Before the Independent Hearings Panel
at Far North District Council

under: the Resource Management Act 1991

in the matter of: Submissions and further submissions in relation to the proposed Far North District Plan

and: Wastewater Treatment Analysis

and: **Lucklaw Farm Limited**

Statement of Evidence of Gavin Michael Sole (Wastewater Treatment) - Hearing 11 (Designations)

Submitter: Lucklaw Farm Limited - S551

Dated: 14 April 2025

STATEMENT OF EVIDENCE OF GAVIN MICHAEL SOLE

INTRODUCTION

1 My full name is Gavin Michael Sole.

2 My qualification is a Bachelor of Technology in Environmental Engineering from Massey University (1998). I have been working in the water industry in New Zealand for 26 years and have experience in water and wastewater reticulation, water and wastewater treatment, solid waste and on-site treatment. My wastewater treatment experience includes wastewater treatment modelling and design, inlet screens, aeration, membranes, anaerobic digestion, oxidation pond upgrades, and biosolids treatment and disposal.

3 I am a Director and Senior Environmental Engineer for Tiaki Environmental Limited based in Christchurch. I started Tiaki Environmental in October 2020. I have previously worked for larger consultancies, Councils and Contractors. My current active work includes industrial wastewater treatment, inlets screens and septage receival for wastewater treatment, wastewater consent reporting, and trade waste bylaw implementation.

4 I have been engaged by Lucklaw Farm Limited to provide evidence on its behalf on the wastewater treatment capacity of the Rangiputa Wastewater Treatment Plant (WWTP).

5 The information that has been used for this analysis is as follows:

5.1 Resource Consent Decision CON20070263501 Notified Replacement April 2007

5.2 SCADA-20241022-083631 Flow and Rainfall (excel worksheet)

5.3 Shilton, A. Pond Treatment Technology, IWA Publishing, 2005

5.4 Water New Zealand, New Zealand Good Practice Guide for Waste Stabilisation Ponds: Design and Operation, November 2017.

CODE OF CONDUCT

6 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the code of conduct for expert witnesses contained in part 7 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement 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.

SCOPE OF EVIDENCE

7 In my evidence I will, briefly, address:

7.1 Current wastewater reticulation and treatment system;

7.2 Current wastewater flows and rainfall;

7.3 Current monitoring results; and

7.4 Treatment capacity Residual matters that the Panel may wish to consider.

CURRENT RETICULATION AND TREATMENT SYSTEM

8 The Rangiputa township has a wastewater reticulation network and a pond treatment system. The reticulation network is mostly a gravity system with one pump station. Most of the gravity network is 150mm asbestos cement pipe with manholes at regular intervals. A map of the reticulation network is shown below (taken from the Far North District Council website - Far North Maps). The solid red lines are gravity pipes ,while the dashed line is a pump station rising main.

Figure 1. Rangiputa Wastewater Reticulation Network

9 The township consists of single dwellings with some that are holiday homes.

10 The Rangiputa WWTP is a three-pond treatment system owned and operated by the Far North District Council (FNDC) with disposal soakage via the last pond. Monitoring is taken from the outlet of Pond 2 and also from Bore 2. The three ponds are as follows:

- Pond 1 – facultative pond with a surface area of 900 m^2 and an assumed depth of 1.0 m (giving a volume of 900 m^3). It is not known if this pond has been desludged during it operational lifetime.
- Pond 2 - maturation pond with a surface area of 625 m^2 and an assumed depth of 1.0 m (giving a volume of 625 m^3). It is not known if this pond has been desludged during it operational lifetime.
- Pond 3 – a bunded ground disposal pond

11 Shown in the figure below is the Rangiputa WWTP with the ponds named.

Figure 2. Rangiputa Wastewater Treatment Plant (WWTP)

There is no screening of the wastewater before it enters Pond 1 (there is an inlet screen on site but is not used or connected). Screening of the wastewater is very important as it reduces the inorganic load (sediment) and sanitary items from building up on the bottom of the pond (this reduces the hydraulic capacity). The inlet screen should be connected.

12 Pond 1 design is based on an areal loading rate of 84 kg BOD/ha/d. This is a Ministry of Works standard design and was used for the design of many oxidation pond systems in the 1970s and 1980s. It is mostly still valid, although higher areal loading rates can be used depending on water and air temperature.

13 BOD is short for Biochemical Oxygen Demand. This is a measure of the organic load and how much oxygen is required to meet biological demands so that the organic matter is fully utilised (utilised for new cell growth for bacteria and algae). Typical domestic wastewater has a BOD concentration of 150-250 mg/L. High strength industrial wastewater can have a BOD concentration of 5,000 to 40,000 mg/L. Higher BOD concentrations require more area for ponds or additional mechanical aeration to meet the oxygen demands.

14 BOD is removed by biological activity in the ponds. The reduction of BOD across a pond is typically 70%. So if the BOD entering Pond 1 is 200 mg/L the BOD at the outlet of Pond 1 should be 60 mg/L. The same should occur across Pond 2, with the BOD at the outlet of Pond 2 expected to be around 18 mg/L. Normally BOD concentrations from pond systems range from 15 to 40 mg/L. The BOD concentration can be influenced by the number of algae in the pond effluent, so it is more realistic to filter the effluent to understand what the BOD concentration is with and without algal influence.

15 This is reflected in Schedule 1.2 c, where the BOD samples needs to be filtered through a Whatman Glass Fibre Size C or equivalent.

16 The Rangiputa WWTP has a resource consent for discharge of wastewater (Consent CON20070263501) issued 17th July 2008 with an expiry of 30th November 2032. The main conditions are:

- Schedule 1.1 (d) flow over 100 m^3/d requires the Consent Holder to identify the cause of the high inflow volume.

- Schedule 1.2 (c) At eight weekly intervals a grab sample of treated effluent shall be collected at the agreed Effluent Sampling Location and analysed for five day Biochemical Oxygen Demand (BOD_5). The sample shall be filtered via Whatmans Glass Fibre size C (GFC), or equivalent, for the purpose of removing algae, prior to undertaking the analysis. The results shall be reported as filtered BOD5.

- Schedule 1.3 (b) At four monthly intervals a sample of groundwater from NRC Sampling Site 104873 shall be collected and be analysed for the following:

Parameter	Units
Conductivity	mS
Nitrate Nitrogen	mg / L
Faecal Coliforms	mg / L

- Schedule 1.4. Reporting is required on an annual basis for the items listed above.

17 There are no limits for the discharge to ground for Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Nitrogen (TN), Total Phosphorus (TP) or Faecal Coliforms (FC). This is likely to change with the renewal of the resource consent in the 2032. It is expected that more stringent conditions would be required for a new consent, which would require an upgraded treatment process.

18 Taumata Arowai is currently reviewing limits for wastewater discharge and will look to have standard discharge conditions as well as standard treatment options for wastewater to achieve the conditions. The proposed discharge limits are out for consultation at the moment with the consultation period closing on 25th April 2025.

19 It is likely that a standard set of discharge conditions will be developed for oxidation pond systems based on discharge limits for BOD, TSS, TP, TN and FC. It is not clear what these will be and when they will take effect e.g. once the consent has expired or immediately.

20 The proposed discharge limits that are out for consultation do not include discharge standards for rapid infiltration beds or soakage fields. These are to be addressed at a later date.

RANGIPUTA WWTP FLOW AND RAINFALL

21 Flow and rainfall data has been provided by the FNDC for analysis. Daily inlet flow data is provided from the 01/09/2021 to 20/10/24. Inlet flow data was analysed from the 13/04/24 to 20/10/24, as data prior to this is not accurate as there have been historical inaccuracy issues with the inlet flowmeter. From the 13/04/24 the inlet flow data looks reasonable, and it is this data that has been analysed.

22 Rainfall data for the same period (13/04/24 to 24/10/24) has also been analysed to determine correlation and impacts of rainfall on wastewater inflows. Rainfall enters the wastewater reticulation through inflow (direct connections to the wastewater reticulation such as stormwater downpipes) or infiltration (groundwater entering the wastewater reticulation through broken pipes or leaking manholes etc). Rainfall typically enters most wastewater reticulation systems and has a significant impact on increasing flow volumes and therefore adverse negative impacts on treatment performance and capacity.

23 Shown in the graph below is Rangiputa WWTP inlet flow data and rainfall for the period 13/04/24 to 19/10/24.

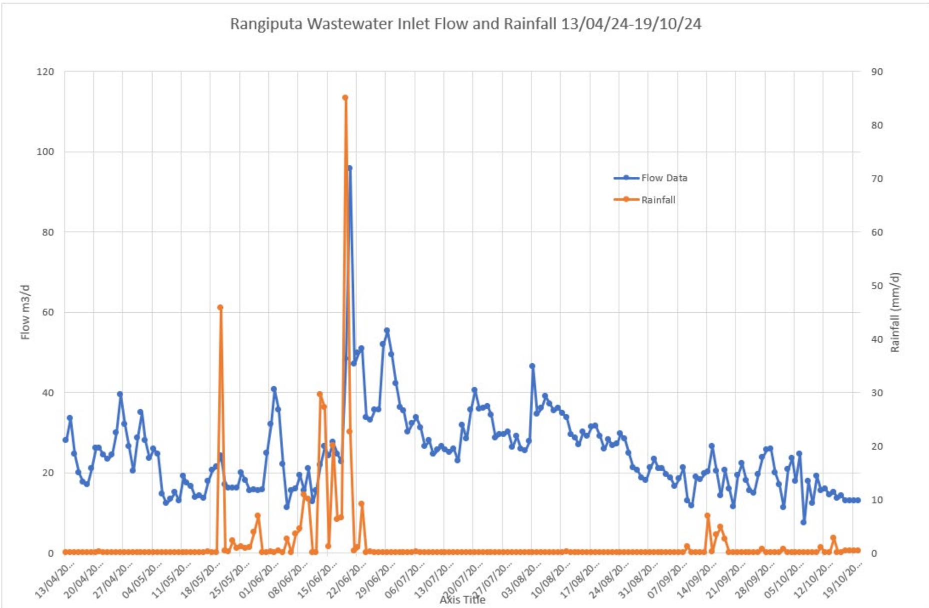

Figure 3. Rangiputa WWTP Inflow and Rainfall (13/04/24 to 19/10/24)

24 From the inflow and rainfall data above the following is surmised:

- Average flow for the data is 25.01 m^3/d - well within the consent limit.
- 90th percentile flow for the data is 36 m^3/d.
- Peak flow is 95.8 m^3/d - very close to the consent limit.
- Peak flow occurred following a significant rainfall event on the 19/06/2024 of 85 mm. This indicates that there is significant inflow within the Rangiputa wastewater reticulation network.

25 To stay within the current consent limits inflow from rainfall events needs to be reduced as much as possible. High flows through a wastewater treatment system wash out the biomass and reduce treatment performance. It can take weeks for the biomass within a wastewater treatment plant to recover from a high flow event.

26 The FNDC should be implementing a program of works to reduce inflow into the wastewater reticulation system. This program of works could include items such as

smoke testing and physical inspections of properties to ensure stormwater downpipes are not connected to wastewater gully traps (this is quite common).

RANGIPUTA TREATMENT CAPACITY

27 The pond system was analysed to determine what the treatment capacity of the current system is to meet the current consent conditions. The analysis looked at a range of flows (20, 40, 60, 80 and 100 m^3/d) as well as varying organic strengths of the wastewater for BOD, which is normally between 150 – 250 mg/L for domestic wastewater (values for 150, 200 and 250 mg/L BOD were used in the analysis).

28 The following was assumed:

- Pond 1 area is 900 m^2.
- Pond 2 area is 625 m^2 .
- Loading rate for both ponds is 84 kg BOD/ha.d
- Removal efficiency for BOD removal for Pond 1 is 70%.
- Oxygen demand for BOD removal is 1.25 kg O_2/kg BOD.
- Aeration efficiency for a surface brush aerator is 1.80 kg O_2/kW.
- Sludge levels in both ponds are at acceptable levels.

29 Given the treatment ability is based on a surface area loading rate, the depth of the ponds does not affect treatment performance. In reality, if the pond has high levels of sludge, this will begin to anaerobically digest at a level that will affect pond performance. No sludge survey appears to have been completed.

30 Pond 1 was first analysed for treatment capacity for varying flows and loads. This analysis is shown in the table below.

Table 1. Rangiputa WWTP Pond 1 Treatment Capacity Assessment

Flow (m^3/d)	BOD Concentration in influent (mg/L)	BOD Incoming Wastewater Load (kg/d)	BOD Treatment Capacity (kg/d)	BOD Treatment Capacity Shortfall (kg/d)	Extra Oxygen Required (kg O_2 /day)	Surface Brush Aerator Kilowatts needed (kW)
20	250	5	7.56	-2.56	-3.20	-1.78
20	200	4	7.56	-3.56	-4.45	-2.47
20	150	3	7.56	-4.56	-5.70	-3.17
40	250	10	7.56	2.44	3.05	1.69
40	200	8	7.56	0.44	0.55	0.31
40	150	6	7.56	-1.56	-1.95	-1.08
60	250	15	7.56	7.44	9.30	5.17
60	200	12	7.56	4.44	5.55	3.08
60	150	9	7.56	1.44	1.80	1.00
80	250	20	7.56	12.44	15.55	8.64
80	200	16	7.56	8.44	10.55	5.86
80	150	12	7.56	4.44	5.55	3.08
100	250	25	7.56	17.44	21.80	12.11
100	200	20	7.56	12.44	15.55	8.64
100	150	15	7.56	7.44	9.30	5.17

Note

- Cells shaded green (showing negative numbers) show that Pond 1 requires no additional aeration.
- Cells shaded orange show a shortfall of less than 2 kg/d BOD treatment capacity.
- Cells shaded red show a shortfall of greater than 2 kg/d BOD treatment capacity.

31 From the table above the following is observed:

- Pond 1 treatment capacity is about 40 m^3/d at a BOD concentration of 200 mg/L with no aeration needed.

- Anything greater than 40 m^3/d at a BOD concentration of 200 mg/L requires additional mechanical aeration.

- A flow of 100 m^3/d at a BOD concentration of 200 mg/L requires a surface aerator with at least 8.64 kW of power with an oxygen transfer efficiency of 1.8 kg O_2/kW.

32 With higher flows the BOD concentrations will be lower due to dilution volumes from inflow and infiltration entering the wastewater reticulation system so Pond 1 will still function well enough.

33 What the analysis shows is that growth with higher levels of flow and load during dry weather flows (i.e. no inflow and infiltration) will be bound at a limit of 40 m^3/d before additional aeration is required. The flow analysis above showed that average flow is approximately 25 m^3/d, allowing for another 15 m^3/d for growth without needing additional aeration.

34 If we assume that water demand is about 750 litres per house per day, this is another 20 houses that could be connected. Above this flow additional aeration would be permanently required, as well as dissolved oxygen monitoring to control start/stop times for aeration.

35 Pond 2 was also analysed with the same flows as Pond 1 and assuming that Pond 1 reduced the BOD concentration by 70% (this also assumes that full aeration requirements are meet for Pond 1).

36 This analysis is shown in the table below.

Table 2. Rangiputa WWTP - Pond 2 treatment Capacity Assessment.

Flow (m^3/d)	BOD Concentration in influent (mg/L)	BOD Incoming Wastewater Load (kg/d)	BOD Treatment Capacity (kg/d)	BOD Treatment Capacity Shortfall (kg/d)	Extra Oxygen Required (kg O_2 /day)	Surface Brush Aerator Kilowatts needed (kW)
20	75	1.5	5.25	-3.75	-4.69	-2.604
20	60	1.2	5.25	-4.05	-5.06	-2.813
20	45	0.9	5.25	-4.35	-5.44	-3.021
40	75	3	5.25	-2.25	-2.81	-1.563
40	60	2.4	5.25	-2.85	-3.56	-1.979
40	45	1.8	5.25	-3.45	-4.31	-2.396
60	75	4.5	5.25	-0.75	-0.94	-0.521
60	60	3.6	5.25	-1.65	-2.06	-1.146
60	45	2.7	5.25	-2.55	-3.19	-1.771
80	75	6	5.25	0.75	0.94	0.521
80	60	4.8	5.25	-0.45	-0.56	-0.313
80	45	3.6	5.25	-1.65	-2.06	-1.146
100	75	7.5	5.25	2.25	2.81	1.563
100	60	6	5.25	0.75	0.94	0.521
100	45	4.5	5.25	-0.75	-0.94	-0.521

Note

- Cells shaded green (showing negative numbers) show that Pond 2 requires no additional aeration.
- Cells shaded orange show a shortfall of less than 2 kg/D BOD treatment capacity.
- Cells shaded red show a shortfall of greater than 2 kg/d BOD treatment capacity.

37 Table 2 shows that Pond 2 works well most of the time even at higher flows. However, this only works if Pond 1 has additional aeration to meet the BOD demand.

38 It is not clear from the operation and maintenance manual if additional aeration is supplied during higher flow periods and what are the specifications of the aerator (kilowatts and oxygen transfer efficiency).

RANGIPUTA WWTP - EVOPORATION AND SEEPAGE

39 Rangiputa Oxidation ponds could be losing water through both surface evaporation and through seepage if the ponds are not fully sealed and/or unlined.

40 If this is the case the New Zealand Good Practice Guide for Waste Stabilisation Ponds: Design and Operation (November 2017, page 32) indicates that evaporation and seepage is about 150 m^3/ha.d for an oxidation pond.

41 Given the pond areas of Pond 1 at 0.09 ha and Pond 2 at 0.0625 ha this is 22.88 m^3/d that potentially be lost due evaporation and seepage (weather and time of year dependent). So, during some periods there may be little or no flow coming out of Pond 2 going to Pond 3.

42 This should be confirmed by actual flow measurements for incoming and outgoing flow.

CONCLUSION

43 The Rangiputa WWTP is a small 2 pond based system with a third pond used for soakage for the treated effluent serving a small coastal community.

44 The wastewater reticulation network is mostly gravity with one pump station. Analysis of wastewater flow and rainfall events indicates that stormwater has a significant negative effect at times increasing the flow through the WWTP to a point where it is almost reaching the consent limit of 100 m^3/d. High wastewater flows can wash out biomass within the WWTP reducing the treatment effectiveness for organic removal.

45 FNDC should investigate causes of stormwater entering the system and reduce this as much as possible.

46 Based on the current size and depth of Ponds 1 and 2 wastewater from the Rangiputa catchment can be treated effectively up to a flow of approximately 40 m^3/d. Above this flow additional mechanical aeration is required to meet oxygen demands.

47 A wastewater inlet screen is on site but appears to be not connected. This should be connected as it stops larger items and sanitary material from entering the pond system. This builds up over time and reduces hydraulic capacity of the WWTP.

Dated: 14 April 2025

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Gavin Michael Sole