**BEFORE THE HEARINGS PANEL**

**IN THE MATTER** of hearings on submissions concerning the Proposed One Plan notified by the Manawatu-Wanganui Regional Council

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# SUPPLEMENTARY EVIDENCE OF DR DAVID HOULBROOKE
# FOR THE WATER HEARING
# ON BEHALF OF HORIZONS REGIONAL COUNCIL

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## 1. PART ONE: INTRODUCTION AND EXECUTIVE SUMMARY

1. I have prepared this report as supplementary evidence to my Section 42A report. It has been compiled in response to some small changes/improvements I have introduced to my decision framework for managing farm dairy effluent (FDE) since submitting my Section 42A report. These revised recommendations are presented here.

2. This evidence is in two parts:
   Part One: This Introduction and Executive Summary.
   Part Two: Revised recommendations to my decision framework for managing farm dairy effluent (FDE).

## 2. EXECUTIVE SUMMARY OF SUPPLEMENTARY EVIDENCE AND REVISED RECOMMENDATIONS

3. After consideration of the technical expert evidence originally submitted, I would like to add some more information to the decision framework for managing FDE and outline any differences from my presented Section 42A report. The refinement presented here is being suggested for consistency with a similar policy advice process with Environment Southland in which I am currently involved. Further refinement of the framework has resulted in the following suggested changes:
   (i) Definition added with regards to coarse soil structure criterion;
   (ii) Change in the recommended threshold for sloping land from $5^{o}$ to $7^{o}$;
   (iii) An increase in minimum FDE storage requirements for well drained soils, from a previously recommended 1 and 3 days to 3 and 6 days for the use of low rate and high rate irrigation systems respectively. This is to provide greater surety of being able to avoid FDE applications to near-saturated soils;
   (iv) Addition of a fifth soil/landscape class for shallow and stony well drained soils, to identify the need to apply low application depths;
   (v) Change in definition in Table 2 from traveling irrigator to 'high rate irrigator'.

4. In addition to the framework presented, I would like to further clarify that I believe that an FDE pond should have a minimum leakage rate of $1 \times 10^{-9}$ m/s.

## 3. PART TWO: CORRECTIONS TO ORIGINAL S42A REPORT

5. After consideration of the technical expert evidence originally submitted, I would like to add some more information to the decision framework for managing FDE and outline any differences from my presented Section 42 report. The changes I would like to

request are a result further development and thinking that has taken place since the original Section 42 submission. The refinement presented here also reflects an approach that is consistent with the one I am taking as part of a similar FDE policy advice process that I am currently involved in with Environment Southland.

6. I would like to replace segment 48 of my Section 42A report entitled **'Revised decision tool for recommendations on minimum appropriate management of farm dairy effluent taking into account soil and landscape features'.** The content of this segment is now as follows:

The best management practice flow charts presented in segment 31 have been modified and presented as Table 1 and Table 2 in order to better represent the minimum appropriate management of farm dairy effluent while still taking into account soil and landscape features. Storage requirements presented in Table 2 are a guide. Actual storage requirements should be calculated on a site specific basis as described in segment 50 below. This decision tool varies in three places from the original charts:

(i) A clause for coarse soil structure has been added to the artificial drainage category to reflect the high degree of preferential flow of applied FDE in soils with coarse soil structures, as reported by McLeod *et al*. (2008). By definition, coarse soil structure is well developed with large pore spaces, strong pedality (ie. peds >10 mm) and often contains clay, silt and translocated organic matter coatings (McLeod *et al*., 2008). Coarse soil structure favours pore size exclusion when transporting microbes. For the purpose of this report any soils with 80% or more peds captured on a 10 mm sieve within the topsoil (A Horizon) are considered to have coarse soil structure.

(ii) The recommended threshold for sloping land has been increased from 5°to 7°. This was changed in order to be consistent with the New Zealand Land Use Capability Survey Handbook. However, this does not imply that LUC mapping should be used to determine slope criteria as slopes will vary considerably within existing mapped LUC classes.

(iii) The earlier best practice storage requirements listed for well drained land have been changed to reflect minimum appropriate management considering the low potential environmental risk of this category. The caveat for the low or close to zero storage recommendation is that travelling irrigators should be run at their fastest speed when soil is close to, at, or beyond field capacity. Storage requirements stated are provided to help reduce the risk of application to saturated soils.

(iv) A fifth soil/landscape class has been added to clearly identify that very stony, well drained land should receive FDE applications of no more than 10 mm depth no matter what the antecedent soil water content is. This restriction at very dry soil water contents will also help mitigate any potential adverse effects of water repellency.

(v) Change in definition in Table 2 from 'traveling irrigator' to 'high rate irrigator'.

Furthermore, it is recommended that the maximum application depth to be applied at any one time should be in accordance with industry best practice described for soils of different texture in the DEC Manual (2006). Single applications of greater than 30 mm depth are not recommended, even if large soil water deficits exist and total N loading would remain below 150 kg N/ha, as research has shown an increased risk of small volume but high concentration direct losses often associated with soil cracking preferential flow paths (Houlbrooke, 2008).

**Table 1.** Minimum criteria for a land applied effluent management system to achieve.

| Soil and landscape feature | Artificial drainage or coarse soil structure | Impeded drainage or low infiltration rate | Sloping land (>7°) | Well drained flat land (<7°) | Other well drained but very stony[X] flat land (<7°) |
|---|---|---|---|---|---|
| Application depth (mm) | < SWD* | < SWD | < SWD | < 50% of WHC[#] | ≤ 10 mm |
| Application rate (mm/hr) | N/A** | N/A** | < soil infiltration rate | N/A | N/A |
| Storage requirement | Apply only when SWD exists | Apply only when SWD exists | Apply only when SWD exists | 24 hours drainage post saturation | 24 hours drainage post saturation |
| Maximum N load | 150 kg N/ha/yr | 150 kg N/ha/yr | 150 kg N/ha/yr | 150 kg N/ha/yr | 150 kg N/ha/yr |

* SWD = soil water deficit,

[#] WHC = water holding capacity in the top 300 mm of soil,

[X] Very stony= soils with > 35% stone content in the top 200 mm of soil

** N/A = Not an essential criteria, however level of risk and management is lowered if using low application rates

**Table 2.** Revised decision tool for matching FDE management practice with soil and landscape features. The guideline storage is based on soils with an annual rainfall <1,100 mm.

| Soil and landscape feature | Artificial drainage or coarse soil structure | | Impeded drainage or low infiltration rate | | Sloping land (>7°) | | | Well drained flat land (<7°) | | Other well drained but very stony[X] flat land (<7°) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Infiltration rate (mm/hr) | N/A | | N/A | | <100 | > 100 | | N/A | | N/A | |
| Irrigator hardware | LR[XX] | HR[#] | LR | HR | LR | LR | HR | LR | HR | LR | HR |
| Minimum SWD* (mm) | 8 | 15 | 8 | 15 | 8 | 8 | 15 | 0 | 0 | 0 | 0 |
| Storage guide (weeks) | 8 | 12 | 8 | 12 | 8 | 8 | 12 | 3 days | 6 days | 3 days | 6 days |

[#] HR = High rate irrigator, [XX]LR = low rate irrigator, * SWD = soil water deficit, [X] Very stony= soils with > 35% stone content in the top 200 mm of soil. Low rate irrigation ≤ 10 mm/hr instantaneous application rate.

7. Tables 1 and 2 listed above are also to replace Table 1 and 2 located in the Executive Summary of my Section 42A report (segment 12). No other changes are required to my Executive Summary.

8. I would like to expand upon segment 54 of my Section 42A report entitled "What is an appropriate sealing requirement?" This question relates to the rate of acceptable leakage from a pond containing FDE. Upon reflection, I do not believe that I answered the question. Considering all the points raised in this segment and the results presented in Table 3 of my original Section 42a report, I believe that a pond leakage rate of no more than 1 x $10^{-9}$ m/s is the most appropriate requirement. Table 3 of my Section 42A report has been included again here for ease. The estimated outputs clearly show that a leakage greater than this amount will result in further losses of contaminants. If pond storage is to be implemented then it will have to be done in a manner that ensures pollution swapping does not take place.

**Table 3.** Estimated daily and yearly pond loss of N and P under a range of different pond leakage rates. Figures are determined for a 500 cow herd.

| Drainage rate | | Drainage volume | N loss | | P loss | |
|---|---|---|---|---|---|---|
| m/s | mm/day | (L/day) | (kg/day) | (kg/yr) | (kg/day) | (kg/yr) |
| 1.00E-09 | 0.0864 | 86.4 | 0.01728 | 4.67 | 0.0026 | 0.70 |
| 1.00E-08 | 0.864 | 864 | 0.1728 | 46.7 | 0.026 | 7.0 |
| 3.80E-08 | 3.28 | 3283 | 0.66 | 177.3 | 0.10 | 26.6 |
| 1.00E-07 | 8.64 | 8640 | 1.728 | 467 | 0.26 | 70 |
| 1.00E-06 | 86.4 | 86400 | 17.28 | 4666 | 2.6 | 700 |

David Houlbrooke
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