BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL

UNDER	**the Resource Management Act 1991 ("the Act")**
IN THE MATTER OF	**resource consent applications to Greater Wellington Regional Council pursuant to section 88 of the Act to discharge contaminants to land, air and water**
BY	**South Wairarapa District Council**
FOR	**the proposed staged upgrade and operation of the Martinborough Wastewater Treatment Plan**

BRIEF OF EVIDENCE OF BRIAN THOMAS COFFEY ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

[EXPERT EVIDENCE ON THE EFFECTS OF PROPOSED WORKS ON SURFACE RECEIVING WATERS]

DATED 20 April 2015

Solicitor:	**Andrew Hazelton** **Hazelton Law**	**Counsel:**	**Philip Milne** **Waterfront Chambers**
Address:	Level 3, Molesworth House, 101 Molesworth Street PO Box 5639, Wellington	**Address:**	Level 5, Legal House, 101 Lambton Quay PO Box 5494, Wellington
Telephone:	(04) 472 7570	**Telephone:**	(04) 499 6653
Fax:	(04) 472 7571	**Fax:**	(04) 499 2323
Email:	Andrew.hazelton@hazelton.co.nz	**Email:**	philip.milne@waterfront.org.nz

EVIDENCE OF BRIAN THOMAS COFFEY
ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

1. My full name is Brian Thomas Coffey. I am a scientist with Brian T. Coffey and Associates Limited, an environmental consulting company based in Whangamata.

Qualifications and experience

2. I hold the degrees of Bachelor of Science, Master of Science with honours and Doctor of Philosophy in Botany from the University of Auckland.

3. I have had 15 years' experience as a Government research scientist in New Zealand, with national management and advisory responsibilities in the field of aquatic biology.

4. Since 1988, I have had 27 years applied experience as an independent consultant:

   - documenting resource inventories;
   - assessing and monitoring the environmental effects of developments; and
   - preparing management plans

   for freshwater, estuarine and marine sites in New Zealand.

5. I am a member of the New Zealand Water and Wastewater Association and I am a past president of the New Zealand Limnological (freshwater sciences) Society.

6. I have been retained by the South Wairarapa District Council ("SWDC") to collaborate with Geange Consulting and provide technical expertise and evidence in relation to aquatic ecology and water quality for the consent renewals for the Featherston, Martinborough and Greytown Wastewater Treatment Plants.

7. I have conducted the annual monitoring of the instream effects of the Martinborough oxidation pond discharge to the Ruamahanga River since 2007.

8. I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2011.

Preamble

9. There are eight major discharges of treated sewage to fresh water in the Wellington region – one from the treatment plant at Paraparaumu, one from Rathkeale College in Masterton, with the rest from the Wairarapa towns of Masterton, Castlepoint, Carterton, Greytown, Featherston and Martinborough. SWDC manages the last three of these.

10. I am relying on the Application for Resource Consents associated with the Martinborough Waste Water Treatment Plant ("MWWTP") and supporting information as lodged with the Greater Wellington Region Council by Geange Consulting/ Mott MacDonald (2014) on behalf of SWDC, to provide a detailed description of the proposed activities to which my evidence relates.

11. In essence, proposed activities involve a four-stage programme of improvements for the existing discharge of treated wastewater from the MWWTP to the Ruamahanga River, that will culminate in a change from a point source river discharge to a land disposal system for treated wastewater from the existing plant by 2035 (with some limited remaining provision for wet weather discharges to the river).

Scope of Evidence

12. My evidence relates to the surface water discharge from the MWWTP (Consent Application 31707: Discretionary Activity Discharge permit [Water] - to discharge treated effluent into the Ruamahanga River) and will address the following matters:

    (a) A description of surface water receiving environments for the treated wastewater discharge that include the lower Ruamahanga River, Lake Onoke and Palliser Bay in Cook Strait.
    (b) A description of the relative contribution of the current MWWTP discharge to contaminant loads (including nutrients) in surface water receiving environments and the effects of these contaminant loads on instream community structure.
    (c) A prediction of post Stage 1A effects of contaminant loads from the MWWTP (following treatment plant optimisation and minor capital works) on surface receiving waters. This stage is outlined in the AEE to begin at the commencement of this consent and occurs for the first two and a half years of the consent.
    (d) A prediction of the post Stage 1B effects of contaminant loads from the MWWTP on surface receiving waters. Stage 1B involves the discharge of 24% (52,731 m^3) of treated wastewater (on an annual basis) to 5.3 ha of vacant land at the MWWTP site during low-flows in the Ruamahanga River (when the river is below half median flow at Waihenga Bridge). This stage is to commence no later than 1 November, 2017 and occurs for a period of 13 years of the consent
    (e) A prediction of the post Stage 2A effects of contaminant loads from the MWWTP on receiving waters. Stage 2A involves the irrigation of 42% (93,200 m^3) of annual wastewater to Pain Farm (a Council owned property) and at this point in time the discharge onto the adjacent land which is undertaken during Stage 1B will cease (as this land is potentially required for Stage 2B storage). Discharge will only occur in the Ruamahanga River when there are capacity issues in the ponds and where the river is at more than three times median flow. This stage will commence no later than 31 December 2030, and will operate without Stage 2B for a period of five years.

(f) A prediction of the post Stage 2B effects of contaminant loads from the MWWTP on receiving waters. Stage 2B involves the construction of additional storage at the MWWTP or Pain Farm. This stage is outlined in the AEE to commence no later than 31 December 2035 and once in place will operate in conjunction with Stage 2A to be the operation system for the MWWTP.
(g) Recommended Mitigation Measures
(h) Effectiveness of the proposed conditions
(i) Response to submissions
(j) Response to s 42A report (Staff Report)
(k) Conclusions

13. However, it will also be necessary to allude to Consent Applications 32044: Discretionary Activity Discharge permit (Land) – to discharge treated effluent to land adjacent to the plant (Stage 1B) and the Pain Farm (Lake Ferry Road)(Stage 2A and 2B) and 33045: Discretionary Activity Discharge permit (Land) – to discharge contaminants to land and water via seepage from the ponds and channel, as there will a combined post Stage 2B discharge to the Ruamahanga River from the MWWTP that will include a point source discharge from the oxidation pond complex together with a diffuse discharge to the river from the land treatment plots to which treated effluent will be irrigated.

Surface water receiving environments for the wastewater discharge

14. The Ruamahanga River is 162 kilometres long and has a catchment area of c. 3430 km^2 downstream of Mt. Dundas in the NE Tararua Range.

15. The MWWTP discharge is to the Lower Ruamahanga River (downstream of the mouth of the Waiohine River) and the Greater Wellington Regional Council ("GWRC") has water quality monitoring sites upstream and downstream of Martinborough (see Figure 1). Figures 2 and 3 show ecological monitoring sites for the discharge.

16. The Waiohine and Huangarua Rivers are significant tributaries to the Lower Ruamahanga River between Gladstone Bridge and Martinborough. Another significant tributary to the Lower Ruamahanga River is from Lake Wairarapa, downstream of the Pukio water quality monitoring site (see Figure 1).

17. Waihenga Bridge, about 2 km north of Martinborough (see Figure 2) is the most downstream flow-monitoring site on the Ruamahanga River and has been operating since 1956. During large floods some of the flood flow is diverted through Jenkins Dip and the Waihenga Bridge is closed when the river reaches 4.5 m. Median River Flow at the Waihenga Bridge is 49.86 $m^3.sec^{-1}$, with highest flows generally occurring between June and November and lowest flows occurring between January to March (Geange Consulting / Mott MacDonald, 2014). Minimum recorded flow at the site has been 4.117 $m^3.sec^{-1}$, the maximum flow recorded flow has been 1,903 $m^3.sec^{-1}$ and the mean annual flood has been 1,064 cumecs.

Figure 1: Locality Sketch for Martinborough showing upstream and downstream water quality sites monitored by the GWRC in relation to tributaries.

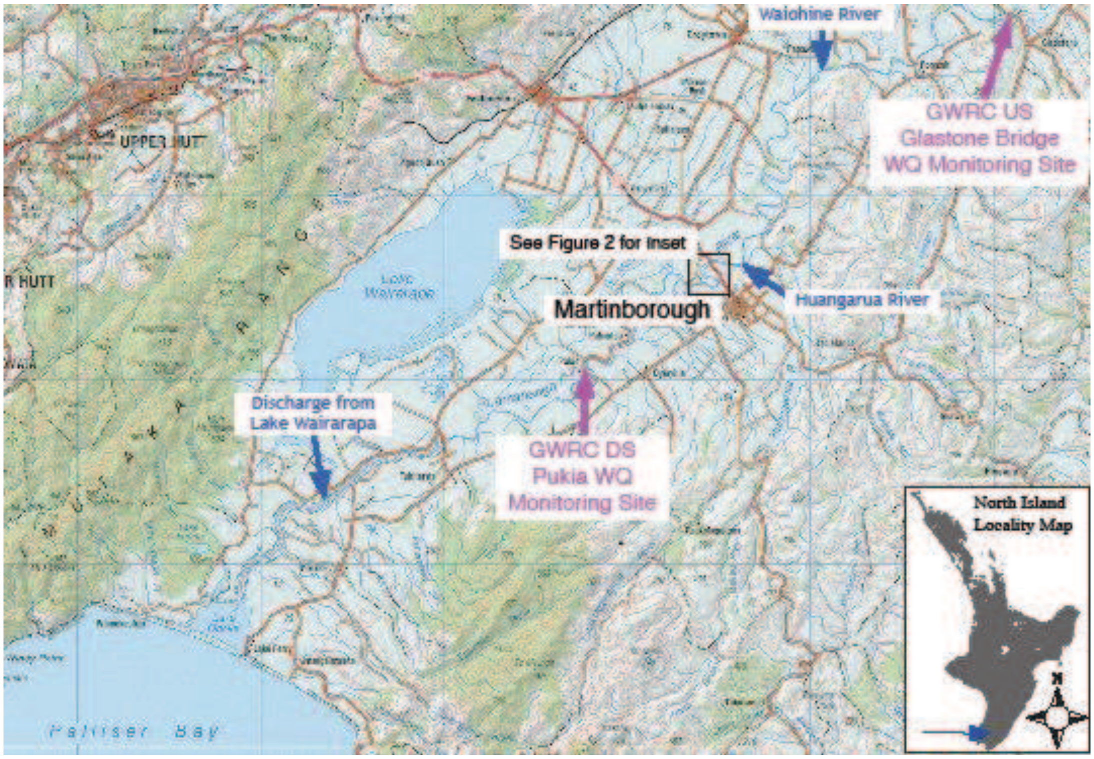

Figure 2: Biological Sampling Sites upstream and downstream of the MWWTP discharge to the Ruamahanga River.

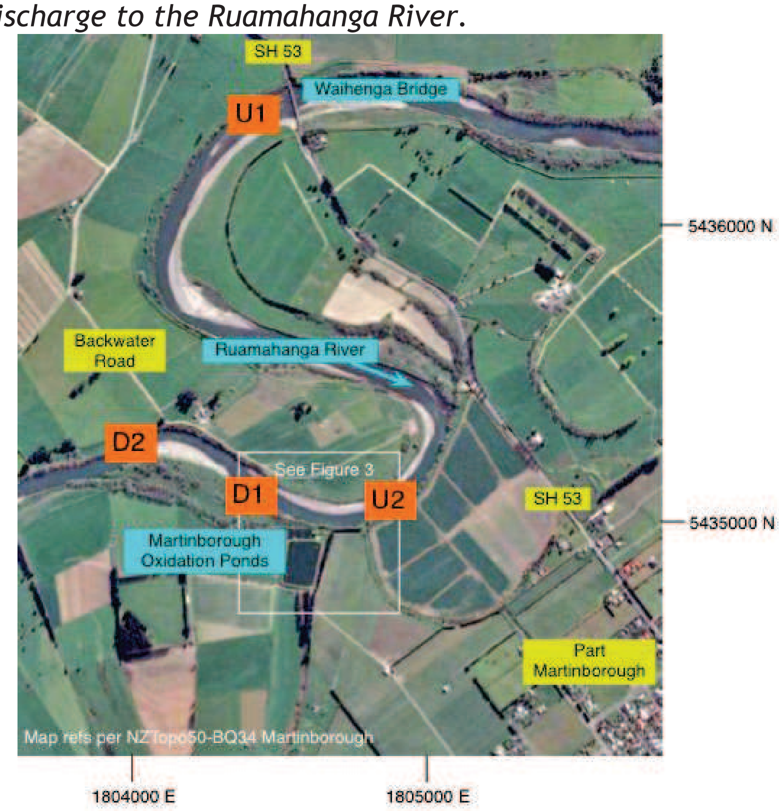

Figure 3: Sampling Sites U2 and D1 in relation to the discharge from the MWWTP to the Ruamahanga River.

18. The Ruamahanga River has a hard bottomed channel that is lined with gravel and is capable of supporting nuisance growths of periphyton. Bed transport forms a series of runs and riffles and in the vicinity of Martinborough and the river is generally in the order of 125 m wide.

19. Macroinvertebrate monitoring at the Gladstone Bridge and Pukio monitoring sites indicated “good” (MCI grade) ecological health and appear to be stable over time (Geange Consulting / Mott MacDonald, 2014).

20. Lake Onoke is a 650 ha, brackish, generally tidal lagoon at the mouth of the Ruamahanga River. It is separated from Palliser Bay by a 3 km long shingle spit. The lake is open to the sea for long periods but in southerly conditions with a low river flow, the exit to the sea becomes blocked by suspended gravels thrown back to the shore by the force of the sea. If a blockage in the exit of Lake Onoke lasts more than a few days, the result can be a pulse of brackish water flowing up the Ruamahanga River and through the barrage gates into Lake Wairarapa itself (Robertson, 1991).

21. I agree with Dr. Ausseil (Appendix to staff report) that the MWWTP will be having some level of cumulative effect on Lake Onoke (along with other land uses in the wider Ruamahanga River catchment) and that this effect will continue to occur during Stage 1A of the proposal. However, whilst it is not possible to quantify the current contribution of the MWWTP discharge to the trophic status of Lake Onoke it will be progressively reduced in response to Stage 1B, 2A and 2B upgrades to become no more than minor after the Stage 2B upgrade.

The relative contribution of the current MWWTP discharge to contaminant loads in surface water receiving environments and the effects on instream community structure

22. Water quality assessments for the Lower Ruamahanga River have been provided by Strong and Smith (2012) and Forbes (2013), and have been summarised by Geange Consulting / Mott MacDonald (2014).

23. SWDC has a database on:
    - flow and water quality in the Ruamahanga River upstream of the Martinborough WWTP discharge, and
    - flow and effluent quality from the Martinborough WWTP.

24. In Appendix 12 of the Assessment of Environmental Effects, Geange Consulting / Mott MacDonald (2014) have used these data to calculate mass loads and downstream contaminant concentrations for five day carbonaceous biochemical oxygen demand ($cBOD_5$), ammoniacal nitrogen (NH_4-N), DRP, TN, DIN, total suspended solids (TSS) and *Escherichia coli* (*E. coli*) in the Lower Ruamahanga River after full mixing with the MWWTP discharge under a range of river flows and treated wastewater discharge rates.

25. Currently, water quality guidelines contained in Appendix 8 of the Regional Freshwater Plan for the Wellington Region (Wellington Regional Council, 2014) relate to the Ruamahanga River at Martinborough and are based on the minimum water quality standards established in Sections 70 and 107 of the Resource Management Act 1991 and Water Quality Classes AE (aquatic ecosystem purposes), CR (contact recreation purposes), F (fishery purposes), FS (fish spawning purposes), WS (water supply purposes) and NS (natural state purposes) in the third schedule of the Resource Management Act 1991.

26. The current discharge complies with these standards and guidelines after full mixing in the Ruamahanga River 500 m downstream of the MWWTP discharge under low summer flow conditions r (Coffey, 1997, 1998, 1999, 2000, 2001, 2002, 2003 and 2004); Forbes, 2013; and Strong and Smith, 2014).

27. There is a relatively long section of the mixing zone on the left bank of the river during low summer flow conditions and it can be up to 300 to 500 m downstream of the MWWTP until the discharge is reasonably mixed with river water (Forbes, 2013).

28. National Bottom Lines prescribed in the National Policy Statement for Freshwater Management (N.Z. Government, 2014) for Ecosystem, Health in rivers includes;
    - <200 mg chl a /m^2 for periphyton biomass
    - 6.9 mg/l nitrate nitrogen,
    - annual median of <1.34 mg/l and annual maximum of <2.20 mg/l for NH_4-N,
    - dissolved oxygen concentration of $> 4 – 5$ mg/l,
    - *Escherichia coli* at <1000 cfu/100 ml as annual median, and
    - Planktonic cyanobacteria <1.8 mm^3/l of potentially toxic taxa or < 10 mm^3/l total cyanobacterial biovolume.

29. Data reported by Forbes (2013) for low summer flow conditions indicate that after full mixing of the MWWTP discharge in the Ruamahanga River, the above standards for chlorophyll a, nitrate nitrogen and *E.coli* were met. Calculations in Appendix 12 of the AEE (Geange Consulting / Mott MacDonald, 2014) illustrate the worst case scenario for ammoniacal Nitrogen also comply with the national bottom line quality standard as specified in the National Policy Statement for Freshwater Management. No data are available for planktonic cyanobacteria in the Ruamahanga River at Martinborough.

30. There is no agreed definition of a "reasonable mixing zone" for a point source discharge to NZ Rivers and Streams.

31. In addition to the three common means of defining a mixing zone ("Effects Based", "Reasonably Mixed" or "Specified Distance/Area" approaches), Cook et. al. (2010) derived a definition based on either a "concentration" approach (essentially the percentage dilution [25%, 50% or 75%] that is considered reasonable for a certain category of contaminant) or a "specified distance approach", that is essentially the same approach used in the Auckland Regional Council Proposed Air, Land, and Water Plan (2013), where reasonable mixing occurs at "*the point where the mixing of the contaminated discharges and the receiving water is assumed to have occurred. Assessment of compliance with the reasonable mixing requirement is undertaken at the point downstream, which is 30 times the receiving water channel width at the point of discharge, and one third of the channel width across*". Either approach can be used for screening permitting activities although Cook et. al. (2010) consider the concentration approach is preferred because it is easier to apply and understand.

32. The GWRC is considering a similar approach to Northland and Waikato Regional Councils for example where their policies for defining a "reasonable mixing zone" for point source discharges to rivers and streams includes a consideration of existing contaminant concentrations in the receiving water body both upstream and downstream of the discharge point and the "assimilative capacity" of the water body.

33. To this end, defaults and guidelines being considered by the Greater Wellington Regional Council to comply with the National Policy Statement for Freshwater Management in the lower Ruamahanga River are summarised in Table 1.

34. The capacity of a natural body of water (lake, river, sea, etc.) to receive waste waters or toxic materials without harmful effects and damage to aquatic life and to humans who consume its water is defined by the "assimilative capacity" of that particular water body.

35. At Gladstone Bridge (see Figure 1), there is no assimilative capacity for dissolved reactive phosphorus ("DRP") below median river flows and there is no assimilative capacity for dissolved inorganic nitrogen ("DIN") below median river flows (Geange Consulting / Mott MacDonald, 2014). This is

because the guideline values proposed in Table 1 are exceeded upstream of the point of discharge from the MWWTP to the Ruamahanga River.

36. At the Pukio water quality monitoring site (downstream of the Martinborough oxidation pond discharge) DRP and DIN concentrations are lower than at the Gladstone site, but there is still no assimilative capacity for either parameter below median river flow (Geange Consulting / Mott MacDonald, 2014). Ammoniacal nitrogen concentrations appear to be reduced relative to Gladstone Bridge concentrations allowing increased assimilative capacity, whilst *Escherichia coli* numbers are relatively unchanged with available assimilative capacity (Geange Consulting / Mott MacDonald, 2014).

Table 1: Greater Wellington Regional Council draft water quality limits for the protection of in-stream values in the Lower Ruamahanga River (Strong and Smith, 2012).

Determinand	Recommended limit	Flow	Season
Escherichia coli	260 cfu/100 mL	<median	Bathing
	550 cfu /100 mL	<3*median	All
	ANZECC (2000) is ≤ 100 cfu/100 mL)		
Nitrate-N	1.7 mg/L (chronic toxicity)	All	All
pH change	0.5 pH units	All	All
Temp change	3 °C	All	All
Total ammonia-N	0.9 mg/L at pH=8 And 20 °C Adjust for pH and temperature ANZECC (2000) is ≤0.021 mg/L)	All	All
Other toxicants	95% protection (ANZECC, 2000)	All	All
Particulate organic matter	5 mg/L	<median	All
ScBOD5	2 mg/L	<3*median	All
Periphyton	120 mg/m2	All	All
	30% filamentous cover		
	60% filamentous cover (thick mats)		
DRP (annual average)	0.014 mg/L (ANZECC [2000] is ≤0.010 mg/L)	<3*median	All
DIN (annual average)	0.180 mg/L (ANZECC [2000] is ≤0.444 mg/L)		
Water clarity	3 m (MfE [1994] is ≥1.6)	<median	All
Water clarity change	<30% change	All	All
DO saturation	>80% saturation (also 3rd schedule of RMA 1991)	All	All

37. The combined discharges from the Masterton, Carterton, Greytown and Martinborough wastewater treatment plants were calculated to contribute approximately 13.6%, 39.4%, 4.0% and 4.2% of total phosphorus ("TP"), DRP, total nitrogen ("TN") and DIN respectively upstream of the Pukio water quality sampling site for the period September 2003 – August 2011, with the Masterton plant contributing 80% of these contributions.

38. It appears from water quality information summarised by Strong and Smith (2012) for the period September 2003 to August 2011, that elevated nutrient loads at the Gladstone Bridge water quality monitoring site reflected the discharge from the Masterton Wastewater Treatment Plant that had been diluted by discharges from the Waiohine and Huangarua Rivers upstream of the Pukio water quality sampling site.

39. Therefore, it is of interest to predict what improvements in terms of background water quality in the Ruamahanga River at Martinborough can be expected from the recent and current upgrades to the Masterton Wastewater Treatment Plant (Masterton District Council, 2007).

40. The upgrade includes the construction of a land disposal/irrigation scheme at Homebush to irrigate effluent to land whenever soil conditions allow, a new outfall diffuser located within the Ruamahanga River erosion protection wall and a change in discharge regime, from a continuous effluent discharge to the river, to a regime that has land disposal as the first preference.

41. In summer (1 November to 30 April) there will be no discharge to the river when the flow in the river is less than 12.3 m^3/s (median river flow) and in winter (1 May to 31 October) there will be no discharge to the river when the flow in the river is less than 6.1 m^3/s (half median river flow)

42. Whenever there is a discharge to the river, the river flow will be at least 30 times greater than the discharge rate of effluent (i.e., a minimum dilution of 30X).

43. In the case of low flow summer conditions, there is the potential therefore, following the completion of the upgrade to the Masterton WWTP, for the combined discharges from the Carterton, Greytown and Martinborough wastewater treatment plants to contribute approximately 2.7%, 7.9%, 0.8% and 0.84% of total phosphorus ("TP"), DRP, total nitrogen ("TN") and DIN respectively upstream of the Pukio water quality sampling site.

44. In my opinion, this is unlikely to create a significant increase in the assimilative capacity of the Ruamahanga River for treated effluent from the MWWTP in terms of nutrient loads.

45. *Escherichia coli*, $cBOD_5$, and TSS downstream of the MWWTP discharge meet the required standards after full mixing with river water (Appendix 12 of Geange Consulting / Mott MacDonald, 2014).

46. Forbes (2013) concluded the discharge from the MWWTP (during extreme low flow conditions) resulted in a concentrated, relatively poorly mixed plume

area, which extended <4 m laterally across the river from the true left bank. Beyond that zone more uniform mixing was found. The discharge was having a locally significant effect in increasing periphyton cover and biomass. Periphyton surveys show the effect of the treated discharge peaks within an area <190 m downstream of the outfall and reliable signs of diminishing periphyton cover are apparent by 250–290 m downstream of the outfall.

47. In summary therefore, the current discharge meets current standards and guidelines in the Regional Freshwater Plan after full mixing, but Stage 2A and / or 2B improvements at the MWWTP would be required to meet the water quality criteria being proposed in Table 1, or there would need to a substantial improvement in water quality upstream of the MWWTP in terms of nutrient concentrations.

A prediction of post Stage 1A effects of contaminant loads from the MWWTP on instream community structure in surface receiving waters.

48. The current situation where the MWWTP discharge is having a significant adverse effect on most indices of macroinvertebrate community on the left bank of the river, 200 metres downstream of the site, when compared to an upstream control site, with a return to upstream conditions at the 500m and 1000m downstream sites, will remain unchanged as a result of Stage 1A works. The requirements of S107 (1) (g) are met 500m downstream of the discharge point. The point at which the effects within the mixing plume reduce from significant (at 200m) to not significant (at 500m) has yet to be established.

A prediction of the post Stage 1B effect of contaminant loads from the MWWTP on instream community structure in surface receiving waters

49. I expect there to be a significant improvement in the condition of instream community structure in the low-river-flow mixing zone for treated effluent from the MWWTP as a result of Stage 1B works that will be completed in 2017. However, the degree of improvement will depend on how much of the land-treatment-effluent finds its way back into the river through coarse gravels during low river flows (see evidence of Katie Beecroft on behalf of the South Wairarapa District Council). I note that Figure 10 of the AEE (Geange Consulting / Mott MacDonald, 2014) shows the adjacent irrigation block that will be operative after the Stage1B upgrade is downstream of the MWWTP and part of it is downstream of the existing river discharge. Therefore the combined discharge of treated effluent from both the point source river discharge and from the land treatment area post Stage 1B is expected to be mixed further downstream than for the point source river discharge alone (Forbes, 2013). It is not clear whether most of the diffuse input from the land treatment site will also have entered the river and be reasonably mixed 500 m downstream of the point source discharge from the MWWTP. This has relevance to the issue of reasonable mixing zones for compliance purposes and to the choice of monitoring points.

50. The removal of 24% of the discharge at flows below half median flow (low flows), will significantly limit the risk of particulate matter settling on the bottom of the river, thus effects on sedimentation which currently occur will be significantly reduced. The level of periphyton growth that is currently occurring in the river will also be significantly reduced during this stage, particularly during November through to March in which the low flows occur.

51. I agree with Dr. Ausseil that it is however difficult to say whether some localised significant adverse effects will still occur within the localised mixing zone downstream of the discharge and what their severity and spatial scale will be.

52. In my opinion, the current situation where there is no assimilative capacity for DRP or DIN due to upstream concentrations of these nutrients and no assimilative capacity available in the river at greater than half median river flows for TN (Appendix 12 of Geange Consulting / Mott MacDonald, 2014) is unlikely to change in spite of recent / current upgrades to the Masterton WWTP.

A prediction of the post Stage 2A effect of contaminant loads from the MWWTP on instream community structure in surface receiving waters.

53. I expect there to be a further and more significant improvement in water quality and the condition of instream community structure in the low-river-flow mixing zone for treated effluent from the MWWTP as a result of Stage 2A works that will be completed in 2030. These works result in two improvements. Firstly, there will be a much higher level of land treatment of discharges at flows below half median. Most of the discharge at these flows will be via land treatment at Pain Farm. Secondly, as compared to stage 1B there will also be a significant reduction of direct discharge at flows between half median and median.

54. The best case scenario would be a 40% reduction in the annual effluent load entering the river from the MWWTP and no discharges to the river during low flow summer conditions.

55. This is because less (hopefully none) of the land-treatment-effluent is expected to find its way back to the river from Pain Farm relative to land disposal plots adjacent to the oxidation ponds and river discharges will be restricted to higher river flows (see evidence of Katie Beecroft on behalf of the South Wairarapa District Council).

56. As a result of Stage 2A improvements, effects on the Ruamahanga River are expected to be no more than minor on any of the water quality or ecological parameters at 200 metres downstream of the discharge point.

A prediction of the post Stage 2B effect of contaminant loads from the MWWTP on instream community structure in surface receiving waters.

57. No significant instream ecological effects are anticipated post 2035 (following completion of Stage 2B when treated effluent will be disposed of to land at

Pain Farm with storage for deferred irrigation) as any river discharges that may be required due to extreme weather conditions or storage limitations will only occur when river flows are greater than 3 times median flow.

58. At flows above three times median flow, periphyton growth is expected to be strongly limited, if not removed, by river flow. On that basis, adverse effects on macroinvertebrate communities are highly unlikely, even in close proximity to the discharge point.

Recommended Mitigation Measures

59. Significant improvements in terms of instream community structure are expected both within and beyond the mixing zone for the MWWTP discharge in the Ruamahanga River following Stage 2A, 1B and 2B upgrades. Instream effects are expected to be no more than minor post 2030 (following the completion of Stage 2A when treated effluent will be disposed of and treated via land at the Pain Farm at flows below median flow and where possible at higher flows. At stage 2B any river discharges that may be required due to extreme weather conditions or storage limitations will only occur when river flows are greater than 3 times median flow. Instream effects at this point will be less minor and are expected to be largely undectable.

60. Accordingly, the relatively minor effects of the MWWTP discharge to the Ruamahanga River that are limited to a reasonable mixing zone on the left bank of the river during Stage 1A, 1B, and 2A are not considered to warrant mitigation measures. However, signage and planting that discourages access to the left bank of the river for a distance of 500 m downstream of the MWWTP may be considered an appropriate component of the Effluent Discharge Management Plan

Effectiveness of Proposed Conditions

61. In my opinion, the conditions proposed in the Application (Geange Consulting / Mott MacDonald, 2014 - Part One: C – Proposed Resource Consent Conditions) are appropriate and scientifically defensible in terms of surface receiving waters for Stage 1A, 1B and 2A of the MWWTP upgrade (i.e. Schedule 2: Discharge permit to discharge treated wastewater to Ruamahanga River).

62. The level of monitoring and reporting proposed in terms of macroinvertebrates and periphyton is in line with best practice and is sufficient for monitoring adverse effects within the mixing zone until Stage 1B of the upgrade is complete. However, it is noted that monitoring of macroinvertebrates and periphyton will be relatively difficult once the river discharge is only occurring at higher river flows following the completion of 1B and 2A upgrades at the MWWTP. On this basis it will probably be necessary to restrict sampling to shallow riffle areas along both banks of the river. Moreover, whilst the staff report has adopted the macroinvertebrate and periphyton monitoring recommendations in the AEE, the frequency of monitoring might be revisited when preparing the Environmental Monitoring Plan referred to in Condition 6 of Schedule 1 of the AEE. It would be

reasonable for example, to review the requirement for annual monitoring if initial monitoring of the stage 1B upgrade shows no significant adverse effects are occurring.

Response to Submissions

63. Federated Farmers (Submission 5) note that water quality assessments in the AEE (Geange Consulting / Mott MacDonald, 2014) are made against ANZECC guidelines and GWRC proposed water quality limits and recommend that consent applications be deferred pending the development of the Ruamahanga Whaitua Plan Change that is tasked with developing catchment objectives and limits over the next two years.

64. I do not support this recommendation as the GWRC has had an effective Water Quality Index (WQI) in place since 2005 (Milne and Perrie, 2005)

65. The WQI is derived from the median values of the following six variables: visual clarity (black disc), dissolved oxygen (%saturation), dissolved reactive phosphorus, ammoniacal nitrogen, nitrite-nitrate nitrogen and Escherichia coli (*E. coli*).

66. The application of the WQI enables water quality at each site to be classified into one of four categories as follows:

- Excellent: median values for all 6 variables comply with guideline values,
- Good: median values for 5 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply,
- Fair: median values for 3 or 4 of the 6 variables comply with guideline values, of which dissolved oxygen is one variable that must comply,
- Poor: median values for <3 of the 6 variables comply with guideline values.

67. The guidelines used in the WQI assessment are listed in Table 1. The WQI is for comparative purposes rather than an absolute measure of water quality; sites with a grade of 'good', 'fair', or 'poor' are all considered degraded to some degree because the median value of at least one of the six physico-chemical or microbiological variables in the WQI exceeded a guideline value. In addition, as the WQI is based on median values (i.e., 50% compliance), sites awarded the same water quality grade may exhibit varying degrees of compliance (from 51 to 100%) with the guideline value. Therefore, to differentiate between 'better' and 'poorer' sites, the sites within each WQI class are ranked based on the number of guideline exceedances for each of the six key variables (i.e., a site that exceeded a guideline on 40% of sampling occasions will be ranked lower than a site with the same WQI grade that exceeded the guideline on 10% of sampling occasions).

68. Fish and Game New Zealand (Wellington – Submission 6) argue the river currently suffers from degraded water quality and that granting the consents sought would continue degradation of the resource (both water quality and amenity).

69. The improvements sought by Fish and Game include that discharge water quality is improved to reduce contaminant loadings, that there is no discharge below medium river flows and that plant upgrades result in moving discharges from surface water to land treatment.

70. All of these are accommodated by the consent application as lodged but they are to be phased in over a time frame provided for by financial constraints. They will not occur immediately as sought by Fish and Game New Zealand.

71. The Martinborough Business Association (Submission 9) has concerns over effects of water quality on recreational amenity.

72. This is currently an issue upstream of the current MWWTP discharge to the lower Ruamahanga River and is exacerbated within the mixing zone for treated effluent from the MWWTP on the left bank of the Ruamahanga River. A progressive improvement in water quality for recreational amenity is expected to occur with the implementation of Stage1B, 2A and 2B upgrades at the MWWTP.

73. Submission 10 by Neville Fisher opposes lifting the average daily discharge rate from the presently consented 465 m^3 to the proposed 650 m^3 per day. I understand the average daily discharge is currently in the order of 574 m^3/day, rather than the theoretical daily flow of 375 m^3/day based on a population of 1,500 persons, due to stormwater infiltration into the sewerage system.

74. Mr. Fisher also considers the proposal will not improve the condition of Lakes Wairarapa and Lake Onoke.

75. The discharge from the MWWTP generally bypasses Lake Wairarapa (unless a blockage in the exit of Lake Onoke lasts more than a few days backflow in the Ruamahanga River enter the barrage gates into Lake Wairarapa (Robertson, 1991). Effects of the existing and proposed upgraded MWWTP on Lake Onoke have been considered under paragraph 21.

Response to s 42A report

76. The s 42A report (staff report) recommends granting of consents subject to conditions. I support this recommendation.

77. The staff report (Section 10.4) also accepts that the significant adverse effects on aquatic life that will continue to occur in a localised mixing zone in the river during Stage 1A of the upgrade (a period of two and a half years) can be considered temporary and involve exceptional circumstances.

78. However, there are matters relating to:

- the extent of a reasonable mixing zone in the Ruamahanga River and

- the revision of wastewater discharge standards and setting of instream water quality standards that have been proposed in the recommended conditions,

that I wish to address in relation to Schedule 2 of the staff report for Consent Application 31707.

The extent of a reasonable mixing zone for the MWWTP discharge in the Ruamahanga River

79. Nicola Arnesen, the author of the staff report who is a highly qualified planner, has based her assessment of effects of the MWWTP discharge on aquatic life, on a report prepared by Dr Ausseil of Aquanet Consulting Limited (Appendix 8 of the staff report).

80. In Section 5.11 of his report, Dr. Ausseil states;
"*It is beyond the scope of my evidence to determine or recommend the extent of a Zone of Reasonable Mixing (ZRM), as planning, and possibly legal considerations apply to the exercise*".
However, Dr. Ausseil did list a number of relevant technical considerations to assist decision making.

81. Dr. Ausseil also made the following comments regarding the proposed staged upgrade to the MWWTP
"*With regards to future stages, the mixing characteristics of the MWWTP discharge with river water at higher river flows (i.e. above half median flow) are unknown, apart from the qualitative conclusion I draw in paragraph 5.5. With regards to effects on water quality and aquatic life, my conclusion is that the scale and spatial extent of effects will reduce compared with their current level once Stage 1B is implemented, followed by further reductions as stages 2A and 2B are in turn implemented. The spatial extent of any "zone of non-compliance" as regards significant effects on aquatic life will similarly reduce over time. I have a high degree of confidence that there will be no significant adverse effects on aquatic life at 200m downstream of the discharge once Stage 2B is implemented (i.e. that the "Zone of non-compliance" will be reduced to 200m or less), and it appears likely that it will also be the case during stage 2A. <u>There is however a higher level of uncertainty on whether it is also going to be the case during stage 1B, and in my opinion, monitoring is warranted to address that uncertainty</u>*".

82. The staff report (Section 9.2) recommended that a zone of reasonable mixing should end 250 metres downstream of the MWWTP discharge despite the current low flow discharge regime not complying with Section 107 (1) (g) at a distance of 200 m downstream of the MWWTP discharge.

83. To address this matter, the staff report recommends that different conditions be placed on consent for the 250 metre point, and then for the 500 metre point. At the 250 metre point, conditions would require SWDC to comply with all water quality standards and Section 107 baseline requirements except for those relating to Section 107 (1) (g), aquatic ecosystems. Then at the 500 metres point all water quality standards and Section 107 baseline

requirements would need to be met. This will only be a temporary situation for the initial Stage 1A.

84. However, as mentioned in paragraph 49, the concept of a reasonable mixing zone at 250 m downstream of the existing discharge from the MWWTP is not valid post Stage 1B upgrades.

85. In terms of instream effects of the MWWTP post the Stage 1B upgrade, there will be a combined effect on the river from the direct point source discharge from the ponds and a diffuse groundwater input from the land disposal area(s). The latter discharge may continue beyond 500m downstream of the direct discharge. Accordingly, if a RMZ is needed at all it should be at least 500m and even at that point may not allow for reasonable mixing of both sources of contamination.

86. Therefore the applicants preferred approach (see Evidence of Kerry Geange) is to monitor baseline parameters at appropriate distances upstream and downstream of the MWWTP to provide a basis to assess the instream effects of the combined discharge following each stage of the upgrade rather than assessing compliance standards at distances of 250 and 500 m downstream of the pond discharge. I support this approach on the basis that the current adverse effects on instream community structure within the mixing zone for the MWWTP discharge to the Ruamahanga River are relatively localised and will be temporary. Furthermore as a measurement point at 500m is likely to pick up most but not necessarily all of the diffuse discharge, I cannot support a compliance point of 250m.

Schedule 2 Revision of wastewater discharge standards (Condition 3) and setting of instream water quality standards (Condition 16) that have been proposed in recommended conditions

87. The staff report (Schedule 2, Condition 3) proposes the following wastewater discharge standards where the AEE (Geange Consulting / Mott MacDonald, 2014) recommended the strike out values in 9 out of any 12 consecutive monthly test results.

a) The concentration of BOD5 shall not exceed ~~60~~ 35 g/m^3 in more than 8 out of any 12 consecutive monthly test results;

b) The concentration of TSS shall not exceed ~~90~~ 55 g/m^3 in more than 8 out of any 12 consecutive monthly test results;

c) The concentration of Total Ammonia-nitrogen (NH4-N) shall not exceed ~~30~~ 20 g/m^3 in more than 8 out of any 12 consecutive monthly test results; and

d) The concentration of TN shall not exceed ~~35~~ 29mg/l in more than 8 out of any 12 consecutive monthly test results.

e) The concentration of DRP shall not exceed ~~7~~ 5g/m^3 in more than 8 out of any 1 consecutive monthly test results.

88. The revised figures are the median values shown in Table 1, Section 2.5.3 of the AEE for effluent discharge quality over the last 5 years and are more stringent than those applied for in the AEE.

89. The staff report has also added water quality standards and Section 107 baseline standards in their recommended conditions of consent (Condition 16) that were not proposed in the AEE. These could be taken to be compliance standards that are to be met 250 downstream of the current MWWTP discharge to the Ruamahanga River. I will deal with each of these in turn.

90. *16(a) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
There are no available records for these parameters in the river upstream or downstream of the MWWTP discharge. However, I have not noticed or recorded such during my annual surveys during low flow summer conditions since 2007. These materials are most likely to be associated with pond water rather than leachate from a land disposal area and hence I would expect compliance with this proposed receiving water standard at all sites in the Ruamahanga River downstream of the current discharge from the MWWTP.

91. *16(b) bacterial and / or fungal slime growths visible to the naked eye as plumose growths or mats.*
There are no available records for the occurrence of a sewage fungus complex in the river upstream and downstream of the MWWTP discharge. However, I have not noticed or recorded such in the mixing plume for the MWWTP discharge in the river during my annual surveys during low flow summer conditions in the river since 2007. I would expect compliance with this proposed receiving water standard at all sites in the Ruamahanga River downstream of the current discharge from the MWWTP.

92. *16(c) the receiving water to become unsuitable for consumption by farm animals*
Stock water quality can be compromised by cyanobacterial blooms that occur in oxidations ponds. An increasing risk to livestock health is likely when cell counts of Microcystis exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µ microcystin-LR toxicity equivalents. There are insufficient data available to derive trigger values for other species of cyanobacteria (ANZEEC, 2000).
Drinking water for livestock should contain less than 100 thermotolerant coliforms/100 mL (median value - ANZEEC, 2000).
Nitrate concentrations less than 400 mg/L in livestock drinking water should not be harmful to animal health. Stock may tolerate higher nitrate concentrations in drinking water provided nitrate concentrations in feed are not high. Water containing more than 1500 mg/L nitrate is likely to be toxic to animals and should be avoided. Concentrations of nitrite exceeding 30 mg/L may be hazardous to animal health (ANZEEC, 2000).
Major ions that can be of concern for livestock drinking water quality include calcium, magnesium, sulphate and total dissolved solids (see ANZECC, 2000).
Aluminium, arsenic, beryllium, boron, cadmium, chromium, cobalt, copper, fluoride, lead, mercury, molybdenum, nickel, selenium, uranium and zinc are

heavy metals or metalloids that may occur in treated domestic and industrial wastewater that can be toxic to livestock (see ANZECC, 2000).
Pesticides and radioactive materials that may be present in some treated wastewaters also present a hazard to livestock drinking water supplies.
On the basis that many of these materials are not monitored in the treated MWWTP discharge (see Condition 3 of Schedule 2), a precautionary approach is warranted where stock water should not been drawn from the river until the WWTP discharge is fully mixed with river water.

93. *16(d) a reduction in horizontal visibility exceeding 30%*
This parameter has not been routinely monitored in the river to date but was not compromised during Forbes mixing study in 2013.

94. 16(e) the DO concentration to fall below 80% saturation
This parameter has not been routinely monitored in the river to date but was not compromised during Forbes mixing study in 2013.

95. *16(f) a reduction in QMCI of greater than 20%*
There has been a 20% reduction in QMCI within the mixing zone of the MWWTP discharge (200 m downstream of the discharge) relative to an upstream control during low flow summer conditions between 2007 and 2014 (e.g. Coffey, 2012). There has not been a 20% reduction of QMCI following full mixing of the MWWTP discharge (500 m downstream of the discharge) relative to an upstream control during low flow summer conditions between 2007 and 2014 (Coffey, 2007 to 2014).
Whilst this threshold 20% change of QMCI that Ausseil (2013) proposed to represent a significant adverse effect on instream community structure has not been formally adopted in the regional freshwater plan (Wellington Regional Council, 2014), it is a threshold I would support within the context of an appropriate mixing zone.

96. *16(g) the concentration of total ammoniacal nitrogen to exceed 0.400 mg/m^3*
Appendix 12 of the AEE has used the ANZEEC default trigger of 0.021 mg/L and the GWRC proposed quality limit of 0.9 mg/L for the protection of 95% of species in freshwater when commenting on ammoniacal nitrogen loads and concentrations in the river in relation to the MWWTP discharge. The new Condition 16 in the staff report is now proposing 0.400 mg/m^3 or 0.0004 mg/L as an instream standard. I can only assume this is a typographical error and it is not consistent with Table 1, ANZEEC (2000) guidelines or N.Z. Government (2014).

97. *16(h) the chlorophyll a concentration (mg/m^2) to exceed 120 mg/m^2*
This limit was exceeded both upstream and downstream of the MWWTP discharge in April 2013 (Forbes, 2013).

98. *16(i) the maximum cover of visible streambed of periphyton as filamentous algae more than 2cm long to exceed 30%*
This limit was exceeded both upstream and downstream of the MWWTP discharge in April 2013 (Forbes, 2013).

99. *16(j) the maximum cover of visible streambed of periphyton as mat algae more than 0.3cm thick to exceed 60%.*
This limit was exceeded both upstream and downstream of the MWWTP discharge in April 2013 (Forbes, 2013).

100. As there is no available data on compliance with stock health (paragraph 92) and evidence of non-compliance with QMCI (paragraph 95), chlorophyll a (paragraph 97), and periphyton cover (Paragraphs 98 and 99) within the mixing plume for the MWWTP discharge, I do not consider the parameters listed in Condition 16 of the staff report are appropriate receiving water standards. However, I agree with the evidence of Kerry Geange that they could be appropriate baseline monitoring parameters.

101. It would also be necessary to monitor an upstream control site as well as a downstream compliance monitoring sites to determine whether it is the combined discharge from the MWWTP (both point source and diffuse discharges) that might cause or breach of parameters listed in Condition 16 (Schedule 2). Appropriate distances for the proposed baseline monitoring would be 200 m upstream of the MWWTP surface water discharge to the Ruamahanga River and at distances of 200 m, 500 m, and 1000m downstream of the MWWTP surface water discharge to the Ruamahanga River.

102. I do not support the comment in Section 9.3 (Stage 1B) of the staff report that states "If the standards are not able to be met at the ZRM point, or if the river health survey shows the ZRM should be altered, then there would need to be a process initiated whereby the applicant would need to reduce the effects within the parameters of the existing system and consent. If this could not be achieved then GWRC would need to initiate a review of the consent, or SWDC would need to apply to vary the consent conditions".

103. In my opinion, unnecessarily prescriptive standards that are unlikely to be met at all times during Stages 1A and 1B may lead to enforcement action that is not focussed on the question of whether such temporary effects are significant adverse effects.

Conclusions

104. The current MWWTP discharge meets standards and guidelines in the Regional Freshwater Plan and the National Policy Statement for Freshwater Management after full mixing at a distance of 500 m downstream of the MWWTP discharge.

105. Stage 2A and / or 2B improvements at the MWWTP would be required to meet the water quality criteria being proposed in Table 1 by GWRC, unless there was to be a substantial improvement in water quality upstream of the MWWTP in terms of reduced nutrient concentrations.

106. Removal of the river discharge during low river flows will significantly improve the current situation, where increased periphyton growth (Forbes,

2013) and significantly reduced metrics of macroinvertebrate community health (Coffey 2007 to 2014) are associated with the mixing zone for treated effluent in the Ruamahanga River.

107. I support the recommendation in the staff report that the consents be granted subject to conditions.

108. However, I do not support the zone of reasonable mixing for the current MWWTP discharge that is proposed in the staff report (250 m downstream of the discharge). I consider a reasonable mixing zone for the current MWWTP discharge in the Ruamahanga River should be 500 m downstream of the discharge where full mixing with river water occurs.

109. Nor do I accept the receiving water quality standards and sampling sites that have been proposed in Condition 16 of Schedule 2 of the staff report on the grounds that:

- some of these standards are not currently complied with upstream of the MWWTP,
- the reference to the threshold concentration for ammoniacal nitrogen appears to be a typographical error and
- the condition does not include a consideration of post Stage 1B diffuse inputs of treated effluent that have been applied to land in the adjacent block, forming part of a combined discharge from the MWWTP.

110. I support the alternative approach proposed by the Applicant that the suggested instream standards be replaced with baseline parameters that are monitoring upstream and downstream of the MWWTP. I consider a dye study would be a useful addition to this baseline monitoring programme.

111. I have reservations regarding the receiving water quality standards proposed in the staff report (Condition 16 of Schedule 2) being achieved within a 250 m mixing zone downstream of the MWWTP discharge to the Ruamahanga River as a result of the proposed Stage 1B upgrade and therefore, I would support the baseline monitoring programme proposed by the applicant prior to the proposed Stage 2A upgrade. However the frequency of monitoring might be revisited if no significant adverse effects occur after the stage 1B upgrade.

112. In summary, the staged conversion of a treated effluent disposal strategy from a point source river discharge to a land disposal system that is a significant distance from the river at Martinborough, will remove the incremental (albeit relatively minor) contribution of contaminants present in the Lower Ruamahanga River and Lake Onoke that are currently sourced from the MWWTP.

Date: 20/04/2015

Signed: BTC

References

ANZECC, 2000. Australia and New Zealand guidelines for fresh and marine water quality, Volume 1. The guidelines.
Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Ausseil, O. M. N., 2013: Statement of evidence of Olivier Michel Nicolas Ausseil before the Board of Inquiry in the matter of the Resource Management Act 1991 and in the matter of the Tukituki Catchment Proposal.

Coffey, B., 2007: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2007.
Brian T. Coffey and Associates Limited, CM: DC970079: SWDC / WRC March 2007. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, March 2007.

Coffey, B., 2008: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2008.
Brian T. Coffey and Associates Limited, CM: DC970079: SWDC / WRC March 2008. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, March 2008.

Coffey, B., 2009: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2009.
Brian T. Coffey and Associates Limited, CM: DC970079: SWDC / WRC March 2009. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, March 2009.

Coffey, B., 2010: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), April 2010.
Brian T. Coffey and Associates Limited, .CM: DC9970079: SWDC / GWRC, June 2010. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, June 2010.

Coffey, B., 2011: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2011.
Brian T. Coffey and Associates Limited, .CM: DC9970079: SWDC / GWRC, May 2011. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, June 2010.

Coffey, B., 2012: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2012.
Brian T. Coffey and Associates Limited, .CM: DC9970079: SWDC / GWRC, June 2012. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, June 2012.

Coffey, B., 2013: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2013.
Brian T. Coffey and Associates Limited, CM: DC9970079: SWDC / GWRC, June 2013. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, June 2013.

Coffey, B., 2014: South Wairarapa District Council Discharge from the Martinborough Oxidation Pond to the Ruamahanga River. Instream Biological Survey for part compliance with Condition 20 of consent WAR 970079 (2624), March 2014.
Brian T. Coffey and Associates Limited, CM: DC9970079: SWDC / GWRC, May 2014. A report prepared for the Wellington Regional Council on behalf of the South Wairarapa District Council, May 2014.

Cooke, J., Milne, P. and Rutherford, K., 2010: A review of definitions of “mixing zones” and “reasonable mixing” in receiving waters.
A report prepared for Auckland Regional Council. Auckland Regional Council Technical Report 2010/045, August 2010. ISSN 1179-0512 (Online) ISBN 978-1-927135-01-3.

Department of Conservation, 2006: Wellington Conservancy Conservation Management Strategy, 2006.
Wellington Conservancy Conservation management Planning Series No. 2.

Forbes, A., 2013: Martinborough, Greytown, and Featherston Treated Wastewater Discharges: Low-flow Assessment of Ecological Effects.
A report prepared for the South Wairarapa District Council by Forbes Ecology, July 2013.

Geange Consulting / Mott MacDonald, 2014: Martinborough Waste Water Treatment Plant. Proposed operation, upgrade and maintenance to 2047. Application for Resource Consents, Activity Description and Assessment of Environmental Effects.
Application by South Wairarapa District Council, 7 April 2014, Ref. 12502.

Masterton District Council, 2007: Masterton Wastewater Treatment Plant and Disposal System. Long-Term Upgrade. Notice of Requirement. Resource Consent Applications. Assessment of Effects on the Environment. Summary Report.
Masterton District Council, May 2007.

Milne J.R. and Perrie A., 2005: Freshwater quality monitoring technical report. Greater Wellington Regional Council, Publication No. GW/RINV-T-05/87.

Ministry for the Environment, 1994: Water Quality Guidelines No.2: Colour and Clarity.
Ministry for the Environment, Wellington.

Morar, S. and Perrie, A., 2014: Rivers State of the Environment monitoring programme. Annual data report, 2012/13.
GW/ESCI-T-13/114, ISBN: 978-1-927217-28-3 (online), December 2013.

newzealand.govt.nz , 2014: National Policy Statement for Freshwater Management 2014.
Issued by notice in gazette on 4 July 2014.

Perrie, A. and Milne, J.R., 2012. Lake water quality and ecology in the Wellington region: State and trends.
Greater Wellington Regional Council, Publication No. GW/EMI-T-12/139.

Resource Management Act 1991. Reprint as at 3 March 2015.

Roberston, H.A., 1991. Lake Wairarapa wetlands management guidelines, Wellington.
Department of Conservation.

Strong, J. and Smith, S., 2012: Assessment of Ecological Effects on the Ruamahanga River, South Wairarapa from the Martinborough Wastewater Treatment Plant.
A report prepared for South Wairarapa District Council by EAM Environmental Consultants. Project No. EAM298, April 2012.

Wellington Regional Council, 2013: Regional Policy Statement for the Wellington Region.
info@gw.govt.nz.

Wellington Regional Council, 2014: Regional Freshwater Plan for the Wellington Region
Publication No. WRC/RP-G-99/31 ISBN 0-909016-69-0 December 1999 Updated July 2014.