MEMORANDUM **Job 10684**

To:	Hilary Lough & Oliver Hunt (Pattle Delamore Partners)
From:	Hamish Lowe & Sam Morris (Lowe Environmental Impact)
Date:	6th December 2022
Subject:	Pōrangahau/Te Paerahi Land Discharge Consent – Version 9 Conditions – OverseerFM Modelling Review Summary

This memo has been prepared following a technical meeting held on the 1st of December 2022 between Central Hawke's Bay District Council (CHBDC) and Hawke's Bay Regional Council (HBRC) associated with the consent conditions to enable the land application of Pōrangahau and Te Paerahi's wastewater. Specifically, this memo has been prepared in relation to Condition 52 (version 8 conditions) relating to nitrogen (N) and phosphorus (P) loading rates to the Discharge Property.

BACKGROUND

As part of the consenting process, consent conditions are currently being developed between CHBDC and HBRC. Prior to this technical meeting, CHBDC prepared and circulated a response and a further marked up copy of consent conditions (effectively becoming version 9 conditions). This technical meeting was then held to discuss these version 9 conditions and CHBDC's changes.

One of the larger outstanding consent conditions being discussed is Condition 52, being the application rates of N and P to the Discharge Property via both wastewater and fertiliser. CHBDC and PDP have both proposed maximum application rates of N and P to the Discharge Property that differ significantly from one another. PDP have also included with version 8 conditions a new whole property average loading rates of N and P - which are significantly lower than what were originally proposed by CHBDC.

PDP notes that their loading limits in version 8 conditions relate to loads modelled at Stage 3a within the OverseerFM summary memo (LEI, 2021:P:C.14a) prepared as part of the main consent application, to which subsequently informed the water quality assessment on the Pōrangahau River (Beca, 2021:P:D.25). PDP have questioned why CHBDC are requesting maximum N and P loading rates above what has been assessed within the LEI reporting.

Further, there has been debate as to the appropriateness of the nitrogen and phosphorus concentration used in calculations and how that relates to treatment plant effluent discharge conditions, with PDP suggesting lower concentrations should be appropriate.

As part of the response prepared by CHBDC associated with version 8 conditions, CHBDC have reviewed the OverseerFM models prepared at the time of consent lodgement, particularly with regard to the whole property average N loading rates. The Stage 3a OverseerFM model

provided with the consent application contained a whole farm average N loading rate of 46 kg N/ha/yr (wastewater and fertiliser when averaged over the property).

Prior to the 1st December technical meeting LEI undertook a sensitivity analysis of the model to consider the resulting impact (leaching). This modelling added fertiliser to reflect a whole farm average loading rate of 100 kg N/ha/yr and 150 kg N/ha/yr.

STAGE 3A MODELLING

As part of the original consent application and associated OverseerFM modelling presented within LEI (2021:P:C.14a), the 'worst case' scenario for N leaching for Stage 3 (i.e. when the system is fully operational) was Stage 3a. Stage 3a models anticipated wastewater application rates for both the Pōrangahau and Te Paerahi communities should a 10,000 m^3 be constructed. It also included growth at 30 years out. As discussed in previous correspondence, the smaller the storage pond, the greater the land irrigation required at times when soil moisture may be higher and thus the greater the anticipated N leaching losses. CHBDC have confirmed within Condition 6 of conditions that a minimum of 20,000 m^3 of storage will be constructed, substantially greater than what is used within modelling.

In addition to the work described above, as part of discussing consent conditions with PDP, a rolling annual wastewater maximum has been established (new condition 5a). While the increase in storage will provide for significant mitigation of effects by ensuring more water is applied under a non-deficit irrigation regime, the annual limit will ensure there is not excessive application of water beyond than anticipated in the AEE.

NITROGEN CONCENTRATIONS

During the technical meeting between HBRC and CHBDC, discussions were had around the nitrogen concentrations of treated wastewater used within the OverseerFM, and how this relates to the nitrogen concentration numbers referenced within Condition 48 of the consent conditions.

Suggested Nitrogen Concentration

With reference to long-term N concentration numbers, CHBDC have suggested the following wording from Stage 2 onwards within Condition 48 relating to effluent quality limits from the new wastewater treatment plant (WWTP) at the Discharge Property. This is as follows:

'The Consent Holder must ensure that the treated wastewater meets the following standards prior to discharge to the irrigation and non-deficit (wet soils) irrigation system:
(c) In accordance with Conditions 3 and 5, the concentration of Total (TN) must not exceed the following:

a. *…*
b. *Stage 2 onwards: 35 g/m^3 for more than 6 out of 12 consecutive monthly samples, or 40 g/m^3 in more than 2 out of 12 consecutive monthly samples.'*

OverseerFM Modelling

Within the OverseerFM modelling, a nitrogen concentration of 20 g/m^3 was used to determine nitrogen loads irrigated at the Discharge Property. At the time, this limit was believed to be a realistic nitrogen concentration to be used as a placeholder within OverseerFM modelling in the absence of definitive numbers.

As noted, OverseerFM modelling was undertaken using average wastewater flow and nitrogen concentration data. With these values being anticipated averages, CHBDC does not consider it to be appropriate for these to then become consenting limits. There is a need for a buffer to account for the refinement of the WWTP design post consent granting and then general operational variability. CHBDC considers a buffer to the compliance median of 35 g/m^3 as being appropriate to manage this.

The key here is a value used as a seasonal average (as was the case with the OverseerFM modelling) to determine design loadings should not be used as a compliance value, with the obvious being there is a risk that 50 % of the time the system will be in non-compliance.

CHBDC have also questioned in the past the need for both a N concentration limit within discharged wastewater, as well as a N mass load condition to the Discharge Property. Whilst there is agreement that the use the discharge to IMU 3 needs to be managed appropriately to ensure high loading rates to this area are not adopted, all the assessments as part of the consent application have been undertaken on a mass load basis rather than a concentration. Although nitrogen concentrations within wastewater are important, it could be argued that having a mass load limit (Condition 52) correspondingly manages nitrogen concentrations, as these are required to determine total N loading rates.

Debate and Recommendation

It is clear the concentration debate is whether a number that reflects the design value (and subsequent effects assessment) or an upper threshold is used – being a ceiling that should not be exceeded.

In CHBDC's view the design number shouldn't be used as it is an average, being that for a portion of the time it will knowingly be exceeded. The appropriate number to use should be the upper number.

Sticking with a road speed analogy, the time taken to get anywhere will be the average speed and this is used to calculate the arrival time. However, this is bounded by an upper speed limit of in most cases 100 km/h.

STAGE 3 WASTEWATER FLOWS

Projected Flows

Based on actual wastewater flow data from the two communities, as well as future projected population growth, the anticipated wastewater flows to the Discharge Property are known and have been modelled within OverseerFM.

In the technical discussions, PDP have highlighted the potential for the irrigation system to result in higher flow and greater nitrogen loads than projected in the assessments and modelling to date. They have then suggested that the higher loads may see a greater chance for leaching, increasing the potential migration of nutrients to surface water.

A separate but related issues is the potential uneven distribution of the water, meaning that some areas (specifically IMU 3) may have far greater leaching.

Greater Flows

Flow estimations from the communities are based on real data and incorporate projected growth. There is a limitation on volumes; so there is a limit to the volume of water and nutrients that are available to irrigate i.e. need to keep in perspective there is not an endless supply of water. To assist with this there is a cap (Condition 5a) on the annual volume that can be applied.

This consideration is important in so far as while there may be a theoretical risk, reality would suggest overloading and rates higher than projected are unlikely.

SENSITIVITY ANALYSIS

If more nitrogen is applied, what happens?

CHBDC are of the view that any variation of the nitrogen load from the anticipated design should be kept in perspective. The current OverseerFM modelling for the farm suggests an average loading rate of 46 kg N/ha/yr (note this is an average – OverseerFM is an annualised average model).

What is the resulting impact of more nitrogen than initially anticipated?

Being an average, some years there may be more applied; equally some years there will be less. This will be a result of a number of factors, particularly seasons with more or less wastewater flows that may impact on treatment and resulting nitrogen concentrations.

To assist with understanding the effects of more nitrogen applied under Stage 3, two scenarios have been considered. It has been assumed that the nitrogen mass loading has increased, while wastewater flows remained the same. The loadings are 100 and 150 kg N/ha/yr. This is to simulate the fact that average wastewater flows are known and thus should be modelled as they are anticipated – also the flows allow for conservative (high) flow projections.

The current Stage 3a system modelled sees a loading of 46 kg N/ha/yr over the whole farm, including fertiliser. This results in an average nitrogen leaching rate of 31 kg N/ha/yr.

Stage 3a – 100 kg N/ha/yr Whole farm average

The OverseerFM model for 100 kg N/ha/yr is a direct copy of the previously reported 46 kg N/ha/yr scenario, with the only difference being the further addition of urea applications across the Discharge Property to increase this whole farm average. Inputs relating to blocks, soils, pasture, animals, irrigation and fertiliser application previously modelled within LEI (2021:P:C.14a) have all remained the same. Table 1 below shows all the fertiliser inputs across the Discharge Property. Wastewater N and P nutrient inputs via irrigation have remained the same and are shown within Table 19 of LEI (2021:P:C.14a) equating to an N load of 63 kg N/ha for IMU 1 and 125 kg N/ha for IMU 3.

Table 1: Discharge Property Fertiliser Applications

Block	Type	Month	Rate (kg/ha)	N Load (kg/ha)
LMU 1	Urea	October	100	46
LMU 1	Urea	December	100	46
LMU 1	Urea	April	80	37
LMU 1	Dicalcic High S	March	300	-
LMU 2	Urea	December (Y1)*	100	46
LMU 2	Urea	February (Y1)*	80	37
LMU 2	Urea	November	100	46
LMU 2	Urea	January	80	37
LMU 2	Dicalcic High S	March	300	-
LMU 3	Cropmaster DAP	October	50	9
LMU 3	Dicalcic High S	March	300	-
IMU 1 - Irrigated	Urea	October	100	46
IMU 1 - Irrigated	Urea	December	100	46

*LMU 2 is currently modelled as a cropping block year round and thus a Year 1 and a Reporting Year is included within OverseerFM.

Table 2 presents a summary of N application rates and N losses from the individual blocks. This model equates to a whole farm average N application rate of 100 kg N/ha and a whole farm N loss of 32 kg N/ha/yr.

By comparison, the original N loss for Stage 3a under a whole farm average N application rate of 46 kg N/ha was 31 kg N/ha. Essentially doubling the whole farm N application rate results in a very minimal increase in N loss – to 32 kg N/ha. This is due to the modelled fertiliser additions being primarily to the LMU 1/IMU 1 blocks that contain significantly lower N loss vulnerability compared to the LMU 3/IMU 3 blocks.

It should be further reiterated that wastewater irrigation modelled within this scenario utilises a 10,000 m^3 storage pond, half of what is currently proposed. Additionally, this model sees the maximum N loading rate to a single block equivalent to 157 kg N ha/yr (IMU 1) with 126 kg N/ha/yr being applied to IMU 3.

Table 2: Discharge Property N Application Rates and Losses

Block	N Applied (kg/ha)	N Loss Total (kg)	N Loss per ha (kg N/ha)
LMU 1	129	245	8
IMU 1 – Irrigated	157	235	12
LMU 2	79	335	22
LMU 3	9	471	35
LMU 3 Irrigated	126	2,333	117
Forestry Block	0	16	2
Whole Farm Average	**100**	**3,687**	**32**

Stage 3a – 150 kg N/ha/yr whole farm average

The OverseerFM model for 150 kg N/ha/yr is a direct copy of the reported 100 kg N/ha/yr scenario above, with the only difference being the further addition of urea applications across the Discharge Property to further increase this whole farm average. This scenario sees multiple fertiliser additions made to the LMU 3/IMU 3 blocks, rather than primarily to the LMU 1/IMU 1 blocks. Table 3 below shows all the fertiliser inputs only across the Discharge Property. As with the previous model, wastewater N and P nutrient inputs via irrigation have remained the same and are shown within Table 19 of LEI (2021:P:C.14a) equating to an N load of 63 kg N/ha for IMU 1 and 125 kg N/ha for IMU 3.

Table 3: Discharge Property Fertiliser Applications

Block	Type	Month	Rate (kg/ha)	N Load (kg/ha)
LMU 1	Urea	October	100	46
LMU 1	Urea	December	100	46
LMU 1	Urea	February	100	46
LMU 1	Urea	April	80	37
LMU 1	Dicalcic High S	March	300	-
LMU 2	Urea	December (Y1)*	100	46
LMU 2	Urea	January (Y1)*	80	37
LMU 2	Urea	February (Y1)*	60	28
LMU 2	Urea	November	100	46
LMU 2	Urea	December	80	37
LMU 2	Urea	January	60	28
LMU 2	Dicalcic High S	March	300	-
LMU 3	Urea	December	80	37
LMU 3	Urea	January	80	37
LMU 3	Cropmaster DAP	October	50	9
LMU 3	Dicalcic High S	March	300	-
IMU 1 - Irrigated	Urea	October	100	46
IMU 1 - Irrigated	Urea	December	100	46
IMU 1 - Irrigated	Urea	February	100	46
IMU 1 - Irrigated	Urea	April	80	37
IMU 3 - Irrigated	Urea	November	40	18
IMU 3 - Irrigated	Urea	January	40	18

Table 4 presents N application rates to and N losses from the individual blocks. This model equates to a whole farm average N application rates of 150 kg N/ha and a whole farm N loss of 39 kg N/ha/yr. By comparison the original N loss for Stage 3a under a whole farm average N application rate of 46 kg N/ha was 31 kg N/ha, signifying that by essentially tripling the whole farm N application rate N losses marginally increase by 8 kg N ha/yr. Additionally, this model sees the maximum N loading rate to a single block equivalent to 240 kg N ha/yr (IMU 1) with 163 kg N/ha/yr being applied to IMU 3.

Modelling a whole farm average rate of 150 kg N/ha/yr sees increased N loading into the LMU 3/IMU 3 blocks due to further N loading into LMU 1/IMU 1 blocks providing for proportionally minimal benefit to farm management. As with the 100 kg N/ha scenario, it should be further reiterated that wastewater irrigation modelled within this scenario utilises a 10,000 m^3 storage pond, half of what is currently proposed.

Table 4: Discharge Property N Application Rates and Losses

Block	N Applied (kg/ha)	N Loss Total (kg)	N Loss per ha (kg N/ha)
LMU 1	175	262	9
IMU 1 – Irrigated	240	391	20
LMU 2	105	487	30
LMU 3	82	688	52
LMU 3 Irrigated	163	2,604	130
Forestry Block	0	16	2
Whole Farm Average	**146**	**4,480**	**39**

DO WE NEED A SEPARATE CAP FOR IMU 3?

The critical area of concern is the potential for IMU 3 to be used as a 'dumping ground' with excessive loading rates used in favour of spreading the water over the wider farm area in a way that allows for nutrient uptake. This would occur with excessive use of the wet soil irrigation criteria. This is a real risk, and to some extent the management of this is dependent on diligent farm management.

The inclusion of a prioritisation condition (condition 50) requires storage to be utilised before the wet soil irrigation can occur. Increasing storage from the initial 11,000 m^3 to 20,000m^3 will significantly reduce the need for wet soil irrigation, noting that water balance modelling has suggested that at 30,000 m^3 there would be limited need for wet soil irrigation provisions.

There could be the excessive/continual use of wet soils irrigation if regular irrigation was not resumed when the conditions were favourable. To provide an incentive for this not to occur a N application cap on IMU 3 is now suggested, with modelling indicating that this could be set at 250 kg N/ha/yr.

SUMMARY

While there is an opportunity to get into the very minor detail of the calculations and discuss the what ifs, there is a need to put this in perspective. There has been a discussion on the Permitted Baseline, and the loading rates are a considerably less here. The scenario modelling has identified that doubling and even tripling of the N loading has minimal impact on nutrient losses from the site. These leaching losses across the two scenarios are not considered overly high for what is being proposed.

There will be natural variability in seasons that will change the flow of wastewater and potential for leaching on the farm. These variations are to a large extent uncontrollable, and the resulting changes in nitrogen leaching will be greater than variability in leaching from wastewater applications, including some variability in concentrations from the wastewater treatment plant.

The variability, and resulting effects, are mitigated within the design through the incorporation of:

a. Storage – meaning water can be irrigated at the right time; and
b. Limits - on application rate, both hydraulic and nutrient.

When setting compliance limits care is needed to ensure design parameters are not used. Should they be used there is the potential that there could be extended periods of non-compliance, especially if the compliance limit adopts the average design parameter.

SUGGESTED CONSENT WORDING

The following changes to conditions are suggested:

Concentration in condition 48 is as requested.

Condition 52:
…accordance with Condition XXX.
(a) Whole of Property Average N load 100 kg N/ha/y
(b) Whole of Property P load 40 kg P/ha/y
(c) Max N Load to IMU3 250 kg N/ha/year; and
(d) Max P Load to IMU3 100 kg P/ha/year.

If you have any questions, please do not hesitate to get in contact.

Yours sincerely,

Lowe Environmental Impact

Sam Morris
sam@lei.co.nz