opinion the Te Puke WWTP is not having an impact on the fish community structure.

Effects on Macroinvertebrates – Waiari Stream

66. With respect to the Waiari Stream, the WQ Assessment shows that while macroinvertebrate diversity and abundance are similar between the upstream

and downstream sites, there is a difference between the macroinvertebrate communities, with greater higher scoring taxa present in the upstream site. In addition, based on the macroinvertebrate community index results, the water upstream of the Te Puke WWTP appears less polluted.

67. The more recent 4Sight 2017 Survey found no discernible difference between the macroinvertebrate communities at the upstream and downstream sites from the WWTP discharge.

68. Although, the 4Sight 2017 Survey macroinvertebrate sampling was limited to macrophytes using Protocol C4.[11] This makes the results more difficult to compare with the WQ Assessment where the C2 Protocol[12] was followed and included sampling of woody debris at the upstream and downstream sites which can be an important substrate for EPT species (if present).

69. Both the WQ Assessment and the 4Sight 2017 macroinvertebrate surveys use 'Protocols for sampling macroinvertebrates in wadeable streams'.[13] A wadeable stream is a stream that is less than 60cm deep. The WQ Assessment estimated the depth of the Waiari Stream to be 1 metre+. As such, I would consider the Waiari Stream non-wadeable. To date macroinvertebrate (and fish) sampling protocols for NZ non-wadable streams have not been developed.

70. Using a wadeable macroinvertebrate sampling protocol for a non-wadeable stream can be problematic because it does not enable sampling of all macroinvertebrate habitat types within the stream bed. It is important that macroinvertebrate substrate sampling reflects the actual available substrate type of the stream bed. For example, the macroinvertebrate results may not be accurate if only macrophytes are sampled, whereas the available substrate is macrophytes/wood and aquatic roots. This is particularly important for soft bottomed streams as many of the EPT species are found on woody debris.

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[11] Stark J, Boothroyd I, Harding J, Maxted J, Scarsbrook M *Protocols for Sampling Macroinvertebrates in Wadeable Streams* (Ministry for the Environment, November 2001).
[12] As above.
[13]As above.

71. To date the macroinvertebrate sampling of the Waiari Stream has been variable and inconclusive. This is due to a number of reasons including the inappropriateness/inconsistency of the use of this sampling method and the influence of other point discharges.

72. I consider that the Te Puke WWTP is having a minor effect on the macroinvertebrate community downstream of the Te Puke WWTP discharge point. However, further monitoring (as described below) is required to confirm and further quantify this effect.

73. I recommend that an Ecological Monitoring Plan (the **Plan**) is developed that describes the methodology and locations for the monitoring of macrophyte cover, macroinvertebrate and fish and that is suitable for a non-wadeable stream such as the Waiari Stream. The Plan should allow for comparable results that will highlight any declining trends in stream ecological health and allow the implementation of management actions. The Plan should target the Te Puke WWTP discharge effects only and include monitoring locations that exclude or account for the Te Puke WWTP mixing zone and the impacts of the 'Southern' and 'Northern' drain and any other non-Te Puke WWTP discharges.

Effects on the Kaituna River

74. I consider the effects on the Kaituna River from the Te Puke WWTP to be negligible. The Officer's Report states the Te Puke WWTP discharge contributes only 2.6% of the nitrogen load to the Maketu Estuary (cumulative effects are discussed below). Mr Zhuo Chen in his evidence estimates a mixing zone within the Waiari Stream of 50 - 60m. The Te Puke WWTP discharge into the Waiari Stream is approximately 2km from the confluence with the Kaituna River. The Kaituna River is a much larger river with higher flows and dilution potential.

75. The WQ assessment ecological survey results found no difference between the Kaituna River upstream (K1) and downstream (K2) results in regards to macroinvertebrate indices. The MCI score indicated a watercourse of severe

pollution, however the survey methodology used was for wadeable streams and therefore may not have produced entirely accurate results.

Assessment of Environmental Effects – Proposed Te Puke WWTP Discharge

76. The installation of the rock chamber will involve the removal of low quality vegetation within the riparian margin of the Te Puke WWTP. This will require reinstatement and will be covered by the proposed conditions of consent.

77. The Te Puke WWTP discharge is expected to increase from a current annual average flow of 1800m^3/day to 2348m^3/day due to population growth. This will reduce the dilution factor of the Waiari Stream by approximately 23%. Unmitigated, this may lead to an increase in the relative contribution of the contaminant loads being discharged into the receiving environment and could contribute to nuisance algal growth (particularly under summer low flow conditions) with flow on effects to fish and macroinvertebrate populations.

78. More stringent nitrogen and phosphorous limits are being proposed as part of the Te Puke WWTP resource consent application, which are included in the evidence of Mr Richard Harkness. Mr Zhuo Chen concludes that the implementation of a number of proposed treatment plant upgrades would enable the updated consent limits to be met.

79. The more stringent consent limits (and associated Te Puke WWTP upgrades) would be implemented by approximately 2026. In the short term (until population growth catches up) the nutrient loading would reduce, which could lead to positive effects on ecology. The proposed monitoring conditions would demonstrate this.

80. The nutrient load calculations above do not take into account the influence of the proposed upstream Waiari water take and the construction of the Rangiuru Business Park on water quality and subsequent ecological effects.

81. The water quality assessment submitted for the Waiari water take consent application describes that the dilution of effluent from the Te Puke WWTP after full mixing would reduce by 26% (140 fold to 103 fold after 60,000m^3/day abstraction). It is possible that this may intensify the ecological effect of the Te Puke WWTP discharge on the instream environment once the water take commences sometime after 2021. Although this may be countered by the fact that the water abstraction will reduce overall nutrient loading upstream of the Te Puke WWTP by up to 15%.

82. Under the conditions of the water take consent RC65637, monitoring is required above and below the intake site as well as above and below 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, DO, invertebrate composition on hard substrates and macrophytes, macro invertebrate indices and abundancy and fish composition and abundance of the species present.

83. I have concerns about the validity of this data for describing the specific contribution from the Te Puke WWTP due to the locations of the upstream and downstream monitoring locations (other point sources are not accounted for). In addition, the macroinvertebrate monitoring protocols specified are applicable for wadeable streams, whereas the Waiari Stream at the point of monitoring is non-wadeable.

84. Notwithstanding the above, the monitoring will provide a baseline of water quality and ecological data that can be used to compare the cumulative effects of the Te Puke WWTP and other point sources against once water abstraction starts.

85. Quantifying the ecological effects of the proposed Te Puke WWTP discharge is complex. This is due to the improvements occurring at the Te Puke WWTP along with the changing upstream and downstream environments. In my opinion the lower water quality consent limits prior to population growth will have a positive effect on stream ecology, although it is possible that some of the effect may be counteracted by the reduced dilution caused by the upstream water take.

86. Once the 30% population growth has occurred then nutrient loading will return to similar levels as they are at present. As outlined in the evidence of Mr Zhuo Chen, water quality will be maintained over the term of the consent. As such, ecological effects from the Te Puke WWTP are not likely to change. Monitoring under the proposed consent conditions along with those required under the current Waiari water take consent should ensure that ecological effects are monitored and managed.

Cumulative effects

87. Mr Richard Harkness and Mr Zhuo Chen will address the issue of cumulative effects on the receiving environment. I will discuss this issue in regards to ecological effects.

88. The discharge from the Te Puke WWTP is one of many various contaminant sources reaching the Waiari Stream and subsequently the Kaituna River then downstream into the ocean via the Ongatoro/Maketu Estuary. The Maketu Estuary is considered to be a more ecologically sensitive environment in regards to eutrophication (causing algal growth and subsequent changes in shallow coastal ecosystems) due to nutrient loading. The Proposed Plan Change 12 to the RNRP is setting new objectives, policies and limits for the Kaituna catchment.

89. Preliminary work[14] undertaken for BOPRC indicates the Maketu Estuary is in poor ecological condition, with nitrogen load into the Maketu Estuary up to

[14] Phizacklea, D *Report to the Regional Direction and Delivery Committee: National Policy Statement for Freshwater Management Implementation Programme* (11 December 2018).

477.4 tons/year. The Officer's Report estimates that the Waiari Stream contributes one third of the nitrogen load to the Maketu Estuary and the Te Puke WWTP discharge contributes 2.6% of the nitrogen load to the Maketu Estuary. As concluded in Mr Zhuo Chen's evidence, he does not do not expect there to be discernible water quality effects beyond the Waiari Stream caused by the Te Puke WWTP.

90. Although the effects of the Te Puke WWTP discharge on the Kaituna River and Maketu Estuary are minor, the importance of a catchment wide approach towards lowering nutrients is acknowledged which includes the Te Puke WWTP.

91. Besides the Te Puke WWTP, other sources of known contaminants that could impact stream ecology include:

(a) Diffuse runoff from nearby farm paddocks and any riparian bank areas that have been used for grazing stock.

(b) The 'Southern' farm drain, immediately upstream of the Te Puke WWTP, and which flows right up to the constructed wetlands' bank and then through a culvert under the Waiari stop-banks, with a direct discharge to the Waiari Stream (refer Appendix A).

(c) The 'Northern' farm drain, which is approximately 170m downstream of the Te Puke WWTP, and which flows through the stop-banks and has a direct discharge to the Waiari Stream (refer Appendix A).

92. The Waiari Stream is reasonably fast flowing (3500 L/s to 4400 L/s) with the majority of its water coming from groundwater/spring aquifers. This means the Waiari Stream has a higher dilution potential and as such provides a varying degree of resilience to the effects of the Te Puke WWTP and wider cumulative effects of the catchment on the instream ecology of the Waiari Stream.

93. WBODC is unable to influence the effects of the nutrient loading of the surrounding farm/drain sources, however there are a number of actions relating to the Te Puke WWTP that may improve the overall catchment effects in the near future in regards to ecology. These are described in Mr Zhuo Chen and Mr Richard Harkness' evidence and are summarised here including:

(a) Te Puke WWTP improvements reducing nutrient loading;
(b) Updated consent conditions with more stringent levels for nutrients;
(c) Decommissioning of the constructed wetland, which will reduce faecal coliform levels;
(d) Investigating options to redirect the Southern farm drain away from the Waiari Stream; and
(e) As suggested in my evidence, additional riparian planting on WBODC owned land.

94. In addition, ecological monitoring (including the Waiari take consent conditions) should ensure that any cumulative impacts will be monitored.

Conclusion

95. I consider that although the Te Puke WWTP is likely to be adding to the nutrient loading of the Waiari Stream, there are also other impacts on stream ecology. Overall, the fast flowing, high volume (spring fed) nature of the Waiari Stream is currently providing resilience to the effects of the Te Puke WWTP and wider cumulative effects of the catchment. In my opinion, the effects of the Te Puke WWTP on stream ecology alone are minor.

96. The Kaituna River and Maketu Estuary are in my opinion receiving negligible inputs from the Te Puke WWTP discharge, although the cumulative effects are noted and should be considered as part of the wider catchment improvements.

97. I consider that the Te Puke WWTP discharge is having a minor effect on macroinvertebrate populations although to date the macroinvertebrate sampling has been variable and inconclusive. The use of current macroinvertebrate sampling protocols (C2 and C4) in the Waiari Stream which apply to wadeable streams are potentially unsuitable to be able to provide an accurate description of the effects of the Te Puke WWTP discharge on the Waiari Stream which I consider as non-wadeable. Other point source discharges like the Southern Drain may also be effecting the validity of the MCI results.

98. Fish monitoring undertaken indicates that the Te Puke WWTP discharge is not impacting fish populations.

99. I recommend that the following mitigation measures should be implemented:

(a) Further riparian planting (on both banks) to improve shading and shelter on the Waiari Stream and increase instream habitat for macroinvertebrates and fish. Acorn saplings have recently been planted on the side of the stop bank in front of the wetland. Conifer saplings have been planted at the bottom of the stop bank running north from Te Puke WWTP land and partially onto the adjacent land owners land. I recommend that this be supplemented further on WBOPDC owned land.

(b) Investigations into the potential to redirect the ‘Southern’ drain into the constructed wetland when it is decommissioned, as I consider that it is contributing to the reduced water quality within the Waiari Stream.

(c) Continued maintenance of the wetland and weirs to ensure efficient operation of the wetland.

Submissions

100. I confirm that I have read the submissions and note that they do not relate to aquatic ecology.

Officer's Report

101. I have read the Officer’s Report and make the following comments:

(a) The Officer’s Report states that the WQ Assessment ecological monitoring occurred on the edge of the Te Puke WWTP mixing zone at 30m and that given the mixing zone was being increased to 60m, the sampling may have been in the area of mixing where adverse effects are anticipated. This is incorrect.

(b) The WQ Assessment undertook upstream and downstream water quality and ecological monitoring 100m away from the Te Puke WWTP discharge, and so was outside of the mixing zone.

102. The remainder of the matters raised in the Officer’s Report are covered within this evidence already.

Conditions

103. I support the proposed conditions, and recommended that the following changes were made to the conditions proposed in the application:

(a) The insertion of ecological monitoring conditions which require an Ecological Monitoring Plan to be prepared which covers macroinvertebrate and fish communities along with macrophyte cover.

(b) The insertion of riparian planting conditions which requires WBOPDC to liaise with local iwi/hapu on additional riparian planting and native plant species to improve shading and shelter on the stream, and increase instream habitat for macroinvertebrates and fish and to carry out the planting in general accordance with the feedback.

(c) To undertake investigations to redirect the 'Southern' drain away from the riparian wetlands and into the constructed wetlands as part of the decommissioning works.

Fiona Davies

Date: 29 March 2019

Schedule 1

Figure 1 – Taxonomic Richness Recorded in 2015

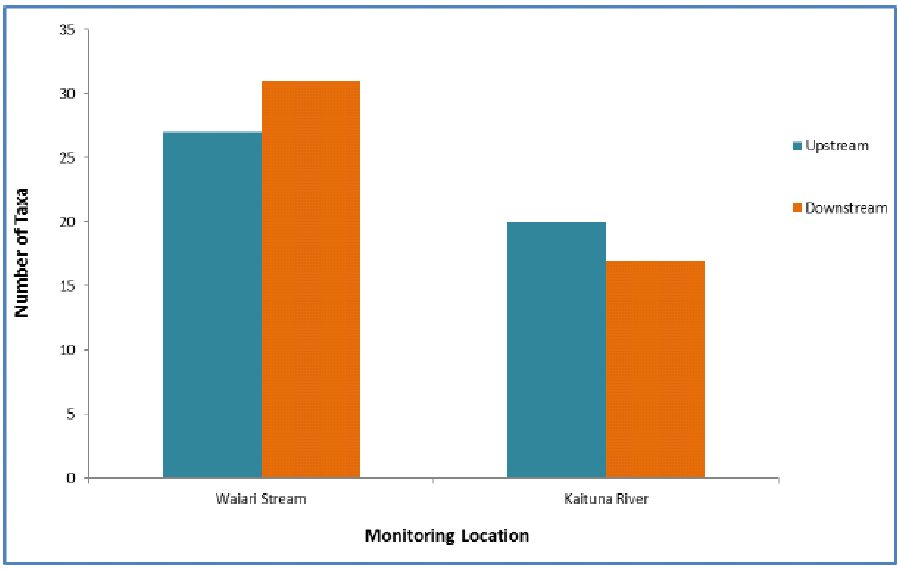

Figure 2 – Taxonomic Abundance Recorded in 2015

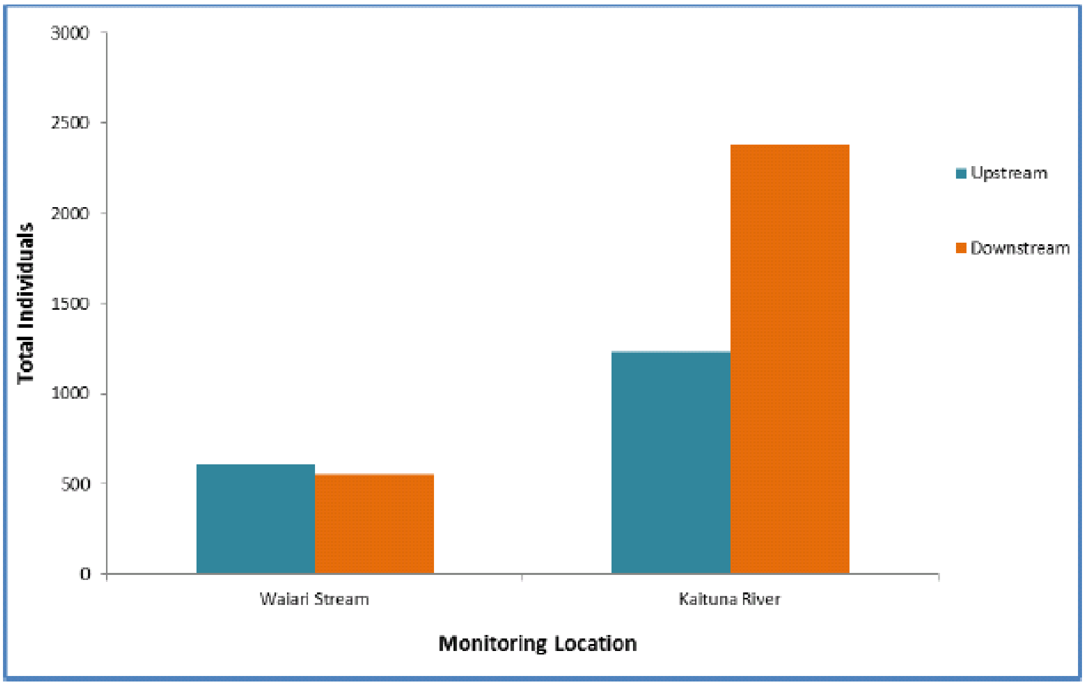

Figure 3 – Macroinvertebrate Community Composition (%) Recorded in 2015

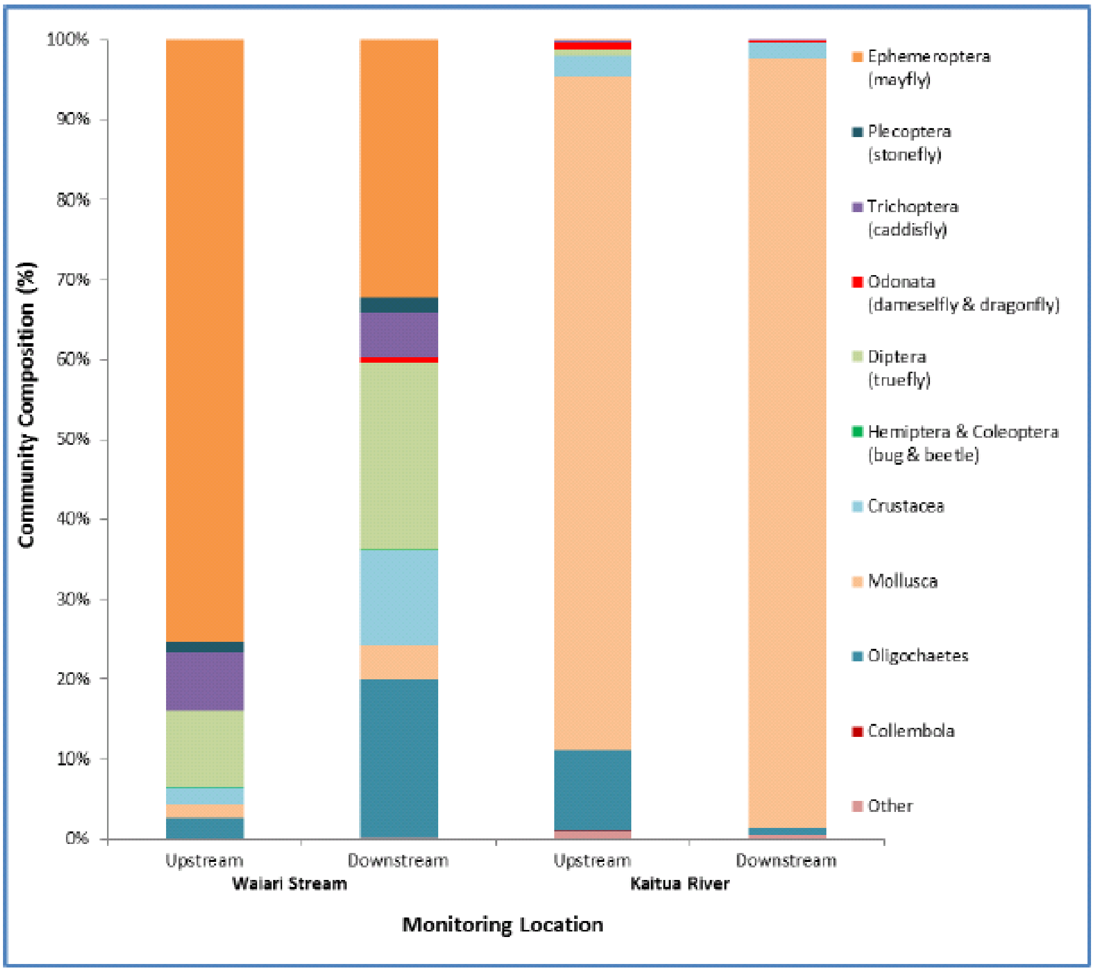

Figure 4 – MCI-Sb Values Calculated from Macroinvertebrate Community Data Recorded in 2015

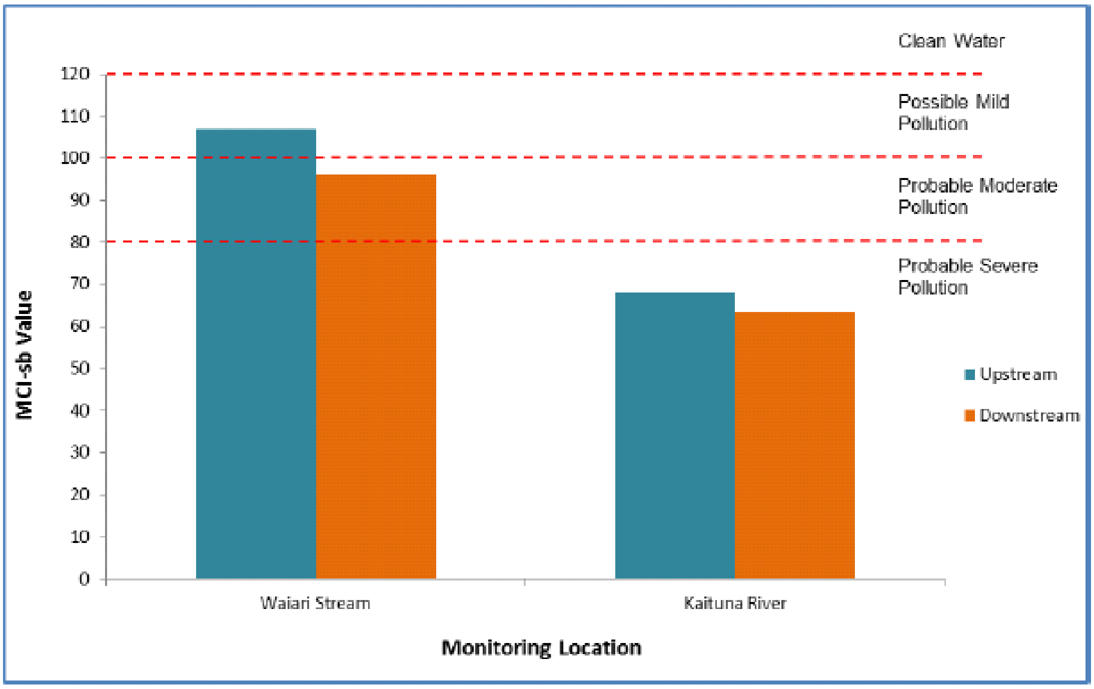

Figure 5 – QMCI-sb Values Calculated from Macroinvertebrate Community Data Recorded in 2015

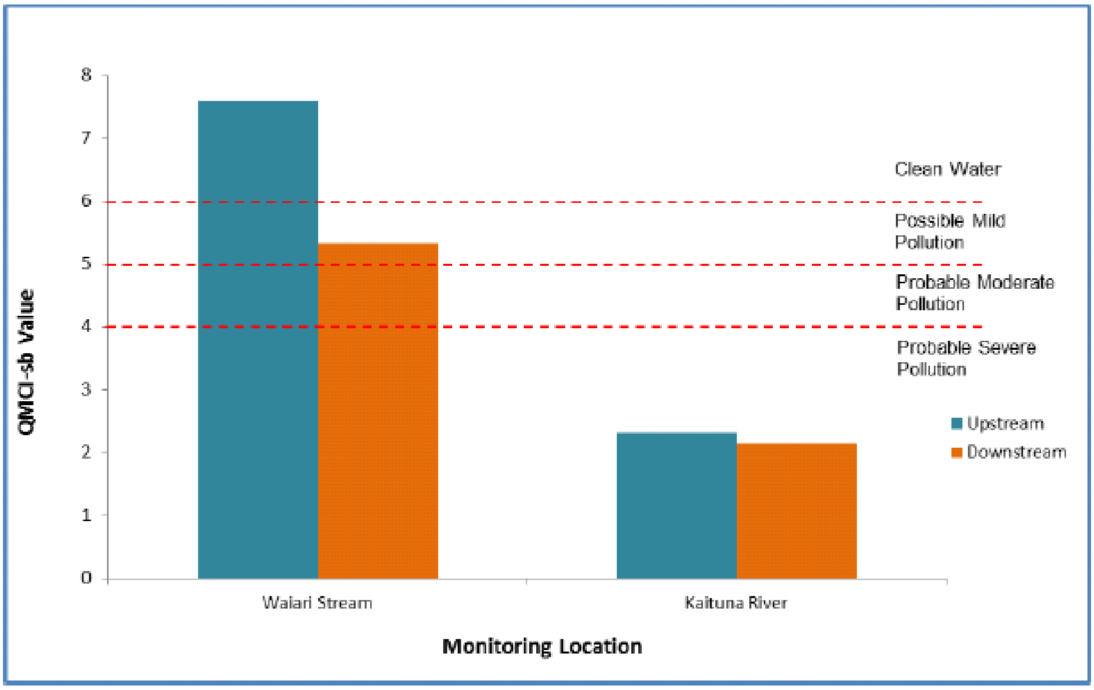

Figure 6 – Percentage composition of major taxonomic groups

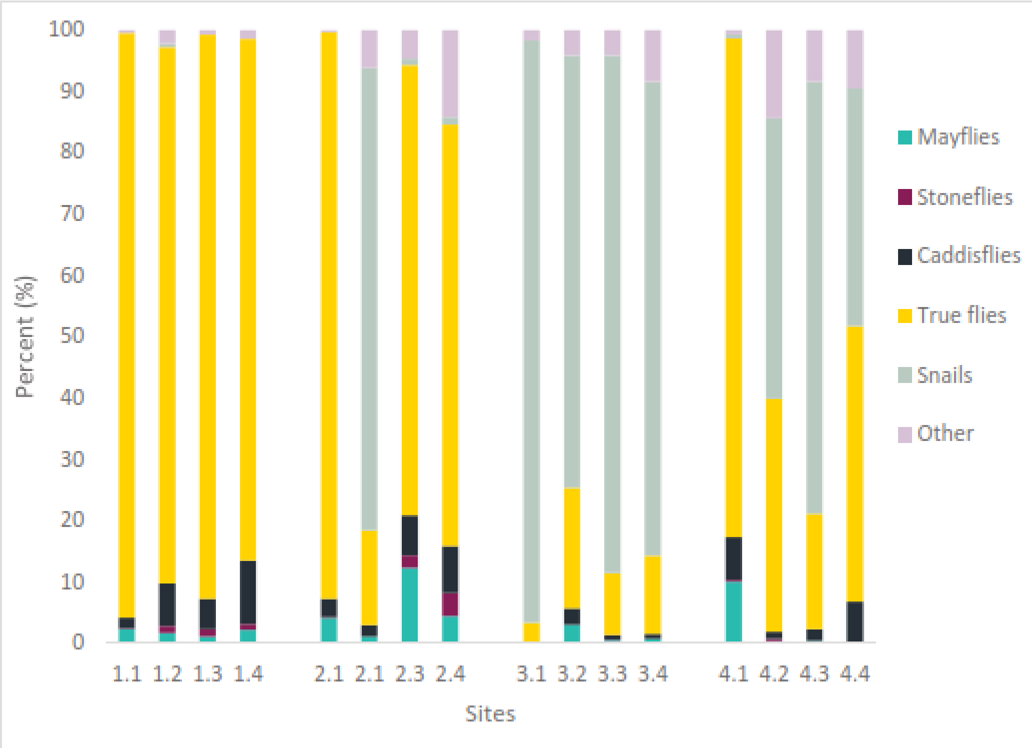

Figure 7 – MCI-sb scores

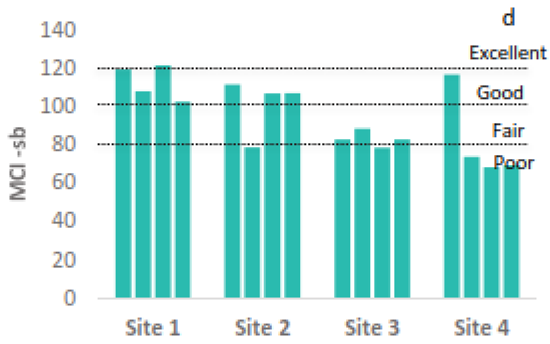

Figure 8 – QMCI-sb scores

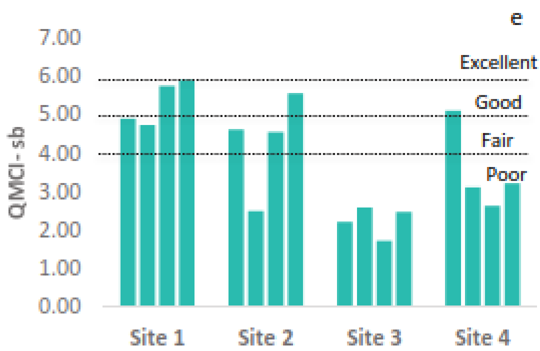

Figure 9 – Macroinvertebrate indices for 2010 – 2012 and the 2017 survey. 2010 –2012 sourced from Bioresearches (2010, 2011 and 2012).

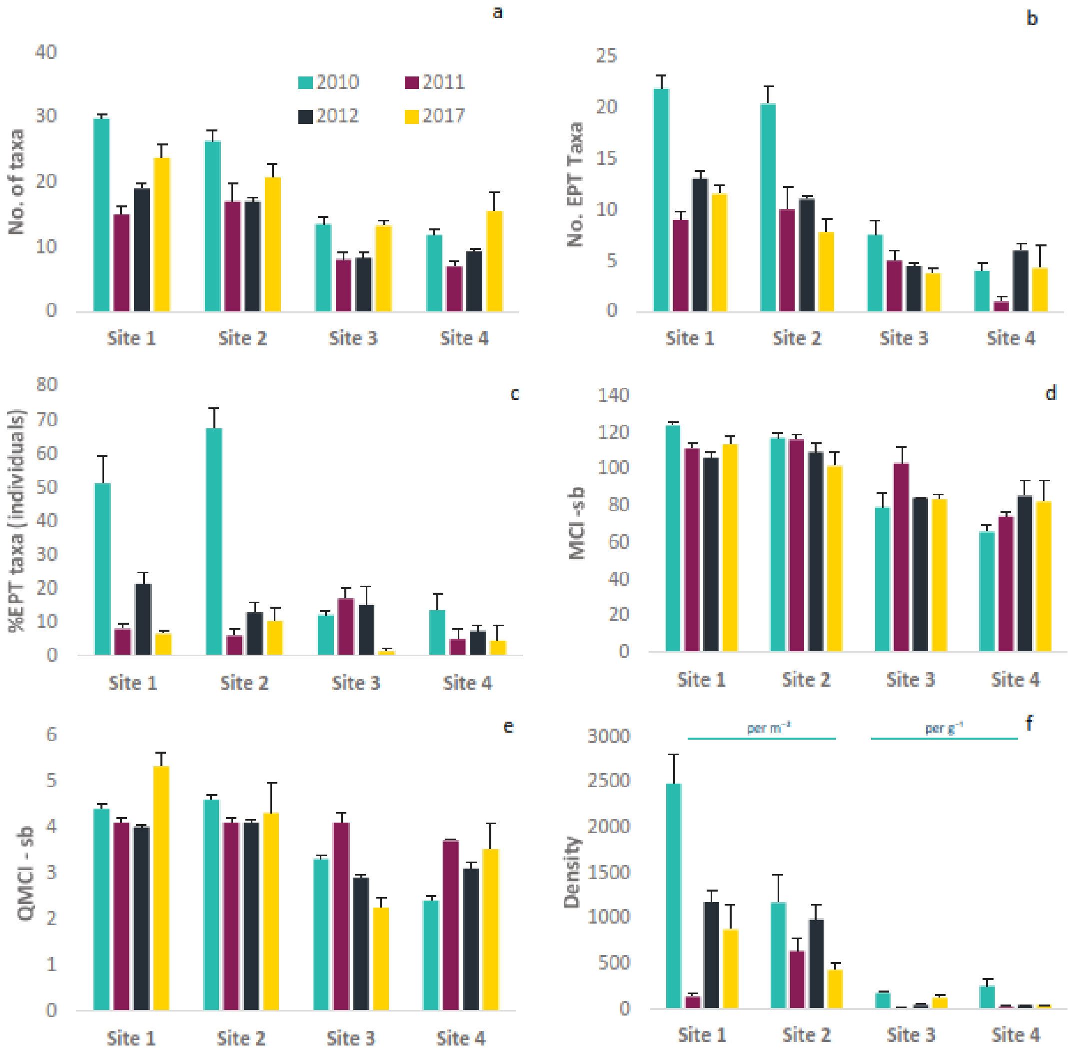

Figure 10 – Macroinvertebrate indices including a) total number of taxa, b) total number of EPT taxa and c) proportion of EPT (individuals).

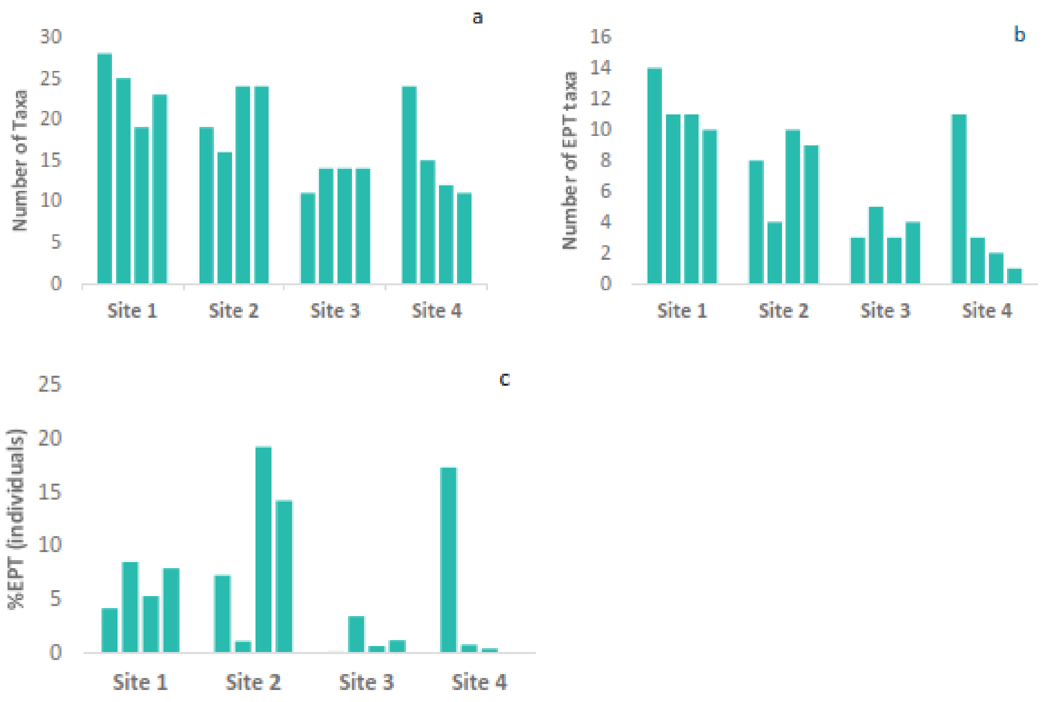

Figure 11 – Macrophyte community composition and percentage stream cover

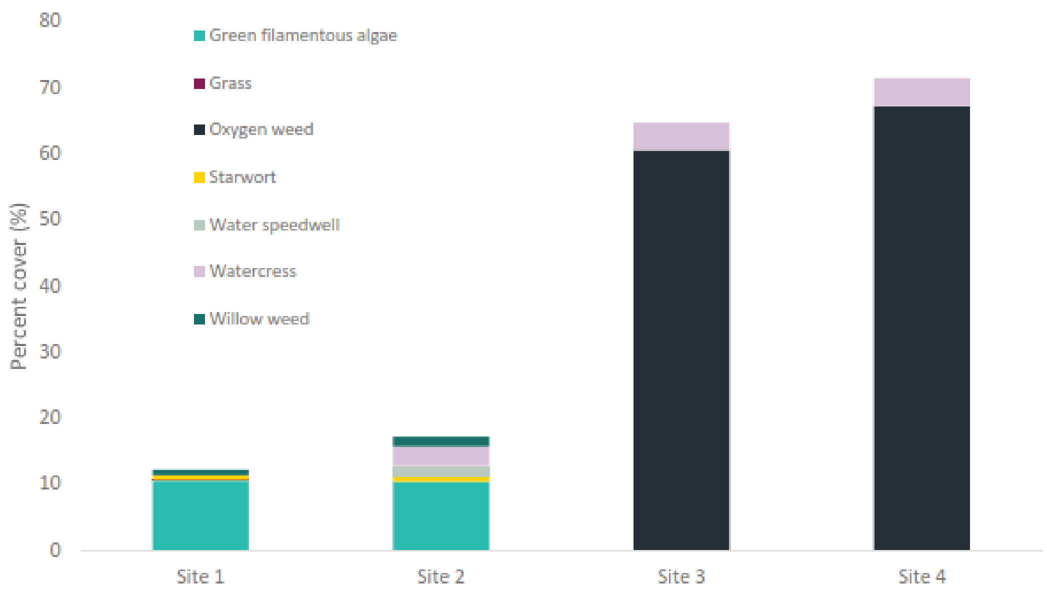

Figure 12 – Water quality parameters recorded

Parameter	WTP Intake				WWTP Outfall			
	Site 1		Site 2		Site 3		Site 4	
Date	15 Feb	16 Feb	15 Feb	16 Feb	15 Feb	16 Feb	15 Feb	16 Feb
Time (NZDST)	14:25	11:50	12:40	10:30	17:20	09:15	15:50	08:25
Temperature (◦C)	14.9	13.8	14.5	13.9	16.4	14.1	16.7	14.2
Dissolved oxygen (%)	106	104	108	103	109	96	117	93
Dissolved oxygen (mg/L)	10.7	10.8	11.0	10.7	10.7	9.8	11.4	9.6
Conductivity (µS/m)	54.6	53.1	54.2	53.4	58.0	56.0	60.7	59.8
pH	7.26	7.65	7.11	7.15	7.51	7.43	7.56	7.60
Turbidity (NTU)	0	1.3	0	0.4	0	0	0	0

Appendix A – Surface Water Monitoring Locations

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

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