AKAROA WASTEWATER SCHEME – IRRIGATION OF TREATED WASTEWATER TO LAND

JOINT STATEMENT OF TECHNICAL EXPERTS # 3 – 26/4/17

Introduction

This is joint statement # 3 of technical experts for the Akaroa Wastewater Scheme. It has been prepared in response to questions raised by the Akaroa Wastewater Working Party and issued to the technical experts by Brent Pizzey from Christchurch City Council on 1st of March 2017.

Question 1: Is the alternative option proposed by the Robinsons Bay residents of ponds and irrigation schemes over multiple areas, irrigated at a lower rate on steeper slopes, viable? Some example alternative areas were identified at the community working party, but other areas may also be viable if steeper land, or land with steeper down slopes was considered acceptable based on a lower watering rate and/or an appropriate type of vegetation (e.g. trees, whether planted or already established), and these should also be considered. Is a maximum slope of 19 degrees rather than 15 degrees appropriate for trees?

A presentation was made to the working party on this topic on Wednesday 15th of March 2017. The presentation outlined a review of the viability of irrigating Misty Peaks Reserve. The review found that irrigation of pasture at slopes greater than 15 degrees, or trees at slopes greater than 19 degrees, would increase the risk of land instability compared to a non-irrigated scenario. Two instability cases were considered – shallow and deep instability.

Assessing the risk of shallow instability, it is generally agreed that trees may be irrigated up to a maximum slope of 19 degrees. For irrigation of trees on land sloping at more than 19 degrees the risk of shallow instability is increased with the application of wastewater at any rate. For this reason irrigation of treed slopes at greater than 19 degrees is not considered advisable.

Assessing the risk of deep instability, risks would only increase if the drainage below the root zone is increased by the irrigation. Initial modelling of this concept by Pattle Delamore and Partners Ltd has identified that it is possible for trees to be irrigated at a rate such that the average annual amount of drainage is the same as for "no irrigation". This would depend on the land being converted from pasture to trees. While the average annual drainage may remain the same, increased drainage would result from wet weather events that occur after irrigation when otherwise the soil would have been dry if no irrigation occurred. This would increase the overall risk of deep instability after such events.

Alternatively, irrigation to pasture at slopes greater than 15 degrees could be considered. Irrigation to pasture assumes that the pasture is to be harvested for beneficial use. Optimum pasture production is achieved when soil moisture is maintained at well above wilting point. Maintaining soil moisture at higher levels than for non-irrigated pasture would result in higher drainage below the root zone. The outcome in terms of stability risks would be the same as for irrigation to trees; soil instability would be increased. We conclude that irrigation of trees at slopes greater than 19 degrees, or to pasture at slopes greater than 15 degrees, would increase the risk of instability, even if the application rate is reduced to a level where the average drainage rate is unchanged from an unirrigated scenario. Based on this assessment the two scenarios described are considered inadvisable.

Question 2: Has the water loading rate proposed been arrived at in a manner that models the potential for long-term soil build-up of nitrogen and subsequent leaching, with respect to each option (type of vegetation, proximity to waterways), and does it account for and/or mitigate the risk of failing to meet design parameters (particularly nitrogen build-up and leaching), as evidenced at Leeston, Selwyn Huts and Rotorua, by, for example, staging the implementation with the option of releasing the balance of the water elsewhere?

The removal of nitrogen in land treatment systems is complex due to the many forms of nitrogen, and its ability to change forms within the soil. The Akaroa treatment system will be an MBR Plant with biological nutrient removal (BNR). The nutrients in the wastewater discharged by the treatment plant will be primarily in soluble forms (90%) including nitrate (71 - 78% of soluble nitrogen depending on time of year) and ammonia-nitrogen (11 – 21% of soluble nitrogen depending on the time of year). Excessive nitrogen can be a health risk to drinking water sources and an environmental risk to surface waters. It is important that a wastewater land application system is designed and managed to mitigate these risks. The soil plant system provides a number of treatment pathways of nitrogen in wastewater. Any remaining organic nitrogen after treatment is entrapped or filtered out of the liquid phase, and then mineralizes slowly and is eventually released as ammonia. The ammonia fraction is lost by volatilization, converted to nitrate by soil bacteria and taken up by the crop/trees or adsorbed to the clay fraction in the soils. Nitrate nitrogen can be leached to groundwater, taken up by the crop, or converted to nitrogen gas via denitrification within anaerobic zones and is either lost to the atmosphere or leaches through the soil profile. This is demonstrated in the following diagram of the Nitrogen Cycle for Soils.

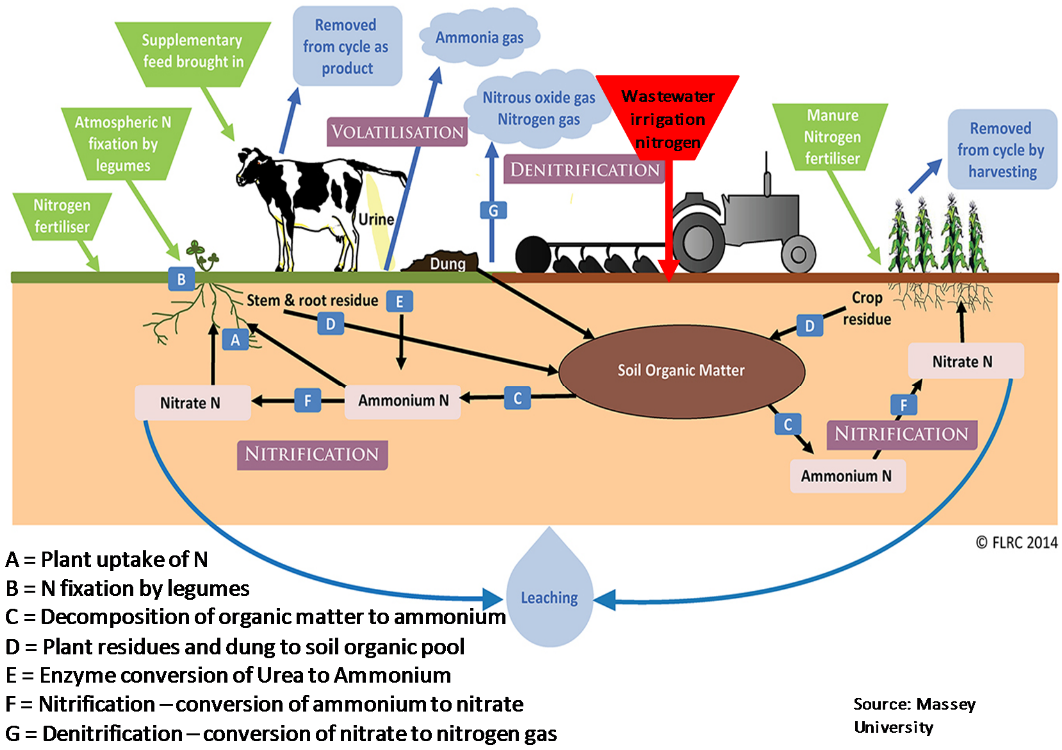

Figure 1. Typical farming inputs and outputs and transformations of nitrogen, with the inclusion of wastewater irrigation application (FLRC 2014).

Nitrification is an effective treatment concept and it is important that the aerobic status of the irrigation field is preserved for this process. This is why short, cyclic application periods are adopted for irrigation schemes. The ammonium saturates the soil during the beginning of the application cycle, allowing the soil microbes to convert the ammonium to the nitrate form. Time between application cycles is such that there is sufficient capacity within the soil so that the subsoils and soil microbes can once again convert the ammonium to nitrate. Incorrectly designed/managed systems can become overloaded and as a result experience excessive nitrogen leaching.

In the context of the proposal to irrigate wastewater to land at Akaroa the nitrogen would be unlikely to build up in the soil due to its predominantly soluble nature. The soluble nitrogen would either be rapidly taken up by plants, or if excess to plant requirements, would leach through the soil, although the irrigation would be managed to minimise such leaching.

This statement summarises the predicted future nitrogen loads, and reviews several land treatment schemes to elucidate success and failure criteria before making conclusions regarding the proposed Akaroa Scheme.

Akaroa Scheme Nitrogen Loading

CH2M Beca report (2016) “Concept Design Report for Alternatives to Harbour Outfall” describes the proposed treatment options. The land based treatment scheme incorporates a Biological Nutrient Removal Membrane Bioreactor (MBR) Treatment Plant. The proposed plant has been specified to treat flows up to 21 L/s and instantaneous flows above this will be stored in a pond prior to treatment. These flows are based on the population projection to 2041. The population predictions were taken from a technical memo produced by Harrison Grierson (2012) which was reproduced in the assessment of effects on the environment (CH2M, 2014) and is shown below.

Table 1. Akaroa Current and Design Population (CH2M Beca, 2014)

Season	2011	Design (2041)
Winter	591	783
Peak Summer	2,919	3,542

The proposed new treatment plant will significantly improve the treated wastewater quality at Akaroa. The predicted total nitrogen load of the treated effluent from the new WWTP was estimated for the inclusion in the CH2M Beca (2014) “Akaroa Wastewater Scheme Upgrading Resource Consents Application and Assessment of Effects on the Environment”, and is summarised below.

Table 2. Predicted (2014) Treated Wastewater Total Nitrogen Load (CH2M Beca, 2014)

Parameter	Winter/Dry Weather	Peak Summer
Total Flow	290 m^3/d	561 m^3/d
Total nitrogen concentration	10 g/m^3	15 g/m^3

The initial assessment of irrigation land area and nitrogen loadings has been based on the data provided in Table 2. Based on this data and an estimated nitrogen uptake rate of 70 kg N/ha/yr for trees approximately 25 hectares would be sufficient to treat the load from the new Akaroa WWTP. Note that the actual nitrogen concentration in the effluent from the proposed treatment plant can be controlled by the treatment process. If necessary the total nitrogen can be reduced to as little as 5 g/m^3 by modifying the treatment process[1]. In comparison a dryland farm will typically apply up to 150 kg N/ha/yr. If a plot of land is converted from pastoral farming to trees and then irrigated with wastewater the overall application rate of nitrogen will be reduced.

For pasture the soil moisture balance indicates that a minimum irrigable area of approximately 27 hectares is required. Annual nitrogen loading will be less than 70 kg N/ha/yr while a good quality pasture cut for hay or balage will take 350 kg or more of N off the land annually. Therefore the nitrogen loading using the current design concentrations for wastewater is sub-optimal for the

[1] Akaroa Wastewater Investigation of Alternative Sites for Land Irrigation, March 2017, Section 5.9

growth of pasture. Supplementation with additional nitrogen would be required to maximise plant growth to allow for the uptake of other nutrients (especially phosphorus) and to provide a harvested crop with sufficient concentrations of nutrients to be a good stock food.

Nitrogen Removal at Other Land Treatment Schemes

The Rotorua Wastewater Scheme involves reuse of wastewater on land within Whakarewarewa Forest. The Whakarewarewa Land Treatment System (LTS) has failed to provide adequate removal of nitrogen from the effluent and, after 25 years of operation, is to be decommissioned. It appears that the key issue is that the amount of nitrogen in the soil has reached saturation and it is now leaching into the Waipa Stream at approximately the same rate as nitrogen is being applied.

The Rotorua Wastewater Treatment Plant (WWTP) treatment capacity is 27,000 m^3 per day. The irrigation field is approximately 380 ha, and is the largest spray irrigation system in the Southern Hemisphere. The spray areas have a 15 m buffer between the irrigation area forestry road and public walking tracks to manage spray drift impacts.

It can be seen from the Rotorua Wastewater Treatment Plant Report, produced by the Rotorua District Council in 2006, that the nitrogen uptake of the Whakarewarewa LTS has diminished over time and as a result the amount of soluble nitrogen entering the Waipa stream has increased. The typical application rate of the Whakarewarewa LTS, through its operational life, was 9 mm/day over 2 hours, all year round. It appears that the Whakarewarewa LTS did not take rainfall or the soil moisture deficit into account. The load at Whakarewarewa LTS ranged from 50 to 100 tonnes of nitrogen per annum (approximately) between 1993 and 2006. This was applied to an area of 380 ha, which equates to a required uptake rate of 130 to 260 kg N/ha/yr to minimise leaching to Waipa stream.

To evaluate the area requirements for pasture irrigation at Akaroa a soil moisture balance approach has been used where the depth of irrigation is dependent on the evapotranspiration losses from the soil. This results in daily application depths that, in summer, do not exceed 7 mm/day while the average is somewhat less. In winter irrigation would only occur if the soil moisture deficit is sufficient. The assessment of the area required for trees is currently based on average application rates of 2.75 mm day in summer and 1.5 mm/day in winter. These are based on nutrient loading being the limitation for irrigation to trees and the current proposed concentration of nutrients in the treated wastewater. Further modelling is currently being undertaken to assess more options for trees.

Nitrogen loading is not the only contributing factor to the efficiency of soils and trees to denitrify organic nitrogen from the irrigated water. The relationship of nutrient availability to yield is non-linear. This is clearly seen in the Whakarewarewa LTS, as efforts were made to reduce the nitrogen loading of the treated wastewater to reduce the amount of nitrogen leaching from the system. It is recommended in the Process Design Manual - Land Treatment of Municipal Wastewater Effluents (US EPA, 2006) that soil and tissue analysis be used to determine if the initial soil reserves are suitable for the application of treated wastewater and will sustain treatment.

Ellesmere WWTP and Upper Selwyn Huts Wastewater Scheme are two land based wastewater disposal systems that were referenced by the Akaroa Treated Wastewater Reuse Options Working Party as failing land disposal schemes. Neither scheme is comparable to what is proposed for Akaroa. At both Ellesmere and Upper Selwyn the treatment processes are fairly basic with high seasonal variability in performance due to the strong influence of climatic conditions. This is very different to the tightly controlled conditions within the proposed Akaroa MBR treatment process.

The land disposal methods at Ellesmere and Upper Selwyn are either high rate (e.g. rapid infiltration) or high application depths (border dyke irrigation), neither of which are comparable to the carefully controlled application by either spray or dripper being considered for Akaroa. Furthermore, Ellesmere and Upper Selwyn are subject to high seasonal groundwater levels which impact on the performance of the disposal area. At Akaroa, in comparison, groundwater has not been found in test pits that have been excavated to 3.5 to 4m depth.

The Selwyn District Council Pines WWTP was designed such that there is sufficient room and ability to service the future population. The initial disposal area was increased from 80 ha (for a population of 30,000 population equivalents (PE)) to approximately 480 ha (for a population of 60,000 PE). Only a portion of this area is currently used. The median total nitrogen concentration is 7 g/m^3. When the treatment plant is treating the future design input from 60,000 PE and irrigated to all 480 ha, it is anticipated that the annual nitrogen loading rates will be up to 600 kg N/ha/yr. The Taupo Wastewater Irrigation scheme operates over two sites at View Road and Rakaunui Road. Currently a total of approximately 185 hectares of pasture is irrigated with secondary treated effluent (pers. comm. Kevin Sears, Taupo District Council Water and Wastewater Manager, March 2017). The typical total nitrogen concentration is 49 g/m^3. At the View Road site the annual nitrogen loading rates are in the order of 360 to 400 kg N/ha/yr. Nitrogen losses to groundwater are less than 30 kg N/ha/yr with nitrate-nitrogen concentrations in the groundwater of less than 4 g/m^3. This is within the consent limits set by Environment Waikato. Nitrate and E.coli monitoring of off-site wells monitored for health purposes provide no indication of potential contamination of groundwater from the LTS. (Sarah Sunich Mott MacDonald New Zealand Ltd, 2014).

Pinus radiata vs Native plantings

The Ngāi Tahu parties have expressed that they would prefer the irrigation of trees to be based on mixed native species including those that are native to the local area. While treated wastewater is irrigated to land where natives are growing in several instances (e.g. from the Omaha WWTP northeast of Warkworth, and at Piha Beach) and is promoted by organisations such as Bay of Plenty Regional Council, there is little information available on the nutrient uptake from wastewater by native vegetation. This topic is currently being researched by Dr Brett Robinson at Lincoln University.

Franklin, H. M. (2014) in "The Interaction of New Zealand Native Plants with Nitrogen in Canterbury's Agricultural Landscapes", investigated the ability of natives to uptake nitrogen. The ability of the native seedlings to uptake nitrogen was compared over an application range between 200 and 1600 kg N/ha. The best response was achieved for a trial application of 200 kg N/ha, with the nitrogen percentage uptake by plants decreasing as the application rate increased above 200 kg N/ha. Further information about irrigation of wastewater to natives is expected to be released by Lincoln University in due course.

Beets and Pollock (1987) reported that nitrogen uptake in *Pinus radiata* increased from approximately 30 kg/ha/yr (age 3) to 120 kg/ha/yr (age 5). They also stated that the nitrogen uptake peaks at age 5 – 6, after which the uptake decreases to 90 kg/ha/yr by age 12. The Whakarewarewa LTS irrigates treated wastewater to *Pinus radiata*.

Summary

An estimated nitrogen uptake rate of 70 kg N/ha/yr, when irrigated to trees over approximately 25 hectares, would be sufficient to handle the load from the new Akaroa WWTP. This is between a quarter and a half of the application rate (130 -260 kg N/ha/yr) used in the Whakarewarewa LTS to minimise leaching to Waipa stream. Additionally the irrigation rate at Whakarewarewa LTS has historically been constant throughout the year, while the irrigation proposal for Akaroa incorporates lower application depths over winter.

The Working Group has put forward some schemes that have not been successful, however there are many other schemes that successfully manage the application of wastewater and the impacts on the environment. These have used the knowledge gained from earlier systems. With appropriate environmental monitoring and careful detailed design there is no reason why the proposal to irrigate wastewater to land at Akaroa cannot be equally successful.

Question 3: What was the rationale in Joint Statement #1 from the technical experts that a single site is preferred, rather than multiple sites, when Council previously indicated a preference for multiple parcels for reasons of resilience (CCC FAQ #120)?

This question relates to 6.2 of the Joint Statement. The Technical Expert Group is open to a range of options including multiple sites. This is acknowledged in the Joint Statement in items:

- 6.1 which states *that the technical experts "wish to draw attention to the possibility that irrigation areas may not necessarily be confined to one location*

  and;

- 6.3 which states that *land for irrigation across a wider extent could be selected….*

While a scheme based on multiple sites is potentially viable, it may be more difficult to implement due to difficulties in procuring multiple parcels of land. A multiple site scheme may also cost more due to increased length of pipelines required to reach each one of the multiple sites. As cost and risk are important aspects of a scheme these factors need to be weighed alongside other technical aspects. Technical Expert Group statement 6.2 is to be read in the context of statements 6.1 and 6.3.

Question 4: Have the setback distance from houses been compared with what has actually been constructed elsewhere. They seem closer than most systems elsewhere when you look on the ground.

Setbacks from wastewater systems relate to risk levels to human and stock health and sensitive ecosystems. For setbacks from land application areas a number of factors are taken into consideration, including the level of pretreatment before being applied to land. Setback distances for the Akaroa wastewater scheme are based on setbacks from other similar and operational wastewater irrigation schemes. A comparison of setbacks for various schemes is provided in the table below:

Table 3. Comparison of Setbacks between Akaroa and Other Irrigation Schemes

Criteria	Spray Irrigation	Surface Dripper
Property boundary setback		
Akaroa - proposed	25 m	5 m
Blenheim MDC U071181	25m to 80 m	No setback
Rolleston CRC101109	25 m	N/A
Greytown	25 m	N/A
Rotorua	15m to public pathways	N/A
Stream setback		
Akaroa	25 m	25 m
Blenheim	10 m	3m

Table 3 shows that the setbacks specified for Akaroa to date are conservative when compared to setbacks for operational irrigation schemes around New Zealand.

The Technical Expert Group recommends that, once actual land application sites have been selected, there should be a re-assessment of setbacks to allow for site-specific conditions that could influence site-specific risk levels.

Question 5: Has irrigation to land behind Akaroa been considered with a sufficiently high level treatment and/or irrigating where drainage would only occur below drinking water intakes?

Irrigation of land behind Akaroa has been considered through the evaluation of an option to irrigate Misty Peaks Reserve. This is discussed in the response to Question 1.

Question 6: Does the frequency calculation for bypass flows include intense rainfall events where the flow rate exceeds the main treatment capacity, but the daily flows do not, and does it account for the fact that the last two years have been unusually dry?

The bypass flow calculation was originally based on hourly flow analysis for specific wet weather events. Christchurch City Council is now proposing to delete the bypass from the treatment scheme and provide full membrane treatment of 100% of treatment plant inflows.

Question 7: What is known about the effects of personal care products and pharmaceuticals on soils and the environment from treated wastewater irrigation schemes?

Emerging organic contaminants (EOCs) are synthetically or naturally-occurring chemicals of an organic nature, which are used in pharmaceuticals and personal care products, veterinary medicines, fire retardants and other industrial products and new generation pesticides.

There have been investigations, both in New Zealand and overseas, to determine whether EOC(s) are removed by land irrigation and what concentrations are present in the receiving environment (usually surface water) downgradient of the area irrigated. In the context of the New Zealand environment the most studied irrigation schemes include Omaha and Rotorua.

Removal of EOCs at Omaha Wastewater Scheme

The Omaha Wastewater Treatment Plant (WWTP) Assessment of Environmental Effects (AEE) (Watercare, 2016) details the irrigation scheme used to dispose 4,300 m^3/day of treated effluent from Omaha WWTP. Treated effluent is irrigated to land at two different sites onto Omaha Beach Golf Course which consists of fairways, plus some trees (5.7 ha), and dune (0.6 ha) and the Jones Road Site, which consists of eucalyptus (7.6 ha), native trees (5.5 ha) and grass (4.3 ha). The geology of the irrigation fields and the wastewaters' pathways to the harbour has been described as sandy (below the golf course), highly organic silty material below the kahikatea forest, and a mix of silty and sandy material beneath the harbour. As part of the AEE investigations, a study of EOCs was conducted by Tremblay and Northcott (2015) and documented in the "Risk assessment of emerging contaminants in treated wastewater in the Auckland region". The Tremblay and Northcott report studied the level of EOCs leaching from recycled water irrigated on four golf courses in the USA (separately investigated by Young *et. al,* 2014),. The study showed a major reduction in pharmaceutical residues in collected drainage water when compared to the wastewater effluent. The study showed that significant removal was achieved following vertical transport through 60 cm of soil.

Watercare (2016), states that the concentration of EOCs within the irrigated wastewater from the Omaha WWTP will be reduced during its pathway to the Whangateau Harbour. This passage of wastewater is comparable to what is proposed for the Akaroa WWTP scheme, involving irrigation of wastewater to land and infiltration through subsoils before mixing with groundwater. Any residue of EOCs eventually discharged to nearby receiving waterways via groundwater flows will be significantly reduced, and the remaining risk to the health of organisms based on the studies discussed above is considered to be very low.

Removal of EOCs at Rotorua Wastewater Scheme

Geilen, G. et al (2017) has recently reported on an investigation of the concentrations of EOCs in the Waipa Stream down gradient of the Whakarewarewa LTS. The following compounds were analysed in nine flow proportional weekly stream samples: aspirin, bisphenol A, caffeine, carbamazepine, clopyralid, diclofenac, diltiazem, 17α-ethinylestradiol, ibuprofen, naproxen, paracetamol, salicylic acid and triclosan [2]. Of those compounds seven (bisphenol A, caffeine, carbamazepine, clopyralid, diclofenac, salicylic acid and triclosan) were detected in the stream water. The remaining compounds were either removed in the treatment plant or by the land treatment system (diltiazem, 17α-ethinylestradiol, ibuprofen, naproxen). The detection of those compounds indicates that the soil was not able to completely adsorb/degrade these compounds during irrigation. Part of the reason for the incomplete removal was attributed to the free draining volcanic soils and high application depths/rates.

Comparison of Akaroa Proposal with the Rotorua Wastewater Scheme

Gielen, G et al (2017) concludes the discussion with the following statement:-

Nevertheless, many emerging contaminants have in principle a better chance to be removed by the soil when they are in good contact with the soil. It is therefore important to encourage this soil contact when designing and operating a sewage effluent irrigation scheme by minimising daily irrigation intensities and avoiding effluent ponding, soil saturation and preferential flow conditions.

The soils in the Whakarewarewa Forest are free draining volcanic soils. This compares with the poorly draining loess based silt loams in most of the areas identified as being suitable for irrigation at Akaroa. The field testing has shown the Akaroa soils to be massive and free of preferential flow paths so that there will be good contact of the irrigated effluent with the soil.

Historically irrigation at the Whakarewarewa Forest was a single weekly application of 70 mm. This created problems with ponding and potential flow through preferential flow paths. More recently the application has been changed to daily applications of 9 to 10 mm over a 2hr period.

In contrast at Akaroa, for pasture, the land area and storage requirements have been based on much lower daily applications of 7 mm/day over summer and 2 mm/day in winter. For trees, the maximum daily application depth is 7 mm/day in summer and 1.5 mm/day in winter. The average daily application depth in summer is approximately 3 mm/day. These application depths are designed to minimise ponding and control the drainage of water through the soil.

The combined effect of finer soils and lower application depths of wastewater at Akaroa will improve the removal performance for EOCs compared to that achieved at Rotorua.

Treatment Plant Removal of EOCs

The proposed land based treatment scheme for Akaroa incorporates a membrane bioreactor (MBR) treatment plant. Scientific studies of EOC removal in MBRs have found they are able to remove EOCs and are more efficient in EOC removal than conventional activated sludge processes. This is due to their ability to operate under longer sludge retention times, higher biomass concentrations and almost complete retention of suspended solids. Nguyen et. al (2013) investigated the efficiency of MBR treatment processes when combined with UV oxidation, nanofiltration or reverse osmosis. The paper "Removal of emerging trace organic contaminants by MBR-based hybrid treatment processes" explains that MBR treatment can effectively remove hydrophobic and readily

[2] Examples of common names, or products including these chemicals can be found at the end of this memo

biodegradable hydrophilic trace organic contaminants, herein referred to as EOCs. During the experiment, it was observed that both MBR and direct UV oxidation separately achieved low removal of carbamazepine (a widely reported problematic compound); when these two processes were combined it resulted in more than 96% removal. 22 EOCs were selected in this study, which was carried out over six months of continuous operation. Nine hydrophobic EOCs were removed by MBR treatment, while the removal efficiencies of the remaining 13 hydrophilic EOCs varied widely from almost complete removal (e.g. salicylic acid and gemifibrozil) to less than 20% (e.g. fenoprop and diclofenac). Hai et. al (2014) stated that MBR technology may not always yield higher removal efficiencies, but they tend to exhibit a more consistent performance.

Summary

It is clear from research including the recent work by G. Gielen et al (2017) that EOCs may be partly or completely removed by a combination of wastewater treatment processes and land treatment. The Akaroa Wastewater Scheme is likely to be more effective in removing them than the Rotorua Scheme as it will incorporate full membrane treatment of 100% of flows, and treatment of the final wastewater on comparatively well suited soils at comparatively lower application rates.

Any residue of EOCs eventually discharged to nearby receiving waterways via groundwater flows will be significantly reduced compared to Omaha and Rotorua, and the remaining risk to the health of organisms (and humans) is likely to be very low.

Question 8: Is it appropriate to use the OVERSEER process for assessing the nutrient loading of the wastewater irrigation scheme?

Environment Canterbury (ECan) has rules about the discharge of nutrients onto land. These rules require the use of OVERSEER or other approved programs to estimate the nitrogen leaching that occurs. The Technical Expert Group considers OVERSEER is not suitable for assessing the irrigation of native trees and has limitations that may also make it unsuitable for assessing the impact of irrigating pasture with wastewater.

Pattle Delamore and Partners Ltd employs spreadsheet based nitrogen mass balance models to assess nutrient losses. Such models can be used as an alternative to OVERSEER to assess the impact of changes in land use associated with irrigation of wastewater.

Note that any model for assessing nitrogen leaching can only provide an estimation of nitrogen loss (OVERSEER for example is stated to be accurate to +/- 30%). Therefore, while models are useful for identifying the relative change in nitrogen leaching, they should not be relied upon to provide a precise forecast of nitrogen leaching.

Common Uses/Names for Chemicals

- Salicylic acid is a common ingredient in topical anti-acne products.
- Gemifibrozil is an oral drug used to treat high cholesterol, sold under the name LOPID®.
- Fenoprop is a herbicide and plant growth regulator which was distributed as Silvex, it is no longer used.
- Diclofenac is the generic name for the anti-inflammatory drug, more commonly known as Voltaren®
- Bisphenol A (BPA) is an organic synthetic compound used in certain plastics and epoxy resins. Commonly used in plastic drink bottles and linings of cans.
- Nonylphenol is commonly used in the manufacturing of antioxidants, lubricating oil additives, laundry and dish detergents.

References

Beets, P. N. and Pollock. D. S. (1987). Uptake and Accumulation of Nitrogen in Pinus Radiata Stands as Related to Age and Thinning. Prepared for Ministry of Forestry, Forest Research Institute. New Zealand Journal of Forestry Science 17(2/3): 353-71. Rotorua, New Zealand.

CH2M Beca Ltd. (2014). Akaroa Wastewater Scheme Upgrading - Resource Consents Application and Assessment of Effects on the Environment. Prepared for Christchurch City Council.

CH2M Beca Ltd. (2016). Akaroa Wastewater - Concept Design Report for Alternatives to Harbour Outfall. Prepared for Christchurch City Council.

Dodgen L, Li J, Wu X, Lu Z, and Gan J. (2014). Transformation and Removal Pathways of Four Common PPCP/EDCs in Soil. *Environmental Pollution (Barking, Essex : 1987)*, *193*, 29–36. http://doi.org/10.1016/j.envpol.2014.06.002

Franklin, H.M. (2014). The Interaction of New Zealand Native Plants with Nitrogen in Canterbury's Agricultural Landscapes. PhD Thesis. Lincoln University.

Fertiliser & Lime Research Centre (FLRC). (2014). Figure 1. Inputs, outputs and transformations of nitrogen in farming systems. Original retrieved on 23 March 2017 from http://www.massey.ac.nz/~flrc/shortcourses/SNM_information.html

Gielen, G & Newick, K (2017) EMERGING CONTAMINANT LEACHING AT CATCHMENT SCALE

Hai, F. I., Nghiem, L.D., Khan, S.J., Price, W.E. and Yamamoto, K. (2014). 'Wastewater reuse: Removal of Emerging Trace Organic Contaminants' in Membrane Biological Reactors, (eds. Hai, F.I., Yamamoto, K. and Lee, C.-H.), IWA publishing, UK, 2014 (ISBN: 9781780400655), pp. 165-205.

Kinney CA, Furlong ET, Werner SL, Cahill JD. (2006). Presence and distribution of wastewater-derived pharmaceuticals in soil irrigation with reclaimed water. Environmental Toxicology and Chemistry. 25:317-326.

Nguyen, L. N., Hai, F. I., Kang, J., Price, W. E. and Nghiem, L. D. (2013c). Removal of emerging trace organic contaminants by MBR-based hybrid treatment processes. International Biodeterioration & Biodegradation, 85, 474-482.

Sarah Sunich Mott MacDonald New Zealand Ltd. 2014. TAUPO DISTRICT LAND TREATMENT SCHEME – REVISITED, Water NZ Conference.

Selwyn District Council. (2015). 5Waters Activity Management Plan, Volume 3: Wastewater. Ellesmere Sewerage Scheme. pg 87 – 103.

Tremblay, L., Northcott, G., 2015. Risk assessment of emerging contaminants in treated wastewater in the Auckland region. Prepared for Watercare Services Limited. Cawthron Report No. 2667. 45 p.

United States Environmental Protection Agency (US EPA). (2006). Process Design Manual – Land Treatment of Municipal Wastewater Effluents. EPA/625/R-06/016. Cincinnati, USA. pg 30 – 33.

Watercare. (2016). Omaha Wastewater Treatment Plant Resource Consent Applications and Assessment of Environmental Effects – (Draft for Consultation Purposes). Report to Auckland Council.

Young *et. al.* (2014). Field-Scale Monitoring of Pharmaceutical Compounds Applied to Active Golf Courses by Recycled Water. Journal of Environmental Quality 43(2):658-670. March 2014.

AKAROA WASTEWATER SCHEME – IRRIGATION OF TREATED WASTEWATER TO LAND

JOINT STATEMENT OF TECHNICAL EXPERTS # 3

SIGNATURE SHEET

Signed by: Andrew Dakers

Signature: Date: 27/04/2017

Signed by: David Painter

Signature: Date: 27/04/2017

Signed by: Andrew Brough

Signature: Date: 27/04/2017

Signed by: Greg Offer

Signature: Date: 27/04/2017

Signed by Richard Young

Signature: Date: 27/04/2017