BEFORE ENVIRONMENT SOUTHLAND

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Lorneville Processing Plant Resource Consent Applications (APP-20158595)

STATEMENT OF EVIDENCE OF MIKE FITZPATRICK ON BEHALF OF ALLIANCE GROUP LIMITED

4 July 2016

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QUALIFICATIONS AND EXPERIENCE

1 My full name is Michael George Fitzpatrick.

2 I hold the degrees of BSc in Chemistry from Waikato University and PhD in Chemistry from the University of Otago and have been involved in environmental research and assessment for 25 years. I am self-employed and work primarily in the areas of environmental and medical chemistry, and toxicology and I have been an associate of Freshwater Solutions Ltd since 2011. My previous positions were principal environmental chemist at Golder Associates (NZ) Ltd and Kingett Mitchell Ltd, lecturer in analytical and environmental chemistry (Department of Chemistry, University of Auckland) and senior analyst at an Auckland testing laboratory.

3 I have been involved in numerous freshwater investigations, the most relevant to this hearing being the:

(a) Assessment of effects of the Fonterra Edendale wastewater discharge to the Mataura River;

(b) Assessment of effects of the Fonterra Stirling wastewater discharge to the Clutha River (Matau branch); and

(c) Assessment of effects of the Alliance Mataura wastewater discharge to the Mataura River.

4 I have been involved in numerous ammoniacal-nitrogen (**ammonia**) specific investigations, the most recent include those on the: lower Wairoa River, Clune Stream, Bonny Glen Stream, Waitekauri River, Ohinemuri River, Oraka Stream, Wairua River, Waihekau Stream, Waitoa River, Waikato River, Firth of Thames, several streams relating to Fonterra Hautapu, and several streams relating to Fonterra Kapuni.

5 In addition I have undertaken reviews of ammonia water quality criteria and derivations of site-specific ammonia water quality criteria, including the:

(a) Review of the USEPA (1998) ammonia criteria, which led to the USEPA ammonia criteria update (1999);

(b) Review of the ANZECC (2000) ammonia trigger values;

(c) Review of the NPS (2015) ammonia guidelines; and

(d) Derivation of a site-specific ammonia water quality criteria for the lower Wairoa River.

6 I visited the Alliance Lorneville processing plant in September 2013.

7 In preparing this evidence I have reviewed:

(a) The reports and statements of evidence of other experts giving evidence relevant to my area of expertise, including:

(i) Dr Mark James;

(ii) Richard Montgomerie; and

(iii) Frances Wise.

(b) The Section 42 Officers' Report and the evidence of Dr Greg Ryder.

8 I have read and agree to comply with the Code of Conduct for Expert Witnesses (Environment Court Practice Note 2014). This evidence is within my area of expertise except where I state that I am relying on facts or information provided by 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

9 My evidence addresses the following matters:

(a) A brief explanation of terms relating to ammonia;

(b) Discussion of the current consent and how it defines ammonia based on the 1984 USEPA acute criteria;

(c) Discussion of the ammonia limits in the National Policy Statement for Freshwater Management 2014 and how these are derived from the ANZECC (2000) methodology; and

(d) Recommending suitable ammonia limits for the discharge.

AMMONIA – AN EXPLANTION OF TERMS

10 Ammonia (NH_3) is a gas that is highly soluble in water. On dissolution in water ammonia exists in two forms, aqueous ammonia (NH_3 *aq*) and the ammonium ion (NH_4^+ *aq*). The relative proportion of these two forms depends on two main factors – pH and temperature.

11 Aqueous ammonia is sometimes called unionised ammonia and the ammonium ion is sometimes called ionised ammonia. Aqueous ammonia and the ammonium ion are both toxic to aquatic animals, but aqueous ammonia exhibits a much higher toxicity than the ammonium ion.

12 Collectively aqueous ammonia and the ammonium ion are called total ammonia. The analytical measure of total ammonia is called total ammoniacal nitrogen. As mentioned in (4), for the purposes of this evidence ammonia means total ammoniacal nitrogen unless stated otherwise.

CURRENT CONSENT AMMONIA LIMITS

13 The current Alliance consent contains two ammonia conditions, one to be met in the first two years (from August 2001) of the consent and the other for the remaining term of the consent.

14 For the first two years of the consent the receiving water was not to exceed 0.11 g/m^3 unionised ammonia, or any five consecutive samples (taken on different days) exceed a median unionised ammonia concentration of 0.08 g/m^3. An unionised ammonia concentration of 0.11 g/m^3 is the 1984 USEPA acute criteria (salmonids present) at pH 8.0 and 10ºC.

15 Following the first two years of the consent ammonia condition reverted to the 1984 USEPA acute criteria (salmonids present), which are pH and temperature dependant and summarised in a table in the consent.

16 Acute criteria are derived from toxicity test data obtained on a range of organisms over a zero to four-day period. Hence, acute criteria are designed to protect organisms that are exposed for relatively short periods of time.

NPS AMMONIA GUIDELINES

17 Although New Zealand guidelines for some key water quality parameters (such as ammonia) have been updated in the NPS (2015), the framework for the protection of environmental values, such as aquatic ecosystems, in New Zealand are the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).

18 Whereas the previous New Zealand guidelines (ANZECC, 1992) provided water quality standards in the traditional sense, i.e., fixed standards that should not be exceeded and that are applicable for all national surface waters, the ANZECC (2000) guidelines do not. Rather, ANZECC (2000) presents trigger values that indicate a potential environmental problem if they are exceeded; ANZECC state that this approach was used due to the uncertainty in the derivation and application of fixed standards.

19 ANZECC (2000) have published trigger values for a wide range of chemical contaminants. Generally, the trigger levels are derived from toxicity tests on aquatic species under laboratory conditions. The majority of trigger values are termed 'moderate reliability' because they are based, in part or whole, on acute toxicity data. However, some trigger values, such as those for ammonia, are afforded 'high reliability' status. ANZECC (2000) state that high reliability trigger values are based on No Observable Effect Concentration (**NOEC**) data.

20 The NOEC-based approach is recognised as being inherently conservative ((Canadian) Ministry of Water Land and Air Protection or MELP, 2004) and, therefore, over-protective. In addition to being conservative my finding is that the derivation of many trigger values by ANZECC are flawed to the extent that it renders them of little scientific or regulatory value. For example the default ANZECC (2000) trigger value for boron is 0.37 g/m^3, which is almost an order of magnitude lower than the re-derived trigger value of 3.5 g/m^3 (Kingett Mitchell, 2004) that has been accepted by Waikato Regional Council.

21 The reasons that many ANZECC trigger values are flawed is generally due to the use of:

(a) Incomplete data. For example with zinc, 55 out of 67 data, or 82%, was inappropriate and appropriate data was ignored;

(b) Inappropriate data. For example with boron, data for rainbow trout was not toxicity related, rather it was related to boron deficiency; and

(c) Estimated NOEC data, sometimes even in place of measured NOEC data.

22 Hence, I exercise caution with respect to ANZECC (2000) trigger values and guidelines derived by the ANZECC (2000) methodology.

23 The ammonia limits in the NPS (2015) were derived by NIWA's Dr Chris Hickey in 2013. The derivation consists of a nine page, non-peer-reviewed memorandum to the Ministry for the Environment (**MfE**), which Dr Hickey himself describes as, '*indicative'*, also stating that '*a thorough literature review and updating of the ANZECC (2000) freshwater data database has not been undertaken as part of this review.'*

24 The NPS ammonia limits derivation was based on a data set containing 20 species, and most data are appropriate. However one of the data is not based on empirical NOEC data, but rather a NOEC estimate. This data is for the rainbow mussel: Dr Hickey's NOEC estimate of 0.24 g/m^3 (at pH 8) does not compare with that of the authors who published the original research (Wang et al., 2007). Dr Hickey's error is not trivial because it is the lowest NOEC in the NPS data set and, as such, it has a significant bearing on the guideline derivation; the ammonia B Attribute (95% protection) annual median concentration of 0.24 g/m^3 comes directly from this erroneous data point.

25 In addition, although Dr Hickey's derivation of the NPS ammonia limits is based on ANZECC (2000) methodology, the presentation of the numeric attribute states as annual maxima is not.

26 Therefore, the caution I exercise with respect to ANZECC (2000) trigger values also translates to the NPS ammonia limit, which I do not consider to be reliable.

REVIEW OF TOXICOLOGICAL DATA FOR AMMONIA

27 In 2014 I conducted an extensive review of the toxicological data for ammonia in relation to aquatic biota. This involved a review of the USEPAs recent re-calculation of its ammonia aquatic life criteria (USEPA, 2013), as well as an exhaustive literature review of scientific papers and reports relating to ammonia toxicity to aquatic biota.

28 In contrast to the NPS ammonia guidelines the USEPA criteria report was available as a draft in 2009 to allow sufficient time for public review and comment. The final report is 246 pages in length, was authored by eight scientists prominent in criteria development and/or ammonia toxicity, and was subject to extensive peer review by seven reviewers.

29 The USEPA criteria report gives particular attention to the effects of ammonia on freshwater mussels. Four chronic criteria concentrations (**CCCs**) are provided, as follows (adjusted to pH = 8, 20ºC for comparison with limits derived using ANZECC (2000 methods):

(a) Mussels present, early life stage (**ELS**) fish present: CCC = 0.78 g/m^3;

(b) Mussels present, ELS fish absent: CCC = 0.78 g/m^3;

(c) Mussels absent, ELS fish present: CCC = 2.7 g/m^3; and

(d) Mussels absent, ELS fish absent: CCC = 2.9 g/m^3.

30 The USEPA chronic criteria are derived by giving consideration to a range of effects endpoints, not just NOECs. As such they are inherently less conservative than those derived using the ANZECC (2000).

RECOMMENDED LIMITS FOR THE LOWER MAKAREWA RIVER

31 In 2014 I conducted a review of ammonia toxicity to aquatic species and derived ammonia trigger values using the ANZECC (2000) methodology. The data set is comprised of 36 species (three amphibians, three crustaceans, 19 fish, two insects and nine molluscs). As such, the data represents a good cross-section of species that are either found in New Zealand, or would act as useful surrogates for species found in New Zealand.

32 The data set I compiled for the derivation of the ammonia trigger values can be used to derive site-specific ammonia trigger values. For example, non-resident species may be removed from the data set and the trigger values re-calculated.

33 I am advised by Mr Montgomerie and Dr James that the habitat in the tidally influenced section of the lower Makarewa River is not suitable for freshwater mussels because of the finer substrate, variable water level and other anthropogenic activities such as channel straightening. No mussels were found during surveys in 2013 and 2014 and anecdotal evidence indicates that they have not been present in the lower Makarewa River for some time. I am also advised the habitat in the tidally influenced section of the Makarewa River is also not suitable for the mayfly *Deleatidium*, and that the macroinvertebrate community and MCI score at Site D1, within the mixing zone, is similar to other Southland tidally influenced river sites. Given the highly modified state of the habitat, poor

background water quality and the dominance of water and habitat tolerant taxa within the Makarewa River (including around the discharge) the effect of the discharge on benthic invertebrates has been assessed as not more than minor.

34 Mussels are not present in the tidally influenced section of the Makarewa River. Hence, removal of freshwater mussels from the data set I compiled afforded the derivation of site-specific ammonia trigger values for the lower Makarewa River.

35 This resulted in a 95% protection ammonia chronic trigger values of 1.9 g/m^3 (pH = 8, 20°C). This concentration is more conservative than the USEPA (2013) chronic criteria (no mussels, ELS fish present), which is 2.7 g/m^3 (pH = 8, 20°C) and approximately three times lower than the current consent.

36 Hence, my recommended chronic ammonia limit for the lower Makarewa River downstream of the Alliance discharge is 1.9 g/m^3 (pH = 8, 20°C) as an annual median. Expressed as an annual 95%-ile, this limit is 2.4 g/m^3 (pH = 8, 20°C). Both limits should be adjusted depending on the receiving water pH and temperature, according to USEPA (2013) methodology. However, I accept that adjusting ammonia limits for temperature may be onerous for consent holders and regulators alike, in which case adjustment for pH only is acceptable as I consider pH to the key determinant, and not adjusting for temperature as well will generally work to make the ammonia limits more conservative

37 I have not formally derived an acute ammonia limit for the lower Makarewa River, however I note the USEPA (2013) acute (one-hour) ammonia criterion (mussels absent, ELS fish present) is 9.9 g/m^3 (pH = 8, 20°C). I consider that acute effects on aquatic species in the lower Makarewa would not be observed at or below this ammonia limit.

38 In her evidence Frances Wise discusses the improvements to site operations and says "*This has resulted in a 35% reduction in the annual median concentration of ammonia-N in the discharged wastewater with a comparable reduction in the measured seasonal median ammonia-N concentrations in the Makarewa River at the downstream compliance point in 2016 when compared to 2013 values*". Based upon these improvements I was asked to comment on an appropriate interim ammonia limit to apply for the 15 year period until the wastewater

treatment upgrade is completed. Based on the site-specific chronic ammonia trigger values that I have derived, I am able to recommend four-day average ammonia limit (four days is the border of acute and chronic effects) of 4.7 g/m^3 (pH = 8) for the lower Makarewa River not to be exceeded more than once every 3 years. This limit was derived using USEPA methodology by which the four-day average limit is the product of 2.5 and the chronic limit, i.e., 2.5 x 1.9 g/m^3. This four-day average ammonia limit is the same number for both pre- and post- the proposed wastewater treatment up-grade however as you will see from the tables in condition 10 (pre-upgrade) and condition 15 (post-upgrade) the 30 day rolling average and annual 95%-ile figures change.

39 Both the chronic limits and acute limits I have recommended would be applied after a reasonable zone of mixing. I note from the evidence of Dr Greg Ryder that he has expressed concern regarding the effects of ammonia on fish migration in the mixing zone. While there is potential for ammonia to affect fish migration in the mixing zone this is not a toxicological effect. Legitimate toxicological endpoints are typically growth, reproduction and mortality, and do not include behavioral effects such as avoidance. Therefore from my perspective as a toxicologist, I do not consider that potential ammonia effects on fish migration in the mixing zone are an effect requiring mitigation.

USEFULNESS OF WHOLE EFFLUENT TOXICITY TESTING

40 I note from the evidence of Dr Greg Ryder that he has proposed a consent condition for Whole Effluent Toxicity (**WET**) Testing. NIWA (2002) has previously reported the results of Lorneville Pond 6 effluent WET testing with green algae (*Selenastrum capricornutum*), water flea (*Ceriodaphnia dubia*) and rainbow trout (*Oncorhynchus mykiss*).

41 Comparison of NIWA's results with effluent dilution ratios for the Makarewa River from 2001-2014 indicates the discharge seemingly has the potential for growth inhibition of green algae. However, as NIWA states in their report 'care must be taken when extrapolating results for protection of organisms in a particular receiving water'. This is due to diverse reasons, such as ion imbalance (SETAC, 2004), use of non-standard and variability in procedures (Burton *et al.*, 1996), and failure to report raw data, including that for the control; with respect to the latter it is noted the NIWA report fails in that regard.

42 In addition, NIWA's WET testing results are contradictory compared with toxicity data, which indicate green algae is the least sensitive species with respect to potential toxicants in the effluent, not the most sensitive.

43 Lastly, although it sounds like a good idea to conduct WET testing on an 'appropriate New Zealand freshwater species', the standard protocols of WET testing mean that it is not straightforward to test on species other than those three already tested by NIWA and the common bully (*Gobiomorphus cotidianus*).

44 Hence, in my opinion, further WET testing will add little to our understanding of the effects of the effluent on aquatic biota of the lower Makarewa River; if anything I consider WET testing results are more likely to prove confusing. I consider resources are better directed toward more standard and robust monitoring programmes than WET testing.

CONCLUSIONS

45 I have derived site-specific ammonia trigger values based on ANZECC (2000) methodology, suitable for the tidally influenced lower Makarewa River where mussels are not present. This resulted in an ammonia trigger value of 1.9 mg/L (pH = 8). This concentration is more conservative than the USEPA (2013) chronic criteria (no mussels, ELS fish present) and approximately three times lower than the current consent.

46 Hence, my recommended chronic ammonia limit for the lower Makarewa River downstream of the Alliance discharge is 1.9 mg/L (pH = 8) as an annual median. Expressed as an annual 95%-ile, this limit is 2.4 mg/L (pH = 8). Both limits should be adjusted depending on the receiving water pH according to USEPA (2013) methodology. It is proposed that this limit will apply after the wastewater treatment upgrade.

47 Based on the site-specific chronic ammonia trigger values that I have derived, I am able to recommend a four-day average ammonia limit of 4.7 g/m^3 (pH = 8) for the lower Makarewa River. This will apply both pre- and post the wastewater treatment upgrade. The USEPA (2013) acute (one-hour) ammonia criterion (mussels absent, ELS fish present) is 9.9 g/m^3 (pH = 8).

48 I do not consider there will be acute or chronic toxicological effects (i.e., effects on growth or reproduction, or mortality) on aquatic species in the lower Makarewa at the respective ammonia limits I have recommended. It is not implausible that fish avoidance of ammonia might occur within the

mixing zone. However, such behavior is not considered a toxicological endpoint.

Mike Fitzpatrick
4 July 2016

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