BEFORE INDEPENDENT HEARING COMMISSIONERS APPOINTED BY THE NORTHLAND REGIONAL COUNCIL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by the Far North District Council for resource consents associated with the operation of the East Coast Bays Wastewater Treatment Plant

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Statement of evidence of Rebecca (Becky) Joanne Macdonald (wastewater) dated 10 June 2019

Qualifications and Experience

1. My full name is Rebecca Joanne Macdonald. I am usually called Becky.

2. I am employed by Jacobs New Zealand Ltd (Jacobs), an engineering and environmental consultancy firm, with a role of the Principal Wastewater Engineer in New Zealand.

3. I hold a Bachelor of Engineering with first class honours (BE Hons) in Chemical and Process Engineering (2000) and a Doctorate in Philosophy Degree (PhD) also in Chemical and Process Engineering (2010), both from University of Canterbury in New Zealand. I am a Member of the Institute of Chemical Engineers (IChemE), a Chartered Engineer with Engineering Council, and a Fellow of IChemE. I am currently the Chair of the New Zealand Board of IChemE. I am a member of the Technical Committee of Water NZ.

4. I have 17 years' experience in the field of wastewater and water engineering. I started my career at Beca Steven Limited and worked for them between 2000 and 2004. I then joined Canesis Network Limited (later purchased AgResearch Limited, a Crown Research Institute in New Zealand) where I worked from 2004 to 2010. During this period, I studied part time towards my PhD. I then spent two years on extended parental leave. In 2012 I returned to consulting engineering, working at Beca Limited until the December 2018. At the beginning of 2019, I started by current role at Jacobs New Zealand Limited.

5. I regularly provide expertise in the field wastewater engineering. Examples of relevant roles I have undertaken in recent years include:

   (a) Technical lead and Project Manager for design, procurement, and construction stages Woodend Wastewater Treatment Plant (**WWTP**) upgrade. This project included adding a second screen to the inlet structure, the construction of a new aeration basin and a new oxidation pond. It was followed by a second stage, during which the constructed wetlands were upgraded with new flow paths and planted zones.

(b) Project Director and technical lead for a project investigating the options for small scale wastewater treatment and disposal at Goose Bay near Kaikoura. The WWTP is located on land owned by Ngāi Tahu and is in a sensitive coastal environment of cultural significance (mahinga kai).

(c) Lead wastewater process engineer for the Christchurch WWTP, under a Continuing Professional Services Agreement. I provided wastewater treatment and processing technical oversight to all projects being undertaken (at times over 20 projects at the plant). Specific project examples include pond upgrades, inlet works modifications for tanker waste, trickling filters repairs, biofilter refurbishment, operational debottlenecking, and many more.

6. I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Practice Note 2014, and I agree to comply with it as if this hearing was before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Background and Role

7. My role in East Coast Bays Wastewater Treatment Plant (the **Plant**) reconsenting is recent. I have undertaken a technical review existing reports by others and formed a professional opinion on appropriate treatment and disposal for this project. The documents I have reviewed that are relevant to the wastewater treatment are as follows:

(a) The 2006 report "East Coast Sewage Treatment Plant Review" by MWH New Zealand Limited;

(b) The Assessment of Environmental Effects (AEE) prepared by VK Consulting Environmental Engineers Ltd 2008;

(c) The section 92 response prepared by VK Consulting Environmental Engineers Ltd, 2010;

(d) The ecological assessment prepared by Wildlands Limited;

(e) The East Coast Bays WWTP: Land Disposal Feasibility Study by Opus in 2013;

(f) The 2018 report "Taipa WWTP Upgrade Issues and Options" prepared for Hui #1 by AECOM New Zealand Limited;

(g) The 2018 report on Taipa WWTP Upgrade Issues and Options prepared for Hui #2 by AECOM New Zealand Limited;

(h) Sludge Survey Report by Conhur of April 2018; and

(i) The section 42A report prepared by Northland Region Council in 2019.

Scope of Evidence

8. My evidence will address the following:

(a) Response to the Council Officer's s42A Report

(b) Treatment and disposal of wastewater from the Plant; and

(c) The proposed conditions.

Existing System

9. I have described the Plant process as it is currently configured as the description of the contained in the s42A Report is not accurate.

10. The Plant is a pond-based system. Initially wastewater flows into the Plant through a new rotary screen to remove large solids with screenings stored in an open topped skip. The average dry weather flow from the Plant noted in proposed Condition 1 of the s42A report was 1570 cubic meters per day. I have reviewed the past five years of flow data and calculated the average dry weather flow to be approximately 650 cubic meters per day. Adjusting for 2 percent population growth over 10 years, and including a safety factor, I estimate the average dry weather flow to be 790 cubic meters per day in 2029. This is the flow rate I have used in my assessment and

review. Using the same approach, I have estimated the 95 percentile wet weather flow to be 2,130 cubic meters per day.

11. Initially screened wastewater flows into three deep basins (with approximately the same dimensions) which operate in series. FNDC advise all three basins are nominally 4.0 meters deep. The 2006 MWH report states each basin has an approximate volume of 6,070 cubic meters, however my calculations estimate a total volume of all three ponds of approximately 6,000 cubic meters. These basins were originally designed with two surface aerators each, however, over time the operation has changed. Basin 1 currently has two 7.5 kW, sub surface, directional (impellor style) aerators and is fully mixed. Basin 2 has no aeration and solids build up in the base over time. Basin 3 contains one 7.5 kW sub surface, directional (impellor style) aerator. Under ideal conditions, the theoretical retention time in all three basins under average dry weather flow conditions is approximately 7.7 days in all three basins.

12. Basin 3 discharges into the oxidation pond, which contains no mixing or aeration. FNDC advise the oxidation pond is nominally 1.6 meters deep and 2006 MWH report identifies an approximate surface of 11,300 square meters. Thus, the theoretical retention time in the oxidation pond is 22.9 days. At the outlet of the oxidation pond, wastewater is pumped through two 30kW pumps (operating in duty / standby arrangement) along a single pressure pipeline to the wetlands, located approximately 1km away.

13. There are four constructed wetlands operating in series, with a total surface area of approximately 8850 square meters stated in the 2006 MWH report. FNDC advise these ponds are nominally 0.5 meter deep, thus, the theoretical retention time is 5.6 days. These wetlands are planted with native wetland plants and have a sub-surface connection between each wetland. Wetland 4 discharges into a local unnamed creek (drain). This creek then connects to Parapara Stream, approximately 200 meters upstream of dairy farm effluent ponds. FNDC advised that the farm recently stopped milk production and is currently only used for stock grazing.

14. FNDC have advised that the basins, oxidation pond, and wetlands are all clay lined. Clay liners do not provide a complete seal to wastewater egress and seepage is commonly observed. Overtime, sludge build up can reduce seepage, especially if there is no agitation. I have concluded that seepage from the oxidation pond and wetlands is likely to be low as these have been operating for many years so will have a layer of sludge on the base. Also, the oxidation pond and wetlands do not have mechanical aerators.

15. The sub surface, directional (impellor style) aerators in basins 1 and 3 create well mixed conditions, particularly in Basin 1 and there is unlikely to be significant sludge layer on the base. If the clay liner is not protected directional mixers can cause scouring of the liner beneath the mixer. During a site visit on 31st May 2019 the Plant operator advised that significant scouring of the liner was observed when the basin was "recently" drained (specific date unknown, but understood to be during 2018).

16. In 2014 to 2018 the annual average influent to the Plant was 572 cubic meters per day and the annual average effluent from the wetlands was 615 cubic meters per day. The AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" found that rainfall on the surface of the ponds and wetlands as well as stormwater flow from surrounding farmland into the wetlands was the cause of this discrepancy. In 2018 period, the peak wet weather flow was 2,655 cubic meters per day and the 95 percentile (wet weather) flow was 1,782 cubic meters per day.

17. The performance of the existing Plant is presented in 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" and FNDC have advised that there has been no significant change in the performance of the Plant since this report was prepared.

Table 1 Taipa WWTP Discharge Quality

Water Quality Parameter	Unit	Trigger Level	Average Level Recorded	Maximum Level Recorded
Ammonia (NH_4-N)	mg/L	5.0	9.4	34.0
TSS	mg/L	60	27	111
BOD	mg/L	60	14	44
Faecal coliforms	cfu/100mL	1,000	269	1,300

18. Table 1 shows *faecal coliforms* presented as an average. *Faecal coliforms* and other pathogens are usually best presented using a log scale as single "high" events can skew the data. Thus, it is normal practice to present typical pathogen levels as a 50th percentile or median.

19. The data presented in Table 1 is from February 2012 to May 2015. The s42A report presents data summarized from 2008 through to 2019. However, this data is presented in a form that cannot be critically reviewed. Given over the last ten years there have been changes in operation of the Plant and changes in the community that produces the wastewater, I do not consider it appropriate to consider data older than 2012, preferably data no old than 5 years.

20. From Table 1, I have concluded that total solids (TS), biological oxygen demand (BOD_5), and pathogens (measured as *faecal coliforms*) are all adequately treated in the Plant in its current configuration. However, adequate ammonia (NH_3-N) treatment is not being achieved. Thus, I have concluded that improvements to the existing Plant should be focused on the reduction of ammonia.

Wastewater Treatment Options

21. Table 2, in the 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" proposes the future treatment quality for

the treated wastewater from the Plant. These treatment conditions are in line with other similar plants.

22. A range of studies have been undertaken on the treatment options for the Plant. The most recent is the 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2". This report describes a long list of 14 treatment options, including business-as-usual (BAU) option of "do nothing". A hui (Hui #1) with stakeholders and local iwi. resulted seven options being eliminated, generating a short list of seven treatment options to take forward for multicriteria assessment.

23. The 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" provides a comprehensive multicriteria assessment of the shortlisted options.

Table 2: Multicriteria Assessment of the Shortlisted Options

Option No	Option Description	Infrastructure Requirements and Technical Limitations						Operational Issues			Environmental Impacts & Constraints						Stakeholder Satisfaction
		Technology Reliability	Safety of Supply	Footprint	Compatibility with Existing Infrastructure	Future Proofing	Constructability	Operational Complexity	Operation & Maintenance Safety	Local Technical Support	Sustainability	Ecological Impact	Noise & Vibration	Visual Impact	Current Consentability	Future Regulatory Requirements	Public Acceptance
1	Sequencing Batch Reactor with UV	H	H	H	L	H	H	M	H	H	M	H	M	H	H	H	H
2	Membrane Bioreactor	H	M	H	L	H	H	L	H	H	L	H	M	H	H	H	H
5	Algae Bioreactor pond upgrade with Electrocoagulation and UV	L	L	H	H	M	H	M	M	L	L	M	H	M	M	M	M
10	Submerged Media pond upgrade with Dissolved Air Flotation and UV	L	H	M	H	L	M	M	L	H	M	L	M	H	M	L	L
11	Enhanced Pond System pond upgrade with UV	M	H	L	M	M	M	H	L	M	H	M	H	M	M	M	M
12	Carrousel configuration pond upgrade with Clarifier and UV	M	H	H	H	M	H	M	H	H	M	H	M	H	H	M	M
14	Business as Usual – pond system with no upgrades and constructed wetlands	L	H	H	H	L	H	H	M	H	M	L	M	H	L	L	L

24. My review of the shortlisted options assessment is largely in agreement with that presented in the 2018 AECOM report, with the following exception:

(a) Five of the shortlisted options include additional disinfection in the form of ultraviolet (UV) light. Ponds expose the wastewater to sunlight which provides disinfection to the wastewater. My conservative calculations indicate pond and wetland area could theoretically provide up to 3 log reduction in pathogens based on an ADWF of 790 cubic meters per day (USEPA, Principles of Design and Operations of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers, EPA/600/R-11/088, August 2011). The data shows that the existing pond-based treatment system and wetlands achieves an average of 269 cfu/100ml and it can be expected that the median is lower than this. This measurement is taken after the wetlands, where there will be a significant contribution from birds and other animals which are not specific human pathogens. Thus, I have concluded that there is no justification for additional disinfection, beyond that provide by the ponds and wetlands. Removing the UV disinfection has no significant effect on the outcomes of the multicriteria assessment. It will however, reduce the capital cost and operating costs by approximately $800,000.

25. The 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" does not provide a recommendation for treatment improvements. It can be seen for Table 2, that Option 1, Sequencing Bio-Reactor (SBR) has the most favourable multicriteria assessment and the lowest capital cost.

26. A well designed SBR is expected to improve the treatment performance of the Plant. The 2018 AECOM report "Taipa WWTP Upgrade Issues and Options prepared for Hui #2" suggest the following treatments improvements can be expected:

Table 3 Anticipated Treated Wastewater Quality with SBR

Parameter	Expected Treated Wastewater Quality
BOD_5 (mg/l)	1 – 15
Total Suspended Solids (mg/l)	2 – 15
Total Nitrogen (including ammonia) (mg/l)	3 – 15
Total Phosphorous (mg/l)	<10

Wastewater Disposal Options

27. The assessment of disposal options has been limited to land disposal in comparison to BAU, treated wastewater from the wetlands discharging into the creek. The 2018 AECOM report “Taipa WWTP Upgrade Issues and Options prepared for Hui #1” provides a comprehensive multicriteria assessment land disposal. Table 4 summarises the criteria that were assessed and presented in the report

Table 4 Multicriteria Assessment Land Disposal

No	Constraint Criteria	Description
1	Distance from WWTP	Radius of 5km from the current WWTP site defines the geographic boundary of any potential land disposal sites
2	Distance from Living Zones	Buffer of 300m from residential, coastal living, and rural living land zones to protect from wind drift of sprayed effluent, though this could be reduced by using sub-soil irrigation
3	Distance from Maraes	Buffer of 500m from Maraes to provide initial filter of sites with potentially higher cultural constraint considerations
4	Land Drainage	Sites with land drains or streams unsuitable – a buffer of 100m from each watercourse has been used for preliminary exclusion of unsuitable sites
5	Land Topography	Slope must be between 0 and 7 degrees, flat to undulating as identified by the Landcare slope class
6	Land Elevation	Elevation of site must be at least 2m (One Tree Point datum)
7	Distance to Power Supply	Maximum distance of 1km from existing high voltage power supply network connection point
8	Land Area	Area of site must be minimum 70ha (see below)

28. The assessment is undertaken using a robust and consistent methodology. Two sites are identified for further investigation, both within 5 km of the existing wetland discharge.

29. Further investigation in to the soils and hydrogeology of both sites is required for FNDC to ascertain if either of these sites is suitable for land disposal and define the discharge conditions such as nitrogen loading and hydraulic loading rates. Land would need to be purchased, or agreement reached with the landowners to use the land for treated wastewater disposal. Further planning requirements for the land and project funding would need to be addressed. It is anticipated that these steps would take several years to complete.

30. The wastewater currently passes through an existing wetland prior to discharge, in which the wetland plants are thriving. Upgrading the Plant with either an SBR or improving the wetlands would provide improved ammonia treatment. Combining improved wastewater treatment whilst continuing the existing discharge from the wetlands into the creek would result in reduced effects on the environment.

Response to the Council Officer's s42A Report

Response to Chapter 5

31. As previously mentioned, the s42A report does not accurately describe the operation of the Plant. I have described the plant as it is currently operated in paragraphs 10 to 13 above.

32. Nutrient removal from pond-based systems can vary with location, due to localized differences in climate (temperature, sunlight and other factors). The result is that design variables must be carefully selected for the local area where the ponds are located. Well designed and operated pond systems, with targeted aeration can provide effective wastewater treatment. Pond based systems work well in remote sites as they have low maintenance requirements and therefore low operating costs. They are also well suited to sites with seasonal fluctuations in population, due to the long retention time buffering out short term spikes in flow and concentration.

Summary

33. Overall, upgrading the Plant with a SBR as a short term, interim solution would provide reduced effects on the environment, while providing time for the land disposal investigations to be undertaken, including consultation and collaboration with the various stakeholders and affected iwi.

34. Wastewater treatment and disposal are intrinsically liked and cannot be considered in isolation. Some disposal solutions require a higher level of wastewater treatment, whereas others require a larger land area for disposal.

35. I recommend a two-staged approach as a pragmatic way forward. Initially FNDC upgrade the Plant to reduce ammonia concentration in the treated wastewater. Following this, a robust investigation into long term land disposal options should be undertaken.

Proposed Conditions

36. I have reviewed the conditions recommended in the s42a report and recommend a number of changes in line with what I have outlined previously in my evidence. These changes are as follows:

37. Schedule 1 Monitoring Programme, Section 1 Wastewater Volumes: Replace paragraphs 1 and 2 with the following:

    The consent holder must keep a record of the daily treated wastewater flow from the wetlands (midnight to midnight). A 30-day rolling average dry weather flow shall be calculated and recorded daily. A dry weather day shall be defined as any day with less than 10 mm rainfall.

    Paragraph 3 is unchanged.

38. Condition #1. The annual average dry weather flow discharged from the wetlands to the unnamed tributary of the Parapara Stream shall not exceed 790 cubic meters per day.

39. Condition #5. The Consent Holder shall check the operability of the flow meter required by Condition 3 no less than monthly and calibrate the flow meter no less than annually. This calibration shall be undertaken by a suitably qualified and experienced person. The calibration data shall be verified and the verified data sent to the assigned Northland Regional Council Monitoring Officer within one month of the calibration.

40. Conditions #8 to #12 (inclusive).

    (a) Condition #8. Within six months the Consent Holder shall have identified the preferred option to reduce ammonia levels in the treated wastewater discharged from the wetlands to an annual 95th percentile 15 grams per cubic meter.

    (b) Condition #9. Within three years the Consent Holder shall have completed implementation of the preferred option and have provided Northland Regional Council Monitoring Officer with 12 months of data showing ammonia levels in the treated wastewater discharged from the wetlands to an annual 95th percentile 15 grams per cubic meter.

(c) Condition #10. The Consent Holder shall monitor water quality in the creek, an unnamed tributary of the Parapara Stream, at NRC Sample Site 105941 no less than monthly. The monitoring data shall be collated and made available to the assigned Northland Regional Council Monitoring Officer annually.

(d) Condition #11. Within three years the Consent Holder shall have identified a preferred option for the disposal of treated wastewater from the wetlands and have advised Northland Regional Council of the preferred option.

(e) Condition #12. Within eight years the Consent Holder shall have implemented the preferred discharge option.