In the matter	of the Resource Management Act 1991
And	
In the matter	of an application for Resource Consents by Oceania Dairy Limited to construct and operate a pipeline to discharge treated wastewater into the ocean.

STATEMENT OF EVIDENCE OF NATHANIEL JAMES WILSON FOR OCEANIA DAIRY LIMITED

28 May 2020

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INTRODUCTION

1 My name is Dr Nathaniel James Wilson.

2 I hold a BSc in Chemistry, a BA in Philosophy, an MSc in Environmental Science (all University of Otago), and a PhD in Environmental Science (University of Auckland). I also hold a certificate in Advanced Nutrient Management from Massey University.

3 I am an environmental scientist, consulting to Babbage Consultants Limited ("Babbage"). Until April 2019, I was an Associate at Babbage, and the manager of Babbage's Environmental Science and Engineering team.

4 I have more than sixteen years' experience in environmental science, including nine years' experience as a consultant. I have also worked in local government (Northland Regional Council from 2003 to 2005 and Watercare since 2019) and in research. Between 2010 and 2011 I was an Alexander von Humboldt Fellow at the University of Bayreuth, and have worked on research projects in New Zealand with NIWA (in 2008) and Mighty River Power during my PhD from 2005 to 2008. I am currently a member of the Royal Society of New Zealand, Water New Zealand, and the Water Services Association of Australasia.

5 My speciality at Babbage was the environmental management of dairy factory discharges. In addition to providing water quality advice to Oceania Dairy Limited ("ODL") since 2015, my relevant experience in the dairy sector includes waste water discharge assessments, field-work, and management advice to Fonterra, Synlait, Open Country Dairy, Miraka, and Westland Milk. In Canterbury, I have worked on projects at Fonterra's Darfield site and Synlait's factory at south of Dunsandel. I was an expert witness in water quality for Fonterra's application for a coal mine at Mangatangi, Waikato, and as the water quality expert for Open Country Dairy's recent application for a new discharge consent at its Waikato Waharoa factory.

6 Elsewhere in New Zealand I have worked on dairy projects at Fonterra Edgecombe (2013-2015), Fonterra Te Rapa and Fonterra Hautapu (2014-2015), Synlait Pokeno (2017-2019), and Open Country Dairy Waharoa (2018-2020). I was also involved in the consenting for Miraka in 2009. At Northland Regional Council, I was the compliance officer for Fonterra's Kauri and Maungaturoto sites (2003-2005).

7 My experience with outfalls and coastal discharges includes Napier City Council's discharge into Hawke Bay (2013-2014), Christchurch City Council's discharge into Pegasus Bay (2012-2013), and Watercare's discharges into the Manukau Harbour, Army Bay, Snells Beach, and the Mahurangi Harbour (2019-2020). I also worked on

the Rena shipwreck in the Bay of Plenty (2011-2012), and carried out water and sediment quality sampling and interpretation after a spill of aviation fuel into Lyttelton Harbour (2014).

8 I have also carried out environmental assessments relating to pulp mills, mining, abattoirs, catchment-scale contaminant load modelling, and various other municipal water and wastewater treatment plants. I am an author on more than a dozen papers in international peer-reviewed journals, on topics including metalloid behaviour in geothermal and freshwater environments, ecotoxicology, and more general chemical changes in Antarctic melt-waters.

9 As of April 2019, I have been the Environmental Care Manager at Watercare Services Limited (Watercare). Watercare is not an affected or interested party, and in this matter I am not representing Watercare. I have no conflict of interest to declare.

10 In preparing this evidence I have reviewed:

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

10.2 Ecology, Bioresearches Limited (evidence presented by Ms Annabel Coates);

10.3 Coastal Processes, Babbage Consultants Limited (evidence presented by Mr Luiz, Lobo Coutinho);

10.4 Wastewater treatment and alternatives, Babbage Consultants Limited (evidence presented by Mr Paul Duder);

10.5 Infrastructure construction, Babbage Consultants Limited (evidence presented by Mr Suman Khareedi)

10.6 Planning, Babbage Consultants Limited (evidence presented by Ms Sukhi Singh); and;

10.7 Oceania Dairy Limited (evidence presented by Mr Shane Lodge).

10.8 The parts of the section 42A report relevant to my area of expertise.

10.9 Submissions relevant to my area of expertise.

CODE OF CONDUCT

11 While this is a Council Hearing, I acknowledge that I have read and am familiar with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014, and agree to comply with it. I confirm that this evidence is within my area of expertise, except where I state that this evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions I express in this evidence.

SCOPE OF EVIDENCE

12 My evidence is confined to the matters associated with soils, groundwater and marine water quality that may occur if ODL is granted consent to discharge under its proposed regime. My evidence includes:

12.1 A description of current discharge quality and disposal practices.

12.2 Current state of the land that ODL discharge to, and environmental constraints on expanding that activity.

12.3 The state of receiving marine water quality, and the effects related to water quality associated with the proposal.

12.4 The effects on soils and groundwater associated with changing the current discharge regime.

EXECUTIVE SUMMARY

13 My key observations and conclusions are:

13.1 Oceania Dairy Limited's current wastewater discharge activities are constrained by the amount of land it can irrigate to.

13.2 The ability to discharge factory via an outfall to the Pacific Ocean would remove Oceania Dairy Limited's current constraints.

13.3 The receiving marine environment is pristine. Any discharge to this environment must aim to meet the strictest relevant guidelines for environmental protection.

13.4 Factory wastewater will be treated sufficiently that the effects on the receiving water quality will be less than minor, even in calm conditions when there may be less dilution than under normal weather conditions. Even within the zone of reasonable mixing, modelling indicates adverse effects related to water quality are very unlikely.

EVIDENCE

Current Activities

Factory wastewater and discharges to land

14 The factory at Waimate produces two discharge streams: treated or high -strength wastewater, and condensate, also known cow water or low-strength wastewater. High strength wastewater comprises milk-powder residues and cleaning chemicals. The principal cleaning chemicals are sodium hydroxide, also known as caustic soda (NaOH), and nitric acid (H_2NO_3). Without treatment, this wastewater stream can have elevated concentrations of fats and other suspended solids, and nutrients such as nitrogen and phosphorus. Depending on the cleaning cycle, this wastewater can also have low pH (<3), or have high pH (>10) and high sodium.

15 As discussed in the S92 response to the application, volumes of proprietary chemical cleaning agents, are small relative to sodium hydroxide and nitric acid. Consequently, concentrations of these other agents are typically only present in trace amounts (µg/m^3-mg/m^3) and most are biodegradable, especially in seawater.

16 As Mr Lodge discusses in his evidence, the factory's treatment process for high strength wastewater has two stages. In the first stage, operators add sulfuric acid or lime (calcium hydroxide) to bring the pH of the wastewater to just below pH 5, and then this wastewater goes into a tank for treatment using dissolved air flotation (DAF). The DAF process forces the fats and suspended matter to the surface, allowing operators to skim the solid "sludge" out from the liquid waste. ODL sends this sludge to pig farmers, who use the DAF-sludge as a supplement to their feedstocks. In the second stage, operators feed lime into the liquid stream to add calcium to solution and raise the pH to >7. The purpose of adding the calcium is to protect soil health, as I will discuss later in my evidence.

17 The treated high strength wastewater has agronomic value. This wastewater is a source of the macronutrients including: nitrogen (100 g/m^3), phosphorus (5 g/m^3), calcium (500 g/m^3), and sulphate (500 g/m^3). The treated wastewater can therefore replace fertiliser when applied to pasture, and can also substitute for irrigation water.

18 Sodium, present at 500 g/m^3 in the treated wastewater, is not a macronutrient. When there is excess sodium, relative to calcium and magnesium, sodium can replace these larger cations in soils, adversely affecting soil structure. In substituting for calcium or magnesium, soils are less able to aggregate, have poorer drainage, and there is a general deterioration in soil fertility. Running dairy cows over such soils exacerbates the adverse effects, and so land under dairying is less tolerant of wastewater irrigation than land under cropping or cut and carry practices.

19 The treated factory wastewater also has elevated chemical and biochemical oxygen demand, and elevated concentrations of suspended solids. These three parameters are contaminants in freshwaters, but not in soils. In soils, soil bacteria can use the milk residues as energy sources, breaking these contaminants down, especially in summer in warmer conditions and drier conditions.

20 Condensate is the water that condenses from steam during the milk-drying process. This waste stream has much lower concentrations of nutrients, and other ions, and so does not need treatment. The principal environmental effects associated with condensate discharge relate to hydraulic loading and temperature effects.

21 To dispose of the two wastewater streams, ODL has consent to irrigate to 316 ha in cut and carry, and to a dedicated condensate only block that has very limited grazing. ODL also has consent to irrigate, at lower loading rates, to 90 ha in dairy, but ODL has yet to exercise that consent due to infrastructure limitations.

22 The receiving soils are a mix of Steward and Darnley type soils. Both these soil types are silty loams with occasional fingers of gravel. Steward soils are well draining. Darnley soils are moderately well draining, having localised iron pans that can retard drainage rates and restrict root growth.

23 The cut and carry land ODL irrigates to is in a mix of lucerne, rye grass and maize. The farmer working under contract to take the wastewater grows this mix of crops to create a balanced diet for the cattle that receive the feed. Lucerne blocks have greatest nitrogen uptake, but lucerne is the smallest of the three crops in both area and yield. Maize blocks have the highest nitrogen losses because maize needs replanting each season, and the preparation for replanting breaks up the nitrogen-rich organic layers in the top soil, causing a loss of nitrogen to groundwater.

24 The current disposal system is very effective during dry weather when soils have a water deficit, and plants can take up the nutrients. If ODL were to irrigate to over-saturated soils, there are no agronomic benefits, and the nutrients go to groundwater.

25 Over irrigation can cause ponding, despite being to moderate- and well-draining soil types. As ponded wastewater evaporates, sodium can build up in the surface soils, which weakens the soil structure and thus can exacerbate ponding issues.

26 Even after it exercises its consent to irrigate to an extra 90 ha of land, I consider that ODL cannot expand its operation without risk of causing adverse environmental effects. At 10,000 m^3/day, ODL would need to obtain rights to irrigate onto land that has a high nitrogen baseline that it could convert to cut and carry operations. In the

Glenavy District farms with such high baselines are typically those in dairy and have border-dyke irrigation. To secure this land ODL would need to convince farmers to give up dairying, and, at the same time, secure a market for the feed it would start producing. To meet its forecast needs, I estimate ODL would need between 600-1000 ha of such land.

27 With an increased discharge volume ODL would face significant problems with ponding and odour because ODL has no alternative to land application of its treated wastewater. ODL could reduce, but not eliminate ponding if it acquired more land. I consider the odour issue more difficult to address without an alternative disposal method outside the irrigation season.

28 The Morven Glenavy Irrigation Scheme services much of the land in the vicinity of the plant. Members of that scheme are already subject to Environment Canterbury Regional Council ("ECan") rules that require discharge to land consents to be held for the nutrient losses associated with their particular farming method. Accordingly, there is the practical difficulty that farmers have less need for the wastewater, because of the scheme availability and because farmers are less receptive to the nutrient rich water from ODL if it adversely affects the nutrient budget under which they are operating.

29 Accordingly while ODL can discharge water over their current irrigation wastewater fields, there will be practical difficulties in obtaining rights to further land for wastewater irrigation. However, as I have said, the purpose of the ocean outfall is to provide a year-round solution, including times when the water table is high or when the agronomic benefits to crops is limited (i.e., winter).

Coastal environment

30 Mr Coutinho describes the physical coastal environment in his evidence.

31 The water quality of the coastal environment based on ECan monitoring, reflects a system with low primary production, as reflected in generally low chlorophyll-a concentrations, and detectable concentrations of dissolved inorganic nitrogen year-round.

32 At present, the receiving coastal environment meets regional standards for ecological protection and contact recreational guidelines for faecal bacteria in marine environments. Water clarity is poor due to fine sediments naturally dispersed from the mouth of the Waitaki River.

33 There are no consented point sources north of the Waitaki River until the proposed outfall at Fonterra Studholme, 15 km north of ODL's proposed outfall and in the direction of the prevailing current. Applying ANZECC (2000) and ANZG (2018) guidance, the receiving environment is thus pristine or undisturbed.

34 There is currently no New Zealand specific marine water quality guidelines in ANZG (2018). To assess the effects of an activity on a pristine ecosystem where there is no or limited site-specific ecotoxicological data, ANZG (2018) recommends comparing the results of "test site" medians to 80th percentile data, with an objective of keeping medians to below the 80th percentile. McDowell et al (2013) have applied this method to New Zealand freshwaters, and I used this approach in the AEE. A summary of reference data is included in Appendix A of my evidence, updated to include the limited data from nearby sites, as Babbage outlined in the S92 response.

35 "Algal bloom" is a term used to describe the rapid population growth of one or more plankton species in a body of water. Blooms are natural phenomena that generally require stable conditions to develop. When the blooms are of a type of plankton that produces toxins, the bloom becomes a "harmful algal bloom". Marine algal blooms, harmful or otherwise, are larger and more common in shallower waters (estuaries, harbours etc.) than on exposed coastlines, but can and do occur in most marine environments, including the area of coastline into which ODL intends to build its outfall. Micronutrients, such as iron, rather than macro-nutrients, are often the limiting factor on the open ocean (e.g. Frew et al 2001).

36 The drivers of algal blooms depend on circumstance. The recent bloom that occurred in the bays around Timaru this year is an example of a non-harmful bloom that formed in warm and calm conditions. Shears & Ross (2009) describe a harmful algal

bloom of the benthic dinoflagellate *Ostreoposis*, which caused a 60 % decline in sea urchin densities along a northern New Zealand reef (off Leigh), and speculated the cause was a combination of sustained calm conditions, in particular no waves, and in warm conditions (with the calm conditions also driving warmer water temperatures). Longdill et al (2008) describe an event in the Central Bay of Plenty for which wind-driven currents brought up cold nutrient-rich waters into a previously stratified water column and triggered a HAB in late 1992-early 1993. Chiswell et al (2016) describe similar upwelling-driven bloom phenomena in Cook Strait, again only when the water column about the area of upwelling was stratified. Temperature and nutrients are therefore influences on algal bloom development, but the principal driver is stable water conditions. The need for stable conditions means algal blooms are temporary phenomena.

Effects of the proposal on water and soil quality

37 Prior to discharging to the marine environment, ODL intends to upgrade its treatment process, as Mr Duder discusses in his evidence. I understand that the upgraded process will include:

37.1 Retaining the DAF process

37.2 Secondary treatment using biological reactor tanks

37.3 Tertiary treatment to remove solid material, and bacteria

38 By adding secondary and tertiary treatment, ODL will substantially improve the quality of its discharge. I include a table comparing current and proposed discharge quality as Appendix B to my evidence.

39 Mr Coutinho discusses the potential effects of building the pipeline from the factory to the coast. Ms Coates describes the potential effects of construction on the marine ecosystem in her evidence. In my evidence, I focus on the effects of the discharge on water quality, along with the effects of having an alternative option will have to continued irrigation to land.

40 As Mr Coutinho discusses, the design of the outfall will achieve at least 300 times dilution within 50 m in calm conditions and at the maximum proposed volume of 10,000 m^3/day (equivalent to 116 L/s). Modelling indicates at least 500 times dilution during normal weather and tidal conditions.

41 I used a mass balance equation to determine concentrations after reasonable mixing. This equation was:

$$c_{Mix} = \frac{C_{Dis} * 1 + C_{Sea} * (D - 1)}{D}$$

Where c_{Mix} = Concentration at the edge of the mixing zone in g/m^3

c_{Dis} = Discharge concentration in g/m^3 (Expected/mean or 95th percentile)

c_{Sea} = Median background water quality in g/m^3

D = Expected dilution (300 in calm conditions, 500 in 80%ile conditions)

42 The most significant toxicant in the proposed discharge is ammoniacal nitrogen. As Babbage outlined in the S92 response, toxicity thresholds for phosphorus and nitrate are higher than will be present in the undiluted discharge (CCME 2012; Kim et al 2013). Concentrations of heavy metals will meet Canterbury Regional Coastal Plan limits after two-fold dilution. With a pH between 6 and 9 units, seawater buffering will limit pH changes to <0.2 units, consistent with ANZECC (1992) guidance.

43 Batley & Simpson (2009) propose a trigger value of 160 mg/m^3 for ammoniacal nitrogen in marine environments. Approximately 15-fold dilution would be necessary for the discharge to meet this trigger value under normal operating conditions, and 30-fold dilution under worst-case scenarios. Therefore, outside the 50 m zone of reasonable mixing, there is no evidence to indicate the proposed discharge will cause adverse ecotoxicological effects.

44 The trigger value that Batley & Simpson (2009) propose is not an indication of toxicity, but rather suggests the threshold at which there is a "trigger" for further investigation. The most sensitive species Batley & Simpson (2009) consider are benthic organisms such as *Hormosira banksia*, which is a reef-dwelling macroalgae, and the sea urchin *Paracentrotus lividus*, which is not present in New Zealand waters. Since the discharge will be buoyant, the risks to benthic species will be low because the discharge plume will rise, rather than disperse over the sea floor.

45 Consequently, even within the zone of reasonable mixing, the ecotoxicological risks will be very low. I draw this conclusion because pelagic organisms (fish etc.) can avoid the area, there will be sufficient vertical dilution to protect plankton and smaller jellyfish etc. that float on or near the surface, and it is very unlikely that any sensitive benthic species are present in the receiving environment.

46 Suspended solids concentrations in the discharge (15.0 g/m^3) will be less than half reference condition for suspended solids (35.0 g/m^3). Modelling that Sneddon et al (2015) carried out for the proposed outfall at Fonterra Studholme indicates that effects on water clarity will be less than 10%, even during calm conditions. I consider the effects of ODL's discharge on water clarity will be similar.

47 Biochemical oxygen demand will need 25-fold dilution in worst-case conditions. Since biochemical demand is a measure of oxygen depletion over 5-days, the risks associated with oxygen depletion within the zone of reasonable mixing is very low and negligible beyond the proposed 50 m mixing zone. Modelling indicates calm conditions will only persist for more than 24 hours in exceptional circumstances.

48 Under normal weather conditions and normal factory operation, nutrients (nitrogen and phosphorus) concentrations after reasonable mixing will be within the reference standards. In calm conditions, concentrations of dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP) could be elevated above their respective reference guideline values.

49 The potential exceedances are not indicative of any ecotoxicological effects, as I discussed earlier in my evidence, but these parameters can contribute to increased microalgal growth and therefore have the potential to drive changes in ecology by altering the food web. I consider the likelihood of the modelled increases causing actual shifts in ecosystem composition is so low as to be *de minimis*.

50 Elevated concentrations of DIN have the potential to promote planktonic growth that would otherwise be limited by the availability of this nutrient, and thus increase the risk of algal bloom development. However, as I discussed earlier, the development of algal blooms, requires consistent calm conditions for extended periods of time (weeks-months; Anderson et al 2002). Such conditions are very unlikely to persist long enough about the proposed outfall, as Mr Coutinho further explains in his evidence.

51 The proposed exceedance for DIN, which can limit algal growth in marine environments is only 1% over the reference condition, so even slightly less calm conditions will result in concentrations that meet ANZG (2018) reference standard. The minimum necessary dilution to meet the reference condition is 307 times (2.3 % more dilution), which would be very likely within a tidal cycle irrespective of swell and wind effects. Overall, I consider the risk of more frequent algal blooms about the outfall as a consequence of increase DIN concentrations is very low, and the potential environmental effects of the breach of the reference condition for DIN in calm conditions to be no more than minor.

52 I also note that historical peaks in chlorophyll-a (a proxy for planktonic algal growth) do not coincide with peaks or troughs of DIN, nor do high DIN correlate with high chlorophyll in the following samples (which would be the case in the event of a lag between nutrient availability and growth). These results, which I include in Appendix A, support the general concept that algal blooms require a specific conditions and the alignment of multiple potential influences, and such risks are very low about the proposed outfall location.

53 The increase for DRP in calm conditions is greater (20 %). However, as Sneddon et al (2015) explained in consenting the Fonterra Studholme outfall, DRP is generally present in excess of biological needs in seawater, and so consequently is not a limiting factor for algal growth in marine environments. This means any effects on algal bloom growth related increased DRP in the receiving environment will be less than minor.

54 There could be enhanced primary production (greater microalgal growth or increased benthic species densities) within the 50 m zone of reasonable mixing where DIN concentrations will be higher than the reference standard. The likely effect of more primary production would be the establishment of filter feeders (typically bivalves such as mussels), as is common at the discharge points of outfalls throughout New Zealand. The high energy environment of the South Canterbury Coast may, however, prevent the establishment of such ecosystems. Ms Coates discusses other ecological considerations in her evidence.

55 In the AEE and the S92 Babbage presented comparisons to 95th percentile events as well. In normal conditions, concentrations of ammonia species and DRP could exceed reference standards. In calm conditions, exceedances for oxidised nitrogen (nitrate and nitrite) could also occur, and therefore exceedances of the DIN standard would also occur since DIN is the sum of ammonia species, nitrite and nitrate.

56 Exceedances during infrequent (e.g., 95th percentile) events are not precluded under ANZG (2018) guidance, for which the principal consideration is median values. Furthermore, consistent with my consideration of elevated nutrient concentrations in calm conditions, there is no evidence to indicate any adverse effects will occur, since the risk of algal blooms will remain very low, and there will not be ecotoxicological effects.

57 Given the dilution, even in calm conditions, other chemicals will be at trace levels (<1 mg/m^3) even in the event of a spill at the factory, as was detailed in the S92 response. Most of the proprietary cleaning chemicals ODL uses will rapidly biodegrade to non-toxic breakdown products such as chloride or oxygen. As discussed in the S92 response, even where rapid degradation does not occur, the risks of bioaccumulation or ecotoxicological effects associated with proprietary chemicals in the discharge are very low.

58 With an outfall in place, ODL will not have to discharge to land in wet conditions, or in the shoulders of the dairy season when irrigation water may not be available to rinse out any treated wastewater residues, which is a major source of odour from the activity. If ODL was able to limit its treated wastewater irrigation to the period during which irrigation water is available, and only discharged when the soils had a water-deficit, then the receiving crops would receive the maximum agronomic benefit and ODL could minimise any adverse environment effects.

59 By only irrigating in the summer irrigation period, ODL should expect to see an improvement in receiving soil quality, less ponding, less odour, and lower concentrations of sodium, nitrate and sulphate in down-gradient groundwater. Any wastewater irrigated to land would not need secondary (membrane reactor) or tertiary (UV) treatment, and so ODL, by retaining its ability to irrigate, can minimise treatment costs and it gives ODL a window for outfall and pipeline maintenance.

Issues raised by Submitters

60 Several submitters, including Forest & Bird, Greenpeace, and some individuals expressed concerns about the cumulative effects of point source discharges along South Canterbury’s coastline. In harbours, cumulative effects can be a significant problem there can be high loading rates into waters with prolonged residence times (weeks-months). Along the South Canterbury coast, there is sufficient energy that contaminants from the ODL outfall will be sufficiently dispersed enough to be undetectable well before the nearest point source (Fonterra Studholme). I do not consider the proposal will meaningfully contribute to adverse cumulative effects in the far-field receiving environment.

Section 42A report

61 The technical report in the S42A report that relates to my evidence is that by Dr Leslie Bolton-Ritchie. In general, Dr Bolton-Ritchie and I are in agreement, but there are some exceptions that I will discuss below, along with any recommendations on consent conditions Dr Bolton-Ritchie made that I endorse.

62 In Paragraph 10 of Dr Bolton-Ritchie's report, Dr Bolton-Ritchie recommends treating the "expected" concentration as mean value for the purposes of compliance. Using a mean is conservative (and therefore protective of ecosystem health) and I support her recommendation.

63 In Paragraph 11, Dr Bolton-Ritchie indicates that faecal coliforms and enterococci spp. should not be grouped together and require units. The AEE grouped the two faecal indicator bacteria types together because the proposed limits were identical (agreed by Dr Bolton-Ritchie and the Council officer). The lack of a units was unintentional, for consistency with the RECP I agree that the units of any compliance condition should be cfu/100 mL.

64 I disagree with Dr Bolton-Ritchie that the limits for metals should be for the dissolved fraction (Paragraph 12). The use of total, or, more specifically, the total-recoverable fraction using standard laboratory testing methods is more appropriate. The dissolved fraction is the more ecologically relevant fraction, but since the dissolved fraction is a subset of the total-recoverable fraction, the use of totals as a consent limit is more conservative. Total samples are also less expensive and easier for OCD to collect since total-recoverable samples do not need filtering.

65 Concentrations of all metals and metalloids of concern in the discharge will be below their respective ANZG 2018 99th percentile guideline values (Paragraph 38 of Dr Bolton-Ritchies's report) in normal conditions. In calm conditions, concentrations of total chromium (0.17 mg/m^3) may not meet the guideline value for chromium (VI) of 0.14 mg/m^3. I do not consider there would be any adverse effects. I base this conclusion on chromium VI being very unlikely to be the dominant species in water with high sulphate concentrations (such as seawater), as discussed in the supporting documentation for chromium VI in ANZG (2018). In addition, the supporting documentation notes the lowest measured No-Observable Effects Concentration (NOEC) for chromium VI is 2.5 mg/m^3, and 2.6 mg/m^3 if only Australasian species are considered. These values, which represent the lowest known concentrations at which no adverse effects are observed in laboratory conditions, are more than ten times the concentrations predicted in calm (i.e., worst-case) conditions.

66 The 99th percentile guideline value for Cr(III), which is the dominant form of chromium in oxidised environments, is 7.7 mg/m^3. This value is more than 400 times higher than modelled for the discharge.

67 I agree with Dr Bolton-Ritchie that there were gaps in the data for trace chemicals that could be present in the outfall in ODL's Section 92 response. I provide an updated version of "Table 2" of Dr Bolton-Ritchie's report as Table B-2 in Appendix B to my evidence. Consistent with my evidence above, concentrations of trace chemicals in the discharge will be below relevant ecotoxicological values prior to discharge. With at least 300 times dilution I thus consider the risks, associated with these chemicals, whether direct (toxicological) or indirect (bioaccumulation) are *de minimis.*

68 Although I do not consider there will be significant "flocculation" of suspended marine solids as a consequence of the proposal, I agree with Dr Bolton-Ritchie that five-yearly sediment monitoring would be appropriate for this type of consent (Paragraph 29). Such monitoring is an effective way to address any residual uncertainty about the potential effects of the discharge. Such conditions are standard for marine outfalls, such as the new (2020) resource consent for the discharge to the marine environment from Watercare's Army Bay wastewater treatment plant, and as applies to Christchurch City Council's treated wastewater outfalls.

69 In Paragraph 37, Dr Bolton-Ritchie cites a value of 500 mg/m^3 for ammoniacal nitrogen in seawater in ANZG (2018). This value is the default trigger carried over from the ANZECC (2000) guidelines. I used more recent (and more protective) research in my assessment, as I discussed earlier in my evidence.

70 I share the general concerns Dr Bolton-Ritchie raises about the potential effects of nutrient loading (Paragraphs 41 and onwards), but I consider Dr Bolton-Ritchie has overstated the actual risks of the proposal. As I discussed earlier in my evidence, and in agreement with Dr Bolton-Ritchie, for coastal algal blooms nitrogen is the limiting nutrient, but I reiterate that blooms along the South Canterbury Coast are contingent on more than just nutrient availability. I maintain that a 1% "exceedance" for dissolved inorganic nitrogen will not lead to more than minor effects on the observed frequency of algal blooms, especially since such exceedances will only occur in calm conditions that are unlikely to persist beyond a matter of hours.

Commissioners' Questions

71 I cover issues related algal blooms and the magnitude of potential effects in Paragraphs 38-49 of this evidence, and my response to the S42A report (Paragraphs 53-61) covers most of the other questions the Commissioners raised that relate to my area of expertise. The outstanding matters relate to what ODL would need to do in the event of an algal bloom forming, potential effects on salinity, and the proposed consent conditions.

72 Should an algal bloom form about the outfall then, irrespective of what has caused the bloom, I consider that ODL would need to either reduce its discharge (diverting wastewater to land irrigation) or reduce its nutrient loading to the coast while the bloom persists. Mr Duder/Mr Coutinho, in his evidence, weighs up the practicalities of these two options.

73 I have not addressed the effects of the discharge on salinity because such effects will be *de minimis*. With 300 times dilution, the maximum possible effect of the proposed dilution would be to cause a 0.3 % change in salinity, equivalent to 0.1‰, which is well within the natural range of variability (± 0.7‰, refer Table A-1 in Appendix A to this evidence). Such a change is very unlikely to affect the receiving environment (pelagic or benthic).

74 In Paragraph 56 I expressed my reservations about the adoption of dissolved metals as the compliance measurement of ODL's untreated discharge, but I agree the use of dissolved metals in the receiving environment is appropriate. However, I have concerns that Conditions 24 and 25 of the consent, which relate to receiving environment water quality, do not allow for natural background variation, especially for trace metals. I therefore propose the following change to condition 25 as currently written (amendments in bold:

74.1 "If the guideline values as outlined in condition (24) are met, **or median concentrations about the mixing zone are below the 80th percentile as measured at the two control sites**….."

74.2 An advice note explaining that the appropriate statistical analysis would need to be agreed upon with Environment Canterbury should also be added if my proposed amendment was accepted.

SUMMARY AND CONCLUSION

75 My key observations and conclusions are:

75.1 Oceania Dairy Limited's current wastewater discharge activities are constrained by the amount of land it can irrigate to.

75.2 The ability to discharge factory via an outfall to the Pacific Ocean would remove Oceania Dairy Limited's current constraints.

75.3 The receiving marine environment is pristine. Any discharge to this environment must aim to meet the strictest relevant guidelines for environmental protection, and therefore ODL will need to treat its wastewater to a higher standard than it currently needs to for its irrigation activities.

75.4 Factory wastewater will be treated sufficiently that the effects on the receiving water quality will be less than minor, even in calm conditions when there may be less dilution than under normal weather conditions. The only predicted exceedances of guidelines for pristine marine waters will occur in rare circumstances that will not persist beyond a matter of hours, and are very unlikely to cause more frequent planktonic algal blooms, which is the principal environmental risk of the proposal on receiving water quality.

75.5 In granting consent, ODL will be able to maximise the agronomic value of its wastewater in summer when it is dry, and reduce its environmental impact in wetter periods of the year and the shoulders of the dairy season.

Nathaniel Wilson
28 May 2020

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Appendix A

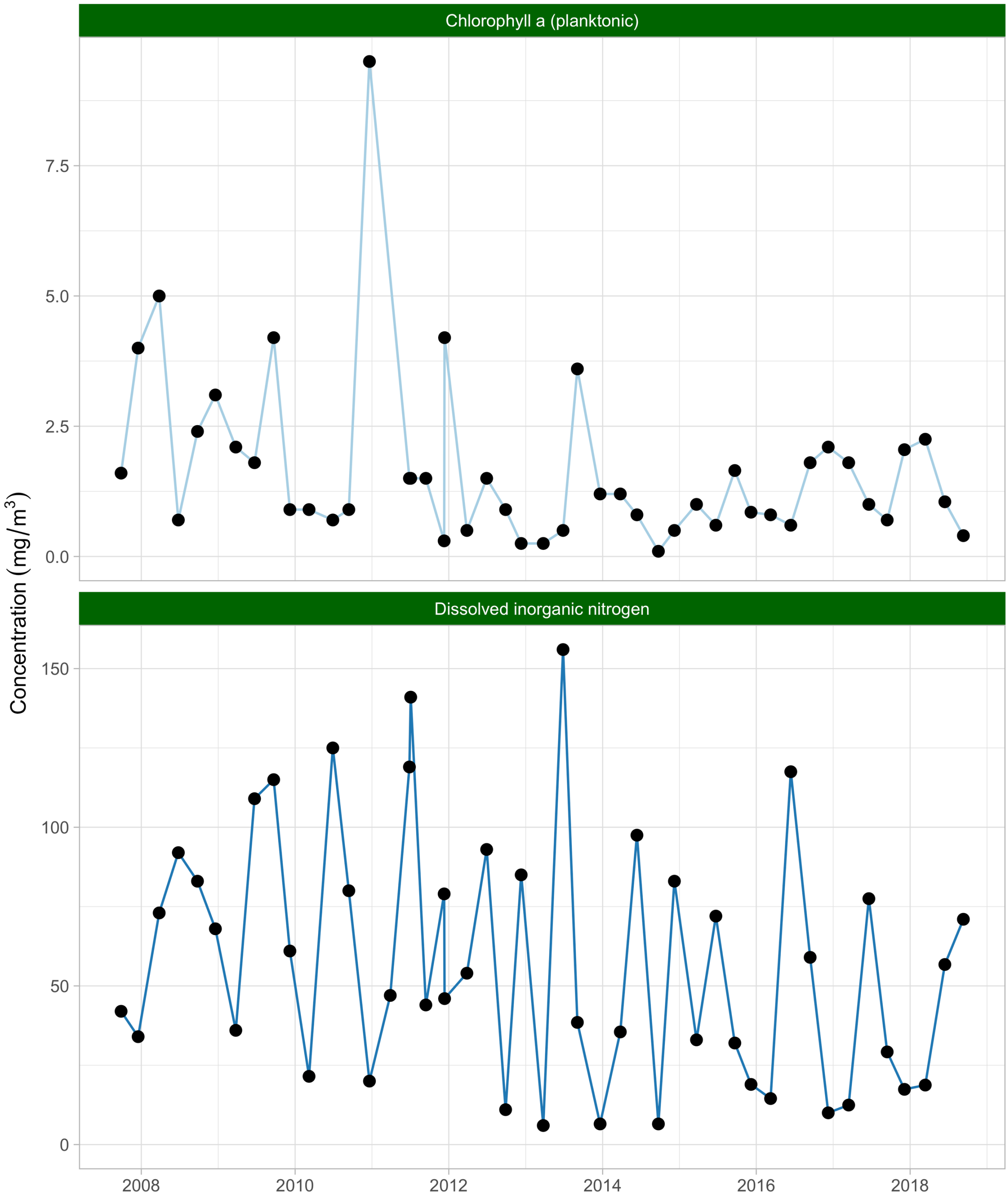
Table A-1 Receiving environment water quality data

Parameter	Units	Median	80 %ile
Temperature	°C	12.8 ± 0.4	15.6
pH	-	8.00 ± 0.02	8.10
Salinity	‰	28.9 ± 0.7	32.7
Total suspended solids	g/m^3	15.0 ± 3.6	35.0
Turbidity	NTU	6.3 ± 1.2	11.0
Ammonia-nitrogen	mg N/m^3	9.0 ± 1.0	16
Nitrite+nitrate		29 ± 5	70
Dissolved inorganic nitrogen		44 ± 5	83
Organic nitrogen		128 ± 8	159
Total nitrogen		175 ±8	250
Dissolved reactive phosphorus	mg P/m^3	4.3 ± 0.6	9.1
Total phosphorus		18 ± 2	32

Source: Environment Canterbury

Figure A-1

Historical data for local marine chlorophyll-a and dissolved inorganic nitrogen concentrations



Appendix B

Table B-1 Current and predicted discharge chemistry

Parameter	Units	Current concentration*	Expected concentration	95%ile concentration
Temperature	°C	30-40 at factory, ambient at discharge		
pH	-	6.8	6-9	
Chemical oxygen demand	g O_2/m^3	1,600	150	300
5-day biochemical oxygen demand	g O_2/m^3	980	30	50
Total suspended solids	g/m^3	220	50	70
Ammoniacal nitrogen	g N/m^3	6.7	2	4
Nitrite + nitrate		47	10	15
Dissolved inorganic nitrogen		54	12	15
Total nitrogen		95	15	20
Dissolved reactive phosphorus	g P/m^3	7.2	2	4
Total phosphorus		14	2	4
Faecal coliforms & Enterococci	cfu/100 mL	300,000	<100	
Arsenic	mg/m^3	<50 mg/m^3	<50 mg/m^3	
Cadmium		<2 mg/m^3	<2 mg/m^3	
Chromium		<50 mg/m^3	<50 mg/m^3	
Copper		<10 mg/m^3	<10 mg/m^3	
Lead		<5 mg/m^3	<5 mg/m^3	
Nickel		<15 mg/m^3	<15 mg/m^3	
Zinc		<100 mg/m^3	<100 mg/m^3	

Note:*Average concentration for July 2018-June 2019 (last full dairy year)

Table B-2 Trace cleaning chemicals and relevant environmental guidance values

Chemical	Product	Guideline/Lowest published ecotoxicity value	Undiluted concentration	Reference
2-(2-butoxyethoxy)ethanol	Topax 56 Topax 545 Ultramaxx Multiclean	>1,000	2	ECHA
2-(2-Ethoxyethoxy)ethanol	Topax 545	>1,000	2	ECHA
Acetic acid	Oxonia Active Perform	32,000	<100	USEPA ECOTOX
Alcohol ethoxylate	Ecolab MIP FPC Alkaline CIP Detergent	100	16	Jackson et al 2016
Alkylamine acetate	Sterilfoam	>2,000	32	López-Galindo et al. 2010
Dimethyldodecylamine n-oxide	Topax 56	>100	1-2	ECHA
Disodium EDTA	DPD free chlorine tablets	880	<1	USEPA
Dodecylbenzene sulfonic acid	Topax 545 Ultramaxx Multiclean	25	1-2	Jackson et al 2016
Fatty alcohol ethoxylates	Ecolab MIP FPC Alkaline CIP Detergent	100	16	Jackson et al 2016
Hydrogen peroxide	Oxonia Active Perform	2,900	420	Chhetri et al 2019
Peracetic acid	Perform	270	140	ECHA
Peroxyacetic acid	Oxonia Active	270	3	ECHA (synonym for peracetic acid)
Phosphate-esters	Oxonia Active Topax 56	16	1	Limited data. Single study on trout by Mayer et al (2005).
Phosphoric acid	Topax 545 Topax 56	NA	15-30	pH effect only
Potassium hydroxide	Topax 686	NA	16	pH effect only
Sodium hydroxide	Glissen Sodium hypochlorite Ultramaxx Multiclean	NA	1-16	pH effect only
Sodium metabisulfite		>8,000	310	ECHA
Pentasodium salt	Ultramaxx Multiclean	Not actually in named product		
Sodium salt		Not actually in named product		
Sodium hypochlorite	Sodium hypochlorite Topax 686	250	15-480	López-Galindo et al. 2010

Chemical	Product	Guideline/Lowest published ecotoxicity value	Undiluted concentration	Reference
Sodium phosphate dibasic		NA	<1	pH effect only
Triphosphoric acid	Ultramaxx Multiclean	Not actually in named product		
Proprietary formula	Solus AP24	>2,500	800	MSDS with precautionary 10^{-3} factor applied

Notes: ECHA: European Chemicals Agency; USEPA: United States Environmental Protection Agency