IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER A hearing of application APP-1994001032.01 for resource consent in relation to the discharge of treated meat works effluent to the Oroua River, Discharge of treated wastewater onto and into land that may enter groundwater, Discharge of odour and aerosols into air, Land Use Consent for a discharge structure in the bank of the Oroua River and a bed level control structure in the Otoku Stream from the AFFCO Plant, Feilding.

Section 42A Report of NEIL THOMAS, Senior Hydrologist on behalf of Manawatu-Wanganui Regional Council

5 October 2016

A. QUALIFICATIONS AND EXPERIENCE

1. My full name is Neil Malcolm Thomas.

2. My evidence is given on behalf of the Horizons Regional Council in relation to applications for resource consents to discharge wastewater resulting from meat processing to land, into groundwater and into the Oroua River.

3. I am currently employed by Pattle Delamore Partners Limited as a hydrogeologist. I have been in that position since May 2011. My role involves preparation of resource consent applications related to groundwater, assessment and review of groundwater consent applications and wider groundwater management studies. I have also worked on various aspects of groundwater management including assessments of groundwater quality and quantity within the Horizons Region, and elsewhere in New Zealand.

4. Prior to working at Pattle Delamore Partners Limited I was employed by Entec UK Ltd (now AMEC) in the United Kingdom for 5 years as a hydrogeologist specialising in groundwater modelling.

5. I hold a Bachelor of Science in Geological Sciences from the University of Leeds and a Master of Science in Hydrogeology, also from the University of Leeds (UK). I am a fellow of the Geological Society (London) and I am a member of the New Zealand Hydrological Society.

6. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise.

B. SCOPE OF EVIDENCE

7. My evidence covers the following areas of the application:

    - Effects on groundwater (quality and quantity) as a result of seepage from the effluent storage ponds.
    - Effects on groundwater (quality and quantity) as a result of land disposal of effluent across paddocks located to the north of the processing plant.
    - Suitability of proposed monitoring conditions.

C. SUMMARY OF APPLICATION DETAILS

8. The following paragraphs summarise my understanding of the application as it currently stands[1].

9. The Applicant operates a meat processing plant located on the outskirts of Feilding. A result of the meat processing activities is meatworks effluent, which the Applicant currently treats via a series of wastewater treatment ponds located adjacent to their site. The treated wastewater is currently disposed of via direct discharge to the Oroua River, direct seepage to groundwater through the base of the wastewater treatment ponds and land irrigation.

10. The existing consent to discharge to the Oroua River restricts the discharge based on the flow in the river. When the flow is greater than 4,000 L/s, the discharge is limited to a maximum of 2,000 m^3/day. When the flow is between 3,000 L/s and 4,000 L/s between March and December, the discharge is limited to 1,000 m^3/day.

11. 2,000 m^3/day of treated effluent can be discharged onto an area of at least 75 ha.

12. An unspecified volume of effluent can be discharge to groundwater via seepage through the base of the treatment ponds.

13. Current volumes of wastewater produced by the plant are estimated as around 256,100 m^3/year. The daily volume ranges from 250 m^3/day to 1050 m^3/day, with an average value of around 700 m^3/day.

14. Volumes of effluent produced by the plant are expected to increase by 20% as a result of increased throughput at the factory over the lifetime of any new consents, if granted. Therefore, the proposed consents allow for an increased volume of discharge to the Oroua River and to land.

[1] LEI (March 2015). Meat Processing Plant Discharge Consents: Application and Assessment of Environmental Effects. Version 5.

15. The proposed discharge to the Oroua River will operate according to the following criteria:

Table 1: Proposed Oroua River discharge criteria		
Flow in the Oroua River at Kawa Wool Gauging Station	**Proposed discharge between 1 December and 31 March**	**Proposed discharge between 1 April and 30 November**
Below median flow (0 L/s to 7,590 L/s)	No discharge	No discharge
Median flow to 20th percentile exceedance flow (7,590 L/s to 16,193 L/s	No discharge	Discharge based on rate of DRP load to river up to a maximum of 3,000 m^3/day
Above 20th percentile flow exceedance (> 16,193 L/s)	No discharge*	Up to 3,000 m^3/day
*Emergency contingency discharge if flow is greater than 3 x median (> 20,913 L/s)	If land application is not possible and ponds are 100 % full, discharge up to 2,000 m^3/day	

16. The flow regime above allows for an increased flow into the Oroua River under certain circumstances (as detailed in Table 1), although the flow cut off under the proposed consent (7,590 L/s) is higher compared to the flow cut off under the existing consent (3,000 L/s).

17. No change to the consent to allow seepage through the base of the ponds into groundwater is proposed.

18. Under the proposed consent the area of land over which treated effluent can be disposed will increase, from the current area of 75 ha to 145 ha. The Applicant states that the increased area will have a theoretical capacity of up to 331,775 m^3/year, but indicates that in practice the annual volume discharged to land will be in the order of 179,300 m^3/day.

19. I have not made any comments regarding the effects of the proposed change to the river discharge regime because that is outside my area of expertise. However, I have provided comments below regarding the effects of the discharge to groundwater, both via seepage through the base of the treatment ponds as well as through land disposal.

D. GENERAL HYDROGEOLOGICAL SETTING

20. The Applicant's site is located around 300 m from the true left bank of the Oroua River (Figure 1). Based on the 1:250,000 scale geological map of the area, the underlying strata consist of recent river deposits (Q3 to Q2) including poorly to moderately sorted gravels with minor sand and silts. Based on that geology, the shallow strata is expected to be relatively permeable and is likely to have a good hydraulic connection with the nearby river.

21. Information on deeper strata is available from descriptions in drillers logs from deeper bores. That information indicates that the deeper strata consist of variable intervals of silts, sands, with occasional clay. The variable nature of the deeper strata implies that vertical groundwater movement is likely to be slow, although it may be enhanced around deeper pumped bores.

22. Indicative groundwater contours were also supplied as part of the application for the shallower strata. Those groundwater levels only represent information from June 2013 (i.e. winter levels), but they generally show that groundwater flows sub-parallel or towards the Oroua River in the reach adjacent to the Applicant's site (i.e. generally south-west). That flow direction is generally consistent with the expected direction of groundwater movement in that area, which is towards the coast. Some seasonal variation in groundwater flow direction may also occur.

23. The groundwater contours were drawn including the stage height of the Oroua River. Whilst the map presented in the application (reproduced as Figure 2 in my evidence) includes a limited number of groundwater level measurements compared to the number of river stage measurements, groundwater levels are generally higher than the nearby river stage measurements, implying that there is a shallow groundwater gradient towards the river.

24. The contours supplied by the Applicant also suggest that the groundwater gradient is steeper underneath and to the south-west of the effluent ponds. That steepening may be an effect from variations in the permeability of the strata in the area, although it could also reflect a slight groundwater mounding effect due to seepage from the ponds.

25. Groundwater levels in shallow bores in the area around the ponds are generally within 2 m to 5 m of the ground surface. Groundwater levels in deeper bores are generally deeper, implying a general downwards gradient from the shallow strata to the deeper strata.

E. SEEPAGE FROM EFFLUENT STORAGE PONDS

26. The wastewater treatment ponds cover an area of around 6 ha and, based on the information provided by the Applicant, were constructed with a clay liner when they were originally developed around 40 years ago. However, there is no evidence to demonstrate whether the clay liner consisted of offsite materials, with a specified permeability, or whether the clay liner consisted of materials derived from site works. The thickness of the liner is also unknown.

27. The uncertainty of the liner thickness or its composition means that some seepage may occur through the base of the ponds. The potential volume of that seepage, and the effects that volume may have on downgradient receptors are discussed in the following paragraphs.

28. The permeability of the liner underlying the ponds has not been tested, and therefore the seepage through the base of the ponds has not been calculated directly. Instead, the Applicant has inferred a volume based on broad scale estimates of pond inflows and assumptions around the scale of noticeable changes in the pond levels. The Applicant indicates that outflows from the ponds cannot be meaningfully compared with inflows because of the two different discharge points (land discharge and discharge to the river), and that the frequency and volume of the discharge is variable.

29. Pond inflows have been estimated based on the number of animals and an assumption that each animal generates 2.5 m^3 of effluent. The results of that estimate, based on data from 2011, 2012 and 2013 suggest a maximum pond inflow of around 1,026 m^3/day and an average of around 700 m^3/day.

30. Given that there are inflows to, and outflows from, the pond, it is unlikely that seepage through the base of the ponds is equal to the inflow. Therefore the inflow estimates provide an upper limit to the seepage volume through the base of the ponds.

31. Seepage through the base of the ponds would result in a steady decline in the effluent levels in the pond. However that decline would be difficult to distinguish against varying inflows and outflows together with rainfall and evaporation effects. A constant seepage rate of 200 m^3/day corresponds to an average daily change in effluent levels of around 3 mm. A change of that magnitude across the 6 ha of the ponds may not be noticeable, in which case a seepage rate of 200 m^3/day is possible.

32. The Applicant has estimated a worst case seepage rate of 50 m^3/day, and has indicated that given that seepage rate, the permeability of the liner is likely to be in the order of 1.0×10^{-8} m/s. In my opinion, there is insufficient justification for adopting that value of seepage or permeability, given the absence of accurate information regarding pond inflows, outflows, the composition or permeability of the pond liner and effluent levels.

33. More work is required to justify the seepage rates, if any, from the ponds. One option would be a water balance, where the inflows (including rainfall), pond level and outflows (including evaporation) are measured with a reasonable degree of accuracy, to define the seepage rate within reasonable uncertainty bounds. Alternative approaches are also available, for example detailed measurements of pond levels and/or investigation of the pond liners.

34. For comparison, for a dairy effluent pond to meet the permitted activity criteria in the One Plan[2], the permeability of the liner must be less than 1×10^{-9} m/s. At present, there is no evidence to demonstrate whether the ponds at the AFFCO Feilding processing site meet that criteria. The water balance information described in paragraph 33 of my evidence should be collected over the course of at least 2 years (to allow for seasonal variations) and an estimate of the permeability of the liner should be determined from that data. That estimate can then be compared to the permitted activity criteria in the One Plan to determine whether the ponds should be relined.

F. EFFECTS OF POND SEEPAGE ON GROUNDWATER QUALITY

35. Groundwater quality information from a variety of neighbouring bores has been collected as part of this application, as well as monitoring for the existing consent. The bores where groundwater quality data has been collected are shown in Figure 3 of my evidence. The bores used to collect groundwater quality data are located both upgradient and downgradient of the effluent ponds and therefore provide information regarding background water quality as well as water quality downgradient of the ponds.

36. The main contaminants of concern that occur within the effluent are phosphorus, bacteria and nitrogen compounds (nitrate nitrogen and ammonia nitrogen) and sampling has occurred to determine the concentration of those parameters in groundwater.

37. Generally, phosphorus does not travel long distances within groundwater because it tends be trapped within, and onto, soil particles. Therefore the effects of phosphorus contamination in groundwater are often of a small scale. Bacterial concentrations in groundwater will reduce with distance from a source via both bacterial decay and filtration within the aquifer matrix. However, filtration within the aquifer matrix can be limited in contaminated aquifers, where discharges have occurred for some time, which is likely to be the case around the AFFCO New Zealand ponds. Further comments regarding bacteria are provided in paragraph 44 of my evidence. Nitrogen is a more conservative contaminant, in that it does not undergo significant degradation in the subsurface. As a result, nitrogen will typically travel further than phosphorus in groundwater.

[2] Horizons One Plan. Rule 14-6(a).

38. Groundwater quality information has been collected on nine occasions since June 2013. One sample was collected in June 2013, followed by a relatively intensive period of sampling in late autumn and winter in 2014 (five samples at monthly intervals between April 2014 and August 2014). Occasional samples have been collected since that time, with the latest samples in May 2015. Due to the variable and relatively short term sampling pattern, it is difficult to reliably determine any seasonal effects.

39. Figure 4 of my evidence shows the concentration of nitrate, total ammonia, chloride and electrical conductivity in each of the sampled bores since June 2013. Chloride and electrical conductivity are also shown because the concentration of nitrogen as ammonia or nitrate nitrogen can vary depending on the redox status of the aquifer, leading to some uncertainty when interpreting the concentrations of those parameters. Chloride provides a general indicator of groundwater quality and electrical conductivity provides an indication of the concentration of dissolved ions within groundwater.

40. The highest values of any of those parameters generally occur within bore 325269C, which is the bore located at the south-western corner (downgradient) of the effluent ponds. However high values of nitrate N (i.e in excess of the drinking water standard of 11.3 mg/L) have also occurred in bore 325413 (located around 1.5 km north and upgradient of the ponds), 325416B (located around 800 m north and upgradient of the ponds) and also bore 325273A (located adjacent to and at the north-western corner of the ponds). Concentrations of nitrate N show an increasing trend in bore 325273A from less than 1 mg/L in April 2014 to 19.7 mg/L in April 2015.

41. Lower values of nitrate, and other parameters occur in bores that are located further to the south of the ponds. The concentrations of those parameters are generally less than the drinking water standards where applicable (1.5 mg/L for ammonia and 11.3 mg/L for nitrate nitrogen).

42. Figure 5 of my evidence shows that the spatial pattern of the maximum concentration of total ammonia nitrogen, chloride, electrical conductivity and nitrate nitrogen observed in each of the monitored bores. It indicates that the highest values are clustered around the ponds, with some higher values also observed in samples from bores located close to the Oroua River upstream of the ponds. In general the data do not indicate obvious evidence of a widespread plume of contamination extending from the ponds, although there are clear effects immediately around the ponds.

43. The location of the monitoring bores in a general downgradient direction is limited to an area to the south of the ponds and there are no bores located between the ponds and the river. The groundwater contours suggest that groundwater flow around the ponds is sub-parallel to the Oroua River, although there are likely to be seasonal variations and at times, groundwater flow could be directed towards the river, resulting in some discharge of groundwater that is impacted by the ponds into the river.

44. Bacterial counts within groundwater samples collected by the Applicant are variable, with the highest values observed in bore 325413, located around 1.5 km to the north of the ponds. Some bacterial effects could occur on groundwater as a result of seepage through the base of the ponds, but shallow groundwater can be contaminated by bacteria by a variety of means, including stormwater disposal. Therefore, it is difficult to distinguish an effect from the ponds directly.

45. Overall, the available data imply that some effect from the ponds is likely in the immediate vicinity of the ponds. However, widespread effects do not seem to have occurred under the current regime. That is because the key indicators of a widespread effect (i.e. nitrogen species in combination with other parameters) are not significantly elevated in bores located downgradient and away from the ponds. The data suggest that existing shallow groundwater quality in other downgradient bores is not generally high, as shown by relatively higher values of electrical conductivity. It is useful to note that some effect from the ponds could bypass the more distant monitoring bores by a more direct pathway towards the Oroua River.

46. Policy 5.6 in the Horizons One Plan states that discharges and land use activities should be managed in a manner which maintains or enhances the existing groundwater quality, or where groundwater quality is degraded as a result of human activity, it should be enhanced. Based on the groundwater quality data discussed, the groundwater quality in the immediate area around the ponds is likely to be degraded as a result of seepage from the ponds. Therefore, the proposed activity should seek to enhance groundwater quality ideally by ensuring that seepage from the ponds is measured accurately and minimised as far as practicable.

G. EFFECTS OF LAND DISCHARGE ON GROUNDWATER QUALITY

47. Under the new consent for land disposal, an increased volume of wastewater will be disposed of across a large area of land located to the north of the AFFCO New Zealand processing plant. At a general level, increasing the volume of effluent that is discharged across land is preferable to discharging any increased effluent volume directly into the river. Therefore, the proposed discharge to land is likely to represent a relative improvement on the current practice, because less effluent will be discharged directly to the river.

48. The proposed increase in the land discharge system will increase the overall flux contaminants to the underlying shallow groundwater. Details of the land discharge system are described in the evidence of Dr David Horne, however, some comments on the potential effects on groundwater are provided in the following paragraphs.

49. The additional land that may be used for effluent discharge is currently operated as a dairy farm (Bryeburn Farm), where some nutrient leaching will already occur. However, there is no information available that demonstrates the magnitude of existing leaching. Therefore, it is difficult to determine whether the proposed discharge will result in an increase, or decrease in the rate of existing leaching. However, I understand from Dr David Horne that the leaching through the base of the soil profile is expected to be in the order of 30 kg N/ha/year to 60 kg N/ha/year as a result of the proposed land disposal.

50. A leaching rate of between 30 kg N/ha/year to 60 kg N/ha/year is within the range that may be expected from a dairy farm. Therefore, the proposed leaching rate may not be a significant change from the existing leaching rate, given that the Bryeburn Farm is a dairy farm. However, that should be confirmed.

51. Whilst the leaching rate may not significantly increase, it is notable that concentrations of nitrate nitrogen and ammonia in groundwater are elevated in bores around the land discharge area (bores 325413 and bore 325416B), which reported concentrations of nitrate nitrogen in bore 325413 up to 55 mg/L and up to 26 mg/L in bore 325416B. Those very high values imply that there are issues around nitrate nitrogen concentrations in shallow groundwater.

52. Those bores are located both upgradient and downgradient of the land disposal area, which may suggest that the high nitrate N concentrations are caused by other activities, as well as the land discharge that currently occurs. It is not possible to show the proportion of those effects that are due to the AFFCO land discharge, because the number of monitoring bores and number of samples is relatively sparse. Nonetheless, it would be reasonable to conclude the effluent discharges may have contributed to those effects.

53. Groundwater contours across the land disposal area suggest that shallow groundwater generally flows towards the nearby Oroua River. Therefore, any nutrients in groundwater that result from the discharge to land are likely to migrate towards the river.

54. A general estimate of the effect of that discharge on the Oroua River can be gained from an estimate of the volume of groundwater discharge into the river, and the concentration of nitrate nitrogen in groundwater. The groundwater contours supplied by the Applicant imply a shallow groundwater gradient of around 0.006, and based on an aquifer cross section discharging into the river of around 5,000 m^2 together with a permeability of around 10 m/day, the groundwater discharge to the river could be around 3.7 L/s (321 m^3/day).

55. If the maximum value of nitrate nitrogen (26 mg/L) observed in the monitoring bores adjacent to the river (and closer to the location where land discharge currently occurs) is representative, that groundwater discharge to the river at low flows (around 1,240 L/s) would increase concentration of nitrate nitrogen in the river by up to around 0.08 mg/L. Further commentary on the effect of that proposed discharges on the river water quality is provided in the evidence of Mr Logan Brown.

56. The Applicant indicates that they will only apply effluent across the area of the land discharge at times when the soil moisture levels will restrict leaching of contaminants, including nitrate-nitrogen into groundwater. Provided that approach is strictly followed I agree that will minimise the effects of the effluent disposal on groundwater quality. However, it will require good monitoring and management practices to ensure that leaching is minimised.

H. CONSENT CONDITIONS

57. Seepage from the ponds occurs, and groundwater quality samples indicate that there is an effect in the area around those ponds. The data suggest that effect is not widespread, but there is a gap in the data in the area between the ponds and the river, where effects could be missed. Therefore monitoring of groundwater quality should take place around the ponds to identify those potential effects if they occur.

58. Around the ponds, monitoring should be required in the three existing monitoring bores (325273A, 325275B and 325269C) at quarterly intervals. Groundwater quality samples from those bores should be analysed for the following parameters:

(a) Temperature

(b) pH

(c) electrical conductivity

(d) chloride

(e) nitrate-nitrogen

(f) ammonia-nitrogen

(g) nitrite-nitrogen

(h) dissolved reactive phosphorus

(i) E.Coli

59. The static groundwater level in the bore should also be recorded at the same time as the groundwater sample is taken.

60. An additional three monitoring bores should also be installed in the area around the ponds. The intention of the additional bores is to clarify whether any effect from the ponds migrates directly towards the river. The three bores should be installed to around 10 m depth, and screened so that the full range of groundwater level fluctuations will be captured. The three bores should be located in the general areas shown in Figure 6.

61. The proposed land discharge will occur against a background of existing elevated nitrate concentrations. The Applicants proposed management regime should, if implemented as proposed, minimise additional effects on the existing poor water quality. Therefore, monitoring should occur to demonstrate that effects are limited.

62. There are currently four monitoring bores around the land treatment area (325413, 325416B, 325016 and 325411) and monitoring should continue in each of those bores on a monthly basis for the first three years of the consent, if granted. Samples should be analysed for the nine parameters listed in paragraph 58 above and static water level measurements should be recorded at the time each sample is taken.

63. Additional monitoring should also occur at the locations shown in Figure 7. Those locations intend to help define any effects from the proposed land discharge. Monitoring should occur on a monthly basis for the first three years of the consent, if granted. Provided that monthly monitoring shows limited effects, quarterly monitoring should occur thereafter. Samples from both the existing four bores, as well as the additional bores should be analysed for the parameters listed in paragraph 58 of my evidence and groundwater level measurements should be taken and recorded at the same time as the water quality samples.

64. The results of the groundwater monitoring should be reviewed each year to determine whether any adverse effects have occurred, and the result of that review should be forwarded onto Horizons Regional Council each year.

I. CONCLUSION

65. The proposed applications to discharge effluent from the wastewater ponds and to discharge treated wastewater to land may have some effects on the underlying shallow groundwater resource.

66. Seepage rates from the treatment ponds are poorly quantified and further work should be undertaken by the Applicant to clarify those effects. The results of that further work should be used to determine the permeability of the liner under the ponds.

67. Groundwater quality data indicates that effects due to pond seepage are evident in the area immediately around the ponds, where a combination of high concentrations of nitrogen, elevated conductivity and elevated chloride concentrations imply that seepage from the ponds occurs. That effect does not appear to be widespread around, and downgradient of, the ponds, with other nearby bores showing generally low concentrations of parameters. No groundwater quality information is available from the area between the ponds and the Oroua River, however based on the information in the application, there are no shallow bores that use groundwater in that area which may be affected by the seepage effect.

68. In my opinion, the impacts to groundwater quality as a result of pond seepage could be more than minor. Therefore, it is my recommendation that conditions are imposed on the consent to monitor groundwater in the existing monitoring bores as well as the additional bores shown in Figure 6 of my evidence. This will help determine the magnitude and extent of any changes in groundwater quality.

69. Groundwater quality data around the land discharge area indicates that some bores, particularly those at the western edge of the area show very high concentrations of nitrate. Those higher concentrations show that some effects from the existing activities across that land have already occurred, although according to the application there are no shallow groundwater users in that area.

70. The proposed approach to land discharge described in the application should minimise additional effects on the existing poor groundwater quality provided that the management measures are strictly implemented. If that is the case, effects on groundwater quality may be less than minor. However, monitoring must occur to demonstrate any effects and a review condition should be included so that adverse effects, if identified, can be addressed and the consent conditions can be modified as required.

Neil Thomas
5 October 2016