Before Independent Hearing Commissioners appointed by Environment Southland

In the matter of	Application APP-20181129 by Southland District Council for resource consent to discharge treated wastewater to land and water, and to use land for construction of an effluent storage facility, for the Tokanui township sewage treatment system at 118 McEwan Street, Tokanui

Evidence of Rainer Hoffmann

30 April 2019

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Qualifications and experience

1. My name is Jochen Rainer Hoffmann.

2. I am a Principal Process Engineer with Stantec New Zealand.

3. I hold a Master of Science Degree in Civil Engineering from the University of Cape Town, South Africa. I have over 41 years' experience in the field of water and wastewater Engineering. I am a Chartered Professional Engineer and a member of Water New Zealand.

4. I have a broad experience in the field of wastewater process engineering ranging from designing pond systems to fully automated mechanised treatment plants. My experience includes options development, process capacity reviews, plant optimisation, asset condition reviews, concept designs, feasibility studies, plant hydraulics, equipment specifications, commissioning and operation.

5. My evidence relates to the seepage of treated wastewater through the base of the pond and the concern that has been raised by Environment Southland that this is inconsistent with best practice management and will adversely affect groundwater quality.

6. The Southland District Council has applied for resource consents to discharge treated wastewater to land and to water, and to use land for the construction of a treated wastewater storage facility (infiltration trench). The proposed upgrade enables the adoption of the best practicable option[1] to fulfil SDC's responsibilities to the communities they serve.

7. I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

8. My evidence includes:

    (a) Overview of Waste stabilisation ponds (**WSP**)

[1] Section 2(1) of the RMA defines this as: ***best practicable option****, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and (b) the financial implications, and the effects on the environment, of that option when compared with other options; and (c) the current state of technical knowledge and the likelihood that the option can be successfully applied.*

(b) A summary of the drop-down tests at Tokanui WSP to determine pond seepage.

(c) A brief description of the construction of WSP.

(d) Potential environmental impact on the receiving water body.

(e) A brief description of best management practice in the context of Tokanui WSP.

(f) Highlighting the difference between Waste Stabilisation Ponds vs Farm Effluent Ponds (FEP).

(g) Illustrating the comparison between slow rate irrigation versus pond seepage.

Overview of waste stabilisation ponds

9. Waste stabilisation ponds (WSP) are amongst the most commonly used methods for treating domestic wastewater in New Zealand and elsewhere in the world, both in developed and developing countries. They are the workhorse of many small communities in New Zealand, are simple to construct and require minimal attendance for operation and maintenance. WSP are specifically designed to manage public health risks associated with wastewater, and substantially avoid significant adverse effects on the receiving environments.

10. WSP are experiencing a resurgence in both New Zealand and overseas and this is due to the development of advanced pond systems and the retrofit and integration of technologies such as algae removal systems (DAF, Membranes, Ballasted Clarification etc), trickling filters or activated sludge processes and the PETRO (Pond Enhanced Treatment and operation) process developed in South Africa, to improve the discharge quality.

11. WSP are shallow man-made basins into which wastewater flows and from which, after a retention time of several weeks, a well-treated wastewater is discharged to the receiving environment. WSP reduce the concentrations of many constituents in wastewater including Biochemical Oxygen Demand (BOD), suspended solids (SS) nitrogen, phosphorus and faecal coliforms and pathogens.

12. WSP use algae and wind action to introduce oxygen to the pond surface waters. The wind and inflow momentum will create currents within the pond which will keep it mixed and allow the water in the pond to return to the front end of the pond where it mixes with the incoming wastewater thus achieving a uniform quality within the large pond. The retention time in the large primary pond is about 80 days at an annual mean flow of 31 m^3/day which equates to a dilution of pond volume to incoming wastewater of 80:1 which further supports my

assessment that the pond quality will be uniform in the pond. Wastewater solids settle to the pond bottom where they partially digest anaerobically and accumulate as digested sludge. The accumulated solids serve as a filter for any potential seepage through the base of the pond.

Pond Seepage

13. A pond drop-down test was undertaken in 2017 and the discharge from the base of the two ponds was measured to be 3.9 mm/day over a surface area of 2 700 m^2 taking into account the loss through evaporation during the test period. The daily loss through the base of the ponds during the test was 10.61 m^3/day. A figure of 10 m^3/day was used for water balance discharge routes. During summer the average discharge from the WSP to surface water is zero due to the loss through evaporation and seepage.

14. The inflow to the WSP during the summer months December 2018 to February 2019 was 28.3 m3/day. The open water evaporation rates for the same period measured at the Invercargill Aero climate station (No. 11104) was 4.1 mm/day. Based on a WSP surface area of 2700m2 the average daily evaporation is 11 m3/day. The daily loss through the ponds during the drop-down test was 10 m3/day. The water balance for this period indicates a discharge of 7.3 m3/day but this has not been observed by the Operator. The Operator has observed no discharge and even a drop in water level in the WSP. At zero discharge the evaporation rate has to be 6.8 mm or higher for the water level to drop. The highest recorded evaporation rate during this period was 8.8mm on 4 January 2019. There is no climate station in close proximity to the Tokanui WSP. The evaporation rate at Tokanui, being an inland town, could be higher during summer.

15. To maintain the water level in the WSP, the inflow should preferably be at least the same as the net evaporation and seepage at all times. During the summer of December 2018 to February 2019 the inflow was higher than the sum of the evaporation and seepage. i.e. 28.3 m3/day vs 21 m3/day.

16. Duncan Mara an acclaimed global expert in pond designs from the University of Leeds, UK has written several pond design manuals which are still relevant and are being used by the Water Industry as a guidance document for pond designs, operation and maintenance. As a general guide Mara (1998) recommends no lining up to 8 mm/day which is double the actual measured seepage of 3.9 mm/day, however lining would be required if the water level in the ponds drop well below current observed levels during extended dry periods. The drop observed is only 20 to 35 mm.

Construction of WSP

17. I have been involved in the construction of many ponds in South Africa and New Zealand and in most cases in situ material which contains clay has been used for the construction of the embankments, and there should be a balance of cut to fill. If the local soils are unsuitable then clayey material will have to be imported or if more cost effective they can be lined with synthetic geomembrane material.

18. Subsurface geology in the Tokanui area generally comprises a thin layer of locally-derived colluvial materials (clay, silt and gravel) overlain by loose deposits up to 2 to 3 metres thick in places. At the Tokanui WSP in-situ clayey silty material was used to construct the pond. The ponds have been constructed in 1972 and there is no historical date on any seepage test conducted during or after construction.

19. The use of synthetic liners is not a very common method for sealing WSP due to the size and cost and liners are only installed when the seepage and evaporation exceeds the inflow to the WSP and if there is a danger that the ponds can drain during dry and warm periods.

20. Lining ponds can be done using different materials (imported clay, synthetic membrane, concrete, bentonite etc) while the ponds are being constructed but it becomes a major exercise after being in operation for many years. This might not be feasible. This is because an alternative treatment system is required to be constructed and to operate for the time a lining is to be installed (likely to take some months).

21. Water New Zealand have recently published the "The Good Practice Guide for Waste Stabilisation Ponds: Design and Operation", November 2017. In section 2.9 Construction it states that: "Ideally, ponds should be constructed in areas with clay or other soils that won't allow the wastewater to **quickly** percolate down through the pond bottom to the groundwater. Ponds in **sensitive** areas must be artificially lined with clay, bentonite, plastic, rubber, concrete, or other impervious materials to prevent groundwater pollution." There is no definition of what 'quickly' means. In terms of the Good Practice Guide there is no clear direction what rate of seepage (mm/day) is acceptable.

22. In the option where the existing ponds are refurbished the untreated wastewater will have to be trucked away for treatment at for example Invercargill WWTP or temporarily treated in a mobile unit to accommodate the incoming wastewater during the construction period which could be several months. Due to the accumulation of sludge on the base of the ponds since the commissioning in 1972 it can be assumed that a considerable volume of sludge has accumulated. Sludge volume will also have to be removed and taken away for disposal before the pond can be lined. A very preliminary cost estimate for lining the ponds with

a PE membrane liner is in the order of $ 500,000. The cost includes site establishment, desludging and trucking it to a landfill site for disposal, levelling and compacting the base, installation of a PE liner, trucking 30 m^3/day of wastewater to Invercargill WWTP for 3 months, 10% Contingencies and 15 % for design, contract management and fees.

Environmental Impact

23. The seepage of pond water through the sludge layer and base of the pond can reasonably be assumed to be similar or better quality than quality of the treated wastewater discharged out of the second pond to the proposed infiltration trenches. The average hydraulic retention time of the raw wastewater in the large pond is in excess of 80 days and the organic loading of about 43 kg BOD/ha/day based on a primary pond area of 2100 m^2 and connected population150 people with a BOD contribution of 60g/person, is well below the 1974 MoW (Ministry of Works) sizing guidelines of 84 BOD/ha/day. The MoW guidelines and the revised Water New Zealand Good Practice Guide for Waste Stabilisation Ponds: Design and Operation Section 2.41. still refers to the design loading of 84 kgBOD/ha/day as the 'base case' for primary facultative ponds.

24. The groundwater is considered moderately sensitive as concluded in the AEE as the groundwater is not used consumptively in the vicinity of the WSP and is not used for potable supply. The groundwater movement is towards the river and will therefore contribute to the overall water quality of the river.

25. In Mr Hughes evidence an assessment of the effects of wastewater on the downstream water quality based on results from historical surface water sampling and the March 2019 water quality survey indicate that:

    (a) Seepage from the oxidation ponds results in minor effects on groundwater quality down-gradient of the ponds. Concentrations of nutrients and microbial indicators are generally lower than background concentrations in the unconfined aquifer, and in the Tokanui River upstream of the discharge; and

    (b) Infiltration of seepage from the oxidation ponds into the Tokanui River over the reach immediately downstream of the ponds does not appear to result in more than minor changes in downstream water quality.

Best Management Practice

26. WSP treatment are used to protect public health and as a treatment process which is an accepted method to protect the public, acknowledging that some seepage to ground will occur.

27. Considering the small size of the community and the effects on the environment and public health being less than minor the treatment of domestic wastewater in the existing WSP is appropriate.

28. The direct discharge and seepage to the river is not excessive and is not causing any issues in the receiving environment based on the monitoring results.

29. More than half of the New Zealand community treatment plants are WSP and to my knowledge only a limited number of WSP are lined. SDC has two treatment plants with WSP that have an HDPE liner. Liners are also used for anaerobic ponds and deep facultative ponds which are specifically designed to hold large quantities of sludge and treat high strength wastewaters.

Waste Stabilisation Ponds vs Farm Effluent ponds (FEP)

30. WSP are purposely designed pond systems based on the Ministry of Works Guidelines which are still relevant and supported by the revised Water New Zealand pond guidelines dated 2017. WSP are natural treatment processes making use of the sunlight, algae and wind action with a constant water level. FEP are essentially storage ponds which receive a high strength wastewater from especially dairy farming activities and their pond level can vary from being full to being empty during summer periods. FEP are not designed for treatment but rather storage although some treatment will occur due to solids settlement and anaerobic degradation. Policy 17 of the proposed Southland Water and Land Plan requires that agricultural effluent systems are maintained and operated in accordance with best practice guidelines. The guidelines referenced in the note to the policy states the "*storage facilities must be sealed so they do not leak or allow contaminants to seep out. All areas where effluent or leachate is stored should be sealed to prevent leachate losses to groundwater".*

31. Interpretation of the above note clearly infers a storage pond and not a treatment pond. Agricultural effluent is a high strength wastewater with concentrations about tenfold higher when compared to untreated domestic wastewater. This is because domestic wastewater is diluted from usual uses such as washing, showering, laundry etc. The FEP is a storage pond and for this reason it can be assumed that there is a considerable potential for groundwater contamination and hence the desire to seal the ponds. The WSP is a treatment pond and the seepage into the underground would be at least the same quality as the discharge from the WSP to the infiltration trenches.

32. Heubeck *et al* (2014) presented a paper titled 'Variability of Effluent Quality and Quantity on Dairy Farms in New Zealand' which included a Southland farm at Dacre, approximately 25 km north-east of Invercargill. Samples (untreated wastewater) were collected over two days in a 30 m^3 tank which was well mixed before taking a sub-sample for analysis in a laboratory. The flow was measured

during that period. Based on the number of head of cattle the average concentrations derived are: Total solids 3 900 mg/L, Total nitrogen 260 mg/L Total Phosphorus 33 mg/l. The typical corresponding untreated domestic wastewater concentrations for solids, total nitrogen and phosphorous from a residential community would be in the order of 300mg/L, 50 mg/l and 12 mg/L respectively.

Slow rate Irrigation versus Pond seepage

33. The treated wastewater from the Pines WWTP near Rolleston, Canterbury is applied to land via centre pivot irrigators. The allowable application rate is 64 mm over a five-day period which equates to 12.8 mm/d. The current application rate based on the capacity of the pumps and irrigators is around 6 mm/day.

34. The Te Anau pond discharge is consented (but not yet constructed) to discharge to land. The Southland District Council is proposing to change to subsurface drip irrigation (SDI) in future and the design is based on a maximum application rate of 6.5.mm/d during peak flows as specified in the Discharge Consent AUTH-302625-01 condition 5 (b). The average irrigation rate is 2.4 mm/d during summer and 1.9 mm/day during winter.

35. The seepage of the treated wastewater from the Tokanui WSP is 3.9 mm/day which is similar to the application rates used for slow rate irrigation on land in other irrigated wastewater areas of the South Island.

Executive Summary

36. Allowing treated wastewater from WSP to discharge via infiltration trenches to the river is no different from allowing seepage through the base of the pond via the groundwater to the river. Both discharge routes of treated wastewater pass through the unsaturated soil where the pond water will achieve further filtration and treatment.

37. A purpose built WSP for the treatment of untreated domestic wastewater differs from a FEP which receives a considerably higher pollution load and is not designed to provide any advanced treatment. The WSP and FEP cannot be compared as their purpose differs i.e. treatment vs storage. Seepage of untreated farm effluent through the soils will result in potential contamination of the groundwater. The requirement to seal FEP is fully justified and will provide environmental benefits. However, the requirement to seal the existing Tokanui WSP at a considerable cost of $ 500,000 to minimise the discharge of treated wastewater through the soil is unlikely to achieve any environmental benefit.

38. Based on the historical surface water sampling and the March 19 water quality survey, seepage from the WSP and proposed infiltration trench is unlikely to

result in more than minor effects on the quality of groundwater in the unconfined aquifer and downstream receiving waters in the Tokanui Stream.

39. The seepage from the Tokanui WSP is not excessive as the water level in the WSP remains static during the summer although a 20 to 35 mm drop in water level has been observed during long dry periods. As stated in section 13 above the drop in water level can be attributed to the potentially higher local evaporation rate.

40. The design and operation of the Tokanui WSP is consistent with 'Good Management Practice'. The construction of a two pond system is common practice in New Zealand and the sizing of the ponds is within the design criteria recommended in the MoW and Water New Zealand pond guidelines.

41. Lining the pond with a membrane could cause issues with the liner in future when the primary pond must be desludged as any desludging mechanism will damage the liner on the floor. Replacement or repair will be costly.

42. Lining the WSPs will not improve the discharge quality but will increase the flow through the infiltration trenches.

Conclusion

43. The lining of WSPs is not common practice in NZ unless the soil is permeable and there is no source of clayey material in close proximity to the construction site. Lining is required if the ponds drain down during dry and hot periods or if there is a deterioration of water quality in the receiving environment.

44. The historical data and March 2019 water quality survey indicate less than minor changes in downstream water quality.

45. At the Tokanui WSP the retrofitting of liners will be challenging and will require considerable effort and expense for no noticeable benefit to the receiving environment and the treated wastewater discharge quality form the WSP.

46. Also, there is a potential risk that during the construction period if large rain events occur some untreated wastewater might bypass to the river.

47. The measured seepage from the Tokanui WSP is not excessive and is within acceptable limits.

Rainer Hoffmann

30 April 2019

References

48. Environment Southland Regional Council (2019), Staff Report for Hearing compiled by Stephen West, Principal Consents Officer, Reference 19/RC/09;

49. Gearing, P (2019), 'Te Anau Wastewater SDI Concept Report', Report prepared for Stantec New Zealand and Southland district council.

50. Stantec (2018), 'Resource Consent Application and Assessment of Environmental Effects', Tokanui Wastewater treatment Plant- Discharge to Land and Water, Prepared for Southland District Council;

51. Environment Southland (2017), Discharge Permit for Te Anau Treated Wastewater, AUTH-302625-01;

52. Mara, D and Pearson, H (1998), 'Design Manual for Waste Stabilization Ponds in Mediterranean Countries', Lagoon Technology International, Leeds, England;

53. Water New Zealand, 'Good Practice Guide for Waste Stabilisation Ponds: Design and Operation' (2017);

54. Mitchell, A (Stantec), Hoffmann, R (Stantec) and Salkeld, C (Sicon Ferguson) (2015) 'Why Waste Water? - Harvesting for Irrigation'. Paper presented at the Water New Zealand Annual Conference.

55. Heubeck, S, Nagels, J and Craggs, R (2014), 'Variability of Effluent Quality and Quantity on Dairy Farms in New Zealand', National Institute of Water and Atmospheric Research Ltd (NIWA);

56. Proposed Southland Water and Land Plan